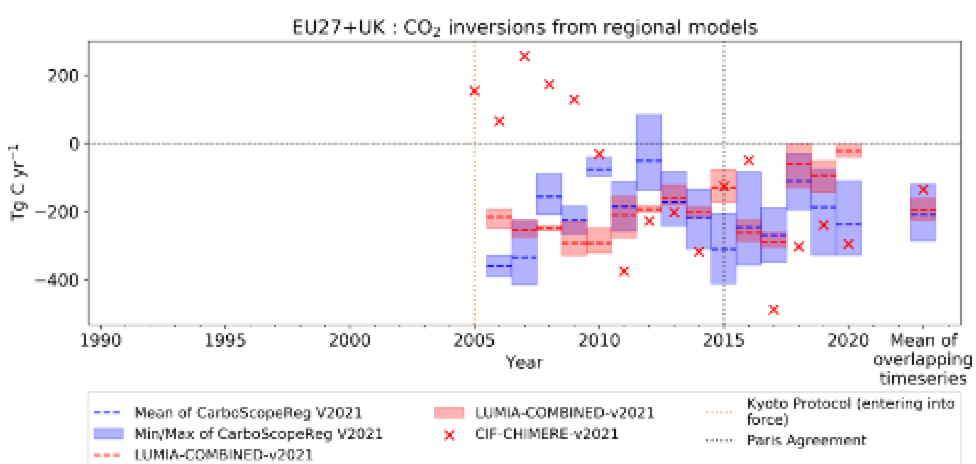
T3.3 Other CO2 regional inversions !

- Community Inversion Framework - CO2 inter-comparison
  - CIF - CHIMERE is working : first results obtained
  - CIF - LMDZ (globa) completed
  - CIF - STILT / Flexpart underway
- As well as LUMIA inversion system

  ⇒ Differences that need to be resolved !
- Synthesis in WP5 still use the different estimates

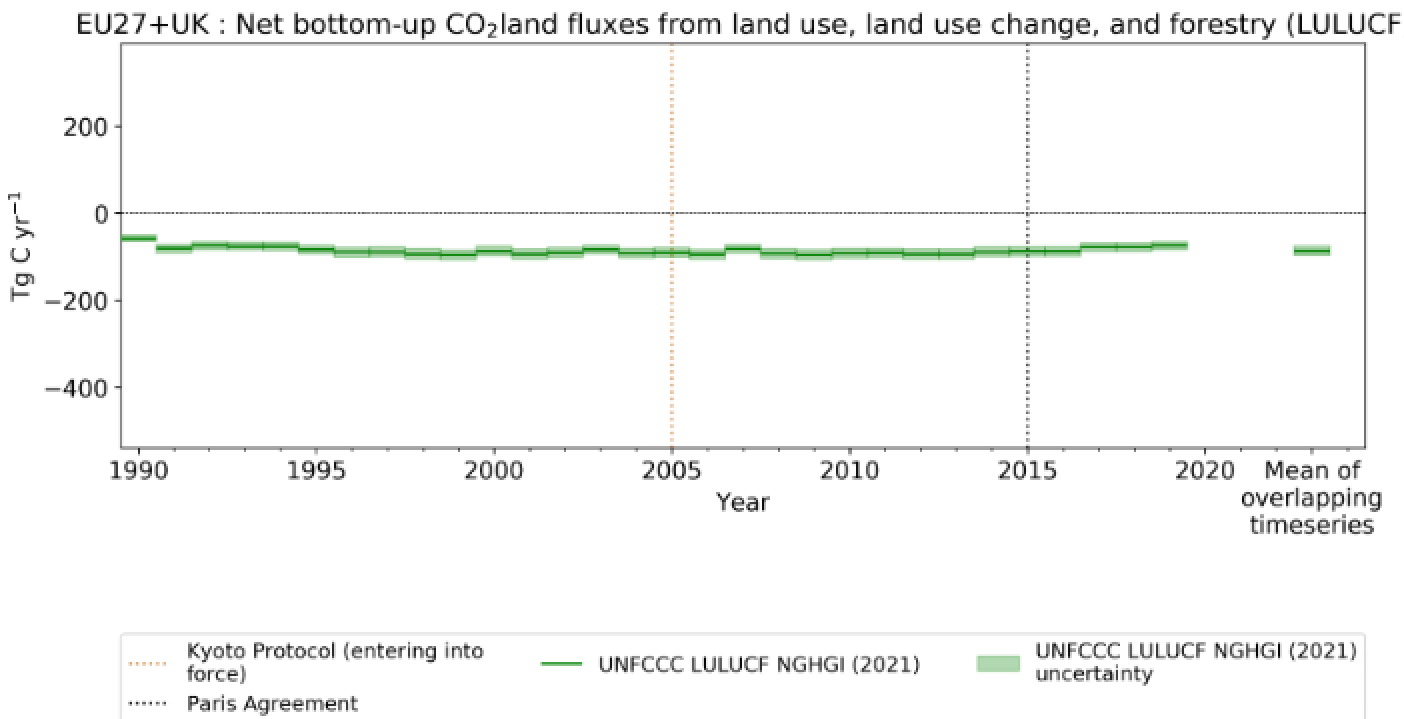
  (See summary talk (P. Peylin) for a few comparisons)



WP3 – NBP ATTRIBUTION

High uncertainty in LULUCF fluxes

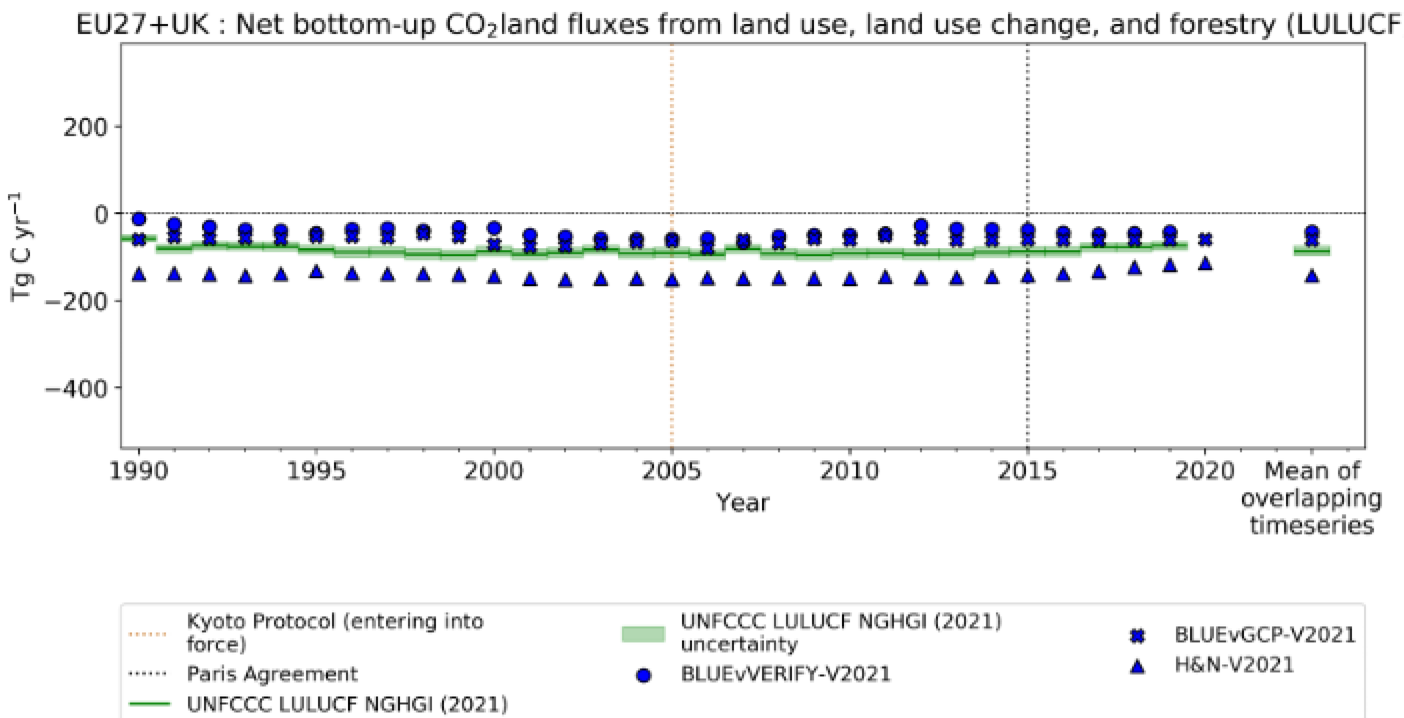
Inventories



WP3 – NBP ATTRIBUTION

High uncertainty in LULUCF fluxes

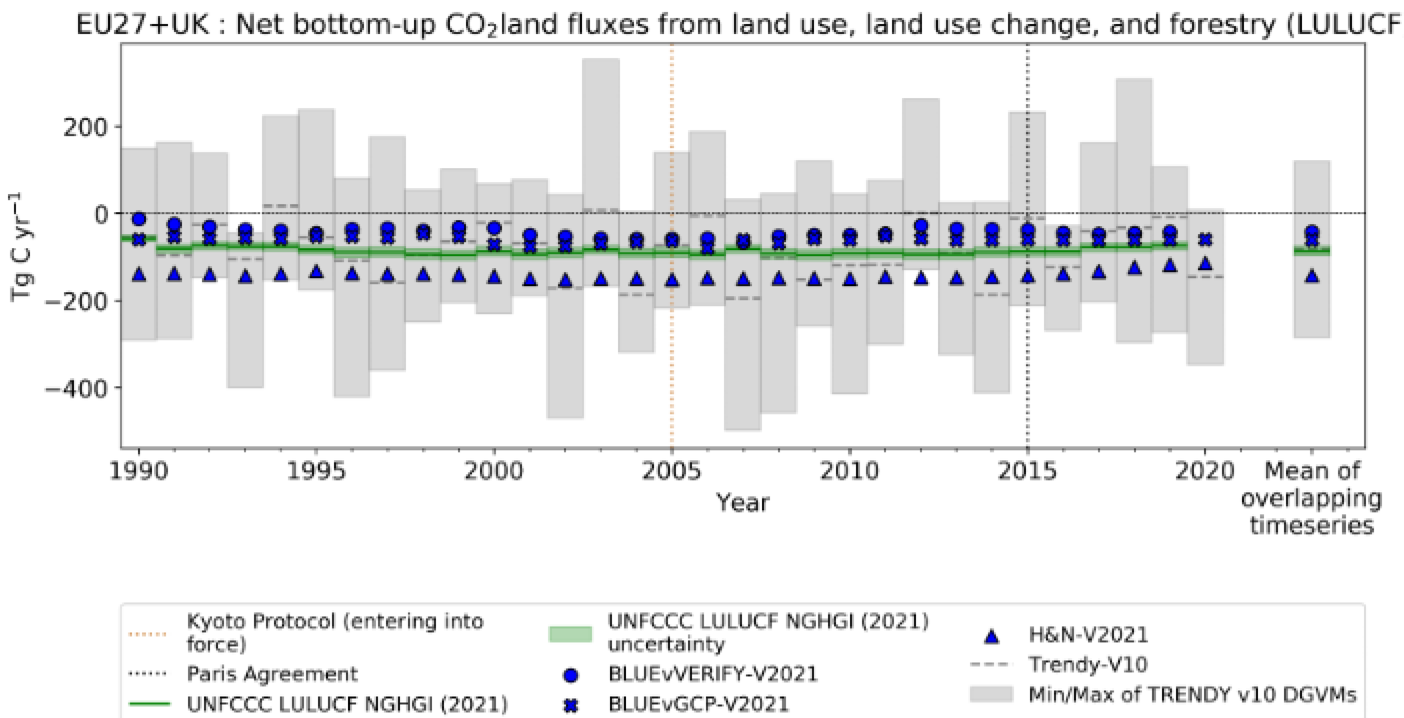
Inventories Bookkeeping



WP3 – NBP ATTRIBUTION

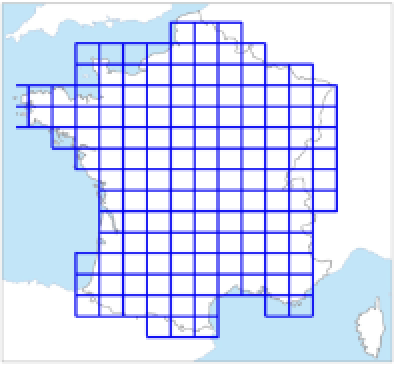
High uncertainty in LULUCF fluxes

Inventories | Bookkeeping | DGVMs



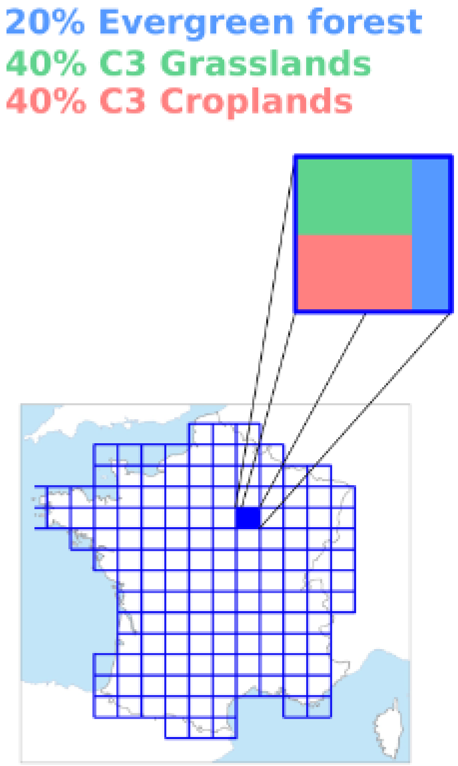
WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)



WP3 – NBP ATTRIBUTION

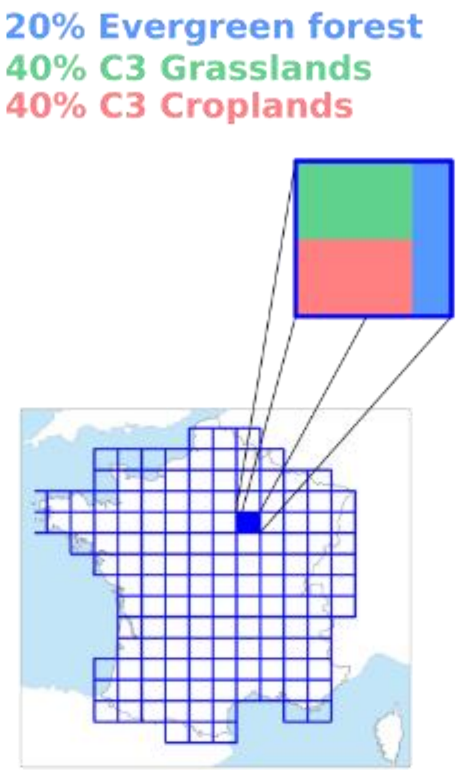
Dynamic global vegetation models (TRENDY)

