Supporting Information for “Impacts of Lower Thermospheric Atomic Oxygen and Dynamics on the Thermospheric Semi Annual Oscillation using GITM and WACCM-X”

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Text in Support of Figures S1, S2, and S3

Figure S1 shows the densities and winds for MSIS and WACCM-X at the lower boundary of GITM. It demonstrates that the seasonal and latitudinal distribution of these parameters is similar between the two models and thus the largest difference between G/MSIS and G/WX is because of different [O] distributions.

Figure S2 shows the distribution of production and loss terms for O at 149 km for different GITM simulations. Panels (e), (f), and (g) show the net chemical source term that is used in the vertical continuity equation. This term is the difference between the production and loss terms for [O]. It can be inferred from these panels that the chemical source term though significant is not the cause of opposite SAO in G/WX and G/NUDGE simulations, because maxima at equinoxes in the globally averaged source terms are observed here. This is because of larger losses during solstices in both these simulations, arising from larger [O] during this time.

Figure S3 shows the intra-annual variations in daily averaged and fitted O/N_2 and ρ at 400 km for GITM simulations compared with WACCM-X, MSIS and different datasets. Here, we show two more simulations than the main manuscript. G/EDDY uses a seasonally varying eddy diffusion coefficient, K_{zz} with WACCM-X 2.0 density and dynamics at the lower boundary of GITM. The seasonal variation in K_{zz} is similar to that used by Qian, Solomon, and Kane (2009). In comparison with G/WX, high K_{zz} in June results in much larger decrease in O/N_2 and ρ than in January, and there is a relative increase during equinoxes. G/WX 2.1 uses the latest version of WACCM-X, 2.1 and shows similar results as GITM driven with WACCM-X 2.0 (G/WX).

References

Qian, L., Solomon, S. C., & Kane, T. J. (2009). Seasonal variation of thermospheric density and composition. *Journal of Geophysical Research: Space Physics*, *114*(A1). Retrieved from https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2008JA013643 doi: 10.1029/2008JA013643

