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Interactive comment on "On the relative roles of dynamics and chemistry governing the abundance and diurnal variation of low latitude thermospheric nitric oxide" *by* David E. Siskind et al.

Anonymous Referee #2

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The manuscript objective is to study the relative roles of dynamics and chemistry on thermospheric mean nitric oxide (NO) and its diurnal variation during solar minimum at low latitudes with emphasis on the migrating semidiurnal tide (SW2) and existing conflicts of NO and electron density modeling in the E-region. The approach is to use a combination of January 2017 SABER/TIMED atomic oxygen and SOFIE/AIM NO data along with 2010 TIME-GCM model simulations (free running and nudged to NAVGEM< 95 km) and comparisons with SNOE data (through the NOEM empirical model). The main findings are as follows: (i) mesospheric zonal mean zonal winds are important to understand the diurnal NO variation because they impact the SW2 tidal magnitude and phase and thus the related downward transport of thermospheric

NO, (ii) tuning the model atomic oxygen towards SABER still results in a too high NO and the standard approach to decrease the soft X-ray flux would drive TIME-GCM electron densities even further away from IRI, pointing to an existing conflict of the NO and electron density model requirements. A suggested remedy is an increased O2+ production (which serves as a a partial sink for NO) as a result of higher wavelength resolution of the EUV spectrum and its penetration down to 110 km (O2 ionization but not N2).

NO is important for the infrared cooling of the thermosphere, as a source of NO+ ions, and as a measure of energetic particle precipitation into the atmosphere. The relative roles of dynamics and chemistry using observations have been understudied before due to limitations with the local times of the available NO data. Part of the presented work is a comparison of the SNOE-based empirical NOEM model and SOFIE which confirms the existence of an altitude offset between the two data sets explained by the semidiurnal tide. Although speculative, the proposal that higher resolution EUV spectra might be needed to remedy NO issues in the model is interesting and reasonably well motived. The manuscript is therefore relevant for solar-terrestrial physics and to the ANGEO readership. I find it well well-written and fully recommend publication once a few minor comments have been addressed. Comments 1, 3 and 6 are the most relevant ones.

1. TIME-GCM is apparently from 2010 runs but used to interpret Jan 2017 data. An argument is made on page 3 that the NO profiles shouldn't differ much from January 2010 to January 2017. It is, however, not clear from the manuscript why this is the case. The manuscript highlights the importance of the mesospheric zonal mean zonal winds for the SW2. Was the SW2 in the data the same during both years? This seems to be quite important for the conclusions and can easily be checked using SABER temperatures, for example.

2. While Figure 3 show the altitude/local time variation of the modeled NO as a contour plot, I would find Figure 2-style line plots for the model helpful, as an additional Figure.

It would more clearly show the data/model differences.

3. What is the error bar of the SOFIE NO? I believe this information is needed to help the reader with his/her assessment of model/data differences. This comment is not only in the light of the Figure 4 discussion above 115 km, but as a general issue for any model/data comparisons.

4. Page 6, line 27-29. What are the reference values?

5. Figure 9. What is the purpose of the Ascension Island MR winds? They are not discussed in the text and even the wind direction is different. There's only a vague reference on page 7, line 13.

6. Page 7, line 24. The discussion of the sunset/sunrise differences is too vague and the argument regarding the importance of daytime chemistry is too hand-waiving. What chemistry and how/why is this consistent with the ss/sr differences? Also, why is it not related to or impacted by the migrating diurnal tide (DW1)? The latter is in a different phase at sunset. Could this explain the difference, e.g., SW2 and DW1 work together during sunrise but against each other during sunset?

7. Figure 10. Typo in the caption and the line thickness of IRI seems to be the same as for TIME-GCM.

8. Overall, all Figures should be checked for axes, labels, etc.

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