Greenhouse gas fluxes over managed grasslands in Central Europe

Lukas Hörtnagl et al.

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PRIMARY RESEARCH ARTICLE

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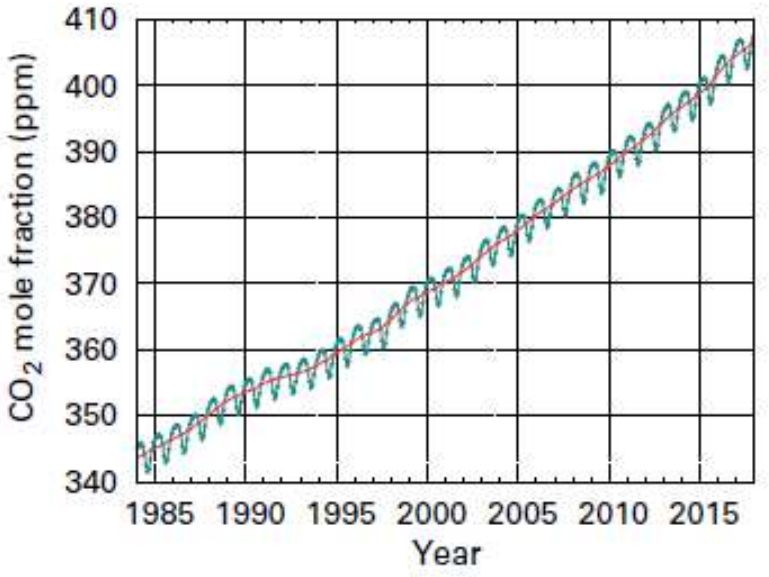
Greenhouse gas fluxes over managed grasslands in Central Europe

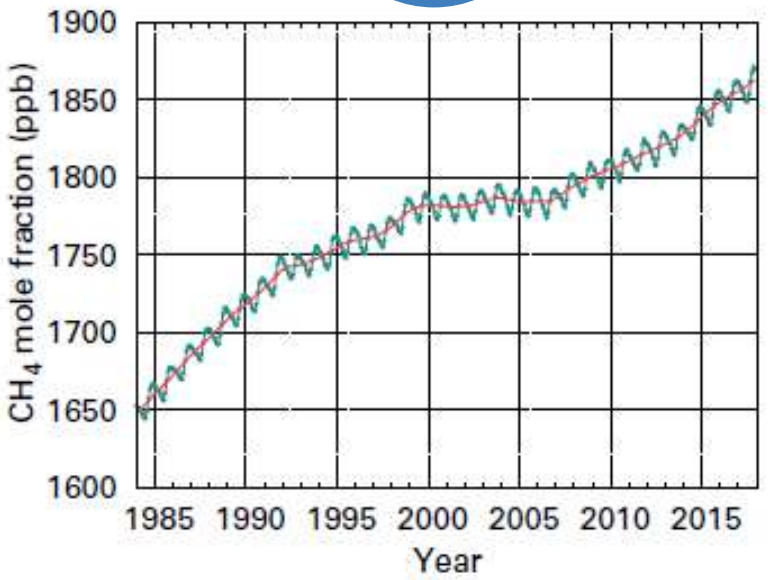
Lukas Hörtnagl[1] | Matti Barthel[1] | Nina Buchmann[1] | Werner Eugster[1] | Klaus Butterbach-Bahl[2] | Eugenio Díaz-Pinés[2,3] | Matthias Zeeman[2] | Katja Klumpp[4] | Ralf Kiese[2] | Michael Bahn[5] | Albin Hammerle[5] | Haiyan Lu[2] | Thomas Ladreiter-Knauss[5] | Susanne Burri[1] | Lutz Merbold[1,6]

