Climatology of mesospheric gravity waves and their sources above Rothera, Antarctica

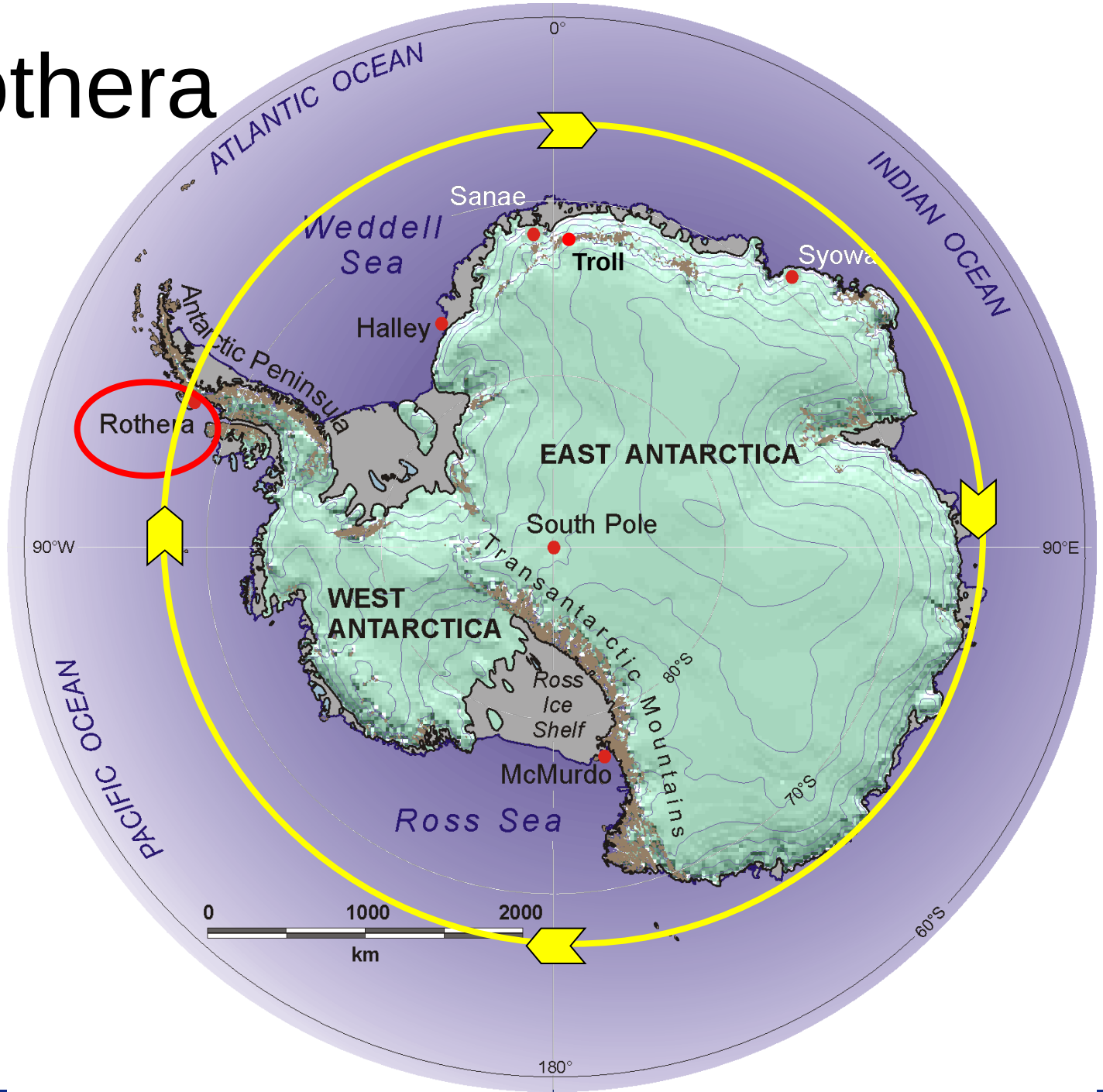
T. D. Demissie, H. Lund, P. J. Espy and R. E. Hibbins
Norwegian University of Science and Technology
Trondheim, Norway

