

Le bilan et flux de carbone sur parcelles agricoles avec

AgriCarbon-EO & SAFYE-CO2



Al Bitar A.

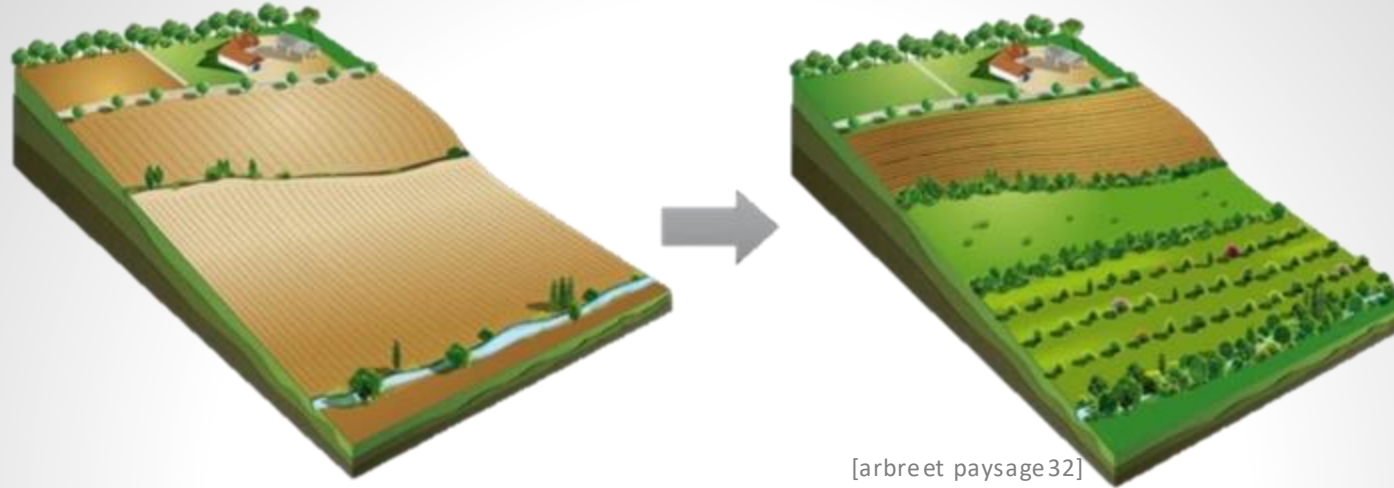
CESBIO (CNRS, CNRS, IRD, UPS, INRAE), Toulouse, France

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Des outils pour l'accompagnement de l'Agroécologie

Intensive farming

- ▶ 2 to 3 crops / year
- ▶ Deep tilling
- ▶ More inputs
- ▶ ...



[arbret paysage32]

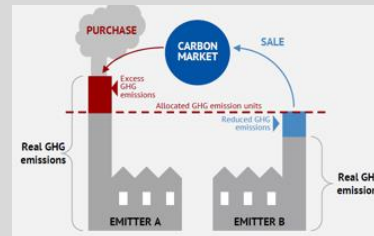
Agro-ecological practices

- ▶ Stockage de carbone
- ▶ Rotation
- ▶ Culture intermediaire

[Minasny et al. 2017, Geoderma]

[Chabi et al. 2017, Nat. Clim.Ch.]

National and international initiatives



Emergence du marché volontaire
« offsetting » « insetting »

EU-Horizon ORCASA

Suivis du stock de carbone dans un cadre MRV



Monitoring

Reporting

Verification

[Smith et al.2020, *Global Change Biology*]

Suivis à des échelles spatiales et temporelles variés

Rapport sur evolution des activités et des cultures

Mesure du SOC, mais à quelle densité d'échantillonnage ?

← **Systeme d'observation: terrain et télédétection (intra-parcellaire, fréquente).** →

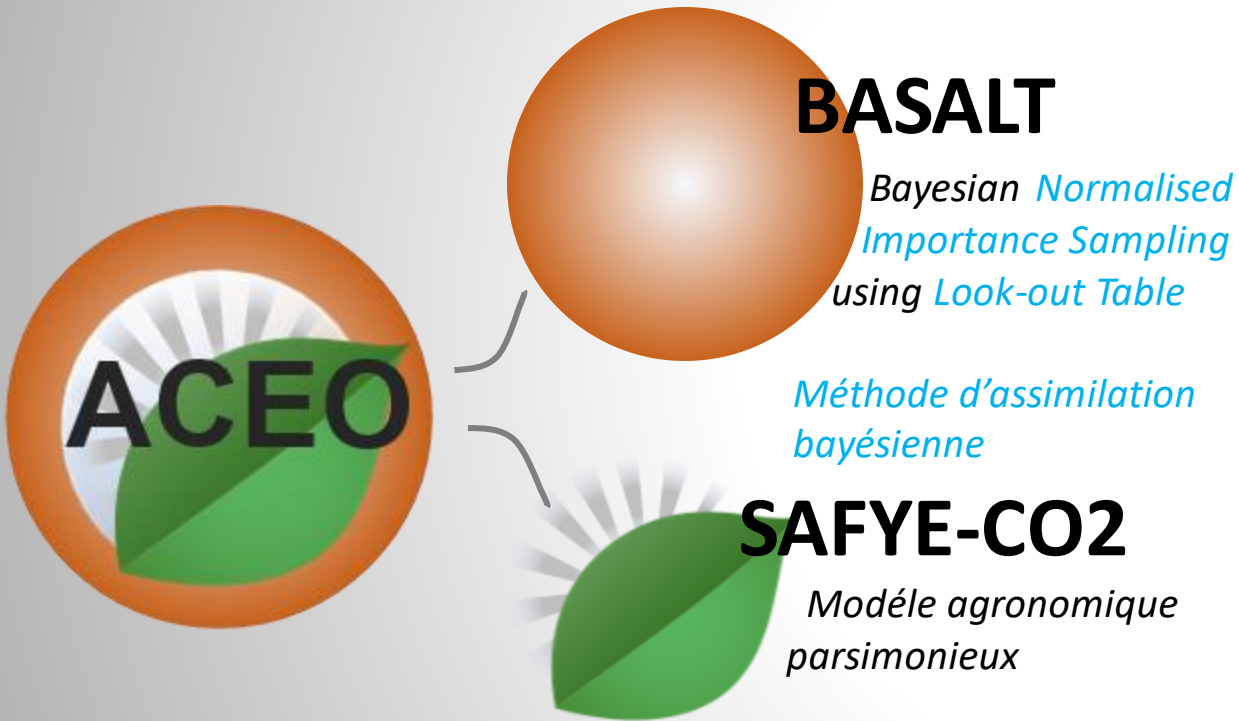
← **Systeme expert : modèle agronomique, machine Learning** →

→ **Motivation du développement d'AgriCarbon-EO**

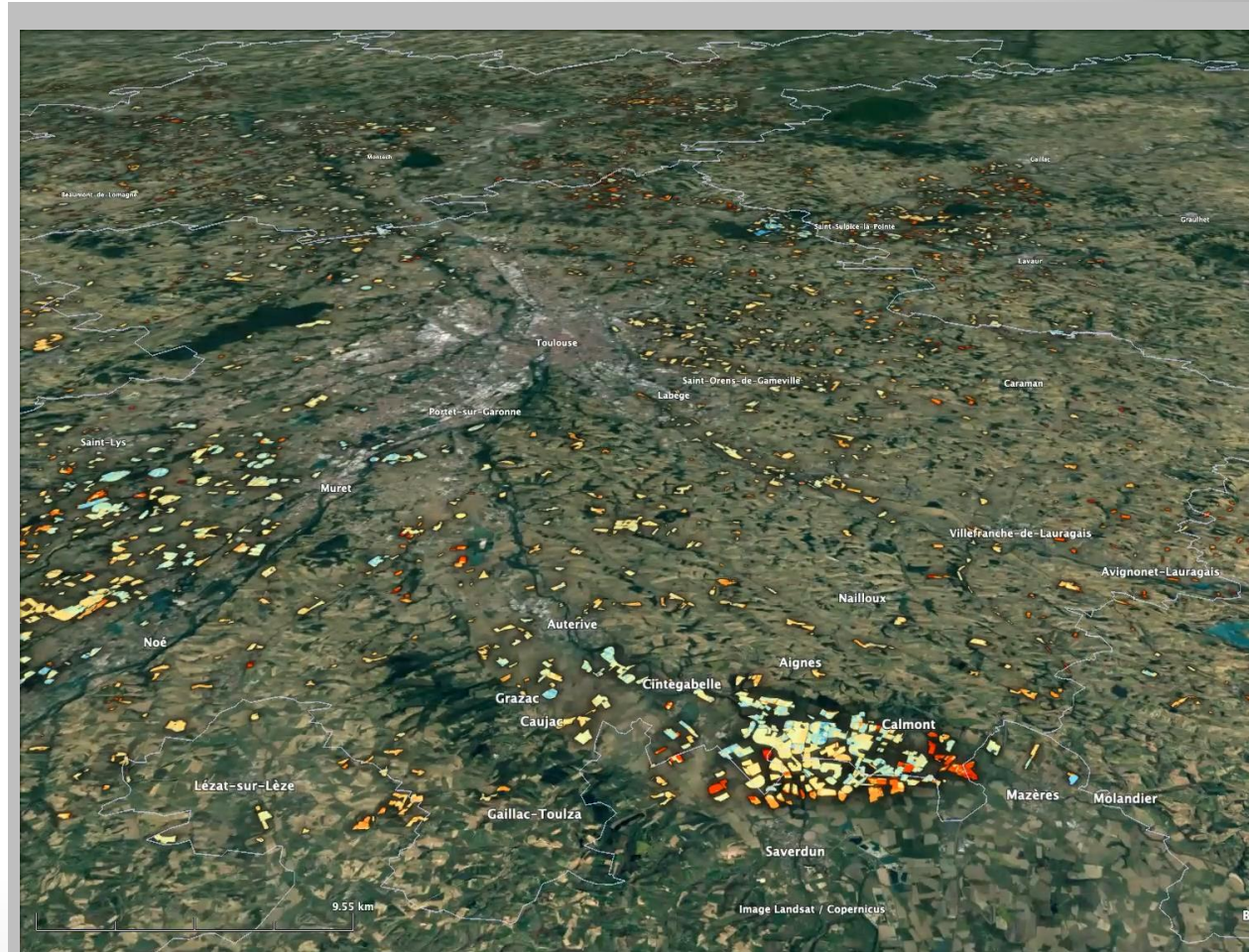
AgriCarbon-EO

Agri carbon-EO « et eau » [ACEO]

