

# DEMMIN - Test Site for Remote Sensing in Agricultural Application

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

*German Aerospace Center (DLR)*

*German Remote Sensing Data Center (DFD)*

Joint Experiment for Crop Assessment and Monitoring (JECAM)

Agriculture and Agri-Food Canada

Ottawa, Canada, 21-23 July 2014

Knowledge for Tomorrow



# Research Areas of DLR

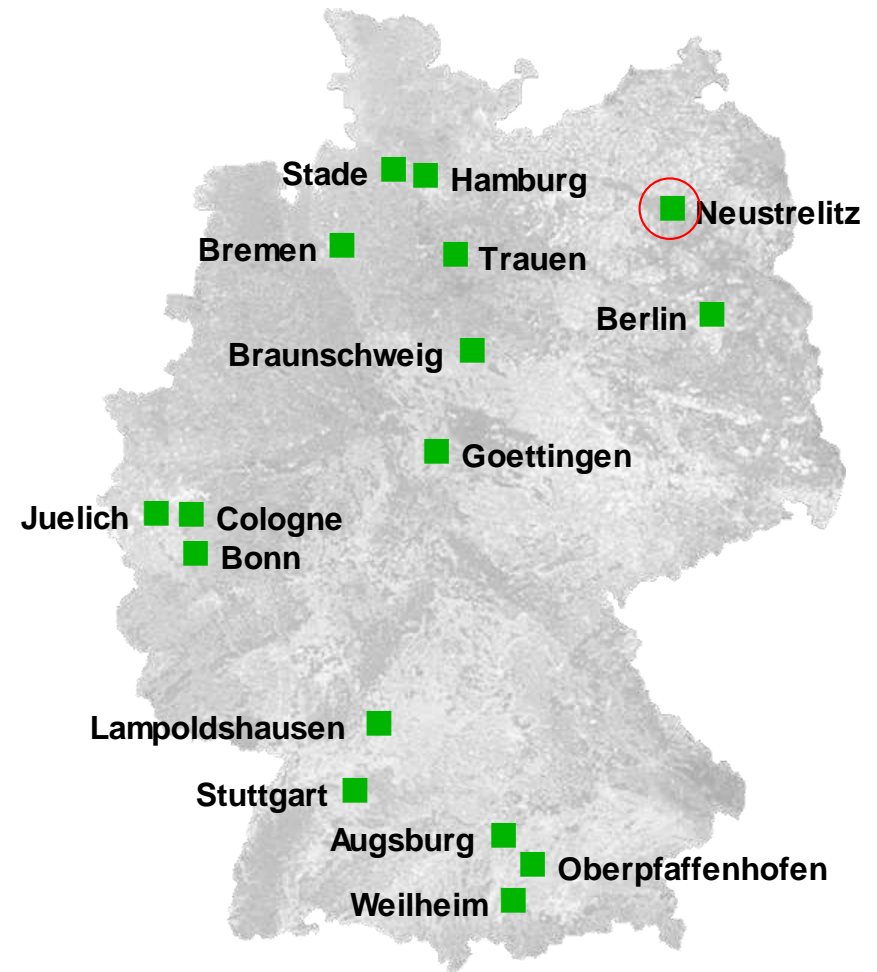
- Aeronautics
- Space Research and Technology
- Transport
- Energy
- Defence and Security (interdisciplinary topic)
  
- Space Administration
- Project Management Agency



# Locations and employees

7700 employees across  
32 institutes and facilities at  
■ 16 sites.

Offices in Brussels, Paris,  
Tokyo and Washington.



# DLR Neustrelitz

- Satellite stations of DLR institutes and facilities:
  - German Remote Sensing Data Center (DFD)
  - DLR Remote Sensing Technology Institute
  - DLR Institute of Communications and Navigation
- DLR Technology Marketing
- DLR\_Campus Neustrelitz
- DLR Location Neustrelitz: 65 – 70 scientists and technicians
- Companies: euomap, HeJoe



# German Remote Sensing Data Center (Prof. Dr. S. Dech)

Department National Ground Segment (H. Maass – holger.maass<@>dlr.de)

The department handles the reception, processing and interim archiving of payload data for e.g. ERS-2, IRS-1C/D, IRS-P3, Landsat-7, CHAMP, GRACE, TerraSAR missions.

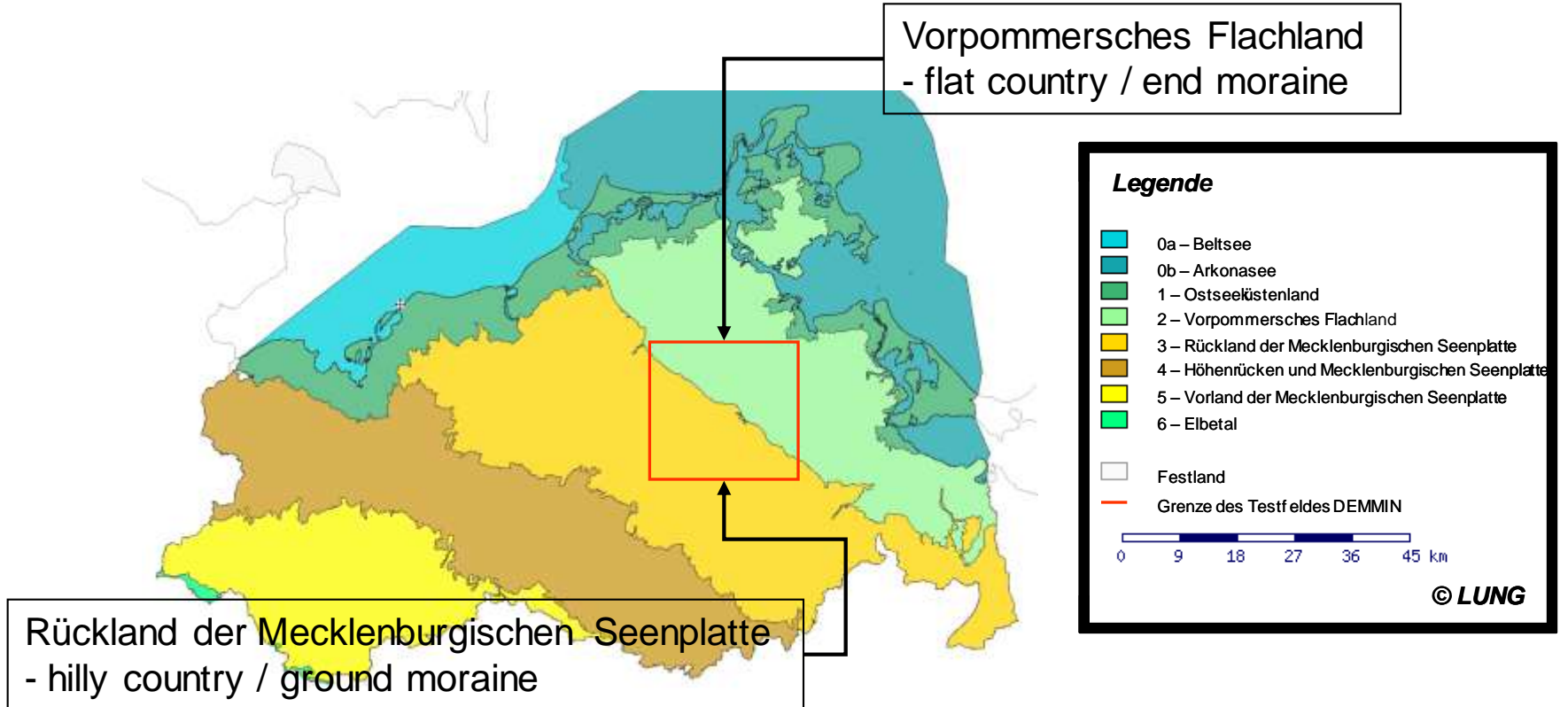
The work is partly carried out as a national undertaking and partly on behalf of ESA, private industry, and in cooperation with international space agencies.