Atmospheric Greenhouse Gases

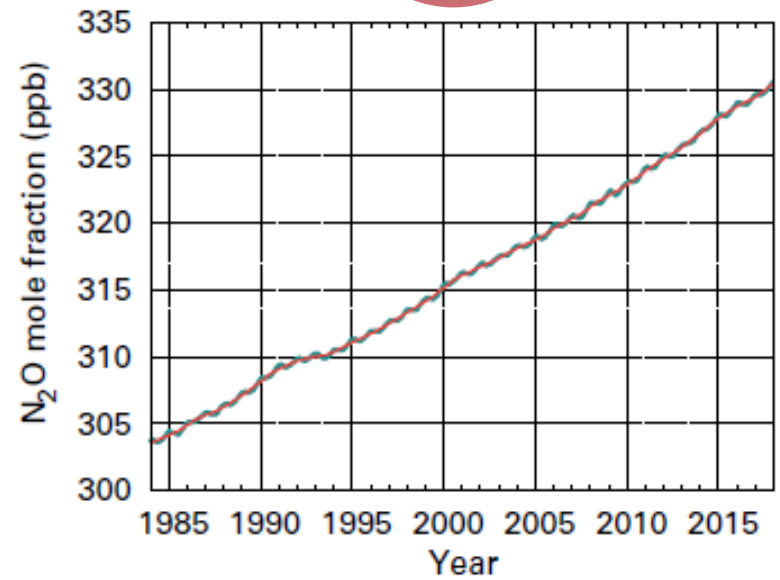
CO_2



CH_4



N_2O

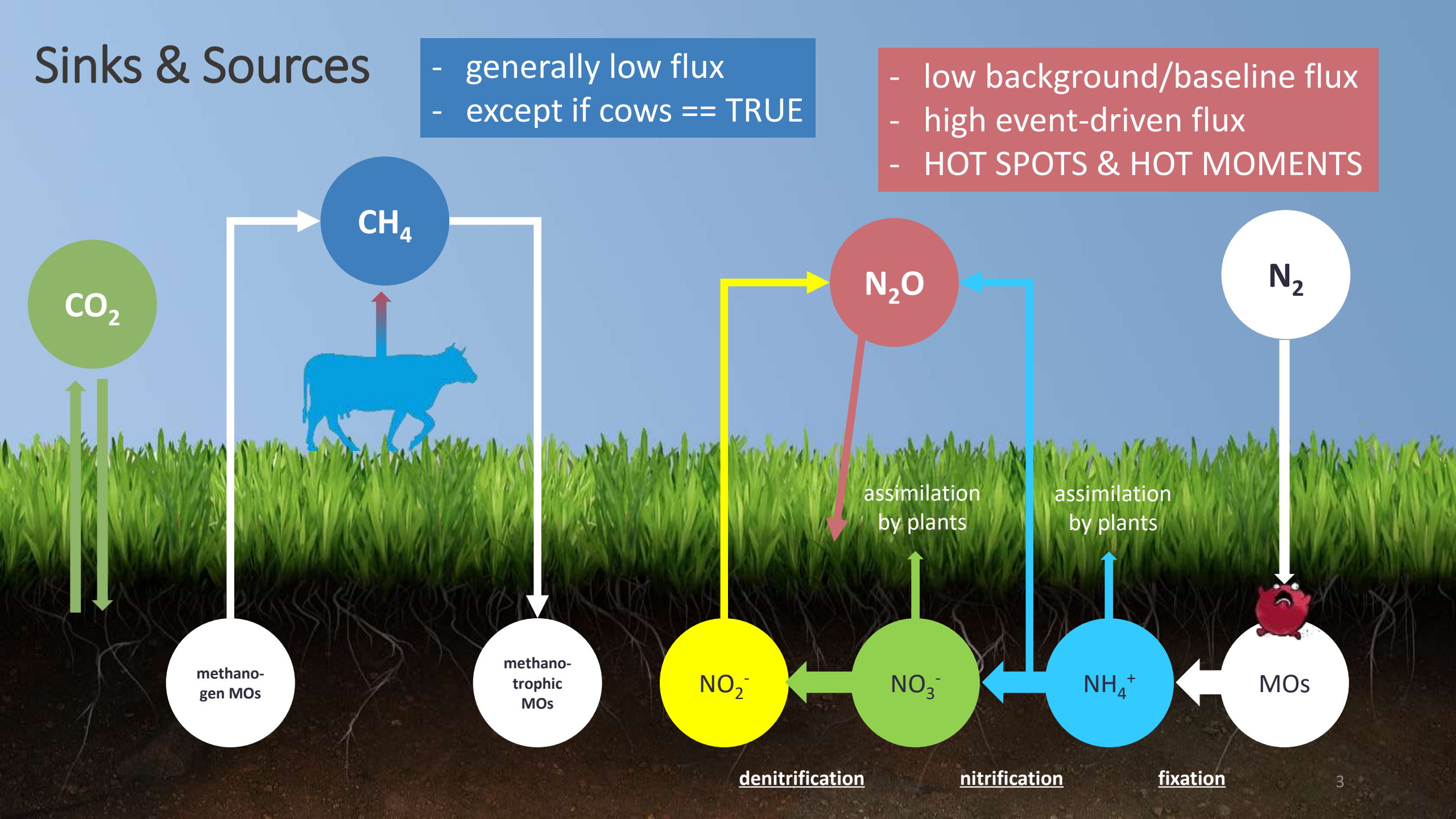


SOURCE: WMO (2019) Statement on the State of the Global Climate in 2018

Sinks & Sources

- generally low flux
- except if cows == TRUE

- low background/baseline flux
- high event-driven flux
- HOT SPOTS & HOT MOMENTS



