ICOS | INTEGRATED CARBON OBSERVATION SYSTEM

Responses of European forest fluxes to the 2022 heatwave and drought recorded by ICOS eddy-covariance stations

Emilie Joetzjer, Sebastien Lafont, Benjamin Loubet, Adrien Jacotot, Matthias Cuntz, Pedro Herig-Coimbra, Auke van der Woude, Peter Woude, Jean-Marc Limousin, Gabriel Destouet, Philippe Ciais, Denis Lousteau, Jean-Christophe Domec & sites PIs

INRAE

Data collection

ICOS - https://www.icos-cp.eu/

ICOS : integrated carbon observation system
Standardised, high-precision and long-term observations of GES

European network : ~ 170 stations
(~25 ecosystems, ~25 associated)
Ocean – Atmosphere – **Ecosystem**

Measurements include :

Eddy covariance system,
Radiation (PAR, CNR4)
Vertical profile of CO2,H2O, WS, WD, RH, TA
At least 2 soil profile to 1m (+ water table depth)
Leaf area index, leaf nutrient content

Data available on https://www.icos-cp.eu/observations/carbon-portal

Data

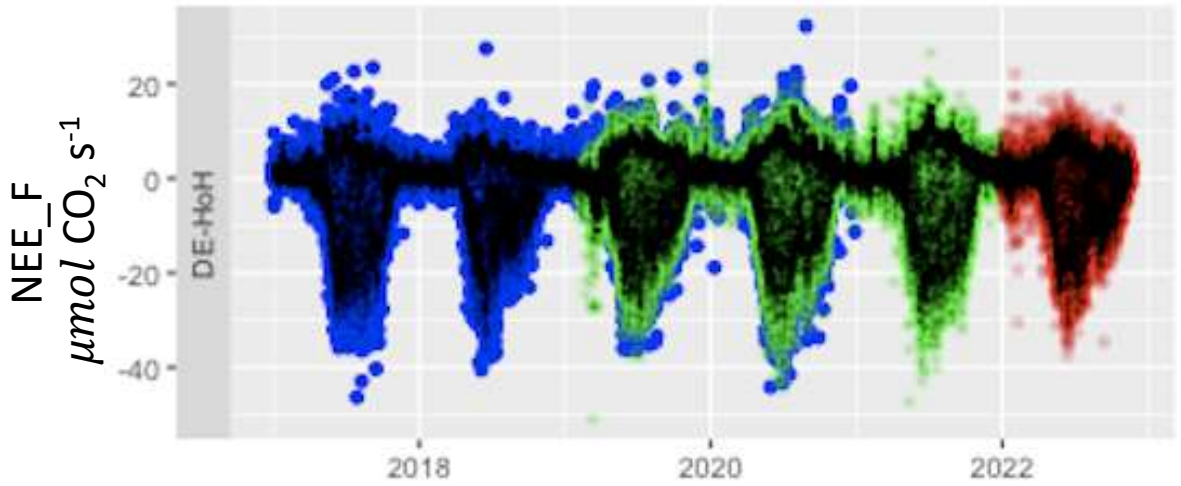
- **Warm winter 2020**

DOI https://doi.org/10.18160/2G60-ZHAK

- **Level 2 2022-01 release**

DOI https://doi.org/10.18160/PAD9-HQHU

- **Near real time (NRT)**



- FR-Hes & FR-Pue : PI's data

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Data

- **Warm winter 2020**

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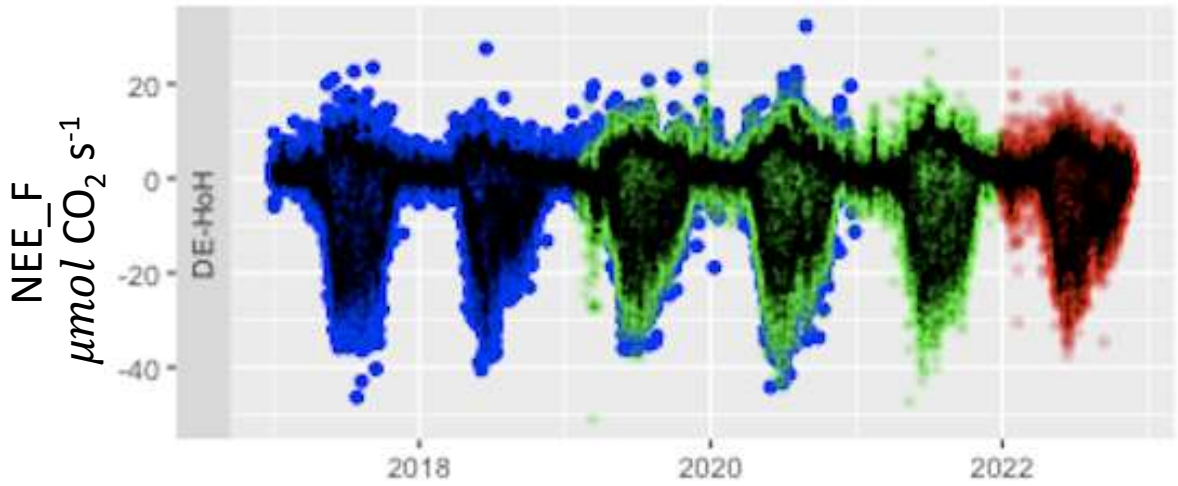

