A PLANETARY BOUNDARY LAYER MODEL AND ITS APPLICATION TO HEAVY RAIN MODELING

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Apparently, PBL plays an important role in a heavy rain formation and its follow-up developments. A meso-scale weather system with its associated strong convection quite often causing heavy rainfalls, to a larger extent, is affected by the PBL processes. Turbulent motion is a most important phenomenon in PBL, which determines the transfer of momentum, heat and mass.

Until now, although the Mellor-Yamada's Level 4 concept (MY-4) has not yet been fully applied to meso-scale PBL modeling, it is predicable that the 2^{nd} order turbulent fluxes will most likely have significant repercussions on simulation of heat-, momentum- and vapour-transfers in PBL, especially in a heavy-rainfall process. Furthermore, with the technological advances, the computing capability seems to no longer a major factor limiting research and development of numerical models. Therefore, it gives rise to the possibility of adopting a MY-4 model, which could practically substitute MY-2.5 in a meso-scale model.

A new Planetary Boundary Layer (PBL) model (namely MY-4 in this paper) was developed with reference to Mellor-Yamada's Level 4 turbulent closure concept. Having been coupled with a meso-scale model, MM5, MY-4 was utilized to simulate a heavy-rain process, which took place over South China during June 8-9, 1998. Its model outputs indicated that the rainfall process was well captured in terms of its intensity and geographical distribution. More importantly, in comparison with MM5's original boundary layer models, MY-4 made the following improvements: (1) MY-4 simulated not only the major weather systems like low vortexes and low-level jets more accurately, thus improving the general weather pattern of the rainfall process, but it also was capable to restrain the occurrence of false rainfall centers with maximum precipitation amounts exceeding 160mm; (2) Having compared with the wind profile observed at Hong Kong, it revealed that MY-4 could reproduce the wind speed fluctuations in a short time scale reasonably well, which was not yet achieved in the original PBL models in MM5. Furthermore, a more detailed comparative study was made on the results simulated by MY-4 and a PBL model (which is based on Mellor-Yamada's Level 2.5 concept) respectively. It showed that each contribution of turbulences generated by the two categories of PBL models to the wind fields at a lower atmosphere were increasingly different even in the first 1-2 hours of integrations. As the analysis demonstrated, under the nonlinear interactions within the meso-scale MM5 model, it was the turbulences in the boundary layer that had the most important impacts on the final model outputs and MY-4 seemed to better reflect this turbulent process hence leading to the aforementioned improvements.