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 :

Air-sea interface thermodynamic and their role in tropical cyclone intensity change using data from an intensive field campaign and high-resolution numerical modelling.

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

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Description du stage :

Contexte :

Due to their immense power, wide range of scales, and significant feedback with the environment, tropical cyclones are among the most destructive and complex meteorological phenomena on Earth. At the tropical cyclone level, the ocean-wave-atmosphere system is intrinsically coupled. The intensity of a mature tropical cyclone is, among other things, modulated by its interactions with the ocean mixed layer and by the heat content, which serve as its primary source of thermodynamic energy. Whereas warm oceanic mixing layers provide favorable conditions for the tropical cyclone intensification, the strong cyclonic winds induce cold and salty wakes. Identifying the processes driving exchanges between the ocean and atmosphere through surface fluxes of latent heat, sensible heat, and momentum is thus essential to understand the entire lifecycle of tropical cyclones. The bulk flux transfer of thermodynamical energy between the ocean and the atmosphere is therefore a crucial subject in atmospheric modelling, and the use of coupled ocean-wave-atmosphere models is necessary to better handle these interactions. However, there are many disparities between the parameterizations used to represent these exchanges. Up to date, the performance of relevant parameterizations has been poorly validated, especially in cyclonic conditions (*e.g.*, wind speed above 33 m s^{-1}), mainly due to the difficulty in obtaining data.

Recently, a new air-sea surface turbulent exchange parameterization, based on the study of 84 intense tropical cyclones, has been developed and implemented in the latest version of the community atmospheric model Meso-NH in the framework of the BASIC project. In the meantime, in the framework of the T-PARCII project (Japanese government project), an airborne campaign has been carried out targeting intense tropical cyclones developed in the northwest Pacific Ocean which are one of the most active basins of tropical cyclones in the world. The T-PARCII campaign targets intense tropical cyclones (category 4–5 on the Saffir-Simpson scale) to observe their dynamic and thermodynamic structure using a dense airborne dropsonde network across the tropical cyclone eye. These data present high temporal and spatial resolutions, which are essential to improve (i) our understanding of local to mesoscale

thermodynamical processes and their role in controlling the intensity changes of tropical cyclones and (ii) the relevant parameterizations in numerical models.

Objectifs :

Among the sampled cyclones during the T-PARCII airborne campaign, a mature intense tropical cyclone (category 4), Trami (2018), was observed using 60 drop soundings in the eyewall and rainbands. Trami translated slowly over the ocean, and it experienced a rapid intensification after redirecting from northwest to north. In this internship, the student will study the intensification mechanism of Trami with a special focus on the air-sea interface processes.

Méthodologie/Outils :

For the analysis, she/he will have the opportunity to develop an ingenious way to compare unique measurement data collected from various platforms (*e.g.,* airborne, dropsondes, spaceborne, ground-based, sea surface-based) and advanced mesoscale ocean-atmosphere coupled model output. A particular focus will be put on the thermodynamical variables (latent and sensible heat fluxes), and their spatial and temporal evolution in the air-sea interface layer of the eyewall. This work will allow us to evaluate the performances of numerical modelling with the new air-sea surface turbulent flux exchange parameterization for representing the lifecycle of intense tropical cyclone, and to improve our understanding of the local to mesoscale processes occurring in the air-sea interface before and during the intensity change, as well as their feedback to the entire tropical cyclone system.

Attendus :

Analysis of numerical simulations (which will be carried out beforehand) and measurement data will be carried out using programming scripts developed by the student, requiring a good command of the Python language. Through this internship, the student will develop skills in numerical simulation methods, air-sea surface exchange parameterizations, and how to handle and compare large sets of numerical and observational data. The student will have the opportunity to work with the T-PARCII team (Japan).