

# **ABL Measurements at MOL-RAO**

## **Serving Numerical Weather Prediction**

**Frank Beyrich**

**with contributions from**

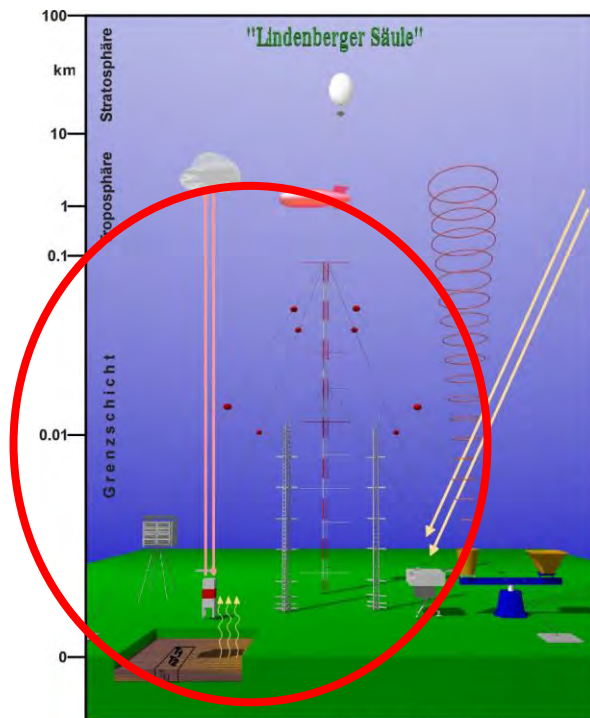
**C. Becker, B. van Kesteren, J.-P. Leps,  
E. Päsche, S. H. Richter, U. Rummel,  
G. Vogel, U. Weisensee et al.**



# 1. Introduction

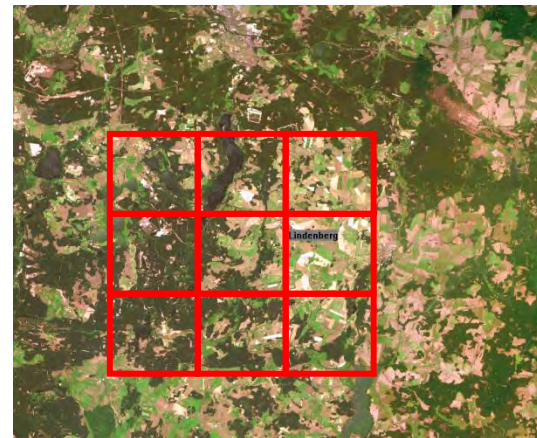
## The Atmospheric Boundary Layer and the „Lindenberg Column“

- ABL = base of the column
- high temporal variability
- large horizontal variability
- strong vertical gradients
- interaction with land surface



Lindenger Säule - Meßsystem

bestehend aus : Bodenbeobachtungen, aerologischen Messungen,  
aktiven und passiven Fernerkundungsmethoden



# 1. Introduction

## Land Surface Processes

### Flow:

friction, channelling, whirls

### Energy:

radiation turbulent transport

### Water:

precipitation, evaporation,  
run-off

### Trace Substances:

emission, deposition

### Soil processes:

heat / water transfer &  
storage

### Vegetation processes:

transpiration, gas exchange,  
assimilation

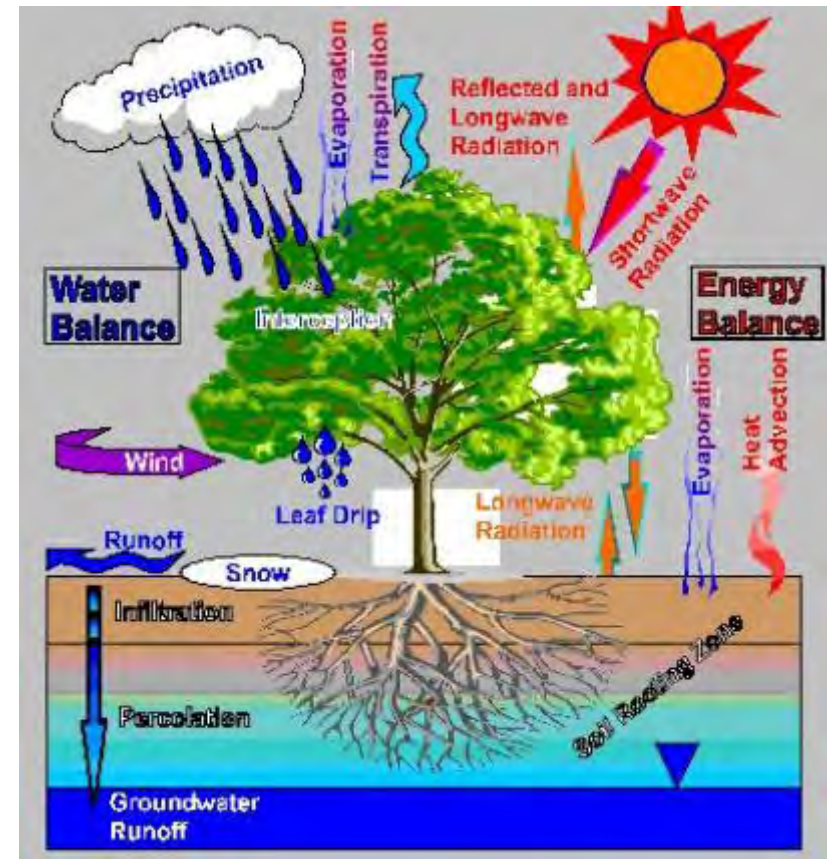
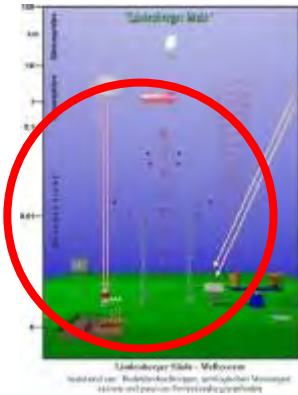


Bild: <http://www.ph.unito.it/>



## 2. ABL Measurements at MOL-RAO

### What do We Need to Measure?



- **state parameters of the air** (temperature, humidity, wind, pressure, tke)
- **process parameters in the air** (precipitation, evaporation, momentum and energy fluxes <radiation, sensible heat, latent heat>, tke)
- **soil state parameters** (temperature, water content)
- **vegetation parameters** (LAI, stomatal resistance, surface temperature)
- **water state and process variables** (temperature, waves)

... in the soil, at the surface, up to ~ 3 km ...  
... above different surfaces ...



