



# IT-Infrastructure, Scientific Computing, Model Data Management Workflows

## Project WASCAL

### Aims and goals

WASCAL's 3 components:

- Competence Center
- Core Research Program
- Graduate Studies Program

### Chronology of WASCAL's development

## DKRZ and WASCAL

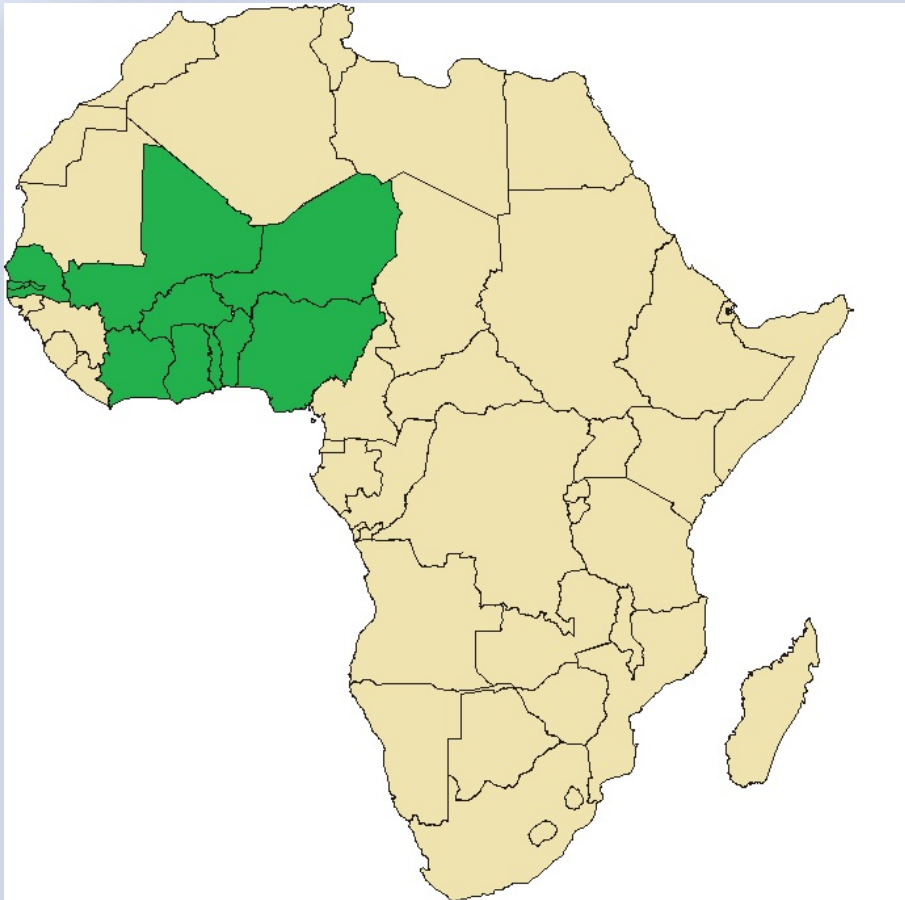