- Permanent receiving station for small remote sensing and science satellites
- Automatic, operational-quality processing and archiving center activities for missions, including NRT (near-real-time) processing and data dissemination
- Development of hardware components and software tools for receiving, processing and archiving satellite data.





# Landscape Zones



Formation of observatory DEMMIN with respect to landscape zones

(<http://www.umweltkarten.mv-regierung.de/script/>)



# Hydrology and Soil Cover



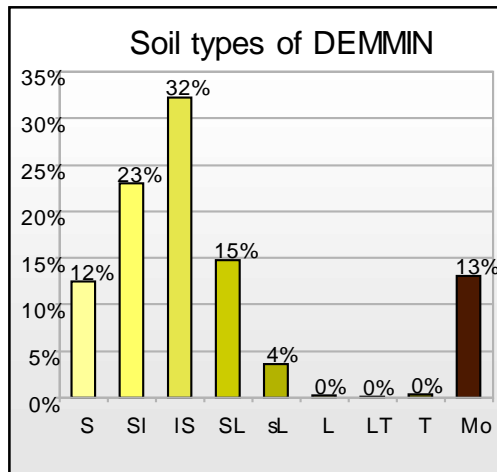
## Hydrological Characterization:

- diffuse, undeveloped water network,
- innumerable lakes and water filled hollows (germ: Sölle)
- Peat bogs along the rivers

Rivers: Trebel, Tollense, Peene

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

Peene: approx. depth 2 - 3 m; approx. slope 0.03%



## Pedological Characterization:

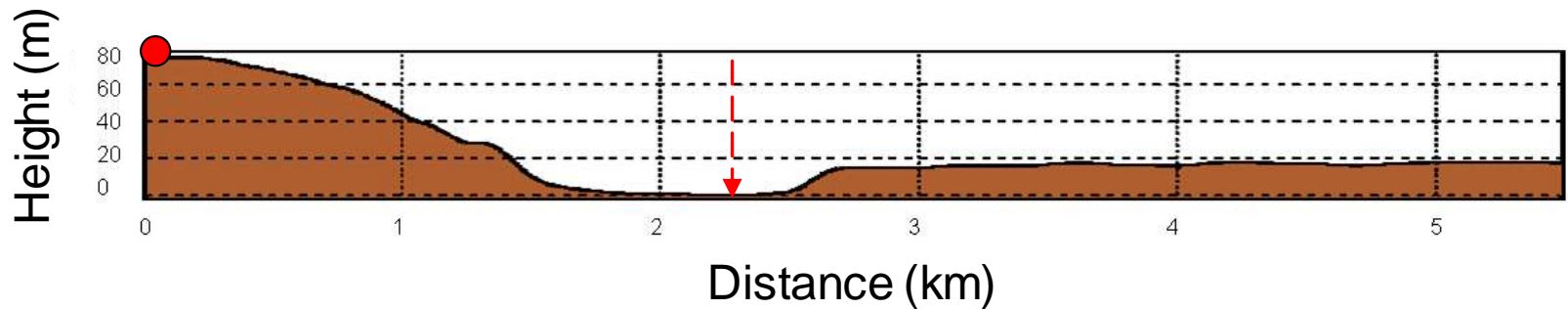
- Sand to sandy-loam soils
- Heterogeneous soil cover



