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# Abstract book

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# Contents

# Atmospheric Processes and Climate Dynamics

## Oral presentations

*Session 1: Wednesday, 24 Sept. 11:00-12:30*

*Session 4: Wednesday, 24 Sept. 13:30-15:00*

# Hot season gets hotter due to rainfall delay over tropical land in a warming climate

Fengfei Song*[1]

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**Abstract**

Tropical land generally experiences the hottest period (spring) in a year just before the onset of wet season. Previous studies suggested that in a warming climate, the wet season would come later, but its origin is debated and its impact on temperature remains unknown. Here, we find that the warming of hot season would be amplified under global warming, and refer to it as "hot-season-gets-hotter" phenomenon. The amplified hot season warming is closely tied to the amplified warming of hot temperature percentiles. The hot-season-gets-hotter phenomenon is mainly due to the rainfall delay and most evident in the Amazon, where spring is warming by almost 1K more than the annual mean and the 99th percentile temperatures are warming ¯30% more than the mean by the end of 21st century in a high emission scenario. Comparing experiments with and without land-atmosphere coupling, it is further found that the rainfall delay is initially driven by the enhanced effective atmospheric heat capacity and then substantially amplified by positive soil moisture-atmosphere feedback. In the satellite period, observations consistently show that the hot-season-gets-hotter phenomenon has already emerged along with the rainfall delay in the Amazon. Intensified hot and dry spring climate can enhance risks of drought, heatwaves and wildfires, threatening the Amazon forest and habitats in the tropics.

**Keywords:** Precipitation, seasonal cylce, temperature extremes, soil moisture, atmosphere feedback

*Speaker

# Evaluation of NEX-GDDP-CMIP6 Model Performance in Simulating Precipitation Variability over Indonesia.

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**Abstract**

Extreme precipitation and related hydrological events are intensifying globally due to climate change, with Indonesia recognized as one of the most vulnerable regions. However, limited high-resolution data are available to accurately characterize these extremes. This study aims to characterize precipitation patterns and evaluate the performance of the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) dataset, which provides statistically downscaled CMIP6 projections at high spatial (25 km) and temporal (daily) resolutions. A total of 35 individual models and one Multi-Model Ensemble (MME) were assessed against the Multi-Source Weighted-Ensemble Precipitation (MSWEP) dataset over the Indonesian region for the period 1985–2014.
The model performance was assessed based on its ability to simulate the spatio-temporal distribution of monthly climatological means and seasonal precipitation cycles using correlation coefficient, normalized standard deviation (NSTD), root mean square deviation (RMSD), and mean bias (MB). Results indicate that most NEX-GDDP models effectively capture the seasonal precipitation pattern, with the ensemble mean closely matching MSWEP. While some models show deviations during peak wet and dry seasons, the overall narrow spread reflects low inter-model variability. Models such as ACCESS-CM2, TaiESM1 and INM-CM4-8 consistently perform well across spatial and temporal representation. Conversely, models like GFDL-ESM4, and HADGEM3-GC31-MM exhibit poor performance across all metrics. This study highlighting the importance of selecting appropriate models for regional climate studies.

**Keywords:** NEX, GDDP, CMIP6, seasonal precipitation cycles, model evaluation, Indonesia

*Speaker

# Quantitative Analysis of Monsoon Pattern Shifts in Pakistan's Climatic Zones: Impacts of Environmental Change and Projections Under RCP Scenarios

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**Abstract**

Pakistan experienced a 100-kilometer spatial westward shift in monsoon rainfall distribution over the past three decades, alongside a temporal delay in summer monsoon onset and an extension of winter rains. We employed integrated RCP climate models to predict localized flooding in KPK, AJK, and GB zones due to intensified monsoon downpours in northern regions, while urban centers face increased risks of flash flooding from extreme rainfall events. A rapid temperature rise to 49∘C (120∘F) has further disrupted monsoon dynamics, altered precipitation intensity and timing, and accelerated glacier melt in the north, which exacerbates flash flood risks. RCP models' quantitative analysis reveals an upward trend in mean rainfall, projecting an increase of up to 50 mm by 2030 when drier periods are excluded from the time series. Extreme precipitation events, defined by thresholds of 50 mm/day and 100 mm/day, are concentrated in key monsoon regions and Sindh's coastal areas, with return periods of 1-2 years. Conversely, dry days ($<$ 1 mm/day) are projected to increase significantly, with 130 dry days/year under the RCP4.5 scenario and 420 dry days/year under RCP8.5 by the end of the century. Key findings include: (1) a 100-kilometer westward shift in monsoon rainfall distribution, (2) delayed summer monsoon onset and extended winter rains, (3) intensified glacier melt and altered precipitation patterns due to rising temperatures, (4) a projected 50 mm increase in mean rainfall by 2030, (5) increased frequency of heavy rainfall events ($\geq$50 mm/day and $\geq$100 mm/day) in monsoon regions and Sindh's coast, with 1-2 year return periods, and (6) a significant rise in dry days ($<$ 1 mm/day) to 130/year under RCP4.5 and 420/year under RCP8.5 by 2100. These findings provide critical insights into the interplay between rising temperatures, shifting precipitation patterns, and their cascading effects on regional hydrology and disaster preparedness in Pakistan.

**Keywords:** South Asian Monsoons, RCP 4.6, RCP 8.5

*Speaker

# Climatic Control on the Variability of Atmospheric Constituents in the Anthropogenically-dominated Monsoon Trough Region of India

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**Abstract**

The constituents of the atmosphere in the troposphere are highly variable depending upon the climatic zonation of the earth, climate, teleconnections and human activities interfering with the radiation balance on earth, thus affecting the rainfall. Here, rainfall variability of the highly industrialized-urban region in the monsoon trough of India has been studied to understand the relationships among land surface temperature as well as greenhouse gases, sea surface tem-perature variability in the Global Ocean, Indo-Pacific Warm Pool region, tropical Indian Ocean, North Atlantic Ocean, Arctic Ocean, and related climatic indices. Principal component analysis of a large-set of data indicates that the seasonal and inter- annual dynamics of the atmospheric constituents of the study area are controlled by the air-mass derived from the Indo-Pacific, Southern Ocean, Tropical Indian Ocean as well as North Atlantic region. The results indicate that, although a general trend of increase in the anthropogenic aerosols reducing the monsoon rainfall. However, the variability in the sea-surface temperature of the global ocean, North Atlantic as well as in the Indo-Pacific region seemed to regulate the intra-seasonal and inter-annual rainfall. It appears that during the summer monsoon and to a certain extent during the winter season, a lot of mineral dust with aerosols derived from biomass burning is transported from the proximal Thar and Middle East Deserts affecting the rainfall. The summer seasonal and inter-annual distribution of atmospheric constituents and connected variability in the rainfall often regulated by the sea surface temperature variations in the tropical Indo-Pacific region through convective mechanism, as well as transport of air-mass from southern - hemispheric to northern hemi-sphere to the study area. Nevertheless, the transport of air-mass from the North Atlantic region through the Mediterranean Sea to the study area seems to be significant in enhancing the build-up of aerosols thereby affecting the winter rainfall.

**Keywords:** South Asian Monsoon trough, Sea surface temperature, Indo, Pacific Ocean and anthropogenic activity

*Speaker

# The Modulation of the Diurnal Variations by the Intraseasonal Oscillations of the Indian Summer Monsoon

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**Abstract**

Using NASA's Integrated Multi-Satellite Retrievals for Global Precipitation Mission version 7 (IMERG) rainfall analysis we show strong diurnal variations of precipitation over parts of the tropical Indian Ocean including the northern Bay of Bengal, eastern Arabian Sea (off the west coast of India) and in the southern Indian Ocean (off the coast of Sumatra). The amplitudes of these diurnal variations in the May through September (MJJAS) period exceed that of the neighboring land. Our analysis suggests that these diurnal variations over the oceans are strongly modulated by the passage of both the high-frequency (10-20 days) and the low-frequency (20-40 days) Intra-Seasonal Oscillations (ISOs) in the MJJAS period. The diurnal amplitudes over these amplify or dampen during the wet or dry spells of these ISOs. However, the 20-40 days ISOs have a stronger bearing on the diurnal variations than the 10-20 days ISOs. This is because the wet spells of the 10-20 days ISOs are more often conflicted with dry spells of the 20-40 days. Using a high-resolution (20 km) regional coupled ocean-atmosphere model that verifies these observational features of the diurnal variations of precipitation over the tropical Indian Ocean, we show that the enhanced surface fluxes during the wet spells of the ISOs sustained by strong stratification of the upper ocean abets the diurnal variations of precipitation.

**Keywords:** Intraseasonal Oscillations, Monsoons, Diurnal variations

*Speaker

# Day-to-Day Variability and Seasonal Patterns of Global Dust Aerosol Optical Depth from IASI Satellite Observations

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**Abstract**

The distribution of aerosols remains a crucial factor in studying the Earth's atmosphere-climate system. In this analysis, global day-to-day Dust Aerosol Optical Depth (DAOD) at 550 nm from July 2022 to June 2023, retrieved from the Infrared Atmospheric Sounding Interferometer (IASI) using the Mineral Aerosol Profiling from Thermal Infrared Radiance (MAPIR) algorithm, has been examined. The results focus on peak DAOD days from December 2022 to February 2023, identified as dust-active periods, and are complemented by global mean precipitation data to assess dust distribution in relation to meteorological conditions. The findings provide strong evidence of peak dust activity in December over the Northern Hemisphere, with the central Sahara (CSA) identified as a major dust source contributing to the dust belt. Additionally, the study establishes December as the peak dust season in the Southern Hemisphere, with dust originating from the Lake Eyre Basin in Australia. Since dust is the dominant aerosol type and constitutes a major portion of global aerosol distribution, it is scientifically necessary to study the day-to-day variability of global aerosols in conjunction with meteorological conditions. This paper characterizes the day-to-day and peak seasonal variations in global dust optical depth using data retrieved from satellite observations of IASI from July 2022 to June 2023.

*Speaker

# Emergence of positive IOD-like warming pattern driven by greenhouse gases and anthropogenic aerosols during the recent four decades

Lu Dong*[1], Shengyao Xin[1], Lixin Wu[1], Fengfei Song[1], Agus Santoso[2], Xiaotong Zheng[1], Bolan Gan[1], and Shichu Liu[1]

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**Abstract**

Most climate models project a positive Indian Ocean Dipole-like (pIOD-like) warming pattern in the tropical Indian Ocean (TIO), featuring stronger warming in the west than the east under global warming. However, it is still unclear whether this warming pattern has emerged in observations. Here, based on observational products, Coupled Model Intercomparison Project Phase 6 (CMIP6) experiments, including all forcing and single-forcing simulations, as well as Pacific and Atlantic pacemaker experiments, we found that the TIO features a pIOD-like warming pattern in observationsduring 1979-2020, confirmed by changes in atmospheric circulation and convection. External forcing makes a major contribution to the observed pIOD-like warming pattern, with greenhouse gases (GHGs) contributing the most through the weakening of Walker circulation. Anthropogenic aerosols also contribute to the pIOD-like pattern, mainly through the local ocean-atmosphere interaction driven by the increased aerosol emissions from South Asia. The CMIP6 inter-model uncertainty in the simulated pIOD-like warming pattern is related to the anomalous zonal winds over the TIO, not with the remote forcing from the Pacific Ocean, highlighting the importance of processes internal to the Indian Ocean. Before the satellite era (1920-1978), although GHG forcing favors the pIOD-like warming pattern but with weaker trend, the increased aerosol emissions from Europe and North America offset the contribution of GHGs via influencing the inter-hemispheric temperature contrast, resulting in an insignificant pIOD-like warming pattern under external forcing and in observations. This study highlights the importance of the combined effects of GHGs and anthropogenic aerosols in the recent emergence of pIOD-like warming pattern.

**Keywords:** Indian Ocean, warming pattern, External forcing, Greenhouse gas, Anthropogenic aerosol

*Speaker

# Regional radiative feedbacks as drivers of Pacific SST gradients in a hierarchy of models

Knapp Scott[1] and Natalie Burls*[1]

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**Abstract**

Large-scale sea surface temperature (SST) gradients in the Pacific Ocean exert a dominant control on tropical atmospheric circulation patterns, influencing climate globally. However, climate models generally fail to reproduce the observed Pacific SST trends over the past several decades, and future projections vary across climate models. The current observed strengthening of the zonal SST gradient in the Pacific is generally predicted to reverse at some point but estimates of this timescale and magnitude are uncertain. We use a simplified coupled ocean-atmosphere box model of the Pacific Ocean to explore the influence of a wide range of regional radiative feedback patterns on the evolution of large-scale temperature gradients in response to CO2 forcing and compare our findings with CMIP6 abrupt 4xCO2 results. We identify thresholds between regimes in which the temperature gradient response is driven primarily by the radiative feedback pattern and regimes in which coupled ocean-atmospheric dynamics act to weaken large-scale temperature gradients despite opposing radiative feedback patterns. We find that temporally constant regional feedback parameters in boxes representing the west, east, north and south Pacific can qualitatively reproduce several features of oceanic heat convergence and Pacific SST gradient evolution seen in the CMIP6 models. This work provides a theoretical underpinning for interpreting the impact of structural model differences in radiative feedback strengths on large-scale SST patterns.

**Keywords:** Pacific Climate, Sea Surface Temperature Patterns, Radiative Feedbacks, Large, scale Climate Dynamics, Pattern Effect

*Speaker

# Contrasting Impacts of Northern and Southern Extratropical Forcings on Tropical Pacific SSTs: Insights from 1979–2024 and Implications for Future Projections

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[2]National Taiwan University – Taiwan

**Abstract**

Growing evidence highlights the critical role of extratropical influences in shaping tropical sea surface temperature (SST) patterns-and, in turn, modulating ENSO and monsoon behavior. However, the mechanisms and timescales of extratropical-to-tropical teleconnections are not yet fully understood.
In this study, we compare equatorial Pacific SST responses to radiative forcings applied in the extratropics of each hemisphere, using a fully coupled climate model. Radiative heating or cooling is imposed separately in the Northern and Southern Hemispheres. In the initial years, equatorial SST responses show opposite signs to the forcings in the northern extratropics, but align with those in the southern extratropics. At this stage, heating the northern extratropics cools the equatorial Pacific more effectively than cooling the southern extratropics. This asymmetry arises because anomalous warming in the northern extratropics is blocked by the rainband and can only influence the equatorial Pacific from the west, thereby triggering Bjerknes feedback more effectively.

On multi-decadal timescales, all experiments show enhanced equatorial responses that align with the signs of the imposed forcings. Notably, southern extratropical perturbations produce stronger subtropical cell and equatorial SST responses, suggesting that the Southern Hemisphere exerts significant long-term control over the tropical Pacific.
These findings have important implications for attributing the long-term equatorial Pacific cooling trend observed during the satellite era and for improving future climate projections. We also illustrate how understanding fast and slow SST responses can inform the interpretation of single-forcing (e.g., aerosol, GHG, and ozone) experiments and extratropical pacemaker experiments that prescribed observed SST in N. Atlantic or Southern Ocean.

**Keywords:** extratropical, tropical teleconnection, interbasin teleconnection, tropical SST pattern

*Speaker

# Unveiling the role of South Tropical Atlantic in winter Atlantic Niño inducing La Niña

Xin Wang*[1]

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**Abstract**

The boreal winter-peaked Atlantic Niño/Niña can influence LaNiña/El Niño (the cold/warm phase of El Niño-Southern Oscillation, ENSO) in the following year. However, the Atlantic Niño-La Niña relationship is more uncertain than the Atlantic Niña-El Niño counterpart. Here, we show that this uncertainty arises from two distinct types of Atlantic Niño events: the Equatorial and Expanded types, which differ in their meridional sea surface temperature (SST) warming. The Equatorial type, with SST warming confined to the equator, has a weaker climate impact due to limited influence on local convective heating in spring when the intertropical convergence zone (ITCZ) shifts southward. In contrast, the Expanded type, with SST warming extending into the southern tropical Atlantic (STA), drive persistent local anomalous convection heating and strong remote atmospheric responses in the tropical Pacific from winter to spring. Our results emphasize the critical role of STA conditions in shaping the influence of winter Atlantic Niño on the Pacific.

*Speaker

# Predictable Equatorial Atlantic variability from atmospheric convection-ocean coupling

Hyacinth Nnamchi*[1] and Mojib Latif[1]

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**Abstract**

The Atlantic Niño exerts profound impacts on regional and global atmospheric circulation and climate, and on equatorial Atlantic biogeochemistry and ecosystems. However, the mode's prediction remains a challenge which has been partly attributed to weak atmosphere-ocean coupling in the region. Here we introduce a framework that enhances the detection of the coupling between meridional migrations of atmospheric deep convection and zonal thermocline feedback. This approach reveals high predictive skill in a 196-member seasonal prediction ensemble, demonstrating robust predictability at 1-5-month forecast initialisation lead-times. The coupled mode is strongly correlated with land-precipitation variability across the tropics. The predictive skill largely originates in the Atlantic Ocean and is uncorrelated with El Niño Southern Oscillation in the Pacific, the leading mode of interannual climate variability globally. These skillful predictions raise hopes for enabled action in advance to avoid the most severe societal impacts in the affected countries.

**Keywords:** Atlantic Niño, Atmosphere–ocean coupling, Equatorial Atlantic variability, Tropical teleconnections, Seasonal prediction

*Speaker

# Ocean-Climate Observations and Modelling

## Oral presentations

*Session 2: Wednesday, 24 Sept. 11:00-12:30*

*Session 5: Wednesday, 24 Sept. 13:30-15:00*

# Enhancing Spatial Analysis of Sea Level Rise in the Bali-Lombok Sea Using Marine AWS, Tide Gauge, Satellite Altimetry, and Numerical Model Integration

Pande Putu Hadi Wiguna*[1], Kadek Setiya Wati[1], I Made Dharma Raharja[2], and Takahiro Osawa[3]

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[2]Udayana University [Bali] – Indonesia
[3]Yamaguchi University [Yamaguchi] – Japan

**Abstract**

Sea level rise poses a growing threat to coastal areas in the Bali-Lombok Sea, where variability is influenced by regional processes such as monsoonal winds, internal tides, and the Indonesian Throughflow. Despite these dynamics, observational coverage remains limited, with only one tide gauge station operated under the IOC Sea Level Monitoring network located in Benoa Bay, Bali. This study aims to enhance the spatial resolution of sea level monitoring by integrating short-term water level data from five Marine Automatic Weather Stations (AWS)-three in Bali and two in Lombok-with Sentinel-3 satellite altimetry and numerical model outputs.
The approach begins by validating AWS water level data from the site nearest to Benoa against the IOC tide gauge record to assess its reliability. Once validated, the remaining four AWS stations are incorporated to strengthen spatial observation coverage and extend sea level monitoring to areas with no existing gauges. This stepwise integration provides a more robust dataset for analyzing regional sea level trends.

Statistical methods such as linear regression and the Mann-Kendall test are applied to detect early signals of sea level rise across the network. Sentinel-3 altimetry measurements are used to cross-validate surface height data, while outputs from the FVCOM ocean model provide additional context for interpreting spatial and temporal patterns.
This multi-source integration builds on methodologies that combine satellite and in-situ data to improve coastal sea level monitoring. The results are expected to demonstrate the feasibility of using AWS networks to supplement limited tide gauge infrastructure. This study supports the early detection of sea level rise extremes and contributes to the enhancement of ocean observing systems, informing climate adaptation and resilience planning for Indonesian coastal zones.

**Keywords:** Sea Level Rise, Marine Automatic Weather Station (AWS), Sentinel, 3, Tide Gauge, Numerical Ocean Modeling

*Speaker

# Advancing Ocean Modeling in the Bay of Bengal: Validating FIO-COM and Assessing Nonbreaking Surface Wave-Induced Mixing Effects

Tahrim Jannat Mowsumi*[1]

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**Abstract**

The Bay of Bengal is a highly dynamic oceanic region influenced by monsoonal variability, freshwater influx, and mesoscale processes. Accurate ocean modeling is essential for understanding regional circulation and thermodynamic interactions. This study aims to validate the high-resolution FIO-COM (First Institute of Oceanography Coupled Ocean Model) dataset using a combination of in situ observational datasets (Argo, RAMA moorings, OISST, EN4 salinity, and L4 gridded temperature) and reanalysis/model-assimilated products (CMEMS and Bluelink). The validation is performed for key oceano-graphic parameters, including sea surface temperature (SST), salinity (SSS), zonal and meridional currents (U, V), sea surface height (SSH) and mixed layer depth (MLD) over the Bay of Bengal from 2013 to 2022. Additionally, a regional ocean model is configured using CROCO (Coastal and Regional Ocean COmmunity model) to simulate ocean dynamics in the northern Bay of Bengal, with a specific focus on nonbreaking surface wave-induced vertical mixing effects. This study applies the Bv theory (Qiao's theory), which describes the impact of non-breaking surface waves on vertical mixing, to assess its influence on upper-ocean stratification, temperature, and circulation patterns. Sensitivity experiments are conducted to quantify how surface wave-induced mixing modifies ocean state variables. The findings provide valuable insights into the role of wave-driven mixing processes in ocean models, contributing to improved parameterizations and forecasting capabilities for the Bay of Bengal.

**Keywords:** Bay of Bengal, Ocean Modeling, FIO, COM, CROCO, Wave, Induced Mixing, Bv Theory, Model Validation, SST, Salinity, Ocean Currents, SSH, MLD, Monsoon, Mesoscale Processes, Sensitivity Analysis, Stratification

*Speaker

# Sea Surface Salinity Variability of Central Indian Ocean - Western Indonesia Waters 1993-2019

Lamona I Bernawis*[1], Ghaida Nabilah[2], Ivonne M Radjawane[1], and Susanna Nurdjaman[1]

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**Abstract**

Sea surface salinity is an indicator of the global hydrological cycle and climate variability. While the open ocean SSS is increased due to global warming, it is interesting to investigate in part of Western Indonesia waters as being tropic rain forest and maritime continent. Surface salinity is influenced by ocean-atmosphere interactions. Trend analysis were performed on salinity, surface temperature, evaporation, and precipitation data to see the relationship among these parameters. In western Indonesia, for 27 years, the decreasing trend in surface salinity was accompanied by a decrease in evaporation and precipitation trends, while in the Central Indian Ocean, an increase in surface salinity trend was accompanied by an increase in evaporation trend. Surface salinity correlation values are strongly related to evaporation and precipitation, which are 0.62 and -0.47. The freshwater flux (E-P) are negative, meaning that precipitation is stronger than evaporation.

Calculation of EOF on salinity to describe the spatial and temporal patterns of variability was conducted. In the Indian Ocean, EOF output of the 3 modes is describes 62.6% of the total variance. Modes 1 and 3 EOF have a strong and significant correlation with monsoons, then Mode 2 correlates with IOD. In Indonesia, describes 3 modes with a total 67.1% of the total variance. Modes 1 and 2 correlate with monsoon and Mode 3 with ENSO. Surface salinity anomaly in the Indian Ocean, 1st Mode of 38.3% influenced by monsoon velocity at AUSMI, 2nd Mode is 14.6% influenced by IOD, and 3rd Mode is 9.7% influenced by monsoon wind speed at WYMI. Salinity anomaly variations in Western Indonesia with 1st Mode of 43.8% and 2nd Mode of 15.2% are influenced by the monsoon velocity at AUSMI and WNPMI then 3rd Mode is 8.1% influenced by IOD and monsoon wind velocity at WYMI.

**Keywords:** Sea Surface Salinity, Evaporation, Precipitation, Monsoon, EOF, ENSO, IOD, Global warming

*Speaker

# Observed Freshwater Dynamics in the Banda Sea

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[2]Diponegoro University – Indonesia

**Abstract**

This study investigates the dynamics of surface and subsurface salinity variations, and assesses the dominant sources of freshwater in the Banda Sea during the boreal spring of 2018 and 2019. The analysis combines observational and ocean-atmosphere satellite data, and provides salinity budget calculations. It showed that spring freshening was observed in the Banda Sea in 2018 and 2019, as indicated by a decrease in mixed layer depth (MLD), followed by a thickening of the barrier layer (BL). During the boreal spring of 2018, the MLD increased from about 70 m to less than 10 m, while the BL thickened to about 40 m. Salinity budget analysis revealed that the main source of freshwater in the Banda Sea is from zonal advection (about 0.04 PSU/day). In addition, the surface flux also contributes to the observed boreal freshening up to about 0.03 PSU/day. A similar mechanism was also observed in the boreal spring of 2019. It was initiated by the shoaling of the MLD from about 80 m to less than 10 m, while the BL thickened to about 70 m. Zonal advection contributes up to about 0.06 PSU/day, while surface flux contributes up to about 0.05 PSU/day. The higher contribution of the surface flux during the boreal spring of 2019 was associated with heavy precipitation, reaching 1.5 mm/hr. Nevertheless, it was observed that freshening in the Banda Sea during boreal spring 2018 had a longer duration than in 2019. These results have important implications for the prediction of air-sea interaction in the Indo-Pacific region.

**Keywords:** Argo float, Banda Sea, freshening, salinity budget, zonal advection

*Speaker

# Transport and Variation of the Indonesian Throughflow at Halmahera Sea through Jailolo and Gebe Straits

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**Abstract**

Seasonal and interannual variability of the transport in Halmahera Sea were investigated with nearly 6 years of mooring measurements at Jailolo and Gebe Straits from November 2015 to October 2017 and October 2019 to February 2023. Acoustic Doppler Current Profilers mounted on the mooring captured variations of the currents of the full depth around 1000m in both Straits. The variability of the mean along-strait velocity at the two Straits is annual cycle , with opposite phases above and below 200m. The upper 200m current flows northward during the boreal winter and southward during the boreal summer and fall. The net mean transport of the intrusion from the western Pacific water into the Indonesian Seas through Gebe Strait is around -0.77 Sv, 1/3 of the Jailolo Strait. The variability of the net transport can be large, ranging from -1.9 Sv southward to 0.3 Sv northward. Thus, the total net mean transport through the Halmahera Sea is -3.21Sv. The norward net transport from Indonesian seas to the western Pacific Ocean usually happens in boreal winter and disappears during the La Nina year.

*Speaker

# Indonesian Throughflow salinity and SST variability since the 1750s

Jens Zinke*[1], Hedwig Krawczyk[2], Padmasini Behera[2], Janice M. Lough[3], Bastian Hambach[4], Miriam Pfeiffer[5], Neal Cantin[3], Paul Wilson[4], Matthew England[6], and Arnoud Boom[2]

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**Abstract**

The tropical southeastern Indian Ocean regarded as a pivotal region for Indo-Pacific climate connectivity. The Australian Northwest Shelf (ANWS) is an area of significant ecological and economic importance, characterized by complex interactions between oceanic and atmospheric systems, including phenomena such as the El Niño-Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and the Madden-Julian Oscillation (MJO). However, long-term instrumental climate data are often lacking for tropical oceans. The geochemistry of massive stony corals provides a valuable record of past hydroclimatic conditions that compensates for this lack and surpasses existing data.

We investigated coral Sr/Ca and $\delta$18O of modern *Porites* sp. coral cores from Browse Island and the Ashmore-Hibernia archipelago (12-14$\circ$S, 123$\circ$E) at sub-seasonal resolution. These paired analyses allowed the reconstruction of both SSTs and seawater oxygen isotope composition ($\delta$18Osw), the latter a proxy for salinity, from 1753 to 2011. We conducted a replication study of four cores from four coral colonies from different locations around the islands for the period 1958 to 2011. The reliability of the coral-based climate records was assessed through calibration and comparison with instrumental environmental variables and modelled (ACCESS-OM2-01) and observed ITF data (Feng et al, 2018).

Our results show that Browse Island and the Ashmore-Hibernia archipelago are optimal sites for reconstructing SST and $\delta$18Osw (proxy for salinity) variability in the major exit passage of the Indonesian Throughflow into the eastern Indian Ocean. SST reconstructions indicate the expansion of the southern edge of the Indo-Pacific warm pool into the Indian Ocean and accelrated warming since the mid-20th cenrury. While the imprint of the IOD seems to be reflected more in sea surface temperature anomalies in the region, the influence of ENSO is recorded in salinity anomalies due to changes in ocean advection, e.g. the Indonesian Throughflow dynamics, and monsoonal precipitation.

**Keywords:** Eastern Indian Ocean, Northwest Australian Shelf, Indonesian Throughflow, Salinity, SST, ENSO, ocean advection

*Speaker

# An absence of moorings in the western Tropical Pacific: what are the main consequences and risks to climate research and prediction?

Sophie Cravatte*[1], Agus Santoso[2], Tom Farrar[3,4], Tong Lee[5], Yosuke Fujii[6], Charlotte Demott[7], Michael J. Mcphaden[8], Janet Sprintall[9], Weigong Yu[10], Shayne Mcgregos[11], Andréa Taschetto[12], and Caihong Wen[13]

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**Abstract**

The Tropical Western Pacific Ocean is characterized by some of the warmest seawaters, driving the global atmospheric circulation and climate. This region has an important role in the genesis of El Niño Southern Oscillation (ENSO), the leading source of seasonal prediction skill across the globe. Observations of the ocean-atmosphere system in this region are thus crucial to describe, understand, and forecast climate globally, and to better understand intraseasonal variability, the monsoons and typhoon genesis.
The Tropical Pacific Observing System (TPOS), established more than 40 years ago, now consists of many platforms, including satellite constellations and Argo floats. One key component of TPOS is the backbone moored array, with a unique ability to provide collocated oceanic and surface atmospheric observations at high temporal resolution. Initially composed of nearly 70 moorings, the TAO-TRITON array suffered from deterioration to the TAO array in 2012, followed by a decommissioning of the western Pacific TRITON array since 2014.

Following this crisis, the TPOS2020 project provided a thorough review for the redesign and enhancement of TPOS, recommending a reconfiguration of the moored array with more

*Speaker

capable moorings better resolving the upper ocean, and measuring all the variables needed to compute full air-sea fluxes. While the new TAO array is actively being implemented east of 165E, there are currently no moorings deployed in the western Pacific and none planned for future deployment.

This absence of moorings west of 165∘E poses an immediate risk to our ability to observe, understand and forecast ocean-atmosphere coupled variability. This presentation will discuss the direct and indirect risks that this gap presents for the climate research and prediction. It will discuss how the risks might be mitigated, and highlight the urgent need to mobilize the international community to ensure TPOS robustness in this important region.

**Keywords:** Moored array, western Tropical Pacific, TPOS, risk

# China's Activities in Ocean Observations in the Northwest Pacific

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**Abstract**

The Northwest Pacific is one of the most dynamically-complex regions in the global ocean. It is the most sensitive region to climate change and the most productive fishing ground in the world ocean. However, it is one of the regions with the least long-term continuous observations, posing obstacles in our understandings on physical, ecological and biogeochemical processes. Here, the recent observational progresses and accomplishments in this region as well as the ongoing efforts of observations conducted by China are reviewed. The development direction of the observation system in the future is also prospected, that is, to develop an integrated open-ocean observation platform for multi-sphere and multi-disciplinary studies. It will provide important observational support for revealing the multi-scale physical biological coupling, energy cascade and climate effects, as well as the deep-ocean carbon cycle.

