

## ***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.***

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Review of ‘On the relative roles of dynamics and chemistry governing the abundance and diurnal variation of low latitude thermospheric nitric oxide’ by Siskind et al., submitted to Annales Geophysicae.

General comments:

The work by Siskind et al. uses several runs of the TIME-GCM model (nudged to NAVGEM or driven with GSWM/ECMWF) to provide possible explanations for the observed differences of equatorial nitric oxide between AIM/SOFIE and SNOE

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(via NOEM) satellite observations. The semi-diurnal tide is found to be responsible for the altitudinal difference between the maximum layers of NO in both satellite derived datasets. Absolute abundance differences between the model and satellites are improved using atomic oxygen profiles similar to SABER observations and by increasing the rate coefficient of a net-reducing-NO reaction.

In general, the manuscript is well structured and reads fluently. Some minor suggestions are given to provide more information and improve figure clarity. The References section needs some improvement. The results and conclusions are supported by the data and the topic is within the scope of Annales Geophysicae. This work is recommended for publication after the following suggestions are implemented.

Specific comments:

p3, first paragraph of Section 2:

- in the description of the SOFIE observations, please specify which latitudes are observed in December 2016-January 2017 and at which local times. Before this paragraph it is stated that SOFIE observes both sunrise and sunset, while later in this section the 5-6 AM hours are given. This paragraph might be ideal to provide some more information.
- when first reading the sentence on line 11, I understood ‘both months’ as the months December and January, even though they correspond to January 2010 and 2017. Please make this more clearer.
- on line 12, it is stated that Figure 1 shows that solar activity was slightly higher than absolute solar minimum. However, this statement cannot be made from the figure. Please also clarify what is considered as absolute solar minimum: solar cycle 24 began in December 2008.
- please provide a one-sentence introduction on the solar F10.7 radio flux and the

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planetary Ap geomagnetic index on line 12.

- on line 13, it is stated that the averaged Ap is 9 for January 2017 and 3 for 2010. This does not correspond with what is seen in Figure 1 (b), where I would say an average Ap is seen of 1 for 2010 and 2 for 2017.

on the TIME-GCM model:

- overall, I think the information given about the model is very limited and scattered over different sections, making it difficult for the reader who is not familiar with TIME-GCM to obtain an overview of the model's capabilities and limitations. Could a paragraph, which probably fits best in Section 2, be included with some more basic information about the model as well as references? What is for example the upper altitude limit of TIME-GCM and vertical spacing?

p4,l21-24: I find this to be a weird phrasing: what is the importance of the Herron (1999) paper? And if Herron recommends a rate coefficient determined at room temperature, then at which temperature was the Fell rate coefficient determined? Please rewrite.

p5,l10-17: in this paragraph the dynamical and chemical lifetimes of NO could be discussed. The Marsh et al. paper (A tidal explanation for the sunrise/sunset anomaly in HALOE low-latitude nitric oxide observations, GRL, 2000), which should be cited in this study, shows that the dynamical lifetime will control NO variations below about 110 km, while chemistry will dominate above. This is similar to the 115 km altitude, where both models break from the dynamical to the chemical controlled regime.

p6, paragraph from l4-9:

- was the rate coefficient increased or multiplied by a factor of 2? And is 'arbitrarily' the

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right word to use here if it was suggested by Herron et al. (1999)?

- one can only compare Figure 6 to the nudged model in Figure 3, so rewrite perhaps to 'Both simulations show significantly lower concentrations than the NO baseline in the nudged model shown in Figure 3.'

- write 'down to the  $4-5 \times 10^7 \text{ cm}^{-3}$  range near the maximum NO density, as seen in SOFIE and NOEM.'

p6,l26: please elaborate a bit more on what is shown in Figure 8, how it is calculated (T variations from which background?) and what is meant by 'This'.

p6,l34: the vertical profile of zonal winds, at which latitudes?

p7, 32: please provide a small discussion on how realistic the used approach is to obtain better agreement of the [O] profile between models and SABER.

p8,l4: please define the abbreviation IRI at first occurrence

p9,l21: similar for DoD and NAVGEM-HA

Technical comments:

Several articles that are referenced in the text are not included in the references section:

p2,l3: Kockarts (1980), Mlynchak et al. (2003), Knipp et al. (2017)

p2,l8: Smith-Johnson et al. (2017)

p2,l9: Randall et al. (2015)

p2,l17: Barth et al. (1998)

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On the References section:

p11,l5: write 'Venkataramani' instead of Ventkataramani  
p11,l6: write 'sudden' instead of suddent  
p11,l12: missing DOI  
p11,l26: write a comma before the start of the article's title, missing DOI  
p11,l35: write 'Paivārinta', provide the full title, missing DOI  
p12,l3: write 'Gómez-Ramírez', missing DOI  
p12,l6: write 'Observation' instead of Observations  
p12,l8: missing DOI  
p12,l16: write 'Pérot'  
p12,l18: write the full title  
p12,l24: missing DOI  
p12,l31: write the full title  
p13,l1: missing DOI  
p13,l29: missing DOI  
p13,l31: write Å instead of A  
p13,l32: write observations instead of 'observatiosn'

On the Figures:

Figure 1: no y-axis labels and units are provided  
Figure 2: no y-axis unit, no x-axis label, what are the black lines on the SOFIE profile?  
Figure 3: NAVGEM-HA has not been defined, providing a colour bar could be useful for the reader to infer NO concentrations throughout the altitude region and aid in the comparison to the SOFIE and NOEM profiles (especially since no nitric oxide profiles are shown from the models), the black contour line labels are not very readable (perhaps white is more clear)

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Figure 4: no y-axis unit

Figure 5: write 'Altitude' on the y-axis for consistency, 'stnd' has not been clarified in the caption.

Figure 6: similar remark for the contour lines as in Fig. 3, providing a colour bar or perhaps showing the NO variations from the nudged model NO baseline would give more information for the reader.

Figure 7: no y-axis labels (T [K], Ratio O/O<sub>2</sub>, NO [ppmv]), write 'dashed lines are for the driven model'

Figure 9: write 'Altitude' as y-axis label for consistency, write a full stop in the last sentence of the caption

Figure 10: write 'equator' instead of equatori

Typos and suggestions:

p2,l10: mesosphere instead of mesospheric  
p2,l27: the Marsh et al. paper was published in 2004  
p4,l19: calculated instead of calcuated  
p4,l26: I believe it should be 'peak NO values in the lower thermosphere'  
p5,l4: write 'slope in the nudged model', 'between 105 and 115 km'  
p5,l5: write 'Just as in the observational data, the nudged model ratio decreases'  
p5,l24 and l25: write labeled instead of labed  
p7,l1: write 'with those discussed . . . and are most likely'  
p7,l16: write 'of the equatorial MLT'  
p7,l20: explanations instead of explainations  
p9,l2-3: write ' a baseline minimum value of the NO peak', 'represents solar minimum conditions near the equator.'  
p9,l25 and l29: write TIME-GCM  
p9,l29: write 'and helped edit'

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