SMOS Quality Working Group

DEMMIN - Test Site for Remote Sensing in Agricultural Application

06 Oct - 08 Oct 2014, Frascati, Italy - (Videoconference, Neustrelitz)

German Aerospace Center (DLR)

German Remote Sensing Data Center (DFD)

Borg, E., Fichtelmann, B.

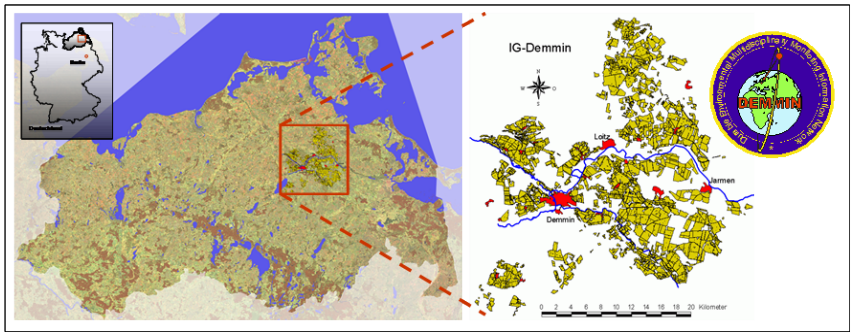
Why do we need a calibration and validation test site for Earth observation?

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



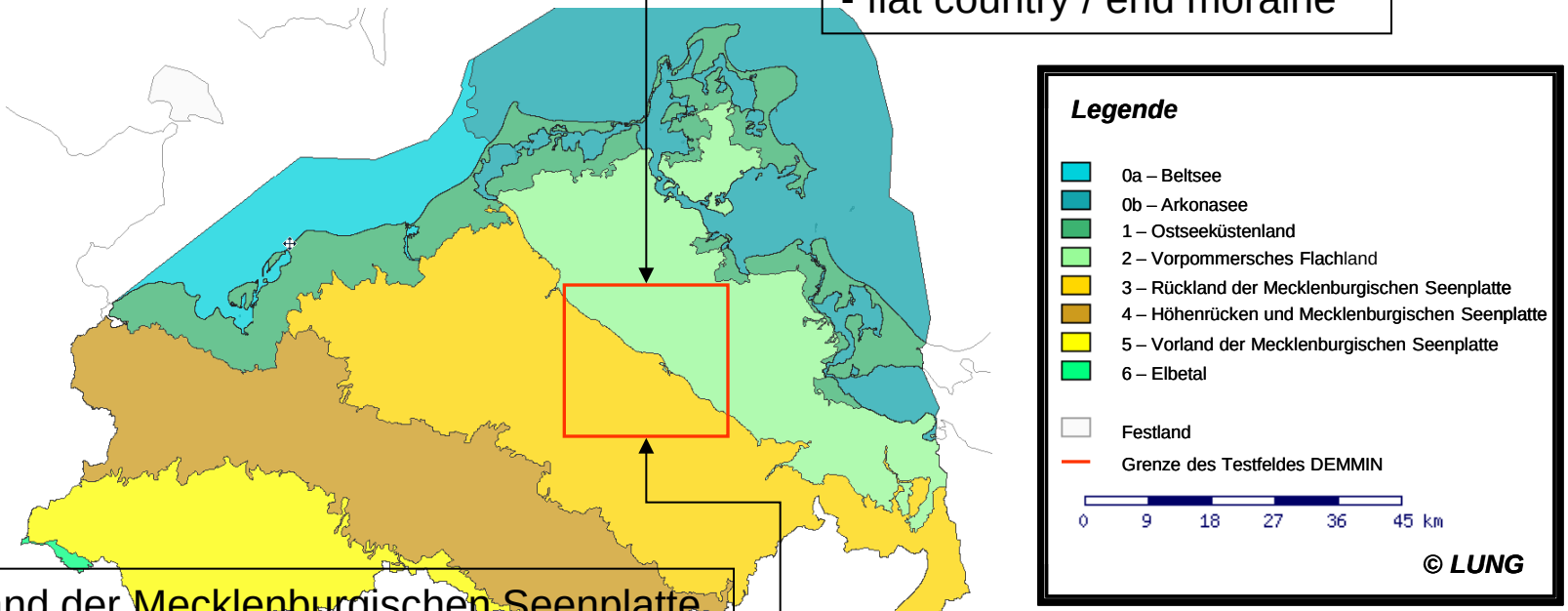
Durable Environmental Multidisciplinary Monitoring Information Network (DEMMIN)

- Cooperation with Farmers (approx. 30,000 ha)
- Size of test-site: 50 km * 50 km

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

Vorpommersches Flachland
- flat country / end moraine



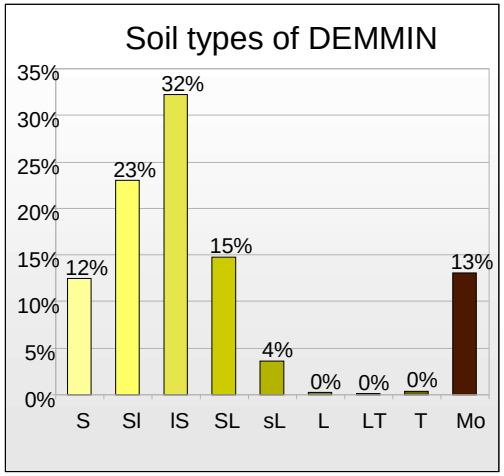
Rückland der Mecklenburgischen Seenplatte
- hilly country / ground moraine

Formation of observatory DEMMIN with respect to landscape zones

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

DLR

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:

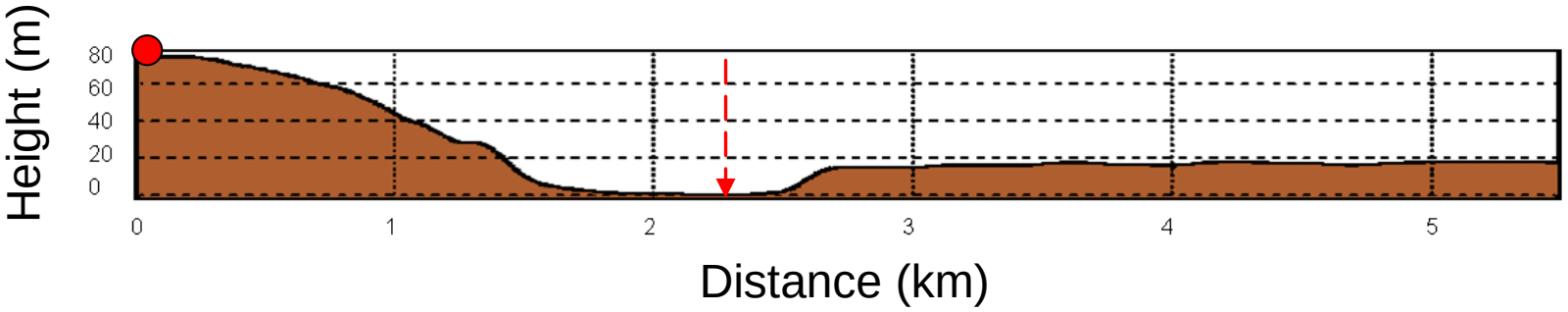
- Sand to sandy-loam soils
- Heterogeneous soil cover

