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Canopy aerodynamic distance (*z-d*) estimation and impact on eddy covariance measurements

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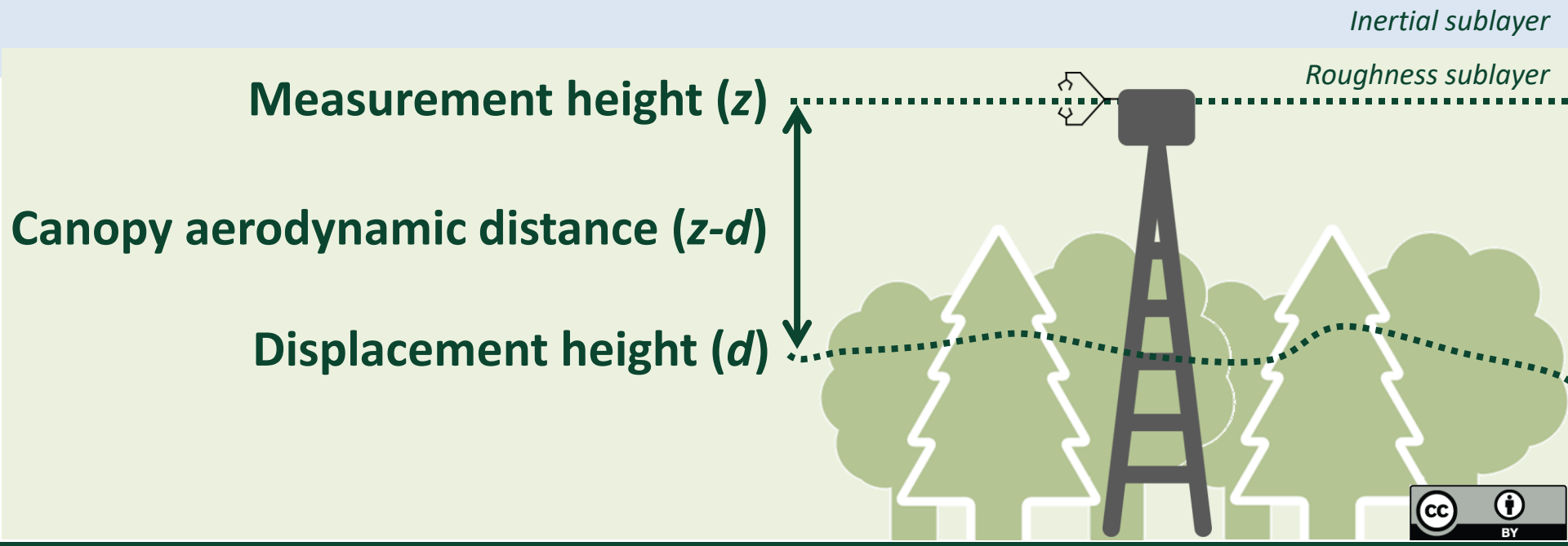
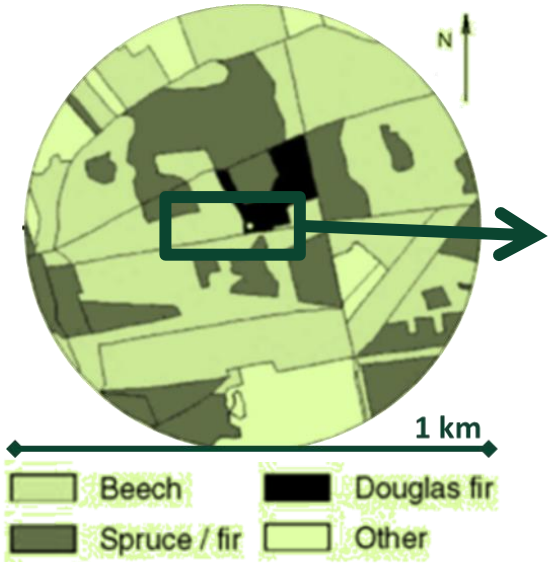
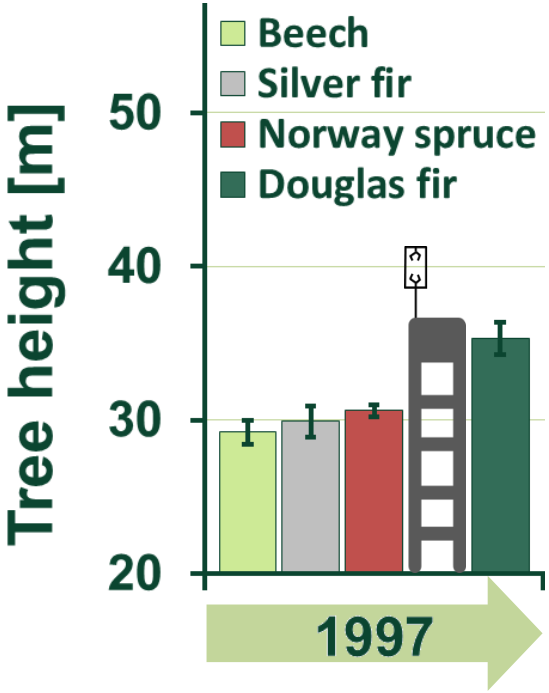
European Geoscience Union, Vienna, 23-28 April 2017

