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On the Effect of Forest Edge on Coherent Structures above a Forest Canopy

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Motivations

In the frame of EGER (ExchanGE processes in mountainous Regions) project the contribution of coherent structures (CS) to the transfer of energy and matter will be analyzed. Combination of these results with measurements at the forest edge and over deforested area will be used to analyze the effect of the forest edge on the temporal scales of CS and their role in flux transport and coupling processes between forest and deforested area.

Experiment setup

The intensive observation period was conducted in June - July 2011 at the FLUXNET site Weidenbrunnen Waldstein (DE-Bay), located at an altitude of 775 m a.s.l. in North-Eastern Bavaria in the Fichtelgebirge Mountains, Germany (50°08'N, 11°52'E). Because of the wind throw by storm "Kyrill" in 2007 the large disturbed and deforested area appeared in the vicinity of the measuring site (Fig. 1).

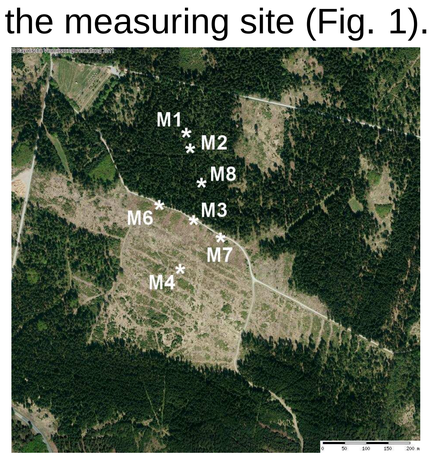

Figure 1: *The Weidenbrunnen Waldstein measuring site after the "Kyrill" storm and locations of the towers M1 - M8.*

The forest edge will be investigated as a source of CS which influence the exchange processes in the whole area and may be the reason for possible horizontal decoupling between forest and clear cut at day time. Observations of CS were obtained by a vertical profile of sonic anemometers equipped with fast gas analyzers deployed on the towers (Fig. 2) installed in deforested area (M4), at the forest edge (M3, M6, M7), and inside the forest (M1, M2, M8).

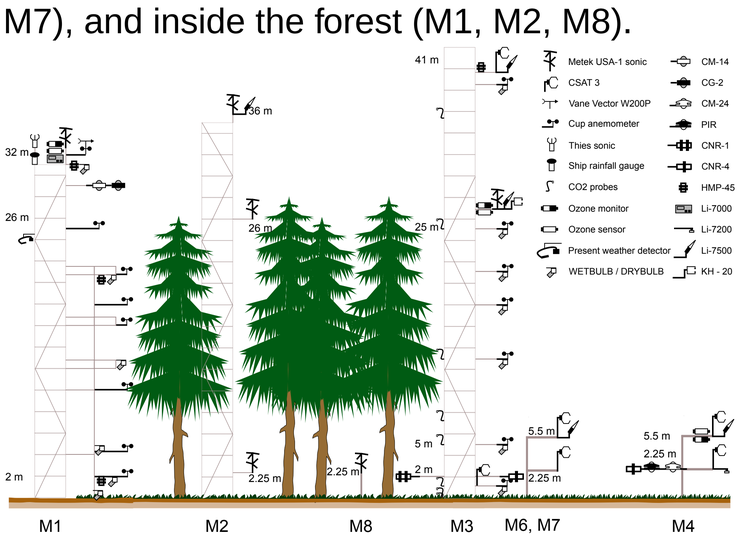

Figure 2: *Installation of instruments during the measurements.*

Analysis of coherent transport

Detection of coherent exchange and estimation of flux contribution of CS is described in (Thomas and Foken, 2005).

- Removal of outliers, planar fit rotation, time lag correction
- Extraction of CS using wavelet transform
- Fluxes $\overline{w'v'_h}$, $\overline{w'T'_s}$, $\overline{w'c'_{CO_2}}$, $\overline{w'c'_{H_2O}}$
- Reynolds-averaged fluxes F_{ent} and fluxes transported by CS F_{cs}
- Flux contribution of the ejection phase F_{ej} and sweep phase F_{sw}

Number and lifetimes of detected CS

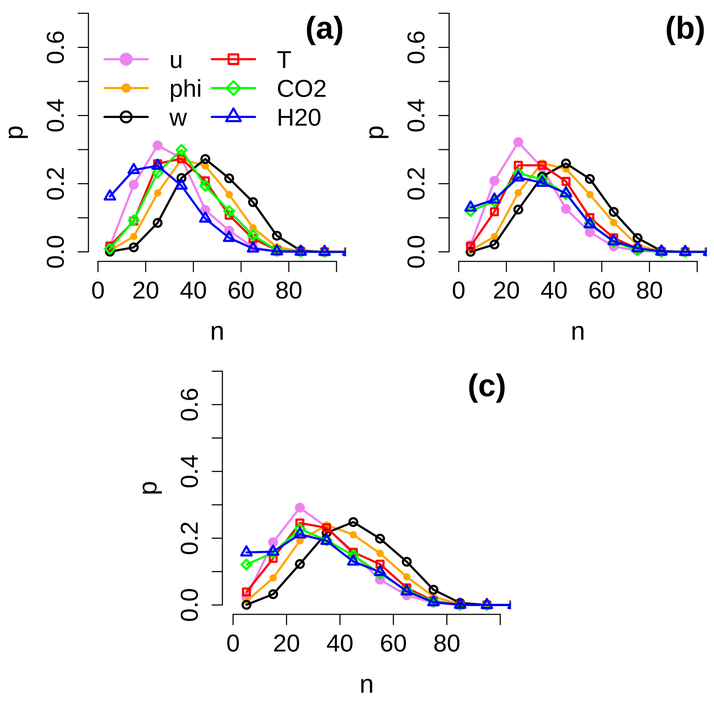

Figure 3: *Probability density functions p of number of CS n detected in 30 min interval in horizontal velocity u (violet), wind direction phi (orange), vertical velocity w (black), sonic temperature T (red), carbon dioxide CO_2 (green), and water vapour H_2O (blue) measurements at the top of the towers M1 (a), M2 (b), M3 (c).*

