



Geophysica MTP Observations During the EUPLEX Campaign



MJ Mahoney & Bruce Gary

Jet Propulsion Laboratory

California Institute of Technology

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Abstract

The Jet Propulsion Laboratory (JPL) Microwave Temperature Profiler (MTP) was the first United States instrument to fly on the Russian Geophysica high-altitude research aircraft. Careful comparison of MTP measurements with radiosondes launched near the Geophysica flight track has allowed us to establish the flight level temperature to an accuracy of 0.2 K. Since the noise on a single MTP measurement at flight level is 0.5 K several MTP cycles must be averaged to achieve 0.2 K accuracy. The MTP observations obtained during the EUPLEX campaign will be a valuable source for accurate middle stratospheric temperature validation of satellite sounders. This will be important for understanding the influence of mesoscale temperature structure between sparsely located radiosonde launch sites, especially when entering or leaving the vortex. Several examples of MTP measured structure will be presented. Isentropes derived from the MTP data also show that stratospheric wave activity was very weak during the EUPLEX campaign, in agreement with the Naval Research Laboratory Mountain Wave Forecast Model.

What's New Since the Zurich Science Team Meeting

A companion poster for the DC-8 MTP calibration discusses a number of important improvements to the MTP retrieval process. The most important were:

- to minimize temperature profile interpolation errors by calculating retrieval coefficients (RCs) at all Geophysica flight levels,
- to improve retrieval accuracy far from the Geophysica flight level by using radiosondes near the flight track as templates to calculate RCs, and
- to carry out an independent assessment of the flight level temperatures compared to radiosondes.

To take advantage of these improvements, new flight levels were selected to calculate RCs, and fourteen new sets of RCs were calculated using temperature profiles from radiosondes that the Geophysica flew close to as templates. The EUPLEX and ENVISAT Validation MTP measurements were reprocessed to take advantage of these improvements and final data has been submitted to the NILU archive.

Summary of Temperature Comparisons with Radiosondes

Based on comparisons with radiosondes launched near the Geophysica flight track, we find the following relationships between radiosonde (T_{raob}), initial TDC ($T_{tdc_initial}$), final TDC (T_{tdc_final}), UCSE (T_{ucse}), and MTP temperature measurements at flight level.

$$T_{tdc_initial} = T_{raob} - (0.20 \pm 0.18) \text{ K}$$

$$T_{tdc_final} = T_{raob} - (0.83 \pm 0.18) \text{ K}$$

$$T_{ucse} = T_{raob} - (1.14 \pm 0.26) \text{ K}$$

$$T_{mtp} = T_{raob} \pm 0.18 \text{ K (averaging several cycles)}$$

At the Zurich meeting, we reported: $T_{tdc_initial} = T_{raob} - (0.39 \pm 0.26) \text{ K}$ based on 11 comparisons performed by BLG. After the meeting, MJM did an independent assessment using software developed for the DC-8 calibration, and found the result shown above for 21 comparisons. The final TDC data for 6 of 7 EUPLEX flights was $(0.63 \pm 0.02) \text{ K}$ colder than the initial data, and the UCSE temperatures were 0.31 K colder than final TDC results.

JPL

Variation of Tmtp - Traob Vs Pressure Altitude for Geophysica Based on 21 RAOBs with Avg Distance <117 km

