Session: C39 Poster: TH162A

Projection of changes in future weather extremes using super-high-resolution global and regional atmospheric models in the KAKUSHIN program

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The future change in weather extremes is projected using a 20-km mesh global atmospheric model in order to contribute to decision-makings for the disaster prevention under the global warming environment in the near future (2030s) and at the end of the 21st century under the Innovative Program of Climate Change Projection for the 21st Century (KAKUSHIN Program) funded by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The model has been developed based on the current Japan Meteorological Agency (JMA) operational global model for daily weather and typhoon forecasts. A high-resolution model is vital to project reliable and possible future changes in tropical cyclone intensity. The 20-km model is the highest among that of the state-of-the-art global climate models in the world, leading to accurate future projections of tropical cyclone intensity. For the present climate simulation, we have used the observed monthly sea surface temperature (SST) and sea-ice concentration dataset during 1979-2003. For the future climate, we have performed the time-slice 25-year simulation corresponding to the near future (2015-2039) and the end of the 21st century (2075-2099). The boundary SST and sea-ice in the future were estimated by using CMIP3 multi-model data under the A1B emission scenario. The reduction in the global tropical cyclone frequency is found, but the regional tropical cyclone frequency change is sensitive to SST distribution pattern. On the other hand, frequency of strong tropical cyclone will increase. There will be a 40%~60% increase in precipitation and a 15%~20% increase in surface wind speeds within 100 km radius of the tropical cyclone center. Information on the uncertainty of future projection is significant for any decision-making processes, and the ensemble technique using the global 60-km model version is used for such a purpose. Downscaling with 5-km and 1-km cloud-resolving models can reproduce local extreme rainfall events realistically and project their future changes. For an example, the downscaling over Japanese summer rainy season indicates an increase in frequency of extreme events over 120 mm/day by more than 25%. These data are also used for various application studies on disaster prevention in collaboration with other national institutes and universities. In particular, changes of disaster environment regarding landslide, debris flow, flood, drought, storm surge and strong wind are being evaluated. Cooperation is extended internationally, including the adaptation studies in monsoon Asia and in Latin America and Caribbean regions.