SIMULATIONS OF HIGH FREQUENCY GRAVITY WAVES DURING TWP-ICE

Michael J. Reeder[1], Mai C. Hankinson[1], Todd P. Lane[2]

[1] Monash University, Australia; [2] The University of Melbourne, Australia
Michael.Reeder@monash.edu

1. Background

High-frequency convectively-generated gravity waves are simulated using WRF and compared against observations taken during Tropical Warm Pool International Cloud Experiment (TWP-ICE). The work presented here focusses particularly on part of the monsoon break period.

2. Model

- **WRF configuration**: 140 vertical levels to 1 hPa, high resolution in the stratosphere, 15-km deep damping layer, 5 nested grids with horizontal resolutions of 33 km, 11 km, 3.7 km, 1.2 km and 400 m (Fig. 1).
- **Initial and boundary conditions**: ERA-Interim. Five separate simulations covering the period from 28 January to 11 February 2006. The work here focuses on Run 2 (Day 31).

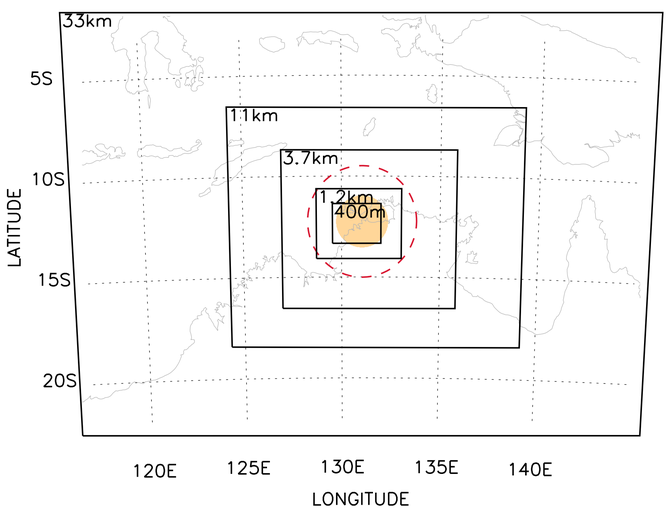

Figure 1: *Computational domains used.*

3. Rain and Wave Activity

- The simulated convection and precipitation from WRF compares reasonably well with the observed rainfall during both the suppressed (Regime 1) and break monsoon (Regime 2) periods (Fig. 2).

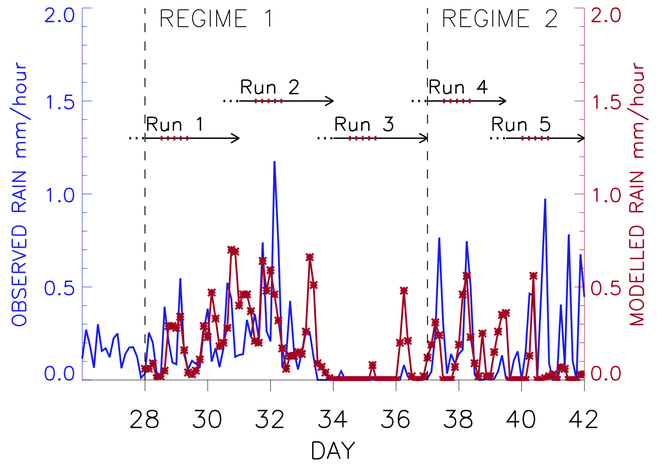

Figure 2: *Simulated and observed precipitation during the suppressed (Regime 1) and break monsoon (Regime 2) periods.*

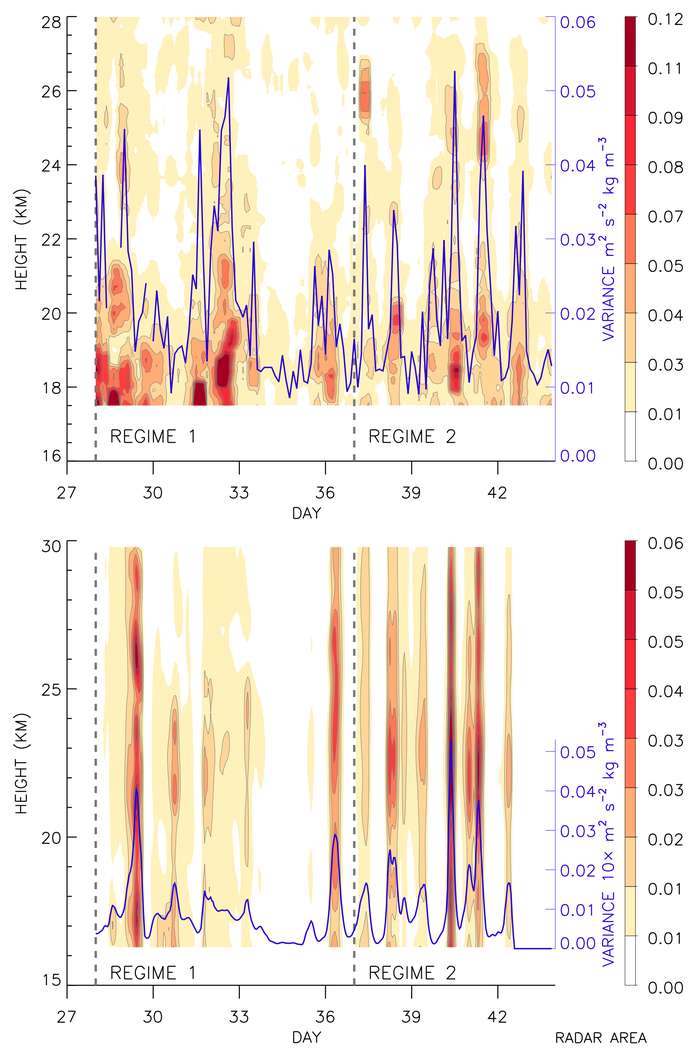

Figure 3: *(a) Observed and (b) simulated wave activity $\overline{\rho w^2}$ as a function height.*

- In the observations, the wave activity is attenuated above about 22 km (Fig. 3a).
- In WRF simulation, the filtering layer is thinner and nearer 19 km altitude, and there is much less attenuation.
- The wave activity simulated by WRF is roughly one order smaller than that observed.

