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

DACCIWA Newsletter

DACCIWA

COORDINATOR'S EDITORIAL

Dear Reader,

Welcome to the second newsletter of the DACCIWA Project! This newsletter is part of a strong dissemination effort to communicate the scientific issues we are addressing with the scientific community, the general public and policymakers. If you missed the first one published in June 2015, you can still access it 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 initial activities to get the project going and about one major setback, the postponement of our main field campaign originally planned for June-July 2015 by one year due to the Ebola crisis in West Africa. Now we have fully adapted our time plans to this change and DACCIWA is operating under "full steam" again. The project meeting in October 2015 in Toulouse was an impressive demonstration of this with in total over 80 participants, including many from Africa, several international guest speakers and representatives of our Advisory Board. Recent months also saw the publication of two DACCIWA overview papers in BAMS and Nature Climate Change. The coming half year will be dedicated more and more to the preparation of the 2016 field campaign and we are getting increasingly exited about this!

Thank you for your continued interest in DACCIWA!

Peter Knippertz, project coordinator

2nd Edition
Autumn 2015

TOPICS IN THIS ISSUE

DACCIWA IN TOULOUSE

On 12-15 October 2015, the first interim project meeting was successfully held in Toulouse with about 80 participants, including many from Africa, several international guest speakers and representatives of our Advisory Board. Presentations on the state of work of each work package and special sessions (e.g. Modelling, Satellite data, etc.) were held. In the discussion rounds attached to the sessions and break-outs, the project members had ample opportunity to exchange ideas and further develop their work towards the upcoming main field campaign in summer 2016.

Participants of the DACCIWA meeting in Toulouse

Dry run for the aircraft campaign in 2016

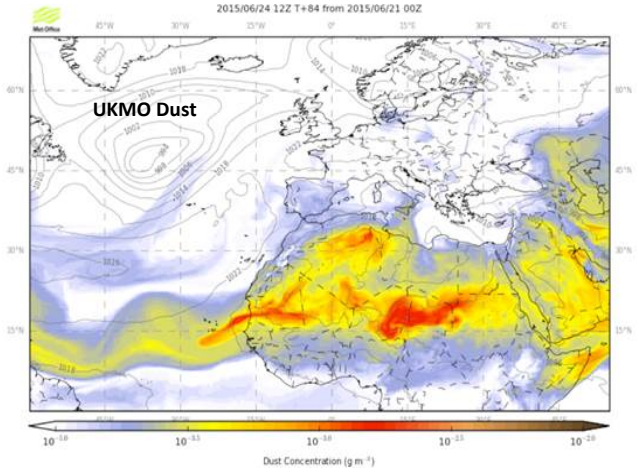
Two DACCIWA Dry Run exercises was in the summers of 2014 and 2015. The overall objective of the Dry Runs was to test the decision making for aircraft operations in the conditions of a field campaign, basically using the information available on the dedicated DACCIWA portal http://dacciwa.sedoo.fr/. For that purpose, a telecon was organized every day at 4 pm continental time (3 pm UK time), for 1 hour in 2014 and 2015.

The meetings were open to all DACCIWA scientists, including students. The core group consisted of people that have significant interests in aircraft operations in SWA, including Aircraft & Modelling Coordinators as well as WP coordinators or their representatives.