MTP

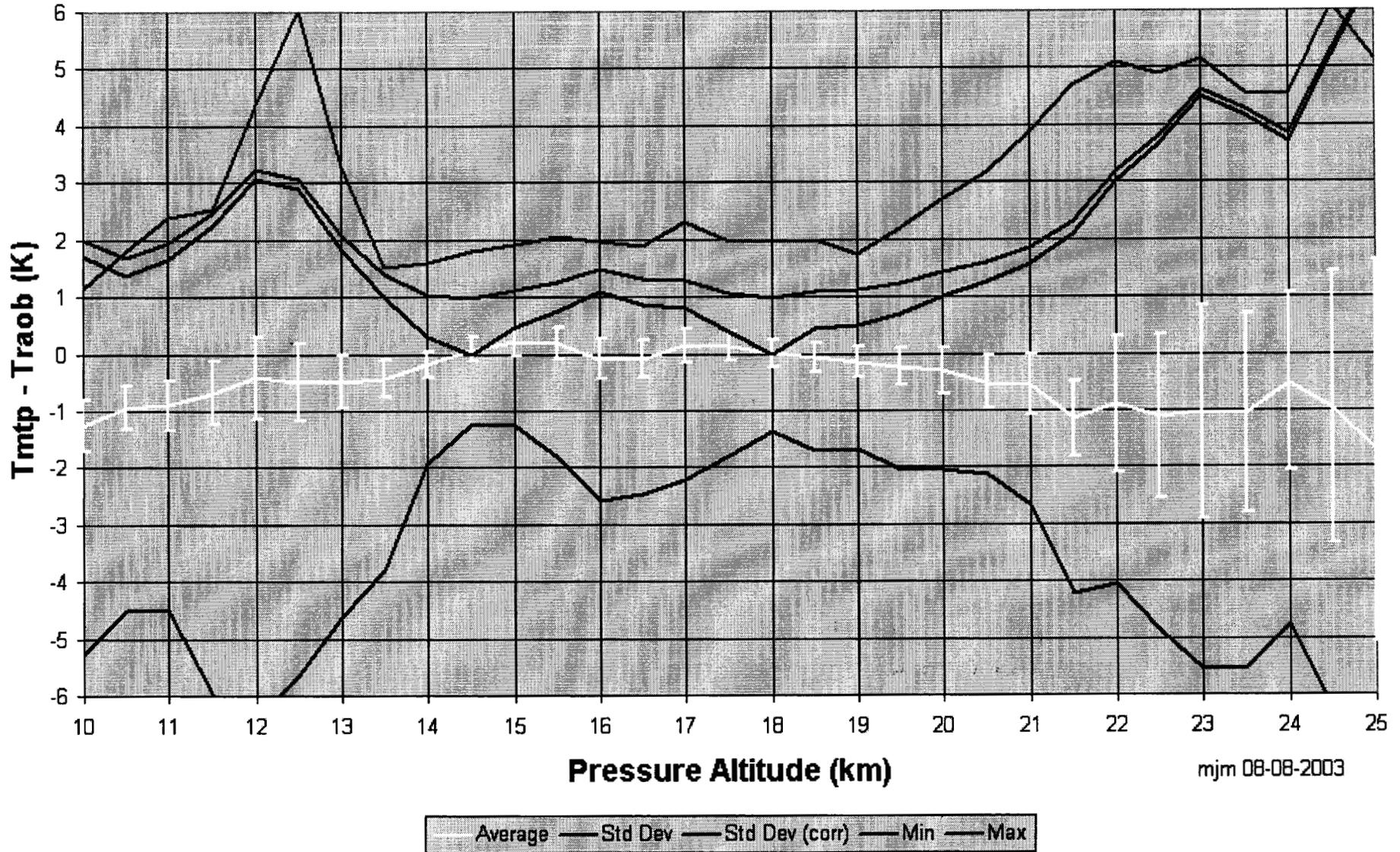


Figure 1. MTP performance compared to radiosonde for the EUPLEX campaign

Figure 1 summarizes the result of comparing MTP temperature profiles to the temperature profiles of 21 radiosondes (RAOBs) that the Geophysica flew close to during the EUPLEX and ENVISAT Validation campaigns. The average flight altitude for these comparisons was 17 km, with a population standard error of 3 km. The average distance to the radiosonde launch sites was 117 km. The white trace is the average bias of the MTP temperatures compared to RAOBs, and the error bars are the standard error of the average biases. The error bars are larger at the higher altitudes because the RAOBs burst and fewer comparisons were possible. The green and brown traces show the maximum and minimum temperature differences measured between the MTP and radiosondes for the 21 comparisons. Note that near 12 km the maximum and minimum differences are largest. This is because when flying at an average altitude of 