



Globally Relocatable Mesoscale Forecasting of the Stratosphere in Support of the SOLVE II Mission



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Mesoscale Forecast Models for SOLVE II

<http://uap-www.nrl.navy.mil/dynamics/html/solve-7646.html>

- 1. NRL Mountain Wave Forecast Model (MWFM)***
- 2. 3D Anelastic Model of Flow over Orography (3DLOM)***
- 3. Navy Operational Global Atmospheric Prediction System (NOGAPS)***
- 4. European Center for Medium-Range Weather Forecasts (ECMWF) Global Spectral Forecast Model***



MWFM: Forecasts & Products



1. *NRL Mountain Wave Forecast Model (MWFM)*

- Ray-based parameterization of mountain waves that operates as a “postprocessor” of global/regional forecast model output
- Standard 12 hourly forecasts over SOLVE area of operations, relocatable/telescopable in the field to specific regions of interest
- Started forecast operations on 26 November, 2002. Forecast maps for each day are being archived
- MWFM 1.0 & 2.0 forecasts will run in “full mode;” new MWFM 3.0 forecasts will run in “test mode.”

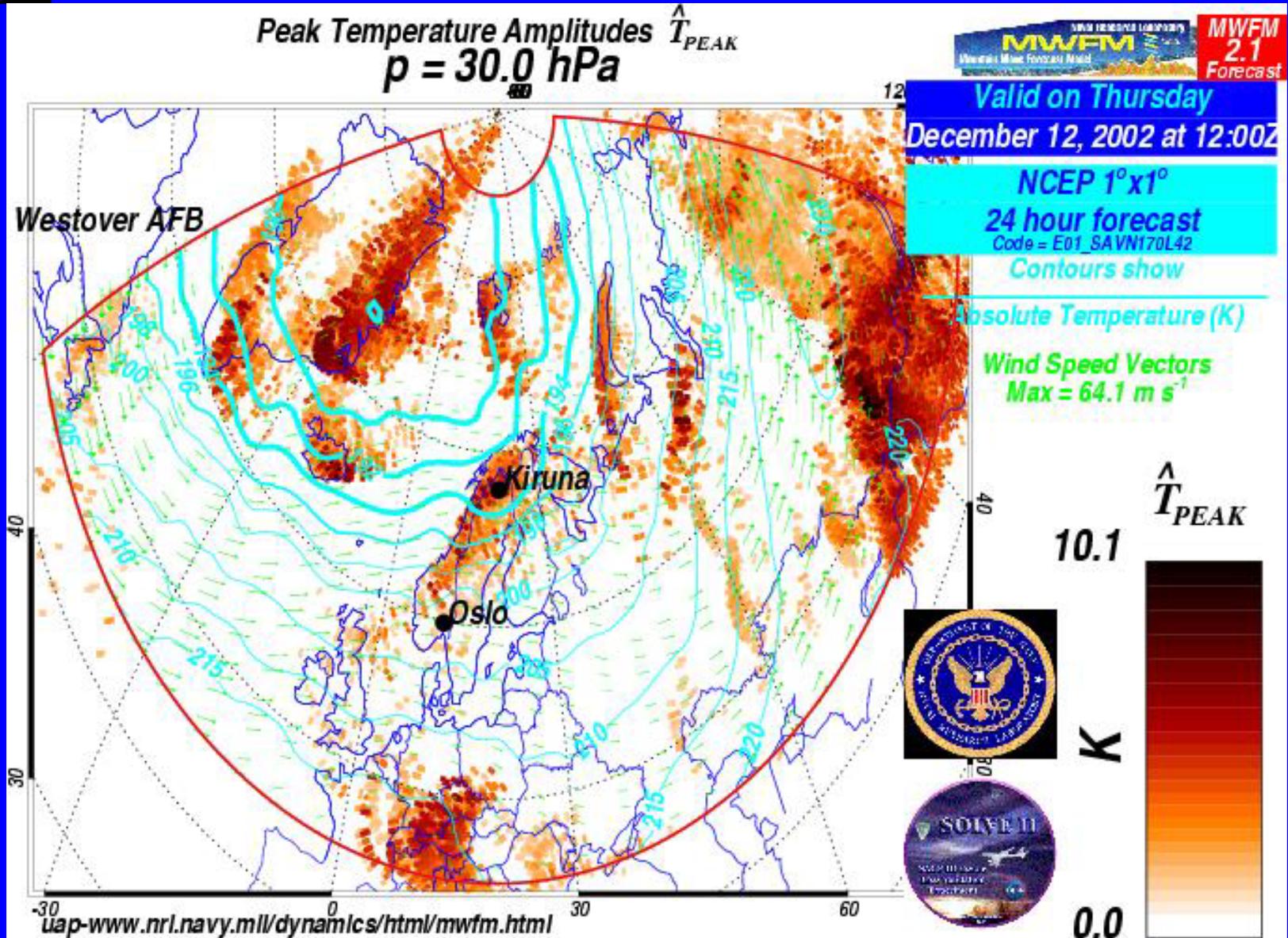
Forecast Products

- Mountain wave-induced temperature perturbations: 100,70,50,30 hPa (other levels possible)
- Mountain wave-induced turbulence: 250-30 hPa (Geophysika?)
- Hemispheric mountain wave temperature fields for use in CTM studies (Drdla)



Sample SOLVE II MWFM Forecast Map

forecast for tomorrow at 12Z and 30 hPa





ER-2 Ferry Flight Home: MWFM Hindcast

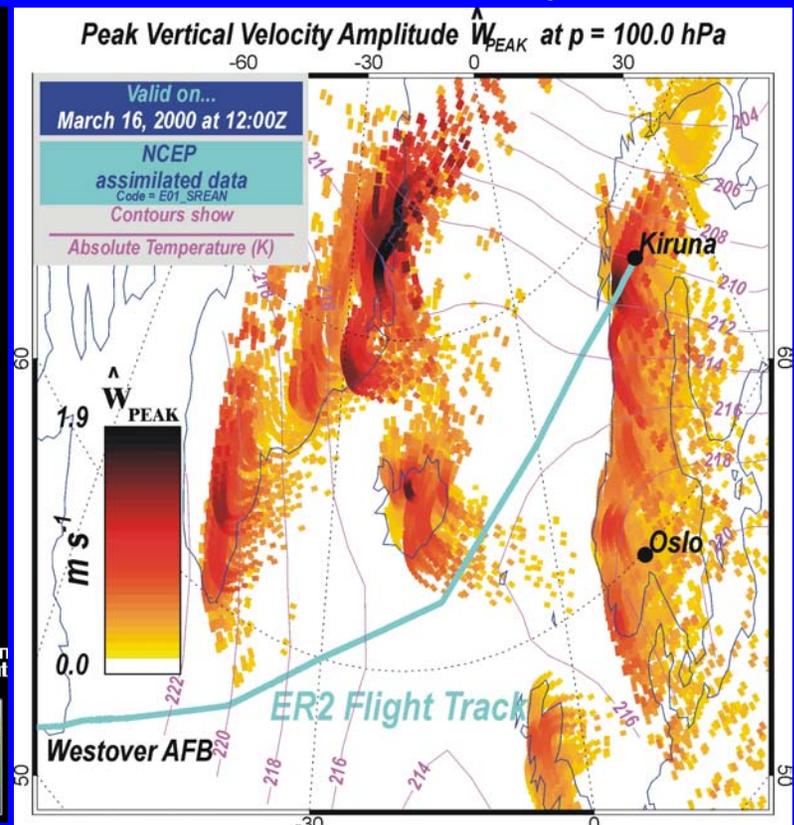
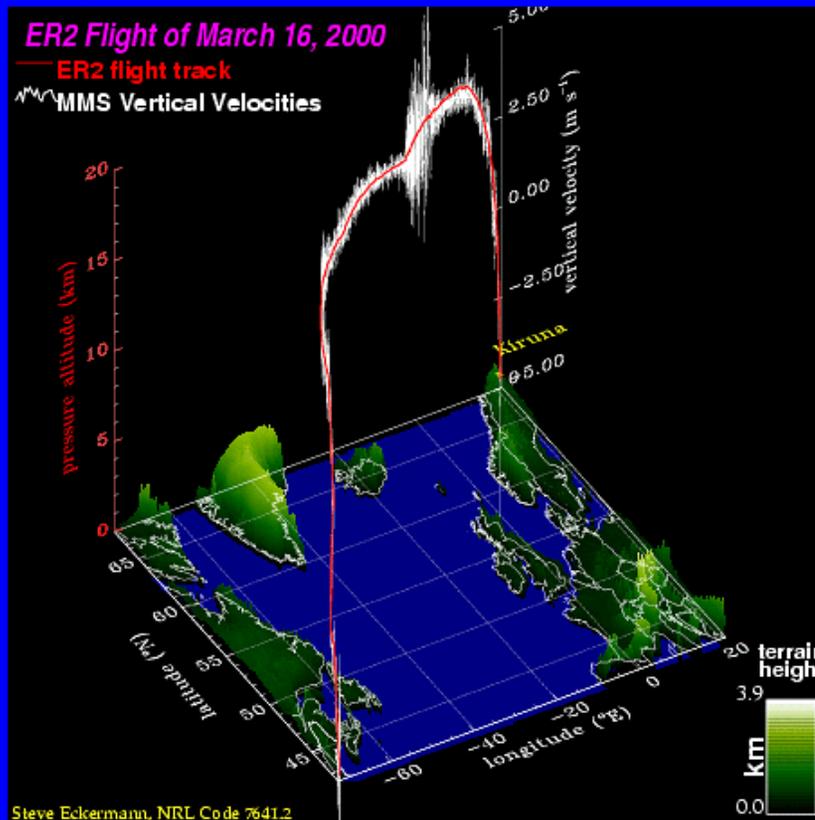
SOLVE I: 16 March, 2000

