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LaPeco 2025

Latin American Physics of Estuaries and Coastal Oceans

November 24-28 th
Puerto Varas - Chile

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Latin American Physics of Estuaries and Coastal Oceans

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Conference focus:

Dynamics of Estuaries and the Coastal Ocean of Latin America

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24-28 th NOVEMBER

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Puerto Varas–Chile

Scientific Program LAPECO – 2025

3rd International Congress on Physical of Estuarine and Coastal Ocean

(Please note that this program is subject to change according to participant confirmations and final details)

Lunes 24 Noviembre

1. CURSO PRE-CONGRESO (REGISTER IS REQUIRED / REGISTRO PREVIO). NO TIENE COSTOS ASOCIADOS, TODOS LOS GASTOS SERÁN CUBIERTOS POR EL CONGRESO.

Lugar: Auditorio Centro i~mar, U. de Los Lagos, Puerto Montt. (Cam. a Chinquihue Km. 6).

Hora	Actividad
09.00 – 11.00	**TEOS-10 and seawater thermodynamics - why should I care?** *Dr. Richard Pawlowicz, Universidad de British Columbia, Canada.*
11.00 – 13.00	**Introduction to oceanographic data analysis with Python/Jupiter** *Dr. Carlos Schettini, Universidade Federal do Rio Grande, Brasil.*
13.00 – 14.00	**Brunch en Centro i~mar**
14.00 – 15.00	**Introduction to oceanographic data analysis with Python/Jupiter.** *Dr. Carlos Schettini, Universidade Federal do Rio Grande, Brasil.*
15.00 – 18.00	**The four pillars for effective communication in the scientific endeavor** *Dr. Arnoldo Valle-Levinson, Universidad de Florida, USA.*
18.00-19.00	**Traslado del Centro i-mar, Puerto Montt al Hotel en Puerto Varas con buses del congreso.**

2. ACREDITACIÓN Y MONTAJE HOTEL WYNDHAM PUERTO VARAS PETTRA

Hora	Actividad
15.00 – 19.00	Acreditación y montaje de póster y espacios publicitarios de auspiciadores
19.00 – 21.00	**Ice breaking**

Martes 25 Noviembre

Hora	Actividad
08.30 – 18.00	Acreditación
09.00 – 10.00	**Ceremonia de inauguración - Hotel Wyndham Puerto Varas Pettra** • Palabras de bienvenida Autoridades • Directora Centro i-mar, Universidad de Los Lagos. • Gerente INTESAL. • **Introducción a LAPECO 2025. Chairman Dr. Iván Pérez-Santos**
10.00 – 10.45	**Charla magistral 1:** Lagrangian Investigations of Coastal Ocean Processes. **Dr. Richard Pawlowicz, Universidad de British Columbia, Canadá**
11.00 – 11.30	**Café de pausa**
Sesión Estuarine Dynamics 1 - Moderador: Debora Barros y Elisa Fernández	
11.30 – 11.45	Operational modeling of storm tides to support coastal flood warnings in Baixada Santista and the Estuarine System of Santos, São Vicente and Bertioga (SP, Brazil) **Matheus Souza Ruiz, Universidade Santa Cecília, Brazil.**
11.45 – 12.00	Dynamics of the Río de la Plata Salinity Front: Spatiotemporal Variability and Drivers **Michelle Jackson, Universidad de la República, Uruguay.**
12.00 – 12.15	Seasonal and Synodic Variability in the Physical Properties of the São José Estuary, Brazil **Luis Carlos Oliveira do Lago, Federal University of Rio Grande, Brasil.**
12.15 – 12.30	Spatial evolution of turbulence and mixing along the estuary-shelf gradient in a highly stratified system **Debora Queiroz Gadelha de Barros, Federal University of Rio Grande, Brasil.**
12.30 – 12.45	Tetrahedral Framework for the Tetraforcing Semienclosed Basin Dynamics **Juan Torres-Cordoba, Universidad de Florida, USA.**
13.00 – 14.30	Libre
Sesión Climate influence - Moderador: Elisa Fernández y Diego Moreira	
14.30 – 14.45	Interacción océano-atmósfera en el Pacífico Oriental: influencia de anticiclones subtropicales en la surgencia y el transporte de la PCUC **Pamela Muñoz Linford, COPAS Coastal, Universidad de Concepción, Chile.**
14.45 – 15.00	Plastic debris transport in the Patos Lagoon during the 2024 extreme flood event **Kristhal Doto, Federal University of Rio Grande, Brasil.**
15.00 – 15.15	Patos Lagoon Digital Twin – An innovative concept for assessing and mitigating risks of extreme flood events in southern Brazil **Elisa Helena Leão Fernandes, Federal University of Rio Grande, Brasil.**
15.15 – 15.30	Wave transformation processes: roughness and sea level influence in Tamandaré reef, Brazil. **Luiza Paschoal Stein, University of São Paulo, Brasil.**
15.30 – 15.45	Coupled wave-current modelling of dispersion in an endangered Caribbean coral reef lagoon **Cecilia Enriquez, Universidad Nacional Autónoma de México, México.**
16.00 – 16.30	**Café de pausa**
Sesión Estuarine Dynamics 2 - Moderador: Debora Barros y Pamela Linford	
16.30 – 16.45	Observations of turbulent kinetic energy production and dissipation in the Rio de La Plata Estuary **Eliana Morquio, Universidad de la República, Uruguay.**
16.45 – 17.00	Variaciones espaciales y temporales de la intrusión salina en estuarios del pacífico de Panamá. **Ian Deago, Universidad Tecnológica de Panamá, Panamá.**
17.00 – 17.15	Spatial and seasonal variability of suspended sediments in the Río de la Plata estuary based on numerical models and in situ observations

	Diego Moreira, Centro de Investigaciones del Mar y la Atmósfera, Argentina.
17.15 – 17.30	Ocean-Dominated Surface and Groundwater Hydrological Dynamics in a Semiarid Coastal Wetland of Central Chile **Lino Yovan, Pontificia Universidad Católica de Chile, Chile.**
17.30 – 17.45	UAV-Based Remote Sensing Algorithm for Hydrodynamic and Water Quality Monitoring in the Río de la Plata Estuary **Facundo Noel Galletta Oroña, Universidad de la República, Uruguay.**
17.45 – 18.00	Disminución del efecto Niño costero 2017 en la variabilidad de las condiciones oceanográficas y estratificación en la ensenada de Huanchaco, Trujillo, La Libertad, Perú. **Jorge Martín Quispe Sánchez, Instituto del Mar del Perú.**
18.00-19.30	**Poster de Estuarine Dynamics 1-2 y Climate influence (Local Beer)**
19.30-21.00	**Cheeses and Beers en Hotel Wyndham Puerto Varas Pettra**

Miércoles 26 Noviembre

08.00 – 11.00	**Accreditation and Industry Day pass**
09.00 – 09.45	**Charla magistral 2:** Dynamics in the Chilean Inland Sea: main drivers in the context of worldwide estuaries. **Dr. Arnoldo Valle-Levinson, Universidad de Florida, USA.**
	Moderador: Arnoldo Valle-Levinson y Lauren Ross
10.00 – 10.15	Deoxygenation in a Subantarctic Glacial System: Zonation and Processes in the Almirante Montt Gulf (Chile) **Gabriel Soto, Instituto de Fomento Pesquero, Chile.**
10.15 – 10.30	Surface Deoxygenation in the Fjords of Northern Patagonia: A Long-Term Analysis Based on Oceanographic Buoy Data. **Francisca Gutierrez, Universidad de Concepción, Chile**
10.30 – 10.45	Meridional Transport Variability and Climate Forcing off Chilean Patagonia (1993–2022) **Octavio Mercado Peña, COPAS Coastal, Universidad de Concepción Chile**
10.45 – 11.00	Atmospheric Rivers as Drivers of Shear and Energy Variability in Puyuhuapi Fjord **Lenna Ortiz, Centro de Investigación en Ecosistemas de la Patagonia, Chile.**
11.00 – 11.30	**Café de pausa**
11.30 – 11.45	Modelación numérica de la conectividad y surgencia en el fiordo Puyuhuapi durante la primavera de 2024: una aproximación a la dinámica de floraciones algales nocivas. **Valentina Iturra Rosales, Universidad de Concepción, Chile.**
11.45 – 12.00	Decrease of deep ventilation contributing to deoxygenation in North Patagonian fjords and channels: Guafo mouth study case. **Camila Paz Sola Hidalgo, Universidad de Valparaíso, Chile.**
12.00 – 12.15	Wave-current interactions in Chacao Channel **Maricarmen Guerra Paris, Universidad de Concepción, Chile.**
12.15 – 12.30	Circulation, mixing, and barotropic tidal energy in a regional interior sea, Northern Patagonia. **Francesca Search, Universidad de Valparaíso, Chile.**
12.30 – 12.45	Circulation in the Guafo Mouth: The gateway to northern Patagonia. **Lauren Ross, Universidad de Maine, USA.**
12.45-13.00	The technology behind the new RBR developments in Ocean instrumentation **Max Vergara, RBR, Canadá**
12.45 – 14.30	**Libre**
	Moderador: Iván Pérez-Santos y Elías Pinilla
14.30 – 14.45	Variability of the Magellan Plume using hydrodynamic modeling **Leandro Suarez, Meric Chile.**
14.45 – 15.00	Winds and tides play with drifters in Corcovado Gulf, northern Patagonian Fjords. **Sebastian Orlando Duran Torres, Fundación Huinay, Chile.**
15.00 – 15.15	Dinámica de los seiches internos en el Fiordo Reloncaví: un estudio numérico CROCO/WRF. **Sergio Andrés Bahamóndez Palza, Universidad de Concepción, Chile.**
15.15 – 15.30	Short-term Spatial and Temporal Variability of Small River Plumes in Patagonian Fjords: a multiscale integration between remote sensing and in situ data. **María Andreina Arias Albornoz, Universidad Católica de Chile, Chile.**
15.30 – 16.00	**Café de pausa**
16.00 – 16.15	Tide, Wind, and Freshwater Influences on Patagonian Fjord and Plume Dynamics. **Megan Williams, Universidad Católica de Chile, Chile.**
16.15 – 16.30	Structure and variability of freshwater conditions off Chilean Patagonia from a high-resolution curvilinear ocean model. **Osvaldo Artal Arrieta, Universidad de la Frontera, Chile.**

16.30 – 16.45	Variabilidad mensual de las propiedades físicas y químicas del fiordo Comau. **Alvaro Jorquera, Nazca, Chile.**
16.45 – 17.00	Advancing Multi-Domain Uncrewed Observing Systems for Scalable Ocean Monitoring and Ecosystem Assessment. **Jan Buermans, ASL Environmental Sciences, Canada.**
17.00 – 18.00	**Panel de discusión:** **Levantado brechas de la industria para generación de ciencia aplicada**
18.00-19.30	**Poster de Industry day (Local Beer)**
19.30 – 21.00	**Seafoods tasting and networking en Hotel Wyndham Puerto Varas Pettra**

Jueves 27 Noviembre

Hora	Actividad
09.00 – 09.45	**Charla magistral 3:** Surgencia costera frente a Chile Centro Sur: Estado del conocimiento y tendencias del enfriamiento superficial en los últimos 80 años**.** **Dr. Marcus Sobarzo, Universidad de Concepción, Chile.**
Sesión Estuarine Dynamics 3 - Moderador: Marcus Sobarzo y Gonzalo Saldías	
10.00 – 10.15	Transverse structure of exchange flows around a mid-estuary coastal constriction **Jorge Armando Laurel Castillo, Consultor independiente, México.**
10.15 – 10.30	Catabatic Winds Drives Reversals of Subtidal Estuarine Circulation Under Hot and Dry Conditions. **Braulio Juarez, Universidad Autónoma de Baja California, México.**
10.30 – 10.45	Interannual variability of daily sea-level maxima. **Arnoldo Valle-Levinson, Universidad de Florida, USA.**
10.45 – 11.00	Disentangling the Physical Forcings Influencing Exchange Flow in a Complex Fjord System. **Elías Pinilla, Universidad de Maine, USA.**
11.00 – 11.30	**Café de pausa**
Sesión Shelf Dynamics 1 - Moderador: Oscar Álvarez y Diego Narváez	
11.30 – 11.45	Circulation controls on a wide and shallow continental shelf with diverse forcing. **Ismael de Jesús Mariño Tapia**
11.45 – 12.00	A modeling study of the influence of an atmospheric river event on circulation and Hydrographic conditions in the Gulf of Arauco, central Chile **Gonzalo Saldías, Universidad del Biobío, Chile.**
12.00 – 12.15	Coastal trapped wave along the Chilean continental margin and their interaction with a long submarine canyon **Sophia Pierina Nativí Merchán, Universidad del Biobío, Chile.**
12.15 – 12.30	Marine heat waves, sea temperature, and the octopus population, in a shallow-tropical sea **Jorge Alejandro Kurczyn Robledo, Universidad Nacional de México, México.**
12.30 – 12.45	Horizontal small-scales features on the inner shelf adjacent to the mouth of Patos Lagoon **Melissa Garcia Balhejos, Federal University of Rio Grande, Brazil.**
12.45 – 13.00	Exploring the hydrodynamic structure of the Magdalena River plume in the Caribbean Sea **Oscar Álvarez-Silva, Universidad del Norte, Colombia.**
13.00 – 14.30	Libre
Sesión Shelf dynamics 2 - Moderador: Paula Birocchi y Salma Espinoza	
14.30 – 14.45	Impact of Atmospheric Rivers on Coastal Oceanographic Conditions off central-southern Chile **Yosvany Garcia Santos, Universidad de Concepción, Chile.**
14.45 – 15.00	Implementation of Operational Models along the Chilean Coast **Diego Narváez, COPAS Coastal, Universidad de Concepción, Chile.**
15.00 – 15.15	Numerical assessment of tidal stream energy in the Brazilian Equatorial Shelf **Alessandro Lopes Aguiar, Universidade do Estado do Rio de Janeiro, Brasil.**
15.15 – 15.30	Diapycnal Mixing and Double Difussion in the Oxygen Minimun Zone off Central Chile - Observational Evidence from Underwater Gliders. **Salma Juliette Espinoza Rivera, Universidad de Concepción, Chile.**
15.30 – 15.45	3D Shelf Sea Modeling: Applications in Europe and the U.S. with Relevance to Latin America. **Stendert Laan, Deltares USA – Silver Spring, MD, USA.**
15.45 – 16.00	Interactions between polymer properties, density-driven stratification and the distribution of microplastics in the water column **Clara Silveira Bainy, Universidade Federal do Rio Grande, Brasil.**

16.00 – 16.30	**Café de pausa**
Sesión Biophysical processes - Moderador: Patricio Díaz y Andrea Piñones	
16.30 – 16.45	Exploring Lagrangian circulation as a bottom-up control of the Antarctic marine ecosystem. **Andrea Piñones, Universidad Austral de Chile, Chile.**
16.45 – 17.00	Hydrographic Variability and Pelagic Species Distribution in Northern Chilean Patagonia: Insights from Combined In-situ and Modeled Data (2014–2025) **Cristián Alfredo Henríquez-Pastene, IFOP.**
17.00 – 17.15	River freshwater and nutrient releases impact on biological production in central-southern Chile using biophysical simulations **Odette Alejandra Vergara Soto, Universidad de Concepción.**
17.15 – 17.30	An atypical population of Dinophysis acuminata in Northwest Patagonia: The strange case of the San Rafael Lagoon Glacier **Patricio A. Díaz, Centro i-imar, Universidad de Los Lagos**
17.30 – 17.45	High-resolution temporal dynamics of diatoms in a large and well-mixed tropical estuary **Paula Birocchi, Universidad de Sao Paulo, Brasil.**
18.00-19.30	**Poster de Estuarine Dynamics y Biophysical processes (Local Beer)**
19.30 – 21.00	**Chilean Wine day en Hotel Wyndham Puerto Varas Pettra**