## 2. ABL Measurements at MOL-RAO

### Sensors

#### Air state variables



#### Turbulence



#### Radiation



#### Soil parameters



#### Precipitation

## 2. ABL Measurements at MOL-RAO

### Sites (I)

#### The Falkenberg Boundary Layer Field Site (GM Falkenberg)

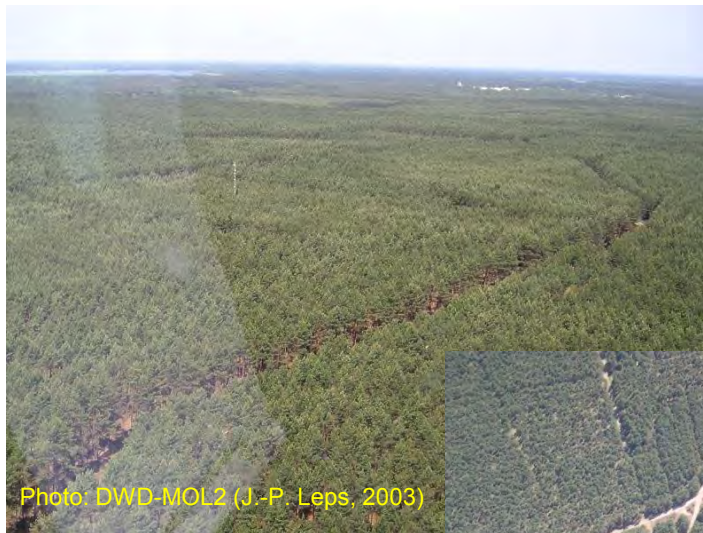




## 2. ABL Measurements at MOL-RAO

### Sites (II)

#### Forest station Kehrigk



## 2. ABL Measurements at MOL-RAO

### Complex Measurement Systems (III)

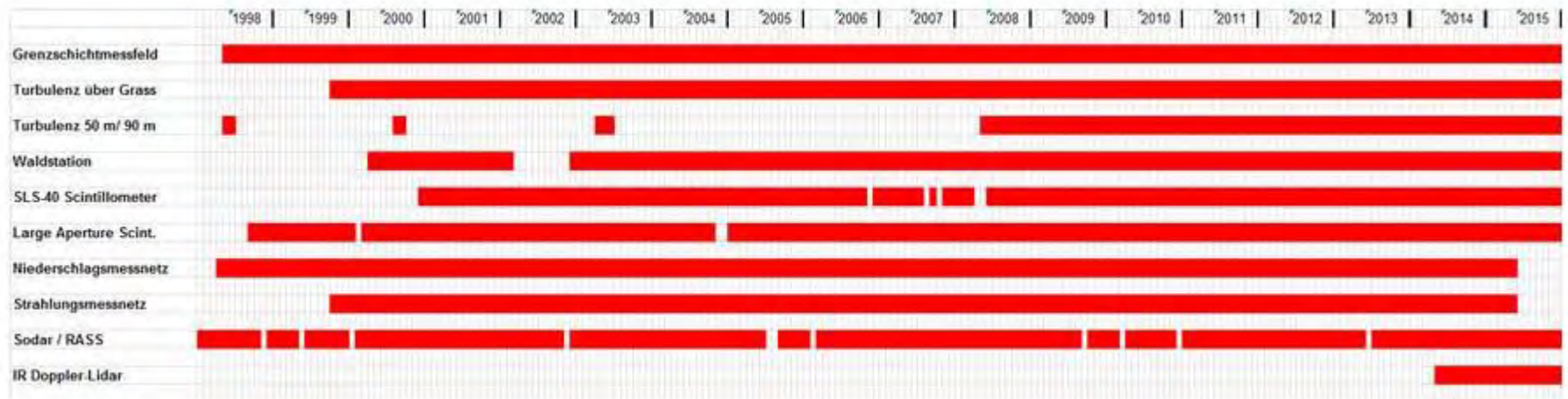
#### Remote sensing/ airborne systems





## 2. ABL Measurements at MOL-RAO

### Operation Times



## 2. ABL Measurements at MOL-RAO

### QA / QC Measures

Site	<ul style="list-style-type: none"><li>• <b>Site</b> selection and characterization</li><li>• <b>Sensor</b> selection and characterization</li><li>• <b>Station</b> set-up and validation</li></ul>
Operation	<ul style="list-style-type: none"><li>• <b>Maintenance</b> regime, (re-)calibrations</li><li>• <b>Data</b> transmission and storage (incl. back-up)</li><li>• Quicklook / <b>visual</b> data <b>control</b></li></ul>
Control	<ul style="list-style-type: none"><li>• <b>Automatic</b> data <b>control</b></li><li>• <b>Manual</b> data <b>control</b></li><li>• <b>Data base</b> (measured values + quality flag)</li></ul>
User	<ul style="list-style-type: none"><li>• <b>Data user / -analysis</b> → feedback</li><li>• <b>optional re-calculation / revision of QC</b> and flagging</li></ul>

## 2. ABL Measurements at MOL-RAO

### Redundant Sensor Systems

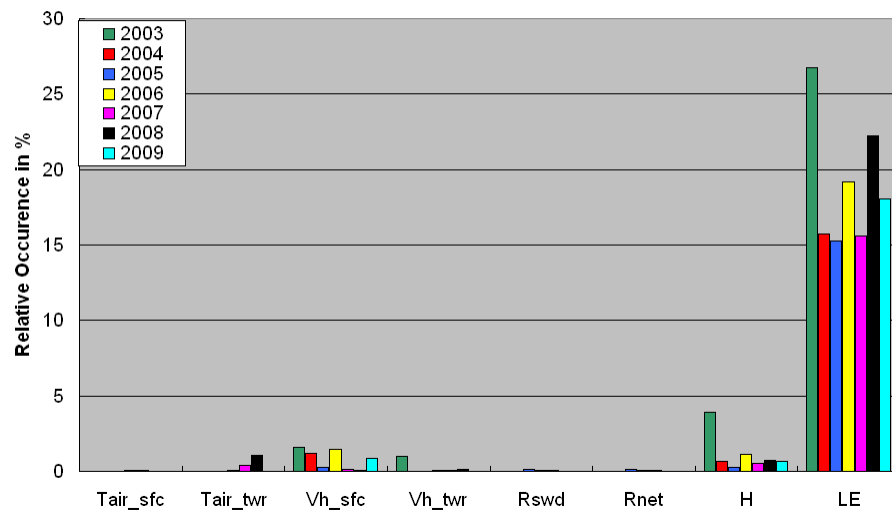
Quantity	Standard Measurement	Redundant Determination	Realization
air temperature	Pt-100 (HMP45)	Pt-100 (Frankenberger)	Y
air humidity	capacitive (HMP45)	psychrometer (Frankenberger)	Y
wind speed	cup anemometer	(sonic anemometer)	(Y)
wind direction	wind vane	(sonic anemometer)	(Y)
air pressure	piezo-resistive	-	N
precipitation	weighing	tipping bucket / Hellmann	Y
snow depth	manual reading	sonic ranging	Y
short wave radiation	thermopile (CM 24)	photo diode (PAR)	(Y)
long wave radiation	thermopile (PIR)	pyro-electric (KT 15)	Y
soil temperature	Pt-100	Pt-100 (2nd profile)	N
soil moisture	TDR (Trime EZ)	Lumbricus / gravimetry (monitoring)	Y
soil heat flux	thermopile (flux plate)	(soil temp. profile)	(Y)
turb. Momentum flux	sonic anemometer	wind speed profile	Y
turb. sensible heat flux	sonic anemometer	temperature profile, scintillometer	Y
turb. latent heat flux	sonic anemometer + IR-hygrometer	air humidity profile	Y