**Keywords:** observations, northwest Pacific

*Speaker

# Mapping sparse ocean observations: What can we learn from synthetic observing systems in models?

Cara Nissen*[1,2], Kristen Falcinelli[3], Mathew Maltrud[4], Alison Gray[3], and Nicole Lovenduski[2]

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**Abstract**

Autonomous observing systems, such as profiling Argo floats, have greatly increased observational coverage of the global ocean. However, observations remain sparse in some regions, and uncertainties persist regarding the ability of current float sampling protocols to accurately capture the full spatio-temporal variability of physical, biogeochemical, and biological properties, which complicates the detection of long-term trends. Synthetic observations extracted from numerical models offer one potential avenue to address these uncertainties. Here, we use the biogeochemical float capabilities of the Energy Exascale Earth System Model version 2 to generate synthetic observations during model run time, i.e., this dataset provides the same snapshot view of the modeled ocean as real-world observing systems do of the real ocean ("online approach"). We use Gaussian process regression to create gridded fields of seawater oxygen and pCO2 from realistic and idealized distributions of the synthetic data. By comparing these reconstructed fields to the model truth, we can quantify uncertainties resulting from the float sampling distribution and the sampling frequency. We then contrast our results to those obtained with synthetic observations extracted from the same model after model run time, i.e., from time-averaged model output ("offline approach"). We find pronounced differences in our ability to reproduce the true climatological and time-varying model fields from the two approaches, which can partly be attributed to the different scales of temporal variability captured in the two approaches. Since the offline approach is more commonly used in the scientific community to inform sampling network design, our results highlight a previously unconsidered source of uncertainty, which needs to be accounted for when aiming to more confidently reconstruct trends in key climate variables, e.g., air sea CO2 fluxes.

**Keywords:** ocean, synthetic observations, models, mapping, Argo floats, biogeochemistry, carbon, oxygen

*Speaker

# Ocean reanalysis inter-comparison over the global Ocean

Hasibur Rahaman*[1], Raheema Rahman[1], Vijay Tallapragada[2], Avichal Mehra[2], Kotta Srinivasu[1], Stephen Penny[3], Eric Hackert[4], James Carton[5], Andrea Cipollone[6], Simona Masina[6], Magdalena Balmaseda[7], Hao Zuo[7], Yosuke Fujii[8], Romain Bourdallé-Badie[9], Richard Renshaw[10], Tong Lee[11], Peter Oke[12], T M Balakrishnan Nair[1], and M Ravichandran[13]

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**Abstract**

To understand climate change and current weather extremes, it is important to have observations of the Earth system going back as far as possible in time. The Ocean is a major component of the Earth system. However, observations over the Ocean have always been unevenly distributed and come with errors. Even satellite observations alone cannot provide a complete and accurate picture of the 3D state of the Ocean at a given point in time. Reanalyses fill the gaps in the observational record, and they do so in a way that is consistent in time, thus minimizing any spurious signals of change by combining models and observations. Accurate ocean reanalyses are essential, as they provide the most realistic representations of past oceanic conditions, serving as benchmarks against which climate models are validated on different time scales. In recent times, the rise of artificial intelligence (AI) has revolutionized data analysis, allowing us to uncover complex patterns in large datasets. Reanalysis datasets have emerged as tools of excellence for these objectives due to their ability to offer a physically consistent global reconstruction of past weather conditions devoid of spatial or temporal gaps. Ocean reanalyses have been routinely produced by most of the operational centers (ECCO: NASA, USA; BRAN:BoM, Australia; SODA: University of Maryland, USA; NCEP-GODAS:NOAA/NCEP,USA;ORAS5: ECMWF,EU; GLORYS:

*Speaker

Mercator Ocean, France, C-GLORS: CMCC, Italy; GloSea5: Met Office,UK,JMA,Japan etc ) across the world. Recently, the Indian National Centre for Ocean Information Services (INCOIS) also released 45 years of ocean reanalysis products (IGORAv1)based on the MOM5 Global Ocean Data Assimilation System (GODAS). We will evaluate sea surface current and sea surface temperature (SST) from all these ocean reanalysis products with independent observations. We will also show how well these reanalysis products reproduce the different climatic modes and the Atlantic Meridional Overturning Circulation (AMOC).

**Keywords:** Ocean Reanalysis, Climate Modes

# The Marine Environment Reanalyses Evaluation Project MER-EP, towards an improved knowledge of the global ocean environment of the past decades, to support ocean applications and ocean prediction

Romain Bourdallé-Badie*[1], Chunxue Yang[2], and Marie Drevillon[1]

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**Abstract**

Ocean reanalyses are reconstructed past ocean states by combining ocean numerical models and observations through data assimilation techniques. They are key in the seamless ocean information value chain. Thanks to their temporal and spatial consistency, continuity, and high accuracy, ocean reanalyses are an important tool for a wide range of applications.

The MER-EP project we present, endorsed by UN Ocean decade action (https://oceandecade.org/actions/marine-environment-reanalyses-evaluation-project/), is an international effort build on previous ocean reanalysis intercomparison exercises such as the Ocean Reanalyses Intercomparison Project (ORA-IP), and on the joint efforts of the ocean prediction community (Copernicus Marine Service, Oceanpredict/ForeSea/OP-DCC), the ocean and climate modelling research community (CLIVAR/GSOP), and on the Ocean Physics and Climate panel of the Global Ocean Observing System (GOOS/OOPC) research program.

Previous intercomparison exercises of ocean reanalyses have targeted specific variables to assess the consistency and discrepancies among various ocean reanalysis products. MER-EP should complement this approach including more systematic regional focus and evaluating different ocean reanalyses to determine their quality and fitness-for-purpose for specific applications and whenever possible provide insights on their conditions of use (eg. which type of reanalysis with which resolution or resolved processes for which application, in which region, etc...).

In this context, the main objective of MER-EP is to improve our knowledge of the ocean by understanding and ultimately improving the reliability and usability of global and regional ocean reanalyses, including physics, waves, biogeochemistry, and sea ice, based on representative and high-priority use cases identified after extensive discussions with academic and private sectors ocean reanalyses users. In the proposed presentation, the MER-EP general organization, the development plans and first results will be presented

**Keywords:** Ocean reanalyses, intercomparison, knowledge of the ocean, waves, biogeochemistry, and sea ice

*Speaker

# Biogeochemical Processes and Climate Interactions

## Oral presentations

*Session 3: Wednesday, 24 Sept. 11:00-12:30*

# Hindcast-based BGC+ Index Simulation for Acidification and Eutrophication Monitoring

A'an Johan Wahyudi*[1]

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**Abstract**

Jakarta's northern waters face significant environmental stress due to anthropogenic activities and climate variability, leading to ocean acidification and eutrophication challenges. These stressors impact marine ecosystems by altering carbonate chemistry, reducing oxygen levels, and triggering algal blooms. Assessing ocean health in this region requires an integrated metric that captures these complex interactions over time. This study introduces the BGC+ Index, a novel indicator that integrates dissolved oxygen, pH, pCO, nutrient balance (N:P and N:Si ratios), chlorophyll-a, micronutrients (Fe), salinity, and temperature to assess ocean health. Using hindcast reanalysis data (2000–2020) from the Global Ocean Ensemble Physics Reanalysis and Global Ocean Biogeochemistry Hindcast, we analyzed seasonal and interannual variations of ocean conditions in Jakarta Bay. Results show fluctuations in the BGC+ Index, with anomalies corresponding to El Niño, La Niña, and Indian Ocean Dipole (IOD) events, which influence nutrient fluxes, oxygen depletion, and biological productivity. The BGC+ Index provides a quantitative framework to evaluate long-term ocean health trends and their links to climate variability. This index serves as a decision-support tool for marine spatial planning, eutrophication mitigation, and climate adaptation policies. The findings emphasize the need for continuous monitoring to address growing environmental challenges in Indonesia's coastal waters.

**Keywords:** BGC+ Index, hindcast simulation, Jakarta Bay, Ocean Acidification, Eutrophication

*Speaker

# Assessing the current state of Indian Ocean acidification, its driving mechanisms, and projected near-future changes

Kunal Chakraborty[1], A. P. Joshi*[1], Prasanna Kanti Ghoshal[1], Balaji Baduru[1], Vinu Valsala[2], V.v.s.s Sarma[3], Nicolas Metzl[4], Marion Gehlen[5], Frederic Chevallier[5], and Claire Lomonaco[4]

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**Abstract**

Changes in Indian Ocean seawater pH in response to variations in sea surface temperature (SST), sea surface salinity (SSS), dissolved inorganic carbon (DIC), and total alkalinity (ALK) over the period 1980–2019, along with their driving mechanisms, have been analyzed using outputs from a high-resolution regional ocean-ecosystem model. The analysis reveals that the rate of pH decline in the Arabian Sea (AS), Bay of Bengal (BoB), and Equatorial Indian Ocean (EIO) is -0.014 ± 0.002, -0.014 ± 0.001, and -0.015 ± 0.001 units per decade, respectively. In the AS and BoB, the highest decadal trend in DIC occurred during 2000-2009, while it was lower in 1990-1999 and 2010-2019. In contrast, the EIO showed an opposite pattern. Ocean acidification accelerated across the Indian Ocean during 2010-2019 compared to previous decades. Furthermore, our analysis indicates that El Niño and positive Indian Ocean Dipole events contribute to enhanced acidification in the region. Increasing anthropogenic CO2 uptake is found to be the dominant driver of the net pH trend (1980-2019), accounting for 79.97%, 94.54%, and 85.72% in the AS, BoB, and EIO, respectively. Ocean warming explains 14.39%, 13.38%, and 7.02% of the pH trends in these regions. In the AS, changes in ALK enhance the pH trend by 5.0%. In the EIO, ALK is the second most significant contributor after DIC, enhancing acidification by 10.67%, similar to the AS. In contrast, ALK plays a buffering role in the BoB, mitigating the pH trend by -5.4%. Additionally, bias-corrected forcing for regional ocean biogeochemical simulations has been developed based on CMIP6 models. Regional downscaling of biogeochemical projections under extreme future climate scenarios suggests that near-future acidification rates in the Indian Ocean are slower than those projected by coarse-resolution CMIP6 models.

**Keywords:** Eastern Indian Ocean, Northwest Australian Shelf, Indonesian Throughflow, Salinity, SST, ENSO, ocean advection

*Speaker

# Variability of Net Primary Productivity in the Northwest Atlantic from a Multi-Datasets Perspective

Ni Putu Asri Ratna Suhita*[1,2,3] and Frederic Cyr[3]

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[2]Nippon Foundation-POGO Centre of Excellence in Observational Oceanography Scholar – Canada
[3]Center for Fisheries and Ecosystem Research, Fisheries and Marine Institute, Memorial University of Newfoundland and Labrador – Canada

**Abstract**

Accurately estimating net primary productivity (NPP) is crucial for understanding ocean productivity and assessing the health and sustainability of marine ecosystems. Observing NPP in situ on a large regional or global scale remains a challenge. Therefore, scientists have shifted to satellite-based models that use chlorophyll-a concentration to estimate NPP and NPP estimates from numerical models. However, with multiple datasets available, it remains unclear which one provides the most reliable representation of NPP. This study aims to assess and compare the variability of NPP over different Ecosystem Production Units (EPUs) in the Northwest (NW) Atlantic, focusing on both seasonal and interannual time scales. We also aim to provide a clearer understanding of how NPP correlates with the long-term ocean-climate variability. We used different available datasets from satellite chlorophyll-a and model outputs with and without assimilation. We observed a large range of variability in NPP across the NW Atlantic; both satellite-derived NPP and model outputs showed similar spatial variation patterns. NPP values are more variable in the southwestern part of the study area. Meanwhile, the region around the Labrador Shelf, closer to the poles, tends to show lower NPP values compared to other areas. Temporally, NPP values are higher from April to June. It can be observed that NPP values gradually begin to increase as the season transitions from spring to summer, driven by the changes in light availability and environmental conditions that promote phytoplankton growth. The long-term trends observed in the annual time series showed fluctuating patterns across all products, with NPP values from satellite chlorophyll-a being generally higher than those from the model outputs. Each EPU also demonstrated distinct variability patterns, some being out of phase between them. Ongoing analysis will explore correlations between annual variations in NPP and ocean-climate indices to explain these relationships.

**Keywords:** climate indices, model outputs, net primary productivity, satellite chlorophyll, a, variability

*Speaker

# Tracking climate impacts on kuroshio marine fish communities using environmental DNA

Jiwei Yang*[1], Hitoshi Araki[2], Hideyuki Doi[3], Toshifumi Minamoto[4], Akihide Kasai[2], Reiji Masuda[3], Masaki Miya[5], Satoquo Seino[6], Hiroki Yamanaka[7], Michio Kondoh[1], and Anemone Project Members[1]

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[3]Kyoto University – Japan
[4]Kobe University – Japan
[5]Natural History Museum and Institute – Japan
[6]Kyushu University – Japan
[7]Ryukoku University – Japan

**Abstract**

Understanding how marine biodiversity responds to rapid ocean warming is essential for predicting the future of coastal ecosystems. Here, we use five years of environmental DNA (eDNA) surveys from Japanese coastal waters influenced by the Kuroshio Current to examine climate-driven shifts in marine fish communities. Our results show that ocean warming has exceeded the thermal tolerance ranges of most fish assemblages, leading to widespread thermal mismatches.

High-latitude Pacific coastal communities, residing near their lower thermal limits, remain within their thermal range but face rapidly narrowing thermal safety margin. In contrast, low-latitude communities, near their upper thermal limits, exhibit higher species turnover driven by poleward shifts, partially mitigating thermal mismatches.

These regional contrasts reveal the hidden vulnerability of high-latitude communities and highlight the role of species range shifts in maintaining resilience under climate stress. Our findings underscore the importance of incorporating thermal niches and regional oceanography into future projections in rapidly warming ecosystems like the Kuroshio.

*Speaker

# "Blue carbon" is an overlooked carbon sink under climatic change

Anna Bobrik*[1] and Pavel Krasilnikov[2]

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**Abstract**

Coastal blue carbon is the organic carbon stored in coastal and marine ecosystems. Coastal ecosystems composed of mangroves, salt marshes and seagrass meadows, represent significant carbon sinks. The loss and degradation of blue carbon ecosystems can release stored carbon back into the atmosphere, increasing carbon dioxide emissions and contributing to global warming. Coastal "blue carbon" ecosystems provide a wide range of ecosystem services that underpin coastal livelihoods and support adaptation to climate change. The main scientific objective of this research is assessment of carbon dynamics at the sea-land interface in the western part of the Russian Arctic, as well as the spatial distribution of carbon fluxes in coastal ecosystems, seawater and the atmosphere based on field research data, remote sensing and mathematical modeling. Potentially, we can consider the possibility of managing coastal landscapes to stimulate long-term fixation of atmospheric carbon. Thus, this study is relevant from a socio-economic point of view, since it works for the development of one of the most dynamically developing areas in the economy – the inclusion of the carbon agenda in the real economy sector. The inclusion of "blue carbon" in this agenda will allow overcoming a number of technical, technological, resource and environmental constraints on the scientific and technological development of the coastal regions of the country. Business needs for organizing carbon farms in the coastal zone were assessed. Scientifically, this work offers the first global assessment of carbon dynamics at the sea-land interface and the spatial distribution of carbon fluxes in coastal ecosystems, seawater and the atmosphere based on remotely sensed data and mathematical modeling. This research was funded by the Russian Science Foundation, grant numbers 23-67-10006.

**Keywords:** Greenhouse gases, carbon, sustainable development

*Speaker

# Artificial Intelligence: Role in Climate-Ocean Research and Prediction

## Oral presentations

*Session 6: Wednesday, 24 Sept. 13:30-15:00*

# AI deep learning for climate forecasts

Jing-Jia Luo*[1]

[1]Nanjing University of Information Science and Technology – Indonesia

**Abstract**

AI deep learning for weather-climate science has attracted increasing attentions in recent years with rapidly expanded applications to many areas. In this talk, I will briefly present our recent progresses on using various deep learning methods for seasonal-to-multi-seasonal predictions of ENSO, the Indian Ocean Dipole (IOD), summer precipitation in China and East Africa, Arctic sea ice cover, ocean waves, as well as the bias correction and downscaling of dynamical model's forecasts. The results suggest that many popular deep learning methods, such as convolutional neural networks, residual neural network, long-short term memory, ConvLSTM, UNet, multi-task learning, cycle-consistent generative adversarial networks, vision transformer, and diffusion model, can be well applied to improve our understanding and predictions of climate. In addition, a brief introduction of AI large models for ensemble weather-subseasonal-seasonal-decadal forecasts, together with the perspective on the future development of AI methods, will also be presented.

*Speaker

# Atlantic and Benguela Niño predictable months in advance, After All!

Noel Keenlyside*[1,2,3], Marie-Lou Bachèlery[4], Julien Brajard[2], Massimiliano Patacchiola[5], Serena Illig[6], Eurico Noleto[1], and Francine Schevenhoven[1]

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[2]Nansen Environmental and Remote Sensing Center [Bergen] – Norway
[3]Nansen-Tutu Centre for Marine Environmental Research – South Africa
[4]Centro Euro-Mediterraneo per i Cambiamenti Climatici [Bologna] – Italy
[5]Department of Engineering, University of Cambridge – United Kingdom
[6]Laboratoire d'études en Géophysique et océanographie spatiales – - – France

**Abstract**

Atlantic Niño and Benguela Niño were believed unpredictable, limited by chaotic atmospheric variability and weak ocean-atmosphere interactions. Failure of state-of-the-art predictions in the tropical Atlantic was also linked to large model biases, with little evidence that reducing these errors would deliver skilful predictions. Here we demonstrate for the first time that Atlantic and Benguela Niño events can be predicted up to 3 to 4 months in advance, through adapting a convolutional neural network (CNN) approach used in ENSO prediction. Trained on centennial scale ocean reanalysis we overcome the errors found in state-of-the-art models. The skill of the CNN model is traced to skilfully capturing ocean heat content precursors and wave dynamic processes. Our prediction system is being available via an interactive dashboard, which we are developing in dialogue with users. I will conclude by discussing new efforts to combine dynamical and data driven models to further enhance climate predictions.

**Keywords:** CNN, Atlantic Niño, model bias, seasonal prediction

*Speaker

# A data-driven approach to mesoscale ocean forecasting

Peter Oke*[1] and Tatiana Rykova[1]

[1]CSIRO Environment – Australia

**Abstract**

Accurate ocean forecasting is essential for monitoring mesoscale features such as eddies, fronts, and boundary currents. Traditional forecasting systems typically produce analyses that are not dynamically consistent - leading to initialisation shock that degrades forecasts. These systems are computationally intensive and generate vast amounts of data, making it difficult for end users to interpret and exploit. Here, we develop a data-driven alternative using analog forecasting. We use along-track sea-level anomaly observations to identify past ocean states that most closely match present conditions in a large archive of model simulations. These historical cases serve as analogs to the present state. The subsequent evolution of each analog is then assembled into an ensemble forecast. We generate 15-day sea-level anomaly forecasts for twelve 5x5 regions around Australia and demonstrate that our system outperforms traditional operational forecasts in 80% of cases. By offering a computationally efficient approach to predicting mesoscale ocean circulation, analog forecasting presents a viable and practical alternative for ocean prediction.

**Keywords:** ocean forecasting, eddies, altimeter data, machine learning, analog forecasting

*Speaker

# Hybrid Approach: Combining Physical and CNN-Based Cloud Fraction Parametrizations for Enhanced NWP Performance

Subhrajit Rath*[1], Deepesh Kumar Jain[1], and Suryachandra A. Rao[1]

[1]Indian Institute of Tropical Meteorology – India

**Abstract**

The Indian Summer Monsoon's rainfall significantly impacts South Asia's agriculture, water resources, and socio-economic stability. To address the limitations of the cloud fraction simplifications in the Monsoon Mission Coupled Model (MMCFS-v2), we developed a machine learning (ML) model to predict continuous cloud fraction values within each grid box. Trained on ERA5 reanalysis data across 37 synoptic vertical layers, our model leverages temperature, wind speed, relative humidity, and cloud water content as key predictors. A shuffling process ensures robust generalization and mitigates biases. Testing revealed a bias of approximately 0.01, indicating strong predictive performance. This ML approach substantially enhances traditional methods, overcoming cloud fraction limitations and improving cloud cover accuracy, particularly in complex monsoon systems.

**Keywords:** Monsoon Mission, Machine Learning, Cloud Fraction, MMCFS, v2, Indian Summer Monsoon, cloud cover

*Speaker

# Key role of the MJO on humid heatwaves in the tropics and in southeast Asia: an opportunity for AI-based forecasting

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[7]DESR/CNRM/GMGEC/PASTEL – Météo-France – France
[8]Météo-France – Météo-France, Direction de la Climatologie et des Services Climatiques, Toulouse, France – France
[9]Leibniz Centre for Tropical Marine Research (ZMT), Bremen – Germany

**Abstract**

Humid heatwaves, with their large variability and extremes, are becoming a crucial health, social and ecological issue under climate change threat, particularly in the densely populated and vulnerable tropics and subtropics, such as southeast Asia. Being able to better understand and predict their occurrence is crucial for effective risk-management. The influence on humid heat of the Madden-Julian Oscillation (MJO), the first intraseasonal mode of the tropical atmosphere, has not yet been evaluated at the global scale. Here we show, using reanalysis data, that the MJO and the associated boreal summer intraseasonal oscillation (BSISO) have a significant influence on humid heat and humid heatwaves over most of the tropics and subtropics, across all seasons, both over terrestrial and marine regions. Depending on the MJO phase, the likelihood of humid heatwaves can either double or be halved in many regions, such as southeast Asia. This MJO influence extends far beyond regions directly impacted by MJO precipitation and convection, notably through horizontal moisture advection. Knowing MJO predictability, we then exploit the machine-learning based global weather forecasting Graphcast model as pre-trained model and fine-tune it, focusing on reducing iterative error accumulation, to improve subseasonal forecasts. Our fine-tuned model GraphFT significantly outperforms Graphcast and the leading deterministic traditional subseasonal forecasting system at 3-4 week leads. These results highlight the

*Speaker

potential of forecasting humid heat episodes, at low computational costs, several weeks in advance.

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**Keywords:** humid heatwaves and heat stress, Madden, Julian Oscillation (MJO), intraseasonal summer oscillation (ISO), artificial intelligence (AI), machine learning (ML), based intraseasonal forecasting, fine, tuning, tropics and subtropics

# Towards Explainable El Niño Predictions and Understanding Climate Model Biases

Sen Zhao*[1], Fei-Fei Jin[1], Malte F. Stuecker[1], Philip Thompson[2], Jong-Seong Kug[3], Michael J. Mcphaden[4], Mark Cane[5], Andrew Wittenberg[6], and Wenju Cai[7]

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**Abstract**

The El Niño–Southern Oscillation (ENSO) provides most of the global seasonal climate forecast skill, yet, quantifying the sources of skillful predictions is a long-standing challenge. Different sources of predictability affect ENSO evolution, leading to distinct global effects. Artificial intelligence (AI) forecasts offer promising advancements but linking their skill to specific physical processes is not yet possible, limiting our understanding of the dynamics underpinning the advancements. In this study, we developed an extended nonlinear recharge oscillator (XRO) model that parsimoniously incorporates the core ENSO dynamics and ENSO's seasonally modulated interactions with other modes of variability in the global oceans. The XRO model exhibits skillful forecasts at lead-times up to 16-18 months, outperforming global climate models and rivalling the best AI forecasts. We showed that knowing the initial state of the upper ocean in the extratropical Pacific, the tropical Indian Ocean and the Atlantic Ocean enhances ENSO predictability at different forecast lead times in distinct seasons. The contributions of these climate patterns to the magnitude of ENSO events and ENSO predictive skills are quantifiable. Furthermore, reforecasts using the XRO trained on climate model output show that reduced biases in both model ENSO dynamics and in climate mode interactions can lead to more skillful ENSO forecasts. The XRO naturally integrates two key theories for climate variability: the recharge oscillator theory for ENSO and the Hasselmann theory for climate variability and predictability outside the tropical Pacific Ocean. The XRO framework's holistic treatment of ENSO's global multi-timescale interactions highlights promising targets for improving ENSO simulations and seasonal forecasts.

**Keywords:** ENSO, Seasonal predictions

*Speaker

# Cascading and Compound Event

## *inc. Climate Variability and Change*

## Oral presentations

*Session 7: Wednesday, 24 Sept. 16:30-18:00*

# Global and Regional Drivers for Exceptional Climate Extremes in 2023-2024: Beyond the New Normal

Shoshiro Minobe*[1], Erik Behrens[2], Kirsten Findell[3], Norman Loeb[4], Benoit Meyssignac[5], and Rowan Sutton[6]

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[5]Laboatoire d'Etudes en géohysique et océanographie spatiales (LEGOS) – CNRS : UMR5566, Centre national d'études spatiales - CNES (FRANCE), Institut de recherche pour le développement [IRD] : UR5566, Université de Toulouse Paul Sabatier – France
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**Abstract**

Climate records have been broken with alarming regularity in recent years, but the events of 2023-24 were exceptional even when accounting for recent climatic trends. Here we quantify these events across multiple variables and show how excess energy accumulation in the Earth system drove the exceptional conditions. Key factors were the positive decadal trend in Earth's Energy Imbalance (EEI), persistent La Niña conditions beginning in 2020, and the switch to El Niño in 2023. Between 2022 and 2023, the heating from EEI was over 75% larger than during the onset of similar recent El Niño events. We show further how regional processes shaped distinct patterns of record-breaking sea surface temperatures in individual ocean basins. If the recent trend in EEI is maintained, we argue that natural fluctuations such as ENSO cycles will increasingly lead to amplified, record-breaking impacts, with 2023-2024 serving as a glimpse of future climate extremes.

**Keywords:** Earth's Energy Imbalance, El Nino, 2023/24 Global Boiling Event, WCRP EPESC LHA

*Speaker

# Accelerating increases in heat waves durations under global warming

Cristian Martinez-Villalobos*[1,2], Danning Fu[3], Paul Loikith[4], and J. David Neelin[5]

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[2]Data Observatory Foundation – Chile
[3]Stanford University – United States
[4]Portland State University [Portland] – United States
[5]University of California [Los Angeles] – United States

**Abstract**

In addition to increasing in frequency, heat waves are expected to last longer under global warming. The probability distributions of heat wave durations are affected by correlations of temperature from one day to the next, and so cannot be simply extrapolated from changes in the probabilities of daily temperature values. Using analysis informed by theory for autocorrelated fluctuations, here we show that changes in long-duration events increase nonlinearly with temperature. This produces an acceleration of the rate increase with warming - each subsequent increment of regional time-average warming T increases the characteristic duration scale of long heat waves more than the previous increment. The curve for this acceleration can be approximately collapsed onto a single dependence across regions by normalizing by local temperature variability. Projections of future change can thus be compared to observations of recent change over part of their range. We illustrate this acceleration in heat waves duration using observed and projected temperatures in two different climate regions: **i.** Chile and South America, **ii.** Indonesia and Southeast Asia. The near-future projected acceleration is supported by this comparison and consistent with theoretical expectations. Furthermore, the longest, most uncommon heat waves for a given region have the greatest increase in probability, yielding a compounding source of nonlinear impacts.

**Keywords:** Heat waves, climate extremes, global warming, nonlinear impacts

*Speaker

# Magnified urban heat island intensity during heatwaves in East Asia

Gensuo Jia*[1]

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**Abstract**

With rising occurrence of heatwaves and ongoing urban expansion, urban residents are facing severer heat-related stress under the combined effects of urban heat island (UHI) and heatwaves. Controversial results, however, have been reported regarding whether the UHI is exacerbated during heatwaves. In this study, we used fused ground and satellite daily maximum air temperature data to evaluate the variation of UHI intensities under heatwaves across over 200 major cities in East Asia during 2003–2020. Overall, urban areas showed an enhanced UHI intensity of up to 0.94∘C during heatwaves, nearly double compared to normal periods. The interaction between UHIs and heatwaves was sensitive to local background precipitation. Under the similar urbanization and vegetation greenness, the amplified warming in urban areas during heatwaves was more pronounced in wet climates. In megapolitan regions characterized by continuous urban development, the UHI intensified much stronger during heatwaves due to the heat accumulation within urbanized areas and the advection of heat from neighboring cities. Meanwhile, the increasing trend of nighttime heatwaves in urban areas than rural areas in both tropical and temperate climates in East Asia is largely due to urbanization, which amplifies heatwaves with urban heat island (UHI) effects. Increased UHI intensity amplifies the effects of nighttime heatwaves in urban clusters, while urban green increase can attenuate the UHI effect particularly in arid climate. The cooling effects of urban greens tend to be weakened as their patches became smaller and isolated, and over dominated by urban surfaces.The results here contribute to understanding the interactions between UHIs and heatwaves which may strongly increase heat risk in cities. Further work on the variations of this interaction under future warming and consequent impacts on human health and energy use is needed.

**Keywords:** urban heat islands, heatwaves, climate extremes, urban, coastal cities

*Speaker

# Enhanced Future Risk of Soil Moisture Drought despite Wetter Conditions in South Asia

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[2]Center for Emerging Technology for Sustainable Development, IIT Jodhpur – India

**Abstract**

Monsoon precipitation is projected to increase under future warming climate over South Asia. Despite this increase in the mean precipitation in the region, previous studies have reported an increase in the future drought risk over South Asia in the warming climate. In this study, we investigate the underlying hydroclimatic mechanisms contributing to the increased risk of drought in future wetter and warmer climate using the state-of-the-art Community Earth System Model-Large Ensemble (CESM-LENS) simulations to elucidate the paradox of drought during the future wetter climate. Our analysis reveals that the frequency and severity of soil moisture drought are projected to increase during the future wetter and warming climate. Moreover, our analysis shows that the increase in the soil moisture drought during wetter and warmer climate is primarily associated with the increase in the intensity of extreme precipitation, which occurs less frequently but induces larger volumes of precipitation in short durations. Therefore, the wetter monsoon season contributes more to the surface runoff rather than to soil moisture storage. Furthermore, our analysis showed that the projected increase in extreme precipitation over central South Asia is strongly associated with the El-Nino Southern Oscillation (ENSO). These findings enhance our understanding of the mechanisms driving soil moisture deficits in a wetter and warmer future and underscore the need for integrated water resource management strategies that account for changes in both precipitation characteristics and temperature-driven evapotranspiration.