4. Wave Spectra

- During the suppressed monsoon regime, the dominant zonal wavelengths lie in the range 20-40 km, the dominant periods are between 20 minutes and 3 hours, and the dominant intrinsic phase speed is 50 m s^{-1} (Fig. 4a).
- In the meridional direction (Fig. 4b), the waves with largest power have intrinsic phase speed of -16 m s^{-1}, and 1 m s^{-1}.

5. Filtering

- The Scorer parameter is calculated from WRF and the critical wavelength λ^* plotted as a function of phase speed (Fig. 5). According to linear theory, only wavelength longer than λ^* can propagate vertically.
- Although not shown, small differences in the simulated stratospheric winds allow convectively generated waves to propagate vertically in the model (Fig. 2).

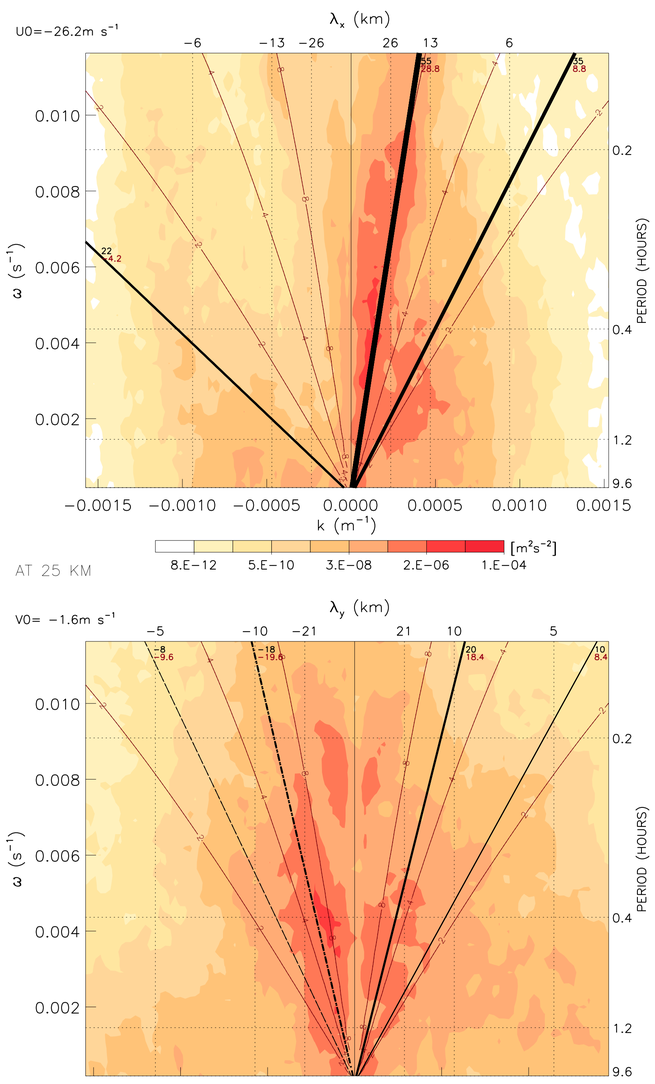

Figure 4: *Power spectra of vertical velocity from the 400 m grid during the suppressed monsoon regime (Run 2). k and l are the zonal and meridional wavenumbers, respectively. ω is ground based frequency. Solid (dashed) lines show positive (negative) intrinsic phase speeds.*

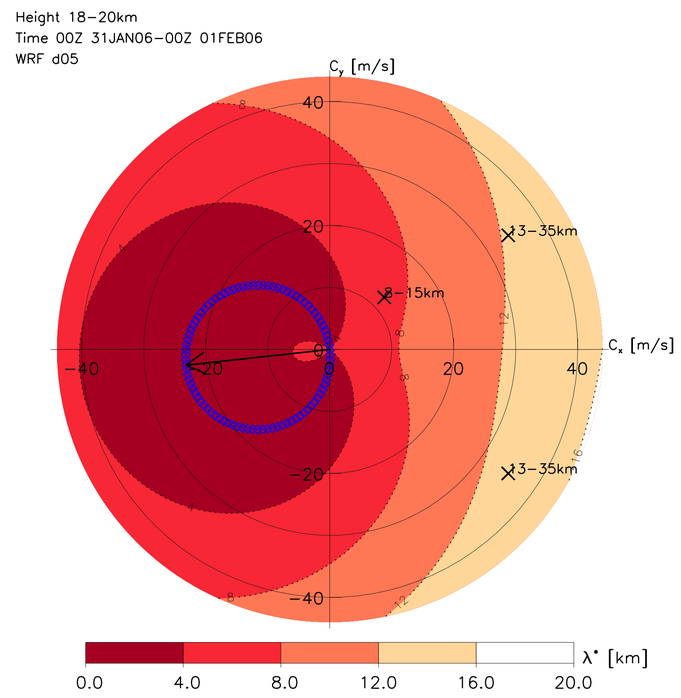

Figure 5: *The critical wavelength λ^* as a function of phase speed from Run 2. c_x and c_y are the zonal and meridional phase speeds. The arrow represents the mean wind in the layer. The blue circle mark possible critical layers. The crosses mark the phase speeds from the model spectra (Fig. 4) and the corresponding range of horizontal wavelengths.*