



Scenari futuri di cambiamento nelle dinamiche di popolazione della zanzara tigre invasiva (*Aedes albopictus*) nelle Alpi



Obiettivi

- Analizzare gli effetti del cambiamento climatico sulla distribuzione e sulla stagionalità di *Ae. albopictus* nelle Alpi per il periodo 2036-2055 e 2066-2085, utilizzando diversi futuri climatici.
- Addestrare un modello di machine learning per prevedere le popolazioni di zanzare per questi periodi.

Dati di partenza

Variabile di risposta

- Osservazioni da ovitrappole



scientific data

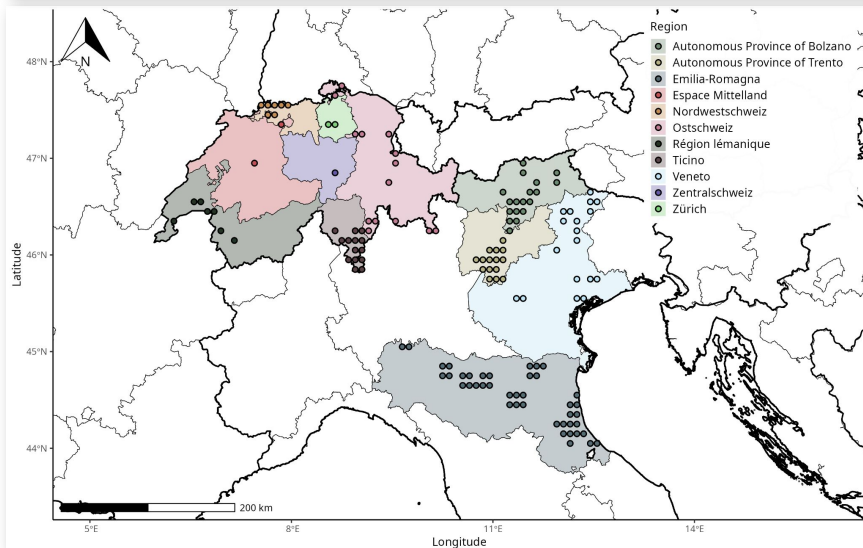
Check for updates

OPEN

DATA DESCRIPTOR

VectAbundance: a spatio-temporal database of *Aedes* mosquitoes observations

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Dati di partenza

Variabile di risposta

- Osservazioni da ovitrappole

Predittori

- Temperature medie settimanali (da E-OBS v31.0)*
- Precipitazioni cumulate settimanali*
- Fotoperiodo*

* lag (da 2 a 10), poiché la distribuzione attuale e futura della variabile target dipende dai valori passati e presenti.

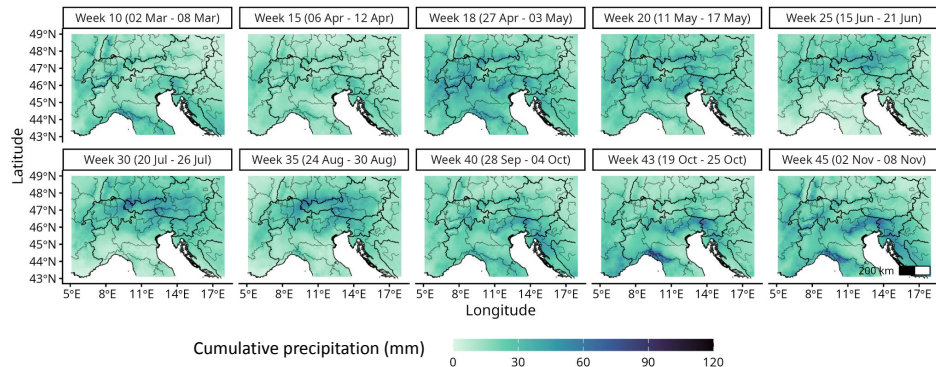
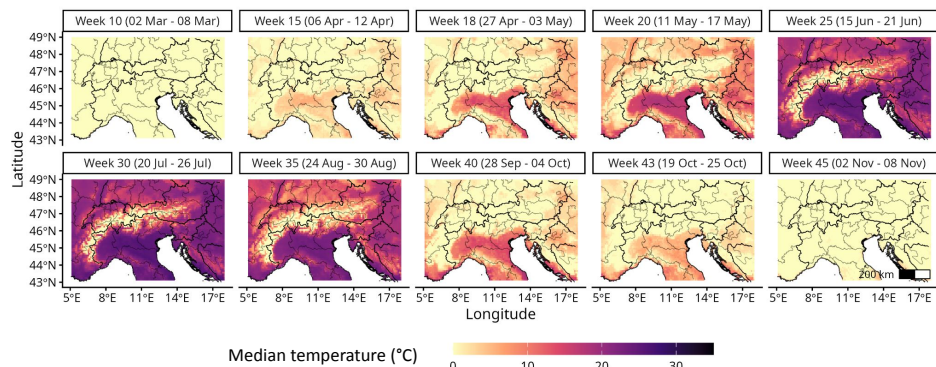
I dati **E-OBS v31.0** hanno una copertura temporale dal 1950 al 2024; per la nostra analisi abbiamo considerato gli anni dal 2005 al 2024.

Risoluzione spaziale

- griglia di 0.1 gradi (~ 11 km)

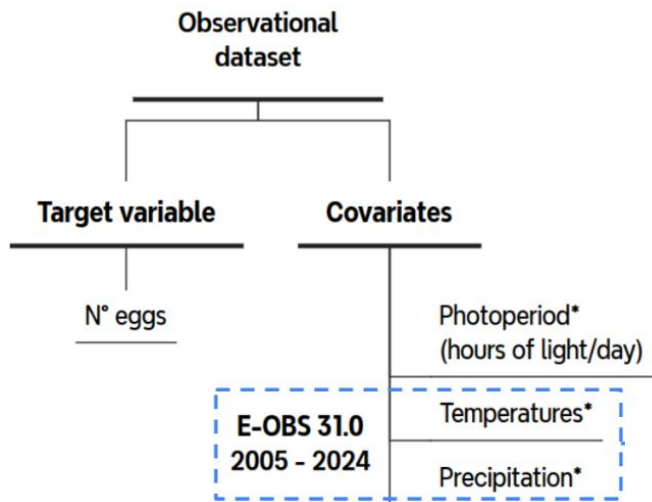
Risoluzione temporale

- 1 settimana



Workflow

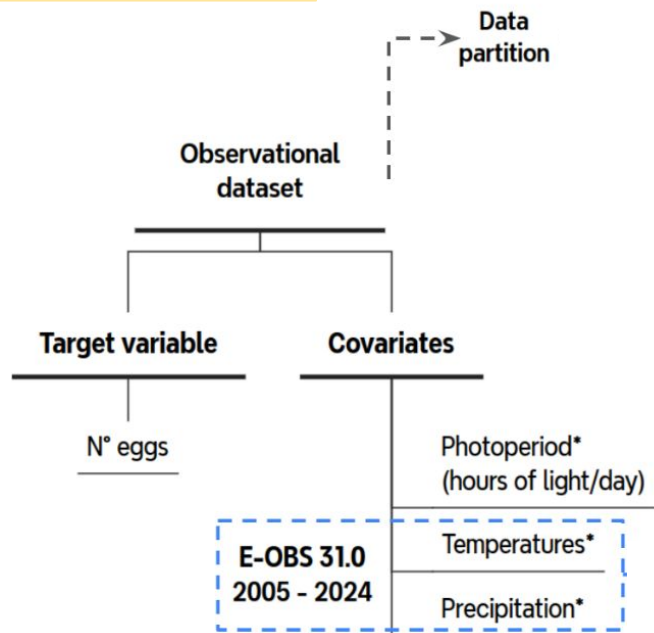
Come avviene
l'addestramento e la
validazione?