Une chaîne de traitement de bout en bout pour les systems

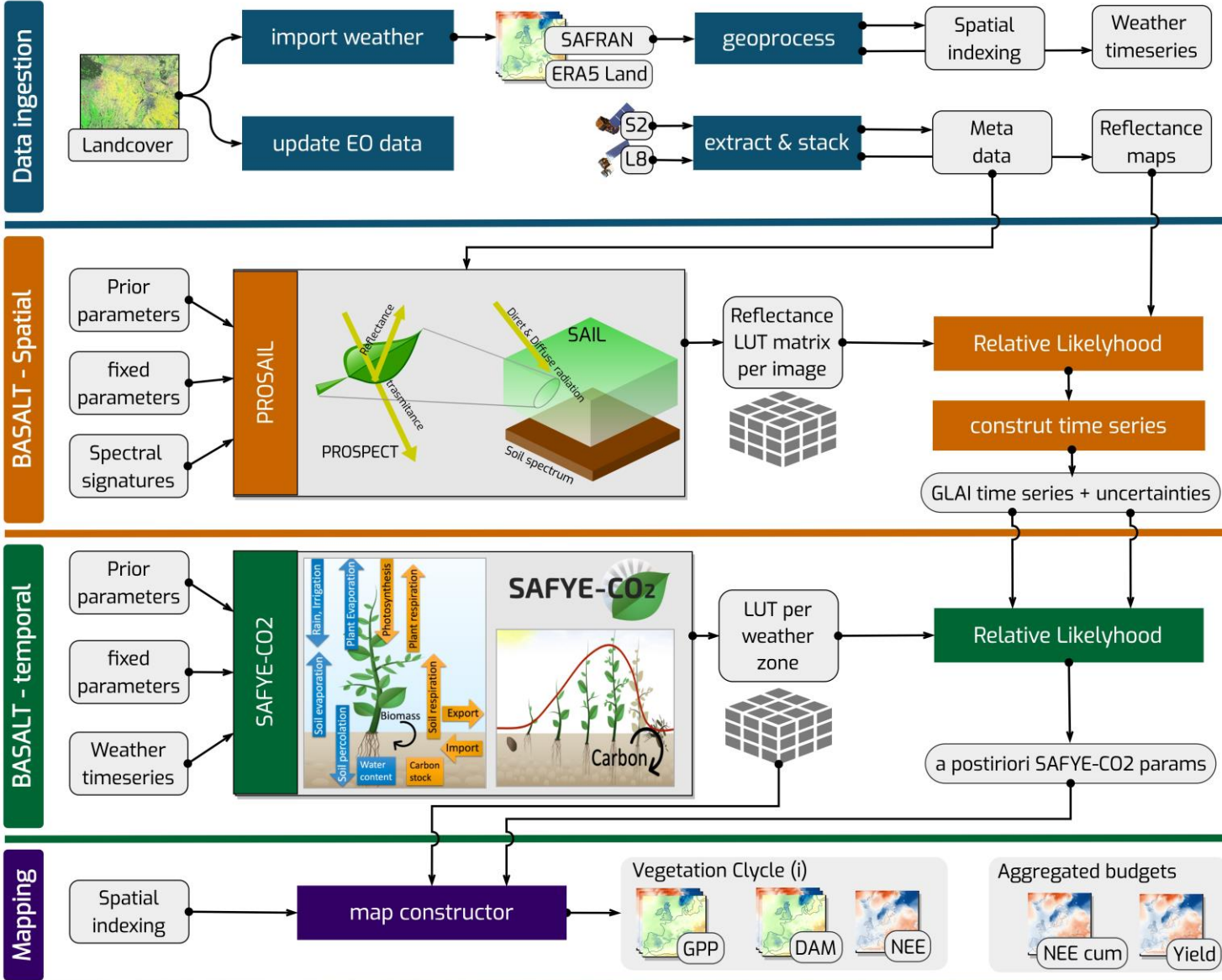


Net Ecosystem Exchange over Wheat for 110x110 km at 10m (in France)



AgriCarbon-EO – Vue d'ensemble

AgriCarbon-EO processing chain



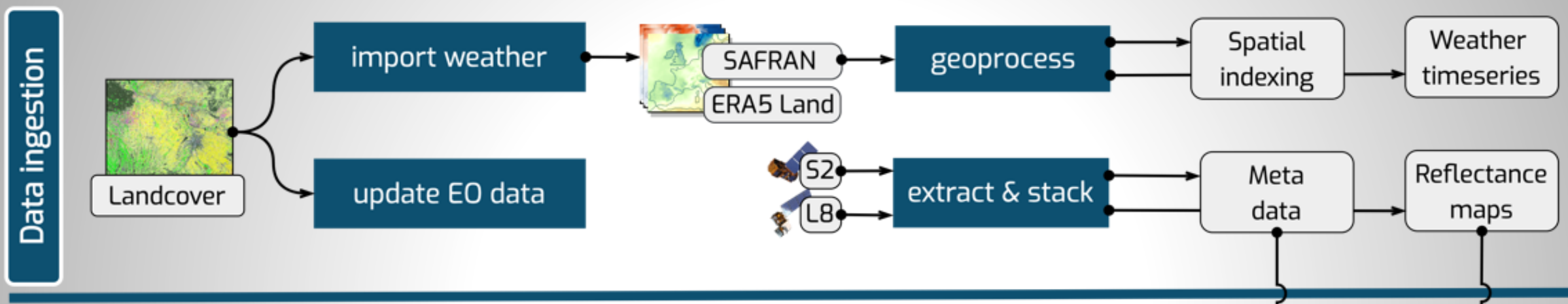
AgriCarbon-EO v1.0.1: Large Scale and High Resolution Simulation of Carbon Fluxes by Assimilation of Sentinel-2 and Landsat-8 Reflectances using a Bayesian approach

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Carte utilisation du sol



Produit RPG



Produit OSO
(vectorisé)

Données de télédétection

Réflectance L2A multispectrale
(MAJA).
10m de résolution natif



Sentinel-2, Landsat8, Venus
(en cours Planet, Sentinel-1)

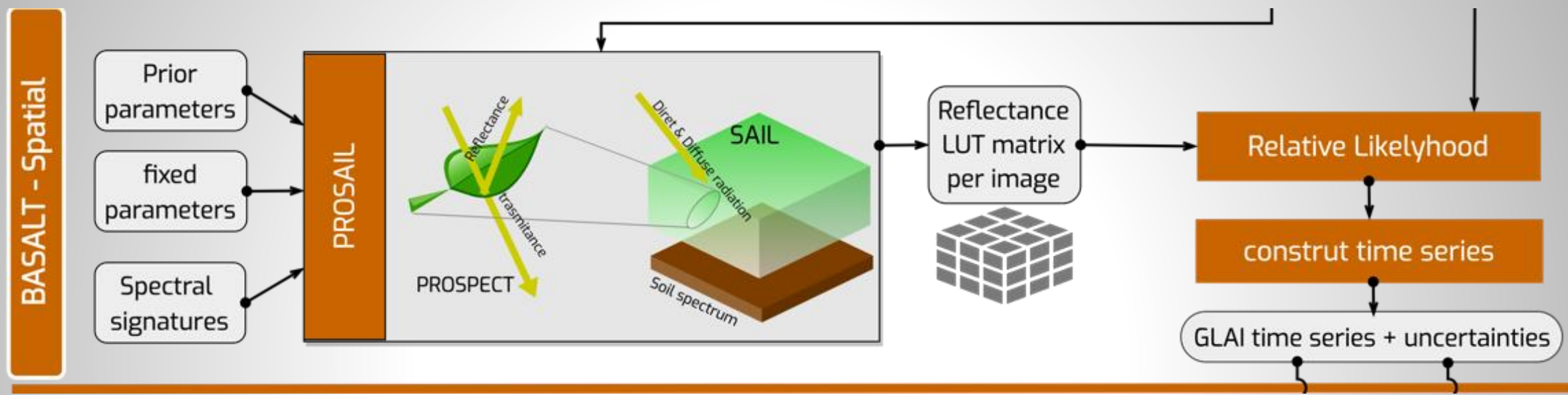


Données météo

- Rg: Incoming global radiation
- 2m air temperature

ERA5-Land par api
ou
SAFRAN météo France

2 GLAI & invertitude associé



Inversion de PROSAIL pour obtention du Green Leaf Area Index (GLAI) et son incertitude.

