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Regional climate experiment in the central mountainous area of Japan

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The mountainous area of the central Japan has a steep and complicated terrain. In the area, huge amount of snowfall is produced in winter season. The snow affects those of vegetation and ecosystem etc. However, the distribution of snow is too difficult to quantify because the number of observation stations is few especially in higher elevation area. The distribution data of precipitation created by radar and rain-gage data show unrealistic pattern. On the other hand, numerical simulations using cloud resolving atmospheric models are recently significantly developing, and reproducibility of simulated precipitation with small grid size become higher in recent. Therefore, it is considered that the simulated results are beneficial to understand the distribution of precipitation. We performed regional climate numerical simulation for the present and future climate with the target of mountainous area of the central Japan and Kanto region. WRF version 3.4 was used as a regional climate model (RCM). Grid sizes of simulations are 24, 6, and 2km. In the present climate simulation, an objective analysis data ERA-Interim (ANAL) was used as the lateral boundary data of RCM simulation. In the future climate simulation, mean climatological differences estimated by GCMs were added to ANAL as the lateral boundary data. This approximated method of RCM simulation is called as the pseudo-global-warming (PGW) method developed by Kimura and Kitoh (2007). In this experiment, mean climatological difference of four CMIP-3 GCMs (csiro_mk3_0, gfdl_cm2_1, miroc3_2_hires, and mri_cgcm2_3) were used. Target period of future climate is the end of 21th century. The climatological variables were calculated by 32 years run. Noah-LSM scheme including single layer snow was used as land surface model.

In the present climate simulation, snow depths in the mountainous area were validated by observation data of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the Japan Meteorological Agency (JMA). The reproducibility of snow depths showed a large variation. However, the simulated snow depth roughly reproduced the observations. In particular, reproducibility of 2-km run was better than that of 6-km run. The characteristic of snow distribution showed realistic pattern especially for 2-km run.

In the future climate simulation, climate change of snow depth was analyzed. Figure shows (a) maximum snow depth in the present climate and (b) climatological change ratio of maximum snow depth. We found that decreases of the snow depth caused by the global warming estimated around 3 K was significant in the surrounding area of high elevation mountains. In the future climate, the frequency of snowfall (rainfall) was projected to decrease (increase) in the lower elevation area due to the global warming. Meanwhile, Changes in snowfall amount in the higher elevation area were projected to be small. In addition, the end date of snow was projected to be delayed from 10 to 35 days. In particular, the delay was significant in the higher elevation area and in the lower elevation area faced to the Sea of Japan.

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