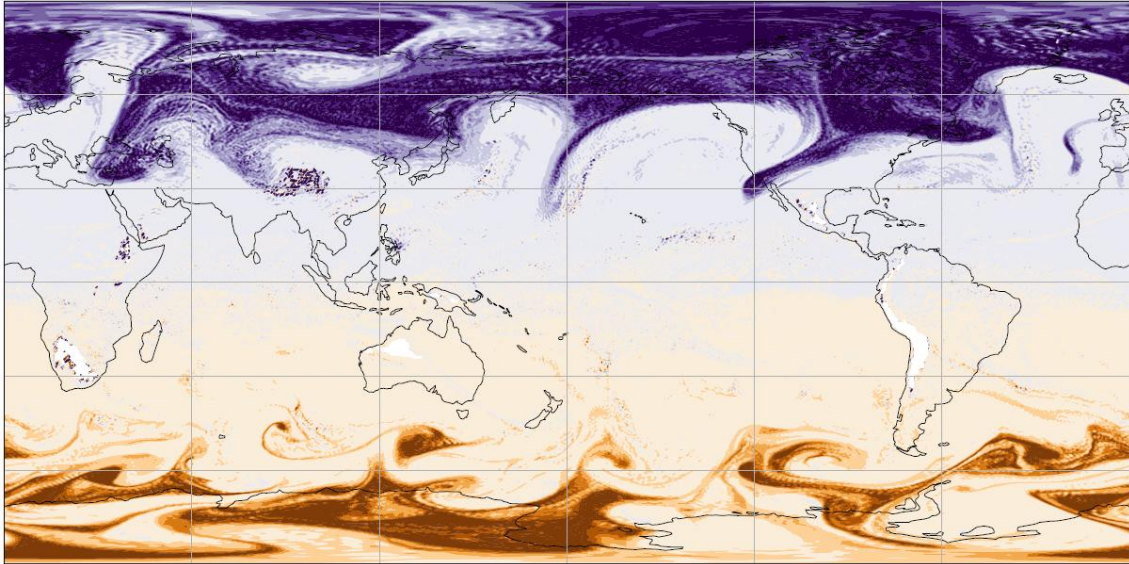


Workshop on Oceanic and Atmospheric Simulation 2026

Date: November 20–21, 2026

Venue: Nagoya University, Higashiyama Campus



Scientific Organizing Committee (SOC):

Tomomichi Ogata (Chair of SOC, Japan Agency for Marine-Earth Science and Technology)

Akira Yamazaki (JAMSTEC)

Ayako Yamamoto (Rikkyo University)

Shoichiro Kido (JAMSTEC)

Shiori Sugimoto (JAMSTEC)

Tomoe Nasuno (JAMSTEC)

Local Organizing Committee (LOC):

Hidegori Aiki (Chair of LOC, ISEE, Nagoya University)

Nao Sasaki

Yoko Yamada

Hana Okuda

Organized by [Institute for Space-Earth Environmental Research \(ISEE\)](#) & [JAMSTEC](#)

In cooperation with [Habitable Japan](#)

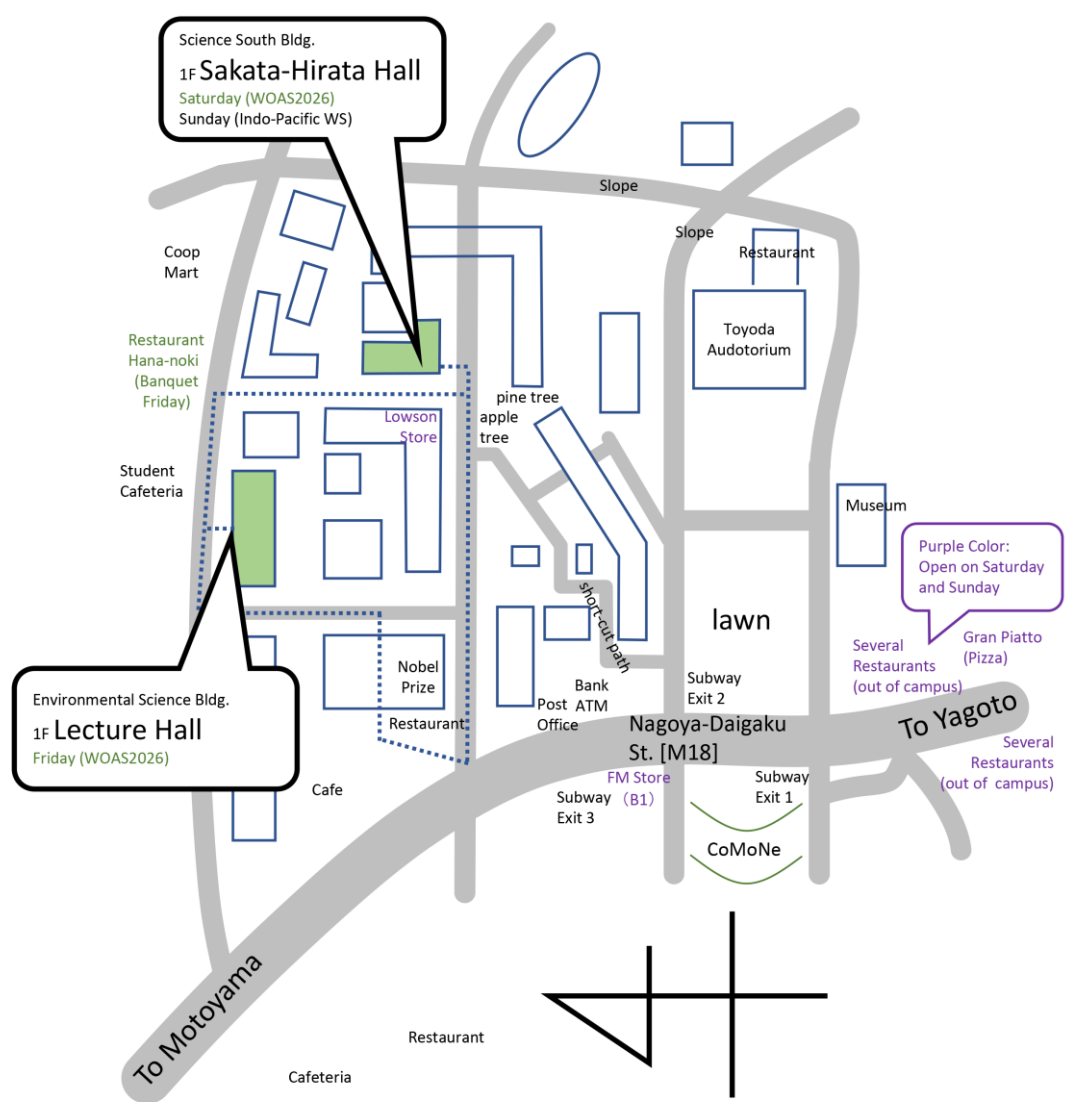
Preface for the Workshop on Oceanic and Atmospheric Simulation 2026

The workshop aims to bring together scientists from a broad range of atmospheric and ocean sciences to promote scientific exchange and collaboration across different research fields. Building on the legacy of the OFES Workshops, this workshop provides an opportunity to share recent advances in numerical modeling, data analysis, and observational studies, and to explore new perspectives on atmospheric and oceanic processes. OFES (Ocean General Circulation Model for the Earth Simulator) is a near-global eddy-resolving ocean model that has been widely used by ocean researchers worldwide since the publication of Masumoto et al. (2004). Since the first OFES Workshop in 2008, research findings obtained using OFES and the value of OFES datasets have been widely disseminated through international conferences, including the OFES Workshops, and scientific publications.

The workshop focuses on a wide range of topics, including air–sea interactions, atmospheric and oceanic dynamics, biogeochemical processes, and extreme weather events. These topics encompass diverse spatial and temporal scales, from regional to global, and approaches ranging from fundamental theoretical investigations to practical applications. Numerical modeling, from idealized experiments to high-performance simulations, plays a central role in understanding these complex processes. Advances in data assimilation, theoretical and statistical analysis, and data visualization further contribute to interpreting model outputs and observational data. Observational studies are also essential for evaluating, constraining, and improving numerical models.

Through presentations and discussions covering these diverse approaches and research topics, the workshop seeks to strengthen interactions among researchers, encourage interdisciplinary collaboration, and advance our understanding of the atmosphere–ocean system.

Campus Map and Workshop Venue



Instructions for presenters

[Oral]

Day 1, November 20, Friday: Lecture Hall (Environmental Science Bldg.)

Day 2, November 21, Saturday: Sakata-Hirata Hall (Science South Bldg.)

	1 st ring	2 nd ring (End of presentation)	3 rd ring (End of discussion)
Invited talk (30-min)	20 min	25 min	30 min
Invited talk (25-min)	15 min	20 min	25 min
Others (20-min)	12 min	15 min	20 min

[Poster Display]

Day 1, November 20, Friday:

11:40~15:30, Lecture Hall (Environmental Science Bldg.)

16:40~17:45, Sakata-Hirata Hall (Science South Bldg.)

Day 2, November 21, Saturday:

11:10~13:10, Sakata-Hirata Hall (Science South Bldg.)

The poster size should be A0 (84 cm wide × 119 cm high, portrait orientation).

Posters can be displayed from 11:40 on Friday, November 20 (Day 1).

After 15:30 on Day 1, LOC members will move all posters from the Lecture Hall to Sakata-Hirata Hall.

Schedule

Day 1: November 20, Friday (Lecture Hall, Environmental Science Bldg.)

Session 1: Weather & Climate Dynamics (Chair: Tomoe Nasuno (tentative))

10:05-10:30 Takeshi Enomoto (invited), Kyoto University

Accurate and efficient spherical transform methods for high-resolution atmospheric dynamical cores

10:30-11:00 Thomas Rackow (invited), ECMWF

Global Kilometre-Scale Coupled Earth System Simulations: New Opportunities for Ocean-Atmosphere Interaction Research

11:00-11:20 Ayako Yamamoto, Rikkyo University

Impact of future Northern Hemisphere atmospheric wave events on surface temperature

11:20-11:40 Yoko Yamagami, JAMSTEC

Investigating midlatitude North Pacific marine heatwaves using an eddy-permitting coupled model

11:40-13:10 lunch/poster

Session 2: Multi-scale Ocean Dynamics 1 (Chair: Tomomichi Ogata (tentative))

13:10-13:35 Yukio Masumoto (invited), The University of Tokyo

The background history behind OFES

13:35-14:00 Hideharu Sasaki (invited), JAMSTEC

A series of OFES Eddying Ocean Simulations

14:00-14:20 Shuya Wang, AIMEC, Tohoku University

Submesoscale topographic wake behind the Hirase Seamount in the Tokara Strait: energy cascade and instability

14:20-14:40 Xinyu Guo, Ehime University

Interannual Variability of Surface Nutrients in the North Pacific and Its Controlling Mechanisms

14:40-15:00 Bunmei Taguchi, University of Toyama

Marine surface air temperature suppression and its response to climate change

15:00-15:30 coffee break

Session 3: Air-sea Interaction 1 (Chair: Shiori Sugimoto (tentative))

15:30-16:00 Iam-Fei Pun (invited), National Central University, Taiwan

Suppression of marine heatwave activity by tropical cyclone-induced upper ocean cooling

16:00-16:20 Rintaro Nakano, The University of Tokyo

Spatiotemporal variability of deep-cycle turbulence in the equatorial Pacific associated with ENSO

16:20-16:40 Risa Furusawa, The University of Tokyo

Role of Preceding Wind Forcing and Oceanic Wave Propagation in the Different Evolution of Canonical El Niño and El Niño Modoki

16:40-17:45 coffee break/**poster**

17:45 close

18:00 WOAS2026 Banquet (Restaurant Hana-noki)

Day 2: November 21, Saturday (Sakata-Hirata Hall, Science South Bldg.)

