

## ***Interactive comment on “Quantifying the contribution of anthropogenic influence to the East Asian winter monsoon in 1960–2012” by Xin Hao et al.***

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1. Although Nat-Hist and All-Hist experiment is well designed to investigate the impact of the natural forcing and anthropogenic forcing, I still suspect that whether the SST in Nat-Hist overestimate or underestimate the influence of anthropogenic forcing and induce uncertainty. Therefore, I think the author should give discuss the uncertainty and explain why there is an increase trend in EAWMI in Nat-Hist. is it reasonable?

Reply: Thank you for your comments. We processed the difference of SST forcing between the All-Hist runs and Nat-Hist runs by empirical orthogonal function (EOF) analysis as EOF1 (Fig. 1a) and associated principal component 1 (PC1; Fig. 1b). The first

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leading mode shows a long-term oceanic warming with explained variance of 91.4%, characterized by negative anomalies in high-latitude oceans of the southern hemisphere, positive anomalies in tropical oceans and mid-latitude oceans of the southern hemisphere and intense positive anomalies in the high-latitude oceans around 60°N. Figure 1c and 1d show the second leading mode of the observed SST obtained from Hadley Centre (downloaded from <https://www.metoffice.gov.uk/hadobs/hadisst/>; Rayner et al., 2003) by rotated EOF analysis. The second leading mode shows similar intensity and characteristics in the long-term oceanic warming with the response of SST to anthropogenic emissions. However, a cooling occurred in the northern Pacific and an obvious warming over Kuroshio region, which didn't capture by the models, may weaken the EAWM (Sun et al., 2016). Thus, this difference may induce an underestimation of the EAWM in Nat-Hist runs.

Previous studies indicated that the Atlantic multidecadal oscillation (AMO) and Pacific decadal oscillation favor a low-frequency variability of the EAWM, and that is the EAWM is weakened (enhanced) during the warm (cold) phase of the AMO/PDO (e.g., Li and Bates 2007; Ding et al., 2014; Hao and He, 2017). As shown in Fig. 2 (in paper), an obviously increasing in EAWMI during 1960-1980 in Nat-Hist runs. During 1960-1980, both the PDO (downloaded from <http://research.jisao.washington.edu/pdo/PDO.latest.txt>) and AMO (Trenberth and Shea, 2006) were in a cold phase (Fig. 2), leading an enhanced EAWM. However, the PDO and AMO were out-of-phase after 1980s. Thus, we consider that the AMO and PDO may be responsible for the increase trend of EAWMI in Nat-Hist runs.

2. Line 186-187 and Fig. 5, “the case with the normalized index larger than 1.0 (smaller than -1.0) is defined as a strong (weak) EAWM event” but why the situation with zero weak event exist? I think may be due to “Note that the time series of the EAWM indices base on outputs of model in the Nat-Hist runs are standardized by the climatology simulated by the All-Hist runs.” (the Line 435-436). This operation induce the averaged value of EAWMI in Nat-Hist is a positive value, so there is zero weak event. I think the

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author should explain why should be standardized EAWMI in Nat-Hist by the climatology of All-Hist. If standardized by itself climatology, does the conclusion of strong event decrease 45% also exist?

Reply: Thank for your comments. The climatology of the EAWM in the All-Hist runs is very close to the results of reanalysis data, but larger than the climatology in the Nat-Hist runs. It would be more reasonable that the strong/weak events are defined on the same standard, so the EAWMI in the Nat-Hist runs are standardized by the climatology simulated by the All-Hist runs.

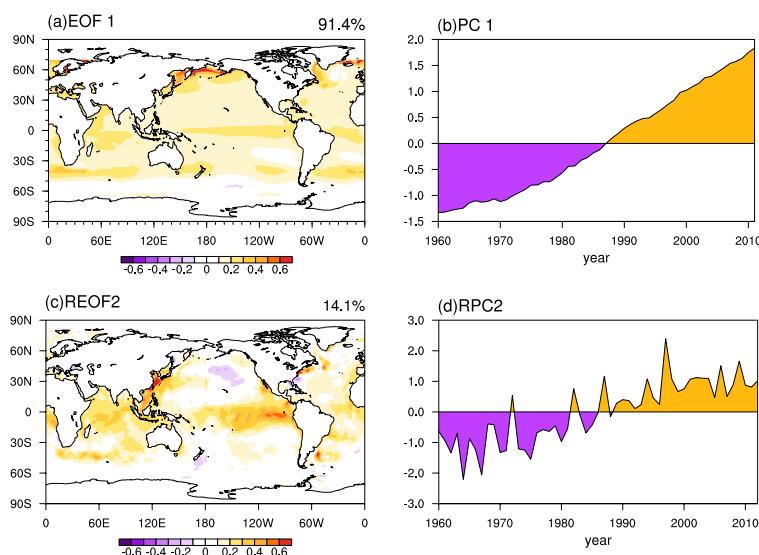
Minor Comments:

1. Line 420, should be “(b), (d) as in (a), (c)”, and the title in Fig. 1d should be “Model-HGT” 2. Line 179-181, “an increase of SLP in the high-latitude East Asia” is contract with “the change of SLP also indicate a weak decrease of the Siberian high and an intensified Aleutian low.”, Based on the fig. 4c, the latter should be right.

Reply: Thank you for your comments. We have revised the mistakes.

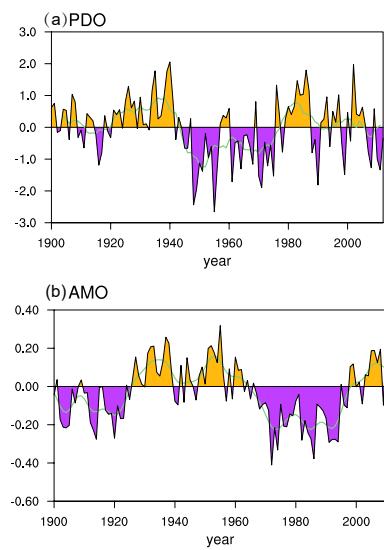
Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2019-99>, 2019.

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**Fig. 1.** The first leading mode (EOF1; a) and associated principal component (PC1; b) of the difference of the winter-mean sea surface temperature forcing between the All-Hist runs and Nat-Hist runs by empiric

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**Fig. 2.** Time series of the Pacific decadal oscillation (PDO; a) and Atlantic multidecadal oscillation (AMO; b) during 1960-2012.

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