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Atmospheric Chemistry and Physics Discussions

Interactive comment on "An improved Kalman Smoother for atmospheric inversions" *by* L. M. P. Bruhwiler et al.

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In response to the Dr. Bousquet's comment that the introductory discussion of our paper is incomplete, we acknowledge that we neglected to mention the issue of aggregation error and the application of inverse techniques to obtain flux distributions at high spatial resolution. We did add a brief discussion of this to the paper, and we'd like to mention a few points here. We agree with the referee that the computational expense of doing atmospheric inversions comes from two sources; the inversion itself, which involves inverting potentially large matrices, and calculating the basis functions to be used in the inversion. As more and more observation sites are added, and as observations are used at higher time frequencies the number of basis functions that need to be calculated increases. Calculation of basis functions for satellite observations could be-

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come an taxing computational and organizational task even if an adjoint model is used. Although we deferred discussion of this for a future publication, our Kalman Smoother has been used as the basis for development of an Ensemble Kalman Smoother. This technique works best on parallel computer architecture and would be the technique of choice for extremely large problems.

Specific Comments

P1893, L25 - A more specific description of Bousquet et al (1999) was added, and the Bousquet et al. (2000) reference was also added.

P1893, 1894 - A more accurate description of the cyclo-stationary inversion was added. Also, while it may be true that the inversion itself in not considerably larger than an annual mean inversion, the amount of computation required to generate monthly basis functions is significantly larger.

P 1904, l8-9 - We mention that we use the GLOBALVIEW data product. It is true that many of the sites we used did not exist from 1980-1985, however, the purpose of this paper is to compare results obtained using two inversion techniques and the conclusions in this work are not sensitive to the network choice. We discuss network selection in detail in a follow-up manuscript.

P1905, l8-9- We added a reference and mentioned the tendency of TM3 to have weak vertical mixing.

P1907, l5 - Typo fixed

P1909, l10- We don't have a robust explanation for why the uncertainties are higher for the 9 month case relative to the Batch calculation than they are the 3 and 6 month transport cases. The reviewer brings up an interesting point. The time period in question corresponds to the the wet season for Amazonia, when moist air is transported from the Carribean and increased convection occurs. Fluxes for Amazonia are particularly ill-constrained during this time, and the signals from this region arriving at

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measurement sites will be very small. The uncertainty differences are also very small, and it is possible that the difference is a numerical artifact.

P1911, l9 - We revised the discussion of the use of priors in the Kalman Smoother. We agree that use of a prior the first time step, and use of sub-regional flux patterns means that the calculation will not be entirely free of influence from prior flux estimates. Still, we note that the use of previous estimates potentially allows the inversion to evolve away from prior flux values. Use of the Kalman Smoother in this manner will become more feasible as more observations hopefully become available.

Figures - We revised the captions so that they are hopefully more useful.

Interactive comment on Atmos. Chem. Phys. Discuss., 5, 1891, 2005.