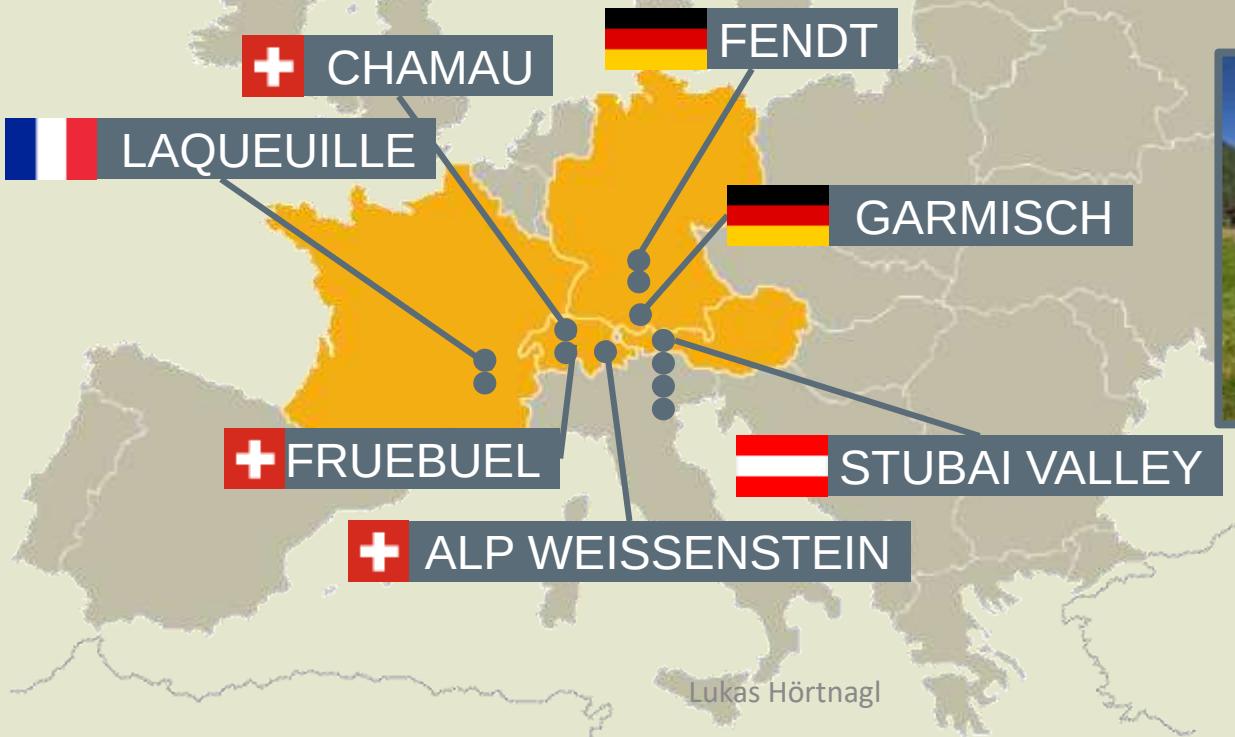
Sites


AT-STU-P


AT-STU-A


FR-LAQ-I

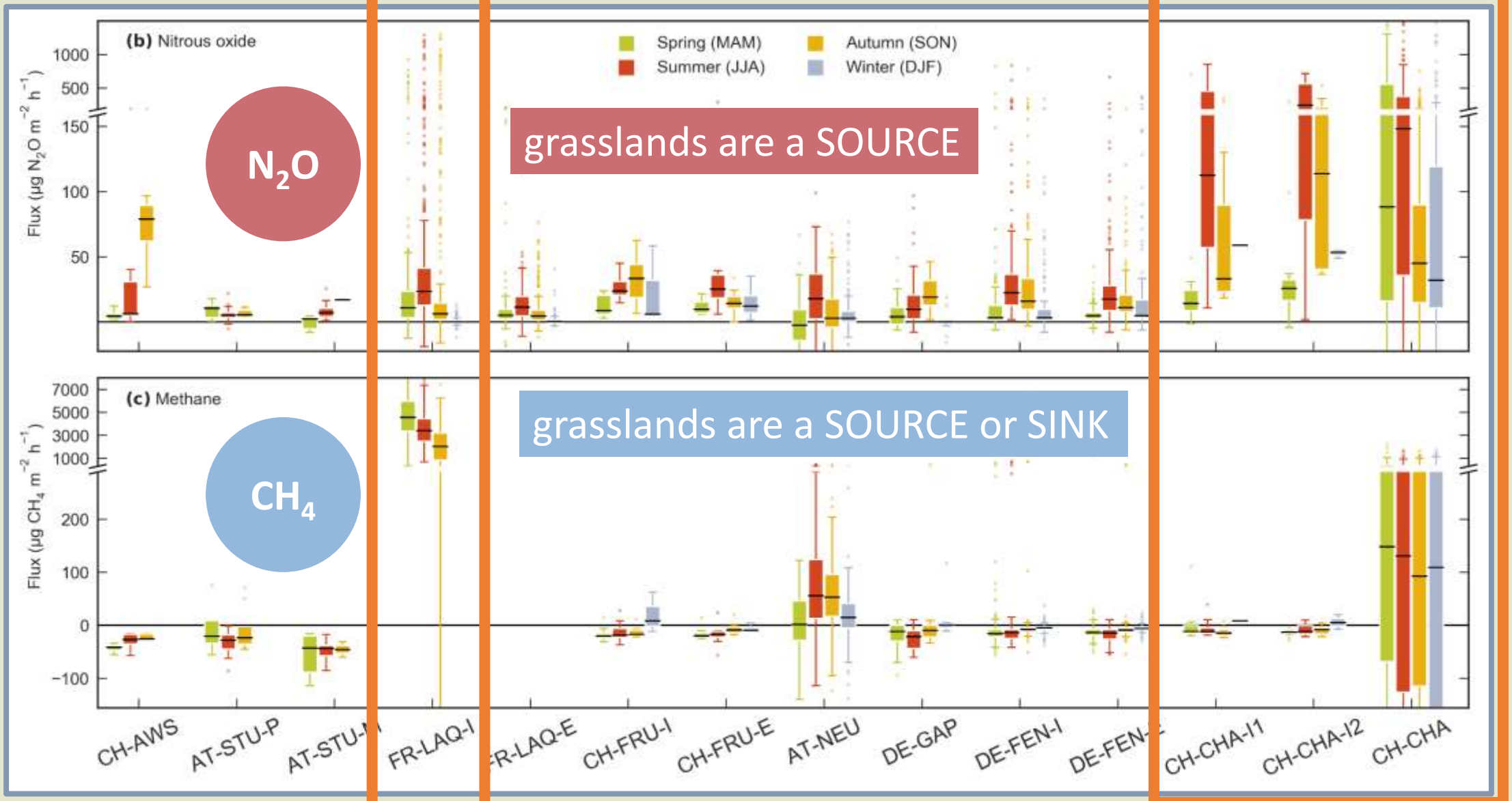

AT-NEU


CHAMAU
FENDT
LAQUEUILLE
GARMISCH
FRUEBUEL
STUBAI VALLEY
ALP WEISSENSTEIN

Sites

		Years	Cows	Sheep	Days	Cuts	Fert	kg N
1978	CH-AWS	1	20		<20		1	
1870	AT-STU-P	<1	15	7	120		1	70
1820	AT-STU-M	<1	15	7	70	1	1	70
1040	FR-LAQ-I	6	15		170		3	210 (syn)
	FR-LAQ-E	6	10		170			
982	CH-FRU-I	1	60		30	1	3	160
	CH-FRU-E	1	60		10	2	1	30
970	AT-NEU	2				3	1	340
734	DE-GAP	2				3	2	120
600	DE-FEN-I	3				5	6	370
	DE-FEN-E	3				3	2	120
393	CH-CHA	2		70	10	5	6	270
	CH-CHA-I1	1		60	20	5	6	250
	CH-CHA-I2	1		160	50	5	6	260

Direct Measurements



