SEASONAL AND INTER-ANNUAL VARIABILITY OF PHOTOSYNTHETIC CAPACITY IN A TEMPERATE FOREST

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1. Introduction

-In temperate forests, the relation between vegetation phenology and carbon sequestration variability remains to be explored.

-To study phenology impact on CO_2 fluxes, two photosynthetic capacity indicators were used :

+NEE at light saturation (NEE_{sat});

+green proportion in canopy pictures (g_{cc}).

-Correlations between these indicators were investigated at seasonal and inter-annual scale.

2. Material

-Site : Vielsalm Terrestrial Observatory (ICOS Belgium): a mixed (deciduous (mainly beeches) – coniferous) temperate forest.

-Four years (2010-2013) of : +eddy covariance (EC) data;
+digital camera pictures.

-Deciduous sub-plot in the main footprint zone.

-Tree ring widths measured by wood coring.

-LAI_{max} and Specific Leaf Area (SLA) from litter collection.

Data	**EC Data**	**Pictures**
Database	European Fluxes	VTO (Be-Vie)
Time frame and resolution	1996-Today half hourly	2010-Today hourly
Description	Fluxes and Weather	Red, Green and Blue (RGB) components
Selection	*daily data *deciduous footprint *no drought (low VPD)	*11, 12 and 13h *deciduous sub-plot, *no snow and no rain

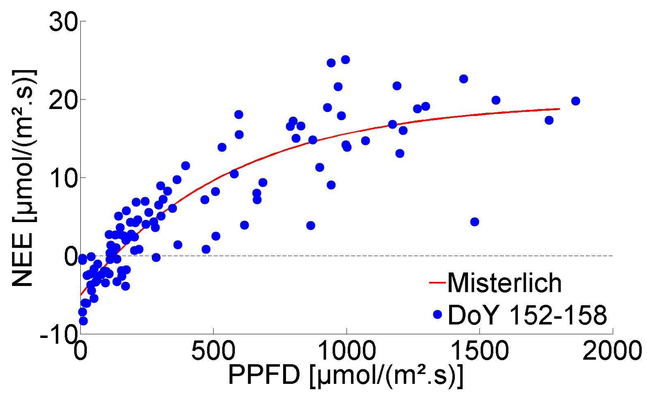
3. Method

2 Photosynthetic capacity indicators

+NEE at light saturation (NEE_{sat})

-Weekly values were deduced from flux light-response curves **for each week** using Misterlich function (below).

$$NEE = (NEE_{sat} - R_d)\left(1 - e^{\frac{-\alpha(PPFD)}{NEE_{sat} - R_d}}\right) + R_d$$

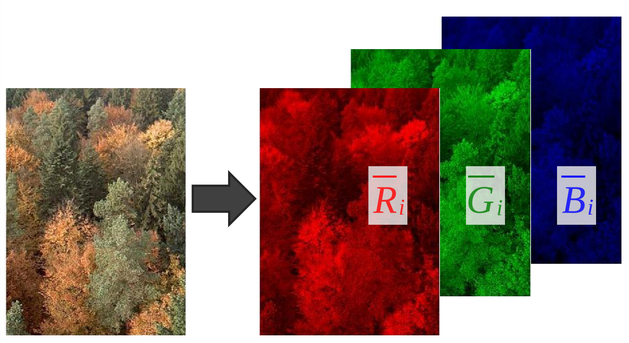


+Green proportion in canopy pictures (g_{cc})

-**For each hour**, g_{cc} was calculated as the mean proportion of green component value (G) in the picture.

-**Daily values**, $g_{cc\text{-}day}$ were calculated as the mean g_{cc} value of three pictures taken at 11, 12 and 13 o'clock.

-**Weekly values** were computed as the mean $g_{cc\text{-}day}$ values.

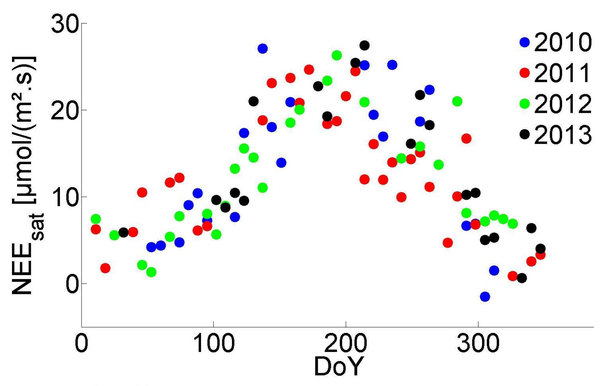


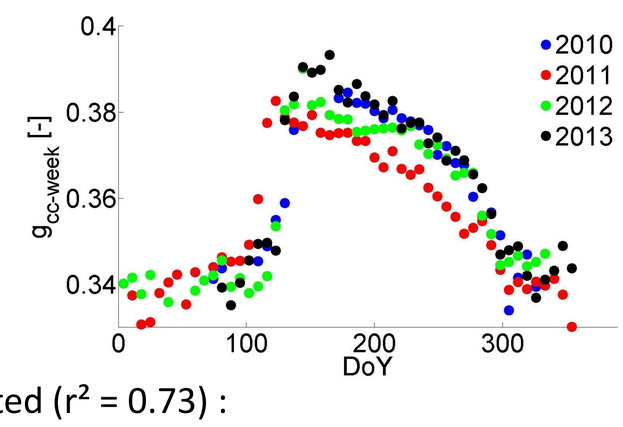
$$g_{cc-day} = \left(\sum_{i=1}^{3} \frac{\overline{G_i}}{\overline{R_i} + \overline{G_i} + \overline{B_i}}\right) \Big/ 3$$

