Wind Observations with the E-Region Wind Interferometer
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Introduction
The E-Region Wind Interferometer (ERWIN-II) is a Michelson interferometer that measures the mesospheric wind (~90 km) by determining the Doppler shift of airglow emissions. Airglow is the emission of light as a result of chemiluminescence; the airglow emissions of interest to us are the green line (557.7 nm) at a height of ~97 km, O2 (866.0 nm) at a height of ~94 km, and the OH (843.0 nm) at a height of ~87 km emissions.

ERWIN-II measures five directions simultaneously (north, south, east, west, and zenith) through the use of a quad mirror; this results in an observation cadence of approximately 3 minutes for observations of all three emissions in all five directions. ERWIN-II is currently located at the PEARL observatory in Eureka, Nu.

Wind Calculations
The line of sight winds are determined by converting the interferogram phase to a wind using

\[ u = \frac{c \Delta \phi}{2 \pi \lambda} \]

where \( \Delta \phi \) is the effective path difference of the Michelson interferometer, \( \lambda \) is the wavenumber of the emission, and \( c \) is the speed of light. The vertical wind is simply equal to the zenith line of sight wind, and the horizontal winds, determined using the line of sight winds taken at an elevation of 38.7° (as shown in Figure 1), are

\[ u = \frac{c \Delta \phi_s}{2 \pi \lambda} \]

where \( \Delta \phi_s \) is the interferometer phase measured at each height. The standard error for each wind measurement is ~2 m/s (as shown in Figure 2). The second data plotted on each graph (the red dots) are the errors as determined from the Schott noise and the visibility

\[ \sigma = \frac{c \lambda}{4 \pi \Delta \phi \sigma_{UV} \sqrt{2I}} \]

where \( \lambda \) is the wavelength of the emission, \( I \) is the intensity, and \( UV \) is the product of instrumental and line visibilities, respectively.

Gravity Wave Analysis
The higher frequency spectras are better observed by removing the tidal and larger scale features, as shown in Figure 6. After the two tidal features (the solid lines) are removed, the resulting wind has a persistent wave with ~3 hour period and amplitude of ~7 m/s, though it does appear to decrease towards the end of the day.

Vertical Wind and Intensity
Figure 7 shows the vertical wind (positive is downward motion) and the zenith intensity for the green line. Since the intensity is related to the height (lower emission will result in higher intensity), this plot is, to a first approximation, showing a comparison between the velocity of the airglow layer, and its height. From this plot, it is observed that there is a 90 degree phase shift for many of the peaks, such that a downward vertical wind is followed by a decrease in the height (increase in the intensity) of the emission.

Conclusion
ERWIN is accurately observing polar mesospheric winds, with a precision of ~2 m/s. The high observational cadence will allow for very detailed observations of small scale phenomena of scales of less than an hour, with a precision of ~1 m/s. Smaller scale phenomena were successfully observed by removal of the larger scale tidal features. Comparisons of the vertical wind and zenith intensity show that there is a correlation between them.

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