RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

FRANCE 2030 — PROGRAMME DE RECHERCHE CARBONE ET ÉCOSYSTÈMES CONTINENTAUX

November 3rd 2025
November 6th 2025
Hugo Senges

SLAM-B

T.3-2

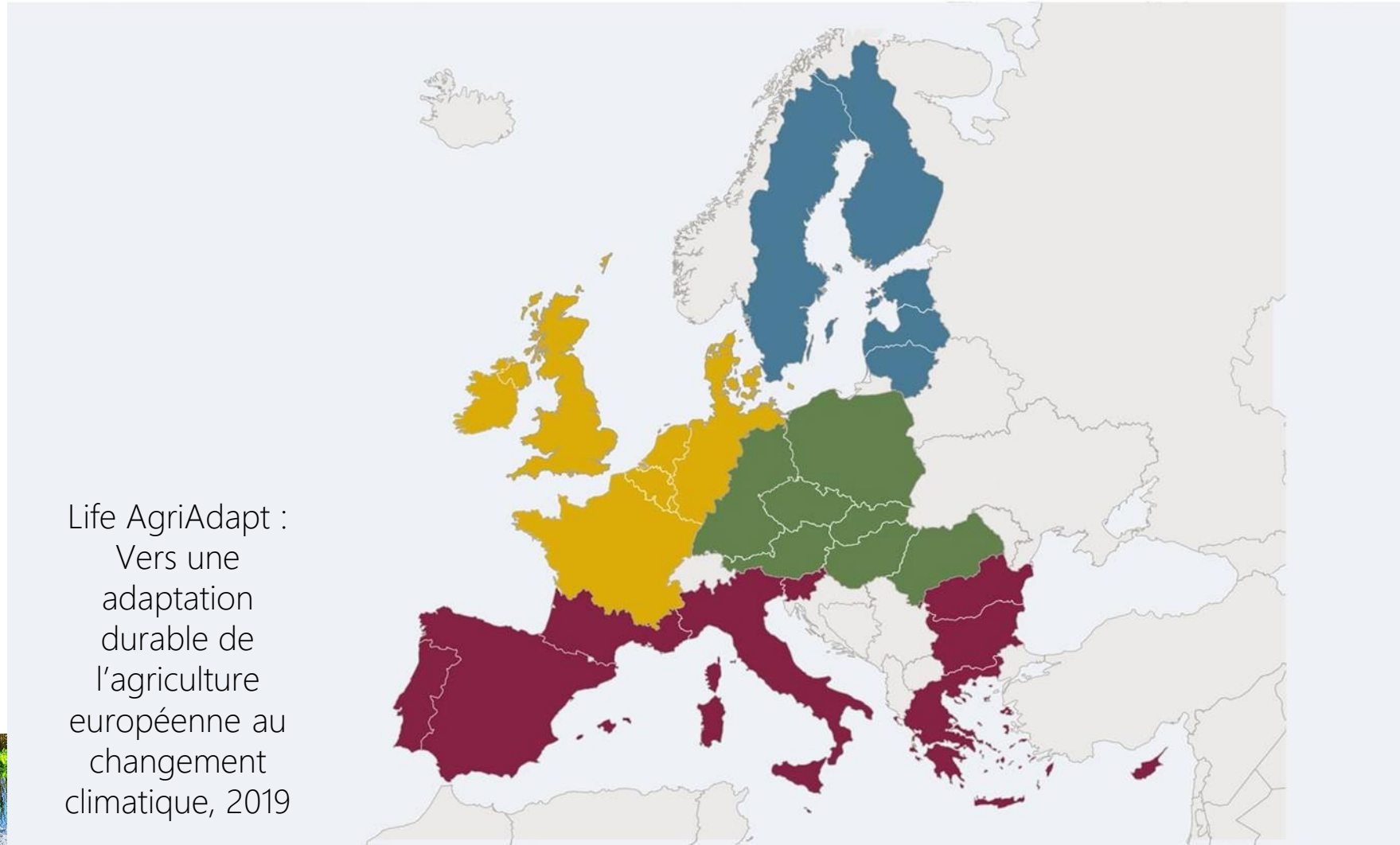
How to use European soil and climate data to simulate agriculture with crop models for bioeconomy scenarios ?

FairCarboN yearly Days of 2025, Port au Roc

cnrs INRAE

Agriculture and climate change in Europe

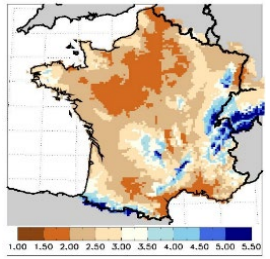
What does IAM bring ?



Life AgriAdapt : Vers une adaptation durable de l'agriculture européenne au changement climatique, 2019

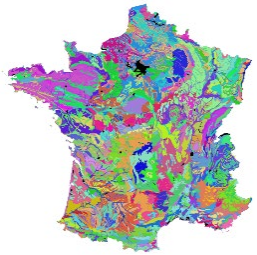
« Baseline » engineering (4p1000 study's legacy)

