Computational Climate Science Research Team

1. Team members

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2. Research Activities

Our research team conducts the pioneering research work to lead the future climate simulation. In order to enhance the reliability of climate model more, we have aimed to construct a new climate model based on the further theoretically physical principles. Conducting such a new model needs tremendously large computer resources. Therefore, it is necessary to design the model to pull out the capability of computers as much as possible. Recent development of supercomputers has a remarkable progress. Hence another numerical technique should be needed under the collaboration of hardware research and software engineering for the effective use on the future HPC, including the K computer and Post K computer.

For the above research purpose and background, our team is cooperating with the computational scientists in other fields and computer scientists. We enhance the research and development for the future climate simulations including effective techniques; we build a next-generation climate model. The establishment of the above basic and infrastructure research on the K Computer is strongly required, because this research leads to the post K computer or subsequent ones in the future.

We continue to conduct four ongoing projects in this fiscal year as following.

1. Construction of a new library for climate study:
   We have proposed the subject "Estimation of different results by many numerical techniques and their combination" as a synergetic research to MEXT in 2011 through the discussion with the Strategic 5 fields (SPIRE). We develop a new library for numerical simulation. The progress in development of SCALE, SCALE-LES and NICAM is reported.
2. Simulation of the transition from closed cell to open cell off the west coast of California:
   In order to achieve an outstanding simulation of SCALE-LES on the K computer, our team conducted the simulation with the high resolution and longer integration to demonstrate the shallow clouds.
3. Grand challenge run for sub-km horizontal resolution run by global cloud-resolving model:
   Another outstanding simulation of global model NICAM on the K computer, with super-high resolution (870m), has been done. We analyze the simulation in cooperation with the SPIRE3. We report the analysis of convection properties in the simulation.
4. Disaster prevention research in establishment of COE project:
   Hyogo-Kobe COE establishment project has accepted 5 subjects in 2012. One of subjects is "the computational research of disaster prevention in the Kansai area". In this subject, one of sub-subjects is "Examination of heavy-rainfall event and construction of hazard map", which our team is responsible for.

3. Research Results and Achievements

3.1 Construction of a new library for climate study

SCALE library development

We are working on research and development of a library (named SCALE) for numerical models in fluid dynamical field especially in meteorological field. We examined feasibility of numerical scheme and methods for developing new ones which are suite on massive parallel computers especially the K computer. In order to validate the schemes and test their performance in atmospheric simulations, we have been developing an atmospheric large-eddy simulation model (named SCALE-LES) as a part of the SCALE library. The SCALE library and the SCALE-LES model are currently available as open source software at our web site (http://scale.aics.riken.jp/). It is also installed on the K computer and is available for the K computer users as an AICS Software (http://www.aics.riken.jp/en/kcomputer/aics-software.html). In this year, we developed components which are necessary for real atmospheric simulations; a boundary turbulence scheme, an urban canopy model, nesting system, and preprocessing tools. We also have improved the library and the model for better performance in both physical and computational aspects.

Development of global atmosphere model NICAM:

Nonhydrostatic ICosahedral Atmosphere Model (NICAM) is used in many of research project on the K computer; for example, HPCI SPIRE field 3, HPCI General Use program (e.g. hp140046: global pollution simulation), and collaborative research with Data Assimilation Research Team in AICS. Productive NICAM simulations show high performance (7-10% of peak) and good scalability (from 10nodes to 20480nodes). Responding the increase of use scene, we developed new components of NICAM. Further improvement of the computational performance on the K computer was also conducted.

Improvement of the stencil operation core: NICAM adopts finite-volume method and horizontal explicit and vertical implicit (HEVI) scheme to solve the Navier-Stokes equations. The part of the geophysical fluid dynamics solver in NICAM is extracted as "Dynamical Core" and packaged to NICAM-DC. We have enhanced the test case of global fluid dynamics following the "Dynamical Core Model Intercomparison Project (DCMIP)".

Development of the river components: For the ocean-atmosphere coupling simulation, coupling library have been developed in the JST CREST program (Development of System Software Technologies for post-Peta Scale High Performance Computing). In collaboration with this program, we implemented the river component of NICAM. The river is important to balance the incoming water from atmosphere via land to the ocean and outgoing (evaporating) water from ocean to the atmosphere. The river submodel is based on the TRIP model (Oki and Sud, 1998). The distances between source and destination point of flow-down are not always 1 grid (neighbor) but 2-4 grids. On the multi-node (MPI) parallel execution, the river-flow needs network communication, which is different from halo exchange for stencil calculation. We have newly developed communication kernel for the general point-to-point data movement on the NICAM's massively parallel framework with icosahedral grid system. Figure 1 shows the sample result of global river storage. The river flow from continent to the ocean is visualized (e.g. Nile river and Amazon River).