# Relief



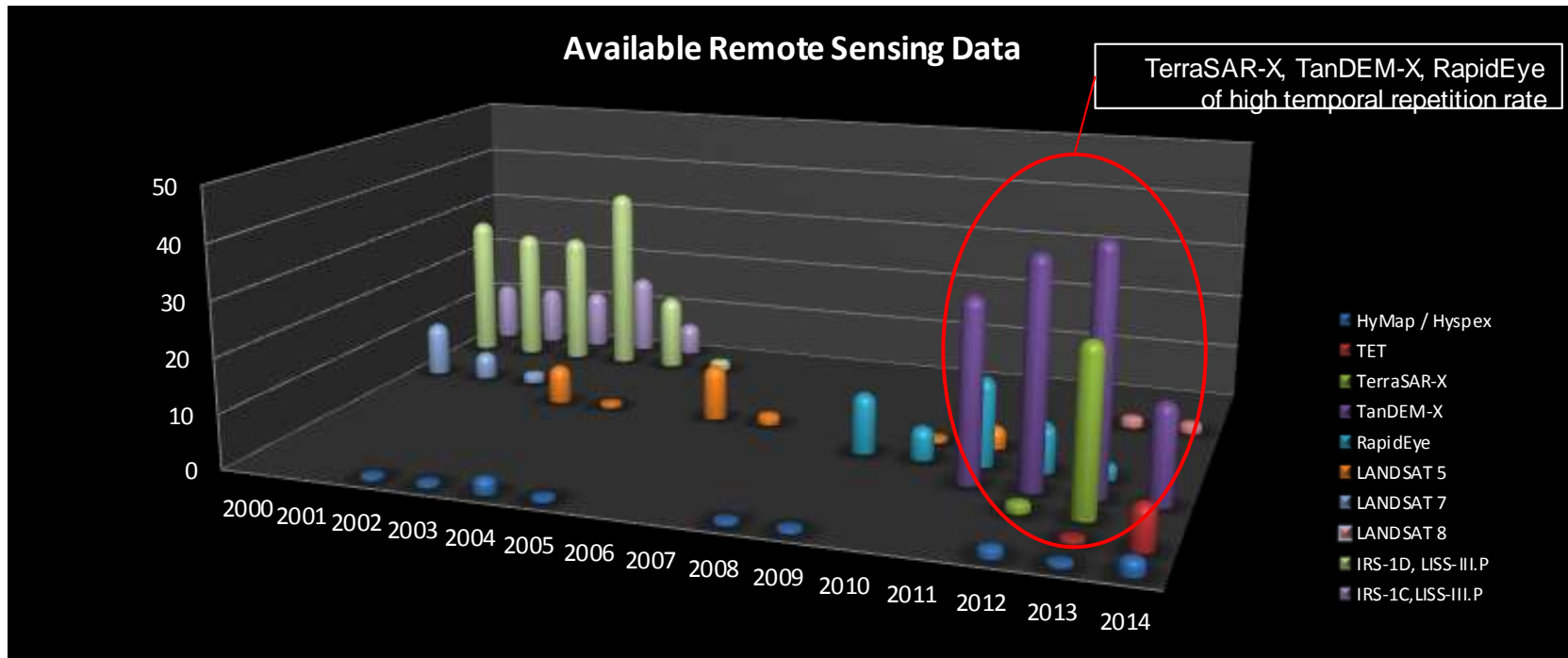
View in the Tollense valley near the village Buchholz



Altitude profile along the view in the Tollense valley. The red pointer assigns the river bed of the Tollense river.



# Available Remote Sensing Data (Exemplarily)



Available data:

- Hyper-spectral data (e.g. HyMap, Hypex)
- Multi-spectral data (e.g. IRS, RapidEye)
- Thermal data (e.g. LANDSAT, TET)
- RADAR data (e.g. TerraSAR-X, Tandem-X)



# Available Environmental and Agricultural Data



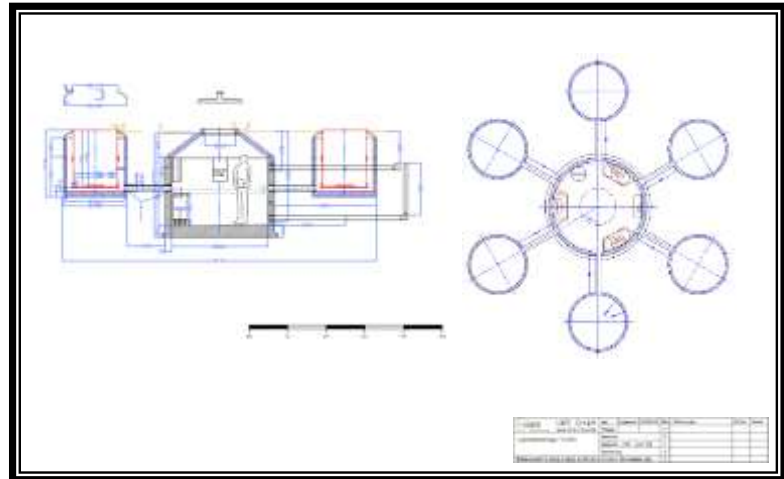
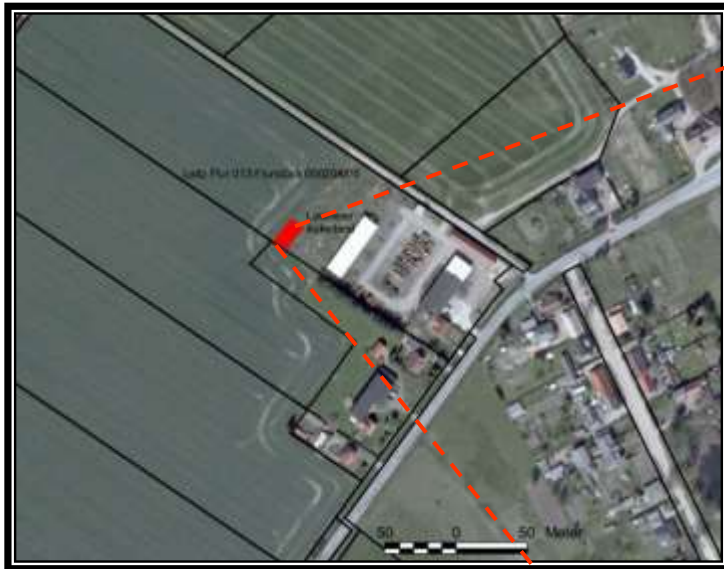
Data Set	Period of Time
Yield Maps	2000 – 2008
Crop Maps	2000 – 2013
Measurement Data	2004 - 2014

Available agronomic process data (e.g. yield and crop maps) and in-situ-data of automated environmental measurement network (e.g. agro-meteorological data)

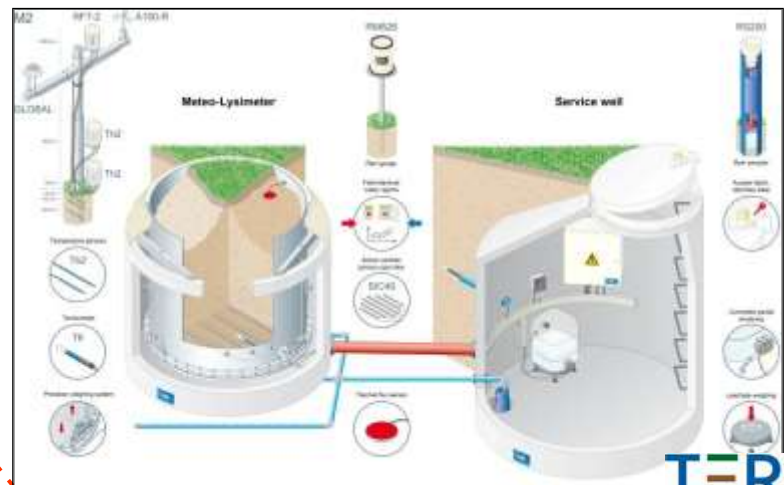
Mean Size of fields is 80 ha and in maximum 300 ha.