(a) Climate



7.671 grid cells

(b) Soil

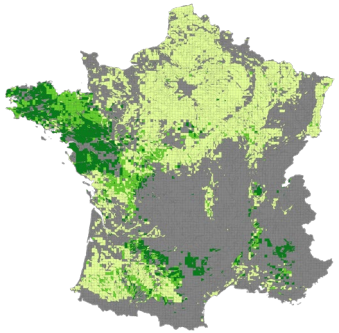


40.000.000 valid pixels

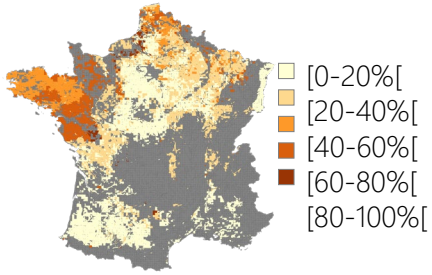
(c) Sampling

45.000 PCU

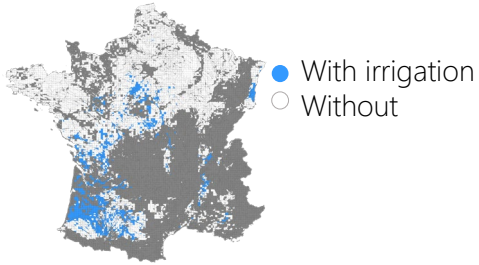
(d) Crop management

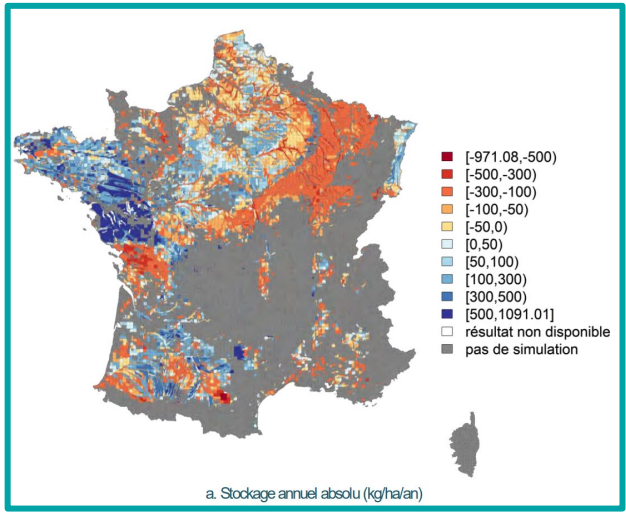


(e) Fertilization



(f) Irrigation

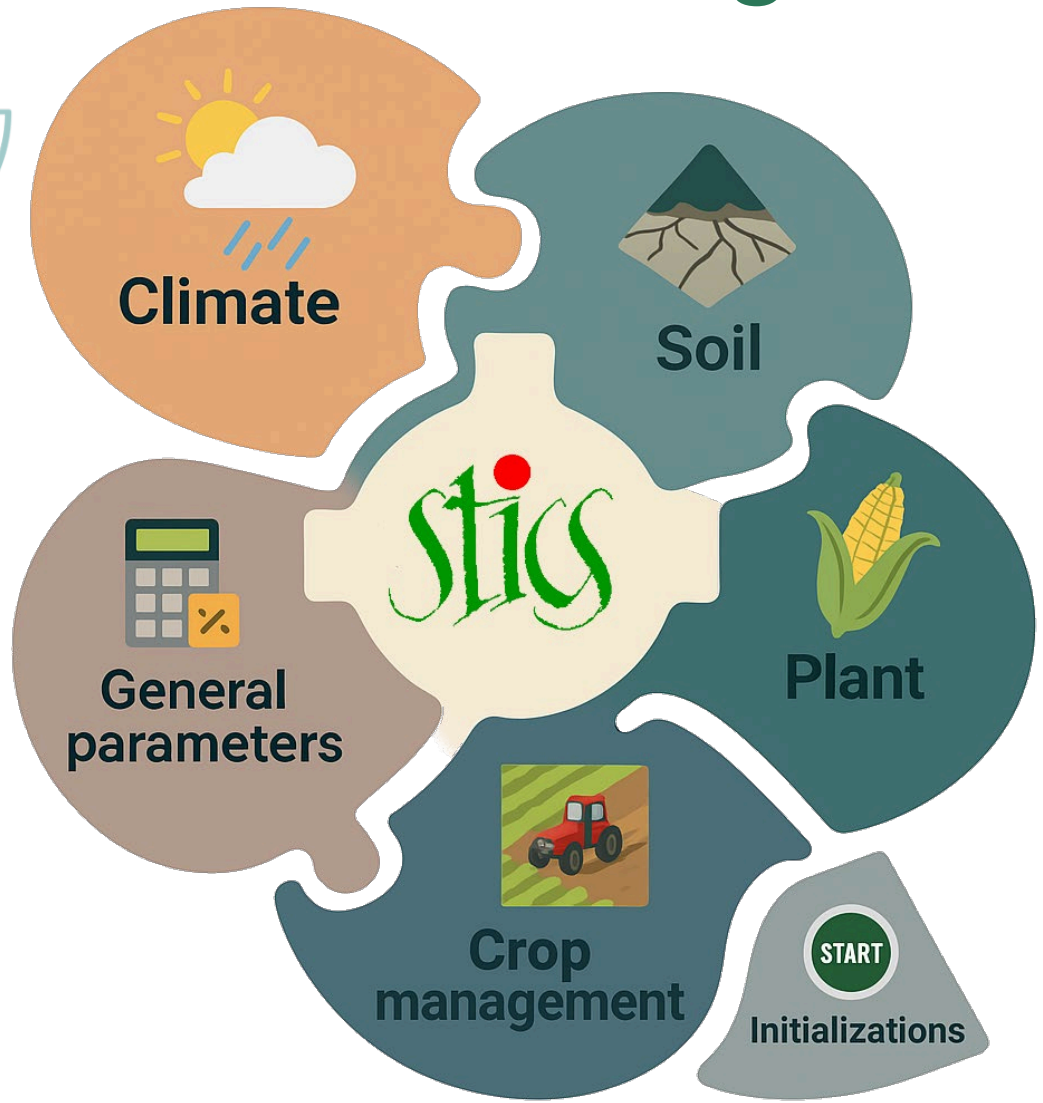




Model output foresight: Absolute SOC stocking

PCU : Pedo-Climatic Unit

