Development and applications of a LES meteorological Numerical model coded in Cartesian coordinate

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1. Introduction

With the continuing increase in computational resources, the meso-scale meteorological models are being run at successively higher resolutions. It is reasonable to expect that a goal of running a regional numerical model with LES (Large Eddy Simulation) turbulent scheme at a very high spatial resolution may be attainable in the near future, and at the same time the topography and objects could be more accurately represented. In such a situation, it seems natural to search for an alternative that will be better suited to handle the step topography and any complex object on the surface for the high-resolution LES model simulations.

2. Concept of the model

Here, a regional numerical model with LES turbulent scheme has been developed in Cartesian coordinate, and it is expected to suitably treat the steep topography and complex objects with a finer resolution. In the model, the finite volume method (FVM) in conjunction with the SIMPLER (Semi-Implicit Method for Pressure-Linked Equation Revised) algorithms is used for calculations of the unsteady, three-dimensional, compressible Navier-Stokes equations on a staggered grid. Abandoning the customary terrain-following normalization, we choose the Cartesian coordinate, and the blocking-off method is introduced to handle all of the steep topography and complex objects. A higher-order upwind convection and the fully time implicit schemes are utilized, and standard LES turbulent scheme is also included.

3. Some results

As applications of LES numerical simulation, the model has been run on calculating various complex turbulent flows, e.g., numerical simulation conducted/compared with wind-tunnel experiment on the thermal and turbulent structures of flow in urban-street canyon; numerical experiment on the three dimensional fine structure (i.e., lobe and cleft structure) of gravity currents in sea-breeze’s head. Details will be given in the meeting.