A 5 year programme on weather, climate and air pollution in West Africa

DACCIWA Newsletter

DACCIWA

COORDINATOR'S EDITORIAL

Dear Reader,

Welcome to the third newsletter of the DACCIWA Project! This newsletter is part of our goal to communicate our research activities with the scientific community, the general public and policymakers. If you missed the first two newsletters, you can still access them on our webpage www.dacciwa.eu, together with a lot more information on the project and the involved parties in Europe and Africa.

The last issue was all about the project meeting in Toulouse in October 2015 and the publication of two DACCIWA overview papers in BAMS and Nature Climate Change. This newsletter gives some insight into the hot phase of the panning for the field campaign in June and July this year. The operations plan for the ground campaign is now written and the first instruments are on their way to Africa. The payloads for the aircraft are being finalised and permissions for our planned operations are being sought from African authorities. Networks for rainfall and air pollution have been installed and are ready for data collection. Last but not least the many scientists involved are preparing their trips, booking flights and hotels, and getting visas and vaccinations. It is a great excitement to be involved in such a big campaign and we are all very much looking forward to it!

Thank you for your continued interest in DACCIWA!

Peter Knippertz, project coordinator

3rd Edition
Spring 2016

TOPICS IN THIS ISSUE

DACCIWA IN SOCIAL MEDIA

If you want to follow the DACCIWA activities on social media you have the following possibilities:

our twitter feed (@DACCIWA)

our Instagram site (www.instagram.com/dacciwa).

DACCIWA-WP2 our Facebook page for the air quality work package (https://www.facebook.com/dacciwa.eu/).

News, tweets and pictures will be uploaded regularely during the whole project and especially during and after the campaign. Please follow-us!

News from the field

Preparing the instrumentation for the Savé supersite

During the DACCIWA field campaign in June and July 2016, numerous instruments will be deployed at the three ground-based supersites in Savé in Benin, Kumasi in Ghana and Ile-Ife in Nigeria. The supersite Savé will be operated jointly by Université Toulouse III - Paul Sabatier, Laboratoire d'Aérologie (UPS) and Karlsruhe Institute of Technology (KIT). An overview of the instruments to be installed was given in a previous newsletter. In addition to these instruments, a second sun photometer will be installed in cooperation with Christine Chiu (University of Reading). All the instrumentation will be shipped together in the beginning of April to allow enough time for the transport and customs. The installation of the instruments at Savé will take around two weeks and will start on 30 May, followed by the 7-week measurement period. Students from Institut National de Recherche Agronomique du Benin (INRAB) and Ile-Ife will visit the site and will be introduced to the operation of the supersite by the teams of KIT and UPS.

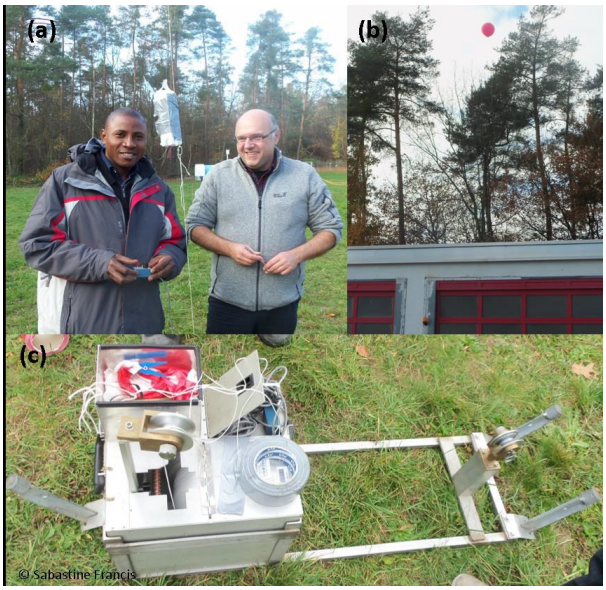
Test setup of KITcube at Karlsruhe in Germany. In the foreground from left to right the x-band rain radar, sodar, microwave radiometers and energy balance station can be seen. In the rear, transport containers, wind lidar and office containers are visible.

