



Grant agreement no. 243964

QWeCI

Quantifying Weather and Climate Impacts on Health in Developing Countries

Deliverable 1.2c: Final, documented database of observations for WP1.1 ready for transfer into the AMMA database

Start date of project: 1st February 2010

Duration: 42 months

Lead contractor: UoC
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Evolution of deliverable

Due date : M26
Date of first draft : 6 July 2012
Start of review : 11 July 2012
Deliverable accepted : 24 July 2012

Project co-funded by the European Commission within the Seventh Framework Programme (2007-2013)		
Dissemination Level		
PU	Public	PU
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)	

Introduction

The QWeCI project aims to identify relationships between atmospheric variables and the occurrence of diseases like malaria and the Rift Valley Fever. This deliverable reports on the construction of an atmospheric database, which provides access to climate-driver variables for various work packages of the QWeCI project. Key variables of the investigated diseases including rainfall amounts, temperature, and humidity are entered into the database.

The status at the surface of the Earth's atmosphere is usually represented by automatic and manual observations. These observations are carried out regularly, for example, every three hours or even every hour by weather stations (usually called synoptic stations) typically measuring a number of characteristics of the atmosphere. These include observations from instruments such as thermometers or barometers and manual observations of clouds, the visibility, the state of the ground, and the present and past weather conditions. According to the World Meteorological Organization (WMO) Resolution 40 (Cg-XII) of the World Weather Watch Program atmospheric observations are exchanged worldwide via the Global Telecommunication System (GTS) by means of predefined reports. These reports include, for example, 3-hourly SYNOP (code format 12 of the WMO) and monthly CLIMAT (code format 71) messages, and hourly METAR (code format 15) reports from airports.

Automated Weather Stations (AWSs) are increasingly added to the worldwide weather station network. These AWSs are able to replace manual observations. They offer the opportunity to measure atmospheric conditions with a high temporal resolution (e.g. every minute). However, AWSs are not able to replace manual observations such as for significant weather conditions. Within QWeCI automated weather observations were introduced in Ghana in the area of Kumasi. The project installed weighing rain gauges at three locations and one AWS in Owabi.

Besides surface station data sets, quality-controlled satellite observations are available since the late 1970s. Satellites are, for instance, used to quantify the distribution of precipitation around the globe over many years. Such products are based on microwave or infrared data, which are calibrated by using precipitation amounts from gauges.

Atmospheric re-analyses are also added to the database. Re-analyses improve operational analyses and provide a consistent analysis of the atmosphere. Such systems are based on data assimilation techniques using a frozen version of an atmospheric model and use as much as possible original observations. For example, in addition to standard observations, the European Centre for Medium-range Weather Forecasts (ECMWF) 40 Year Re-Analysis (ERA-40) product made use of data from past field experiments such as the 1974 Atlantic Tropical Experiment of the Global Atmospheric Research Program (GATE). The ECMWF Interim Re-Analysis (ERA-Interim) is the latest global atmospheric reanalysis produced by the ECMWF.

Structure of the atmospheric database

The atmospheric database of the QWeCI project can be entered via a web portal (see <http://qweci.uni-koeln.de>; Figure 1), which is integrated into the web-based Java framework of work package 5.1. In the first step, short profiles are presented of different data sets, which reveals information in terms of the name and the originator of the data, the data content, as well as regarding the covered period (Figure 2). Subsequently, the user can either enter particular metadata, visit the original provider of the data, or is able to directly download data files (Figures 3-5).



The screenshot shows the QWeCI web portal. At the top, there are logos for the University of Cologne and the QWeCI project. The main heading is "Quantifying Weather and Climate Impacts on health in developing countries". Below this, there is a paragraph of text discussing the impacts of climate variation on diseases, particularly vector-borne diseases in Africa. A sidebar on the left lists various project components. A large graphic of a mosquito over a map of Africa is also visible.

Figure 1: Web portal of the UoC regarding QWeCI available at <http://qweci.uni-koeln.de>.

Detailed metadata is provided for each data set according to the **ISO 19139** geographic information metadata eXtensible Markup Language (**XML**) schema implementation. This catalog is divided into various categories consisting amongst others of an abstract, resource overview, content information, graphical overview, lineage, resource constraints, data quality, and distribution information (Figure 4 & 5). All this information is provided by the web portal and is in addition available by an XML file.

A link is provided to the originator of the data sets. Here the user might be able to access the original data, download recent data updates, to find different versions of the data set and additive information. Note that the original data files have been frequently processed in order to provide end-user friendly file formats such as **Comma-Separated Values (CSV)** or the **Network Common Data Format (NetCDF)**.

The data sets of the QWeCI atmospheric database can be either downloaded from a public accessible **FTP (File Transmitting Protocol)** server of the UoC computer centre (free access via <ftp://ftp.uni-koeln.de/institute/qweci>) or via a password protected FTP service of the UoC QWeCI server (restricted access via <ftp://qweci.uni-koeln.de>). Downloadable are

the data files, example graphics of the data, the metadata XML file of the data set, as well as supporting files (Figure 3).

The screenshot displays the 'Atmospheric Database' interface. At the top, it features the QWeCI logo with the tagline 'Quantifying Weather & Climate Impacts on health in developing countries' and the University of Cologne logo. The main content area is titled 'Atmospheric Database Version 1.0' and lists seven data sets, each with a thumbnail image, a title, a description, originator, type, and period. Access and download options are provided for each set.

