Multiyear analysis of energy balance closure over a cropland in the silty-loam region of Belgium

Boland Francois[1], De Ligne Anne[1], Heinesch Bernard[1], De Cock Nicolas[1]

[1] University of Liège — Gembloux Agro-Bio Tech
TERRA, Biosystems Dynamics and Exchanges (BIODYNE)

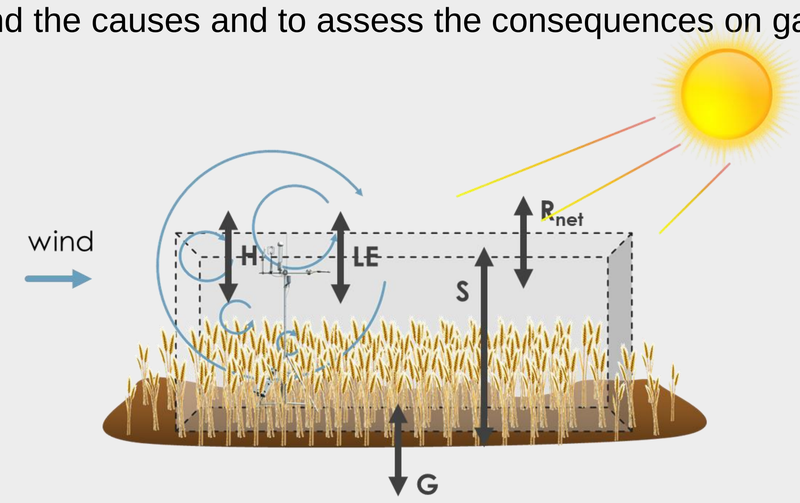
Contact : francois.boland@uliege.be

Context

Flux measurement quality through Eddy Covariance (EC) can be assessed through the energy conservation principle and this is called the **energy balance**. However, many studies indicate a **general lack of closure** (imbalance) of **20-30%** in contrasted ecosystems and climates. This **systematic** problem has been subjected to intense research for the last 30 years in order to understand the causes and to assess the consequences on gas flux measurement quality.

The energy balance states that the sum of latent (LE) and sensible heat (H) fluxes measured by EC is equal to the difference between net radiation flux (R_{net}), ground heat flux (G) and air (S_H and S_{LE}), biomass (S_C and S_P) and ground (S_G) change of heat storage ($S = S_{LE}+S_H+S_G+S_C+S_P$) which are measured by independent systems from EC :

Energy balance closure ⇔ $H + LE = R_{net} - G - S$

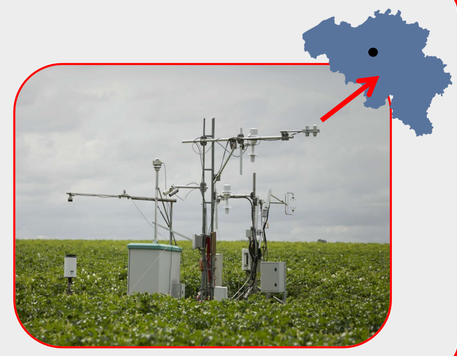


Objective

- To contribute to the general understanding of EC accuracy at measuring gas and energy fluxes while identifying the drivers that lead to improvement or worsening of the energy balance

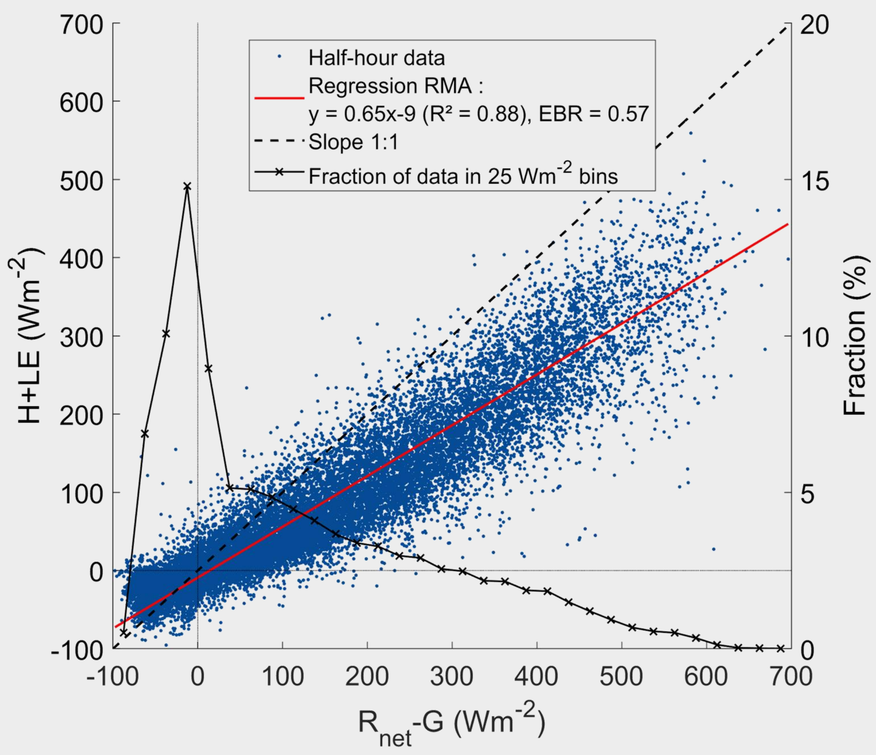
Material and methods

- Study case : ICOS Lonzée site 4-year rotation over 12 *ha* of cropland
- 3-year of data selected
- Energy balance assessment :
  - Energy Balance Ratio (EBR)
  - Reduced Major Axis regression (RMA)



