BLLAST Flux maps ~~& Drainage Flow Analysis~~

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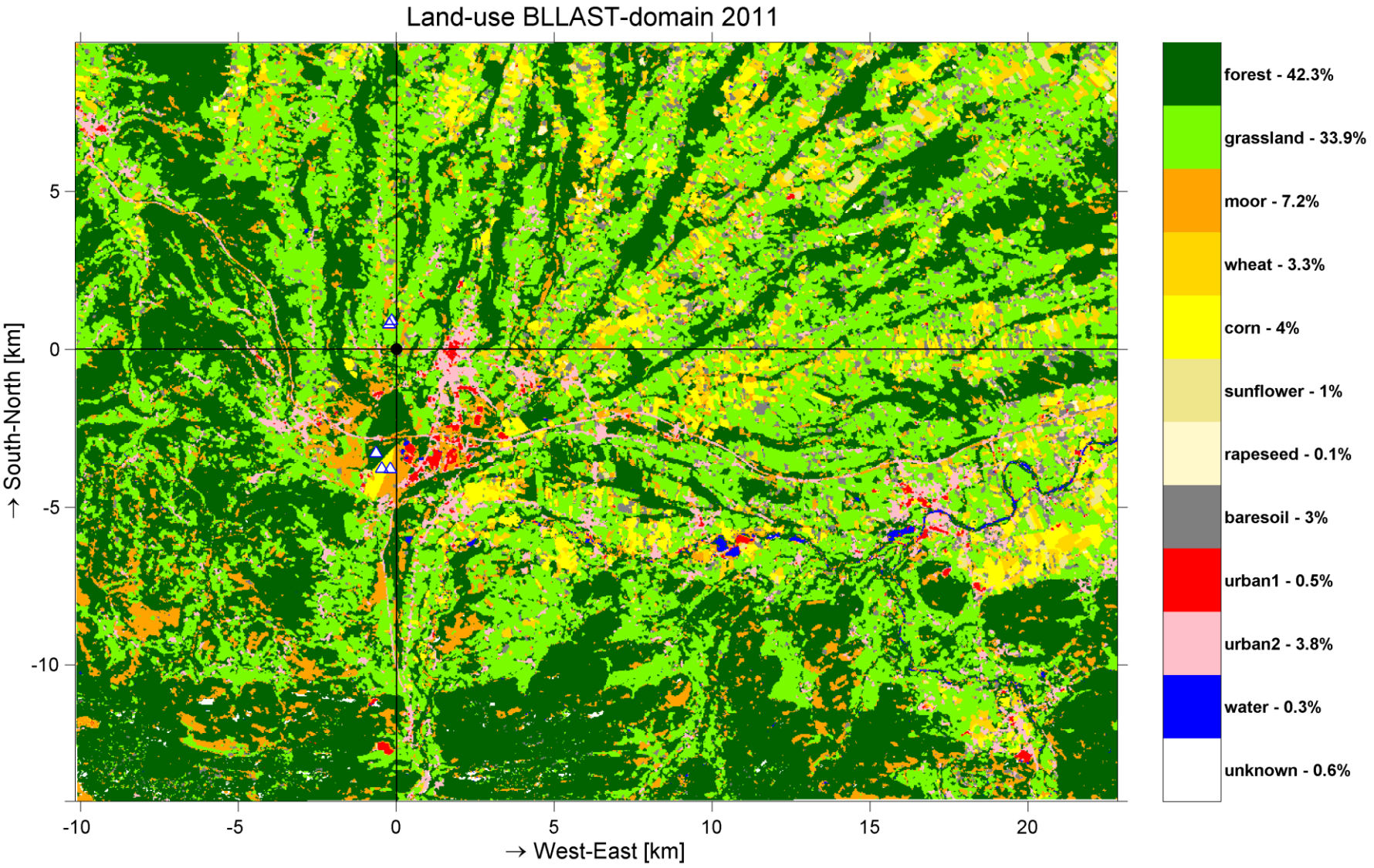
GOAL: 2-km grid flux maps (*H* + *LvE*) for the BLLAST domain centered around the Valimev tower for all IOP's

Available data

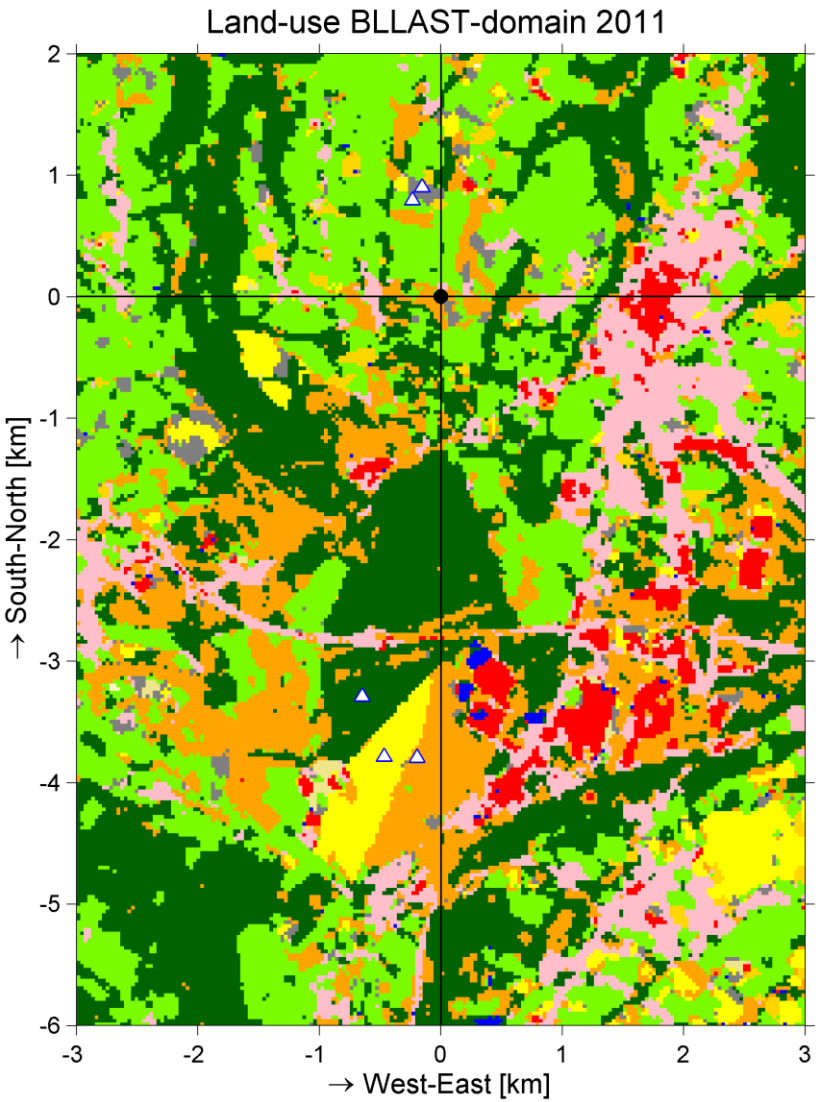
- 30m-resolution Landuse (LU) map with Universal Transverse Mercator (UTM) projection (Cartesian)
- EC-flux stations at 5 sites with *uniform* footprint (forest, moor, corn, wheat, grass)
- EC-flux stations at 1 site with mixed footprint (60m-Valimev-tower 30m, 45m, 60m)
- Standard Energy Balance and Met-data at most sites

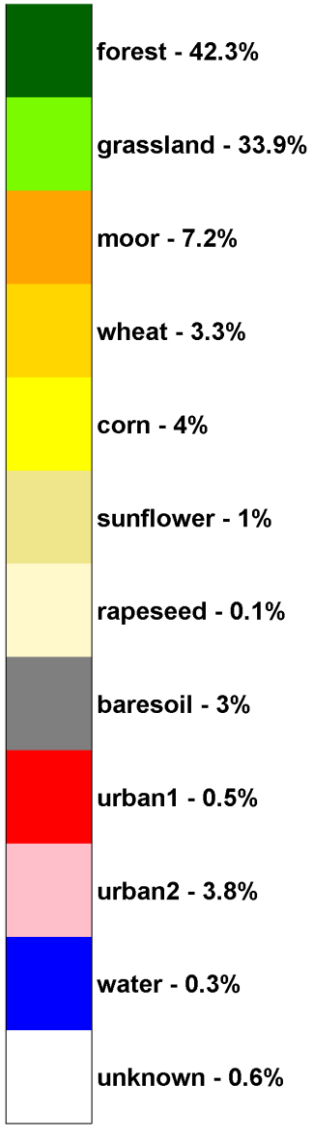
→ Time-series data: 30min averaged data

Available data - Landuse map



Available data - Landuse map + EC stations





→ forest (EC)

→ grassland (EC)

→ moor (EC)

→ wheat (EC)

→ corn (EC)

