CRCF Methodologies

Agriculture and agroforestry on mineral soils

How EO assimilation contributes to building a Transparent, Accurate, Consistent, Complete, & Comparable MRV for SOC

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European Environment Agency

esa

Verified Carbon Standard
A VERRA STANDARD

Quality Assurance Principles

Real &Measurable

Permanent

Additional

Independently

Audited

Unique

Conservative

Transparently Listed

GREENHOUSE GAS PROTOCOL

Corporate standard Accounting Principles

Transparency

Accuracy

Consistency

Completeness

Relevance

UNFCCC
Enhanced Transparency Framework (ETF)

TACCC Principles

Transparency

Accuracy

Consistency

Completeness

Comparability

Reinterpretation from for Carbon farming

TACCC Principles

Transparency

Accuracy

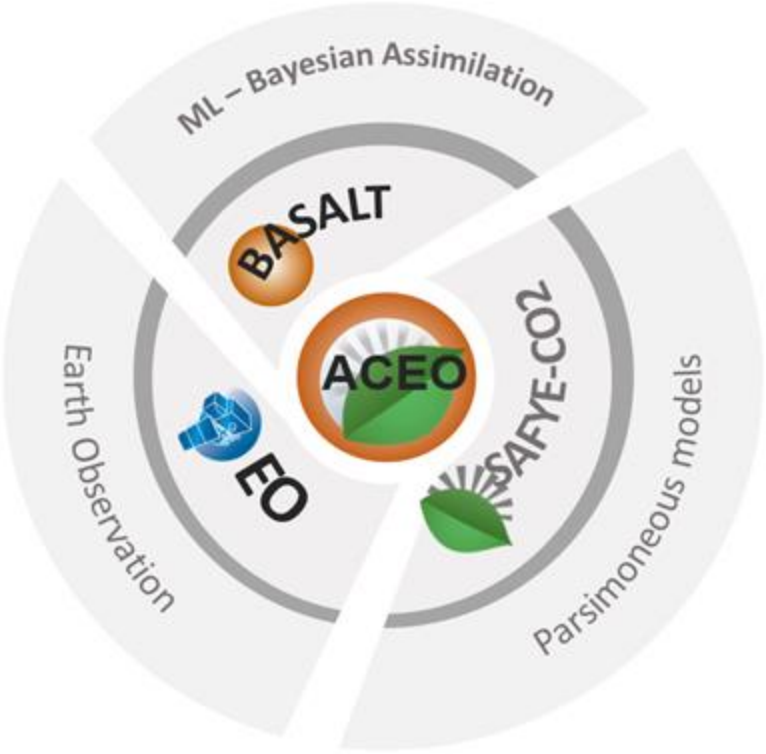
Consistency

Completeness

Comparability

Specify technological solutions

e.g. AgriCarbon-EO®



Inform Policies - CRCF

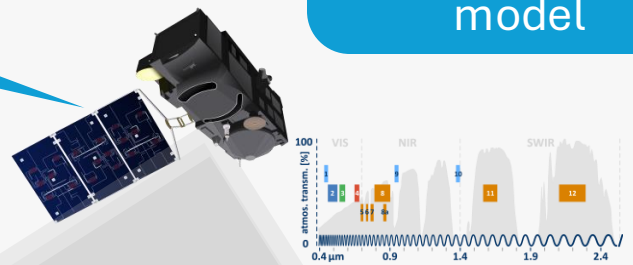
Completeness

All mandatory reporting elements must be included.

EO reduces enables lesser complexity by constraining the crop model

Carbon farming is not only about soil need a crop model

Weather, practice, Soil properties



Radiative module

GPP

Respiration

Vegetation module

Harvest

O. Amend.

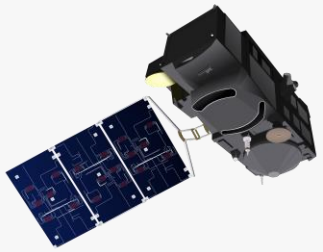
Residus

Soil module

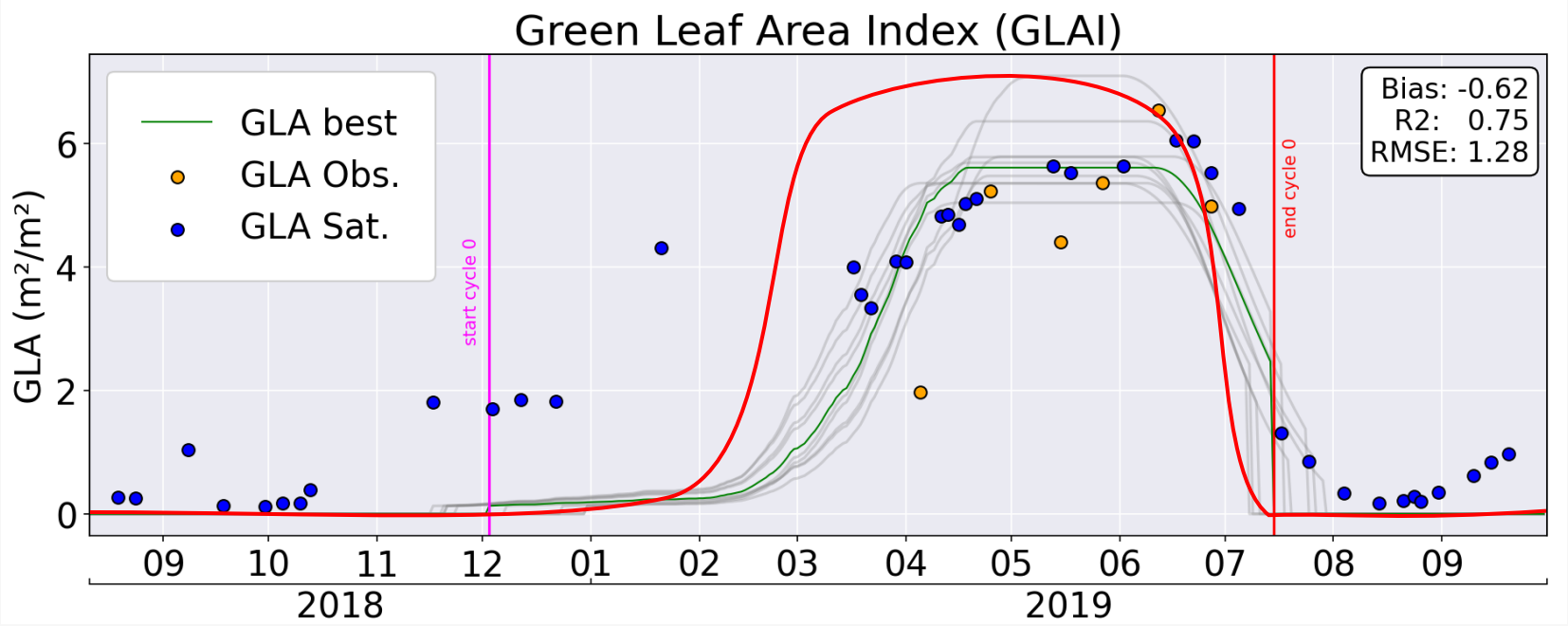
Complete
But not complex
“Parsimoneous”

Accuracy

Correct, credible, & reliable information.
Uncertainties should be reduced.



