

# Provision of Nested Model-Based District-Scale Weather & Climate Information for Supporting a Proactive Strategy for Meningitis Vaccination

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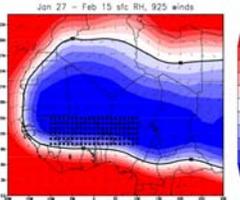
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**Introduction:** Meningococcal meningitis is one of the deadliest and most terrifying illnesses in Africa because of the swift onset of its epidemics and the severity of its impact. The meningitis season ends with the higher humidity levels that come with the onset of the West African monsoon. The most robust and useful weather/meningitis relationship comes from the strong correlation between the start of the rainy season and the abrupt decline in the transmission of the disease. The focus of this specific component of a Google.org funded project, involving partnership of several institutions in the US & Africa (NCSU, UCAR, IRI, NHRC, RMU), is to investigate the feasibility of using the nested or downscaling numerical modeling method to provide accurate advance weather and climate information at the district scale that can be used to support a proactive meningitis vaccination campaign in Ghana initially, and ultimately the entire meningitis belt across West Africa. We present preliminary results on the merits of regional modeling capabilities & propose a framework for international research collaboration in the integration of health information and climate information for supporting MERIT's vaccination campaign.

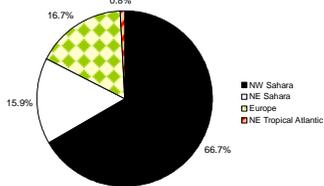
**Objectives:** (1) Identify geographical pathways and sources of atmospheric humidity in West Africa, (2) investigate the feasibility of using the nested or downscaling numerical modeling method to provide accurate advance weather and climate information at the district scale that can be used to support a proactive meningitis vaccination (3) propose an international framework for research collaboration in the integration of health information and climate information to support MERIT's vaccination campaign.

**Parcel Trajectory Analysis using Global Model Reanalysis Data:** Analysis focuses on three different time periods representing the dry Harmattan (Jan 27 – Feb 15), transition period (Apr 16 – May 4), and monsoon onset (Jun. 11 – Jun 30).

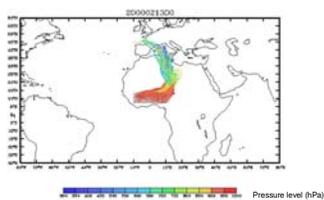
### Surface Relative Humidity



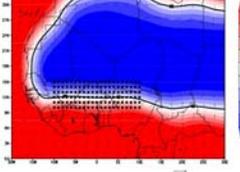
### Parcel Source Regions



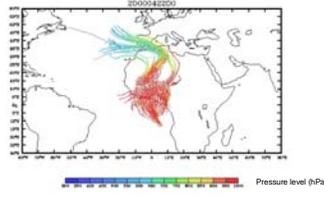
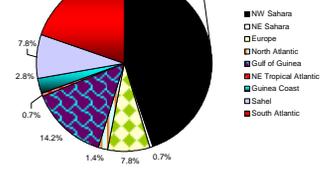
### Sample Trajectory for Individual Days



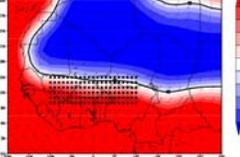
### Surface Relative Humidity



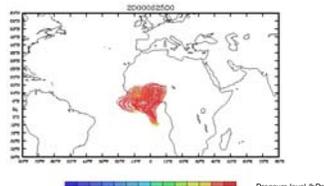
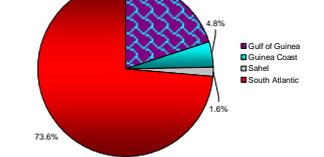
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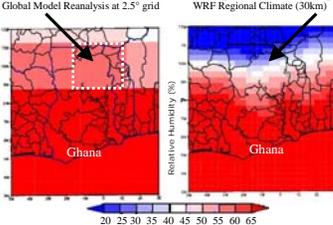
### Surface Relative Humidity



