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Association of temperature and total precipitation anomalies with West Nile Virus human cases in Central Macedonia, Greece

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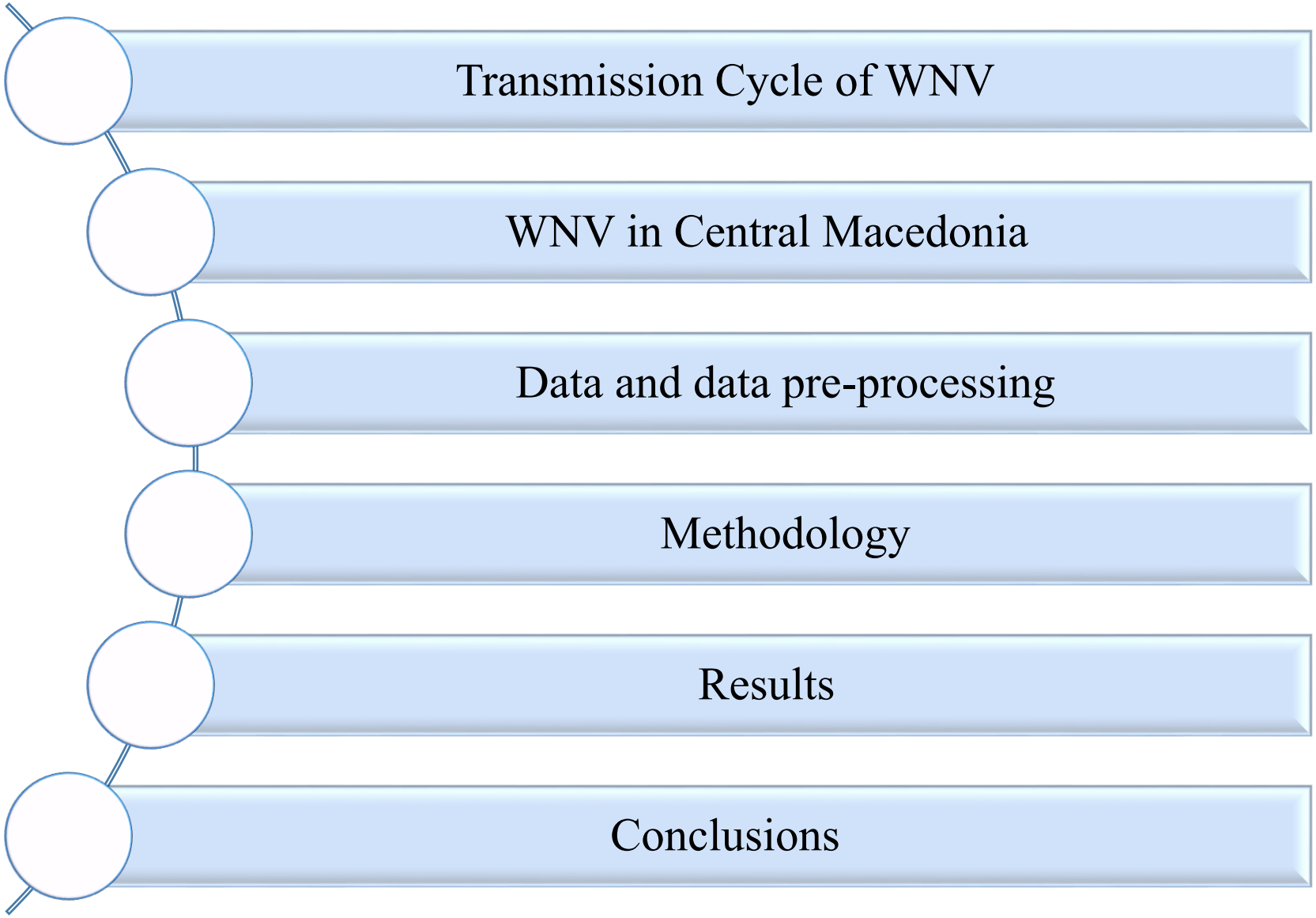
Structure of this presentation:



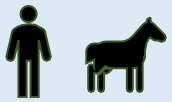
The virus is maintained in nature in a mosquito-bird-mosquito transmission cycle.

WILD BIRDS

- Wild birds are the predominant reservoir hosts of WNV.