**Keywords:** Soil moisture drought, Climate change, Monsoon precipitation, Extreme precipitation, CESM, LENS

*Speaker

# Southeast Asia's highest CMIP6-based convection permitting climate change projections todate

Aurel Moise*[1], Sandeep Sahany[1], Muhammad Hassim[1], Chen Chen[1], Venkatraman Prasanna[1], Xin Rong Chua[1], Harika Pavan Raavi[1], Fei Luo[1], Jianjun Yu[1], Anupam Kumar[1], and Trina Ng[1]

[1]Centre for Climate Research Singapore (CCRS) – Singapore

**Abstract**

Following an extensive CMIP6 GCM sub-selection process, we settled on six CMIP6 GCM's for further downscaling over Southeast Asia. As such, Singapore's Third National Climate Change Study (V3), released in January 2024, provides now high-resolution (8km and 2km) dynamical downscaled projections for Southeast Asia across three greenhouse gas emission scenarios (SSP126, SSP245, SSP585). This presentation will prvide details of the analysis of this dataset with respect to climate variability and change as well as application examples in the impacts domain for Southeast Asia.

**Keywords:** Climate change, convection permitting, tropical processes, climate impacts

*Speaker

# Ocean Processes and Extremes

## Oral presentations

*Session 8: Wednesday, 24 Sept. 16:30-18:00*

*Session 11: Thursday, 25 Sept. 08:30-10:30*

# Quasi-convergence Conditions during Normal, El Niño, and La Niña Years for the Maritime Continent

Aditya R. Kartadikaria*[1], Ahmad Faujan[2], Moh. Adli Daffa Amrullah[2], and Muhammad Rais Abdillah[3]

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[2]Study Program of Oceanography, Bandung Institute of Technology – Indonesia

[3]Research Group of Atmospheric Science, Bandung Institute of Technology – Indonesia

**Abstract**

The Maritime Continent is among the most complex and dynamic tropical ocean systems, highly sensitive to global climate variability such as the El Niño–Southern Oscillation (ENSO). Despite its sensitivity, the Naga Report by Wyrtki (1961) has long served as a foundational reference for spatial mapping of seasonal variability for oceanographic variables in the Southeast Asian Waters. As the above work, this study creates hypothetical ENSO climatology maps in terms of seasonal variability using MITgcm, a three-dimensional general circulation model, to investigate the long-term impacts of persistent El Niño and La Niña conditions on regional ocean dynamics. The model is run over a 40-year period (10-year spin-up and 30-year analysis), driven by climatological boundary conditions constructed from the ERA5 and HYCOM datasets according to a composite of El Niño, La Niña, or Normal conditions until reaching annual quasi-convergence fields. The climatology of the Normal Year was validated against available WOA18, climatology of BRAN and HYCOM datasets to ensure its reliability. The simulations reveal significant deepening (shallowing) of the mixed layer, weakening (strengthening) of the Indonesian Throughflow, and suppression (enhancement) of upwelling in the eastern Indonesian seas during El Niño (La Niña) Year. The model also captures the shifts in the baroclinic structure, indicating a redistribution of heat and water mass across the archipelago. This study may contribute to the formulation of an initial acceptable background for a climatology dictionary, which provides a model-based reference framework to support, compare, and inform future oceanographic predictions for the Maritime Continent.

**Keywords:** Normal Year, El Niño Year, La Niña Year, Climatology, The Maritime Continent

*Speaker

# Dramatic effect of Indonesia Throughflow variability to cyclone events in the Banda Sea

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[1]Indonesian Agency for Meteorology, Climatology and Geophysics – Indonesia

**Abstract**

This study aims to assess the impact of the Indonesian Throughflow (ITF) on changes in ocean heat content (OHC), heat transport (HT), and the occurrence of cyclone events in the Banda Sea over a 10-year period. During El Niño events, meridional currents and ITF transport within the upper 0–300 meters of the ocean experience a noticeable weakening. Conversely, during La Niña, these currents tend to strengthen. In terms of the vertical profile, heat transport in the Makassar Strait is observed to strengthen during La Niña, particularly in the Labani Channel and along the coast of Central Sulawesi. Similarly, in the Lifamatola Strait, increased heat transport is detected in the Lifamatola Channel and the Halmahera Strait. A lag correlation analysis between heat transport and the Oceanic Niño Index (ONI) reveals time lags of approximately 7–8 months during El Niño and 3–4 months during La Niña. Furthermore, the correlation between heat transport in the two straits and OHC in the Banda Sea indicates a time lag of 3–4 months.Ocean heat content in the Banda Sea increases in tandem with the strengthening of heat transport due to a more vigorous ITF. During El Niño (La Niña), sea surface height (SSH) tends to decrease (increase), leading to weakened (strengthened) ITF and heat transport, and consequently, a decrease (increase) in OHC. Findings show that variations in HT and ITF transport are associated with differences in cyclone characteristics. Short-lived, Category 1 tropical cyclones are typically linked to periods of increased OHC, while longer-lasting tropical depressions (TD) are associated with decreased OHC. Both TD and tropical cyclone events are predominantly located in the southern Banda Sea.

**Keywords:** cyclone, ITF, banda sea, heat transport, ocean heat content

*Speaker

# ENSO-controlled coastal upwelling off north New Guinea regulates interannual deep-water renewal in Kao Bay, Halmahera Island of Western Equatorial Pacific

Gerry Salamena*[1]

[1]Deep-Sea Research Center of BRIN – Indonesia

**Abstract**

Kao Bay (basin depth: 480 m) is a fjord-like embayment with a shallow sill (30 m) restricting the deep layers of the system to Pacific Ocean. The flushing of the deep layers has been investigated by geochemistry studies, indicating interannual deep-water renewal possibly linked to ENSO activities in WEP. Yet, no oceanographic studies had revealed which ocean processes under ENSO responsible for supplying high density water at the vicinity of the bay, subsequently replenishing the bottom. This study fills the gap by investigating circulation systems, New Guinea Coastal Undercurrent (NGCUC) and Halmahera Eddies (HE), in WEP carrying respectively South and North Pacific Tropical Water (SPTW and NPTW). This study considers boreal winter coastal upwelling producing cool upwelled water transported to Kao Bay via NGCUC. TRITON T13 off New Guinea and T16 near Halmahera Island combined with HYCOM models were employed. The interannual variation of boreal winter coastal upwelling linked to ENSO variability (r = 0.92) at the north New Guinea (at T13) was evident at offshore Kao Bay and T16. Pacific water mass reaching offshore Kao Bay and T16 resulting from the ocean teleconnection of the coastal upwelling was characterized as a mixture of NPTW and SPTW. The upper layers of offshore Kao Bay and T16 showed similarity regarding a comparable mixture between NPTW and SPTW. The deep layers of these locations indicate the SPTW predominance (70–100 % for offshore Kao Bay; 60 % for T16). The comparable NPTW-SPTW mixture water at the upper layers of offshore Kao Bay fjord was identified to eligibly replenish the bottom of the fjord due to its temperature and salinity characteristics and this eligibility occurs mostly during boreal winter of El Nino years. Deep-water renewal in Kao Bay linked to strong coastal upwelling off north New Guinea might indicate the El Nino onset.

**Keywords:** Deep, water renewal of Kao Bay, New Guinea Coastal Undercurrent, Coastal Upwelling off north New Guinea, El Nino

*Speaker

# Intraseasonal Sea Level Variability in the Java Sea and Its Ocean-Atmosphere Driving Mechanisms

Azka Afta Tarissa Sinaga*[1] and Faruq Khadami*[1]

[1]Institut Teknologi Bandung – Indonesia

**Abstract**

The Java Sea is well known to be highly influenced by its monsoonal dynamics through atmospheric and ocean processes. It has been shown that the intraseasonal variability of the Indian Ocean dynamics may influenced the Java Sea, yet the interactions and mechanisms remains unclear. This research investigates a certain variability pattern in the Java Sea due to Indian Ocean intraseasonal variability and its driving mechanisms. Using daily sea level anomaly (SLA) from 11 tide gauge stations along west Sumatra to north Java coast and satellite altimetry data from 2022–2024, both data shows a compatible fit for further discussions. The intraseasonal signals obtained using a 20–100 days band-pass filter shows that sea level rise reaching ±0.15 m during March/May in most stations. Composite analysis reveals an eastward propagation of positive SLA emerges from equatorial Indian Ocean and along west Sumatra to south Java waters with 30–60 days period, identical with the Kelvin waves characteristics. The eastward propagation along the Indonesian coasts to south Java waters also emphasizes a "leakage" to Java Sea through Sunda Strait and eastern Indonesia straits with lag of 4–10 days. Despite the lower magnitude, the SLA is soon to be amplified by local wind forcing. Correlation analysis is performed to confirm the role of the local wind forcing as amplifiers for the leaked SLA in Java Sea. Meanwhile, winds from the equatorial Indian Ocean serve as generator of the eastward propagation. Collectively, these results highlight the characteristics and driving factors of intraseasonal sea level variability of the Java Sea and its potential of providing information for further coastal hazards risks mitigation such as recurring tidal floods in north Java coasts.

**Keywords:** Intraseasonal Variability, Java Sea, Kelvin Wave, Sea Level Anomaly, Wind Forcing

*Speaker

# ENSO-driven variability of water masses in the Tasman Sea

Tatiana Rykova*[1] and Peter Oke[1]

[1]CSIRO Environment – Australia

**Abstract**

Observations from Argo profiles between 2005 and 2023 show that shallow water masses in the Tasman Sea vary on a quasi-decadal cycle. The origin of the water mass changes is traced to the south-western Pacific, where they are modified by anomalies of precipitation and shortwave radiation. When conditions over the south-western Pacific are more cloudy, there is more rain and less incident shortwave radiation, producing surface waters that are fresher and colder. Conversely, when the conditions are clear, there is less rain and more heating, producing surface waters that are more saline and warmer. The modified shallow waters advect with the gyre circulation, "feeding" the East Australian Current (EAC) with water that has the same quasi-decadal variability. Interannual variability of upper ocean properties of the EAC and its eddies may significantly impact the poleward transport of heat, freshwater, and biota.

**Keywords:** ENSO, eddies, water masses, EAC, Tasman Sea

*Speaker

# Toward a mechanistic characterisation of marine heatwaves

Neil Holbrook*[1,2], Zijie Zhao[1,2], Antonietta Capotondi[3,4], Sophie Cravatte[5,6], Jules Kajtar[2,7], and Alex Sen Gupta[8,9]

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[7]National Oceanography Centre, Southampton, United Kingdom – United Kingdom
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**Abstract**

Mechanistic understanding of marine heatwaves (MHWs) requires a suitable definition for their detection, an approach to characterise their evolution, and an effective method to understand their causality. Much of our recent knowledge regarding MHWs has been achieved using a point-wise statistical definition that quantitatively defines MHWs as measurable warm ocean temperature extremes relative to a given threshold. While this commonly used definition is easy to use, with MHWs readily detectable and with near-global coverage from satellite sea surface temperature data, it does not quantify the spatial scale of events, their evolution in space and time, nor the association of that evolution with the key drivers. To overcome some of these limitations, more recent studies have investigated the evolution of MHWs as objects evolving in space and time to help broaden our understanding of MHWs. Our new approach represents an important step toward mechanistically characterising the space and time evolution of MHWs – it not only builds upon and extends object-based kinematic studies of MHWs but additionally connects these spatiotemporally evolving MHWs with their key drivers. Finally, we examine the potential predictability of these MHWs based on a linear inverse modelling approach.

**Keywords:** marine heatwaves, detection, mechanisms, predictability

*Speaker

# Surface and Subsurface Dynamics of Northeast Pacific Marine Heatwaves

Antonietta Capotondi*[1]

[1]University of Colorado [Boulder] – United States

**Abstract**

In recent decades, the Northeast Pacific Ocean has experienced very intense and long-lasting warm conditions known as marine heatwaves (MHWs), and has emerged as a hotspot for ocean extremes. Such events include the 2014-2016 MHW, colloquially known as 'the Blob", which persisted for about two years and caused devastating ecological impacts. Local drivers of MHWs in this region, including surface atmospheric forcing and ocean advection, are modulated by the influence of large-scale climate modes of variability, like the El Niño Southern Oscillation (ENSO) and Pacific Decadal Variability (PDV). In particular, PDV appears to play a critical role in the development and evolution of these events. Apart from their surface expressions, Northeast Pacific MHWs also exhibit intense subsurface signals which are particularly relevant for biological impacts. While some studies have examined statistical links between surface and subsurface MHWs in this region, a more comprehensive mechanistic understanding of their connection is still missing. In this presentation, we will discuss the dynamics associated with the onset, evolution and decay of Northeast Pacific MHWs and will examine the processes involved in the downward propagation of surface anomalies and their possible oceanic implications.

**Keywords:** Marine heatwaves, Ocean extremes, ENSO, Pacific decadal variability, Ocean heat content

*Speaker

# Identification of Extreme Sea Levels and Concurrent Marine Heatwaves-Extreme Sea Levels in SETIO Waters 1993-2022

Denise Boedihardjo*[1]

[1]Institut Teknologi Bandung – Indonesia

**Abstract**

The continuous increase in global temperatures has led to a significant rise in sea surface temperatures, influencing various oceanographic parameters, particularly sea levels. When extreme sea level (ESL) events coincide with marine heatwaves (MHWs), they form compound events known as CHESLs (Concurrent Marine Heatwaves and Extreme Sea Levels), which can intensify coastal hazards. This study aims to identify and characterize ESL and CHESL events in the Southeastern Tropical Indian Ocean (SETIO), encompassing the waters off western Sumatra, southern Java, and Nusa Tenggara from 1993 to 2022. The analysis focuses on four coastal stations: Padang (A), Cilacap (B), Prigi (C), and Benoa (D). Sea level anomaly (SLA) and sea surface temperature anomaly (SSTA) data obtained from satellite altimetry were analyzed using statistical methods. The results show positive linear trends in both SLA and SSTA, with spatial variations across stations. Over the 30-year period, 22 ESL and 4 CHESL events were identified in Padang; 16 ESL and 4 CHESL in Cilacap; 18 ESL and 4 CHESL in Prigi; and 23 ESL and 4 CHESL in Benoa. ESL occurrences are primarily associated with the Australian monsoon (DJF; 45%), La Niña conditions (76%), and negative Indian Ocean Dipole phases (40%). CHESL events predominantly occur during the Indian monsoon (MAM; 53%), La Niña (76%), and N-IOD (82%). N-IOD influence is strongest at Padang, while La Niña dominates at the remaining stations. ESLs tend to occur in nearshore regions with shallower depths, where coastal surges are more pronounced. In contrast, CHESLs are more frequently observed in offshore areas, potentially due to enhanced stratification and large-scale ocean-atmosphere interactions. A 66.7% increase in combined ESL and CHESL event frequency is observed over the past decade.

**Keywords:** Extreme Sea Levels (ESLs), Concurrent Marine Heatwaves and Extreme Sea Levels (CHESLs), Southeastern Tropical Indian Ocean (SETIO), monsoon, ENSO, IOD, statistical analysis

*Speaker

# Variability of Marine Heatwaves in the Tropical Indian Ocean with special emphasis on El-Niño decay phase

Srujitha Pothula*[1], Jasti S. Chowdary*[1], Gopinadh Konda[2], G. Srinivas[3], Ananth Parekh[1], and C. Gnanaseelan[1]

[1]Indian Institute of Tropical Meteorology – India
[2]IBS Center for Climate Physics – South Korea
[3]CSIR National Institute of Oceanography [India] – India

**Abstract**

Marine Heatwaves (MHWs) in the Tropical Indian Ocean (TIO) emerged as critical extreme events with far-reaching consequences for marine ecosystems, regional climate patterns, and socioeconomic sectors. In recent decades, the MHW characteristics in the TIO have increased significantly, driven by long-term TIO warming and also contributed by climate variability modes such as El-Niño Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and Pacific Decadal Oscillation (PDO) etc,. While several studies have examined the influence of these major climate modes on MHW activity in the TIO, the role of El-Niño decay years in modulating MHW characteristics remains unexplored. This study investigates the variability of MHWs during March-June (MAMJ) season across selected El-Niño decay years from the observed sea surface temperature for the period 1982-2024. Time series analysis indicates an increase in persistent and long-duration MHWs in recent decades during El-Niño decay years. The composites of El-Niño decay years reveal distinct spatial patterns, with hotspots in the MHW metrics such as frequency, duration and intensity. The physical mechanisms driving these anomalies are further examined, with a particular focus on wind variability and associated latent heat fluxes. Our results highlight that the decaying phase of El-Niño plays a pivotal role in enhancing MHW activity over the TIO. These findings offer new insights into the mechanisms governing extreme ocean warming events and underscore the importance of monitoring post El-Niño conditions for improved predictions of regional MHWs.

**Keywords:** Marine Heatwaves, Extreme events, El Niño decay, Tropical Indian Ocean, Ocean warming

*Speaker

# Positive Indian Ocean Dipole Intensifies Marine Heatwaves along the West African Coast

Lei Zhang*[1], Heng Liu[1], Michael Mcphaden[2], Weiqing Han[3], and Haiyu Li[4]

[1]South China Sea Institute of Oceanology – China
[2]NOAA Pacific Marine Environmental Laboratory – United States
[3]University of Colorado [Boulder] – United States
[4]Hohai University – China

**Abstract**

Marine heatwaves (MHWs) along the West African (WA) coast during the austral summer have devastating impacts on local marine ecosystems and productivity. Through observational data analysis and numerical model experiments, we demonstrate reveal that positive Indian Ocean Dipole (pIOD) events can significantly intensify MHWs in the WA region during the austral summer via two distinct processes. First, pIOD induces westerly wind anomalies over the equatorial Atlantic, triggering thermocline deepening along the WA coast through equatorial and coastaloceanic Kelvin waves, which favorsing the development of MHWs. Second, pIOD enhances rainfall over central Africa, increasing the Congo River discharge and leading to a shallower mixed-layer in the WA region, further promotingcontributing to MHW formation. AdditionallyBased on these findings, we develop construct an empirical model using pIOD as the sole predictor for WA MHWs, demonstrating high predictive skill with a three-month lead timewhich exhibits high predictive skill with a one-season lead time. In a warming climate, the remote influence of pIOD on South Atlantic MHWs may is expected to further intensify, underscoring the importance critical need toof incorporateting this favor into marine hazard forecasts forecasting for the region.

*Speaker

# Caribbean Sea Marine Heatwaves tied to Indian Ocean Marine Heatwaves

Jianping Li*[1] and Zeyu Li*[1]

[1]Ocean University of China – China

**Abstract**

Marine heatwaves (MHWs) are not a phenomenon confined to local areas. Instead, they may interact with other regions through specific teleconnection patterns. Numerous studies have revealed the occurrence, variability, and future trends of MHWs. However, the connections between MHWs in different regions still require further research. By employing observational data and climate model simulation, this study finds that the boreal spring MHWs in the Caribbean Sea Marine are tied to the previous winter Indian Ocean MHWs. The boreal winter MHWs in the equatorial Western Indian Ocean trigger atmospheric upward motion, initiating a westward-propagating Indian Ocean-Pacific-Atlantic (IPA) wave train. Influenced by the IPA, anomalous Hadley circulation and atmospheric warming occur above the Caribbean Sea, leading to intensification through increased downward latent heat flux. The IPA facilitates a close teleconnection between the MHW processes in the two ocean basins, which enables the transfer of energy and climate signals across regions, thereby further intensifying the following spring MHWs in the Caribbean Sea region.

**Keywords:** Marine heatwaves (MHWs), Caribbean Sea Marine, equatorial Western Indian Ocean, teleconnection, air, sea interaction

*Speaker

# Drivers of the extreme North Atlantic marine heatwave during 2023

Matthew England*[1], Li Zhi[1], Maurice Huguenin[1], and Andrew Kiss[2]

[1]UNSW – Australia
[2]ANU – Australia

**Abstract**

During 2023 an unprecedented and near basin-scale marine heat wave developed during Northern Hemisphere summer, peaking in July. The warming spread across virtually all regions of the North Atlantic, including the subpolar ocean where a cooling trend over the past 50-100 years has been linked to a slowdown in the meridional overturning circulation. Yet the mechanisms that led to this exceptional surface ocean warming remain unclear. Here we use observationally-constrained atmospheric reanalyses alongside ocean observations and model simulations to show that air-sea heat fluxes acting on an extremely shallow surface mixed layer, rather than anomalous ocean heat transport, were responsible for this extreme ocean warming event. The dominant driver is shown to be anomalously weak winds leading to strongly shoaling mixed layers, resulting in a rapid temperature increase in a shallow surface layer of the North Atlantic. In addition, solar radiation anomalies made regional-scale warming contributions in locations that approximately correspond to some of the region's main shipping lanes, suggesting that reduced sulphate emissions could have also played a localised role. With a trend toward shallower mixed layers observed over recent decades, and projections that this will continue into the future, the severity of North Atlantic marine heatwaves is set to worsen.

*Speaker

# Subsurface Marine Heatwaves in the Tropical Western Pacific Ocean: Extreme Events, Drivers and the Role of Subsurface Eddies

Shijian Hu*[1] and Shihan Li[2]

[1]Hohai University – China
[2]Institute of Oceanology, CAS – China

**Abstract**

Marine heatwaves (MHWs), which are discrete extreme oceanic warming events, have important impacts on the marine ecosystem, fishery resources, and social economy. Previous studies based on sea surface temperature suggest that MHWs in the tropical western Pacific Ocean are very weak. However, we find that the MHWs observed by the Tropical Atmosphere Ocean/Triangle Trans-Ocean Buoy Network buoys in the tropical western Pacific Ocean are unexpectedly strong in the subsurface layer (50–300 m depth). The ensemble mean intensity of subsurface MHWs shows a peak of about 5.2 ∘C at 150 m with an ensemble mean duration ranging from 13 to 22 days. It seems that the subsurface MHWs are strong and frequent in April–June but relatively weaker and less frequent in September and October than in other months. Anomalous sea surface convergence and Ekman down-welling play an important role in the evolution of subsurface MHWs in both onset and decay phases. Strong subsurface MHWs are likely to affect the fishery production of tropical western Pacific. Subsurface MHWs are widely observed across global oceans, extending beyond the tropical western Pacific region. We find that quite a few of subsurface MHWs in the western tropical Pacific Ocean show significant co-occurrence with subsurface anticyclonic eddies using in situ observations from buoys and Argo floats. These co-occurring events are characterized by a lens-shaped temperature structure with a subsurface warm core and encircled by an anomalous anticyclonic circulation pattern. Subsurface anticyclonic eddies, accompanying with subsurface oceanic convergence and downwelling, lead to strong downward heat transport and onset of subsurface MHWs.

*Speaker

# Societal Impact

## Oral presentations

*Session 9: Wednesday, 24 Sept. 16:30-18:00*

*Session 12: Thursday, 25 Sept. 08:30-10:30*

# Impact of ENSO and the IOD on global economy

Wenju Cai*[1]

[1]Ocean University of China – China

**Abstract**

The El Niño-Southern Oscillation (ENSO) is a consequential climate phenomenon affecting global extreme weather events often with largescale socioeconomic impacts. To what extent the impact affects the macroeconomy, how long the impact lasts, and how the impact may change in a warming climate are important questions for the field. Using a smooth nonlinear climate-economy model fitted with historical data, here we find a damaging impact from an El Niño which increases for a further three years after initial shock, amounting to multi-trillion US dollars in economic loss; we attribute a loss of US$2.1T and US$3.9T globally to the 1997-98 and 2015-16 extreme El Niño events, far greater than that based on tangible losses. We find impacts from La Niña are asymmetric and weaker, and estimate a gain of only US$0.06T from the 1998-99 extreme La Niña event. Under climate change, economic loss grows exponentially with increased ENSO variability. Under a high-emission scenario, increased ENSO variability causes an additional median loss of US$33T to the global economy at a 3% discount rate aggregated over the remainder of the 21st century. Similar analysis for the Indian Ocean Dipole (IOD) find that the impact is far smaller from that of ENSO, but is similarly nonlinear though more regionally distinctive, and intensifies under greenhouse warming. Thus, exacerbated economic damage from changing ENSO and IOD in a warming climate should be considered in assessments of mitigation strategies.

**Keywords:** ENSO, the IOD, climate variability, greenhouse warming, economic impact

*Speaker

# Impacts of the 2020–2023 Triple-Dip La Niña on Rainfall in Southeast Asia

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**Abstract**

As global warming amplifies the frequency of consecutive La Niña events, the risk of natural hazards in Southeast Asia has risen. The 2020-2023 period marked the first consecutive La Niña event of the 21st century-a rare "triple-dip" phenomenon that defied previous understanding of consecutive La Niña development. While previous studies have examined the physical mechanisms behind the 2020-2023 "triple-dip" La Niña, including inter-basin interactions, little is known about the impact of this event on seasonal rainfall characteristics across Southeast Asia and the associated hydrometeorological and societal impacts. Here we use observational datasets (1950-2023) to analyze the regional rainfall patterns and intensity in Southeast Asia during the 2020-2023 "triple-dip" La Niña. Our objective is to identify unique features of seasonal rainfall, explore possible regional processes, and assess the societal implications of these changes. We find that most of the Maritime Continent, particularly Indonesia and Peninsular Malaysia, experienced significantly wetter conditions-up to two to three times higher rainfall compared to typical La Niña years, leading to severe flooding events. In contrast, Vietnam and parts of Malaysia saw drier conditions, with rainfall up to two times lower than normal, resulting in drought conditions. Singapore also experienced a drier winter monsoon from 2021 to 2023. Despite La Niña's cooling influence on the Pacific, both 2021 and 2022 were warmer than any year before 2015, underscoring the complex interplay of warming and cooling factors. These unusual rainfall patterns during the "triple-dip" La Niña have had significant impacts on food security, particularly in agriculture-dependent regions of Southeast Asia, where the sector accounts for roughly 15% of gross domestic product (GDP). Understanding the regional variability of the "triple-dip" La Niña in Southeast Asia is, therefore, crucial, especially in the context of changing ENSO teleconnections and a warming climate.

**Keywords:** Southeast Asia, La Niña, Rainfall, ENSO teleconnection, Climate Impact

*Speaker

# Impacts of Marine Heatwaves on the Bay of Bengal's Coastal Ecosystems and Communities: Drivers, Adaptation Strategies, and Enhancing Resilience

Mohan Kumar Das*[1,2], Md. Amit Hasan[1], and Sheikh Fahim Faysal Sowrav[1]

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[2]South Asian Meteorological Association (SAMA) – India

**Abstract**

Marine heatwaves (MHWs), which are prolonged periods of unusually high sea surface temperatures (SST), have become more frequent, intense, and prolonged due to climate change. In the Bay of Bengal, the northern region has experienced over 100 MHW events in the past 30 years, with some SSTs exceeding the climatological mean by more than 4∘C. These heatwaves are primarily driven by factors such as heat flux, ocean currents, solar radiation, monsoons, and changes in ocean circulation. MHWs significantly impact coastal ecosystems and communities, influencing tropical cyclone formation, coral bleaching, and fisheries' stability. This study investigates the effects of MHWs on Bangladesh's coastal regions, focusing on the key drivers and exploring adaptation strategies. It examines the role of rising SSTs and climate phenomena like the Indian Ocean Dipole (IOD) and the El Niño-Southern Oscillation (ENSO) in amplifying cyclonic activity, as seen in recent tropical cyclones. The research incorporates remote sensing data, in-situ temperature measurements, and water quality monitoring to assess MHW intensity and frequency. Socioeconomic data from local communities are also analyzed to understand the impacts on livelihoods, health, and infrastructure. Ultimately, the study aims to inform the development of adaptive strategies that enhance coastal resilience and support sustainable development, advocating for improved monitoring systems and early warning mechanisms to mitigate the adverse effects of MHWs on Bangladesh's coastal communities.

**Keywords:** Heat Flux, SST, IOD, ENSO, Socio, Economic Impacts

*Speaker

# Impact of warming Indian Ocean on different facets of life in India

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**Abstract**

India is highly vulnerable to the impacts climate change and related ocean warming (1.7-3.8∘C increase/century) and sea level rise (1.7 mm/year during the last century). Changes in the characteristics of cyclones result in unpredictable floods and abnormal waves that increasingly erodes coast, and salinate aquifers. Accelerated rises in sea level is a threat to the coastal cities and low lying islands (3 cm rise could cause the sea to intrude inland by 17 meters). Expansion of Indian Ocean Warm Pool (temperature exceeding 28∘C), variability in net primary production, decline in chlorophyll (fall by 8-10% by 2100), increase in heat content (rise to 16-22 zettajoules/decade in near future), changes in pH level, increase in marine heatwave days (from 20 to 220–250 days/year), acidification, coral bleaching and changing coastal circulation are changing marine ecosystem leading to loss of biodiversity and fish migration, affecting national economy and livelihood of millions depending on fisheries. Due to the rise in the ocean's heat content (Indian Ocean Dipole) 66% increase in extreme events can be expected and erratic monsoons may lead to severe and frequent floods and droughts by the end of the century. Changing runoff pattern of major river will invite salinity intrusion far inland. Increasing number and severity of thunderstorms results in casualties and tremendous loss associated with floods and lightning. Worsening forest fires ignited by lightning leads to biodiversity loss and human animal conflicts. All these have several socio-economic impacts such as migration to interior and competition and conflicts over resources allocation, falling availability and rising costs of food and water, health issues and societal unrest. This study analyses the impact of warming ocean on different facets of life in India. Current policies and strategies have been critically analysed to suggest guidelines for appropriate strategies for adaptation and impact mitigation.

**Keywords:** Climate change, warming Indian ocean, marine ecosystem, biodiversity loss, socio, economic impact, adaptation, mitigation

*Speaker

# Projection of Climate Change Impact on Oldeman Climate Classification in Indonesia

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**Abstract**

The agricultural sector, especially the food crop subsector, plays an important and strategic role in development in Indonesia. However, this agricultural sector still faces various challenges that affect food crop productivity, such as crop failure due to unpredictable rainfall. Global climate change has a significant impact on rainfall patterns in various regions. This study aims to determine how the changes and distribution of future Oldeman agroclimatic zones in Indonesia are as a result of climate change. The rainfall projection data used is from the CMIP6 global climate model scenarios SSP2-4.5 and SSP5-8.5. Out of 9 CMIP6 models, 5 of the best models were selected through the RMSE (root mean square error) evaluation metric and Pearson correlation. These models include EC-EARTH3, ACCESS-CM2, MIROC-ES2L, CNRM-CM61, and CNRM-ESM2-1. The analysis was conducted on daily rainfall data with a spatial resolution of 0.25◦ from the baseline year (1984-2014) and the near-future projection period (2015-2040), mid-future (2041-2070), and far-future (2071-2100). The results of the study indicate a shift in agroclimatic zones in various regions, including a decrease in zones A, B, and C1, which indicates a decreasing number of consecutive wet months. Meanwhile, zones C2, D, and E are expanding, especially in the eastern part of Java Island, Bali, and Nusa Tenggara, which shows an increasing number of consecutive dry months. **Keywords**: projection, rainfall, CMIP6, agroclimatic zone, Oldeman classification, Indonesia.

