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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Strategies for measuring canonical tracer relationships in the stratosphere" *by* O. Morgenstern and J. A. Pyle

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Reply to Reviewer 1:

We think the general comments are fair. Indeed we believe the decisions on which platforms to use should be left to the people running a campaign. We only aim to provide a strategy on how to arrive at objective statements on which strategy is best for a particular purpose.

Special comments: 1. Like any model, SLIMCAT produces systematic errors, and fine-scale details of tracer patterns are not reproduced by the model. The systematic errors are responsible for placing the canonical correlations into the wrong positions; in as far as they are still recognizable as separate curves, the systematic errors can be tolerated. Regarding the occurrence of small-scale features in measurements: Certainly the model dissipates features at a scale which larger than in nature. This however

happens to all tracers analogously and only affects tracer-tracer relationships through increased mixing or numerical diffusion. This can cause tracer-tracer relationships to become indistinguishable or blurred; therefore a relatively high-resolution model is necessary for this type of study.

2. There is no reason other than brevity why balloon- and aircraft remote-sensing instruments are not included here. A statement to this effect is added.

3. As discussed in 1., within limits systematic errors are tolerable. We aim to simulate varying precision; this is what the stated measurement uncertainty of HALOE data expresses. Indeed if a lot of measurements of a single air parcel was available, then any effective precision could be achieved. In reality, however, generally measurements are not redundant, in which case lacking precision may make a determination of separate canonical correlations difficult or impossible.

4. Lower stratospheric lifetimes could be quoted here. Globally averaged lifetimes were chosen only for simplicity. Regarding CH_3Br, we did not quote a stratospheric lifetime (which would be much shorter than 30 years) but an equivalent lifetime that would ensue if the tropospheric sink could be switched off. A gas with a global lifetime of 0.7 years but only stratospheric sinks would otherwise be unsuitable for the discussion because it would not form canonical correlations with long-lived gases.

5. The sentence is modified to make the statement clearer. Indeed the number and position of measurement sites need not be changed, but the type of measurements presently taken does.

Reply to Reviewer 2:

General comments: We agree with the reviewer about the usefulness of in-situ balloon-borne data, although we would not go as far as to recommend taking them only in one location. Indeed the text suggests that a reliable separation of midlatitude and polar canonical correlations can be achieved by taking into account measurements

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from two locations in the two regions. Potential vorticity is perhaps not a long-lived tracer on the timescales of interest here, but any other longlived chemical tracer would do. Morgenstern et al. [2002] contains a discussion on the choice of reference tracer. About the "sitting on the fence": We indeed would prefer to leave the decision about which platform(s) and instruments to use for future campaigns to the people running those campaigns. Our aim is to provide an ojective strategy on which instruments to deploy in which places to achieve certain goals, in this case identifying the canonical correlations. This was recognized and appreciated by Reviewer 1. Regarding the use of forecast information: Such forecasts can cover a timescale of up to a few days and are already routinely used in campaigns such as SOLVE/THESEO. In an effort to keep the measurement strategy simple and free of subjective decisions, we have not explored the use of forecast information in depth though added a paragraph to section 5.

Specific comments:

1. The error introduced by a large footprint size is difficult to assess in this CTM. I could not find specific information on footprint size on the HALOE homepage; it is of order or smaller than the gridscale of the model. Therefore, to simulate the effects of footprint averaging one would need a substantially better model resolution, especially in view of the small footprint sizes of forthcoming satellite instruments. Generally, if there is a lot of variability in two tracer fields that in reality have a tight but curved relationship, then footprint averaging would cause the curves to broaden in the same way as mixing does. In the case of two separate canonical curves the area between the two curves could be partially filled in due to footprint averaging, which one could erroneously attribute to mixing.

2. The reviewer is right that $\cos^{-10}$ of latitude gives a large weight to poleward measurements. Figure 7 shows the resulting scatter diagrams of CFC-11 and CH_3Br versus N_2O from HALOE data with a small perturbation. "By eye" the midlatitude and polar curves are visible, although for the polar curve the density of points is not a lot

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greater than for the region inbetween the two curves. This is just a consequence of the distribution of measurements of HALOE with measurements being restricted to regions south of 63°N. Giving increased weight to high-latitude measurements serves to shift the calculated canonical correlation towards what an observer would define as the polar curve. The necessity of such extreme weighting of course mainly highlights a weakness of the method of analysis, which was designed to be simple and was not optimized for HALOE data. A comment to this effect is added to the main text.

3. "Canonical" in this context means the relationship is valid globally. In view of separate and distinct "canonical" correlations the term becomes questionable, but to remain consistent with the existing body of literature using this term, we have chosen not to invent anything new.

Interactive comment on Atmos. Chem. Phys. Discuss., 2, 2075, 2002.