BRIDGING THE GAP BETWEEN HISTORICAL AND ICOS ECOSYSTEM FLUX DATA SERIES

Methodological choices and their impact on net fluxes

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Wallonie service public SPW

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ICOS INTEGRATED CARBON OBSERVATION SYSTEM

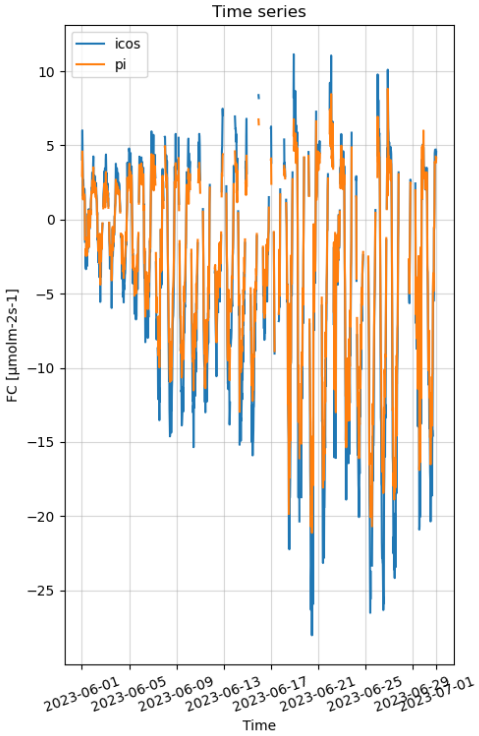
CONTEXT: ICOS STATIONS

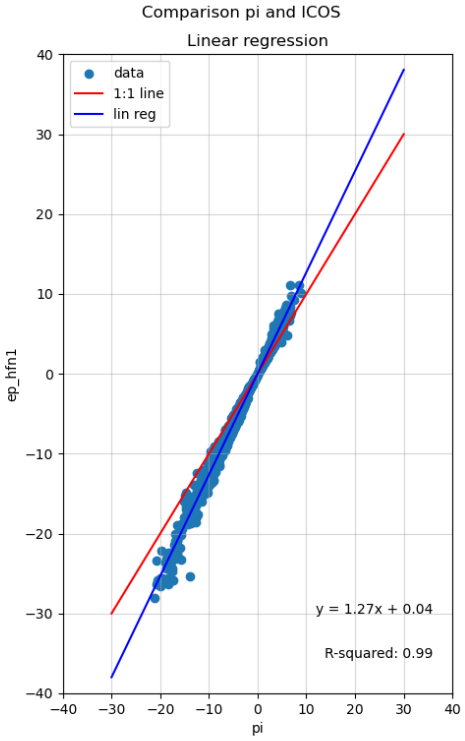
- Standardised, fully automated procedures (ICOS) come at the expense of expert, site-specific knowledge and human control (PI)
- Challenge: to use the PIs knowledge to improve ICOS processing pipe-line without losing its standardised/automated aspects
- Holistic comparison of PI vs ICOS has not yet been performed for turbulent flux computation → it could lead to such improvements

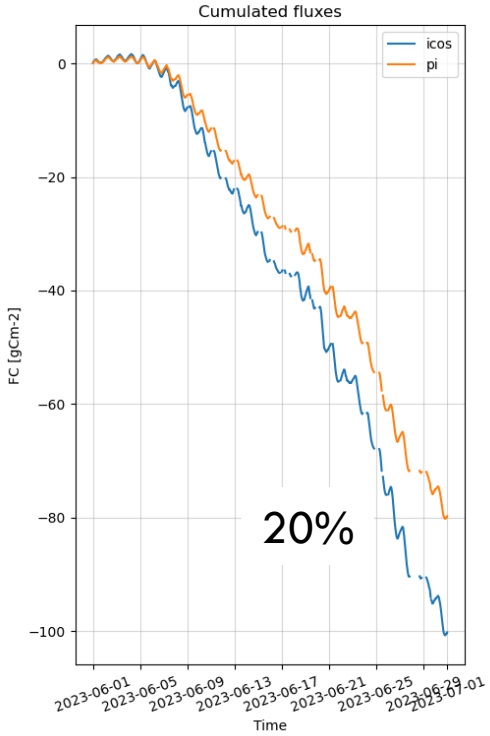
CONTEXT

Methodological improvements → Bridge the gap

BE-Lon







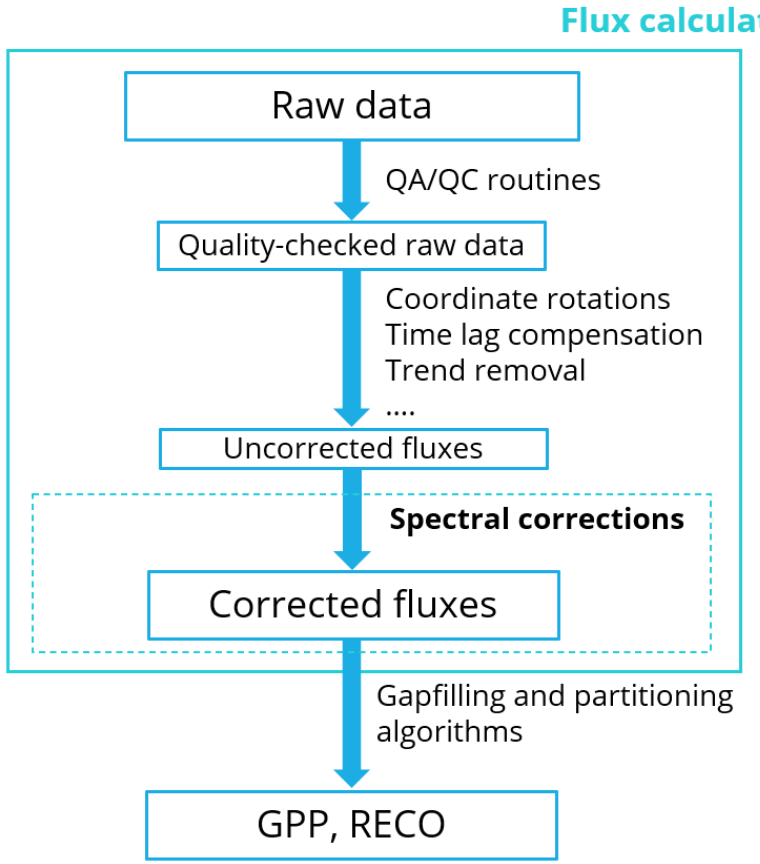
Objectives:

1. *Understand* the differences PI vs ICOS on turbulent fluxes for our station

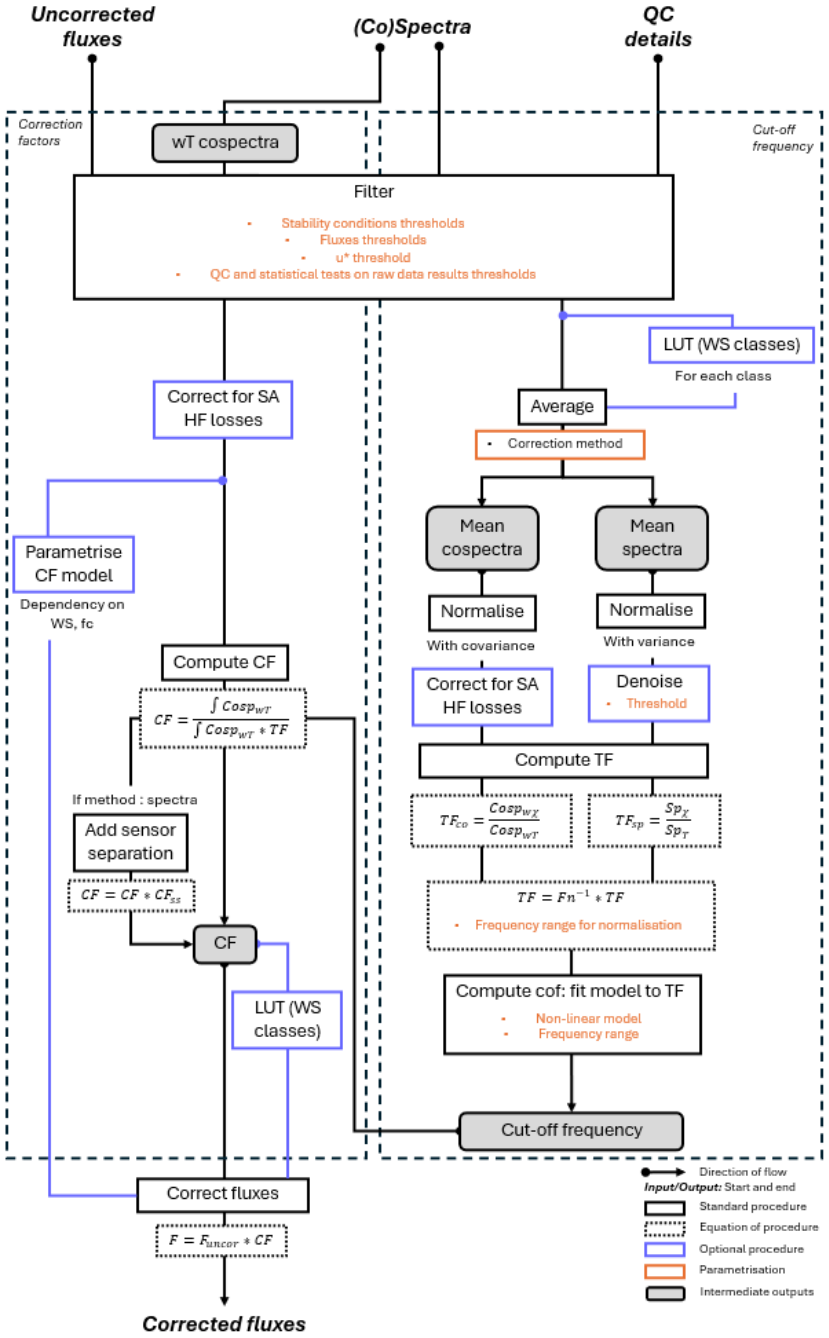
2. *Validate* on a panel of network stations

3. *Suggest* improvements to the ICOS pipeline where relevant

Analysis restricted to CO2



STUDY FOCUS: SPECTRAL CORRECTIONS



STUDY FOCUS: SPECTRAL CORRECTIONS

- General SC procedure (not unique but widely used options)
- Importance of applying this with expert knowledge
- Challenge of automating all the steps

Individual fundamental choices well-studied, but full chain and complete interactions between all choices are not fully mastered

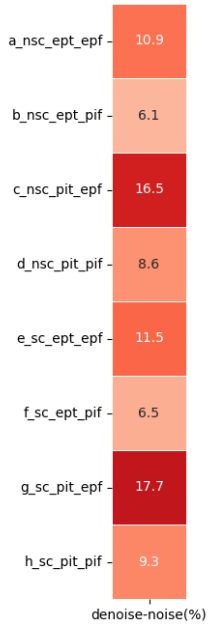
→ Analysis of the impact of some specific parametrisation (orange) and methods (blue) and tentative search for solutions

RESULTS AND DISCUSSION

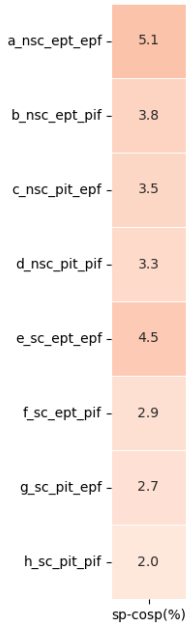
Options tested

SA corrections	SC : corrected NSC : not corrected
Frequency range for TF fit	EPT : default EP PIT : pi selected
Fluxes thresholds for filtering	EPF : default EP PIF : pi selected