MOSQUITOES

- Mosquitoes of the genus *Culex* are generally considered the principal vectors of WNV.
- Mosquitoes become infected when they bite infected birds and the virus circulates in their blood for a few days.

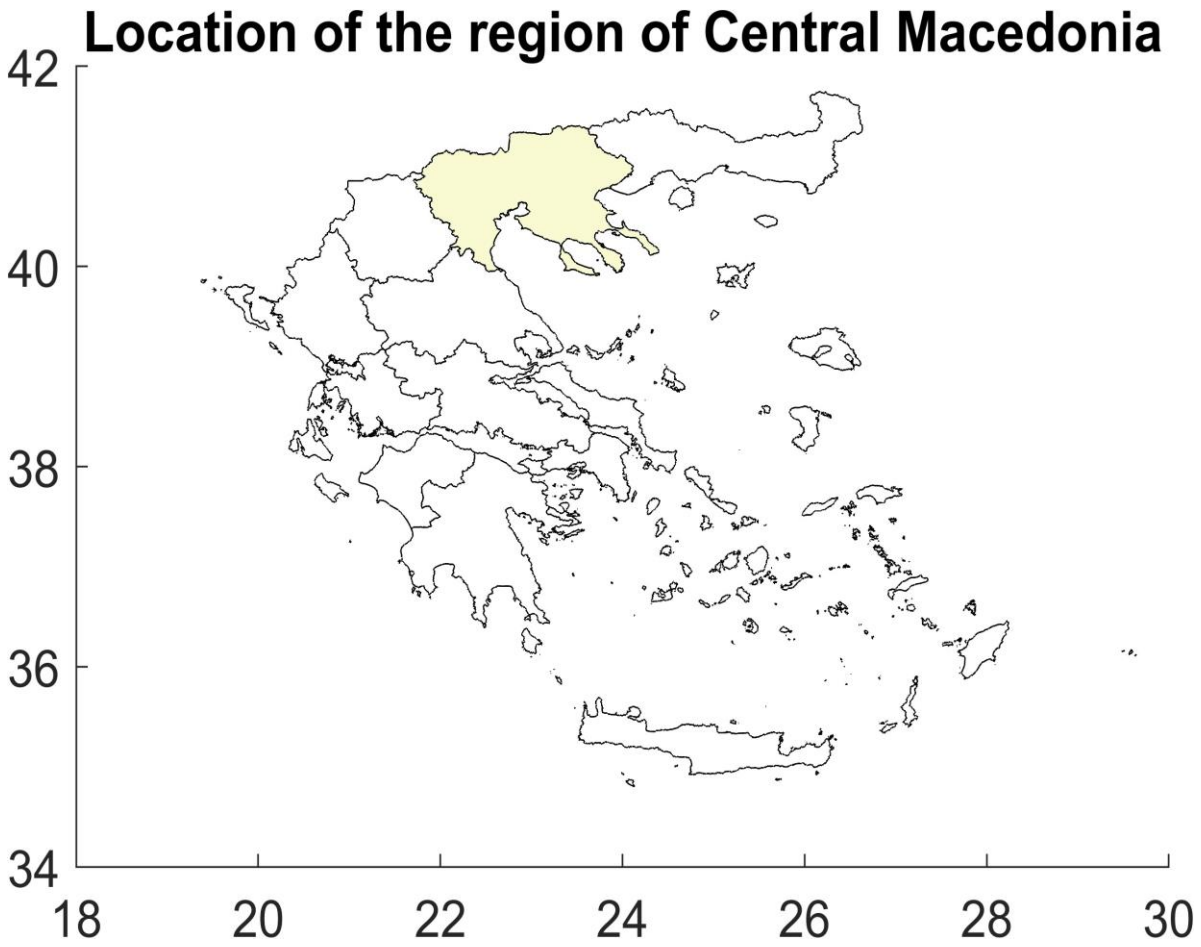


HOSTS

- Bites of infected mosquitoes may inject the virus into humans and animals.
- In elderly and immunocompromised people, symptomatic infections can result in neurologic diseases.

Currently no human vaccine is available.

Central Macedonia is a region in Northen Greece.



Useful information:

Coordinates: 40.7°N 23.0°E

Population (2021): 1,795,669 inhabitants

Area: 18,810.52 km^2

The region is divided into 38 municipalities.

