Use of footprint modelling for the characterisation of complex measurement sites

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Outline

I Introduction
II Concept
III Results
IV Conclusions

Introduction

- Motivation -

Quality assessment at complex sites:

What is the influence of terrain heterogeneity on micrometeorological measurements?

- influence on flux data quality
- composition of sources and sinks affecting the signal

Combination of quality assessment tools for eddy covariance measurements with footprint analyses

Introduction

- Objectives -

Average flux contributions emitted from different types of land use to the total flux measured

Representative footprint climatology for the specific measurement position

Spatial structures in the flux data quality to identify the influence of the characteristics of the surrounding terrain on the measurements

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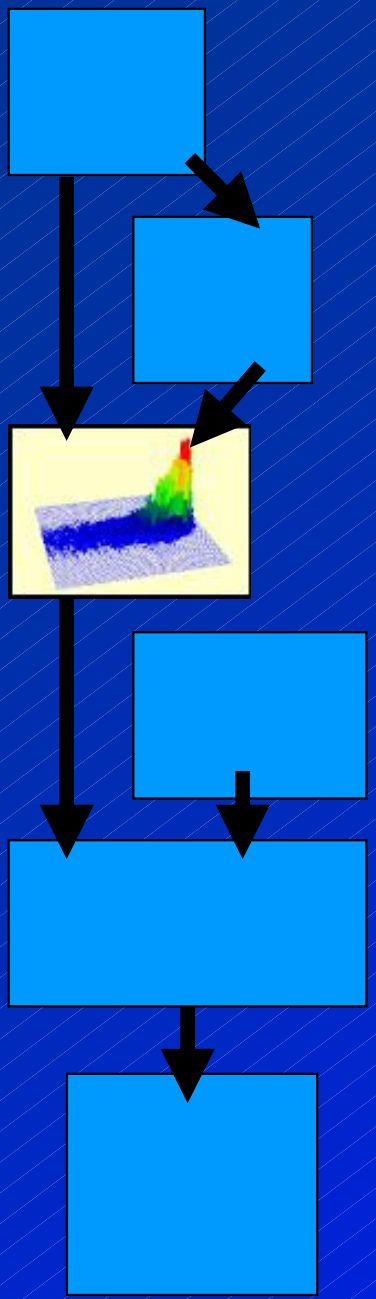


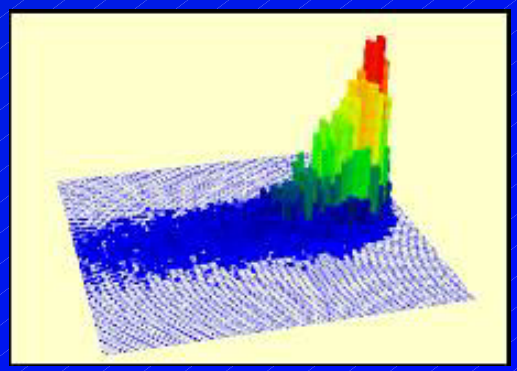
Footprint analysis

Concept

- Footprint model -

Forward Lagrangian Stochastic trajectory model of Thomson type, version of Rannik et al. (2003)*

