



Ecosystem greenhouse gas fluxes in a changing climate

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Swiss FluxNet = Six Permanent Flux Sites



OEN2: since 12/2003,
2nd longest time
series globally



Basel



LAE: since 4/2004



DAV: since 1/1997



FRU: since 8/2005



Zurich

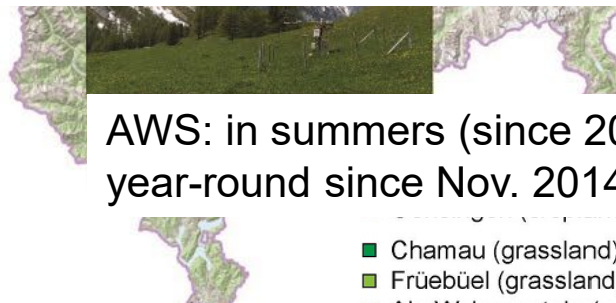
e.g., **ICOS** | National Network Switzerland



➤ **Long-term flux, meteo, auxiliary data sets
(currently > 123 site-years)**



Geneva



AWS: in summers (since 2006),
year-round since Nov. 2014

- Chamau (grassland)
- Frübüel (grassland)
- Alp Weissenstein (grassland)

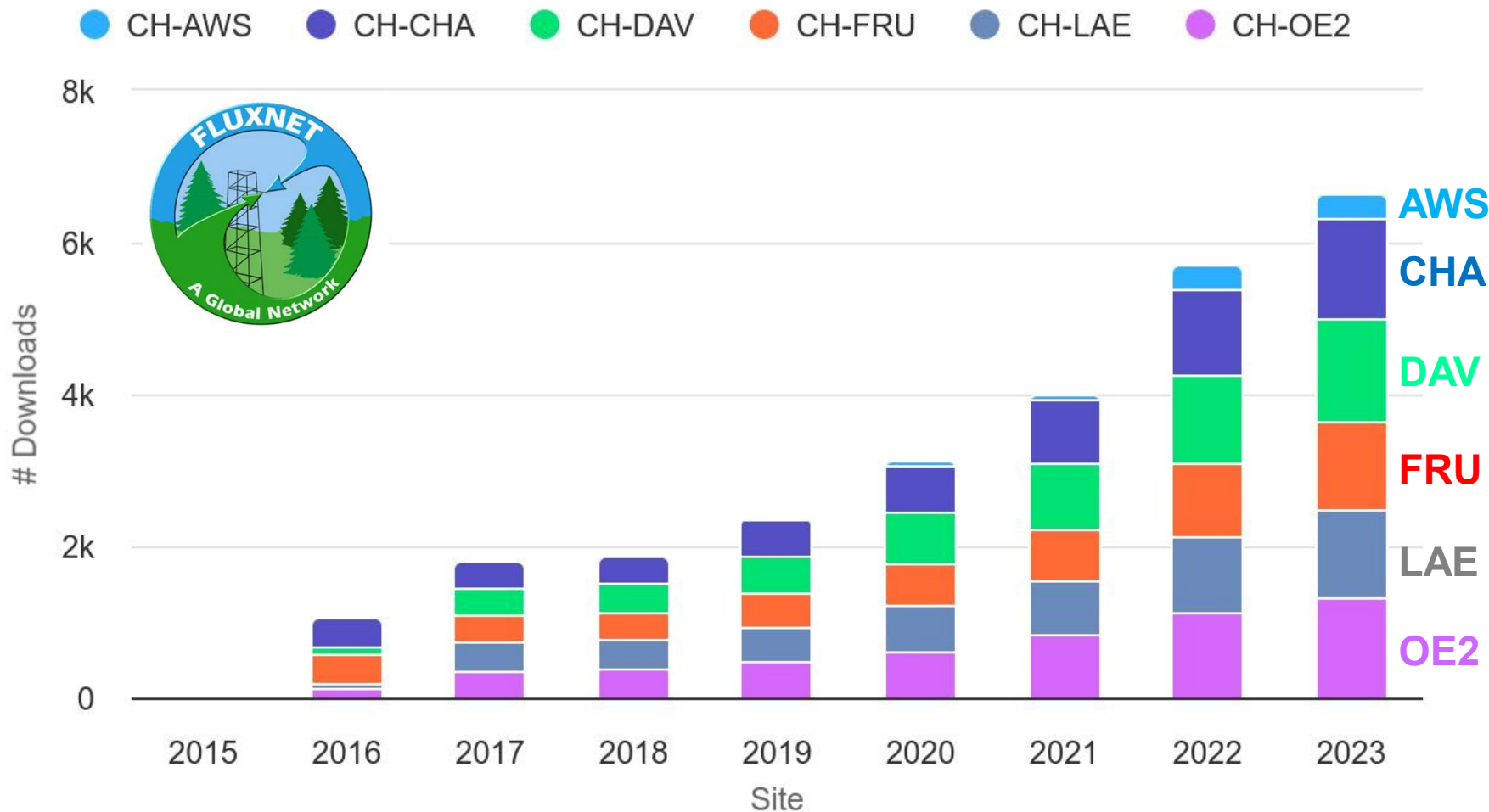
plus 4 temporary sites
(funded on project base)

