



Climate-Sensitive Vector Dynamics Modelling Workshop



September 19-20, 2024
Bologna, Italy



An early warning support system for climate-sensitive vector-borne diseases

Dr Kamil Erguler

Associate Research Scientist

Climate and Atmosphere Research Center (CARE-C)
The Cyprus Institute

k.erguler@cyi.ac.cy

19.09.2024



Funded by



EMME-CARE
EASTERN MEDITERRANEAN
MIDDLE EAST - CLIMATE &
ATMOSPHERE RESEARCH CENTRE

wellcome



Climate-driven vector-borne disease risk assessment



Wellcome Trust Digital Technology Development Awards
Climate-Sensitive Infectious Disease Modelling

Model and data repository

Open-access repository of vector-pathogen models, climate projections, environmental variables, and surveillance data

Short/medium/long-term predictions

Risk maps, seasonal activity, temporal projections of vector activity and disease transmission

Decision support tool

Web-based interactive GIS platform to display risk, run customized scenarios, and inform prevention and control

Aedes albopictus

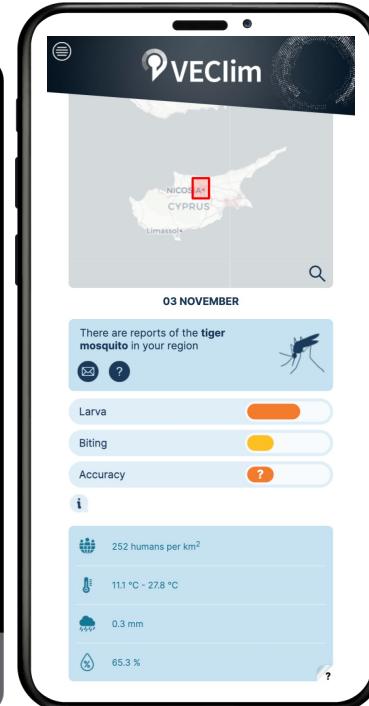
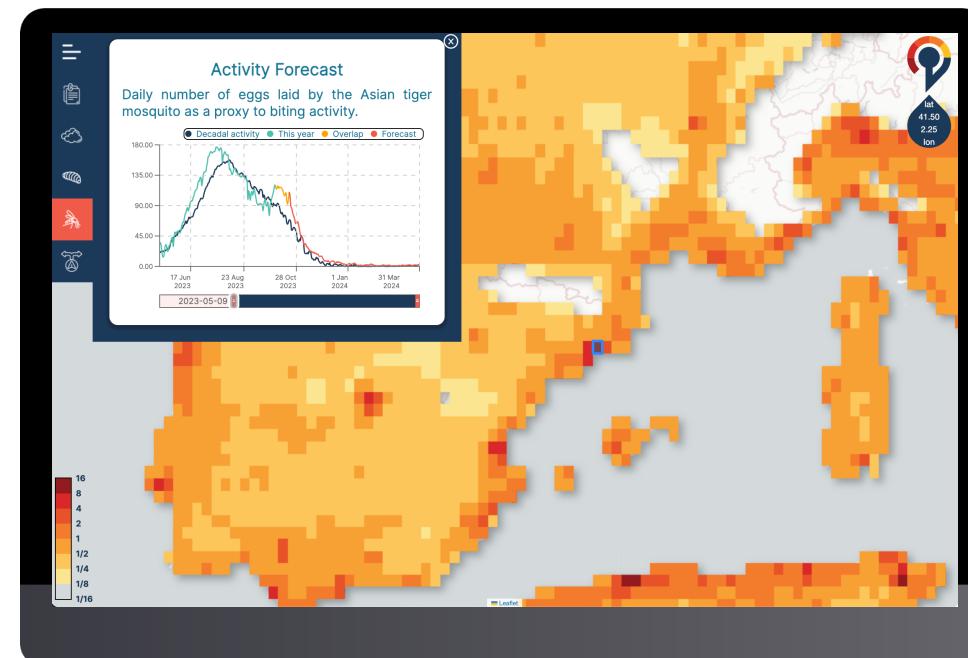


**Invasive
Aggressive
Competent**
chikungunya
dengue, zika

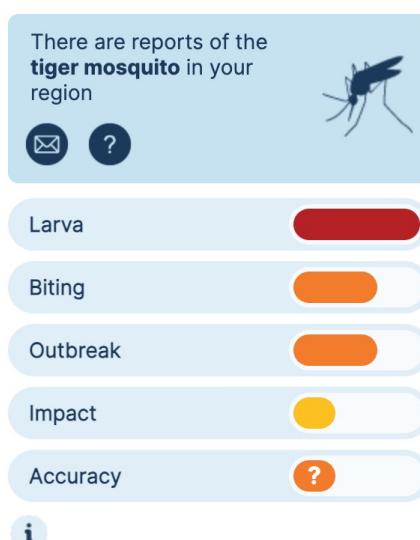
Phlebotomus papatasii



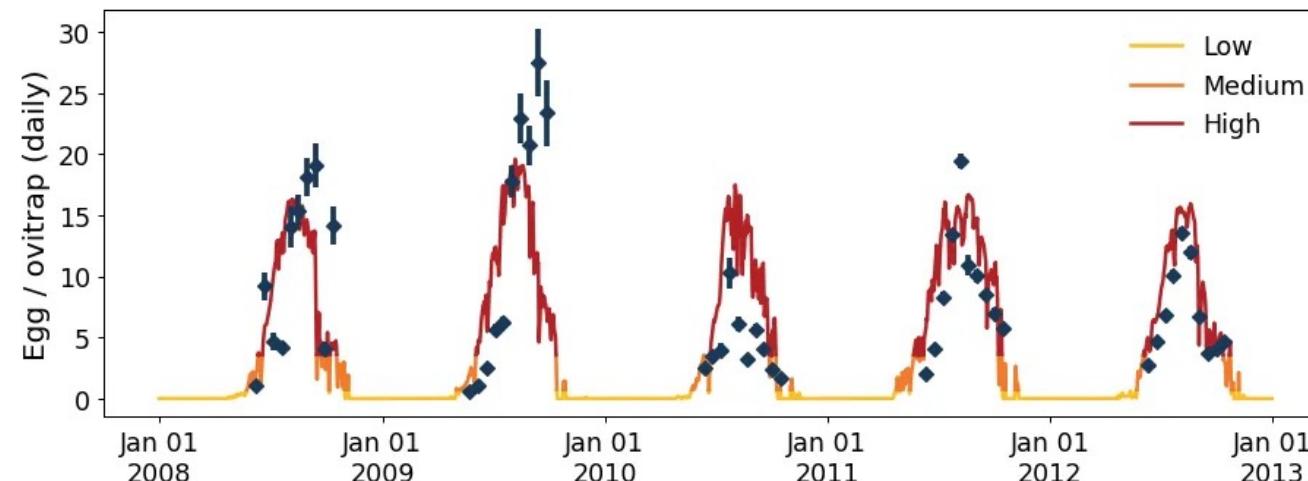
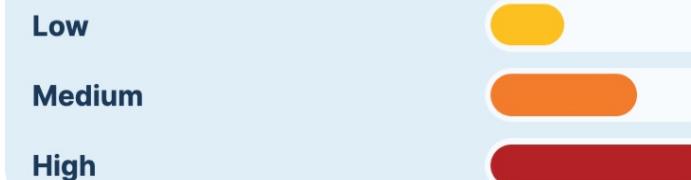
**Non-invasive
Neglected
Competent**
leishmaniasis
sand fly fever



VEClim's risk indicators



Larva: Larvae in a typical breeding site
Biting: Mosquito activity (bites on people)
Outbreak: Outbreak risk due to an imported case
Impact: Average impact of an imported case



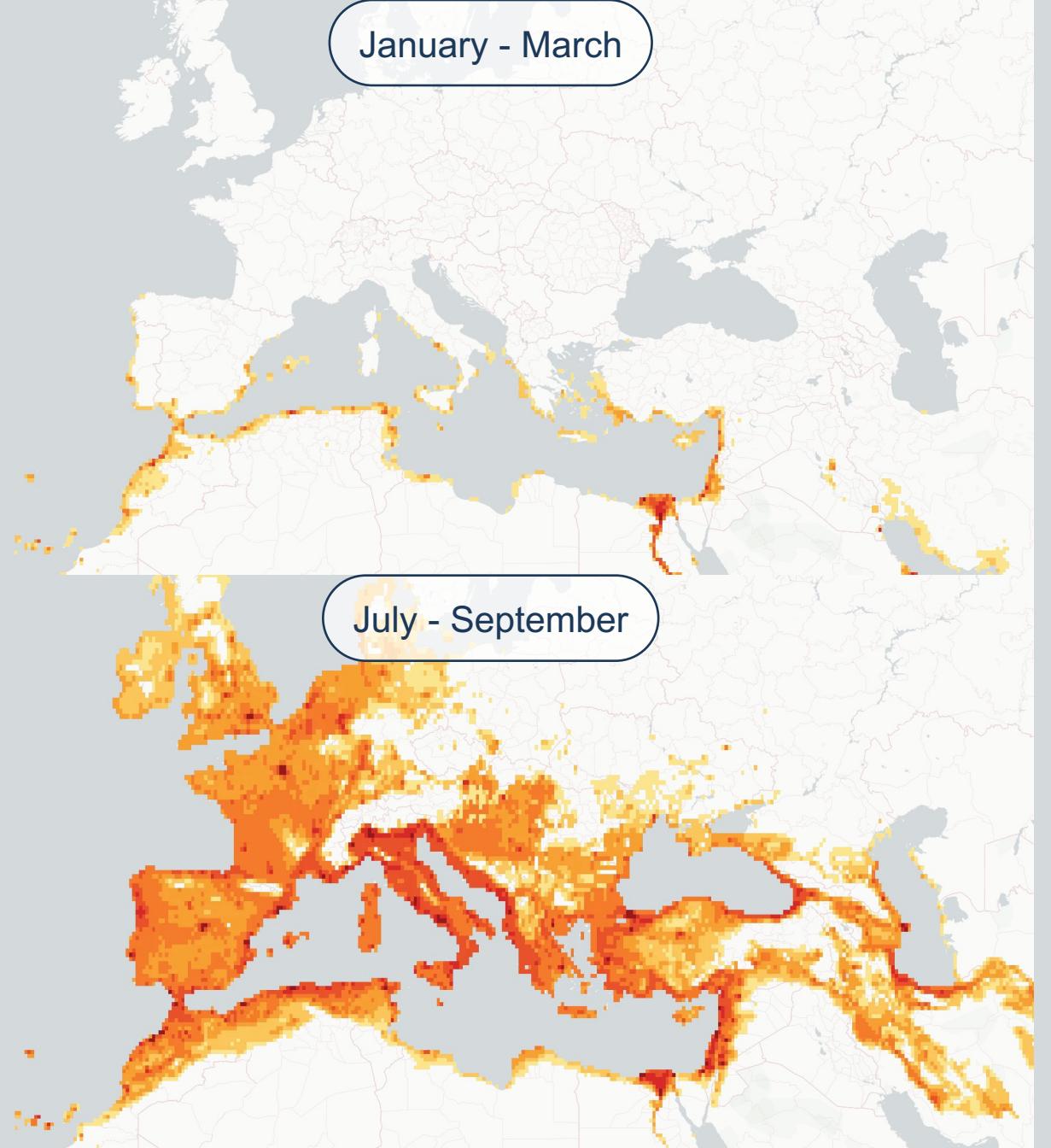
Current configuration

VEClim presents a set of indicators of daily vector activity and disease risk at 0.25° resolution based on ERA5 decadal averages and an age-structured population dynamics model of *Aedes albopictus* and CHIKV transmission.