SOURCE: Hörtnagl et al. (2018)

Net GHG Balance (Budgets)

CO_2

available for 10 sites:
all were net CO_2 sinks in all years
exception: CH-CHA grassland restoration year

N_2O

available for 14 sites:
all were net N_2O sources in all years

CH_4

available for 13 sites:
all were either a weak net CH_4 sink or source
exception: CH-LAQ-I strong source (cows in footprint)

All 3 GHGs available for 9 sites:
Annual CO_2 sink strength offset by concurrent N_2O and CH_4 emissions by 21%

NGB negative (cooling) for all sites except restoration year

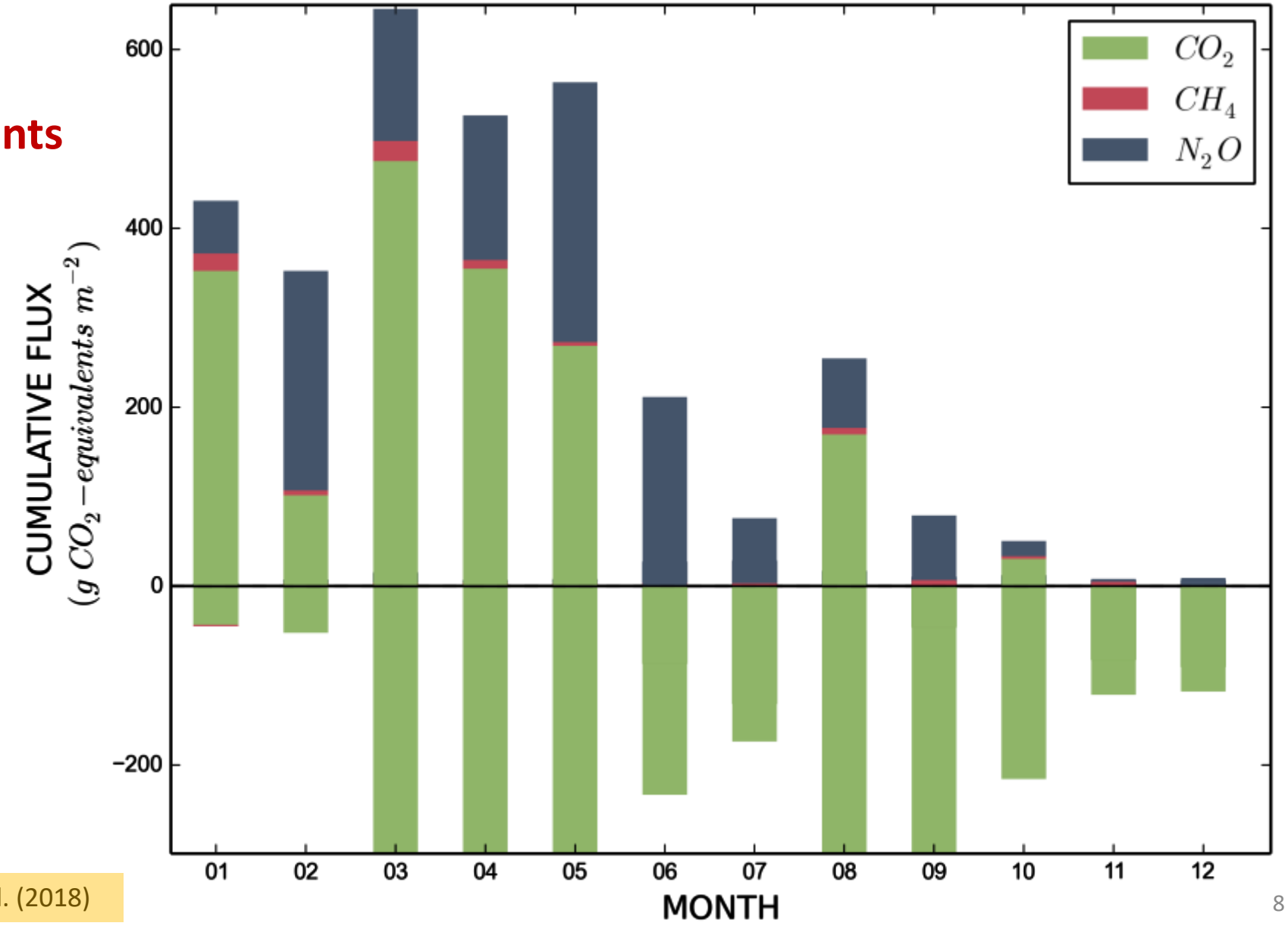
Variability across sites:
between 2% and 48%

Net GHG Balance (Budgets)

