

Sentinel 2 and Deep Learning methods to map *Culex pipiens* distribution in central Italy

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Vector of many diseases

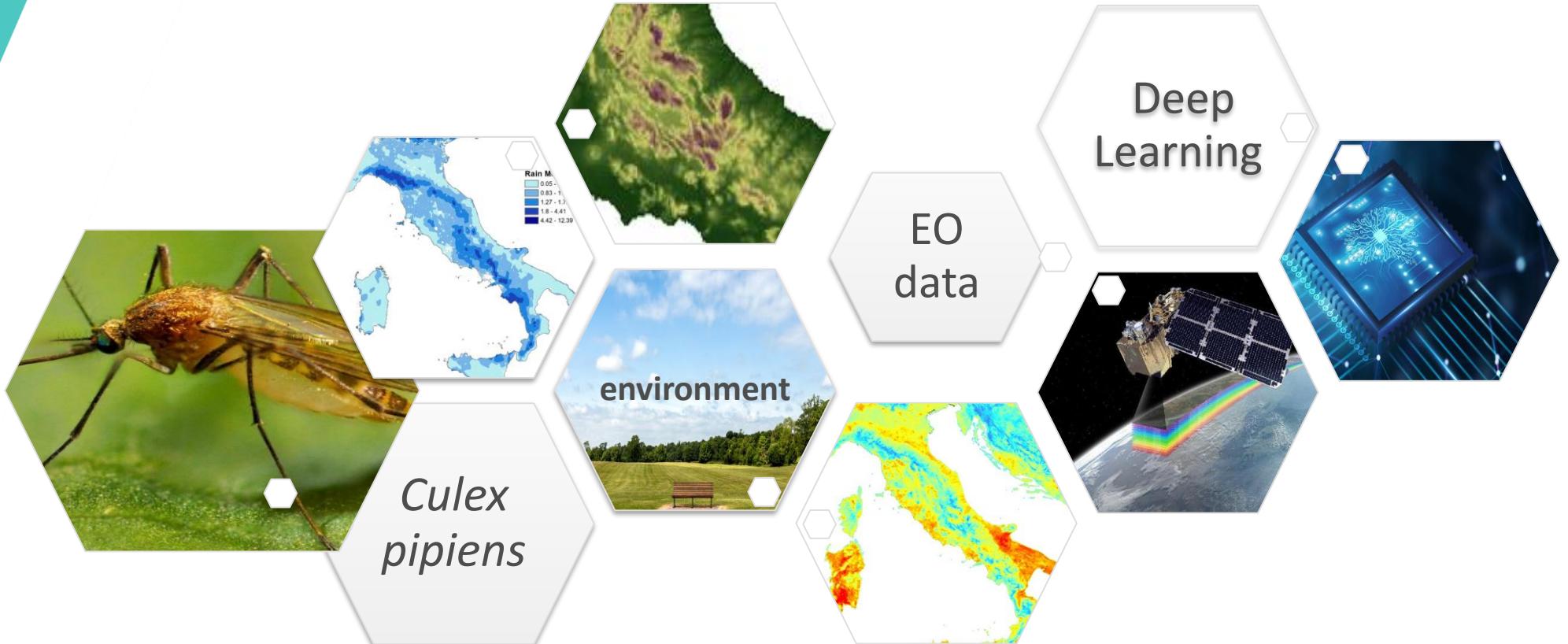


- **West Nile fever**
- Usutu
- Eastern Equine encephalitis
- Japanese encephalitis
- Rift Valley fever
- St. Louis encephalitis
- And others ...

