In estimates of climate sensitivity obtained from global models, the need to represent clouds introduces a great deal of uncertainty. To address this issue, approaches using a high-resolution global non-hydrostatic model are promising: the model captures cloud structure by explicitly simulating meso-scale convective systems, and the results compare reasonably well with satellite observations. We review the outcomes of the recent studies aimed at reducing the uncertainty in climate models due to cloud processes using a global non-hydrostatic model (Satoh et al. 2018). In our studies, we use the non-hydrostatic icosahedral atmospheric model (NICAM) to study cloud processes related to climate change. NICAM performs numerical simulations with much higher resolution (about 3.5, 7, or 14 km mesh) than conventional global climate models (GCMs) using cloud microphysics schemes without a cumulus parameterization scheme, which causes uncertainties in climate projection.

We mainly had three research targets: analyzing cloud changes in global warming simulations with NICAM with the time-slice approach; sensitivity of the results to the cloud microphysics scheme employed; and evaluating circulation changes due to global warming. We had implemented a double-moment bulk cloud microphysics scheme and evaluated its results using satellite observation and large-eddy simulations, as well as comparing it with a bin cloud microphysics scheme. The future projection simulations show in general an increase in high cloud coverage, contrary to results with other GCMs. Changes in cloud horizontal-size distribution and structures of tropical/extratropical cyclones can be discussed with high resolution simulations.

As highlights of recent studies, we also describe results from the coordinated program called DYAMOND and RCEMIP (Wing et al. 2018; Ohno and Satoh 2018).

References:

DYAMOND: https://www.esiwace.eu/services/dyamond