Viernes 28 Noviembre

Sesión Estuarine Dynamics 4 - Moderador: Cristian Rojas y Carlos Schettini	
09.00 – 09.15	Geometry Shapes the Flow: Asymmetric Dynamics in Narrow Channels and Their Impact on Estuarine Connectivity. **Zeneida Elizabeth Wong Chang, Universidad de Concepción, Chile.**
09.15 – 09.30	Unprecedented ADCP-based characterization of tsunami–tide–river coupling in the Valdivia River for the 2025 Kamchatka tsunami. **Nicolás Donoso Castro, INNOVEX, Chile.**
09.30 – 09.45	Influence of artificial river-mouth openings on tidal wave propagation in a small estuary. **Camila Bastías Rojas, Universidad de Concepción, Chile.**
09.45 – 10.00	Effects of sediments on exchange flow in a macrotidal and turbid estuary. **Cristian Rojas, Universidad de Maine, USA.**
10.00 – 10.15	River-wave interactions at small-scale river mouths **Raúl Flores Audibert, Universidad Técnica Federico Santa María, Chile.**
10.15-10.30	Extreme River Discharges in Patos Lagoon: Hydrodynamic Effects and Flooding Risks. **Elisa Helena Leão Fernandes, Federal University of Rio Grande, Brasil.**
10.15 – 11.00	**Café de pausa**
Sesión Morphodynamics and Sediment dynamics Moderador: Aldo Sottolichio y Carlos Schettini	
11.00 – 11.15	Preliminary Analysis of Coastal Morphological Changes in La Paz Lagoon Using Satellite Imagery **Leonardo Tenorio Fernández, Instituto Politécnico Nacional, México**
11.15 – 11.30	Estimation of wave forcings from remote measurements: case study of the Maipo river mouth **Sebastián Véliz Cuéllar, Universidad Técnica Federico Santa María, Chile.**
11.30 – 11.45	Evolution of tides in relation to morphology and river discharge changes **Aldo Sottolichio, Université de Bordeaux, Francia.**
11.45 – 12.00	Inner shelf hydrodynamics and mud dynamics adjacent to the Patos Lagoon mouth **Carlos Schettini, Universidade Federal do Rio Grande, Brazil.**
12.00 – 12.15	Spatial and temporal variability of suspended particulate matter on Brazil's Southern inner shelf **Ornella Bertholdo Calloni, Universidade Federal do Rio Grande, Brazil.**
12.30 – 13.00	**Ceremonia de clausura - LAPECO AWARDS**
12.30 – 14.00	Libre
14.30 – 20.00	**Tour oficial: Parque Nacional Vicente Pérez Rosales (Opcional, previa acreditación)**

Posters Session

Martes 25 Noviembre (18.00-19.30)

Topics	Authors	Tittle of abstract
Estuarine dynamics	Andres Garcia-Ruiz	Critical environmental factors in the physical deterioration of structural timber in estuarine environments - Insights from a global literature review
	Anneke ten Doeschate	Resolving double-diffusive mixing with microstructure sensors in coastal and ocean waters
	José Mauro Vargas Hernández	Tidal forcing dominates instantaneous and residual currents in a tropical estuarine system.
	Claudia Morales-Garrido	Fire and Ice: Dynamics oceanography in North Patagonia in Falkor too (SOI)
	Daniel Andrés Olivares Norambuena	Development and Assessment of a Curvilinear Ocean Model for the coastal ocean of Chilean Patagonia
	Darinka Andrea Pecarevic Estay	Tidal and subtidal flows in a shallow-short channel of the northern Patagonian Fjord
	Joan Manuel Higueras Sepúlveda	Observational and analytical study of the residual and tidal circulation in a deep estuarine system of complex bathymetry
	Jorge Martín Quispe Sánchez	Disminución del efecto Niño costero 2017 en la variabilidad de las condiciones oceanográficas y estratificación en la ensenada de Huanchaco, Trujillo, La Libertad, Perú.
	Leonardo Ferreira Caminha	Environmental effects of the closure of the Linguado Channel: a focus on the physical-chemical parameters of the water
	Marcela Rojas	Turbulent Mixing in Patagonian Fjords and Channels
	Maria Schliermann	Spatial Variability of glacial freshwater sources along Patagonian and Fuegian Fjords
	Michelle Jackson	Evaluating Estuarine Salinity Using Numerical Modeling and Threshold-Based Analysis
	Pedro Paulo de Freitas	Intertidal Hydrodynamics in Urindeua Bay on the Eastern Amazon Coast, Brazil.
	Rodolfo Adrián Gómez Sepúlveda	Tidal Deformation and Hydrodynamics Interactions in a Multi-River Estuary
	Valentina Besoain	Exploración de la dinámica del oxígeno superficial en el fiordo de Reloncaví mediante modelos aditivos generalizados (GAM) durante el otoño de 2024
	Valentina Iturra Rosales	Modelación numérica de la conectividad y surgencia en el fiordo Puyuhuapi durante la primavera de 2024: una aproximación a la dinámica de floraciones algales nocivas.
	Felivalentín Lamas Torres	Tidal and Wind Forcing Effects on Residence Time in a Low-Inflow Estuary: A 3D Modeling Approach in La Paz Lagoon, Mexico.
Climate influences on estuaries and coastal oceans	Cécile PUJOL	Extreme temperatures events in the semi-enclosed inner seas of Northern Chilean Patagonia
	Fabián Enrique Salgado Oporto	Centinelas del Océano: Pinnípedos revelan la dinámica oceanográfica de los fiordos de la Patagonia chilena

	Luiza Paschoal Stein	Persistent wind forcing overrides wave and tidal controls circulation on coral reef circulation: the shallow Tamandaré reef, Brazil.
	Maibelin Castillo Alvarez	Sea surface temperature variability in Jardines de la Reina National Park (Southeastern Cuban shelf)
	Stacy Anushka Ballyram	Fuentes de variabilidad de las aguas del Fiordo Comau (42°22.767 S, 72°25.534 W), Patagonia norte, Chile

Miércoles 26 Noviembre (18.00-19.30)

Topics	Authors	Tittle of abstract
Sediment dynamics	Camilo Rodríguez Villegas	Submarine canyon-coast dynamic in northern Chilean Patagonia: how resting cyst advection and resuspension can create new risks to the onset of *Alexandrium catenella* toxic bloom for oceanic stakeholders
	Camilo Rodríguez Villegas	Dinoflagellate cyst assemblages' distribution in mussel seed-bank hotspot in Northwestern Patagonia: Effect of physico-chemical interactions on lipophilic toxic-producers
	Gabriel Pereira de Oliveira	Erosion from Mud Pellets in Beach Environments
Others topics	Alejandro Ríos Santana	Searching for Optimal Salt-Marsh Restoration Sites in the Guadalquivir Estuary (Spain)
	Catalina Aguirre	Impact-based extreme-wave intensity scale for high-resolution coastal forecasting
	Julie Angus	Advancing Multi-Domain Uncrewed Observing Systems for Scalable Ocean
	Lauanne Oliveira Pimentel	Perceptions of Coastal Zone and Estuary - A Comparison between Urban Population and Local Community in the Extreme South of Santa Catarina, Brazil
	Naity Paola Alejandra Rodríguez Benavides	Forzantes Oceanográficas y su impacto en las tensiones estructurales de un sistema de cultivo en el mar interior de Chiloé, Región de Los Lagos, Chile.
	Poliana Teresa Leiva Garay	Submesoscale Variability in the Surface Ocean off Central Chile Based on Sea Surface Temperature Observations
	Vanessa Alejandra Carril Pardo	The influence of a submarine canyon and wind stress curl on the circulation and dynamics over the continental shelf
	Valeria Martin	Caracterización de las condiciones ambientales oceanográficas en época de verano tardía del Área Conservación de Múltiples Usos y Parque Marino "Francisco Coloane", región de Magallanes y la Antártica Chilena.

Jueves 27 Noviembre (18.00-19.30)

Topics	Authors	Tittle of abstract
Biophysical process	Angela María Baldrich	Influence of seasonal environmental variability on bloom dynamics of toxic phytoplankton at a harmful algal bloom hot-spot in northwestern Patagonia

	Humberto Javier Godoy Arteaga	Factores oceanográficos y climáticos implicados en el desarrollo de una intensa floración de *Heterosigma akashiwo* en la Patagonia Noroccidental
	Katherine Daza	Hydrodynamic links to abundance of whales and birds in a hypersaline coastal lagoon
Morphodynamics	Idania Coromoto Briceño de Urbaneja	Coastal Erosion in the Maule Region: A Call for Resilient Management
Shelf dynamics	Aidan Parfett	The influence of semidiurnal internal tides on the circulation and upwelling in a submarine canyon
	Claire Ormart	Cross-shelf transport response to wind stress variability over the head of the
	Oscar Pizarro	New insights into diapycnal mixing processes within the OMZ off northern Chile from turbulence microstructure measurements.
	Danilo Augusto Silva	Stratification as a trap: the role of river-induced stratification on carbon retention and dispersal
	Danilo Augusto Silva	Microplastic export from a heavily urbanized estuary and its impact on a coastal marine reserve
	Danilo Augusto Silva	Salinity Maximum (Smax) intrusions driving mechanisms on a mid-latitude continental shelf
	Francesca Search	Circulation and hydrographic conditions in an upwelling-influenced bay of central Chile
	Joao Pedro Mancio de Amorim	Kinematics and dynamics of a low-salinity filament in the Brazil Current region
	Karina Ramos Musalem	Tidal rectification and exchange at the neck of Punta Banda Canyon: a tides-only modeling framework
	Martina Raquel Monasterio Sandoval	Barotropic tide dynamics in the Strait of Magellan: understanding propagation, reflection, and resonance through its basins and constrictions
	Nicolás Cisternas	Temporal variability scales of the Gulf of Arauco currents in response to wind and tides
	Pamela Muñoz Linford	Nueva evidencia sobre la dinámica estacional del Agua Modal Subantártica y su rol en la formación de aguas modificadas sobre la plataforma de la Patagonia sur
	Pedro Paulo de Freitas	Spatiotemporal variability of the M2 tide along the Amazon Coast, Brazil
	Sebastian Andrés Díaz Ceballos	On the influence of a long submarine canyon on the circulation and cross-shore transport over an idealized continental shelf

Operational modeling of storm tides to support coastal flood warnings in Baixada Santista and the Estuarine System of Santos, São Vicente and Bertioga (SP, Brazil)

Matheus Souza Ruiz (1), Regina de Souza Ferreira (1), Renan Braga Ribeiro (1) and Alexandra Franciscatto Penteado Sampaio (1)

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The Baixada Santista Metropolitan Region, located on the central coast of São Paulo State, Brazil, has a continuous coastline of approximately 65 km. This coastal strip contains a diverse range of ecosystems, including estuaries, sandy beaches, rocky shores, and mangrove forests. The region holds significant socioeconomic importance for Brazil, driven largely by industrial activities, tourism, and the largest port complex in Latin America, located in the Santos Estuary. The region's complex coastal geomorphology and high population density make it particularly vulnerable to storm tide induced coastal flooding associated with the passage of cyclones. To address these challenges and enhance the safety of port navigation and the effectiveness of civil defense actions, this study details the operationalization of a comprehensive, three-dimensional hydrodynamic model, Delft3D-FLOW, for the entire Baixada Santista region. Building upon previously validated methodologies, the implementation employs a nested-grid approach to downscale from regional to local scales. The high-resolution inner grid (~80m) accurately represents the complex estuarine channels, bays, and mangrove areas, using detailed bathymetric data, and is forced by tides, winds, elevation, temperature, salinity and river discharges. The resulting forecasts support critical decision-making, being operationally used by local civil defenses, integrated into the 'Sala de Situação da Baixada Santista', and distributed via an open API. The model's performance is continuously validated by comparing its outputs with observational data. Results demonstrate high accuracy in reproducing sea level variations, with skill scores consistently above 0.96 and an average RMSE of approximately 0.15m, even during storm surge events. The successful implementation of this high-resolution model represents a significant advancement for the region, providing a robust and reliable tool for an early warning system against coastal flooding. Furthermore, it serves as a critical asset for port operations, environmental impact assessments, urban drainage plans, and climate change adaptation strategies for this susceptible coastal region.

Dynamics of the Río de la Plata Salinity Front: Spatiotemporal Variability and Drivers

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We investigate the spatiotemporal variability of the salinity front in the Río de la Plata estuary, with a focus on quantifying the influence of key hydrodynamic forcing mechanisms, river discharge, tides, and wind. This analysis integrates three complementary sources of information: in-situ salinity measurements, satellite-derived turbidity front data, and output from a three-dimensional numerical model calibrated for the region.

The in-situ dataset was obtained using CTD sensors deployed at two nearshore stations over multiple years between 2015 and 2023. Satellite data consist of a 22-year time series of daily MODIS satellite imagery used to infer the turbidity front location. The numerical model employs a horizontal resolution of 1000 m and 18 sigma layers in the vertical, spanning more than 30 years and encompassing a broad range of climatic and hydrological conditions.

To assess the sensitivity of the salinity front's position and variability to individual forcing factors, we conducted idealized numerical simulations and focused analyses of selected time periods. The results provide a detailed characterization of the salinity front dynamics and clarify the relative importance and interplay of each hydrodynamic driver.

Understanding the mechanisms that govern salinity front variability in this estuary is critical for improving forecasting models and for managing estuarine ecosystems influenced by frontal dynamics.

Seasonal and Synodic Variability in the Physical Properties of the São José Estuary, Brazil

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São José Bay is the one of the largest estuarine systems in South America. This study aimed to investigate the seasonal and synodic variability of water physical properties in order to characterize the interaction between the macrotidal regime and the seasonal variability of river discharge. We assessed the historical time series of river discharge (1963 - 2023), the tidal regime, and the spatial and temporal measurements of water properties in four oceanographic surveys, encompassing wet and dry seasons and both spring and neap tides. The tidal regime was characterized through harmonic analysis and Hilbert transform, while the relative influence of tide and river was quantified using the flow ratio parameter. Water–column stratification was assessed through buoyancy frequency and potential energy anomaly, and estuarine classification followed the framework proposed by Geyer and MacCready (2014). Results revealed a dominant semidiurnal meso to macrotidal regime, with tidal ranges reaching up to 6 m during spring tides. The river contribution is relatively small, contributing between 0.1% to 1% of the exchanged volume. During the dry season the system is well-mixed, and during the wet season, the increase in river discharge induces stratification. During the wet season the system is a strain–induced periodically stratified estuary, with maximum stratification occurring during neap tides. São José Bay exhibits two distinct hydrodynamic regimes: a well mixed state during the dry season and periodic stratification in the wet season, driven by the combined seasonal and synodic modulation of tide and river discharge.

Spatial evolution of turbulence and mixing along the estuary-shelf gradient in a highly stratified system

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Estuarine inlets are critical gateways where riverine and oceanic forces converge, creating complex mixing patterns that control the material exchange between land and sea. The Patos Lagoon, the world's largest choked lagoon, connects to the Atlantic Ocean through the Rio Grande channel — a microtidal system where wind forcing and river discharge dominate over astronomical tides. To investigate the mechanisms driving mixing in this environment, we carried out an intensive, high-resolution survey of temperature, salinity, currents, and turbulence. During a period of ebb flow, we drifted along the channel thalweg and into the buoyancy plume, starting nearly 8 km upstream of the inlet and ending about 5 km offshore on the inner shelf. Current profiles were recorded continuously with an acoustic Doppler current profiler, while vertical profiles of salinity, temperature, and shear were obtained with a free-fall microstructure profiler (Micro-CTD). The Micro-CTD was deployed 152 times along the track, giving an average spacing of ~85 m between casts. Turbulent kinetic energy dissipation rates were calculated from these profiles. Considering the hydrodynamic regime of the system, dominated by subtidal variability, we obtained a snapshot of the flow evolution along the channel–plume transition. Turbulence along the channel showed small-scale horizontal variability, apparently related to changes in cross-sectional area, with the lowest dissipation values occurring downstream of the widest section. The transition from laterally constrained channel flow to open inner-shelf flow occurred over a short horizontal distance, marked by an internal hydraulic jump. The highest dissipation rates were observed in this region, particularly in the upper layer.

