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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Composite study of aerosol export events from East Asia and North America" *by* Y. Luan and L. Jaeglé

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This manuscript provides a valuable contribution to the substantial body of work investigating the long-range transport (LRT) of air pollution. It's rather unique in two senses: (1) it compares Asia-to-North America (i.e., trans-Pacific) and North America-to-Eurasia (i.e., trans-Atlantic) outflow and transport; and (2) as a composite study covering 7 years and over 200 events, it provides one of the more comprehensive studies of the topic to date. It is generally well-written with the conclusions being well-supported by the data presented. Additionally, the figures do an excellent job of graphically displaying the most important results. I recommend publication of this manuscript pending an address of the following minor comments:

p. 21978, line 6 - At what altitudes (model levels) and during which season(s) is this statement pertaining to?

p. 21978, line 11-12 - Regarding transport to the Arctic, what is the transit time (relative to the 6-8 days for trans-Pacific transport) and does this vary by season? The subtropical Pacific High mentioned is not a persistent annual feature, correct - during which season(s) is its impact most significant?

p. 21978, line 15-16 - Again, what is the seasonality of the dipole structure of SLP anomalies?

p. 21978, line 21 - Explicit mention of sulfate and SO2, but what about BC, dust, nitrate, organics, etc.?

p. 21979, line 9, 26 - How does "organic carbon" differ from "carbonaceous aerosols"? Consider using consistent terms or discuss how they differ.

p. 21980, line 3-9 - Lofting by WCB's dominates during spring, correct? Again, seasonality of features should be discussed.

p. 21980, line 13 - What does "pollution" refer to here - anthropogenic only? Dust and biomass burning emissions included?

p. 21980, line 14-15 - It's not just deposition, but cloud scavenging right? This would be particularly important in interpreting MODIS retrievals.

p. 21981, line 5 - Again, how is "pollution aerosols" defined?

p. 21981, line 5-9 - Other papers to consider citing and discussing given their relevance include Fischer, E.V., et al., GRL (2009), Vol. 36, L03821 and Yu, H. et al. Science (2012), Vol. 337, no. 6094, pp. 566-569.

p. 21981, line 5-13 - A discussion of shortcomings of satellite retrievals is warranted (e.g., vertical resolution; deciphering cloud particles vs aerosols; etc.)

p. 21981, line 19-24 - This is a very important point (i.e., validating models against obs) and is worth expanding on. One good source might be some of the results from the HTAP experiments (see, for example, www.htap.org).

p. 21982, line 1-3 - This could really benefit / bolster confidence in the conclusions if even *some* in situ observations were used to test not just the model's ability, but also the satellite retrievals. AERONET or other ground-based lidar data may be available, or CARIBIC/MOSAIC data collected aboard commercial aircraft.

p. 21982, line 15 - Throughout the paper, I kept wondering if we were always talking about *total column* AOD *at 550 nm*. It might be worth stating that it is (or is not) total column at 550 nm up front and then not having to continually re-state throughout, but it's an important point. What about cloud layers above aerosols - MODIS wouldn't capture these aerosols, but presumably GEOS-Chem would?

p. 21982, line 12-13 - Are there any differences, biases, corrections, papers to cite, comparing MODIS retrievals from the Aqua platform vs the Terra platform? Has anyone looked at retrievals from both?

p. 21982, line 23 - It's unclear to me how a single pass "can represent daily averages" as they are mere snapshots in time.

p. 21983, line 4 - Is fine mode here aerosols with D < 1um?

p. 21983, line 16 - Are these 47 vertical layers still up to 0.01 hPa?

p. 21983, line 19 - Worth inserting a sentence or two about known strengths and weaknesses of GEOS-Chem broadly speaking (as it relates to the LRT of aerosols).

p. 21983, line 22-24 - It's worth discussing in a sentence or two how much SOA would be expected to be formed - can an estimate be provided or are there studies that have attempted to quantify this?

p. 21984, line 1 - What is meant by "resistance-in-series"?

p. 21984, line 5 - What about non-convective scavenging - is it nominal?

p. 21984, line 7-10 - Am I understanding this correctly that over the 7 year study, the same year's (2000) emissions are used by that meteorological fields for all 7 years

is used? While this might be OK for the US where anthropogenic emissions probably didn't vary substantially from 2004-10, the same cannot be said of Asian (anthropogenic, and probably not natural) emissions. If this characterization is accurate, a discussion of how this might affect the results is needed. If I misunderstand the inputs, further clarification is needed.

p. 21984, line 22 - What are these "frequent pollution export events" driven by - WCB? strong winds over desert source regions? etc.

p. 21984, line 28 - Declaring that the model exhibits a "negative bias" *assumes* MODIS is ground truth, which is why either some discussion of MODIS validation from in situ obs is needed, or a direct comparison of obs here - if even briefly - would be warranted.

p. 21985, line 2 - Is this a + or - 20% bias? or both?

p. 21985, line 15-16 - Why are BB emissions confied to the BL while otehr aerosol types are not? Spring isn't necessarily a big BB season in this box. It's a really big source from SE Asia (i.e., Indonesia) during spring, but it typically travels the Pacific south of the box. Perhaps the issue is using the same emissions database every year (see comment p. 21984, line 7-10). If this is really the case, GEOS-Chem and many models have a long history of inability to accurately capture the largest events (see, for example, Swartzendruber et al, JGR (2008), Vol 113, D10305; Reidmiller et al (2009), ACP, Vol 9, 557-572.

p. 21986, line 7-9 - Why is the focus solely on sulfate and not including dust and/or BB emissions, which are large contributors to LRT events?

