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

L. M. P. Bruhwiler et al.

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We would like to thank Dr. Roedenbeck for his comments, and we are pleased with his interest in our work!

In response to Dr. Roedenbeck's comments concerning our claim that the Fixed-Lag Kalman Smoother may be run with the use of prior flux estimates, we have revised the discussion on page 1911. The Kalman Smoother is indeed formulated in terms of the usual Bayesian estimator, however, because it solves for fluxes at each time step sequentially rather than solving for fluxes at all time steps simultaneously, it becomes possible to use flux estimates generated by the Kalman Smoother at previous time steps as priors flux estimates. This is an alternative to using fluxes from the CASA model, or the Takahashi et al. (1999) as prior flux estimates. The inversion will there-

fore be constrained only by the atmospheric observations used (possibly except for the very first time step). We are currently exploring different methods for using estimates from the Kalman Smoother as prior flux estimates, however, for the current sparse observational networks, the results appear to be very noisy. As more observations become available, specifying prior flux estimates from previous estimates will likely become more sucessful.

Concerning the Detailed Comments:

Page 1897, L3-5 : We use either the NCEP-NCAR Reanalysis, or the EMCWF ERA-15. We did not mean to imply that we used them both in the same run. We clarified this in the text.

Page 1898, L1: We added mention of long-range transport errors.

Page 1899, L13: We fixed this typo.

Page 1900, L11: The pseudo-inverse is the inverse of a non-square matrix.

Page 1901, L 3-4: Except for the very first time a particular flux is estimated, Q will generally be non-diagonal. Our point was that if the number of source regions is small compared to the number of observations, then the second formulation of the Kalman Smoother equations is less costly because the size of the matrix inverted to calculate Q is number of source regions x number of source regions rather than number of observation sites by number of observation sites.

Page 1901, L5 - We added mention of monthly time steps in observations and fluxes.

Page 1901, Eqs 14, 15 - We added more detail on the sizes of the vectors and matrices and we removed the bold face type for the terms in Equation 15.

Page 1902, L 7-18 - The underlying idea behind our technique is that one need not wait until the basis functions reach their well-mixed values. The peaks are what constrain the solutions the most. In the example shown in Fig 1, most of the information about

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the North Atlantic at the particular time step shown arrives within the first few months. On the other hand, by the time a pulse from Cape Grim, for example, arrives at Mace Head, it contains little spatial information from nearby source regions.

Page 1902, Eq 16 - This is the equation that is solved at each time step and results from the various approximations we discussed.

Page 1902, L 21 - We added more detail on how the fluxes are estimated sequentially.

Page 1905, L 22 - We used the recommended wording.

Page 1907, Eq 22, 23 - The confusing terms were leftover from an earlier revision and we replaced them with the correct terms.

Page 1908, L 19-22 - We tried to make this sentence more clear.

Page 1909, L 1-7 - We agree that it's an important feature of our covariance propagation technique that the flux estimates agree better with the Batch results if covariance propagation is included, however, the differences are well within the uncertainty estimates. We did add language to emphasize this point, however.

Page 1909, L 15 - Out intent in this section was to discuss the advantages and drawbacks of using only pre-calculated basis functions to estimate the fluxes. It is computationally cheaper to use only pre-calculated transport fields, however there are prices paid in accuracy as we discuss. We added more to this discussion in order to help clarify it.

Figure Legends : We have revised these where appropriate to make them more helpful.

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