- **Objectives:**
  - Is turbulent transport impacted by canopy aerodynamic distance ($z - d$) variability in the roughness sublayer?
  - How to estimate canopy aerodynamic distance?



- **The Vielsalm Terrestrial Observatory (VTO)**





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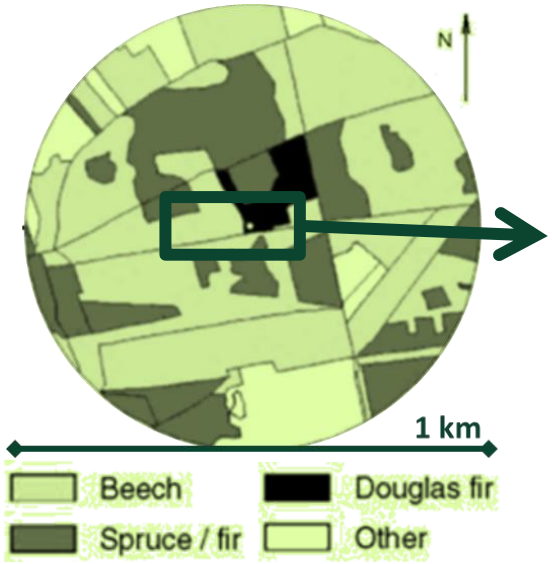