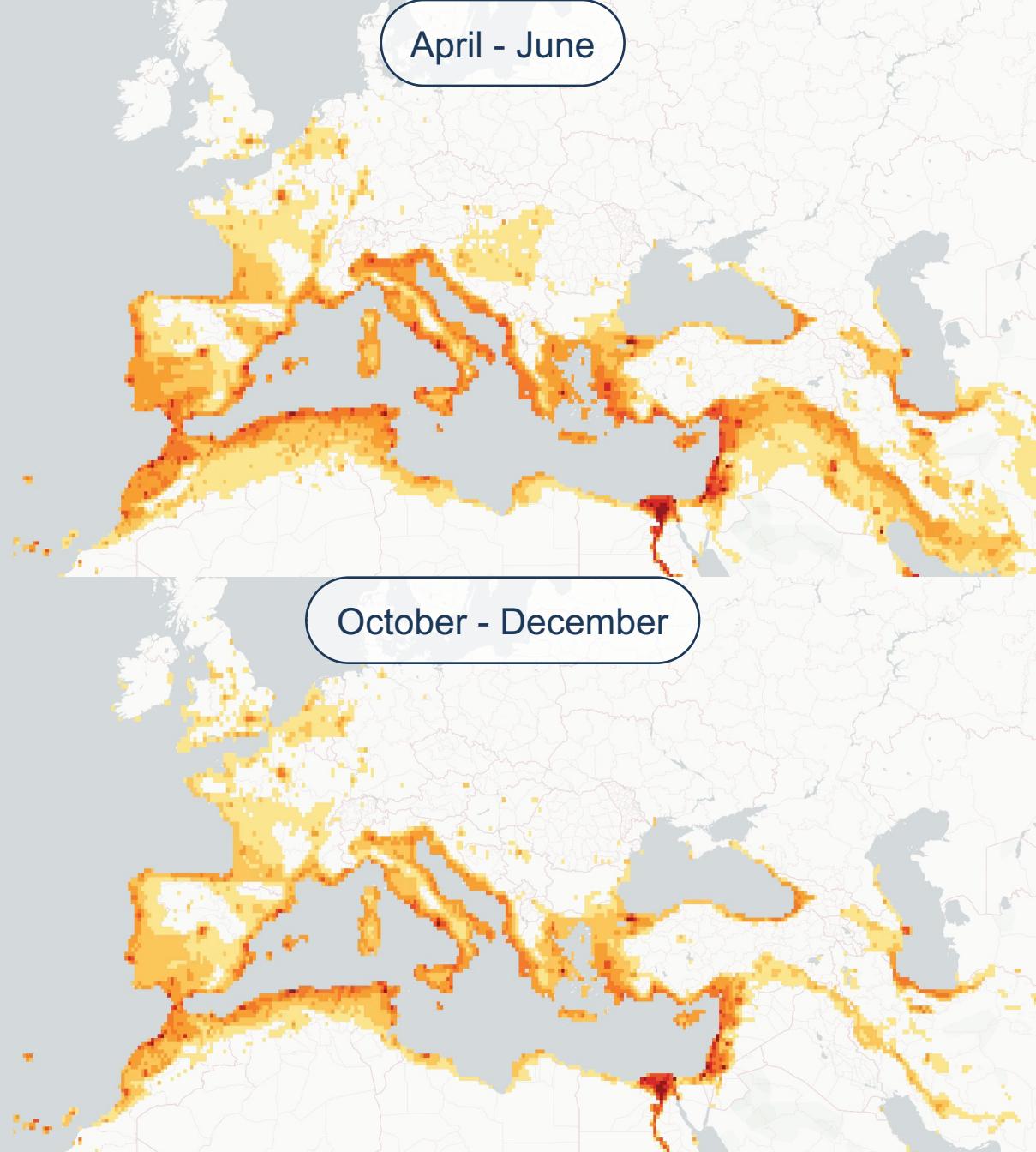
Erguler et al. 2016-2017



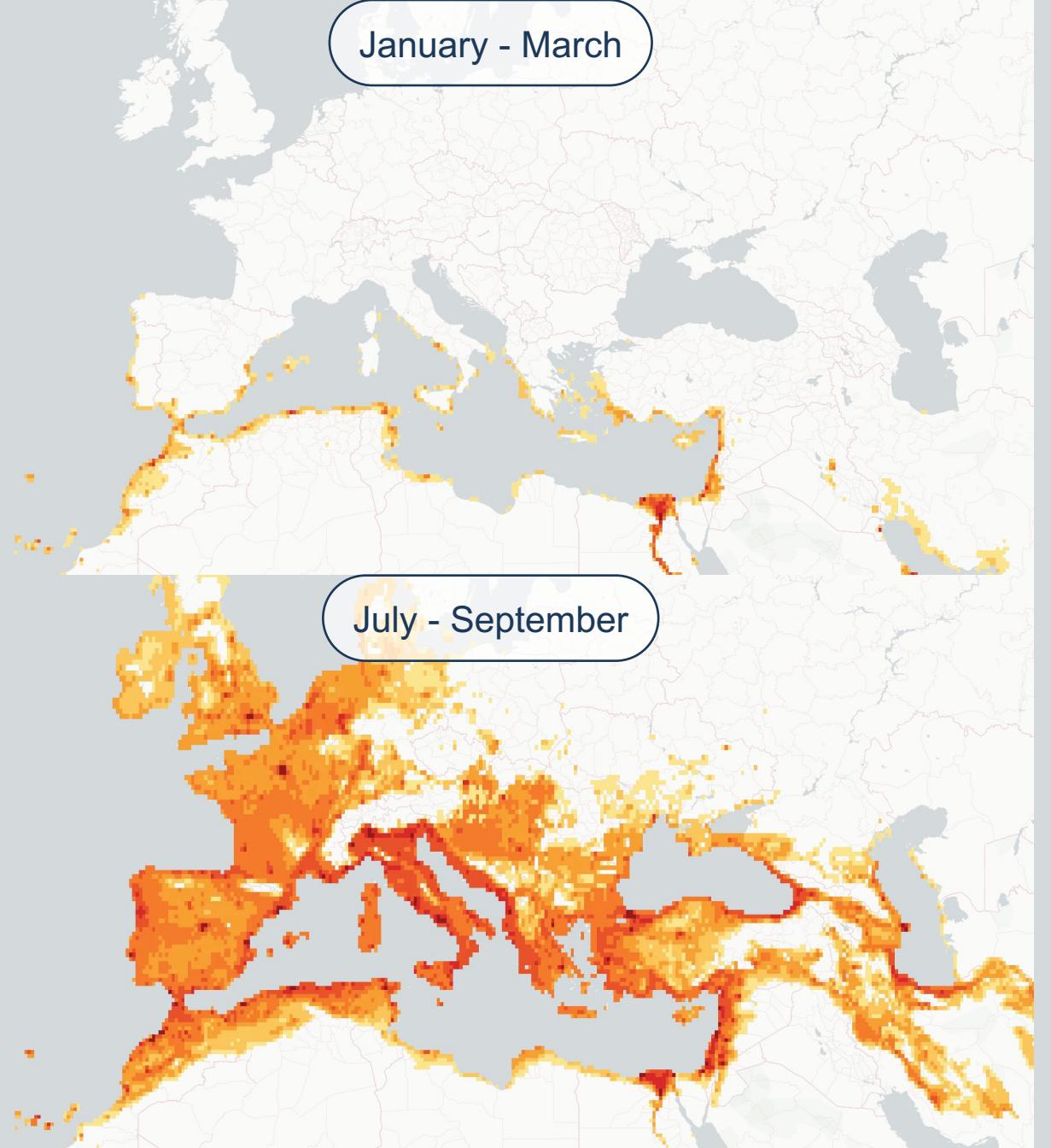
January - March



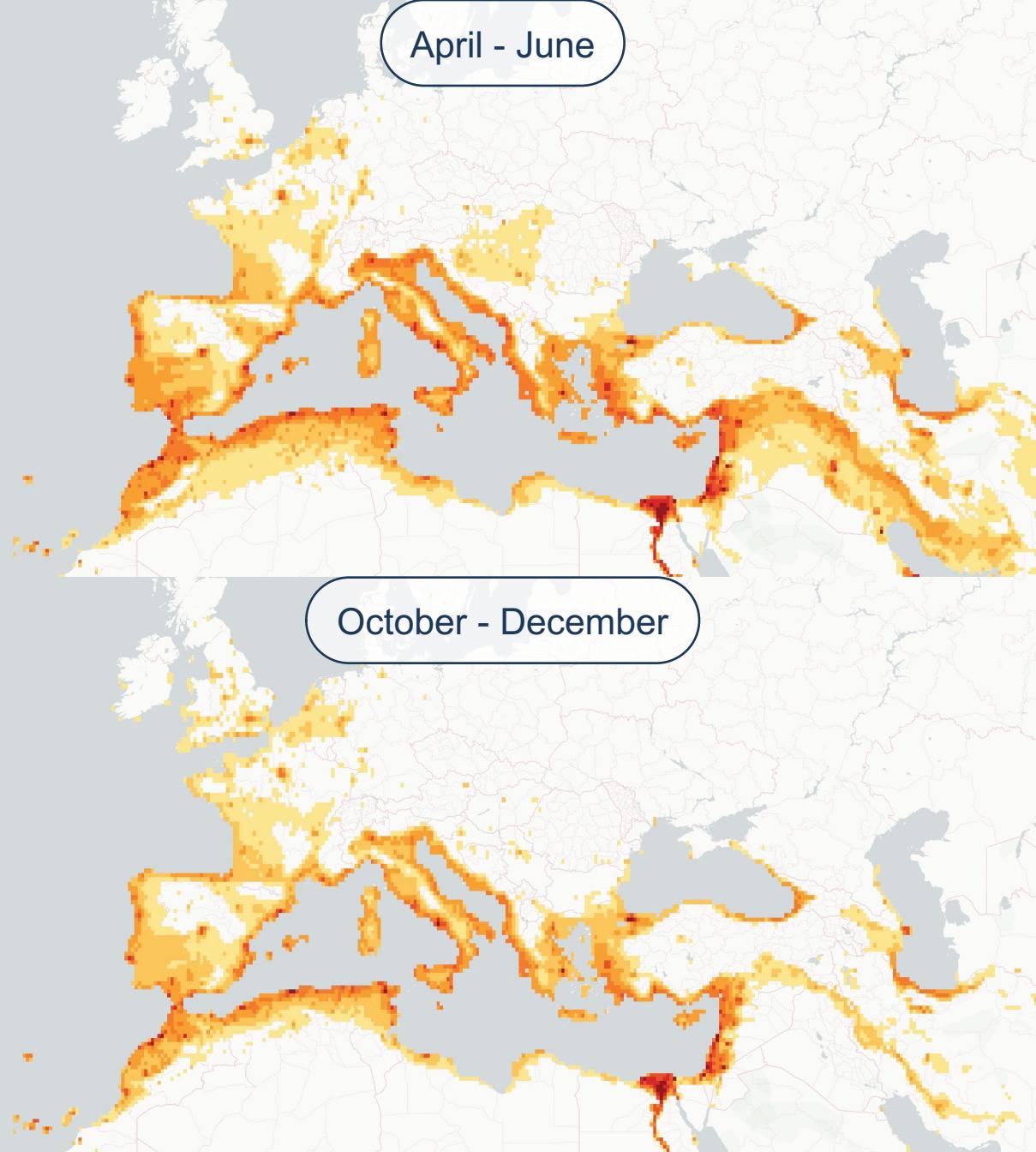
April - June



July - September

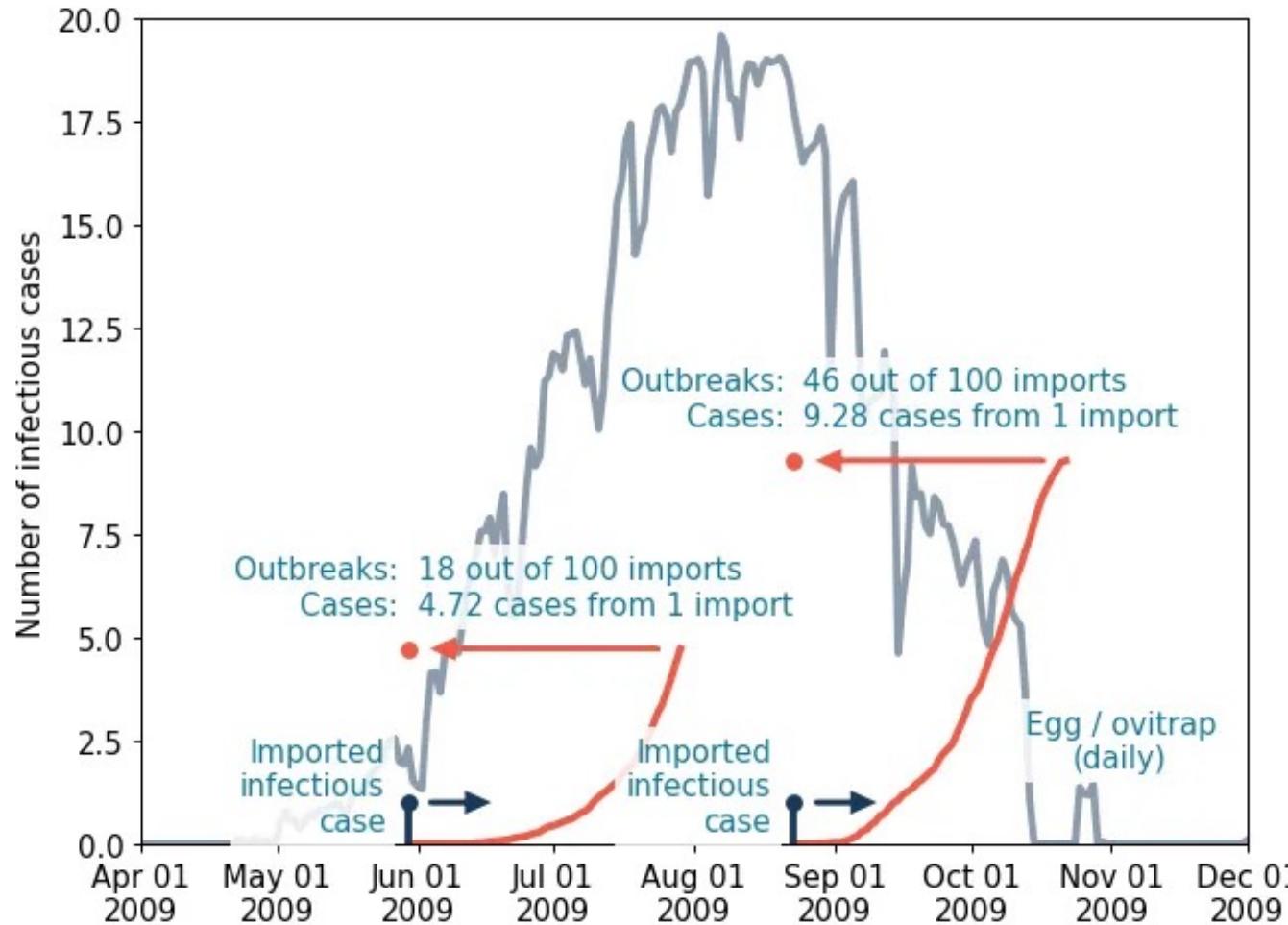


October - December

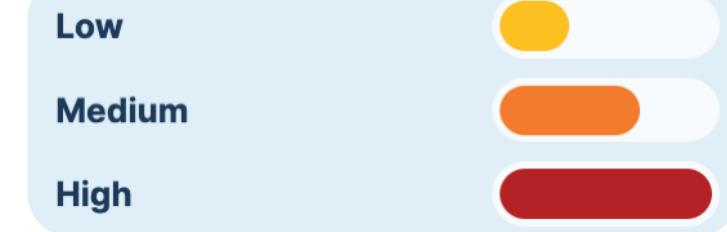


Expected activity from 2010 to 2020

Relative activity and risk indicators (disease-related)



