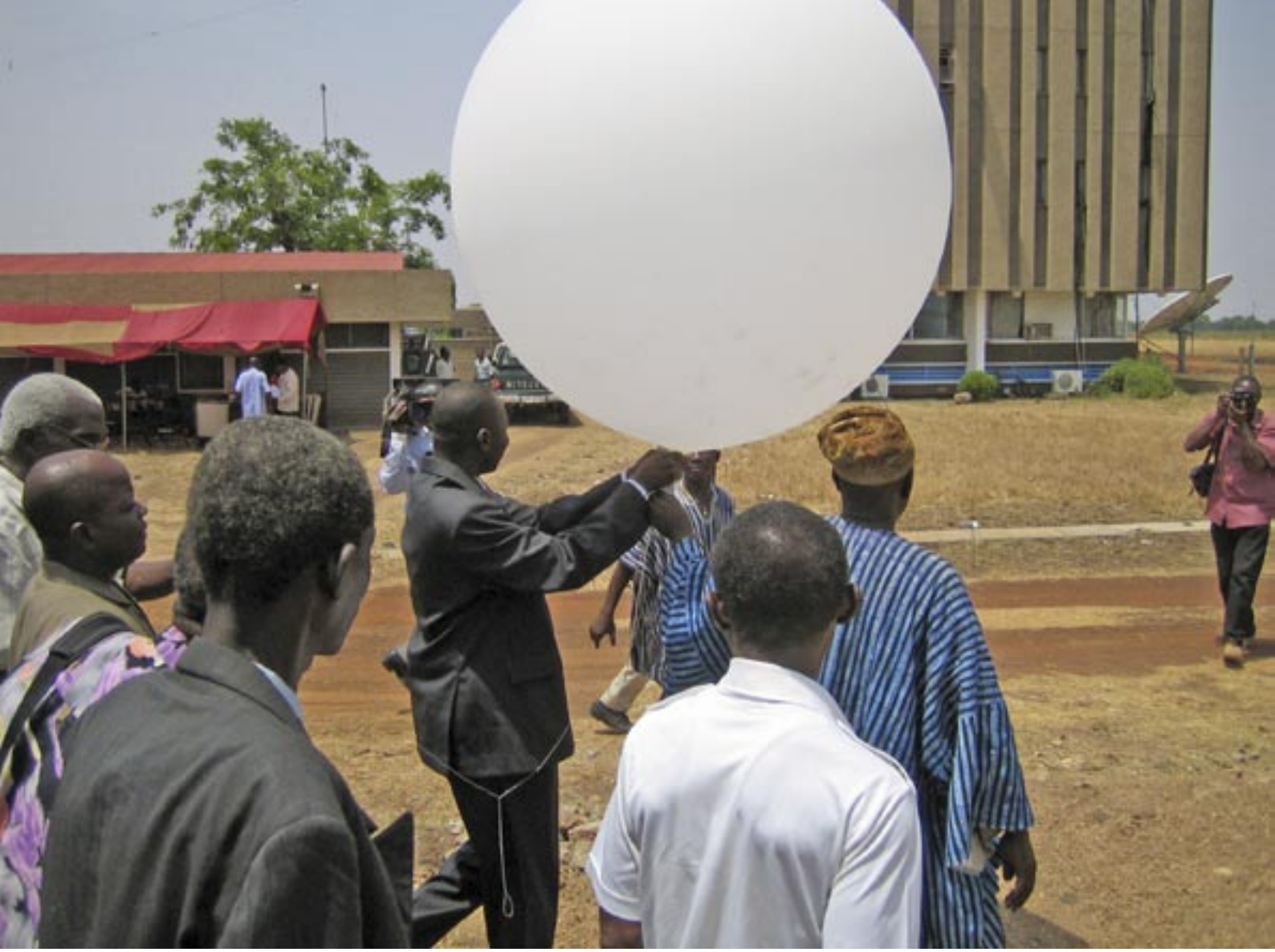

Launch of the first Vaisala Radiosonde RS92 from the Tamale station in Ghana, created by the AMMA project. Picture taken by Andreas Fink.

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Editor-in-Chief
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Knowing is half the battle

AMMA - the African Monsoon Multidisciplinary Analyses

An essential step is to improve the ability to forecast the weather and climate in the West African region.

Significant inter-annual variations in rainfall in West Africa in recent decades have resulted in extremely dry years. The environmental and socio-economic impacts have been devastating. This rainfall variability has raised important issues related to sustainability, land degradation and food and water security in the region.