17 km, the MTP is not able to resolve sharp tropopause temperature structure, or alternatively, there is significant variability in the tropopause temperature. The pink trace is the population standard deviation for the 21 comparisons, and the blue trace is an estimate of the retrieval error, which is arrived at by removing 1 K in quadrature from the pink trace to correct for the fact the the MTP and RAOBs are not co-located. For level flight, the expected standard deviation in flight level temperatures separated by 117 km is ~ 1 K; this is due to real temperature gradients in the atmosphere. Based on these comparisons, and assuming an average flight level of 17 km, the retrieved MTP temperature profiles have an accuracy of <1 K from 13.5 to 20 km, <2 K from 13 to 21.5 K, and <3 K from 10 to 22 km.

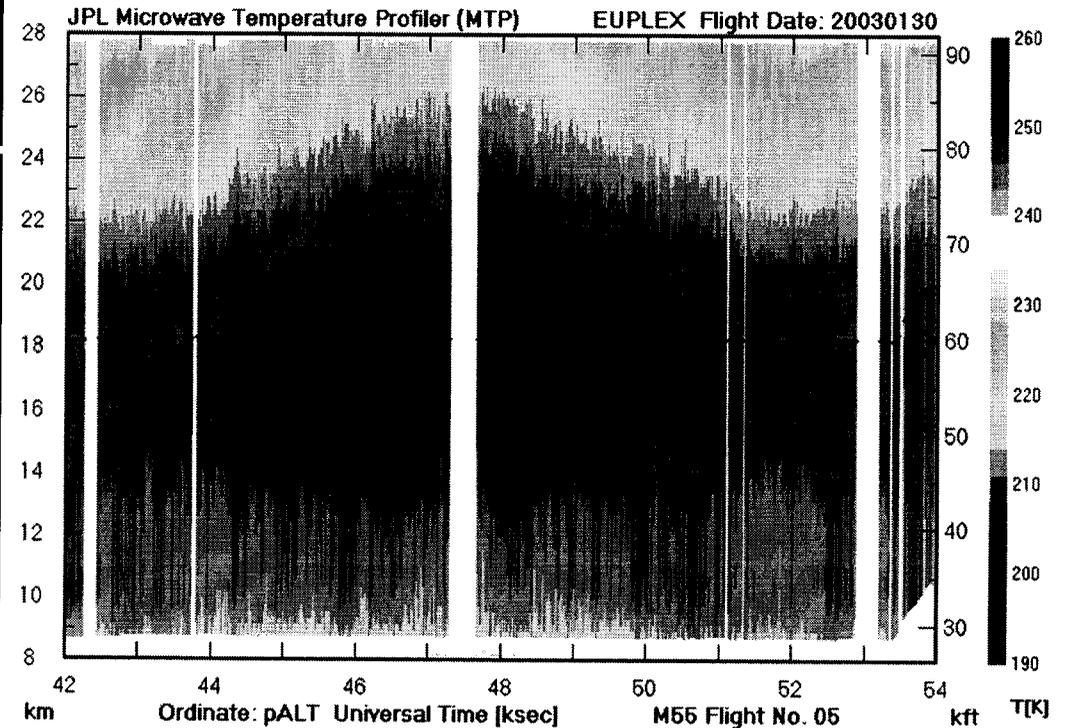
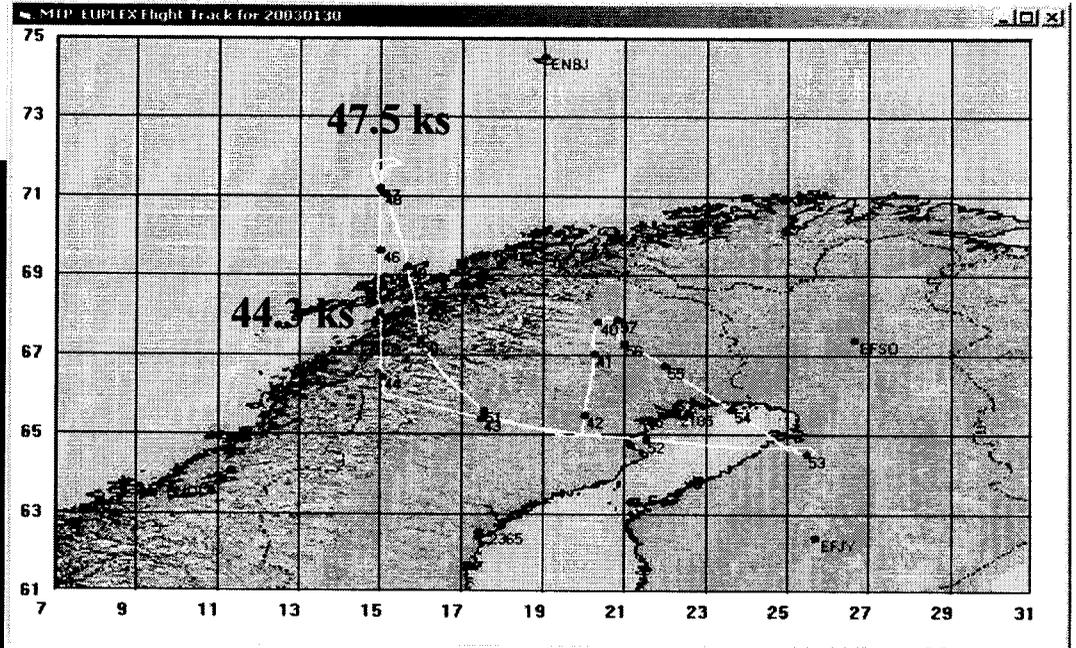
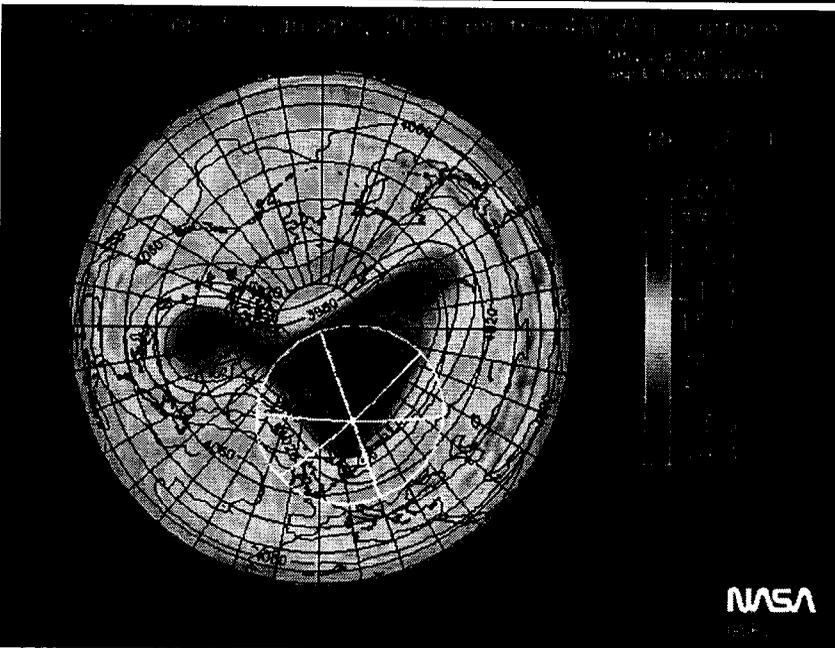
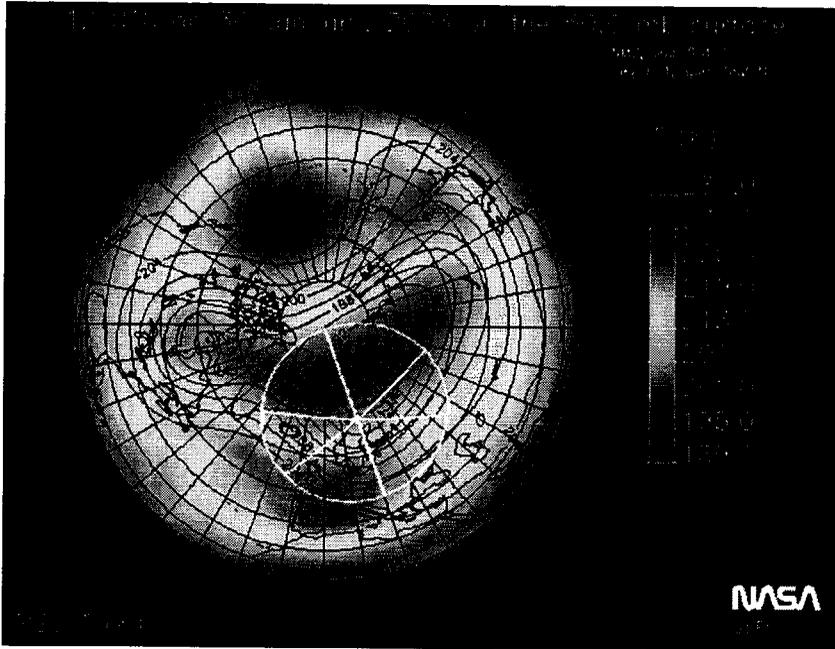
Three Examples of Isentrope Surface Behaviour

