# Airplane measurements above a patchy agricultural dominated landscape in Central Europe

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## Goals

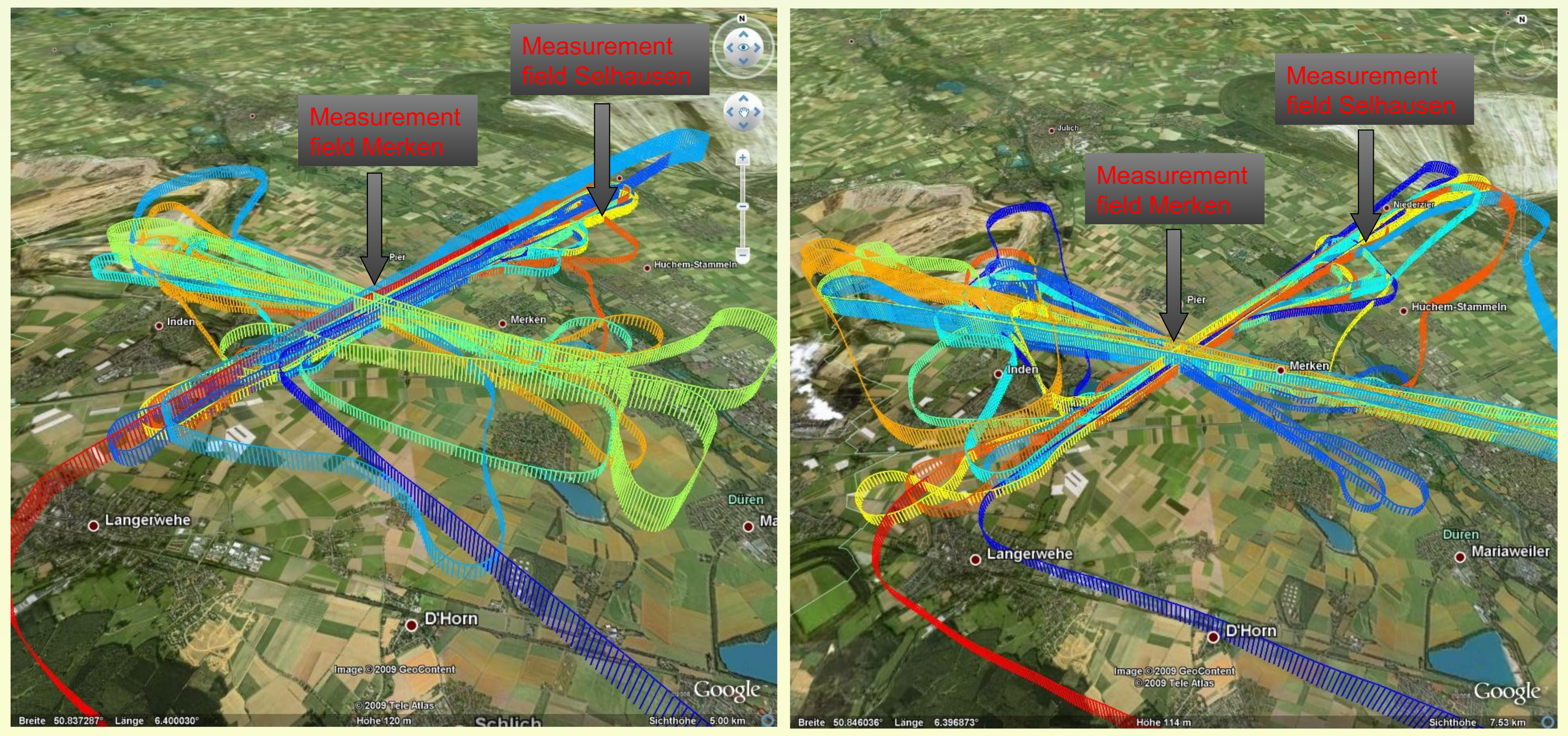
- Analysis of correlated temporal and spatial structures: A synthesis correlation of fluxes and Atmospheric boundary layer (ABL) parameters with surface and vegetation properties
- Quantification of the spatio-temporal variability of energy, $H_2O$, and $CO_2$ fluxes over different surfaces and estimation of regional budgets
- Relationships between the variability of fluxes and other parameters of the soil-vegetation-atmosphere system with focus on the ABL
- investigate the variability of water vapor and CO2 and their turbulent fluxes in the atmospheric boundary layer close to the ground
- Determination of the contribution of biogenic/anthropogenic emissions in observed space-time structures of $CO_2$ and $H_2O$ concentrations

## Aircraft Experiments

During the FLUXPAT campaign in 2008 the MetAir Dimona research aircraft performed several fligths above the patchy, agricultural dominated landscape near Juelich/Germany.