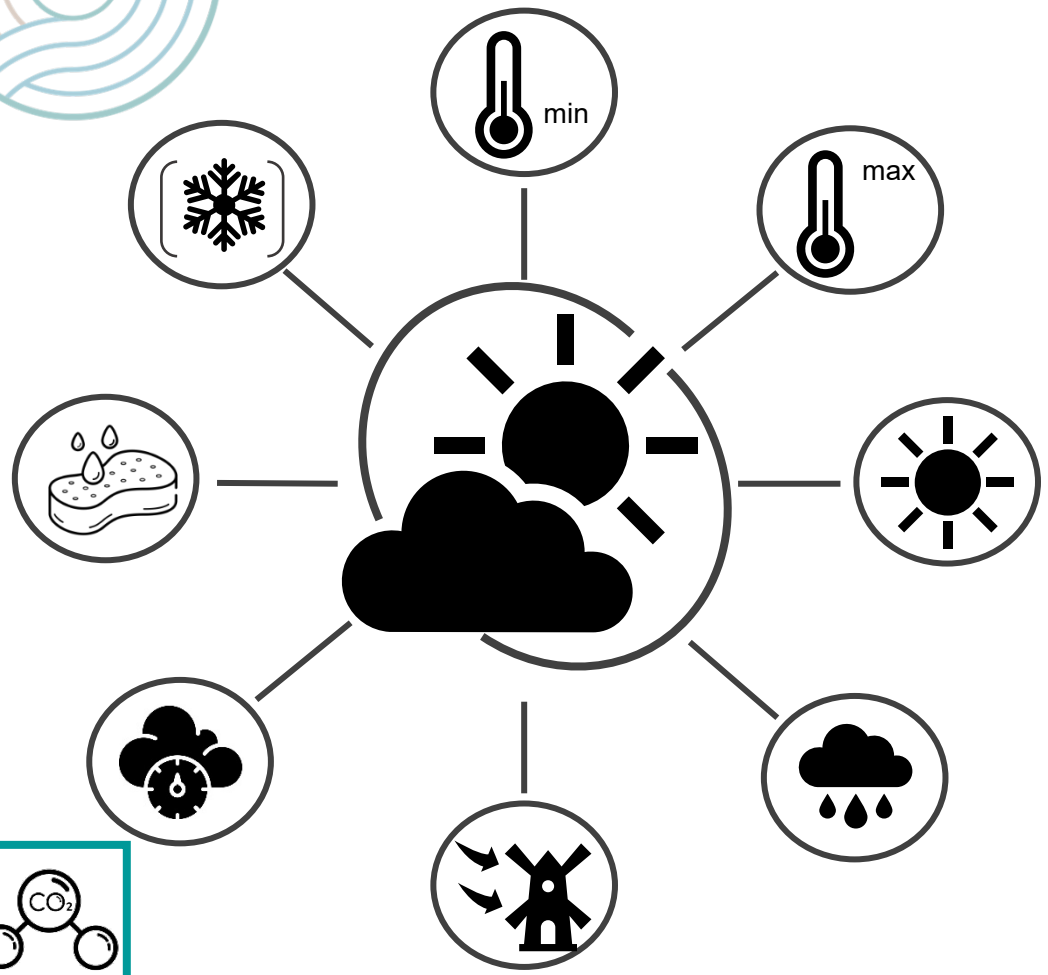
« Baseline » engineering



Simulation plane step by step

- Inventory of data available in national and European
  - Climate series
  - Soil map
  - Land use
  - Crop rotations
  - Farm management
- Design of the simulation at European scale
  - Outputs definition
  - Dataset documentation
  - Spatialization
  - Standardization of intermediate data
  - Time horizon
  - References