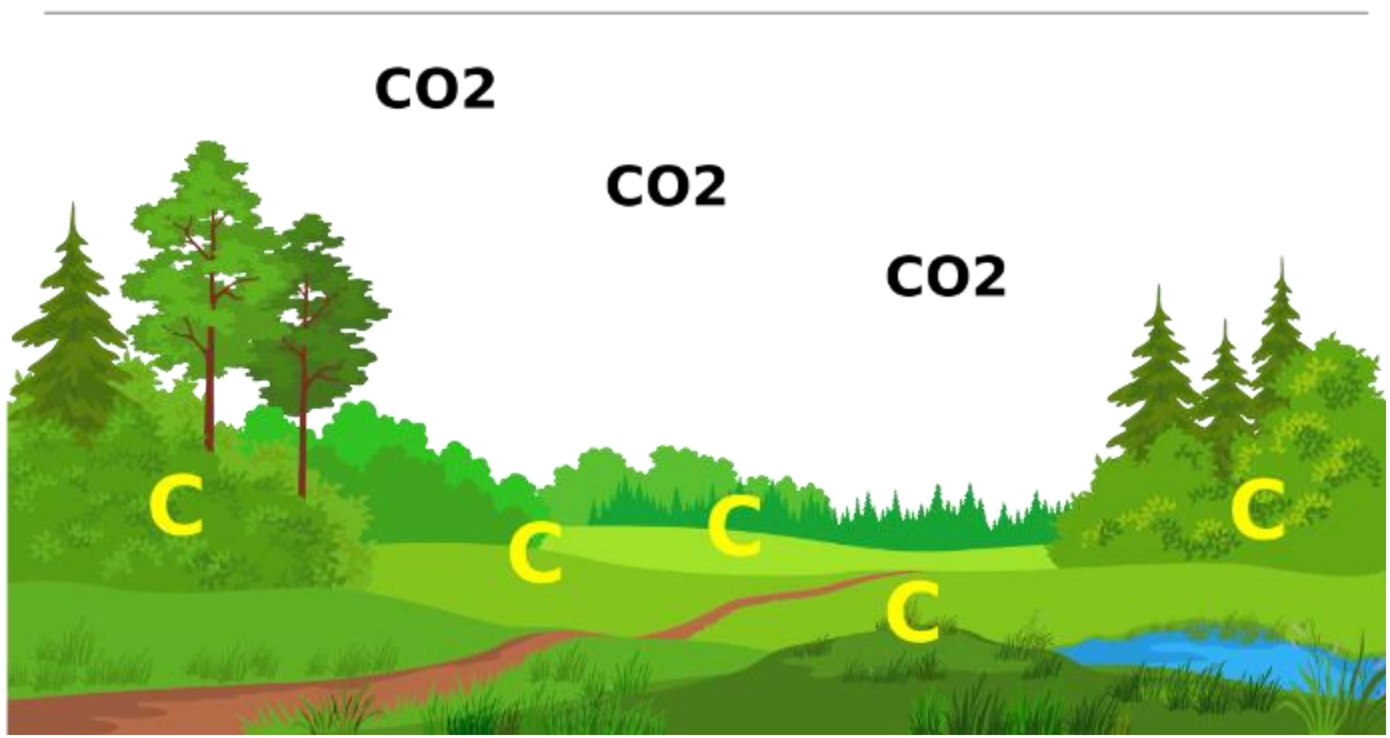


WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Net biome production (NBP)





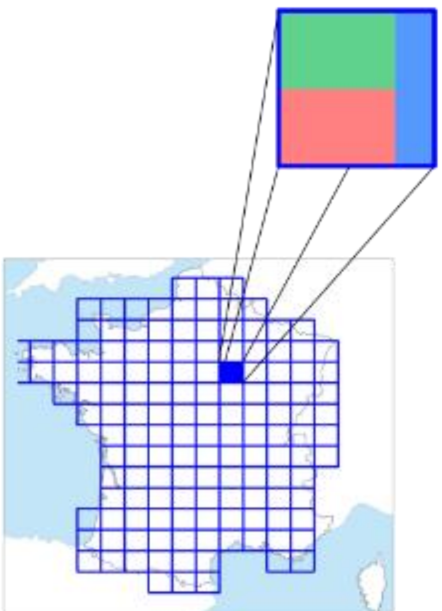
WP3 – NBP ATTRIBUTION

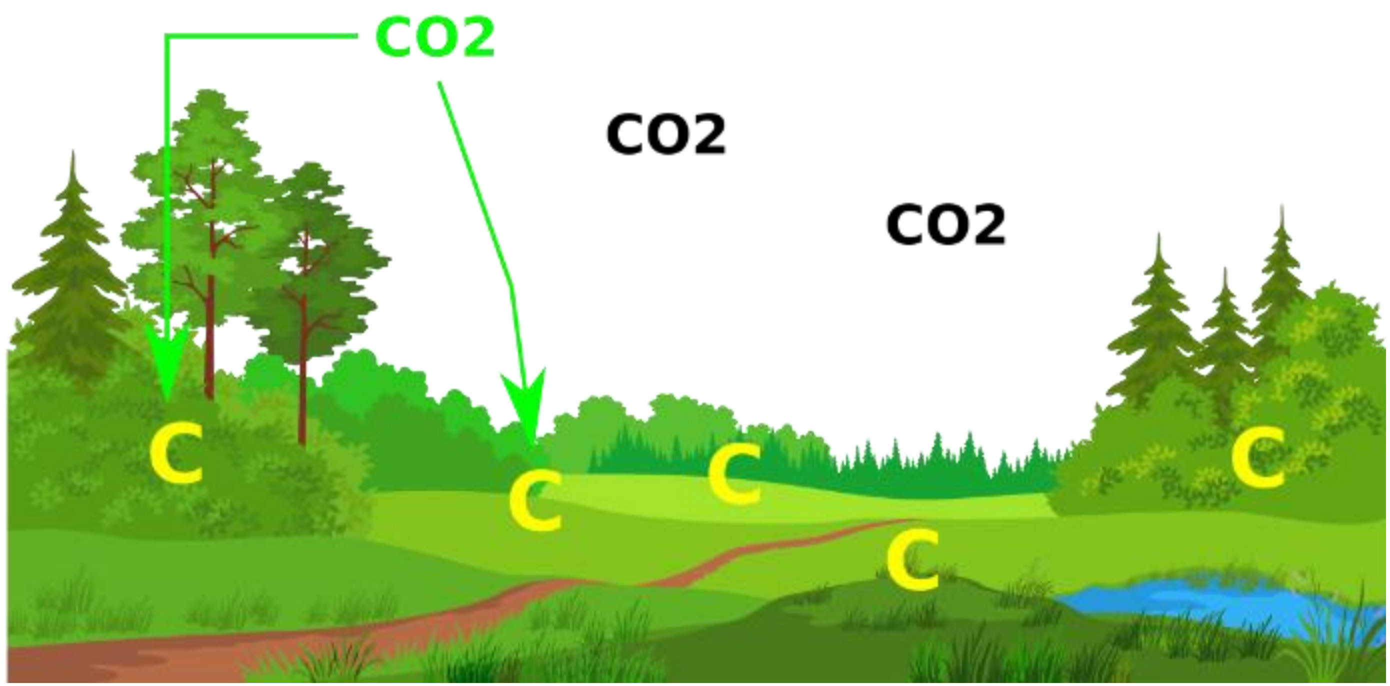
Dynamic global vegetation models (TRENDY)

Net biome production (NBP)

NBP = Photo

20% Evergreen forest
40% C3 Grasslands
40% C3 Croplands





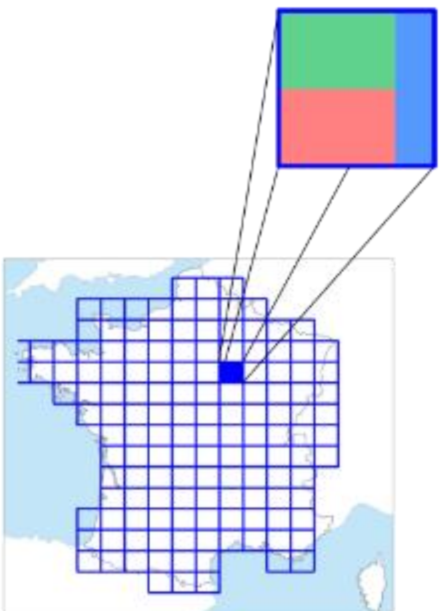
WP3 – NBP ATTRIBUTION

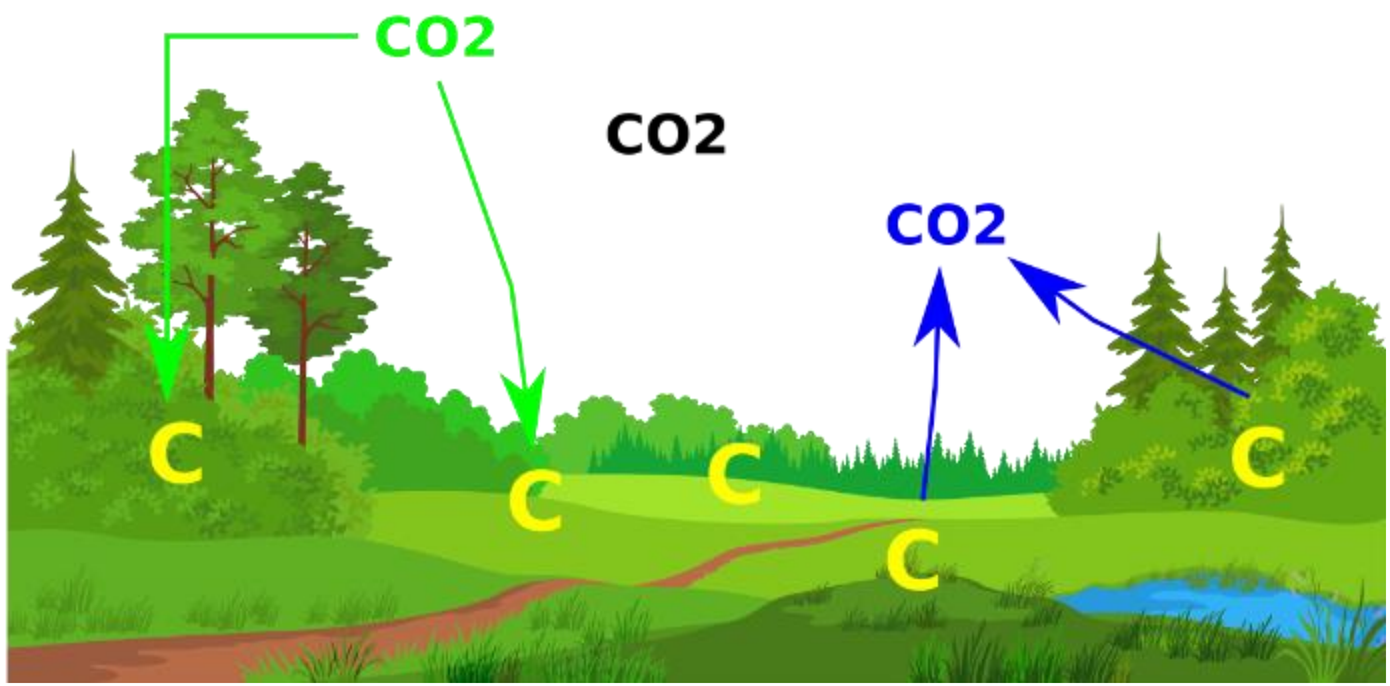
Dynamic global vegetation models (TRENDY)

Net biome production (NBP)

NBP = Photo - Resp

20% Evergreen forest
40% C3 Grasslands
40% C3 Croplands



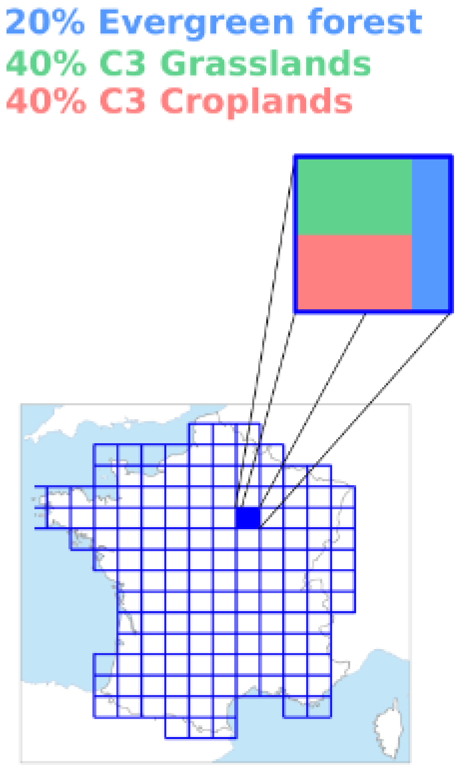


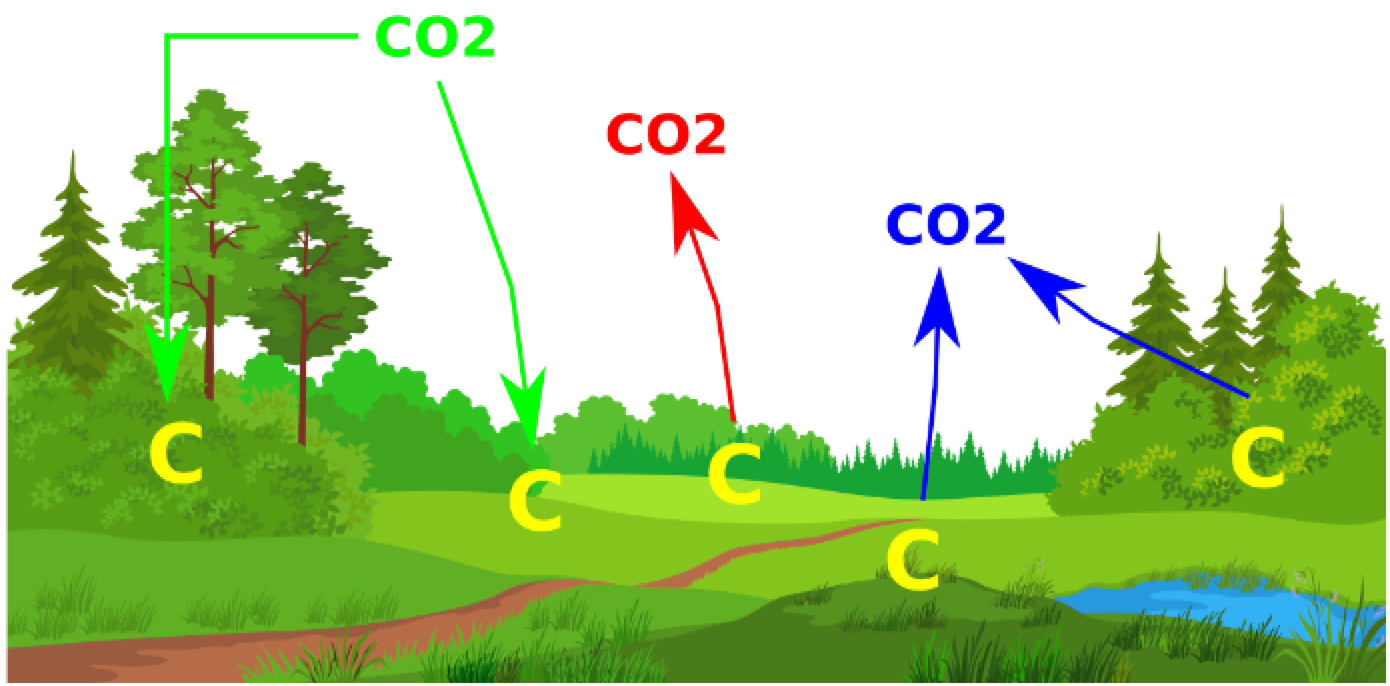
WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Net biome production (NBP)