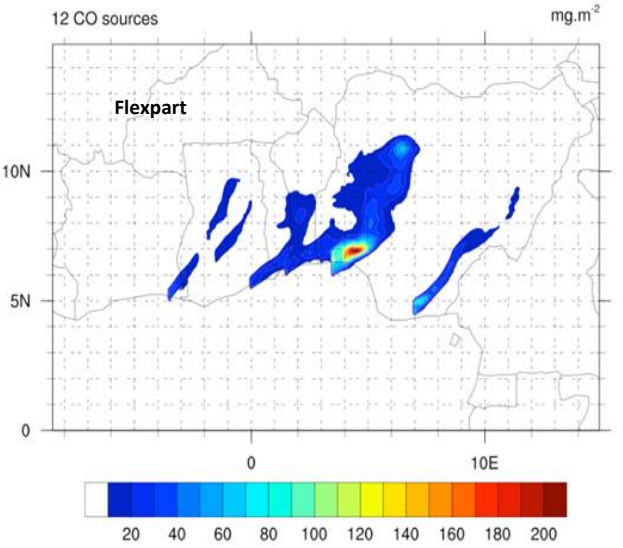
The daily telecons were conducted by a moderator. A review of the meteorological situation as well as an overview of cloud and chemical/aerosol compounds fields based on the model forecast outputs and satellite imagery available was made by two project scientists. This was followed by discussions on where the aircraft should be deployed to produce the most interesting DACCIWA science, and what type of flight plan should be pursued. During the last part of the meeting, a review of the "pseudo aircraft operations" conducted on the previous day was conducted on the basis of satellite imagery and products as well as model analysis (rather than forecast), when available. The minutes of the meeting (including a short text on the meteorological situation, a few key figures, and a list of decisions and actions) were produced by two scientific secretaries. All documents were uploaded on the dedicated DACCIWA SharePoint directory.

Most of the flights planned during the 2015 Dry Run would have been successful.

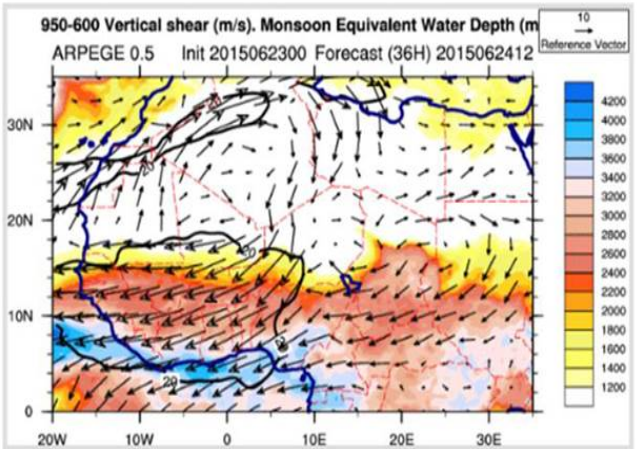
Somewhat contrasted meteorological conditions were experienced during the two Dry Run exercises. In 2014 (30 June -11 July) disturbed conditions at the coast were observed during the first week of the Dry Run with many mesoscale connective systems in the Soudanian region making aircraft operations in SWA difficult. The weather during the second week was more cooperative as deep convection had moved northward over the Sahel after the so-called monsoon onset. During the 2015 Dry Run exercise (21 June – 11 July), very dry conditions were experienced in SWA, which were favourable for aircraft operations. Most of the flights planned during the 2015 Dry Run would have been successful. The reasons for the differences in the meteorology between the two years are not entire clear yet, and could be related to: (i) an earlier monsoon onset in 2015, (ii) the impact of El Niño, (iii) the impact of SST in the Gulf of Guinea, among other plausible causes.
Based on the experience gained from the two Dry Run exercises, the decision was made to shift the aircraft campaign by one week (27 June -17 July 2016), in order to maximize the chance of operating the aircraft after the monsoon onset (its climatological date being 20 June ± 8 days).