Background Picture from D. Fritts

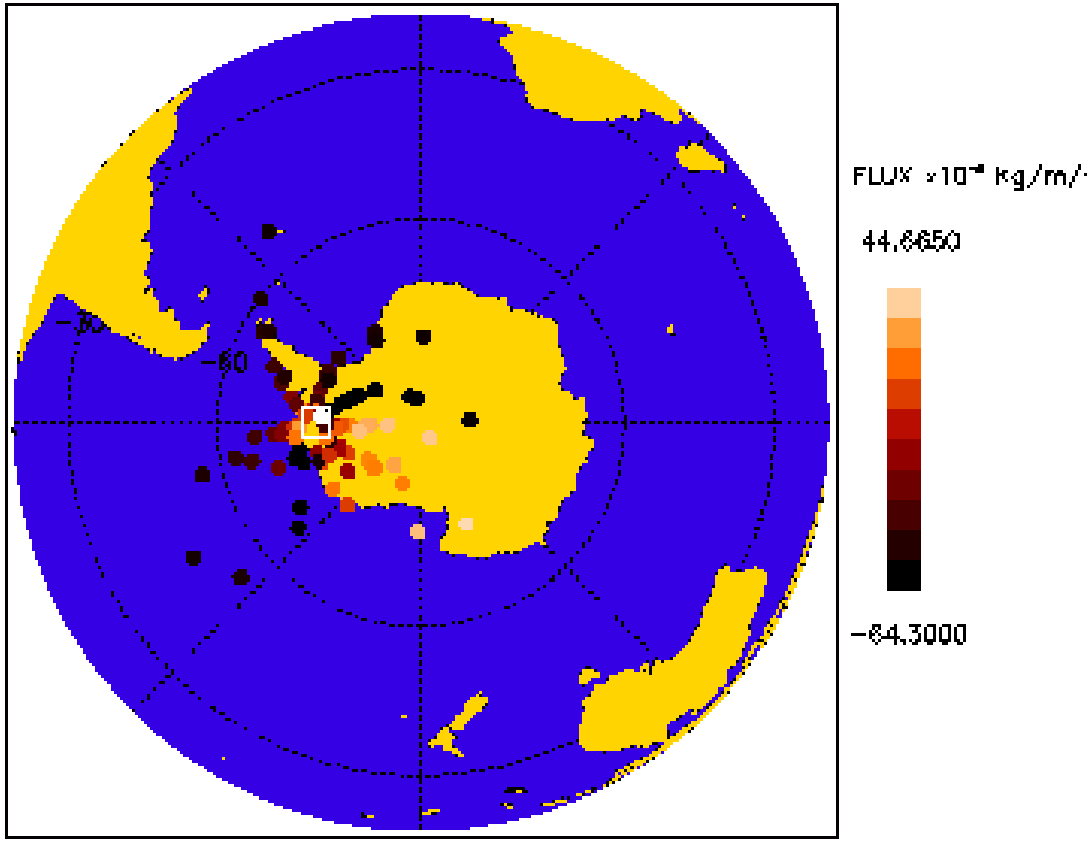
Motivation

- Can one use nightglow airglow temperatures from Rothera, Antarctica to infer gravity-wave variance?
- Why?
  - Many multiple year data sets available for trend analysis
  - Over 50 NDMC stations available to supplement radar observations for global coverage

Rothera

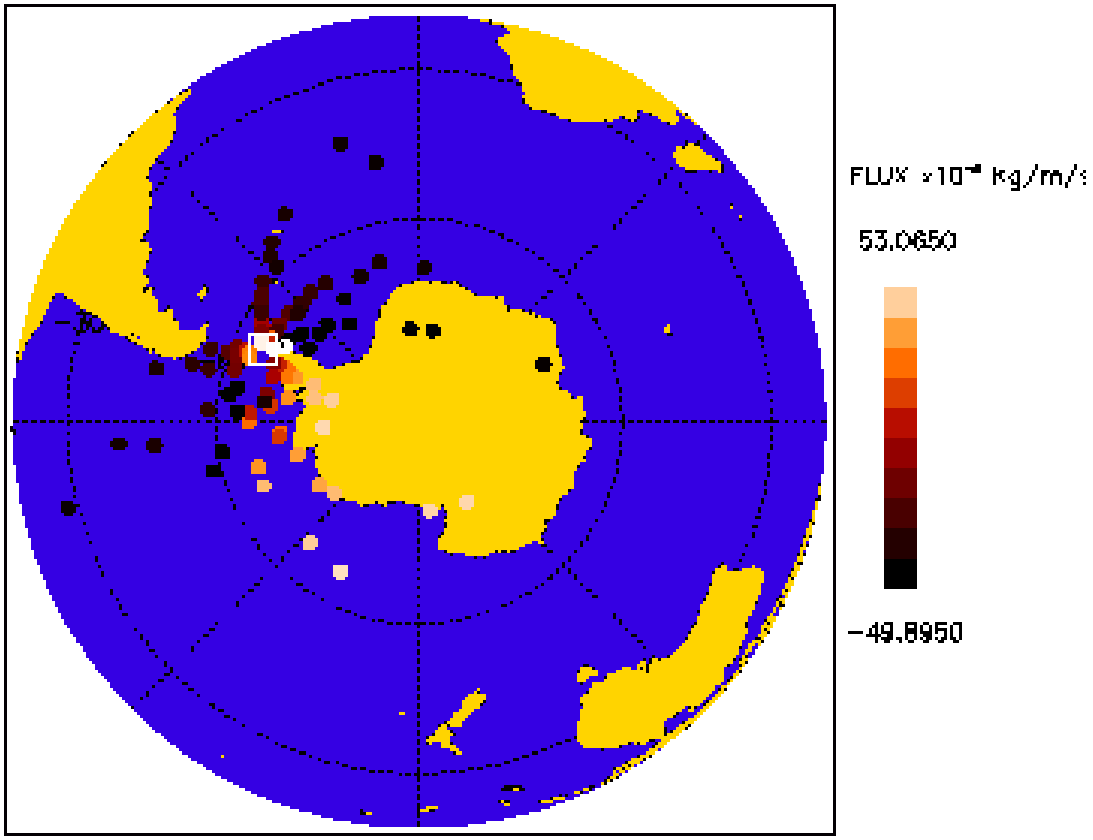

ATLANTIC OCEAN
INDIAN OCEAN
PACIFIC OCEAN
Weddell Sea
Ross Sea
Sanae
Troll
Syowa
Halley
Antarctic Peninsula
Rothera
EAST ANTARCTICA
South Pole
WEST ANTARCTICA
Transantarctic Mountains
Ross Ice Shelf
McMurdo
0°
90°W
90°E
180°
80°S
70°S
60°S
0
1000
2000
km

