The paper is relevant to the area of aircraft routing and addresses the choice between multiple optimal routes dependent on a range of objectives. As such this is not a major change to routing strategies, but rather a next step in an evolving process. This means that the novelty of the approach lies in applying an established algorithm to a new setting. The advance this affords allows the previously defined AirTraf model to be used in a different and more integrated way. The method described is mostly clear, but some of the assumptions supporting the use of AirTraf in contrail avoidance are not properly justified, given research results previously published on the nature of super saturated icy regions. This is further explored in the more detailed file that is attached below.

Results are somewhat limited by the use of a single month, which when looking at climatic conditions provides a narrower range of possible variable value combinations than is most useful. However, conclusions across this reduced timeframe given the other model assumptions are supported by the research that has been completed. Given the reliance of the results on a combination of different models and the limited explanation in this paper of the climate inputs and methods for fuel use calculation, it would be difficult to reproduce results from this work alone, but taken alongside previous research and given the limited access to models available, replication of some of the results could be possible.

The work is properly referenced and the need for the model is justified, with the paper title including all necessary detail. The abstract is concise and reflects the paper content, but could be better worded (see attached comments). The main structure of the paper is good, but there are occasions where order within sections would be improved by small changes. The language and grammar of the paper need minor corrections, which have been noted in the attached comments. Clear definitions of formulae, symbols and abbreviations are, however, all present in the paper.

Overall my recommendation is for the paper to be accepted subject to minor revisions. Where assumptions weaken the usefulness of the model, this stems more from the original AirTraf usage than the current decision-making tool, so whilst these choices do need more justification in this paper, they are not grounds for major revisions.

Comments on gmd-2023-88

The paper is recommended for publication with minor revisions. These are listed below. It is hoped that this extra level of scrutiny is of use to the authors in improving the manuscript before publication.

1) Abstract: lines 4-6 “This paper…solutions”. This phrase does not read properly. Suggest: “…which allow the reduction of the flights’…”
2) Line 14: “to 3-5% of the total”, the “to” and the “the” are not required.
3) Line 26: None of the references that have been included alluded to work on minimising just carbon dioxide emissions. Given the uncertainty of non-carbon dioxide effects, which is not alluded to until the Discussion Section, this should be mentioned here. There is also no justification for the use of strategic rather than tactical planning for avoidance of ice super saturated regions (ISSR) to prevent contrail formation, which often cannot be accurately forecast pre-flight (Reutter 2020).

4) Lines 35-42: These would read better if requirements and solutions were given together, rather than listing all requirements and then all solutions. A list structure would also make the arguments clearer, rather having numbered points lost in a passage of prose.
5) Line 45: “This modelling chain allows to select…” does not make sense as it stands. Allows who to select?
6) Line 68: Space needed after the comma.
7) Line 73-76: This description is very unclear. What do you mean by nudging? Please explain in more detail exactly which climate indices are used and how these are processed.
8) Section 2.1: Using reanalysis data does not take into account the difficulty in forecasting ISSR, which should be acknowledged. Seasonal patterns in ISSR formation are also not included when a single month is considered. In addition, Reutter et al (2020) show that ERA Interim reanalysis data misrepresents ice supersaturation at flight altitudes and that there is a significantly larger fraction of ISSR in measurements of water vapour. A resolution of 2.8 degrees is also shown to be inadequate for identifying the distribution of ISSRs, where in some seasons the majority of these are <100 km in width.
   Although it is understood that these comments are pertinent to the AirTraf model, more justification of your assumptions for this model is needed if you are to propose it as a foundation for the current SolFinder decision making tool, which is weighing up routes based on at least one contrail avoidance objective function.
9) Line 79: “on” is not required.
10) Please explain briefly for clarity which atmospheric conditions are used.
11) Line 80: “on” is not required.
12) A detailed description of the method for obtaining fuel use is not given here. This is important given that BADA data does not rely on a physics based model, so you would need to explain why you used this in preference to Poll and Schumann’s method as given in (Poll, An estimation method for the fuel burn and other performance characteristics of civil transport aircraft during cruise. Part 1: fundamental quantities and governing relations for a general atmosphere. 2021a, Poll, An estimation method for the fuel burn and other performance characteristics of civil transport aircraft during cruise. Part 2: determining the aircraft's characteristic parameters. 2021b). Although this is part of the AirTraf model, it becomes even more relevant when the results obtained using multiple objective functions which rely on atmospheric conditions are being compared, as is true for SolFinder. These conditions would inform the fuel use in the physics-based method.
13) Line 94: delete “s” of “facts” as singular is needed here.
14) A further explanation of why just one choice has been made for cost of fuel and time would be useful here. Presumably results will be affected by these weightings and so when discussing the relative merits of different solutions, these findings are dependent on pricing assumptions. Was any sensitivity analysis considered with different values?
15) Line 117: no need for capital F on future.
16) Line 139: “This allows to flexibly identify” should read ”This allows flexible identification of”.

