

Review of “Arctic sea ice, Eurasia teleconnection pattern and summer surface ozone pollution in North China: in terms of climate variability”

The authors have greatly improved the manuscript responding to the three reviewers’ comments. I believe this paper is suitable for publication after minor revisions. My two main concerns are that the NOP and MOP need to be clearly defined as a range of O<sub>3</sub> concentrations. This is not clear to me and thus how Figure 2 is calculated is not clear to me either. I am troubled by two statements in the conclusion section:

If “the processes how the weather conditions impact the photochemical reaction were not deeply discussed here” then I do not understand what was shown in this paper.

“However, the reason why the cooler high troposphere contributed to the surface ozone pollution was still an open question and needed further attention”. If this is true, then why did the two temperature fields get compared in the first place? What meteorological understanding would lead this to be shown in Figure 2?

I have inserted these specific comments at the appropriate line number in my Minor and Technical Comments below.

Two additional references that have recently been published may be of interest to the authors to include in their introduction:

*Int J Climatol.*

Inter-annual variation of the spring haze pollution over the North China Plain: Roles of atmospheric circulation and sea surface temperature

By Chen S, Guo J, Song L, Li J, Liu L, Cohen JB.

<https://rmets.onlinelibrary.wiley.com/doi/10.1002/joc.5842>

ACP

Impacts of meteorology and emissions on summertime surface ozone increases over central eastern China between 2003 and 2015

by Lei Sun, Likun Xue, Yuhang Wang, Longlei Li, Jintai Lin, Ruijing Ni, Yingying Yan, Lulu Chen, Juan Li, Qingzhu Zhang, and Wenxing Wang

<https://www.atmos-chem-phys.net/19/1455/2019/>

Minor and Technical Comments:

Line 10: define how many years is meant by “recently”

Line 12: Make sure O<sub>3</sub> has a subscript 3 everywhere

Line 14: To have both “major” and “significant” is too much. I recommend removing “significant”

Line 24: This opening sentence does not make sense to me. Has social and economic development been serious in China?

Line 25: Explain “haze” pollution. Is this from particulate matter or from a mix of other pollutants as well?

Line 28: Change decreasing to decrease.

Line 28: Why? Are the controls specific to winter or only targeting what might impact haze? I could imagine some controls might have also helped the O<sub>3</sub> precursors.

Line 29: Be specific, are “the negative effects of surface O<sub>3</sub> pollution” regarding human health, agriculture, economy, etc?

Line 32: remove “i.e.”

Lines 33-34: Why is this important? No explanation of ozone precursors, authors should consider explaining what those are before this statement.

Line 35: Why are both O<sub>3</sub> and the precursors large?

Line 39: Define NO<sub>x</sub> and VOC. I would also suggest adding “with sunlight” after “react”

Line 47: Add references for sentence ending in “mean ozone existed”.

Line 51: The sentence “The photochemical reaction was the main local sources of O<sub>3</sub>” is in reference to which paper? And with NO<sub>x</sub> or VOCs?

Line 61: Do the authors mean “previous studies of O<sub>3</sub> pollution in China mainly focused on ....”? Consider adding “of O<sub>3</sub> pollution in China” or some other description of these previous studies.

Line 62: Is there a “lack of long-term surface O<sub>3</sub> observations” at all or publicly available?

Line 65: change “was” to “is”

Line 66: The authors may want to stress here that this may have possible seasonal forecast application.

Line 67: Can I suggest adding subsections 2.1 Observation-based data (Line 68) and 2.2 Model-based data (Line 78) or something like? And maybe a section 2.3 Teleconnection before Line 89

Lines 68, 69 and 72: I am confused by the terminology of “observation duration of the surface O<sub>3</sub> concentration was much shorter than the meteorological measurements”. Is the “much shorter” in relation to “the hourly O<sub>3</sub> concentration data from 2014 to 2017, ” or the Shangdianzi station “observed from 2006 to 2017”? Eleven years of data versus four years of data is definitely a different story for short term vs long-term.

