EU-wide ensemble approach for the standardised baseline

StatEO26, Frascati, Italy

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Joint Research Centre – European Commission

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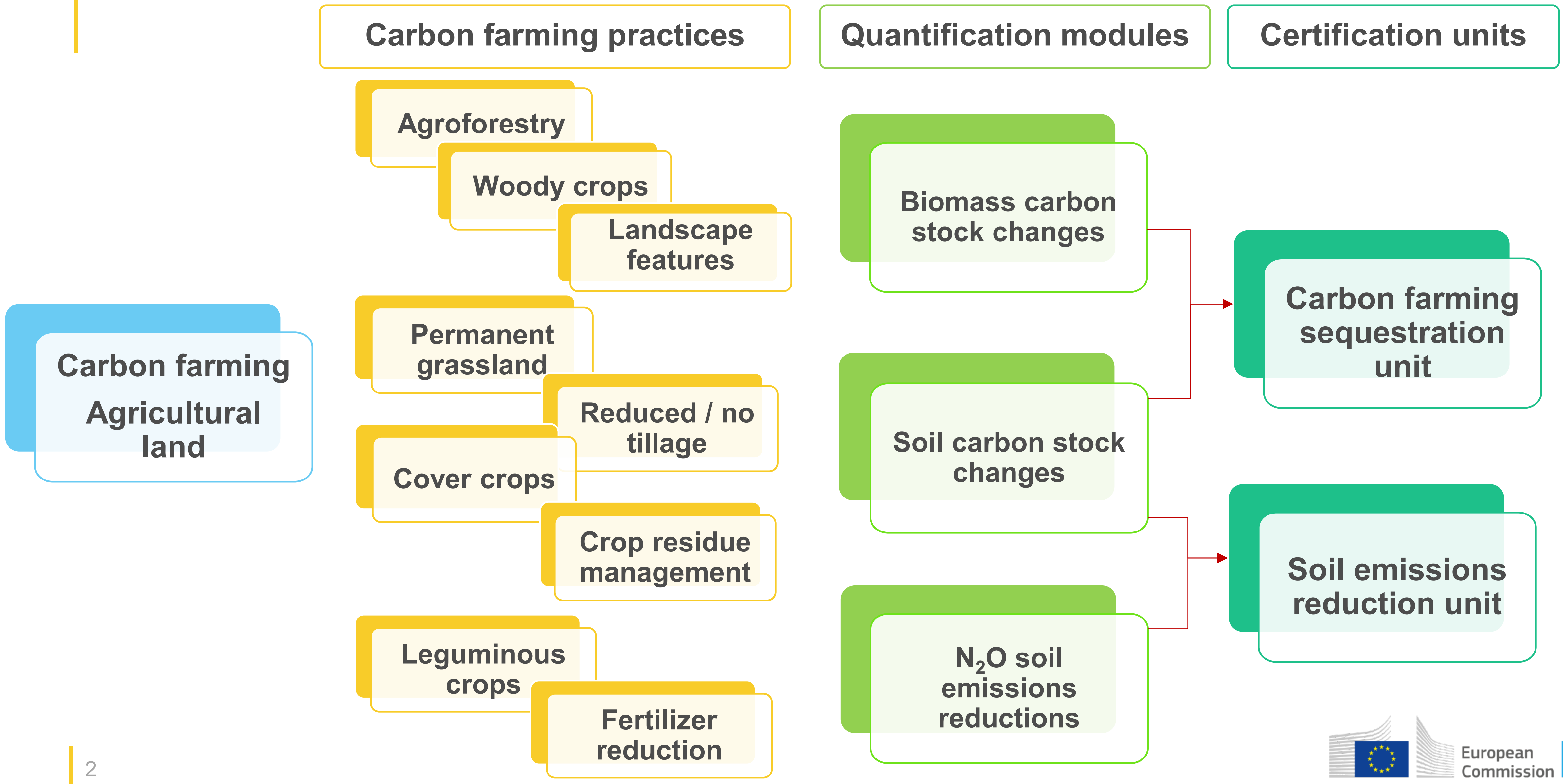
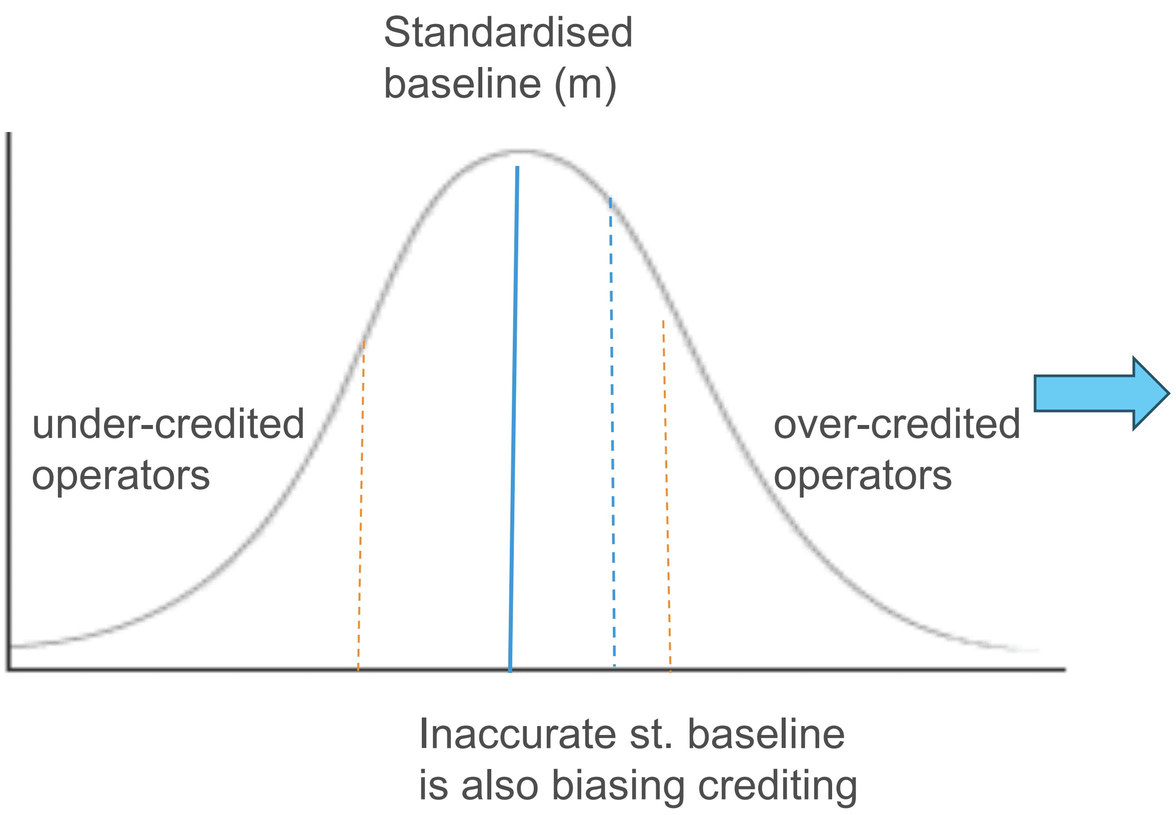
Scope of certification – Agricultural land