Session 4: Air-sea Interaction 2 (Chair: Ayako Yamamoto (tentative))

9:00-9:30 Malte F. Stuecker (invited), University of Hawaii at Manoa

Global climate mode resonance due to rapidly intensifying El Niño-Southern Oscillation

9:30-9:50 RAKESH TEJA KONDURU, EORC, JAXA

Unravelling the Heavy Precipitation Prediction over Yakushima & its neighborhoods through Precipitation Data Assimilation and Ocean-Atmosphere Interactions over the Takara Strait Kuroshio region

9:50-10:10 Arunkumar R, Central University of Rajasthan, India & Kagawa University, Japan

Sensitivity Analysis of Microphysics Parameterizations for High-Resolution Rainfall Simulation using the WRF-Urban Model

10:10-10:30 Tomoki Tozuka, The University of Tokyo

Generation Mechanisms of Coastal El Niño: Role of the Coastal Bjerknes Feedback Revealed by Regional Ocean Model Experiments

10:30-10:50 Masami Nonaka, JAMSTEC

Does the subsurface ocean affect sea surface temperature anomalies in summer over the North Pacific?

10:50-11:10 Kento Usui, The University of Tokyo

Roles of mesoscale air-sea interactions in the Kuroshio Extension revealed by an ocean model

11:10-13:10 group photo/lunch/**poster**

Session 5: Air-sea Variability & its Application (Chair: Akira Yamazaki (tentative))

13:10-13:40 VO LUONG Hong Phuoc (invited), Viet Nam National University, Ho Chi Minh city

From Hydrodynamics to Coastal Resilience: Understanding Mangrove–Coast Interactions in Southern Vietnam

13:40-14:00 Yuchun Lin, National Taiwan Ocean University

The Influence of Environments on the Intensity Change of Typhoon Soudelor

14:00-14:20 Ning Li, University of Hawaii at Manoa

Short term and extended range wave forecasting for Hawaii

14:20-14:40 Shiori Sugimoto, JAMSTEC

Influence of SST and Topography on Extreme Precipitation during Typhoon Hagibis (2019)

14:40-15:00 Yoo-Jun Kim, AORI, The University of Tokyo

The Role of Time- and Spatially Varying Wind in Coastal Circulation Based on High-Resolution Oceanic and Atmospheric Simulations

15:00-15:25 coffee break

Session 6: Multi-scale Ocean Dynamics 2 (Chair: Shoichiro Kido (tentative))

15:25-15:45 Motoki Nagura, JAMSTEC

Triad resonance between vertically propagating equatorial waves in an idealized OGCM

15:45-16:05 Yusuke Terada, JAMSTEC

Vertical phase propagation of the Equatorial Deep Jets

16:05-16:25 Takeshi Anami, The University of Tokyo

A Decadal Regime Shift in the Hemispheric Asymmetry of the Subtropical Cells Associated with Tropical Pacific Decadal Variability

16:25-16:45 Nan Yuan, WPI—AIMEC (Tohoku Uni.)

Barotropic water exchange between the ice cavity and the open ocean in an inviscid and frictionless fluid

16:45-17:05 Muh. Nur Hidayat, National Research and Innovation Agency (BRIN)

Multi-Constituent Tidal Modulation of Sea Level and Circulation in the Northern Bay of Bengal: A Year-Long ROMS Experiment

17:05-17:25 Borui Wu, Nagoya University

A Hadley Ascending Cloudless Zone in the Southeastern Tropical Pacific Shapes ENSO Wave Dynamics

(19:00 Indo-Pacific WS icebreaker (If attending, TBD, Sakae-area))

Poster session list

1 Xinru Li, Advanced Institute for Marine Ecosystem Change
Exploring Global Upper Ocean Marine Heatwaves in Coupled GFDL

2 Taek-Bum Jeong, Pusan National University
Assessing Tropical Inter-basin Connections Through SST Restoring Experiments

3 Peien Xu, The University of Tokyo
Phase-Dependent Mixed-Layer Heat Budget of Tropical Instability Waves in the Eastern Equatorial Pacific

4 Nobumasa Komori, Keio University
An intercomparison of eddy-resolving ocean reanalyses in the western North Pacific

5 Yoshikazu Sasai, JAMSTEC
Decadal variability of simulated phytoplankton and nitrate distributions over the North Pacific Ocean

6 Shuhei Matsugishi, Atmosphere and Ocean Research Institute, The University of Tokyo
Development of a Model for High-Resolution Climate Simulation Combining MIROC and NICAM

7 Akira Yamazaki, JAMSTEC
Importance of representing stormtrack activity on simulating Northern Hemisphere blocking

8 Hiromichi Sato, Atmosphere and Ocean Research Institute, The University of Tokyo
Growth and Decay Patterns of Mesoscale Eddies

9 Chuyuan Zhuang, Kyushu University
Weakened Seasonality of Mixed Layer Temperature along the East China Sea Kuroshio

10 Gaku Nishihira, RIAM, Kyushu University
Variability of the Tsushima Warm Current transport by the Pacific Decadal Oscillation and subpolar winds

11 Terushi Tada, The University of Aizu

Why did the 2015 El Niño impacts not materialize? Disentangling ENSO, IOD, and decadal variability

12 Hill Kento, Hokkaido University

Influence of wind forcing on Gulf Stream path variability and its nonstationary relationship with the North Atlantic Oscillation

13 Shinnosuke Yoshida, Hokkaido University

Frictional versus Buoyancy Control on the Energetics of the Antarctic Circumpolar Current

14 Aparna Raut, Japan Meteorological Corporation

A Multimodal Meta-Learning Framework to Predict Streamflow Drought Onset from Large-Scale Atmospheric Triggers and Catchment Characteristics

15 Hidenori Aiki, Nagoya University

Strong downward wave energy transfer over Shenyang in winter

Oral Presentations (Day 1)

Session 1: Weather & Climate Dynamics

Accurate and efficient spherical transform methods for high-resolution
atmospheric dynamical cores

[Invited] Takeshi Enomoto (Kyoto University)

High performance computers, such as the Earth Simulator, enable km-scale atmospheric simulations that resolve sub-synoptic scales and upscale energy cascades, fostering realistic multi-scale interactions. Atmospheric general circulation models using the spectral transform method have long served as the de facto standard for numerical weather prediction and climate projection due to their high accuracy and efficiency. However, these spectral models encounter severe bottlenecks at high resolutions stemming from the computational cost of the spherical transform, which scales with the cube of the truncation wave number N , and of the numerical errors of the associated Legendre functions (ALFs).

This talk presents a method to compute ALFs based on the four-term recurrence formula using double-precision arithmetic, enabling stable spherical transforms at a large truncation wave number $N > 1700$ [1]. Furthermore, a novel scalar and vector spherical transform approach using double Fourier series on the sphere is proposed. By eliminating the explicit computation of ALFs, this approach reduces transform errors by a few orders of magnitude [2]. Although the computational complexity remains $O(N^3)$, the prefactor is reduced, making it several times lower than the traditional methods.

References

Enomoto, T., 2015: Comparison of computational methods of associated Legendre functions. SOLA, 11, 144–149, doi:10.2151/sola.2015-033.

Nomura, S., and T. Enomoto, 2027: An Efficient and Stable Solver for the Shallow Water Equations on Regular Latitude-Longitude Grids Using Spherical Fourier Transforms. Computational Science and Its Applications – ICCSA 2026 Workshops, O. Gervasi, B. Murgante, C. Garau, A.M.A.C. Rocha, M.N. Faginas Lago, A.C. Braga, and Y. Karaca, Eds, Cham, Springer Nature Switzerland, 117–134, doi:10.1007/978-3-032-30539-8_8.

Session 1: Weather & Climate Dynamics

Global Kilometre-Scale Coupled Earth System Simulations: New Opportunities for Ocean-Atmosphere Interaction Research

[Invited] Thomas Rackow (ECMWF)

Recent advances in computing and Earth system modelling are enabling fully coupled global simulations at kilometre-scale resolution. International efforts such as the 2025 Global Kilometre-Scale Hackathon (HK25), nextGEMS, EERIE, and Destination Earth (DestinE) are driving the development of a new generation of models capable of explicitly representing key atmospheric and oceanic processes across a wide range of scales.

As part of HK25, ECMWF produced two global coupled IFS-FESOM simulations and one atmosphere-only IFS (AMIP) simulation, representing some of the highest-resolution global Earth system simulations currently available. The coupled simulations employ a fully coupled atmosphere-ocean-sea-ice configuration with 2.8 km atmospheric resolution and approximately 5 km ocean resolution. This enables the explicit representation of processes such as atmospheric deep convection, mesoscale ocean eddies, tropical cyclone cold wakes, and fine-scale sea-ice structures. The two coupled experiments differ only in their treatment of atmospheric deep convection, providing a unique framework for investigating its role in coupled climate and weather phenomena. To facilitate distributed analysis during HK25, cloud-ready Zarr datasets on the HEALPix grid were generated, enabling efficient remote access and analysis across hackathon sites worldwide. The resulting data have supported a range of initial case studies and provide a valuable resource for the wider research community.

These simulations will form a core contribution to the forthcoming DYAMOND3 intercomparison and are among the first fully coupled global simulations conducted at this scale within a coordinated international framework. Beyond model intercomparison, they offer unprecedented opportunities to investigate ocean-atmosphere interactions, including air-sea fluxes, mesoscale SST-atmosphere coupling, tropical cyclone-ocean feedbacks, and the influence of ocean variability on weather and climate extremes. The presentation will introduce the simulation framework, data infrastructure, and selected early scientific results, and discuss the role of kilometre-scale coupled modelling within the broader vision of Destination Earth.

