

Field Experiments for NWP: The LITFASS Experience

Frank Beyrich

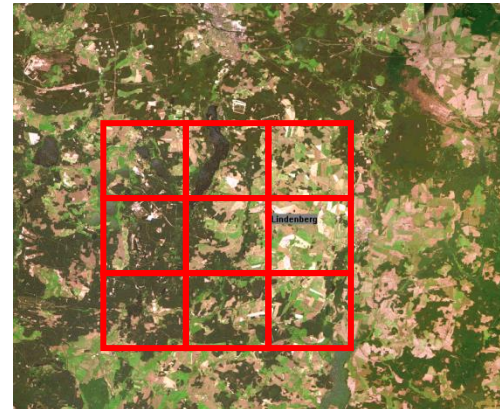
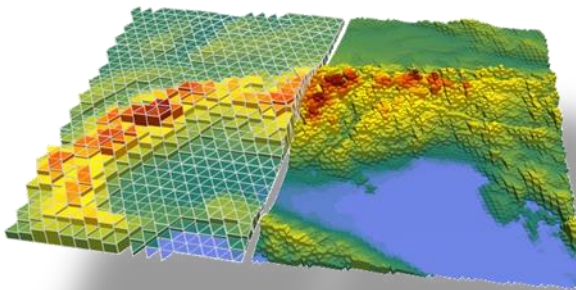
**Deutscher Wetterdienst
Meteorologisches Observatorium Lindenberg
– Richard-Aßmann-Observatorium**





- data assimilation
- model verification
- parameterization development

- test of sensors, systems, and measurement strategies



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	Routine operation	Field campaign
Data assimilation	X	(X)
Model verification	X	(X)
Parameterization development	(X)	X
Test of sensors, systems, measurement strategies	(X)	X

Micrometeorological / ABL experiments

- Great Plains / O'Neill (1953)
- Wangara (1967)
- Kansas (1968)
- Minnesota (1973)

→ Monin-Obukhov Similarity Theory (MOST) universal functions

Micrometeorological / ABL experiments

- Instrumented tower (T, q, V)
- Sonic anemometer
- Frequent radiosondes
- Tethered balloon

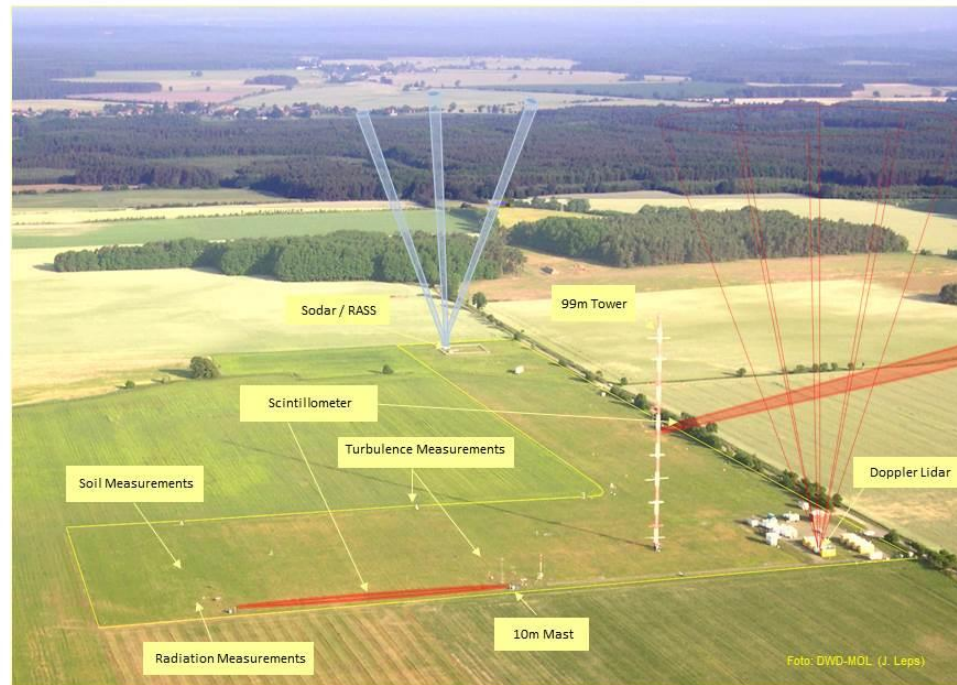
and later:

- sodar, lidar ...
- aircraft
- several sites

raw data usually stored

Many of these measurements are operational nowadays ...

Supersites and observatories are nothing more than an operational field experiment ...



