SPECIAL
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Estimation of the Minimum Canopy Resistance for Croplands and Grasslands Using Data from the 2002 International H_2O Project

JOSEPH G. ALFIERI AND DEV NIYOGI
Purdue University, West Lafayette, Indiana

PETER D. BLANKEN
University of Colorado, Boulder, Colorado

FEI CHEN AND MARGARET A. LEMONE
National Center for Atmospheric Research, Boulder, Colorado

KENNETH E. MITCHELL AND MICHAEL B. EK
NOAA/NCEP, Camp Springs, Maryland

ANIL KUMAR
Purdue University, West Lafayette, Indiana, and National Center for Atmospheric Research, Boulder, Colorado

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ABSTRACT

Vegetated surfaces, such as grasslands and croplands, constitute a significant portion of the earth's surface and play an important role in land–atmosphere exchange processes. This study focuses on one important parameter used in describing the exchange of moisture from vegetated surfaces: the minimum canopy resistance ($r_{c_{\min}}$). This parameter is used in the Jarvis canopy resistance scheme that is incorporated into the Noah and many other land surface models. By using an inverted form of the Jarvis scheme, $r_{c_{\min}}$ is determined from observational data collected during the 2002 International H_2O Project (IHOP_2002). The results indicate that $r_{c_{\min}}$ is highly variable both site to site and over diurnal and longer time scales. The mean value at the grassland sites in this study is 96 s m^{-1} while the mean value for the cropland (winter wheat) sites is one-fourth that value at 24 s m^{-1}. The mean $r_{c_{\min}}$ for all the sites is 72 s m^{-1} with a standard deviation of 39 s m^{-1}. This variability is due to both the empirical nature of the Jarvis scheme and a combination of changing environmental conditions, such as plant physiology and plant species composition, that are not explicitly considered by the scheme. This variability in $r_{c_{\min}}$ has important implications for land surface modeling where $r_{c_{\min}}$ is often parameterized as a constant. For example, the Noah land surface model parameterizes $r_{c_{\min}}$ for the grasslands and croplands types in this study as 40 s m^{-1}. Tests with the coupled Weather Research and Forecasting (WRF)–Noah model indicate that the using the modified values of $r_{c_{\min}}$ from this study improves the estimates of latent heat flux; the difference between the observed and modeled moisture flux decreased by 50% or more. While land surface models that estimate transpiration using Jarvis-type relationships may be improved by revising the $r_{c_{\min}}$ values for grasslands and croplands, updating the $r_{c_{\min}}$ will not fully account for the variability in $r_{c_{\min}}$ observed in this study. As such, it may be necessary to replace the Jarvis scheme currently used in many land surface and numerical weather prediction models with a physiologically based estimate of the canopy resistance.

1. Introduction

Grasslands and croplands constitute approximately 40% of the earth's terrestrial surface (Foley et al. 2005). Due to the ubiquitous nature of these landscapes, they play an important role in land–atmosphere exchange processes and subsequent atmospheric phenomena (Burba and Verma 2005). For example, the distribution of grasslands and croplands has been linked to the differential partitioning of the surface energy balance and thus the evolution of the convective boundary layer (Alapaty et al. 1997; McPherson and Stensrud 2005;

Corresponding author address: Dev Niyogi, Purdue University, 915 W. State St., West Lafayette, IN 47907.
E-mail: dniyogi@purdue.edu

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