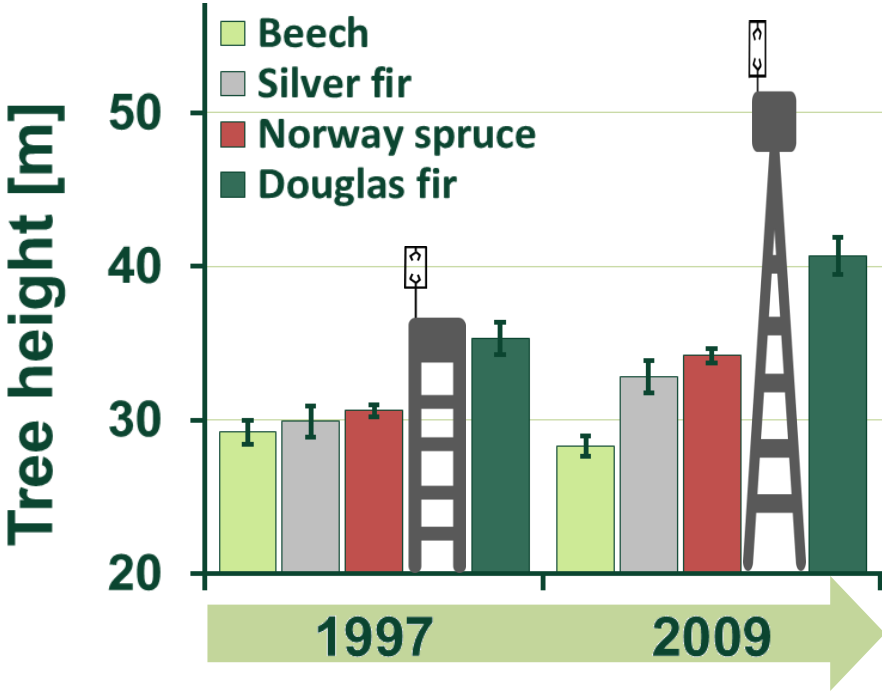

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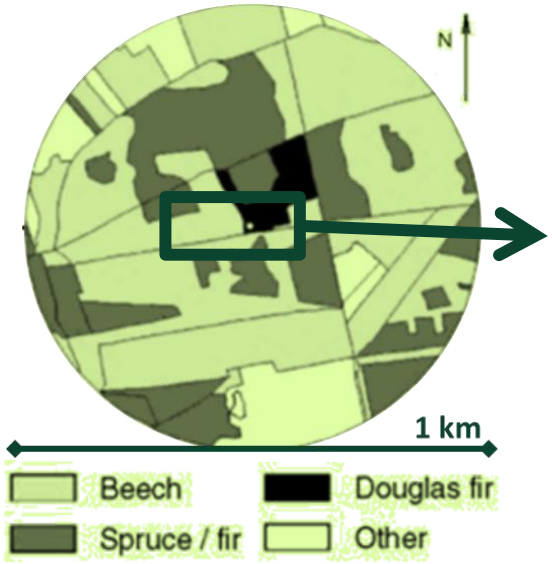