Tetrahedral Framework for the Tetraforcing of Semienclosed Basin Dynamics

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Several bidimensional frameworks have been proposed to classify semi-enclosed basins on the basis of dominant physical forcings. However, a two-axis framework constrains the num- ber of drivers being represented, often oversimplifying the system's dynamics by omitting other fundamental processes. Building on an existing dynamics-based framework, we propose a three-dimensional model that integrates wind and shelf forcing alongside the more tradi- tional tides and density gradients forcirngs . These four drivers are represented as vertices of a tetrahedron, allowing each pairwise interaction to be quantified through non-dimensional numbers: the Wedderburn number (wind stress vs. baroclinicity), the stress number (wind stress vs. tidal stress), a Remote wind stress number (wind stress vs. 'shelf stress'), a Remote Tidal stress number (shelf vs. Tidal stresses), a densimetric tidal Froude number (tidal stress vs. baroclinicity), and a Remote Froude number (shelf stress vs baroclinicity). To account for the dynamic depth and frictional modulation of circulation, we incorporate the Ekman number, which is visualized as a color gradient applied to each point within the tetrahedral framework. This model enables the representation of any semi-enclosed basin as a cloud of points distributed across or within the tetrahedron's surfaces, where each point reflects temporal and spatial variability in hydrodynamic forcing. The resulting framework provides a scalable, comparative, and transferable method for classifying and analyzing semi-enclosed coastal systems across a range of physical settings.

Interacción océano-atmósfera en el Pacífico Oriental: influencia de anticiclones subtropicales en la surgencia y el transporte de la PCUC

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La Corriente Subsuperficial de Perú-Chile (PCUC) es una contracorriente típica de los sistemas de surgencia de margen oriental, forzados por vientos paralelos a la costa inducidos por anticiclones subtropicales. Estos vientos generan transporte de Ekman hacia el océano, favoreciendo la surgencia de aguas frías y ricas en nutrientes cerca de la costa, intensificando la productividad y contribuyendo a la formación de zonas de mínimo oxígeno (OMZ). La PCUC se origina en la región ecuatorial del Pacífico oriental, donde la convergencia de los anticiclones subtropicales modula el gradiente de presión zonal que impulsa la Corriente Subsuperficial Ecuatorial, su principal afluente. La PCUC se desarrolla adosada a la costa (~0–200 km) y se extiende hasta ~48°S, transportando Agua Ecuatorial Subsuperficial (ESSW), con bajo oxígeno y rica en nutrientes, originada en la OMZ del Pacífico sur. Su propagación hacia el sur es reforzada por los vientos costeros del anticiclón del Pacífico Sur que, al intensificar el gradiente de presión meridional, favorecen el transporte subsuperficial y el ingreso de ESSW a sectores profundos de la Patagonia norte mediante una rama costera. En este estudio se utilizaron datos climatológicos y mensuales del reanálisis ERA5 para caracterizar la evolución estacional e interanual de los campos de viento y presión superficial sobre el Pacífico, junto con salidas del modelo oceánico global Mercator, tanto físico (temperatura, salinidad, corrientes) como biogeoquímico (oxígeno disuelto), en la zona ecuatorial y a lo largo del margen sudamericano, para evaluar la dinámica entre la variabilidad de los anticiclones subtropicales (modulada por forzantes como ENSO), la intensidad de la PCUC y su propagación hacia el sur, así como su rol en el transporte de ESSW y las implicancias que tiene su llegada a zonas costeras y australes del margen sudamericano, donde puede afectar la disponibilidad de oxígeno y nutrientes para los ecosistemas.

Plastic debris transport in the Patos Lagoon during the 2024 extreme flood event

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Plastic pollution in aquatic environments is a pressing global issue, with macroplastics (MaPs, >5 mm) contributing significantly due to their persistence, mobility, and potential ecological impact. Coastal lagoons and estuaries are key transitional zones where land-based plastic waste is often retained, redistributed, or exported to the ocean. Understanding the transport mechanisms and accumulation patterns of macroplastics in these systems is essential for developing effective environmental management strategies. This study focuses on the Patos Lagoon (southern Brazil), the world's largest choked coastal lagoon, and evaluates the influence of extreme hydrometeorological conditions on the transport and fate of macroplastics. Hydrodynamic simulations were conducted using the TELEMAC-3D model, configured with high-resolution bathymetric data, oceanic boundary conditions, and freshwater discharges from the main tributaries. The simulation period covered two months, allowing the evaluation of short- to medium-term particle dynamics under contrasting hydrological conditions. Two scenarios were analyzed: (i) one representing high river discharges associated with an extreme rainfall event which occurred in May 2024, and (ii) a reference scenario using long-term average (climatological) discharges. The hydrodynamic results were combined with the TrackMPD model for simulating MaPs transport. A single type of MaPs was used in the experiment: low-density polypropylene (PP), a common polymer in aquatic litter due to its widespread use and buoyant behavior. Results showed that extreme discharge conditions led to increased dispersion of macroplastics throughout the lagoon and enhanced export toward the inner continental shelf, with particularly intense transport along the coastal zone. In contrast, under climatological discharge conditions, macroplastics remained largely confined within the lagoon, especially in the northern sector. These contrasting outcomes reinforce the importance of understanding MaPs dynamics under river discharge contrasting conditions in order to contribute to the definition of management strategies of the problem in coastal environments.

Patos Lagoon Digital Twin – An innovative concept for assessing and mitigating risks of extreme flood events in southern Brazil

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Recent projections by the Intergovernmental Panel on Climate Change indicate that global warming will turn permanent and further intensify the severity and frequency of extreme weather events (heat waves, rain and intense droughts), making coastal regions the most vulnerable areas. Therefore, the risk of natural disasters and regional impacts on water, food, energy, social and health security represents one of the world's greatest challenges of this century. Conventional methodologies for monitoring these regions during extreme events, however, are usually not available to managers and decision makers with the necessary urgency. We present a novel framework concept for assessing extreme flood events risks in coastal zones using a suite of field data combined with numerical and computational models that provide a virtual replica of the natural environment, the Patos Lagoon Digital Twin. The study case is the extreme flood event which occurred in the southernmost region of Brazil in May 2024, considered the largest flooding event in 125 years of data. Results indicate that the Patos Lagoon Digital Twin is a comprehensive framework that provided the basis for accurate decision-making during the May 2024 extreme flood event, highlighting its potential for applications to other natural environments and to design solutions to mitigate their effects. Furthermore, the Patos Lagoon Digital Twin promoted the opportunity of integration between academia and security forces, which proved to be essential and should be replicated in future events and elsewhere, increasing the safety of communities living in coastal regions with high quality and relatively low costs approaches.

Wave transformation processes: roughness and sea level influence in Tamandaré reef, Brazil.

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Coral reefs are ecosystems with high morphological and biological complexity, providing important ecosystem services. Their three-dimensional structure allows them to dissipate up to 90% of wave energy, playing a key role in coastal protection. Environmental changes, such as sea level rise, can reduce the protective efficiency of reefs. This study aims to assess wave attenuation and dissipation under current conditions and future climate change scenarios involving sea level rise and loss of roughness, in the Tamandaré reef (Pernambuco, Brazil). Observational data and numerical simulations of wave and hydrodynamic models were used. Results shows that tides significantly influence wave height by modulating the amount of transmitted energy. The second reef crest showed an average attenuation capacity of 56% of the incident wave height, and reef morphology plays an important role in wave dissipation, which is greater in steeper areas. Scenarios of sea level rise and loss of roughness resulted in increased wave energy transmission through the reef, especially at low tide, reducing coastal protection. Roughness degradation, associated with the loss of structural complexity due to coral bleaching, proved to be even more impactful than sea level rise itself, indicating a growing risk of erosion even under current conditions. Therefore, conserving reef morphology and roughness is essential to mitigate climate change impacts on coastal reef zones, as both factors were shown to be fundamental for wave attenuation.

Coupled wave-current modelling of dispersion in an endangered Caribbean coral reef lagoon

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Coral reefs are critical ecosystems facing severe threats due to rising temperatures and other stressors. In the Mexican Caribbean, coral reefs are further threatened by massive sargassum arrivals and high levels of organic matter in submarine groundwater discharges. Coupled hydrodynamic modeling of waves and currents is essential to understand the dynamics of these ecosystems, where the wave breaking over coral reefs dominate the circulation. To provide information for effective management strategies, a high-resolution coupled Delft3D-SWAN model of the National Park Arrecife de Puerto Morelos in the Mexican Caribbean was developed. The model was calibrated and thoroughly validated against in situ measurements demonstrating good and excellent performance (ARMAE <0.2). Two case studies were conducted to simulate dispersion under different wave, tide and wind scenarios: 1) particle tracking for reef restoration, and 2) sargassum transport simulations. Results show that including wave-current interactions is crucial for realistic simulations, and that different combinations of wind, waves, and tides have significant impacts on particle trajectories and residence times near the reef.

Observations of turbulent kinetic energy production and dissipation in the Rio de La Plata Estuary

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This study presents results from field-based measurement methods that allow the estimation of turbulent kinetic energy production and dissipation. Observations were carried out in the shallow (< 10 m), micro-tidal (< 1 m), highly stratified Rio de La Plata estuary. The main objective is to compare the kinetic energy production and dissipation rates to assess the energy balance and characterize the turbulent regime of the system. The production is estimated from high-frequency point velocity measurements obtained using an Acoustic Doppler Velocimeter (ADV) by Nortek. The dissipation is derived from shear measurements collected with a micro structure profiler (MicroCTD) by Rockland, with CTD capability. Additionally, current profiles were recorded using an Acoustic Doppler Current Profiler (ADCP). The collected data also allows estimation of the Kolmogorov microscale, a key parameter in the dynamics of cohesive sediments, which limits the maximum size of suspended aggregates. The results show a mean turbulent kinetic energy production of approximately $1 \cdot 10^{-4} m^2/s^3$, while dissipation rates are around $7 \cdot 10^{-7} m^2/s^3$. Estimated Kolmogorov scales are around 0,4 mm. These measurements were obtained over a relatively stationary four hour period under stratified conditions with nearly unidirectional currents of approximately 0,3 m/s.

Variaciones espaciales y temporales de la intrusión salina en estuarios del pacífico de Panamá.

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El río Juan Díaz es un sistema urbano que a traviesa zonas densamente pobladas, mientras que el río Pacora en su porción baja está caracterizado por la presencia de manglares. Ambos sistemas tropicales desembocan en la costa pacífica de Panamá y están dentro del sitio Ramsar Bahía de Panamá. Esta investigación se desarrolló con el objetivo de analizar la variabilidad espacio-temporal de la intrusión salina en los estuarios de los ríos Juan Díaz y Pacora, así como evaluar la influencia de los factores hidrodinámicos y climáticos en su comportamiento. Para ello, se formuló la siguiente pregunta de investigación: ¿Cómo varía temporalmente la intrusión salina en estuarios de la Bahía de Panamá y qué influencia tienen los factores hidrodinámicos en su comportamiento?. Para responder esta pregunta, se realizó mediciones de alta resolución de salinidad, temperatura y profundidad que se realizaron por un periodo de tres meses en la porción estuarina de los ríos Juan Díaz y Pacora, acompañados de variables meteorológicas como precipitación, velocidad y dirección del viento con una estación DAVIS ubicada en La Casa de Wanda, adyacente al río Juan Díaz. Mediante esta investigación se determinó que la influencia del incremento de los caudales y variables climáticas, genero una mayor variabilidad de la intrusión salina en los ríos de Juan Díaz y Pacora.

Spatial and seasonal variability of suspended sediments in the Río de la Plata estuary based on numerical models and *in situ* observations.

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A distinctive feature of the Río de la Plata (RdP) is its high concentration of suspended sediments. The sediments are primarily supplied by the Bermejo River and transported by the Paraná River, estimated at millions of tons per year. These sediments impact various socioeconomic and environmental aspects (e.g., dredging, water purification, fisheries, etc.), making the understanding of associated processes scientifically and practically relevant. Although a pronounced seasonal cycle is recognized, the underlying causes of this cycle, spatial variations along the RdP, the physical processes involved, and the timescales of sediment transport remain poorly understood. In this work, we address these issues through process-oriented numerical simulations. The results show how the seasonality of liquid and solid discharges affects different regions of the RdP, revealing a complex and highly nonlinear system. They demonstrate that discharged sediments take approximately one month to reach the Adjacent Continental Shelf. However, in each region, the seasonal sediment cycle does not only depend on discharge seasonality but is also modulated by various processes occurring in each area, such as transport, deposition, resuspension driven by tides and wind, and flocculation. These processes operate differently across regions, act on different timescales, and are not necessarily in phase with the discharge cycle. Our results show that incorporating the seasonal variability of liquid and solid discharges, along with all relevant forcings, is essential for producing realistic simulations. They allow for estimating regional deposition rates, revealing that the RdP retains 99.9% of the supplied sediments, a remarkably high rate that underscores its active sedimentological behavior.

Ocean-Dominated Surface and Groundwater Hydrological Dynamics in a Semiarid Coastal Wetland of Central Chile

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Coastal wetland hydrology is shaped by complex interactions among atmospheric, inland, and oceanic forcings. However, in semiarid regions with limited precipitation and groundwater recharge, oceanic processes can become the dominant control when these systems are hydraulically connected to the sea. Understanding the hydrological drivers of these systems is crucial for ecosystem protection and management. We investigated groundwater and surface water dynamics in a small coastal wetland in central Chile (Pichicuy, in the region of Valparaíso) using high-resolution water level monitoring, compared against atmospheric and oceanic data. Our two-year study revealed that the system is primarily dominated by oceanic forcing through a subsurface mechanism called "overheight," the superelevation of groundwater above mean sea level. This occurs when seawater inflow during wave runup and high tides exceeds seaward discharge during low tides, creating a net inland hydraulic gradient that maintains elevated groundwater levels in the coastal zone. Occasionally, wave overtopping and dune breaching disrupted this subsurface-dominated regime, shifting the system toward partially surface-driven processes, such as direct tidal inflow into the lagoon, which gradually diminished as the sandbar reformed. However, even during these surface perturbations, the hydrological response remained modulated by the overheight mechanism and oceanic boundary conditions. Notably, groundwater remained fresh within approximately 100 m of the shoreline despite dramatic surface water salinity fluctuations caused by overtopping and tidal influences. Following disturbance events, the system returned to overheight-driven conditions within days to months as inland hydraulic heads decreased and sediment accretion restored the sandbar. These rapid transitions and high variability in hydrological forcing are critical considerations for wetland ecosystem protection and climate change adaptation strategies in semiarid coastal environments.

UAV-Based Remote Sensing Algorithm for Hydrodynamic and Water Quality Monitoring in the Río de la Plata Estuary

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This work presents an image-based remote sensing algorithm for the spatiotemporal quantification of hydrodynamic and water quality variables, using surface images of water bodies captured by an unmanned aerial vehicle (UAV). The processing is implemented in Python 3 and includes a sequence of image processing levels structured as follows: N0: Original multiband capture; N1: Band alignment and acquisition of geolocation metadata; N2: Correction of optical distortions and reflectance normalization; N3: Geometric rectification; N4: Pixel georeferencing; N5: Construction of coherent mosaics or time series. The algorithm can assume invariant water conditions to build a coherent mosaic from photos taken at different locations. Otherwise, if the surface-variable changes its position and/or intensity over time, the algorithm allows for the construction of time series of the surface distribution of the analyzed variable. Two applications of the algorithm in the Río de la Plata estuary are presented. The first study was carried out near Montevideo, Uruguay, monitoring a dredging discharge using flights with a DJI Inspire 2 drone and RGB camera. The images were georeferenced, allowing to identify/visualize the temporal evolution of a sediment plume with high spatial resolution (50 px/m), as well as its longitudinal and transverse behavior relative to the current, showing good agreement with independent measurements of current and turbidity. The second study was conducted on the coast of San José, Uruguay, using the same drone equipped with a thermal-multispectral camera to monitor a thermal discharge from a power plant. The infrared thermal band images were georeferenced to generate accurate surface temperature maps with good spatial resolution (2 px/m), surpassing conventional field methods in both detail and efficiency. Additionally, in this second application, algorithms were developed to correct thermal drift errors and edge effects in infrared sensor images, improving the accuracy of the final mosaic.