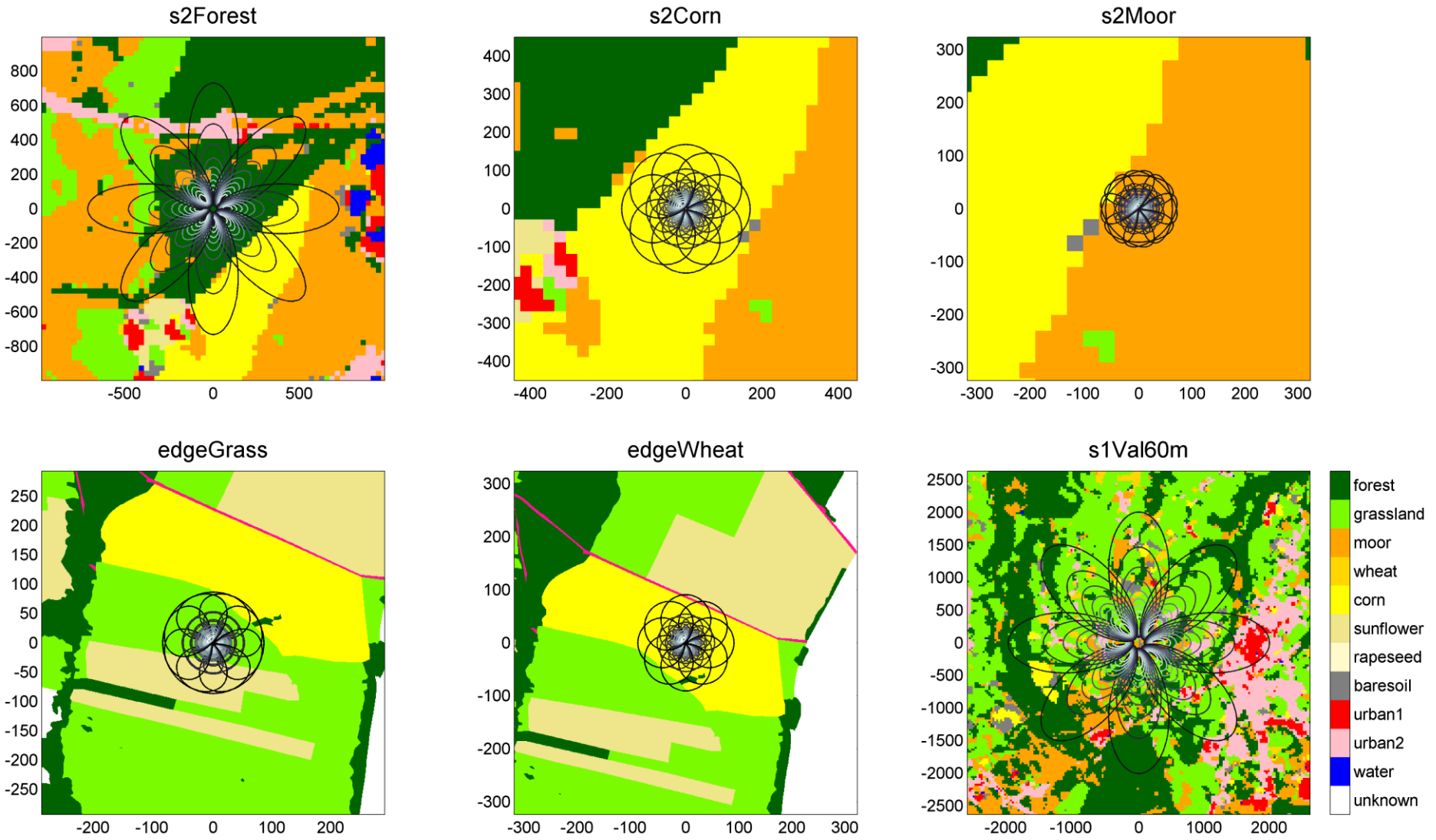
Task: Determine the fluxes per landuse from the available data

1. Footprint (FP) method
2. Direct method

→ List with assumptions we make

→ Test the validity of the assumptions

LU-flux assignment – FP-method



Prototype FP's for typical day-time conditions

LU-flux assignment – FP-method

$$H_{EC1} = a_{EC1_1} H_{LU1} + a_{EC1_2} H_{LU2} + \cdots + a_{EC1_n} H_{LU_n}$$

$$H_{EC2} = a_{EC2_1} H_{LU1} + a_{EC2_2} H_{LU2} + \cdots + a_{EC2_n} H_{LU_n}$$

…

$$H_{EC_m} = a_{EC_{m,1}} H_{LU1} + a_{EC_{m,2}} H_{LU2} + \cdots + a_{EC_{m,n}} H_{LU_n}$$

- Determine FP-weights, $a_{EC_{m,n}}$, of each LU for each EC-system for each time-step
- Solution for $H_{LU_{1..n}}$ as long as:
  - $m > n$
  - for a certain LU_n $\sum_{m=1}^{M} a_{EC_{m,n}} \neq 0$

Advantage:

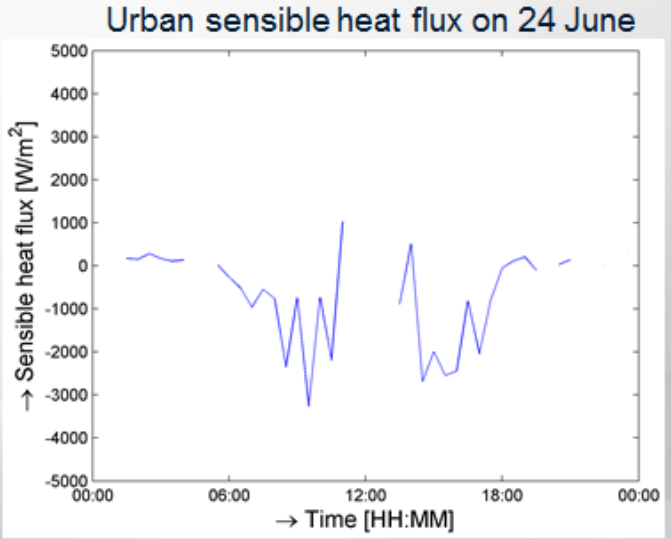
- Takes care of mixed-FPs of assumed uniform-FP EC-stations
- Makes use of mixed-FP EC stations (Valimev tower)
- Allows H_{LU} flux estimates for non covered surfaces (urban, bare-soil, some crops)

Disadvantage:

- Relies heavily on data quality of ALL systems
- Relies heavily on the performance of the footprint model

Additional land-use flux (Urban)

- Large fluctuations in graph
- Data gaps
- Sink of all the assumptions made in the FP-method



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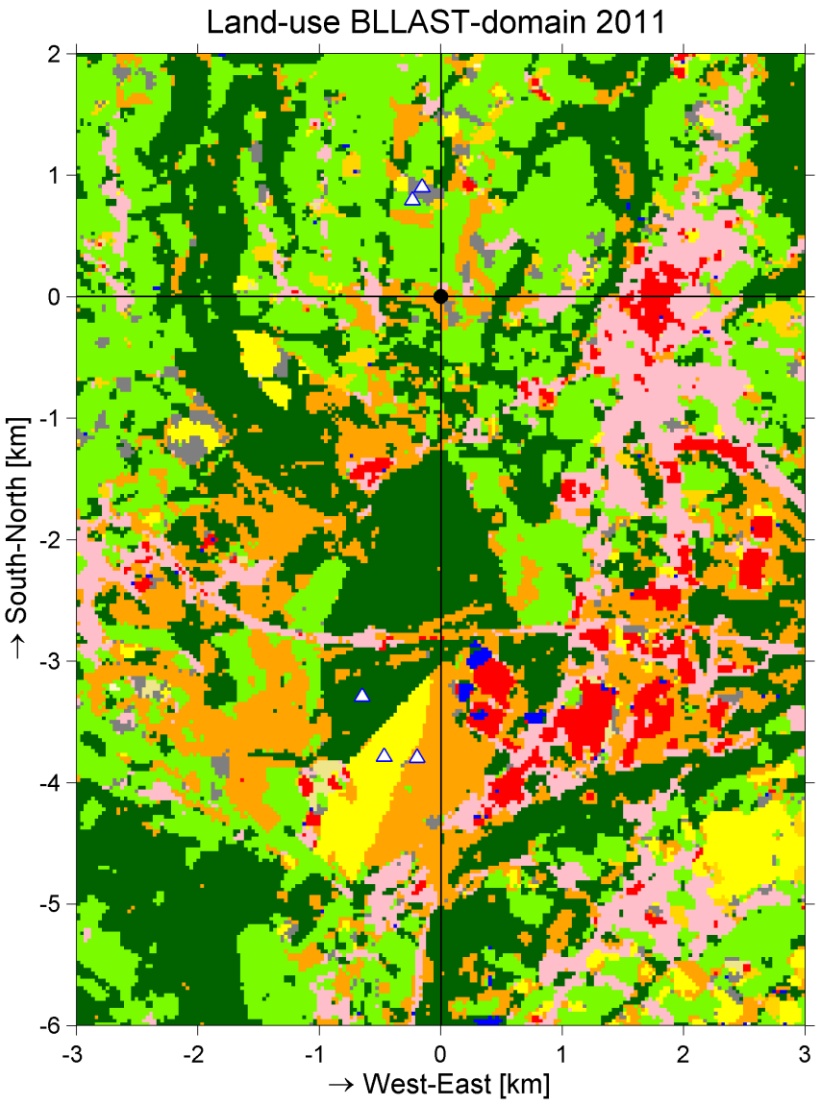
CONCLUSION: FP-method fails