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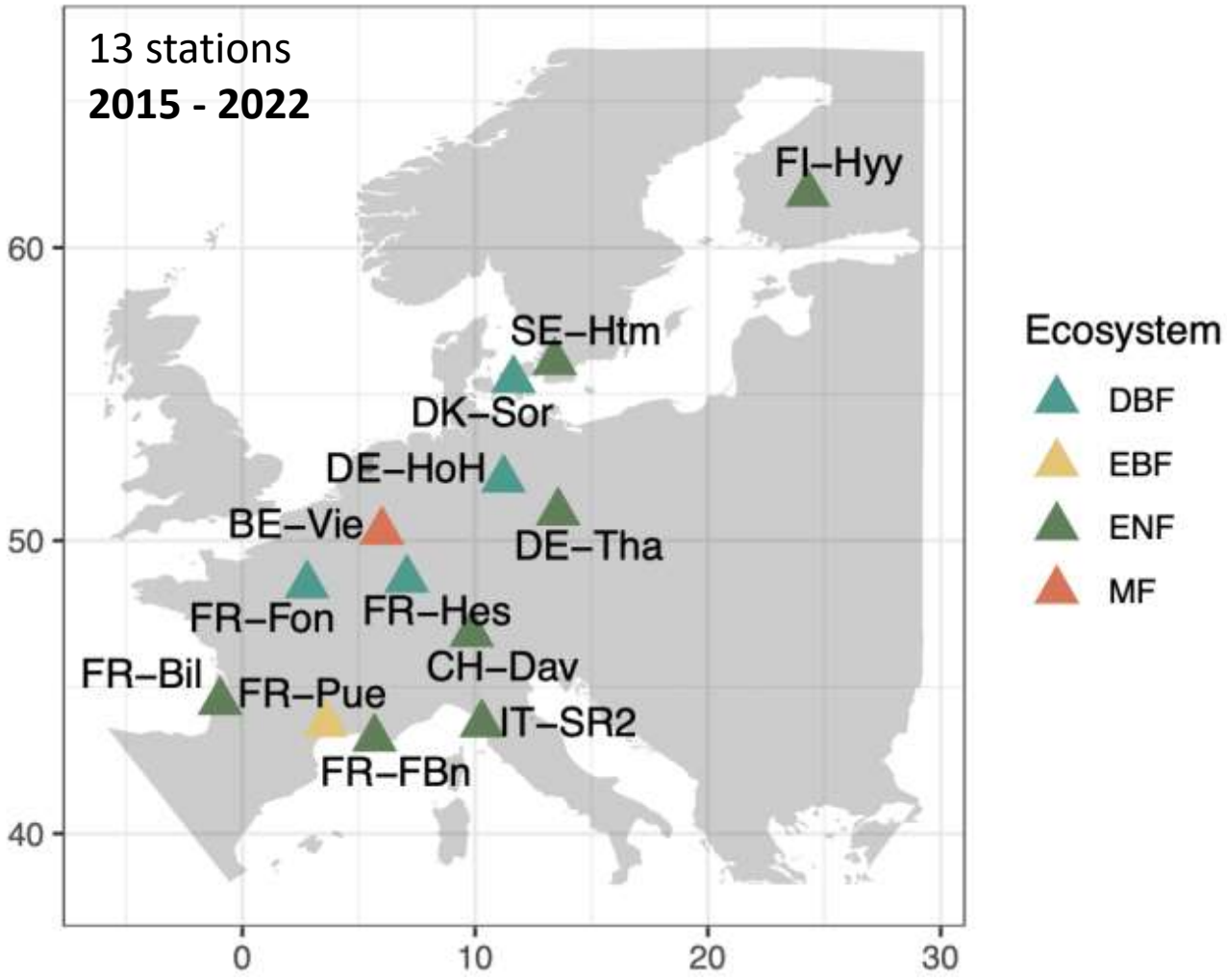
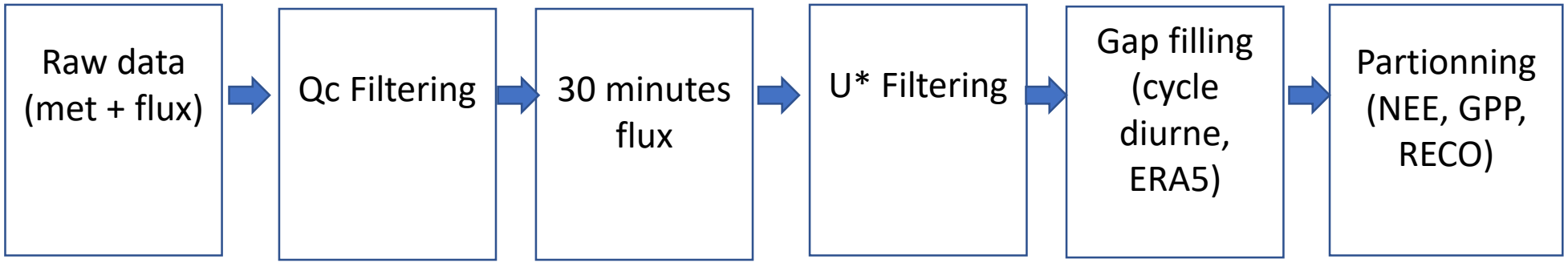
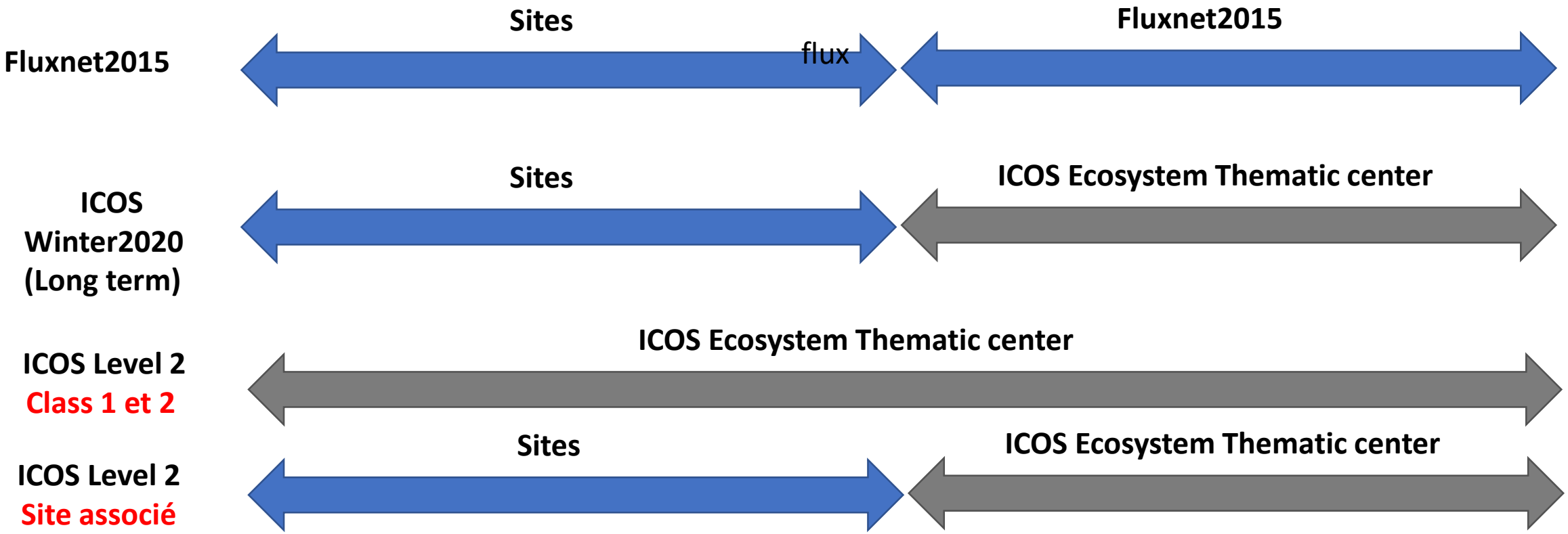
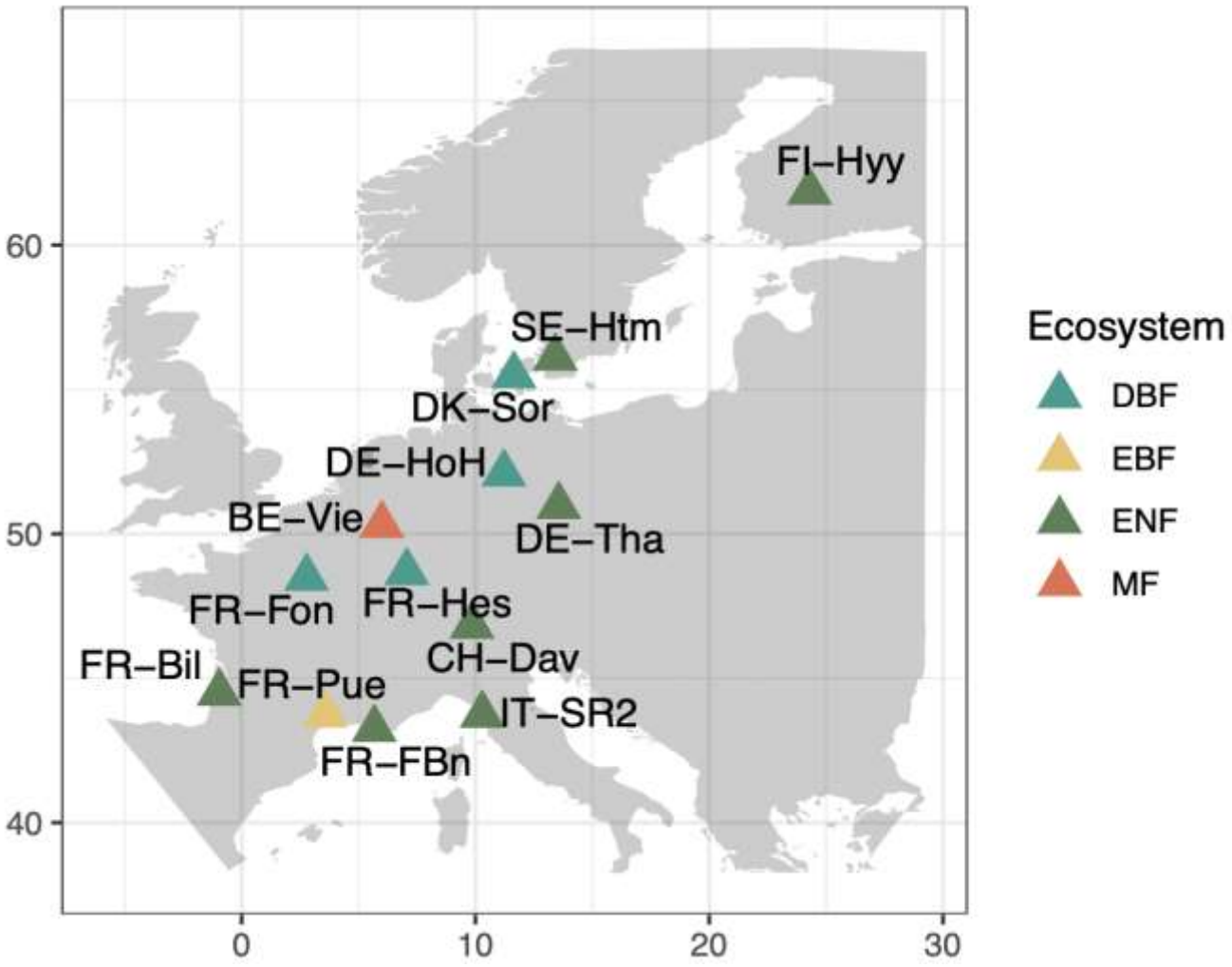