Borg et al. (2009)

DLR

Relief

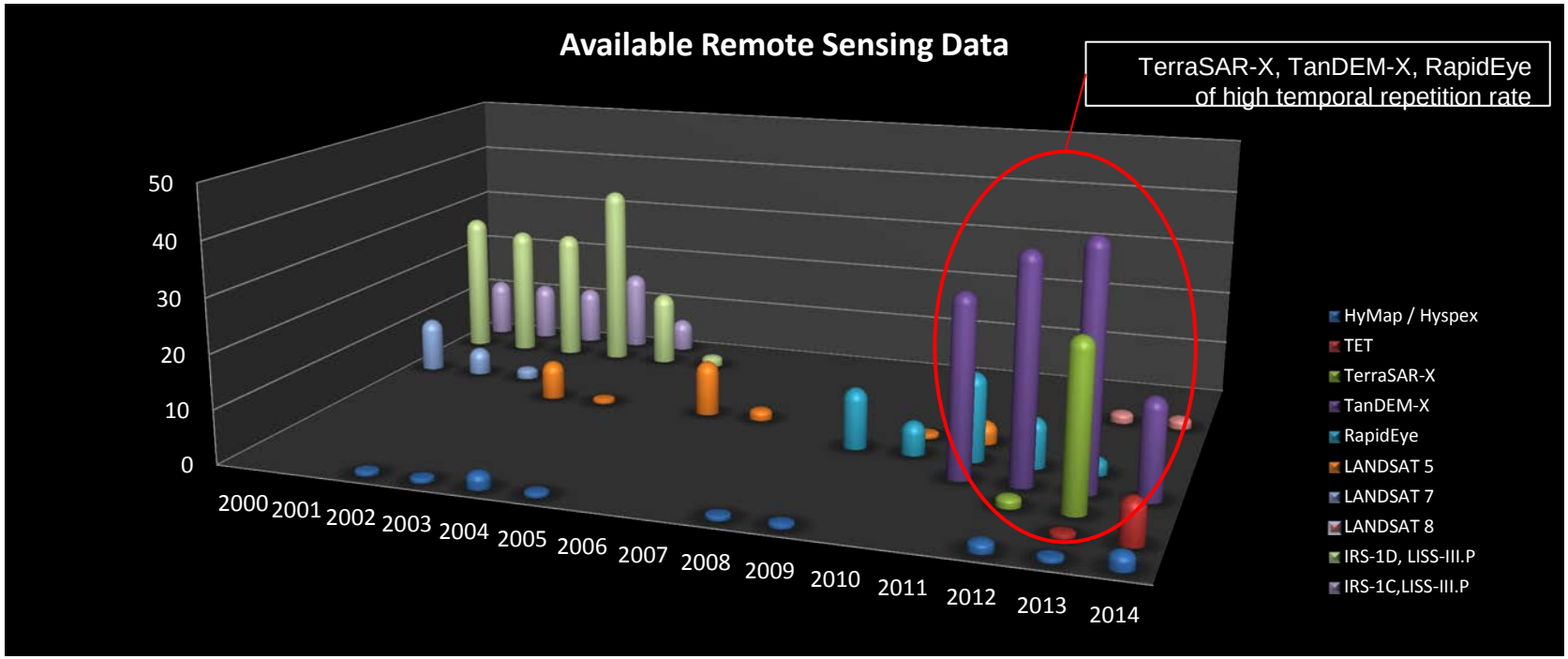
View in the Tollense valley near the village Buchholz



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 Data (Exemplarily)



Available data:

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

DLR

Available Environmental and Agricultural Data

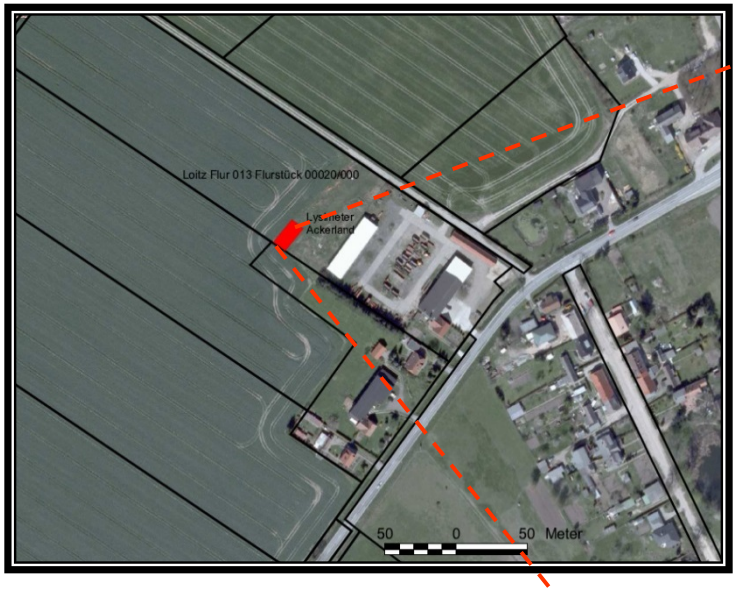
Data Set	Period of Time
Yield Maps	2000 – 2008
Crop Maps	2000 – 2013
Measurement Data	2004 - 2014