Line 72: make sure to add a space between “to2017”.

Line 76: The sea ice data should not be in the same paragraph as the ozone data. Can the authors make it a new paragraph and add more details about this dataset such as the time period it covers, is this a widely used data set at that resolution?

Line 78: Give more detail about the ERA-Interim dataset. It is available from 1979-present. Besides the horizontal resolution, can the authors provide the vertical resolution of the data used.

Line 83: Give more detail about the NCEP/NCAR dataset. It is available from when to when, vertical resolution of the dataset, etc?

Line 86: The BLH is not from the NCEP/NCAR dataset but from a different reanalysis altogether. Describe the NOAA-20CR reanalysis (horizontal and vertical resolution, period of coverage, how it is different to NCEP/NCAR).

Line 88: Consider moving daily precip data to the 2.1 Observation section if it is an observation data set and not a model dataset.

Line 91: I do not care for the use of “vice versa” used throughout the paper instead of writing it out what the alternative conditions may be. Perhaps this is a technical edit to discuss with ACP.

Line 93: Consider adding “for summertime” following “the calculation procedure for the EU index here”

Line 95: Give all equations numbers. This would then be Equation 1 and the authors can reference it in the paper as such.

Line 100: What is the top of the atmosphere for this model?

Line 107: I think change “The observations, with” to “Observations with”

Line 108: Change “server” to “severe”

Line 109: I do not agree fully with the statement “the ozone polluted region has expanded” as over time the measurement coverage has increased spatially so it is possible the other areas were already polluted but just not observed. Can the authors defend this statement?

Line 111: In the figure the crosses to indicate the ozone is above the severe threshold of 265 make the circles actually look like a darker shade of red. Is there a reason the authors chose not to use colors based on the thresholds?

Line 115: Can SDZ still be considered one of the “background monitoring stations” as the authors argue it represents urban centers?

Line 121: I do not understand why the large daily difference in MDA8 contradicts the quasi-constant emission of ozone precursors.

Line 125: Are NOP levels anything above 100 micrograms per meter cubed or less than 100? or are NOP levels between 100 to 215 and then MOP is anything above 215? The definition of NOP and MOP are not clear to me and this is VERY IMPORTANT for Figure 2.

Line 129: Why is NOP in brackets?

Line 129: Do the authors have enough data for a trend analysis?

Lines 131-133: This sentence does not make sense. Maybe remove “although” and add “and” after “(Figure 2),”

Line 132: If the composites are for MOP and NOP conditions, then what are they differenced from to get positive and negative values? It is very important to make sure the NOP and MOP definitions are made abundantly clear. If NOP is anything up to 100 and MOP is anything above 215, then are the authors using the conditions between the two (100 to 215) as the control?

Line 133: significant by which test?

Line 135: Insert references to which Figure 2 panel the reader should look at. For example, “The anomalous southerlies (Fig. 2a), higher BLH (Fig. 2c), less rainfall (Fig. 2e), warmer surface air temperature (Fig. 2g), and cooler temperature in the high troposphere (Fig. 2g) favored surface O3 pollution (i.e., MOP conditions).” Remove the vice versa.

Line 139: change was to were and add “in North China” after “surface O3 concentration”.

Line 141: I’d like to suggest that the OWI calculation in line 159 becomes Equation 2 and then wherever the authors “denote” a variable for this equation then Equation 2 is referenced. Such as here would become “denoted as V10ml, Eqn. 2”.

Line 141: I would also suggest saying the region given in the brackets here is the box in Fig 2a.

Line 141: The authors switched gears and started describing the NOP with the sentence “The cloudy skies...” I would suggest consider keeping the MOP description together separate from the NOP.

Line 145, 149, 153: state boxed regions are from which panel in Fig 2 and add the Eqn. 2 reference.

Line 148: Explain why one would look for this “difference in the temperature at the surface and 200 hPa”. Is it a good coincidence or what are the links in the meteorology for cold air aloft to

be expected with clear conditions instead of cloudy conditions? What led the authors to make this plot?