Processing level ICOS

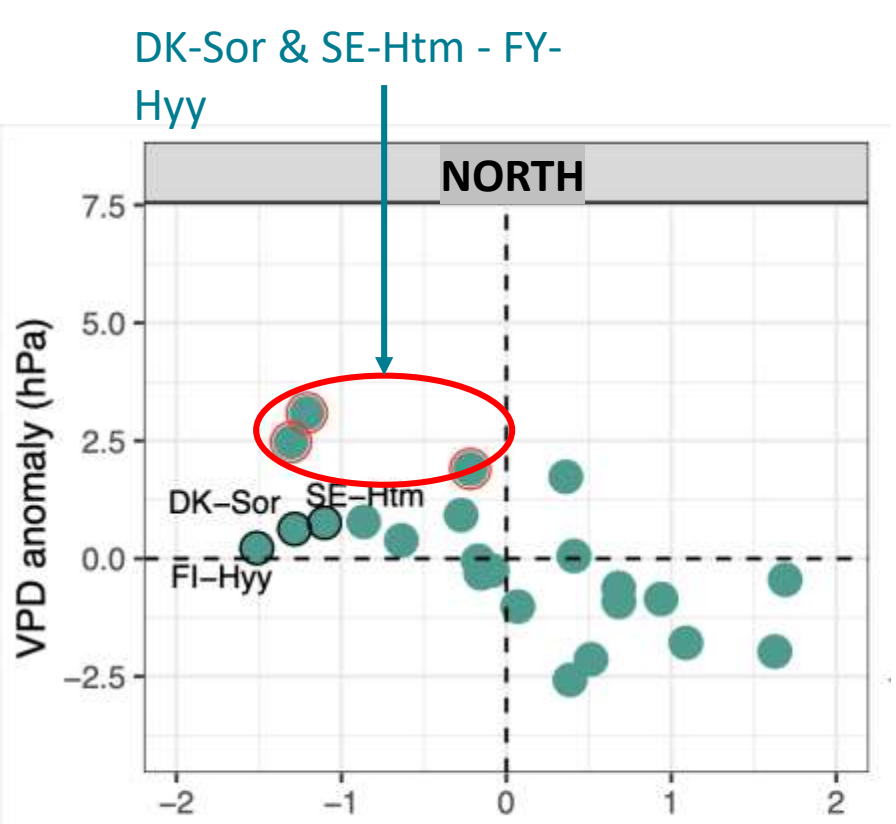





FI–Hyy
SE–Htm
DK–Sor
DE–HoH
BE–Vie
DE–Tha
FR–Fon
FR–Hes
CH–Dav
FR–Bil
FR–Pue
IT–SR2
FR–FBn
60
50
40
0
10
20
30
Ecosystem
DBF
EBF
ENF
MF

Preliminary results

SPI 3 vs. VPD anomalies



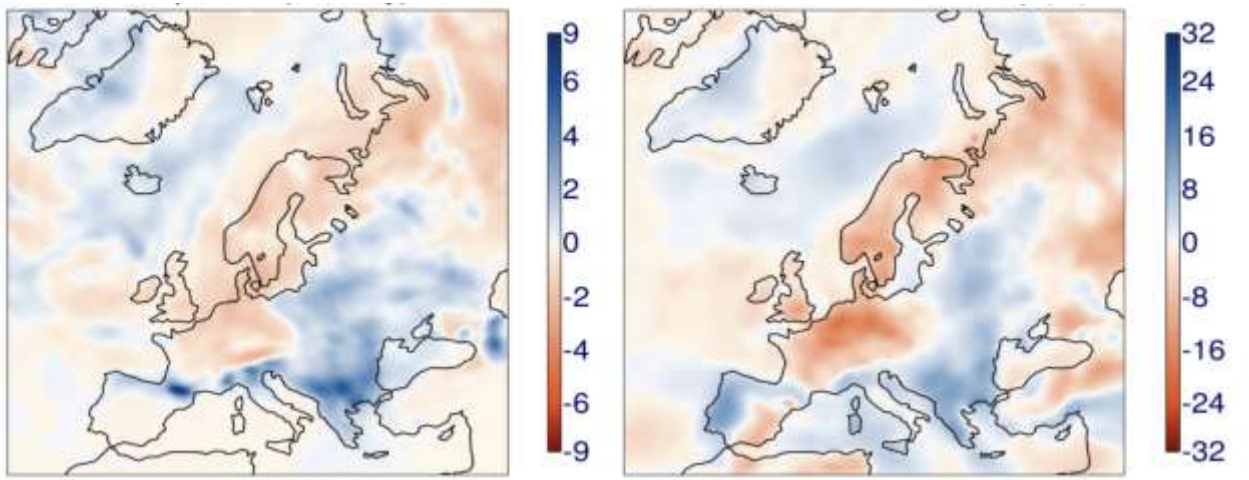
◯ 2022 anomaly

◯ 2018 anomaly

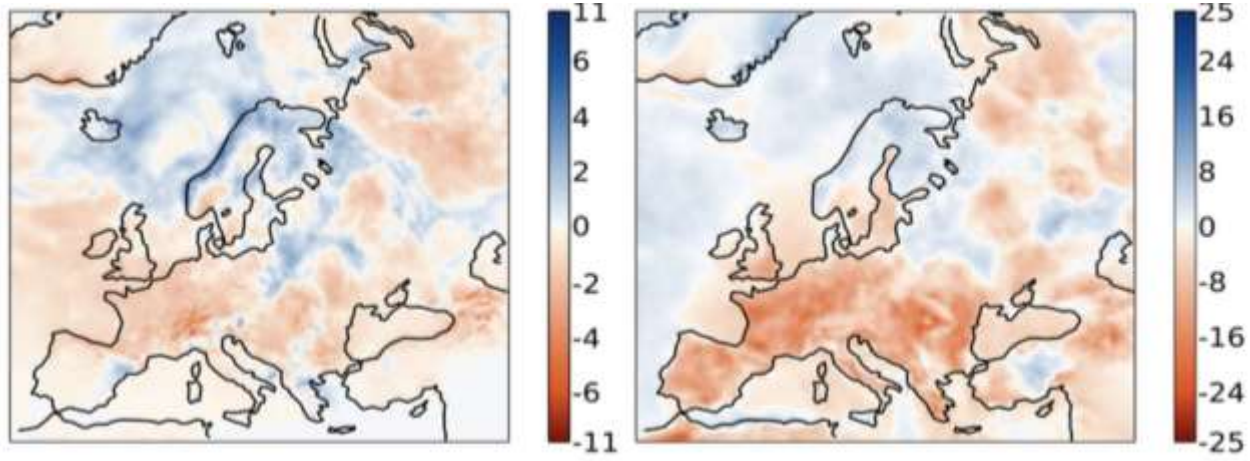
Summer (JJA) anomalies
Diurnal data (Rg > 0.1 W.m^{-2})
Baseline 2015-2022