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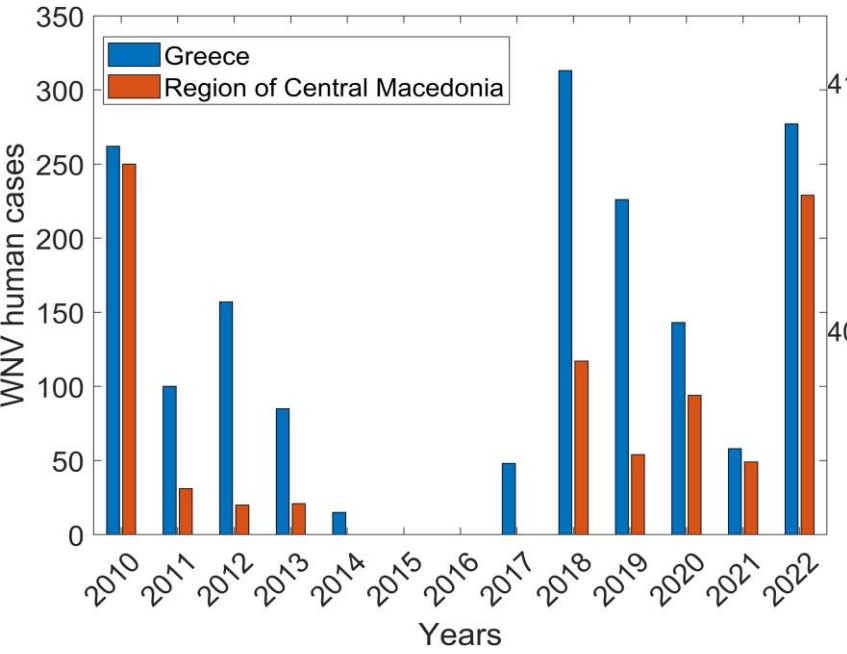
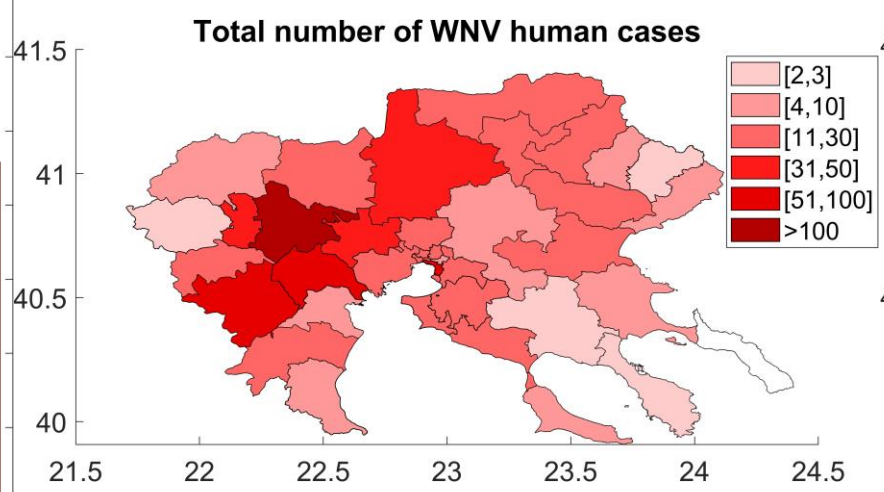
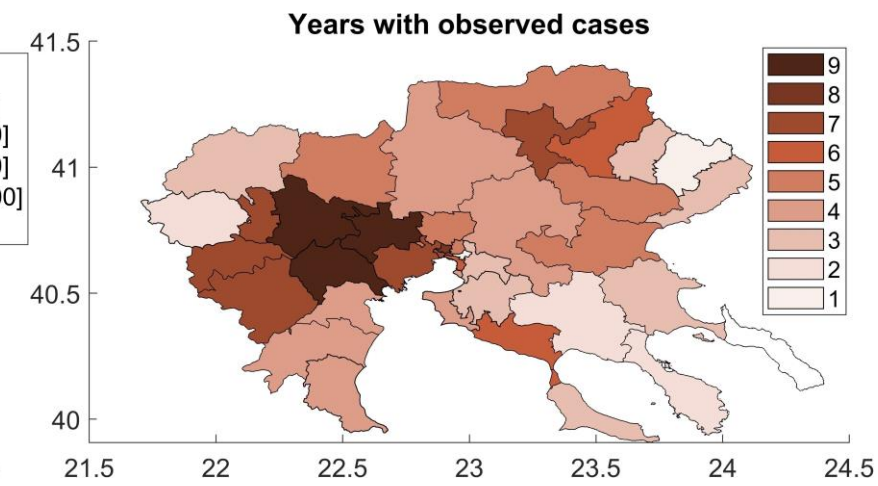