* lagged up to 10 weeks

Workflow

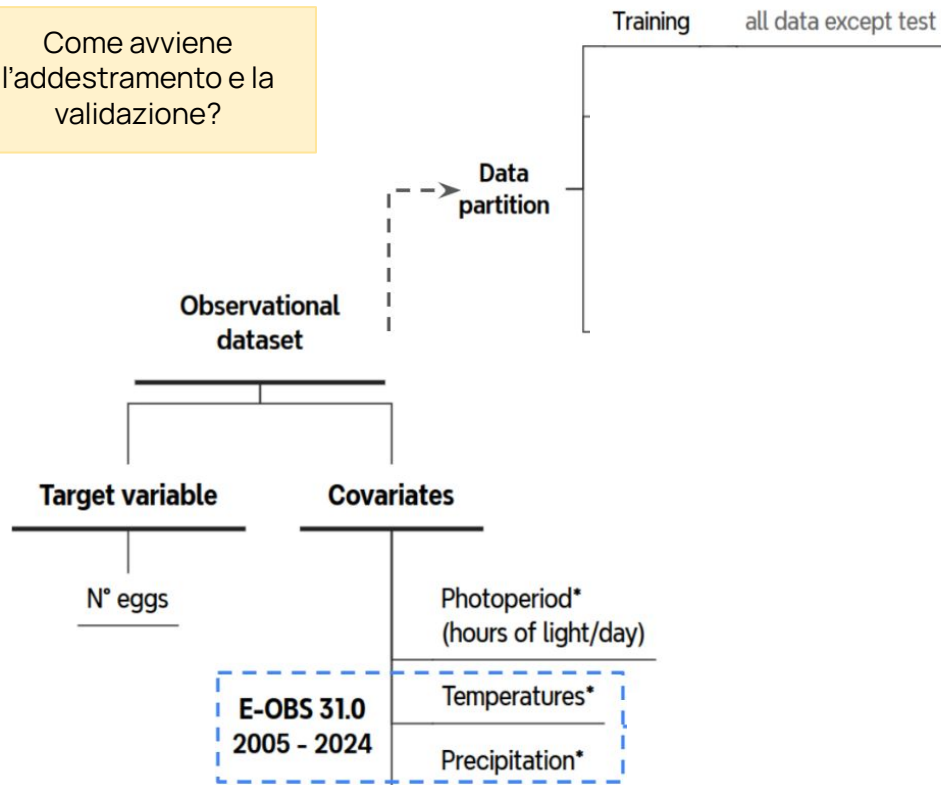
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Workflow

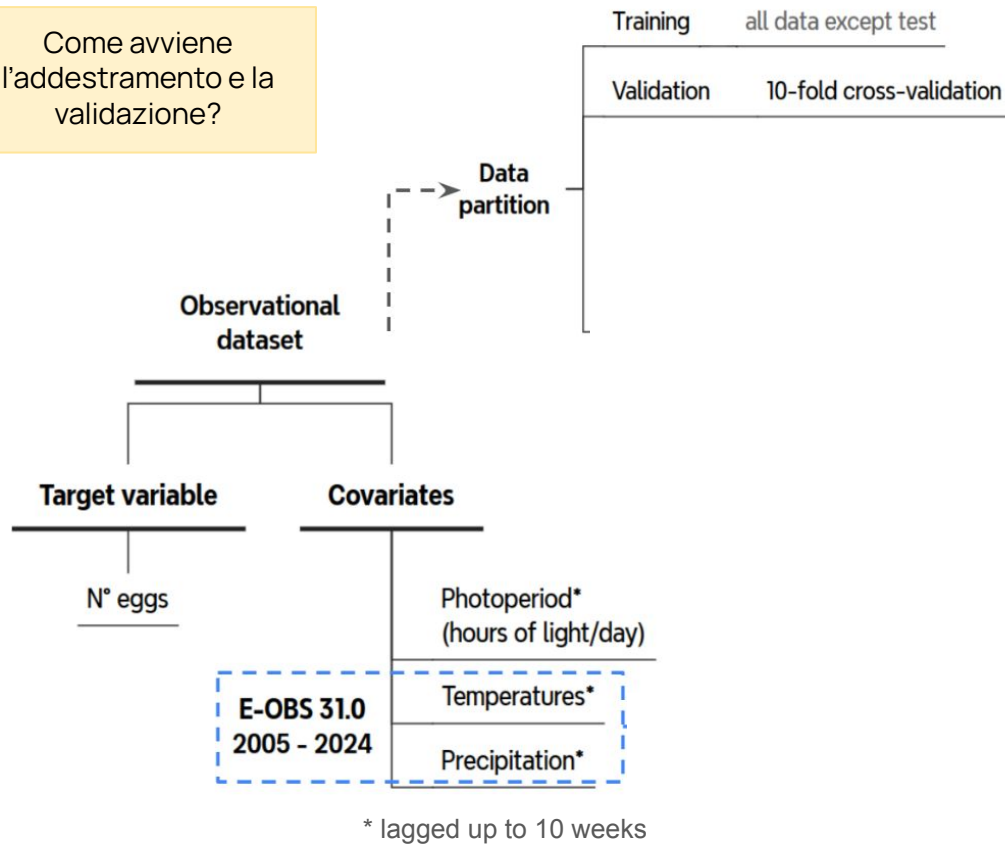
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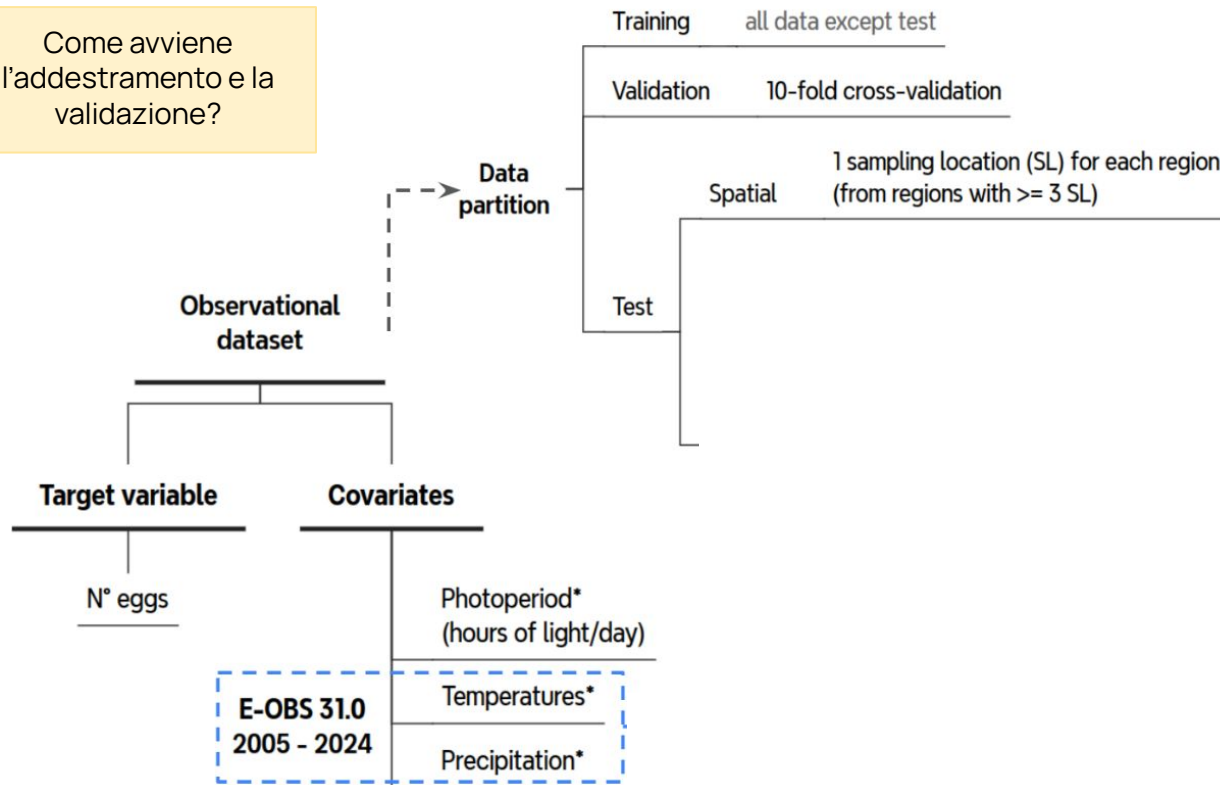
Workflow