Swiss FluxNet = FAIR, Open Access Data



Swiss FluxNet

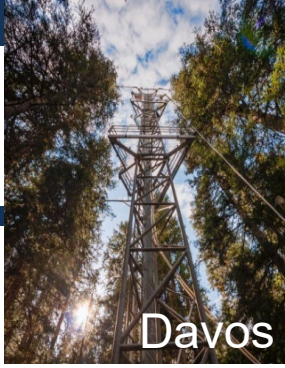
Dataset Downloads



- Fluxnet2015 dataset (release Dec. 2015)
- Swiss FluxNet data: 26'800 downloads (2016-2023)
- New global release is being prepared

Highcharts.com

Long-term Changes in Climate at Davos



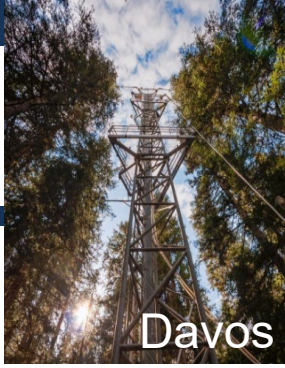
Figures removed, manuscript is in the making ;-)

Over the last 26 years (since 1997)

- **Annual mean air temperature: +1°C**
- **Annual max. air temperature: +2°C**
- **Strong decrease in SWC**

(Krebs et al., in prep.)

Long-term C budget: Spruce Forest = C Sink

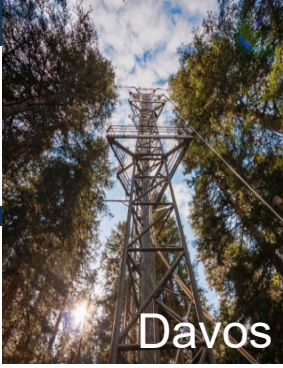


Figures removed, manuscript is in the making ;-)

- **Within last 26 yrs, typically a C sink ($130 \text{ g C m}^{-2} \text{ yr}^{-1}$)**
- **Sink increased until 2015, then reduction**
- **C sink activity starts in April**
- **Largest uptake already in May**

(Krebs et al., in prep.)

Annual NEE & Carbon Uptake Phenology (CUP)

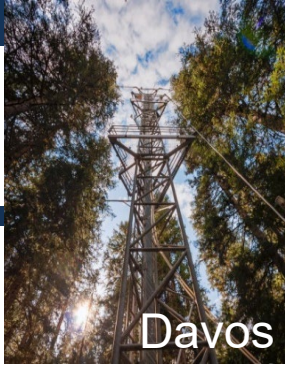


Figures removed, manuscript is in the making ;-)

- No significant trends in SOS, EOS, CUP_{net} length over time
- The longer the CUP_{net} length, the earlier the season starts, the later the season stops: the higher is C sink (much in contrast to stem growth)

(Krebs et al., in prep.)

Drivers of Daily NEE in a Spruce Forest



Figures removed, manuscript is in the making ;-)

Main drivers:

- Daylength, short-wave incoming radiation R_g , T_{air} , SWC (cf. stem growth)
- High T_{air} in summer (JJA) limits C sink strength

(Krebs et al., in prep.)

