NO-Hur - A tale of two towers

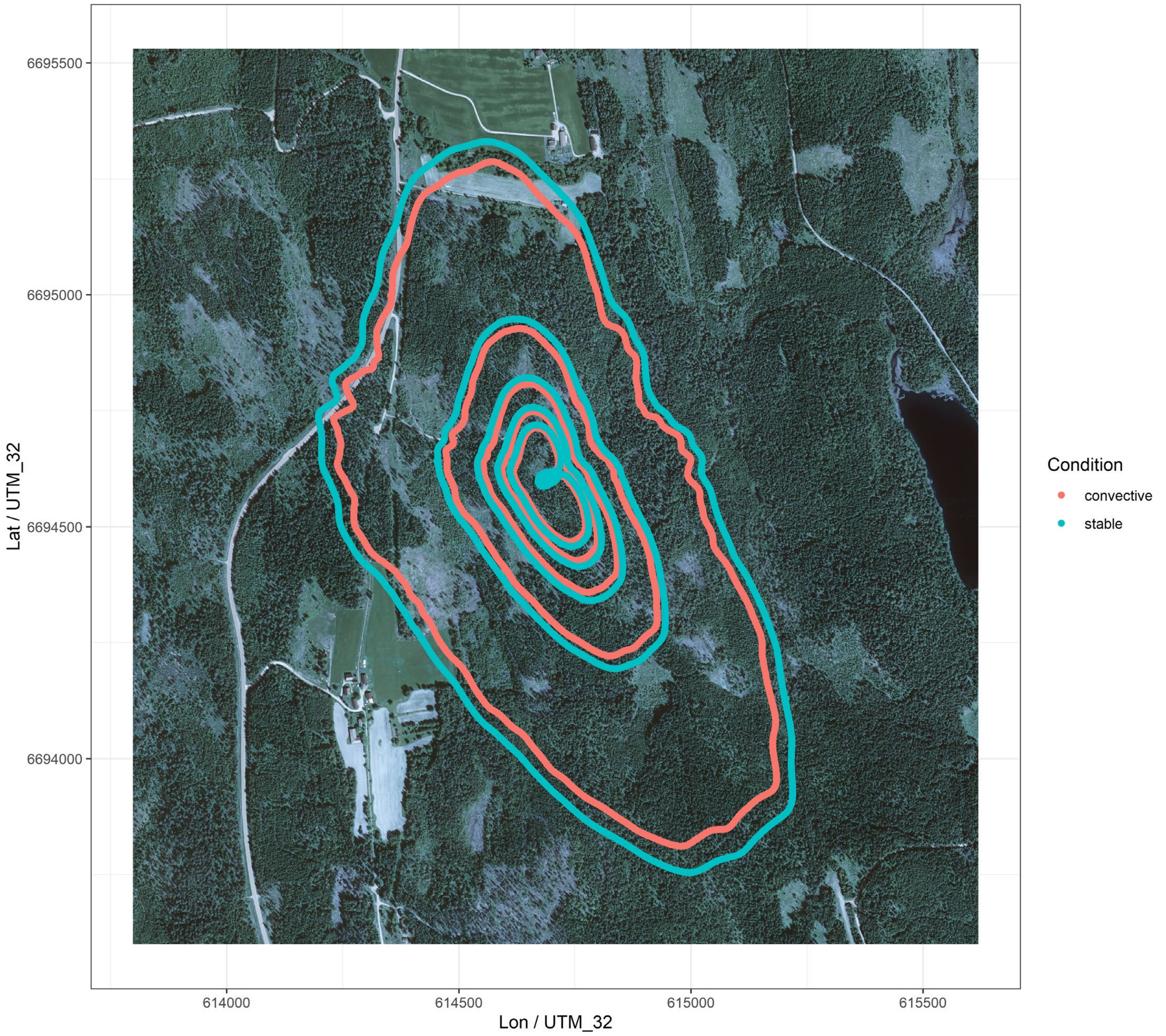
~~Charles Dickens~~

Holger Lange

the Past

the Future
(should be: the Present)

NO-Hur:
A good footprint is worth a million crowns



Thanks, Junbin!

The Hurdal tower building project

«the worst of times, …»

- New tower position and height acknowledged by ETC April 2019
- Start bidding round April 2019
- End bidding round June 2019, winner: ELV Jarlsø AS
- Contract signed September 2019
- Expected delivery: February 2020
- Accumulation of excuses I: no subcontractor found, road construction not part of the contract, building allowance from Hurdal missing, bad weather, …
- Tower material ordered and arrived at ELV Jarlsø AS in March 2020
- Accumulation of excuses II: Corona, subcontractors, summer holidays, …, very long response times / manager unreachable
- Responsible manager (was?) retired October 9th

The Hurdal tower building project

«…, the best of times»

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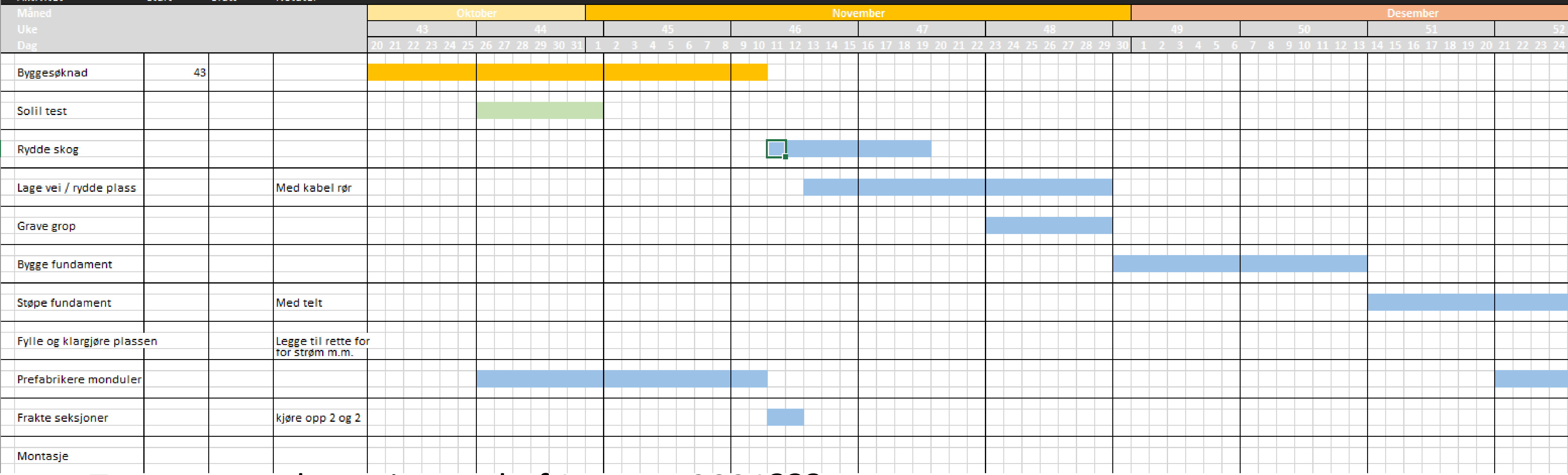
- Meeting with new manager October 12th
- Binding timetable delivered October 16th
- Weekly meetings every Friday

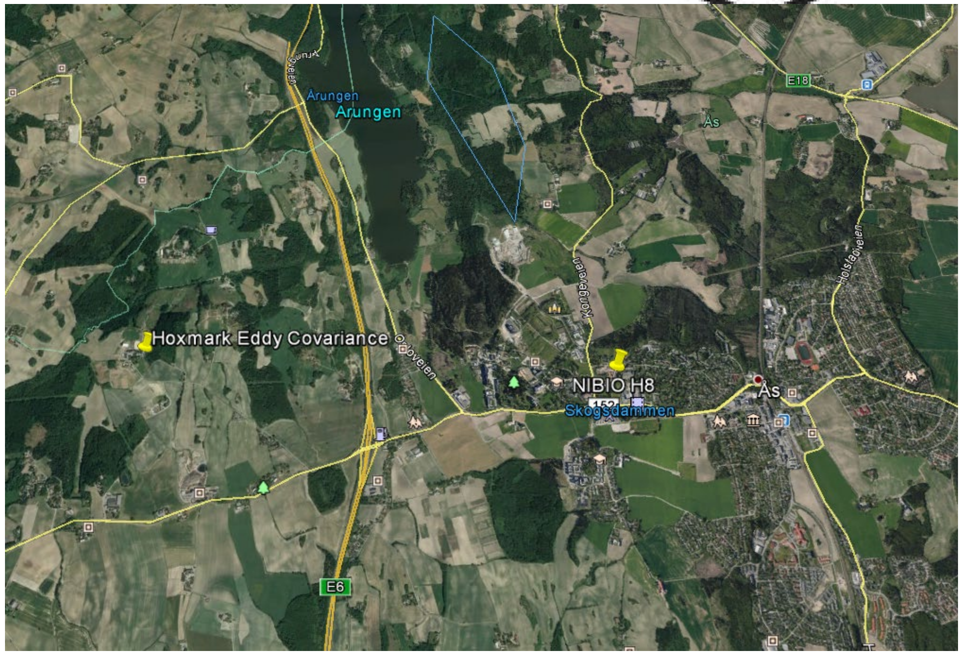
Tidslinje for NIBIO Hurdal

Aktivitet	Start	Slutt	Notater
Byggesøknad	43		
Solil test			
Rydde skog			
Lage vei / rydde plass			Med kabel rør
Grave grop			
Bygge fundament			
Støpe fundament			Med telt
Fylle og klargjøre plassen			Legge til rette for for strøm m.m.
Prefabrikere monduler			
Frakte seksjoner			kjøre opp 2 og 2
Montasje			



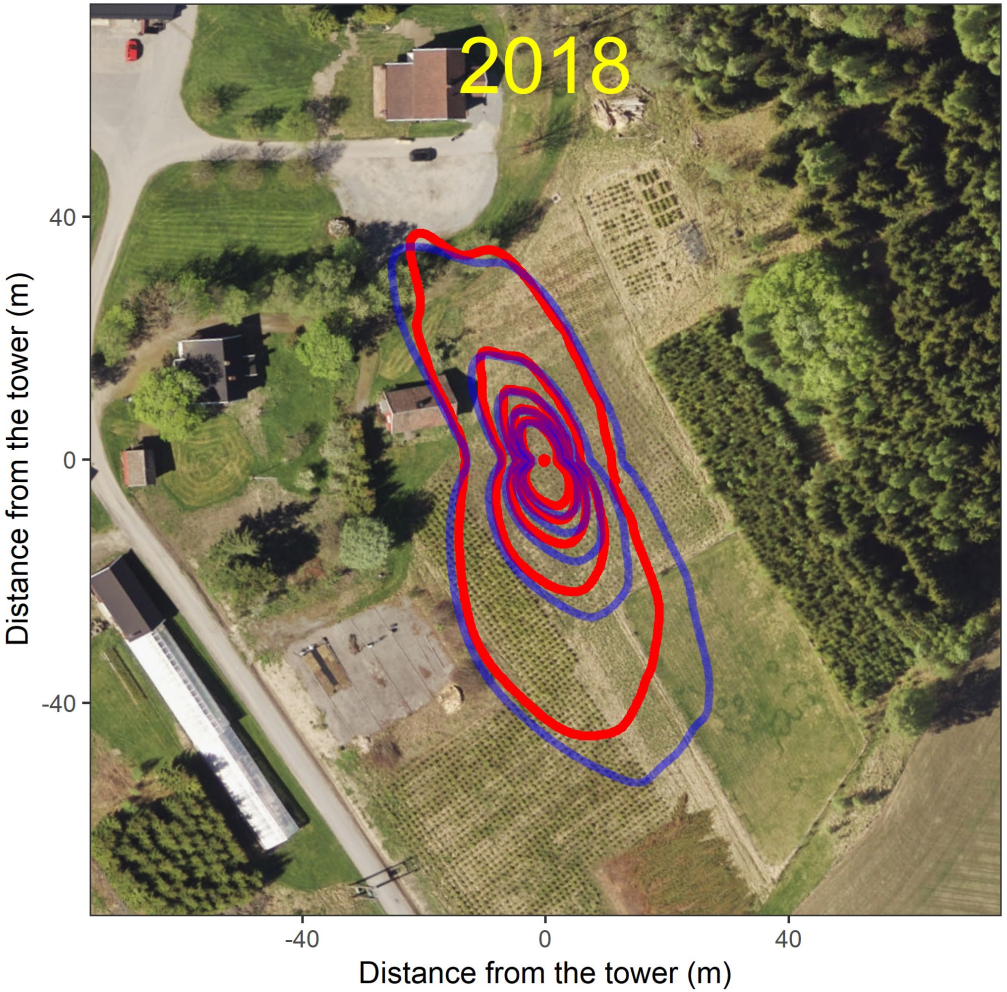
- Tower up and running end of January 2021???