- considers transport processes within canopy
- models also diabatic conditions



*Rannik et al. (2003), Bound Layer Meteorol 109, 163-189

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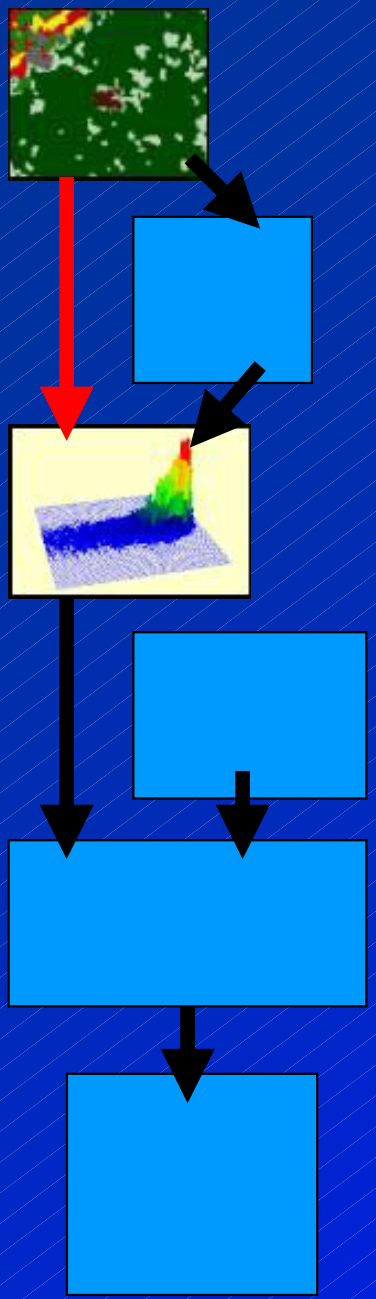


