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Model developments in TERRA_URB, the upcoming standard urban parametrization of the atmospheric numerical model COSMO(-CLM)

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In order to address urban climate at the regional scales, a new efficient urban land-surface parametrization TERRA_URB has been developed and coupled to the atmospheric numerical model COSMO-CLM. Hereby, several new advancements for urban land-surface models are introduced which are crucial for capturing the urban surface-energy balance and its seasonal dependency in the mid-latitudes. This includes a new PDF-based water-storage parametrization for impervious land, the representation of radiative absorption and emission by greenhouse gases in the infra-red spectrum in the urban canopy layer, and the inclusion of heat emission from human activity. TERRA_URB has been applied in offline urban-climate studies during European observation campaigns at Basel (BUBBLE), Toulouse (CAPITOUL), and Singapore, and currently applied in online studies for urban areas in Belgium, Germany, Switzerland, Helsinki, Singapore, and Melbourne. Because of its computational efficiency, high accuracy and its to-the-point conceptual easiness, TERRA_URB has been selected to become the standard urban parametrization of the atmospheric numerical model COSMO(-CLM). This allows for better weather forecasts for temperature and precipitation in cities with COSMO, and an improved assessment of urban outdoor hazards in the context of global climate change and urban expansion with COSMO-CLM.

We propose additional extensions to TERRA_URB towards a more robust representation of cities over the world including their structural design. In a first step, COSMO's standard EXTernal PARarameter (EXTPAR) tool is updated for representing the cities into the land cover over the entire globe. Hereby, global datasets in the standard EXTPAR tool are used to retrieve the 'Paved' or 'sealed' surface Fraction (PF) referring to the presence of buildings and streets. Furthermore, new global data sets are incorporated in EXTPAR for describing the Anthropogenic Heat Flux (AHF) due to human activity, and optionally the Surface Area Index (SAI) derived from the Floor Space Index (FSI). In a second step, it is focussed on the urban/rural contrast in terms of turbulent transport in the surface layer by means of model sensivity experiments: On the theoretical basis of the TKE-based surface-layer transfer scheme of COSMO, we investigate the consistency between empirical functions for thermal roughness lengths and the urban/rural canopy morphology.