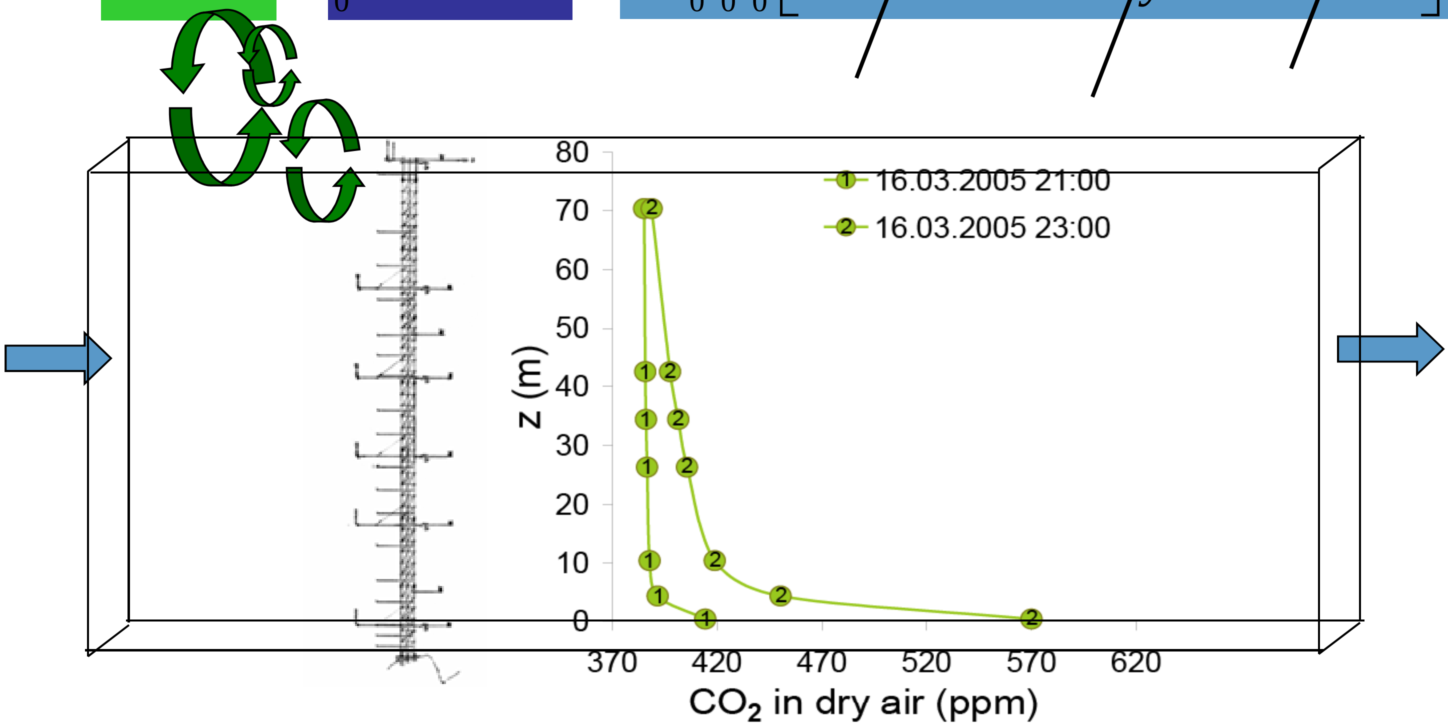
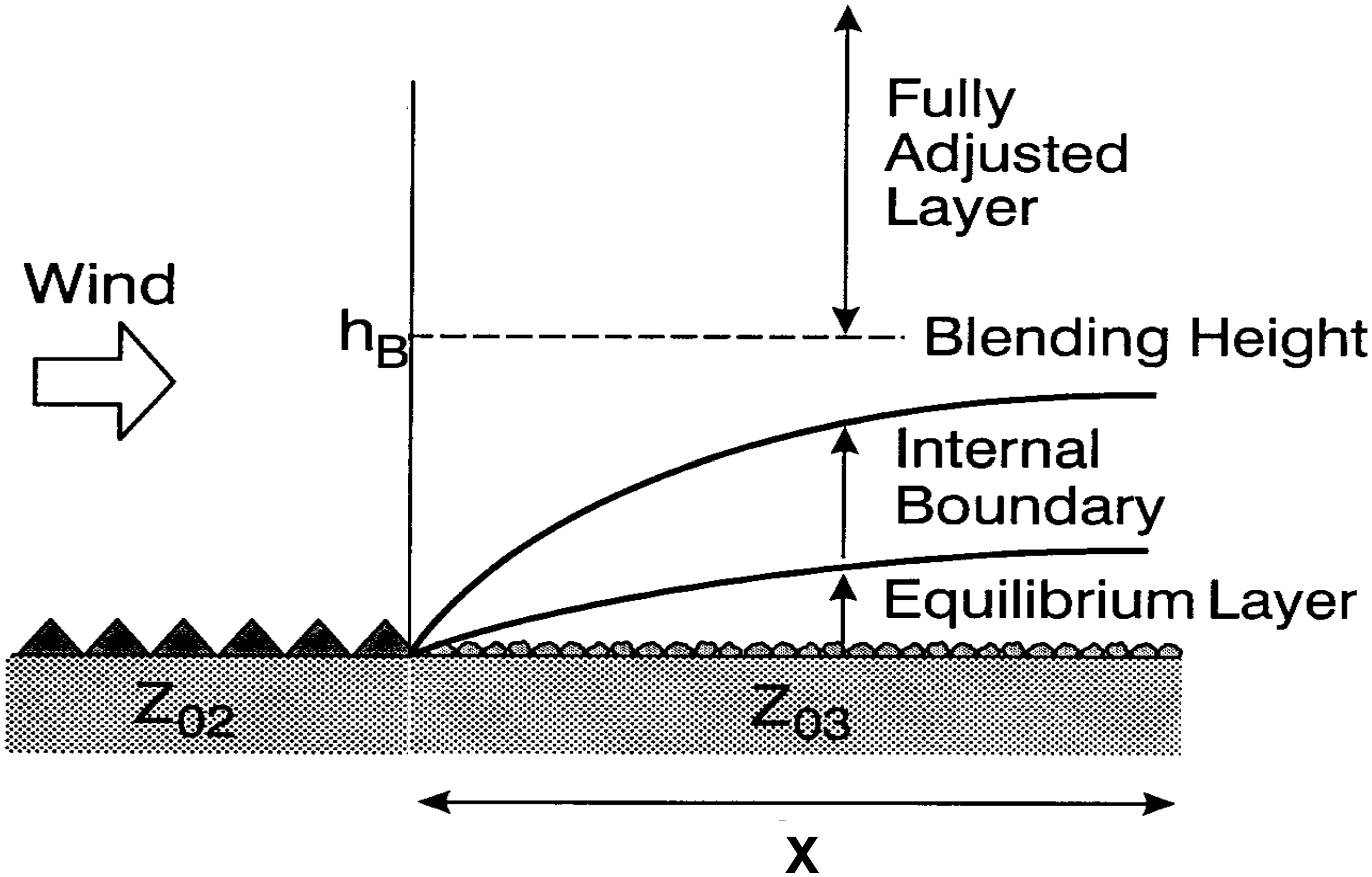
$$F_c = \overline{c_d}\,\overline{w'\chi_c'} + \int_0^h \overline{c_d}\,\frac{\overline{\partial \chi_c}}{\partial t}\,dz + \frac{1}{L^2}\int_0^L\int_0^L\int_0^h \left[\overline{uc_d}\,\frac{\overline{\partial \chi_c}}{\partial x} + \overline{vc_d}\,\frac{\overline{\partial \chi_c}}{\partial y} + \overline{wc_d}\,\frac{\overline{\partial \chi_c}}{\partial z}\right] dx\,dy\,dz$$