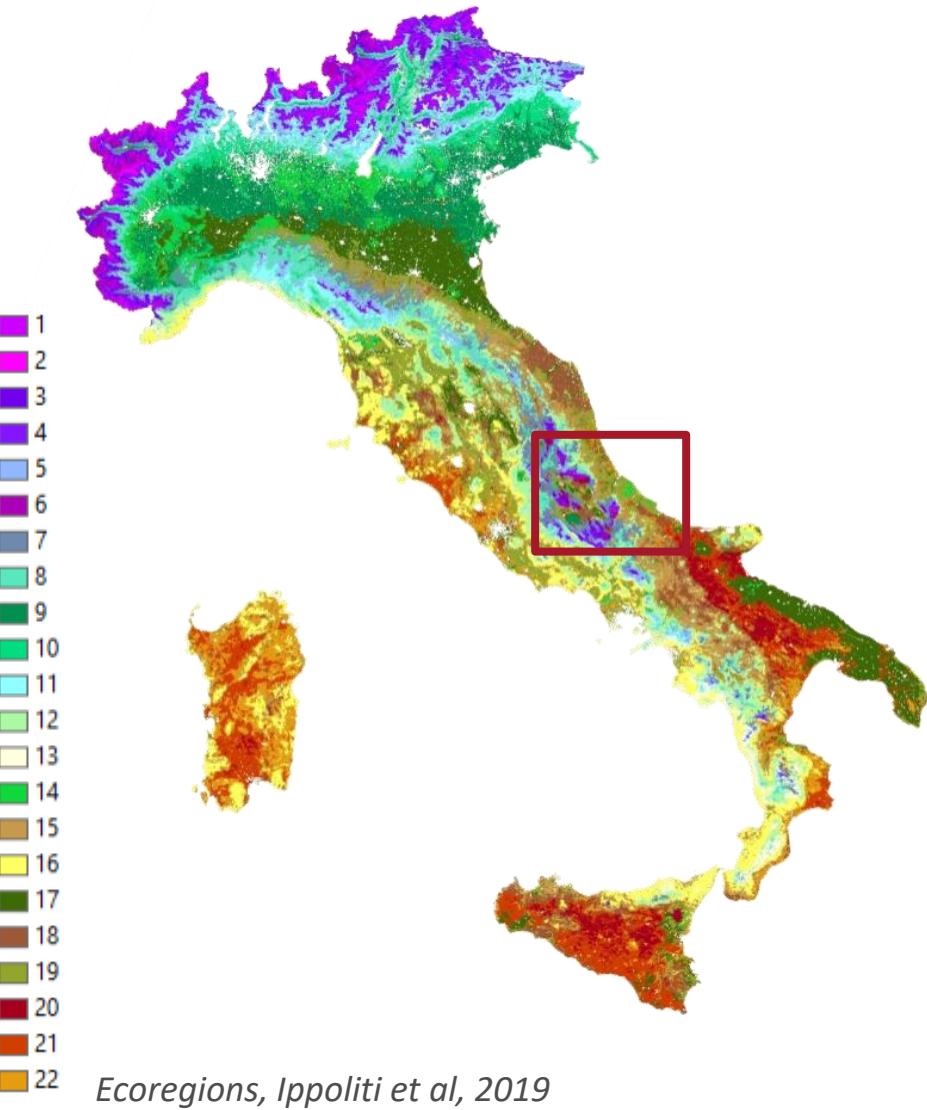
Able to adapt to a wide variety of environments



Research aim

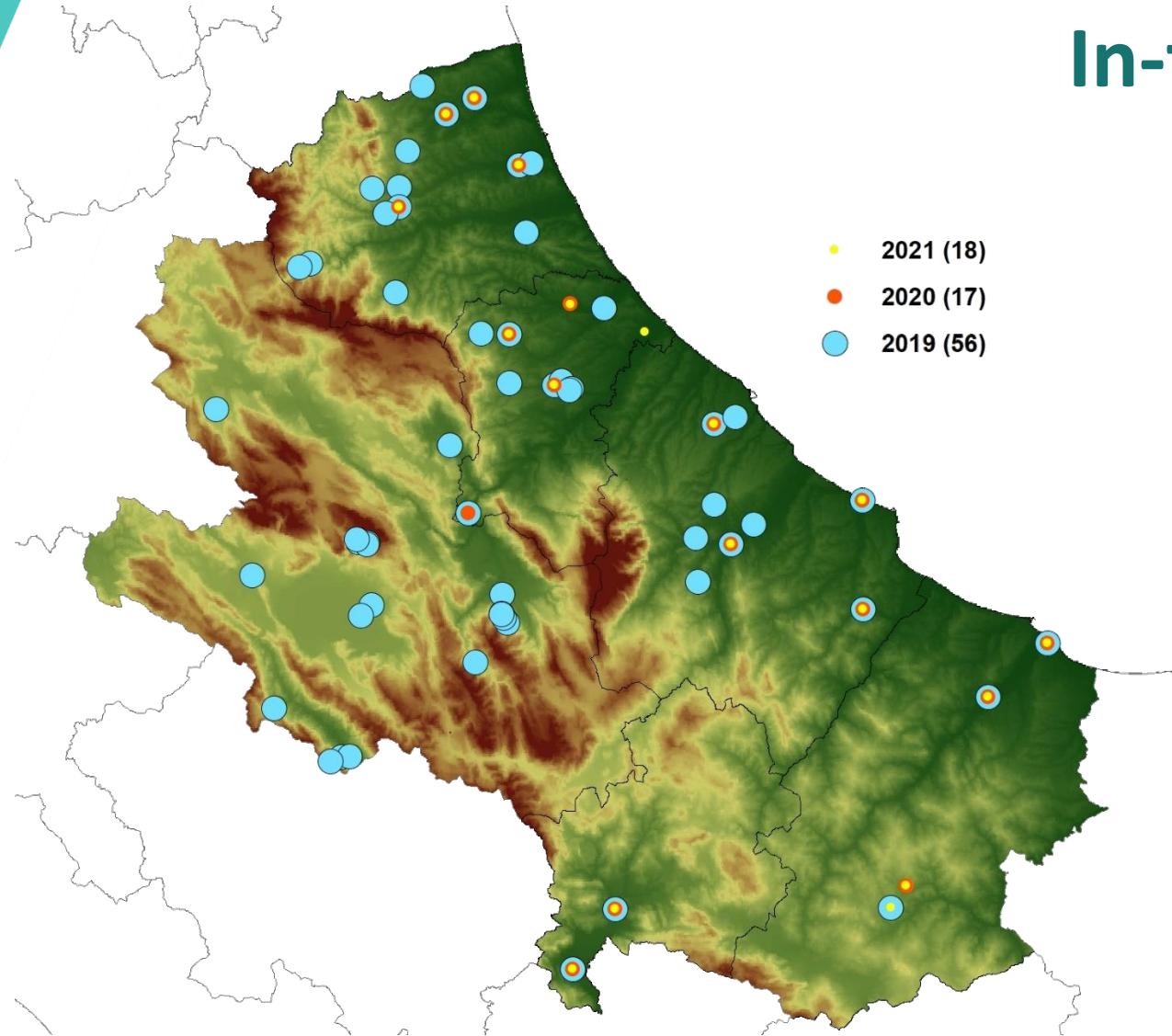


to predict the spatio-temporal environments in central Italy suitable for the presence of *Culex pipiens*, exploiting EO data cubes and DL modeling



