We thank Liu et al. (2019) for the discussion. After careful reading of their objections to the Shen et al. (2018) work, we think that the Shen et al. (2018) work is correct and we do not agree with the Liu et al. (2019) objections.

Based on Figure S3 of Pendergrass et al. (2018), CMIP5 models can in general capture the wintertime RH trends during 1973-2016. We acknowledge that the uncertainty could be large on a smaller, regional scale as in Beijing. We do not include data prior to 1973 due to the large amount of missing data in in-situ meteorological observations. This is the reason that the HadISDH dataset (Smith et al., 2011; Willett et al., 2014) only provides data after 1973 (https://www.metoffice.gov.uk/hadobs/hadisdh/). Now we re-plot the Figure S3 of Pendergrass et al. (2018) but with a larger ensemble of 26 CMIP5 models, and we find that our conclusion still holds. We also plot the trends for 1960-2017 in CMIP5 models, and the spatial pattern does not change.

$PM_{2.5}$ concentrations are noisier on the daily scale, so it is not surprising to find that the daily correlation with meteorology is smaller than the monthly one. Also, the daily correlation of $PM_{2.5}$ with the haze weather index used by Cai et al. (2017) is 0.60, even smaller than the correlation Shen et al. (2018) found with PC1 ($r = 0.68$).

Liu et al (2019) still argues that the use of PC1 should not exclude the use of other proxies. But in fact in our last reply, we made clear that Shen et al. (2018) considered all variables used in Cai et al. (2017) and Zou et al. (2017). Shen et al. (2018) also discussed why we did not ultimately use zonal wind at 500 hPa (U500) and the temperature gradient between 850 and 250 hPa to infer future trends of $PM_{2.5}$ (Figure S11 and Section 5).

The extreme value model is more suitable for studying extreme events, as is well accepted in many previous studies (Coles, 2001; Rieder et al., 2013; Shen et al., 2016). The study of Pendergrass et al. (2019) was peer-reviewed, so in our view Liu et al. should give detailed reasons if they think this work is debatable.

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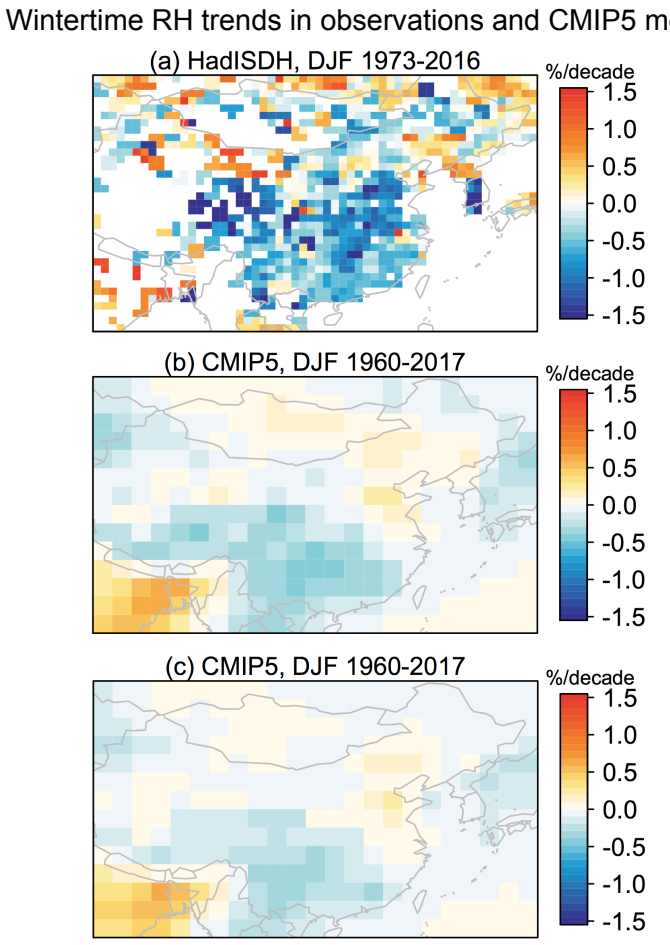

Figure 1. (a) Linear trends in observed RH from 1973 to 2016, calculated from the gridded monthly mean RH dataset HadISDH. This data is produced by the Hadley Centre for Climate Prediction and Research and is available online (https://www.metoffice.gov.uk/hadobs/hadisdh/). (b) The average of linear trends in CMIP5 simulations of ground-level RH over China in the same time period. Historical simulations are used for 1973-2005 and RCP4.5 simulations are used for 2006-2016. This panel is same as Figure S3 of Pendergrass et al. (2018) except it uses a larger ensemble of 26 CMIP5 models here. These models are ACCESS1-0, ACCESS1-3, BCC-CSM1-1, BNU-ESM, CCSM4, CNRM-CM5, CSIRO-Mk3, CanESM2, GFDL-CM3, GFDL-ESM2G, GFDL-ESM2M, GISS-E2-H, GISS-E2-R, HadCM3, HadGEM2-CC, HadGEM2-ES, INM-CM4, IPSL-CM5A-LR, IPSL-CM5A-MR, IPSL-CM5B-LR, MIROC-ESM-CHEM, MIROC-ESM, MIROC5, MRI-CGCM3, NorESM1-ME, NorESM1-M. (c) Same as (b) but for 1960-2017.