Standardization of the Eddy Covariance Instruments and Methods: Needs, Evaluation and Optimization

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INTRODUCTION

Why *STANDARDIZATION*?

- Use of two instruments for data acquisition (EC setup)
- Covariance on the two datasets
- Complex series of processing
- Each step introduce uncertainity

....Standardization of setup/ processing (calculation + filtering) methods helps to minimized the variability in fluxes i-e CO_2, latent (LH) & sensible heat (H) due setups/processing methods? (ICOS & NEON)

OBJECTIVE

"Effect of Standardization of setup and processing on fluxes"

Key Questions

1. Do heterogeneous setups and processing introduce variability in fluxes?
2. How much standardizing **processing, instruments and/or methods** (like in ICOS) is important?
3. Which component of the standardization between setup and processing weighs more in terms of fluxes variability?

METHODOLOGY

1. DATA COLLECTION

13 Sites

- **ICOS setup (LI7200 & HS-50/100)**
- **NON Standardized (ST) setups**
- **PI Results**

2. DATA PREPARATION & PROCESSING

Data and Metadata were prepared and processed by ICOS standard processing scheme. EddyPro software from Licor was used to process the data with the help of Rflux in the HPC hosted at Tuscia & Lund University.

3. DATA ANALYSIS

Median diurnal cycles was calculated from 6 subsets of 3 months of growing season (each subset = 48 half hours) to have equal percentages of day and nighttime data. Results were evaluated based on Reduced Major Axis Regression.

Data Analyzed for

- **ICOS vs NONST setups**
- **ICOS vs NONST Calculation**
- **ICOS vs NONST Calculation + Filtering**

ICOS Processing
Calculation + QC filtering

- **Spikes count/removal** *Vicker & Mahrt 1997*
- **Coordinate Rotation** *DR & PF*
- **Detrending** *BA & LD*
- **Time Lag** *Covariance maximization with default*
- **Spectral correction(high pass filtering)** *Moncrieff et al. (2004)*
- **Spectral correction(low pass filtering)** *Fratini et al. (2012)*
- **Quality Check** *Vitale et al. (2020)* → **FLUX DATA** *(Fc, LE, H)*

Sabbatini *et al*. (2018)

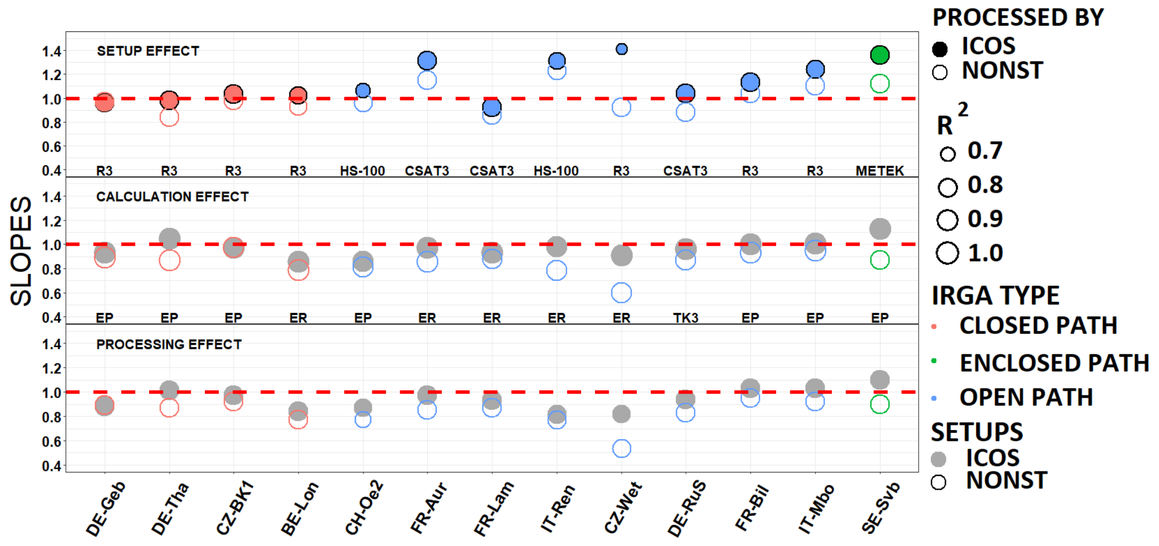
PI Processed Data ***Calculation (spike removal, coordinate rotation, detrending, time lag, Compensation of density fluctuation & spectral corrections + Qc filtering. Software used: TK3, Edire & Eddypro***

