

Interactive comment on “Episodes of cross-polar transport in the Arctic troposphere during July 2008 as seen from models, satellite, and aircraft observations” by H. Sodemann et al.

Anonymous Referee #1

Received and published: 1 December 2010

General Comments:

The manuscript by Sodemann et al. uses two case studies to examine transport of a pollution plume across the Arctic in two different types of transport models. Aircraft and satellite data are used for model evaluation. Both models are found to be able to accurately simulate cross-polar transport, especially in the horizontal, although there is too much diffusion of fine structure in the Eulerian model. The authors conclude that the two types of models provide complementary information and are both necessary for analysis of pollution plume transport and processing.

This work is scientifically valuable, particularly in the context of the recent Interna-

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tional Polar Year (and this special issue), and provides important results for interpreting model, aircraft, and satellite based studies of polar pollution transport. The paper is generally very well written and organized. I recommend this paper for publication in ACP once the following comments have been addressed.

Specific Comments:

1. In general, it would be useful to the reader to have a table or maps showing CO emission totals for the different simulations. The different values used across different simulations will impact the simulated concentrations, and remembering the relationships is non-trivial. Also, it would help for comparison to other (and future) studies.

2. I don't see the point of including WRF-CHEM in the analysis. It is only used for one small part of the comparison, where the two main models are also used, it is never compared to the data, it doesn't show the ability to do anything the other models can't do, and it is discarded due to the low bias. If there is a good reason for including it, more justification and discussion of results are needed.

Pg 26368, line 14: In polar summer we would expect relatively high OH concentrations, leading to significant chemical destruction of CO. This should be mentioned and the implications discussed here or elsewhere in the paper.

Pg 26369, line 16: You should spell out and define CFL here; not all readers will know what it is.

Pg 26370, lines 23-26: WRF-Chem & FLEXPART emissions are compared to one another, but not to TOMCAT. This information would be useful in interpreting concentration results.

Pg 26371: Time of IASI overpass is never mentioned, but the CALIPSO overpass time is given.

Pg 26371, lines 20-21: Can you be more explicit that you use only ONE (mean) AK for comparison of all model/satellite points? It took me a second read-through to realize

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this important point. Even though you show the AKs looking fairly similar during the study period, there will be some small error associated with the use of a mean. I don't think there's anything wrong with this methodology, but the reader needs to be aware.

Pg 26376, line 19: This would be a good place to discuss the implications of having no CO loss by OH in FLEXPART.

Pg 26379, section 3.2: Either here or in Section 2.4, it would be worth stating that IASI CO has been evaluated and performed successfully in the Arctic (Pommier et al., 2010).

Pg 26379, lines 16-17: If the models are sampled at the same space and time as the satellite observations, why are there no missing data patches in the model maps?

Pg 26380, line 3: You state that the middle (IASI) column in Fig. 7 uses a different color scale, but the color scale in the figure appears to be the same for all columns.

Pg 26384, line 17: In the figures altitudes are shown in kilometers, not meters. Please change the altitudes in the text to km for consistency and ease of comparing description to illustration (here and elsewhere).

Pg 26385, line 27: "south of Greenland" – but the flight track shows the plane not ever going south of Greenland on this flight. Do you mean the southern part of the flight track, over Greenland? Please clarify.

Pg 26387, line 5: "Asia" forest fire – do you mean Siberian?

Pg 26387, section 4.1: Much of this discussion doesn't seem relevant until the implications for pollution transport are given in the last sentence. I would suggest restructuring the section so that you first explain the relevance of these events to transport from mid-latitudes, then describe their occurrence.

Pg 26388, lines 19-21: A citation would be appropriate here (i.e., Zhang et al., 2009). Also, an emissions table as suggested above would be really helpful for this discussion,

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because the Streets inventory used in TOMCAT is updated relative to the EDGAR inventory. At the very least, you should remind the reader here that the two models do not use the same emissions, and that the TOMCAT emissions are more up-to-date.

Pg 26390, lines 1-3: It would be worth reiterating that an additional drawback of the Lagrangian model is the lack of chemical production, and especially chemical loss.

Technical Corrections:

Pg 26363, line 13: Insert "The" before "main aspect"

Pg 26365, line 15: "counteracts" should be "counteract"

Pg 25365, line 19: "are" should be "is"

Pg 26370, line 1: Delete either "passes over" or "has passed over"

Pg 26370, line 16: "Modis" should be "MODIS"

Pg 26373, line 15: "20 percentile" should be "20th percentile"

Pg 26374, line 21: Text states tropopause is 2 pvu contour at 325 K, but figure caption states it is at 315 K.

Pg 26375, line 1: Text states 12:00 UTC but figure is labeled at 06:00 UTC

Pg 26378, line 12: I think you either mean 7 July (not 8 July) or Fig. 6b, e, h (not 6a, d, g)

Pg 26384, line 23: "dashed black line" – you mean gray shading

Pg 26389, line 27: "a Eulerian" should be "an Eulerian"

Fig. 1: Unclear why 1a comes before 1b when 1b is discussed first in the text. In 1b, are the gray lines just for retrievals during the analysis period in July 2008?

Fig. 2: Blue tropopause contour is very hard to see. Can you try another color (e.g. white, gray, etc.?) Also, both the text and the caption state that the two models use

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different color scales, but only one colorbar is shown!

Fig. 3: I don't see white dashed 90% RH lines, only solid lines for both 80% and 90% RH (true of all other figures with RH lines)

Fig. 7: The legend on the FLEXPART colorbar seems to be erroneous – values above 1100 are an order of magnitude too low. Also, is it possible to use gray to show missing data instead of white? Because white is included in your color scale for low values, it is hard to distinguish low CO from missing data.

Figs. 9&10: (a) and (b) are swapped from what is described in the text and legends. Also, the CALIPSO profile plot shown to the right of (a) is not described in the legend, and AttCol and AttDep are never defined.

References:

Pommier, M., Law, K.S., Clerbaux, C., Turquety, S., Hurtmans, D., Hadji-Lazaro, J., Coheur, P.-F., Schlager, H., Ancellet, G., Paris, J.-D., Nédélec, P., Diskin, G.S., Podolske, J.R., Holloway, J.S., Bernath, P., 2010. IASI carbon monoxide validation over the Arctic during POLARCAT spring and summer campaigns. *Atmospheric Chemistry and Physics* 10, 10655-10678.

Zhang, Q., Streets, D.G., Carmichael, G.R., He, K.B., Huo, H., Kannari, A., Klimont, Z., Park, I.S., Reddy, S., Fu, J.S., Chen, D., Duan, L., Lei, Y., Wang, L.T., Yao, Z.L., 2009. Asian emissions in 2006 for the NASA INTEX-B mission. *Atmospheric Chemistry and Physics* 9, 5131-5153.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 10, 26361, 2010.

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