Land use data

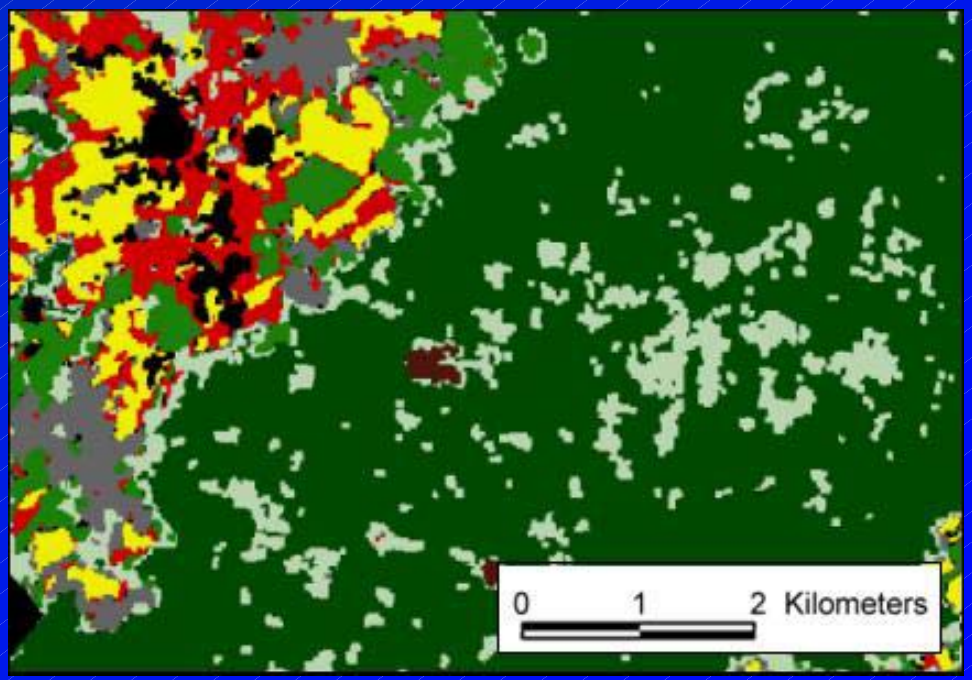
Footprint analysis

Concept

- Land use data -

Satellite remote sensing data

Discrete high resolution matrices



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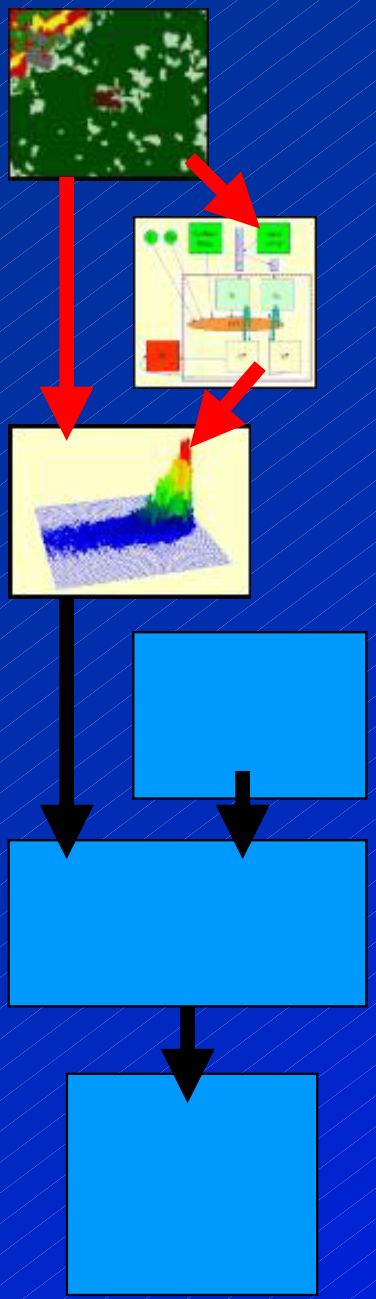

Land use data

Aggregation model

Footprint analysis

Concept

- Flux aggregation model -

Microscale flux aggregation model (Hasager & Jensen, 1999)*

- calculation of effective z_0 values based on land use maps

-considers land use composition and structure of the terrain

*Hasager, CB and Jensen, NO (1999), Quart J Royal Meteorol Soc 125, 2075-2102

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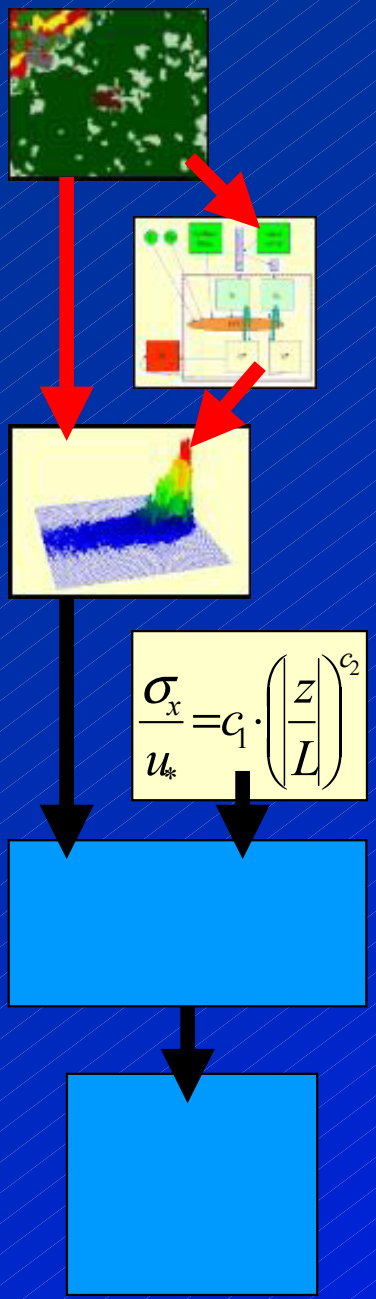

Land use data

Aggregation model

Footprint analysis

Data quality assessment

Concept

- Flux data quality assessment -

Modified approach developed by Foken & Wichura (1996)*

Quality flags for stationarity and integral turbulence characteristics

$$\frac{\sigma_x}{u_*} = c_1 \cdot \left(\left|\frac{z}{L}\right|\right)^{c_2}$$

Final quality flag for different fluxes as a combination of both

*also Foken et al. (2004), Post-field data quality control. In: Lee, X (ed), Handbook of Micrometeorology: A guide for surface flux measurements. Kluwer, Dordrecht, pp. 81-108