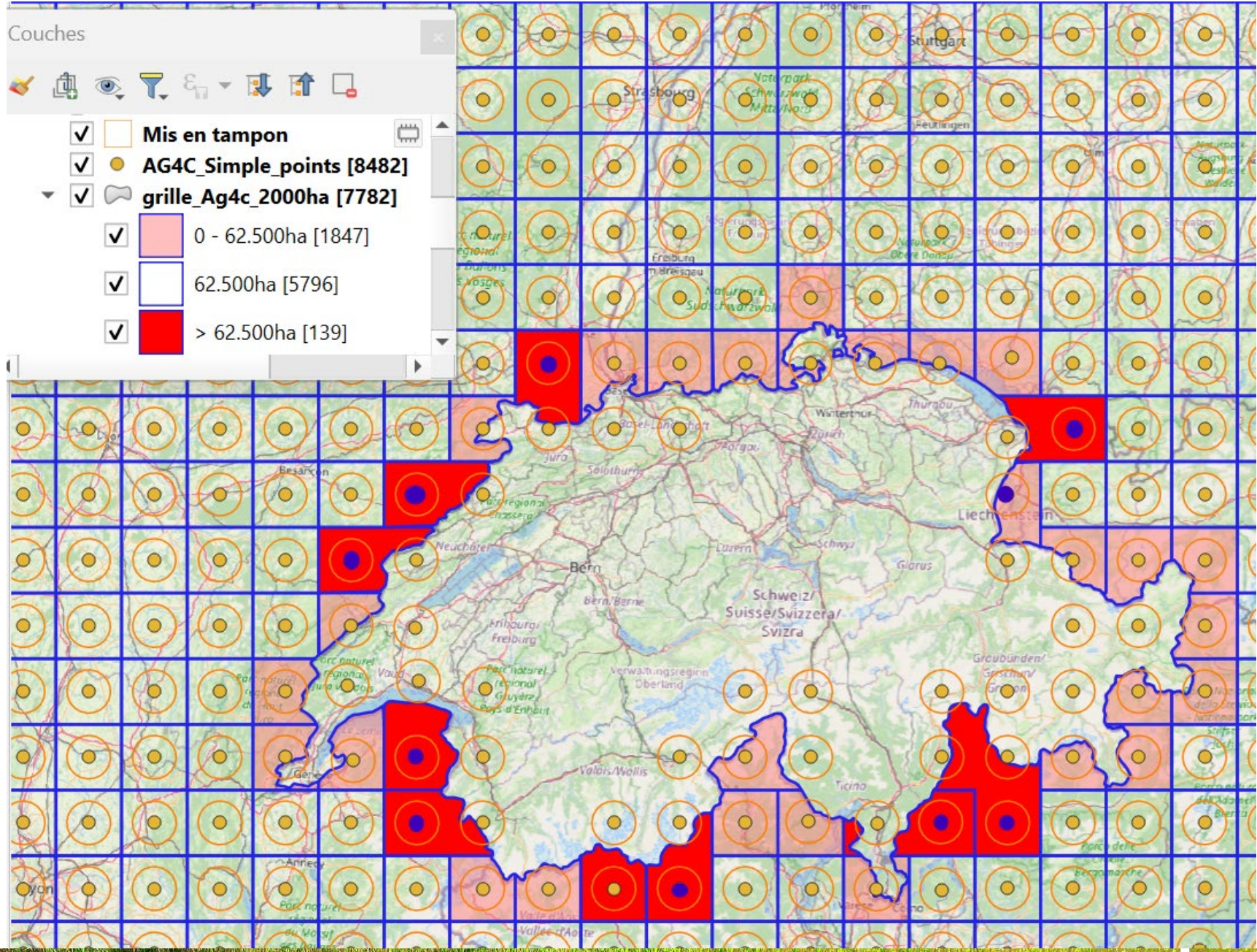
Setting up the climate inputs



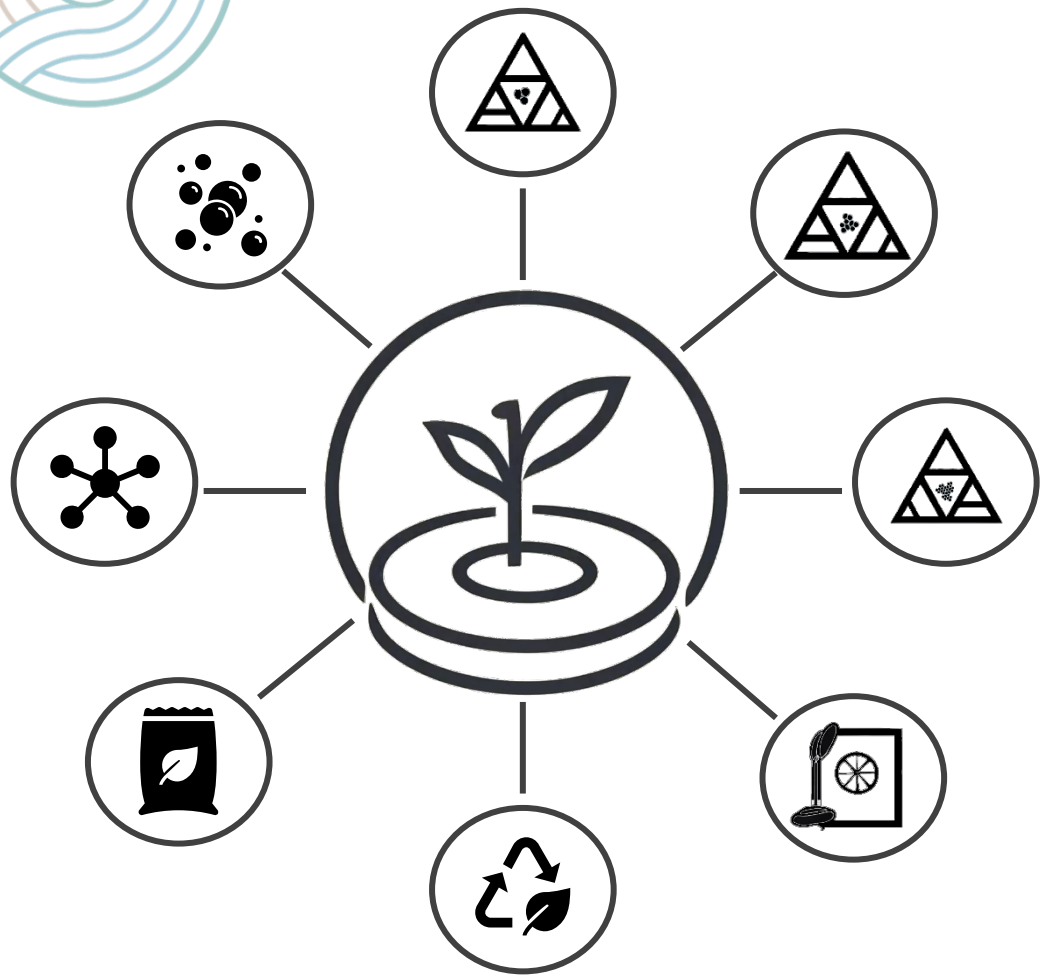
Climate series

- Formalism and constraints
  - Resolutions, variables and units
  - Format (.csv, NetCDF...)
  - Daily completeness
- State of the art and technical specifications of existing data
  - AgEra5
  - E-Obs gridded
  - ISIMIP climatic projections
  - **Agri4Cast**
- Compatibility of the chronicles with the projections...

