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A Comprehensive Evaluation for the Mean State of Atmospheric Circulation in CMIP5 Models over East Asia

Can Zhao (1,2), Zhihong Jiang (1), and laurent Li (2)

(1) Key Laboratory of Meteorological Disaster of Ministry of Education, Collaborative Innovation Center on Forecast and Evaluation of Meteorological Disaster, Nanjing University of Information Science and Technology, Nanjing, China, (2) Laboratoire de Meteorologie Dynamique, University Pirre and Marie CURIE, Paris, France

The mean state of atmospheric circulation (MSAC) is a basic aspect for evaluating models performance. MSAC obtained from a reanalysis dataset over East Asia during 1961-2005 is used to evaluate simulations of 39 climate models from Coupled Model Intercomparison Project phase 5 (CMIP5) with a set of quantitative performance metrics. Five atmospheric fields (AFs), in terms of their geographic distribution in a domain, are evaluated, including sea level pressure (SLP), zonal (U850) and meridional (V850) wind at 850hPa, geopotential height at 100hPa (Z100) and 500hPa (Z500). Furthermore, five atmospheric centers of action (ACAs) are evaluated, including the Mongolian High (MH), Aleutian Low (AL), India Low (IL), Western Pacific Subtropical High (WPSH) and South Asia High (SAH). All of them play an important role in climate anomalies over East Asia. But they have rarely been assessed in previous studies. Winter and summer are considered separately in the evaluation procedure. Closed-Circulation-System Indices (CCSI), including the center position (λ_c,θ_c), intensity P and coverage area S, are used to describe ACAs. Models' systematic bias is taken into account in the evaluation. Results show that CMIP5 models have a general good performance in simulating AFs and ACAs, but with systematic biases, which manifests as insufficient intensity for both high- and low-pressure systems. Models' performance shows a good consistency between winter and summer, with a correlation coefficient of 0.84, calculated with the comprehensive ranking metrics M_R. Although there is a basic consistency between simulated AFs and ACAs, models performance in their simulation shows some difference. In addition, models have poor consistency in simulating ACAs' center position and intensity. They show little agreement in the simulation of MSAC and extreme events. Despite the inconsistency, some models do consistently rank high or low for many aspects examined in the study. Overall, five leading performances in winter are from CNRM-CM5, CCSM4, CanESM2, BCC-CSM1.1 and the MME. While in summer they are from CCSM4, NorESM1-M, CESM1-CAM5, the MME and BNU-ESM. Results can have implications in choosing preferred CMIP5 models for climate projection and constructing better statistical downscaling model in the study of regional climate projection.