Crop Model Assumptions vs Reality



Implication on other variables: GPP, NEE, SOC

Accuracy

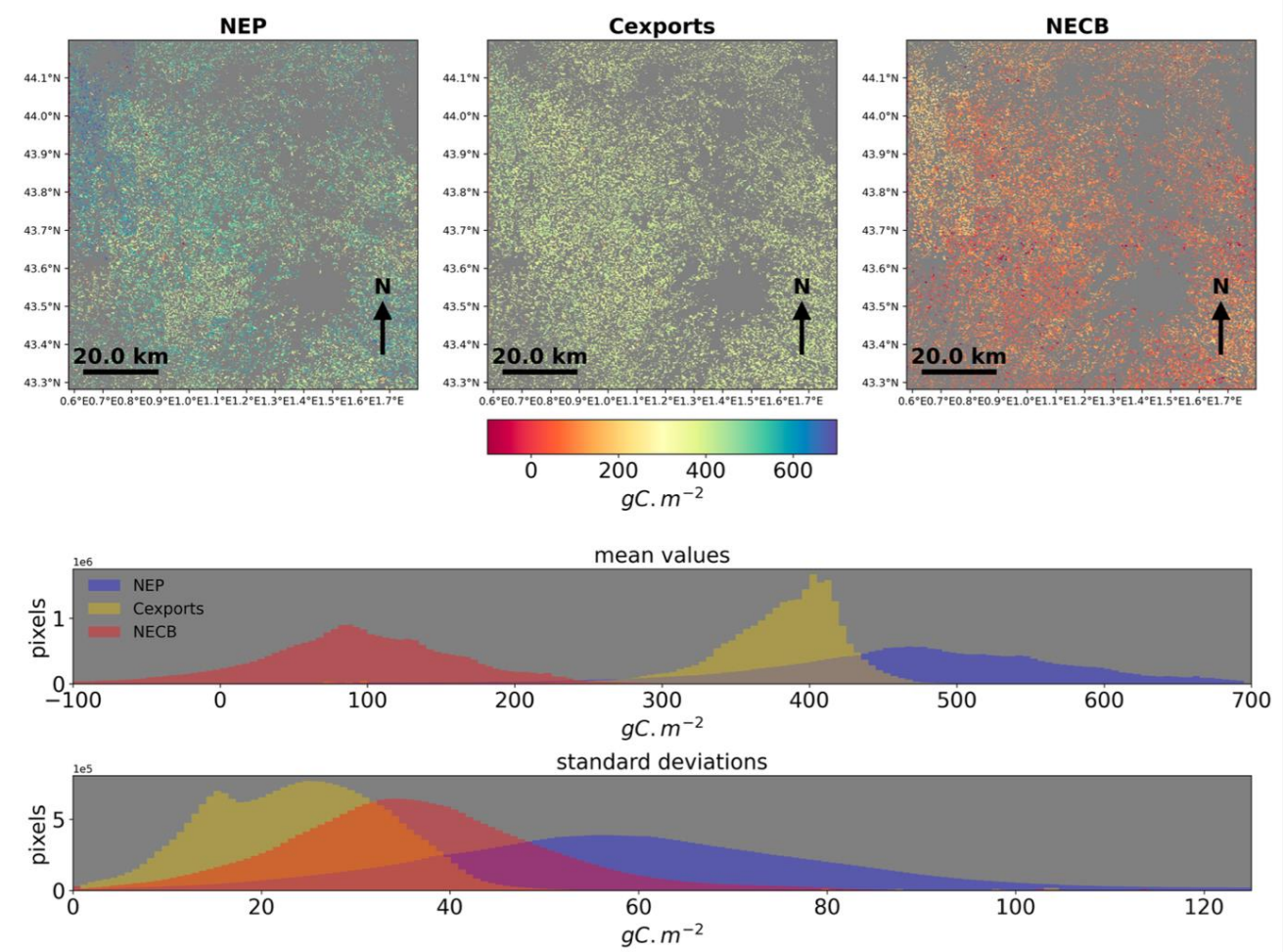
Correct, credible, & reliable information.
Uncertainties should be reduced.

ML
e.g. Bayesian Normalised Sampling (a tier3 “Mont-carlo” approach)

Model
Leaf Area Index
[mean & uncertainty]

EO
Leaf Area Index
[mean & uncertainty]

Enables propagation of uncertainties across the processing chain.



$$\log(\text{Likelihood}) = \Sigma\,[-0.5 \times \log(2\pi\sigma^2) - ((vo - \mu o)^2 / (2\sigma^2))]$$