Why? Identify vortex structure and whether there is wave activity

- 2003.01.30 (Figures 2 & 3):
 - Start within a weak vortex near the edge of a cold pool
 - Isentropes rise as expected going deeper into the vortex
 - Wave activity is weak as forecast
- 2003.02.06 (Figures 4 & 5):
 - Start deep within both the vortex and the cold pool
 - Isentropes are 1 km higher, and there is no wave activity as forecast
- 2003.02.09 (Figures 6 & 7):
 - Start near the vortex edge, but within the cold pool
 - Moderate wave activity near the vortex edge dies out deeper into the vortex

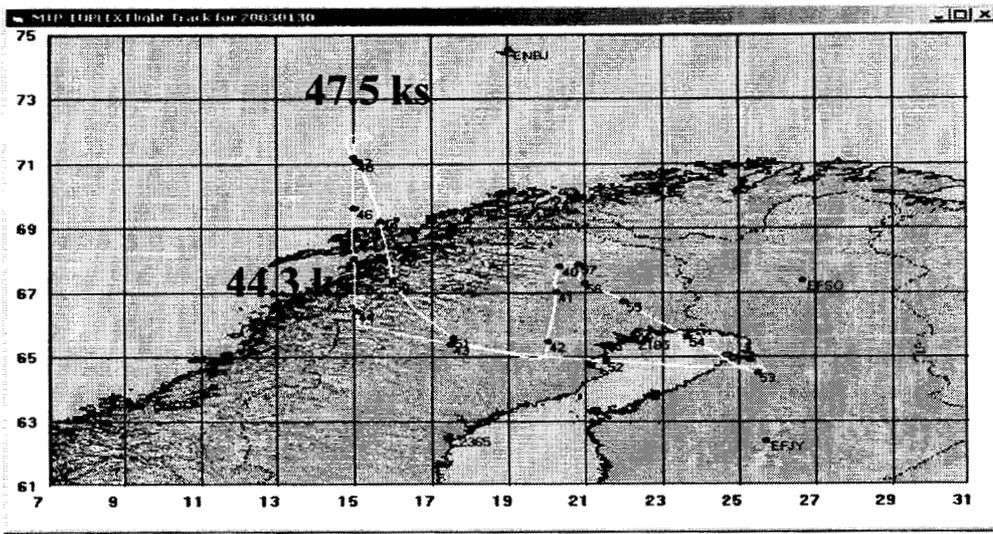
2003.01.30

Inside Vortex at Edge of Cold Pool



Principal Investigator: MJ Mahoney (Michael.J.Mahoney@jpl.nasa.gov)

History: Flight: 2003 01 30 00:00:00 Retrieved: 2003 09 22 19:50:18 Edited: 2003 09 22 19:51:01 Plotted: 2003 09 22 19:51:46



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Isentropic Altitude Cross-Section
EUPLEX - M55 20030130

