

# Ipve Workshop - land product validation and evolution

ESA/ESRIN - Frascati, Italy, 28-30 January 2014

## DEMMIN - Calibration and Validation Site for Remote Sensing

E. Borg, C. Schiller, B. Fichtelmann, D. Jahncke, F. Renke

[erik.borg@dlr.de](mailto:erik.borg@dlr.de)



Knowledge for Tomorrow



# Overview

Challenge of complex environmental processors

Motivation for operational remote sensing test sites

Site characteristic of test site DEMMIN

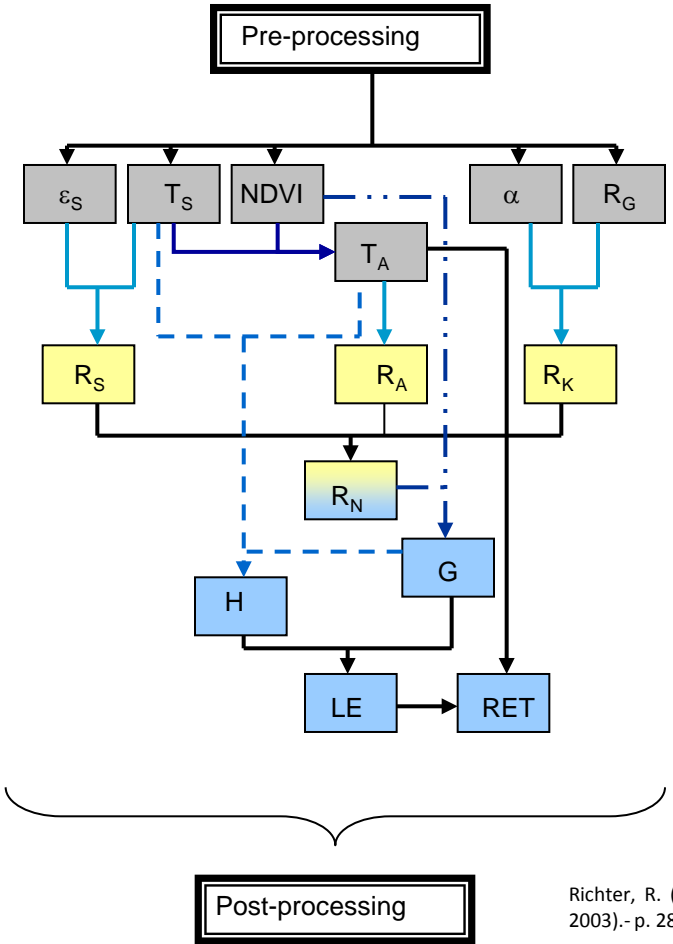
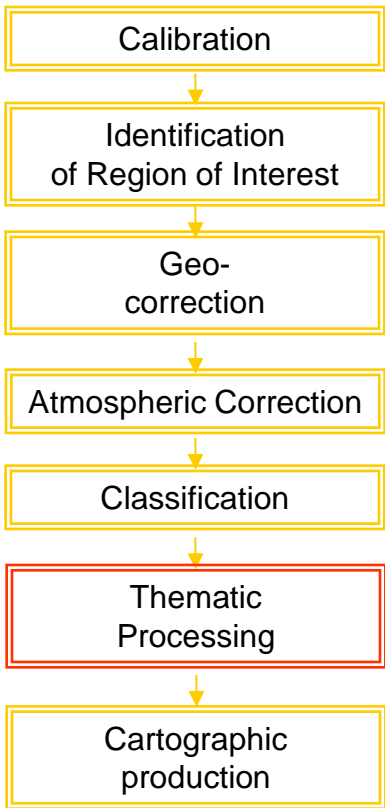
Infrastructure of DEMMIN

Operational processing chain for in-situ-data

Terrestrial Environmental Observatories - TERENO



# Remote Sensing: Evapotranspiration



**Legend**

$$RET [mm/s] = f ( LE [W/m^2], T [^\circ C] )$$

$$RET = \frac{LE}{(2,498 - 0,00242 \cdot T) \cdot 10^6 \frac{Ws}{m^2}} \cdot mm$$

(DWVK, 1996)

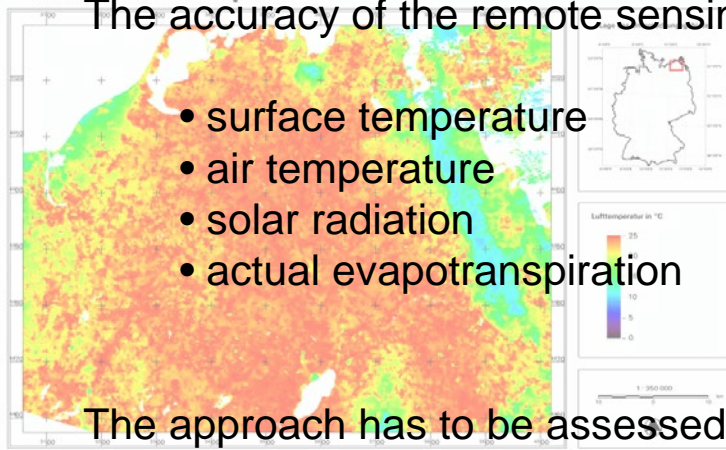
Richter, R. (2003): Value Adding Products derived from the ATCOR Models (Version 5.5, January 2003).- p. 28. [http://www.rese.ch/pdf/atcor\\_value\\_adding.pdf](http://www.rese.ch/pdf/atcor_value_adding.pdf)

Wloczyk, C. (2007): Entwicklung und Validierung einer Methodik zur Ermittlung der realen Evapotranspiration anhand von Fernerkundungsdaten in Mecklenburg-Vorpommern. Dissertation, S. 143, ISBN: 978-3-86009-010-7



# Results of the Experimental RealET-Processor

Karte der Lufttemperatur



The accuracy of the remote sensing based parameters:

- surface temperature
- air temperature
- solar radiation
- actual evapotranspiration

The approach has to be assessed as robust.

