German Gamma Dose rate (GDR) network

Ulrich Stöhlker

German Federal Office for Radiation Protection

Freiburg - Breisgau, Germany

German GDR network

1900 GDR stations
Distance approx. 15 km
In the 25 km zone (NPPs)
distance approx. 8 km

Measured data:
ambient dose rate
every 10 minutes

Range: ca. 50 nSv/h - 5 Sv/h
two Geiger-Müller counting tubes

GDR data above threshold
station will generate an early warning

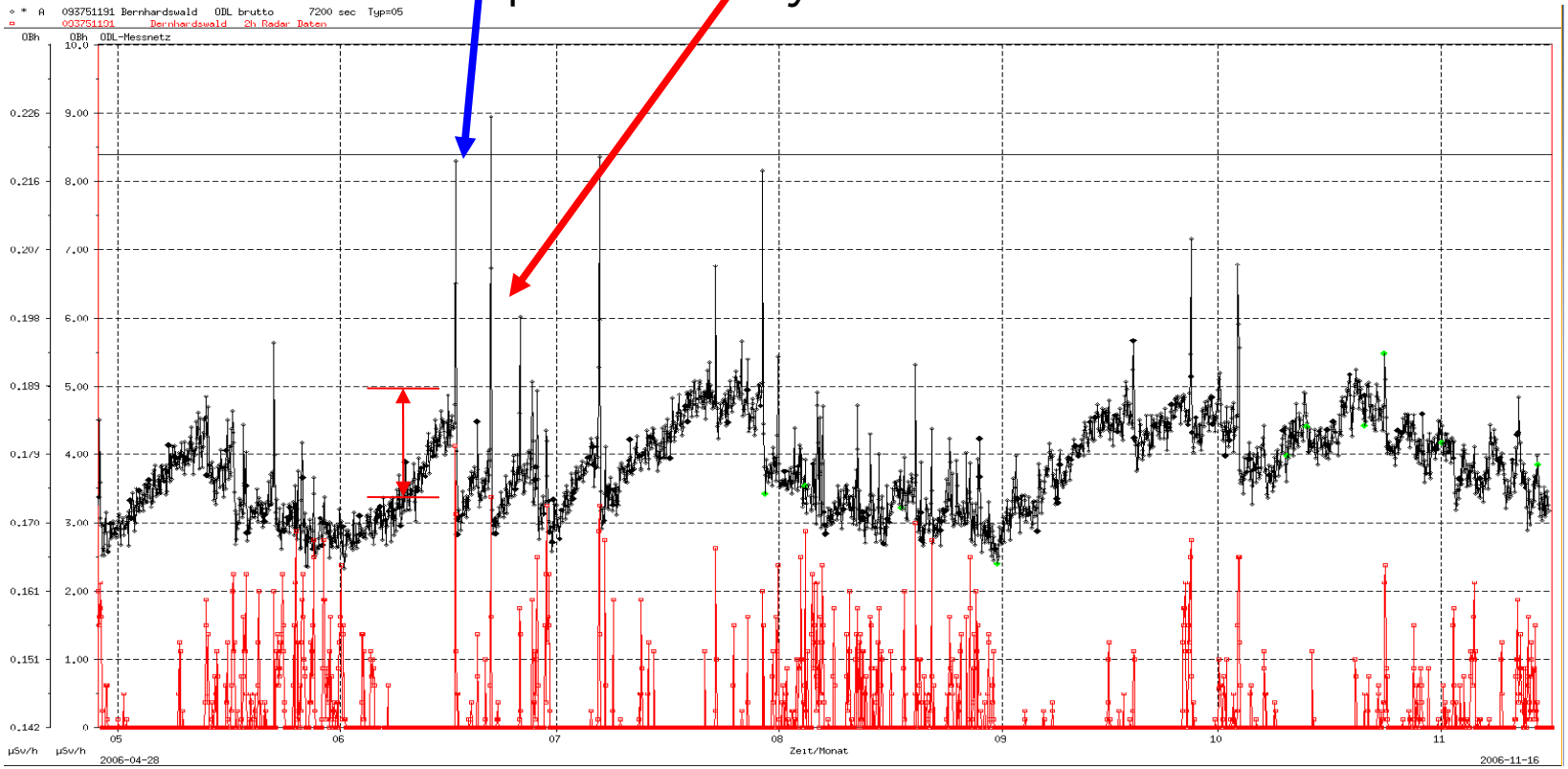
What do we measure ?
Time series of GDR and rain from weather radar

Wash-out by rain: **surface effect**:

deposition of radio-nuclides to the ground <-> GDR increases **suddenly**

Water content of the soil increases: **soil effect**:

Absorption of activity in soil <-> reduction of the terrestrial GDR

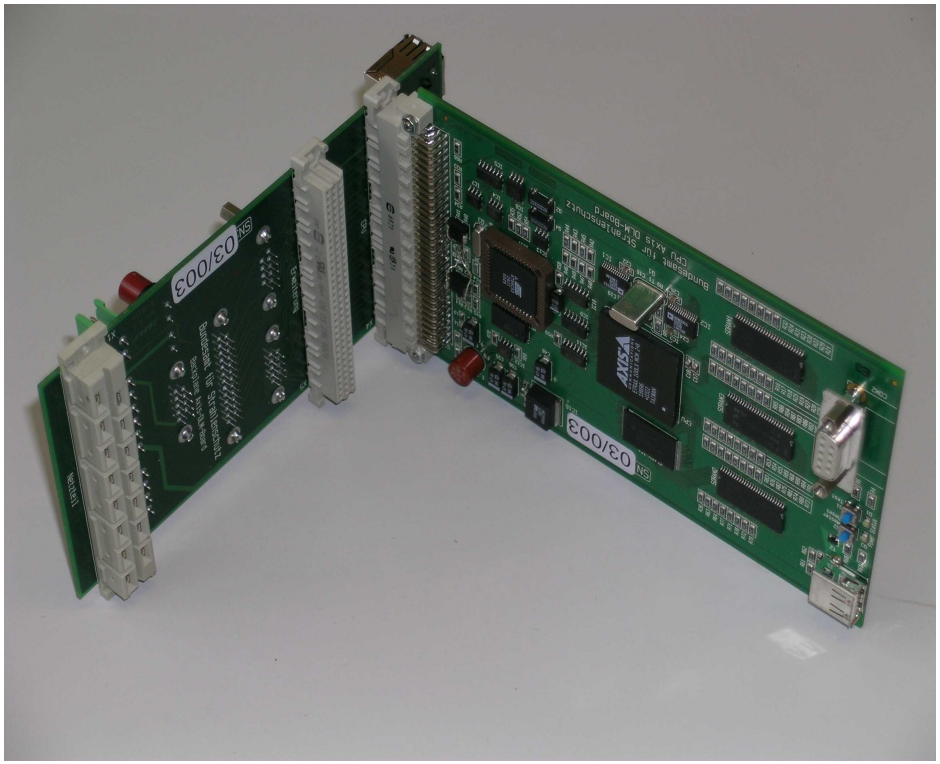


Bundesamt für Strahlenschutz

Measurement techniques: New data loggers

Linux based data logger developed by BfS (open source HW & SW)

Mainboard: AXIS CPU ETRAX 100LX, 4+16 Mbytes RAM, LAN, USB
Backplane: 2x RS232, RS485, USB, LPT, power in, power modem, rechargeable battery,
Counter: intelligent interface to the Geiger-Mueller probe (ATMEL)



Operating system: LINUX
Software language: C, shell script
Software developed by BfS
User interface: html with cgi
Version control: cvs

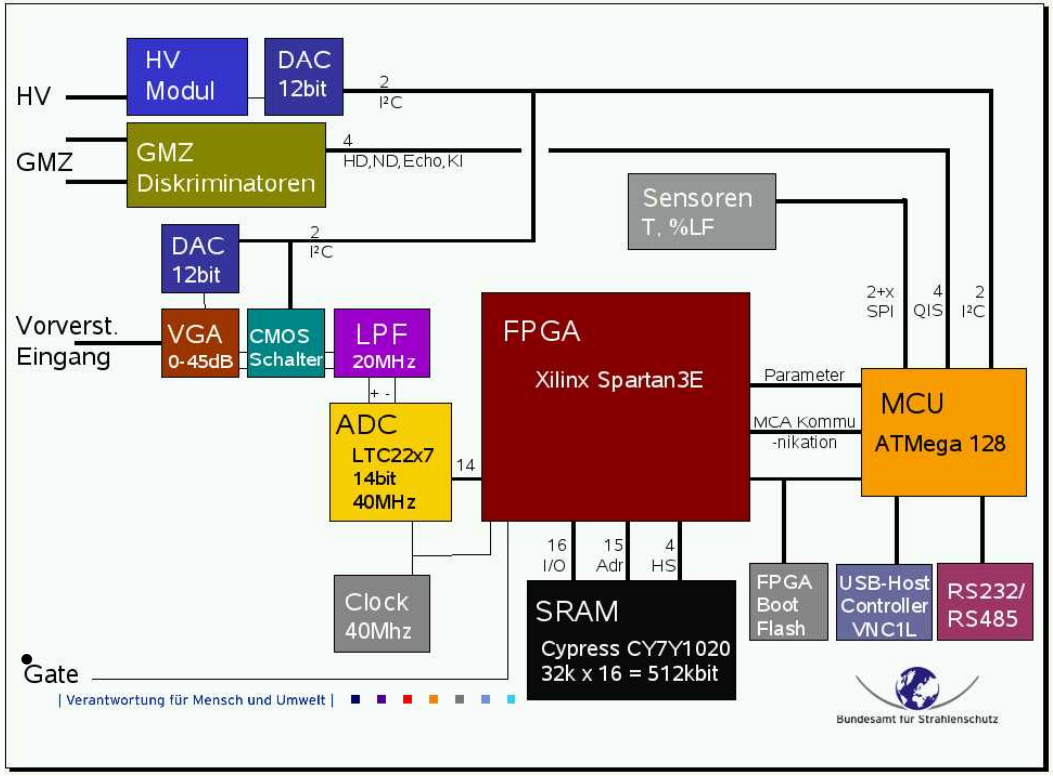
Actual status
development startet in 2003
and finished in 2006
Today 380 MWS3 are installed