Data Set	Thumbnail	Description	Originator	Type	Period	Access/Download
GSOD	Map of Africa	Federal climate complex Global Surface summary of Day version 7	National Climatic Data Center (NCDC), USA	Station time series derived from SYNOP and METAR reports	1973 - 2009	Free access & Download
SYNOP	Map of Africa	Synoptic reports from the DWD archive	German National Weather Service (DWD)	Station reports from the SYNOP code distributed by the GTS	1967 - 2007	Restricted access & Download
MIDAS	World map	Met Office Integrated Data Archive System land surface stations data	Met Office	Meteorological values distributed by the GTS	1983 - 2009	Restricted access & Download
GHCN	Map of Africa	Global Historical Climatology Network version 2	National Climatic Data Center (NCDC), USA	Station time series derived from CLIMAT reports	1850 - 2009	Free access & Download
GMet	Bar chart	Historical Meteorological time series from Ghana	Ghana Meteorological Services Department	Rainfall, temperature, relative humidity, and evapotranspiration time series	1960 - 2009	Restricted access & Download
KuPTiS	Bar chart	Kumasi Precipitation Time Series	Institute of Geophysics and Meteorology, University of Cologne	Unfiltered and filtered time series from weighing rain gauges	2008 - 2011	Restricted access & Download
OwabiAWS	Weather station	Owabi Automatic Weather Station data	Institute of Geophysics and Meteorology, University of Cologne	Meteorological time series from an Automatic Weather Station (AWS)	2008 - 2011	Restricted access & Download

Figure 2: Short profiles of the data sets as presented by the web-based Java framework.

