Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2016-10-RC1, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Increasing summer net CO_2 uptake in high northern ecosystems inferred from atmospheric inversions and remote sensing" *by* L. R. Welp et al.

Anonymous Referee #3

Received and published: 17 March 2016

This paper uses the results from two atmospheric inversion models and long-term surface temperature and NDVI records to compute trends in the CO2 fluxes in the Arctic and Boreal regions (excluding Europe). The authors conclude that the Boreal region has become an increasingly large sink for CO2, with no statistically significant change in the Arctic, even though the seasonal cycle amplitude in CO2 in both regions has increased. The authors argue that this is due to the balance between increased summertime uptake and fall CO2 emissions.

The paper is well-written and clear, and suitable for publication in ACP. I recommend that this paper is published after addressing the following comments.

Main Comments:

I would recommend that the authors look at the more recent solar-induced fluorescence (SIF) measurements (e.g., GOME-2, GOSAT, OCO-2) in their analyses. SIF is reported to be more directly related to photosynthesis than greenness indices are, and show some significant differences in the Boreal and Arctic regions (e.g., Joiner et al. 2013). GOME-2 has the longest time series (launched in 2006), and I recognise that this does not cover the main time period of the inversions, but it should be helpful to determine whether NDVI is fully capturing the productivity cycle in the Boreal region.

This analysis does not directly consider the timing of the onset of the growing season, but it is obvious in Figure 3a that even between the two models using the same CO2 concentration data, the phase and duration of the growing season are inconsistent. This raises several questions: Are monthly fluxes temporally fine enough for this analysis (i.e., would the results change if you were to look at, say, bi-weekly fluxes)? Do the two inversions show a similar change in the timing of the onset of the growing season over time? Do they show consistent changes in the length of the growing season?

Minor Comments:

Title: I suggest you clarify the title by specifying that the inversions use surface concentrations and that the remote sensing is of NDVI and temperature P2L22: ... trigger *a* massive... P2L35: Is (1997) referring to a paper? P5L2: Be careful to state that GLOBALVIEW-CO2 isn't "data". From the ESRL webpage (http://www.esrl.noaa.gov/gmd/ccgg/globalview/co2/co2_intro.html): "GLOBALVIEW-CO2 is derived from atmospheric measurements but contains no actual data." P6Para24: Please clarify. I find the first two sentences very confusing. P9L25: In order *to* investigate... P10L6: You show the average growing season NDVI. Would the integrated NDVI over the growing season be better correlated with CO2 uptake? P10L13: How does the month of the maximum NDVI change over time? Is there a trend? P10L27: How is significance defined here? P12L28: ... warm summers may *be* driven... P12L27: Schneising et al. (2014) also came to a similar conclusion. P13L22: ... to different *latitude* bands... Figure 3: The two inversions differ in their

mean seasonal cycle amplitudes by a factor of two in the Arctic, and they have significantly different onsets of the growing season in the Boreal zone. Can you explain why?

References:

Joiner, J., Guanter, L., Lindstrot, R., Voigt, M., Vasilkov, A. P., Middleton, E. M., Huemmrich, K. F., Yoshida, Y., and Frankenberg, C.: Global monitoring of terrestrial chlorophyll fluorescence from moderate-spectral-resolution near-infrared satellite measurements: methodology, simulations, and application to GOME-2, Atmos. Meas. Tech., 6, 2803-2823, doi:10.5194/amt-6-2803-2013, 2013.

Schneising, O., M. Reuter, M. Buchwitz, J. Heymann, H. Bovensmann, and J. P. Burrows (2014), Terrestrial carbon sink observed from space: variation of growth rates and seasonal cycle amplitudes in response to interannual surface temperature variability, Atmos. Chem. Phys., 14(1), 133–141, doi:10.5194/acp-14-133-2014.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-10, 2016.