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Climatology of the surface energy balance over the Metropolitan Area of Rio de Janeiro (MARJ) based on remote sensing data

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The knowledge of the energy balance is fundamental to understanding the urban heat island (UHI) phenomenon and urban thermal behavior. As urban materials have different thermal capacities and conductivities they can remove surface water and change the natural drainage networks. The net effect is a modification in radiative, thermal, aerodynamic and moisture of the preexisting surface features, changing the heat fluxes regimes and humidity. The development of the Metropolitan Area of Rio de Janeiro (MARJ) was very fast in the past few years becoming one of the megacities of the world and increasing the need to understand the implications of urbanization on different environmental parameters as there is an energy balance intensification associated with the urbanization increase. However, the energy balance components are not easily obtained in large areas, as they are measured by expensive and often private sensors, which do not cover all existing surface types. An alternative means to these sensors is the use of remote sensing as a tool to obtain the net radiation (Rn) and the sensible (H) and latent (LE) heat fluxes. In this context, the aim of this work is to study UHI in MARJ based on the analysis of Rn, H and LE and land-use patterns retrieved from Landsat data covering a 32-year period between 1984 and 2015. The different heat fluxes were obtained based on Surface Energy Balance Algorithm for Land (SEBAL) whereas land cover maps were produced in the Ecognition 8.9 software to characterize the heat fluxes in the “urban”, “rural/urban low density” and “vegetation” classes. Climatology of Rn, H and LE were constructed for MARJ and a monthly analysis was performed. UHI intensity, based on Rn, H and LE, between “urban”, “rural/urban low density” and “vegetation” areas was established for each month. The joint analysis of the land-use maps and Rn, H and LE have shown that 1) “urban” and “vegetation” classes always present the highest (lowest) and lowest (highest) H (LE) values, respectively. The H (LE) of “rural or urban low density” is high (low), but always in between the “urban” and “vegetation” ones, representing a transition area involving rural and urban landscapes; and 2) Rn, H and LE were higher in the summer months and the differences between “urban” and “vegetation” classes are more intense for these months.