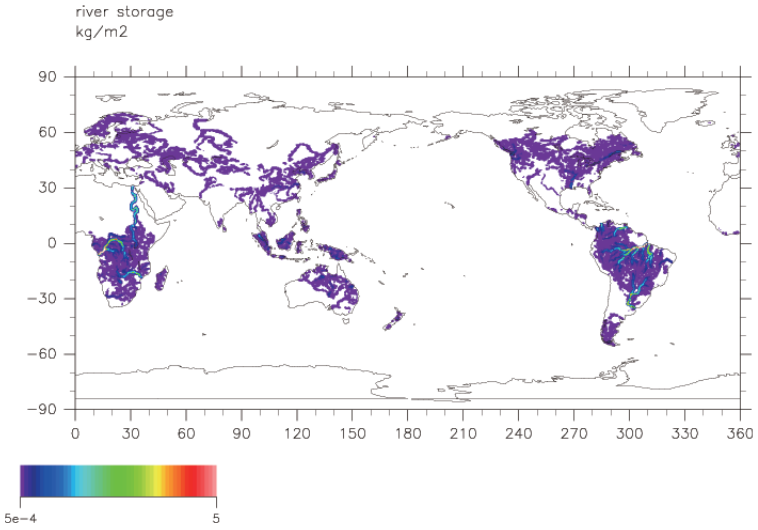

Figure 1: A sample of global distribution of river storage [kg/m2], calculated by the NICAM

Development of the ocean components: Atmosphere faces the ocean water at the bottom boundary. NICAM uses “slab” ocean component in default. The slab ocean submodel provides ocean surface condition such as sea surface temperature and sea ice amount, with responding the energy/water inflow/outflow of the atmosphere. The water depth of the mixing layer near the sea surface is an important parameter of slab ocean, which affects to the temporal and spatial variation of atmosphere-ocean heat exchange. We implemented a new sub-grid model in mixing layer of slab ocean submodel. The model is based on the Kawai and Wada (2007). The depth of mixing layer is diagnosed from accumulated, net energy input (wind stress, heat exchange, precipitation, evaporation and solar radiation) to the lowermost layer of the ocean. Figure 2 shows the global distribution of mixing layer depth, simulated by using new ocean sub-layer component. The difference of the depth between tropical region and mid- and high- latitude region is reproduced more realistically.

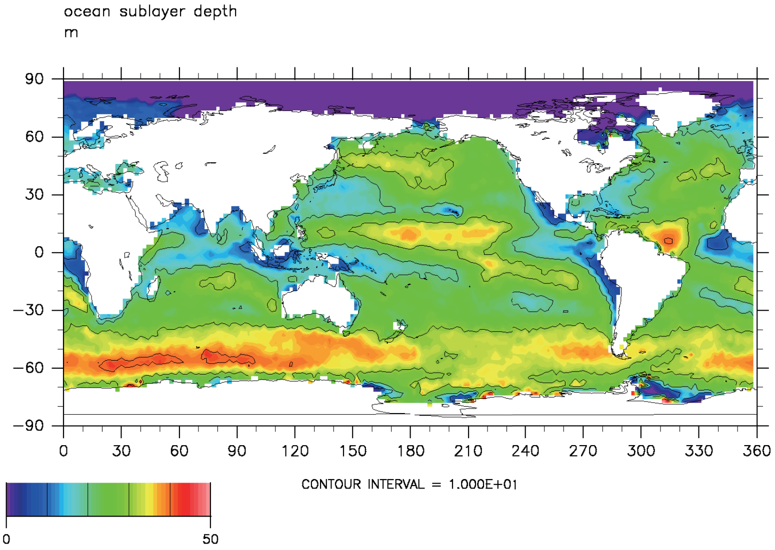

Figure 2: A sample of global distribution of mixed layer depth [m] calculated by the NICAM

