Projecting the spatial-temporal trends of extreme climatology in South Korea based on optimal multi-model ensemble members

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Abstract

Extreme climate events can have a large impact on human life by hampering social, environmental, and economic development. Global circulation models (GCMs) are the widely used numerical models to understand the anticipated future climate change. However, different GCMs can project different future climates due to structural differences, varying initial boundary conditions and assumptions about the physical phenomena. The multi-model ensemble (MME) approach can improve the uncertainties associated with the different GCM outcomes. In this study, a comprehensive rating metric was used to select the best-performing GCMs out of 11 CMIP5 and 13 CMIP6 GCMs, according to their skills in terms of four temporal and five spatial performance indices, in replicating the 21 extreme climate indices during the baseline (1975−2017) in South Korea. The MME data were derived by averaging the simulations from all selected GCMs and three top-ranked GCMs. The random forest (RF) algorithm was also used to derive the MME data from the three top-ranked GCMs. The RF-derived MME data of the three top-ranked GCMs showed the highest performance in simulating the baseline extreme climate which was subsequently used to project the future extreme climate indices under both the representative concentration pathway (RCP) and the socioeconomic concentration pathway scenarios (SSP). The extreme cold and warming indices had declining and increasing trends, respectively, and most extreme precipitation indices had increasing trends over the period 2031−2100. Compared to all scenarios, RCP8.5 showed drastic changes in future extreme climate indices. The coasts in the east, south and west had stronger warming than the rest of the country, while mountain areas in the north experienced more extreme cold. While extreme cold climatology gradually declined from north to south, extreme warming climatology continuously grew from coastal to inland and northern mountainous regions. The results showed that the socially, environmentally and agriculturally important regions of South Korea were at increased risk of facing the detrimental impacts of extreme climatology.

Keywords : performance evaluation, GCM ranking, multi-model ensemble, climate extremes, trend analyses

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