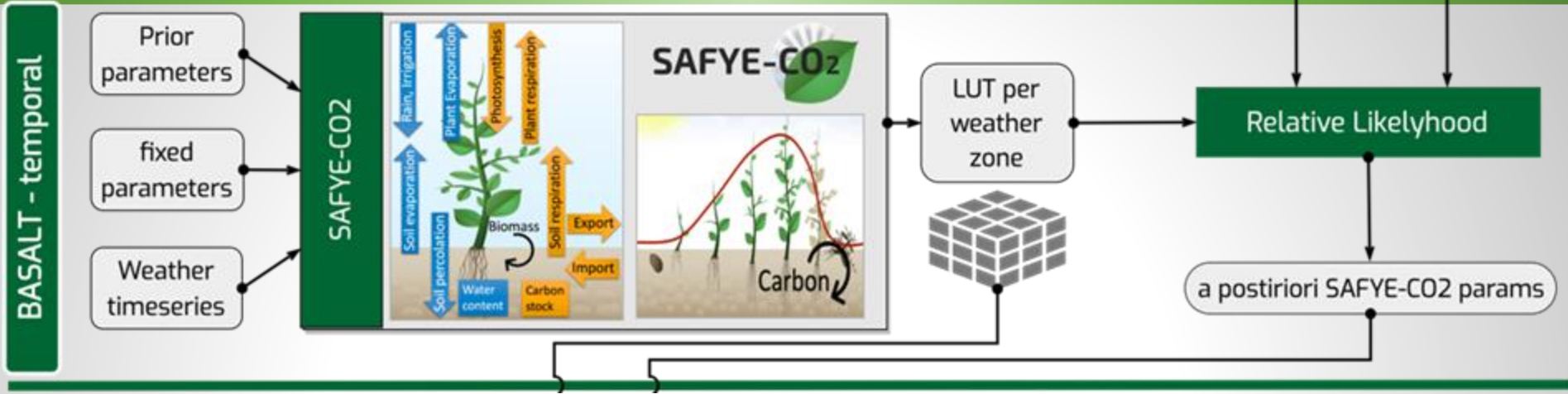
Posteriori Prob. distribution

$$P(\vec{\theta}, x) = \frac{P(x|\vec{\theta})P(\vec{\theta})}{P(x)}$$

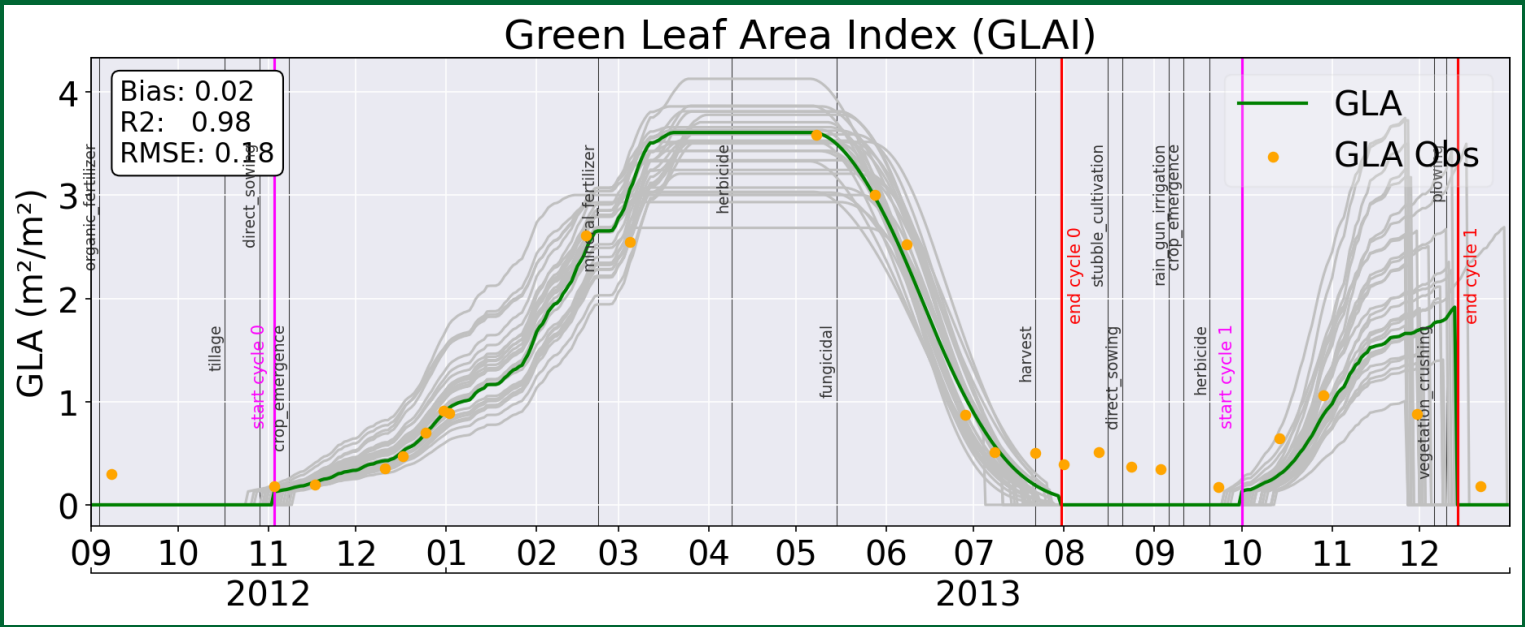
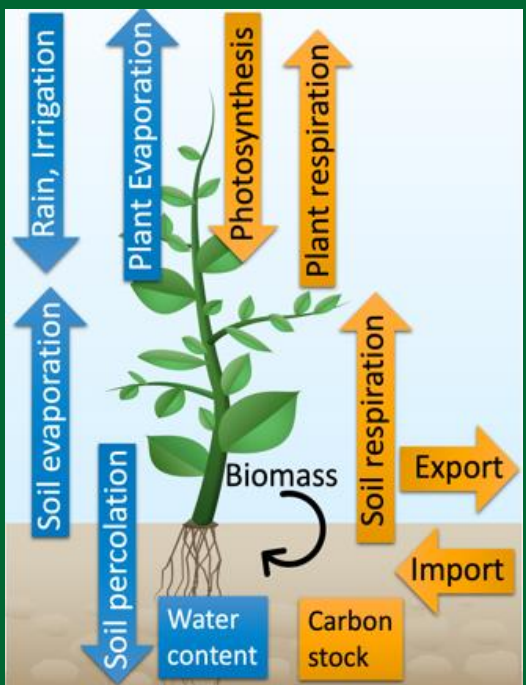
Conditional probability likelihood

Probability distribution of prior parameters

Probability distribution of observation

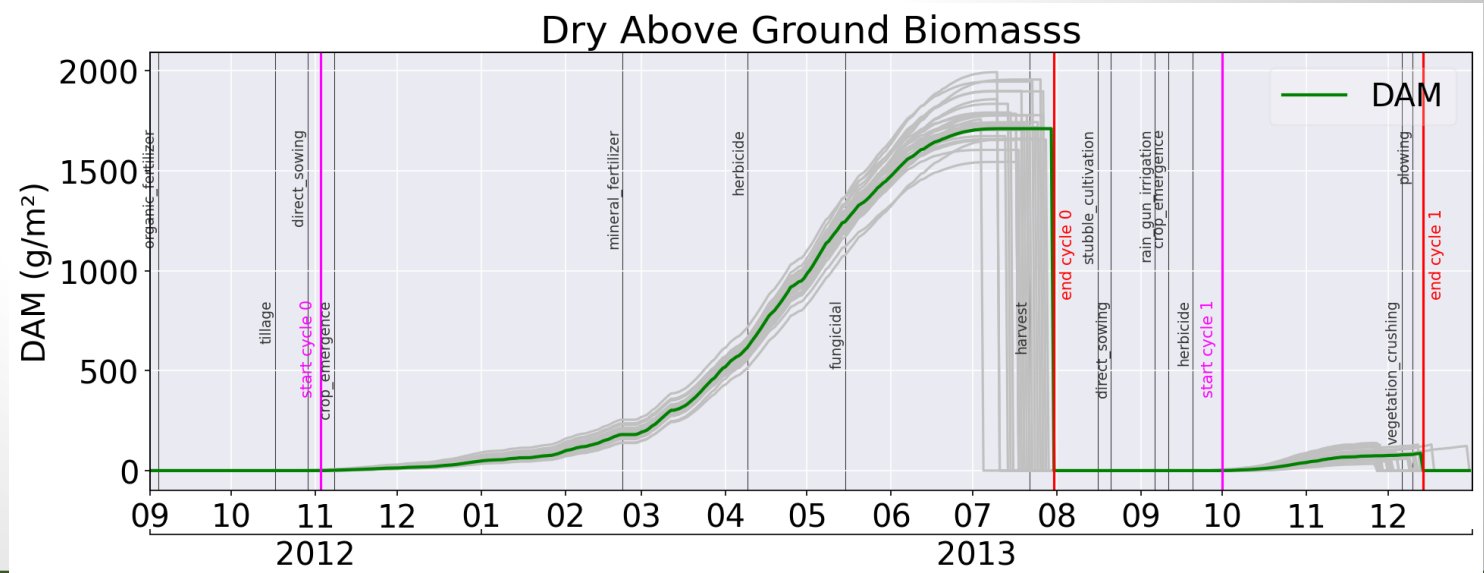
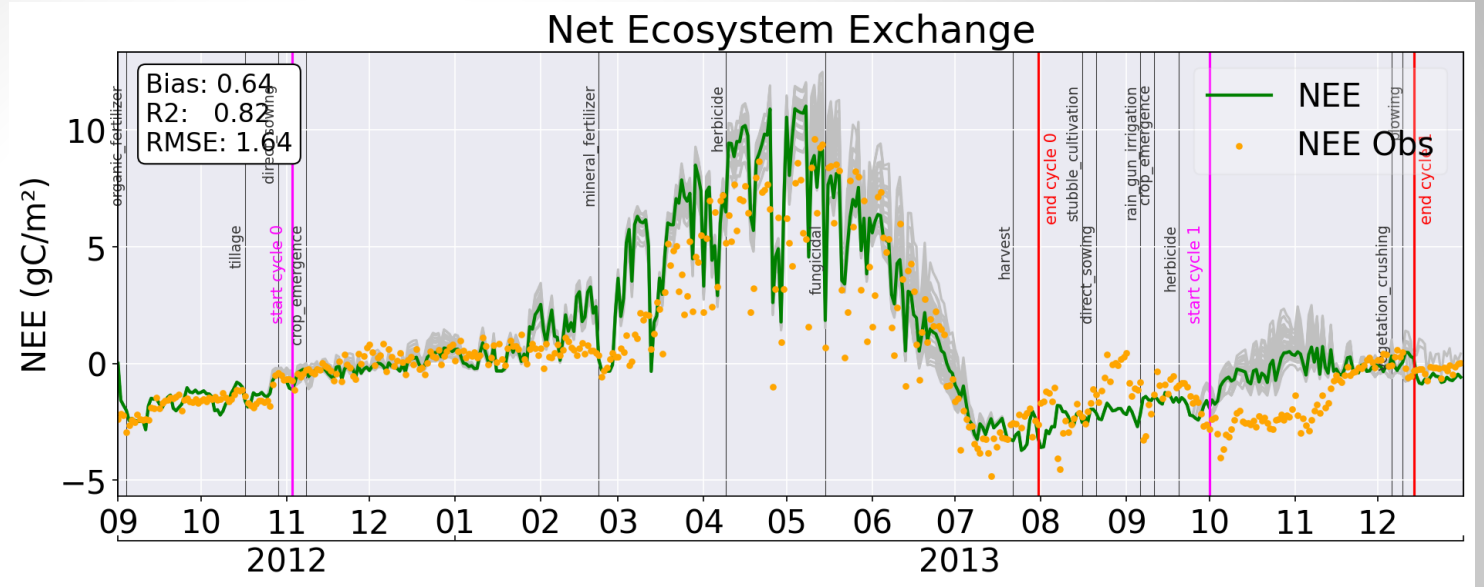