Based on a French initiative, AMMA - the African Monsoon Multidisciplinary Analyses - was formed by an international scientific group to investigate the problem. AMMA aims to improve our understanding of the West African Monsoon and its influence on the environment, both regionally and globally. It also seeks to explain how the variability of the West African Monsoon is connected to issues of health, water resources, food

security and demography. The objective of AMMA is to improve our capabilities to forecast the weather and seasonal rainfall over the region and improve the early warning systems for food security.

Implementing relevant monitoring and prediction strategies is of vital importance. In order to reach the desired goals, the multidisciplinary research carried out in AMMA also needs to be effectively integrated with the local prediction and decision-making activity.

The West African Monsoon

The Western part of the tropical African continent gets most of its annual rainfall during the summer months from June to September. This rainy season is associated with the seasonal reversal of the winds in the lowest level of the atmosphere, which is called the monsoon.

In winter, the wind blows from the cool continent to the warm ocean. Following the Sun's movement during the course of the year, the continent warms faster than the ocean. This thermal contrast drives the surface pressure contrast between the ocean (high pressure) and the continent (low pressure) and the set-up of the monsoon circulation in northern summer.

Similar to a giant sea-breeze, at the beginning of the summer, the wind changes and eventually blows from the ocean to the continent. Over the ocean, the air parcels are moist and transported over the continent where this moisture is released, through deep vertical movements within convective storms, in the form of precipitation. This is only a simplified picture of the West African Monsoon, and other factors also contribute to it.

Noticeable anomalies in recent years

It is expected that the science from AMMA will contribute to a better understanding of the strong decennial variability that characterizes the West African Monsoon: an overall decrease in precipitation has been recorded since 1968, and there have been some extremely dry years between 1982-1984. In the past ten years, precipitation has again approached long-term averages.

"I would suggest two possible explanations for this phenomenon: firstly, there is the long-term evolution of global oceans whose sea surface temperatures impact the tropical atmospheric circulation. The warming of oceans in the southern hemisphere and cooling in the northern hemisphere explain most of the long-term Sahelian rainfall decrease. Secondly, interannual anomalies could be explained by the occurrence of phenomena such as El Niño. Also, the reduction in vegetation, partly due to anthropogenic pressure seems to have reduced rainfall," explains Serge Janicot, Research Director at the Institut de Recherche pour le Développement, Laboratoire d'Oceanographie et du Climat (LOCEAN).

Mr. Janicot is a meteorologist and a specialist in tropical issues, particularly the African climate. His role in AMMA is to study climate variability, the effects of ocean variability on the African climate, and the seasonal monsoon cycle. He is also actively involved in the AMMA radiosounding program, and coordinates various AMMA activities.

The West African Monsoon also contributes to many global weather phenomena. For example, it plays a role in the formation of US hurricanes, and transfers Saharan dust and aerosols in the atmosphere.

The AMMA observations

Dramatic rainfall changes are likely to occur in West Africa in the future, too, due to natural fluctuations or as a result of the global climate change. An essential step is to improve the ability to forecast the weather and climate in the West African region.

Building AMMA was possible thanks to the participation of the international scientific community, funds from the participating countries as well as the European Commission (EC), and the existence of observation networks in Western Africa. AMMA has reinforced, optimized and completed these networks in order to meet its objectives. The scientists involved wrote a proposal to the EC and received the green light for partial financing of the project. European countries, such as France and the UK, also agreed to share the estimated costs of 50 million euros. Vaisala is a member of the AMMA consortium funded by the European Commission.

"AMMA was launched in 2000. It was preceded by a project called the West African Monsoon Project, funded by the EC. During the West African Monsoon Project meteorologists, climatologists and hydrologists joined forces and realized the need for a field campaign," Mr. Janicot says.

"Particularly important is the involvement and participation of the African community. Over 200 Africans are now involved in the AMMA activities. All ASECNA (Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar) radiosounding stations have been upgraded, and new stations and equipment have been bought."