Session 1: Weather & Climate Dynamics

Impact of future Northern Hemisphere atmospheric wave events on surface temperature

Ayako Yamamoto (Rikkyo University)

The link between atmospheric waviness and extreme weather events carries significant socioeconomic implications. However, future atmospheric waviness trends remain elusive due to uncertainties arising from the diversity of existing definitions and the lack of sufficient dynamical formalism in existing metrics. In this study, we employ the local wave activity (LWA) metric, whose prognostic equation explicitly links wave activity tendencies to physical forcing mechanisms, and apply it to ERA5 and HighResMIP. By extracting persistent, large-scale anticyclonic and cyclonic waviness events, we assess future changes in their statistics and examine future surface temperature changes associated with these waviness events in the wintertime Northern Hemisphere. The results reveal that in the future climate, while the frequency of the waviness events of both polarities tend to decrease compared to the current climate, associated temperature anomalies nevertheless intensify when compared to their respective climatological states. Thus, our results propose an alternative mechanism for the projected increase in temperature variability in the future, such that stronger thermal anomalies arise in association with increasingly transient midlatitude circulation. In this talk, we will further explore the physical drivers behind the temperature change using temperature budget analysis.

Session 1: Weather & Climate Dynamics

Investigating midlatitude North Pacific marine heatwaves using an eddy-permitting coupled model

Yoko Yamagami (JAMSTEC)

The mid-latitude North Pacific has experienced pronounced warming since 2020, accompanied by frequent marine heatwaves (MHWs) and extreme summer temperatures around East Asia. Using a climate model coupled to an eddy-permitting ocean model, we show that mid-latitude North Atlantic sea surface temperature (SST) anomalies amplified MHWs in the Kuroshio–Oyashio Extension (KOE) region and extreme summer temperature anomalies around Japan. The simulations indicate that forcing from the North Atlantic amplifies KOE SST anomalies, whereas differences among the scenario experiments are likely attributable to anthropogenic aerosol forcing. Both anthropogenic aerosol forcing and the influence from the North Atlantic weaken the Aleutian Low, contributing to a northward shift of the Kuroshio Extension. In 2023, the North Atlantic influence further increased the occurrence of MHWs and the probability of extreme summer temperature anomalies around Japan. Interestingly, these effects are weaker in low-resolution simulations.

Session 2: Multi-scale Ocean Dynamics 1

The background history behind OFES

[Invited] Yukio Masumoto (The University of Tokyo)

OFES is a high-resolution, long-term prognostic ocean model, whose outputs are widely utilized by many researchers worldwide. The first version of OFES was developed particularly for the first-generation Earth Simulator, which began operations in 2002. In this presentation, some background stories on my commitment to the development of the first version of OFES is introduced to share information of the early OFES activities. Some results on the upwelling system off Java/Sumatra Islands revealed from the OFES results and future perspectives in ocean modeling will also be discussed.

Session 2: Multi-scale Ocean Dynamics 1

A series of OFES Eddy Ocean Simulations

[Invited] Hideharu Sasaki (JAMSTEC)

In the early 2000s, it was crucial to represent oceanic mesoscale eddies and fronts in global ocean models. OFES based on MOM3 was developed to conduct near-global eddying ocean simulations at a horizontal resolution of 0.1° using the 1st generation of Earth Simulator (ES). With support from several researchers and NEC technical staffs, a 50-year climatological run was conducted (Masumoto et al. 2004). Following it, a hindcast simulation forced by NCEP reanalysis data from 1950 (Sasaki et al. 2006) was conducted to investigate various oceanic phenomena. Based on the collaboration with the IPRC, the outputs are open to the public from the APDRC. The hindcast run also simulates CFC-11, which represents the pathway of meridional overturning circulations (Sasai et al. 2004). Another OFES hindcast simulation with the NPZD model forced by QuikSCAT satellite observations represents well the oceanic phenomena influenced by orographic winds (Sasaki and Nonaka 2006, Sasai et al. 2007).

Additionally, North Pacific OFES has been conducted. The 2nd generation of the ES enabled to conduct the North Pacific OFES at a horizontal resolution of $1/30^\circ$, which permits submesoscale circulations. The seasonality of submesoscale circulations, strong in winter, is demonstrated. Furthermore, an upscale energy cascade from submesoscale to larger scales is suggested (Sasaki et al. 2014).

OFES was upgraded in 2020 and named OFES2 (Sasaki et al. 2020). OFES2 includes the sea-ice model (Komori et al. 2005), a tidal parameterization (St. Laurent et al. 2002), and the vertical mixing scheme is replaced to represent the upper ocean more realistically (Noh and Kim, 1999). OFES2 is forced by JRA55-do, which is not extended after Jan 2024. The atmospheric data should be replaced to extend OFES2 further. OFES2 is mostly the same as the ocean model in CFES. Hopefully, not only OFES2 but also CFES will continue to help our research activities in the future.

The updated ES3 and ES4 enable us to conduct the ensemble simulations using OFES and OFES2. The ensemble simulations, forced by the same atmospheric data but starting from slightly different initial conditions, suggest the predictability of ocean circulation, such as the Kuroshio Extension (Nonaka et al. 2016, 2020). It is expected that various experiments using OFES are conducted using the next ES coming soon.

Session 2: Multi-scale Ocean Dynamics 1

Submesoscale topographic wake behind the Hirase Seamount in the Tokara Strait: energy cascade and instability

Shuya Wang (AIMEC, Tohoku University)

Submesoscale topographic wakes are generated when background flows encounter topographic features like seamounts and islands. By performing high-resolution numerical simulations, this study explores the topographic wake of the Hirase Seamount in the Tokara Strait, where the strong Kuroshio Current passes through. The kinetic energy (KE) budget analysis based on the coarse-graining approach demonstrates that the cross-scale KE flux rather than the buoyancy flux is the primary energy source for mixing in the wake, particularly in the recirculation region on the left side of the Kuroshio axis. The horizontal (strain and divergent) and vertical components of KE flux contribute comparably to the total downscale KE flux at scales smaller than 5 km, and the fact does not change whether the semidiurnal tidal current is included or not. High KE dissipation rates are mostly found in the regions with negative potential vorticity (PV), although some high values appear in the positive PV zones where shear instability occurs. Further submesoscale instability diagnosis, based on PV or PV with curvature effect, suggests that the hybrid centrifugal/symmetric instability dominates in the wake, consistent with the fact that horizontal and vertical terms of energy flux are equally important in the forward energy cascade. The results of this study provide a direct, quantitative insight into the energy cascade and highlight the overlooked role of symmetric instability in driving the forward energy cascade and hence mixing in the topographic wake.

Session 2: Multi-scale Ocean Dynamics 1

Interannual Variability of Surface Nutrients in the North Pacific and Its Controlling Mechanisms

Xinyu Guo (Ehime University)

Surface nutrients in the North Pacific play a crucial role in regulating marine primary productivity and ecosystem structure. Their spatiotemporal variability reflects the coupling between physical processes and biogeochemical cycles and is therefore essential for understanding variations in marine ecosystems and primary productivity. However, due to limitations in the spatial and temporal coverage of observational data, the mechanisms driving interannual variability of nutrients in the North Pacific remain insufficiently understood.

In this study, we used the monthly results of a physical–biogeochemical coupled model (OFES2-NPZD) to investigate the interannual variability of surface dissolved inorganic nitrogen (DIN) in the North Pacific during a period of 1981–2020. The surface DIN from model exhibits pronounced interannual variability with significant regional differences. In the subarctic region north of 40°N, the standard deviation is high and exceeds 1 mmol m⁻³. The variability is higher in the eastern subarctic Pacific than in the western subarctic Pacific. In the mid-latitude region (30°–40°N), the standard deviation is generally above 0.1 mmol m⁻³, whereas in the low-latitude region south of 30°N, it is below 0.01 mmol m⁻³.

Empirical Orthogonal Function (EOF) analysis is performed on the surface DIN time series after removing the seasonal cycle and linear trend. The time series of the first two modes (PC1 and PC2) are significantly correlated with the PDO and NPGO index, indicating a strong influence of climate modes. EOF1 exhibits a pronounced meridional dipole pattern: during the positive phase of PC1, DIN concentrations decrease in the subarctic region but increase in the mid- and low-latitude regions, primarily driven by changes in mixed layer depth. EOF2 shows a zonal dipole pattern: during the positive phase of PC2, DIN increases in the eastern Pacific and decreases in the western Pacific, mainly associated with horizontal advection. In addition, upwelling, Kuroshio transport, and local biogeochemical processes also contribute to the interannual variability of DIN.

Session 2: Multi-scale Ocean Dynamics 1

Marine surface air temperature suppression and its response to climate change

Bunmei Taguchi (University of Toyama)

Surface air temperature (SAT) over the oceans is commonly assumed to closely track sea surface temperature (SST). Using buoy observations, atmospheric reanalysis, and a climate model simulation, we show that this coupling breaks down across broad, persistently convective regions of tropical oceans. Importantly, this departure is not confined to transient convective cooling events: it persists in monthly and longer-term averages, producing a systematic suppression of marine SAT relative to SST. Analysis of daily variability indicates that this mean SST–SAT disequilibrium arises not primarily from the strongest individual cooling events, but from the frequent recurrence of precipitation-associated convective cooling. Repeated convective cooling thus provides a weather-to-climate rectification mechanism that leaves a persistent imprint on marine SAT.

Because SAT suppression is maintained by recurrent convective cooling, changes in background SST and convective conditions may modulate the strength of SAT suppression and thereby alter how efficiently ocean warming is communicated to the marine atmospheric boundary layer. Preliminary analyses of a subset of CMIP6 historical and future simulations suggest that regions warming more strongly than the tropical mean tend to experience increased convective precipitation, accompanied by an enhanced SST–SAT disequilibrium. These results suggest that changes in convective activity provide a pathway through which spatially heterogeneous ocean warming can modify the SST–SAT disequilibrium.

Session 3: Air-sea Interaction 1

Suppression of marine heatwave activity by tropical cyclone-induced upper ocean cooling

[Invited] Iam-Fei Pun (National Central University, Taiwan)

Marine heatwaves (MHWs) have drawn substantial scientific attention due to their profound biological and economic impacts, especially in the context of climate change. This study highlights the crucial role of tropical cyclones (TCs) in disrupting MHWs by altering ocean temperatures. As demonstrated by Tropical Cyclone Bavi, intense sea surface temperature (SST) cooling, reaching up to 7°C, immediately terminated a mature MHW and suppressed subsequent MHW development for up to eight months. More generally, based on post-TC MHW cases (reoccurring within one month) during 2014-2023, we discovered that MHW disruption duration is proportional to the magnitude of TC-induced SST cooling, approximately 5-7 days per degree of cooling. At a broader scale, a 20-year (2004-2023) analysis revealed 99% significant inverse relationships between seasonal MHW and TC activity. These findings suggest that TCs can act as natural regulators, effectively mitigating heat stress from MHWs and potentially serving as a lifeline for marine ecosystems.