Key features:

- Excluding the period 2014-2017, in the region of Central Macedonia, from 13% (2012) to 95% (2010) of the country's total human cases are recorded.
- In the period 2010-2022, 51% of the total human cases in Greece were recorded in the region of Central Macedonia.
- At least one human case was recorded in all (38) municipalities.
- In 5 out of 38 municipalities (13%) human cases were observed in one or two years during this period, while in 11% of the municipalities (4 out of 38) cases were reported in more than seven years.

Region of great epidemiological interest

- Until 29.08.2023: 89 WNV human cases in Greece in 2023 (33 of them in Central Macedonia).

- **Environmental data**
  - 2m temperature
  - Total precipitation

  from the European Centre for Medium-Range Weather Forecasts (ECMWF) with 0.25° X 0.25° resolution for the period 1980-2022.
- **Epidemiological data**
  - For the number of infected humans during the period 2010 – 2021, data was obtained from the National Public Health Organization (EODY) at the municipal level following a relevant request
  - Data for 2022 were collected from the weekly surveillance reports published by EODY on its official website at municipality level.

The aim is to convert the environmental data at the municipality level.

- **Environmental data**

(hourly) grid points ⇒ (monthly) municipal level

grid points that fall within the area of each municipality ⇒ daily values ⇒ monthly values.

The period 1980 to 2009 was used to construct the mean state ("climate"), the period 2010-2022 was used to identify anomalies.

Anomaly: a measure of the variation (increase or decrease) of the specific climatic parameter in year in relation to the average prevailing climatic conditions during the period 1980 to 2009.
For instance : $T_{ANOM}(\text{year}, \text{month}) = T_{AVG}(\text{year}, \text{month}) - T_{AVG}(1980 - 2009, \text{month})$.

Multiple linear regression was used to estimate the influence of temperature anomaly and total precipitation anomaly in annual WNV human cases.
Specifically: $Y = b_0 + b_1 * X_1 + b_2 * X_2$, where:
Y= Annual WNV human cases,
$X_1 = T_{ANOM}(\text{year}, \text{month})$,
$X_2 = TP_{ANOM}(\text{year}, \text{month})$,
b_0, b_1, b_2: regression coefficients, month: from January to June, year: the research year, 2010≤year≤2022.

We try to group adjacent municipalities with a similar number of WNV human cases and find a relationship of the form $\text{Annual human cases} = b_0 + b_1 * T_{ANOM}(\text{year}, \text{month}) + b_2 * TP_{ANOM}(\text{year}, \text{month})$. So, knowing $T_{ANOM}(\text{year}, \text{month})$ and $TP_{ANOM}(\text{year}, \text{month})$ we could find the annual number of WNV human cases.

The years where the municipalities belonging to the same group had an outbreak have been included in the study.

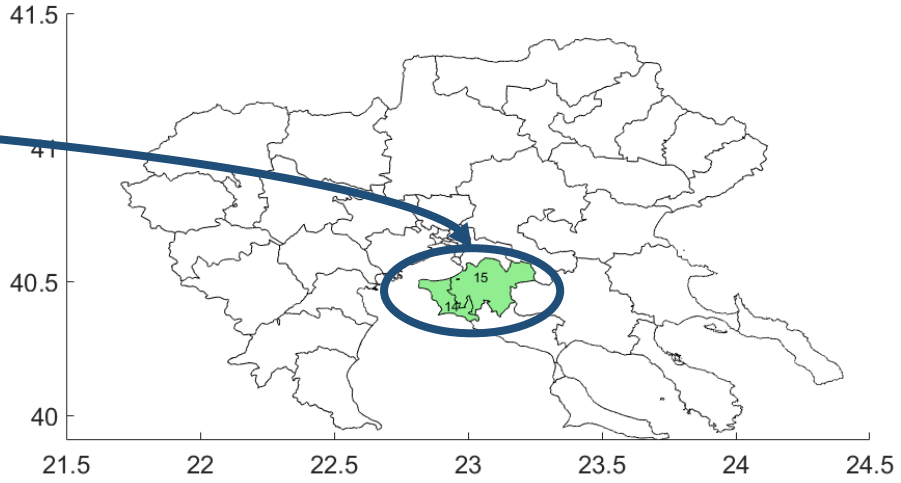
Correlations between the annual human cases and monthly anomalies from January to June were examined at the 95% CI.