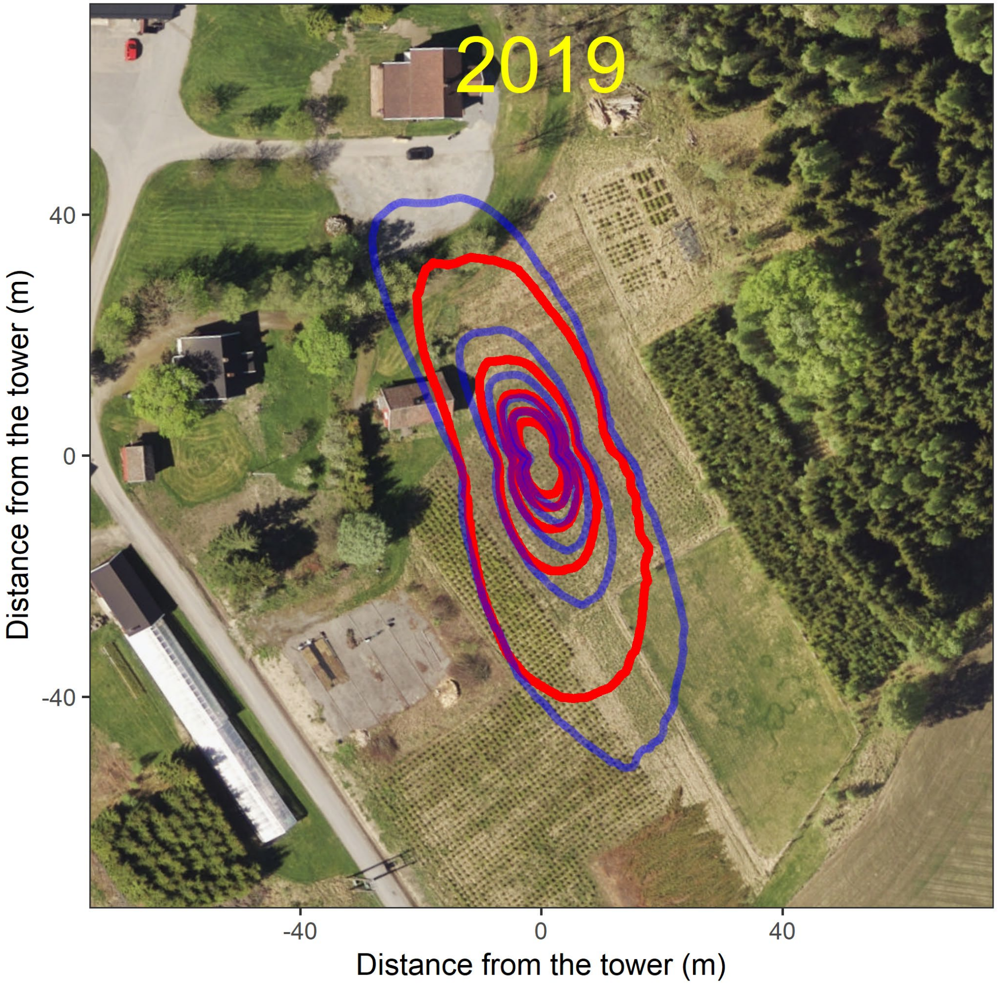
Our «pilot» EC system at Hoxmark

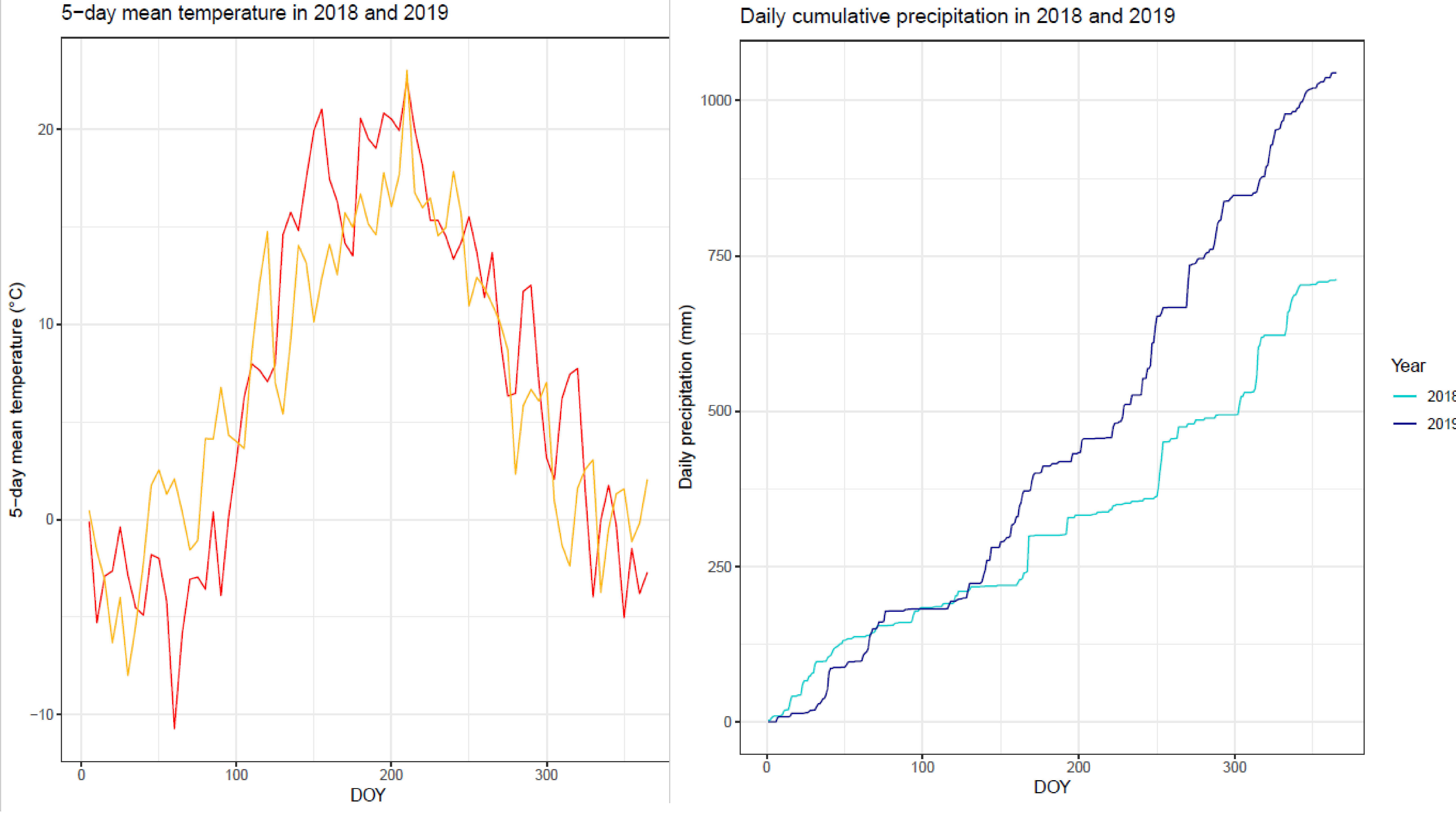


59° 40'8.07"N
10° 43'2.57"Ø
92 m asl

Hoxmark footprint: could hardly be better!