Line 151: The authors could look at ozone from ERA-Interim, as this dataset has assimilated satellite-retrieved ozone. Otherwise, the authors should state clearly that this is “not shown” in the paper and then reference An et al., 2009. There are other papers which also show this such as Ott et al., 2016, JGR.

Line 158: Is “long-term” meaning a 10 year period here?

Line 159: As stated before, make OWI as a separate Equation from the text.

Line 168: “the historical period before 2007 and the projected future” assumes the O<sub>3</sub> emissions are the same as for the 11 year period from 2007 to 2017?

Line 170: This first sentence should be a general one so I would suggest removing the “the” before reanalysis and the “was” before improved.

Line 175: Is it possible to add 2006 to Table S1?

Line 180: “Before the mid-1990s” but looking at the figure is it also after 1983?

Line 181 and 183: Does “insignificant” in line 181 contradict the “strong” in line 183?

Line 182: Over what time period do the “emissions of O<sub>3</sub> precursors increase persistently and linearly”?

Line 189: Can the authors be more definitive than “appeared to be the positive phase of the EU pattern”. Can the authors provide a reference if they can’t be certain.

Line 196: What does “After 2007, the EU index and the observational SDZ MDA8 synchronously changed” mean? During period with data, one can see good agreement between the JJA EU and O<sub>3</sub>?

Line 198: Consider changing “intensified” to “large”. Also, “homodromous” is an odd choice of word.

Line 202: Add (Fig. 7c) after “300 hPa”

Line 210: Add “likely” before facilitated

Line 218: Check spelling of NCAR

Line 227: Insert “(SI)” after “sea ice” as SI is used later in that sentence.

Line 232: “could induce EU-like pattern”....so are they the EU or are they something else? Be clear what we see in Fig 10c. Line 236-237 the authors sound very confident that it is the EU pattern.

Line 246: Is ASI for Arctic Sea Ice?

Line 253: Should the reference be Fig 12c not 12b?

Line 253-254: I think the statement “the photochemical reaction was significantly decelerated and the generation of surface O<sub>3</sub> was rather weak” is speculative since this was not specifically shown. It should be stated as such.

Line 255: I also think the statement “The wet deposition effect was also significantly enhanced” is speculative since not shown specifically.

Line 256: Change “but” to “and”

Line 257: At the end of this paragraph I am left wondering, What scientific question did this section answer. Make this clear.

Line 260: Change “Spatially” to “In general”

Line 261: Is the EU predictable on seasonal time-scales?

Line 262: Does “long-term” mean 11 years or is it reference to the reanalysis datasets?

Line 262: Add “and ozone” before “observations”

Line 264: Add “which may help for seasonal forecasting” after “climatic driver”.

Line 267: This final sentence in this paragraph is what I was looking for at the end of Section 5 (line 257).

Line 270: Can the authors pick one “induce” or “enhance” or can the accumulated sea ice in May do both?

Line 273: “was accelerated” sounds too bold to me. Maybe “supported” instead?

Line 274: Can the authors provide a reference for “were barotropic and could persist for a long time”

Line 274: “fairly” in fairly high seems weak for something that is over an air quality standard. Can the authors be less vague and more quantitative, possibly linking back to the thresholds used in MOP.

Line 275: Perhaps the authors want to add “and O<sub>3</sub>” before “measurements”

Line 276: “casually verified”. I don’t think the authors want to describe their work as casual.

Line 277: Describe How the OWI extended the time range of this study.

Line 282: “lucubrated” is a bit of an odd word

Line 283: if “the processes how the weather conditions impact the photochemical reaction were not deeply discussed here” then what did the authors show in this paper?

Line 284: Add references for “many previous studies”

Figure 2: Can the authors add MOP and NOP headers above the left and right panels, respectively? Also what are the units for each variable?

Line 474: Remove “s” at the end of “ERA-Interim datasets”

Figure 7: Shading temp in (b) and (c) might have matched shading in (a) better?

Figure 8: What are the units for the Y-Axis?