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living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

Using Sentinel-2 data time series for the mapping of land use typologies during fallow periods over France

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cnes CESBIO KERMAP

24/05/2022 - Bonn

OBJECTIVES (1/2)

Monitoring land-use typologies during fallow periods.

- ✓ **An environmental issue**
  - *To improve soil fertility by minimizing runoff and soil erosion.*
  - *To increase soil organic matter (SOM)*
  - *To mitigate global warming via an increase of surface albedo*

- ✓ **A political issue**
  - *Global warming - recommendations outlined in the Sixth IPCC*
  - *European and French Nitrates Directive*

- ✓ **A scientific issue**
  - *Identifying winter land-use typologies for cropland over large areas*
  - *Analyzing reliable and exhaustive field data sets*

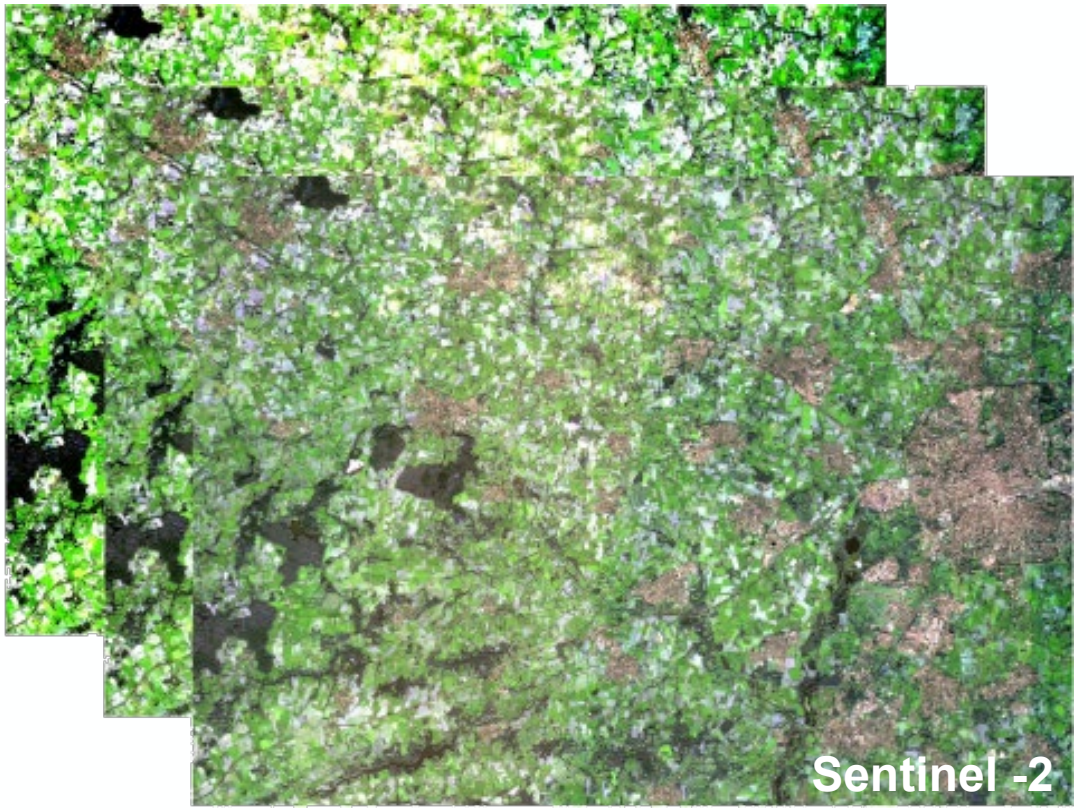
OBJECTIVES (2/2)

Land-use typologies during fallow periods are complex

=> A large diversity of scenarios (floristic composition, bare soil, straw, litter, mulch, etc)