2012 / 2013
CO2 equivalents

2012 NGB:
grassland restoration
+ 2.5 kg CO_2-eq. m^{-2}
only (+) NGB in study

2013 NGB:
- 4.5 kg CO_2-eq. m^{-2}

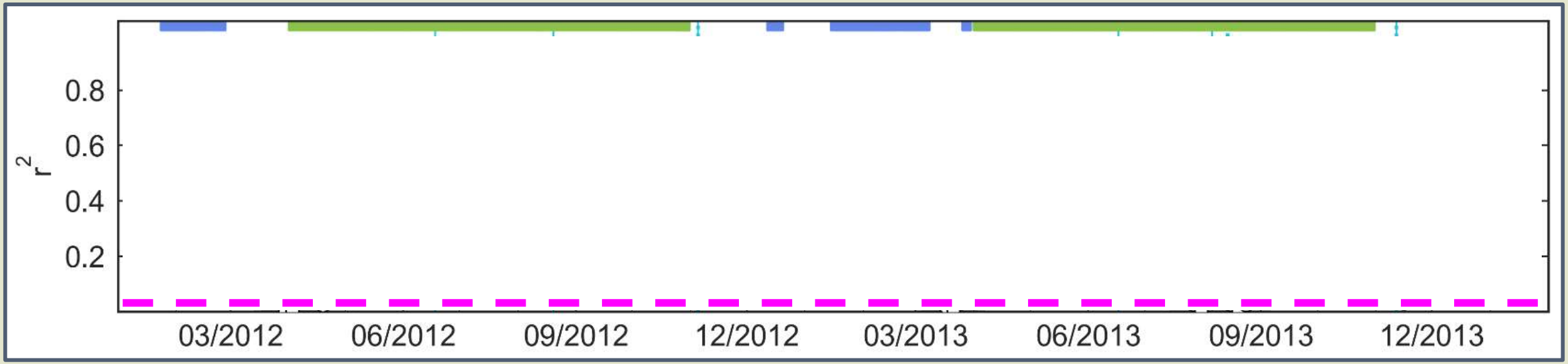


SOURCE: Merbold et al. (2014), Hörtnagl et al. (2018)

Effect of Soil Temp & WFPS

N_2O

- **Soil Temp and WFPS are widely available**
- MLR: average r^2 = 0.19 (between 0.02 and 0.47)
- Example: DE-FEN-E (AC, 3 years): **r^2 = 0.02 ***



SOURCE: Hörtnagl et al. (2018)

