Prediction of Future Rainfall Variations after global warming in the Kyushu Island by Large Ensemble

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Introduction

According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Report, Humanand activity continues to affect the Earth's energy budget through changes in land surface properties and changes in atmospheric concentrations caused by emissions of gases and aerosols that are important in thermal radiation. Therefore, it is highly probable that extreme rainfall will increase in the future. In order to evaluate the impact of global warming on precipitation and to formulate efficient and effective flood adaptation measures, it is essential to predict climate change and quantitatively evaluate the uncertainties involved. The recently developed ensemble climate prediction database (database for Policy Decision making for Future climate change, hereafter d4PDF), which contributes to global warming countermeasures, can statistically evaluate the frequency and intensity of precipitation by performing a number of ensemble experiments. This study focuses on the Kyushu region (Figure 1), where many flood disasters have already occurred, and examines the characteristics of rainfall change after warming using d4PDF.

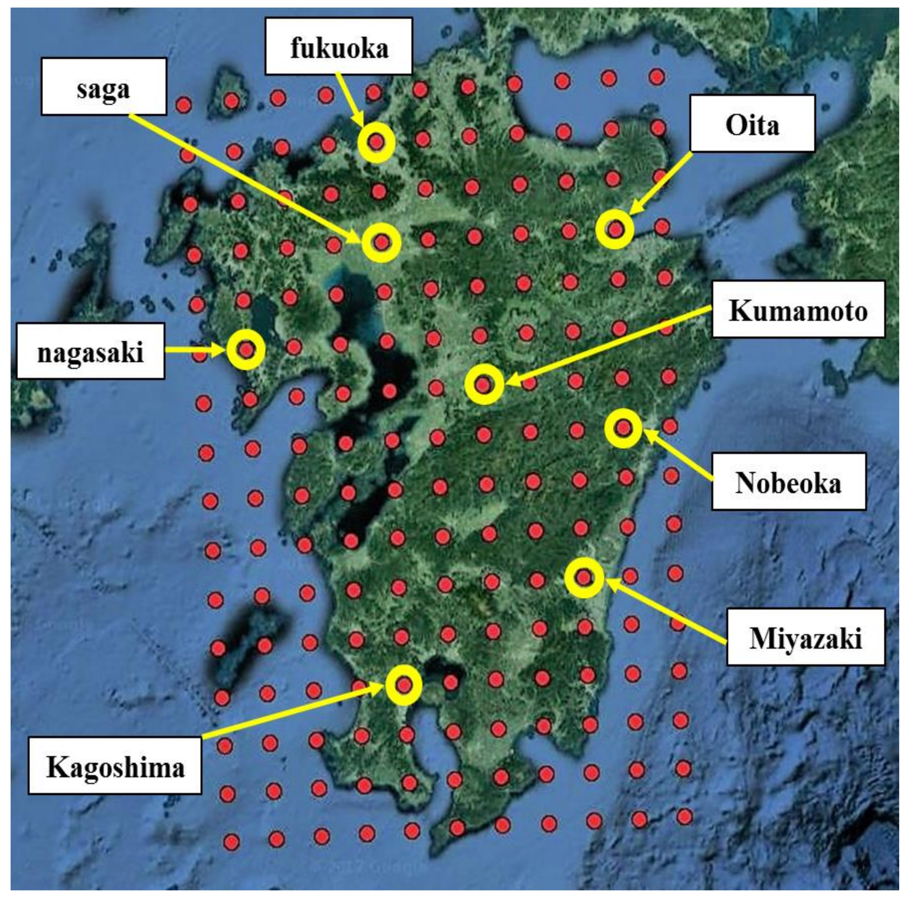


Figure 1. Analysis target area

Data and method

d4PDF consists of a global experiment using the Meteorological Research Institute Global Atmosphere Model MRI-AGCM3.2 with a horizontal resolution of about 60 km and a regional experiment using the Meteorological Research Institute Regional Climate Model NHRCM with a horizontal resolution of about 20 km. In this study, analysis was performed using the results of the latter regional experiment covering Japan.