Internal boundary & equilibrium layers



Height-to-fetch ratio

100:1 fetch rule of thumb

$$z_m \leq X / 100$$

- Neutral conditions
- > for stable conditions
- < for unstable conditions

Instrument placement

- Often a compromise between a representative footprint and avoiding advective effects

High frequency attenuation

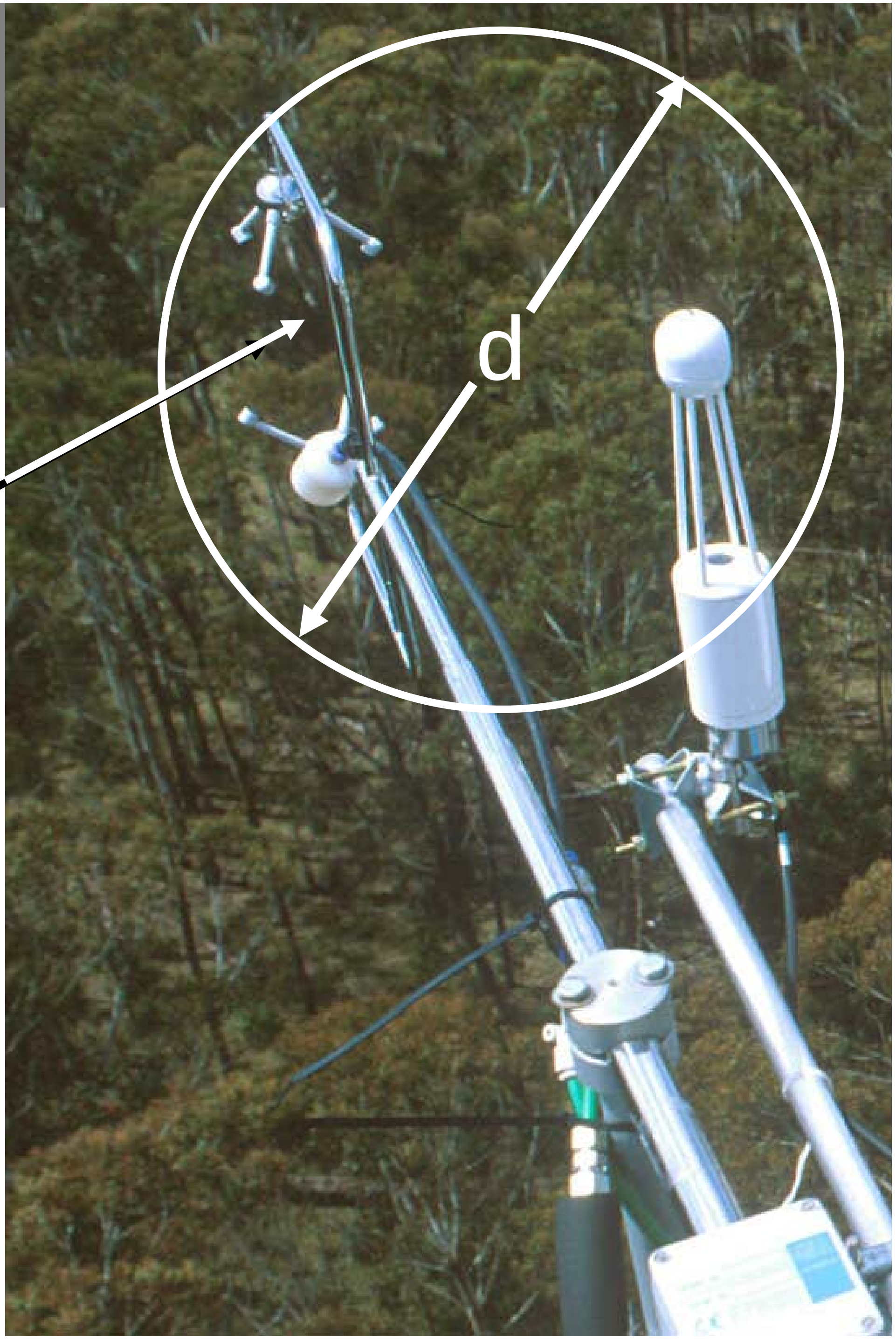
Line-averaging along instrument path

– loss of variance

Spatial separation between instruments

– loss of covariance

- Samples eddies > ~2d



Variance and covariance

Variance

$$\overline{\chi_c'^2} = \frac{1}{\Delta t}\int_t^{t+\Delta t} (\chi_c - \overline{\chi_c})^2 dt \approx \int_0^\infty S_{\chi_c \chi_c}(n) dn$$