For example:
Municipalities with IDs 14 & 15
3 common years with WNV human cases (2010,2018,2022)
$\text{Annual human cases} = 8.83 - 3.43 * T_{ANOM}MAY + 1.21 * TP_{ANOM}MARCH$,
Coefficient of model determination (R^2) = 0.97 , p-value=0.004

unknown

known

known



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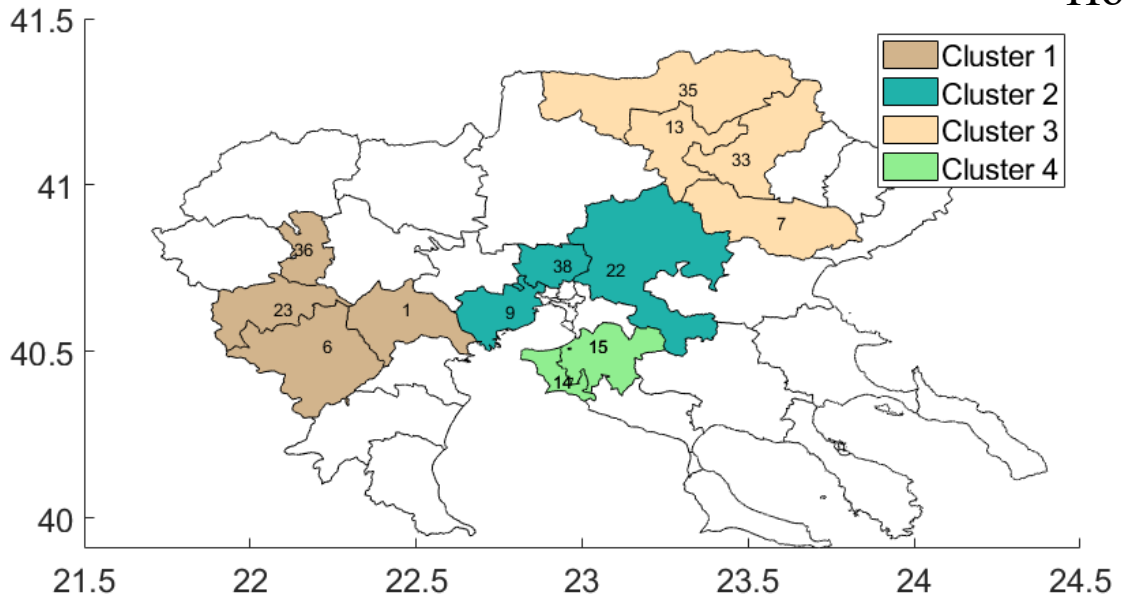
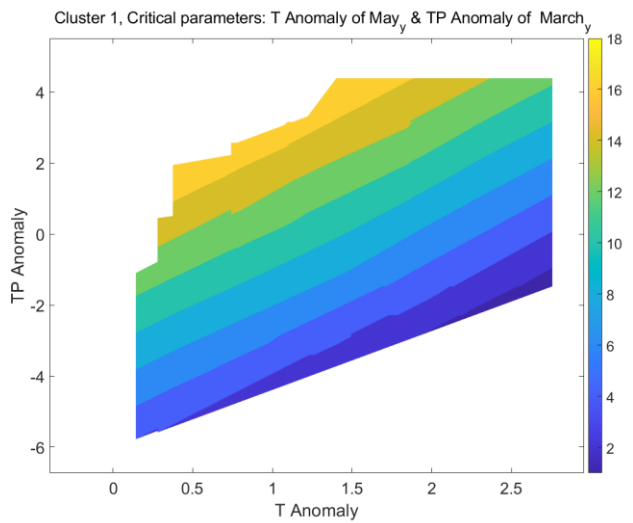
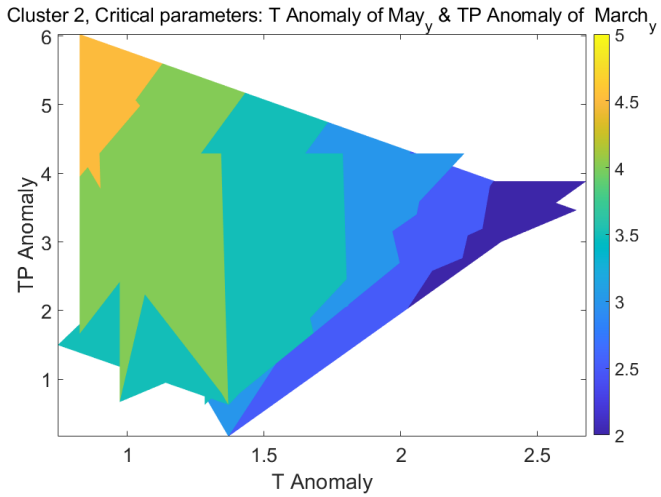
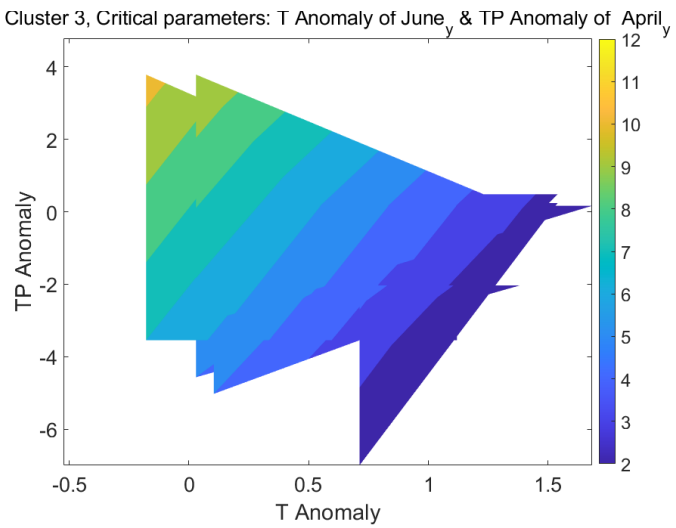
How do temperature and total precipitation anomalies affect human cases?