**Keywords:** projection, rainfall, CMIP6, agroclimatic zone, Oldeman classification, Indonesia

*Speaker

# Spatial Distribution and Prediction of Extreme Rainfall Over Indonesia for Supporting Key Pilar of Indonesia Early Warning for All

Adi Ripaldi*[1,2], Tania June*[2], Akhmad Faqih*[2], Supari Supari*[1], and Muhammad Taufik*[2]

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**Abstract**

Studies related climate changes impact and the mechanisms of extreme rainfall events in Indonesia region are crucial for both meteorological experts and stakeholders, as well as for the community in efforts to adapt and mitigate hydrometeorological disaster risks, and in sustainable development planning. This research aims to identify the characteristics of extreme rainfall in Indonesia over the past 30 years, with findings that can be used as early information and reference for supporting one of early warning for All pilar in monitoring and predicting extreme climate event. This allows for anticipatory measures to be taken, both through short-term and long-term management strategies, as well as identifying regions that are vulnerable to and frequently experience extreme rainfall events in Indonesia. The analysis of extreme rainfall is conducted using extreme climate indicator indices based on the recommendations of the World Meteorological Organization (WMO) Expert Team on Climate Change Detection and Indices (ETCCDI). The characteristics of extreme rainfall in Indonesia in this study are based on extreme rainfall indices from 1991 to 2020, with indicators of intensity, frequency, and spatial distribution duration varying for each region.

**Keywords:** extreme, early warning, ETCCDI, hydrometeorological disaster

*Speaker

# An Application of WRF-ARW/WRF Hydro Model Coupled in Flood Simulation in South Tapanuli Region (Case Study 12 - 15 March 2025)

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**Abstract**

The South Tapanuli Regency surrounds Padangsidempuan City with the characteristics of Lubukraya and Sibualbuali mountains in the north and the Bukit Barisan hills in the east with increased vulnerability to river flooding/Batang Gadis water flow. However, operational fluvial flood forecasting oriented to impacts is still far from mature in the region. Currently the first attempt to introduce a warning system based on the region, which is based on the combination of state-of-the-art numerical weather prediction models with sophisticated spatially-explicit hydrological models. The modeling methodology and forecasting scheme of the system are presented, as well as the results of the prototype, obtained in pre-operational mode. Future developments and challenges that need to be addressed in terms of validating the system and improving its efficiency. This research highlights that the standard approach used in weather forecasting in the South Tapanuli region to provide flood-related information and warnings can, and should, be replaced by a sophisticated coupled hydrometeorological system, which can be implemented without significant costs provided. This is very important in building effective early warning for fluvial floods in the area. From the results obtained that the prediction of river water discharge at three points from the upstream, middle and downstream where the average discharge in the middle is greater than in the upstream and downstream which indicates a buildup of discharge in the middle of the river basin area located in the city of Padangsidempuan on March 13-15, 2025 which turned out to be a flood along the banks of the river causing damage to gardens, houses or shops and loss of life. This condition occurs repeatedly every year Only the time of the incident between December and April each year so that with this wrf-hydro model it can be determined 15 days before the incident.

**Keywords:** flood, forecast, hydrometeorology, WRF, Hydro, impact, based, warning, sidempuan

*Speaker

# Assessing the Socioeconomic Footprint of Tornado Events in Indonesia: A 14-Year Spatio-Temporal Impact Analysis (2010–2024)

Kiki Kiki*[1,2], Yonny Koesmaryono[2], Rahmat Hidayat[2], Perdinan Perdinan[2], and Donaldi Sukma Permana[1]

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[2]Bogor Agricultural University – Indonesia

**Abstract**

Tornadoes, which in Indonesia are known by the local name "puting beliung," are one of the most frequent extreme weather phenomena that can have devastating impacts. Although there have been many studies related to this extreme phenomenon, comprehensive studies that measure the socioeconomic consequences over time are limited. Recent climate change projections suggest that rising air temperatures could lead to an increase in the frequency, intensity, and unpredictability of extreme weather events in many regions of the world, potentially increasing the risk of future disasters. This study presents a 14-year (2010-2024) spatio-temporal analysis of tornado occurrence in Indonesia, integrating the frequency of occurrence and the severity of impacts to assess disaster risk at a regional scale. Using official tornado event data from the Indonesian National Meteorological Agency (BMKG), the Indonesian National Disaster Management Agency (BNPB), and other disaster-related government agencies, we compiled more than 2,000 reported tornado events throughout the study period, including their impacts such as casualties, house damage, and economic losses. A composite index of tornado risk was developed by combining the frequency of occurrence with a weighted assessment of the impact indicators. The results show significant spatial clustering in the island regions of Java, Sumatra, and Sulawesi, with clear seasonal patterns during the wet season and seasonal transition periods. Some areas were identified as high-risk zones due to high tornado frequency and high vulnerability. This study highlights important aspects for improved early warning systems, risk communication, and disaster mitigation. Our findings offer a data-driven foundation to support policy-making for disaster risk reduction due to the tornado phenomenon in tropical island regions.

**Keywords:** Tornado, Puting Beliung, Indonesia, Disaster Risk, Socioeconomic Impact, Risk Index

*Speaker

# Bridging Science and Society through CLIVAR Initiative: Tropical Cyclones as a Catalyst for Coastal Fisheries and Mangrove Resilience in the Goni and Haiyan Corridors (Catanduanes and Aklan) in the Philippines

Jimmy Masagca*[1,2,3], Jennifer Berces[1], Raymond Sucgang[4], Therese Jean Sarabia[5], Amelia Navejas[5], Amelia Gonzales[6], Cicely Samar[5], Mark Joe Masagca[2], Estrella Tribiana[2], Rev. Fr. Jayvee De Los Santos[7], Bryan Ray Solano[8], Jaymark Echano[6], Marlowe-Vitto Sancho[6], Mark Lorenz Trinidad[2], and Kenneth Tuplano[2]

[1]Catanduanes State University – Philippines
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[3]IUCN CEC and IUCN Climate Crisis Commission – Switzerland
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**Abstract**

This paper examines the critical role tropical cyclones play in shaping coastal ecosystems, livelihoods, and community resilience in Catanduanes and Aklan in the Goni and Haiyan Corridors of the Philippines, within the framework of the CLIVAR (Climate and Ocean: Variability, Predictability, and Change) initiative. Focusing on the interactions between tropical cyclones, mangroves, and coastal fisheries, the paper highlights the dual impact of these climatic events: ecological challenges such as mangrove degradation and socio-economic pressures on coastal fisheries and livelihoods in the brackish water areas. By integrating meteorological data, ecological assessments, and community feedback, the paper bridges the gap between scientific understanding and societal needs. The findings advocate for sustainable mangrove management, fisheries conservation, and science-informed policy measures that promote resilience against climatic variability. This paper underscores the necessity of connecting scientific inquiry with societal applications to support adaptive strategies for coastal communities (by introducing examples from the islands of Catanduanes and Aklan) under the CLIVAR framework.

**Keywords:** CLIVAR framework, coastal ecosystems, tropical cyclones, Catanduanes, Aklan, integrated mangrove aquaculture, tropical cycloe tracking

*Speaker

# Empowering Communities in Tamilnadu: Human Dimensions and Foresight of Oceanic and Climatic Shifts

R Sangeetha*[1] and Krishnaveni Muthiah*[1]

[1]Anna University – India

**Abstract**

Tamil Nadu's extensive coastline and diverse climatic zones make it highly susceptible to the impacts of climate change, which intensify climate and ocean variability and challenge the predictability of these systems. Rising temperatures-projected to increase by over 3∘C by century's end-are expected to reduce overall precipitation while increasing the intensity of extreme rainfall events, posing major threats to agriculture, water resources, public health, and coastal ecosystems. This underscores the urgent need to integrate advanced climate and ocean monitoring, improve modeling of regional climate drivers, and conduct socio-economic vulnerability assessments with people's participation to enhance the predictability of climate impacts. Inclusive adaptation strategies, such as strengthening community resilience, incorporating indigenous and local knowledge, and implementing equitable governance frameworks, are essential to mitigate these risks and support sustainable development. To assess the immediate impacts of cyclonic events, a real-time field survey was conducted by Institute for Ocean Management, Anna University, Chennai on November 28, 2024, in Odaikuppam, Besant Nagar, Chennai, during Cyclone Fengal. The survey engaged a cross-section of the community-including fishermen, fisherwomen, petty shop owners, college students, and other local residents-using a structured questionnaire focused on emergency response plans, government support, community preparedness, and infrastructural damage. The results revealed significant vulnerabilities: 52% of respondents lacked a cyclone emergency response plan, 46% were uncertain about recovery support, and 36% reported receiving no aid, while only 18% confirmed having received assistance. Regarding damage, 62% reported severe infrastructural impacts, 12% described the damage as very severe, and only 6% experienced no damage. These findings highlight the critical need for improved disaster preparedness, more effective communication of support mechanisms, and resilient infrastructure. The study emphasizes the importance of community-led resilience initiatives and equitable resource distribution to better protect vulnerable populations in Tamil Nadu from the escalating risks posed by cyclonic events.

**Keywords:** cyclone disasters, questionnaire, climate and ocean variability, people's participation

*Speaker

# Comparative Analysis of Drought Classification Using SPI and SPEI Across Arid and Semi-Arid Climatic Zones of India (1981–2020)

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[1]Yogi Vemana University – India

**Abstract**

India's arid and semi-arid landscapes, pivotal for regional agriculture and livelihoods, face escalating water scarcity amidst changing climatic patterns. This study investigates the complex drought dynamics across four distinct climatic zones (Cold Arid, Cold Semi-Arid, Hot Arid, and Hot Semi-Arid) using the Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI) at 1, 3, 6, 12, and 24-month time scales from a 40 year long dataset, spanning 1981 to 2020. By classifying drought events into Moderate, Severe, and Extreme categories, we quantified drought frequency, intensity, and duration, revealing significant discrepancies between SPI and SPEI. Notably, SPEI, which accounts for temperature-driven evapotranspiration, consistently identified higher drought frequencies, intensities, and durations compared to SPI, particularly at longer time scales. Our results demonstrate that the Hot Arid and Hot Semi-Arid zones consistently experience heightened drought conditions, exhibiting prolonged and intense droughts, with SPEI indicating up to 13.27% frequency of extreme droughts at the 24-month scale. The increased frequency of extreme droughts at longer time scales underscores the growing risk of severe water deficits, impacting regional socio-economic stability. This study highlights the superior sensitivity of SPEI in capturing climate-driven drought dynamics, crucial for effective drought monitoring and management. The spatial analysis reveals that prolonged drought events, particularly under SPEI, are concentrated in economically vital agricultural zones, demanding urgent attention for sustainable water resource management. These findings provide critical insights for developing region-specific mitigation strategies and enhancing climate resilience in comparable arid and semi-arid regions globally.

**Keywords:** SPI, SPEI, Drought Classification, Arid Region, Semi, Arid Region, India, Climate Change.

*Speaker

# Could solar radiation management (SRM) ameliorate or exacerbate the impacts of climate change in Africa?

Lennard Chris*[1]

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**Abstract**

As the impacts of breaching 1.5∘C of global warming become more severe, SRM is likely to increasingly feature in political discussions as a potential climate intervention that could slow the warming and offset some of its worst impacts.
Given Africa is the continent most vulnerable to climate change impacts, understanding the implications of SRM for the continent is vital as it may mitigate or exacerbate these impacts. Therefore, within SRM research, African considerations must be central, influencing how SRM is researched is developed and executed so that in future geopolitical SRM discussions the African perspective is Africa-informed, scientifically sound and authoritative.

In this paper we present results from current SRM research being conducted across Africa. This includes investigations of how SRM may ameliorate or exacerbate the risks associated with global warming in the context of extreme events, atmospheric processes like cut-off lows, monsoons and drought, marine biogeochemistry and ocean circulation, and sectoral impacts on agriculture, hydrology, water availability and and biodiversity.

We will also present the African Climate Research Hub that will coordinate and facilitate SRM research in Africa over the next few years. The hub will additionally facilitate building capacity for SRM and climate research through training opportunities, and foster transdisciplinary collaboration with stakeholder and policy communities to co-produce policy relevant SRM information.

In presenting the current African SRM research together with the goals and activities of the African Climate Research Hub, we demonstrate that (a) there is capacity for SRM research in Africa, and (b) we have a mechanism to consolidate and grow this capacity into a research network that integrates SRM knowledge relevant for African policy development.
This results a diverse SRM expert community in Africa to answer the question, "Could Solar Radiation Management (SRM) ameliorate or exacerbate the impacts of climate change in Africa?"

**Keywords:** Solar Radiation Management, SRM, Africa, Capacity development

*Speaker

# Advancing Ocean20: Strengthening Science to Society initiatives through partnerships

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[1]South African Environmental Observation Network – South Africa

**Abstract**

Under South Africa's G20 Presidency, Ocean20 presents a vital platform to champion inclusive, science-driven ocean governance that bridges knowledge and action. In advancing the ideals of Ocean20, South Africa envisions a transformative agenda that connects ocean science to society through equitable, cross-sectoral partnerships. This vision is rooted in the understanding that healthy oceans are foundational to climate resilience, food security, economic development, and cultural heritage, especially for coastal and small-island nations. Leveraging its strategic position at the convergence of three oceans and its deep commitment to the African Union's Blue Economy Strategy, South Africa proposes a bold initiative to foster transdisciplinary collaboration among governments, academia, industry, and society. By promoting open access to ocean data, co-creating locally relevant knowledge, and scaling accessible technologies and innovations, this initiative aims to ensure that scientific undertakings translate into tangible benefits for people and the planet. The South African G20 Presidency calls for an inclusive Ocean20 that supports nature-positive investments, empowers the next generation of ocean stewards, and strengthens mul-tilateral cooperation to safeguard the ocean commons. Through science-to-society pathways, Ocean20 can become a catalyst for regenerative ocean economies that are just, sustainable, and resilient.

**Keywords:** science to society, Blue Economy

*Speaker

# Climate Variability and Change

## Oral presentations

*Session 10: Thursday, 25 Sept. 08:30-10:30*

# Evaluating Three Decades of NMME Hindcasts to Assess Model Performance in Predicting ENSO Onset

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**Abstract**

El-Niño Southern Oscillation (ENSO) phase transitions-shifts between neutral, La Niña, and El Niño states-reshape global climate patterns. Accurate predictions of these transitions are critical for agriculture, water management, and disaster preparedness. This study evaluates North American Multi-Model Ensemble (NMME) operational models to assess their performance in predicting Niño3.4 region sea surface temperature anomalies during ENSO onset seasons. A 30-year analysis (1991–2020) identified 18 ENSO episodes-nine El Niño and nine La Niña-exceeding the Niño 3.4 region's $\pm 0.5 \circ$C threshold for $\geq 5$ consecutive seasons. ENSO onsets predominantly occurred in non-winter seasons, with El Niño typically initiating in boreal spring–summer and La Niña emerging in boreal summer-fall. NMME models generally captured observed mean and variance well, but some models diverged significantly at longer lead times. Skill assessments reveal a seasonal pattern: correlation analysis and squared error skill scores both indicate lower prediction accuracy for late boreal spring to early summer targets, but notably improved performance for boreal fall and winter targets. Some ENSO events are inherently difficult to predict, as seen with the poorly forecasted 2017 La Niña and 1994 and 1997 El Niño onsets. This underscores the event-specific and model-dependent nature of ENSO onset prediction.

**Keywords:** ENSO, Onset, NMME, El Nino, La Nina, Skill

*Speaker

# Role of Salinity Barrier Layers on Atlantic Niño Events

Hailong Liu*[1] and Xiao Ma[2]

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[2]Shanghai Jiao Tong University – China

**Abstract**

Previous studies have confirmed the diverse spatiotemporal characteristics of Atlantic Niño events. Our research further reveals the crucial preparatory role of equatorial western Atlantic barrier layers (BL) and the triggering effect of westerly wind bursts (WWB) on different varieties of Atlantic Niño. Strong easterly winds typically facilitate the formation of thick BL by deepening isothermal layer depth in the western Atlantic through horizontal transport. The existence of BL accumulates the necessary heat for the onset of Atlantic Niño. Additionally, the timing of BL occurrences, the presence of easterly wind anomalies preceding WWB, and the duration of westerly wind anomalies jointly contribute to Atlantic Niño diversity. Persistent westerly wind anomalies following strong easterly winds often lead to Atlantic Niño events lasting over 6 months, while short-lived events occur when westerly wind anomalies cease shortly after their onset.

**Keywords:** Barrier Layer, Atlantic Nino

*Speaker

# Understanding 21st-Century ENSO Complexities: The Interplay of Tropical and Subtropical ENSO Dynamics

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**Abstract**

El Niño-Southern Oscillation (ENSO) dynamics have evolved significantly in the 21st century, driven by the interplay between tropical and subtropical ocean-atmosphere coupling processes. Tropical ENSO dynamics, associated with conventional ENSO, focus on recharge-discharge processes tied to tropical Pacific ocean-atmosphere interactions, which dominated the eastern Pacific and single-year ENSO events of the 20th century. In contrast, subtropical ENSO dynamics offer a new perspective, emphasizing the role of subtropical Pacific ocean-atmosphere interactions that propagate to the tropical Pacific, influencing ENSO formation. This subtropical mechanism has gained prominence in the 21st century, shifting ENSO patterns toward the central Pacific with multi-year durations. The competition between tropical and subtropical ENSO dynamics also governs the occurrence of extreme ENSO events. The rising importance of subtropical ENSO dynamics is linked to anthropogenic global warming, Maritime Continent deforestation, and natural decadal variability, such as the Atlantic Multi-decadal Oscillation. Furthermore, the role of inter-basin interactions in ENSO dynamics varies depending on whether tropical or subtropical dynamics dominate. This presentation will introduce a dynamical framework to explain how the interplay between the conventional tropical ENSO dynamics and the emerging subtropical ENSO dynamics drives complexities in ENSO's spatial patterns, duration, and extreme intensities in the 21st century.

**Keywords:** 21st, Century ENSO Complexity, ocean, atmosphere interactions, inter, basin interaction, oean SST extreme

*Speaker

# Strengthening of the equatorial Pacific upper-ocean circulation over the past three decades

Franz Philip Tuchen*[1], Renellys C. Perez[2], Gregory R. Foltz[2], Michael J. Mcphaden[3], and Rick Lumpkin[2]

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[2]NOAA Atlantic Oceanographic and Meteorological Laboratory – United States
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**Abstract**

Thirty years (1993-2022) of concurrent satellite and in-situ observations reveal a long-term strengthening of the equatorial Pacific upper-ocean circulation. Enhanced southeasterly and cross-equatorial winds have caused an annual mean, basin-wide acceleration of the equatorial westward surface currents by ~20% and an acceleration of poleward flow north (south) of the equator by ~60% (~20%). Moored velocity data reveal a deepening of the Equatorial Undercurrent (EUC) core at 170∘W and significant shoaling at 140∘W and 110∘W, but no significant changes in EUC core velocity. This is because the strongest subsurface zonal velocity trends occur above the EUC core before and after the seasonal maximum of EUC core velocity. As a result, vertical current shear above the EUC core is enhanced.
Consistent with trends in EUC core depth, a significant basin-wide steepening of the equatorial thermocline is observed. This has implications for interannual variability, as previous studies found that a shallower thermocline in the eastern equatorial Pacific is associated with a decrease in El Nino Southern Oscillation (ENSO) amplitude in this region. Both the accelerating equatorial current system and the enhanced thermocline slope are consistent with an observed steepening of the zonal sea surface height gradient due to increased wind-driven westward mass transport at the surface.
Interestingly, during February-March, both surface and subsurface currents show eastward velocity trends, in contrast to westward surface current trends during the remainder of the year. We will discuss potential drivers of the boreal spring trend reversal, including an observed long-term increase in equatorial Kelvin wave activity as well as pronounced signatures of interannual to decadal variability due to ENSO and other modes of natural variability.

**Keywords:** Equatorial Pacific, ENSO, Decadal variability, Ocean observations, Upper ocean dynamics

*Speaker

# Tug of war between atmosphere and ocean in controlling ITCZ

Aixue Hu*[1], Guo Yaru[1], Gerald Meehl[1], Maria Molina[1,2], Hui Li[1], Nan Rosenbloom[1], and Gary Strand[1]

[1]National Center for Atmospheric Research [Boulder] – United States
[2]University of Maryland [College Park] – United States

**Abstract**

The meridional shift of the Intertropical Convergence Zone (ITCZ) in response to greenhouse gas–induced warming has a significant impact on both regional and global rainfall patterns. Changes in the Atlantic Meridional Overturning Circulation (AMOC) can modulate this ITCZ movement. By analyzing ERA5 reanalysis data, CMIP6 1% CO experiments, and a set of specially designed simulations using CESM2, we found that CMIP6 models exhibiting a southward shift of the ITCZ show better agreement with ERA5. Our analysis suggests that the weakening or collapse of the AMOC is a fundamental driver of this southward ITCZ migration. Results from CESM2 indicate that a collapsed AMOC can shift the rainfall maximum from north of the equator to the south in the absence of background warming. However, under greenhouse gas forcing with a weakened AMOC, the southward shift is much smaller. This implies that without AMOC weakening, greenhouse gas–induced warming-being stronger in the Northern Hemisphere-would have driven the ITCZ further northward. Therefore, the observed southward migration of the ITCZ in recent decades may serve as a potential indicator of AMOC slowdown.

**Keywords:** ITCZ, AMOC

*Speaker

# Impacts of Climate Change on the Tropical Pacific and El Niño Southern Oscillation

Matthew Collins*[1]

[1]University of Exeter – United Kingdom

**Abstract**

It is likely that climate change will alter the tropical Pacific atmosphere-ocean system with impacts around the globe. This talk will cover topics including the mean-state pattern of sea surface temperature (SST) change and the discrepancy between observations and models, physical processes responsible for uncertainties in future tropical Pacific SST patterns, and the impact of those mean-state SST pattern changes on rainfall in N. and S. America and the atmospheric circulation in the Southern Hemisphere. The talk will also discuss changes in the variability of the El Niño Southern Oscillation (ENSO) including the time of emergence of changes in the mean state and ENSO, the time of emergence of changes in the Walker Circulation, and changes in ENSO teleconnection patterns in North America and Europe.

**Keywords:** climate change, ENSO, tropical Pacific

*Speaker

# Nonlinear ENSO response to formation of a permanent El Niño-like state under persistent greenhouse warming

Tao Geng*[1]

[1]Laoshan Laboratory – China

**Abstract**

Under transient greenhouse warming, El Niño-Southern Oscillation (ENSO) is projected to increase pre-2100, accompanied by an easier establishment of atmospheric convection in the equatorial eastern Pacific, where sea surface temperature (SST) warms faster than surrounding regions. After 2100, how ENSO variability may change remains unknown. Here we find that under a high emission scenario, ENSO variability post-2100 reverses from the initial increase to an amplitude far smaller than that of the 20th century. The fast eastern warming persists and shrinks the equatorial Pacific non-convective area, such that establishing convection in the non-convective area, as during an El Niño, requires smaller convective anomaly, inducing weaker wind anomalies leading to reduced ENSO SST variability. The nonlinear ENSO response is thus a symptom of the persistent El Niño-like warming pattern. Therefore, the oscillatory ENSO impact could be replaced by that from the permanent El Niño-like mean condition with cumulative influences on affected regions.

**Keywords:** ENSO, greenhouse warming, permanent El Niño

*Speaker

# Emulating GCM Experiments with reduced-complexity models: Insights into tropical interbasin interactions

Kido Shoichiro*[1], Richter Ingo[1], Kosaka Yu[2], Tozuka Tomoki[3], Tokinaga Hiroki[4], and Chang Ping[5]

[1]Application Laboratory, Research Institute for Value-Added-Information Generation, Japan Agency for Marine-Earth Science and Technology – Japan

[2]Research Center for Advanced Science and Technology, The University of Tokyo – Japan

[3]Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo – Japan

[4]Research Institute for Applied Mechanics, Kyushu University – Japan

[5]Department of Oceanography, Texas AM University, College Station, Texas – United States

**Abstract**

The climate system is interconnected, meaning changes in one part of the world can influence weather and ocean patterns elsewhere. For example, variations in sea surface temperatures in the tropical Atlantic Ocean can impact conditions in the Pacific and Indian Oceans. Scientists often use complex computer models, called general circulation models (GCMs), to study these connections. However, these models require significant computational resources, making it difficult to explore a wide range of possibilities. In this study, we tested two simpler statistical models to see if they can replicate the results of GCM experiments. We found that these simpler models can reproduce key features of more complex simulations, particularly how changes in the tropical Atlantic influence other ocean regions. Using these models, we also examined how many simulations, or ensemble members, are needed to produce reliable results. We discovered that larger ensembles (more than 50 simulations) are necessary for consistent findings. This study shows that two simpler statistical models can help researchers understand climate interactions more efficiently. While they cannot replace complex GCMs, these simpler models can guide experiments and improve our ability to study the Earth's climate system.

**Keywords:** Tropical interbasin interaction, pacemaker experiment, linear inverse model

*Speaker

# Breakout Session 1: Climate, atmospheric processes, societal impacts

## Oral presentations

*Thursday, 25 Sept. 11:00-12:25*

# Remote Triggering of a North Pacific Marine Heatwave by the 2022 Indian Summer Monsoon

Chunzai Wang*[1]

[1]Chinese Academy of Sciences – China

**Abstract**

An unprecedented marine heatwave (MHW) struck the mid-to-high latitudes of the western North Pacific during the summer of 2022. We show that this extreme event in July was fueled by excessive precipitation occurring thousands of kilometers away. A persistent atmospheric blocking pattern developed over the MHW region, suppressing convection and cloud formation while increasing shortwave radiation reaching the ocean surface-ultimately driving sea surface temperatures higher. This blocking system was intensified by atmospheric disturbances triggered by latent heat release from intense precipitation associated with the Indian summer monsoon. These disturbances propagated as quasi-stationary Rossby waves, reinforcing the atmospheric conditions favorable for the MHW. We validate this mechanism using a numerical model driven by observed anomalous diabatic heating. Our findings highlight how an extreme subtropical event can trigger another extreme event at higher latitudes through a long-range atmospheric teleconnection.

**Keywords:** Indian Summer Monsoon, Marine Heatwave, Atmospheric Teleconnection

*Speaker

# Impacts of the unprecedented global marine heatwaves in 2023 and 2024

Katie Smith*[1] and Dan Smale[1]

[1]Marine Biological Association of the UK – United Kingdom

**Abstract**

Between 2023 and 2024, the global ocean experienced record-breaking marine heatwaves (MHWs), with sea surface temperatures reaching unprecedented levels. These events, driven by anthropogenic climate change and exacerbated by El Niño conditions and low cloud cover, had far-reaching consequences for physical oceanography, marine ecosystems, and coastal communities. The frequency and intensity of MHWs during this period led to cascading impacts-ranging from disrupted weather patterns and intensified storms to widespread coral bleaching, fish mortality, and socioeconomic losses in fisheries and tourism. Here, we synthesize observed physical, ecological, and societal impacts of the 2023–2024 MHWs, highlight case studies of successful interventions, and discuss barriers to action. We emphasize the urgent need to enhance forecast accuracy, build regional response plans, and accelerate the sharing of intervention outcomes. As ocean heat extremes become more frequent and intense, timely and coordinated global strategies are essential to mitigate impacts, build resilience, and safeguard marine systems and the communities that depend on them.

**Keywords:** Ocean extremes, societal impacts, biological impacts, physical impacts, forecasting, interventions

*Speaker

# Linking Large-Scale Climate Drivers to Hydroclimate Variability over South Asia

Satyaban Bishoyi Ratna*[1]

[1]Climate Research and Services, India Meteorological Department – India

**Abstract**

Understanding the influence of large-scale ocean-atmospheric interactions, such as the El Niño–Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD), on the South Asian summer monsoon has long been a critical area of research due to its far-reaching implications for regional hydroclimate extremes. Building upon earlier work on monsoon teleconnections, this study extends the analysis by linking these climate drivers to societal impacts through a focused assessment of hydroclimate variability over South Asia.

The study examines the relationship of ENSO and IOD with seasonal rainfall anomalies and the frequency and intensity of heavy precipitation events. It also explores key drought indices, including the Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI), to better characterize the spatial and temporal footprint of drought conditions. Notably, the contrasting monsoon outcomes during two strong El Niño years-1997 and 2015-are analyzed to highlight the complexity of teleconnections and the modulating influence of the IOD. While the 1997 monsoon remained near-normal due to a concurrent strong positive IOD, the 2015 monsoon was significantly deficient despite a similar El Niño magnitude, underscoring the need for multi-driver assessments.

The analysis is further extended to evaluate the skill of seasonal forecasts from the Copernicus Climate Change Service (C3S) models in predicting these hydroclimatic anomalies, helping to identify strengths and limitations in current predictive capabilities. By highlighting the predictability of hydroclimate extremes and their societal relevance-particularly in agriculture, water resources, and disaster risk reduction-this study contributes to the advancement of climate-informed planning and decision-making in South Asia.

**Keywords:** South Asian Monsoon, ENSO, IOD, Hydroclimate Variability, Climate Services, Societal Impact

*Speaker

# Impacts of regional aerosol forcing uncertainty on the simulated historical global warming

Harun Rashid*[1]

[1]CSIRO Environment – Australia

**Abstract**

Climate models with identical anthropogenic forcings simulate varying levels of historical warming, primarily due to the models' uncertain representations of aerosol forcings. Yet, the role of regional aerosol forcing in this simulation uncertainty has not been systematically studied. Here, using a large ensemble of CMIP6 models, I demonstrate that anthropogenic aerosol-forced North Atlantic (NA) surface temperature variability plays a significant role in modulating the greenhouse gas-driven global-mean warming in historical simulations, explaining about 7% of the ensemble-mean surface temperature change. However, its representation varies considerably across individual models. Consequently, models with high NA forcing often underestimate the anthropogenic global warming (and vice-versa), regardless of their climate sensitivities. This regional forcing uncertainty is organised into a coherent hemispheric pattern, with the largest uncertainties occurring near the aerosol source regions. Given the significant uncertainty in model simulations, our results highlight the importance of regional aerosol forcing in historical and potentially future warming.

