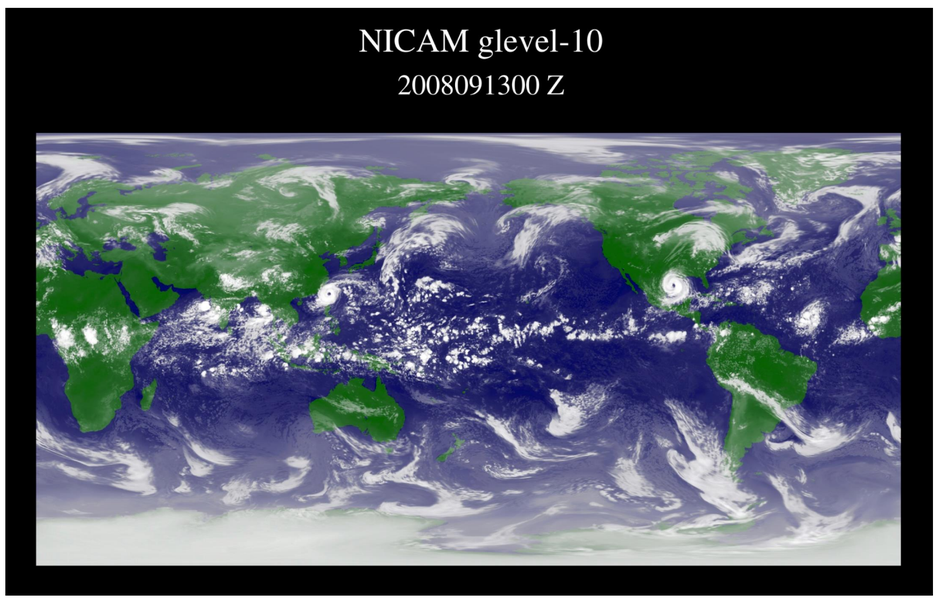
Division of Global Environmental Sciences

Simulation of Atmospheric General Circulation by Global Cloud Resolving Model, NICAM



NICAM (Nonhydrostatic ICosahedoral Atmospheric Model) is able to reproduce the multi-scale cloud systems realistically, cumulus convection, Tropical cyclones, Arctic cyclones, the Madden–Julian Oscillation (MJO), and Intertropical Convergence Zone (ITCZ).

In Fig. 1, NICAM with glevel-10 (7-km horizontal resolution) well simulates Typhoon Shinraku near the Philippine Islands and Hurricane IKE near the Gulf of Mexico.

Fig. 1: Numerical simulation of the general circulation of the atmosphere produced by 7-km resolution NICAM.

Development of LES Model for thermal environment at city scale

Our group has been developing a Large Eddy Simulation (LES) model for urban environment. The main features of the model include (i) Building resolving, (ii) Roadside trees are resolved in vertical direction, (iii) Multiple reflections of short- and long-wave radiation between buildings and trees by radiosity method, (iv) resolving shadows from buildings and trees, and (v) incorporation of cloud physics and atmospheric radiation models. Numerical simulation of thermal environment around Tokyo station was conducted using Oakforest-PACS supercomputer. The total number of grid points is about 100 million.