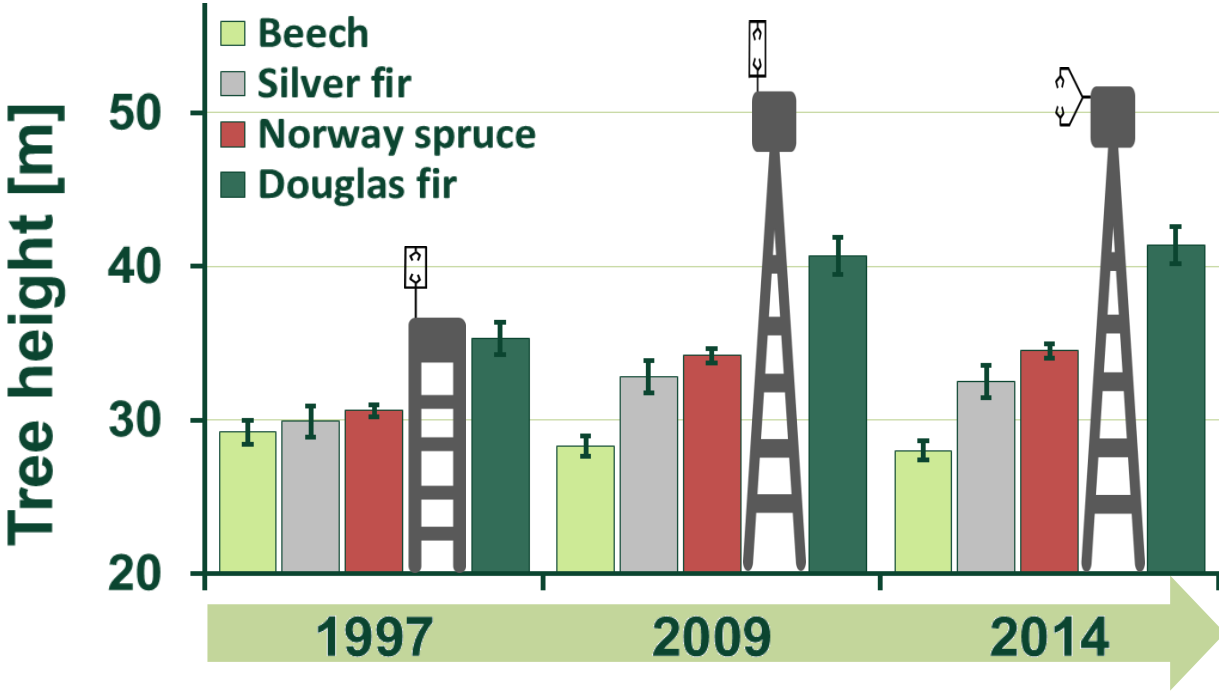
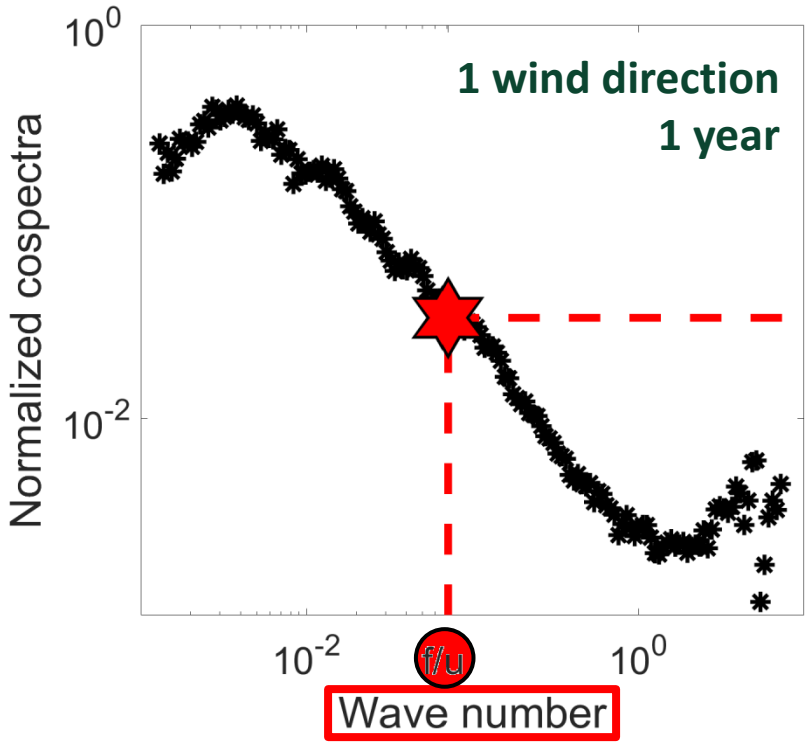
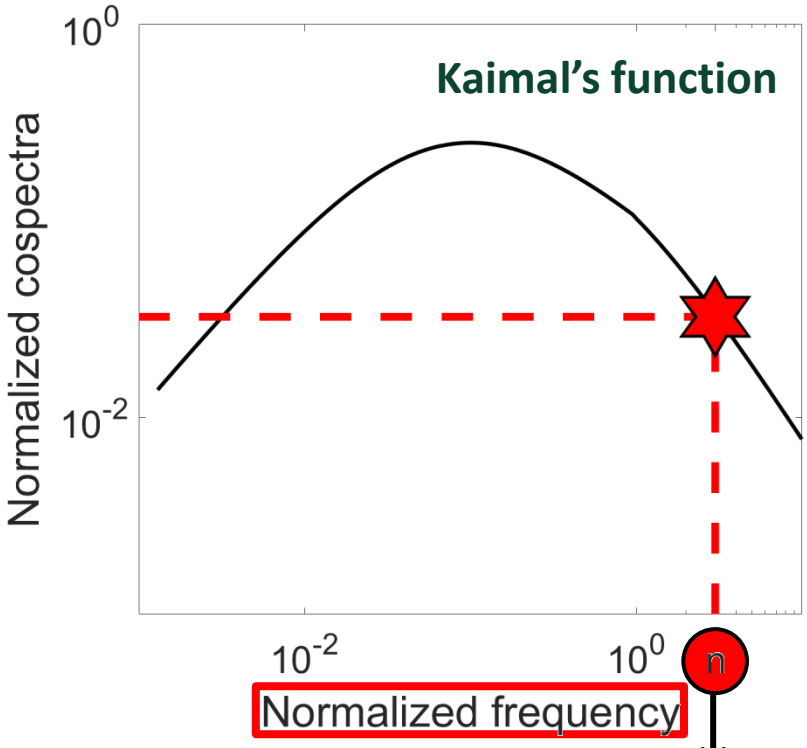




