# Proposed Pilot Projects for the UCAR Africa Initiative

**Presented to the President's Council on 17 November 2006**

**Prepared by: Roelof Bruintjes, Arlene Laing, Raj Pandya, Mel Shapiro, and Tom Warner**

## Background

This document presents a consensus recommendation from the UCAR Africa Initiative team, a group that includes members of UCAR, NCAR, and UOP. This document outlines a set of pilot activities that will launch the UCAR Africa Initiative. These pilot projects were chosen because they:

- Offer clear benefit to African people
- Address scientific concerns that are important to Africa and significant globally
- Contribute to longer-term research capacity in the atmospheric sciences
- Include collaboration with African scientists and stakeholders
- Build on demonstrated UCAR expertise with minimal ramp-up
- Offer the probability of near term success
- Encourage international collaboration

## Science Goal

Increase knowledge of the role of African weather, climate, and biogeochemical processes in the Earth system

## Societal Impacts Goal

Use that knowledge to develop improved operational systems and dissemination that will improve lives in Africa, including contributing to the development of operational early warning systems for environmental hazards that threaten public health, food security, and economic well-being

## Supporting Goals

In order to achieve these overarching objectives, the UCAR AI will first focus on capacity-building efforts, which will

A. Enhance existing observational networks and improve data sharing to facilitate the acquisition and use of real-time observations, including weather radar (Proposed Activity A)
B. Advance regional numerical weather prediction and the use of weather and climate information (Proposed Activity B)
C. Offer educational and collaborative opportunities for students and professionals in the atmospheric and related sciences (Proposed Activity C)

## Collaboration

The group believes that international collaboration is an important component of a successful long-term effort. Toward that end, we propose that AI efforts continue to (i) identify potential UCAR partnerships with ongoing and proposed international programs, such as the African Monsoon Multidisciplinary Analysis (AMMA) and The Observing system and Research Predictability Experiment (THORPEX); ii) solicit

expertise from colleagues at NOAA, NASA, and UCAR member institutions who are currently involved in research and operational applications in Africa; iii) assess funding opportunities from US national and international agencies (e.g., the World Bank and the World Health Organization), humanitarian organizations, and private foundations, in order to expand UCAR's engagement in an international program on weather, climate, and associated societal applications in Africa. Although not part of this proposal, travel funds and administrative support are necessary for programmatic development and to nurture these collaborations.

## Introduction

The vulnerability of most African populations to environmental disasters has been dramatically highlighted during recent decades. Noteworthy examples include: droughts in the Sahel from the mid 1970s to early 1980s; drought in East Africa in 1984 and 2006; tropical cyclones and floods in southeastern Africa in 2000; droughts in southern Africa in 2002; and extreme dry and wet conditions combined with locust outbreaks in the Sahel during 2004. As recently as September 2006, floods left tens of thousand of people homeless in Niger and Burkina Faso. The loss of property, livestock, and crops was exacerbated by water-related diseases such as cholera and malaria. Other diseases such as meningitis are associated with dust storms, the extremes of which are prevalent during the dry season (December to April).

The ability of African societies to reduce their vulnerability to environmental disasters is tied to the quality and application of weather and climate information and prediction. On a daily basis, knowledge of the spatial and temporal variability of precipitation is needed to manage agriculture, water resources, public health, and renewable energy. On a long-term basis, local and regional changes in precipitation are likely as human activity induces inadvertent changes in the atmosphere from local (urbanization, biomass burning) to regional (deforestation and other land surface changes), and global scales (greenhouse gases, aerosols).

The benefits of an improved understanding and a more robust operational capability would be profound. In marginally suitable climates such as the Sahel, or where the monsoon is uncertain, it is especially important to have accurate weather forecasts to aid in decision making by subsistence farmers. Also, agriculture in many areas is vulnerable to locust populations, and the effects of outbreaks could be mitigated through accurate rainfall predictions. Public health in Africa would also benefit in numerous ways. Dust storms are regionally common and have significant impacts on meningitis and many respiratory illnesses such as bronchitis and emphysema; improved dust storm prediction would allow vulnerable individuals to avoid exposure. In addition, malaria could be reduced by eliminating opportunities for standing water when rain is forecast. Lastly, in terms of public safety, prediction of heavy rainfall would reduce the loss of life from flooding, while the prediction of aviation-sensitive weather would improve safety on a continent where air transport is heavily relied upon for commerce.

Before African scientists and operational meteorologists can be in a position to address the long-term societal and scientific goals outlined in this proposal, an improved data collecting and weather-forecasting infrastructure is needed. Additionally, members of the African Meteorological and Hydrological services have suggested that improved products and dissemination will enhance in-country support for their efforts, and augment their long-term effectiveness. For these reasons, the

initial activities outlined here address the development of additional research and operational capacity in Africa.

## Proposed Activity A.) West Africa Regional Radar Network: $110,000[1]

The use of radar in rainfall and cloud structure measurements has become an important tool over the past twenty years. Because meteorological radars provide a wealth of information about precipitating cloud systems it has also become essential to employ state-of-the-art software systems to display and analyze the data. While networks of weather radars are common in many western countries, large parts of Africa and other developing countries are not currently covered by weather radars. Recently, African countries have started to acquire weather radars but in many cases have lacked the infrastructure to maintain or calibrate the radars and interpret and analyze the data collected from these radars.