Model forecast chemistry/aerosol products; UKMO Dust



Model forecast chemistry/aerosol products: columnar CO

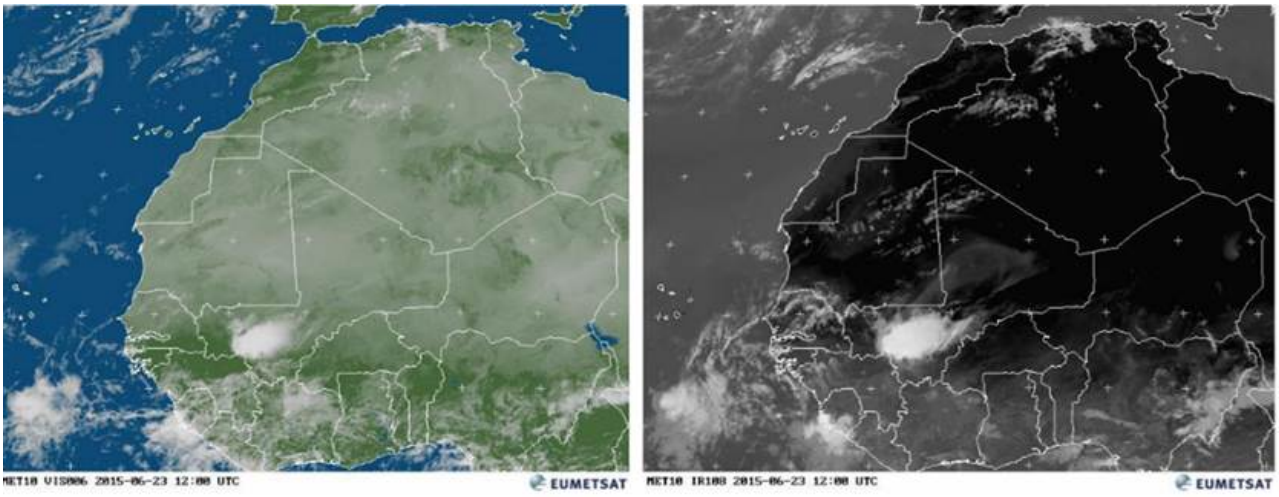


Model forecast monsoon dynamics—meteorological products: vertical wind shear and monsoon-layer depth from Météo-France

DACCIWA news

Dry run for the aircraft campaign in 2016 (cont.)

Other lessons were learned from the Dry Run exercises:
1. The dry run was a success when it came to forecasting organized convection. Maps of wind shear and mid-level dryness from the MISVA website were really useful for that purpose,
2. There is a need for building climatologies over SWA for the June-July period, based on space-borne and surface observations, to accompany the decision making processes regarding aircraft operations in the field next year: (i) regional scale distribution of gas and aerosols; (ii) stratocumulus base height; (iii) land-sea breeze front location; (iv) mid-level clouds occurrence and structure,
3. There are issues with many of the composition forecasts used during the Dry Run (e.g. little black carbon from megacities). There is also evidence that the wet and dry depositions may be too effective in most models. Hence, there is a need for building climatologies of regional scale distribution of gas and aerosols for the purpose of model evaluation.
Contact: Cyrille Flamant (cyrille.flamant@latmos.ipsl.fr)

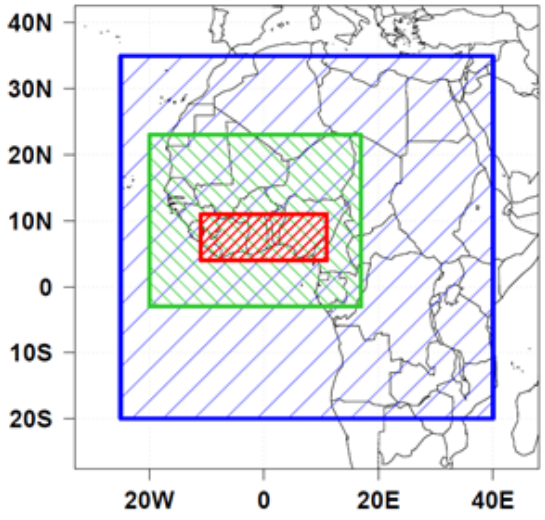


Satellite imagery (to access flight decision)

