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# Simulation of Atmospheric Pollution Dispersion over Complex Terrain Region of Jharkhand with FLEXPART-WRF with incorporation of improved Turbulence Intensity relationships

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The complex terrain region of Patratu, Jharkhand in southern Chota Nagpur of eastern India has high air pollution problems besides complex mesoscale flow and meteorology. The FLEXPART-WRF mesoscale Lagrangian Particle dispersion model is used to simulate the dispersion of elevated effluent releases of nitrogen dioxide ($NO_2$) and suspended particulate matter (SPM) from Patratu thermal power plant over Patratu at a high resolution of 1 km. The WRF is integrated with nested domains (27, 9, 3 km resolutions, 51 vertical levels). The relationships for turbulent intensities in the default diffusion parameterization of the Hanna scheme of FLEXPART is modified with new empirical relationships derived as a function of atmospheric stability from one year fast response turbulence measurements from a nearby observational site at Ranchi. The pollutant dispersion simulated by FLEXPART is evaluated with modified version of the model and using the WRF simulated atmospheric flow field and thermodynamical structure with three alternative PBL schemes [Yonsei University (YSU), Asymmetric Convective Model version 2 (ACM2) and Mellor- Yamada Nakanishi and Niino Level 2.5 PBL (MYNN2]. Results indicate that the new turbulence intensity relationships in FLEXPART provide better comparisons for concentrations of $NO_2$ and SPM with available observations relative to the default relationships. Further, the meteorological parameters simulated using YSU significantly reduces the bias in modeled pollutant concentrations in terms of lesser mean absolute error (MAE), root mean square error (RMSE), normalized mean square error (NMSE), fractional bias (FB) and FAC2 (Factor of 2). These parametric tests enabled to fine tune and validate the FLEXPART-WRF dispersion model with YSU PBL physics and improved Hanna relationships to realistically simulate pollution dispersion over complex terrain of the study region. The study demonstrates the utility of high quality turbulence measurements in pollution dispersion model for better diffusion parameterization needed in air quality modeling.

[Key words: WRF model, FLEXPART, Planetary Boundary layer, Complex Terrain, Air quality]