Long-term C Budget: Mixed Forest = C Sink



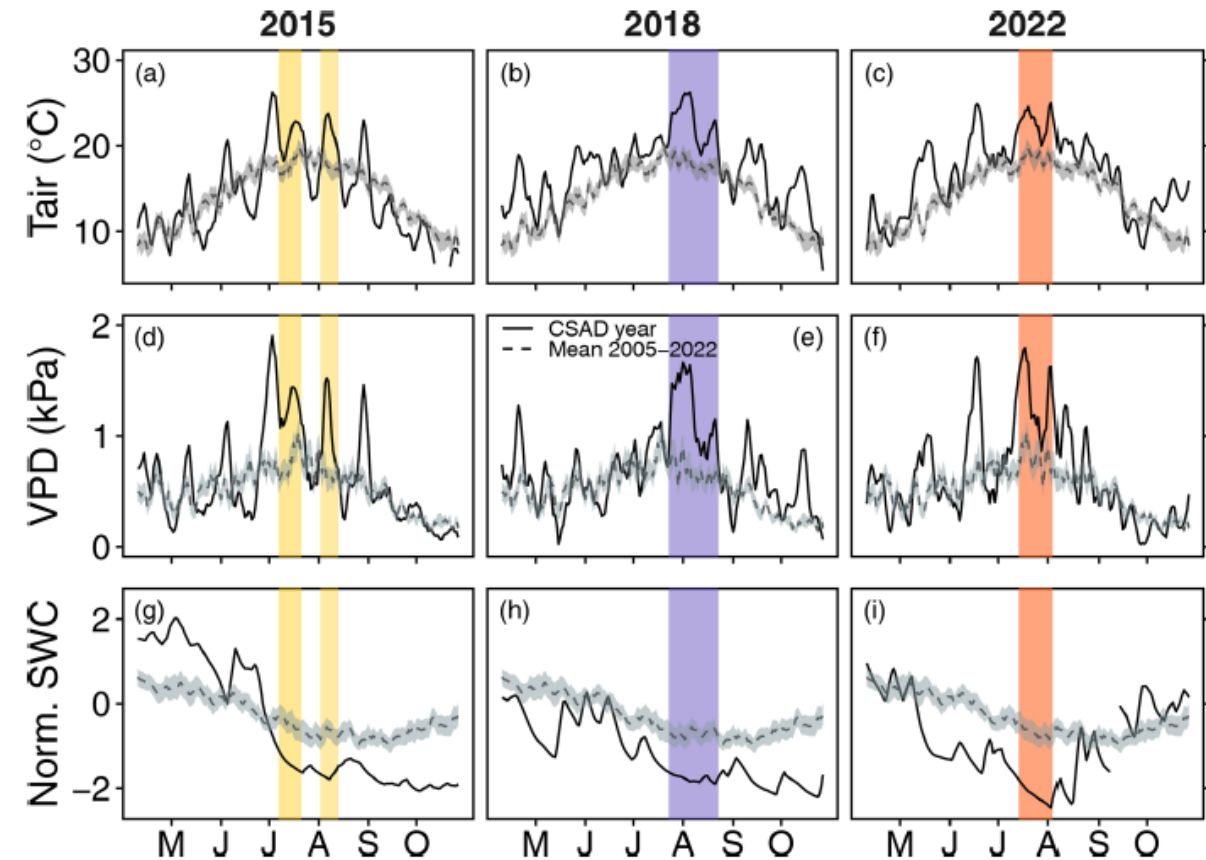
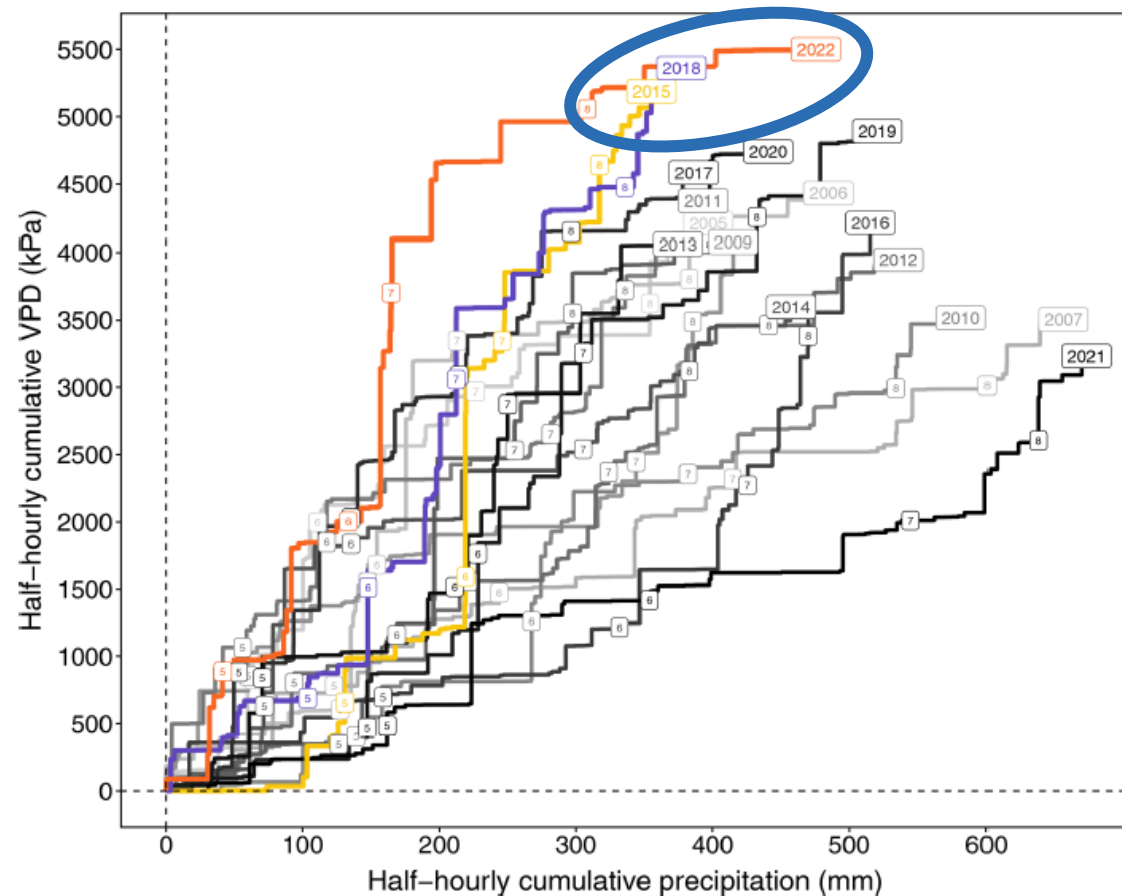
Figures removed, manuscript is in the making ;-)