Safye-CO₂

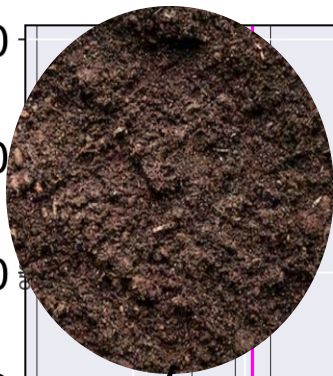
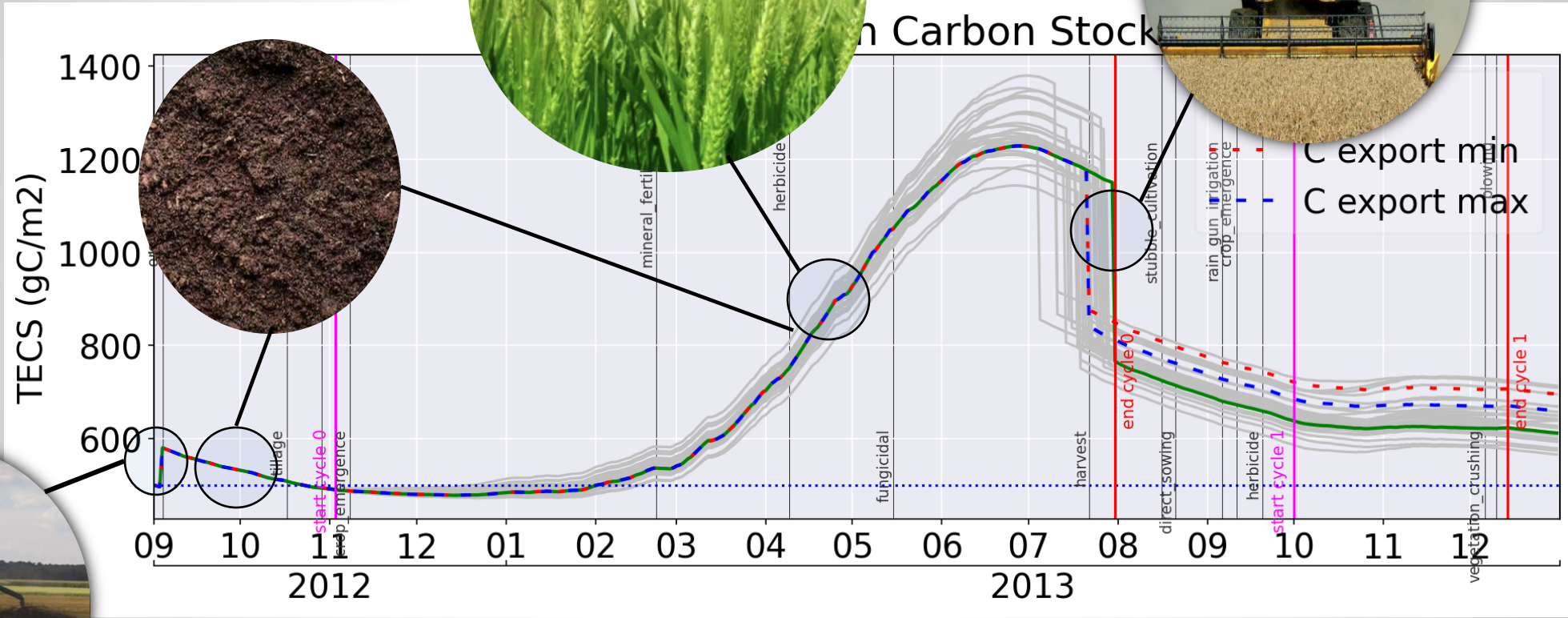


Photosynthèse

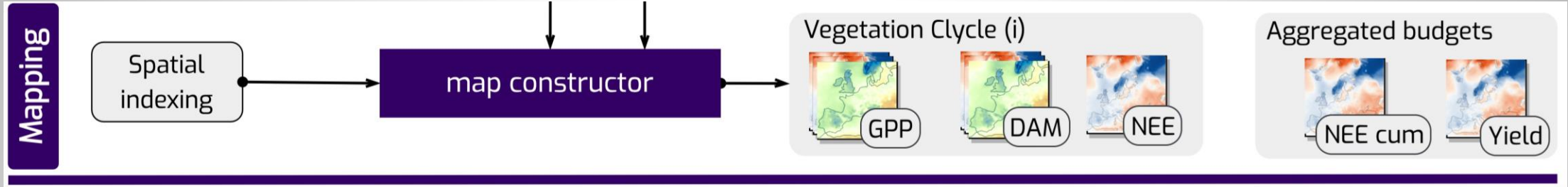
Net Ecosystem Exchange



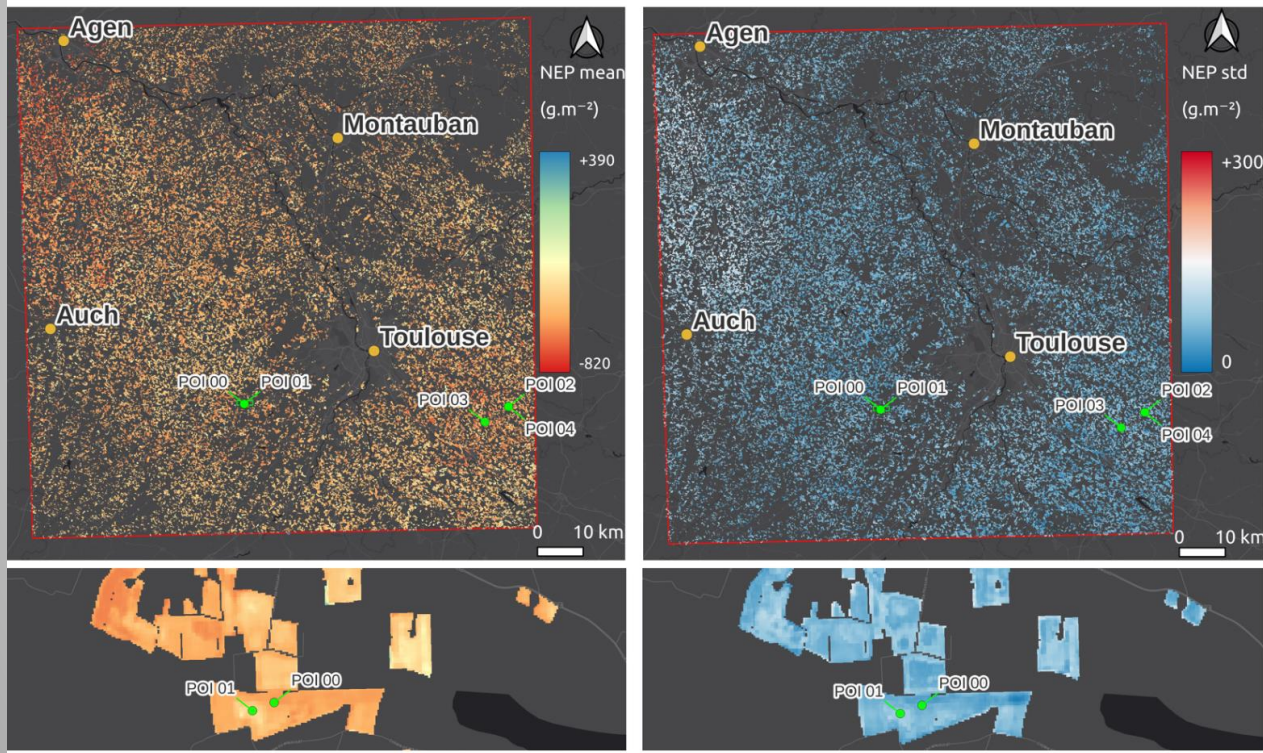
NEW



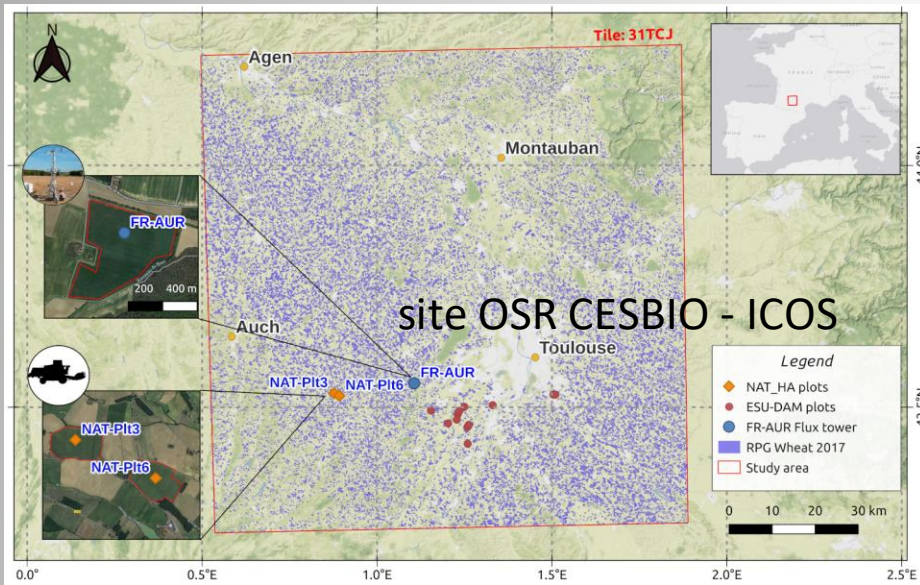
Mapping



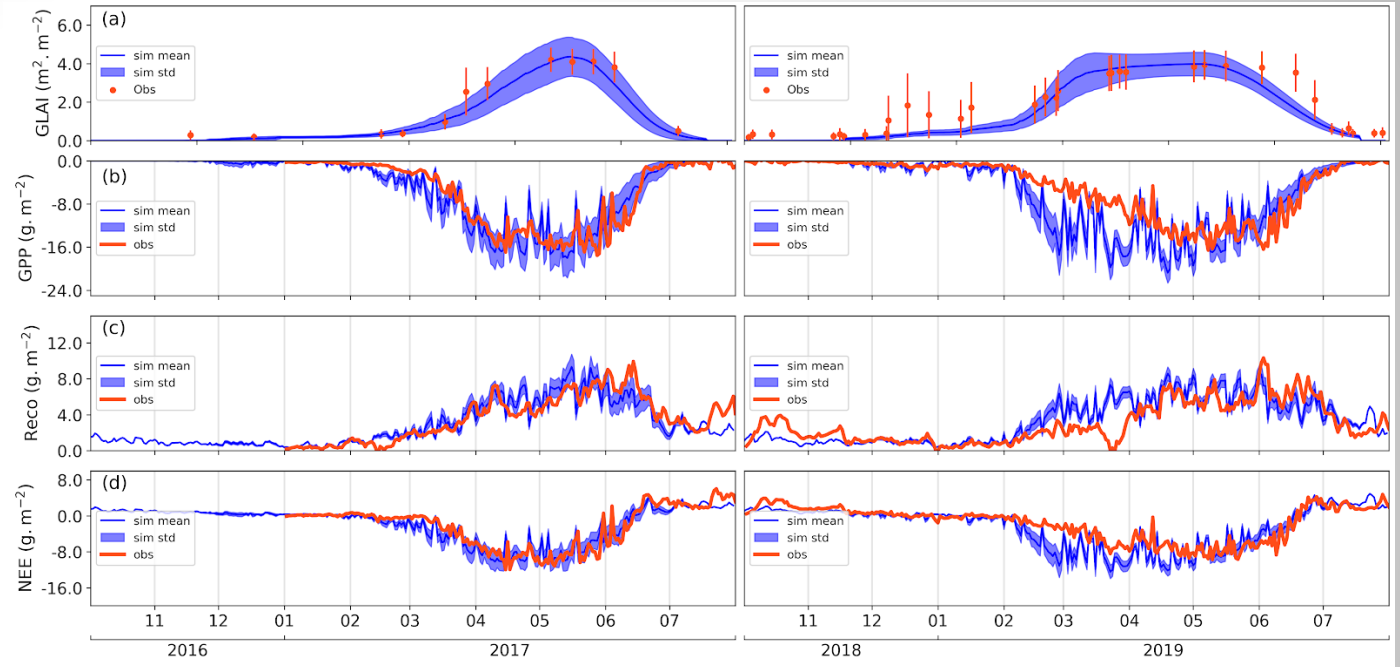
Exemple 1: NEE (T31TCJ, Sudouest, France)