News from modelling

Simulating aerosol-cloud interactions in Southern West Africa

By using the regional scale atmospheric model COSMO-ART we quantify the influence of the atmospheric composition on radiative forcing, the two-way coupling between aerosols and cloud droplets as well as precipitation and shed light on the characteristics of cloud microphysics and dynamics in southern West Africa (SWA). The figure to the right shows the currently used simulation domains. Based on the blue domain with a grid mesh size of 28 km and a relatively large extension, even the Saharan mineral dust emissions and the biomass burning emissions in Central Africa can be considered. The green (red) box shows the first (second) nesting with a grid mesh size of 5 km (3 km). Within the second nesting we use explicit convection and a two-moment microphysical scheme to consider aerosol-cloud interactions (ACI).
We have a particular interest in the influence of aerosols on the nocturnal low-level stratus. A case study for June 7-8, 2014 shows remarkable changes in the simulated specific cloud liquid water content when using the aerosol-cloud interactions. The figure on the next page top right shows a cross-section (in southwesterly direction over Togo and Benin) of the cloud water anomaly of two simulations (ACI minus with-



COSMO-ART simulation domains: blue 28 km, green 5 km and red 3km

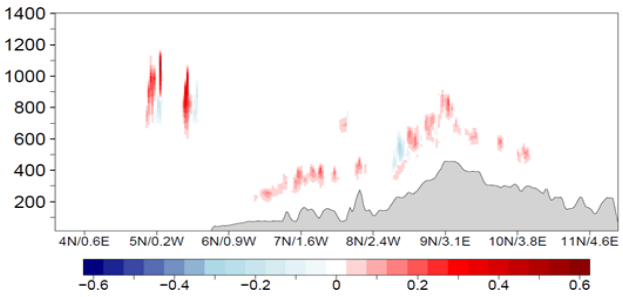
Simulating aerosol-cloud interactions in Southern West Africa (cont.)

out ACI). When considering the interactions with aerosols, the cloud water shows a positive anomaly in a shallow layer (relatively homogeneous at approx. 200-300 m above ground level) between 6.5°N and 10°N (red contour). The simulated cloud cover (not shown) at 8 June 2014, 7 UTC shows an increased horizontal extension and a reduced cloud base in comparison to the simulation without ACI. An analysis of additional cases is necessary to come to robust conclusions but these preliminary results indicate a strong aerosol influence on the

A case study for June 7-8, 2014 shows remarkable changes in the simulated specific cloud liquid water content when using the aerosol-cloud interactions

SWA cloud characteristics.

In addition to the work on our primary objectives, numerical forecasts with COSMO-ART for the aircraft campaign in June/July 2016 will be performed (see blue domain in in figure on the previous page bottom). The German Weather Service (DWD) provides ICON forecasts for the meteorological boundary conditions. The simulated distributions of aerosols and trace gas concentrations will support the decision-making of the flight routes for the DACCIWA research aircrafts. In the figure below the black carbon number concentration for several cross-sections over SWA in number per cubic centimeter is presented for a pre-operational forecast valid for 12 September 2015, 9 UTC. The locations of the cross-sections are emphasized by the upper right map. For the aircraft campaign we will realize forecasts for the following day and provide them on the website dacciwa.sedoo.fr.



Specific cloud liquid water content (ACI minus no ACI) between 0 and 1800 m above sea level (in g kg^{-1}) in southwesterly direction over Togo and Benin at 8th June 2014 (7 UTC).

