

## ***Interactive comment on “Global Atmospheric Chemistry – Which Air Matters” by Michael J. Prather et al.***

### **Anonymous Referee #1**

Received and published: 10 February 2017

#### General comments

-The manuscript presents an interesting method to test chemistry-climate models (CCMs) based on aircraft measurements. The method is motivated by the limited representativeness of aircraft measurements for the large grid cells of CCMs. While the proposed method can contribute to the evaluation of CCMs, alternative methods should be considered as well. For example, CCMs can assimilate meteorological analyses (model nudging) to realistically represent atmospheric conditions, so that the output can be directly compared to measurement data. And even though the grid size of models is coarse compared to aircraft measurements, some of the sub-grid scale variability can be accounted for by interpolating model results across the flight tracks.

-The manuscript includes chemistry-transport models (CTMs) for which it should be

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unproblematic to represent realistic meteorology. Therefore, the method is particularly useful for CCM groups who have not implemented nudging techniques. Please mention this. Nevertheless, the new method is a practical and interesting addition to the techniques used to evaluate CCMs and CTMs. A more extensive discussion of pros and cons of different methods is recommended.

- The manuscript generally reads well, but the abstract and introduction need improvement. The introduction presents confusing statements, and the reader is guessing what the work actually focuses on up to L123. Please consider a more traditional structure of the introduction and present the concepts of representativeness (measurements vs model output) and chemical reactivity early on. I found the text partly confusing and unclear, often not to the point and sometimes not relevant. Examples and details are given below.

-Provided that the presentation, notably of the abstract and introduction, are improved, and the application of the method is described in the context of alternative methods, the manuscript will be acceptable for publication in ACP. However, since a methodology rather than new science is presented, it may also be considered to refer this manuscript to GMD, or add to the title that it is a technical note.

-Sect. 5 seems to suggest that the NASA A Tom missions are unique in providing high-frequency measurements across the Pacific and Atlantic Oceans. Such measurements have been made since decades, which is a great asset to the atmospheric chemistry community and in particular modelers (probably underused), and it should be mentioned that these datasets can also be applied in the presented methodology. The focus on the NASA A Tom missions in the manuscript are distinctive, which does not do justice to the more general applications of the method.

-The ending of the paper is unsatisfactory, with a promise of interesting things to come. Is it possible to present a sneak preview? This could make the manuscript more scientifically interesting rather than only technical, and help justify that it is published in ACP

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rather than GMD.

#### Specific comments

The title is not very informative about the paper contents. Please reconsider.

L27: Few tenths of km?

L9-34 present technical details, before the reader knows what the work is about. Better first explain the objectives. And/or consider deleting these sentences.

L45: Understanding chemical heterogeneity is important, but not a sole prerequisite to understand global atmospheric chemistry. Please reformulate.

L48: Depends on where you are and what you are looking at. Please reformulate.

L52: "we ask which air is more important for the chemical evolution of human-driven air pollution". More important in view of what?

L55-56: What do you mean?

L57: Do you aim to understand the impact of heterogeneity?

L58: Thus, the integration of chemical reactivity controls the residence time of ozone? Please reformulate.

L67-68: see Chatfield and Delany, 1990.

L71: It may be helpful to define "heterogeneity" more precisely. Related to sub-grid scale processes? Dependence on grid size and compound considered? First you suggest that we simplify heterogeneity in view of modeling (L63-66) and now you use a model result to illustrate heterogeneity.

L76: Atmospheric rivers are narrower and related to tropical-extra-tropical interactions.

L78-79: Why/how does this indicate that chemical heterogeneity plays a role?

L79: Figure 1 seems trivial and could be omitted.

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L84: Depends on scale.

L110-113: Nudging to meteorological analyses is typically applied to avoid this problem.

L114-119: Please also consider comparing CTM or nudged-CCM output at the location and time of the measurements. See S4D routine of Jöckel et al., 2010 (<http://www.geosci-model-dev.net/3/717/2010/>).

L123, L128: Now the central issue becomes clear: representativeness. It would be helpful to present this earlier in the abstract and introduction.

L189: Please explain why.

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Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-1105, 2017.