Response to community discussant comments from Wenyu Zhou

[Review comments in gray italic style

Our responses in Normal text style]

Nice work on intermodel comparison of the ITCZ influences. I enjoy reading the manuscript and have the following three comments.

Thank you for the compliment and for your constructive comments.

1. The investigation focuses on the annual mean. How about the effect on the seasonal timescales? Zhou et al. showed that future ITCZ contraction can induce a early-summer Hadley contraction, amid the annual-mean Hadley expansion.

The experimental design and simulations don't include an annual cycle. So what we're analyzing should be thought of as more like perpetual single season's ITCZ (an equinoctal season).

Our response to your third comment is also relevant here.

We are adding citations to Zhou et al. (2019) and Zhou et al. (2020) in the revised manuscript.

2. It may be clarified that the ITCZ width here is the annual-mean ITCZ width, which in essence reflects the extent of the seasonal migration of the ITCZ and is very different from the physical width of the ITCZ band when we view it at short (hourly, daily, monthly, and seasonal) timescales.

An original motivation and goal was to look at the distribution of precipitation intensity in the ITCZ associated with width. We had forgotten to state this particular motivation in the original draft, and will add it in the revision (see also the response to Reviewer 3). But it is why we included daily precipitation, 500 hPa vertical velocity, near-surface specific humidity, which can be useful for analyzing precipitation on these timescales. We don't request shorter than daily timescale data because we wanted to keep storage requirements down and hopefully increase potential models contributing to the full MIP.

3. The (annual-mean) ITCZ width is modified by perturbing the equatorial q-flux which changes the equatorial SST. I am thus surprised hat the paper did not mention the effect of SST pattern on the ITCZ width in the introduction (third paragraph around Line 25). As shown in Zhou et al., 2019, enhanced equatorial warming reduces the extent of the seasonal migration of ITCZ and narrows the annual-mean ITCZ width. Furthermore, the intermodel spread in the ITCZ change is largely explained by their different SST warming pattern. The SST warming pattern is a result of complex atmosphere-ocean coupled dynamics and cannot be attributed to the factors that the paper has listed.

We don't address the seasonal cycle here (see our response to Reviewer 3 for more discussion of this decision), so what this MIP would focus on is somewhat orthogonal to these findings. Also, the focus of this metric clearly projects onto annual-mean ITCZ width, but seems to be mostly focused ITCZ location on seasonal timescales.

Part of our motivation for the persistent equinox configuration with peak meridional temperatures centered at the equator, rather than off the equator (like the QOBS profile) was to isolate the variations in width from potential interactions with location.

Since our simulations use a slab ocean and have fully interactive SSTs, they would capture any thermally-coupled interactions between the ITCZ and SST, in contrast to prescribed SST simulations, which have only unidirectional effects of SSTs on the atmosphere.

We don't claim or expect this experimental design to answer all questions. But what we would hope that further work applying this experimental design and carrying out more analysis focused on specific aspects of them is deeper understanding of some of the components that constitute the complex coupled dynamics of comprehensive simulations, such as those that Zhou et al., (2019) have documented. This seems to us like it may become a good example of where making use of a hierarchy of model (configurations) could deepen our understanding of our climate.

We've added a citation to Zhou et al., (2019).

Additional References

Zhou, W., S.-P. Xie, and D. Yang, 2019: Enhanced equatorial warming causes deep-tropical contraction and subtropical monsoon shift. *Nature Climate Change*, https://doi.org/10.1038/s41558-019-0603-9.

——, L. R. Leung, J. Lu, D. Yang, and F. Song, 2020: Contrasting Recent and Future ITCZ Changes From Distinct Tropical Warming Patterns. *Geophysical Research Letters*, **47**, e2020GL089846, https://doi.org/10.1029/2020GL089846.