In order to assure high quality measurements, the instruments were tested extensively prior to the shipping (figure above). Due to frequent power failures, the instruments need to be installed in the surrounding of the generator. To capture the surface energy balance over different land-use types, two energy balance stations will be installed at the Savé site. The UPS energy balance station will be run close to the generator, while the KIT station will be run with solar panels and setup over a different land-use type further away from the generator. The data transfer from various instruments, to the central control unit is via WLAN which is a great advantage in rough terrain.

The supersite Savé is surrounded by trees of up to 14 m height. To provide an unlimited view of the horizon for the scanning x-band rain radar will be installed on a tower consisting of two containers on top of each other. For this purpose, a steel rack was manufactured at KIT which allows a secure placement of the x-band rain radar on top of the containers. The steel rack is removable and can be stored in one of the containers. For the setup of this structure a crane is required (figure top right).

Installation of the x-band rain radar on top of a tower consisting of two transport containers. Test setup at KIT in Karlsruhe, Germany .

At the supersite Ile-Ife a tethered radiosonde system will be operated to obtain profiles of temperature and humidity to complement wind measurements by a sodar. The tethered radiosonde system was developed at KIT and consists of a modified GRAWMET radiosonde which is equipped with an external power supply to allow for multiple uses. The radiosonde is attached to an electrical winch and is lifted by a 350 g balloon. The maximum height of the tethered radiosonde is 1000 m but strongly depends on the horizontal wind speed.



(a) Martin Kohler from KIT instructs Sabastine Francis from Ile-Ife on running the tethered radiosonde system. (b) Test launch of tethered radiosonde at KIT in Karlsruhe, Germany. (c) Tethered radiosonde system consisting of a GRAWMET radiosonde, electrical winch and a 350 g balloon

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News from the field

Participation of the British Antarctic Survey Twin Otter in the DACCIWA Field Experiment

The Twin Otter research aircraft waits to be serviced in Canada. Back in the UK it is now being prepared for the DACCIWA mission in West Africa.

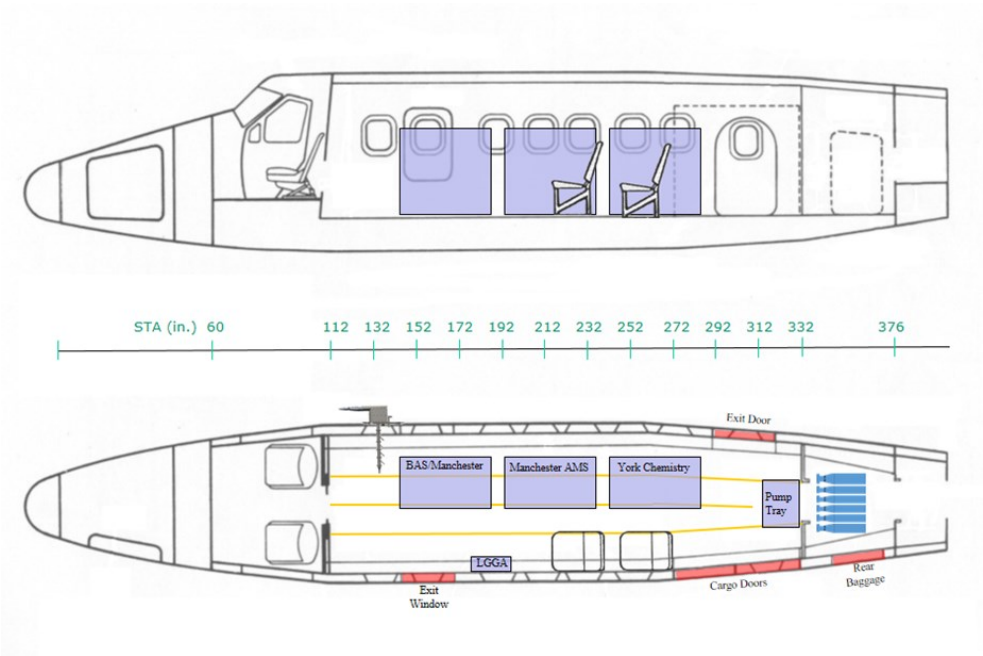
The year delay in the DACCIWA field programme resulting from the Ebola epidemic across the DACCIWA region in 2015 has meant that the UK BAe-146 Airborne Research Aircraft will be unable to participate in the intensive measurement period. This is because of a pre-existing commitment to another programme that is timed to coincide with the Indian monsoon and so it cannot be re-scheduled.

