The European Commission's science and knowledge service

Joint Research Centre

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A (pale) green revolution for the ‘Green Deal’

E. Lugato,

A. Cescatti, G. Ceccherini, A. Jones, G. Duveiller

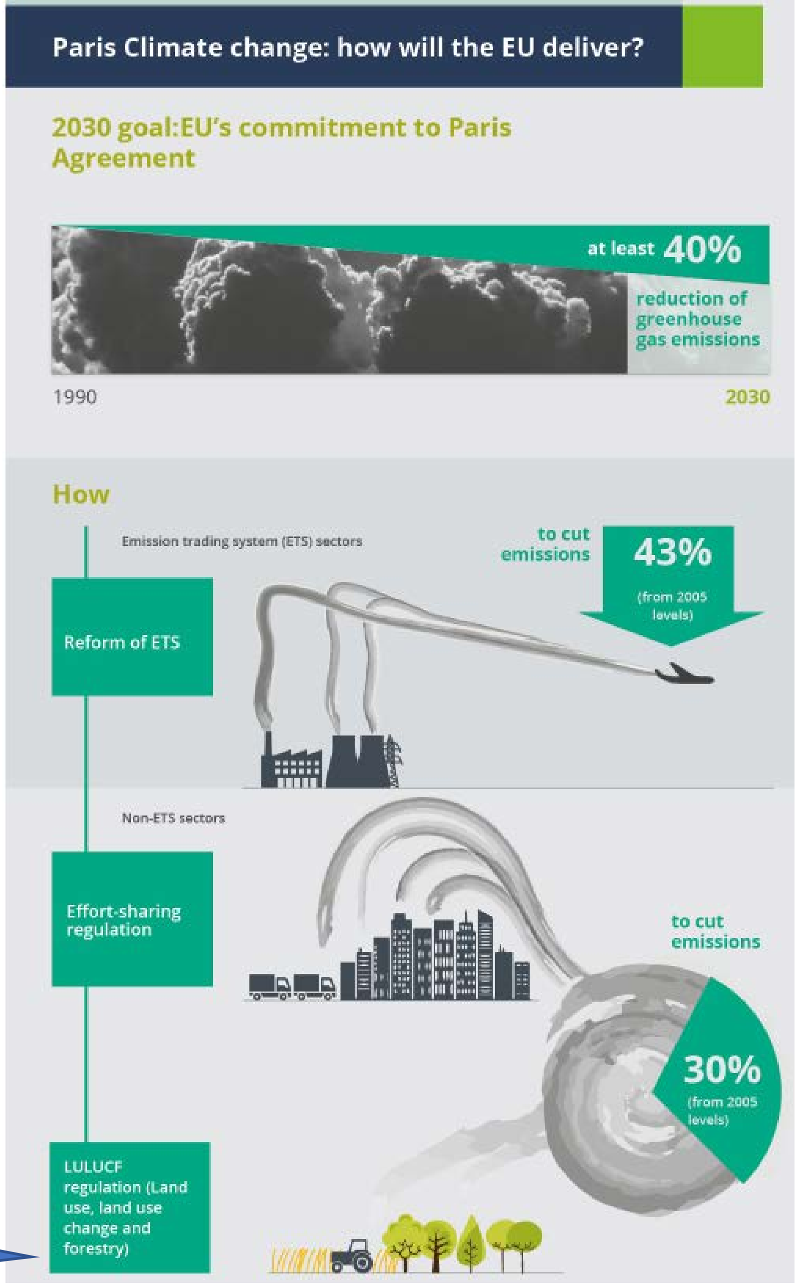
Workshop "Can albedo change offset the climate benefit of carbon sequestrating practices?"

EU climate strategies and targets

- **up to 2020**
  Kyoto Protocol

- **from 2021 to 2030**
  Inclusion of greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF) into the 2030 climate and energy framework

upgrades of the current accounting methodology
CO_2, N_2O, CH_4



No debit rule 2021-2030

ETS

- Power & heat
- Energy-intensive
- Aviation

Non-ETS

- <u>Agriculture</u>
- Transport
- Taste
- Industrial

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Green Deal

Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, Europe needs a new growth strategy that transforms the Union into a modern, resource-efficient and competitive economy where

- there are no net emissions of greenhouse gases by 2050
- economic growth is decoupled from resource use
- no person and no place is left behind

The European Green Deal is our roadmap for **making the EU's economy sustainable.** This will happen by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all.

EC Proposal for European Climate Law (2020)

- 50-55% GHG reduction by 2030
- AFOLU = 0 by 2035

Agriculture forest and other land uses (AFOLU)

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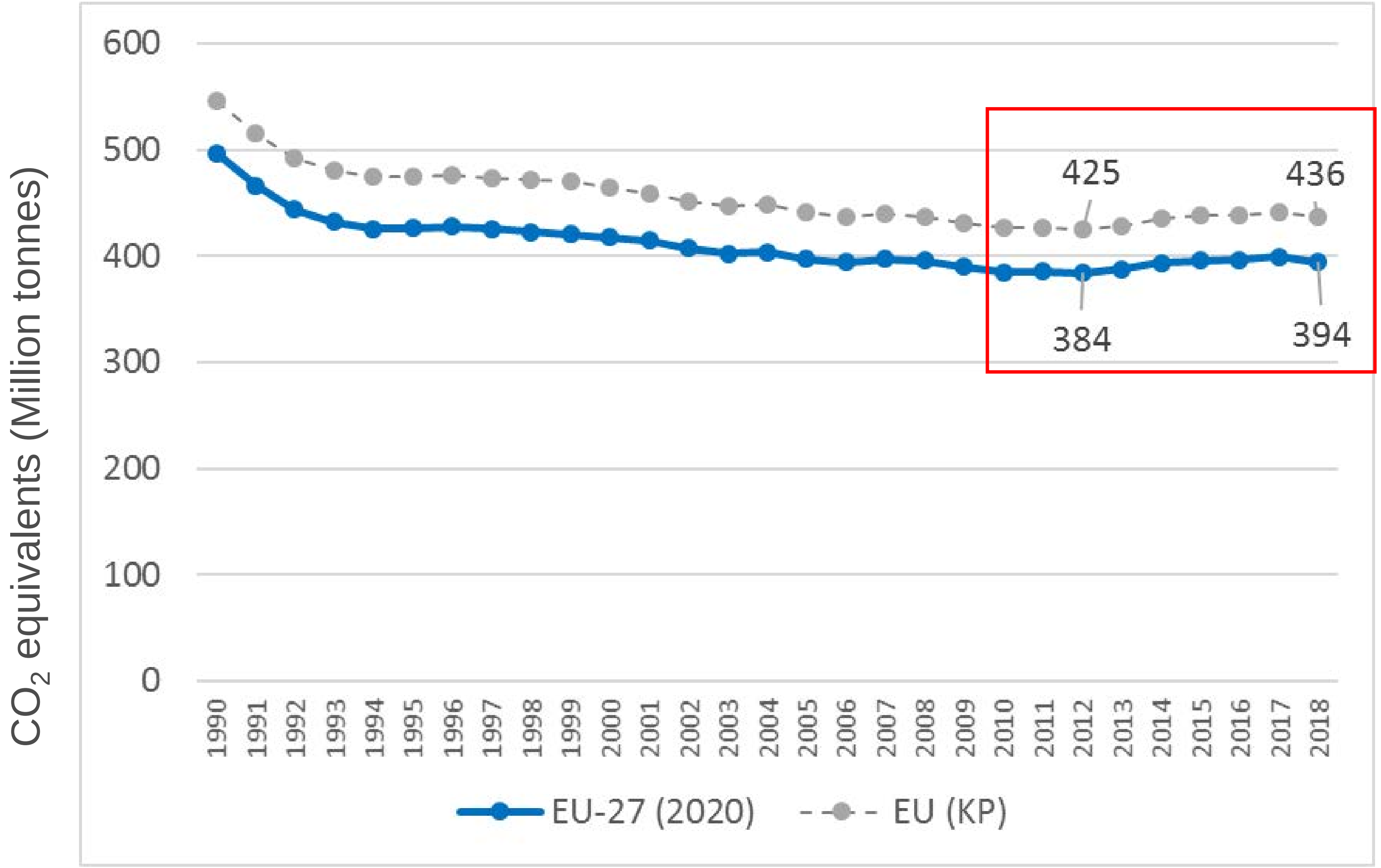
GHG emissions trend from AFOLU



