MTeX: The Mesosphere-Lower Thermosphere Turbulence Experiment

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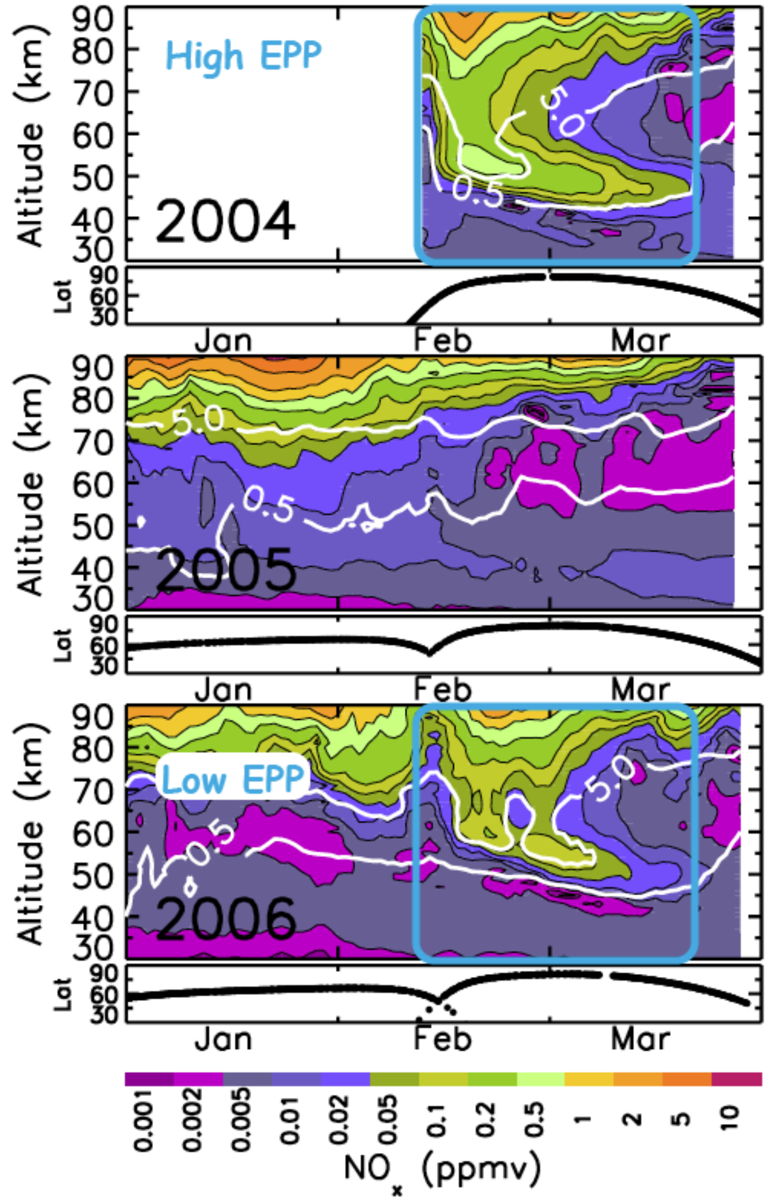
NOx in Middle Atmosphere

Observations show NOx in stratosphere and mesosphere does not just dependent on Energetic Particle Precipitation but on meteorological conditions.

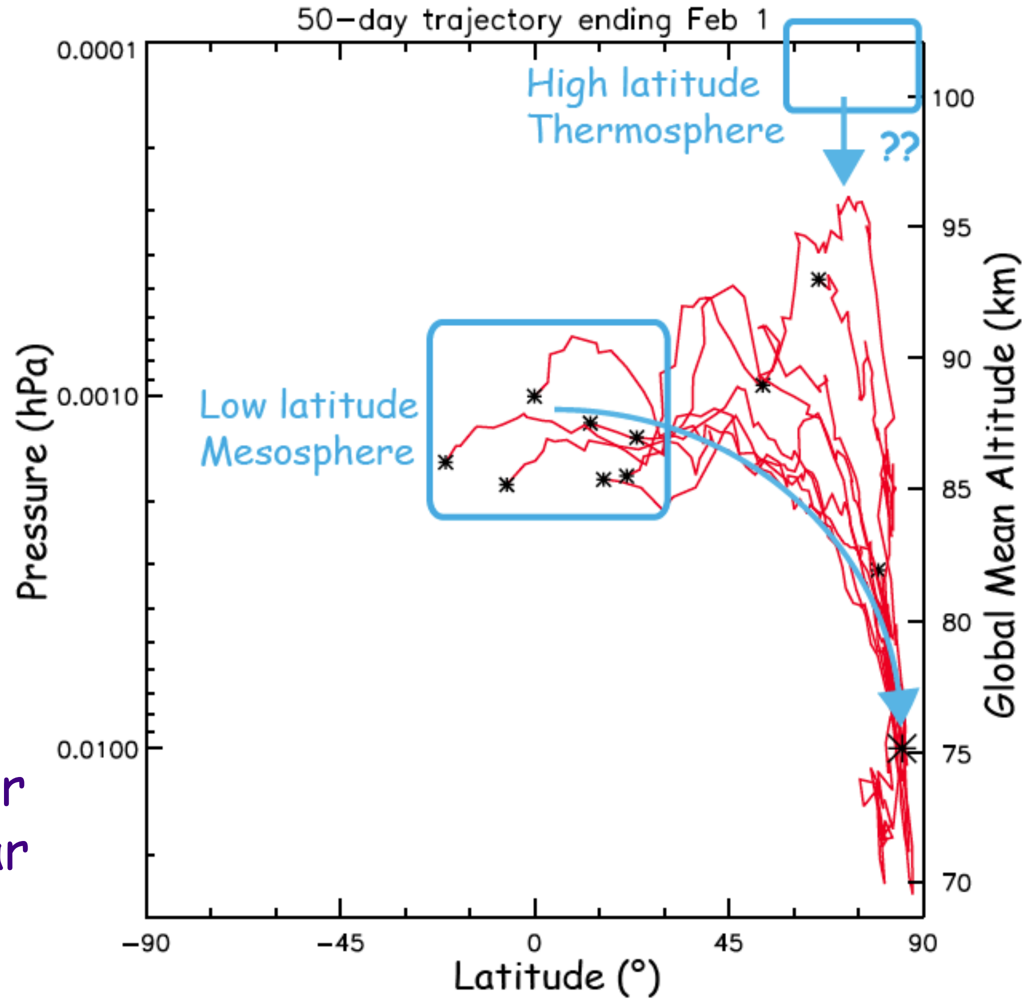
The meteorological conditions can result in significant impacts on the ozone layer in years of relatively modest geomagnetic activity.