Example of gravity wave propagation using CIRA-86 background winds



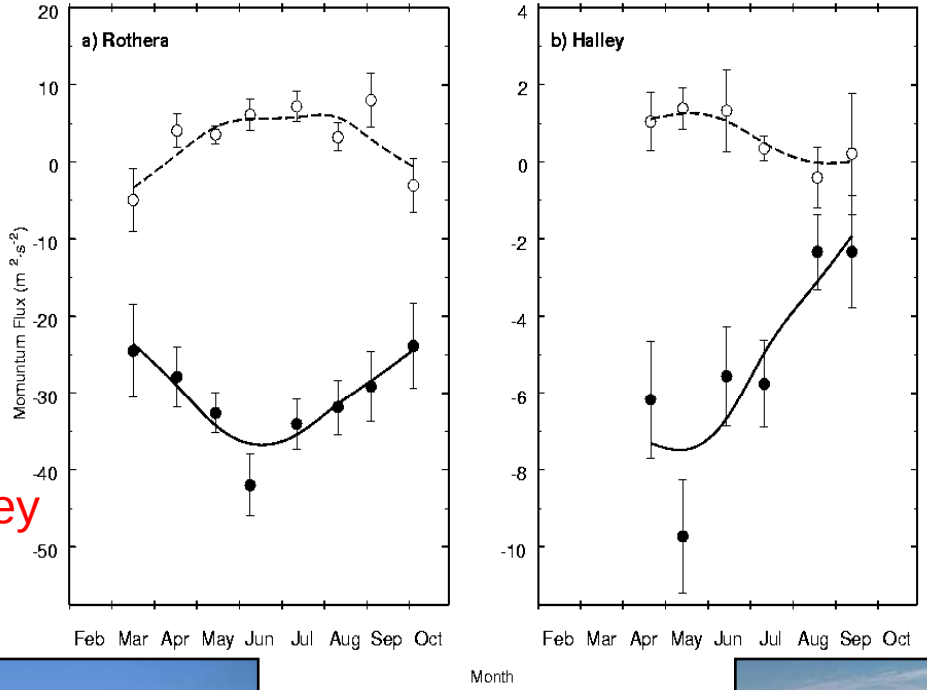
- 280 source waves of varying wavenumber, frequency and initial velocity launched from 5km at location indicated by white box (75°S, 90°W).
- Circles indicate gravity waves that reach 65km.

Example of gravity wave propagation using CIRA-86 background winds



- 280 source waves of varying wavenumber, frequency and initial velocity launched from 5km at location indicated by white box (65ºS, 65ºW).
- Circles indicate gravity waves that reach 65km.

Monthly Average Momentum Flux

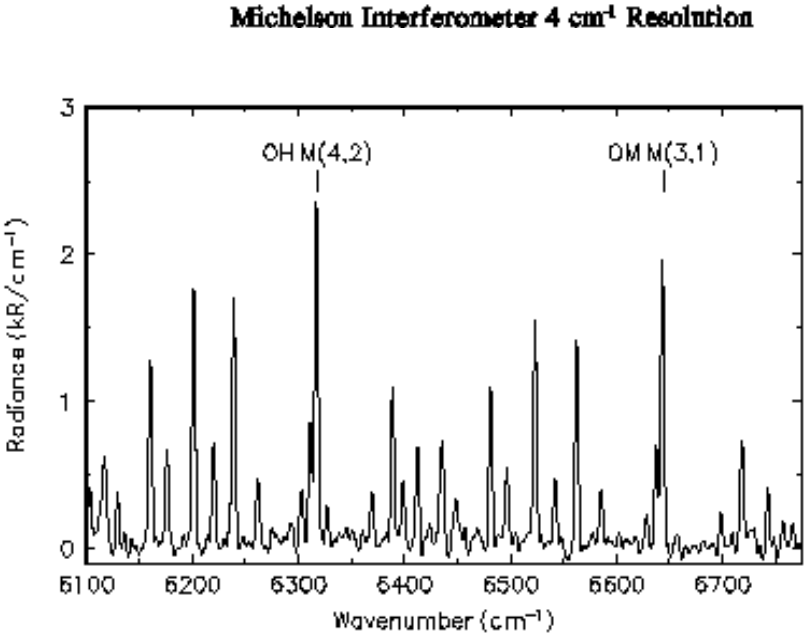


10x Halley

Rothera (67.6°S, 68.1°W)

Halley (75.5°S, 26.7°W)