**Ausgangsdaten**  
 LANDSAT 7 / ETM+ vom 01. Mai 2000 (Ausschnitt)  
 Path: 194, Row: 22  
 verwendete Kanäle: 3, 4, 6  
 Empfängerzeit: 10:00:7.3  
 Räumliche Auflösung: 30 m (RDS im Kanal 5)

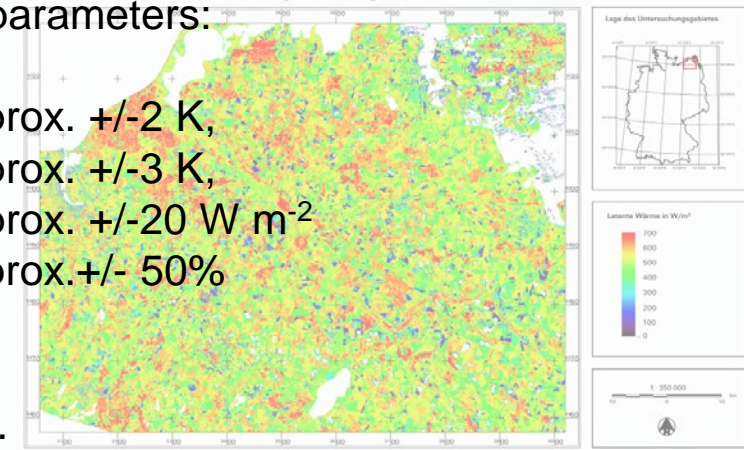
**Prozessierung**  
 - Dekodierung  
 - Atmosphärenkorrektur mit ATCOR  
 - Anpassen eines Algorithmus zur Ableitung der Lufttemperatur aus NOAA-AVHRR Daten (nach Goward et al. 1994) auf LANDSAT Daten

**Bearbeiter**  
 Carola Wloczyk  
 Rudolf Richter  
 Erik Ring  
 Michael Axten  
 Bernd Fuhrmann

**Kartengangaben**  
 Projektion: UTM  
 Datum: WGS84

DLR  
 Februar 2002

Karte der realen Evapotranspiration



- approx. +/- 2 K,
- approx. +/- 3 K,
- approx. +/- 20 W m<sup>-2</sup>
- approx. +/- 50%

**Ausgangsdaten**  
 LANDSAT 7 / ETM+ vom 01. Mai 2000 (Ausschnitt)  
 verwendete Kanäle: 3, 4, 6  
 NOAA 14 AVHRR vom 30. April 01. und 02. Mai 2000  
 (Steckbrieflicher Ausschnitt aus 8 Szenen)  
 verwendete Kanäle: 1, 2, 4, 9

**Prozessierung**  
 - Dekodierung Atmosphärenkorrektur mit ATCOR  
 - Ableitung der Lufttemperatur aus den NOAA-Daten nach Goward et al. 1994  
 - Anpassen dieses Algorithmus auf LANDSAT Daten  
 - Ermittlung des vertikalen Nennwertes mit Hilfe zur Tagessumme der Temperatur  
 - Lösung der Energiebilanzgleichung mit angepasstem Algorithmus auf der Basis der Arbeitse von Richter 2000

**Bearbeiter**  
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Map of Air Temperature

Map of Actual Evapotranspiration

Wloczyk, C. (2007): Entwicklung und Validierung einer Methodik zur Ermittlung der realen Evapotranspiration anhand von Fernerkundungsdaten in Mecklenburg-Vorpommern. Dissertation, S. 143, ISBN: 978-3-86009-010-7



# Lessons learned from the experiment

The processor is very complex. A number of intermediate products based on empirical models can be derived.

For validation of the generated products:

The station density and distribution of available official environmental measurement networks was not optimal for validating remote sensing relevant parameters,

The stations fulfill different tasks : measuring of environmental parameters, measuring of traffic-related parameters.

The stations do not measure all the parameters that are needed.





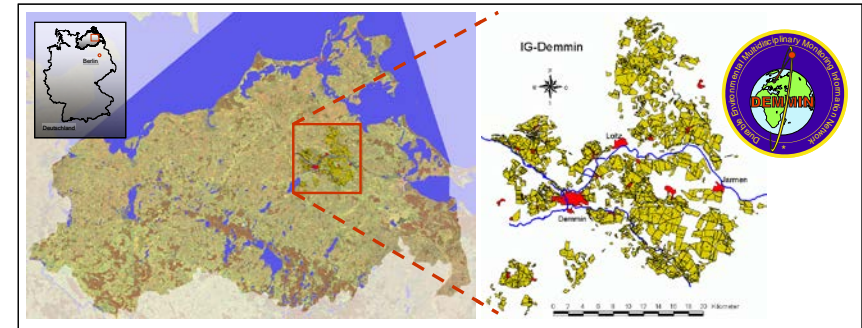
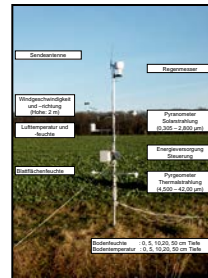
# Durable Environmental Multidisciplinary Monitoring Information Network (DEMMIN)

Remote Sensing includes diverse e.g. platforms, sensors, methods for interpretation