Precipitation (mm d^{-1}) | **Surface air relative humidity (%)**

July **2018**

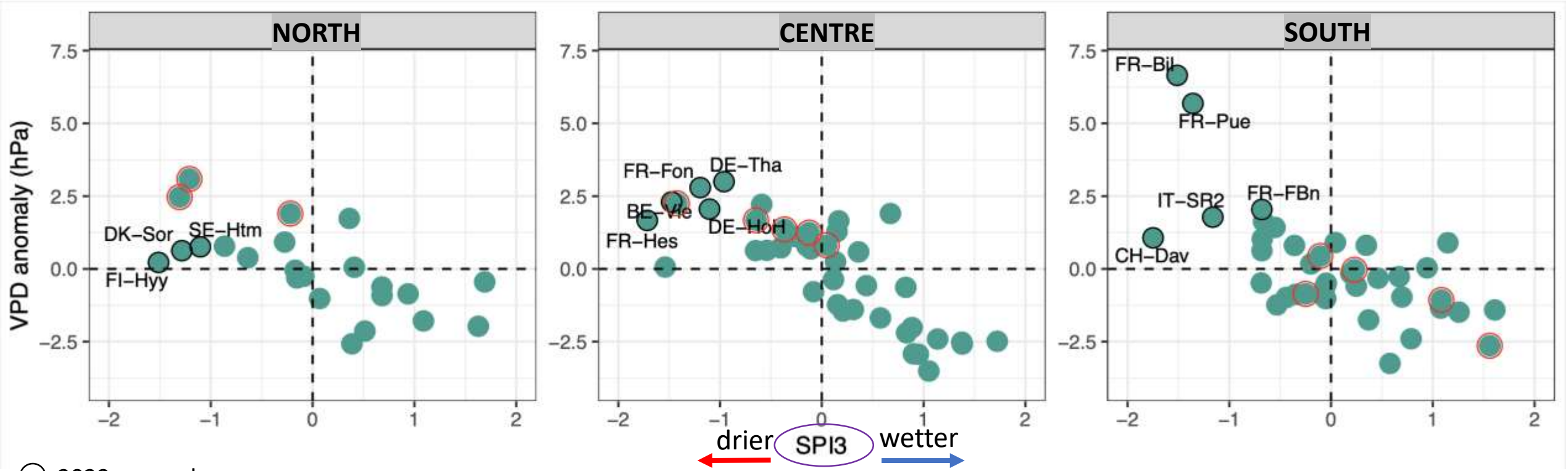


July **2022**



ERA-5 / Copernicus / Baseline 1981-2010

SPI 3 vs. VPD anomalies



○ 2022 anomaly

○ 2018 anomaly

Standardize Precipitation Index (3-months)

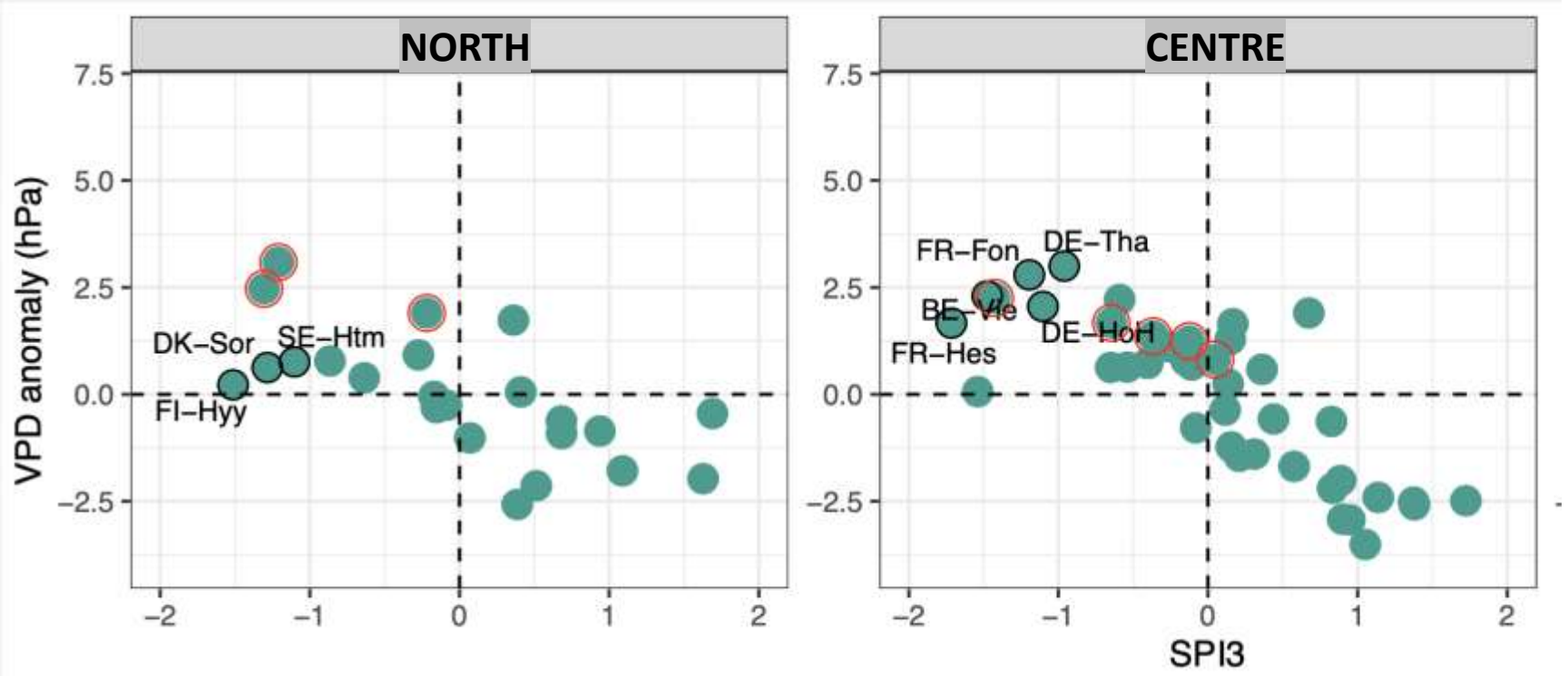
Meteorological drought index

Summer (JJA) anomalies

Diurnal data (Rg > 0.1 W.m^{-2})

Baseline 2015-2022

SPI 3 vs. VPD anomalies



◯ 2022 anomaly

◯ 2018 anomaly

Higher VPD & P deficits since 2015 (at least)