MMS Vertical Velocity Fluctuations
Measured on ER-2



ER-2 Flight Track

MWFM Vertical Velocity "Hindcast"





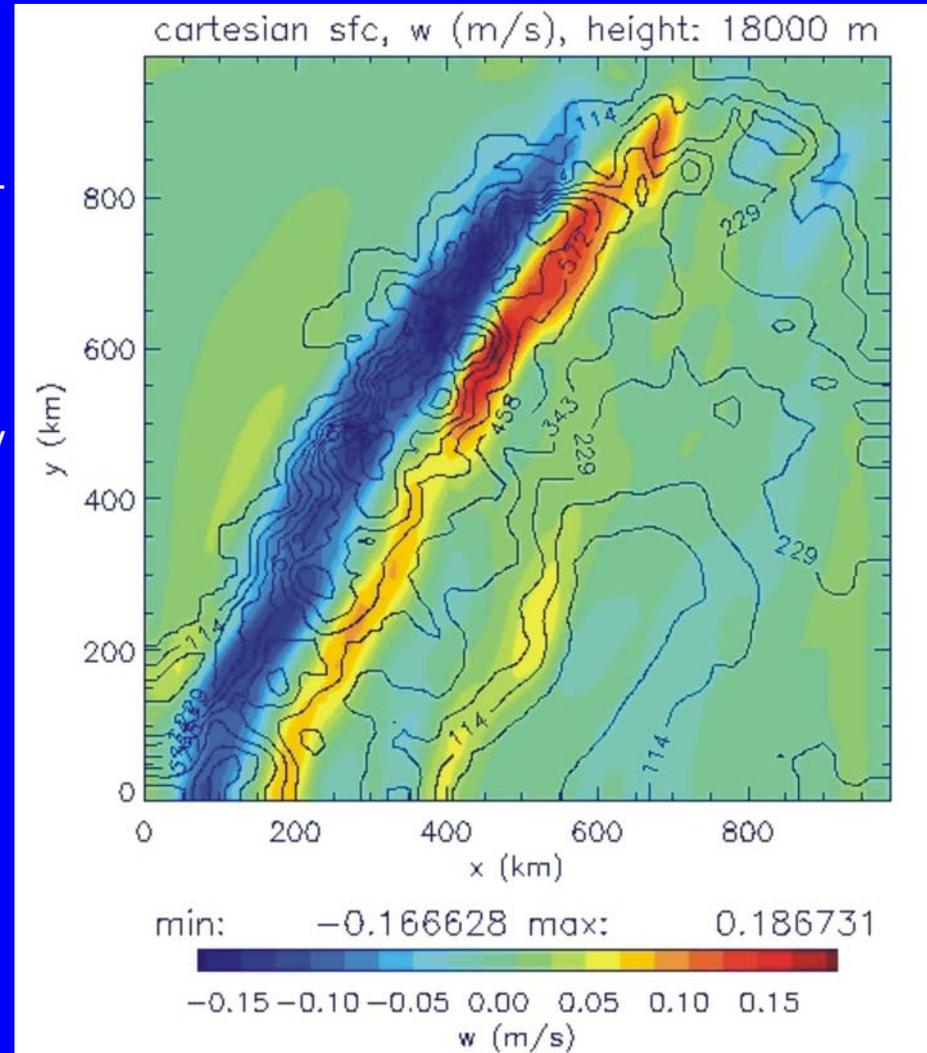
3DLOM: Forecasts & Products

2. 3D Lindeman Orographic Model (3DLOM)