Flights took place in straight lines (legs) parallel and perpendicular to the prevailing wind in certain levels between 80 and 400 meters.

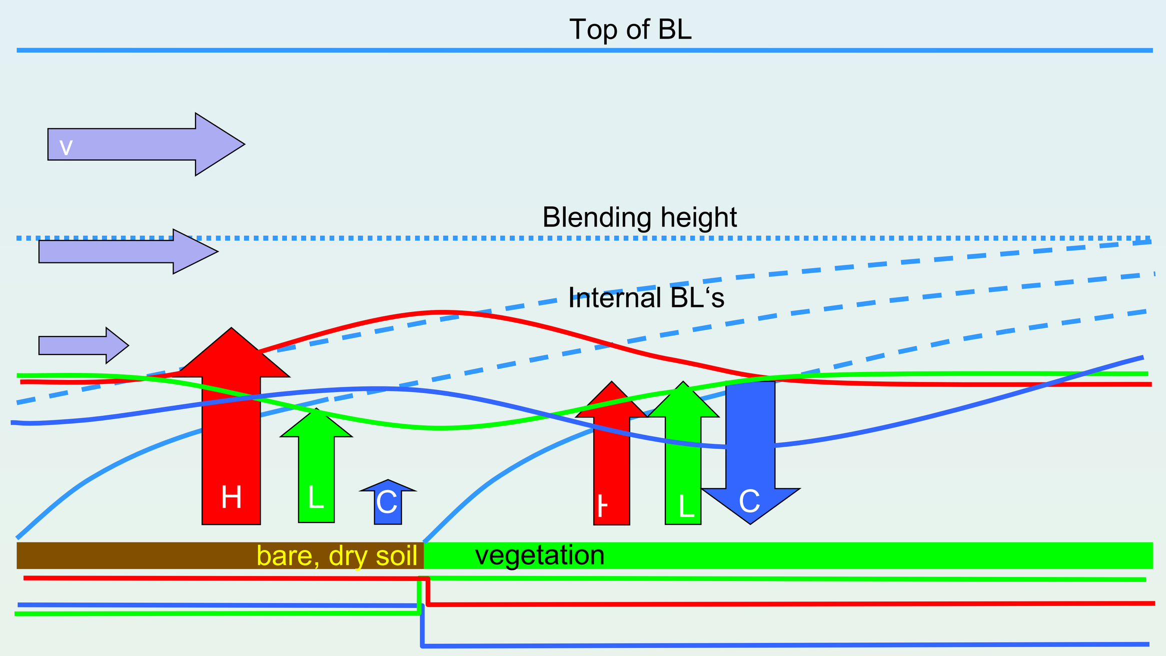
The flights are focused on two main measurement fields in Merken and Selhausen.




Flight patterns from 1.7.2008, left: morning, right: afternoon; colors from blue to red represent time.