Contact:
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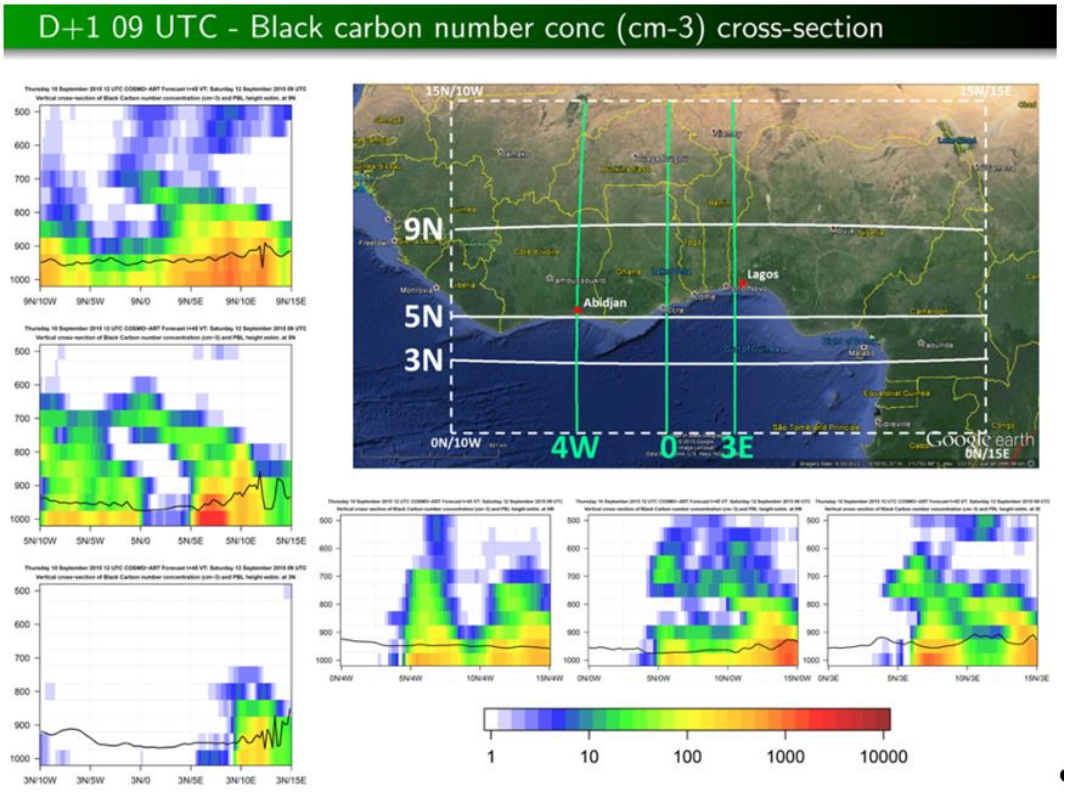


Simulated black carbon number concentration (in number per cubic centimeter). Cross-sections along 9°N, 5°N and 3°N (left, from top to bottom) and along 4°W, 0°W and 3°E (bottom, from left to right) from 1000 hPa to 500 hPa. The black line indicates an estimation of the height of the planetary boundary layer. Initialization on Thursday 10 September 12 UTC, valid for Saturday 12 September 2015 9 UTC (t+45h).

News from the Field

Savé Supersite

During the DACCIWA field campaign in June and July 2016, Savé in Benin will be one of the three supersites for ground based observations; the other two will be Kumasi in Ghana and Ile-Ife in Nigeria. Savé is situated about 200 km north of the Gulf of Guinea. The region is relatively flat and mainly used for agriculture. The observations will be performed at two sites in the surroundings of Savé, namely on the fields of the Institut National des Recherches Agricoles du Bénin (INRAB) and the aerodrome of Savé.

Savé aerodrome

The supersite will provide the radiation and energy balance components of the Earth's surface, the mean atmospheric conditions of temperature, humidity and wind, turbulence characteristics in the atmospheric boundary layer (ABL), cloud and precipitation properties as well as some aerosol and chemistry measurements.

For this, in-situ and remote sensing systems will be installed such as energy balance stations, radiosondes, frequent radiosondes, a sodar, two lidars, a wind profiler, a microwave radiometer, a ceilometer, a cloud radar, an x-band rain radar and distrometers. Aerosol properties will be measured with a spectrometer and sun photometers. Two unmanned aerial vehicles (UAVs) will be flying during the core phase of DACCIWA, i.e. when the research aircrafts will be in operation. They will capture the mean atmospheric conditions, the momentum flux and the turbulent fluxes of sensible and latent heat in the ABL. Besides the meteorological and aerosol characterization of the low atmosphere, some of WP3's objectives concerning the biogenic emissions

Savé supersite at INRAB

will be fulfilled at Savé site. Surface and vegetation emissions (NO_x and VOC fluxes) and concentrations of ozone and carbon monoxide will be measured.

