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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Relationship between Lower Stratospheric Ozone in the Southern High Latitude and Sea Surface Temperature in the East Asia Marginal Seas" *by* Wenshou Tian et al.

Anonymous Referee #1

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This paper explores a possible linkage between the SST over East Asia Marginal Seas and the lower stratospheric ozone concentration over the Antarctica. The authors illustrated the correlation between the two from Reanalysis data and observation-constrained model simulations. They explained it by the SST-excite planetary waves that propagate across the equator and influence the stratosphere, and validated the mechanism by simulations of CESM. What the authors proposed is a novel mechanism for the coupling between the stratosphere and the surface. However, I have some concerns about the robustness of their results, and hope the authors can address them.

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Discussion paper

Main comments:

1.The ozone data. The ozone data employed in this study is from MERRA2 reanalysis and the TOMCAT/SLIMCAT simulations. While both data are constrained by observations in some way, they are not observations. Especially over southern high latitudes where direct observations are relatively sparse, the observational constrains would be quite weak. Since the study is build on the weak-but-significant correlation between the stratospheric ozone and the SST, it is important to establish the existence of such correlation and make sure it is not due to some artifact such as model biases.

Satellite observations of ozone is widely used in previous studies, which the authors claimed to have used in the abstract but is not even mentioned in the main text. I understand that most satellite observations of ozone has no coverage during polar night, but the largest variation of stratospheric ozone over Antarctica usually occurs in austral spring when photo-chemistry is active and the dynamical coupling with the troposphere is strong, and the satellite does cover this season. Another possibility is to use the ozone-sonde observations. Antarctic stations such as South Pole and Syowa maintain ozone-sonde observations back to 1960s. If the authors can show consistent results from these more direct observations, even if the correlations may not be as strong, it would greatly improve the confidence level for the proposed ozone-SST relation.

2. The authors showed results from time-slice and transient simulations and the quantify the contribution to ozone trends from SST warming based on these simulations. It is comforting to see these model simulations to be consistent with reanalysis, but the authors have not taken the full advantage of model simulations to establish the robustness of the results. Given that the SST-related stratospheric signal is usually small compared to the random internal variations, one may wonder if some of the signal appears just by chance. For example, the time series in Fig. 13(c) probably does not have a statistically significant trend judging by eyes. For the time-slice simulations, it should be straightforward to quantify the statistical significance. For the transient simu-

lations, since the authors have two ensemble member (T2 and T3), it would be nice to show how different are the two member. If the difference between these two member is larger than the signal (T1-(T2+T3)/2), then the T1-(T2+T3)/2 may contain considerable contribution from random noise besides the SST over East Asia Marginal Seas, then the 17% contribution to ozone depletion trends may also be questionable.

Minor points:

It is not clear whether you are referring to the boreal or austral seasons throughout the paper since both hemispheres are involved in the paper. It is important to clarify this, because if the authors mean austral seasons, then the mechanisms do not work. The cross-equator propagation of anomalous planetary waves only occurs in austral summer and autumn, but that is the season when Southern Hemisphere stratosphere is dominated by easterlies and the prohibits vertical wave propagation into the stratosphere.

P6 L23: "Rieder et al. 2014, Zhang et al. 2015b" The authors cited these references to support the argument that MERRA2 ozone compares well with satellite observations. However, Rieder et al. did not even mention satellite observations. Zhang et al only compared data over China, which is not the region of interest in this paper.

P7 L7-9 "Figure 1 shows . . . past five decades" What do you mean by "ozone variations" here? Do you mean anomalies (with seasonal cycle removed)? Also, there is only 36 years not five decades.

P7 L11-13: The authors claimed the difference between MERRA2 and SLIMCAT ozone is small, but from the Fig. 1, the magnitudes of the difference is comparable to the magnitudes of ozone anomalies itself. Also, as the author stated later, "the regions of significant correlation are generally different for the two ozone datasets", which is another proof that the difference between the two datasets is not small.

P11 L12-14: "In addition, .. this location" From the Fig. 5, it looks like most wave rays

reaching 60S do not stop there, but refract to lower latitudes.

P13 L18: “zonal circulation” I think you mean meridional circulation or zonal-mean circulation. Note that the meridional circulation in the stratosphere is better described by the Transformed Eulerian Mean (TEM) velocity rather than the conventional meridional wind, because the TEM formula includes the contribution from eddies, which is often important in the stratosphere.

P14 L4-7: “This may be . . . wave activity.” This discussion on how SST warming over East Asia Marginal Seas leads to a weaker wave activity in the Southern Hemisphere stratosphere is very puzzling. Can you support your arguments with more evidence, such as observations of convective activity?

Figure 9. Can you also show the EP flux anomalies in the troposphere? Does the tropospheric EP flux anomalies support your proposed mechanism?

Figure 13 caption: “SST variations (x-1)” I don’t think you timed SST variations by -1 in the figure, as it shows increasing and warming trends. Also the unit for panel (d) should be K.

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