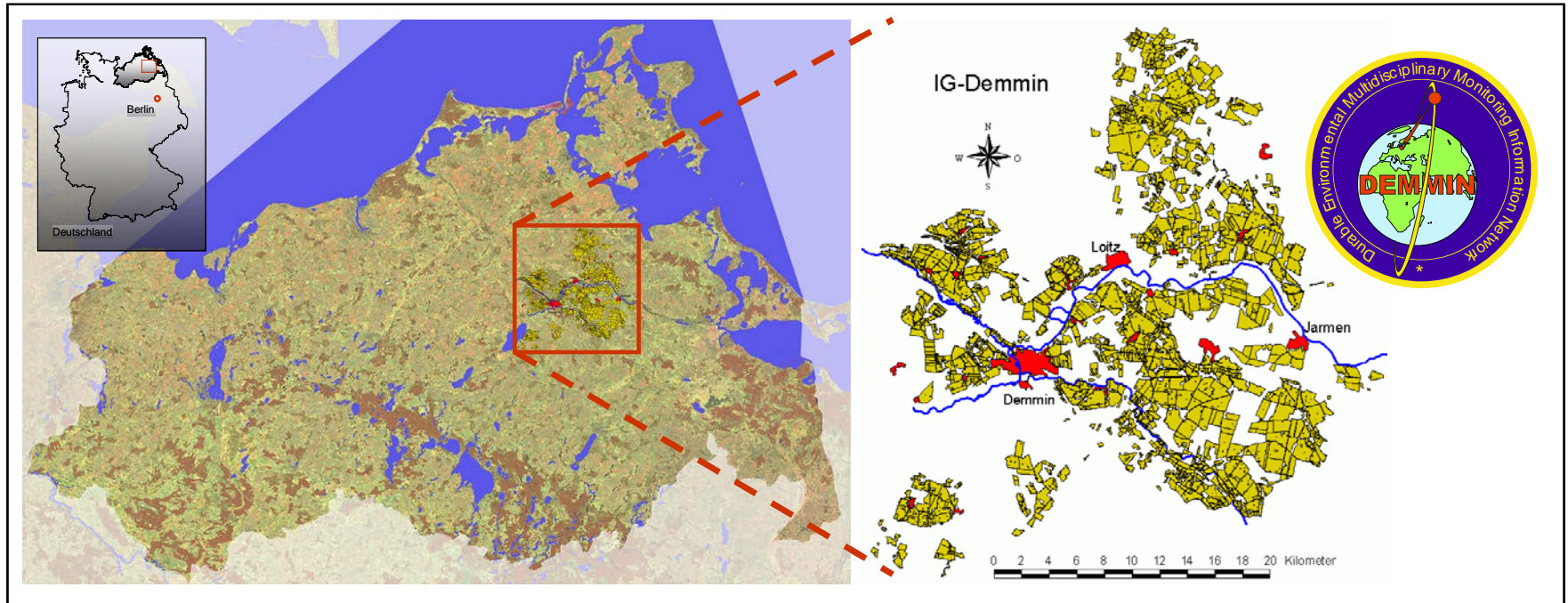
There is an urgent requirement for in-situ-data for validation of value added data

Cal-val of remote sensing requires numerous environmental parameters

Requirement for operationally measured cost- and labour-effective in-situ-data



# What is DEMMIN ?



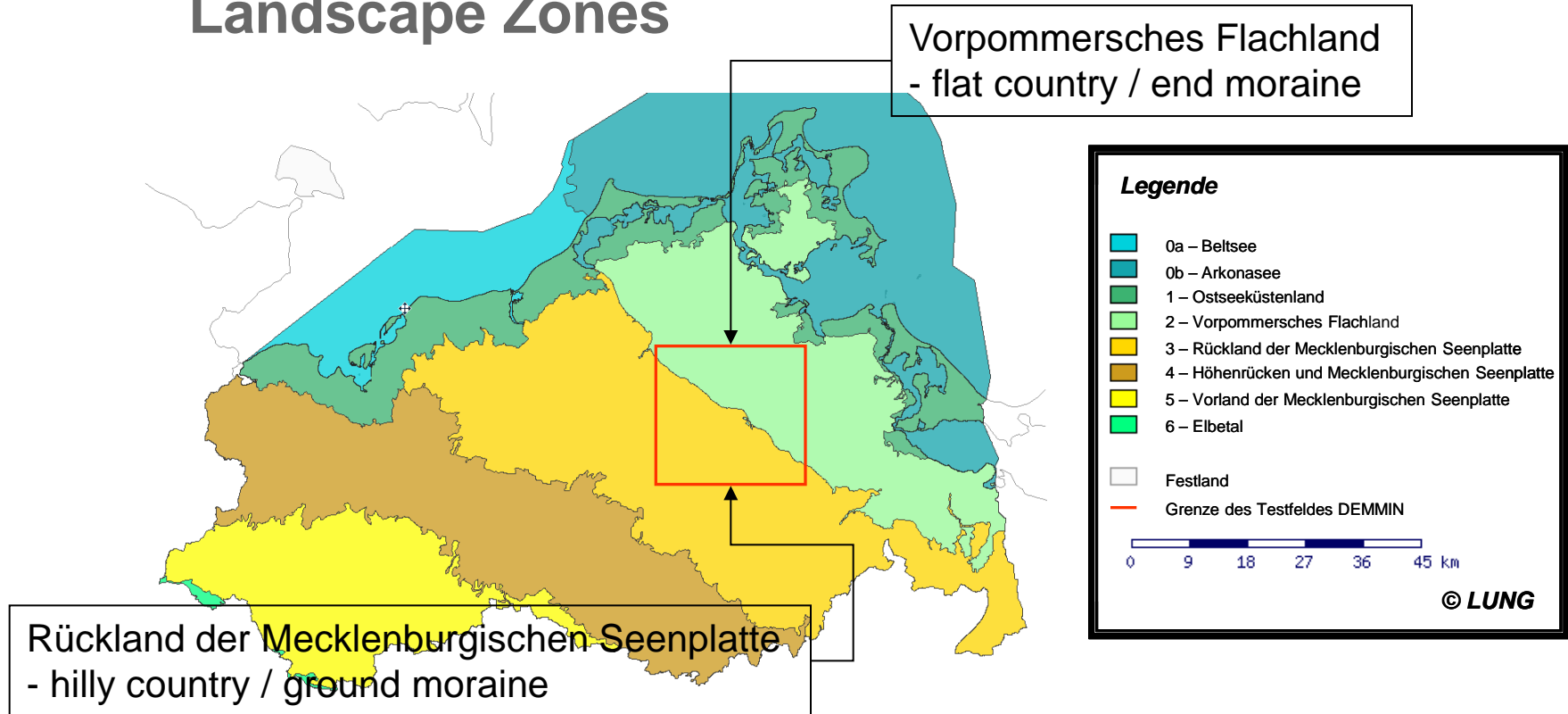
Cooperation with Farmers managing approx. 30,000 ha

Test-site region has an dimention of 50 to 50 km<sup>2</sup>

Borg, E., Lippert, K., Zabel, E., Löpmeier, F.J., Fichtelmann, B., Jahncke, D., Maass, H. (2009): DEMMIN – Teststandort zur Kalibrierung und Validierung von Fernerkundungsmissionen.- In: 15 Jahre Studiengang Vermessungswesen – Geodätisches Fachforum und Festakt, Neubrandenburg, Eigenverlag (Hrsg.: Rebenstorf, R.W.).- 16.-17.01.2009.- S. 401-419.