Summer (JJA) anomalies
Diurnal data (Rg > 0.1 W.m^{-2})
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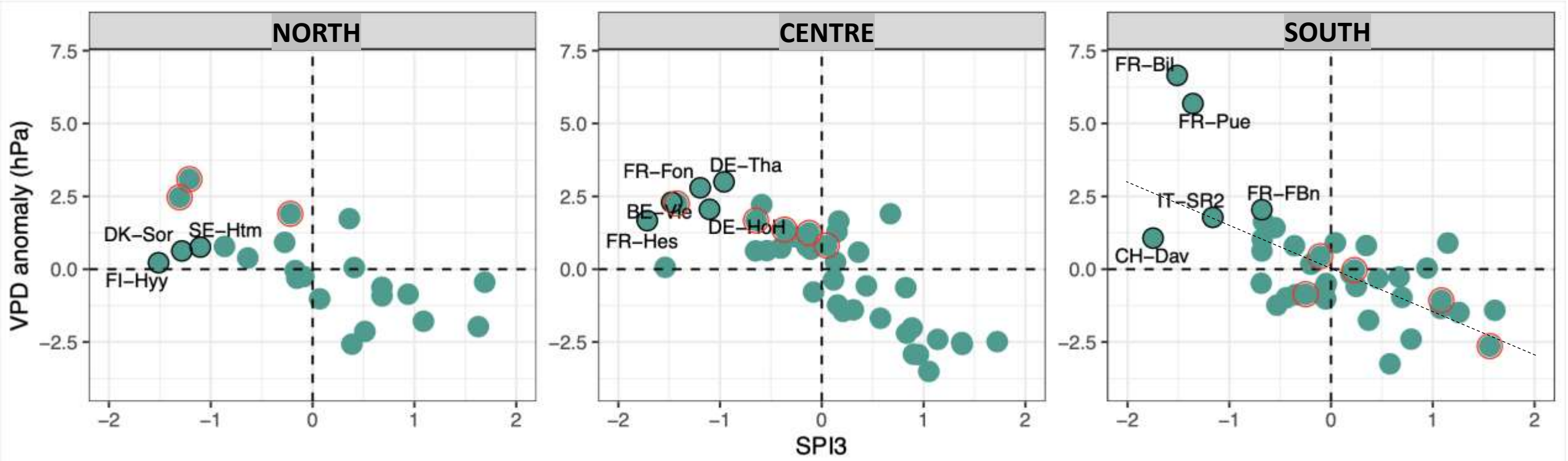


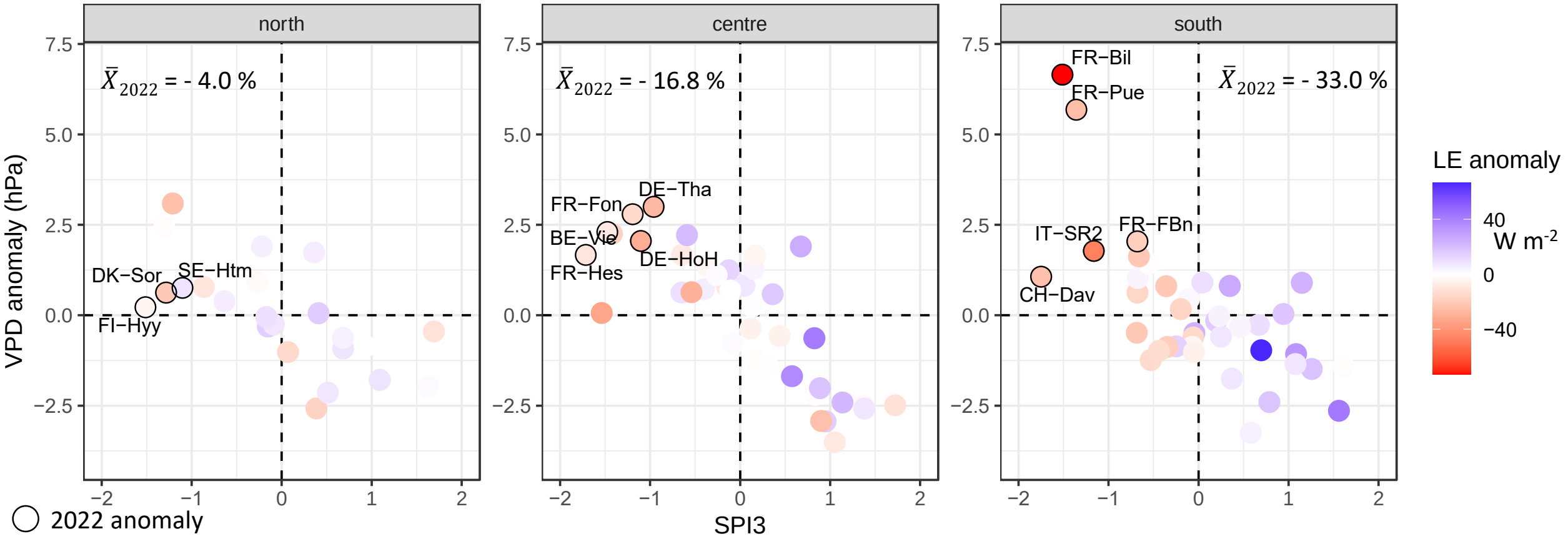
◯ 2022 anomaly

◯ 2018 anomaly

Summer (JJA) anomalies
Diurnal data (Rg > 0.1 W.m^{-2})
Baseline 2015-2022

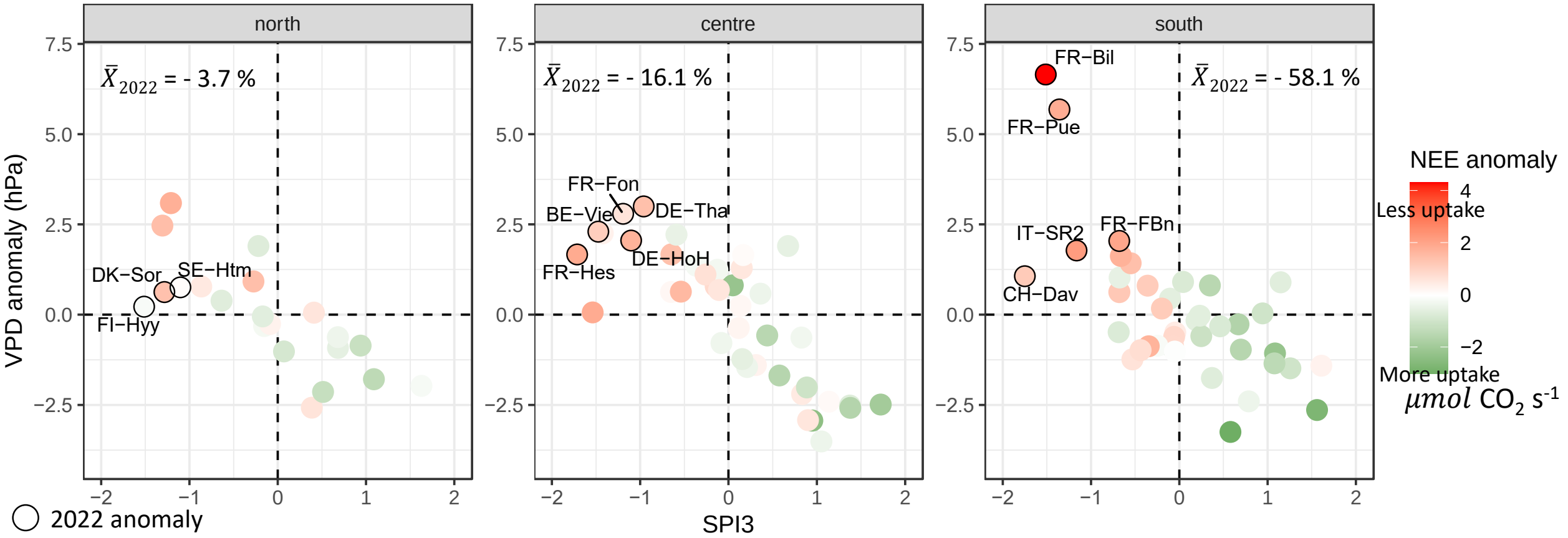
Higher VPD & P deficit since 2015 (at least)
Extreme [5.5-7 hPa] VPD anomalies at **FR-Bil & FR-Pue**