Session 3: Air-sea Interaction 1

Spatiotemporal variability of deep-cycle turbulence in the equatorial Pacific associated with ENSO

Rintaro Nakano (The University of Tokyo)

In the equatorial region, turbulence in the upper ocean exhibits a pronounced vertical cycle associated with the diurnal cycle of solar radiation. This phenomenon is known as the deep cycle (DC). It arises as trade-wind-induced shear is confined near the surface by daytime solar heating, whereas nighttime surface cooling allows turbulence to descend through the mixed layer. Below the base of the mixed layer, the balance between vertical shear and stratification creates a potentially unstable state, often referred to as marginal instability (MI). This allows turbulence to penetrate below the mixed-layer base and continue to descend until solar heating resumes. Because DC may influence large-scale phenomena such as the El Niño–Southern Oscillation (ENSO) through vertical mixing, studying DC is important for understanding the mechanisms of ENSO and the climate system. However, the spatiotemporal variability of DC remains largely unexplored, partly due to limited observations.

In this study, deep-cycle turbulence (DCT) in the equatorial Pacific is simulated using a regional ocean model, and its characteristics are compared among different ENSO phases. The model successfully reproduces the essential observed features of DCT, despite some biases in the simulated background fields. The simulated DCT in the central and eastern Pacific tends to penetrate deeper toward the west, while its intensity increases toward the east, partly due to the eastward shoaling of the Equatorial Undercurrent core. The results also show that DCT in the eastern equatorial Pacific is more intense and penetrates deeper during El Niño Modoki events, which is likely related to a deeper thermocline and stronger trade winds in this region. In contrast, DCT in January 1998, near the peak phase of the extreme 1997–98 canonical El Niño, is much weaker than during El Niño Modoki and La Niña events, partly due to weaker trade winds. These results suggest that DCT characteristics can be affected by variability in the background state. Indeed, statistical analysis indicates that the MI layer depth, which plays a key role in DCT development, strongly constrains DCT penetration depth in the eastern equatorial Pacific, whereas wind stress and stratification are the controlling factors in the central equatorial Pacific.

Session 3: Air-sea Interaction 1

Role of Preceding Wind Forcing and Oceanic Wave Propagation in the Different Evolution of Canonical El Niño and El Niño Modoki

Risa Furusawa (The University of Tokyo)

Canonical El Niño events are associated with maximum anomalous warming in the eastern equatorial Pacific. On the other hand, during El Niño Modoki events, positive sea surface temperature (SST) anomalies peak in the central tropical Pacific, while negative SST anomalies develop in the western and eastern tropical Pacific. Since the climate impacts of canonical El Niño and El Niño Modoki are very different, understanding their distinct mechanisms is important for improving our ability to predict which type of El Niño will develop. During canonical El Niño, anomalous thermocline deepening and associated subsurface warming reduce cooling by vertical mixing, thereby playing a dominant role in the development of positive SST anomalies in the eastern equatorial Pacific. In contrast, zonal advective feedback is considered important for the development of positive SST anomalies in the central equatorial Pacific during El Niño Modoki. This is because this region is near the eastern edge of the western Pacific warm pool, where the mean zonal SST gradient is strong. However, it remains unclear why some events develop into canonical El Niño while others evolve into El Niño Modoki. The purpose of this study is to investigate the mechanism responsible for the difference between canonical El Niño and El Niño Modoki.

Composite analyses reveal that SST in the eastern equatorial Pacific is significantly lower as early as March during El Niño Modoki events than during canonical El Niño events. The largest difference in temperature is found below the base of the mixed layer and is associated with a shallower thermocline during El Niño Modoki events. Further examination reveals that the shallower thermocline may be related to stronger westerly wind anomalies along the equator around 150°W in the preceding June for El Niño Modoki events than for canonical El Niño events. Associated negative sea surface height (SSH) differences propagate westward, consistent with an upwelling Rossby wave-like feature. After reaching the western boundary, the negative SSH differences propagate eastward, resembling an upwelling Kelvin wave-like feature. A 1.5-layer shallow-water model forced by respective wind stress anomalies in the year preceding El Niño reproduces the negative SSH differences in the eastern equatorial Pacific, supporting the proposed mechanism.

Oral Presentations (Day 2)

Session 4: Air-sea Interaction 2

Global climate mode resonance due to rapidly intensifying El Niño-Southern Oscillation

[Invited] Malte F. Stuecker (University of Hawaii at Manoa)

The El Niño-Southern Oscillation (ENSO) influences climate variability globally, encompassing various other modes of variability, and thus represents a key predictable climate signal on seasonal timescales. Yet, its response to greenhouse warming remains uncertain, with models projecting a range of outcomes. Here, we demonstrate that in response to warming, a state-of-the-art high-resolution climate model (AWI-CM3) simulates a rapid transition from a moderate-amplitude irregular regime, as observed in the current climate, to a highly regular oscillation with intensifying amplitude. This behavior can be attributed to increasing air-sea feedbacks, which approach criticality in the second half of this century, and growing atmospheric noise. As ENSO intensifies in this model, it synchronizes with other prominent climate modes, such as the North Atlantic Oscillation and the Indian Ocean Dipole, thereby imprinting its regular, predictable variability on them. If realized, this global climate mode resonance would have wide-ranging whiplash impacts on regional hydroclimates. Finally, I discuss some indications for this scenario in a small number of other climate models.

Session 4: Air-sea Interaction 2

Unravelling the Heavy Precipitation Prediction over Yakushima & its neighborhoods through Precipitation Data Assimilation and Ocean-Atmosphere Interactions over the Takara Strait Kuroshio region

Rakesh Teja Konduru (EORC, JAXA)

We untangle the unique precipitation mechanisms on Yakushima Island and its surrounding regions during winter, pre-Baiu, and Baiu seasons, focusing on the influence of Kuroshio Current Sea Surface Temperature (KSST) over the Tokara Strait. Our research aims to understand how Yakushima's topography affects heavy rainfall patterns in the broader Kyushu area. We will use in-situ observations and climate modeling with the SCALE-RM to assess KSST's impact on precipitation dynamics around Yakushima and southern Kyushu. By conducting sensitivity experiments, we will evaluate the roles of KSST and topography in shaping local heavy precipitation. Additionally, recognizing the limitations of satellite data for detailed island-scale precipitation, we have developed an innovative data assimilation method using the Threshold Adjusted Method (TAM) Local Ensemble Transform Kalman Filter (LETKF). This method integrates GSMaP Gauge, local rain-gauges, RADAR AMeDAS, PR-KuPR Diurnal Blend Dataset, and model simulated precipitation to estimate high resolution precipitation over island and improve prediction of heavy precipitation. This research, as part of the Hotspot-3 project, addresses the impact of changing oceanic conditions and regional topography on precipitation patterns in southern Kyushu of Japan for future climate resilience.

Session 4: Air-sea Interaction 2

Sensitivity Analysis of Microphysics Parameterizations for High-Resolution Rainfall Simulation using the WRF-Urban Model

Arunkumar R (Central University of Rajasthan, India & Kagawa University, Japan)

This study investigates rainfall simulation over different urbanized regions, including semi-urban areas, using the WRF-Urban model. Heavy rainfall events were identified based on the India Meteorological Department (IMD) threshold of 64.5 mm day⁻¹. Multiple datasets, including IMD Doppler Weather Radar (DWR), ERA5 reanalysis, IMD gridded rainfall, and rain-gauge observations, were utilized for model evaluation. Sensitivity experiments were conducted using WRF-Urban and non-urban configurations with eight different microphysics schemes (MPS) to examine their influence on rainfall simulation and hydrometeor representation. Among the evaluated schemes, the Morrison scheme showed the best performance, with a strong correlation with observations ($r = 0.78$), whereas the Thompson scheme exhibited comparatively lower performance ($r = 0.30$). Furthermore, the Spatial–Amplitude–Location (SAL) method was employed to evaluate the spatial characteristics of simulated rainfall in terms of structure, amplitude, and location. The SAL analysis showed results consistent with the conventional statistical evaluation, with the Morrison scheme providing better representation of the observed rainfall structure, amplitude, and location, while the Thompson scheme showed larger discrepancies. These results highlight the importance of selecting an appropriate microphysics parameterization for accurately simulating the intensity and spatial characteristics of heavy rainfall over urban and semi-urban regions.

Session 4: Air-sea Interaction 2

Generation Mechanisms of Coastal El Niño: Role of the Coastal Bjerknes Feedback Revealed by Regional Ocean Model Experiments

Tomoki Tozuka, The University of Tokyo

Coastal El Niño is characterized by anomalously warm sea surface temperatures (SSTs) along the west coast of South America. Although distinct from basin-scale El Niño events, it exerts strong climatic and societal impacts in the coastal region. This study quantitatively investigates the generation mechanisms of positive SST anomalies associated with coastal El Niño events using a regional ocean model.

An online mixed layer heat budget analysis that closes exactly shows that the anomalous warming is primarily driven by positive anomalies in vertical mixing, zonal advection, and vertical advection. The positive vertical mixing anomaly is associated with anomalous subsurface warming, while the positive zonal and vertical advection anomalies are related to anomalous onshore Ekman transport and coastal downwelling, respectively. In contrast, the surface heat flux acts as a negative feedback through enhanced latent heat loss associated with anomalous SST warming and reduced solar radiation associated with increased cloud cover.

To isolate the effects of wind forcing in the coastal and eastern equatorial Pacific, two sets of five-member sensitivity experiments are conducted. In one experiment, interannual variations in wind forcing are retained only in the coastal region east of 85°W, whereas in the other, they are retained only in the eastern equatorial Pacific west of 90°W. Coastal warming is substantially stronger in the experiment forced by local coastal wind anomalies: the April SST anomaly averaged over the Niño 1+2 region reaches 0.54°C, compared with only 0.25°C in the experiment forced by eastern equatorial Pacific wind anomalies. These results demonstrate the dominant role of local wind forcing and highlight the importance of the coastal Bjerknes feedback in the development of coastal El Niño events.

Session 4: Air-sea Interaction 2

Does the subsurface ocean affect sea surface temperature anomalies in summer over the North Pacific?

Masami Nonaka (JAMSTEC)

Since 2022, warm sea surface temperature anomalies (SSTAs) have been observed over the North Pacific, particularly around the subarctic frontal zone (SAFZ). Because the temperature anomalies are not limited to the surface layer but extend to several hundred meters depth, a dynamical oceanic response to atmospheric variability is expected to induce a meridional shift of the frontal zone, as well as surface and subsurface ocean temperature anomalies. This is consistent with the multi-year timescale of the anomalies. However, seasonal variability of SSTAs during these years clearly shows that warm SSTAs develop from winter to summer, being larger in summer than in winter. The seasonal development of temperature anomalies is rather limited to the surface layer, strongly suggesting that surface thermal forcing also plays an important role in driving summer SSTAs. In this study, we investigated to what extent the subsurface ocean can affect summer SSTAs in the North Pacific SAFZ, using ocean observation and reanalysis data products. Here, we consider winter SSTA as a proxy of temperature anomalies induced by ocean dynamical variability that drives subsurface variability. The results show that the influence of winter SSTAs can be comparable to the impact of surface thermal forcing from spring to summer.

