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Atmospheric Chemistry and Physics Discussions

Interactive comment on "How waviness in the circulation changes surface ozone: a viewpoint using local finite-amplitude wave activity" *by* Wenxiu Sun et al.

Anonymous Referee #2

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This study explores the relationship of wave activity and surface ozone in the United States. In general, I think this manuscript is well structured and the topic is suitable for ACP. But the physical mechanism linking the wave activity with surface ozone is not clear. Also I feel this study seems to over interpret the role of wave activity (or asymmetric regional circulation), and I am not very convinced it is a useful metric that can explain much of the future changes of surface ozone. I think the authors need to address these concerns before ACP accepts this paper.

Major comments.

The physical mechanism linking AWA and ozone is unclear. If AWA affects ozone

through altering the transport, why not directly use the wind or vorticity? If the authors think the asymmetric regional circulation can add more information, they should show what is lacking if they only use the general circulation patterns.

As mentioned by this study, AWA is reflective of asymmetric regional circulation changes with respect to the zonal mean, which is only part of the weather variability that influences ozone air quality. Other weather factors like temperature and general circulation patterns should play even more important roles in modulating ozone variability. If we say weather can affect ozone in the thermal (e.g. temperature and relative humidity) or dynamical pathways (transport and ventilation), then AWA is only part of the dynamical one. So it is not surprising that it can explain only a small fraction of ozone variance (Figure 5). So this study shouldn't over-interpret the importance of AWA. I think the authors need to more accurately describe why AWA is useful.

Given this, we shouldn't expect AWA to be able to capture the future ozone changes. The authors claim that in many locations the linear regression model using AWA as the predictor can explain the magnitude of the simulated ozone changes (P12L24-25), but the spatial patterns as shown in Figure 9 and 10 are quite different. Even the magnitude of predicted ozone changes from these two methods may match in some gridboxes, this may be just a coincidence and it can't support that AWA can be used to predict (or predict much of) future ozone changes.

Also, weather variables are not independent. Or we can say that the slopes of ozone with AWA should also include effects of other meteorological variables. So will this affect the conclusion that AWA is reflective of asymmetric regional circulation changes with respect to the zonal mean? Does AWA really explain some part of ozone variances that can not be explained by other variables?

Equation 4 and 5. Will the domain size affect pi0,j0? Shouldn't the domain also move with the location of gridbox (i0,j0)?

Minor comments. P1L5. It is not surprising to find high fraction of explained covariance

if using MCA. The author should further give the numbers of explained variance in MDA8 ozone.

P1L22. Please specify the timeframe of 'future' change.

P2L3-4. Please make it clear that the stagnant weather definition used by Kerr and Waugh (2018) is from Wang et al. (1998). Ozone may still be strongly dependent on the stagnant weather, but the definition of stagnant weather from Wang 1998 may not be appropriate. This paper is cited in Kerr and Waugh (2018).

P2L30. There are already some studies that have tried to explain the relationship of wave activity and surface ozone air quality (e.g., Shen et al. (2017) and maybe some papers cited therein, https://doi.org/10.1073/pnas.1610708114).

P3L10. Turner et al. (2013) didn't use real observations, so this may explain why they found weak relationships. Many studies that use real observations indeed found strong correlations between cyclone frequency and high-ozone events. I think the authors should cite these observations based studies rather than Turner et al. (2013).

P5L15. The authors should give a brief summary of the ozone chemistry used in the model.

P5L21. Are these three ensemble simulations the same? It is not clear to readers.

P8L31. This study should also report the explained variance of MDA8 ozone.

P9L22. Seems Figure 4 can be moved to the supplement.

P10L10. It seems the AWA can only explain a small fraction of ozone variance.

P12L24. I don't see that the pattern in Figure 9 can match that in Figure 10.

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