Come avviene
l'addestramento e la
validazione?



Workflow

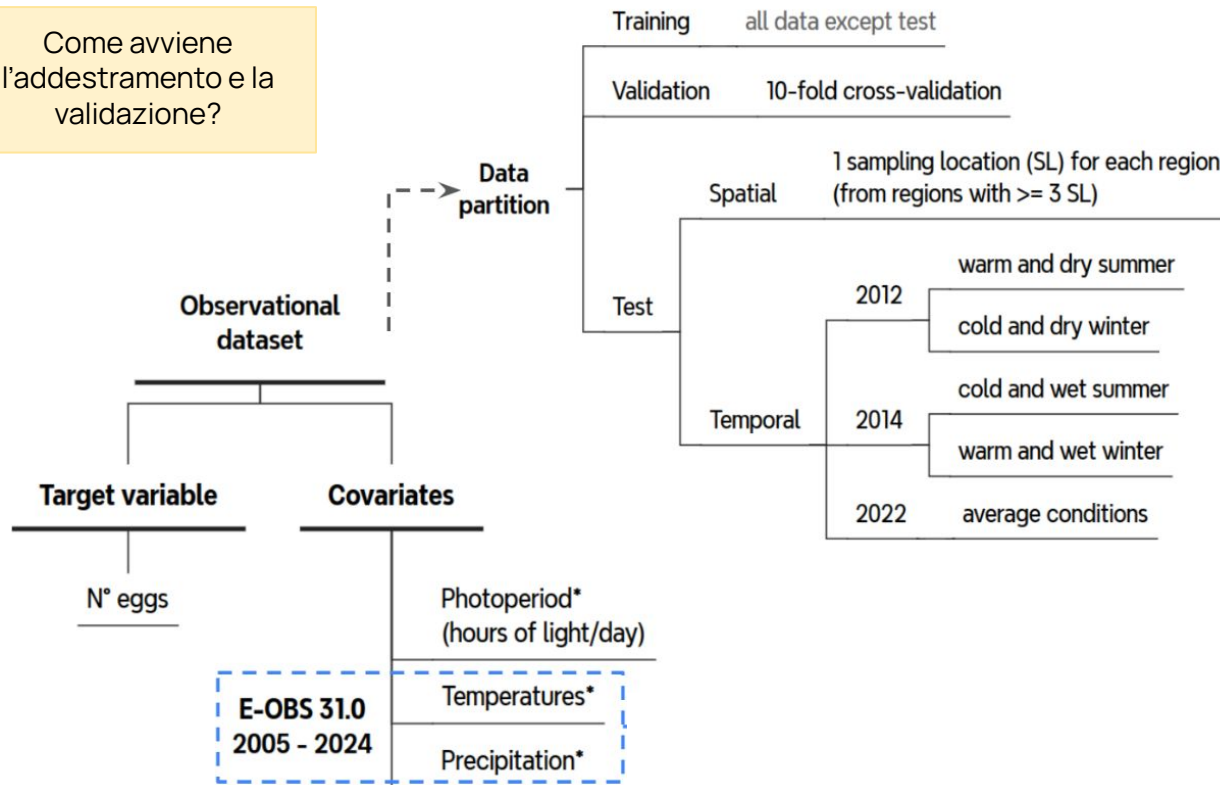
Come avviene
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* lagged up to 10 weeks

Workflow

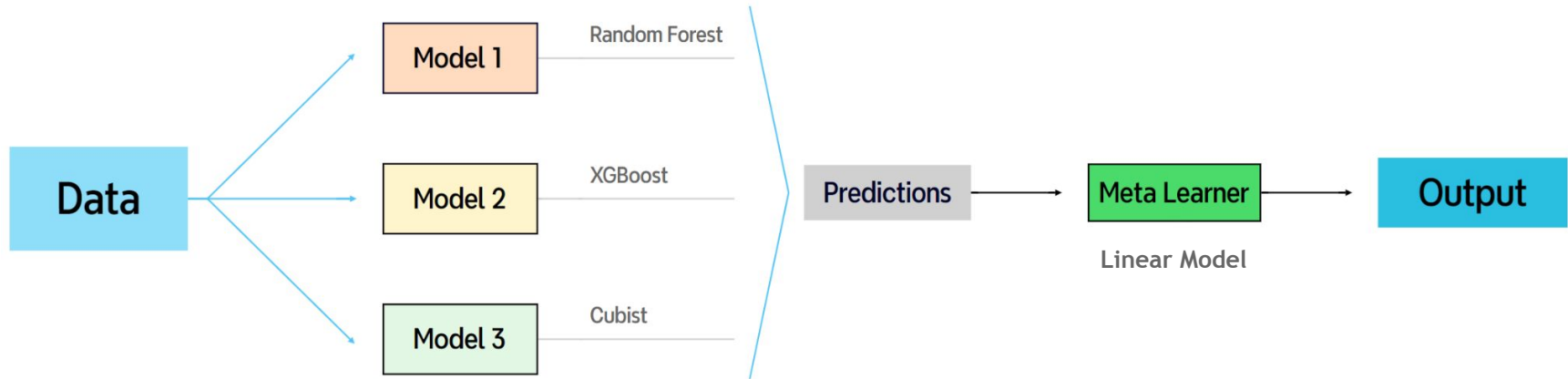
Come avviene
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* lagged up to 10 weeks

