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 processes and its 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 :

Tropical cyclones are among the most destructive and complex meteorological phenomena on Earth due to their immense power, wide range of scales and significant feedback with the environment. At 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 serves as its primary source of thermodynamic energy. Whereas warm oceanic mixing layer provide favourable conditions for the tropical cyclone intensification, they induce cold and salty wakes. The cyclone-induced cooling highly depends on the translation speed of the cyclone system, wind power input, and the subsurface conditions dictated by the ocean eddies and mixed layer. Understanding the processes driving exchanges between the ocean and atmosphere through surface fluxes of latent heat, sensible heat, and momentum is essential. The bulk flux transfer of thermodynamical energy between the ocean and the atmosphere is thus 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.

Objectifs :

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 community atmospheric model Meso-NH in the framework of BASIC project. In the meantime, in the framework of T-PARCII project (Japanese government project), airborne campaign has been carried out targeting intense tropical cyclones developed in the northwest Pacific Ocean where of the most active basins of tropical cyclone 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 is 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 model. Among the sampled cyclone during T-PARCII airborne campaign,

a mature intense tropical cyclone (category 4), Trami (2018), was observed using a few dozens of drop soundings in 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 surface turbulent flux exchange.

Méthodologie/Outils :

For the analysis, she/he will have an opportunity to develop ingenious way to compare a unique measurement data collected from various platforms (*e.g.,* airborne, dropsondes, space-borne, ground-based, and sea surface-based) and advanced mesoscale ocean-atmosphere coupled model output. A particular focus will put on the intensity factor and thermodynamical variables, and their spatial and temporal evolution in the marine-atmospheric boundary layer of the eyewall. 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.

Attendus :

This work will allow us not only (i) to evaluate the performances of numerical modelling with the new and already-existing air-sea surface turbulent exchange parameterizations for representing the tropical cyclone intensification using unique measurement dataset, but also (ii) to improve our understanding about the local to mesoscale processes occurring in the air-sea interface before and during the intensity change as well as their feedback to entire tropical cyclone system.