Session 4: Air-sea Interaction 2

Roles of mesoscale air-sea interactions in the Kuroshio Extension revealed by an ocean model

Kento Usui (The University of Tokyo)

At the oceanic mesoscale, active coupling between the ocean and the atmosphere takes place. Mesoscale air-sea interactions can be classified into two dynamical processes: the influence of surface oceanic currents on surface wind stress, referred to as current feedback (CFB), and the influence of sea surface temperature (SST) on surface winds, known as thermal feedback (TFB). Although oceanic mesoscale structures prevail in the Kuroshio Extension region, the role of these mesoscale air-sea interactions in this system is not fully understood, partly because high-resolution coupled numerical simulations are computationally expensive. Therefore, in this study, both TFB and CFB are incorporated in an ocean model, and their roles in the Kuroshio Extension are examined.

While CFB is widely implemented in ocean models, TFB is rarely incorporated. By introducing an empirical linear relationship between mesoscale SST perturbations and surface wind speed perturbations derived from satellite observations, TFB is incorporated in an ocean model. Compared with a simulation in which both TFB and CFB are active (TCFB-EXP), the Kuroshio Extension in a simulation without mesoscale air-sea interactions (NOFB-EXP) shows higher fluctuations, especially in the upstream region. Spectral analysis shows weaker mesoscale energy in TCFB-EXP than in NOFB-EXP, suggesting that TFB and CFB kill mesoscale eddies and thereby moderate fluctuations in the Kuroshio Extension path.

Session 5: Air-sea Variability & its Application

From Hydrodynamics to Coastal Resilience: Understanding Mangrove–Coast Interactions in Southern Vietnam

[Invited] VO LUONG Hong Phuoc (Viet Nam National University, Ho Chi Minh city)

Mangrove forests form a dynamic interface between terrestrial and marine environments, where tides, waves, currents, sediment transport, and vegetation interact to shape coastal stability and resilience. Understanding these interactions is particularly important in Southern Vietnam, where mangrove coasts are increasingly exposed to climate variability, coastal erosion, sea-level rise, and human pressures. This study investigates the hydrodynamic processes governing mangrove–coast interactions and their implications for sediment dynamics, coastal stability, and nature-based coastal protection. Field observations combined with numerical modelling are used to examine the spatial and temporal variability of water levels, tidal currents, waves, suspended sediment transport, and their interactions with mangrove vegetation. Observations from mangrove environments in Southern Vietnam show that vegetation substantially modifies local hydrodynamic conditions by reducing current velocities, altering tidal propagation and inundation patterns, and influencing sediment transport and deposition. Differences between exposed mudflats and vegetated mangrove areas further demonstrate the importance of flow–vegetation interactions in controlling sediment redistribution and retention within the coastal system. These hydrodynamic and sedimentary processes play an important role in determining the capacity of mangrove systems to maintain coastal stability and respond to changing environmental conditions. The results highlight that mangrove protection and restoration should not be considered solely from an ecological perspective, but should also account for local hydrodynamic regimes, sediment availability, and morphological conditions. Integrating hydrodynamic understanding into mangrove management can therefore provide a stronger scientific basis for identifying suitable conservation and restoration strategies.

Session 5: Air-sea Variability & its Application

The Influence of Environments on the Intensity Change of Typhoon Soudelor

Yuchun Lin (National Taiwan Ocean University)

Previous studies have demonstrated that background oceanic and atmospheric conditions influence not only tropical cyclone formation but also storm intensity. Typhoon Soudelor in August 2015 was notable for undergoing two periods of rapid intensification while traversing the Philippine Sea, where the 26 °C isotherm depth (Z26) exceeded 100 m and numerous warm-core eddies were present. Before the storm's arrival, an anomalous upper-level anticyclone developed south of Japan, creating a region of weak vertical wind shear (Vs) that extended into the Philippine Sea. This study investigates how variations in Z26, Vs, and other environmental factors may have contributed to Soudelor's rapid intensification. Regression analysis suggests that Vs accounted for the largest proportion of the storm's intensity variation (62%), followed by Z26 (27%) and other factors. Composite analyses further show that weak vertical wind shear associated with the anomalous anticyclone is a robust feature of the western North Pacific during the developing summers of strong El Niño events, defined by an Oceanic Niño Index (ONI) greater than 1.5.

Session 5: Air-sea Variability & its Application

Short term and extended range wave forecasting for Hawaii

Ning Li (University of Hawaii at Manoa)

Hawaii has a complex wave climate influenced by year-round trade wind waves and seasonal swells generated by extratropical cyclones in both the North and South Pacific, as well as energetic sea states associated with passing subtropical systems (e.g., cold fronts and Kona storms) and tropical cyclones. These synoptic- and mesoscale weather systems produce highly variable wave conditions at wave energy test sites, characterized by rapid day-to-day fluctuations as well as pronounced seasonal and interannual variability. Accordingly, both short-term wave forecasts (up to approximately one week) and extended-range outlooks at seasonal time scales are required to support the operation and maintenance of wave energy converter test sites across the Hawaiian Islands. To address this need, we have developed a numerical wave modeling system based on third-generation spectral wave models, employing a suite of nested grids spanning from the global ocean to the nearshore regions of individual islands. With global surface winds and their regional downscaling as input forcing, the modeling system can resolve the multi-modal sea states in Hawaii. We have operated the system to provide daily 7-day wave forecasts, as well as a long-term wave hindcast covering the period from 1980 to 2024. The comprehensive hindcast dataset further enables investigation of the relationships between monthly wave anomalies and large-scale climate modes, particularly the El Niño–Southern Oscillation (ENSO). Building on this analysis, we develop a statistical–dynamical framework for seasonal wave forecasting.

Session 5: Air-sea Variability & its Application

Influence of SST and Topography on Extreme Precipitation during Typhoon Hagibis (2019)

Shiori Sugimoto (JAMSTEC)

We developed the Post-event Understanding system using Large-ensemble Simulations for Extremes (PULSE) to automatically conduct post-event diagnosis of extreme precipitation. PULSE is a large-ensemble dynamical downscaling system based on the Weather Research and Forecasting (WRF) model, using the 63-member ALERA3 reanalysis dataset as initial and boundary conditions. The system implements sensitivity experiments using climatological sea surface temperature (Clim-SST) and smoothed topography (Low-topo).

We applied PULSE to the heavy rainfall associated with Typhoon Hagibis in October 2019. Three nested domains with horizontal grid spacings of 25, 5, and 1 km were used. The simulations reproduced the observed precipitation well, with a spatial correlation coefficient of 0.86 and an RMSE of 57.52 mm/42 h against the National Synthetic Radar GPV.

Compared with the Clim-SST experiment, the control (CTL) experiment showed higher SLP near the typhoon center and lower SLP along its northern periphery. These SLP anomalies were associated with SST differences between the two experiments: cold SST anomalies related to the meandering of Kuroshio current and the typhoon passage, and warm SST anomalies along the coast of central-eastern Japan. This SLP anomaly pattern enhanced low-level moisture transport toward land along the northern periphery of the typhoon and strengthened moisture convergence over the Kanto Plain and mountainous areas of central Japan, resulting in increased 42-h accumulated precipitation in the CTL experiment.

Comparison with the Low-topo experiment showed substantial changes in moisture transport and precipitation distribution, particularly over mountainous regions. Around Hakone, more than 60% of CTL ensemble members simulated precipitation exceeding 500 mm/42 h, whereas such heavy rainfall was absent in the Low-topo experiment, indicating an important contribution of mountainous topography as well as SST distribution.

Session 5: Air-sea Variability & its Application

The Role of Time- and Spatially Varying Wind in Coastal Circulation Based on High-Resolution Oceanic and Atmospheric Simulations

Yoo-Jun Kim (AORI, The University of Tokyo)

Wind forcing plays a central role in oceanic circulation, including circulation in small bays where complex coastal orography modulates local winds both in time and space. However, their role in the circulation of such bays remains unclear because local winds are difficult to observe directly over the sea. Here, we used oceanic and atmospheric simulations with 100 m horizontal grid spacing, together with observations, to investigate wind-driven circulation under time- and spatially varying wind forcing in Otsuchi Bay. The simulation forced by time- and spatially varying winds reproduced the observed SSS distribution more closely than the simulation forced by time-varying but spatially uniform wind, which is a common simplification in coastal oceanic simulations. This improvement was explained by bay interior upwelling away from the coastline, which was not evident under spatially uniform wind forcing. This upwelling was driven by wind stress divergence rather than by wind stress curl. Spectral analysis showed that the relative importance of two mechanisms varied across timescales. Divergence-driven vertical motion was strongest at periods shorter than the local inertial period, but it became relatively weaker than curl-driven motion at longer periods. This study demonstrates that short-timescale wind stress divergence can drive bay interior upwelling and modify the SSS distribution in small bays. This finding further suggests that upwelling in small bays is not limited to coastline- confined upwelling or curl-driven Ekman upwelling. Accounting for divergence-driven upwelling is therefore important for understanding and modeling coastal circulation in small bays, with potential implications for the vertical transport of biogeochemical materials.

Session 6: Multi-scale Ocean Dynamics 2

Triad resonance between vertically propagating equatorial waves in an idealized OGCM

Motoki Nagura (JAMSTEC)

Past theoretical studies have pointed out the possibility of wave-wave interactions between equatorial wave modes, and a previous observational study (Nagura and McPhaden 2025) detected 60-day variability in zonal velocity at middepths in the central equatorial Indian Ocean and speculated that wave-wave interactions contributed to its generation. The current study conducts numerical experiments using OFES OGCM and corroborates the hypothesis of the previous studies. The OGCM is highly idealized with a rectangular domain, a flat bottom, and uniform stratification, and is forced by zonal wind stress near the equator that oscillates at 180- and 90-day periods, mimicking wind forcing in the equatorial Indian Ocean. The result exhibits the generation of 60-day variability in zonal velocity at the model's middepths, consistent with the previous observational study. A spectral analysis shows that simulated zonal velocity variability mostly follows the dispersion relation of equatorial waves, indicating a weakly nonlinear regime. A bispectral analysis of the zonal momentum advection term reveals that 180- and 90-day waves excited by surface winds interact at middepths and supply energy to 60-day variability. Numerical searches for resonant triads of equatorial wave modes indicate that the energy supply detected by bispectral analysis arises from triad resonance among vertically propagating equatorial Rossby waves. It was also found that the two low-frequency waves (i.e., 180- and 90-day waves) of a resonant triad tend to propagate vertically in opposite directions.