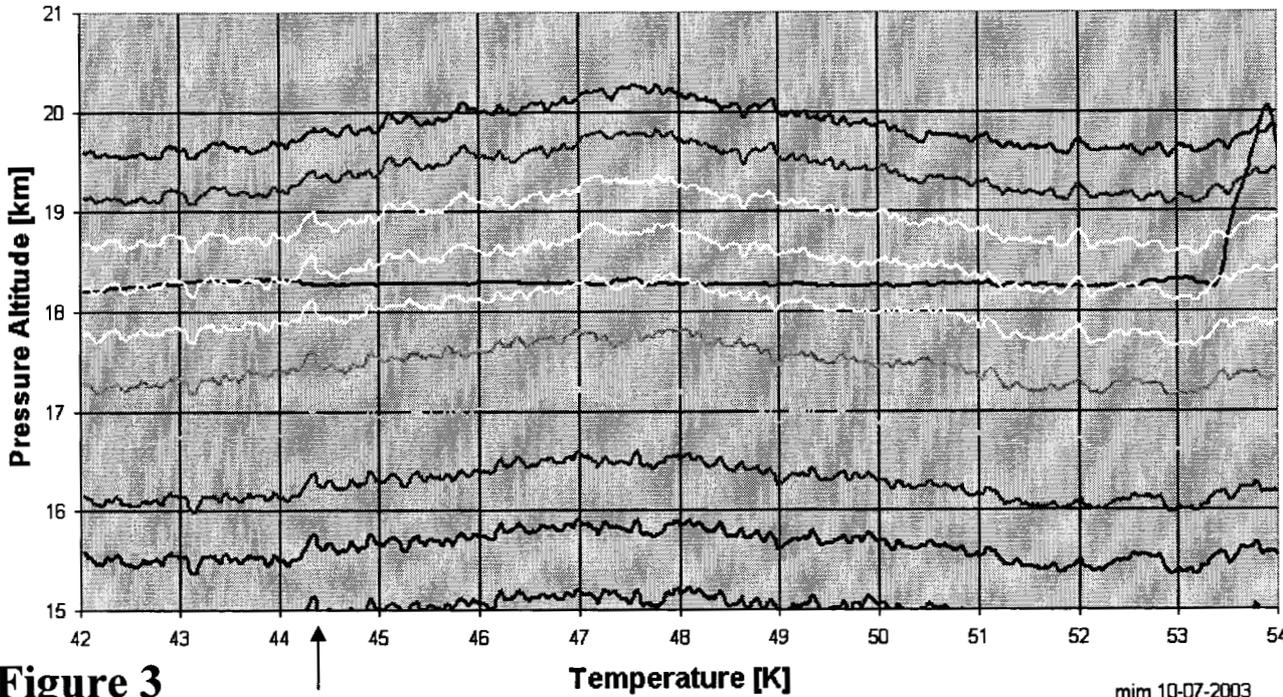
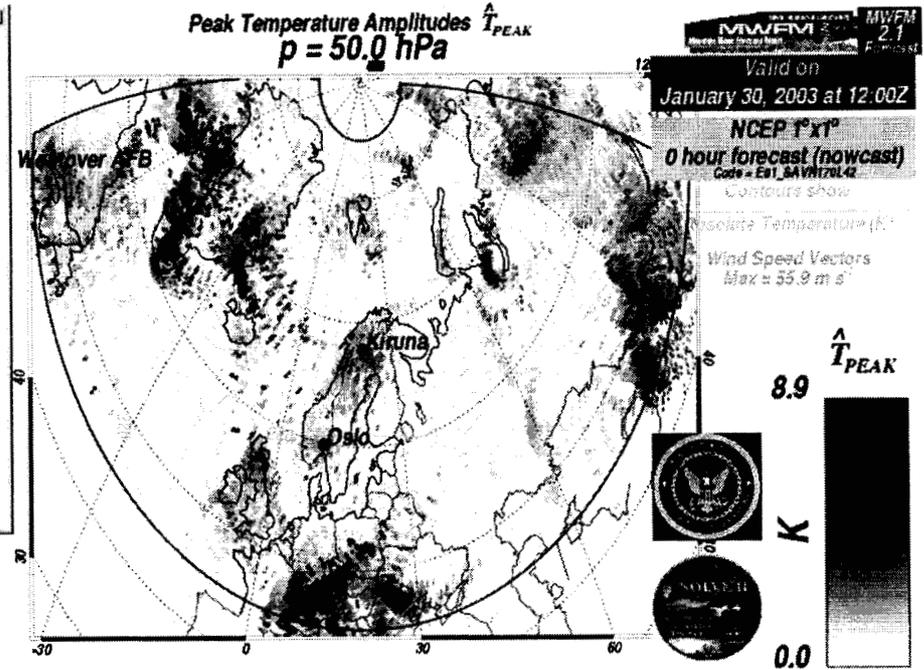
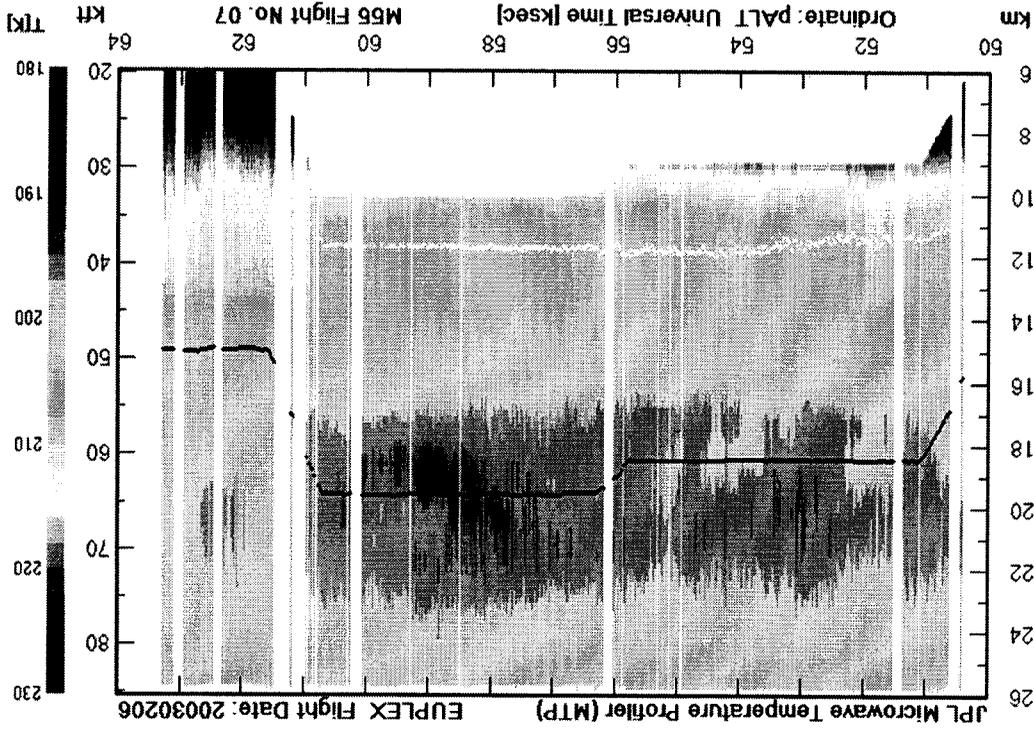
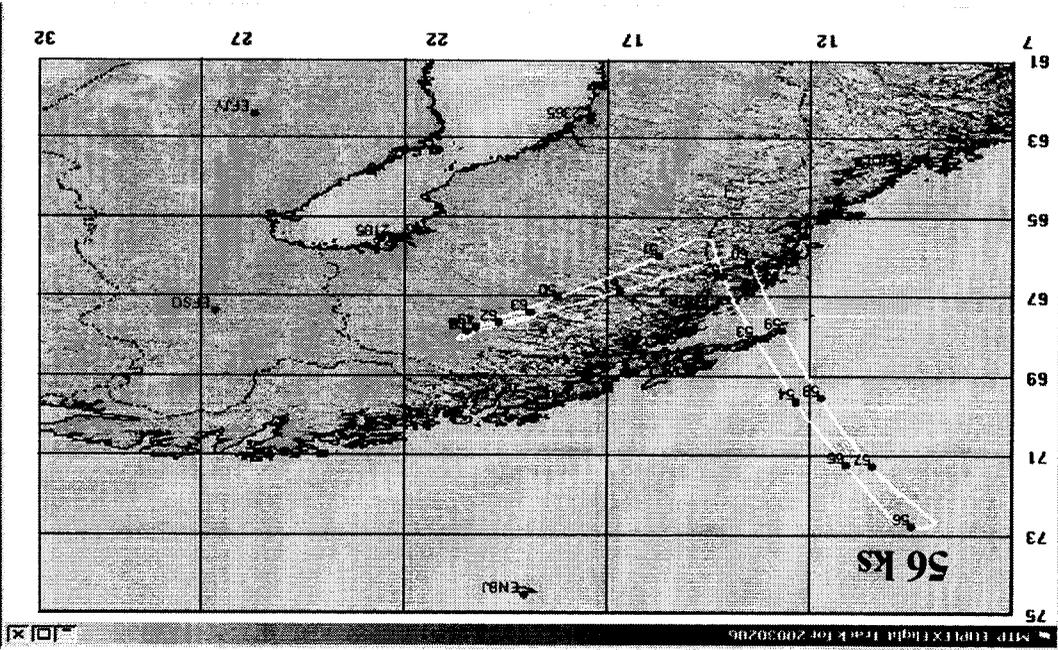
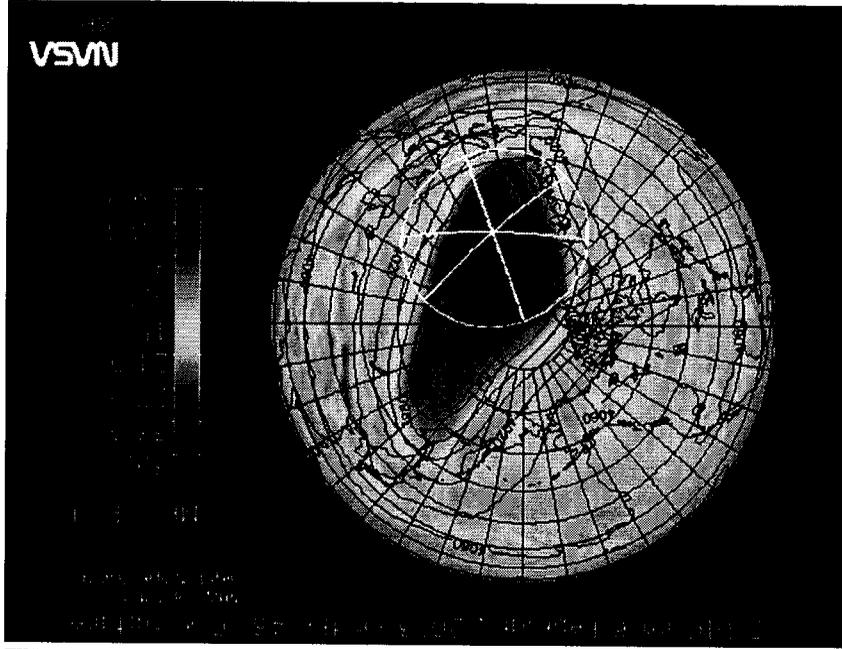
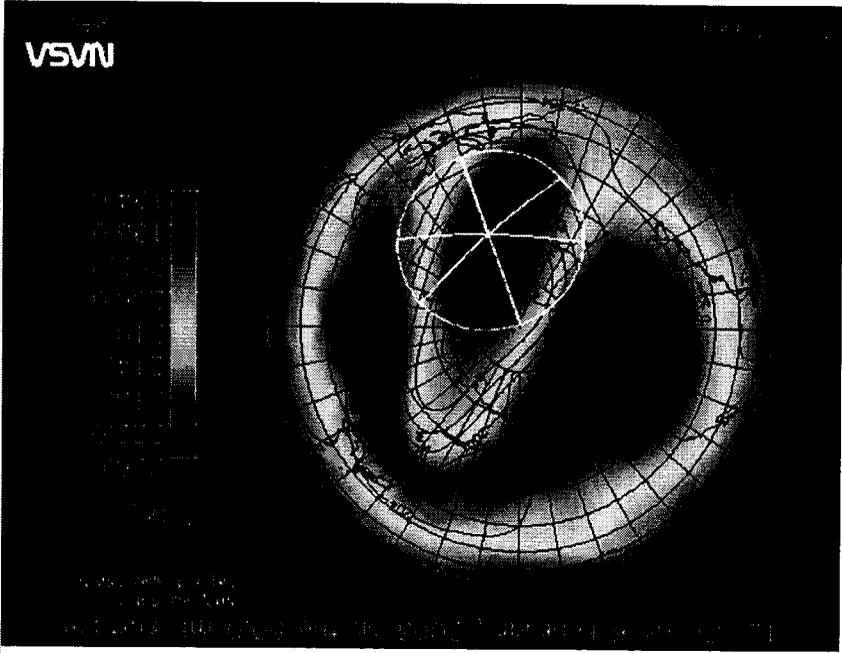