### DKRZ mission and competences

- Scientific computing
- Data management

### IT-Infrastructure

### Ongoing activities

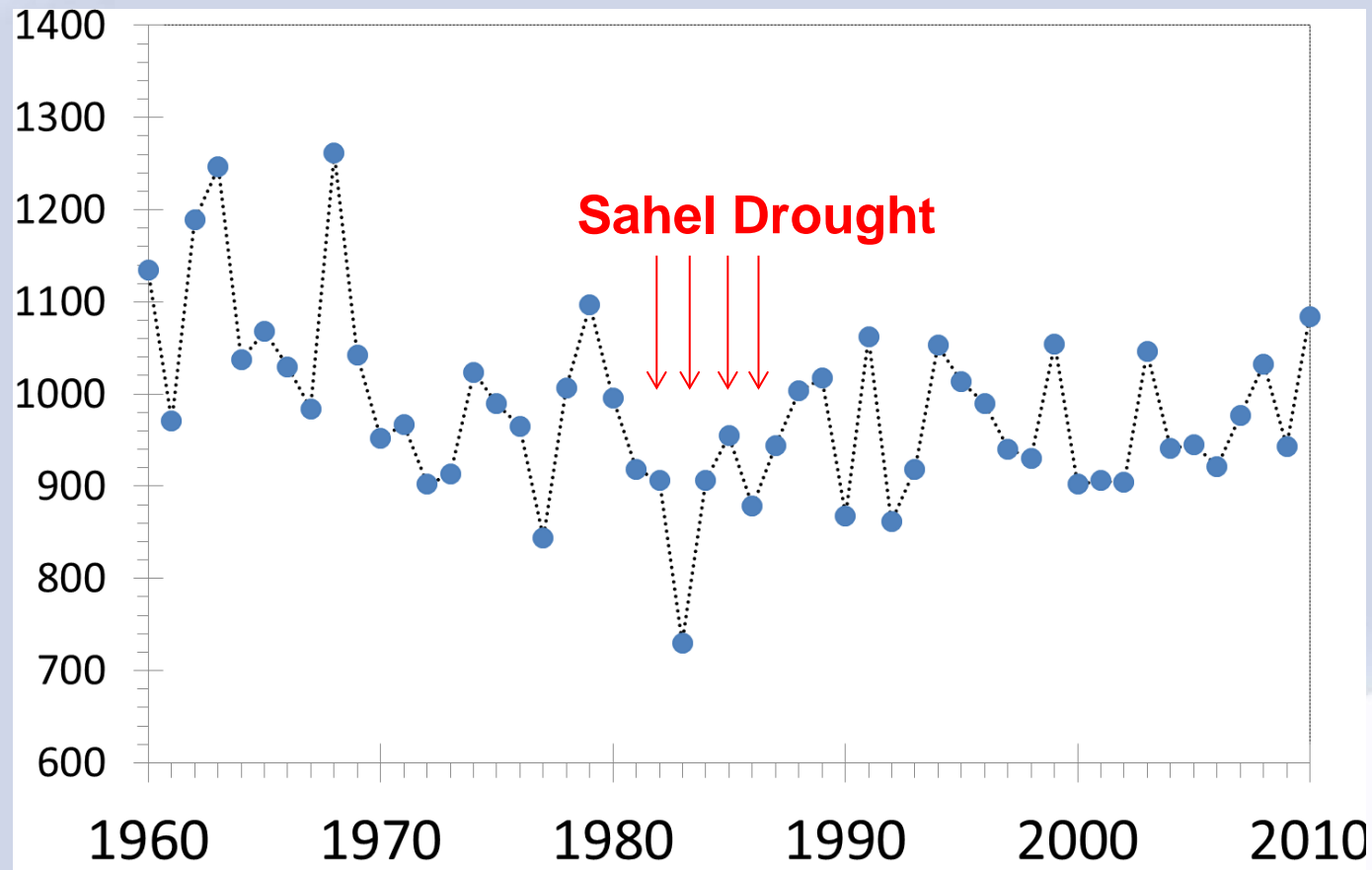
# WASCAL Partner Countries

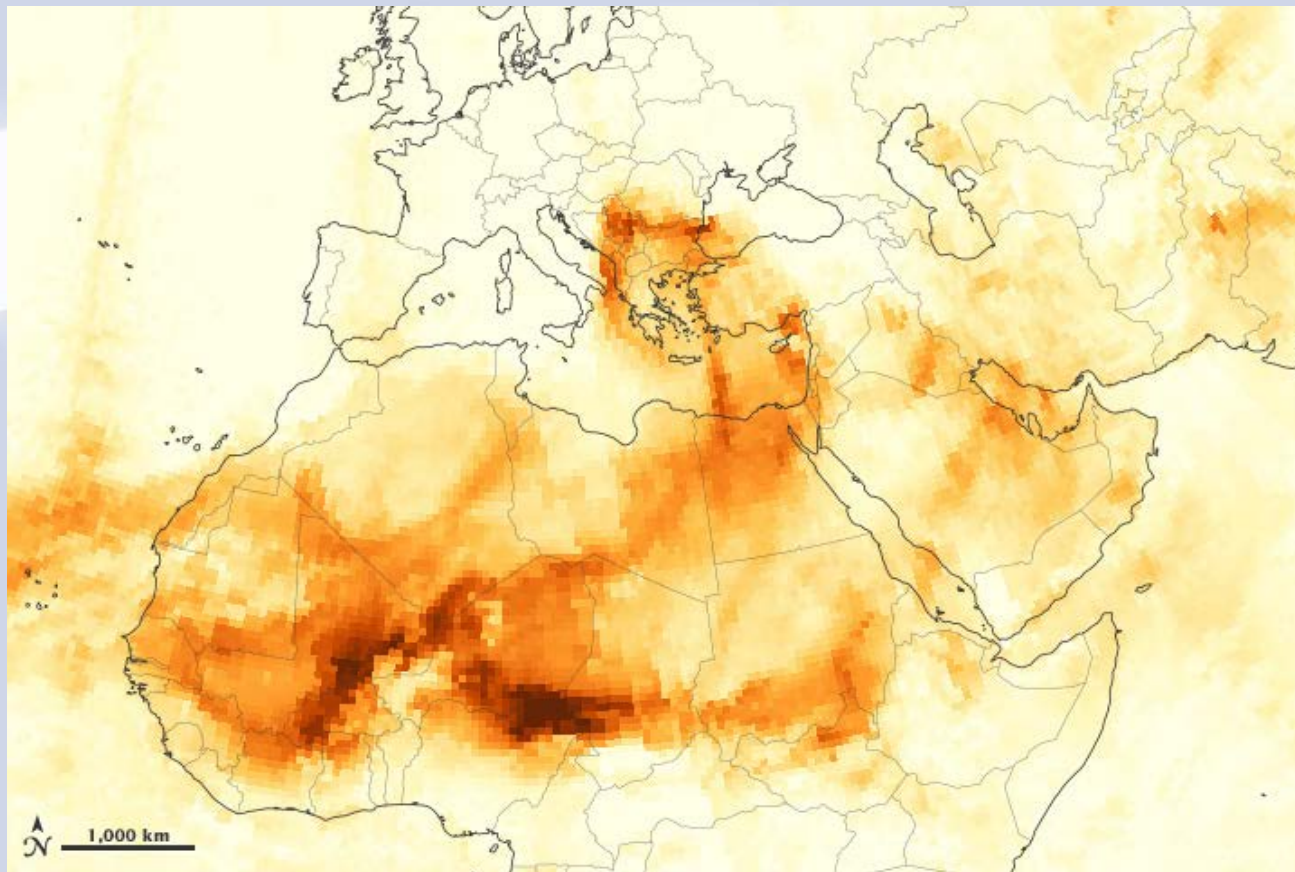


- Benin
- Burkina Faso
- Côte d'Ivoire
- The Gambia
- Ghana
- Mali
- Niger
- Nigeria
- Sénégal
- Togo

