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Comment on acp-2021-613

Anonymous Referee #2

Referee comment on "Dipole pattern of summer ozone pollution in the east of China and its connection with climate variability" by Xiaoqing Ma and Zhicong Yin, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-613-RC2, 2021

The manuscript compares a relatively short (2015 – 2019) observational record of June-July-August average ozone over eastern China to output from the GEOS-Chem model. With the ability of GEOS-Chem to adequately simulate ozone demonstrated, the authors analyze an extended GEOS-Chem simulation over 1980 – 2019 driven by MERRA-2 but using constant anthropogenic emissions. Through EOF analysis, they find a dipole in ozone variability (DP-O3), with centers of opposite sign over North China (NC) and the Pearl River Delta (PRD). The interannual variability in DP-O3 is then linked to variations in May sea-ice extent in the Arctic ocean to the north of Svalbard and Franz Josef Land (SI_FJL). Variability in sea-ice gives rise to anomalous Rossby wave forcing that propagates downstream and produces meteorological conditions over China that modify the photochemical production and accumulation of ozone. The authors similarly make a link between DP-O3 and variability in sea surface temperatures over the Indian Ocean, the Subtropical Indian Ocean Dipole (SIOD). These links between SI_FJL and SIOD and meteorological conditions over China are then reinforced through analysis of the variability in a large ensemble (40 members) of the CESM model. To close, the SI_FJL and SIOD indices are combined to create a new index (SEI) that explains a larger percentage (~40%, r=0.62) of the variance in DP-O3.

The paper is generally well organized and the development of the statistical relationships are easy to follow. I do not have a strong background in statistical analysis but the use of correlation and composites seems solid, particularly for derived impacts of sea-ice variability which has parallels with similar hypothesized links between sea-ice and interannual variability of the east Asian monsoon. The effects of the Subtropical Indian Ocean Dipole SST anomalies in January-February-March are statistically weaker and the authors suggest a mechanism involving subsurface heat content anomalies that migrate across the Indian ocean towards Sumatra by June-July-August that seems speculative. Overall, though, I only have minor comments that are itemized here.

Lines 89 – 90: It might be helpful for the reader if the mention of the fifth generation ECMWF reanalysis also included the phrase 'ERA5', as it is frequently referred to.

Lines 123 – 126: The spatial correlation coefficient is definitely a significant aspect of assessing model performance, but since the paper is about the dipole pattern the temporal behavior will be important. Can the authors present one or two widely used metrics, such as root mean square error of MDA8 ozone for the 2015 – 2019 period? Preferably, this would be presented separately for both the NC and PRD regions.

Line 143: '…three years with the lowest and highest simulated SI in 143 each member.' Was sea-ice for a particular region, such as the Barents sea mentioned earlier, used or was it overall Arctic sea-ice extent? Was a particular month used?
Line 168: Just to clarify, the timeseries of the DP-O3 timeseries shown in panel (a) of Figure 2 is the JJA average of the EOF each year? But the EOF is calculated daily?
Lines 184 – 185: The caption on Figure 2 should have some brief description of what SI_FJL, SIOD and SEI are. I know these are all described in detail a bit further down in the text, but a brief description to give the reader some idea of what is being presented is helpful.
Lines 187 – 191: Some of the acronyms used in the caption for Figure 3 are easily understood, but others like Ssr and MIcc are not.
Lines 195 – 196: Was there any detrending of the sea-ice anomalies performed before the calculation of SI_FJL?
Line 249: The presentation of May SST anomalies in panel (a) of Figure 5 show positive anomalies extending well north of 80N. Isn't there almost always sea-ice present in this area?
Lines 272 – 273: Was there a range of years from which the three highest and lowest SI_FJL anomalies were taken from the CESM large ensemble?