# Lysimeter Station: Context TERENO SoilCAN



- Automated lysimeter station Rustow –
- 6 metal 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)



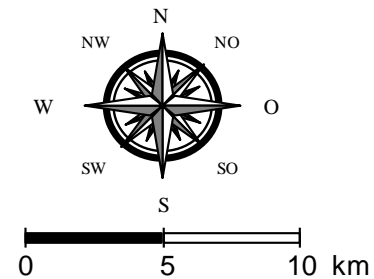
# Environmental Measurement Network



## Environmental Measurement Station

 German Aerospace Center

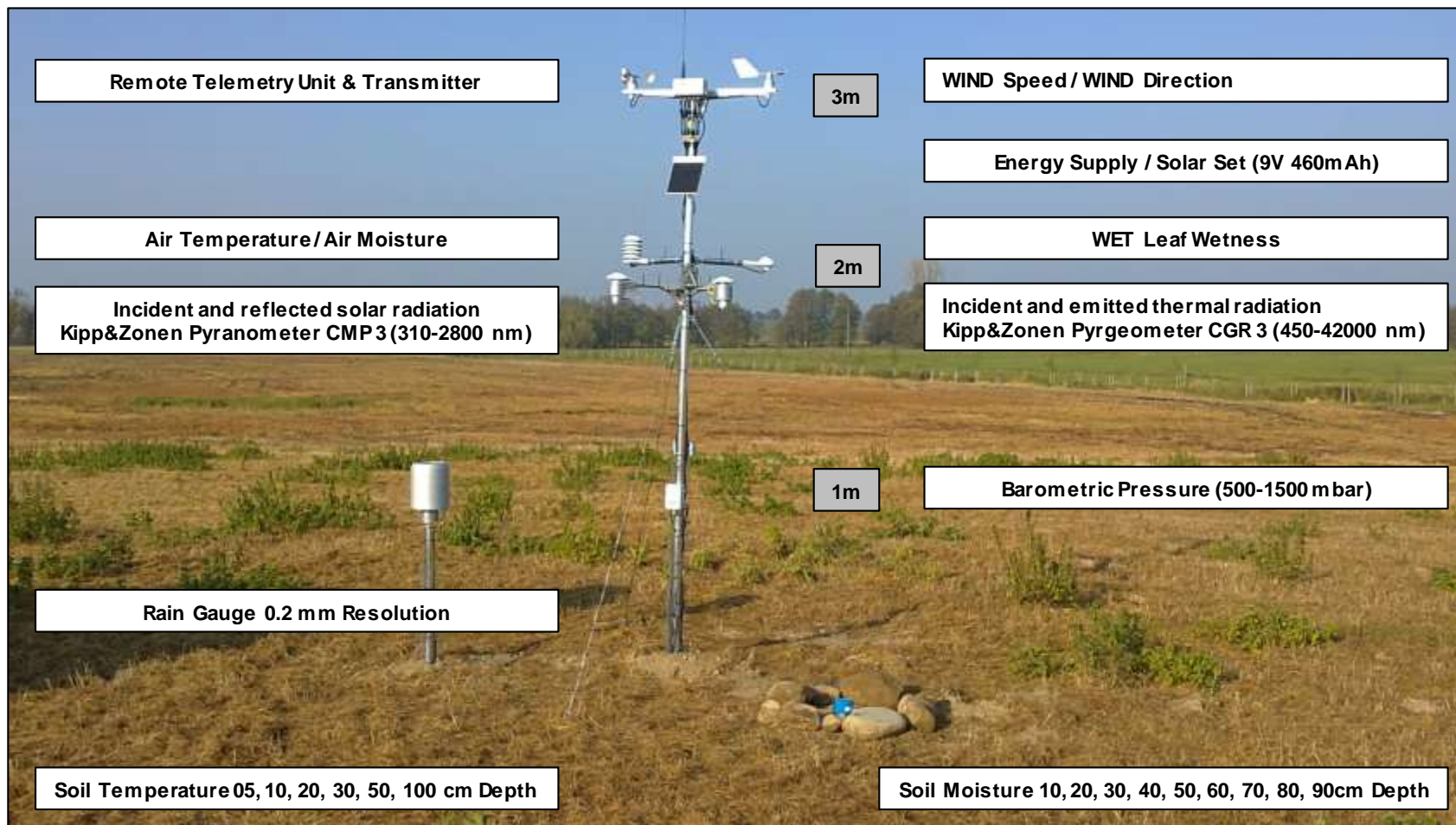
 Geo-Research Center, Potsdam



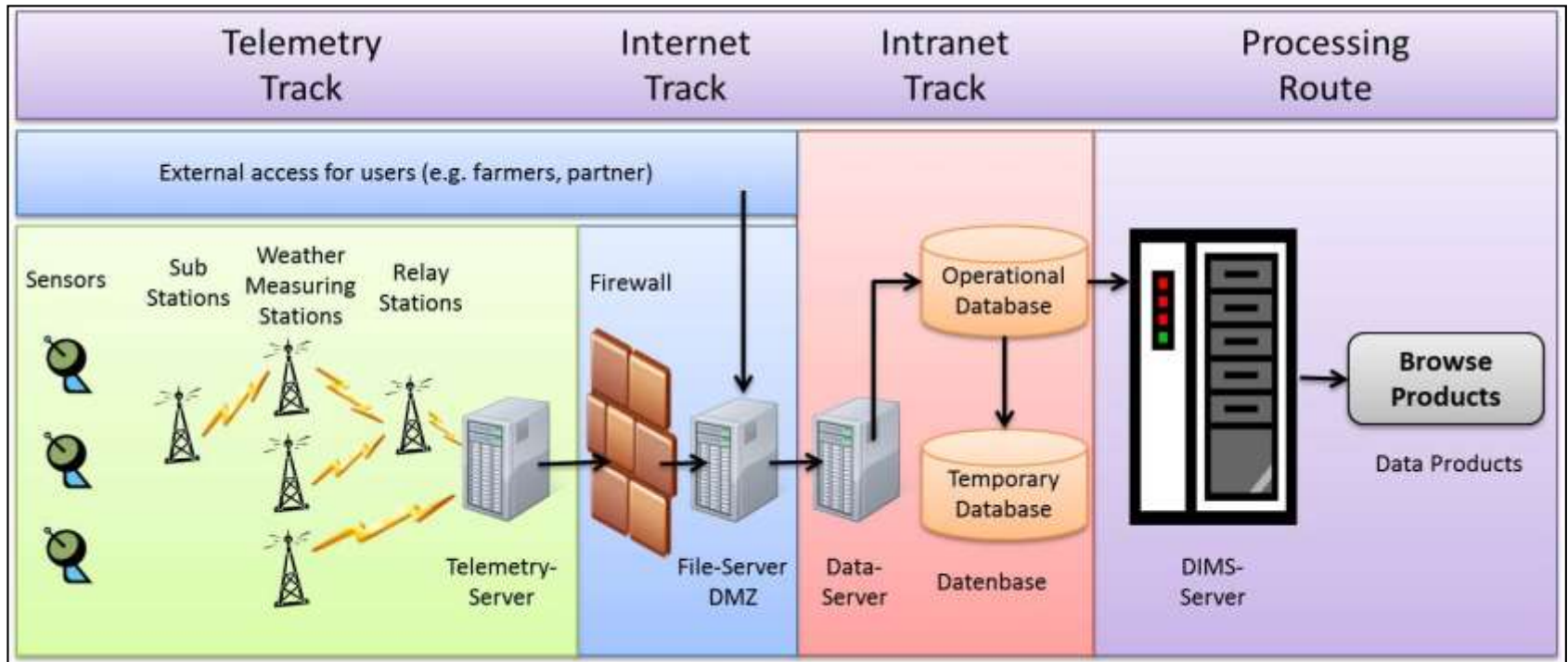
- 40 environmental stations,
- Measurement interval 15 minutes-slot = 900 sec, 15 samples,
- Data transfer via telemetry transfer,
- Web-data access on data server
- plus approx. 70 soil moisture probes