- Anelastic nonlinear regional model in terrain-following coordinates.
- Free-slip (frictionless) lower boundary conditions are used, as well as radiative lateral boundaries and a diffusive sponge layer to absorb waves at the upper boundary (40 km)
- 3DLOM is a new-generation version of the Vosper Orographic Model (3DVOM) run successfully during SOLVE I
- 3DLOM will be run in a regular operational forecast mode over Scandinavia and Spitzbergen, but can be relocated and run over any region of interest that crops up during the mission

Forecast products

- 3D mountain wave temperature and wind perturbation maps.

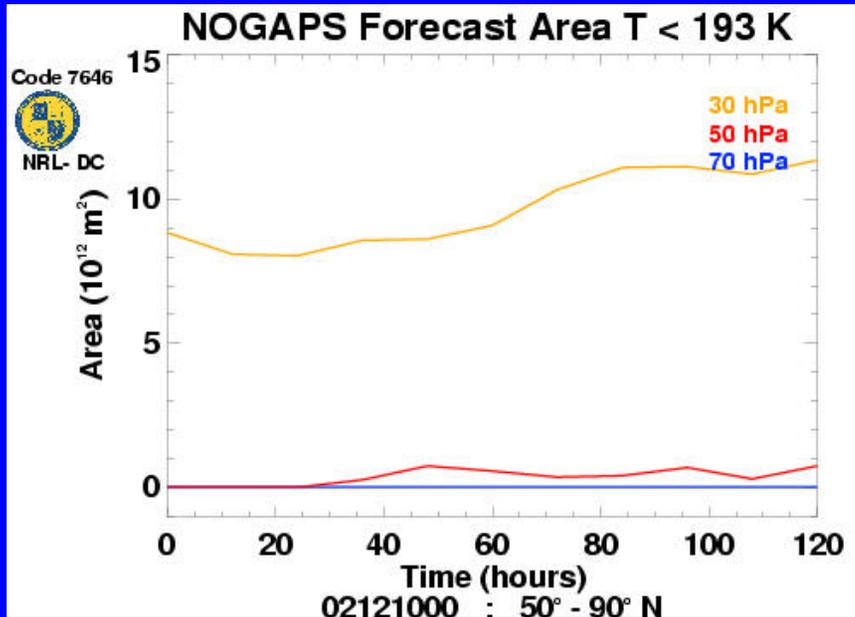




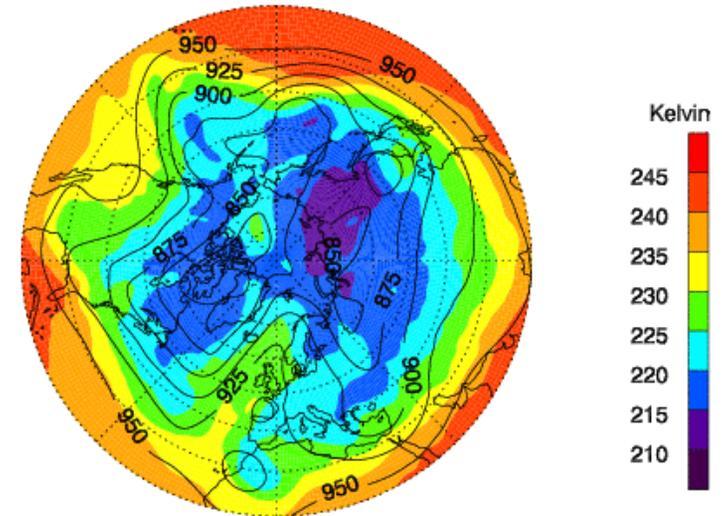
NOGAPS Forecasts & Products

3. Navy Operational Global Atmospheric Prediction System (NOGAPS)

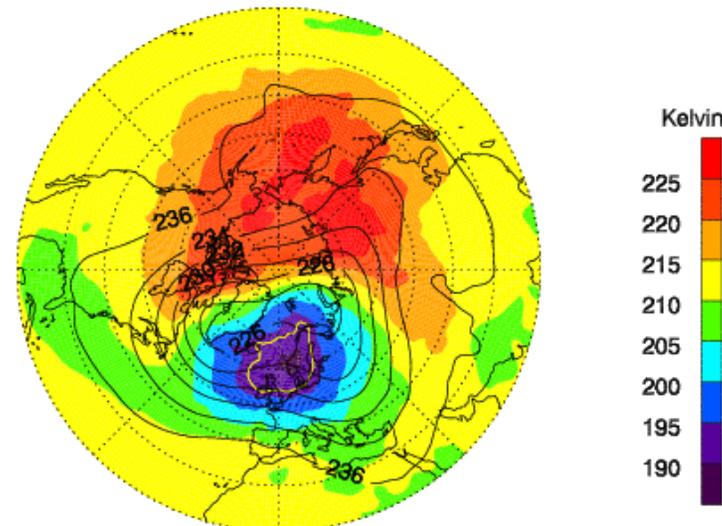
- utilizes output from the T239L30 (~50 km resolution) operational NOGAPS model run twice daily at Fleet Numerical (FNMOC) in Monterey, CA
- Synoptic temperatures at 300,100,70,50,30 hPa studying “minihole” events and PSC areal extents



300 hPa : 02010300 : t = 096 h



30 hPa : 02010300 : t = 096 h





ECMWF: Forecasts & Products

4. European Center for Medium-Range Weather Forecasts (ECMWF) Global Spectral Forecast Model

- Access being arranged through a formal SOLVE II scientific collaboration with Dr. Bryan Lawrence, Head of the British Atmospheric Data Centre at the Rutherford Appleton Laboratory
- Access forecasts from the global spectral T511L60 model (~20 km horizontal resolution) extending from 0-60 km
- Runs every 6 hours and generates forecasts in 3 hour increments – we will access a much smaller subset for data volume reasons.

