Project No: 603502

DACCIWA

"Dynamics-aerosol-chemistry-cloud interactions in West Africa"

Deliverable

D 7.2

Campaign forecasting

Due date of deliverable:	31/07/2016
Completion date of deliverable:	28/07/2016
Start date of DACCIWA project:	1st December 2013
Project duration:	60 months
Version:	[V1.0]
File name:	[D_7.2_DACCIWA_v.1.0.pdf]
Work Package Number:	**7**
Task Number:	**7.2**
Responsible partner for deliverable:	**ECMWF**
Contributing partners:	**KIT, MO**
Project coordinator name:	Prof. Dr. Peter Knippertz
Project coordinator organisation name:	Karlsruher Institut für Technologie

The DACCIWA Project is funded by the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 603502.

Dissemination level		
PU	Public	**x**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Nature of Deliverable		
R	Report	**x**
P	Prototype	
D	Demonstrator	
O	Other	

DOCUMENT INFO

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Changes with respect to the DoW

Issue	Comments
MO already had a campaign support tool in place and therefore uploading of plots to the dacciwa.sedoo website would have created unnecessary additional work.	The MO tool was configured to optimally serve DACCIWA purposes and access was granted by the MO. Plots were also put on a ftp server, from where they were downloaded to a local server at the Operations Centre in Lomé during the campaign.

Dissemination and uptake

Target group addressed	Project internal / external
DACCIWA campaign team	Internal

Document Control

Document version #	Date	Changes Made/Comments
v0.1	11/07/2016	First version submitted to DACCIWA partners for comments.
v0.3	21/07/2016	Pre-final version after comments to be approved by GA
v1.0	28/07/2016	Final version

Table of Contents

1 Introduction

This report provides a description of the activities conducted in DACCIWA WP7 Task 7.2 "Tailored forecasts for field campaign". The activities were closely tied to the aircraft component of the DACCIWA field campaign in June and July 2016, but served other components as well.

An important first step was a consultation with the involved scientists about their specific needs with respect to plots and data from operational forecasts (parameter choice, domain, time resolution and visualisation) to optimally plan field activities. This process was started and then iteratively refined during the specific DACCIWA aircraft meetings in Paris (June 2014, November 2014, February 2016, April 2016) as well as in connection with the 2nd DACCIWA science meeting in Toulouse in October 2015. As an example, the final "wish list" for MO and ECMWF products with regard to meteorological products is provided in the Appendix. Another important step in the process were the two DACCIWA Dry Runs conducted in July 2014 and June-July 2015. These consisted of daily telecons, in which the current weather and forecasts were analysed and possible flight plans were discussed for the following days. These flight plans were then retrospectively evaluated against the real weather evolution to improve planning procedures for the actual campaign in 2016. These Dry Runs helped us to better understand the usefulness of certain forecast products and observations for our purposes.

Given the objectives of the DACCIWA campaign, there was a need for both meteorological and chemical forecast information and thus for a relatively large range of forecast products. In addition to the involved operational centres (MO and ECMWF), which provided special forecast products tailored to our specific needs, members of the DACCIWA science team also ran their own models and made output available for the flight planning and ground-site teams. All forecasts are saved for detailed analysis after the field campaign.

In the following sections, we will detail the range of products, how they were made available to the project team and how they were ultimately used during the campaign.

2 Platforms

The main platform for providing near-real time information on forecasts and observations is the website http://dacciwa.sedoo.fr/ set up by DACCIWA beneficiary CNRS. This site links information from several forecast models with observations from the DACCIWA supersite as well as satellite products. Additional information was provided on a dedicated webpage for the DACCIWA supersite in Kumasi and downloaded to a server in the Operations Centre in Lomé. For the daily forecasting procedure, some standard meteorological information from free web sources was also taken into account.

2.1 Sedoo site

The DACCIWA sedoo site is based on a standard system developed by CNRS designed to support meteorological campaigns. It allows quick browsing of forecast and observational products by time, variable, display type, forecast lead-time etc. As shown in Fig. 1, the site is structured in "Reports", "Models", "Observations" and "Links" (in this case a link to the MISVA site explained below). Each category then can have further subcategories (e.g. Atmospheric Models and Chemical Models) followed by individual products under each subcategory. The navigation bar at the left-hand side also allows direct access to the various sections and subsections as well as a convenient way to change the date, which is particularly useful for post-