Figure 3

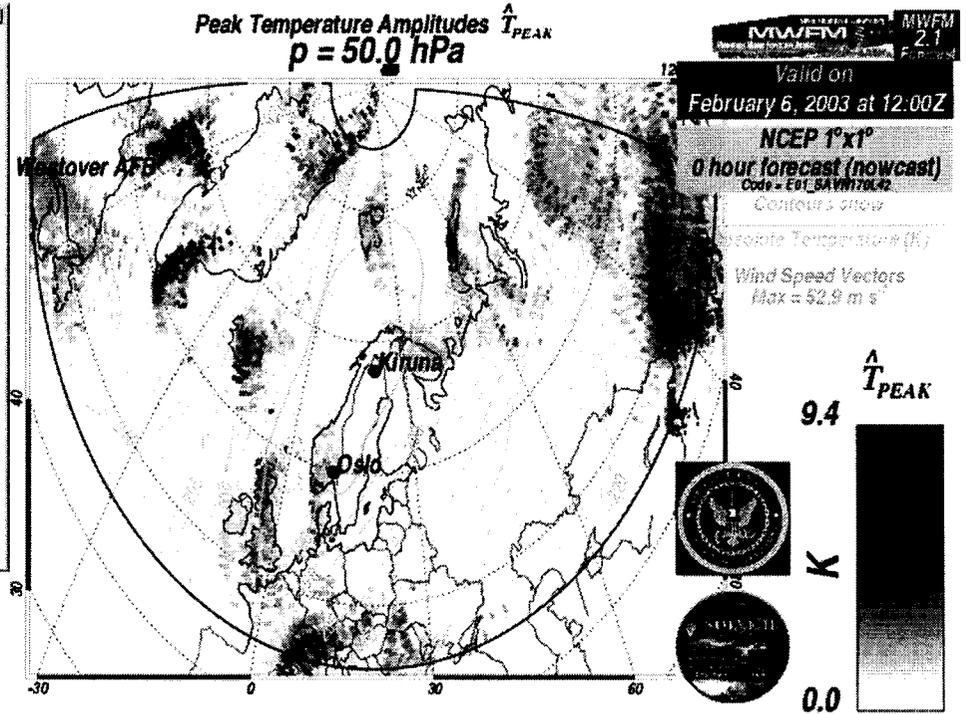
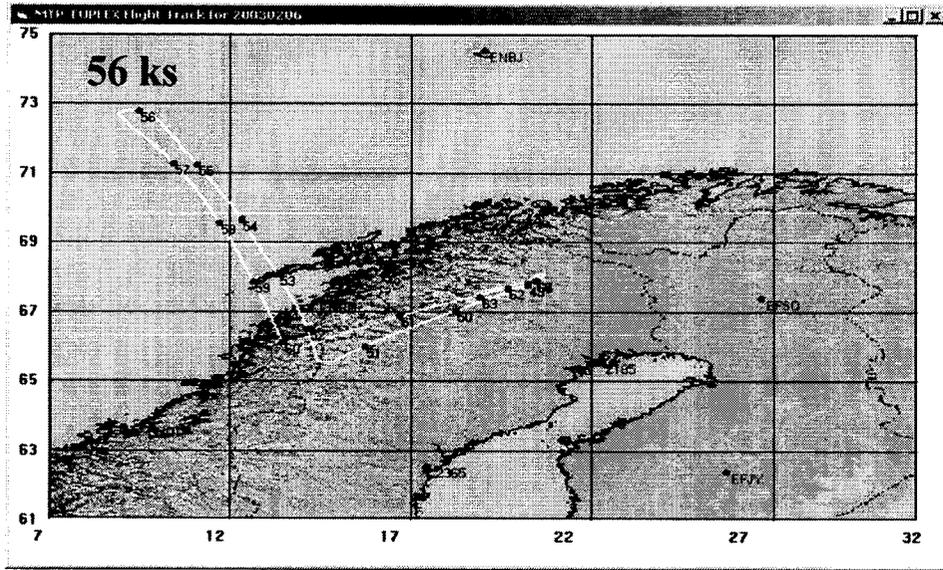
mjm 10-07-2003

