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Editorial: Oceanographic processes linking nearshore, continental shelf, and shelf break

Feng-Hsun Chang[1*], Yun-Chi Lin[2*], Kuo-Ping Chiang[2,3*], Ya-Han Nien[2], Chih-hao Hsieh[1,4,5,6,7], Wei-Jen Chen[1], Chin-Chang Hung[8], Toru Kobari[9], Hiroaki Saito[10] and William Savidge[11,12]

[1]Institute of Oceanography, National Taiwan University, Taipei, Taiwan, [2]Institute of Marine Environment and Ecology, National Taiwan Ocean University, Keelung, Taiwan, [3]Center of Excellence for the Oceans, National Taiwan Ocean University, Keelung, Taiwan, [4]Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan, [5]Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei, Taiwan, [6]Department of Life Science, National Taiwan University, Taipei, Taiwan, [7]National Center for Theoretical Science, National Taiwan University, Taipei, Taiwan, [8]Department of Oceanography, National Sun Yat-sen University, Kaohsiung, Taiwan, [9]Aquatic Sciences, Faculty of Fisheries, Kagoshima University, Kagoshima, Japan, [10]Atmosphere and Ocean Research Institute, The University of Tokyo, Kashiwa, Japan, [11]Skidaway Institute of Oceanography, University of Georgia, Savannah, GA, United States, [12]Department of Marine Sciences, University of Georgia, Athens, GA, United States

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EDITED AND REVIEWED BY
Marta Marcos,
University of the Balearic Islands, Spain

*CORRESPONDENCE
Feng-Hsun Chang
fhchang422@ntu.edu.tw
Yun-Chi Lin
yunchi@mail.ntou.edu.tw
Kuo-Ping Chiang
kpchiang@mail.ntou.edu.tw

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Editorial on the Research Topic
Oceanographic processes linking nearshore, continental shelf, and shelf break

The coastal ocean is a body of water that connects the coast to the shelf break. As a highly dynamic region lying on the outer edge of a continent, the coastal ocean's various processes interactively influence its physical, chemical, and biological dynamics. To promote a holistic understanding of the coastal ocean and its influences, we collected studies investigating physical, chemical, and biological dynamics and their interactions in coastal oceans. Through the collected studies we aim to determine the impacts of physical processes, like the interactions between currents and topography, on the distribution and dynamics of chemical substances, such as nutrients and gases. Moreover, to delineate how the influences of chemical dynamics will propagate to organisms and food-web dynamics, like plankton biogeography or fishery production. Under this premise, we organize this editorial by first introducing the studies that investigate marine physical processes, and then the studies that describe the consequent chemical dynamics and biological interactions. We compile the studies in the same region in the editorial for the sake of coherence (Table 1).

Northwestern Pacific

The western boundary current in the northwest Pacific Ocean, Kuroshio, and its interactions with local weather and topographical features influence the hydrological and

TABLE 1 Summary of research contributions within this research topic.