# Environmental Measurement Network - Station



# Operative Processing Chain for In-situ-Data

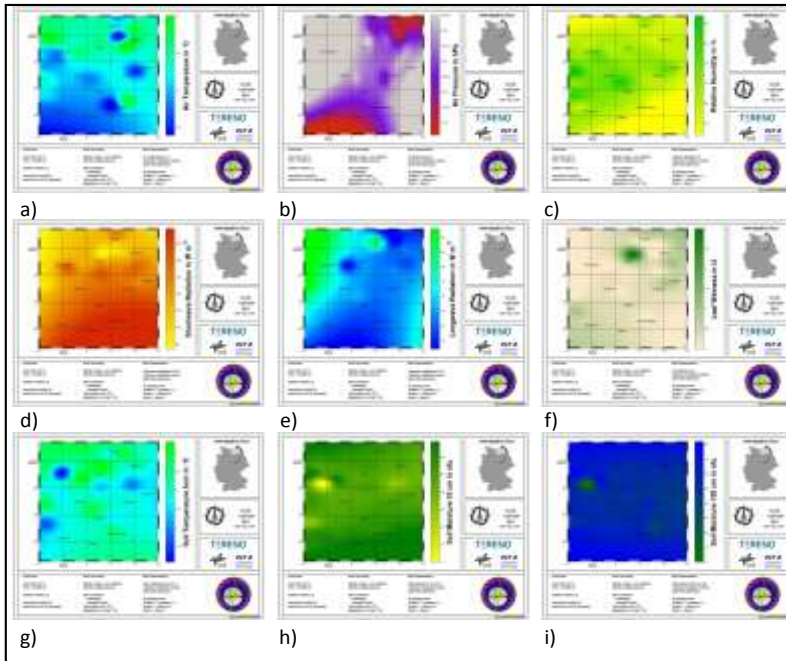


Borg, E., Schiller, C., Daedelow, H., Fichtelmann, B., Jahncke, D., Renke, F., Asche, H. (2014): Automated Derivation of Value Added Information Products on Basis of In-Situ-Data for Validation of Remote Sensing Data. - 12th International Conference on Computational Science and Applications (ICCSA 2013),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





# In-situ-Data Browse Products

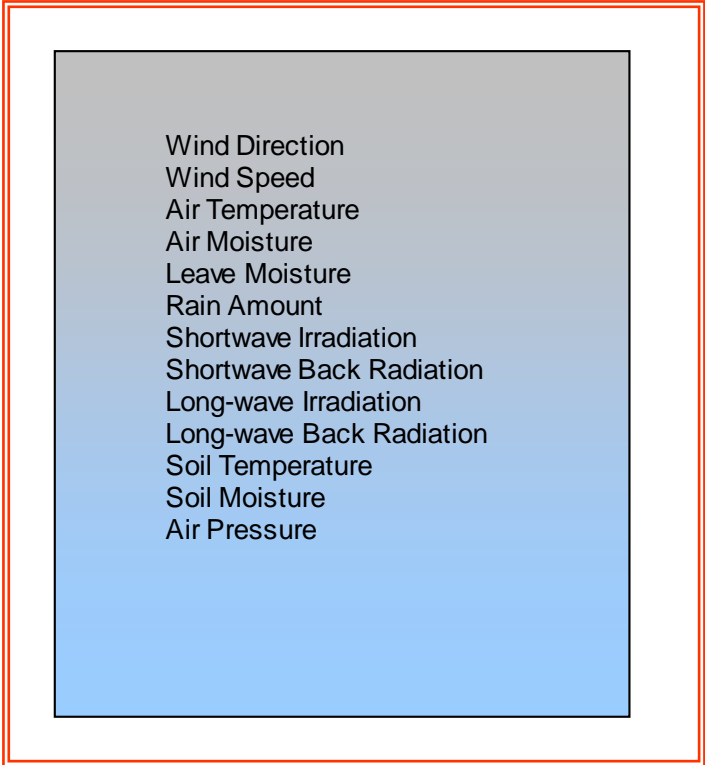
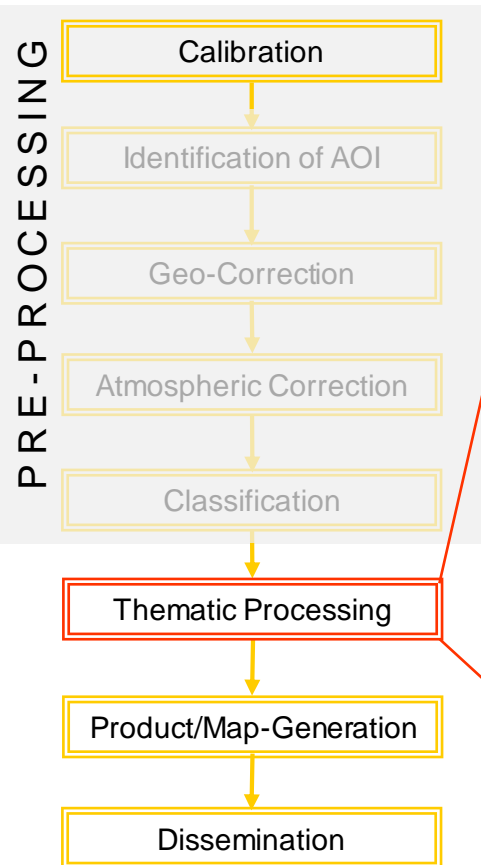


