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Earth System Dynamics
Discussions

Interactive comment on "Synchronized spatial shifts of Hadley and Walker circulations" *by* Kyung-Sook Yun et al.

Anonymous Referee #1

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General Comments

"Synchronized spatial shifts of Hadley and Walker Circulations", by Yun et al., is an interesting analysis of the phase and amplitude of the time series of modes of Hadley and Walker cell circulations. However, the closest thing to a central hypothesis in the paper, ". . .that the seasonally evolving warm pool SST anomalies after the peak ENSO phase serve as a pacemaker linking the phase-synchronized special shifts in the WC and HC variability. . ." is well-established by the analyses presented in the paper, but it feels more like a summary of some of the results than a hypothesis to be tested by the analysis. Rather than aiming for a specific objective or to test a hypothesis, this paper seems more an exploration of modes of Hadley cell-related and Walker cell-related variability. As a consequence, the paper feels at times like a collection of figure panels

with a loose narrative joining them. Indeed, the discussion of the figures can be as brief as the captions themselves. Indeed, I get the feeling that there is more to discuss when looking at these figures than is discussed in the text. At other times, I feel like too much is being made of a blob of color in one figure or other. But the analysis of the synchronization of the Walker and Hadley modes (or at least the 2nd Walker Cell mode and the 1st Hadley cell mode) is interesting, and the authors make a pretty convincing case that the synchronization of these modes peaks after an El Niño – hence the above pacemaker analogy – rather than through random chance. I think the analysis of phase and amplitude was a highlight of the paper. The paper concludes with a brief discussion of the importance of synchronized shifts in explaining precipitation variability in East Asia and the South Atlantic–a discussion I found wanting. All in all, though, this was an interesting analysis of the connections between Hadley and Walker cell shifts, and this manuscript has the potential to be a great place to start for readers of ESD wanting to examine the phenomenology of such synchronization more closely.

Specific Comments

- Since the synchronized circulation induced by the SST anomalies in the warm pool is a diagonal (i.e. oriented NW-to-SH) overturning circulation, how useful do you think the Hadley Cell-Walker Cell framework is in characterizing it?

- Why use forced AMIP, CMIP, and Historical obs if you're focusing on variability? Why not use a larger dataset, like the CESM LE?

- HC1, HC2, WC2, WC2âĂŤcan you be clear about what you think each mode physically corresponds to?

- Some figures have seemingly redundant panels; Figure 2, for example, has b, c, d, and e, but they're not discussed much. It seems like b, and c show the same message as d and e. If these panels tell an interesting story, please share it. Otherwise, cut down on the number of panels to be commensurate with the text.

- How different is the global pattern of velocity potential and precip phase-synchronized HC and WC compared to other just-after-ENSO years?

- I mentioned I found the precipitation discussion wanting. Part of that may be because of weaknesses of Figure 5. The first four panels of Figure 5 all look almost the same, with very slight differences in shading between the SA and EA boxes in some panels. If you're discussing the difference, maybe show the anomalies of some panels with respect to the othersâĂŤagain, they all just look like Walker-like ink splots, and the differences inmagnitude aren't all that clear. Also, panel 5e shows the box-and-whisker plots for. . .strong AND weak points? The Strong and Weak points themselves are superimposed using color (which is muddied a bit in print). So this panel tells several different, related storiesâĂŤmore than the paper tells. And while there is a difference in the precipitation anomalies between the strong PSYN models and the weak PSYN models, it seems just as likely to me that some model physics are causing the hydrological differences and the synchronization, but that the two aren't necessarily directly related. Perhaps diabatic heating and cooling by the altered hydrology of one model, owing to its physics, produces the synchronization, rather than (as your paper posits) the other way around.

Technical Corrections

- Line 29: I would add Kris Karnauskas's 3D Hadley circulation paper to this list: Karnauskas, K.B., Ummenhofer, C.C. On the dynamics of the Hadley circulation and subtropical drying. Clim Dyn 42, 2259–2269 (2014). https://doi.org/10.1007/s00382-014-2129-1

- Line 35–36: I would change, ". . .changes during. . ." to ". . .changes, generally during. . ."

- Line 40: this question-in-a-sentence could have its syntax improved.

- Line 114: ". . .there no. . ." should be ". . .there is no. . ."

- Line 125: a bit more intro to the C-mode would be nice.

- Figure 1a, b: The font inside the figures gets small enough as to render it very hard to read in print.

- Figure 1c, d: based on the panel titles, "Interannual CC of. . .", I thought the plot was showing a running (windowed?) cross-correlation between WC2, HC1, and. . .something else. After flipping back and forth and checking the y-axis, I realized that it was showing the PC time series themselves, thereby _illustrating_ the correlation.

- Figure 2 (line 184): be clear that the COLOR of the dots specifies the absolute derivative, while the position of the dots illustrates the phase difference.

- Figure 3: the green and blue dots on red are very muddy on my printed pageâĂŤand I'm not even colorblind!

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