6-2013

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Michael Negale
*Utah State University*

Kim Nielsen
*Utah Valley University*

Michael J. Taylor
*Utah State University*

Dominique Pautet
*Utah State University*

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Winter climatology of short-period mesospheric gravity waves over Alaska

Mike Negale1, K. Nielsen2, M. J. Taylor1, P. D. Pautel1
1Center for Atmospheric and Space Sciences, Utah State University, 2Department of Physics, Utah Valley University

Introduction

Momentum deposition by short-period (<1 h) gravity waves is known to play a major role in the global circulation in the mesosphere and thermosphere (MLT) region (e.g., Fritts and Alexander, 2003). Observations of these waves over the Arctic region are few and their impact on the Arctic MLT region is of high interest, but has yet to be determined.

The Mesospheric Airglow Imaging and Dynamics (MAID) project was initiated in January 2011 to investigate short-period gravity waves over central Alaska.

Maid is a collaborative project between Utah Valley University (UVU) (Principal Investigator: Ken Nielsen), Utah State University (USU), and the University of Alaska, Fairbanks (UAF). The project combines a multi-wavelength airglow imager with a co-located Poker Flat Research Range (PFRR), with additional campaign data from the Poker Flat Incoherent Scatter Radar (PFISR) and the National Inst. of Information and Communications Technology (NICT) MP radar.

The main goals of this program are:

- Establish a long-term climatology of short-period gravity waves observed in the Arctic MLT region.
- Determine dominant source regions and potential sources of the observed waves.
- Investigate the impact of large-scale waves (tidal and planetary wave motions) on the short-period wave field.
- Perform quantitative comparison between Arctic and Antarctic winter-time wave dynamics.

In this poster, we focus on quantifying the climatology of short-period gravity waves during two winter seasons (2011-2012) over central Alaska.

Observations and Data Analysis

Measurements of short-period, quasi-monochromatic gravity wave events were made from PFRR, Alaska (65° N, 147° W) using a Keo Sletten all-sky, multi-wavelength CCD imaging system. The imager remotely senses several faint airglow emissions primarily in the MLT region. Figure 1a shows an example of an event in the OH emission (λ6300 Å) altitude exhibiting extensive band structure. Raw images were calibrated using the star field. The stars were removed and the image was then transformed to uniformly spaced geographic coordinates, through a process commonly known as unwarping, and rotated into a 500 x 500 km geocentric grid as shown in figure 1b. Using images obtained sequentially in time, an unambiguous 3-D spectral analysis (Coble et al., 1996; Gardiner et al., 1998) was performed on a selected region of interest to determine the horizontal wave parameters as shown in figure 1c.

Comparisons with other High Latitude Measurements

In this section we compare our results from PFRR (65° N) with other recent and ongoing high-latitude measurements of short-period gravity waves in the Arctic at: Resolute Bay (74° N) (Suzuki et al., 2009), Svalbard (78° N) (Dyrland et al., 2012), and ALOMAR (69° N) and in Antarctica at Rothera (Nielsen, 2007). The relative locations of these high-latitude sites are indicated in figure 6.

Our determination of strong eastward propagation during the winter is most intriguing as it differs strongly from previous results to date.

The reported eastward wave propagation is attributed to critical level filtering of the upward propagating gravity waves by the background wind field.

Importantly, the PFRR eastward propagating waves exhibited relatively low phase speeds suggesting they were not restricted by the critical level filtering (discussed below).

Future work: Further investigation of these high speed events, their potential sources, and collaborative measurements with PFISR to study their penetration into the lower thermosphere.

Acknowledgments

This project is funded by the National Science Foundation, Office of Polar Programs grant OPP-1023265 entitled Collaborative Research: An Investigation of Mesospheric Waves over the Arctic in Winter. This is a collaborative project between the Arctic Lower and Upper Polar Atmosphere. This material is based upon the work supported by the National Science Foundation Graduate Research Fellowship under Grant No. 1147384