

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

**Anonymous Referee #2**

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### **General Comments**

This paper addresses an important issue: the information that can be obtained on chemical tracer distributions using different measurement platforms. The authors make clear that they specifically focus on the measurements necessary to distinguish the tracer-tracer relationships that are characteristic of different regions partially separated by a leaky transport barrier - i.e., the stratospheric polar vortex and the surrounding mid-latitude surf zone. It is shown how very few ground based stations are required to establish these tracer-tracer relationships, provided that the stations involved lie under both the polar vortex and mid-latitude air (e.g., Kiruna). Moreover, the measurement of a vertical profile of concentration need not be taken very frequently, since these relationships typically vary on the timescale of months. Thus it appears that balloon borne measurements are extremely useful and give information relevant to the en-

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tire stratosphere even though they may be launched from a single location (as during SOLVE/THESEO).

Aircraft measurements are less good for distinguishing the two relations due to their limited altitude range and the fact that aircraft fly not far above the tropopause where air masses are younger and the tracer-tracer relationships are less distinguishable.

Satellite measurements give sufficient coverage, provided that the orbit passes far enough polewards, but the uncertainty of the measurements maybe a limitation. The authors' show how tracer-tracer relationships cannot be distinguished if the random errors of the measurements greatly exceed the current accuracy of methane measurements on HALOE (about 2%).

The paper is well written and I recommend publication in ACP. I thought that the authors sat on the fence about which platform would be best for future campaigns. The results would seem to suggest that the global coverage of satellites is not necessary for stratospheric long-lived tracer measurements since their distributions could be captured using a reference tracer such as potential vorticity and tracer-tracer relationships. The same information could be gleaned from a few balloon launches, in addition to detailed vertical information pertinent to mixing issues. The most difficult issue would then be to decide when a stratospheric warming has occurred which could change the tracer-tracer relationships and to launch soon afterwards. The authors do not discuss targetting observations based on forecast information which would add considerably to their discussion.

### Specific Comments

1. When the accuracy of satellite measurements is discussed in Section 3.4 the issue of the footprint size of the measurement is not mentioned. If the footprint size is greater than the width of many tracer filaments, then the satellite would measure the average over the filaments. If a tracer-tracer relationship is non-

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linear does this introduce an additional error when attempting to distinguish the polar and mid-latitude air?

2. p.2084, l.6: What is meant by  $\cos^{-10}(\phi)$ ? Does this mean  $(\cos \phi)^{-10}$ ? If so this would represent an extreme weighting towards points close to the pole. Mid-latitude air can also pass over Kiruna at times (67.8N) so these occasions would be given extreme weight compared to its undisturbed location. The authors' state that the points cluster onto two curves on a scatter plot clearly discernable by eye. Perhaps a different method to fit to the separate mid-latitude and polar relationships would have been desirable (for example, calculating the density of points on the scatter plots and finding the locus of the maximum)?
3. What makes a tracer-tracer relationship "canonical"?

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

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