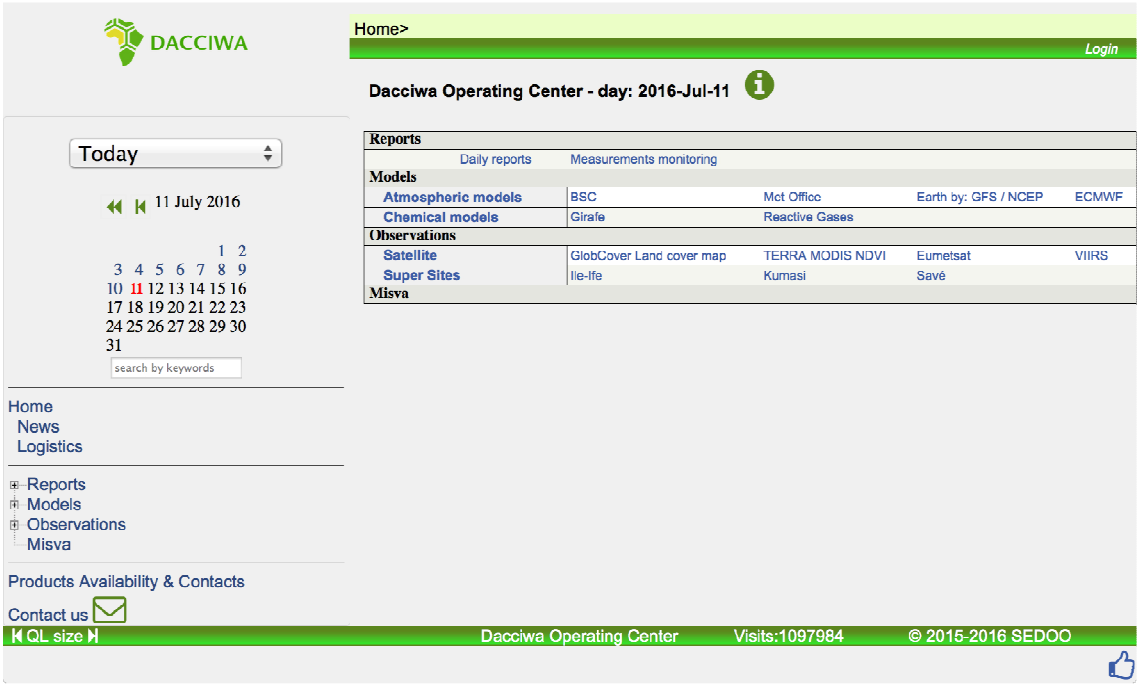

Fig. 1: Screenshot of DACCIWA sedoo webpage available at http://dacciwa.sedoo.fr/

analysis after the campaign. A keyword search is also included.

Sedoo has also been operating a similar site for MISVA for several years, which contains a number of products relevant to DACCIWA. As shown in Fig. 2, the overall set-up is similar to the DACCIWA site. Particularly during the Dry Runs, when the DACCIWA was not fully developed, MISVA products were regularly used.

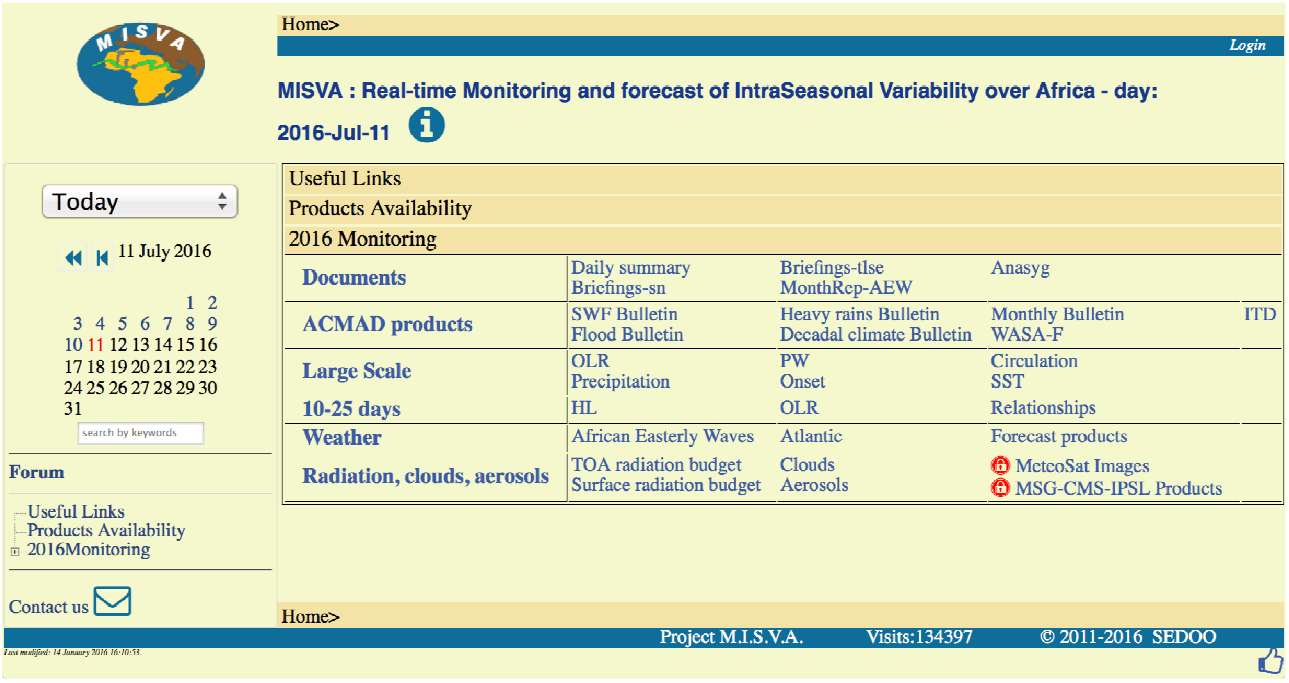

Fig. 2: Screenshot of MISVA sedoo webpage available at http://misva.sedoo.fr/

2.2 *NCAS campaign tool*

The DACCIWA supersite in Kumasi was operated by the DACCIWA beneficiaries UoL and KNUST. UoL is closely linked the UK National Centre for Atmospheric Science (NCAS), which has developed a web tool similar to sedoo, designed to support campaigns with NCAS staff involvement. In contrast to sedoo, however, this site is password protected, but access was granted to all DACCIWA scientists for the campaign. Figure 3 shows a screenshot of the configuration. The most relevant sections used during the campaign are "Missions" where status of instruments and other daily observations are logged, "Quicklooks", where plots of various instruments deployed in Kumasi are provided, and "Model products", where output from forecasts using the Weather and Research (WRF) model run by NCAS for West Africa are uploaded.

