Temporal Evolution of the Long-Term Distributional Biases of Climate Models as a Parameter for the Regional Evaluation of the Simulation of Climate Change

*Martin Gomez-Garcia[1], Akiko Matsumura[1], Shiro Hishinuma[1], Daikichi Ogawada[1]

1. Nippon Koei Co. Ltd., Reasearch and Development Center

Owing to the climate variability of the General Circulation Models (GCM), the discrepancy between their outputs and observational datasets at scales that range from hours to years is practically random. Thus, the associated errors need to be evaluated in terms of the long-term (multidecadal) distributional properties of the atmospheric variables. A recently developed bias-correction method corrects the systematic errors (i.e., biases) in the climate mean state and in three distributional measures of the daily and the interannual variability (namely the frequency of extremes, the skewness, and the scale of the variable at each timescale). The adjustment of these biases is done in such a way that the corrections at one timescale do not affect the probability distribution at another. Therefore, this bias-correction method is able to preserve the GCM-simulated climate trends and extensively reproduce the long-term frequency of the observed extreme weather (e.g. 98th percentile of wet days, maximum seasonal mean of surface temperature).

Generally, the bias-correction of GCMs faces the challenge of including the simulated changes of climate, which supposes alterations in not only the mean but also other aspects like the skewness and the frequency of extremes. The abovementioned bias-correction method includes the effect of the simulated climate change in the correction of the distributional biases. However, considering the coarse resolution of the GCMs and the imperfections in the parameterizations of the subgrid physical processes, the fundamental assumption that the distributional biases are predictable (i.e., stationary) is made.

In this study, we explored the possibility of evaluating the sensibility with which GCMs simulate the response of the earth-system components to external forcing (i.e., climate change) by comparing the temporal evolution of the distributional biases at different timescales over specific regions. For the short period in which the observed data was available, our results revealed that many CMIP5 GCMs are indeed able to simulate with a quasi-stationary bias the changes caused by climate change. Moreover, being able to identify the regions in which certain models do not show the errors with a systematic behavior in either the climate mean state, the daily variability or the interannual variability can be useful for the further development of climate models. We expect that with the data of the GCM outputs of the future phases of the CMIP project, the period in which the observed and the modeled data coincide becomes longer and, thus, our conclusions can be supported by more robust evidence.

Keywords: Bias correction of GCMs at different timescales, Climate trends and climate variability, Evaluation of the ability of GCMs to simulate climate change