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Land Surface Processes Simulation Over Thar Desert in Northwest India

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Abstract—Land surface processes in data scarce arid north-western India and their influence on the regional climate including monsoon are now gaining enhanced scientific attention. In this work the seasonal variation of land surface parameters and surface-energy flux components over *Lasiurus sindicus* grassland system in Thar Desert, western India were simulated using the mesoscale WRF model. The data on surface fluxes from a micrometeorological station, and basic surface level weather data from the Central Arid Zone Research Institute's experimental field station (26°59′41″N; 71°29′10″E), Jaisalmer, were used for comparison. Simulations were made for typical fair weather days in three seasons [12–14 January (peak winter); 29–31 May (peak summer), 19–21 August (monsoon)] during 2012. Sensitivity experiments conducted using a 5-layer soil thermal diffusion (5TD) scheme and a comprehensive land surface physics scheme (Noah) revealed the 5TD scheme gives large biases in surface fluxes and other land surface parameters. Simulations show large variations in surface fluxes and meteorological parameters in different seasons with high friction velocities, sensible heat fluxes, deep boundary layers in summer and monsoon season as compared to winter. The shortwave radiation is underestimated during the monsoon season, and is overestimated in winter and summer. In general, the model simulated a cold bias in soil temperature in summer and monsoon season and a warm bias in winter; the simulated surface fluxes and air temperature followed these trends. These biases could be due to a negative bias in net radiation resulting from a high bias in downward shortwave radiation in various seasons. The Noah LSM simulated various parameters more realistically in all seasons than the 5TD soil scheme due to inclusion of explicit vegetation processes in the former. The differences in the simulated fluxes with the two LSMs are small in winter and large in summer. The deep mixed layers are distributed in the northeastern parts in summer, northern areas in southwest monsoon and in southwestern parts during winter seasons and associated with the land-cover and vegetation dynamics. Our results present a baseline simulation study in this data scarce arid region.

Key words: Arid climate, WRF, land surface parameters, Noah, 5TD, micrometeorology.

1. Introduction

Given the vast extent of arid and semi-arid regions (≈40 % of the earth's land surface), land–atmosphere interactions play an increasingly important role in understanding weather, climate and regional/global environmental change (Niyogi *et al.* 2010). Arid and semi-arid regions are characterized by low rainfall, sparse but highly dynamic moisture driven vegetation growth, and high temperatures. The regional climate in the arid and semi-arid areas is dynamically coupled to the land surface processes. The Thar Desert situated in the north-western India is a highly populated desert region in the world. It is presently facing changing environmental factors such as precipitation variations, land use alterations and vegetation changes (Goswami and Ramesh 2008). The associated changes in greenness fraction, albedo, surface roughness, net radiation, transport of heat and moisture fluxes, and temperature (Charney 1975; Moran *et al.* 1994; Unland *et al.* 1996) could significantly alter the land–atmosphere coupling in this region.

Modeling of the surface processes over arid eco-regions is very important to study the seasonal variation of various components of surface energy

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