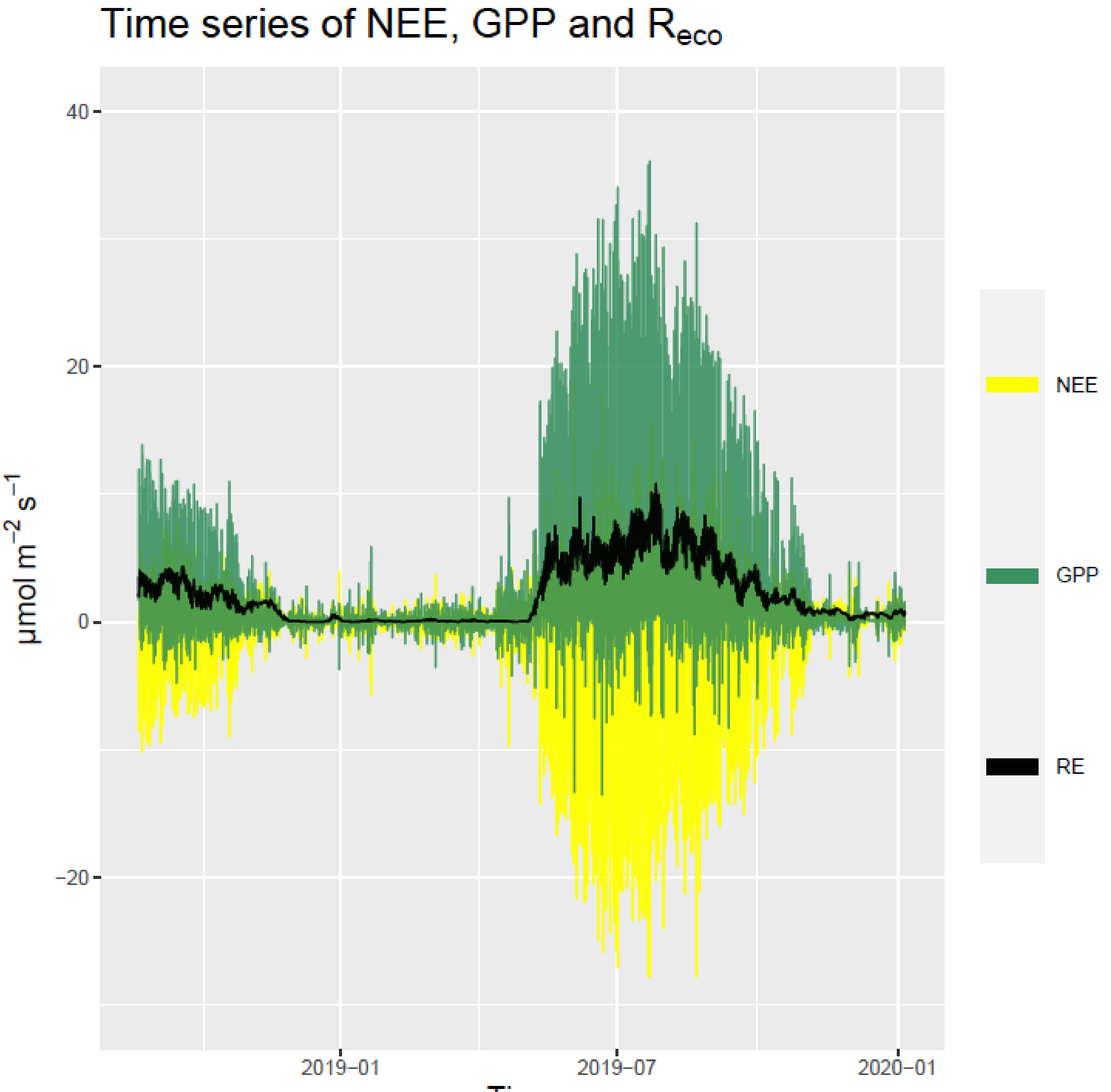






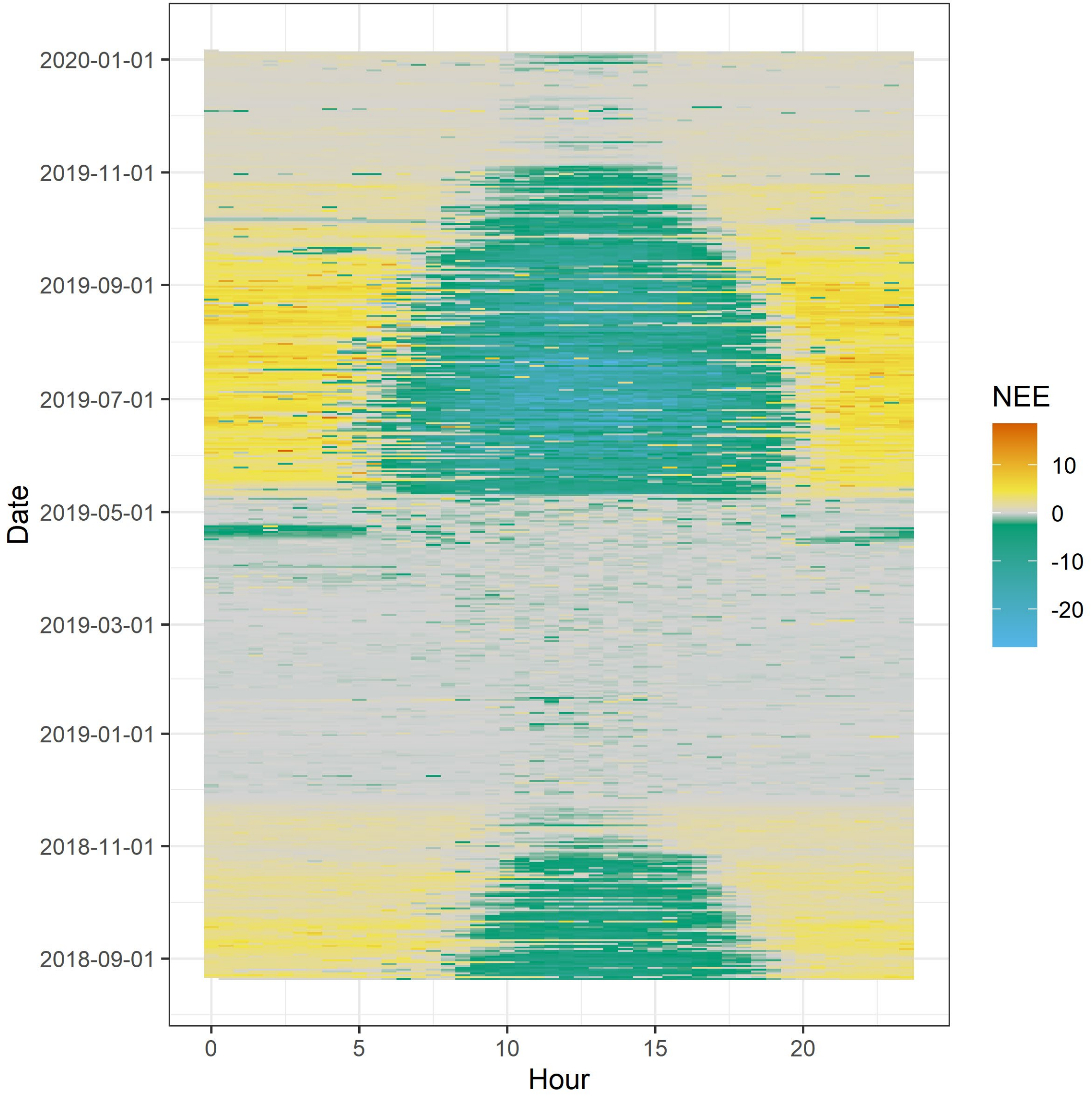
5−day mean temperature in 2018 and 2019
5−day mean temperature (°C)
DOY
Daily cumulative precipitation in 2018 and 2019
Daily precipitation (mm)
DOY
Year
2018
2019

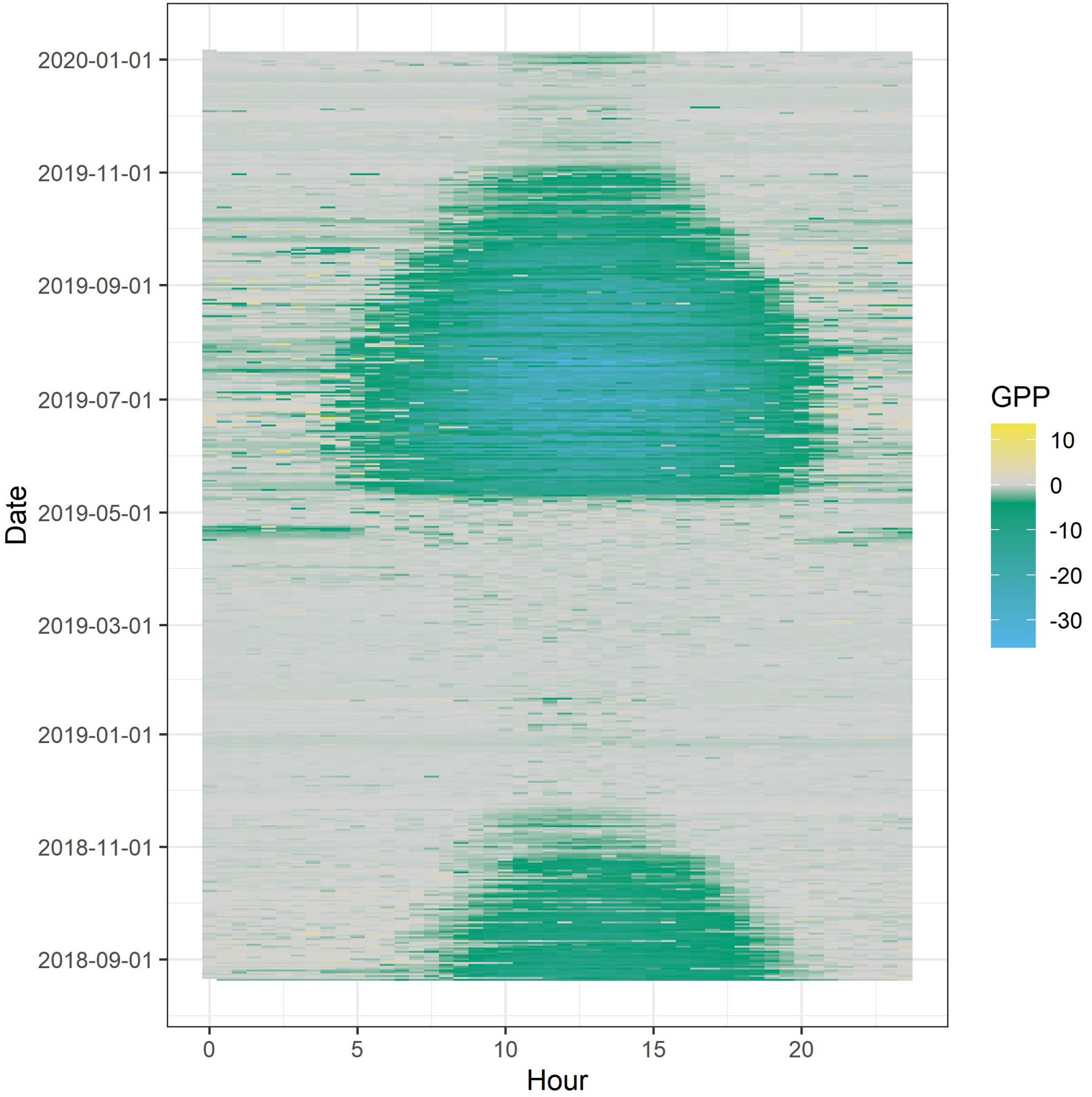
Hoxmark time series



ICOS INTEGRATED CARBON OBSERVATION SYSTEM

Hoxmark fingerprints





ICOS | CARBON OBSERVATION SYSTEM

Reduction in NEP in 2018 in the North

ICOS stations in Sweden, Finland and Denmark

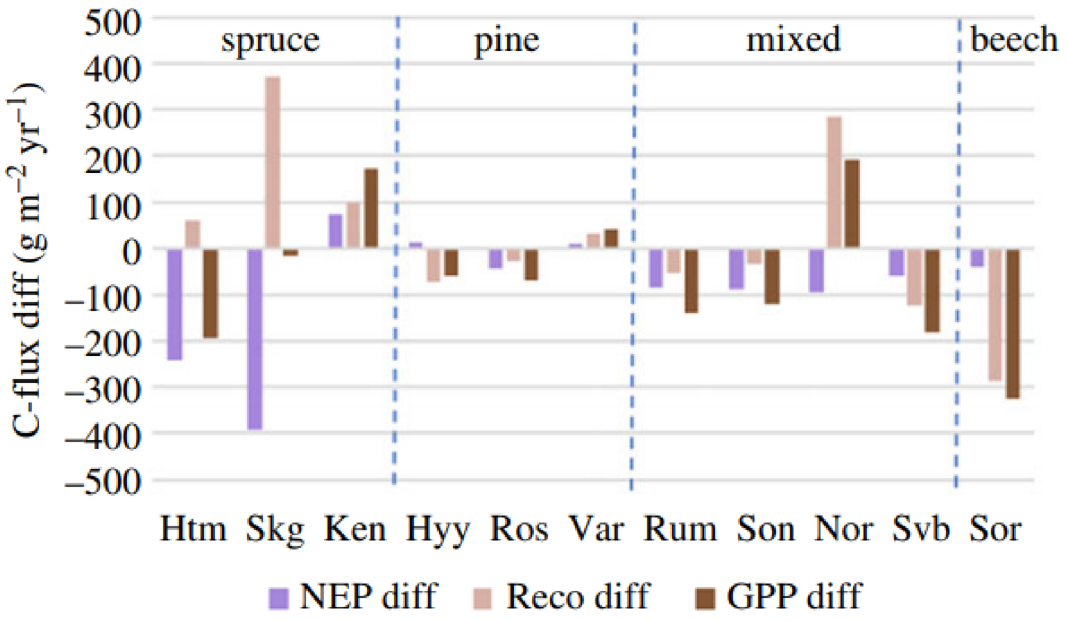
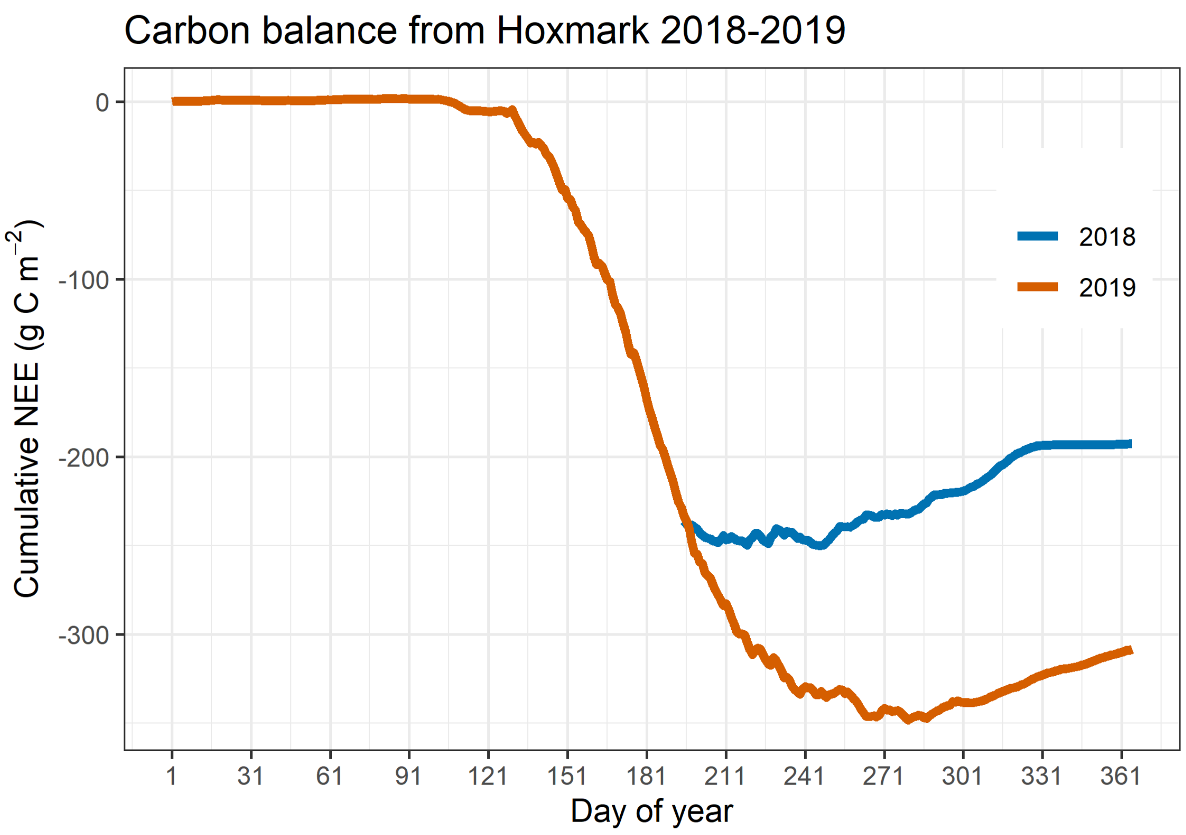


