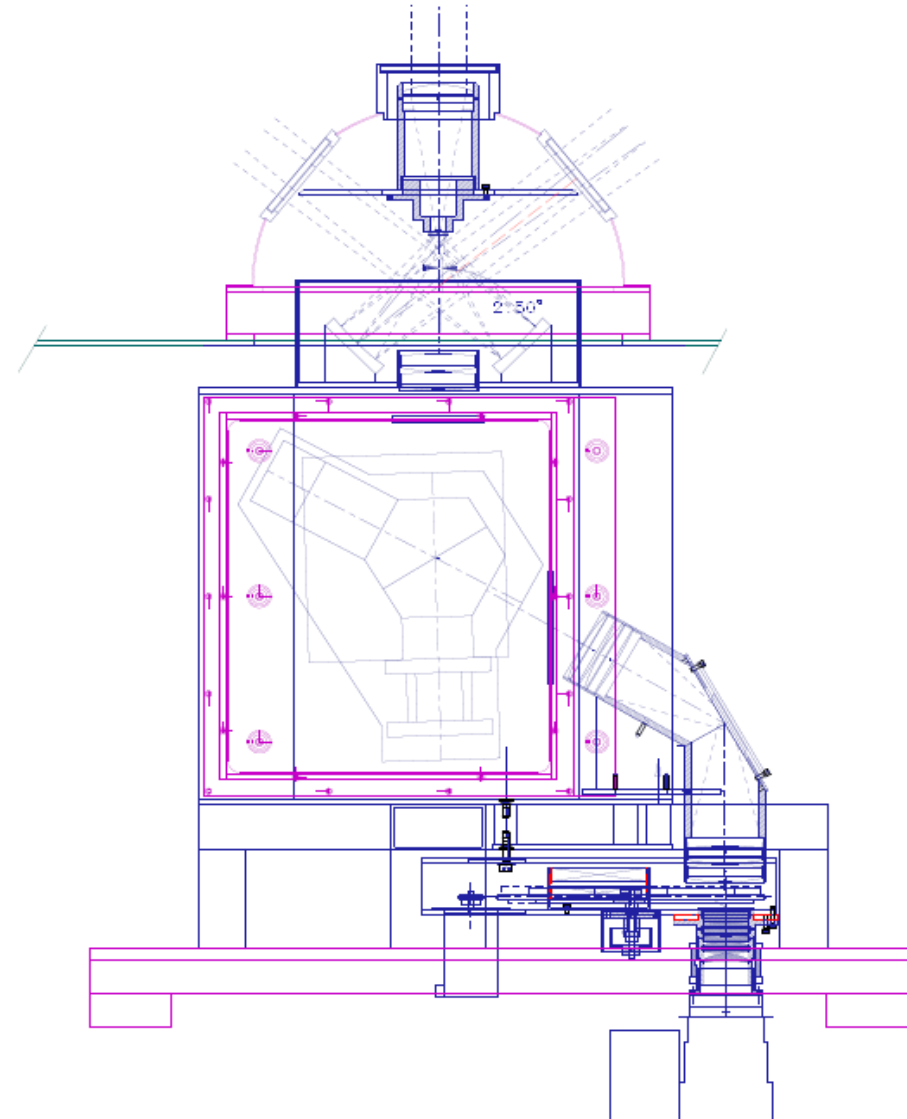


Wind and Gravity Wave Observations with ERWIN-II

Samuel Kristoffersen (UNB) and William Ward (UNB)

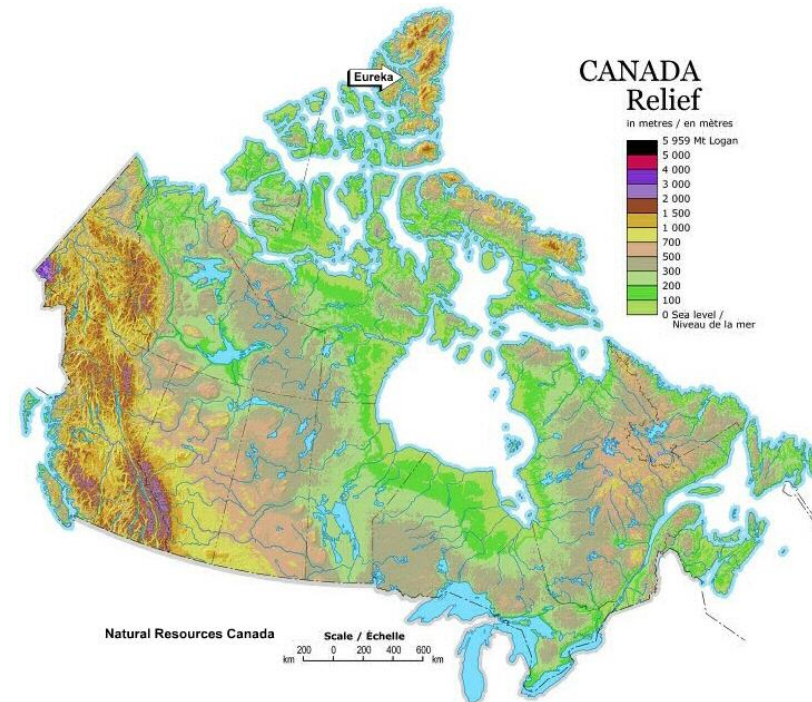
ERWIN

- ERWIN is a Michelson interferometer which detects airglow
 - Greenline, O₂, and OH emissions
- Determines winds, via Doppler shift, in the mesopause (~90 km).
- Has an observational cadence of ~3 minutes for all three emissions



PEARL

- Polar Environment Atmospheric Research Laboratory
- Located in Eureka, Nunavut (80 N, 86 W)
- Operated by CANDAC (Canadian Network for the Detection of Atmospheric Change).
- Collaboration between researchers from all over Canada to measure atmospheric dynamics, chemistry and radiative effects in the arctic



