地球物理学报 » 2012, Vol. 55 » Issue (2) :441-451 doi:10.6038/j.issn.0001-5733.2012.02.008

引用本文(Citation):
缪育聪, 刘树华, 吕世华, 张宇.土壤热扩散率及其温度、热通量计算方法的比较研究. 地球物理学报, 2012,55(2): 441-451,doi: 10.6038/j.issn.0001-5733.2012.02.008

MIAO Yu-Cong, LIU Shu-Hua, LÜShi-Hua, ZHANG Yu.A comparative study of computing methods of soil thermal diffusivity, temperature and heat flux.Chinese J.Geophys. (in Chinese),2012,55(2): 441-451,doi: 10.6038/j.issn.0001-5733.2012.02.008

土壤热扩散率及其温度、热通量计算方法的比较研究

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A comparative study of computing methods of soil thermal diffusivity, temperature and heat flux

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摘要 本文利用绿洲系统能量与水分循环过程观测试验的2005年6月11日至15日在甘肃金塔绿洲中部观测的土壤温度、湿度和通量资料,在分析了观测期间土壤温度、湿度和通量特征的基础上,采用振幅法、相位法、谐波法和热传导对流法计算了5~20 cm土壤层的土壤热扩散率.在此基础上,以深度为5 cm的土壤层为上边界条件,计算了10 cm、20 cm深度的土壤温度和10 cm深度的热通量.结果表明:谐波法能很好地计算土壤温度,10 cm和20 cm深度的计算值相对观测值的标准差分别为:0.21 ℃ 和0.18 ℃ ;热传导对流法计算的土壤温度好于振幅法和相位法,但由于忽略了土壤水分通量密度的日变化,该方法用于土壤含水量有明显日变化的浅层土壤时,会出现计算误差.谐波法的计算土壤热通量与实测值最为接近,计算值与实测值的相关系数达到0.868.

关键词 土壤温度, 土壤热扩散率, 土壤热通量, 谐波法, 振幅法, 相位法, 热传导对流法

Abstract: The measurements from "The Oasis System Energy and Water Cycle Field Experiment" were taken over a farmland underlying surface in the Jinta Oasis of Gansu Province during a period from 11 to 15 June, 2005. Based on the analyses of the characteristics of soil temperature, soil moisture and soil heat flux, the thermal diffusivity of 5~20 cm soil layer is calculated by using four methods (Amplitude method, Phase method, Harmonic method, and Conduction-convection method). Taking the 5 cm soil temperature as the upper boundary, the soil temperature of the depth 10 cm and 20 cm and the heat flux of the depth 10 cm are modeled by the four methods. The results showed that the soil temperature modeled by Harmonic method is the most accurate, the standard errors of the two depth modeled values against the observation are 0.21 ℃ and 0.18 ℃ . The Conduction-convection method provided better temperature modeled results than Amplitude method and Phase method, but the results would have errors when the method is used to simulate the temperature of shallow soil whose moisture has a significant diurnal variation. The soil heat flux modeled by Harmonic method is better than any other method mentioned above, the correlation coefficient between the modeled value and the observation is 0.868.

Keywords Soil temperature, Soil thermal diffusivity, Soil heat flux, Harmonic method, Amplitude method, Phase method, Conduction-convection method

Received 2010-12-13;

Fund:

国家重点基础发展计划项目(2009CB421402)资助.

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