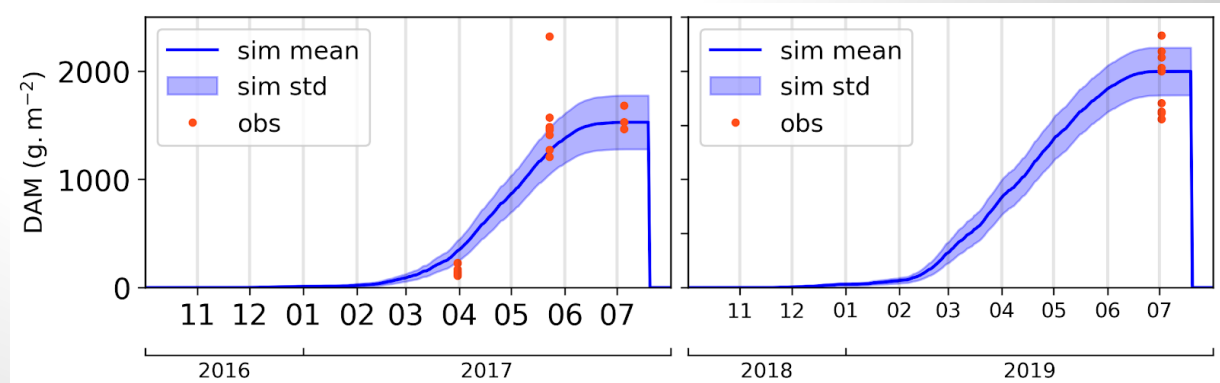
Validation Blé d'hiver SO France



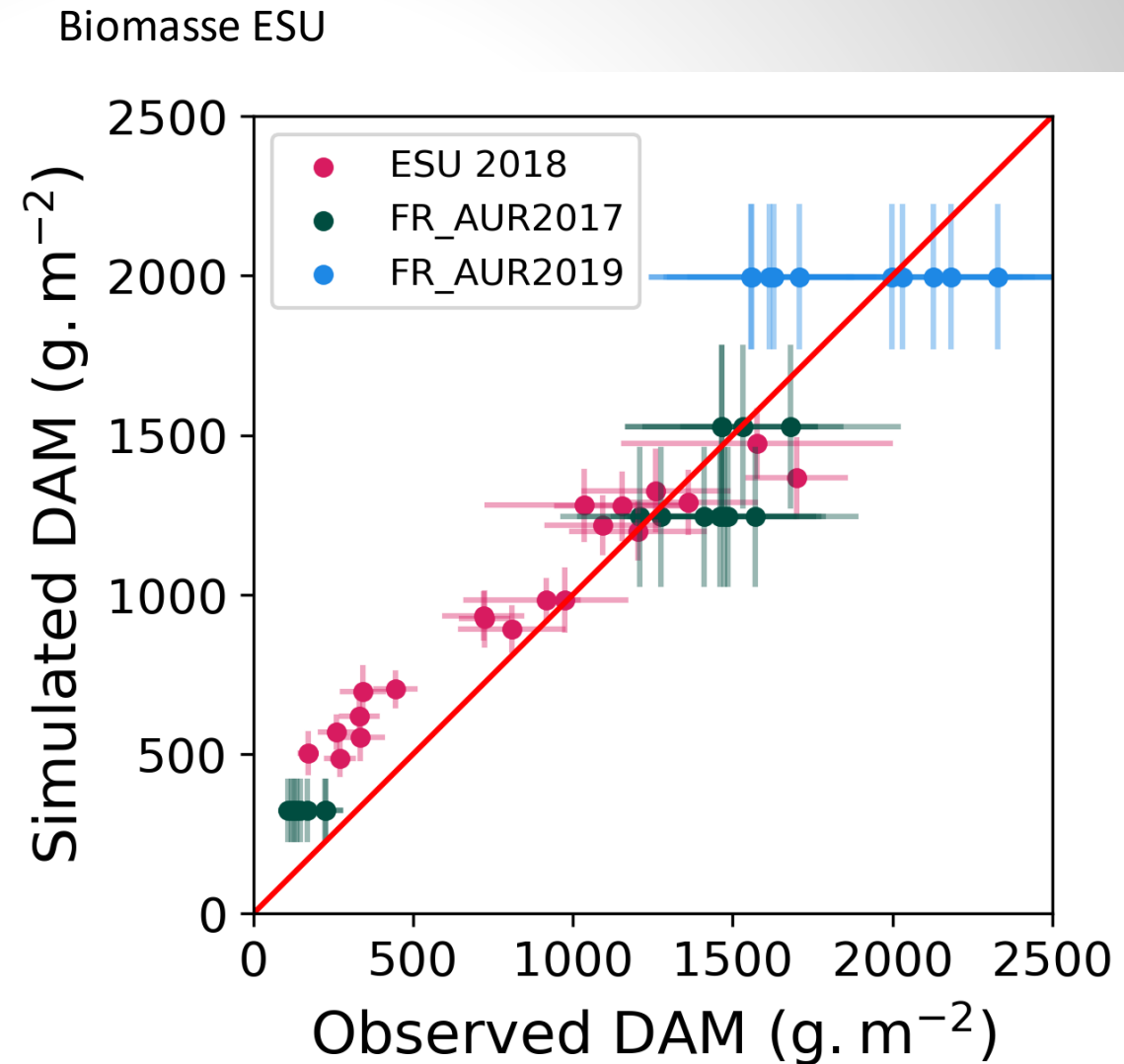
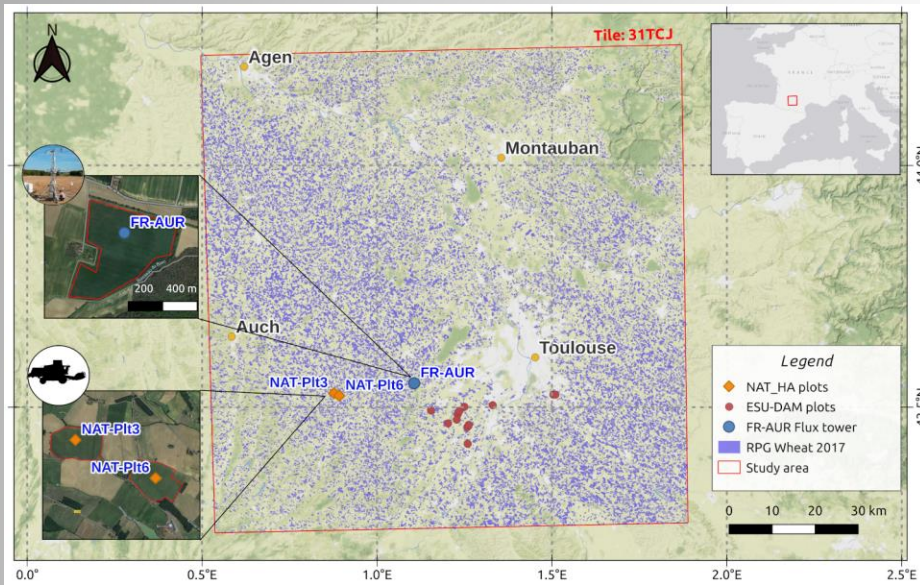
Validation Flux CO2