Sample products showing parameter distribution of a) air temperature, b) air pressure, c) relative humidity, d) shortwave, e) longwave radiation, f) leaf wetness, g) soil temperature – 5 cm, h) soil moisture – 10 cm, i) soil moisture – 100 cm (<http://demminweb.dlr.de>)





# In-situ-Data Processor: Evapotranspiration



## Legend

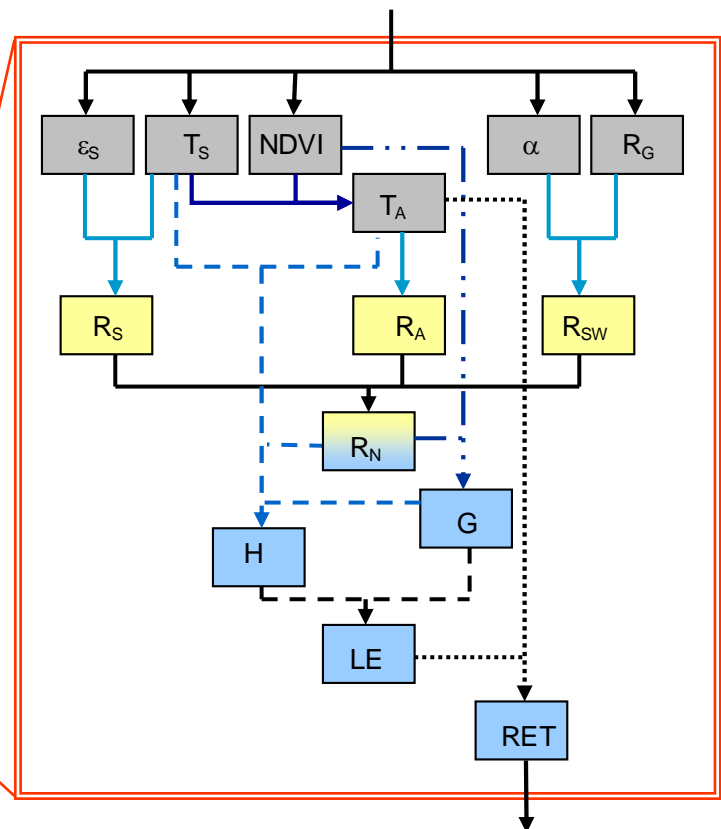
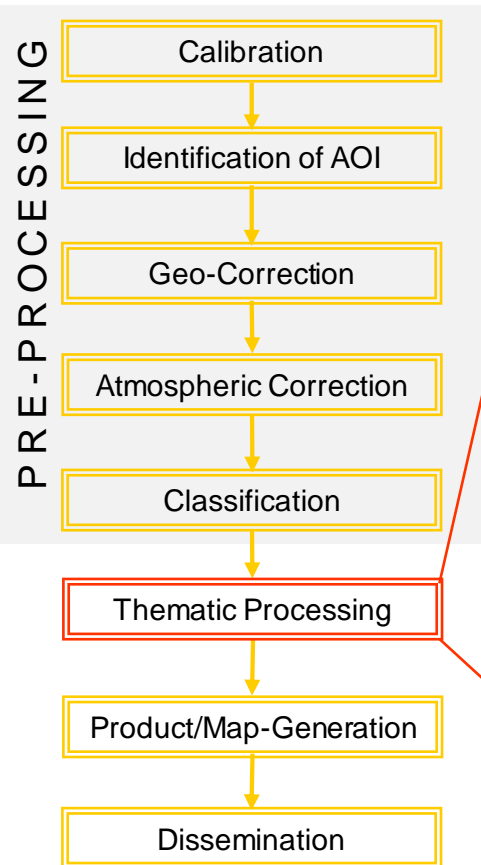
- $L^*$  Heat of vaporization
- $s$  slope of the saturation vapor pressure curve
- $R_n$  Net radiation
- $G$  Ground heat flux
- $\rho$  Density of air
- $c_p$  Specific heat of air
- $r_a$  Aerodynamic Resistance
- $e_s(T) - e$  Saturation deficit,  $f = (T, e)$
- $\gamma$  Psychrometer constant
- $r_s$  Stomata resistance
- $T$  Air temperature
- $e$  Vapour pressure

$$ETa = \frac{1}{L} \cdot \frac{s \cdot (R_n - G) + \frac{\rho \cdot c_p}{r_a} \cdot (e_s(T) - e)}{s + \gamma \cdot \left(1 + \frac{r_s}{r_a}\right)}$$





# Remote Sensing: Evapotranspiration



## Legend

- $\epsilon_S$  surface emissivity
  - $\alpha$  albedo
  - $T_S$  surface temperature
  - $T_A$  air temperature
  - $R_G$  incident (or global) solar radiation
  - $R_S$  emitted surface radiation
  - $R_A$  atmospheric longwave radiation
  - $R_N$  net radiation
  - $R_{SW}$  shortwave net radiation
  - $H$  sensible heat flux
  - $G$  ground heat flux
  - $LE$  latent heat flux
  - $RET$  actual evapotranspiration
  - $NDVI$  normalized difference vegetation index
- Basic Parameters
  - Radiation Components
  - Components of Energy Balance