LU-flux assignment – Direct-method

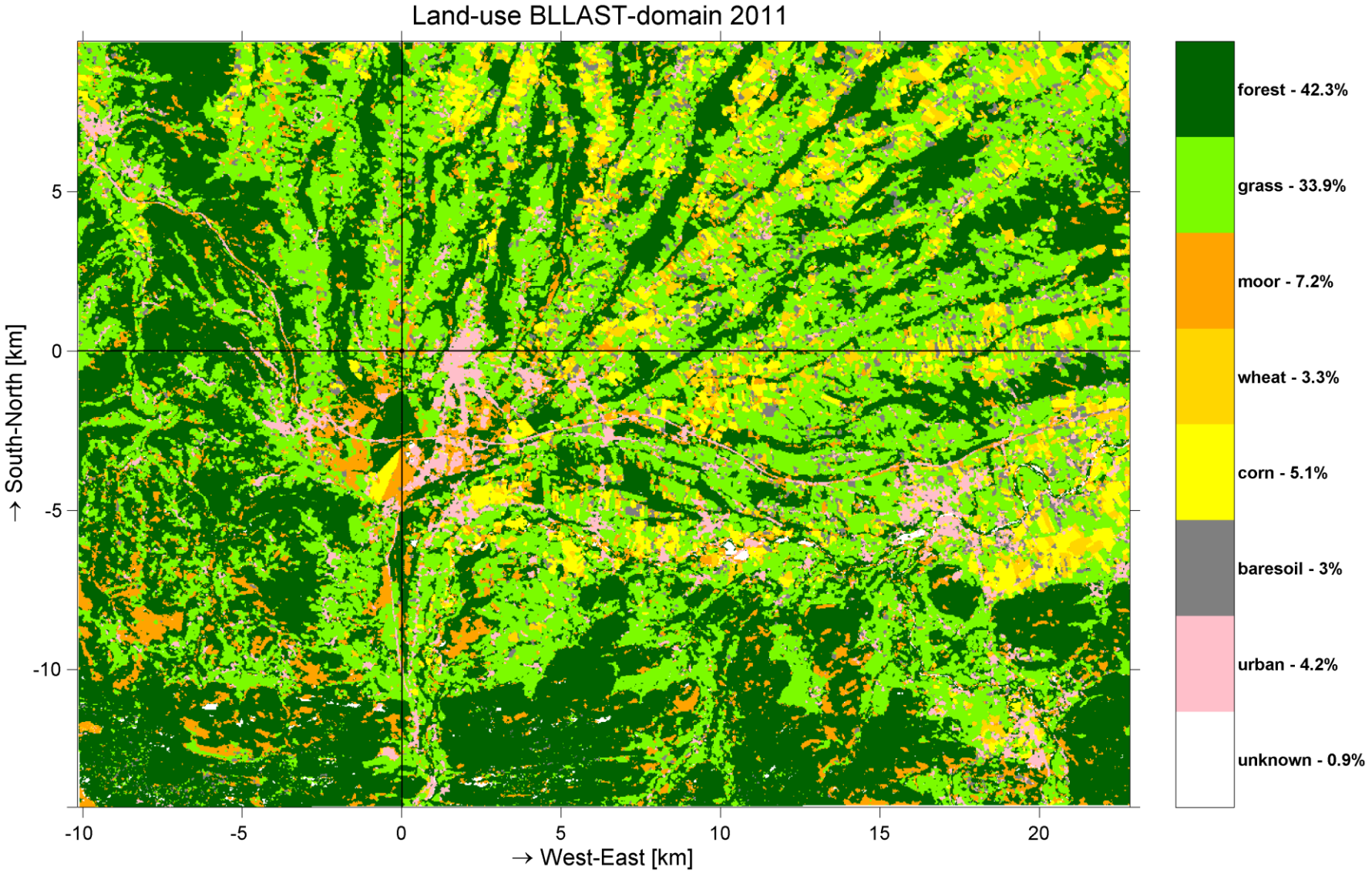
- Assign fluxes of EC-stations in forest, moor, corn, wheat, grass to these landuse-classes (assumes an uniform footprint)
- Assign fluxes of EC-station in corn to the landuse-classes sunflower and rapeseed
- Assign modelled fluxes to land-use classes of baresoil and uban1/urban2

LU-flux assignment – Direct-method



forest - 42.3%	→ forest (EC)
grassland - 33.9%	→ grassland (EC)
moor - 7.2%	→ moor (EC)
wheat - 3.3%	→ wheat (EC)
corn - 4%	→ corn (EC)
sunflower - 1%	→ corn (EC)
rapeseed - 0.1%	→ corn (EC)
baresoil - 3%	→ baresoil (EB-model)
urban1 - 0.5%	→ urban (EB-model)
urban2 - 3.8%	→ urban (EB-model)
water - 0.3%	→ unknown (*)
unknown - 0.6%	→ unknown (*)

LU-flux assignment – Direct-method



Simplified LU-map

$$R_n = (1-\alpha)S_{in} + L_{in} - \varepsilon\sigma T_s^4$$

$$G = G_{frac} R_n$$

- To solve
- Measured
- Set Constant
- Phys Constant

day-time:

$$H = \beta \frac{R_n - G}{1+\beta}$$

$$L_v E = \frac{R_n - G}{1+\beta}$$

night-time:

$$H = R_n - G$$

$$L_v E = 0$$

Set Constants				
	α	ε	G_{frac}	β
Urban	0.15	0.92	0.3/0.5	5
Bare-soil	0.17	0.96	0.3/0.5	5

Lemonsu et al. (2004) and Grimmond&Oke (1999)

LU-flux assignment – Direct-method – Model Urban and Bare-soil fluxes

$$U_* = \sqrt{\frac{U(z_m)}{r_{am}}} \qquad with\ r_{am}(z_m, z_{0m}, L_{mo})$$

$$T_s = \frac{Hr_{ah}}{\rho c_p} + T(z_h) \quad with\ r_{ah}(z_h, z_{0h}, L_{mo})$$

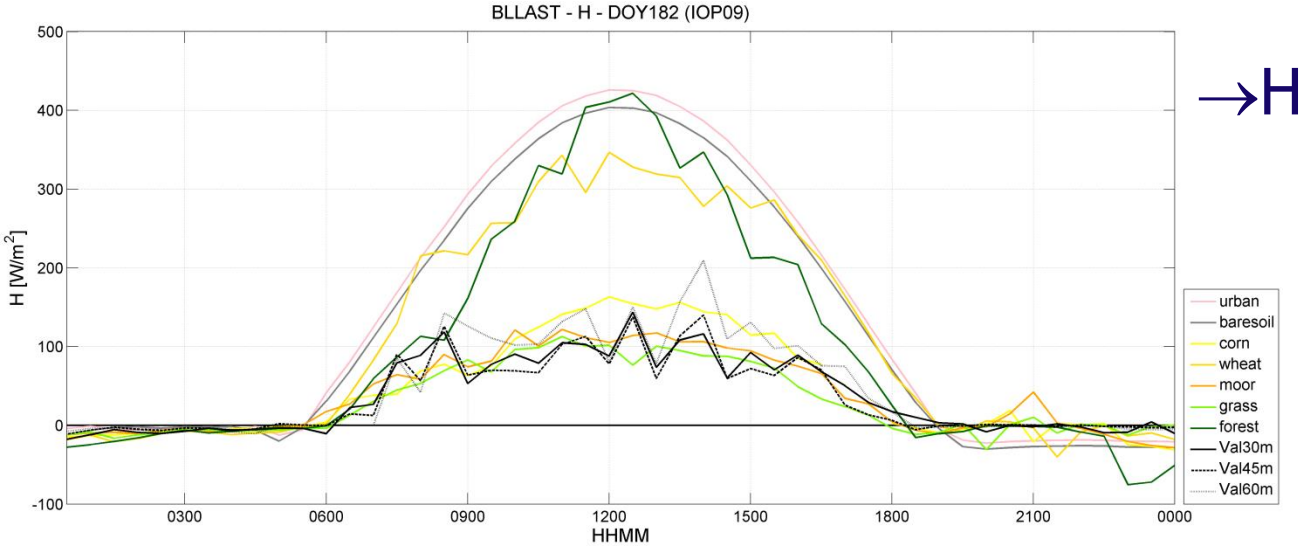
- to Solve
- Measured
- Set Constant
- Phys Constant

$\rightarrow z_{0h}$ scaling after Kanda, 2007 (urban) and

Zilitinkevitch, 1995 (bare-soil)

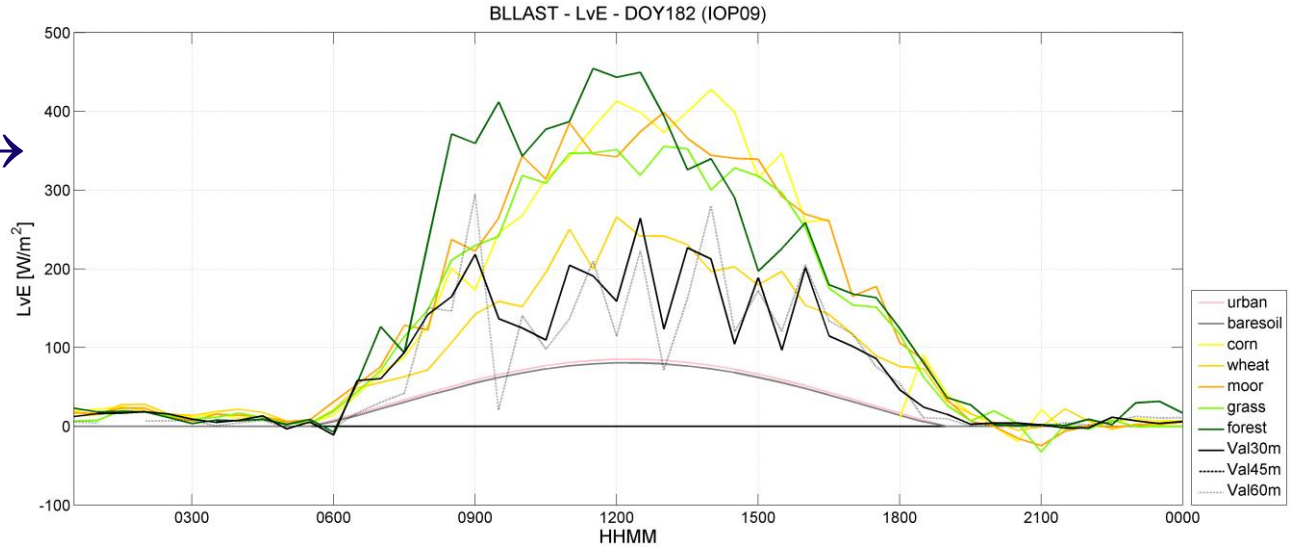
Set Constants			
	z_m & z_h	z_{0m}	d
Urban	30m	0.5m	3m
Bare-soil	30m	0.05m	0m

