



Stage de recherche au LACy

Laboratoire de l'Atmosphère et des Cyclones

UMR8105 - Université de La Réunion, 97490 Saint-Denis de La Réunion

Titre du stage :

Numerical study of processes constraining tropical cyclone intensification: the case of Belal (2024)

Nom et statut du(des) responsable(s) de stage :

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Description du stage :

Contexte :

Tropical cyclones (TCs) are among the most destructive natural hazards, not only because of their extreme winds but also due to the storm surges, ocean waves, and heavy rainfall they generate. While forecasts of TC tracks have significantly improved over the past two decades, forecasts of TC intensity remain more uncertain. Accurately predicting intensity is crucial for anticipating impacts, yet the physical processes driving intensification are complex and not fully represented in models. Improving TC intensity forecasts therefore requires a better understanding and representation of mechanisms that can inhibit intensification.

A recent and illustrative case is the TC Belal (2024), which passed near Réunion Island and brought torrential rains. Forecasts from both AROME (french weather service operational model) and IFS(European Center for Medium-Range Weather Forecasts) models suggested a favorable environment for Belal's intensification, at least up to 36 hours before its expected peak. Based on these predictions, forecasters issued the maximum level of TC alert for Réunion. However, while Belal did impact the island, it was much weaker than predicted. This raises a the following question: why did Belal fail to intensify as forecasted?

Objectifs :

The main objective of this internship is to identify and analyze the physical processes that prevented TC Belal from intensifying as forecasted. Several features in Belal's environment and temporal evolution appear to be strong candidates for explaining this unexpected outcome, including: (i) the sudden development of a strong peripheral rainband to the south, aligned with Belal's trajectory, which may have disrupted its internal structure and slowed its forward motion or (ii) a possible dry-air intrusion from the western basin, which could also have played a significant role.

Méthodologie/Outils :

To achieve these objectives, the student will analyze advanced numerical simulations conducted with the MesoNH model at different resolutions. The work will proceed in two main stages. First, the evaluation of simulations by characterizing the initial environment and the TC structure simulated by the model and comparing the simulations with all available observational data to assess realism. Second, the test of the existing hypothesis which means investigate specific mechanisms (e.g., rainband development, dry-air intrusion) that may explain Belal's lack of intensification.

Attendus :

The analysis will require the student to develop dedicated processing scripts, with an emphasis on Python programming and a good ability to work in a Linux environment. In addition to a strong motivation for studying tropical cyclones, the internship calls for an evident interest in tropical meteorology and numerical modeling. The student will collaborate closely with Météo-France tropical cyclone forecasters, ensuring that operational insights are integrated into the scientific investigation. This project require both autonomy and the ability to work effectively within a team. Throughout the internship, the student will acquire valuable expertise in numerical simulation methods, tropical meteorology, cyclone dynamics, and advanced Python-based atmospheric data analysis.