# High Climate Variability in West Africa

e.g. annual areal precipitation amount [mm], Volta basin, GPCC





The heaviest loads of dust (highest aerosol concentrations) emanating from the Bodele Depression in Chad. 40 million tons of dust are swept across the Atlantic from the Sahara to the Amazon each year, half of which are coming from the Bodele Depression.

Image source: Ozone Mapping Profiler Suite (OMPS) on the Suomi NPP satellite, May 29, 2013,  
<sup>4</sup>  
<http://earthobservatory.nasa.gov/IOTD/view.php?id=81276>



# Severe Land Cover Changes in West Africa



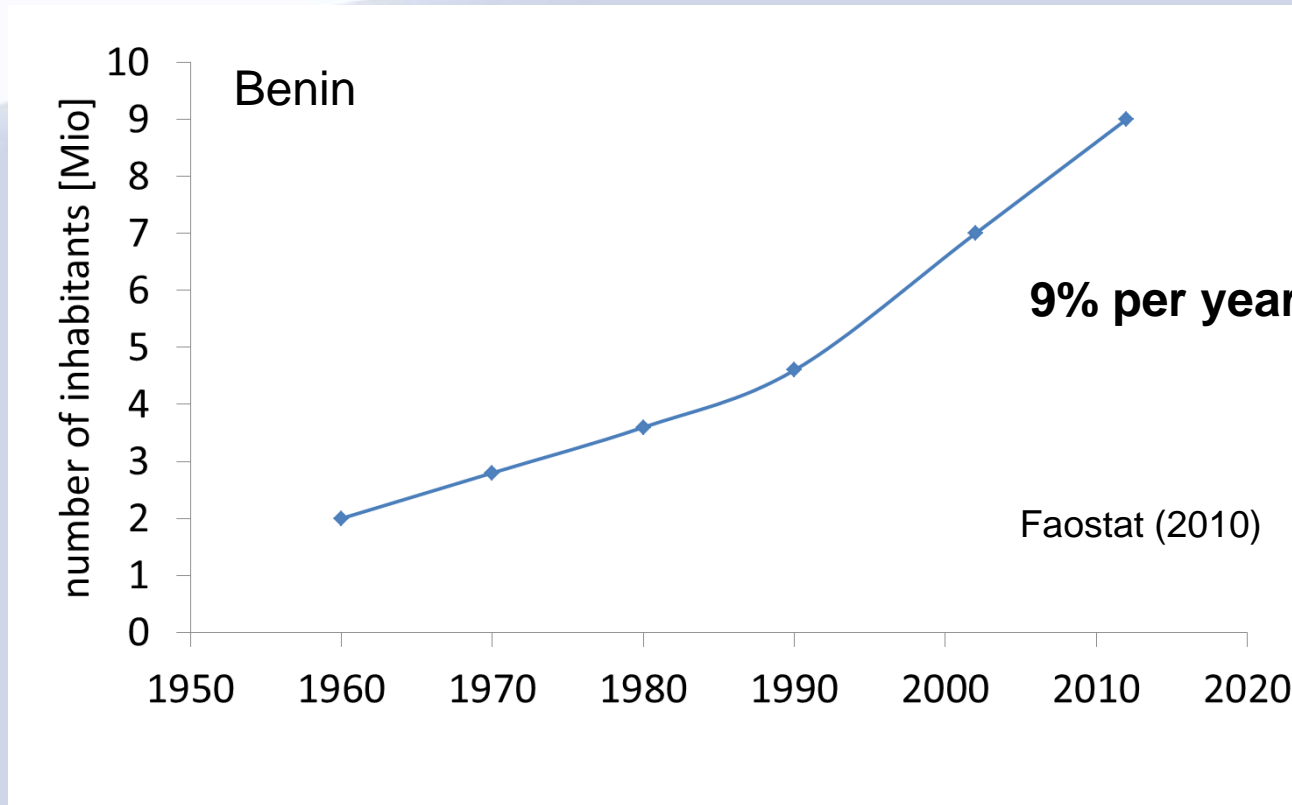
- Conversion of forest to agriculture
- Closed forest cover
- Fragmented forest



Le Monde, Institute of Research for Development (IRD), 1996; UNEP, International Soil Reference and Information Centre (ISRIC), World Atlas of Desertification, 1997.