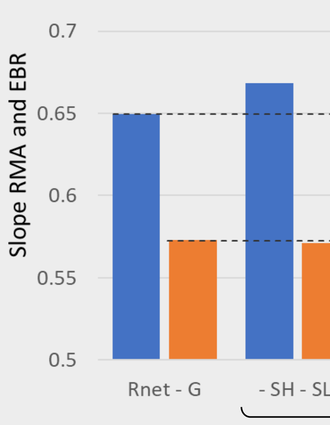
Results

Energy balance closure at the Lonzée site :



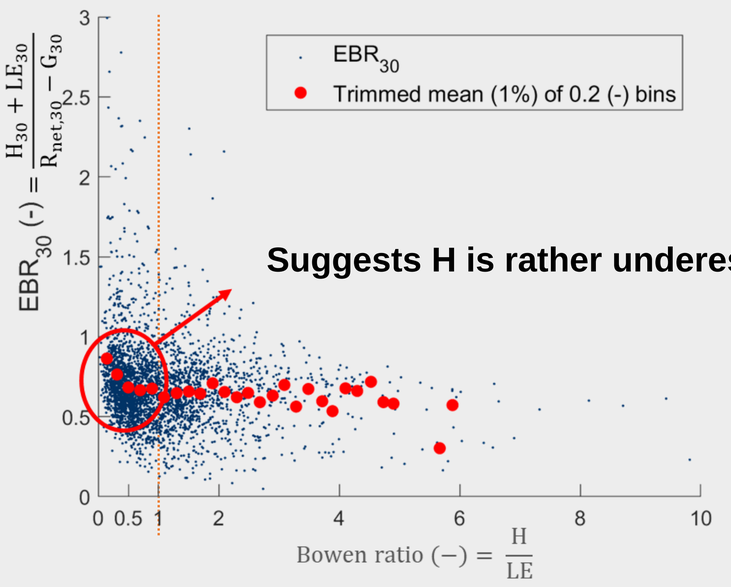
Mean residue = 50 Wm^{-2} (= R_{net} – G – H – LE)

Role of S terms in the energy balance



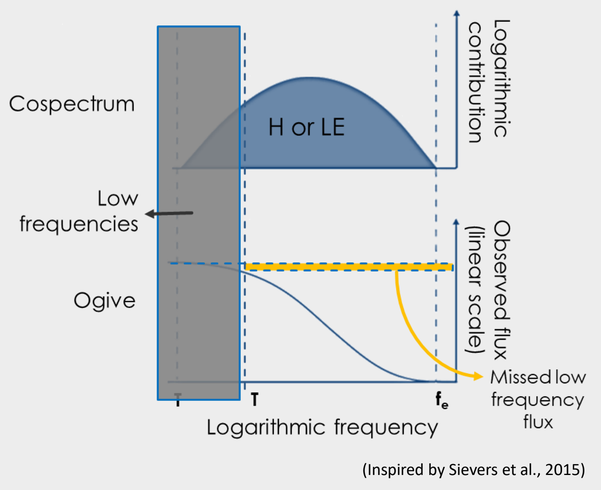
Significant improvement of energy balance with S terms

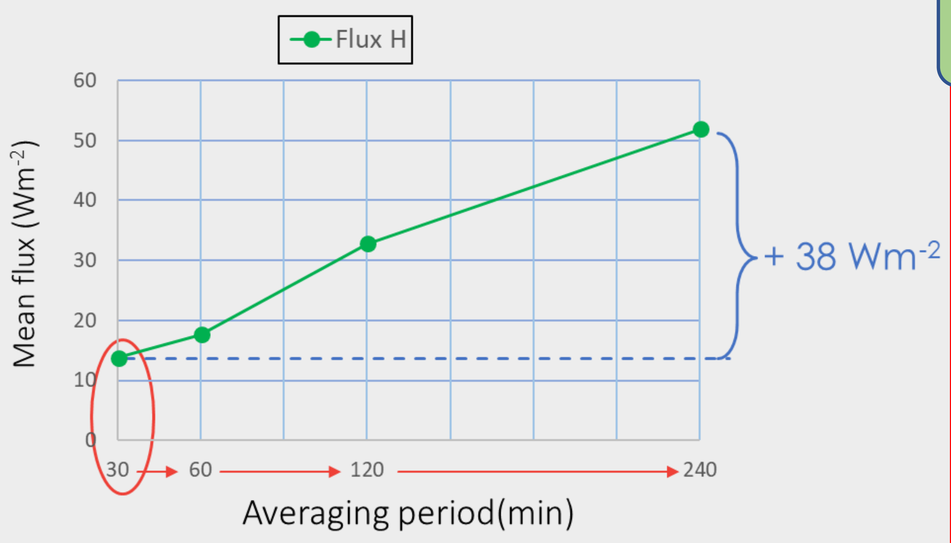
H and/or LE underestimation



Suggests H is rather underestimated than LE

Influence of increasing the averaging period and low frequency contribution on turbulent H and LE fluxes





Increasing the averaging period up to 4h decreases the residue by 38 Wm^{-2}

Conclusions

→ **Evaluation of the rates of change of heat storage (S fluxes) allows improving the energy closure by 4-7%**

→ **H fluxes seem to be particularly underestimated for 30-min period**

→ **Increasing the averaging period up to 4h for EC computation leads to improvements of the energy balance closure by offsetting the 50 Wm^{-2} mean residue by 38 Wm^{-2}**