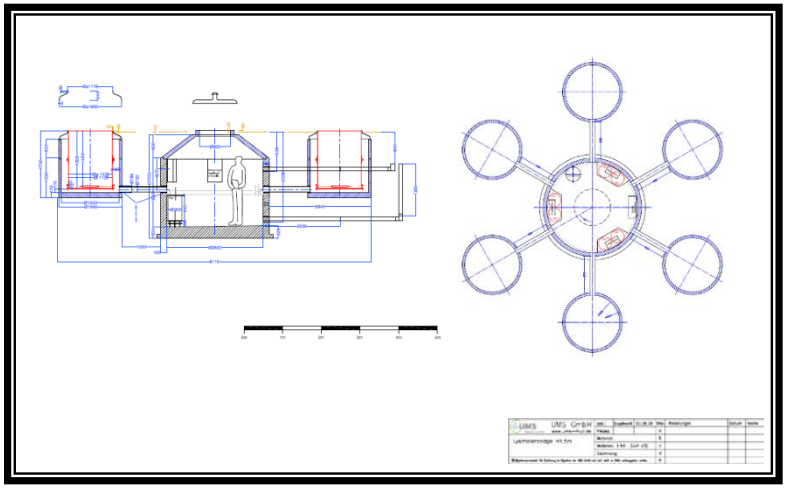
Available agronomic process data (e.g. yield and crop maps) and in-situ-data of automated environmental measurement network (e.g. agro-meteorological data)

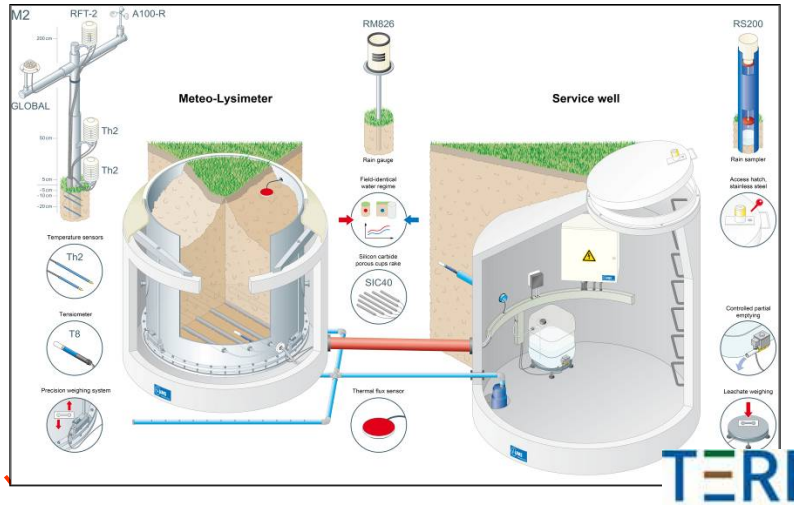
Mean Size of fields is 80 ha and in maximum 300 ha.

DLR

Lysimeter Station: Context TERENO SoilCAN







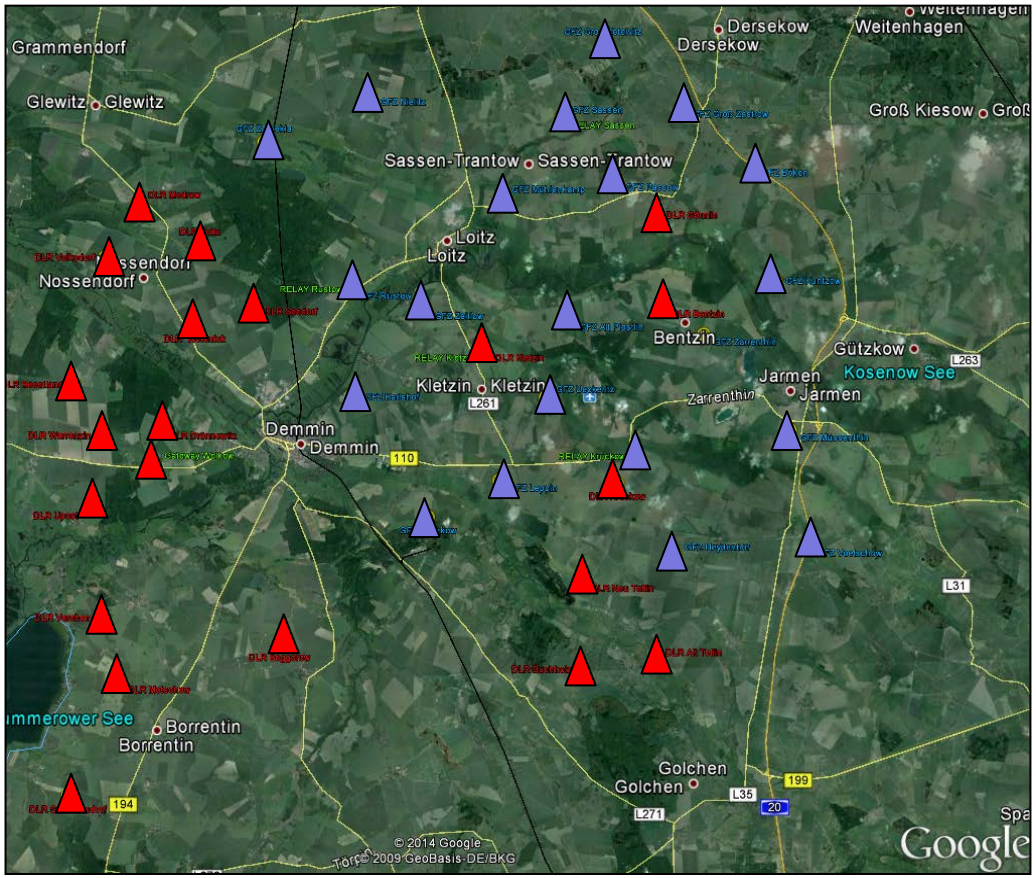
- Automated Lysimeter station Rustow –
- 6 metal cylinder filled with undamaged soil monoliths placed on a balance

Von Unold, G. (2011): http://www.ums-muc.de/lysimeter_systeme/lysimeter/meteo_lysimeter.html (last access: 18.08.2013)