[http://www.grida.no/graphicslib/detail/deforestation-in-west-africa-case-cote-divoire\\_8cb5#](http://www.grida.no/graphicslib/detail/deforestation-in-west-africa-case-cote-divoire_8cb5#)

# Tremendous Population Increase in West Africa



> 80 % of the West African population are living from the income produced in agriculture; **often subsistence agriculture**

**Severe land use changes are expected for the future due to increasing agricultural activity**

# WASCAL – Primary Objectives

Establishment of a **W**est **A**frican Science **S**ervice Center on **C**limate Change and **A**dapted **L**and Use (**WASCAL**):

- to investigate the impacts of climate change and land use change on ecosystems and society in West Africa
- to develop adaptation strategies to reduce the negative consequences of climate change, climate extremes and land use change
- to strengthen capacities and competences in research, education and policy making of West-African countries

In partnership with West African and German universities, research centers and services



## General aim of WASCAL:

Identification of robust and adaptable land use systems and the development of measures for maintenance or re-establishment of functional ecosystems that support the sustainable development of society and preserving natural resources for future generations.

The **Competence Center** (CC) shall bring together the West African research community, enable information exchange with German partners and thus make available expert knowledge existing in Germany with respect to climate change and adapted land use, strengthening the capacity of the region to judge the consequences of land management practices.





## The **project's goals are to**

- strengthen the conditions and capacities in West Africa,
- study science-based scenarios and options for enhancing the resilience of natural and societal systems in the face of impending climate change
- support politicians and decision-makers designing and implementing land management structures that ensure the availability of vital ecosystem services and that form the livelihood of the local population
- collaborate in the education of future generations of scientists and politicians having profound knowledge of climate change related subjects and who will be able to develop applicable adaptation strategies and contribute evidence-based contributions to the international climate change discussion.



CC

# WASCAL Competence Center

**Observation networks** are maintained and data managed in Competence Center in **Ouagadougou**, Burkina Faso

1. Climate Network (Kunstmann)
2. Hydrology Network (Diekkrüger)
3. Socio-economy and Household Network (Wünscher)
4. Biodiversity Network (Linsenmayr)
5. Remote Sensing Group (Müller)
6. Data Management (Kunkel/Rogmann)
7. Scientific Computing (DKRZ)

## **Establishment of meteorological networks within the core research sites**

- additional observations needed e.g. for validation of RCMs, land surface models and as input for hydrological and agricultural models ...
- highly needed for further sub disciplines e.g. agricultural field experiments
- Installations of eddy covariance stations, climate stations and further hydrological measurement devices within the core research sites

**Installation started in September 2012**

## **Establishment of a transnational climate observation network for the WASCAL countries**

- to improve the existing networks of meteorological services
- to gain observations for a refined regional climate analysis and evaluation of climate simulations

**activity is going to start soon (hopefully)**

# Hydro-Meteorological Observation Networks

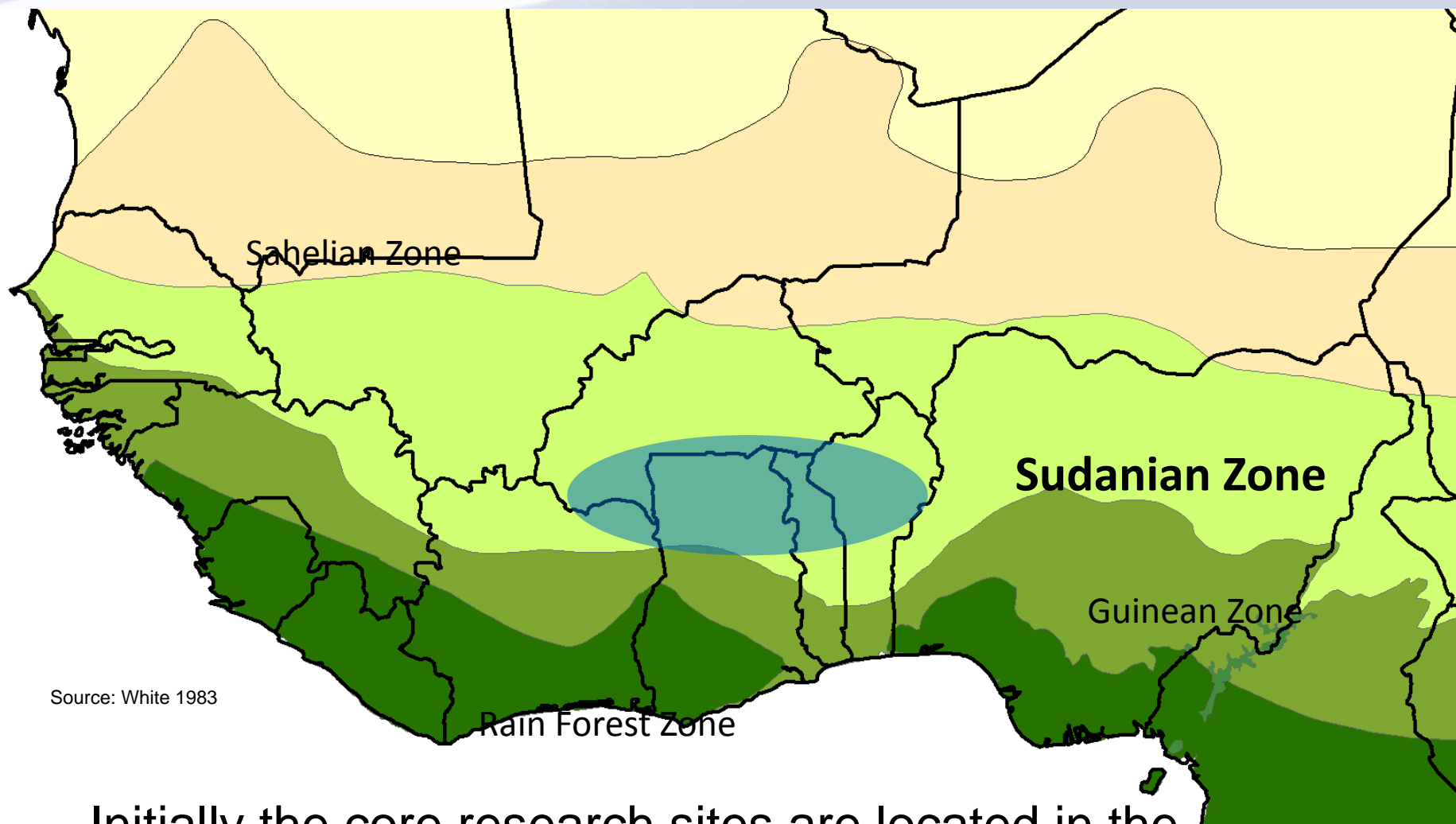
## A. Local-scale observation network within the WASCAL core research sites:

- 3 micro-meteorological towers, 25 climate stations (**partially installed by hydro group**)
- 30 discharge- and 60 groundwater gauges (**installed by hydro group**)
- installation of climate stations will be finalized this year (2013)

## B. Large-scale, transnational network covering WASCAL countries

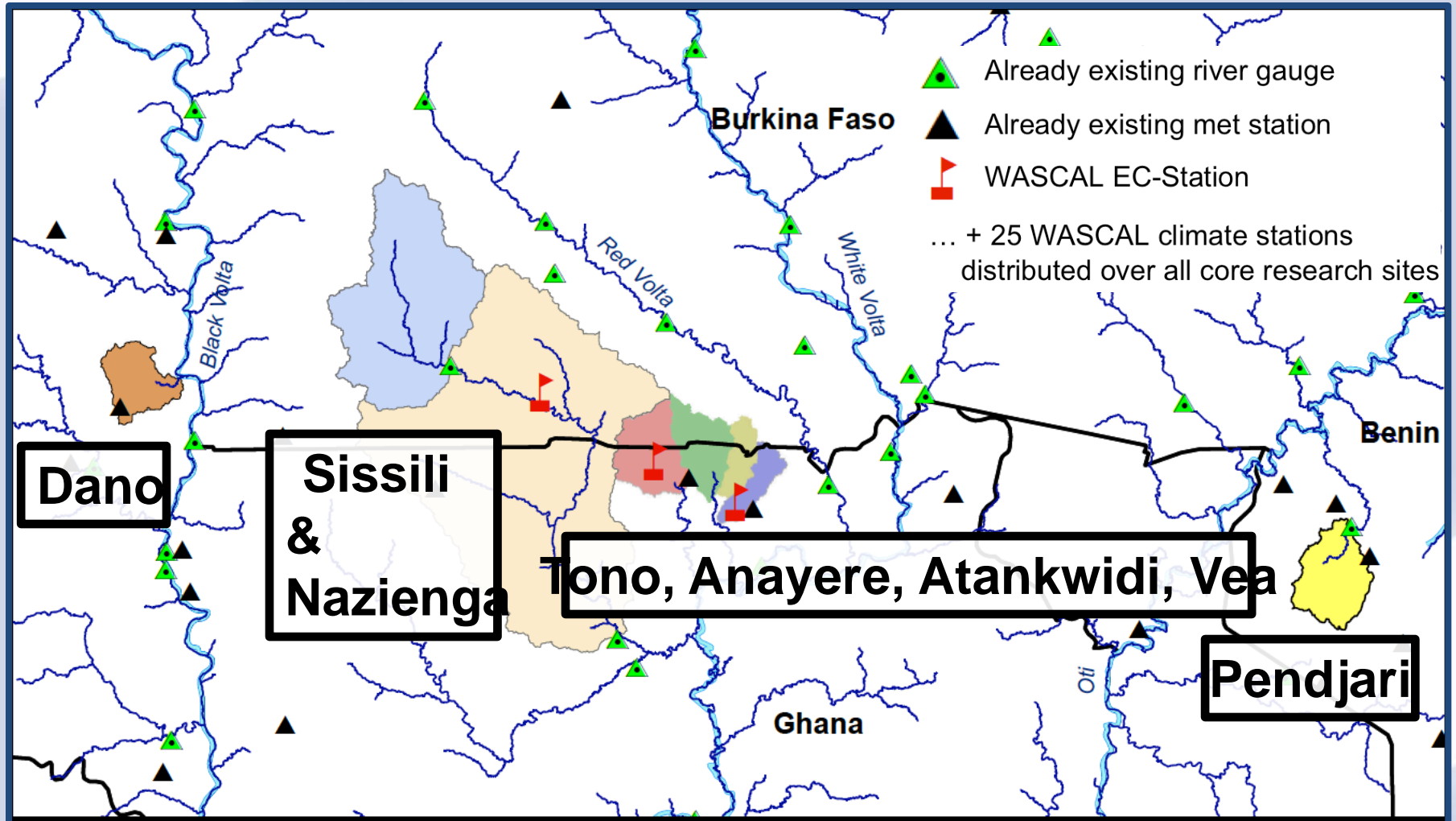
- 36 climate stations with an automatic data transfer (GCOS compatible)
- 80 discharge- and 120 groundwater gauges (**to be done by hydro group**)
- + program for collecting past observations
- + program for training of met staff

