

Interactive comment on “Case studies of ozone transport between North America and Europe in summer 2000” by G. Guerova et al.

Anonymous Referee #2

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General Comments In this paper the intercontinental pollution transport from North America to Europe is investigated. Simulations with the global model GEOS-CHEM are compared to different sources of trace gas measurements: 1.) CO and NO₂ from satellites, 2.) ozone recorded at a mountain site in the Alps, and 3.) vertical ozone profiles from MOZAIC flights. The impact of North American ozone on the total ozone distribution over Europe is quantified. The paper is well structured and its overall length is appropriate. However, the proportions between different sections and figures/text are not always optimal as indicated in several examples below. The ratio figures/text is quite high, but the referee has no suggestions for figures that are unnecessary. A lot of information is contained in the Figures 10-14 which could be discussed in more

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detail in section 5.2. The referee has the feeling that the authors miss the point to give proper credit to related work and clearly indicate their own new/original contribution (novel concepts). The English language of the paper is good but can still be improved. It is recommended that a native speaker reads the paper.

Specific Comments The title of the paper is not suitable chosen. The reader gets the impression that only the transport of ozone is described, however you have to read almost the whole paper (15 pages) before you find results on ozone. The first part of the paper contains a detailed description of the CO and NO₂ transport. The title could be changed to “Case studies of CO, NO₂ and O₃ transport between North America and Europe in summer 2000”. Another suggestion would be a more general title like “North American contribution to total ozone over Europe in summer 2000”. In section 1 a description of “state of the art” is almost missing. In the first paragraph only a few papers on the topic are mentioned though a deeper discussion into the results from these papers is missing and should be included (especially from the Li et al., 2002 paper). Only results from two papers by Li et al. (2005a) and Auvray and Bey (2005) are discussed in more detail. Some papers on “factors that affect the ozone concentration in polluted air masses during the transport across the North Atlantic” should be briefly mentioned and discussed (e.g. Wild et al., JGR, 1996; Reeves et al., JGR, 2002; Wild and Akimoto, JGR, 2001). A paper showing NO₂ transport from North America to Europe in GOME (Stohl et al, ACP, 2003) should also be included as a reference since it fits very well to the topic of the paper. Papers on observations of LRT like Jaffe et al, GRL, 1999; Huntrieser et al., JGR, 2005 can be included. In comparison to the lack of background information in section 1 the observation datasets in section 2 are described in large detail.

In section 3.2 it is mentioned that the model underestimates ozone in the FT. Some possible explanations/uncertainties are given (stratospheric downward flux, uplift of EU sources, transport from North America). What implications can this have on the mixing ratios given: NA-O₃ in the FT over EU ~10-13 ppb? Does it mean that the influence

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from NA-O3 can be about twice as high as given in this paper? These uncertainties should be discussed in more detail in the conclusions. In section 4.1 the three different pathways of pollution transport from North America to Europe are listed i)-iii). It is not clear to the reader if this is a finding by the authors of the present paper or if it is a result according to Li et al. (2005a). Further, in section 4.2 it is not clear how much of the description of the single LRT events (1-9) is adopted from Li et al. (2005). In section 4 all single long range transport (LRT) events in summer 2000 are described in the text. The referee suggests to cut the description of cases not shown in any figures. Instead essential information on every single LRT event could be summarized in a table (e.g. source region over North America, pathway over the North Atlantic in Lon/Lat/Altitude, meridional/zonal transport, in WCB/ around Azores anticyclone, entering region Lat/Altitude over Europe). In section 6 (Summary and conclusions) almost the same text as in the abstract is repeated. This part should be rewritten and include more conclusions. The quality of most figures is good. In the Figures 3, 10-13, showing a comparison between GEOS-CHEM and MOZAIK, the edges of the standard deviation GEOS-CHEM are sometimes hard to recognize. Perhaps short vertical lines at the edges could help. The black contours of the continents are well highlighted in Figure 10-13. However, in Figure 5-8 the line strength and the size of the labelling of the axes should be increased.