Transport

These events have been conventionally understood in terms of the incursion of thermospheric
air into the mesosphere and stratosphere.

WAACM studies show that the residual circulation transports air meridionally from the low latitudes rather than vertically from the polar thermosphere.



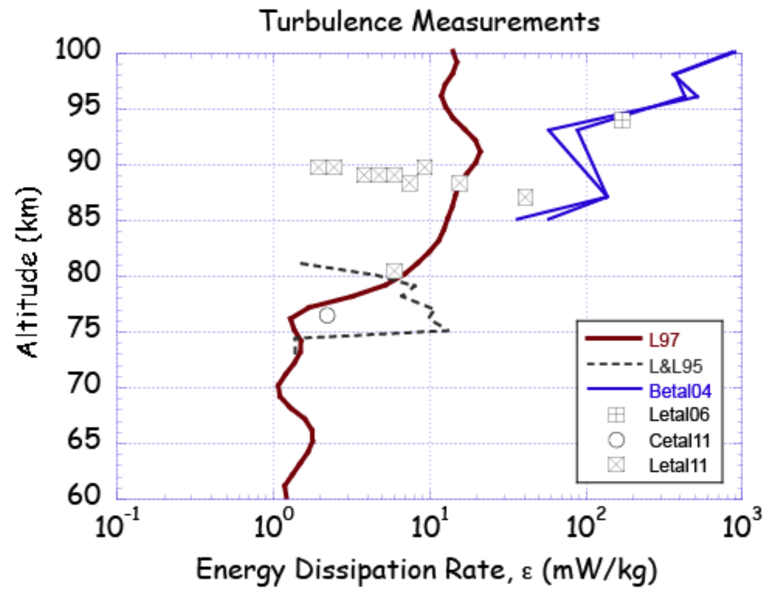
Coupling can only be explained by diffusive transport.

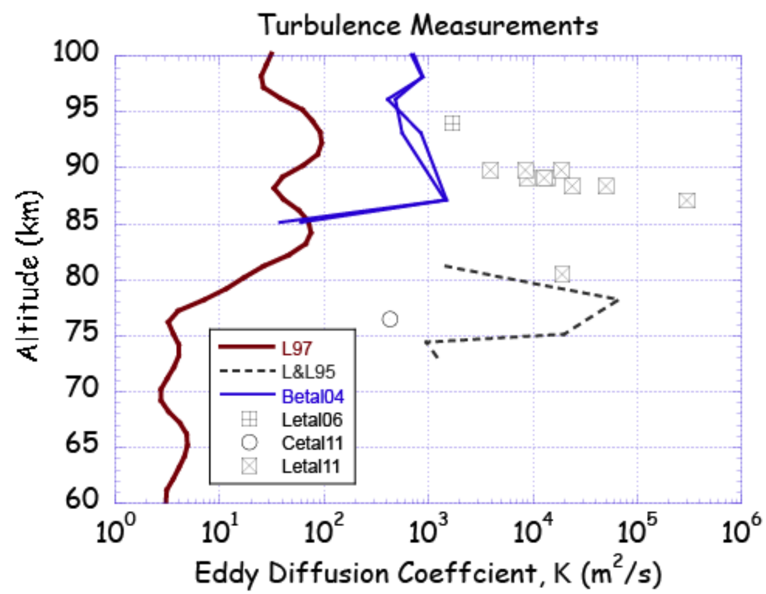
Turbulence

In-situ, release expansion, metal layer motion, measurements yield a very large range of values of energy dissipation rates, ε, and eddy diffusion coefficients, K.
Large range of turbulent values is due to measurements reported in wide variety of conditions.

$$\varepsilon = \frac{1}{0.81} \times \left(N^2 \times K\right)$$

For ε = 1 -1000 mW/kg is equivalent to heating rates of 0.086 - 86 K/day.