3.2 Simulation of the transition from closed cell to open cell off the west coast of California

Using SCALE-LES model, we have investigated shallow clouds (e.g. stratus, stratocumulus, cumulus), which have important role in energy budget of the Earth through radiative process. The cloud cover largely contributes to determine the radiative properties of shallow clouds. Thus, the transition from low cloud cover to high cloud cover is one of the important processes. To investigate the key mechanism determining the cloud cover, we conducted the numerical simulation of the transition in a single calculation domain covering extremely wide calculation domain (300 × 28 × 1.7 km^3) with extremely fine grid resolution ($dx = dy =$ 50m, $dz =$ 5m). The transition from high cloud cover (“cumulus under stratocumulus”) to low cloud cover (“isolated cumulus”) was reproduced successfully as shown in Figure 3. Through the analysis of the results, we proposed a concept to explain how the cloud cover is determined; the relationship between “cloud broadening distance" and "distance of each cumulus" determines cloud cover.

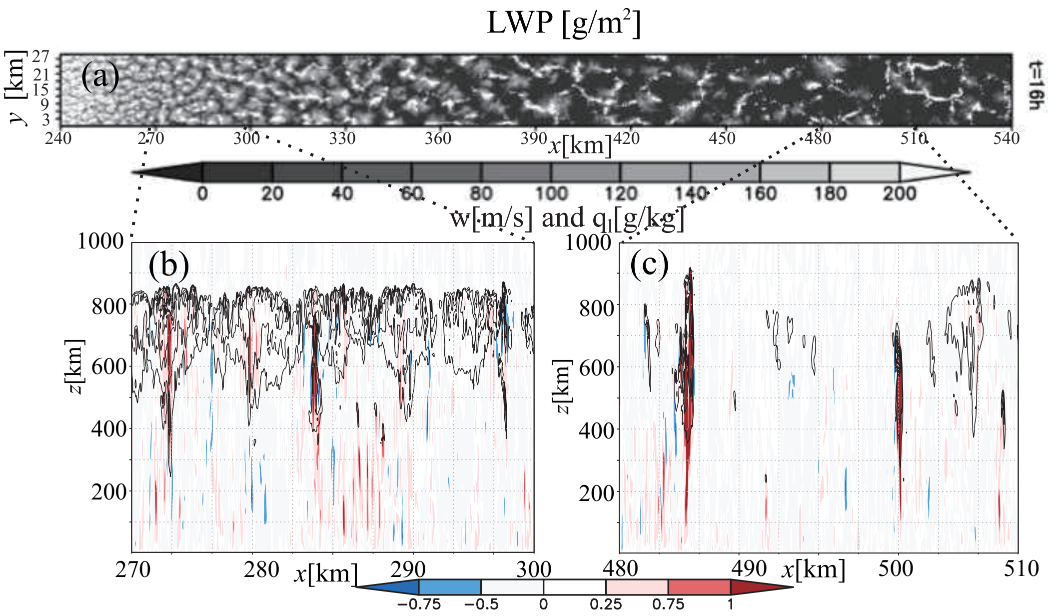

Figure 3: Spatial distribution of (a) the liquid water path at t = 16 h. The x–z slice shows the liquid water mixing ratio (ql = qc+qr) (contour) and vertical velocity (shaded) at t = 16 h in (b) 270km < x < 300 km, y = 15 km and (c) 480 km < x < 510 km, y = 15 km. The contour line in (b) and (c) corresponds to 0.25, 0.5, 0.75, and 1.0 g kg-1, respectively.

3.3 Grand challenge run for sub-km horizontal resolution run by global cloud-resolving model

Analysis of global sub-km experiment

Using the K computer, we have succeeded in conducting the global simulation with the world's highest resolution, 870 m. The result of analyses of deep atmospheric convection using the simulation data has been published in 2013 (Miyamoto et al. 2013). We showed that the convection that plays a key role in global atmospheric motion is resolved when the resolution is less than 2-3 km.

We started additional analyses to reveal the differences in convection properties in various atmospheric disturbances. Various cloudy disturbances always exist in the Earth's atmosphere, and they play important roles in global energy budget. Since their element is the convection, we focused on the differences in convection under four representative cloudy disturbances: Madden-Julian Oscillation (MJO), Tropical Cyclones (TC), Mid-latitudinal Lows (MDL), and Fronts (FRT). The paper describing the results was published in the 2014 fiscal year (Miyamoto et al. 2015). We first defined the four disturbances and then detected the convection from the subkilometer simulation.