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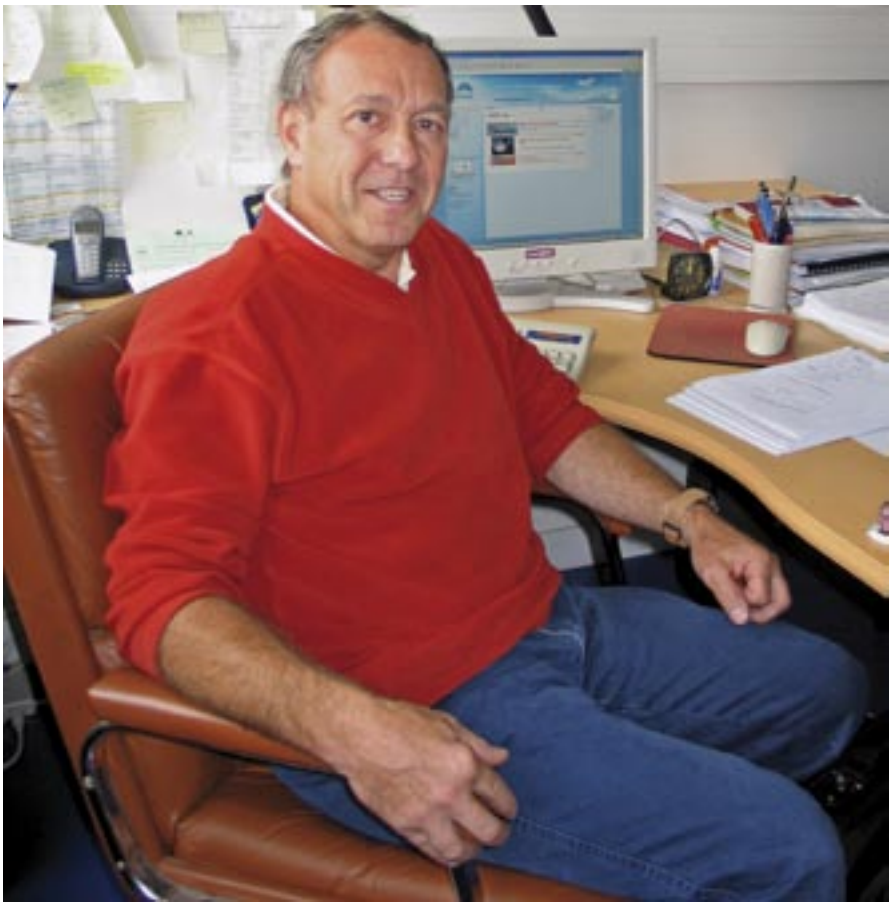
In the summer of 2006, 20 radiosounding stations were in operation in West Africa, performing one, two or four soundings per day with Vaisala equipment. In addition to this, two Intensive Observing Periods were carried out with eight soundings per day.

Good equipment is absolutely necessary

"The great challenge and question is what is going to happen to the observation frequency and the equipment in the long run, after the AMMA activities are finished. This is not only a question of money. Understanding the importance and benefits of good forecasts is vital here. For these, efficient networks and good equipment are absolutely necessary," Mr. Janicot says.

"Even if obtaining and maintaining a radiosounding network is expensive, it cannot be replaced by, for example, satellite observations. It is a very important investment, as in-situ measurements cannot be replaced by anything else at the moment." ›››



Mr. André Gribkoff coordinates the AMMA SAFIRE research aircraft operations and the necessary modifications to the planes.

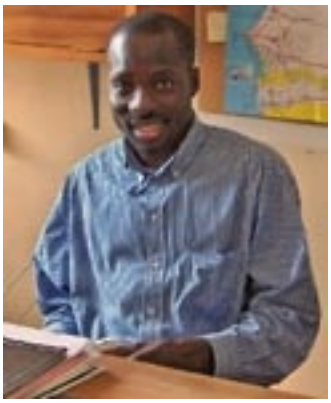
Coping with the varying climate

Amadou Thierno Gaye from Senegal is a Professor at Dakar University Cheikh Anta Diop (UCAD), and Director of the Laboratoire de Physique de l'Atmosphere et de l'Ocean of the Ecole Superieure Polytechnique of UCAD.

Mr. Gaye is the Co-Chairman of the AMMA African group and a member of the International Scientific Steering Committee. He was mainly involved in the Special Observing Period -3 operations.

"Personally, I am mainly interested in the water cycle and rainfall processes. Many scientists at UCAD participate in AMMA activities. UCAD also acts as the host of the AMMA-Africa office in the EC funded project," Mr. Gaye says.

"AMMA has re-enforced the radiosounding network by upgrading old stations and creating new stations. In some mesoscale sites, new rain gauges have been deployed. The Enhanced Observing Period and Long-term Observing Period instruments enable the long-term monitoring, that is, three-ten years, of the African monsoon environment. The radiosounding equipment and the dropsondes used are provided by Vaisala."