Evapotranspiration anomalies



Summer (JJA) anomalies
Diurnal data (Rg > 0.1 W.m^{-2})
Baseline 2015-2022

Net Ecosystem Exchange anomalies



Summer (JJA) anomalies
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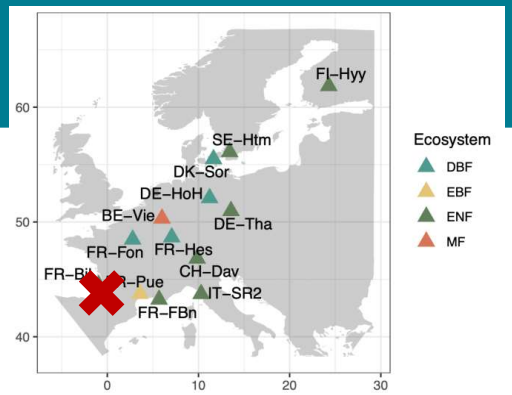
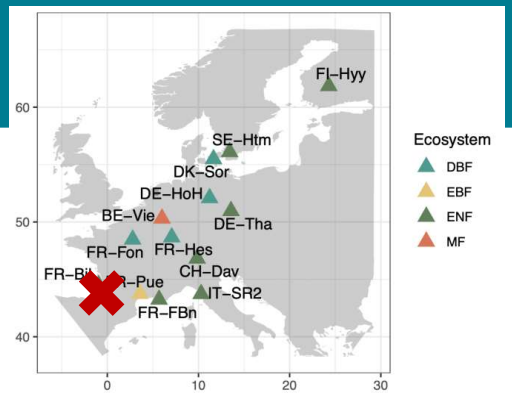
FR-Bil



- Managed Pine forest plantation (Landes forest – close to Bordeaux) *Taborski et al., 2022*
- Soil : sandy podzol & shallow roots
- PIs : D. Loustau & J-C Domec

FR-Bil



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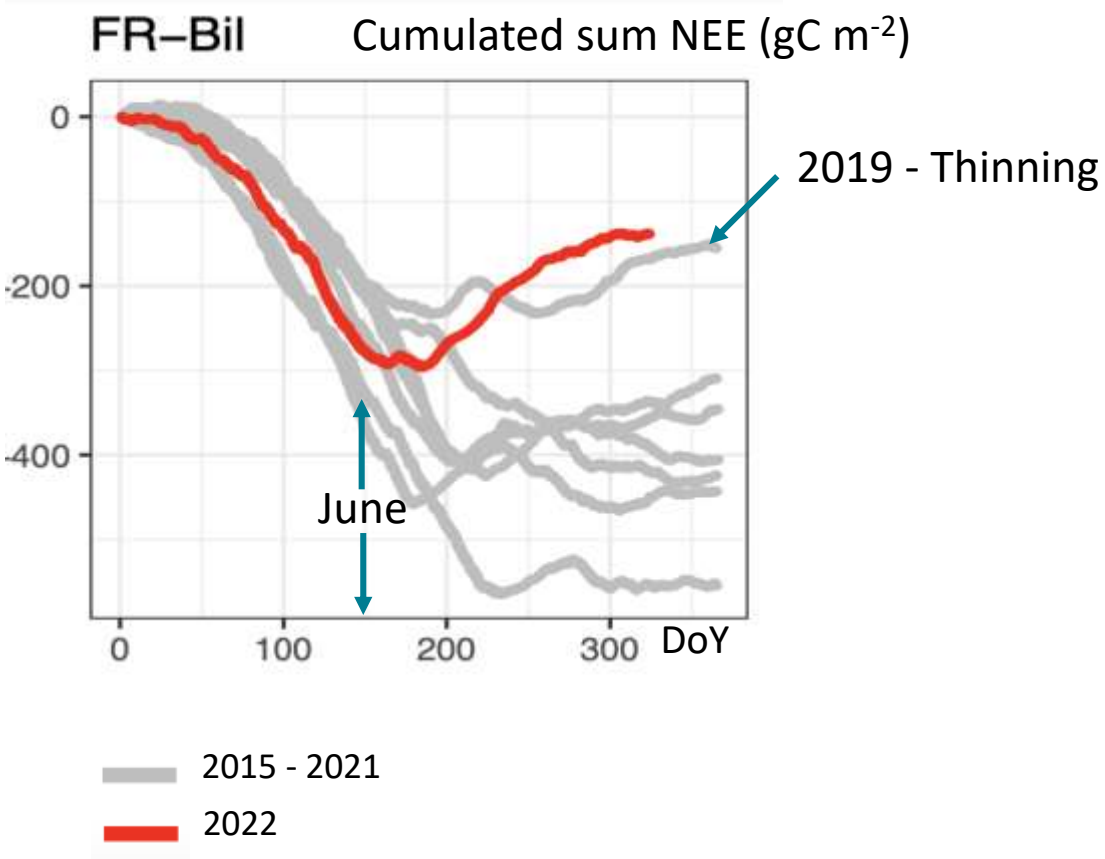
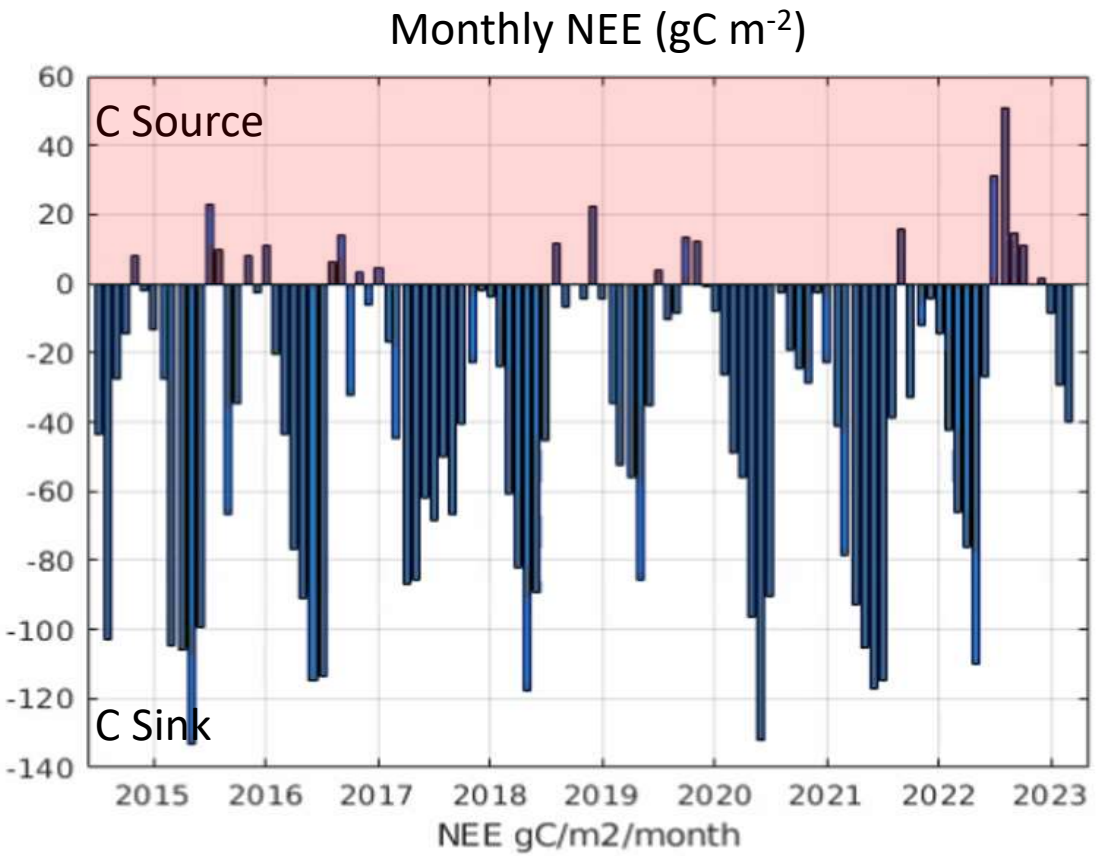
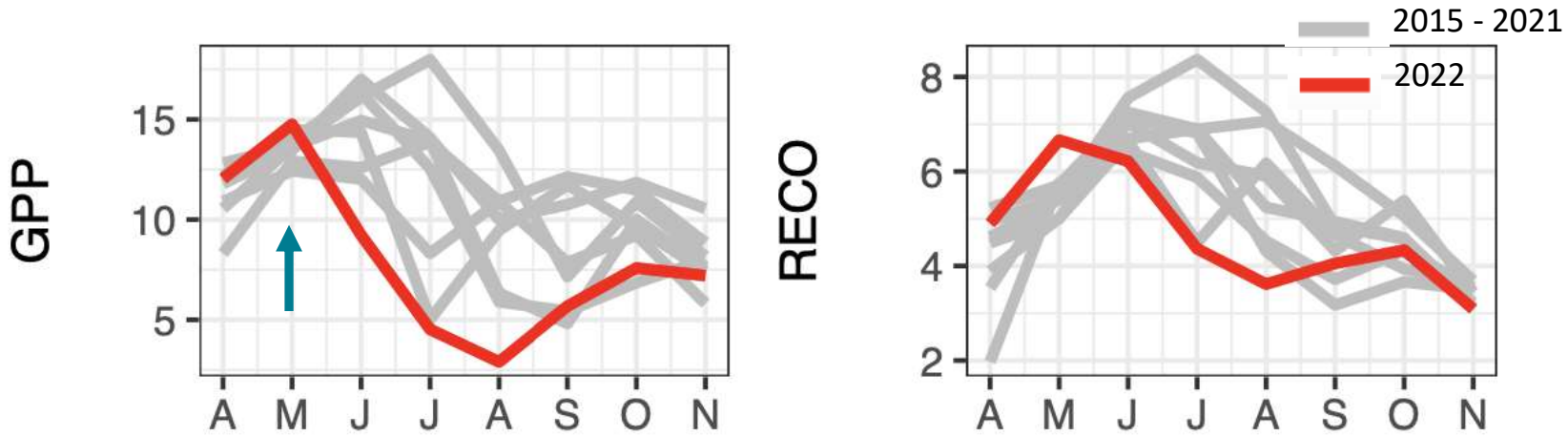