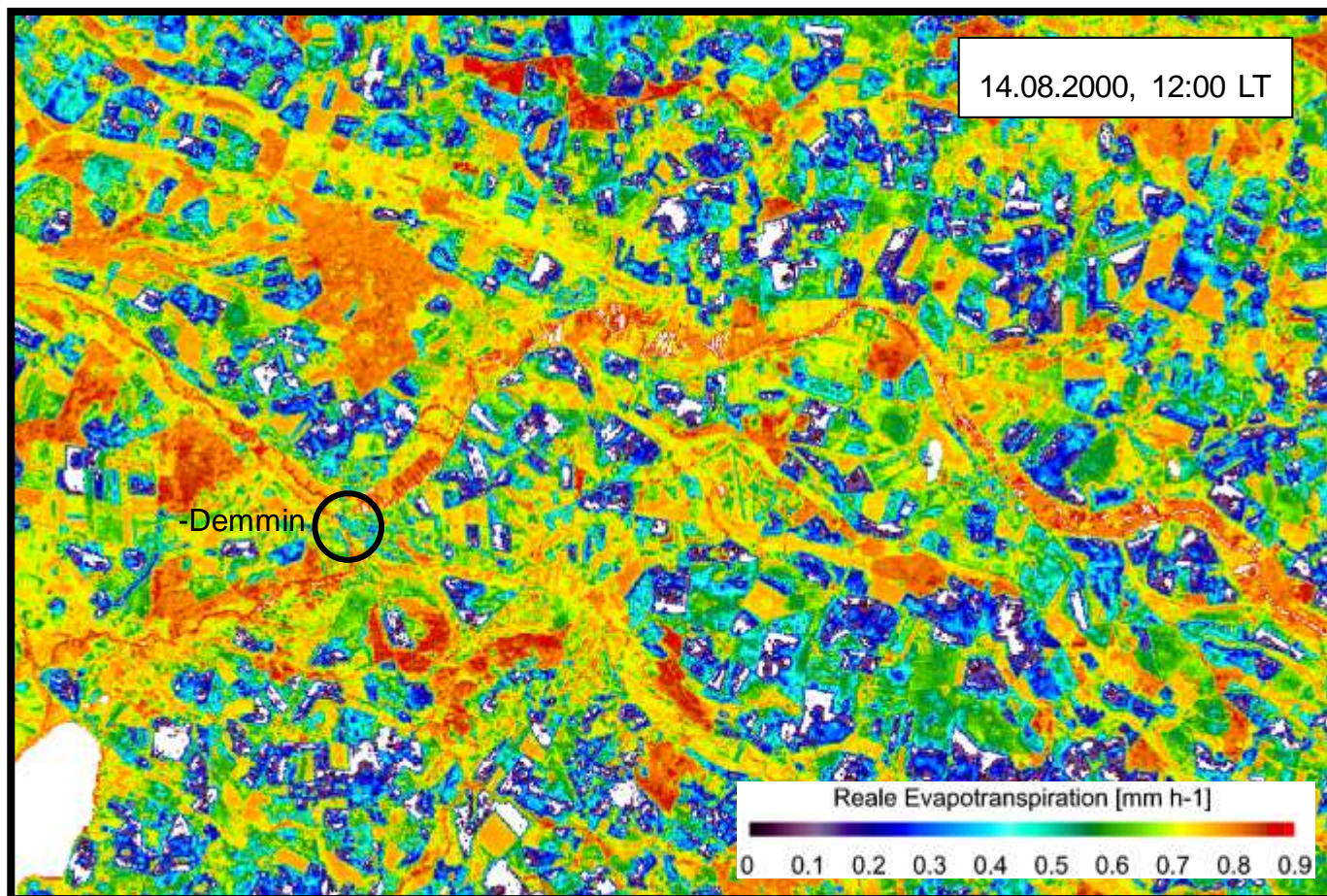
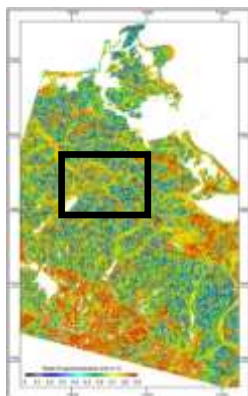
Richter, R. (2003): Value Adding Products derived from the ATCOR Models (Version 5.5, January 2003).- p. 28.  
[http://www.rese.ch/pdf/atcor\\_value\\_adding.pdf](http://www.rese.ch/pdf/atcor_value_adding.pdf)

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





# Remote Sensing: Evapotranspiration DEMMIN



Estimated hourly evapotranspiration, based on one instantaneous value

Cloudless sky

Water surfaces masked (Baltic Sea, lakes)

© C. Wloczyk 2008





# Results of the Experimental RealET-Processor

## Accuracy:

- surface temperature approx. +/-2 K,
- air temperature approx. +/-3 K,
- solar radiation approx. +/-20 W m<sup>-2</sup>
- actual evapotranspiration approx. +/-50%

The approach has been assessed as robust.

WLOCZYK, C., RICHTER, R., BORG, E., NEUBERT, W. (2006): Sea and lake surface temperature retrieval from Landsat thermal data in Northern Germany. *International Journal of Remote Sensing*, **27**(12), 2489–2502.

WLOCZYK, C., RICHTER, R. (2006): Estimation of incident solar radiation on the ground from multispectral satellite sensor imagery. *International Journal of Remote Sensing*, **27**(6), 1253-1259.

WLOCZYK, C., BORG, E., RICHTER, R., MIEGEL, K. (2011): Estimation of instantaneous air temperature above vegetation and soil surfaces from Landsat 7 ETM+ data in northern Germany. *International Journal of Remote Sensing*, **32**(24), 9119-9136.





# Lessons learned from the experiment

Complex processor → a number of intermediate products can be derived

Meteorological station network of German Meteorological Service (DWD):

- intended use: weather forecast, securing (air) traffic...
- validation of remotely sensed parameters:
  - no intended use!
  - station density and distribution partly inappropriate
  - some parameters needed for evapotranspiration estimation are not measured (e.g. radiation parameters)
    - dedicated meteorological / hydrological measurements are needed for validation of remotely sensed evapotranspiration
    - DEMMIN



# Cooperation

TERENO-Initiative (TERrestrial ENvironmental Observatories):

- surface temperature approx. +/-2 K,
- air temperature approx. +/-3 K,
- solar radiation approx. +/-20 W m<sup>-2</sup>
- actual evapotranspiration approx. +/-50%



**TERENO**  
TERRESTRIAL ENVIRONMENTAL OBSERVATORIA



# Performed and Planned Campaigns (Selection)

## AGRISAR 2006:

- Objective: assessment of Sentinel missions-1 /-2 and improving of interpretation methods for radar and optical data, generation of in-situ and airborne data (weekly), simulation of prospective sentinel data and information products
- Partner: >15 research centers (e.g. University Canfield, University Valencia, Universität Alicante, National Institute for Aerospace Technology, International Institute for Geo-Information Science and Earth Observation, Denmark, Technical University of Denmark, University Gent, German Aerospace Center, ITRES Research.