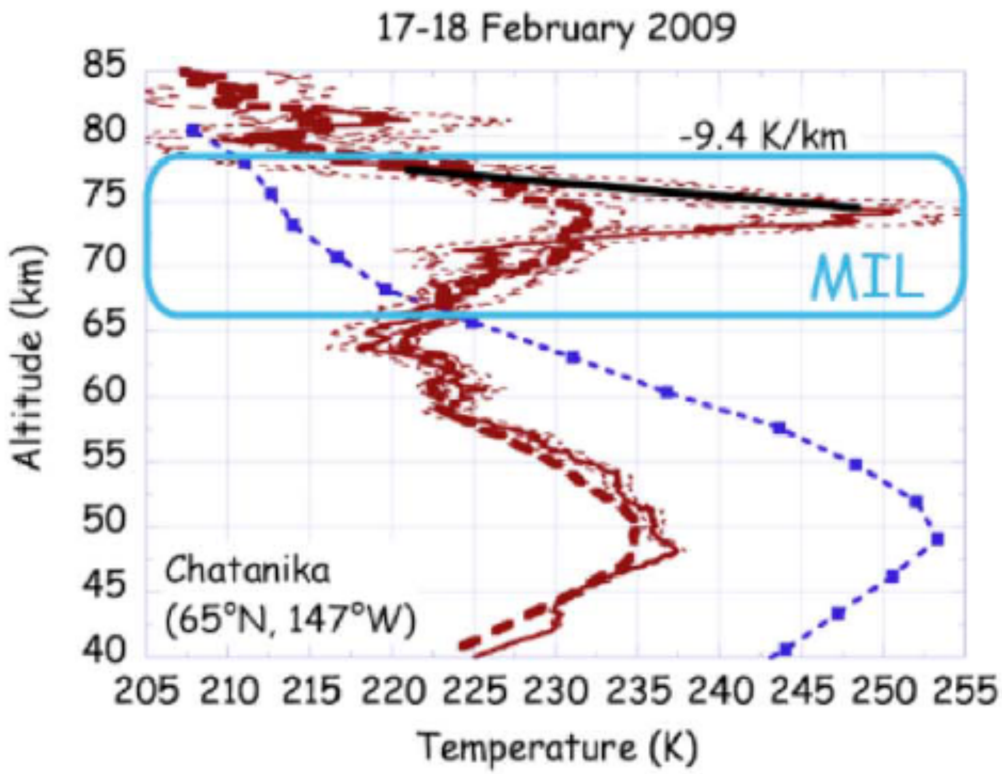


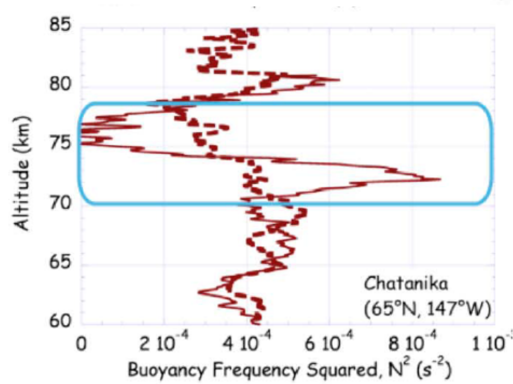
MILs-1

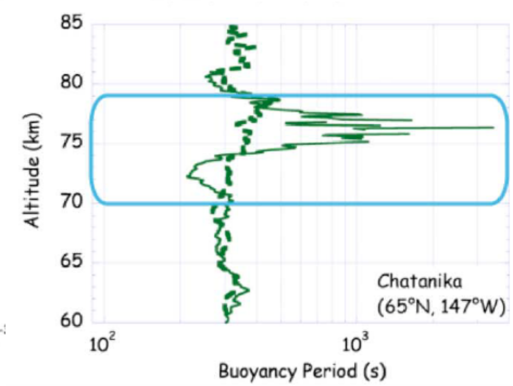
Mesospheric Inversion Layers (MILs) form over long periods with overlying adiabatic lapse rates- indicating presence of instability and turbulence.

Radar studies have shown enhanced scattering layers co-located with MILs.

The stability varies significantly over the altitude range of the MIL.