Supersites and Observatories

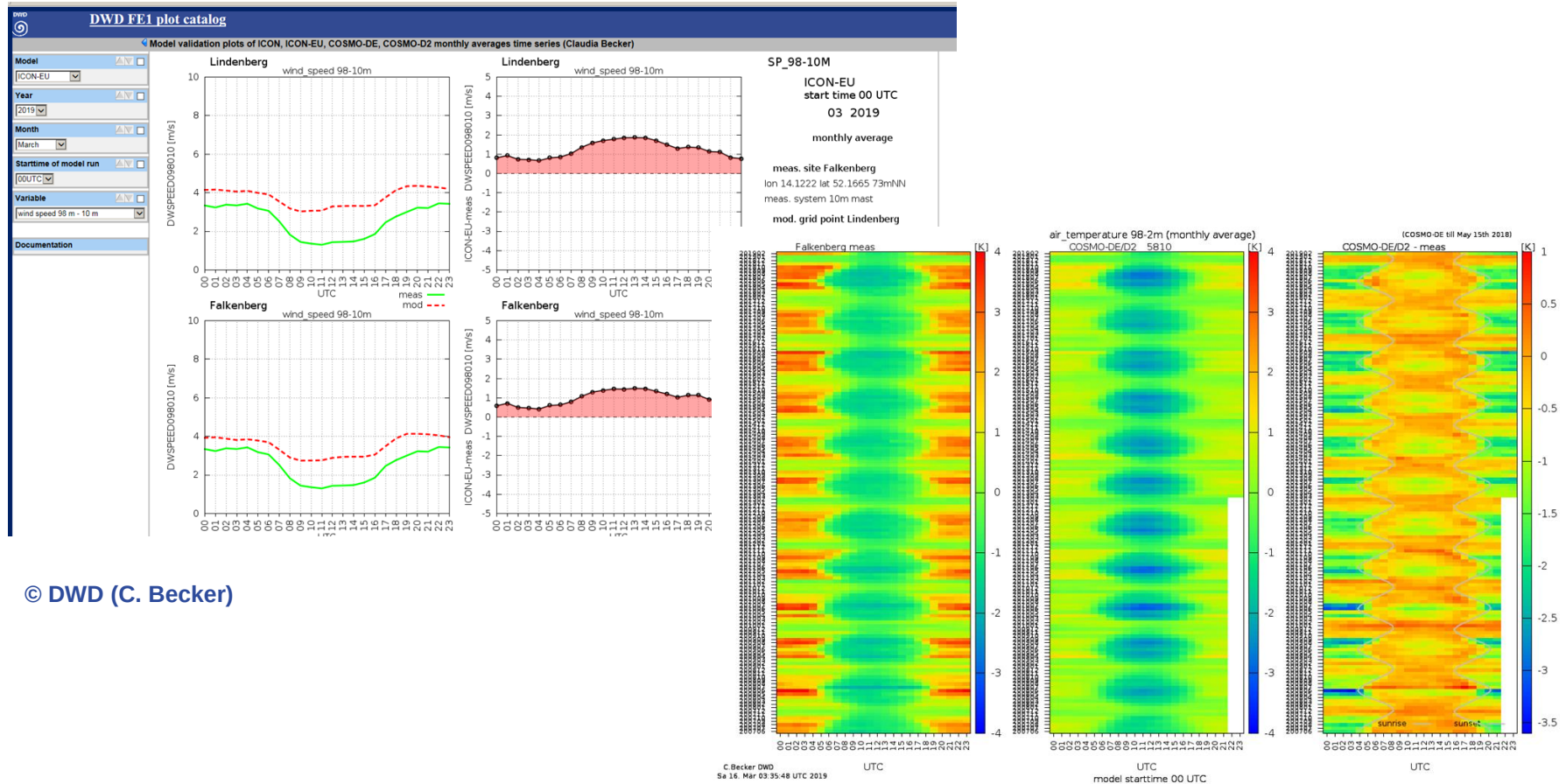


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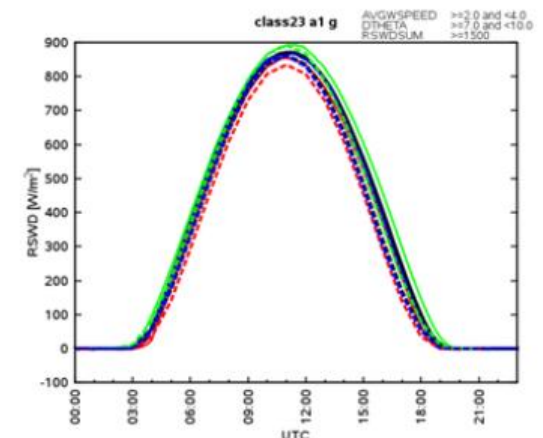
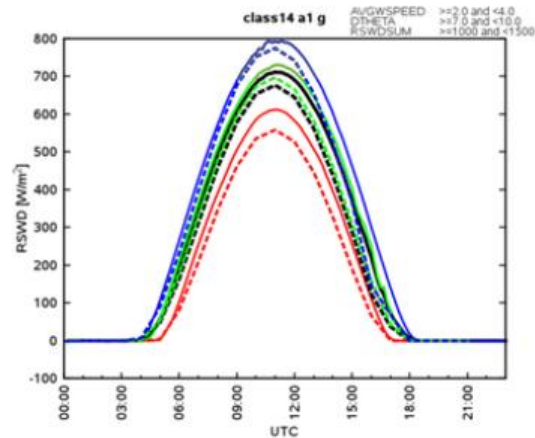
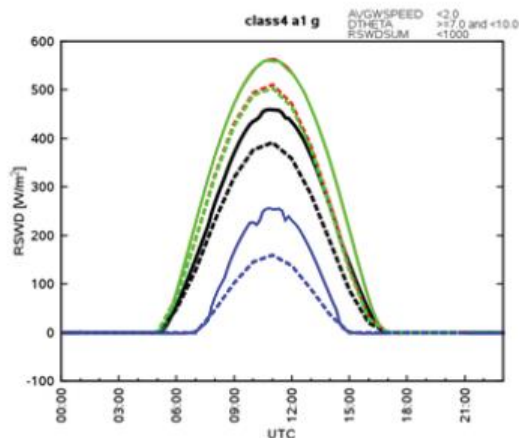
- ... broad spectrum of in-situ and remote sensing instruments
- ... even raw data often stored
- ... cover the full spectrum of weather situations and atmospheric conditions at a given site over a longer time period

(Long-term) validation on NWP model output



Cluster Analysis / Conditional Validation: CBL Evolution

- Goal: Analyse CBL evolution with / without cloud formation**
- **Case selection: conditional data base request**
 - **Classification according to season, stability, radiation, wind**
 - **Calculation of mean diurnal cycles for each class**
 - **Comparison data vs. model**



