Response to Anonymous Referee #1

We thank the reviewer for the insightful and helpful comments. Each comment will be responded to in turn below. The referee comments are italicized for clarity.

We have applied a correction to the later Park Falls and Lamont TCCON data, as described on the TCCON wiki Data Description page:
`https://tccon-wiki.caltech.edu/Network_Policy/Data_Use_Policy/Data_Description`.
This correction decreases the 1.3 ± 0.7 ppm/K in the original paper to 1.2 ± 0.7 ppm/K, but does not affect the interpretation of our results.

- *The use of GoSAT in this study does not add any value to the analysis, nor any extra credence to the results. The only use I see for it is to confirm the wide spread nature of the XCO2 drawdown variations, which could also be simply stated without the description of GoSAT in section 3, or its mentioning in the abstract. I suggest to remove the details about the GoSAT XCO2 and its relatively shallow (to the high standard of the rest of the paper) analysis. This would also save one table, and one figure (7).*

  We have reworked the GOSAT analysis using the latest ACOS version 3.3, which has four years of data available. This substantially increases the value of the GOSAT data. Because we're using data that are corrected by the ACOS team, we are able to remove table 1 and simplify the GOSAT description section. The GOSAT results add a geographic picture, showing, for example, that Bremen is in a region where the CO_2-δT relationship is systematically lower.

- *Page 10264, line 20: I got a bit lost here in the positive/negative logic in this sentence, could you please describe which variable causes which effect and use decreases/ increase in uptake/release of carbon?*

  We have clarified the text:

  "This positive relationship between temperature and atmospheric CO_2 is attributed primarily to an increase in ecosystem respiration (R_e) with increasing surface temperature, and a concurrently muted gross primary production (GPP, or photosynthesis) (Doughty and Goulden, 2008)."

- *Page 10268, line 15: I do not think the biosphere fluxes in Carbontracker are balanced as fires and regrowth are calculated from the same vegetation pools.*

  We did not intend to imply that CarbonTracker has a balanced biosphere - just that their a priori fluxes (based on CASA) are balanced.

- *Page 10270, line 7: Did you also try this with the Mauna Loa CO2 growth rate? Using the global value might increase some of the signal attributed to the polynomial terms because inclusion of the SH dampens growth rate variations that originate on the NH, and are thus seen first and most strongly at Mauna Loa.*

  On your suggestion, we reanalyzed using the Mauna Loa CO_2 growth rate. The slopes derived from the TCCON data decreased when using the Mauna Loa growth rate (from 1.2 ± 0.7 ppm/K using the global growth rate to 1.0 ± 0.7 ppm/K using Mauna Loa only—see Tables 1 and 2 below). This has been noted in the revised manuscript:

  "Using the Mauna Loa growth rate instead of the global mean ESRL growth rate decreases the overall slopes by ~ 0.2 ppm/K."

- *Page 10271, line 25: What is the rationale for not including 2000-2003 in the mean?*

  When this study began, we focused on the TCCON data, which begin in 2004. The addition of CarbonTracker data came later in the analyses. We have subsequently used the 2000-2010 means to compute the anomalies, and the results negligibly increase the overall slopes (second decimal place changes between Tables 1 and 3 below).

- *Page 10271, line 29: Considering the strong increase in biomass going into the tropics, what would be the effect of shifting the 30N boundary of your analysis further south? This is similar to the possibility that some of the observed/simulated anomalies originate in the tropics and are transported into your domain, thus not representing high-latitude sensitivity to temperature.*

  Shifting the lower boundary from 30N to 20N increases the CO_2–δT slopes by ~ 0.2 ppm/K (see Tables 1 and 4 below).

- *Page 10272, Line 14: There must be some surface flux data to back this IAV up with measurements of the quantity you are most interested in. Have you tried to find this?*

  There are several papers that describe the interannual variability in surface fluxes. We've added these references and the following text:

  "Tower flux measurements have shown a strong sensitivity of carbon exchange to surface temperature at several locations, including Niwot Ridge, Colorado (Sacks et al., 2007), in the Howland Forest, Maine (Richardson et al., 2007), and in the North American prairie region (Arnone et al., 2008)."