Standardised baseline concept definition



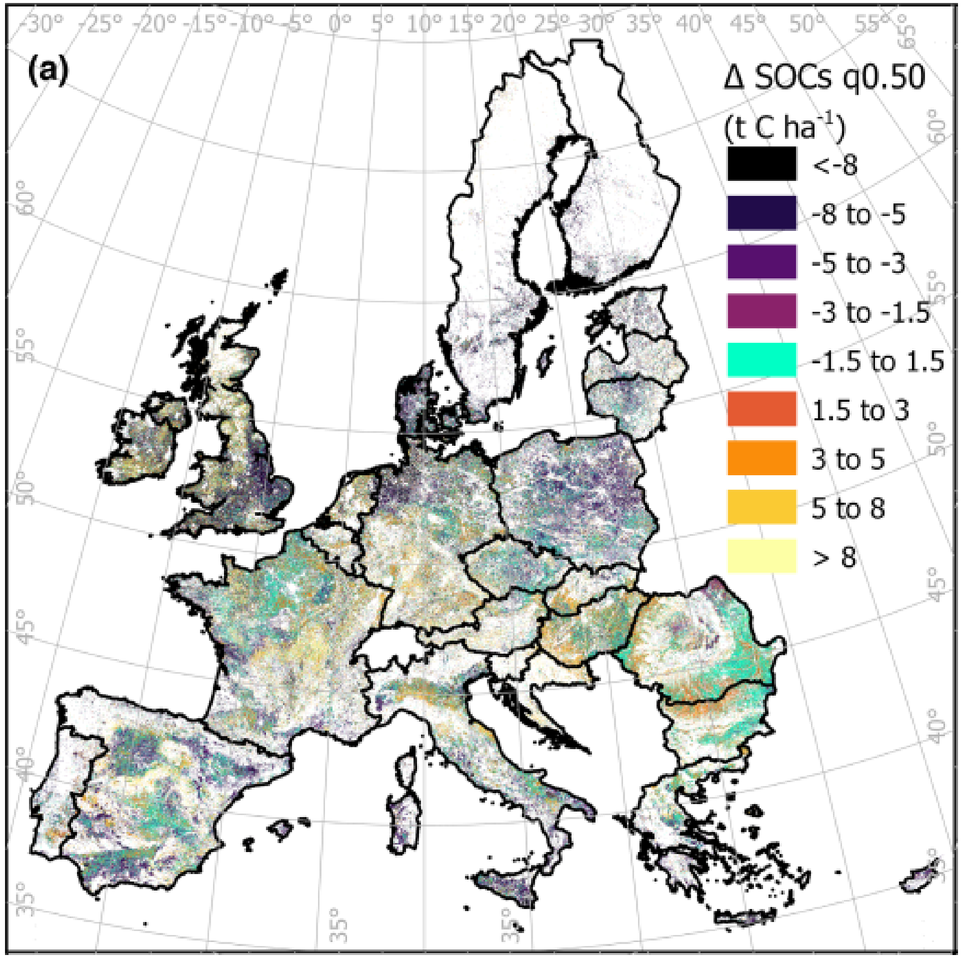
EU-wide ensemble data and model approach

Statistical model based on LUCAS repeated points

DayCent meta-model

Regional model extrapolation with common covariates

Methodology : statistical model LUCAS



Soil organic carbon stocks in European croplands and grasslands: How much have we lost in the past decade?

De Rosa et al. 2024

Changes from publication:

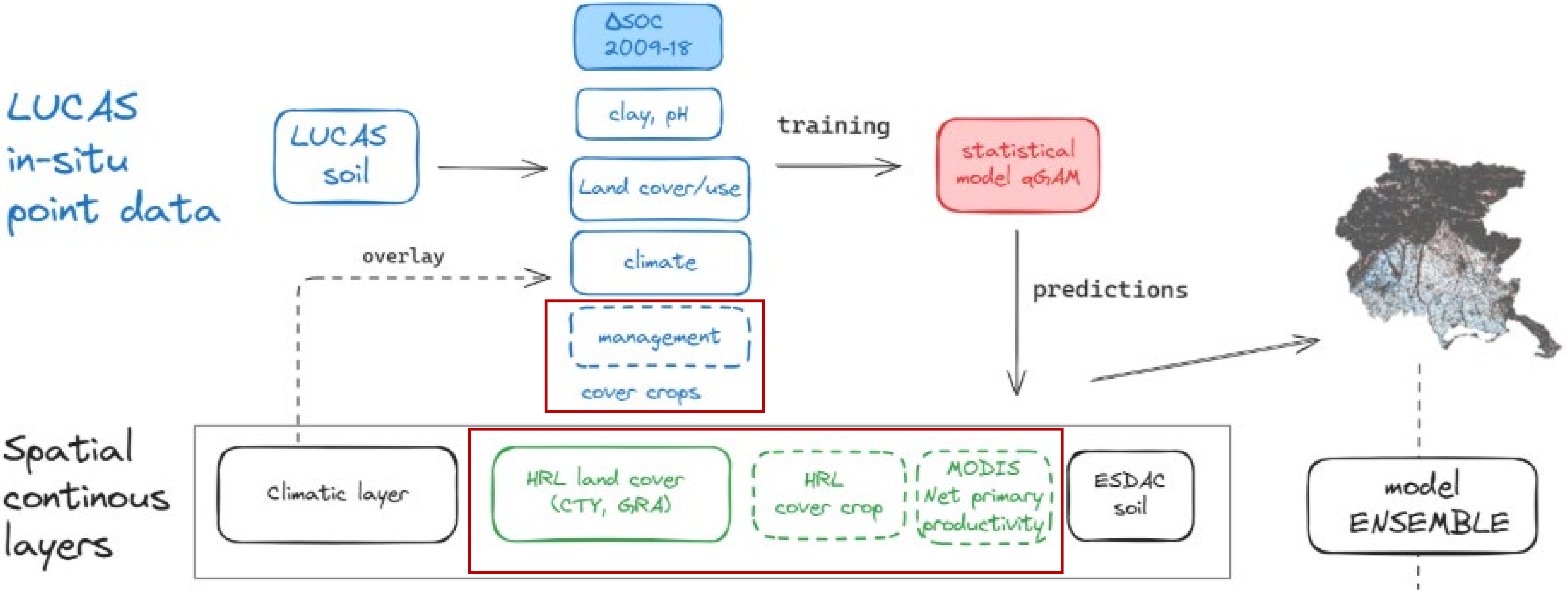
Simplification of LC

- Permanent grassland
- Cropland
- Low ley-cropping systems
- High ley-cropping systems

Added additional LC classes (EEA HRL layers)