PASSIVE MESOPAUSE TEMPERATURE MONITOR



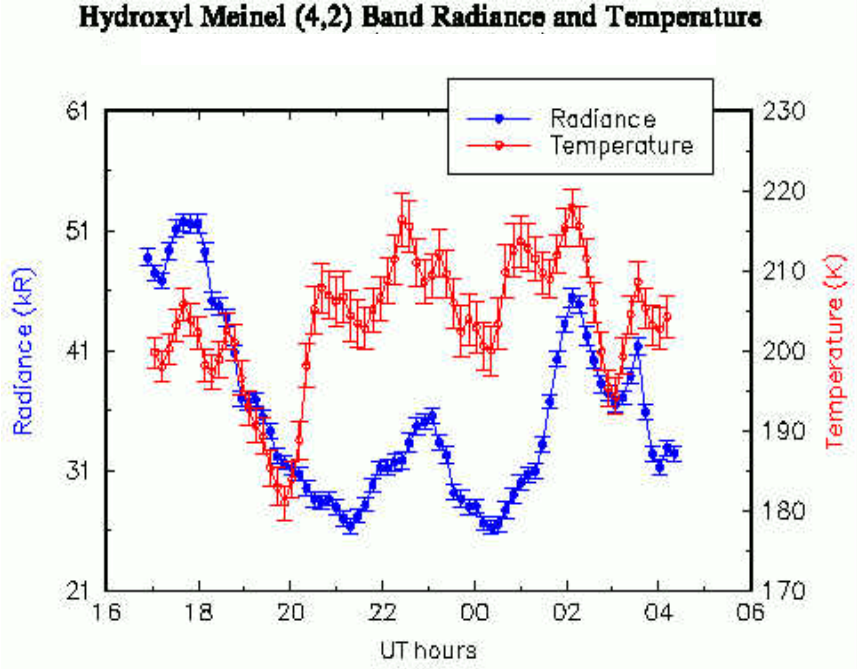
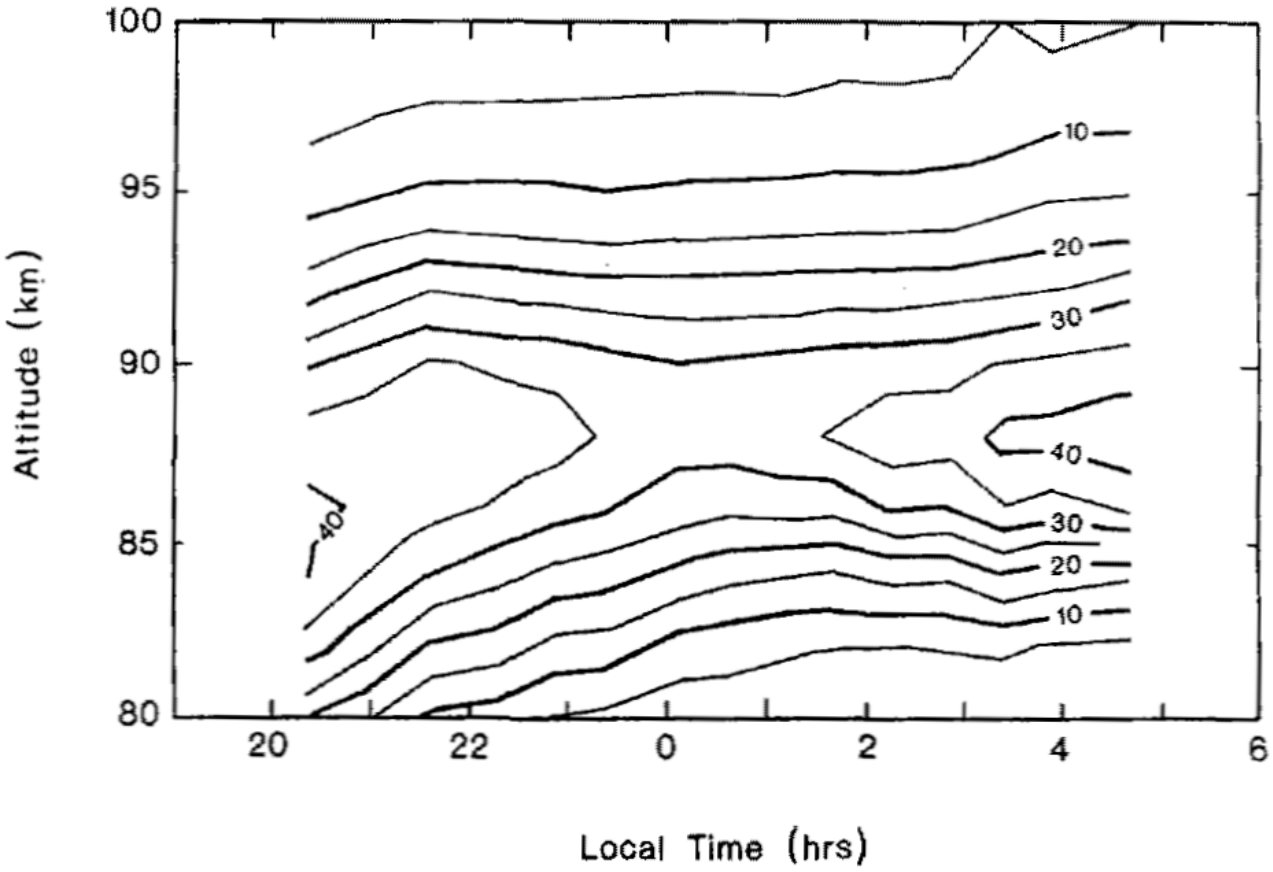