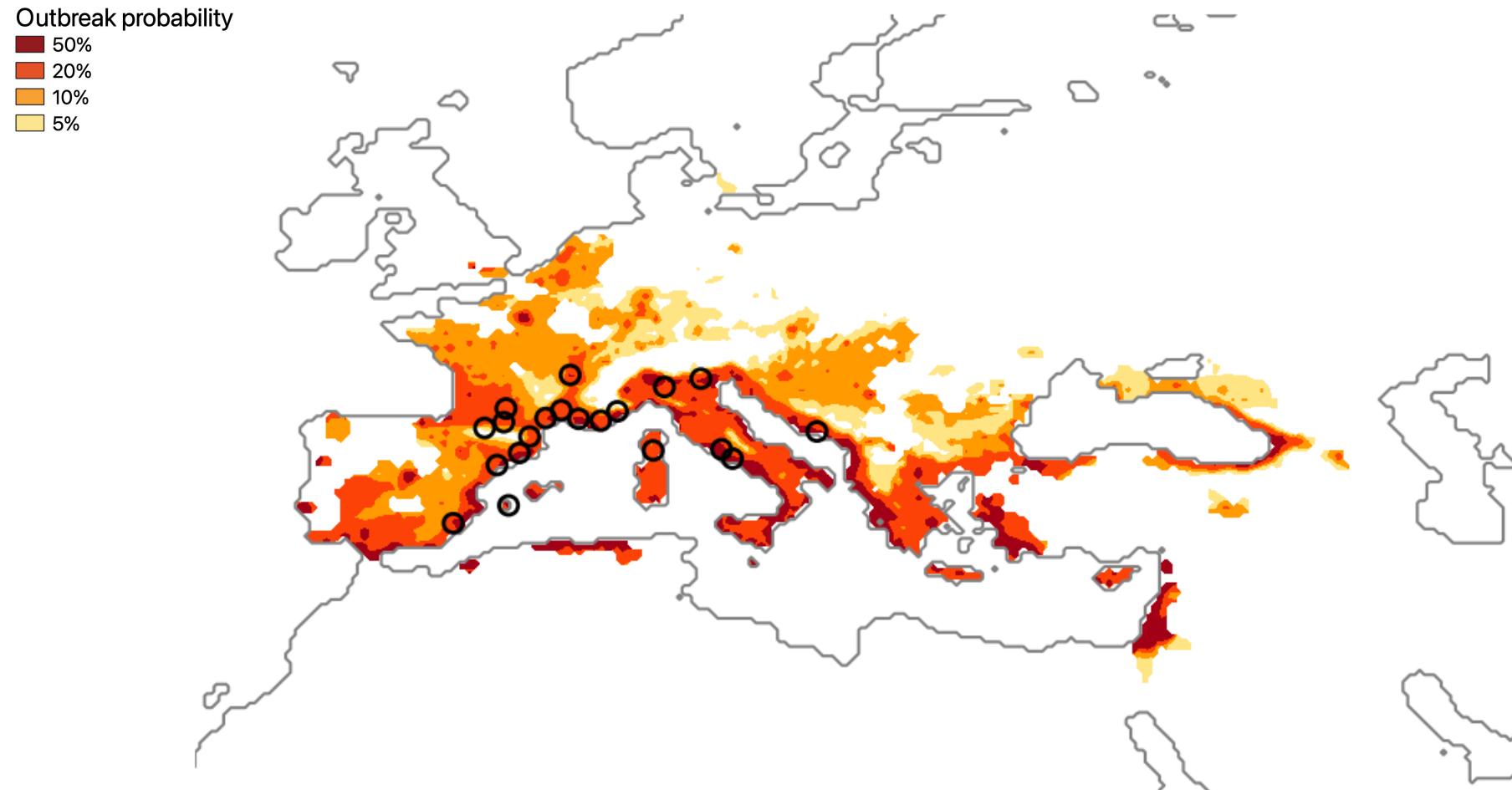
Lower than 1%
Less than 10 cases



Larger than 50%
More than 500 cases



Outbreak probability vs. Dengue outbreaks



The likelihood of an imported case resulting in an outbreak in Europe from 2010 to 2020.
Circles: regions of the observed dengue outbreaks between 2010 and 2023.

Decadal averages Medium-range forecasts Long-range projections

→ Decadal averages

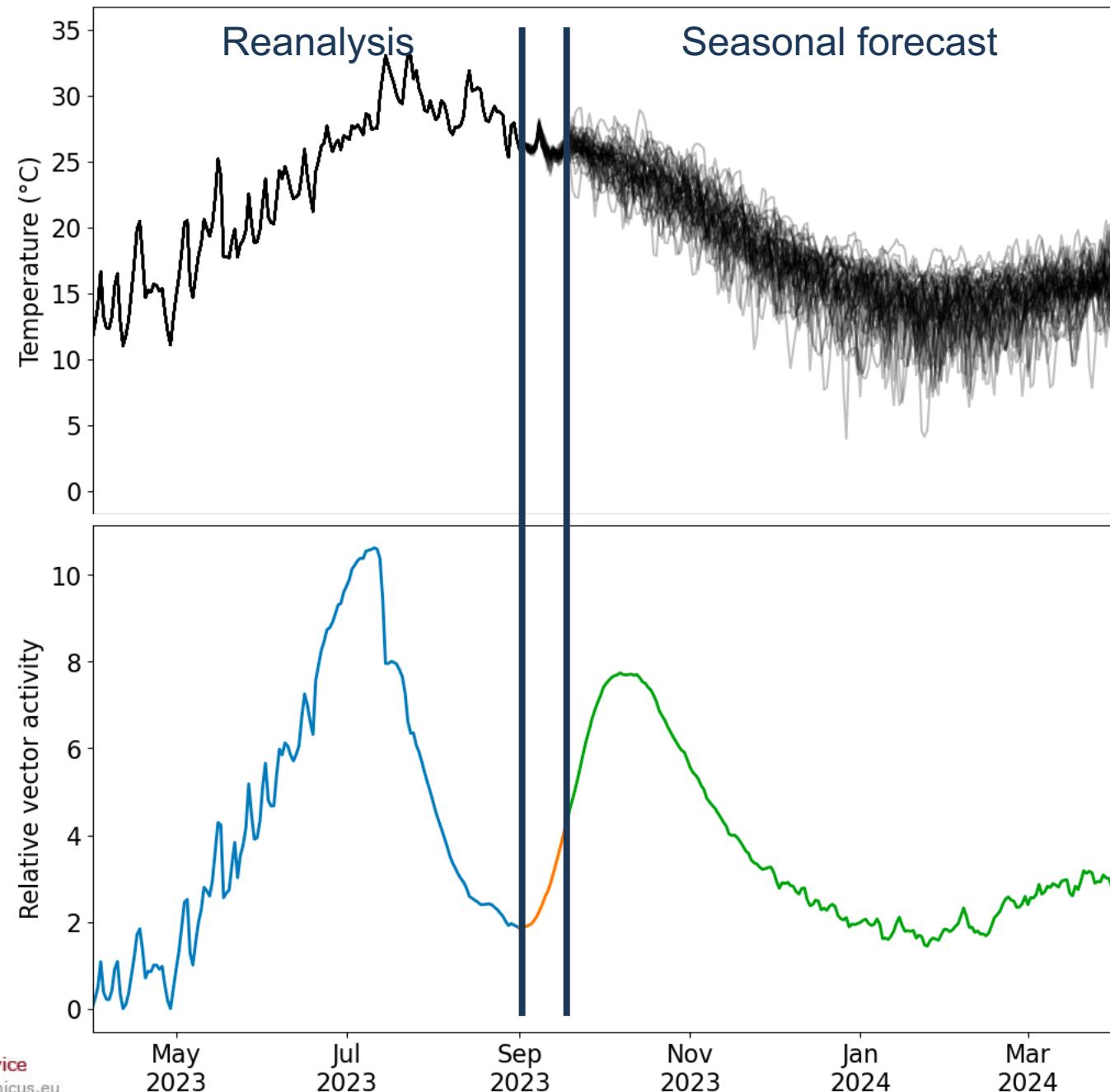
- Reanalysis dataset (2010-2020)
- Daily at 25 km resolution

→ Seasonal forecast

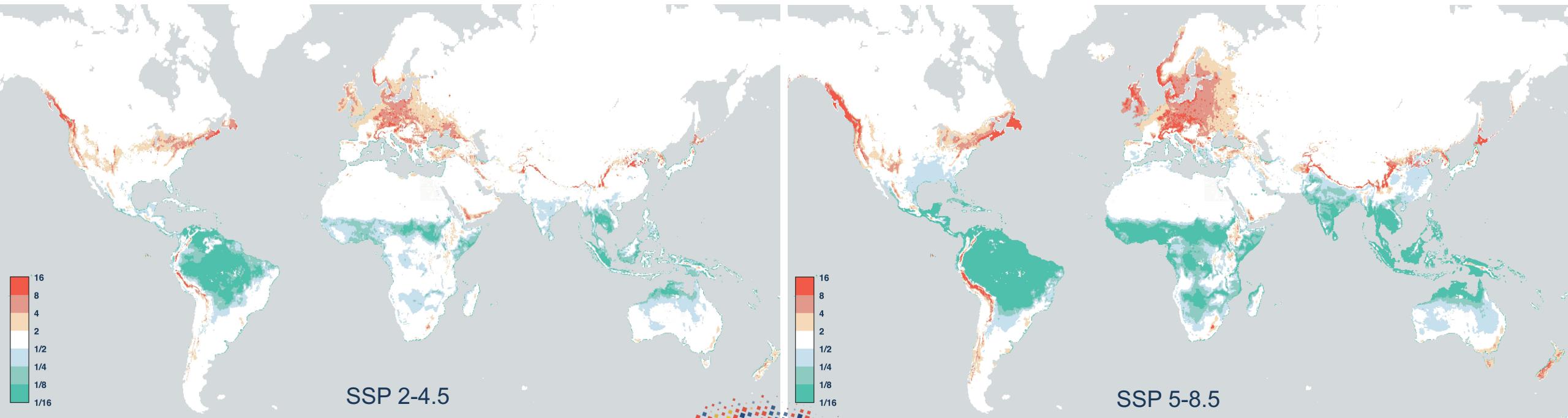
- Present & future (3-6 months)
- Daily at 25-100 km resolution

→ Climate projections

- NEX-GDDP-CMIP6 (2090-2100)
- SSP2-4.5 & SSP5-8.5
- Daily downscaled at 25 km resolution

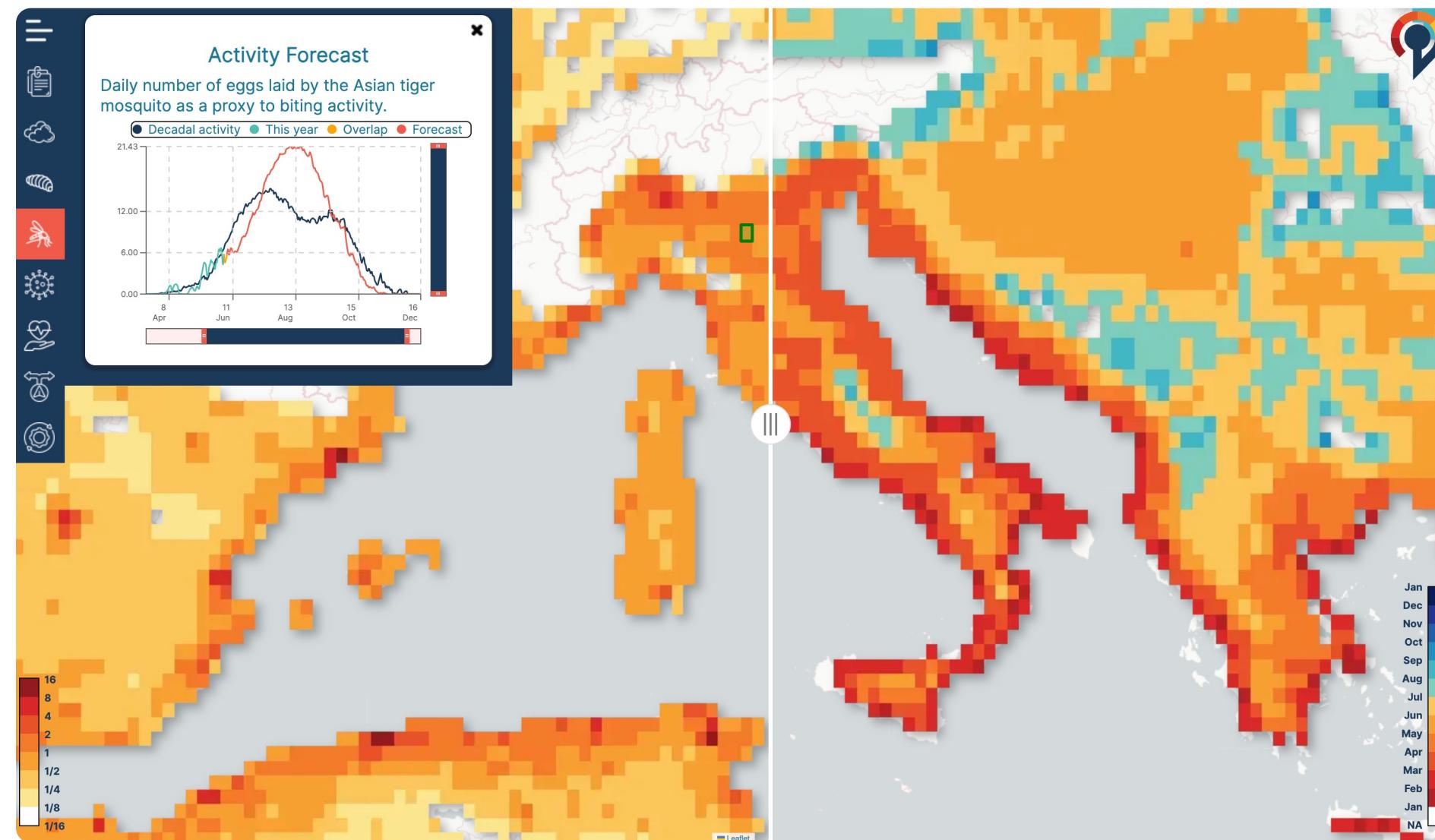


Expected activity in 2090-2100 compared to 2010-2020



Coming soon!

