

Nicolás Bodnariuk

Currículum Vitae

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Keywords

Physical oceanography, climate science, dynamical system theory, ocean modelling, non-linear interactions in the coupled ocean-atmosphere system, topological data analysis

Expertise

I am a physical oceanographer with a strong interest in geophysical fluid dynamics and the application of mathematical methods to the study of the climate system. My current research focuses on the dynamics of the double-gyre circulation from the perspective of dynamical systems theory. I leverage concepts from algebraic topology to analyze the structure of the system's attractors, aiming to gain insights into the underlying mechanisms that drive large-scale ocean circulation patterns. As part of this work, I have developed my own numerical model of the double-gyre system, which I wrote in the Julia Programming Language, to explore its nonlinear dynamics under controlled conditions.

In parallel, I have worked extensively with oceanic and atmospheric reanalysis datasets to investigate the influence of large-scale climate organization on regional dynamics, particularly over the South Atlantic Western Continental Shelf. I apply statistical tools such as Empirical Orthogonal Functions (EOF), Multichannel Singular Spectrum Analysis (MSSA), and related techniques to identify dominant modes of variability and their spatiotemporal evolution. This work has included the analysis of interannual variability in ocean circulation and its relationship to broader climate patterns, using reanalysis data to bridge scales and uncover robust connections between global drivers and regional responses.

Beyond numerical and theoretical work, I have been actively involved in field campaigns. My last campaign focused on the deployment of surface drifters for Lagrangian experiments to characterize transport processes and mesoscale dynamics in shelf and open ocean regions. Additionally, I participated in sediment sampling efforts in the Río de la Plata estuary aimed at validating satellite observations of sediment content in the water. I also work extensively with satellite imagery, such as sea surface temperature and chlorophyll-a products, and apply techniques from dynamical systems theory, including Lagrangian Coherent Structures (LCS) analysis, to identify organized flow patterns and coherent transport features in the ocean.

Professional references

- Sabrina Speich: sabrina.speich@lmd.ens.fr
- Michael Ghil: michael.ghil@lmd.ens.fr
- Denisse Sciamarella: denisse.sciamarella@cnrs.fr
- Claudia Gloria Simionato: simionato@cima.fcen.uba.ar
- Saraceno Martín: saraceno@cima.fcen.uba.ar
- Alberto Ricardo Piola: apiola@hidro.gov.ar or piolaar@gmail.com

Education

- 2022** **Ph.D. in Atmospheric and Oceanic Sciences**, University of Buenos Aires, Argentina.
- 2015** **Master's Degree in Physical Oceanography**, Universidad Nacional del Sur, Argentina.

Postdoctoral Experience

Since March 2024, I have been working as a postdoctoral researcher at the Laboratoire de Météorologie Dynamique (LMD, CNRS) in France, within the framework of the ANR project *Méthodes Topologiques pour la dynamique de la Planète* (TeMPlex, ANR-23-CE56-0002). My work focuses on applying topological methods to the study of large-scale ocean dynamics, with particular emphasis on the wind-driven double-gyre system. As part of this effort, I developed an idealized Quasi-Geostrophic model in the Julia programming language to investigate key dynamical features of the system. I also supervise Master's students and contribute to the book *Mathematics for the Environment* (by Ghil, Haraux, Roux, and Bodnariuk), collaborating on both conceptual content and the development of theoretical, numerical, and applied exercises. Additionally, I took part in organizing the first TeMPlex workshop (September 2024) and conducted a collaborative research mission in Argentina during January and February 2024. I regularly review scientific manuscripts for leading journals in oceanography and climate sciences, and I actively participate in science communication initiatives such as the *Fête de la Science* at École Normale Supérieure (ENS).

Prior to this, I held a postdoctoral position at the Argentine National Council for Scientific and Technical Research (CONICET) from August 2022 to March 2024. During this period, I analyzed oceanic and atmospheric reanalysis products to investigate interannual variability in the southwestern Atlantic region. In parallel, I employed dynamical systems approaches to study the organization of oceanic flows and contributed to the planning of Lagrangian observational campaigns in the Malvinas Current region.