Agriculture

mainly N_2O, CH_4

Data source: EEA (2020). UNFCCC

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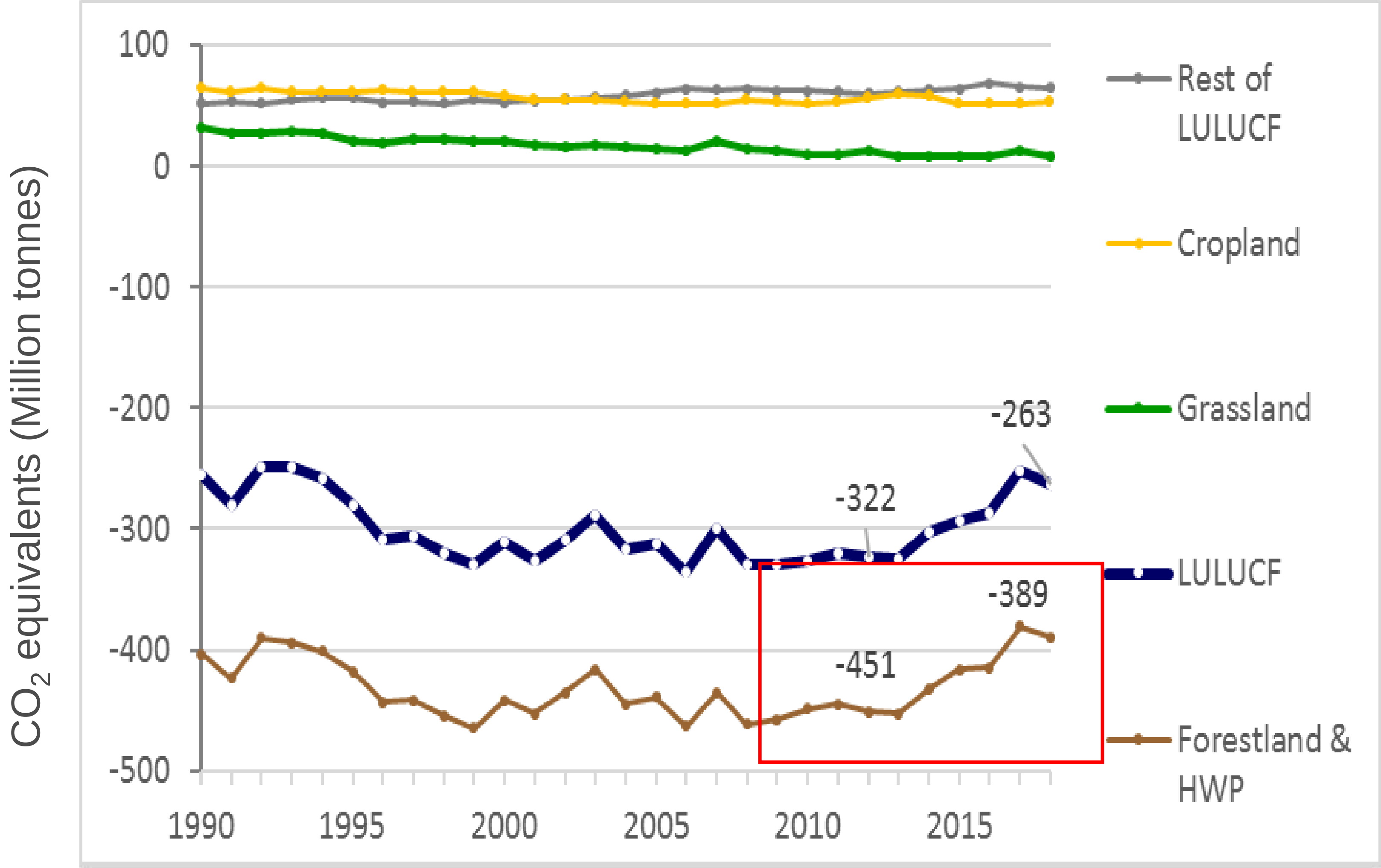
GHG emissions trend from AFOLU



AFOLU = 0 by 2035????

- Climate change
- Extreme events
- Forests ageing
- Sensitivity of SOC pool to warming

MAXIMIZE MITIGATION POTENTIAL!

Looking beyond biogenic GHG

Data source: EEA (2020). UNFCCC

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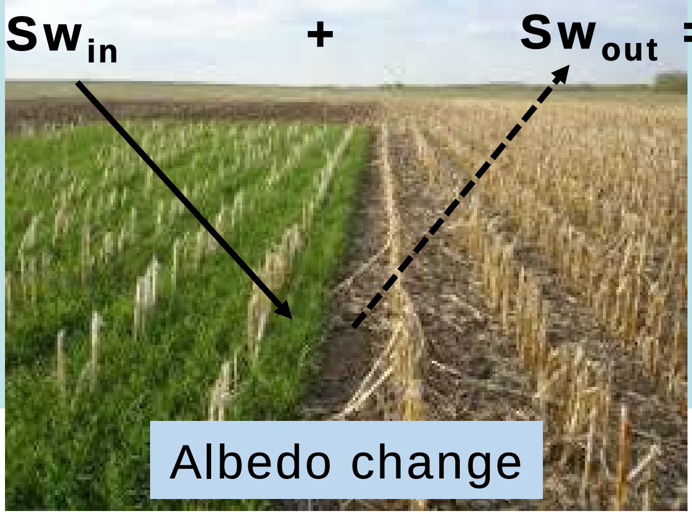
Agricultural management:

Cover crop (CC)

- **Biogeochemical mitigation** (CO_2, N_2O, CH_4)
  Studies largely focused on C sequestration

- **Biogeophysical mitigation**

Sw_{in} + Sw_{out} = +- at TOA



CC adoption at pan-European level
0.16 Mg CO_2e ha^{-1} y^{-1}

Carrer et al., 2018

Carbon sequestration in agricultural soils via cultivation of cover crops – A meta-analysis

Christopher Poeplau[a,b,*], Axel Don[a]

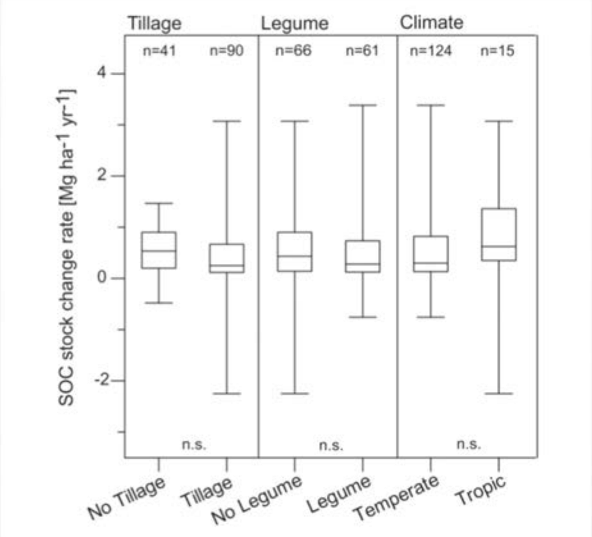
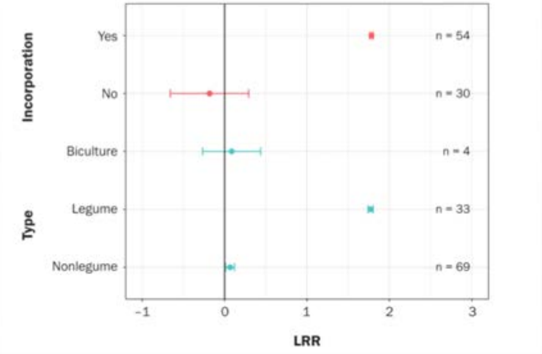


Fig. 5. Boxplots with number of observations for the categorical variables tillage vs. no tillage, plant functional type (no legume vs. legume) and climate zone (temperate vs. tropic).

Figure 4
Mean response ratios (LRR; 95% confidence intervals also shown) for management factors included in the meta-analysis: the type of cover crop and soil incorporation of cover crop residues.