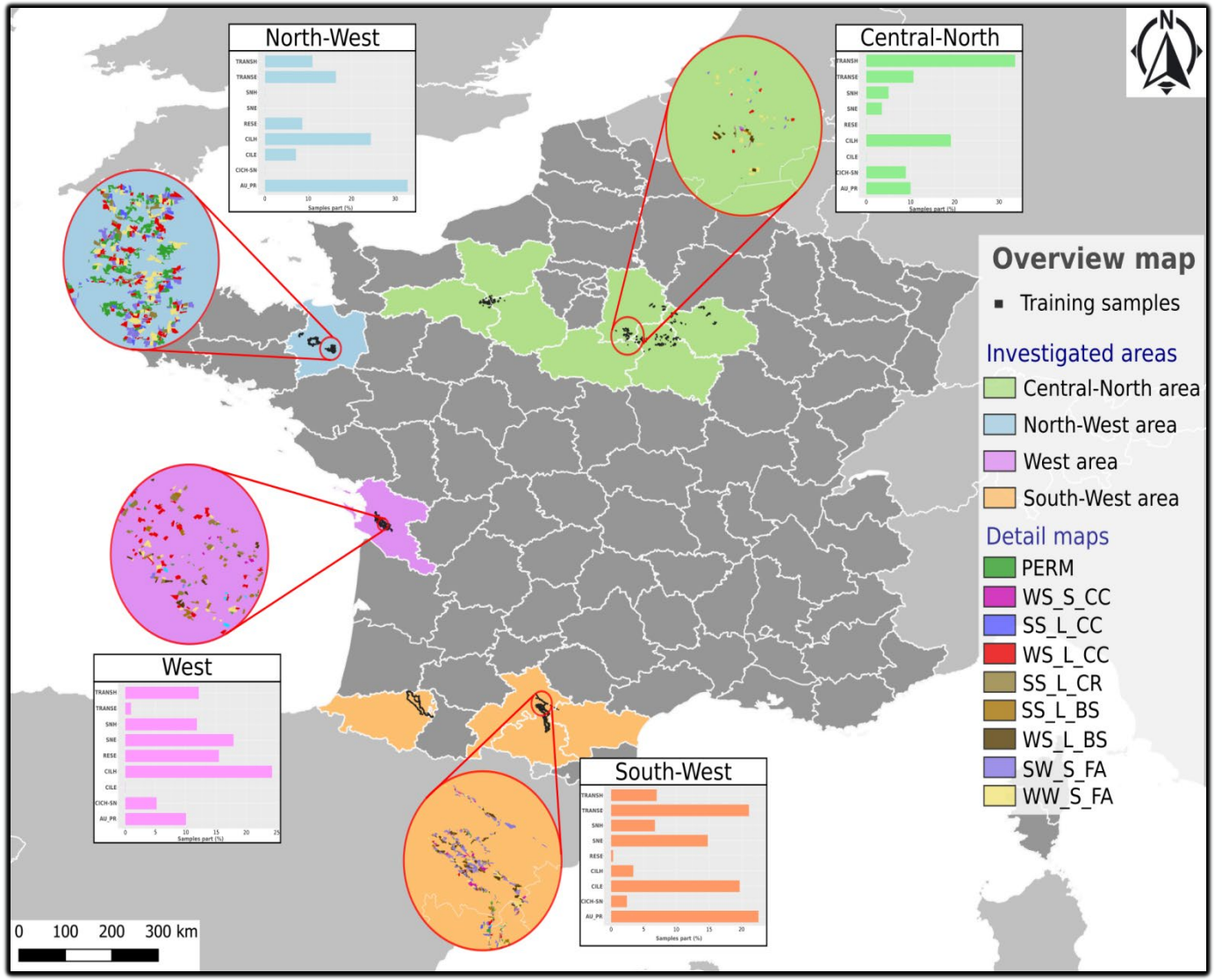
The use of Sentinel-2 time-series is meaningful in this context

Characteristics : spectral information, monthly synthesis, wintertime coverage



Four Areas

- ✓ **Central North**
  - 11,600km² (samples area)
  - 445 fields samples
- ✓ **North West**
  - 2,130km² (samples area)
  - 1 368 fields samples
- ✓ **West**
  - 285km² (samples area)
  - 306 fields samples
- ✓ **South West**
  - 1 600 km² (samples areas)
  - 1 841 fields samples



Land-use typologies (LUT)

Crop rotation	LUT	Concerned land-use	Temporality
Winter-Winter	WW_S_FA	Bare soil, regrowths	~ 1 to 3 months
Winter-Spring	WS_S_CC	Cover crop, Catch crop	~ 8 to 9 months
	WS_L_CC	Catch crop, Green manure	~ 8 to 9 months
	WS_L_BS	Bare soil or crop residues	~ 8 to 9 months
Spring-Spring	SS_L_CC	Cover crop, Catch crop	~ 5 to 6 months
	SS_L_CR	Crop residues	~ 5 to 6 months
	SS_L_BS	Bare soil	~ 5 to 6 months
Spring-Winter	SW_S_FA	Bare soil	~ 1 month
Permanent	PERM	Grassland, orchard	12 months