To address this potential measurement gap, DACCIWA is working with the British Antarctic Survey who, we are delighted to say, have stepped in to extend the fit of its Twin Otter aircraft to meet our needs. The British Antarctic Survey operates a fleet of four de Havilland Canada Twin Otter aircraft and a De Havilland Canada Dash-7.

The Twin Otter aircraft provide the UK airborne science capability in the polar regions and support UK scientific operations in Antarctica, transferring people, fuel, food and scientific equipment to remote camps, landing on unprepared snow. One of these aircraft is certified to fly with a scientific payload for atmospheric science. The aircraft, known as the MASIN (Meteorological Airborne Survey Instrumentation), was fitted with a range of airborne instruments in 2004 and has since which taken part in a large number of scientific missions.

The MASIN Twin Otter has an endurance of 4 to 4.5 hours and a range of 1000km that will need to be increased with a long range tank for the transit to Togo from the UK. This will mean that the scientific payload will have to be shipped to Togo in advance and fitted to the aircraft before the start of science. The aircraft has a science speed of 60m/s and an operating ceiling of 4000 m since it is not pressurised. The crew includes a pilot and a maximum of 4 mission operators / scientists. Operations over the ocean will be limited since we will not be flying with a life raft in order to fit a greater science payload.

The aircraft is already fitted with a suite of atmospheric science instruments which includes: temperature, humidity, wind speed and turbulence, wing mounted hardpoints for cloud physics probes and aerosol and gas inlets for sampling. The Universities of York and Manchester and the National Centre for Atmospheric Science are working hard with the MASIN team to enhance this measurement capability. New instrument racks have been built and are currently being installed into the aircraft for testing in the UK before being shipped to Togo. The new equipment fitted will include instruments to measure a wide range of a gas phase compounds that is being led by the University of York: ozone, car-



Instrument fitting of the Twin Otter for the DACCWA mission

Meet the DACCIWAs

Geoffrey Bessardon

My name is Geoffrey Bessardon and I am a PhD student at the University of Leeds working on the DACCIWA project under the supervision of Dr. Barbara Brooks, Dr. John Marsham, and Prof Alan Blyth.

I was born and grew up in Grenoble in the French Alps where I obtained a BSc in Mechanical Engineering followed by a MSc in Environmental Fluid Dynamics. I had the opportunity to write my master's thesis at Monash University in Melbourne (Australia), where I worked on turbulence in the stable boundary layer.

I choose to study atmospheric science, because I have always been interested in the outdoors, I think growing up in such an amazing place as the French Alps explains this interest, as well as science. Atmospheric science is a good way to discover new places as well as to strengthen my scientific skills.

I have chosen to work in DACCIWA because I have never been to West Africa before and the idea of helping exposed populations while doing great science and discovering a new part of the world to me is really exciting.

For DACCIWA, I am working on the night-time boundary layer, I will be involved in the ground measurement field campaign and spend 2 months in Kumasi, launching radiosondes and working with the ground-based instruments. My goal is to understand the transport of humidity, aerosols, and turbulence at night with the aim to forecast the morning formation of low-level clouds. To achieve this goal, my focus is on the nocturnal low-level jet (NLLJ), a major contributor to the transport of heat and moisture in the West African monsoon.

Since I started with DACCIWA, I have focused on NLLJ physical processes comparing conceptual models with observations and reanalyses in the Sahel. My first results showed the importance of pressure changes in this area, and I hope that the field campaign will help to have a better representation of the pressure field.