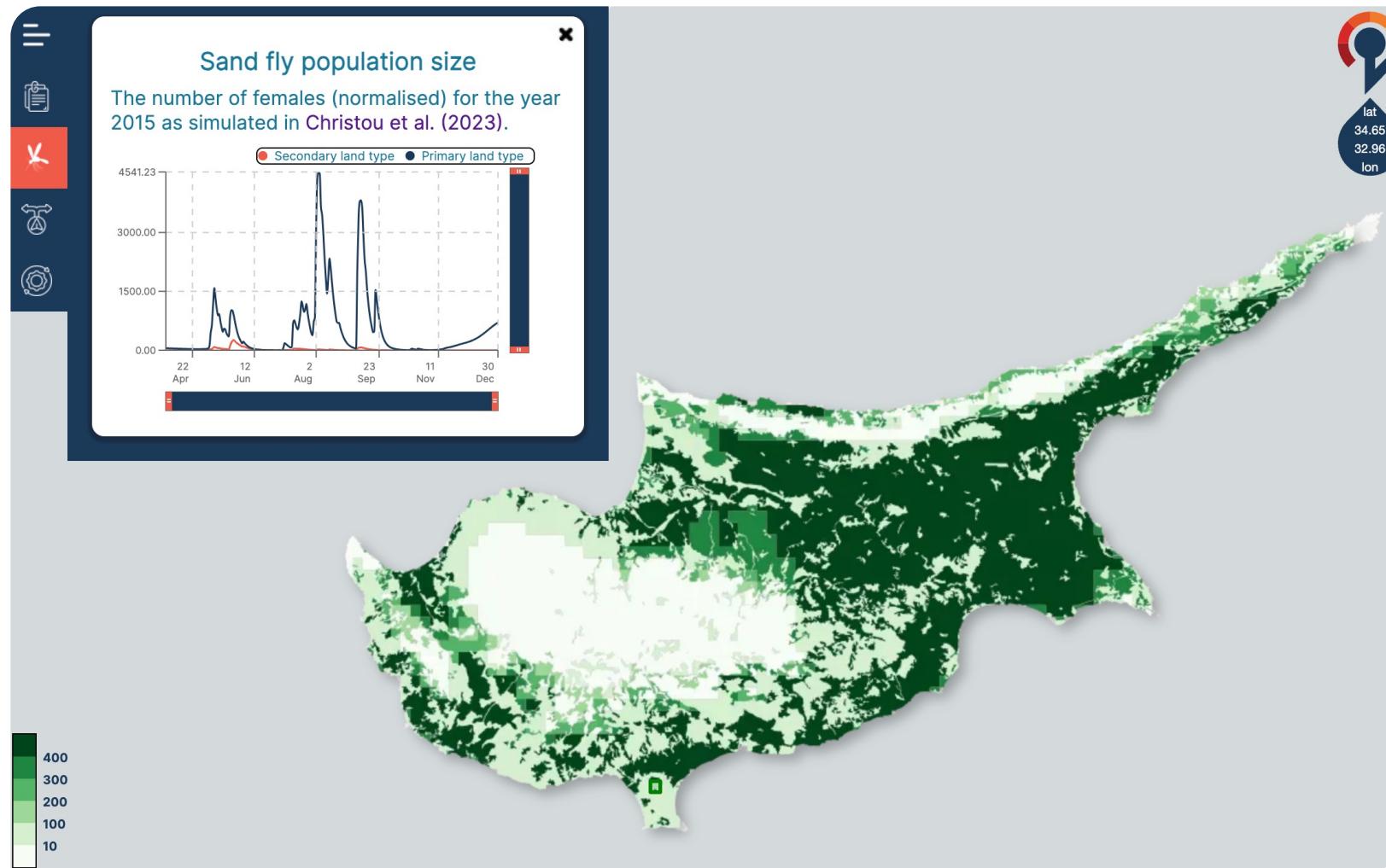
VEClim's GIS & tile server



Current configuration

VEClim's versatile GIS tools enable browsing simulation results and risk indicators spatially and temporally, overlaying and analyzing different outputs at the same time.

VEClim's GIS & tile server

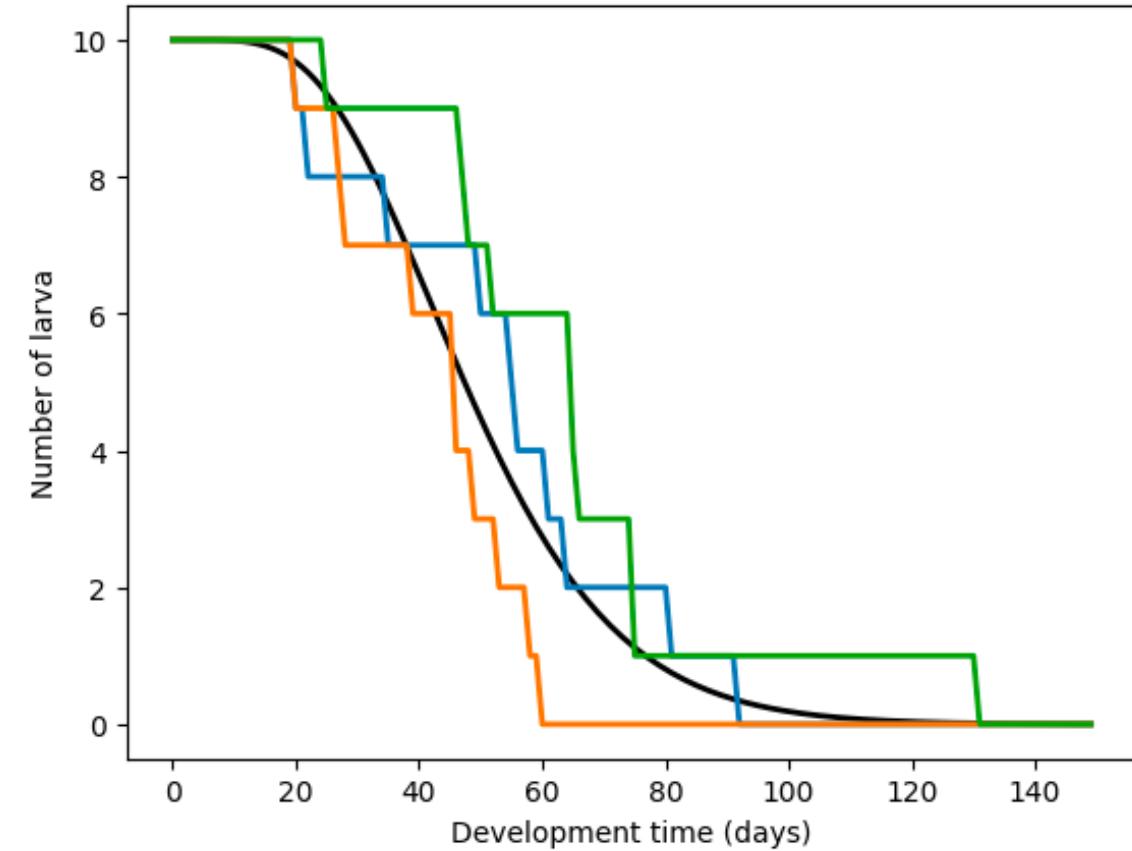


Current configuration

The platform enables studying different models and predictions, operating at any spatial and temporal resolution and over custom geospatial ranges.

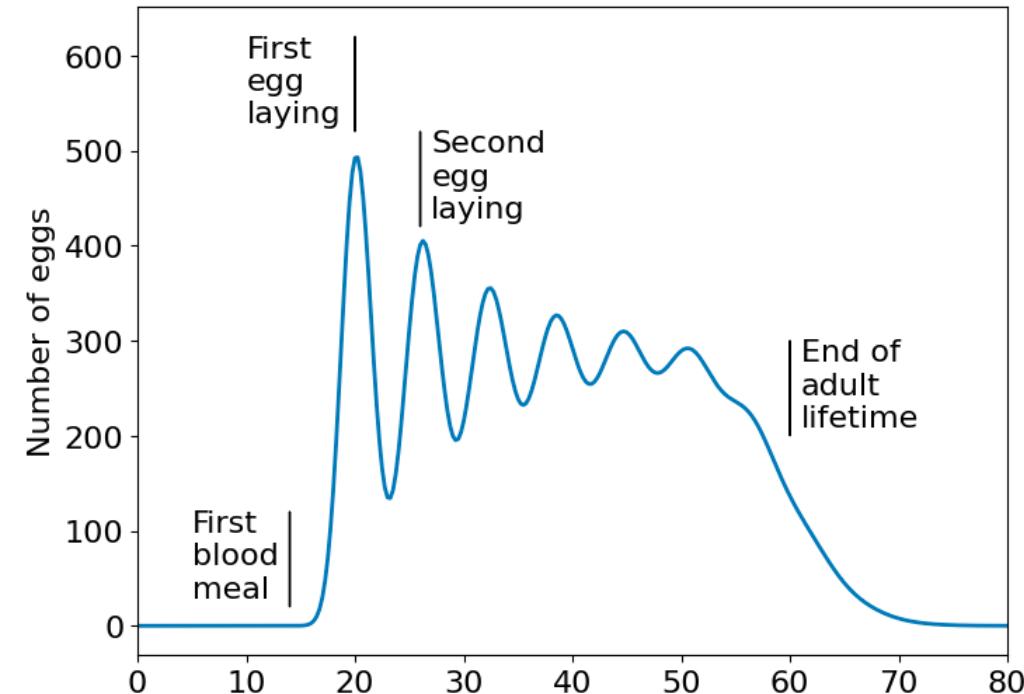
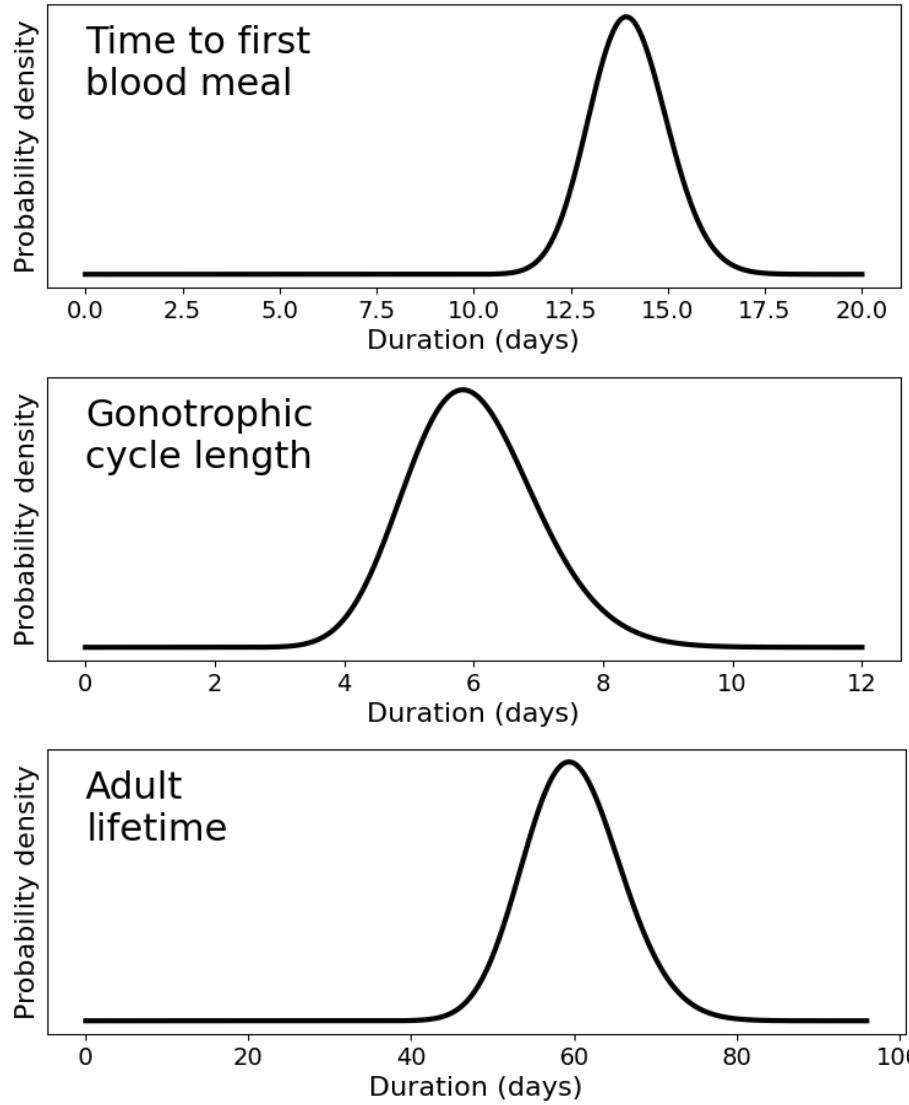
PopJSON: a JavaScript Object Notation representation

```
{  
  "model": {  
    "title": "Climate-sensitive population dynamics",  
    "type": "Population",  
    "url": "https://github.com/kerguler/Population",  
    "deterministic": true,  
    "parameters": {  
      "algorithm": "Population",  
      "istep": 0.001  
    }  
  },  
  "populations": [  
    {  
      "id": "larva",  
      "name": "The larva stage",  
      "processes": [  
        {  
          "id": "larva_dev",  
          "name": "Larva development time (days)",  
          "arbiter": "AGE_GAMMA",  
          "value": [10, 4]  
        }  
      ]  
    }  
  ]  
}
```