- **Aerodynamic measurement height estimation based on cospectra :**
  - **Observed mean cospectrum**
  - **Theoretical cospectrum**



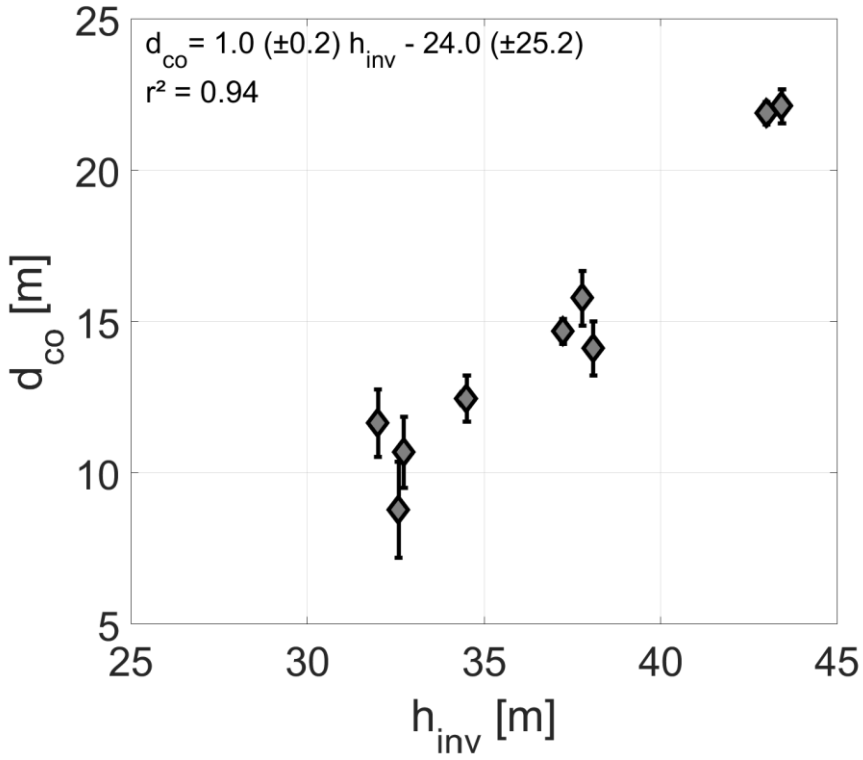


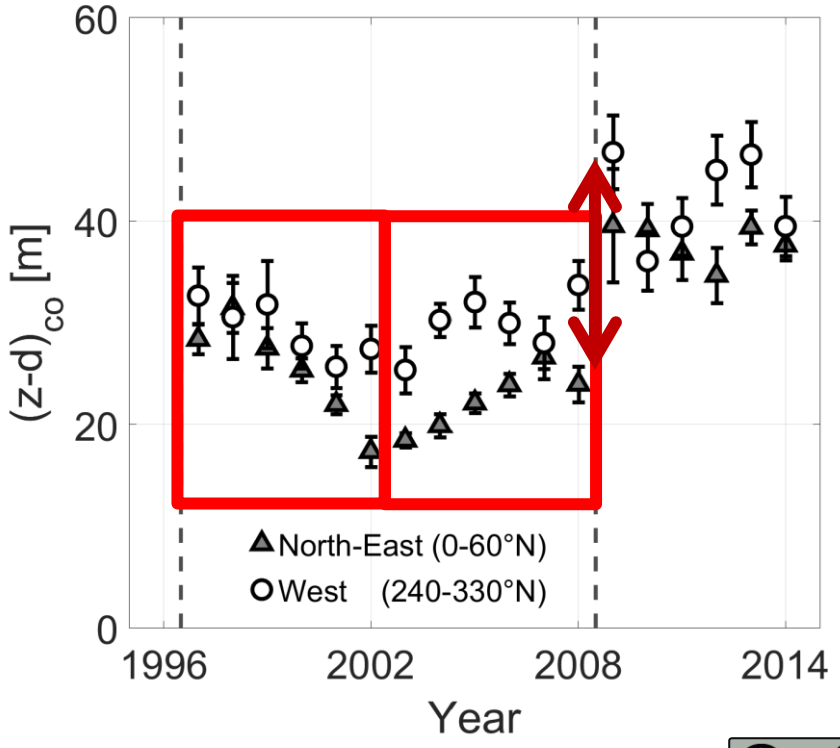
Poster A29, 17:30–19:00, Hall A

$$z - d = \frac{n}{f/u}$$

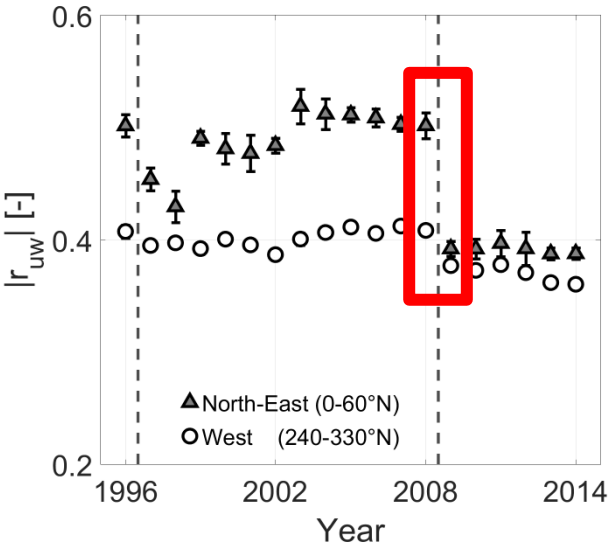
$$(z - d)\frac{f}{u}$$

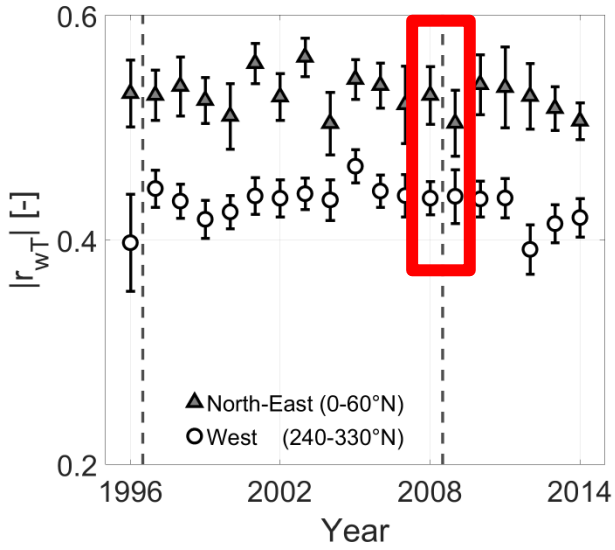
- **Canopy aerodynamic distance (*z-d*):**
  - Validation by confronting the results to :
    - the expected changes in *d* (as canopy height was variable)
