,

STAGE DE RECHERCHE de MASTER 2ème ANNEE

Master SOAC / WAPE

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LABORATOIRE : Laboratoire de l'Atmosphère et des Cyclone (LACy) – UMR8105 (Île de la Réunion)

SUJET 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

COORDONNEES DU RESPONSABLE :
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NATURE DU SUJET :

Théorie	Un peu
Modélisation num.	Beaucoup
Expérimentation	Pas du tout
Analyse de données	Beaucoup
Instrumentation	Pas du tout

SUJET :

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 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. While a warm oceanic mixing layer provide favourable conditions for the tropical cyclone intensification, they induce cold and salty wakes. Cyclone-induced cooling strongly depends on the cyclone's translation speed, 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 (*i.e.*, 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 Meso-NH community atmospheric model in the framework of BASIC project. Simultaneously, the T-PARCII project, a Japanese government initiative, has conducted an airborne campaign targeting intense tropical cyclones in the northwest Pacific, one of the world's most active cyclone basins. 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 offer high temporal and spatial resolutions which is essential to (i) improve our understanding of local to mesoscale thermodynamical processes and their role in controlling the intensity changes of tropical cyclones and (ii) select the relevant parameterizations in numerical model. Among the sampled cyclones during T-PARCII

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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 experienced a rapid intensification after redirecting from northwest to north.

In this internship, the student will investigate Trami's intensification mechanisms, focusing on air-sea surface turbulent flux exchanges. For the analysis, she/he will have an opportunity to develop innovative methods 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. 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.

REMARQUES :

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.

This 6-month internship will take place in La Réunion, with active collaboration with LAERO (Toulouse) and ISEE (Nagoya University, Japan). The financement of both the salary and the plane ticket is secured.