**Keywords:** Climate models, global warming, multiple regression models, anthropogenic forcings, regional aerosol forcing

*Speaker

# Breakout Session 2: Ocean processes, modelling, observations, biogeochemistry

## Oral presentations

*Thursday, 25 Sept. 11:00-12:25*

# Advancing Ocean Observations for Climate Action: The Synergy of CLIVAR, GOOS, and GCOS

Sabrina Speich[1], Weidong Yu*[2], and Commetees Goos And Gcos[3]

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[2]Sun Yat-Sen University [Guangzhou] – China

[3]GOOS CCOS – IOC-UNESCO, World Meteorological Organization – France

**Abstract**

Understanding climate variability and change necessitates a robust, fit-for-purpose ocean observing system designed around scientifically-informed p riorities. The Climate and Ocean: Variability, Predictability and Change (CLIVAR) project significantly c ontributes t o this objective by identifying critical oceanic processes and regions influencing c limate dynamics, thereby providing essential scientific e vidence for t he s trategic p lanning of t he Global Ocean Observing System (GOOS) and the Global Climate Observing System (GCOS). In particular, CLIVAR research elucidates key phenomena such as ocean heat uptake, Atlantic Meridional Overturning Circulation (AMOC) variability, El Niño-Southern Oscillation (ENSO) dynamics, and coupled ocean-atmosphere interactions, clearly defining o bservational requirements and informing targeted deployment strategies, including autonomous observing platforms and sustained deep-ocean monitoring.

Conversely, the coordinated and systematically evaluated observational frameworks established by GOOS and GCOS ensure consistent, high-quality data availability, essential for CLIVAR-driven scientific r esearch. Examples include t he global Argo profiling float network, sustained moored buoy arrays, and satellite altimetry missions, which collectively support the monitoring of critical climate processes, enable validation and improvement of climate models, and facilitate the detection and interpretation of emergent climate signals.

Enhanced collaborations between CLIVAR science and GOOS/GCOS observing coordination are crucial for developing the scientific b asis n ecessary f or e ffective cl imate mitigation solutions, such as marine carbon dioxide removal (CDR), and robust national adaptation pathways. Such collaborations underpin scientifically i nformed d ecision-making i n critical sectors including coastal resilience planning, ecosystem conservation, fisheries management, and sustainable aquaculture practices. Moreover, CLIVAR contributes to a better rationalization of observing systems through Observing System Experiments (OSE), Observing System Simulation Experiments (OSSE), and innovative approaches leveraging artificial intelligence. By integrating scientific i nsights a nd a pproaches w ith s ystematic observations, CLIVAR and GOOS/GCOS together strengthen the global community's capacity to respond effectively t o c limate v ariability a nd c hange, e nhancing r esilience a nd f ostering sustainable adaptation strategies.

**Keywords:** observations, climate science, mitigation and adaptation

*Speaker

# Robust Yet Diverse Southern Ocean Teleconnection from Antarctic Meltwater: Insights from SOFIA

Xiyue Zhang[1], Ariaan Purich*[2], and Clara Deser[3]

[1]University of Nevada – United States
[2]Monash University – Australia
[3]NCAR – United States

**Abstract**

Southern Ocean sea surface temperatures (SSTs) have displayed multi-decadal variability over the past century. Previous studies have shown that observed Southern Ocean cooling and warming can impact tropical SST trends, which has implications for the pattern effect and climate sensitivity. The efficiency of the Southern Ocean teleconnection depends on processes such as the subtropical low cloud feedback. Here, we analyze simulations from the Southern Ocean Freshwater Input from Antarctica (SOFIA) Initiative, which allows us to examine the robustness of the SO teleconnection in multiple coupled climate models. In response to additional freshwater added around the Antarctic margins, all seven coupled climate models evaluated show negative SST anomalies that extend into the Northern Hemisphere and a northward shift of the Intertropical Convergence Zone. However, models vary in the magnitude of the Southern Ocean teleconnection, partly because the Southern Ocean cooling anomalies vary by a factor of three. Surface heat budget analyses shed light on the relative importance of shortwave cloud feedback, wind-evaporation-SST feedback, and ocean dynamics across models.

**Keywords:** Southern Ocean, Antarctic meltwater, Pacific

*Speaker

# Development of ECCO downscaled regional simulations of the Antarctic coastal seas

Yoshihiro Nakayama*[1], Park Taewook[2], Mattia Poinelli[3], and Shuntaro Hyogo[4]

[1]Dartmouth College [Hanover] – United States
[2]Korea Polar Research Institute – South Korea
[3]University of California [Irvine] – United States
[4]Hokkaido University [Sapporo, Japan] – Japan

**Abstract**

Warm ocean heat travels into ice shelf cavities and contributes to the melting and thinning of Antarctic ice shelves and thus Antarctica's contribution to sea level rise. While various mechanisms-such as winds, sea ice formation, and ocean circulation at multiple scales-play critical roles, there is no firm consensus about what has changed over the last century, what is driving the current ice shelf melting and ice loss, what are the regional differences, and what is going to happen in the future. Additionally, understanding the ocean's past, present, and future state-including its circulation, ecosystem dynamics, and carbon cycle-remains a critical research gap. The challenge is that the available observation is sparse and existing ocean models have difficulty in capturing realistic ocean.
In the Nakayama research group, we address these challenges by (1) utilizing ECCO (Estimating the Circulation and Climate of the Ocean) global ocean state estimates and (2) developing high-resolution regional ocean hindcast simulations. For example, our Amundsen-Bellingshausen Seas regional configuration successfully captures key oceanic features-from large-scale hydrographic structures to seasonal and interannual shifts in the thermocline. By achieving good agreement between model simulations and observations, we can infer critical processes in the real ocean despite the lack of observations, such as ocean heat intrusion pathways, the physical drivers of ice shelf melt, and the role of submesoscale variability.

In this talk, we will demonstrate how global and regional models provide powerful tools for addressing key scientific questions and uncovering regional differences in ocean hydrography, circulation, and the forces driving Antarctic ice shelf melting. Given that ECCO/MITgcm are user-friendly models with well-documented user guides and accessible configuration files and outputs, we will also showcase best practices for accessing simulated data, evaluating ocean models, and conducting comprehensive analyses, including sensitivity simulations and particle tracking.

**Keywords:** Antarctica, Southern Ocean, Continental shelves, ice, ocean interaction, modeling

*Speaker

# Physical processes and biological productivity in the upwelling regions of the tropical Atlantic

Peter Brandt*[1,2], Mareike Körner[3], James Normen Moum[3], and Marcus Dengler[1]

[1]GEOMAR - Helmholtz Centre for Ocean Research [Kiel] – Germany
[2]Faculty of Mathematics and Natural Sciences, Kiel University – Germany
[3]College of Earth, Ocean, and Atmospheric Sciences, Oregon State University – United States

**Abstract**

The eastern tropical Atlantic hosts highly productive ecosystems that are vital for local livelihoods-especially food security via fisheries-as well as for biodiversity and global climate variability, due to strong ocean-atmosphere interactions. While boundary upwelling has traditionally been viewed as primarily wind-driven, our recent studies reveal more complex mechanisms that may become increasingly important under climate change. Three distinct tropical upwelling systems exhibit strong seasonal cycles in sea surface temperature and productivity: the tropical Angolan upwelling system, the equatorial upwelling system, and the tropical NW African upwelling system.

The Angolan upwelling system is unusual in that it is not driven by local winds. Unlike the Benguela system farther south, where persistent alongshore winds drive strong upwelling, winds off Angola remain weak year-round. Instead, seasonal upwelling is forced by equatorial Kelvin waves-generated by winds in the western equatorial Atlantic-that form coastal trapped waves upon reaching the eastern boundary. Combined with tidal mixing on the shelf, these processes explain the timing of the productivity season, pointing to a degree of seasonal predictability.

The equatorial Atlantic upwelling system is wind-driven but involves multiple processes operating on different timescales. Zonal mass redistribution, triggered by zonal winds, causes upwelling in the eastern basin. Mixing in the shear zone above the Equatorial Undercurrent (EUC) is linked to diurnal surface warming and a surface jet that propagates downward during the day. The EUC itself shifts vertically in response to a resonant wave mechanism driven by seasonal winds. Together, these processes shape the seasonality of biological productivity. Their individual responses to warming may critically affect the system's future evolution.
Looking ahead, we will present **FUTURO**-a year-long, coordinated, multi-platform, and multidisciplinary observational campaign in the NW African upwelling system, planned for 2028 (https://futuro-campaign.org).

**Keywords:** tropical upwelling systems, tropical Atlantic, biological productivity

*Speaker

# Breakout Session 3: Indo-Pacific Ocean, Climate, and Linkage

## Oral presentations

*Thursday, 25 Sept. 11:00-12:25*

# Indonesian Throughflow Monitoring Program: Past, Present, and Future

Raden Dwi Susanto*[1]

[1]University System of Maryland – United States

**Abstract**

Knowledge of the Pacific to Indian Ocean Exchange through the Indonesian seas is essential for understanding the role of the ocean in Earth's climate system. The Indonesian seas, with their complex geography and narrow passages, provide the only pathway for low-latitude Pacific water to flow into the Indian Ocean, known as the Indonesian Throughflow (ITF). The ITF plays an integral role in global ocean thermohaline circulation, impacting mass, heat, and freshwater budgets and influencing ENSO and monsoon. ITF is also important for downstream biogeochemistry, ocean heat-content variability in the Indian Ocean, input and constraints for ocean-climate models. In the past, the main throughflow passages have been monitored but over different years, and for varied lengths of time, making it impossible to assemble a simultaneous picture of the multiple corridors of the ITF. We will give an overview of the last three decades of the ITF monitoring programs, such as Arlindo Circulation, INSTANT, MITF, SITE, MOMSEI and JUV, and TRIUMPH.

Even though ITF has been measured for the last three decades, no detailed measurements of full depth variability have been done, nor has its impact on mixing and upwelling along the eastern tropical Indian Ocean been investigated. This absence of data represents a significant gap in our understanding of the role of this shallow chokepoint in regulating the inter ocean exchange, air-sea interactions, and water-mass transformation. It is essential to have detailed simultaneous measurements of the ITF, mixing, and upwelling. We have developed an international collaboration among scientists from the National Re-search and Innovation Agency, the First Institute of Oceanography-China, and the University of Maryland that has culminated in a program called TRIUMPH (**Th**ro**R**oughflow **I**ndonesian seas, **U**pwelling, and **M**ixing **PH**ysics). Update on the latest cruise in September-October 2024 and future plans will be discussed.

**Keywords:** Indonesian throughflow, upwelling, mixing, interocean exchange, heat and freshwater budgets

*Speaker

# Drivers of Indo-Pacific upper ocean heat and freshwater variability: A synthesis of coral proxies and ocean models

Sujata Murty*[1,2], Caroline Ummenhofer[2], Janet Sprintall[3], Shouyi Wang[2,4], Laura Gruenburg[5], Arne Biastoch[6], and Claus Böning[6]

[1]University at Albany [SUNY] – United States
[2]Woods Hole Oceanographic Institution – United States
[3]Scripps Institution of Oceanography – United States
[4]MIT-WHOI Joint Program in Oceanography/Applied Ocean Sciences Engineering – United States
[5]Stony Brook University [SUNY] – United States
[6]GEOMAR Helmholtz Centre for Ocean Research Kiel – Germany

**Abstract**

The Maritime Continent provides pathways for heat and freshwater transport from the Pacific to the Indian Ocean, serving as an important oceanic connection for Indo-Pacific climate. Yet, the short length of robust observational datasets limits examination of past Indo-Pacific Warm Pool variability and the resulting implications for regional climate. Coral geochemical proxy records allow insights into variability on seasonal to multi-decadal timescales prior to the period of satellite and *in situ* observations. Here, we synthesize published coral $\delta$18O records, *in situ* observations, and ocean variability (salinity, temperature, thermocline depth, heat content) from the Nucleus for European Modeling of the Oceans (NEMO) ocean model simulations to explore drivers of seasonal to multi-decadal variations across the Indo-Pacific Warm Pool. This proxy-model synthesis allows for examination of thermohaline properties along key oceanic pathways associated with variations in the Interdecadal Pacific Oscillation. The proof-of-concept provided by these results suggest that the paleoproxy records capture important features of regional hydrography and the associated variability in upper ocean heat and freshwater. Such proxy-model comparison at a broader spatial scale is critical for understanding the drivers of variability related to changes in Indo-Pacific oceanic teleconnections over recent centuries and provides important context for projecting future changes in the region.

**Keywords:** Coral, Indonesian Throughflow, Maritime Continent, Interdecadal Pacific Oscillation, Paleoclimate, Ocean model

*Speaker

# Tropical basin interactions in changing climates since the Last Glacial Maximum

Yuko Okumura*[1], Jin-Sil Hong[1], and Jud Partin[1]

[1]University of Texas at Austin [Austin] – United States

**Abstract**

To understand how changing climates affect the El Niño-Southern Oscillation (ENSO) and its interactions with the tropical Atlantic and Indian Oceans, we analyze a suite of multi-century timeslice simulations conducted with the Community Earth System Model version 1.2. The model is run with boundary conditions and radiative forcings from the Last Glacial Maximum (21 ka) to preindustrial (0 ka) at 3 ka intervals, as well as a doubling of 0 ka CO2 for a future climate scenario. In the glacial and deglacial simulations (21-12 ka), reduced greenhouse gases and boreal fall-winter equatorial insolation strengthen and expand the Pacific cold tongue. With this background state change, ENSO weakens considerably compared to 0 ka (26-53%), exerting less impact on the Atlantic and Indian Oceans. While changes in Atlantic and Indian Ocean variability differ across the glacial-deglacial simulations, the weaker ENSO consistently becomes less sensitive to variability in these remote oceans, resulting in diminished tropical basin interactions. In the CO2 doubling simulation, by contrast, both ENSO and its interactions with the Atlantic and Indian Oceans significantly strengthen. It is suggested that changes in the tropical Pacific background state controlling ENSO amplitude also modulate the sensitivity of ENSO to remote oceanic influences. These results have important implications for interpreting past tropical basin interactions based on paleoclimate proxy records and predicting future changes.

**Keywords:** tropical basin interaction, ENSO, climate change, paleoclimate

*Speaker

# Interactions between Pacific and Indian Ocean interannual variability

Malte Stuecker*[1]

[1]International Pacific Research Center (IPRC) Department of Oceanography, School of Ocean and Earth Science and Technology (SOEST), University of Hawaii at Mānoa, Honolulu – United States

**Abstract**

The El Niño-Southern Oscillation (ENSO) is the dominant mode of variability in the tropical Pacific, whereas the two leading patterns of variability in the Indian Ocean are the Indian Ocean Dipole (IOD) and the Indian Ocean Basin Mode (IOBM). How climate variability in these two tropical oceans interact with each other and what implications this has for both seasonal predictability and future climate projections remains an active area of research and is one key focus of the CLIVAR TBI RF. Major challenges for obtaining robust assessments on the dynamical nature of Pacific-Indian Ocean climate interactions can be traced to two key issues: First, statistical inferences have been hindered by a relatively small sample size due to the interannual timescale of the phenomena in the context of observations that only span several decades. Second, pronounced biases in the representation of the dynamical processes in tropical climate variability as well as the tropical climate mean state in state-of-the-art climate models make the interpretation of simulated Indo-Pacific climate interactions challenging. Here I will provide an overview of recent hypotheses related to Indo-Pacific climate interactions as well as discuss potential pathways for (i) improving dynamical understanding of Indo-Pacific climate, (ii) improving the skill of Indo-Pacific seasonal climate predictions, and (iii) reducing the uncertainty of Indo-Pacific future climate projections.

*Speaker

# Atmospheric Processes and Climate Dynamics

## Poster presentations

*Session 4*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# Introducing TBIMIP: The Tropical Basin Interaction Model Intercomparison Project

Ingo Richter*[1], Shoichiro Kido[1], Tomoki Tozuka[2], Yu Kosaka[2], Ping Chang[3], and Hiroki Tokinaga[4]

[1]Japan Agency for Marine-Earth Science and Technology – Japan
[2]University of Tokyo – Japan
[3]Texas AM University [College Station] – United States
[4]Kyushu University – Japan

**Abstract**

The tropical ocean basins can communicate with each other through both atmospheric pathways, such as Rossby and Kelvin waves, and oceanic pathways, such as the Indonesian Throughflow. This mutual influence, referred to as tropical basin interaction (TBI), may have profound implications for the variability of the climate system at intraseasonal to interdecadal time scales, and may also shape the way the climate system responds to external forcing. TBI has received substantial attention in recent years, but progress is hampered by the relatively short observational record on the one hand, and climate model biases and inconsistent experimental protocols on the other. One of the major activities of the CLIVAR Research Focus on TBI has been to develop, in collaboration with various international modeling centers, an experimental protocol for a coordinated set of climate model experiments (TBIMIP) to analyze the pathways of TBI and to quantify their relative importances. These experiments have now been completed by several global climate models.
Here, I will give an overview of some initial results of TBIMIP and discuss their implications. In addition, I will discuss potential follow-up experiments suggested by the outcome of TBIMIP, and present statistical approaches that may be used to augment the output from existing global climate model experiments, such as TBIMIP and CMIP.

**Keywords:** interbasin interaction, global climate models, statistical models, TBIMIP

*Speaker

# Land surface feedback and rainfall bias in the dynamical models with different physical parametrizations

Pratibha Gautam*[1], Rajib Chattopadhyay[1], Susmitha Joseph[1], and Atul Kumar Sahai[1]

[1]Indian Institute of Tropical Meteorology – India

**Abstract**

Proper representation rainfall and soil-moisture feedback in the dynamical model is crucial for weather and climate forecasts. The biases in rainfall and soil moisture, as well as their relationship, are investigated during the strong active phase using different physical parameterizations in both the CFS (Climate Forecast System) model and the CFS free run.The model's seasonal and sub-seasonal features of rainfall and soil moisture are different from the observation. Feedback between soil moisture and precipitation is not correct in the models. The reason for the strong correlation between the rainfall and soil -moisture in the CFS model is that maximum soil moisture and maximum rainfall occur simultaneously in the same region. This suggests a direct relationship between rainfall and soil moisture in the model more rainfall leads to more soil moisture over the same region. The bias plots of rainfall and soil moisture indicate that changing the microphysics or convection schemes does not significantly impact the biases in soil moisture or other land surface-related parameters. From the skill analysis during strong active days, we found that the skill of soil moisture and 2-meter temperature almost similar across each lag day for all physics combinations. The model skill decreases as the active days (day 0) extends further from the initial conditions in each physics combination. We observed that incorrect treatment of soil texture properties, which lead to error in the soil -moisture pattern in the model further leads to error in the evaporation, and other surface related parameters can weaken the feedback loop that typically establishes a lead-lag relationship.

**Keywords:** Climate Forecast System, soil texture, pre, condtioning

*Speaker

# Modulation of Diurnal Rainfall Cycle by BSISO during Boreal Summer over western part of Indonesia and Southeast Asia

Donaldi Permana*[1] and Nurdeka Hidayanto[1]

[1]Indonesian Agency for Meteorology, Climatology and Geophysics – Indonesia

**Abstract**

The Boreal Summer Intraseasonal Oscillation (BSISO) is the dominant mode of intraseasonal variability in tropical rainfall on the large scale during MJJAS. The characteristic of the BSISO during its propagation through the tropical Asia has always been a challenge, particularly the modulation of diurnal rainfall cycle during different BSISO phases over western part of Indonesia and Southeast Asia (SEA). Aiming to investigate the modulation of diurnal rainfall cycle by BSISO during MJJAS (boreal summer) in Western Indonesia, remote sensing derived rainfall data GPM IMERGv07 Final Run, Half-Hourly during MJJAS 2010 - 2023 (2028 days; 14 years) with spatial resolution 0.1º have been utilized.The results suggest the existing interaction between BSISO and diurnal rainfall cycle at western Indonesia and SEA. Typically, high precipitation rates occurs varyingly between afternoon and midnight. The further inland, high precipitation rates shifts to between night and early morning (particularly, over Borneo). In Sumatra and parts of Borneo, hourly precipitation enhanced (suppressed) during BSISO phase 1-3 (5-7) by ~ 2-folds. At eastern Borneo, hourly precipitation enhanced (suppressed) during phase 4-6 (1-3), particularly between night and early morning. This results could benefit forecasters in understanding the interaction between BSISO to diurnal rainfall cycle during regional extreme precipitation events at subseasonal to seasonal (S2S) time scale.

**Keywords:** BSISO, western Indonesia, diurnal rainfall cycle

*Speaker

# The influence of intraseasonal oscillations on rainfall variability over Central Africa: case of the 25–70 days variability

Claudin Wamba Tchinda*[1], Tchakoutio Sandjon Alain[2], Derbetini A. Vondou[1], Angennes Lucie Djiotang Tchotchou[1], Audryck Nzeudeu Siwe[1], and Armand Nzekou[3]

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[3]Laboratory of Industrial Systems and Environmental Engineering, Fotso Victor University Institute of Technology, University of Dschang, Bandjoun, Cameroon. – Cameroon

**Abstract**

The influence of intra-seasonal oscillations (ISO) on rainfall in Central Africa (CA) during the March–May (MAM) season is assessed using the National Oceanic and Atmospheric Administration Climate Prediction Center daily gridded rainfall data. ISO indices are defined using the time series analysis of the first two principal components resulting from the empirical orthogonal function, applied to daily filtered outgoing longwave radiation. Based on these indices, a total of 71 strong Intraseasonal
Events (SIEs) and 66 weak Intraseasonal Events (WIEs) were selected using threshold method. The results show that SIEs are associated with enhanced rainfall conditions over almost all the study area, while WIEs provide a meridional dipole-like rainfall pattern, consisting of increasing precipitation in the western part and decreasing in the eastern part of CA. The relationship with Madden–Julian Oscillation (MJO) was also examined. The positive rainfall anomalies associated with MJO phases progress eastward and are modulated by the 850 and 200 hPa horizontal wind. The circulation, linked to geopotential height anomalies at lower layers, tends to strengthen (reduce) the convective activity over the region during extreme ISO events and for the MAM season throughout the study period. Uncentered pattern correlation was further used to assess the link between ISO and MJO phases during the MAM season and we found a correlation of 0.5 in precipitation anomalies between phases 1 and 2 of the MJO and the SIEs; – 0.4 and – 0.6 between phases 5 and 6 and the SIEs respectively, suggesting a strong relationship between ISO events and MJO.

**Keywords:** Madden, Julian Oscillation, Central Africa, intra, seasonal variability, rainfall

*Speaker

# Modelling the extreme rainfall and land use land cover change induced flood hazard vulnerability in the north-eastern region of Bangladesh

Md. Anowarul Islam*[1] and Toru Terao[2]

[1]Shahjalal University of Science and Technology – Bangladesh
[2]Kagawa University – Japan

**Abstract**

The floodplain area in the north-eastern region of Bangladesh has significant agro-ecological importance to the regional as well as national economy, which is highly vulnerable to flood hazards. The contribution of different factors to flood hazards, such as human activities, changes in land use and drainage density, are well investigated. However, as an emerging factor, the contribution of extreme rainfall to the flood hazard in this region remains unknown. There is also a lack of adoption of the proper techniques such as GIS and Remote Sensing (RS) for modelling the flood hazard vulnerability in this region. This study aimed to investigate the impact of extreme rainfall on flood hazard vulnerability using GIS and RS techniques. The fine resolution satellite data with the adoption of analytical hierarchy process (AHP) and multi-criteria decision analysis (MCDA) for flood hazard modelling using GIS and remote sensing are used. The investigation shows that during extreme rainfall events, the upstream receives plenty of rainfall, and the runoff of this huge rainwater enhances the flood hazard vulnerability in the downstream of the study area. The high vulnerability with low drainage was also noticed during the flood mapping. Around 72% area is highly vulnerable to extreme rainfall-induced flood hazards. It was also addressed that in comparison with other factors, the extreme rainfall is the key factor and that it acts as a trigger force to enhance the flood hazard vulnerability in this region. Therefore, modelling the flood hazard to control and reduce vulnerabilities in north-eastern Bangladesh has significant priorities for flood management in regional aspects as well as the national level. It is expected that the findings can help with proper mapping of the flood hazard vulnerability and to address the flood risk mitigation strategies that can minimize the devastating impacts of floods on lives and properties.

**Keywords:** Extreme rainfall, Flood hazard, Vulnerability, Bangladesh

*Speaker

# Long-term rainfall variability along the west coast of India and its teleconnections

Busnur Manjunatha*[1], Jithin Jose[2], Prashantha Kumar[2], and Hk Ramaraju[3]

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**Abstract**

The west coast of India and the adjoining Western Ghats are principal watershed areas for both west-flowing as well as east-flowing rivers of the Peninsular India. The long-term variability of the seasonal and interannual rainfall (145 years) along the northern Konkan and Goa Coast, the central Karnataka Coast, and the southern Kerala Coast has been studied along with tele-connecting forces. The results indicate an increasing trend in the annual rainfall was observed in the former sector, no change in the middle sector, whereas a decreasing trend in the latter sector. This is due to the impact of desert dust in the troposphere that intensifies convection in yielding high rainfall, particularly in the former sector. This is accelerating in recent years in the scenario of global warming. The Principal Component Analysis (PCA) of data and atmospheric/ocean teleconnections indicates that the rainfall of the Konkan-Goa and Karnataka Coasts are prominently influenced by the Southern Oscillation Index (SOI). The Niño 3.4 temperature in the Central Pacific Ocean during the summer and SOI during the winter season inversely affect the rainfall of the Konkan-Goa and Karnataka Coasts, with the exception of summer rainfall along the Kerala Coast. In addition to the dominance of the SOI on the summer monsoon rainfall of the Konkan and Goa Coastal region, the influence of NE Atlantic temperature during the winter, spring, and summer seems significant. The dominance of the SOI on the summer monsoon rainfall of the Konkan and Goa Coastal regions clearly noticed, however, the influence of NE Atlantic temperature during the rainfall of the winter, spring, and summer seems significant. However, this is inversely related to the Arctic Oscillation during the winter and Azores High during the Spring season, suggesting that the North Atlantic temperature induces rainfall over Konkan and Goa during the summer monsoon season.

**Keywords:** Long-term rainfall trend, SST links, global and regional teleconnections, Indo, Pacific and North Atlantic tele-links

*Speaker

# Ocean-Climate Observations and Modelling

## Poster presentations

*Session 5*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# Regional water mass transformation due to global climate change

Emil Stanev*[1]

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**Abstract**

Data from profiling floats over the last 15 years (more than 6,000 profiles) show a significant change in the water masses in the Black Sea. The warming trend in the Cold Intermediate Layer (CIL) of _˜0.05 ∘C/year was more than double that of previous decades. The temperature in the core of this water mass approached that of the water in the deeper layers (_˜9 ∘C), which meant its disappearance. This evolution was due to the warmer winters, which limited the efficiency of water formation events (only three significant events during the studied period). In the absence of a pronounced CIL, the relative role of salinity variability in the thermohaline state of the upper layers increased: the density ratio decreased three times during the last 15 years. The changes in the surface and intermediate water masses, as well as the change in the thermohaline properties of the Bosphorus inflow, largely affected the regime of the deep thermohaline intrusions. The warm intermediate layer and the deep cold intermediate layer showed strong trends caused by the increasing trends in the intensity and frequency of warm intrusions. Such trends can affect nutrient cycling, oxygen distribution and the overall stability of the water column, thereby affecting biogeochemical cycles and the resilience of marine ecosystems. Recent Argo observations have challenged the conventional view of stagnant intermediate and deep Black Sea waters, revealing active mixing processes reshaping the thermohaline structure. This strong regional change in water masses can be seen as a precursor to the changes expected in the larger oceans.

**Keywords:** Profiling floats, water masses, thermohaline intrusions

*Speaker

# Diffusive and Adiabatic Meridional Overturning Circulations in the Cooling Abyss of the Indo-Pacific Ocean

Lei Han*[1]

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**Abstract**

Recent field campaigns have consistently documented bottom-intensified mixing near the seafloor, suggesting diabatic downwelling in the abyssal ocean. This phenomenon appears to contradict with the mass balance of the abyssal ocean, where dense bottom water plunges into the region from the Antarctic side. Previous studies have sought to resolve this apparent paradox by proposing mixing-induced diabatic upwelling along bottom slopes. In contrast, this study offers an alternative perspective, highlighting the role of isopycnal displacement in the transient abyss. Motivated by emerging evidence of a cooling phase in the abyssal Indo-Pacific, likely linked to the last Little Ice Age, this study reinterprets the interior-downwelling paradox from the perspective of unsteady thermal states. Idealized numerical experiments were conducted to explore the abyssal overturning dynamics, with a focus on the behavior of advective, adiabatic, and diffusive overturning circulation streamfunctions in both cooling and warming scenarios. The results reveal that while the direction of diabatic overturning (upwelling or downwelling) depends on the transient state of the ocean, advective overturning circulation consistently exhibits an upwelling pattern, underscoring the inherent robustness of upward water parcel movement within abyssal dynamics.

**Keywords:** bottom ocean cooling, meridional overturning circulations, abyssal upwelling, abyssal recipes

*Speaker

# Study of the Depth of Thermocline (DOT) Based on Planktonic Foraminifera Abundance During the Younger Dryas Period in the Makassar Strait

Rima Rachmayani*[1], Muhammad Abyan Nauli Harahap[1], and Marfasran Hendrizan[2]

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[2]National Research and Innovation Agency of the Republic of Indonesia – Indonesia

**Abstract**

The Younger Dryas (YD) represents a phase within the Last Deglaciation, characterized by a cooling event that followed a warming period during the Last Glacial Maximum (LGM); signifies a cold event in the Northern Hemisphere (NH) and a warming event in the Southern Hemisphere (SH), encompassing the tropical region of Indonesia. This research seeks to elucidate paleoceanographic conditions in the Makassar Strait during the YD period, employing planktonic foraminifera as a proxy. This study analyzes changes in sea surface temperature (SST), the relative abundance of planktonic foraminifera assemblages, their impact on the depth of the thermocline (DOT), and the intensity of the Indonesian throughflow (ITF). This study presents an average SST of 28.21∘C, with a change of 0.64∘C, indicating an upward trend associated with a warming period in the SH. The fluctuations in DOT during the YD period were identified through relative changes in planktonic foraminifera. The percentage of foraminifera residing in the mixed layer ranged from 46.34% to 67.17%, with an average of 55.4%. In contrast, foraminifera in the thermocline layer varied from 32.82% to 53.66%, averaging 44.57%. These findings indicate a relatively deeper DOT during the YD compared to the previous deglaciation period. A detailed examination of the YD period reveals that fluctuations in the $\delta$18O record occur, specifically deepening and shallowing, in relation to significant events during the YD. These events include the onset of the YD in tropical regions, the weakening of the El Niño-Southern Oscillation (ENSO), and the termination of the YD period. The ITF intensity was analyzed using the Log (Zr/Rb) value, which indicated an increase in ITF intensity during the YD. However, the Log(Zr/Rb) proxy does not fully align with other proxies, such as thermocline-dwelling foraminifera, SST, and Mg/Ca. This suggests the presence of an additional factor impacting the low value of Log(Zr/Rb).