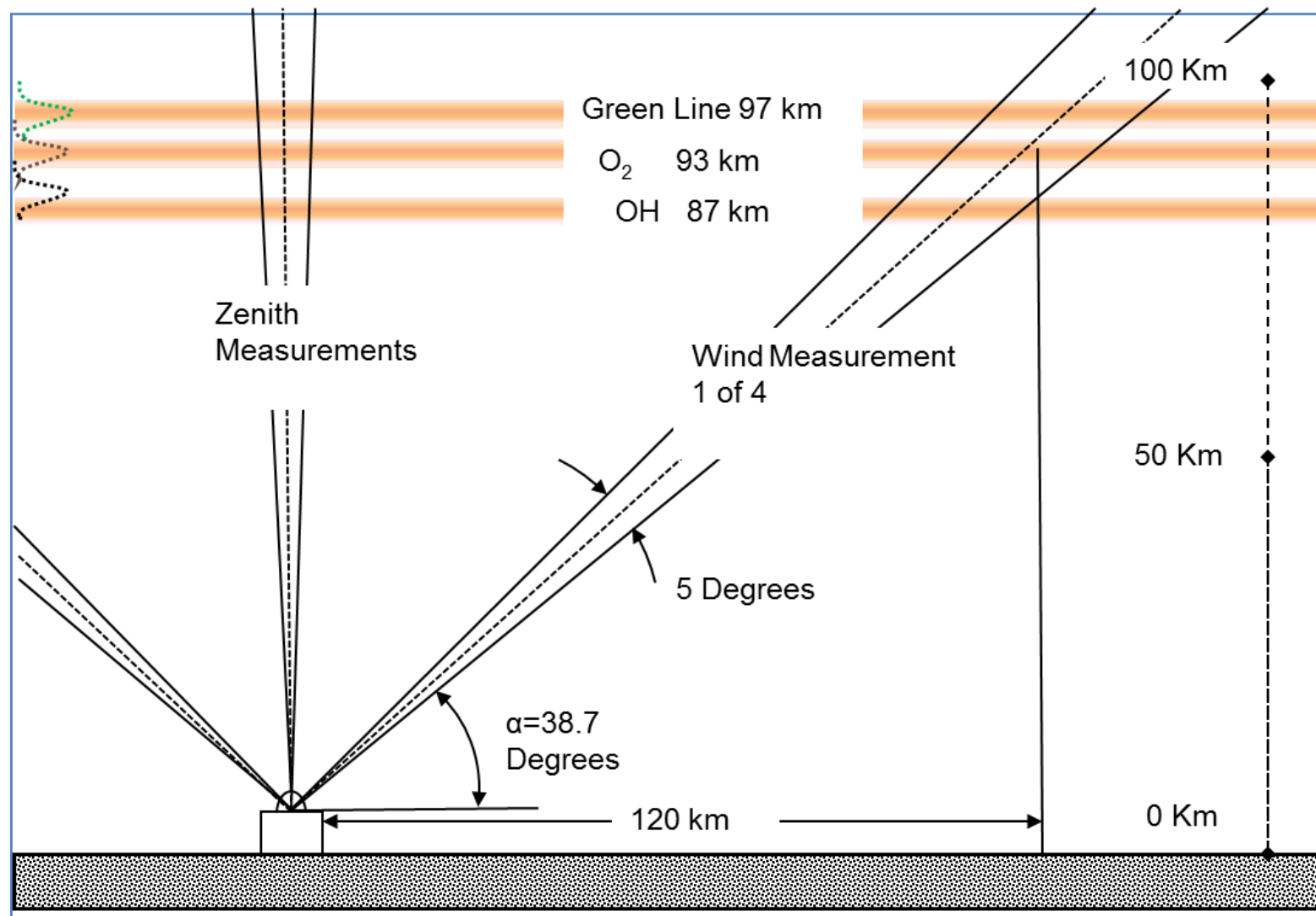
Wind Calculation

The phase difference between the viewing direction, say N, and zenith, Z, is used to calculate wind.

$$v_N^{LOS} = v_N \cos(\alpha) + v_V \sin(\alpha)$$

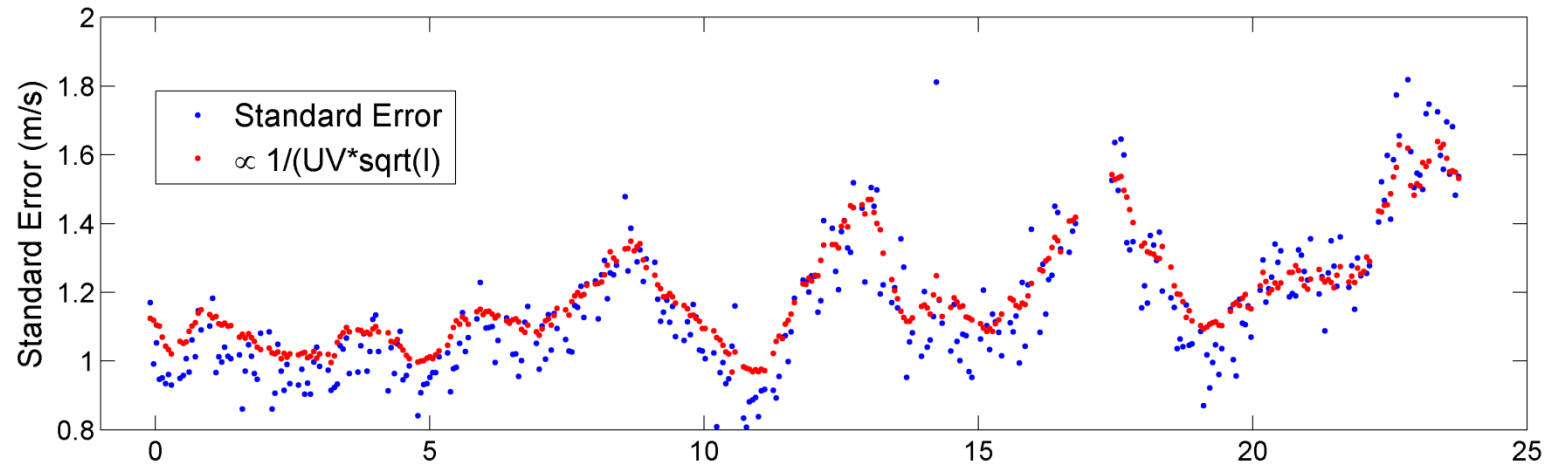
$$v_N = \frac{c(\phi_N - \phi_Z \sin \alpha)}{2\pi\sigma D \cos \alpha}$$

$\sin(\alpha)$ accounts for the different line of sight angles between north view, and zenith view.