    - the observed changes in *z* (as the measurement height was changed)

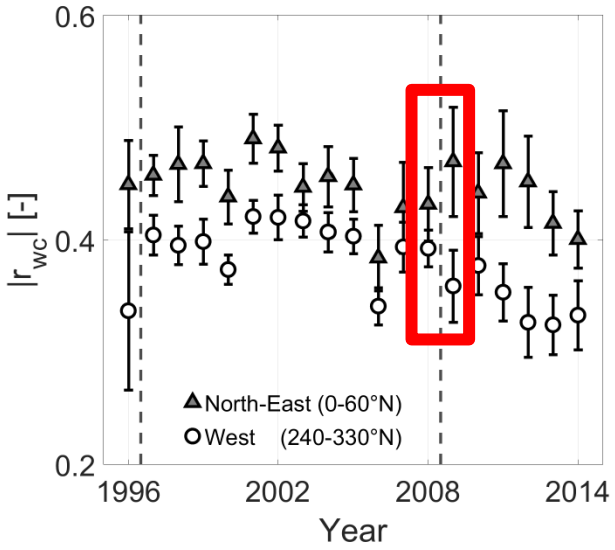




- **Correlation coefficients :** $r_{uw} = \frac{\overline{u'w'}}{\sigma_u \sigma_w}$; $r_{wT} = \frac{\overline{w'T'}}{\sigma_w \sigma_T}$; $r_{wc} = \frac{\overline{w'c'}}{\sigma_w \sigma_c}$
  - may be referred to as normalized covariances or transport efficiencies as they indicate how much *w* is related to *u*, *T* and *c*.
  - repeatable measurements require constant correlation coefficient during all the measurement period