Processing Sentinel-2 time series

- ✓ Download Sentinel-2 Level 3A Products (Monthly synthesis – Theia hub)
- ✓ Analysis of quality assessment and mask application
- ✓ Calculation of Vegetation Indices (NDVI, NDWI)

Classification process

- ✓ Cropland winter land-use typologies classification
  - **Random Forest (RF)**
  - **Support Vector Machine (SVM)**
  - **K-Nearest Neighbor (K-NN)**
  - **Multiple Layer Perceptron (MLP)**

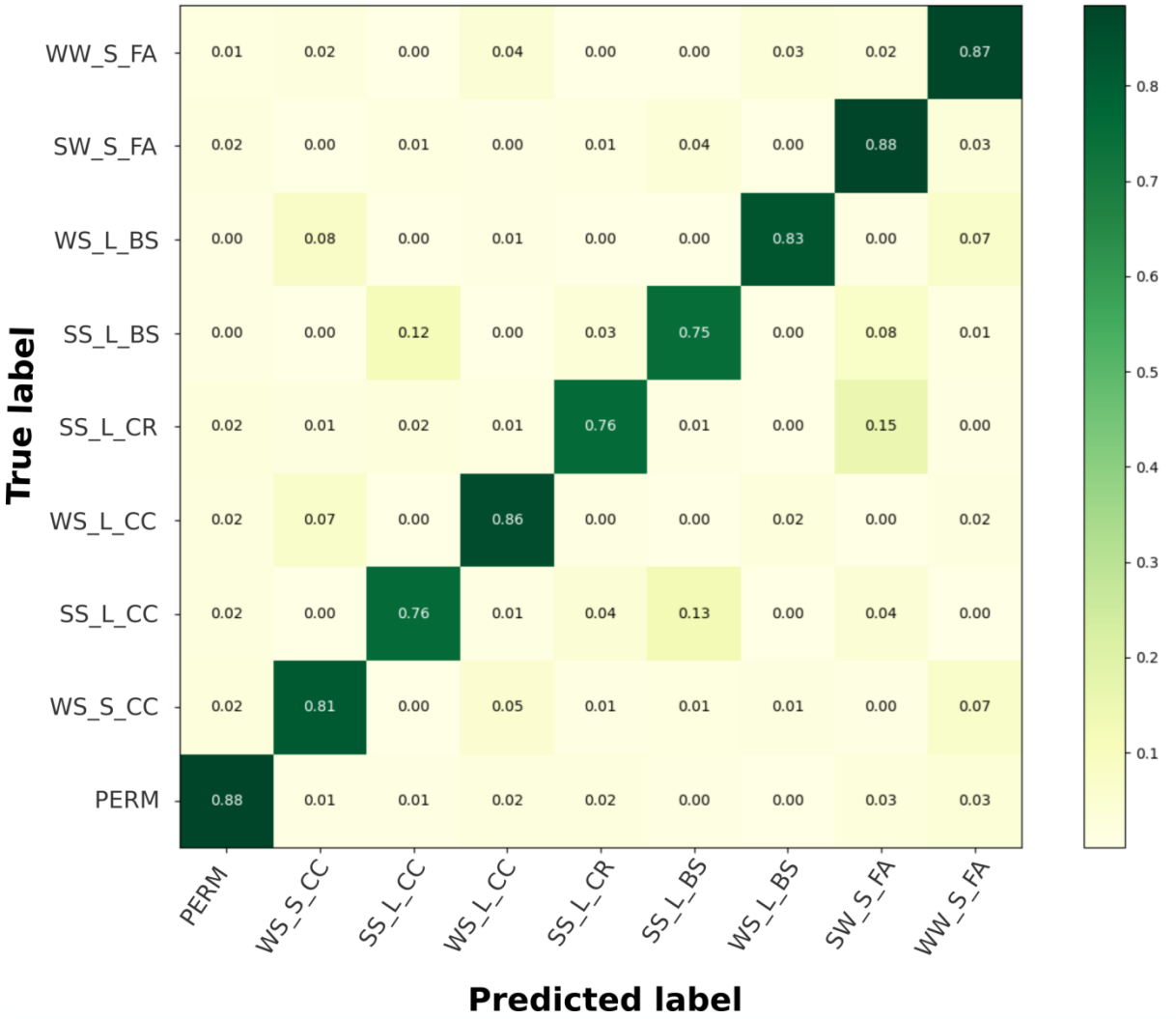
- ✓ Evaluation of classification algorithms
  - **80% of fields for the training and 20% of fields for the validation**
  - **Based on these selected plots, all pixels were used to perform classification**
  - **Classification accuracy (F1-Score and Kappa index)**