Accuracy

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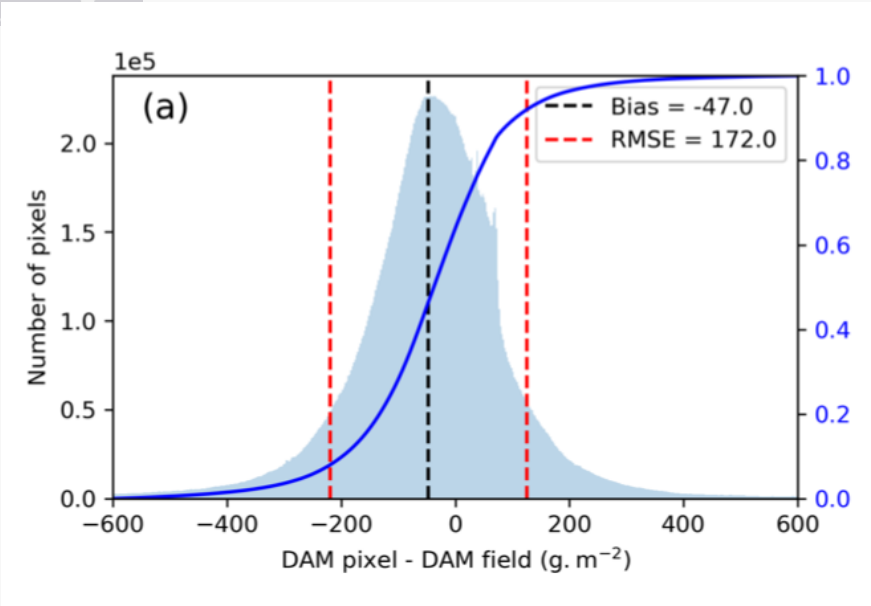
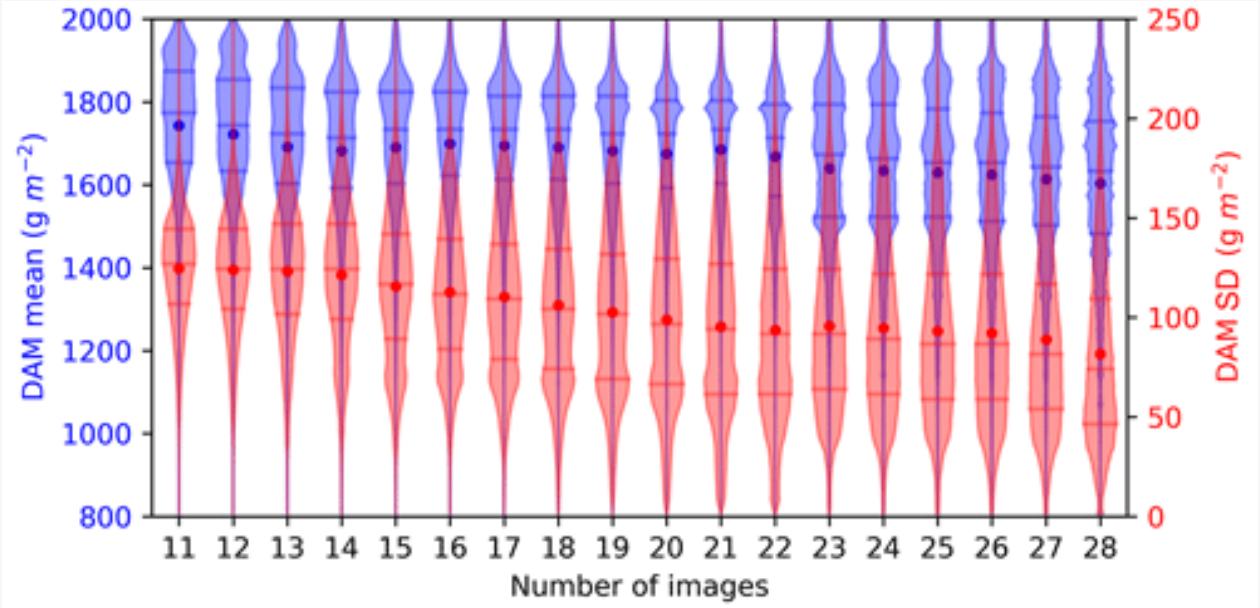
Uncertainties should be reduced.





High resolution ➔ Reduces bias

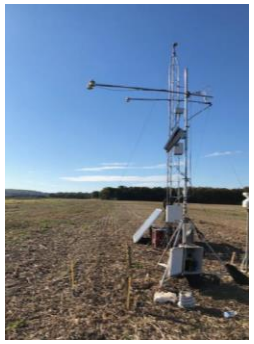
EO informs the system ➔ Reduces the uncertainties
The higher the number of EO images the higher is the decrease in standard deviation.

Consistency

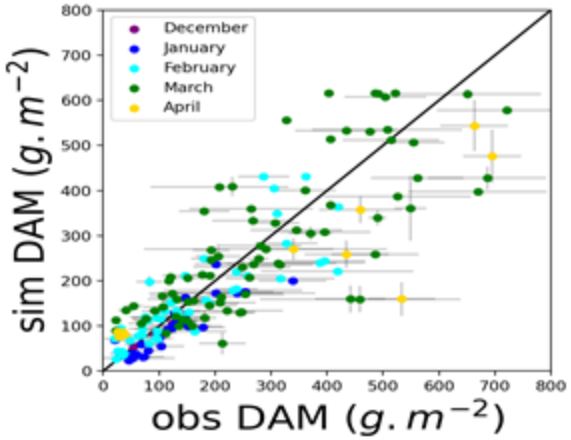
The information should not contradict or imply contradictions within or across years (location)

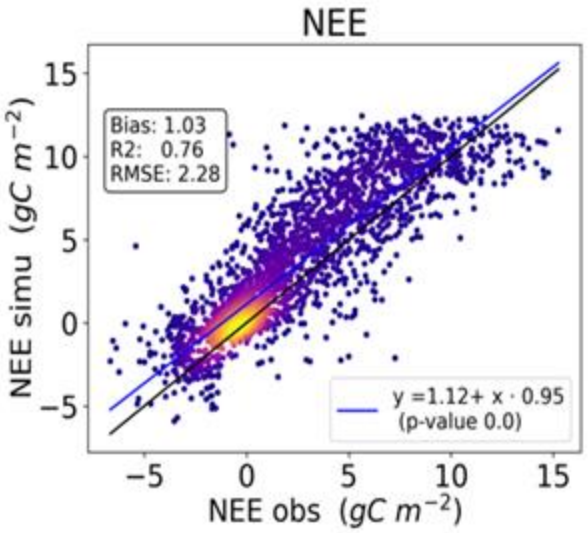
Validation against flux towers

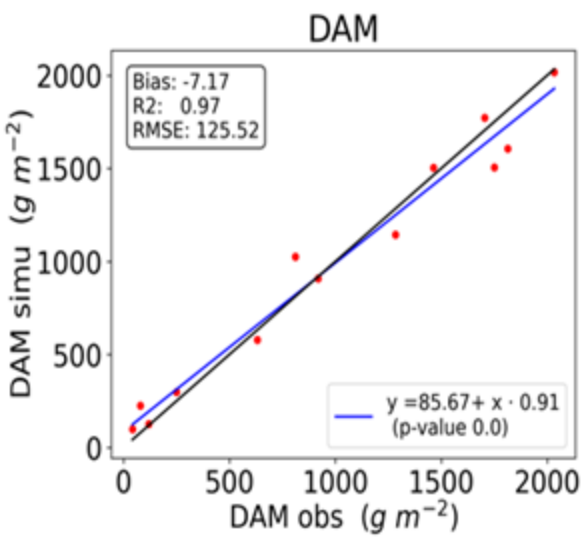
ICOS Integrated Carbon Observation System