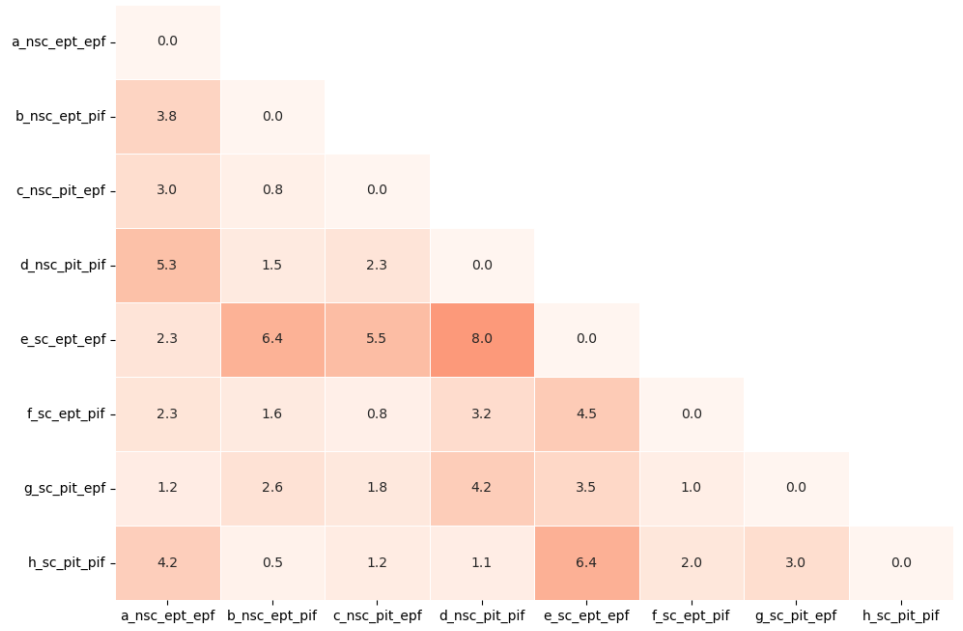
Effect of noise removal



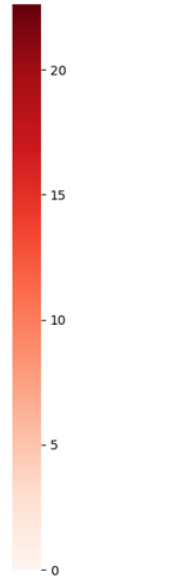
Effect of (co)spectra use



Cross-effect of 3 pairs of other options

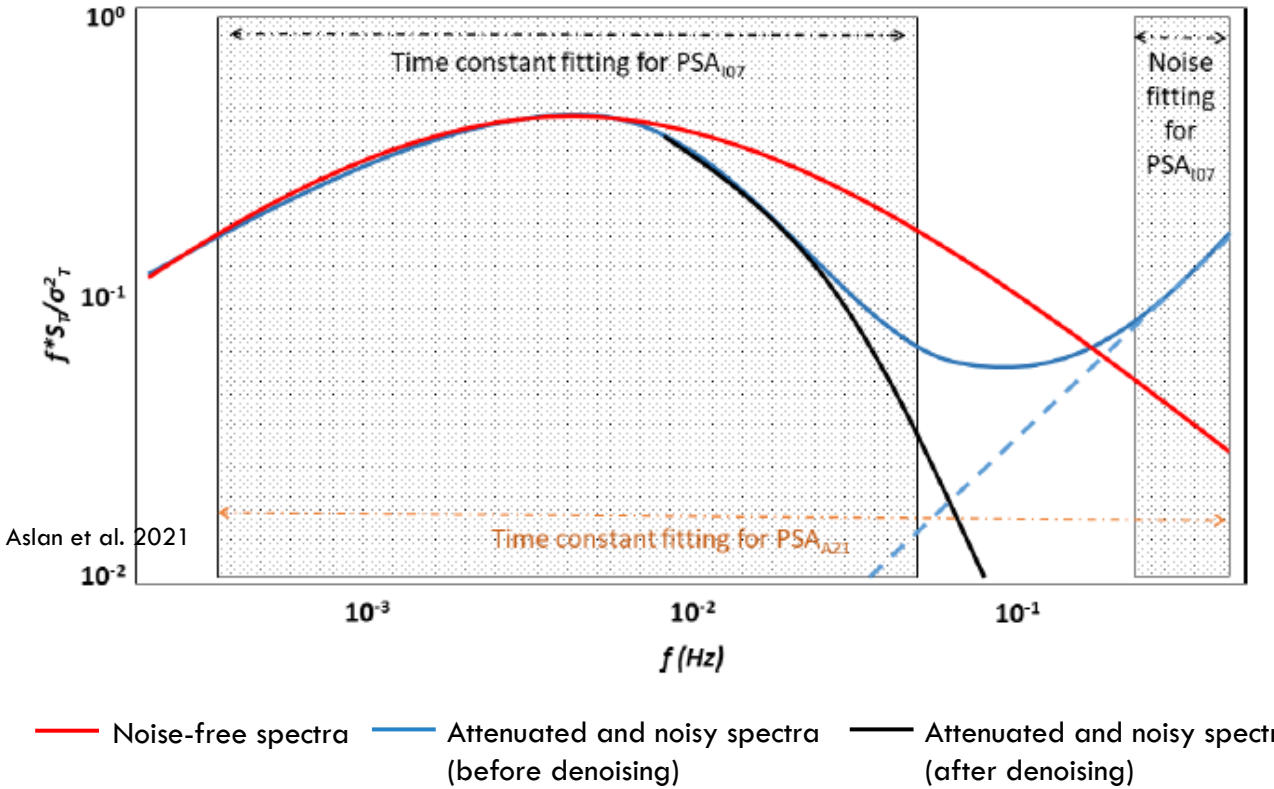


Relative difference on cum. fluxes (%)



RESULTS AND DISCUSSION: DENOISING

The current denoising procedure is problematic when the SNR is high



Aslan et al. 2021

Noise : potential bias in TF computation for spectral approach

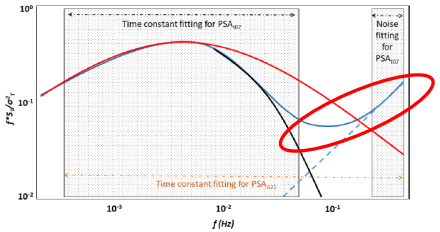
Removal option:

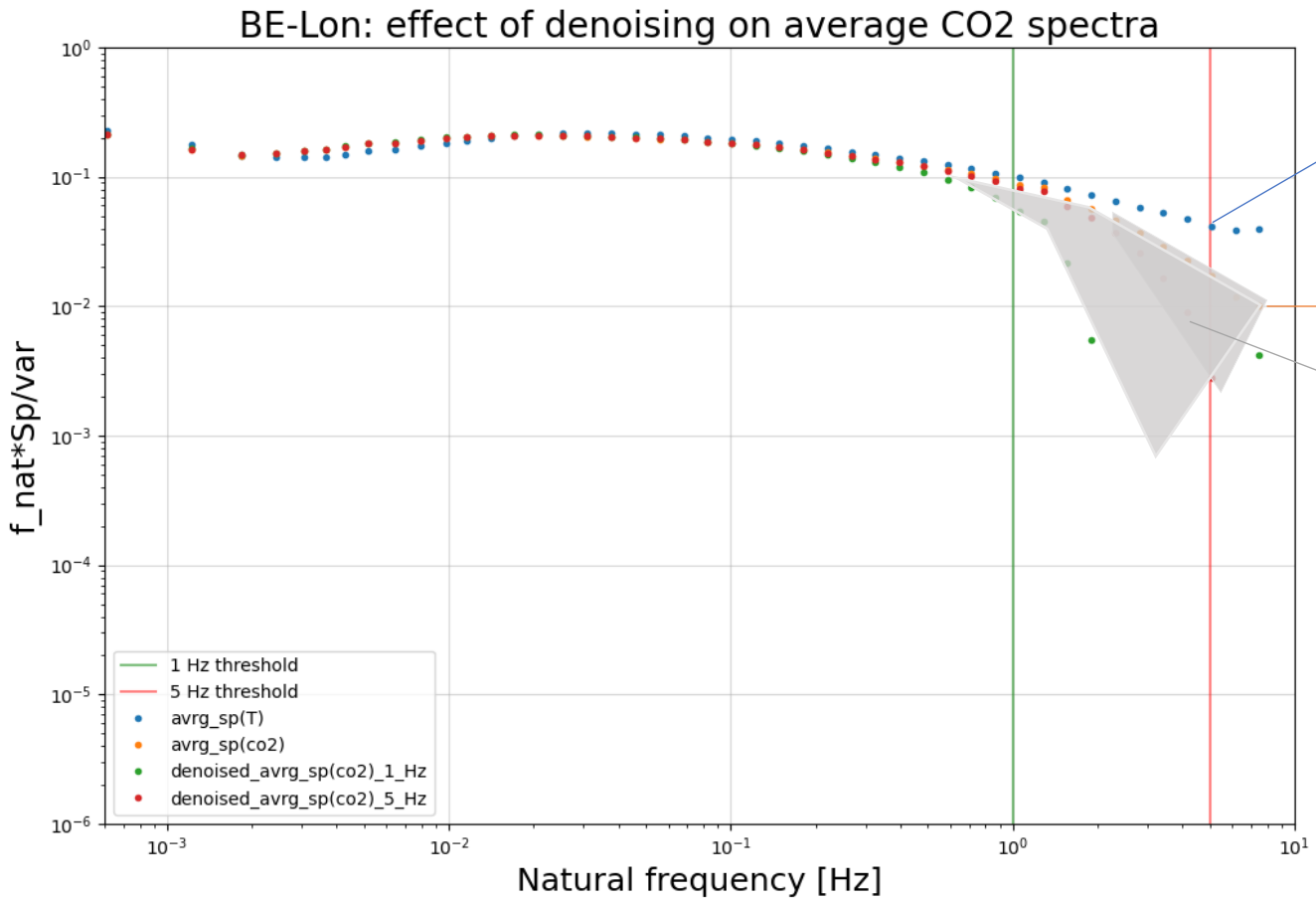
1. fit unconstrained linear equation in a defined frequency range where only noise is present
2. extrapolation to all the frequencies