Authors	Topic	Oceans	Currents	Methods	Scientific fields
Berden et al. (2022)	Cross-shelf exchange	Atlantic	Southwestern Atlantic shelf	Model	Physics
Chang et al. (2021)	Predatory-prey diversity	Pacific	Southern East China Sea	Sequencing	Biology
Chen et al. (2022)	Reoxygenation of the hypoxia	Pacific	East China sea	Measurement	Chemistry
Chen et al. (2022)	Effects of the coastal uplift (picoplankton)	Pacific	Kuroshio	Cruise	Biology
Chen et al. (2022)	Shear flow	Pacific	Kuroshio	Model	Physics
Cheng et al. (2022)	*Uroteuthis edulis*	Pacific	Kuroshio	Cruise	Biology
Chung et al. (2022)	Picoeukaryotes	Pacific	East China Sea	Sequencing	Biology
Drozdova et al. (2022)	DOM production	Siberian shelf sea	East Siberian and Laptev seas	Cruise	Chemistry
Durán Gómez and Nagai (2022)	Nutrients	Pacific	Kuroshio	Model	Chemistry
Fukuda et al. (2022)	Sinking POC	Pacific	Kuroshio	Cruise	Chemistry
Hilborn and Devred (2022)	MODIS-Aqua data	Arctic	Eastern Beaufort Sea	Satellite	Biology/ Chemistry
Isada et al. (2021)	Nutrients and organic matters	Pacific	Oyashio current	Coastal region	Chemistry
Kurczyn et al. (2021)	Advection of upwell water	Gulf of Mexico	Yucatan Current.	Measurement/ Satellite/ Model	Physics
Kuroda et al., 2022	Harmful algae (*Karenia* spp.)	Pacific	Oyashio	Cruise	Biology
Lee et al. (2022)	Wave and tidal	Pacific	Tairua Beach, New Zealand	Model	Physics
Li et al. (2022)	Impact of mesoscale circulation	Pacific	East Australian Current	Satellite	Physics
Lin et al. (2022)	Chlorophyte	Pacific	East China Sea	Sequencing	Biology
Liu et al. (2022)	Freshwater pathway	Atlantic	Gulf of Mexico	Model	Physics
Lizarbe Barreto et al. (2021)	Phytoplankton increase	Pacific	Kuroshio	Satellite	Biology
Ma and Smith (2022)	Primary productive	Atlantic	Gulf stream	Measurement	Biology/ Chemistry
Manta et al. (2022)	Shelf water exchange	Atlantic	Western boundary currents	Model	Physics
Morimoto et al. (2022)	Heavy rain	Pacific	Kyucho current	Model	Physics
Muglia et al. (2022)	Gulf stream	Atlantic	Gulf stream	Model	Physics
Phillips et al. (2022)	Coastal seascape	Pacific	East Australian Current	Cruise	Biology/ Physics
Roughan et al. (2022)	Shelf transport pathway adjacent	Pacific	East Australian Current	Model	Physics
Toyoda et al. (2021)	Surface-layer circulation	Pacific	Kuroshio	Satellite	Physics
Tseng et al. (2022)	Methane	Pacific	Tamsui River in Taiwan	Measurement	Chemistry
Wang et al. (2022)	Wind-driven upwelling and downwelling	Atlantic	Wilmington Canyon, Mid-Atlantic Bight	Measurement	Physics
Weisberg and Liu (2022)	Shelf circulation and ecology	Atlantic	Gulf of Mexico Loop Current	Review	Physics
Xi et al. (2022)	Temperature	Pacific	Kuroshio	Satellite	Physics
Xue et al. (2021)	Shelf-sediment	Pacific	Coastal region	Measurement	Chemistry
Yang et al. (2021)	Land-ccean interaction	Pacific	South China Sea & East China Sea	Measurement	Physics/ Chemistry
Zhurbas and Väli (2022)	Wind control	Atlantic	Southeastern Baltic sea	Model	Physics

biogeochemical dynamics along its pathway. In the subtropical region where Kuroshio travels northward and passes the steep east coast off Taiwan, the isotherms and isopycnals typically exhibit onshore lifting and offshore deepening (Jan et al., 2017). As a result of the tilting isotherms, cold and nutrient-rich subsurface water is upwelled to the euphotic zone (Chen et al.), while the magnitude of the coastal uplifting is proportional to Kuroshio's current speed. Subsequently, the higher nutrient level raises the chlorophyll-*a* concentration and the biomass of autotrophic picoplankton, which in turn raises the heterotrophic bacterial biomass. The upwelling along the Kuroshio also reduces the abundance of *Prochlorococcus* while increasing the abundance of *Synechococcus* and picoeukaryotes, both of which are favorable at high nutrient concentrations. Further north, the Kuroshio encounters submarine canyons northeast of Taiwan and impinges onto the East China Sea's (ECS) continental shelf. The Kuroshio impingement interacts with the winter monsoon, forming a nutrient-rich cold dome off the coast of northeastern Taiwan (Jan et al., 2011), sustaining high productivity in the area (Wong et al., 2000; Liu et al., 2003). Cheng et al. in this issue provides another line of evidence showing the positive impacts of Kuroshio impingement on the catch rate of swordtip squid (*Uroteuthis edulis*), a primary target species of the commercial fishery in this region.

