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The Improvement of Turbulent Heat Flux Parameterizations in Tropical GCMs Simulations Using Low Wind Speed Excess Resistance Parameter

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Abstract : The parameterization of turbulent heat fluxes is needed for modeling land-atmosphere interactions in Global Climate Models (GCMs). However, current GCMs still have difficulties with producing reliable turbulent heat fluxes for humid tropical regions, which may be due to inadequate parameterization of the roughness lengths for momentum (z0m) and heat (z0h) transfer. These roughness lengths are usually expressed in term of excess resistance factor (κB^(-1)), and this factor is used to account for different resistances for momentum and heat transfers. In this paper, a more appropriate excess resistance factor (κB^(-1)) suitable for low wind speed condition was developed and incorporated into the aerodynamic resistance approach (ARA) in the GCMs. Also, the performance of various standard GCMs κB^(-1) schemes developed for high wind speed conditions were assessed. Based on the in-situ surface heat fluxes and profile measurements of wind speed and temperature from Nigeria Micrometeorological Experimental site (NIMEX), new κB^(-1) was derived through application of the Monin–Obukhov similarity theory and Brutsaert theoretical model for heat transfer. Turbulent flux parameterizations with this new formula provides better estimates of heat fluxes when compared with others estimated using existing GCMs κB^(-1) schemes. The derived κB^(-1) MBE and RMSE in the parameterized QH ranged from -1.15 to – 5.10 Wm-2 and 10.01 to 23.47 Wm-2, while that of QE ranged from - 8.02 to 6.11 Wm-2 and 14.01 to 18.11 Wm-2 respectively. The derived κB^(-1) gave better estimates of QH than QE during daytime. The derived κB^(-1)=6.66 Re_*^0.02-5.47, where Re_* is the Reynolds number. The derived κB^(-1) scheme which corrects a well documented large overestimation of turbulent heat fluxes is therefore, recommended for most regional models within the tropic where low wind speed is prevalent.

Keywords : humid, tropic, excess resistance factor, overestimation, turbulent heat fluxes
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