In 2010 1400 stations of the German GDR network will use Linux based data loggers

Detectors with spectroscopic features

Development of new detector electronics in co-operation with University of Freiburg (prototype available November 2008)

- low cost digital 4k Multi Channel Analyser (MCA) including HV & preamplifier
- interface for one high dose (HD) Geiger-Mueller tube (1 mSv/h – 1 Sv/h)
- Low dose (LD) detector with **spectroscopic** detectors (CZT, LaBr3)



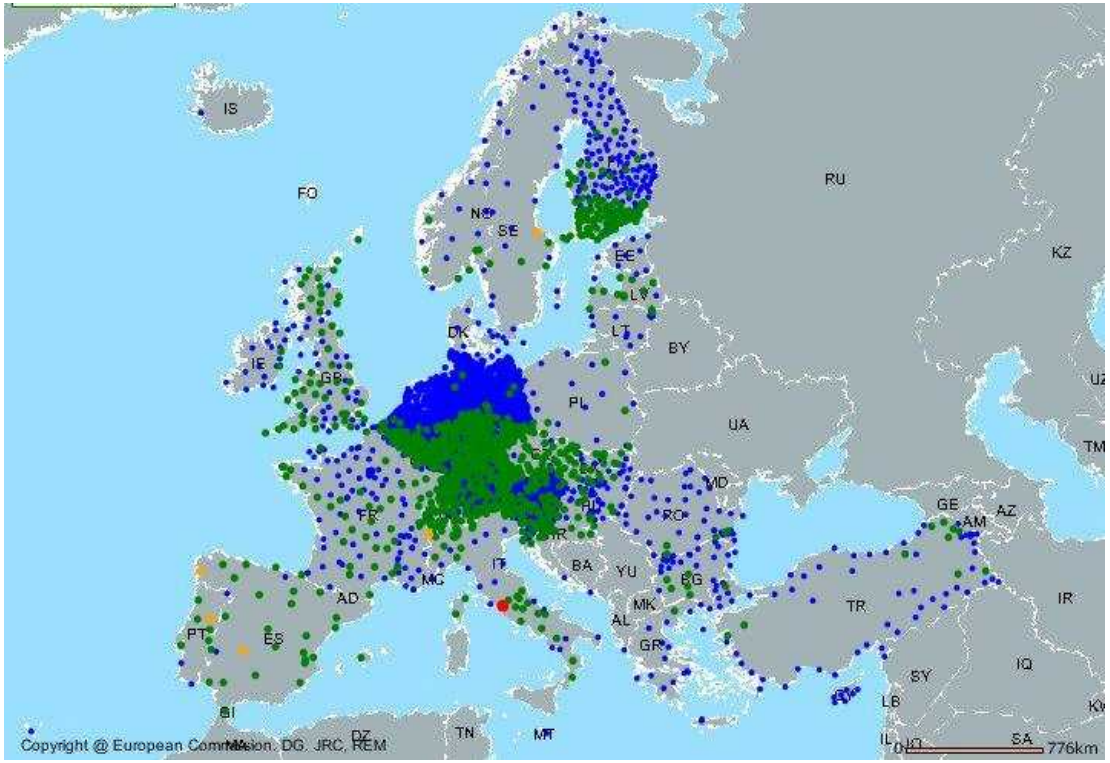
Additional features:

- fast 40MHz sampling rate
- filter algorithms implemented in FPGA
- standalone ATMega MCU
- RS232 interface for GPS receiver
- RS485 interface to data logger
- low power consumption (1W)
- I²C interface for additional sensors
- e.g. temperature, humidity, air pressure and motion sensors

Bundesamt für Strahlenschutz

GDR networks in Europe

European countries established gamma dose rate monitoring networks during the cold war periode and improved these networks after the Chernobyl accident in 1986.



