Oceanic Origin of Sahel Precipitation Jump Observed from Space

W. Timothy Liu, Xiaosu Xie, and Kristina B. Katsaros Jet Propulsion Laboratory California Institute of Technology

Significance

The socioeconomic vulnerability of the agricultural society of West Africa to the vagary of summer rainfall was overlooked by the world in the past

• AMMA underscores the fundamental gaps in our knowledge and systematic errors in dynamical models used for prediction

Sahel Precipitation Jump



 Past hypothesis
relate southern
rainfall to meridional migration of ITCZ and northern region to easterly jets

Monsoon-the basic definition

Monsoon is the seasonal reversal of wind between land and ocean that has strong rain effect

Synoptic rain events should be linked to seasonal oceanic influence in monsoon context.

 Interannual and decadal modifications of monsoon in terms of global teleconnection between rain and SST must be interpreted through regional ocean-land exchanges.

Moisture transport between ocean and land, available at wide spectrum of spatial and temporal scales, is the crucial factor between wind and rain **Moisture Transport**

$$\Theta = \frac{1}{g} \int_{0}^{p_{0}} qUdp$$
$$W = \frac{1}{g} \int_{0}^{p_{0}} qdp$$
$$\Theta = UeW$$

Ue is depth averaged velocity weighted by humidity Ue=f(Us) Liu (1993)-polynomial Liu & Tang (2005) - Neural Network Ue = U_{850mb} Heta & Mitsuta (1993) Both Us & U_{850mb} Xie et al. (2008) – SVM Ue is different from Us, because upper level advection is different from the surface advection

Oceanic influence from Gulf of Guinea and Atlantic







Interannual Anomalies



Summary

 Sahel Rain is in-phase with integrated moisture transport (IMT) from Atlantic, peaking in August

 Rainfall in south and IMT from Gulf of Guinea are two months ahead

• In August, onshore IMT extends far up in the troposphere supplying moisture and instability for heaviest rainfall in the Sahel.

• The anomalous wet season in 1999 is caused by the positive (eastward) anomalies of IMT from the Atlantic and the anomalous dry summer of 2005 is associated with negative (westward) anomalies of IMT over the Atlantic.