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Atmospheric Chemistry and Physics Discussions

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 #2

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This paper describes episodes of pollution transport to the Arctic observed during an international campaign (POLARCAT) and simulated with both an Eulerian and a Lagrangian model. Both horizontal and vertical transport are analysed by comparing model simulations of CO and BC (for the Lagrangian model) to satellite data (IASI and CALIPSO) and aircraft data (in-situ and lidar). The general good agreement between measurement and models shows that both models are able to simulate the main feature of the plume transport in the Arctic. However, numerical diffusion leads to a strong underestimation of narrow structures in the Eulerian model. Authors conclude that both models are useful for the analyse of pollution plume transport and evolution.

The subject of the paper is of scientific interest as transport of polluted plumes over long distances is still a challenge for global model. In this context the comparison between a Lagrangian and an Eulerian model is particularly valuable. The high number of measurement from different platforms (in-situ aircraft data, aircraft lidar, satellite data) used for model-to-data comparison provides a good canvas to validate and interpret model simulations. The paper is generally well written and organize. For these reason, I recommend this paper for publication in ACP once the following comments have been addressed:

Specific comments:

The majority of the plumes encountered had a fire origin. Authors compare simulations from different models that have different fire emissions. It is therefore difficult to estimate if differences between models are due to differences inherent to the models themselves or to differences in the fire emissions. Authors should try to estimate the differences coming from the fire emissions used. There are of 2 orders : ground emissions and fire injection height. Indeed WRF-CHEM (the only model using a parametrisation of fire injection height) simulates an injection height of 4.6 km when TOMCAT and FLEXPART emit BB fire emissions in the lower layers. Authors should at least show a map of total CO fire emission over the analysed period to estimate ground emissions differences. More interestingly, they could compared simulations (averaged over the analysed period) with the different models just over the emission regions. A comparison between WRF-CHEM simulation and the others would show differences arising from different injection height, and comparison between TOMCAT and FLEXPART would help to distinguish between differences coming from model formulation and emissions.

Abstract: You should perhaps mention the origin of smoke plumes (anthropogenic plumes from Asia and biomass burning plumes)

Section 2:

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Can you mentioned the time-step used for ECMWF input data, for both FLEXPART and TOMCAT ?

Pg 26368 section 2.1: What is the horizontal and vertical resolution of the FLEXPART output grid ? Is it the same than ECMWF data? Depending on these resolutions will the narrower structures appear or not.

Pg 26369 line 10-12: What is the altitude of the surface layer in TOMCAT ? It is useful in order to compared with FLEXPART that distribute the emissions in the first 150m.

Section 3:

Pg 26374 line 20: different color scales are mentioned in the text but only one is shown in Figure 2.

Pg 26376 line 20 : It would be useful to give an estimation of mean OH concentrations during this period of the year in the Arctic and then evaluate the mean CO life time.

Pg 26378 line 12 : It was not easy for me to understand where is the small plume that is shed east of the main plume in the TOMCAT simulation (when it is clear in FLEXPART and WRF-CHEM simulation). May the feature be circled in Figure 6g ?

Pg 26378 line 29-28: You suggest that differences in model TCO maximum may come from differences in anthropogenic emission inventories. You also mention differences in fire emissions. I though it was possible with FLEXPART simulations to know the origins of air masses ? In that case, this would help to know which differences are more likely to dominate.

Pg 26380 line 10: Is it easy for you to estimate the width of this narrow filament ? This could be interesting for further studies to know how small can be the feature well represented by FLEXPART.

Pg 26384 section 3.4: Model simulations are interpolated along the flight and compared with data. Are data averaged along the flight ? If this is 1 second data and if we

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consider that aircraft flew at 250 m.s-1, then aircraft data represent features with characteristic length down to 250m. Depending on model resolution (or output resolution for FLEXPART), some of the variability observed in data cannot be reproduced even if the model perfectly transport the plume. You can mention it in the paper.

Section 4:

Pg 26388, line 4-6. You first suggest that the low bias of FLEXPART compared to IASI may be due to a "wrong" background CO. Is not background CO taken from measurement (and therefore "true")? But maybe measurement chosen for establishing CO background are too "local" compared to area where FLEXPART and IASI are compared. Can you explain this a bit in your paper ?

Conclusion: Conclusions seems to me too general. If you manage to evaluate a minimum width of filament that are resolved with FLEXPART simulations, I think it is worthwhile to mention it in the conclusion.

Technical corrections

Pg 26377, line 9 : No need for brackets for "Rastigejev et al., 2010)

Pg 26378, line 6 : "towards higher altitudes, the and a singularity". "the" is probably supposed to be place before "higher"

Pg 26382, line 11: FLEPXART instead of FLEXPART

Pg 26386 line 7: "The dynamical tropopause from the ECMWF analysis confirms that the aircraft sampled in the stratosphere at around 15:30 UTC." Something is missing in this sentence.

Figure 7 : There is a problem in the colorbar of the first column (FLEXPART).

Figure 9 : Caption and figures order do not correspond

Figure 11 : caption: c) black solid line is defined as FLEXPART anthopogenic CO,

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when figure legend defines it as anthropogenic + biomass burning

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Interactive Comment