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Comment on angeo-2021-6

Anonymous Referee #1

Referee comment on "Winds and tides of the Extended Unified Model in the mesosphere and lower thermosphere validated with meteor radar observations" by Matthew J. Griffith et al., Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2021-6-RC1, 2021

Review for "Winds and tides of the ..." By Griffith et al

This paper is a well-written paper describing analysis (and comparison with data) of data from the extended Met Office's Unified Model into the mesosphere and lower thermosphere. In particular, the authors compare the mean zonal and meridional winds with measured values month by month. They also compare the model results with observations for the amplitudes and phases of the 24 hr and 12 hr tides month by month. I believe this paper is worthy of publication after the following comments are addressed.

line (l) 17: Shouldn't it be "westward rather than eastward"?

l 43 or l 51 (or thereabouts). You might want to mention (or at least referenced) that migrating and non-migrating tides are generated in-situ in the thermosphere from the dissipation of GWs from deep convection mainly in the ITCZ (Vadas et al, 2014, JGR). This changes the TEC distributions, and could potentially modify the conditions for seeding equatorial plasma bubbles in the F region.

l 109: I believe you should add the HIAMCM as #8 to this high-top GCM list, since this GCM goes to z=450 km (Becker & Vadas, 2020, JGR). This GCM is unique in that it reproduces the TAD (traveling atmospheric disturbance) hotspot observed over the wintertime Southern Andes (e.g. Park et al, 2014, Trihn et al, 2018). These TADs are composed of tertiary GWs from MW breaking at lower altitudes. The HIAMCM only models the neutrals from dynamics from below, and is a high-res GW-resolving model down to horizontal wavelengths of 165 km. The tides in the thermosphere agree pretty well with MSIS and HWM14 (Becker & Vadas, 2020), and this model includes ion drag, molecular viscosity, non-hydrostatic corrections. The model has explicit moisture cycle and radiative transfer. However the methods used are idealized compared to comprehensive GCMs. Additionally the HIAMCM has no chemistry. For these reasons, the word "Mechanistic" is

included in the name of the model (HIAMCM= (HI Altitude Mechanistic general Circulation Model). Note that when the HIAMCM had a top of z~100 km, the tides (amplitudes and phases) were compared to data (Becker, 2017, JAS). At that time, the model was called KMCM, was lower resolution, and only had a GW parameterization scheme. However, the moisture and radiative transfer methods were essentially the same as in the HIAMCM.

Somewhere in the introduction the authors should mention an important recently-published paper by Stober et al (2021, AG). This paper examine the mean winds and diurnal and semidiurnal tidal amplitude and phases (and momentum fluxes) obtained from meteor radar data at six Southern Hemisphere locations (midlatitude to polar). They found that the results agreed reasonably well with Becker and Vadas (2018, JGR), thereby pointing to secondary GWs and multistep vertical coupling as a mechanism by which GWs transfer energy and momentum to higher altitudes during the wintertime.

x-axis and y-axis number and labels for Figs 4-7, 16-17:
These numbers and labels are virtually unreadable (too small). Please make them 2-3 times larger.

l 261: sentence is confusing. remove "than those observed"?

l 262: "and -40 m/s at heights near 80 km in january". I don't see this in fig 6a?

l 320: "Sep., Oct."
l 337: "at for"