- Arable + cover crops
- Orchards

Methodology : statistical model LUCAS



Land Monitoring Service

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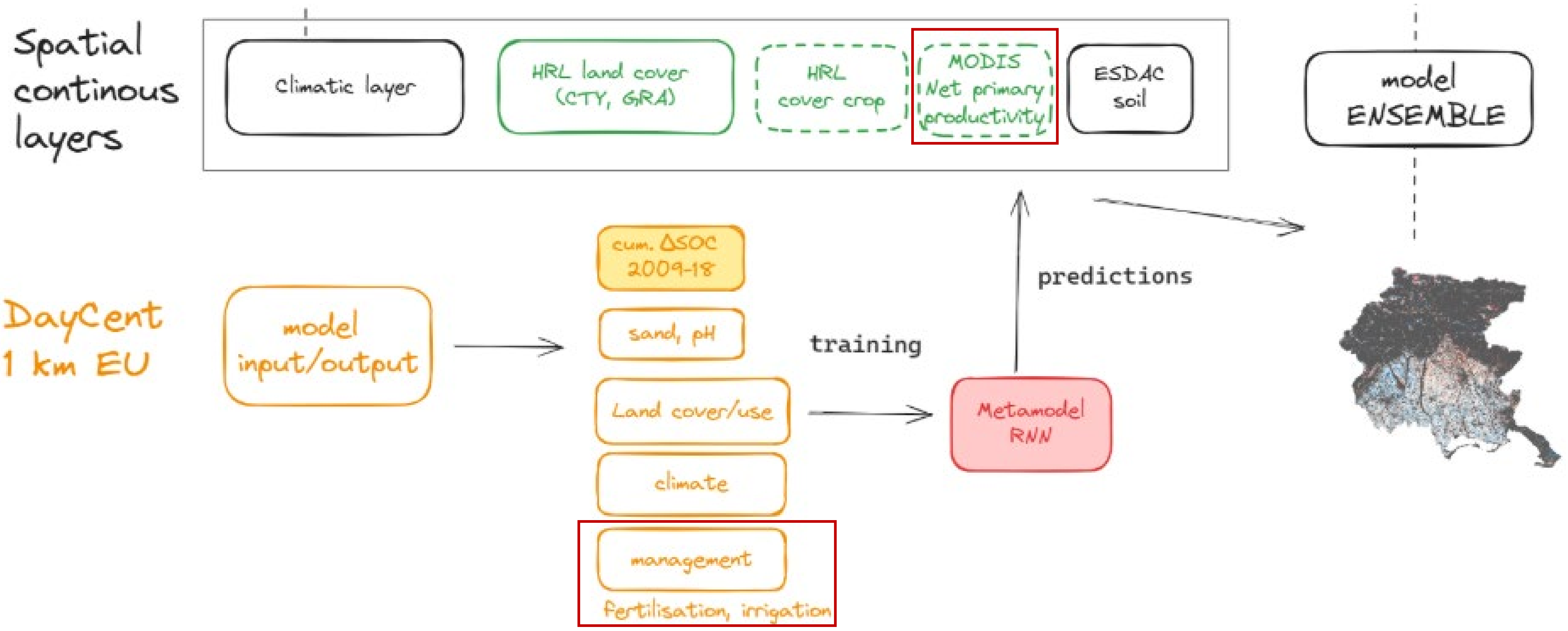
VLCC cropping system harmonised map

Land Monitoring Service

Fahl et al. 2026

Methodology: DayCent metamodel



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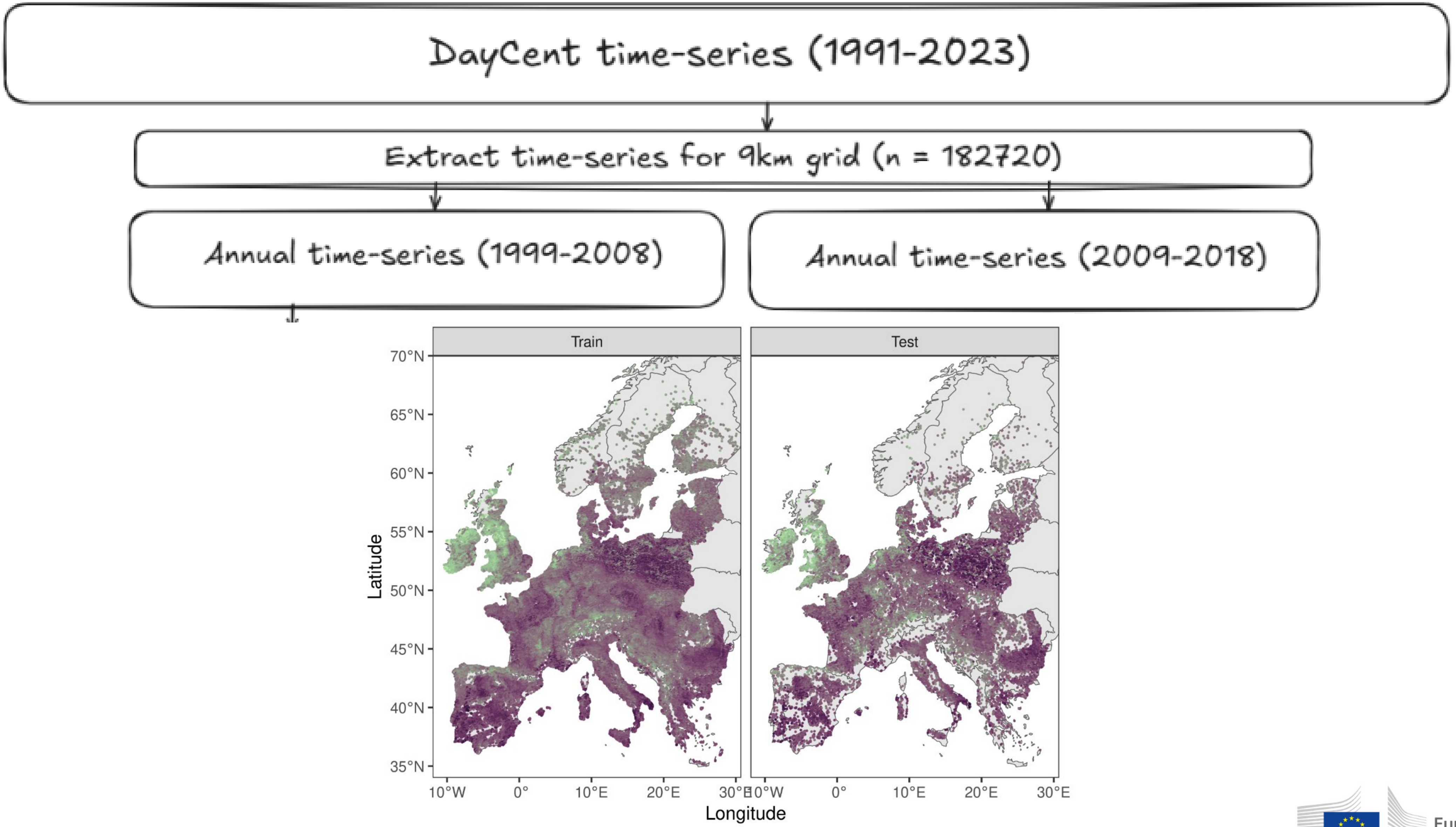
Methodology: DayCent metamodel



- Systematically sampled by GPS coordinates

Methodology: DayCent metamodel

Predictors

Static variables ('99):