AMMA aims to develop applications to cope with the varying West African climate. "We hope that one important outcome of the project will be early warning systems for the safety of people and management of socio-economic activities."

"The best support we can offer in the future, apart from money, is enabling the local organizations to carry out the work themselves. We can provide education, and build and maintain strong links between the scientific communities, for example in the form of exchange scholarships. The number of motivated, better educated people willing to improve their countries' situation is growing. We need to support these efforts."

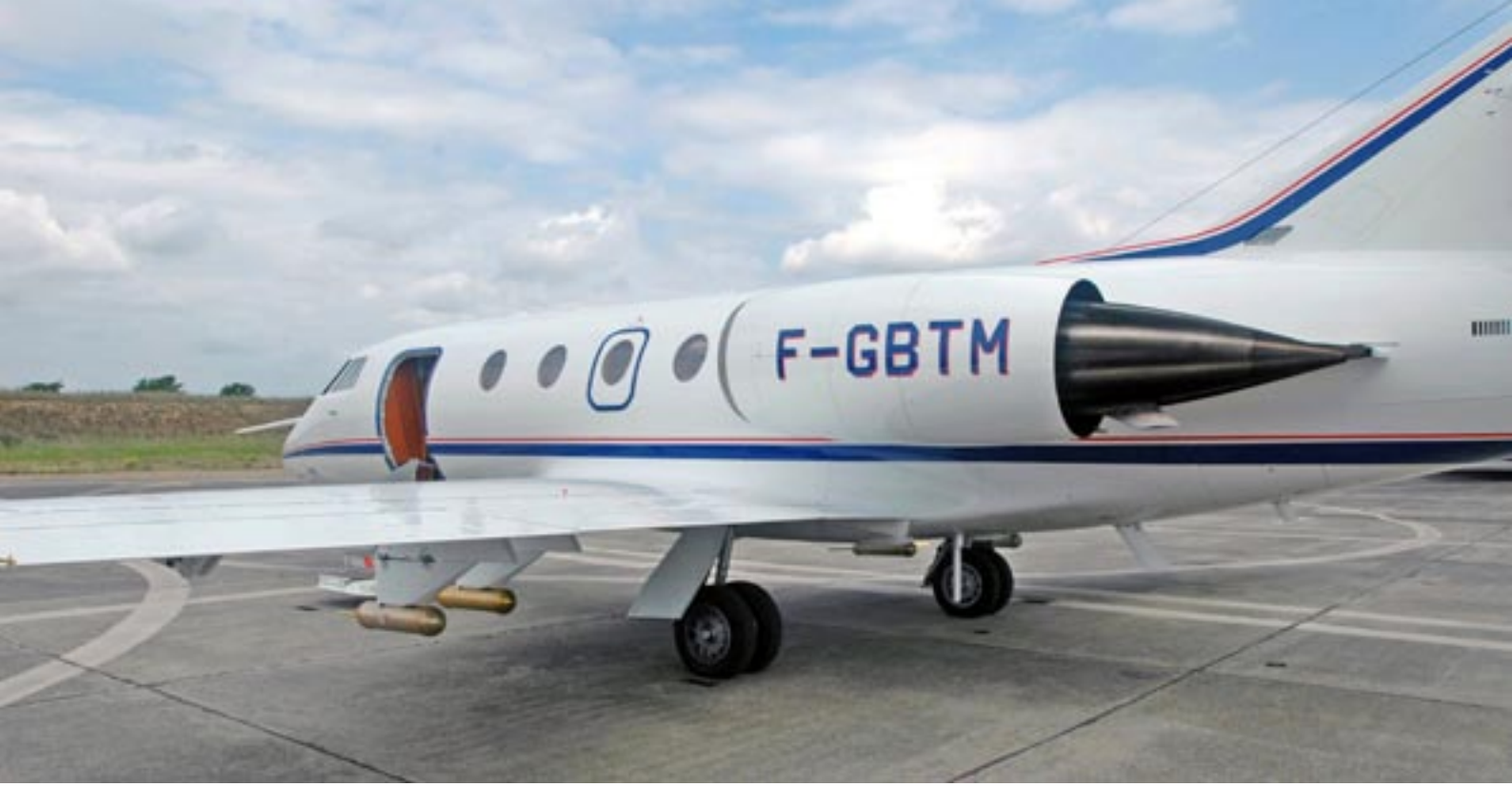
Impacts on people and lives

The impacts of the West African Monsoon are many. Agriculture and food security suffer along with an abrupt decrease in water resources. Cattle populations are diminished, and hydropower electricity plants are shut down. Malaria epidemics occur during the rainy season when the mosquito density increases in response to precipitation, temperature and humidity. During the dry season, meningitis affects 25,000 to 200,000 people annually. One of the AMMA goals is to understand the relationship between intra-seasonal, seasonal and inter-annual climate variability and these diseases.

