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Geoscientific Model Development Discussions

Interactive comment on "Boreal summer intraseasonal oscillation in a superparameterized GCM: effects of air-sea coupling and ocean mean state" *by* Yingxia Gao et al.

Anonymous Referee #2

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This study explores the role of mean SST biases in simulating the observed characteristics of BSISO. The study is carried out using a suite of numerical experiments in which an atmospheric model (SPCAM3) is configured with observed boundary forcing (uncoupled) and coupled to a mixed-layer ocean model (coupled). Each of these configurations is branched out into further configurations. The mixed-layer ocean model (MC-KPP) is first constrained to an observed climatology and then to the climatology of a coupled GCM (SPCCSM3). The boundary forcing is constructed from the SST of the two coupled simulations. Based on these experiments, the authors suggest that ocean mean state determines the skill of BSISO simulation in a coupled model. The manuscript is well written, and it is worthy of publications subject to addressing the

specific comments below.

One objective of the study is to "examine the role of [. . .] and mean state bias in the simulated BSISO using a configuration of SPCAM3 coupled to a mixed-layer ocean model". To overcome the limitations of the 1D model, MC –KPP is constrained to an ocean mean state. Please explain what the advantage is of running the new simulations and not just analyze SPCAM3 and SPCCSM3. SST biases in SPCCSM3 and SPK-SPC are very similar.

L65-66: There are other studies (e.g., Waliser et al. 1999; Bernie et al. 2005, 2007; Danabasoglu et al. 2006; Misra et al. 2008; Stan 2018) showing that air-sea coupling improves the representation of diurnal cycle, which is relevant for intraseasonal variability. This other side of the argument should also be mentioned here.

L97: Since MC-KPP must be constrained to a reference ocean climatology, some tuning is involved in this process to ensure a realistic behavior in the ocean currents. Please clarify if MC-KPP is retuned when is constrained to SPC.

L98-99: MC-KPP has some limitations for the study of air-sea coupling because atmospheric variables can be modified by horizontal advection whereas ocean surface variables cannot. Physical mechanisms involved may not be representative of what happens in observations. Please discuss this limitation.

Section 2.2 Please explain what the expected outcome for each experiment is. It's a lot of mix and match without a clear path why they are conducted.

L113: What is the resolution of the ocean model in SPCCSM3? Please add some details about the ocean model in SPCCSM3.

L117: Please explain the reasoning behind the 31-day smoothing. Why not using monthly data?

L120-121: ERAI is not the common data set used for validation of precipitation and OLR. Why this choice? Fig. 2a shows a double ITCZ feature, which is not seen in

other datasets used for validation of precipitation (CMAP, GPCP).

L127: OLR is generally viewed as a proxy of convective precipitation. This should be precipitation or OLR.

L153-154: SPK-OBS displays the “bull’s eye” feature specific to most SPCAM simulations. This feature disappeared in the SPCCSM simulations and hence was explained by the lack of coupling which would compensate for some unrealistic features caused by the periodic domain of CRM. Can the authors comment on the nature of these features in SPK-OBS, which is used as a coupled model?

L162: The SST variability in SPC is lower than in OBS because the horizontal resolution of SPC is probably much coarser than in OBS.

L169-171: Without comparing the mean state of SPK-OBS (SPK-SPC) and SPA-KOBS (SPA-KSPC) we cannot say that coupling and mean biases have a negative feedback of BSISO. This would be true only if the mean precipitation remains the same.

L175-181: Except for the southward propagation there is arguable any difference between observations and all simulations. Please revise these statements.

L198-200: Please explain what features show the delay between the suppressed convection and warm SST.

L202-204: The size of convective region is arguably different between observations and all model simulations. Please revise or show difference plots in support of a large difference.

L224: Please explain how one can use Fig. 8 (right column) to determine propagation of convection.

Section 3.4: The comparison between models and observations based on the BSISO indices can be very misleading because models can have their own BSISO with a different lifecycle than observations and this type of analysis will still consider 8 phases.

A fair comparison can be done only if the phase compositing is constructed using PC1 and PC2 of observations for models as well. Here this is not possible because SST of the coupled model does not match an observed forcing. The only relevant analysis is to compare the lag-correlation of PC1 and PC2 for MISO 1 (with the 30-60 day period) and PC3 and PC4 for the MISO 2 ($\sim$14-day period).

L300-310: The SST gradients in MC-KPP have very little physical meaning (1D ocean model) and no analysis related to SST gradients is shown in the results. How realistic it is to base the interpretation of results on the SST gradients “simulated” by MC-KPP?

Figure 1: The SST field is not an ERAI product.

Figure 8: Please add the statistical significance of regression coefficients.

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