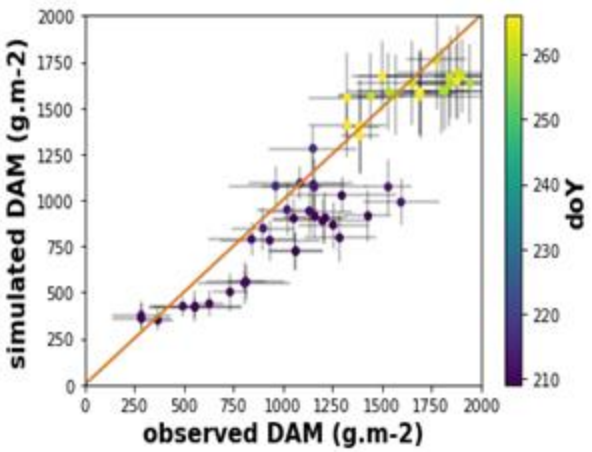


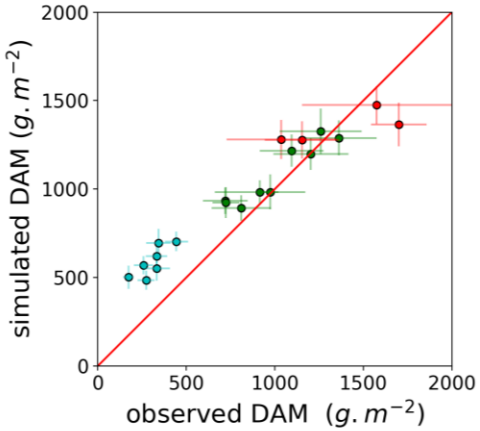
Validation for Maiz, covercrops







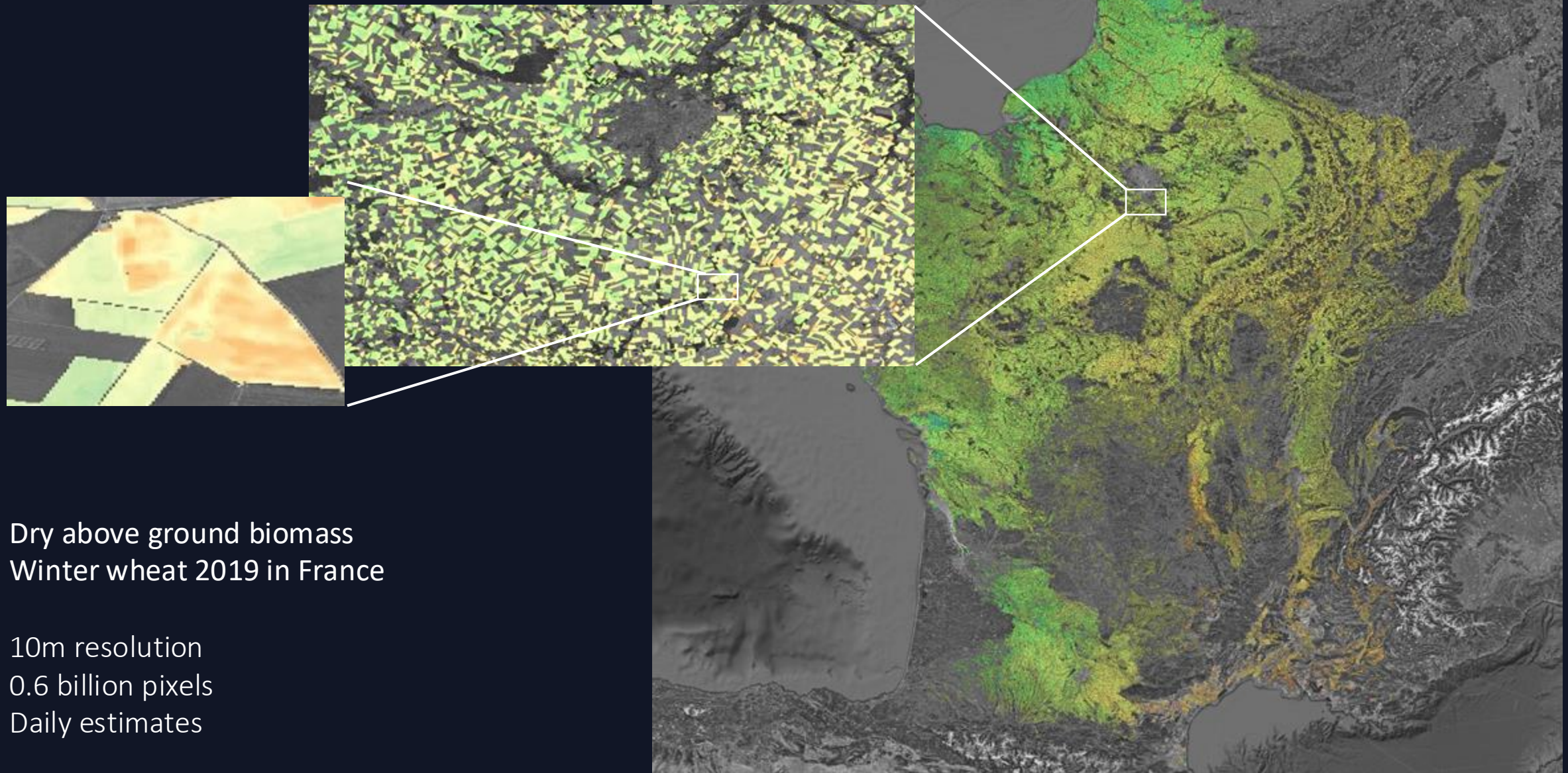




Consistency

From intra-field to National scale

A scalable solution



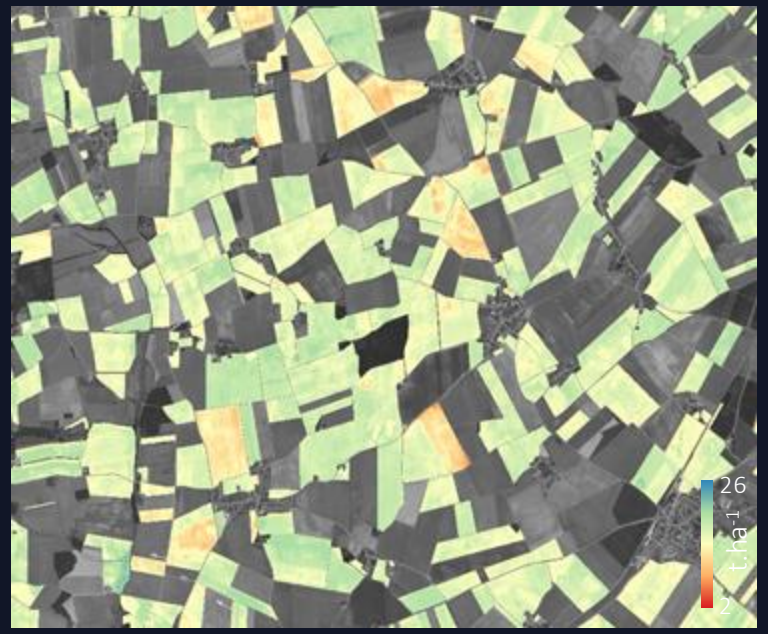
Dry above ground biomass
Winter wheat 2019 in France