NBP = Photo - Resp - Harv





WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

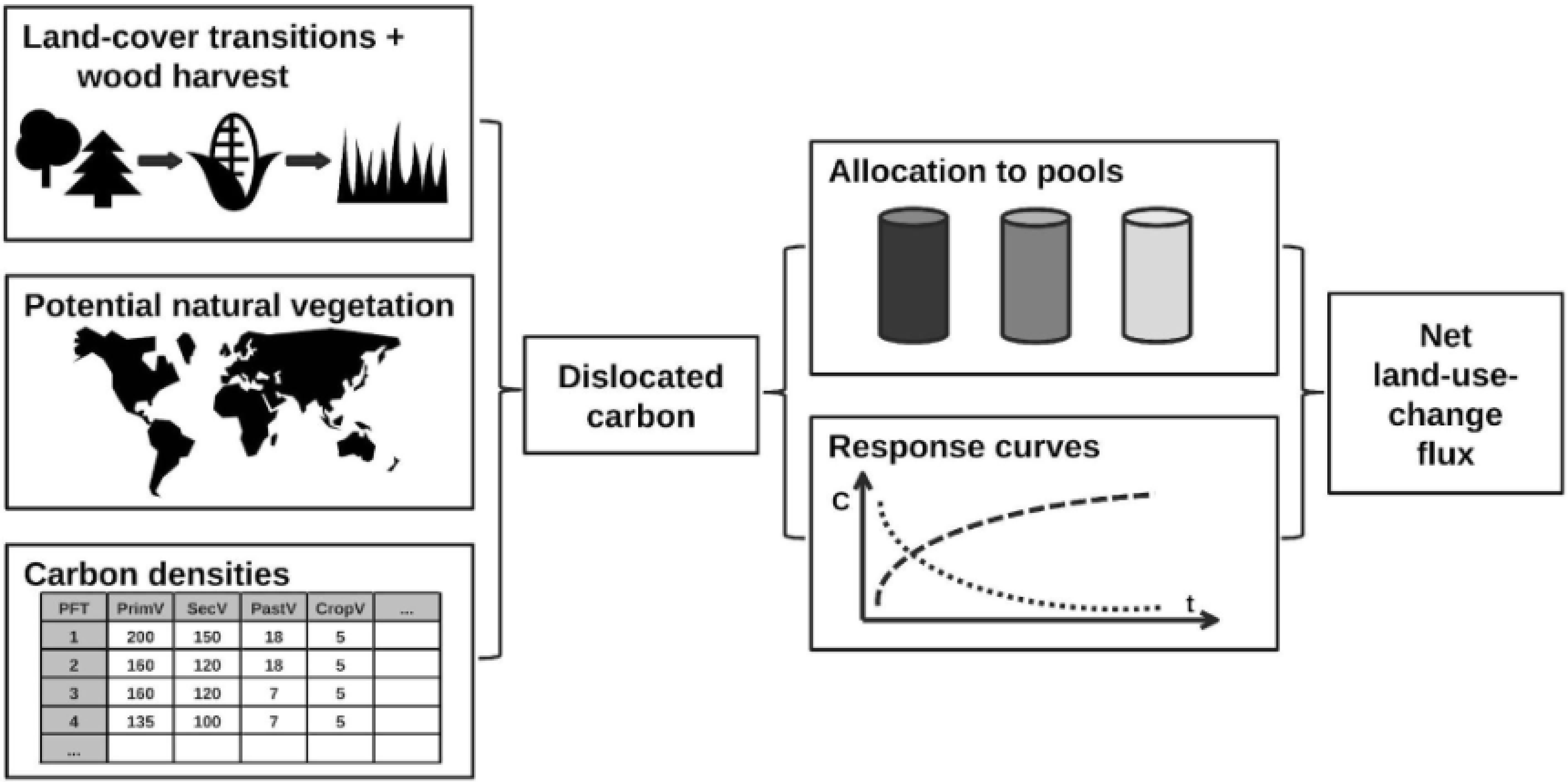
Factorial experiments

	S0	S1	S2	S3	*S4 (if app.)*
CO_2	static	dynamic	dynamic	dynamic	*dynamic*
Climate	static	static	dynamic	dynamic	*dynamic*
Land cover/land use	static	static	static	dynamic	*dynamic*
Nitrogen deposition (if applicable)	*static*	*static*	*static*	*dynamic*	*static*

Difference between simulations gives the effect of that driver (e.g., S2-S1 gives the climate influence)

WP3 – NBP ATTRIBUTION

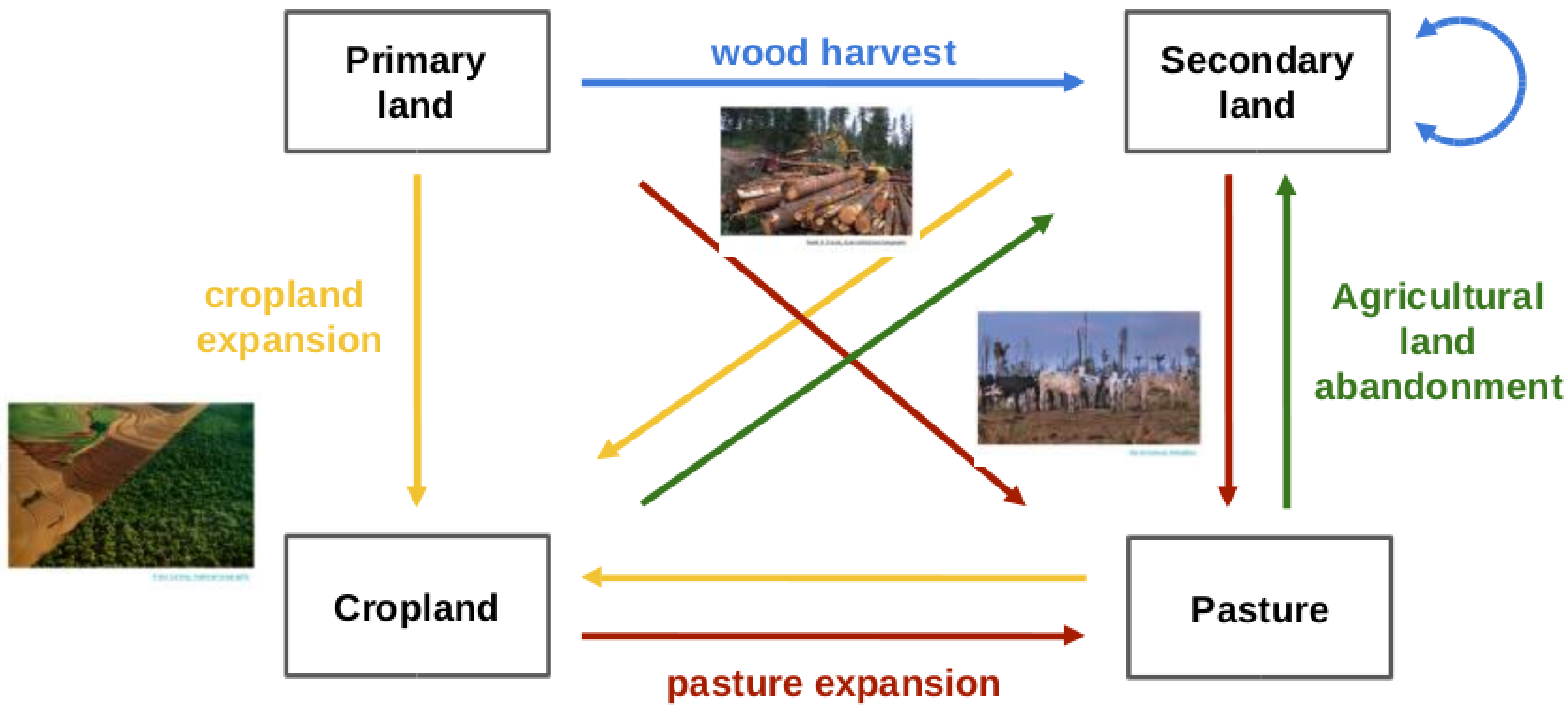
Bookkeeping models (BLUE)



PFT	PrimV	SecV	PastV	CropV	...
1	200	150	18	5	
2	160	120	18	5	
3	160	120	7	5	
4	135	100	7	5	
...					

WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

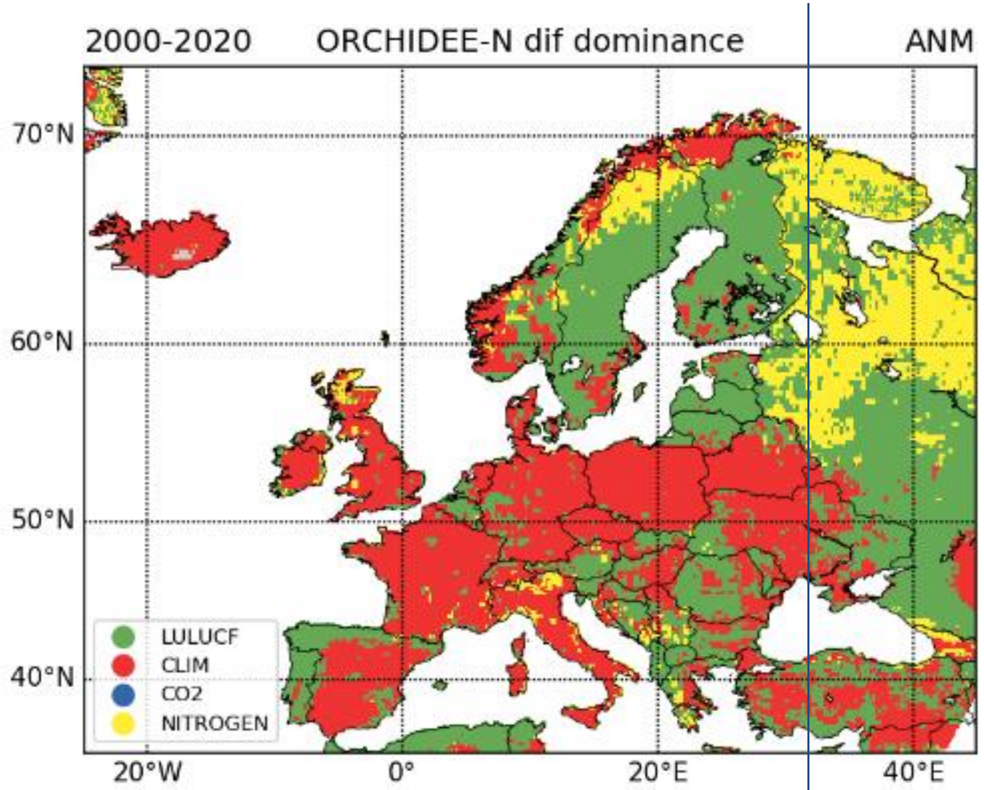


Adapted from Kerstin Hartung

WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

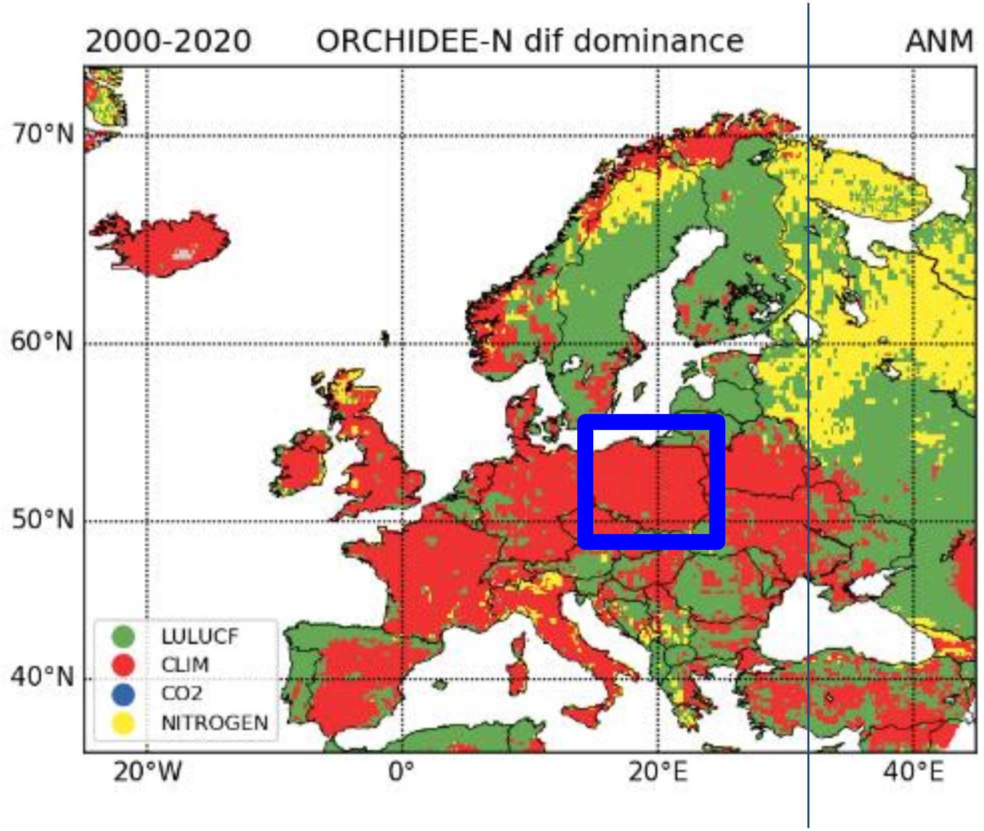
Factorial experiments



WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

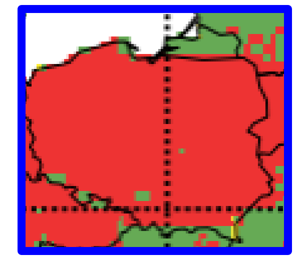
Factorial experiments

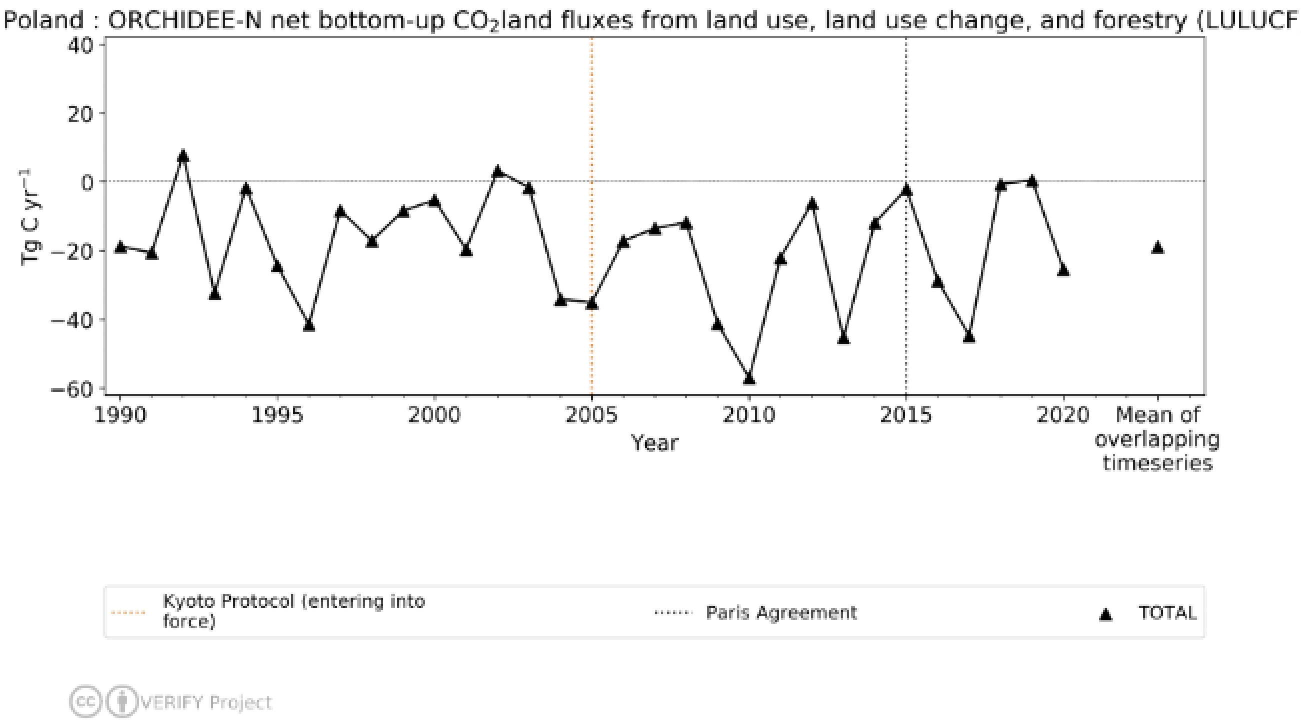


WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Factorial experiments

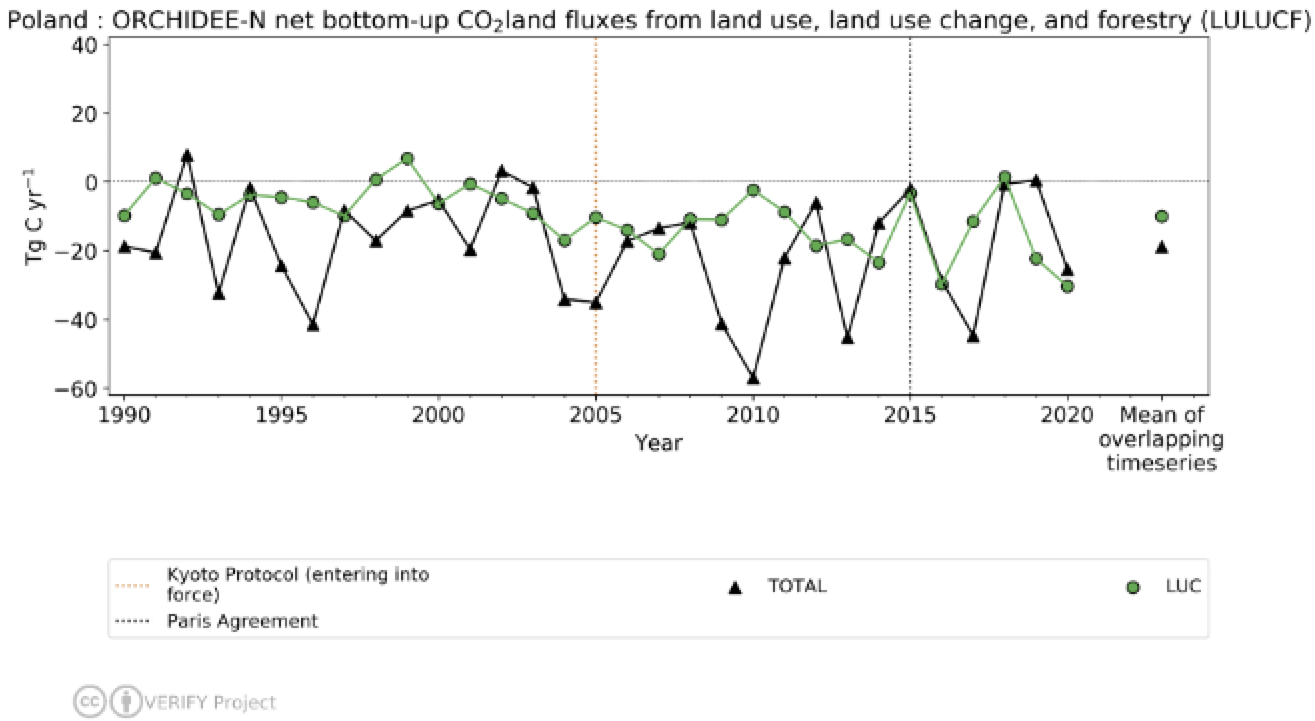


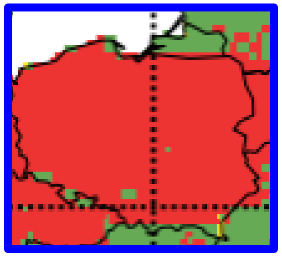


WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Factorial experiments

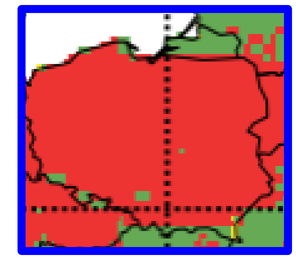


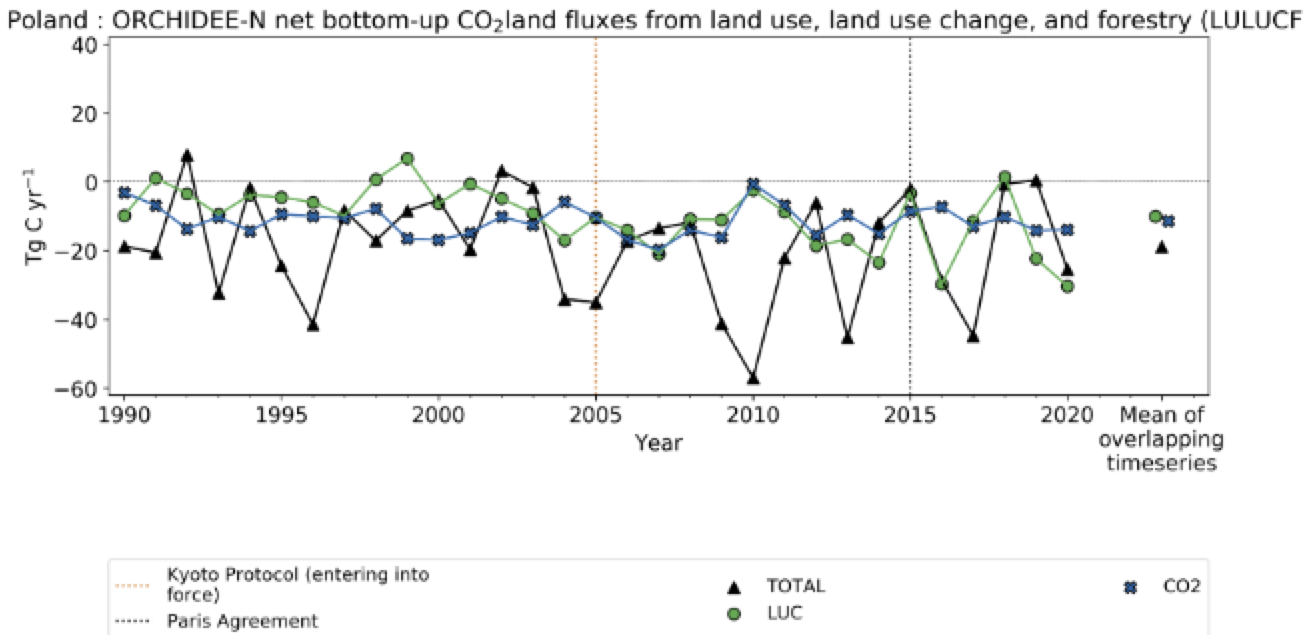


WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Factorial experiments

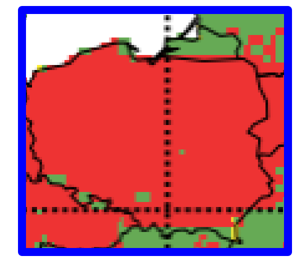


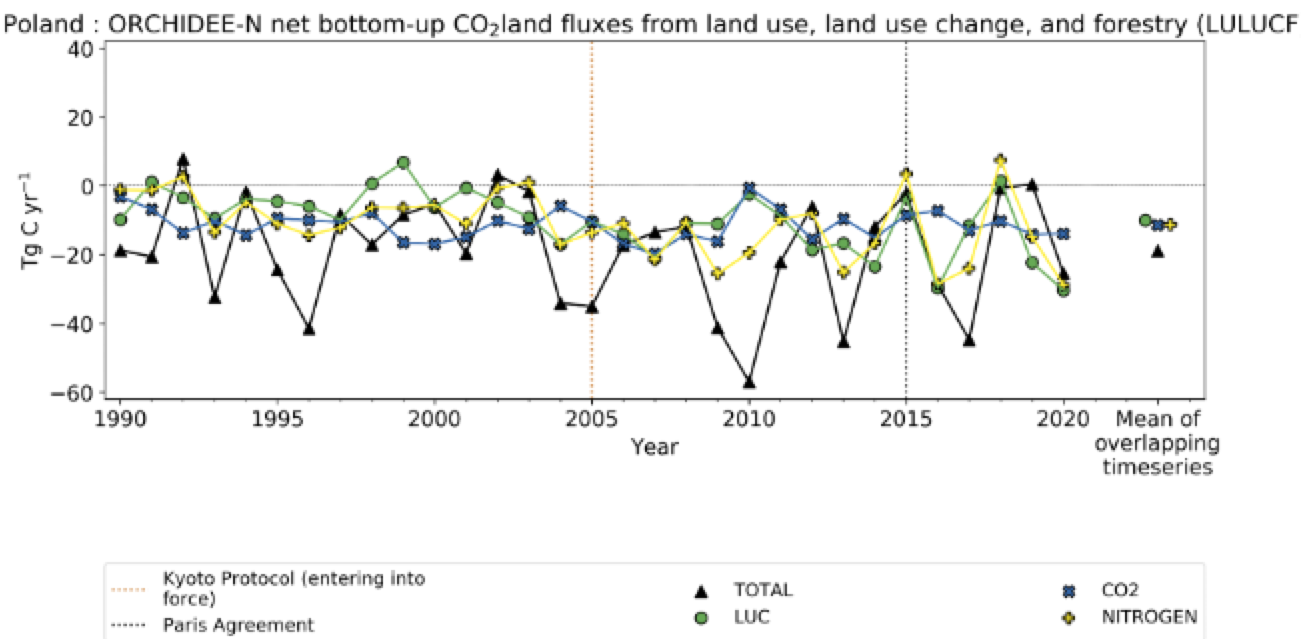


WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Factorial experiments

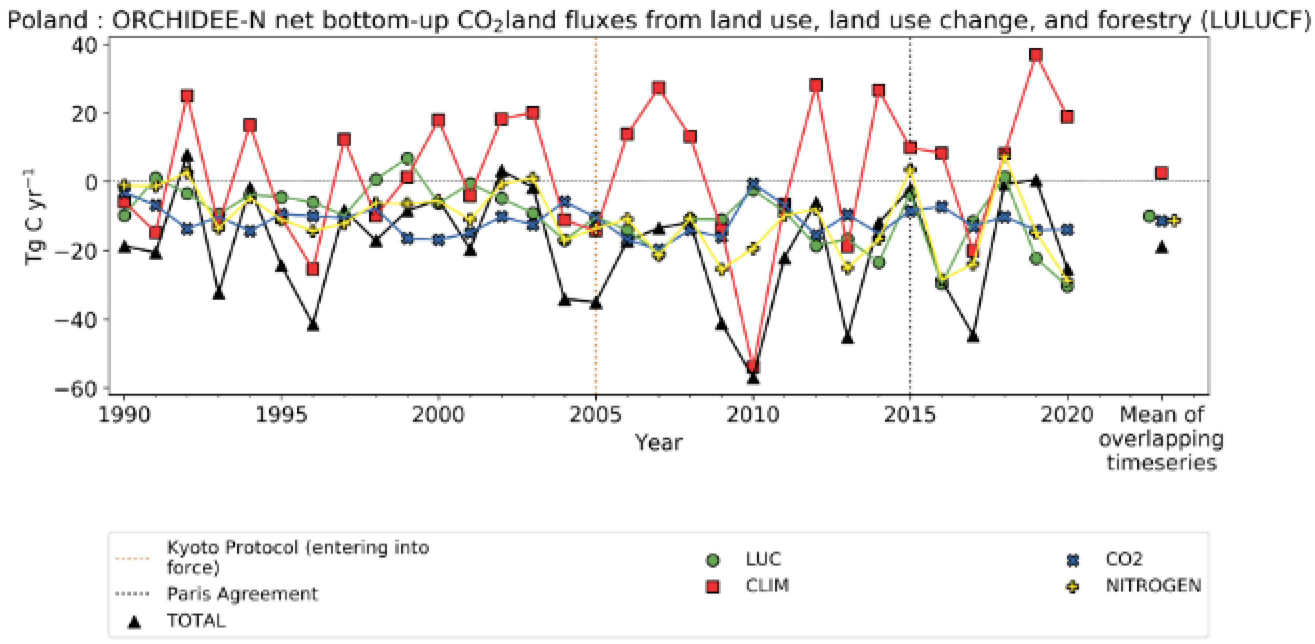


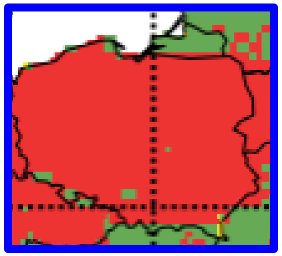


WP3 – NBP ATTRIBUTION

Dynamic global vegetation models (TRENDY)