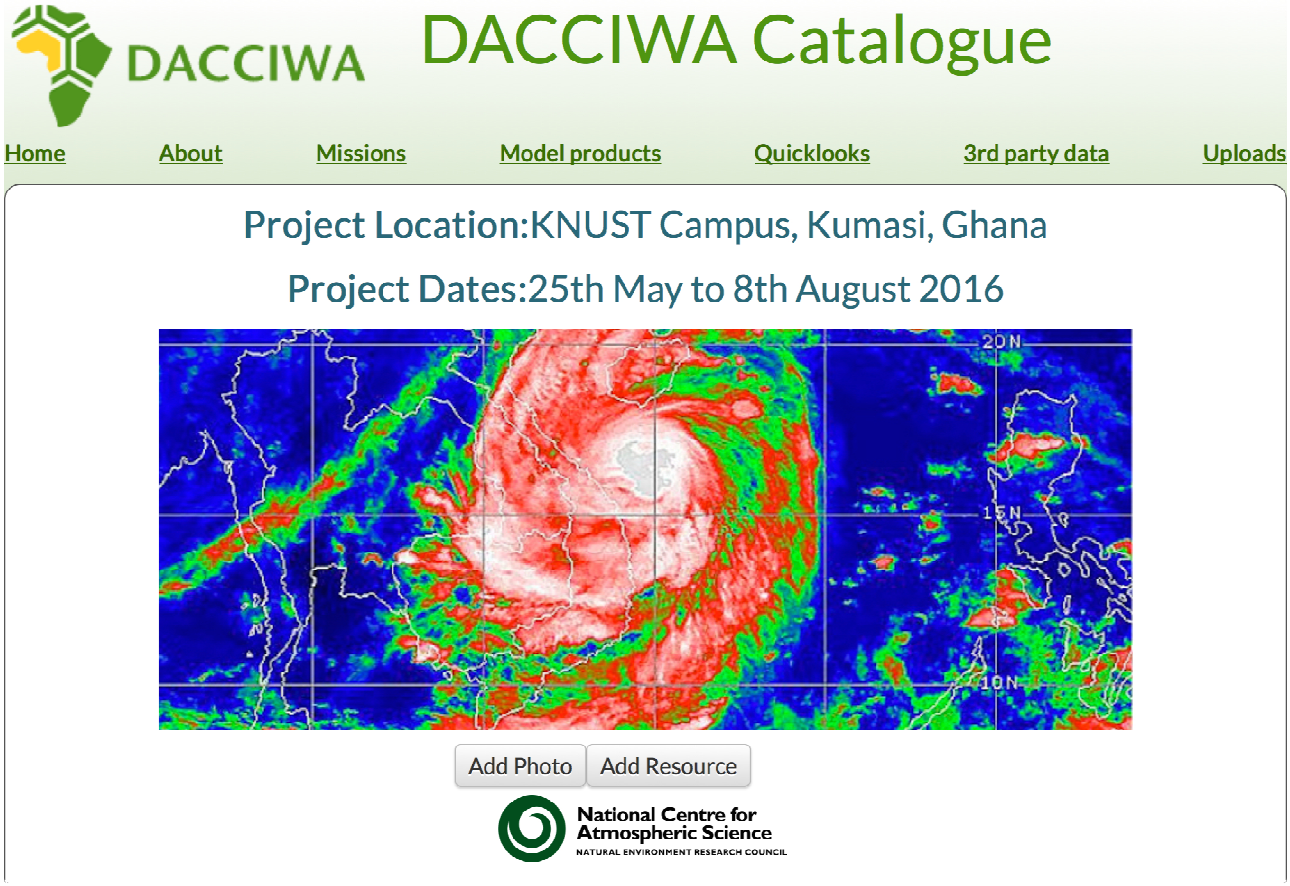

Fig. 3: Screenshot of NCAS DACCIWA webpage available at https://sci.ncas.ac.uk/dacciwa/

2.3 *Websites from operational services*

Both operational DACCIWA beneficiaries also provided forecast information on their respective websites. In the case of ECMWF, this mostly pertains to chemistry forecasts from the CAMS model (see Fig. 4). These are not password protected and thus available to other researchers as well. The MO also set-up an internal, password protected website that can be used for campaign support. This system was configured to serve DACCIWA needs and also allows a user-friendly browsing of forecast plots through pop-up menus for time, map, parameter, lead-time etc. (see Fig. 5).

