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Evaluation of a coupling between a 2-moment microphysics scheme and a multi-moment aerosol scheme in Meso-NH for tropical cyclone modelling

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The main issue in front of the cyclone threat is to forecast both the track, the intensity and the main consequences (wind, precipitation, storm surge and swell) associated to a tropical cyclone. The past decade has been marked by a steady decrease of forecast track errors. However, the intensity forecasting remains a major issue in scientific research. The key role of cloud microphysics and aerosols on the structure and the intensity of tropical storms has been recently underlined.

The purpose of this study is to understand the role of aerosols activation as cloud condensation nuclei and ice freezing nuclei on tropical cyclone behavior. A 2-moment microphysics scheme (LIMA ; Vié et al., 2015) was coupled to an aerosol scheme (ORILAM ; Tulet et al., 2005) in the French mesoscale model Meso-NH. It is evaluated on simulations of the tropical cyclone Dumile that passed next to La Réunion (South West Indian Ocean) in January 2013. Three simulations were performed: the first one (S1) with a simple 1-moment microphysics scheme and the two others (S2 and S3) with the 2-moment LIMA scheme. The last two simulations differ from how sea salt aerosols were treated. In S2, these aerosols were only prescribed as initial conditions and at the lateral boundaries, while in S3, they were produced at each time step following the explicit emission scheme of Ovadnevaite et al. (2014).

First, the ability of LIMA to represent the intensity and the precipitation produced by Dumile is evaluated. The simulation results are compared with measurements from the polarimetric microwave radiometer Windsat. Using the 2-moment microphysics scheme LIMA allows a better representation of the cold rain in the outer rainbands when compared to the simple 1-moment scheme, with consequences on the global intensity. The microwave imager MADRAS on board Megha-Tropiques is used to validate the cloud ice parameterization (Phillips et al., 2008, 2013) implemented in LIMA.

The results of simulation S3 show better agreement with observations from both lidar CALIOP on board CALIPSO and microwave imager TMI on board TRMM than the results of simulation S2 where sea salts are not regenerated at each time step. For a better perception of the whole tropospheric column, we also used the original DARDAR-Cloud algorithm (Delanoë and Hogan, 2010) to investigate cold microphysical processes in areas of strong updrafts. Our results show the strong interest in regenerating sea salt aerosols at each time step for tropical cyclone modelling.