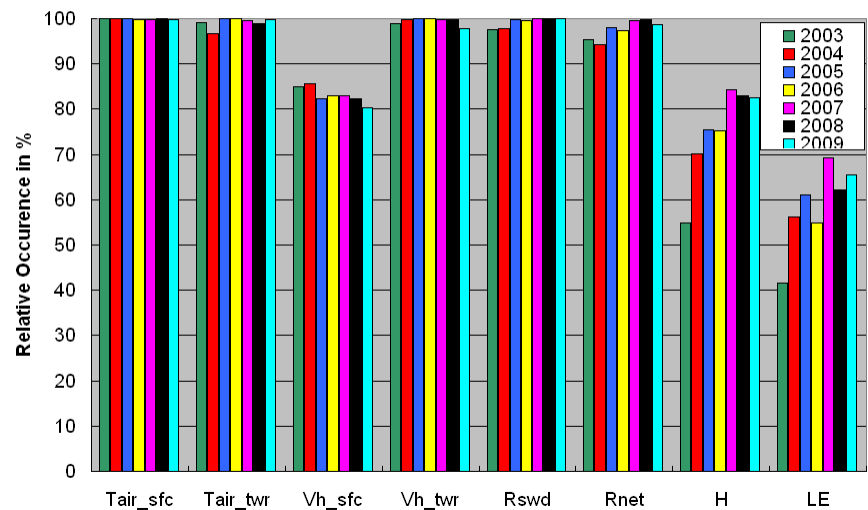
## 2. ABL Measurements at MOL-RAO

### Results of QA/QC Activities: Data Availability and Data Quality

Missing Data in CEOP Falkenberg Data Set



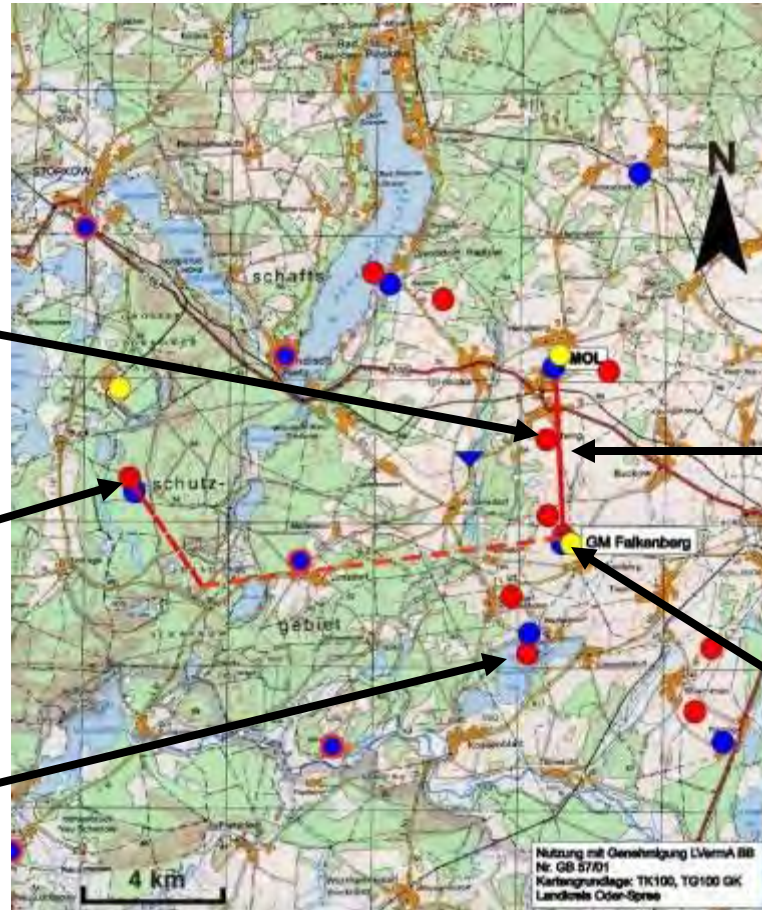
Good Quality Data in CEOP Falkenberg Data Set