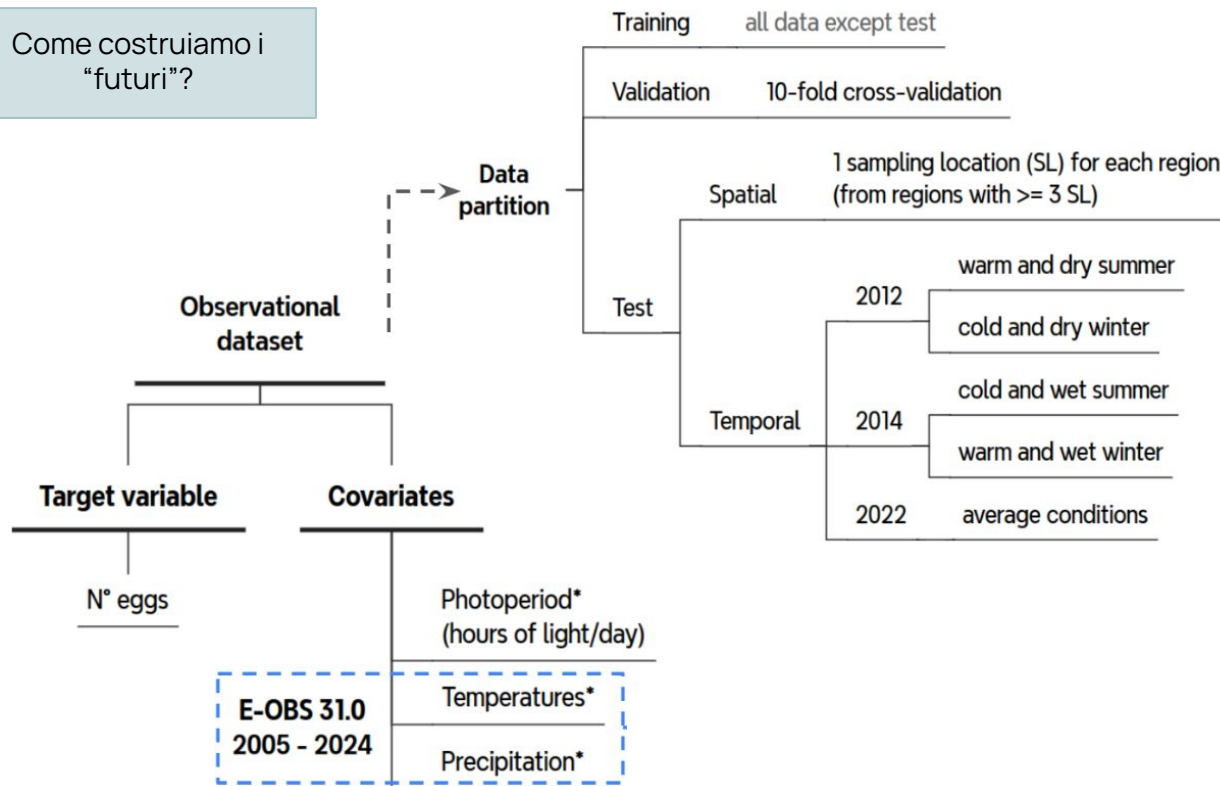
Stacked generalisation

La tecnica dello “stacked generalisation “ (o stacking) combina predizioni fornite da più algoritmi di apprendimento (*stimatori di base*) con un algoritmo di combinazione (*stimatore finale*), spesso regressione logistica.



Workflow

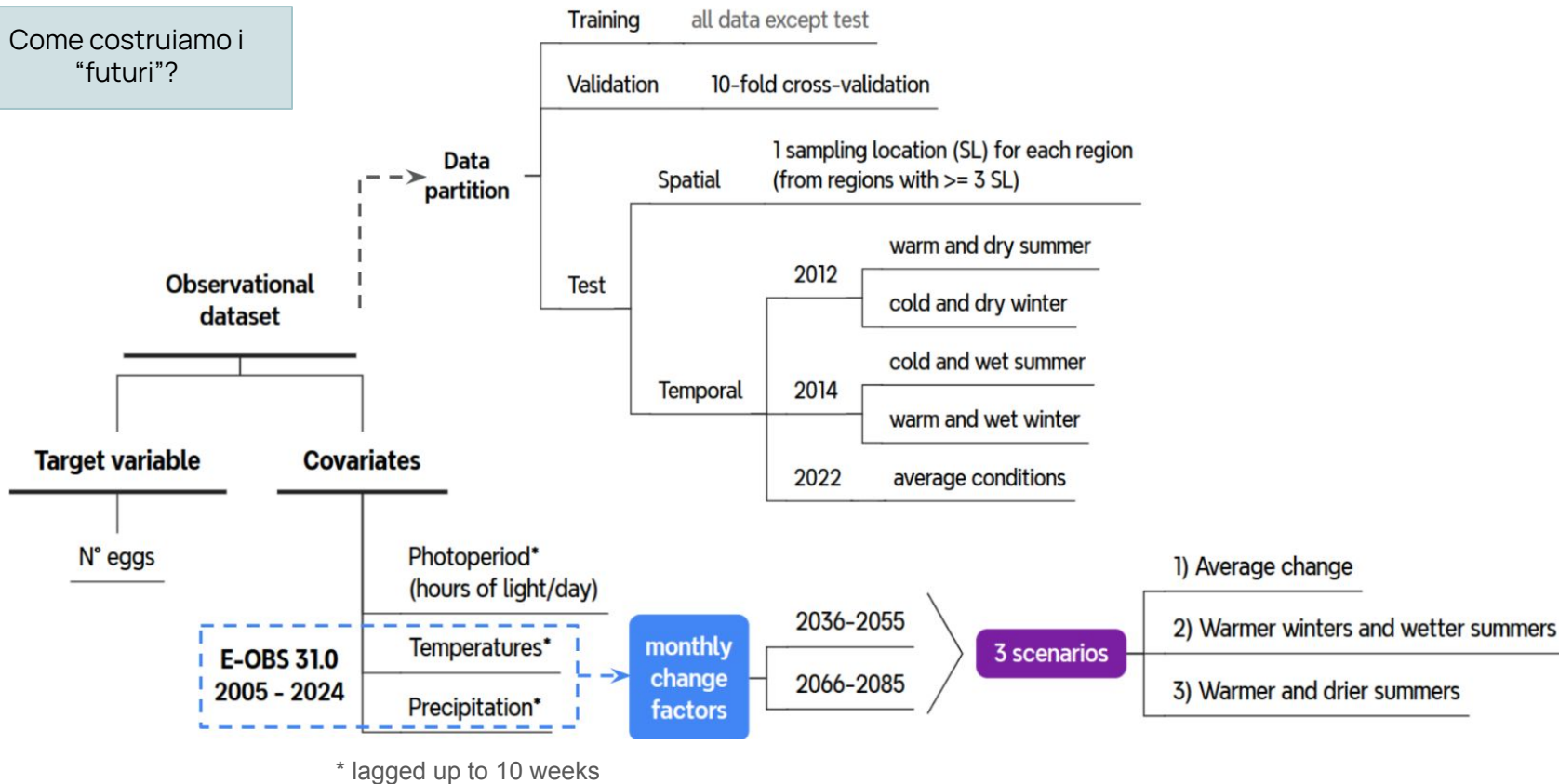
Come costruiamo i
"futuri"?