Agri4Cast : 7.000 climate grid cells to redraw



Setting up the soil inputs



Soil maps

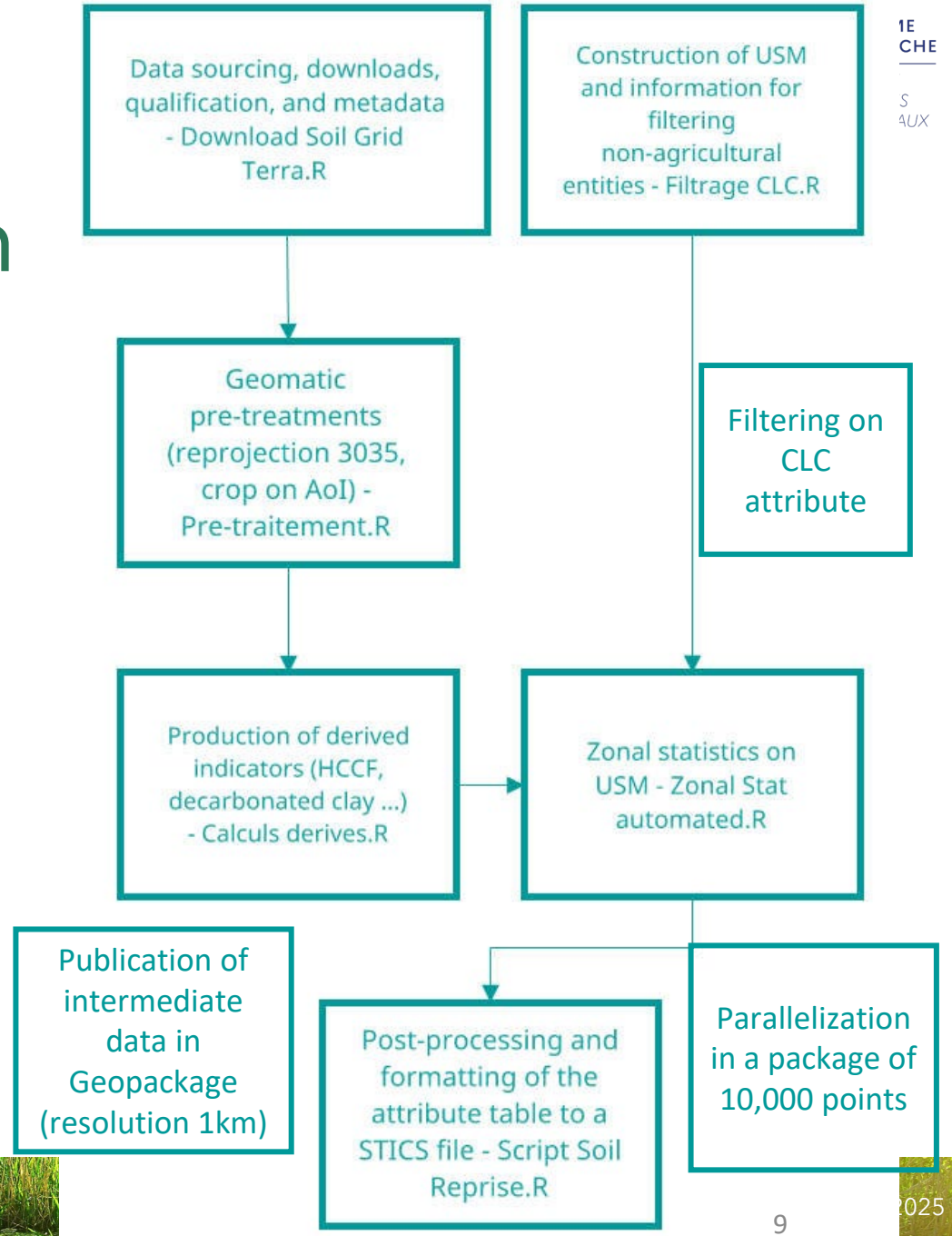
- Formalisme and constraints
  - Resolutions, variables and units
  - Spatialization
  - Qualification
- State of the art and technical specifications of existing data
  - European Soil Database
  - Punctual ground profiles: WoSiS
  - Topsoil dataset: Lucas
  - **SoilGrid**
- The depth problem…

Designing PCU while optimizing the calculation

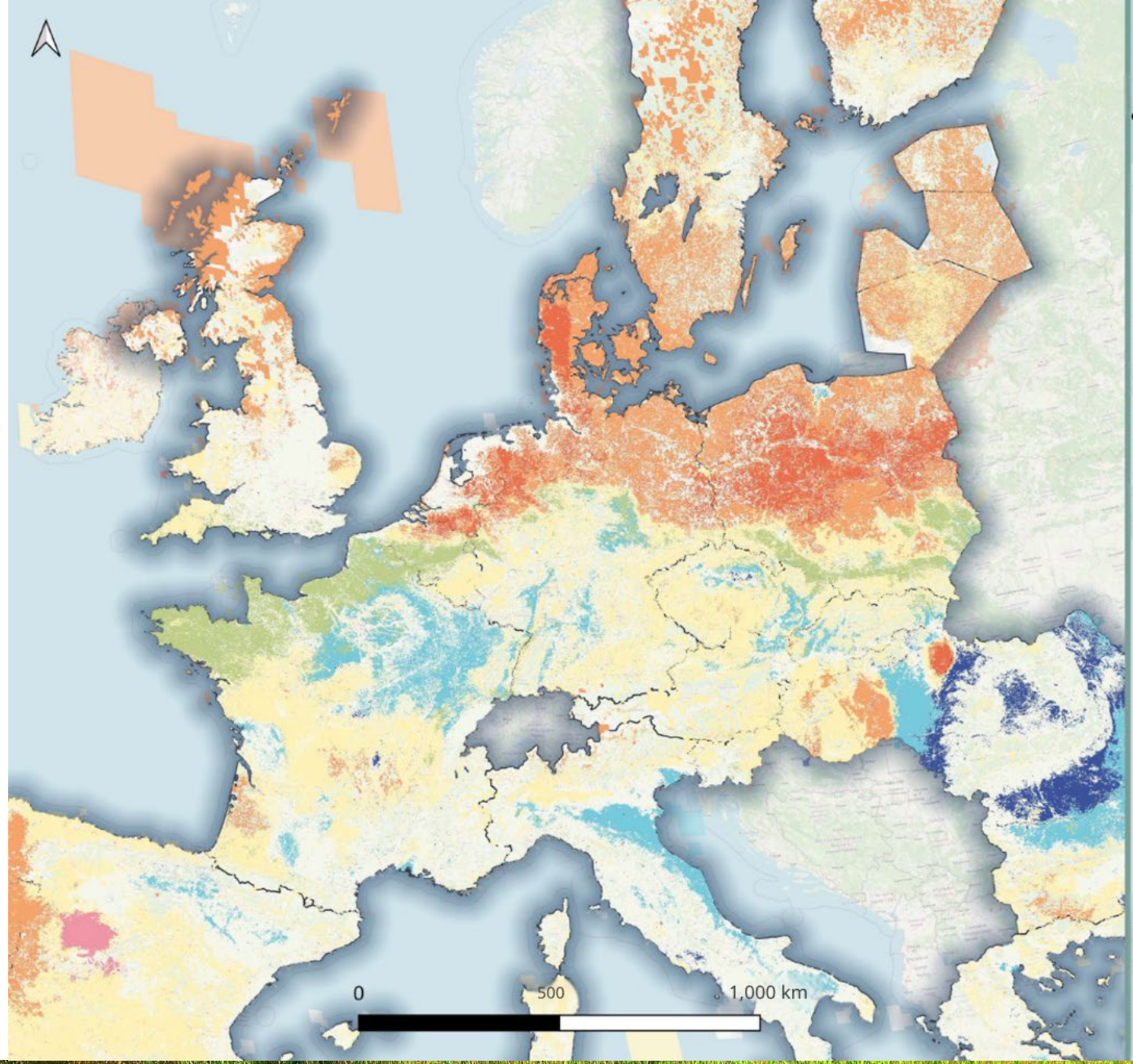
- Desired propreties
  - 100,000 simulable UPC in order of magnitude
  - Avoid spatial averages for pedological variables
  - Be as representative as possible of the diversity of soils
  - Scalability and open Science

- Solutions explored:
  - Crossing of soil maps with climate grid cells
  - Subdivision of climate grid cells
  - Agglomerative clustering
  - Sampling on holistic VoI
  - **Partition by k-moyennes**

Classifications qualification…



K-means: How many classes ? And on what basis ?