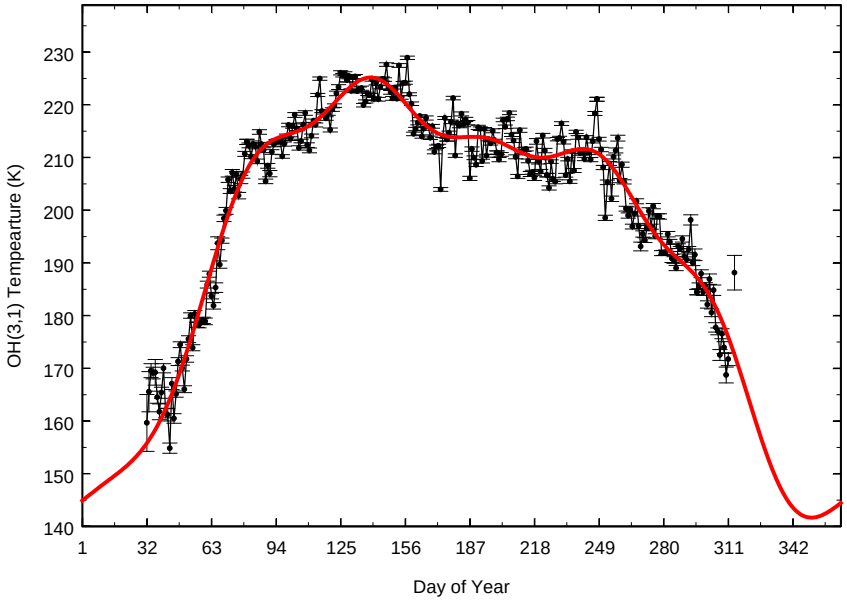
Photo-Chemical and Tidal Variations

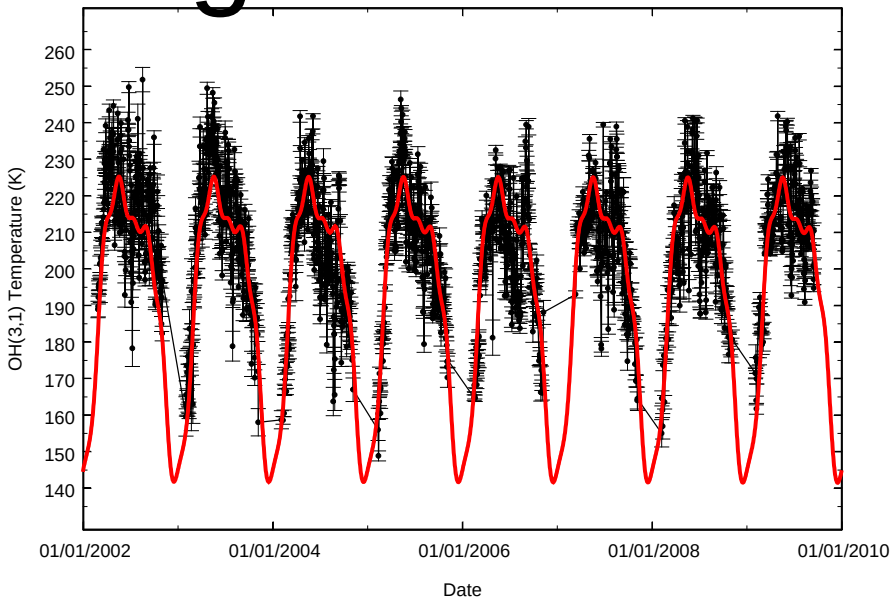


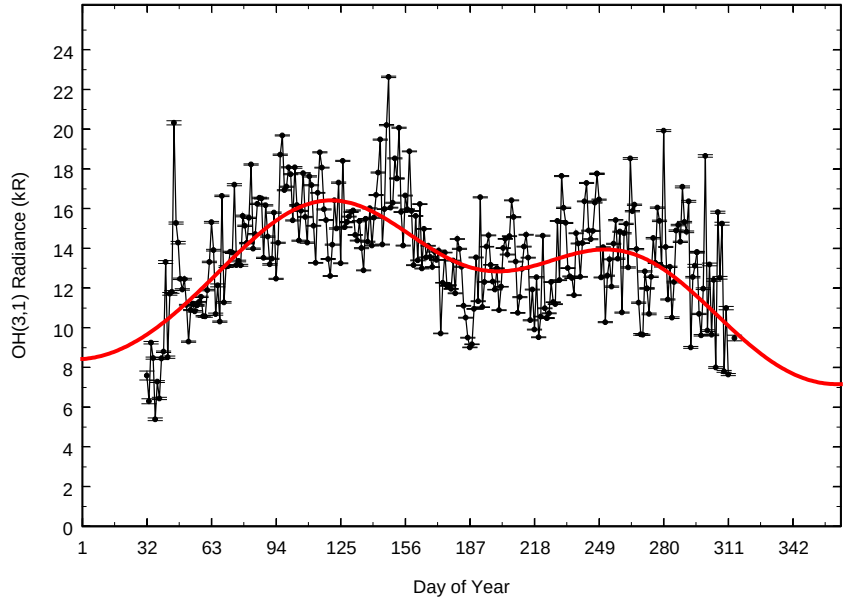
OH (8,3) Volume emission ratio vs. Local time at 40°N
Nearly factor of 2 variation due to chemistry and tides.

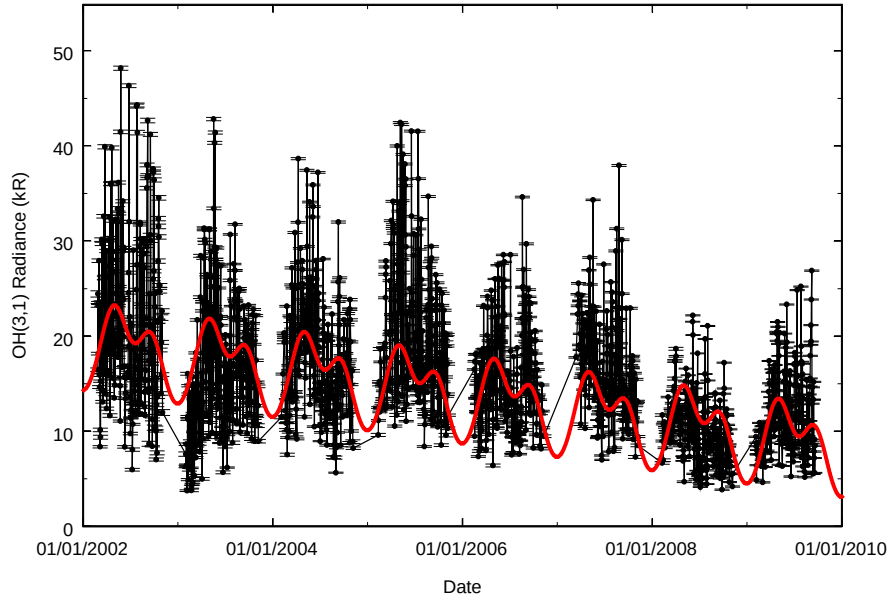
Lowe et al., *Journal of Atmospheric and Terrestrial Physics,* Vol. 58, pp. 1863-1869, 1996

