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Interactive comment on "Density correction of NRLMSISE-00 in the middle atmosphere (20–100 km) based on TIMED/SABER density data" *by* Xuan Cheng et al.

Anonymous Referee #2

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Density correction of NRLMSISE-00 in the middle atmosphere (20–100 km) based on TIMED/SABER density data

by

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Absolute neutral air density observations at the upper atmosphere are rare and very often empirical models such as NRLMSIS-00 are the only source of information of the neutral air density. 30 years ago, this was also the case in the middle atmosphere, which is the primary atmospheric region of interest in the submitted manuscript. The authors aim to correct the NRLMSIS-00 at altitudes between 20-100km with respect to

the SABER observations onboard TIMED. The correction includes climatological information on planetary waves and tides as well as solar effects to obtain a better model. Further, the authors claim that there is no other information available to account for the density at the middle atmosphere, which accounts for the variability due to atmospheric waves. The manuscript is not acceptable for publication as major statements and a substantial part of the implemented wave dynamics is not correct making the whole manuscript obsolete.

Major concerns: 1) There is no need to improve the NRLMSIS-00 climatology to account for atmospheric waves. There is high-quality density information available throughout the middle atmosphere from meteorological analysis as well as reanalysis data sets (see NAVGEM-HA, MERRA2, ECMWF, etc.). Further, nudged GCM's provide additional information on the wave-driven variability of the neutral air density or long-term changes in the middle atmosphere (WACCM, WACCM-X etc.). Some of these data sets even allow us to resolve the day-to-day variability of the neutral air density variability due to planetary waves and tides as well as gravity waves.

2) Planetary waves and tides show a strong seasonal and inter-seasonal variability. In particular, the phases of atmospheric waves are variable, causing issues using empirical climatologies for a certain atmospheric wave. This variability manifests in the occurrence of sudden stratospheric warmings, which evolve quite different from year to year.

This phase variability is also an important issue for tides, which show a significant response to changes in the middle atmosphere resulting in a interday variability that cannot be covered using 60-day climatological output.

3) Why correct an empirical model, which is still very good, if one has weather models that provide the neutral air density and the associated variability for free?

4) Further, the reviewer is concerned about the claims of the authors that SABER represents a 'true' measure of the neutral air density. At the MLT SABER observes

mostly CO2 and converts it to an absolute neutral density assuming a volume mixing ratio, which shows also rather large errors (see Remsberg et al., 2008 and Rezac et al., 2015). The errors at the MLT of the volume mixing ratio are as high as 15-30%. This also limits the possibility to draw fundamental conclusions about the absolute density scale. Further, it is worth to consider that some a priori information in the SABER retrievals is taken from WACCM (chemical equilibrium codes).

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