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Predictability of seasonal Sahel rainfall using GCMs and lead-time improvements through a coupled model

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The ability of several atmosphere-only and coupled ocean-atmosphere General Circulation Models (GCMs) is explored for the prediction of seasonal July-September (JAS) Sahel rainfall. The atmosphere-only models driven with observed sea surface temperature (SST) over the period 1968-2001, confirm the poor ability of most models to represent Sahel rainfall variability. However, application of a model output statistics (MOS) to the predicted low-level wind field over the tropical Atlantic and western part of West Africa, yields good Sahel rainfall skill for all models. Skill is mostly captured in the leading empirical orthogonal function (EOF1), representing large-scale fluctuation in the regional circulation system over the analysis domain. This finding has operational significance for the utility of GCMs for short lead-time prediction based on persistence of June SST information, but studies have shown that for longer lead-time forecasts, there is substantial loss of skill, relative to that achieved using the observed JAS SST. The potential of coupled GCMs is therefore explored for extending the lead-time of Sahel rainfall predictions. Some of the models studied, when initialized using April information, show potential to at least match the levels of skill achievable from assuming persistence of April SST. One model (NCEP CFS) was found to be particularly promising. Diagnosis of the hindcasts available for the CFS (lead-times up to six months, for 1981-2008) suggests that, especially by applying the same MOS approach, skill is achieved through capturing interannual variations in Sahel rainfall (primarily related to El Niño / Southern Oscillation in the period of study) as well as the upward trend in Sahel rainfall that is observed over 1981-2008, which has been accompanied by a relative warming in the North Atlantic, compared to the South Atlantic. At lead-times up to six months (initialized forecasts in December) skill levels are maintained with the correlation between predicted and observed Sahel rainfall at approximately r=0.6. Achieving the interannual skill and achieving skill at the longer lead-times, is substantially dependant on the application of the MOS, with information again mostly represented by EOF1. The suggestion is that coupled GCMs are capable of breaking through the lead-time prediction barrier for Sahel rainfall, with valuable information available in at least one model now, and encouraging further experiments and diagnosis with other coupled models at these longer lead-times.