GLOBAL ATMOSPHERIC SIMULATIONS WITH THE T1279L96 RESOLUTION

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An atmospheric general circulation model (AGCM), which runs extremely efficiently on the Earth Simulator (ES)[1] was developed[2]. The ES is a gigantic vector parallel computer system. With the combination of our AGCM, AFES (***A***GCM ***f***or the ***ES***), and the ES, we have performed 10-km mesh (T1279L96) global atmospheric simulations, targeting typhoon genesis, Baiu-Meiyu frontal zone and wintertime cyclogenesis. A snapshot of global precipitation field from one of such simulations is shown in Fig. 1. It shows both large-scale features, such as the inter-tropical convergence zone and mid-latitude lows, and meso-scale features, such as the typhoons that are located over the western North Pacific and fronts which are associated with cyclonic activities. Although verification of model results is still underway, Fig. 1 suggests the feasibility of use of global ultra-high resolution simulations for studies on, for example, self-organization of meso-scale structures in the general circulation, and the interaction between meso-scale phenomena and larger-scale circulation.

AFES is a primitive equation spectral Eulerian AGCM. Physical processes include a simplified form of Arakawa-Schubert cumulus convection scheme with the effect of downdraft and rather sophisticated radiation scheme. AFES was adopted from an AGCM jointly developed by Center for Climate System Research, the University of Tokyo and Japanese National Institute for Environmental Studies[3]. However, AFES has been totally rewritten from scratch with FORTRAN90, Message Passing Interface (MPI) and microtasking. The original code was written in FORTRAN77 and not parallelized.

AFES achieved the computational speed of about 27 Tflops (about 65% of the peak performance) with the full configuration of the ES (about 41 Tflops, 640 nodes, 5120 CPUs)[2]. It was recognized as the fastest computation in the world at the Super Computing 2002, November, 2002, Baltimore, MD, USA, and won Gordon Bell Prize for peak performance. Fig. 2 shows AFES's speed as a function of the number of processors. It clearly shows AFES is very scalable up to 5120 processors or the full configuration of the ES.

Fig. 3 shows an example of meso-scale features simulated in the typhoon genesis experiment. A clear "eye" of one of the typhoons is well simulated. Although vigorous verification against observations is yet to be done, Fig. 3 is certainly very encouraging.

So far AFES is merely an ultra-high resolution version of a conventional AGCM. We have been working on "modernizing" AFES. We have been experimenting with some other cumulus parameterization schemes rather than the Arakawa-Schubert-type scheme. Also we have implemented conservative Semi-Lagrangian scheme in tracer transport[4].

The T1279 resolution is used for rather short-term (10~16 days) simulations due to computational resource. We plan to use T319~639 resolution for more climate-oriented studies, such as interannual variability or global warming, in the near future.

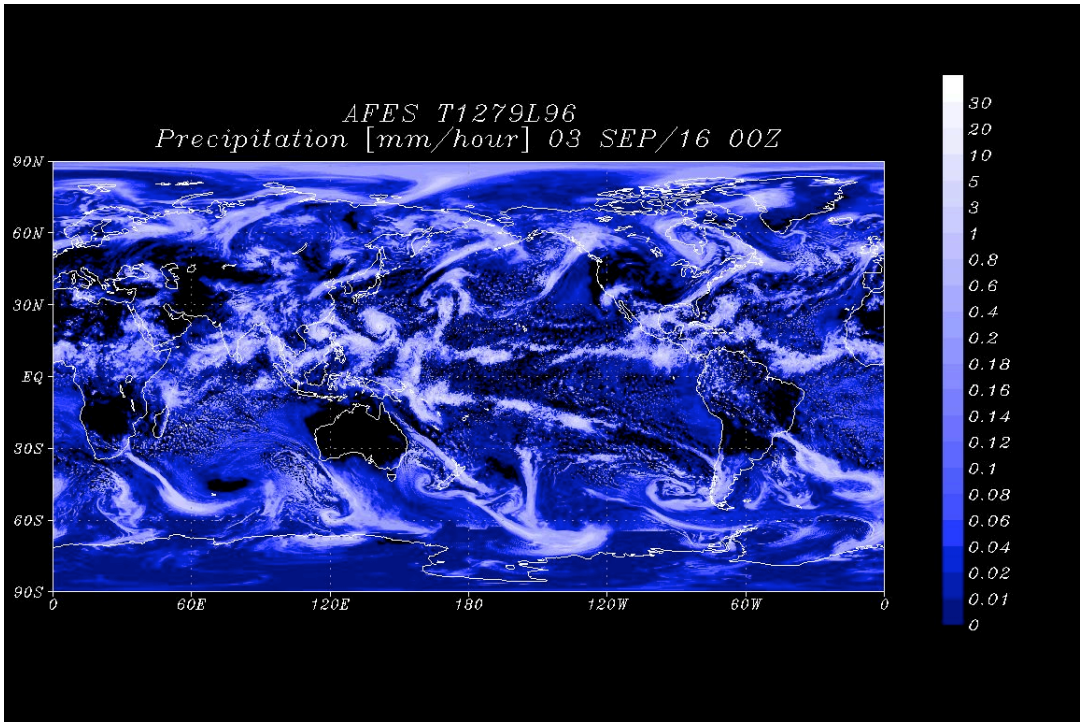

Fig. 1. Snapshot of global precipitation field from one of T1279L96 simulations.

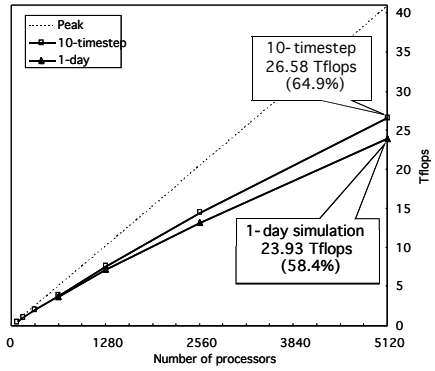

Fig. 2. Scalability of T1279L96 AFES.

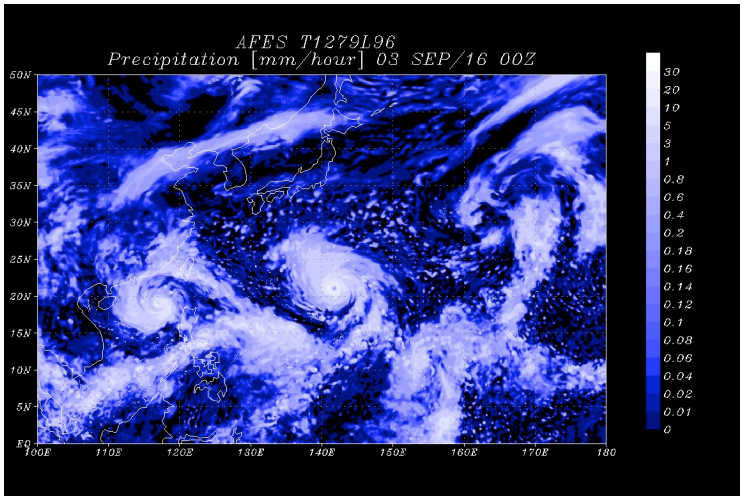

Fig. 3. Magnified figure of Fig. 1. around the Japan area.

References

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