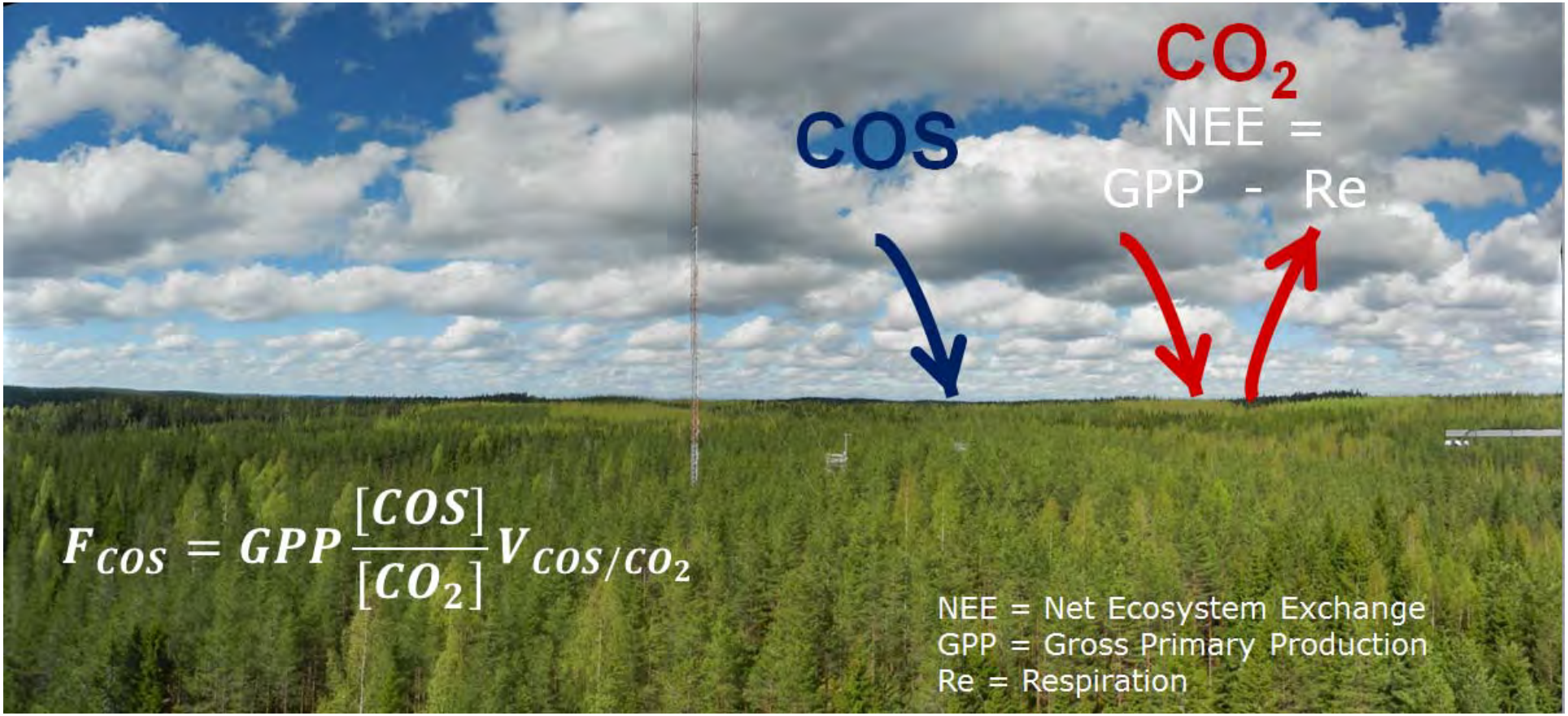
university of groningen / faculty of mathematics and natural sciences

Understanding COS fluxes in a boreal forest: towards COS-based GPP estimates.

Linda M.J. Kooijmans[1], Kadmiel Maseyk[2], Timo Vesala[3], Huilin Chen[1,4], Ivan Mammarella[3], Ulli Seibt[5], Mari Pihlatie[3], Wu Sun[5], Helmi Keskinen[3], Arnaud P. Praplan[3], Alessandro Franchin[3], Janne Levula[3]

1) Centre for Isotope Research, University of Groningen, Groningen, The Netherlands,
2) Department of Environment, Earth and Ecosystems, The Open University, Milton Keynes, United Kingdom.
3) Department of Physics, University of Helsinki, Helsinki, Finland.
4) Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO, USA
5) Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, California, USA.

Carbonyl sulfide (COS) as tracer for photosynthetic Carbon uptake



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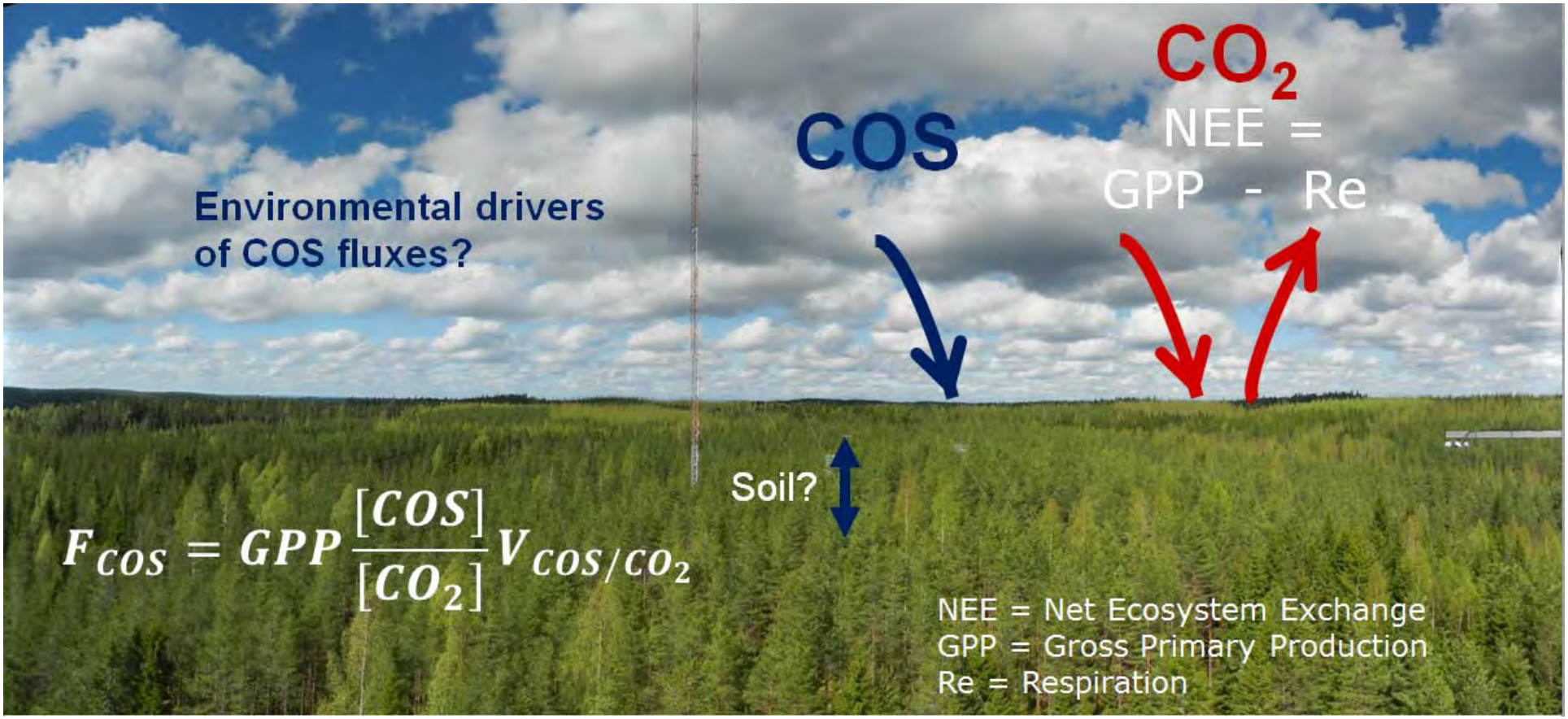
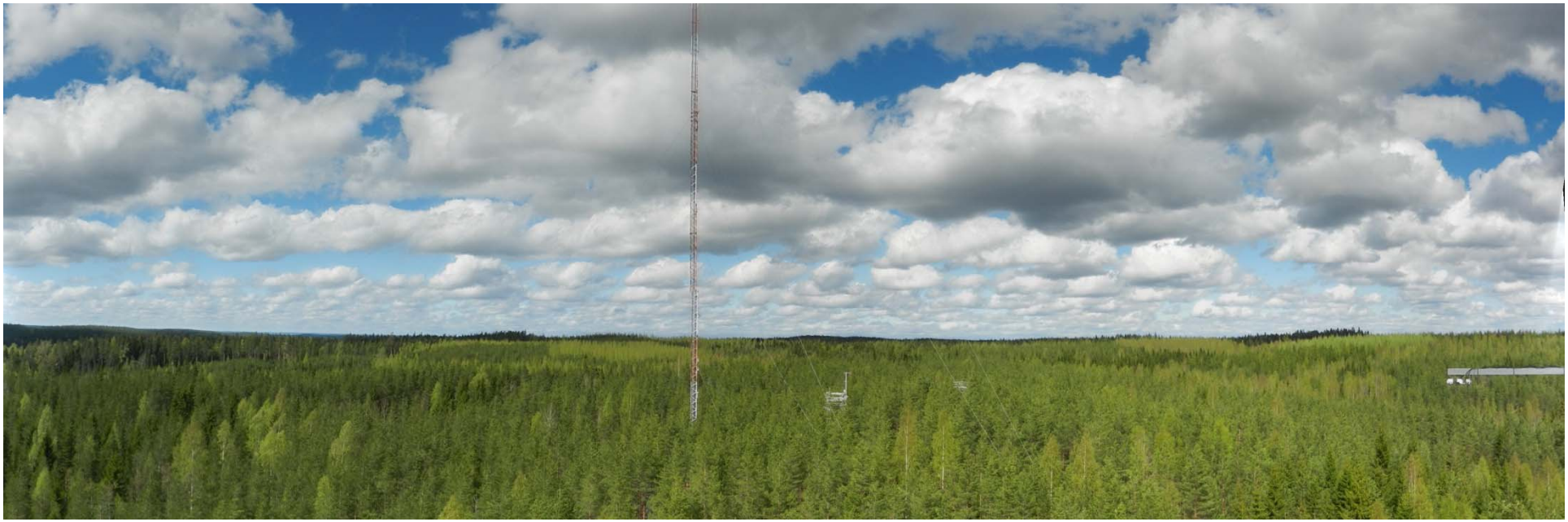


