Climate Dynamics of Africa in the NCEP Climate Forecast System

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The ability of the different versions of the NCEP Climate Forecast System (CFS) to correctly simulate the climatology and variability of the African climate system is evaluated. Emphasis is on the circulation characteristics that support the precipitation climatology and the physical processes of rainfall variability associated with droughts and floods over several regions in sub-Sahara Africa. The model integrations are the CFSv1, CFSv2 April and June ICs, and the experimental high resolution CFS-T382 April IC. CDAS is used for control of the flow patterns, while GPCP, CMAP, and PREC/L are used for control of the precipitation. Examining the climate base state over West Africa, a latitude-height cross section formed using CDAS reveals important observed circulation features: The low level westerly jet (LLWJ) extends as deep as 800 hPa near 15°N; the mid-level African easterly jet is centered at about 600 hPa; the tropical easterly jet (TEJ) is present at about 200 hPa with wind maxima around 5°N. These three basic features of the West African monsoon system are present in all versions of the CFS. However, the LLWJ do not extend as deep into the troposphere as in CDAS. The TEJ in the CFS is also diffused with no clearly marked area of maximum velocity. The three observational climatologies of the summer precipitation over Africa show a zonal precipitation band punctuated by three regional precipitation maxima, centered respectively on the west coast, the Cameroon highlands in the eastern Guinean coast, and the Ethiopian highlands in the east. The climatologies are very similar. Each of the CFS versions captures the zonally oriented precipitation maximum feature with some degree of realism. However, precipitation does not extend as far north as observed. The CFS T-382 provides a more reasonable simulation. Both CFSv1 and CFSv2 have unrealistic precipitation amounts over the Gulf of Guinea region. To evaluate the degree to which the CFS captures precipitation interannual and decadal variability of the West African monsoon system, the Sahel rainfall increase of the past 10 years and the physical processes associated with it, are examined. SST anomalies in the Atlantic and the precipitation response are analyzed for both April and June ICs. Both CFS T-382 April IC and CFSv2 April IC capture reasonably well the warming trend in the tropical north Atlantic and the Sahel rainfall recovery. The CFSv1 did not. However, for June IC, both CFSv1 and CFSv2 represented the SST increase in the tropical north Atlantic. Unlike CFSv1, CFSv2 did not reproduce the Sahel rainfall increase. Forecast skill assessments for the Jul-Sep season April IC show moderate (low) skill scores over central (western) Sahel for CFSv1. CFSv2 is an improvement over CFSv1 only for the western end of the Sahel. For June IC, skill scores for CFSv1 are higher than that for CFSv2 across West Africa. CFS T-382 April IC has higher skill scores than CFSv1 and CFSv2, and represents an improvement over them for West Africa. The ability of the CFS to correctly simulate the physical processes associated with rainfall variability in East Africa and southern Africa is also evaluated and presented.