Today there is still a non negligible potential of nuclear hazards with respect to:

- **nuclear facilities**
- **atomic bomb scenarios**
- **terroristic attacs**

Since 15 years exchange of GDR data between all EU member states continuously in routine and emergency

Bundesamt für Strahlenschutz

European GDR networks

Exchange of data

- EURDEP (data format of the EURopean Data Exchange Platform)
- IDF: International Data Format

With 3 mirror sites

- JRC-Ispra / Italy (main server)
- DG TREN / Luxembourg (mirror server)
- BfS-Freiburg / Germany (mirror server: focus on research community)

Harmonization & standardisation of data

Main problem is still the heterogeneity of European GDR data

Heterogneity in terms of
- probes,
- data treatment and
- time resolution

Harmonization procedures on the European scale:
- AIRDOS / EURDEP
- EURADOS
- BfS has developed the Inter-calibration platform on the Schauinsland to perform long-term inter-comparisons (national and international). BfS invits partners to participate in INTERCAL meetings to discuss results

Can GDR networks be used for other applications ?

Use the network for its basic purpose

- Provide reliable information about the radiological situation

Use the network to derive additional information from the observed data

- Provision of terrestrial dose rate data for the modelling of greehouse gases
- Correlation between GDR and soil humidity for floodwater prediction
- Correlation between GDR and soil humidity for the calibration of the SMOS satellite

Use the network as infrastructure for the installation of additional sensors

- Atmospheric water vapor concentration based on GPS tomographie

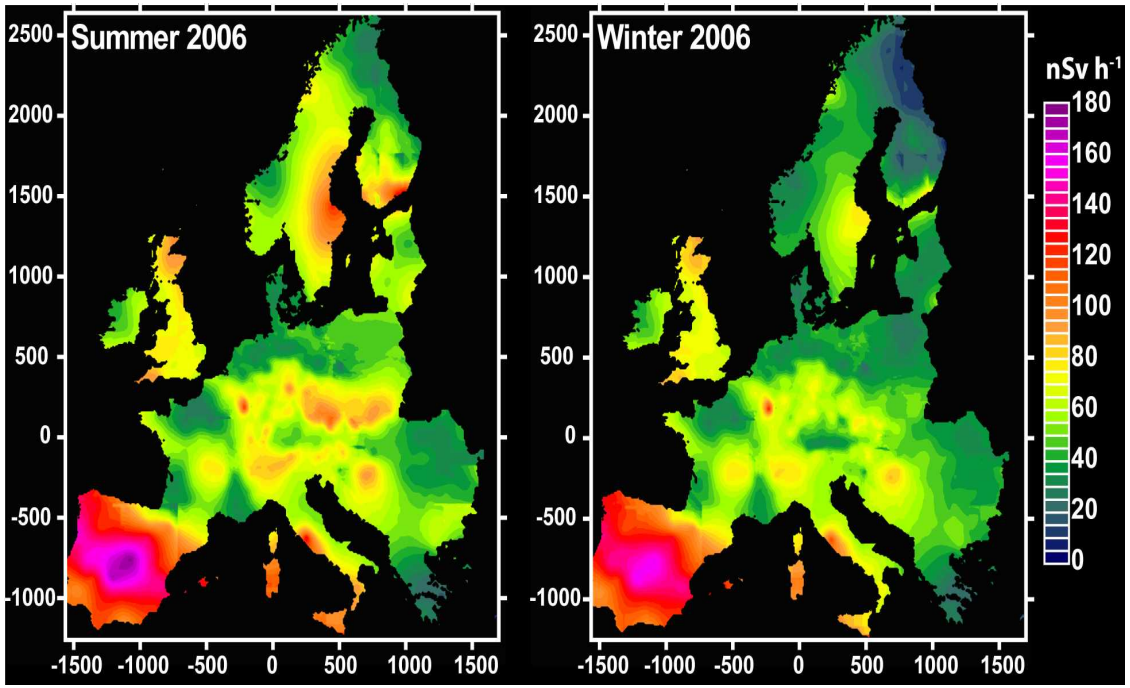
Data harmonization on the European scale
Example 1: Europen map of terrestrial dose rate

Harmonisation procedures

Characterisation of probes
EURADOS/Schauinsland
- self-effect
- response to cosmic radiation
- height above ground

Database with all parameters
- AIRDOS (JRC-Ispra + experts)

