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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Constraint of anthropogenic NO_x emissions in China from different sectors: a new methodology using multiple satellite retrievals" *by* J.-T. Lin et al.

Anonymous Referee #1

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This paper makes a valuable contribution to estimating NOx emissions using multiple satellite retrievals. A new methodology is developed to combine tropospheric NO2 column retrievals from GOME-2 and OMI. The algorithmic development is laudable. Nonetheless major issues need to be resolved prior to publication in ACP.

The comparison in Figure 2 indicates a large difference between the retrieved and simulated tropospheric NO2 column concentrations. This difference needs to be better explained. The conclusion that a priori bottom-up emissions are basically correct is surprising in spite of this difference.

A possible explanation for the model-satellite discrepancy in Figure 2 is implied by

criticizing the Martin et al. method and speculating that nighttime evolution of NOx impacts that method. Is there any direct evidence that nighttime evolution of NOx causes the bias in Figure 2?

What may be happening is that systematic errors in the OMI and GOME-2 retrievals contribute to the discrepancy in Figure 2, but some of those errors cancel in the Lin et al. method. A more formal calculation of the error in the difference between the two retrievals could elucidate that effect. As written it is concerning that the expected errors in the top-down estimate are smaller than the expected errors in the satellite retrievals.

The retrieved tropospheric NO2 column concentrations are higher than the simulated values for East China. Yet the top-down estimate for East China is actually lower than the prior emission budget. The description in section 4 implies that the most important cause of this discrepancy in sign is that the top-down estimate is based on changes in the retrieved columns. Thus more confidence is placed in the difference in retrievals between the two instruments than in the retrieval from either instrument alone. This may offer reduction in systematic errors that are common to the two instruments, but other errors arise in the comparison of two different instruments. The authors could consider reformulating the methodology to use more information from the absolute observations from each instrument, in addition to their difference.

Table 1 should contain a more complete description of level-2 NO2 retrievals: such as spectral window, cloud parameters, and surface reflectivity.

The discussion of retrieval errors includes many important topics. The use of the same surface reflectivity database for both satellites should be added. This is concerning due to different spectral windows in the retrievals, diurnal variation of surface reflectivity, and BRDF effects which vary with sun-satellite geometry.

The Lin et al. method depends on accurately modelling the growth of the PBL depth in morning to represent the diurnal variation in the NO2 column. Please discuss.

The different cloud pressures reported for the different products (FRESCO & O2-O2) are concerning if two retrievals are being compared. Whether the cloud is reported in the PBL or just above could have a systematic effect on the inferred diurnal variation. Please discuss.

How is the averaging kernel treated? Does Omega_r continue to depend on the TM4 NO2 profile? If it does, that could be a source of systematic error in Figure 2 and in the application of the Martin et al. method used for comparison.

Sec. 2.3. What is the diurnal variation in tau_a? A plot would be helpful.

How is tau_a actually calculated? Eq. 2 does not clearly explain. Loss of NOx to PAN could lead to an underestimate of effective tau_a if the PAN rapidly regenerates NOx. It may be better to treat NOx and PAN as a chemical family.

Is tau the NOx lifetime in the column? Or something else?

Sec 2.4 implies that the Lin et al. method does not require assumptions on emission diurnal variation. Page 19216, l12 indicates that the Lin et al. method assumes diurnal variation for 20 hours of the day. The Lin et al. method only determines diurnal variation for 4 hours of the day. Please clarify in sec 2.4.

The close agreement between the top-down and prior bottom-up emission estimates for China is presented as evidence for success of the Lin et al. method. Comparisons over the US or Europe would be more convincing since the bottom-up emissions are better known there.

Abstract, l17-20: Errors in the inversion are implied to be <15%. In fact, each sensitivity test addresses a source of error. Their combination should be presented here and in the conclusions.

Abstract: 9:30 and 1:30 are close to the equator crossing times. The times for China should be used here and on page 19216. They may be closer to 10:00 and 1:00.

p19226, l23: Is horizontal transport really neglected? Doesn't GEOS-Chem account for transport? What about NOx from lightning?

P19217, l16, add "our" before GEOS-Chem

P19218, l25, 2x10 molec/cm2 ???

P19219, l2, check number 10 molec/cm2

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 19205, 2009.