A065 High resolution Earth system modeling on large supercomputers

Nonhydrostatic Icosahedral Atmospheric Model (NICAM) studies on the supercomputer Fugaku: Challenges and next directions

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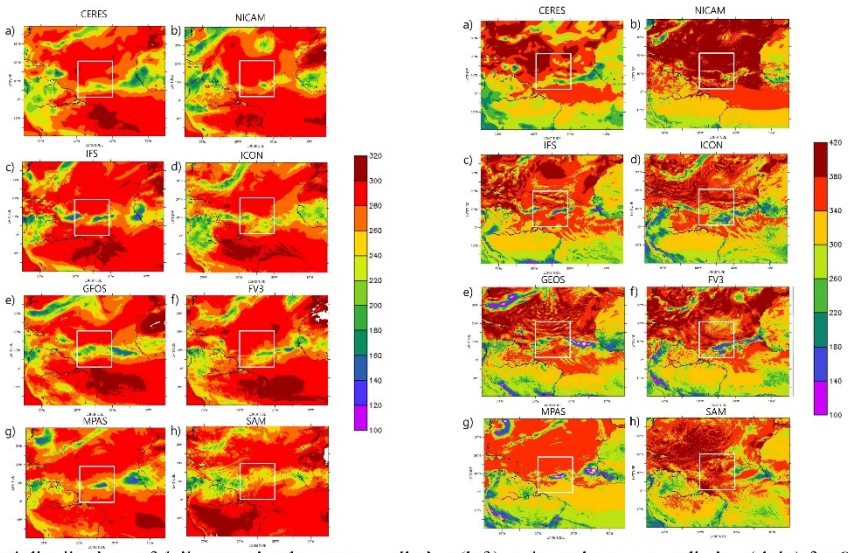
NICAM (Nonhydrostatic Icosahedral Atmospheric Modeling) has been used to conduct global storm resolving simulations with a mesh size of O(km) over the globe (Satoh et al. 2017). Using the supercomputer “Fugaku”, we explore studies in the following directions: 1. Large-ensemble simulations (1000 members), 2. longer-duration simulations (100

years: HighResMIP; Kodama et al. 2021), 3. higher-resolution simulations (less than a kilometer dx; Miyamoto et al. 2013), 4. high-resolution atmosphere-ocean coupled model simulations (atmosphere 3.5 km × ocean 0.1 deg: NICOCO; Miyakawa et al. 2017), and 5. large ensemble data assimilations with NICAM-LETKF (Yashiro et al. 2020). In this talk, we first review the current activities of NICAM on Fugaku.

As the most uncertain component of atmospheric models in general, we intercompared the cloud properties of the DYAMOND simulation data (Stevens et al. 2020; Roh et al. 2021). We found that the domain averaged outgoing long-wave radiation is relatively similar across the models, but the net shortwave radiation at the top of the atmosphere shows significant differences among the models (Figure). The vertical profiles of cloud concentration are widely divergent among models, and cloud water content exhibits larger intermodel differences than cloud ice. This result implies more focused evaluations of clouds are required for improving the global storm resolving models. The forthcoming satellite "EarthCARE" (Illingworth et al. 2015) provides a comprehensive dataset for cloud evaluations of atmospheric models, particularly by the first cloud Doppler radar from space. We present possible strategies for the new era of satellite collaboration studies with global storm resolving models.



Horizontal distributions of daily outgoing longwave radiation (left) and net shortwave radiation (right) for CERES (a), NICAM (b), IFS (c), ICON (d), GEOS (e), FV3 (f), MPAS (g), and SAM (h) on the 11th Aug. 2016. The unit of contour is $W \cdot m^{-2}$. The white box is the analysis domain. After Roh et al. (2021).

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Plain-Language Summary (Optional)

NICAM (Nonhydrostatic Icosahedral Atmospheric Modeling) is a global storm resolving model which runs a mesh size of O(km) over the globe. Using the supercomputer “Fugaku”, we have conducted computational intensive studies. In this talk, we first review the current activities of NICAM on Fugaku.

As the most uncertain component of atmospheric models in general, we analyzed the cloud properties of the simulation data by the intercomparison project of global storm resolving models (DYAMOND). We found that the vertical profiles of cloud concentration are widely divergent among models, and cloud water content exhibits more significant intermodel differences than cloud ice. This result implies more focused evaluations of clouds are required for improving the global storm resolving models, such as using the dataset of the forthcoming satellite “EarthCARE” .