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News from the field

Participation of the British Antarctic Survey Twin Otter in the DACCIWA Field Experiment (cont.)

bon monoxide, NO_x, sulphur dioxide, carbon dioxide, methane and hydrocarbons, CO2, CH4, and hydrocarbons. Aerosol and cloud physics instruments are being installed by the University of Manchester, to add to the core fit already available on MASIN. This will enable aerosol number, size distribution, absorption, online aerosol composition including black carbon and CCN properties, and cloud and drizzle properties to be measured.

The excellent turbulence measurements on the MASIN Twin Otter and the slow operating speed of the aircraft will allow some new observations to be made. The NOx instrumentation will run at 10Hz rather than 1Hz and the single particle soot photometer measures single particles. These measurements should allow for eddy correlation measurements of the flux to be made directly and hence provide direct regional scale measurement of the emissions of oxides of nitrogen and black carbon from the African cities for the first time providing an excellent link to the emissions characterisation in WP2.

The Universities of York and Manchester and the National Centre for Atmospheric Science are working hard with the MASIN team to enhance the measurement capability.

All of this work over the last 8 months has meant that nearly all of the equipment planned for the BAe146 has been shoe-horned into the MASIN Twin Otter and this will provide a fantastic capability for DACCIWA science.

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Meetings

Chemistry modelling meeting

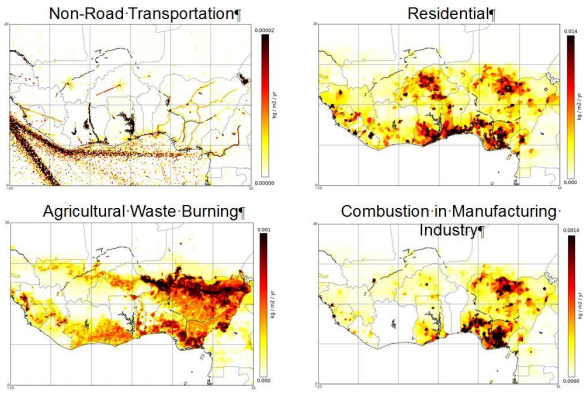
On the 7th April, 9 DACCIWAns from UPS Toulouse, UPMC Paris, University of York, ETH Zurich and LPC2E Orlean met at LMD in Paris to discuss the current and future chemical modelling. Input from KIT Karlsruhe, ECMWF Reading was received. The objective of this meeting was to discuss mainly gas phase chemistry and so straddled the WP2 / WP3 interfaces.
Each group presented their modelling tools and their scientific objectives. The spatial scales of interest ranged from the local (100s m)

Meetings

Chemistry modelling meeting (cont.)

through to the regional (10s km) to the global and climate scale (100s km) with differing science objective linked to the different scales. The emphasis then turned to anthropogenic and biomass burning emissions for the region.

Our understanding of anthropogenic emissions is poor. The default standard for global modelling are the EDGAR emissions. These available at 0.1°x0.1° (10km) resolution. These emissions are based on available data reported to international agencies etc. Unsurprisingly the EDGAR emissions for West Africa showed a range of issues. On the sector level some countries seem to have no emissions in some categories. Some emissions seem to increase each year by country population rather than spatial resolved populations. There is undoubtedly activities which are not included in the inventory (2 stroke engine on scooters, rubbish burning, alternative economy activity). Africa specific, continentally based emissions estimated may offer an better solution. As part of the DACCIWA project a continental emissions dataset based on Liousse et al. [2014] will be made available for simulating composition of the atmosphere over Afri-



EDGAR CO emissions for some of the different sectors considered. This shows the different locations of different emissions sources in West Africa. Also note the some countries seem to have no activity in some sectors which probably reflects issues with reporting data to international agencies.

ca. A complementary dataset is being prepared by NCAR / Harvard (Weidemeyer / Marais) and will also be a useful dataset for the DACCIWA project.

There was an agreement for the models to output boundary conditions for that the University of York GEOS-Chem modelling would produce boundary conditions for the LMD CHIMERE modelling which would then produce boundary condition for the UPS MesoNH model.