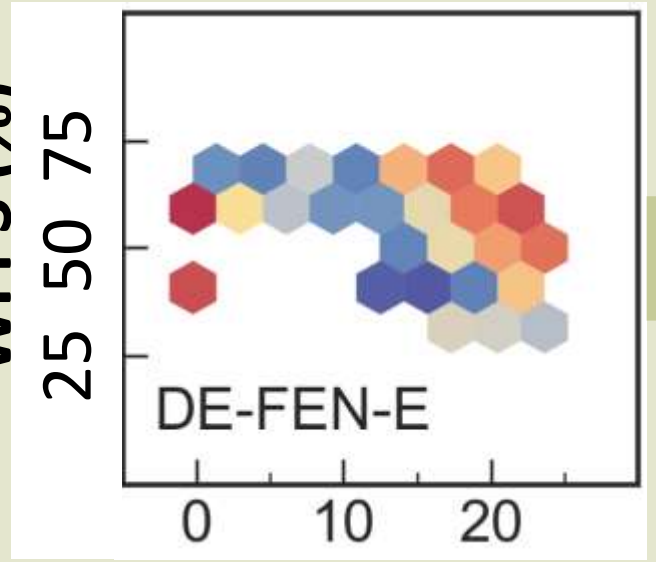
Effect of Soil Temp & WFPS: Percentiles

Measured Flux
8
42
51
14
22
28
41
3
5

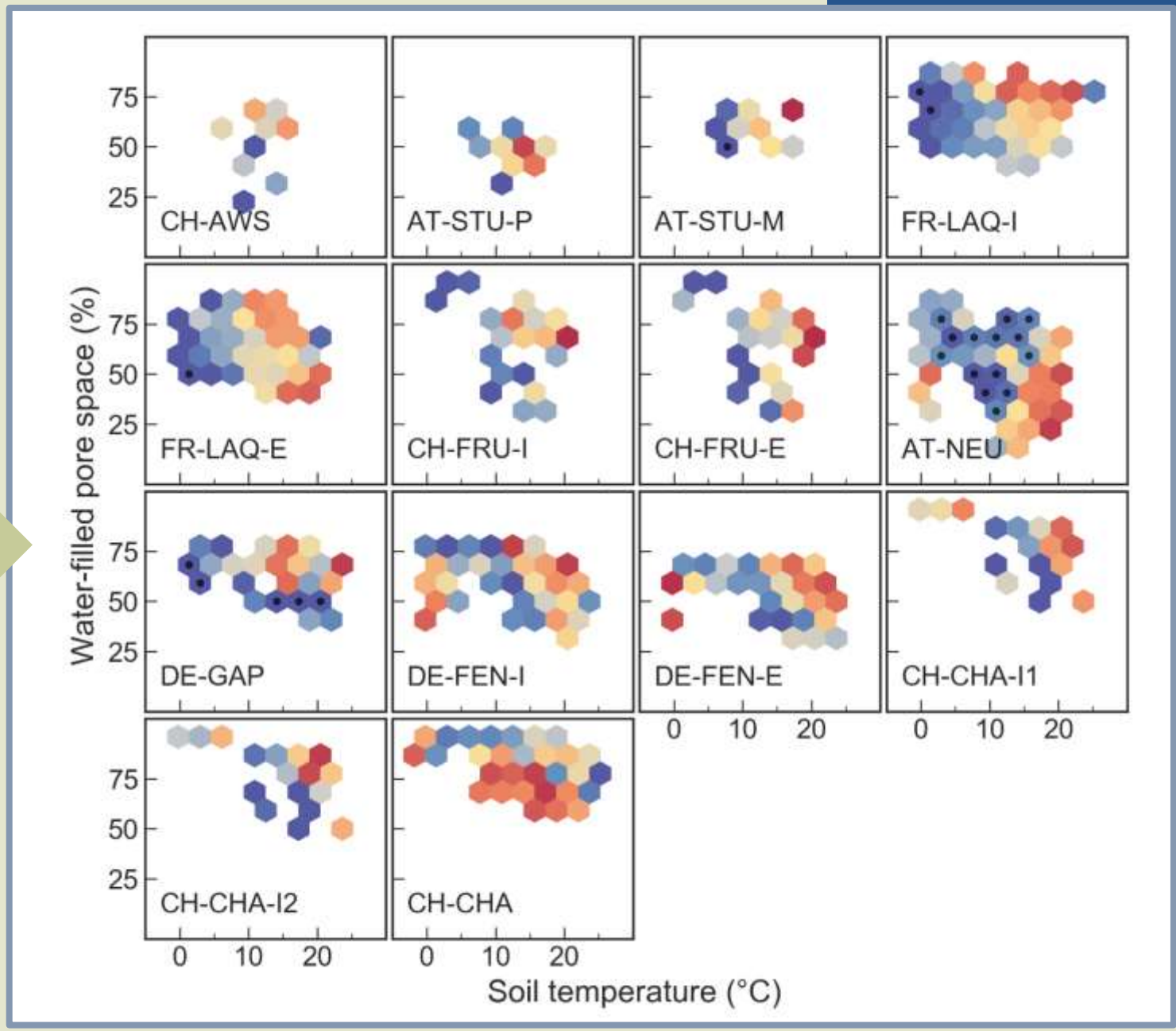
- strictly linear, site-specific percentile values
