5. Water Research Horizon Conference – Towards Real-time Data Collection and Visualization for Water Management

Remote sensing calibration and validation test site DEMMIN useable for hydrological applications

Germany, Berlin, 17-18 June 2014

German Remote Sensing Data Center (DFD)

Borg, E.[1], Pacher, B.[2], Wloczyk, C.[1], Schiller, C.[3], Kuenlenz, S.[4], Renke, F.[1], Jahncke, D.[1]

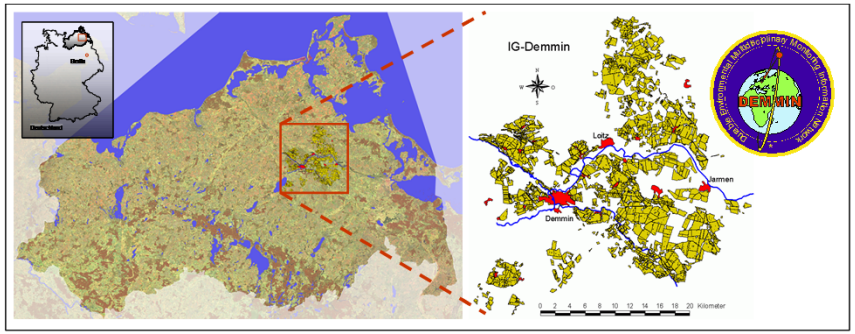
Durable Environmental Multidisciplinary Monitoring Information Network (DEMMIN)

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



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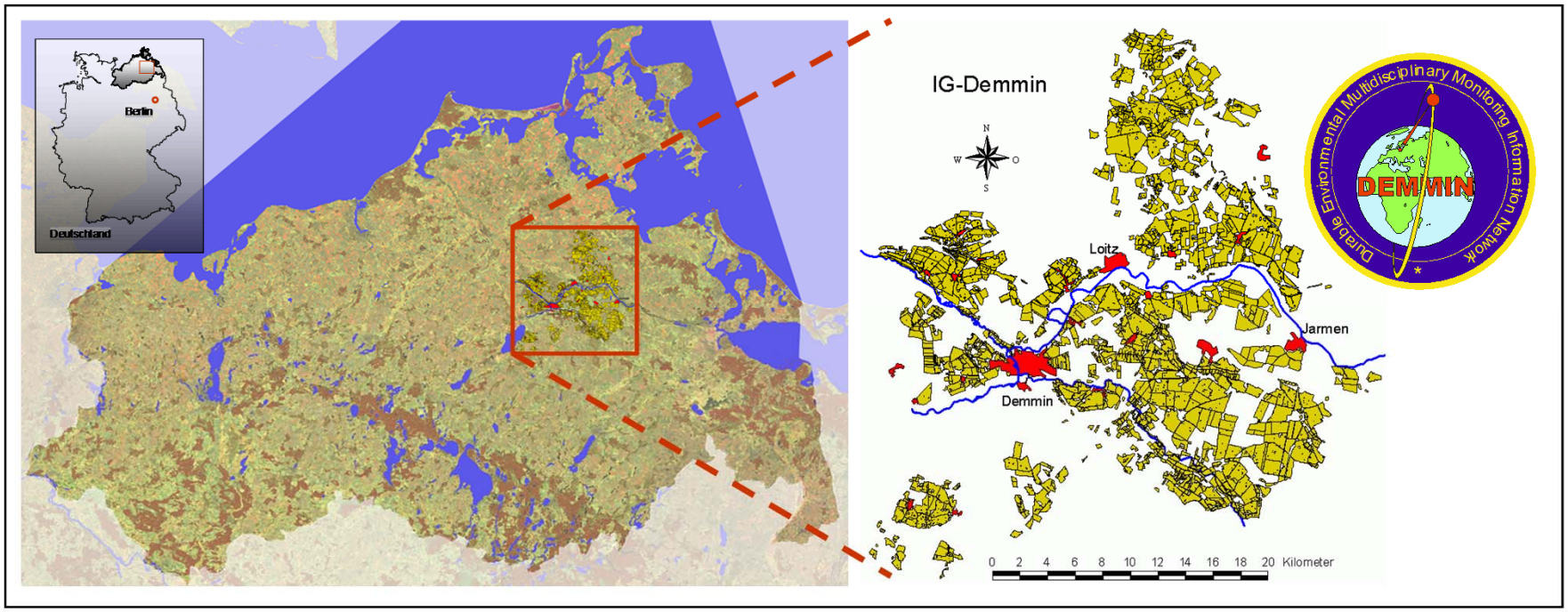
What is DEMMIN ?



Cooperation with Farmers managing approx. 30,000 ha

Test-site region has a dimention of 50 to 50 km²

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.