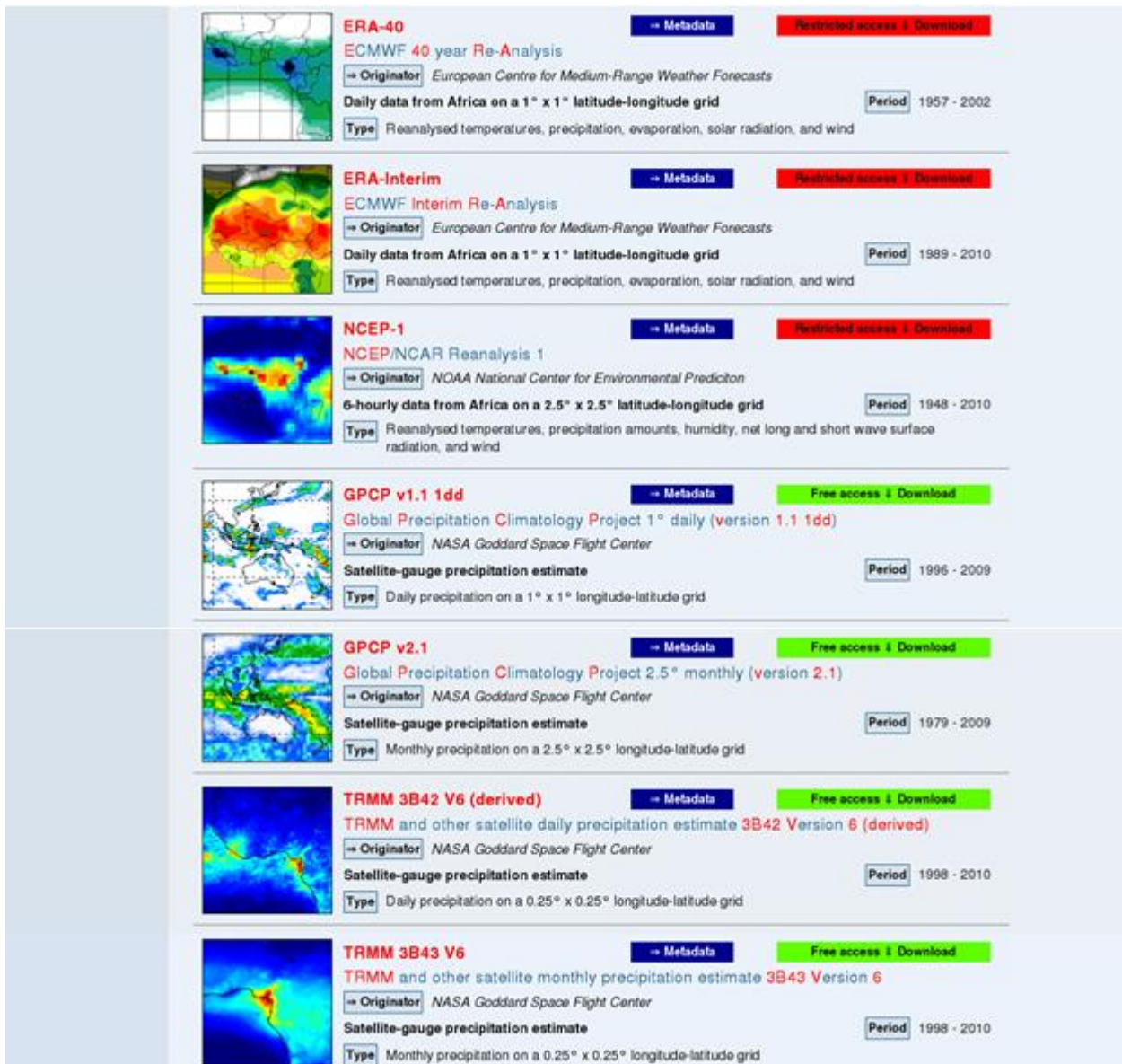


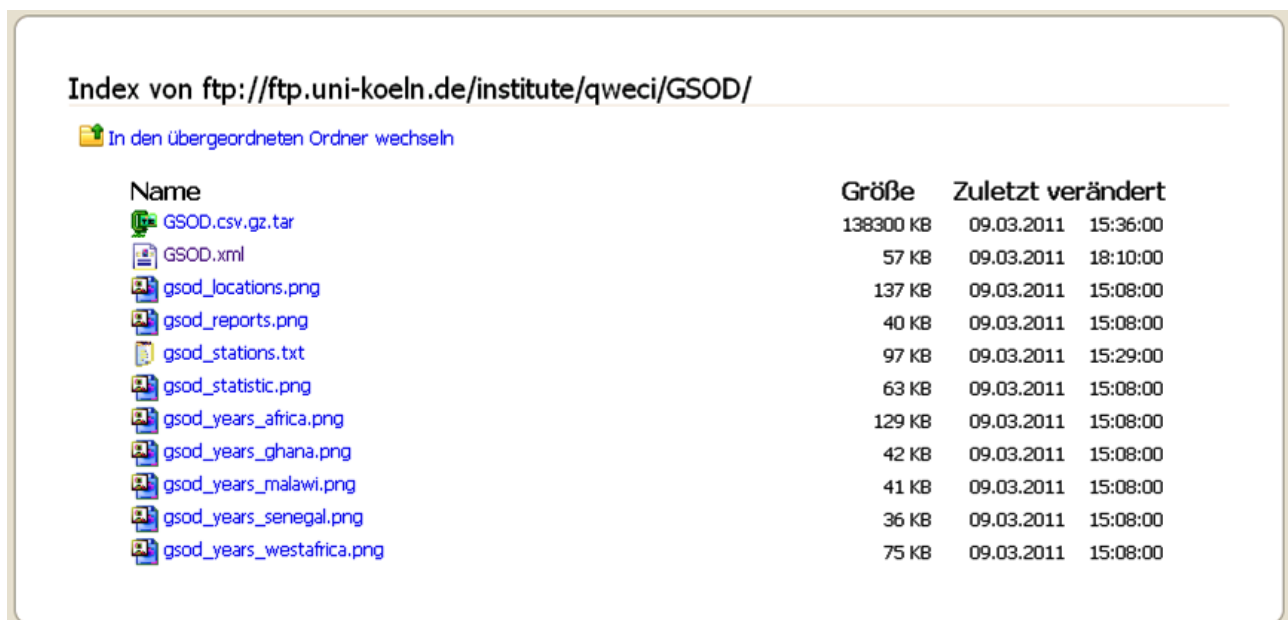
Figure 2 (continued)

Data sets


In the following, data sets are presented, which were already entered into the atmospheric database. The version 1.0 of the atmospheric database includes altogether fourteen different data sets:

- **GSOD: Federal climate complex Global Surface summary of Day version 7**

The federal climate complex Global Surface summary of Day (GSOD) data set is produced and regularly updated by the National Climatic Data Center (NCDC). In the data set a subset of the global surface summary of day data was extracted for Africa. The daily entries of GSOD include 18 surface meteorological elements, which were derived from SYNOP and METAR reports. The historical time series are generally available for 1973 to the present. Some stations in Africa reveal data back to before 1900. The variables included in the data set differ from station to station, they include mean temperature, mean dew point, mean sea level pressure, mean station pressure, mean visibility, mean wind speed, maximum sustained wind speed, maximum wind gust, maximum temperature, minimum temperature, precipitation amount, snow depth, as well as an indicator for the occurrence of fog, rain or drizzle, snow or ice pellets, hail, thunder and tornado/funnel clouds of a particular day.



Index von <ftp://ftp.uni-koeln.de/institute/qweci/GSOD/>

 [In den übergeordneten Ordner wechseln](#)












Name	Größe	Zuletzt verändert	
 GSOD.csv.gz.tar	138300 KB	09.03.2011	15:36:00
 GSOD.xml	57 KB	09.03.2011	18:10:00
 gsod_locations.png	137 KB	09.03.2011	15:08:00
 gsod_reports.png	40 KB	09.03.2011	15:08:00
 gsod_stations.txt	97 KB	09.03.2011	15:29:00
 gsod_statistic.png	63 KB	09.03.2011	15:08:00
 gsod_years_africa.png	129 KB	09.03.2011	15:08:00
 gsod_years_ghana.png	42 KB	09.03.2011	15:08:00
 gsod_years_malawi.png	41 KB	09.03.2011	15:08:00
 gsod_years_senegal.png	36 KB	09.03.2011	15:08:00
 gsod_years_westafrica.png	75 KB	09.03.2011	15:08:00

Figure 3: Directory of the GSOD data set on the public accessible FTP server of the UoC computer centre (downloadable via <ftp://ftp.uni-koeln.de/institute/qweci/GSOD/>).