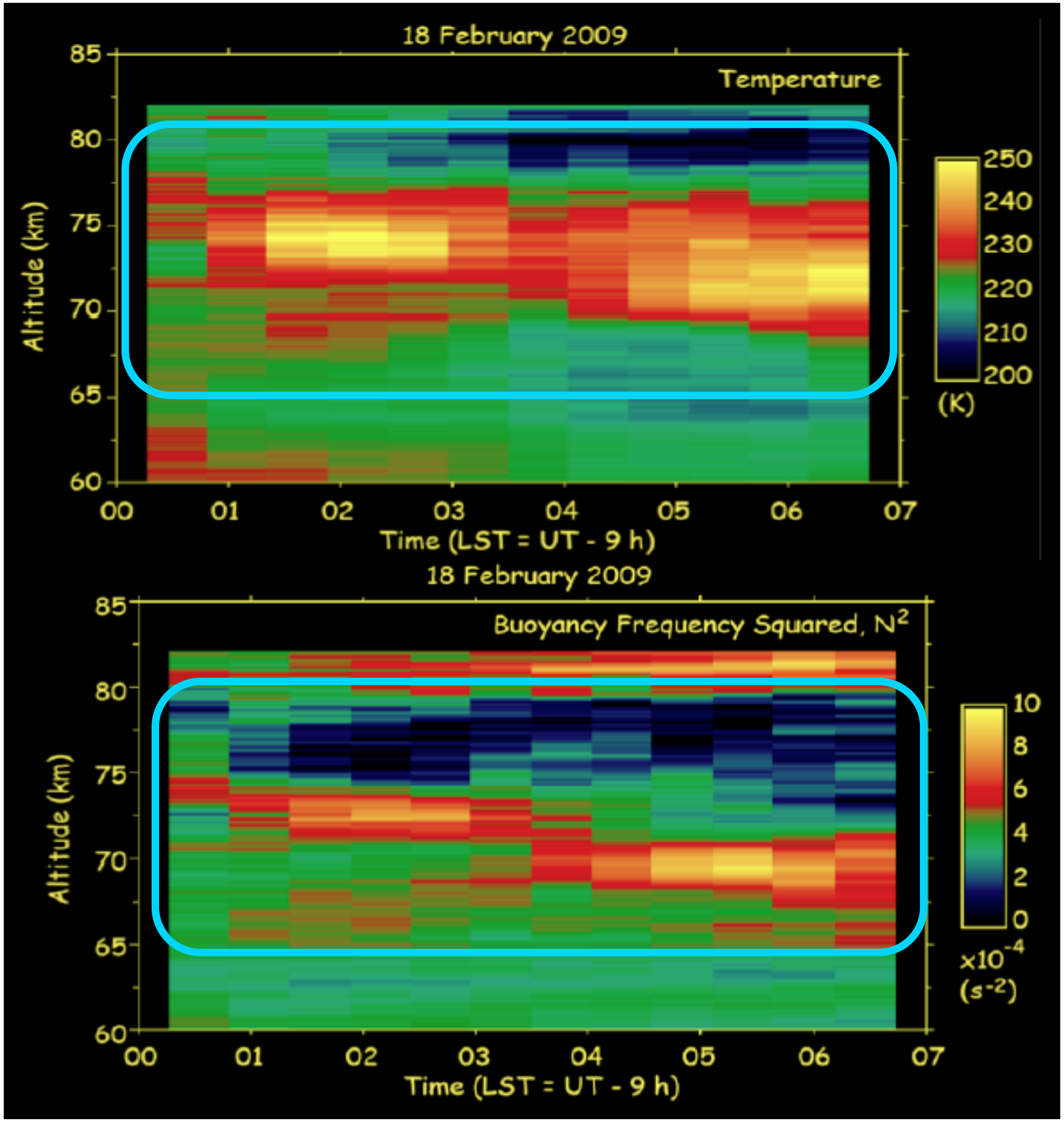


MILs-2

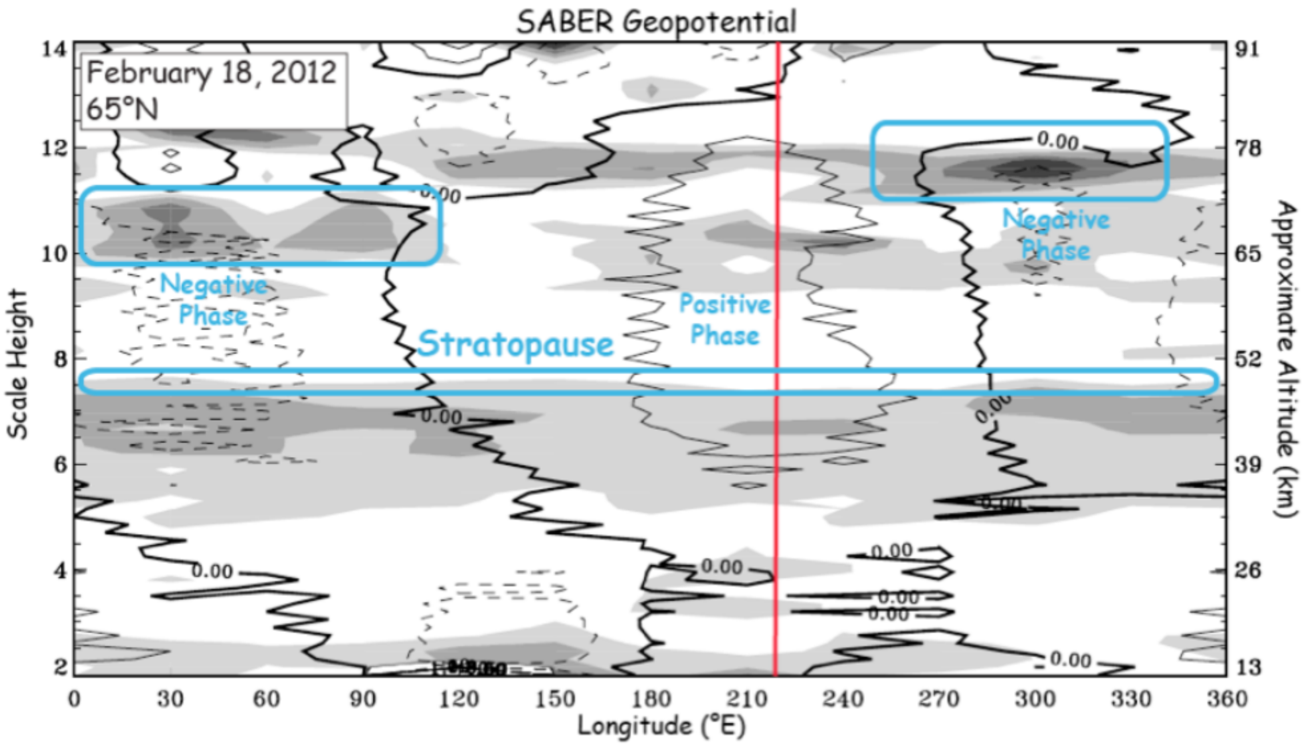
The MILs persists for over 6 h.