Figure 6. Anomalies in C-fluxes between reference year and 2018 for NEP, Reco and GPP for all sites. (Online version in colour.)

NON-ICOS station Hoxmark

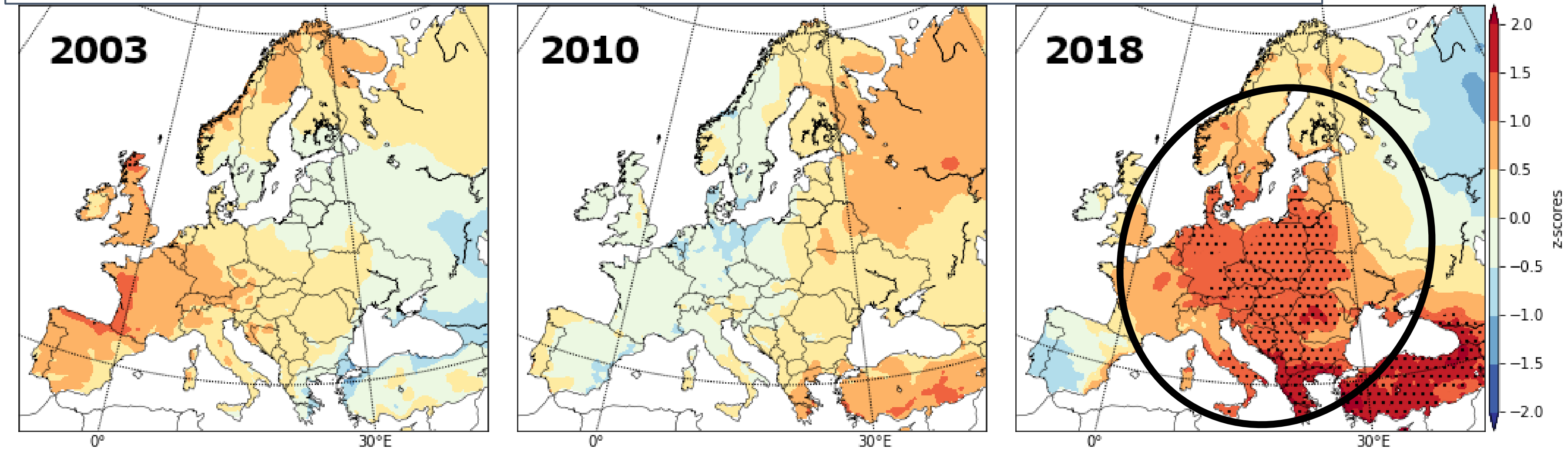


ICOS INTEGRATED CARBON OBSERVATION SYSTEM

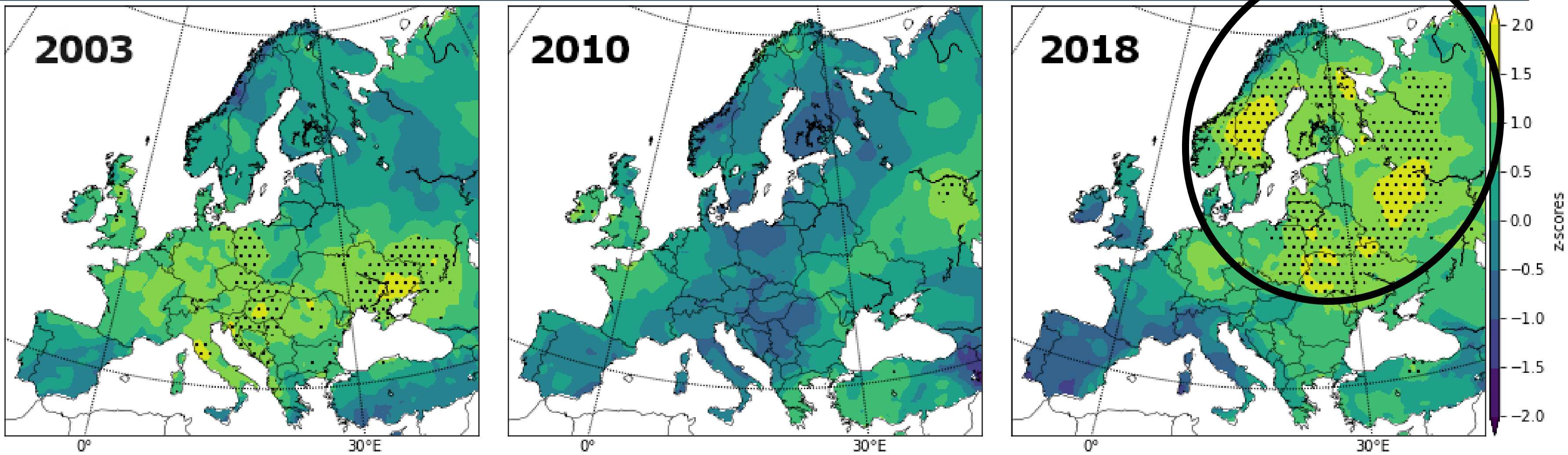
Lindroth et al. 2020

Impact comparison: 2003, 2010 and 2018

Spring (MAM) 2m daily average **temperature** anomalies (ERA5)



Spring (MAM) surface shortwave radiation (ERA5)

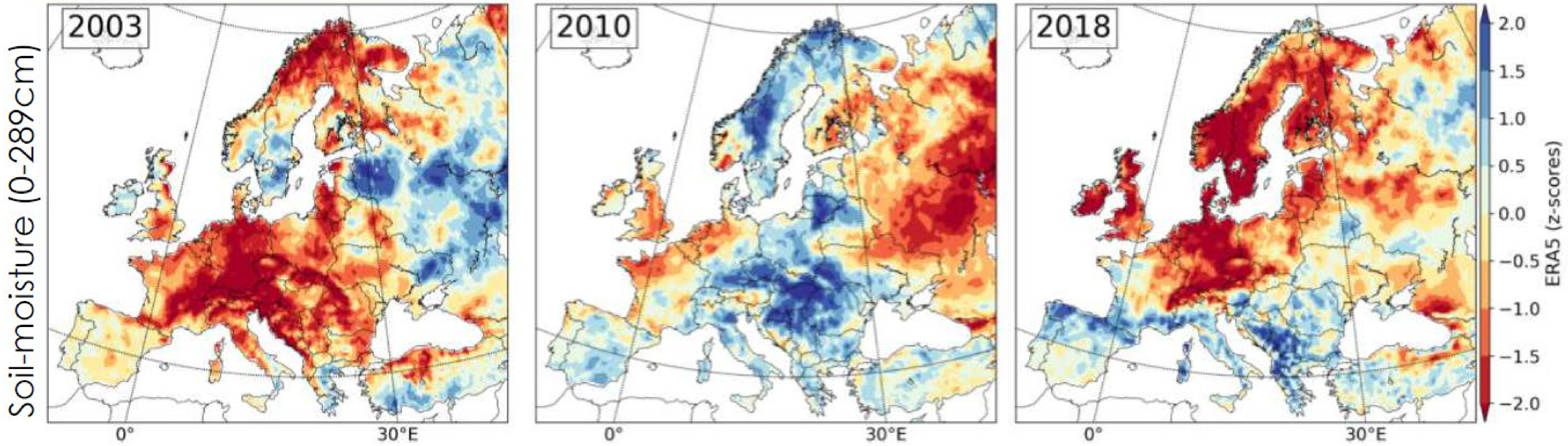


Reference period: 1979 - 2018
Stippling: <5% or >95%

Bastos et al. 2020

Impact comparison: 2003, 2010 and 2018

- Soil moisture



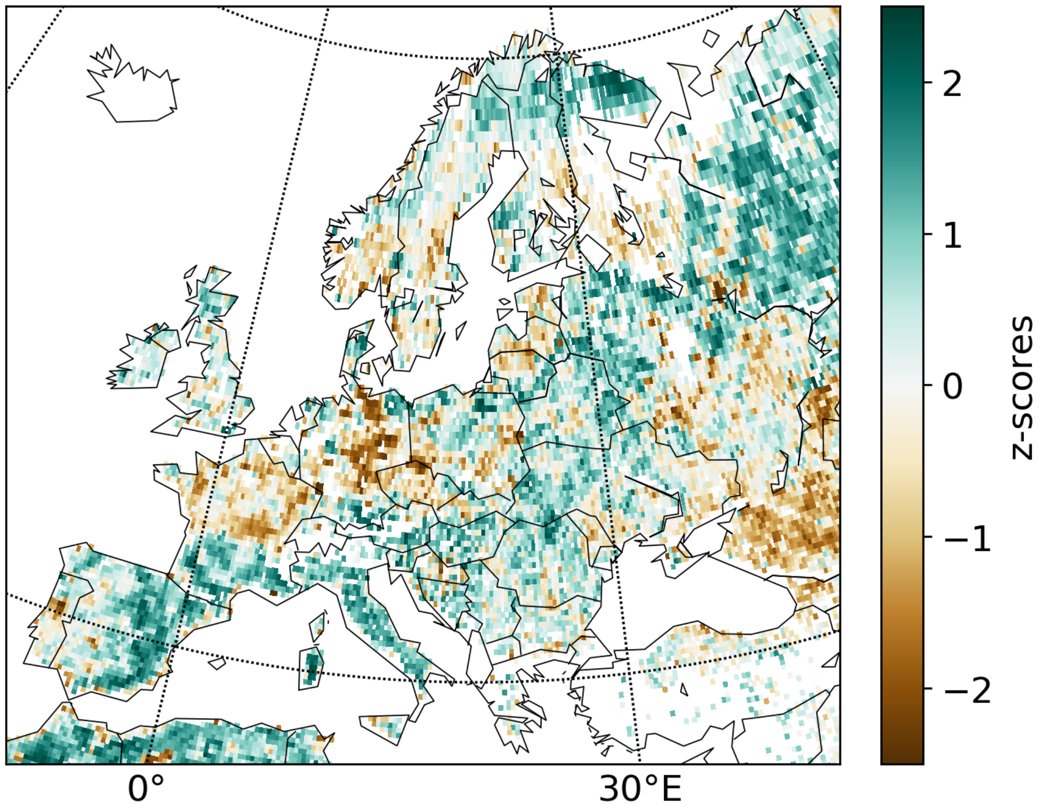
ICOS INTEGRATED CARBON OBSERVATION SYSTEM