**Keywords:** Younger Dryas (YD), planktonic foraminifera, depth of thermocline (DOT), Makassar Strait, Indonesian throughflow (ITF)

*Speaker

# A Fully Coupled High-Resolution Ocean-Atmosphere Model around the Lombok Strait

Nafiis Abdillah Akram[1], M.d. Bitya[2], N.j. Trilaksono[3], and Aditya R. Kartadikaria*[4]

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[3]Research Group of Atmospheric Science, Faculty of Earth Sciences and Technology, Bandung Institute of Technology – Indonesia

[4]Research Group of Environmental and Applied Oceanography, Bandung Institute of Technology – Indonesia

**Abstract**

Ocean-atmosphere coupled model is a numerical approach that integrates ocean and atmospheric models into a unified system, enabling two-way information exchange throughout the simulation. Within this framework, atmospheric forcing parameters in the ocean model are directly derived from the atmospheric component, meanwhile sea surface temperature (SST) is dynamically coupled from the ocean to the atmosphere, establishing a fully interactive feedback system. Despite these advantages, the implementation of coupled models remains limited in Indonesian Waters, particularly in the Lombok Strait region. In this study, a coupled modeling system was developed by integrating MITgcm as the ocean model and WRF as the atmospheric model through the Earth System Modeling Framework (ESMF). Simulations were performed for the period January 2004 to February 2005, with a primary focus on evaluating the model's performance in representing SST. The results indicate that the coupled model significantly reduces the 1.52∘C warm bias observed in the uncoupled simulation. Significant reduction effects are pronounced in coastal zones and topographically constrained areas that are highly responsive to atmospheric interactions. Comparison against MODIS Aqua satellite data confirms that the coupled model generates SST spatial distributions that align more closely with observations. These findings demonstrate that coupled systems enhance the accuracy of numerical simulations.

**Keywords:** MITgcm, WRF, ESMF, Lombok Strait, SST

*Speaker

# A new ocean regional projection dataset with 10 km resolution for the North Pacific d4PDFv2-Ocean and its application to coastal downscale modeling around Japan

Shogo Urakawa*[1], Hideyuki Nakano[1], Takahiro Toyoda[1], Kunihiro Aoki[1], Yuma Kawakami[1], Norihisa Usui[1], Nariaki Hirose[1], Toru Sugiyama[2], Masao Kurogi[2], Shiro Nishikawa[2], Kei Sakamoto[3], Yusuke Ushijima[4], and Hiroyuki Tsujino[1]

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[2]Japan Agency for Marine-Earth Science and Technology – Japan
[3]Division of Earth and Planetary Sciences, Kyoto University – Japan
[4]Center for Marine Environmental Studies, Ehime University – Japan

**Abstract**

Japan Agency for Marine-Earth Science and Technology and Meteorological Research Institute/Japan Meteorological Agency have been creating multiple ocean projection datasets for the North Pacific for the past decade, and are now challenging to release a new dataset d4PDFv2-Ocean. Here we use a one-way-offline-nested ocean model coupling a global one and a North Pacific one with horizontal resolutions of 100 km and 10 km, respectively. This model is driven by atmospheric forcing produced with a climate projection system based on MRI-ESM2. This system is an atmosphere-ocean coupled model but its ocean temperature and salinity are nudged to reference states with a timescale of 10 days. The reference states consist of monthly climatology from 1961 to 2020, intrinsic internal variability, and externally forced variability extracted from a CMIP6 experiment. This special treatment is intended to include interactions between atmosphere and ocean in shorter time scales than 10 days but remedy atmospheric model biases induced by using predicted SST from the ocean model instead of using prescribed SST. We consider 6 patterns for the internal variability and use 6 CMIP6 models for the externally forced variability. That means we have "multi-model flavored" atmospheric forcing datasets with 36 members. Now we have finished ocean projection calculations of 24 ensemble members under the SSP2-4.5 scenario. This presentation shows preliminary results from these large ensemble experiments for the North Pacific, especially focusing on the ocean states around Japan. We also discuss its application to further downscaling in the coastal areas of Japan.

**Keywords:** regional ocean climate projection, OGCM

*Speaker

# Ocean modelling for climate research: the role of the CLIVAR OMDP

Dorotea Iovino*[1], Manita Chouksey[2], and Omdp Members[3]

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[2]Leibniz-Institut für Ostseeforschung Warnemünde – Germany
[3]Clivar OMDP – United States

**Abstract**

The CLIVAR Ocean Model Development Panel (OMDP) plays a central role in advancing the development of ocean models to enhance our understanding of the ocean's role in the climate system. The panel stimulates the development of innovative ocean model frameworks and promotes cross-community collaboration through workshops and shared scientific activities, such as the Polar Heat workshop (planned for winter/spring 2026), co-organised with other CLIVAR panels, which fosters interdisciplinary discussion around polar ocean processes.
A key focus of the panel is the systematic exploration of how various model process representations and parameterisation schemes influence ocean dynamics through coordinated sensitivity and multi-model intercomparison studies, such as the Ocean Model Intercomparison Project (OMIP). In this context, OMDP also supports the development of the ERA5-driving ocean reanalysis to provide standardised atmospheric forcing for global ocean model simulations, enabling consistent and comparable experiments across modelling centres.
The panel also leads efforts in validating ocean models, both in standalone ocean-only configurations and in fully coupled systems, using satellite and in-situ measurements, and reanalysis products. Additionally, it offers guidance on observational requirements essential for improving model realism and constraining key processes. Recognising the importance of scientific exchange, the panel fosters collaboration among global and regional ocean modelling communities, promoting knowledge sharing and the development of best practices. This includes the strengthening of synergies with the CORDEX community through the joint task force on Regional Ocean Climate Projections. Through webinars, workshops, and working groups, the OMDP provides a platform for sharing knowledge in ocean modelling, from process-based approaches to emerging tools such as machine learning and data-driven techniques.

**Keywords:** ocean modelling, process, based/ML approaches, OMIP

*Speaker

# Seasonal and Interannual Variability of Freshwater Flux in the Labrador Coastal Current: Insight from OSNAP Mooring Data

Md Shahadat Hossain*[1] and Frederic Cyr[2]

[1]NF-POGO Centre of Excellence, Ocean Frontiers Institute, Dalhousie University – Canada
[2]Center for Fisheries and Ecosystem Research (CFER), Fisheries and Marine Institute of Memorial University of Newfoundland and Labrador – Canada

**Abstract**

Ocean circulation plays a significant role in regulating the Earth's climate by redistributing heat around the globe. There are few places on Earth where the ocean currents experience an intense exchange of heat, nutrients, carbon, and oxygen. The subpolar North Atlantic (SPNA) is such a place where warm, salty currents exchange heat with the atmosphere, become cold and dense, and eventually sink and travel southwards. The phenomenon of this overturning circulation is negatively impacted by the warming trend of global temperature. Studies found that the overturning is at its weakest point in the past 1600 years. Climate change is accelerating the melting of Arctic and Greenland ice, which is adding freshwater to the SPNA. The addition of excessive freshwater is causing stratification in the water column, limiting deep water formation, and ultimately slowing down the overturning in the SPNA. This study aims to investigate the seasonal and interannual variability of freshwater flux (FWF) in the Labrador coastal current (LCC) from 2020-2024. Data from the Overturning in the Subpolar North Atlantic (OSNAP) morning CSI was utilized to estimate the FWF and its variability. This study suggests a strong seasonal signal in freshwater flux, interannual variability. Current velocity and upstream freshwater sources influenced the interannual variability of FWF. FWF estimations in the LCC have been limited in OSNAP. This study aims to fill the knowledge gap and provide a quantitative analysis of FWF in this region. The results of this study will significantly improve the understanding of the overturning in the SPNA and will also provide valuable insights into the variations in salinity in the SPNA.

**Keywords:** Freshwater content, OSNAP, Atlantic Meridional Overturning Circulation (AMOC), Ocean freshening, Salinity anomaly.

*Speaker

# Biogeochemical Processes and Climate Interactions

## Poster presentations

*Session 3*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# Significant Intraseasonal Variability of Surface Chlorophyll-a in the Western Pacific Western Boundary Current System

Hui Zhou*[1], Xueqi Liu[1], and Shuo Wang[1]

[1]Institute of Oceanology, Chinese Academy of Sciences [China] – China

**Abstract**

Satellite ocean color data reveal that the Western Boundary Current System of the Western Pacific, despite being at the ENSO origin, exhibits surface chlorophyll-a variability predominantly driven by intraseasonal signals rather than interannual or seasonal changes. Spatially, these signals are most pronounced in three key areas: the North Equatorial Current (NEC) bifurcation zone, the North Equatorial Counter Current (NECC) source region, and the New Guinea Coastal Current/Undercurrent (NGCC/NGCUC) region.
In the NEC bifurcation zone, intraseasonal signals account for 30%-40% of the variance in surface chlorophyll-a, influenced chiefly by EKE and MJO. This oligotrophic region, marked by salinity fronts and serving as the sole spawning ground for Japanese eels near 140∘E, likely experiences significant impacts on eel growth and catch quantities in East Asia due to these strong intraseasonal variations.

Similarly, in the NECC source region, intraseasonal signals explain 30%-45% of the vari-ance. Here, EKE-driven intraseasonal variations are linked to the meander path and active mesoscale eddies of the NECC, resembling the Kuroshio Extension with its strong eastward inertial jet. The $\beta$-effect enables even weak curved jets to transfer energy to eddies via instability, thereby modulating the intraseasonal variability of surface chlorophyll-a.
In the NGCC/NGCUC region, the intraseasonal signal explains over 40% of the variance near the boundary, primarily influenced by MJO-related wind fields.

**Keywords:** Intraseasonal variability, Chlorophyll, a, western boundary current system, MJO

*Speaker

# Impact of Satellite Chl-a and Other Physical Parameters on Deriving Reliable Export Production Estimates over Indian Ocean.

Aditi Deshpande*[1], Gayatri Uchale[1], Rama Aslekar[1], Smitha R[2], and Vinu Valsala[3]

[1]Savitribai Phule Pune University – India
[2]SAC-ISRO – India
[3]Indian Institute of Tropical Meteorology – India

**Abstract**

The Arabian Sea is a highly productive coastal upwelling system characterized by phytoplankton blooms both in summer (western part) and winter (northern part). In this study, the daily (or 3-daily) surface ocean Chla parameter is utilised for the calculation of compensation depth (Zc). The Ocean Tracer Transport Model is forced using GFDL MOM-4 data and reanalysed chlorophyll data. A comparison shows an increase in compensation depth during ON and DJF, with maximum depth in the southern Indian Ocean. Model run using reanalysed chlorophyll shows deeper compensation depth than that using GFDL chlorophyll. In the reanalysis data, the compensation depth maxima occurs closer to Madagascar, whereas in GFDL the maxima is situated south of the Southern Indian Ocean (for the months of DJF and ON). There is a clear overestimation of the compensation depth (larger mean value) in the run forced with reanalysed chlorophyll data as compared to GFDL. In addition, new production and export production values have also been analysed. The comparison of variability of export production and new production shows distinct differences in patterns between model run forced by GFDL chlorophyll data and reanalysed chlorophyll data. However, the first two principal component series of export production and new production over Arabian Sea, Bay of Bengal and Southern Ocean have low values of correlation with modes of variability such as El Niño and Indian Ocean Dipole.

*Speaker

# A Strategic Approach to Marine Protected Areas Based on Larval Connectivity in the Lombok Strait

Dhafin Delano Rizqi Santosa[1], G.a.v. P. Sudirga[1], and Aditya R. Kartadikaria*[2]

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[2]Research Group of Environmental and Applied Oceanography, Bandung Institute of Technology – Indonesia

**Abstract**

Designing effective Marine Protected Areas (MPAs) in Indonesia requires a solid understanding of ecological connectivity to support sustainable fisheries and local livelihoods. This study explores the larval dispersal pathways among MPAs in the Lombok Strait using a very high resolution (1/150∘) ocean circulation model based on the MITgcm. Virtual particles, representing Auxis thazard (frigate tuna) larvae, were released from coastal zones adjacent to each MPA throughout the year of 2004. Their trajectories were computed using Ocean Parcels with a fourth-order Runge-Kutta time integration scheme. The results were used to construct a larval connectivity matrix and evaluate network centrality through graph-based analysis using NetworkX. The results indicate that MPAs around Bali and Lombok function as major larval recipients, or sinks, under prevailing oceanographic conditions. Furthermore, four MPAs were identified as having the ideal distance for a networked Marine Protected Area system, exhibiting mutual import and export connectivity. These MPAs are Meru Betiri National Park, Nusa Perida MPA, West Lombok MPAs, and Central Lombok MPAs. This has key implications for MPA network design, highlighting the importance of these areas in ensuring population replenishment. On a broader scale, enhancing ecological connectivity through well-placed MPAs can help stabilize fish stocks, improve food security, and support the economic resilience of coastal communities. Case studies from Indonesian MPAs show that conservation areas contribute not only to ecological goals but also to tourism growth and alternative incomes, benefiting local economies and social structures (Rosadi & Prasetyo, 2022; AFD, 2023). Integrating biophysical modeling with socio-economic considerations offers a robust framework for adaptive marine spatial planning in Southeast Asia.

**Keywords:** Marine Protected Areas, Larval Connectivity, Particle Tracking, MITgcm, Fisheries

*Speaker

# Climate Variability as a Driver of Coastal Ecosystem Stressors in the Coral Triangle: A Case Study from the Derawan Islands, Indonesia

Khadami Faruq*[1], Ayi Tarya[1], Ivonne M Radjawane[1], and Iwan P Anwar[1]

[1]Oceanography Study Program, Institut Teknologi Bandung – Indonesia

**Abstract**

The Derawan Islands, located off the eastern coast of Kalimantan, are part of the Coral Triangle, a region recognized for its exceptional marine biodiversity. This area is influenced by both seasonal monsoonal cycles and interannual climate variability, including the El Niño–Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and freshwater discharge from the Berau River Estuary. Using 20 years (2003–2022) of satellite-derived data on turbidity (total suspended matter, TSM) and sea surface temperature (SST), this study explores the spatial and temporal dynamics of potential stressors to the coastal ecosystem in the Derawan region. Seasonal analysis reveals warmer SSTs during April–May, while turbidity and salinity fluctuate in response to freshwater discharge from the Berau River, modulated by monsoonal wind patterns. From May to August, increased turbidity from the river plume extends toward coral reef areas north of the estuary. Interannually, ENSO and IOD events drive prolonged SST anomalies and changes in precipitation, indirectly affecting freshwater input and turbidity levels. Notably, extreme El Niño events in 2010, 2016, and 2020 were associated with significant reductions in both TSM and rainfall. Conversely, negative IOD phases exhibit a strong negative correlation with turbidity, indicating increased turbidity during periods of intensified rainfall and freshwater influx. The co-occurrence of elevated SST and turbidity during La Niña events suggests the presence of compound stressors, which may pose heightened risks to marine ecosystems. Increased precipitation during La Niña can also enhance river discharge, promoting the expansion of low-salinity water plumes across coral habitats. This study identifies several climate-driven stressors that may impact the Derawan coastal ecosystem, though further in-situ validation is needed to assess their direct effects on local biodiversity.

**Keywords:** Climate variability, Coastal ecosystem stressors, Derawan Islands, Coral Triangle, Turbidity, Sea surface temperature

*Speaker

# Assessing Carbon Sink Dynamics in India: Projections from Climate Models

Smrati Gupta*[1] and Yogesh Tiwari[1]

[1]Indian Institute of Tropical Meteorology – India

**Abstract**

In light of escalating global warming and increasing greenhouse gas emissions, this study investigates the evolving dynamics of carbon dioxide (CO) sequestration by the terrestrial biosphere through Gross Primary Productivity (GPP), leveraging historical and future climate model simulations. Terrestrial ecosystems currently absorb about 30% of anthropogenic CO emissions via primary productivity. This research examines the combined effects of land use changes, climate change, and physiological responses to shifting meteorological conditions on the carbon sink capacity of the terrestrial biosphere. Focusing on India, a region particularly vulnerable to climate impacts, the analysis utilizes data from the Climate Models Inter-comparison Project (CMIP). Recent results indicate an upward trend in GPP across India. Historical and future scenario analyses using CMIP models reveal a historical GPP trend of 2.37 gC $m^2$ $y^2$, with projections under high-emission scenarios suggesting an increase to around 6 gC $m^2$ $y^2$, based on the SSP-585 pathway of CMIP6. The findings demonstrate spatial variability in GPP trends, with significant increases in regions such as the Northeast, Indo-Gangetic Plains, and the Western Ghats, while some southern areas show minimal growth in future projections. The study also evaluates the influence of recent land use changes, including shifts in forest and crop cover, on GPP and explores the potential impacts of projected increases in rainfall from CMIP6 models. This research provides critical insights into changing GPP patterns in India, highlighting the intricate interplay between climate change, land use, and carbon cycling. The findings are pivotal for enhancing future climate models and underscore the need to integrate empirical observations to refine predictions of terrestrial ecosystem responses to ongoing environmental shifts in the tropical Southeast Asian region.

**Keywords:** Climate change, Gross Primary Productivity, CMIP6, Terrestrial biosphere, carbon cycle, biogeochemical cycle

*Speaker

# Artificial Intelligence: Role in Climate-Ocean Research and Prediction

## Poster presentations

*Session 6*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# Machine learning-based long-term spatial reconstruction of surface total alkalinity for the northern Indian Ocean.

Joshi Apurva P*[1], Prasanna Ghoshal[1], Kunal Chakraborty[1], Rajdeep Roy[2], Jayaram Chiranjivi[2], Sridevi B[1], and V.v.s.s Sarma[3]

[1]Indian National Centre for Ocean Information Services – India
[2]Indian Space Research Organization, Regional Remote Sensing Centre, National Remote Sensing Centre, Kolkata – India
[3]CSIR National Institute of Oceanography [India] – India

**Abstract**

Ship-based observations of surface TA were collected from different sources for the period 1978-2019 for the long-term spatial reconstruction of high-resolution surface TA. We assume that the changes in surface TA primarily depend on the changes in surface temperature (SST), surface salinity (SSS), and the mixed layer depth (MLD). This study uses a decision tree-based advanced machine learning algorithm (XGB) combined with an ensemble approach to predict the surface TA of the north Indian Ocean (NIO) from 1993 to 2020. We find that INCOIS-TA performs better than the two global ML-based TA products. The open ocean region of the Arabian Sea (AS) and the Bay of Bengal (BoB) show low uncertainties (less than 22 $\mu$mol/kg). The coastal regions and the southwestern region are found to have higher uncertainties, which could be attributed to a lack of sufficient observations. The TA values in AS are higher (_˜150-350 $\mu$mol/kg) than in the BoB. The northern BoB has the lowest TA values (_˜ 2050-2130 $\mu$mol/kg) in the NIO region, which is primarily controlled by low SSS. The northern AS has the highest TA values (greater than 2400 $\mu$mol/kg), which is controlled by both upwelling and convective mixing processes. We find that the MLD has a strong control on TA seasonality, however, both SSS and MLD dominantly control its trends. Normalized TA (nTA) shows that decreasing SSS in the north BoB (due to the increasing river discharge consisting of high alkaline waters) is increasing the nTA, which is essentially buffering the acidification trend in this region. We identify three zones having significant (p less than 0.1) nTA trends. Observational efforts need to be enhanced in the high uncertain regions identified in this study.

**Keywords:** Total Alkalinity, North Indian Ocean, Machine Learning, XGBoost, Uncertainity

*Speaker

# Hybrid Model Based on MCS Numerical Scheme and ANN Artificial Intelligence for Simulation and Risk Evaluation of Coastal Erosion in South Bali

Komang Dharmawan*[1], P. V. Swastika[1], I.p. W. Gautama[1], and I.g. N.l. Wijayakusuma[2]

[1]Udayana University, Department of Mathematics, Faculty of Mathematics and Natural Science – Indonesia

[2]Udayana University – Indonesia

**Abstract**

Sea-level rise due to global warming poses a real threat to coastal regions, including South Bali-a national strategic area reliant on tourism. Landsat satellite imagery analysis reveals coastal erosion reaching up to 55 meters in Legian and Seminyak beaches between 1972 and 2020. This situation highlights the urgency of protecting coastal areas through science-based mitigation and environmental conservation approaches. This study aims to develop erosion mitigation strategies through simulation-based design of optimal wave barrier structures, both rigid breakwaters and porous media such as mangrove vegetation. We propose a hybrid model integrating numerical simulation, artificial intelligence, and risk management theory. The initial fluid run-up model will be simulated using the momentum-conserving staggered grid (MCS) scheme, both with and without wave barriers. The simulation results will then serve as training data for an artificial neural network (ANN) to evaluate amplitude damping and optimal structural dimensions of the wave barriers. Infrastructure risks near the shoreline will be analyzed using the fragility function approach within a risk theory framework. The main novelties of this research include: (1) integration of the MCS–ANN model in the context of erosion mitigation; (2) combined simulation of rigid structures and porous media in a unified model; and (3) application of risk functions in coastal fluid modeling-an interdisciplinary approach rarely explored. This innovation supports national priority programs in technology-based disaster mitigation and climate change adaptation and SDG-13 Climate Action. The study involves a multidisciplinary team from Udayana University and the Meteorology, Climatology, and Geophysical Agency (BMKG) of Indonesia.

**Keywords:** Coastal erosion, sea, level rise, momentum, conserving staggered grid (MCS), artificial neural network (ANN), hybrid modeling, climate change adaptation, disaster mitigation.

*Speaker

# Ocean Prediction Model for SSH and SST in the Western Indian Ocean using Deep Learning Technique

Balla Maggero*[1]

[1]Institute of Meteorological Training Research – Kenya

**Abstract**

Deep learning techniques of neural networks are widely used for the forecasting of ocean variables due to their good prediction performance. However, most of the models are based on a single point and a single variable, without considering the interactions between different variables, so they lack physical significance to some e xtent. In this study, a prediction model for multiple oceanic variables combining multivariate empirical orthogonal function (MEOF) analysis and a Conv1DLSTM neural network is established in the Western Indian Ocean, which can effectively solve these problems. The MEOF analysis in this study has four main functions: (a) establishing the spatial correlation between different discrete points; (b) considering the correlation between different variables; (c) reducing calculations; and (d) decorrelation. To serve as the basis, the principal component series are used to train and verify the Conv1D-LSTM model. This model performs satisfactorily under both normal and extreme conditions, and it is expected to provide a reference for further research on deep learning-based methods
in the field of marine p rediction. The prediction model in this study also has some advantages in real-time operational applications. Notably, the training set and the testing set in this study are completely independent. In the prediction process, we need to store only the EOFs obtained from the decomposition of the training set, and when the newly arrived real-time data are available, we can obtain the corresponding PCs by inverted MEOF analysis; then, the Conv1D-LSTM model can be used for prediction. Finally, the real-time forecast results can be reconstructed by combining the predicted values of PCs and the EOFs stored previously.

**Keywords:** multivariate empirical orthogonal function (MEOF), WIO, Conv1D, LSTM model, deep learning, SSHA and SST, Western Indian Ocean

*Speaker

# Role of Artificial Intelligence and Remote Sensing (AIRS) to study the Air-Sea CO2 exchange and Aquatic toxicology to develop physicochemical and Spectroscopic methods, to Control Water Aquatic Pollution.

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**Abstract**

Study aims to apply Artificial Intelligence and Remote Sensing to study Aquatic toxicology, Air-Sea CO2 exchange, Ocean Energy, Air-Sea CO2 exchange to correlate with Climate Variability, and develop physicochemical and Spectroscopic methods, to control Aquatic pollution resulting due to toxins by developing innovative technologies to harness Ocean Energy by making use of Green Technology. "Green Technology" encompasses evolving methods and materials, from techniques for generating energy to non-toxic cleaning products. As the conventional sources of energy e. g. fossil fuels (oil, coal, gas) are not only depleting but, are the source of environmental pollution due to the emission of toxic gases i.e. Green House Gases (GHG) and Aquatic toxicology involving contaminant resulting the toxin aquatic environment; affecting humans, marine life in and around these aquatic environment. Hence, it's imperative to develop strategies to study Aquatic toxicology, Air-Sea CO2 exchange, and marine feeding, nutrition management, disease prevention and harvesting the cultured organisms.

Efforts are focused on developing physicochemical and spectroscopic methods, to discuss strategies to control Aquatic/marine pollution resulting due to toxins, toxic gases, and GHG by making use of Catalytic oxides of first-row transition metal oxides and saving marine life (underwater).

Using AI to study deep sea morphology, air-sea exchange during extreme atmospheric forcing, biophysical interactions on Air-Sea CO2 exchange with Climate Variability, for estimating energy and material (e.g. carbon, nitrogen) exchange between the upper and deep ocean and to understand spatial and temporal non-homogeneity in deep-ocean mixing; distribution of deep-ocean mixing intensity, and the physics that drives that distribution & the energetics of the ocean and reducing the uncertainties in global circulation and climate models.

**Keywords:** Artificial Intelligence, Remote Sensing, Aquatic toxicology, Air, Sea CO2 exchange, Ocean Energy, Climate Variability, physicochemical and Spectroscopic methods, Aquatic pollution, Ocean Energy, Green Technology, Green House Gases (GHG)

*Speaker

# Cascading and Compound Event

## *inc. Climate Variability and Change*

## Poster presentations

*Session 7*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# Unique Patterns of the Indian Ocean Dipole events since 2019

Salvienty Makarim*[1], Agus Santoso*[2], Weidong Yu*[3], Herlina Ika Ratnawati*[4], Albertus Sulaeman*[5], Erma Yulihastin*[4], and Widodo Pranowo*[5]

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[2]UNSW Australia, Clivar Office, OUC China – China
[3]Sun Yat-Sen University – China
[4]National Research and Innovation Agenccy – Indonesia
[5]National Research and Innovation Agency – Indonesia

**Abstract**

The Indian Ocean Dipole (IOD) is a dominant climate driver in the Indian Ocean, altering ocean and atmospheric circulations over the Indian Ocean and beyond. Recent studies have suggested that modes of climate variability like the IOD may change under greenhouse forcing. As the planet continues to warm, it is necessary to observe and monitor the climate. Here, we analyze recent IOD events, finding some unique characteristics in negative IOD event in 2022 and positive IODs in 2019 and 2023 as reflected by their sea surface temperature, salinity, current, and rainfall patterns. Our analysis reveals that the 2022 negative IOD started earlier in May, and ended in October. The Indonesian Archipelago experienced an intensive rainfall from May to December 2022, induced sequentially by the Asian Monsoon, the negative IOD, the Australian Monsoon and the La Niña events. During the 2019 positive IOD, cool SST and upwelling in the Eastern Indian Ocean were strong and the IOD ended in December 2019. However, the 2023 positive IOD was short lived from the end of August up to November, coinciding with an El Niño condition in the Pacific. The cooler SST off Sumatra during the 2023 IOD was stronger than off Java SST anomaly, leading to meridionally asymmetric rainfall pattern over Sumatra. The unique IOD characteristics in 2019, 2022 and 2023 appear to be linked to the warmer background Indo-Pacific SST. The IOD events involve changes to the Indonesian Throughflow through Indo-Pacific atmospheric teleconnection.

**Keywords:** IOD, Asian Monsoon, Australian Monsoon, La Niña, El Niño, Indonesian Throughflow

*Speaker

# Assessing the impact of Western Central Pacific SST anomalies on rainfall over Indonesia

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**Abstract**

Research has been conducted to analyze impact of Western Central Pacific (WCP) sea surface temperature anomalies (SSTA), Indian Ocean Dipole (IOD), and El Niño–Southern Oscillation (ENSO) on the seasonal rainfall spatial patterns over Indonesia. Rainfall and SSTA derived from the remote sensing data for 17 years have been used here. Linear and partial correlations were used to analyse the spatial relationship between rainfall over Indonesia with WCP SSTA, IOD, and ENSO. In general, the linear spatial correlation patterns of Indonesian rainfall with WCP SSTA confirmed fairly similar temporal patterns between rainfall with ENSO and greatly different with spatial patterns of rainfall responses to IOD. Spatial patterns of partial correlations between rainfalls due to WCP SSTA during June-July-August (JJA) season indicated ENSO not affect the rainfall over most part of the Indonesian region and IOD just impact on small part of the southwestern region of Indonesia. During September-October-November (SON) season, all three indices have simultaneous effects on Indonesian rainfall, where WCP SSTA influence rainfall in the northern part, ENSO in the eastern and southeastern part, while IOD in the southwestern part. Moreover, during December-January-February (DJF) and March-April-May (MAM) season, three indices confirmed unclear responses with rainfall in the most part of Indonesian region, except outside Indonesia in the northeastern part which has interaction with ENSO.

**Keywords:** rainfall, Indonesia, Western Central Pacific, IOD, ENSO

*Speaker

# Monitoring ENSO under a warming climate: Southeast Asia Perspective

Thea Turkington*[1], Wee Leng Tan[1], Chen Schwartz[1], Paromita Chakraborty[1], Simon Peatman[1], and Aurel Moise[1]

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**Abstract**

Recent years have seen research and operational communities investigating the influence of climate change on ENSO monitoring, particularly regarding warming sea surface temperatures. ENSO is a key climate driver for seasonal and intra-annual climate variability in Southeast Asia. The current status and prediction of ENSO and related climate services are used by agriculture, water resources, health, and other sectors in the region. However, in recent years there has been greater divergence between the traditional ENSO sea surface temperature (SST) indices (e.g., Oceanic Nino Index, ONI) and recently developed ones such as the Relative Oceanic Nino Index (RONI) that considers the temperature difference between the Nino3.4 region and the tropical mean SST. This work focuses on the 2023 – 2024 period from the point of view of different SST-based indices (ONI, RONI, as well as one developed by Meteorological Service Singapore), comparing observed pattern with atmospheric variables including OLR, trade-winds, and subsurface indicators such as depth of the 20○ isotherm. Rainfall and temperature anomalies for Southeast Asia are also compared with composites from past El Niño and La Niña events. The 2023/2024 response in rainfall and temperature for the region in many ways followed the ENSO state based on newer indices such as RONI. As ENSO events will continue to be a key driver of climate variability for Southeast Asia under future climate change, the results presented here highlight the importance of also adapting how we monitor the climate in a warming world.

**Keywords:** ENSO, monitoring, climate services

*Speaker

# Evapotranspiration in a Changing Climate: A Multi-Parameter Analysis of Recent Trends and Seasonal Variations

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**Abstract**

Evapotranspiration (ET) is a vital component of the hydrological cycle, highly sensitive to climatic variability and atmospheric demand. This study investigates the long-term trends in actual ET and its relationship with key meteorological parameters across Southern Peninsular India during the period 2000–2023. ET data from the GLDAS model was analysed+ alongside air temperature, precipitation, wind speed, solar radiation, and vapor pressure deficit (VPD) sourced from ERA5 and IMD datasets. The Mann-Kendall trend test and Sen's slope estimator were applied to detect trends, while Pearson correlation analysis was used to assess the association between ET and meteorological drivers. The results indicate a statistically significant increasing trend in ET across large parts of the region, particularly during the pre-monsoon and post-monsoon seasons. Air temperature and VPD showed strong positive correlations with ET ($r > 0.6$), highlighting the increasing atmospheric demand as a dominant driver. Precipitation trends were spatially inconsistent, with notable declines in some districts, suggesting that ET rise is increasingly driven by evaporative demand rather than moisture supply. Wind speed exhibited a declining trend over the study period, potentially offsetting ET increases in some zones. Solar radiation showed minor interannual variability but contributed to seasonal ET dynamics. These findings suggest a growing divergence between ET and precipitation patterns, with important implications for water balance, crop water requirements, and drought preparedness in Southern Peninsular India. The study underscores the need to integrate evolving ET trends into regional water management and climate adaptation strategies to ensure sustainable agricultural and hydrological planning under changing climatic conditions.