If not performed in the right conditions

- **Risk** : removal of true signal thus artificially attenuating it → fluxes are overcorrected

RESULTS AND DISCUSSION: DENOISING



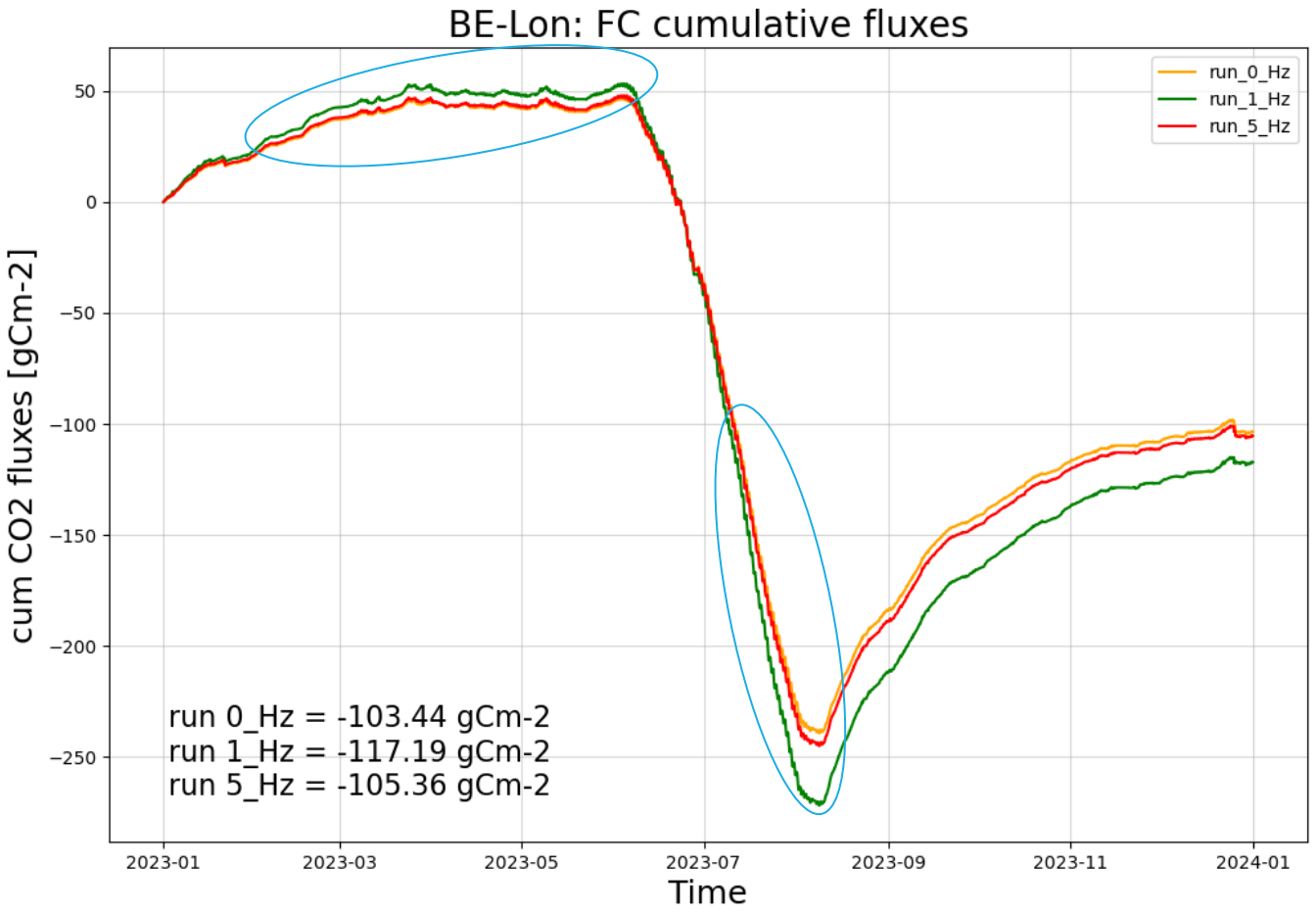


Ideal (sonic T)

Not denoised (co2)

