Investigation of Mesospheric Gravity Waves over South Pole and McMurdo Stations Using two Advanced Mesospheric Temperature Mappers

P-D Pautet¹, MJ Taylor¹, and Y. Zhao¹

¹Center for Atmospheric and Space Sciences (CASS), Utah State University, Logan, UT, USA
International ANGWIN Instrument Network

~1300 km
Advanced Mesospheric Temperature Mapper (AMTM)

- **Capability:** High-resolution mapping of gravity wave intensity and temperature field at ~87 km and wave phase relationship.
- **Temperature precision/pix**
  - ~1-2 K in ~30 sec.
- High-latitude capability as emission lines avoid auroral contamination.

AMTM at South Pole since 2010. Operates from mid-April to end of August

AMTM at McMurdo since 2017. Operates from mid-March to end of September
Nightly Temperature Averages

South Pole

McMurdo

3-day smoothing
Nightly Temperature Averages

Similar temperatures and large scale (planetary waves?) perturbations
Are large scale waves also observed over both sites?
Long-Period (2-12hrs) Waves over Antarctica

Temperature precision: 1K

- Continuous large amplitude oscillations (>10K) during the whole winter!
• Continuous strong wave activity throughout winter each year to year
• Dominant wave periods between 5-9 hrs
• Diurnal and semi-diurnal signatures are not strong.
Fe Lidar Observations at McMurdo (Chen et al., 2013; 2016)

- Identified as inertia-gravity waves (waves with frequency close to the inertial frequency and therefore affected by the rotation of the Earth)
- Periods from ~3 to ~11 h
- Lasting up to 45 h
- Dominant vertical wavelength 20-30 km
- Horizontal wavelength 1000-2200 km
- Sometimes several long-period waves simultaneously
- Shallow angle of propagation (~1-2°)
- Possible sources: unbalanced flows at stratospheric altitude

Continuous 50-hr temperature Fe lidar measurements showing persistent 4-9 hr waves
Can we see the same waves over both sites?

Inertia-gravity waves observed 1360km apart?
Comparison Between McMurdo and South Pole

 Courtesy X. Chu

 Distance ~1360 km

 Fe Temperature on 23 JN 2011

 OH Rotational Temperature (K)

 Relative Band Intensity
MCM Lidar/SP AMTM Temperature Comparison - Jun 29th, 2011

Fe Temperature (K) on 29 JN 2011 @ McMurdo

Courtesy X. Chu

Δt~3hrs
Collaborative Study: Fe Lidar (X. Chu) at Murdo with AMTM at South Pole
AMTM Datasets Comparison
June 16-30, 2017

MCM+SP - June 16-30

- OH (3, 1) Rotational temperature SP
- OH (3, 1) rotational temperature MCM

OH Rotational Temperature (K)

Time from 16 June 0UT
AMTM Datasets Comparison
June 16-30, 2017

MCM+SP - June 16-30

Filtered OH Rotational Temperature (K)

OH (3,1) Rotational temperature SP
OH (3,1) rotational temperature MCM

Time from 16 June 0UT
Comparison Example

Cross correlation between MCM and SP temperature data

Position of maximum correlation

Cross Correlation MCM-SP

Time from 16 June 0UT
Summary - Future Work

• Several periods of simultaneous observations between McMurdo and South Pole have been identified for the 2017 winter season
• They show a permanent display of IGWs at both site with strong similarities

Future work:
• Identification of the different IGWs within the observation period (wavelet)
• Cross-correlation between the SP and MCM data sets
• Measurements of the time difference between the two sites
• Determination of the IGW parameters
• Comparison with the Fe lidar data when simultaneous measurements occurred
• Assessment of the possible sources?