InGOS measurement campaign: Hyytiälä, Finland

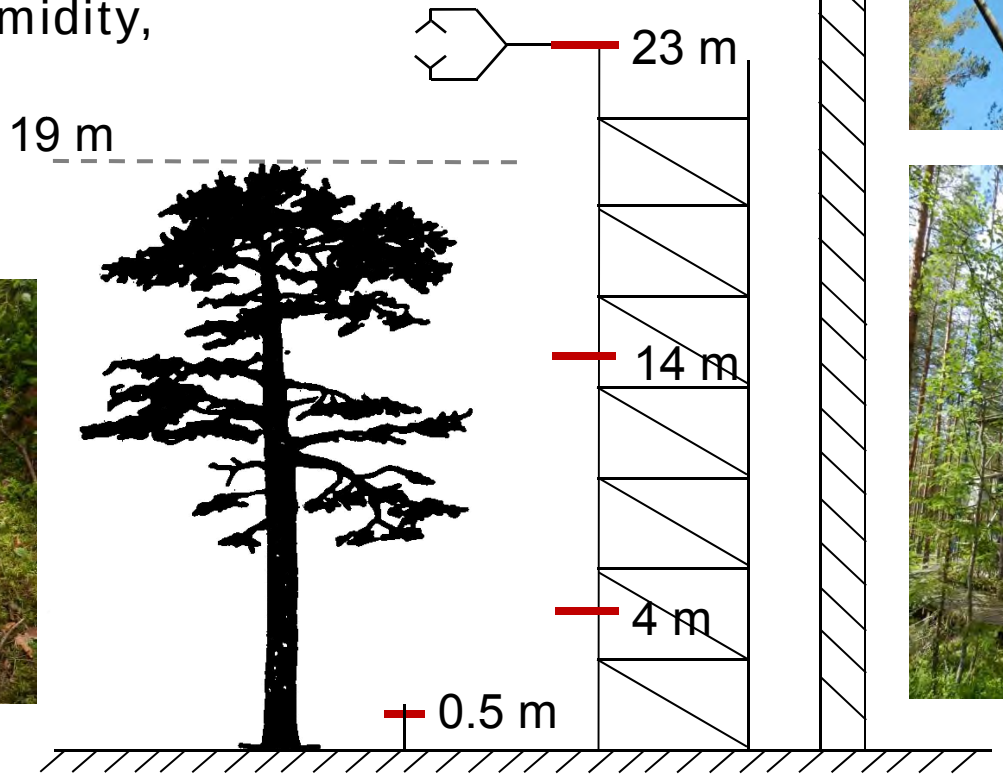


Measurement setup

COS and CO_2 measurements:

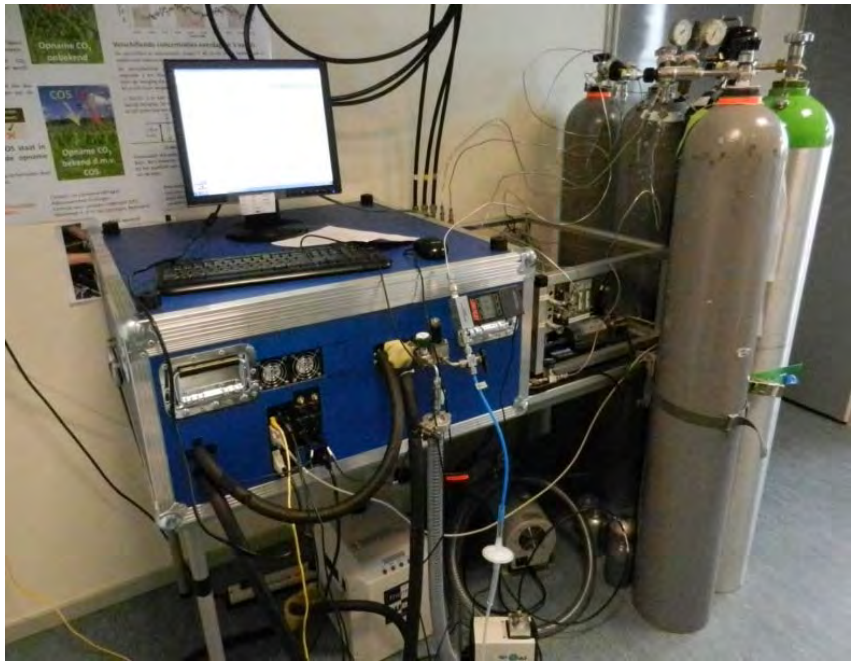
- Eddy-covariance (23 m)
- Profile: 0.5, 4, 14, 23, 125 m
- Soil chamber fluxes