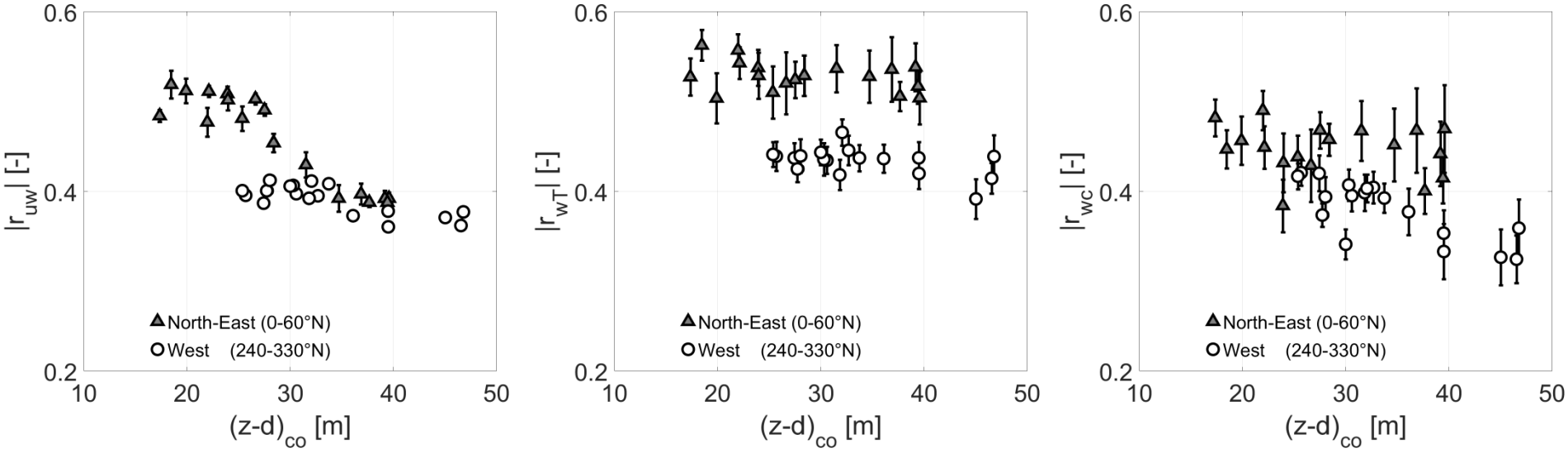






- r_{uw} (neutral conditions): pronounced temporal dynamics
- r_{wc} **and** r_{wT} (unstable conditions)**:** no temporal dynamics.
- r_{uw}**,** r_{wc} **and** r_{wT} : pronounced spatial variability ($r_{uw} > r_{wT} > r_{wc}$).

- **Canopy aerodynamic distance and correlation coefficients :**



– Momentum correlation coefficient (r_{uw}) is strongly linked to *z-d*.

→ Characteristic of the roughness sublayer.

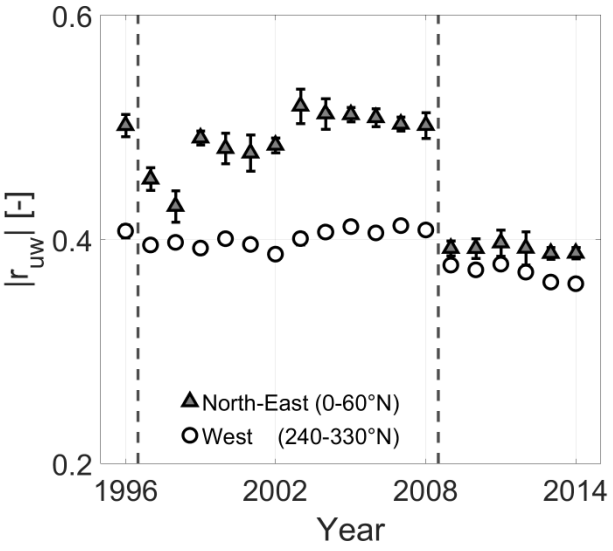
– Heat and CO_2 correlation coefficients (r_{uw}, r_{wc}, r_{wT}) independent of *z-d*.