LU-flux assignment – Direct-method - Model Urban and Bare-soil fluxes



→H

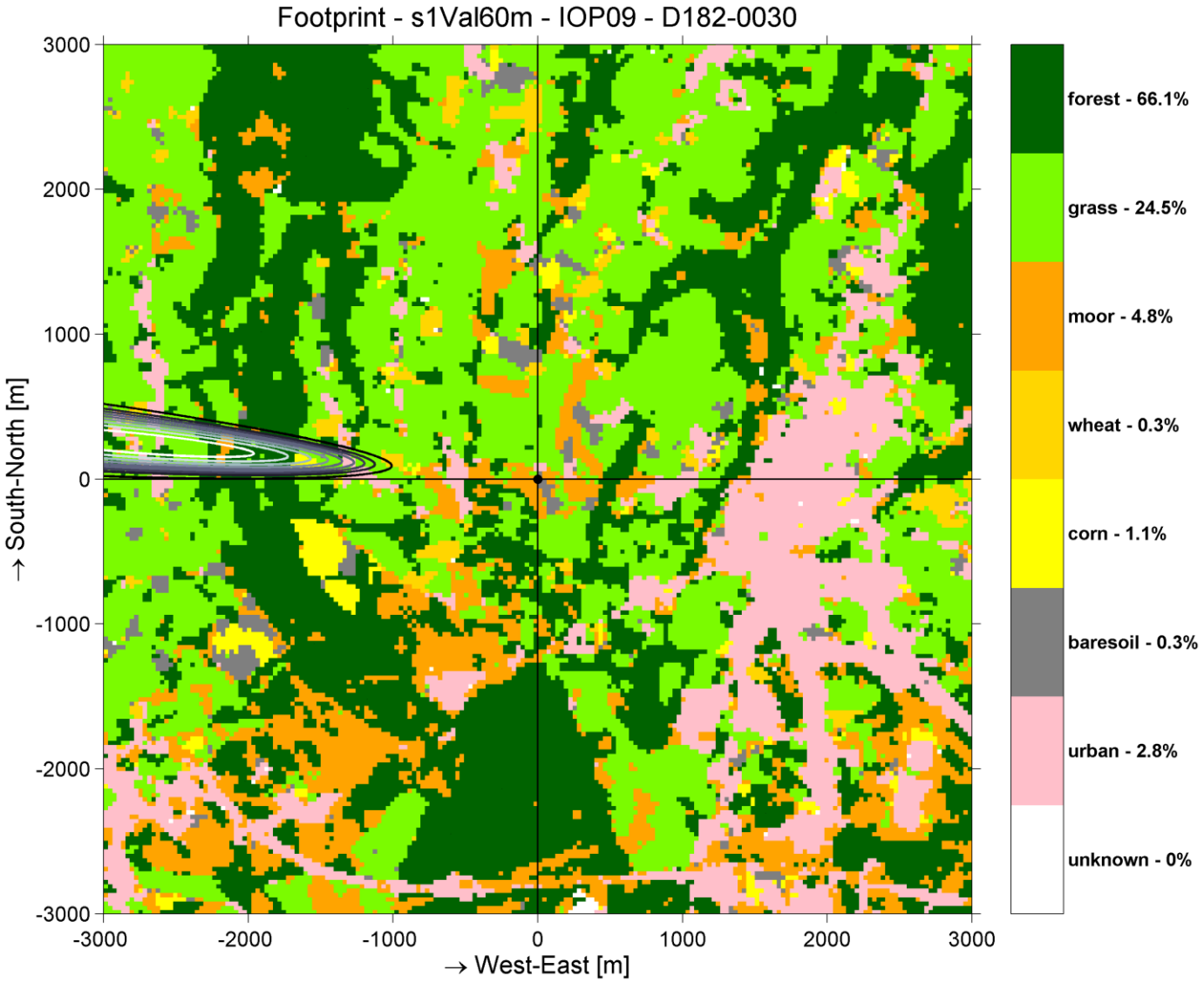
LvE→



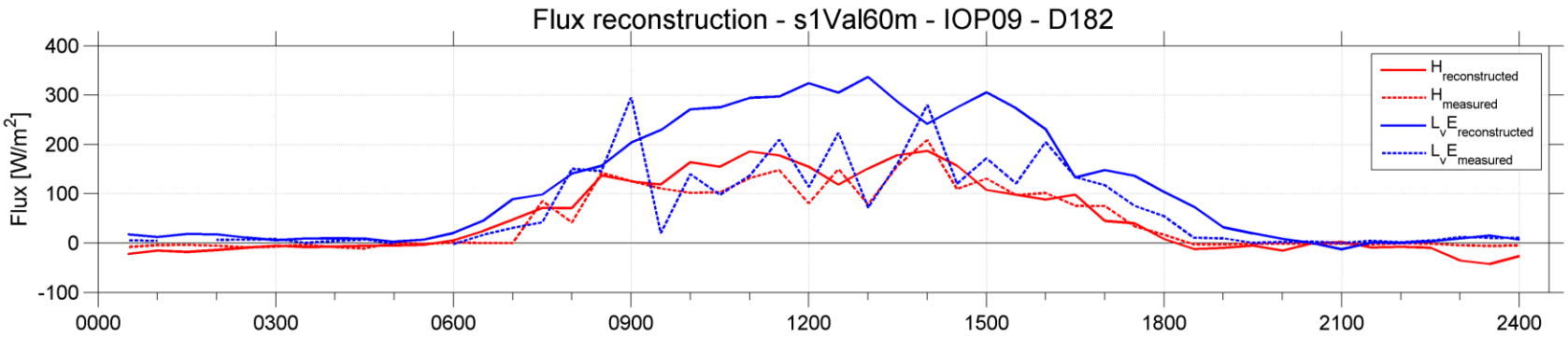
List of Assumptions:

- Accuracy of the LU-map
- Measured fluxes cover only 1 vegetation type (uniform FP)
- Measured fluxes representative for other surfaces with same/similar vegetation type
  - Vegetation growing stage
  - Soil type and water content
  - Radiation and wind forcing
  - …
- Simple EB-model to estimate Urban/Bare-soil fluxes
- ….

LU-flux assignment – Direct-method - Validation



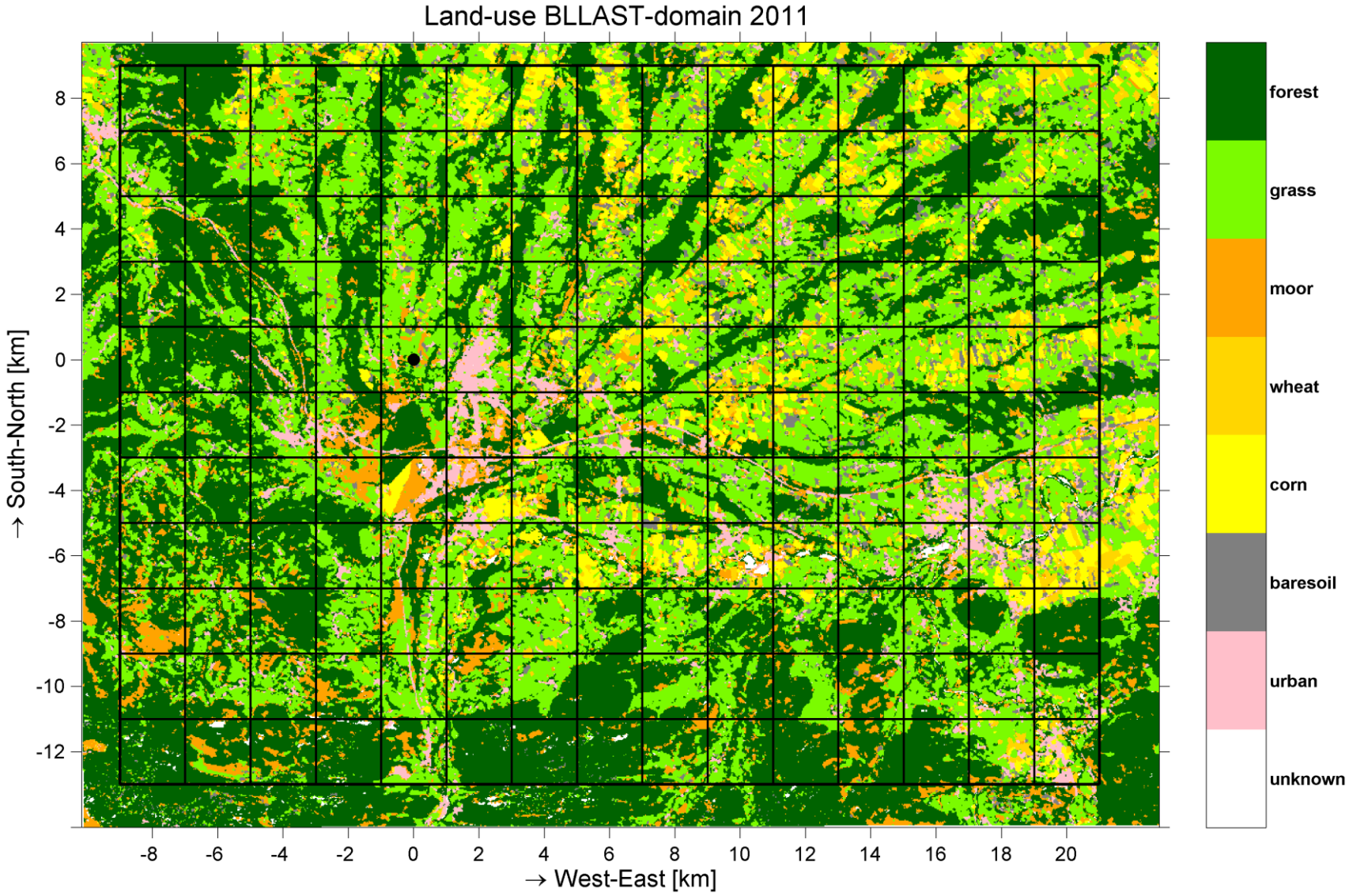
LU-flux assignment – Direct-method - Validation