- **SYNOP: Synoptic reports from the DWD archive**

The SYNOP data set includes meteorological messages, which are based on data exchanged under the WMO World Weather Watch Program according to WMO Resolution 40 (Cg-XII). The archive includes data from SYNOP messages as distributed by weather stations. The data was provided by the archive from the German Weather Service (DWD). A subset of the SYNOP data set available in the DWD archive was extracted for Africa for

the WMO block numbers 60, 61, 62, 63, 64, and 65. Included in the synoptic reports are atmospheric variables such as air temperature, dew-point temperature, atmospheric pressure, wind speed, the precipitation amount, present and past weather, cloud observations, etc. The archive contains data from 1966 to 2010 and is most complete since about 2000. For example, on average for each weather station contained in the data set, more than four synoptic messages are available per day in 2009.

The screenshot displays the QWeCI Atmospheric Database interface. At the top, it features the QWeCI logo (Quantifying Weather & Climate Impacts on health in developing countries) and the University of Cologne logo (Institute of Geophysics and Meteorology). The main content area is titled 'Atmospheric Database → Metadata: GMet' and includes a 'back' button. The 'Short Profile' section shows a bar chart of rainfall data and a 'Restricted access' button. The 'Abstract' section provides detailed information about the GMet data set, including its originator (Ghana Meteorological Services Department), abstract, keywords, contact information, and update status.

Figure 4: Metadata of the GMet data set with the extended 'Short Profile' and 'Abstract' sections.

- MIDAS: Met Office Integrated Data Archive System land surface stations data

This data set includes land surface observations from African weather stations as stored in the database of the Met Office Integrated Data Archive System (MIDAS). The station reports are available for the period 1853 to present. The data set comprises daily and hourly weather measurements, hourly wind parameters, maximum and minimum temperatures, soil temperatures, sunshine duration, and radiation measurements as well as daily, hourly, and sub-hourly rainfall amounts. The spatial and temporal coverage of the

observational data set depends of the variables considered, but the data set provided is defined in a 3-hourly scale for the period 1974-2009 and contains all the stations for Africa included in the original MIDAS database.

- GHCN: Global Historical Climatology Network version 2

The Global Historical Climatology Network (GHCN) monthly data is produced and regularly updated by the United States National Climate Data Center (NCDC). Here a subset of the global GHCN version 2 data set was extracted for Africa. The GHCN database contains monthly historical mean, maximum and minimum temperatures, precipitation amounts, and pressure data for synoptic weather stations, which were mostly gathered from CLIMAT reports. The period of record varies from station to station some of the stations in Africa extend back to the 19th century.