Disminución del efecto Niño costero 2017 en la variabilidad de las condiciones oceanográficas y estratificación en la ensenada de Huanchaco, Trujillo, La Libertad, Perú.

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Con datos hidrográficos de cinco prospecciones realizadas a escala mensual durante los meses de abril, mayo, junio, julio y agosto, 2017, por el Instituto del Mar Perú, se analizó los efectos en la disminución de las condiciones cálidas del evento Niño costero 2017 en la variabilidad estacional y espacial (longitudinal, transversal y profundidad) de la temperatura, salinidad, densidad y corrientes marinas en la Ensenada de Huanchaco (EH), Trujillo, La Libertad, Perú, la distribución de la temperatura, salinidad y densidad tuvo una relación directa con la estacionalidad. Se encontró la presencia de la surgencia impulsada por el viento del sureste, con mayor índice de surgencia inducida por el viento en los meses de julio y agosto (invierno), máxima frecuencia de Brunt-Väisälä, condiciones de rezagos de aguas cálidas con anomalías térmicas de +2,8°C., aguas de mezcla (34,885 de salinidad), vientos del sureste (3,1 m/s) con la termoclina, haloclina y picnoclina más pronunciadas en abril, debido principalmente a la mayor radiación solar recibida, mientras tanto, en mayo y junio se observó condiciones termohalinas (anomalías térmicas de 1,5°C, y 1,2°C y salinidad de 34,83 y 35,035) ambos con tendencia a la homogenización en la superficie y condiciones de estabilidad en la estructura vertical con presencia dominante de aguas costeras frías y vientos promedio de 4,2 m/s, del sureste. La distribución de temperatura, salinidad y densidad difieren estacional y espacialmente, produto de la radiación solar, estratificación por calentamiento, la surgencia y el flujo impulsado por el viento, fluctuando de una condición de rezago de aguas cálidas a una condición homogénea y fría es decir de um ambiente estratificado y cálido, separado al parecer por un período corto de transición.

Deoxygenation in a Subantarctic Glacial System: Zonation and Processes in the Almirante Montt Gulf (Chile)

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The Almirante Montt Gulf (AMG) is a semi-enclosed system of interconnected fjords and basins. Its restricted oceanic communication and strong stratification, resulting from the melting of the Southern Patagonian Ice Field, favor conditions of limited deep-water ventilation. These characteristics make it susceptible to deoxygenation processes. This study spatially characterizes low-dissolved oxygen zones (LDOZs) in the AMG, identifying associated physical and biogeochemical processes.

An integrated monitoring strategy was employed, including oceanographic campaigns, instrumental moorings (ADCP, DO, T°, S), and nutrient analyses, complemented by a 3D hydrodynamic model coupled with a water age model. The results show that while the surface layer (0–50 m) maintains high DO levels, deep layers (>50 m) exhibit persistently hypoxic and even anoxic zones. A strong correlation was identified between older waters (>150 days) and low DO levels (<0.5 mg/L), especially in the Worsley and Poca Esperanza fjords. Nitrate reduction in these areas suggests active denitrification under anoxic conditions.

The AMG stands out as one of the main reservoirs of hypoxic/anoxic water in the Chilean austral fjords. These findings have relevant implications for aquaculture planning and environmental monitoring in the face of climate change scenarios, where an intensification of stratification and reduced ventilation are predicted. The need to maintain monitoring programs and coupled modeling to project the evolution of these processes is emphasized

Surface Deoxygenation in the Fjords of Northern Patagonia: A Long-Term Analysis Based on Oceanographic Buoy Data.

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Abstract

Ocean deoxygenation is an increasing phenomenon driven by global warming, with the loss of oxygen solubility in seawater being one of the main causes of the decline in dissolved oxygen (DO) in the ocean. Other contributing factors include increased stratification, organic matter degradation, and reduced ocean circulation and water ventilation. Recent studies in Boca del Guafo have detected signs of deoxygenation using a DO time series measured at 170 m depth. In this study, surface DO data collected by two oceanographic buoys, one located in the Puyuhuapi Fjord and the other in the Reloncaví Sound, were analyzed for the period 2012–2023. The main objectives were to assess trends in surface deoxygenation, analyze anomalies in physical variables, and identify patterns and changes in the surface oxygen balance and its relationship with climate drivers. Additionally, ocean-atmosphere dissolved oxygen fluxes were calculated using these time series. The results show a sustained decrease in surface DO at both locations individually and across the full time period, confirming the presence of deoxygenation in these waters. Furthermore, the analysis of air-sea DO fluxes revealed that in the Puyuhuapi Fjord, the balance between DO production and consumption was dominated by biological consumption. In contrast, the Reloncaví Sound showed a greater export of DO to the atmosphere. These findings will be presented and discussed during the conference.

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Meridional Transport Variability and Climate Forcing off Chilean Patagonia (1993–2022)

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We examine how large-scale climate modes modulate the southward meridional transport of the Patagonian coastal current between 38°S and 55°S during 1993–2022. Monthly meridional transport (OSCAR v2.0, 25 km) was averaged over a 100-km coastal band and analyzed with Morlet wavelets, cross-wavelet transform and wavelet coherence against the Southern Annular Mode (SAM), ENSO (Niño 1+2, 3, 3.4) and the South Pacific High (SPH) index, together with zonal transport, wind stress and sea-level anomaly (SLA). Hovmöller maps and the climatology show a robust seasonal cycle with stronger southward transport in austral winter–spring, peaking south of 50°S and propagating northward along the coastal band. Cross-wavelet and coherence reveal that El Niño episodes (1997–1998, 2009, 2015–2016) consistently weaken the southward transport (i.e., make it less negative or reverse it) at interannual periods of approximately 24–64 months, while La Niña phases (1998–2001, 2010–2011, 2017–2018) intensify the southward transport (more negative). Positive SAM is linked to multi-year intervals of enhanced southward transport—most clearly observed in 2003–2006 and 2013–2016—whereas negative SAM accompanies weakened southward flow. Coherence is strongest at 49.75°S and extends to 54.75°S with reduced persistence; phase arrows indicate small lags (≈0–6 months) relative to ENSO and more persistent, low-frequency coupling with SAM/SPH. Transport–SLA coupling is consistent with the expected physics: stronger southward transport coincides with elevated coastal SLA, while weakened southward transport accompanies lower SLA. These results demonstrate that the southward transport of the Patagonian coastal current is primarily dominated by the seasonal cycle, but is significantly modulated interannually by ENSO and by sub-to-multi-annual variability associated with SAM/SPH. Together, these forcings control the amplitude, duration and latitudinal reach of wintertime southward flows along Chilean Patagonia.

Atmospheric Rivers as Drivers of Shear and Energy Variability in Puyuhuapi Fjord

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Atmospheric rivers (ARs) are narrow, elongated bands of intense water vapor and heat transport that typically form over the oceans, accounting for approximately 90% of the poleward vapor transport. On average, around 40 ARs reach Western Patagonia each year, contributing 45%–50% of the region's annual precipitation. ARs are categorized based on the magnitude of integrated vapor transport (IVT) and their duration—two key factors that significantly influence their hydrometeorological impact. In this study, we analyzed the influence of two moderate-to-strong ARs —classified as category 3 and 4— on the dynamics of the Puyuhuapi Fjord, one of the largest fjords in the Aysén region. We used high-resolution current velocity data from an Acoustic Doppler Current Profiler (ADCP) covering the upper 25 meters of the water column, along with time series from an oceanographic/meteorological buoy located in the Puyuhuapi Channel (44°33.3′S; 72°43.6′W), part of the COPAS SUR-AUSTRAL project. The observations correspond to December 2017. We estimated the wind power input to the surface layer as the dot product between wind stress and surface current velocity, which showed a moderate but non-significant increase during the AR events. In contrast, current measurements revealed a significant increase in velocity, vertical shear, and shear kinetic energy (SKE), indicating a dynamic response of the fjord to these intense atmospheric forcings. Vertical shear (du/dz, dv/dz) increased substantially, reaching values up to 10^{-2} s^{-1}. SKE also intensified markedly, suggesting enhanced vertical energy transfer, potentially linked to mixing processes and internal wave activity. These findings suggest that ARs can act as energetic drivers of submesoscale variability in fjords, with implications for stratification, vertical mixing, and biogeochemical cycling in these sensitive coastal environments.

Modelación numérica de la conectividad y surgencia en el fiordo Puyuhuapi durante la primavera de 2024: una aproximación a la dinámica de floraciones algales nocivas

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Los fiordos patagónicos son ecosistemas caracterizados por la interacción constante entre el aporte de agua dulce proveniente de ríos y precipitaciones, e intrusiones de agua salina desde el océano. Esta mezcla de masas de agua de distinta densidad genera fuertes gradientes verticales, caracterizados por una intensa picnoclina e influenciando los patrones de circulación local. El fiordo Puyuhuapi forma parte de este complejo sistema de fiordos patagónicos y, en las últimas décadas, ha sido escenario de intensas floraciones algales nocivas (FAN) debido a su fuerte estratificación termohalina y sus prolongados tiempos de residencia del agua. Con el objetivo de comprender cómo la circulación y el transporte afectan la dinámica de las FAN en este sistema, se implementó un modelo lagrangiano de partículas en movimiento, acoplado a un modelo hidrodinámico forzado por mareas y condiciones de viento a partir del modelo WRF, el cual presentó una correlación de 0,48 con respecto a mediciones reales, en una simulación correspondiente al período entre el 13 de septiembre y el 28 de noviembre de 2024. Al rastrear el desplazamiento de las partículas y reconstruir sus trayectorias pasadas y futuras, el modelo permitió identificar las zonas que desempeñan un rol relevante en la conectividad del fiordo durante la temporada, entre ellas la zona media cercana al río Cisnes, así como detectar puntos de surgencia local mediante el ascenso de partículas. Además, se evidenciaron zonas de retención, como la cabecera del fiordo, que permiten comprender los patrones de distribución de especies FAN y las posibles regiones desde las cuales se desplazan. Esta información es fundamental para entender la dinámica espacio-temporal de microalgas tóxicas en una zona severamente afectada por este tipo de eventos.

Decrease of deep ventilation contributing to deoxygenation in North Patagonian fjords and channels: Guafo mouth study case.

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Deep ventilation is a critical oceanographic process that renews water properties such as temperature, salinity, and dissolved oxygen (DO), sustaining biogeochemical cycles and regulating the ocean’s capacity to absorb carbon and heat. In northern Patagonian fjords, ventilation events are crucial to counteract the impacts of hypoxic waters transported southward by the Equatorial Subsurface Water (ESSW). However, climate-driven changes such as surface warming and increased stratification may be reducing the frequency and intensity of these ventilation events, contributing to long-term deoxygenation. This study investigates the physical drivers, frequency, and variability of deep ventilation events at Guafo mouth between 2016 and 2024. Using ERA5 reanalysis data to evaluate wind stress, Ekman transport, pumping, and layer depth, alongside in situ time series of temperature, salinity, density, and DO from moored instruments and CTDO profiles, we identify periods of enhanced DO concentrations and associate them with downwelling-favorable conditions. Preliminary results show a seasonal pattern of DO increase during late winter and early spring, likely influenced by low-pressure systems and intensified westerly winds. The decreasing occurrence of these events suggests a weakening of deep ventilation, reinforcing concerns about ongoing deoxygenation in this vulnerable region. These findings provide novel insight into the mechanisms governing oxygen renewal in the Patagonian fjords and highlight the importance of sustained observation systems in a changing ocean.

Wave-current interactions in Chacao Channel, Chile

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Chacao Channel is a high-flow tidal channel (Re~O(10^8)) located in the Chilean northern Patagonia (41-47° S). The channel is characterized by strong bidirectional currents (> 3 m/s) and high turbulence intensities. South pacific swells propagate towards the channel's west mouth while strong winds generate surface-gravity waves during occasional severe weather events. The combined occurrence of strong currents and wind-generated surface gravity waves is a nonlinear coupled process in which both the incident wave field and the currents are modified. These interactions can generate hazardous conditions for navigation, affect coastal protection and increase loading over offshore infrastructure. In this work, we investigate the evolution of bulk wave parameters in Chacao channel western section for various wave and tidal flow conditions using both field measurements and numerical modeling. Wave measurements were conducted in Ancud, a bay located a few kilometers into the channel from its western mouth. Wave propagation into the channel is further explored using a SWAN numerical model forced by incoming swell waves, and time and space varying currents obtained from a hydrodynamic model of the entire region. Measurements show that significant wave height, mean wave period and mean wave direction are strongly coupled with the current magnitude and relative direction. Numerical results show a region of maximum wave heights and increased breaking near the channel's Pacific entrance, and regions of strong refraction into the channel during spring ebb tide. The location of the wave heights maximum is coupled with the channel's outflow jet strength through the tidal cycle. Obtained results suggest that currents must be incorporated into forecast wave models to improve local sea state predictions and consequently navigation safety. A coupled CROCO- WAVEWATCH III model is being implemented for the region to assess the effect of waves on local tidal currents and what the implications of wave-current interactions are for the complex dynamics of this particular tidal channel.

Circulation, mixing, and barotropic tidal energy in a regional interior sea, Northern Patagonia

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The austral Chilean fjord system has multiple interior micro-basins that act as barriers between the fjords and oceanic waters, restricting the flow of water between them. The most extensive of these is the Chiloé Interior Sea, formed by the Ancud and Corcovado gulfs, and has both a high scientific and economic interest. This study provides a preliminary assessment using in-situ observations to describe tidal circulation within the micro-basin and its role in mixing. Seven months of wind, sea-level, and current time-series were collected within the micro-basin, and were complemented with towed currents and hydrography across one of the mayor channels seperating the two gulfs. Semi-diurnal kinetic energy was calculated using the current time series and towed measurements to estimate tidal energy loss and possible availability for mixing processes. Tidal harmonics were the main source of sea level variation within the interior sea. While, higher tidally explained variance was observered in the Corcovado Gulf currents compared to the Ancud Gulf. Tidal range amplification was observed from south to north of the interior sea. The importance of diurnal and semi-diurnal harmonics were visible in sea-level and currents, semi-diurnal M2 being the most important. Stronger barotropic, periodical reversing currents were observed in the Corcovado Gulf, while this structure was lost in the Ancud Gulf. Hydrographic conditions showed a change between a mixed water column during high tide and slightly stratified durning low tide, with higher Richardson numbers at high tide than low tide. Large spatial-temporal variations in semi-diurnal kinetic energy between gulfs and over tidal circles were observed, with only <6% of making it from Corcovado to Ancud. This work highlights the importance of tides as a major circulation driver as well as a kinetic energy source for mixing with the Chilean Patagonia.

Circulation in the Guafo Mouth: The gateway to northern Patagonia

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Circulation and exchange are important factors governing material transport in all coastal areas, including Chilean Patagonia, a region that boasts one of the largest aquaculture industries in the world and provides habitat for several protected marine mammal species. Linkages between coastline shape and forces of hydraulic conditions, such as tides, wind, sea level gradients, and river discharge are thereby important considerations when understanding constituent concentrations and transport related to water quality issues, which threaten aquaculture activities and endanger wildlife and humans. The primary connection between the Pacific Ocean and the fjords of Chilean Patagonia is through the Guafo Mouth, however the structure and drivers of circulation, and its impact on water quality, has yet to be studied. The research presented here characterizes circulation patterns and variability in the Guafo Mouth to help inform ocean-fjord exchange. Measurements of current velocities, salinity, temperature, dissolved oxygen, and nutrients were collected from 2020 to 2023 in the channel. These measurements, in addition to a numerical model of the study area and reanalysis data, provide parallel evidence of subtidal flows driven by the competition between barotropic and baroclinic pressure gradients. Depending on the sign of the barotropic pressure gradient, the barotropic flow either augments (when negative) or opposes (when positive) the circulation produced by horizontal density gradients. When the near-bottom subtidal inflow enhances, offshore waters with high nutrient content and low dissolved oxygen can be advected in-channel. This occurred at periods between ~40 and 70 d concurrent with poleward pulses of the Peru-Chile Undercurrent that is known to transport nutrient rich and low dissolved oxygen waters southward off the coast of Chile. These findings imply that ocean-fjord exchange through the Guafo Mouth, which is controlled by water level gradients from the Pacific Ocean to the inner fjords, directly influences the import of dissolved oxygen and nutrients.