Do cover crops increase or decrease nitrous oxide emissions? A meta-analysis

A.D. Basche, F.E. Miguez, T.C. Kaspar, and M.J. Castellano

Aims of the study

Quantifying the whole mitigation potential of CC and its temporal trend using a consistent data-model framework at EU level

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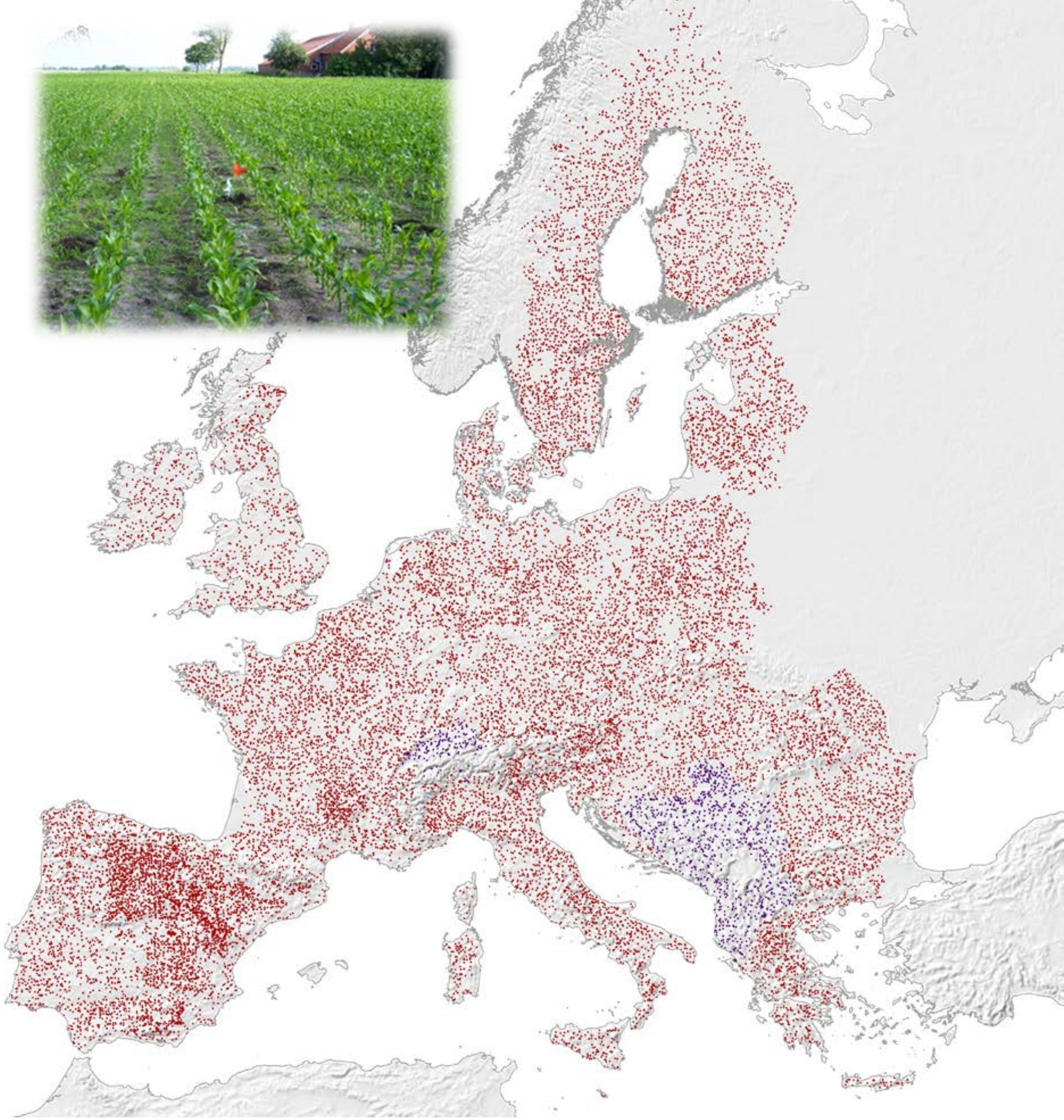
Land **U**se and **C**overage **A**rea frame **S**urvey

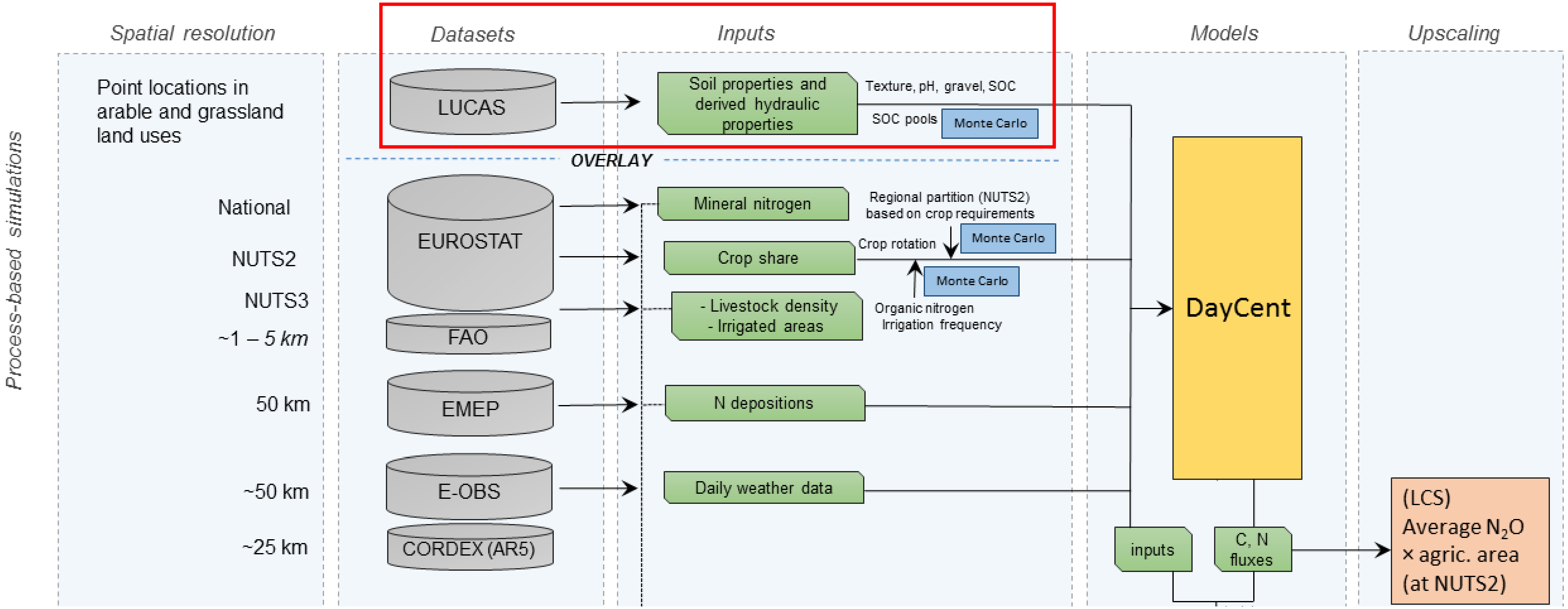


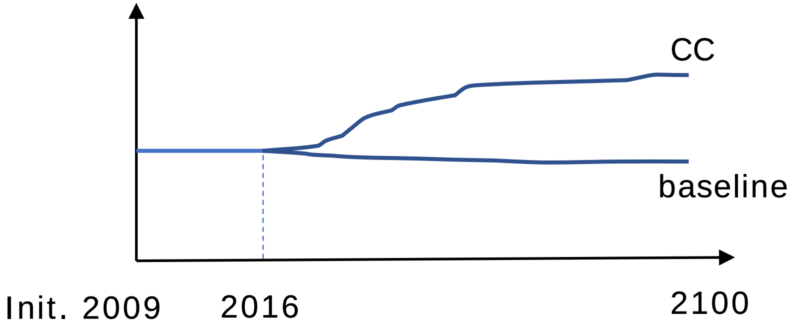
Soil component

- ~ 22’000 topsoil samples
- main physico-chemical soil properties

- 2009 completed
- 2015 completed
- 2018 under analysis

Ground-based data model integration





Daily difference in CO_2 and N_2O

Daily difference in biomass to albedo and to mitigation potential

- Dynamic quantification of C (and N) fluxes
- Scenarios
- Drivers
- LUCAS 2015, 2018 (model validation)

Lugato et al.2020 Maximising climate mitigation potential by carbon and radiative agricultural land management with cover crops. ERL.