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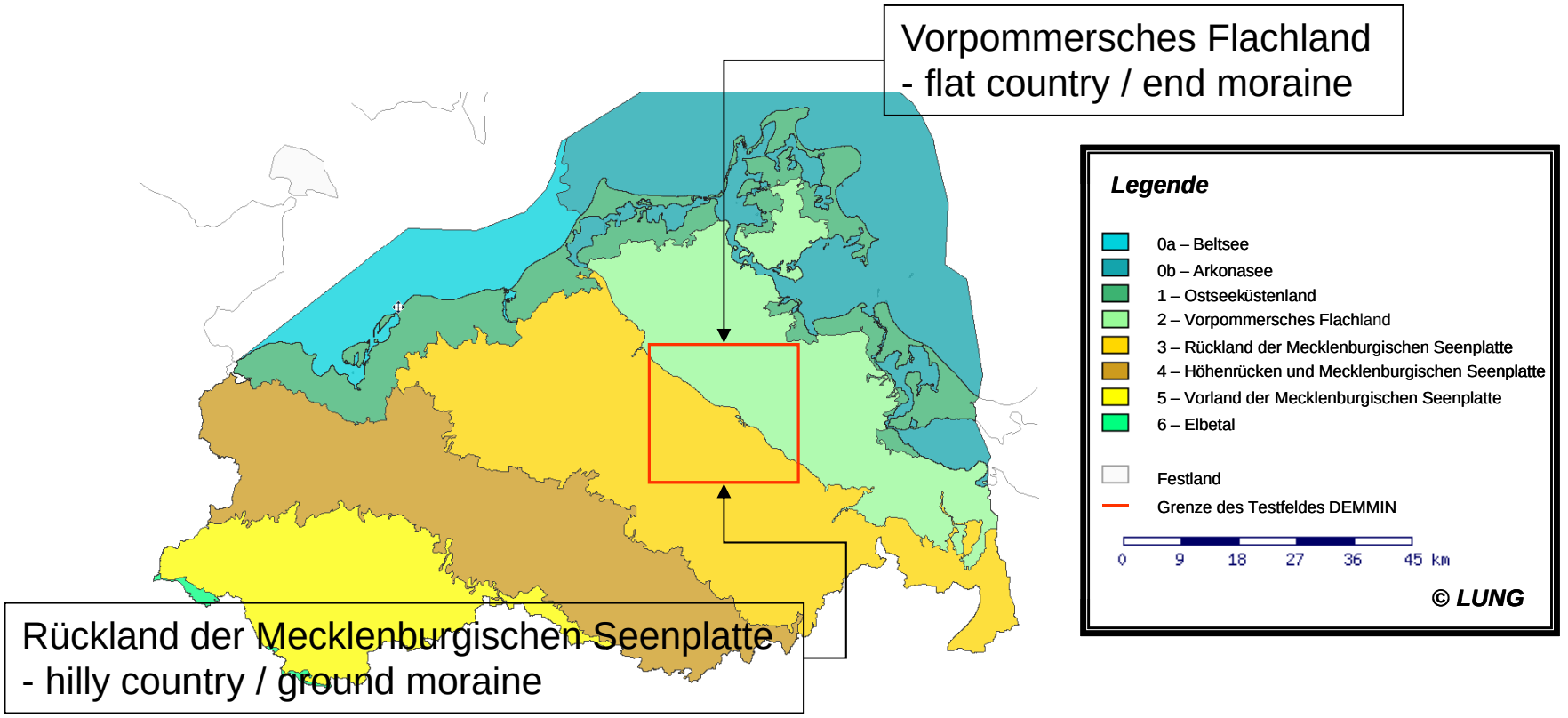
Landscape Zones



Formation of observatory DEMMIN with respect to landscape zones

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

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Hydrology

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

Rivers: Trebel, Tollense, Peene
Lakes: Kummerower lake - 0.2 m over NN
Malchiner lake - 0.6 m over NN

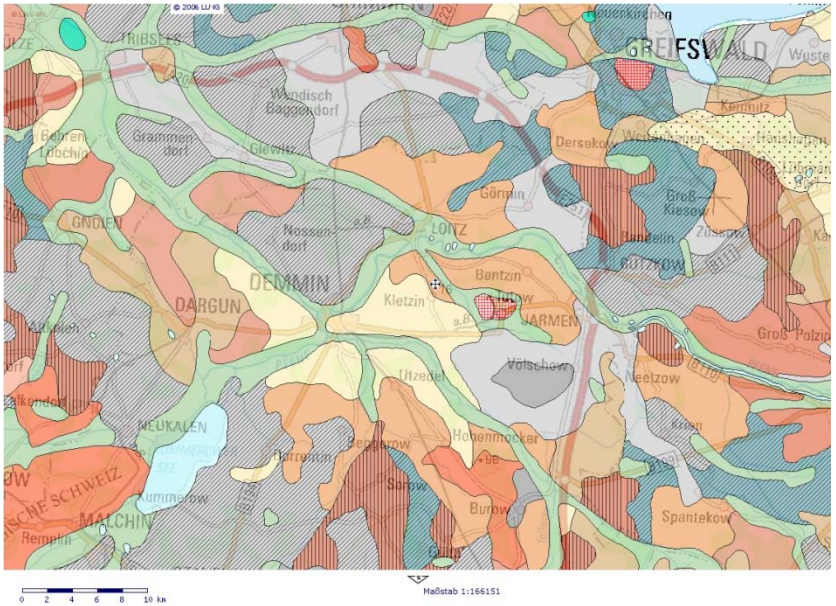
Peene: approx. river depth 2 - 3 m;
approx. river slope (Malchin to Peene mouth 0.03%)

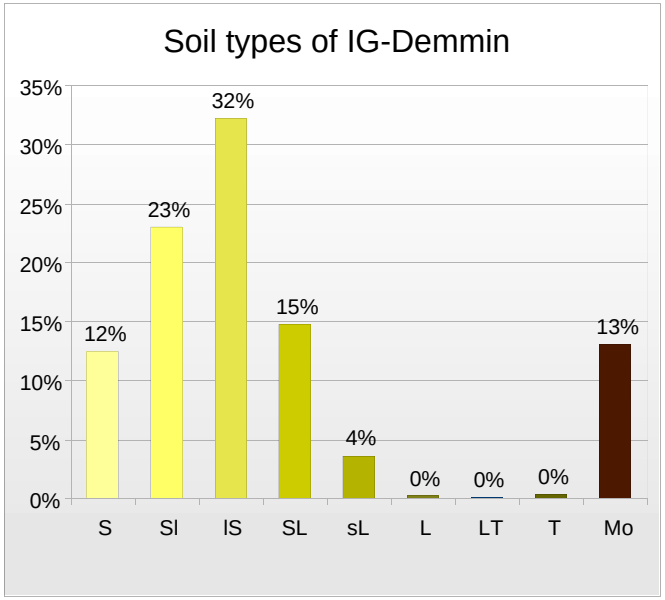
Peene in the region of old peat-ditches. Especially notable are the natural meanders.