TAKE HOME MESSAGE

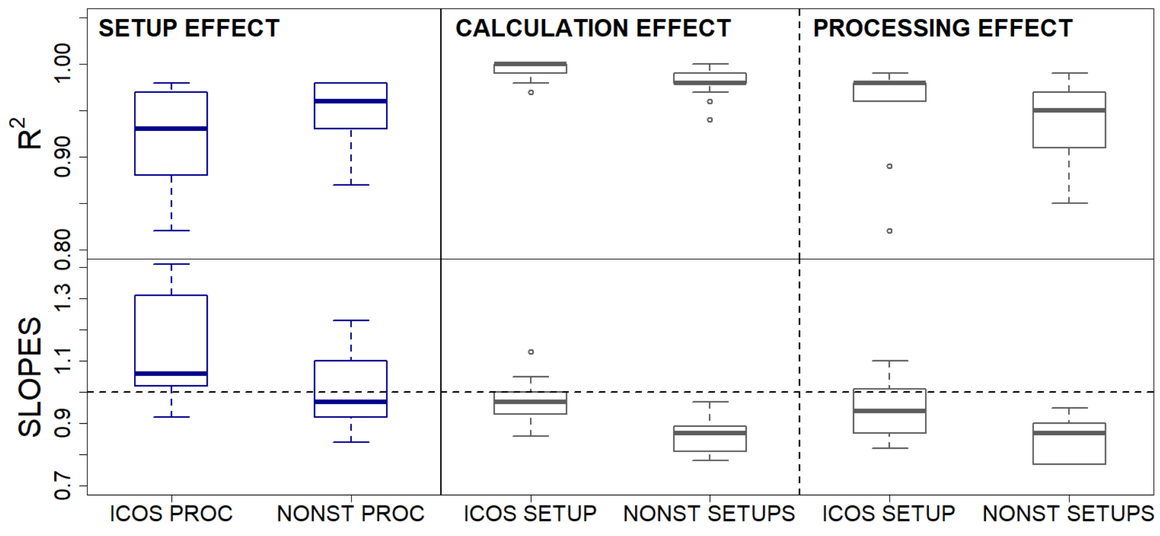
- ***Heterogenous setups*** introduced differences in the calculated fluxes.
- ***ICOS setup*** has smaller variation between two different processing methods for ***FC*** than NONST setup.
- ***STANDARDIZATION of setup*** improves data comparison as compared to heterogenous setups.
- ***STANDARDIZED Processing*** has less impact on fluxes, might be its not fully optimized for NONST setups but we are working in this direction.
- Results of the experiment are just for evaluation of the differences and variability present in the calculated fluxes due to vast range of models for IRGAs and sonic anemometers.

"standardization of instruments is optimal to reduce the variability introduced by different setups"

RESULTS



- **Fig 1** presents site-wise comparison between ICOS & NONST setups & processing methods for **FC**. RMA regression evaluated that differences in FC obtained from enclosed and open path IRGA are more obvious as compared to enclosed and closed path. Variability was also noted in the results shared by PIs of the respective sites.
- Different calculation methods for ICOS setup reduce variability significantly in maximum sites.
- Processing (calculation + Filtering) induce small variability in setups, but different processing methods have relatively less impact on ICOS setup.



- In **Fig: 2** we evaluate that in comparison of ICOS and NONST setups, ICOS processing is contributing more variability in relation with NONST processing. (**SETUP EFFECT**).
- Calculated Fluxes (without filtering) from ICOS setup demonstrate small variability between ICOS and NONST processing methods in contrast with NONST setups (**CALCULATION EFFECT**). But processing (calculation + filtering) increases variability in both ICOS and NONST setups (**PROCESSING EFFECT**).