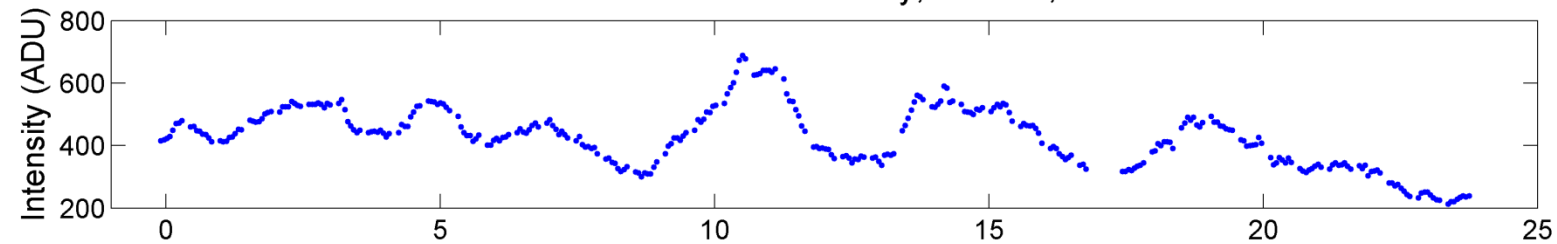


Wind Precision: ~ 1 m/s

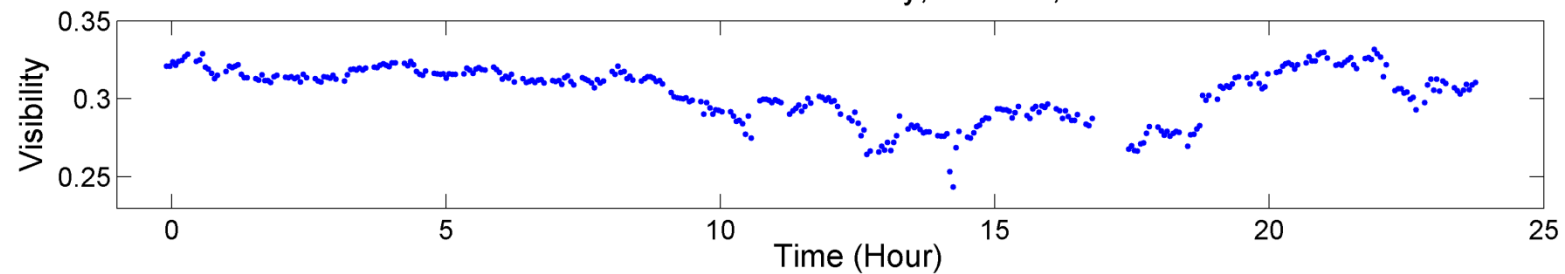
Green Line Wind Standard Error Dec 22, 2008



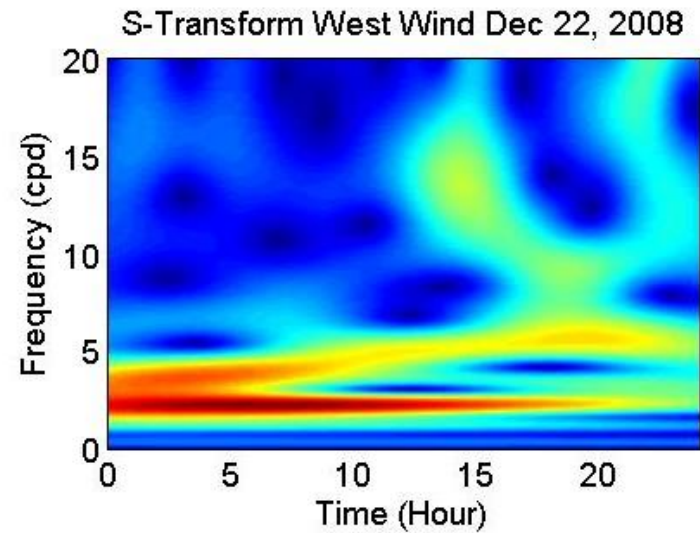
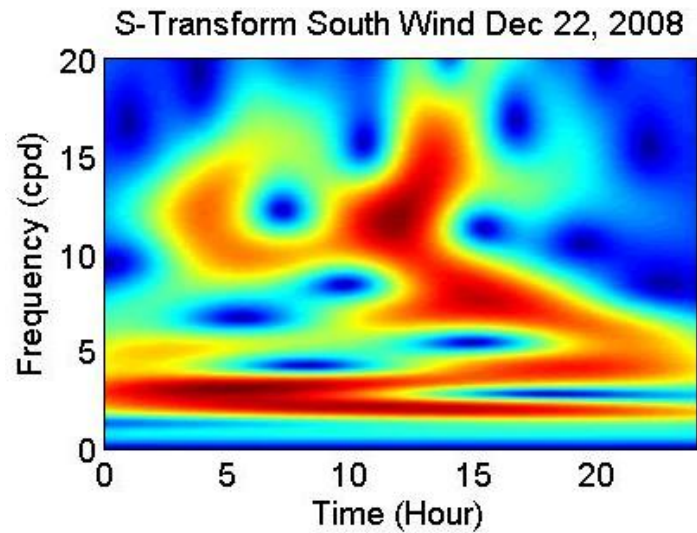
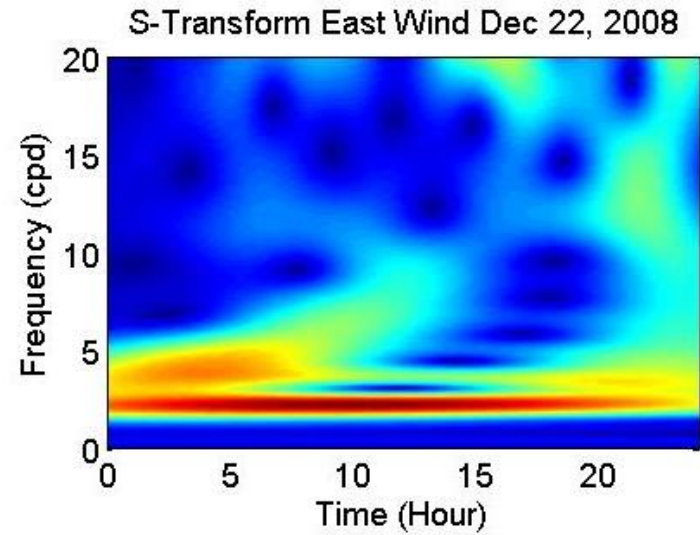
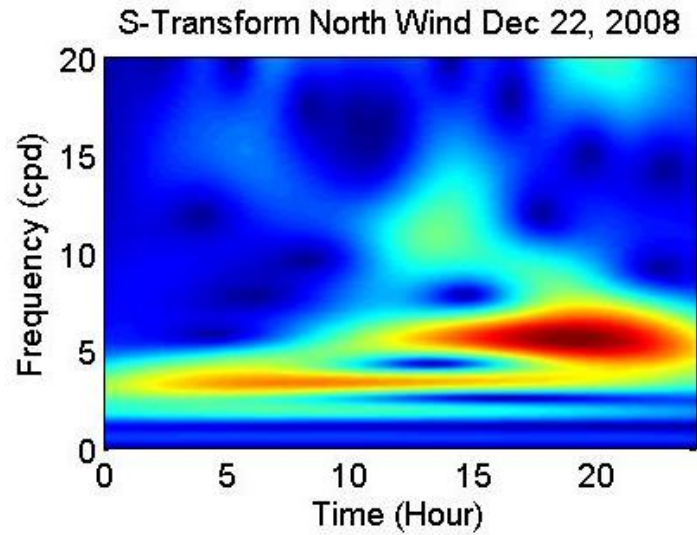
Green Line North Intensity, Dec 22, 2008



