Observations of migrating tides in the mid-latitude MLT using an array of SuperDARN HF-radars

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Supplementary material for the EGU General Assembly 2020 online activities "Sharing Geoscience Online"

Method

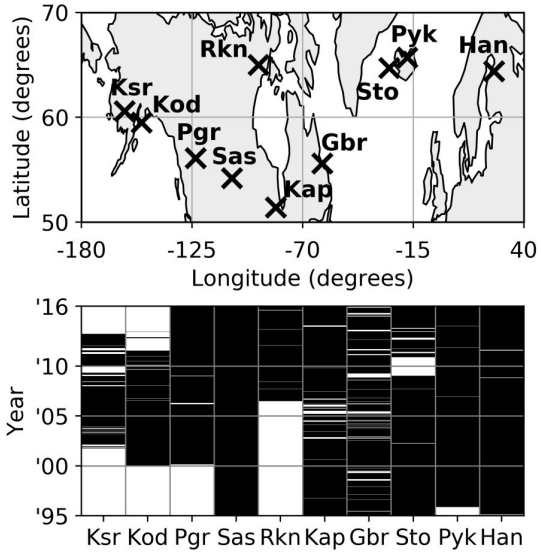

Figure 1: Abbreviated names, geographic locations, and time of operation between 1995 and 2016 (black marking lower panel) of the SD radars used in this study.

The amplitude and phase of DW1, SW2, and TW3 are calculated by least-squares fitting the function $G(\lambda, t)$, representing these tidal modes along with a mean wind, given by

$$G(\lambda, t) = \sum_{k=1}^{3} A_k \sin(k\,[\Omega t - \lambda] + \phi_k) + G_0, \tag{1}$$

where $k = 1, 2, 3$ represent DW1, SW2 and TW3, respectively, and where $\Omega = 2\pi/24$ hr^{-1}; λ is the geographic longitude; G_0 is the mean. The time development is determined by fitting $G(\lambda, t)$ over a 10-day window that is stepped forward in time with hourly steps over the range of available data.

Results

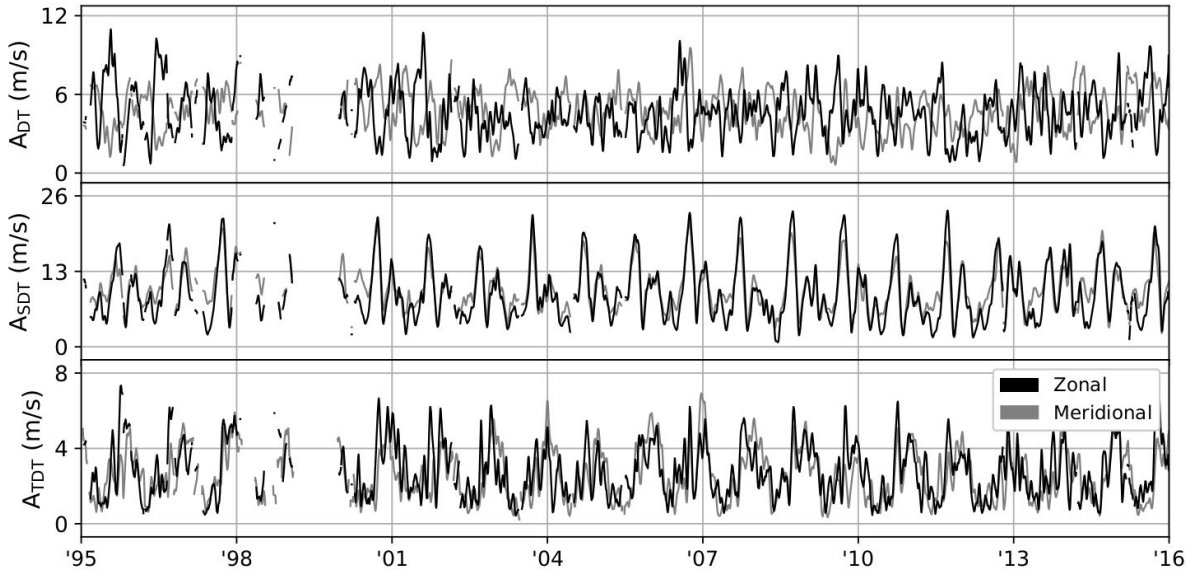

Figure 2: Amplitude of DW1 (top), SW2 (middle), and TW3 (bottom) in SuperDARN zonal (black) and meridional (grey) meteor winds between 1995 and 2016.