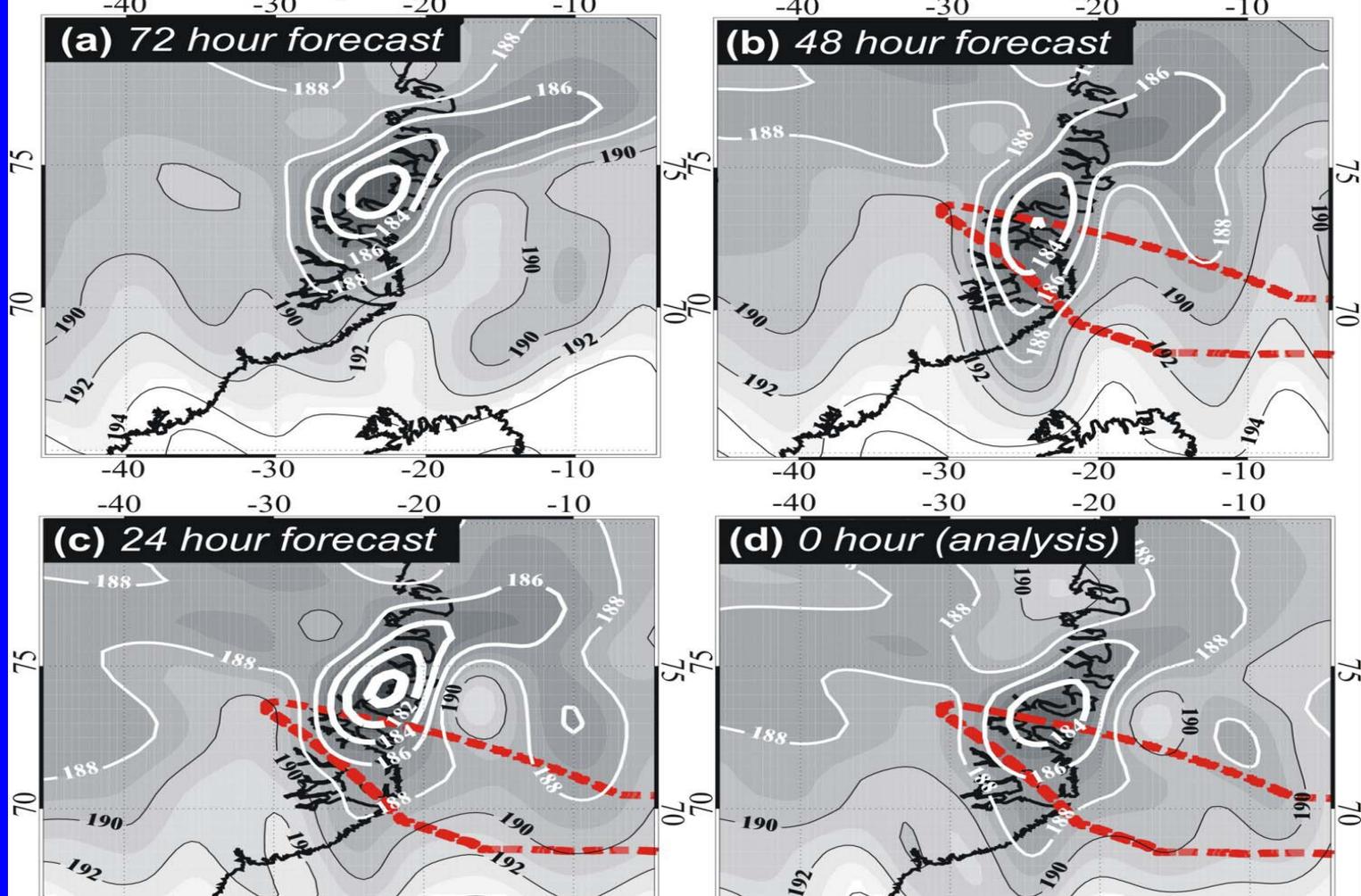
Forecast Products

- Temperatures, winds and geopotential heights over SOLVE area of operations
- A new “gravity wave” product derived from ECMWF divergence fields
- Prognostic ECMWF ozone fields (?)



