



Analyses Multidisciplinaires de la Mousson Africaine

ISP2 Version 2

African Monsoon Multidisciplinary Analyses
Afrikanske Monsun: Multidisiplinære Analyser
Afrikaanse Moesson Multidisciplinaire Analyse
Analisi Multidisciplinare per il Monsone Africano
Afrikanischer Monsun: Multidisziplinäre Analysen
Analisis Multidisciplinar de los Monzones Africanos
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The International Science Plan for AMMA
2010-2020
Executive Summary

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AMMA, African Monsoon Multidisciplinary Analyses, launched in 2002, is an international interdisciplinary research program concerned with the variability of the West African Monsoon (WAM) and its impacts on communities in that region.

Purpose

While large uncertainties remain about future prospects for regional climate variability and change in West Africa (IPCC 2007), the impacts of climate variability on the continent, especially in the Sahelo-Saharan zone, are already making themselves felt. Observations have shown that this region experienced one of the largest rainfall deficits on the planet last century. The region is particularly vulnerable to weather and climate variability. This is due to the societal dependence of various activities on weather and climate, such as rain-fed agriculture (on which 80% of Sahel's population depend). Economic and institutional capacities are often too limited to confront situations and adapt to their consequences.

Researchers from Africa, Europe and the USA are working together to study crucial questions posed by these issues. The need to improve weather and climate forecasting for implementation of early warning systems motivated the scientific community to define three major objectives for AMMA:

- To improve our understanding of the WAM and its influence on the physical, chemical and biological environment regionally and globally.
- To provide the underpinning science that relates variability of the WAM to issues of health, water resources, food security and demography for West African nations and defining and implementing relevant monitoring and prediction strategies.
- To ensure that the multidisciplinary research carried out in AMMA is effectively integrated with prediction and decision making activity.

Phase 1 of AMMA 2002-2010

Strong international multi-agency coordination generated a research community of 600 committed participants. Within this community, 250 African researchers, grouped into a network called AMMA-Africa, have been working on AMMA science.

Thanks to this international coordination, AMMA has achieved a lot during its first phase: 500 papers in quality peer-reviewed publications, including 10 special issues; the organization of international conferences (Dakar 2005, Karlsruhe 2007 and Ouagadougou 2009) bringing together an average of 400 researchers; an unprecedented multi-scale multidisciplinary database used across the world and mirrored in Africa; the deployment of long-term observation systems since 2001, and more far-reaching field campaigns between 2005 and 2007, with several periods of intense observation.

After 8 years of activity, AMMA has become a flagship research program on climate and meteorology in West Africa and is now planning for the next 10 years. The research has led to significant advances in our knowledge and understanding of the multi-scale multidisciplinary aspects of the coupled ocean-atmosphere-land WAM system – going a long way to addressing the first objective of AMMA. The AMMA program has also succeeded in laying the groundwork in terms of science and establishing research collaborations to address its second and third objectives.

Among the many highlights of AMMA, the program has achieved:

- ❑ major progress in understanding the continental water cycle, with measurements and models synthesized from scales of meters to the whole continent;
- ❑ comprehensive measurements and analysis of the ocean dynamics in the Gulf of Guinea, and their interaction with the monsoon system;
- ❑ new understanding of land-atmosphere interaction, and its role in weather and climate prediction for the region;
- ❑ for the first time, a comprehensive understanding of the emissions of climatically important gases and aerosol particles from West Africa into the global atmosphere;
- ❑ programs of measurements of health, agricultural and water systems, coordinated with environmental measurements and analyses;

Training and education has been a priority for AMMA. AMMA has helped with the training of about 160 PhD students, of which half were African. About 80 doctoral theses have already been completed, of which 28 were by Africans. Three summer schools, and four training workshops were successfully implemented bringing together students, researchers and forecasters from Africa and all over the world. Through AMMA, new Masters programs have also been established. All of these activities demonstrate AMMA's emphasis on education and training. The strong intention of AMMA communication is to diffuse knowledge and to increase awareness of issues related to weather and climate and their impacts on societies, especially in Africa.

Phase 2 of AMMA: Scientific priorities

AMMA's 2nd Interantional Scientific Plan hinges on 3 key interacting research themes: (1) interactions between society, environment and climate, which necessitate the second theme: (2) study of predictability and improvement of meteorological, seasonal and climate forecasting, which itself requires the third theme: (3) continued effort to enrich our knowledge of the monsoon system.

(1) Society, Environment and Climate Interactions

Study of these interactions is an essential aspect of the 2nd phase of AMMA. The research will be organized around seven broad themes of scientific study: (i) water resources, (ii) land use, land cover and productivity, (iii) agriculture and food security, (iv) health, (v) energy, (vi) ecosystems, (vii) urban zones and African megacities.

(2) Weather, seasonal and climate predictability and forecasting

The AMMA program will work towards improving our ability to make weather and climate forecasts, and increasing our confidence in climate change projections. In order to do this, the

knowledge acquired from phase 1 must be “pulled-through” to improve dynamical models used for weather and climate prediction.