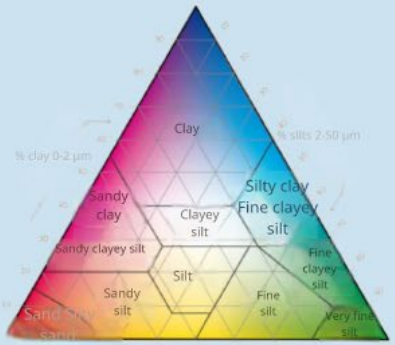


Representation of pedological classes according to their affiliation to a texture category

Texture categories

- Clay
- Silt
- Clayey silt
- Fine clayey silt
- Sandy clayey silt
- Fine silt
- Sandy silt
- Silty sand

These classes are derived from the texture triangle below:

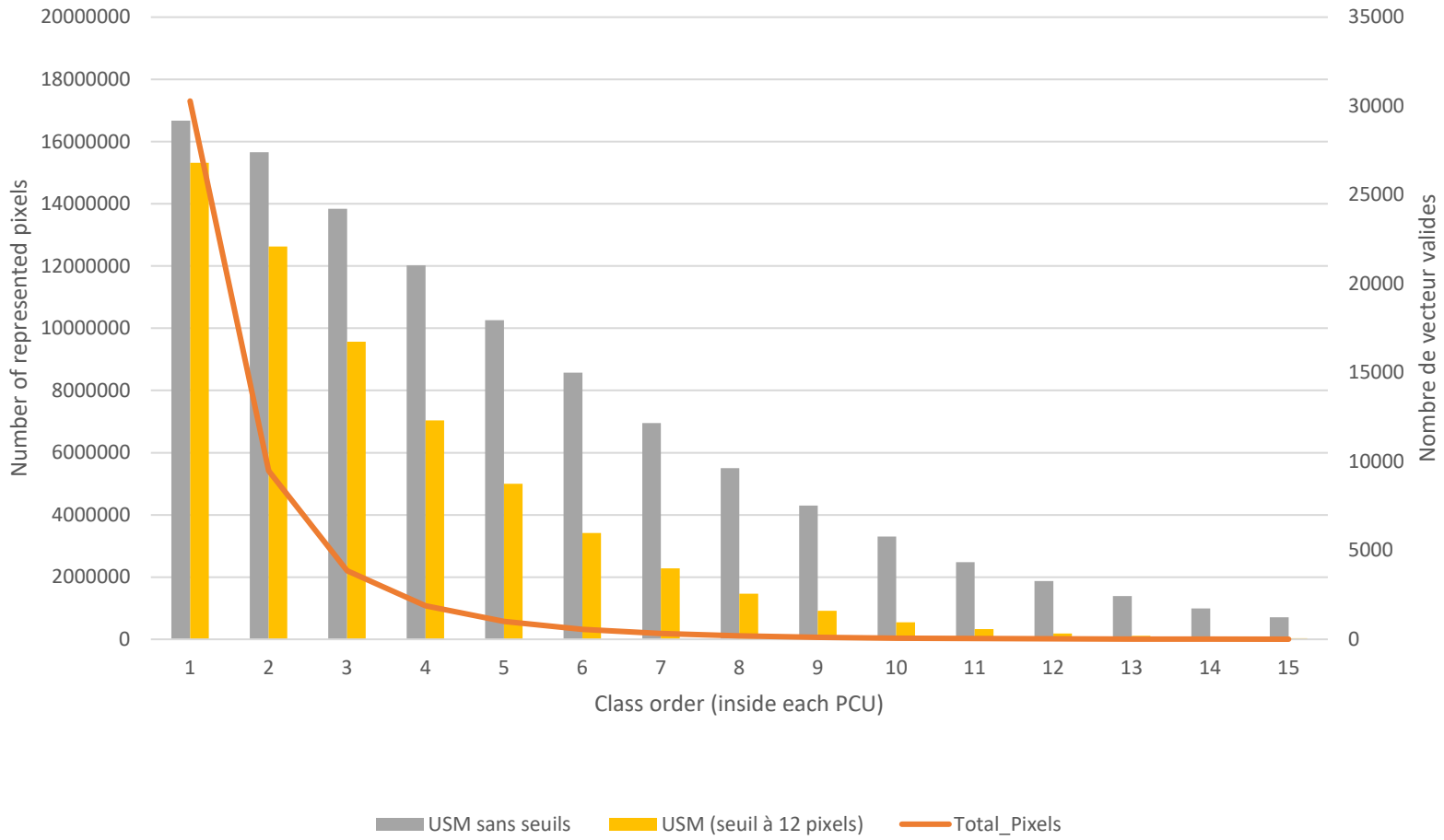


The colored pixels come from the classification into 80 classes by K-means on 17 variables. Only the areas under crops are represented at a 250m step (here dilated to 5km for readability). OpenStreetMap map background (grayed countries are out of scope of the SLAM-B study)

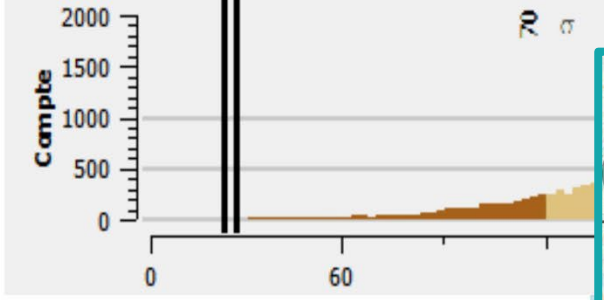
7,700 climate
elected for ea
Each one rep
its cell, as lon
pixels.
Selection bas
pixel and clas

K-means: How many classes ? And on what basis ?