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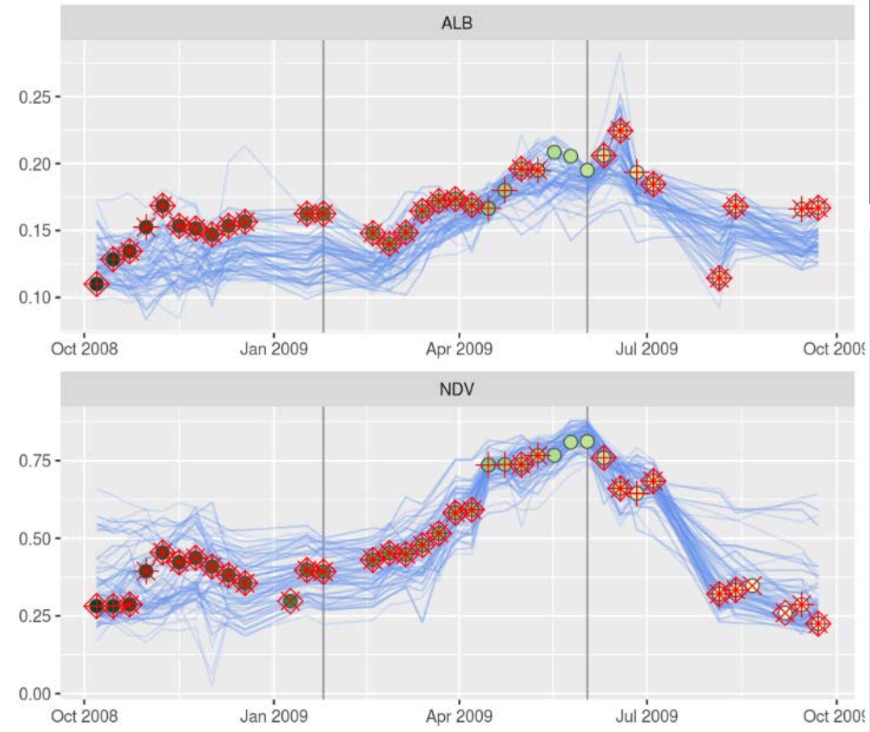
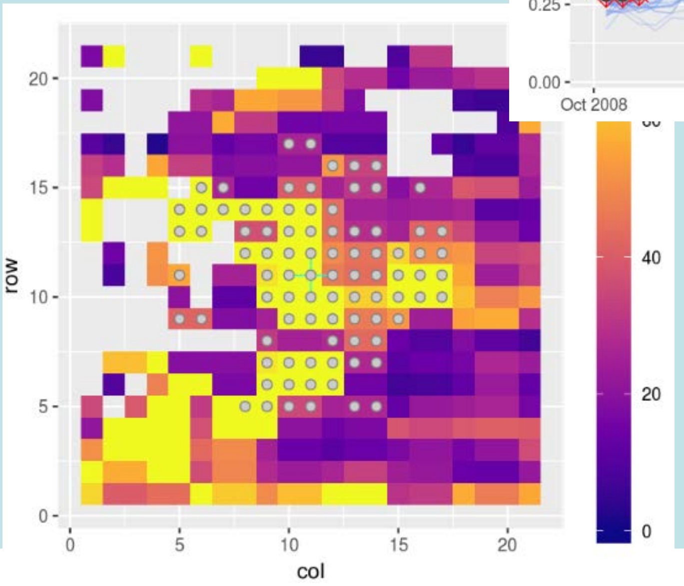
Biophysical relation from remote sensing

For every LUCAS point...

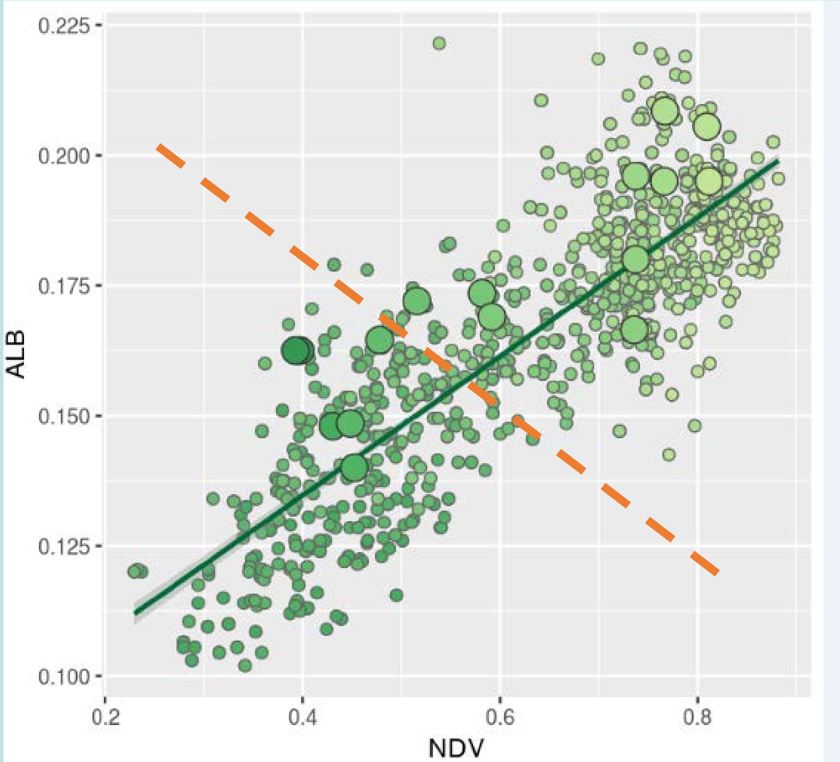


Extract time series of albedo and NDVI (as proxy for cover fraction)



Determine nearby "pure enough" cropland pixels *[SNR method see Duveiller et al. 2015 (RSE)]*

Establish a local relationship between vegetation cover and albedo



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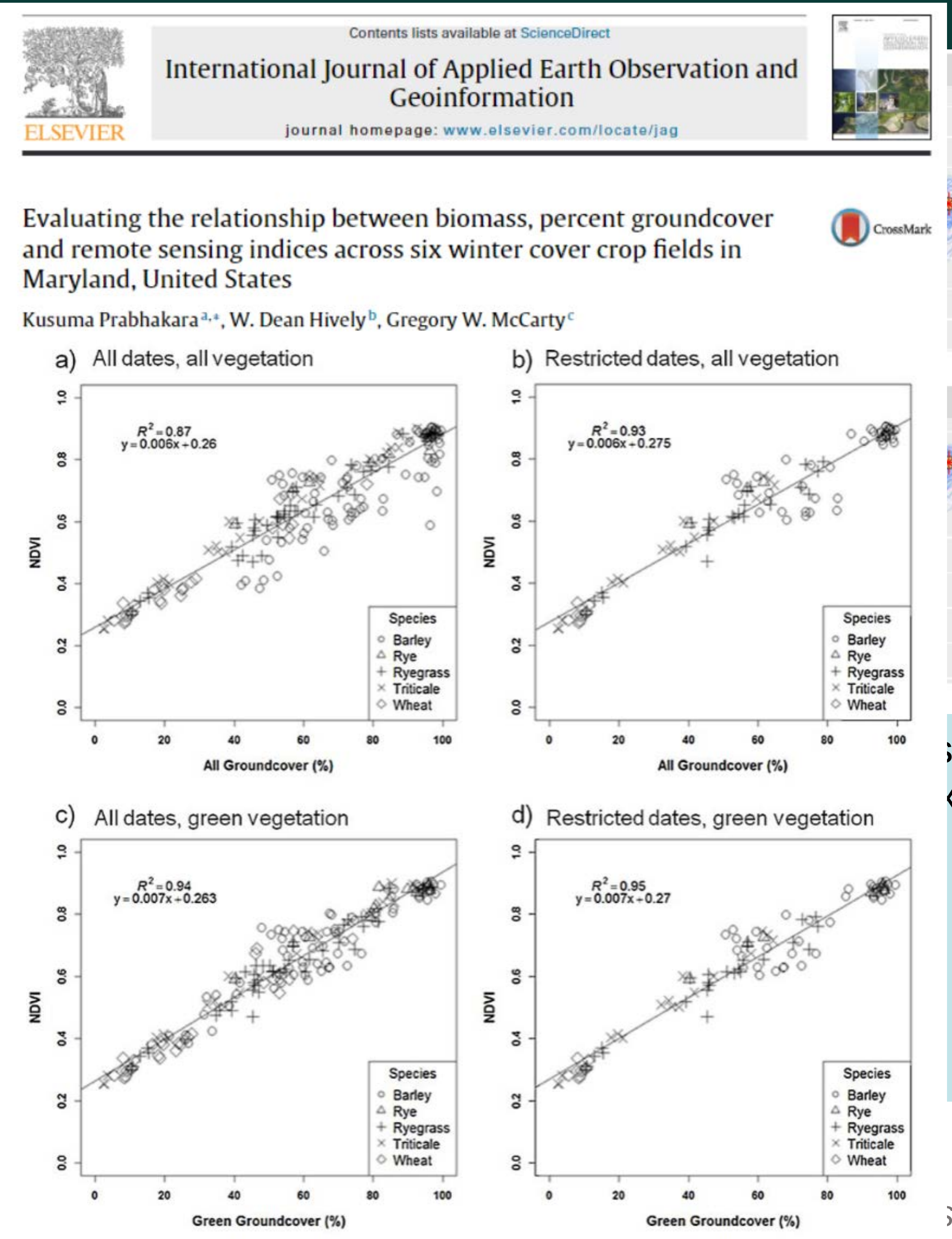
Biophysical relation from remote sensing


