Mission Scientist Report (by S.D. Eckermann)
IOP12, RF18
Mission Date: 7 July 2014
Takeoff Time: 0512 UTC (1712 NZST)
Landing Time: 1425 UTC (0225 NZST July 8)
Duration: 9.2 hours
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Objective: To study deep forecast nonorographic GWs southeast of Tasmania apparently associated with upstream jet-exit region, and the dynamics of a forecast downstream wake of deep long-horizontal-wavelength gravity waves extending to the southeast of Tasmania and its interaction with vortex-edge lateral shear.

Track design: The flight track is summarized in Fig. 1. The flight began with a long westward ferry past WP2 to the first way point at WP1. We then returned to WP2 along the same leg, then traveled southwest to WP3 then east to WP4 along a track parallel to WP1-WP2 to trace out a “Z” flight pattern designed to sample across phase fronts over a geographical region roughly coincident with the largest forecast stratospheric wave amplitudes at these flight times. We then retraced part of the “Z” from WP4, back to WP3, then back to WP2, then returned to Christchurch along the same direct great-circle route as outbound. The flight level remained at FL400 throughout the flight.

Dropsondes: Dropsondes were used to document the upstream profile of a strong upstream jet associated with frontogenesis well to the west that is at the western extreme of the GV range. We sampled profiles at the respective way points, and found strong differences in tropopause heights with very high tropopauses in the near-jet region to the west and lower tropopauses near 300 hPa to the east. An additional drop between WP2 and WP3 appeared to occur directly within a narrow filament associated with a tropopause fold. With real-time help from Campbell Watson and Sonja Gisinger on the ground to study this, an additional sonde was dropped at the same location on the return leg, as well as another between WP4 and WP3 on the return leg that also attempted to hit the tropopause fold structure further to the south. We dropped a total of 9 sondes at the following times: (1) WP1 0808 Z, (2) WP2 0859Z, (3) halfway between WP2 and WP3
Instrument problems: LAMS did not operate. Lidars had some early alignment problems that were rectified early in the mission. Due to the earlier takeoff time to avoid fog on return, daylight delayed start of some data taking, particularly the north-viewing side camera of the airglow imager which did not operate until ~0630Z when the Sun had fully set.

Results: After a long ferry of about 2 hours to pass WP2 we entered the region of scientific significance (see Fig. 1). Based on forecast guidance, flight levels winds were not expected to show much enhanced gravity-wave structure, with most of the forecast wave activity of interest occurring in the stratospheric range sampled by MTP and the Rayleigh lidar, and possibly extending into the mesosphere to be observed by AMTM, airglow side cameras and the Na lidar. Nonetheless WIC vertical velocity amplitudes enhanced by about a factor of 2 as we entered this science region and remained near these levels throughout the execution of the “Z” flight plan. As discussed in the dropsonde section above, going across from WP1 to WP2 we saw clear evidence of the filament associated with a tropopause fold and dropped and additional sonde midway between WP2 and WP3 which appeared to show the fold structure. AMTM saw good wave banding out of the south-viewing side camera (see Fig. 6) but little to the north, and also noticed that airglow intensities overall were a lot weaker than in previous flights. Na lidar saw 50-60 km wavelength waves along WP3-WP4. The MLT (mesosphere and lower thermosphere) instruments seem to all observe a major change in structure between the outbound and return legs of WP3 to WP4, with retrieved airglow temperatures dropping by nearly 20K on the return leg relative to the outbound and the Na lidars seeing a surge in Na return signal of around 30%. MTP also saw heavily structured temperature profiles near WP4, most noticeably on the return leg. Comparison with the AIRS overpasses suggests the “Z” flight pattern intercepted large-amplitude long-horizontal-wavelength gravity waves, but we will need to wait for the Rayleigh and MTP data to be fully postprocessed to discern whether the onboard instruments observed this structure. Additional drops on the return leg also sought to define to fold structure in a little more detail.
Figure 1: RF18 flight track for the GV (yellow), way points (WP, red), and dropsonde locations (DS, purple). Winds along the flight track are also depicted.
Figure 2: Flight track for RF18 (see Fig. 1) with the gravity-wave-induced brightness temperature perturbations from the AIRS nadir swath imagery taken on 7 July at ~1400Z superimposed, showing excellent intercepts with the “Z” flight strategy.
Figure 3: Planned flight track (see Fig. 1 for actual route) overlayed with the ECMWF IFS analyzed 1 hPa divergences valid at 1200 UTC on 7 July 2014.
Figure 4: +36 hour forecasts of 5 hPa divergence from the COAMPS 15 km forecast runs, valid at 1200 UTC on 7 July 2014.
Figure 5: Skew-T plots from dropsondes D1 (left), DS2 (center) and DS3 (right) – see Fig. 1 for dropsonde locations. Note the larger variations in temperature and tropopause structure across this flight leg associated with a narrow filament that produced a tropopause folding event at or near DS3.

Figure 6: possible wave banding in AMTM left camera at ~0909 UTC.