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Large-eddy simulation of turbulent winds during the Fukushima Daiichi Nuclear Power Plant accident by coupling with a meso-scale meteorological simulation model

Hiromasa NAKAYAMA (1), Tetsuya TAKEMI (2), and Haruyasu NAGAI (3)

(1) Japan Atomic Energy Agency, Ibaraki, Japan (nakayama.hiromasa@jaea.go.jp), (2) Disaster Prevention Research Institute, Kyoto University, Kyoto, Japan (takemi@storm.dpri.kyoto-u.ac.jp), (3) Japan Atomic Energy Agency, Ibaraki, Japan (nagai.haruyasu@jaea.go.jp)

The Fukushima Daiichi Nuclear Power Plant (FDNPP) consists of various buildings and structures over complex hilly terrain. For simulating wind flows over various arrangements of obstacles over complex surface geometries, a computational fluid dynamics (CFD) technique has been commonly used. In CFD models, complex surface geometries can be explicitly represented at high resolutions. In particular, the CFD simulations using large-eddy simulation (LES) are effective to simulate not only boundary-layer structures but also turbulent natures of wind fluctuations within and over roughness obstacles. Therefore, an approach to couple LES-based CFD model and a meso-scale meteorological model (MM) should be a next-generation real-time prediction system to simulate turbulent winds over complex surface geometries under real meteorological conditions. One of the important issues to be solved to couple LES and MM models is to impose time-dependent turbulent inflow data for LESs from the MM model outputs, because the MM models are not able to reproduce high-frequency turbulent fluctuations appropriate to drive LES models. Therefore, the recycling method proposed by Kataoka and Mizuno (2002) is applied to coupling between MM and LES models.
In this study, we apply the coupling calculation to prediction of turbulent winds during the FDNPP accident and report detailed information on turbulent structures under the influence of buildings and complex surface geometries.