Session 6: Multi-scale Ocean Dynamics 2

Vertical phase propagation of the Equatorial Deep Jets

Yusuke Terada (JAMSTEC)

The Equatorial Deep Jets (EDJs) are equatorially trapped, vertically alternating eastward and westward currents observed at intermediate depths (about 500 – 2000 m depth) in all three major basins. The EDJs exhibit inter-annual or decadal variability depending on the basin with a downward phase propagation. According to linear wave theory, the observed downward phase propagation of the EDJs implies the EDJs transport energy upward. Several studies have revealed that intraseasonal Yanai waves originating from the upper ocean or western boundaries serve as the energy source for the EDJs. However, this is inconsistent with the fact that the EDJs are mostly generated by the Yanai waves from the upper ocean; the reason for this inconsistency remains unclear. Here, we perform a series of idealized simulations to reproduce Yanai wave-driven EDJs and identify the factors influencing their vertical phase propagation. Sensitivity experiments with different bottom friction suggest that, in addition to the location of the energy input to the EDJs, the spatial distribution of energy sinks also determines the direction of the vertical energy transport by the EDJs and associated phase propagation. Furthermore, we discuss the impact of background stratification on EDJ generation by Yanai waves and the resulting vertical phase propagation.

Session 6: Multi-scale Ocean Dynamics 2

A Decadal Regime Shift in the Hemispheric Asymmetry of the Subtropical Cells Associated with Tropical Pacific Decadal Variability

Takeshi Anami (The University of Tokyo)

The decadal variability of the sea surface temperature (SST) in the tropical Pacific, often referred to as Tropical Pacific Decadal Variability (TPDV), is known to have global impacts. Understanding its underlying mechanisms is essential for improving decadal prediction skill. The shallow meridional overturning circulations connecting the tropics and subtropics in the Northern and Southern Hemispheres, respectively, called the Subtropical Cells (STCs), are important elements of TPDV because the convergence of the subsurface pycnocline flows can alter the equatorial SST by changing the strength of equatorial upwelling. Although previous studies have demonstrated a significant anticorrelation between the equatorial SST and the STC convergence on decadal timescale, the relative importance of the northern and southern STCs remains poorly investigated.

In this study, we discuss the relationships between TPDV and the STCs, with a particular focus on the hemispheric difference, using output from a long-term ocean general circulation model called OFES2. Wavelet coherence analysis revealed that the STC in the Southern Hemisphere is significantly coherent with the TPDV index throughout the studied period, while the one in the Northern Hemisphere is coherent only after 1990. This asymmetry is likely attributed to changes in the location and amplitude of the wind anomalies related to TPDV. Before 1990, major zonal wind stress anomalies were found in the off-equatorial southern central Pacific, whereas after 1990, they were located around the western equatorial Pacific with a structure symmetric about the equator. Considering the stronger decadal power spectrum of SST in the tropics in recent decades, we suggest that the emergence of hemispheric symmetry in the STCs may act to amplify the decadal variability in the tropical Pacific.

Session 6: Multi-scale Ocean Dynamics 2

Barotropic water exchange between the ice cavity and the open ocean in an inviscid and frictionless fluid

Nan Yuan (WPI—AIMEC, Tohoku Uni.)

Water exchange between ice-shelf cavities and the open ocean plays a critical role in regulating basal melting and sea-level rise in West Antarctica, yet the underlying small-scale dynamics remain poorly understood. This study investigates an $O(1\text{km})$ exchange process near an ice front using an idealized barotropic, inviscid, and frictionless model configuration. The simulations show that the approaching flow undergoes pronounced vertical deformation immediately upstream of the ice front. A western-boundary-current-like jet develops adjacent to the ice front, while the lower portion of the water column becomes vertically compressed and intrudes beneath the ice draft into the cavity. As a result, the flow locally departs from vertically coherent Taylor-column behavior near the ice-front gate. The analysis suggests that this cross-front exchange is enabled by localized finite-Rossby-number adjustment associated with geometric constraints imposed by the ice draft, strong vertical shear, and vortex tilting/stretching within a narrow near-front transition region.

Session 6: Multi-scale Ocean Dynamics 2

Multi-Constituent Tidal Modulation of Sea Level and Circulation in the Northern Bay of Bengal: A Year-Long ROMS Experiment

Muh. Nur Hidayat (National Research and Innovation Agency (BRIN))

The northern Bay of Bengal is characterized by strong monsoonal atmospheric forcing, freshwater-induced stratification, shallow coastal waters, and energetic tides, yet the contribution of multi-constituent tidal forcing to regional circulation and sea-level variability remains incompletely quantified. Here, we use the Regional Ocean Modeling System (ROMS) to perform two controlled simulations from 1 December 2022 to 1 January 2024, with 2023 used as the principal analysis period. Both experiments employ identical atmospheric forcing, initial and lateral boundary conditions, model configuration, and a 60-s baroclinic timestep. The control experiment excludes tidal forcing, whereas the tidal experiment incorporates eight astronomical constituents (K1, K2, M2, N2, O1, P1, Q1, and S2).

Both simulations completed the full integration without numerical instability and produced 9,505 continuous hourly records. Preliminary domain-wide diagnostics show that inclusion of tides substantially increases sea-level and depth-averaged current variability. The sea-level range expands from -0.55 – 2.28 m in the control experiment to -2.36 – 3.94 m with eight constituents. The depth-averaged zonal velocity range similarly increases from -1.20 – 0.83 m s⁻¹ to -2.10 – 2.12 m s⁻¹. In contrast, maximum three-dimensional meridional velocities are comparable between the two simulations, indicating that energetic background circulation also contributes to velocity extremes. Notably, the largest sea-level excursions occur in mid-May 2023, coincident with Extremely Severe Cyclonic Storm Mocha, highlighting a potentially important interaction between atmospheric forcing and tidal dynamics in shallow northern waters.

These experiments provide a numerical framework for quantifying tidal modification of seasonal circulation and event-scale sea-level variability in the northern Bay of Bengal. Ongoing analysis will evaluate the spatial structure, seasonal dependence, and observational consistency of these responses.

Session 6: Multi-scale Ocean Dynamics 2

A Hadley Ascending Cloudless Zone in the Southeastern Tropical Pacific Shapes ENSO Wave Dynamics

Borui Wu (Nagoya University)

Intense diabatic heating over the tropical Pacific has long been regarded as the dominant atmospheric driver of large-scale tropical waves during ENSO, such as eastward-propagating equatorial Kelvin waves. Here we identify a complementary wave source associated with cold air anomaly over the southeastern tropical Pacific Ocean (SETP). This cold-air source radiates Rossby waves toward the western tropical Pacific during austral summer, revealed by the seamless diagnostics of wave energy transfers. We show that this wave radiation originates from an unexpected upper-tropospheric diabatic source over the SETP, where cloudiness and latent heating are weak in a zonal-mean framework. Both the diabatic source and the associated westward Rossby-wave energy flux are enhanced during La Niña and weakened during El Niño. We identify this source region as a Hadley ascending cloudless zone, where negative thermal-forcing anomalies acting on anomalously cold air generate a diabatic source of wave energy in a zonal mean framework. This previously unrecognized wave source forms the cold pole of basin-scale east–west interactions across the tropical Pacific, complementing the canonical eastward Kelvin-wave pathway and revealing a new mechanism for atmospheric wave propagation and energy transfer during ENSO.

Poster Presentations

Poster #1

Exploring Global Upper Ocean Marine Heatwaves in Coupled GFDL

Xinru Li (Advanced Institute for Marine Ecosystem Change)

Periods of anomalously high ocean temperatures, known as 'Marine Heatwave' (MHW), have severely affected marine organisms' health, function, and services they provide, causing substantial biological and socioeconomic disruptions over the past few decades. While there have been many efforts to understand sea surface MHWs, our understanding of their vertical structures is relatively limited. However, subsurface MHW can have dramatic ecological impacts, and may also influence other oceanic properties (e.g., dissolved O₂, pH), causing compound ocean extremes. In this study, we evaluated MHW climatology through the upper 700m during the preindustrial and recent historical times using daily temperature outputs from global simulations performed with the coupled GFDL CM4 climate models. By comparing the simulated MHW between the two models, we analyzed the role of different representations of ocean physics and vertical coordinate types in model performance. We also assessed the global patterns of the sensitivity of MHW simulations to the temporal resolution of temperatures by comparing them against the detected MHWs using monthly data.

Model preindustrial control simulations demonstrate errors in ocean potential temperature due to temperature anomalies relative to the first year of simulation (i.e., model drift). Given the non-negligible drift shown in previous studies, we calculated the trend in daily temperature of the piControl model runs, and corrected temperatures by removing the trend over preindustrial and historical periods. We then detected MHW characteristics based on the de-drifted temperatures and systematically analyzed the influence of model drift on simulated MHWs to identify locations where the MHW metrics are most sensitive to drift-induced trends. For example, preindustrial model drifts of GFDL CM4 lead to overestimated annual peak heat intensity up to 0.1-0.4 °C over the tropical Pacific and the mid to high latitudes of the upper 700m. This suggests the trend associated with drift can induce a shifting baseline that should also be accounted for when analyzing MHWs from climate model output. Our study contributes to understanding MHW through the water column and reveals critical factors for better MHW simulation that could benefit future projection.

Poster #2

Assessing Tropical Inter-basin Connections Through SST Restoring Experiments

Taek-Bum Jeong (Pusan National University)

Inter-basin interactions among the tropical Indian, Atlantic, and Pacific Oceans modulate climate variability beyond their respective basins, yet the sensitivity of these teleconnections to basin-scale sea surface temperature (SST) biases remains poorly constrained. We investigate this sensitivity using a coupled climate model (FOCI-OpenIFS) with a common SST-restoring framework applied independently to each basin following the TBIMIP (Tropical Basin Interaction Model Intercomparison) protocols. FOCI-OpenIFS couples the OpenIFS atmosphere model (Tco95 configuration, approximately 100 km horizontal resolution) with the NEMO ocean and sea-ice model (ORCA05 configuration, nominal 0.5° horizontal resolution). The experiments comprise a control simulation with freely evolving SST, Tier 1 experiments restoring observed SST anomalies while retaining the model mean-state bias, and Tier 2 experiments restoring the full observed SST field. Basin-specific climate indices (tropical EOF-based or area-averaged) are used to characterize the dominant modes of variability and assess their responses to local and remote SST restoring. Restoring SST in the target basin substantially increases the temporal correlation with the corresponding observed climate index and reproduces its dominant spectral timescales. Remote SST restoring also modifies the simulated variability of climate indices in other basins, either enhancing or weakening their correlation with observations depending on the restoring basin and experimental configuration. These responses indicate basin-dependent differences in the strength of tropical inter-basin teleconnections and highlight the sensitivity of simulated remote climate variability to basin-scale SST biases.

