Initial response to Comment from Anonymous Referee #1
James S. Wang, et al.

This comment is a partial response to the comment of Referee #1. We address a couple of the most important concerns here, and will prepare a complete response during the paper revision process.

We thank the referee for pointing out, in his/her General and Detailed comments, the lack of quantitative discussion of the sensitivity of our study results to boundary conditions (b.c.) and a priori uncertainties. As for the effect of b.c., we have realized upon further thought that we do not overestimate the constraint on fluxes provided by ASCENDS observations in neglecting b.c. uncertainties, contrary to what we stated in the first paragraph of Section 4.2 (on page 12839). The reason is that we did not include the information on boundary concentrations provided by the observations in the calculations, i.e. we did not save the information for the locations and times of the particle boundary crossings from our Lagrangian particle dispersion model runs, and thus did not include the relevant elements in the Jacobian matrices. If we had kept the information on b.c. and included the b.c. as parameters in the state vector, we would expect that the inversion could reduce b.c. uncertainties in addition to providing the same constraints on the regional fluxes as in our reported results.

To demonstrate this, we have conducted a test inversion for July (1.57 µm and 0.5 ppm RRV error case) in which b.c. are added as parameters (specifically, weekly average CO2 mixing ratios over each of the four lateral walls of the domain), with corresponding elements added to the Jacobian. Given that the actual Jacobian values are not available, we prescribed values that are somewhat realistic: 0.5 ppm ppm^{-1} if an observation occurs in the same week as or after a b.c., and 0 if an observation occurs before a b.c. We assumed a priori uncertainties of 1 ppm for the b.c., with no correlations among b.c. uncertainties or between b.c. and flux uncertainties. As expected, the reduction in flux uncertainties is essentially unchanged from our reported results, while the inversion also helps to constrain the b.c., resulting in weekly uncertainty reductions of 7-13%. (The flux uncertainty reductions are not identical, presumably due to a posteriori correlations between the flux and b.c. parameters, but the new uncertainty reductions are smaller than the reported ones by a factor of 0.01 or less.)

Thus, our statement about the amount of flux uncertainty reduction reported here likely being higher than it would be if we accounted for b.c. uncertainties is actually incorrectly pessimistic. We will change this statement in the manuscript and describe our new sensitivity test.

And as for a priori uncertainties, we had carried out an alternative inversion to test sensitivity to the prior uncertainties, but did not report the results. We will consider adding that to the manuscript. In brief, the results are sensitive to a decrease in the assumed a priori uncertainties. In a test in which a priori flux uncertainties were not enlarged by a factor of 4 to match those of our companion global ASCENDS OSSE (i.e. they are based only on the temporal variability of the CASA-GFED model fluxes), the a posteriori uncertainties are substantially smaller than those of the standard regional inversion. However, these low a posteriori uncertainties are primarily a consequence of the low a priori uncertainties rather than a result of improvement provided by ASCENDS observations; in fact, the uncertainty reductions in this test are smaller than those in the standard inversion. Thus, the results based on the larger a priori uncertainties provide a more useful assessment of the ability of the measurements to meet the mission requirements. We will consider carrying out an additional test in which the prior uncertainties are enlarged further (i.e. are larger than those in the standard inversion). We expect that the posterior uncertainties will be similar to those of the standard inversion given the high density of observations, as suggested by the referee.