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Clear sky (Weak to moderate wind, medium stability): 3 different radiation classes

Modification of COSMO Cloud Scheme Using Cloudnet Data

Parametrization scheme of stratiform clouds:

Correction of cloud fraction for subvisible ice clouds at levels $p < 500$ hPa

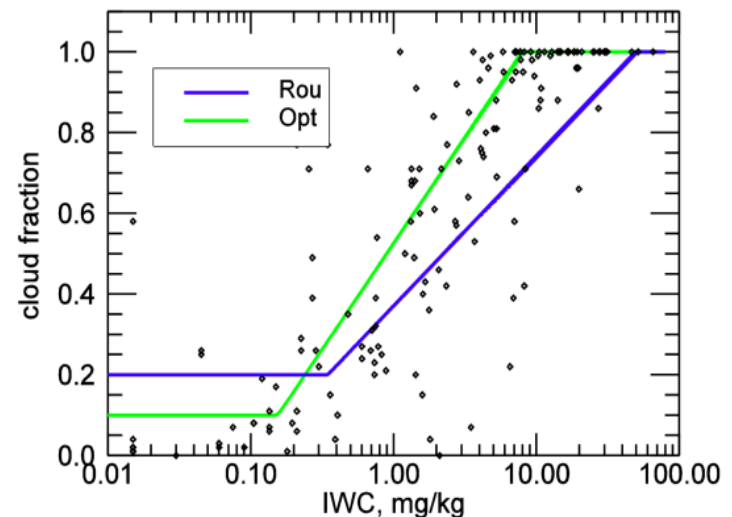
$$C = \min \left[1, \max \left(a, \frac{\log(q_i) - \log(10^{-7})}{\log(b) - \log(10^{-7})} \right) \right]$$

a, b: empirical parameters ($a=0.2$, $b=5 \times 10^{-5}$),
 q_i : ice water content (iwc)

Verification based on radar derived
cloud fraction and ice water content.



Improved scheme (Opt)
Parameters: $a=0.1$ and $b=8 \times 10^{-6}$



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- **Observatories may provide climatology, core measurement program, infrastructure, and logistics for field experiments**