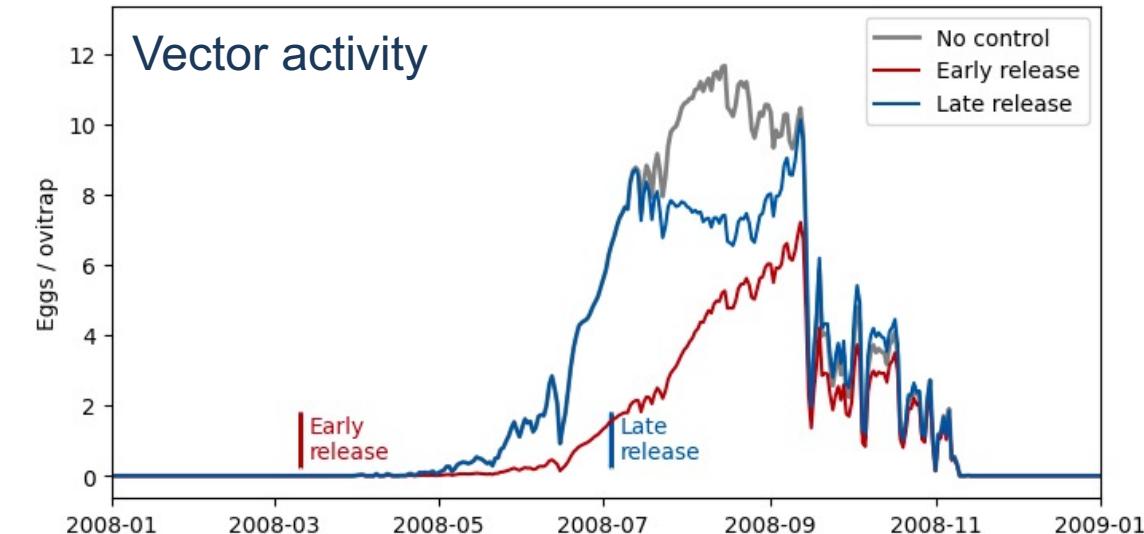
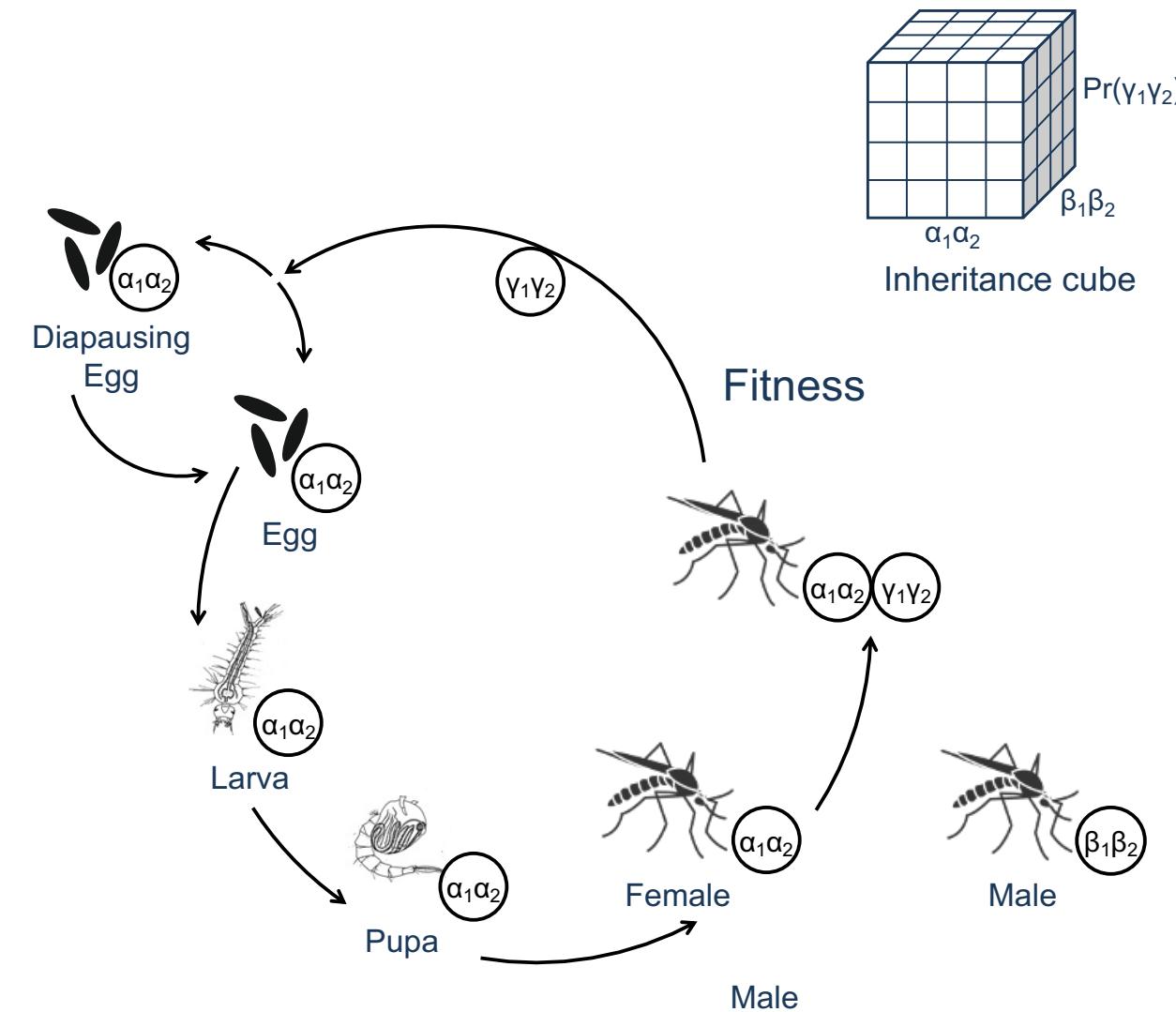
clarity - reproducibility - transferability

Dynamic multi-process modelling with PopJSON and the Population package

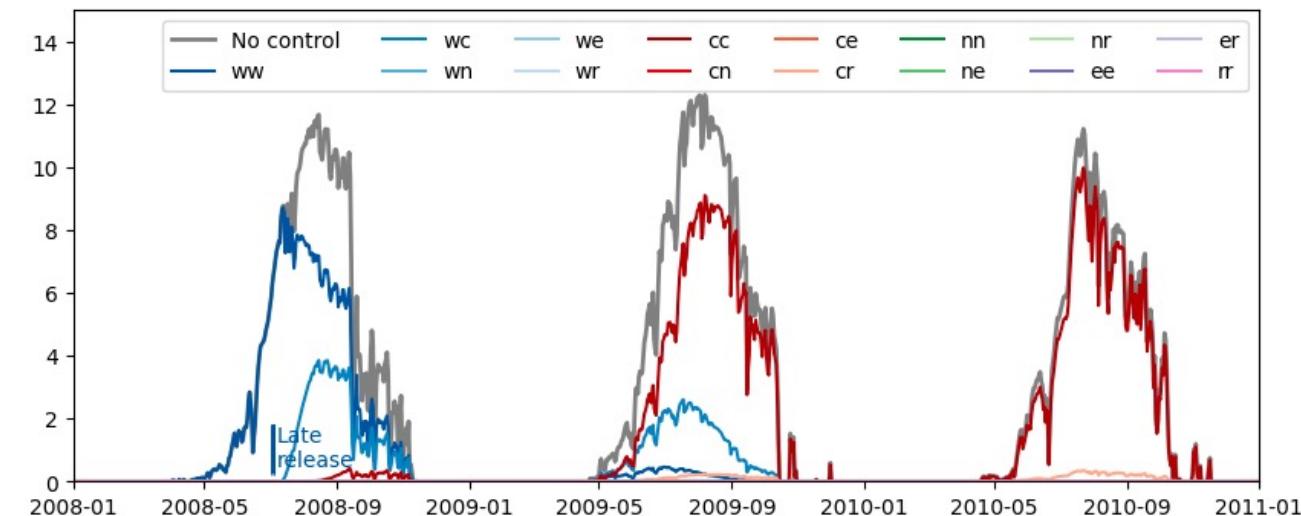


Dynamics of genetic control

Sterile insect technique

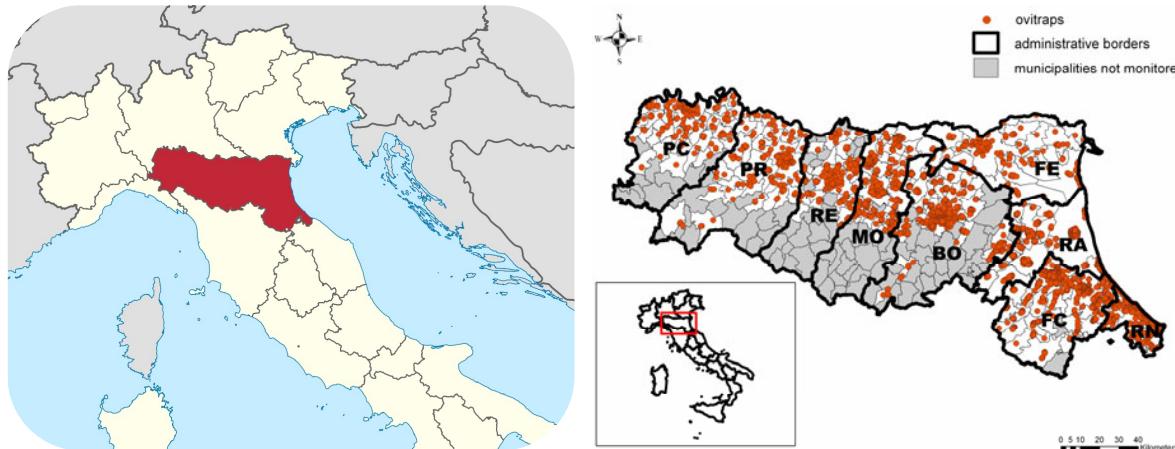


Classical replacement gene drive

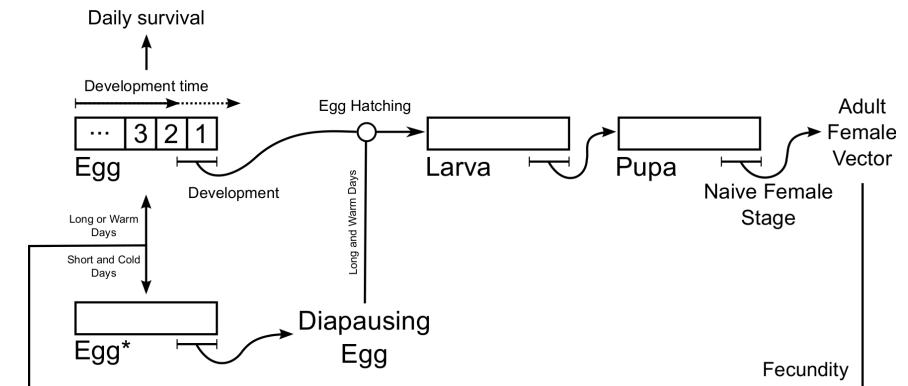
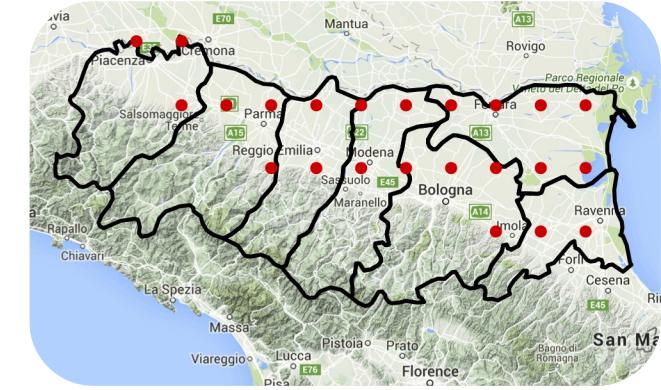
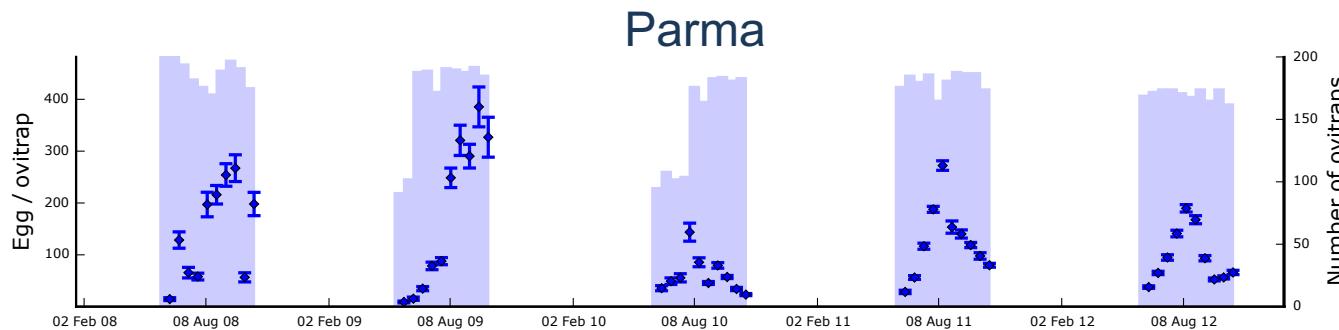