The main objectives of the measurements are related to WP1 and are designed to capture the diurnal cycle of wind and cloud formation in the monsoon layer, especially the formation of the nocturnal low-level jet (LLJ) and its impact on the development of the low-level stratus, the clearing in the morning and the transition to cumulus clouds and eventually deep convection later in the afternoon. The observations will also serve as ground truth data for cloud and radiation measurements from platforms like satellites and aircraft. On the one hand the data will be used for the validation of large eddy simulation (LES) models and on the other hand the LESs shall support the data analysis.

A few facts about operations at Savé site!

20 Intensive Observation Periods (IOPs) during 13/6 - 01/08/2016

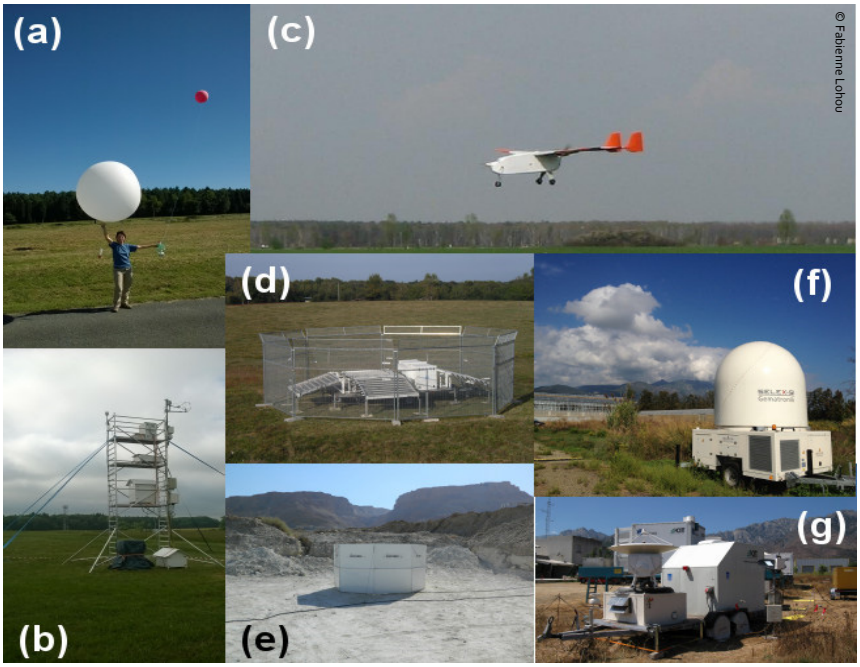
Out of IOP days: 1 normal radiosounding per day (up to 20 km height)

During IOP days: 4 to 5 normal radiosoundings per day (up to 20 km height)

11 frequent radiosoundings per day (up to 2 km height)

UAV _ALADINA: will document the turbulence in the nocturnal low level jet, the stratus when fully developed and during breaking transition phases.

UAV_OVLITA: will perform vertical soundings in the afternoon.



Instruments to be installed at Savé site

(a) frequent radiosounding with two balloons, (b) surface energie balance station and biogenic emissions, (c) UAV ALADINA for flux measurements in the subcloud layer, (d) UHF and (e) sodar (f) wind profilers, X-band and (g) cloud radar .

Contact: Fabienne Lohou (fabienne.lohou@aero.obs-mip.fr)

Meet the DACCIWAs

Sekou Keita

My name is Sekou Keita, I am an PhD student from Côte d'Ivoire. My PhD project is entitled: «African anthropogenic emission inventory: uncertainties and specificities» and is supervised by V. Yoboué (Côte d'Ivoire) and C. Liousse (France). This projet is part of DACCIWA workpackage 2, called «Atmospheric pollution and Health».