LAPECO Conference Abstract

Advancing ocean observations: The technology behind RBR's next-generation instrumentation:

Max Vergara,

PhD TECHNICAL SALES MANAGER RBR LTD

Accurate, precise in-situ measurements of physical and biogeochemical processes are essential for understanding ocean dynamics. A continuing challenge for the scientific community is obtaining reliable, energy-efficient instruments with fast sampling rates, sufficient memory, and integrated deployment systems.

To address this, RBR has focused on two major developments: (a) the RBRtridente, a novel multichannel active fluorometer, and (b) the RBR Glissando, an automated profiling system designed to collect high-resolution oceanographic data while underway.

The RBRtridente incorporates a highly constrained optical geometry to isolate a small measurement volume and employs custom narrow bandpass filters to precisely target the excitation and emission spectra of chlorophyll-a (excited at 435 or 470 nm), phycocyanin (PC), and phycoerythrin (PE). This architecture minimizes off-axis light and spectral crosstalk between channels, ensuring accurate fluorescence measurements.

The RBRglissando enables rapid profiling, with deployment rates up to 10 m/s and retrieval rates of 5 m/s, allowing vessels to maintain cruising speed while collecting data. Wi-Fi communication between the CTD and winch allows the use of a 3 mm Dyneema® line, minimizing drag while maintaining tensile strength. The system operates fully automatically through RBR's Ruskin software, providing hands-free operation, automated free-fall profiling, and seamless data transfer.

With low-power requirements and compact design, these developments deliver robust and precise tools that empower researchers to conduct high-resolution studies of ocean dynamics efficiently and reliably.

Variability of the Magellan Plume using hydrodynamic modeling

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The Strait of Magellan in the Chilean Patagonia connects the Atlantic and Pacific oceans through a narrow passage. Historic and current pressures from navigation, oil and coal industries, wind and hydrogen renewable energies, combined with changes due to anthropogenic climate change and local population growth make the region both complex and relevant. On the Atlantic side of the Strait, a large tidal range caused by the Patagonian Shelf produces very strong currents, up to 5 m/s, in the first and second narrows that introduces mixing between the central basin, with fresher water from rain and ice melting, and the Atlantic ocean. These exchanges are responsible of what is known as the Magellan Plume, which consist of fresher waters which go out of the strait, and extends northward within the Patagonian shelf.

Using a FVCOM numerical modeling that has been validated to estimate the tidal current energy resource, and using remote sensing satellite data to obtain a characterization of the plume, we intend to understand the influence of hydrodynamic conditions on the temporal and spatial variability of the Magellan Plume. These characterizations will also help to inform the role of the flow through the Strait of Magellan on the continental shelf.

Winds and tides play with drifters in Corcovado Gulf, northern Patagonian Fjords.

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In northern Patagonia fjords, current studies have been primarily based on anchored systems, as opposed to the use of Lagrangian systems, which are constantly evolving and allow for a better understanding of marine surface circulation. Lagrangian drifters were deployed at the Guafo Mouth (43.5°S, 73.5°W) during March, June, August, and November 2023. The data analysis was complete with satellite altimetry, surface currents (GLO12, Copernicus), winds (ERA5), as well as in-situ measurements of water column currents (ADCP), sea level, and winds. The drifters collected information over ranges of 3-28 days, with average speeds ranging from 0.17 to 0.45 m/s and a maximum of approximately 2 m/s, traveled distances from 30 to 800 km. A wavelet analysis reveals significant variations in the ~12-hour band, mainly associated with the semidiurnal tide and mostly during spring tidal periods. In contrast, during neap tides, a considerable variation occurred in the 4-day band, indicating a significant effect of wind fluctuations. In general, the wavelet spectra of the drifters and the correlations with the numerical models corroborated that in certain areas within the Guafo Mouth and the Pacific Ocean coast, the effects of tidal currents and inertial oscillations are more significant, such as the southern coast of Chiloé and the vicinity of the Moraleda Channel. Off the Guafo Mouth (west coast of Chiloé), the effects of wind (4- to 16-day band) become more relevant and tend to be more significant during the winter months, influencing the ocean surface circulation in the area.

Dinámica de los seiches internos en el Fiordo Reloncaví: un estudio numérico CROCO/WRF

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Los seiches internos son oscilaciones baroclínicas estacionarias producidos por forzantes externas en cuerpos de agua cerrados o semicerrados que permiten la resonancia de ondas. En el fiordo Reloncaví (41.6°S, 72.5°W), al norte de la Patagonia chilena, estos seiches afectan la picnoclina e isotermas, influyendo en la mezcla vertical y distribución de nutrientes. Este fiordo es altamente estratificado, con fuerte influencia mareal y morfología compleja, siendo además clave para la acuicultura nacional como fuente principal de semillas de mitílidos. El presente estudio busca cuantificar los efectos del viento, las mareas y el aporte fluvial en la dinámica de los seiches internos del fiordo Reloncaví, evaluando su impacto en la amplitud, periodicidad y persistencia. La investigación emplea simulaciones numéricas océano-atmósfera (CROCO/WRF) de alta resolución (dx≈300m), validadas con datos observacionales entre 2008 y 2009 (ADCP, CTD, sensores de presión y estación meteorológica). Las condiciones de frontera oceánica fueron obtenidas del modelo MOSA-IFOP, ERA5 para WRF, y TPXO para mareas. Los resultados reproducen una picnoclina marcada entre 4-7m de profundidad en el fiordo, debida a la descarga de los ríos Puelo y Petrohué, aunque los valores de salinidad superficial siguen estando subestimados en 8PSU. Las amplitudes de marea obtenidas para las principales componentes (M2, S2, N2, K1 y O1) son comparables con series de tiempo en Cochamó y la boca del fiordo. Las simulaciones con WRF fueron comparadas con una estación meteorológica en Punta Iglesia, y los gráficos QQ-plot indican que la temperatura y presión superficial siguen distribuciones similares con subestimaciones inferiores al 9% en valores altos, mientras que las rosas de viento muestran las mismas direcciones principales para modelo y observaciones. Próximos pasos incluyen mejorar la representación de la descarga de ríos y un análisis de frecuencias de la picnoclina para identificar los principales modos de variabilidad de los seiches presentes.

Short-term Spatial and Temporal Variability of Small River Plumes in Patagonian Fjords: a multiscale integration between remote sensing and in situ data.

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River plumes can transport nutrients, sediments, and pollutants to the ocean, affecting water stratification, thermal structure, and coastal circulation. This water layer moves and expands due to the influence and interaction of river flow, tides, wind, rainfall, Coriolis force, bathymetry, and water properties. While much research has focused on plumes driven by large river discharges, considerably less is known about the dynamics of small plumes, particularly in fjord environments. This study examines the spatial and temporal variability of a small river plume in the Melimoyu Fjord, Northern Patagonia, Chile, using remote sensing to investigate the relations with environmental drivers during summer. We analyzed 41 satellite images from the 2022-2025 austral summers, applying supervised classification techniques to identify optical water types based on surface color and temperature. We then calculated the plume area using the classified images and compared with environmental variables considering the satellite overpass hour. A multiple linear regression analysis between the river plume area of the 41 images and physical drivers showed that tidal state, rainfall, and wind zonal component are the most influential variables on the extension of the plume area. Our findings indicate that the extent of this small river plume is highly variable in space and time, with areas ranging from 2.8 km^2 to 33.6 km^2 within a few days. The use of daily images allowed us to observe a larger plume during high rainfall, but also during falling tides. Meanwhile smaller areas were observed during low rainfall and rising tides. The role played by wind is more uncertain, but the results demonstrate that there are predominant wind speed and directions according to the Fjord topography that can influence the plume. These findings highlight the strong spatiotemporal variability of small river plumes in fjords, providing new insights into the interplay between freshwater input and local environmental conditions.

Tide, Wind, and Freshwater Influences on Patagonian Fjord and Plume Dynamics

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Chilean Patagonia is comprised of steep mountains, deep fjords, and complex channels, and is rapidly changing due to both climate change and increasing pressure from the aquaculture industry. Despite the region's environmental importance, much work is needed to understand the dominant drivers of hydrodynamics, including understanding how glacially-fed rivers deliver freshwater, sediments, and nutrients that influence stratification, circulation, and ecosystem dynamics within the fjords. The Marchant River flows from an alpine glacier on the volcano Cerro Melimoyu into a deep tidal fjord in the remote Aysén region of Chilean Patagonia. A field campaign was carried out in the Melimoyu fjord in the Chilean region of Aysén from January to February 2024 to study the river plume and it's interaction with the coast. Three temperature chain moorings and one ADCP were deployed at 10m and 30m depth on the steep slope along the Marchant River mouth. Water level was measured in the fjord, estuary, and river, and transects with a surface ADCP were made to quantify riverine streamflow. The river discharge baseline was approximately 30 m3/s during the study, with higher flow after storm events. Within the coastal fjord region, larger events caused a surface freshening for several days, before returning to a tidally pulsed plume. In addition to tidal forcing, diurnal wind plays a strong role in pushing the plume onshore. Within the water column, a semidiurnal internal tide causes shoaling of the pycnocline, but this signal is disrupted by storm events. Details of these interacting wind, freshwater, barotropic, and baroclinic tide processes will be discussed.

Structure and variability of freshwater conditions off Chilean Patagonia from a high-resolution curvilinear ocean model

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The Chilean Patagonia is an economically important area supporting diverse activities such as fisheries, aquaculture, navigation, and tourism. However, its remote location and harsh climatic conditions limit the availability of continuous long-term in-situ measurements. Consequently, numerical modeling has become essential for advancing on the oceanographic understanding in the area at both regional and local scales. This study evaluates the structure and variability of freshwater conditions along the entire coastal ocean off the Chilean Patagonia (41–60°S, 60–86°W) using a climatological hydrodynamic model developed by the Center for Oceanographic Research COPAS-Coastal. The model employs a curvilinear grid that follows the continental margin, with variable horizontal resolution ranging from ~10 km in the open ocean to ~1 km near the coast, and 32 vertical sigma levels following the bottom topography. The tidal forcing includes 10 constituents derived from the TPXO7 model, and freshwater inputs from 41 rivers are incorporated from a validated hydrological model. We evaluated the impact of the spatial resolution of boundary conditions on the structure of freshwater conditions by comparing two contrasting datasets: the World Ocean Atlas (WOA) with 1° horizontal resolution, and the GLORYS reanalysis product with 1/12° resolution. All analyses were performed on a numerically stable model. Although simulations forced with WOA exhibit a spatially coherent freshwater structure, with errors around ±0.5 PSU, their vertical structure is deficient compared with observations from Argo profiling floats. This is primarily due to WOA's inability to resolve key circulation features such as the Peru–Chile Undercurrent and associated thermohaline spatial structure. These results highlight the importance of selecting appropriate boundary conditions in high-resolution models and demonstrate the utility of regional models in capturing spatial variability in freshwater conditions that coarser products can not resolve properly.

Monthly variability of the physical and chemical properties of the Comau Fjord.

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During this study, the Comau Fjord exhibited a clear stratified water column, characterized by strong gradients in temperature, salinity, dissolved oxygen, and pH within the upper 30 m, particularly during spring and summer. The surface layer remained well oxygenated, while the deeper layers showed lower oxygen concentrations without evidence of an oxygen minimum zone. Freshwater, especially from the Vodudahue River, played a key role in stratification and pH distribution. The Modified Subantarctic Water Mass (MSAAW) dominated during spring and summer, whereas Subantarctic Water (SAAW) was more prevalent in autumn and winter. Nutrient profiles revealed well-defined nutriclines, with phosphate, nitrate, and silicate concentrations increasing with depth. These patterns reflect a complex dynamic shaped by freshwater inputs, seasonal conditions, and physical structure, supporting surface productivity and nutrient retention at depth.

A stratified and spatially heterogeneous circulation pattern was observed in Comau Fjord. At Loncochalgua station, a surface outflow toward the northwest and a deep inflow from the southeast were dominant, reflecting the influence of the Lloncochaigua River. In Quitralco 1 and 2, the flow was inward throughout the entire water column, indicating the intrusion of oceanic waters. The highest current velocities were recorded between 8 and 20 m depth (up to 0,84 $m \cdot s^{-1}$), with more stable and slower flows in deeper layers (>50 m). Combined forcings modulated the circulation (river discharge, tides, wind, and bathymetry), promoting a two-layer estuarine system with seasonal variability and intensified currents during winter.

Advancing Multi-Domain Uncrewed Observing Systems for Scalable Ocean Monitoring and Ecosystem Assessment

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Abstract:
The Air-Sea Ocean Monitoring System (ASOMS) project is developing an integrated, long-endurance hybrid observing system that combines uncrewed surface vehicles (USVs), uncrewed underwater vehicles (UUVs), and uncrewed aerial systems (UAS) to deliver scalable and persistent ocean monitoring. ASOMS leverages a system-of-systems approach using proven commercial platforms, advanced oceanographic instrumentation, and AI-driven analytics to collect and interpret data across the air-sea interface and throughout the water column.

The observing fleet includes Open Ocean Robotics' solar-powered USV, Seahawk Robotics' UAS, and a long-range UUV glider. Together, these platforms offer complementary capabilities to operate in remote and challenging environments. The USV supports extended-duration missions, large sensor payloads, and real-time communications, and in the future will serve as a mobile launch and data relay platform for aerial and subsurface assets.

ASOMS integrates advanced sensors including ASL Environmental Sciences' AZFP (Acoustic Zooplankton Fish Profiler) and Rockland Scientific's MicroRider turbulence profiler, enabling high-resolution measurements of biological activity and physical ocean processes. These instruments, combined with AI-enhanced analysis, support novel insights into ecosystem dynamics, biodiversity, and climate-related changes.

The project also develops new multi-robot concepts of operation (CONOPS) for coordinated deployment in complex marine conditions, and energy efficiency is optimized through Glas Ocean's AI models. This five-company syndicate is generating extensive datasets to train AI models for environmental monitoring and maritime domain awareness.

ASOMS directly addresses urgent needs in monitoring marine protected areas, supporting offshore renewable energy, and enhancing Arctic surveillance. Its modular, cost-effective design is well-suited for Indigenous-led stewardship and hard-to-reach regions. This presentation will share results from recent deployments, early-stage AI integration, and the system's potential to transform scalable ocean observation.

Transverse structure of exchange flows around a mid-estuary coastal constriction

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Four shipboard campaigns sought to capture the fortnightly variability of the exchange-flow spatial structure in a mixed-tides estuary with a coastline constriction. Underway velocity profiles and station CTDs were collected during spring (24 h) and neap (12 h) tides at two estuarine zones. Zone 1 (control, with no constriction) was close to the Peace River mouth whereas Zone 2 was on both sides of a coastline constriction, where a bridge crosses the estuary. Spring-tides sampling followed a bowtie transect shape, while the neap tides experiment featured a Z transect shape. At Zone 1 (control), the spring-tides residual flow exhibited a laterally sheared structure, with net inflow close to the left bank (looking seaward), and a net outflow over the rest of the section. Consistently, minimum salinities appeared over the residual outflow region. Neap tides displayed the typical gravitational circulation with inflow in a bottom layer and outflow in a surface layer. At Zone 2, affected by the constriction, the residual flow was different on either side of the constriction. The cross-section that was upstream of the constriction displayed a lateral sheared structure during both spring and neap tides, with net inflow over the left bank (looking seaward). At the downstream section, residual outflow developed in the middle of the section (deepest part), restricted to the surface, while residual inflow appeared in the rest of the cross section. Spatial reconstruction of the velocity fields around the constriction, exhibited recirculation zones where pollutants are likely to be accumulated. This shall be the topic of future studies.