Tasks:

- Divide the LU-map in a 2km-grid
- Determine the %-contribution of each landuse in each grid and use these to upscale the fluxes

Upscaling - Landuse map – 2km grid



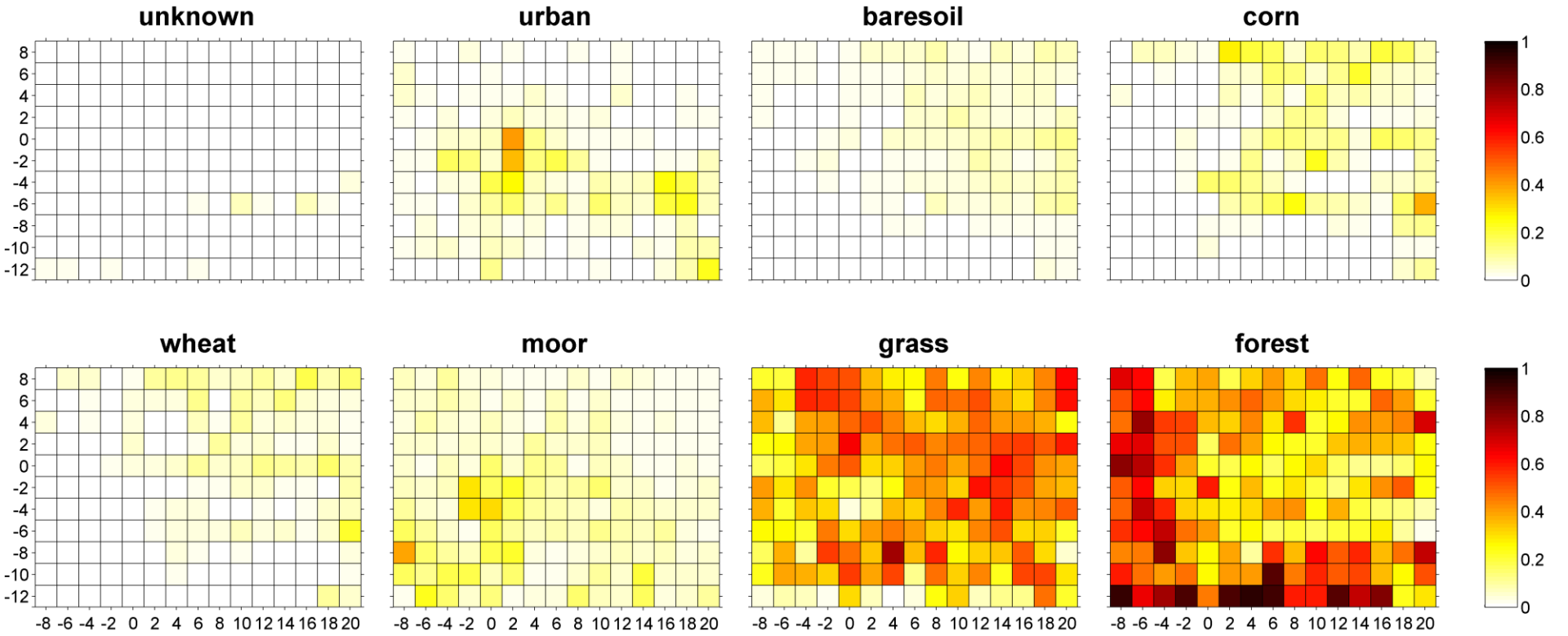
Upscaling - % contribution of each LU

$$\overline{H_{i,j}} = b_{1_{i,j}} H_{LU1} + b_{2_{i,j}} H_{LU2} + \cdots + b_{n_{i,j}} H_{LU_n}$$

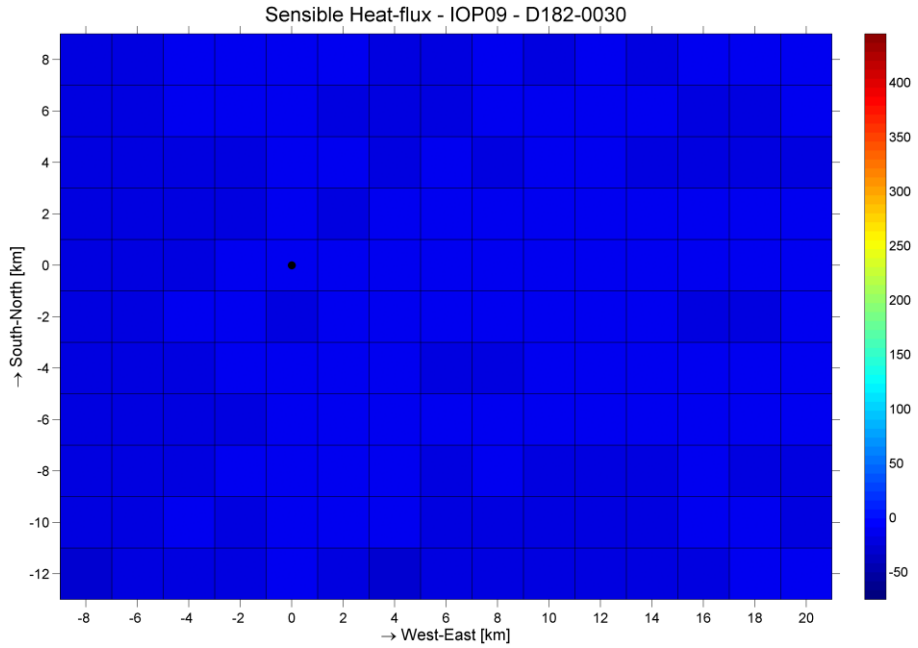
- Determine LU-weights, $b_{n_{i,j}}$, of each pixel (i,j)
- Unknown LU-class or missing LU-flux $\rightarrow$ proportionally distributed over other LU's in pixel

Upscaling - % contribution of each LU

$$\overline{H_{i,j}} = b_{1_{i,j}} H_{LU1} + b_{2_{i,j}} H_{LU2} + \cdots + b_{n_{i,j}} H_{LU_n}$$