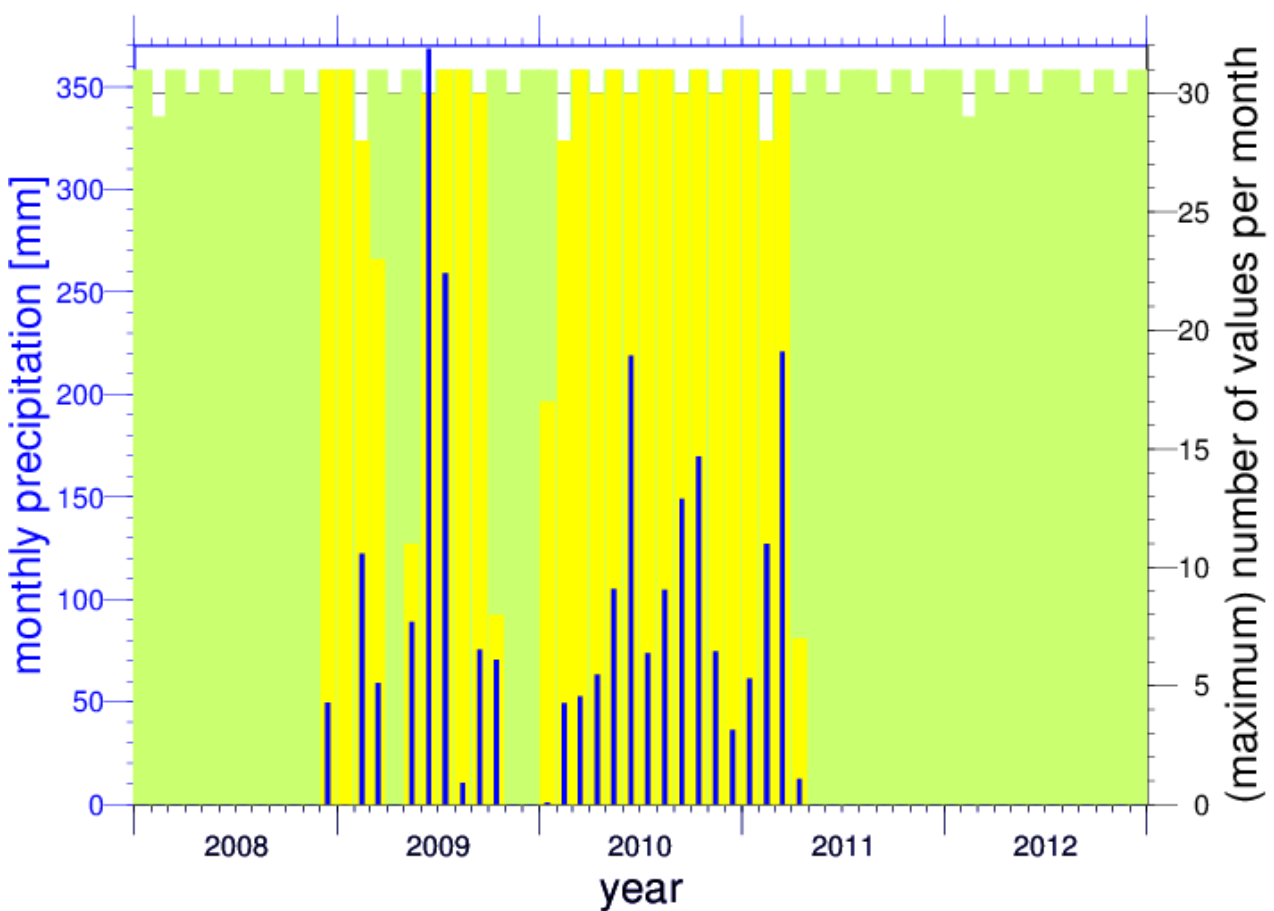


Figure 5: Observed monthly precipitation amounts (blue bars; left axis), numbers of available daily rainfall values (yellow bars; right axis), and maximum possible numbers of daily precipitation values per month (green bars; right axis) between 2008 and 2011 at the Kumasi Airport station.

- GMet: Historical Meteorological time series from Ghana

The historical Meteorological time series from Ghana data set contains both daily and monthly data of several synoptic weather stations as well as hydro-meteorological stations

from Ghana. Daily data include minimum and maximum temperatures, precipitation amounts, as well as sunshine duration. The period of record varies from station to station and includes various data gaps. For most stations data is available between 1960 and 2008.

- KuPTiS: Kumasi Precipitation Time Series

The Kumasi Precipitation Time Series (KuPTiS) database contains unfiltered minutely rainfall data and filtered minutely, hourly, and daily precipitation time series collected at four weather stations in the Kumasi area of Ghana. Installed were weighing precipitation gauges of the OTT type with a resolution of 0.1 mm of rain and a temporal resolution of one minute. The data covers in general the period between December 2008 and May 2012.

The rainfall observations suffer in terms of artificial rainfall peaks (mostly 0.1 or 0.2 mm of rain in one minute). Therefore, a filter regarding artificial rainfall was used to select realistic rainfall events. Note that this filter cannot perfectly select precipitation values. Some rainfall events will not be included by the filter and some artificial rainfall peaks will be embedded into the filtered data. In this database, the unfiltered minutely data and filtered minutely, hourly, and daily rainfall data is available.

The rain gauges were installed by the Institute of Geophysics and Meteorology from the University of Cologne and have been donated to the Kwame Nkrumah University of Science and Technology (KNUST). The automatic rain stations were downloaded and monitored by staff from KNUST.



Figure 6: Pluviometer and solar power supply on the ground of the Emena hospital in Kumasi (Ghana) in April/May 2010.

- OwabiAWS: Owabi Automatic Weather Station data

The Owabi Automatic Weather Station (OwabiAWS) data includes observations from an hydro-meteorological weather station in the Kumasi region of Ghana. The weather station but not the AWS is maintained by the Ghanaian meteorological agency. The AWS is situated within a rural area, in the vicinity of an artificial lake. The surface around the AWS is covered by seasonally varying grass. For some periods the grass was cut by the staff of the weather station.

The station was installed by the Institute of Geophysics and Meteorology of the University of Cologne/Germany. The station was put in operation on 01 May 2010. Currently, data is available until May 2012. The AWS has been donated to the Kwame Nkrumah University of Science and Technology (KNUST) and is operated by staff from KNUST.

The OwabiAWS data comprises various observed meteorological variables from the AWS. Included are the ten-minutely rainfall amount (measured with a tipping bucket pluviometer), heat flux (two heat flux plates at 20 cm below surface), temperature (platinum resistance thermometer, PT100), relative humidity (capacitive humidity sensor), matrix potential (equitensiometer; information about soil moisture), three dimensional wind vector (ultrasonic anemometer at a height of about 4.5 m, including further related information, e.g. standard deviations), shortwave (pyranometer) and longwave (pyrgeometer) radiation, and pressure (barometer) data. Temperature and humidity are measured in both 2 m and 4 m height above ground.