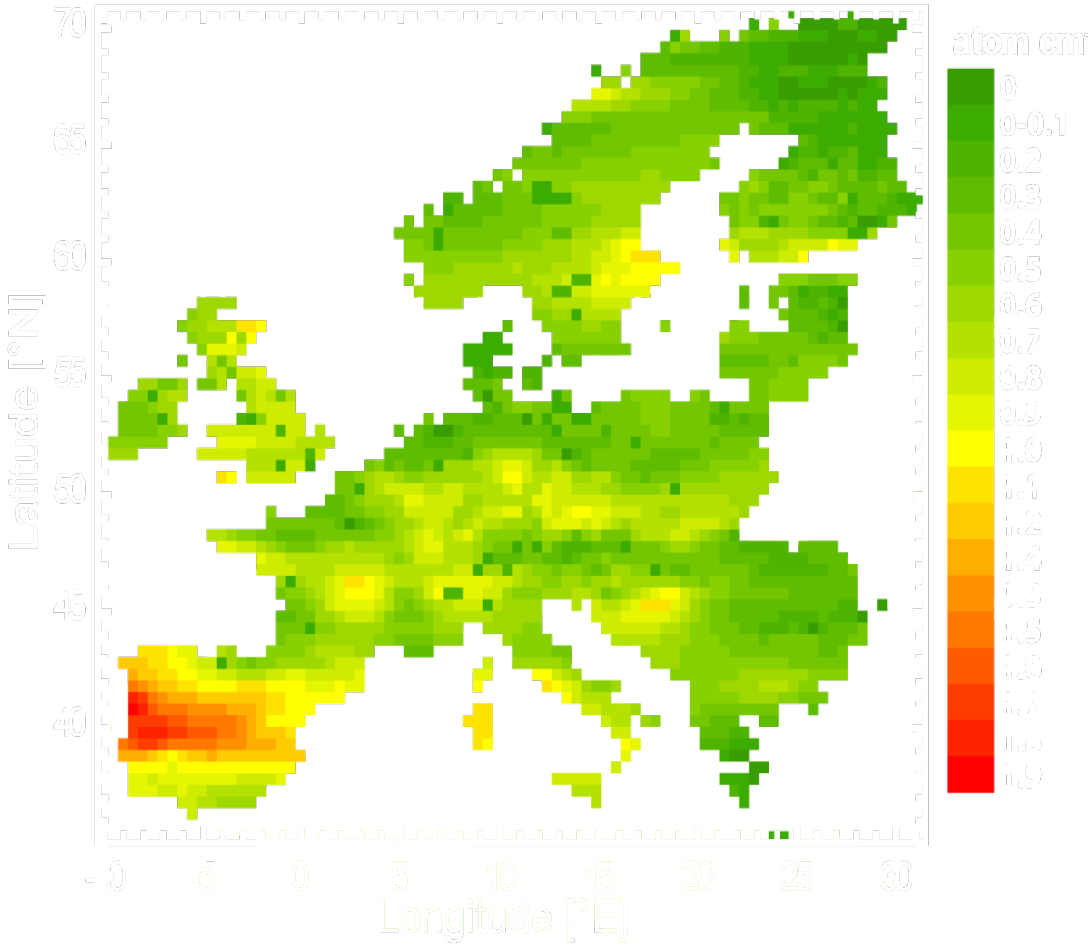
Application of corrections
- Prototype development Thesis Thomas Szegvary, UNI-Basel
- Project to be discussed with JRC, Ispra: EURDEP mirror server in Freiburg will generate maps of the terrestrial GDR in Europe for research community



Mean terrestrial GDR for summer (left) and winter (right)for 2006 in Europe (Szegvary et a., 2007)

Bundesamt für Strahlenschutz

Estimation of greenhouse gas emissions based on GDR/Radon correlation method



Example1 extension:

60 % correlation between GDR and Radon flux

Radon flux map (annual mean) for Europe (0.5 x 0.5) in 2006

(data available at http://radon.unibas.ch)