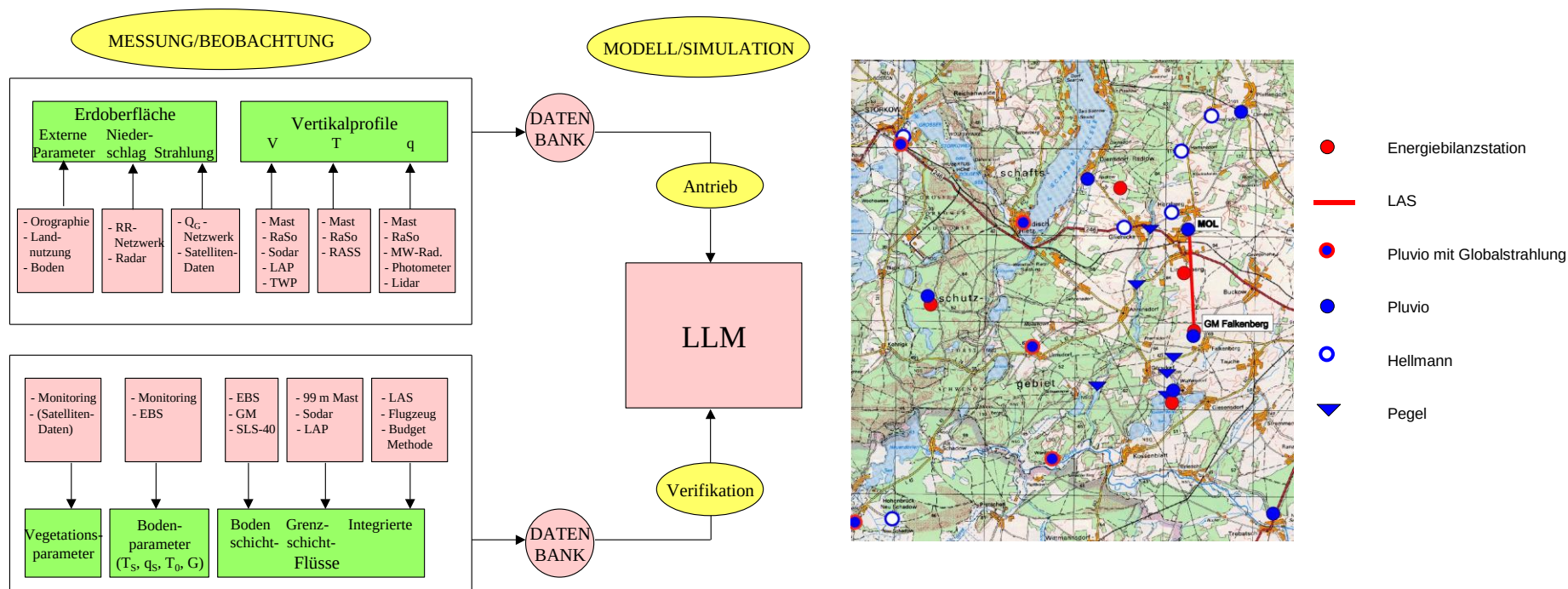


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The place of field experiments

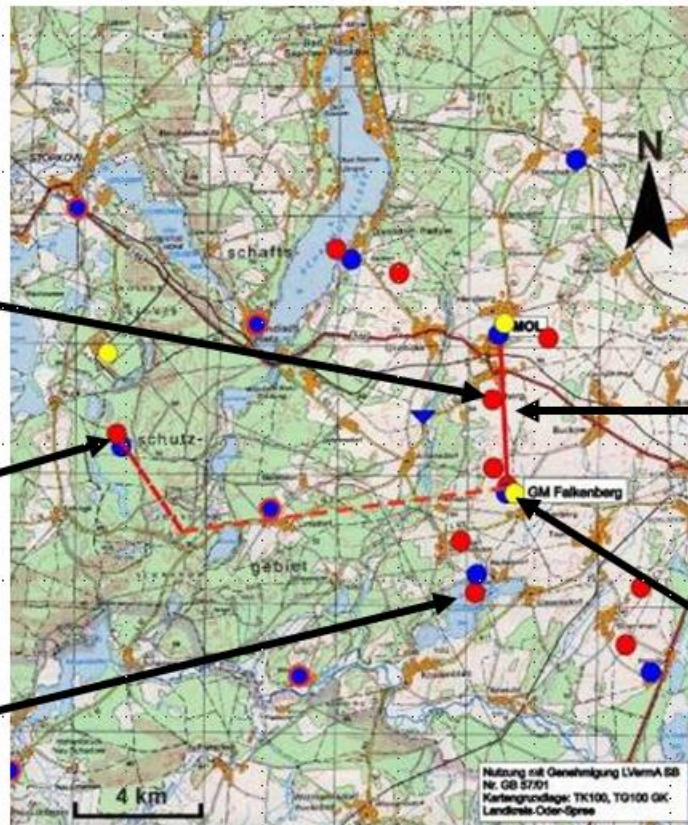
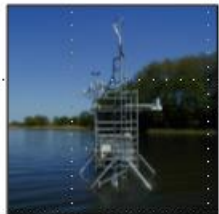
- **Process studies (special instrumentation)**
- **Spatial dimension (large number of sites)**
- **Test of measurement systems and strategies (large number of instruments of the same type)**
- **Non-automatic measurements (e.g., tethered balloons, aircraft)**

Lindenberg Inhomogeneous Terrain: Fluxes between Atmosphere and Surface – a long-term Study