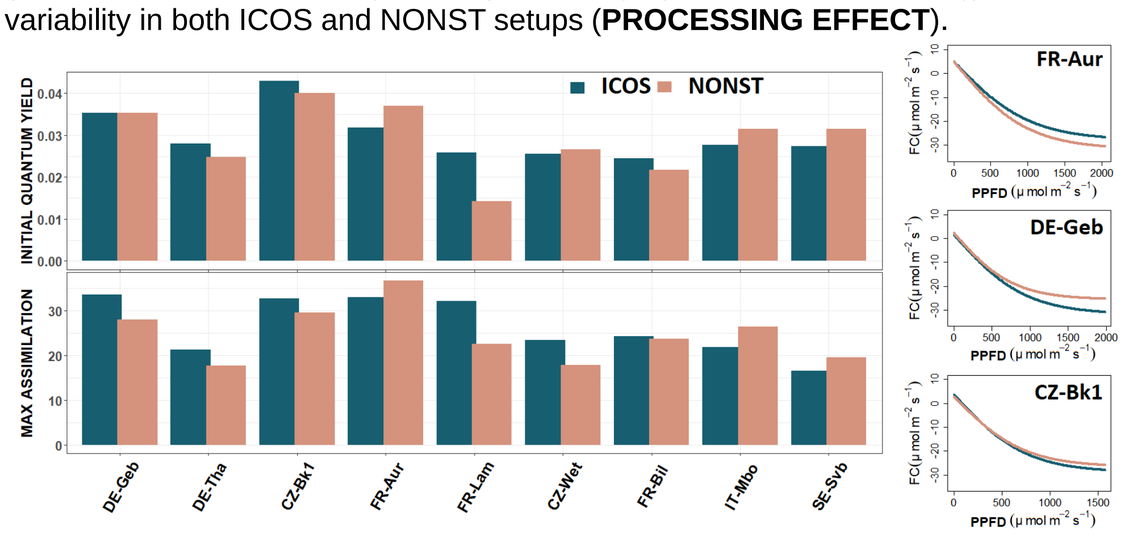
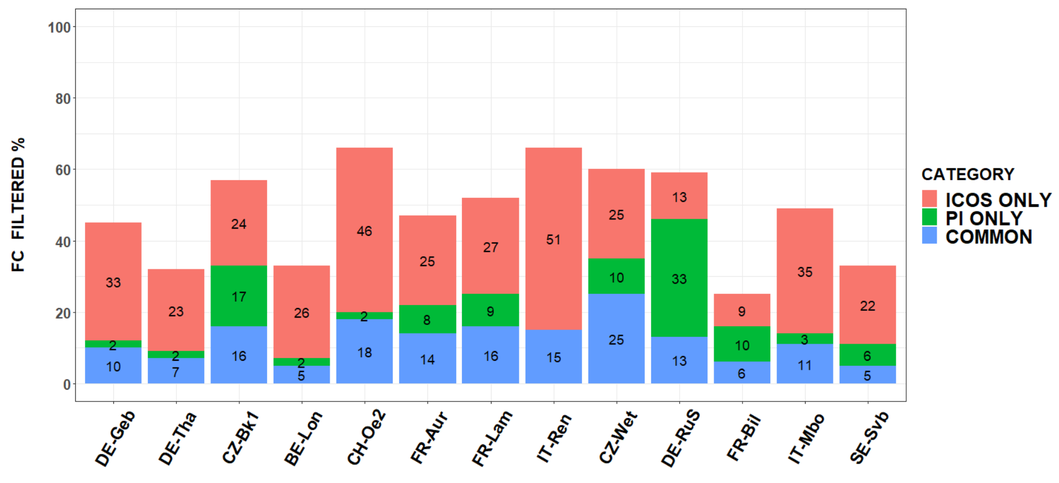


Fig 3 is an example of 2 parameters and LRCs fitting of ICOS and NONST setups for 3 sites. Only daytime FC data are used to approximate the net FC as a function of the photosynthetic photon flux density **(PPFD)**. It is evident from the plot that **Initial quantum yield** and **maximum assimilation rate** varies differently for ICOS and NONST setups among respective sites**.** Fitting of the LRCs shows that the variability prensent in FC obtained from ICOS and NONT setups is in direct relationship with increasing level of PPFD. Standardization of setups will also play vital role in correct estimation of Net Ecosystem Exchange, Gross Primary Production and Ecosystem Respiration.



In **Fig 4** we see that ICOS QC method filters more data points than PIs. There are some percentage of common data filtering because of Foken and Wichura (1996) tests that are part of all QC methods used by PIs. The quality check in ICOS can delete up to 40% of the data, which is usually met (reference: Labelling Reports available in the ICOS Carbon Portal). This indicates that the huge percentage of data lost in the ICOS setup was due to real system issues.