Atmospheric Gravity Wave Events in Antarctica

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Introduction

Gravity waves (GW) transfer energy and momentum between layers of the upper atmosphere. They are triggered by events such as thunderstorms and strong winds in the troposphere. A Utah State University all-sky IR camera at McMurdo Station, Antarctica captured images of gravity waves in the higher mesosphere and lower thermosphere region over the winter season (April-October) in 2012. The IR camera took one picture every ten seconds for approximately fifteen hours every night.

Methods

Images from the all-sky IR camera were pre-processed using a program that performed the following steps:

1. **Star Removal**: Removes all single stars (not the Milky Way) using a filtering algorithm.
2. **Flat Fielding**: Removes background noise from each image and corrects for lens warping and detector defects.
3. **Calibration and Unwarping**: Projects the image onto a 2D plane to correct for the all-sky lens, creating a linear scale.

Pre-processed images were then analyzed using a 3D spectral analysis IDL program, which performed the following functions:

- A 3D FFT computed the three-dimensional spectrum as a function of frequency, zonal wave number, and meridional wave number (w, k, l)
- 2D spectra were created showing the distribution of GW phase speed and their amplitude as a function of direction of propagation.

Results

Variation in directionality and amplitude can be seen on an hourly, nightly, and monthly basis. These variations can be caused by events such as wind filtering and source anisotropy.

Conclusions

The IDL program provides an efficient way to analyze large amounts of data in a relatively short time. This spectrum-based technique can lead to more accurate wave filtering interpretations in the mesosphere. This will allow for faster analysis and will give more accurate results without bias caused by differing extraction criteria. The only evident limitation is the program’s inability to distinguish between airglow and events that look like airglow, such as aurorae.

References: