Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "Unprecedented strength of Hadley circulation in 2015–2016 impacts on CO$_2$ interhemispheric difference" *by* Jorgen S. Frederiksen and Roger J. Francey

Anonymous Referee #2

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Frederiksen and Francey consider the influence of various atmospheric transport processes on the interhemispheric difference in CO2 as observed through data records from Mauna Loa and Cape Grim. Based on an earlier study by the same authors considering the varying strength of interhemispheric transport by eddy transport, they add advective interhemispheric transport through the Hadley circulation to the picture. This allows the authors to better explain the variations in the interhemispheric CO2 difference observed in the most recent years.

Identifying transport influences on the interhemispheric CO2 difference is relevant to inverse calculations using observed atmospheric CO2 gradients to infer variability in

CO2 sources and sinks, because the transport models used there may misrepresent these influences. I find it an interesting study, and would like to recommend publishing it in ACP. However, I find the paper quite hard to understand to a wider readership (as myself) interested in the carbon cycle but not necessarily familiar in detail with the concepts of atmospheric circulation. Therefore, I suggest some revisions that may help to improve the accessibility, as detailed below.

Specific comments:

You may consider to repeat some more information from FF16. Currently the paper can only be understood when also having read FF16. Also some more background information would help, e.g.:
- Can you add a general sentence about Rossby wave dispersion and the mechanism how it transports atmospheric tracers?
- Is the interhemispheric "duct" a pre-established concept, or is FF16 the place where it was first introduced? Why is the duct located over oceans only? Is it obvious why Pacific and Atlantic ducts are anticorrelated?

P1 L25: I did not understand the formulation "on the basis of long-term correlations". Why would eddy transport necessarily be expected to correlate with SOI?

Please specify somewhere where the wind data (used to calculate the indices) are taken from (NCEP?). If the winds are taken from re-analysis, a statement of the uncertainty in the upper-troposphere winds would be appropriate, because the study relies on them. How can they be validated?

P2 L10: What does "uses the overlap" mean? This needs an explicit description.

Same paragraph: Add the year (always 2015?) to all dates given.

P3 L8: "Modelling" is a very broad term, that could mean anything. Please add a brief description what has been done (e.g. saying "atmospheric transport simulation" with a description of the CO2 fluxes used). Reading FF16 did not actually clarify to me what

you refer to here.

P3 L25: It would help (here and at various other places) to split long sentences by commas, here e.g. after "15N", for a faster perception which parts belong together. (Also, e.g., P4 L8 after "wind" and "(140W-170W)", P8 L20 after "duct", P8 L26 after "open".)

P5 L22-24: I found this sentence unclear. Maybe "with" in line 22 should be "which"?

Sect 5: I would find it interesting to know which fraction of interannual variability in $C_{mlo-cgo}$ can be explained by transport variability alone? Is it $r^2 = 25\%$? (In addition, I found the description of the correlation analysis not easy to follow, e.g. with respect to the two quantities C and C*.)

P7 L7-8: Briefly say where the information on anomalously high/low NBP is coming from (biosphere model? eddy covariance data?).

P7 L11: Is "indicated" the right word here? Do you mean "connected"?

P8 L28-31: De-compact the formulations, e.g. saying "vertical velocity w at 300hPa" (and again comma after 15N)

Fig 1a: Unclear what the inset "OCO-2 Satellite" refers to in the graphics.

Fig 5: The labelling is much too small to be readable. Also, it would be helpful to add row and column headings to the panels.