Natural peat bogs formed by through flow along Peene

Borg et al. (2009)

Soil Cover





Heterogeneity of soil cover within the test site DEMMIN. Sandy and loamy soils are dominant.
(http://www.umweltkarten.mv-regierung.de/script/)

Proportional quotas of the soil type in IG DEMMIN.

Borg et al. (2009)

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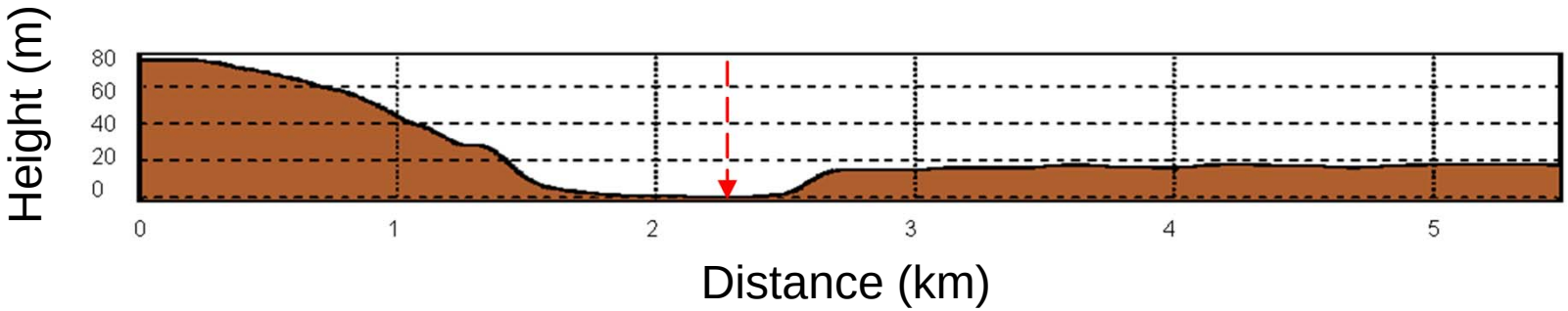
Relief

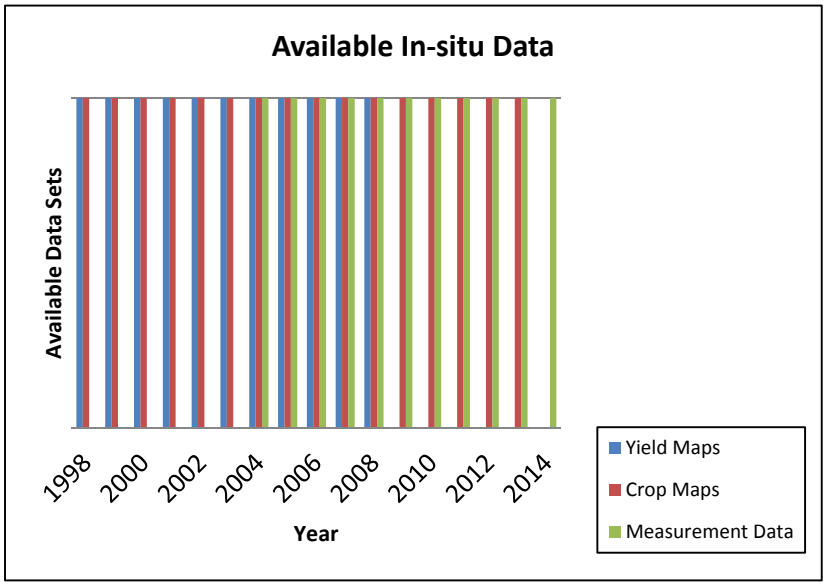
View in the Tollense valley near the village Buchholz

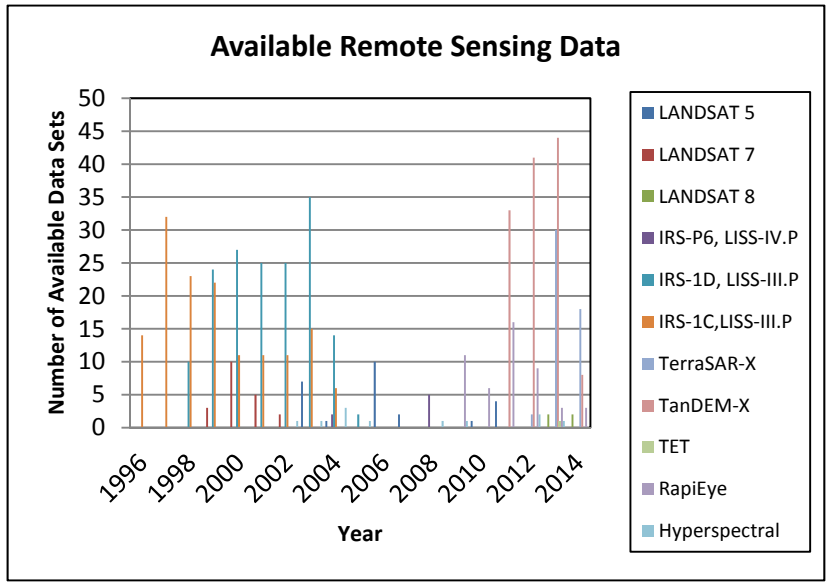


Altitude profile along the view in the Tollense valley. The red pointer assigns the river bed of the Tollense river.