Scholarships

- 2022–2024** Postdoctoral Scholarship, Argentine National Council for Scientific Research (CONICET).
- 2016–2022** Doctoral Scholarship, Argentine National Council for Scientific Research (CONICET).
- 2014–2015** Training Scholarship for Advanced Undergraduate Students: Introduction to Research, Universidad Nacional del Sur, Argentina.

Appointments

- 2023** **Permanent Researcher Position at CONICET, Argentina**
Selected through the 2022 national competitive call and ranked within the merit list in September 2023. **Due to funding cuts associated with national policy changes, the position could not be formally assigned.**
- 2022** **Instructor (theory and practice)**, Universidad Nacional del Sur, Argentina.
Course: Physics of the Atmosphere.
- 2021–2024** **Graduate Teaching Assistant**, Universidad de Buenos Aires, Argentina.
Courses: Theoretical Oceanography, Fluid Mechanics.
- 2013–2016** **Undergraduate Teaching Assistant**, Universidad Nacional del Sur, Argentina.
Courses: Physical Oceanography, Continuum Mechanics, Physics of the Earth System, Classical Mechanics.

Honors and awards

- 2016** **Government of the Province of Buenos Aires Award.**
Awarding Institution: Government of the Province of Buenos Aires.
Reason: Highest overall average graduate of 2015 (Universidad Nacional del Sur).
- 2016** **Honorable Deliberative Council of the City of Bahía Blanca Award.**
Awarding Institution: Honorable Deliberative Council of the City of Bahía Blanca.
Reason: Academic excellence in the Master's degree in Oceanography (Universidad Nacional del Sur, 2015).

Peer reviewed publications

1. Torres Alberto, M.L., **Bodnariuk, N.**, Saraceno, M. and Acha, M.A., 2025. Subantarctic front variability: a potential driver of Patagonian scallop (*Zygochlamys patagonica*) recruitment fluctuations. *Marine Ecology Progress Series*, 762, pp.51–63. <https://doi.org/10.3354/meps14856>
2. Alonso, G., Simionato, C., Dinápoli, M., Saurral, R. and **Bodnariuk, N.**, 2024. Positive storm surges in the Río de la Plata Estuary: forcings, long-term variability, trends and linkage with Southwestern Atlantic Continental Shelf dynamics. *Natural Hazards*, 120, pp.5007–5032. <https://doi.org/10.1007/s11069-024-06402-w>
3. Dinápoli, M.G., Simionato, C.G., Alonso, G., **Bodnariuk, N.** and Saurral, R., 2024. Negative storm surges in the Río de la Plata Estuary: mechanisms, variability, trends and linkage with the Continental Shelf dynamics. *Estuarine, Coastal and Shelf Science*, 305, 108844. <https://doi.org/10.1016/j.ecss.2024.108844>
4. Saraceno, M., **Bodnariuk, N.**, Ruiz-Etcheverry, L.A., Berta, M., Simionato, C.G., Beron-Vera, F.J. and Olascoaga, M.J., 2024. Lagrangian characterization of the southwestern Atlantic from a dense surface drifter deployment. *Deep Sea Research Part I*, 208, 104319. <https://doi.org/10.1016/j.dsr.2024.104319>
5. **Bodnariuk, N.**, Saraceno, M., Ruiz-Etcheverry, L.A., Simionato, C., Andrade-Canto, F., Beron-Vera, F.J. and Olascoaga, M.J., 2024. Multiple Lagrangian jet-core structures in the Malvinas Current. *Journal of Geophysical Research: Oceans*, 129, e2023JC020446. <https://doi.org/10.1029/2023JC020446>
6. **Bodnariuk, N.**, Simionato, C.G. and Saraceno, M., 2022. Water exchanges between the Northern Argentinean Shelf and the open ocean on interannual timescales: remote influences. *Journal of Geophysical Research: Oceans*, 127, e2022JC018517. <https://doi.org/10.1029/2022JC018517>
7. **Bodnariuk, N.**, Simionato, C.G., Saraceno, M., Osman, M. and Diaz, L.B., 2021. Interannual variability of the latitude of separation of the Brazil Current: Teleconnections and oceanic Rossby waves propagation. *Journal of Geophysical Research: Oceans*, 126, e2021JC017557. <https://doi.org/10.1029/2021JC017557>
8. **Bodnariuk, N.**, Simionato, C.G., Osman, M. and Saraceno, M., 2021. The Río de la Plata plume dynamics over the Southwestern Atlantic Continental Shelf and its link with the large scale atmospheric variability on interannual timescales. *Continental Shelf Research*, 212, 104296. <https://doi.org/10.1016/j.csr.2020.104296>
9. **Bodnariuk, N.**, Simionato, C.G. and Saraceno, M., 2021. SAM-driven variability of the southwestern Atlantic shelf sea circulation. *Continental Shelf Research*, 212, 104313. <https://doi.org/10.1016/j.csr.2020.104313>
10. Torres Alberto, M.L., **Bodnariuk, N.**, Ivanovic, M., Saraceno, M. and Acha, E.M., 2021. Dynamics of the confluence of Malvinas and Brazil currents, and a southern Patagonian spawning ground, explain recruitment fluctuations of the main stock of *Illex argentinus*. *Fisheries Oceanography*, 30, pp.127–141. <https://doi.org/10.1111/fog.12507>