* lagged up to 10 weeks

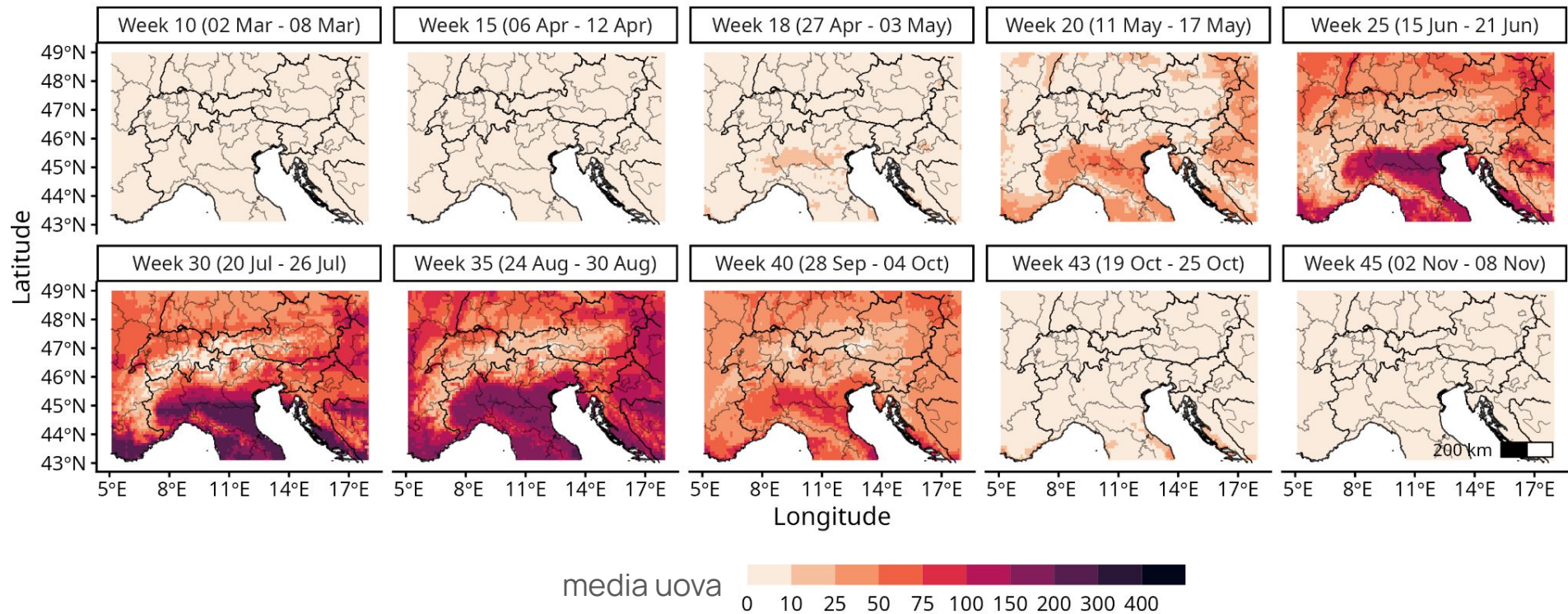
Workflow

Come costruiamo i
"futuri"?



2005-2024

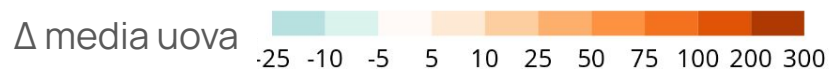
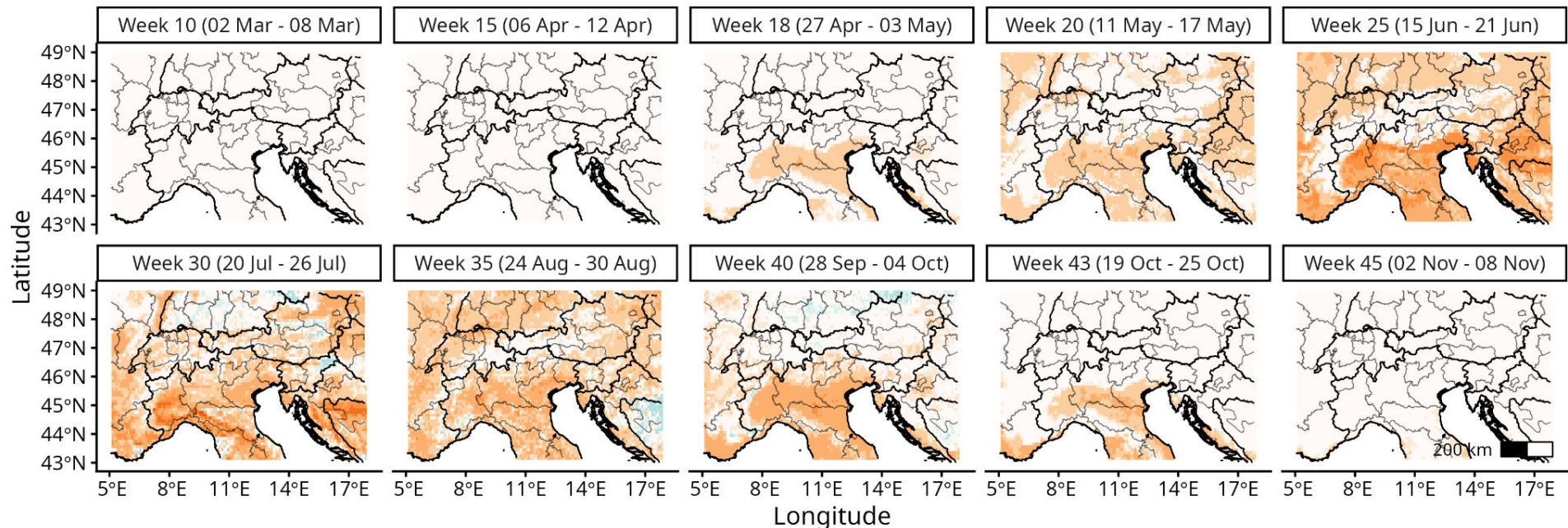
Scenario corrente medio: la nostra baseline



Blaħa et al. (*under rev*)

Δ futuro (2036-2055)

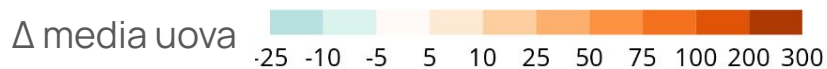
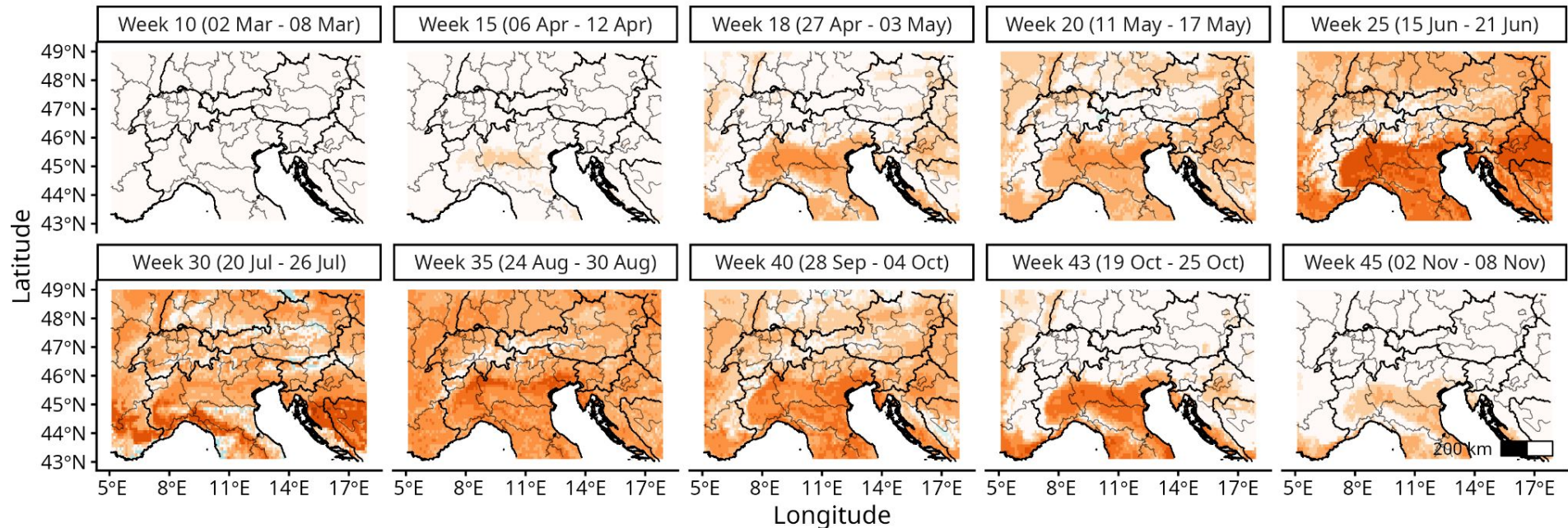
Scenario futuro medio - baseline