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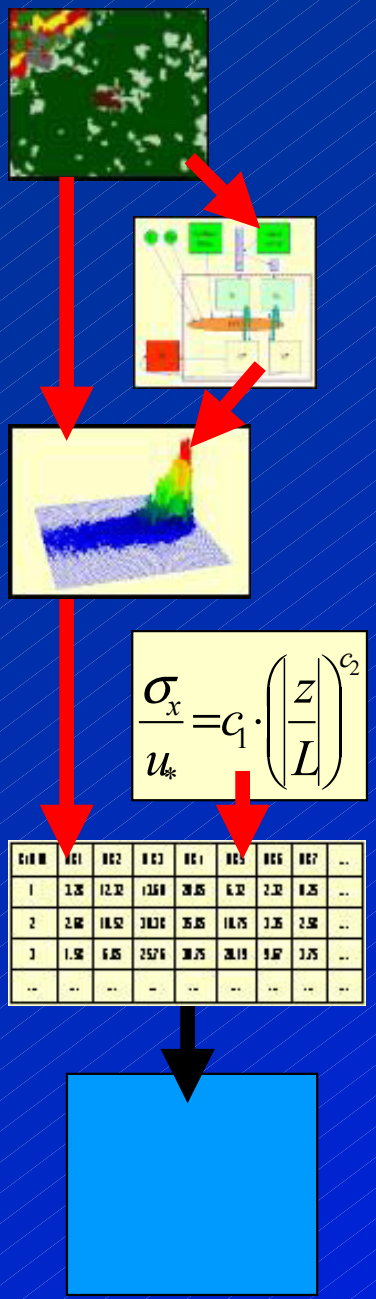


Land use data

Aggregation model

Footprint analysis

Data quality assessment

Database

Concept

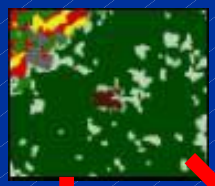
- Database -

Collect and sort data quality and footprint results

Statistics for each cell (lines) and various quality features (columns)

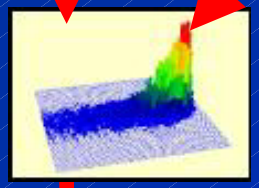
Concept

- Visualisation of results -



Land use data

Aggregation model

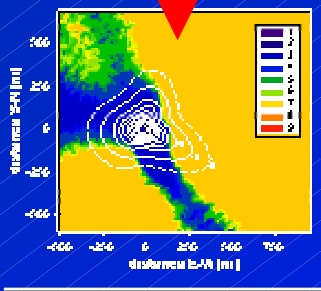


Footprint analysis

$$\frac{\sigma_x}{u_*} = c_1 \cdot \left(\left|\frac{z}{L}\right|\right)^{c_2}$$

Data quality assessment

Database

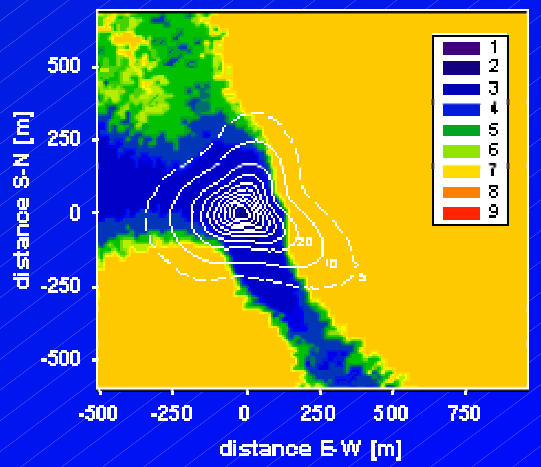


Visualisation of results

Production of 2D matrices

Colours indicate average quality results for each cell

Isolines represent the footprint climatology for the data set



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Results

- Dataset information -

Location: FLUXNET site GE1
Waldstein / Weidenbrunnen
(DE-Wei)