FR-Bil

Carbon fluxes (μmol CO_2 s^{-1}) monthly (April-November) seasonal cycle 2015 - 2022

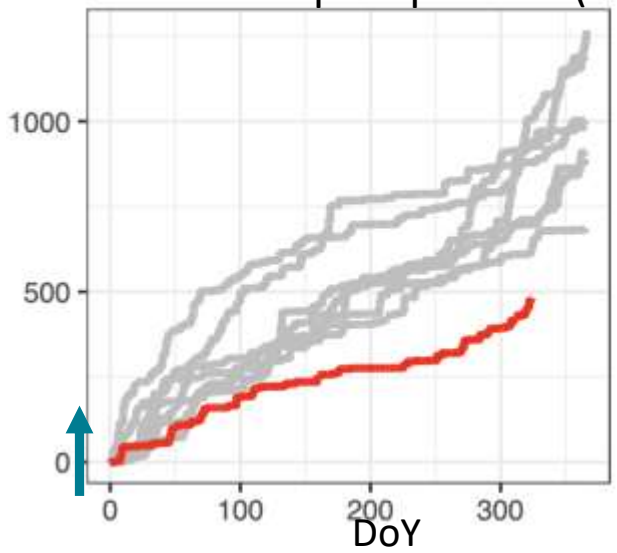


- Early drop (May) in GPP

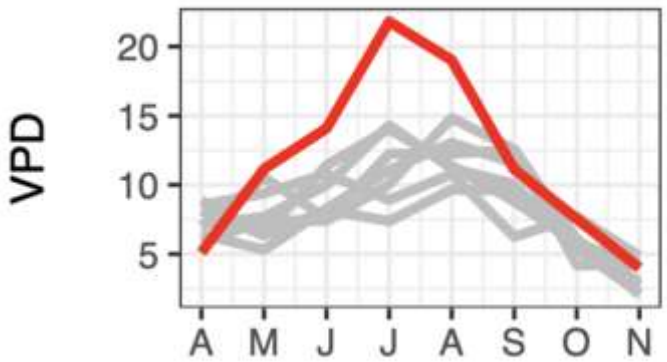
Moderate P deficit during winter, deficit intensification after May => sandy soil & shallow roots

FR-Bil

Cumulated precipitation (mm)



VPD (hPa) seasonal cycle



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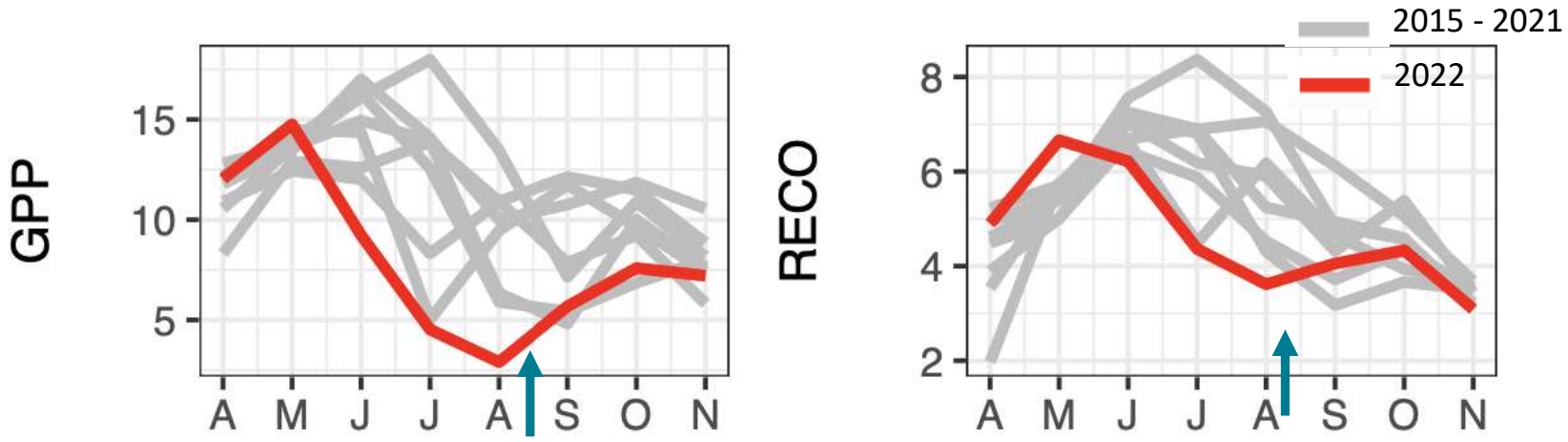


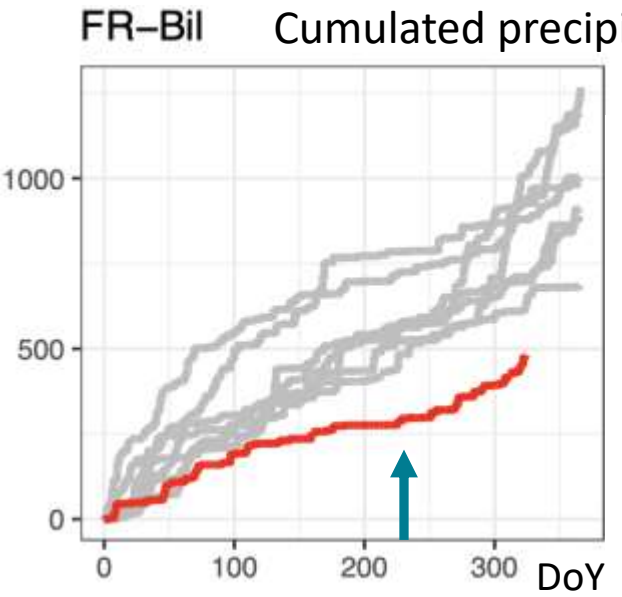
- Early drop (May) in GPP

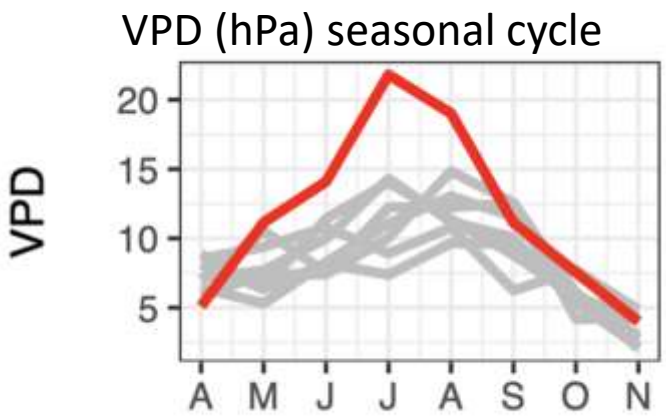
Moderate P deficit during winter, deficit intensification after May
=> sandy soil & shallow roots

- Precipitation in August

⇒ ↗ GPP & RECO
But GPP remains anomalously low
=> Drought legacy (needles fall / degradation (color))

- VPD ?