SOC, C:N, Sand, pH, Land use, Livestock

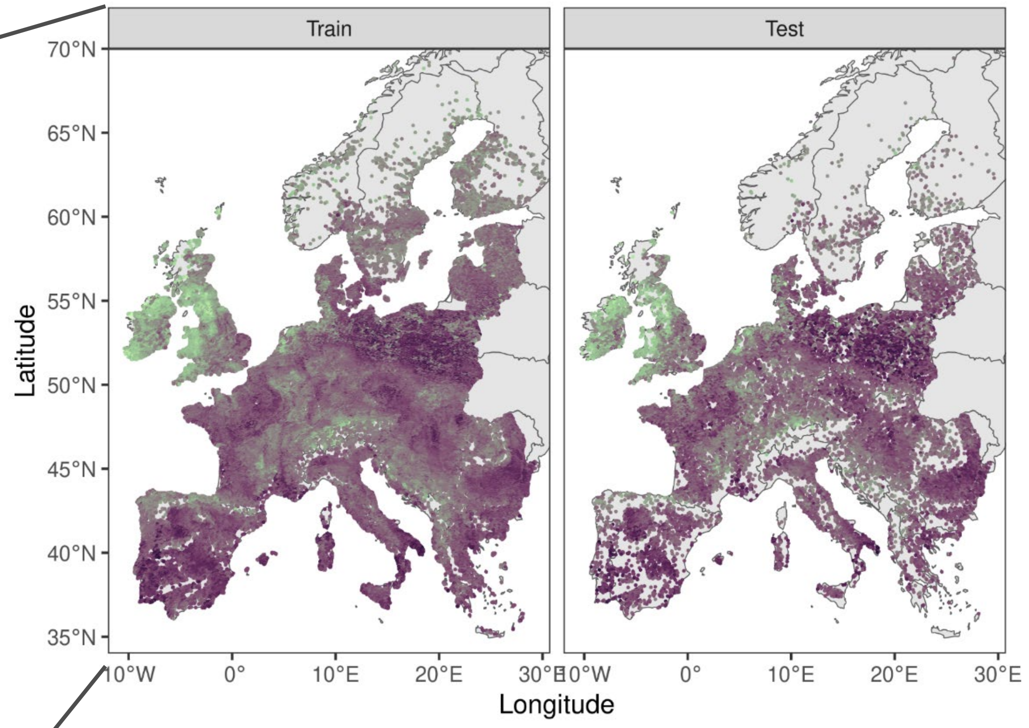
Dynamic variables ('99-'08):

quantile Random Forest:

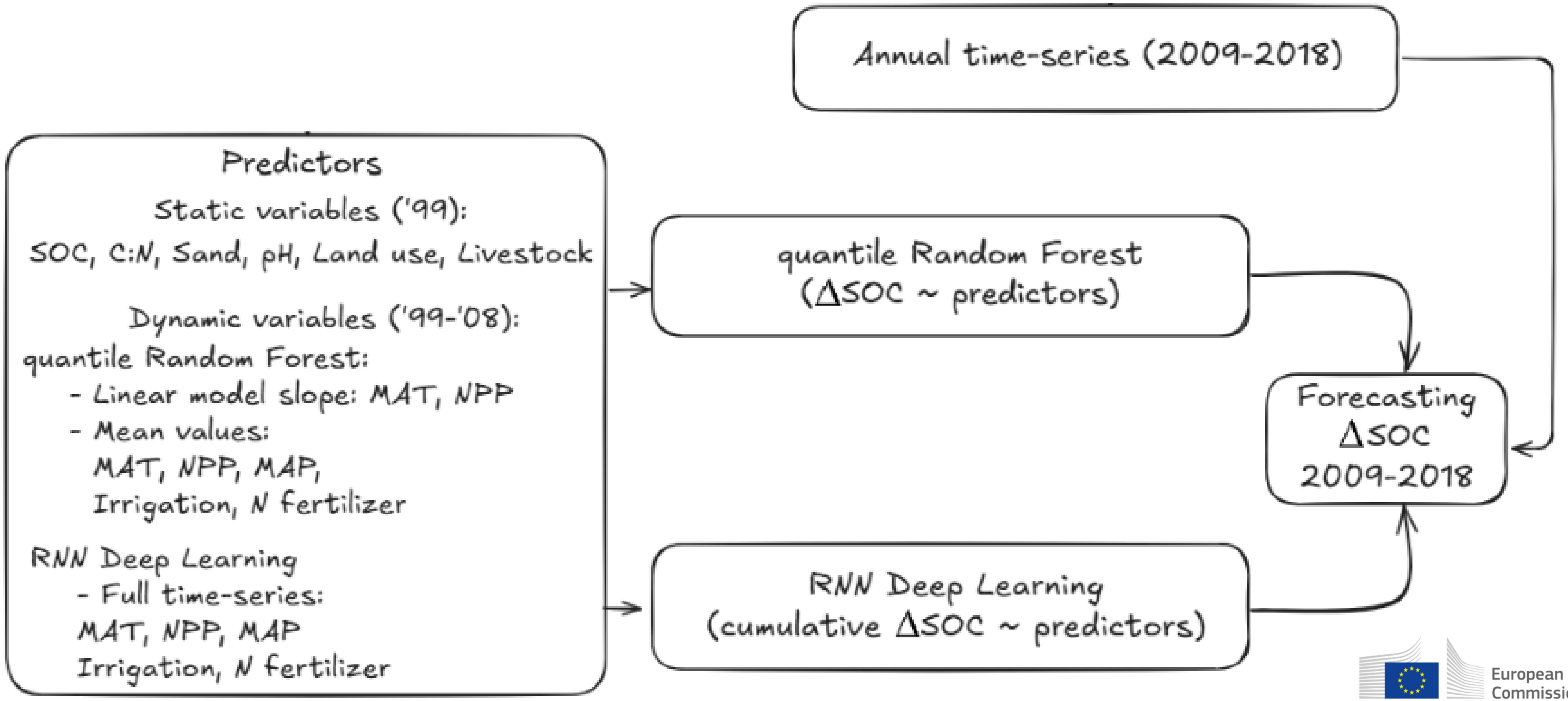
- Linear model slope: MAT, NPP
- Mean values:
  MAT, NPP, MAP,
  Irrigation, N fertilizer

