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

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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
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 (65°S, 65°W).
- 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

Michelson Interferometer 4 cm⁻¹ Resolution

Hydroxyl Meinel (4,2) Band Radiance and Temperature
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.

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 m² 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