Contents lists available at ScienceDirect

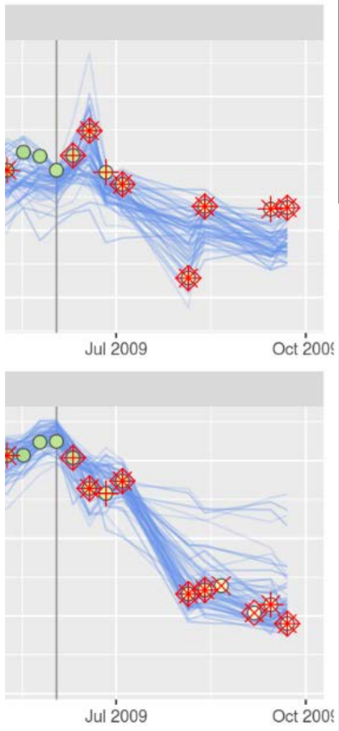
International Journal of Applied Earth Observation and Geoinformation

journal homepage: www.elsevier.com/locate/jag

ELSEVIER

Evaluating the relationship between biomass, percent groundcover and remote sensing indices across six winter cover crop fields in Maryland, United States

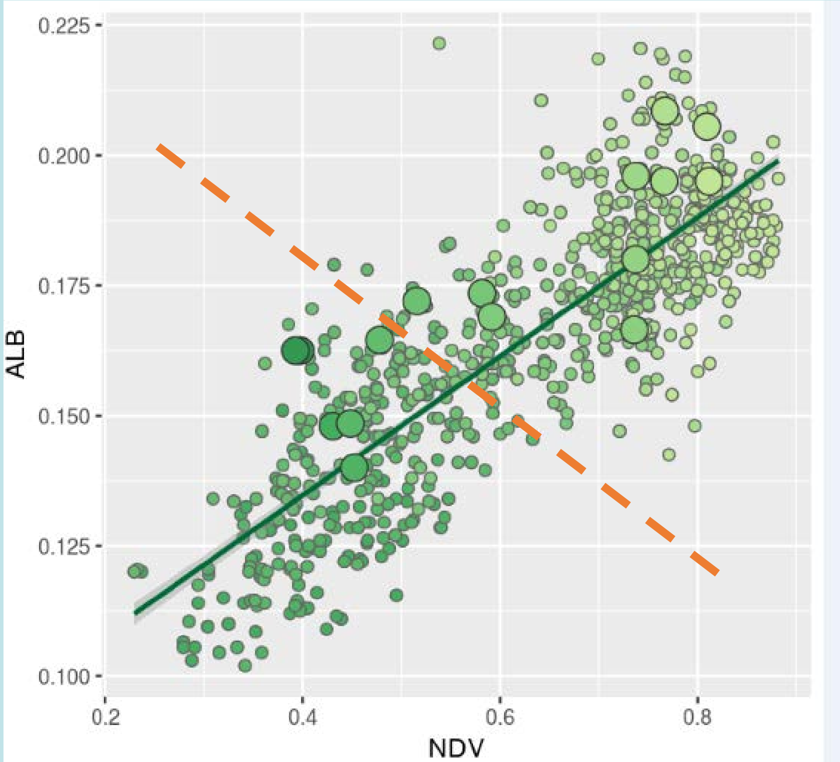
Kusuma Prabhakara[a,*], W. Dean Hively[b], Gregory W. McCarty[c]



series of albedo and
ky for cover fraction)

SE)]

Establish a local relationship between vegetation cover and albedo



Relation to convert Daycent daily biomass time series into groundcover --> albedo

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Metric conversion to CO_2 equivalent

$$RF_{\Delta\alpha}(t,I) = \left(\frac{1}{dd} * \sum_{i=1}^{dd} SWin_i * Ta_i * \delta\alpha_i\right) * \frac{A}{A_{Earth}} \quad (3)$$

Radiative forcing ($w\ m^{-2}$)

Shortwave incoming r.

Atmospheric transmittance

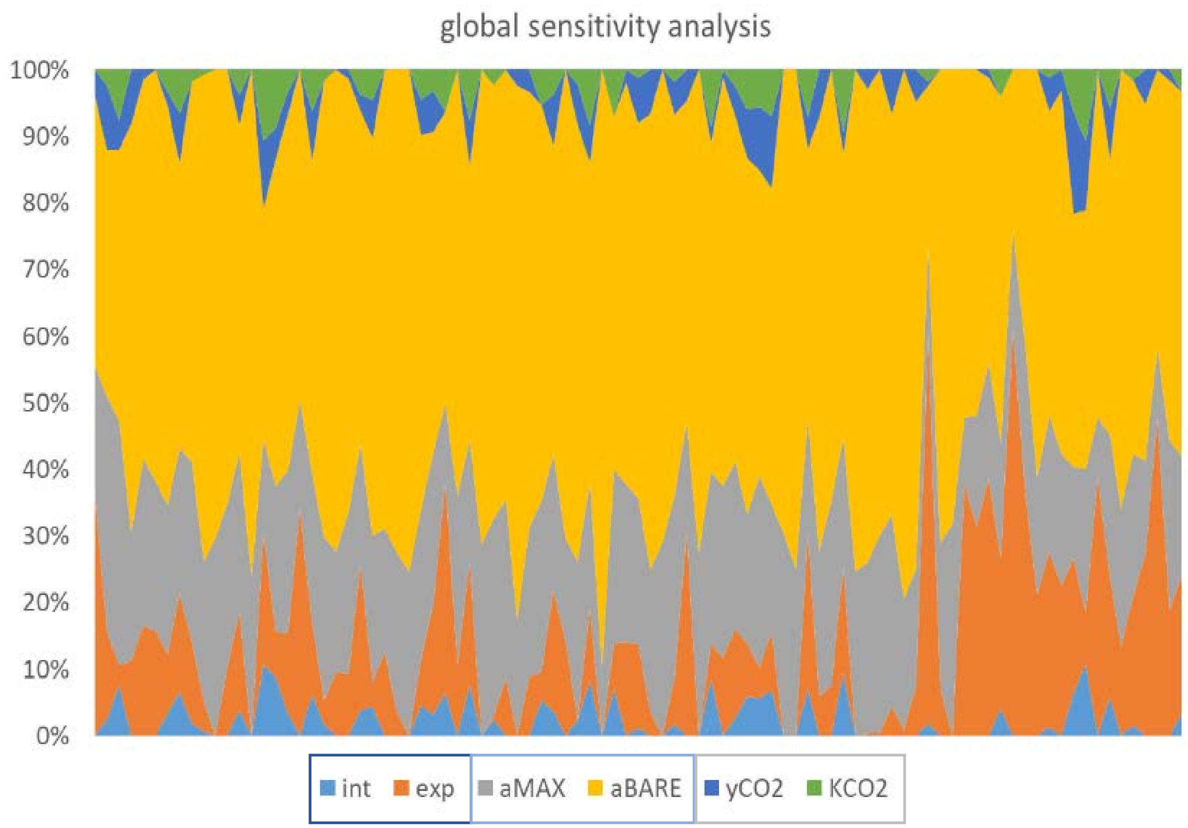
Albedo change

$$GWP_{\Delta\alpha}(TH,I) = \frac{\sum_{t=0}^{t=TH} RF_{\Delta\alpha}(t,I)}{kCO_2 \sum_{t=0}^{t=TH} yCO_2(t)\,dt}$$