# Landscape Zones



DEMMIN is part of German lowlands formed by glaciers and melting waters during Pomeranian stage of Pleistocene

(LUNG – Mecklenburg/Vorpommern: <http://www.umweltkarten.mv-regierung.de/script/>)





# Hydrology



- characterized by
- diffuse, undeveloped water network,
  - internal drainage areas,
  - diverse lakes,
  - many bifurcations,
  - diverse hollow forms (germ: Sölle)

Rivers: Trebel, Tollense, Peene

Lakes: Kummerower See - 0.2 m above sea level  
Malchiner See - 0.6 m above sea level

Peene: approx. river depth 2 - 3 m;  
approx. river slope (Malchin to Peene  
mouth 0.03%)

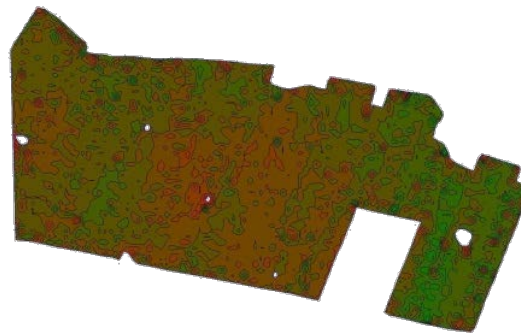
Peene in the region of old peat-ditches. Especially notable are the natural meanders.

Natural peat bogs along the valleys of the rivers.

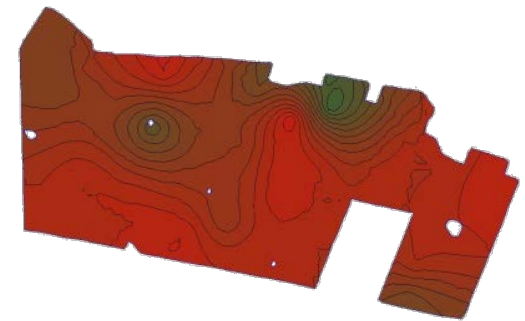
Borg, E., Lippert, K., Zabel, E., Löpmeier, F.J., Fichtelmann, B., Jahncke, D., Maass, H. (2009): DEMMIN – Teststandort zur Kalibrierung und Validierung von Fernerkundungsmissionen.- In: 15 Jahre Studiengang Vermessungswesen – Geodätisches Fachforum und Festakt, Neubrandenburg, Eigenverlag (Hrsg.: Rebenstorf, R.W.).- 16.-17.01.2009.- S. 401-419.



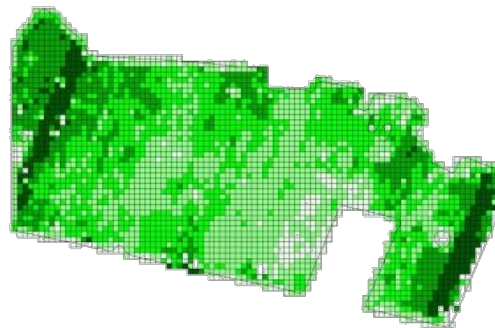
# Environmental and Agricultural Data



Yield mapping



Soil investigations



N-Sensor / Biomass

Mean Size of fields is 80 ha  
and in maximum 300 ha.

Borg, E., Lippert, K., Zabel, E., Löpmeier, F.J., Fichtelmann, B., Jahncke, D., Maass, H. (2009): DEMMIN – Teststandort zur Kalibrierung und Validierung von Fernerkundungsmissionen.- In: 15 Jahre Studiengang Vermessungswesen – Geodätisches Fachforum und Festakt, Neubrandenburg, Eigenverlag (Hrsg.: Rebenstorf, R.W.).- 16.-17.01.2009.- S. 401-419.