11. Beron-Vera, F.J., **Bodnariuk, N.**, Saraceno, M., Olascoaga, M.J. and Simionato, C., 2020. Stability of the Malvinas Current. *Chaos*, 30(1), 013152. <https://doi.org/10.1063/1.5129441>

Forecoming publications

12. Bonel, J. C., **Bodnariuk, N.**, Charo, G. D., Letellier, C., Saraceno, M. and Sciamarella, D., 2025: Templex for Lagrangian dynamics in the Southwestern Atlantic. *Chaos: An Interdisciplinary Journal of Nonlinear Science*. Submitted 30 December 2024 (in review process with minor modifications).
13. **Bodnariuk, N.**, Charo, G. D., Sciamarella D., Ghil M., 2025: Building a Templex up from joining loci of chaotic attractors (near completion; to submit to *Chaos: An Interdisciplinary Journal of Nonlinear Science*).
14. **Bodnariuk, N.**, Simonnet, E., Speich, S., Sciamarella D., Ghil M., 2025: From Order to Chaos: A Topological Approach to Ocean Gyre Dynamics (near completion; to submit to *Journal of Advances in Modeling Earth Systems (JAMES)*).

Contribution to book chapters

1. Piola, A.R., **Bodnariuk, N.**, Combes, V., Franco, B.C., Matano, R.P., Palma, E.D., Romero, S.I., Saraceno, M. y Urricariet, M., 2024. Anatomy and dynamics of the Patagonia shelf-break front. In: Acha, E.M., Iribarne, O.O. and Piola, A.R., eds. *The Patagonian Shelfbreak Front. Ecology, Fisheries, Wildlife Conservation*. Aquatic Ecology Series, vol. 13. Cham: Springer, pp.11–47. https://doi.org/10.1007/978-3-031-71190-9_2

Forecoming books

1. Ghil, M., Haraux, A., Roux, J. and **Bodnariuk, N.**, 2025: Mathematics for the environment (the book is near completion; Springer-Nature series in Applied Mathematical Sciences).