Predicting tiger mosquito abundance

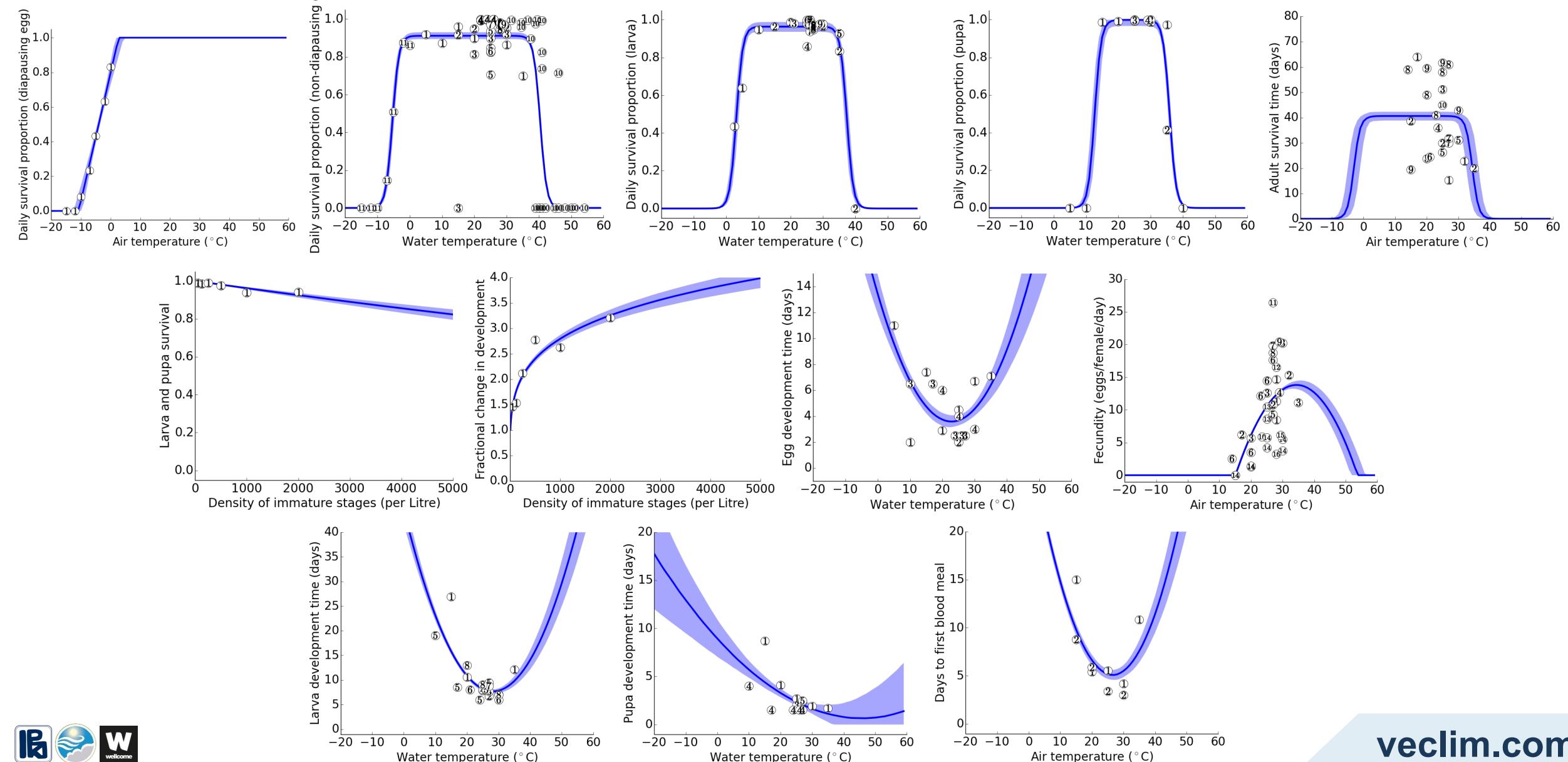


Albieri et al. Bull. Insectology 63(2) (2010)

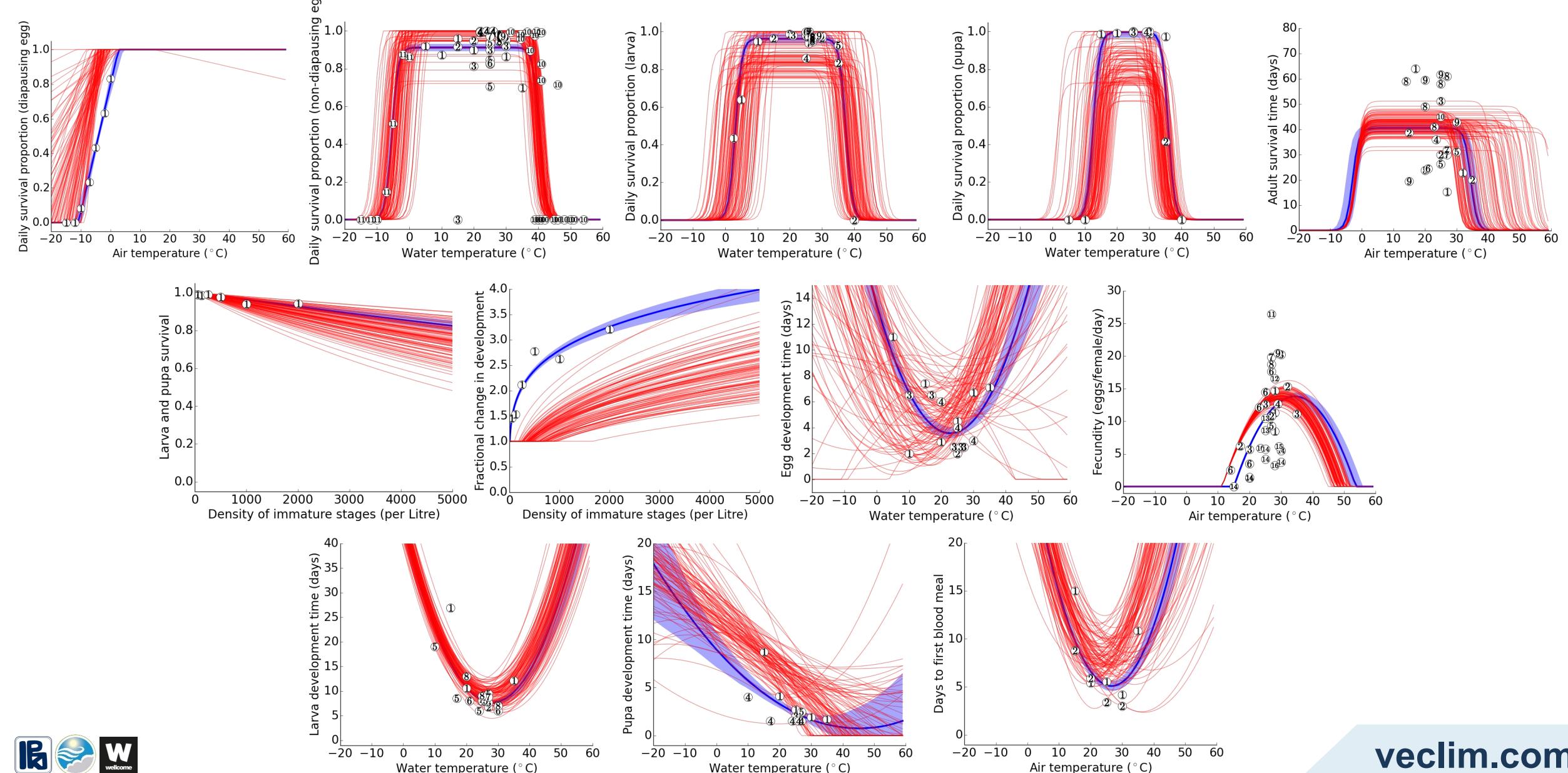


- Temperature and precipitation (E-OBS)
- Human population density (SEDAC)
- Photoperiod