Blaha et al. (*under rev*)

Δ futuro (2066-2085)

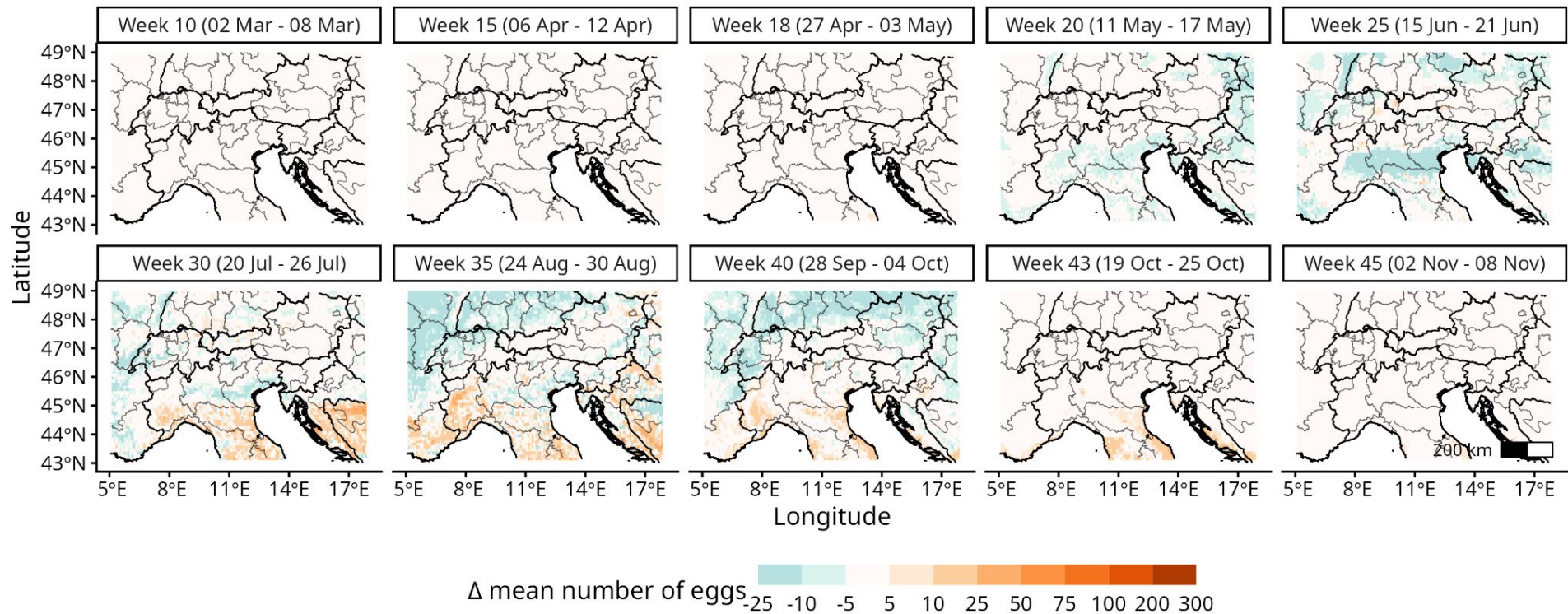
Scenario futuro medio - baseline



Blaha et al. (*under rev*)

Δ futuro (2036-2055)

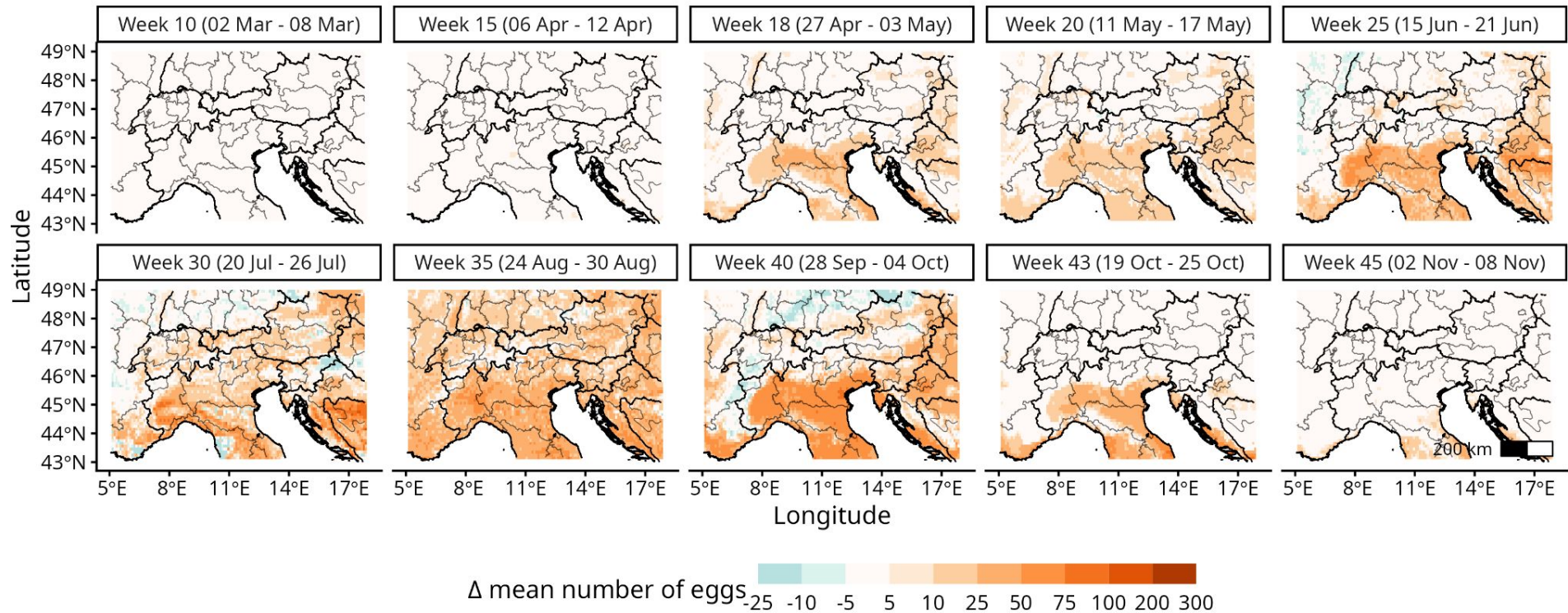
Inverni più caldi con estati piovose - baseline



Blaha et al. (*under rev*)

Δ futuro (2066-2085)