The aim of this project is to reduce uncertainties of emission inventories in Africa. In this frame, many sources of emissions are studied: anthropogenic (traffic, domestic fires, waste burning, charcoal making), biomass burning, road dust and flaring for the period 1990 – 2012 and future projections 2030 and 2050. Here are a few examples of first actions that I have conducted: For anthropogenic emission inventories, I have recently updated an algorithm where Fuel Consumption (FC) are combined with Emission Factors (EF) to derive emissions. In terms of EF measurements, two ground

Sekou Keita at work

field campaigns were performed in March and July 2015 to obtain EF for aerosol mass, black carbon (BC), organic carbon (OC) and volatile organic compound (VOC) for TPM size. Also campaigns in combustion chambers were organized in May 2015 in Toulouse and in October 2015 in Edinburgh (coll. H. Coe and S. Haslett) to obtain EF measurements for wood and charcoal for aerosol mass, BC, OC for TPM and PM2.5 sizes.

Contact: Sekou Keita (sekkeith@yahoo.fr)

News from the Field

First wet season field campaigns on Air Pollution and Health

Four intensive campaigns on air pollution and health measurement are scheduled in the framework of DACCIWA-WP2, two during the dry season and two during the wet season.
The first one took place last July 2015, in Abidjan and Cotonou with the following main objectives:
1. Size-measurements of aerosols in order to document the chemical composition of aerosols and their pro-inflammatory impact for each source site studied in WP2. In Abidjan we studied the domestic fire site at Yopougon, the traffic site at Adjamé and the waste burning site at Akouédo and in Cotonou we studied the traffic site at Dantokpa. Three aerosol impactors for ultra-fine, fine and coarse particles were running in parallel (figure below) for each site, three times in each campaign. Then each set of collected filters (figure bottom of the page) was sent to Paris and Toulouse for analysis, (i) in vitro toxicological measurements, (ii) pro-oxydant capacity of aerosols, (iii) aerosol chemical composition with determination of aerosol mass, carbonaceous aerosol including water soluble organic carbon, trace elements and ionic species.

Three aerosol impactors are running in parallel at each WP2 site: here at the traffic site of Adjamé at Abidjan in Ivory Coast.

2. Measurement of emission factors for gases and particles for the main African specific urban sources. Domestic fires with rubber wood (figure next page top) and charcoal, charcoal making and many representative two-and four- wheel vehicles were investigated.
These ground campaigns were associated to measurements in the combustion chamber in Toulouse (in March and September 2015) and in Edinburgh in Edinburgh (in October 2015, collaboration H. Coe and S. Haslett) . First results of the campaign will be presented at the AGU conference in December 2015 by Sekou Keita et al. (see box to the left).
In addition to the measurement campaign different collaborations have been developed (e.g. CHAIREPOL program in Abidjan and in Cotonou). In Abidjan census of hospital admissions for respiratory

Example of collected filters with aerosol impactors at the domestic fire site of Yopougon (Abidjan in Ivory Coast) : IQ3-1 filter (on the left) include particles larger than PM2.5, IQ3-2, (PM1- PM2.5), IQ3-3, (PM0.2-PM1) and the back up filter (on the right) with particles smaller than PM0.2.

News from the Field

First wet season field campaigns on Air Pollution and Health (cont.)

diseases were registered in the different districts close to the studied sites during the wet season.
The next campaign in Abidjan and Cotonou will take place from 5 -17 January 2016.

Emission factor measurements above a domestic rubberwood fire at Yopougon in Ivory Coast with filters, CO/CO2 and VOC sampling.

Thanks to everyone who helped making this campaign successful despite some challenges with the material transfer (figure on the right) and the electricity supply.

Finally all the material arrived.