We used four datasets from d4PDF: (1) past experimental data (2500 years), (2) 2 ℃ rise experiment data (3240 years), (3) 4 ℃ rise experiment data (5400 years), and (4) actual measurement data from the Meteorological Agency AMeDAS. The past experimental data is a data set obtained from experiments reproducing past climates, the 4 ℃ rising experimental data is a data set obtained from experiments expressing a climate in which the global average surface temperature rose 4 ℃ compared to before the Industrial Revolution, The experimental data of 2 ℃ rise is a data set obtained from an experiment expressing a climate in which the global average surface temperature rises 2 ℃ compared to before the Industrial Revolution.

Results and discussions

1. Verification of model bias

Verification of model bias by creating a histogram of 1 hour (5mm increments) and 48 hours annual maximum precipitation (25mm increments) of d4PDF past experimental data closest to each observation point at 92 points in the Kyushu region was performed. As a result of verification at all points, it was thought that the trend was generally represented in the Kyushu region, and only the result of Maehara, Fukuoka prefecture is shown in Figure 2 and Figure 3. The line graph drawn by the blue line shows the past experimental data, and the bar graph drawn by the blue line shows the measured data of the Japan Meteorological Agency. From Figure 2, it can be seen that 1 hour annual maximum precipitation differs greatly between past experiments and measured data, and that the measured data has higher intensity precipitation more frequently. On the other hand, from Figure 3, it can be seen that for the 48 hours annual maximum rainfall, high intensity precipitation occurs more frequently in the measured data, but the bias is relatively small. In the future, it is necessary to correct the bias when assessing the specific flood risk.