At the continental shelf of ECS, the hydrographical and biogeochemical dynamics are further complicated by the interaction of multiple water masses, including the Kuroshio, China Coastal Current, Taiwan Warm Current, and Changjiang River runoff. Among these water masses, the nutrient and CO_2-laden freshwater discharge from Changjiang River typically causes hypoxia and low pH level on the inner shelf of the ECS, particularly outside the estuary. According to Chen et al. (2022) in this issue, coastal upwelling events associated with the intrusion of the Kuroshio can alleviate the hypoxia. Upwelling allows the accumulated CO_2 in the hypoxic layer to be ventilated while allowing the regenerated nutrients reaching the surface to be utilized. Vertical mixing during upwelling events also replenishes oxygen to the deeper water column, relieving oxygen stress on the resident fauna. Meanwhile, the freshwater discharge from Changjiang River influences the community composition of picoeukaryotes in addition to the influences directed to biogeochemical cycling. According to Chung et al. in this issue, such a phenomenon happens as the picoeukaryotic community composition shifts from photosynthetic picoeukaryote dominance in the non-flooding season to mixotroph and heterotroph dominance during the flooding season. Furthermore, chlorophytes are an important component among eukaryotic picophytoplankton in the ocean (Not et al., 2004). Lin et al. in this issue suggest that chlorophyte composition is closely related to water masses, as its salinity, temperature, and silicate concentration significantly influence the distribution of chlorophytes. This study discovered that Chloropicophyceae in oligotrophic Kuroshio water and Mamiellophyceae in more eutrophic waters dominate chlorophyte communities. Chang et al. in this issue investigates the diversity and community relationships between planktonic bacteria and their main predator, heterotrophic nanoflagellates (HNF) within the biologically diverse and hydrographically complex ECS environment. They find that bacterial and HNF diversity are positively associated, and this relationship is possibly governed by the trophic interaction between bacteria and HNF. The ECS shelf's complex hydrography promotes highly dynamic biological interactions. However, the consequences for the pelagic ecosystem and biogeochemical cycles still worth further investigation.

The Kuroshio has long been known to either take a relatively straight path or take a large meander path along the south coast of Japan after leaving the ECS shelf (Kawabe, 1985). To depict the Kuroshio path, Barreto et al. analyzed the altimetry data and revealed that the Kuroshio takes a large meander path from 2004-2005 and from 2017 to the present. When taking the large meander path, the Kuroshio flows closer to the southeast coast of Kyushu after passing the Tokara Strait south of Kyushu. The path that is closer to the coast induces stronger trapped near-inertial internal waves as well as more turbulent mixing in the coastal regions of southeastern Japan (Nagai et al., 2019). Chen et al. in this issue provides additional theoretical support explaining the increased shear instability and turbulent kinetic energy that appears as the Kuroshio flows through topographical ridges. Meanwhile, Durán Gómez and Nagai in this issue developes an ecosystem model showing how strong vertical turbulent mixing, associated with the passage of the Kuroshio over abrupt topography, propagates eastward along the coast and increases the chlorophyll-*a* concentration in the coastal region. Following that, the Kuroshio path bends further seaward (southward) as it approaches the Izu Ridge and flows nearly northward before meeting the south-flowing subarctic western boundary current called Oyashio. On the Kuroshio's landside, the large meander path creates cyclonic eddies. These cyclonic eddies, combined with turbulence, supply ample nutrients to the euphotic zone, elevating the chlorophyll-*a* concentration (Lizarbe Barreto et al.).

On the other hand, the large meander regime creates anti-cyclonic circulations in some regions located on the south side of Japan's main island, such as Suruga Bay. Combining mathematical simulations with *in situ* observations, Toyoda et al. in this issue discovers that Kuroshio's northward intrusion into the western Suruga Bay creates an anti-cyclonic circulation in the bay, which contrasts the cyclonic circulation during a non-large meander regime. In addition, regional circulation is also affected by local weather. Combining observational data and numerical modeling, Morimoto et al. in this issue shows that heavy rain around the Bungo Channel between Kyushu and Shikoku decreases water density, intensifies the gravitational circulation, and thus induces the intrusion of large amounts of cold and nutrient-rich bottom water to the Bungo Channel. The bimodal characteristic of Kuroshio's path, the local topographical features, and weather interactively influence the circulation patterns, hydrography, and biological dynamics of the coastal regions south of Japan.