Factorial experiments

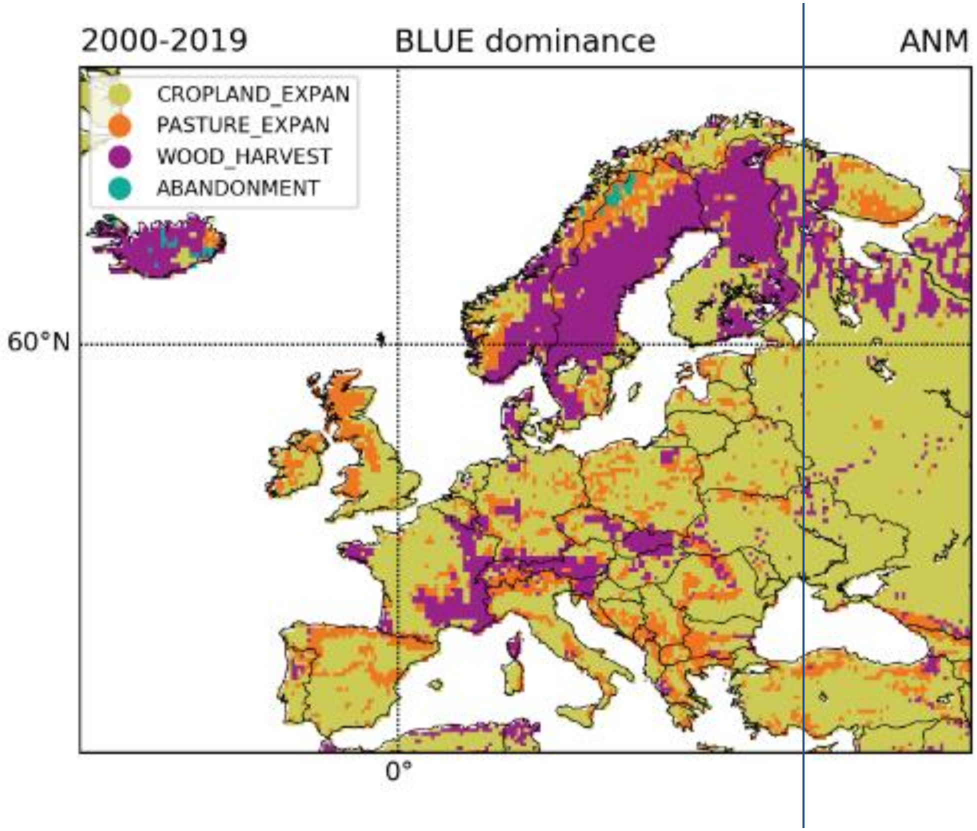




WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

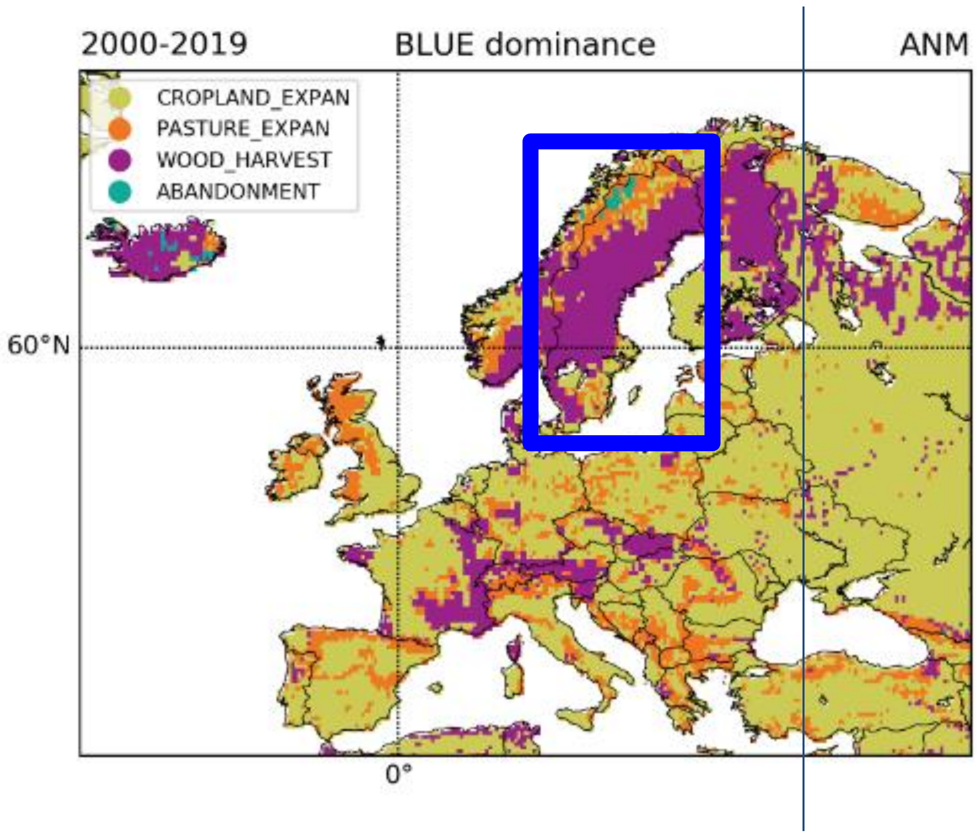
Emission components



WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

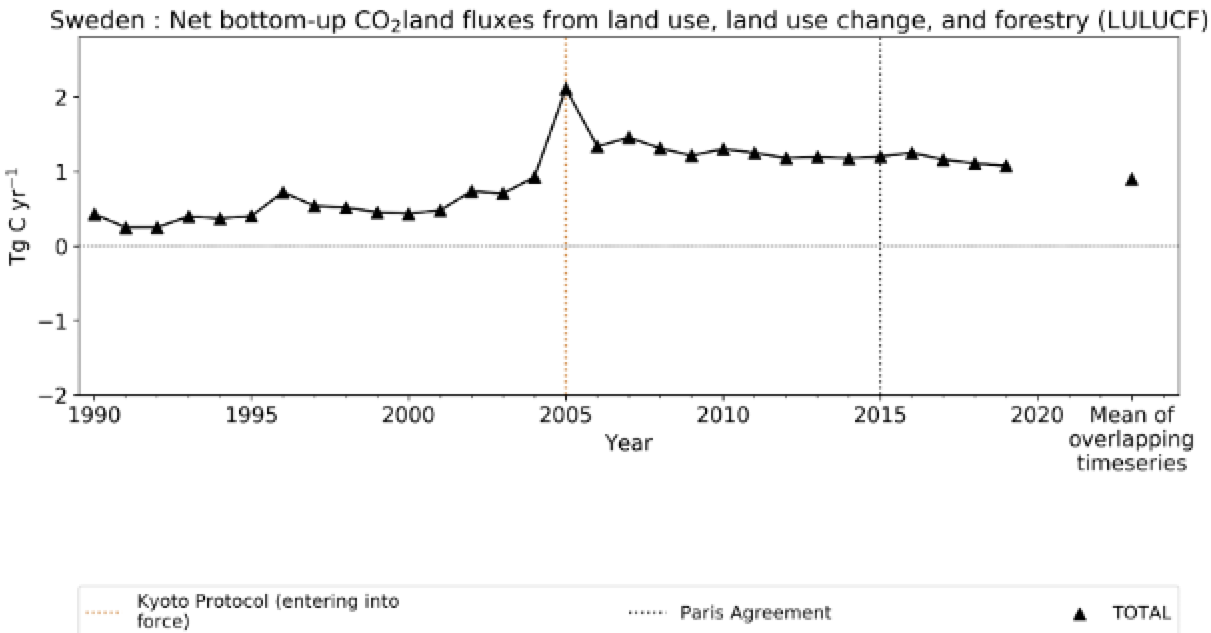
Emission components

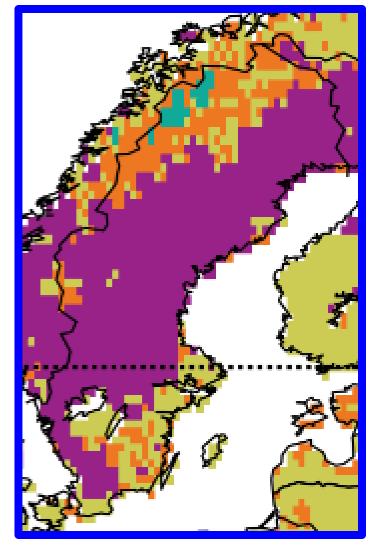


WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

Emission components

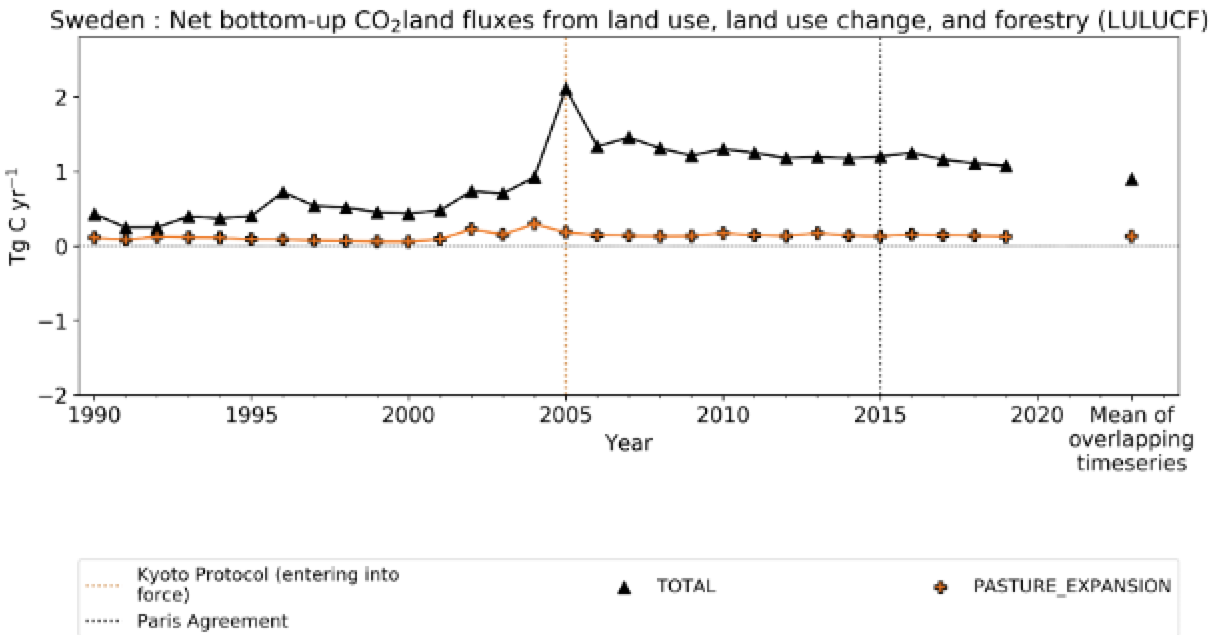


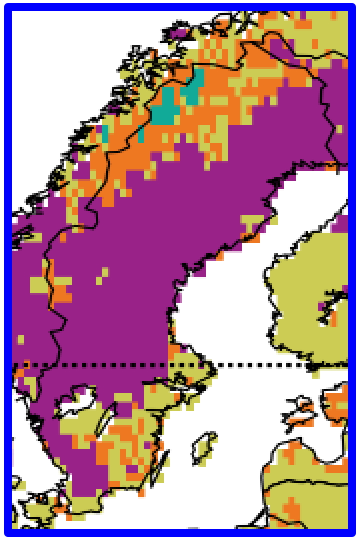


WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

Emission components

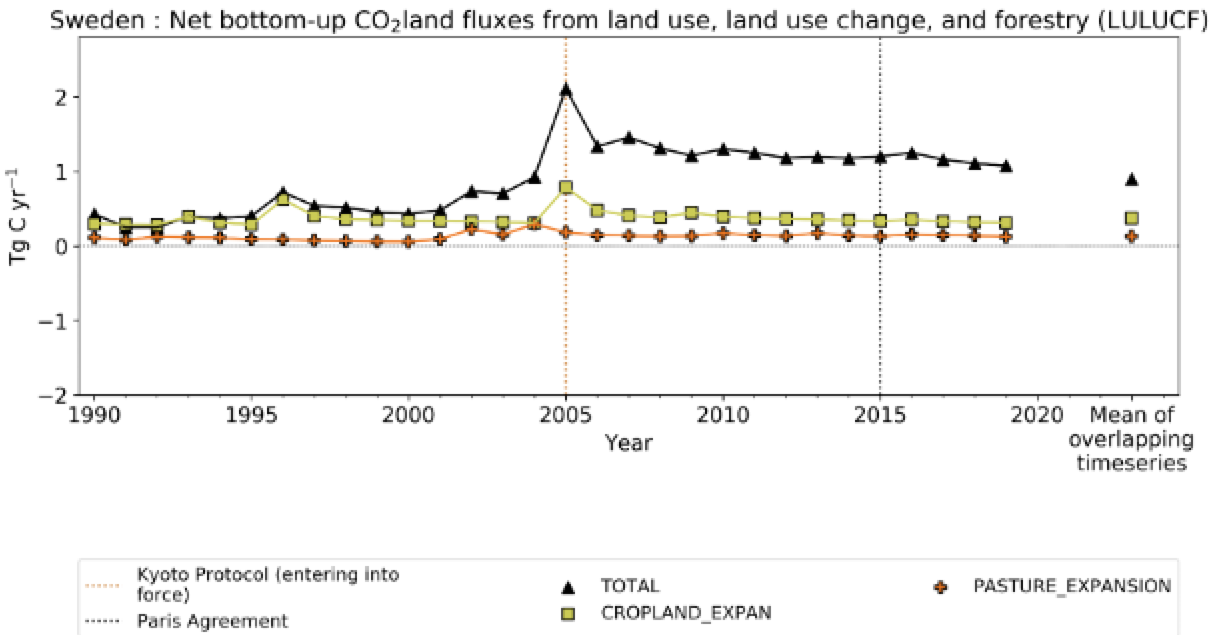


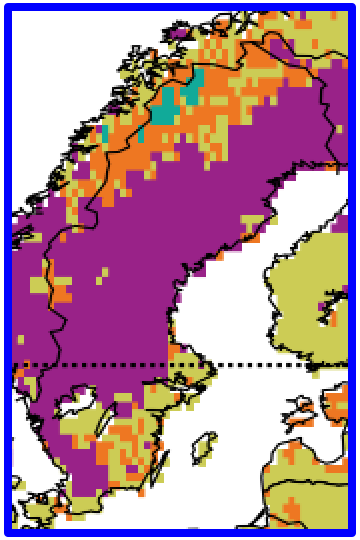


WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

Emission components

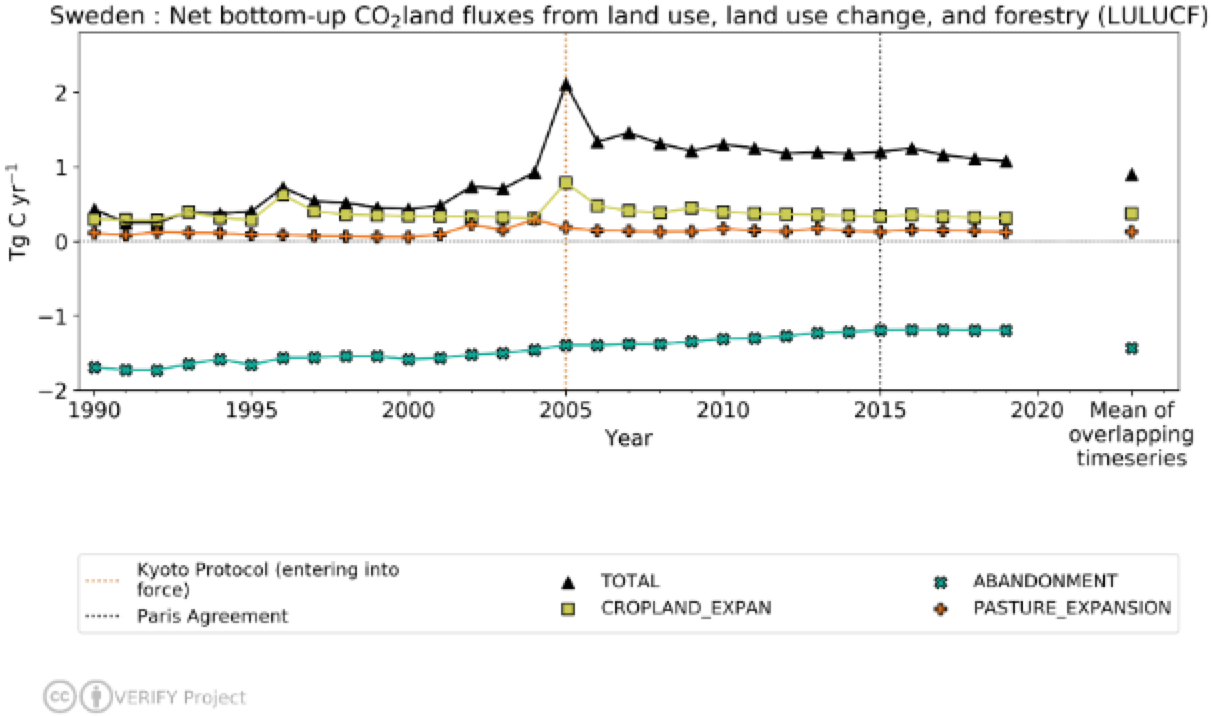


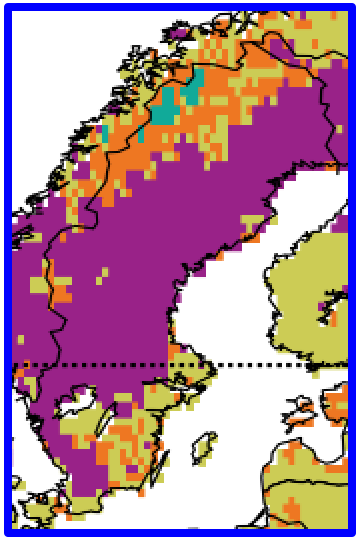


WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

Emission components

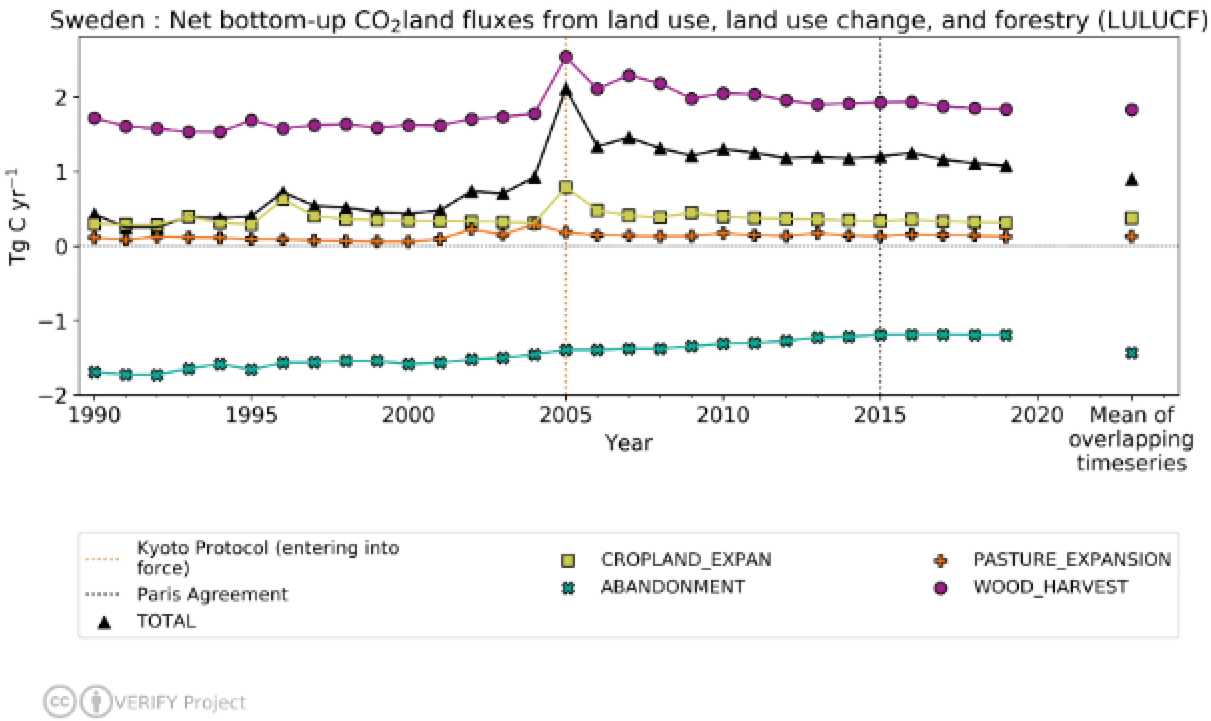


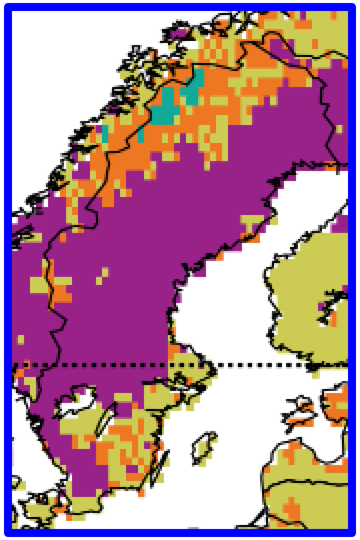