RNN Deep Learning

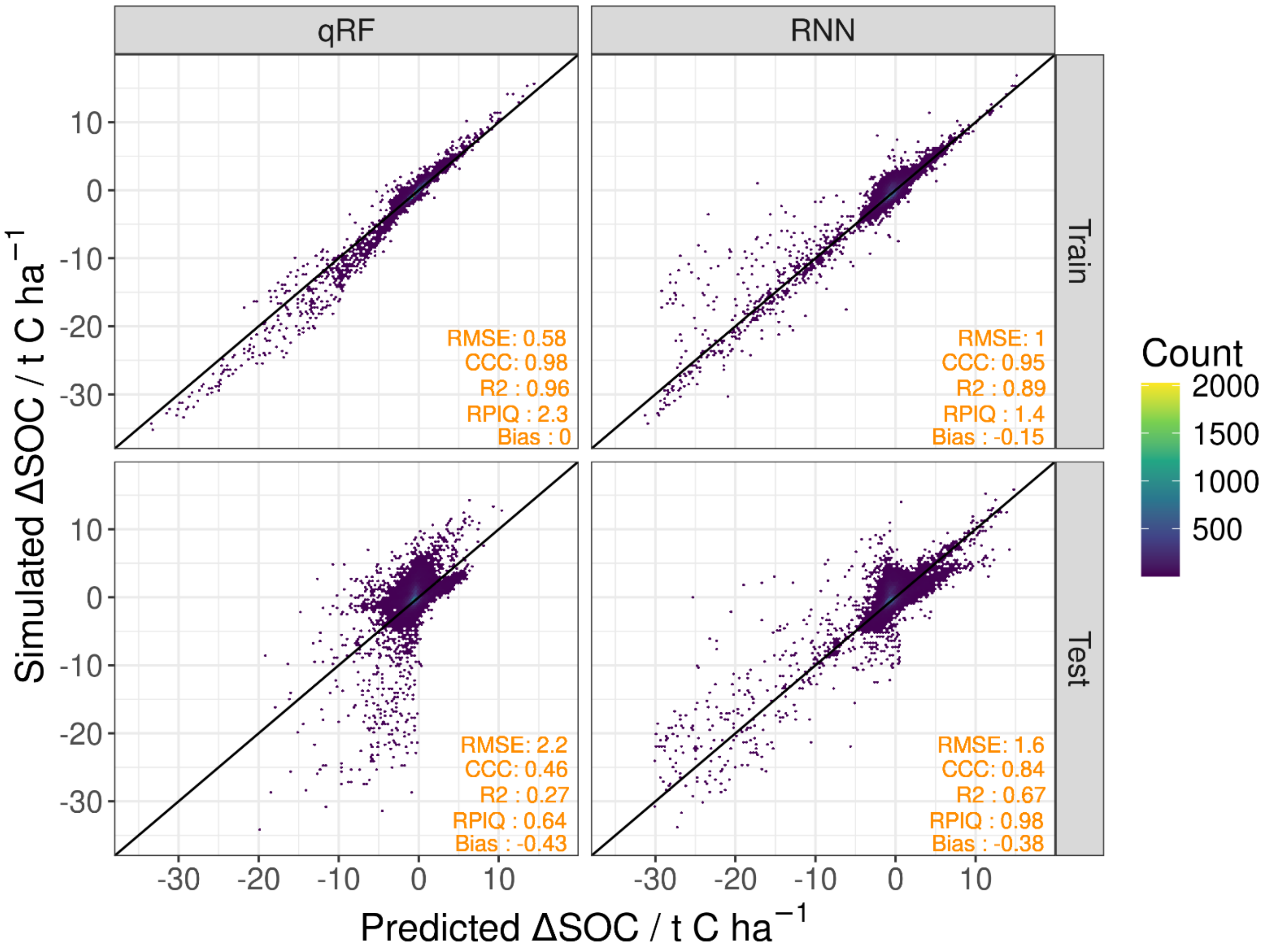
- Full time-series:
  MAT, NPP, MAP
  Irrigation, N fertilizer



Methodology: DayCent metamodel

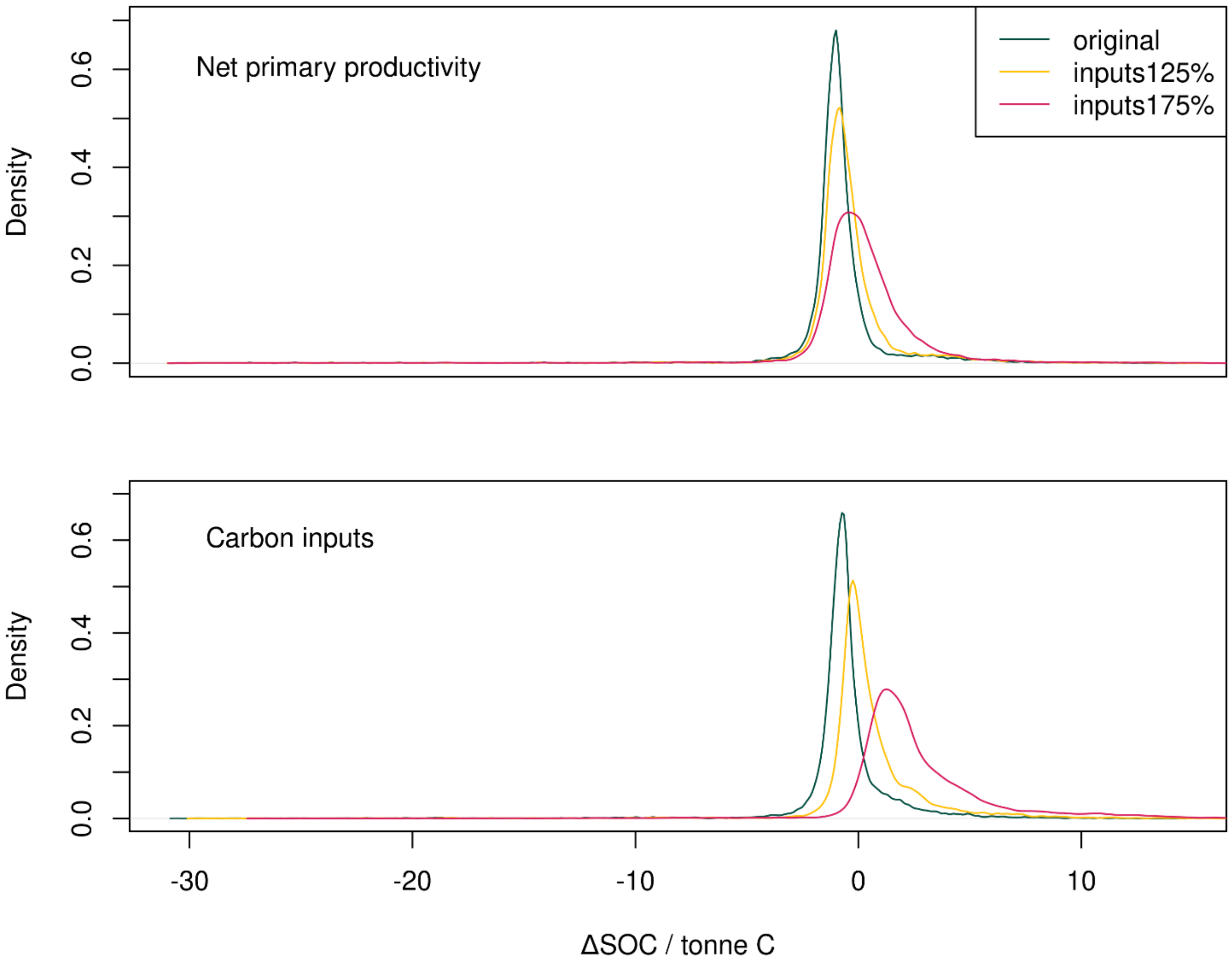


Results : DayCent metamodel



- Both models reproduce the training data well, with qRF outperforming RNN
- Forecasting capacity of RNN superior to qRF

Results : DayCent metamodel (sensitivity)



- RNN model performs in line with first-order kinetics
- Weaker sensitivity for NPP compared to carbon inputs