The region of instability (blue-black) overlies a region of enhanced stability (yellow-red).

At Chatanika MILs are detected ~40% of the time in January and February.

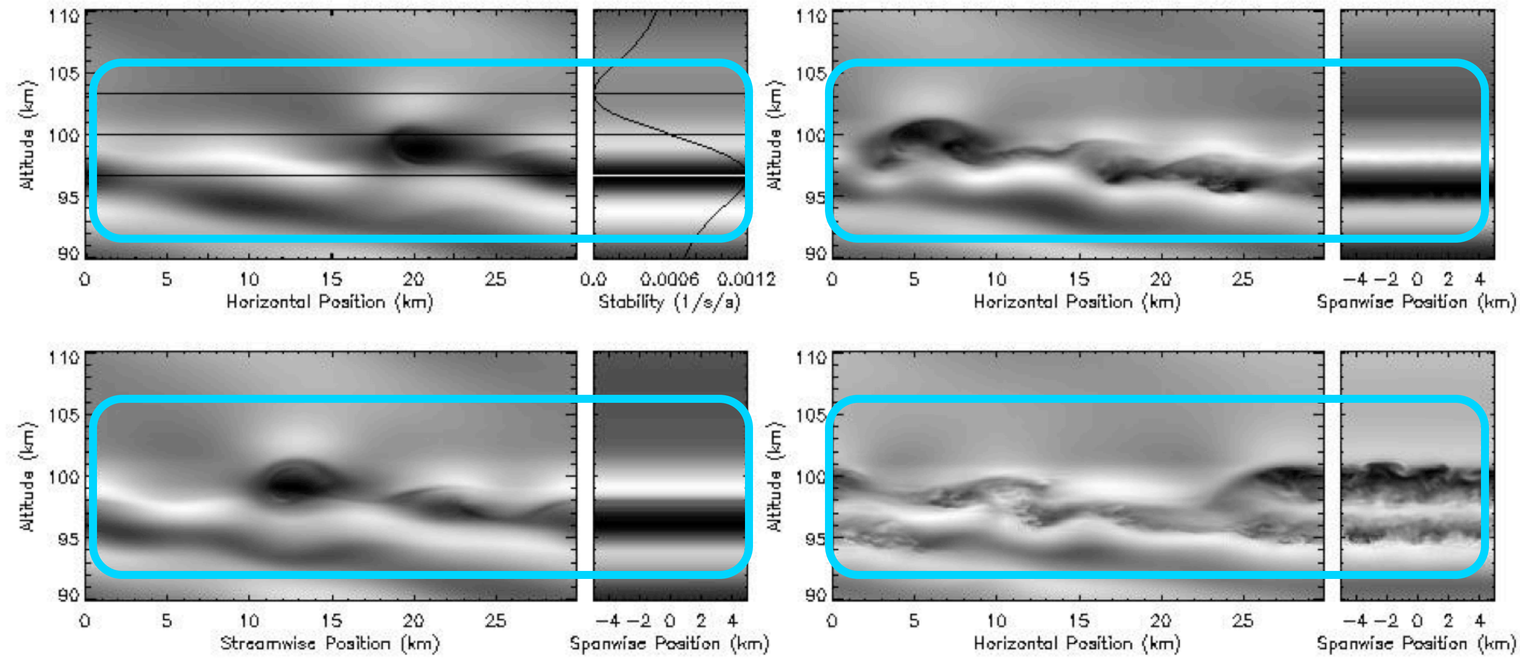


MILs-3



The MIL is part of a global-scale structure associated with a quasi-periodic planetary wave (PW). The sharpest gradients are associated with the negative phase of the breaking PW.