radiative efficiency of CO_2

CO_2 impulse response function

Global sensitivity by Montecarlo sub-set of LUCAS



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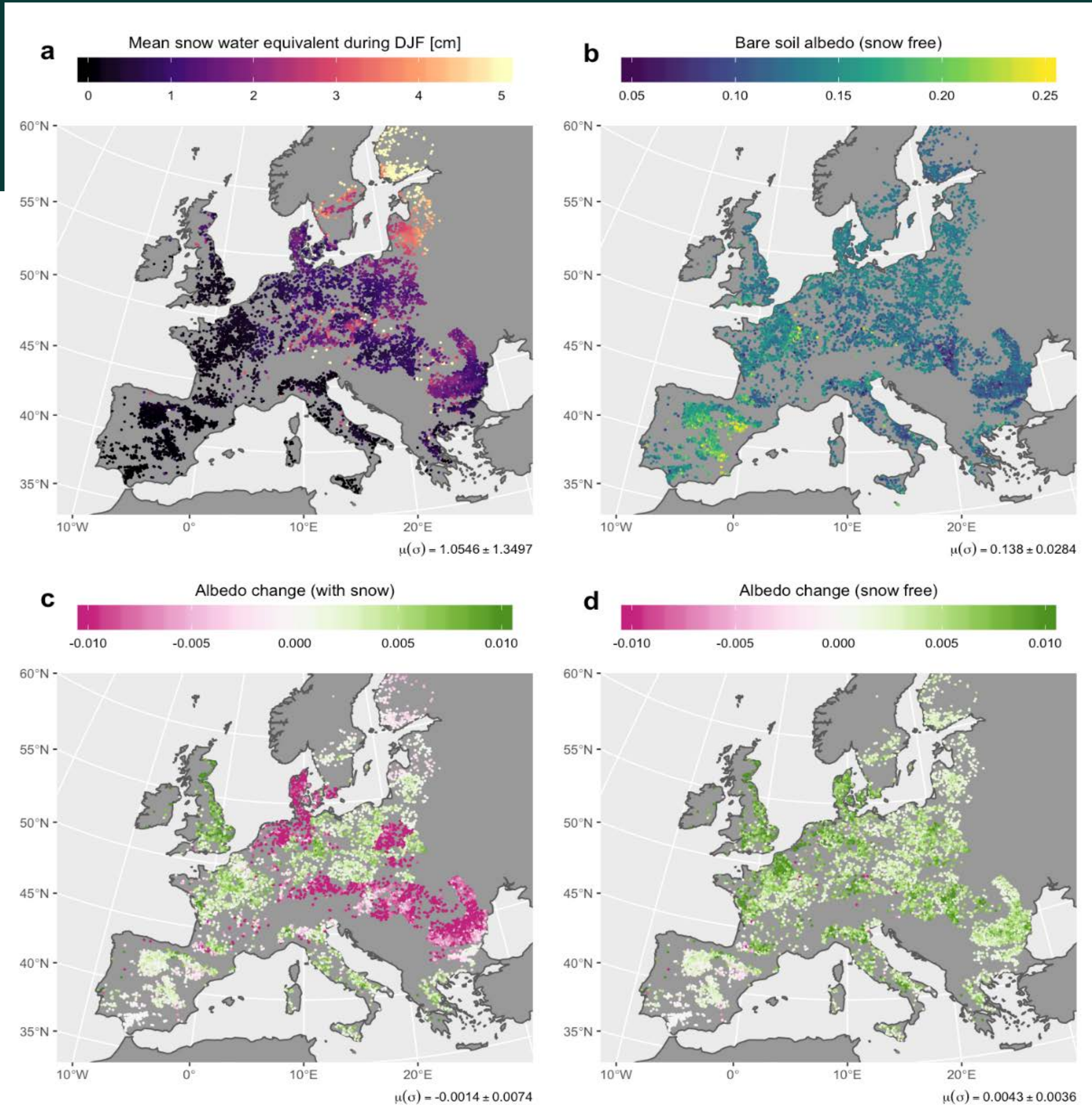
Results