In-field sampling campaigns

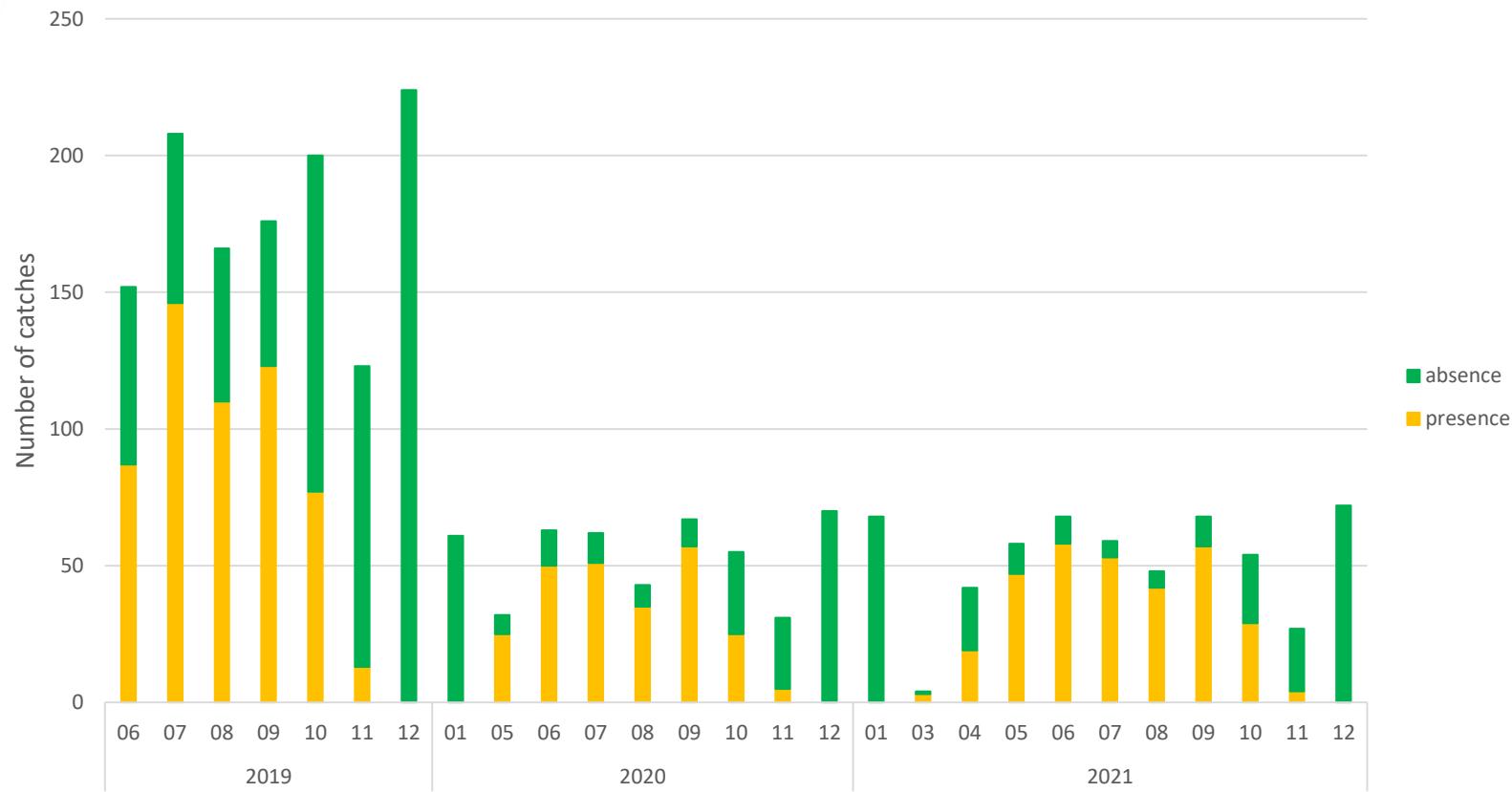




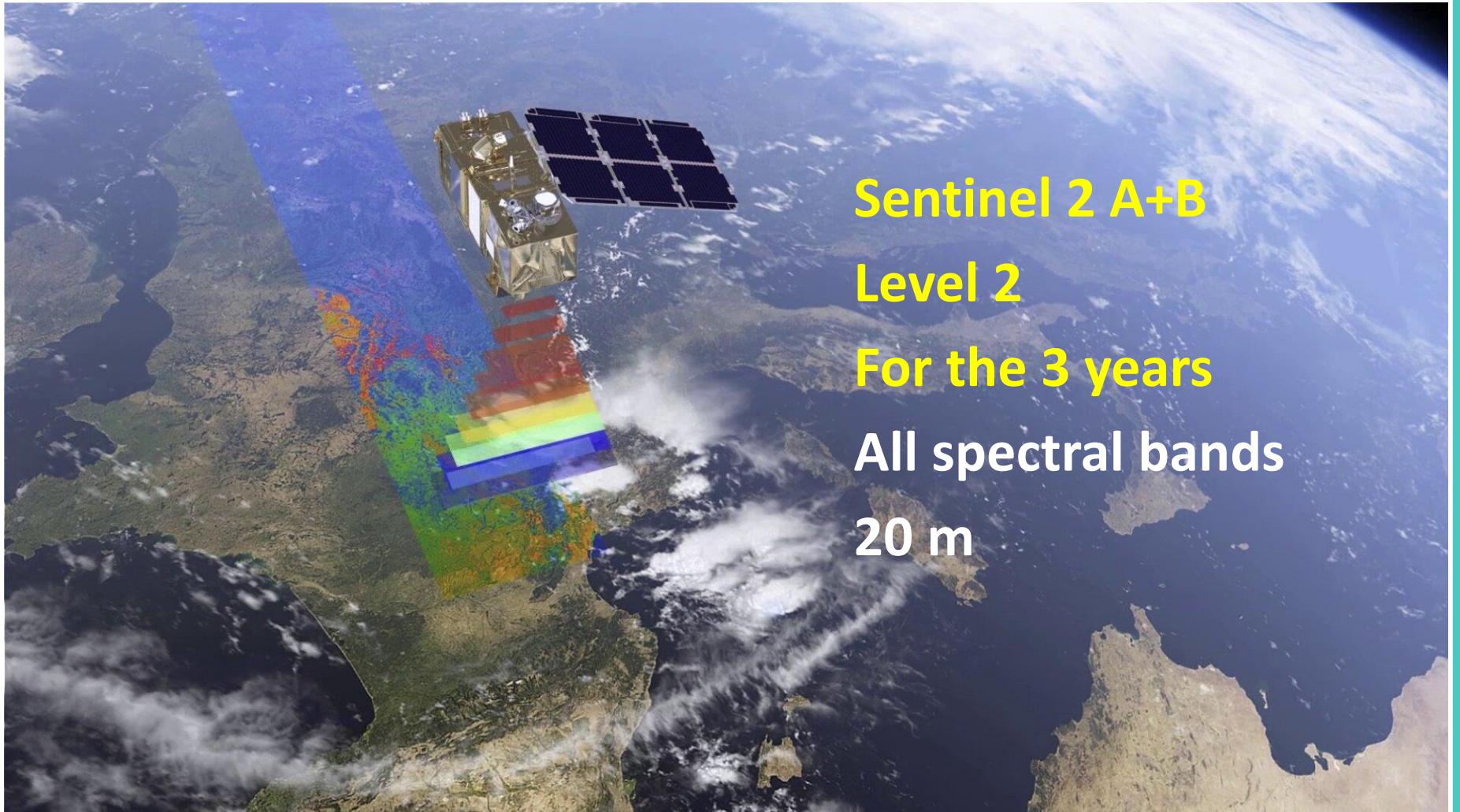
In-field sampling campaigns

- Average of 20 samplings per year
- During vector season (May to November)
- Plus pseudo-absence in winter months (December and January)

