8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

MULTI-MOMENT EULER SCHEME

FOR COMPUTATIONAL FLUID DYNAMICS

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Key Words: *CIP, IDO, conservative form, multi-moment scheme, Euler scheme*

ABSTRACT

The Cubic Interpolated Propagation (CIP) method[1] and the Interpolated Differential Operator (IDO) scheme[2] are based on interpolation functions constructed by values, gradients and local-integrated values of the dependent variable. Since these values are time-integrated by the given partial differential equations, the CIP and the IDO schemes are categorized into multi-moment schemes. The polynomial interpolation function using multi-moments are able to describe the profile of high wave numbers accurately and it is quit unique to capture the phase speed much better than other single-moment schemes[3]. The non-conservative multi-moment schemes have been widely applied to many problems in fluid mechanics, astrophysics, meteorology, electro-magnetism, civil engineering and so on. For both compressible and incompressible flows, problems with sever conditions are successfully solved[4] and especially good results are obtained for two-phase flow problems as shown in Fig.1. A typhoon simulation was also carried out by the meso-scale atmospheres model (Fig.2). It is well known that the CIP method uses a semi-Lagrangian procedure and the fractional step method. The IDO scheme solves the equation in an Eulerian way, so that the conservative scheme has been developed recently[5]. The point values, line-integrated values, area-integrated values, and volume-integrated values are employed and located as a staggered configuration. In spite of the

Fig.1 Bubbly flow computed by CIP method.

collocated configuration that all the variables, for instance, the velocity and the pressure, are located at the same position, numerical stability is compatible with high-order accuracy. For not only compressible flows but also incompressible flows, the conservative IDO scheme shows the best feature of the multi-moment scheme compensating additional memory use.

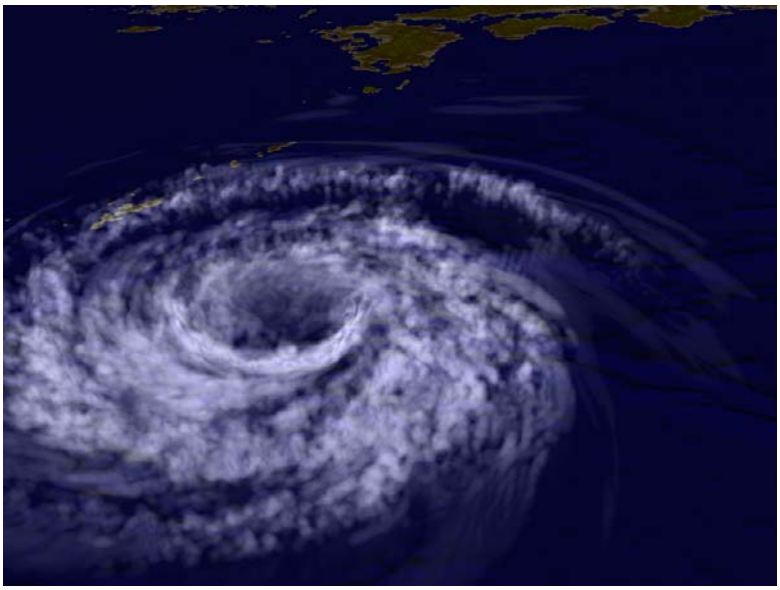

Fig.2 Typhoon simulation by meso-scale atmoshere model.

Some of these numerical simulations were done on the TSUBAME supercomputer in Global Scientific Information and Computing Center, Tokyo Institute of Technology, which has more than 10,000 Opteron CPU cores. The Infiniband interconnection works well to keep high performance of parallel computing with domain decomposition. We have begun to use GPU (Gpahics Processing Unit) as a SIMD-type accelerator and we would like to discuss a hierarchy parallel computation connecting SIMD acceleratord , multi-core CPU inside node, and distributed memory cluster over the node.

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