# 3. Heterogeneous Land Surface

## Field Experiment: LITFASS-2003

micrometeorol. /  
flux measurements



Airborne measurements



Scintillometry

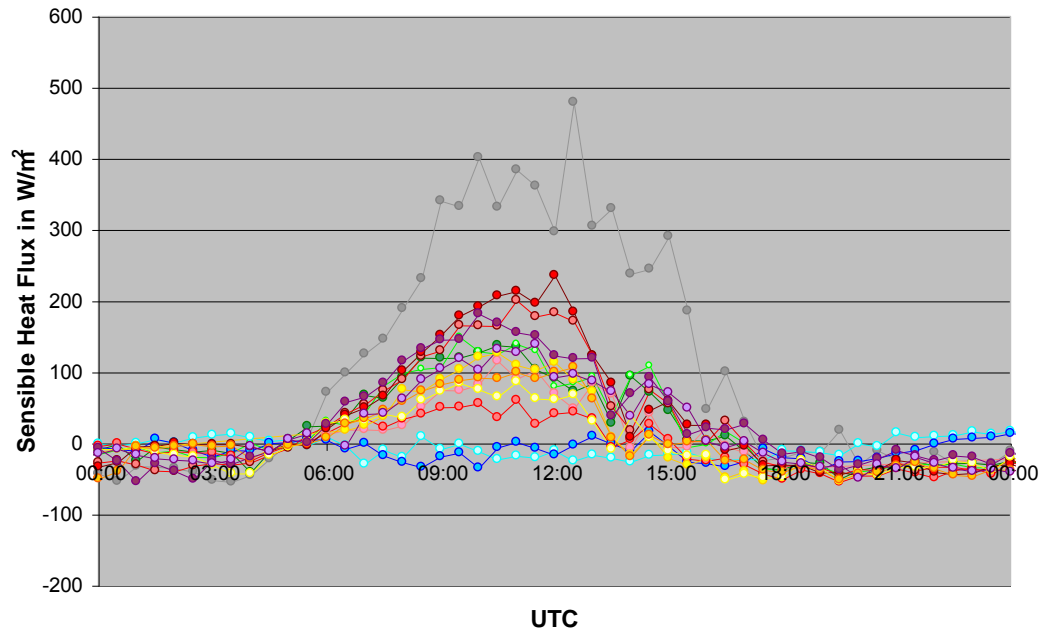


Ground based  
remote sensing

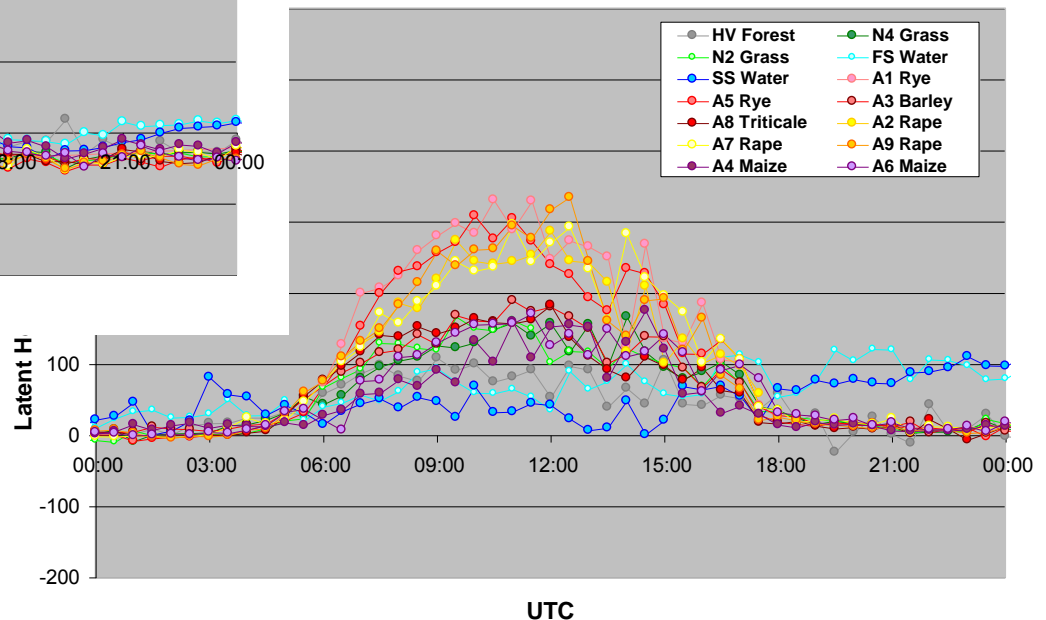


# 3. Heterogeneous Land Surface

## Surface Fluxes over Different Land Use Types



- large differences between forest, farmland, water
- factor 2-3 for farmland
- $\text{var}(H) > \text{var}(LE)$





# 3. Heterogeneous Land Surface

## Strategies to Determine Area-Averaged Fluxes (from Measurements)

**Suitable (weighted)  
averaging of local  
measurements**

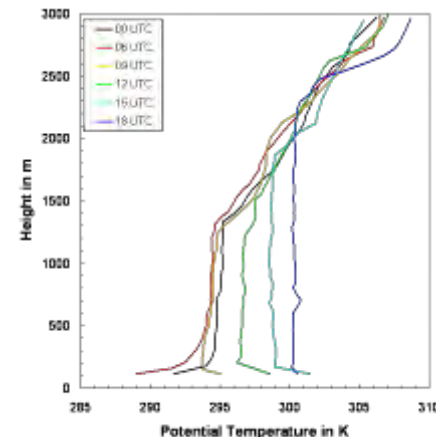


**Aircraft  
measurements**



© J. Bange (TU Braunschweig)