## Approaches

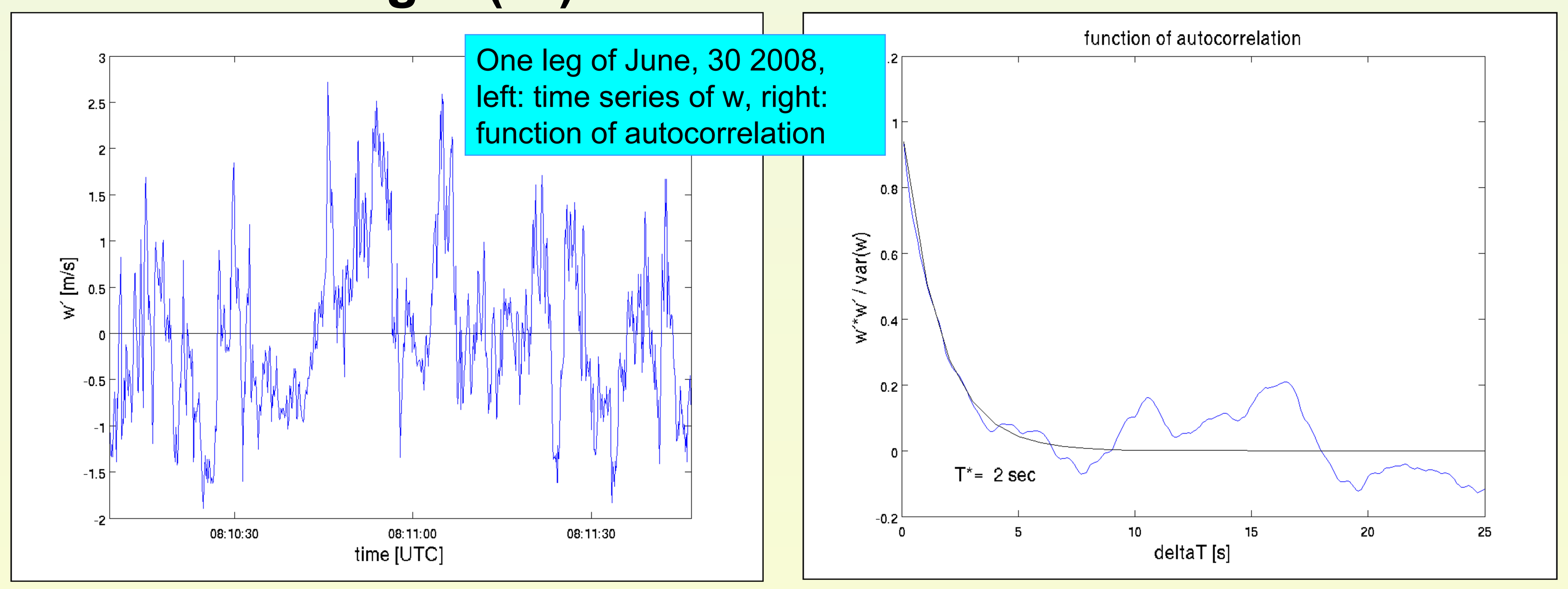
Fluxpat: basic idea




The fluxes of sensible and latent heat and $CO_2$ (H,L,C) depend on atmospherical conditions as wind, stability etc. but are also strongly influenced by soil and vegetation at the surface. Boundaries between different surfaces lead to internal boundary layers (IB) in the ABL separating volumes with different fluxes. These IBs are inclined with wind direction and speed.

With increasing distance to the surface the gradient across these IBs becomes smoother due to the turbulent exchange across. Above a certain level the so called "Blending Height" (e.g. Foken, 2006), the differences between the IBs vanishes. The wind direction defines the main axes of turbulent exchange. It is expected that parallel and perpendicular to the wind different characteristics can be found (correlation lengths, averages, standard deviations, covariances/fluxes etc.). These parameters should correlate to the patterns of surface and vegetation.