- ✓ Extension to the whole France.

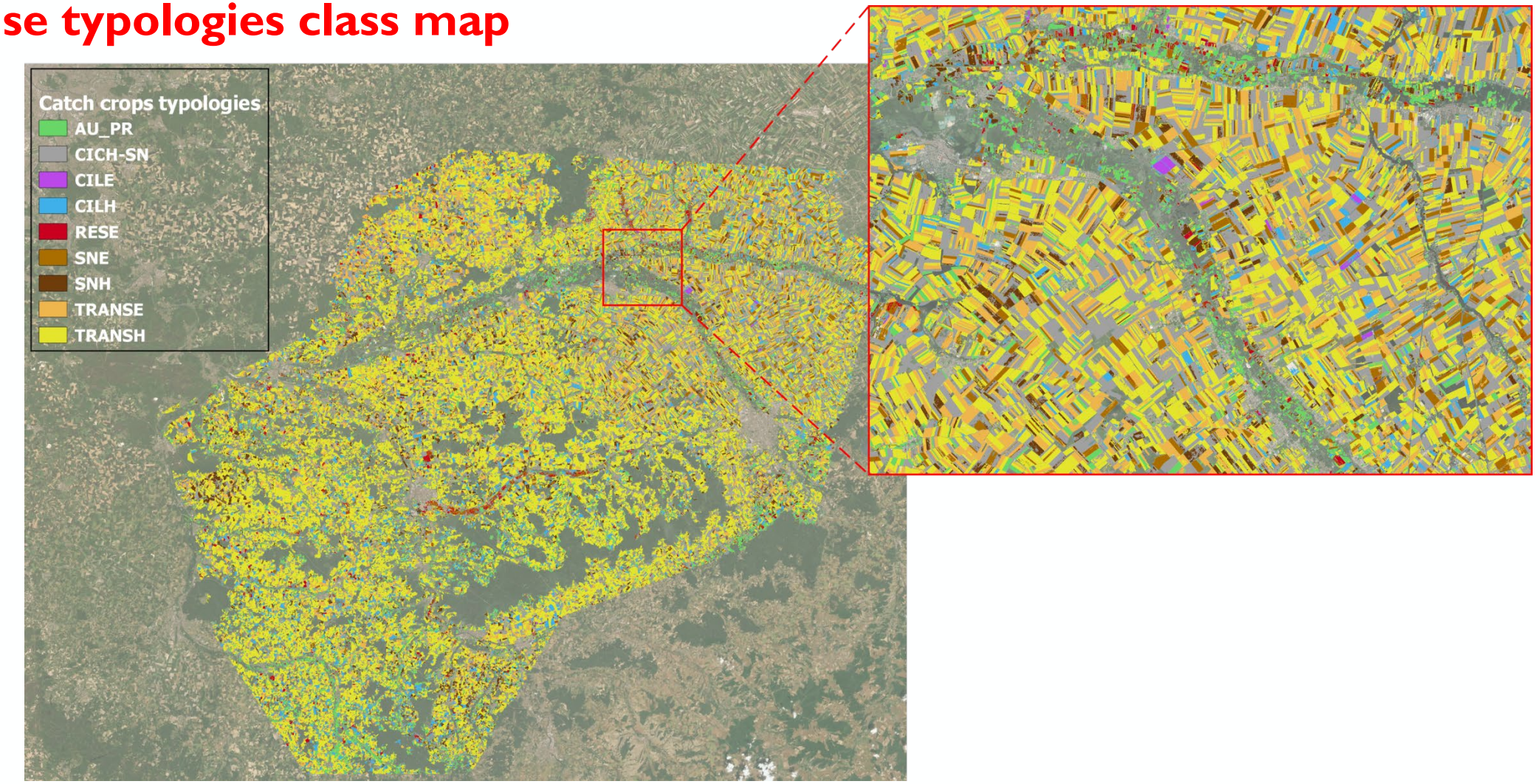
Classification results

- ✓ **Best classification accuracy is obtained with Random Forest**