Taking composites of convective properties such as vertical velocity (w) and precipitation revealed that the convection structures are significantly different (Fig. 4). In the tropical disturbances, MJO and TC, the convection is tall consistent with the tropopause height. On the other hand, the midlatitudinal disturbances, MDL and FRT, have short convection. The MJO convection is strongest out of the four and it is stronger than the global average. In contrast, the TC convection is relatively weak. It may be interpreted by the environmental factors of convection in the two disturbances. In MJO (TC), convective available potential energy is large (weak), whereas low-level convergence is weak (strong). Thus, the convection in MJO can obtain more energy than TC. The convection in TC appears to be forced to form by the strong convergence caused by the TC vortex. The difference between MDL and FRT can be interpreted in the similar way.

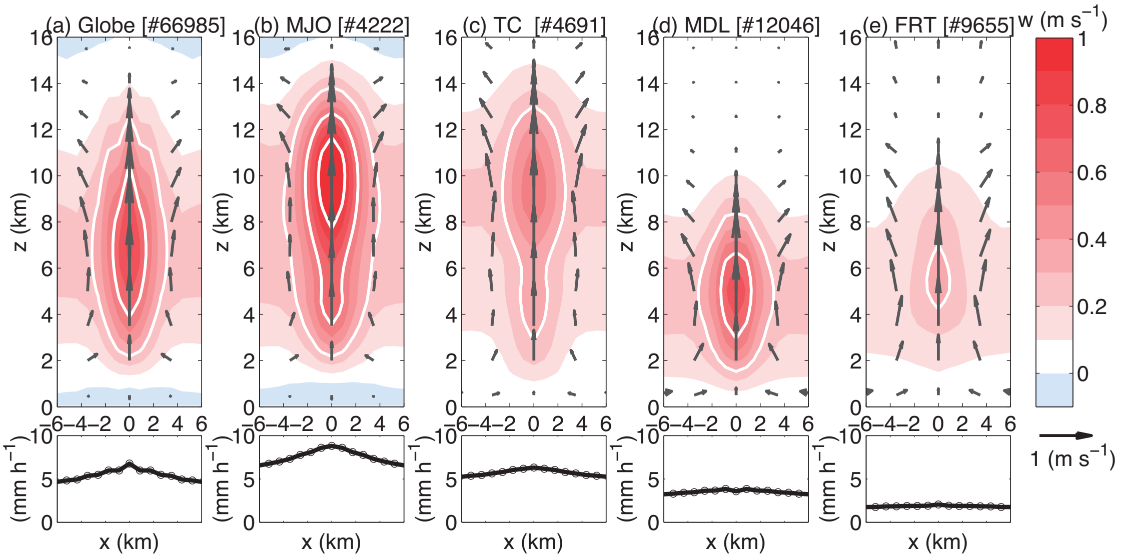

Figure 4: (Top) Radius-height composites of vertical velocity (w, shaded) and velocity vector of radial and vertical velocities (arrows) for the simulated convection detected in (a) the globe, (b) MJO, (c) TC, (d) MDL, and (e) FRT. The white contours of w are at w = 0.3, 0.6 and 0.9 m s-1. The number of convection cells is shown in the figure title. (Bottom) Radial distributions of composited precipitation. (Figure 2 of Miyamoto et al. 2015)

3.4 Hyogo-Kobe COE establish project

We conducted four months timeslice experiment using SCALE-LES with the boundary data of NICAM AMIP-type experiment, to validate the model performance on the climate simulation around the Hyogo/Kobe area. The simulation period of each timeslice run was five days including first-one day for the spinup. The horizontal grid interval of the model was 7.5km, 2.5km, and 0.5km for the domains 1, 2, and 3, respectively. The output from the innermost domain (domain 3) was used for analysis.

The amount and spatial distribution of four-month mean precipitation were successfully simulated by SCALE-LES and agreed well with the observation, although the simulated precipitation was overestimated in the mountain areas. In addition to the spatial distribution, the occurrence frequency of hourly precipitation in the Kansai region was also successfully represented by SCALE-LES, as shown in Fig. 5. The frequency of heavy rainfall more than 50 (mm/hr) is different between the observation and model result. This is because the number of heavy rainfall event varies depending on the year, namely, one year for the simulation is not enough for the climatological analysis of heavy rainfall. From these analyses, we validated the utility of SCALE-LES for the climate simulation around the Hyogo/Kobe area. On the other hand, several issues become identified such as the model biases described above. After the improvement of the model performance, we will start the long-term climate simulation in the next fiscal year.