LITFASS-2003

micrometeorol. / flux measurements



Airborne measurements

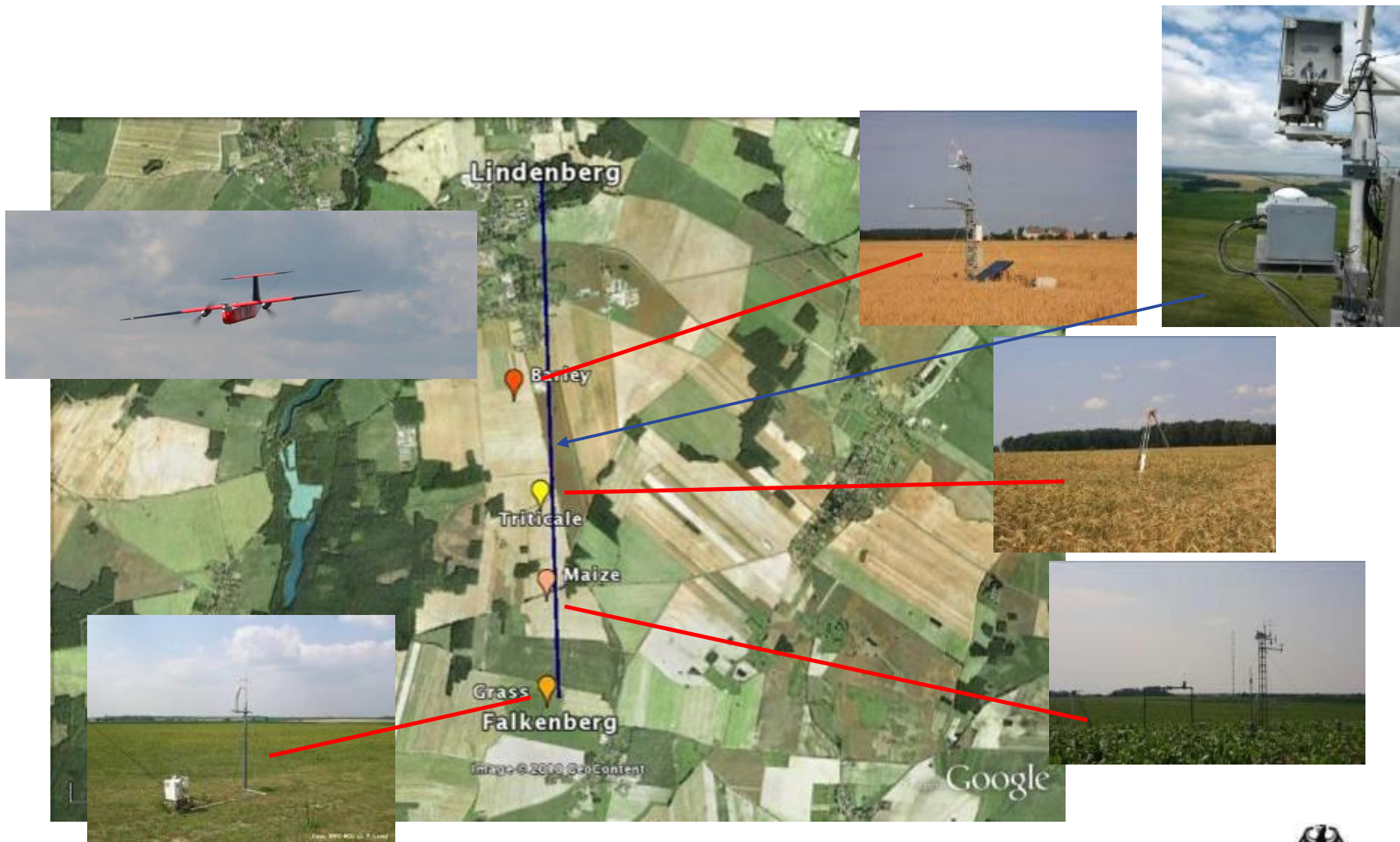


Scintillometry



Ground based remote sensing

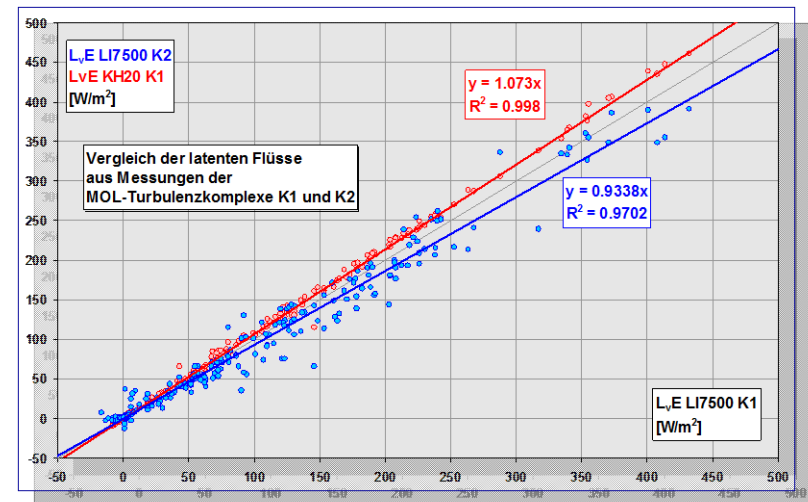




Uncertainties of turbulent fluxes from eddy-covariance measurements with state-of-the-art sensors is 5-10 % for H and 10-15% for LE, resp., data processing algorithms may add additional uncertainty of the same magnitude → harmonization of algorithms

