

Interactive comment on “A Joint Global Carbon Inversion System Using Both CO₂ and CO₂ Atmospheric Concentration Data” by Jing M. Chen et al.

Anonymous Referee #2

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This manuscript presents an interesting approach for using ¹³CO₂ data as extra constraints for top-down flux inversions based on in-situ surface CO₂ data. This approach has taken into account spatial variation of isotropic discrimination and disequilibrium by using a terrestrial biosphere model and an ocean model to simulate the discrimination rates. The manuscript is well written, and their results are interesting. It should be published after minor revision.

Major comments:

My major concern is that the uncertainties in model simulation of D_j and C_i (Eqs. 6 and 8) have been properly taken into account in the flux inversions.

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1. Ideally D_j should be part of the state vector, with prior estimates taken from the biospheric or oceanic model simulation. Treating D_j as a single fixed value could result in artificially enlarging the impacts of $^{13}\text{CO}_2$ data, as well as distorting the spatial distribution of the posterior fluxes.

2. The observation errors for $^{13}\text{CO}_2$ should also be enlarged to account for possible modelling errors (Eq.10). Actually it is a bit surprising that the uncertainties for both land and oceanic fluxes inferred from $^{13}\text{CO}_2$ data only (Table 6) are smaller than those directly based on surface CO_2 data (Table 3), considering that they have fewer sites.

3. In the joint inversion, the observation error correlation between CO_2 and $^{13}\text{CO}_2$ data, (for example, due to the common model transport errors) has not been taken into account.

Minor comments:

1. Line 17, Page 4 ‘...60 months’ The time period 2000-2004 could be mentioned here.

2. Eq. 9, Page 7: It would be helpful if the authors can add some discussions on temporal variation of D_j in the following sections.

3. Line 1, Page 13: ‘A transport-only ...’ What is the spatial resolution of TM5 ?

4. Line 34: ‘equal the sum of ...’ Uncertainty of (ab) usually is not equal to such a simple linear sum.

5. Figure 13. I only see blue solid line (instead of the green one in the caption). Also, it seems that over Northern hemisphere, the posterior model CO_2 concentrations have a larger seasonal cycle than the GV data. What is the reason ?

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