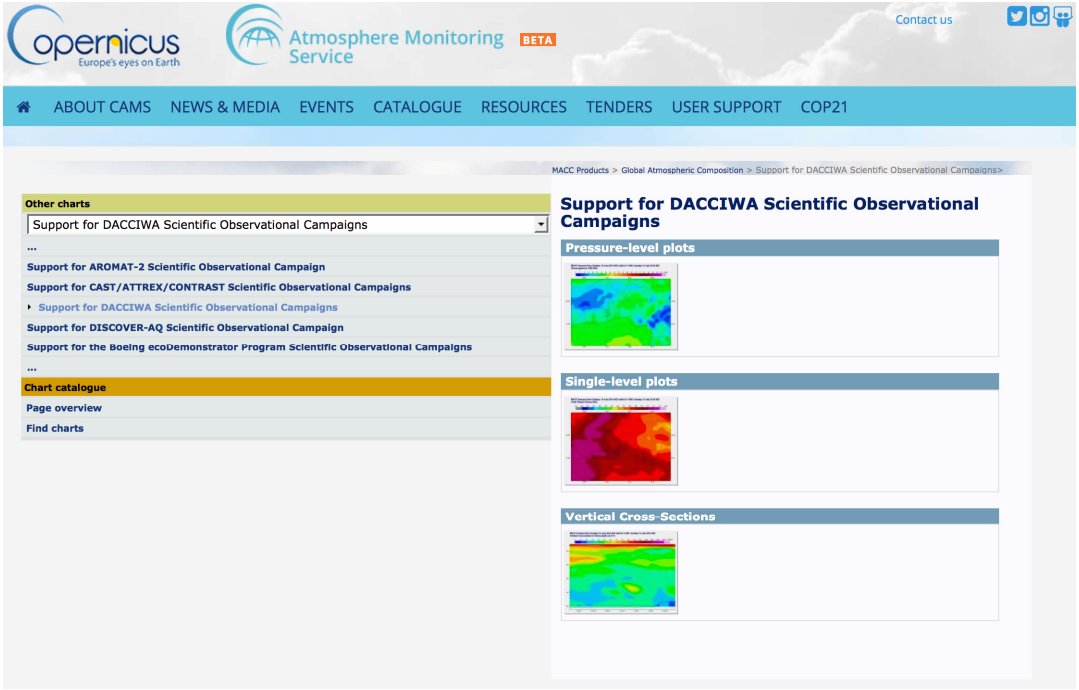

Fig. 4: Screenshot of ECMWF DACCIWA webpage available at http://macc.copernicus-atmosphere.eu/d/services/gac/dacciwa/

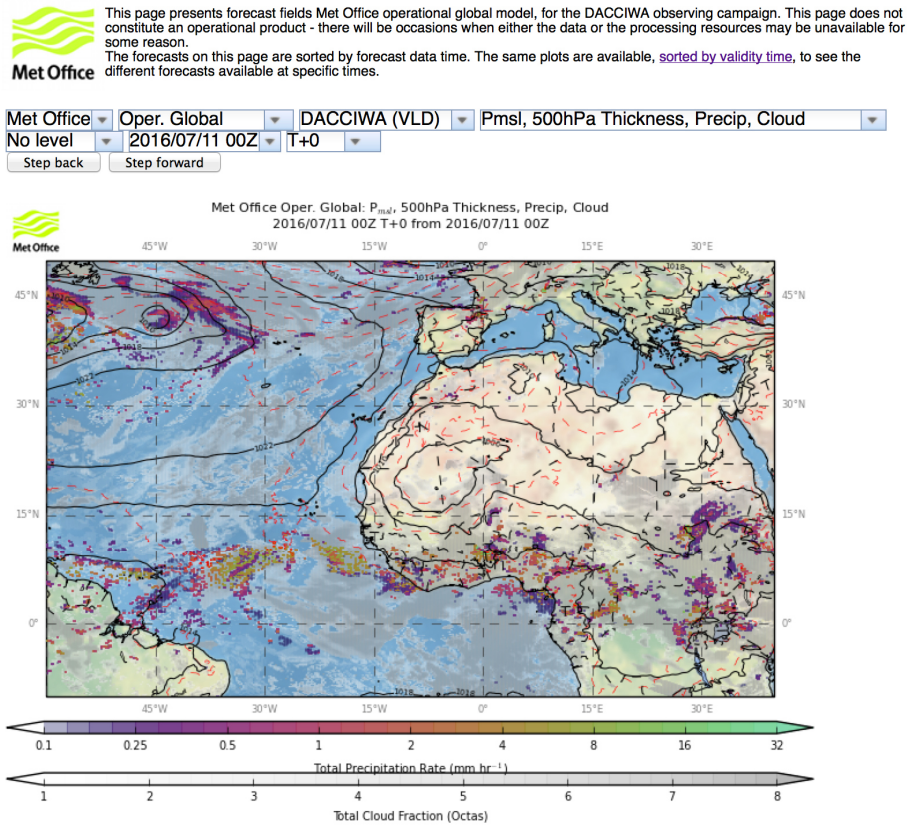

Fig. 5: Screenshot of ECMWF DACCIWA webpage available at http://ensembles-eu.metoffice.com/met-res/flying_forecasts/UKMO_Forecast_Monitoring/DACCIWA_by_dt.html

2.4 Server in DACCIWA Operations Centre

During the aircraft campaign from 25 June to 17 July 2016, an Operations Centre was set up in the Onomo hotel in Lomé where the majority of team members stayed. Amongst many other things, a server was set up in this centre that all scientists could log on to from their own laptops. Scripts were developed that automatically download forecast products from a range of sources. This served as a back-up solution for times with slow or now internet (which fortunately did not occur) and to make available products that could not be accessed from other sources (e.g. a high-resolution run using the MO model conducted by the UoL, a high-resolution run using the WRF model conducted by Cécile Kocha, former researcher at DACCIWA beneficiary UPMC). This was also used as a back-up server for observational data from the campaign.

2.5 Other resources

In addition to the above, a number of useful free web resources were identified and communicated to all team members involved in forecasting. This includes for example pages with current satellite imagery and visualised products (http://en.sat24.com/en/wa/visual; www.eumetsat.int/website/home/Images/RealTimeImages/index.html) or synoptic observations from worldwide weather stations (http://www.ogimet.com/gsynop.phtml.en).

3 Products

As already discussed above a wide range of products were used for the daily forecasting. These can be grouped in observations (3.1), meteorological forecasts (3.2) and chemical forecasts (3.3).