Seasonal and Longer Term

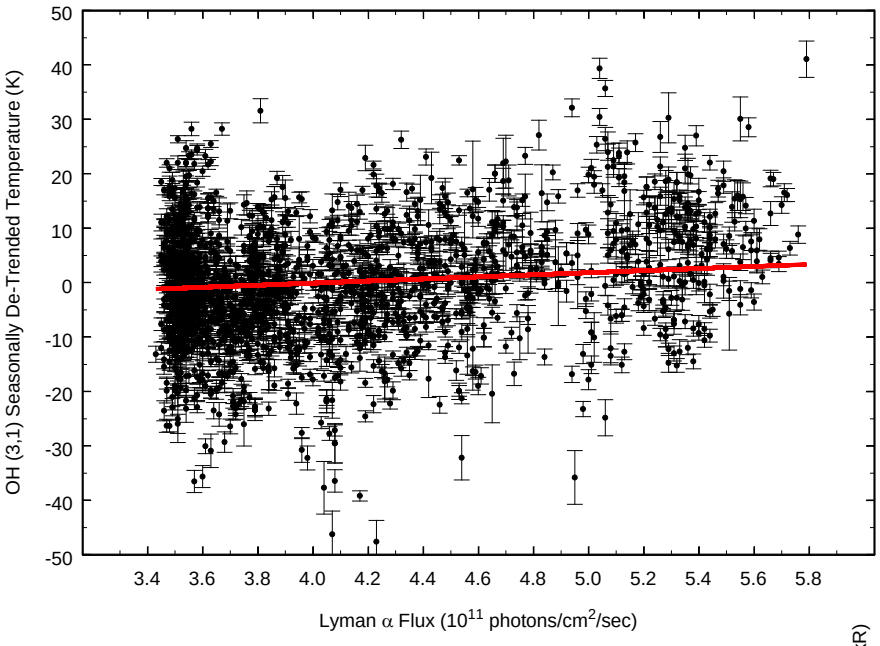


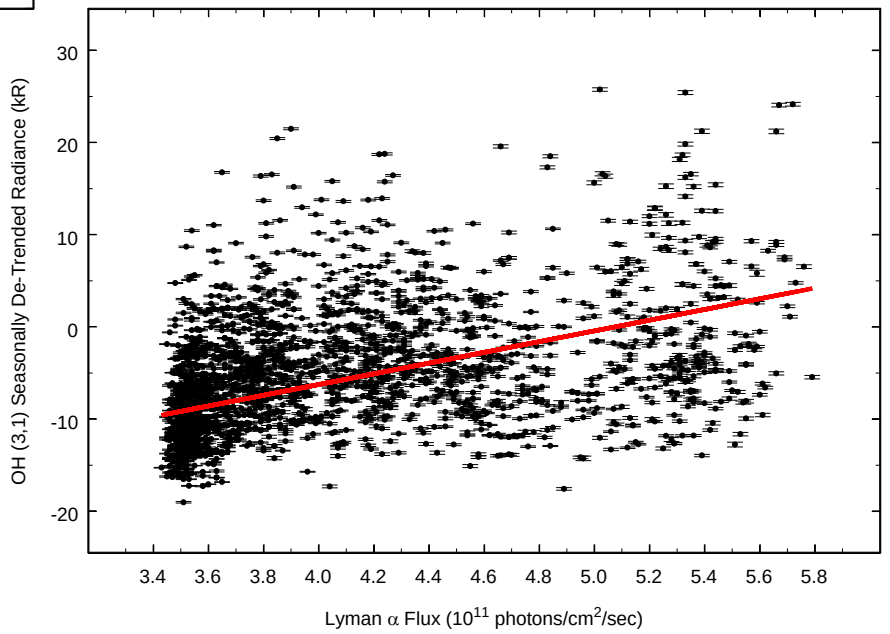




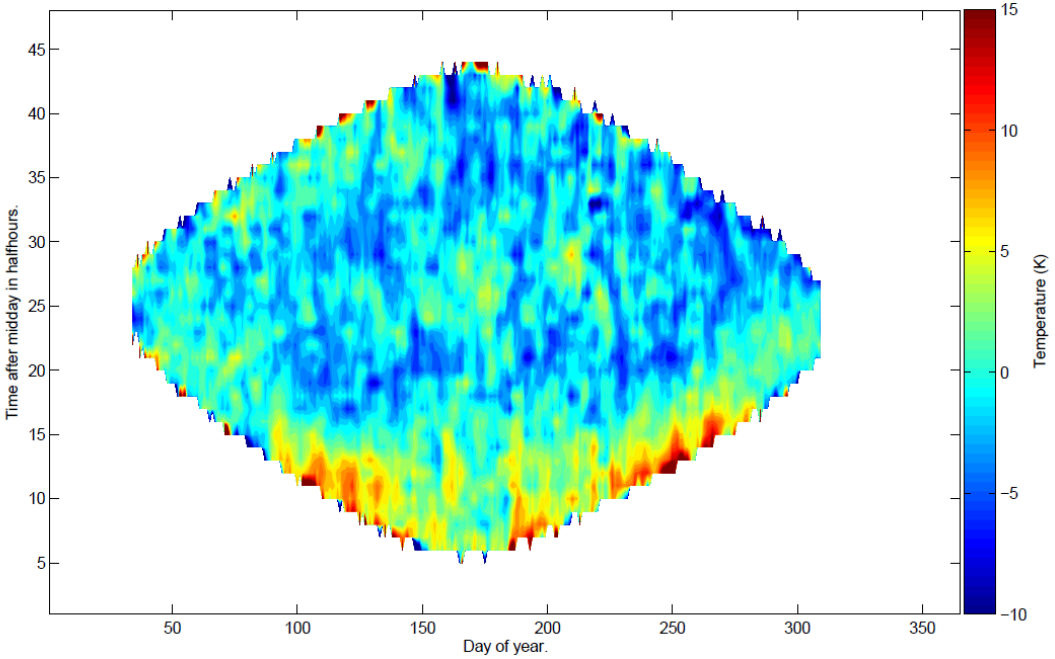


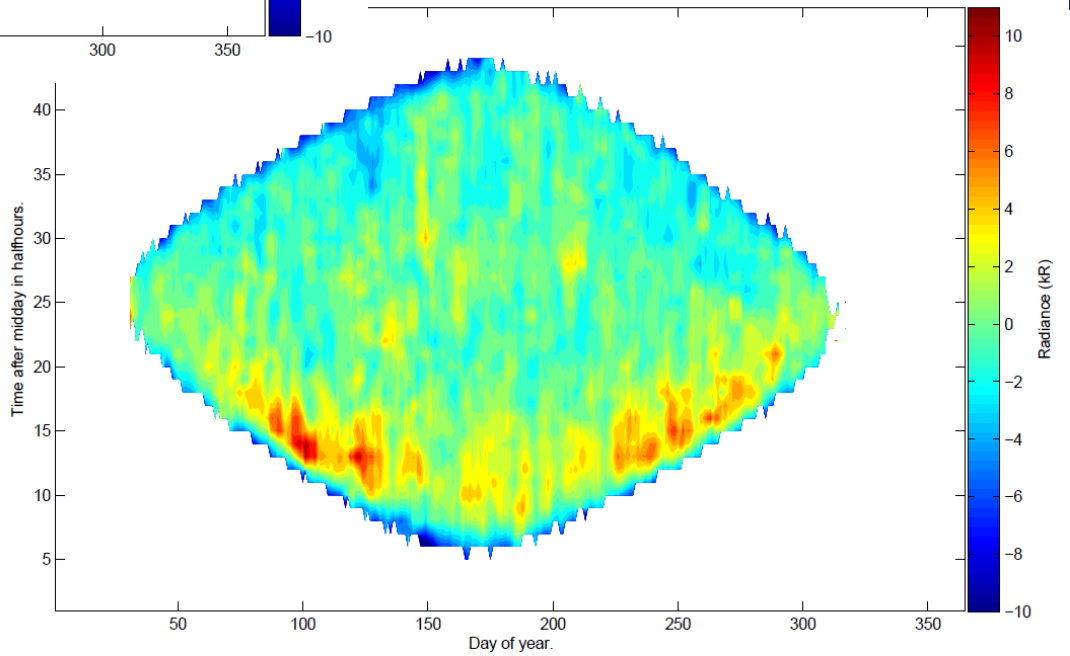
Solar Cycle Variation



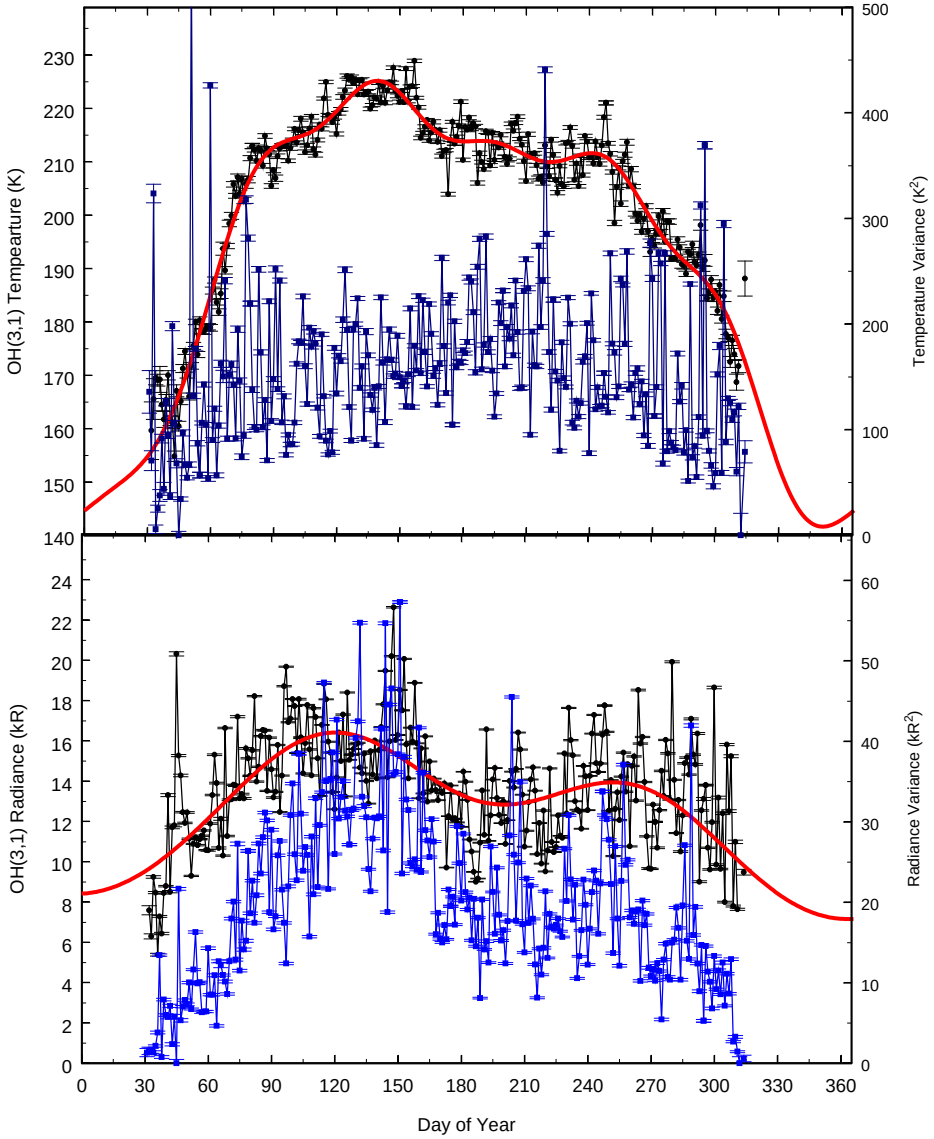


Residual Diurnal Variations





Residual Variances



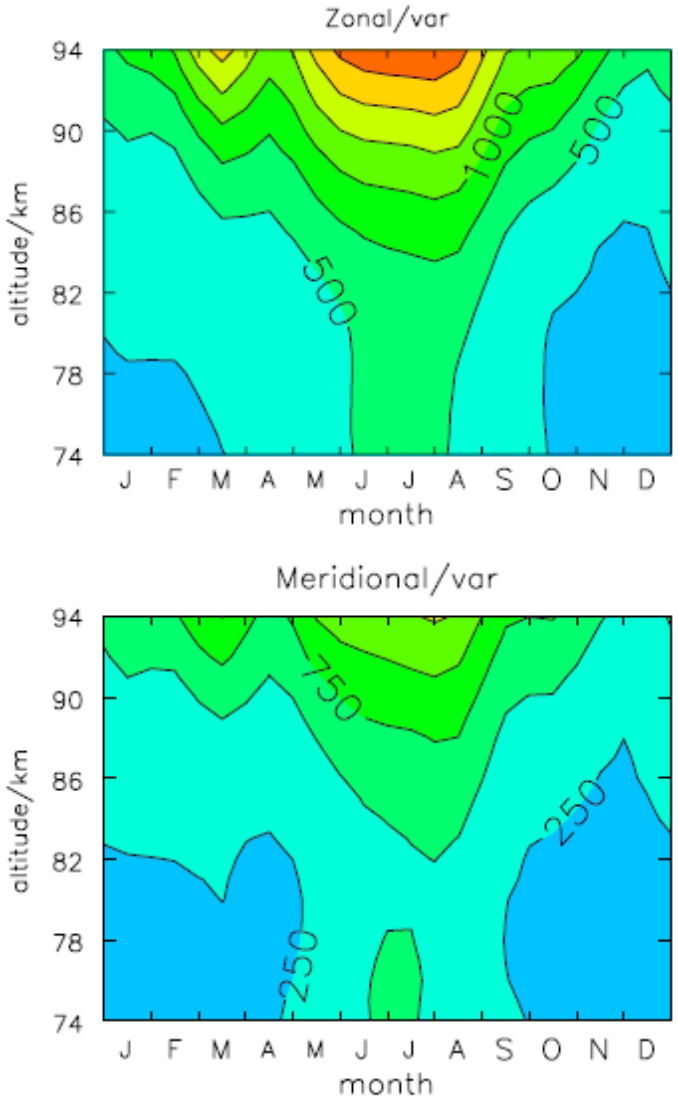
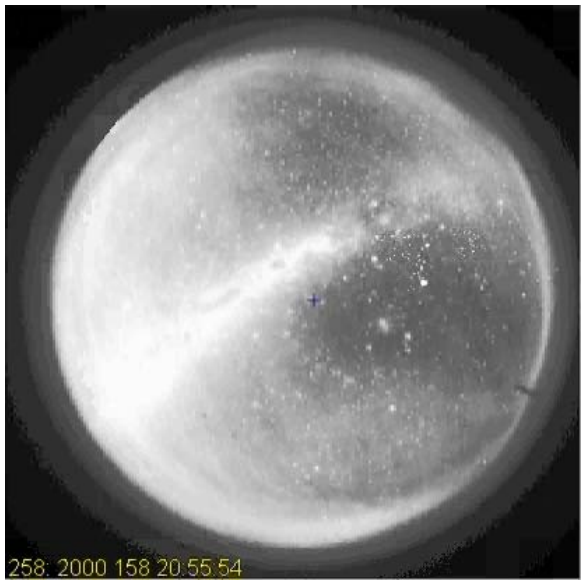


