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近地层能量闭合度对陆面过程模式影响

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On the effect of the near-surface layer energy closure degree on land surface process simulations

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摘要

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摘要 大量近地层观测试验表明,利用涡动相关法观测的湍流通量小于近地层可利用能量,即近地层能量是不闭合的,这种不闭合度一般为20%甚至更高.而陆面过程模式是基于地气间能量平衡建立,并且模式中的湍流边界层参数化方案通常根据实际观测的湍流通量来确定,因此能量不闭合必将对陆面过程模式造成一定的影响.本文利用2007年春季SACOL站的近地层观测资料,依据能量守恒将能量不闭合中的残余能量通过波文比分配到观测的湍流通量中,即修正涡动相关法观测的湍流通量使得近地层能量达到平衡;之后分别利用观测和修正的湍流通量,建立了能量不闭合和闭合情形下的湍流参数化方案,借助陆面过程模式SHAW,通过数值模拟和对比分析方法考察近地层能量闭合度对陆面过程模式的影响.研究表明近地层能量闭合对陆面过程模式有显著的影响:在陆面过程数值模拟中,当应用近地层能量不闭合的湍流通量形成的湍流参数化方案时,陆面过程模式会明显高估地表长波辐射及土壤温度;但当应用修正湍流通量使得近地层能量达到闭合形成的湍流参数化方案后,在不改变任何地表土壤物理生化属性的情况下,陆面过程模式能较好地模拟地表长波辐射和土壤温度.

关键词 近地层能量闭合, 湍流参数化, 湍流通量, 陆面过程模式

Abstract: Many surface-layer observations have shown that the sum of sensible and latent heat fluxes was lower than the available energy when using the eddy covariance method. It means the observed energy was unclosed. The unclosed degree was usually 20% and even more in particular cases. The land surface models were developed based on the concept of energy balance between the atmosphere and land surface, and the parameterization scheme of the boundary layer in the land surface models were often developed from the observed turbulent heat fluxes. Thus, energy closure degree was bound to affect land surface models. Based on the data observed at SACOL site in spring, 2007, following the law of energy conservation, the residual part of the energy from its imbalance was distributed into the turbulent heat fluxes through the Bowen ratio so as to modify the direct measurement and make energy closed. Then two turbulent boundary layer parameterization schemes were developed as energy closure and unclosure schemes from the observed and modified turbulent heat fluxes. The impacts of energy unclosure and closure on land surface process simulations were investigated by using the land surface model SHAW with numerical simulation and comparing the simulations with the observation. The results suggest that the energy closure remarkably affect the land surface models. For taking using of the energy unclosure turbulent boundary layer parameterization schemes the model obviously overestimated upward longwave radiation and soil temperature. And in the case of using the schemes by modifying the measured turbulent heat flux to make the energy closed, the model is able to better simulate upward longwave radiation and soil temperature with any physical and bio-chemical properties of soil that are kept unchanged.

Keywords Surface energy closure, Turbulent boundary layer parameterization, Turbulent heat fluxes, Land surface process models

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