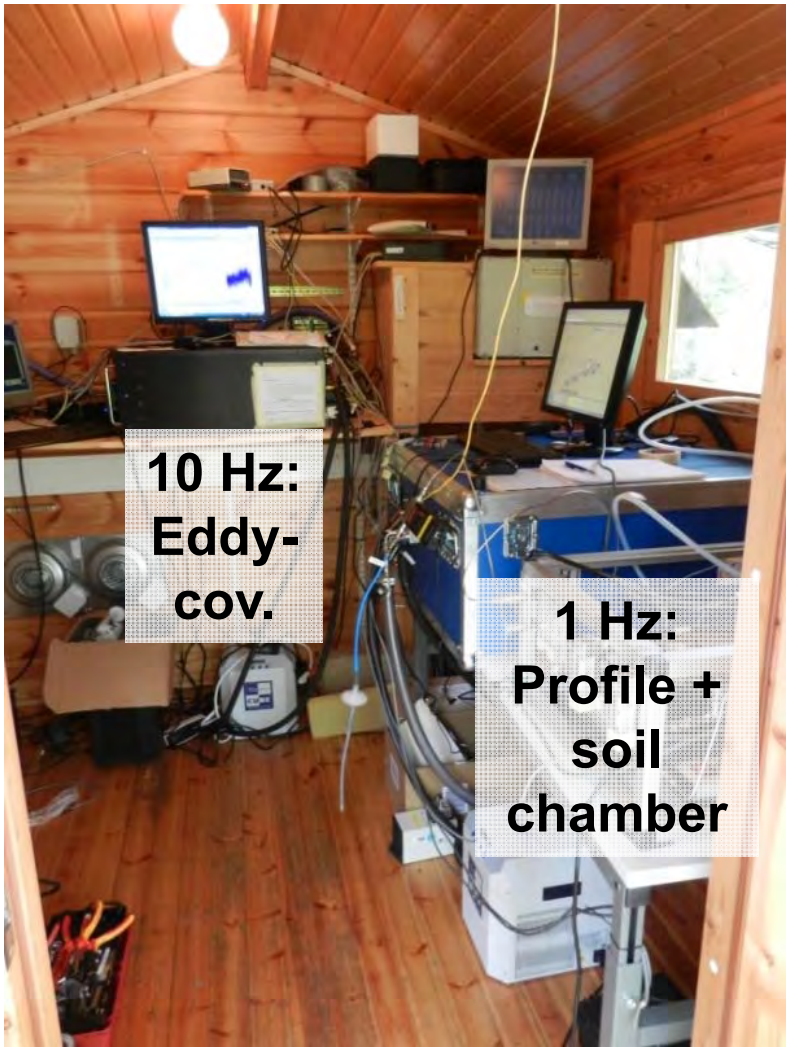
- Meteorological variables, Soil temp. and humidity, ^{222}Radon, etc.



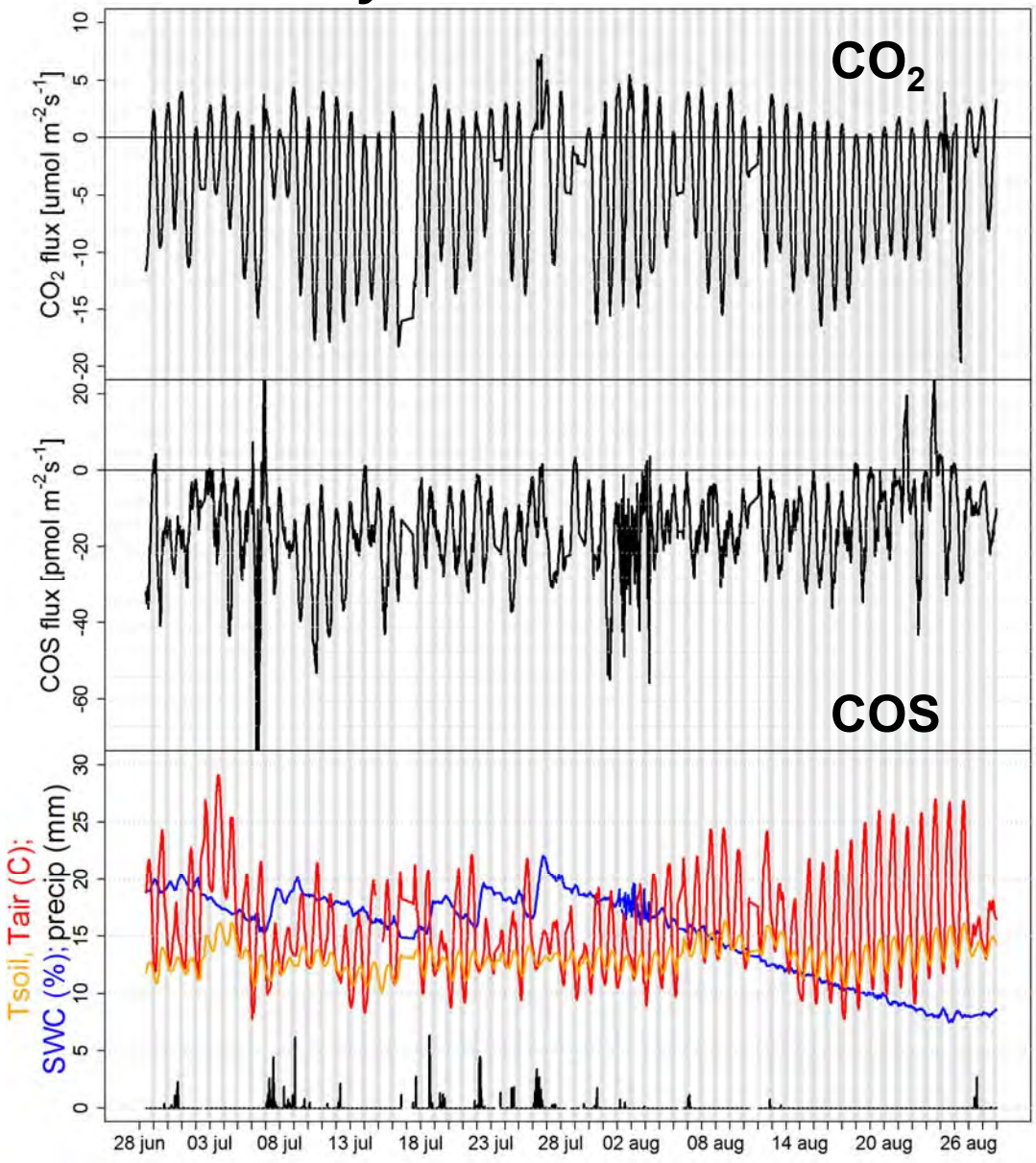
Aerodyne QCLS for COS, CO_2, CO and H_2O measurements

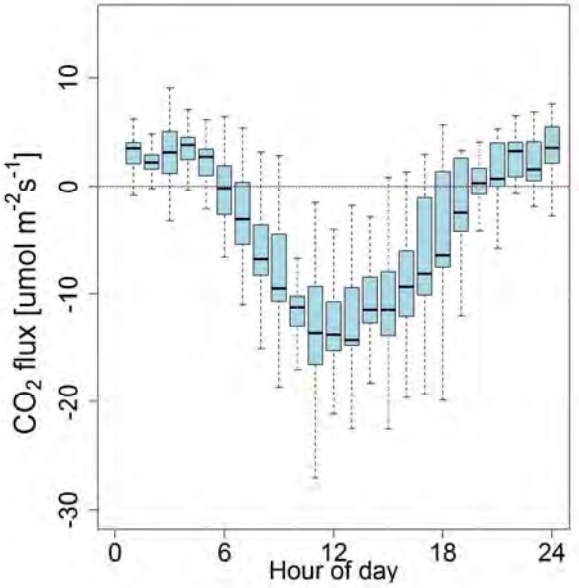
Precision (2 minute meas.): between 3.4 – 4.1 ppt COS, 0.03 – 0.04 ppm CO_2.
Reproducibility: 2.1 ppt COS, 0.1 ppm CO_2.