- fluxes in relation to site-specific ranges of potential drivers

Effect of Soil Temp & WFPS

N_2O



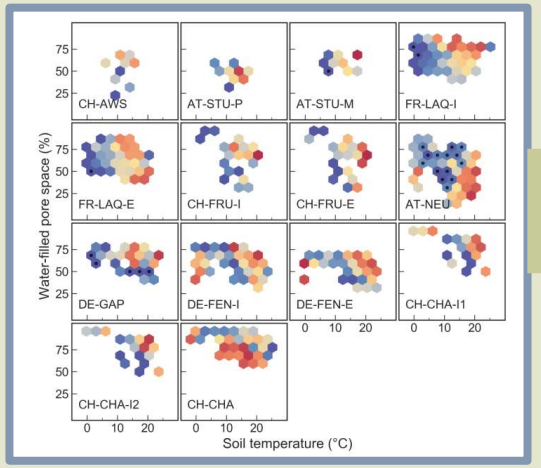
All Sites



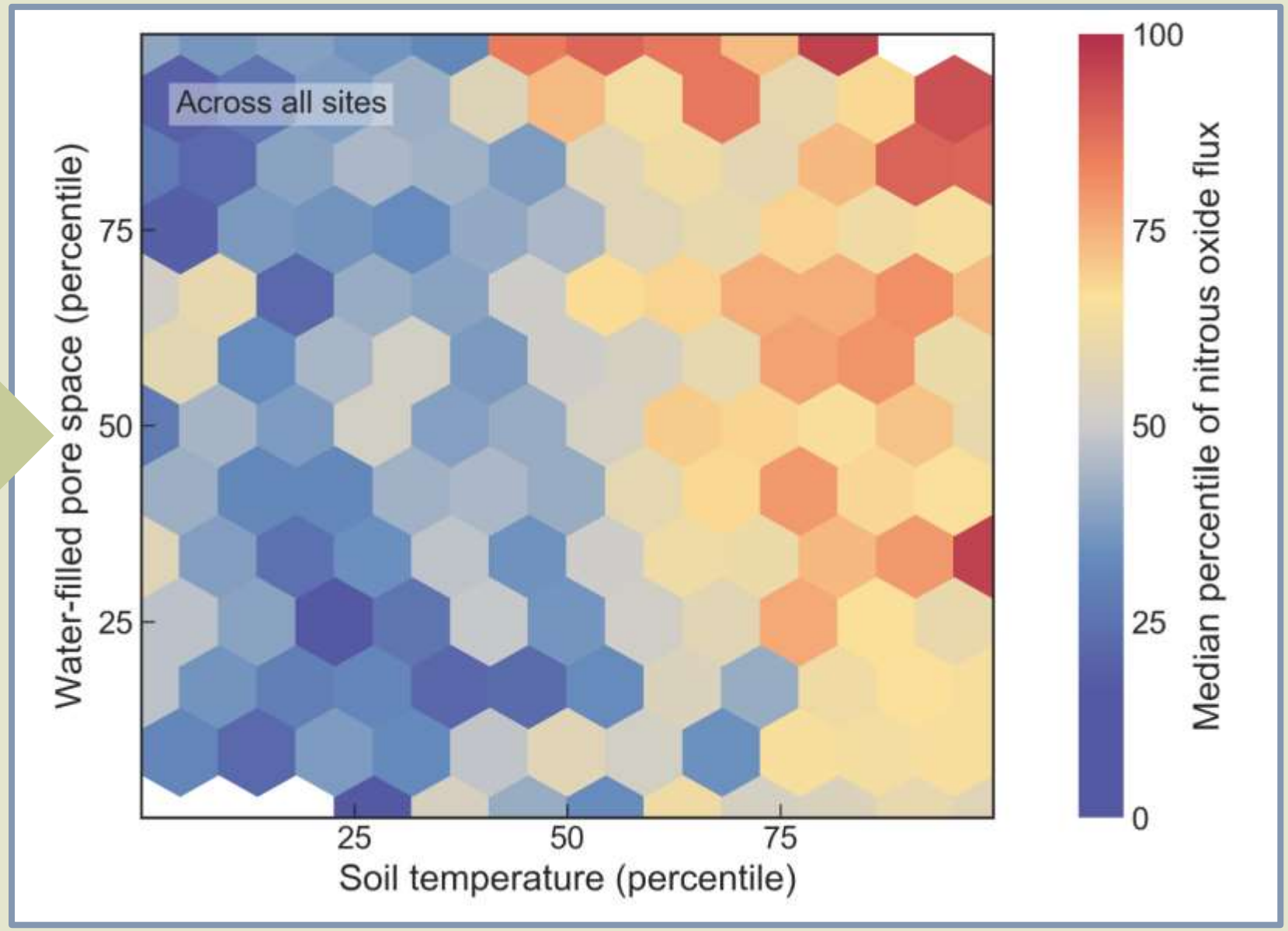
SOURCE: Hörtnagl et al. (2018)