Forecast Evolution of Mesoscale Cold Pool on January 23, 2000 during SOLVE I

ECMWF Temperatures: 30 hPa: 23 January, 2000 12Z



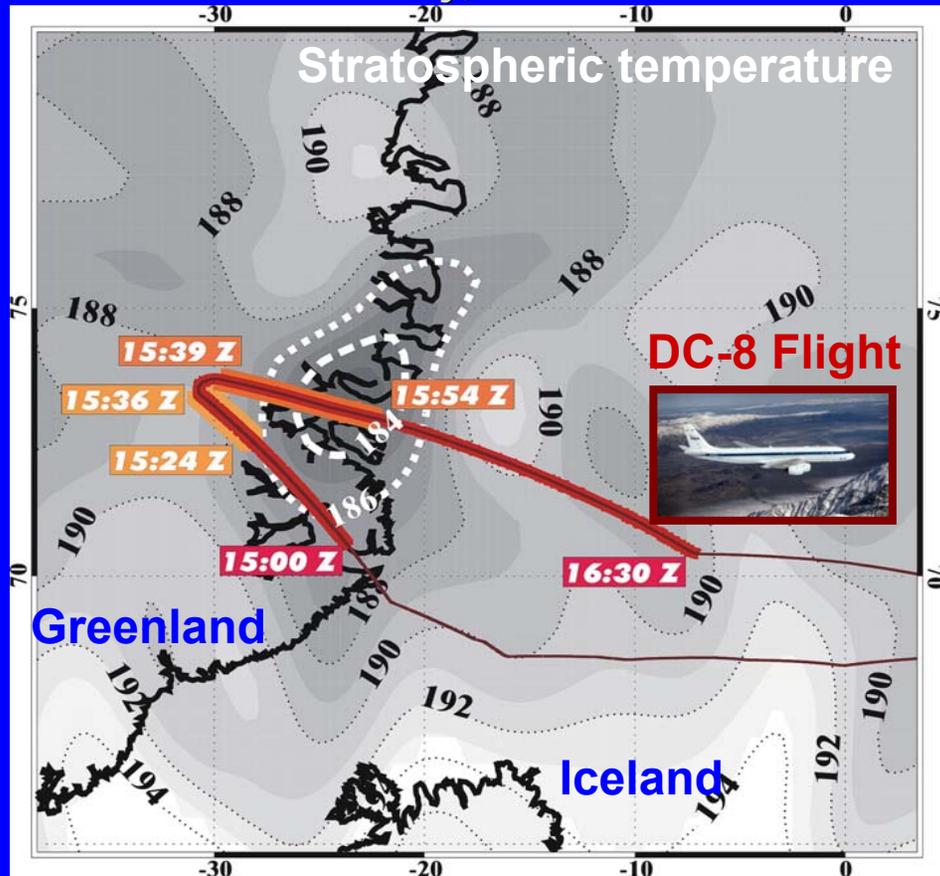
Persistent forecast feature → resolved mountain wave