Ground truth database



The database was made up of 2301 records



EO dataset

Sentinel 2 A+B

Level 2

For the 3 years

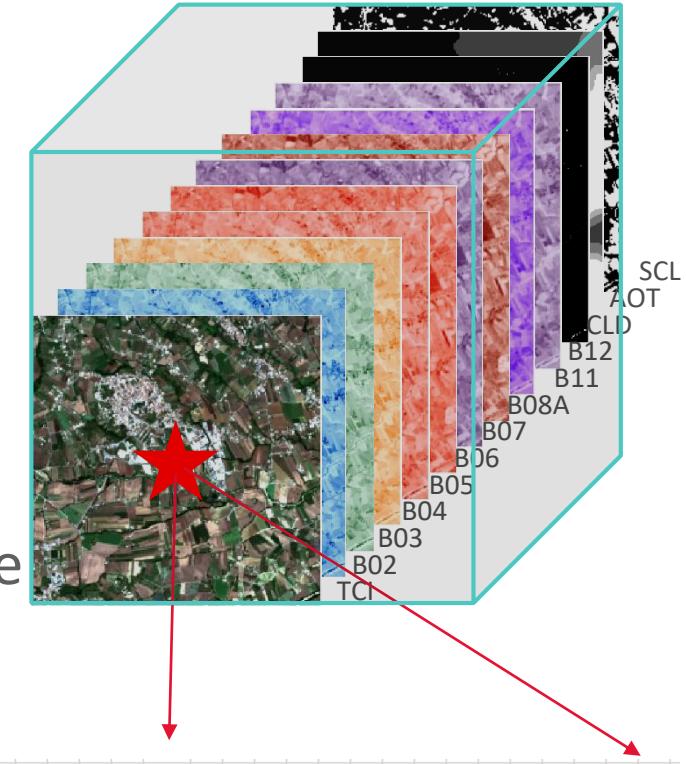
All spectral bands

20 m

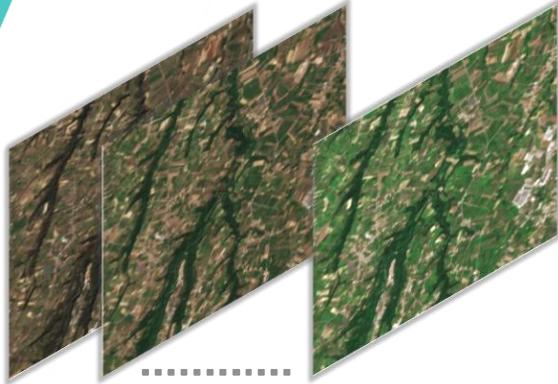


EO dataset

- For each trap location (star)
- Sentinel 2 were cropped
- In squares of 224x224 pixels