Catabatic Winds Drives Reversals of Subtidal Estuarine Circulation Under Hot and Dry Conditions

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Extreme weather conditions can alter subtidal estuarine circulation, which is typically driven by tides, winds, or density gradients. In semi-arid estuaries, subtidal circulation responses depend on multiple factors, including wind magnitude and direction, evaporation rates, and the spring–neap tidal cycle. This study presents evidence of two events in which tidally driven subtidal circulation shifted to density-driven circulation, modified by wind forcing. In the first event, wind and increased evaporation enhanced the inverse salinity gradient. Consequently, the tidally driven outflow observed in the deep channel shifted to an inflow when the strengthened inverse salinity gradient coincided with a neap tide. The second event involved stronger winds than in the first, also coinciding with a neap tide, which induced a vertically sheared subtidal circulation. A dimensionless analysis was used to diagnose the role of each forcing mechanism in the observed circulation patterns. This analysis confirmed that the first event was predominantly density-driven, while the second was influenced by both density gradients and wind. These findings enhance our understanding of wind-driven dynamics in estuarine systems and reveal a previously undocumented effect of hot, dry Santa Ana winds on estuarine circulation.

Interannual variability of daily sea-level maxima and *sunny-day flooding* in coastal areas

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Astronomic forcing is the main driver of non-storm daily maxima in sea level, linked to perigean spring tides and *sunny-day flooding*, throughout Earth. Such forcing arises from gravitational and radiational influences that generate distinct sea-level reactions in different regions of the planet. Moreover, at any given site, the forcing and the response vary throughout the year and from year to year. This variability occurs on top of the century-long rising trend in sea level, i.e., on top of sea-level rise. Coastal municipalities will be best prepared for sunny-day flooding events if they know the years with greatest vulnerability. Throughout the eastern coast of the United States, sunny-day flooding, or king tides, impact coastal municipalities in the period September-November. However, the height of the daily maxima, or the potential impact, associated with periods of sunny day flooding, changes from year to year. Some years are worse than others in terms of sunny-day flooding. This study helps understand when, where and why daily-maxima in sea level vary from year to year and from site to site. For instance, the 94% of the variance of the daily maxima in water level at Boston, Massachusetts is reproduced with six harmonics related to astronomic influences, mainly the lunar nodal cycle of 18.61 y. Consistently, 98% the variance of daily maxima at Pensacola, Florida, is explained with the same harmonics. This approach should be tested with tide stations in Latin America.

Disentangling the Physical Forcings Influencing Exchange Flow in a Complex Fjord System

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Exchange flow in fjords is commonly understood as a two-layer circulation driven by horizontal density gradients caused by freshwater input at the head, resulting in surface outflow and compensating inflow at depth. However, in geomorphologically complex systems like those in Northern Patagonia, multiple forcing mechanisms can interact across space and time, altering this classical structure. What mechanisms control exchange flow in such systems where freshwater sources, tides, wind, and boundary conditions converge? In this study we analyze the drivers of estuarine exchange flow in Northern Patagonia using a high-resolution 3D hydrodynamic model and the Total Exchange Flow (TEF) framework. Simulations include baroclinic forcing, tides, and wind across three sections aligned along a north–south axis: Reloncaví Sound (north), Desertores Pass (center), and Corcovado Gulf (south). Corcovado, the southernmost section, is most exposed to oceanic conditions and wind, serving as the main connection with the open shelf. Exchange flow is strongest in Corcovado, with the mean exchange flow nearly twice that of Desertores and four times that of Reloncaví. Annually, baroclinic forcing explains 50–62% of the exchange outflow, Q_{OUT}, tides up to 19% (especially in Desertores), and wind up to 35%. In winter, wind can account for 50–70% of Q_{OUT} in Corcovado, while baroclinic forcing dominates Reloncaví outside of winter (>80%). Seasonal reversals of baroclinically driven exchange flow occur during winter, lasting up to four months in Reloncaví and Corcovado, and around two months in Desertores. These events coincide with weakened or inverted horizontal salinity gradients and highlight the system's sensitivity to modest changes in density, typical of stratified fjords with weak horizontal salinity gradients (<1 g/kg). We interpret these reversals as episodes of baroclinic pumping, or exchange flows driven by horizontal density gradients featuring less dense water at the ocean boundary than in the fjords, causing surface inflow and deeper outflow. These may arise from remote shelf forcing, local wind–freshwater interaction, or both. Their signal can be masked by wind-driven circulation, yet they remain active in the estuarine balance. Understanding these mechanisms helps refine conceptual models of fjord circulation and improves predictions of biogeochemical tracer transport (e.g., oxygen, nutrients) under climate-sensitive scenarios involving shifts in wind regimes and freshwater inputs.

Circulation controls on a wide and shallow continental shelf with diverse forcing.

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The present study investigates the circulation on a wide continental shelf under the influence of standing and propagating tides, persistent trade winds with diurnal modulations (breezes), and western boundary currents. The combination of such forcing generates an apparently simple circulation, where currents on the shallow shelf follow closely wind direction, but modulated either by standing diurnal tides or diurnal wind fluctuations due to strong sea breezes. We use numerical modelling (DELFT 3D), time series gathered in the field using bottom mounted ADCPs (5, 10 and 20 m), and meteorological station data, to analyze the seasonal, subtidal, and supratidal variability of temperature, sea level, and coastal currents on a shallow and wide (~200 km) continental shelf in the Gulf of México (Yucatán shelf). We analyze these data with cross-wavelet analysis, standard cross-spectral techniques, but also with multi-variate cross-spectral (MVCS) techniques to investigate the combined effects of several mutually coherent inputs. Spatial patterns are characterized with EOF analysis. Cross spectra between horizontal velocity and surface elevation demonstrate a phase lag of ~ 90º at diurnal frequencies, suggesting quasi standing wave behaviour. Tidal currents occur simultaneously to wind effects due to a very periodic sea breeze pattern, therefore their relative contribution might be difficult to identify with standard techniques, but MVCS shows that the current modulation is predominantly due to tides and sea breezes do not contribute consistently to this behavior. Subtidal sea level variability is additionally linked to lower frequency wind effects, and under certain circumstances evidence of a geostrophic balance between low frequency sea level and circulation exists (consistent with Coriolis effects). This and the effects of friction partially explain why coastal currents flow in the same direction of winds with an absence of Ekman dynamics (spiral). The effects of western boundary currents (Yucatan current) on shelf circulation is also investigated.

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A modeling study of the influence of an atmospheric river event on circulation and hydrographic conditions in the Gulf of Arauco, central Chile

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River outflows deliver freshwater and dissolved and particulate constituents into shelf waters, forming buoyant plumes that influence coastal circulation and stratification. The spreading of these plumes is governed primarily by buoyancy, tides, Coriolis effect, and wind forcing. Typically, freshwater accumulates near the river mouth, forming a bulge, while part of the outflow propagates downstream as a coastal buoyancy-driven current. Although river discharge variability off central-southern Chile has been studied at interannual, seasonal, and synoptic scales, the impact of extreme atmospheric events on plume dynamics remains poorly understood. We use a high-resolution numerical model forced with ERA5 atmospheric data to investigate the circulation and hydrographic conditions in the Gulf of Arauco before, during, and after the late June 2023 Atmospheric River (AR) event. This event lasted ~6 days, brought intense rainfall and strong winds, and generated Biobio River discharges exceeding 8,000 $m^3 s^{-1}$. Simulations were conducted with and without river discharge to isolate the plume's effects. Results show marked changes in circulation and hydrography during the AR event. The freshwater plume spread across the entire gulf, enhanced by concurrent wind forcing. Freshwater content (FWC) increased by more than 2 m throughout the gulf, peaking a few days after AR landfall and persisting for over a week. Stratification, measured by potential energy anomaly (PEA), exceeded 200 J m^{-3} over most of the gulf. Intensified southward plume transport (velocities ~0.5–1 m s^{-1}) developed, forming a cyclonic gyre that bifurcated south and east of Santa María Island. These findings highlight the strong, lasting influence of extreme atmospheric river events on coastal hydrography and circulation, with potential implications for shelf–gulf exchanges, nutrient transport, and ecosystem response in central Chile

Coastal trapped wave along the Chilean continental margin and their interaction with a long submarine canyon

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Coastal trapped waves (CTWs) are subinertial oscillations that propagate along continental margins and play a key role in shaping coastal circulation and variability. This study investigates the propagation characteristics of CTWs along the Chilean coast between 18°S and 43°S, with a particular focus on their interaction with complex bottom topography, including the Biobio Submarine Canyon. We integrate three primary data sources: (i) hourly sea level observations from 19 coastal tide gauge stations; (ii) ocean reanalysis data from GLORYS4 (0.25°) and GLORYS12 (1/12°) products; and (iii) high-resolution regional simulations using the CROCO model, configured both with and without the Biobio Canyon. Sea level anomalies were bandpass filtered (3–90 days) using a fourth-order Butterworth filter to isolate CTW signals. The results show a coherent southward-propagating CTW signal across all platforms, with estimated phase speeds of 1.5–3.5 m/s. Spectral analysis reveals a dominant peak around 50 days at all latitudes, along with an intensification in the 10–30 day band toward the south. GLORYS12, with its finer resolution, better resolves wave propagation over narrow shelves and steep topography. CROCO simulations reproduce wave-like features in both configurations but show notable differences in amplitude and structure when the Biobio Canyon is included. Stratification analysis reveals a latitudinal shift in the Burger number, suggesting a transition from baroclinic to barotropic dominance. Empirical Orthogonal Function (EOF) analysis identifies a leading southward-propagating CTW mode and highlights spatial variability associated with topographic features. Simulations show that the Biobio Canyon enhances vertical exchange, disrupts alongshore flow continuity, and strengthens cross-shelf transport during CTW events. Idealized tests indicate that suppressing CTWs significantly reduces coastal variability, confirming their dominant role, with wind stress acting as a secondary modulating force.

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Marine heat waves, sea temperature, and the octopus population, in a shallow-tropical sea

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Marine heat waves (MHWs) are periods of exceptionally warm ocean temperatures lasting weeks to years and are widely recognized for their capacity to disrupt marine ecosystems. The Yucatan Shelf (YS) is a broad, shallow continental shelf that extends several kilometers offshore. It is one of the most biodiverse regions in Mexico, with extended areas of coral reefs, seagrass meadows, and coastal mangroves, home to many marine organisms. Early studies have found that MHWs in the YS have increased in frequency and duration, with recorded anomalies of +2 to +4°C, promoting coral bleaching and affecting reefs like Arrecife Alacranes and Campeche Bank reefs. Also, the prolonged warming has been shown to reduce the photosynthetic efficiency of seagrasses, and temperature-sensitive species (like grouper, snapper, and octopus) may change migration or reproduction patterns. In this study we asses sea bottom temperature from four ADCPs located in the inner shelf (<40 m depth), and the Sea Surface Temperature from satellite data, to validate and compare data from the GLORYS12V1 product. This work aims to analyze the MHWs that have occurred in the YS over the past 30 years to understand the natural variability of the Sea Bottom and Sea Surface Temperature in the study region and explore the MHWs events that impacted the YS. The study region is also an area affected by upwelling events that are essential to maintaining the health of the marine ecosystems. It is of interest to understand how upwelling events and MHWs interact, and how the Sea Temperature in is affected, in order to hypothesize how this variable may affect the octopus population of the YS.

Horizontal small-scales features on the inner shelf adjacent to the mouth of Patos Lagoon

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The inner shelf near river mouths is an area characterized by steep gradients in water properties. The circulation and distribution of water properties are controlled by complex interactions between freshwater input, tides, wind, and waves, interacting with local morphology. These forcings, acting synoptically, produce small-scale features ranging from meters to a few hundred meters, and in some cases, a few kilometers, evolving on corresponding timescales of minutes to hours. We assessed the small-scale horizontal features on the inner shelf adjacent to Lagoa dos Patos based on 22 near-monthly surveys from December 2019 to November 2022. These surveys focused primarily on monitoring cetaceans using an inflatable boat, tracking nearly parallel to the coast along the inner shelf, east and west of the lagoon mouth. A continuous flow chamber was installed on the boat, where a continuous flow sensor (CTD) was installed to record salinity, temperature, turbidity, chlorophyll-a, and dissolved oxygen. Data were recorded at 1 Hz intervals, with an acquisition rate ranging from 1 to 10 seconds. The data were georeferenced through synchronization with data recorded by a GPS signal receiver. Preliminary results showed that salinity exhibited the greatest spatial variation in the autumn months of 2020 and 2022, while the smallest spatial variation was observed in the spring months of 2020 and 2021, in the autumn of 2021 and 2022, and in the summer of 2020, 2021, and 2022. Turbidity demonstrated particular spatial variations in the spring, autumn, and summer months of 2021 and in September 2020, with the largest variations concentrated in the surf zone..

Exploring the hydrodynamic structure of the Magdalena River plume in the Caribbean Sea

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This study investigates the velocity and salinity structure of a large surface-attached, low-latitude, and microtidal plume during a period of high freshwater discharge and variable wind conditions. The plume was analyzed through observations at multiple transects along, across, and diagonal to the shoreline, carried out during the oceanographic cruise MSM112, using ADCP measurements and a CTD chain. Results show that the plume is very shallow, with a large aspect ratio of $O(10^4)$ and rapid changes in its extension and direction within hours in response to forcing variability. The velocity and salinity structures reveal a marked asymmetry between the downwind and upwind sides of the plume. Downwind, the plume is faster, narrower, and more mixed and remains supercritical beyond the near-field. Consequently, the near-field is more consistently delimited by the bulk Richardson number than by the Froude number. Upwind, the interaction between opposing river momentum and wind-driven flows generates vortices and fronts. Finally, the Kelvin number indicates that the Coriolis effect, often neglected in low-latitude coastal systems, also influences the plume dynamics when the system exceeds a critical horizontal extension.

Impact of Atmospheric Rivers on Coastal Oceanographic Conditions off central-southern Chile

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Atmospheric Rivers (ARs) are key drivers of extreme precipitation and hydrological variability along the west coasts of continents. While many studies have focused on their atmospheric impacts, the oceanographic response remains underexplored. Using remote sensing and in situ observations, this study examines how ARs affect river plumes, hydrodynamics and biogeochemical conditions in central-southern Chile (33–40°S). Synoptic atmospheric conditions associated to the passage of different oriented AR (i.e., Tilted and Zonal ARs) produce contrasting river plume dynamics, while TARs favor coastally trapped and southward-advected plumes by the northerly winds, ZARs generate dispersed and offshore plumes influenced by southerly winds. High resolution mooring data show that both TARs and ZARs initially enhance vertical mixing and currents by strong winds, followed by stratification due to the arrival of the river plume. Biogeochemical samplings before and after the passing of a series of ARs show that TARs increase surface nitrates, silicic acid and chlorophyll-a more than ZARs. The results provides novel insights on response of river plumes and water column changes to the passage of ARs in the coastal ocean.

Implementation of Operational Models along the Chilean Coast

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Operational models are useful tools to provide ocean and meteorological information for coastal economic activities such as port operation, fisheries and tourism. However, their implementation requires a long development time to sort out the complexities of the topography, coupling of different models and validation using in situ observations. As part of an ongoing effort, we have implemented 3 numerical models (WRF, CROCOS, SWAN) to provide wind, current and wave forecast to 3 locations in northern, Arica (18.5 ºS) and Antofagasta (23.6 ºS) and central, Coronel (37 ºS) Chile. The model's spatial resolution varies between 300m and 1km to capture mesoscale and sub-mesoscale variability. The models are validated with observations obtained from oceanographic buoys deployed in the same locations. The validations show relatively high correlations (0.6-0.8) and normalized standard deviations around 1. There are differences among models, SWAN wave forecast seems to be more robust than WRF wind and CROCOS ocean forecast. The models also show some observed features in the wind, currents and wave spatial pattern. For example, the wave model presents good skill forecasting storm surges in the 3 locations, and the wind model has been able to capture low pressures systems and atmospheric rivers, although with not good skill in the absolute values of precipitation and wind magnitude. Of the 3 locations, Coronel results show larger deviations, mainly because is a more complex system with strong river influence and abrupt bathymetry by the proximity of a submarine canyon. Our results suggest that although some features are well represented by the models, more work needs to be done to generate a reliable product. For instances, one pending task is to fully coupled the wind model with the ocean and wave model.