Environmental dependency of life processes

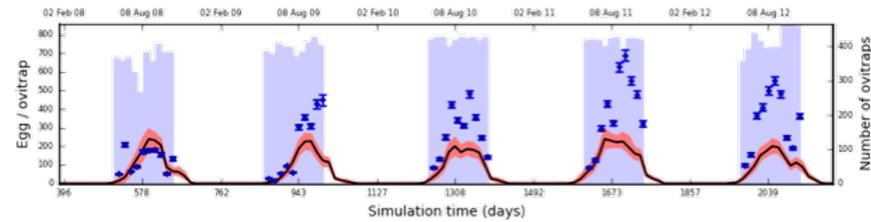


Environmental dependency of life processes

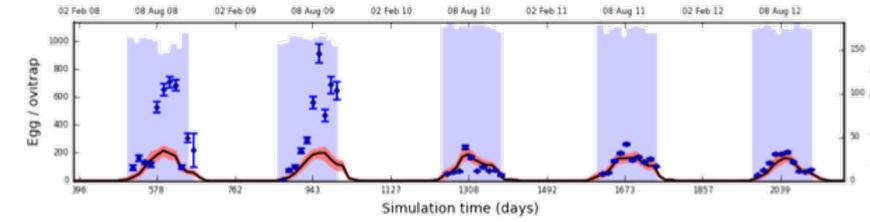


Goodness-of-fit over Emilia-Romagna

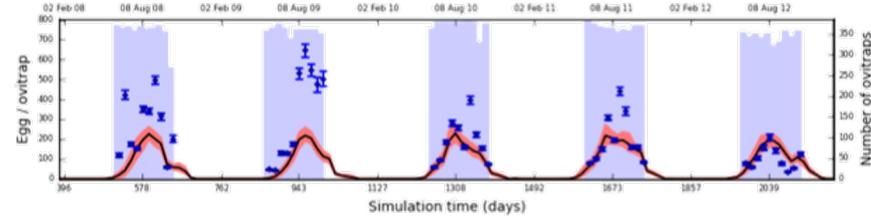
Bologna



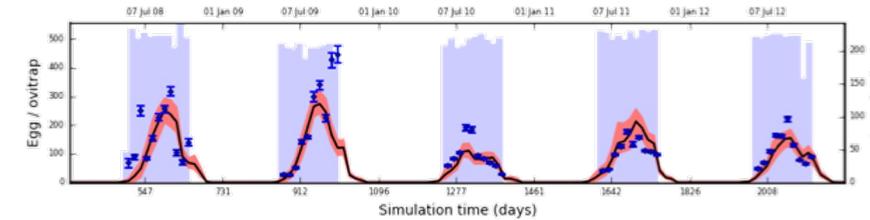
Piacenza



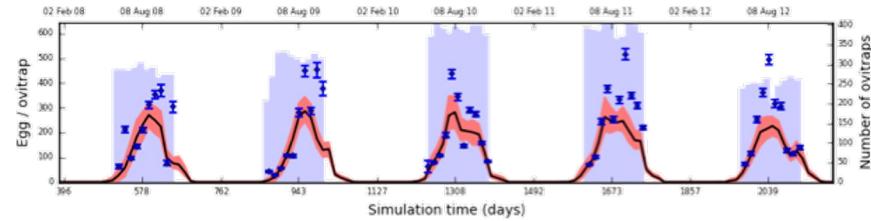
Ravenna



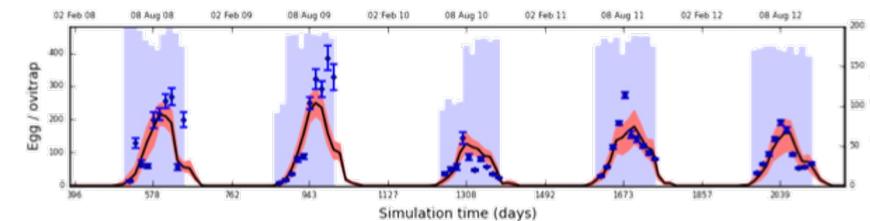
Reggio Emilia



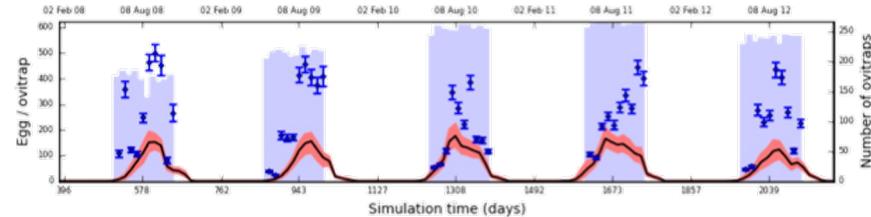
Modena



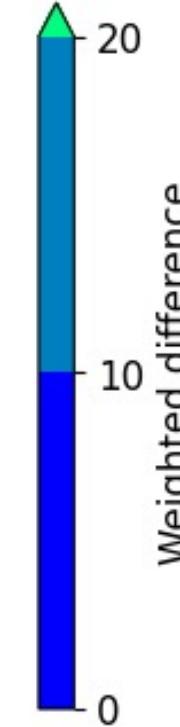
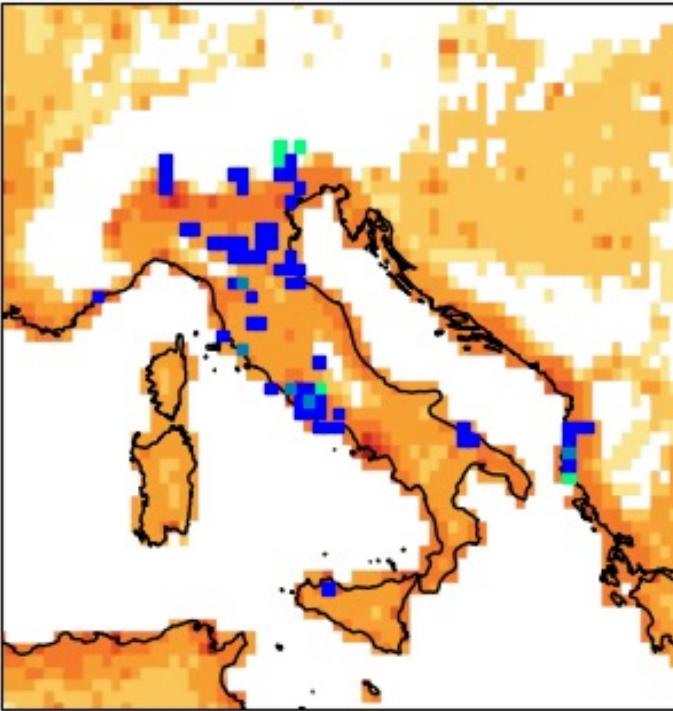
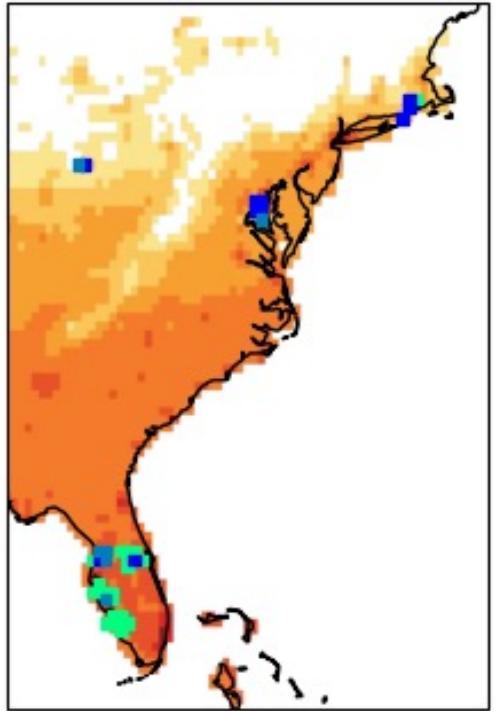
Parma



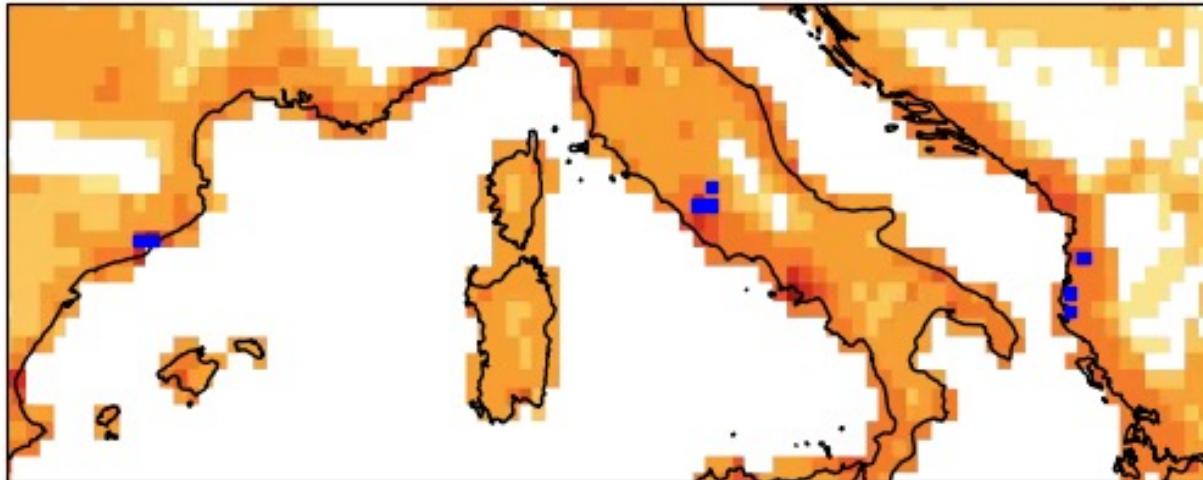
Ferrara



**Surveillance period:
2008 - 2012**



AIMSurv



Global applicability assessment

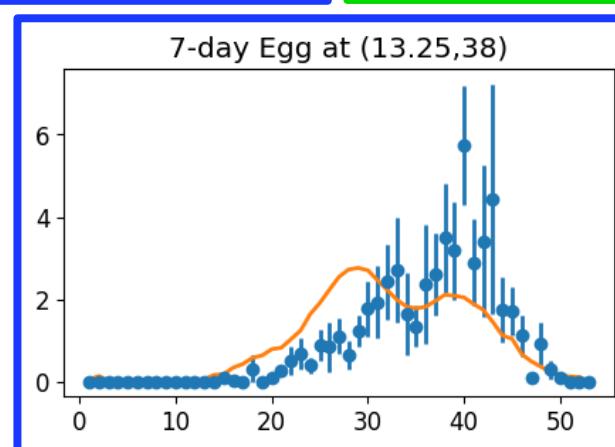
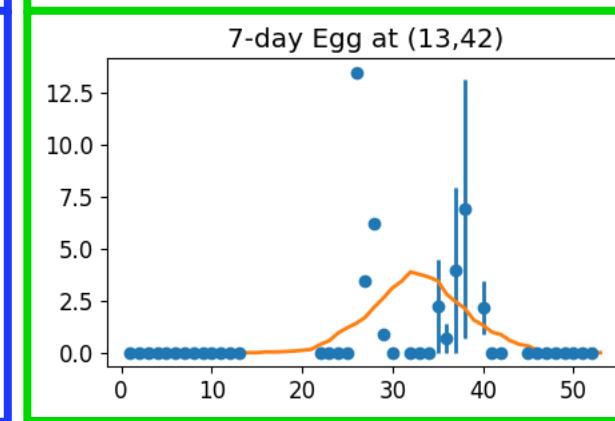
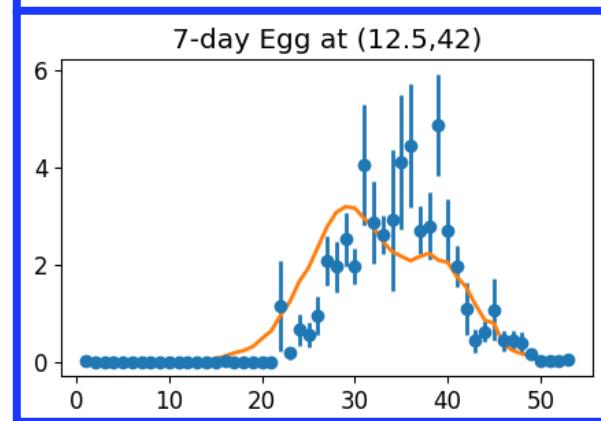
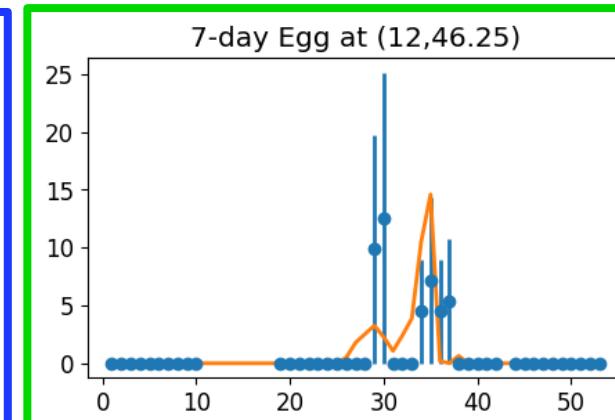
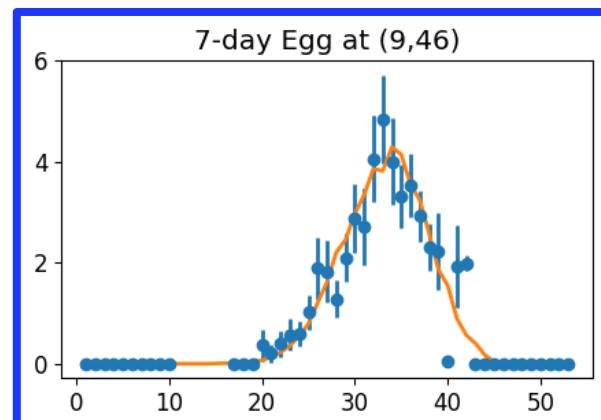
Methods

- Gridded
 - 25 km
- Filtered
 - At least 50 data points
 - Sampling: 1-day adult, 7-day egg

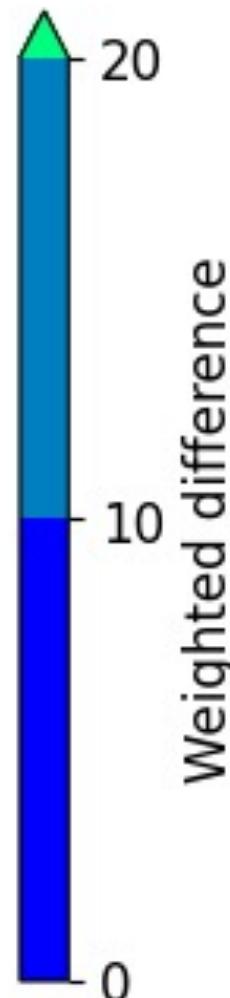
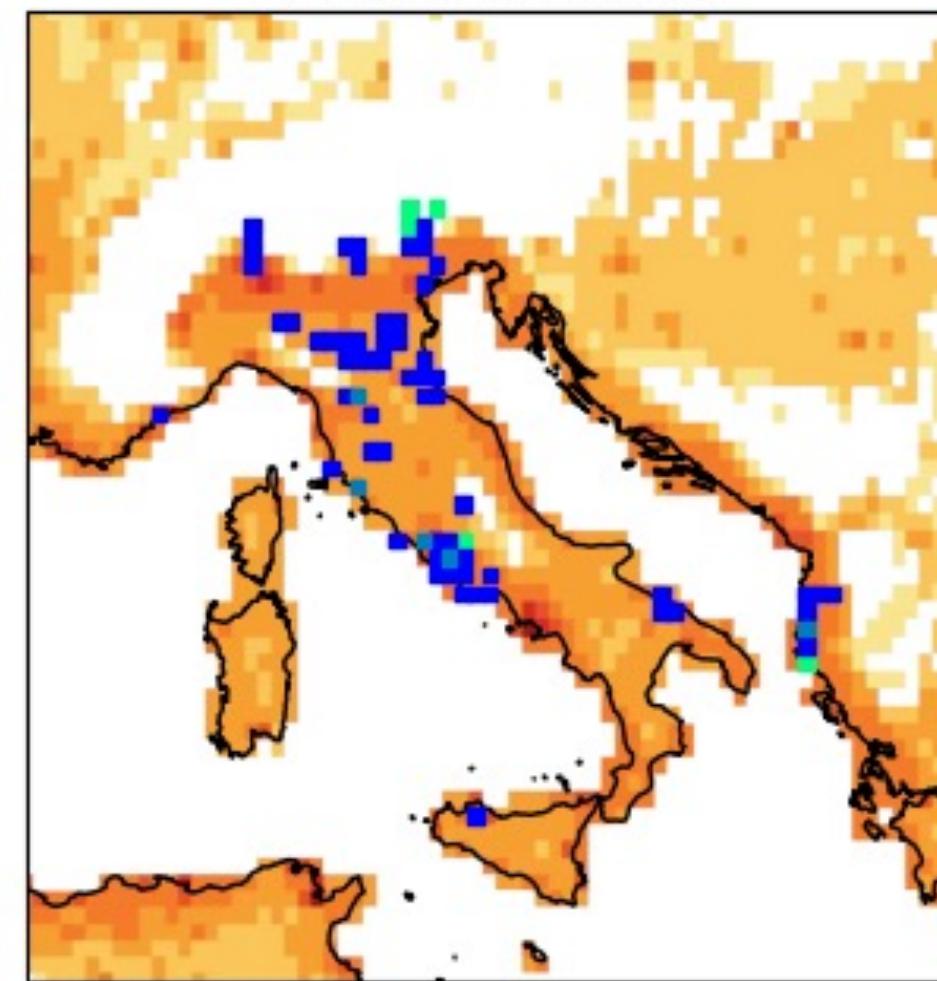
Results

- Predictive in
 - Italy
 - Temperate and similar climates
- Needs improvement in
 - High altitudes
 - Tropical regions

