Mission Scientist Report (by J.D. Doyle)

IOP10, RF16

Mission Date: 4 July 2014

Takeoff Time: 0555 UTC (1755 NZST)

Landing Time: 1300 UTC (0100 NZST July 5)

Duration: approximately 7 hours

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NCAR Staff: Lee Baker, Ed Ringleman, John Munnerlyn, Clayton Arendt

**Objective**: To sample gravity waves over the Mt. Aspiring transect under very strong WSW winds (>30 m/s) and to coordinate the mission with the DLR Falcon, which joined the G-V for part of the mission along the main flight leg.

**Track design**: The flight began with a ferry to way point 1 on the west side of the classic DEEPWAVE track 2a over Mt. Aspiring at FL400. We flew 5 legs back and forth along WP1-WP2, mostly at FL400, although one leg was flown at FL430. The GV dropped 2 curtains of 5 dropsondes each along the Mt. Aspiring leg before the Falcon joined the GV, on the first two legs. The DLR Falcon joined the GV between 0800Z and 1030Z on the WP1-WP2 flight leg, flying below the GV at various altitudes with their Doppler Wind Lidar pointing downward and the GV Lidars upward. After the Falcon exited the pattern, the GV flew at FL430 to WP3 and turned around half way to the way point to keep the mission under 7 hours. After returning to WP2 at FL400, the GV did one more WP2-WP1-WP2 at FL400 and dropped 5 more sondes. A total of 7 cross mountain transects were performed on the Mt. Aspiring 2a flight track. The flight track is summarized in Fig. 1.

**Dropsondes**: Dropsondes were used to document the upstream profile of the incident flow. We dropped 16 sondes in all. There were no fast falls. Three curtains of 5 dropsondes each were deployed on the 2a transect before and after the Falcon departed, and a sonde was dropped at the end of the leg, approximately halfway to WP3.

**Instrument problems**: The UHSAS was not used. Some instrument communication with the ground had a glitch on takeoff and John Munnerlyn addressed it. Some issues with chat early on with dropping communication with the ground. The Falcon position did not show up on the catalog maps.
**Results:** The forecast models were predicting strong waves for this case. ECMWF (Fig. 2) showed strong 700-mb cross mountain flow from the west, among the strongest of the project. The WRF (Fig. 3) showed strong gravity wave generation and COAMPS showed moderately strong energy fluxes.

The Hokitika windprofiler (Fig. 4) showed strengthening winds during the flight with speeds exceeding 30 m/s at 2 km and above. The 0900 UTC radiosonde from Hokitika (Fig. 5) showed the strong westerlies, an inversion at around 700 hPa (may induce some wave trapping), and small scale waves in the stratosphere, which may be a signature of vertical propagating waves.

The vertical velocities for the first 5 transects along 2a showed among the largest wave amplitudes of the project at FL400 with vertical velocities of around -9.5 m/s in one of the waves, as shown in Fig. 6. The waves were not very repeatable or steady as apparent in Fig. 5. Likewise, potential temperature showed some large amplitudes as well, and a lack of steadiness to the waves (Fig. 7). One leg was performed at FL430, and the wave amplitudes were surprisingly smaller in spite of the winds being somewhat weaker. Wave breaking may have been taking place above the aircraft level.

The vertical velocity for the northeast to southwest leg is shown in Fig. 8. Surprisingly coherent waves were seen with vertical velocities of around 2 m/s. The southbound leg was flown at FL430 and the northbound at FL400. Once again, the waves were not very steady.

The last two legs across Aspiring (Fig. 9) showed relatively smaller vertical velocities, in spite of the increasing winds at 700 mb (Fig. 4) during the flight.

The Yale group reported large energy fluxes (28 and 27 W m⁻² for the first two legs), the largest magnitudes to date in the project, with shorter wavelengths than had been seen previously (around 30 km waves carrying most of the energy).

The MTM and sodium lidars reported seeing many wave structures over the South Island, particularly early in the flight. An example is shown in Fig. 10.
Figure 1: RF16 flight track for the GV and dropsonde locations. Winds along the flight track are shown.
Figure 2. ECMWF forecasts valid at 06Z 4 July for 700 hPa (left) and 200 hPa (right).

Figure 3. Forecasts from WRF valid at 0900 UTC 4 July along the Aspiring 2a section.
Figure 4. Hokitika wind profiler for the period during which RF16 took place.
Figure 5. Hokitika sounding on the upstream side of the mountains valid at 0900 UTC 4 July.
Figure 6. Longitude versus vertical velocity for first 5 cross mountain legs across Mt. Aspiring.

Figure 7. Longitude versus potential temperature for first 5 cross mountain legs across Mt. Aspiring.
Figure 8. Latitude versus vertical velocity for first 2 legs east of the South Island along the “V”.

Figure 9. Longitude versus vertical velocity for the last 2 cross mountain legs across Mt. Aspiring.
Figure 10. AMTM at 0750 UTC from the left camera.