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20 cm蒸发皿蒸发量的数学物理模型研究

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A mathematical and physical model study on the 20 cm pan evaporation

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摘要

本文以能量守恒原理和边界层梯度输送理论为基础,应用Monin-Obukhov相似函数计算蒸发皿水面感、潜热通量,参数化蒸发皿侧壁热传输能量,建立了一个单层的20 cm蒸发皿蒸发模型.之后利用"古浪非均匀近地层观测试验"中连续14天观测的每小时20 cm蒸发皿数据对所建模型进行检验.研究分析结果表明:模型能够很好地反映蒸发皿水面与地表之间所形成的非均匀性,合理地概括蒸发皿与周围环境之间的相互作用和蒸发皿蒸发的物理过程.另外,模型成功模拟了蒸发皿蒸发的日变化过程,模拟的日蒸发量均方根误差(RMSE)和平均相对误差(MRER)分别为0.44 mm·d^{-1}和3.7%,日蒸发量观测值与模拟值的相关系数为0.998.

关键词 能量守恒, 非均匀下垫面, 蒸发皿, 蒸发, 数值模拟

Abstract:

Based on the energy conservation principle and the boundary layer gradient transport theory, this paper built a single layer 20 cm evaporation pan model. In this model, both sensible and latent heat fluxes of the evaporation pan were calculated by Monin-Obukhov similarity function. Meanwhile, the heat transport of the lateral wall was parameterized. Following that, the model was verified by the continuous 14-day hourly measurements from the "Gulang Heterogeneous Underlying Surface Layer Experiment". Analysis results showed that the model could reflect the non-uniformity between water surface and land surface. In addition, the results indicated that day performance of the model was good with a root-mean-square error (RMSE) of 0.44(mm·d^{-1}), a mean relative error ratio (MRER) of 3.7% and a correlation coefficient of 0.998.

Keywords Energy conservation, Non-uniform underlying surface, Evaporation pan, Evaporation, Numerical simulation

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