  Sacks, W. J., D. S. Schimel, and R. K. Monson (2007), Coupling between carbon cycling and climate in a high-elevation, subalpine forest: a model-data fusion analysis., Oecologia, 151(1), 54–68, doi:10.1007/s00442-006-0565-2.

  Arnone, J. A., P. S. J. Verburg, D. W. Johnson, J. D. Larsen, R. L. Jasoni, A. J. Lucchesi, C. M. Batts, C. von Nagy, W. G. Coulombe, D. E. Schorran, P. E. Buck, B. H. Braswell, J. S. Coleman, R. a Sherry, L. L. Wallace, Y. Luo, and D. S. Schimel (2008), Prolonged suppression of ecosystem carbon dioxide uptake after an anomalously warm year., Nature, 455(7211), 383–6, doi:10.1038/nature07296.

  Richardson, A. D., D. Y. Hollinger, J. D. Aber, S. V. Ollinger, and B. H. Braswell (2007), Environmental variation is directly responsible for short- but not long-term variation in forest-atmosphere carbon exchange, Global Change Biology, 13(4), 788–803, doi:10.1111/j.1365-2486.2007.01330.x.

- *Page 10274, line 15: I guess this is similar to my suggestion above. How would you account for this transport, and how would it influence your sensitivity? I know these questions cannot be answered easily, but maybe some discussion can be added.*

  A dynamical tracer may help in accounting for some of this transport, but the tracer we have used in the past (mid-tropospheric potential temperature, as described by Keppel-Aleks et al. (2011, 2012)) would not help remove additional noise, as it would alias into the dynamical signal. (For a related discussion, please see the comments to Referee #2.)

- *Page 10672, line 23: Perhaps an analysis of d13C might help to reveal such drought related influences, but one would have to revert back to surface flask samples again.*

  This is a good idea, which will be added to the discussion section as a path forward.

- *Page 10277: I was a bit surprised that the authors did not try to provide some more context for the calculated climate sensitivity of uptake in boreal regions. This topic is currently debated actively for the tropical regions, in the context of climate simulations and the ability of the latest IPCC models to capture recent CO2 growth variations (Cox et al., 2013). Perhaps an interesting addition to the discussion could be attempted.*

  The long-term sensitivity of the boreal biosphere to climate is, of couse, the ultimate goal of this investigation. However, we believe that it is still premature to make predictions of how carbon exchange will behave further into the future in the absence of a quantitative process-level description. We have, however, made the climate-sensitivity context explicit in the introduction.

- *Page 10289: The large negative values of parameter a0 for SIB need some explanation*

  A linear atmospheric increase was fit to the SiB data, so the very large negative value of a0 represents the amount of CO_2 at year 0, if the increase were to be extrapolated that far back. The measurements and CarbonTracker were fit after subtracting the ESRL atmospheric growth rate, so the trend was already removed, resulting in a small a0. A note has been added to the table caption to clarify.

  "The large negative values of a_0 for SiB and SiB2009 are the result of using a straight-line fit to the data (i.e., α) instead of subtracting the ESRL growth curve, and fitting the detrended curve."

Table 1: Revised slopes from TCCON, GOSAT, and models.

