Response to anonymous Referee #2

We thank the reviewer for their helpful suggestions. The reviewer comments are shown in italic font, and our response is shown below each comment, in plain text.

These are significant findings that merit publication in ACP. Before publication, however, the paper would benefit from revisions that emphasize these results, which will be most useful in enabling the carbon cycle community to properly assess (and potentially improve) the errors and biases in inverse model-derived fluxes. As it reads now, the paper goes into great detail providing explanation of the SBLM, at the expense of discussion.

The revised paper includes greater discussion of the results in relation to future remote sensing capabilities (response to specific comment 13, and overall comments A and B, by Reviewer 1), and to convective parameterization (response to comment 5 by Reviewer 1), and on how our results are relevant to current data assimilation methods (response to comment 9 by Reviewer 1).

With regards to the explanation of the SBLM, the first half of section 2 was quite clear while the second half didn't make any links back to the physical system. It is not until a later section that the authors give physical meaning to the quantities h, F, and E introduced in the equations.

We added a description of the kinds of physical processes that can be represented by the stochastic model, at the end of the revised Section 2. For example, synoptic time-scale variability in boundary layer height and surface fluxes (deeper boundary layers coinciding with greater surface uptake due to solar forcing, for example), will be captured by the observationally-derived cross spectral densities and used to generate synthetic time-series having covariation similar to the observations.

I also felt that section 3.1 on input datasets would benefit from reorganization, since information on the datasets was unclear and presented in a somewhat random order.

We added explanation of the horizontal advection inputs, and free-troposphere CO_2 measurements (in response to comment 4 by Reviewer 1), and also divided section 3.1 into two sub-sections to introduce the observations and Carbon Tracker inputs separately.