- Within last 20 yrs, typically a C sink ($180 \text{ g C m}^{-2} \text{ yr}^{-1}$)
- C sink activity starts in May, role of understory vegetation
- Largest uptake in summer, strong impact of phenology

(Scapucci et al., in prep)

Short-Term Response to Extreme Summer

- Extreme summer at Lägeren = low MAP at high VPD
- Within last 20 years: 2015, 2018, 2022

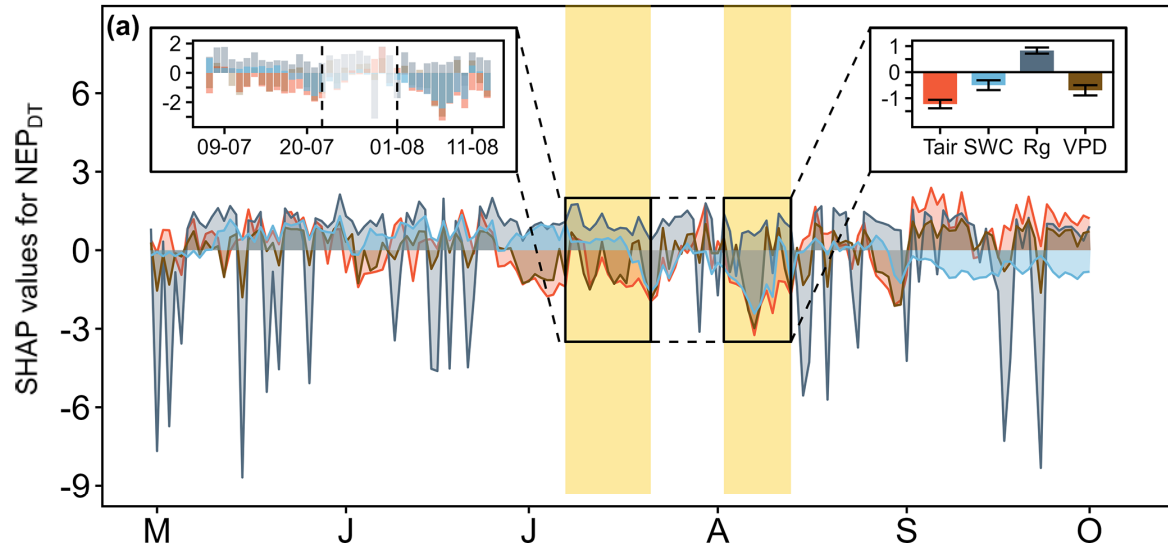


(Scapucci et al. 2024)