17) It seems that only the flight position is being optimised here, neglecting the question of the airspeed. Previously AirTraf has been applied with flights at a constant Mach No., but airspeed has a bearing on fuel use and thus changes emissions too. As you are changing the temporal climate window every twelve minutes, the airspeed becomes more critical and some of the effects could be minimised more effectively by controlling both position and airspeed (C. K. Wells 2022, C. W. Wells 2023).
18) Line 152: Should Section A be Appendix A here for clarity? Also probably worth reiterating that the VIKOR algorithm is discussed fully in Appendix A in line 166 too and again in the caption for Figure 2. Given the importance of the VIKOR method in this system, I would prefer it to be at least described to some extent in the text and then this enlarged upon in Appendix A, but perhaps word count was an issue?
19) Line 152: “using as an example” reads better, you are missing the “an”.
20) Line 162: Repetition of “follow” distracts from the start of the strategy description.
21) Section starting at line 175 is quite hard to follow, but appears important in justifying choice of parameters, so needs clarification.
22) Line 178: Should be “solutions” plural.
23) Line 194: “requires to” does not make sense here. Change to “wishes to” or “needs to”?
24) Line 203 includes an extra equation line label that needs removing.
25) In Figure 4 the red crosses are difficult to see. Perhaps a lighter green could be used for the surrounding markings?
26) Line 221: “it” is not needed here, “as is shown” suffices.
27) Line 222: “identify” is needed rather than “identified” here.
28) Line 230: Apostrophe missing in section title.
29) Figure 5 would be clearer if accompanied by a table displaying airport pairings.
30) Table 1: Again the choice of parameters is not fully justified, particularly the resolution, time step and choice of time period.
31) Line 265: Should read “Relative to our problem”
32) Figure 6: Do daily and monthly means have any real value here? If routes are different and days have different atmospheric conditions, averaging removes useful detail from the data. Can data be displayed to show results for each airport pair each day?
33) Line 294: “Pareto-fronts” here as you are using the plural.
34) Figure 9: Blue lines are too close in colour to differentiate in places. Could the colour choice be extended to make this diagram clearer?
35) Line 306: Short trajectories do not necessarily reduce fuel consumption, if you are mapping with respect to the ground and not the air. It is the air distance which allows for reduced fuel use.
36) Line 314: “which allow to minimize fuel use” should be “which allows minimal fuel use”.
37) Line323: “resulting distributions from objective function values” reads better here.
38) Line 328: “of” is needed after independent, not “to”.
39) In Figure 10 you specify flown distance, but not whether this is air distance or ground distance which, as mentioned before, is an important distinction.
40) The last part of Section 3.2 regards the relative effects of different emission factors as certain, whereas there is still much uncertainty in the actual radiative forcing

effects (Teoh 2020). This should be clarified here, rather than being left to a small paragraph at the end of the Discussion Section.

41) Line 345: “This study…10%” does not read properly. Please correct this.
42) Line 352: should read “than were found”.
43) Line 356: This is the first mention of computational time. Given your 12 minute time step, is this system running fast enough to allow the optimal trajectory under changing forecasts to be found from the multiple options calculated? To justify the method, a discussion section on the timing of calculations is needed.
44) In Section 4 you should also be addressing:
    i. Use of reanalysis data v. probabilistic data in a real time flight scenario.
    ii. Computational time issues.
    iii. Coarseness of the resolution when discussing contrail formation.
    iv. Limitation of using just one month for atmospheric data.
    v. Fuel burn being heavily dependent on airspeed and thus the limitation of using a single Mach number for the trajectories.
45) Line 386: “AirTraf…patterns” this is hard to follow and needs correcting. Splitting content between two sentences would make it far easier to express the meaning you are after.
46) Line 394: Can you explain this more clearly please? It sounds like you will concentrate your efforts on those flights where a significant emissions saving is possible and ignore the others, but please clarify potential levels of significance. This would also be a useful piece of analysis to include in the current paper. A scatter graph of % climate improvement against % cost change, with coding to show what changes are considered significant at a 5% level in comparison with the flights actually flown each day would make the current research more relevant.
47) Line 416: “In fact”, again use the singular here, not the plural. Also, “using i_{best} as a reference point” reads better.
48) Line 417: Use “of” in place of ”in” here. Place “a” in “such a reference point” and include “of the” between “each” and “objective”.
    The description of the VIKOR method is very clear in this appendix.

Works Cited

Poll, D. and Schumann, U. 2021a. "An estimation method for the fuel burn and other performance characteristics of civil transport aircraft during cruise. Part 1: fundamental quantities and governing relations for a general atmosphere." *The Aeronautical Journal* 125 (1284): 257-295.

Poll, D. and Schumann, U. 2021b. "An estimation method for the fuel burn and other performance characteristics of civil transport aircraft during cruise. Part 2: determining the aircraft's characteristic parameters." *The Aeronautical Journal* 125 (1284): 296-340.

Reutter, P., Neis, P., Rohs, S. and Sauvage, B. 2020. "Ice supersaturated regions: properties and validation of ERA-Interim reanalysis with IAGOS in situ water vapour measurements." *Atmospheric Chemistry and Physics* 20 (2): 787-804.

Teoh, R., Schumann, U., Majumdar, A. and Stettler, M. 2020. "Mitigating the Climate Forcing of Aircraft Contrails by Small-Scale Diversions and Technology Adoption." *Environmental science technology* 54 (5): 2941-2950.

Wells, C., Kalise, D., Nichols, N., Poll, D. and Williams, P. 2022. "The role of airspeed variability in fixed time, fuel-optimal aircraft trajectory planning." *Optimization and Engineering.*

Wells, C., Williams, P., Nichols, N., Kalise, D. and Poll, D. 2023. "Minimising emissions from flights through realistic wind fields with varying aircraft weights." *Transportation Research Part D: Transport and Environment* 117.