The group agreed to meet again electronically after the field campaign but before the annual meeting in November to discuss progress.

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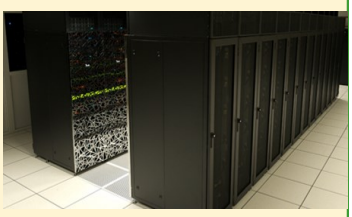
Meet the DACCIWAs

Irene Reinares Martínez

I am Irene Reinares Martínez, a PhD student at Laboratoire d'Aérologie (LA), Toulouse, France, where I conduct my research for Workpackage 6 on "Precipitation processes". My PhD project is entitled "Aerosol-Cloud Interactions in West Africa" and is supervised by Jean-Pierre Chaboureau (LA). The perspective of joining DACCIWA was very stimulating for me. On the one hand, I have the opportunity to enlarge my knowledge on the topic of my interest, West African weather systems and can participate in a large field campaign. On the other hand, I have the possibility to work in collaboration with renowned researchers in an international framework and get an insight into the complex organization of a big European project.

In 2013 I obtained my Bachelor's degree in Physics from the University of Zaragoza, Spain. During my Bachelor, I spent the first years in Zaragoza learning general and fundamental physics. The last year of my Bachelor's degree I studied at the University of Cergy-Pontoise, France. I benefitted from an Erasmus exchange that served me to specialize on complex systems through a Master program on "Theoretical Physics and Applications". Given that in the meantime my interests had turn to environmental physics, I decided to enroll at the University of Pierre and Marie Curie, Paris, France, where I obtained a Master degree in Physics in 2014, with a focus on ocean and atmospheric physics and climate.

Currently in the second year of my PhD, I am focused on the study of precipitation processes in the south of West Africa. I aim at better understanding the relationship between aerosols, cloud dynamics and rain, and to analyze the scale interactions between clouds and dynamics by using Méso-NH, the French research meteorological model. A reference simulation over an extended domain of Africa for an AMMA (African Monsoon Multidisciplinary Analyses) case study has been performed. Convection is explicitly represented in the simulation, where a grid spacing of 2.5 km was used (giving a total of ~ 3.4 x 10^8 grid points and ~7 TB of data). Costly numerical resources from a super-calculator at CINES (see Figure above), the computational French center for higher education, were needed.



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News from the field

The DACCIWA radiosonde campaign

The plans for the DACCIWA Radiosonde campaign are now in a final stage. The figure shows the designated launching sites and deployed radiosonde types. Two changes were decided with respect to the locations compared to the DACCIWA proposal: for logistical and meteorological reasons soundings will be made from Accra instead of Tamale; a new site at Lamto Geophysical Research Observatory in Ivory Coast will help to compensate the loss of dropsonde capability due to the replacement of the British BAe146 by the Twin Otter. We would like to thank our Ivorian partners from Université Félix Houphouët-Boigny (UFHB) and the Lamto Observatory to support the operations at this "last minute" site.

From an operational point of view, there are four different types of sites, as indicated by different colors in the figure. The blue and yellow stations are operated by the Agence pour la Sécurité de la Navigation Aérienne en Afrique et à Madagascar (ASECNA) or the National Meteorological Services (NWSs). They are at the same time surface SYNOP stations reporting into the Global Telecommunication System (GTS) at six-hourly intervals. Currently, 00 and 12 UTC soundings are conducted at Abidjan and Douala and send to the GTS. Enugu, Lagos, Cotonou, and Abuja perform once-daily 12 UTC soundings, which are currently not available in the GTS. Parakou is currently a PILOT balloon station only, and thus will be a re-activated AMMA radiosonde station during the DACCIWA campaign.

