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Impacts of Built-Up Area Expansion in 2D and 3D on Regional Surface Temperature

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Many studies have reported the thermal effects of urban expansion from non-built-up land; however, how changes in building height in built-up land influence the regional thermal environment is still uncertain. Thus, taking the transitional region between the Chinese megacities of Beijing and Tianjin as the study area, this study investigated the impacts of built-up land expansion in 2D and 3D on regional land surface temperature (LST). The expansion in 2D refers to the conversion from non-built-up land to built-up land, whereas the expansion in 3D characterized the building height change in the built-up land, referring to the conversion from low- and moderate-rise building (LMRB) to high-rise building (HRB) lands. The land use change from 2010 to 2015 was manually interpreted from high spatial resolution SPOT5 and Gaofen2 images, and the LST information in the corresponding period was derived from Landsat5/8 thermal images using an image-based method. The results showed that between 2010 and 2015, approximately 87.25 km2 non-built-up land was transformed to built-up land, and 13.21 km2 LMRB land was built into HRB land. These two types of built-up land expansions have induced opposing thermal effects in regard to regional surface temperature. The built-up land expansions from cropland and urban green land have raised the regional LST. However, the built-up land expansion from LMRB to HRB lands has induced a cooling effect. Thus, this study suggested that for the cooling urban design, the building height should also be considered. Furthermore, for future studies on thermal impacts of urbanization, it should be cautioned that, besides the urban area expansion, the building height change should also be emphasized due to its potential cooling effects.