- Wind Speed: 16 kts
- Wind Direction: NW
- Lee Waves? Weak
- Wave at 44.3 ks near west coast of Norway
- Isentropes rise (as expected) as M55 flies deeper into the vortex

2003.02.06 Deep Inside Vortex & Cold Pool



Principal Investigator: Michael J. Mahoney (michael.j.mahoney@jpl.nasa.gov)
 History: Flight 2003 02 06 00:00:00 Retrieved: 2003 09 22 20:05:47 Edited: 2003 09 22 20:06:08 Plotted: 2003 09 22 20:13:06



JPL Isentrope Altitude Cross-Section
EUPLEX - M55 20030206

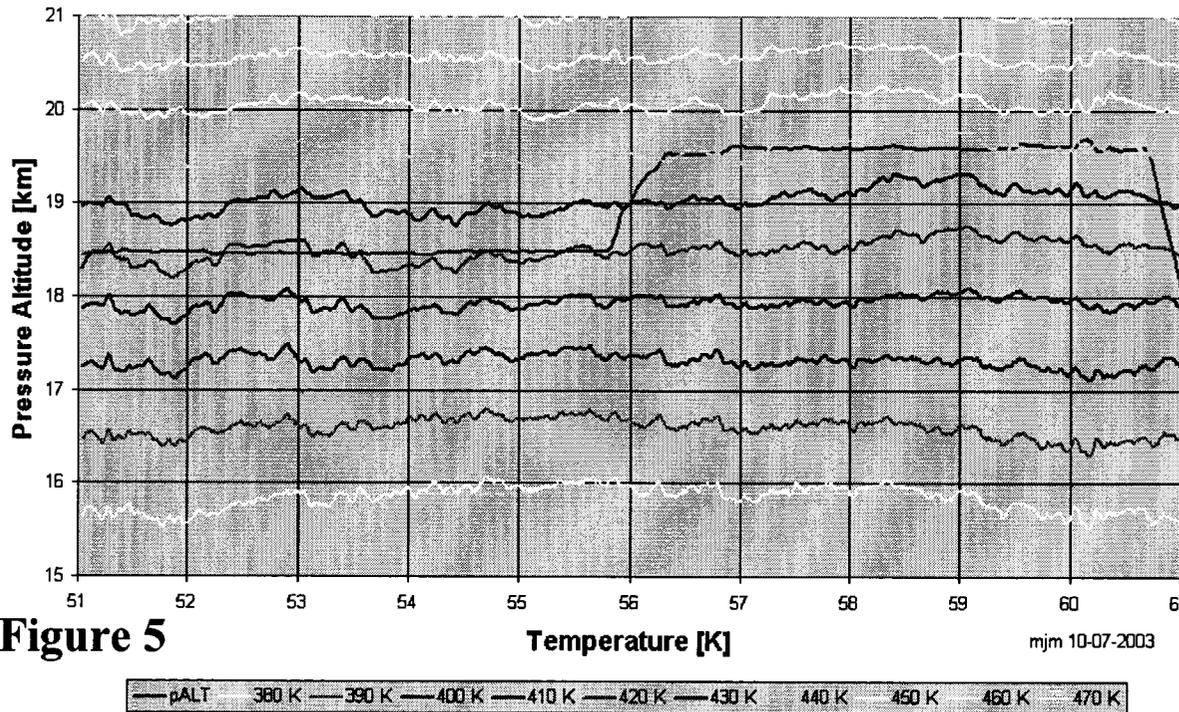
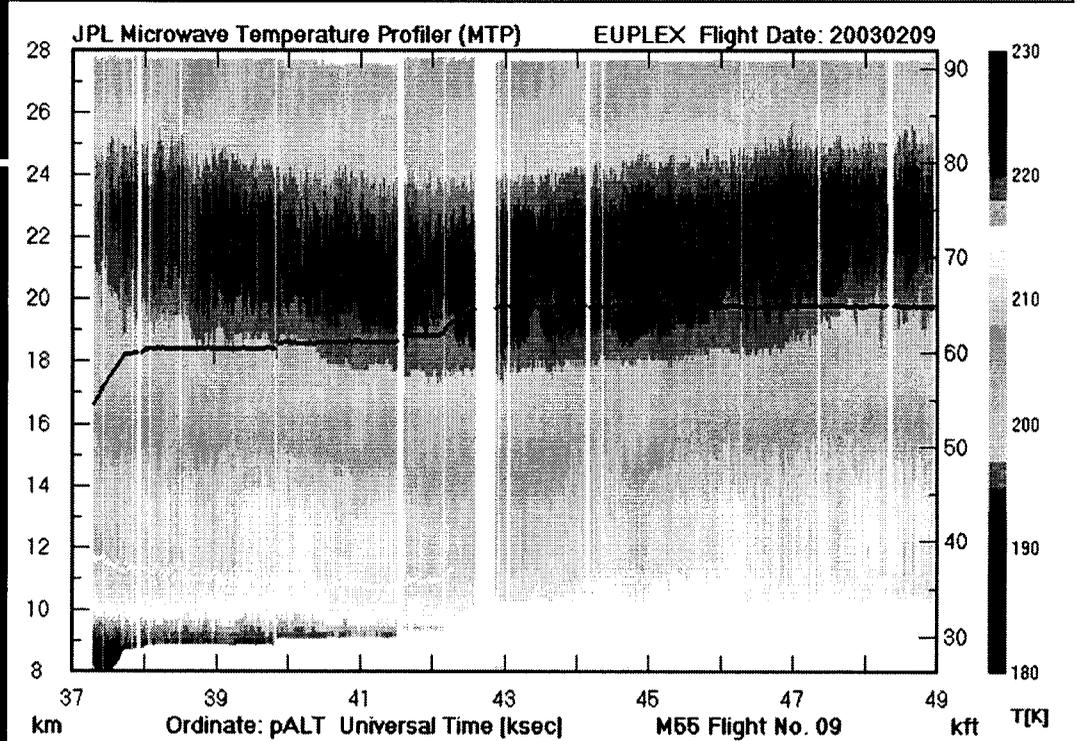
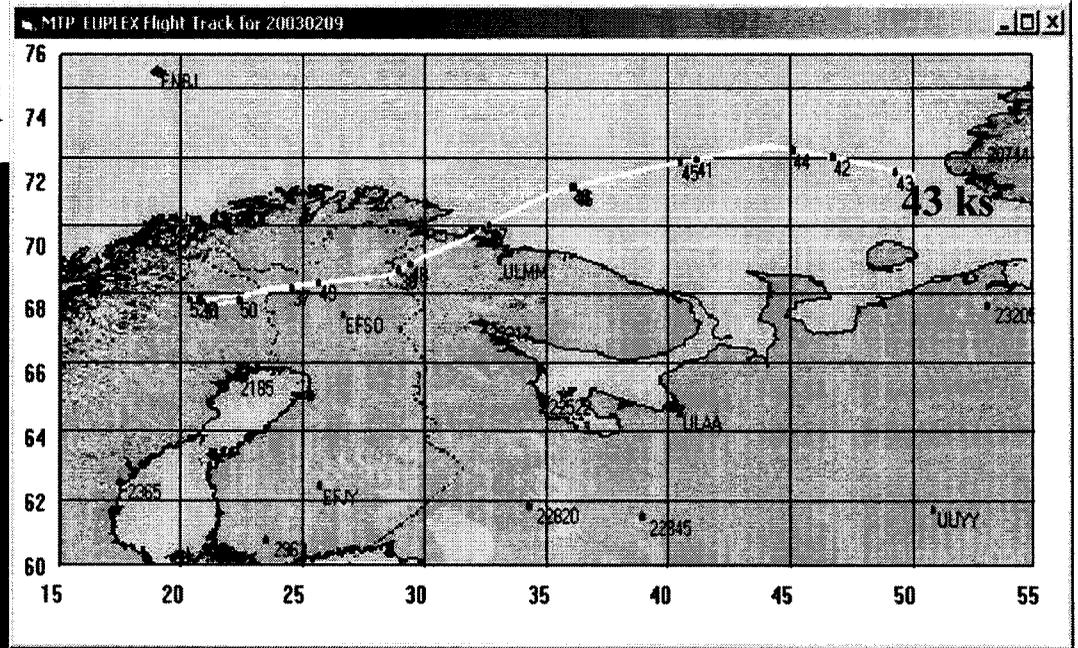
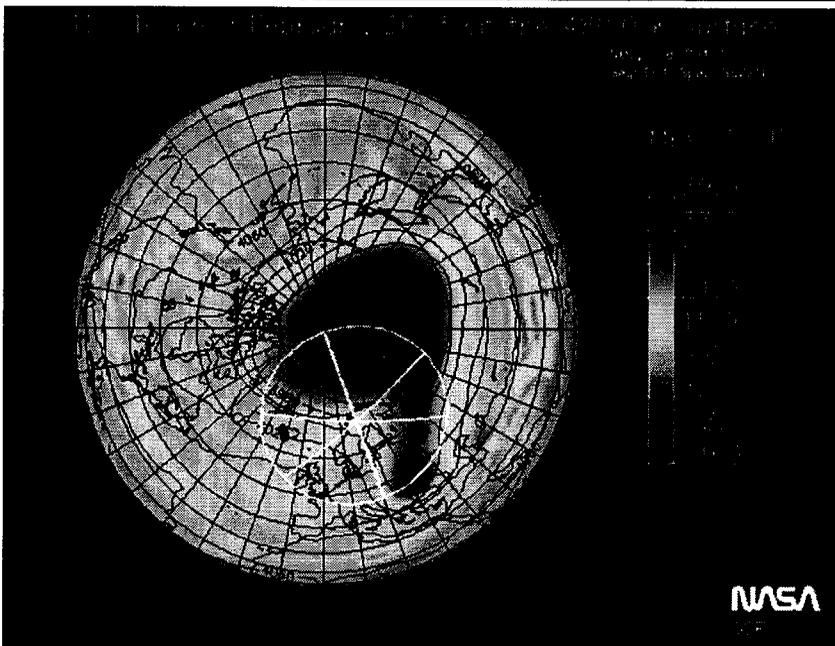
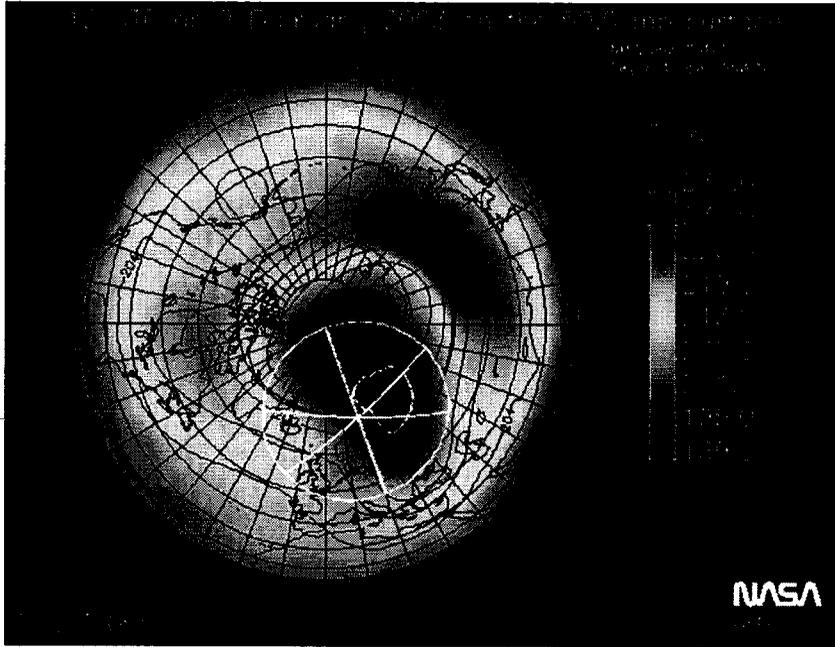


