NC STATE UNIVERSITY

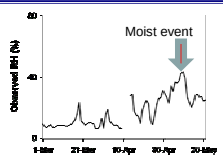
Investigation of the Interactions among Transient Atmospheric Wave Disturbances over West Africa During Boreal Spring of 2009

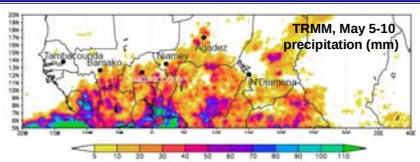
R.J. Mera[1,2] and F.H.M. Semazzi[1]

[1]North Carolina State University, Climate Modeling Laboratory climlab.meas.ncsu.edu, [2]Oregon Climate Change Research Institute

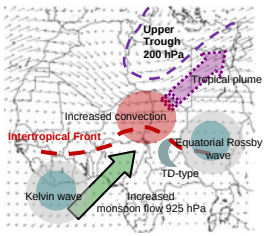
Introduction: Weather and climate of the West African monsoon during the boreal spring is of primary concern for the population in the region due to its influence in areas such as health. The end of meningitis outbreaks, for example, tends to coincide with influx of moisture at the end the dry season. This study serves as a complement to work currently under development at the University Corporation for Atmospheric Research (UCAR) Africa Initiative by analyzing the influence of transient atmospheric disturbances and evaluating the skill of WRF forecasts of weather variables that are relevant to meningitis management in the region.

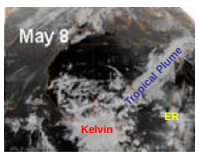
Objectives: (1) Identify the occurrence of equatorial systems (Madden-Julian Oscillation, Kelvin waves, Equatorial Rossby waves and Tropical Depressions (TD-type) over West Africa during spring 2009 (2) Explore interactions between atmospheric wave disturbances. (3) Analyze the WRF regional model 's ability to simulate transient systems.





Transient Systems: Early May 2009 saw a significant moist event that penetrated areas of the Sahel that had seen continuous dry season conditions until that point. Rainfall during this time reached as far north as Agadez (Niger); places like Niamey (Niger) saw relative humidity reach 40% (deemed important for cessation of meningitis in the region, *Besancenot et al., 1998*)

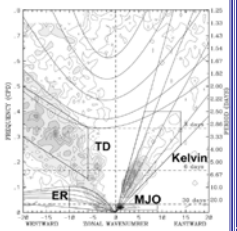




← Schematic of main constituents of the May 2009 event portrayed in the Meteosat-7 IR image

Multi-scale interactions: During May 4-11, several systems converged over the Sudano-Sahel and caused increased convection that brought significant precipitation and moisture to the region. This consisted of equatorially-trapped waves (Kelvin and Equatorial Rossby), a westward-propagating TD-type disturbance, and forcing from the extratropics due to a strong upper-level trough over Libya and the associated tropical plume

Equatorial waves: We use a wavenumber–frequency filtering technique (*Wheeler and Kiladis, 1999*) to separate different wave types present in outgoing longwave radiation (OLR) observations.



After Janicot et al. (2009)

Concluding Remarks:

The spring of 2009 was marked by a series of westward-propagating, transient events that modulated the moisture in the atmosphere over the Sudano-Sahel.

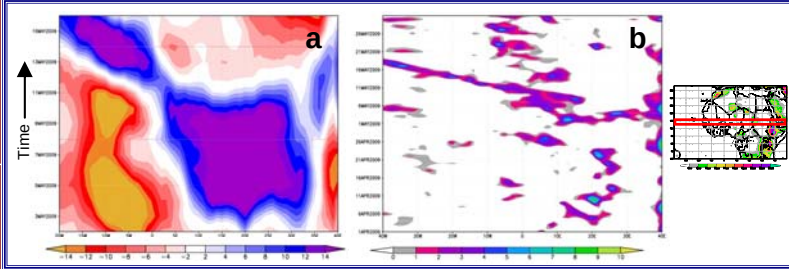
An Equatorial Rossby wave provided nearly-stable positive moist anomalies over the central Sahel throughout late April and early May.

Wave phasing between a Kelvin wave and a developing Rossby couplet / TD-type system in early May 2009 allowed for intensification of the early-season easterly wave.

The May 2009 event may also be linked to forcing from the extratropics by way of a Tropical Plume, as described in Knippertz and Fink (2008).