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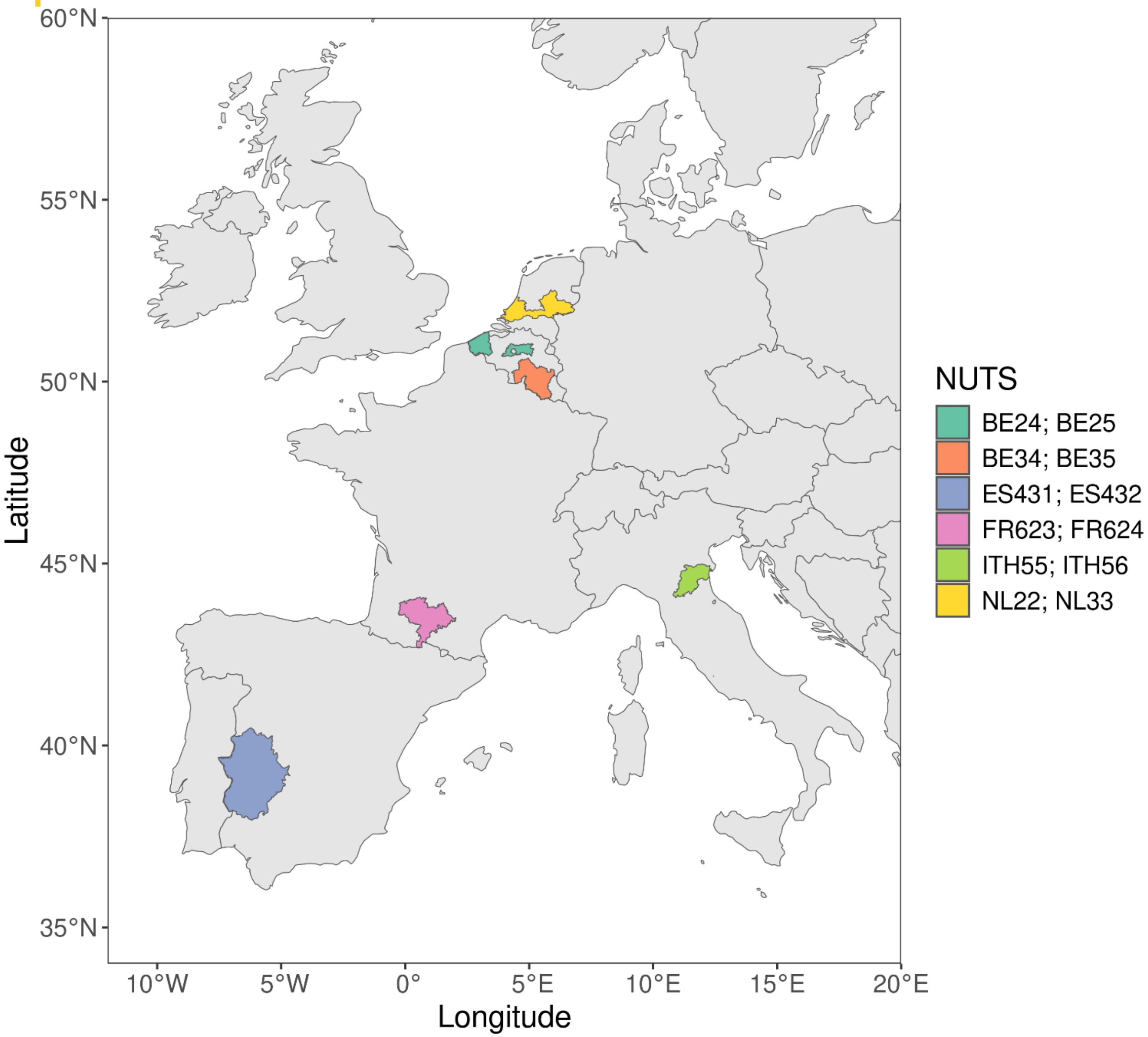
Methodology : overview case study areas



- Captures wide range in pedo-climatic conditions across EU
- Case-study areas from Mission Soil projects (MARVIC, MRV4SOC)

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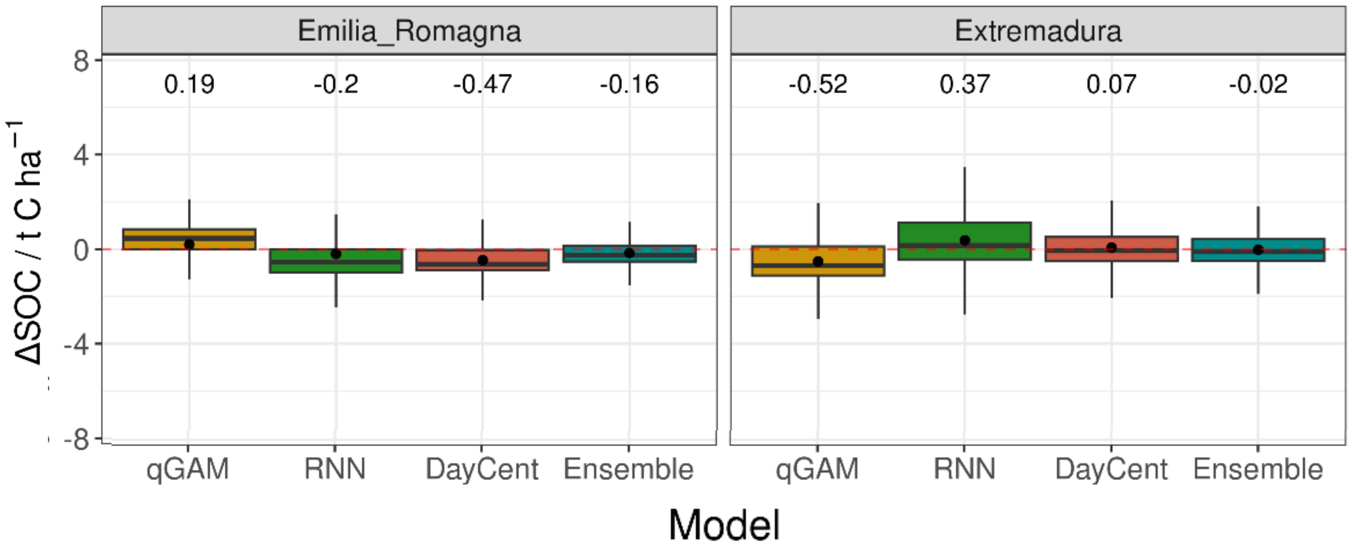
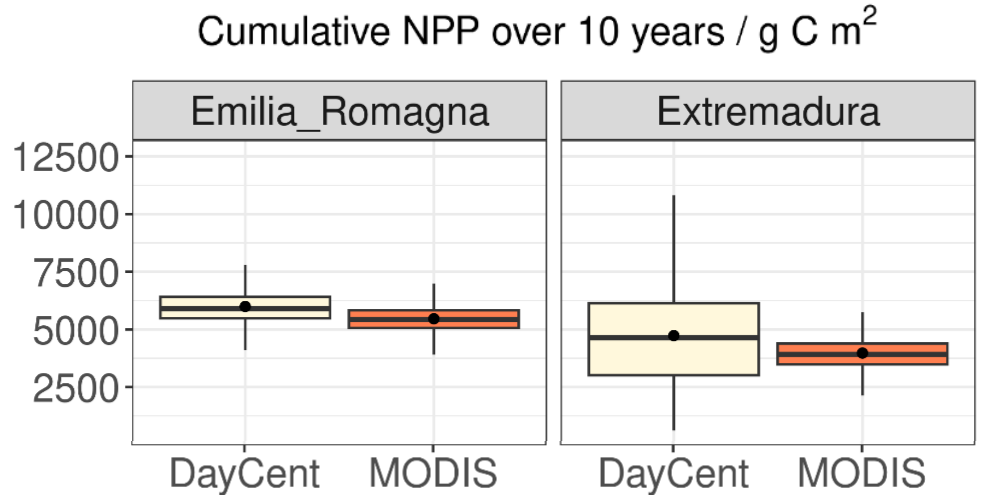
Results : Upscaling for regional baselines



