OBSERVATIONS OF MESOSPHERIC GRAVITY WAVES OVER THE ANDES

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Gravity Waves – Mountain Waves
Andes Lidar Observatory
Ground measurements

Atmospheric Gravity Waves
• Mountain Waves

Andes Lidar Observatory
• Ground measurements

SABER measurements
THE EARTH'S ATMOSPHERE

1. TROPOSPHERE: 0 TO 12 KM
2. STRATOSPHERE: 12 TO 50 KM
3. MESOSPHERE: 50 TO 80 KM
4. THERMOSPHERE: 80 TO 700 KM
5. EXOSPHERE: >700 TO 190,000 KM

OZONE LAYER: 20 TO 30 KM
KARMAN LINE: 100 KM

NOT TO SCALE
MOUNTAIN WAVES

Strong Wind
Vertically propagating wave
Andes Mountains
2715 m

Cerro Pachon,
30.2°S, 70.7°W

Gemini Observatory
Andes LIDAR Observatory
Installed Aug 2009: 65+ months
1100+ nights of data

ANDES LIDAR OBSERVATORY
OH layer: ~87 km
Example OH Analysis

- OH Temp Avg = 188.2 ± 0.4
- Std.dev = 7.6
- OH Band Int Avg = 38155.5 ± 687.9
- Std.dev = 12647.1

Variance

Time (hours)

Band Intensity (counts)
Increased temperature variance during winter months

(Jiang et al., 2002)
Increased wave activity in winter observed from ground
SABER INSTRUMENT

Sounding of the Atmosphere using Broadband Emission Radiometry

Aboard the TIMED satellite
SABER DATA

Measure temperature in zone

Method from John and Kumar, 2012 and Jiang, 2002
INSTANTANEOUS PROFILES
BACKGROUND TIDAL PROFILE
Gravity wave perturbation revealed

Growing wave travelling upward
Increased wave activity observed from space during the winter along with fall and spring.
COMPARE SABER WITH GROUND MEASUREMENTS
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REFERENCES


• John, S.R., and Kumar, K.K. (2012), TIMED/SABER observations of global gravity wave climatology and their interannual variability from stratosphere to mesosphere lower thermosphere, Climate Dynamics, 39(6), 1489-1505


• Zhao, Y., M. J. Taylor, and X. Chu (2005), Comparison of simultaneous Na lidar and mesospheric nightglow temperature measurements and the effects of tides on the emission layer heights, J.
Into the Mesosphere

All-sky Images courtesy of Alan Liu, University of Illinois compiled by Neal Criddle
\[ T_{OH} = \frac{\text{SomeNumber}}{\ln\left[ stuff \left( \frac{P_1(2)}{P_1(4)} \right) \right]} \]

2 K Precision

Goldman et al., 1998
STEP 3: AT EACH HEIGHT ESTIMATE WAVES WITH WAVENUMBER 0-6.
STEP 3: AT EACH HEIGHT ESTIMATE WAVES WITH WAVENUMBER 1.
STEP 3: AT EACH HEIGHT ESTIMATE WAVES WITH WAVENUMBER 2.
STEP 3: AT EACH HEIGHT ESTIMATE WAVES WITH WAVENUMBER 3.
STEP 3: AT EACH HEIGHT ESTIMATE WAVES WITH WAVENUMBER 0-6.
Mesospheric Temperature Mapper

- Sensitive bare CCD Imager developed to measure mesospheric temperature variability using airglow emissions.
- Field of view ~90°, (180 x 180 km at 90 km altitude). Sequential observations (30 sec. exposure) of:
  - NIR OH (6, 2) Band ~ 87 km
  - Background (~857.5 nm)
- Cycle time: ~ 3 min per OH temperature determination. (Precision ~2K).