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Atmospheric Measurement Techniques Discussions

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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.

Anonymous Referee #2

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Changes in the amplitude and phase of atmospheric carbon dioxide (CO2) reflect changes in geographical patterns and strengths of uptake and emissions and in atmospheric transport processes. Unfortunately, this information remains woefully underutilised in our quest to understand how uptake and emissions of CO2 are changing with time, even though a number of previous studies have made this point using a variety of statistical approaches . Here, the authors present a new methodology to characterise the rise and fall of seasonal cycles so that it can be used as a model metric. They apply this approach using column CO2 data from GOSAT. A focus on using

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Discussion paper

seasonal information to test carbon cycle models, particularly those models that are used in Earth system models, is very welcome.

Determining the amplitude and phase of a time series is a notoriously difficult problem, especially a time series with a superimposed time-dependent trend, normally requiring a lengthy time series to minimise the effect of edge effects. The GOSAT record runs from 2009 to present so I am curious while they curtailed their analysis at 2012. Armed with only a few seasonal cycles the authors will find it difficult to properly remove the lower frequency variations, which will arguably pervade the column measurements more so than surface measurements.

The authors have used a spectral method to remove short-term variations less than 80 days. It would be useful (for at this reader) to understand why they chose that value as a cut-off.

I thought that the math was presented in an unnecessarily complicated way. Surely, the second derivative and first derivative taken together are sufficient to determine the peak, trough and any saddle point found in the time series. Saddle points can be found in Arctic seasonal cycles, for instance.

Nevertheless, the method appears to be sound. The authors appear to focus on model evaluation instead of using the method to improving understanding of the carbon cycle. Consequently, there is little in the way of physical interpretation of the metrics in sections 3.2 and 3.3. How do the authors take into account the uncertainties associated with the column data?

For the model analysis, do the authors sample the model when/where there are observations?

Line 350: "We suggest that the latitude of the inversion of period asymmetry is a characteristic indicator of global atmospheric dynamics and biosphere productivity." It would be useful for the reader to understand the origin of this suggestion.

Line 360: “It may be possible to add this emergent pattern as a benchmark to evaluate models that attempt to reproduce more direct indicators of biosphere activity...” How important is atmospheric transport in determining zonal variations in this emergent pattern?

For the reasons outlined in the (balanced and frank) discussion I am left wondering how the metric will be used to “correct” models given the uncertainties associated with emissions from fossil fuel combustion and cement production. Could similar patterns emerge from nature and models for different reasons?

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