# Environmental Measurement Network - Deviation



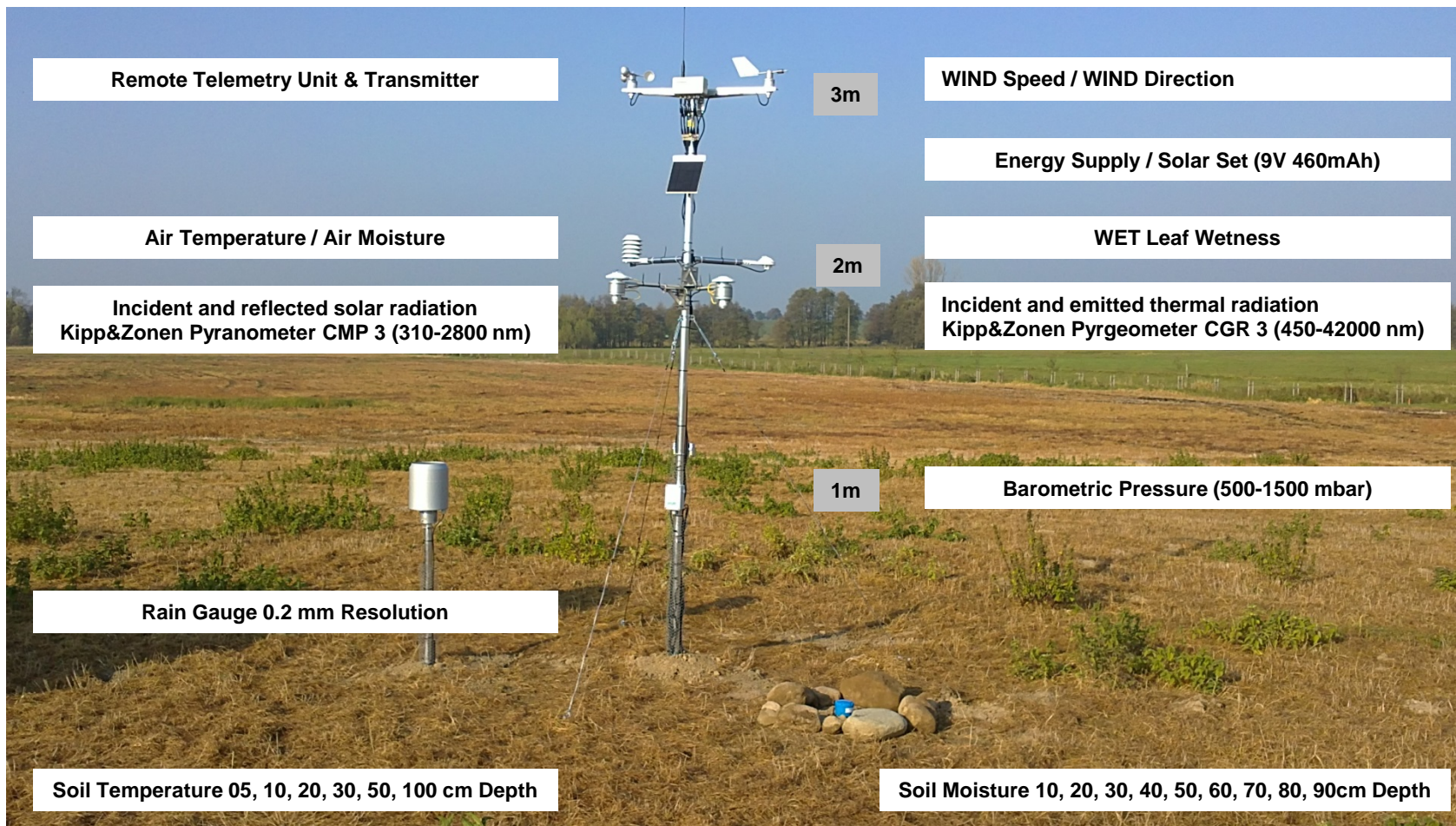
### Legend

- DLR Environmental Measurement Station
- GFZ Environmental Measurement Station
- Telemetry RELAY Station and Telemetry Gateway
- Soil Moisture Measurement Station
- Crane for Hyperspectral Measurement
- Lysimeter Hexagon
- Corner Reflector
- Locality
- Country Road
- Interstate Road
- Freeway





# Environmental Measurement Network - Station



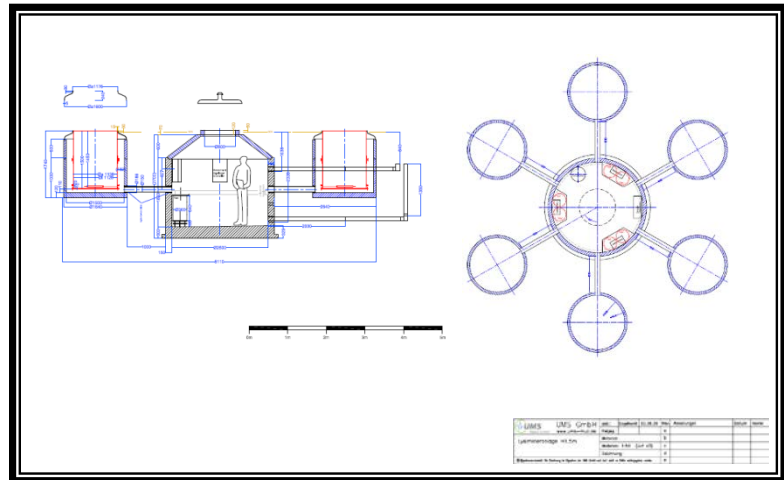
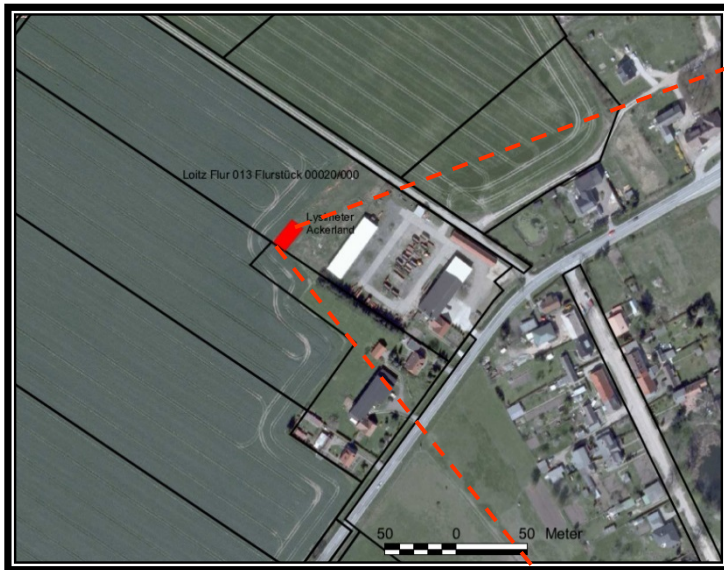