**Budget  
methods**



**Scintillometry**



$$F_X = \frac{\sum p_i F_{Xi}}{\sum p_i}$$

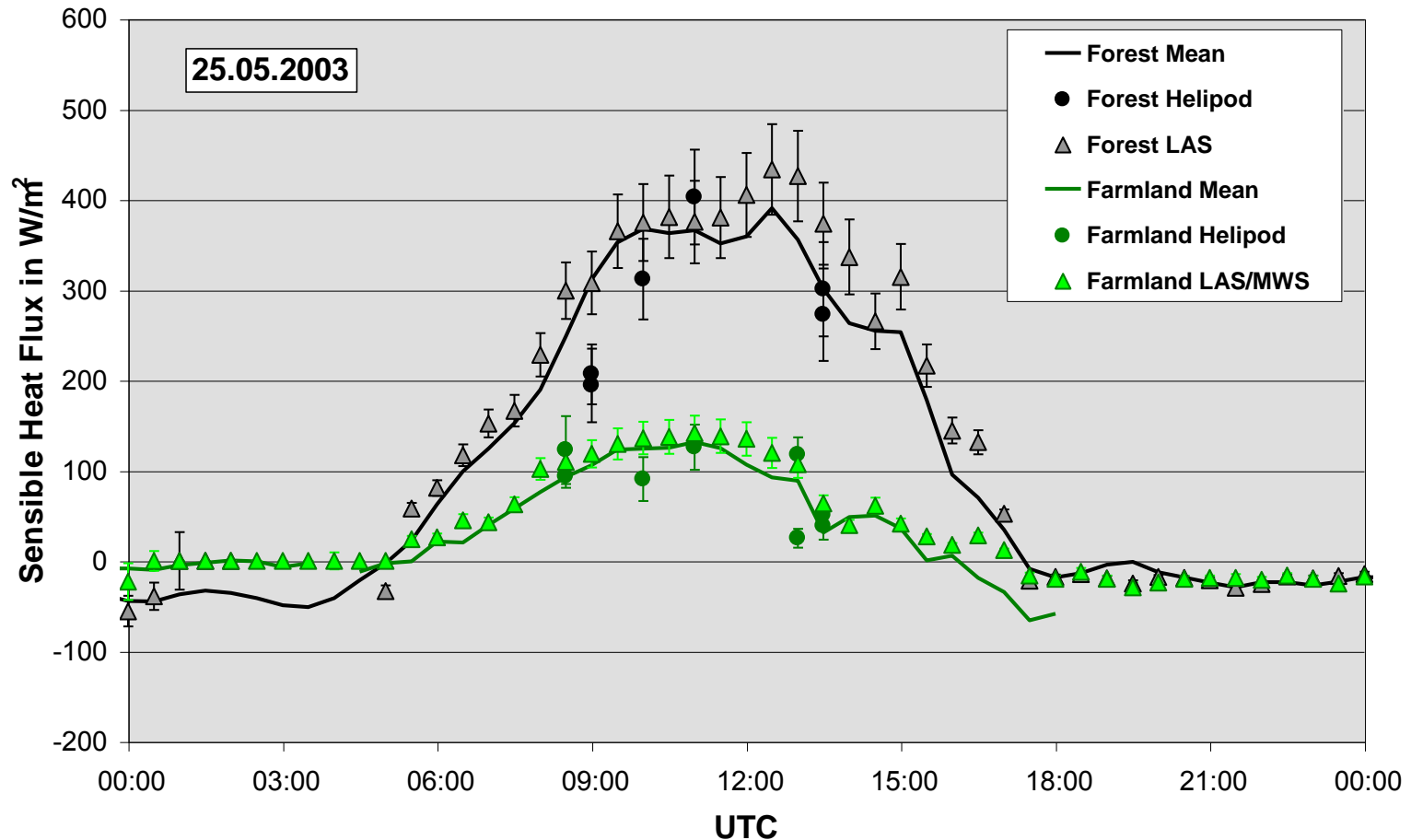
$$F_X \sim \langle w'X' \rangle$$

$$F_X \sim \left( \frac{d\bar{X}}{dt}; \frac{\partial h}{\partial t} \right)$$

$$F_X \sim C_X^2 / \phi_X(z/L)$$

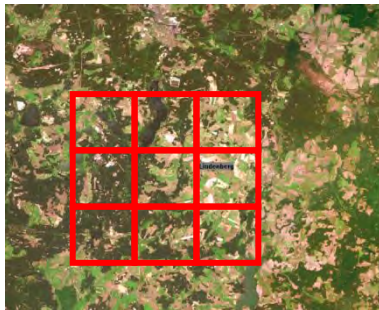
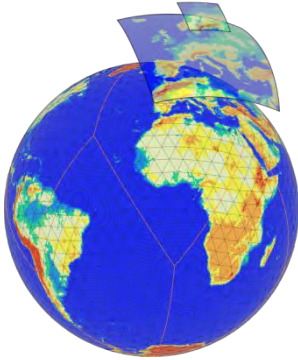
# 3. Heterogeneous Land Surface

## LITFASS-2003: Area-Averaged Fluxes

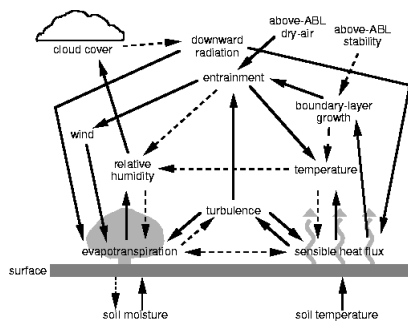


# 4. Contributions to NWP

## Aspects



- operational diagnostics
- long-term validation
- cluster analysis / conditional validation
- data sets
- case studies
- parametrization development
- external (land surface) parameters
- spatial variability