Green Line North Visibility, Dec 22, 2008



Gravity Wave Signatures



Gravity Wave (10.8 cpd)

- Meridional wavelength

$$\lambda_y = 570 \text{ km}$$

- Zonal wavelength

$$\lambda_x = 9100 \text{ km}$$

- Horizontal wavelength

$$\lambda_H = 569 \text{ km}$$

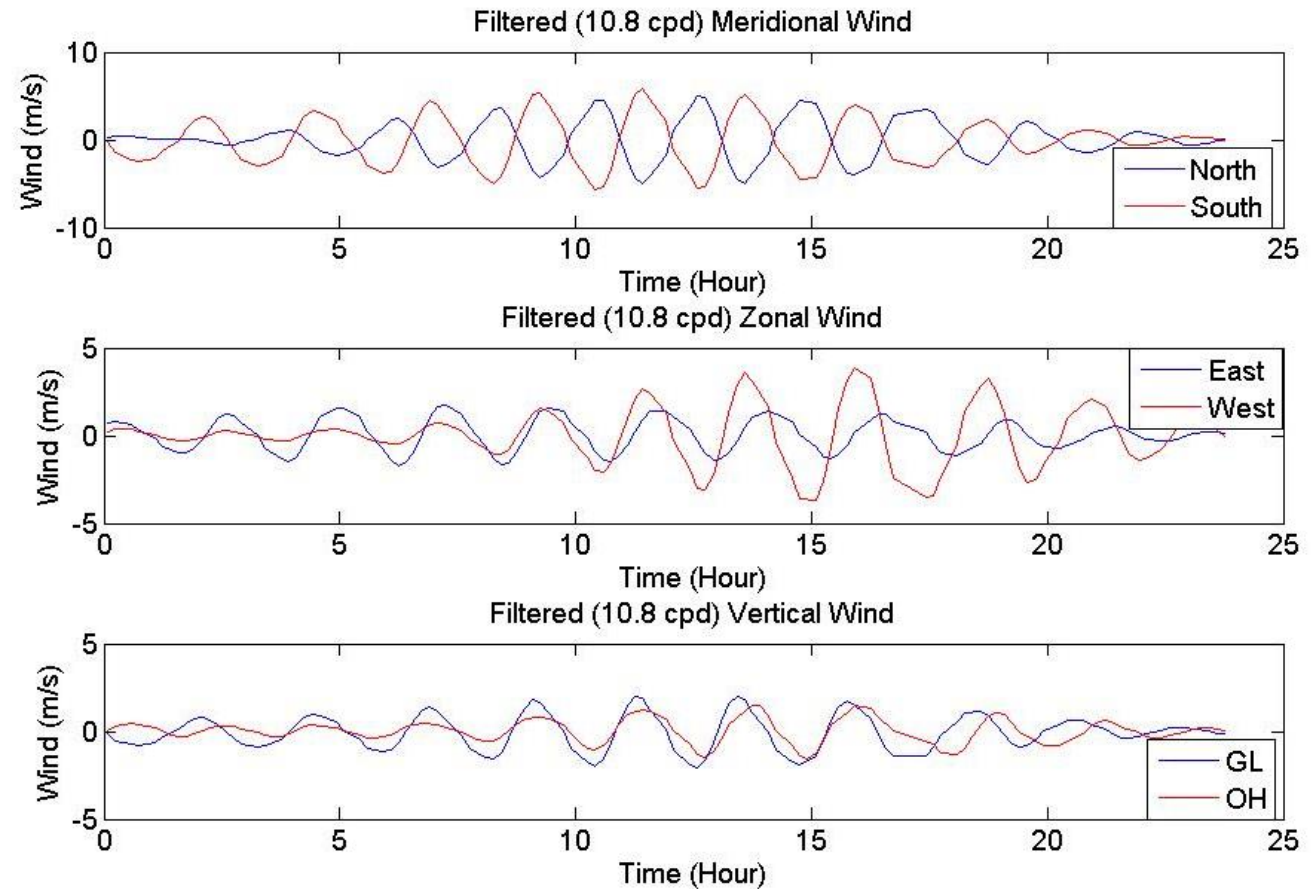
- Vertical wavelength

$$\lambda_z = 48 \text{ km}$$

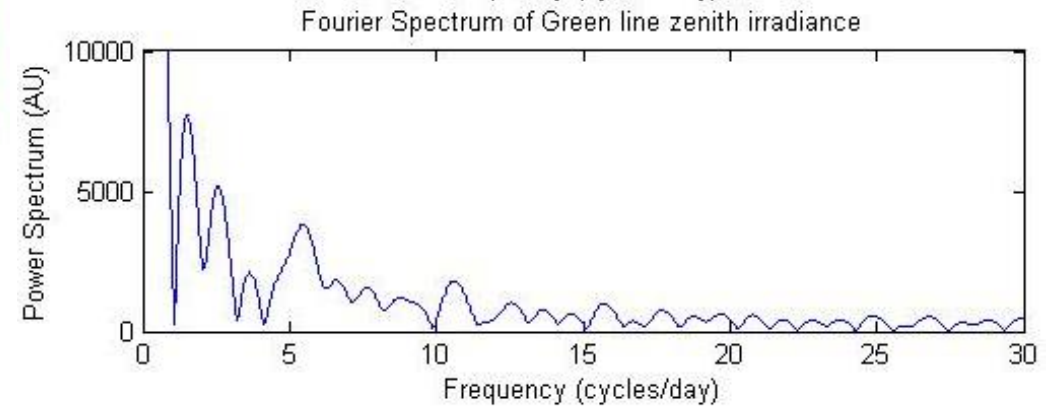
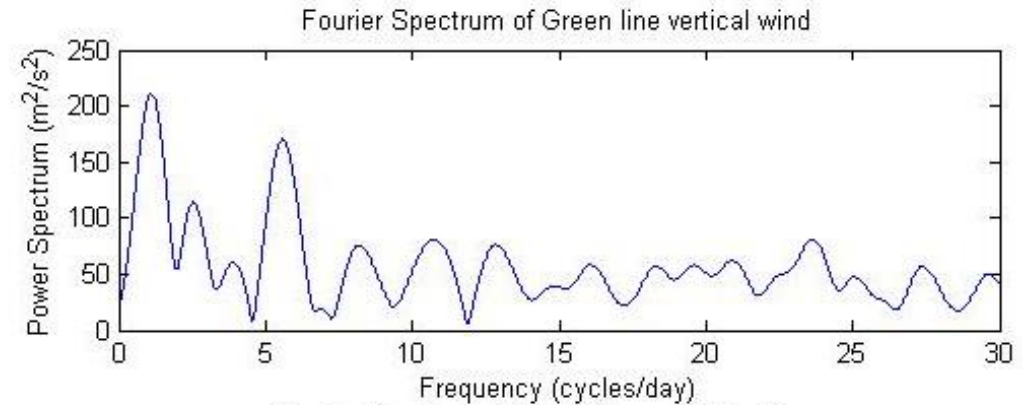
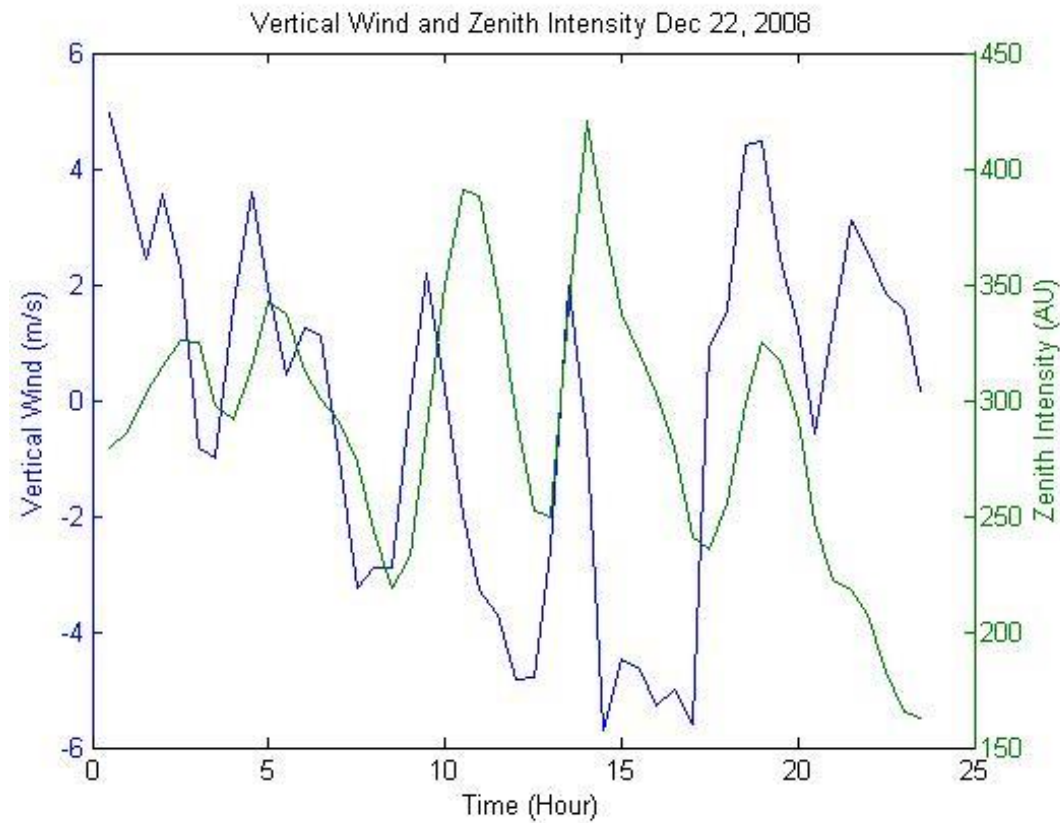
- Wave vector is