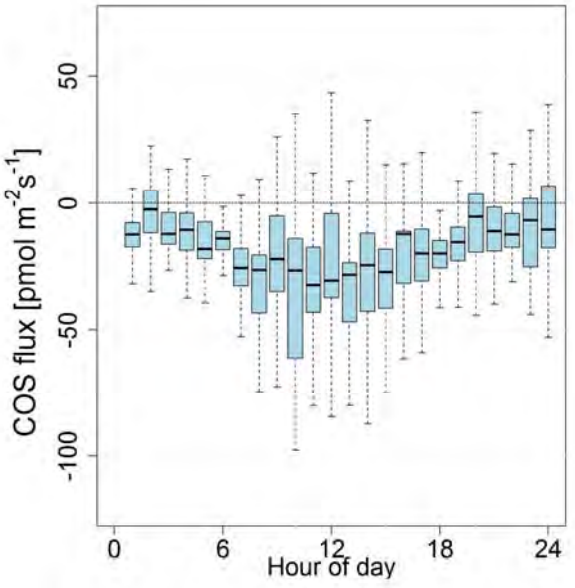




Ecosystem COS and CO_2 flux at 23 m







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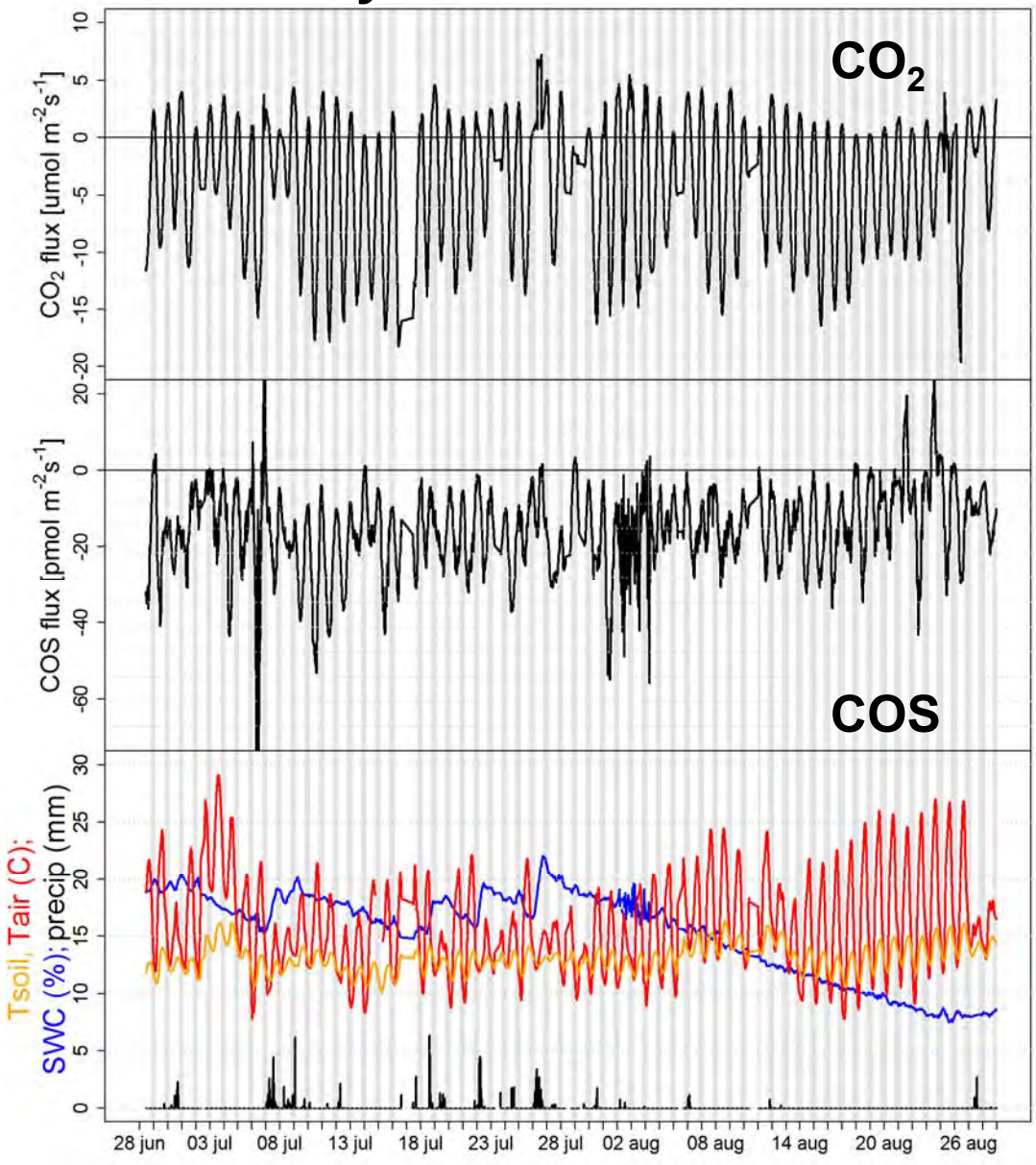
