CANOPY PROXIMITY ESTIMATION AND IMPACT ON LONG TERM TURBULENT FLUXES ABOVE A HETEROGENEOUS FOREST

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Estimation difficult for single point measurements in the roughness sub-layer above heterogeneous forests

z = sonic anemometer height
d = displacement height (proportional to canopy height)

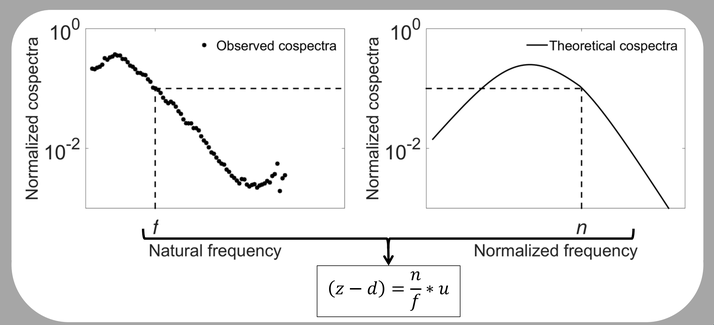
Canopy aerodynamic proximity (*z-d*) impact on long term turbulent fluxes at the Vielsalm Terrestrial Observatory

Impact on momentum flux can be tracked with the correlation coefficient r_{uw}, corresponding to the momentum transport efficiency

20 years of momentum, sensible heat, water and carbon dioxide fluxes above a mixed and spatio-temporal heterogeneous forest

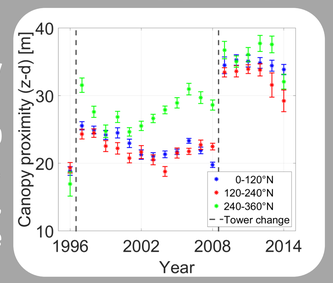
Canopy proximity (*z-d*) estimation

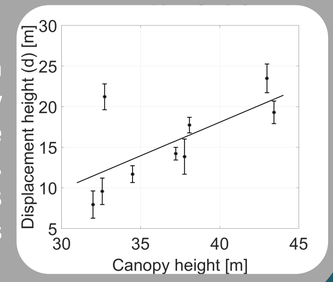
- Computation of the mean unstable sensible heat cospectra by year and by 30 or 120° azimuthal direction sector.
- For each observed cospectral density (Figure):
  - Ratio between the observed natural frequency (*f*) and the corresponding theoretical normalized frequency (*n*).
  - Multiplication by the mean wind speed (*u*) to obtain (*z-d*).
- Computation of the mean (*z-d*) for each year and sector.



Canopy proximity (*z-d*) and canopy height

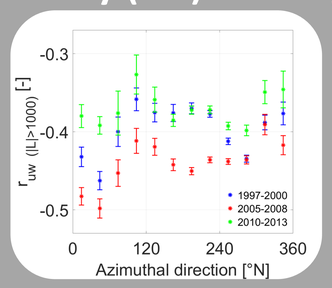
- (*z-d*) is variable (Figure):
  - → Tower changes are correctly detected in 1997 and 2009.
  - → Overestimation between 240 and 360°N, from 2002 to 2008.
  - → Between 0 and 120°N, significant ($p<0.05$) decrease of (*z-d*) from 1997 to 2009.
- (*d*) vs canopy height (Figure):
  - → Significant ($p<0.05$) relation between d and the canopy height derived from 3 tree height inventories in 1996, 2009, and 2014 in 3 azimuthal direction sectors (0-30, 0-90 and 270-300°N).

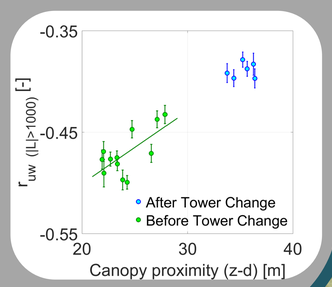




r_{uw} and canopy proximity (*z-d*)

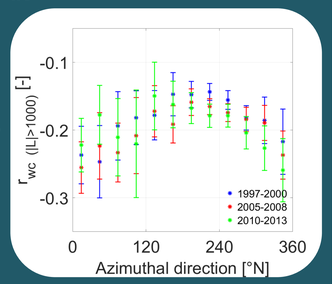
- r_{uw} in near-neutral conditions ($|L|>1000$ m) is variable (Figure):
  - → Tower and surrounding environment change impact as values differ between 1997-2000 and 2010-2013.
  - → Lower values observed than in the inertial sublayer (0.35).
- r_{uw} vs (*z-d*) (Figure):
  - → Only significant ($p < 0.05$) between 0 and 60°N before the tower change in 2009.
  - → Other parameters have to be considered to explain the r_{uw} variability in other azimuthal directions.





Conclusions and outlook

- Canopy proximity (*z-d*) estimation method based on the comparison of theoretical and observed cospectra gives globally coherent results.
- Momentum transport efficiency is variable spatio-temporally and can partly be explained by (*z-d*).
- Further investigations are needed. Notably regarding the edge effect between Douglas fir and beech subplots.
- CO_2 transport efficiency (r_{wc} for $\overline{w'c'}>0$) is variable spatially (Figure), but no relation was found with (*z-d*), suggesting other parameters are involved. It has to be taken into account in analysis to avoid introducing a bias.



- Open question:
  Is there an impact of canopy proximity on turbulent fluxes on other eddy covariance sites?

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