NUMERICAL AND EXPERIMENTAL DETERMINATION OF SURFACE TEMPERATURE AND MOISTURE EVOLUTION IN A FIELD SOIL

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Abstract

Knowledge about the dynamics of soil moisture and heat, especially at the surface, provides important insights into the physical processes governing their interactions with the atmosphere, thereby improving the understanding of patterns of climate dynamics. In this context the paper presents the numerical and field experimental results of temperature and moisture evolution, which were measured on the surface of a sandy soil at Abeokuta, south-western Nigeria. An unconditionally stable numerical method was used, which linearizes the vapour concentration driving-potential term giving the moisture exchanged at the boundaries in terms of temperature and moisture content, and simultaneously solves the governing equations for each time step. The model avoids stability problems and limitations to low moisture contents and the usual assumption of constant thermal conductivity. Instantaneous temperature measurements were made at the surface using a thermocouple, while the gravimetric method was employed to determine the volumetric water contents at some specific hours of the experimental period. The observed experimental data compared fairly well with the predicted values, with both having correlation coefficients greater than 0.9 and consequently following a common diurnal trend. The sensitivity of the model was very high to the choice of simulation parameters, especially grid size refinement and time step. While the model underestimated the soil moisture content at 6 a.m. and 10 p.m., the measured temperatures were however overestimated. When compared to moisture content, average errors for temperature were low resulting in a minimal absolute difference in amplitude of 0.81 °C.