Abstract of Thesis

Mesoscale atmospheric circulations over complex topographic and coastal regions play important role in air pollution transport and local air quality issues. In the present study, planetary boundary layer (PBL) flow-field parameters over the complex topographic region of Ranchi in tropical India and coastal region of Chennai in Southern India are simulated using WRF mesoscale model. Sensitivity experiments are conducted with five different PBL schemes with triple nested domain having horizontal resolution of 27, 9 and 3 km and 51 vertical levels. Eight fair weather days are selected in four different seasons (winter, pre-monsoon, monsoon and post-monsoon) are chosen. The simulated parameters are validated with available *in situ* meteorological observations over study regions. Simulations reveal that the low-level flow field is highly influenced by the topography circulations, land-sea breezes and widely varies in different seasons over study regions. After validating with the available observations, it is noticed that Asymmetric Convective Model version 2 (ACM2) followed by Mellor Yamada Nakanishi and Niino Level 2.5 (MYNN2) and Yonsei University (YSU) reasonably simulated the local scale circulations and diurnal variations of surface meteorological variables, surface layer fluxes and vertical atmospheric structure. Site specific, season and stability dependent turbulence intensity relationships (σ_u/u_*, σ_v/u_* and σ_w/u_*) are developed/obtained using atmospheric surface layer turbulence measurements over study regions. These relations are used to modify the existing Hanna diffusion scheme in the Lagrangian particle dispersion model (FLEXPART) and model performance for simulating ground level concentrations (GLCs) of NO_X simulation over study regions is examined. Three better performed PBL schemes *i.e.* ACM2, MYNN2 and YSU are tested for dispersion simulation and comparisons are made with available air quality data for different seasons. Simulations with FLEXPART-WRF revealed distinct seasonal variation of dispersion patterns and it has been found that the modified Hanna diffusion scheme improved NO_X concentration estimations by reducing the negative bias seen with default Hanna diffusion scheme. WRF simulated meteorological parameters using ACM2 and MYNN2 significantly reduced the bias in modeled pollutant concentrations. The study demonstrates the utility of high quality seasonal turbulence measurements in pollution dispersion model for better diffusion parameterization needed in air quality modeling.

Key words: FLEXPART-WRF, Complex Terrain, Coastal Region, Air quality, Land-Sea breezes, Turbulence Intensity Relationships