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

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Why *STANDARDIZATION*?

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

....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 calculation "

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?

1. DATA COLLECTION

EXPERIMENT

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

Data Analyzed for:
- **ICOS vs NONST setups & processing**
- **ICOS vs NONST setups**
- **ICOS vs NONST Calculation + Filtering**
- **ICOS vs NONST Calculation**

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 RMA Regression.

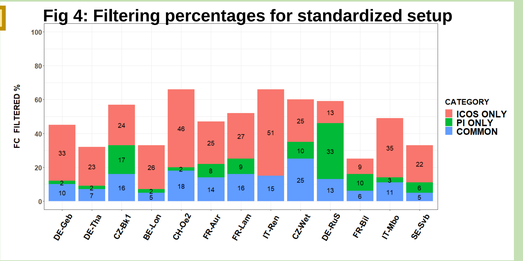
CONCLUSION

- ***Heterogenous setups*** introduced differences in the calculated fluxes.
- ***ICOS setup*** has smaller variation between two different processing methods for ***FC*** and ***LE*** flux than NONST setup (same analysis was also done for LE and H fluxes).
- ***STANDARDIZATION of setup*** improves data comparison as compared to heterogenous setups. But H fluxes obtained from two different sonic anemometers were more comparable probably due to the use of one sensor for H flux.
- ***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 "

Fig 4: Filtering percentages for standardized setup

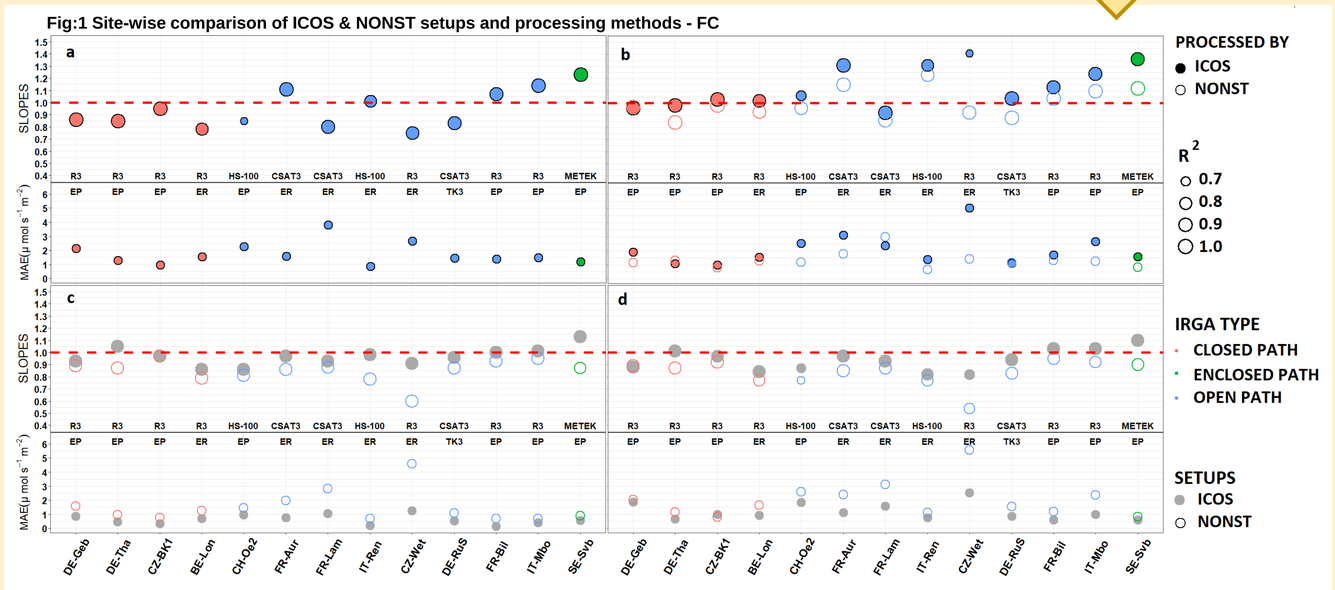


Quality check (QC) filtering is very essential in efficient data cleaning.