Poster #3

Phase-Dependent Mixed-Layer Heat Budget of Tropical Instability Waves in the Eastern Equatorial Pacific

Peien Xu (The University of Tokyo)

Tropical instability waves (TIWs) redistribute heat and biological tracers in the eastern equatorial Pacific, but how the mixed-layer heat budget evolves through their cycle, and how chlorophyll and mixed-layer depth (MLD) jointly affect penetrative shortwave heating (Q_{psw}) remain unclear. Using daily output from an eddy-resolving, offline ocean-ecosystem simulation, we construct event-normalized phase composites and diagnose the term-by-term mixed-layer heat budget. We also apply Shapley attribution within a counterfactual pathway diagnostic to quantify how chlorophyll and MLD shape Q_{psw} within the mixed layer. Horizontal advection is the dominant contributor to the phase-dependent mixed-layer temperature tendency, while vertical mixing provides persistent cooling and the second-largest resolved phase variation. In contrast, Q_{psw} provides substantial persistent warming but varies only weakly over the TIW cycle, indicating that it is more important for the mean heat balance than for the phase-dependent temperature tendency. MLD influences Q_{psw} through opposing penetration path-length and heat-capacity effects, whereas the direct chlorophyll effect is much weaker. Consequently, pronounced TIW-scale chlorophyll and MLD variability does not necessarily translate into comparably strong Q_{psw} variability. These results demonstrate that biological influences on tropical Pacific climate depend strongly on concurrent mixed-layer variability and cannot be inferred from chlorophyll variability alone.

Poster #4

An intercomparison of eddy-resolving ocean reanalyses in the western North Pacific

Nobumasa Komori (Keio University)

We performed an intercomparison of three eddy-resolving ocean reanalyses—FORA-WNP30, GLORYS12V1, and BRAN2020—for the western North Pacific over the period 1993–2016. While all three products exhibit high consistency in large-scale surface mean fields due to data assimilation, notable discrepancies are found in mesoscale variability and subsurface structures, reflecting differences in model configuration and assimilation schemes. Furthermore, a vertical section analysis along 137°E reveals discernible discrepancies in the representation of subsurface water masses among the products. FORA-WNP30, employing a four-dimensional variational (4D-VAR) scheme, exhibits high spatiotemporal variability in sea surface height (SSH). However, its sea surface salinity (SSS) variability is strongly dampened by a short restoring timescale. GLORYS12V1 retains intense coastal SSS variability due to the absence of strong surface restoring. However, it exhibits lower eddy kinetic energy levels compared to the others, likely due to dissipative viscosity parameterization. BRAN2020 shows systematic differences east of Japan, including reduced SSH variability and lower temporal correlations. These are attributed to its simplified bathymetry (capped at 5000 m), which eliminates topographic steering effects and alters eddy propagation speeds. Additionally, BRAN2020 exhibits a weaker vertical salinity contrast around the North Pacific Intermediate Water (NPIW), suggesting the influence of excessive vertical mixing. Our results highlight that horizontal resolution is not the sole determinant of performance; bathymetry, subgrid-scale parameterizations, and boundary conditions play equally critical roles in reproducing regional ocean dynamics.

Poster #5

Decadal variability of simulated phytoplankton and nitrate distributions over the North Pacific Ocean

Yoshikazu Sasai (JAMSTEC)

The chlorophyll is an important indicator for autotrophic biomass and primary production in the ocean. The decadal variability of chlorophyll is essential to understanding how marine ecosystems are affected by climate change. The surface chlorophyll variability and its dynamics in the global ocean are investigated based on satellite ocean color observations from 1997. The surface chlorophyll concentration shows spatial and temporal variations over the North Pacific related to climate variability. In this study, we have investigated the decadal variability of phytoplankton and nitrate concentrations over the North Pacific Ocean using outputs from an eddy-resolving coupled physical-biological ocean model. The model reproduces the decadal variability of surface and subsurface phytoplankton and nitrate over the North Pacific Ocean. The model also indicates that the responses of phytoplankton and nitrate concentrations differ between the subpolar and subtropical gyres. We will focus on the decadal variability of surface and subsurface phytoplankton and nitrate concentrations with mesoscale eddies, thermocline, gyre circulations, and upwelling/downwelling and their characteristics.

Poster #6

Development of a Model for High-Resolution Climate Simulation Combining MIROC and NICAM

Shuhei Matsugishi (Atmosphere and Ocean Research Institute, The University of Tokyo)

In recent years, many leading modeling groups have been developing high-resolution climate models that couple atmospheric models with horizontal resolutions of around 25 km to eddy-resolving ocean models with resolutions of approximately 10 km. Our group has also initiated the development of a high-resolution climate model as a flagship model for the next 5–10 years. As its atmospheric component, we are developing NICAM-M by incorporating the physical parameterizations of MIROC6 (Tatebe et al., 2019) into the highly scalable NICAM dynamical core (Tomita and Satoh, 2004), with future application to high-resolution atmosphere–ocean coupled simulations.

An initial evaluation was conducted at a horizontal resolution comparable to MIROC6 (GL06; 112-km mesh/T85). With the original MIROC6 parameter settings, NICAM-M produced excessive low-level clouds and a substantial bias in the top-of-atmosphere radiative budget. Tuning of the turbulence, shallow-convection, and cloud microphysical parameters improved the cloud amount and radiation balance.

The tuned NICAM-M reproduces climatological features and biases comparable to those of MIROC6 and can be efficiently executed at higher resolutions. The 28-km mesh NICAM-M also showed 1 year simulation performance comparable to that of the 14-km mesh NICAM which same as kilometer scale modeling settings. NICAM-M provides a seamless modeling framework from conventional coarse resolutions to kilometer-scale grids. As a next step, we plan to extend this framework to high-resolution atmosphere–ocean coupled simulations to investigate the effects of air–sea interactions and model resolution on climate simulations.

Poster #7

Importance of representing stormtrack activity on simulating Northern Hemisphere blocking

Akira Yamazaki (JAMSTEC)

Identifying major climate constraints that explain Northern Hemisphere blocking frequency over the Pacific (PB) and Atlantic (AB). Atmospheric general circulation model simulations using hydrostatic and nonhydrostatic dynamical cores with horizontal resolutions ranging from 300 km to 25 km are contrasted. PB and AB frequencies are found to increase with resolution and are generally overestimated in the nonhydrostatic model. Blocking frequency is found to jointly increase with transient (high-frequency) and quasistationary (low-frequency) eddy activities near blocking with increasing resolution, regardless of the model. This suggests that those eddies are primary constraints on blocking simulations. Finally, those eddy forcings balanced each other to maintain blocking likely via an eddy-feedback mechanism, which could not be reproduced in the nonhydrostatic model.

Poster #8

Growth and Decay Patterns of Mesoscale Eddies

Sato Hiromichi (Atmosphere and Ocean Research Institute, The University of Tokyo)

1. Introduction

Mesoscale eddies, with spatial scales of approximately 10–100 km, play an important role in various oceanic processes, including lower-trophic-level ecosystems (e.g., Gaube et al., 2014). Because the direction of vertical motion within eddies differs between their growth and decay phases (Flierl & McGillicuddy, 2002), it is important to consider the life-cycle stage of an eddy when examining ecosystem dynamics within it.

Mesoscale eddies can grow through mechanisms such as baroclinic and barotropic instabilities (e.g., Ji et al., 2018), whereas their decay has been attributed to processes such as friction and radiation (Arbic & Flierl, 2004). Since the mechanisms responsible for eddy growth and decay differ, eddy amplitude has been expected to exhibit asymmetric evolution between the growth and decay phases. Contrary to this expectation, however, globally averaged eddy amplitudes have been shown to evolve approximately symmetrically during growth and decay. This symmetry can be explained by stochastic autoregressive models (e.g., Samelson et al., 2014), suggesting that variability associated with eddy–eddy interactions plays a dominant role. On the other hand, asymmetry has also been reported for long-lived eddies (Chen et al., 2019), and the characteristics and mechanisms underlying eddy growth and decay remain incompletely understood.

In this study, we revisit the symmetry between the growth and decay phases of mesoscale eddies by applying cluster analysis to temporal variations in eddy amplitude and classifying their growth and decay patterns.

2. Data and Methods

We analyzed satellite-observed mesoscale eddies globally from January 1998 to September 2023. We used the publicly available AVISO+ eddy dataset derived from geostrophic velocity fields at a horizontal resolution of $0.125^\circ \times 0.125^\circ$, based on SSALTO/DUACS satellite altimetry data.

After preprocessing the dataset, we applied K-means clustering separately to anticyclonic and cyclonic eddies based on the temporal evolution of their amplitudes over their lifetimes. Eddy lifetime was normalized such that the time of detection was defined as 0 and the time of disappearance as 1. Before clustering, the amplitude of each eddy was normalized by its maximum amplitude. A fitted curve was then obtained for the amplitude evolution from the beginning to the end of each eddy track, and clustering was performed using the resulting one-dimensional representation of each fitted curve.

3. Results and Discussion

The growth and decay patterns of both anticyclonic and cyclonic eddies during the approximately 25-year study period were classified into six clusters. Anticyclonic and cyclonic eddies exhibited broadly similar growth and decay patterns.

Globally, eddies with more symmetric growth and decay patterns tended to have longer lifetimes. The relative frequency of each cluster also varied geographically with region, latitude, and longitude. In particular, regions characterized by high eddy kinetic energy and large numbers of eddies, such as the Kuroshio Extension and Gulf Stream regions, tended to have a higher proportion of clusters exhibiting symmetric growth and decay patterns.

Further analysis of the Kuroshio Extension region showed that many eddies with asymmetric growth and decay patterns reached their maximum amplitudes when baroclinic instability was inferred to be strong. In contrast, eddies with symmetric growth and decay patterns frequently exhibited signatures suggesting excitation through interactions with other eddies.

These results suggest that the growth and decay characteristics of mesoscale eddies cannot necessarily be represented by a single globally averaged symmetric life cycle, but may reflect different dynamical processes depending on the eddy type and regional environment.

4. Acknowledgments

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Poster #9

Weakened Seasonality of Mixed Layer Temperature along the East China Sea Kuroshio

Chuyuan Zhuang (Kyushu University)

Long term changes in the seasonal cycle of ocean temperature can have far reaching ecological and societal implications. Previous studies suggest that the amplitude of the sea surface temperature (SST) seasonal cycle has intensified over the Northern Hemisphere. Yet, how these changes vary regionally remains poorly understood. In this study, we investigate changes in the SST seasonal cycle in the western North Pacific.

We use FORA-JPN60 to examine the oceanic condition in the western North Pacific from 1982 to 2020. The horizontal resolution is $1/33^\circ \times 1/50^\circ$ with 60 vertical levels, and daily outputs are analyzed.

We first estimate the monthly mean Mixed Layer Temperature (MLT), mixed layer velocities, and net downward surface heat flux, defined as a sum of shortwave, longwave, sensible and latent heat fluxes at each grid point. We then define the seasonal amplitude as the difference between the warmest and coldest monthly mean MLT, referred to as summer and winter, respectively.

