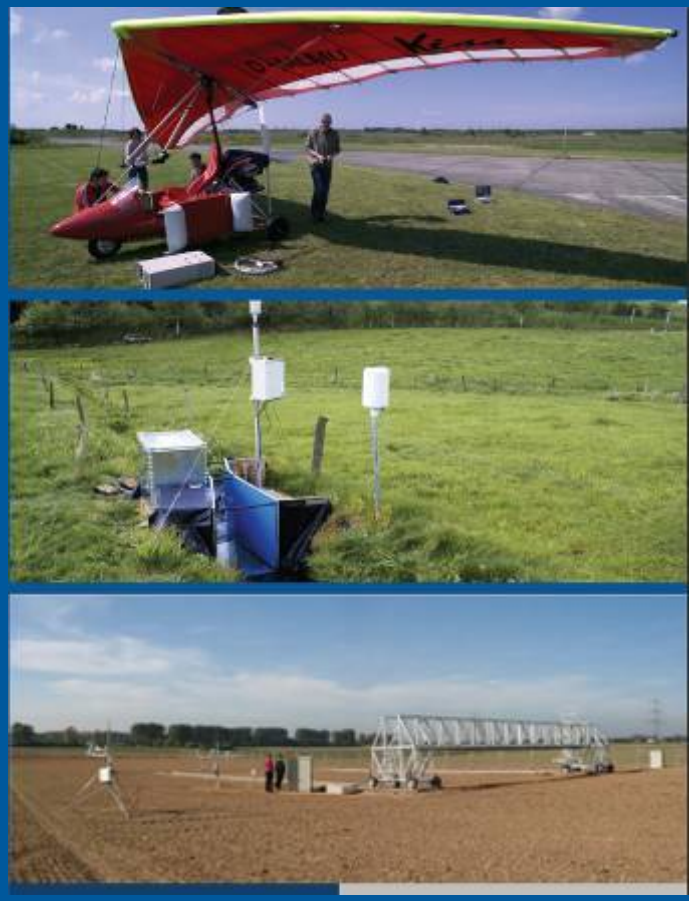
TERENO

Terrestrial Environmental Observatories

Harry Vereecken



TERENO Kick-Off-Workshop

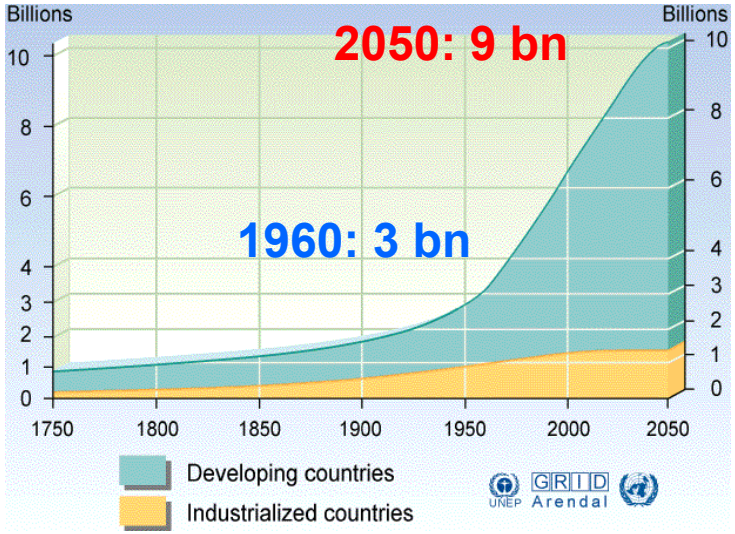
September 22nd, 2008

HELMHOLTZ | ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Facts of Global Change

World population development from 1950 to 2050:



Soil, water, air and vegetation

- Climate change is affecting all compartments of the terrestrial system
- 50% of the global land surface has been changed by human activity; 23 % of the land surface is degraded in quality
- Loss of agricultural land (e.g. in China -3,5 Mio ha since 2002)
- In 2003: 2 % of the agricultural land was lost: Production of rice, corn and wheat -18%
- Worldwide loss of biodiversity
- Decline of water availability (49,000 km^3 per year) and water quality
- 1/3 of the earth‘s annual renewable water may be affected by pollution in 2050 (Gleick et al., 1998) due to waste water

HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Motivation

- The effects of Global Change on terrestrial systems are regionally differentiated
- Global Change affects all compartments of the terrestrial environment (water, soil, vegetation, atmosphere) with complex feedback mechanisms
- Existing measurement networks are typically focused on specific compartments and research questions
- Long-term hydrological and ecological data are urgently needed for validating terrestrial environmental models
- There is a need for capacity building in the field of terrestrial research by bringing together different research communities