$$g_{cc-week} = \left(\sum_{j=1}^{7} g_{cc-day,j}\right) \Big/ 7$$

4. Results

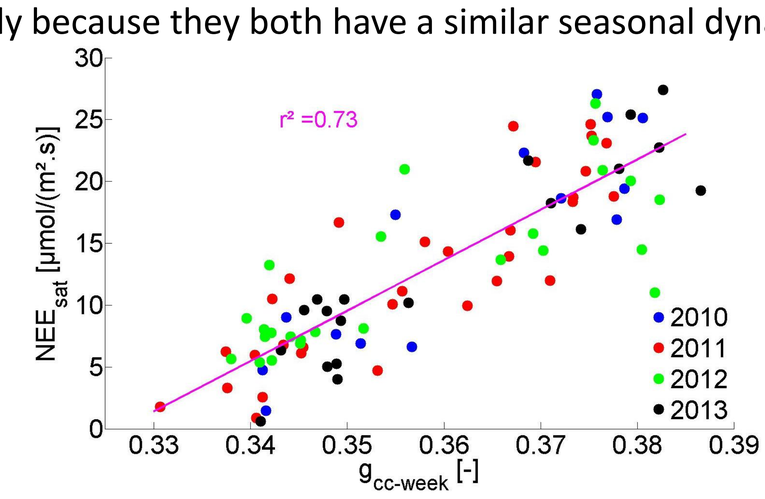
-Seasonal dynamic for both indicators.





-Both indicators were strongly correlated ($r^2 = 0.73$) :

- mainly because they both have a similar seasonal dynamic.

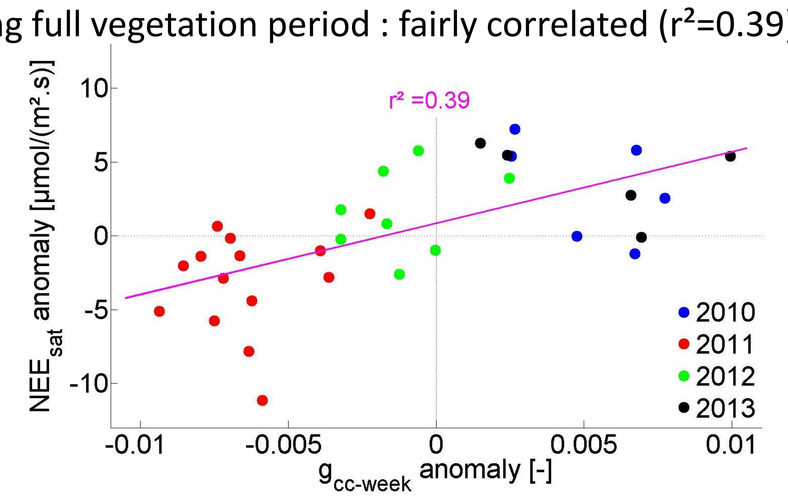


-To get rid of the seasonal dynamic, indicator anomalies were computed as :

- the difference between one week data and the mean of the same week value for the four years.

-Then, indicator anomalies were compared :

- at inter-annual scale : badly correlated (data not shown);
- during full vegetation period : fairly correlated (r^2=0.39).



-Both indicators suggest lower photosynthetic capacity in 2011.

-This result corroborates with tree ring measurements. Indeed, in 2011 :

- the lowest tree ring widths in the 1998-2011 period were observed.
- the lowest LAI_{max} and SLA in the 2009-2011 period were observed.

These low values have been related to a dry and warm spring (highest spring Ta, Rd and VPD in the 1998-2011 period)[1].

5. Conclusion

Our results suggest:

- A continuous decrease of photosynthetic capacity during the full vegetation period.
- Correlation between what is measured (NEE_{sat}) and what is seen (g_{cc}), not only at seasonal but also at inter-annual scale.
- A lower photosynthetic capacity during full vegetation period in 2011:
  - corroborated by trunk and canopy development measurements;
  - related to spring drought.

[1]Soubie, R., 2014. Evaluation de l'évapotranspiration réelle, de ses composantes et de sa régulation dans un peuplement composé de hêtre et de douglas: analyse comparative de l'effet espèce et des méthodes d'évaluation. Thèse de doctorat, Université Catholique de Louvain (FRIA, Région Wallonne).

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