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Is the link between early and peak monsoon rainfall in South America reproduced in seasonal forecasts?

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Previous observational studies have disclosed a link between peak summer monsoon rainfall in central-east South America, comprising part of the monsoon core region, and antecedent conditions in spring. Rainfall in this region during part of spring shows significant inverse correlation with rainfall in peak summer, especially during ENSO years. The corresponding precipitation anomalies appear in the first modes of spring and summer variability for South America. A surface-atmosphere feedback hypothesis involving soil moisture in spring has been proposed to explain this relationship, and a crucial role of the mountains in central-east Brazil is suggested by modeling experiments. Low spring precipitation leads to low spring soil moisture and high late spring surface temperature in that region; this induces a topographically-enhanced low-level anomalous convergence and cyclonic circulation over Southeast Brazil that enhances the 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 temperature anomalies in the southern part of central-east Brazil seem to be the most related to the precipitation over the entire region in peak summer.

There has not been any assessment of climate models' ability in reproducing this relationship between early and peak summer monsoon rainfall in central-east South America. This is one of the regions in which the seasonal forecasts for austral summer precipitation (DJF) have no skill. Such an assessment could shed some light on

the reasons for this bad performance. Therefore, we analyze austral spring/summer seasonal forecasts with focus on the interannual variability and on the relationship between the spring conditions and the summer forecast.

Output from the CPTEC/COLA AGCM seasonal simulations for the SMIP2 project are used in the analysis. This spectral atmospheric model was integrated with T62L28 resolution for the SMIP2 period (1979 to 2001), applying observed SST as boundary conditions. The model is run each year for four overlapping seasons, considering simulations of six months. In this study, the ensemble mean of five simulations for SONDJF will be analyzed.

The model is not able to reproduce the differences between the first and second observed spring and summer rainfall modes for South America, at least not through modes that explain comparable variance, and therefore its first mode, related to ENSO, explains a much higher fraction of the variance than the first observed mode, both for spring and summer. In spite of the exaggerated response of the model to ENSO, it does not represent certain important characteristics of the observed spatial distribution of the precipitation anomalies, which are important for the spring-summer relationship in central-east Brazil. It shows a dipole-like structure with opposite anomalies in central-northern and southeastern South America, both in spring and summer, and does not reproduce the strong precipitation anomalies in central-east Brazil in spring present in the observed mode. This might be ascribed to the incomplete simulation of ENSO teleconnections over South America, especially over central-east Brazil.

If the spring precipitation anomalies in central-east Brazil are not well represented, then the relationship between spring and summer precipitation cannot be reproduced. The correlation between the first spring and summer modes from the model is negative, which means that the model tends to produce anomalies of the same sign in spring and summer in most of this region, while the tendency to changing sign prevails in the observed modes.

It is not possible to say that the model does not reproduce the inverse relationship between precipitation in central-east Brazil in spring and summer, as the precipitation in spring is not well simulated in this region, and therefore cannot trigger the processes that lead to reverse precipitation anomalies in peak summer. The analysis of one of the members of the ensemble (not shown) suggests that this relationship would be reproduced provided that the precipitation anomalies over central-east Brazil in spring are correctly represented.