Differences between the RNN and DayCent can be explained by differences in:

- DayCent simulated NPP and MODIS NPP
- Difference in land cover class frequency between CORINE and EEA HRL layer

Results : Upscaling for regional baselines



- MODIS NPP was consistently lower than DayCent
- Lower C inputs >> lower ΔSOC?

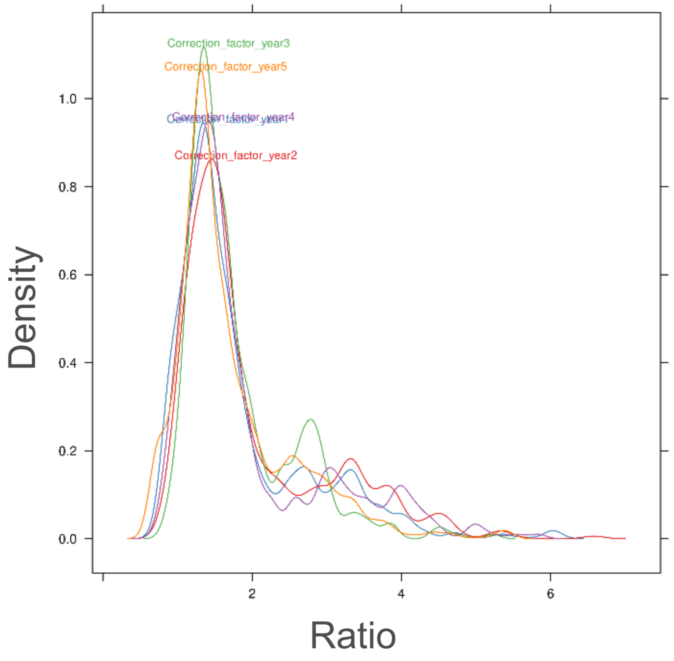
EEA HRL Land Cover [% of each class]

	Arable	Ley	Grassland
Emilia Romagna	88.4 (-1.9)	2.5 (-7.2)	9.1 (9.1)
Extremadura	68.8 (-27.8)	1.5 (-1.1)	29.7 (28.8)

- Lower inputs compensated by changes in land cover compared to CORINE
- Ley cropping and arable land predominantly replaced by grassland

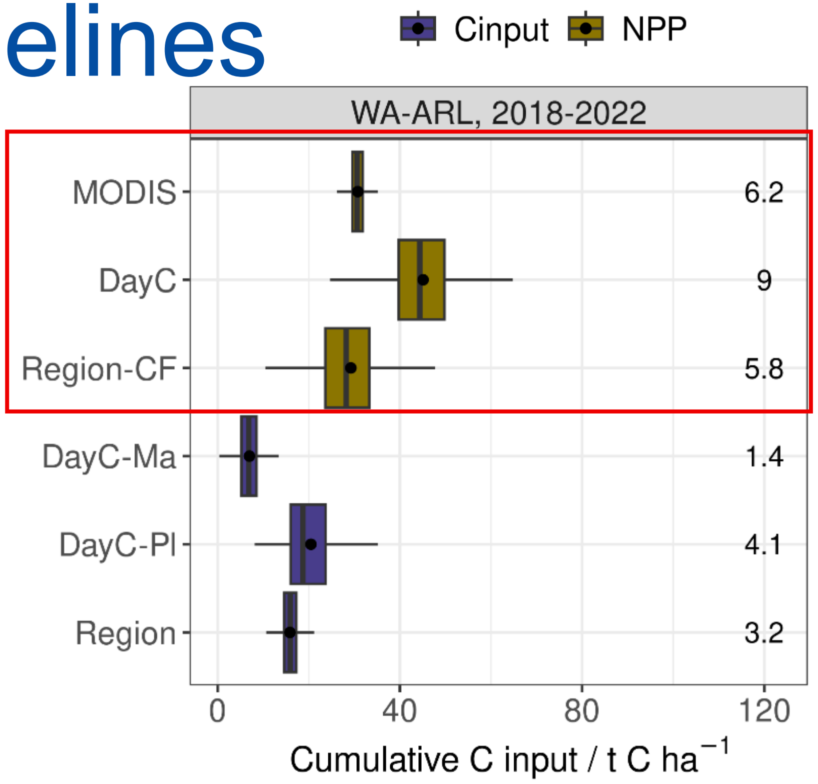
Results : Comparing regional baselines

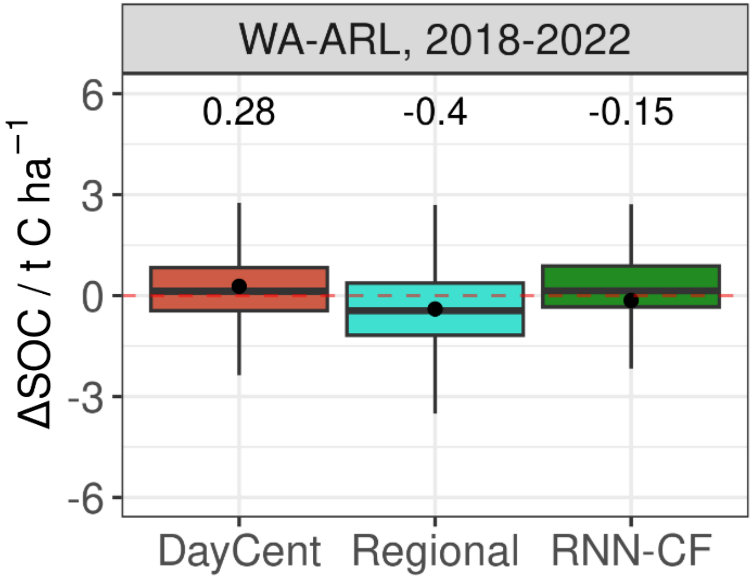
NPP / C input



Correct regional C input data based on DayCent simulated NPP / C input ratio

- Differences between the EU-wide baseline and regional approaches:
- Different C input sources can quantify potential uncertainties due to aggregation and other assumptions





Conclusions : EU-wide ensemble baseline

- Ensemble can provide conservative estimate based on different methods
  → Not only different models but also C input estimates in ensemble

- EO-derived layers of SOC change drivers affect regional estimates
  → Quantifying the effect of aggregation and land cover/land use assumptions

- Need to incorporate management time-series data and bioclimatic data derived from remote sensing
  → Parcel-level agricultural management data