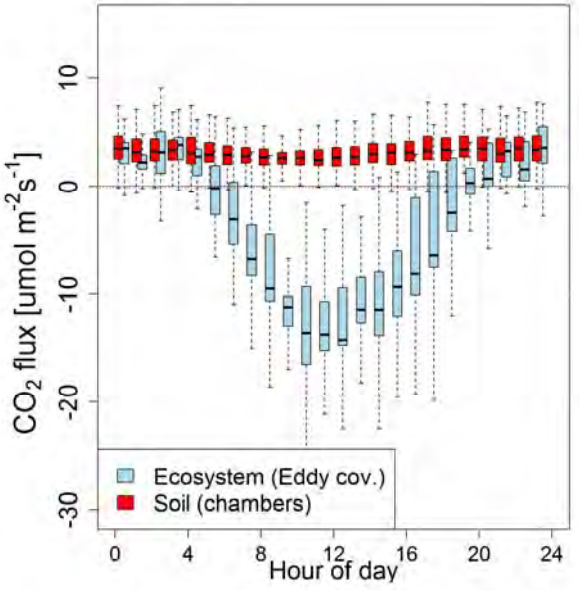
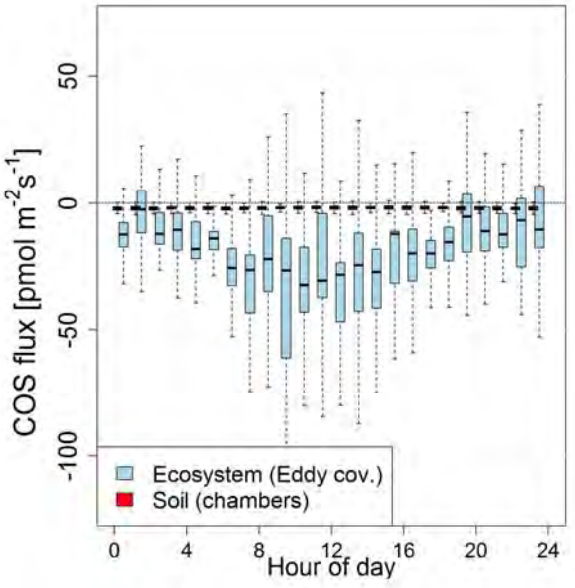
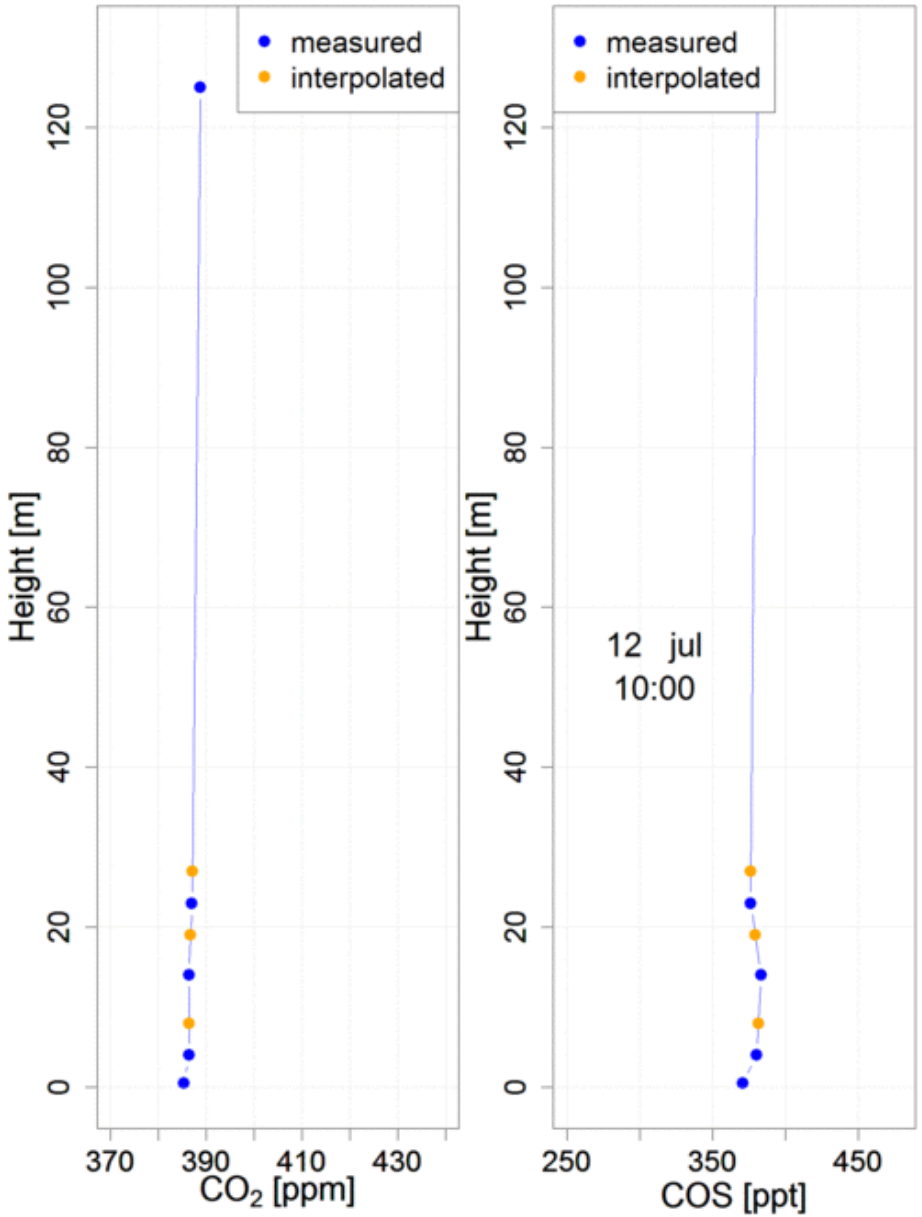
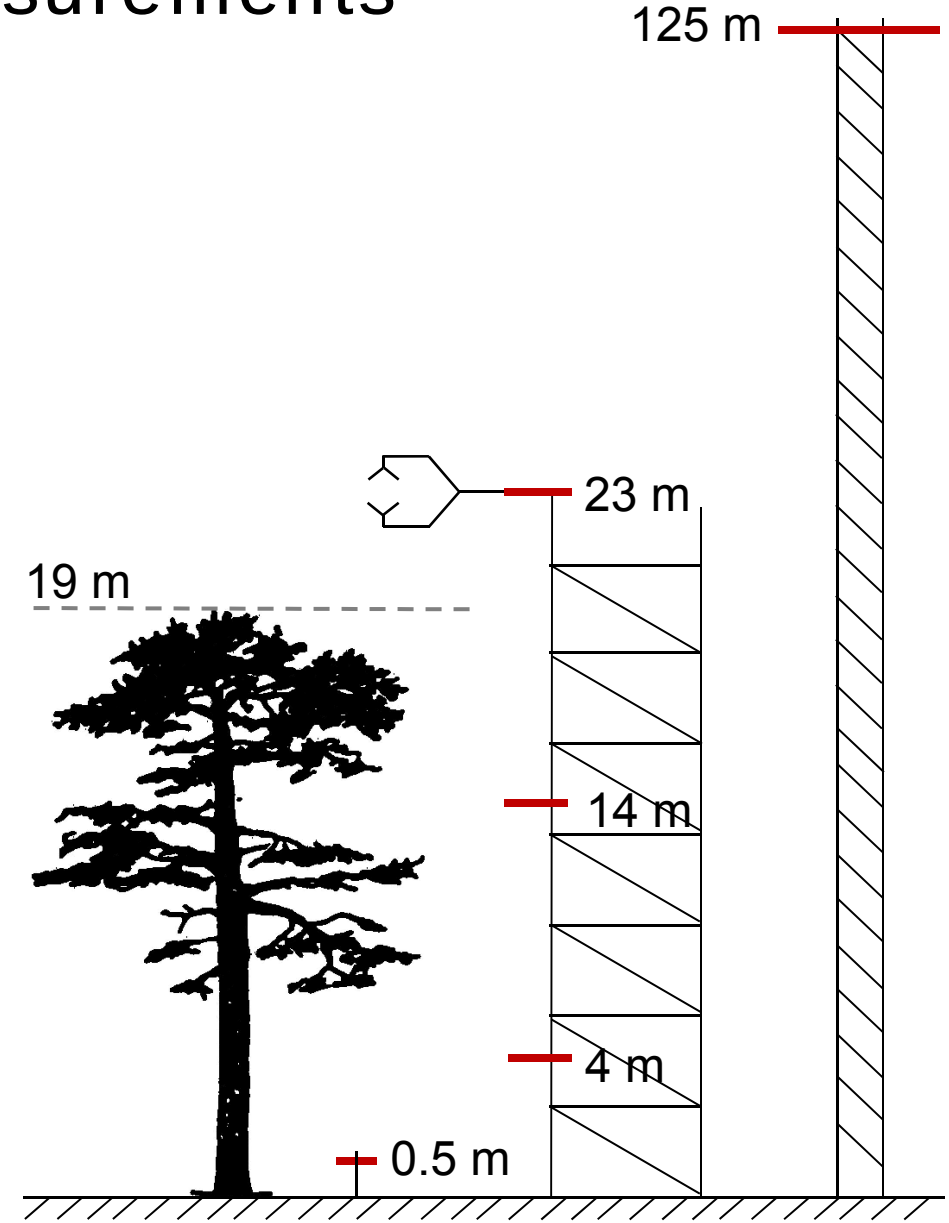