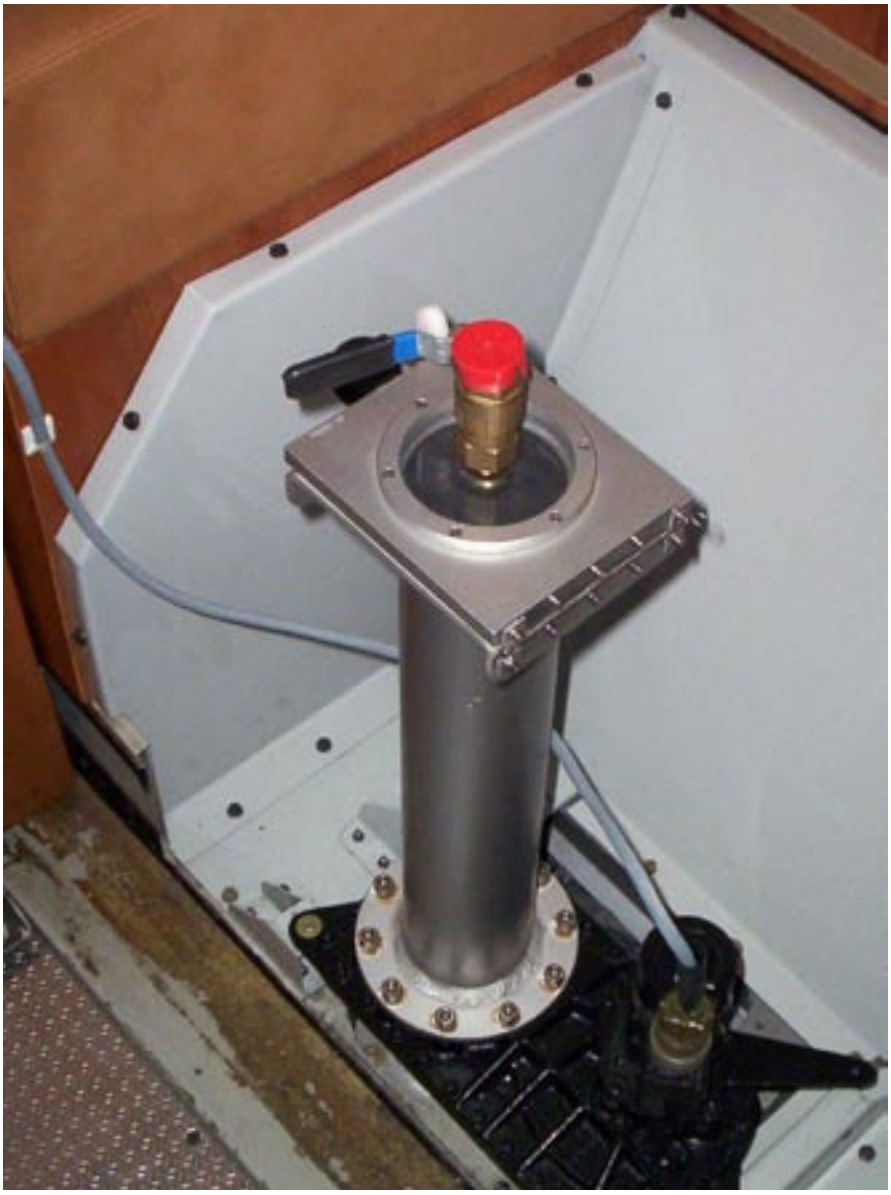
Airborne observations

Mr. André Gribkoff is the Deputy Director of a French group called Service des Avions Français Instrumentés pour la Recherche en Environnement (SAFIRE). SAFIRE brings together the staff and three research aircraft of the L'Institut National des Sciences de l'Univers (INSU), Centre National de la Recherche Scientifique (CNRS), Météo-France and the Centre National d'Études Spatiales (CNES). SAFIRE's main task is to operate the aircraft during experimental research campaigns. Mr. Gribkoff's role is technical: he coordinates the research aircraft operations and the necessary modifications to the planes. He also participates in the research flights themselves - for AMMA, Mr. Gribkoff has over 70 hours of airtime behind him.