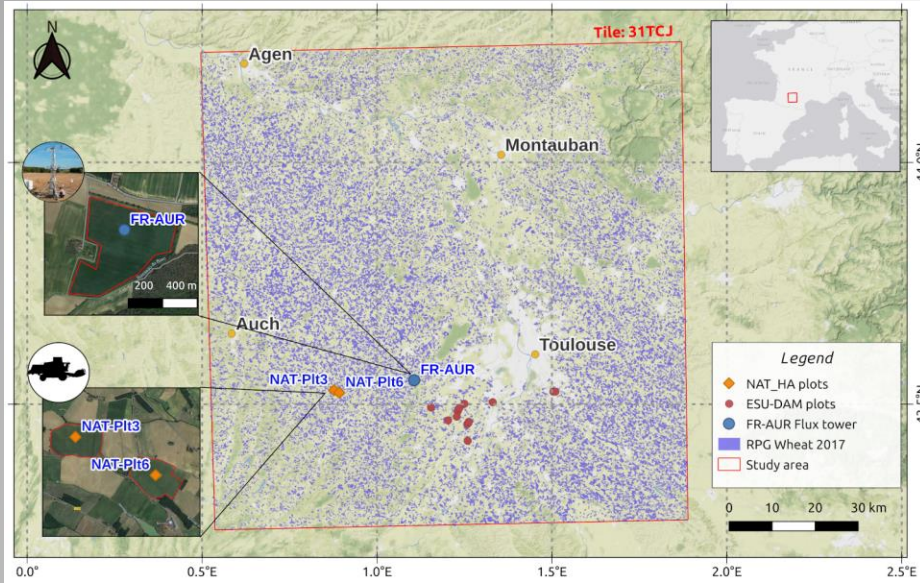
Validation de la Biomasse



Validation Blé d'hiver SO France



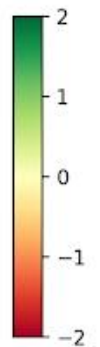
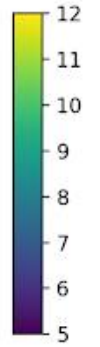
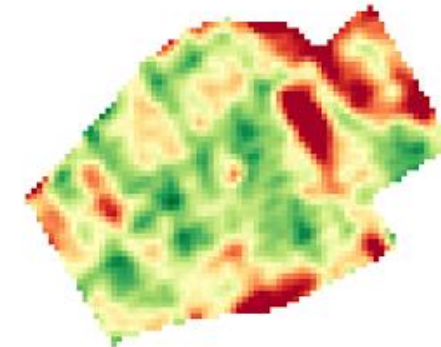
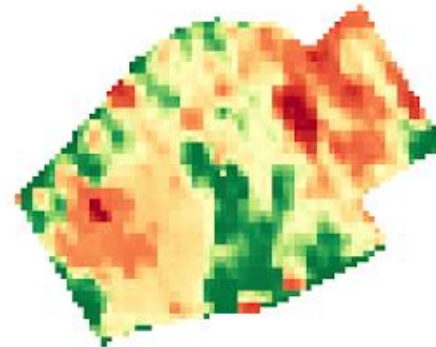
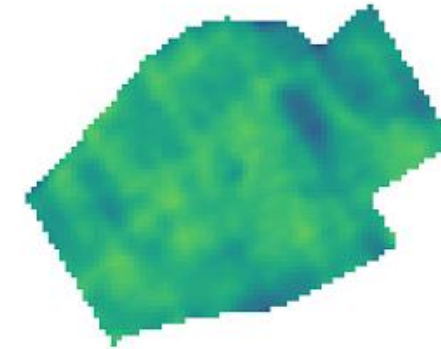
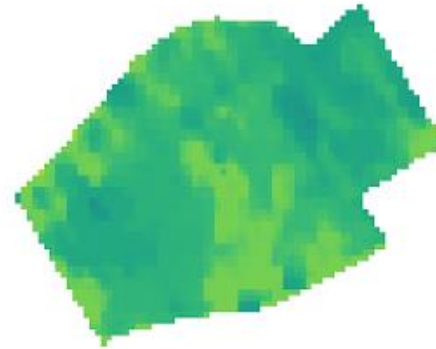
Validation Blé d'hiver SO France



Rendement Moissonneuse-Batteuse

simulation

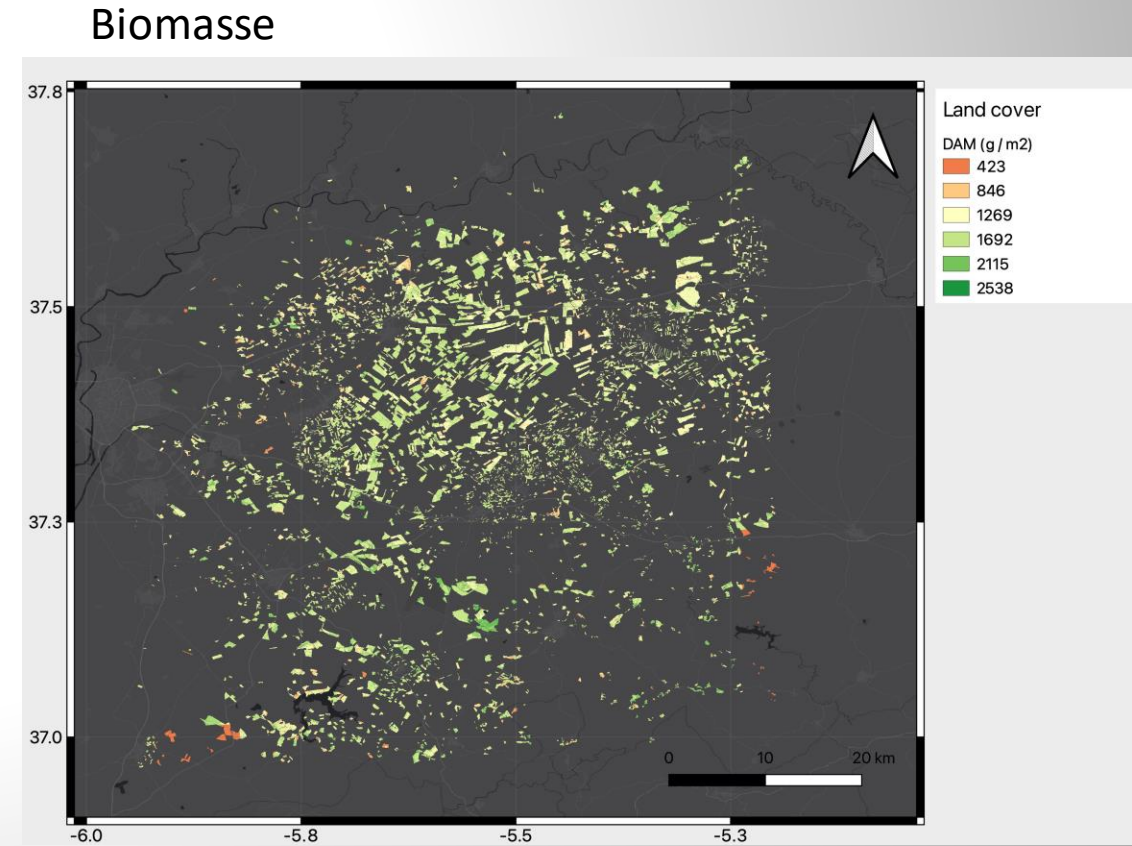
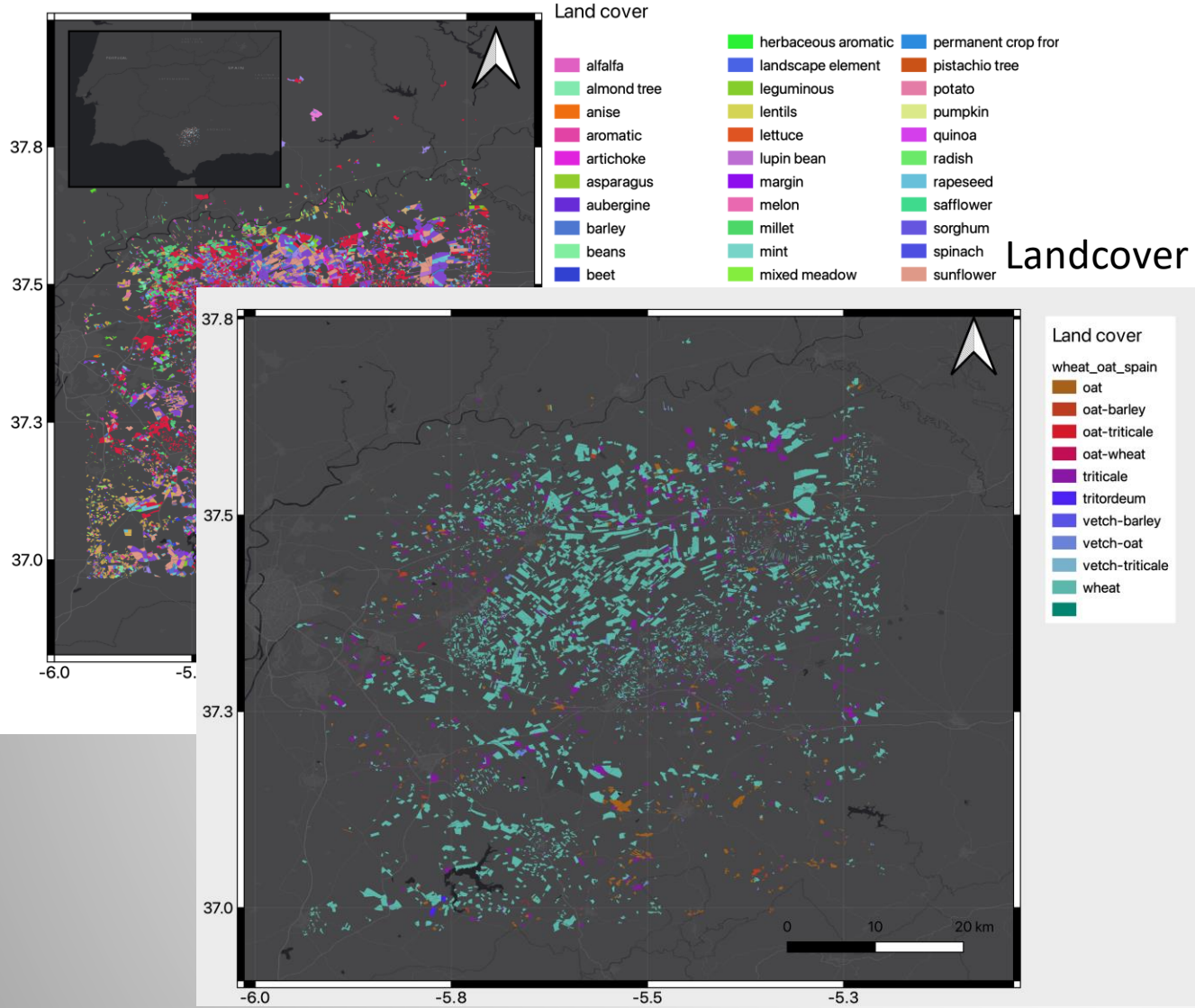
observation



Yielded ($t \cdot ha^{-1}$)