**Keywords:** Evapotranspiration, Trend Analysis, Vapor Pressure Deficit, Climate Change, Southern Peninsular India, GLDAS, ERA5, Meteorological Parameters.

*Speaker

# SPATIAL-TEMPORAL CHARACTERISTICS OF GLACIER COVER OVER MOUNTAINS OF EASTERN AFRICA REGION

Daniel Mbithi*[1], Franklin Opijah[1], John Nzioka[2], and Richard Onwong'a[3]

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[2]Wangari Maathai Institute of Environment Studies – Kenya
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**Abstract**

Black Carbon is evidently one of the greatest contributors to uncertainties in radiative forcing estimates and hence climate change projections. This study assessed spatial-temporal characteristics of black carbon and glacier cover over selected mountains of East Africa. The study methodology involved the use of time series plots, wind roses, and the HYbrid Single Particle Lagrangian Trajectory Model (HYSPLIT). The variations in BC concentrations are associated with changes in snow cover over the mountains of East Africa considered. The study recommends ground based BC observations at varying altitudes over the mountains for specific level of concentrations of BC particulate matter.

**Keywords:** Black Carbon, Glacier, Snow, Eastern Africa

*Speaker

# Spatial and temporal variability of extreme rainfall events and their precursor features over Peninsular Malaysia

Sheeba Chenoli*[1], Alzian Nur 'aliyah[1], Firdzaus Mohd Nor Mohd Fadzil[1], Azizan Abu Samah[1,2], and Diong Jeong Yike[3]

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[3]Malaysian Meteorological Department – Malaysia

**Abstract**

We present the first spatial and temporal variability analysis of extreme rainfall events (ERE) using daily Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) from 1981–2021 over Peninsular Malaysia. Regional variability of rainfall extremes was analysed using the coupled Empirical Orthogonal Function method and K-means clustering algorithm, revealing five regions: South (R1S), West (R2W), Northwest (R3NW), East (R4E), and Southwest (R5SW). During the southwest monsoon season, western regions' ERE fluctuates, peaking in July (R2W) and August (R5SW). In May and October, EREs are predominant over R3NW. EREs are widespread across Peninsular Malaysia during the Northeast monsoon, especially over R4E. El Niño years vary across ERE metrics (annual count, sum, and mean maximum), whereas La Niña events show more pronounced peaks in these metrics, particularly in November and March. Combined El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) generally decrease ERE metrics. This study also aims to identify distinct weather patterns represented by a two-tiered weather regime that includes primary atmospheric patterns (tier-1) observed across the entire planetary-scale dataset, followed by a detailed examination within each tier-1 configuration (tier-2) explicitly focusing on regional-scale domains preceding the monthly extreme rainfall events (EREs) at five and ten day lag times. Preceding regimes become more akin to those coinciding with EREs as the timeframe shortens from 15 to 5 days, indicating refined convergence of atmospheric conditions. Secondly, regimes leading up to EREs abruptly change in the five days preceding events, deviating from the initially similar cluster fifteen days earlier. Considering the self-precedence of most regimes, the study deduces a monthly pattern for monthly precursors of EREs.

**Keywords:** Extreme rainfall, precursor features, regionalization, Peninsular Malaysia, CHIRPS, precipitation climatology

*Speaker

# Ocean Processes and Extremes

## Poster presentations

*Session 8*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# The dynamical mechanisms controlling the equilibrium state transition within the Mindanao-New Guinea Confluence

Li Yuxuan*[1] and Yang Dezhou[1]

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**Abstract**

Sensitive experimental results of local monsoon forcing in the Mindanao-New Guinea Confluence show that the local monsoon is the key controlling factor for the seasonal transition between the penetrating, choking, and eddy-shedding states in the confluence zone, and reveals that the local monsoon controls the transition of equilibrium states by changing the relative strengths of the Mindanao Eddy-Halmahera Eddy and the Mindanao Current-New Guinea Coastal Current/Undercurrent through the input of the vorticity anomalies. It is further found that the local monsoon has to adjust the changes of the leakage and retroflection transports of Mindanao Current through altering the equilibrium state, and then control the variations of upper ITF. Furthermore, based on the theory of equatorial and off-equatorial linear Rossby waves, different phases of equatorial Rossby waves, and off-equatorial Rossby waves at different latitudes were added to the model boundary. The simulation results show that the equatorial Rossby waves are an important factor influencing the equilibrium state transition in the Mindanao-New Guinea Confluence, whereas the off-equatorial Rossby waves have almost no effect. The Rossby waves with different phases cause a leading/lagging of the equilibrium state transition time, and may lead to the occurrence of multiple equilibrium state transitions one year-round. The local wind forcing together with the Rossby wave experiments reveal the meridional seesaw mechanism, i.e., the meridional sea-surface height gradient change is the primary cause of the equilibrium state transition within the confluence zone. The zonal geostrophic current anomalies induced by the mechanism explains the change of the upper ITF by regulating the leakage and retroflection flows. The study links the dynamical processes generated by the confluence of the two western boundary currents, providing new insights to explain the equilibrium transition within the Mindanao-New Guinea Confluence and the variations in the ITF upper-layer transport.

**Keywords:** regional ocean model, equilibrium state transition, Mindanao Current and New Guinea Coastal Current confluence system

*Speaker

# Characteristics of Non-Linear Internal Waves in the Nusa Penisa Sill, Lombok Strait and the Influence of the Indonesian Throughflow

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**Abstract**

Internal waves, primarily observed as internal solitary waves (ISW), along with the Indonesian Throughflow (ITF), are key unique features of the Lombok Strait and the comprehension of their dynamics is therefore critical to understanding the strait's ecosystem; however, detailed studies on the interplay between the two remain limited. This study aimed to investigate the detailed characteristics of ISWs and its relation to the ITF using a three-dimensional non-hydrostatic MITgcm simulation with realistic topography and forcings. The results reveal that the ISWs are generated along the Nusa Penida Sill, coinciding with regions of critical flow (Pr=1). Simulation shows correspondence of weaker (stronger) ITF and northward ISWs with increased (decreased) propagation speed, shorter (longer) wavelengths, greater (smaller) amplitudes, and fewer (more) solitons in a packet. Time-varying Froude Number further indicates that ITF modulates generation of ISWs: months with weaker (stronger) ITF correspond to northward ISWs with earlier (later) generation time and southward ISWs with later (earlier) generation.

**Keywords:** Internal Waves, Lombok Strait, Indonesian Throughflow, MITgcm

*Speaker

# Salinity characteristics during Marine Heatwaves in Bay of Bengal

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[2]Scripps Institution of Oceanography – United States

**Abstract**

Marine heatwaves (MHWs) are prolonged periods of anomalously warm sea surface temperatures. They have emerged as a critical stressor on marine ecosystems and regional climate. The Bay of Bengal (BoB), characterized by its strong stratification due to substantial freshwater input from precipitation and river discharge, exhibits a unique susceptibility to MHWs. While temperature has traditionally been the primary focus in MHW studies, salinity plays a pivotal role in modulating upper-ocean stratification, mixed layer dynamics, and heat storage. This study investigates the characteristics of salinity on the evolution and intensity of MHWs in the BoB. The study highlights the need to incorporate salinity dynamics in MHW diagnostics and prediction frameworks, especially for the freshwater-influenced tropical oceans like the BoB.

**Keywords:** MHW, Bay of Bengal, Salinity stratification

*Speaker

# Societal Impact

## Poster presentations

*Session 9*

*Poster Viewing: Wednesday, 24 Sept. 15:30-16:30*

# Climate Change induced Sea Level Rise and Coastal flooding Vulnerability in Chennai region, TamilNadu

G Sudharson*[1] and Krishnaveni Muthiah*[1]

[1]Anna University – India

**Abstract**

Global climate change, driven by anthropogenic greenhouse gas emissions, is causing a rise in global mean sea level (GMSL) through thermal expansion and ice melt. The Intergovernmental Panel on Climate Change (IPCC) provides a range of future sea-level rise (SLR) projections based on different Shared Socioeconomic Pathways (SSPs), highlighting a spectrum of potential increases by the end of the century and beyond. This study focuses on Sea Level Rise impacts in Chennai region, a densely populated and the vulnerability to coastal flooding under the different SLR scenarios. High-resolution satellite imagery, digital elevation models, historical tide gauge records, and future SLR projections from SIMCLIM AR6 data will be integrated to conduct Digital Terrain Analysis. This analysis will involve overlaying the resulting inundation maps with critical infrastructure, densely populated areas, and ecologically sensitive zones like mangroves, wetlands to identify highly vulnerable locations. The findings will generate detailed inundation maps and vulnerability areas, providing crucial information for urban planners, policymakers, and disaster management agencies.This information will enable the development of effective adaptation strategies, thereby mitigating the adverse impacts of climate change and SLR on coastal Chennai.

**Keywords:** Climate Change, Sea Level Rise, Coastal Flooding, Inundation Mapping, Geospatial Analysis and Adaptation Strategies.

*Speaker

# Gaps and Challenges in Addressing the Societal Impact of Climate Variability and Climate Change in the Indian Coastal Metropolitan City due to Interactions with Complex Ocean and Atmospheric Processes: An Example of Bridging Science and Society in Southeast Asia and Beyond

Shailendra Mandal*[1] and Supriya Rani[2]

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[2]Department of Physics, H. D. Jain College, Veer Kunwar Singh University, Ara, Bihar – India

**Abstract**

Vulnerability of coastal communities through interactions with complex ocean and atmospheric processes at various temporal and spatial scales is a major issue, which has gained attention recently. Changed frequencies and intensities of compound events, combined with marine heatwaves and sea level rise and extremes, are expected to have mostly adverse effects on coastal society. Coastal communities are highly vulnerable to climate change, mainly because of three reasons, high resource dependency, high exposure and limited adaptive capacity. A study on 136 coastal cities showed that cities in east and south east asia would face increase in exposure of population and assets to coastal flooding. A wide number of often-conflicting human socio-economic activities occur in these areas. These include urbanization, fisheries, tourism, industrial and energy production and delivering, and agriculture. Human activities often struggle with the need to preserve natural ocean systems and their ecological processes. Coastal areas are categorized as one of the areas that are predominantly exposed to current and projected climate risks associated with climate change due to interactions with complex ocean and atmospheric processes. In the perspective of climate change, urbanized and infrastructured coastal areas are of specific concern since they can drastically limit and even impede natural adaptive processes. The proposed methodology is considered as a decision support tool, which helps the decision-makers to detect the vulnerability degree of any areas exposed to climate variability and change based on the parameter to give the priority for climate proofing infrastructure. This study concludes that the rudimentary measures, which are needed just to address societal impact of climate variability and climate change in the coastal community due to interactions with ocean and atmospheric processes, are necessary as a stepping stone to transformative pathways for addressing the gaps and challenges for bridging science and society in southeast Asia and beyond.

**Keywords:** Coastal metropolitan city, Societal impact, Climate variability and change, Interactions of ocean and atmosphere, Vulnerability assessment, Sea level extremes

*Speaker

# Risk of Extreme Precipitation on Dam Infrastructure under changing climate over India

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[3]Center for Emerging Technology for Sustainable Development, IIT Jodhpur – India

**Abstract**

India's aging dam Infrastructure is at a critical juncture due to climate change and rapid urbanization. According to the National Large Register of Dams (NLRD) report (2019), the country has more than 5700 dams, which were designed based on the estimation of extreme events (such as design storm, 100-year return period precipitation, and Probable Maximum Precipitation (PMP)). These extreme events were evaluated based on historical meteorological data and do not consider the effect of future climate change, which poses significant challenges to the safety of dam infrastructure. Here, we analyzed the risk of extreme precipitation events on dam infrastructure due to changing climate considering the observed and Global Climate Models (GCMs) datasets. Using observed meteorological datasets, we evaluated the changes in the frequency and intensity of high precipitation (precipitation more than the 99th percentile) during the period 1951-2022 and found that the frequency and intensity of high precipitation have increased over the majority of dams except dams located in Brahmaputra River. The increase in frequency and intensity of high precipitation occurred during the period 1987-2022. Furthermore, we estimated the 100-year return period precipitation using Generalized Extreme Value (GEV) distribution and PMP using the modified Hershfield method during the period 1951-1986 and 1987-2022. Our results showed that the risk of extreme precipitation has increased in the last few decades. In addition to the observed analysis, we estimated the 1-day PMP for the historical period (1976-2010) using historical data of precipitation from CMIP6-GCMs. We then compared historical PMP values with future precipitation values of CMIP6-GCMs. The results of this analysis indicate that future precipitation values surpass the historical PMP, with an increasing frequency, which indicates the risk of extreme precipitation has been increasing in the future. Overall, our findings highlight the escalating hydrological risks to dam infrastructure due to climate change.

*Speaker

# Tidal reconstruction of Three Cruise Ships Harbouring Simultaneously in Benoa Harbour in Respect to Modern Navigation File S-100

Candrasa Surya Dharma*[1], Albert Mahendro Yudhono[1], Filan Muhammad Kelvin[2], and Aditya R. Kartadikaria[3]

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**Abstract**

Benoa Harbour holds significant importance as a vital maritime gateway and a strategic asset for the region's economy, facilitating the berthing of large cruise ships and many other vessel types. The dynamics of the harbour are mostly governed by tides, so understanding tidal variations is crucial for safe and efficient navigation and berthing operations within the harbor. This study focuses on the tidal conditions on February 21, 2025, when the harbouring of three prominent cruise vessels: the Silver Nova, the Queen Elizabeth, and the Viking Sky, occurred. To analyze the tidal dynamics, we employ MIKE 21/3D hydrodynamic model and validate using observed data from Pushidrosal. This research emphasizes the importance of accurate tide prediction and offers a high-resolution representation of the tidal flow, which is crucial for understanding the complex interactions between tidal forces and harbor geometry. The study also addresses the integration of this data with the S-100 framework, the latest international standard for hydrographic data. Specifically presenting the successful simulation data into S-104 (water level information) and S-111 (surface currents) formats. This conversion ensures that the data is compatible with modern Electronic Chart Display and Information Systems (ECDIS), enhancing navigational safety and efficiency in Benoa Harbour. In general, we found that the tidal type in the Benoa Harbour is a mixed tide prevailing semidiurnal, 280 cm tidal range from chart datum, the northwest flood current with 0.62 m/s and 0.52 m/s during southeast ebb tides. The integration between high-resolution model output to support the S-104 and S-111 formats is the findings in this research and provides crucial, standardized data to enhance navigational safety for vessel traffic and operational efficiency, in Benoa Harbour.

**Keywords:** Tide, S, 104, S, 111, Prediction, ECDIS

*Speaker

# Seawater Ingress Monitoring at River mouths due to tidal dynamics

Krishnaveni Muthiah*[1]

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**Abstract**

Climate change is the issue of great concern to a developing coastal region that threatens the quality and sustainability of ground water resources of coastal aquifer. Sea water intrusion is caused by two sources: climatic stress such as sea level rise, drought and tide, and human factors such as groundwater pumping and mariculture. The rise in seawater level, a tidal dynamics and other factors causes the ingress of sea water into the river mouths. Tamilnadu a maritime state of India in which the rivers originate from Western ghats and runs into Bay of Bengal. The state comprises of 17 major river basins. In the present study, the site investigations are carried out at the tail reaches of 13 river basins to find out the extent of sea water ingress into the river and the salinity level. The surface water and ground water samples are analysed for salinity levels. It is found that the salinity level ranges from 5000 to 100000 ppm in the study basins. Also, it is observed that the tidal influence ranges from minimum of 1.0 Km in Mudavanar sub basin to a maximum of 28 Km in Vellar basin. Based on this analysis, the suitable locations for tail end regulator are proposed by considering the field conditions such as Coastal Regulation Zone, salt pans, Mangroves, prawn culture, nearby villages and Coastal Regulation Zone for the study basins.

**Keywords:** climate change, sea level rise, tidal dynamics, sea water ingress, river basins, tail end regulator

*Speaker

# Climate Variability and Predictability of the Mediterranean: research progress and climate change impacts in the MENA region

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**Abstract**

In the last decades in the Mediterranean region, temperatures have risen faster than the global average and model projections agree on its future warming and drying, with a likely increase of heat waves and dry spells. Further, countries around the Mediterranean basin are characterized by strong differences, as shown by various socioeconomic and environmental indicators, such as per capita gross domestic product (GDP), energy supply, CO2 emissions, and water availability. Environmental issues are exacerbated by societal aspect, as the whole region is densely populated with many Middle East and North African (MENA) countries expected to double their population by the mid-twenty-first century. A growing dependence on irrigation in MENA countries will likely increase their economic and social vulnerability, because of future reduced total water availability and rapidly growing competing urban water demands. This study is an outcome of the work carried on within the MedCLIVAR network. It describes recent progresses on the understanding of the climate of the Mediterranean region and the impacts of its future evolution on the environment and people. MedCLIVAR (Mediterranean CLImate VARiability) has been running continuously for about 10 years. It was initially proposed at the 2003 European Geosciences Union assembly in Nice (France), endorsed by the international Climate Variability and Predictability (CLIVAR) office in 2005, and supported by the European Science Foundation.

**Keywords:** Climate Variability, Predictability, Mediterranean region, MedCLIVAR, MENA region, North Africa.

*Speaker

# Water security through science -based cooperation and Echo-hydrology for sustainability

Oyebola Adebola Elemide*[1,2,3]

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**Abstract**

The International year of water cooperation reflects t he g lobal r ecognition t hat fresh water is vital for human health, prosperity and peace and that international agreed development objectives in particular poverty eradication, gender equality, food security and the safeguarding of ecosystems and their life -supporting functions, cannot be faced without resolving current and future water challenges.
When it comes to considering regional and global water policy issues, the physical status and quality trends of groundwater resources have yet to be taken adequately into account. Because geological formations have no regard for water catchments or national boundaries resources in many aquifers are shared by adjacent states and require trans-boundary management.

Water challenges are among the greatest dangers for humanity. To face them and to succeed in sustainable development, we need cooperation among all water users, managers, and those providing the governance framework. By its very nature, water is a cross-cutting issue that demands attention at all levels and involves many stakeholders across sectors, sometimes with conflicting and competing needs. Water cooperation, therefore, takes many forms, from managing shared underground aquifers and river basins to scientific data exchange to financial and technical cooperation. Cooperation in education, capacity development, and awareness raising prepares people for the future. Global changes such as demographic growth,land use change,urbanization and climate change place a serious pressure over water resources. In particular, the impacts of climate change, including changes in temperature, precipitation, and sea level, are expected to have varying consequences for the availability of fresh water in the world

**Keywords:** Water, security, cooperation, sustainability, Hydrology

*Speaker

# Science to Society: An Educational Model for Climate Resilience in Bangladesh and its Potential for Regional Application

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[2]Notre Dame College Dhaka – Bangladesh

**Abstract**

Climate change is significantly impacting Bangladesh, manifesting not only in increased cyclones, sea-level rise, and salinity intrusion, but also in more frequent and intense heatwaves and altered rainfall patterns. These changes are disrupting the socio-economic fabric of the nation. Recognizing the critical role of parents, teachers, and educational institutions in addressing these challenges, a study revealed a substantial knowledge gap regarding the science of climate change among students (65%), parents (86%), and teachers (53%) at the secondary and higher secondary levels.

To address this, the NDNSC-SEE model was implemented, engaging 2,376 stakeholders (grades 3-12) across Bangladesh for five months. This integrated approach utilized workshops, seminars, climate action Olympiads, problem-solving activities, poster sessions, and a Green School modeling challenge. The initiative successfully improved participants' understanding of climate change, its causes, impacts, and potential solutions. Notably, 74% of participants reported increased knowledge, and 82% expressed a stronger commitment to adopting sustainable lifestyles. Urban participants demonstrated higher climate literacy (71%) compared to rural participants (32%).

The NDNSC-SEE model, a cost-effective and student-teacher-led initiative, proves effective in enhancing climate awareness and action. Its potential application in other South Asian countries facing similar challenges is evident. However, the study also identified critical gaps in knowledge, technology utilization, integration of indigenous practices, understanding of life cycles, water and energy concepts, community support, and educational initiatives. Addressing these gaps is crucial to effectively empower future generations to combat climate change and build a sustainable world.

**Keywords:** Climate Action, Knowledge Gap, Youth action, community engagement

*Speaker

# Pan-CLIVAR Meeting

## Oral presentations

*Tuesday, 23 Sept.*

*Friday 26 Sept.*

# Connecting the WCRP Academy and the CLIVAR Community

Laurice Jamero[1], Christopher Lennard*[2], Melissa Hart[3], and Narelle Van Der Wel[4]

[1]WCRP Academy Support Unit – Philippines
[2]WCRP Academy – South Africa
[3]WCRP Academy – Australia
[4]World Climate Research Programme – Switzerland

**Abstract**

The WCRP Academy is the research training advisory and coordination arm of the World Climate Research Programme. Recognizing the vital role of climate science education in increasing the number and diversity of experts ready to tackle the climate crisis, the Academy serves as a hub which connects training providers and users of training.
This presentation will provide a quick walkthrough of the WCRP Academy's online training catalogue and discuss the various initiatives we have undertaken to curate and disseminate climate science training opportunities according to the needs of our main target audience: early career researchers from the Global South.
Through short activities during the session, the Academy also aims to gauge the interest of the CLIVAR community in creating a page on our website dedicated to the theme of "Climate and Ocean" where related training opportunities can be specifically highlighted, along with other relevant training resources (e.g. publications, news, recordings of online lectures). We will also explore existing mentoring and capacity development efforts within the CLIVAR community, with the hope of distilling best practices and lessons learned that can be shared and applied across WCRP. Lastly, given that the WCRP Academy Support Unit is located in the Philippines, we also hope to discuss how we can make a more significant contribution towards addressing the specific climate training needs of the Southeast Asian region.

**Keywords:** Climate education, climate training, early career researchers

*Speaker

# CORDEX Southeast Asia Climate Projections and Their Relevance to Society

Fredolin Tangang*[1], Faye Cruz[2], and Jerasorn Santisirisomboon[3]

[1]Universiti Brunei Darussalam – Brunei
[2]Manila Observatory – Philippines
[3]Ramkhamhaeng University, Bangkok – Thailand

**Abstract**

Southeast Asia is recognised as a region with very high exposure and vulnerability to the impacts of climate change. As global efforts to mitigate climate change and limit global warming to below 1.5∘C remain uncertain, it is critically important for countries in the region to assess the risks of future climate change impacts, and to formulate adaptation measures and policies that enhance climate resilience. A fundamental requirement for such assessments is access to high-resolution climate projections-something that was lacking in the region a decade ago. The establishment of CORDEX Southeast Asia (CORDEX SEA) in 2013 has addressed this gap by conducting coordinated regional climate downscaling simulations. Since its inception, CORDEX SEA has produced multi-model climate projections at a 25 km resolution using CMIP5 GCMs for the Southeast Asian domain, and further downscaled these to 5 km resolution for key vulnerable sub-regions. CORDEX SEA is currently finalising multi-model projections based on CMIP6 GCMs. CORDEX SEA is also undertaking a project called CARE for Southeast Asia Megacities, which aims to generate city-scale climate projections for key climate extremes in five megacities across the region. While high-resolution climate projections offer valuable information, estimating the compounding risks posed by climate variability-such as El Niño, La Niña, the Indian Ocean Dipole (IOD), and the Madden–Julian Oscillation (MJO) in future periods-remains a scientific challenge. These modes of variability are expected to compound the impacts of climate-related hazards such as heavy precipitation, droughts, and heatwaves in a warmer future climate over this region. This talk highlights these issues.

*Speaker

# Towards reliable SST predictions in the Tropical Pacific Cold Tongue

Anna-Lena Deppenmeier*[1], Jofia Joseph[2], Frank Bryan[2], and Dan Whitt[3]

[1]University of Liverpool – United Kingdom
[2]National Center for Atmospheric Research – United States
[3]NASA Ames Research Center – United States

**Abstract**

Variations in the eastern Pacific Cold Tongue dominate variability of the zonal SST gradient that drives ENSO, which provides basin-wide subseasonal and global seasonal prediction skill in weather, ocean, and climate patterns. Cold tongue SSTs are influenced by both surface heat fluxes and vertical heat transport in the ocean: the strong eastward flowing Equatorial Undercurrent lies under the westward flowing South Equatorial Current, which leads to strong vertical current shear. This creates a marginally stable regime that is primed to mix often and deeply. Heat is transported from the surface layer into the thermocline, and eastward momentum is transported to the surface. Accurate representation of processes controlling cold tongue SST in climate models is critical to harness the potential global predictability and prediction skill that results from coupled ocean-atmosphere dynamics in the eastern tropical Pacific. However, climate models misrepresent the cold tongue in ways that have far reaching effects. Model developers need direct, clear observational targets to accurately represent processes leading to cold tongue variability. We assess present-day capabilities for providing observational guidance based on subsurface ocean data that can be used to evaluate climate model skill and inform model development. This analysis informs how a targeted field campaign focused on ocean vertical mixing and its effect on SST could reduce model biases. The PUMACAT – Pacific Upwelling and Mixing Physics Act to Couple Atmosphere to Thermocline – field campaign and modeling exercises will yield co-located observations of both the ocean and the atmosphere to inform their interaction on time scales from sub-daily to seasonal. Here we demonstrate how analysis of model simulations can inform the observing strategy of the future campaign.

*Speaker

# Understanding regional pCO2 model biases and uncertainties in the Biogeochemical Southern Ocean State Estimate (B-SOSE)

Angela Kuhn*[1], Matthew Mazloff[1], Sarah Gille[1], and Ariane Verdy[1]

[1]Scripps Institution of Oceanography – United States

**Abstract**

The Southern Ocean accounts for more than 40% of the global oceanic CO2 uptake, playing an important role in the global climate balance. The partial pressure of oceanic CO2 (pCO2) determines seasonal and geographic variations in the CO2 flux between the ocean and the atmosphere. However, climate models often poorly represent the phasing of the pCO2 seasonal cycle in the Southern Ocean. Previous studies have shown that the leading drivers of pCO2 vary seasonally and meridionally. The varied nature of seasonal and regional pCO2 drivers poses a challenge for model parameterization, as biogeochemical models depend on initial conditions with intrinsic uncertainties and parameter values that are fixed in time and space. In this study, we aim to understand the source of the pCO2 regional model biases, using the Biogeochemical Southern Ocean State Estimate (B-SOSE) and pCO2 observations from the Surface Ocean CO2 Atlas and BGC-Argo floats. Through detailed sensitivity analyses and optimization exercises for parameters and initial conditions, we determined that biogeochemical parameters, including phytoplankton growth and mortality rates, are key to establishing the correct phasing of the pCO2 seasonal cycle in the Southern Ocean. The optimized parameters also modify the meridional patterns of temporal correlation between surface pCO2 and other variables, such as temperature, productivity and dissolved inorganic carbon, bringing the B-SOSE system dynamics closer to observations. That is, biogeochemical parameters play a key role in determining the distribution of leading pCO2 drivers. We also found that alkalinity initial conditions strongly modify pCO2 mean values, without significantly affecting phasing. Challenges remain in jointly optimizing the phasing and mean values of the pCO2 annual cycle. We demonstrate that the model response to perturbations is frequently non-linear and non-independent. This potentially limits the optimization performance and, thus, larger parameter space exploration may be required to generate further model improvements.

**Keywords:** Southern Ocean, parameter estimation, biogeochemical model, pCO2

*Speaker

# El Nino 2023/24 and the Skill of Drought Warning Issued by BMKG

Supari Supari*[1], Robi Muharsyah[1], Amsari Mudzakir Setiawan[1], Adi Ripaldi[1], Alif Akbar Syafrianno[1], Indra Gustari[1], Fatchiyah Fatchiyah[1], Dian Nur Ratri[1], Niken Wahyuni[1], Tiar Maharani[1], Adyaksa Budi Raharja[1], Novi Fitrianti[1], Rosi Hanif Damayanti[1], Damiana Fitria Kussatiti[1], Marlin Denata[1], Alexander Eggy Christian Pandiangan[1], Muhammad Isra Agfi Ramadhan[1], Arda Yuswantoro[1], Fathiya Nurrahmanita[1], Diah Ariefianty[1], Syahru Romadhon[1], Mia Rosmiati[1], Suci Pratiwi[1], Hasalika Nurjannah[1], Ridha Rahmat[1], Dyah Ayu Kartika[1], and Yohanes Agung Kristomo[1]

[1]Directorate of Climate Change, Indonesia Agency for Meteorology, Climatology and Geophysics (BMKG) – Indonesia

**Abstract**

The 2023/2024 El Niño phenomenon, which occurred from June 2023 to April 2024, caused severe droughts in southern Sumatra, Java, Bali, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT), southern Kalimantan, and most of Sulawesi, particularly between July and October 2023. Based on monthly rainfall predictions, BMKG issued an early drought warning in early February 2023, anticipating its occurrence during the 2023 dry season. This study evaluates the reliability of monthly rainfall predictions using the corrected ECMWF model for the July–October 2023 period in the Java-Bali region, which was among the most affected by El Niño. The evaluation employs two assessment metrics: Mean Absolute Error (MAE) and Percentage of Correct Grid (PCG). The analysis results indicate that predictions for August and September, the driest months, achieved high accuracy, with MAE values below 20 mm per month for forecast ranges of 2 to 7 months ahead. The PCG values for the same forecast range varied from 50% (for the August forecast issued in February) to 85% (for the August forecast issued in May and June). BMKG's success in providing an accurate early drought warning has enabled the government to formulate strategic policies to mitigate the impacts of El Niño, including water resource management strategies and agricultural assistance. This highlights BMKG's crucial role in supporting government efforts to maintain national food security.