Effect of Soil Temp & WFPS

N_2O

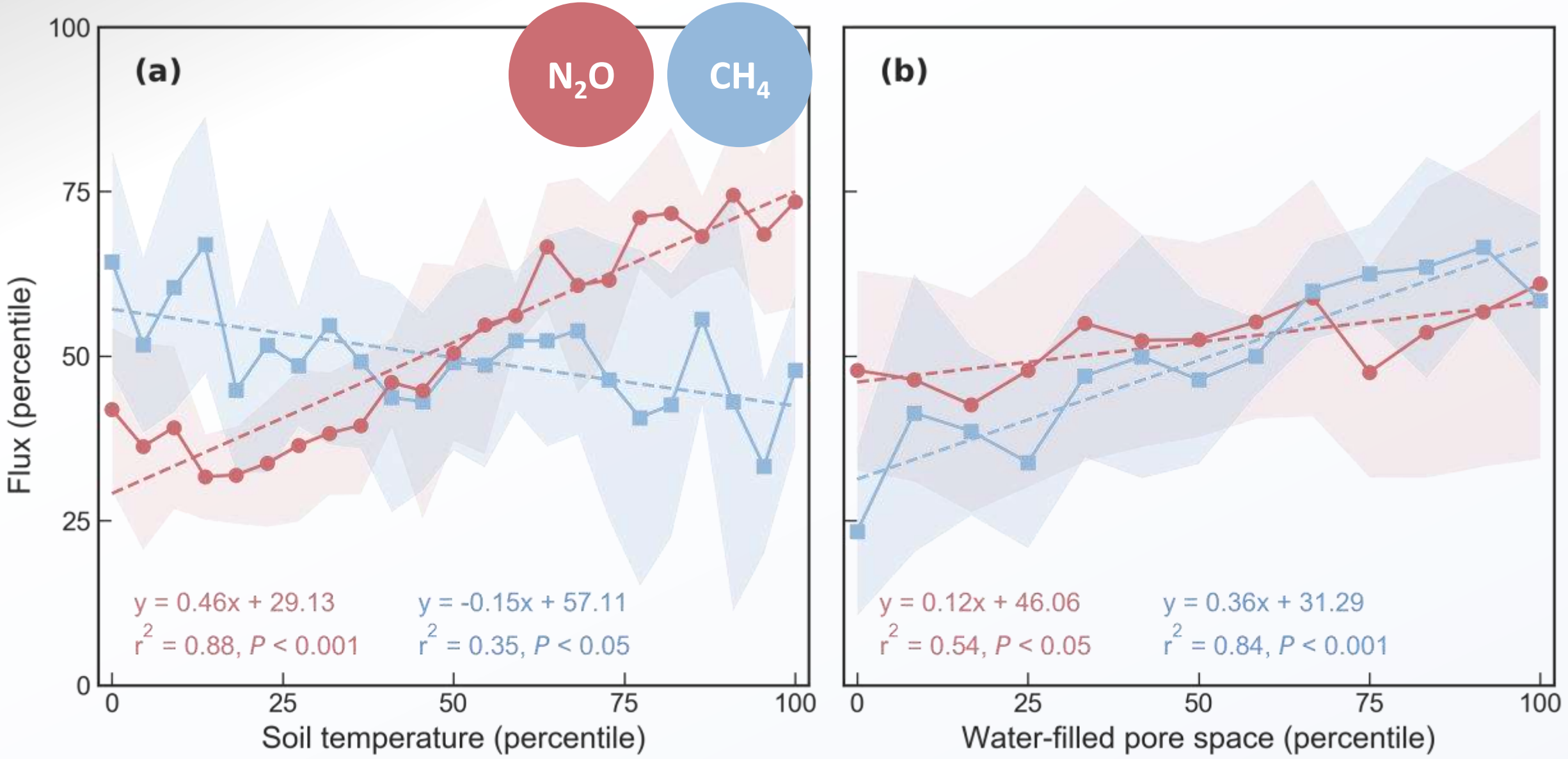


All Sites



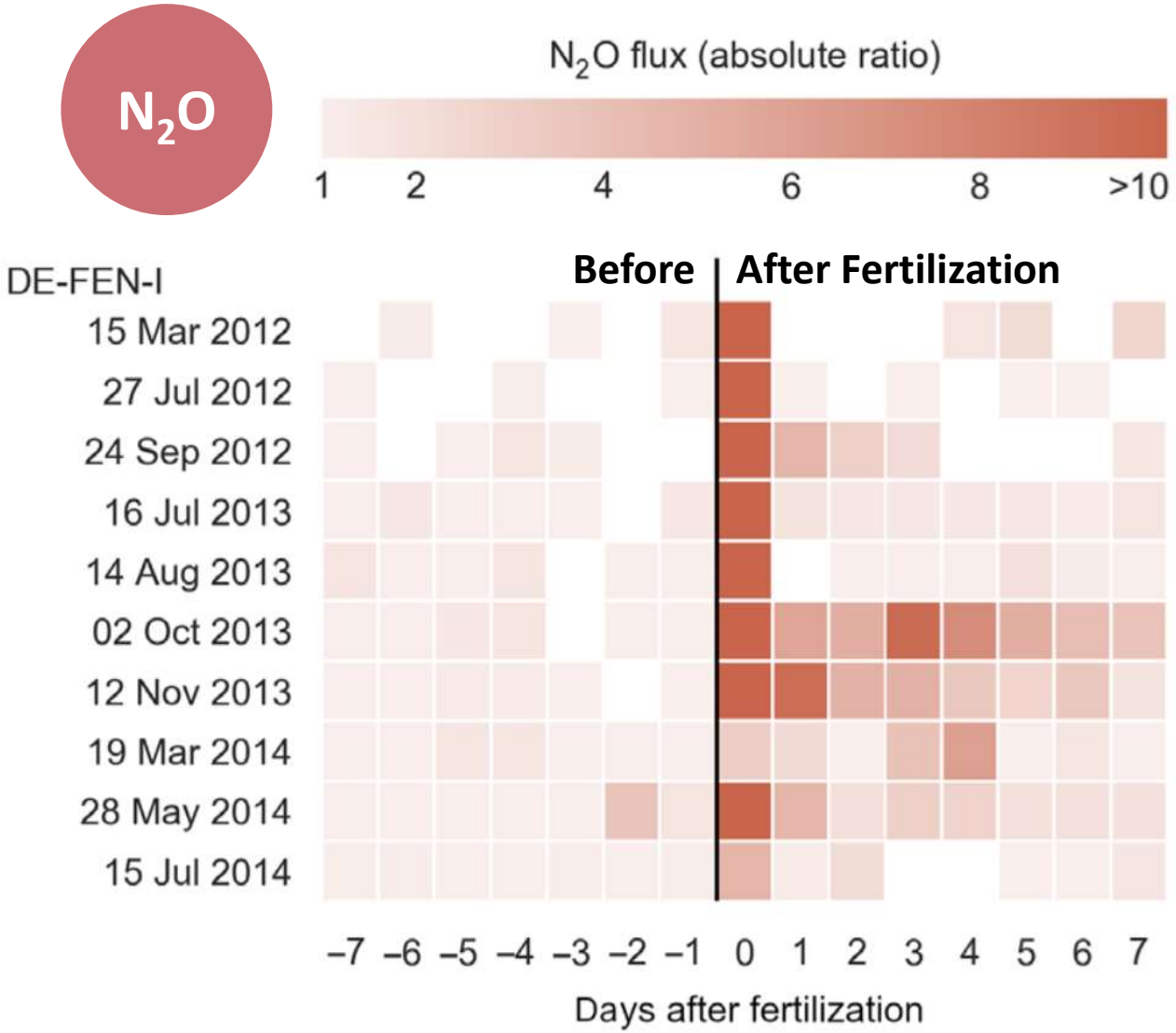
SOURCE: Hörtnagl et al. (2018)

Effect of Soil Temp & WFPS: Percentiles Everywhere



SOURCE: Hörtnagl et al. (2018)

Fertilization Effect (Slurry)



- High resolution data needed around fertilization dates
- Available for 3 sites, e.g. DE-FEN-I

Flux Magnitude:

- Day 0: 10x higher
- Day 1: 5x higher
- Days 2-7: 2x higher

Each fertilizer application resulted in immediate N_2O-N emissions of **7% of the annual cumulative loss**.

N_2O-N emission factor (10 sites):
1.8% (between 0.1% and 4.9%)

SOURCE: Hörtnagl et al. (2018)

The Last Slide

Thank you for listening!

Take-aways:

- Grassland management led to increased N_2O and CH_4 emissions, but **the CO_2 sink strength** was generally the most dominant component of the annual GHG budget.
- In terms of CO_2 equivalents, non-CO_2 gases **offset** concurrent CO_2 uptake by **21%**
- The only positive NGB (warming effect) was found during **grassland restoration**
- **N_2O-N emission factor** of **1.8%** higher than IPCC 1%
- Site-specific **data normalization** facilitated the identification of environmental conditions that indicated enhanced GHG source / sink activity (sweet spots)

Data collection (please contribute):

- CH_4 fluxes currently collected via FLUXNET (synthesis, already 60 sites)
- N_2O and CH_4 EC raw data currently collected in RINGO (ICOS): holukas@ethz.ch