Anomaly

Application ASP projet NIVA

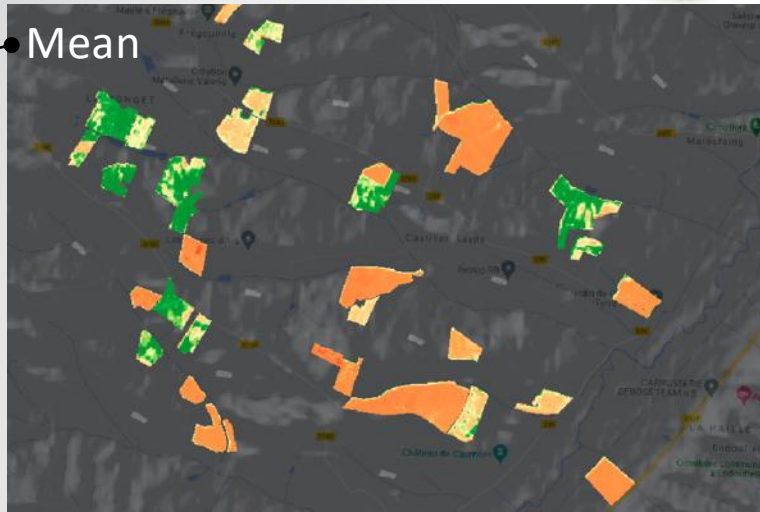


Dry Above Ground Biomass – with cover crops

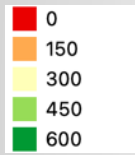
DAM - Crop cover



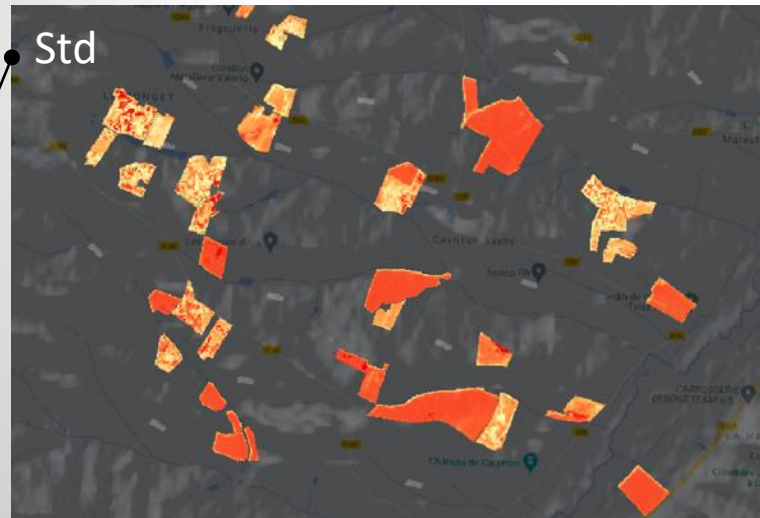
Mean



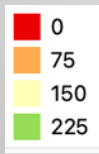
Not a negligible biomass production, but very heterogeneous



Std



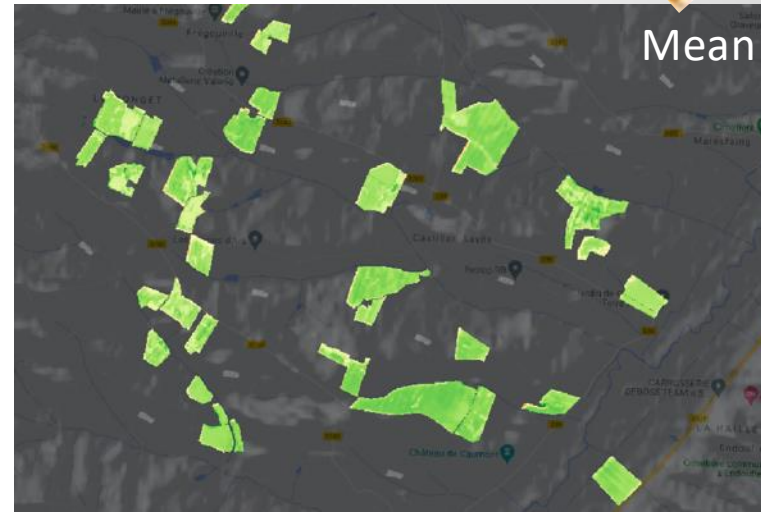
Lower because lower DAM, but relatively high uncertainty (30-50 %)



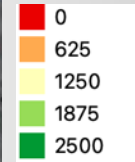
DAM - Maize



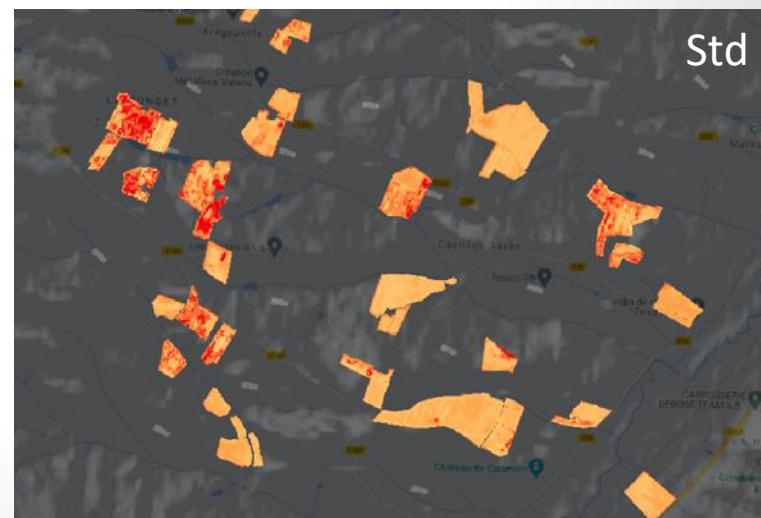
Mean



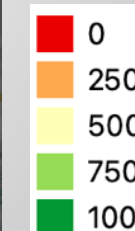
Standard values, and much more homogeneous. (Inputs, Agri. practices).



Std

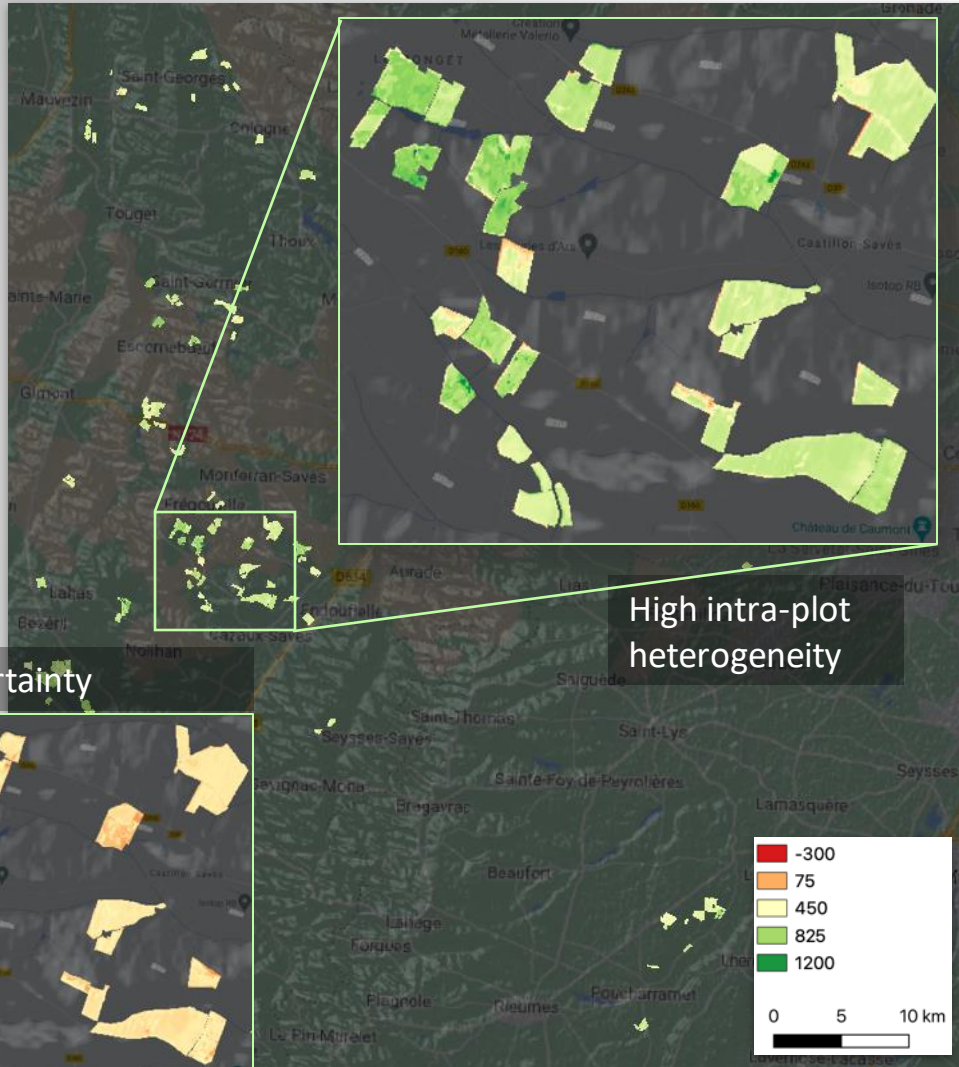


Uncertainty varies at intra-field but less than cover crops.

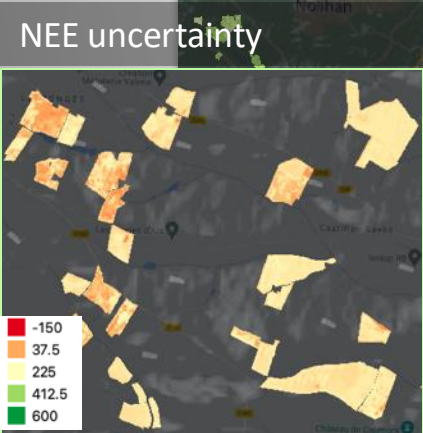
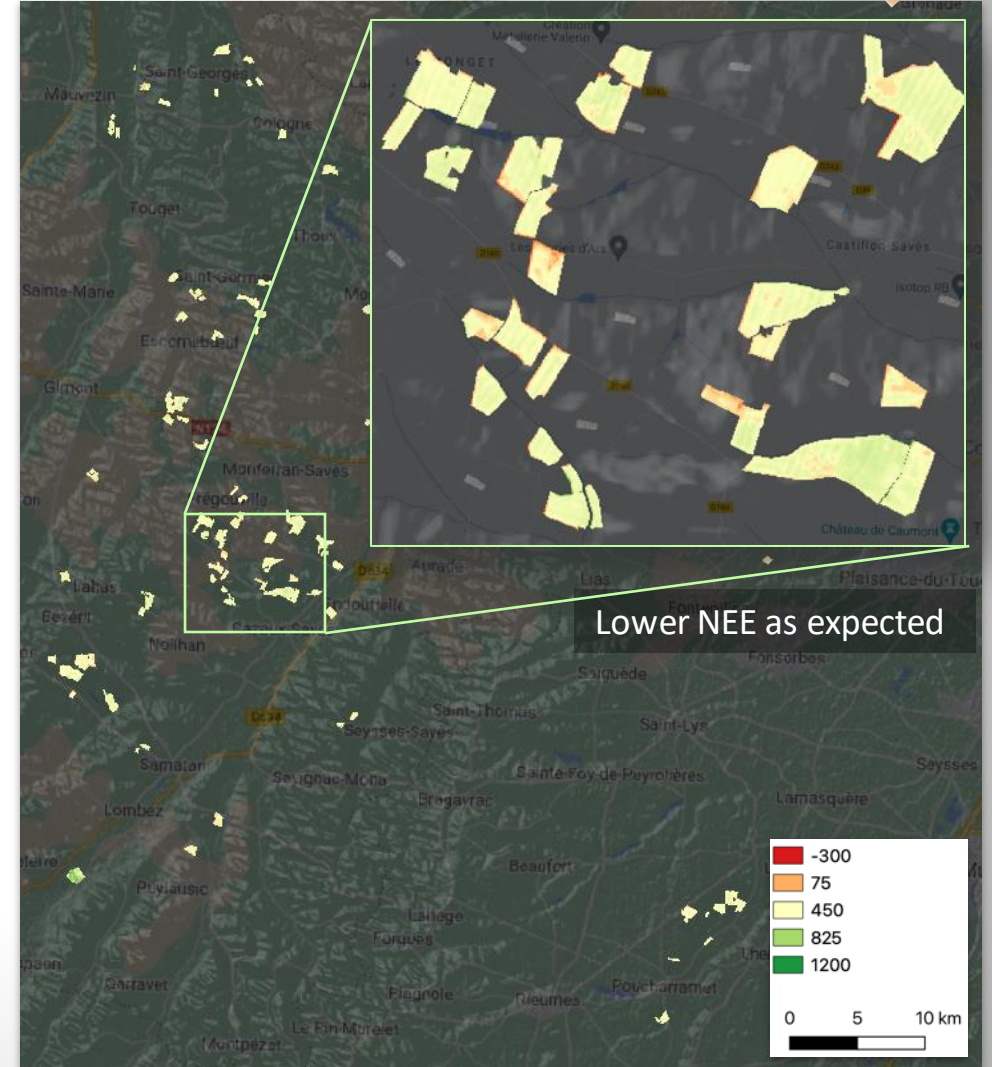