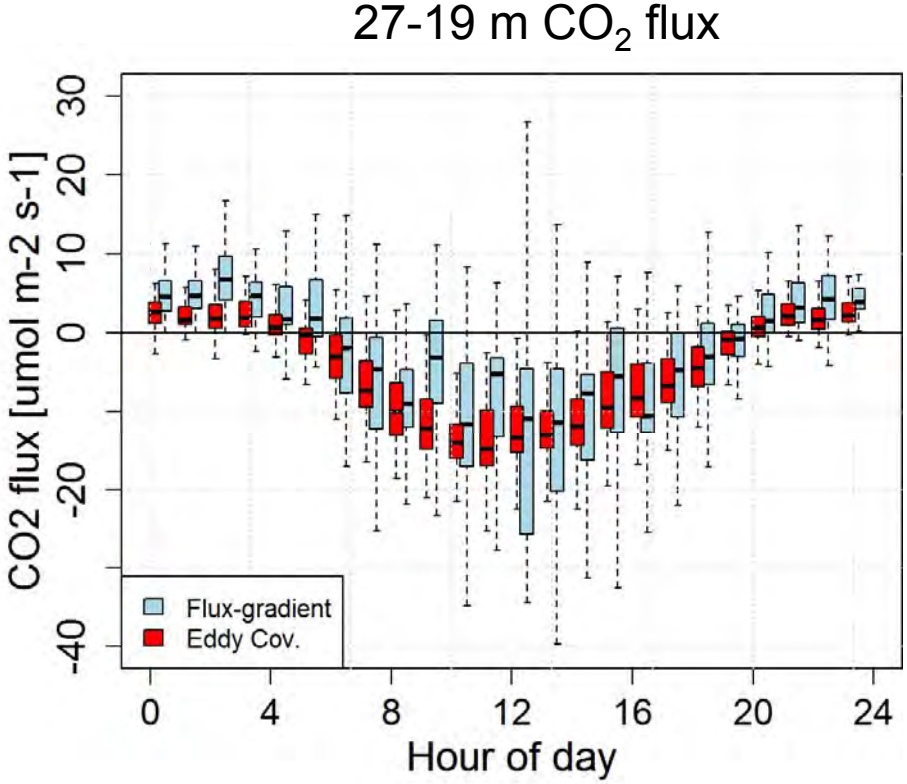


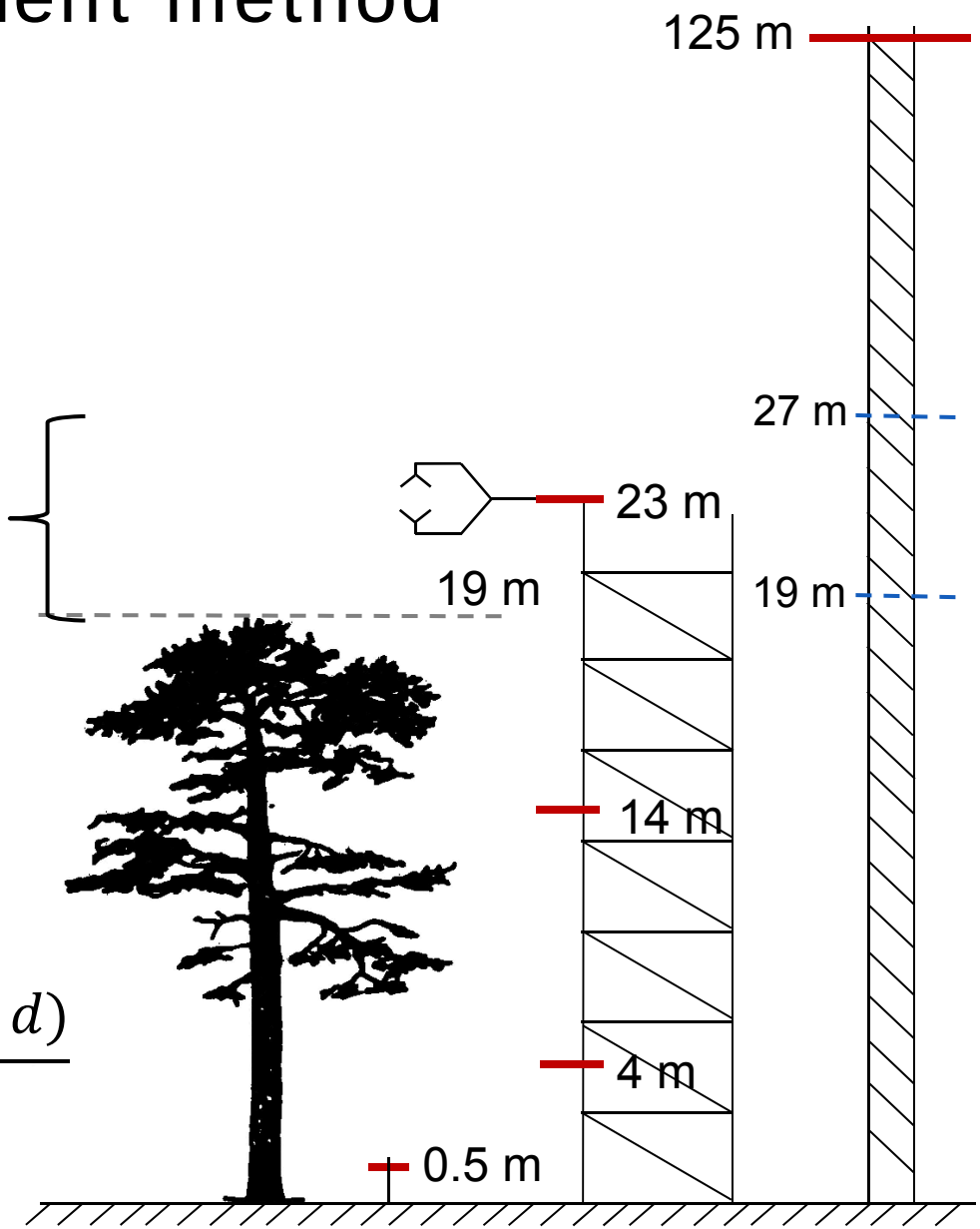
Profile measurements





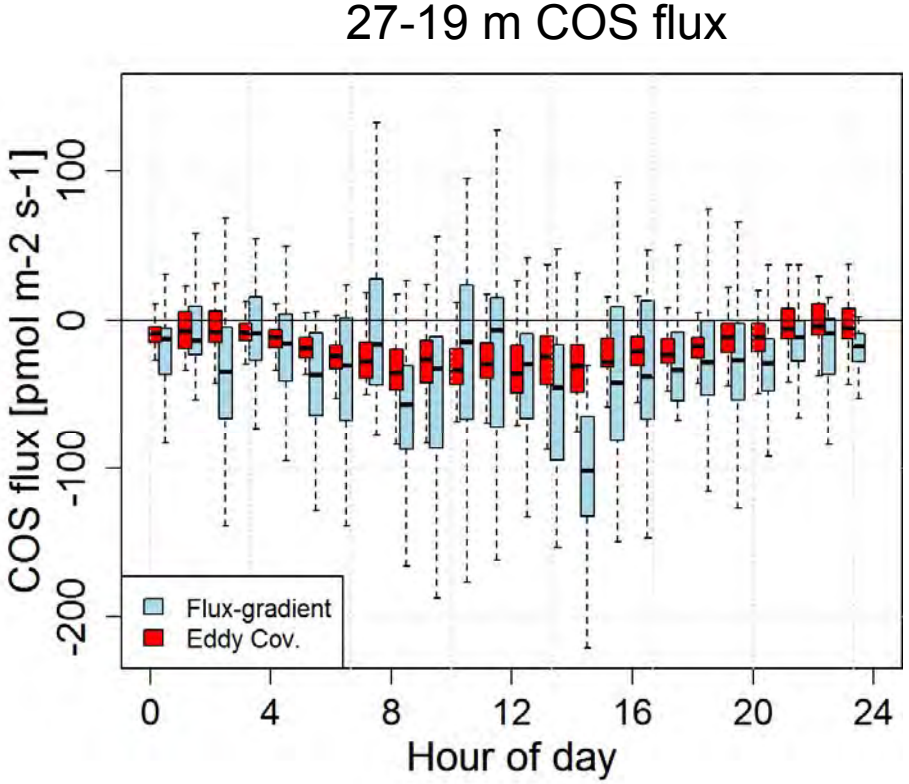
Flux-gradient method

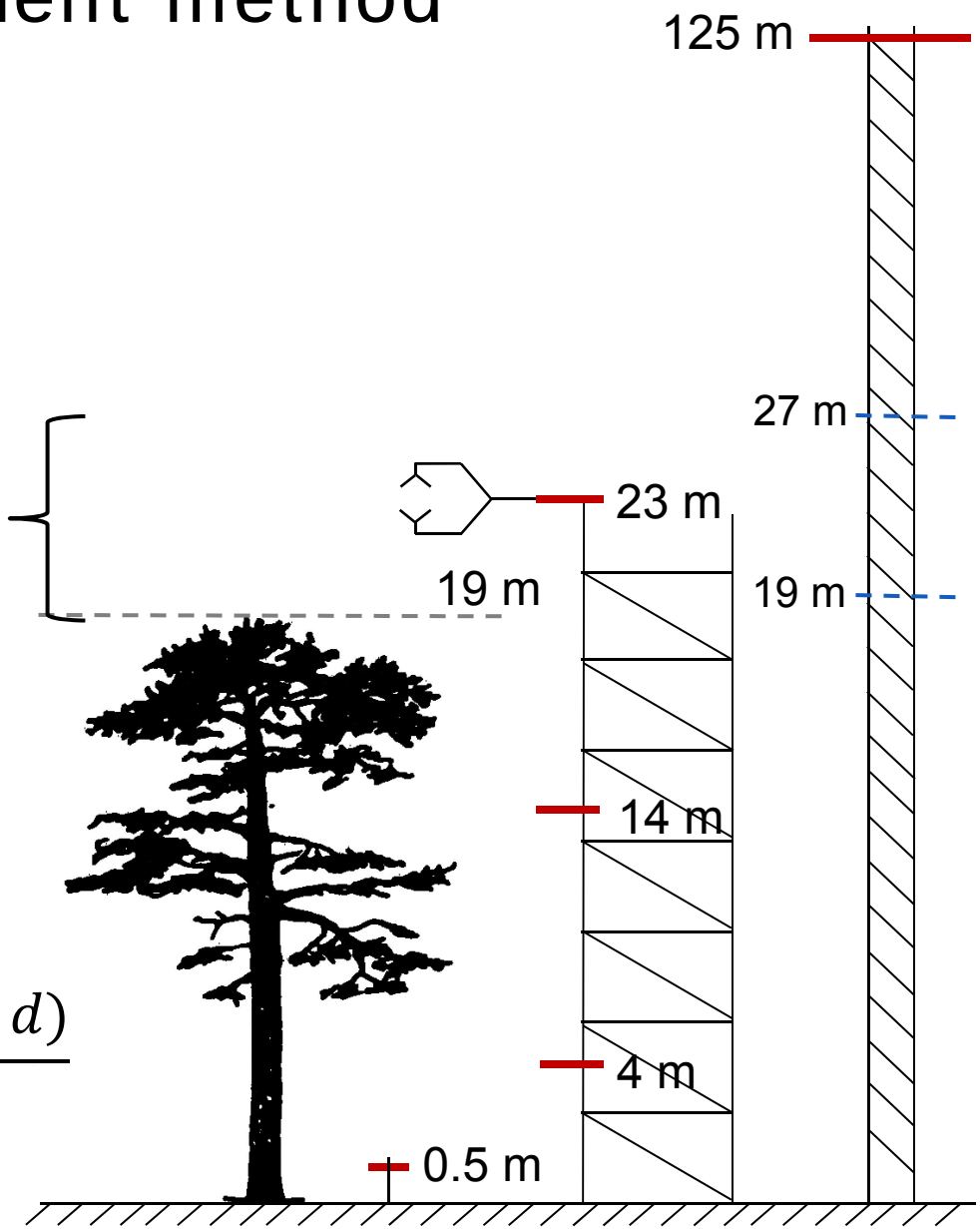




$$F_{CO_2} = -K \frac{\Delta C_{CO_2}}{\Delta z} \rho \qquad K = \frac{u_* k (z - d)}{\varphi_m}$$

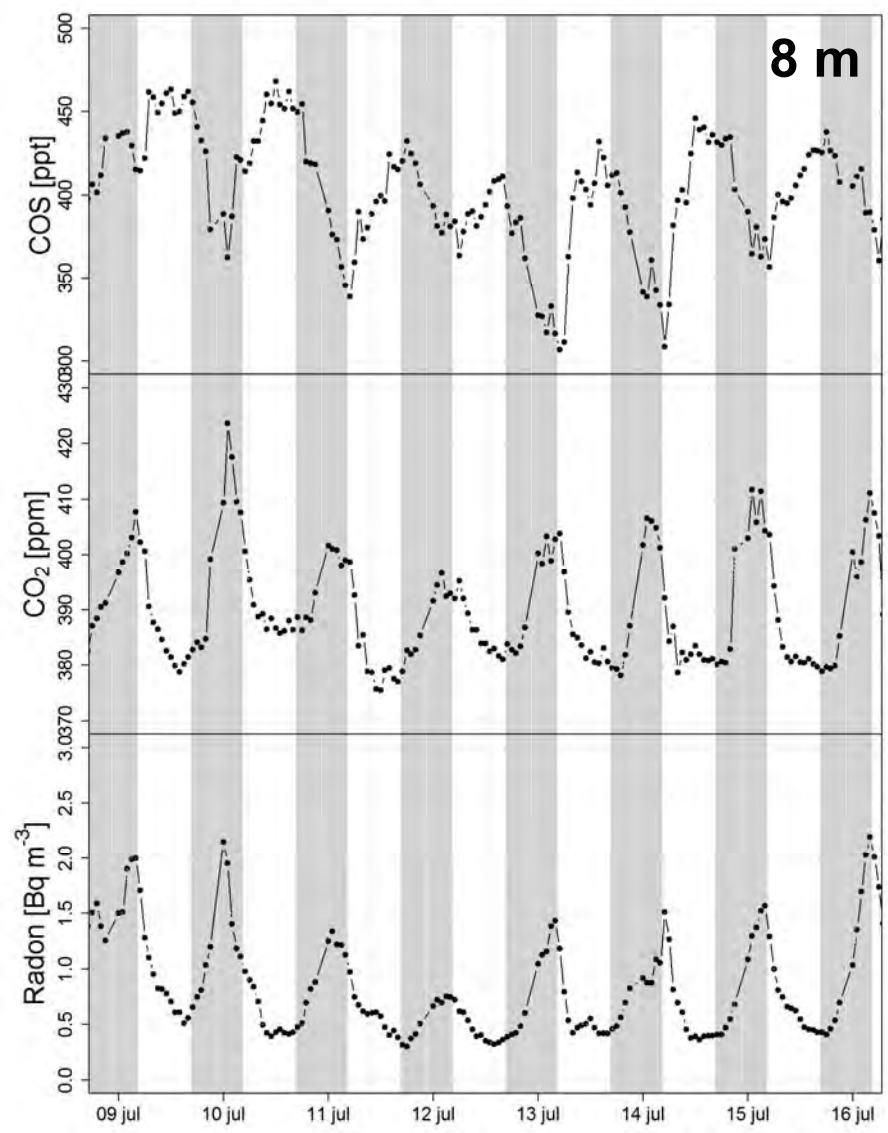