GSFC/LaRC Lidar Data from DC-8 Flight

SOLVE 1: 23 January 2000

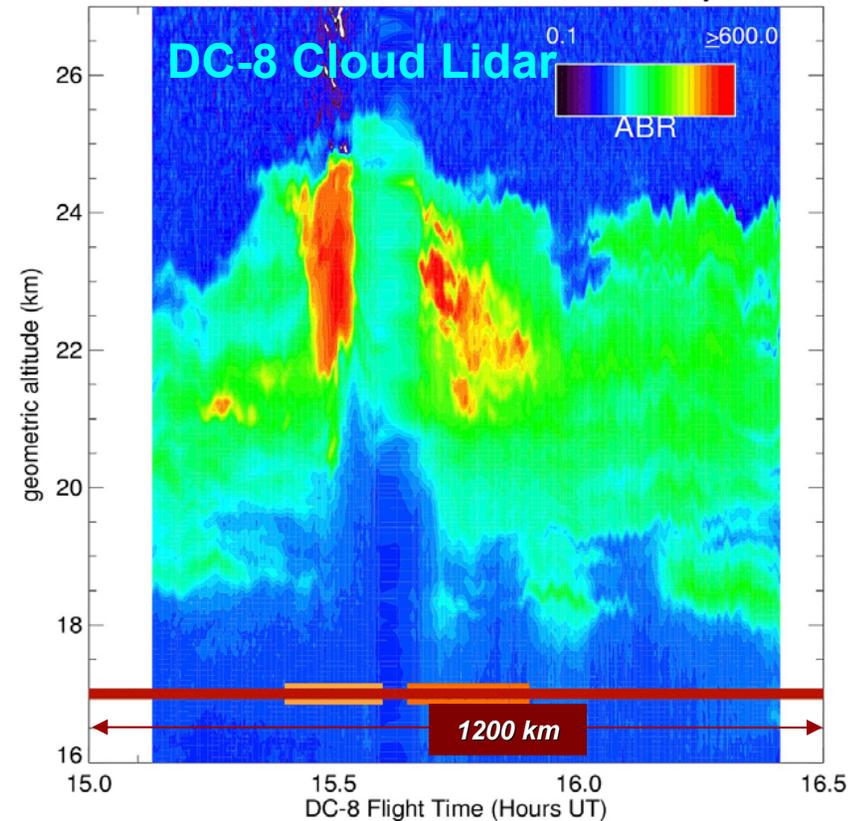
ECMWF 30 hPa Analysis Temperatures
23 January, 2000 12 Z



1064 nm Aerosol Backscatter Ratio

$$\gamma = (\beta_a + \beta_m) / \beta_m$$

GSFC/LaRC Lidar 1064 nm ABRs, DC8: January 23, 2000



“Mesoscale cold pool” forecast in stratosphere over Greenland (left). NASA DC-8 underflight (left) revealed thick resulting stratospheric cloud (right).



Science Goals

- Use forecasts to aid overall science return of SOLVE II DC-8 flights through accurate operational forecasting of stratospheric air at sub-NAT temperatures (~ 194 K or less)
- Use mountain wave forecasts to identify and probe mountain wave PSCs and address renewed interest in their role in denitrification (e.g., *Dhaniyala et al., Geophys. Res. Lett., 2002*)
- Investigate the form and reliability of gravity waves explicitly simulated by the latest high-resolution global weather forecast models (e.g., ECMWF, NOGAPS)
- Study dynamics of “miniholes” and their role in producing extremely cold stratospheric temperatures at synoptic scales (through coherent column ascent) and mesoscales (through increased gravity wave transmission and/or production)



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