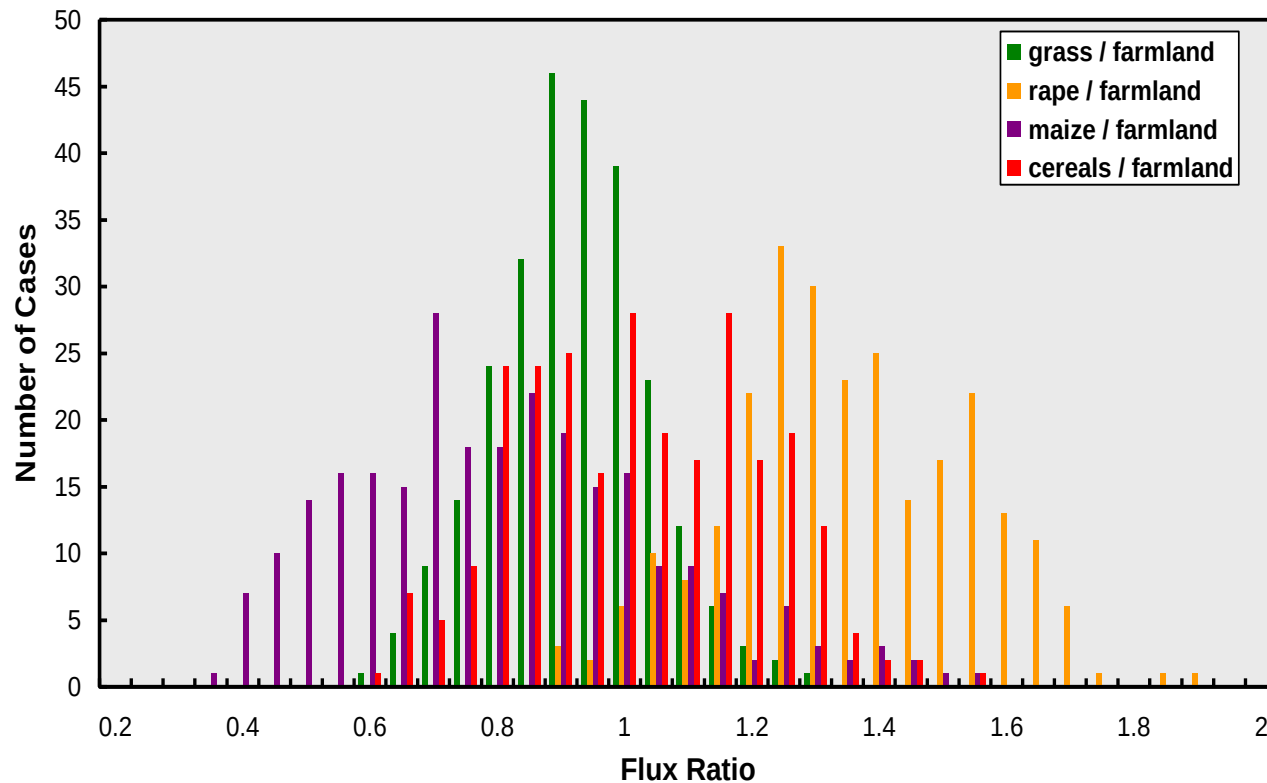


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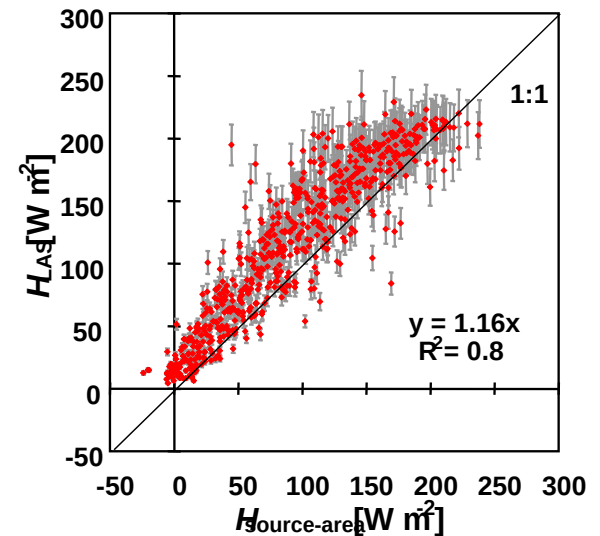
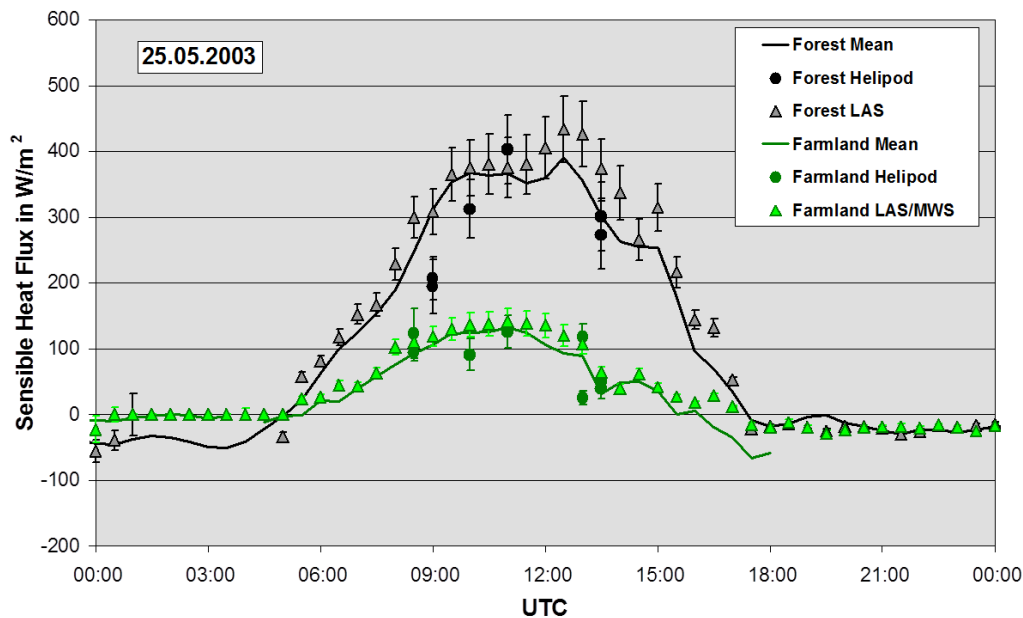