Flux-gradient method





$$Fcos = -K \frac{\Delta C_{cos}}{\Delta z} \rho \qquad K = \frac{u_* k (z - d)}{\varphi_m}$$

Radon-tracer method



$$F_{COS} = F_{Rn} \frac{\Delta C_{COS}}{\Delta C_{Rn}},$$

$$F_{Rn} = 2.8\ mBq\ m^{-2}\ s^{-1}$$

Manohar et al,. 2013

Radon-tracer method

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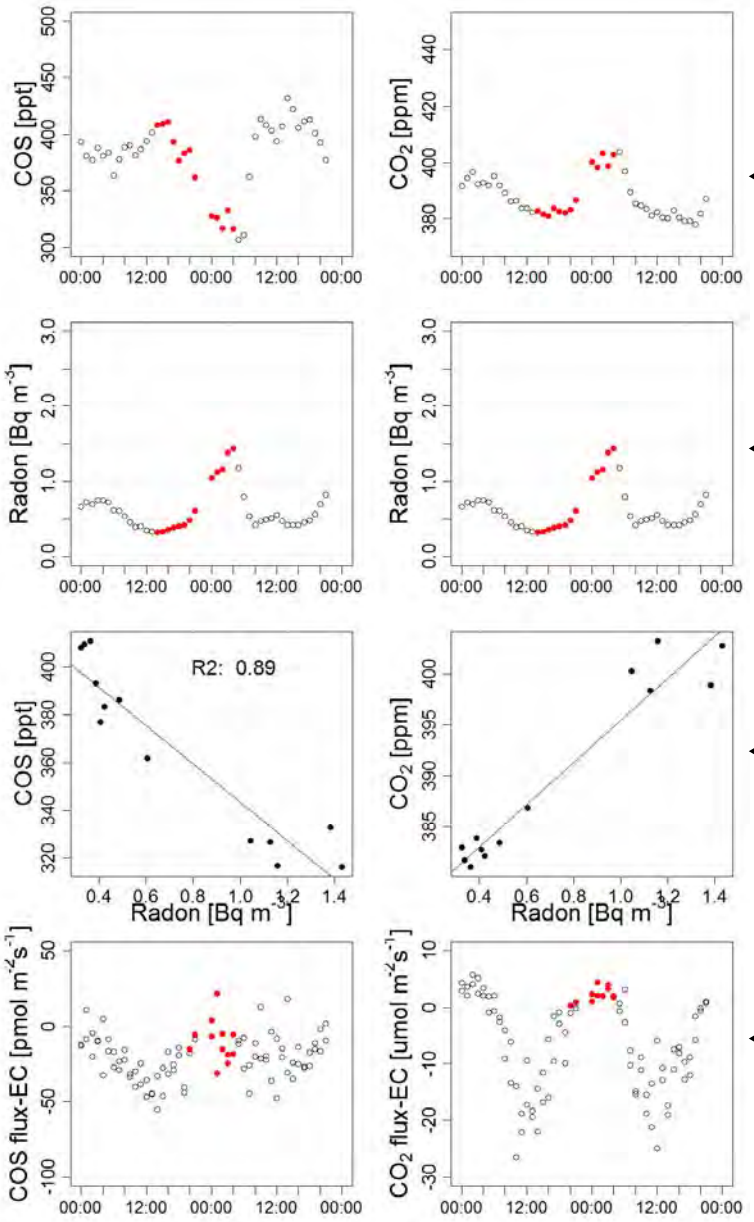