10m resolution
0.6 billion pixels
Daily estimates

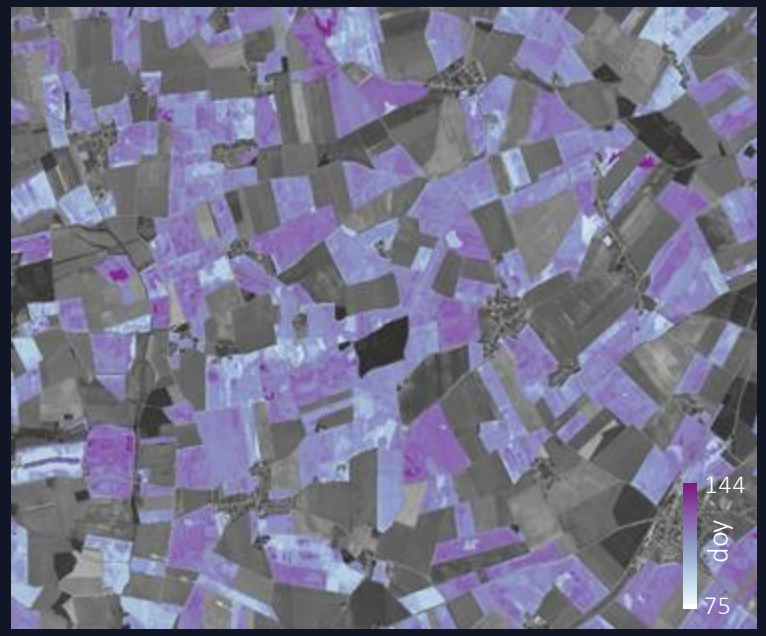
Consistency

Coherent-set Of agri-environmental variables

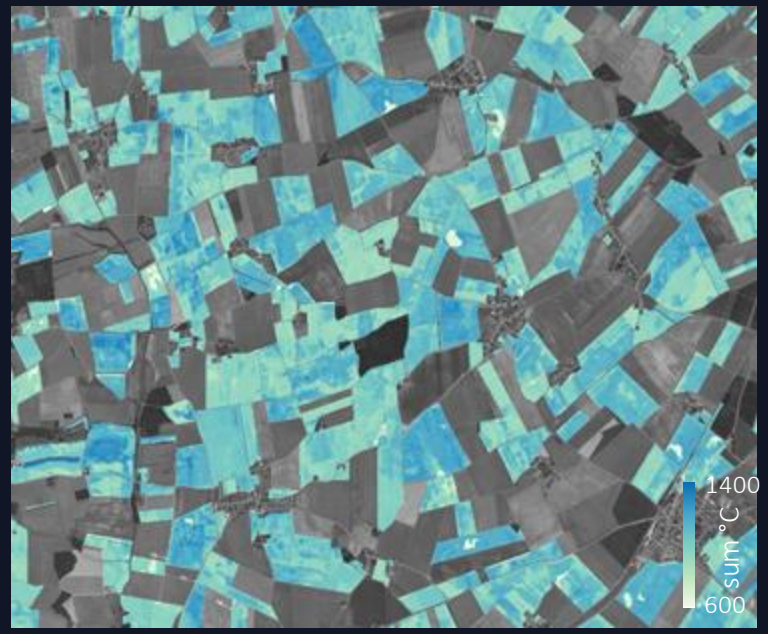
Dry Above ground biomass



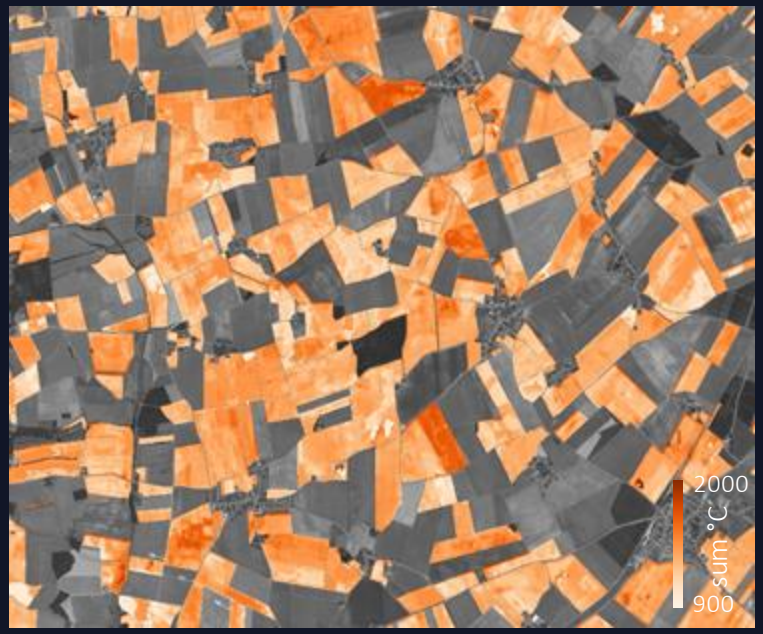
Net annual CO_2 flux



Day of emergence



Maturation phase