Distribution of classified pedological information and modalities of the classes of occurrence (SG250_KM80_Aprairial)

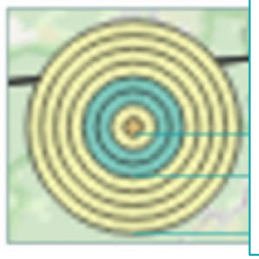


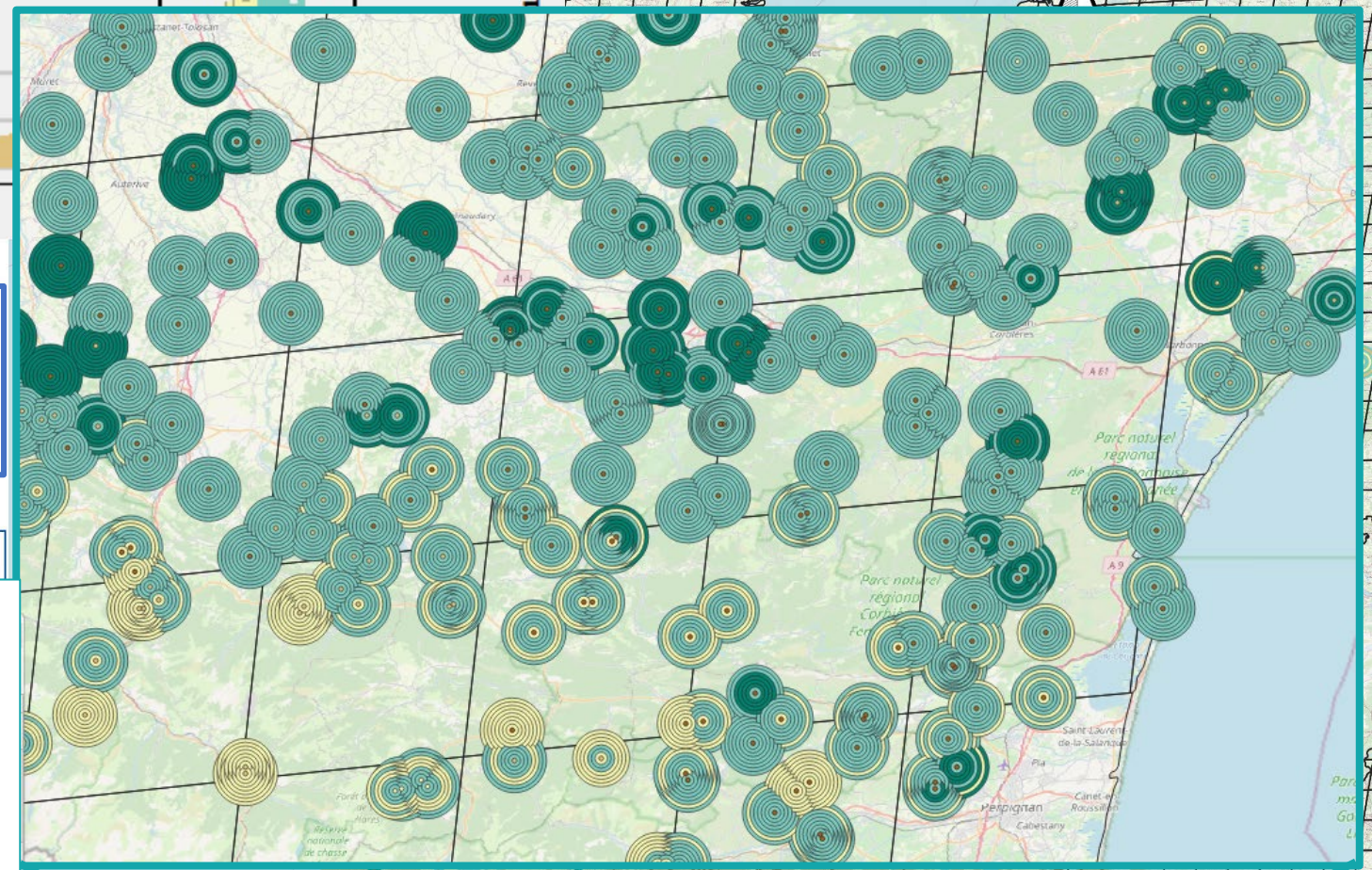
Preliminary test : initialization on France

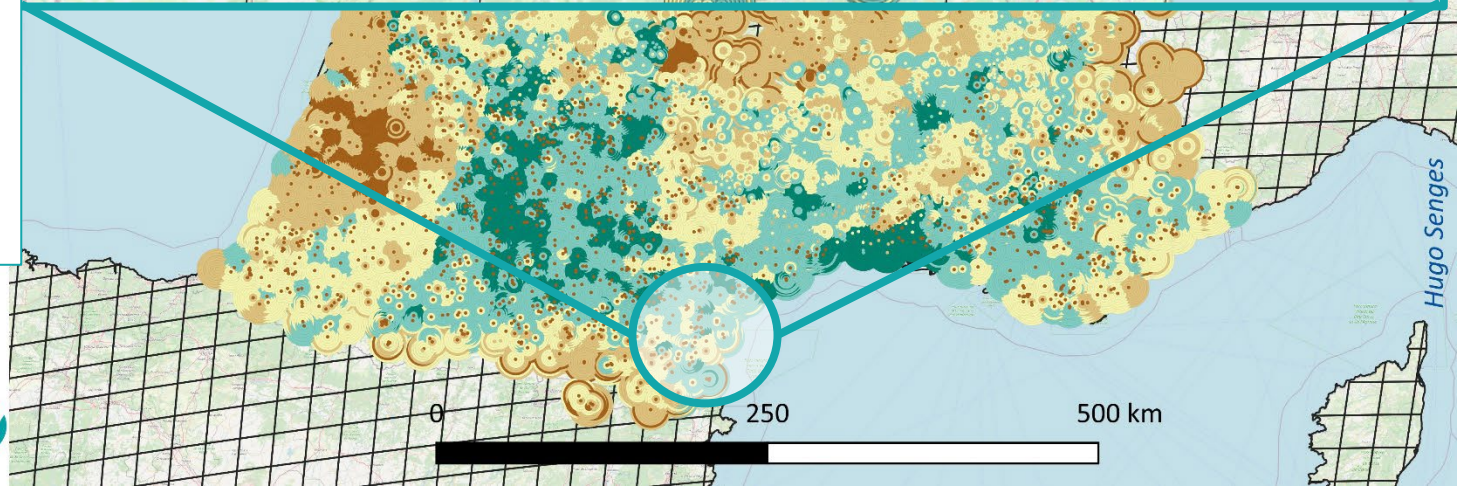


Distribution of the annual filling of water capacity between 2001 and 2009 close to the entire France simulation (out of 7450 points)