NEE – over the double experiment

NEE : Cover crop + Maize

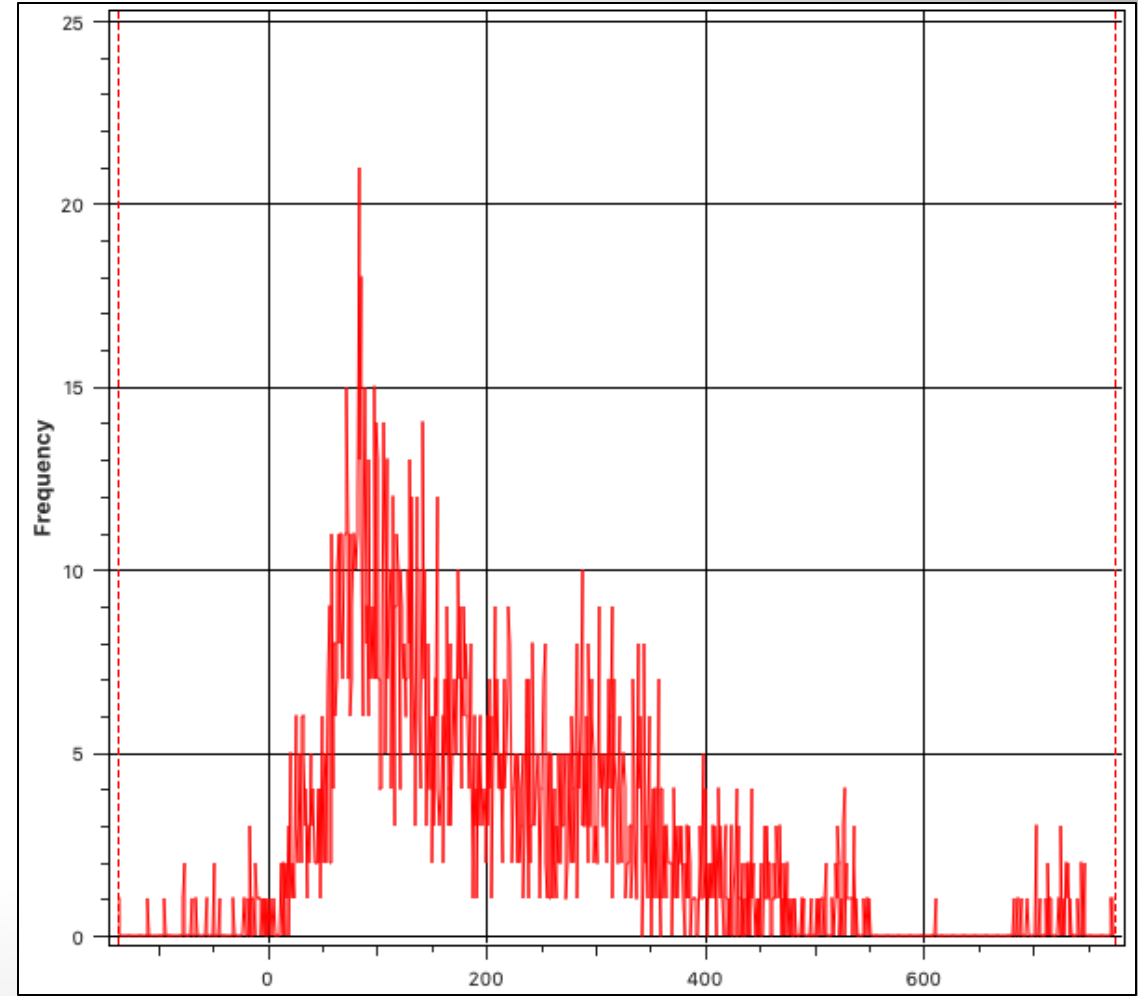
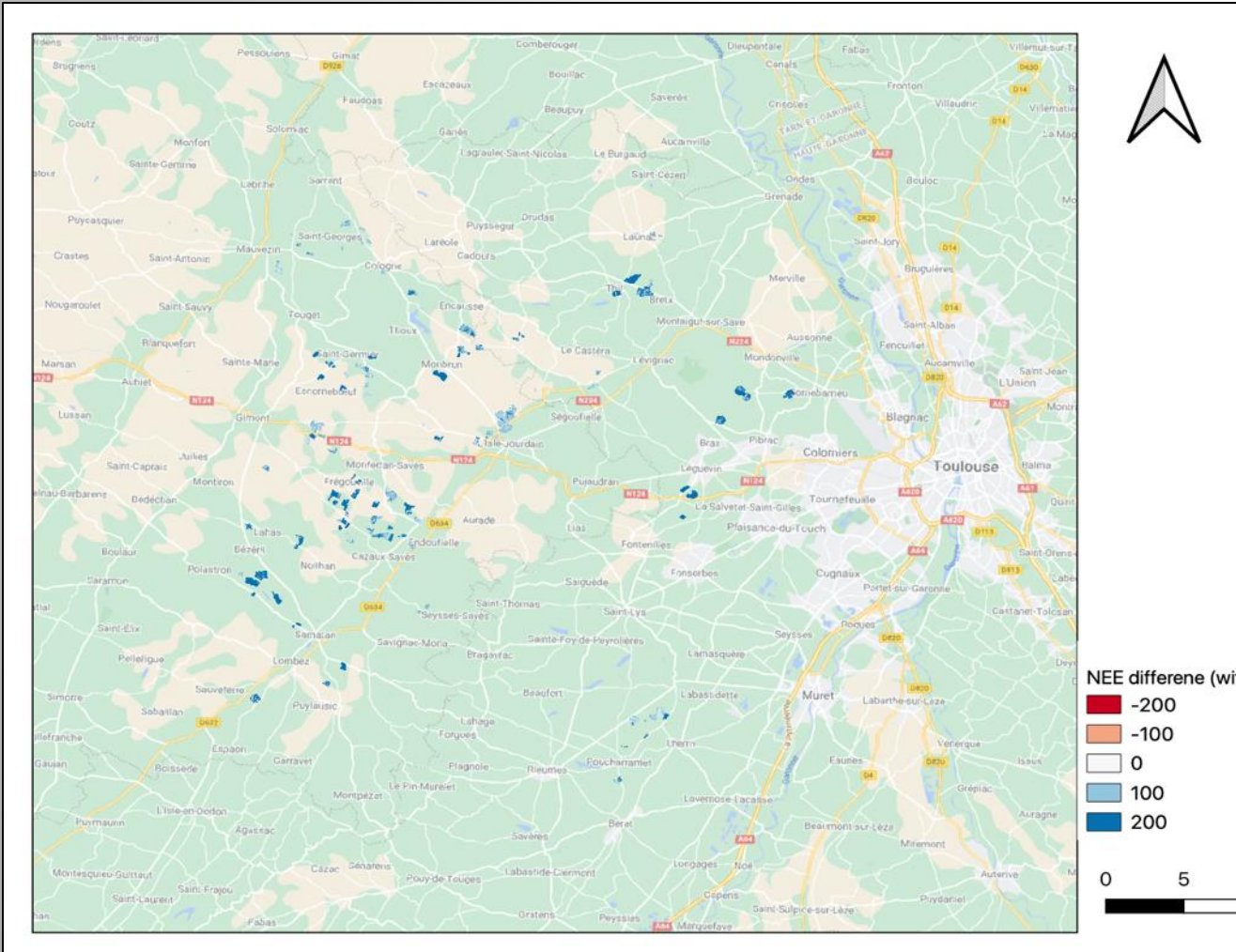


NEE : Bare soil + Maize



Map of $NEE(\text{grass} + \text{corn}) - NEE(\text{soil} + \text{corn})$

Histogramme $NEE(\text{grass} + \text{corn}) - NEE(\text{soil} + \text{corn})$





AgriCarbon-EO python v1.0.1

**Amélioration des performances en
vus d'une campagne de calculi à
l'échelle nationale**



SAFYE-CO2 python v2.0.5

**Elargissement de la liste des
cultures et amélioration de la
méthodologies**

**-Déposé à la TTT Toulouse Technologie Transfert
après mandat des tutelles**

-Licence recherche et évaluation

Partenariats:

- MyEasyFarm (ESA Booster)
- NetCarbon (Thèse Cifre)
- E2L (SCO Quantica)
- Airbus (SCO Quantica)
- Kermap (Stage Evaluation)

- Nataïs
- ASP (projet Niva)
- Arvalis (SCO Quantica)

Projet

- H2020 ORCASA
- H2020 Marvic
- Tiga Dijon
- CNES/ ESA Bouster
- SCO Quantica
- CROP21 (effort propre)



<https://www.cesbio.cnrs.fr/agricarbonateo>