Fig. 5. Monthly mean variance of the raw winds after subtracting tidal components and system noise. Contours are plotted at 250 $m^2 s^{-2}$ intervals.

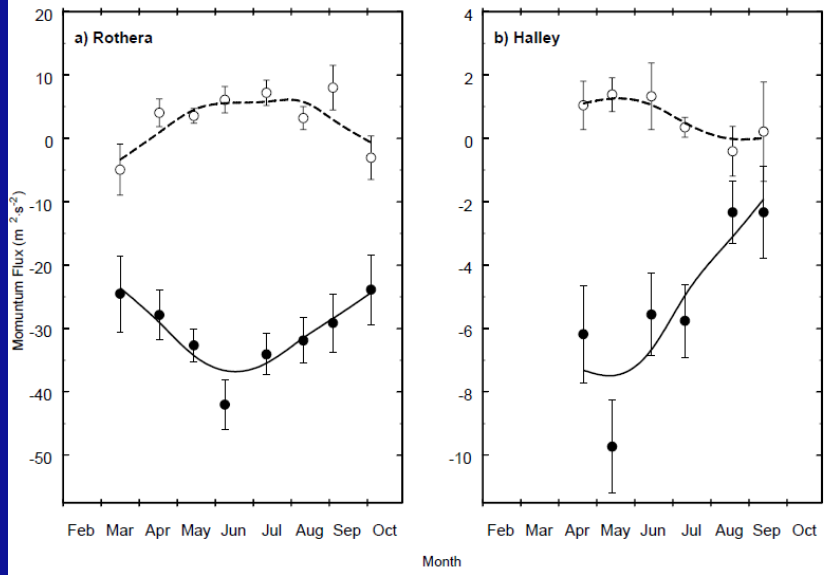
Conclusions

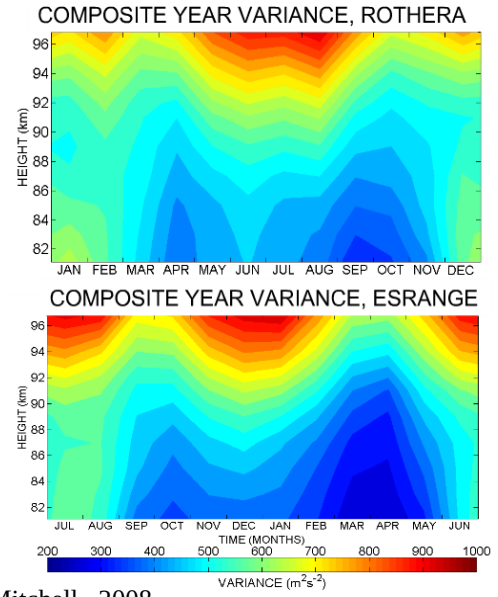
- Seasonal and inter-annual variations can be characterized by harmonic components and Solar-cycle variations
- Temperature variance parallels that seen in the winds
- Radiance may have additional chemistry driven diurnal components associated with gravity waves.
- Initial indications of a decreasing variance in time

Ground-Based Observations



- 2-D time history of gravity wave
- Momentum flux can be calculated and forcing climatology available
- Use wave parameters for ray tracing to sources
- Optical measurements not possible daytime and high latitude summer
- Time resolved radar variance observations indicate similar wave activity at high altitudes—PMC observations?





From Bolden and Mitchell., 2008