Induced-albedo radiative change



- Bare soil albedo = 0.14

- CC almost increases the soil albedo except in clear soils

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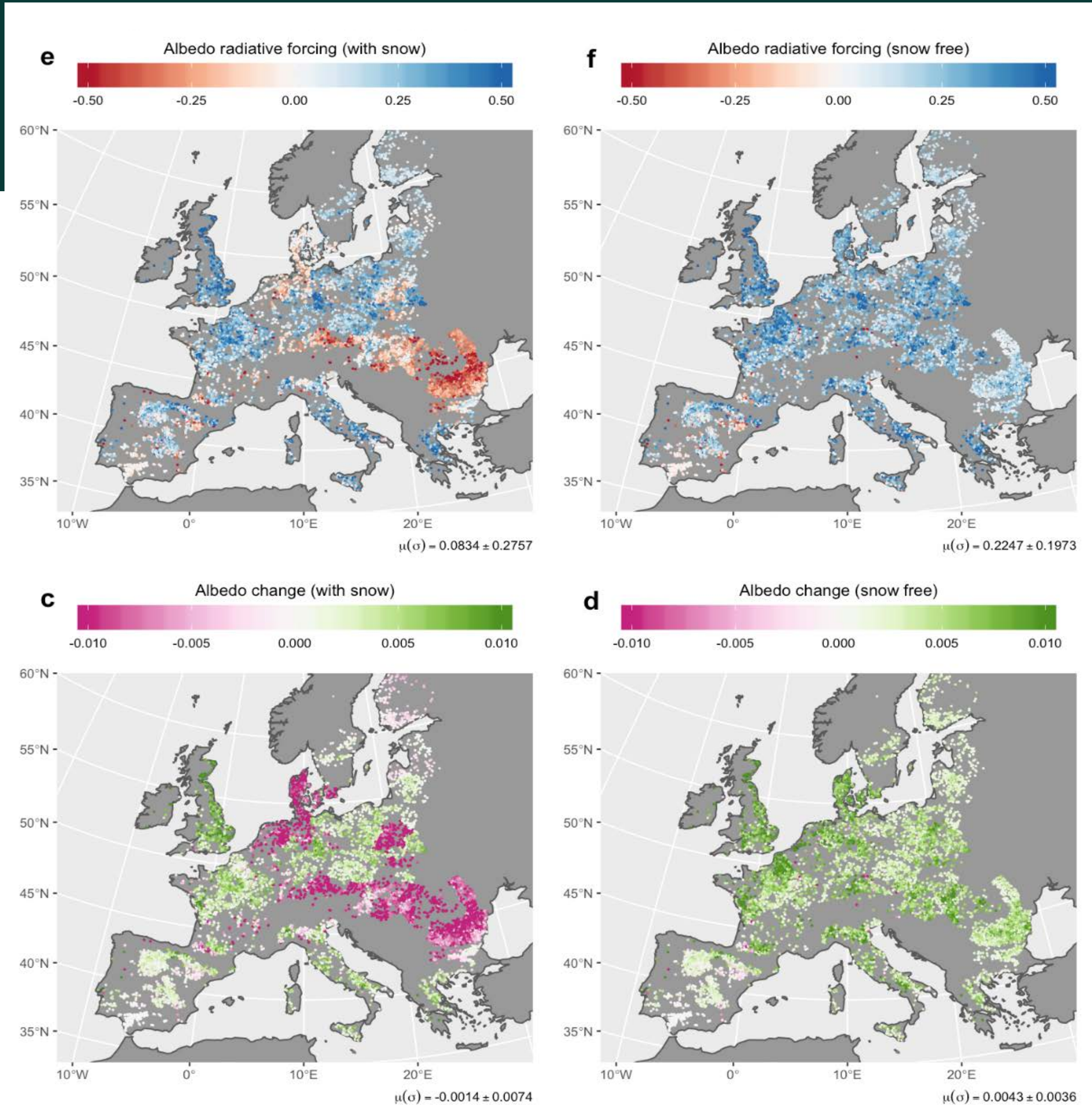
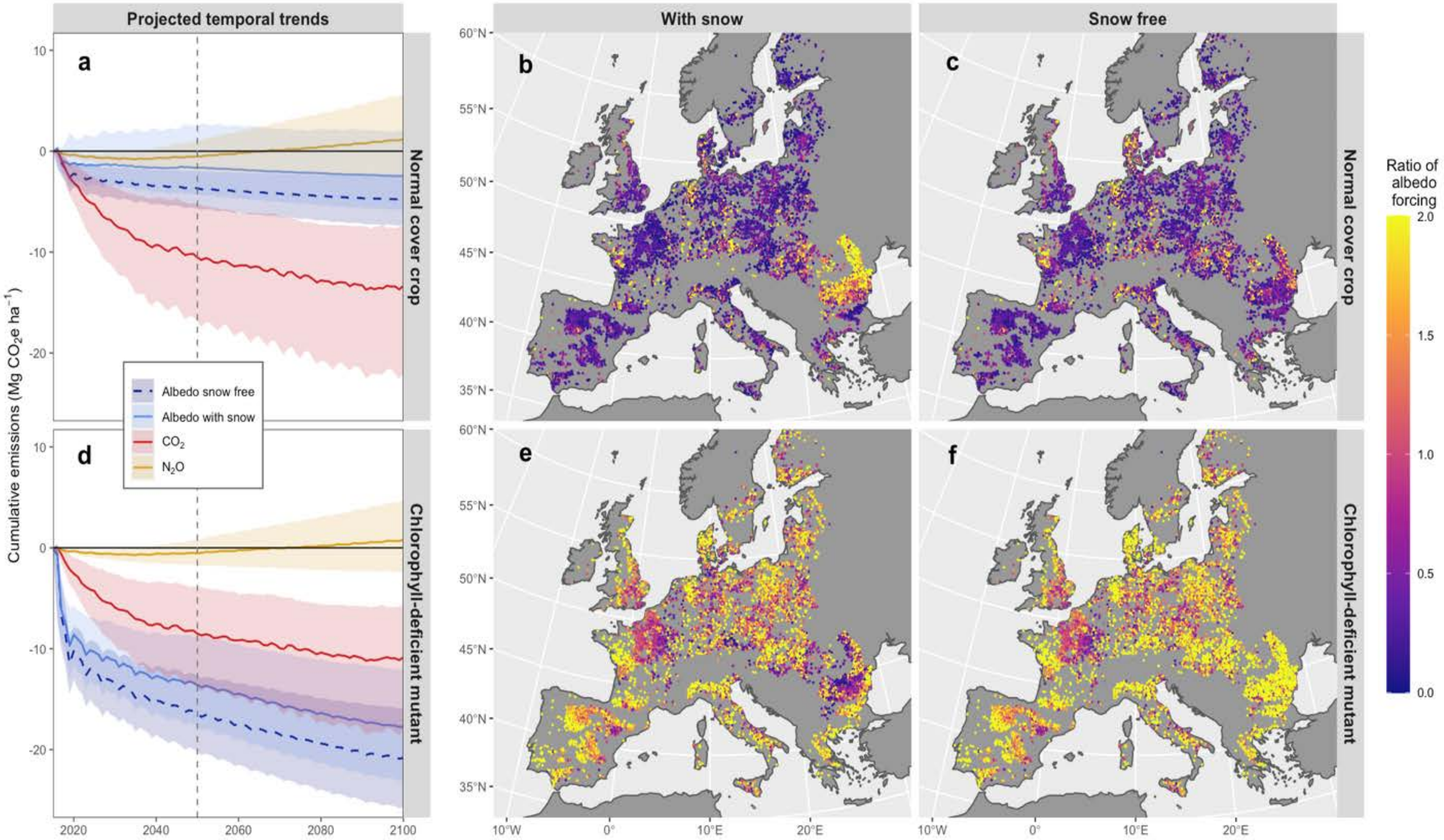
Results

Induced-albedo radiative change

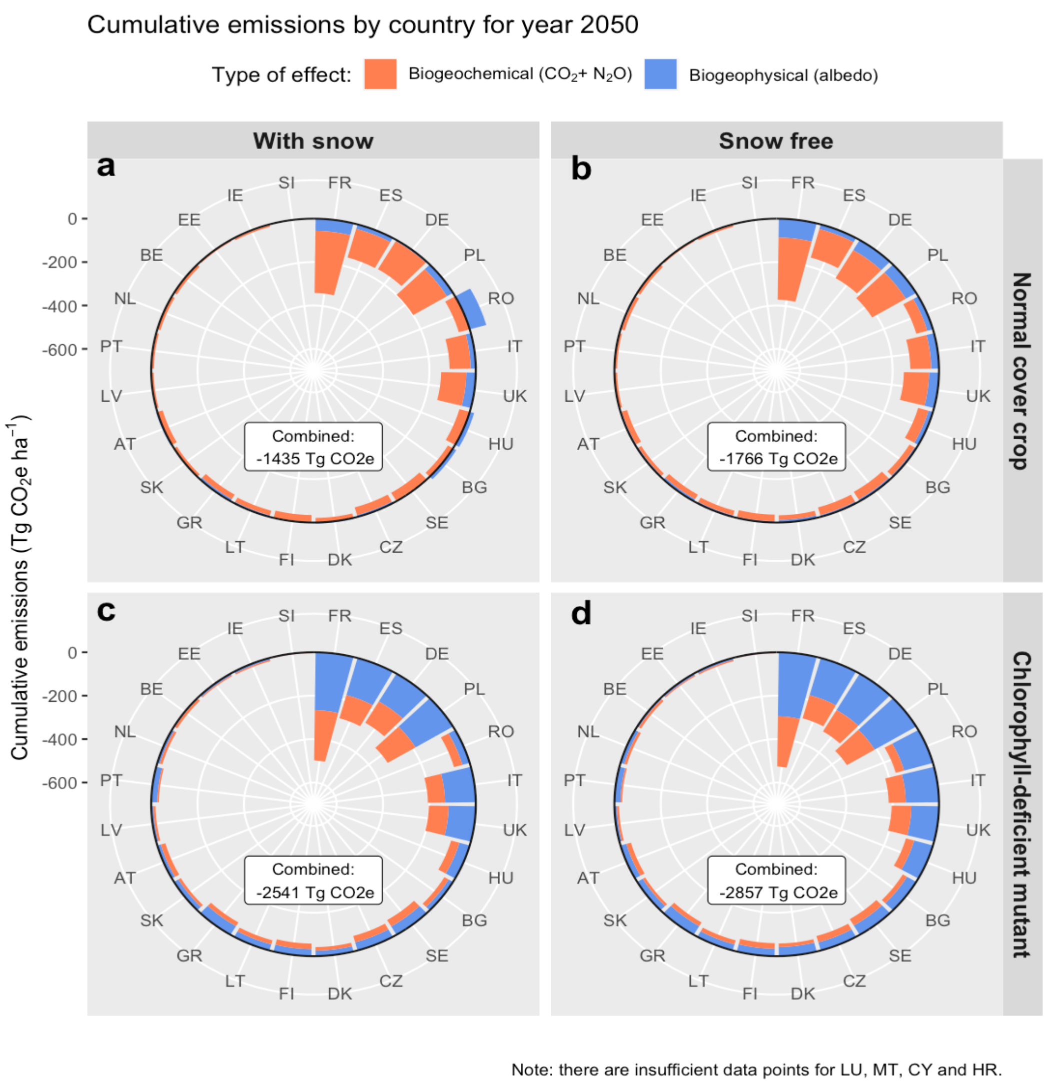


- Bare soil albedo = 0.14
- CC almost increases the soil albedo except in clear soils

