

Anonymous Referee #2

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The paper describes and evaluates the first version of the Taiwan Earth System Model. The model is derived from NCAR's Community Earth System Model version 1.2, with specific parts being replaced and modified in order to optimize its performance for the East and Southeast Asia region.

The main value of TaiESM is thus in regional application and to serve as an ESM infrastructure that facilitates integrating national climate research efforts. In addition, there can be a broader interest in using TaiESM and its output, as its closeness to the host system provides an opportunity for studying how specific changes in model representations affect regional and global biases. In the long term, innovations developed in TaiESM may also feed back to the host model.

The description part of the paper focuses on the modifications and new innovations, which are motivated from regional precipitation deficiencies of the CESM host system. The evaluation part provides a non-exhaustive but sufficient general evaluation (model stability, global climate sensitivity, spatial surface biases etc.) and some more specific evaluation such as the diurnal cycle of precipitation. The paper offers a measured balance between highlighting the strengths of TaiESM and documenting its weaknesses.

The paper is well written and I expected it to become a key reference for further model development of TaiESM as well as inform any studies using the model or its output. It is thus well within the scope of the journal and I recommend its publication. I have only some very minor specific comments that the authors may want to consider:

Response: We thank the reviewer for the comprehensive summary and encouraging comments. Below please see our point-by-point responses. The line numbers correspond to the change-tracked manuscript.

L73-75 language suggestion: "account" -> "accounts", "for application" -> "and designed for application"

Response: Corrected. (Lines 73-35)

L107-108 "Wang et al. (2015) reported significant improvements": One could state here which model system (or at least which type of model system) Wang et al. used.

Response: CESM1.0.3 with CAM5.1 was used in their paper. This info is added to the text (Line 107).

L122-124 "where propagating convective organizations emitting from the coastline or topographical regions (Kikuchi and Wang, 2010), demonstrated as the gradual phase change in Figure 1": unclear formulation

Response: We have rewritten this and next paragraphs to make it clearer. (Lines 125-132)

L155 "grid" -> "grid box"

L156 "by two PDFs" -> "by the two PDFs"

L157 "The triangular PDF provide" -> "The triangular PDF provides"

Response: These errors are corrected. (Lines 163-166)

L164 "adapted" or "adopted" ?

Response: It is "adopted". (Line 172)

L223-224 "several microphysical properties of clouds are modified to minimize radiation imbalance": Was the TOA imbalance positive or negative before re-tuning? It could be interesting for readers to know which properties exactly were re-tuned and in which direction these were tuned.

Response: Following the reviewer's suggestion, we have added Section 2.4 to discuss more details about tuning TaiESM. (Lines 231-250)

L249 "the less imbalance" -> "the comparatively less imbalance"

Response: Done. (Line 281)

L251 "0.0088 K century⁻¹ in 500 years, which is significant": Maybe change to "is statistically significant"? The trend is very small and seems insignificant for most practical applications.

Response: Done. (Line 283)

L274-275 "In addition, the long-term mean of evaporation minus precipitation (E - P) is -1.16 mm day⁻¹, and it may also contribute to the freshening of the ocean.": I would think this is the main reason of the ocean freshening. An E-P imbalance of -1 mm/day corresponds to quite a few meters per century and it could be an idea to caution the reader (either here or in the summary section) to account for this drift when using TaiESM output for sea level studies.

Response: We thank the reviewer to point out that the value of (E-P) is too large. We deleted this sentence because there is large uncertainty in estimating (E-P). TaiESM does not directly output the amount of evaporation, and we calculated it using the surface latent heat flux. However, the magnitude of uncertainty in this calculation is probably larger than the difference between evaporation and precipitation. Therefore, we decide not to discuss the issue related to the change in global salinity here.

L290-291 "greater contribution to addition": unclear formulation

Response: "addition" is revised to "additional". (Line 322)

L293-294 "The relation between ... must be due to": Should this be "The different relation between... must be due to" ?

Response: Done. (Line 324)

L297 "with the" -> "against" ?

Response: Done. (Line 329)

L340-341 " SWCF is not as strong as that in the observational data. It indicates that polar cloud in TaiESM is too thin optically": Could sea ice/snow albedo bias potentially also contribute to weaker SWCF?

Response: We examined the bias of surface albedo over the Arctic Ocean and found that while the sea ice extent in TaiESM is lower than observation, albedo in TaiESM is larger. Therefore, it does contribute to the smaller SWCF over the Arctic Ocean in TaiESM. We have modified this sentence in Lines 372-375.

L413 "no land-sea model": What does that mean? No dynamic land ice model and/or ice shelf model?

Response: "land-sea model" should be "land ice model" and corrected. (Line 447)

L434 "." missing at end of sentence

Response: This sentence is removed.

L458 "almost similar": Do you mean "mostly similar"?

Response: Corrected. (Line 513)

Figure 1: The differences between CESM1.2.2 and TaiESM are hard to discern by eye when comparing (b) and (c). It therefore could be an idea to add another row of

panels that shows the TaiESM - CESM1.2.2 differences. Also, given that CESM1.2.2 and TaiESM use the same horizontal grid it is somewhat surprising that the regions with missing value in (b) don't match those in (c).

Response: We found that plotting the differences in precipitation peaks makes the figure quite noisy. Therefore, we have added several boxes in the figure to highlight the area with remarkable differences.

For the missing value, we masked out the areas with the amplitude of diurnal precipitation smaller than 0.8 mm day^{-1} in the original figure. To make the figure clearer, we lower the threshold to 0.5 mm day^{-1} . (Line 117)