Temporal Analysis of Atmospheric Gravity Waves using an All Sky Imager

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The PEARL All Sky Imager (PASI) is a CCD imager system which views 6 different spectral regions using narrow band interference filters. These target emissions at: 589.3 nm (for Na), 572.5 nm (background), 427.8 nm (for aurora), 557.7 nm (oxygen green line), 630.0 nm (oxygen red line) and 720-910 nm notched at 865 nm (for OH). These filters alternate sequentially between the different positions on the filter wheel and the OH filter. The imager is designed to take an image roughly every minute and is stationed at PEARL in Eureka, Nunavut.

### Instrument

The images go through three different correction techniques: median filter star removal, Van Rhijn effect and Atmospheric Extinction

### Data Processing

#### Van Rhijn Effect

\[
I(\theta) = \left[1 - \frac{B_p}{B_p + h_{\text{OH}}} \right]^2 \sin^2 \theta \cdot I(0)
\]

#### Atmospheric Extinction

\[
F(\Omega) = \cos \theta + 0.15 \left(93.085 - \frac{\theta - 180}{\pi}\right)
\]

With the corrected image, a background can be created by taking the average of a five minute and is stationed at PEARL in Eureka, Nunavut.

### Results

From the power spectrum images, we can declare that there is a wave present once a certain wavenumber is a local maxima, is large enough and has been present for long enough. We then take the phase information from the 2D FFT and use that to find the respective phase for the wave at that particular time period. Once we know the phase, we use that to find the angular frequency between two time periods during the wave event. Afterwards we find the angular frequency for the wave event by finding the average of the angular frequencies between each time period.

\[
\varphi = \tan^{-1} \frac{\text{Im}(\text{FFT})}{\text{Re}(\text{FFT})} \quad \omega_i(t) = \frac{\varphi(t+1) - \varphi(t)}{t_{i+1} - t_i}
\]

If we use the spatial frequencies and the angular frequency then we can find the direction that the wave is propagating in and the speed it is travelling at.

### Conclusion

As we see from the results above, we can see that there is some similarities between the different time events. It’s found that the wave period for most of the atmospheric gravity waves are around the 15 to 20 minute mark, that the phase speed is around the 20-25 m/sec mark and that the most common horizontal wavelength is around 30 km.

In order to know more about the characteristics of gravity waves during the stratospheric warming event, more data will need to be analysed to determine if there is a shift from the normal gravity wave events.

### Acknowledgement

PEARL is supported by:
- Canadian Foundation for Innovation (CFI)
- Canadian Space Agency (CSA)
- Foundation for Climate and Atmospheric Science (CCFAS)
- Environment Canada (EC)
- Government of Canada IPY funding
- Meteorological Service of Canada
- Ontario Ministry of Research and Innovation
- Natural Sciences and Engineering Research Council (NSERC)
- Nova Scotia Research Innovation Trust (NSRIT)
- Continental Shelf Program (PSCP)
- National Oceanoographic and Atmospheric Administration (NOAA)

### References