Borg et al. (2009)

Available Remote Sensing and Environmental In-situ-Data of DEMMIN





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

Available multi-, hyperspectral (e.g. LANDSAT, IRS, RapidEye) and RADAR data (e.g. TerraSAR-X, Tandem-X)

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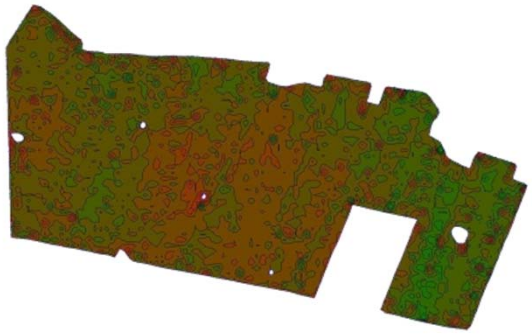
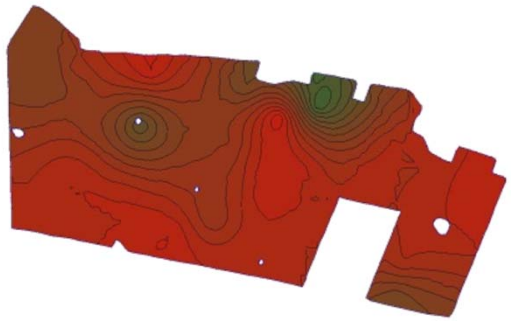
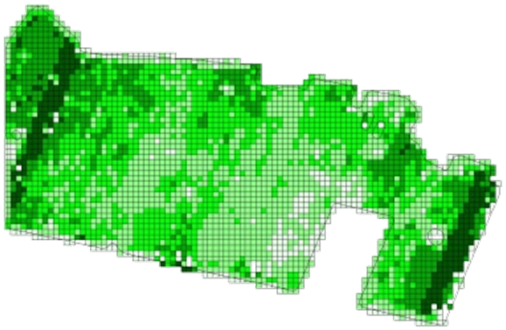
Environmental and Agricultural Data



Yield mapping



Soil investigations

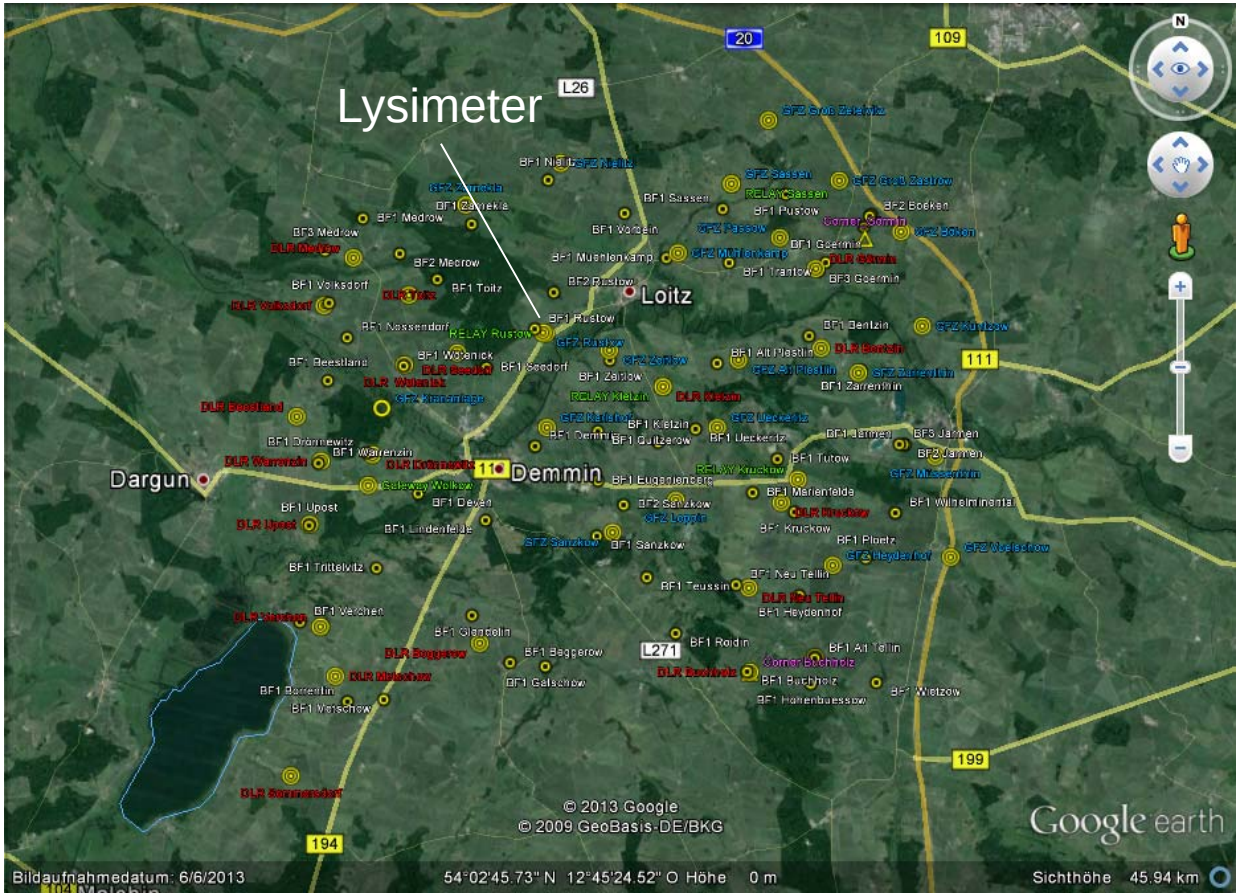


N-Sensor / Biomass

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

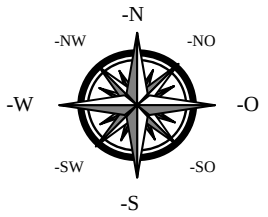
Borg, E., Lippert, K., Zabel, E., Löpmeier, F.J., Fichtelmann, B., Jahncke, D., Maass, H. (2009): DEMMIN – Teststandort zur Kalibrierung und Validierung von Fernerkundungsmissionen.- In: 15 Jahre Studiengang Vermessungswesen – Geodätisches Fachforum und Festakt, Neubrandenburg, Eigenverlag (Hrsg.: Rebenstorf,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