Further north, the Kuroshio converges with the Oyashio, a colder and fresher subarctic ocean current, and turns eastward to form the so-called Kuroshio Extension. The convergence zone – the Kuroshio-Oyashio Inter-Frontal Zone (KOIZ) – and the Kuroshio Extension are characterized by dynamic hydrography and active frontal features due to the contrasting properties of the two currents (Yasuda, 2003). The temporal and spatial variability, as well as the intensity of those fronts, are critical for the subsequent biogeochemical dynamics in the KOIZ and the Kuroshio Extension region. Analyzing 17 years of satellite observations of sea surface temperature (SST), Xi et al. in this issue investigates the spatial and temporal variations of the KOIZ fronts. Xi et al. report that fronts are more common on the north side of KOIZ in winter but become more common on the south side in spring. In addition to frequency, the cross-frontal gradients are steeper north of the KOIZ due to stronger mesoscale eddies. Meanwhile, the basin-scale ocean-atmosphere climate variability, including the Pacific Decadal Oscillation and North Pacific Gyre Oscillation, significantly influences the interannual variability of fronts in the KOIZ and the Kuroshio Extension region. Aside from influencing the hydrography in offshore regions, Oyashio can also interplay with marine heatwaves and warmer coastal currents, such as Modified Soya Warm Current and Tsugaru Warm Current, to trigger the onset of a harmful algal bloom on the southeast coast of Hokkaido, Japan (Kuroda et al.).

Along the coastal regions from Taiwan to Japan, physical processes can increase phytoplankton biomass, which in turn influences the cycling of particulate and dissolved organic matters (POM and DOM). Yang et al. in this issue measures the elemental (N/P) ratio, ^{7}Be and $^{210}Pb_{ex}$ isotopes of suspended sediments to specifically pinpoint the time when the monsoon regime shifts from southwestern to northeastern in October in the Taiwan strait, and depict the dynamics of circulation and frontogenesis as a result of the interactions between river runoffs, coastal currents, and the seasonal monsoon. In the Kuroshio region south of Japan, Fukuda et al. in this issue measures the flux and attenuation of POM. They argue that particle size affects the POC flux and attenuation, while chemical properties (e.g., the C/N ratio of sinking particles) do not cause any effect. In the semi-enclosed coastal sea of northeastern Japan, Isada et al. in this issue characterizes seasonal and spatial changes in the optical absorption properties of CDOM, phytoplankton, and non-algal particles (NAP) as a function of temperature, salinity, nutrients, and water transparency along the river–salt marsh–eelgrass meadows–coastal waters continuum. They discover that in addition to the river input, mariculture and eelgrass meadows influence nutrient cycling and CDOM absorptive characteristic, which in turn influence the water transparency of the system. Moreover, further north in Siberian Sea Shelf in the Arctic Ocean. Drozdova et al. in this issue examines the spectral signatures of fluorescent dissolved organic matter (FDOM) and its spatial distribution. They argue that microbial activity is enhanced on the east part of the shelf as the autochthonous-derived chromophoric DOM components, which are suggestive of heterotrophic reworking of marine organic matter, dominate the shelf waters. These studies demonstrate how biological interactions affect the production, transportation, and fates of organic matters, which subsequently affect biogeochemical cycling.