In close cooperation with national met and hydro services, ACMAD, AGRHYMET, WMO-GCOS, University Bonn



Initially the core research sites are located in the Sudanian savannah belt, which is considered to be the **potential breadbasket of West Africa**







GRP on the West African Climate System (GRP-WACS) has been initiated by the FUTA: 19 doctoral students, 10 students are already in their second year, 3 are currently in Germany

# Summary of selected climate research activities within WASCAL

- Installation of eddy covariance stations, climate stations and further hydrological measurement devices within the core research sites has been almost finished
- Initiation of first simulation experiments using regional climate models, land surface models and further models
- WASCAL competence center became an international institution this year + it has already recruited first senior scientists and further staff

# WASCAL Partner Organisations

- West African universities (11+):

*Université d'Abomey-Calavi (Benin), Université de Ouagadougou (Burkina Faso), University of the Gambia (The Gambia) Kwame Nkrumah University of Science and Technology (Ghana), Université de Cocody-Abidjan (Côte d'Ivoire) Université de Bamako (Mali), Université Abdou Moumouni de Niamey (Niger), Federal University of Technology Akure (Nigeria) Federal University of Technology Minna (Nigeria), Université Cheikh Anta Diop de Dakar (Senegal), Université de Lomé (Togo)*

- National meteo- and hydro- services in West Africa (12+)

- National agricultural research centers in West Africa (6+):

*INRAB - Benin, INERA - Burkina Faso, CSIR - Ghana, CNRA - Côte d'Ivoire, IER - Mali, ITRA - Togo*

- Regional and international institutions (9+):

*VBA , AGRHYMET/CILSS, Institut 2iE, FARA, AGRA, UNU-EHS, IWMI, IFPRI, WMO*

- German universities and research centers (8):

*University of Bonn , Karlsruhe Institute of Technology, University of Augsburg, German Aerospace Centre, German Climate Computing Centre, University Würzburg, University Rostock, Research Centre Jülich*

# Chronology of WASCAL's development

Previous projects in West Africa funded by the BMBF:

GLOWA - VOLTA

BIOTA West Africa

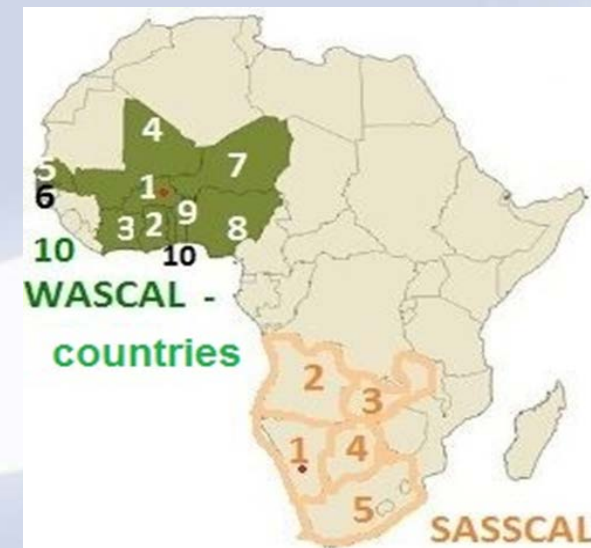
IMPETUS

**2009 – 2012 WASCAL Preliminary phase**

**WASCAL (BMBF 2012 – 2016): Main Phase**

**SASSCAL – South Africa, Namibia,  
Angola, Zambia, Botswana**

**Since 2012 (Center in Windhuk, Namibia)**





## Preparatory phase: **July 2010 - September 2012**

- Development of the research concept & scientific agenda
- Initiate first activities within the *Core Research Program*
- Initiate selected *Graduate Research Programs*

## Main phase: **October 2012 – February 2016**

- Establishment of the International Competence Centre
- Establishment of 6 PhD Graduate Research Programs and 4 Master Programs
- Realization of the activities within the Core Research Program



# DKRZ and WASCAL

## Mission of DKRZ:

to provide high performance computing platforms, sophisticated and high capacity data management, and superior service for premium climate science.

