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Interactive comment on "Weak-constraint inverse modeling using HYSPLIT Lagrangian dispersion model and Cross Appalachian Tracer Experiment (CAPTEX) observations – Effect of including model uncertainties on source term estimation" *by* Tianfeng Chai et al.

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The revised version is included here.

Please also note the supplement to this comment:
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Weak-constraint inverse modeling using HYSPLIT-4 Lagrangian dispersion model and Cross Appalachian Tracer Experiment (CAPTEX) observations – Effect of including model uncertainties on source term estimation

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Abstract. A HYSPLIT-4 inverse system that is based on variational data assimilation and a Lagrangian dispersion transfer coefficient matrix (TCM) is evaluated using the Cross Appalachian Tracer Experiment (CAPTEX) data collected from six controlled releases. For simplicity, the initial tests are applied to release 2 for which the HYSPLIT has the best performance. Before introducing model uncertainty terms that will depend on source estimates, the tests using concentration differences in the cost function results in severe underestimation while those using logarithm concentrations differences results in overestimation of the release rate. Adding model uncertainty terms improves results for both choices of the metric variables in the cost function. A cost function normalization scheme is later introduced to avoid spurious minimal source term solutions when using logarithm concentration differences. The scheme is effective in eliminating the spurious solutions and it also helps to improve the release estimates for both choices of the metric variables. The tests also show that calculating logarithm concentration differences generally yield better results than calculating concentration differences and the estimates are more robust for a reasonable range of model uncertainty parameters. This is further confirmed with nine ensemble HYSPLIT runs in which meteorological fields were generated with varying planetary boundary layer (PBL) schemes. In addition, it is found that the emission estimate using a combined TCM by taking the average or median values of the nine TCMs is similar to the median of the nine estimates using each of the TCMs individually. The inverse system is then applied to the other CAPTEX releases with a fixed set of observational and model uncertainty parameters and the largest relative error among the six releases is 53.3%. At last, the system is tested for its capability to find a single source location as well as its source strength. In these tests, the location and strength that yield the best match between the predicted and the observed concentrations are considered as the inverse modeling results. The estimated release rates are mostly not as good as the cases in which the exact release locations are assumed known, but they are all within a factor of 3 for all the six releases. However, the estimated location may have large errors.

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Fig. 1.