DLR

TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIA

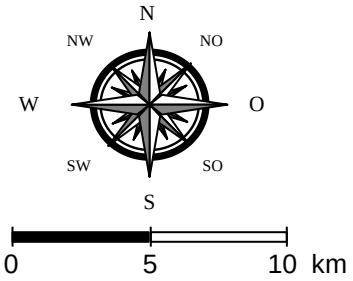
Environmental Measurement Network



Environmental Measurement Station

German Aerospace Center

Geo-Research Center, Potsdam

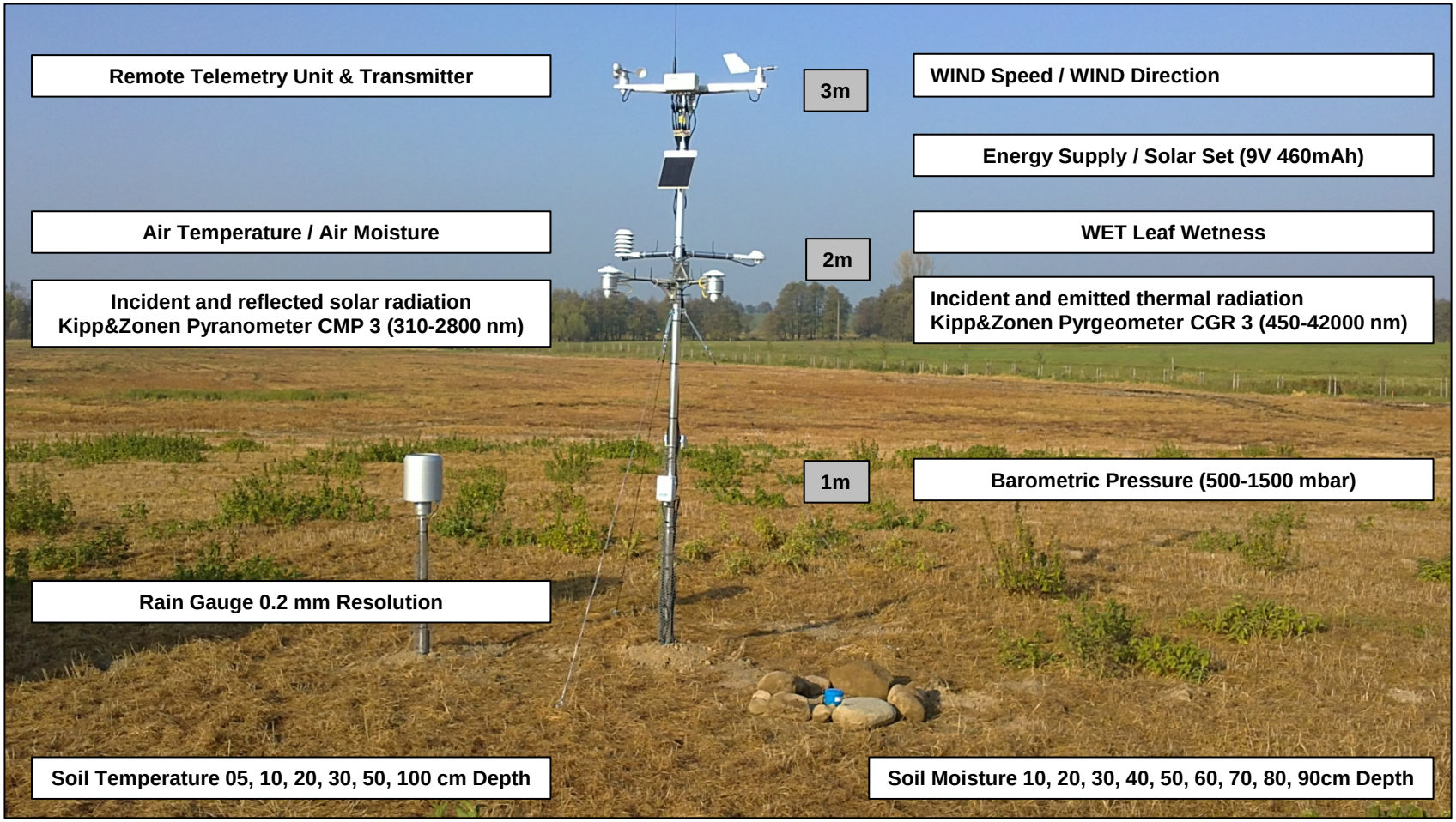


- 40 environmental stations,
- Measurement interval 15 minutes-slot = 900 sec, 15 samples,
- Data transfer via telemetry transfer,
- Web-data access on data server
- plus approx. 70 soil moisture probes

DLR

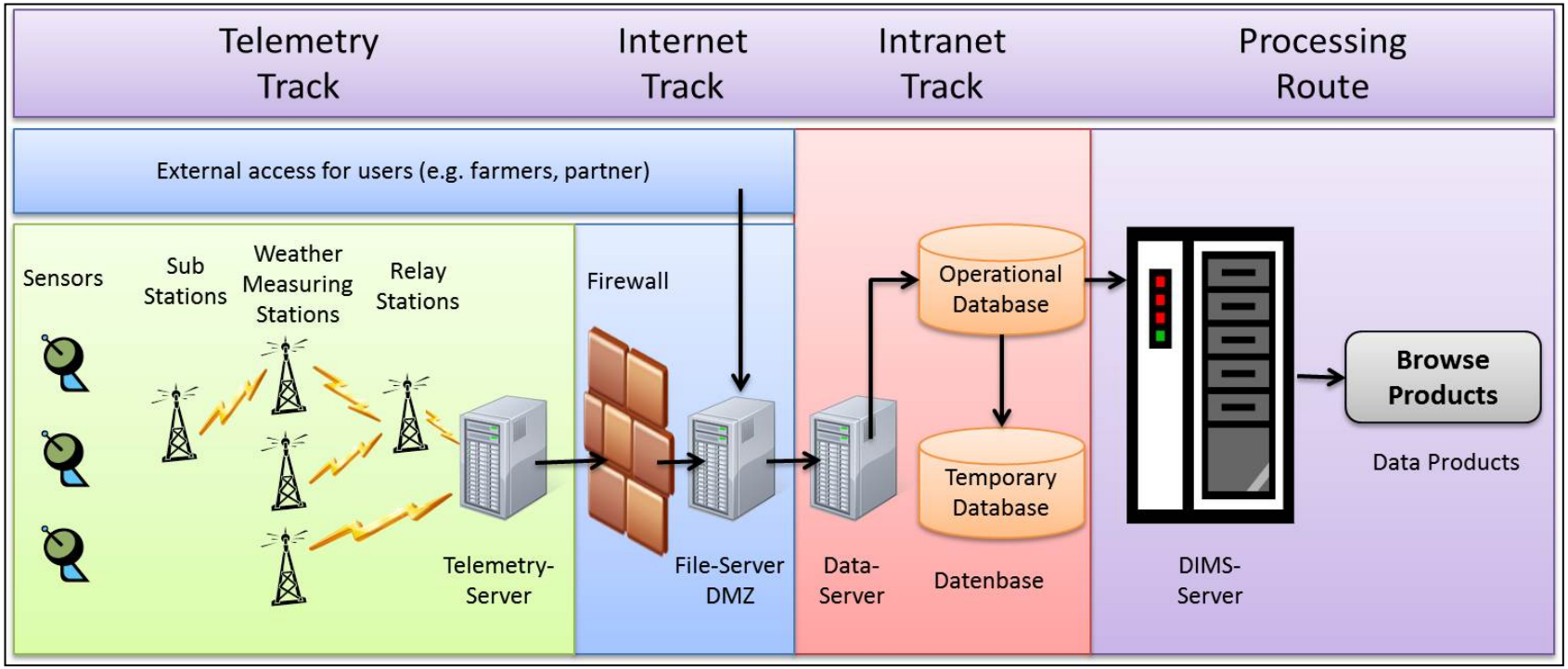
TERENO
TERRESTRIAL ENVIRONMENTAL OBSERVATORIA