The research activity will be organized around 4 four major themes: (i) Evaluation and improvement of models; (ii) Utilization of current models (by way of new tools, ensemble prediction systems for example); (iii) Improvement of use of available observations (satellite observations, for example); and (iv) Recommendation and implementation of permanent observing systems to improve monitoring capabilities and forecasts. These themes will be promoted equally for weather (e.g. mesoscale convective storms, easterly waves and Kelvin waves, tropical cyclogenesis) and climate (intra-seasonal, seasonal and inter-annual to decadal) forecasting, as well as for climate change scenarios.

One of the essential aspects of integrating the knowledge acquired into improvement of forecasting models is the reinforcement of links between the AMMA scientists and operational centers, represented by people working on model improvement and data assimilation.

(3) Monsoon system

Improving dynamical models for weather and climate prediction requires continued improvements and refinements in our knowledge and understanding of WAM variability and predictability. The second phase of AMMA is focused on the essential feedback loops at three key scales: weather, intra-seasonal and multi-annual.

At the **weather scale** (less than 10 days), emphasis is placed on interactions; between convection and its environment, between ocean, atmosphere and continental surface, and between chemistry, aerosols and atmosphere.

The studies at the **intra-seasonal time scale** (10-90 days) will receive increased emphasis in this second phase to meet the demands of society (forecasting of dry intervals in the monsoon, useful for agriculture for example) but also to move ahead in our understanding of the annual cycle. The promising avenues opened during phase 1 must be followed up in greater depth, particularly the role of the ocean and its interactions with the atmosphere and interactions with the other tropical regions and mid-latitudes.

The **multi-annual time scales** (inter-annual, decadal and climate change) are still a major concern for AMMA. At the inter-annual to decadal time scale, AMMA is continuing to assess the relative contributions of WAM variability to the key feedback loops between the WAM and the different ocean basins, the continental surfaces and aerosols.

In parallel, AMMA must work towards better understanding of the nature and causes of human-induced climate change, particularly in regard to the disagreement between projections for the 21st Century presented in the last IPCC report.

Crossing these scale-based studies, AMMA also aims to extend the understanding of energy and water cycles of the WAM system (with hydrological studies of watersheds for example).

Observations

In order to support the whole range of these studies, AMMA must continue to develop and implement its strategy for observations with, as the backbone, the maintenance of environmental monitoring systems over the long term. Four major objectives will be pursued:

- (i) Long term maintenance and improvement of observing systems installed before or thanks to AMMA (for example AMMA-CATCH, PHOTONS-AERONET, PIRATA, SSS, GPS, IDAF). They are essential for accurate documentation, over a wide range of

- scales, of climate, the water cycle, the coastal environment, vegetation, soil, agricultural and socio-economic transitions
- (ii) Maintenance of the operational observations (atmosphere, continental surface and ocean) at a level as close as possible to that reached during the first phase of AMMA, and improvements in the areas where AMMA was not able to do this.
 - (iii) Ensure the best links between these research observations, data from operational networks and satellite observations, making best use of the fact that some satellite missions relevant for AMMA have recently been launched or will be launched in the near future.
 - (iv) Ensure that all the data is available for a wide community, including operational agencies and research scientists in Africa and overseas.

Moreover, AMMA supports the implementation of new experimental campaigns for studying the key processes which were not sufficiently dealt with in the first phase, including especially those that relate to evolution of the Atlantic cold tongue and the Saharan heat low.

Governance and Coordination

It is essential now more than ever before for AMMA to build up its international collaboration. In its second phase, AMMA must be coordinated, as a program enriched with contributions and collaborative ventures generated by the many initiatives under way, and the associated sources of funding, which otherwise runs the risk of dispersion of efforts. In this framework, the African community of AMMA (AMMA-Africa), financed more strongly than during the first phase by sources managed in Africa, must be supported by a stronger system of governance.

For these reasons and to meet the scientific and human challenges, the coordination of AMMA becomes even more vital for the program's success and necessitates the constitution of a permanent International Executive Office (IEO).

Capacity development and training

Education and training activities are strong priorities for AMMA phase 2. In addition, the program intends to reinforce the capacity in Africa in term of information systems (gathering, processing, storing, distributing and use of information), data processing facilities and data bases for resources, environment, climate and meteorology. A larger human and funding mobilization is necessary to support research and applications.

Communication of Science

Whether it is oriented towards the community of researchers, the media, decision-makers or end-users, the diffusion of new scientific knowledge remains a major issue for AMMA. AMMA continues to contribute to awareness-building among the general public, particularly in Africa, on the societal objectives of research conducted in the program. The 2nd phase will give the opportunity to set up a network of people active in scientific communication, generated from the network of journalists formed during phase 1. Awareness-building of end-users and decision-makers in Africa can be achieved by reinforcing the partnership with local institutions and associations.