Signal lost to denoising

RESULTS AND DISCUSSION: DENOISING

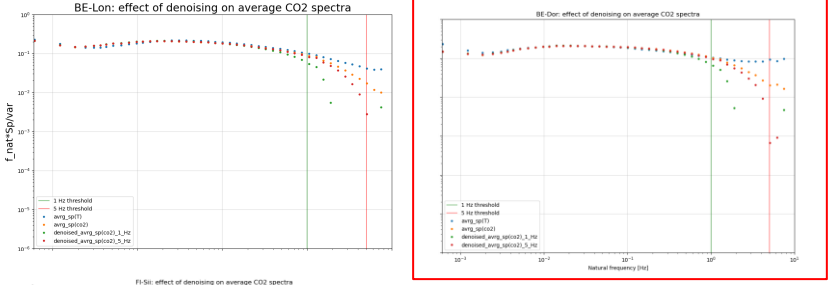


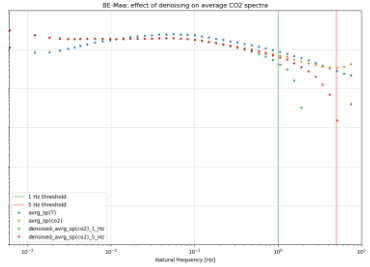
Note :
0 Hz = noise retained

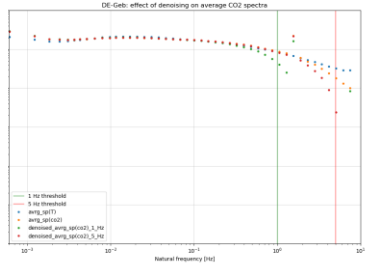
RESULTS AND DISCUSSION: DENOISING

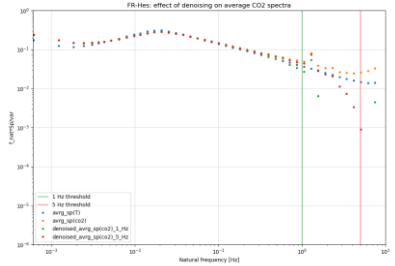
Small (z-d)/L

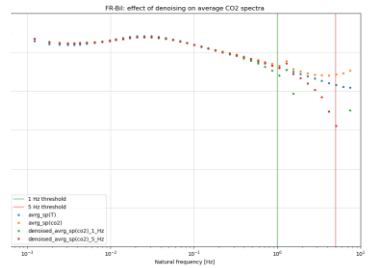
Large (z-d)/L

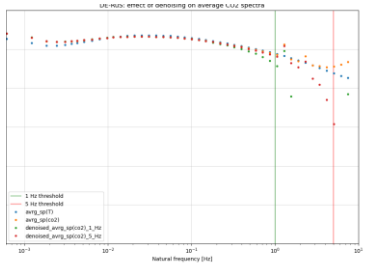


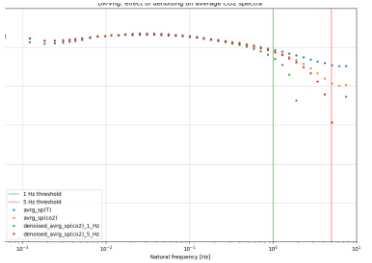


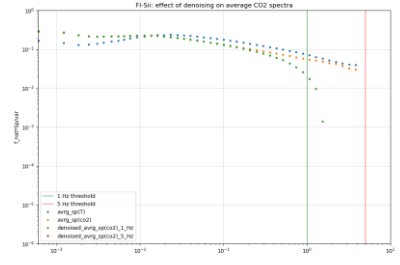


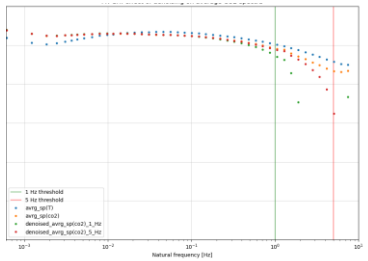


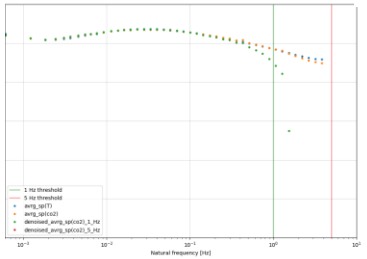


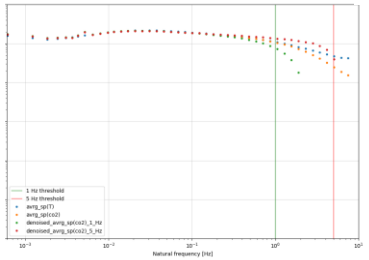


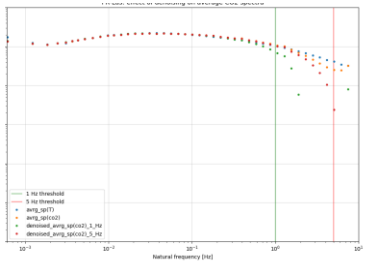


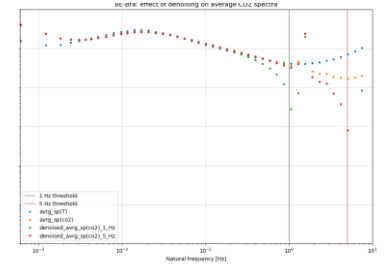