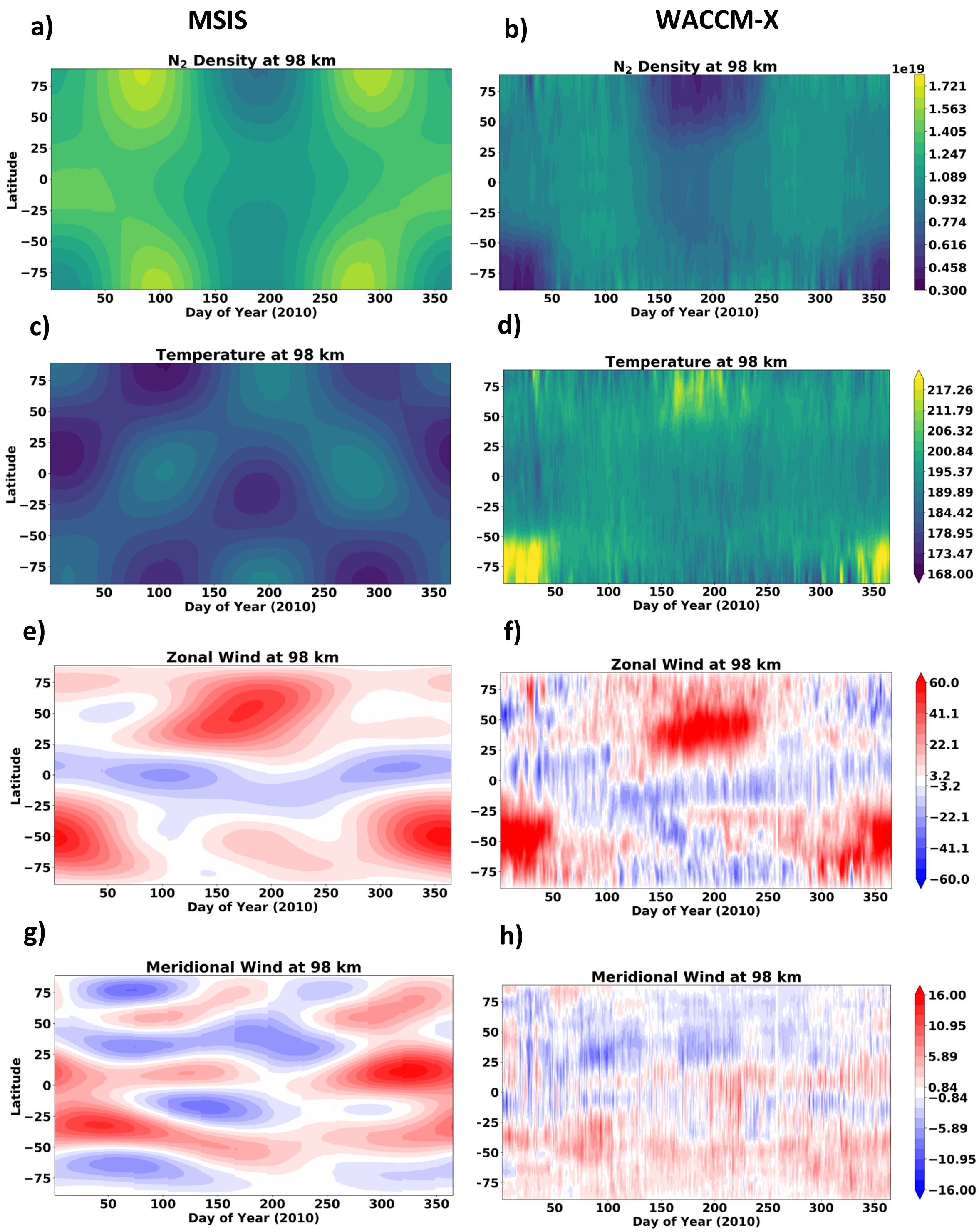

Figure S1. Diurnally averaged zonal mean quantities at the lower boundary (98.3 km) for MSIS in the left panel and WACCM-X in the right panel. (a), (b) N_2 density is in m^{-3}. (c), (d) Temperature is in K. (e), (f) Zonal Wind is in m/s. (g), (h) Meridional wind is in m/s.

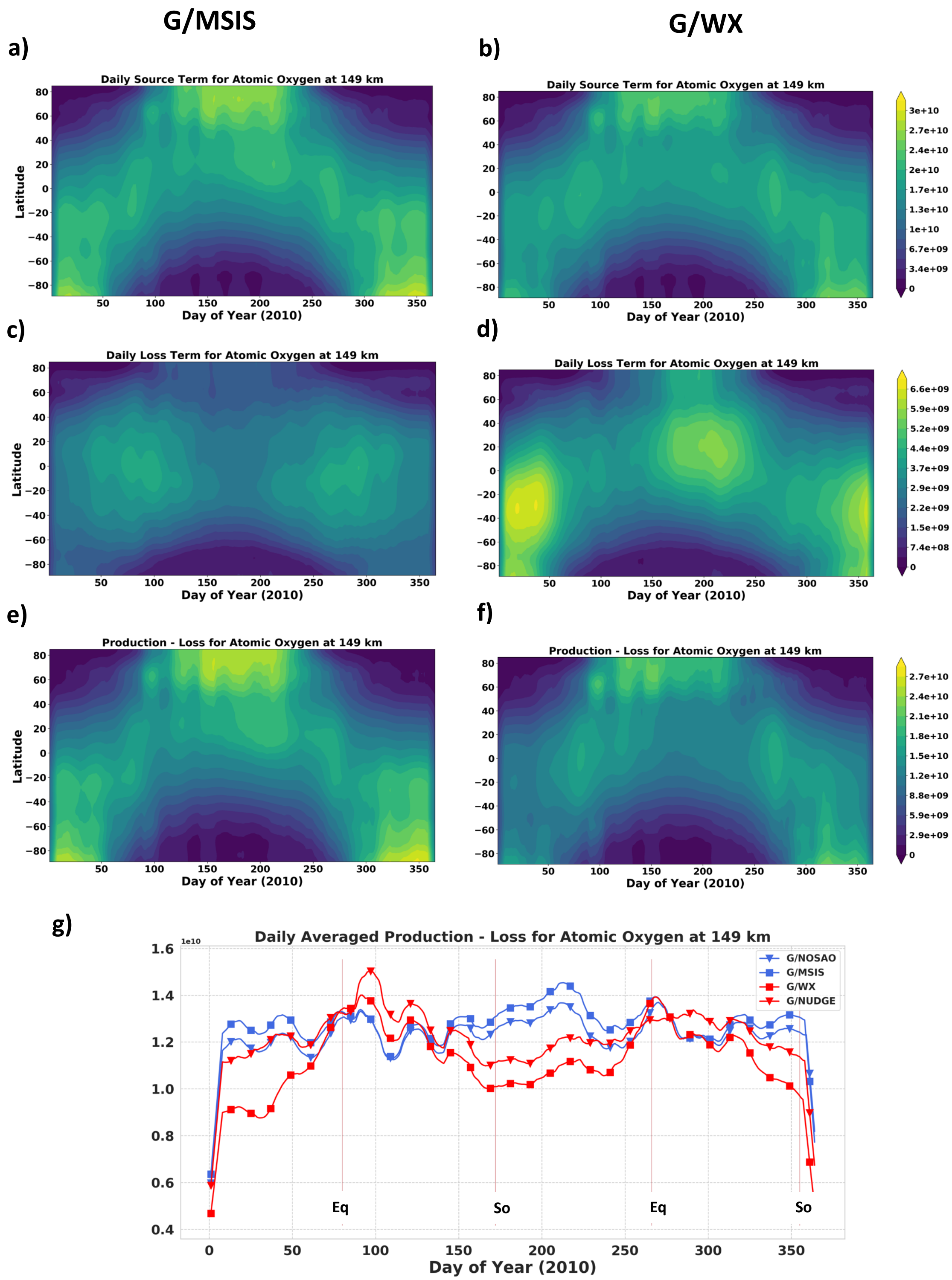

Figure S2. Diurnally averaged zonal mean chemical production ((a) and b)), loss ((c) and d)) and the difference between production and loss terms ((e) and f)) for O at 149 km. The panels on the left are for G/MSIS and the panels on the right are for G/WX, g) Global mean of the difference between production and loss terms for different simulations. The red vertical lines indicate the days of equinoxes and solstices.