Environmental Measurement Network - Deviation

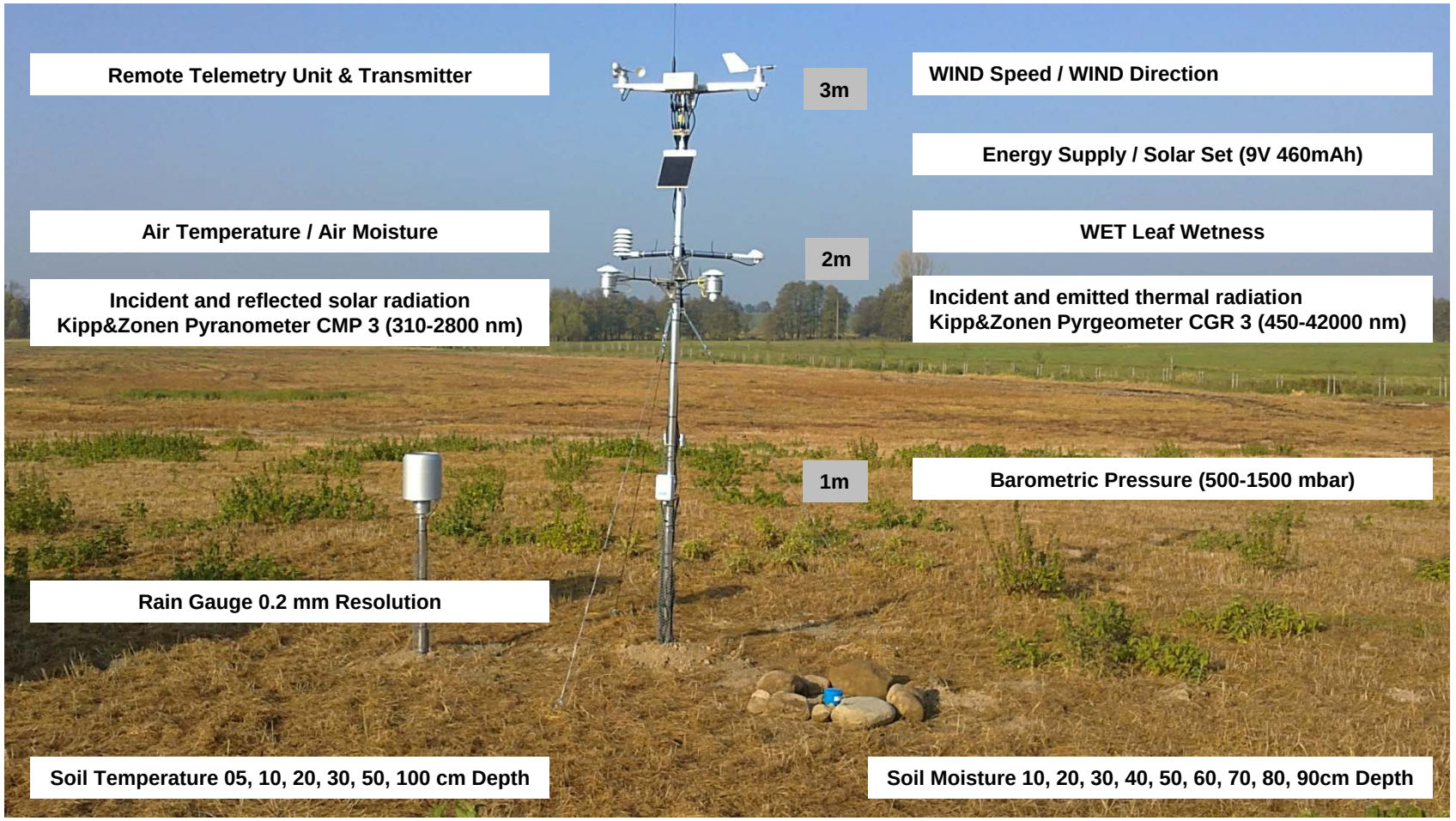


Legend

- 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
- 96 Country Road
- L271 Interstate Road
- 20 Freeway



Environmental Measurement Network - Station



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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

