10.6 THE INTERNATIONAL PERLAN PROJECT:
SOARING STRATOSPHERIC MOUNTAIN WAVES IN NEW ZEALAND

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1. INTRODUCTION

The Perlan project is an international scientific endeavor to soar a manned sailplane into the stratosphere using stratospheric mountain waves.

There are two phases of the Perlan Project. Phase one uses a certified production DG505M sailplane to reach 62,000 feet to demonstrate the feasibility of the project. This phase requires the use of pressure suits in an unpressurized cabin. Phase 2 of the project is to soar to 100,000 feet (30 km) in a manned sailplane with atmospheric instrumentation. This phase will require a special pressurized sailplane to be built.

Phase I of the project to soar to 62,000 feet began with flight tests in the Sierra Nevada mountains of California, U.S.A., during April of 2002. High altitude attempts took place in the South Island of New Zealand during July and August of 2002. Some of the initial results from the New Zealand campaign flights, meteorology and atmospheric modeling will be presented in this paper. Details of the Perlan Project can be found in Carter and Teets, 2001; Teets and Carter, 2002; and Carter, et al., 2003.

2. THE NEW ZEALAND 2002 CAMPAIGN

The 2002 Perlan field campaign took place from July 11 – August 14, 2002, in Omarama, New Zealand. Omarama lies on the eastern side of the southern Alps on the south island of New Zealand. A total of fifteen flights were made during this campaign. The weather conditions were unfavorable for high altitude attempts during the majority of the campaign. The three notable days for any type of attempts were July 20, August 10 and 11. Details of the July 20, 2002, flights are written up in Carter, et al., 2003.

A unique combination of meteorological conditions are required to get mountain waves to penetrate into the stratosphere to altitudes of more than 100,000 feet (30 km). These requirements include: (1) atmosphere must be influenced by the Polar vortex edge, (2) prefrontal conditions, (3) close to perpendicular winds hitting a mountain range, and (4) increasing wind speeds with height and fairly constant wind directions at all levels. These conditions are detailed in Carter and Teets, 2001, and Teets and Carter, 2002. Strong stratospheric mountain waves have been identified during the winter months over New Zealand. Details on why New Zealand was chosen as our staging location are discussed in Carter and Teets, 2001; Teets and Carter, 2002; and Carter, et al., 2003.

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3. PERLAN FLIGHT ON AUGSUT 11, 2002

On August 11, 2002, the DG505 Perlan sailplane flew to 30,140 feet GPS altitude. Both pilots, Steve Fossett and Einar Enevoldson wore pressure suits for the high altitude attempt. Though the August 11th day was not a "textbook" day for an attempt to soar into the stratosphere it was one of the better days during campaign and it was our last fly day in New Zealand. One reason this day was not conducive for soaring into the stratosphere was due to the fact that the outer edge of the Polar Vortex was not affecting the region. Thus we did not have the upper-level wind support required.

The August 11 Perlan glider flight path from Omarama is shown over the topography in Figure 1. On this day prefrontal conditions were occurring over the south island of New Zealand. Figure 2 is a high resolution visible satellite image for 1132 a.m. local New Zealand time on August 11 (2332Z August 10). The mountain waves over the south island are easily visible in this satellite image. For reference, Omarama is approximately 45°S latitude and 170°E longitude.

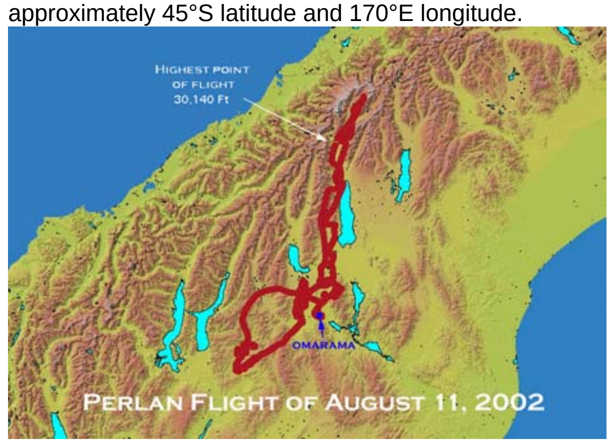

Figure 1. Flight of Perlan DG505 sailplane from Omarama north to the Mt. Cook region of New Zealand (shown in red). The sailplane made it to 30,140 feet in the lee of the Mt. Cook region.

The winds were strong and west to northwesterly at all levels (Figure 3). Figure 3 shows a comparison of wind speeds and wind directions measured from the DG505 glider versus those measured from the GPS sonde launched from Lauder, New Zealand. This particular sonde was launched at 2130 UTC August 10, 2002 (9:30 a.m. LST August 11, 2002). The sondes were launched by the National Institute of Water and Atmospheric Research. Ltd. (NIWA), Lauder, New Zealand. Differences in these data arise from the fact that the sonde was launched much earlier in the day than the flight occurred and the sonde was launched from a different location than from where the flight originated by approximately 50 miles. The temperatures measured from the Perlan glider compared well to those measure by the NIWA GPS sonde (Figure 4).