## TERENO (SoilCAN - The German Lysimeter Network )

- Objective: Measurement and documentation of climate-relevant parameters , climate research and climate impact consulting for regional development of climate-sensitive regions
- Partner: 6 research centers (e.g. Research Center Jülich – FZJ, Helmholtz Centre for Environmental Research – UFZ, Karlsruhe Institute of Technology – KIT, German Research Centre for Geosciences – GFZ, German Aerospace Center - DLR) and partners.

## TechnologieErprobungsTraeger (TET) 2013:

- Objective: Validation of the fire detection system onboard the TET Mission



# Performed and Planned Campaigns (Selection)

PHENOS (funded by Federal Ministry of Economics and Energy (BMWi), DLR Project Management Agency ):

- Objective: development and validation of algorithms / models for the operational detection of optimal phenological time slots for an cost optimized land use classification for Sentinel 2 data.

Tech4Times (funded by Federal Ministry of Economics and Energy (BMWi), DLR Project Management Agency ):

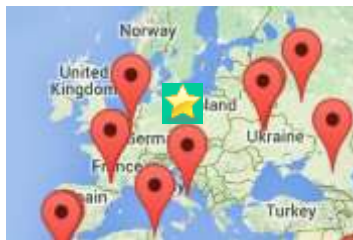
- Objective: Validation of remote sensed crop parameters for precise yield estimation





# Strategic Planning

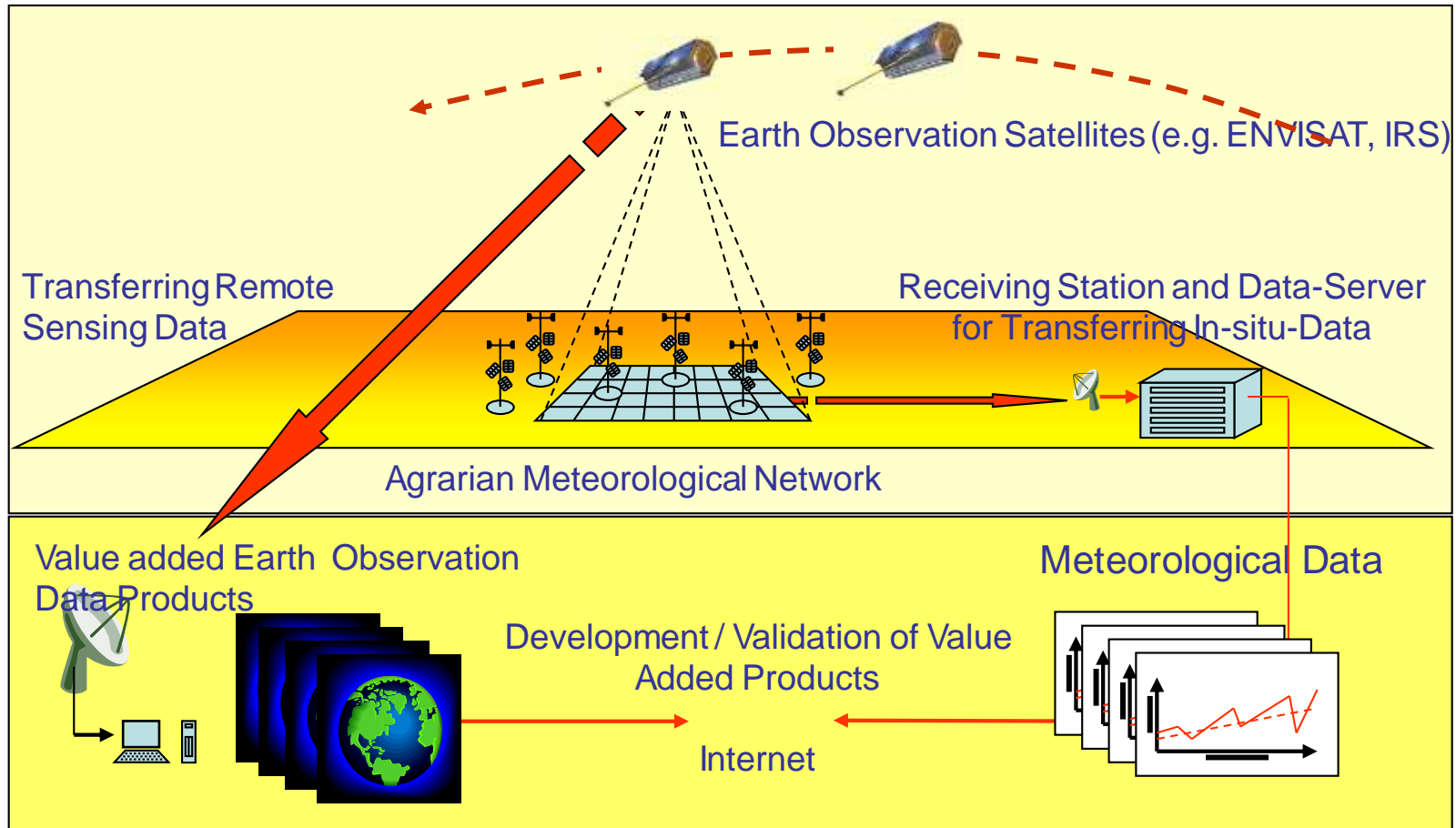
- The DLR wants to develop the test site DEMMIN into a technical and technological blueprint for the calibration and validation of remote sensing data, missions, applications, and value added information products.
- The test site DEMMIN measures numerous in-situ data and environmental parameters that affect the remote sensing process.
- The measurements are operationally carried out by semi- and automated cost- and labour-effective measurement infrastructure and measurement strategies.
- DEMMIN is developed to an in-situ-component of the COPERNICUS initiative.



★ DEMMIN can fill a gap in Central Europe



# 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.



# Contact

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