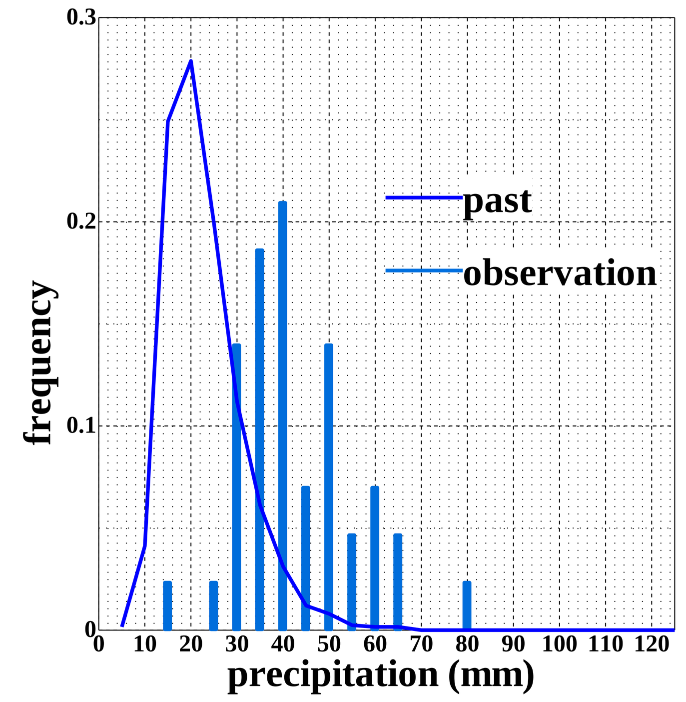


Figure 2. 1-hour maximum precipitation in Maebara

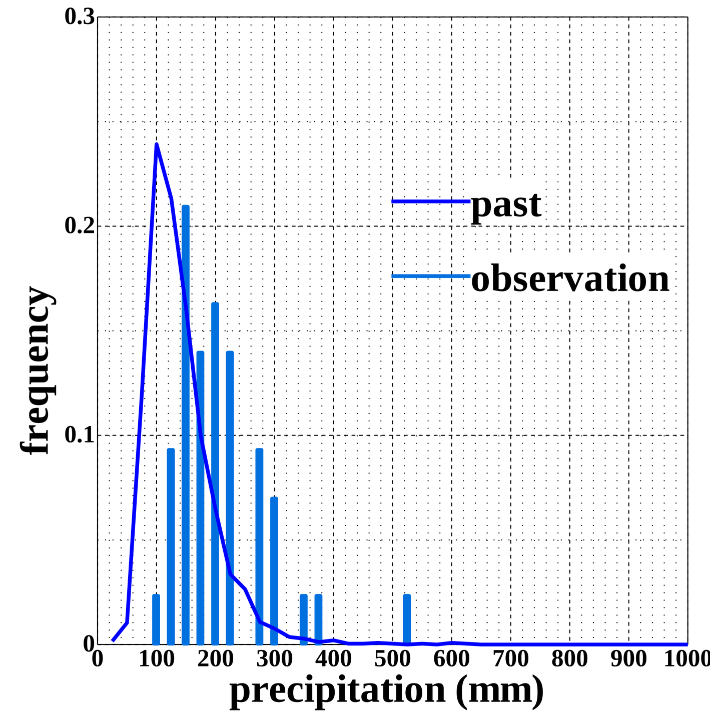
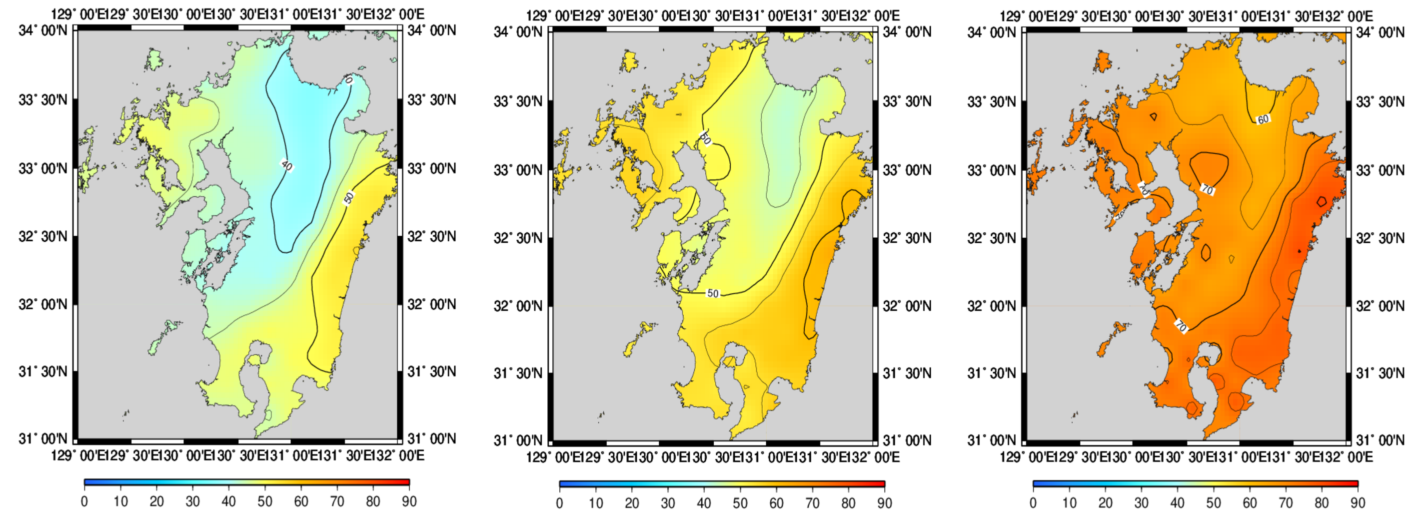


Figure 3. 48-hour maximum precipitation in Maebara

2. Future change in annual maximum precipitation with a recurrence interval of 50 years

By applying the Gev distribution to all ensemble data at 176 points in the target area, the spatial distribution and change characteristics of the annual maximum rainfall at a recurrence interval of 50 years were verified. From the results, the maximum rainfall for 1 hour and with 50-year probability was calculated.



(a) Past experimental data (b) 2℃ experimental data (c) 4℃ experimental data

Figure 4. Future change of 1-hour maximum precipitation

Figure 4 (a), (b) and (c), it can be confirmed that as the global warming progresses, the color changes from cool to warm and the precipitation increases.

Conclusion

✔The model bias was confirmed in d4PDF data by comparison with the measured data.

✔It was found that the annual maximum hourly rainfall increased throughout Kyushu as the temperature increased due to the effects of global warming.