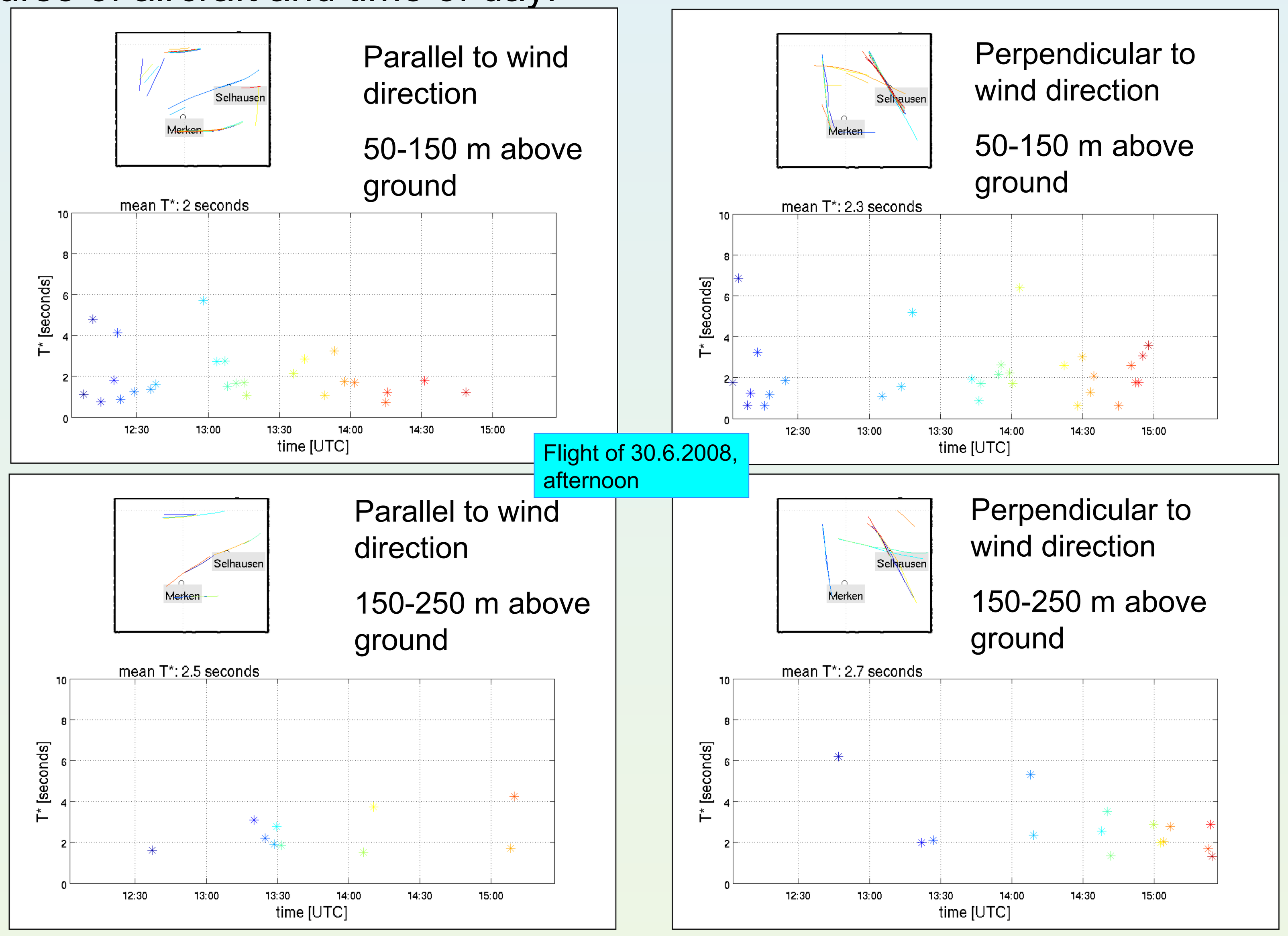
### Autocorrelation of w and the determination of the correlation length (T*):




The correlation length is a measure for the size of the largest events in the time series. From the time series we calculate the autocorrelation function and fit a function $f(\Delta T) = \exp(-\Delta T/T^*)$ to determine $T^*$, in this case 2 seconds. Following Lenschow et al.(1994) data rows should take a multiple of $T^*$ to calculate reliable mean values for the determination of fluxes etc.

## First analysis

Analysis of the dependency of T* for w from different legs on altitude, course of aircraft and time of day:




| Mean T* [seconds] | parallel to wind | | | perpendicular to wind | | |
|---|---|---|---|---|---|---|
| Flights | 50 - 150 m | 150-250 m | 250 - 450 m | 50 - 150 m | 150-250 m | 250 - 450 m |
| 24.6.morning | 2 | 2,7 | 3,2 | 2,1 | 2,5 | 5,7 |
| 30.6.morning | 1,8 | 2,3 | // | 2,5 | 3 | // |
| 30.6.aftern. | 2 | 2,5 | // | 2,3 | 2,7 | // |
| 1.7. morning | 2,8 | 1,9 | // | 3,2 | 2,4 | // |
| 1.7. aftern. | 1,7 | 2,6 | 2,9 | 1,8 | 2,5 | 4 |
| 2.7. morning | 2,2 | 4,3 | // | 2 | 3,3 | // |

After a first analysis it seems as if the correlation length:

- is larger in the upper levels
- is smaller in the lowest levels for the legs parallel to the wind than in the legs perpendicular to the wind
- but nevertheless there is large scatter in the data

## Outlook

- Dependency of $T^*$ on height, leg orientation and stability will be examined for statistical significance
- $T^*$ will be analyzed for Temperature (T), water vapor mixing ratio (q) and carbon dioxide (c). It is expected that different characteristics will be found for the active scalars w and T and the passive scalars q and c
- Correlation of ABL parameters with properties and patterns at the surface (vegetation, soil etc. )
- Further aircraft campaigns this year

**References:** D.H. Lenschow, J. Mann, and L. Kristensen ; How Long Is Long Enough When Measuring Fluxes and Other Turbulence Statistics? ; Journal of Atmospheric and Oceanic Technology ; Volume 11, Issue 3 (June 1994)
T. Foken; Angewandte Meteorologie, Mikrometeorologische Methoden; Springer 2006