Figure 5

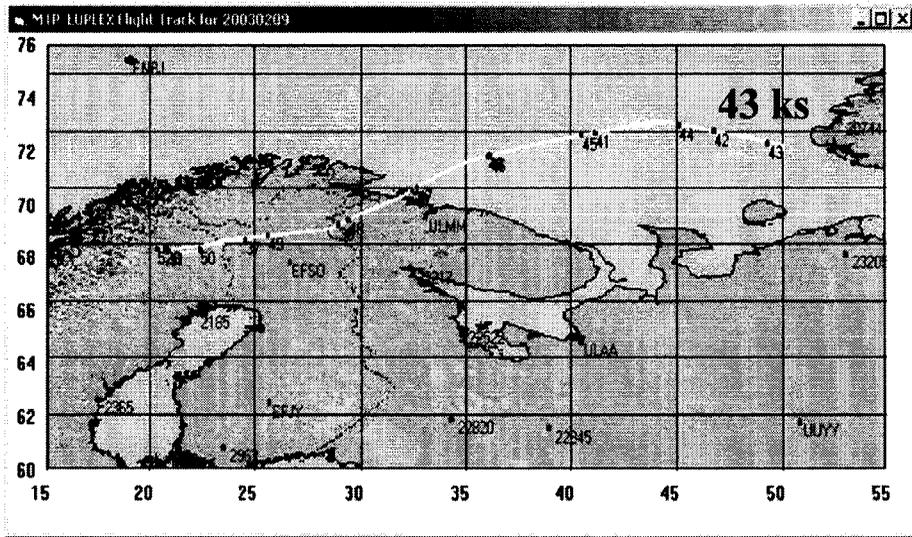
- Wind Speed: 10 kts
- Wind Direction: NW
- Lee Waves? None
- This is as expected deep in the vortex
- Isentropes are 1 km higher
- May be low amplitude, $\lambda \sim 200$ km inertio-gravity waves present over the ocean

2003.02.09

Vortex Edge: Into Vortex, Cold Pool

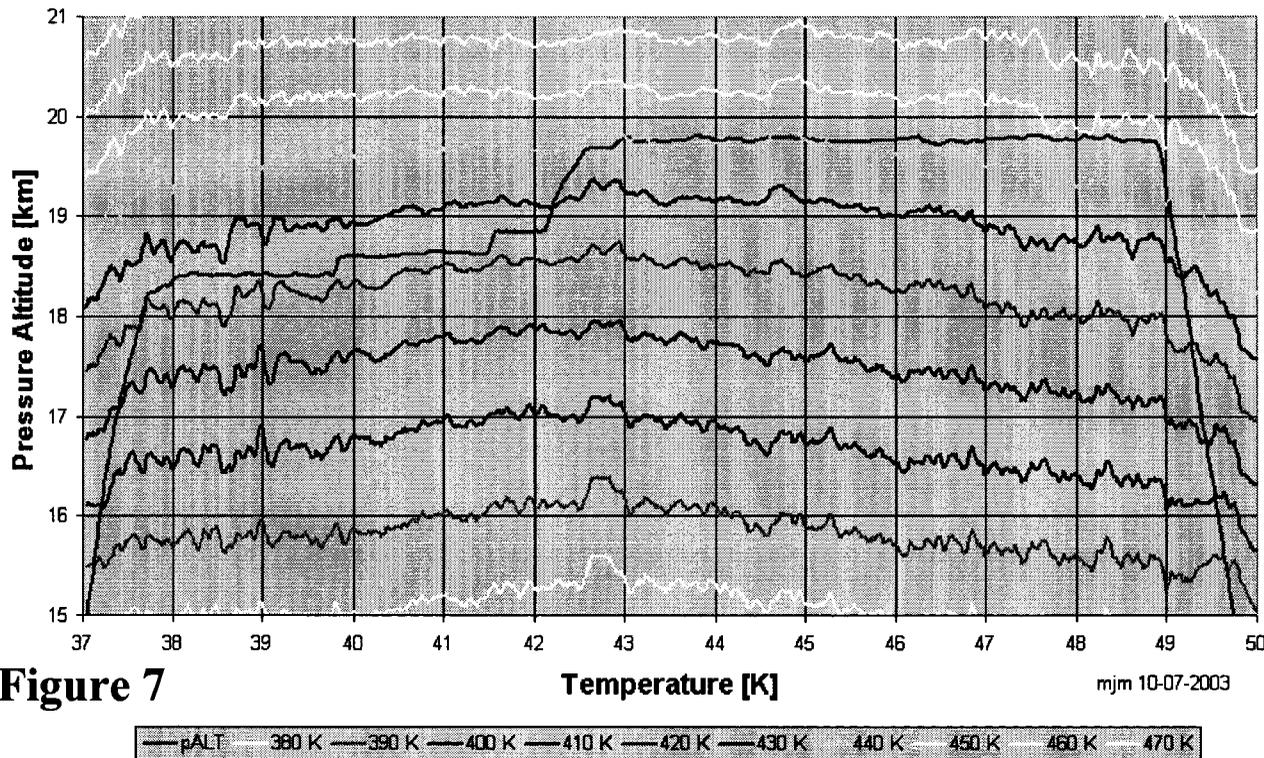
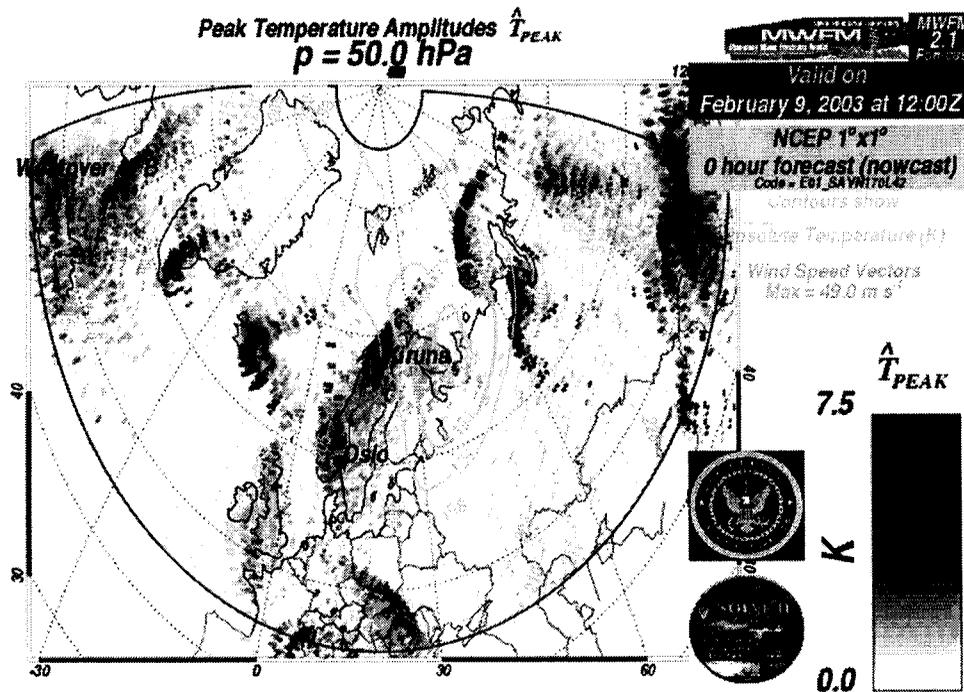


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Isentropes Altitude Cross-Section
EUPLEX - M55 20030209



- Wind Speed: 27 kts
- Wind Direction: WNW
- Lee Waves? Moderate
- 500 meter mesoscale fluctuations present near edge of vortex; these die as the M55 goes deeper
- Tropopause inversion vanishes deep in vortex

Acknowledgements

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