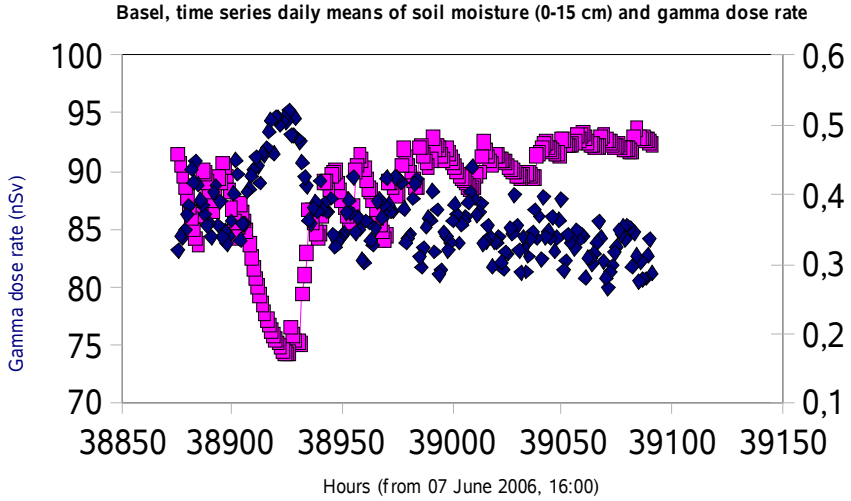
Bundesamt für Strahlenschutz

Correlation between GDR and soil humidity

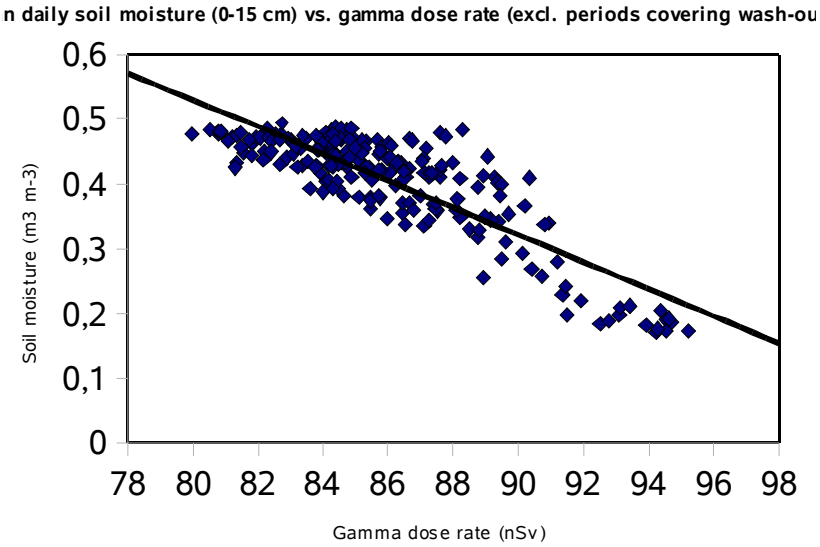
Example 2 & 3: In cooperation with soil scientists from University Basel: Correlation between GDR and soil humidity for

- floodwater prediction (work in progress)
- the calibration of the SMOS satellite (proposal)

GDR and humidity of the soil in 15 cm depth as function of time



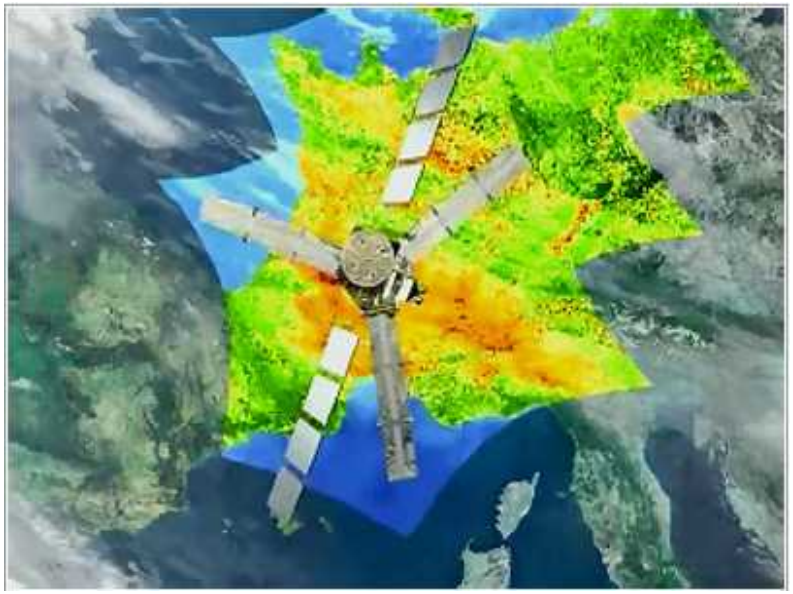
Humidity of the soil as a function of GDR at a measuring station at the University of Basel



