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• Original Paper •

Regional Features and Seasonality of Land–Atmosphere Coupling over Eastern China

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ABSTRACT

Land–atmosphere coupling is a key process of the climate system, and various coupling mechanisms have been proposed before based on observational and numerical analyses. The impact of soil moisture (SM) on evapotranspiration (ET) and further surface temperature (ST) is an important aspect of such coupling. Using ERA-Interim data and CLM4.0 offline simulation results, this study further explores the relationships between SM/ST and ET to better understand the complex nature of the land–atmosphere coupling (i.e., spatial and seasonal variations) in eastern China, a typical monsoon area. It is found that two diagnostics of land–atmosphere coupling (i.e., SM–ET correlation and ST–ET correlation) are highly dependent on the climatology of SM and ST. By combining the SM–ET and ST–ET relationships, two "hot spots" of land–atmosphere coupling over eastern China are identified: Southwest China and North China. In Southwest China, ST is relatively high throughout the year, but SM is lowest in spring, resulting in a strong coupling in spring. However, in North China, SM is relatively low throughout the year, but ST is highest in summer, which leads to the strongest coupling in summer. Our results emphasize the dependence of land–atmosphere coupling on the seasonal evolution of climatic conditions and have implications for future studies related to land surface feedbacks.

Key words: soil moisture, surface temperature, land–atmosphere interaction, evapotranspiration, coupling

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1. Introduction

In the early 21st century, the Global Land–Atmosphere Coupling Experiment presented a basic concept for studying the effects of land surface factors on atmospheric predictability based on model intercomparison (Koster et al., 2004, 2006). The strength of land–atmosphere coupling is used to denote the potential contribution of land surface states to the variabilities of atmospheric circulation and climate variables such as precipitation and temperature. Soil moisture (SM) acts as a reserve of water and energy because soil retains wet and dry conditions longer than the atmosphere. Therefore, the soil has the potential to affect the atmospheric conditions through different coupling mechanisms (Koster and Suarez, 2001; Wu and Dickinson, 2004; Seneviratne et al., 2006b; Wei et al., 2008; Spennemann and Saulo, 2015). Land–atmosphere coupling, in terms of the degree of SM that affects precipitation and surface temperature (ST), has been extensively studied (Seneviratne et al., 2006a; Zhang et al., 2008a, 2008b, 2009, 2011; Wei and Dirmeyer, 2012; Ruscica et al., 2014; Guillod et al., 2015; Tuttle and Salvucci, 2016). In fact, we need to consider the impact of SM on evapotranspiration (ET) and further ST, rather than the atmospheric control of ET and ST, to better understand the land–atmosphere coupling.

The impact of SM on ET is considered to be the first segment of the connection from land surface states to the atmosphere (Dirmeyer, 2011). First of all, SM is an important source of the atmospheric water. Through ET, a major component of the continental water cycle, SM returns approximately 60% of the total precipitation that falls on land back to the atmosphere (Oki and Kanae, 2006). Secondly, SM also plays an important role in the land surface energy balance,

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