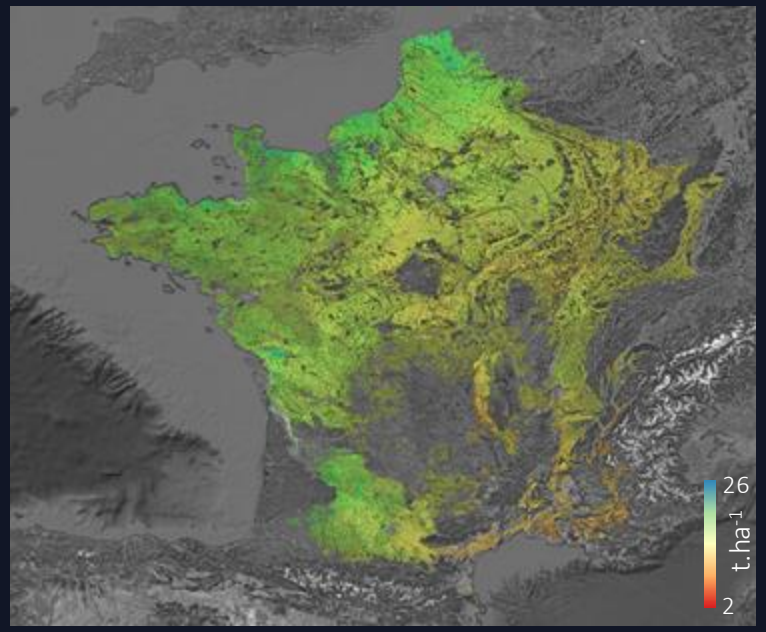


Senescent phase

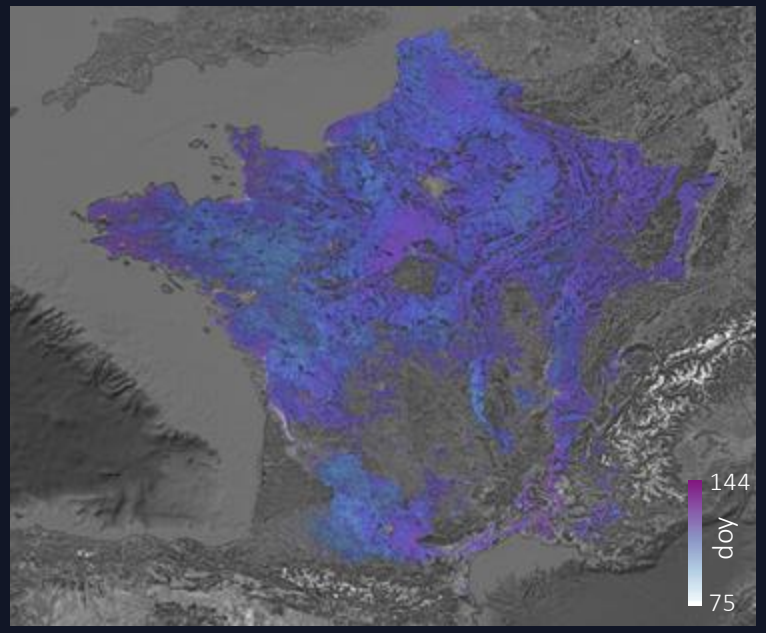
Consistency

Coherent-set Of agri-environmental variables

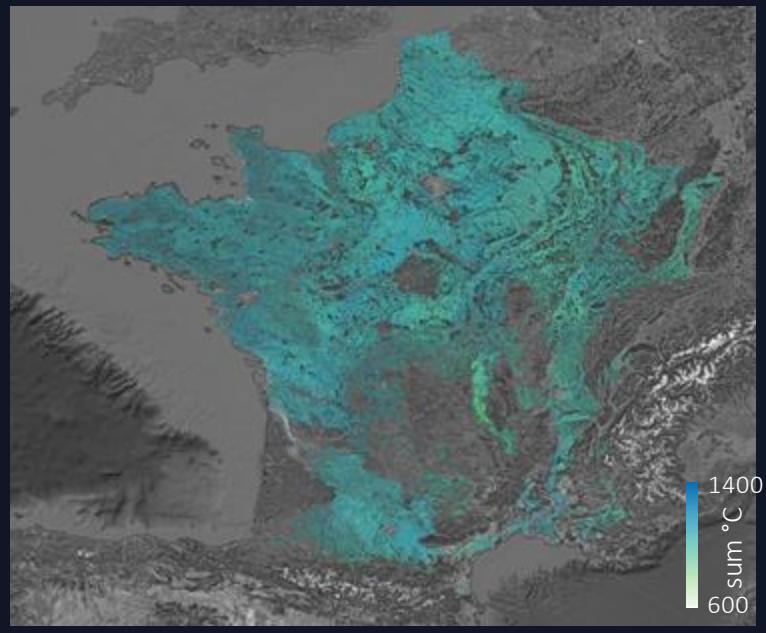
Dry Above ground biomass



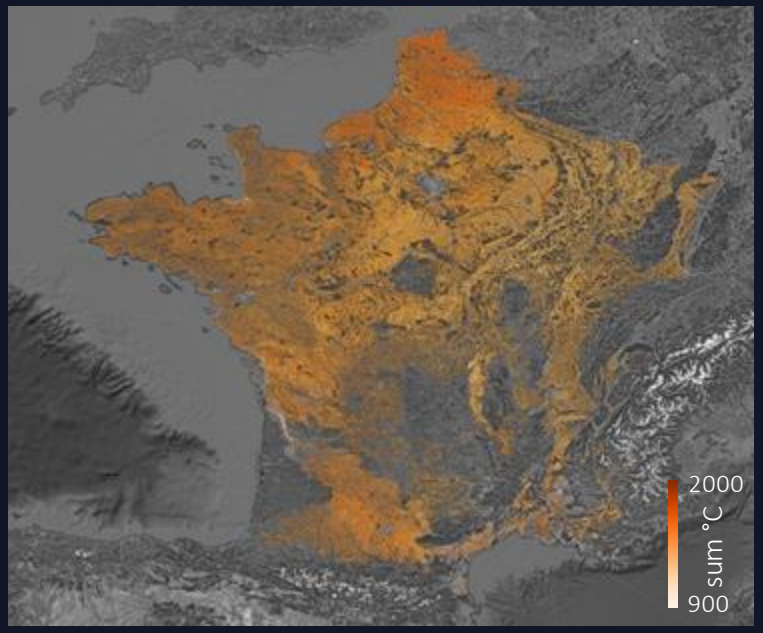
Net annual CO_2 flux



Day of emergence



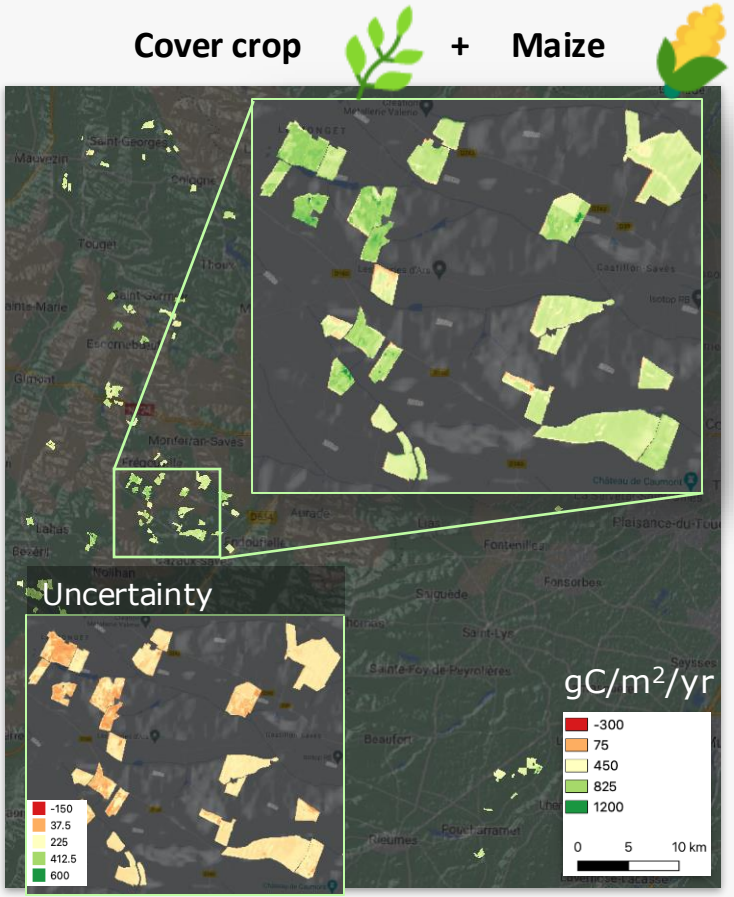
