The Role of Gravity Waves in the Formation and Organization of Clouds During TWPICE

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1. Background

- This research project has only just begun, and the poster describes the research direction and a describes a few preliminary results.
- All convective clouds emit gravity waves. While it is certain that convectively generated waves play important parts in determining the climate, their precise roles remain uncertain, and their effects are not generally represented well in climate models.
- A numerical simulation of the gravity waves generated by convection over northern Australia is shown in Fig. 1.

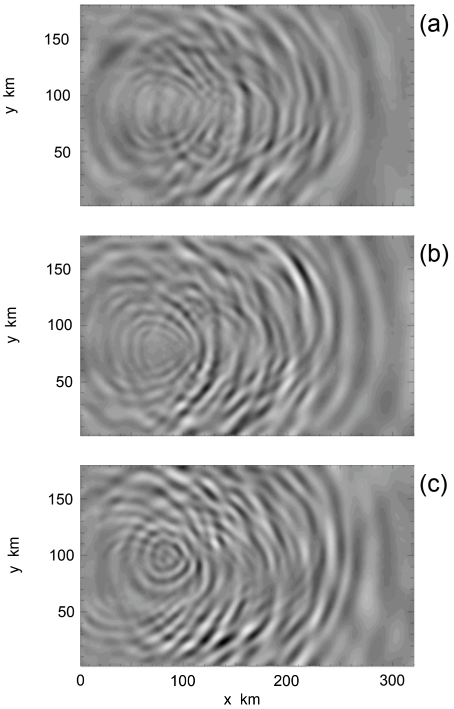

Figure 1. *Horizontal cross section through idealized three-dimensional simulation of convection above the Tiwi Islands off Northern Australia (the islands centred at 131°E, -11.6°S in Fig. 2). The vertical velocity at a height of 40 km is shown at (a) 1230 LST, (b) 1300 LST and (c) 1330 LST. (From Lane et al. (2001) JAS, 58, 1249 - 1274.)*

- These waves transport momentum and energy large distances from the site of their generation, exerting a stress on the atmosphere wherever they dissipate. In this way, convectively generated gravity waves play an influential role in determining the large-scale circulation as they couple the troposphere to the upper atmosphere through the redistribution momentum and energy.
- The project will investigate the part played by convectively generated gravity waves:
  - i. in the formation of cirrus,
  - ii. in the initiation and organization of further convection, and
  - iii. in the subgrid-scale momentum transport and associated large-scale stresses imposed on the troposphere and stratosphere.

2. Formation of Cirrus

- Gravity waves have the potential to lift moist layers in the upper troposphere to produce extensive layers of cirrus (see Fig. 2).
- The vertical velocity and temperature perturbations associated with such waves may lead to supersaturation near the tropopause, which in turn can lead to cirrus nucleation.

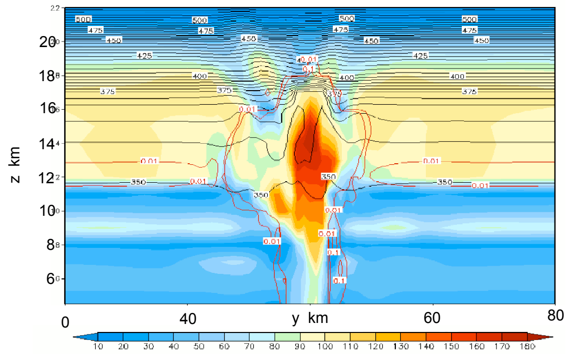

Figure 2. *Relative humidity with respect to ice (colored) from an idealized three-dimensional WRF simulation of a deep convective cloud in a background environment observed during TWP-ICE. Total cloud mixing ratio (cloud water plus all ice types) contoured at 0.01 and 0.1 g/kg (red contours) with potential temperature (black contours). (Acknowledgement: M. Hassim.)*

3. Ensemble Simulations of TWPICE

- The project will use a combination of detailed numerical simulation and analysis of the observations taken during TWP-ICE. As an example, see Fig. 3.
- Output from the simulation will be used to drive an offline detailed microphysics calculation describing the production of cirrus.

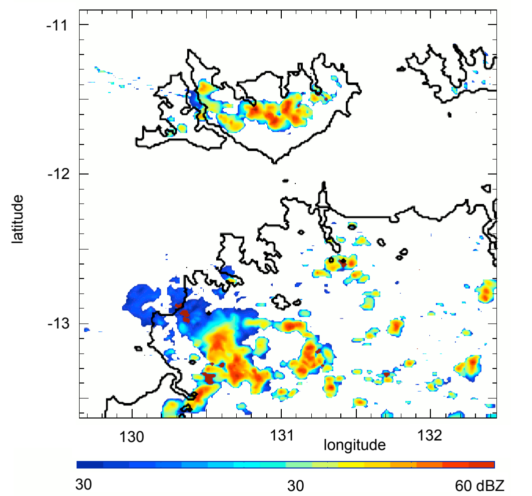

Figure 3. *Simulated column-maximum radar reflectivity from a cloud-resolving WRF simulation during TWP-ICE at 0600 UTC 9 February 2006)*