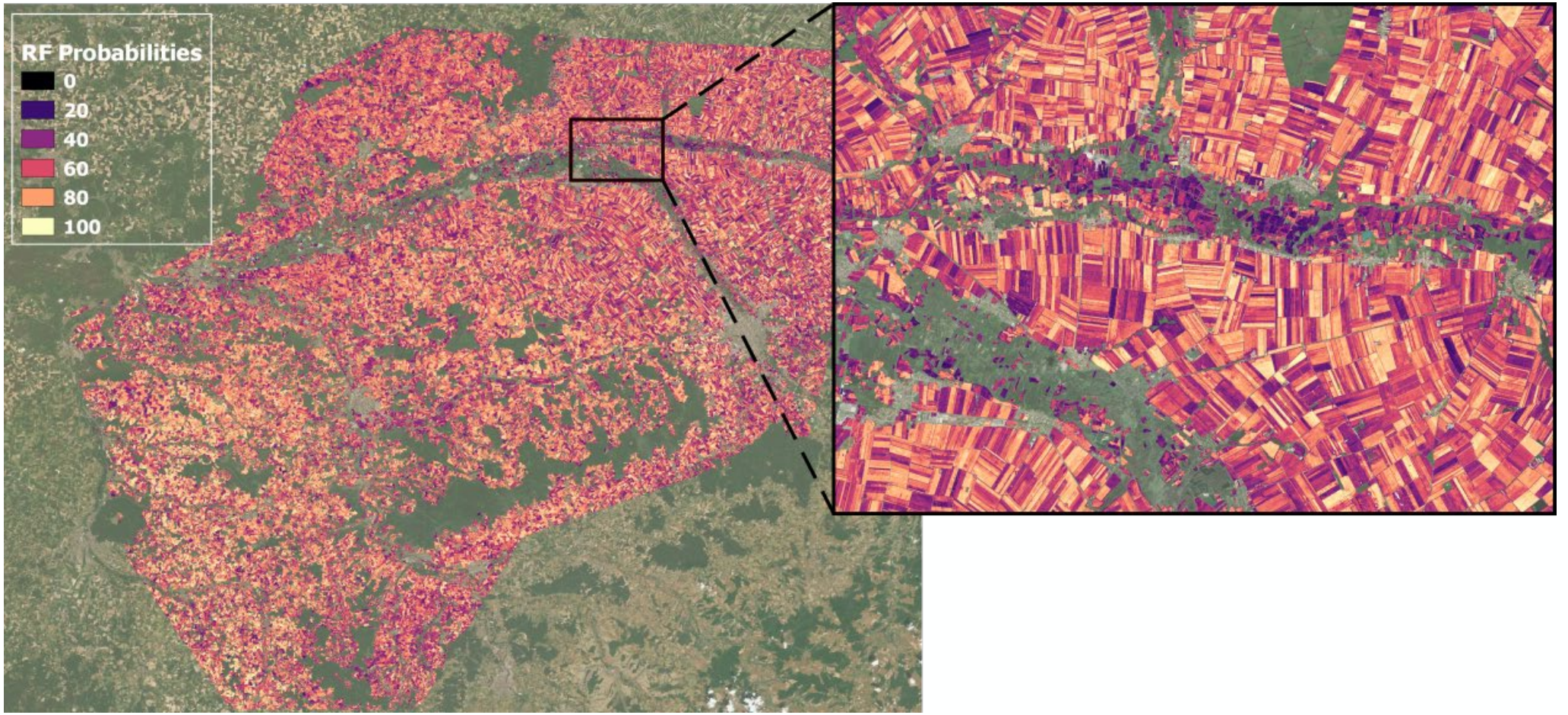
Algorithms	Sentinel-2	
	Kappa	F1-score %
RF	0.82	85
SVM	0.81	83
KNN	0.78	81
MLP	0.79	82