Environmental Measurement Network - Station



DLR

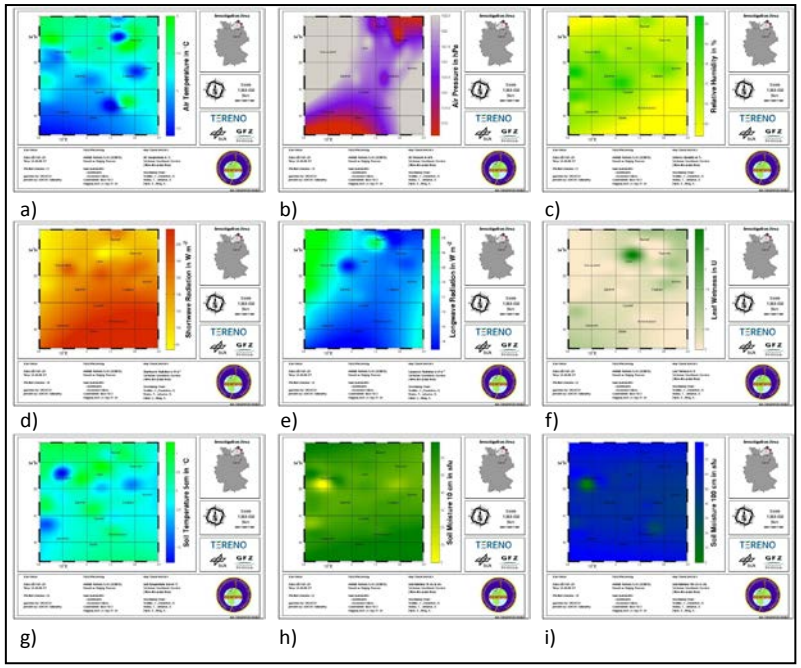
Operative Processing Chain for In-situ-Data



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.

DLR

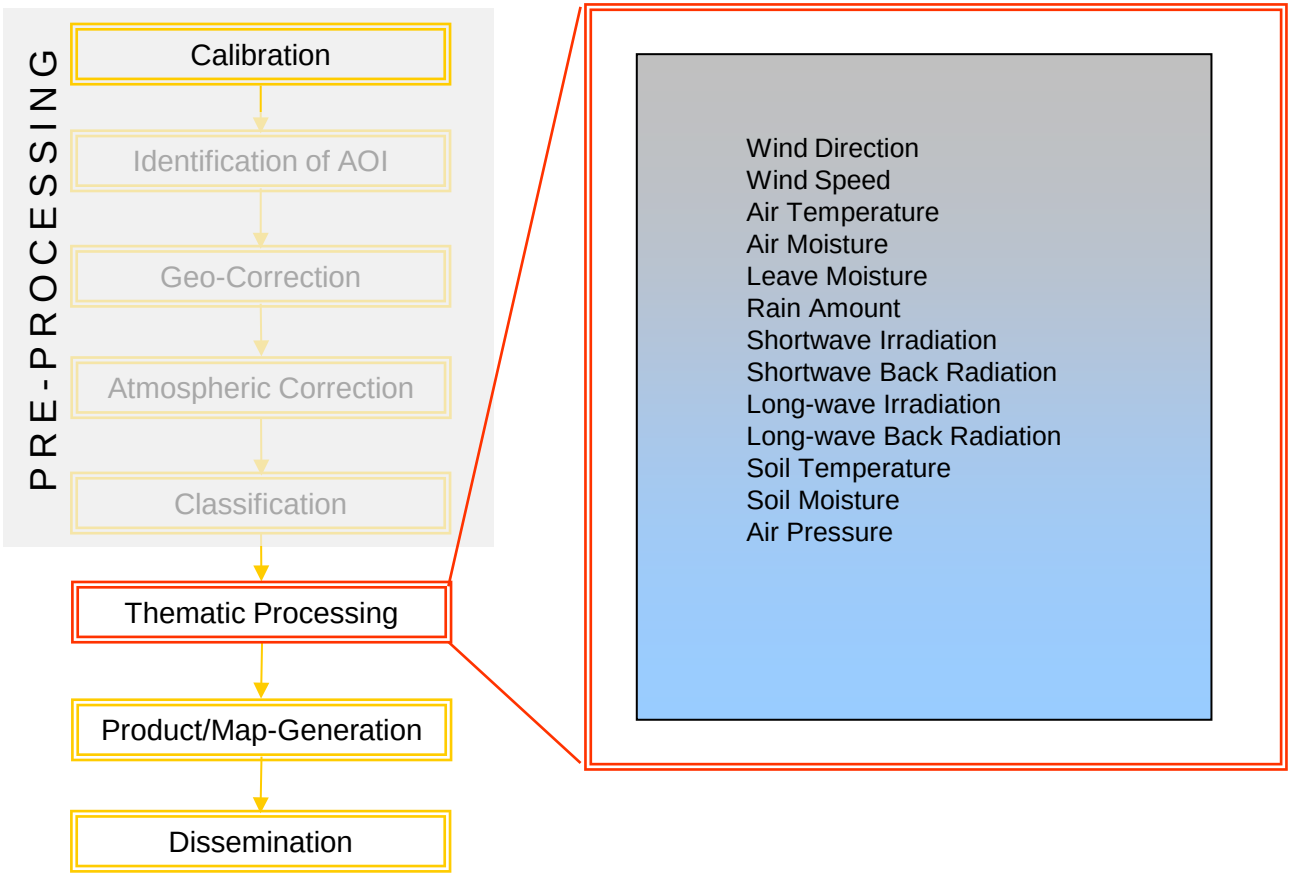
In-situ-Data Browse Products



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)