"For the AMMA scientific measurements, I was in the Falcon 20 aircraft. We had one pilot, one co-pilot and three operators on each flight. Three to four other aircraft were also involved in the measurements. The Falcon 20 aircraft is multi-use, so the equipment varies depending on the campaign. We fly over both land and sea, and measure meteorological parameters around convective clouds and sometimes even inside the clouds, at an altitude of 10-12 km. The objective is to get as close as possible ›››

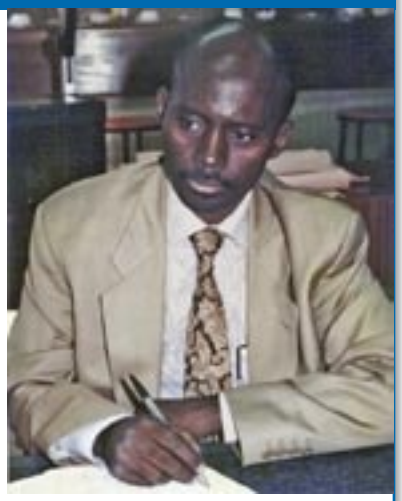


The French Falcon 20 research aircraft.



Falcon 20 launching system for the Vaisala dropsondes.

Air traffic security in Africa and Madagascar



Jean Blaise Ngamini from ASECNA's headquarter in Senegal is in charge of the meteorological network and the processing of meteorological data collected in ASECNA's member states. ASECNA, or Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar, is the agency responsible for air traffic security in Africa and Madagascar.

ASECNA is a key partner for AMMA as it operates the largest network of radiosounding stations in the region. ASECNA contributes to the AMMA project with its personnel, equipment and logistic network in Africa and Europe.

"AMMA has reinforced the observation networks in the West African region with the installation of four new radiosounding stations in Nigeria, Ghana and Benin, and by upgrading many stations in our network. ASECNA also appreciates the readiness of Vaisala in providing equipment and consumables during this period of intense activity in our region. The number of African States that have an operational upper air station is very small, due to the cost of equipment and consumables. Maintaining prices at an accessible level would be very helpful."

Three observing periods

The Long-term Observing Period (LOP) is concerned with:

- historical observations to study interannual-to-decadal variability
- additional long-term observations (2002 – 2010) to document and analyze the interannual variability of the West African Monsoon

Special Observing Periods (SOP) study processes specific to the main phases of a monsoon cycle, that is:

- the dry phase lasting from November to May
- the onset phase leading to the monsoon jump (end of June)
- the well-developed monsoon from the end of June to mid-September
- the period most favorable for the tropical cyclogenesis over the Atlantic, lasting from mid-August to mid-October.

The Enhanced Observing Period (EOP) is a link between the LOP and the SOP. Its main objective is to document the annual cycle of the surface conditions and atmosphere during 2005 – 2007.

The EOP concentrates on three main types of observations:
Atmospheric: radiosoundings, surface flux measurements, remotely sensed observations
Land: hydrological and vegetation measures
Ocean: research vessels in the Gulf of Guinea and tropical Atlantic for a total of four cruises

to the nucleus of the cloud, without too much risk," Mr. Gribkoff explains.

"The dropsondes we use for the measurements are all produced by Vaisala. During the last Enhanced Observing Period we also used a lidar and radar. The longest flight-times were around three-four hours, during which we dropped a maximum of sixteen sondes. We are able to launch one dropsonde every six minutes. The Vaisala dropsondes became a real favorite during the campaigns, as they are very easy to operate."

According to Mr. Gribkoff, it takes several years to prepare a plane for flights like these. "There are less than ten companies in the world who are able to provide planes like this. First we launch a tender to find a suitable carrier. The required modifications to the plane are included in the tender. With 35 years of experience in the field, I would say that realistically the purchase takes about one year, and the modifications in theory one year - but in reality up to three years. So it is a long and costly project that takes quite a bit of patience." Mr. Gribkoff was the Project Manager of the Falcon 20 modifications project.

Research aircraft are no small investments, either. For example, the Falcon 20 cost about 7.5 million euros. The purchase costs were covered by INSU and CNRS, and the operating costs are paid by the different participating organizations and the EC. ■

Further information:
www.amma-international.org