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

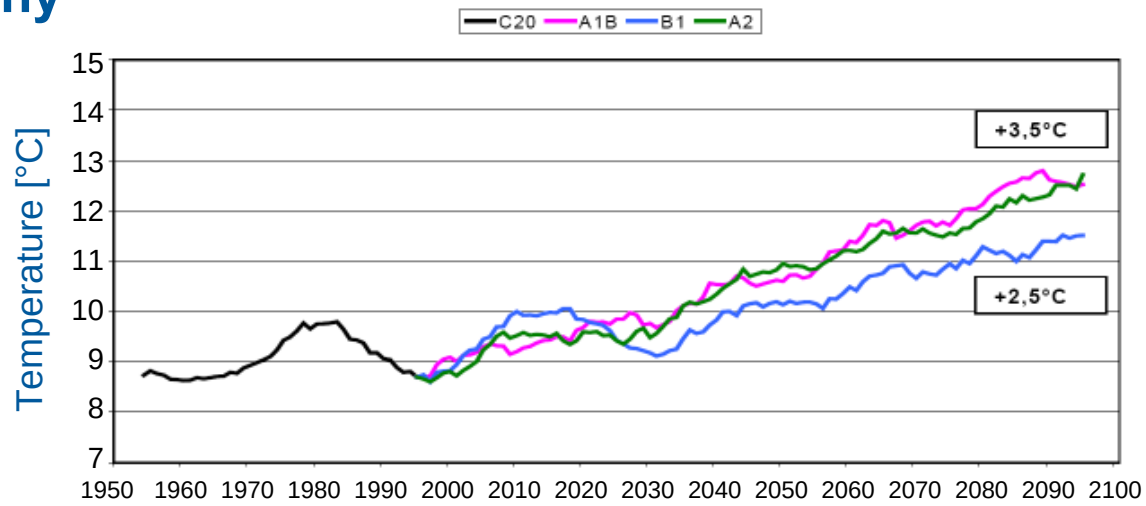
HELMHOLTZ
ASSOCIATION

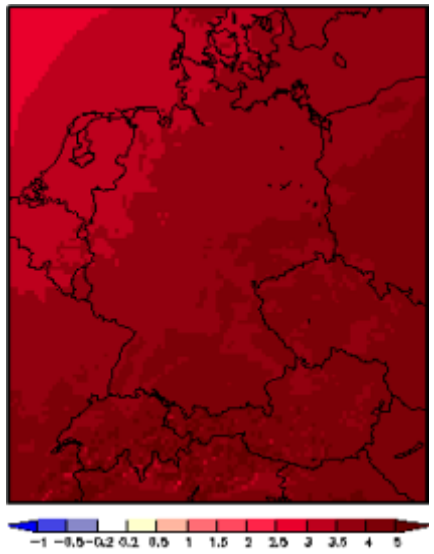
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Climate Change in Germany

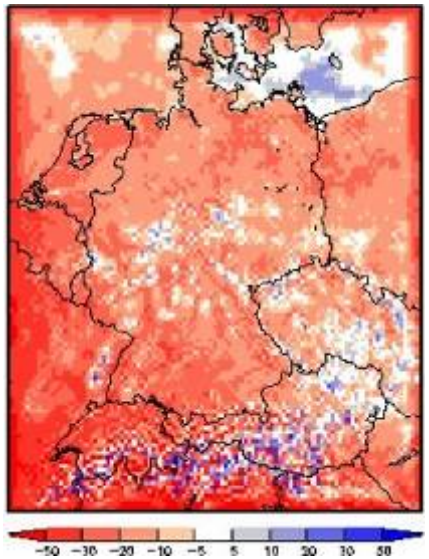
Climate models are projecting significant climate change in Germany in the next 100 years:

- Increase in temperature (2.5 – 3.5°C)
- Decrease in precipitation (up to 30 %)





Temperature increase in 2100 [°C]



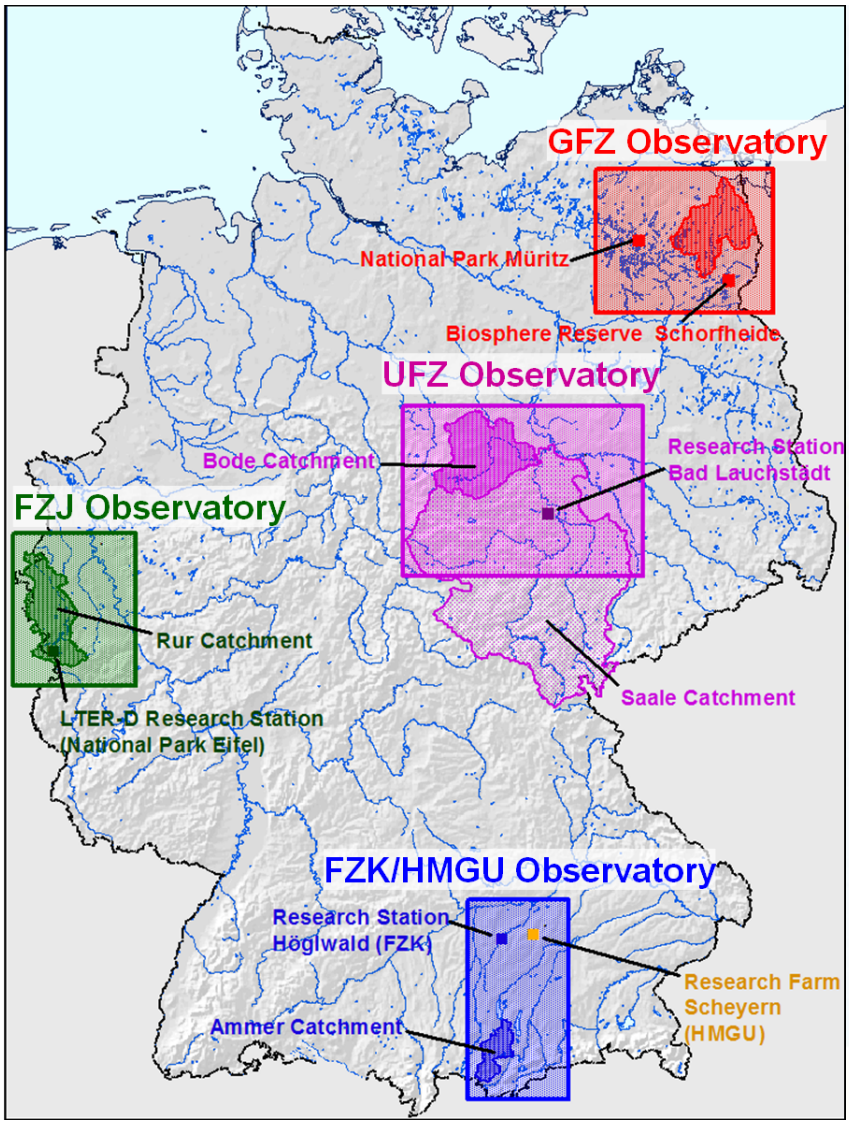
Precipitation decrease in 2100 [mm]

Umweltbundesamt:
Künftige Klimaänderungen in Deutschland – Regionale Projektionen für das 21. Jahrhundert
Hintergrundpapier
April 2006, aktualisiert im September 2006

HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

The TERENO Network



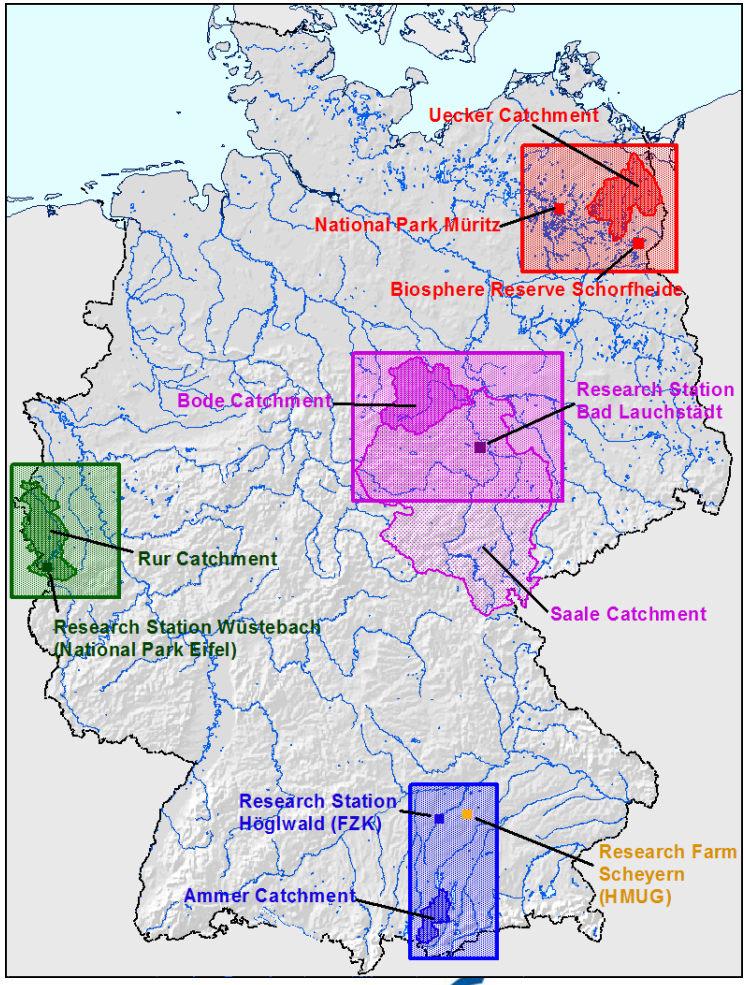
- **Lower Rhine Valley / Eifel Observatory**
  Lead coordination: FZJ
- **Halle/Leipzig Observatory**
  Lead coordination: UFZ
- **Bavarian Alps / pre-Alps Observatory**
  Joint coordination: HMUG / FZK
- **Planned German Lowland Observatory**
  Lead coordination: GFZ

HELMHOLTZ
ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

General Scientific Objectives

- To provide long-term environmental data in a multi-scale and multi-temporal mode
- To study long-term influence of land use changes, climate changes, socioeconomic developments and human interventions in terrestrial systems
- To analyse the interactions and feedbacks between soil, vegetation and atmosphere from the point to the catchment scale
- To determine effective parameters, fluxes and state variables for different scales
- To bridge the gap between measurement, model and management

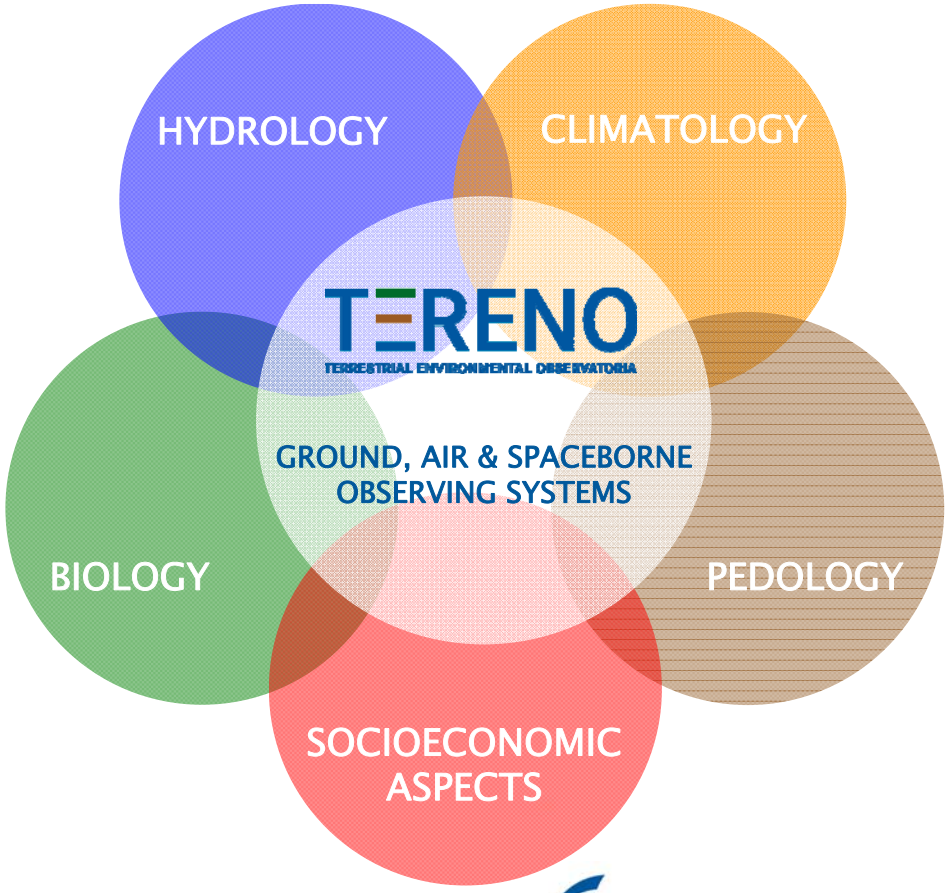


HELMHOLTZ
ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

TERENO – The concept

- To bring together scientists from different scientific communities and to integrate disciplines
- To exploit the availability of novel technologies and high performance computer facilities for terrestrial research
- To establish common measurement platforms as the basis for long term data sets
- To combine observation and experimentation
- To foster synergies within the research Area Earth and Environment and between Helmholtz-centers and national and international Research organizations