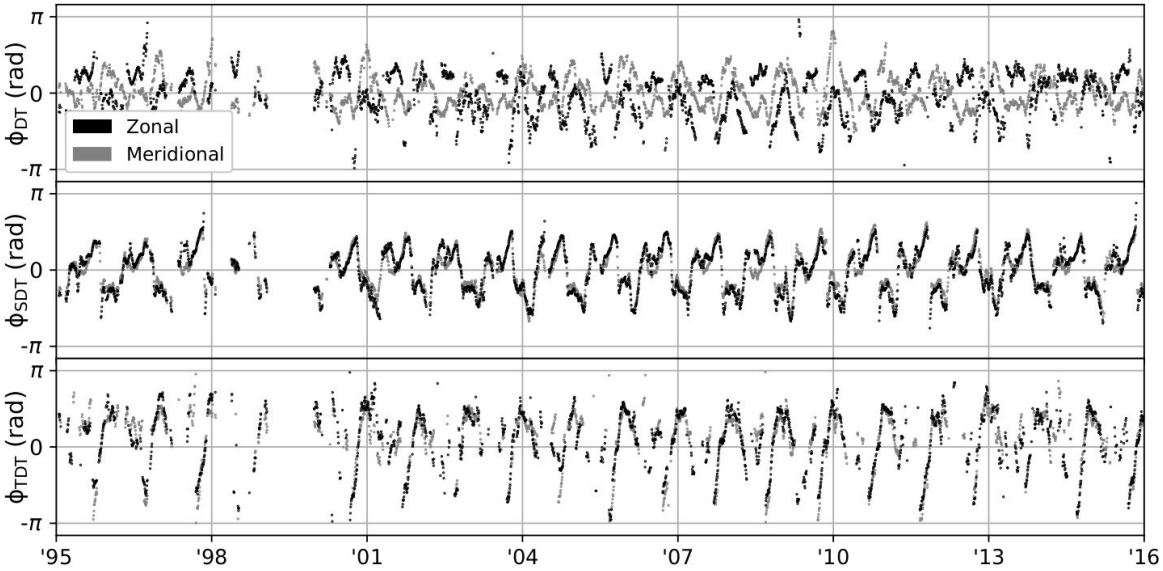

Figure 3: Phase of DW1 (top), SW2 (middle), and TW3 (bottom) in SuperDARN zonal (black) and meridional (grey) meteor winds between 1995 and 2016. Only phases for when amplitudes are greater than 1 m/s are shown for sake of clarity.

Note: phases are first sub-sampled every day at 00:00 hrs and then centered over zero radians by subtracting the (circular) mean phase between 1995 and 2016

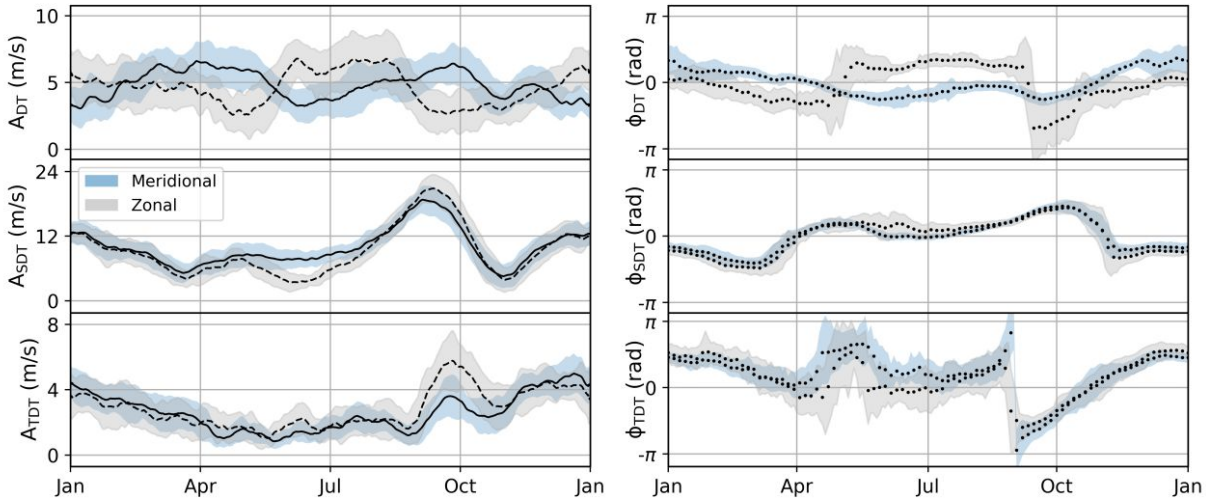

Figure 4: Climatologies of DW1 (top), SW2 (middle), and TW3 (bottom) based on SD meridional (blue) and zonal (grey) meteor winds between 1995 and 2016. Shading marks the (circular) standard deviation around the mean.

Validation

- Tides fitted to winds from the High-Altitude version of the Navy Global Environmental Model (NAVGEM-HA) sampled at the locations of available SuperDARN meteor wind measurements (NAVGEM-SD), are compared against those fitted to a full longitude circle along 60 degrees North (NAVGEM-360). Here NAVGEM-HA is sampled at 85 km altitude, where tidal amplitudes are found to most closely match those of SuperDARN.

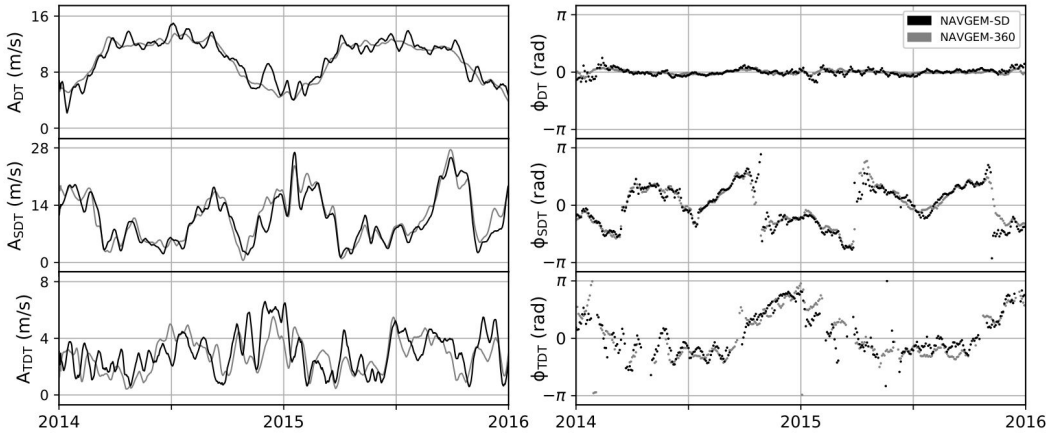

Figure 5: Amplitude and phase of DW1 (top), SW2 (middle) and TW3 (bottom) in NAVGEM-SD (black) and NAVGEM-360 (grey) at 82.5 km altitude for the years 2014 and 2015.