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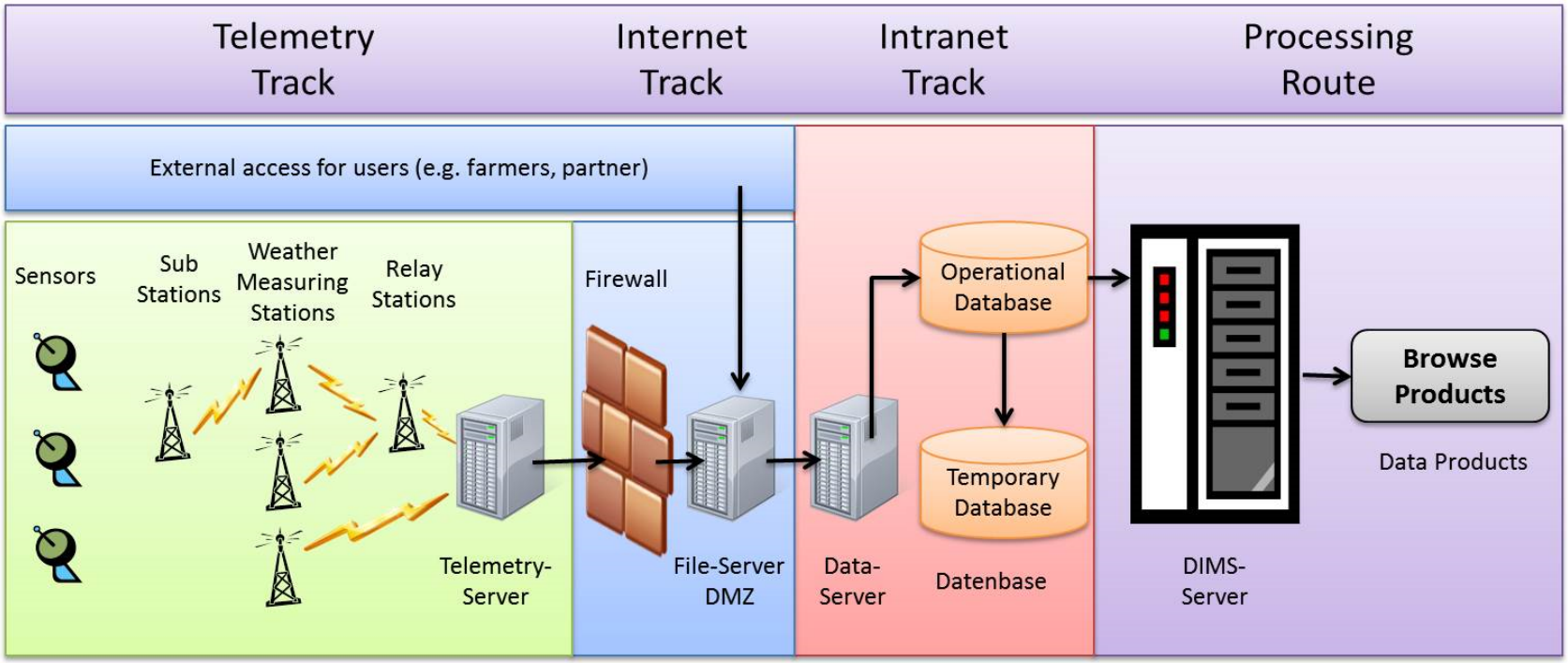
Operative Processing Chain for In-situ-Data



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.

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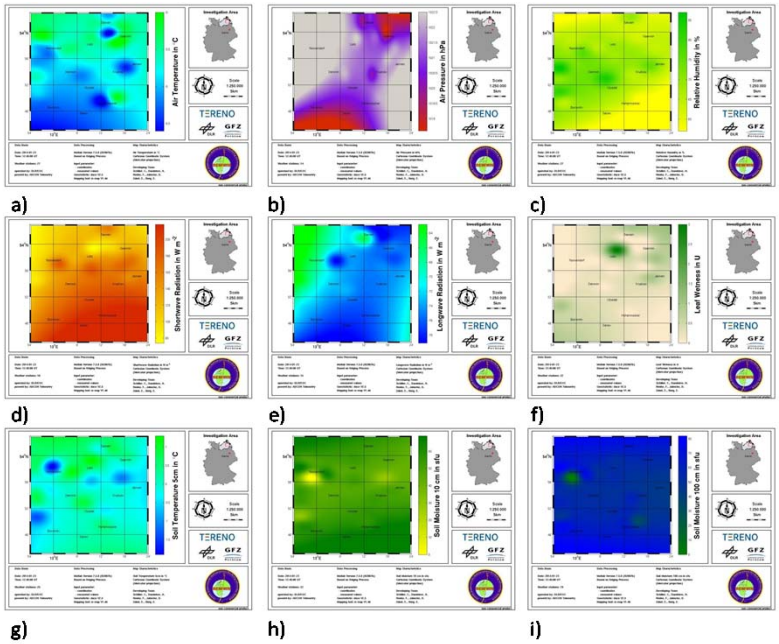
In-situ-Data Browse Products



