Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
https://doi.org/10.5194/gmd-2021-180-RC2, 2021

Comment on gmd-2021-180

Anonymous Referee #2

Referee comment on "A unified framework to estimate the origins of atmospheric moisture and heat using Lagrangian models" by Jessica Keune et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-180-RC2, 2021

Review of Keune et al (2021) A holistic framework to estimate the origins of atmospheric moisture and heat using a Lagrangian model.

This study addresses uncertainty in the estimation of precipitation and heat sources derived from Lagrangian parcel trajectory methods. A framework is proposed to assess uncertainty in the input quantities and the associated trajectories, based on FLEXPART and ERA-Interim reanalysis. The study presents an important contribution to the field and the authors have done well to develop a framework that assesses a complex collection of uncertainties. I support the publication of this study, after the issues outlined here are addressed.

General comments

- I suggest it will be easier for the reader to understand the methodology if the *need* for such a methodology was more clearly explained in the introduction. The motivation of the study, besides estimating the uncertainty in identified sources, could be clarified by outlining the specific uncertainties you wish to examine. My understanding from reading the manuscript is that you wish to (i) evaluate the sensitivity of identified source regions to the air parcels released and (ii) the loss/gain of moisture/heat from/to those parcels along their trajectories. Is this correct? As for (i), it's unclear why this is necessary – what exactly is the issue with FLEXPART that you are trying to rectify? Is the issue that FLEXPART normally tracks all air, and you want to constrain it to only track moisture for precipitation (or heat) specifically? Why aren't the reanalysis fields of precipitation and evaporation used in the selection and tracking of parcels? And is the impact of the number and height of the parcels released, and trajectory timestep, considered? As for (ii), I'm unclear why it is necessary – could you expand on this? For instance, L53 states: "… moisture losses between source and sink regions are not accounted for." I'm a bit confused here – I thought FLEXPART intrinsically accounted for losses and gains between source and sink through the use of the positive and negative

change in specific humidity along the trajectory (as stated in lines 49-50)? Is the problem that precipitation and evaporation must be *inferred* from the specific humidity change, and that you would like to quantify the precipitation/evaporation explicitly? This is an important point for the reader to understand the rest of the paper, including the need for linear or 'random' attribution of moisture – could you clarify please?

- This framework for assessing uncertainty really only relates to FLEXPART-type studies. This is fine, but it needs to be discussed somewhere. For example, could you comment on how the framework might be applied to other types of models? This would make the proposed framework more widely applicable.
- The need for and steps involved in the random attribution of moisture needs further clarification. I find the explanation hard to follow, and I'm a bit lost in matching the notation in the 3 steps to the rest of the text. Could you clarify the general idea of the approach, and each of the steps involved? This relates to the first comment above, that the need for such attribution needs further explanation.
- The results figures are clear and well thought-out, but the meaning and implications of the numerical results could be further drawn out. For Figures 3 and onwards, what are the implications of these statistical results, both physically and for future studies? Furthermore, there is a clear difference in results that are based on the two attribution methodologies - but how can the reader assess if either are realistic or even necessary?

Minor comments

- L18: I'm not sure what is meant by 'synergistic impacts'. Do you simply mean that the bias corrections reduce the identified uncertainties?
- L107 and 111 and other places in the document: I'm not sure what is meant by a 'diagnosis' of surface fluxes. Are you referring to an evaluation between simulated and observed fluxes, or something else?
- L131: 'all air parcels … are evaluated independently…' – what is the aim here?
- L113: Which 'other existing methods' are you referring to? Could you cite some examples please?
- L140: '…source contributions can be further constrained by means of a receptor quantity…'. Do you mean source contributions can be scaled to match the precipitation in the sink?
- L232: Could you expand a little on the importance of only using parcels that are within the ABL? L235 states the impact is considerably small for 6h time steps. Does this mean that back-trajectory methods don't need to consider the height of the ABL, or that it has a minor impact?
- L393: '…the timesteps for the calculation of trajectories are adapted to Lagrangian timescales…'. What is the trajectory timestep? How was is determined?
- L36: Suggest rephrase grammar to "Tracking air parcels enables the state of the atmosphere and its changes in space and time to be inferred, …"
- L156: The first sentence of section 2.2. makes it sound as though it follows from what is said above. Perhaps rephrase to something like: 'To characterize the physical processes influencing the air parcels, the changes in air parcel properties…'.
- L497: Change 'he3at' to 'heat'.