3.1 Observations

Besides, freely available information such as satellite images and observations from synoptic weather stations, it was essential for the flight planning to know the specific conditions at the DACCIWA ground supersites, as they were regularly overflown by the research aircraft. Therefore observations from Kumasi, Savé and Ile-Ife were plotted as quicklook images in near-real time and uploaded to the sedoo site (Savé, Ile-Ife) and the NCAS site (Kumasi). An example displaying radar data from Savé is shown in Fig. 6. Particularly the additional information on cloud cover, cloud base height, cloud layer thickness and precipitation proved to be highly important for the flight planning, as these information are often hard to extract from other sources.

An additional component was the near-real time provision of vertical profiles of temperature, humidity and wind as measured by radiosondes. These were launched as part of the radiosonde campaign organised by WP 6 and coordinated by Andreas H. Fink. Sondes were launched at the two supersites in Savé and Kumasi, at two new DACCIWA sites in Accra (Ghana) and Lamto (Ivory Coast) and in collaboration with national weather services and Agence pour la sécurité de la navigation aérienne en Afrique et à Madagascar (ASECNA) at Abidjan, Cotonou and Parakou. Data from these in total seven locations were sent to weather services in Europe in order to be ingested into data assimilation systems. At the same time, the data were sent to KIT to be plotted up automatically and then send back to e-mail addresses of DACCIWA researchers involved in forecasting. They were then also uploaded to the server in the Operations Centre in Lomé. An example of such a plot is shown in Fig. 7.

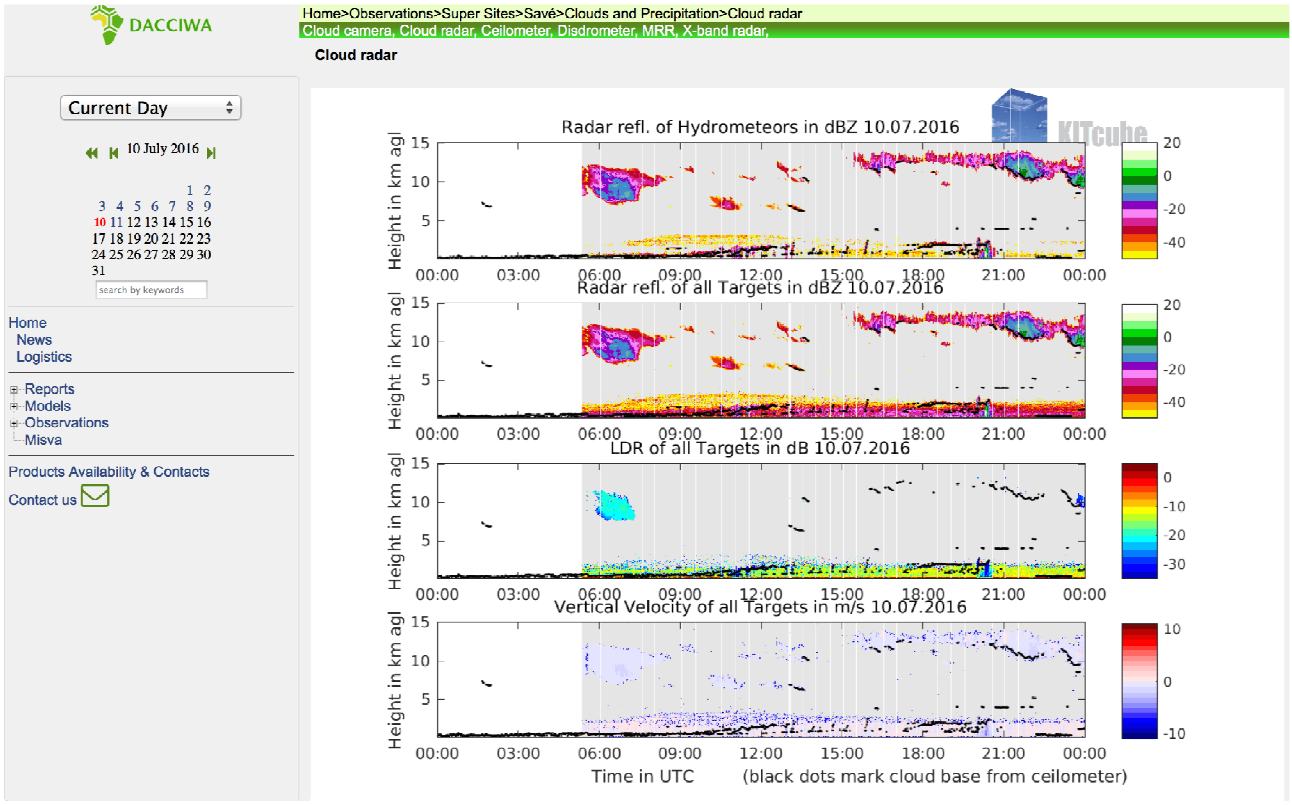

Fig. 6: Screenshot of cloud radar observations from the DACCIWA supersite in Savé as provided on the sedoo webpage.