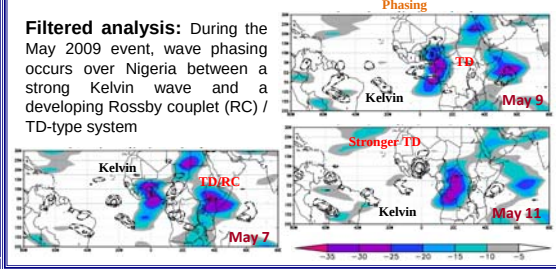
Convergence of intraseasonal phenomena during the May event allowed for abundant convection throughout tropical Africa and is consistent with the summertime intraseasonal convective maxima.

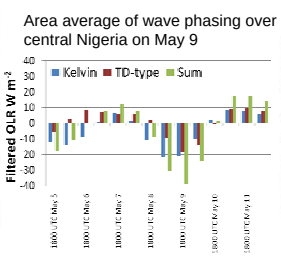
The WRF regional model is able to capture westward-propagating events.

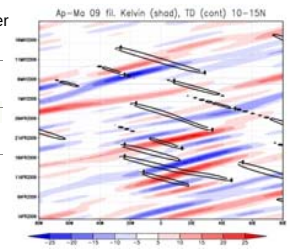


Unfiltered analysis: a) 3-day running mean of precipitable water (kg m^{-2}) for all points along 15N and b) meridional wind (m s^{-2}). In (a) we highlight the slow-moving moist background anomaly; in (b) the faster, westward-moving TD-type system exemplified by the southerly flow. NCEP Final Analyses (FNL) was used for these plots.

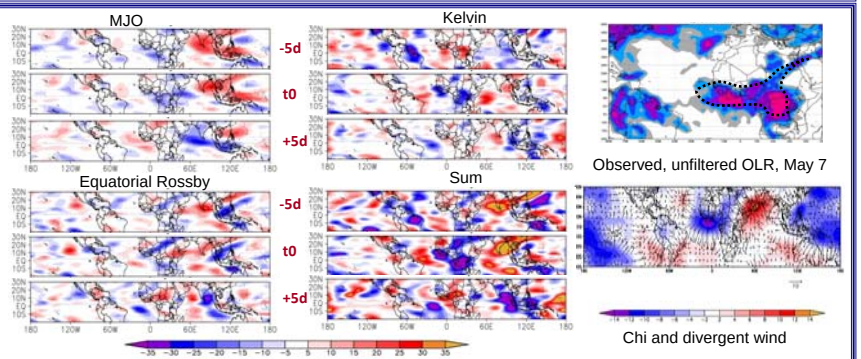
Filtered analysis: During the May 2009 event, wave phasing occurs over Nigeria between a strong Kelvin wave and a developing Rossby couplet (RC) / TD-type system



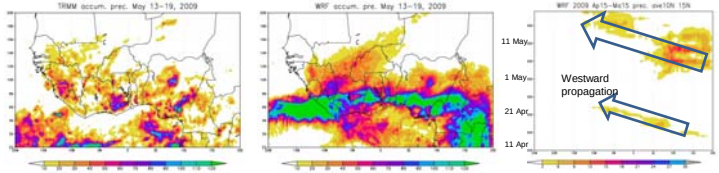




Intraseasonal Phenoma: Filtered OLR shows convergence between different systems over the Sudano-Sahel and most of tropical Africa: slower-moving MJO and Equatorial Rossby waves. In addition, a particularly strong Kelvin wave also influences the convection, which is at its maximum on May 7 (t0). This finding is consistent with previous work on intraseasonal maxima (minima) of precipitation during the boreal summer *(Matthews 2004, Janicot et al. 2009, Gu 2009).*



Regional Climate Modeling: The Weather Research and Forecasting Model (WRF Version 3.0) was tested to determine its ability to simulate transient events. The model (b) captures the rainfall pattern in Tropical Rainfall Measuring Mission (TRMM, a).The Hovmoller, time-longitude diagram (c) displays the westward motion of the TD-type system.



Funding and Collaborators: Primary funding for this study was provided by the National Oceanic and Atmospheric Administration (NOAA) Interdisciplinary Scientific Environmental Technology (ISET) program and Google.org. Collaborators include the principal investigators Rajul Pandya at the University Corporation for Atmospheric Research (UCAR), and Fred Semazzi (North Carolina State University), as well as Mary Hayden, Thomas Hopson, Arlene Laing, Jeff Lazo, Thomas Warner, Thomas Yoksas at National Center for Atmospheric Research (NCAR)/UCAR, Madeleine Thomson and colleagues at the International Research Institute (IRI) for Climate and Society, and Benjamin Lamptey (Ghana).