Atmos. Meas. Tech. Discuss., 6, C1828–C1831, 2013
www.atmos-meas-tech-discuss.net/6/C1828/2013/

Atmospheric Measurement Techniques Discussions

Open Access

AMTD

6, C1828–C1831, 2013

Interactive Comment

Interactive comment on "Assimilating airborne gas and aerosol measurements into HYSPLIT: a visualization tool for simultaneous assessment of air mass history and back trajectory reliability" *by* S. Freitag et al.

G. Allen (Referee)

grant.allen@manchester.ac.uk

Received and published: 30 July 2013

Summary

This paper nicely describes and tests a method for interpreting Lagrangian back trajectories in the context of source areas and atmospheric processing (e.g. cloud processing, photochemical ageing), specifically for airmasses observed/sampled during aircraft research flights. The back trajectory model of choice is HYSPLIT – a well characterised and much-used model with excellent functionality.

The central premise to the paper is that by running multiple trajectories at some nominal frequency (e.g. 0.1 Hz as chosen here) along a flight track, it is possible to gain confidence in source apportionment/airmass history by segregating trajectories according to in situ measurements whilst simultaneously looking for consistent patterns/differences in airmass origins and trajectory clusters. This general method and approach to source apportionment is not novel and has been used by several authors previously (e.g. O' Shea et al., 2013, below). However, a full description of the method and a detailed analysis of the efficacy of the method in terms of its contextual utility (e.g. in synoptic flow patterns versus large-localised convection) and typical uncertainties (meteorological and numerical errors) has not been published. Therefore, this paper represents a very useful resource for others to follow in terms of correctly using and interpreting back trajectory analysis generally and provides a publically available tool for use specifically with aircraft data (in the form of the matlab code supplement).

The paper is generally well written, the figures are of good quality and scientific excellence has been applied in the work carried out. Given that the study provides an assessment of a method and a new publically available tool that is useful to the atmospheric science community, this work is well within the scope of AMT. I would recommend publication in AMT subject to a couple of comments below.

Specific comments:

1/ Meteorological error: Although referred to and described, there is little new discussion of this in this work. Numerical error is well treated by examining forward and back trajectories in terms of sub-grid scale wind field interpolations etc. I worry that this component of the total advective error could dominate, especially in regions of the globe where the GDAS meteorological reanalysis data is poorly constrained by assimilated datasets. As this paper nicely aims to provide advice on ttrajectory errors/uncertainty and on how long trajectories can be trusted for into the past from release, it would be good to adderss meteorological error more fully. As the authors will be aware, the accuracy of any trajectory is ultimately limited by the accuracy and resolution of the

AMTD
6, C1828–C1831, 2013

3D wind fields used. It is beyond the scope to fully treat this problem by examining differences between all the multitudinous GCM outputs but it may be possibly to look at known systematic wind biases between such models to calculate a simple along-path integrated error or perhaps by looking at differences in trajectories initialized across the full range of met data available to HYSPLIT - I note there are several US models formatted for HYSPLIT use offline). Some typical/example analysis would be of great use to those following the work and could otherwise lead to others using/quoting numerical error sources only (and hence potentially grossly under-estimating) when discussing trajectories.

2/ Advice on suitability and context: There is some good discussion on the utility and accuracy of trajectories for synoptic flow patterns and large convective regions (e.g. the ITCZ and frontal uplift). Trajectories are not so good for PBL/MBL transport and detrainment/entrainment from the UT (as noted by the authors), nor are they useful for localised cellular convection. It is very difficult (if not currently impossible) to quantify this uncertainty. I wonder if a sub-section summarising this and some best practice advice could be included somewhere. It will help to prevent the flagrant misuse of Lagrangian trajectories in future publications (I hope).

Technical and other comments:

1/ Abstract: Change "...need of calculating..." to "...need to calculate..."

2/ P. 5348, line 22-25: This multiple trajectory method is conventionally called the ensemble method – would be worth including this definition.

3/ P. 5348, line 26: The O'Shea reference could be cited here as an example study that has also successfully used a similar method to the one described.

4/ p. 5349, line 15: recommend changing "consistent" to "detailed"

5/ p. 5349, line 19: Not sure that I agree that if general changes/differences in the trajectories is seen that it lends credence to the trajectories themselves. It lends credence

AMTD
6, C1828–C1831, 2013

to the observed differences in the in situ data and points to a shift in airmass but the trajectories are still subject to the same sources of error that they always were. I think this just needs rewording slightly.

6/ P. 5350, line 8: "ubiquitous"

7/ P. 5357, line 10: "reasonableness" is not an aceeptable word – recommend "reliability"

8/ p.5357, line 12: Recommend change "…should…" to "…could be expected to…". Similarly, replace "can" with "may" later in sentence when referring to cloud.

9/ P. 5360, line 8-10: Are you sure the ozone is stratospheric in origin and not photochemically produced in the FT – this discussion seems a bit beyond the scope of this work.

10/ P.5361, line 11. Recommend change "always" to "typically".

O'Shea, S. J., Allen, G., Gallagher, M. W., Bauguitte, S. J.-B., Illingworth, S. M., Le Breton, M., Muller, J. B. A., Percival, C. J., Archibald, A. T., Oram, D. E., Parrington, M., Palmer, P. I., and Lewis, A. C.: Airborne observations of trace gases over boreal Canada during BORTAS: campaign climatology, airmass analysis and enhancement ratios, Atmos. Chem. Phys. Discuss., 13, 14069-14114, doi:10.5194/acpd-13-14069-2013, 2013.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 5345, 2013.