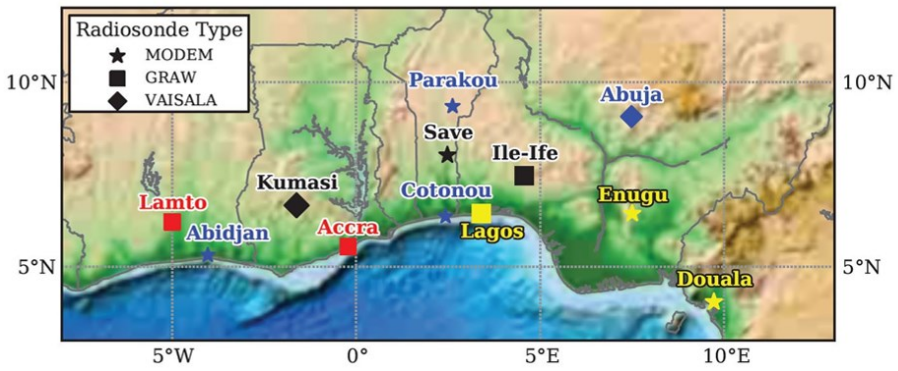
The provision of consumables and operations of enhanced soundings at the four blue stations Abidjan, Cotonou, Parakou, and Abuja have been subcontracted to the company AEROEQUIP that successfully conducted research soundings during the FENNEC project at the remote Mauritanian station Zouérate. Lamto and Accra will operated by KIT in partnership with the Ghana Meteorological Agency (GMet) in Accra, and with UFHB and the LAMTO Geophysical Observatory in Lamto. The DACCIWA ground sites Kumasi, Save, and Ile Ife will also launch sondes in addition to their extensive monitoring program.

Radiosond launch in Tamale (Ghana) 2016. Training by the French company MODEM.

Sondes at blue and red stations will be launched four-times daily at 00, 06, 12, and 18 UTC during the three-week aircraft campaign 27 June – 17 July 2016. Test soundings will start earlier, as early as beginning of June in Accra for example. Accra will also stay active until end of July 2016. At the DACCIWA ground sites Kumasi and Save, 06 UTC sondes will be launched between 13 June – 31 July 2016, with an enhancement to four times daily measurements during IOP days with aircraft operations over land. Our Nigerian partner from Obafemi Awolowo University (OAU) will solely conduct tethered soundings in the boundary layer at Ile Ife using a loaned KIT ground station - just another example of the fruitful collaboration within the DACCIWA consortium.

Efforts are undertaken to submit the soundings to the GTS in real time. For the non-operational stations this will be achieved by using the TEMP Mobile Format suitable for temporally active stations. Except for Abidjan, this solution is currently negotiated with the NWS/ASECNA for Cotonou, Parakou, and Abuja. We also strive for collecting and archiving all ascents at high resolution (i.e. at 5-m vertical resolution with GPS positions) in the DACCIWA database. This is also true for Douala (Cameroon) that operationally conducts twice-daily soundings and, if operational in June-July 2016, TEMPS from Lagos and Enugu will also be collected from Nigerian Meteorological Agency (NIMET).

If sounding plans can be achieved, the DACCIWA network will be unique and by far supersede the number of stations active during AMMA – though for a much shorter period. The support by NIMET, GMET, DMN Benin, Société de Développement et d'Exploitation Aéroportuaire et Maritime (SODEXAM) Ivory Coast, and ASECNA in the preparation of the campaign is already striking and we look forward to work with our African partners during the next three month to realize this success.



Planned DACCIWA Radiosonde network and deployed sonde types. Blue: Operational or re-activated AMMA stations with enhanced sounding frequency; Black: DACCIWA super-sites; Red: DACCIWA stations operated by KIT, GMet, and UFHB; Yellow: Operational ASECNA and NWS stations outside the DACCIWA network