Technical Corrections

Abstract: Change “North Atlantic ocean” to “North Atlantic Ocean”

Change “Measurements of NO₂ and O₃” to “Measurements of NO₂ and CO”

Change “Model simulations are then used to examine” to “Model simulations are then used to quantify the impact of the LRT events on observed European ozone distributions: 1.) measured at a European mountain site and 2.) measured by aircraft in the vicinity of some European cities.”

“WCB/post-frontal” WCB has to be written out the first time it is mentioned

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“that reach Europe after leaving North America” cut “after leaving North America” since the next sentence starts with this again

“After leaving North America” be consistent, don’t mix “high latitudes”, “40° and 55°N” and “mid-latitudes”, use words or numbers.

“PBL, FT” has to be written out the first time it is mentioned

To “Based on model sensitivity simulation” add “that North American ozone contributes to 2-8 ppb in boundary layer and to 10-13 ppb in the free troposphere over Europe.”

To “For some episodes” add “contribution in the model (30% or higher) to total ozone is not observed as enhancement in the measurements.”

1. Introduction:

Change “is of major importance as” to “is of major importance since”

Change “The LRT between North America” to “The LRT between these continents”

“transported over long distances” also mention that ozone can be produced in-transit (transport of ozone precursors)

Cut the last sentence of the first paragraph. A similar text is already available at the beginning of paragraph 3.

Change “The O3 flux due to” to “The O3 flux, due to”

Change “They found that export from North America” to “export of pollution from”

Change “to examine further the North American outflow” to “to further examine the North American pollution outflow”

Change “MOPITT CO observations offer a good signature” to “provide”

Change “The Jungfraujoch station presents” to “has”

Change “most of LRT events” to “most LRT events”

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At some place in the paper you have to write out what you define as “summer 2000” (the selected months June, July and August).

3.2 Model evaluation:

Change “monthly means O3 show a too low seasonal variations” to “monthly O3 means show too low seasonal variations”

“10 1015” is it correct that there is no sign between the two numbers 10 and 10?

4.2 June 2000:

Change “cyclone stay stationary” to “stays”

5.2 O3 profiles over Brussels, Paris and Frankfurt:

“during four representative LRT events” mention here that you selected LRT1, 2, 4 and 9

The first and the last sentence of the first paragraph have the same content/meaning (cut one)

Change “The observed and model O3 profiles” to “modeled”

For the case LRT1 the observations indicate that the North American ozone plume is descending over Brussels (Fig. 10e). Why is this dynamical feature not visible in the model simulations? Could it be due to the vertical resolution of the model?

“This enhancement probably reflects the O3 diurnal variation associated with local photochemical activity during stagnation period.” The referee thinks that it is very unlikely that the huge ozone increase within 6 hours can be due to the explanation given.

LRT9 is a puzzling case, but it is also important to show this kind of cases.

6. Summary and conclusions:

To “We find that a substantial North American contribution” add “North American con-

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tribution (30% or higher) to total ozone over Europe is not always visible as pronounced ozone enhancement in the measurements (e.g., LRT4 and LRT9).”

Figures:

In Figures 5-8 would it be possible to draw the plots with the same colour scale (min-max range) for GEOS-CHEM CO and MOPITT CO, and for GEOS-CHEM NO₂ and GOME NO₂?

Is there any explanation for the enhanced NO₂ values seen in GOME NO₂ in the middle of the Northern Atlantic (Fig. 5d) which seem to be located north of the LRT1 event?

Fig. 10-13 (d-e) perhaps use dark green instead of the light green colour (more pronounced)?

Fig. 14: quite busy figures with all dots. Perhaps it would be better to use lines for the selected LRT cases? For July it is not possible to distinguish between LRT3 and LRT6 (both blue).

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