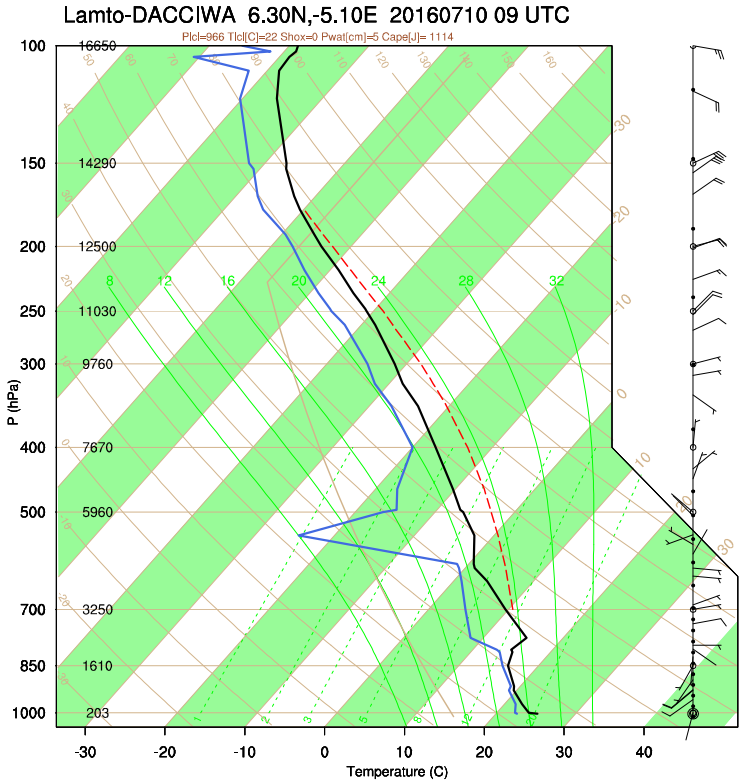

Fig. 7: Operational display of radiosonde data from Lamto (Ivory Coast) for 10 July 2016, 09 UTC.

3.2 Meteorological forecasts

In total, meteorological forecasts from six models were considered. These are:

- the operational model of the UK MO in its standard global operational configuration and in a limited area version with 4-km grid spacing run specifically for DACCIWA by UoL
- the operational global ECMWF model (both high-resolution and ensemble prediction system runs)
- the WRF model run specifically for the Kumasi supersite by NCAS and for the DACCIWA domain by Cécile Kocha, formerly associated with DACCIWA beneficiary UPMC
- the COSMO-ART model run by KIT, mainly for chemistry forecasts but also generating its won meteorological fields
- the French ARPEGE model that provides products to the MISVA site
- the U.S. American GFS that provides animated streamline plots to the DACCIWA sedoo site

Particularly for the first four, many types of plots were specifically designed for DACCIWA based on the consultations before the campaign (Paris aircraft meetings, project meetings, Dry Runs; see Introduction). These are too numerous to list here, but an impression can be gained from the "wish list" provided in the Appendix or by going directly to the sedoo page that is freely available and will be sustained after the campaign. As an important example, the forecast providers produced vertical cross sections through our main areas of interest where both ground and aircraft observations were taken. Examples for such cross sections are provided in Fig. 8. Another useful product provided for DACCIWA specifically are ensemble prediction meteograms for locations of interest. An example for Ile-Ife is shown in Fig. 9.

Fig. 8: Examples of cross sections provided by MO for a number of forecast variables.