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

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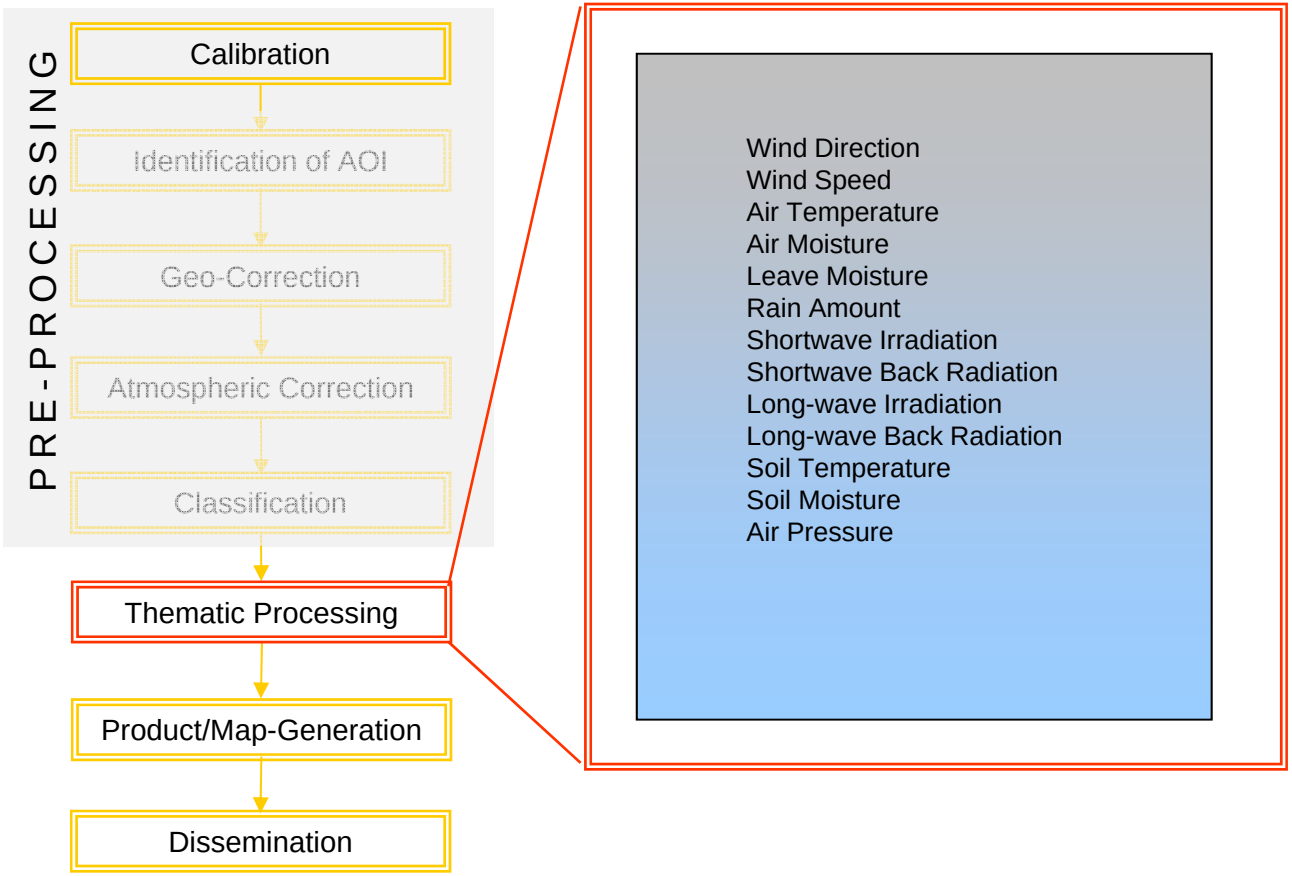
In-situ-Data Processor: Evapotranspiration