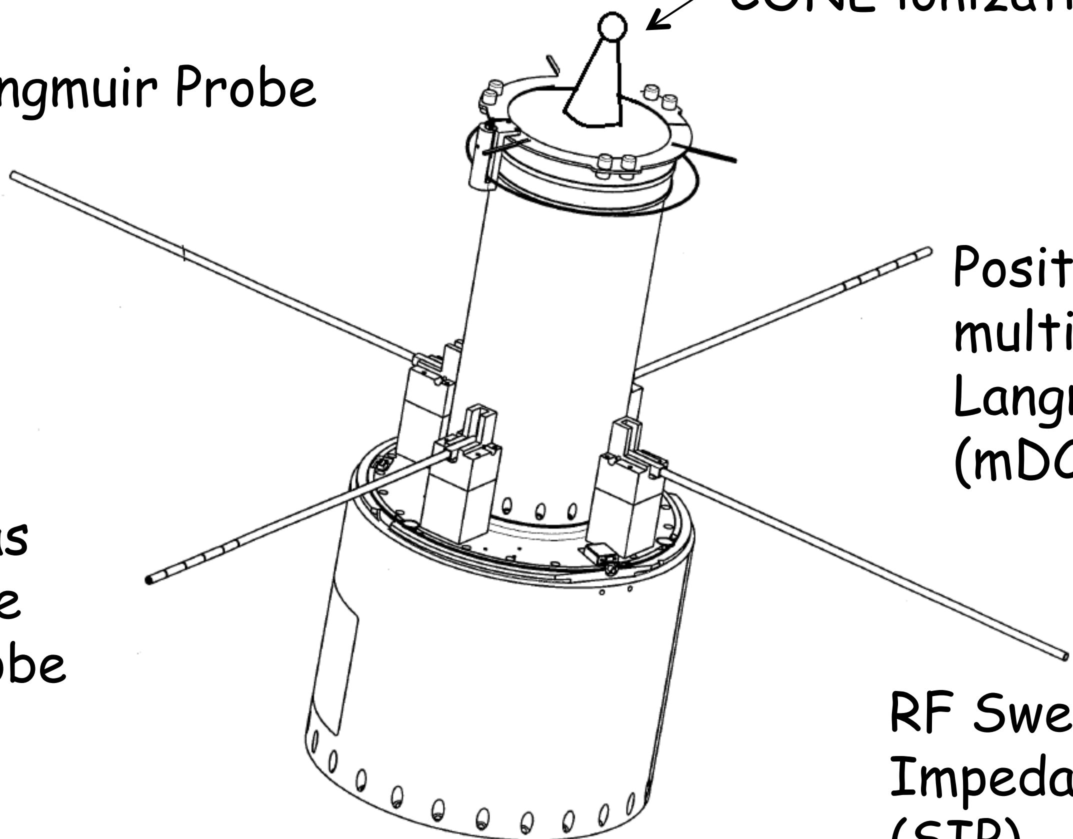
Numerical Models



Simulations over ~1 gravity wave period (N/3) reveals that gravity wave instabilities and turbulence are confined to the MIL stable region and are confined below the adiabatic layer above it.

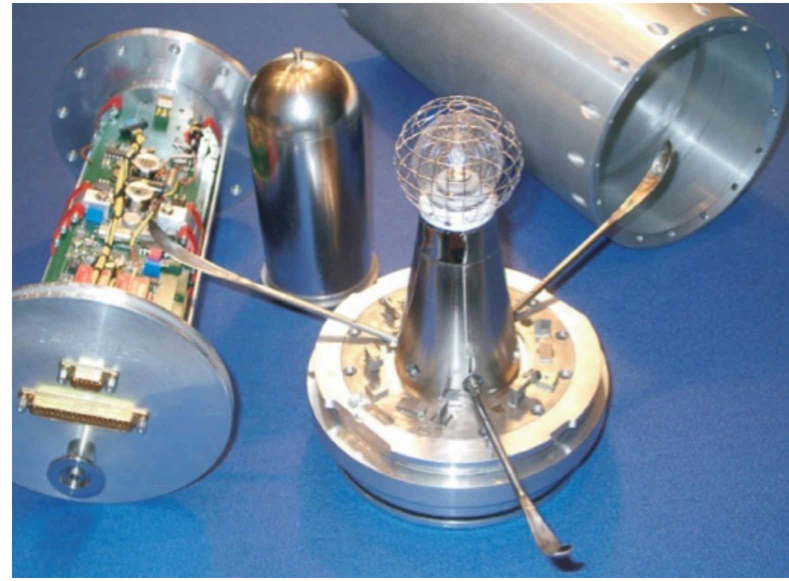
MTeX Experiment

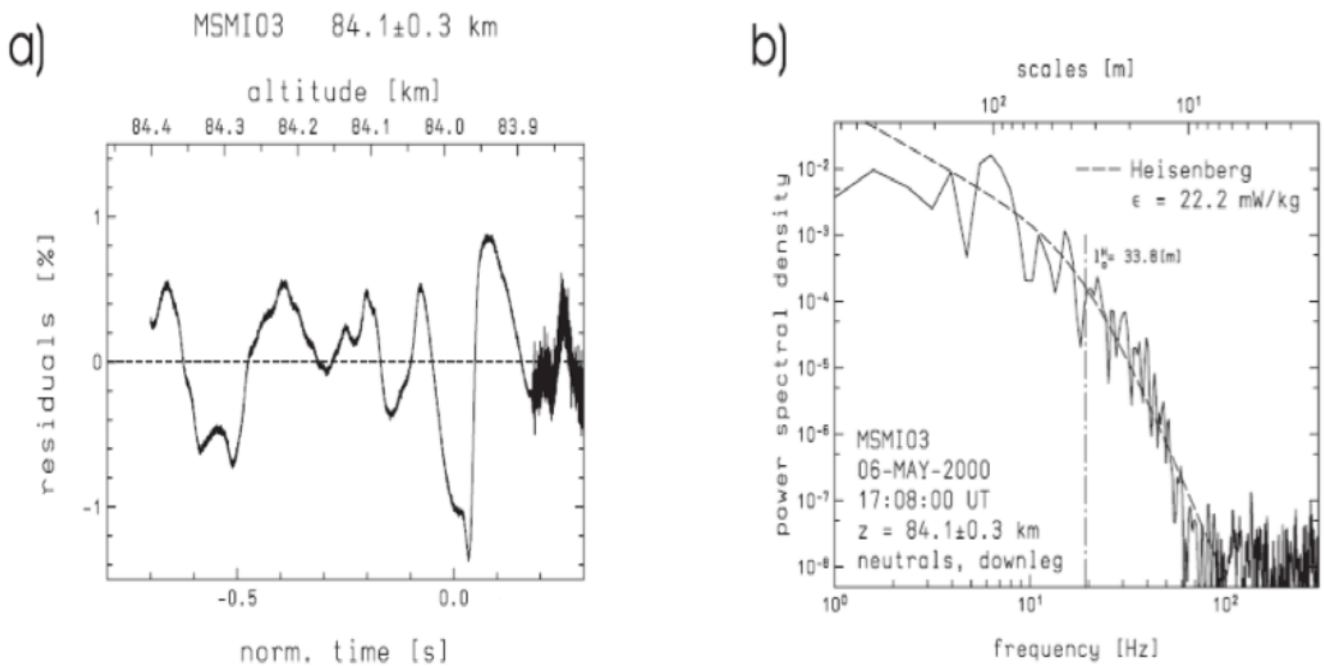
Two identical payloads launched into same volume within 2 hr in one night. Each rocket payload is a combined neutral and plasma sensor suite.