Land-use typologies class map

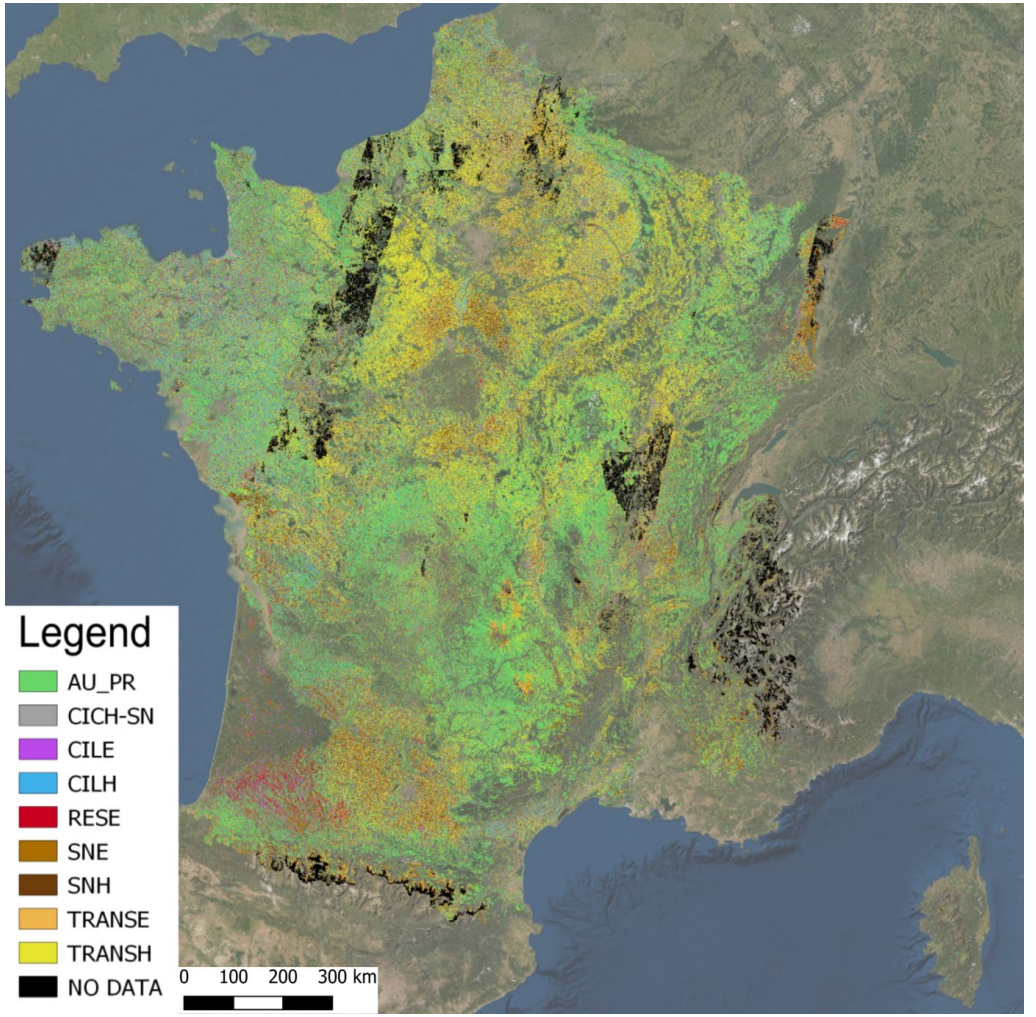


Land-use typologies probability map



Global land-use typologies map

- ✓ **Annual crops – 61,5 % of the areas :**
  - ✓ 54 % in winter crops
  - ✓ 26 % in cover crops during fallow period
  - ✓ 20 % in bare soil or crop reisdues
- ✓ **Permanent crops – 33,5 % of the areas**
- ✓ **No data – 5 % of the areas**



CONCLUSION - PERSPECTIVES

✓ **Sentinel-2 monthly synthesis time-series are useful for mapping winter land-use typologies of cropland over large areas**

✓ **Best results are obtained with RF algorithm**

- *F1-score 85%*
- *Kappa index of 0.82*

✓ This is the first map describing the status of cropland during the winter fallow period for whole France

× **No-data, misclassification errors and artifacts in several areas (~5%)**

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THANK YOU !

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