Recent climate anomalies in the Sahel: natural variability or climate change?

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Introduction

The Sahel, a narrow band of land sandwiched between the Sahara desert and the Savanna lands in the Gulf of Guinea region, experienced extremely heavy rains during the period from June to October 2005. The season was the wettest in over 30 years and flooding persisted for months in this semi-arid region of West Africa, particularly at its western end. At the same time record breaking tropical storm (TS) activity occurred in the Atlantic. Many of these storms originated off the coast of West Africa. The indication that climate change may have contributed to extreme climate anomalies has been the subject of numerous debates both within the research community and with the public. The physical processes associated with the exceptionally wet 2005 Sahel rainfall are examined with the emphasis on the role of the dominant modes of variability on the synoptic (large-scale) features.

The 2005 Sahel rainfall season

Overall, the rainy season across the Sahel was characterized by enhanced rainfall activity, with amounts about 15% above the long term climatological mean for the period 1950-2005. However, this represents a 60% increase in rainfall considering the most recent 30 years climatological mean for 1971-2000. In the western part of the Sahel, the rainfall season was marked by highly frequent heavy rainfall episodes. The rainfall increase was even more significant (Fig. 1) and resulted in flooding in many locations and an increase in infectious disease outbreaks, mainly cholera and malaria. This marks a sharp contrast from the long term drying trend that started in the early 70s and continued into the 80s and the 90s. Over the past 3 years, the coupled ocean – atmosphere system has been quite similar to observed conditions during the 50s and 60s. In particular, during the 2005 rainfall season, the Atlantic dipole mode (ADM) featuring a warm tropical north Atlantic and a cool Gulf of Guinea was quite prominent. This is a known mode of variability of Sahel rainfall on the interdecadal time scale and is conducive to enhanced rainfall across the Sahel (Lamb et al., 1992). The ADM appeared during the spring and persisted throughout the summer. The persistence of the enhanced temperature gradients maintained the intertropical discontinuity (ITD) to the northern fringe of the Sahel and created favorable conditions for the formation and development of African wave disturbances. The low level westerlies, the northward position of the African Easterly Jet (AEJ), and enhanced cyclonic vorticity along the equatorward flank of the jet supplied moisture and energy to the disturbances. Due to the importance of land surface feedback in Sahel rainfall characteristics, the wet soils also contributed to maintaining the favorable rainfall conditions through evaporation and enhanced soil moisture gradients between the Sahel and the Gulf of Guinea region.

As the Sahel was being soaked with extreme heavy rains, the number of Atlantic tropical storms (ATS) and hurricanes surged. Some of these made landfall in the US, including Hurricane Katrina and Rita, which devastated parts of Louisiana and the Gulf states.

Consistent with the "rainfall recovery" in the Sahel, there has been an increase in ATS over the past 5 years. From June to November 2005, the Atlantic was host to 26 tropical storms compared to an average of 10, which represents an increase of 160%.

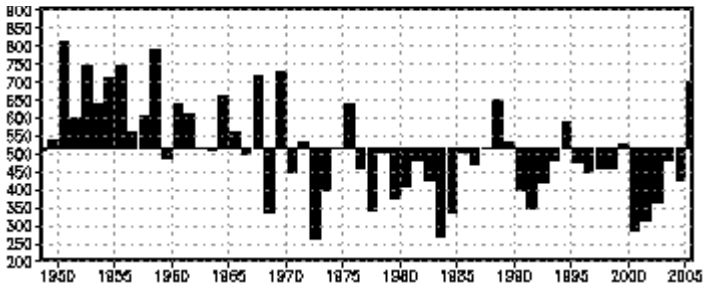

Fig. 1: Senegal Jul-Sep rainfall index in mm for the area (12.5-15N,15-17.5W) and for the period 1948-2005. Base period is 1948-2005.

Climate Change?

For several decades, research has focused on the causes of the dryness in the Sahel. Earlier studies identified desertification and land degradation as a possible cause for the persistent drought in the Sahel. Other studies suggest that build up in dust as a result of changes in land surface, exacerbated by anthropogenic factors, may have influenced large-scale climate (Nicholson, 2000). There is clear evidence of rising global temperatures due to a gradual increase in greenhouse gases (GHGs) such as CO_2 and N_2O. This tendency may ignite large scale climate fluctuations, which ultimately may have an impact on Sahel rainfall (Biasutti and Gianini, 2006). However, the regional atmospheric response to these increases is not very clear. Will it be a very wet or a very dry Sahel, or just a Sahel with more frequent dry years as Cook and Vizy (2006) suggested? Projections into the future in coupled model forced by various GHG increase scenarios do not provide consistent results. The literature on climate change research is growing and undoubtedly our understanding of the land-ocean-atmosphere coupling has improved. Ultimately there will be a breakthrough on the understanding of regional climate response to anthropogenic effects. Until then, it is plausible to believe that the ongoing multi-decadal signal, which explicitly includes an enhanced West African monsoon system, was at least partly responsible for the heavy rains in the Sahel and the enhanced ATS activity during 2005. An advanced understanding of the influence of modes of variability at all time scales on Sahel rainfall, and the ability of the models to accurately represent these modes of variability will help improve seasonal to interannual climate predictions for the benefit of society (Thiaw and Bell, 2004). This was certainly the case for the summer of 2005 as many climate models predicted reasonably well the enhanced rainfall activity across the Sahel.

References

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