Maturation phase



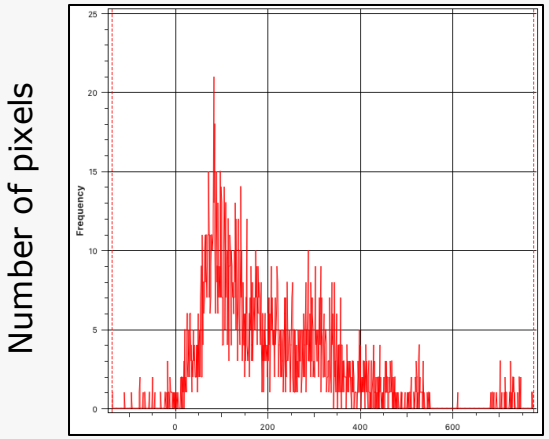
Senescent phase

Comparability

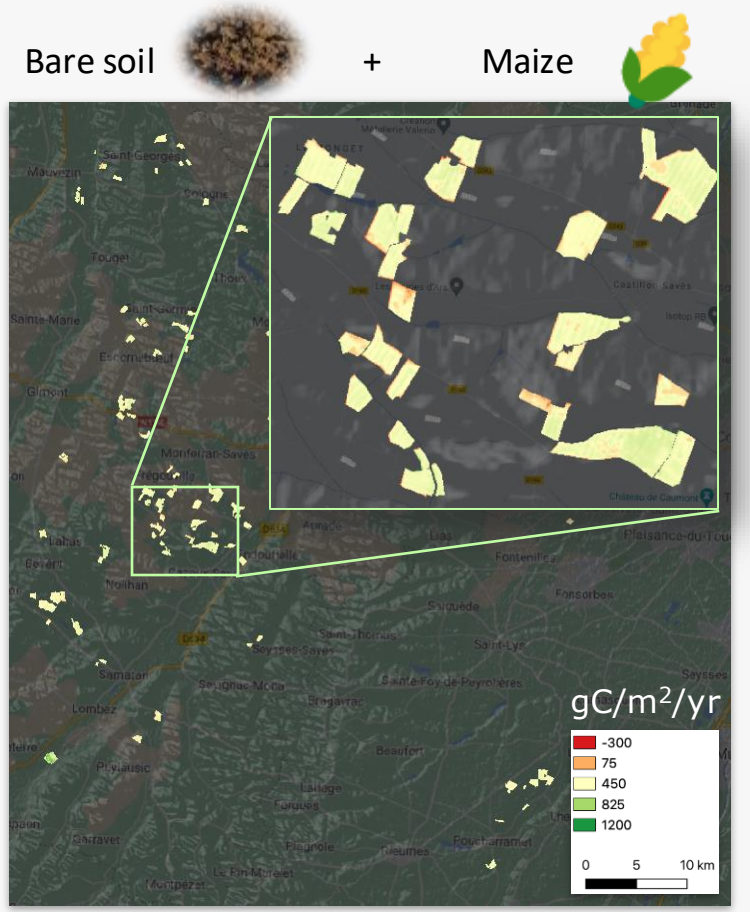
*Reported removals should be **comparable**.*



Histogram of the difference



On average 200gC of Dry Mass/ha/yr or approx 0,3 t C/ha stored/yr thanks to the cover crops