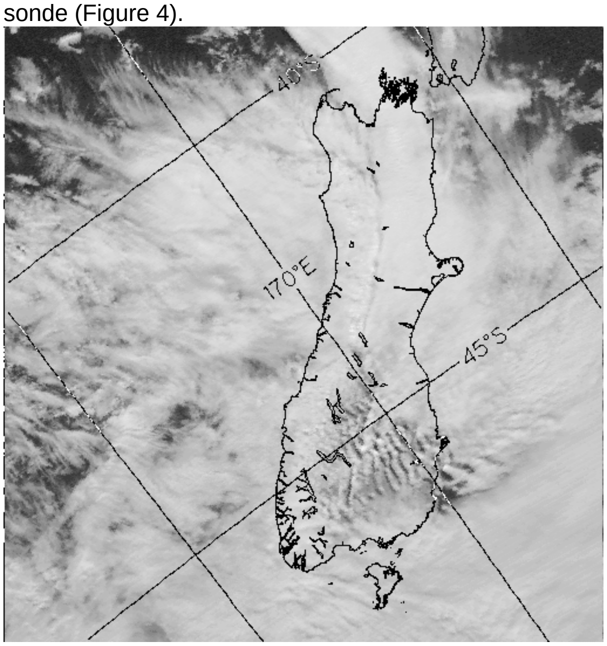

Figure 2. Visible satellite image at 1132 NZ Local Time, August 11, 2002. (Image Courtesy of NIWA, Ltd.).

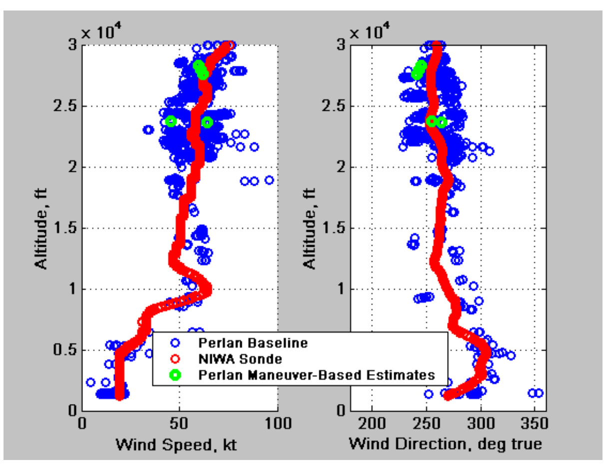

Figure 3. Wind speeds and directions from August 11, 2002, as measured by the Perlan glider and the NIWA GPS sonde.

The temperatures measured by a CuSonde mounted on the tow plane is also shown as a comparison on this plot. The tropopause was located at approximately 36,100 feet (using the NIWA GPS sonde).

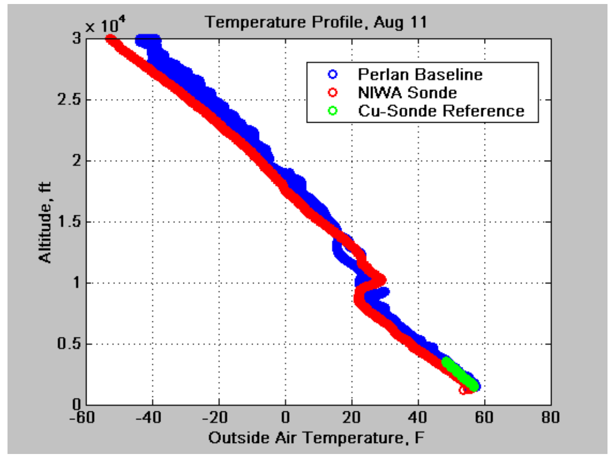

Figure 4. Temperatures measured by the Perlan glider compared to those measured by the NIWA GPS sonde and the CuSonde.

4. MODELING THE ATMOSPHERIC CONDITIONS

Many of the New Zealand wave cases are being modeled using the Penn State/NCAR (National Center for Atmospheric Research) MM5 Mesoscale Modeling system 5 model. Some of the results from the August 11, 2002, wave day will be presented. The model was set up with a 3 km x 3km horizontal resolution outer domain and an inner 1 km x 1 km domain.

The modeled temperatures compared fairly well with those measured both by the NIWA sonde and the Perlan glider. Figure 5 is a cross section of temperature from the 1 km x 1 km horizontal resolution inner domain at 2315 UTC August 10, 2002. The Perlan glider reached the 30,140 foot level at 2321 UTC on August 10th. The location and the temperature where the glider reached the 30,140 foot level is indicated on this figure. The modeled data show the temperature to be approximately –45°C at this level and the GPS sonde measured –47.6°C at this level earlier in the day. The Perlan glider measured approximately –41°C.