Results – mitigation potential



Results – mitigation potential



Mitigation potential in arable mineral soils

40 – 49 Tg (Mt) CO_2e y^{-1}

72 – 82 Tg (Mt) CO_2e y^{-1}

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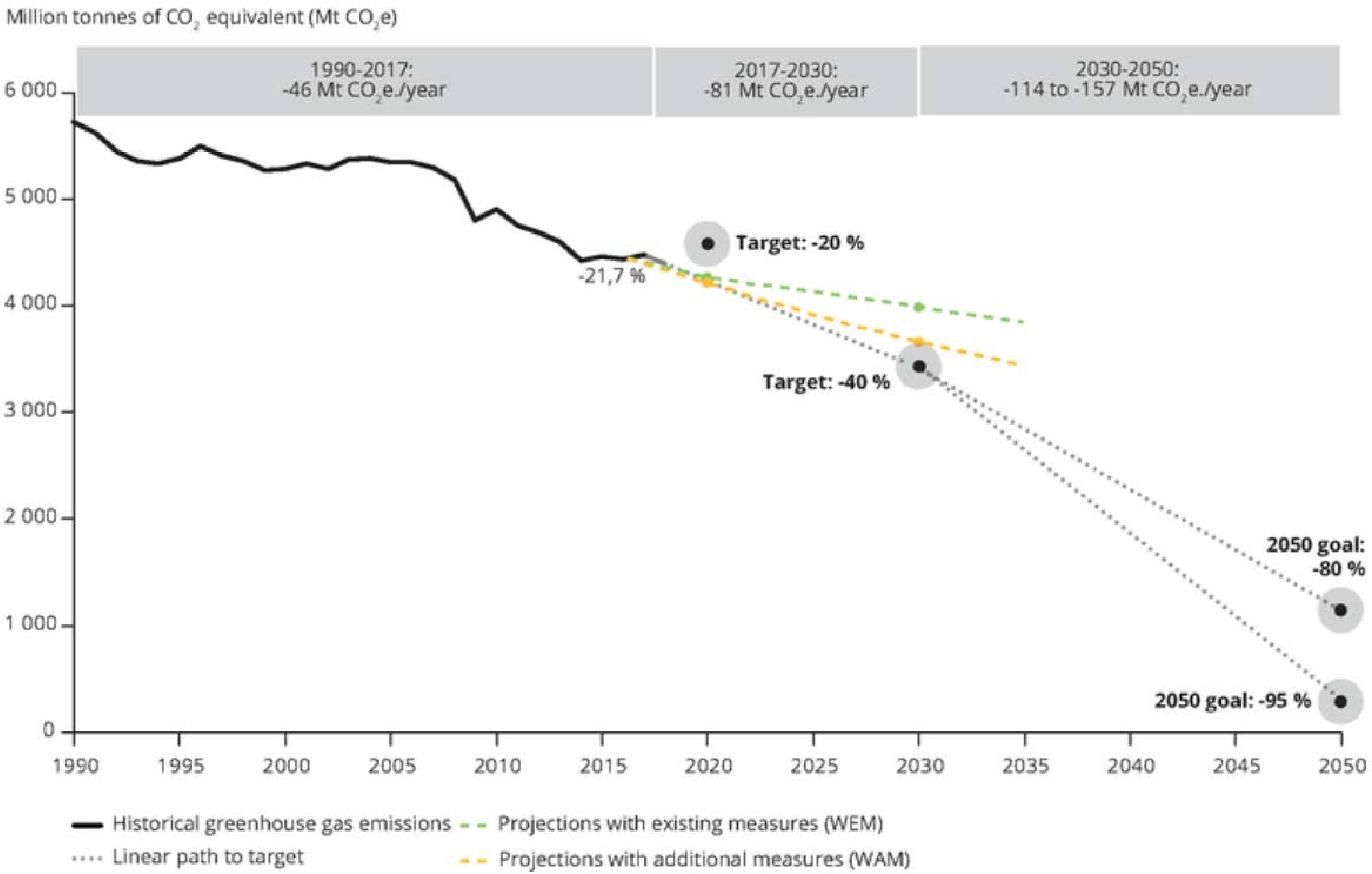
Results – mitigation potential



Note: there are insufficient data points for LU, MT, CY and HR.

Mitigation potential in arable mineral soils

40 – 49 Tg (Mt) $CO_2e\ y^{-1}$

72 – 82 Tg (Mt) $CO_2e\ y^{-1}$

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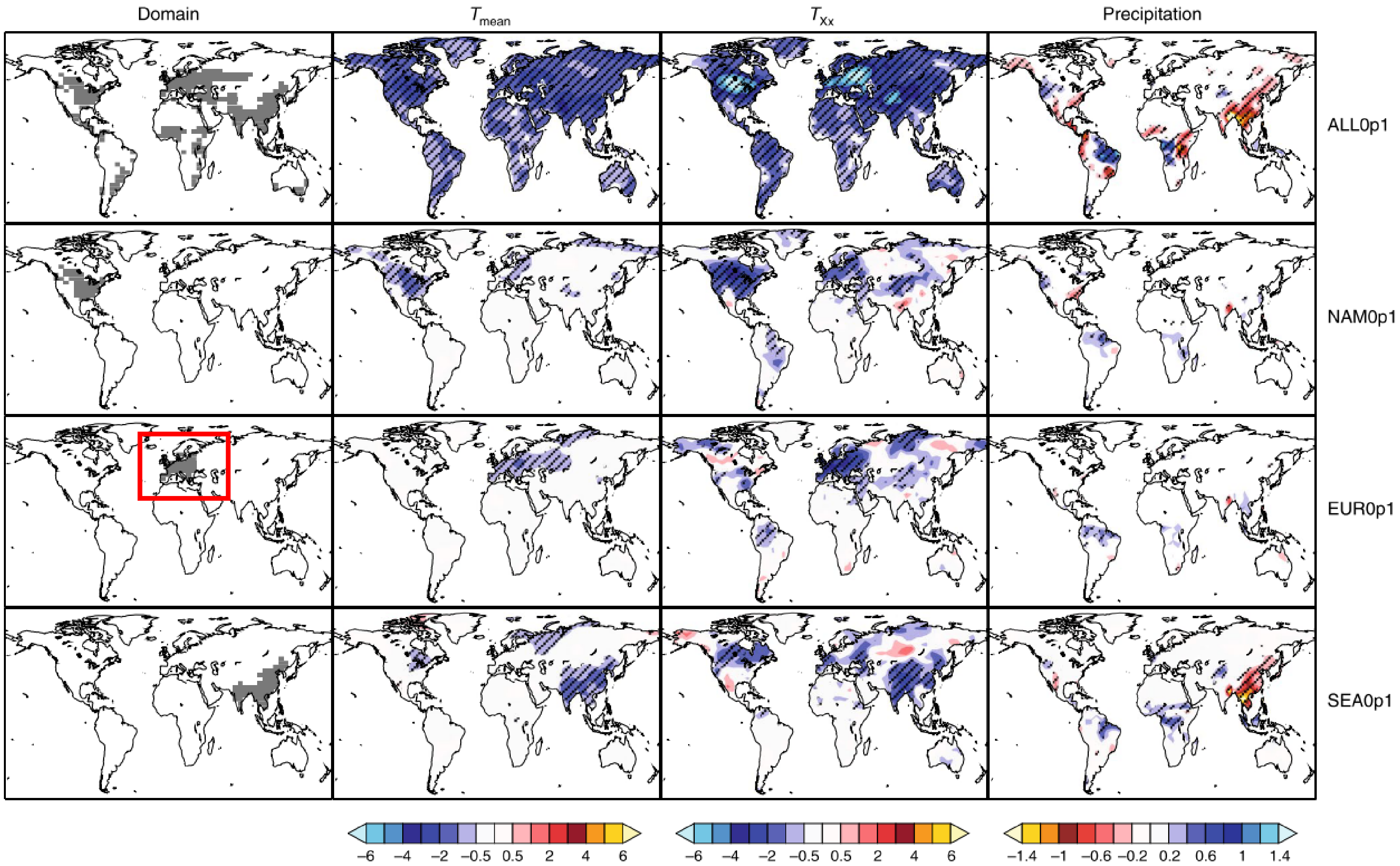
Mitigation *vs* local effects

Seneviratne et al. 2018



0.1 albedo change

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Conclusions

- CO_2 sequestration is the dominant flux but saturates in time
- Change in albedo would be equivalent to 99 – 430 Mg CO_2e by 2050
- Albedo change gains has an instantaneous effect and can be increased by ‘clear’ varieties
- Considering local feedbacks and climate teleconnection!!!
- **Can we account for mitigation by radiative management?**

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You can find me at

European Soil Data Centre - https://esdac.jrc.ec.europa.eu/

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Thanks

Any questions?

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