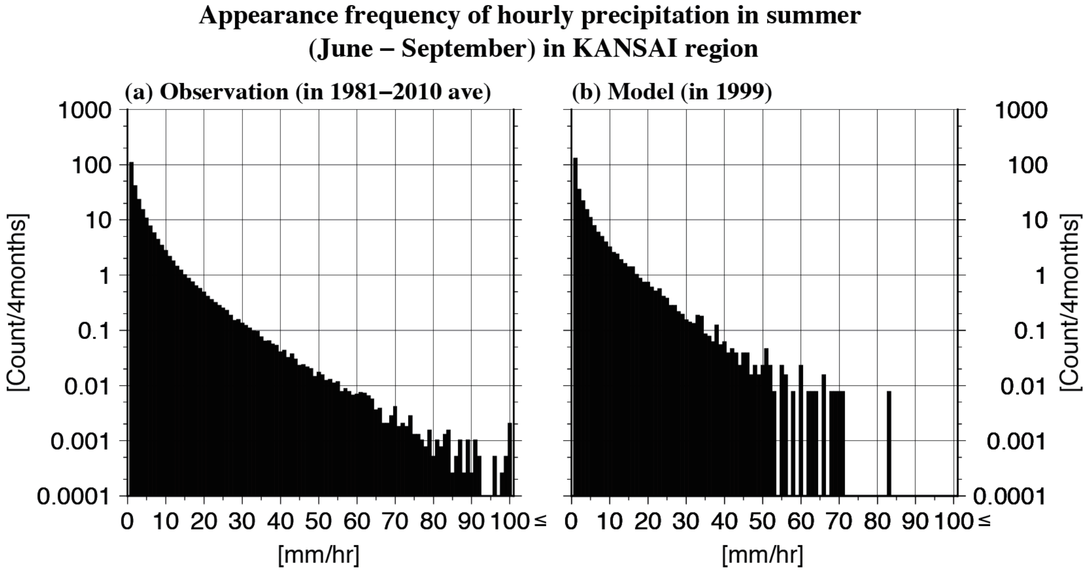

Figure 5: Appearance frequency of hourly precipitation from June to September in the Kansai region: (a) AMeDAS observation averaged between 1981 and 2010, (b) simulation by SCALE-LES averaged in 1999.

5. Schedule and Future Plan

In the next year, we will continue to develop, update and maintain the numerical library for the K computer (SCALE library). Cumulus parameterization and high-accuracy dynamical scheme will be implemented. We also try to enhance the performance of each existing scheme. At the same time, we will work on the following three projects in the collaboration with other team in AICS and the scientist in other institute.

(1) On the Hyogo/Kobe COE establish project, we will conduct the long-term climate simulation by using SCALE-LES to examine the heavy rainfall over Kobe city area. NICAM AMIP-type run for the current climate will be used for the boundary. We will obtain the geographical distribution of the frequency of heavy rainfall and evaluate it with the observational datasets provided by Kobe/Hyogo government. We will also conduct the future climate simulation and highlight the future change of the local heavy rainfall.

(2) We will also contribute to the CREST, Strategic Basic Research Programs “Innovating "Big Data Assimilation" technology for revolutionizing very-short-range severe weather prediction” to develop the main climatological model in SCALE library. In collaboration with the Data Assimilation team in AICS, we contribute to develop the SCALE-LETKF (Local Ensemble Transform Kalman Filter).

(3) We join the POST K Science priority project under the collaboration with JAMSTEC. NICAM-LETKF is one of the target applications. Our team will continue to develop and update that application.

The comprehensive analysis of the two grand challenges run by NICAM and SCALE-LES before will be wrapped up. The new concept for the profitability of deep convection will be established and highlighted by using NICAM simulation results. Comprehensive understanding of the Shallow clouds will be advanced with the result of SCALE-LES.