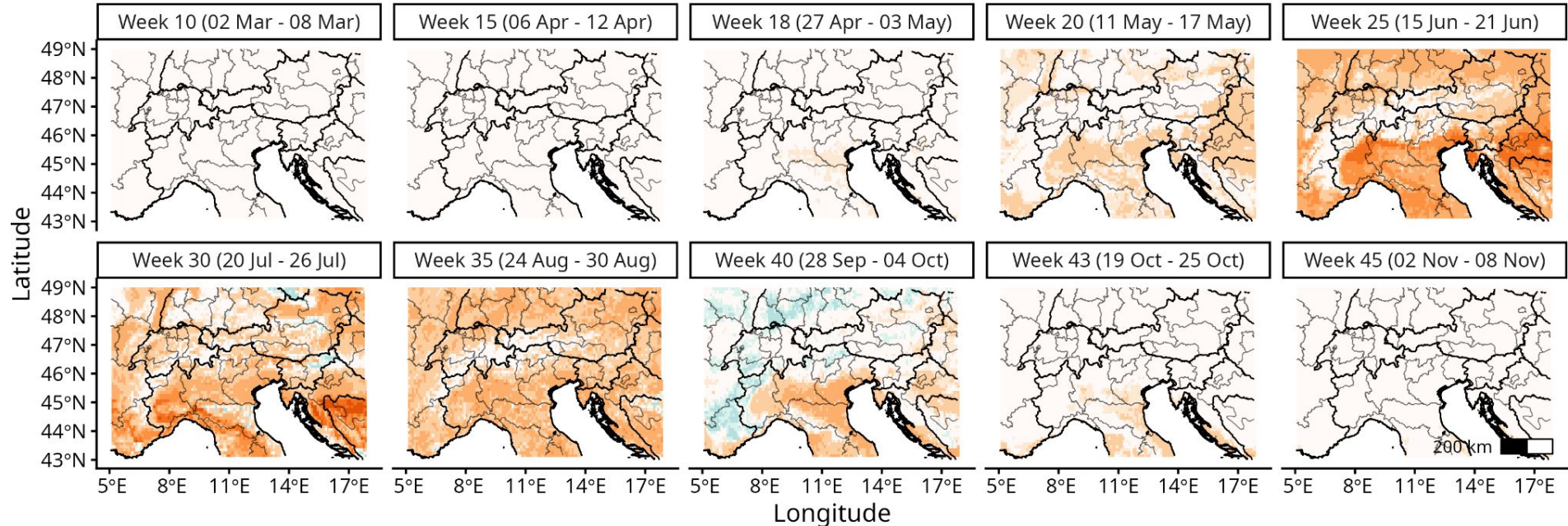
Inverni più caldi con estati piovose - baseline



Blaha et al. (*under rev*)

Δ futuro (2036-2055)

Inverni più caldi con estati più secche - baseline



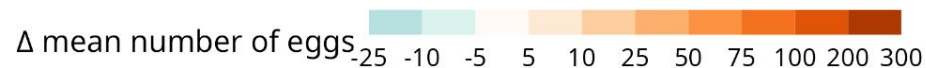
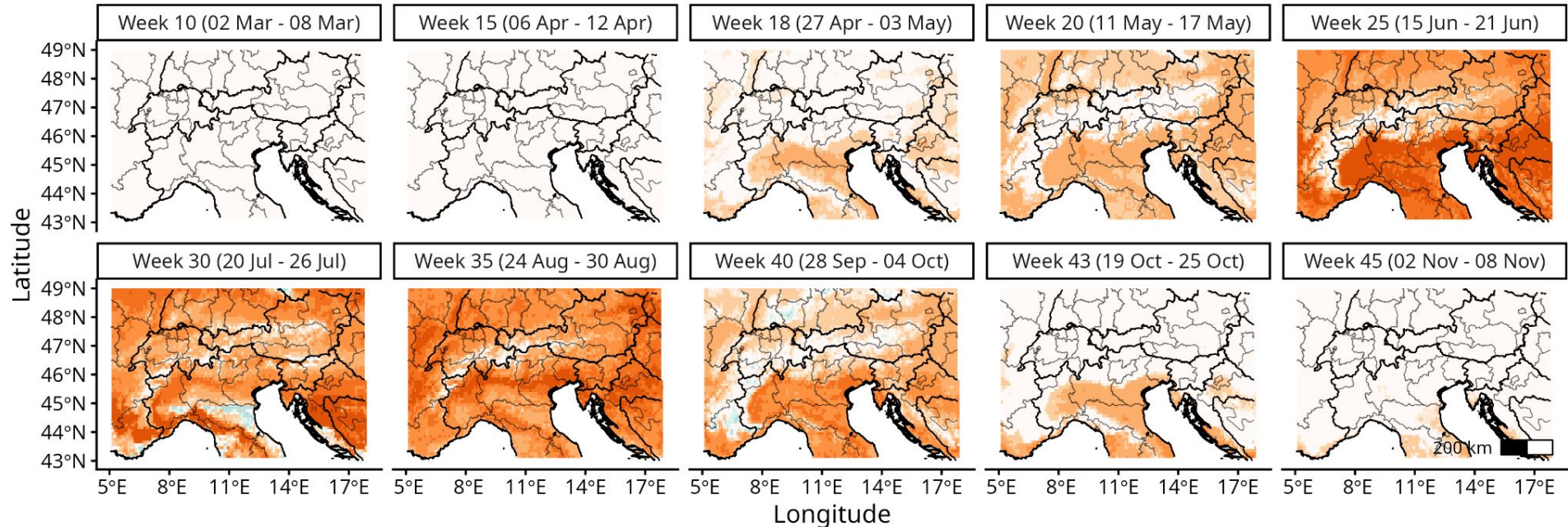
Δ mean number of eggs

-25 -10 -5 5 10 25 50 75 100 200 300

Blaha et al. (*under rev*)