## DKRZ competences:

- High performance compute, storage, and visualization systems
- optimized for climate research
- Parallelization and optimization of climate models and workflows
- Efficient management of highest data volumes
- 3D visualization to communicate research results
- Support of current projects on climate research

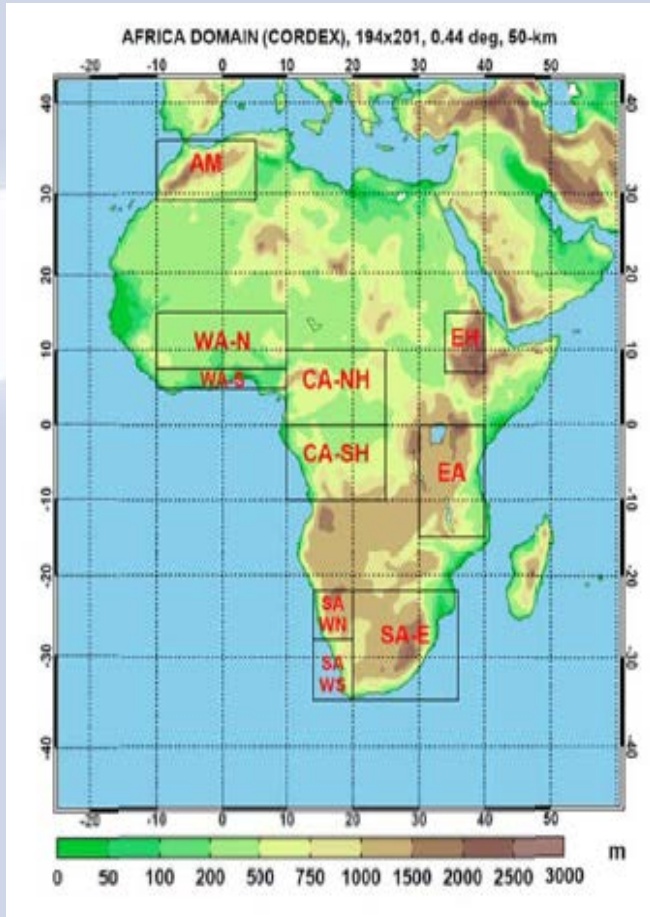
# Computer Hall



**Compute Nodes**

**Disk Subsystem**

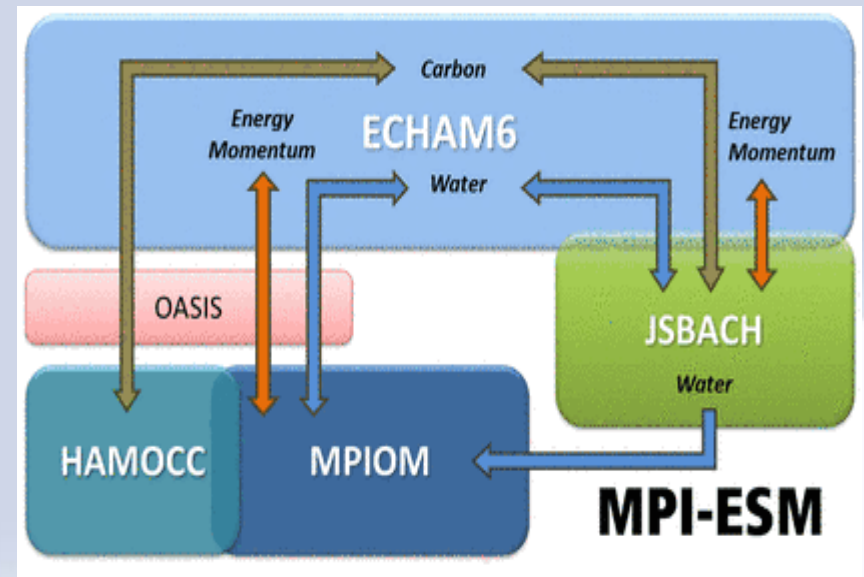
**Air Conditioning**



CORDEX Climate Simulations for Africa using COSMO-CLM (CCLM) and REMO

**2009 - 2012**

CMIP5 calculations with the MPI Earth system model, the MPI-ESM.





**DKRZ contributes to WASCAL goal** of supporting the efforts of scientists, decision takers and stake holders to adapt to and mitigate climate change in rural West Africa.

The Data Management Department of DKRZ is **supporting the WASCAL Competence Center** in establishing and operating a high performance computing infrastructure.

Such **computing facilities are a prerequisite for developing new tools** for national and regional organizations.

**WASCAL Core Research Program: developing models of climate change and** weather, landscape dynamics, agricultural systems, markets and livelihoods, risk management and interdisciplinary systems analysis.

The computing facilities of the WASCAL CC will be used to **simulate scenarios**, among them alternative land use options under climate change, and **analyze the results and discuss these with people locally.**



# Ongoing activities

**Provide consultation** on the IT-Infrastructure in the WASCAL CC, e.g. specifications for a Linux cluster at the CC, plus workstations and PCs

**Managing DKRZ computing project 726** “WASCAL – Regional climate simulations West Africa” (542,250 CPUh, 50,000 GB). 13 users, **5 of whom are from West Africa**, the others from the **team of climate scientist Prof. Dr. Harald Kunstmann**

Simulations are performed on DKRZ super computer “blizzard”, an IBM Power6 machine, with **RCMs WRF** and **RegCM**, with **CCLM** completing the multi-model ensemble **to be added soon**.