CONE

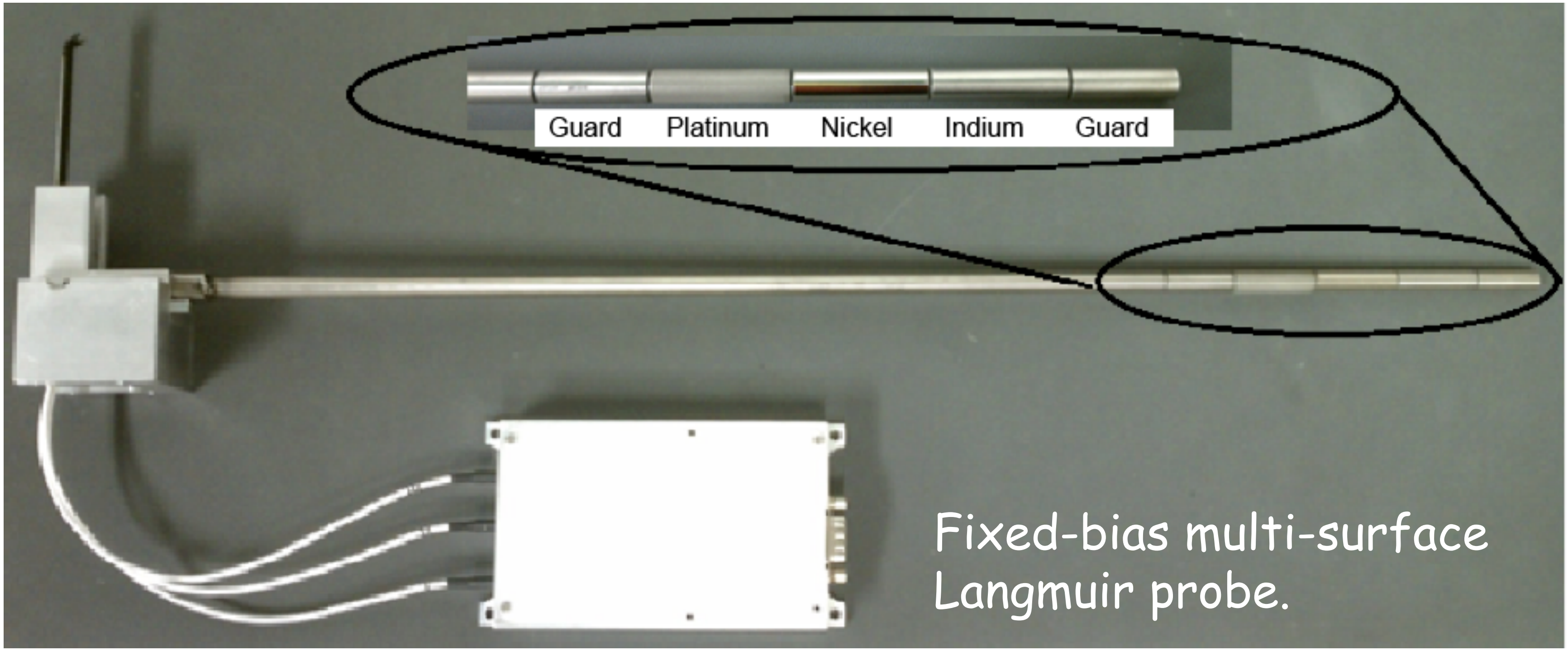
CONE is an ionization gauge that measures fine scale fluctuations at turbulent scales that can be then used to determine the energy disspiation rate.