- Standardised baseline method can inform future GHG accounting
  → iMRV project in collaboration with EEA to develop tools

Thank you

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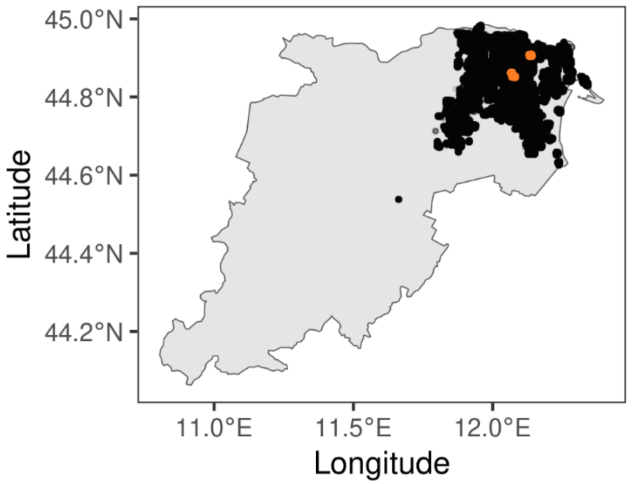
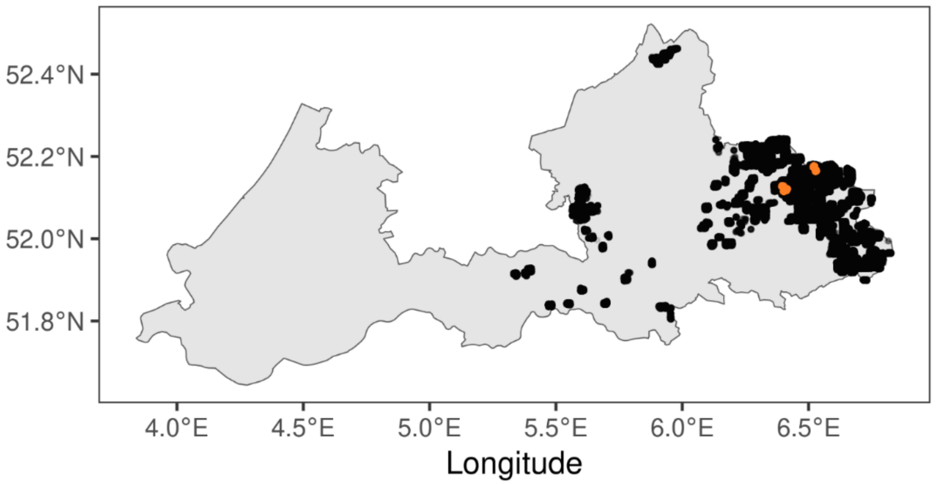
Results : Dynamic clustering for a regional baseline

*CRCF Art. 4.8: "representative of the standard performance of comparable practices and processes in similar **social, economic, environmental, technological and regulatory** circumstances and take into account the **geographical context**, including local **pedoclimatic** and regulatory conditions"*





- Excluding management variables
  - Mineral and organic N application
  - NPP
  - Irrigation
- Multivariate outlier detection

(Garret 1989; Filzmoser 2005)

- 2240 and 980 hectares selected

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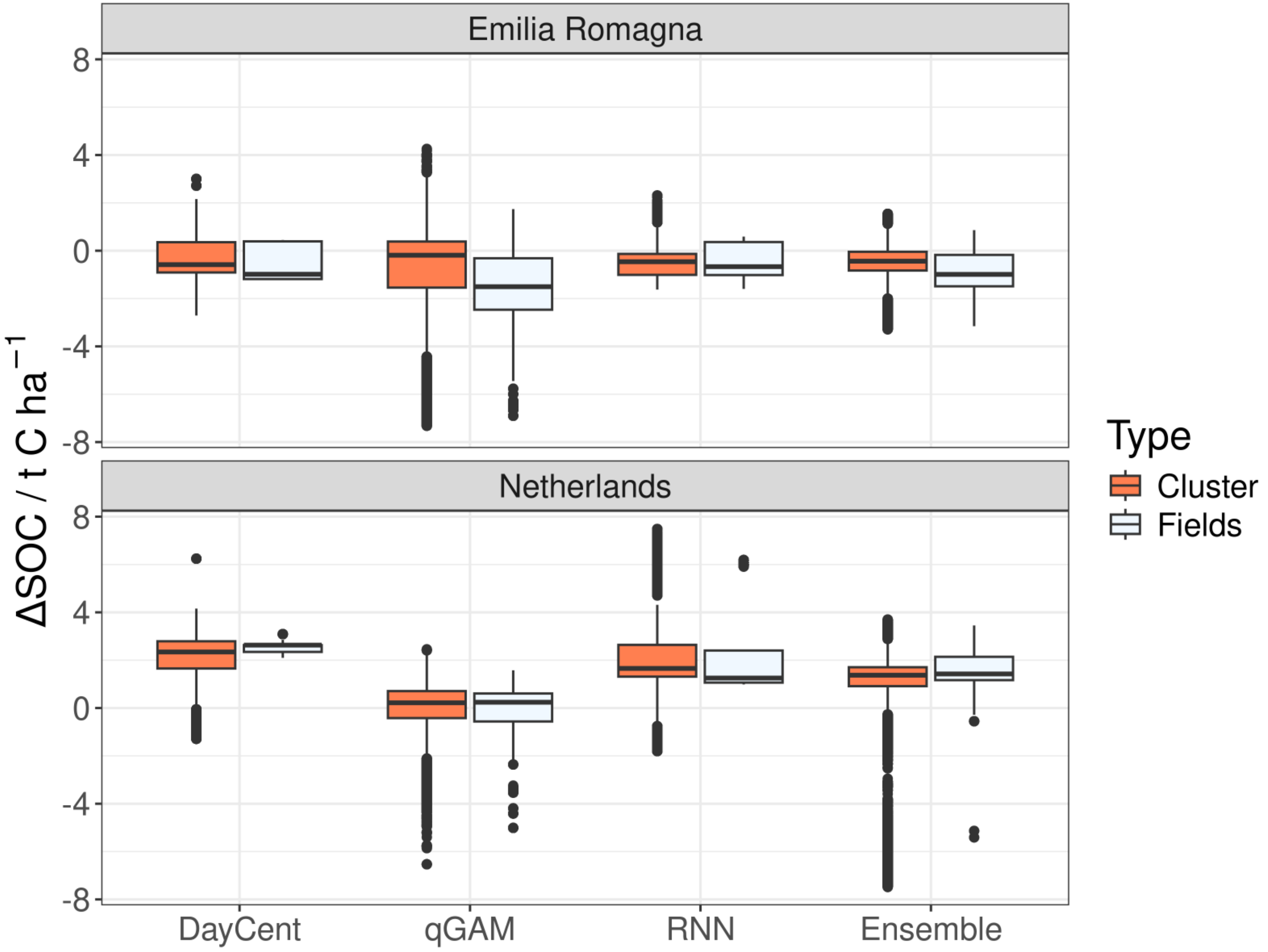
Results : Dynamic clustering for a regional baseline



- Differences between modelling approaches
- Ensemble had some mitigating effect on relative differences
- Large relative differences can be small in absolute terms