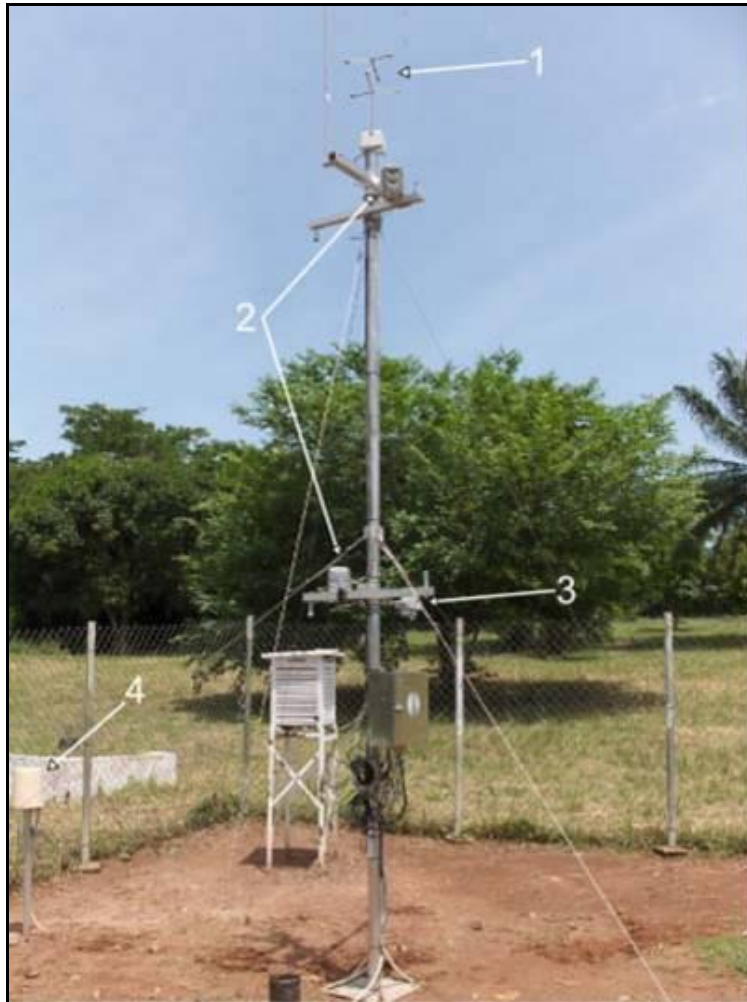


Figure 7: Automatic weather station in Owabi (Ghana). Legend: 1: ultrasonic anemometer, 2: Capacitive humidity measurement and temperature, 3: CNR1 net radiometer, and 4: tipping bucket pluviometer.

Unfortunately, data gaps are present in the temperature and humidity time series. Note that the ventilation of the temperature and humidity sensors broke down partly. The user therefore should carefully use the temperature and relative humidity values! The pyranometers are upward and downward directed, which allows the calculation of the radiation balance at the ground. Note that the radiation measurements suffer partly from contaminations of the glass dome (shortwave radiation) and solar blind silicon window (longwave radiation). The upward shortwave radiation measurement suffers from the end of March 2012 from technical problems (defective contact). This data was therefore deleted.

The original temporal resolution of the data was one second and was aggregated or averaged to a time resolution of ten minutes. Rainfall amounts are automatically summed up and the other parameters are automatically averaged to the time interval by the AWS.