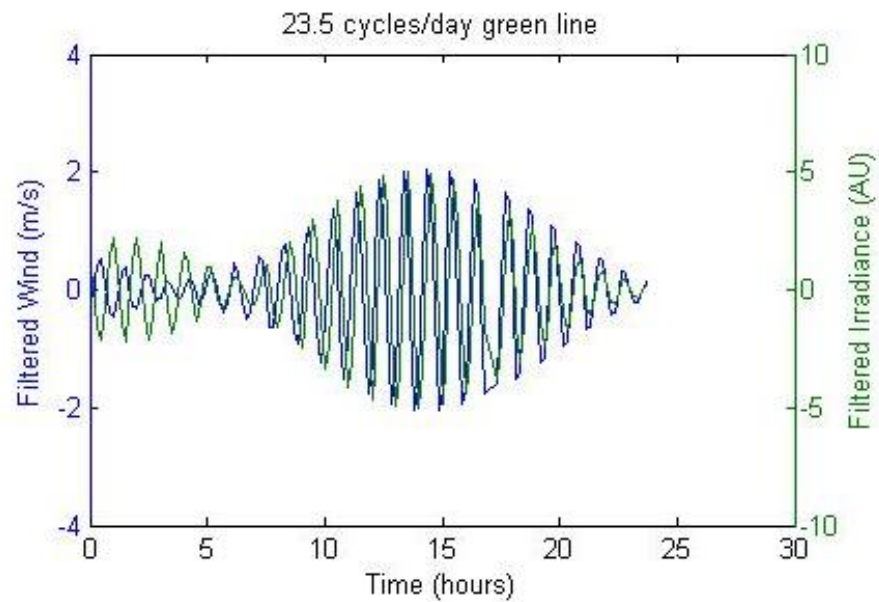
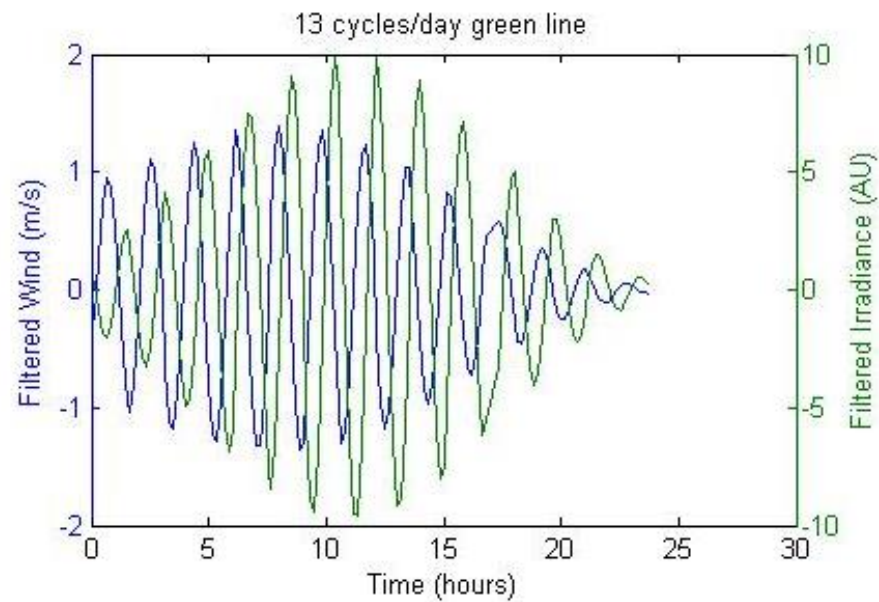
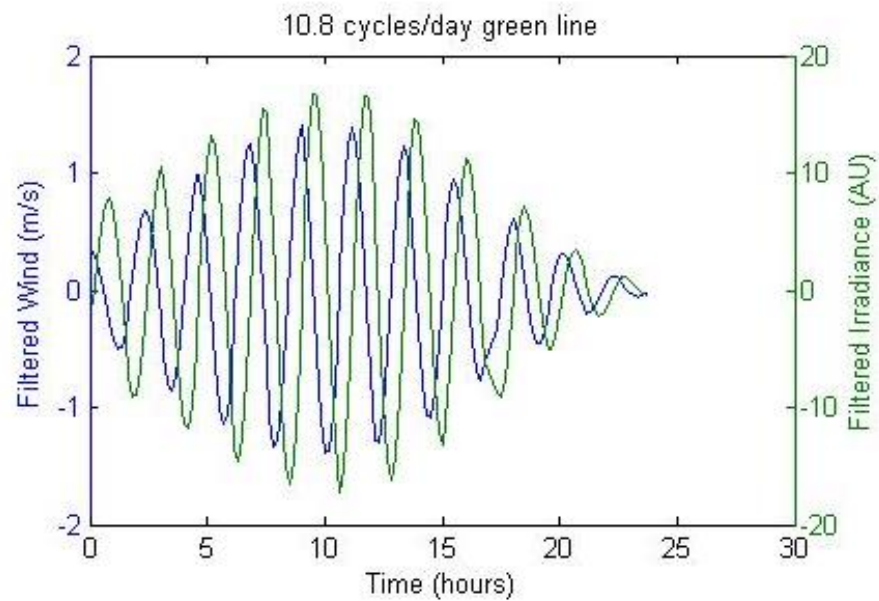
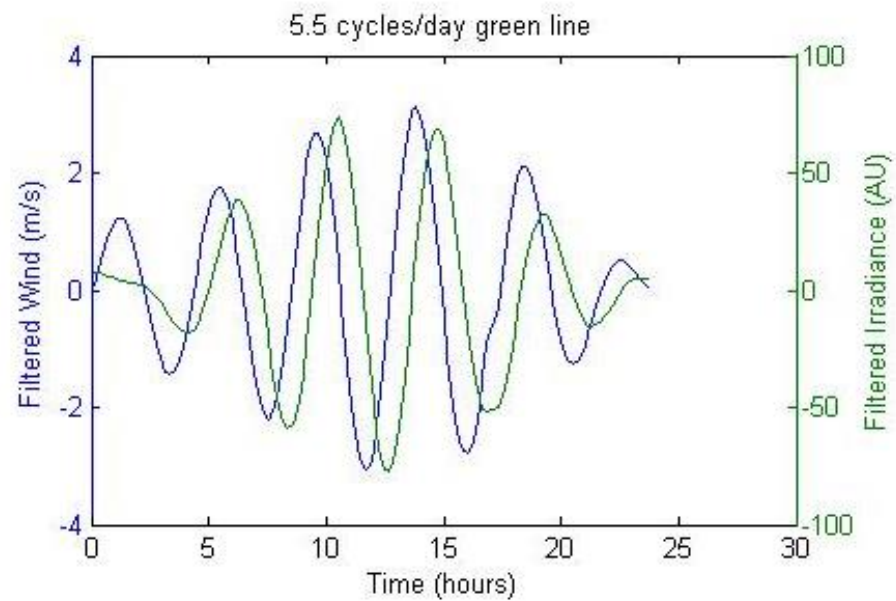
$$k = 1.32 \times 10^{-4} \text{ m}^{-1}; \varphi = 93.6^\circ; \theta = 85.2^\circ$$