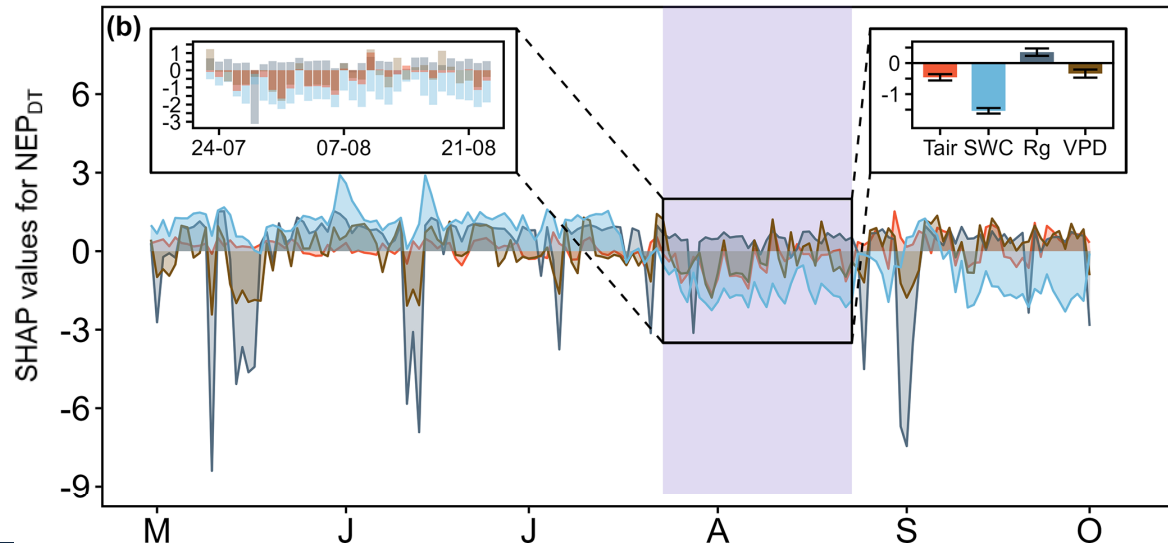
Short-Term Response to Extreme Summer



2015

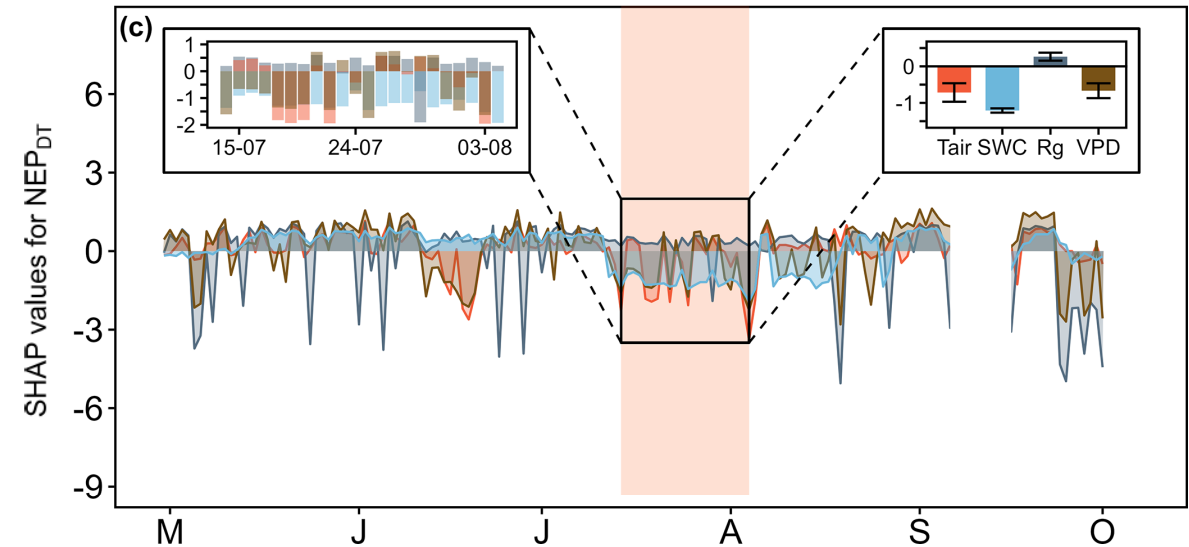


2018



Pos. daytime NEP = sink; neg. SHAP = less sink

