

Research project offer - Proposition de stage 2027

Location : OMP-LEGOS, Toulouse, France

Department :

Research group : LITTORAL Team

Supervisors : Rafael Almar[1], Julien Boucharel[1], Nicolas Robin[2], Marius Aparicio[2]

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OFFER DESCRIPTION

Title : Climate variability and shoreline predictability along the Northwestern Mediterranean coast

Keywords : Shoreline evolution · Climate variability · Reduced-complexity modelling · Coastal morphodynamics

Proposed duration and period : 5-6 months internship, Mar to Sept, 2027

Context

Understanding and predicting shoreline evolution under changing climatic conditions remains a major challenge in coastal morphodynamics. While shoreline responses to individual storms are relatively well documented, the mechanisms linking large-scale climate variability to coastal morphological changes at seasonal to interannual timescales remain poorly understood.

The Northwestern Mediterranean Sea offers an environment to investigate these processes. Along the Gulf of Lion coast, shoreline evolution is influenced by variable wave conditions, episodic storms and complex sediment transport processes. These regional forcing conditions may themselves be modulated by large-scale climate modes, including the North Atlantic Oscillation (NAO), Scandinavian Pattern (SCAND), the Western Mediterranean Oscillation (WeMO) and the El Niño–Southern Oscillation (ENSO), through atmospheric teleconnections (Cañellas et al., 2010; Ineson & Scaife, 2009; *Shaman & Tziperman, 2011*).

This internship aims to investigate how climate variability influences regional shoreline evolution and whether such information can improve coastal morphological predictions. The study will combine satellite-derived shoreline observations (among others) and dynamical system theory tools such as convergent cross-mapping (Sugihara, 2012), and the use of the reduced-complexity model XRO (Zao et al., 2024 ; Boucharel et al., 2026) to better understand coastal evolution.

REQUIRED APPLICANT PROFILE AND SKILLS

Study Level

Master students (2nd year - University or Engineering School) in Physics or Climate Science

Objectives and work	The main objective of this internship is to investigate the mechanisms linking large-scale climate variability and shoreline evolution along the Gulf of. The work will first consist in characterizing shoreline variability using satellite-derived observations and time-series analysis techniques to identify dominant spatial and temporal patterns and links, from storm-driven changes to seasonal and interannual fluctuations. The student will then implement and evaluate the XRO shoreline prediction model at selected coastal sites. Hindcast experiments will assess its ability to reproduce observed shoreline evolution and determine whether incorporating climate-related information can improve predictive skill at seasonal to interannual timescales. The internship will combine time-series analysis, statistical methods, climate diagnostics and reduced-order modelling to better understand how large-scale climate variability is transmitted to coastal morphological dynamics.
Required profile and skills	A background in physical oceanography, climate science, or environmental physics is required. Experience in scientific programming (Python or MATLAB) and time-series analysis is desirable. An interest in dynamical system theory will be appreciated.
Possibility to continue with a PhD (Yes/No)	Possibly
Candidature	Required documents: Resume & cover letter Application deadline: November 25, 2026 Send to: Rafael.almar@ird.fr, marius.aparicio@univ-perp.fr
References	**Cañellas, B., Orfila, A., Méndez, F. J., Álvarez, A., & Tintoré, J. (2010).** Influence of the NAO on the northwestern Mediterranean wave climate. *Scientia Marina, 74*(1), 55–64. https://doi.org/10.3989/scimar.2010.74n1055 **Ineson, S., & Scaife, A. A. (2009).** The role of the stratosphere in the European climate response to El Niño. *Nature Geoscience, 2*, 32–36. https://doi.org/10.1038/ngeo381 **Shaman, J., & Tziperman, E. (2011).** An atmospheric teleconnection linking ENSO and southwestern European precipitation. *Journal of Climate, 24*(1), 124–139. https://doi.org/10.1175/2010JCLI3590.1 **Sugihara, G., May, R., Ye, H., Hsieh, C.-H., Deyle, E., Fogarty, M., & Munch, S. (2012).** Detecting causality in complex ecosystems. *Science, 338*(6106), 496–500. https://doi.org/10.1126/science.1227079 **Zhao, S., Jin, F.-F., Stuecker, M. F., Thompson, P. R., Kug, J.-S., McPhaden, M. J., Cane, M. A., Wittenberg, A. T., & Cai, W. (2024).** Explainable El Niño predictability from climate mode interactions. *Nature, 630*, 891–898. https://doi.org/10 **Boucharel, J., Almar, R., Jin, F.-F., Zhao, S., Stuecker, M. F., & Dewitte, B. (2026).** Climate mode interactions amplify coastal flood risks and their seasonal predictability. *Nature Geoscience, 19*, 317–324. https://doi.org/10.1038/s41561-025-01903-0