5. Publication, Presentation and Deliverables

(1) Journal Papers

1. Kodama C., M. Terai, A. T. Noda, Y. Yamada, M. Satoh, T. Seiki, S. Iga, H. Yashiro, H. Tomita, and K. Minami, 2014 : Scalable Rank- Mapping Algorithm for an Icosahedral Grid System on the Massive Parallel Computer with a 3-D Torus Network, Parallel Computing, 40, 8, 362-373, doi:10.1016/j.parco.2014.06.002.
2. Kodama C., S. Iga, and M. Satoh, 2014: Impact of the Sea Surface Temperature Rise on Storm-Track Clouds in Global Non-hydrostatic Aqua-Planet Simulations, Geophys. Res. Lett., 41, 10, 3545-3552, doi:10.1002/2014GL059972.
3. Y Tsushima, S. Iga, H. Tomita, M. Satoh, A. T. Noda, and M. J. Webb, 2014: High cloud increase in a perturbed SST experiment with a global nonhydrostatic model including

explicit convective processes, Journal of Advances in Modeling Earth Systems, 6, 3, 571–585, doi:10.1002/2013MS000301.

4. Satoh M., H. Tomita, H. Yashiro, H. Miura, C. Kodama, T. Seiki, A. T Noda, Y. Yamada, D. Goto, M. Sawada, T. Miyoshi, Y. Niwa, M. Hara, T. Ohno, S. Iga, T. Arakawa, T. Inoue, and H. Kubokawa, 2014: The non-hydrostatic icosahedral atmospheric model: description and development, Progress in Earth and Planetary Science, Progress in Earth and Planetary Science, 1, 18, doi:10.1186/s40645-014-0018-1.
5. Yamaura T., and T. Tomita, 2014: Two Physical Mechanisms Controlling the Interannual Variability of Baiu Precipitation , Journal of the Meteorological Society of Japan, 92, 4, 305-325, doi:10.2151/jmsj.2014-403.
6. Yun K.-S., K.-J. Ha, J.-Y. Lee, and Y. Kajikawa, 2014: Interdecadal Changes in the Asian Winter Monsoon Variability and Its Relationship with ENSO and AO, Asia-Pac. J. Atmos. Sci., 50, 4, 1-10, doi:10.1007/s13143-014-0042-5.
7. Miyakawa T., M. Satoh, H. Miura, H. Tomita, H. Yashiro, A. T. Noda, Y. Yamada, C. Kodama, M. Kimoto and K. Yoneyama, 2014: Madden–Julian Oscillation prediction skill of a new-generation global model demonstrated using a supercomputer, Nature Communications, 5, 3769. doi:10.1038/ncomms4769.
8. Miyamoto Y., R. Yoshida, T. Yamaura, H. Yashiro, H. Tomita and Y. Kajikawa, 2014: Does convection vary in different cloudy disturbances?, Atmos. Sci. Lett., accepted.
9. Tsushima Y., S. Iga, H. Tomita, M. Satoh, A. T. Noda, and M. Webb, 2014: High cloud increase in a perturbed SST experiment with a global nonhydrostatic model including explicit convective processes, Journal of Advances in Modeling Earth Systems, 06, 571-585, doi:10.1002/2013MS000301.
10. Seiki T., M. Satoh, H. Tomita, and T. Nakajima, 2014: Simultaneous evaluation of ice cloud microphysics and non-sphericity of the cloud optical properties using hydrometeor video sonde and radiometer sonde in-situ observations, J. Geophys. Res. Atmos., 119, 6681-6701, doi:10.1002/2013JD021086.
11. Yashiro H., A. Naruse, R. Yoshida, and H. Tomita, 2014: A Global Atmosphere Simulation on a GPU Supercomputer using OpenACC: Dry Dynamical Core Tests, TSUBAME e-Science Journal (ESJ), 12, 8-12,
12. 宮本佳明, 2014: Maximum Potential Intensity (新用語解説), 天気, 61(9), 799-801, http://www.metsoc.jp/tenki/pdf/2014/2014_09_0043.pdf.
13. 八代尚, 富田浩文, 宮本佳明, 2014: スーパーコンピュータ「京」の利用：5. 1km 格子間隔を切る大気大循環シミュレーションへの道のり, 情報処理学会誌「情報処理」55, 8, 811-816, http://id.nii.ac.jp/1001/00102187/.