Global applicability assessment

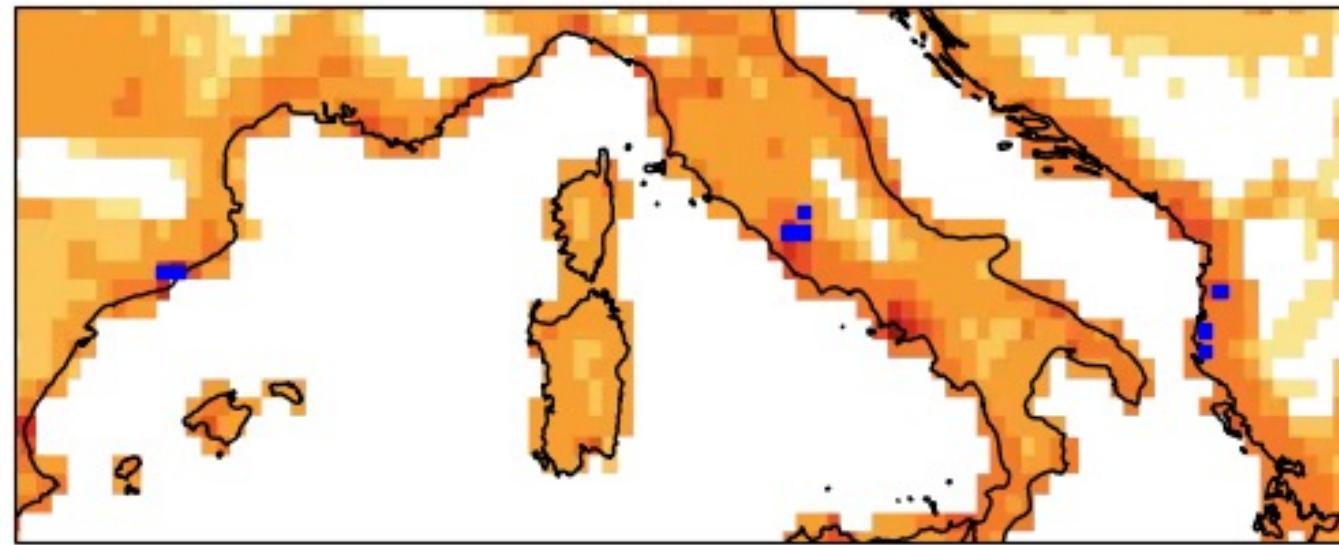


VectAbundance

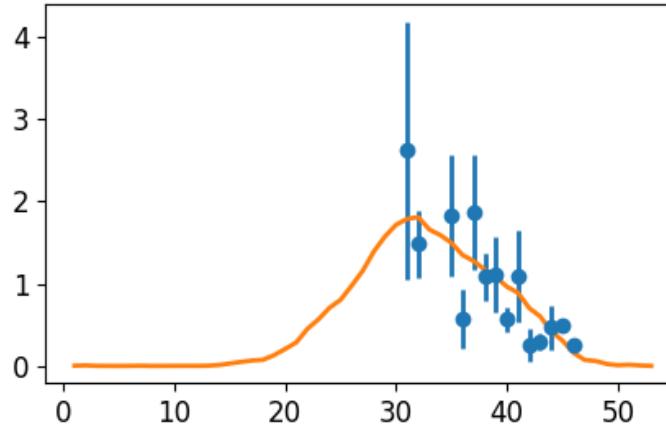


Global applicability assessment

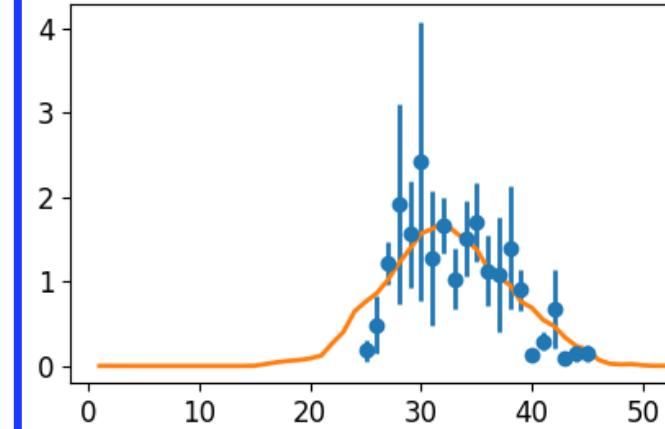
AIMSurv



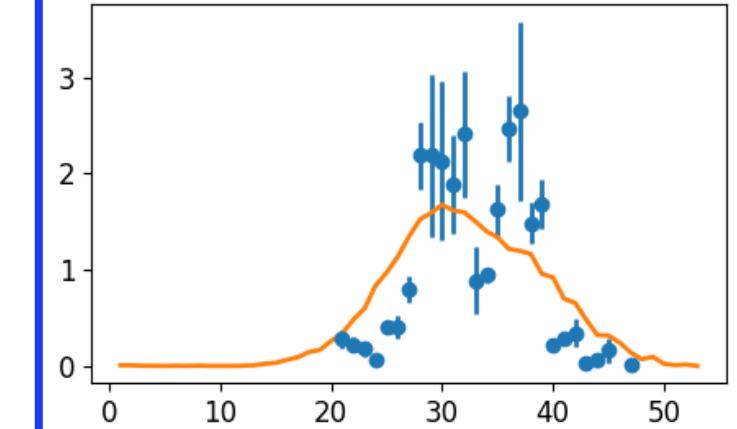
7-day Egg at (2,41.5)



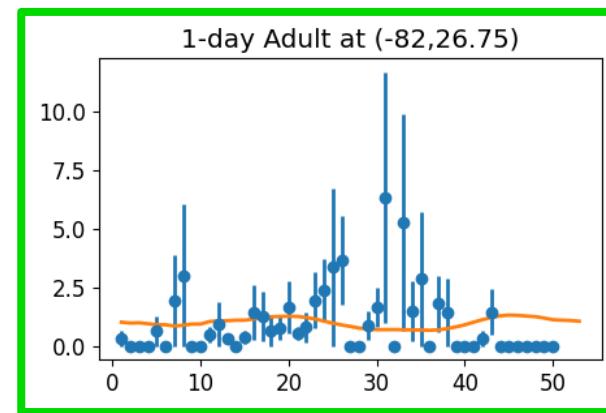
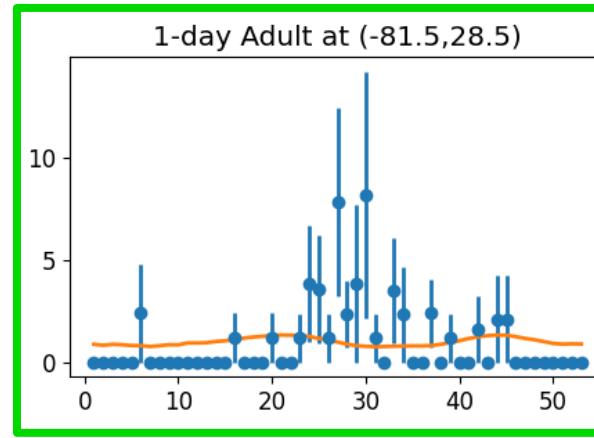
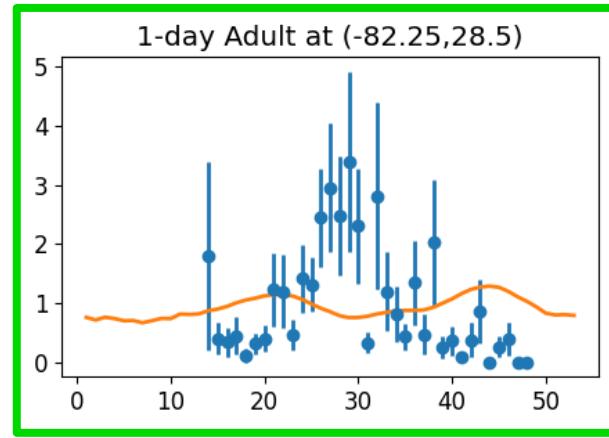
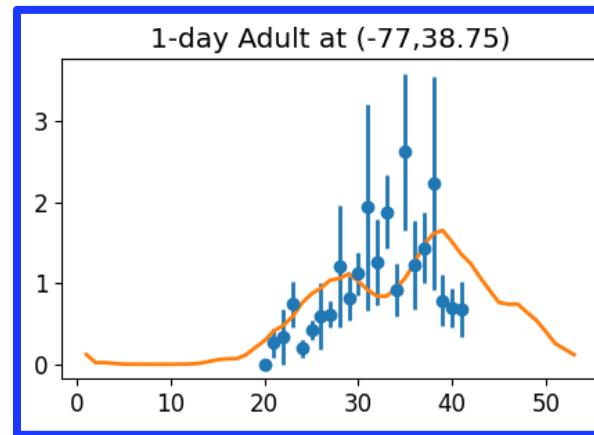
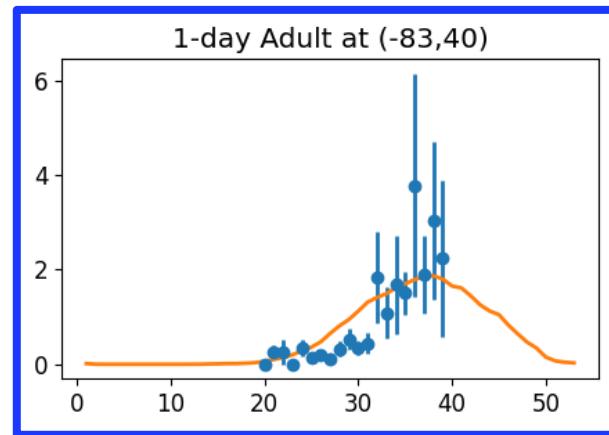
7-day Egg at (12.75,42.25)



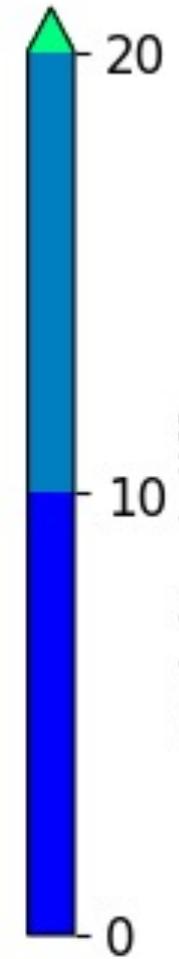
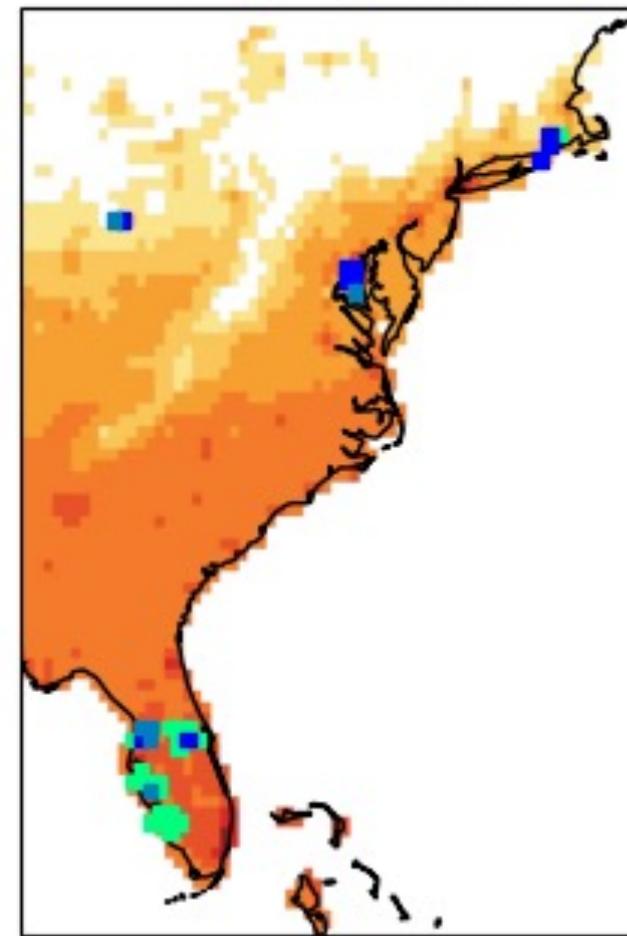
7-day Egg at (19.75,41.25)



Global applicability assessment

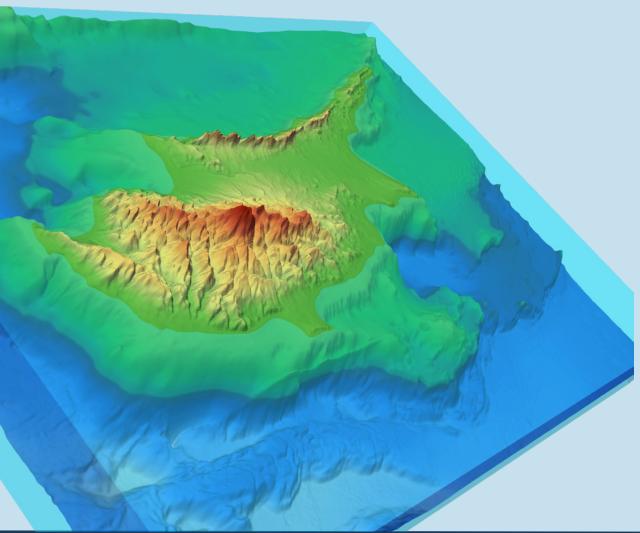


VectorBase





THANK YOU



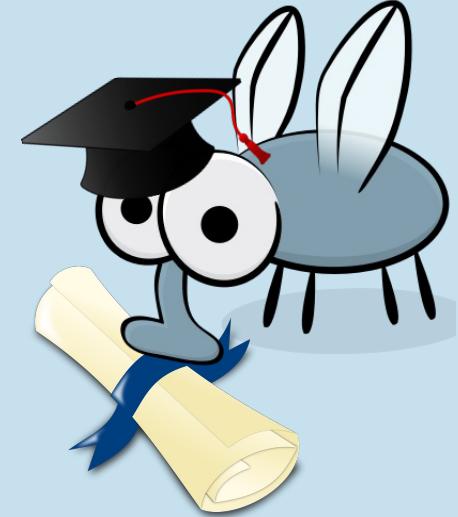
Ahmet



Hande



George



LOOKING
FOR
TEAMMATES!

Funded by

