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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Analysis of aircraft and satellite measurements from theintercontinental chemical transport experiment (INTEX-B) to quantifylong-range transport of East Asian Sulfur to Canada" *by* et al.

Anonymous Referee #2

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This paper estimates the long-range transport of sulfate that originates from East Asia to Canada during the INTEX-B field experiment period (17 April to 15 May 2006), and estimate the implications of this long-range transport to North America. The study uses a CTM (GEOS-Chem) and current emission inventories to isolate the impact solely from anthropogenic emissions from East Asia. Trends of SOx emission in East Asia from 2000 to 2006 is estimated from satellite aerosol optical depth data from MISR and MODIS to be 6.2% to 9.6% per year. It concludes that during the INTEX-B time frame (spring 2006), the East Asian emission accounts for 65% of total sulfate over British

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Columbia at 600 hPa, 30% in the surface of western Canada, and 40% over regional sulfate burden between 1 and 5 km.

This study is interesting and well written. However I do have several concerns and comments which should be addressed in the revision before the paper being published.

1. Uncertainties associated with the model. It shows in several places in the paper that GEOS-Chem simulated sulfate and total aerosols are consistently higher than both aircraft and satellite observations. How does this overprediction affect the conclusions about Asian impact on Canada? Would it be possible that the Asian impact is overestimated? This uncertainty should be clearly and thoroughly addressed. If the partial reason of overprediction of sulfate is because of the possible errors in SO2 oxidation, then why not also compare with the SO2 data measured during INTEX-B to see if this is still the case here?

2. Estimate of Asian sulfate emission growth. The growth of sulfur emission over East Asia from 2000 to 2006 is estimated in this study by the differences between model-simulated AOD with fixed 2000 emissions over East Asia and the satellite retrieved AOD over the 7-year period in the same region. The trend of this difference is designated as (1) sulfur emission trends and (2) MISR and MODIS AOD trends, both are somehow misleading. (1) can only be assumed if the trends of all other aerosol species, including nitrate, organics, black carbon, and dust, are all correctly simulated by the model, which has not been proved; (2) the trend should not be called MISR or MODIS trend because it is not - it is just the difference between the model and satellite data. I am wondering if the model uses SOx emission trend (e.g. from Streets), will the MODIS or MISR trends from 2000 to 2006 be reproduced? To me it would be a more straightforward comparison.

3. Asian sulfate over the last two decades. The evolution of Asian sulfate over the last two decades is assessed by comparing the measurements by 4 flights in May 1985 with the data taken by C-130 during INTEX-B in spring 2006 over similar domains. There

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are serious problems with this method. First, using such short time measurements to infer a 21 year change is inappropriate and meaningless. Differences in meteorological conditions and locations can introduce large differences and variations in aerosol concentrations. As shown in Figure 9, large differences in sulfate concentrations exist among the 4 flights in 22-25 April, especially at lower altitudes where the difference can be as high as a factor of 5 to 6. You cannot conclude that the Asian emission changed by a factor of 5 in these four days! The bottom line is that the daily and spatial variations are much larger than the trend to allow assessment of trend of Asian influence by two very short term measurements apart from 21 years. Second, the differences in instrument sensitivity, calibration, data collection methods between the 1985 and 2006 measurements may also be large such that the data uncertainty is larger than the actual difference. This point was not even mentioned. Third, the model is much higher than the data in both time periods; how reliable is the model estimated Asian fraction?

4. Asian plume transport. The Asian plume development and transport during 18-25 April 2006 is illustrated in Figure 8. However this plume is most likely mainly the dust plume (e.g. the 2nd panel in Figure 5 shows significantly higher dust than sulfate in April), not the sulfate plume which is the focus of this study. This should be clarified.

5. Asian influence on local air quality. It is stated in the abstract that "East Asian emissions degrade local air quality" (in Vancouver). This point should be better explained. What is the air quality standard in Canada? How does the estimated 0.14 to 0.19 microgram/m3 or 0.27 microgram/m3 sulfate from Asia degrade the local air quality, e.g., how many days this Asian emission makes the air quality from "good" to "bad" or exceeds the health standard? It is shown in Figure 10 that Asian sulfate is about 30% of total surface sulfate at the surface over western Canada between 125W and 110W, and is much smaller (5-10%) over east of 100W. It should be pointed out that these percentages are estimated for the maximum Asian outflow season (April to May) and with a model which systematically over estimates sulfate concentrations. I wonder, on an annual average, what is the annual averaged Asian influence over eastern and

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western Canada?

Other specific comments:

1. Page 4025, line 19: What is "a larger scale factor"?

2. Page 4028, line 24: "East Asian emissions" - do you mean "East Asian sulfur emissions"?

3. Page 4028, last paragraph: How did the other anthropogenic emissions, such as BC, OC, NOx, ammonia, change with time?

4. Page 4029, line 2: AOD in excess of 0.4 is an arbitrary number. By color, geos-chem has 20 gridboxes exceeding AOD 0.6 while MISR has only 2.

5. Page 4029, line 19: As I pointed out earlier, the "trend" is not the MISR or MODIS AOD trends. "Significant trends in the model-satellite data difference" is more appropriate.

6. Page 4030, line 20-21: "mist chamber" and "filter pack" should be switched to match the description of bias in the line after (i.e. GEOS-CHEM has larger bias for mist chamber data).

7. Page 4031, line 13: It is not clear how the comparison "provides additional evidence for scaling the AMS and PILS measurements".

8. Page 4034, line 5-7: How the simulated features spatially shifted (e.g., toward north, south, etc.)? Why is this "typical of simulations"? How different is the simulated and real meteorology (e.g., wind direction)? The explanation given here sounds hand-waving without evidence.

9. Page 4034, line 21-22: "Enhancement" - compared to what?

10. Bottom of page 4034 and top of page 4035: What are the domains of "East Asia" and "Southeast Asia"? I thought East Asian domain was outlined in previous figures

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(Fig 1 and 5); but where is Southeast Asia?

11. Figure 5 shows three very different figures which should be separated into three figures.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 4017, 2008.