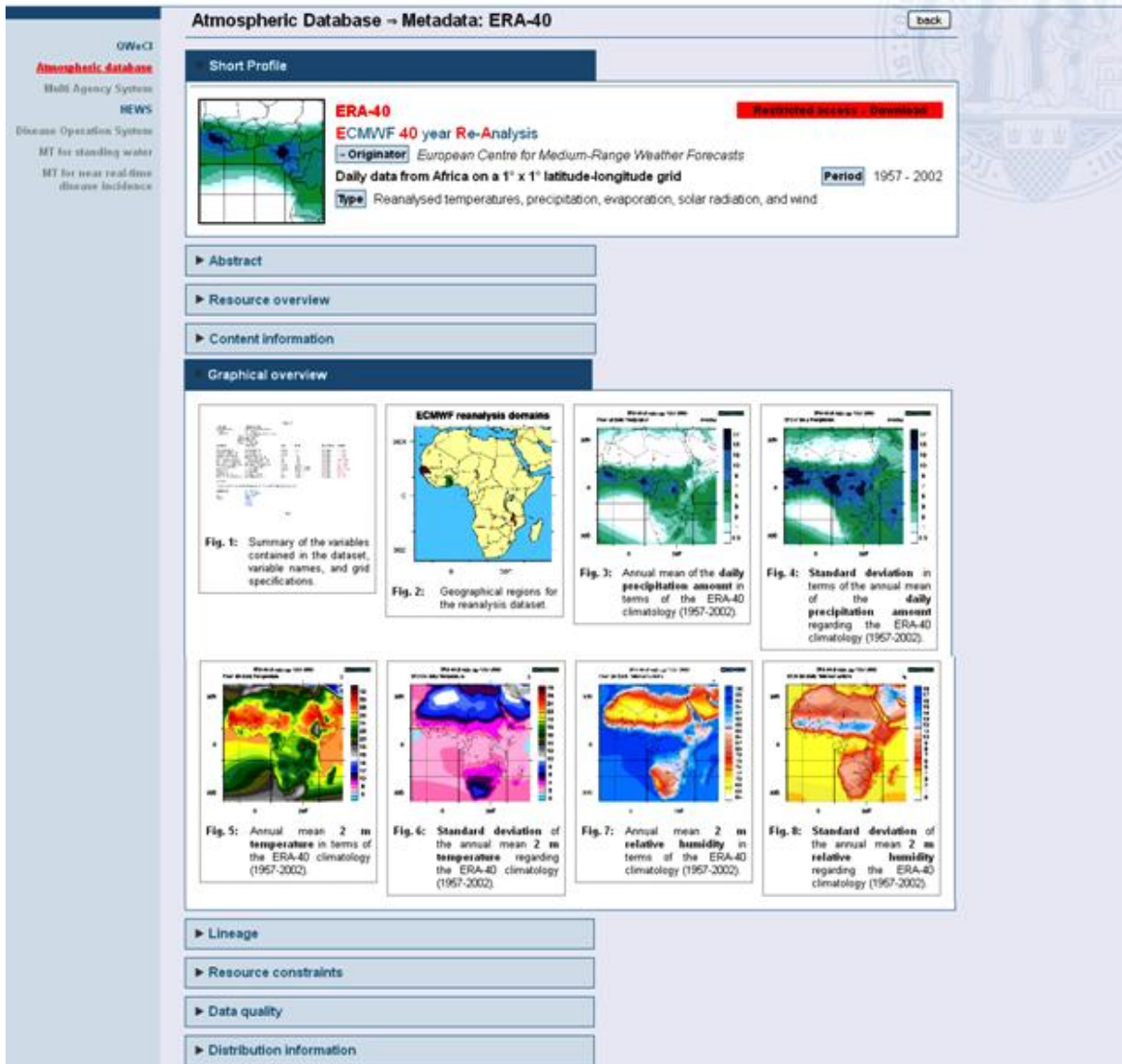


Figure 8: Metadata of the ERA-40 data set with the extended 'Short Profile' and 'Graphical overview' sections.

- ERA-40: ECMWF 40-year Re-Analysis

ECMWF 40-year Re-Analysis (ERA-40) covers the period from September 1957 to August 2002. The three dimensional variation technique was applied using the T159L60 version of the Integrated Forecasting System to produce the analyses every six hours and forecasts each three hours. The analysis involved comprehensive use of satellite data, starting from the early vertical temperature profile radiometer data in 1972, later including data from various satellites. Cloud motion winds were used from 1979 onwards. ERA-40 makes also use of data from past field experiments such as GATE. The QWeCI database contains a subset of the ERA-40 data. Only daily mean and daily accumulated surface variables were added to the database. For the height of 2 m included are the daily mean temperature, maximum and minimum daily temperature and relative humidity. The data set furthermore comprehends the zonal and meridional wind component, skin temperature, and ground

temperature and soil moisture below surface, evaporation, total precipitation, and incoming solar radiation.

- ERA-Interim: ECMWF Interim Re-Analysis

The ECMWF Interim Re-Analysis (ERA-Interim) is the latest global atmospheric reanalysis produced by the ECMWF, covering dates from 01 January 1989 onward to present. The ERA-Interim project is conducted in part to prepare for a new atmospheric reanalysis to replace ERA-40, which will extend back to the early part of the 20th century. Like for ERA-40 only a subset of the data set was extracted for the QWeCI atmospheric database. Analogous to ERA-40 only surface variables are included.

- NCEP-1: NCEP/NCAR Reanalysis 1

The NCEP/NCAR Reanalysis 1 (NCEP-1) project (NCEP: National Center for Environmental Prediction; NCAR: National Center for Atmospheric Research) is using a state-of-the-art analysis/forecast system to perform data assimilation using past data from 1948 to the present. The reanalysis includes the recovery of land surface, ship, radiosonde, pibal, aircraft, satellite, and other data. The quality controlling and assimilating of this data with a data assimilation system is kept unchanged over the reanalysis period. This eliminates perceived climate jumps associated with changes in the data assimilation system. The data assimilation and the model used are identical to the global system implemented operationally at the NCEP on 11 January 1995. Except that the horizontal resolution is T62 (i.e. about 210 km). Note that several errors in the reanalysis were detected (see <http://www.esrl.noaa.gov/psd/data/reanalysis/problems.shtml>). For this reason, the NCEP-DOE AMIP II Reanalysis (R-2; DOE: Department of Energy; AMIP: Atmospheric Model Intercomparison Project) updates NCEP-1 for the satellite period after 1979 (see <http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-83-11-1631>).

In the presented data set, the raw 6-hourly NCEP-1 data was re-interpolated to a regular horizontal resolution of a 2.5° x 2.5° latitude-longitude grid for the period 1948 to 2010. The data covers Africa and ranges between 25°W and 60°E in longitude and between 45°S and 45°N in latitude.

- GPCP v1.1 1dd: Global Precipitation Climatology Project 1° daily (version 1.1)

The Global Precipitation Climatology Project (GPCP) was established to quantify the distribution of precipitation around the globe over many years. In support of this work an international group of precipitation experts developed and produced the GPCP Version 1.1 satellite-gauge One-Degree Daily (1DD) combined precipitation data set. The 1DD product provides precipitation estimates on a 1-degree grid over the entire globe at 1-day (daily) for the period October 1996 - present. The 1DD product is consistent with the Version 2 monthly product in the sense that the 1DD approximately sum to the monthly satellite-gauge estimate. All precipitation products are produced by optimally merging estimates computed from microwave, infrared, and sounder data observed by the international constellation of precipitation-related satellites, and precipitation gauge analyses.

- GPCP v2.1: Global Precipitation Climatology Project 2.5° monthly (version 2.1)

The Global Precipitation Climatology Project (GPCP) 2.5-degree version 2 monthly product covers the period January 1979 to the present, with a delay of two to three months for data reception and processing. All precipitation products are produced by optimally merging estimates computed from microwave, infrared, and sounder data observed by the international constellation of precipitation-related satellites, and precipitation gauge analyses. The precipitation gauge analysis used in the GPCP satellite-gauge is created by the Global Precipitation Climatology Centre (GPCC).