DLR

In-situ-Data Processor: Evapotranspiration



Legend

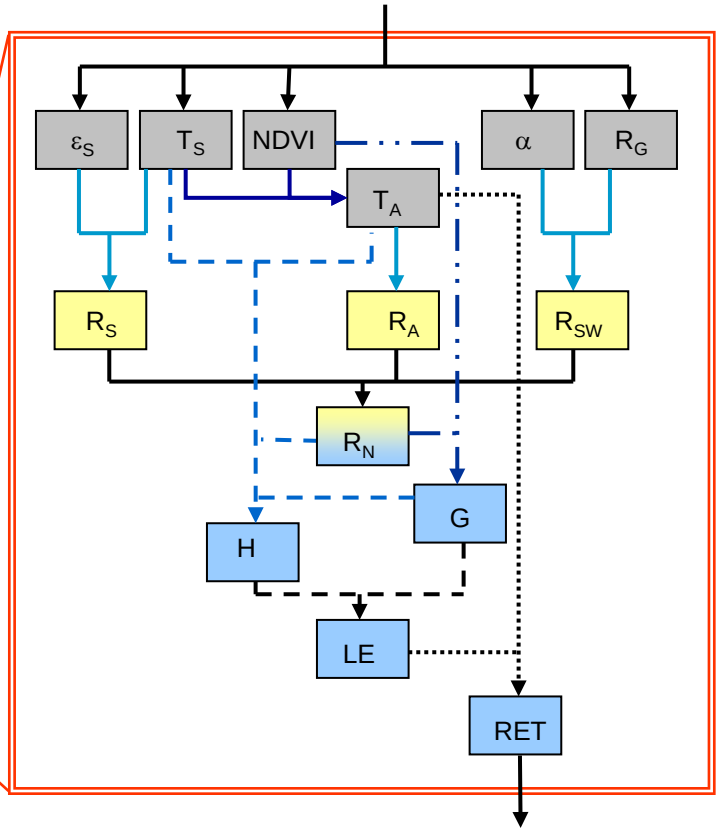
L^*	*Heat of vaporization*
s	*slope of the saturation vapor pressure curve*
R_n	*Net radiation*
G	*Ground heat flux*
ρ	*Density of air*
c_p	*Specific heat of air*
r_a	*Aerodynamic Resistance*
$e_s(T)$-e	*Saturation deficit, f=(T, e)*
γ	*Psychrometer constant*
r_s	*Stomata resistance*
T	*Air temperature*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

PRE-PROCESSING

- Calibration
- Identification of AOI
- Geo-Correction
- Atmospheric Correction
- Classification
- Thematic Processing
- Product/Map-Generation
- Dissemination



Legend

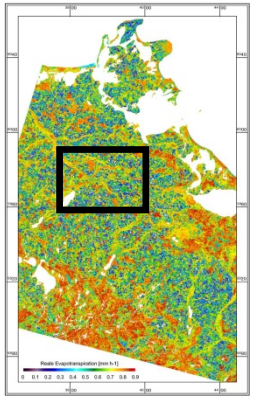
ε_S	*surface emissivity*
α	*albedo*
T_S	*surface temperature*
T_A	*air temperature*
R_G	*incident (or global) solar radiation*
R_S	*emitted surface radiation*
R_A	*atmospheric longwave radiation*
R_N	*net radiation*
R_{SW}	*shortwave net radiation*
H	*sensible heat flux*
G	*ground heat flux*
LE	*latent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

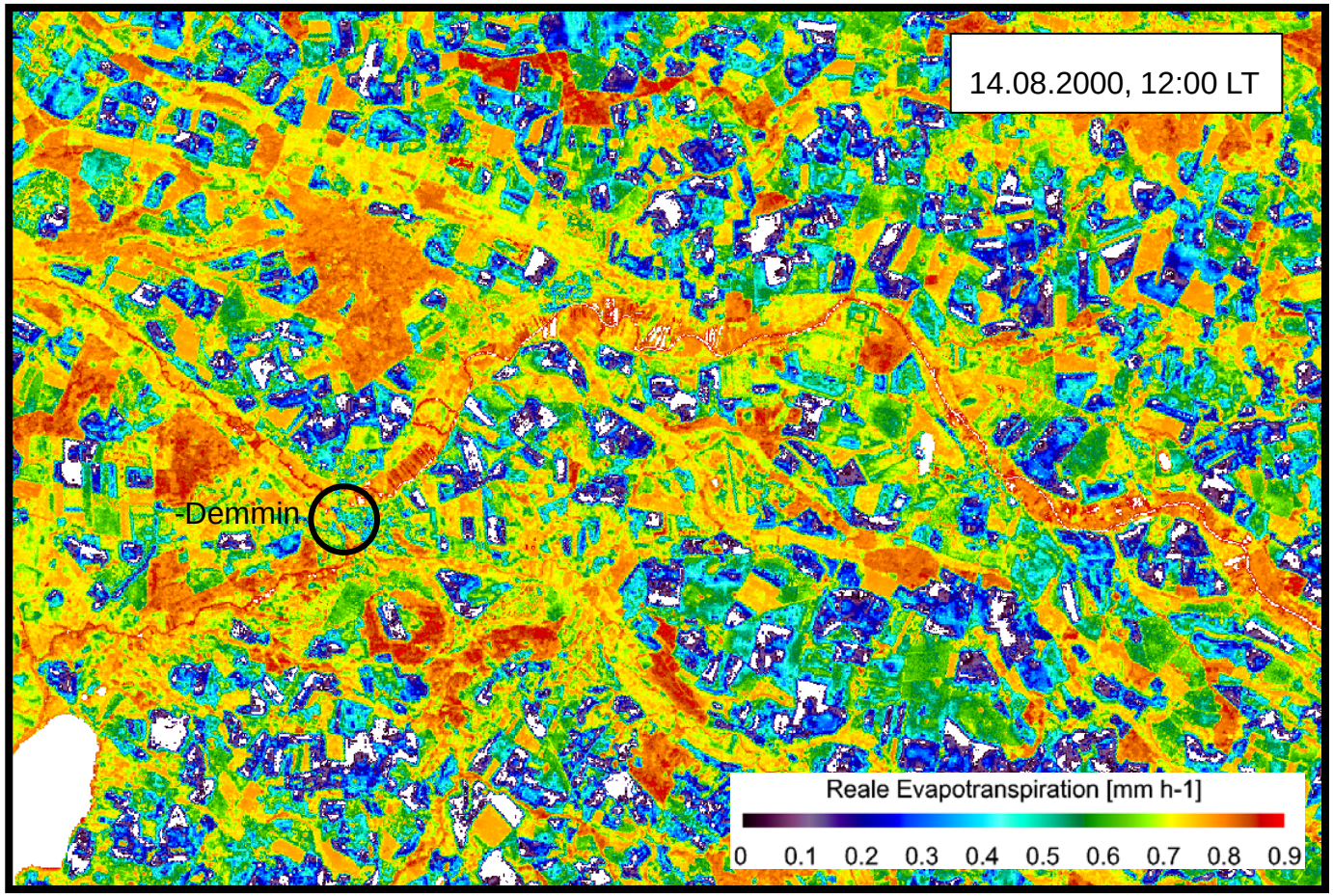
Remote Sensing: Evapotranspiration DEMMIN