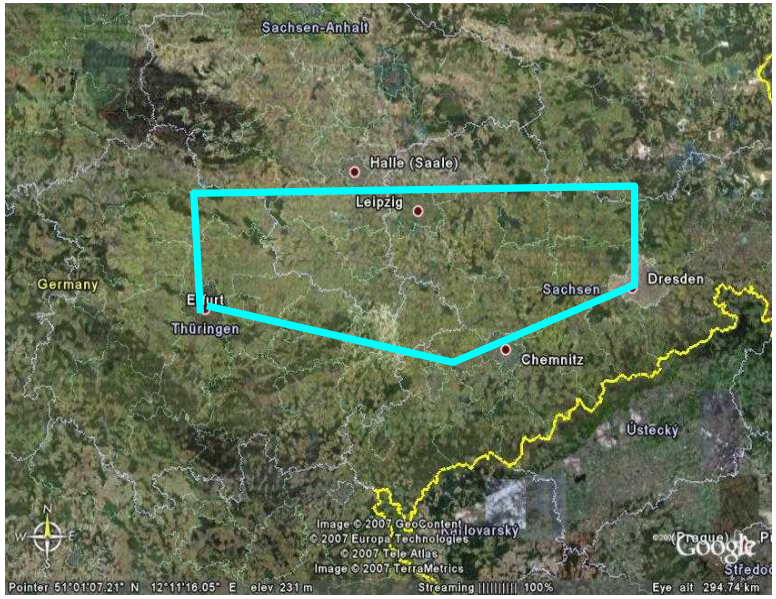
Bundesamt für Strahlenschutz

Correlation between GDR and soil humidity for the calibration of the ESA - SMOS satellite

Example 2: BfS & UNI-Basel have prepared a proposal for the calibration of SMOS satellite based on the correlation between GDR and soil humidity (will be presented 22.05.08 at ESA-ESTEC Noordwijk)



Soil Moisture and Ocean Salinity (SMOS) satellite
Launch early 2009

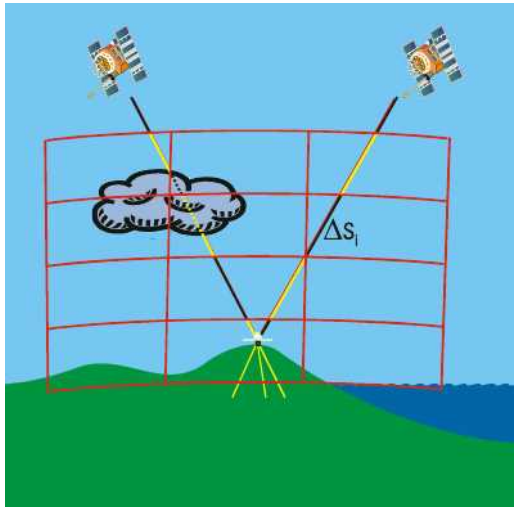


Proposed calibration area around Erfurt, Leipzig and Dresden

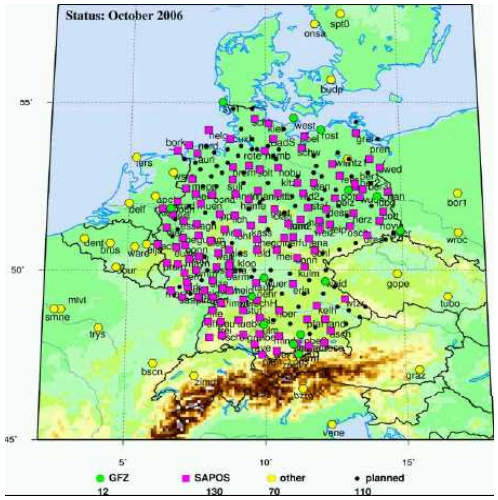
Bundesamt für Strahlenschutz

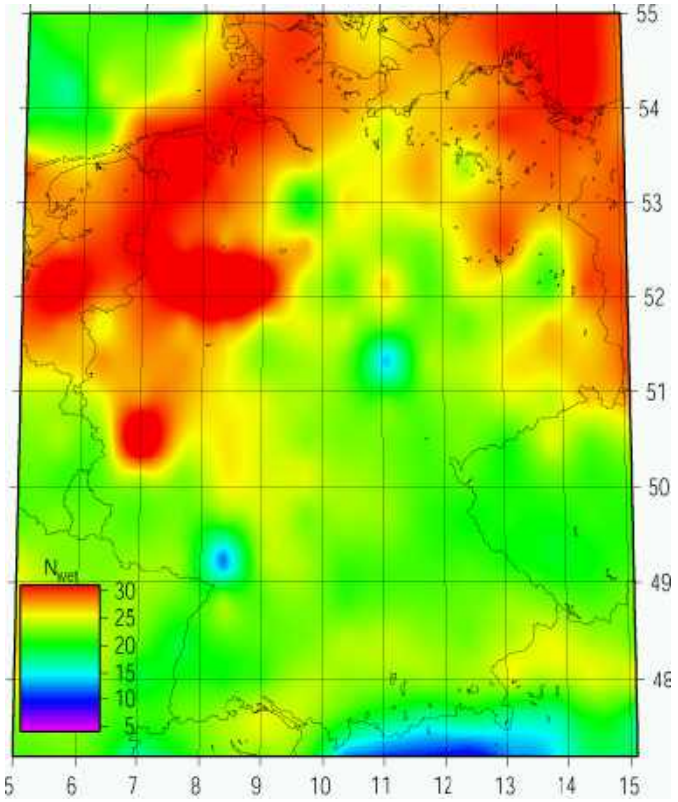
Atmospheric water vapor concentration based on GPS tomographie

