# Review on "Aircraft routing with minimal cost impact: the REACT4C climate cost function modelling approach (v1.0)" by V. Grewe et al.

The paper presents a modelling approach for aircraft routing to minimize their climate impact. The approach is based on different modelling tools: a model to design air traffic routes, an emission model and a chemistry-climate model. The output of the model chain comprises the climate impact of air traffic routes taking into account $CO_2$ and non-$CO_2$ effects (NOx, $O_3$, $CH_4$, $H_2O$, contrails).

## General comments:

Although I think that the basic idea behind this modelling approach, that is minimizing the climate impact of air traffic, is an important contribution to the climate change discussion and the development of mitigation strategies, and, therefore, deserves publication, I really have trouble to assess whether the described approach is valid or not. While the design of the flight path and the calculation of the emissions along that flight path seem to be straight forward, the calculation of the climate cost functions remains a mystery to me. This part of the model chain involves so many different grids, sub-grids, regions, trajectories, modules, assumptions etc., and the actual interaction is not clear at all. Together with the use of precalculated input (RF) this seems to be piecemeal. For example, the fit of the relation between instantaneous and adjusted radiative forcing of ozone changes in Fig. 11 based on two different studies without any overlap. This makes it impossible to identify potential shortcomings and uncertainties of the present study.

The paper is a bit lengthy and would benefit from a shortening, e.g. Sect. 3.1 could be shortened or skipped. I included a little sketch at the end of the review, showing my understanding of different grids/trajectories and how they interact. Maybe that helps to understand where my confusion comes from. I am convinced that the authors can do much better in explaining their approach. Therefore, I would give the paper a second chance after major revisions.

By the way, I was not able to open all supplements. Two documents were included as symbolic links only (Ozone-perturbation.pdf, airtrac_130730.pdf).

## Specific comments:

- P 4347, l 2: "… substantial contribution to …"
- P 4347, l 20-23: Does this statement refer to NOx emissions in particular or to aircraft emissions in general?
- P 4347, l 24: REACT4C – either explain the meaning of the acronym or add a reference to the appendix
- P 4349, l 8: Which properties do you mean? Properties of contrails?
- Sect. 2.1: In which horizontal/vertical resolution is EMAC run?
- Sect. 2.2.1: Does SAAM include worldwide city pairs or only the North Atlantic flight corridor?

- P 4351, l 8: I assume that "a set of full 4-D trajectories" means 84 routings as described in Sect. 2.2.3.
- P 4351, l 14-16: Isn't it necessary to consider load balancing for all optimisation models to get realistic air traffic routes and, therefore, realistic information about the climate impact of different flight routes?
- P 4352, l 4-6: Route generation – when you are talking about alternative routes, how is the reference trajectory defined? Shortest way?
- P 4352, l 9: What do you mean by "larger"? Which grid size is used for the present approach?
- P 4352, l 17: What is the spatial and temporal resolution of the 4-D trajectories?
- P 4353, Eqn. 2 and l 8: Do I understand this correctly – the number of conflicts is $\geq 0$ (which makes sense), but the entries of the conflict matrix are $\leq 0$?
- P 4354, l 1: How many flight legs "m" are considered?
- Sect. 3.1: Here is one of my major problems, the approach of the predefined time-regions is not clear to me. Are the time-regions to be interpreted as a kind of sub-grid of the GCM grid? Is AIRTRAC a box model that is applied for the time regions? I assume that the Lagrangian trajectories are not identical to the 4-D flight trajectories calculated by SAAM. If so, clearly distinguish between both types of trajectories by using different terminology.
- P 4354, l 24: Figure 4 shows Figure 6 and vice versa.
- Sect. 3.2.1: How do the predefined time-regions correspond to the SAAM flight routes? What are the reasons for choosing those longitudes, latitudes and pressure levels?
- P 4356, l 19: Those 50 trajectories are Lagrangian trajectories, right?
- P 4357, l 3: 24 emission points??? How are the defined?
- P 4357, l 4:
- P 4357, l 20-23: Why is the standard deviation for ozone smaller than for NOx?
- P 4359, l 17: Which species are combined to families?
- P 4360, Eqn. 10: What means "$D_{O3,1}$" and "$D_{O3,2}$"? D (=depletion) = L (=loss)? In Eqn. 8 loss is written as "L".
- P 4360, l 14: "Production of OH:" needs a new line
- Eqn. R3: $O(^1D)$
- Eqn. 44: What is "ρ"?
- P 4369, l 15: which
- P 4370, l 16: "… and the difference…"
- P 4371, l 14: Why is August used as reference months?
- P 4376, l 14: What is shown in Fig. 14? One flight route?
- P 4378, l 13: "For all these reasons…"
- Fig. 3: How is the grouping of the cells done?

- Fig. 5: This figure is not very meaningful. Since this paper includes a lot of figures, I would skip this one here.
- Fig. 6 (currently Fig. 4) is also not very helpful. I think it is enough to list the locations of the different time –regions the table.
- Fig. 7: Why don't you simply use % as units?
- Fig. 9: RFinst and RFadj: Colour coding and figure caption do not match.
- Fig. 14, caption: "… by an emission…"