The location of the Perlan glider in the wave at 30,140 feet is shown in Figure 6. This figure is a cross section showing potential temperature, circulation vectors, and potential vorticity. The glider at this point was in the lee of the Mount Cook region. The vertical velocities for the same cross-section are shown in Figure 7. The numbers have been removed from this plot to show the patterns of up and down drafts (red=up, blue=down). This cross section is essentially along the wind direction. Thus, upwind is to the left and downwind to the right. A "kink" in the vertical velocities at the tropopause level is seen. This model result along with others (Carter, et al., 2003) have shown the when the Perlan glider is nearing the tropopause there is a characteristic "kink" and sometimes an actual disconnect in the waves. Model results indicate that the glider must go upwind when nearing and passing through the tropopause region in order to stay in lift. Sometimes however the glider is in a region where the lift does not continue upward in that particular area and must look elsewhere.

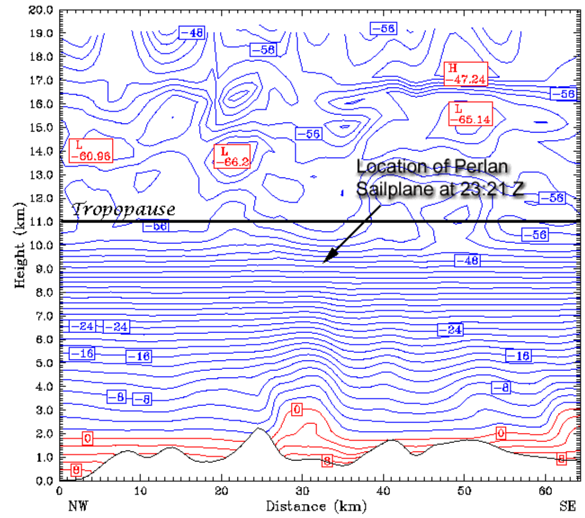

Figure 5. MM5 output of temperature (°C) with altitude (km) at 2315 UTC august 10, 2002. The location of the Perlan glider at 30,140 feet is indicated.

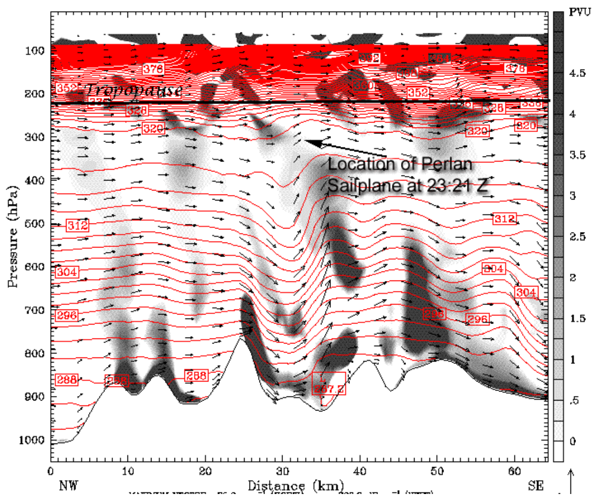

Figure 6. Cross-section showing the location of the Perlan glider in the wave. This MM5 model output is for 2315 UTC August 10, 2002. Plotted are potential temperatures, circulation vectors, and potential vorticity.

6. CONCLUSIONS

The next New Zealand field campaign will take place between June - September 2003 in Omarama New Zealand. It is anticipated that during the 2003 New Zealand campaign such ground-based instruments as Lidar, wind profilers, and live cameras will be added to the project as well as additional instrumentation on the sailplane such as cloud particle sampling probes, SiC detectors, newly developed and modified UV-A sensors, and a BAT (Best Aircraft Turbulence) probe. Also, the possible fly days will be doubled to 44 days. A third pilot will also be added to the project.

The international Perlan project represents a balanced collaborative effort between model, observation and theory and is expected to have high scientific return.

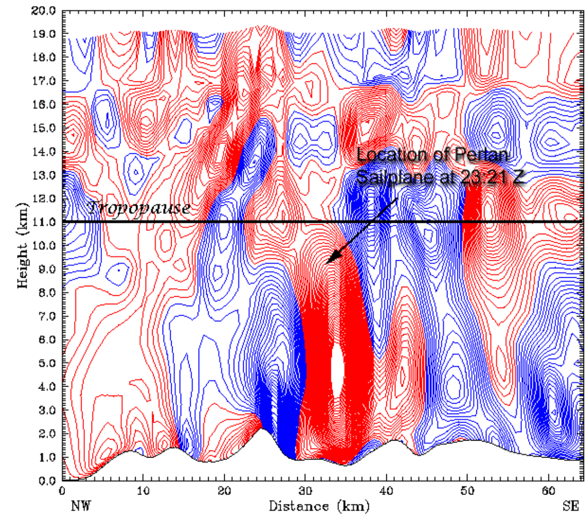

Figure 7. Vertical velocities for 2315 UTC August 10, 2002 form the MM5 model run. Red are upward and blue are downward. The location of the Perlan glider at 30,140 feet is shown.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

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