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Measurements over grass at GM Falkenberg can be considered as representative for farmland

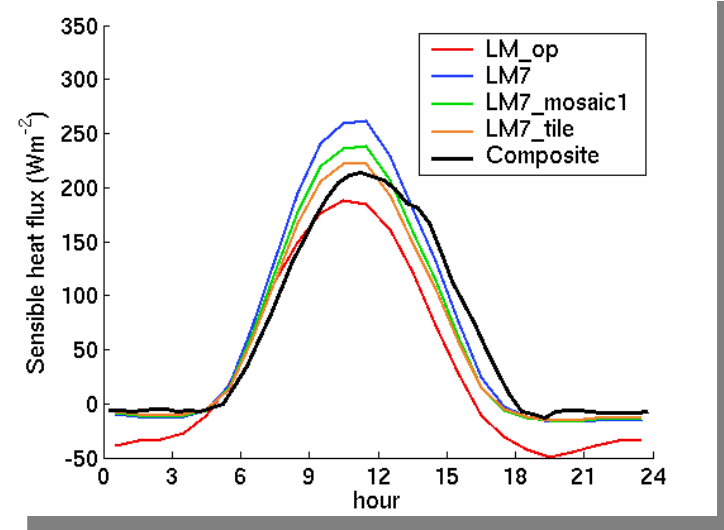
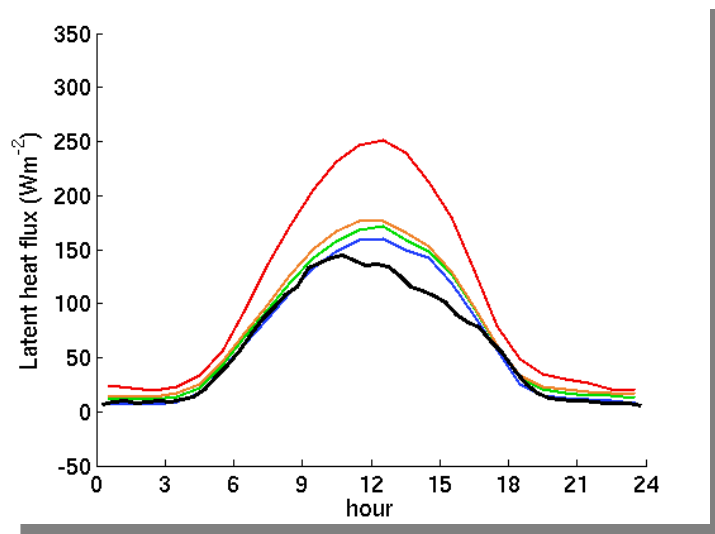