Conferences and Scientific Meetings (last years)

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| 2025 | EGU General Assembly , Vienna. Oral presentation, evaluator at PICO sessions, and co-convener of the course “Chaos Topology and the Climate Sciences.” |
| 2025 | The Mathematics of Climate Tipping Points and Their Impacts , Edinburgh. Poster presentation. |
| 2023 | OSTST Meeting , San Juan de Puerto Rico. Oral and poster presentations. |
| 2022 | XI National Meeting on Marine Sciences / XIX Oceanography Colloquium , Comodoro Rivadavia, Argentina. Oral presentations (awarded) |
| 2022 | XIII ICSHMO , New Zealand. Oral presentation |

Participation in University Committees

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| 2014–2015 | Member of the Curriculum Commission for the Oceanography Program, Universidad Nacional del Sur (UNS), Bahía Blanca, Argentina. |
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Teaching activities and science communication

I have gained valuable experience in science communication through participation in various public outreach events, including Earth Sciences Week, Science Club, Plaza Ciencia, Data Science Week, Tecnópolis at University of Buenos Aires (Argentina) and at Fête de la Science (ENS, France). These activities involved presenting scientific topics to diverse audiences to promote awareness and interest in atmospheric and oceanographic sciences. Additionally, I have contributed to mentoring high-school students in introductory scientific activities in Argentina. Complementing this outreach work, I have accumulated extensive teaching experience at both undergraduate and graduate levels. Over several years, I have supported and led courses covering core topics in physical oceanography, fluid mechanics, atmospheric physics, and related fields, working as a teaching assistant and instructor at major universities in Argentina.

Participation in Research Projects

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| 2021–2024 | SABIO – Studies of Physical Processes in the Southwest Atlantic to Understand Biological Productivity and the Regional Ecosystem
Institution: CNES–EUMETSAT
Director: Martín Saraceno |
| 2020–2023 | Development of an Operational Forecasting System for Sea Level and Currents on the Argentine Continental Shelf with Assimilation of Altimetric and Tidal Data
Institution: University of Buenos Aires
Director: Claudia G. Simionato |
| 2017–2022 | Toward Operational Modeling of the Northern Argentine Continental Shelf
Institution: University of Buenos Aires
Director: Claudia G. Simionato |
| 2017–2022 | High-Impact Meteorological and Climatic Events
Institution: Implementing Unit
Director: Claudia G. Simionato |
| 2017–2020 | On the Permeability of the Malvinas Current
Institution: Office of Naval Research (ONR)
Director: Martín Saraceno |
| 2017–2019 | Foundations for the Operational Modeling of the Argentine Continental Shelf
Institution: University of Buenos Aires (UBACyT)
Director: Claudia G. Simionato |
| 2017–2018 | Operational Modeling of the Río de la Plata and its Maritime Front for the Study of Processes, Monitoring, and Forecasting (PICT)
Institution: National Agency for Scientific and Technological Research (ANPCyT)
Director: Claudia G. Simionato |
| 2014 | Dynamics of Fronts and Continental Discharges on the Southwest Atlantic Shelf
Institution: Universidad Nacional del Sur (Bahía Blanca)
Director: Elbio Daniel Palma |

Other professional activities

Journal reviewer: *Chaos: An Interdisciplinary Journal of Nonlinear Science*, *Ocean Dynamics*, *Geophysical Research Letters*, *Scientific Reports*, *Journal of Geophysical Research: Atmospheres*, *Journal of Geophysical Research: Oceans*.

Organization of International Workshops and Conferences: First Meeting o ANR Templex (<https://anr-templex.cnrs.fr/>)

Evaluations in conference committees: Evaluator for a PICO session at the European Geosciences Union (EGU) General Assembly.

———— Courses Completed During Doctoral and Postdoctoral Studies

University of Buenos Aires, Argentina

- Circulation and Water Masses of the Southwestern Atlantic and its Ecological Impact
- Statistical Methods in Atmospheric Sciences
- Seminars in Oceanography
- Satellite Remote Sensing and Oceanographic Applications
- Acquisition and Processing of Oceanographic Data
- Climate Models: Past, Present and Future
- Interdisciplinary School of Transport in Geofluids: From Oceanic Eddies to Black Holes
- Introduction to Programming in Python
- Machine Learning for Space Weather

Universidad de Concepción, Chile

- Basic Modeling Course with CROCO
- Advanced Modeling Course with CROCO

University of Edinburgh, UK

- Introduction to the Mathematics of Climate Tipping Points and their Impacts

———— Languages

Spanish (native), English (advanced C2), French (advanced B2), German (intermediate B1).