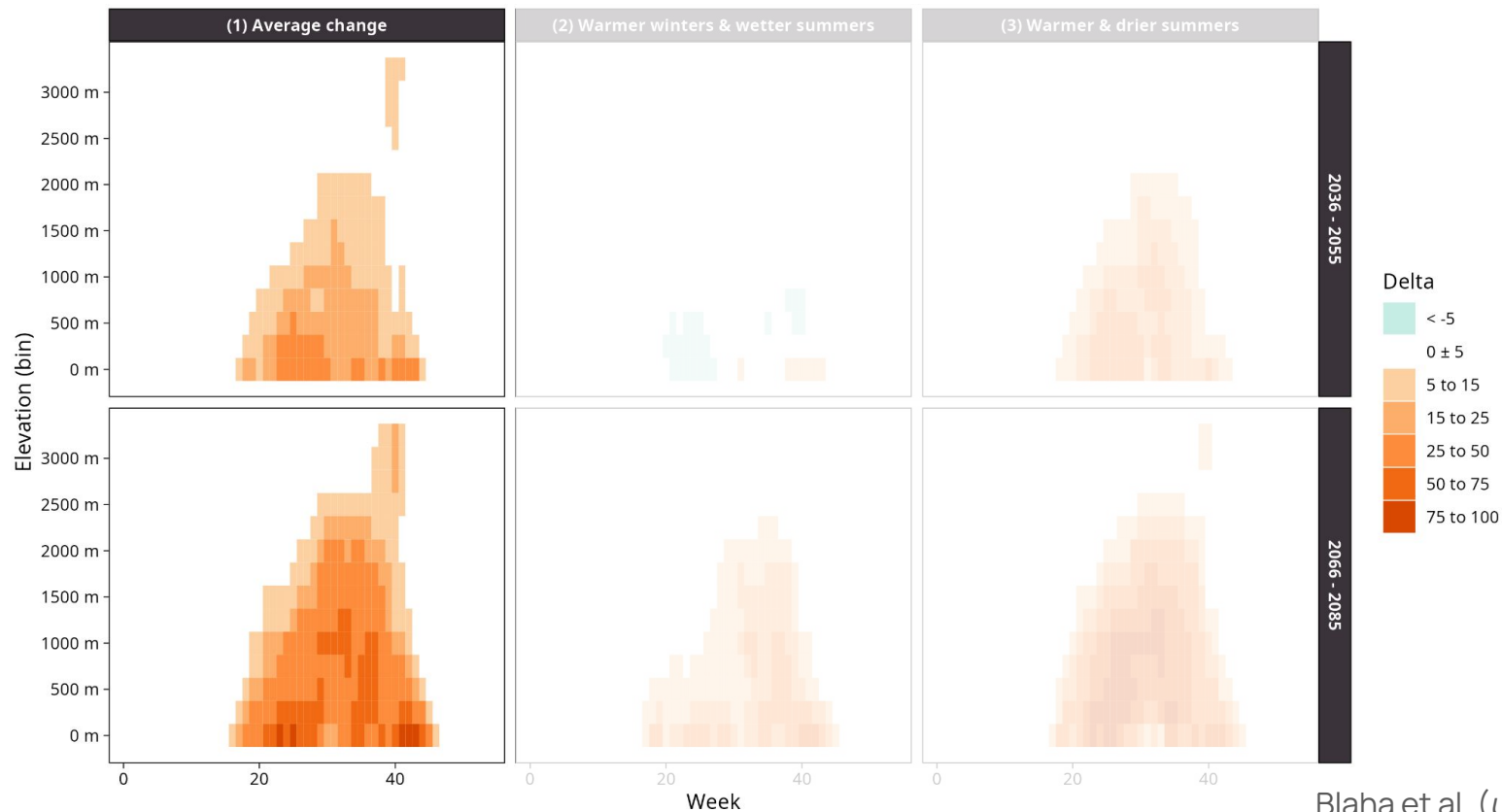
Δ futuro (2066-2085)

Inverni più caldi con estati più secche - baseline



Blaha et al. (*under rev*)

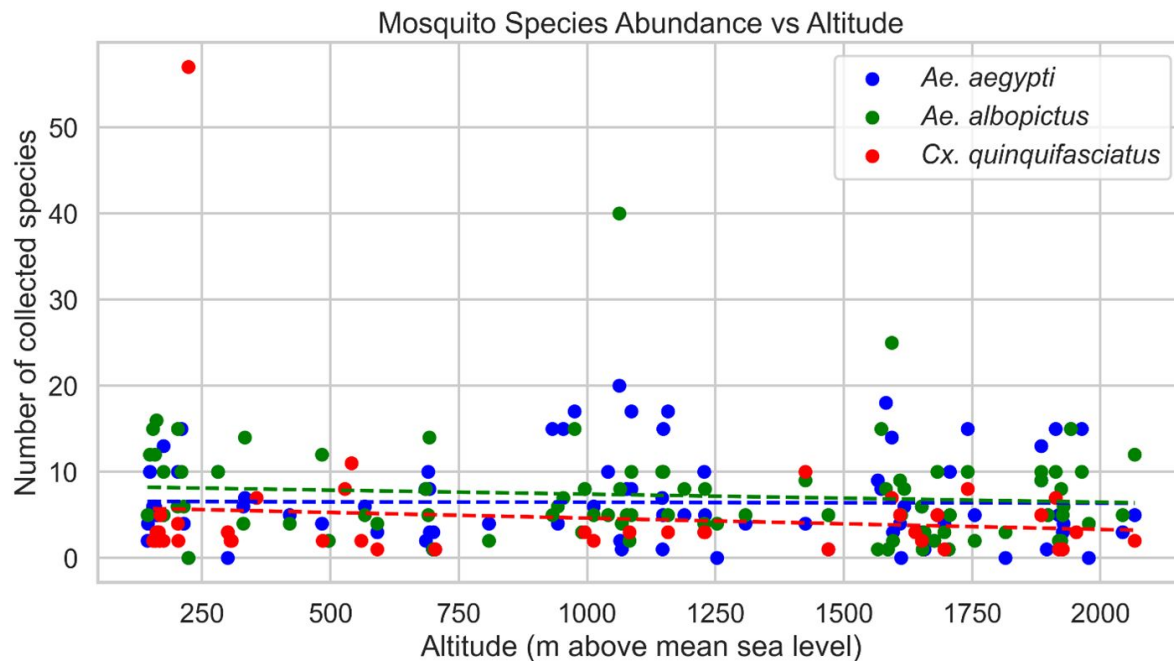
L'attività di ovodeposizione potrebbe spingersi fino a **2000 m s.l.m.** in diversi futuri climatici.



Blaha et al. (*under rev*)

Utopia o potenziale realtà futura?

Ae. albopictus è presente anche a **2066** m s.l.m. in Nepal!



Baral et al., 2026 *PlosOne*



Conclusioni

- **Espansione altitudinale e stagionale**

Il riscaldamento climatico favorirà l'espansione di *Aedes albopictus* verso quote più elevate e prolungherà significativamente la stagione di attività della zanzara nelle Alpi.

- **Le Alpi da barriera a hotspot emergente**

Le Alpi stanno passando da barriera storica all'invasione a nuovo paesaggio favorevole all'insediamento e alla persistenza di questa specie.

- **Necessità di sorveglianza climatica coordinata**

Le regioni montane devono essere considerate frontiere future di colonizzazione e rischio sanitario, richiedendo monitoraggio precoce.



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Grazie!

Climate-change-driven shifts in the population dynamics of the invasive tiger mosquito (*Aedes albopictus*) in the Alps

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Abstract

The recent global expansion of the Asian tiger mosquito (*Aedes albopictus*) across tropical and temperate regions provides a clear example of the mobility and adaptability of invasive species. Among multiple drivers influencing the spread of this species, climate change is emerging as a major driver, creating conditions that favour its persistence and expansion into higher latitudes and elevations. Hence, as global warming continues to make the climate of mountain areas milder, understanding *Ae. albopictus*' range and seasonality expansion in the Alpine area is fundamental, as it could introduce and propagate mosquito-borne diseases in previously free areas. Our objective is to evaluate the likely impact of climate change on the distribution and seasonality of *Ae. albopictus* for the periods 2036-2055 and 2066-2085 in the Alps. We use entomological data collected for public health surveillance, along with temperature and precipitation datasets from surface observations and regional climate model simulations, to train a machine-learning mosquito population model and predict its spatial distribution under both current and future climate conditions. Our results demonstrate how increasing temperatures and altered precipitation regimes increase the abundance and seasonal expansion of *Ae. albopictus*. In particular, rising temperatures are projected to push the species' range to higher altitudes and to lengthen the duration of climatically suitable conditions. Projected warming increased mean season length by 1.8-3.6 weeks, depending on location, and expanded suitable elevation by several hundred metres across future climates, demonstrating consistent climate-driven increases in both seasonal activity and spatial reach of *Ae. albopictus* in the Alps.

KEYWORDS

climate warming, global change, invasive species, machine learning, mosquito, range shift, species distribution modelling

<https://ecoevorxiv.org/repository/view/12054/>