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Improving land surface emissivty parameter for land surface models using portable FTIR and remote sensing observation in Taklimakan Desert

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Because land surface emissivity (ε) has not been reliably measured, global climate model (GCM) land surface schemes conventionally set this parameter as simply assumption, for example, 1 as in the National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Prediction (NCEP) model, 0.96 for soil and wetland in the Global and Regional Assimilation and Prediction System (GRAPES) Common Land Model (CoLM). This is the so-called emissivity assumption. Accurate broadband emissivity data are needed as model inputs to better simulate the land surface climate. It is demonstrated in this paper that the assumption of the emissivity induces errors in modeling the surface energy budget over Taklimakan Desert where ε is far smaller than original value. One feasible solution to this problem is to apply the accurate broadband emissivity into land surface models.

The Moderate Resolution Imaging Spectroradiometer (MODIS) instrument has routinely measured spectral emissivities in six thermal infrared bands. The empirical regression equations have been developed in this study to convert these spectral emissivities to broadband emissivity required by land surface models. In order to calibrate the regression equations, using a portable Fourier Transform infrared (FTIR) spectrometer instrument, crossing Taklimakan Desert along with highway from north to south, to measure the accurate broadband emissivity. The observed emissivity data show broadband ε around 0.89-0.92. To examine the impact of improved ε to radiative energy redistribution, simulation studies were conducted using offline CoLM. The results illustrate that large impacts of surface ε occur over desert, with changes up in surface skin temperature, as well as evident changes in sensible heat fluxes.

Keywords: Taklimakan Desert, surface broadband emissivity, Fourier Transform infrared spectrometer, MODIS, CoLM