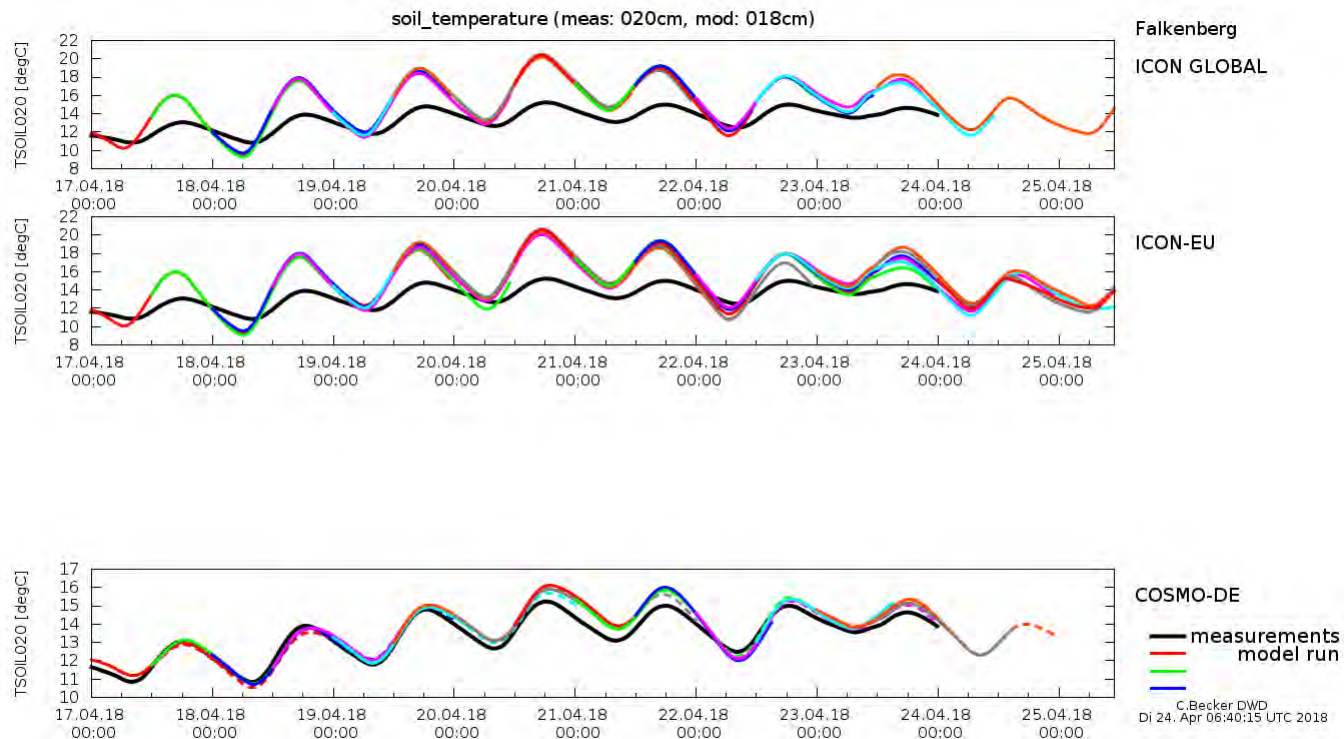


© Mike Ek



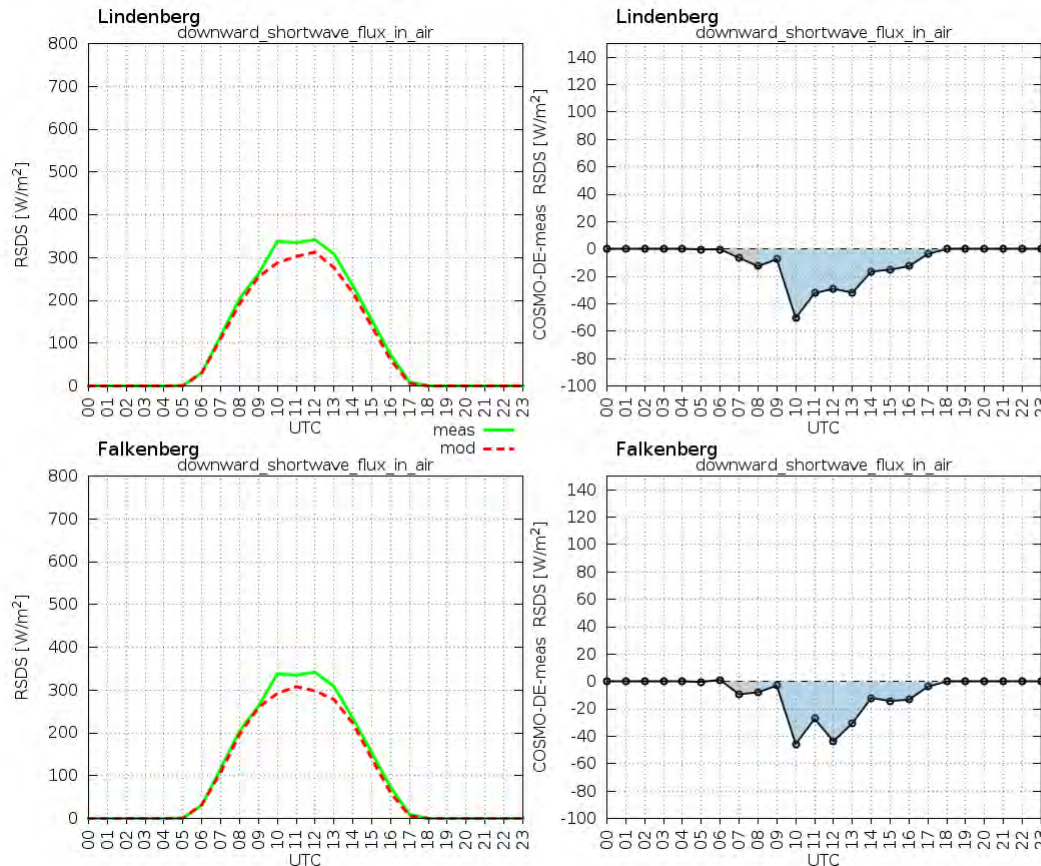
# 4. Contributions to NWP

## Operational Diagnostics: Time Series



# 4. Contributions to NWP

## Operational Diagnostics: Mean Monthly Diurnal Cycles



SWDIRS\_RAD+SWDIFDS\_RAD

COSMO-DE  
start time 00 UTC  
03 2018

monthly average

meas. site Falkenberg  
lon 14.1222 lat 52.1665 73mNN  
meas. system radiation scaffold I

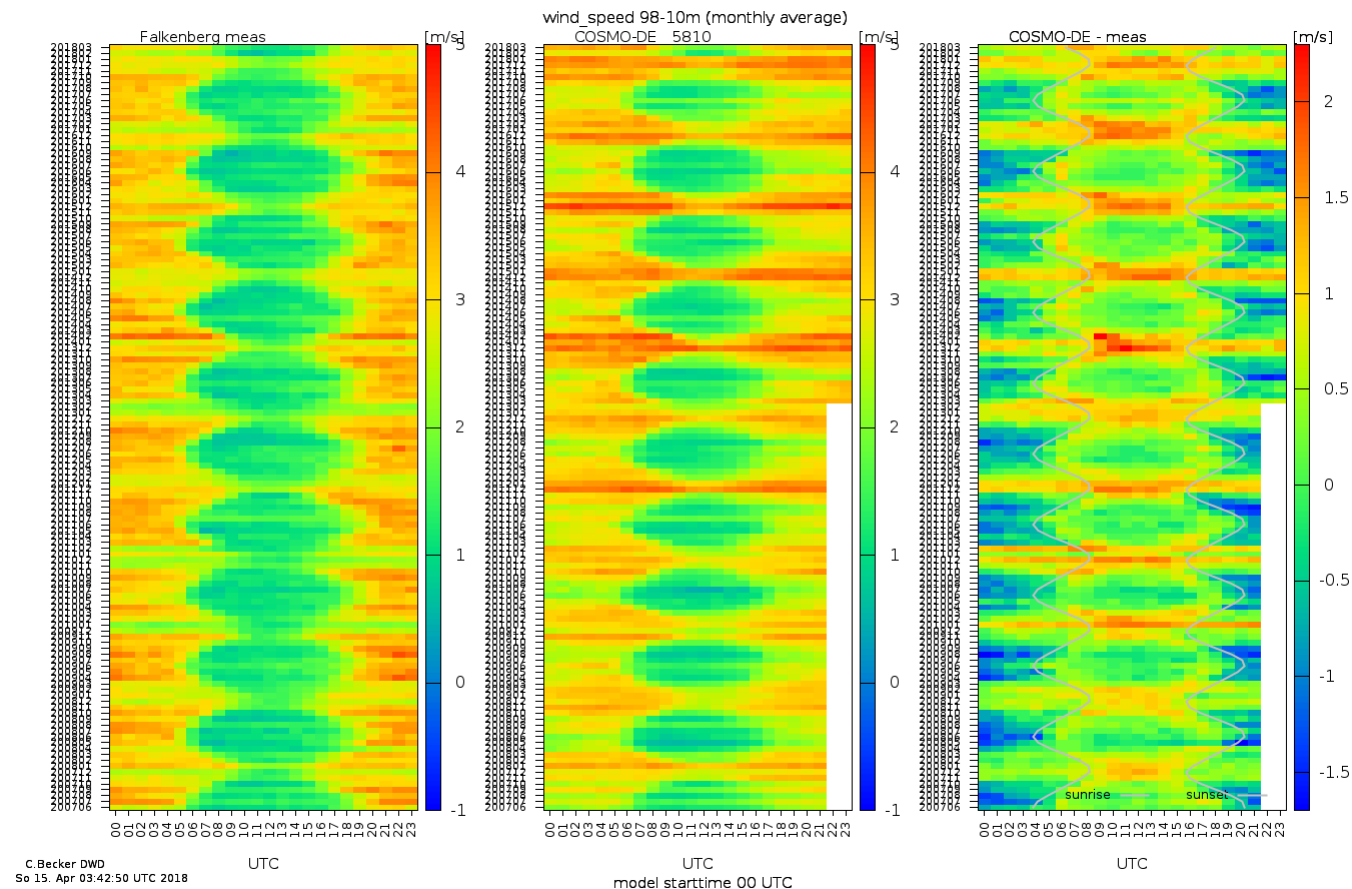
mod. grid point Lindenberg  
stations\_id 3015  
lon 14.1217 lat 52.2306 98.28mNN  
soiltype 5 (loam)

mod. grid point Falkenberg  
stations\_id 5810  
lon 14.1149 lat 52.1556 67.78mNN  
soiltype 5 (loam)

