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Short Period Gravity Waves in the Arctic Atmosphere Over Alaska

Michael Negale  
*Utah State University*

Kim Nielsen  
*Utah Valley University*

Michael J. Taylor  
*Utah State University*

Britta Irving  
*University of Alaska, Fairbanks*

Richard Collins  
*University of Alaska, Fairbanks*

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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 lower thermosphere (MLT) region ~80–100 km (e.g. Fritts and Alexander, 2003). The propagation of gravity waves is strongly influenced by the local wind and wave ducting by temperature and gravity waves. The mesopause region is characterized by high winds, high temperatures, and strong density fluctuations on a wide range of spatial and temporal scales. This results in a highly turbulent mesopause region (e.g. Fritts and Alexander, 2003). The mesopause region is also highly susceptible to gravity waves, which can propagate upward from the lower atmosphere, causing disturbances in the mesopause region (e.g. Fritts and Alexander, 2003). The mesopause region is highly turbulent due to the interaction of gravity waves and local winds, which can induce density fluctuations and waves. The mesopause region is also highly susceptible to gravity waves, which can propagate upward from the lower atmosphere, causing disturbances in the mesopause region (e.g. Fritts and Alexander, 2003). The mesopause region is also highly susceptible to gravity waves, which can propagate upward from the lower atmosphere, causing disturbances in the mesopause region (e.g. Fritts and Alexander, 2003). The mesopause region is also highly susceptible to gravity waves, which can propagate upward from the lower atmosphere, causing disturbances in the mesopause region (e.g. Fritts and Alexander, 2003). The mesopause region is also highly susceptible to gravity waves, which can propagate upward from the lower atmosphere, causing disturbances in the mesopause region (e.g. Fritts and Alexander, 2003).

Imager Observations:

Images of different argon wave emissions allow for observations of gravity waves at different altitudes (as illustrated in Figure 1). A sequence of images observed on 14 January 2012 exhibiting an extensive wave field is shown in Figure 2. The wave signature was strongest in the (O + 3) and (Na + 5) emissions, while there is little evidence of it in the O2 emission (c). As expected, the thermospheric Oi emission shows no signature of the wave field (d). Lidar Observations:

Figure 3 shows the average temperature profile measured by the lidar for this night of 14 January 2012. While the all-sky imager permits accurate measurements of the horizontal wave parameters, the lidar provides essential temperature profiles. Together, these two instruments can measure several of the key parameters needed to characterize the wave motions as well as investigate their propagation nature. Additional radar measurements of the background wind field enable the estimation of the gravity wave such as its intrinsic period, phase speed, and angle of ascent/descent through the atmosphere. (Yao et al., 1995).

Image Data Processing

Using traditional spectral analysis techniques there is an inherent 180° ambiguity in the derived wave propagation. This can be resolved, by using images obtained sequentially in time to determine the unambiguous 3D horizontal wave number spectrum (Coble et al., 1998). This 3D spectrum is computed as follows (Gardner et al., 1996):

- Calculate the (u, v, k) spectrum from the processed images (where u is the temporal frequency, k is the zonal wavenumber, and l is the meridional wavenumber).
- Then integrate over the negative frequencies.

Figure 5 illustrates the methodology of the unambiguous spectrum technique showing an isolated peak corresponding to the observed wave event.

Data Analysis

Using the processed images and their positions, the lidar is calibrated and rotated so that the top of the image points north and the right of the image points east, known as standard coordinates (Figure 4b).

The stars are then removed and the image is flat fielded to enhance the full field wave structure (Figure 4c).

The derived wave parameters (i.e., wave amplitude and wavelength) are then input into the ARF program to calculate the wave parameters. The wave parameters are then used to determine the vertical distribution of the wave field. The ARF program is a high-speed, high-resolution program that can process images in real-time, providing near-real-time wave parameter estimates. The wave parameters are then used to determine the vertical distribution of the wave field. The ARF program is a high-speed, high-resolution program that can process images in real-time, providing near-real-time wave parameter estimates.