(2) Invited Talks

14. Yashiro H., Recent performance of NICAM on the K-computer and activities towards post-petascale computing, Workshop on Scalability, Reading, United Kingdom, April 14-15, 2014.(Invited)
15. Tomita H., Numerical techniques of cloud resolving model and large eddy simulation on the future HPC system, World Weather Open Science Conference 2014, Montreal, Canada, August 16-21, 2014.(Invited)
16. Tomita H., A numerical technique of global CRM and LES on future high performance computer, 2014 KIAPS International Symposium, Seoul, Korea, October 27-29, 2014.(Invited)
17. Yashiro H., M. Satoh, and H. Tomita, NICAM 870m mesh simulations on the K computer and a road toward global LES, AGU fall meeting, San Francisco, CA, USA, December 15-19, 2014.(Invited)
18. Tomita H., Climate Projection and Numerical Weather Prediction toward the Exa-Scale Era, International Super Computing Conference, Leipzig, Germany, June 22–26, 2014.(Invited)
19. Tomita H., Requirement of simulation code for big data assimilation, The fourth International Symposium on Data Assimilation, Kobe, Japan, February 23-27, 2015.(Invited)
20. Yashiro H., A Simulation of Global Atmosphere Model NICAM on TSUBAME2.5 Using OpenACC, GPU Technology Conference 2015, San Jose, CA, USA, March 16-20, 2015.(Invited)
21. 富田浩文, 京を使った高解像度全球大気シミュレーションの成果とこれからの展望, SS研 HPC フォーラム 2014 Bridge to Exa ～アプリケーションの観点から～, 東京(汐留シティセンター), Aug 26, 2014.(Invited)

(3) Posters and Presentations

22. Miyamoto Y., T. Takemi, A Triggering Mechanism for the spontaneous axisymmetric intensification of tropical cyclones, 31st Conference on Hurricanes and Tropical Meteorology, San Diego, CA, USA, March 31-April 4, 2014.(Oral)
23. S. Iga, H. Tomita, Improved Smoothness and homogeneity of icosahedral grids using the spring dynamics method, PDEs 2014 Science Workshop, Boulder, CO, USA, April 7-11, 2014.(Oral)
24. Kajikawa Y.,T. Yamaura, H. Tomita, M. Satoh, Indian Summer Monsoon Onset in 2012 Simulated by Global Cloud-system Resolving Model NICAM, Takio Murakami Memorial Symposium on Tropical Meteorology and Monsoon, Honolulu, HI, USA, July 2-3, 2014.(Oral)

25. Sato Y., S. Nishizawa, H. Yashiro, Y. Miyamoto, H. Tomita , Transition from closed cell to open cell structure of stratocumulus simulated by high resolution Large Eddy simulation model covering wide calculation domain, 14th Conference on Cloud Physics, Boston, MA, USA, July 7-11, 2014.(Poster)
26. Nishizawa S., H. Yashiro, M. Odaka, Y. Takahashi, Y. Hayashi, H. Tomita, S. Takehiro, M. Ishiwatari, K. Nakajima, Y. Sato, K. Sugiyama, High-resolution Large-eddy Simulation of the Martian Planetary Boundary Layer, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Poster)
27. Sato Y., S. Nishizawa, H. Yashiro, Y. Miyamoto, H. Tomita, Potential of Retrieving Shallow-cloud Life Cycle from Next Generation Satellite Observations Through Cloud Evolution Diagrams: a Suggestion from a Large Eddy Simulation, AOGS 11th Annual Meeting, Sapporo, Japan, Jul 28y-August 1, 2014.(Poster)
28. Kajikawa Y., T. Yamaura, H. Tomita, M. Satoh, Indian Summer Monsoon Onset in 2012 Simulated by Global Cloud-system Resolving Model NICAM, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Poster)
29. Yoshida R., Y. Kajikawa, H. Ishikawa , Impact of Boreal Summer Intraseasonal Oscillation on Environment of Tropical Cyclogenesis Over the Western North Pacific, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Poster)
30. Yashiro H., Y. Kajikawa, Y. Miyamoto, R. Yoshida, T. Yamaura, H. Tomita, Diurnal Cycle of the Precipitation in a Sub-kilometer Global Simulation, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Poster)
31. Kajikawa Y., Y.-W. Seo, K.-S. Yun, K.-J. Ha, R. Johnson, Role of the SST Over the East China Sea in the Linkage Between East Asian Winter and Summer Monsoon Variability, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Oral)
32. Yamaura T., T. Tomita, Two Physical Mechanisms in the Interannual Variability of Baiu Precipitation, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Oral)
33. Miyamoto Y., Y. Kajikawa, R. Yoshida, T. Yamaura, H. Yashiro, H. Tomita, Deep Moist Atmospheric Convection in a Sub-kilometer Global Simulation, AOGS 11th Annual Meeting, Sapporo, Japan, July 28-August 1, 2014.(Oral)
34. Nishizawa S., H. Yashiro, Y. Sato, T. Yamaura, S. A. Adachi, R. Yoshida, Hirofumi Tomita, and Team SCALE, Our activity for next generation meteorological simulations in future HPC systems, Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Oral)
35. Sato Y., Y. Miyamoto, S. Nishizawa, H. Yashiro, Y. Kajikawa, H. Tomita, Transition from cumulus under stratocumulus to isolated cumulus simulated in a single calculation domain,

Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Oral)

36. Yoshida R., An Impact of Vertical Grid Arrangement in Baroclinic Wave Test, Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Poster)
37. Adachi S. A., Impact of urban parameters in an urban canopy scheme on urban climate simulation, Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Poster)
38. Miyamoto Y., Deep Moist Atmospheric Convection in a Sub-kilometer Global Simulation , Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Poster)
39. Miyamoto Y., A linear thermal stability analysis of discretized fluid equations, Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Poster)
40. Yashiro H., H. Tomita, M. Satoh, Recent computational performance and scalability of NICAM: toward to the exa-scale computing, Joint Workshop of 6th International Workshop on Global Cloud Resolving Modeling and 3rd International Workshop on Nonhydrostatic Numerical Models, Kobe, Japan, September 24-26, 2014.(Poster)
41. Miyamoto Y., R. Rotunno, G. H. Bryan, Developing an analytical model of maximum potential intensity for tropical cyclones incorporating the effects of ocean mixing, Third Capacity Building Workshop of the WMO/IOC Data Buoy Cooperation Panel (DBCP) for the North Pacific Ocean and Its Marginal Seas (NPOMS-3), Kyoto, Japan, October 6-8, 2014.(Oral)
42. Terai M., H. Yashiro, K. Sakamoto, S. Iga, H. Tomita, M. Satoh, K. Minami, Performance Optimization and Evaluation of a Global Climate Application Using a 440m Horizontal Mesh on the K Computer, SC14, New Orleans, LA, USA, November 16-21, 2014.(Poster)
43. Kajikawa Y., Y.-W. Seo, K.-S. Yun, K.-J. Ha and R. Johnson, Role of the SST Over the East China Sea in the Linkage Between East Asian Winter and Summer Monsoon Variability, AGU fall meeting, San Francisco, CA, USA, December 15-19, 2014.(Oral)
44. Ma X., T. Yoshikane, M. Hara, S. A. Adachi , Y. Wakazuki, H. Kawase, F. Kimura, A comparison of river discharge calculated by using a regional climate model output with

different reanalysis datasets in 1980s and 1990s, AGU Fall meeting, San Francisco, CA, USA, December 15-19, 2014.(Poster)

45. Hara M., S. A. Adachi , H. Kusaka, F. Kimura, Future change of wintertime urban heat island intensity over Japan, AGU Fall meeting, San Francisco, CA, USA, 15-19 Dec 2014.(Poster)
46. Adachi S. A., M. Hara, X. Ma, F. Kimura, Impact of urban parameters in an urban canopy scheme on urban climate simulation, 5th AICS international symposium, Kobe, Japan, December 8-9, 2014.(Poster)
47. Yoshida R., H. Yashiro, H. Tomita, An Impact of Vertical Grid Arrangement in Baroclinic Wave Test, 5th AICS international symposium, Kobe, Japan, December 8-9, 2014.(Poster)
48. Sato Y., Transition from cumulus under stratocumulus to isolated cumulus simulated in a single calculation domain, 5th AICS international symposium, Kobe, Japan, December 8-9, 2014.(Poster)
49. Miyamoto Y., Y. Kajikawa, R. Yoshida, T. Yamaura, H. Yashiro, H. Tomita, Deep Moist Atmospheric Convection in a Sub-kilometer Global Simulation , 5th AICS international symposium, Kobe, Japan, December 8-9, 2014.(Poster)
50. Kajikawa Y., Long term variability of the Asian monsoon onset, Asian monsoon Hydroclimate - Review of MAHASRI and Beyond -, Nagoya, Japan, March 4-5, 2015.(Oral)
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