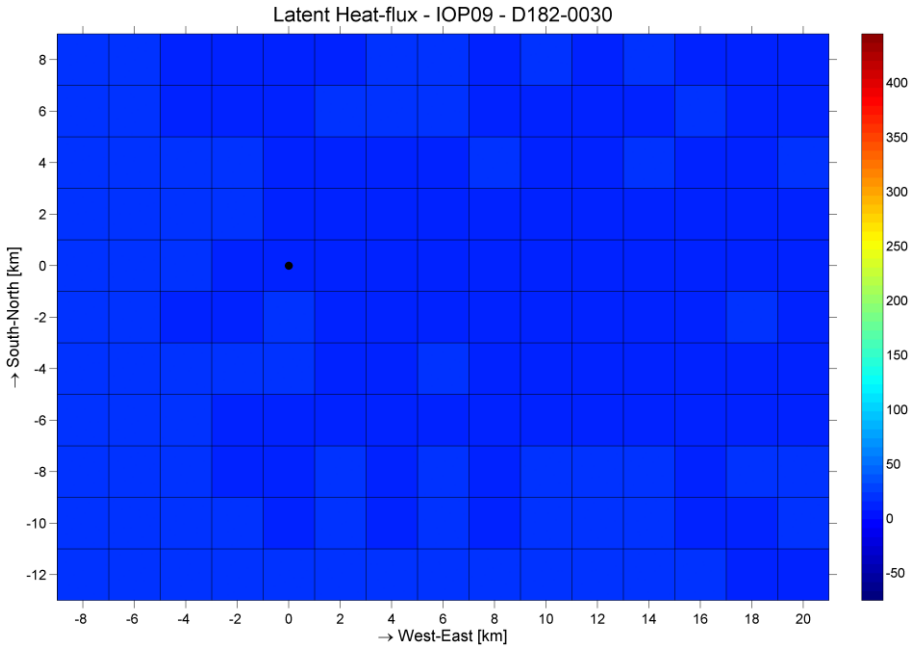


Upscaling - Result

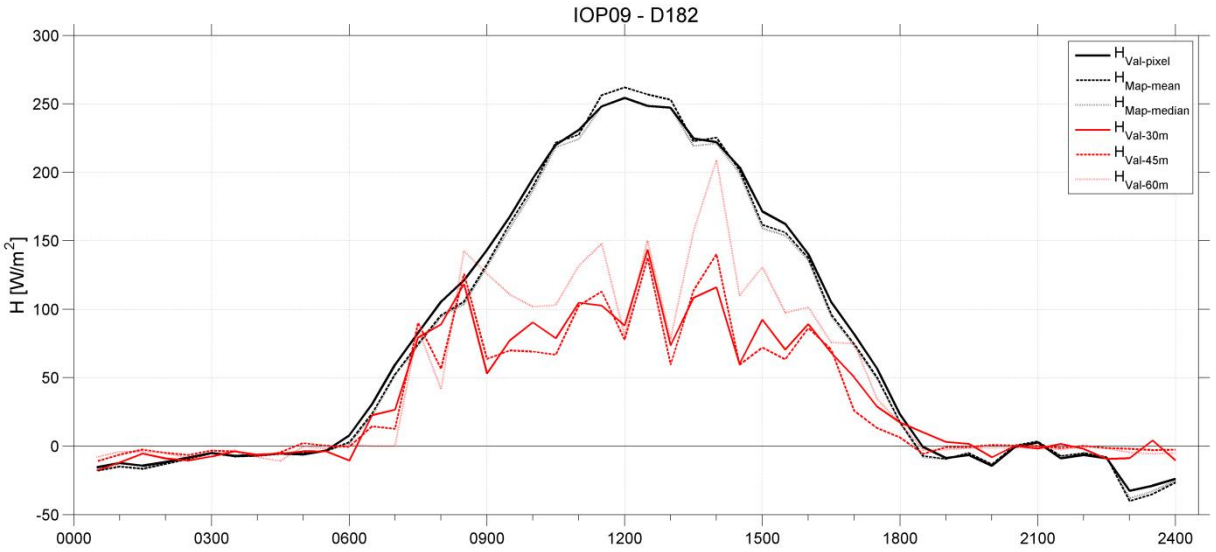


→H

LvE→

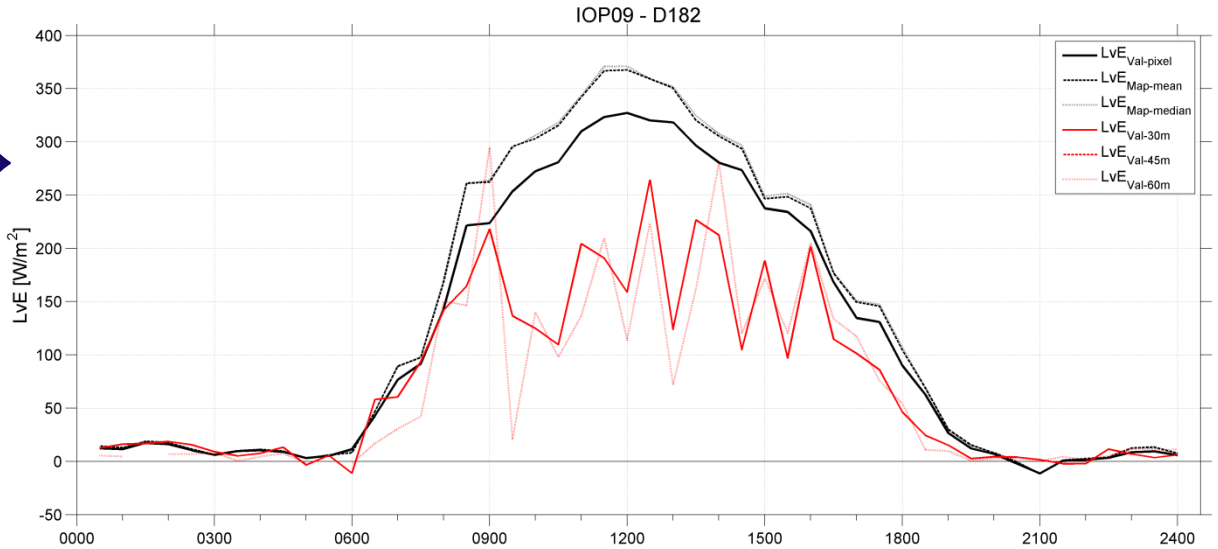


Upscaling - Result

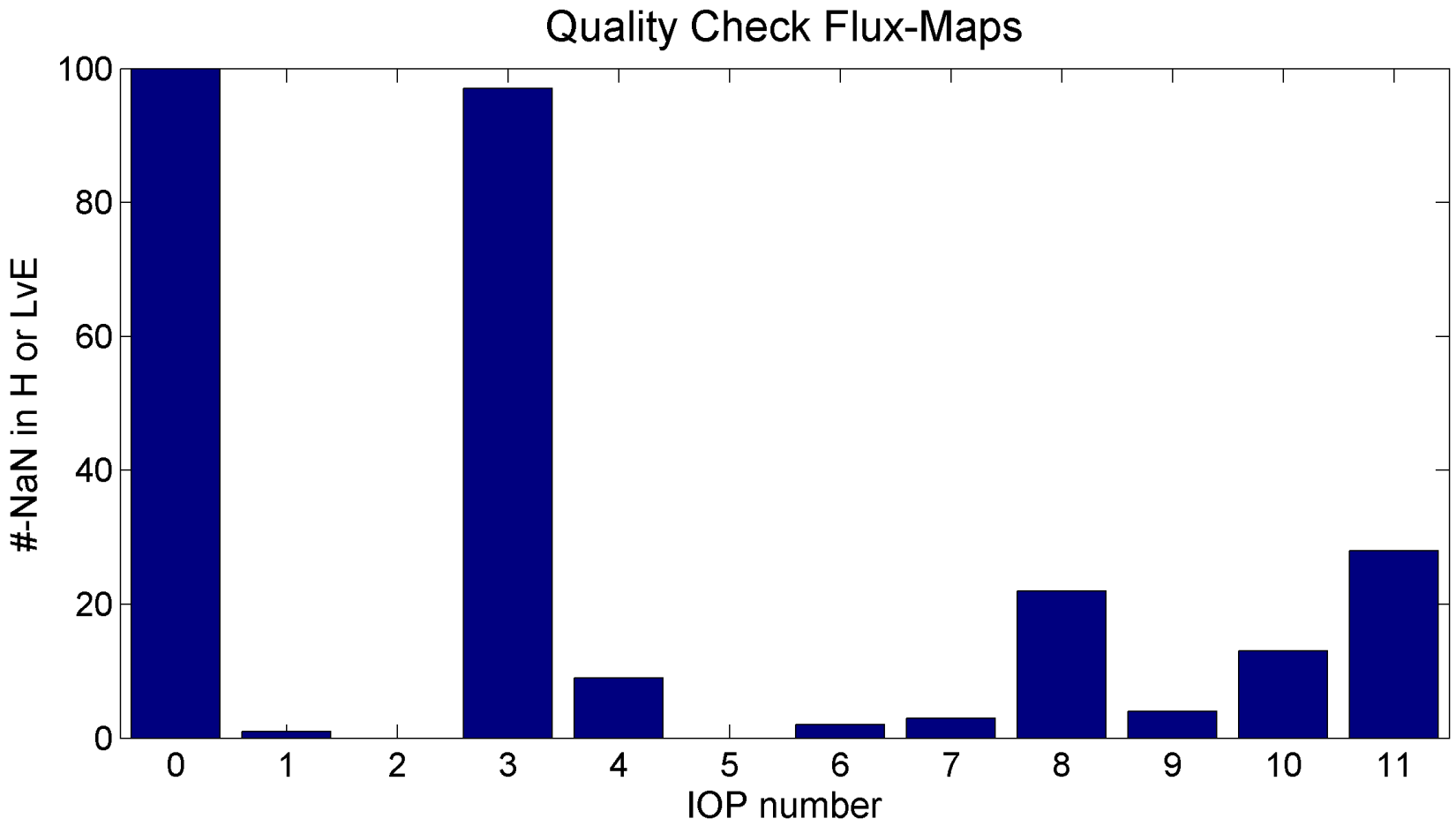


→H

LvE→



Upscaling – Quality-index



What is available?:

- 1 txt-file per 30min interval per flux (*H+LvE*)
- Quicklooks as shown here
- All IOP's
- Rudimentary documentation (readme + this ppt)

Do you need something else? → *oscar.hartogensis@wur.nl*

- Other grid definition (resolution or coordinate system)
- Work with more problematic IOP's
- …

Thesis Lisanne Nauta – 2 drainage flow cases during BLLAST

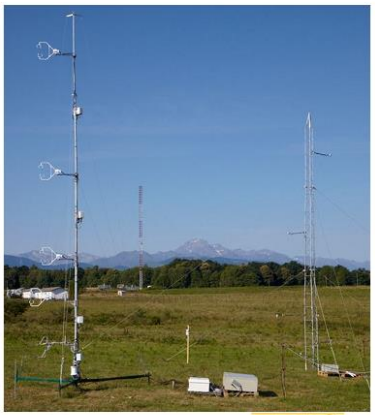
Wageningen University
Meteorology and Air Quality Group

Master Thesis

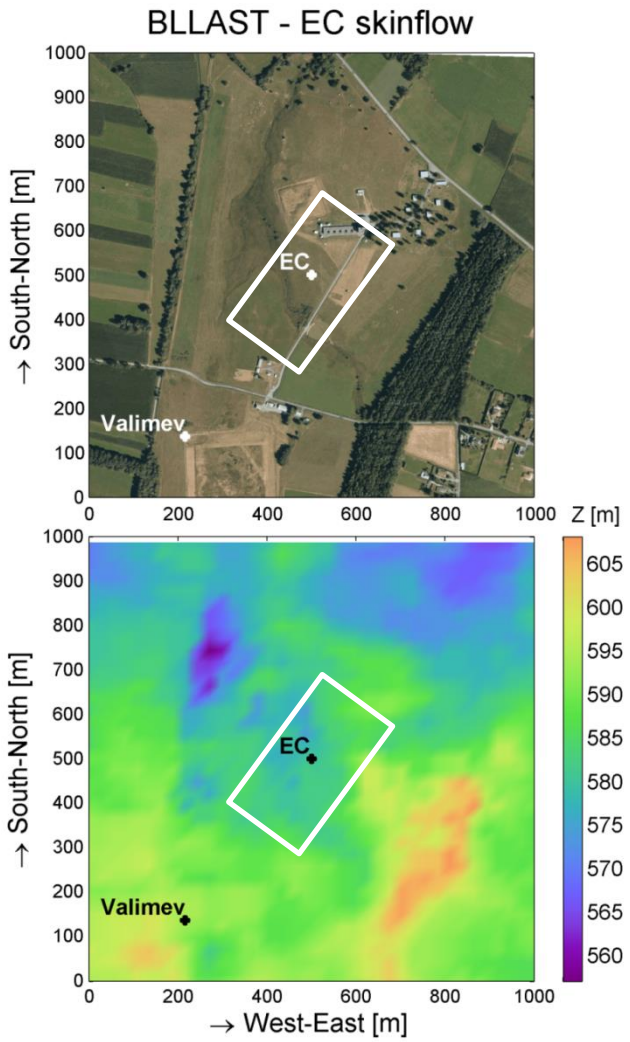
Shallow Drainage Flows over Light Sloping Terrain during BLLAST 2011: Two Case Studies

