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Gravity waves generated by deep tropical convection: estimates from balloon observations and mesoscale simulations

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We study convective gravity waves (CGW) in the Tropics using numerical mesoscale simulations with the Weather Research and Forecast (WRF) Model and in-situ measurements by long-duration stratospheric balloons launched during the PreConcordiasi campaign (February – May 2010).

The first part of this work focuses on Tropical Storm Gelane above the Indian Ocean, over which one of the balloons flew. A specific set up of the WRF simulations that includes the assimilation of satellite radiances is performed so as to simulate the convective cells associated with the storm as close as possible to the observed ones. The characteristics of the waves generated by this storm are obtained in the balloon observations and in the numerical simulations, and compared together as well as to those derived in previous studies. Our results emphasize that high-frequency, short horizontal-wavelength waves carry most of the momentum fluxes above the storm. Some discrepancies between the observations and simulations are found and discussed. They result from a number of factors : specific sampling of the wave field by the balloon flight, limited resolution of the numerical simulation, and issues in the large-scale wind field that is used to initialize the mesoscale simulation.

In the second part of the study, we use all three balloon flights to assess the importance of cyclones as wave sources in the Tropics. It is in particular confirmed that such meteorological situations constitute hotspots of gravity-wave generation in the Tropics, although their global effect remains moderate due to the limited area covered by cyclones in the tropical belt. The intermittency of the gravity wave field is quantified using approaches recently introduced for this purpose (Gini coefficient, Probability Distribution Function). Finally, inspection of the balloon locations at times when significant peaks of gravity-wave momentum fluxes are found suggest that convective sources and orography contribute to events of similar intensities. Waves associated with convection dominate nevertheless in terms of occurrence frequency.