Southwestern Pacific

The East Australian Current (EAC) is the western boundary current of the west Pacific Ocean in the southern hemisphere. The EAC flows poleward along southeastern Australia, often intruding onto the continental shelf on Australia's central east coast. The physical processes and subsequent biogeochemical dynamics accompanied with the EAC to some degree resemble those in the Kuroshio region. Roughan and Middleton (2002), for example, have identified four mechanisms bringing nutrients onto the continental shelf: wind-driven upwelling, encroachment of the EAC onto the continental shelf, topography-induced current acceleration, and the separation of the EAC from the coast. In this issue, Roughan et al. further demonstrates the circulation variability of EAC, influences of such circulation on shelf-ocean water transportation, and the upwelling processes around the productive Hawkesbury Shelf. In addition, Li et al. in this issue investigates the largest river plume (Hawkesbury River plume) in the Hawkesbury Shelf region. The authors find that the circulation of EAC and rainfall interactively influence the north and south extensions of the plume, but the river plume is largely trapped in the shelf region. These findings clarify the fate of river-borne material on the adjacent continental shelf under various forcing scenarios. To better understand and manage the ecosystem, Phillips et al. in this issue uses satellite and *in situ* measurements of temperature, salinity, and current velocity, together with acoustic measurements of pelagic biomass (zooplankton and fish), to characterize the seascape variability in southeast Australia. The southeast Australia is known for being a hotspot of ocean warming and ecosystem tropicalization. According to Phillips et al., two seascape categories are identified: one characterized by warm and less saline water and the other characterized by cool and more saline water. The seascape category made up of less warm saline water indicates a greater influence of the EAC on the coastal region. These findings emphasize the critical role of offshore oceanographic processes in driving coastal seascape variability and biological activity in a region experiencing rapid ocean warming and ecosystem changes.

Northwest Atlantic

The western boundary current in the western North Atlantic Ocean, the Gulf Stream, interacts with some topographical features (e.g., shelf break and seabed rises) and local processes (e.g., wind and river discharge) to influence the hydrography and biogeochemical cycles. When the Gulf Stream travels northward, it meanders and encounters the Charleston Bump, a rocky seabed that rises around 31-32°N. The meander and subsequent propagation of the Gulf Stream is depicted by Muglia et al. in this issue, who analyzes data from a bottom-moored Acoustic Doppler Current Profiler (ADCP) with high-frequency radar (HFR) offshore of Cape Hatteras. They reveal that when the Gulf Stream deflects seaward, the induced vertical circulation and vertical shear create a cold dome that pumps nutrients from the deep. In addition to the Gulf Stream, local wind also generates upwelling events in coastal regions. Wang et al. in this issue combines measurements from underwater gliders and numerical modeling to show that upwelling favorable winds induced a cross-slope pressure gradient that injected deep cold canyon water onto the Mid-Atlantic Bight (MAB) shelf. The cold, nutrient-rich upwelling plume spread northeastward along the shelf and broadened in the cross-shelf direction until a wind reversal produced downwelling favorable conditions, causing some upwelled waters to return to depth in the canyon. The significant amount of nutrients entrained by upwelling events have the potential to nourish this region and make it a productive and important fishing ground. Ma and Smith in this issue demonstrates that the complex physical processes and ensuing nutrient dynamics propagate to affect the primary production at the MAB shelf. Surprisingly, the shelf break frontal features might not significantly contribute to the increased productivity at the MAB. Ma and Smith (2022) also claim that combining satellite chlorophyll, sea surface temperature, photosynthetically active radiation (PAR), and a photosynthesis model promotes a more robust resolution of primary productivity at smaller vertical and horizontal scales than by using traditional ^{14}C incubations.

Aside from the Gulf Stream, the Yucatán Current and Loop Current in the Gulf of Mexico also causes an upwelling and interact with freshwater discharge and local winds. The Yucatán Current commonly induces upwelling on the eastern side of the Yucatan shelf, but upwelling events at the west side of the Yucatán Peninsula received relatively little attention. Combining *in situ* and remote observations as well as numerical modeling, Kurczyn et al. in this issue describe the westward advection of upwelled Caribbean Subtropical Underwater from the eastern Yucatan Shelf across the Campeche Banks. Kurczyn et al. note that the colder, denser water was confined to a thin near-bottom later as it propagated westward. However, further investigation is needed to understand the chemical and biological consequences of such upwelling at the shelf west of the Yucatán Peninsula. On the other hand, the Loop Current and its accompanying mesoscale eddies influence both the vertical and horizontal transport of freshwater discharged from the Mississippi River and the neighboring Atchafalaya River (MARS) into the Gulf of Mexico. In their study, Liu et al. in this issue finds that, the MARS discharge is largely transported westward in winter but can be transported either westward to the continental shelf or eastward out of the Gulf in summer. Reviewing decades of studies on the Loop Current, local wind, and their collective influences on the hydrography, nutrient dynamics, and the ecological consequences at the west Florida continental shelf, Weisberg and Liu argue that the variation of the Loop Current path on an inter-annual basis, as well as the variation of wind direction and stress at the intra-annual basis, collectively determine the vertical movement of water on the shelf.

