Mission Scientist Report (by J.D. Doyle)

IOP12, RF19

Mission Date: 8 July 2014

Takeoff Time: 0550 UTC (1750 NZST)

Landing Time: 1145 UTC (1145 NZST July 8)

Duration: approximately 6 hours

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**Objective:** To sample gravity waves over the Southern Ocean, particularly between Auckland Islands and Macquarie Islands, which was a region forecasts to have deep propagating gravity waves.

**Track design:** The flight began with a long leg to the SE to way point 1 near Macquarie Island. We flew 4 legs back and forth along WP1-WP2, at FL400 to sample the deep propagating gravity waves with the lidars and ATMT. The flight track is summarized in Fig. 1.

**Dropsondes:** Dropsondes were used to document a tropopause fold between WP2 and WP3 on the outbound. A total of 6 sondes were deployed beginning at -49.5 S and every degree thereafter until near the end point of Macquarie Island. The sixth dropsonde was deployed before the turn and upstream of Macquarie. A seventh sonde was deployed at -51.5 S, which was the sonde with the most interesting potential vorticity structure. This last dropsonde was deployed on the return leg.

**Instrument problems:** There were some issues with the sodium lidar and some adjustments needed to be made before the flight. Additional time before the next flight and future flights may be needed to properly adjust the instrument.

**Results:** The forecast models were predicting strong signals from deep propagating waves for this case. The ECMWF (Fig. 2) at 250-mb depicted a complex jet stream structure with a strong jet to the northwest over Australia and a second jet to the south. The forecast gravity waves can be seen in the horizontal divergence forecasts from the IFS valid at 0900 UTC 8 July at 150, 50, 10, and 1 hPa (Figs. 3-6). By 1200 UTC, the wave packet was forecasted to move a little closer to the flight track and amplify (Figs. 7 and 8).
The MTM and sodium lidars reported seeing many wave structures over the South Island, particularly early in the flight. Examples are shown in Figs. 9 and 10.

As described earlier, the aircraft track was fortuitously made over a region of a tropopause fold, as forecasted by ECMWF in Fig. 11 in plan-view form, and in Fig. 12 along the flight track. The dropwindsondes deployed in the outbound leg are shown in Figs. 13a-f. They show a general lowering of the tropopause to the south and then a higher tropopause again. Some of the soundings show a complex structure to the tropopause.

Finally, the AIRS satellite imagery for 1, 10, and 60 hPa are shown in Figs. 14-16, respectively, valid at 1407 UTC 8 July. The AIRS imagery shows an active gravity wave fields near the region where the GV sampled and the flight path crossed the wave structures. The repeat legs should have sampled these waves multiple times.
Figure 1: RF19 flight track for the GV and dropsonde locations. Winds along the flight track are shown.
Figure 2. ECMWF forecasts valid at 12Z 84 July for 750 hPa, showing the jet stream.
Figure 3. Forecasts from ECMWF of the horizontal divergence at 150 hPa valid at 0900 UTC 8 July.
Figure 4. Forecasts from ECMWF of the horizontal divergence at 50 hPa valid at 0900 UTC 8 July.
Figure 5. Forecasts from ECMWF of the horizontal divergence at 10 hPa valid at 0900 UTC 8 July.
Figure 6. Forecasts from ECMWF of the horizontal divergence at 1 hPa valid at 0900 UTC 8 July.
Figure 7. Forecasts from ECMWF of the horizontal divergence at 1 hPa valid at 1200 UTC 8 July.
Figure 8. Forecasts from ECMWF of the horizontal divergence at 1 hPa valid at 1200 UTC 8 July with the planned flight track projected on the field.

Figure 9. ATMT camera quick look image from left camera at 0646 UTC 8 July.
Figure 10. Sodium lidar quick look image at 0929 UTC 8 July.
Figure 11. Forecasts of the dynamical tropopause from ECMWF valid at 0600 UTC and 1200 UTC 8 July.
Figure 12. Vertical cross sections from ECMWF valid at 0600 UTC and 1200 UTC 8 July showing the isentropes, potential vorticity (shading), and the cloud water and ice.
Figure 13a. Dropwindsonde valid at 0656 UTC July.
Figure 13b. Dropwindsonde valid at 0706 UTC July.
Figure 13c. Dropwindsonde valid at 0717 UTC July.
Figure 13d. Dropwindsonde valid at 0727 UTC July.
Figure 13e. Dropwindsonde valid at 0738 UTC July.
Figure 13f. Dropwindsonde valid at 0749 UTC July.
Figure 14. AIRS image valid at 1407 UTC 8 July 2014 at 2 hPa.
Figure 15. AIRS image valid at 1407 UTC 8 July 2014 at 10 hPa.
Figure 16. AIRS image valid at 1407 UTC 8 July 2014 at 60 hPa.