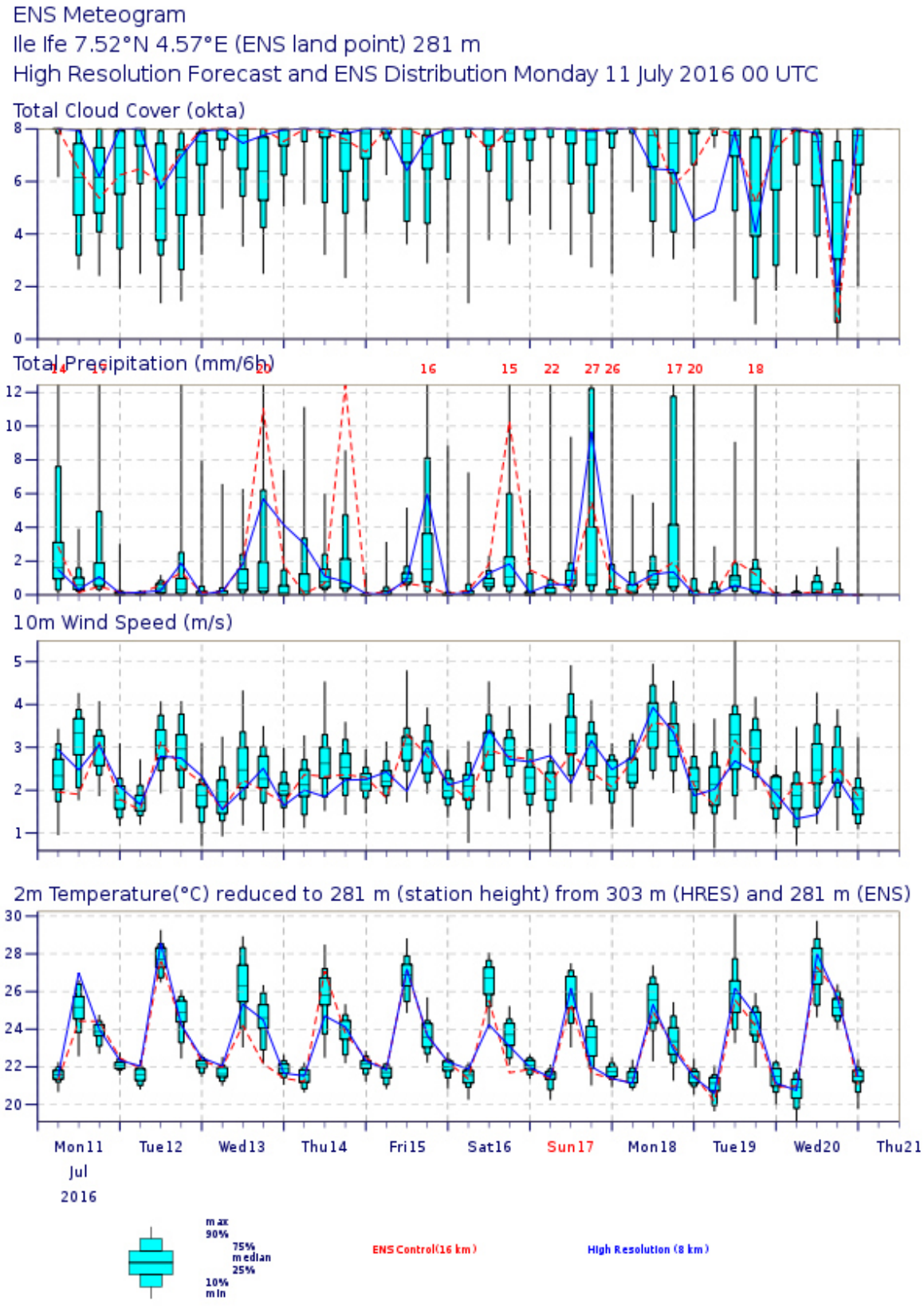

Fig. 9: Examples of an ensemble prediction meteogram for the DACCIWA supersite of Ile-Ife.

3.3 Chemical forecasts

In total, chemical forecasts from five models were considered and provided on the DACCIWA sedoo website. These are:

- the operational global ECMWF CAMS model (Copernicus Atmosphere Monitoring Service)
- the COSMO-ART model run by KIT specifically for DACCIWA
- the UK MO global model that contains some information on atmospheric composition such as dust
- the operational DREAM model from the Barcelona Supercomputing Centre specialised on dust forecasts
- the GIRAFE Lagrangian model designed specifically for DACCIWA based on anthropogenic (MACCITy and ECLIPSE) and biomass burning emissions (MODIS and GFAS)
- the HYSPLIT Lagrangian model that provides city plumes transport and dispersion for Accra, Abidjan, Lomé, Cotonou and Kumasi.

Consultations before the campaign (Paris aircraft meetings, Dry Runs) helped to establish an optimal list of tracers for chemistry. It was decided to focus on primary emitted species (carbon monoxide, dust and passive tracers) although reactive chemical species are also available from the CAMS and COSMO-ART models. Output from the five first models listed above was directly uploaded to the sedoo page. They were used to forecast large-scale biomass burning and dust intrusions. The HYSPLIT model was run daily at the Operations Centre to refine urban plume flight plans (see Figure 10) together with surface wind speed and direction for the major cities.

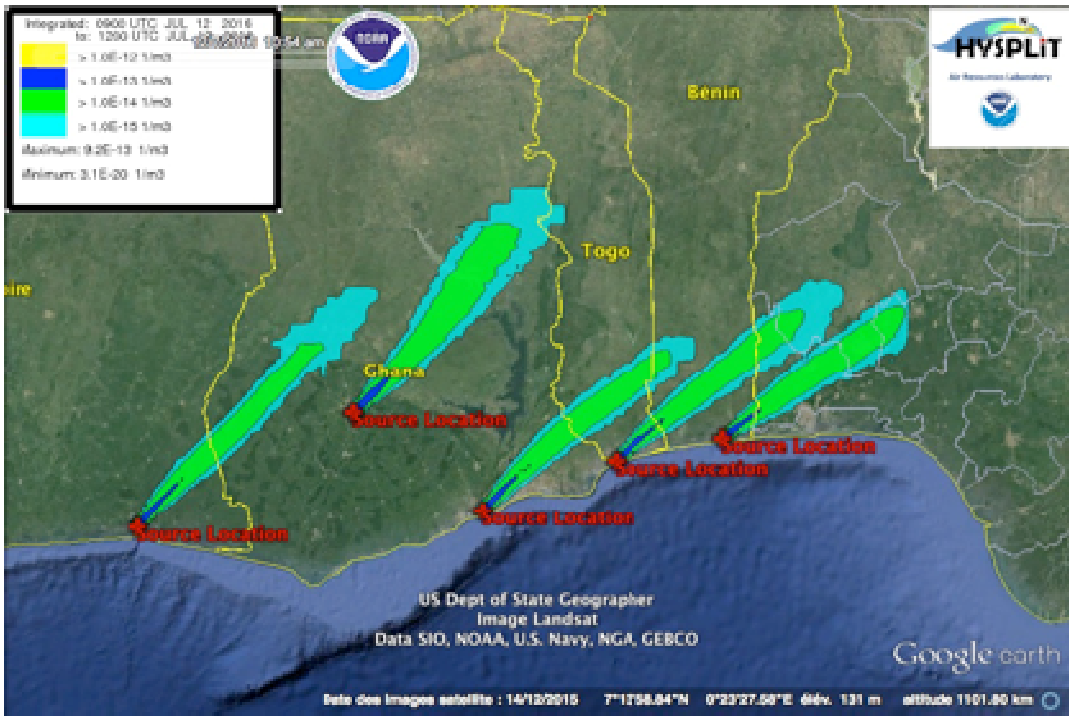

Fig. 10: Examples of Lagrangian plumes simulated by the HYSPLIT model for the DACCIWA major cities.

4 Forecasting procedure

Every morning during the campaign, a selected team of forecasters gathered in the Operations Centre at the Onomo hotel in Lomé at 10 UTC. This team included DACCIWA scientists as well as representatives of the Direction Générale de la Météorologie Nationale (DGMN, Togolese national weather service). Current observations and forecasts were discussed and forecasts from previous days evaluated. Based on these discussions three presentations were prepared: one by the DGMN on local forecasts for Togo, one by the meteorological forecast team for the broader DACCIWA region and one by the chemistry forecast team on atmospheric composition forecasts. These presentations were made available to all on the DACCIWA SharePoint.