To examine the governing process, we estimate the mixed layer heat budget and evaluate the MLT tendency, surface heat flux, and horizontal heat advection terms. The seasonal amplitude strengthened over much of the western North Pacific, but weakened along the East China Sea (ECS) Kuroshio. This weakening results from seasonally asymmetric warming, with winter warming exceeding summer warming. Along the ECS Kuroshio, the winter MLT trend exceeds the summer trend by about 0.3°C per decade, indicating that winter MLT has warmed faster than summer MLT, thereby reducing the seasonal amplitude.

The annual mean mixed layer heat budget indicates that an increase in horizontal heat advection is balanced by enhanced surface heat release. This heating by advection is strongest in winter, and its increase is also largest in winter, suggesting that horizontal heat advection plays an important role in the weakening seasonal cycle along the ECS Kuroshio, where the current is strong. This seasonally asymmetric warming is consistent with the findings of Sasaki and Umeda (2021), where the SST trend along the ECS Kuroshio was reported to be strongest in winter, with the overall warming induced by increased ocean heat advection and balanced by enhanced surface heat release. We also identify pronounced subsurface warming of Kuroshio. Future work will further quantify the individual contributions of surface heat flux, entrainment, vertical mixing, and horizontal diffusion to the observed changes.

Poster #10

Variability of the Tsushima Warm Current transport by the Pacific Decadal
Oscillation and subpolar winds

Gaku Nishihira (RIAM, Kyushu University)

Tsushima Warm Current (TWC) plays a key role for modulating sea water temperature in the Japan Sea. Mechanisms of variation of TWC transport suggest two processes: Wind forcing over the central north Pacific associated with the Pacific decadal Oscillation (PDO), and monsoonal wind stress over the Okhotsk Sea. We evaluate how is inter-annual variability of TWC transport controlled.

We conclude that TWC transport should be considered on a seasonal basis. From spring to fall, TWC transport is explained by PDO index. PDO-related wind forcing change Kuroshio Extension path, and it generate coastal trapped waves (CTWs). High-resolution ocean reanalysis data captures westward propagation of CTWs along south coast of Japan. In winter, TWC transport is insignificantly correlated with PDO index. Wintertime TWC transport is explained by combination of PDO index and Ekman transport by monsoonal wind stress over the Okhotsk Sea. Sea surface height anomalies show barotropic adjustment over the Japan sea.

Poster #11

Why did the 2015 El Niño impacts not materialize? Disentangling ENSO, IOD, and decadal variability

Terushi Tada (The University of Aizu)

El Niño Southern Oscillation (ENSO) is the dominant mode of inter-annual climate variability in the tropics. Despite multiple decades of ENSO impact research, there is a lack of forecast skill in predicting ENSO impacts, although SST variations during ENSO can be well predicted in advance. The case of the strong 2015 El Niño is an example. It was predicted that California, Peru, and equatorial East Africa will be affected by deluges during the El Niño. However, these impacts did not materialize. Here, we hypothesize that this dilemma results from the conflation of ENSO impacts with other co-occurring phenomena, especially the Indian Ocean Dipole (IOD) and decadal climate variations. The goal of our investigation is to separate El Niño impacts from other co-occurring factors using filtering approaches as well as multiple regression based approaches, and to obtain a more robust measure of ENSO impacts. We hope that this approach can benefit predictability, especially from the users perspective of predictability. To this end, we focus on surface air temperature and land precipitation as the key variables of interest.

We used sea surface temperature (SST) data merged from COBE-SST (1958–1981) and OISST2.1 (1982–present). We constructed the Niño3 index for ENSO and the Dipole Mode Index (DMI) for IOD, and extracted their interannual variations using a time filter. The decadal variations were isolated by applying a 7-year low-pass filter to all data examined. ENSO and IOD impacts are isolated using both multiple regression analysis as well as composite analysis.

Poster #12

Influence of wind forcing on Gulf Stream path variability and its nonstationary relationship with the North Atlantic Oscillation

Hill Kento (Hokkaido University)

The Gulf Stream (GS) path shifts meridionally on interannual to decadal timescales, and these shifts can influence climate variability over the northern hemisphere. Several mechanisms have been proposed to explain GS path variability, such as changes in the deep current, effects of the oceanic Rossby wave, and wind forcing patterns. In particular, wind stress associated with the North Atlantic Oscillation (NAO) is considered to contribute to this variability. However, the temporal and spatial characteristics of GS path variability induced by wind stress near the GS remain unclear, and the extent to which this variability corresponds to the observed GS shift has not been adequately quantified. In this study, thin-jet theory incorporating wind stress forcing was applied to the GS to estimate GS latitude anomalies generated by wind stress curl anomalies near the GS. The GS latitude anomalies simulated by thin-jet theory were significantly and positively correlated with those derived from satellite observations since 1993, particularly at periods of 4–9 years, and also correlated with those derived from an eddy-resolving ocean model simulation since 1960. These results indicate that wind stress near the GS is one of the important mechanisms contributing to the GS shifts, particularly on interannual timescales. Furthermore, the lag relationship between the NAO and the GS latitude anomaly derived from thin-jet theory was not stationary, with the NAO lead shortening from 2 years to 1 year around 1995. This change in lag was accompanied by changes in the spatial structures of sea level pressure and wind stress curl anomalies associated with the NAO, with the wind stress forcing that generates GS latitude anomalies occurring farther upstream after 1995. The resulting reduction in the time required for the wind-forced GS latitude anomalies to propagate into the GS region is considered to have caused the shortening of the NAO lead. These results indicate that the GS response to the NAO depends not only on the strength of the associated wind stress forcing but also on its spatial pattern.

Poster #13

Frictional versus Buoyancy Control on the Energetics of the Antarctic
Circumpolar Current

Shinnosuke Yoshida (Hokkaido University)

The Antarctic Circumpolar Current (ACC) plays a central role in the global ocean circulation by connecting the Atlantic, Pacific, and Indian Oceans. In the ACC, wind forcing tends to steepen isopycnals by supplying potential energy (PE), whereas baroclinic instability releases this energy through baroclinic energy conversion and eddy energy dissipation. Because these processes are concentrated downstream of major ridges and plateaus, previous studies have mainly focused on large-scale topography. However, mesoscale seafloor roughness with horizontal scales of 10–100 km is widespread in the Southern Ocean and can enhance near-bottom eddy energy dissipation through non-propagating form drag.

Frictional-control theory predicts that, under fixed wind forcing, enhanced eddy energy dissipation is accompanied by stronger baroclinic energy conversion and increased ACC baroclinicity. In contrast, some numerical studies have shown that seafloor roughness can increase ACC baroclinicity while reducing baroclinic energy conversion. We hypothesize that this apparent inconsistency arises from surface buoyancy forcing, which modifies PE input and hence baroclinic energy conversion.

To test this hypothesis, we conduct idealized MITgcm simulations in a β -plane reentrant channel with a Gaussian ridge, varying both seafloor roughness and the strength of surface buoyancy forcing. We analyze the energy budget, focusing on the vertical eddy density flux associated with baroclinic energy conversion.

Under weak buoyancy forcing, seafloor roughness enhances baroclinic energy conversion, consistent with frictional-control theory. Under strong buoyancy forcing, however, PE input by surface buoyancy forcing becomes larger in the smooth-bottom experiment, reversing the rough–smooth contrast in baroclinic energy conversion. Nevertheless, ACC baroclinicity remains greater with rough topography regardless of buoyancy-forcing strength. These results indicate that enhanced eddy energy dissipation associated with seafloor roughness robustly increases ACC baroclinicity, whereas baroclinic energy conversion can vary substantially with surface buoyancy forcing. Thus, a reduction in baroclinic energy conversion need not directly cause enhanced baroclinicity, but may instead reflect differences in PE input by surface buoyancy forcing.

Poster #14

A Multimodal Meta-Learning Framework to Predict Streamflow Drought Onset from Large-Scale Atmospheric Triggers and Catchment Characteristics

Aparna Raut (Japan Meteorological Corporation)

The frequency and severity of droughts are increasing in river basins throughout Europe because of a changing climate. Early warning detection of streamflow drought onset remains a critical challenge in hydrometeorology for both gauged and ungauged catchments. Traditional machine learning frameworks are often unable to adapt to local catchment dynamics or regularise significantly when transferred across different hydro-climatic regimes. We propose a multimodal Model-Agnostic Meta-Learning (MAML) framework that predicts the timing of streamflow drought onset across 520 European catchments by integrating dynamic atmospheric drivers from the ERA5 reanalysis along with catchment attributes. Feature importance gain and correlation analyses reveal that antecedent thermal stress (14- to 30-day air temperature), 30-day precipitation deficits, and persistent moisture flux blocking (60-day Integrated Vapour Transport) account for more than 50% predictive gain, confirming that the model effectively leverages evaporative demand and large-scale atmospheric high-pressure patterns. We test MAML on few-shot ($K=3, 5$) adaptation in gauged basins. In gauged basins, MAML quickly adapts to local catchment memory, reaching an outstanding benchmark (ROC-AUC = 0.985, CSI = 0.868). Therefore, the framework integrates large-scale atmospheric dynamics along with catchment-scale hydrological memory, offering a reliable foundation for proactive drought risk mitigation and water security.

Poster #15

Strong downward wave energy transfer over Shenyang in winter

Hidenori Aiki (Nagoya University)

The group-velocity diagnostic scheme of Aiki et al. (2026, JAS), consisting of the GPWEF and THWEF, has been applied to the JRA-3Q atmospheric reanalysis for the 30-year period from 1990 to 2019. Perturbation fields have been defined relative to the zonal mean at 6-hourly intervals. The THWEF has provided the first realization of the concept of group velocity for unstable waves. The strongest downward wave energy flux in the global lower troposphere has been found over Shenyang, East Asia. This region, as well as the Hudson Bay region in North America, has been recognized for pronounced outbreaks of cold air during winter. In contrast, previous studies of the North Pacific storm track, in which perturbations have been defined relative to the time mean, have shown no pronounced signal over Shenyang. This contrast has indicated that the downward wave energy flux over Shenyang has arisen from the baroclinic instability of stationary waves, involving the release of available potential energy from the basic state. The associated energy source has been identified in the middle troposphere over Shenyang. Interestingly, upward wave energy radiation into the upper troposphere has been found to be weak, whereas downward radiation into the lower troposphere has been found to be strong. This feature has been found to be consistent with the universal picture of wave energy circulation based on Eady's unstable waves exhibiting an Upwind Sinking Downwind Rising (USDR) structure. Specifically, in the lower troposphere, wave energy transfer associated with the intrinsic group velocity has compensated for the insufficient eastward advection by the westerly mean flow, allowing wave energy to be transferred from Shenyang across the Sea of Japan and into the Pacific Ocean.