**Internet connection test** between the local server at WASCAL Competence Center ([www.wascal.org](http://www.wascal.org)) in **Ouagadougou** and the anonymous ftp server at DKRZ / ZMAW in **Hamburg**.





# **Project 726 “WASCAL – Regional climate simulations West Africa”**

## **General objective:**

Development of a scientific computing concept for regional climate modelling including a data management concept for data and metadata

## **Tasks:**

- 1) Planning of a HPC concept for WA regional climate models
- 2) Adjustment of this concept to DKRZ climate computing environment
- 3) Tailoring of application adapted model data products
- 4) Data transfer planning according to existing network capacities
- 5) Layout of the data repository and concept of the data access
- 6) Cooperation and coordination with database of observational data



# Climate Group at Uni Augsburg and KIT

**A) Regional climate change simulation experiments using state-of-the-art regional climate models such as RegCM4, WRF and CCLM**

**to investigate the impacts of climate change**

**can start now**

**B) Development and evaluation of a regional climate model using a land surface model with additional hydrological process descriptions and an enhanced representation of land surface properties**

**to investigate the impacts of land surface changes under changing climate conditions**

**started in March 2013**

# Network Connections in Europe

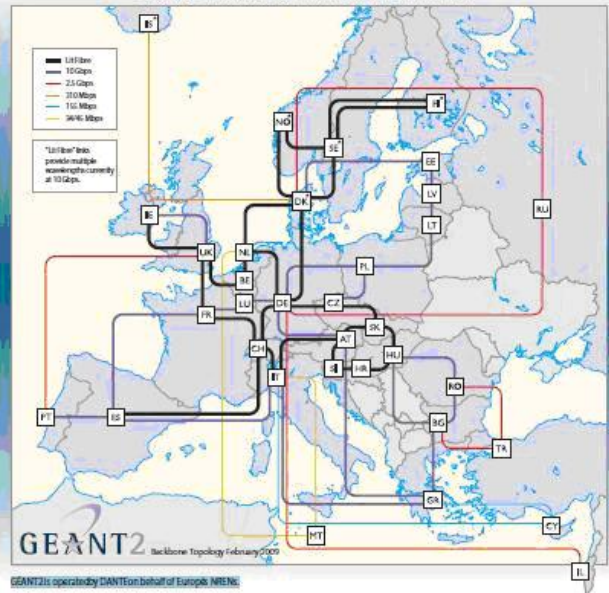


## GEANT2 www.geant2.net

### GÉANT2

#### Lighting the pathway for European Research and Education

The first international hybrid research and education network.  
Lighting dark fibre for greater network performance.



GEANT2 is operated by DANTE on behalf of European NRENs:

|          |                |        |         |         |             |          |                |
|----------|----------------|--------|---------|---------|-------------|----------|----------------|
| Albania  | Czech Republic | Spain  | Croatia | Iceland | Lithuania   | Poland   | Slovenia       |
| Belgium  | Denmark        | Sweden | Hungary | Latvia  | Malta       | Portugal | Slovakia       |
| Bulgaria | Estonia        | France | Ireland | Malta   | Netherlands | Romania  | Slovenia       |
| Cyprus   | Finland        | Greece | Israel  | Norway  | Norway      | Russia   | Turkey         |
|          |                |        |         |         |             |          | United Kingdom |

\*Connection between these countries is part of NORDUnet (the Nordic regional network)

GEANT2 is co-funded by the European Commission within its 6th R&D Framework Programme.

("Lit Fibre" links provide multiple wavelengths currently at 10 Gbps)

- Lit Fibre
- 10 Gbps
- 2.5 Gbps
- 310 Mbps
- 155 Mbps
- 34/45 Mbps

... to other continents

## Géant2 – TransEurasia Information Network



# Internet connection test

## Result:

Files sizes: between 2.4 GB and 9,6 GB

Transfer rate: between 183 KB/S and 340 KB/s

Transfer time series: between 7:10 AM – 2:30 AM local time

Duration: Two (2) weeks in August 2013

Internet connection : 3 MB/s in upload and 3 MB/s in download

Ping or round-trip time means time to receive an answer after a request on wascal server: [www.wascal.org](http://www.wascal.org)

Via ADSL (old connection): TTL 150 -300 ms (milli seconds)

Via wimax VSAT (new connection): TTL 600- 995 ms

**Test performed by:** Symphorien MEDA / IT / Geoportal

Administrator, **observed by** Dr. M. Bamba SYLLA, Senior Scientist, Climate Modeling, Climate Change and Meteorology



# WASCAL RCM Data Workshop at DKRZ, Hamburg

## 1-2 Oct. 2013

### Day 1:

- WASCAL RCM Simulations at DKRZ
- Selected regional climate model studies for (West) Africa
- Future WASCAL simulation experiments in 2014

### Day 2:

- Climate Model Data Management:
  - Management of climate model data at WDCC/DKRZ
  - Global climate data from ESGF
  - Data processing, analysis and visualization
- Report of DKRZ Project 726 for 2013 **until 31 Oct. 2013**
- Preparation of proposal for computing resources 2014 (at DKRZ and elsewhere) **until 31 Oct. 2013**



**Thank you !**