Covariance

= eddy flux

$$\overline{w'\chi_c'} = \frac{1}{\Delta t}\int_t^{t+\Delta t} (w - \overline{w})(\chi_c - \overline{\chi_c}) dt \approx \int_0^\infty C_{w\chi_c}(n) dn$$

⇧ Time domain ⇧ Frequency domain

$S_{\chi c}$ = contribution of the total variance of χ_c per unit *dn*

$C_{w\chi c}$ = contribution of total covariance of $w\chi_c$ per unit *dn*

Eddy fluxes: 1D, steady state, homogeneous flows

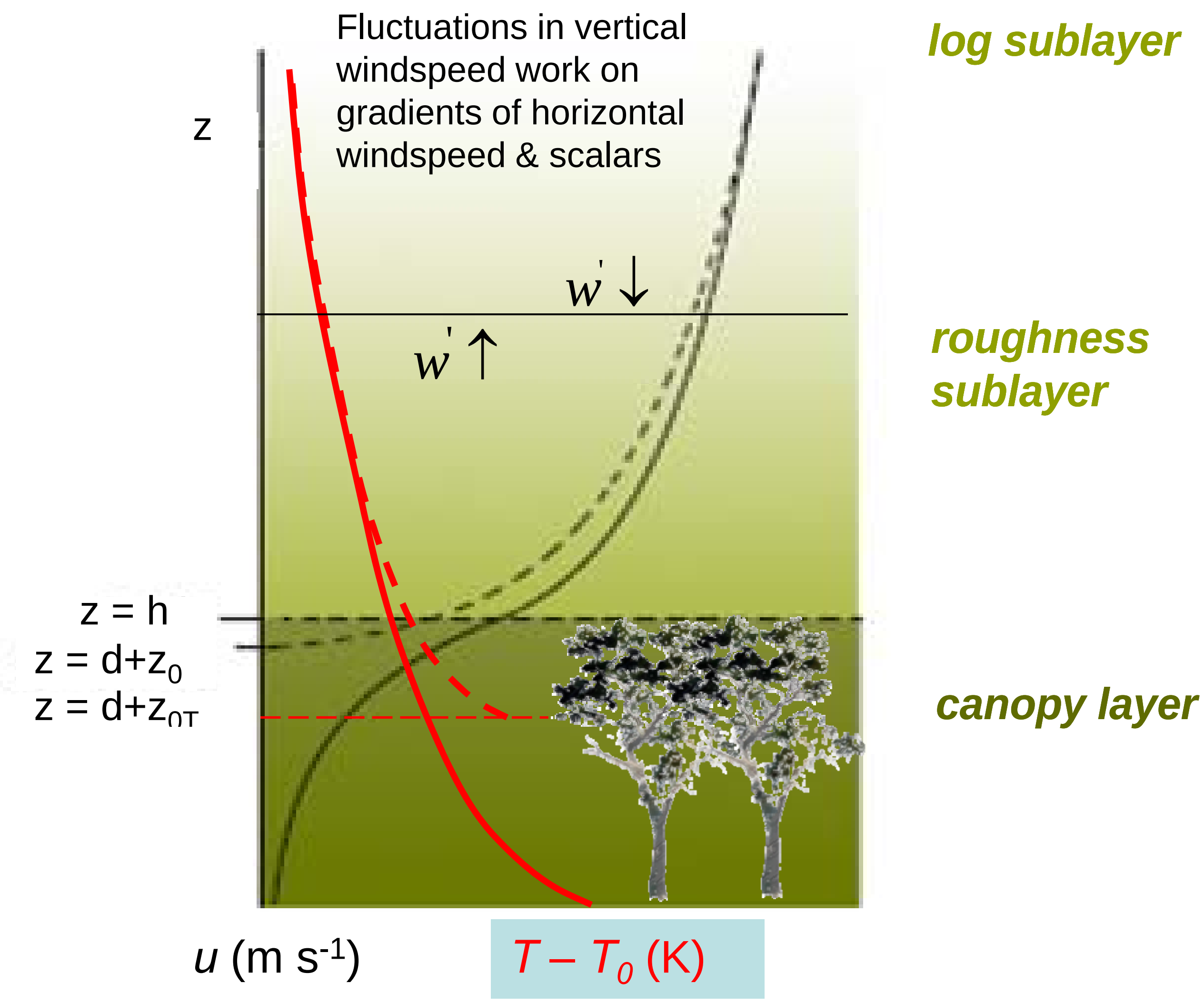
$$\overline{\tau} = -\overline{\rho}\,\overline{w'u'}$$