WP3 – NBP ATTRIBUTION

Bookkeeping models (BLUE)

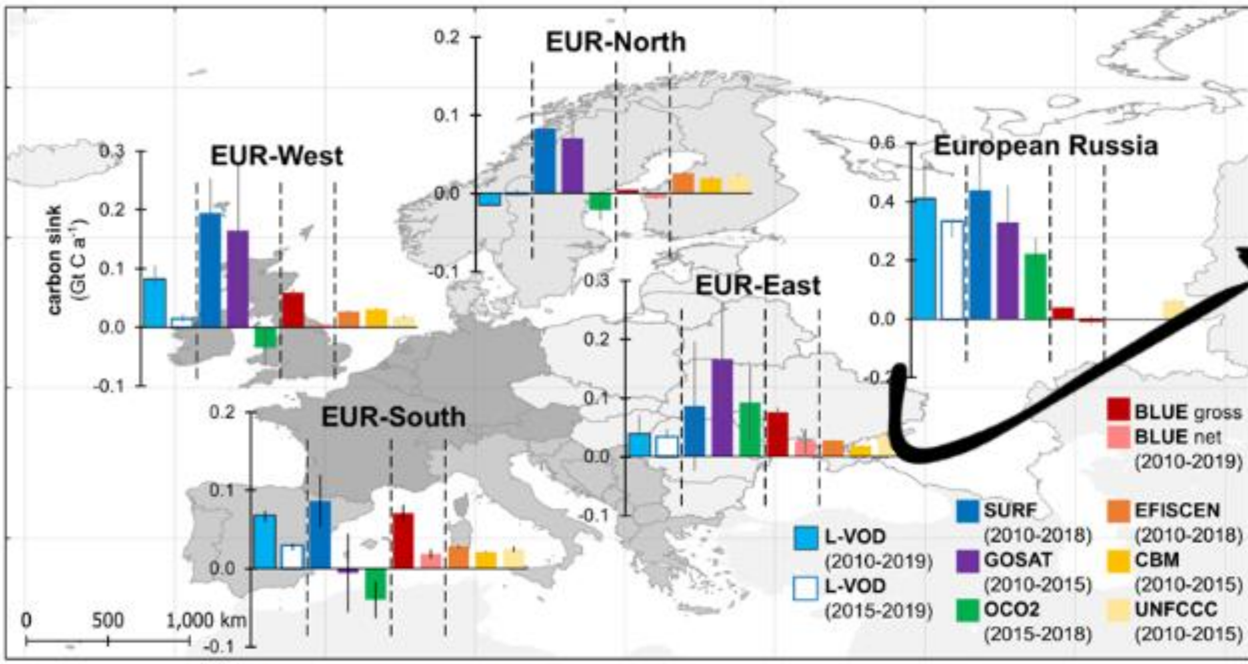
Emission components





WP3 – EASTERN EUROPE SINK

1. How large is the EE carbon sink?



Carbon uptake from L-VOD AGB change, satellite inversions (SURF, GOSAT, OCO2), land use emission models and inventories (BLUE, EFISCEN, CBM, UNFCCC) across Europe between 2010 and 2019.

75% of the pan-European carbon uptake

EUR-East and Russia

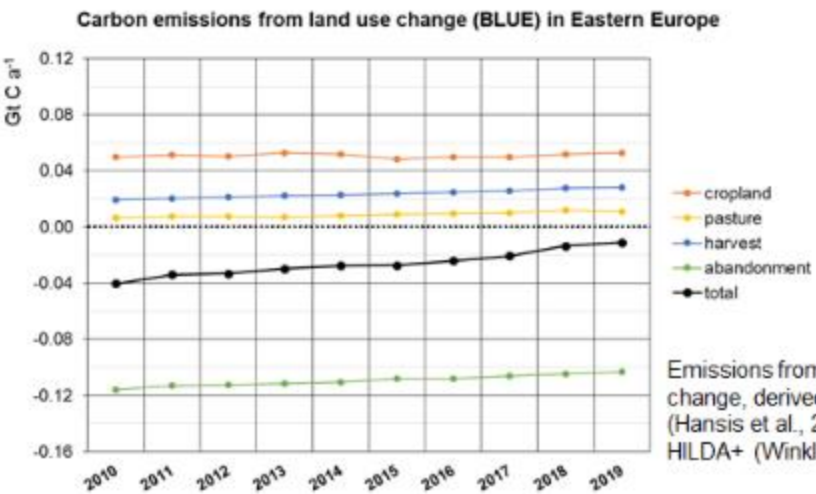
L-VOD* (2010-2019)	~0.46 Gt C a^{-1}
SURF (2010-2018)	~0.53 Gt C a^{-1}
GOSAT (2010-2015)	~0.50 Gt C a^{-1}
OCO2 (2015-2019)	~0.32 Gt C a^{-1}

*biomass only

Winkler et al., in prep.

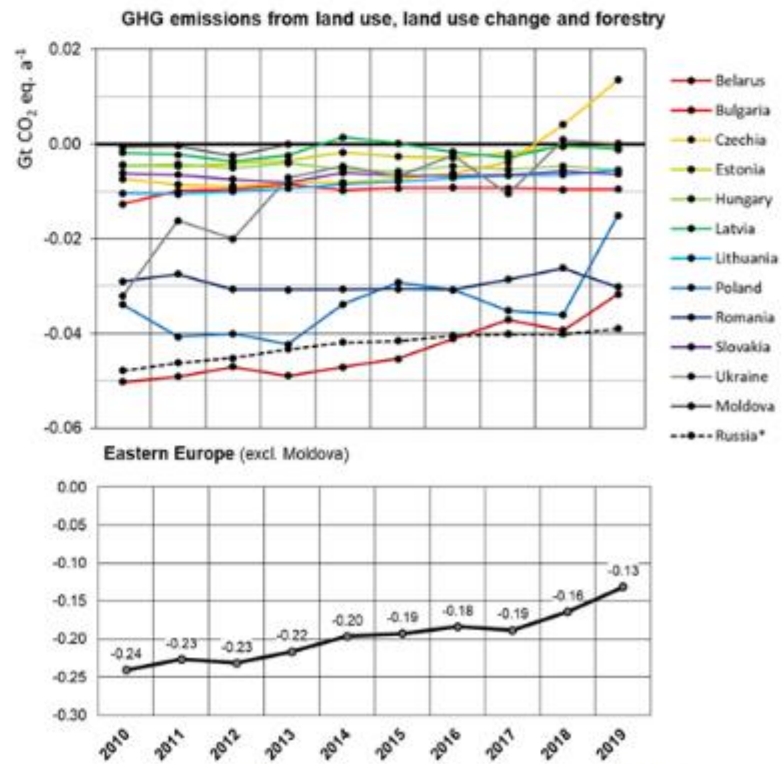
WP3 – EASTERN EUROPE SINK

2. What are the temporal patterns?



Emissions from land use change, derived from BLUE (Hansis et al., 2015) and HILDA+ (Winkler et al., 2021)

Decline of the land carbon sink

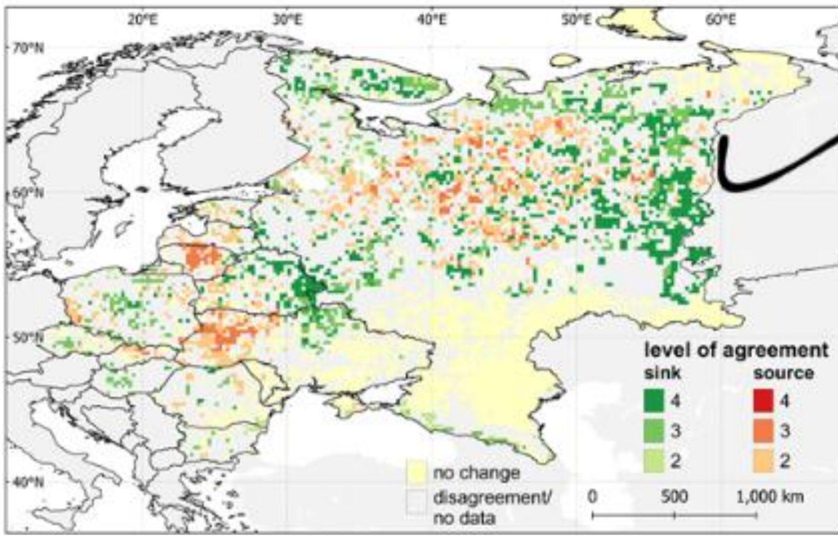


Emissions from land use, land use change and forestry (UNFCCC).