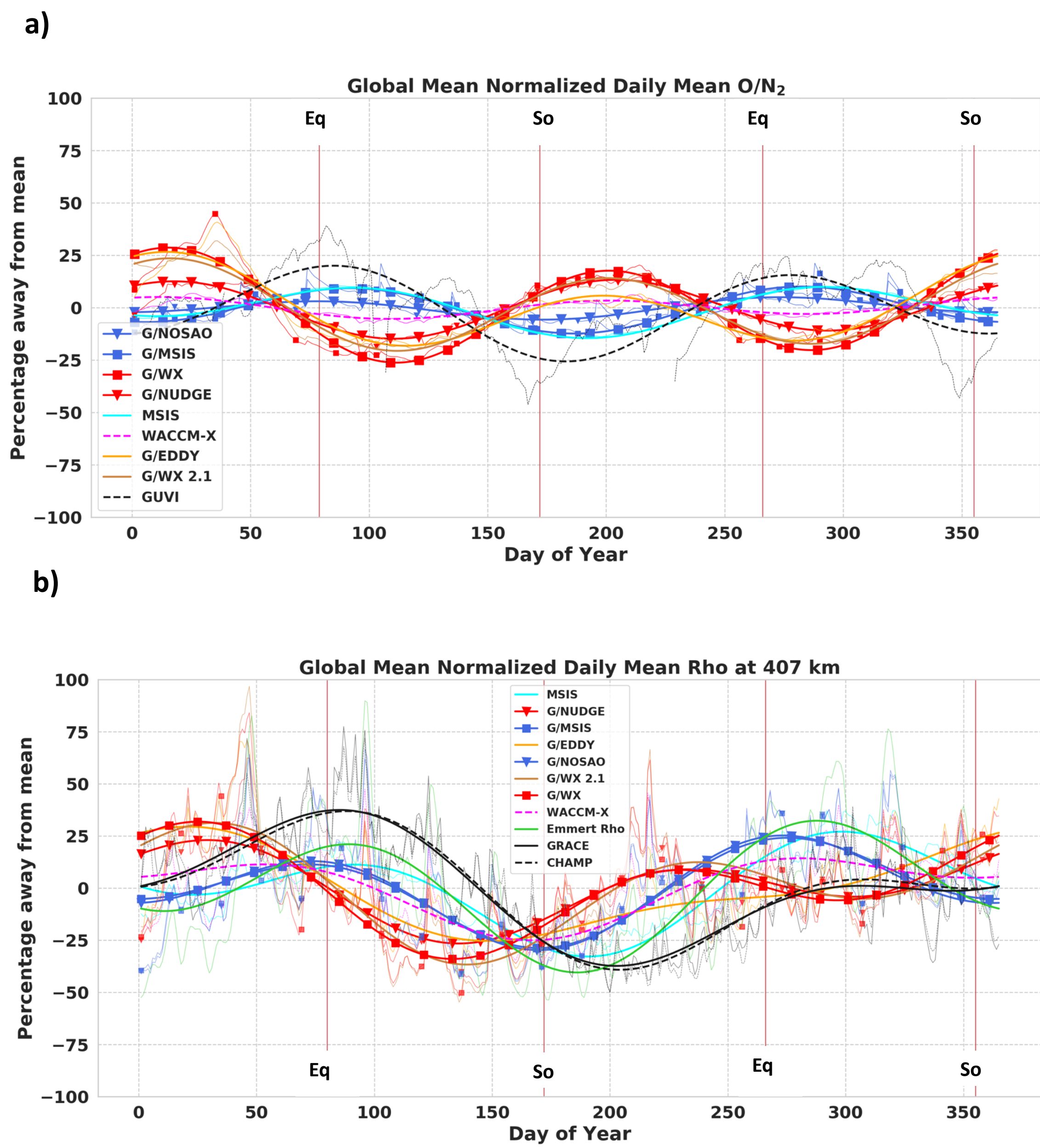

Figure S3. Diurnally averaged, normalized global means for a) O/N_2, b) ρ at 407 km, for different GITM simulations, WACCM-X model, MSIS, and observational datasets. The thin lines indicate the raw data and the thicker lines indicate the fitted values. CHAMP and GRACE datasets are normalized to 400 km and averaged for 2007-2010. The red vertical lines indicate the days of equinoxes and solstices.