Gradient change of soil moisture effect on next-day precipitation identified via a Random Forest-Granger causality model

*Lu Li[1], Wei ShangGuan[1], Shu Peng Zhang[1], Jin Jing Pan[1], Nan Wei[1], Yong Jiu Dai[1]

1. Guangdong Province Key Laboratory for Climate Change and Natural Disaster Studies, School of Atmospheric Sciences, Sun Yat-sen University

Surface soil moisture influences precipitation through its impact on water and energy cycles. Understanding of soil moisture-precipitation (SM-P) coupling on synoptic scale is important for improving short-term weather forecasting. However, the sign and pattern of SM-P feedback are still controversial, mainly caused by the difficulty to establish causal relationship. In this paper, we use empirical models to separate local land-atmosphere coupling effect from low frequency variation and persistence effects, and use Granger causality to identify the casual relationship between surface soil moisture and subsequent precipitation over China. Five experiments are designed to investigate the impact of the discrepancy of datasets and empirical models on SM-P feedback. Differences of SM-P feedback using different SM-P datasets are minor compared to those of empirical models. We improved the SM-P feedback model by using random forest to eliminate low frequency variation and persistence effects instead of generalized linear model. Moreover, we present a novel SM-P feedback framework by considering spatial impact of data, raising a new feature selection method and a new SM-P coupling index. The corresponding pattern of SM-P feedback shows that (1) positive SM-P feedback appears almost all over China. (2) The effect of surface soil moisture on next-day precipitation probability decreases from arid to humid regions over China. (3) The effect of low frequency variation and persistence on precipitation is larger than the effect of soil moisture, but we must emphasize that soil moisture also plays an important role in arid and semi-arid regions. Our finding statically supports the hypothesis that strong SM-P feedback locates in transition zones and SM-P coupling is higher during wet periods for dry regions.

Keywords: Soil moisture-precipitation feedback, random forest, granger causality