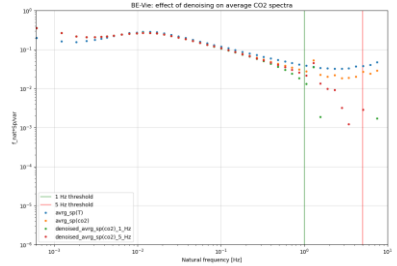


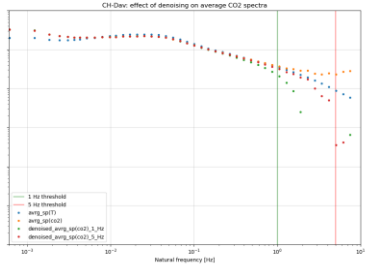


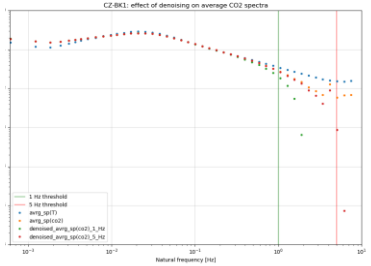


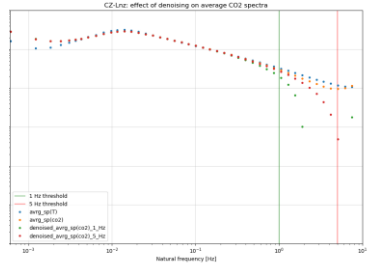


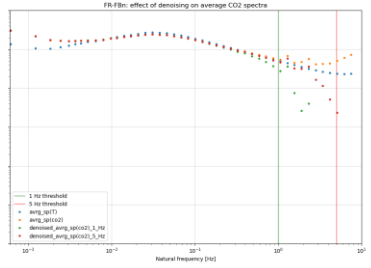


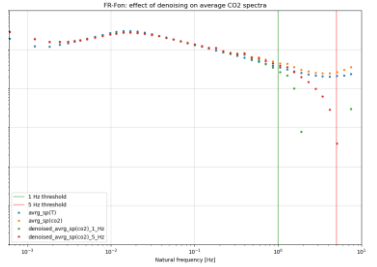


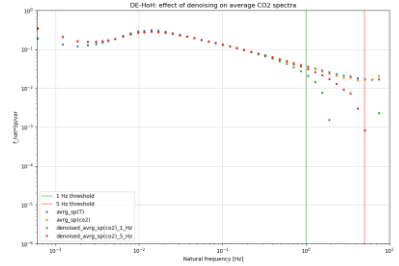


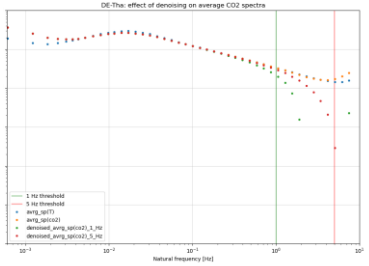


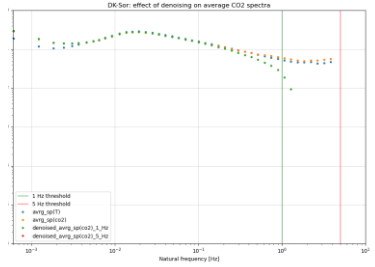


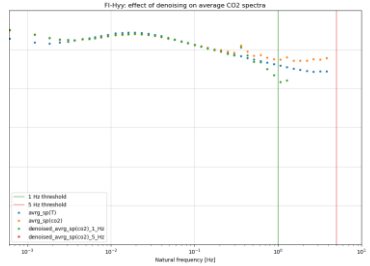


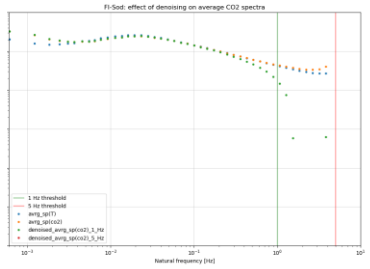


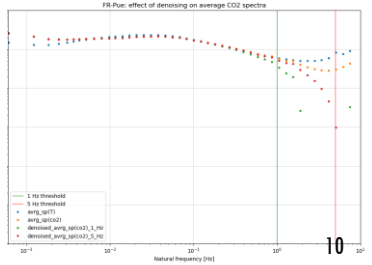








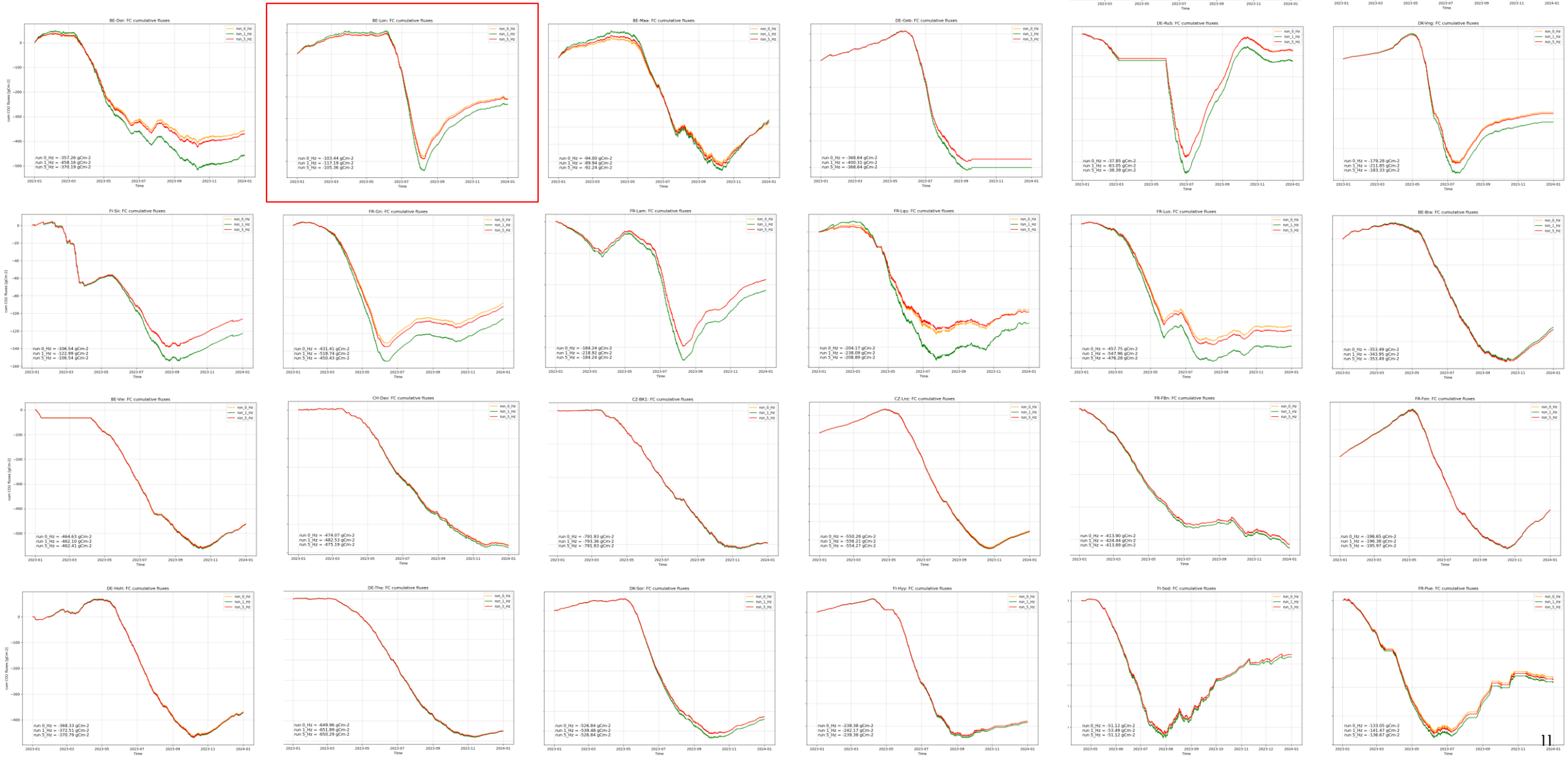




RESULTS AND DISCUSSION: DENOISING

Small (z-d)/L

Large (z-d)/L



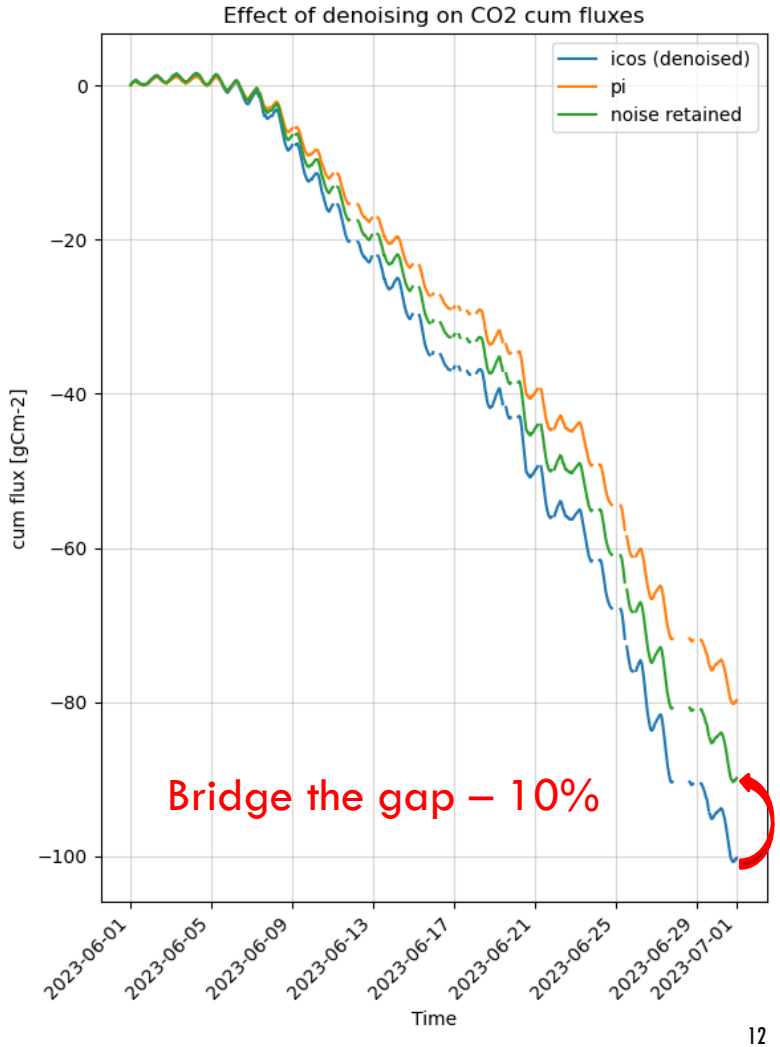
RESULTS AND DISCUSSION: DENOISING

Current procedure :