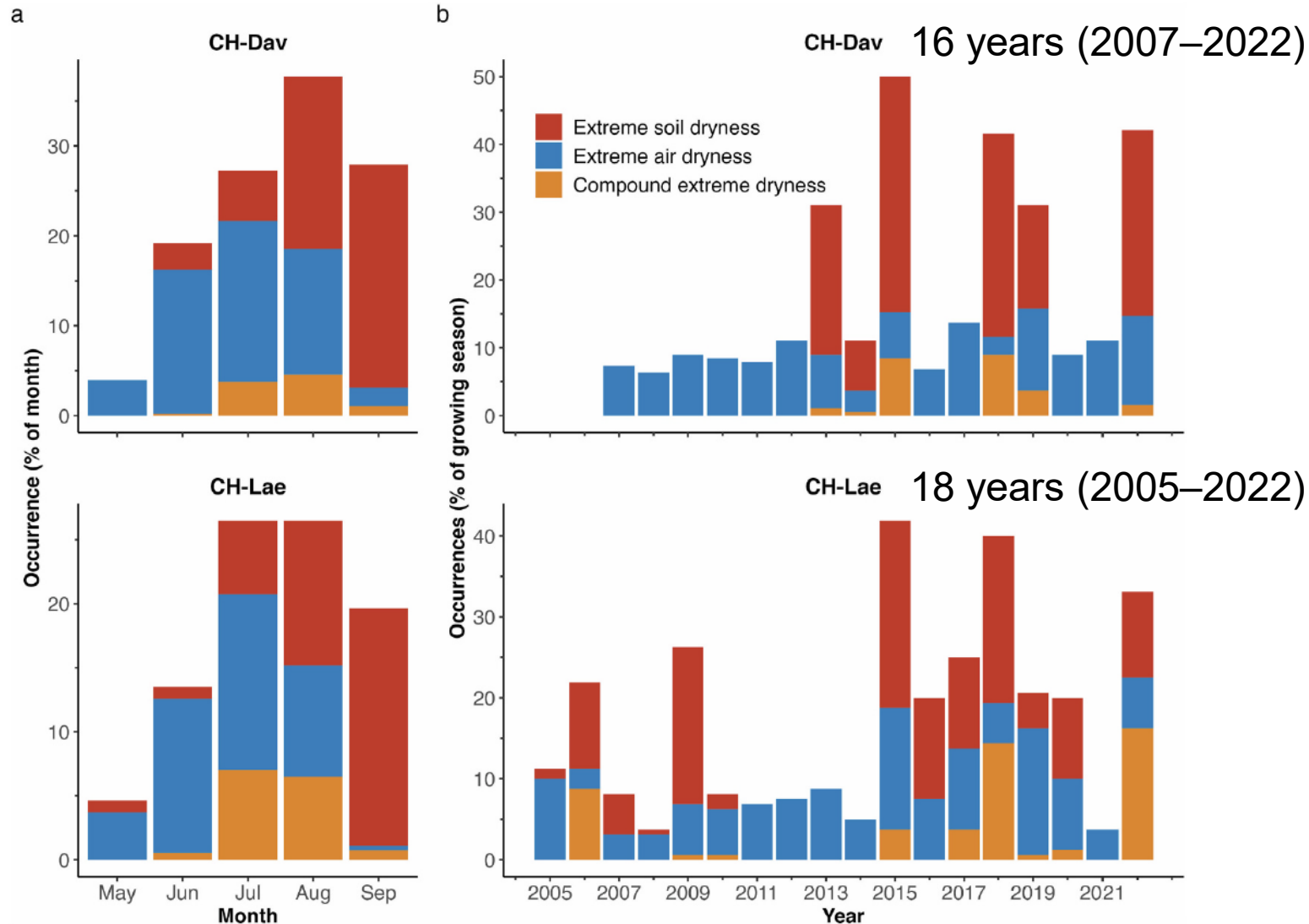
2022



- NEP drivers changed over growing seasons
- Negative impacts on C sink: Tair, VPD, SWC
- Drivers differed strongly among extremes (Tair in 2015; SWC in 2018 and 2022)