**Keywords:** Drought Warning, El Nino, Rainfall Prediction, Skill of Prediction

*Speaker

# Coordinated regional ocean climate projections: why, where are we and where are we going? A CLIVAR-CORDEX task force

Angelique Melet*[1], Samuel Somot[2], Elizabeth Drenkard[3], Sheila Estrada[4], Jason Holt[5], Dorotea Iovino[6], Marine Herrmann[7], Markus Meier[8], Andrew Orr[9], Marcus Thatcher[10], Shogo Urakawa[11], and Xuebin Zhang[10]

[1]Mercator Ocean – Mercator Ocean International – France
[2]CNRM-GAME/Météo-France – Météo France, CNRS : UMR3589 – France
[3]NOAA GFDL – United States
[4]CICESE – Mexico
[5]NOC – United Kingdom
[6]CMCC – Italy
[7]Laboratoire d'études en Géophysique et océanographie spatiales (LEGOS) France
[8]Leibniz Institute for Baltic Sea Research Warnemünde – Germany
[9]BAS – United Kingdom
[10]CSIRO – Australia
[11]Meteorological Research Institute, Japan Meteorological Agency – Japan

**Abstract**

More granular, regional-to-local ocean climate information on the past, present and future marine and coastal environments is needed for impact analysis, for decision making across society and to support ocean climate services and climate adaptation measures. Global coupled climate models from the current and next Coupled Model Intercomparison Project (CMIP6, 7) are designed for examining large-scale climate information and do not have fine enough resolution to meet these societal needs. Dynamical downscaling approaches based on high-resolution ocean-only or ocean-atmosphere regional climate models can fill this gap. Yet, efforts have been fragmented so far, ocean regional climate models are currently underrepresented in the Coordinated Regional Climate Downscaling Experiment (CORDEX) of the World Climate Research Programme (WCRP), and a coordinated framework is lacking. To address this gap, a joint CORDEX-CLIVAR OMDP (Climate Variability Ocean Model Development Panel) task force has been established to develop a strategic plan for a longer-term initiative on regional ocean climate projections within the WCRP. This presentation will describe the current state-of-the-art and international efforts, the objectives of the task force, results from a survey on stakeholders data request for regional ocean climate projections from the HORIZON Europe SEACLIM project, a proposition for a coordinated framework on regional ocean climate projections and their evaluation, an updated set of reference oceanic regions for regional ocean climate assessment such as done in the IPCC and its Interactive Regional Atlas.

**Keywords:** regional ocean climate projections, regional models, coordination, ocean physics, ocean biogeochemistry, sea ice

*Speaker

# The impact of storms on Southern Ocean energy and carbon cycling

Nicole Lovenduski*[1], Katy Christensen[1], Cara Nissen[2], and Mathew Maltrud[3]

[1]University of Colorado Boulder – United States
[2]University of Amsterdam – Netherlands
[3]Los Alamos National Lab (LANL) – Los Alamos, New Mexico 87545, United States

**Abstract**

Mid-latitude cyclones may play an outsized role in Southern Ocean air-sea CO2 exchange by injecting energy and entraining deep, carbon-rich water into the surface ocean. Despite their potential importance, the role of these storms in Southern Ocean carbon cycling is not well understood. Until the advent of autonomous biogeochemical sensors such as Argo floats, biogeochemical sampling in the Southern Ocean was conducted primarily by ships that purposely avoided sampling during strong storms. Further, studies based on Earth system models have been hampered by coarse model resolution and long averaging intervals, preventing the detailed study of carbon cycle processes on the scales of synoptic storms. Here, we use a novel high-resolution model with the capacity to simulate autonomous Biogeochemical-Argo floats to explore the impact of synoptic storms on Southern Ocean physical and biogeochemical properties. Our model study reveals the influence of storms on eddy kinetic energy, mixed layer depth, and air-sea CO2 exchange at unprecedented spatiotemporal scales, and quantifies our ability to sample storm-driven anomalies with current and idealized BGC-Argo arrays.

**Keywords:** Southern Ocean, Argo, models, autonomous, carbon

*Speaker

# Digital Twins of the Ocean for Sustainable and Climate-Responsive Marine Management

Joanna Staneva*[1]

[1]Department of Hydrodynamics and Data Assimilation, Institute of Coastal Systems-Analysis and Modelling, Helmholtz-Zentrum Hereon – Germany

**Abstract**

The Digital Twin of the Ocean (DTO) is an advanced tool supporting climate-resilient and sustainable ocean governance. It integrates satellite and in situ observations with hydrodynamic and biogeochemical models to create dynamic, high-resolution virtual representations of marine systems. These digital twins enable the simulation of "What-If" scenarios to explore the impacts of climate variability, sea-level rise, and anthropogenic pressures on marine and coastal environments. The DITTO programme, launched under the UN Decade of Ocean Science, provides an international coordination framework for the development and application of DTOs. It promotes open, interoperable, and scalable digital twin architectures.
Artificial Intelligence (AI) plays a central role in enhancing DTO functionality. AI approaches support data fusion, downscaling, gap-filling, forecasting and projections. These methods improve the predictive skill of digital twins, especially in simulating extreme events such as storm surges, compound flooding, and marine heatwaves. In the context of climate variability and change, AI strengthens the capacity of DTOs to generate actionable insights from complex, multi-source datasets, aligning with the goals of next-generation ocean-climate services.

DTOs are designed for flexible use across different spatial scales and thematic priorities. They enable climate-relevant applications by connecting scientific modeling with policy development, risk management, and stakeholder engagement.

One prominent use case is the evaluation of Nature-Based Solutions, such as mangroves, wetlands, and seagrass meadows. Current applications include the Wadden Sea, the North Sea, and the tropical coasts of West Africa and Asia, all of which are vulnerable to multi-hazard climate extremes. DTOs simulate their performance under climate stressors, guiding adaptation and restoration strategies to reduce risk and enhance ecosystem services.
Through the integration of AI and coupled modelling systems, DTOs contribute to advancing predictive understanding of the ocean-climate system. They offer a powerful, transferable approach to inform sustainable solutions and support science-policy interfaces in a changing climate.

**Keywords:** Digital Twin of the Ocean, Artificial Intelligence, Climate Variability, Marine Extremes, Ocean Modelling, Sustainable Ocean Management, Machine Learning, Sea, Level Rise, Coastal Resilience, Scenario Simulation

*Speaker

# List of oral and poster presentations

## by alphabetical order

# List of presentations at the CLIVAR Symposium

| | |
|---|---|
| **Aadhar Saran**<br>Enhanced Future Risk of Soil Moisture Drought despite Wetter Conditions in South Asia | **Day 3 – Session 7**<br>16:30-18:00<br>Oral |
| **Akram Nafiis Abdillah (presented on site by Kartadikaria Aditya R.)**<br>A Fully Coupled High-Resolution Ocean-Atmosphere Model around the Lombok Strait | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P-04** |
| **Anoruo Chukwuma**<br>Day-to-Day Variability and Seasonal Patterns of Global Dust Aerosol Optical Depth from IASI Satellite Observations (ONLINE) | **Day 3 – Session 1**<br>11:00-12:30<br>Oral |
| **Apurva P Joshi**<br>Assessing the current state of Indian Ocean acidification, its driving mechanisms, and projected near-future changes | **Day 3 – Session 3**<br>11:00-12:30<br>Oral |
| **Apurva P. Joshi**<br>Machine learning-based long-term spatial reconstruction of surface total alkalinity for the northern Indian Ocean | **Day 3 – Session 6**<br>15:30-16:30<br>**Poster N° S6-P-01** |
| **Arshad Adnan**<br>Quantitative Analysis of Monsoon Pattern Shifts in Pakistan's Climatic Zones: Impacts of Environmental Change and Projections Under RCP Scenarios | **Day 3 – Session 1**<br>11:00-12:30<br>Oral |
| **As-syakur Abd. Rahman**<br>Assessing the impact of Western Central Pacific SST anomalies on rainfall over Indonesia | **Day 3 – Session 7**<br>15:30-16:30<br>**Poster N° S7-P-02** |
| **Badiaa Chelli**<br>Climate Variability and Predictability of the Mediterranean: research progress and climate change impacts in the MENA region | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-06** |
| **Bernawis Lamona**<br>Sea Surface Salinity Variability of Central Indian Ocean – Western Indonesia Waters 1993-2019 | **Day 3 – Session 2**<br>11:00-12:30<br>Oral |
| **Bharghavi Kandula**<br>Comparative Analysis of Drought Classification Using SPI and SPEI Across Arid and Semi-Arid Climatic Zones of India (1981–2020) | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Bobrik Anna**<br>Blue carbon is an overlooked carbon sink under climatic change | **Day 3 – Session 3**<br>11:00-12:30<br>Oral |
| **Boedihardjo Denise**<br>Identification of Extreme Sea Levels and Concurrent Marine Heatwaves- Extreme Sea Levels in SETIO Waters 1993-2022 | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |

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| **Bourdallé-Badie Romain**<br>The Marine Environment Reanalyses Evaluation Project MER-EP, towards an improved knowledge of the global ocean environment of the past decades, to support ocean applications and ocean prediction | **Day 3 – Session 5**<br>13:30-15:00<br>Oral |
| **Brandt Peter**<br>Physical processes and biological productivity in the upwelling regions of the tropical Atlantic | **Day 4 – Breakout 2**<br>11:00-12:25<br>Oral |
| **Burls Natalie**<br>Regional radiative feedbacks as drivers of Pacific SST gradients in a hierarchy of models | **Day 3 – Session 4**<br>13:30-15:00<br>Oral |
| **Cai Wenju**<br>Impact of ENSO and the IOD on global economy | **Day 3 – Session 9**<br>16:30-18:00<br>Oral |
| **Capotondi Antonietta**<br>Surface and Subsurface Dynamics of Northeast Pacific Marine Heatwaves | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |
| **Chen Zhaohui**<br>China's Activities in Ocean Observations in the Northwest Pacific | **Day 3 – Session 5**<br>13:30-15:00<br>Oral |
| **Chenoli Sheeba**<br>Spatial and temporal variability of extreme rainfall events and their precursor features over Peninsular Malaysia | **Day 3 – Session 7**<br>15:30-16:30<br>**Poster N° S7-P-06** |
| **Collins Matthew**<br>Impacts of Climate Change on the Tropical Pacific and El Niño Southern Oscillation | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Cravatte Sophie**<br>An absence of moorings in the western Tropical Pacific: what are the main consequences and risks to climate research and prediction? | **Day 3 – Session 5**<br>13:30-15:00<br>Oral |
| **Deb Biplob**<br>Science to Society: An Educational Model for Climate Resilience in Bangladesh and its Potential for Regional Application | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-08** |
| **Deshpande Aditi (presented on site by Roxy Koll)**<br>Impact of Satellite Chl-a and Other Physical Parameters on Deriving Reliable Export Production Estimates over Indian Ocean | **Day 3 – Session 3**<br>15:30-16:30<br>**Poster N° S3-P-02** |
| **Das Mohan Kumar**<br>Impacts of Marine Heatwaves on the Bay of Bengal's Coastal Ecosystems and Communities: Drivers, Adaptation Strategies, and Enhancing Resilience | **Day 3 – Session 9**<br>16:30-18:00<br>Oral |
| **Dharmawan Komang**<br>Hybrid Model Based on MCS Numerical Scheme and ANN Artificial Intelligence for Simulation and Risk Evaluation of Coastal Erosion in South Bali | **Day 3 – Session 6**<br>15:30-16:30<br>**Poster N° S6-P-02** |

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| **Dhrubajyoti Samanta**<br>Impacts of the 2020–2023 Triple-Dip La Niña on Rainfall in Southeast Asia | **Day 3 – Session 9**<br>16:30-18:00<br>Oral |
| **Dong Lu**<br>Emergence of positive IOD-like warming pattern driven by greenhouse gases and anthropogenic aerosols during the recent four decades | **Day 3 – Session 4**<br>13:30-15:00<br>Oral |
| **Ehsan Muhammad Azhar**<br>Evaluating Three Decades of NMME Hindcasts to Assess Model Performance in Predicting ENSO Onset | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Elemide Oyebola Adebola**<br>Water security through science -based cooperation and Echohydrology for sustainability | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-07** |
| **England Matthew**<br>Drivers of the extreme North Atlantic marine heatwave during 2023 | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |
| **Faruq Khadami**<br>Climate Variability as a Driver of Coastal Ecosystem Stressors in the Coral Triangle: A Case Study from the Derawan Islands, Indonesia | **Day 3 – Session 3**<br>15:30-16:30<br>**Poster N° S3-P-04** |
| **Gautam Pratibha**<br>Land surface feedback and rainfall bias in the dynamical models with different physical parametrizations | **Day 3 – Session 4**<br>15:30-16:30<br>**Poster N° S4-P-02** |
| **Geng Tao**<br>Nonlinear ENSO response to formation of a permanent El Niño-like state under persistent greenhouse warming | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Goswami Virendra**<br>Role of Artificial Intelligence and Remote Sensing (AIRS) to study the Air-Sea CO2 exchange and Aquatic toxicology to develop physicochemical and Spectroscopic methods, to Control Water Aquatic Pollution | **Day 3 – Session 6**<br>15:30-16:30<br>**Poster N° S6-P-04** |
| **Han Lei**<br>Diffusive and Adiabatic Meridional Overturning Circulations in the Cooling Abyss of the Indo-Pacific Ocean | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P-02** |
| **Hasanapuram Sushmitha**<br>Evapotranspiration in a Changing Climate: A Multi-Parameter Analysis of Recent Trends and Seasonal Variations | **Day 3 – Session 7**<br>15:30-16:30<br>**Poster N° S7-P-04** |
| **Holbrook Neil**<br>Toward a mechanistic characterisation of marine heatwaves | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |
| **Hossain Md Shahada**<br>Seasonal and Interannual Variability of Freshwater Flux in the Labrador Coastal Current: Insight from OSNAP Mooring Data | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P-07** |

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| **Hu Aixue**<br>Tug of war between atmosphere and ocean in controlling ITCZ | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Hu Shijian**<br>Subsurface Marine Heatwaves in the Tropical Western Pacific Ocean: Extreme Events, Drivers and the Role of Subsurface Eddies | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |
| **Hwang Yen-Ting**<br>Contrasting Impacts of Northern and Southern Extratropical Forcings on Tropical Pacific SSTs: Insights from 1979–2024 and Implications for Future Projections | **Day 3 – Session 4**<br>13:30-15:00<br>Oral |
| **Iovino Dorotea**<br>Ocean modelling for climate research: the role of the CLIVAR OMDP | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P-06** |
| **Iskandar Iskhaq**<br>Observed Freshwater Dynamics in the Banda Sea | **Day 3 – Session 2**<br>11:00-12:30<br>Oral |
| **Islam Md. Anowarul**<br>Modelling the extreme rainfall induced flood hazard vulnerability in the north-eastern region of Bangladesh | **Day 3 – Session 4**<br>15:30-16:30<br>**Poster N° S4-P-05** |
| **Izumo Takeshi**<br>Key role of the MJO on humid heatwaves in the tropics and in southeast Asia: an opportunity for AI-based forecasting | **Day 3 – Session 6**<br>13:30-15:00<br>Oral |
| **Jia Gensuo**<br>Magnified urban heat island intensity during heatwaves in East Asia | **Day 3 – Session 7**<br>16:30-18:00<br>Oral |
| **Kartadikaria Aditya R.**<br>Quasi-convergence Conditions during Normal, El Niño, and La Niña Years for the Maritime Continent | **Day 3 – Session 8**<br>16:30-18:00<br>Oral |
| **Keenlyside Noel**<br>Atlantic and Benguela Niño predictable months in advance, After All! | **Day 3 – Session 6**<br>13:30-15:00<br>Oral |
| **Kiki Kiki**<br>Assessing the Socioeconomic Footprint of Tornado Events in Indonesia: A 14-Year Spatio-Temporal Impact Analysis (2010–2024) | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Krishnapillai Shadananan Nair**<br>Impact of warming Indian Ocean on different facets of life in India | **Day 3 – Session 9**<br>16:30-18:00<br>Oral |
| **Lennard Chris**<br>Could solar radiation management (SRM) ameliorate or exacerbate the impacts of climate change in Africa? | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Li Jianping**<br>Caribbean Sea Marine Heatwaves tied to Indian Ocean Marine Heatwaves | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |

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| **Li Yuxuan**<br>The dynamical mechanisms controlling the equilibrium state transition within the Mindanao-New Guinea Confluence | **Day 3 – Session 8**<br>15:30-16:30<br>**Poster N° S8-P-01** |
| **Liu Hailong**<br>Role of Salinity Barrier Layers on Atlantic Niño Events | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Luo Jing-Jia**<br>AI deep learning for climate forecasts | **Day 3 – Session 6**<br>13:30-15:00<br>Oral |
| **Maggero Balla**<br>Ocean Prediction Model for SSH and SST in the Western Indian Ocean using Deep Learning Technique | **Day 3 – Session 6**<br>15:30-16:30<br>**Poster N° S6-P-03** |
| **Makarim Salvienty**<br>Unique Patterns of the Indian Ocean Dipole events since 2019 | **Day 3 – Session 7**<br>15:30-16:30<br>**Poster N° S7-P-01** |
| **Mandal Shailendra**<br>Gaps and Challenges in Addressing the Societal Impact of Climate Variability and Climate Change in the Indian Coastal Metropolitan City due to Interactions with Complex Ocean and Atmospheric Processes: An Example of Bridging Science and Society in Southeast Asia and Beyond | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-02** |
| **Manjunatha Busnur**<br>Long-term rainfall variability along the west coast of India and its teleconnections | **Day 3 – Session 4**<br>15:30-16:30<br>**Poster N° S4-P-06** |
| **Martinez-Villalobos Cristian**<br>Accelerating increases in heat waves durations under global warming | **Day 3 – Session 7**<br>16:30-18:00<br>Oral |
| **Masagca Jimmy**<br>Bridging Science and Society through CLIVAR Initiative: Tropical Cyclones as a Catalyst for Coastal Fisheries and Mangrove Resilience in the Goni and Haiyan Corridors (Catanduanes and Aklan) in the Philippines | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Mbithi Daniel**<br>Spatial-Temporal Characteristics of Glacier Cover Over Mountains of Eastern Africa Region | **Day 3 – Session 7**<br>15:30-16:30<br>**Poster N° S7-P-05** |
| **Melet Angelique**<br>Coordinated regional ocean climate projections: why, where are we and where are we going? A CLIVAR-CORDEX task force | **Day 3 – Keynote**<br>10:05-10:30 |
| **Minobe Shoshiro**<br>Global and Regional Drivers for Exceptional Climate Extremes in 2023-2024: Beyond the New Normal | **Day 3 – Session 7**<br>16:30-18:00<br>Oral |

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| **Moise Aurel**<br>Southeast Asia's highest CMIP6-based convection permitting climate change projections todate | **Day 3 – Session 7**<br>16:30-18:00<br>Oral |
| **Morris Tamaryn**<br>Advancing Ocean20: Strengthening Science to Society initiatives through partnerships | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Mowsumi Tahrim Jannat**<br>Advancing Ocean Modeling in the Bay of Bengal: Validating FIO-COM and Assessing Nonbreaking Surface Wave-Induced Mixing Effects | **Day 3 – Session 2**<br>11:00-12:30<br>Oral |
| **Murty Sujata**<br>Drivers of Indo-Pacific upper ocean heat and freshwater variability: A synthesis of coral proxies and ocean models | **Day 4 – Breakout 3**<br>11:00-12:25<br>Oral |
| **Musyaffa Ahdan (presented on site by Kartadikaria Aditya R.)**<br>Characteristics of Internal Solitary Waves in the Lombok Strait and the Influence of the Indonesian Throughflow | **Day 3 – Session 8**<br>15:30-16:30<br>**Poster N° S8-P-02** |
| **Muthiah Krishnaveni**<br>Seawater Ingress Monitoring at River mouths due to tidal dynamics | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-05** |
| **Nakayama Yoshihiro**<br>Development of ECCO downscaled regional simulations of the Antarctic coastal seas | **Day 4 – Breakout 2**<br>11:00-12:25<br>Oral |
| **Nissen Cara**<br>Mapping sparse ocean observations: What can we learn from synthetic observing systems in models? | **Day 3 – Session 5**<br>13:30-15:00<br>Oral |
| **Nnamchi Hyacinth**<br>Predictable Equatorial Atlantic variability from atmospheric convection-ocean coupling | **Day 3 – Session 4**<br>13:30-15:00<br>Oral |
| **Oke Peter**<br>A data-driven approach to mesoscale ocean forecasting | **Day 3 – Session 6**<br>13:30-15:00<br>Oral |
| **Okumura Yuko**<br>Tropical basin interactions in changing climates since the Last Glacial Maximum | **Day 4 – Breakout 3**<br>11:00-12:25<br>Oral |
| **Permana Donaldi**<br>Modulation of Diurnal Rainfall Cycle by BSISO during Boreal Summer over western part of Indonesia and Southeast Asia | **Day 3 – Session 4**<br>15:30-16:30<br>**Poster N° S4-P-03** |
| **Pratama Khafid Rizki**<br>Dramatic effect of Indonesia Throughflow variability to cyclone events in the Banda Sea | **Day 3 – Session 8**<br>16:30-18:00<br>Oral |

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| **Prasetya Ratih**<br>Evaluation of NEX-GDDP-CMIP6 Model Performance in Simulating Precipitation Variability over Indonesia | **Day 3 – Session 1**<br>11:00-12:30<br>Oral |
| **Putu Hadi Wiguna Pande**<br>Enhancing Spatial Analysis of Sea Level Rise in the Bali-Lombok Sea Using Marine AWS, Tide Gauge, Satellite Altimetry, and Numerical Model Integration | **Day 3 – Session 2**<br>11:00-12:30<br>Oral |
| **Rachmayani Rima**<br>Study of the Depth of Thermocline (DOT) Based on Planktonic Foraminifera Abundance During the Younger Dryas Period in the Makassar Strait | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P-03** |
| **Rahaman Hasibur**<br>Ocean reanalysis inter-comparison over the global Ocean | **Day 3 – Session 5**<br>13:30-15:00<br>Oral |
| **Ramaraju Hk**<br>Climatic Control on the Variability of Atmospheric Constituents in the Anthropogenically-dominated Monsoon Trough Region of India | **Day 3 – Session 1**<br>11:00-12:30<br>Oral |
| **Rashid Harun**<br>Impacts of regional aerosol forcing uncertainty on the simulated historical global warming | **Day 4 – Breakout 1**<br>11:00-12:25<br>Oral |
| **Rath Subhrajit**<br>Hybrid Approach: Combining Physical and CNN-Based Cloud Fraction Parametrizations for Enhanced NWP Performance | **Day 3 – Session 6**<br>13:30-15:00<br>Oral |
| **Richter Ingo**<br>Introducing TBIMIP: The Tropical Basin Interaction Model Intercomparison Project | **Day 3 – Session 4**<br>15:30-16:30<br>**Poster N° S4-P-01** |
| **Ripaldi Adi**<br>Spatial Distribution and Prediction of Extreme Rainfall Over Indonesia for supporting Key Pilar of Indonesia Early Warning for Al | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Rykova Tatiana**<br>ENSO-driven variability of water masses in the Tasman Sea | **Day 3 – Session 8**<br>16:30-18:00<br>Oral |
| **Salamena Gerry**<br>ENSO-controlled coastal upwelling off north New Guinea regulates interannual deep-water renewal in Kao Bay, Halmahera Island of Western Equatorial Pacific | **Day 3 – Session 8**<br>16:30-18:00<br>Oral |
| **Sangeetha R**<br>Empowering Communities in Tamilnadu: Human Dimensions and Foresight of Oceanic and Climatic Shifts | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Santosa dhafin Delano Rizqi (presented on site by Kartadikaria Aditya R.)**<br>A Strategic Approach to Marine Protected Areas Based on Larval Connectivity in the Lombok Strait | **Day 3 – Session 3**<br>15:30-16:30<br>**Poster N° S3-P-03** |

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| **Satyaban Bishoyi Ratna**<br>Linking Large-Scale Climate Drivers to Hydroclimate Variability over South Asia | **Day 4 – Breakout 1**<br>11:00-12:25<br>Oral |
| **Shoichiro Kido**<br>Emulating GCM Experiments with reduced-complexity models: Insights into tropical interbasin interactions | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Sinaga Azka Afta Tarissa**<br>Intraseasonal Sea Level Variability in the Java Sea and Its Ocean-Atmosphere Driving Mechanisms | **Day 3 – Session 8**<br>16:30-18:00<br>Oral |
| **Singh Shikha**<br>Salinity characteristics during Marine Heatwaves in Bay of Bengal | **Day 3 – Session 8**<br>15:30-16:30<br>**Poster N° S8-P-03** |
| **Siregar Plato**<br>An Application of WRF-ARW/WRF Hydro Model Coupled in Flood Simulation in South Tapanuli Region (Case Study 12 - 15 March 2025) | **Day 4 – Session 12**<br>08:30-10:30<br>Oral |
| **Smrati Gupta**<br>Assessing Carbon Sink Dynamics in India: Projections from Climate Models | **Day 3 – Session 3**<br>15:30-16:30<br>**Poster N° S3-P-05** |
| **Smith Katie**<br>Impacts of the unprecedented global marine heatwaves in 2023 and 2024 | **Day 4 – Breakout 1**<br>11:00-12:25<br>Oral |
| **Song Fengfei**<br>Hot season gets hotter due to rainfall delay over tropical land in a warming climate | **Day 3 – Session 1**<br>11:00-12:30<br>Oral |
| **Stanev Emil**<br>Regional water mass transformation due to global climate change | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P-01** |
| **Stuecker Malte**<br>Interactions between Pacific and Indian Ocean interannual variability | **Day 4 – Breakout 3**<br>11:00-12:25<br>Oral |
| **Sudharson G**<br>Climate Change induced Sea Level Rise and Coastal flooding Vulnerability in Chennai region, TamilNadu | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-01** |
| **Suhita Ni Putu Asri Ratna**<br>Variability of Net Primary Productivity in the Northwest Atlantic from a Multi-Datasets Perspective | **Day 3 – Session 3**<br>11:00-12:30<br>Oral |
| **Supari Supari**<br>El Niño 2023/24 and the Skill of Drought Warning Issued by BMKG | **Day 3 – Keynote**<br>09:40-10:05 |
| **Surya Dharma Candrasa (presented on site by Kartadikaria Aditya R.)**<br>Tidal Reconstruction of Three Cruise Ships Harbouring Simultaneously in Benoa Harbour in Respect to Modern Navigation File S-100 | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-04** |

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| **Susanto Raden Dwi**<br>Indonesian Throughflow Monitoring Program: Past, Present, and Future | **Day 4 – Breakout 3**<br>11:00-12:25<br>Oral |
| **Tiwari Mayank (presented on site by Aadhar Saran)**<br>Risk of Extreme Precipitation on Dam Infrastructure under changing climate over India | **Day 3 – Session 9**<br>15:30-16:30<br>**Poster N° S9-P-03** |
| **Tuchen Franz Philip**<br>Strengthening of the equatorial Pacific upper-ocean circulation over the past three decades | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |
| **Turkington Thea**<br>Monitoring ENSO under a warming climate: Southeast Asia Perspective | **Day 3 – Session 7**<br>15:30-16:30<br>**Poster N° S7-P-03** |
| **Urakawa Shogo**<br>A new ocean regional projection dataset with 10 km resolution for the North Pacific d4PDFv2-Ocean and its application to coastal downscale modeling around Japan | **Day 3 – Session 5**<br>15:30-16:30<br>**Poster N° S5-P05** |
| **Vasubandhu Misra**<br>The Modulation of the Diurnal Variations by the Intraseasonal Oscillations of the Indian Summer Monsoon | **Day 3 – Session 1**<br>11:00-12:30<br>Oral |
| **Wahyudi A'an Johan**<br>Hindcast-based BGC+ Index Simulation for Acidification and Eutrophication Monitoring | **Day 3 – Session 3**<br>11:00-12:30<br>Oral |
| **Wamba Tchinda Claudin**<br>The influence of intraseasonal oscillations on rainfall variability over Central Africa: case of the 25–70 days variability | **Day 3 – Session 4**<br>15:30-16:30<br>**Poster N° S4-P-04** |
| **Wang Chunzai**<br>Remote Triggering of a North Pacific Marine Heatwave by the 2022 Indian Summer Monsoon | **Day 4 – Breakout 1**<br>11:00-12:25<br>Oral |
| **Wang Xin**<br>Unveiling the role of South Tropical Atlantic in winter Atlantic Niño inducing La Niña | **Day 3 – Session 4**<br>13:30-15:00<br>Oral |
| **Wang Zheng**<br>Transport and Variation of the Indonesian Throughflow at Halmahera Sea through Jailolo and Gebe Straits | **Day 3 – Session 2**<br>11:00-12:30<br>Oral |
| **Wiratmo Joko**<br>Projection of Climate Change Impact on Oldeman Climate Classification in Indonesia | **Day 3 – Session 9**<br>16:30-18:00<br>Oral |
| **Yang Jiwei**<br>Tracking climate impacts on kuroshio marine fish communities using environmental DNA | **Day 3 – Session 3**<br>11:00-12:30<br>Oral |
| **Yu Jin-Yi**<br>Understanding 21st-Century ENSO Complexities: The Interplay of Tropical and Subtropical ENSO Dynamics | **Day 4 – Session 10**<br>08:30-10:30<br>Oral |

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| **Yu Weidong**<br>Robust Yet Diverse Southern Ocean Teleconnection from Antarctic Meltwater: Insights from SOFIA | **Day 4 – Breakout 2**<br>11:00-12:25<br>Oral |
| **Zhao Sen**<br>Towards Explainable El Niño Predictions and Understanding Climate Model Biases | **Day 3 – Session 6**<br>13:30-15:00<br>Oral |
| **Zhang Lei**<br>Positive Indian Ocean Dipole Intensifies Marine Heatwaves along the West African Coast | **Day 4 – Session 11**<br>08:30-10:30<br>Oral |
| **Zhou Hui**<br>Significant Intraseasonal Variability of Surface Chlorophyll-a in the Western Pacific Western Boundary Current System | **Day 3 – Session 3**<br>15:30-16:30<br>**Poster N° S3-P-01** |
| **Zinke Jens**<br>Indonesian Throughflow salinity and SST variability since the 1750s | **Day 3 – Session 2**<br>11:00-12:30<br>Oral |

## List of presentations at the Pan-CLIVAR Meeting

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| **Deppenmeier Anna-Lena**<br>Towards reliable SST predictions in the Tropical Pacific Cold Tongue | **Plenary – 23 Sept.**<br>17:00-18:00<br>Oral |
| **Kuhn Angela**<br>Understanding regional pCO2 model biases and uncertainties in the Biogeochemical Southern Ocean State Estimate (B-SOSE) | **Plenary – 23 Sept.**<br>17:00-18:00<br>Oral |
| **Lennard Chris**<br>Connecting the WCRP Academy and the CLIVAR Community | **Plenary – 23 Sept.**<br>08:30-09:30<br>Oral |
| **Lovenduski Nicole**<br>The impact of storms on Southern Ocean energy and carbon cycling | **Plenary – 26 Sept.**<br>08:30-10:30<br>Oral |
| **Staneva Joanna**<br>Digital Twins of the Ocean for Sustainable and Climate-Responsive Marine Management | **Plenary – 26 Sept.**<br>08:30-10:30<br>Oral |
| **Tangang Fredolin**<br>CORDEX Southeast Asia Climate Projections and Their Relevance to Society | **Plenary – 23 Sept.**<br>17:00-18:00<br>Oral |