- For each revisit time
- For all spectral bands (avail at 20 m)
- Associated to the trap/pres-abs/date



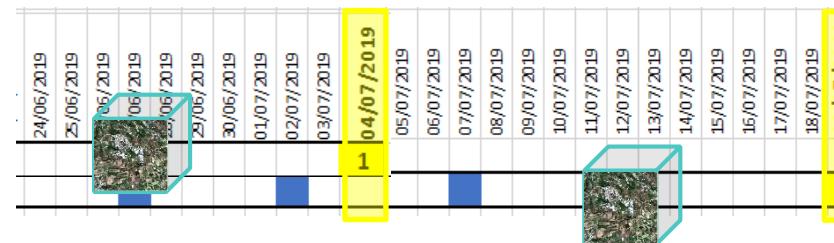
Data preparation for Deep models



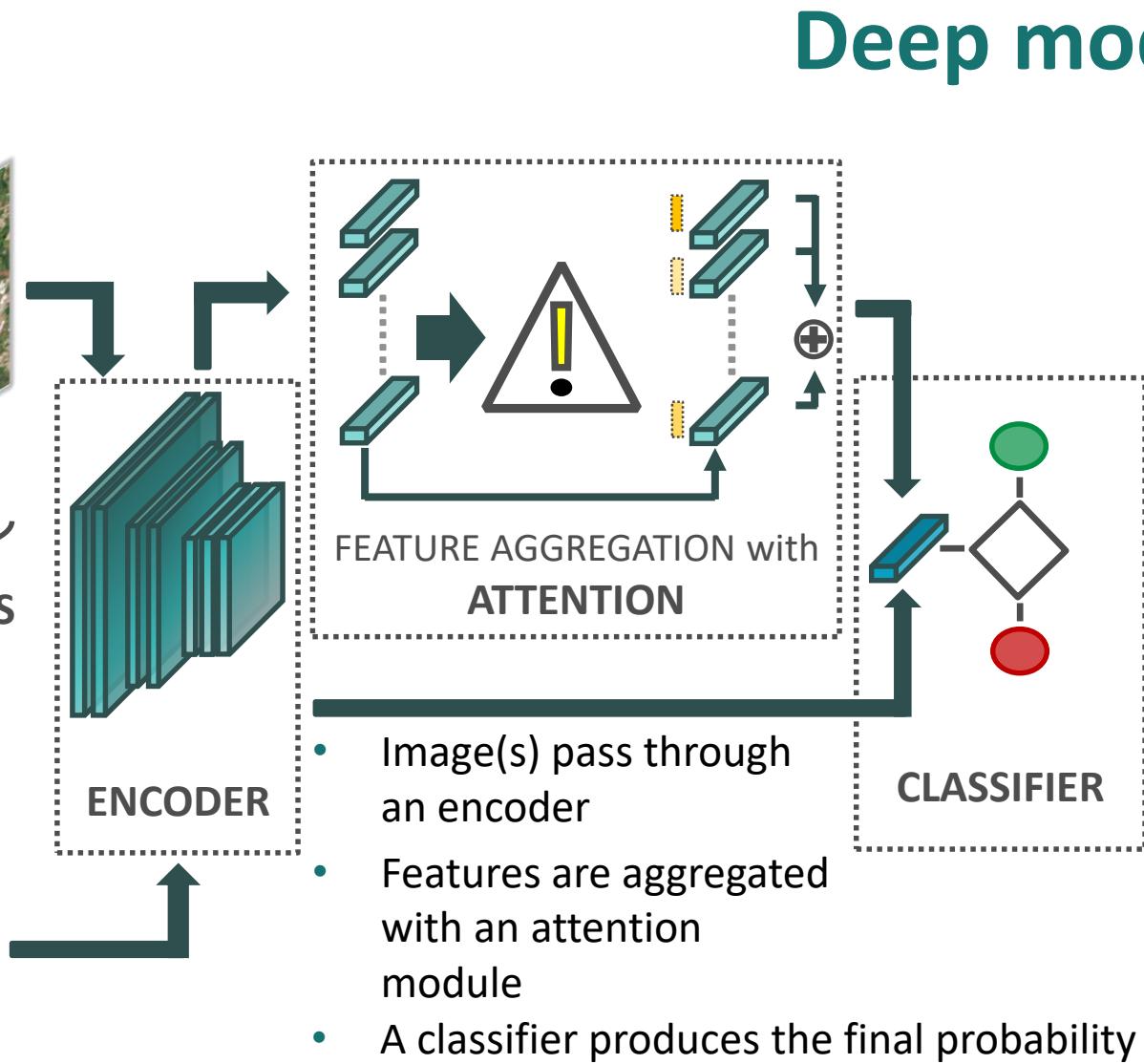
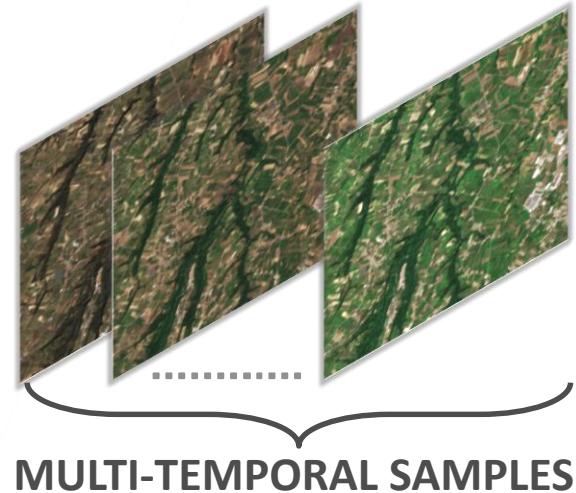
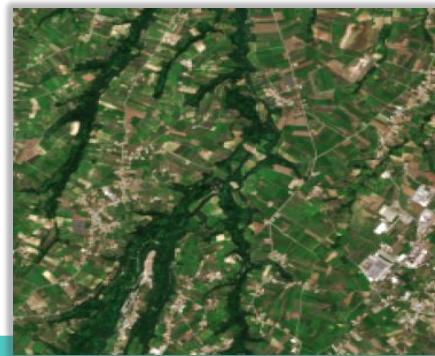
MULTI-TEMPORAL
ACQUISITIONS
- TEMPORAL MODEL