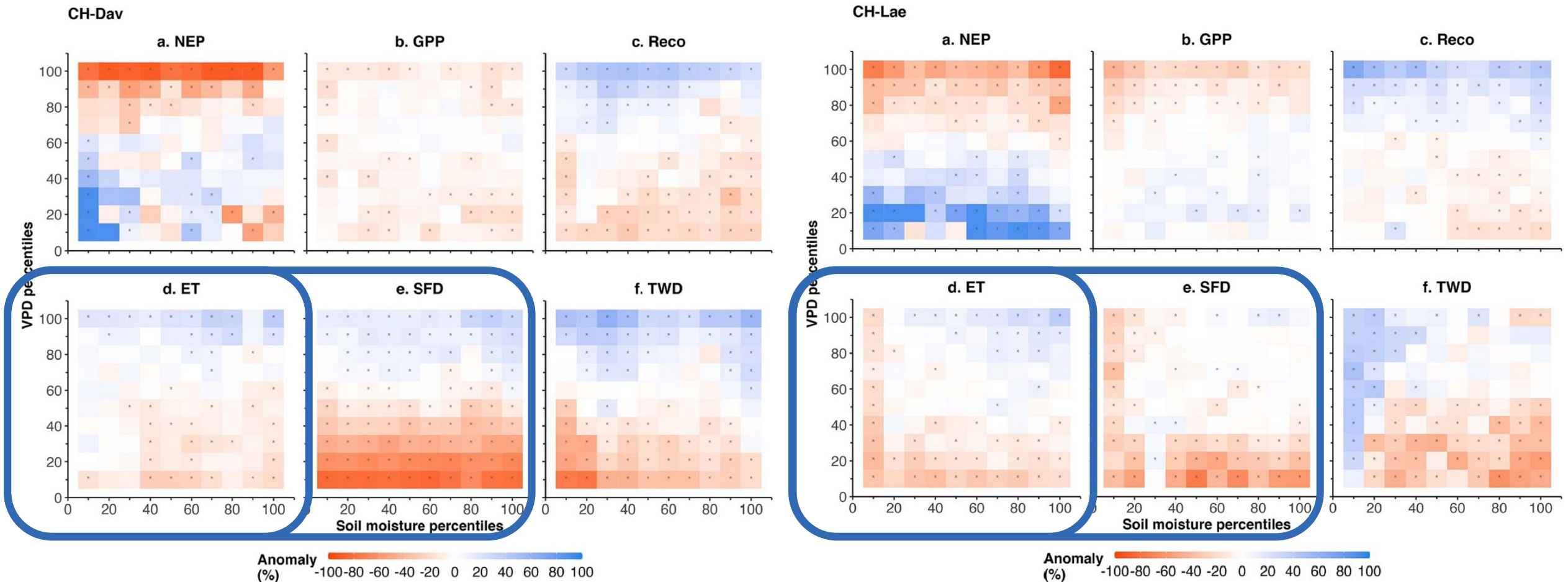
(Scapucci et al. 2024)

Extreme Events: Soil, Air, Compound Dryness



- Extreme soil dryness events rather at end of growing season
- Extreme air dryness rather early in the season
- Extreme compound events typically in July and August
- More extreme events in recent years

Impacts of Extreme Dryness on ET



- CH-Dav: $VPD > SM$
- Similar ET and T responses of forests and trees

CH-Lae: VPD & SM

(Shekhar et al. 2024)



Ecosystem GHG fluxes in a changing climate

- Both forests are (still) C sinks
- C sink scales with CUP length (Davos)
- More extreme events in recent years
- C sink strength vulnerable: Ta, VPD, SM
- Similar ET & T responses of forest & trees

Credits: Matthias Painter