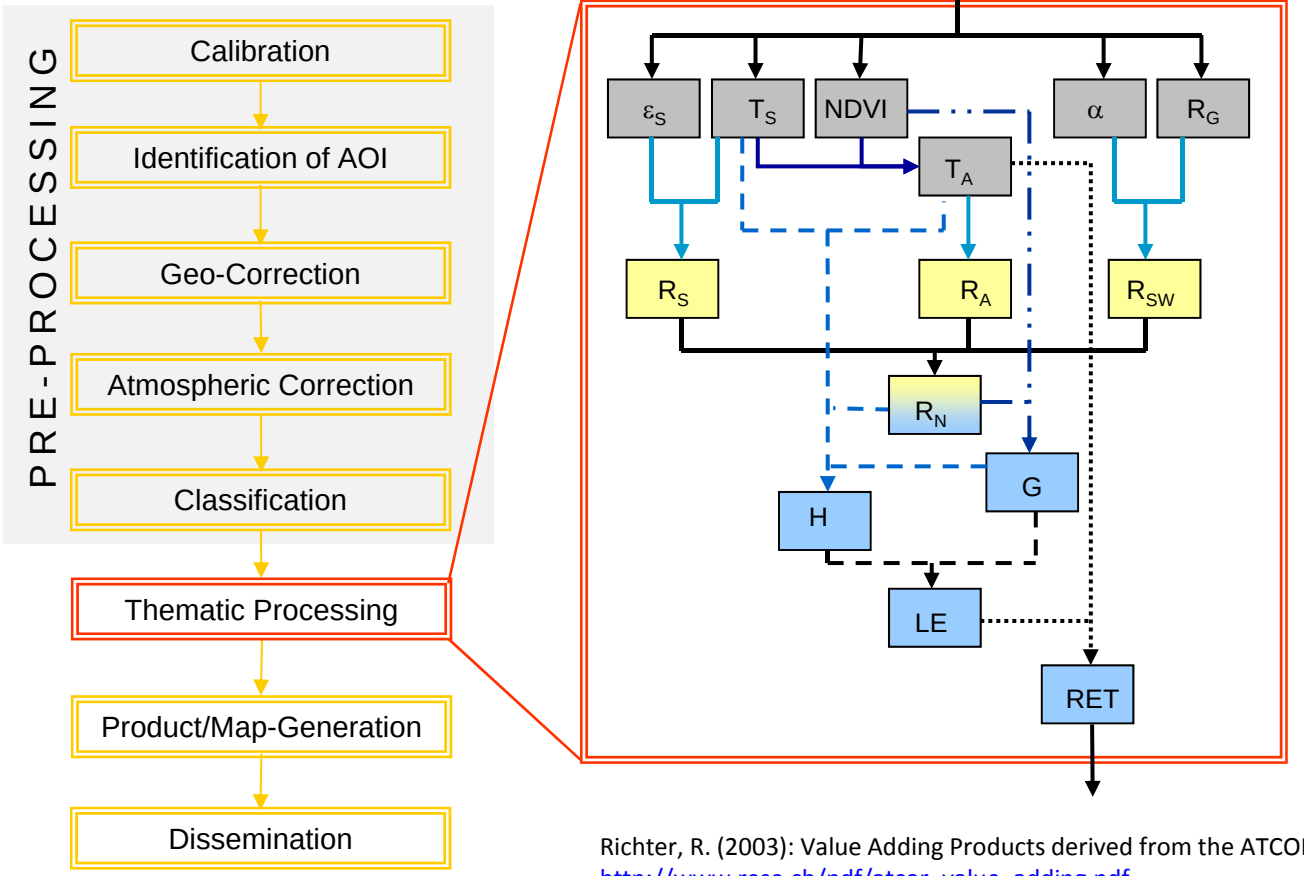


Legend

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

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

Remote Sensing: Evapotranspiration



Legend

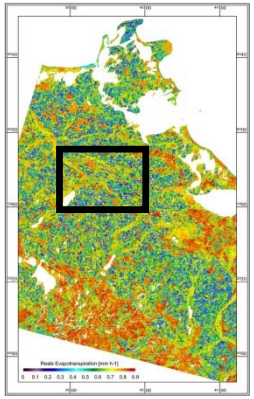
ε_S	*surface emissivity*
α	*albedo*
T_S	*surface temperature*
T_A	*air temperature*
R_G	*incident (or global) solar radiation*
R_S	*emitted surface radiation*
R_A	*atmospheric longwave radiation*
R_N	*net radiation*
R_{SW}	*shortwave net radiation*
H	*sensible heat flux*
G	*ground heat flux*
LE	*latent 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

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

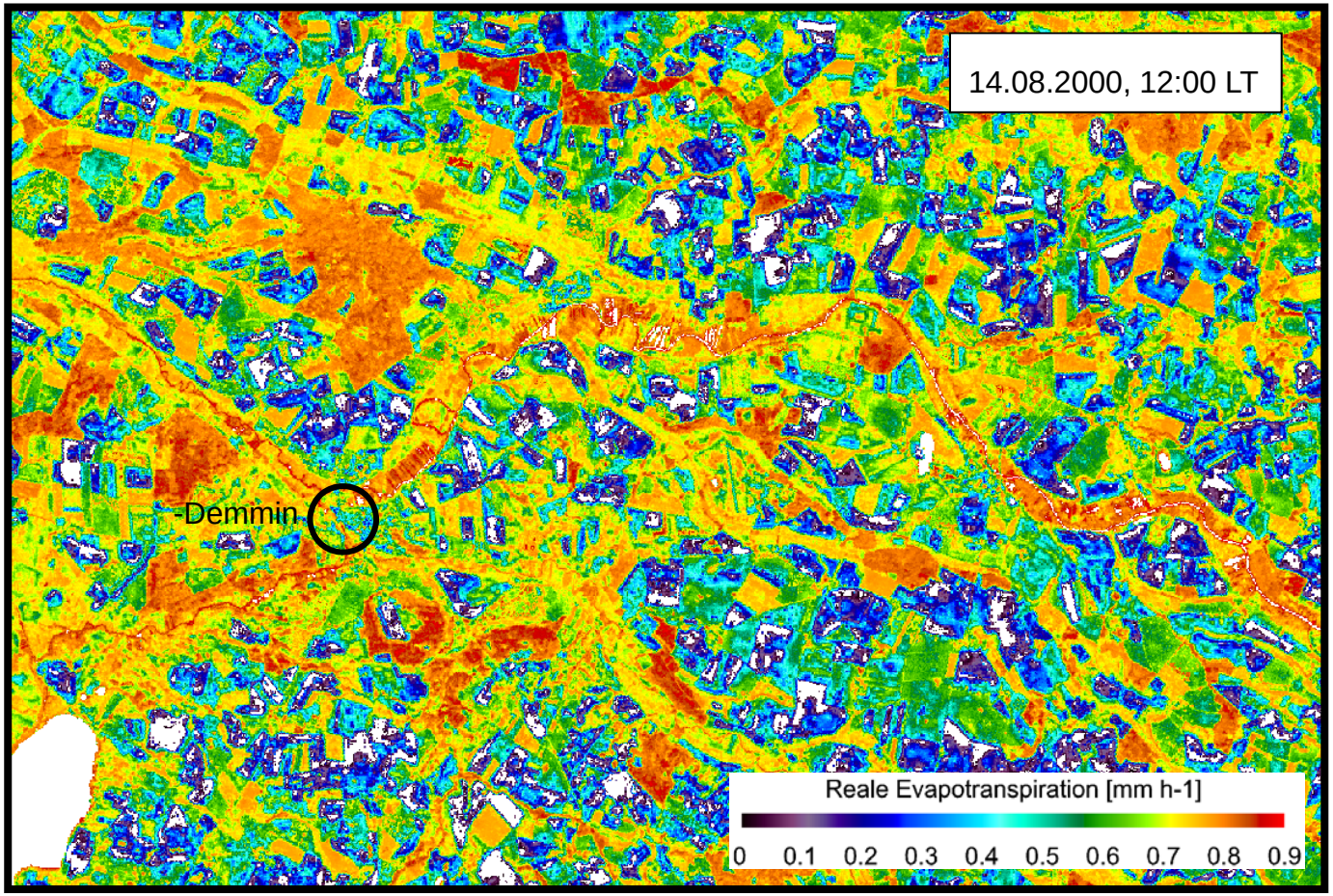
Remote Sensing: Evapotranspiration DEMMIN



Estimated hourly evapotranspiration, based on one instantaneous value

Cloudless sky

Water surfaces masked (Baltic Sea, lakes)



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Results of the Experimental RealET-Processor

Accuracy:

• surface temperature	approx. +/-2 K,
• air temperature	approx. +/-3 K,
• solar radiation	approx. +/-20 W m^{-2}
• 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.

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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

Contact

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Thank You for Your Attention!