Estimated hourly evapotranspiration, based on one instantaneous value

Cloudless sky

Water surfaces masked (Baltic Sea, lakes)



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%

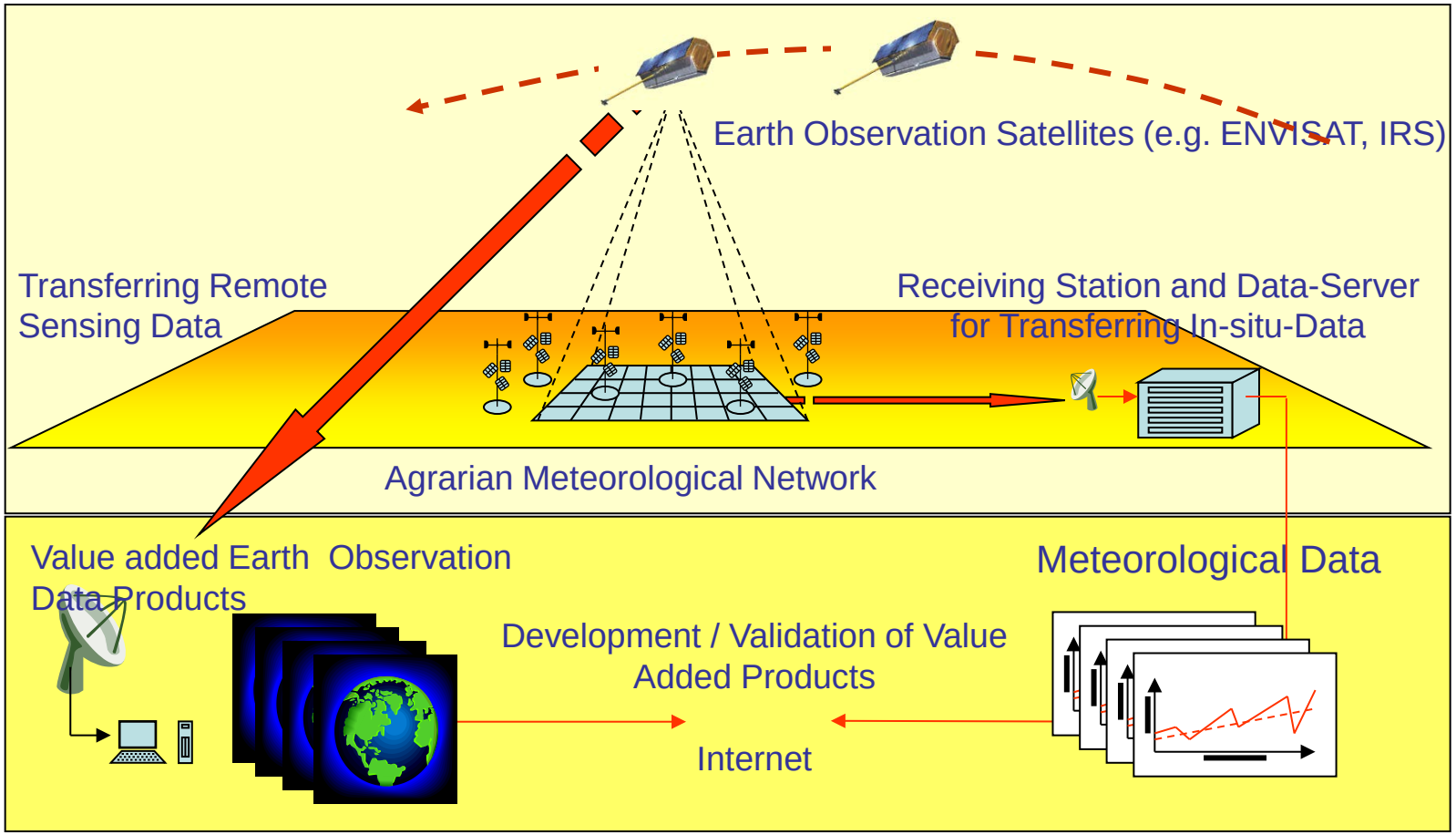
The approach has been assessed as robust.

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.

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.