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.

Fig:1 Site-wise comparison of ICOS & NONST setups and processing methods - FC



RESULTS

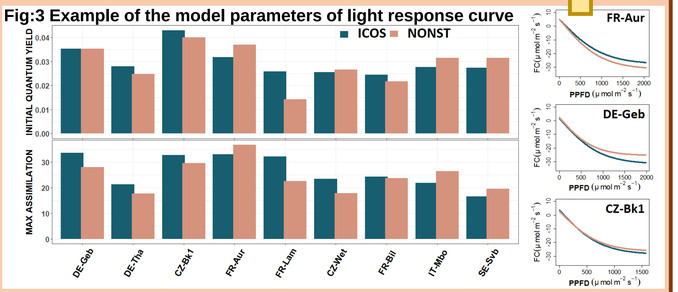
Fig 1: Here we presents the results of RMA regression for FC. Panel **a** represents overall differences in ICOS and NONST setups and methods, b is comarison between ICOS and NONST setups with same processing, **c** shows the results of regression between ICOS and NONST processing (calculation) methods for setups and **d** represents the same analysis performed on processing (calculation + filtering) methods. Size of the circle represents value of R^2. Model of sonic anemometer and software **(EP = EddyPro, ER = Edire & TK3)** used are written for additional information.

- In site wise comaprison, we see that fluxes from ICOS and NONST setups processed with different methods varies from each other (**a**).
- The differences in FC obtained from enclosed and open path IRGA are more obvious as compared to Fc from enclosed and closed path IRGA (as fluxes from closed path and enclosed path are more consistent with each other. Effect of different setups on FC is generally alike in terms of mean absolute error. This variability was also noted in the results shared by PIs of the respective sites (**b**).
- It is noted that differences between fluxes obtained from ICOS and NONST processing (calculation only) schemes reduced significantly in maximum sites (**c**).
- ICOS and NONST processing schemes for ICOS setup are close to each other with small MAE as compared to fluxes from non ICOS setup. In most of the sites (9 out of 13) ICOS processing is overestimating fluxes respect to PIs results. For NONST setups ICOS processing is overestimating fluxes in all sites. Two different processing methods have relatively less impact on ICOS setup in contrast with non ICOS setup (**d**).

Light response curve (LRC) explains the variation in the rate of photosynthesis as function of light. We use **logistic sigmoid model** by Antje Moffat to extract information about parameters i-e maximum assimilation rate, initial quantum yield and daytime ecosystem respiration

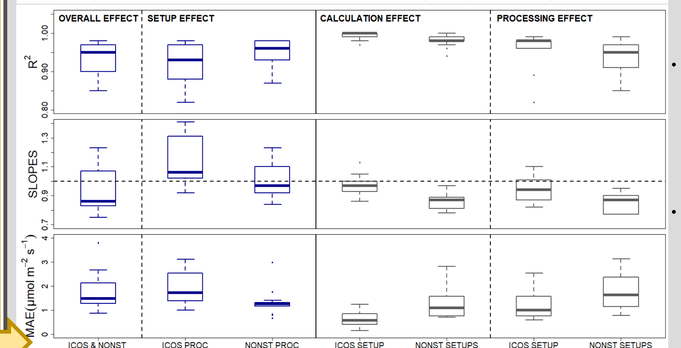
Fig 3 is an example of 2 parameters and LRCs fitting of ICOS and NONST setups for 3 sites. Only daytime FC flux data are used to approximate the net FC flux as a function of the photosynthetic photon flux density (**PPFD**).

Fig:3 Example of the model parameters of light response curve



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.

Fig 2: Impact of ICOS & NONST instrumental setups & processing methods



- In **Fig: 2** we evaluate that overall high variability is present in the calculated fluxes due to different setups and processing methods (**OVERALL EFFECT**).
- In comparison of ICOS and NONST setups, ICOS processing is contributing more variability in relation with PIs processing. This might be due the fact that PIs are more aware of the sites condition, and the methods used by them are more suitable (**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**).