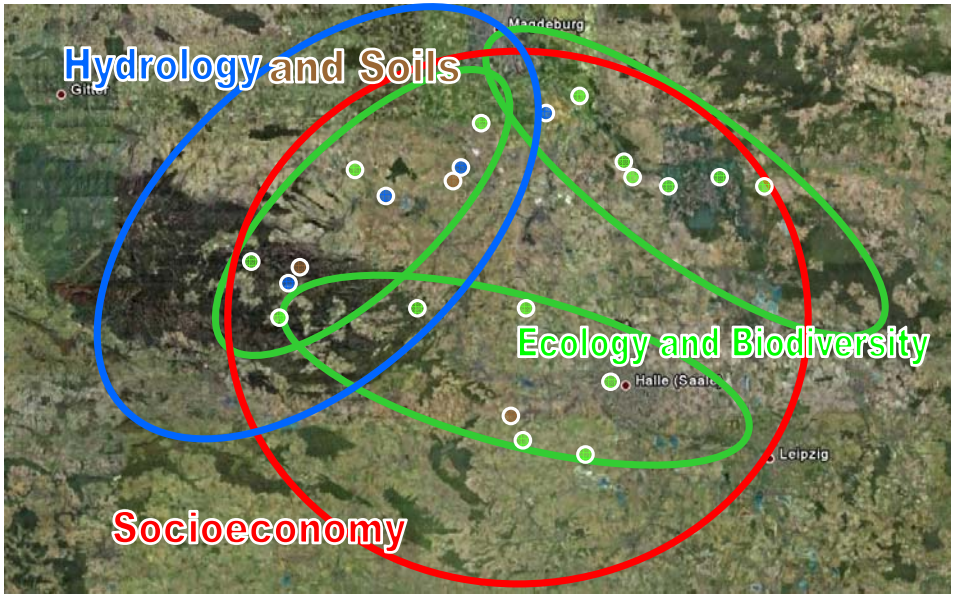
HELMHOLTZ
ASSOCIATION

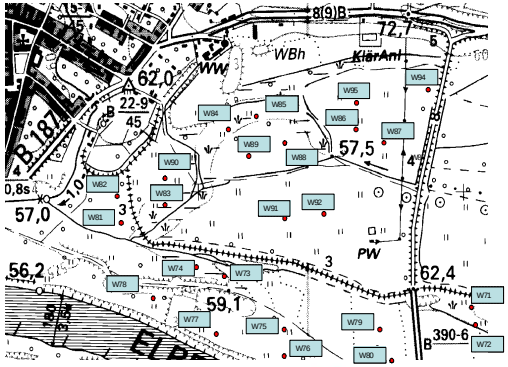
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Integrating different disciplines in TERENO

E.g. Floodplain habitats - Assessment targets

- Soil, hydrology, matter fluxes
- Organisms groups
  - Vegetation primary producers
  - Carabides as predators important indicators for land use intensity and hydrology quality
  - Molluscs important indicators for hydrology and connectivity
  - Mosquitoes possible disease vectors
  - Amphibians highly mobile, sensitive to landscape context
- Habitat mapping by remote sensing and fieldwork





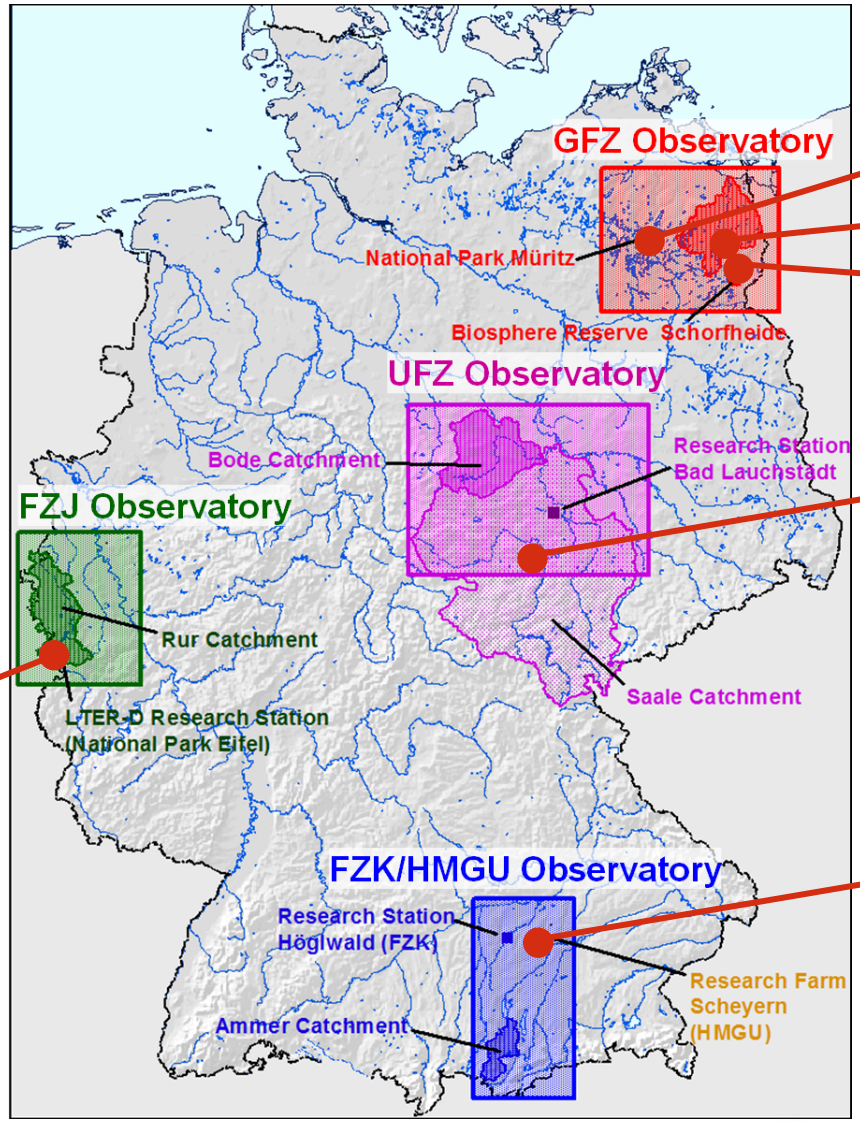
Example: Floodplain Testsite Roßlauer Oberluch