Bastos et al. 2020

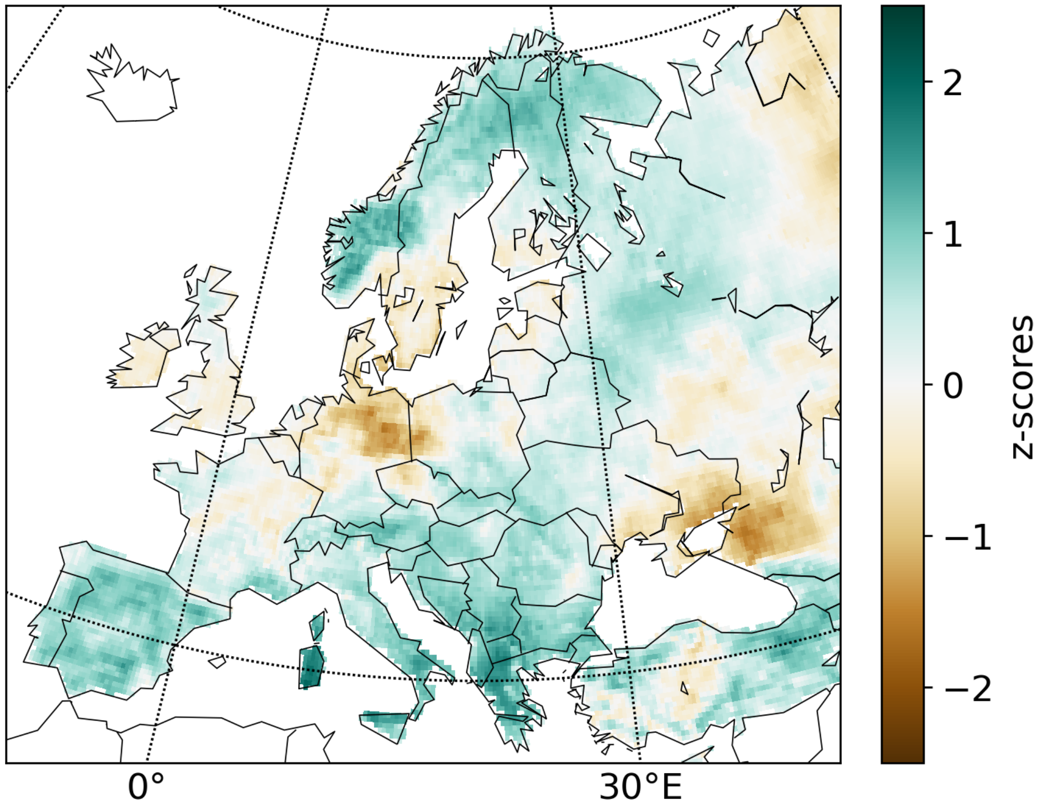
Impacts: aboveground biomass changes

Anomalies in **2018** above ground biomass inferred from L-VOD and by vegetation models

SMOS L-VOD (2010 -)



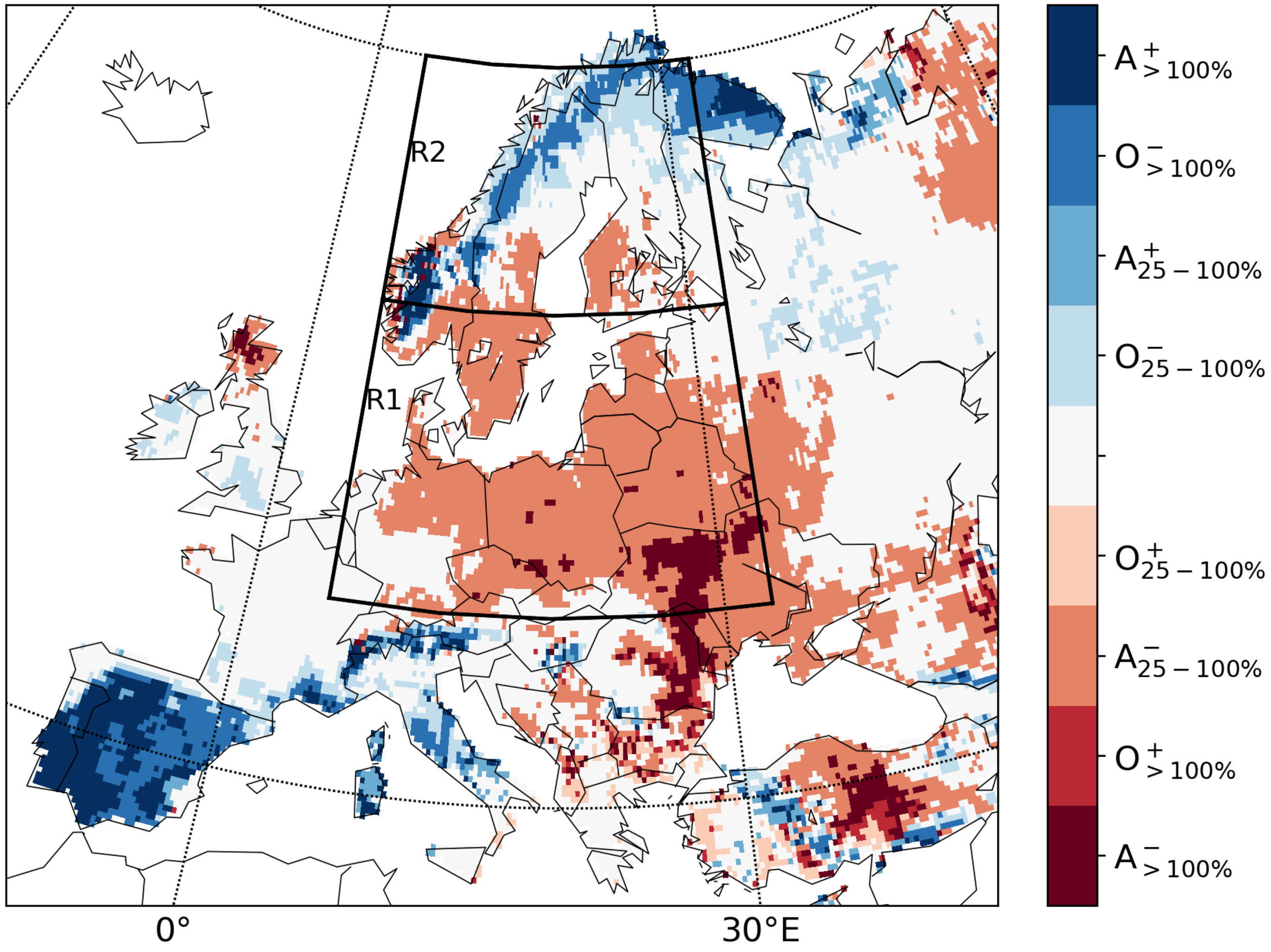
Ensemble mean of 11 DGVMs



Bastos et al. Sci. Adv. (2020)

ICOS INTEGRATED CARBON OBSERVATION SYSTEM

Regional asymmetries



A - Spring amplified summer anomaly

O – Spring offset summer anomaly

Sink legacy effect from spring

Source legacy effect from spring

Bastos et al. 2020

Combining remote sensing earth observations and in situ networks for the detection of extreme events

1. Definition and identification of “ecosystem extreme events” with remote sensing
2. The role of existing measurement networks (Fluxnet, ICOS) for extreme events
3. Conclusions

Partially based on:

- Mahecha et al. (2017): Detecting impacts of extreme events with ecological in situ monitoring networks. *Biogeosciences* **14**(18), 4255.
- Sippel et al. (2018): Drought, Heat, and the Carbon Cycle: a Review. *Current Climate Change Reports* **4**, 266-286.

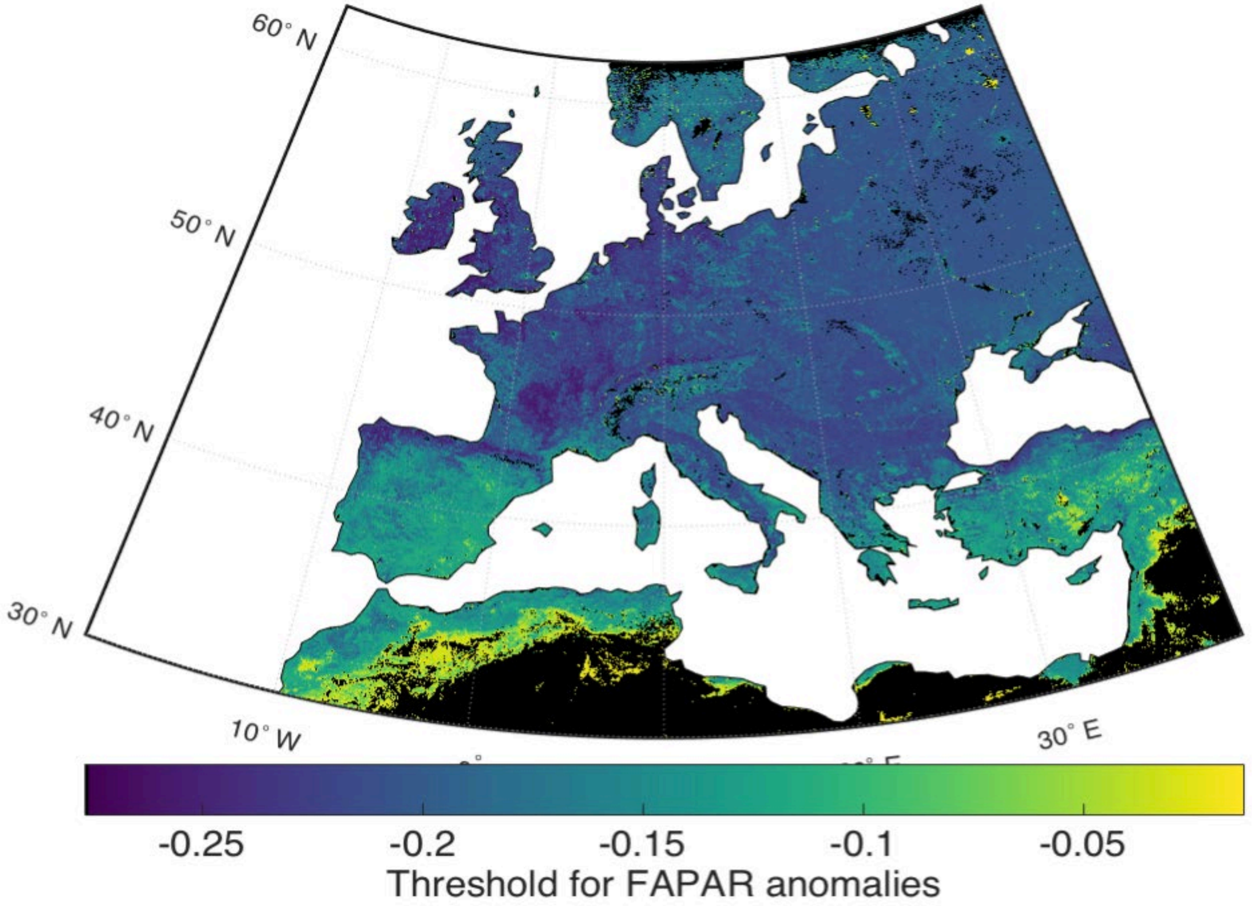
What are extreme events (in ecosystem productivity)?