Numerical assessment of tidal stream energy in the Brazilian Equatorial Shelf

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The Brazilian Equatorial Shelf (BES) is one of the few macrotidal regions worldwide. In addition, estuaries may have ideal technical conditions for tidal energy conversion: strong currents and proximity to the coast and urban/industrial infrastructures. This is the case of the estuarine channels in BES, for which a numerical tidal potential density assessment was done. This study used a high-resolution numerical configuration of the ocean model ROMS forced with realistic surface and lateral forcing, as well as with tides and river discharges. Strong currents were found in three regions in BES due to the large daily transport crossing the estuarine channels inside each region: Amazon, Pará, and Maranhão, and for a considerable time fraction. In these regions, speeds higher than 1 m s^{-1} were found during about 45% of the time leading to a power density around 2300 W m^{-2} at the surface layer, reaching peaks higher than 10500 W m^{-2}. Operation time versus tidal power (OTP) diagrams for the three regions show that even with a sharp reduction of operation time (40%) it is still possible to extract a high portion (90-95%) of the total power density available when speeds are higher than 1.0 m s^{-1}. Currents and power density show significant time variability. The most energetic site is located in Maranhão region. Considering only the time the speed is higher than the cut-in, the mean tidal power available increases in the most energetic site to values at the surface of 4000 W m^{-2}, for cut-in speed 1 m s^{-1}, reaching peak values higher than 10500 W m^{-2} during 5% of the time (95% percentile). The power decreases linearly towards the bottom, to mean values around 400 W m^{-2}.

Diapycnal Mixing and Double Diffusion in the Oxygen Minimum Zone off Central Chile: Observational Evidence from Underwater Gliders

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The southeastern Pacific hosts highly productive upwelling ecosystems, where the export of organic matter generates intense demand for dissolved oxygen (DO) in subsurface waters. Combined with limited ventilation, this leads to the formation of an intense Oxygen Minimum Zone (OMZ). Off the coast of Chile, the OMZ is associated with the Equatorial Subsurface Water (ESSW), a water mass that is nutrient-rich, saline, and relatively warm, bounded above and below by cooler, fresher, and more oxygenated waters. Mixing among these water masses contributes to the ventilation of the OMZ as the ESSW moves southward.

This study examines the mechanisms of diapycnal mixing within the OMZ and evaluates the relative contributions of (a) double-diffusive instabilities (salt fingers) and (b) shear-driven turbulent mixing to the turbulent fluxes of DO. Temperature, salinity, and DO data were collected using underwater gliders off Concepción (36°30′S). Conditions favorable for double diffusion were identified using the density ratio (R_ρ, and the Turner angle), and an empirical diffusivity coefficient associated with salt fingering was estimated. In parallel, the Thorpe scale was used to derive turbulent kinetic energy dissipation rates and a diffusivity coefficient associated with mechanical mixing.

The results reveal very low diffusivity within the OMZ core, with favorable conditions for salt fingering beneath the core that enhance mixing. In contrast, shear-driven turbulent mixing contributes more significantly to vertical fluxes in the upper oxycline. These findings are key to understanding the ventilation dynamics of the OMZ in our study region.

3D Shelf Sea Modeling: Applications in Europe and the U.S. with Relevance to Latin America

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Three-dimensional hydrodynamic numerical models are essential tools for understanding the dynamics of shelf seas, including stratification, mixing, and circulation processes that influence ecosystems and water quality. This contribution presents modeling work by Deltares using the Dutch Continental Shelf Model (DCSM-FM) and the Bays Eutrophication Model (BEM) for two contrasting environments: the North Sea in northwestern Europe and Massachusetts Bay in the northeastern United States. DCSM-FM, developed in the Delft3D Flexible Mesh Suite for the Dutch government, is a general-purpose model that simulates sea level, currents, temperature, and salinity at high spatial and vertical resolution. It incorporates tidal and meteorological forcing, river discharges, and surface heat fluxes. The model supports a wide range of Dutch and European research and policy applications and plays a key role in translating global ocean model output to regional shelf-scale dynamics. For example, it has been used to assess the large-scale impact of offshore wind energy infrastructure on circulation and stratification patterns. Lessons learned during its development have informed the creation of shelf sea models in other regions worldwide. A notable example is the BEM, developed in support of the Massachusetts Water Resources Authority (MWRA), which downscales North Atlantic reanalysis data to simulate hydrodynamics in the Gulf of Maine and, ultimately, local circulation and exchange processes in the shallow Massachusetts and Cape Cod Bays. The model resolves seasonal stratification, wind-driven exchange, and freshwater inflows, forming the physical basis for nutrient and dissolved oxygen transport simulations. Both models are forced with Copernicus Marine Service reanalysis products, ensuring consistency with large-scale circulation. The modeling framework and methodology are directly applicable to Latin American shelf systems, which often exhibit similar coastal geometry, upwelling regimes, and data challenges. Potential applications include climate change adaptation, aquaculture siting, pollution dispersion, and environmental monitoring.

Coastal Plume Influence on Microplastic Transport: A Sensitivity Study

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Microplastics (MPs, 1 µm–5 mm) are persistent pollutants in the land–ocean continuum, making estuaries key zones for their distribution. Along their pathway to the sea, MPs interact with strong physical and chemical gradients, such as those induced by salinity stratification, which influence their horizontal and vertical distribution and retention. This study examines the role of the Patos Lagoon coastal plume, a frontal system extending onto the inner shelf, in controlling MPs distribution in the water column. The plume carries MPs particles in suspension throughout its vertical extent, depending on polymer properties (density), transport characteristics (settling/rising velocity) and local hydrodynamics. Hydrodynamics outputs from the TELEMAC-3D model were used as input for the Lagrangian particle-tracking model TrackMPD to simulate the trajectories of four polymer types with different densities. The Rouse number was calculated along the trajectories to determine the dominant transport modes, and a two-way ANOVA with post-hoc Tukey tests assessed the influence of polymer type, water density (constant value and variable throughout the water column), and their interaction. Results indicate that lighter polymers reached offshore areas in both scenarios, transported mainly as surface or rising-suspended load, with minimal influence of the water's density variation. Denser polymers exhibited shorter trajectories, with resuspension near the jetty mouth and deposition at the west jetty. In all dense-particle cases, sinking began within minutes, reaching greater depths under variable water density. Transport type was strongly dependent on polymer density, varying between settling-resuspension, bedload, and immobile states. Results also indicate that polymers with densities similar to water tend to float (constant water density scenario), but under variable density throughout the water column they behave like dense polymers and are transported as wash load. These findings represent preliminary results, providing insights into the interaction between polymer properties, density-driven stratification, and hydrodynamic conditions in coastal plume environments.

Exploring Lagrangian circulation as a bottom-up control of the Antarctic marine ecosystem

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The ocean circulation in the Bransfield Strait located in the northern Antarctic Peninsula is influenced by the Antarctic Circumpolar Current (ACC) and the Antarctic Peninsula Coastal Current (APCC). In the Bransfield Strait these dynamic features interact bringing contrasting water masses that provide an environment for a high biological production. In this study, we explore the contribution of the ACC and APCC to generate conditions for the formation of a biologically favorable environment. Using the Regional Ocean Modeling System (ROMS) configured for the Antarctic Peninsula, a Lagrangian module was implemented and designed to simulate the passive and active transport of particles, in and out of the Bransfield Strait. The results showed that remote transport pathways were controlled primarily by ACC intrusions from the western boundary of the Bransfield Strait. Thus, the main dynamic feature responsible for the export of particles form the region is the Bransfield Current, advecting the particles in and out in less than 3 months. Particles released in the center of the Bransfield Strait followed the pathway of mesoscales eddies, with retention time scales consistent with the development of planktonic larvae. Particles released along the eastern boundary of the Bransfield Strait were controlled by the advection of the APCC and were retained and mixed inside the Strait. The findings of this study elucidate potential dispersal pathways for planktonic organisms, such as Antarctic krill larvae. Given the pivotal role of Antarctic krill in the Southern Ocean food web, these results could inform ecosystem-based management strategies. Study funded by ANID-FONDECYT 1254132

Hydrographic Variability and Pelagic Species Distribution in Northern Chilean Patagonia: Insights from Combined In-situ and Modeled Data (2014–2025)

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Abstract:

Northern Chilean Patagonia, spanning from the Interior Sea of Chiloe (MIC) to Aysén, hosts a highly productive pelagic ecosystem dominated by key fishery species such as the southern sardine (*Sprattus fuegensis*), anchoveta (*Engraulis ringens*), and common sardine (*Strangomera bentincki*). From 2014 to 2025, the Instituto de Fomento Pesquero conducted integrated campaigns combining hydroacoustic surveys and oceanographic sampling to assess species abundance, distribution, and dynamics in relation to physicochemical conditions. Results revealed marked spatial segregation: *S. fuegensis* dominates the western MIC and Aysén fjords, *S. bentincki* is found throughout the MIC, and *E. ringens* concentrates in the eastern MIC. These patterns suggest strong environmental modulation driven by estuarine and coastal hydrographic heterogeneity, with implications for connectivity, recruitment, and fisheries management under multi-scale forcing.

To assess hydrographic variability, a common horizontal grid was developed across all cruises. Temperature and salinity profiles (~150 per year, 0–100m) were interpolated at each depth. Gaps were filled using in situ data and validated outputs from GLORYSv12 and CHONOS ocean models. Species distributions were derived from scientific echosounders, producing integrated acoustic density estimates every half nautical mile. Empirical Orthogonal Function (EOF) analysis was applied to the hydrographic dataset and correlated with pelagic biomass to identify dominant environmental–biological patterns.

Hydrographic profiles showed strong stratification, with estuarine water in the upper 10 m and oceanic influence below 100m. In Aysén, bathymetric constraints and freshwater input promote two-layer circulation. Dissolved oxygen profiles, available for a subset of cruises, revealed a subsurface anoxic zone (<1 ml/L) from Guafo Mouth to Puyuhuapi Channel. EOF by depth strata (0–100/0–15/15–60 m) explained 65.5/63.9/67.8% of temperature and 49.0/35.9/59.1% of salinity variance. These results highlight EOF as a useful exploratory tool and emphasize the need to integrate in situ and modeled data to address spatiotemporal gaps in estuarine physical–biological coupling.

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River freshwater and nutrient releases impact on biological production in central-southern Chile using biophysical simulations

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This study examines the impact of river discharge on chlorophyll biomass and its spatial distribution in central-southern Chile (35°-38°S) utilizing a regional dynamical-biogeochemical coupled model, in situ and satellite observations.
We specifically concentrate on the Biobío River plume, a relatively under-researched river plume that discharges into the Gulf of Arauco, a very productive region that supports many major epipelagic, mesopelagic, and benthic resources within the Southern Humboldt Current System. Simulations with and without river discharge are compared. The river discharge, strongest in austral autumn-winter and early spring, has various impacts. First, low-salinity riverine waters increase surface stratification, the surface mixed layer thickness decreases and surface chlorophyll increases. Second, riverine nutrients have diverse effects: silicate inputs trigger a surface chlorophyll increase, while nitrate and phosphate inputs have little effect. Last, the effect of riverine nutrients on surface chlorophyll depends on wind conditions: when coastal upwelling forced by southerly winds takes place, riverine nutrients are transported out of the bay by northward currents, while subsurface nutrients upwelled in the southern part of the bay stimulate primary productivity. In contrast, when upwelling favorable winds are weak, the nutrients provided by the rivers to the Gulf of Arauco are retained, enhancing primary production in the bay.

An atypical population of *Dinophysis acuminata* in Northwest Patagonia: The strange case of the San Rafael Lagoon Glacier

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Current paradigms assume that *in situ* growth of rare holoplanktonic dinoflagellates is triggered by the onset of stratified conditions. These conditions have been associated with the formation of retention areas in the pycnocline which facilitate the aggregation of inoculum populations and with thin layers enhancement of prey acquisition and sexual reproduction in mixoplanktonic species of *Dinophysis*. An alternative habitat allowing year-round occurrence of *Dinophysis acuminata* is described here in a well-mixed Austral glacier lagoon in the Chilean Patagonia. Between November 2020 and July 2025, ten oceanographic cruises were carried out to the San Rafael Lagoon, an unexplored proglacial water body in Northwest Patagonia, with a focus on Harmful Algal Blooms (HAB). Surprisingly, populations of the mixoplanktonic toxin producer, *Dinophysis acuminata*, with moderate densities in winter (500 cell L^{-1}) and cell maxima (up to 5700 cells L^{-1}) in summer were always present in the lagoon. Molecular analysis (ITS and partial plastid 23S rRNA gene) confirmed the optical identification of the species, while toxin analysis revealed that this population only produces pectenotoxin 2 (PTX-2). This cold (4-7 ºC) and well mixed brackish (salinity14-15) lagoon, with freshwater inputs from glacial melting, didn't appear as a suitable habitat for *D. acuminata*. Distribution of physical properties and a hydrodynamical model, revealed the existence of an anticyclonic eddy. This retentive structure seems to provide conditions for a permanent moderate population of *Dinophysis* with a unimodal distribution with a summer maximum. These results question the view of mixed water columns as unfavorable habitats for *Dinophysis* growth. Thus, the key role of stratification promotes a retention body or eddy which may act as an "incubator" for the inoculum of *D. acuminata* are discussed.

High-resolution temporal dynamics of diatoms in a large and well-mixed tropical estuary

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We conducted a high-resolution analysis of diatom populations in the microphytoplankton size range using data collected at 30-minute intervals over a 20-month period by an automated imaging system deployed near the mouth of Baía de Todos os Santos (BTS), Brazil. Seven diatom taxa were identified and quantified through automated classification using a Convolutional Neural Network (CNN). Frequency-domain analysis revealed distinct environmental drivers acting across different temporal scales. At high-frequency scales (<53 hours), solar radiation was the predominant factor influencing diatom abundances. At intermediate to monthly scales (53 hours to 13 days, neap-spring cycles of 13–15 days, and monthly scales), canonical correspondence analysis (CCA) indicated that dissolved oxygen, temperature, and salinity were the primary environmental drivers. Multiple linear regression (MLR) models highlighted colored dissolved organic matter (CDOM) and the north-south wind component as key predictors for *Coscinodiscus wailesii* abundances. K-strategist marine taxa, including *Rhizosolenia robusta* and the *Rhizosolenia–Proboscia* complex, exhibited peak densities during neap tides, coinciding with stronger intrusion events of oligotrophic oceanic waters into the bay. Conversely, r-strategist coastal and estuarine taxa, including *C. wailesii*, *Bacteriastrum-Chaetoceros* complex, and *Guinardia striata*, reached maximum abundances during spring tides, associated with enhanced river discharge and pronounced ebb flow conditions. These taxon-specific distribution patterns demonstrate the influence of environmental forcing across multiple temporal scales on diatom populations. Our findings show the effectiveness of frequency-domain analytical approaches in resolving the complex interactions between environmental variability and phytoplankton dynamics, enhancing understanding of bottom-up regulatory processes and inter-taxa ecological interactions in coastal tropical ecosystems.

Geometry Shapes the Flow: Asymmetric Dynamics in Narrow Channels and Their Impact on Estuarine Connectivity

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Understanding circulation patterns and water mass interactions in narrow marine channels is essential for coastal management and aquaculture planning. This study analyzes the hydrodynamics of the Yal Channel, located between Lemuy Island and Chonchi in southern Chile, based on an intensive oceanographic campaign conducted in November 2024. The main objective was to characterize the circulation dynamics and hydrodynamic constraints operating in this system. The methodology included the deployment of two fixed Acoustic Doppler Current Profilers (ADCPs), installed at 30 m depth at the Chonchi side and 60 m on the Lemuy side, to capture vertical and temporal current variability. In addition, three cross-channel transects were conducted using CTD profiles during flood and ebb tides phases, complemented by a towed ADCP to obtain detailed spatial coverage. Preliminary results reveal a notable intensification of current velocity toward the Lemuy Island shore, along with significant vertical variations in flow speed and direction. Marked differences were identified in the cross-channel currents component, as well as temporal lag correlations between both ADCP. These patterns reflect the influence of channel bathymetry and geomorphology in modulating flow structures. This analysis represents a step forward in characterizing circulation in the Yal Channel and provides key information for understanding water mass exchange processes in narrow estuarine systems. The results contribute relevant inputs for the development of numerical models, studies on regional connectivity, and the integrated management of the Chilo Inland Sea.