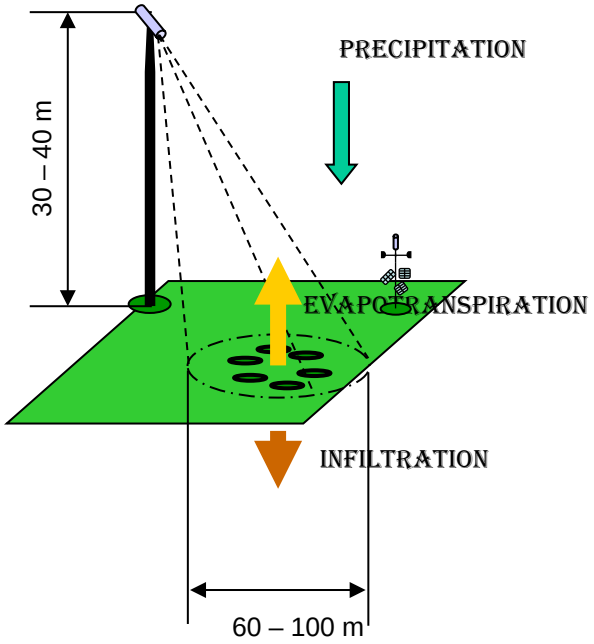
DLR

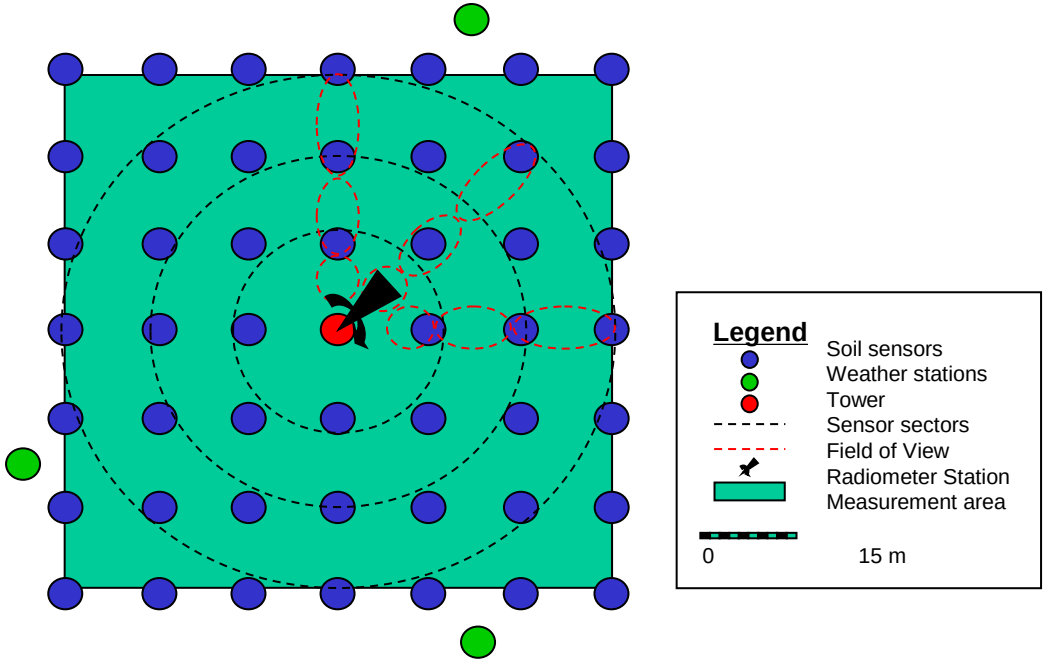
Objectives at Calibration and Validation Test Site DEMMIN

Objectives:

- Placing a L-band radiometer,
- Monitoring L1 performance of SMOS mission,
- SMOS/SMAP Synergy for SMAP Level 2 Soil Moisture Algorithm Evaluation

Remote Sensing: Evapotranspiration DEMMIN



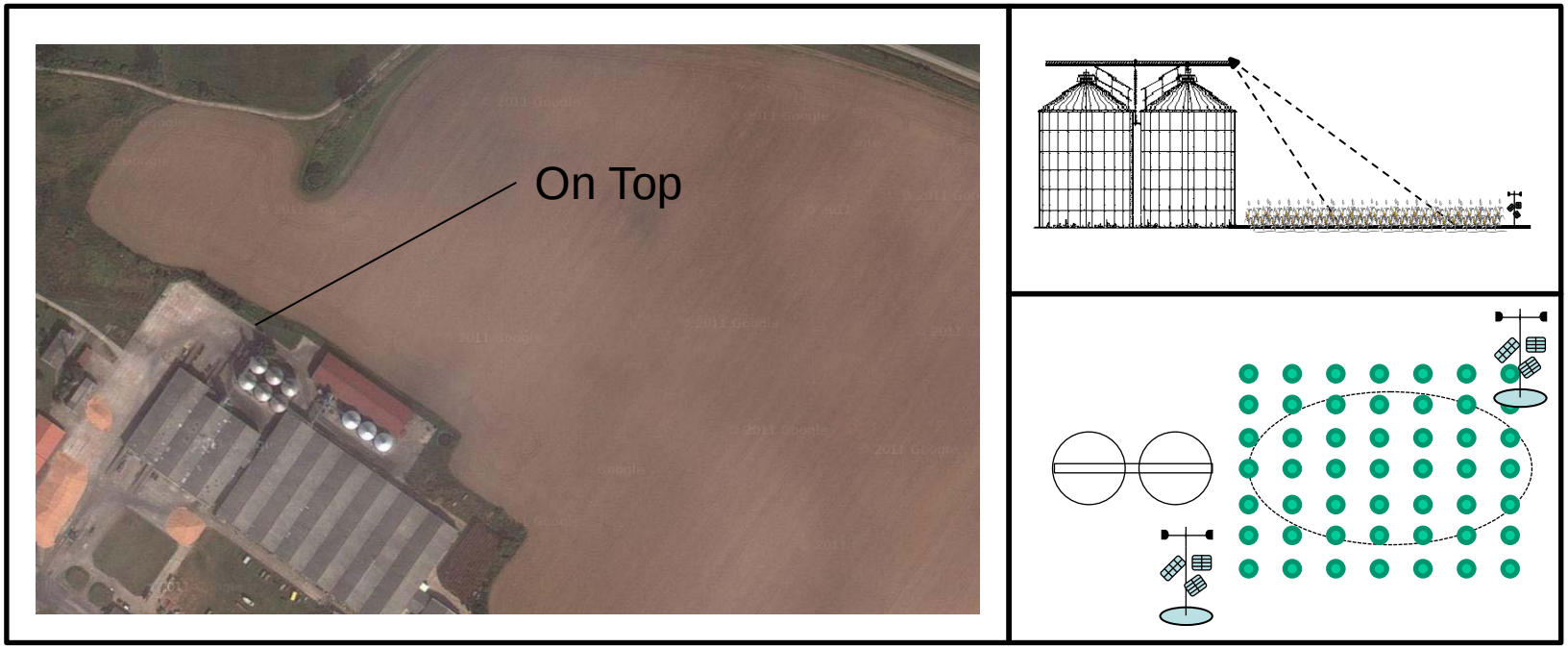


Measurement area for:

- calibration of remote sensing sensors/–missions,
- validation of remote sensing based models and information products

to derive soil moisture, temperature, and evapo-transpiration.

Location



Location

Contact

Dr. Erik Borg

German Aerospace Center (DLR) e.V.
Member of the Helmholtz Association
German Remote Sensing Data Center (DFD)
National Ground Segment

Kalkhorstweg 53
17235 Neustrelitz

Telephone:	03981/480-183
Telefax:	03981/480-299
E-mail:	erik.borg@dlr.de
Internet:	http://www.dlr.de/eoc/

Thank You for Your Attention!