- Focus is on losses in carbon / productivity (anomalies, deviations from the long-term behavior)
- Use proxies from remote sensing, e.g.
  Fraction of Absorbed Photosynthetic Active Radiation (FAPAR)

Method to find extreme events

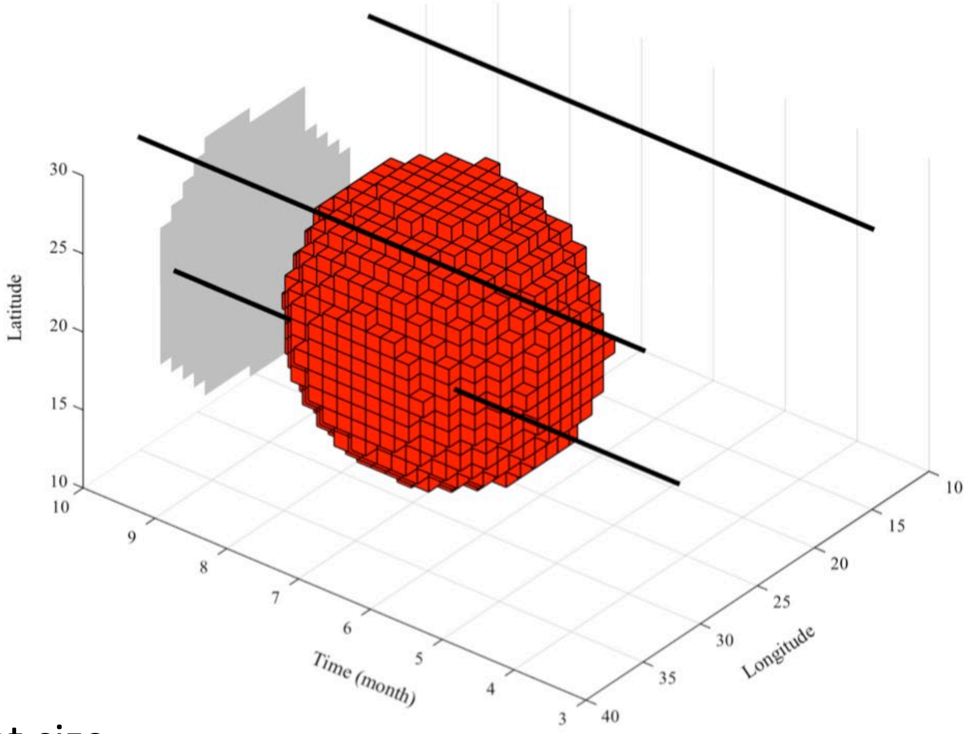
- Estimate mean seasonal cycles (MSCs) at each grid cell
- PCA of the MSCs -> phenologically similar regions
- Identify these regions based on binned PCA scores (image: first three PCs coded as RGB)

- Choose a small quantile (q=0.025) and require contiguous spatiotemporal extremes (within a spatial search radius and a prescribed time window)
- Determine the corresponding *anomaly* in Fapar (region-specific anomaly threshold)



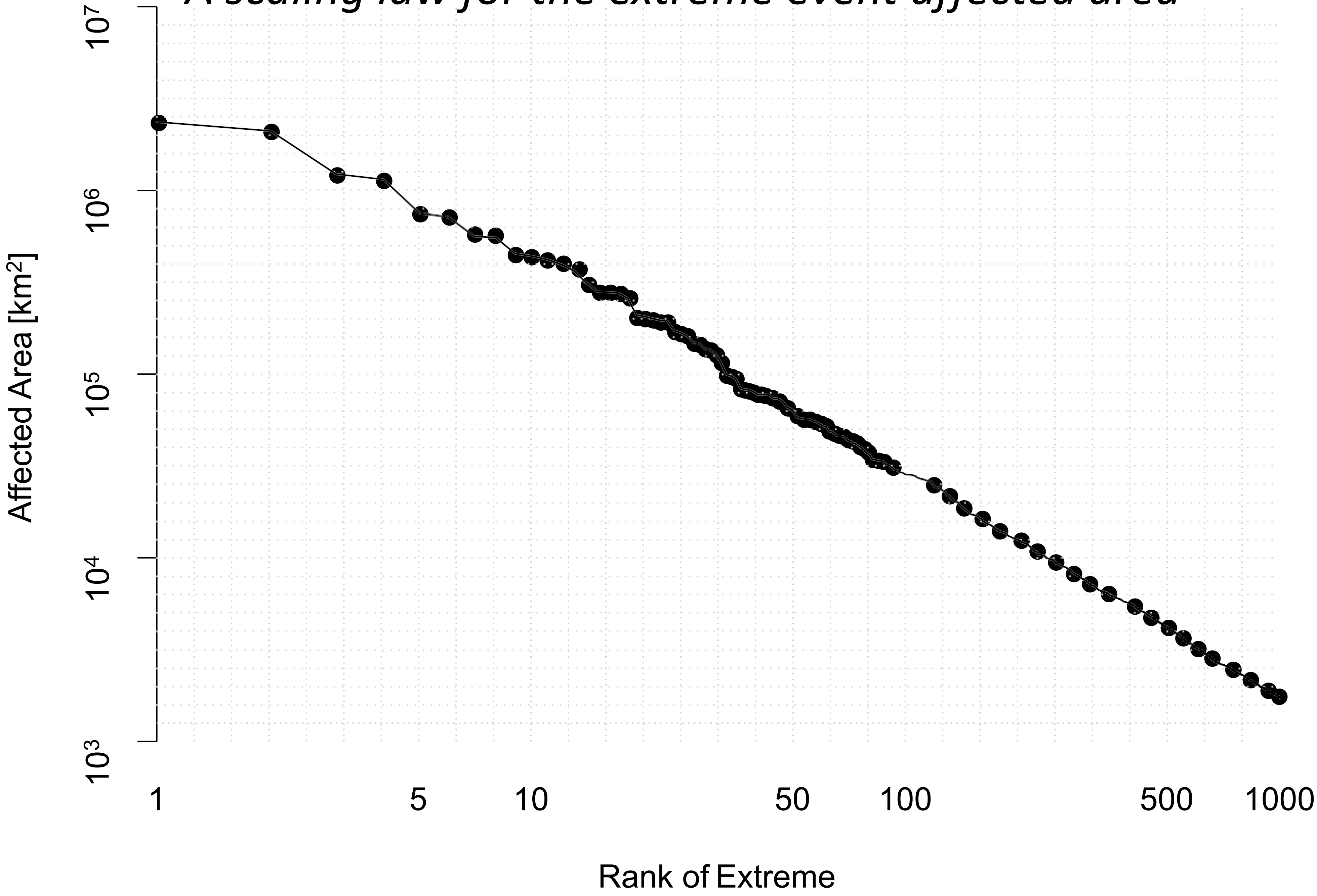
What are extreme events in ecosystem productivity?

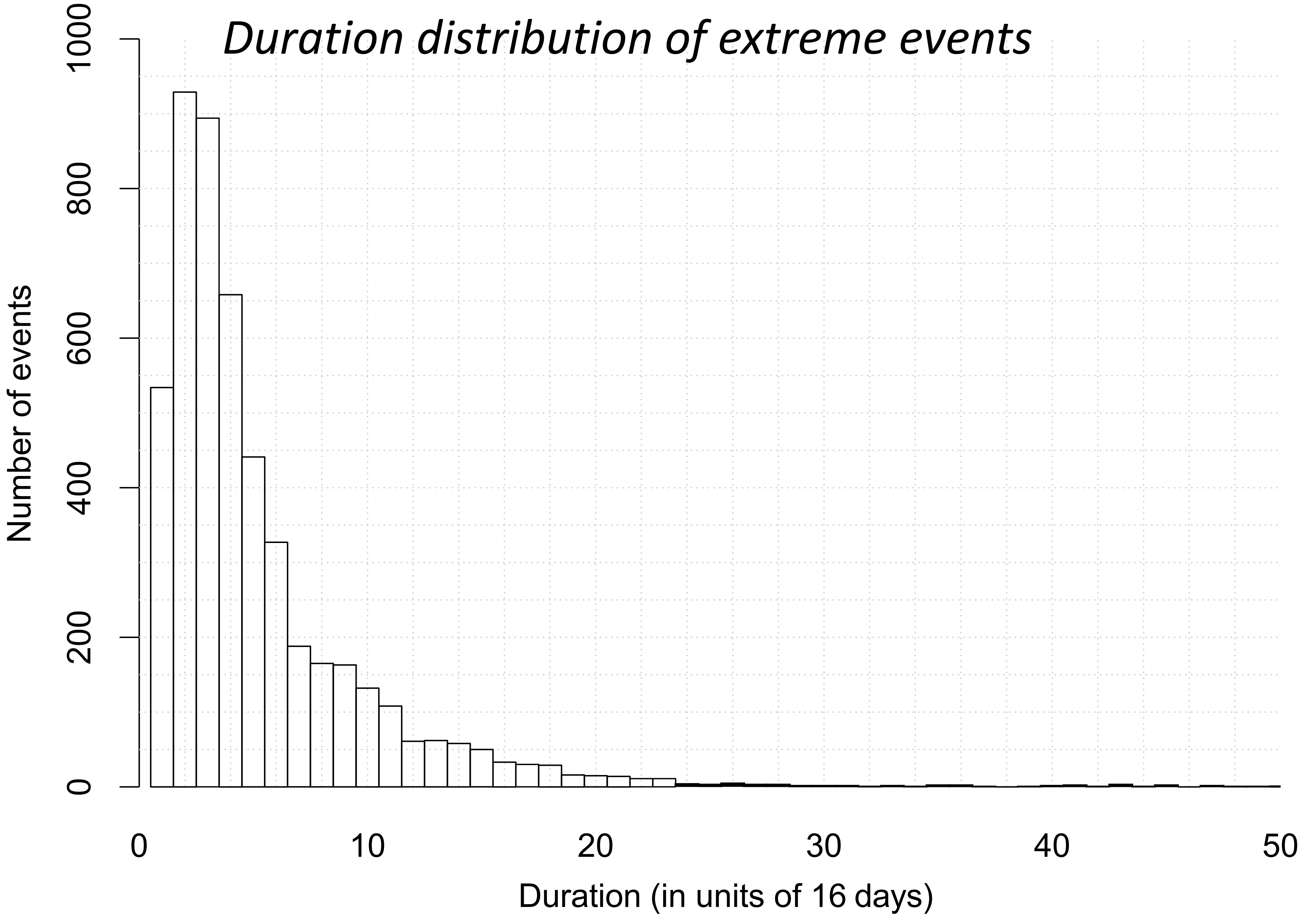
- Each extreme event consists in a set of “3D” voxels (2 spatial x 1 time dim.)
- Search radius has to be defined, e.g. 5 km x 16 days
- Events are defined as “detected” if at least one site “sees” them



- Characteristics of extreme events:
    - Affected area
    - Duration
    - Event size = affected area x duration
    - **Total impact** = integral of the anomaly across the event size
    - **Rank** the extreme events according to total impact

A scaling law for the extreme event affected area





Duration distribution of extreme events
Number of events
0
200
400
600
800
1000
0
10
20
30
40
50
Duration (in units of 16 days)

