Characterizing E-region Neutral Wind Dynamics at Sondrestrom

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Neutral Winds

- Neutral winds play an important role in coupling processes between the magnetosphere, ionosphere, and thermosphere.
- Neutral wind dynamics in E-region poorly understood
  - Affected both by neutral atmosphere below and ionized atmosphere above
  - Motion driven by various processes including gravitational and thermal forcing as well as coupling with ionized atmosphere
- Several instruments (MF, Meteor Radars) can measure motions of neutral winds in lower thermosphere but only Incoherent Scatter Radar (ISR) techniques allow for observation above 110 km
  - Lack of neutral wind data above ~100-105 km has been historically problematic
Sondrestrom ISR

- Goal of project to characterize high latitude wind dynamics under geomagnetically quiet conditions during low solar activity
- Located at 67°N 309°E
- Data taken from two campaigns in September 1-30, 2005 and March 6 – April 6, 2006
- Neutral wind data derived from measured ion drift velocity and calculated ion-neutral collision frequency
- Altitude range is from 95-125 km for both zonal and meridional components
- Data downloaded from Madrigal using Matlab interface
Typical Data, March Zonal, 105 km
Smoothed Monthly Average Winds

Zonal Wind March

Meridional Wind September
Lomb-Scargle Periodogram Analysis

- Spectral analysis of data necessary in order to find significant frequencies in data
- Standard FFT methods unfit for use in this case
  - Useful data sampled at uneven intervals
- Lomb-Scargle method used
  - Can analyze unevenly sampled data
Data from each campaign were then fit to harmonic components derived from LS analysis

$$U_n(t) = A_{12} \cos(\frac{2\pi}{12}(t-P_{12})) + A_{24} \cos(\frac{2\pi}{24}(t-P_{24}))+B$$

Amplitude and Phase of each component from monthly average analyzed
Semi-diurnal Tide

Blue: Data
Red: GSWM

March

September
Diurnal Tide

Blue: Data
Red: GSWM

March

September
Daily Variation

Variation of 12h 24h components investigated
5-day running averages centered around each day of campaign
Data gaps filled with monthly average
Variations in Mean Wind

March Zonal Mean Component

LS Periodogram: 108.14 km
September Semi-diurnal Tide

- Peak at 95-100 km seen only in first half of month
Meridional Diurnal Tide

- Peak at 110-115 km shows variability over course of both campaigns
- Indication of planetary waves
Conclusion

- Neutral wind data from Sondrestrom ISR during two campaigns were analyzed in an effort to characterize neutral winds in the area.
- Semi-diurnal and diurnal tides found to be dominant in spectral analysis.
  - 8 hour tide also found in March data.
- Harmonic fitting in general agreement with GSWM for March data.
- September data found to be in disagreement.
- Long term variation (5-day, 8-day) found in both semi-diurnal and diurnal components during both fall and spring equinox.
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