Scintillometry is a technique able to provide area-representative turbulent flux estimates at NWP grid scale

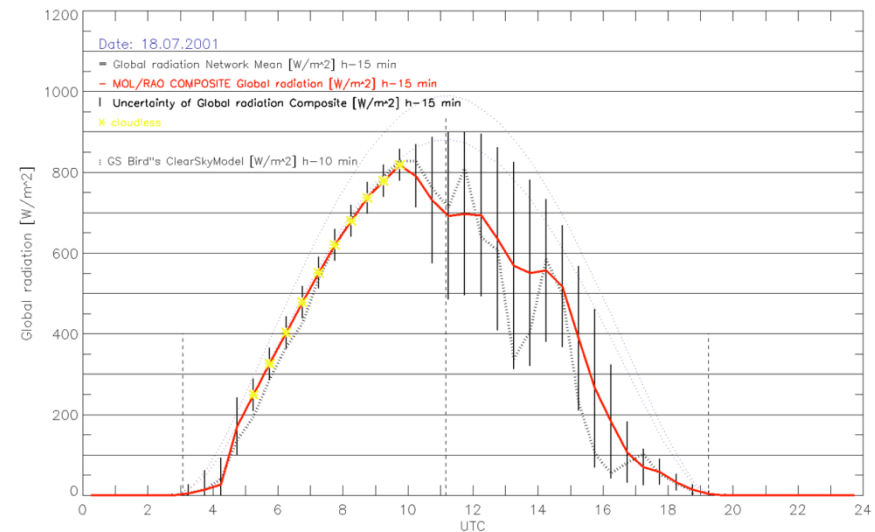
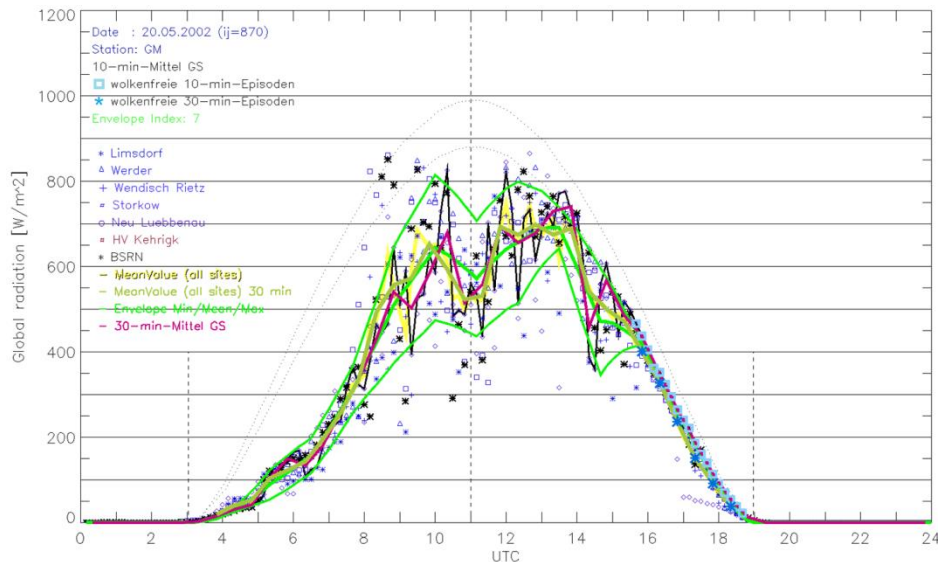


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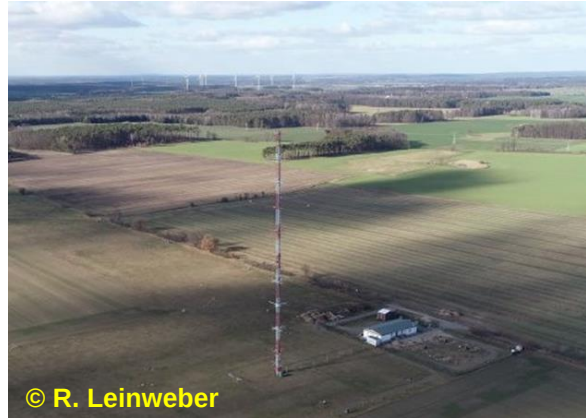
The tile and mosaic approaches are suitable strategies to take into account land-surface heterogeneity in an NWP model grid cell



An estimate of the regional variability of incoming shortwave radiation can be obtained from the temporal variability measured at a given site.



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The place of field experiments

- **Process studies: Cold pools, gusts, and coherent structures**
- **Spatial dimension: sub-mesoscale**
- **Test of measurement systems and strategies: Doppler lidar scanning strategies**
- **Non-automatic measurements: aircraft**



Thank you for your attention!