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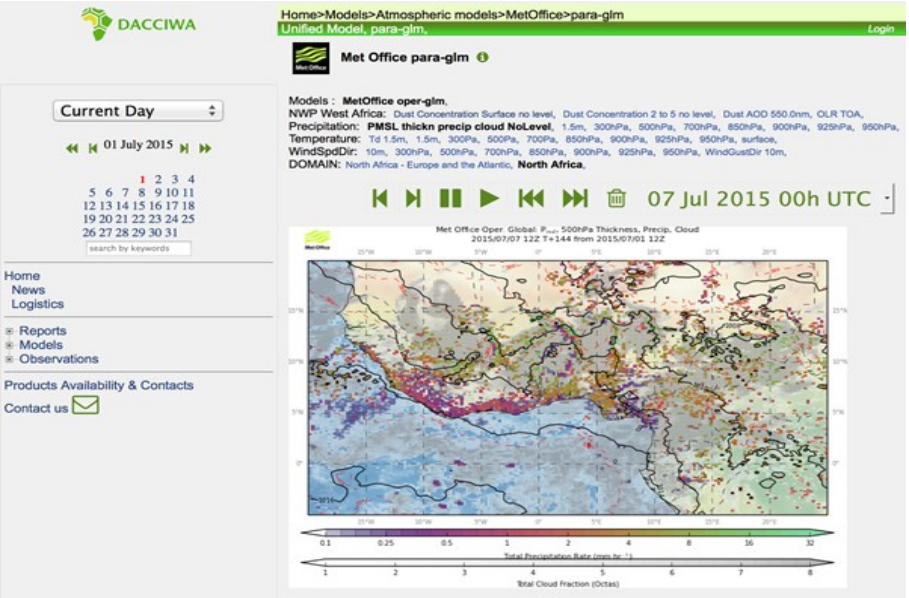
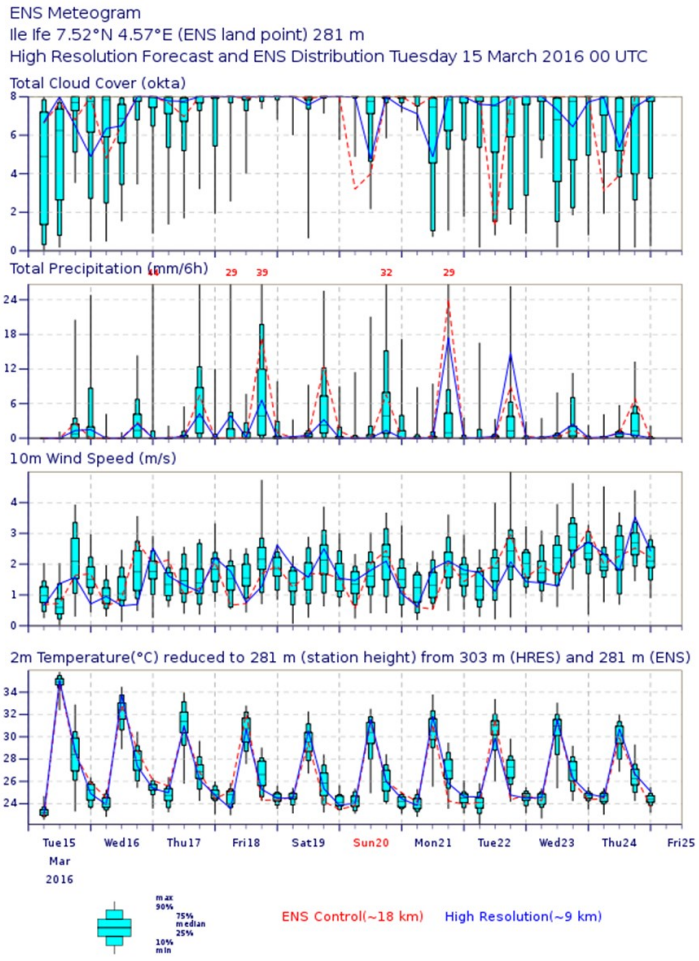
Forecasting for the DACCIWA field campaign

Reliable weather forecasts are an important necessity for the daily organisation of a successful field campaign, both for the flight planning activities as part of the aircraft operations, but equally for decisions about intensive measurement periods for the ground sites. In order to optimise the availability and usefulness of forecasts for DACCIWA, it was decided to upload a wide range of charts specifically tailored to the needs of the field activities to a website (http://dacciwa.sedoo.fr website). An example is shown below, illustrating the easy switching between dates, fields and maps and the ability to animate forecasts in time.