Plasma Sensors

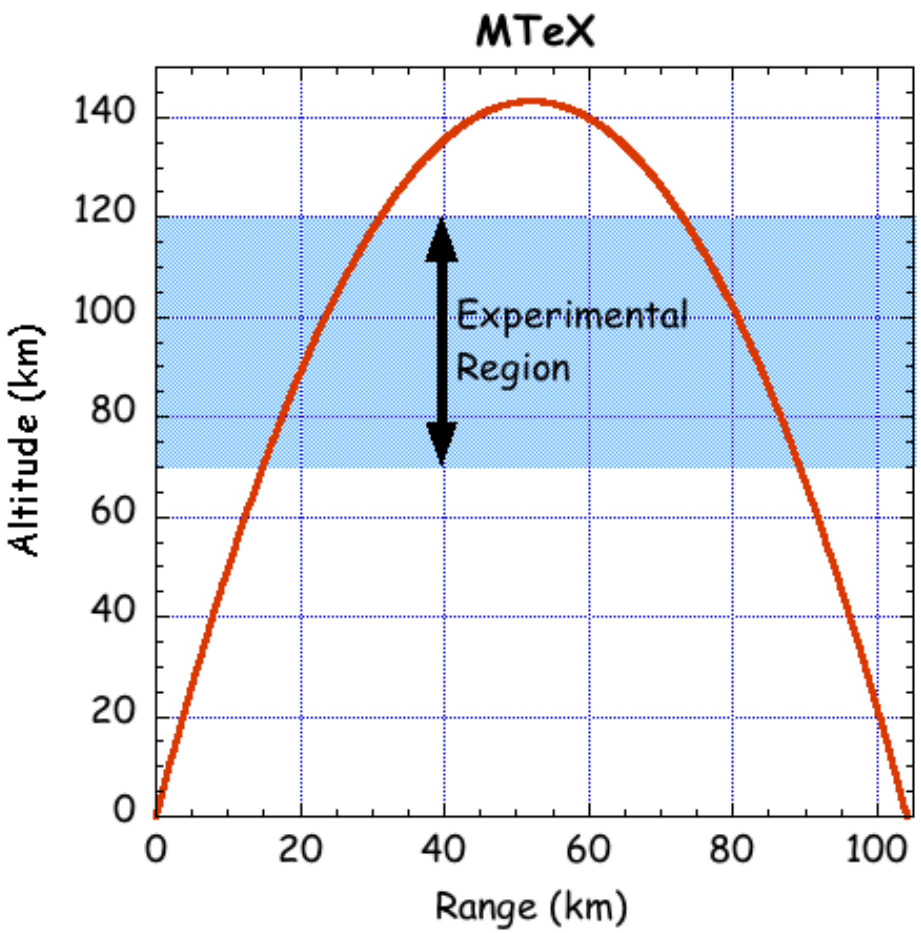
Langmuir Probes built at Embry Riddle Aeronautical University (ERAU).
Impedance probe may be built in collaboration with Utah State University.
Plasma instrument suite integration will be overseen by ERAU.



Rocket Trajectory

Rocket will reach apogee at ~140 km at ~50 km from Poker Flat.

Rocket trajectory designed to allow turbulence measurements on both upleg and downleg yielding two measurements per rocket.



Related Measurements

The Poker Flat Incoherent Scatter Radar (PFISR) observations will be used as additional input to the experiment providing measurements of ionization and (depending on the level of
Ionization) winds and turbulence.

All-Sky Cameras, Photometers, and Spectrometers at the Davis Science Center will provide observations of auroral conditions.

Resonance lidar observations providing measurements of sodium and/or iron layers.

MTeX Summary

1. 13-25 January 2015
2. Turbulent transport is the “missing link” in understanding the vertical transport between the thermosphere and mesosphere that controls how ozone-active chemicals travel downward into the ozone layer.
3. Measurements of turbulence have a wide set of values due to the variety of background conditions. What is a “representative” value of turbulence?
4. We will measure turbulence in a persistent meteorological environment with well-defined persistent mesospheric inversion layer associated with large scale planetary-wave activity.
5. We will use high-resolution numerical modeling to investigate wave-breaking scenarios driven by the observations that allow direct estimation of eddy diffusion and dissipation rates.

AGU FALL MEETING

San Francisco | 9–13 December 2013

SA018. Vertical Coupling and the Disturbance of the Winter Polar Atmosphere

Section/Focus Group: SPA-Aeronomy (SA)
Co-Sponsors: Atmospheric Sciences (A)
Conveners:

1. Richard Collins, University of Alaska Fairbanks , rlc@gi.alaska.edu
2. Larisa Goncharenko , Massachusetts Institute of Technology, lpg@haystack.mit.edu
3. Walter Robinson , North Carolina State University, walter_robinson@ncsu.edu

Description:

The Arctic atmosphere has shown large variability in recent winters. Disturbed winters have been characterized by disruption of the polar circulation and vortex during stratospheric sudden warming events driven by planetary waves. Observations have shown related disturbances at high- at mid- and low-latitudes in the upper- middle- and/or lower atmosphere. These disturbances with time-scales of weeks provide a natural laboratory for understanding coupling between the troposphere, stratosphere, mesosphere, and thermosphere. We invite contributions from both observational and modeling studies that illustrate coupling processes in the preconditioning and response of the atmosphere to stratospheric sudden warming events.

https://fallmeeting.agu.org/2013/scientific-program/session-search/sessions/sa018-vertical-coupling-and-the-disturbance-of-the-winter-polar-atmosphere/