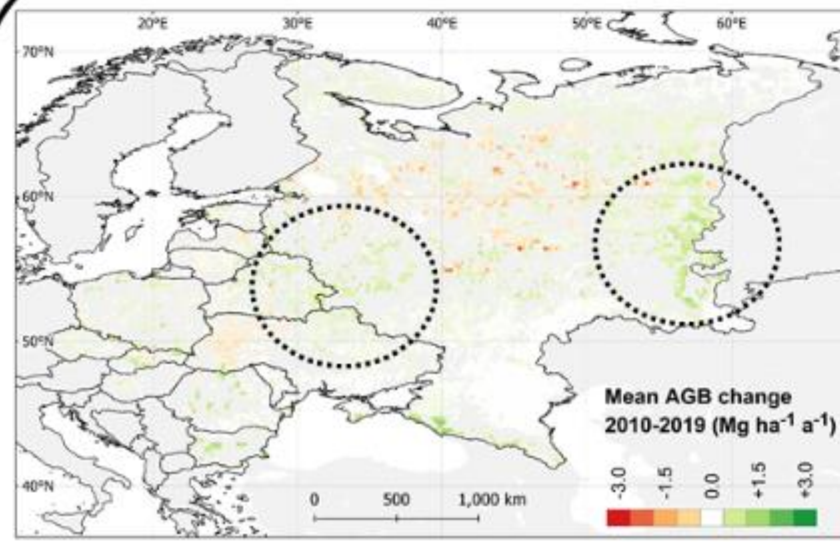
Winkler et al., in prep.

3. What are the spatial patterns?

Hot spot regions of carbon uptake



Agreement of datasets: Sources are defined by AGB < -0.05 Mg C ha^{-1} a^{-1}, sinks by AGB > 0.05 Mg C ha^{-1} a^{-1}.

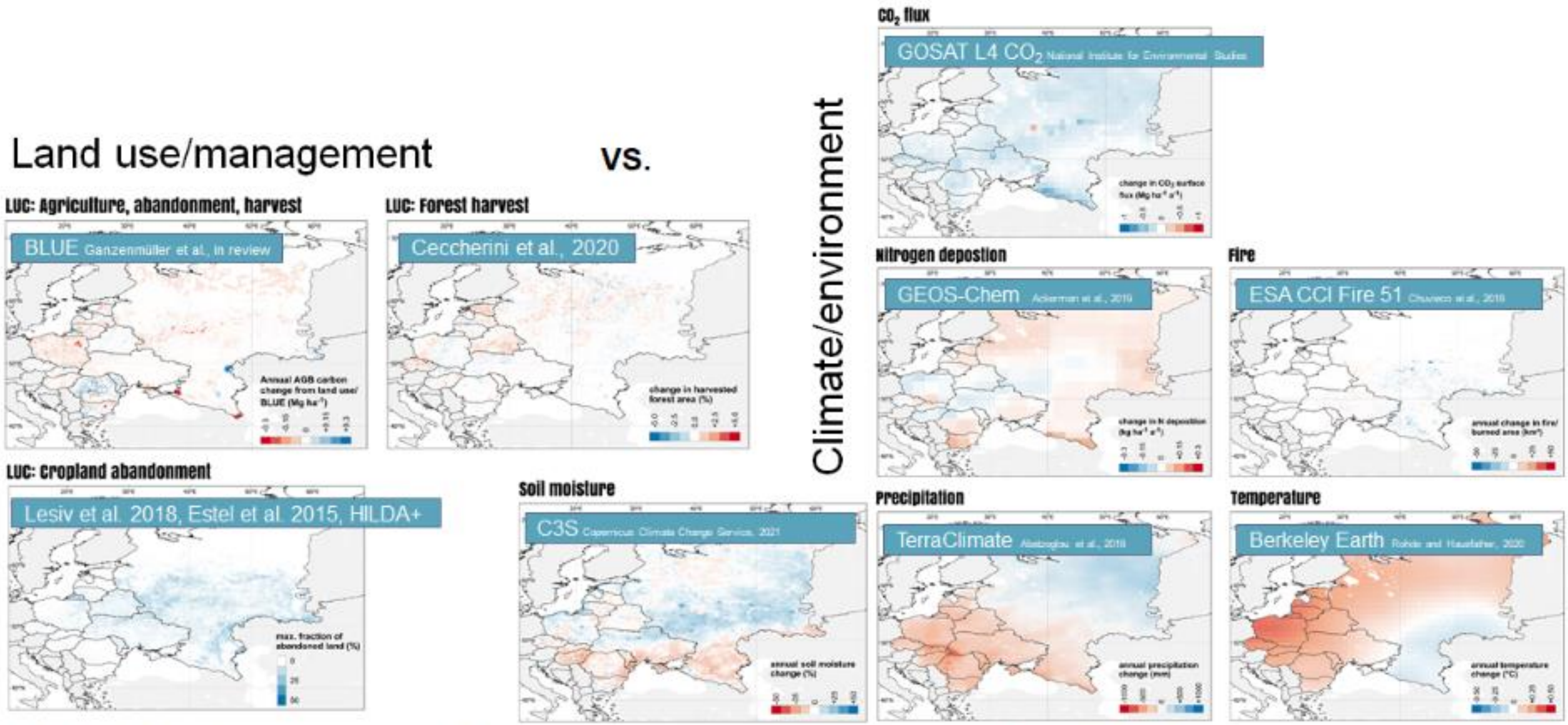


Carbon gains and losses in AGB (in Mg C ha^{-1} a^{-1}) in Eastern Europe during 2010-2019 from a) TRENDY S3 (mean of 15 models), b) JPL: Xu et al. 2021, c) L-VOD and d) bias-adjusted WRI: Harris et al. 2021.

Winkler et al., in prep.

WP3 – EASTERN EUROPE SINK

4. What are the drivers?



Spatial trends of possible underlying drivers and influencing factors of AGB carbon change in Eastern Europe during 2010-2019.

Winkler et al., in prep.

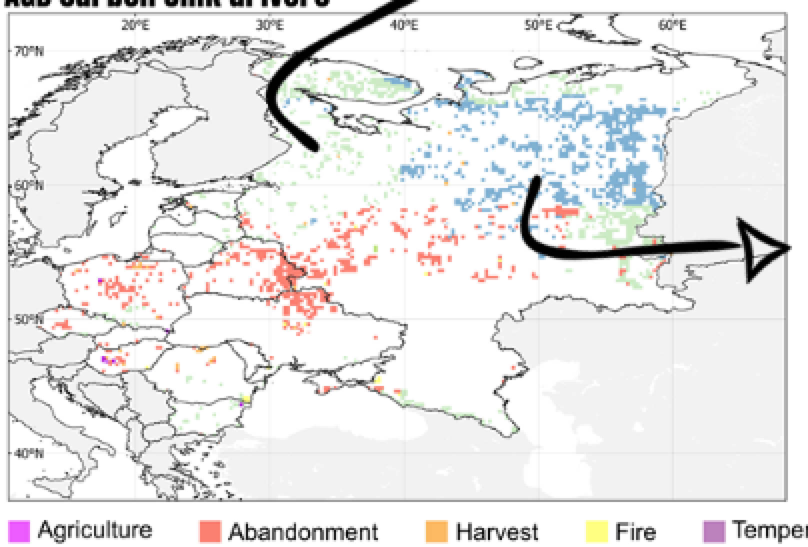
WP3 – EASTERN EUROPE SINK

4. What are the drivers?

Land use/management:
Cropland Abandonment in border region Belarus/Ukraine/Russia

Climate/environment:
Precipitation and Nitrogen deposition in eastern European Russia

AGB carbon sink drivers



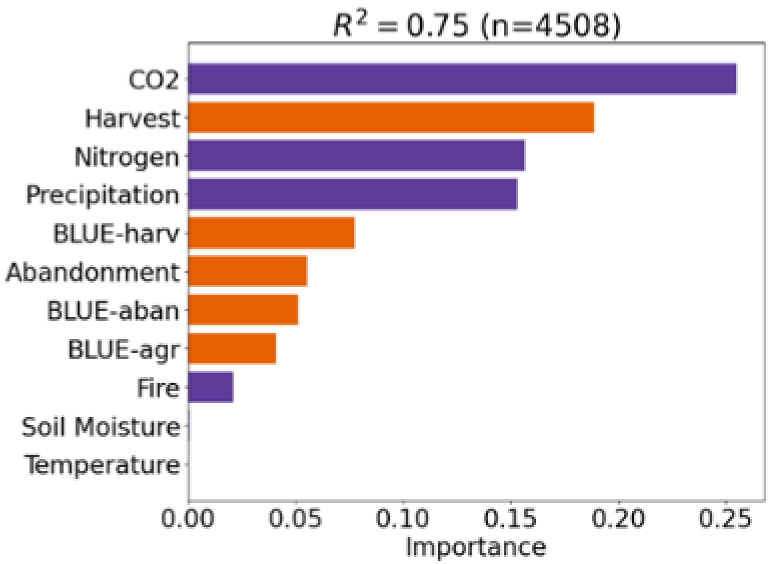
Spatial patterns of drivers of AGB carbon change in Eastern Europe during 2010-2019.

Winkler et al., in prep.

WP3 – EASTERN EUROPE SINK

4. What are the drivers?

AGB carbon sink



Land use/management

Environment

Relative feature importance of driver variables for AGB change across Eastern Europe (Random Forest regression)

Driver analysis based on Random Forest regression

- ❑ Climate factors, CO2 fertilization and N deposition as most important drivers
- ❑ Land use/management, wood harvest as cause of the decreasing land carbon sink?

Winkler et al., in prep.

WP3 – EASTERN EUROPE SINK

Take-away

- Eastern Europe: ~0.46 Gt C a^{-1} → **75% of the European carbon uptake**
- Decline of the carbon sink 2010-2019
- Hot spot regions Russian Ural region and ~border Belarus/Ukraine/Russia

Driver analysis

- Land use change (abandonment) in hot spot region
- Climate change (CO_2 fertilization, N deposition, precipitation) in European Russia
- Forest management (harvest) as reason for the declining sink?

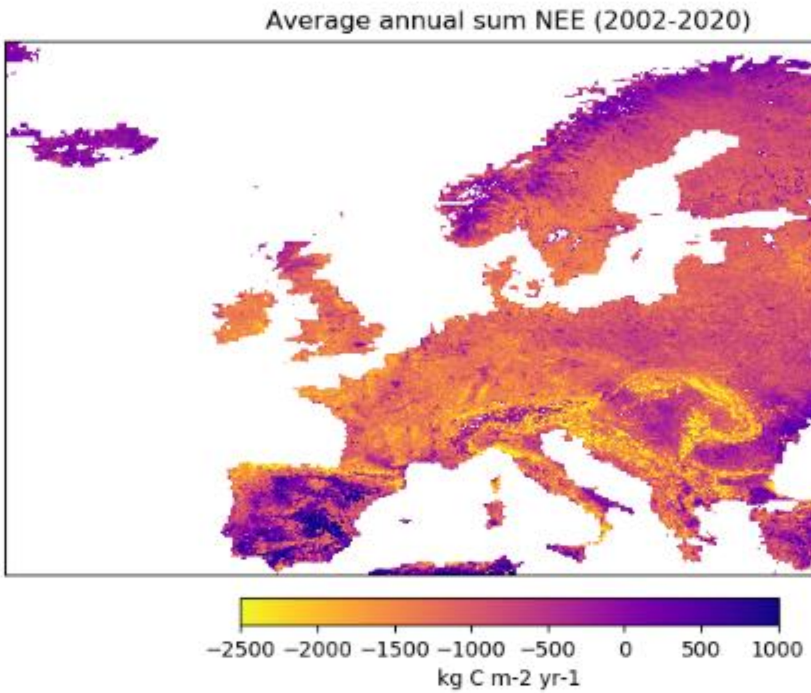
Vladimir Evgenievich Pamphilov https://pitt.libguides.com/c.php?g=494797&p=3385702

Winkler et al., in prep.

WP3 : T3.4 - ADDITIONAL PRODUCTS

⇒ More data were produced within WP3

- FLUXCOM (data-driven flux estimates): 3-hr ; ~ 5 km



➢ Not used yet in the CO2 synthesis because of too large NEE !

➢ But recent progresses reveal a bias partly linked to shortwave radiation forcing !

- Carbon Cycle Data Assimilation Systems (Fusion of process-based models and observations)

T3.4 Carbon Cycle Data Assimilation Systems

BETHY-CCDAS

Assimilation of

- Satellite soil moisture
- Satellite L-VOD
- In situ atm. CO2 data
- Nighlights (for FF model)

Two-step assimilation

- Fossil Fuel at 0.1 in FFDAS
- Biogenic fluxes at 0.25 in CCDAS

Optimisation of

around 70 parameters in CCDAS and 1.5M in FFDAS

ORCHIDEE-CCDAS

Assimilation of

- FluxNet in situ data
- Satellite Fluorescence
- In situ atm. CO2 data (using LMDZ model)

Optimisation of

- around 150 parameters
- stepwise assimilation of each datastream

CTDAS

Dynamic a-priori fluxes

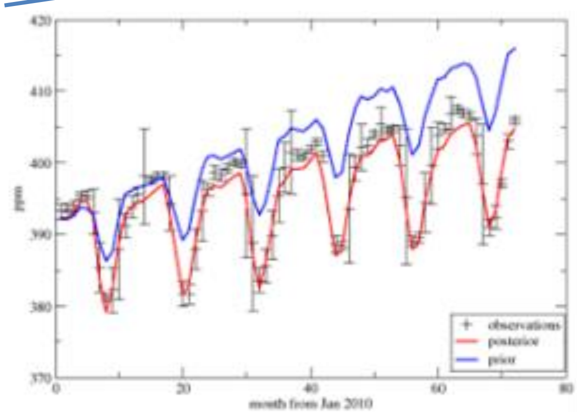
Near real-time statistical data (EU, Eurostat,...) and weather data to fill in short-term variations in fluxes at ~2km