Author:
Lisanne NAUTA

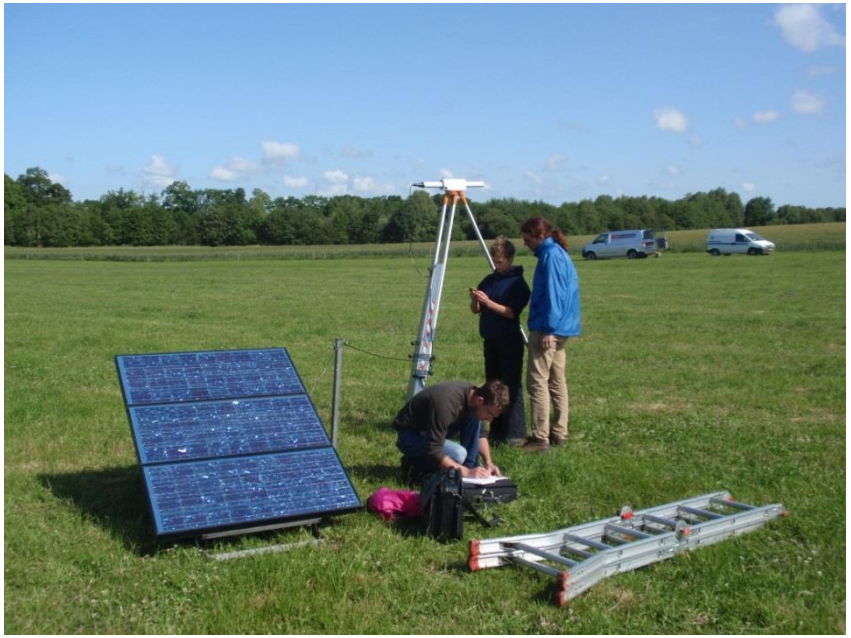
Supervisor:
Dr.Ir. Oscar HARTOGENSIS



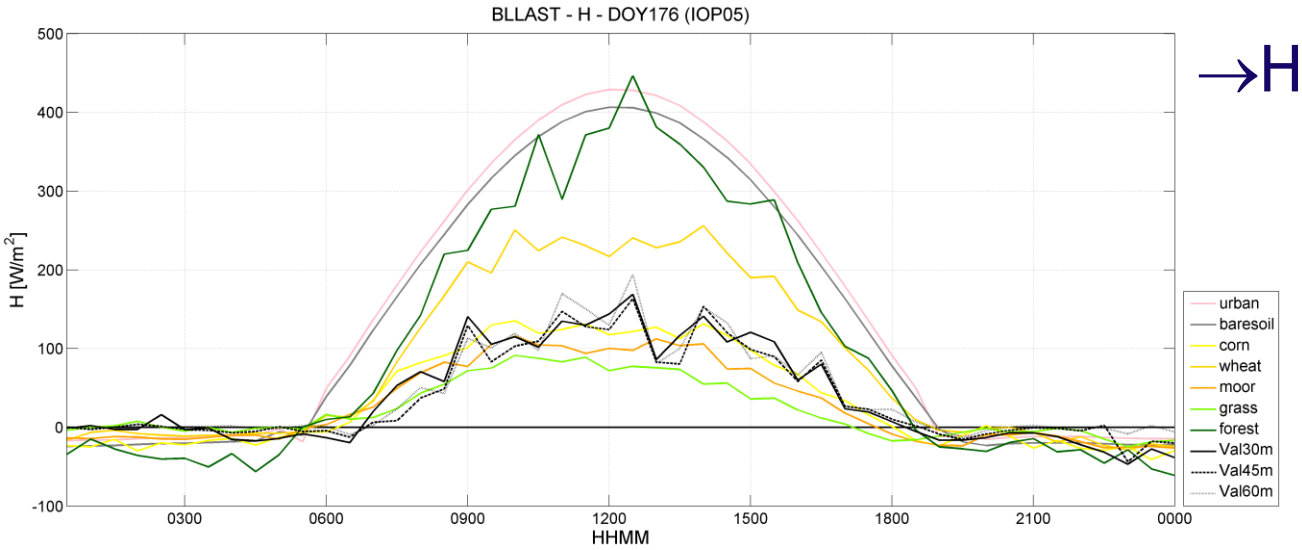
December 5, 2013



Thank you

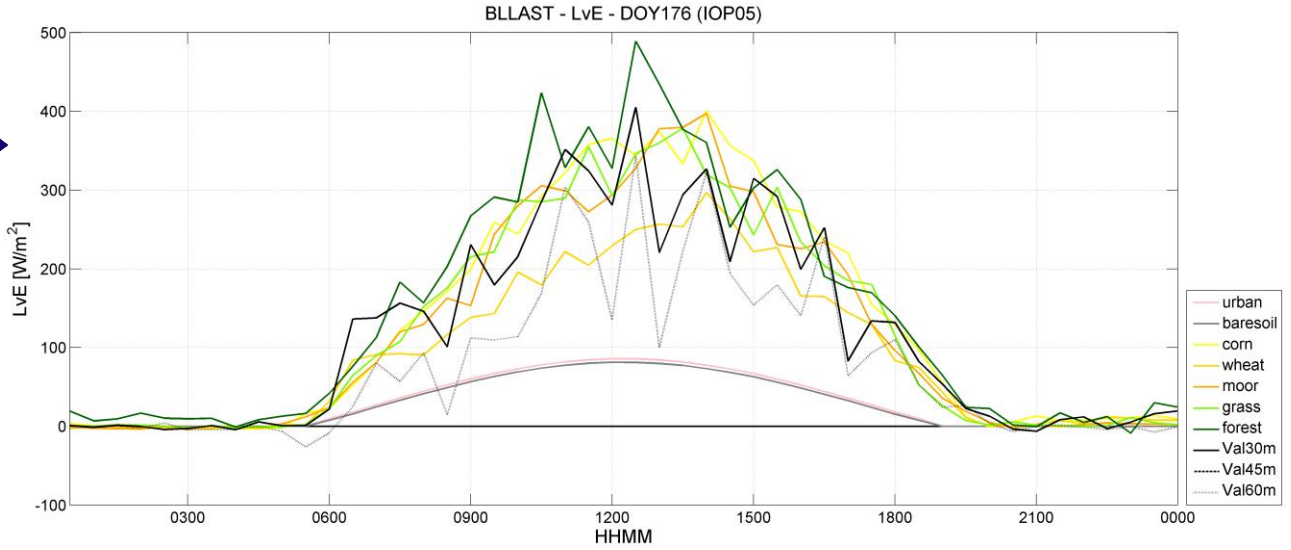


LU-flux assignment – Direct-method - Model Urban and Bare-soil fluxes

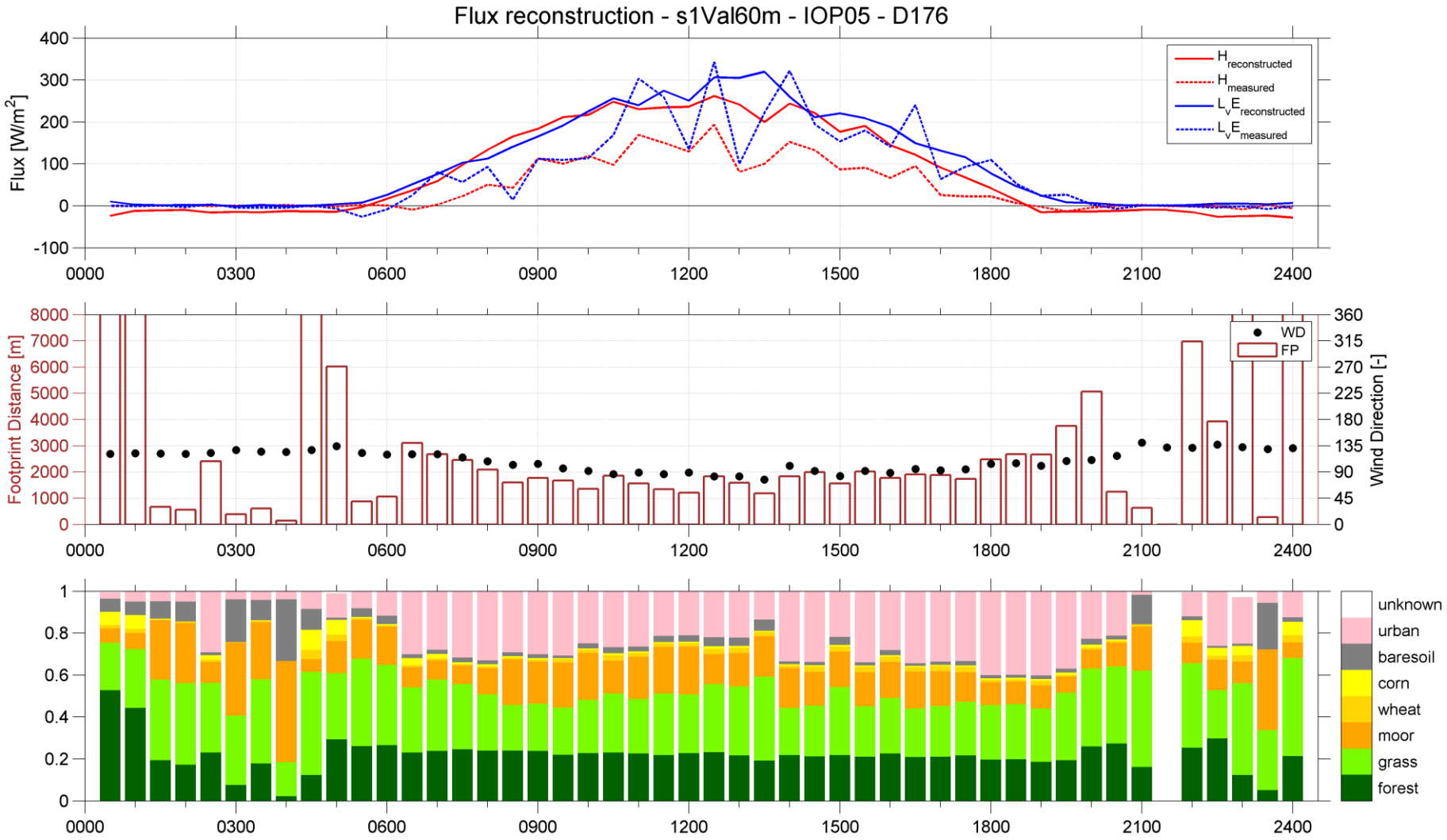


→H

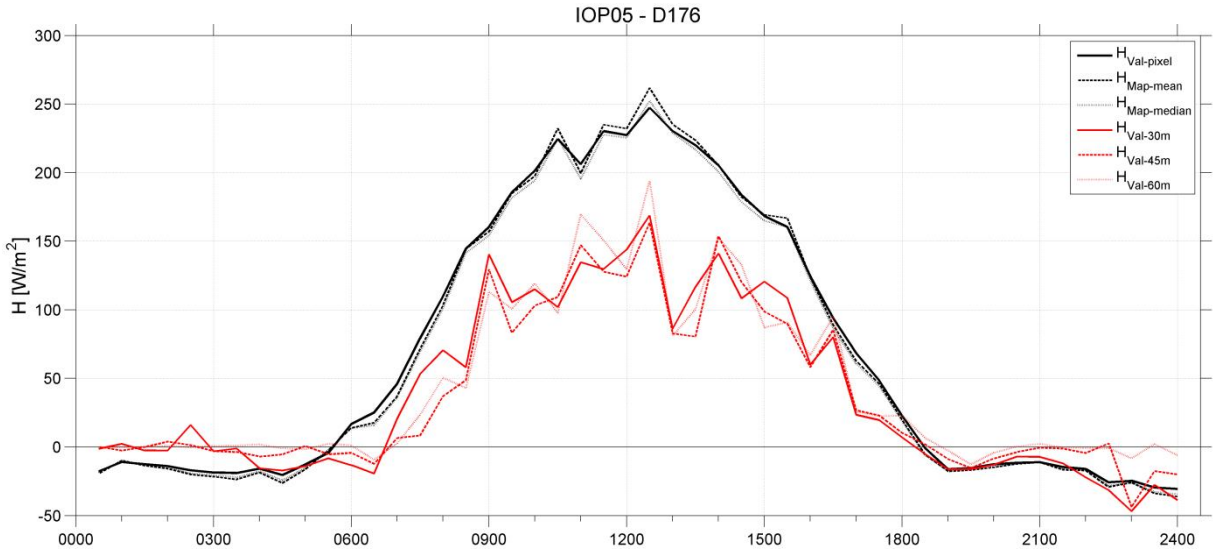
LvE→



LU-flux assignment – Direct-method - Validation

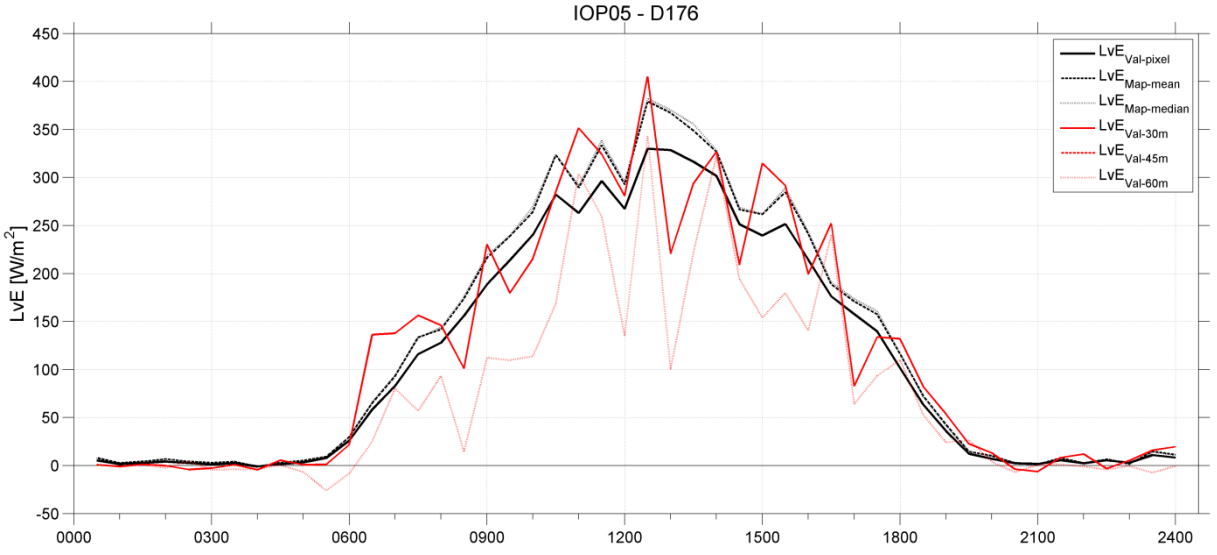


Upscaling - Result



→H

LvE→

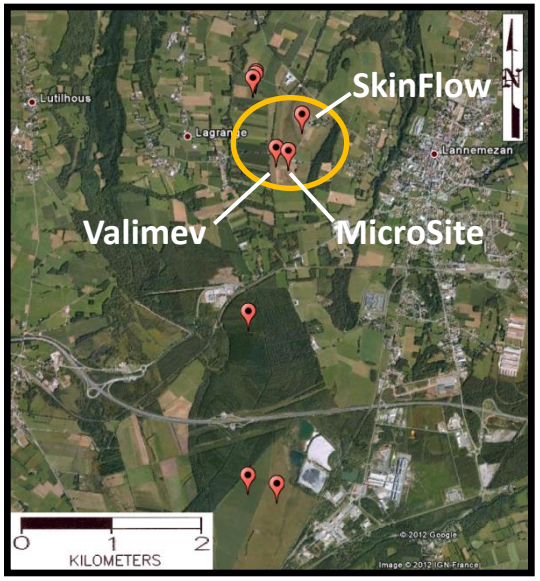


Super Site 1

MicroSite *(20 Hz)*
- 2m: CSAT3 & LICOR7500

Valimev tower *(10 Hz)*
- 30m: CSAT3 & LICOR7500
- 45m: Gill
- 60m: CSAT3 & Krypton