# Automatic Environmental Measurement Network

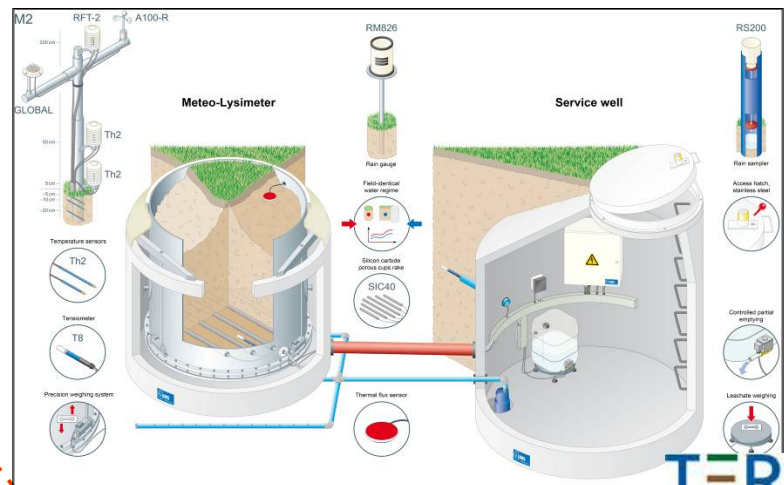
- At present 40 meteorological stations
  - Measurement interval 15 minutes (programmable), slot = 900 sec, 15 samples
  - Data transfer between meteorological station and data server is realized by telemetry transfer
  - Web-based data access on data server
- 
- Higher measurement interval is possible, but energy consuming
  - Free frequency for cost-efficient direct data transfer



# Lysimeter Station: Context TERENO SoilCAN



- Automated lysimeter station Rustow –
- 6 medal cylinder filled with undamaged soil monoliths placed on a balance



Von Unold, G. (2011): [http://www.ums-muc.de/lysimeter\\_systeme/lysimeter/meteo\\_lysimeter.html](http://www.ums-muc.de/lysimeter_systeme/lysimeter/meteo_lysimeter.html) (last access: 18.08.2013)

# Infrastructure of Environmental Network

## DLR – Environmental measuring systems

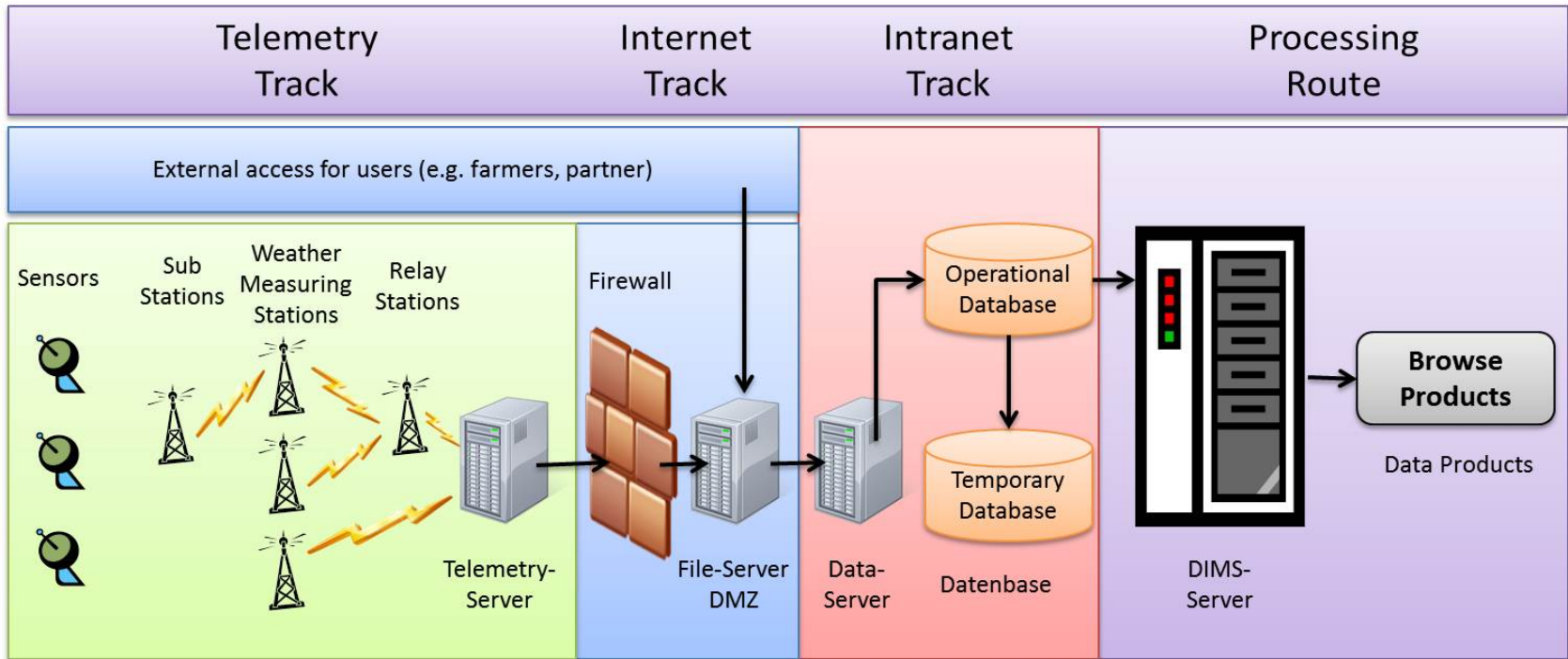
- 1 Basis station + Basis station gateway
- 3 Frequencies
- 20 Climate stations (+ 8 add small stations)
- 1 Test station (Radio control)
- 3 Relay-Stations
- 1 Lysimeter-Hexagon
- 3 Radar reflectors

## GFZ – Environmental measuring systems

- 20 Climate stations
- 1 Relay stations
- > 60 Soil moisture probes
- 1 Radar reflector
- 1 Crane