Involved organization:
Univ. Paul Sabatier Toulouse III, Université Paris Diderot - Paris 7, Univ. Houphouet Boigny, Abidjan, CHAIREPOL, Environment Ministry Ivory Coast, Institut Pasteur Abidjan, Univ. Cotonou, LAMP Clermont Ferrand, LISA Paris, Univ. Littoral Dunkerque

DACCIWA/WP2-CHAIREPOL meeting at Cotonou

Contact: Cathy Liousse: cathy.liousse@aero.obs-mip.fr)

Meet the DACCIWAs

Sabastine Francis

Sabastine Dekaa Francis obtained his Bachelor of Technology degree in Statistics, from The Federal University of Technology, Yola, Nigeria and a Master degree in Mathematical Statistics, from the DACCIWA beneficiary Obafemi Awolowo University (OAU), Ile-Ife, Nigeria. Due to his interest in the application of Mathematics and Statistics in the science of weather and climate, Sabastine Francis further attended the African Regional Centre for Space Science and Technology Education (ARCSSTEE), OAU Campus, where he obtained a Postgraduate Diploma in Satellite Meteorology and Global Climate. Having been employed by the Nigerian Meteorological Agency (NiMet), Sabastine Francis attended further training on Weather and Climate at the United States of America's National Weather Service/CPC/NCEP/NOAA in 2010, were he obtained a Certificate in Climate Predictions.

Sabastine Francis is currently a DACCIWA Ph.D. student at the Obafemi Awolowo University, Ile-Ife, Nigeria and his research interest in the DACCIWA project is to:

- Identify rainfall types over Nigeria
- Identify variability of rainfall systems over Nigeria during the 2014 raining season
- Investigate the dynamic and thermodynamic environments of single cases of the rainfall season in 2014 for each individual rainfall type, using NiMet rain gauges data and radiosonde data, which will also be compared with ERA-Interim and satellite datasets
- Validate Satellite products based on types of rainfall and rainfall accumulations.

In order to further equip Sabastine for the task ahead in the DACCIWA project, he has been offered a three-month stay at the Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany for the period October to December 2015, where he is working jointly with Marlon Maranan, the DACCIWA Ph.D. of Andreas Fink. A primary goal of his research visit to KIT is to get familiar with ERA-Interim and satellite data sets and the application of diagnostics to describe the synoptic environment of rainfall systems. The work of Sabastine Francis will contribute to the Deliverables of work package 6 "Precipitation processes".

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Acknowledgments

DACCIWA has received funding from the European Union 7th Framework Programme (FP7/2007-2013) under the Grant Agreement no. 603502 .

Next Newsletter

Spring 2016

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DACCIWA publication: Nature Climate Change

The possible role of local air pollution in climate change in West Africa

The climate of West Africa is characterized by a sensitive monsoon system that is associated with marked natural precipitation variability. This region has been and is projected to be subject to substantial global and regional-scale changes including greenhouse-gas-induced warming and sea-level rise, land-use and land-cover change, and substantial biomass burning. We argue that more attention should be paid to rapidly increasing air pollution over the explosively growing cities of West Africa, as experiences from other regions suggest that this can alter regional climate through the influences of aerosols on clouds and radiation, and will also affect human health and food security. We need better observations and models to quantify the magnitude and characteristics of these impacts.

Peter Knippertz, Mat J. Evans, Paul R. Field, Andreas H. Fink, Catherine Liousse & John H. Marsham, 5 (815–822) 2015
http://dx.doi.org/10.1038/nclimate2727

DACCIWA publication BAMS

The DACCIWA Project: Dynamics–Aerosol–Chemistry–Cloud Interactions in West Africa

Knippertz et al. 2015: AMERICAN METEOROLOGICAL SOCIETY interactions in West Africa. Bull. Amer. Meteor. Soc. 96, 1451–1460. doi:10.1175/BAMS-D-14-00108.1

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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)

Academic partners associated through subcontracts

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