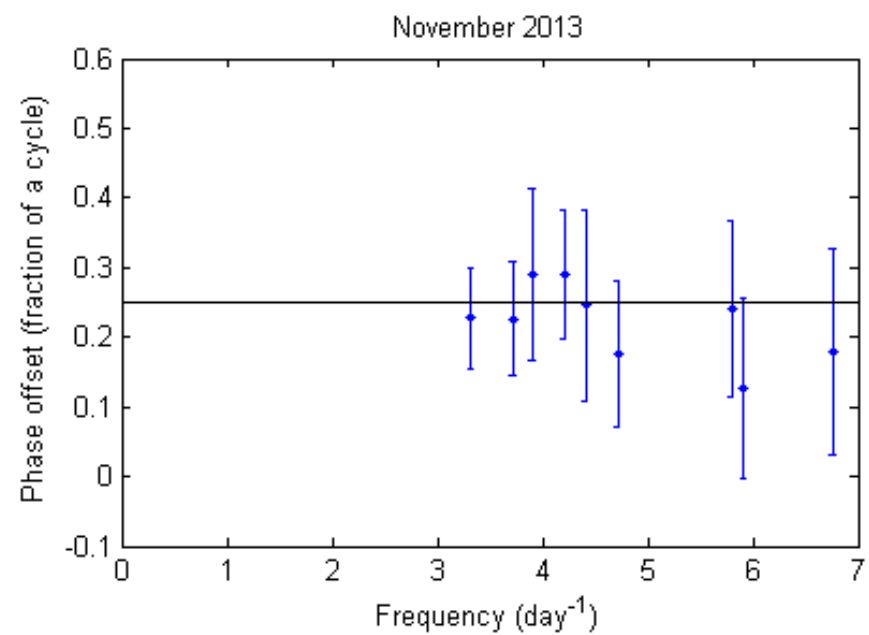
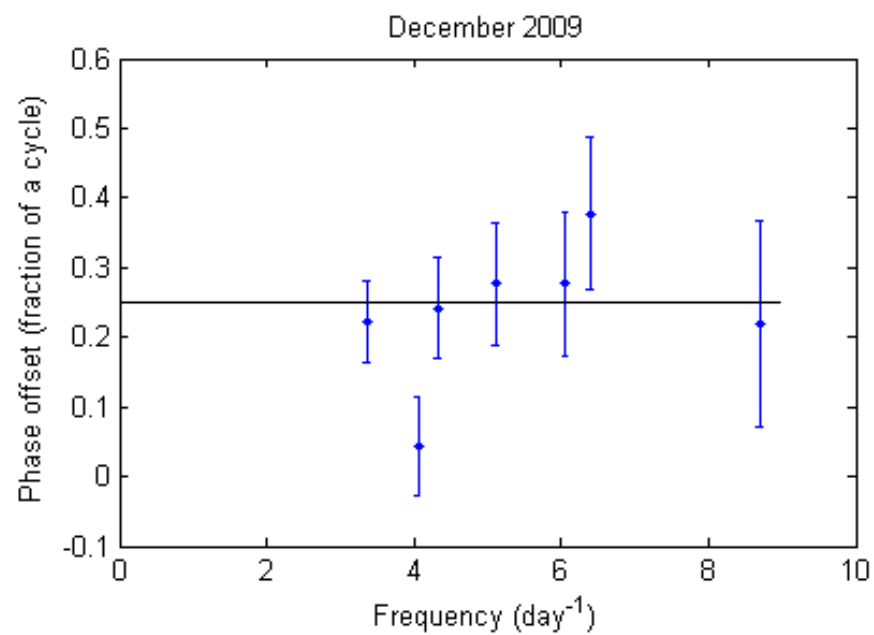
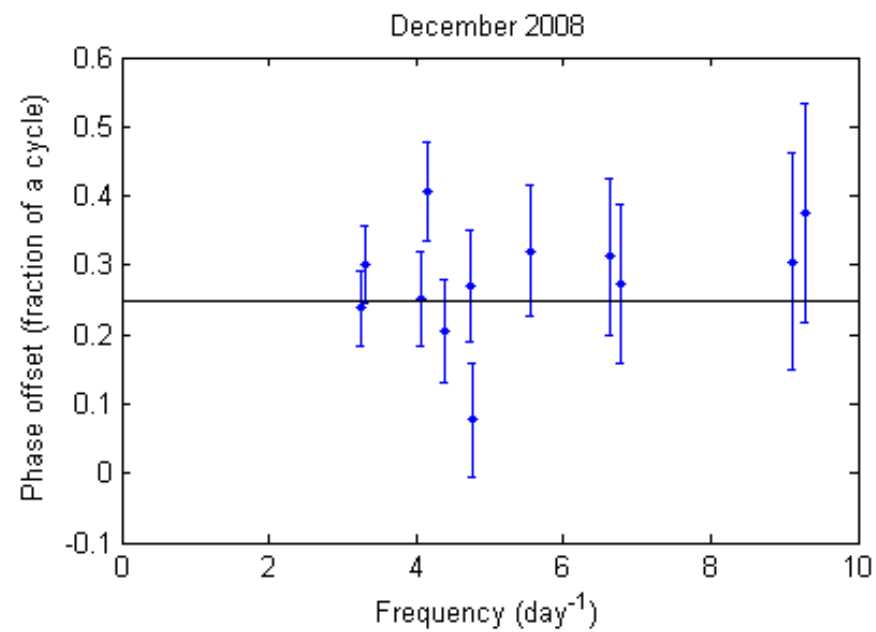
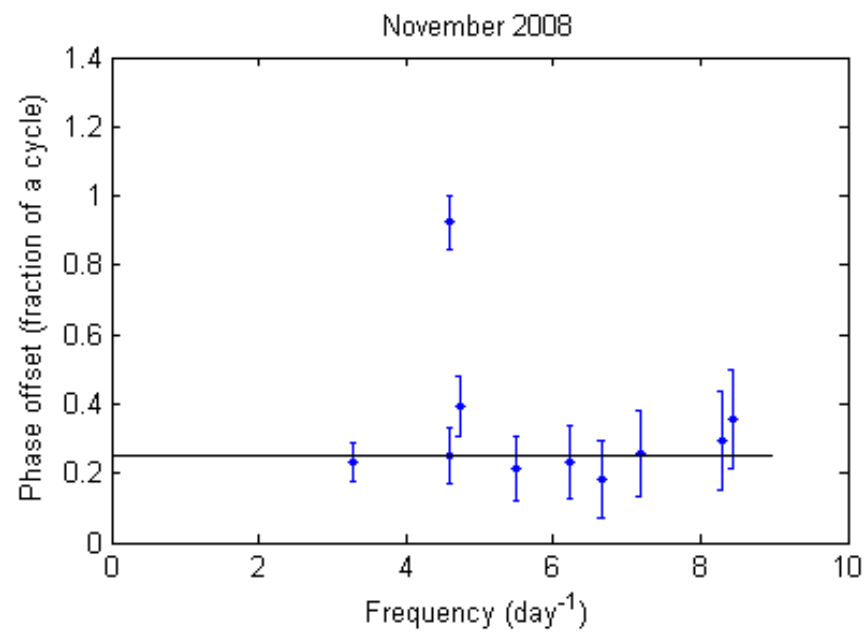
$$N = 0.0119 \text{ s}^{-1}$$