Site	TCCON	GOSAT	SiB	SiB 2009	CarbonTracker
Park Falls	1.73 ± 0.92	1.32 ± 1.43	1.59 ± 1.16	0.91 ± 1.13	1.45 ± 0.99
Lamont	1.10 ± 1.13	1.21 ± 0.83	1.18 ± 0.53	0.77 ± 0.53	0.92 ± 0.67
Bremen	0.42 ± 1.41	-0.36 ± 2.14	-0.11 ± 1.03	-0.40 ± 1.10	0.35 ± 0.71
Białystok	1.25 ± 2.06	-0.30 ± 1.78	0.71 ± 1.72	-0.05 ± 1.62	0.69 ± 0.70
Weighted Mean	1.19 ± 0.72	0.70 ± 0.81	0.91 ± 0.59	0.43 ± 0.58	0.81 ± 0.39
Weighted Mean without Bremen	1.41 ± 0.84	0.90 ± 0.81	1.21 ± 0.71	0.66 ± 0.68	0.97 ± 0.46

Table 2: Slopes from TCCON, GOSAT, and models when using the Mauna Loa growth rate instead of the ESRL global growth rate.

Site	TCCON	GOSAT	SiB	SiB 2009	CarbonTracker
Park Falls	1.58 ± 0.92	1.22 ± 1.44	1.59 ± 1.16	0.91 ± 1.13	1.40 ± 0.99
Lamont	0.87 ± 1.13	1.15 ± 0.83	1.18 ± 0.53	0.77 ± 0.53	0.82 ± 0.67
Bremen	0.31 ± 1.41	-0.45 ± 2.14	-0.11 ± 1.03	-0.40 ± 1.10	0.28 ± 0.71
Białystok	0.86 ± 1.96	-0.39 ± 1.78	0.71 ± 1.72	-0.05 ± 1.62	0.64 ± 0.70
Weighted Mean	0.99 ± 0.70	0.62 ± 0.81	0.91 ± 0.59	0.43 ± 0.58	0.74 ± 0.39
Weighted Mean without Bremen	1.18 ± 0.81	0.82 ± 0.81	1.21 ± 0.71	0.66 ± 0.68	0.90 ± 0.46

Table 3: Slopes from TCCON, GOSAT, and models when using 2000-2010 anomalies instead of 2004-2010.

Site	TCCON	GOSAT	SiB	SiB 2009	CarbonTracker
Park Falls	1.74 ± 0.92	1.35 ± 1.45	1.59 ± 1.16	0.91 ± 1.13	1.44 ± 0.99
Lamont	1.15 ± 1.14	1.25 ± 0.84	1.18 ± 0.53	0.78 ± 0.53	0.91 ± 0.67
Bremen	0.42 ± 1.41	-0.38 ± 2.16	-0.11 ± 1.03	-0.40 ± 1.10	0.35 ± 0.71
Białystok	1.17 ± 2.08	-0.31 ± 1.80	0.72 ± 1.72	-0.05 ± 1.62	0.68 ± 0.69
Weighted Mean	1.19 ± 0.73	0.71 ± 0.82	0.91 ± 0.59	0.44 ± 0.58	0.80 ± 0.39
Weighted Mean without Bremen	1.41 ± 0.85	0.92 ± 0.82	1.21 ± 0.71	0.66 ± 0.68	0.96 ± 0.46

Table 4: Slopes from TCCON, GOSAT, and models when using 20N–60N instead of 30N–60N.

Site	TCCON	GOSAT	SiB	SiB 2009	CarbonTracker
Park Falls	1.95 ± 1.03	1.54 ± 1.67	1.81 ± 1.28	1.04 ± 1.25	1.65 ± 1.09
Lamont	1.33 ± 1.25	1.45 ± 0.96	1.36 ± 0.61	0.87 ± 0.60	0.98 ± 0.74
Bremen	0.59 ± 1.63	-0.46 ± 2.48	-0.15 ± 1.09	-0.45 ± 1.17	0.36 ± 0.78
Białystok	1.47 ± 2.46	-0.32 ± 2.06	0.83 ± 1.98	-0.06 ± 1.87	0.75 ± 0.77
Weighted Mean	1.40 ± 0.84	0.83 ± 0.94	1.02 ± 0.67	0.48 ± 0.65	0.88 ± 0.43
Weighted Mean without Bremen	1.63 ± 0.98	1.07 ± 0.94	1.39 ± 0.81	0.75 ± 0.78	1.07 ± 0.51