# Operative Processing Chain for In-situ-Data



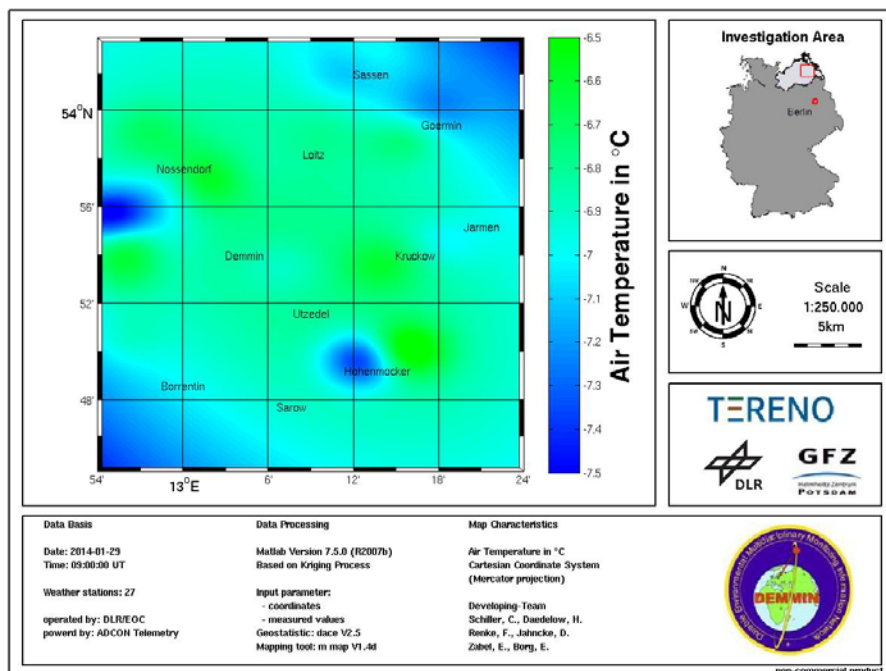
Borg, E., Schiller, C., Daedelow, H., Fichtelmann, B., Jahncke, D., Renke, F., Asche, H. (2014): Automated Derivation of Value Added Information Products on Basis of In-Situ-Data for Validation of Remote Sensing Data.- 12th International Conference on Computational Science and Applications (ICCSA 2013), Portugal.- in progress.







# In-situ-Data Browse Products



- Automated derivation of in-situ-data
- 19 Basic products
- xx Additional products

<http://demminweb.dlr.de>

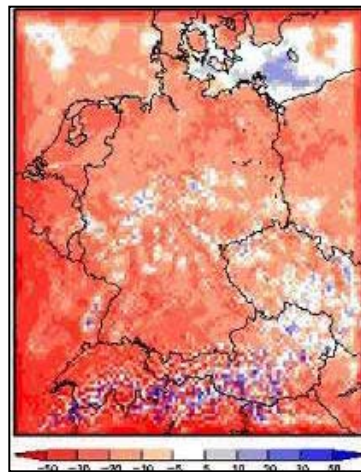
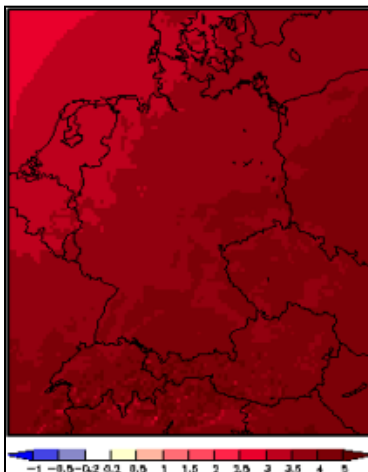


# TERrestrial ENvironmental Observatories (TERENO)

## Climatological Forecast

Climatological models forecast a significant climate change (Period: 100 years)

- increase of annual mean temperature between 2.5 to 3.5 C° ,
- decrease of annual mean precipitation of up to 30 %



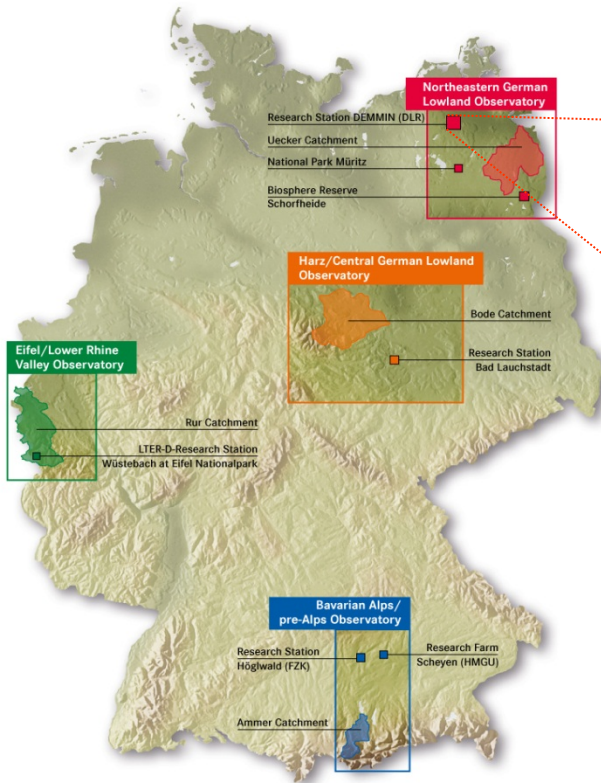
● Regions of high stress

Spatial distribution of climate change on regional scale

Klimageschichte Mitteleuropas - 1200 Jahre Wetter, Klima, Katastrophen (Glaser, 2008)  
Umweltbundesamt: Künftige Klimaänderungen in Deutschland Regionale Projektionen für das 21. Jahrhundert  
Hintergrundpapier April 2006, aktualisiert im September 2006



# TERrestrial ENvironmental Observatories (TERENO)



Durable Environmental Multidisciplinary Monitoring Information Network - DEMMIN ©, DLR

**USGS** [http://calval.cr.usgs.gov/sites\\_catalog\\_template.php?site=demm](http://calval.cr.usgs.gov/sites_catalog_template.php?site=demm)

**TERENO** <http://www.tereno.net>

**ESA** <ftp://uranus.esrin.esa.int/PH/Deliverables/>

**NEREUS** <http://www.nereus-regions.eu/home>



Map:

Bogena, H., Haschberger, P., Hajnsek, I., Dietrich, P., Priesack, E., Munch, J., Papen, H., Schmid, H.-P., Vereecken, H., Zacharias, S. (2008): TERENO – A new Network of Terrestrial Observatories for Environmental Research. In: 2008 Fall Meeting. AGU. AGU 2008 Fall Meeting, 2008-12-15 - 2008-12-19, San Francisco (USA).