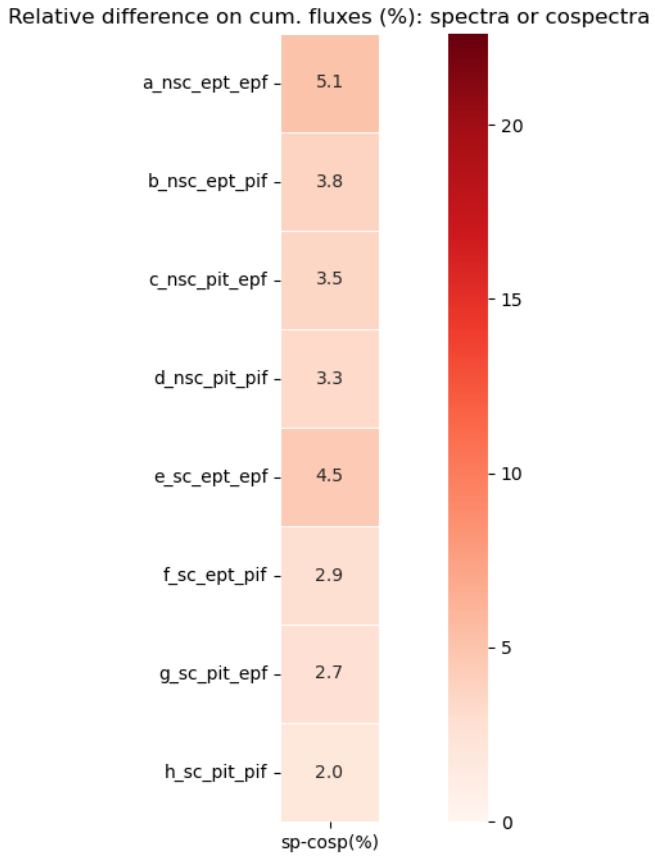
- Tricky to apply with a default threshold : potential major impact on fluxes
- Important effect of SNR and signal attenuation

Needs :

- Implement a robust, automated and comprehensive procedure that can be applied in all SNR and attenuation scenarios → Aslan et al. 2021
- Practical limitations in the pipe-line to be overcome



RESULTS AND DISCUSSION: (CO)SPECTRA

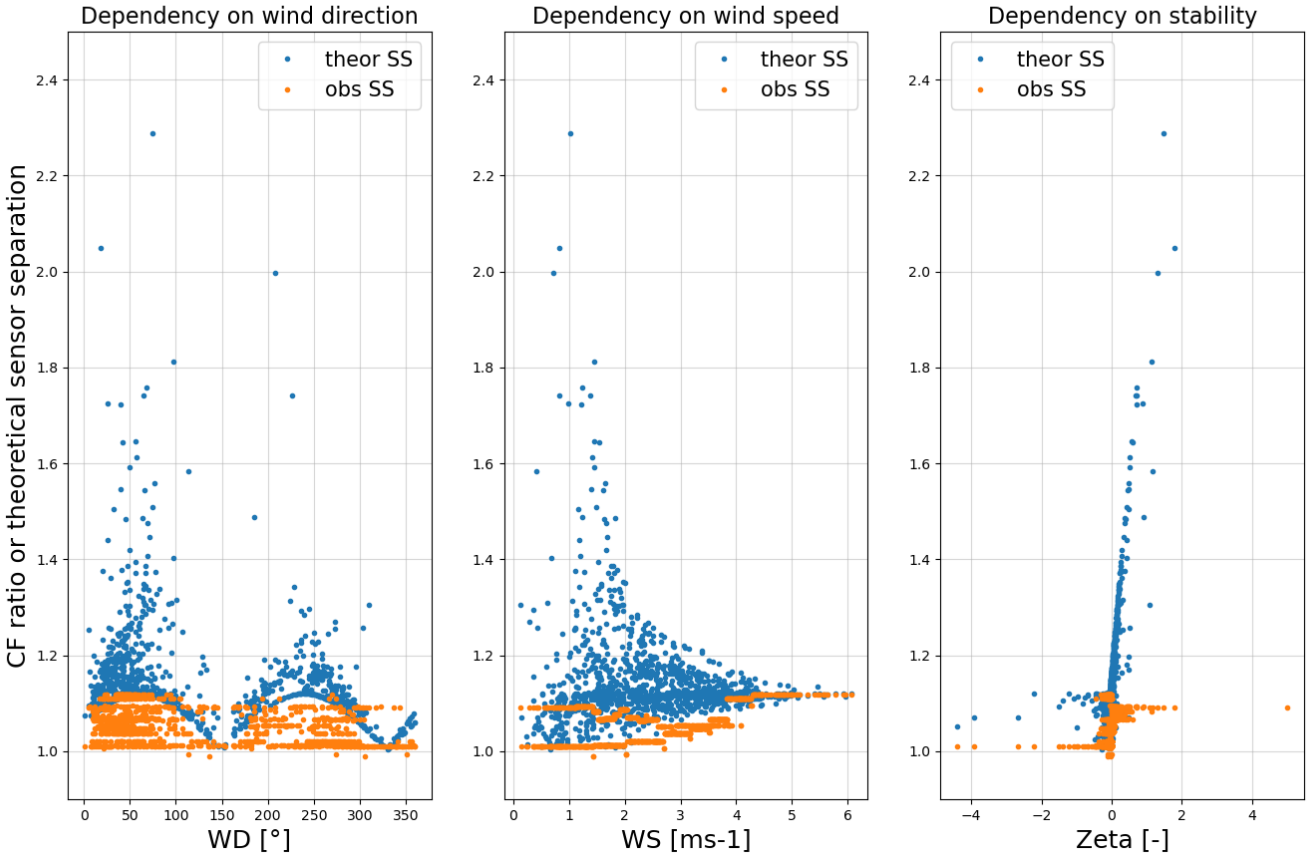


- Fundamental choice

	Pros	Cons
spectra	Pure signal (not polluted by w)	Needs theoretical description of sensor separation Noise removal needed in some cases
cospectra	No denoising needed No sensor separation description needed	TF determination could be difficult because of « pollution » of irga signal by w Time lag compensation