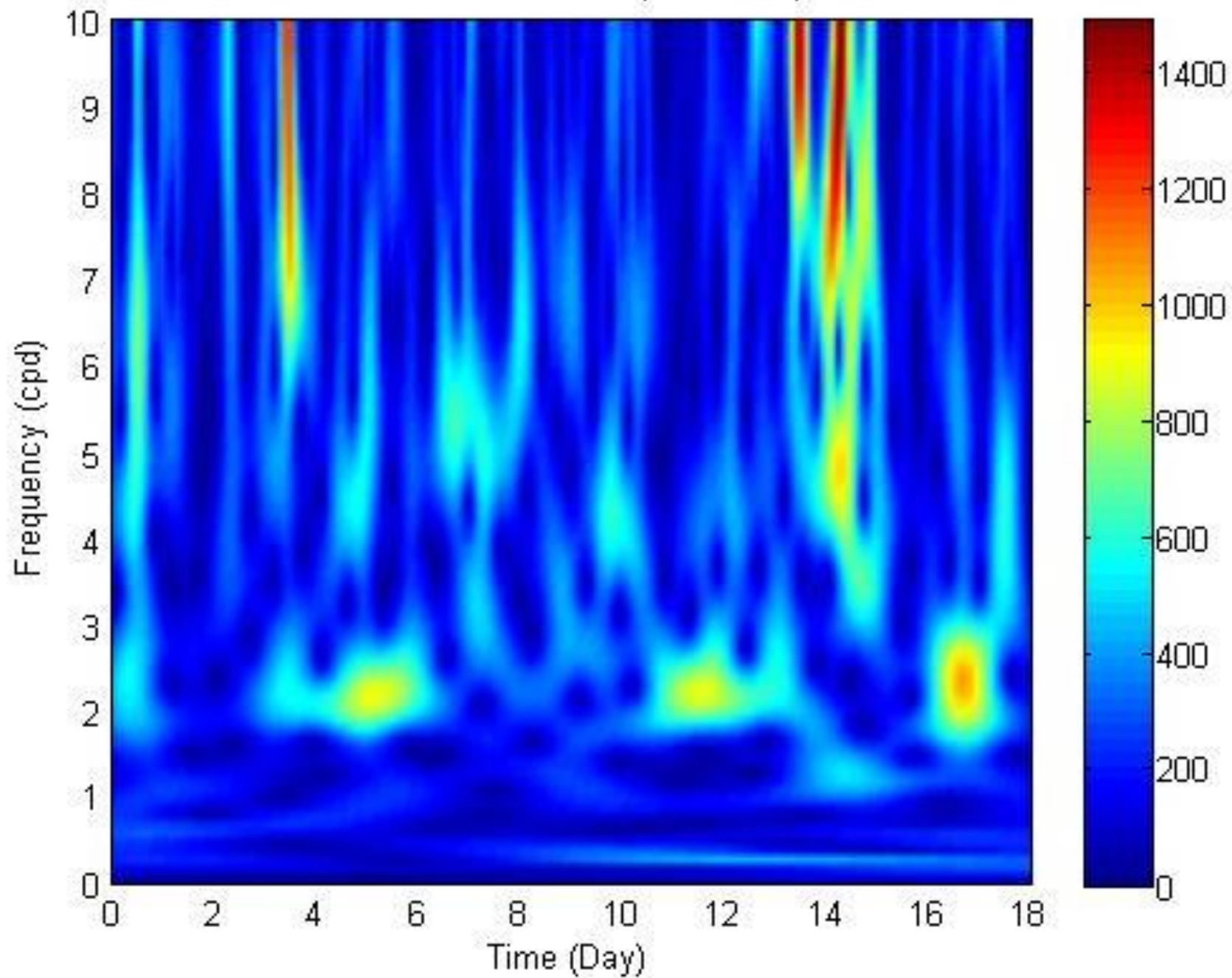
Vertical Wind and Zenith Intensity





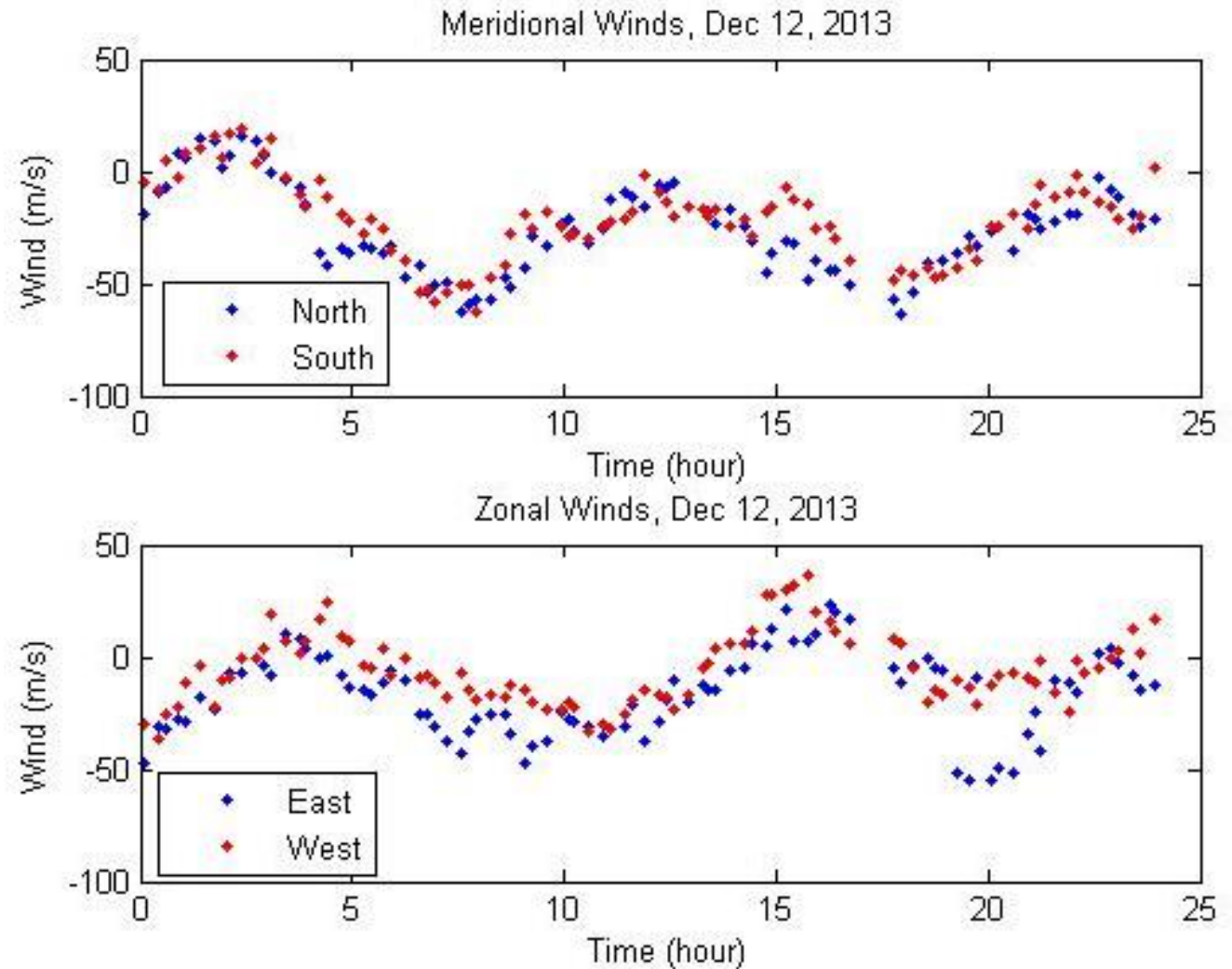


S-Transform of Zonal Wind, Dec 1-18, 2013



Observed Tide

- Zonal Wavelength – 6800 km
- Meridional Wavelength 6200 km
- Observed Frequency – 2 cpd
- Observed wavenumber $1.02 \approx 1$
- Eastward propagating non-migrating semidiurnal tide



Conclusion

- ERWIN is providing reliable wind measurements in the polar region, with a precision of better than 2 m/s.
- Vertical winds have been measured, and comparisons with intensity show correlations consistent with vertical motion of the airglow layers.
- Tides and gravity waves have been observed, though there are some inconsistencies which need to be further investigated.

Acknowledgements

- Funding support from CANDAC/CFCAS and CREATE gratefully acknowledged.
- Thanks to my supervisor William Ward.
- Thanks to the operations personnel at Eureka for their support.
- Thanks to Stephen Brown for his work on developing ERWIN-2 and installing it at PEARL.