Stratified random study design (monitoring plots covering flood channels, semi-natural wet grassland and mesophilic grassland)

HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Integrating TERENO and LTER sites



NLP Müritz

Uckermark

Schorfheide-Chorin

Leipzig-Halle

NLP Eifel Wüstebach

Scheyern

Next step:
Linking up
DFG-Biodiversity
Exploratories

HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Combining geophysics, meteorology and remote sensing to quantify effective water and carbon fluxes at the field scale

Far-field GPR

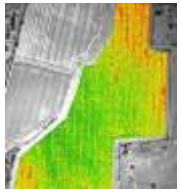
CO_2 closed chambers

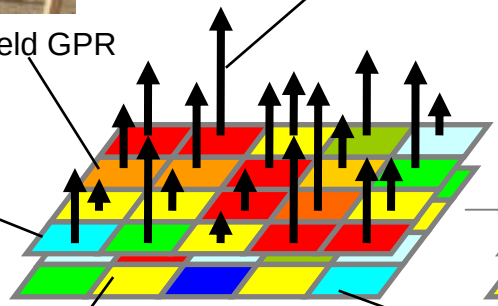
Eddy covariance

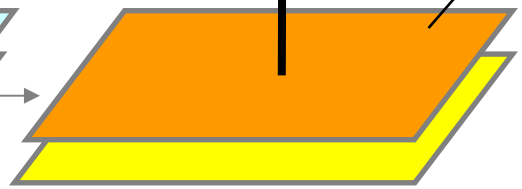
Eco-Dimona

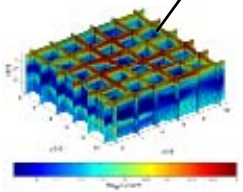
L-band radiometer

IR-thermography









Electrical resitivity tomography

13.5 m TDR Trench
Temperature, soil water content, CO_2, Matric potential

HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

The TERENO remote sensing platform

From the local to the regional Scale…

Remote sensing

satellite borne

airborne

groundbased

Satellite data

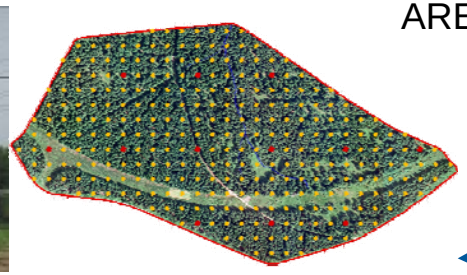
EO-1 with HYPERION
SMOS with MIRAS (Microwave Imaging Radiometer using Aperture Synthesis)

Flight campaigns

Eco-Dimona and DLR - DO228 with E-SAR and ARES sensor

validation
calibration
(e.g. SMOS CAL/VAL)

Ground truth



Field spectrometer, radiometer and sensor networks

Development of algorithms:
- landuse change
- soil moisture retrieval
- soil properties estimation (e.g. C_{org}, N)

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATIONS

Environmental Sensing with Multi-Sensors

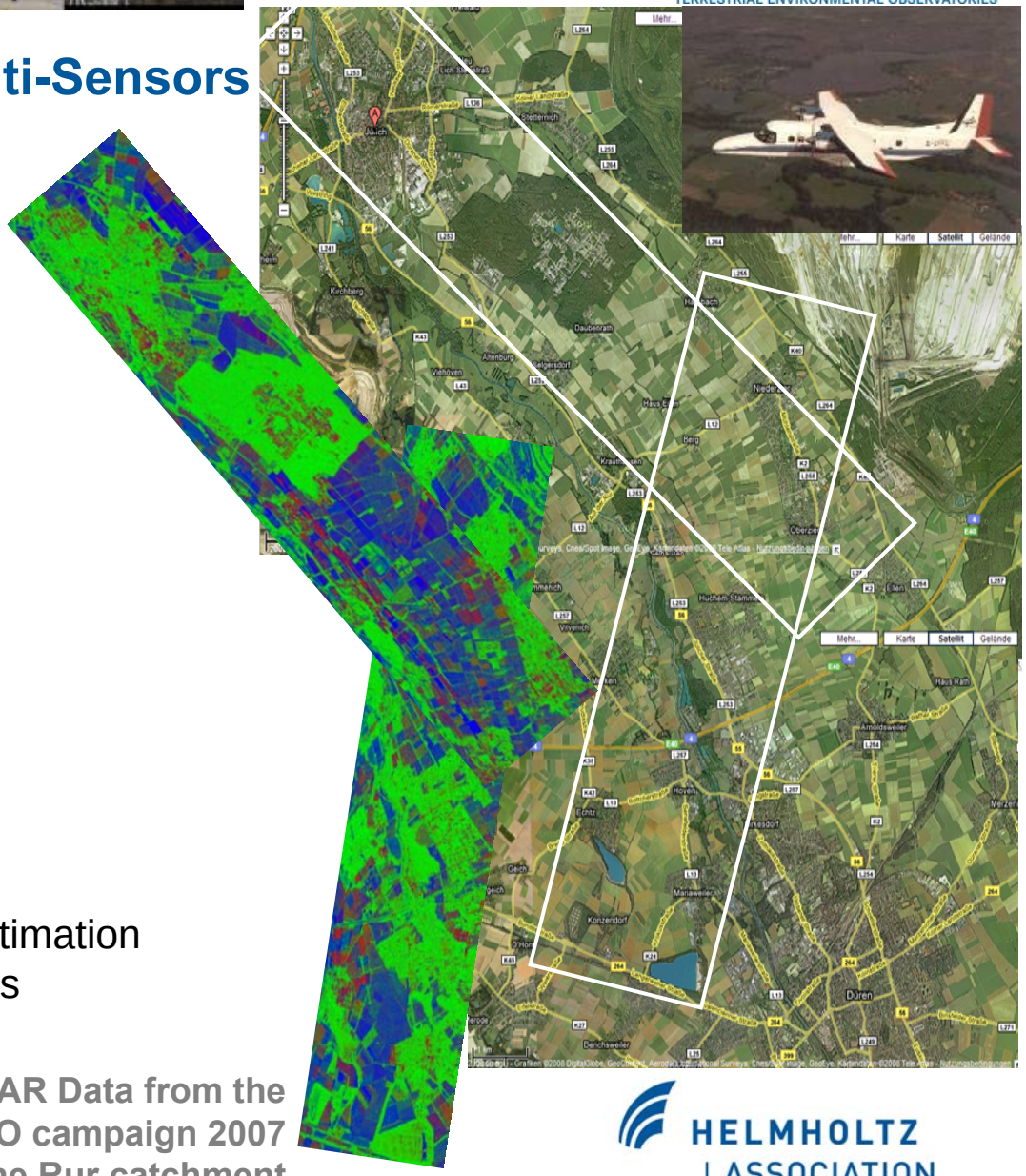
Example of an airborne campaign:

Campaign Preparation:
- Flight planning
- Testsite location

Campaign Execution:
- Calibration instrument
- Measurement campaign

Data Processing:
- Flight position processing (DGPS)
- Raw data processing

Parameter Estimation:
- Algorithms for environ. parameter estimation
- Validation with ground measurements

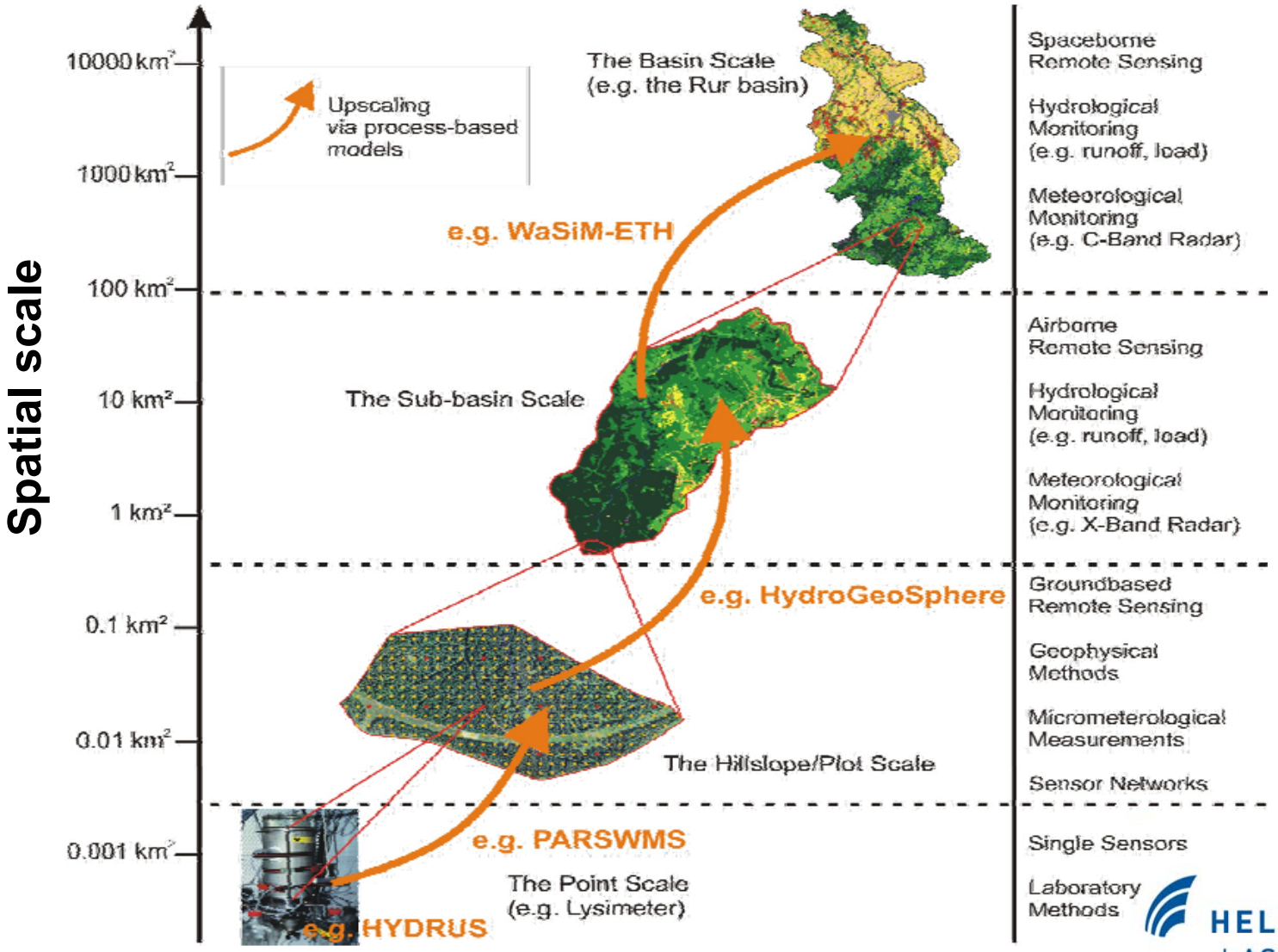


SAR Data from the
SARTEO campaign 2007
over the Rur catchment

HELMHOLTZ
ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Scaling concept for soil moisture



HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Challenge: Integrated and coupled modelling

⇒ Met./climate variables, air chemistry

⇐ Biogenic/microbial exchange, transpiration

⇒ Met./climate variables

⇐ Latent & sensible heat fluxes, land surface & soil properties

⇒ Dynamic vegetation properties, leaching

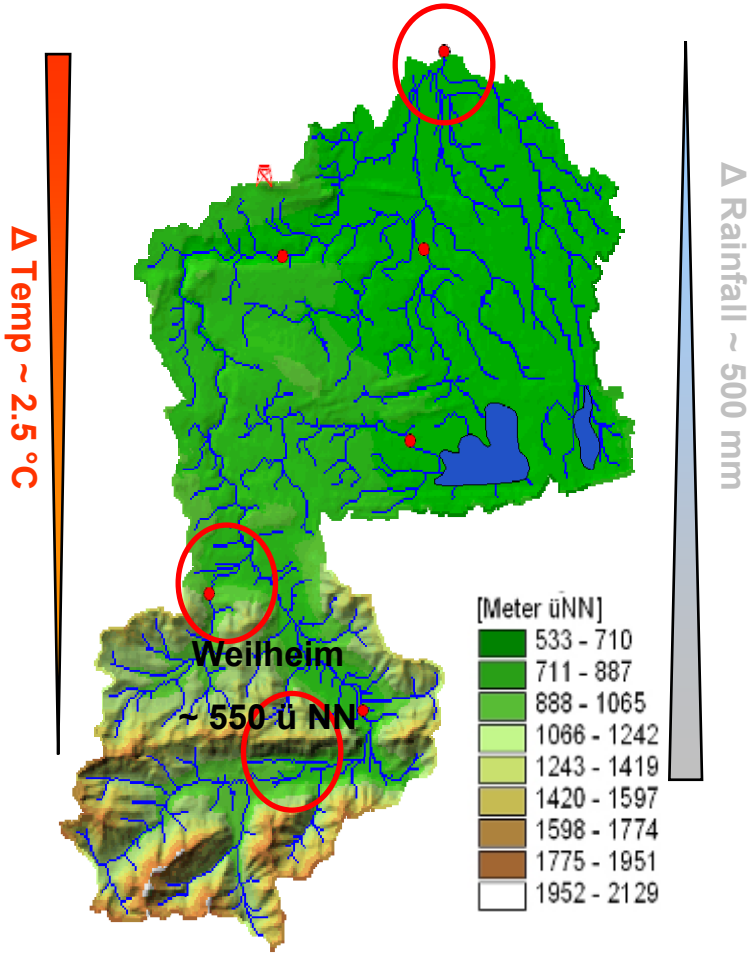
⇐ Water availability, land surface & physical & chemical soil properties

+ anthropogenic impact/management

HELMHOLTZ
ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Climate-Feedback-Experimentations



- Climate station

Eddy covariance

(E-Balance, CO_2, H_2O)

- Micro-Rainfall radar MRR2

- Lysimeter ~ 1m³

- Measurement of N_2O, NOx, CO_2, CH_4 on lysimeter systems

HELMHOLTZ ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Impact of land use changes on agro-ecosystems

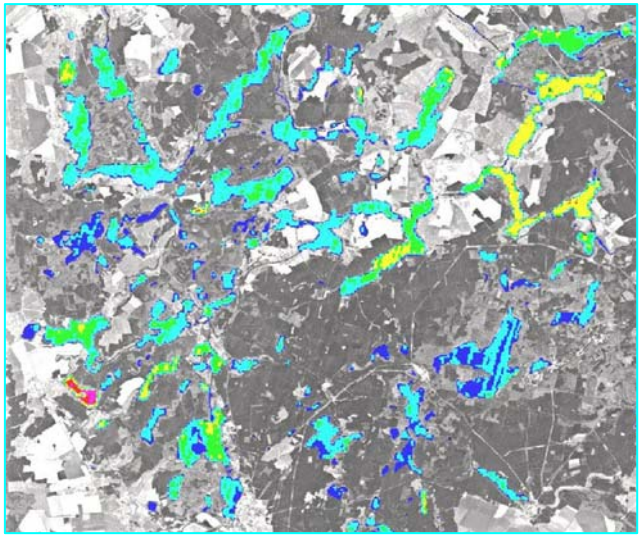
- Adapted and sustainable plant production systems in crop rotations of plants for food, feed and bioenergy
- Optimized energy and trace gas fluxes and balances
- Improved use of soil microbial functions for better plant nutrition and plant protection

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

Combination of process observations with geoarchives

- Region impacts of Global Change on near-natural terrestrial ecosystems and landscape in space and time
- Integrated system analysis of climate- and landscape development/process understanding
- Combination of real-time process observations (e.g. soil moisture, hydrology, vegetation) and evaluation of geoarchives (seaborne, colluvials, peats, soils)

Remote Sensing



Field observation

Geoarchive

HELMHOLTZ
ASSOCIATION

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

TERENO Organization

Scientific Steering Committee
Representatives of the involved Helmholtz Centers

Advisory Board
Independent experts and cooperation partners

TERENO Coordination
Heye Bogena (FZJ)
Steffen Zacharias (UFZ)
Harald Kunstmann (FZK)

SSC members:
FZJ: Vereecken, Pütz
UFZ: Teutsch, Dietrich
HMGU: Munch, Priesack
FZK: Schmid, Papen
DLR: Haschberger, Hajnsek

Coordination Teams (CT)