SINGLE
ACQUISITION –
BASELINE MODEL



SINGLE IMAGE BASELINE



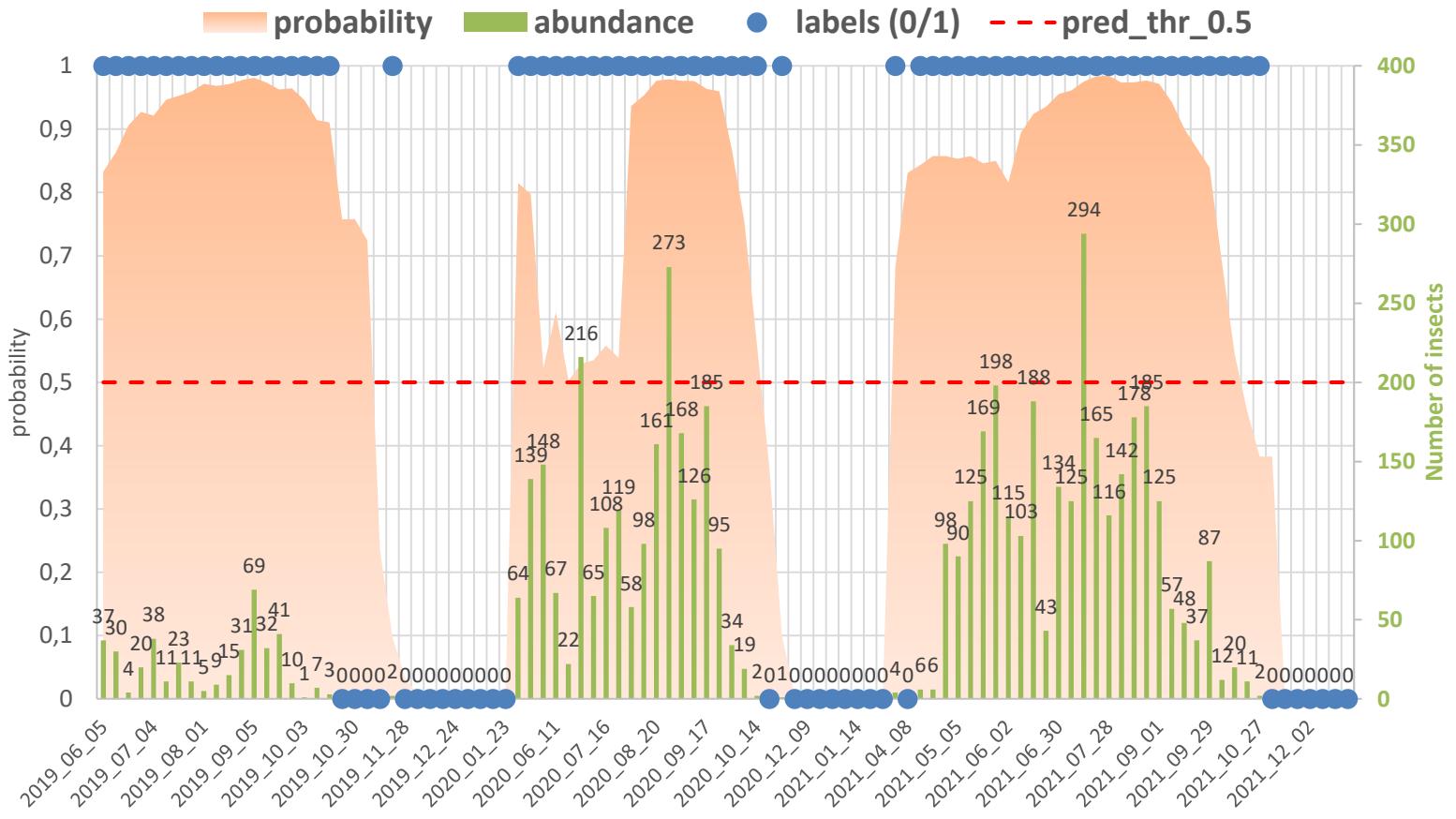
Deep models

- Data is split in **5 folds**.
- Proportion of *positive-to-negative* samples for each fold is kept:

	# Positive	# Negative
Train (avg)	894	948
Test (avg)	223	237

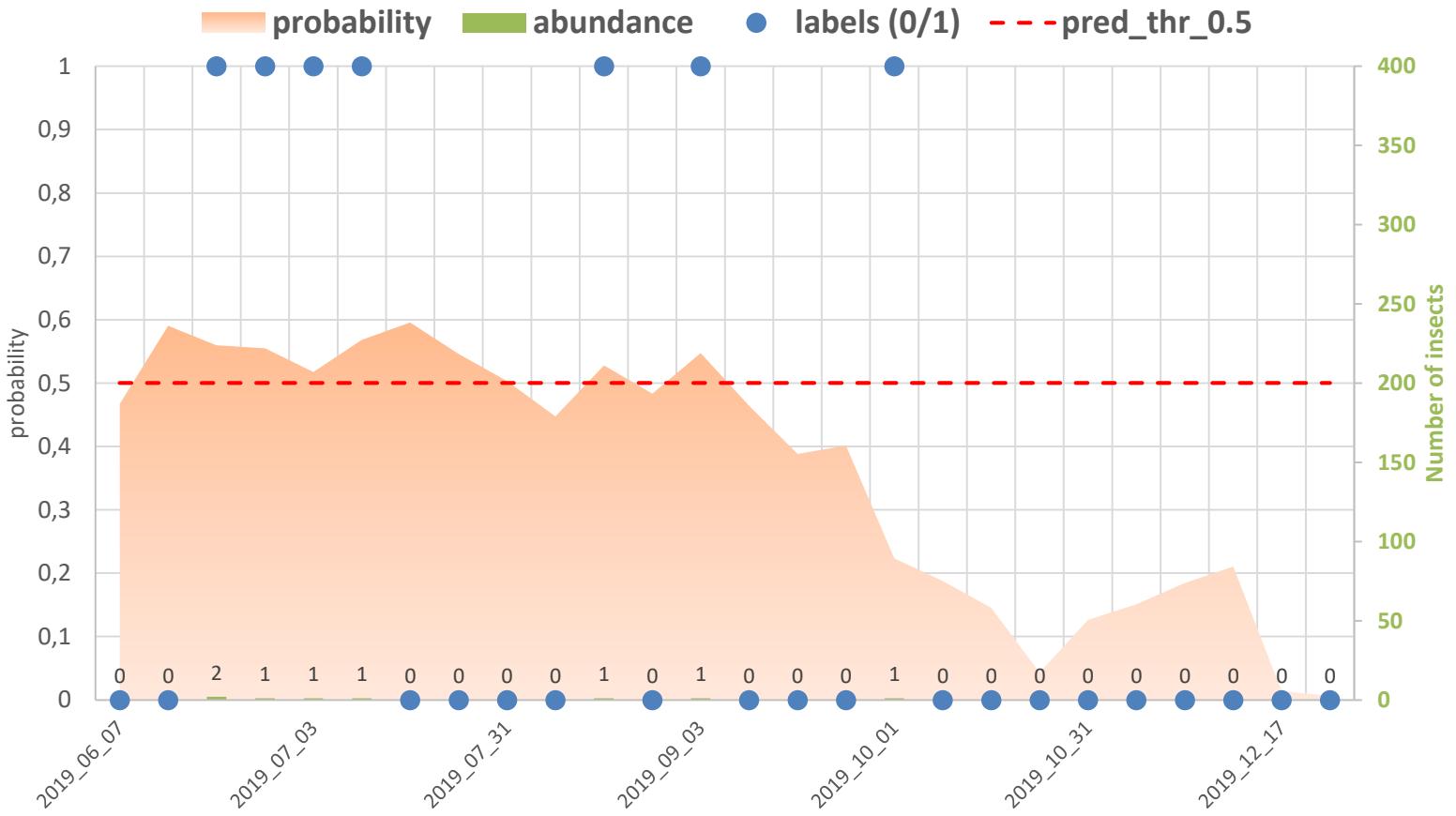
- Results are averaged across folds

	F1-score	Sensitivity	Specificity
Baseline	78.63%	87.15%	68.61%
Multi-Temporal	81.62%	85.32%	79.27%