### Parcel Source Regions



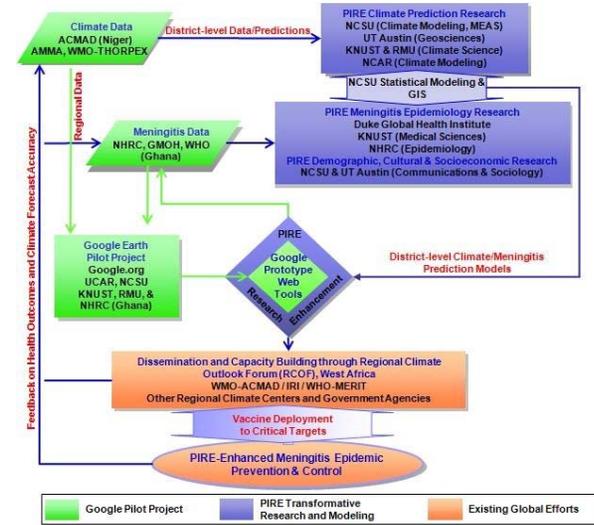
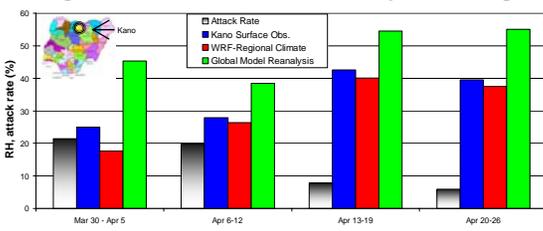
### Dynamical Downscaling Advantage



WRF Regional Model (red) accurately reproduces the anticorrelation between onset of observed high humidity (blue) and the abrupt decline in the transmission of the disease (grey-black) over Kano, Nigeria. GCM-based data (green) overestimates humidity.

Attack Rate: No. cases / 100,000, per week  
 WHO Multi-disease Surveillance Centre, Ouagadougou, Burkina Faso  
<http://www.meningvax.org/press-reports.htm>

### Meningitis Attack Rates & Relative Humidity at Kano, Nigeria



Elements of a Proposed Climate/Health Integration Research Framework Under Consideration for Funding by the National Science Foundation PIRE Program in the US

**Conclusions and recommendations:** Our parcel trajectory analysis is providing new insight of the pathways for atmospheric humidity over the Sahel during the dry season, the transition period, and the early monsoon. Air masses can be traced to upper levels of the atmosphere from the mid-latitudes during the Harmattan, and to lower level parcels traversing the South Atlantic and Gulf of Guinea regions during the monsoon. The nested numerical modeling method (spatial foot print 30 km) provides more accurate weather and climate information than information taken directly from global climate models (GCMs) which have a much larger spatial foot print (275 km). The higher resolution model and can be used to diagnose moisture regime preceding the West African Monsoon for health efforts in the region and help to guide vaccination decisions at the district level.

We propose an international research collaboration framework (above) focusing on development of a new end-to-end paradigm that seamlessly links meteorological observations from multiple monitoring sensors to the generation of meningitis-relevant weather information products that can be integrated into local prevention efforts. The research components comprise: (1) climate sensor science and development of algorithms that transform digital signals from satellites and other platforms into meteorological data; (2) optimally combining observations and data from the global observing network and unconventional monitoring platforms (e.g., COSMIC GPS satellite constellation); (3) creation of forecasts based on high-resolution numerical weather and climate models; (4) integration of climate and meningitis information in the meningitis-vaccination decision system; and (5) integration of cultural, social, political, economic, and educational metrics into preventive strategies against meningitis. The unifying problem to be addressed in the proposed collaboration is the cascade and minimization of uncertainty among the key research component.

**Funding and Collaborators:** Primary funding for this study was provided by the National Oceanic and Atmospheric Administration (NOAA) Interdisciplinary Scientific Environmental Technology project (ISET; PI Climate, Fredrick Semazzi) and Google.org project. Collaborators: Rajul Pandya (Co-PI, University Corporation for Atmospheric Research, UCAR), Fredrick Semazzi (Co-PI, North Carolina State University), Mary Hayden, Thomas Hopson, Arlene Laing, Jeff Lazo, Thomas Warner, & Thomas Yokkas 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).