# TERrestrial ENVIRONMENTAL Observatories (TERENO)

Initiative of the Helmholtz community,

Objective:

Analysis of long-term regional landuse changes and their socio-economic effects as a result of the global climate change  
**Currently, what does this mean for remote sensing?**

Realization of single campaigns are required to understand data at different scale levels to support environmental modeling

**but we have to switch to more operational monitoring for environmental modeling**

Basis:

Development of an observation platform consisting different terrestrial observatories of different regions with the focus to remote sensing and in-situ measurements

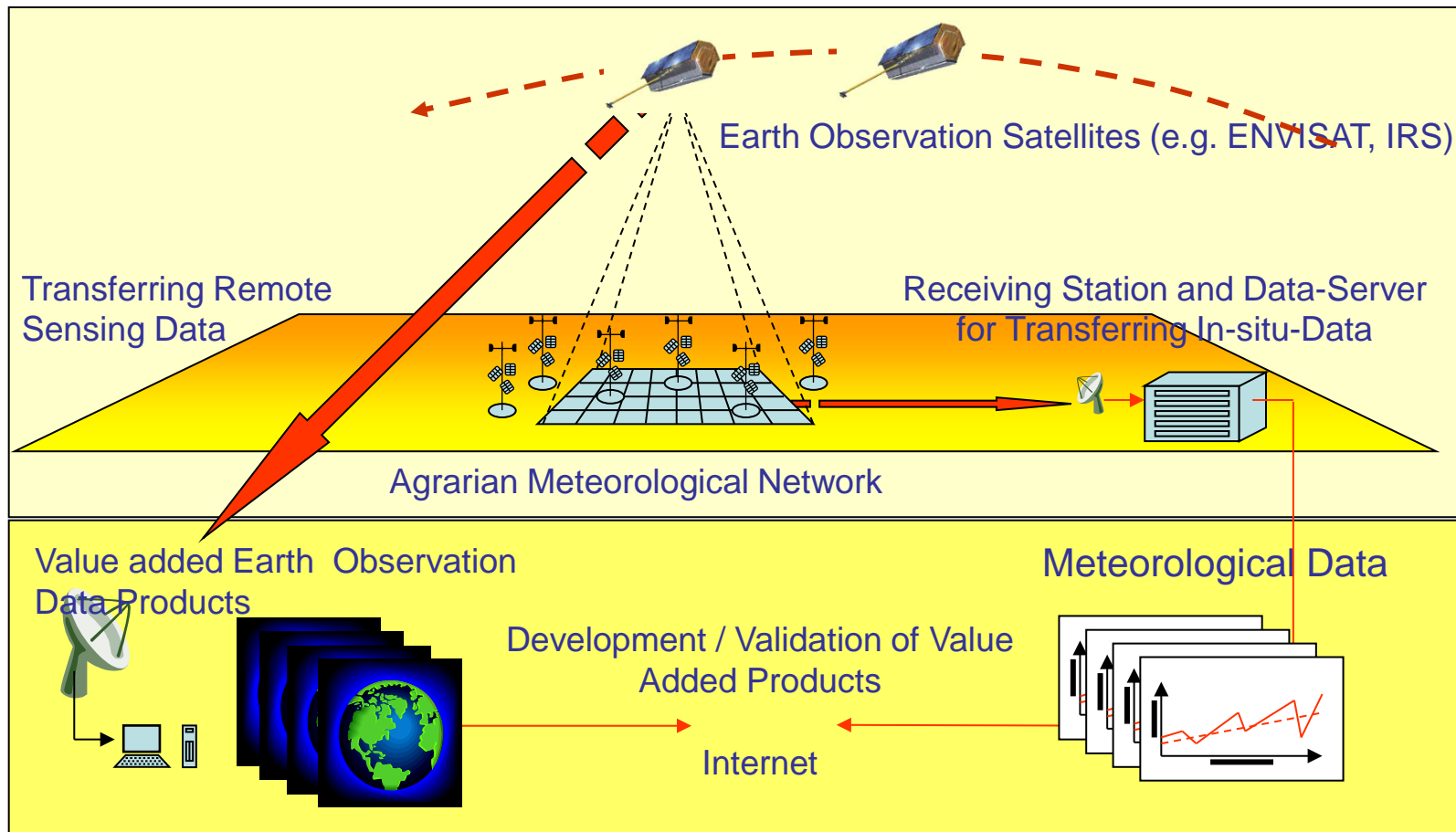
ZACHARIAS, S.; BOGENA, H., SAMANIEGO, L. MAUDER, M., FUß, R., PÜTZ, T., FRENZEL, M., SCHWANK, M., BAESSLER, C., BUTTERBACH-BAHL, K., BENS, O., BORG, E., BRAUER, A., DIETRICH, P., HAJNSEK, I., HELLE, G., KIESE, R., KUNSTMANN, H., KLOTZ, S., MUNCH, J. C., PAPAN, H., PRIESACK, E., SCHMID, H. P., STEINBRECHER, R., ROSENBAUM, U., TEUTSCH, G., VEREECKEN, H. (2011): A Network of Terrestrial Environmental Observatories in Germany.- In: Vadose Zone Journal (Soil Science Society of America).- Vol. 10, S. 955–973.

**TERENO**  
TERRESTRIAL ENVIRONMENTAL OBSERVATORIA





# Measurement Strategy for Remote Sensing



Borg, E. (2010): CAL/VAL Site DEMMIN for Remote Sensing.- In NEREUS – network of European regions using space technology.- Ed.: NEREUS Earth Observation / GMES Working Group.- p. 13-14.



**Thank You for Your Attention!**

Knowledge for Tomorrow