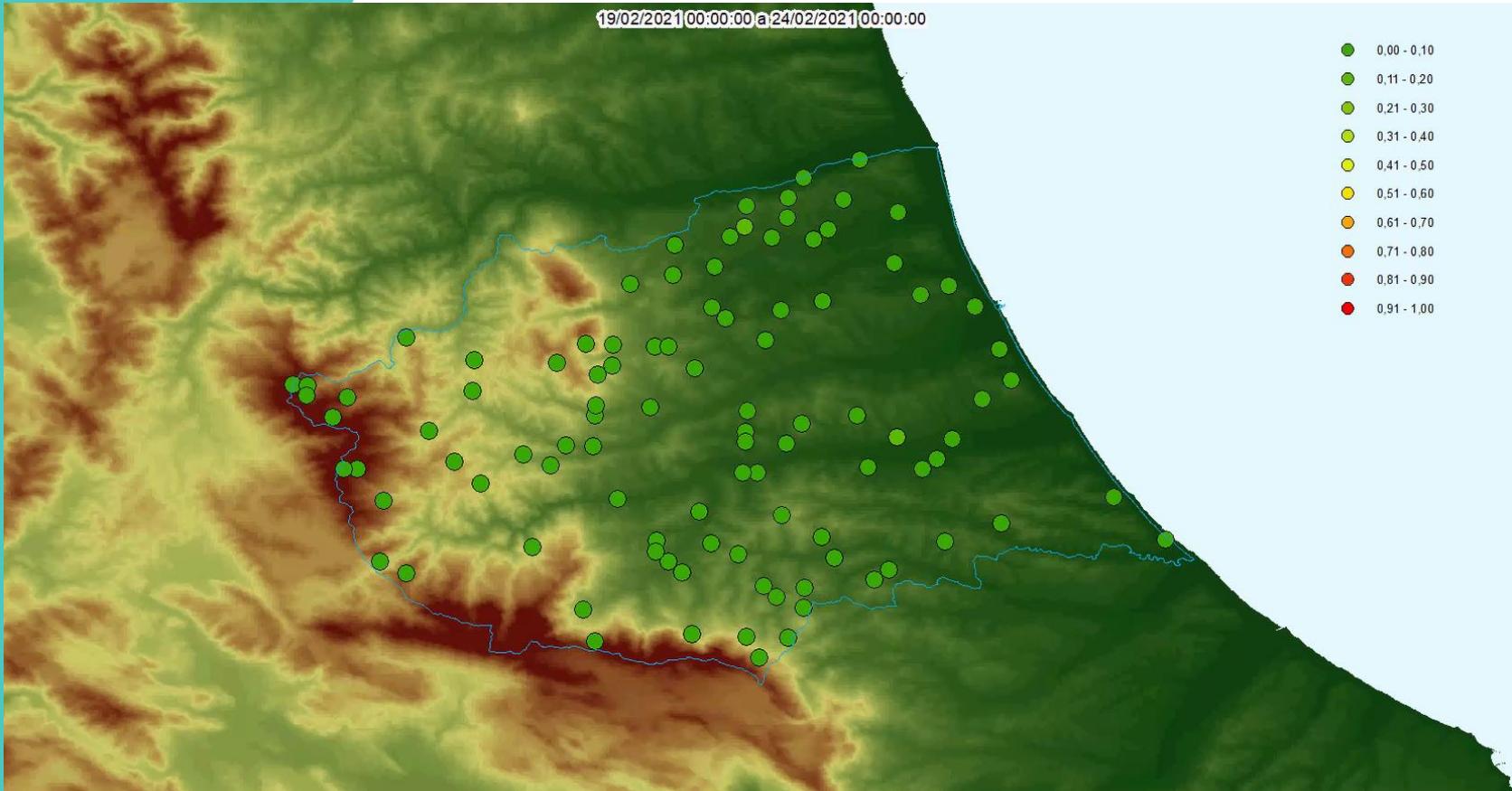
Site TE05_NER

The model well catches the seasonality in a positive site, with abundance of *Cx. pipiens* (green bars)



Site TE10_RIP

The model well catches the characteristics in a pretty negative site (considering the threshold of 0.5)



Prediction

- In terms of spatio-temporal simulation of the occurrence of the species
- in Teramo province
- in unseen locations

- *Culex pipiens* is widespread, as expected
- the temporal patterns is catched by the model
- giving useful information for targeting surveillance activities in the following seasons
- the methodology adopted can be extended to the national territory and to other vectors

Conclusions



Funding
Italian Ministry of Health

IZSAM 01/18 RC: Artificial intelligence and remote sensing:
innovative methods for monitoring the vectors and the
associated ecological/environmental variables.



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Thank you

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Thank you

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Research Topic

Satellite Earth Observation for Animal Health and Vector-Borne Diseases
(by 18 March 2023)