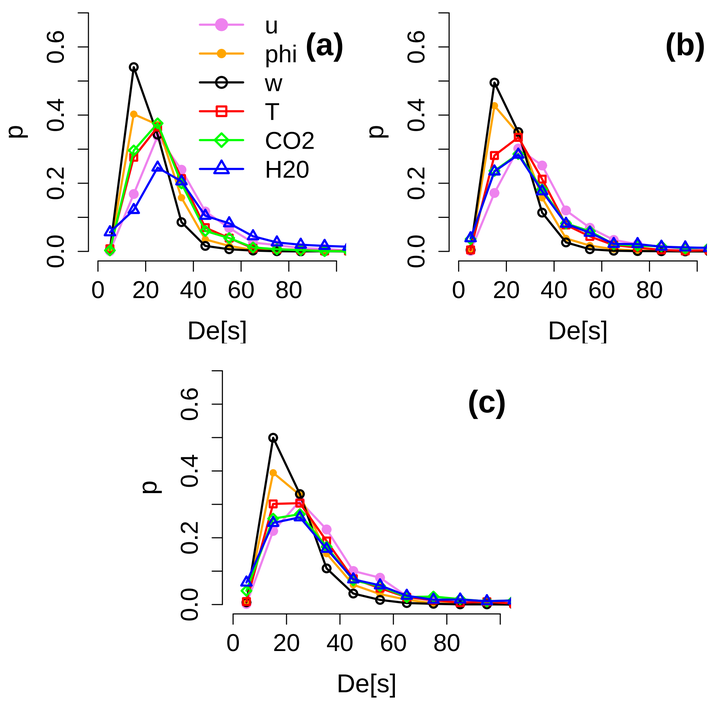

Figure 4: *Same as Fig. 3 but for temporal scales of CS D_e.*

Flux contribution

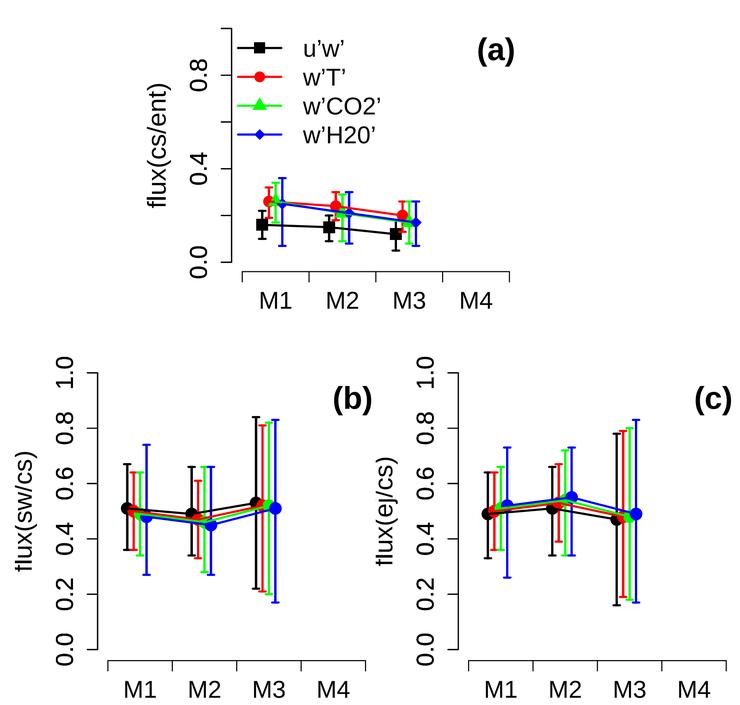

Figure 5: *Median of the flux contribution of CS to the entire flux (a), of ejections (b) and sweeps (c) to the coherent flux as a function of location for the momentum $\overline{w'u'}$ (black), sensible heat $\overline{w'T'}$ (red), carbon dioxide $\overline{w'CO'_2}$ (green), and latent heat $\overline{w'H_2O'}$ (blue) transport. Error bars represent 25 and 75% quantiles.*

Following Serafimovich et al (2011) and using relational properties such as sweep and ejection ratios of CS detected at the towers and the variations of the flux contribution, coupling processes within and between the heterogeneous forest and the atmosphere will be investigated.

Conclusions

- Vertical wind velocities w show more coherent structures with shorter lifetimes than other parameters
- Flux transport by sweeps prevails at the forest edge, whereas ejections contribute more efficiently above the canopy

Open points and future plans

The poster presents preliminary results. Therefore, following detailed analysis will be resumed focusing on the following points:

- Accurate analysis of all data applying quality assessment and quality control based on the long-term observations at the measuring site
- Investigation of properties of CS for different flow regimes and directions

References

Serafimovich A, Thomas C, Foken T (2011) Vertical and horizontal transport of energy and matter by coherent motions in a tall spruce canopy. Boundary-Layer Meteorol 140:429–451, DOI 10.1007/s10546-011-9619-z

Thomas C, Foken T (2005) Detection of long-term coherent exchange over spruce forest using wavelet analysis. Theor Appl Climatol 80:91–104, DOI 10.1007/s00704-004-0093-0

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