Northeast Atlantic

Zhurbas and Väli examines the effects of regional wind forcing on deep water transport within the Baltic Sea. They discovered that winds blowing perpendicular to the channel orientation enhance deep-layer water transport through channels due to the Ekman transport. Thus, the surface wind field has a stronger influence on the flushing and renewal of bottom water in the Baltic Sea basins.

Southwest Atlantic

In the south Atlantic Ocean, a major western boundary current, the Brazil Current, and a branch of the Antarctic Circumpolar Current, the Malvinas Current, converge around 30-40°S off the coast of Argentina and Uruguay. Because the warm and salty Brazil Current meets the cold, fresh and nutrient-rich Malvinas Current, the Brazil-Malvinas convergence (BMC) zone has highly dynamic hydrology. Cross-shelf exchange between the Southwestern Atlantic shelf and the open ocean is also highly variable in the BMC zone. To depict the variability and drivers of the cross-shelf exchanges, Berden et al. in this issue implements a high-resolution ocean model (Copernicus Marine Environment Monitoring Service (CMEMS) global ocean reanalysis (GLORYS12V1) during 1993–2018). They verify the model results with satellite altimetry data and *in situ* on-board observation. Berden et al. reports that the annual mean cross-shore transport is 2.09 ± 1.60 Sv toward the open ocean, with a maximum in January and a minimum in June due to local alongshore wind stress that affects the sea level anomaly. Inshore transportation can occur and reaches 6.53 Sv. during certain extreme conditions. Complementing Berden et al.'s research findings, Manta et al. combined *in situ* observation, Argo temperature and salinity profiles, and satellite data to depict a 3-D circulation structure in the BMC zone. They discovered that the Rio de la Plata waters plume near the surface, as well as the Subantarctic Shelf Waters under the subtropical thermocline, also transport comparable amounts of water offshore.

Anthropogenic influences on coastal processes

Aside from the physical processes mentioned above, human activities and global changes profoundly impact marine environments. To address this issue, Lee et al. in this issue proposes a new model framework for predicting the long-term evolution of beach profiles under rising sea levels or severe weather caused by climate changes. Meanwhile, Hilborn and Devred in this issue partition 17 years of satellite-measured sea-surface temperature, suspended particulate matter, and chlorophyll-*a* concentration of the Eastern Beaufort Sea into six regions using the self-organizing maps technique. Their regional classification corresponds to the physical characteristics of the EBS, as observed in other studies. With the inter-annual and monthly variation of sea-ice concentration in these regions, Hilborn and Devred shows that the Eastern Beaufort Sea experiences more non-uniform impacts from climate changes than previously thought. Furthermore, Xue et al. in this issue indicates that increasing ship traffic significantly decreases the seabed sediment's particle size and changes the biogenic element ratio of the sediments. Tseng et al., on the other hand, in this issue describes the seasonal distributions of methane in a populous urban coastal sea area in the Tamsui River, the third longest river in Taiwan. Their study emphasized the anthropogenic impacts of climate change and the biogeochemical dynamics in coastal regions across the globe.

Summarily, the diversity of the contributions of this Special Issue highlights the complexity of biogeochemical responses to physical forcing in the sea. These results demonstrate the interactive impacts of physical processes occurring at multiple spatial and temporal scales on biogeochemical cycles, food-web dynamics, and biodiversity. This Special Issue emphasizes the need for holistic approaches and/or interdisciplinary studies to investigate the physical oceanography, biogeochemical cycles and ecosystem structure, and dynamics of the coastal ocean.

Author contributions

F-HC and Y-CL wrote the draft of the manuscript; K-PC and Y-HN organized the articles; C-HH, W-JC, C-CH, TK, HS, WS contributed substantially to revisions. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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