Légende :

annual filling rate of water capacity in %	Depending on the simulated data	For the soil layer 0-30cm in:
0 - 70 60 - 80 80 - 85 85 - 90 90 - 100		2001 2005 2009





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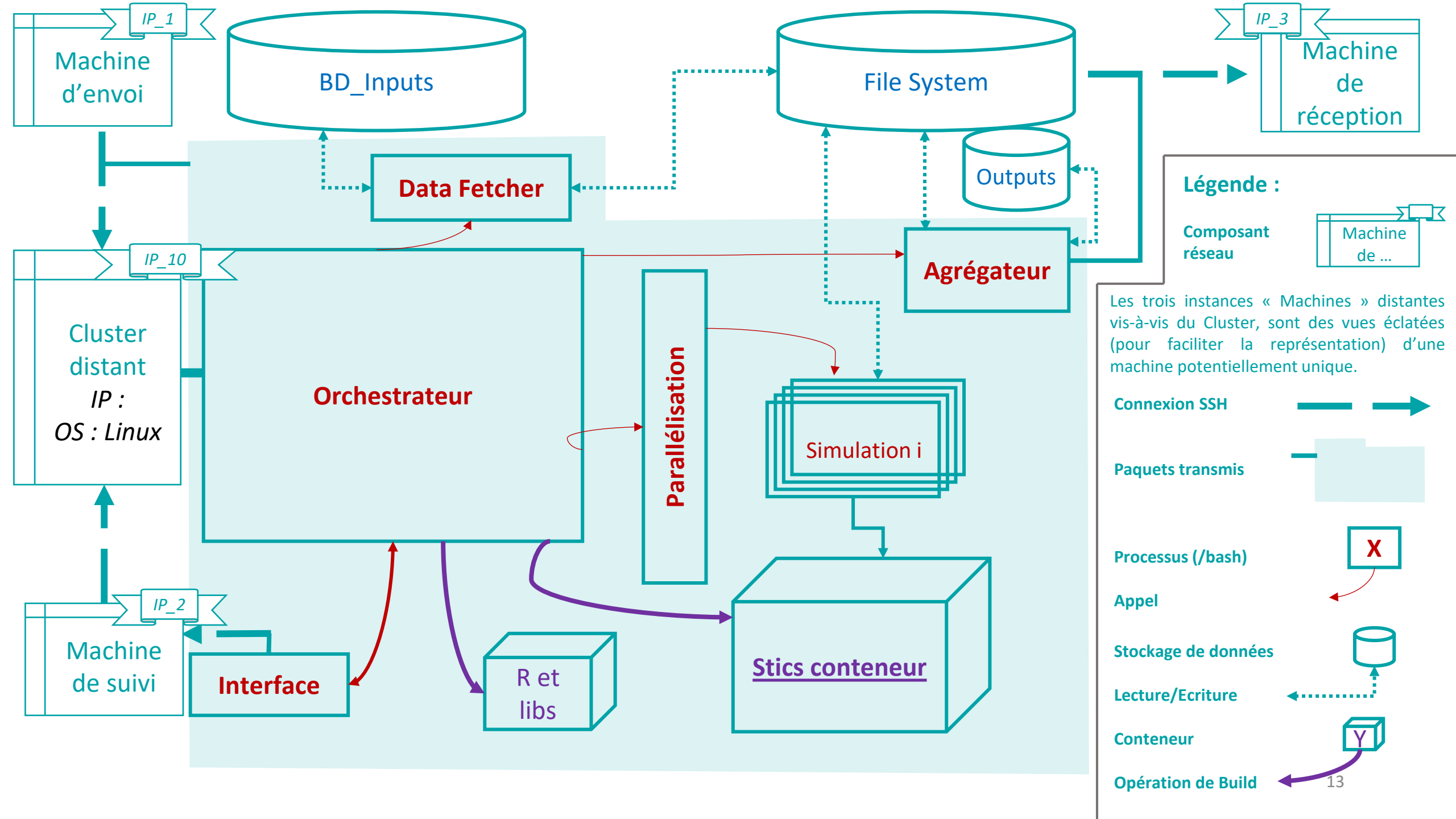
INRAE


IP_1
Machine d'envoi
BD_Inputs
File System
IP_3
Machine de réception
Data Fetcher
Outputs
IP_10
Cluster distant
IP :
OS : Linux
Orchestrateur
Agrégateur
Parallélisation
Simulation i
IP_2
Machine de suivi
Interface
R et libs
Stics conteneur
Légende :
Composant réseau
Machine de ...
Les trois instances « Machines » distantes vis-à-vis du Cluster, sont des vues éclatées (pour faciliter la représentation) d'une machine potentiellement unique.
Connexion SSH
Paquets transmis
Processus (/bash)
X
Appel
Stockage de données
Lecture/Ecriture
Conteneur
Y
Opération de Build

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Outlooks

Following the first advances of this GT3, tasks T3.2 (Cover of bare soils), T3.3 (Interactions crop residues and bioeconomy) and T3.7 (Potential level and consequences of biogas production), were brought together in a single task of modelling cropping systems at EU level.
At the time are validated the following milestones:

- **Resumption of the conceptual framework developed as part of the 4p1000 study, with instantiation of the STICS model**
- **Characterization and definition of simulation units**
- **Instantiation of the study regions for simulations**

Remains to be validated:

- **Europe-wide scenarios for the deployment of crop systems for biogas production**
- **Summary of bioeconomy scenario simulations**