p. 21986, line 11 - Any particular reason why 2007 was chosen? Is it representative of all years; is the "episodicity" characteristic of every year?

p. 21986, line 17 - Where is the size distribution data coming from to support the assertion that the outflow timeseries is lognormally distributed? Or is lognormal referring

to something other than size?

p. 21986, line 22-23 - How common are these multi-day outflow events - both in the model and in MODIS retrievals?

p. 21986, line 25-26 - Can "reasonable correspondence" be quantified at all?

p. 21987, line 4 - This is a question throughout - when stating "pollution" is this anthropogenic only? sulfate only?

p. 21987, line 7-9 - It would be interesting to see a figure of dust vs. sulfate contribution to AOD (if even only at 550 nm), and also BB - both Siberia and SE Asia are very large sources.

p. 21987, line 14 - "Seasonal averages" implies 90-day avg, no? But it was a 60-day running mean before, right?

p. 21987, line 20 - "Agrees well with MODIS" - I disagree with this conclusion. The MODIS anomalies have far less spatial extent in all seasons and are concentrated west of the 150E line.

p. 21987, line 27 - Again, the Fischer, E.V. et al (2009) study from GRL is worth citing here.

p. 21988, line 21 - Worth citing Lyatt's AGU presentation from several years back. I can't remember if it was turned into a paper, but it was one of the better visualizations of outflow processes I've seen and is worth citing.

p. 21989, line 13 - Reidmiller et al., (2009), ACP, 557-572 and (2010) ACP corroborate Liang's findings and may be worth citing.

p. 21990, line 1 - It might be worth citing some of the results from either the INTEX-B and/or ARCTAS field campaigns.

p. 21990, line 7 - The multi-model, international HTAP report (www.htap.org) should be

cited here

p. 21990, line 9 - What level is this 10-20% referring to? Total column? Is it relevant/important to surface air quality?

p. 21990, line 15 - This conclusion regarding the MODIS AOD anomalies is a stretch. The MODIS panels look more like noise than any coherent pattern.

p. 21990, line 25 - Is the plume transported offshore? aloft? both? What about dust from due west?

p. 21991, line 19-20 - The seasonal dependency is very strong, so the 40% figure here is somewhat misleading.

p. 21991, line 23 - insert: "...precursors over E. Asia COUPLED WITH STRONGLY FAVORABLE METEOROLOGICAL CONDITIONS FOR EXPORT FROM EAST ASIA."

p. 21991, line 24 - Again, is Fig 7c relevant for all seasons (see comment from p. 21991, line 19-20).

p. 21992, line 8 - Has anyone looked at plugging in an SOA scheme in GEOS-Chem for N American export? If so, it's worth citing here.

p. 21992, line 10-13 - Why is the seasonality of export so much stronger in E Asia than N America?

p. 21992, line 24 - "...events display a dipole structure SIMILAR TO THAT WHICH FACILITATES EXPORT FROM EAST ASIA, ..."

p. 21993, line 24-25 (Fig. 10b) - These two pathways are very faint / not clear. Consider overlaying splitting arrows to depict this feature more clearly.

p. 21993, line 25-27 - In situ observations from Mace Head, Ireland and/or Pico Nare site in Azores may show this concurrence and provide real confirmation.

p. 21994, line 16 - Re-state more clearly to read: "... sulfate during export FROM the

boundary layer TO THE FREE TROPOSPHERE OFF East Asia compared to..."

p. 21995, line 6 - "Asian midlatitude cyclones [IN ALL SEASONS??] are usually..."

p. 21995, line 14, 16 - Comparing NE China to Central China?

p. 21995, line 18-21 - Worth citing ACE-Asia studies here?

p. 21995, line 29-p. 21996, line 1 - This sentence on OMI seems out of place and just thrown in here. If deemed necessary to retain, specify which year this is referring to.

p. 21996, line 3 - "...NE Pacific Ocean at 3-6 km altitude DURING [SEASON, YEAR]."

p. 21996, line 7-8 - Is it that there's more efficient export from the BL *OR* far more OS2 emissions to begin with? I've seen no indication you can conclude it's one or the other, and therefore, BOTH factors should be attributed for the difference.

p. 21997, line 16-27 - It's worth saying something about the inability of MODIS and GEOS-Chem to capture this. What is this due to? clouds?

p. 21997, line 23 - At what altitude (or total column?) is this 10-20% referring to?

Figure 2c - last line of caption: "A 5-day running mean was applied to the daily AOD FOR BOTH MODIS AND GEOS-CHEM."

Figure 3top - This is a somewhat common problem with figures using a dotted or dashed line; they do not appear in the legend.

Figure 3 (caption), last line - "Red triangles indicate the 33 enhanced Asian export LRT+ days AS DEFINED BY GEOS-CHEM (NOT MODIS) as described in Sect. 3.1."

Figure 4c - Dotted liens do not appear in legend

Figure 4a&b - Make red line a different color (green or yellow) so it jumps out from figure more clearly. Amend caption text accordingly.

Figure 4 - Does gray indicate that no data is available? Also in line 1 of the caption:

"Seasonal composites of AOD anomalies (DEFINED AS ... EVENT - 60-DAY MEANS?) and extinction..."

Figure 5 caption - line 2: are SLP anomalies events vs seasonal mean?; line 3: state wind FIELDS, so wind DIRECTION since arrow size indicates wind speed.

Figure 7 - Again, dotted lines do not appear in legend. Also, worth stating in caption that these are AOD at 550 nm.

Figure 9 caption - line 1: "meteorological field" should be singular not plural; line 3: state wind FIELDS, so wind DIRECTION since arrow size indicates wind speed.

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