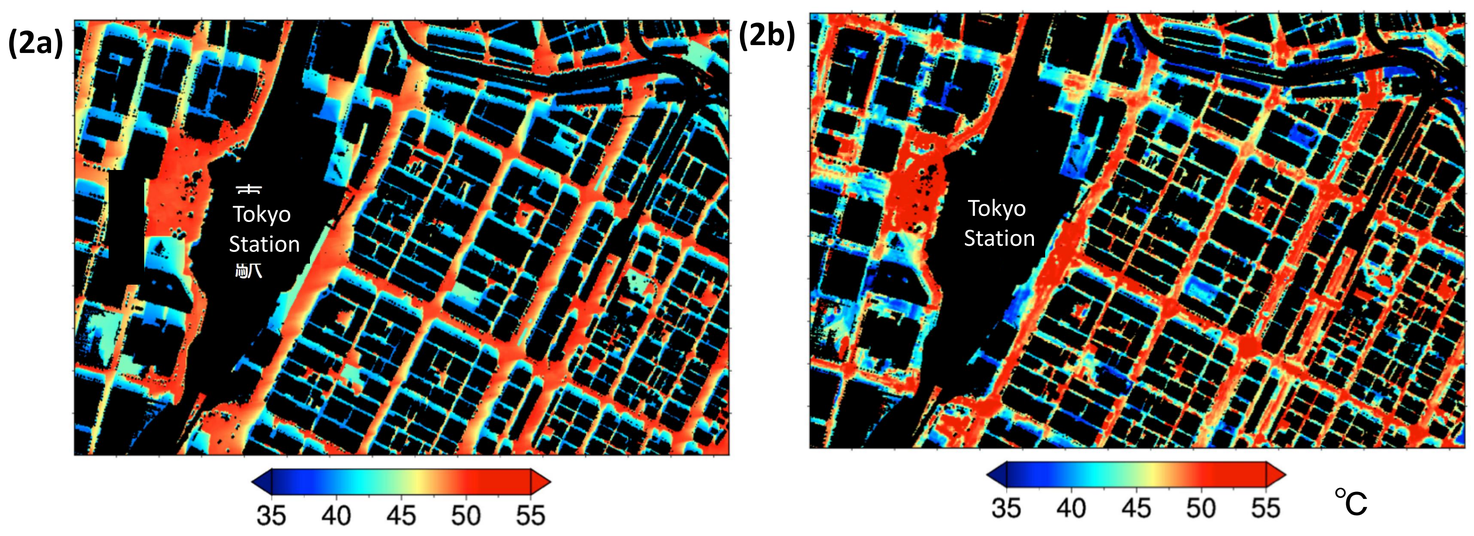


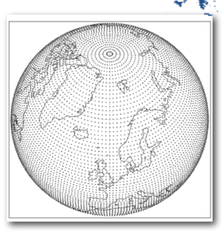
Fig. 2: Road skin temperature distribution estimated by the CCS-LES model (2a) and helicopter observation (2b). Black indicates buildings.

Hurricane forecast using an operational numerical weather prediction model

ECMWF OpenIFS

A easy-to-use version of Integrated Forecast Systems (IFS) operated at ECMWF (European Centre for Medium-range Weather Forecasts).

- Hydrostatic global spectral model
  (max resolution T1279: about 14km grid interval)
- Reduced Gaussian Grid
- Hybrid MPI-OpenMP scheme
  (Non-GPU, Non-FPGA)



Experimental settings

Version	cy40r1 (ECMWF, 2014) operational ver. in 19 Nov. 2013 - 11 May 2015
Initial condition	Atmosphere: GFS high-res analysis Land & Sea: ERA5 reanalysis
Model resolution	T639 L91 (32km grid spacing on the equator and 91 vertical levels)
Forecast length	240 hours (960 time steps with dt =900 s)
Computer	
Parallelisation	256 MPI procs (16 nodes * 16 procs/node) 4 OpenMP threads/process

Results - forecast of Hurricane Joaquin (2015) -

The experimental result showed a cyclone track similar to the NCEP control forecasts (thick line), suggesting that the initial conditions had a larger impact on the track forecast than NWP models in this case.

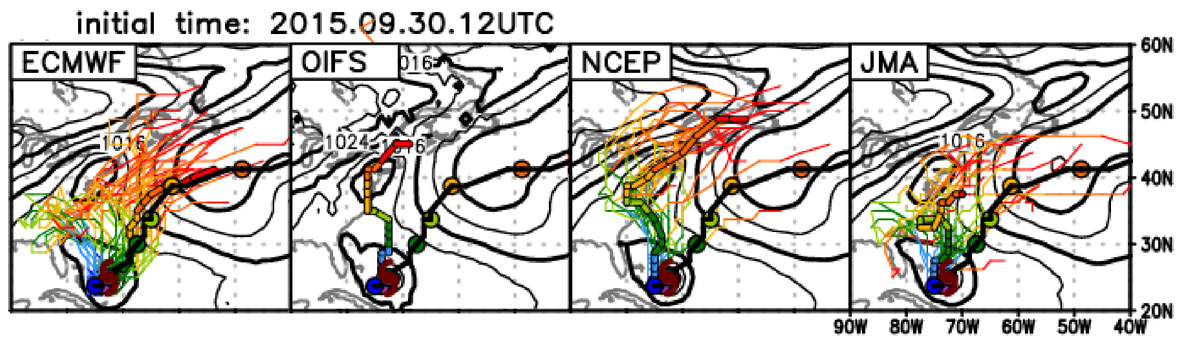


Fig. 3: Predicted cyclone tracks of Hurricane Joaquin (coloured lines) by ECMWF (Europe, left), the OpenIFS experiment (second left), NCEP (US, second right) and JMA (Japan, rightmost). Black lines shows observed track.

Remark

Computation time have decreased by 40% with Intel MKL Library in comparison with LAPACK.

Computation Time	3:12:38 (19 minutes for 1 day forecast)
Data size of output	9.9 GB