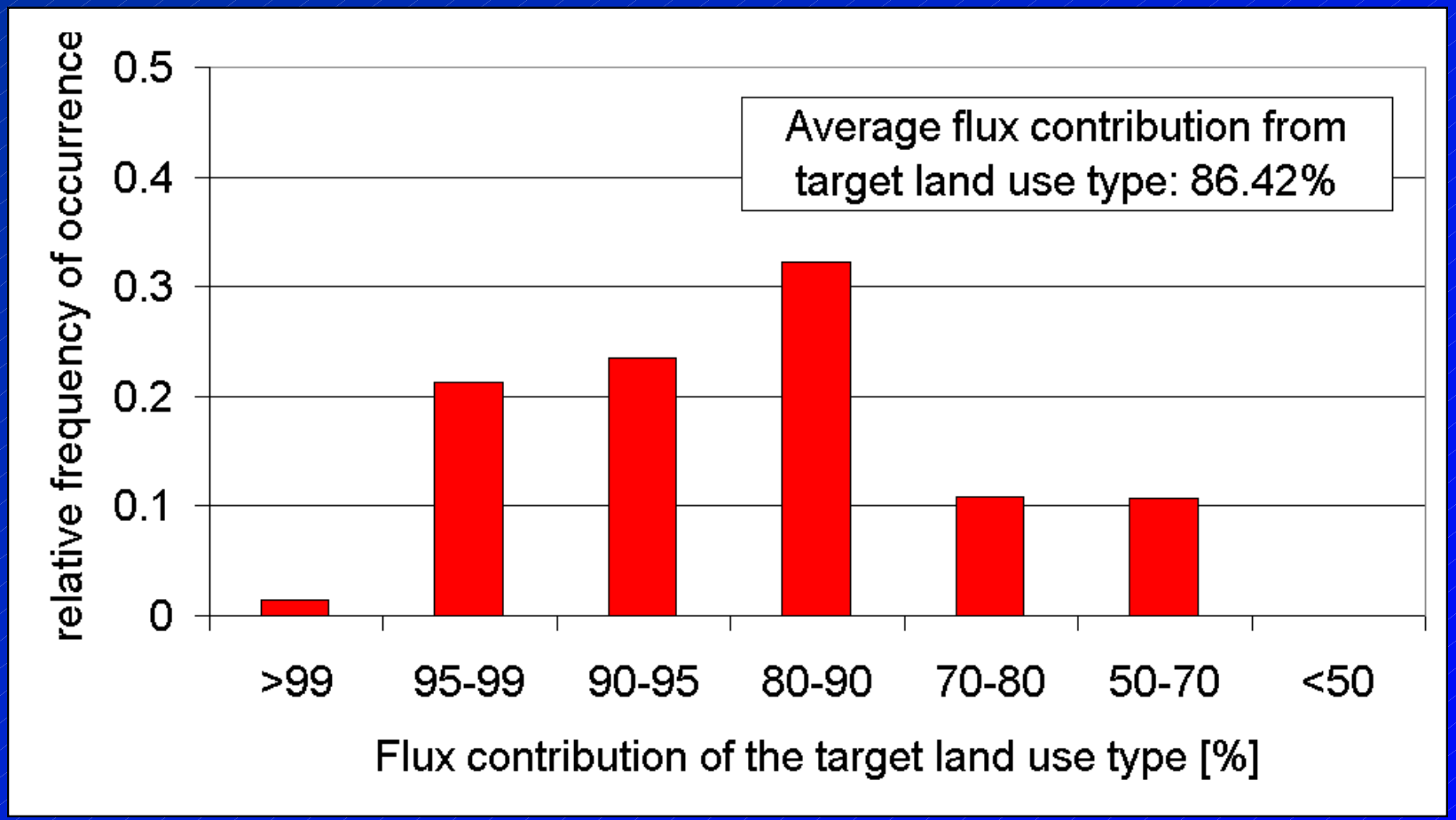
50° 09' N, 11° 52' E, 775 m a.s.l.