- TRMM 3B42 V6 (derived): TRMM and other satellite daily precipitation estimate 3B42 Version 6 (derived)

This daily satellite precipitation estimate was derived from the algorithm 3B42 (version 6) of the Tropical Rainfall Measuring Mission (TRMM). The daily TRMM 3B42 version 6 precipitation estimate is a secondary archive and is directly derived from the 3-hourly TRMM and other satellite precipitation estimate (3B42 version 6). The data set has a daily temporal resolution for the period 1998 to 2009 and is defined over a regular grid (resolution 0.25° x 0.25°). The area covered ranges between 20°W and 55°E in longitude and between 35°S and 38°N in latitude.

The daily values were computed as an average of all the values for a grid box at 00, 03, 06, 09, 12, 15, 18, and 21 UTC. This has 1.5 hours of mismatch at the start and end of the day since the precipitation estimate of 3B42 version 6 is related to the 3 hour period centered on the 3-hourly nominal times (e.g. 22:30 UTC to 1:30 UTC for 00 UTC). However, this is usually not important compared to the other errors in the estimate.

The daily precipitation estimate was derived from the 3B42 algorithm of the Tropical Rainfall Measuring Mission (TRMM), which is a joint US-Japan satellite mission to monitor tropical and subtropical precipitation and to estimate its associated latent heating. The purpose of algorithm 3B42 is to produce TRMM merged high quality (HQ)/infrared (IR) precipitation and root-mean-square (RMS) precipitation-error estimates. These gridded estimates are on a 3-hour temporal resolution and a 0.25° x 0.25° spatial resolution in a global belt extending from 50°S to 50°N latitude.

The 3B42 estimates are produced in four stages; (1) the microwave estimated precipitation from the TRMM and other low earth orbit (LEO) satellites are calibrated and combined, (2) infrared precipitation estimates based on geosynchronous earth orbit (GEO) satellites are created using the calibrated microwave precipitation, (3) the microwave (step 2) and IR (step 3) estimates are combined, and (4) rescaling to monthly observed rain gauge data is applied. Note that each precipitation field of the 3B42 algorithm is best interpreted as the precipitation rate effective at the nominal observation time.

- TRMM 3B43 V6: TRMM and other satellite monthly precipitation estimate 3B43 Version 6

This data set includes the Tropical Rainfall Measuring Mission (TRMM) and other satellite monthly precipitation estimate (known as the TRMM 3B43 version 6 data product). TRMM is a joint US-Japan satellite mission to monitor tropical and subtropical precipitation and to estimate its associated latent heating. The TRMM 3B43 data set is an intermediate product of the TRMM 3B42 algorithm.

The purpose of the algorithm 3B42 is to produce TRMM merged high quality (HQ)/infrared (IR) precipitation and root-mean-square (RMS) precipitation-error estimates. These gridded estimates are on a 3-hour temporal resolution and a $0.25^\circ \times 0.25^\circ$ spatial resolution in a global belt extending from 50°S to 50°N latitude.

The 3B42 estimates are produced in four stages: (1) the microwave estimated precipitation from the TRMM and other low earth orbit (LEO) satellites are calibrated and combined, (2) infrared precipitation estimates based on geosynchronous earth orbit (GEO) satellites are created using the calibrated microwave precipitation, (3) the microwave (step 2) and IR (step 3) estimates are combined, and (4) rescaling to monthly observed rain gauge data is applied. Note that each precipitation field of the 3B42 algorithm is best interpreted as the precipitation rate effective at the nominal observation time.

The TRMM 3B43 data set is constructed within the fourth stage, which is executed once per calendar month to produce monthly precipitation estimates by combining the 3-hourly merged high-quality/IR estimates with the monthly accumulated Climate Assessment and Monitoring System (CAMS) or Global Precipitation Climatology Centre (GPCC) rain gauge analysis. The 3-hourly merged high quality/IR estimates are summed for the calendar month, and then the rain gauge data are used to apply a large-scale bias adjustment to the 3B42 estimates over land. The monthly gauge-adjusted merged estimate is then combined directly with the rain gauge estimates using inverse error variance weighting.

Future prospects

In the future, further data sets can be added to the atmospheric database. The atmospheric database is now released on M30 of the QWeCI project as version 1.0 (D1.2c). The next updated version of the database could contain additional data sets. In addition, further functionalities like a search function could be included. From a technical point of view such features are relatively easy to include since the database is incorporated into the web-based Java framework of work package 5.1.

The atmospheric measurements from the QWeCI project were further transferred to the AMMA database (AMMA: African Monsoon Multidisciplinary Analysis). This means that the KuPTiS and OwabiAWS data sets are additionally included and can be made accessible via the AMMA database.

Note that other QWeCI atmospheric measurements outside from Ghana were currently not provided to the database. Newly incoming data sets from the QWeCI project such as rainfall measurements from Senegal will be also included to the QWeCI atmospheric database. If possible, this data will be in addition transferred to the AMMA database. Furthermore, the KuPTiS and OwabiAWS data sets will be updated at the end of the QWeCI project.