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The role of land-atmosphere interactions in the evolution of the summer monsoon rainfall in South America

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A relationship between peak summer monsoon rainfall in central-east Brazil, which is part of the South American monsoon core region, and antecedent conditions in spring (early season) is disclosed through diagnostic analysis using observed surface temperature and precipitation data. Rainfall in this region during part of spring holds significant inverse correlation with rainfall in peak summer, especially during ENSO years. A surface-atmosphere feedback hypothesis is proposed to explain this relationship: low spring precipitation leads to low spring soil moisture and high late spring surface temperature; this induces a topographically-enhanced low-level anomalous convergence and cyclonic circulation over Southeast Brazil that enhances moisture flux from northern and central South America into central-east Brazil, setting up favorable conditions for excess rainfall. Antecedent wet conditions in spring lead to opposite anomalies. The main links in this hypothesis are confirmed through correlation analysis of observed data: spring precipitation is negatively correlated to late spring surface temperature in central-east Brazil, and late spring surface temperature in southeast Brazil is positively correlated with peak summer monsoon precipitation in central-east Brazil. The intermediary links of the surface-atmosphere feedback are tested in sensitivity experiments with the regional model RegCM3. These experiments confirm that the proposed links are possible: reduced soil moisture in central-east Brazil is shown to increase surface temperature and produce a cyclonic anomaly over southeast Brazil, as well as increased precipitation in central-east Brazil. A crucial role of the

mountains of Southeast Brazil in anchoring the patterns of intraseasonal variability, and sustaining the “dipole”-like precipitation mode observed over South America is suggested by the experiments. The low predictability of monsoon rainfall anomalies in central-east Brazil during austral summer might be partially ascribed to the fact that the models do not reproduce well the topographical features and the land-atmosphere interactions that are important for the variability in that region.