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COMPARISON OF O₃ FLUXES MEASURED WITH THE EDDY COVARIANCE AND THE GRADIENT METHODS ABOVE A MAIZE FIELD

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INTRODUCTION. The fluxes of ozone (O₃) are measured either with the gradient method or the covariance method. However, both methods are subjects to bias or uncertainties. The present poster presents a comparison of the two methods, list the potential biases and analyses some of them.

THEORY. Flux measurements using either the gradient or the covariance method are based on the mass balance equation which can be expressed as :

$$\frac{\partial \bar{c}}{\partial t} = - \frac{\partial (\overline{w \cdot c} + \overline{w' c'})}{\partial z} - \frac{\partial (\overline{u \cdot c} + \overline{u' c'})}{\partial x} + Q_{chem}$$

$F_z = \text{vertical flux}$

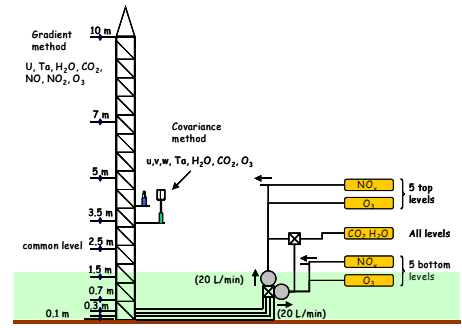
which gives after integration over z

$$F_z(z) = F_z(z_0) - \int_{z_0}^z \frac{\partial \bar{c}}{\partial t} dz - \int_{z_0}^z \frac{\partial (\overline{u \cdot c} + \overline{u' c'})}{\partial x} dz + \int_{z_0}^z Q_{chem} dz$$

Storage Local advection Chemical reactions

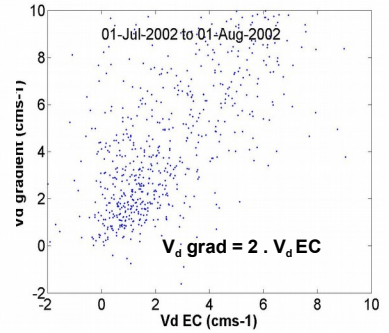
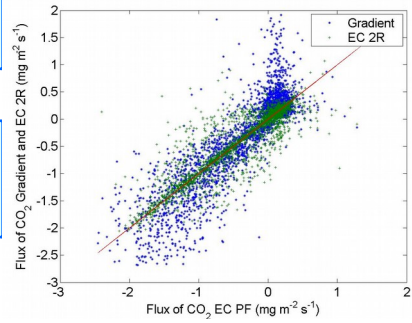
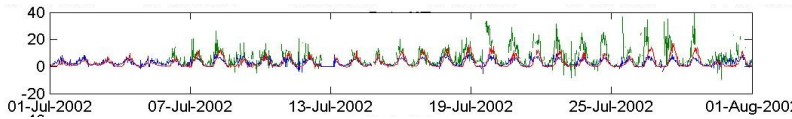
This equation shows three potential errors common to the gradient and the covariance method: **storage**, **local advection** and **chemical reactions**

DATASET. Between June and September 2002, the fluxes of carbon dioxide (CO₂) and ozone (O₃), and nitrogen oxides (NO and NO₂) were measured above a growing maize crop, together with the components of the energy balance - sensible (H), ground (G) and latent heat fluxes (H), net radiation (R_n) -, the meteorology, and the canopy structure. All the fluxes, except the NO_x, were measured simultaneously with the gradient and the covariance technique.



- ERRORS SPECIFIC TO THE GRADIENT METHOD.**
- Chemical reactions in the tubes (O₃-NO)
 - Chemical reactions over the gradient height (O₃-NO_x)
 - Sequential sampling (assumes stationarity)
 - Slope of the terrain

- ERRORS SPECIFIC TO THE COVARIANCE METHOD**
- High frequency attenuation in the tube
 - Rotation of the ultrasonic anemometer (ψ ≠ 0 or not)
 - High pass filtering (detrrending)



Estimation of flux errors estimates specific to the grad

Error	Expre
Chemical reactions in the tube	[O ₃] _{can}
Chemical reactions over the gradient height	see p4
Sequential sampling	[O ₃](z)
Vertical advection	Fzadv
Slope of terrain	z* = z

Estimation of flux errors estimates specific to the cov

Error	Magnitude of correction
Tube attenuation	up to 20%
Rotation / Averaging	10-25%
Angle of Attack	5-15%

- CONCLUSIONS.** This analysis shows that :
- Attention must be paid to the gradient sequential sampling interval
 - Tube attenuation corrections must be applied to covariance estimates
 - Rotation and averaging procedures are should be compared