Numerical Simulation of Seasonal Mesoscale Atmospheric Flow-Field Parameters using ARW over Singapore Region: Impact of Land Use Land Cover

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In this study, we analyse the effect of land use land cover (LU-LC) information on the simulation of seasonal planetary boundary layer (PBL) flow-field parameters for air quality assessment and prediction over Singapore region using ARW mesoscale model. We compare the results achieved using the standard MODIS global land cover data and a regional land cover map produced at the Centre for Remote Imaging, Sensing and Processing (CRISP), Singapore. The high-resolution simulations are conducted with triple-nested domains (horizontal grid resolutions; 27, 9 and 3 km) and 51 unequally spaced vertical sigma levels. The ARW model is run with six hourly NCEP FNL data with 1.0° x 1.0° for the initial and boundary conditions. The evolution of PBL variables, rainfall and thermodynamic vertical structure of the atmosphere are modeled in four seasons (northeast monsoon season, first inter-monsoon period, southwest monsoon season and second inter-monsoon period). The model-simulated parameters are validated with in situ available meteorological observations and accumulated rainfall at four stations as well as one-radiosonde ascents at 0000 and 1200 UTC over Singapore. The simulation results highlight the broad variation of the low-level flow field in different seasons. The use of CRISP regional land cover map improved the agreement between observations and model simulated diurnal trends in surface meteorological parameters, accumulated rainfall and thermodynamic vertical structure of the atmosphere compared to the use of MODIS global land cover data. Stronger winds are found during monsoon seasons as compared with inter-monsoon periods. Similarly, wind direction simulations are better represented in monsoon seasons than on inter-monsoonal periods. Overall, the results of this study indicate possibilities to improve regional level air quality monitoring and prediction capabilities around Singapore by utilizing up-to-date land cover products designed to take into account regional land cover characteristics.

Key words: ARW model, Planetary Boundary layer, Land Use Land Cover, MODIS