Unprecedented ADCP-based characterization of tsunami–tide–river coupling in the Valdivia River for the 2025 Kamchatka tsunami

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An unprecedented record of the combined interaction between tsunami, tide, river flow, and storm conditions was obtained in the Valdivia River during the July 29th, 2025 Kamchatka earthquake-generated tsunami. High-resolution measurements of surface elevation and currents at three equidistant vertical levels allowed for a detailed description of river flow responses and oscillation periods under this rare combination of forcing mechanisms. The observational deployment consisted of an Acoustic Doppler Current Profiler (ADCP) placed approximately 9 km upstream from the river mouth, near the Estancilla area, in 9 m water depth. The instrument was installed two hours before the expected tsunami arrival and operated continuously for four days with a 2-minute sampling interval. The ADCP record was complemented with tide gauge data from Corral and measurements from the nearest Deep-ocean Assessment and Reporting of Tsunamis (DART) buoy, located offshore Concepción. The first tsunami waves arrived at 16:30 local time with small amplitudes; however, more energetic waves reached the river after 17:15, with the largest wave heights recorded at 21:15 and 01:15 (July 30th). Although peak currents remained below 1 m/s, they exhibited marked variations in both magnitude and direction, suggesting potential hazards for unprepared maritime or riverine activities. The tsunami signal persisted for several days, with detectable fluctuations lasting up to three days after the initial arrival. To further investigate the interaction between the tsunami signal, tidal background, and river discharge variability, we employed wavelet analysis to characterize dominant periods and their temporal evolution. These results highlight the complex superposition of processes in estuarine systems under multi-hazard forcing. This ADCP dataset represents a unique contribution for validating and improving numerical models aimed at simulating tsunami–tide–river interactions, supporting risk assessments for communities located in estuaries and tidal rivers worldwide.

Influence of artificial river-mouth openings on tidal wave propagation in a small estuary

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Small estuaries characterized by seasonally varying freshwater discharges are frequently found along mediterranean microtidal coasts dominated by energetic wave conditions. These estuaries tend to be morphologically very dynamic, often featuring a sediment bar that follows a natural seasonal cycle - alternately connecting and disconnecting the estuary from the ocean. Such systems are known as Intermittently Open and Closed Estuaries (IOCEs). During extended dry seasons and prolonged periods of low river discharge, some IOCEs may not open naturally. This can lead to water stagnation, degraded water quality, and increased flood risk within the estuary. Artificial breaching of the sediment bar using excavators is a common intervention aimed at reestablishing the connection with the ocean to restore water quality and mitigate flood hazards. However, there is currently no standardized protocol in our country to guide when, where, or how such breaches should be carried out effectively. In this study, a hydraulic model was implemented, calibrated, and validated for an IOCE located in Laguna Cáhuil, Chile, to evaluate the effects of artificial mouth-opening scenarios on tidal wave and seawater propagation upstream into the estuary. A series of scenarios were simulated, combining openings of varying geometries and locations with different river flow rates and tidal conditions. The results show that the estuary's hydrodynamic response depends strongly on the geometry and location of the opening, with tidal propagation upstream being closely linked to river discharge magnitude and flood duration. The most efficient configuration was identified as the one that enables the fastest evacuation of floodwater during a flood event with a two-year return period, thereby reducing flood risk. Future work will focus on evaluating mixing processes within the estuary and the propagation of saltwater as far upstream as the Salinas de Barrancas de Cáhuil, located approximately 4 km from the estuary mouth.

EFFECTS OF SEDIMENTS ON EXCHANGE FLOW IN A MACROTIDAL AND TURBID ESTUARY

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A common feature of estuaries is the development of a region of localized higher suspended sediment concentration (SSC) known as estuarine turbidity maximum (ETM). Elevated SSCs enhance stratification leading to the suppression of turbulence which in a positive feedback can further increase SSC in the ETM by more than an order of magnitude. Despite the importance of SSCs on the damping of mixing in estuaries, the impact of sediment-induced stratification is still scarcely documented, and hence its impact on estuarine exchange flow is unknown. Therefore, the goals of this study are (1) to quantify the effects of sediment-induced stratification on the total exchange flow (TEF) and (2) to determine when and where these effects are significant. Two realistic numerical scenarios of a highly turbid and macrotidal estuary are studied: one with suspended sediments as a passive tracer and one where sediments are an active tracer, where water density calculations include SSC. Results indicate settlement during neap tides and resuspension during spring tides when the sediments can reach the surface. On spring tides, larger SSCs near the bottom (maximum of 10 g/L) compared to the surface (maximum of 1.5 g/L) are observed during peak flood currents in the navigation channel when sediments are an active tracer. Comparing density between the models, differences exceeding 3 kg/m^3 in the water column are observed from the end of ebb to max flood near the ETM. To understand the long-term effects of these changes over the exchange flow, TEF was calculated downstream and upstream besides of the ETM. When sediments are an active tracer, TEF bulk-values decrease as much as 2000 m^3/s (30\%) at the ETM, 1000 m^3/s (25\%) upstream and 800 m^3/s (13\%) downstream. The difference in the bulk-values appears to be due to the modulation between greater salinity stratification during neap tide and larger sediment-induced stratification during spring tides. Downstream, the temporal modulation of the TEF bulk-values was mostly related to temporal variability in salinity stratification, which enhanced every neap tide, whereas upstream the temporal variability of the SSC was the dominant factor, which enhanced every spring tide. These results highlight the importance of considering suspended sediments in hydrodynamics models in order to accurately capture the hydrodynamic processes.

Wave-river interactions at small-scale river mouths

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Small rivers discharging directly into the surf zone represent a common, dynamic and underexplored setting where fluvial and coastal processes interact over short spatial and temporal scales. In these systems, the initial dispersion of freshwater is not only influenced by river discharge, but also by wave-induced processes within the surf zone. Understanding the interplay between river outflow and wave forcing is crucial for characterizing plume dynamics, sediment transport, and water quality along adjacent shorelines. This study presents field measurements conducted in two small river mouths in central Chile (the Maipo and Cahuil river mouths), encompassing both the estuarine zone and the surf zone. Time series of salinity, water level, and velocity were obtained at high temporal resolution, and complemented by concurrent wave data, river discharge, and drone imagery. The observations reveal that plume structure and discharge behavior are significantly influenced by short-period gravity waves, but also by long-period infragravity waves associated with wave groups. In particular, fluctuations in salinity and velocity at the river mouth and the near-field correlate with the infragravity band and the arrival of wave groups, suggesting that these low-frequency oscillations can enhance or suppress plume discharge depending on wave group phasing. These results provide new insights into the role of infragravity waves in controlling small-scale plume dynamics, highlighting the need to consider both short and long wave components in surf zone–estuary coupling. The findings have implications for mixing processes, pollutant dispersion, and the development of predictive models for river mouth behavior under changing wave climates.

Extreme River Discharges in Patos Lagoon: Hydrodynamic Effects and Flooding Risks

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In face of a changing climate, extreme events are becoming not only more frequent but also more intense, posing unprecedented challenges to coastal risks mitigation and resilience. Understanding how these regions respond—and how they can better prepared—is essential for safeguarding ecosystems, infrastructure, and communities. In this context, this study applies the TELEMAC-3D hydrodynamic model to investigate changes in circulation patterns in Patos Lagoon, located in southern Brazil under extreme river discharges arising from extreme precipitation events. The model was implemented using high-resolution bathymetric data and oceanic (tides and current velocities), continental (river discharge data from the main tributaries) and surface (winds) boundary conditions. Two simulations were performed: one representing the extreme flooding event which occurred between April and May 2024 and the other representing an extreme event 50% stronger. Preliminary results indicate the influence of wind variability and reveal substantial differences in water level dynamics and salinity gradients throughout the lagoon–estuary continuum. The 50% stronger scenario led to intensified freshwater outflows, disruption of vertical stratification, and altered exchange flows at the estuarine mouth. Additionally, higher current velocities were detected along the western margin of the estuarine access channel. In both scenarios, water levels exceeded established flooding thresholds in several cities adjacent to the lagoon, highlighting the system's vulnerability to flooding extreme events. These findings underscore the importance of high-resolution hydrodynamic modeling for anticipating and managing the impacts of extreme events in complex coastal environments.

Preliminary Analysis of Coastal Morphological Changes in La Paz Lagoon Using Satellite Imagery

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Bathymetric changes, turbidity, and shoreline position are dynamic indicators highly sensitive to anthropogenic modifications. These parameters are crucial for the environmental and socio-economic services of coastal systems. This study presents a preliminary analysis of changes in bathymetry, turbidity, and shoreline position over the past two decades, using multispectral satellite imagery (Landsat 7 ETM+, Sentinel-2 MSI) and very high-resolution imagery (QuickBird, WorldView, Pleiades) for the La Paz coastal lagoon, located in the southwestern Gulf of California, Mexico. Strict image selection criteria were applied to minimize cloud cover, tidal variation, and sun-glint effects. Bathymetry was estimated through an analytical model based on log-ratio reflectance indices, calibrated with official nautical chart data; turbidity was derived from algorithms validated for coastal waters; and shoreline delineation was performed manually in QGIS. La Paz Lagoon is a semi-enclosed coastal system of high ecological and socio-economic importance, protected by the sandy barrier of El Mogote. Its hydrodynamic and sedimentary regimes are influenced by tides, wind, continental inputs, and extreme events such as hurricanes. Results show a general trend of decreasing mean depth in the inlet, interrupted by localized increases in the north-northwest sector, associated with coastal erosion and human activities. Between 2006 and 2024, shoreline change analysis revealed an accumulated erosion of ~21 ha and accretion of ~5.7 ha, with the latter concentrated near stream mouths. Hurricanes Newton (2016) and Lorena (2019) caused abrupt bathymetric changes and significant turbidity increases, particularly near active streams such as El Cajoncito. These findings underscore the high vulnerability of the system to both natural and anthropogenic disturbances and demonstrate the value of satellite remote sensing for coastal monitoring. Complementary in situ measurements and hydrodynamic modeling are recommended to strengthen management and conservation strategies for La Paz Lagoon.

ESTIMATION OF WAVE FORCINGS FROM REMOTE MEASUREMENTS: CASE STUDY OF THE MAIPO RIVER MOUTH

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The interaction between fluvial flow and wave action at river mouths generates highly dynamic processes that influence coastal morphology, sedimentation, and energy distribution. This study presents a novel remote sensing-based methodology for estimating wave forcing induced by breaking waves. The approach combines drone-based aerial imagery with deep learning techniques, such as convolutional neural networks (CNNs), to accurately detect breaking patterns through image segmentation. From the segmented patterns, geometric parameters are derived to estimate three key physical variables: observed phase speed, energy dissipation rate, and the direction of incoming wave forcing. These variables are then used to compute breaking-induced wave forcing and produce high-resolution maps that quantitatively characterize system behavior under diverse environmental conditions. The methodology is applied to the Maipo River mouth in San Antonio, Chile, an estuarine-marine environment with high morphodynamic variability, allowing the identification of spatial patterns consistent with variations in wave and environmental conditions. This approach represents a significant advance for coastal process studies, as it enables detailed, direct monitoring of wave energy and its interaction with rivers without the need for in-situ instrumentation. It is particularly valuable in highly dynamic environments and for analyzing the temporal evolution of momentum exchange, energy dissipation, and their morphodynamic implications. Beyond its scientific relevance, this methodology supports applications in coastal planning and risk assessment.

Evolution of tides in relation to morphology and river discharge changes over 70 years in a macrotidal estuary

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In macrotidal estuaries, understanding the interplay between morphology, tidal dynamics and river discharge, is crucial for anticipating future morphodynamics. As a major consequence of this interaction, long-term tidal amplification has been reported in several estuaries during the XX century, which can have major effect on future extreme water levels but also on water mixing and sediment transport. This study analyzed the jointly evolution of tides and morphology of a prototypical macrotidal, convergent and highly urbanized estuary (the Gironde estuary, France) between the 1950s and the beginning of the XXI century. Data analyzed include GIS-based bathymetry maps, tidal gauge records at 9 stations, and river discharge data. Results show that between 1953 and 2017, the morphology of the estuary is subject to fluctuations controlled by sediment erosion and deposition, leading to changes in cross section by the order of +-2%, except for a generalized increase of 6% in the upper estuary between 1994 and 2000. These changes seem to be closely linked to the position and extent of the estuary estuarine turbidity maximum (ETM), which migrated and expanded upstream in the tidal rivers due to the decrease of the river discharge in the same period. The analysis of tides shows relative stability of tidal range and asymmetry in the lower estuary, but a significant increase in the upper estuary (up to 7%), which started after 1994, concomitantly with changes in cross section. Harmonic analysis show that the M2 component increased progressively after 1994 and until 2007, while the M4 component increased gradually along the upper estuary but with less temporal variations. These results show that contrary to other urbanized estuaries that experienced tidal amplification after artificial narrowing and deepening, the Gironde estuary has been clearly controlled by river discharge and by the location of ETM.

Inner shelf hydrodynamics and mud dynamics adjacent to the Patos Lagoon mouth

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Along the coast to the west of the Patos Lagoon mouth, mud deposits occur on the inner shelf. On certain occasions, after storms, sediments from these deposits are remobilized, transported, and deposited on the beach. The objective of this study is to investigate the mechanisms driving sediment movement on the inner shelf. Over a period of approximately 100 days, between late autumn and early winter, an acoustic Doppler current profiler (ADCP) was deployed to record current and wave data, along with a set of four turbidity sensors in a vertical array near the seabed, at a depth of 8 m. To prevent vertical displacement under energetic conditions, the instruments were mounted on a post embedded in the seabed. Acoustic backscatter data recorded by the ADCP were calibrated to provide suspended sediment concentration (SSC) values. During the observation period, six storms generated by cold front passages were recorded, resulting in increased along-shelf current intensity, wave height, and SSC. The baseline SSC in the water column averaged ~50 mg/L, increasing to >200 mg/L during storms. In one of the storms, the formation of fluid mud was observed, with concentrations >10 g/L. Residual alongshore currents were barotropic and strongly dominated eastward, resulting in corresponding sediment transport. Cross-shore currents displayed a predominant vertical reversal pattern, but were not related to wind.

Spatial and temporal variability of suspended particulate matter on Brazil's Southern inner shelf

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This study examines the variability of suspended particulate matter (SPM) on the inner continental shelf between Rio Grande (Brazil) and Cabo Polônio (Uruguay) over an 11-year period (2012–2022). In this region, the Patos Lagoon and the Río de la Plata are significant sources of SPM, discharging 2,400 m^3/s and 23,000 m^3/s, respectively. Satellite imagery from the MODIS sensor (250 m resolution) was analyzed using Python. A total of 259 cloud-free images were selected, representing 6% of the days in the 11-year span. Monthly averages were created, and images were processed into grayscale with pixel inversion and noise reduction to enhance visual analysis. The coastline was segmented into 96 quadrilaterals arranged in four columns parallel to the shore. Results show that turbidity is consistently highest near the coast, with peak values in summer and the lowest in winter. Offshore columns displayed different seasonal patterns. Seasonal wind variations influence sediment transport, showing that summer brings calmer winds, while winter features stronger N-NE winds that promote offshore movement of sediments. Two cold front events with satellite data were analyzed, the first in April 2017 showed widespread sediment distribution under N-NE winds, while the second, in August 2019, showed coastal sediment accumulation under S-SW winds. Field data from an oceanographic cruise in 2024 confirmed that turbidity is higher near the seafloor, but coastal shallow waters maintain high turbidity throughout the water column. Despite limitations, the satellite-based method effectively captured long-term SPM dynamics.