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Interactive comment on "Migrating tide climatologies measured by a high-latitude array of SuperDARN HF-radars" *by* Willem E. van Caspel et al.

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The authors would like to thank the reviewer for their comments on our work. We address each comment individually by stating the original Refereree Comment (RC) followed by the Author's Response (AR).

RC1: This is my main comment for this work. Do SuperDARN radar tides com- pare well with your model (NAVGWM-SD)? I saw NAVGEM-SD and NAVGEM -360 com- parison, and results look great. Authors mentioned in the section 2.3, NAVGEM – HA show good agreement with tides and winds from previous radars and satellite ob- servations. I am wondering if your tides show good agreement with NAVGEM. Can you

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add SuperDARN radar tidal results in Figure 5 along with NAVGEM-SD and NAVGEM-360? Or can you show us comparisons between modeling work and SuperDARN radar observed tides?

AR1: The purpose of including the NAVGEM-HA analysis was to validate the SuperDARN tidal analysis method. That is, that the combination of radars, each measuring the tidal oscillations at different locations, can be used to extract the unambiguous migrating components without bias due to the discrete spatial sampling of SuperDARN. We did not include a direct comparison between SuperDARN and NAVGEM-HA on the basis that the SuperDARN tides represent a broad vertical average (calculated from a Gaussian meteor echo distribution centered on ∼100 km altitude with a FWHM of 25-35 km), whereas NAVGEM-HA can be used up to an altitude of ∼90 km for tidal analysis. The SuperDARN meteor winds therefore represent tidal measurements of a region that is largely outside of the NAVGEM-HA model domain. A detailed comparison between the modeled and observed tides would require the model domain to be extended up to ∼ 125 km altitude below the sponge layer, such that vertically averaged model winds can be compared to those measured by SuperDARN. Nonetheless, we think the inclusion of the SuperDARN tidal modes in Figure 5, as suggested by the reviewer, is a worthwhile addition, not in the least because it demonstrates more clearly that the modeled and measured tidal modes share similar seasonal characteristics, further justifying the use of NAVGEM-HA to validate the SuperDARN tidal analysis method. The SuperDARN measurements have therefore been included in Figure 5 of the revised manuscript, and a brief description of the above reasoning has been included as a third paragraph in section 4.1.

RC2: It is hard to see where are DOY 250, 260, 365 etc mentioned in the page 4-5 for Figures 2-3. Also it is hard to see where is “late summer” and “mid-winter” from Figure 2 and 3. Would you add vertical lines for every year (currently every two years)? Can you also specify “late summer’ and “mid-winter”(which months are you talking about?).

AR2: Throughout the manuscript, text referring to certain time periods has been changed so as to be more clear about what time period is being referred to in Figures 2-4 (e.g., ‘mid-winter’ (December - January)). Vertical lines have been added for each year in Figures 2-3, and Figure 4 now shows DOY on its x-axis (see AR3).

RC3: Authors discussed a lot about DOY 260. Would you indicate DOY 260 in some of your figures? X-axis is years and it is hard to see from Figures 2-3.

AR3: The labeling on the x-axis of Figure 4 has been changed to Day Of Year (DOY), and a vertical line at DOY 265 is included in the bottom left panel showing the climatology of the amplitude of the migrating terdiurnal tide (TW3, bottom left panel). What was referred to as the DOY 260 amplitude peak is now referred to as the DOY 265 amplitude peak, to more precisely reflect its exact timing.

RC4: Figure 5: What are you plotting? Zonal wind? Or meridional wind? (I think it is zonal wind, but it is not clear).

AR4: Figure 5 plots the migrating tidal modes in the meridional wind, which is now clarified in the figure caption.

RC5: Authors discussed that radars can see high-temporal reso- lutions, resulting in the peak around DOY 260. Would you discuss more about this? What are temporal resolution of previous terdiurnal tide work?

AR5: To the best of the author’s knowledge, previous observational studies capable of unambiguously isolating the migrating component of the terdiurnal tide in the northern hemisphere mid- to high-latitude MLT region have exclusively relied on satellite observations. Such observations are limited to temporal resolutions of monthly timescales. For example, Smith (2000) combines UARS data over two yaw cycles (70 day average) to retrieve TW3 tidal amplitudes at 60N. As a result, features such as the DOY 265 maximum observed by SuperDARN are not distinguishable in their figure 2. Other studies capable of isolating the mid- to high-latitude migrating terdiurnal tide have used SABER/TIMED satellite data (e.g., Moudden et al., 2013; Pancheva et al., 2013), but in addition to being limited to 20- to 60-day means, they only report temperature tides, which further complicates the comparison with SuperDARN.

Model studies seem to show mixed results in terms of the temporal resolution of their tidal analysis and the effective temporal resolution of their results. The cited works by Akmaev (2001) and Smith et al. (2001) describe model results showing a qualitatively similar seasonal cycle as the observed SuperDARN TW3 (i.e., a broad amplitude maximum in the zonal and meridional winds during winter). These studies have used monthly mean specifications of the background atmosphere. For example, in Figure 2 of Smith et al. (2001), no DOY 265 peak is distinguishable at 97 km altitude. The study by Yue et al. (2013) employs a model that is configured using a mixture of daily mean and monthly mean atmospheric background fields. They report monthly mean TW3 tidal amplitudes at 110 km altitude, where a DOY 265 amplitude peak is not visible at 60N (their Figure 3).

However, the TW3 model study using the Canadian Middle Atmospheric Model by Du et al. (2010), where a monthly-mean sliding window is used to analyze internally generated 3-hourly model winds, does show an amplitude peak around DOY 265 around 100 km altitude at 60N (their figure 3). Because of this qualitative agreement with the SuperDARN observations, reference to their model study has been included in the discussion section of the revised manuscript.

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