← COS / CO_2 concentration

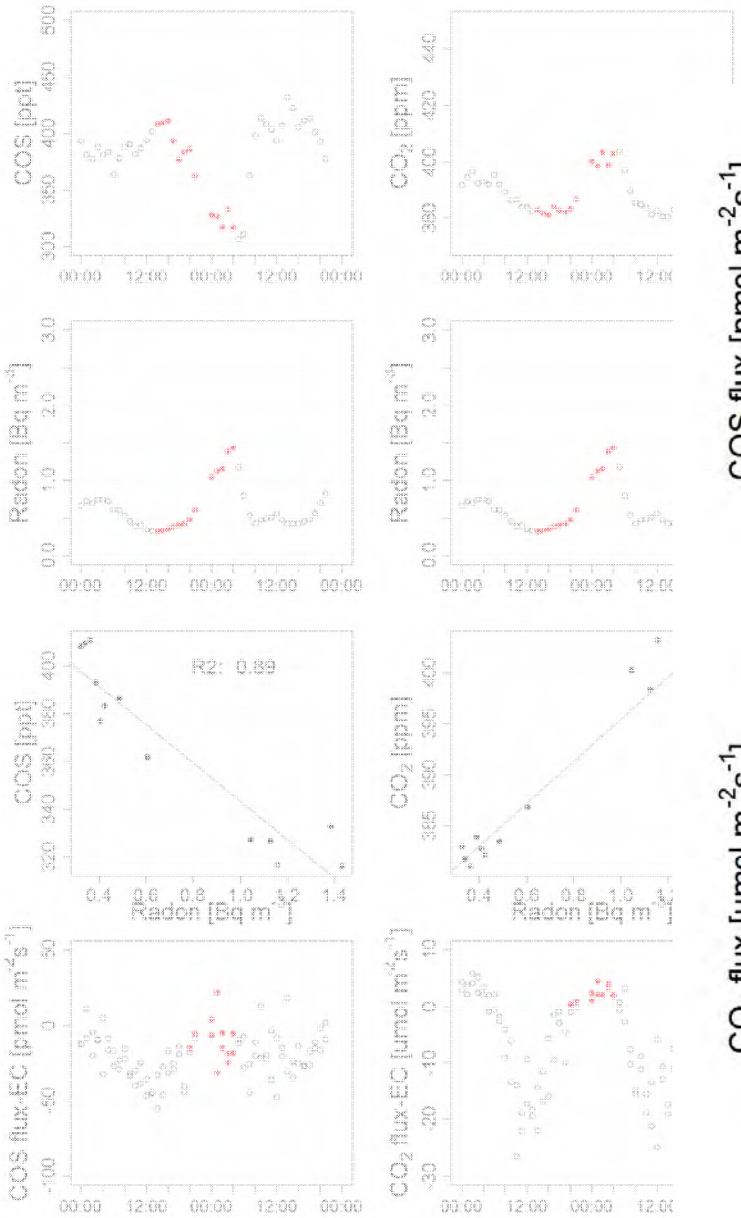
← Radon concentration

← COS / CO_2 vs radon correlation

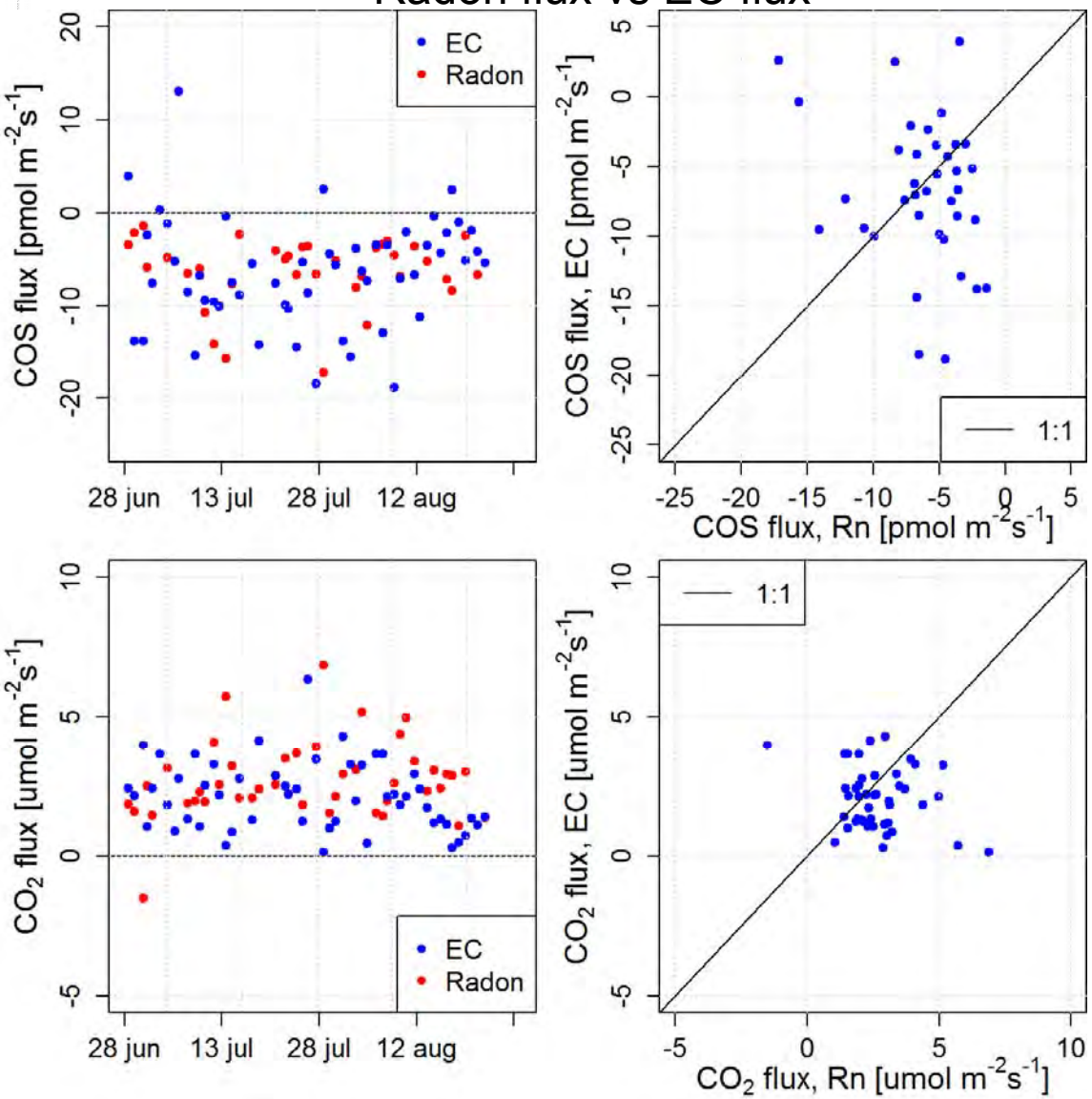
← COS / CO_2 eddy covariance flux

Radon-tracer method

$$F_{COS} = F_{Rn}\frac{\Delta C_{COS}}{\Delta C_{Rn}},\quad F_{Rn} = 2.8\ mBq\ m^{-2}\ s^{-1}$$



Radon flux vs EC flux



Conclusion

- Ongoing field campaign on COS fluxes in Finland.
- Radon-tracer method for nighttime COS an CO_2 fluxes is promising.
- Flux-gradient method for COS fluxes requires further investigation.

Next...

- Compare different flux measurement techniques (Radon tracer method, flux-profile, soil, eddy covariance).
- Derive COS-based GPP estimates for the Hyytiälä site.