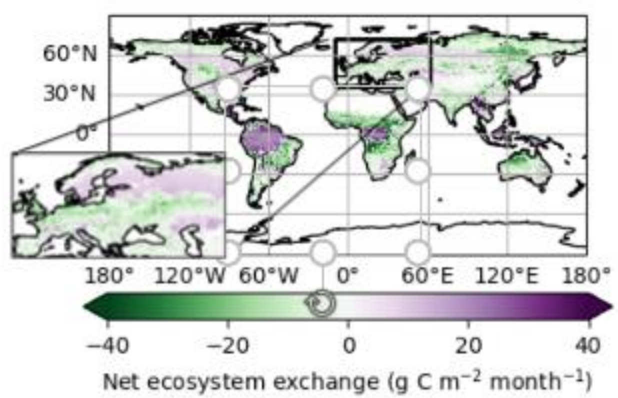
Assimilation of

- ICOS CO2 mole fractions
- Δ14C, CO, NO2

Optimisation of

~10 params per country, sectorial FF emissions, NEE / PFT

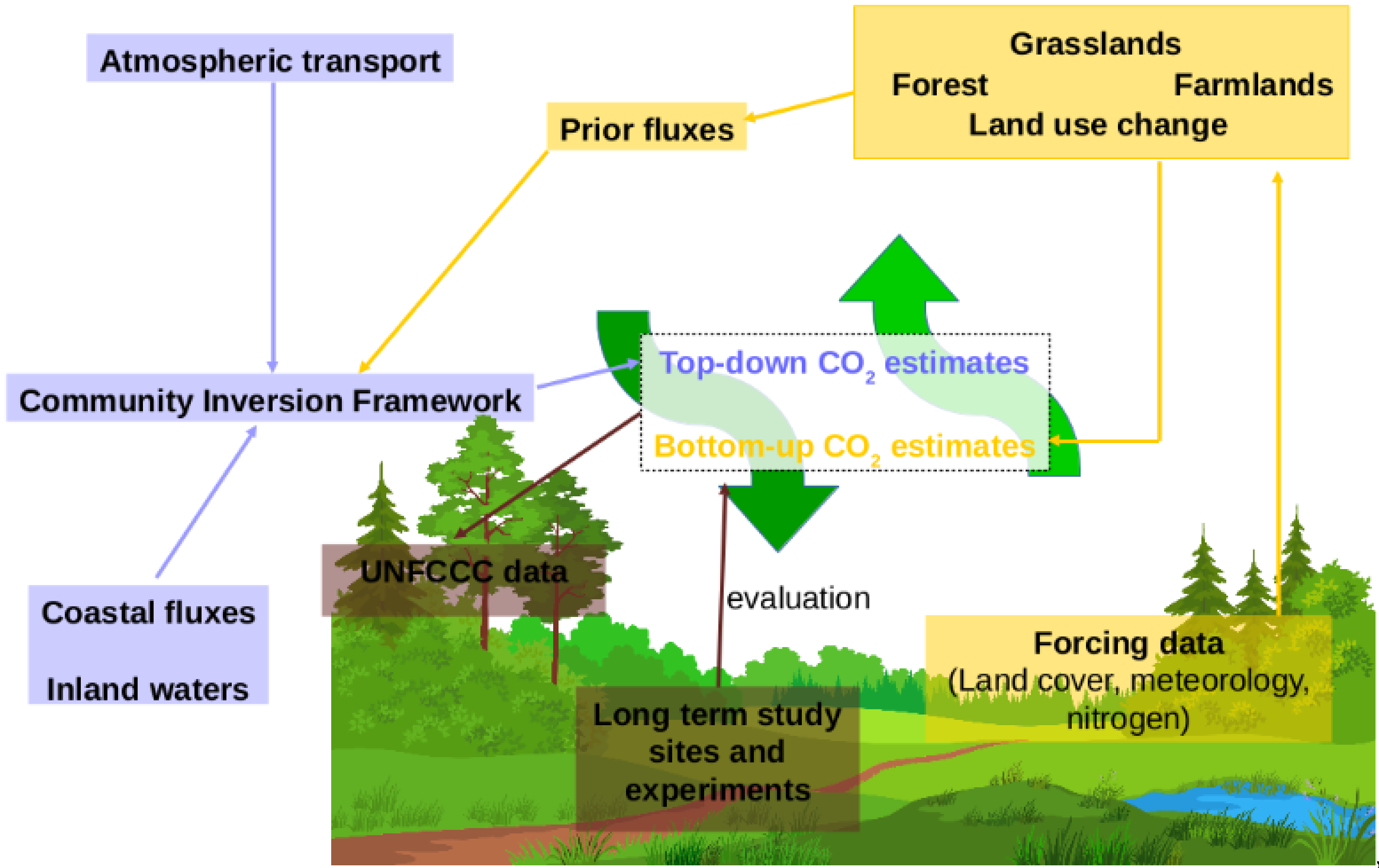




⇒ see D2.13

WP3 "CO2 land Pre-operational system"

Pre-operational system for CO_2 fluxes from terrestrial ecosystems



WP3 – Status of last deliverables

D3.7	Attribution analysis	CEA	Draft on-going
D3.14	National forest inventory and high resolution forest cover for eastern Europe	WEnr	Final version ready (proof reading phase)
D3.16	Analysis of NEE and carbon balance of Eastern Europe	CEA	Draft done based on a paper
D3.17	Final version of pre-operational system for terrestrial CO2 verification	UNIABD	Draft on-going

VERIFY

Thank you for your attention.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776810

WP3 PARTNERS

Two co – leaders:

University of Aberdeen (**UNIABDN)**,
Commissariat à l'énergie atomique (**CEA**),

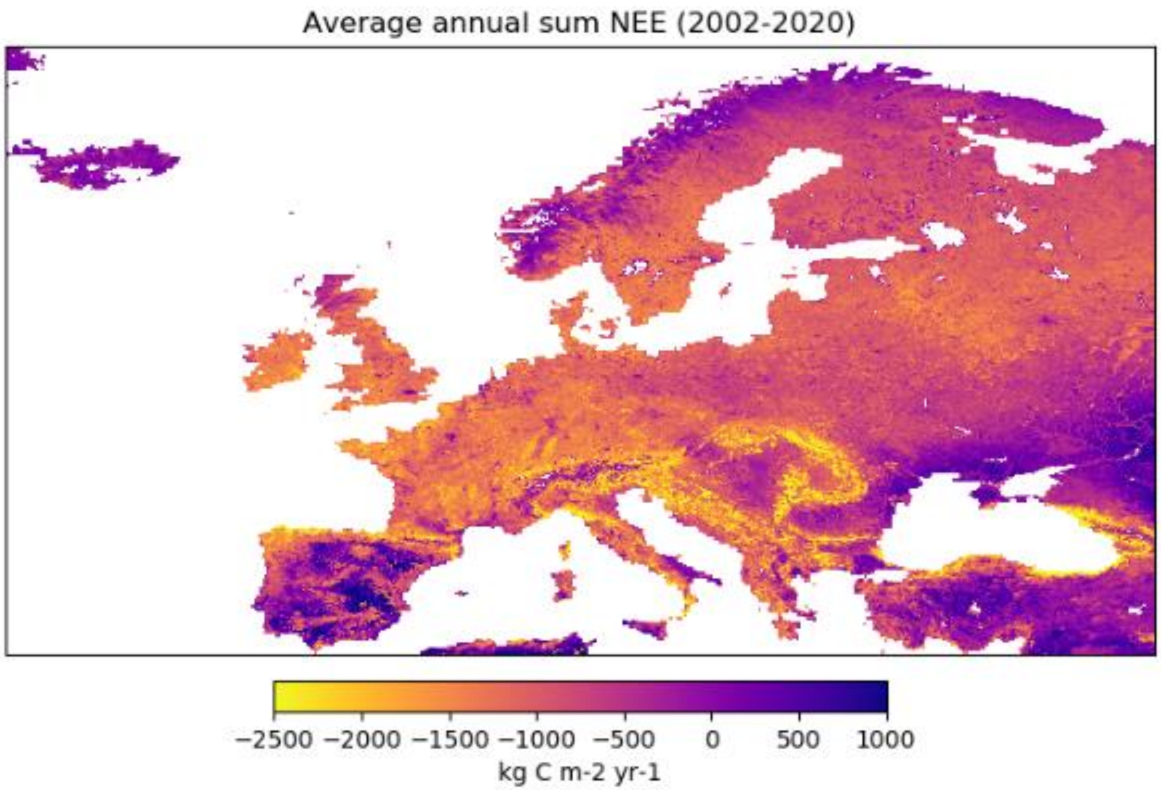
18 partners:

Joint Research Centre (**JRC**), Karlsruhe Institute of Technology (**KIT**),
Max Planck Society for the Advancement of Science (**MPG**),
Norwegian Institute for Air Research (**NILU**),
International Institute for Applied Systems Analysis (**IIASA**),
Integrated Carbon Observation System (**ICOS**) ERIC,
European Centre for Medium-Range Weather Forecasts (**ECMWF**),
Wageningen Environmental Research (**WEnR**),
University of Bremen (**UBremen**), University of East Anglia (**UEA**),
Vrije Universiteit Amsterdam (**VU**), Lund University (**ULUND**),
University of Bergen (**UiB**), Wageningen University & Research (**WUR**),
Université libre de Bruxelles (**ULB**), Saint Petersburg State University (**SPbU**),
Ural Federal University (**UrFU**), Ludwig-Maximilian Munich University (**LMU**)

Additional slides

WP3 – BOTTOM-UP DATA-DRIVEN BIOGENIC FLUXES

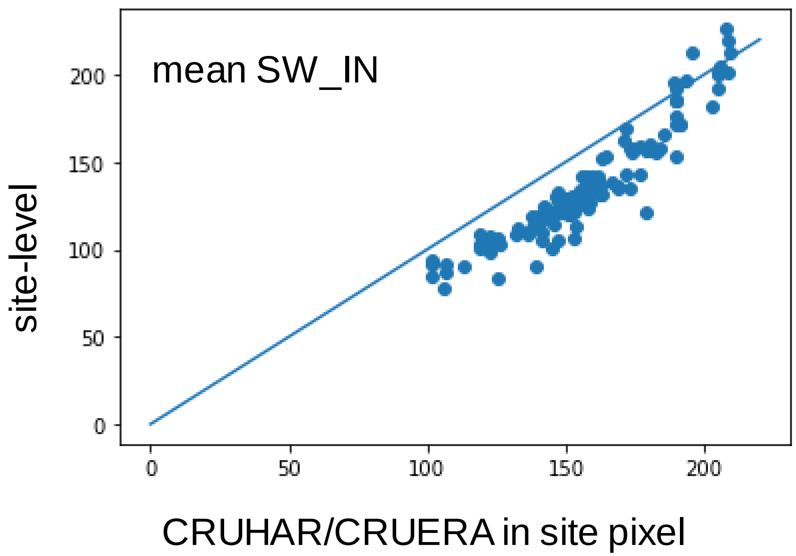
New generation Fluxcom: upscaling of eddy-covariance measurements using Earth observation and machine learning

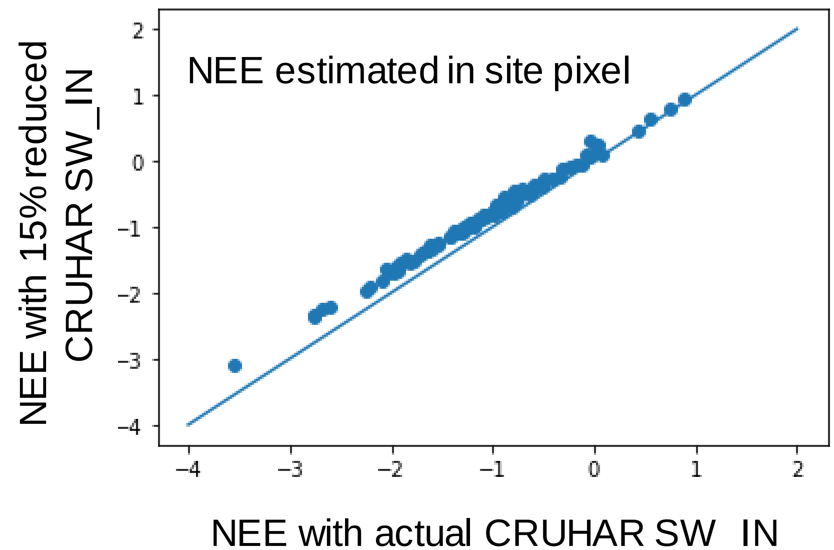


European flux estimates every 3 hours, 0.05deg

WP3 – BOTTOM-UP DATA-DRIVEN BIOGENIC FLUXES

The importance of meteorological fields: very strong sink in Fluxcom NEE partly related to bias in shortwave incoming radiation:

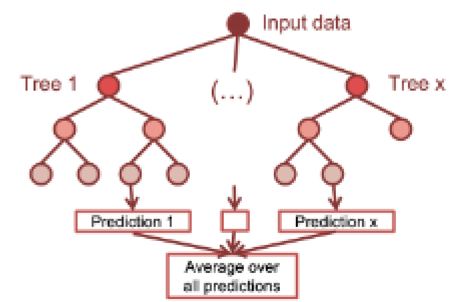




15% average bias between site-level and gridded incoming radiation → 21% biased NEE on average

WP3 – Coastal Air-Sea CO_2 Fluxes

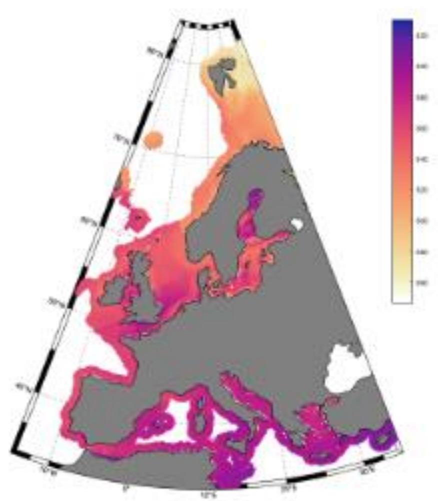
Meike Becker, Are Olsen,
University of Bergen



Annual updated coastal CO_2 flux maps on the European shelf (1998-2020):

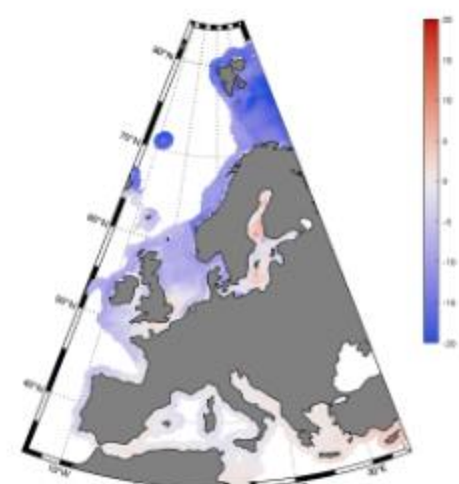
Fitting a set of driver data (e.g. temperature, chlorophyll concentration, mixed layer depth, ice concentration) against surface ocean *p*CO_2 observations

***p*CO_2 / µatm (average 1998-2020)**



- **Sinks for CO_2:**
  - Barents Sea
  - Nordic Seas
  - Northern and Central North Sea
  - Atlantic shelf
- **Sources for CO_2:**
  - Southern North Sea and English Channel
  - Baltic Sea
  - Mediterranean

Air-Sea CO_2 Flux / gC m^{-2} yr^{-1}



2010-2020