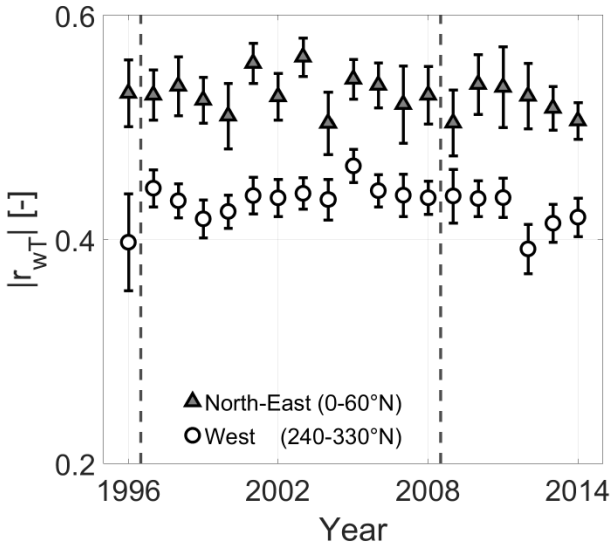
→ More homogeneous sources-sinks distribution.

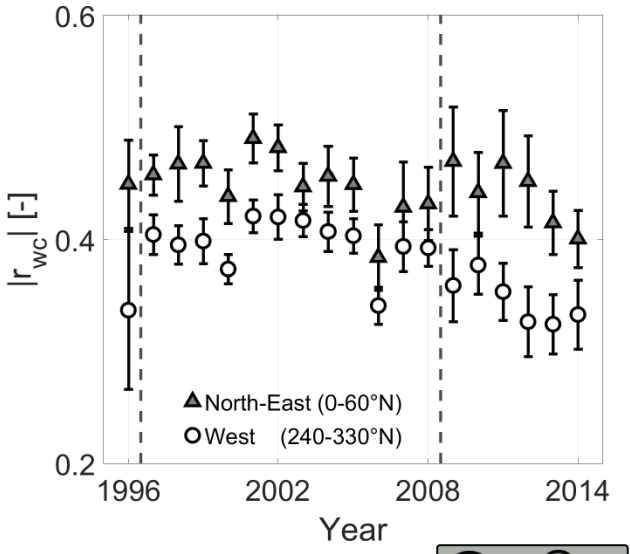
– Difference between azimuthal direction sectors in r_{wc} and r_{wT} (more pronounced)

→ Not related to *z-d* variability.

- **Why is there a difference between NE and W for r_{wT} and r_{wc}?**
  - Tree height transition between high Douglas firs and beeches?
- **Why is it more pronounced for r_{wT} than for r_{wc}?**
  - Horizontal/vertical heterogeneity in sources/sinks distribution?
  - Large turbulence structures?
  - Occurrence of cloud passages?
  - Active role of temperature?







- **Canopy aerodynamic distance (*z-d*) estimation:**
  - Original *z-d* estimation method based on single point eddy covariance measurements with a relatively high temporal and spatial resolution.
  - *z-d* temporal dynamics and spatial variability fairly well reproduced.
- **Relation to turbulence statistics**
  - r_{uw} directly related to *z-d* → roughness sublayer.
  - r_{wc} and r_{wT} not related to *z-d* even in the roughness sublayer
  - Other parameters need to be considered in order to explain the observed spatial variability.
- **Next step**
  - Consider the fluxes themselves by considering footprint issues.

Thank you for your attention

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More information?

- quentin.hurdebise@ulg.ac.be
- Poster session (A29, 17h30, Hall A)
- Paper submitted (AFM)