ENS DE LYON

ISblue
The interdisciplinary graduate school for the blue planet

Ifremer

IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

M2 INTERNSHIP PROPOSAL

ANISOTROPIC MULTI-SCALE CHARACTERIZATION OF CONVECTIVE ROLLS IN THE MARINE ATMOSPHERE BOUNDARY LAYER FROM OCEAN SAR IMAGES

Keywords: Image Processing, Ocean Surface Dynamics, Satellite Imagery, Multi-scale Analysis.

Context

Marine atmosphere boundary layer (MABL) studies are needed to advance understanding in the turbulent fluxes of heat, momentum and water vapor that govern air-sea interactions. A frequently observed feature of this turbulent MABL is roll vortices that leads to an extra-contribution to air-sea exchanges [1]. However, this extra-contribution is still not fully resolved in models, and then leads to uncertainties in climate dynamics. Thus, new detailed characterizations of roll vortices are needed to apprehend their role in the MABL structure.

In the last years, satellite Synthetic-Aperture Radar (SAR) imagery is becoming central in the characterization of fine scale ocean surface dynamics, since it provides high-resolution data during both day and night and independently of the weather conditions [2]. Thus, SAR allows the study of roll vortices, which are frequently observed as wind streaks over water due to enhanced and reduced surface wind convergence [2]. In this project, we will focus on the current Sentinel-1 mission that provides more than 120.000 small images (20 Km) of the open ocean per month at a 4m resolution and with a distance of 100 Km among images. So, it could provide enough data to characterize the global spatial and temporal variations of roll vortices.

Finally, today the multiscale complex nature of the roll vortices imprints on SAR images is well accepted by the scientific community [1]. So, in order to better describe ocean dynamics from remote sensing data, new techniques able to perform a non-linear multiscale analysis of the satellite acquisitions are needed. In this project, we propose the development of a new methodology based on the combination of wavelet decomposition [3] and the analysis of scale-invariance and long-range dependences [4]. We focus on its application to characterize the multi-scale properties of wind streaks observed from SAR images of Sentinel-1.

Objectives

The main objective of this internship is the development of a multi-scale methodology able to characterize convective rolls in the MABL from SAR imagery. First, the student will familiarize with the physics of the marine atmosphere boundary layer [1] as well as with the existing Sentinel-1 SAR database from [5]. Second, the student will familiarize with existing methodologies of multi-scale analysis [2,6,7,8] and finally, the student will perform a multi-scale characterization of convective rolls from SAR images.

Candidates

Candidates are required to be in Bac+5 level education in the field of either applied mathematics, signal and image processing, oceanography or physics. Good knowledge of fluid physics and turbulence theory, with a special focus on ocean and atmosphere, are a plus. Python programming knowledge with previous experiences in programming is required.

Advisors

The internship will be advised by Carlos Granero-Belinchon (IMT Atlantique), Pierre Tandeo (IMT Atlantique), Alexis Mouche (Ifremer), Stéphane Roux (ENS de Lyon) and Nicolas Garnier (ENS de Lyon). Motivated students should send a CV to: carlos.granero-belinchon@imt-atlantique.fr.

Depending on the sanitary conditions, the internship could take place at IMT Atlantique, or by teleworking. Expected length is 6 months.

References

[1] G.S. Young, SAR signatures of the marine atmospheric boundary layer: Implications for numerical forecasting, Johns Hopkins APL Technical Digest (Applied Physics Lab), 2000
[2] C. Wang et al. Remote Sensing of Environment, Volume 250, 112031, December 2020
[3] S. G. Roux et al. IEEE Transactions on Image Processing 22 (11), 4353-4363, 2013
[4] C Granero-Belinchón et al. IEEE Transactions on Signal Processing, 67 (14), 3796-3805, 2019.
[5] C. Wang et al. Geoscience Data Journal, Volume 6, Issue 2, 105-115, November 2019
[6] S. K. Maji et al. IEEE Geoscience and Remote Sensing Letters, 1-5, January 2020
[7] A.M. Tarquis et al. Nonlinear Processes in Geophysics, Volume 21, Issue 2, March 2014
[8] H. Wendt et al. Signal Processing, Volume 89, Issue 6, 1100–1114, June 2009