Take home messages

Drought impact on forest ecosystem

- Most ICOS forest ecosystem stations experienced a deficit of precipitation and higher VPD conditions

CENTRE and SOUTH regions : records in JJA anomalies since 2015 (at least)
⇒ CENTRE ~ - 16 % in LE & NEE
⇒ SOUTH ~ - **33 % in LE & - 58% in NEE**

ICOS data

- Many datasets available – including Near Real Time Data
- **BUT – interactions with sites PIs are crucial**

- **paper drought overview in Review**

ICOS EC forest + ICOS atm + Remote sensing + DGVM + fire emissions

- **Analysis on the drought 2022 impact on forest ecosystem**

⇒ Focus on processes (high temperature & VPD)

Temperature extremes of 2022 reduced carbon uptake by forests in Europe

Auke M. van der Woude[1,2,+], Wouter Peters[2,1,+,*], Emilie Joetzjer[3], Sébastien Lafont[4], Benjamin Loubet[4], Denis Loustau[4], Pedro-Henrique Herig-Coimbra[4], Gerbrand Koren[5], Philippe Ciais[6], Michel Ramonet[6], Yidi Xu[6], Ana Bastos[7], Santiago Botía[7], Stephen Sitch[8], Tobias Kneuer[10], Dagmar Kubistin[10], Remco de Kok[2,9], and Ingrid T. Luijkx[2]

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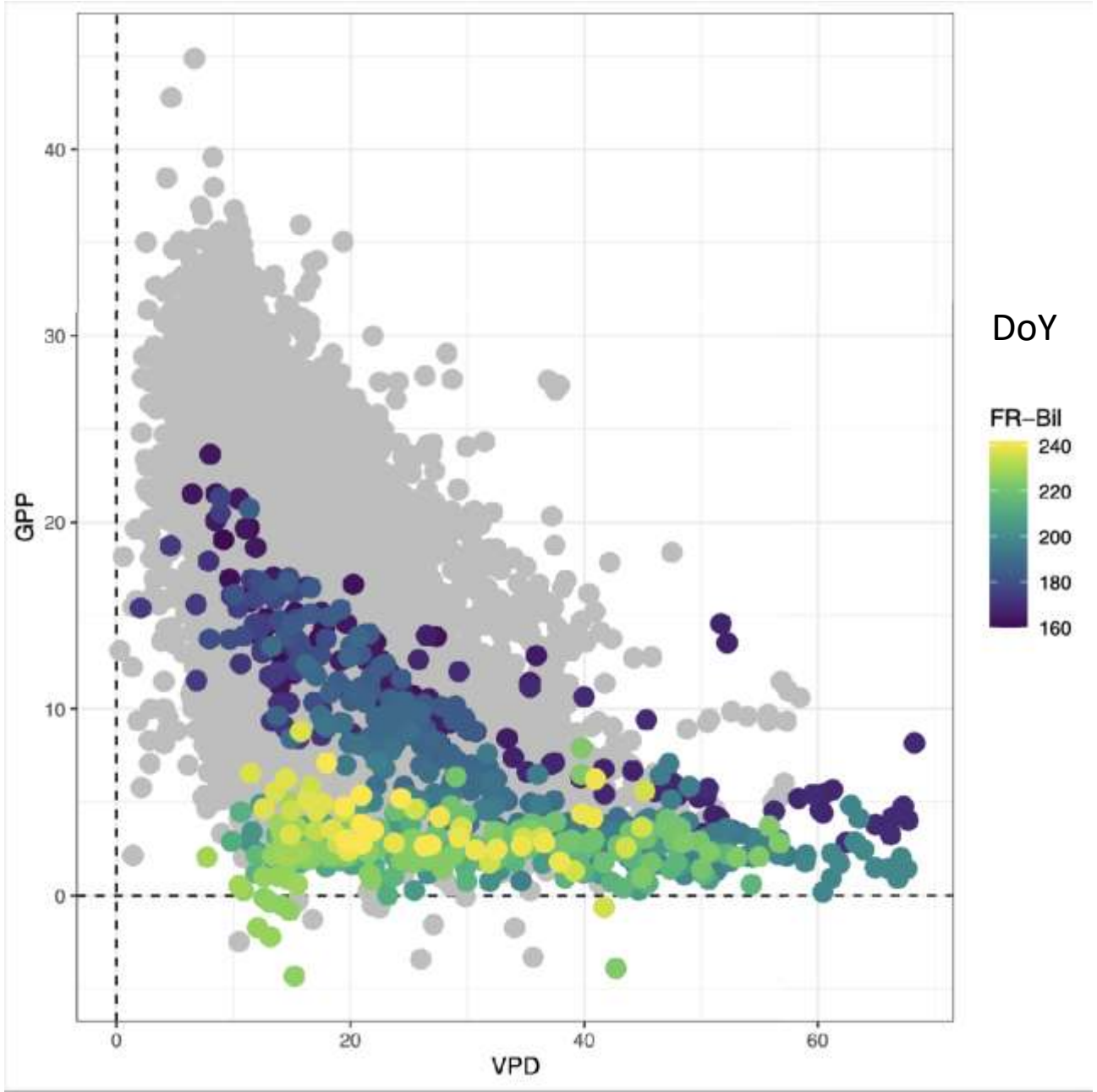
[+]these authors contributed equally to this work

Status: Under Review

FR-Bil



Rg filtered : Top 20p Rg

Bilan ICOS-France-Ecosystème

Au 14 juin 2023

mise à disposition des données ICOS France

Sites Français	Classe	code ICOS	PFT	ICOS Winter2020	ICOS LEVEL2	mise à jour	Données Brutes disponibles
Grignon	2	FR-Gri	Culture	2004-2020	2021-2022	temps réel	oui
Barbeau (fontainebleau)	1	FR-Fon	Decidus	2005-2020	2019-2022	temps réel	oui
Auradé	Associé	FR-Aur	Culture	2005-2020	2019-2022	fin d'année	n.a
Lamasquère	2	FR-Lam	Culture	2005-2020	2019-2022	Temps réel	oui
Météopole (Toulouse)	Associé	FR-Tou	Jachère	2018-2020	2018-2022	fin d'année	n.a
Hesse (Nancy)	2	FR-Hes	Décidus	2014-2020	à venir	temps réel	oui
Bilos (Les Landes)	2	FR-Bil	Conifère	2014-2020	2019-2022	temps réel	oui
FontBlanche (marseille)	2	FR-FBn	Conifère	2008-2020	à venir	temps réel	non
La guette (Orleans)	Associé	FR-LGt	Tourbières	2017-2020	2017-2022	fin d'année	n.a
Puechabon (Montpelier)	2	FR-Pue	Chene Vert	n.a	2021-2022	temps réel	oui
Lusignan (poitier)	2	FR-Lus	Prairie	n.a	à venir	temps réel	non
Laqueuille (Clermon-Ferrand)	2	FR-LQu	Prairie	n.a	à venir	temps réel	oui
Mejussaume (Rennes)	Associé	FR-Mej	Prairie	n.a	2019-2022	fin d'année	n.a
Estrées Mons	Associé	FR-EM2	Culture	n.a	2017-2022	fin d'année	n.a