Integrated water vapor (IWV) along the line of sight between ground pased GPS receiver and satellite is the base for 3D reconstructions



Slants and 3D water vapor (Figure from Troller, ETH)





3D IWV at 500m from a 3D reconstruction based on the German ground network (139 stations used) (figures from Wickert, GFZ)

Bundesamt für Strahlenschutz

GPS tomography

GFZ-Potsdam and BfS started a cooperation in 2005 -> using the German GDR network to establish a dense 1-frequency GPS network in Germany to measure the atmospheric water vapour concentration to optimise weather forecast

The first step was to define the technical requirements and to find low cost GPS receivers with high accuracy

BfS and GFZ have decided to propose a project which might be funded by the German ministry of environment: realisation of a dense prototype GPS network with 10 stations in the vicinity of a NPP to derive 3D wind field data from GPS tomography to improve prognostic short range atmospheric dispersion calculations

INTAMAP: INTeroperability And automated MAPping

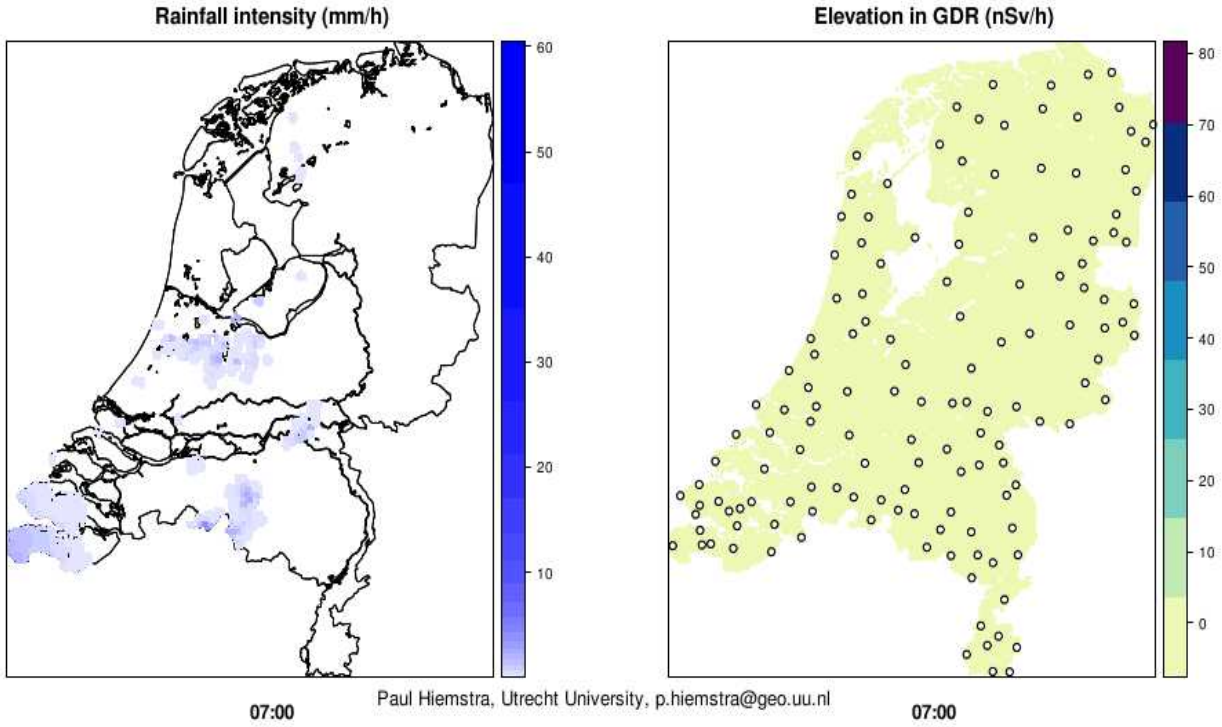
All examples have shown: mapping point data needs automatic and high quality interpolation techniques

EU project INTAMAP: an **automatic**, interoperable service providing real time interpolation between point observations

- EURDEP providing radiological data as a case study

- Provides real time predictions to aid risk management through a Web Processing Service interface

- Combines state of the art geo-statistica methods in an interoperable framework



Acknowledgements

Part of this work has been funded by the European Commission, under the Sixth Framework Programme, by the Contract N. 033811 with the DG INFSO, action Line IST-2005-2.5.12 ICT for Environmental Risk Management.

The views expressed herein are those of the authors and are not necessarily those of the European Commission.