Contribution ID: **6** Type: **Invited Talk**

# Development of a global large-eddy simulation model by the Nonhydrostatic Icosahedral Atmospheric Model (NICAM)

*Wednesday 9 October 2024 12:30 (30 minutes)*

We introduce numerical techniques and physical implementation for the development of a global large-eddy simulation model by the Nonhydrostatic Icosahedral Atmospheric Model (NICAM). NICAM has been studied for global kilometer-scale simulations since the first global 3.5-km mesh aqua-planet simulation by Tomita et al. (2005). Miyamoto et al. (2013) conducted a global 870-m mesh simulation using the K computer in Japan. Using the supercomputer Fugaku, we conducted a global 220-m mesh simulation. The model with this horizontal mesh scale is in the range of large eddy simulation (LES) for specific types of flow fields, including deep convection (Brian et al. 2003), although a higher resolution of O(10m) is ideal for more general purposes of LES.

To enable NICAM to function as a global large-eddy simulation model, we introduced the Smagorinsky-type LES scheme for turbulence. We also applied a smoother grid modification method by a transfer function based on Iga and Tomita (2014) instead of the spring dynamics and introduced several numerical stabilizations and less computationally demanding methods, such as using single precision arithmetic. We conducted the NICAM simulations for the horizontal mesh ranging from 220 m to 3. 5 km to analyze the resolution dependency and the turbulence scheme dependency between the eddy-diffusivity (Mellor-Yamada) type scheme and the Smagorinsky scheme. Additionally, we applied the satellite simulator, the Joint Simulator for Satellite Sensors, to the simulation results to compare with the recently launched satellite EarthCARE (Roh et al. 2024).

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**Primary author:** SATOH, Masaki (AORI, The University of Tokyo)

**Co-authors:** Dr MATSUGISHI, Shuhei (Atmosphere and Ocean Research Institute, The University of Tokyo); Dr OHNO, Tomoki (Atmosphere and Ocean Research Institute, The University of Tokyo); Dr ROH, Woosub

**Presenter:** SATOH, Masaki (AORI, The University of Tokyo)

**Session Classification:** Pushing the Frontier of Atmospheric Modelling