Al Bitar et al. IGARSS 2022

EO assimilation enables to produce scenarios vs Business as Ussual

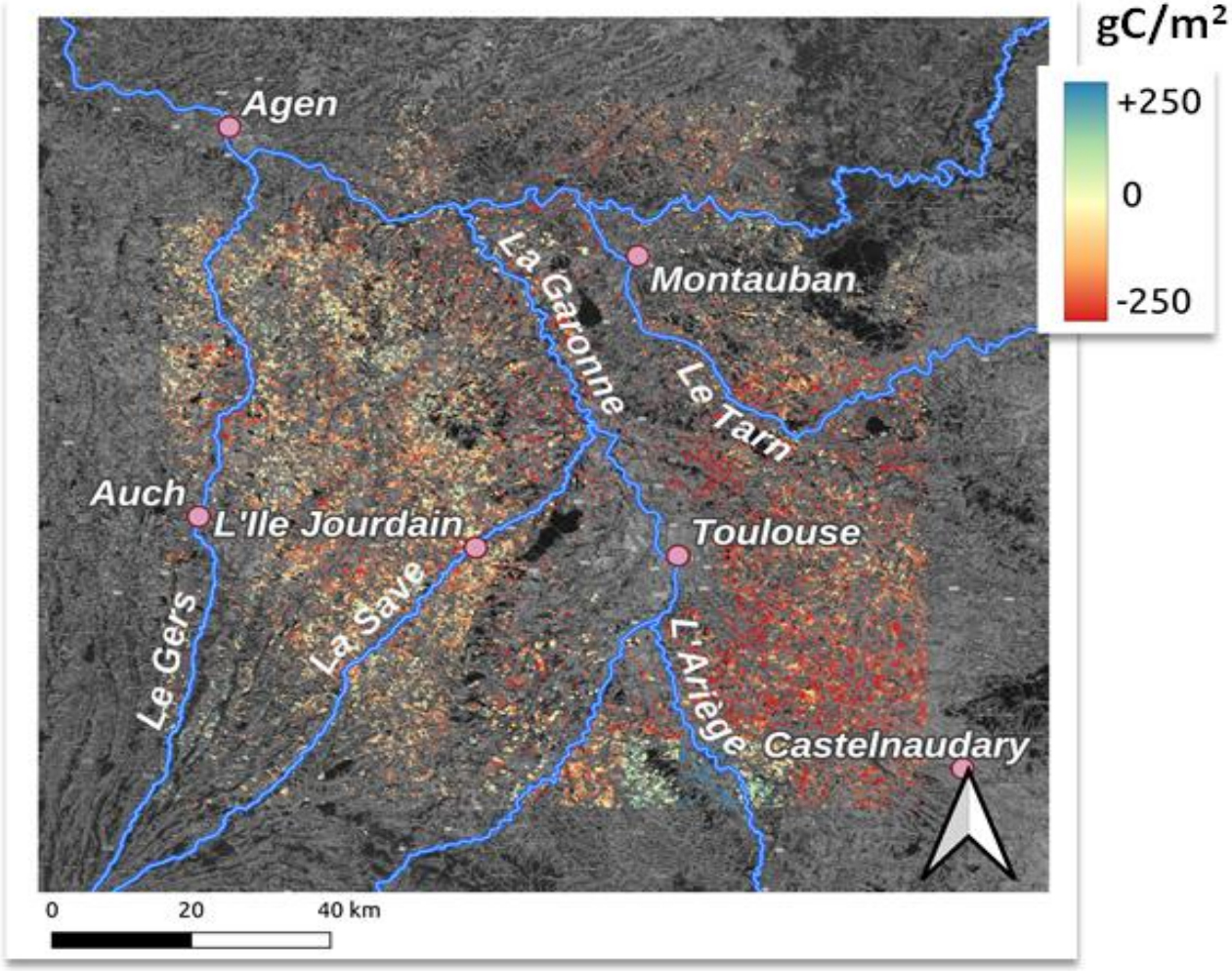
Comparability

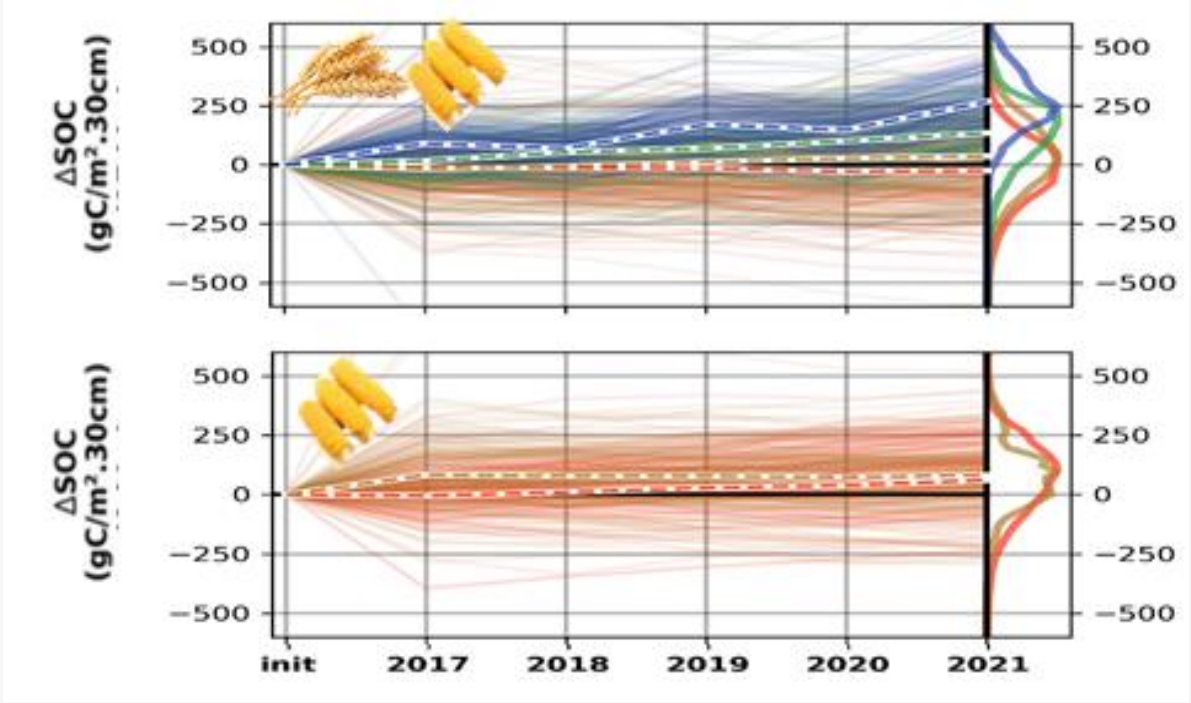
Scenario 1: only grains are harvested and no organic amendment applied

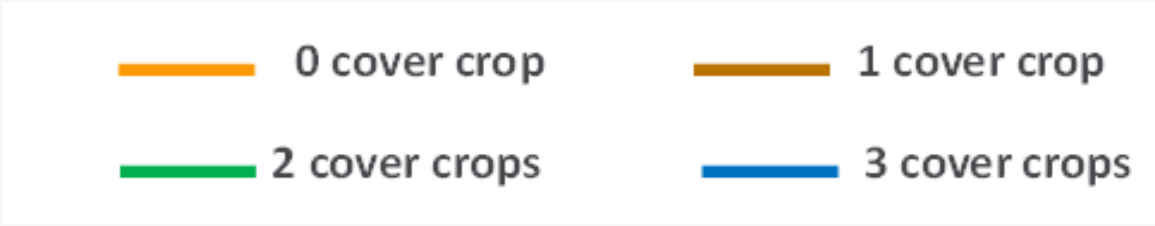
Scenario 2: grains + straw are harvested and no organic amendment applied

EO assimilation enables to produce scenarios vs Business as Ussual

Comparability







EO assimilation enables to produce plot/farm specific baselines

Transparency

provide clear, factual, objective information, including underlying sources, assumptions, and methodologies

1. Traceable and Reproducible Data Sources
→ **trace** the raw data and **reproduce** analyses, increasing trust.

2. Consistent, Wall-to-Wall Coverage
➔ **Complete spatial coverage**

3. Model Integration = Physically Coherent Estimates

4. Transparent Uncertainty Quantification
➔ Assimilation produce **error covariance estimates**

5. Independent Cross-Validation ➔verification credibility.

6. Automation & Auditability ➔ Reduce double counting

Informing Policies

1. Enforces Evidence-Based Policy Design
EO assimilation provides quantified, spatially explicit evidence

2. Advances Harmonised MRV Frameworks
Same datasets support CRCF, CAP, and LULUCF reporting.
Improves comparability and avoids double-counting.

3. Enables Transparent and Auditable Accounting
EO assimilation produces **traceable and uncertainty-quantified** estimates.

4. Intriduces Dynamic Monitoring and Adaptive Governance
Detects trends, reversals, and policy impacts in near-real time.

5. Ensures Performance-Based Incentives
Shifts from practice-based to **result-based payments** (€/tCO_2eq).

6. Ensures Policy Coherence and Integration
Aligning with sectoral policies common data streams across the Soil Monitoring Law, CRCF, and CAP.