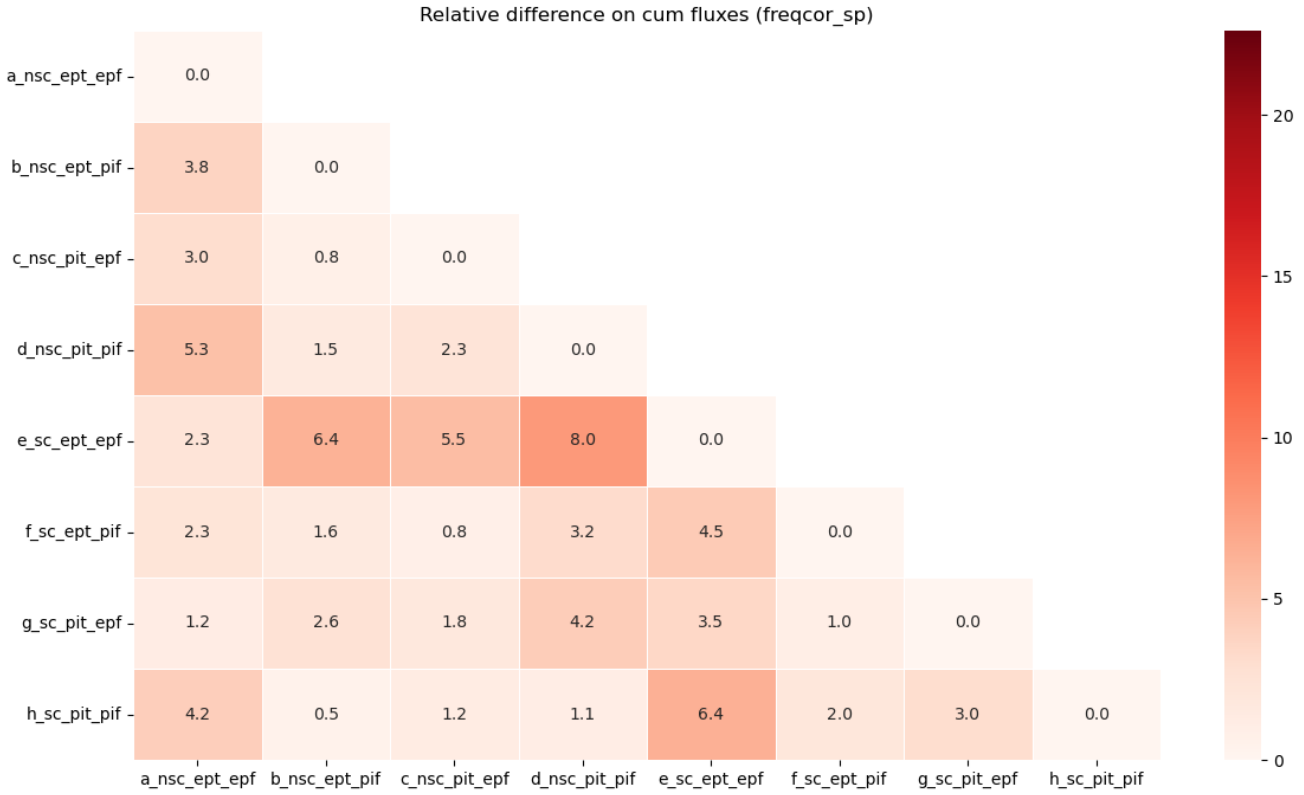
RESULTS AND DISCUSSION: (CO)SPECTRA

Observed and theoretical sensor separation CF dependencies



- Sensor separation plays a major role in the spectral correction for enclosed-path analysers
- Empirical and theoretical sensor separation CF do not match
- Questions on the applicability of theoretical equations (e.g. Horst and Lenschow 2009) on our site

RESULTS AND DISCUSSION: OTHER PARAMETERS



- Set of fundamental choices and factual parametrisations

<u>Specific results :</u>

- SA correction : perform (suggested)
- HH filtering : has to be very strict
- TF range : > 2 Hz with enclosed GA

<u>General :</u>

- Cumulative impact and cross-effects : small % that add up to important differences
- Challenge of full automation

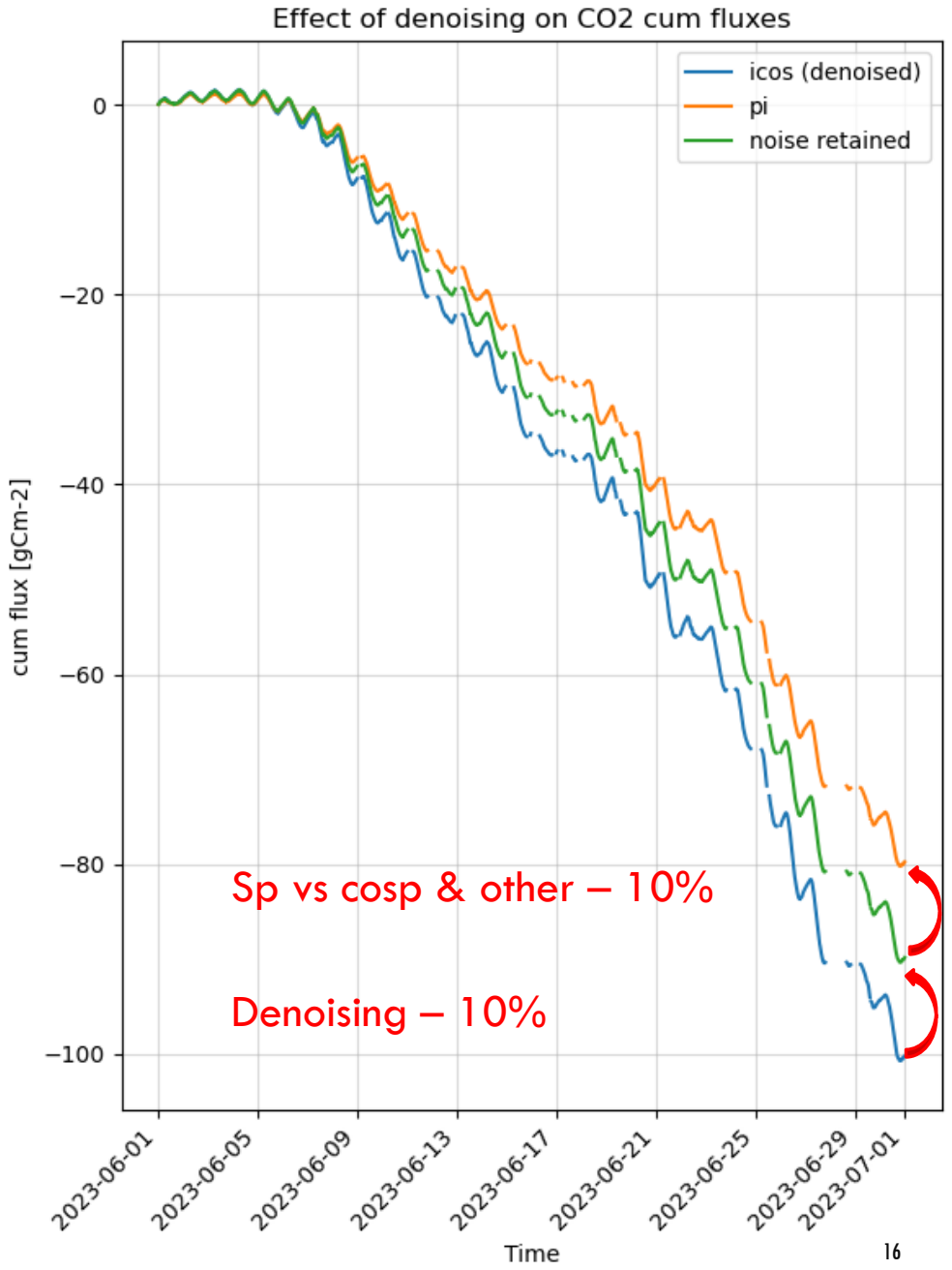
CONCLUSIONS

Objectives:

✓ 1. *Understand* → better comprehension of the potential causes of the differences

✓ 2. *Validate* → partial multi-site validation performed

3. *Suggestions* ?



CONCLUSIONS

- If spectral procedure maintained

→ Test the implementation of Aslan et al. 2021

- More work on fundamental spectra vs cospectra question needed

→ Robustness of sensor separation theoretical correction?

- Optimisation of specific parameters needed

→ Automation possible?
→ Inclusion of a site-specific pre-run to initialise the best parameters?

Overall, overcome technical limitations that prevent the methodological evolution of ICOS pipeline

THANK YOU FOR YOUR ATTENTION

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