$$\overline{H} = \overline{\rho}c_p\overline{w'T'}$$

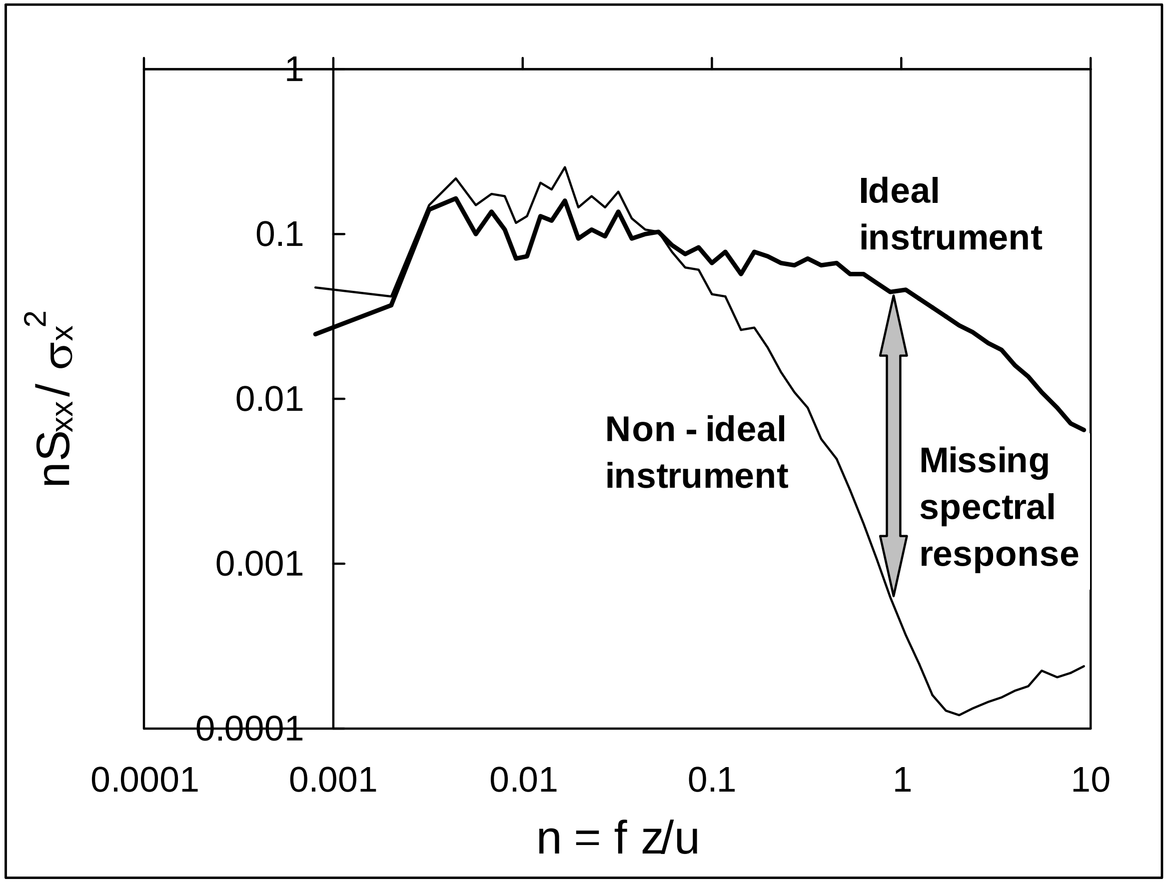
$$\overline{E} = \overline{c_d}\,\overline{w'\chi_v'}$$

$$\overline{F_c} = \overline{c_d}\,\overline{w'\chi_c'}$$

Covariances



Variance spectrum - high-cut filter



Covariance spectrum – high cut filter