Screenshot of the dacciwa.sedoo.fr forecast page showing a precipitation and cloud forecast from the UK Met Office



Screenshot Meteogram for Ile-Ife from the ECMWF Ensemble Prediction System. The green box plots illustrate the range of values from the 50 ensemble members

In addition to more standard horizontal distributions, meteograms for locations participating in the campaign and cross-sections along the monsoon flow through supersites are included.

The forecasts include meteorological fields and information on atmospheric composition such as aerosol species and trace gases. They are provided by the two operational centres involved in DACCIWA, the European Centre for Medium-Range Weather Forecasts (ECMWF) and the UK Met Office. In addition, products generated by DACCIWA scientists such as chemistry and aerosol forecasts from the COSMO-ART model run at the Karlsruhe Institute of Technology and GIRAFE (reGIonal ReAl time Fire plumEs, http://girafe.pole-ether.fr) predictions build on the particle dispersion model FLEXPART coupled with ECMWF meteorological fields and emission inventories. Also some observational data will be available on this page to facilitate the evaluation of past forecasts.

Forecasts include meteorological fields and information on atmospheric composition such as aerosol species and trace gases

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Next Newsletter

Autumn 2016

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DACCIWA publications

Evaluating Satellite-Based Diurnal Cycles of Precipitation in the African Tropics

Content in short

- Comparison of diurnal cycle in rainfall between intensively gauged Ouémé and Niamey AMMA-CATCH mesosites and seven different satellite rainfall estimations, 2000-2011
- Afternoon and late night rainfall peak at the Ouémé site (Benin), the later related to squall lines arriving from the Nigerian Jos Plateau.
- Interannual and intraseaonal variability in intensity of peaks detected
- Overall TRMM 3b43 V7 and CMORPH showed best performance, with CMORPH better in timing of diurnal peak and TRMM in estimating rainfall amounts
- Infrared PERSIANN showed delay in rainfall peak by about two hours

Refercence:

Uwe Pfeifroth, Jörg Trentmann, Andreas H. Fink, Bodo Ahrens
Journal of applied meteorology and climatology, Volume 55, January 2016, (23-39)
doi: 10.1175/JAMC-D-15-0065.1

Variabilities in Rainfall Onset, Cessation and Length of Rainy Season for the Various Agro-Ecological Zones of Ghana

Content in short

- Onset, cessation and length of rainy season in four, previously identified agro-ecological zones in Ghana
- Quantification of above-mentioned rainy season characteristics based on cumulative curves of daily rainfall and number of rain days for the period 1970-2012
- Dates from both criteria differ somewhat in absolute terms on a yearly basis, but are consistent in derived climatologies
- Wavelet analysis shows characteristic spectral bands of multi-year variability in onset and cessation dates across the four zones

Refercence:

Leonard K. Amekudzi, Edmund I. Yamba, Kwasi Preko, Ernest O. Asare, Jeffrey Aryee, Michael Baidu and Samuel N. A. Codjoe, Climate, 2015, 3, (416-434)
doi:10.3390/cli3020416

DACCIWA

Project Partners

- Karlsruher Institut für Technologie (DE)
- University of Leeds (UK)
- University of York (UK)
- The University of Reading (UK)
- The University of Manchester (UK)
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DE)
- Université Paul Sabatier Toulouse III (FR)
- Université Blaise Pascal Clermont-Ferrand II (FR)
- Université Paris Diderot - Paris 7 (FR)
- European Centre for Medium-Range Weather Forecasts (UK)
- Eidgenoessische Technische Hochschule Zürich (Switzerland, CH)
- Kwame Nkrumah University of Science and Technology Kumasi (Ghana, GH)
- Obafemi Awolowo University (Nigeria, NGR)
- Université Pierre et Marie Curie - Paris 6 (FR)
- Met Office (UK)
- Centre National de la Recherche Scientifique (FR)

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- Université Félix Houphouet Boigny, Abijan, Ivory Coast
- Université d'Abomey-Calavi, Cotonou, Benin