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Geoscientific Model Development Discussions

Interactive comment on "Climate Assessment Platform of Different Aircraft Routing Strategies in the Chemistry-Climate Model EMAC 2.41: AirTraf 1.0" *by* Hiroshi Yamashita et al.

Anonymous Referee #1

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Summary This paper describes a new model which will eventually be used in calculating the climate impact of aircraft routes. There are several different parts to the model, which are detailed in the paper, including generating the route either by calculating a great circle or time-optimal route (the two constraints which are described and tested here), calculating the fuel use along the route, and the emissions for example of water vapour and NOx along the route. A thorough assessment is made of the model and its ability to generate the routes and calculate the various parameters; the model performs well and appears to be fit for purpose. The paper is generally clear and the different components of the model are well-described. My only major concern regards the vertical flight profiles, please see the major comment below. I recommend the paper for

publication after revision.

General comment In the calculation of the time-optimal flights, the flight altitude is allowed to vary freely between FL290 and FL410. Some of the resulting time-optimal flight profiles display significant altitude changes during the flight, as shown in Figure 14 (b), where the flight altitude profile along the flight is 'm' shaped (i.e. increases, decreases, increases and then decreases again). This is in contrast to the familiar stepped profiles, where the aircraft altitude increases are done as step climbs when enough fuel has been burned off, or alternatively a gradual increase in height to a maximum cruising altitude, followed by a descent. It is difficult to see how (or why) an aircraft would do this 'm' profile in real life, given air traffic constraints, for example. Given how unusual these profiles are, some justification or explanation for why these profiles are allowed in this study should be given, as well as a comment on how realistic it would be for an aircraft to fly this profile.

Minor comments 1. p3 L61 – the Spichtinger et al (2003) study referenced by the authors analyses the vertical distribution of ice-supersaturated regions. The mean length of 150 km is from Gierens and Spichtinger (2000), as stated in the Spichtinger paper.

2. p3, final paragraph (L84 - 99). As I understand it, the aim of the study presented in the paper is to introduce, describe and validate the AirTraf model, not to investigate 'how much the climate impact . . .can be reduced by aircraft routing' – that is a separate study which would use AirTraf. This paragraph is therefore confusing to the reader, and there is extra detail here which is not all necessary to understand this paper. Please re-phrase the aims of the study to be consistent with what is presented in the paper, remove unnecessary detail about future studies and I also suggest removing Figure 1 which is not needed here.

3. p4 L121, p5 L159 and caption of Figure 3 - "one-day flight plan". It is not clear what you mean by this phrase (it sounds like you are referring to a single flight on a

single day, rather than many flights on a single day). It would be helpful to give a short description the first time you use the phrase.

4. p4 L126 – "AirTraf continuously treats overnight flights". What does this mean?

5. p7 L201 – "local weather conditions provided by EMAC". Specifically, the wind field is used?

6. p8 L260 – You assume that the sum of the alternate, reserve and extra fuel is 3% of the total fuel. Is there any justification for this number? I acknowledge that this kind of data is almost impossible to get from airlines, but have other studies used a similar number, for instance?

7. p20 L647 – 656. The explanation of why the flight altitude profiles are optimal is that the flight changes altitude to benefit from changes to the true airspeed and to increase its tailwind or reduce its headwind. The argument is currently not well supported by the figures (Figure 16, and S5 and S6) which show the altitude distribution of the true airspeed and tailwind indicator. The variations in these quantities at flight altitude are hard to see, since the vertical scale on the plots is 0 – 15 km. The case might be made much clearer simply by re-plotting these figures with a limited altitude range (i.e. only plot the range of altitudes relevant to the aircraft), and re-scaling the colour bar.

8. p22 L727 – 729 and Figure 22. "The maps show the time-optimal case has low values of the fuel use" (compared to the great circle case). The great circle case at FL290 clearly has a lower fuel use, as shown in Table 11. However, I do not think this is clear from Figure 22; the flights in the time optimal case are spread over a larger area than in the great circle case therefore it is difficult to assess objectively whether the fuel use is higher or lower in the time-optimal case. I do not think that this figure adds any weight to your argument. I suggest removing it.

9. p25 L824. I cannot find AirTraf or any status information for it on the list of submodels on the MESSy website (accessed on 24/02/2016).

10. Figure 15, 16, S4 – S6 – Please add units to the colour bar and/or text.

11. Table 8. It is difficult to compare the flight time for the time-optimal with the great circle at different altitudes, since the mean flight altitude of the time-optimal flights is given in m and the altitude of the great circle flights in feet. Please add either the mean flight altitude in feet for the time-optimal flights, or the flight altitude in m for the great circle flights to aid the comparison.

12. Table 11, Caption. 'sum of flight time, fuel use, NOx and H2O emissions. . ..'. This implies that the table shows the quantity flight time + fuel use + NOx + H2O, when in fact they are displayed separately. Please re-phrase.

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