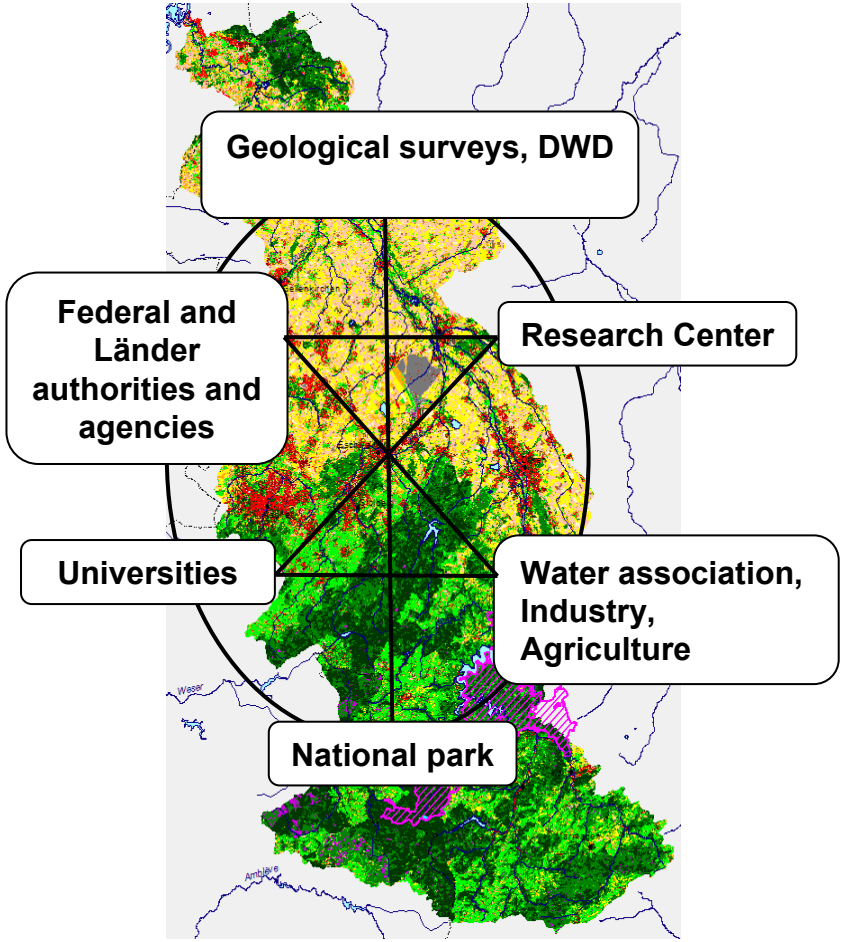
- CT Atmosphere
- CT Biosphere
- CT Pedosphere
- CT Hydrosphere
- CT Environmental Sensing
- CT Data management
- CT Integrative Modeling

Interdisciplinary Implementation and support of the Instrumentation

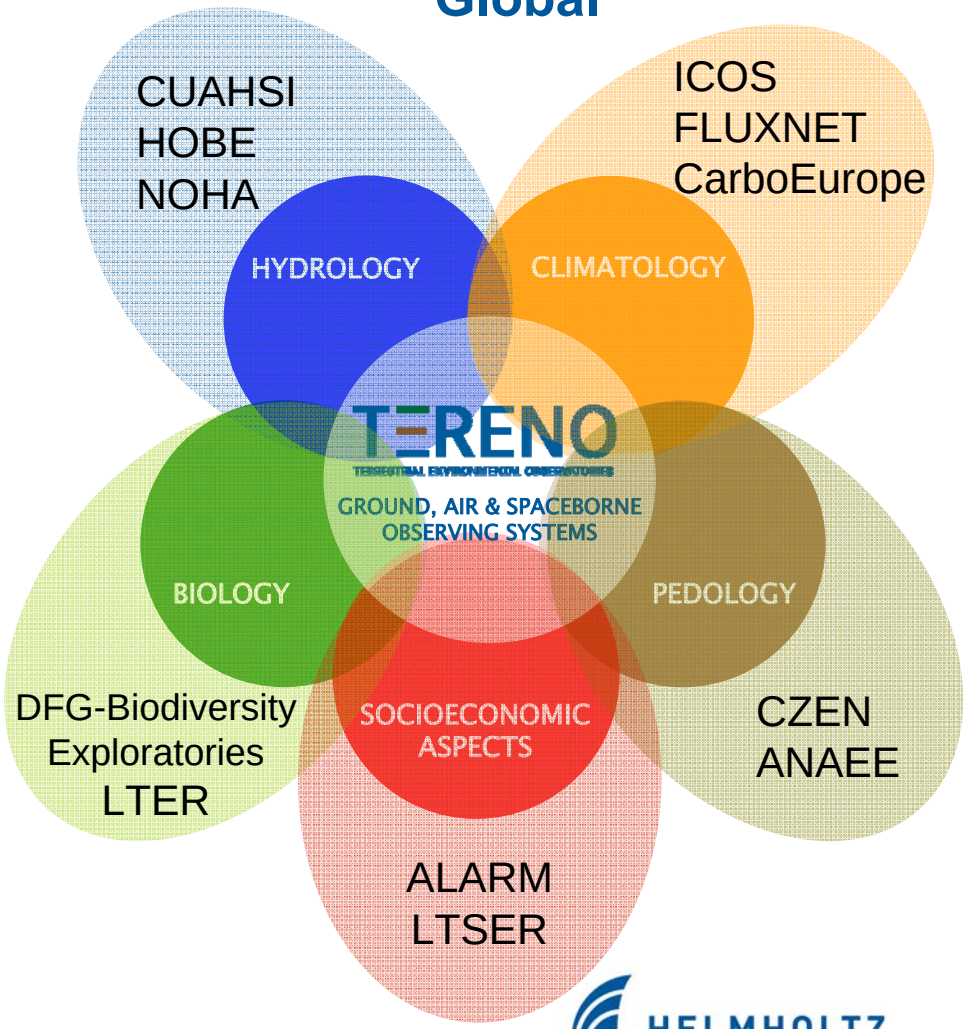
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIES

TERENO Networking

Local



Global



More information at: www.tereno.net

HELMHOLTZ ASSOCIATION