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Atmospheric Chemistry and Physics Discussions

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Interactive Comment

Interactive comment on "Quantification of chemical and physical processes influencing ozone during long-range transport using a trajectory ensemble" *by* M. Cain et al.

Anonymous Referee #3

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This study suggests a new approach of vertical turbulent mixing in a Lagrangian photochemical model introducing shadow trajectory for chemical background. Using the coupled photochemistry and turbulent mixing model, explained are chemical and physical processes of long-range transported chemical plumes over the North Atlantic captured during the ICARTT 2004 field campaign. Based on comparison of the Lagrangian measurements and simulations, the authors showed fairly reasonable performance of the model in simulating long-range transport of chemical plumes through several case simulations, and also described the relative importance of physical and chemical processes during the transport by separating corresponding terms in the governing equation. The manuscript is well structured. The reviewer recommends this study to be

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Interactive Discussion

Discussion Paper

published in ACP after considering several comments listed below.

1)'Lagrangian air mass or control volume' needs to be defined at the initial time. Some description of its time-evolution might be useful, especially in terms of its volume.

2)More details (or a schematic diagram) of mixing processes between the Lagrangian air mass and adjacent background (shadow trajectory) make the manuscript readable. In addition, the terminology 'mixing' should be clarified in the manuscript. Does it mean 'vertical turbulent mixing'? please clarify and use it consistently through the manuscript.

3)According to 'mixing' process explained in section 3, atmospheric boundary layer height might be an important parameter in the model.

4)The Lagrangian trajectories of chemical plumes studied were calculated using the ECMWF which has coarse spatial ($\sim$1.125 deg) and temporal (6-hr) resolutions. Is it enough to track accurate position of plume ensemble members? The plumes captured by aircraft are much narrower and shorter in time as compared.

5)Clear explanations of 'reference trajectory' and 'shadow trajectory' might be necessary. What does 'the centroid of the trajectory ensemble (P3031)' mean?

6)Based on the previous observational study, the atmospheric thermal structure over the North Atlantic can be characterized by strong stable condition. In the strong stable marine boundary layer condition, turbulent mixing might be significantly suppressed, happen only sporadically. In addition, the atmospheric boundary layer heights are quite low ($\sim$100 m), or sometimes it does not well defined. So, it is expected that a turbulent mixing has a minor impact. This condition can be included in the interpretation of the author's model simulations.

7)Several studies on dry deposition velocity of O3 shows it ranges from 0.006$\sim$0.15 cm/s, where high end can be measured over unstable marine conditions such as Gulf of Mexico in USA. In the reviewer's viewpoint, the value of 0.2 cm/s used in the manuscript for case 3 is a quite large value if we consider commonly very stable marine condition

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over the North Atlantic.

8)Spatial distribution of the ensemble trajectories is not shown in Figs. 1-4. Wide spread of the trajectories is expected after long-range transport because of strong wind shear in the vertical direction over the North Atlantic.

9)Model-observation discrepancy in Figs. 1-4 might be also attributed to both the poor initialization and the poor representation of the plume by the aircraft. Inclusion of analysis and explanation regarding this might be necessary.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 3019, 2012.

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