The presentations were given at 11 UTC to all present DACCIWA scientists allowing ample opportunity for questions and discussions. Finally, the flight operations for today, tomorrow and possible subsequent days were discussed in the light of the most recent forecasts.

Based on these discussions summary sections were written for the Daily Meeting Report that was then circulated to all by e-mail and also uploaded on the DACCIWA SharePoint.

Finally, the most current developments were monitored, mostly using satellite imagery and communicated to the scientists on-board the aircraft via Iridium chat for short-term changes to flight plans. Updates to forecasts and possible consequences for next day's flights were also discussed during the daily evening meetings at 19 UTC.

Additional forecasting sessions looking specifically at local conditions were held at the three supersites Savé, Kumasi and Ile-Ife on a daily basis.

5 Summary

Forecasting the meteorological and chemical state of the atmosphere is an essential ingredient to observational campaigns, particularly those using large research aircraft as DACCIWA. To support this process, WP7 coordinated a campaign forecasting activity to optimally support this process. The activity included (a) consultation of team members to identify optimal sources and display of information, (b) discussions with operational weather services to provide these, (c) own model simulations specifically for the campaign, (d) set-up of web-based tools to conveniently browse and evaluate model output but also near-real time observations, for example from the DACCIWA supersites, (e) set-up a server in the Operations Centre to allow local access to products, and (f) hold daily forecasting sessions to optimally inform planning activities. The experienced gathered in this process will be fruitful for the longer-term DACCIWA research, as it has illustrated the strength and weaknesses of models in a daily forecasting routine.

Appendix

Wish list: Meteorological forecast products for DACCIWA field campaign

Ideally we would want identical plots from MO and ECMWF (fields, geographical domain, projection, colour scale etc.)

Large Domain (LD): 10°S–30°N, 20°W–25°E
Small Domain (SD): 0°–15°N, 10°W–15°E
Very small Domain (VSD): 05°-10°N, 0°-5°E
Very Large Domain (VLD): 10°S–50°N, 60°W–40°E

1) Horizontal distributions every 3 hours (analysis to +120h):

a) 2D fields
- (SD) cloud cover (low-, mid-, high-level; 3 separate or combined colour shadings)
- (SD) pseudo satellite images: VIS (grey shading), IR (grey shading with rainfall as colours)
- (LD) vertically integrated WV 1000–300 hPa (monsoon layer depth, colours), vertical wind shear vector 600–925 hPa as vectors + absolute values as lines
- (LD) anomalies[#] of vertically integrated WV 1000–300 hPa (monsoon layer depth, colours) and of mass-weighted mean flow 950-600 hPa as vectors
- (SD) anomalies[#] of vertically integrated WV 700–500 hPa (midlevel dry-layers, colours), vertical wind shear vector 600–925 hPa as vectors + absolute values of same quantity as lines
- (SD) Surface: T2m (colours), Td2m (lines, 14°C bold), 10m wind (vectors)
- (LD) MSLP (lines) with 24h pressure tendencies (isallobars, colours)
- (SD & LD) CAPE (colour), CIN (lines)
- (SD) mass-weighted mean flow 950-600 hPa: isotachs (lines), relative vorticity (colours), streamlines
- (LD) BL depth (lines), convergence (colours)
- (VSD) cloud base

b) 3D fields
- (LD) levels 925, 850, 600*:* streamlines with isotachs (lines) plus humidity (colour)
- (VLD) level 200, 300, 500: streamlines with isotachs (lines) plus meridional wind (colour)
- (LD) levels 300, 500, 700, 850, 925: Temperature (lines), RH (dashed lines), Q (colours)
- (VSD) levels 925, 850: wind, temperature (lines), RH, equivalent potential temp., vorticity

2) Specific plots for special sites

a) Meteograms (standard plus precipitable water and cloud base, every 3 hours out to +120h)

Locations (11):
- Supersites: Kumasi (6.68°N, 1.56°W), Savé (8.02°N, 2.28°E) & Ile Ife (7.55°N, 4.55°E)
- Capitals: Abidjan (5.15°N, 3.56°W), Accra (5.36°N, 0.10°W), Lomé (6.10°N, 1.15°E), Cotonou (6.21N, 2.23°E), Lagos (6.35°N, 3.20°E)
- Others: Parakou (9.21°N, 2.37°E), Abuja (9.15°N, 7.00°E), Niamey (13.29°N, 2.10°E)

b) Pseudo-radiosondes every 3 hours (analysis to +72h)
t-log p, if possible with instability indices
same locations as 2a)

[#] with respect to the zonal mean at the same time for the longitudinal width of the plot (i.e. 20°W–25°E for LD and 10°W–15°E for SD)

c) Vertical cross sections (height: 1000-700hPa) every 3 hours (analysis to +72h)
Locations:

1) 0-15°N, SW–NE oriented (along monsoon flow) through Yamoussoukro (6.54°N, 5.21°W), Kumasi (6.68°N, 1.56°W), Accra (5.36°N, 0.10°W), Savé (8.02°N, 2.28°E), Ile-Ife (7.55°N, 4.55°E)
2) 10°W-10°E, E-W oriented through 5.5°N (Abidjan and Accra), 6.5°N (Kumasi, Lagos) 7.75°N (Ile-Ife and Savé)

Parameters (stacked panels):
zonal wind, meridional wind, horizontal windspeed, specific humidity, relative humidity, cloud water mixing ratio, ice mixing ratio, theta, theta-e, divergence, vectors (horizontal component: horizontal wind along section, vertical component: vertical wind*1000)

3) Additional
- SST (daily analysis): anomalies in colour, absolute as lines