The objectives of the proposal are to sustain a network of radars for a period of at least three years in collaboration with Burkina Faso and Mali institutions and scientists:

1. Two new EEC Doppler C-band weather radars (in Ouagadougou and Bobo Dioulasso in Burkina Faso) upgraded with NCAR HIQ receiver and analyses software.
2. A Doppler C-band radar in Bamako, Mali with the NCAR HIQ receiver and analyses software.
3. Network Mali and Burkina Faso radars and potentially Niger and Senegal radars.
4. Stream data to UNIDATA for collaborative scientific analyses between African and other scientists.
5. Education and training (A training program in the calibration and maintenance of the radars and software packages).

The upgrades will remain beyond the completion of the AMMA program and could be utilized in subsequent years to gather longer-term radar climatology of the region. They will also provide valuable information on long-term rainfall patterns in the Sahel region and ground-validation for TRMM and GPM.

## Proposed Activity B.) An Improved Operational Modeling in West Africa: $125,000

Presently, there are no permanently running mesoscale models providing products for Africa. While there are coarser-resolution models operated by the French, the UKMO, and the ECMWF, which provide services for selected countries, there are several problems with this system. First, products from these systems are not uniformly available in all countries. Second, the models' products have not been designed to meet specific local needs. Third, raw digital products are often not available to drive coupled models for hydrological or agricultural purposes. Fourth,

[1] These figures include salaries and benefits, but do not include UCAR or NCAR overhead.

these models are not run by African meteorologists. For all these reasons, capacity building in the area of numerical weather prediction (NWP) is not taking place.

We propose to use the WRF model as the basis for a prototype operational system for the continent in general, and for West Africa in particular. Our initial focus will be in West Africa because Dr. Ben Lamptey will be returning to Ghana in one year, after the second year of his UCAR ASP post-doctoral appointment, and he will likely assume a leadership role in the Ghana Meteorological Agency and/or a University there. Ben has been an operational forecaster in Ghana, and he has many contacts with stakeholders there and with leaders in the meteorological communities of many West African nations.

There will be two phases to our effort of building NWP capacity in West Africa. This proposal focuses on the first, wherein a prototype operational WRF model is set up for the region, operational products are provided to African meteorological services through a web interface, and model forecasts are verified against data and the model improved as needed. This Phase-I effort provides the foundation for the funding of Phase-II through the Millennium Challenge Corporation (MCC), a U.S. government entity that has earmarked $547,000,000 for capacity building in Ghana alone. An RFP is expected from the MCC later this calendar year. An historical requirement of organizations that wish to be funded by the MCC is that they already have a presence in the country. Our involvement in the Phase-I effort should establish our commitment to that country, and enable us to participate in a more-substantial, longer-term effort that is funded through the MCC. The second phase will include: the production of higher-resolution model products over a larger area; training for Africans in the maintenance of an operational NWP system; installation of a modeling system in Africa; collaborations with African scientists and stakeholders in the agricultural and water-resources communities to enable more-productive use of the new weather guidance; and training in the use of mesoscale model products for this region.

*Phase-I tasks*

Phase-I tasks are shown chronologically, as follows. The overall duration of the work will be about 15 months.

- Purchase a modest-sized Linux cluster for running the operational model.
- Install an operational version of WRF on the cluster. Adapt the model ingest system to use local observations. It is anticipated that an 8-node cluster could support the grid configuration in Fig. 1, where the inner-grid forecasts would be 24 h in length and the outer grid forecasts would be 36 h long. New forecasts would be initiated every 6 h, and the grid increments would be 13.5 km and 40.5 km.
- Run the model operationally, with verification at NCAR of the veracity of the forecasts. Perform model modifications as necessary to tune it for West Africa.
- Provide prototype products publicly via the web.
- Through Ben Lamptey's contacts in Ghana and elsewhere in West Africa, identify stakeholders with whom we can work in Phase-II.

*Cost estimate*

- NCAR staff salary (model setup, monitoring and verification) – 0.4 FTE: $80,000
- Travel (liaison with the University and Meteorological Agency in Accra, Ghana) – 1 person, 1 week: $5,000

- Computing equipment (8-node cluster) - $40,000

## Proposed Activity C.) Workshop on collaboration between West Africa institutions and the UCAR AI: $25,000

The Burkina Faso and Mali governments would like to co-sponsor a workshop with UCAR/NCAR in Ouagadougou in early 2007. Because of a WMO meeting in Ouagadougou just after the workshop, many of the other West African countries will already have delegates in Burkina Faso. The workshop would provide delegates from other countries the chance to learn more about our collaborative work and potentially become part of it. In addition, the workshop would provide UCAR/NCAR the opportunity to learn more about the needs in Africa and the potential for establishing and enhancing meteorological networks and scientific interactions. The tentative workshop dates are during the week of 4 to 9 February 2007.

Funding requested: $25,000 with $10,000 to co-sponsor the workshop and $15,000 for travel and shipping of equipment.