SkinFlow mast *(20 Hz)*
- Lowest 2 levels: Kaijo Denki & T-couple
- 2,3,5,8m: CSAT3 & T-couple



MicroSite
University of Bergen

Valimev tower
Laboratoire d'Aérologie

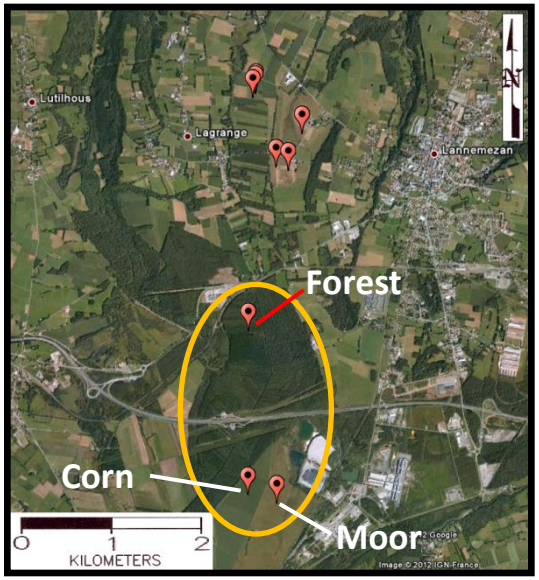
SkinFlow mast
University of Utah &
Wageningen University

Super Site 2

Overview

Forest mast *(10 Hz)*
- 20m: CSAT & T-couple
- 30m: CSAT & LICOR

Corn & Moor *(20 Hz)*
- CSAT & LICOR



Forest mast
University of Utah &
Wageningen University

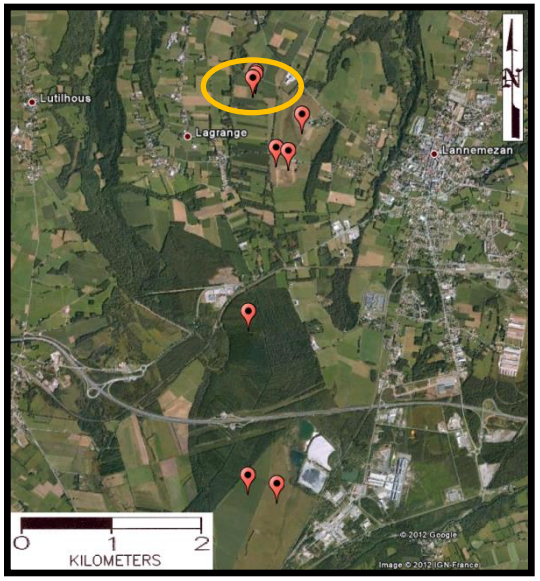
Corn
Météo France

Moor
Météo France

Edge Site

EDGE SITE

Grass, Edge, Wheat *(20 Hz)*
•CSAT & LICOR



Edge
Wageningen University

Wheat
University of Bonn

Grass
Forschungszentrum
Jülich & Bonn University