ICOS and Fluxnet

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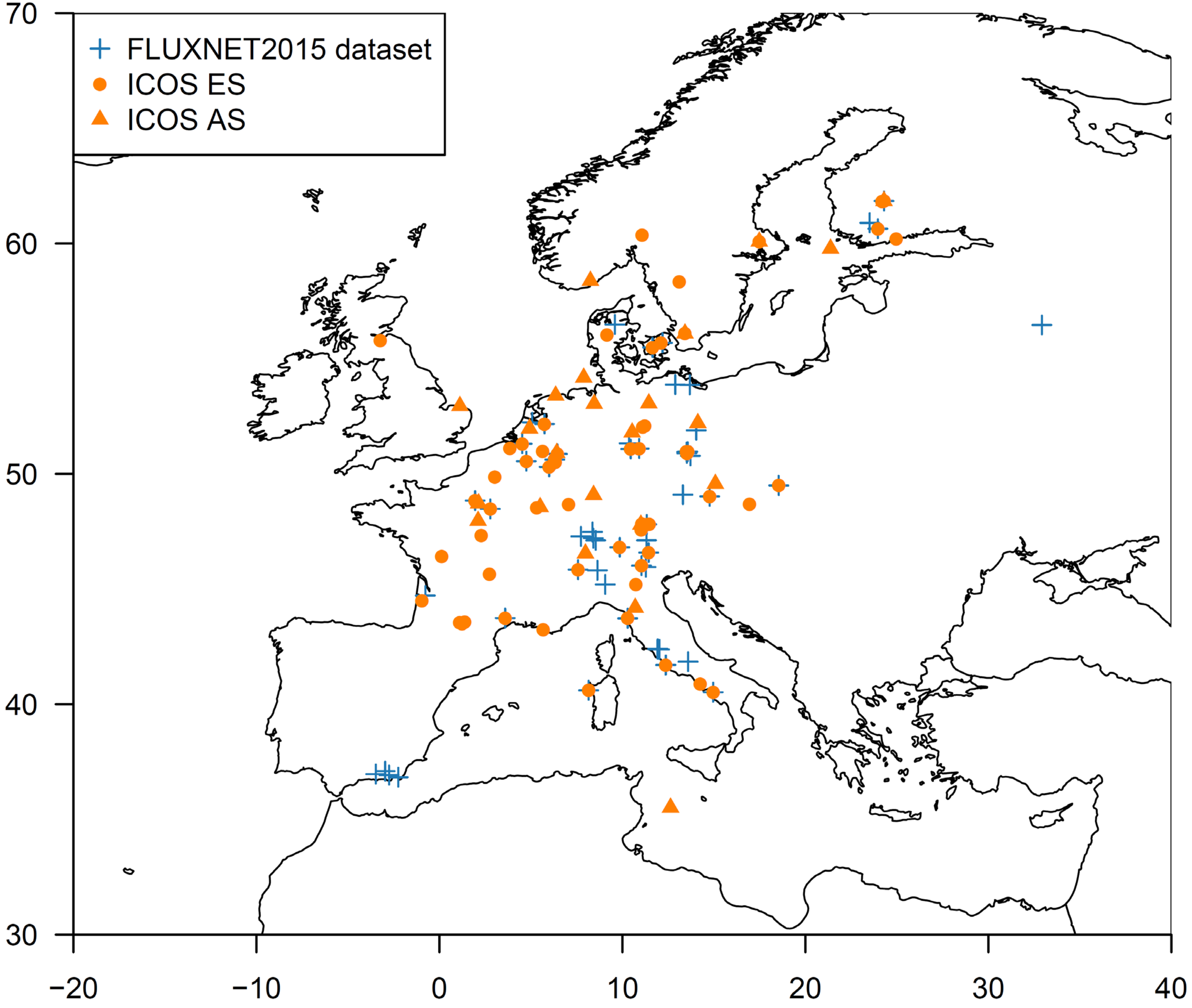
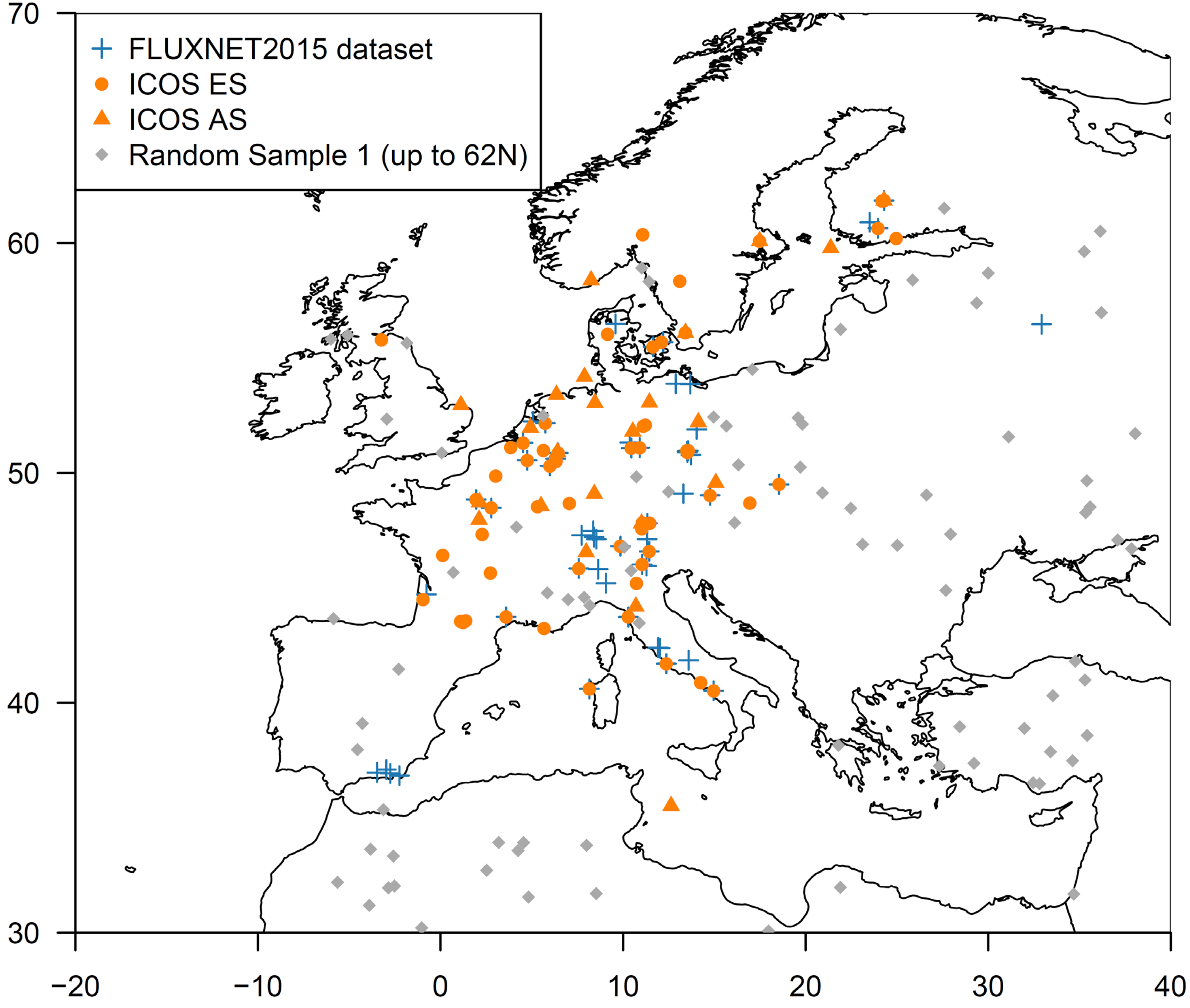


Real measurement networks: ICOS, Fluxnet and random sample



Real measurement networks: ICOS, Fluxnet and random sample

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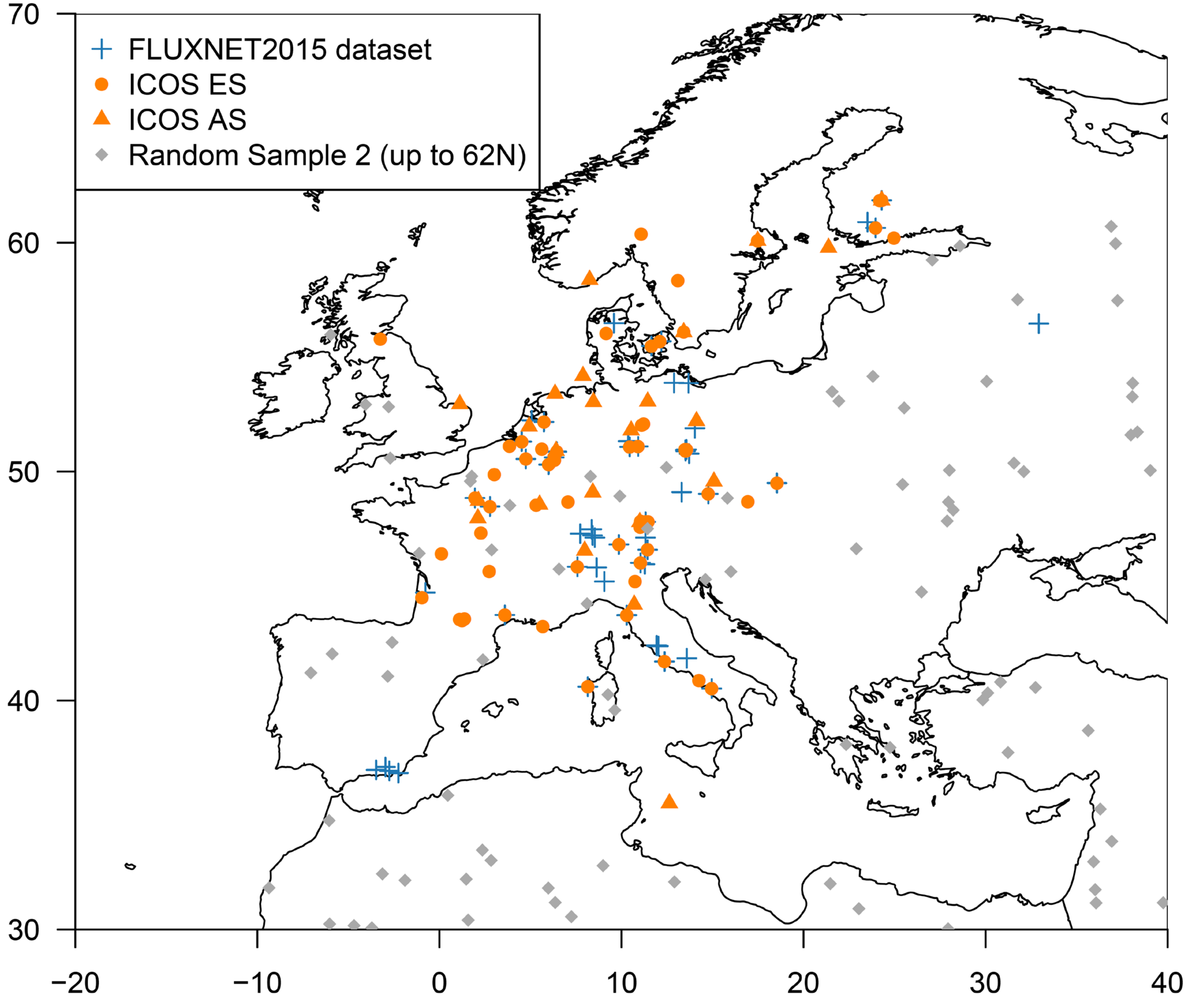

