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Atmospheric Measurement Techniques Discussions

Interactive comment on "A segmentation algorithm for characterizing Rise and Fall segments in seasonal cycles: an application to XCO_2 to estimate benchmarks and assess model bias" *by* Leonardo Calle et al.

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The study by Calle et al titled "A segmentation algorithm for characterizing Rise and Fall segments in seasonal cycles: an application to XCO2 to estimate benchmarks and assess model bias" examines unique aspects of the atmospheric co2 seasonal cycle using a new segmentation algorithm to characterize annual co2 rise and fall segments. A key application for carbon cycle science is attribution of model biases in co2 uptake patterns and underlying mechanisms by characterizing seasonal phase and amplitude biases in atmospheric co2 predictions. In particular, this directly addresses the prob-

lem of linking errors in the atmospheric co2 seasonal cycle amplitude change to corresponding errors in the timing and amplitude of biogenic co2 uptake. The method is well described, using conventional software and accepted smoothing techniques, and with enough detail that most interested users should be able to implement on their own (although some author assistance may be needed to account for local minima and maxima, which appears to be a science on its own). The applications are interesting and inciteful – I especially like the LUC sensitivity analysis. Some clarification is needed with respect to figures and in describing the main results, but the revisions are minor overall. I'm happy to recommend this paper for publication after addressing the comments below.

Minor comments

Sec 2.4 -> did you account for the averaging kernel in calculating xco2? I'm not sure how this varies geographically, but it may impose a different latitude gradient in xco2 than inferred from a simple pressure weighting

Sec 2.6.1 -> might be helpful to provide an example of time series with local minima/maxima and show how the algorithm differentiates these from seasonal mean values

Sec 2.7 -> I'm confused about the method to estimate the latitude gradient using the "average latitude of each TransCom region." Why not use the entire zonal average for each latitude band?

Sec 3.1, L290 -> the problem with using predefined transcom regions is the lack of coverage in critical sub-regions. I understand removing these regions from the analysis, but it seems archaic at this point to still use these regions. I will also point out that Eurasia Boreal has similar reduced coverage as NA Boreal (Fig S2), so it's odd that only the former region is analyzed

L316-318 -> this whole sentence is very confusing. Amplitude increases with latitude in GOSAT. What else is there to say?

L318 -> Why is a range (0.74-0.77 ppm) for latitude slope reported? Convention is to report slope +/- uncertainty (e.g., 0.75 +/- 0.05 ppm). If referring to the upper and lower bounds due to errors in the slope, please specify.

Fig 4 -> The CO2amp and Period values in the figure don't make sense. Also why are there no points from 20-40N and between 40-50N? There is plenty of coverage according to Fig S2. I wonder if using zonal averaged to compute these latitude gradients would reduce this clumpiness

L321 -> It doesn't make sense to report a mean slope value (1.25 ppm / 10 deg lat) for a log-linear slope. Maybe just report the value for a certain latitude range (i.e., 30-40N)

L322-232 -> over what latitude range?

Sec 3.2 -> Why didn't you compare in situ observations to models?

L 348 -> Should mention somewhere that phases are equal at 2N. The switch in asymmetry in northern latitudes, specifically the rapid spring and slow fall transition at high northern latitudes, is consistent with findings in Parazoo et al (2016), who suggest that poleward transport of southern signals, which experience earlier spring and later fall, cause delayed but rapid spring drawdown and early but prolonged fall senescence in northern latitudes (Parazoo, N. C. et al, 2016, Detecting regional patterns of changing co2 flux in Alaska, PNAS)

L350-354 -> The question of whether the point of inversion changes over time due to biosphere activity could easily be answered with the model. Why not try this?

L357-359 and Fig 4 -> OCO-2 is mentioned in text and caption but I don't see any values plotted, and there is not mention of this data in the methods

Sec 3.4 -> A few comments: (1) The meaning of individual bars representing regional asymmetries in Fig 6 (10 bars total per region) is not explained in the text or the figure

caption. Assuming each bar represents 1 asymmetry between fall and rise segments, and there are 4 full years of GOSAT data, this should produce 7 bars. But 10 are shown, so maybe I'm misunderstanding the plot (thus the request for more cation detail). (2) There appears to be a mistake in identifying regions without all period asymmetries in the same direction: Africa Southern should be replaced with Australia? (3) All regions which have the same direction of period asymmetry are in the Northern Hemisphere, with the period of rise (fall transition) exceeding period of fall (spring transition), consistent with latitudinal results and 2N transition described earlier in the papers

L405: I do not understand how the statement "systematic bias in the sensitivity of models to seasonal changes in climate" explains model underestimates in amplitude of rise and fall segments. Please clarify with more detail and/or an example. It seems that the simplest explanation is that models underestimate growing season net uptake. Indeed, the situation in the next paragraph, in which models are too short in the rise (fall transition too short) and too long in the fall (spring transition too long) in the NH, is also consistent with a scenario in which models underestimate NH growing season net uptake (or perhaps, the timing of peak uptake is delayed)

Technical

L316 -> remove "either" at end of sentence?

Fig 3 -> need to move legend somewhere so it doesn't block time series

Figure 4 sub-panels need labels

L342 -> first sentence should refer to Fig 4

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