C.Becker DWD  
So 15. Apr 04:52:31 UTC 2018

# 4. Contributions to NWP

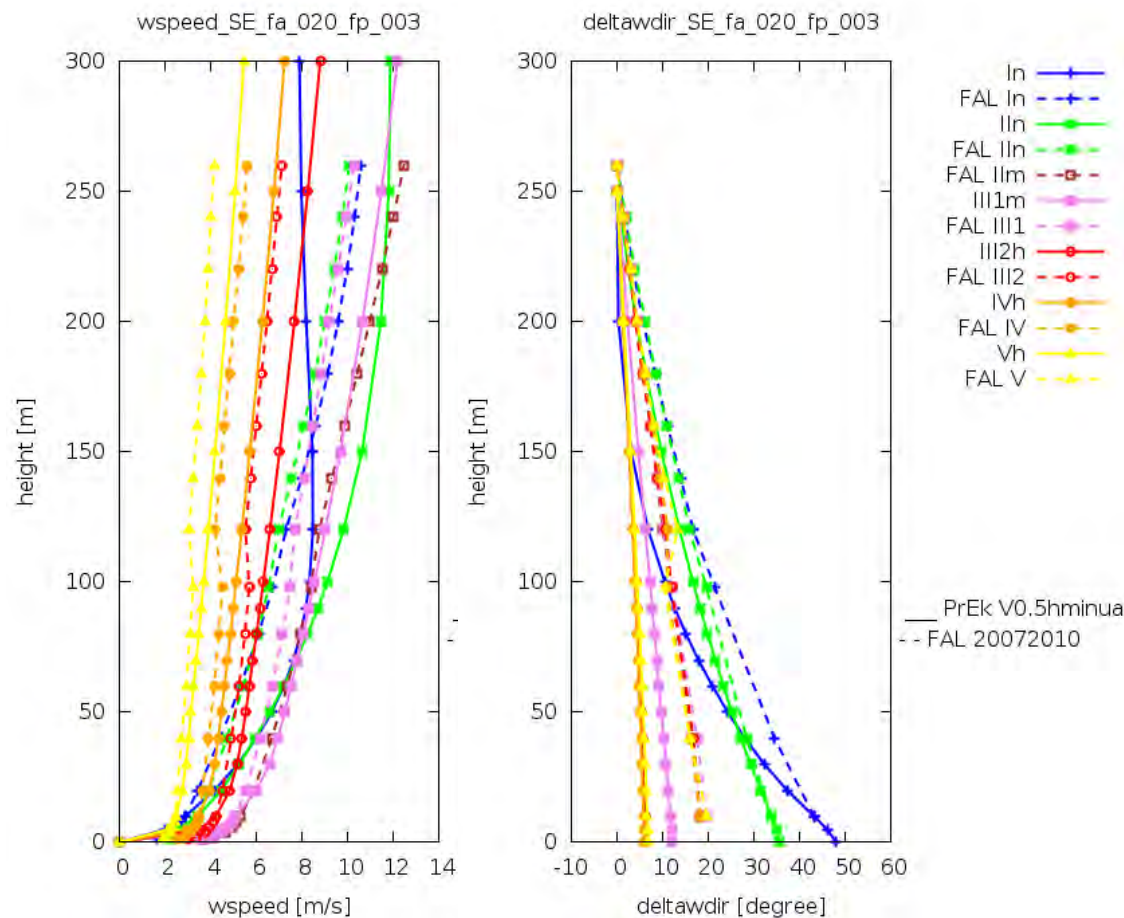
## Longterm Validation





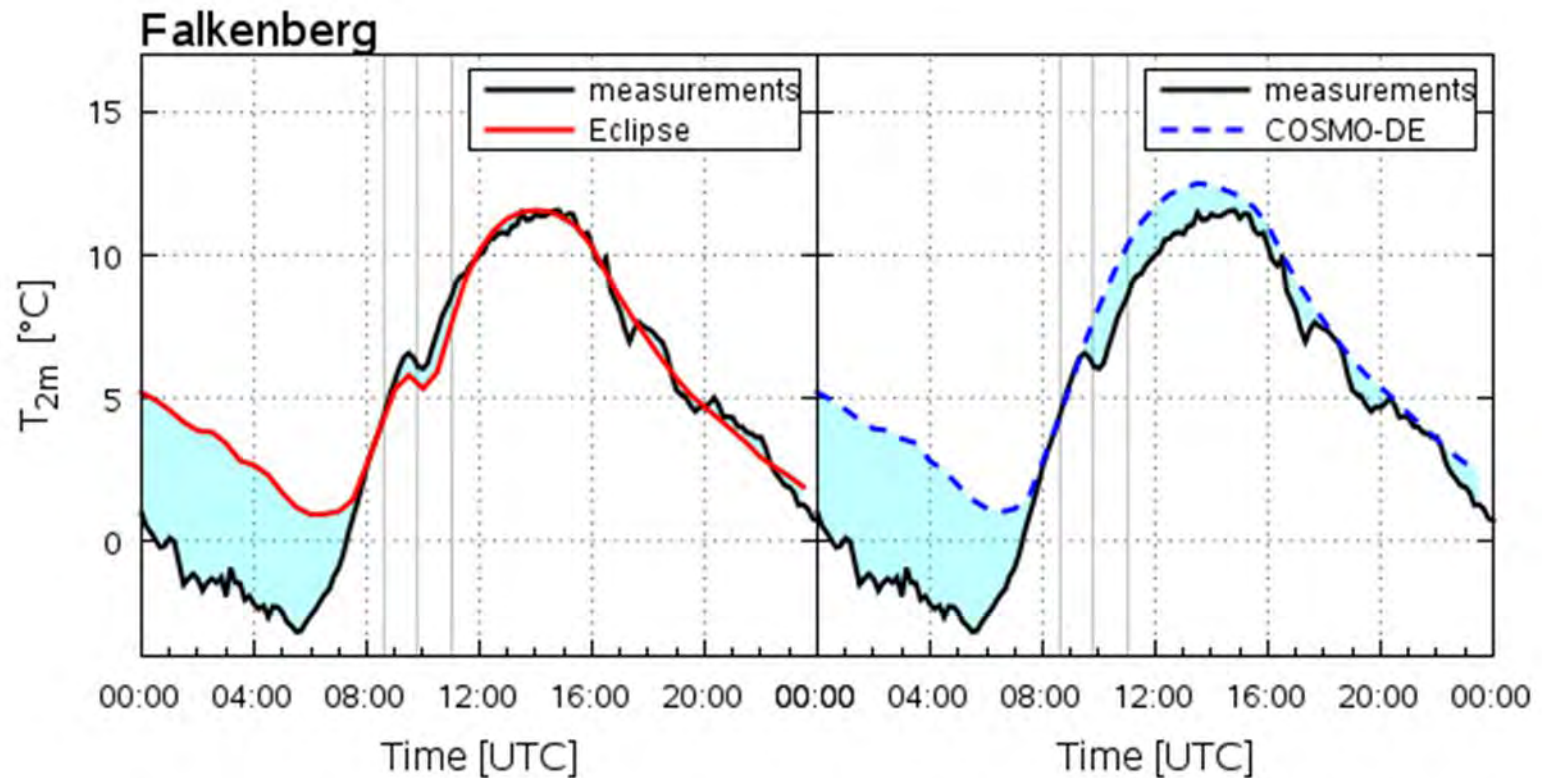
# 4. Contributions to NWP

## Conditional Validation: Profiles for VDI-3783/8



## 4. Contributions to NWP

### Case Studies: Solar Eclipse March 2015

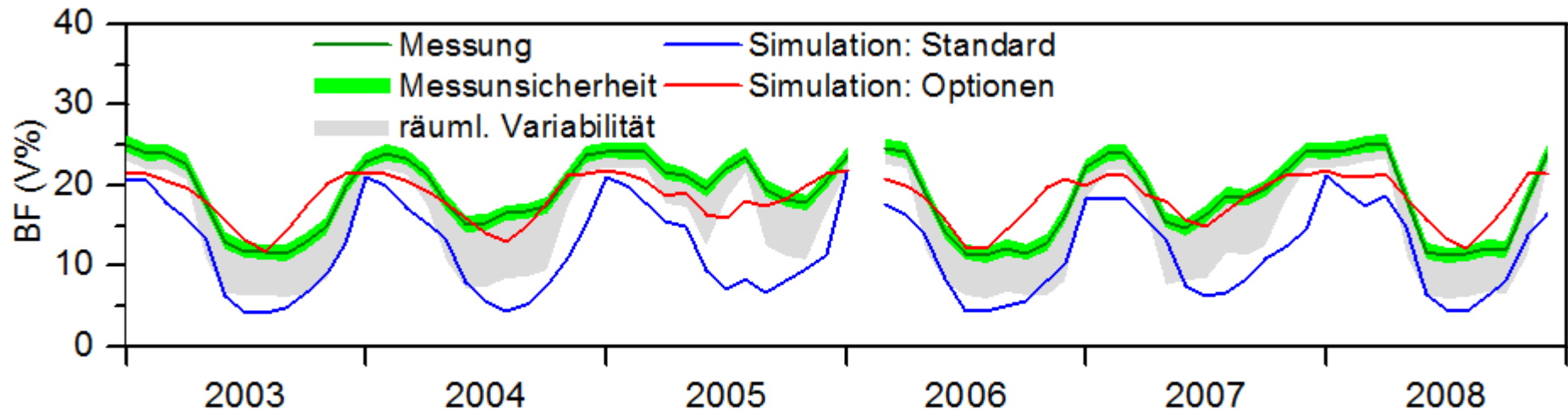


# 4. Contributions to NWP

## Parametrization Studies: Soil Moisture in TERRA

Improved simulation of soil water content through

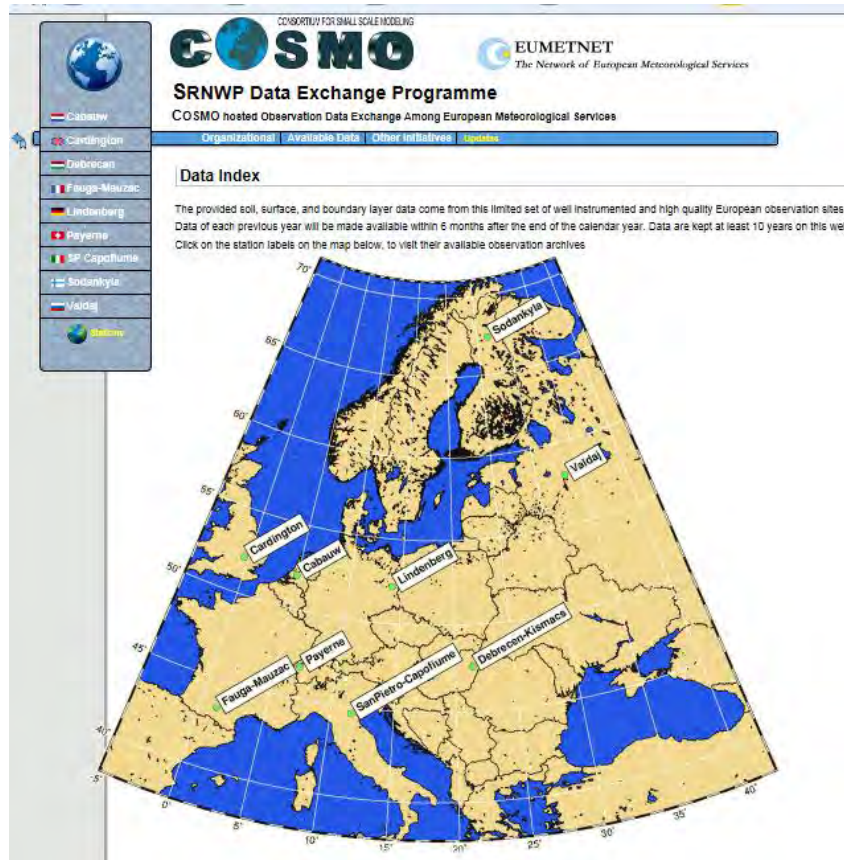
- consideration of bare soil evaporation
- modified root density distribution with depth
- use of vegetation parameters (LAI, plcov) from satellite data
- modified deep soil water exchange
- Consideration of enlarged infiltration



Zeitlicher Verlauf der Bodenfeuchte am GM Falkenberg in den Jahren 2003-2008

# 4. Contributions to NWP

## Data Sets: The SRNW Data Pool



### NET

of European Meteorological Services

### Services

You are in: /observations/Lindenberg

th. For documentation, metadata information about the station an any other available documentation you may look at the [support](#) folder

[Home](#)

 <b>2006</b> 24 items 20/12/2016	 <b>2007</b> 24 items 20/12/2016	 <b>2008</b> 24 items 20/12/2016	 <b>2009</b> 24 items 20/12/2016	 <b>2010</b> 24 items 20/12/2016	 <b>2011</b> 24 items 20/12/2016
 <b>2012</b> 24 items 20/12/2016	 <b>2013</b> 24 items 20/12/2016	 <b>2014</b> 24 items 20/12/2016	 <b>2015</b> 24 items 20/12/2016	 <b>2016</b> 24 items 22/12/2017	 <b>2017</b> empty 22/12/2017

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(0 visits from this browser)





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