Real measurement networks: ICOS, Fluxnet and random sample

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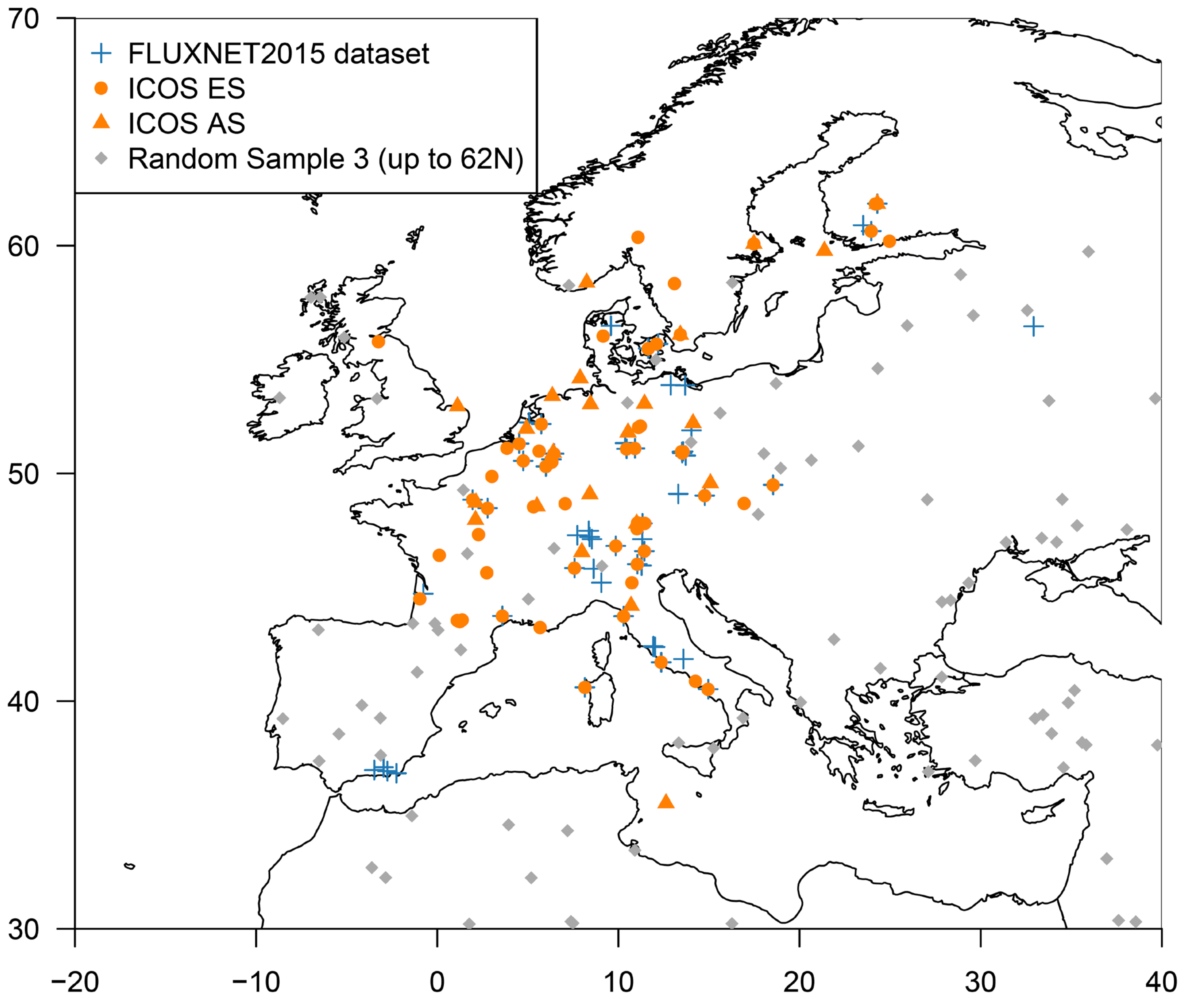

Real measurement networks: ICOS ES and Fluxnet in Europe

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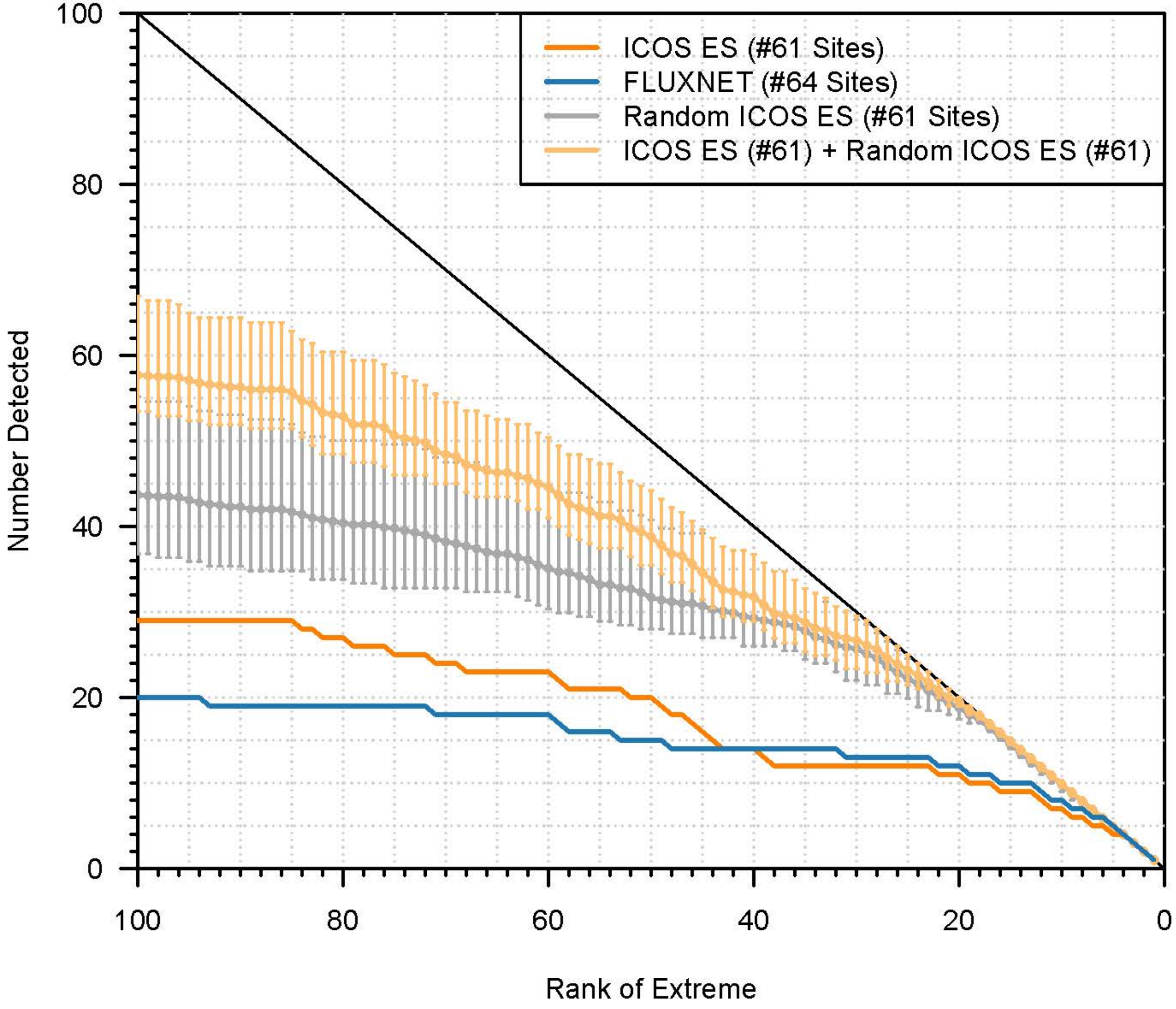

- ICOS ES (61 sites) detects more extremes than FLUXNET (64 sites)
- A random placement of ICOS ES sites would provide much better detectability
- Augmenting existing ICOS ES sites with the same amount of random ones further improves detection

Real measurement networks: ICOS ES+AS and Fluxnet in Europe

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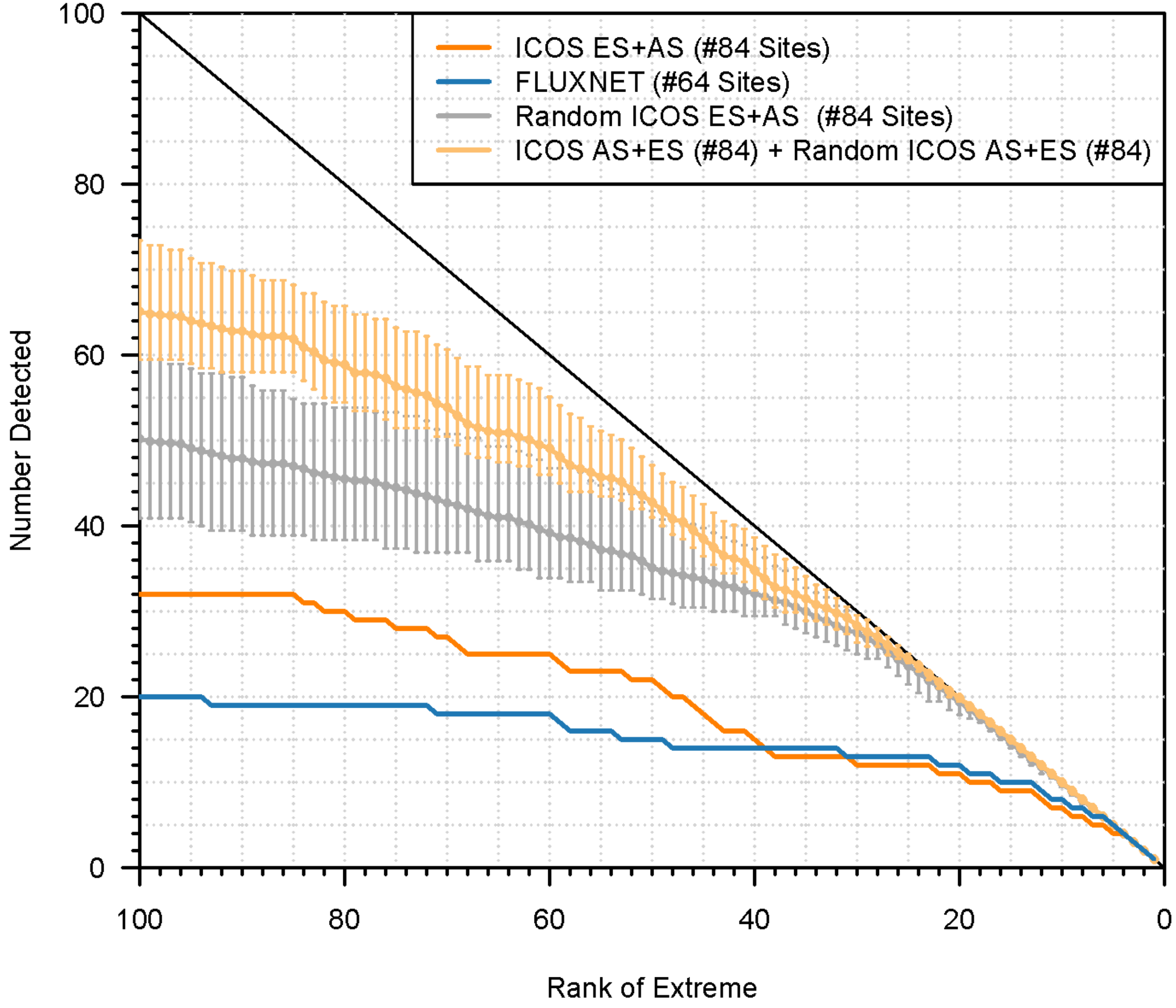

- ICOS ES+AS (84 sites) is much better than FLUXNET for smaller extremes
- Randomization leads to almost 100% detection of the 30 largest extremes

Conclusion: “ecosystem extremes” and monitoring networks

- Remote sensing provides proxies to quantify ecosystem extremes relevant for the (terrestrial) carbon cycle
- Observation networks constitute a crucial tool towards detection of them
- Detection probabilities of “3D” extreme events exhibit power-law type scaling with network size
- A systematically clustered network design may be suboptimal due to the spatial irregularity of extreme events
- ICOS would benefit substantially from additional sites, especially in Spain, Southeast Europe and Western Russia
- Here, no conclusion possible for the boreal (FAPAR not a suitable proxy there)