Spruce forest, $h_c \approx 19$m

Time: May – July 2003,
3456 30-minute datasets

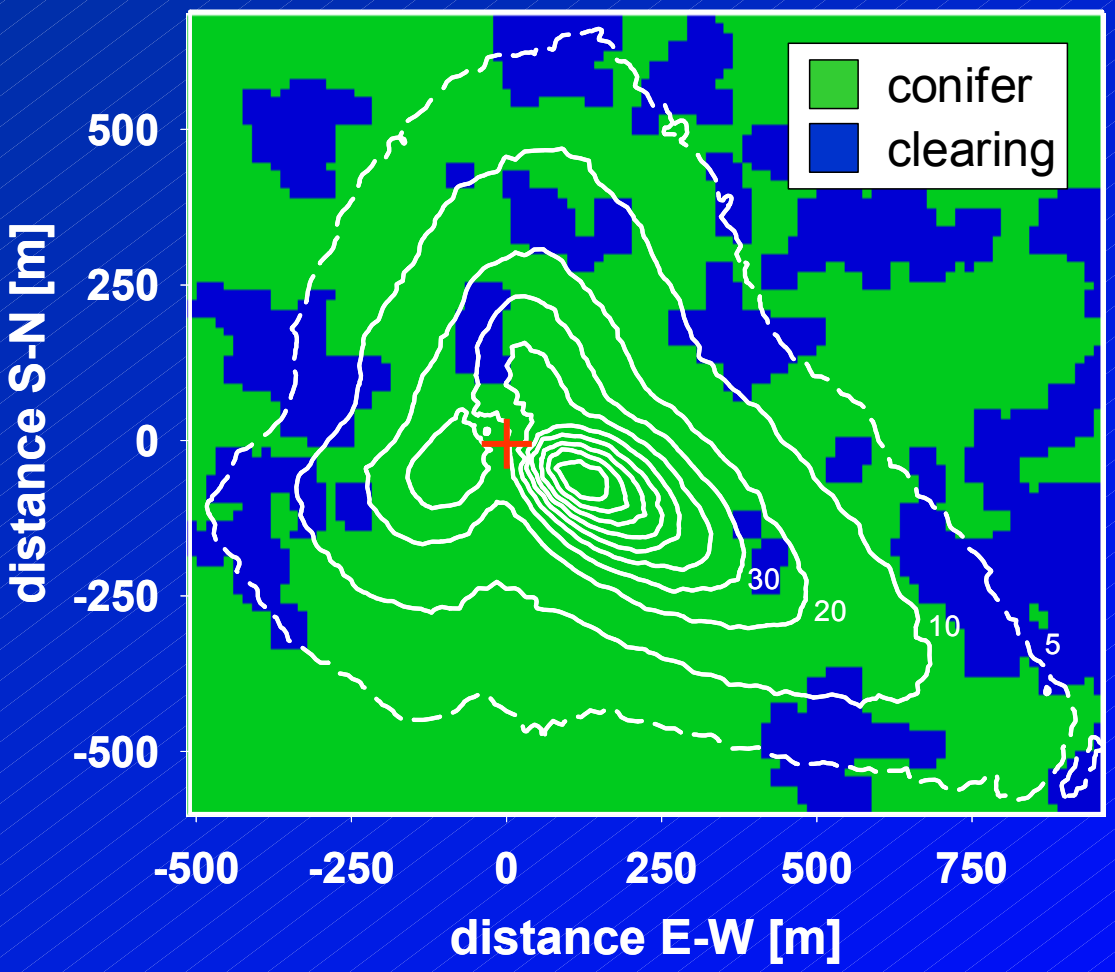
Results

- Evaluation of flux contributions -



Results

- Footprint climatology -



Footprint climatology for stable stratification, with land use structure

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Results

- Parameter visualisation -

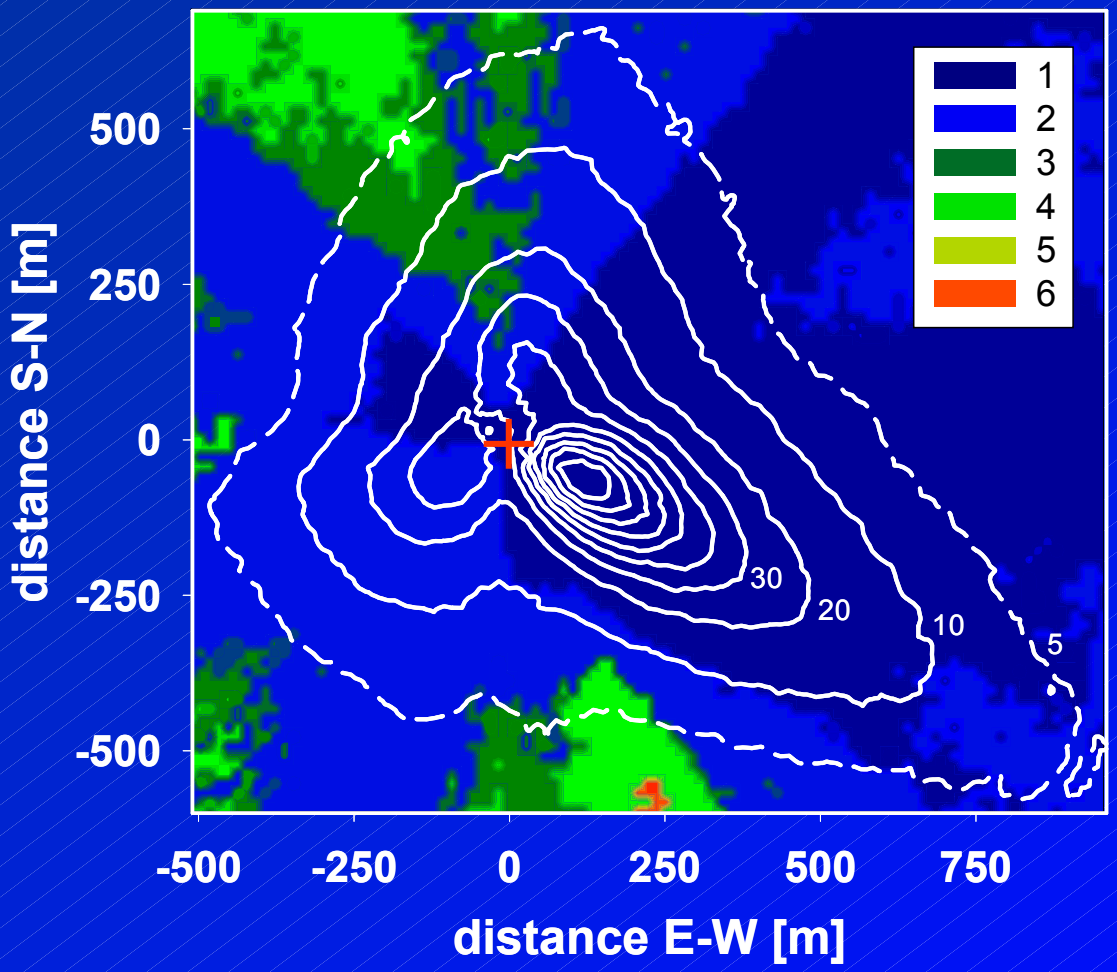
Determination of footprint weighted average values for each cell of the terrain matrix

- median for discrete parameters (e.g. quality flags)
- arithmetic mean for continuous parameters (e.g. vertical wind speed)

Objective: Identification of spatial structures in the averaged flux data characteristics

Results

- Parameter visualisation -



Quality assessment for the latent heat flux with footprint climatology, for stable stratification.

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Conclusions

Development of an additional quality tool to assess the influence of heterogeneous terrain on flux data

Certain simplifications concerning the footprint model compromise the accuracy of the results

Especially useful to determine the representativeness concerning the target landuse type at FLUXNET sites

Evaluation of the performance of a coordinate rotation method (e.g. Planar Fit)