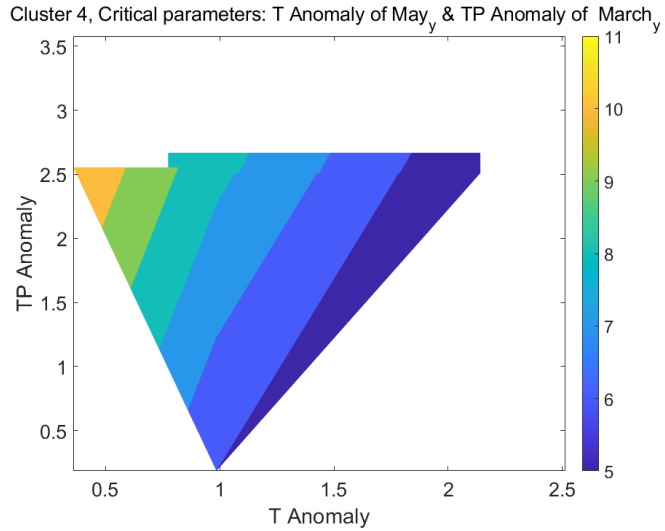


Cluster	Municipalities	R-squared	p-value	X_1	X_2
1	1,6,23,36	0.52	0.001	T Anom May	TP Anom March
2	9,22,38	0.62	0.05	T Anom May	TP Anom March
3	7,13,33,35	0.73	0.0002	T Anom June	TP Anom April
		BUT ALSO...0.65	0.001	T Anom May	TP Anom March
4	14,15	0.97	0.004	T Anom May	TP Anom March









So: ↑TP Anomaly March or April + ↓T Anomaly 2 months later ⇒ ↑WNV human cases this year

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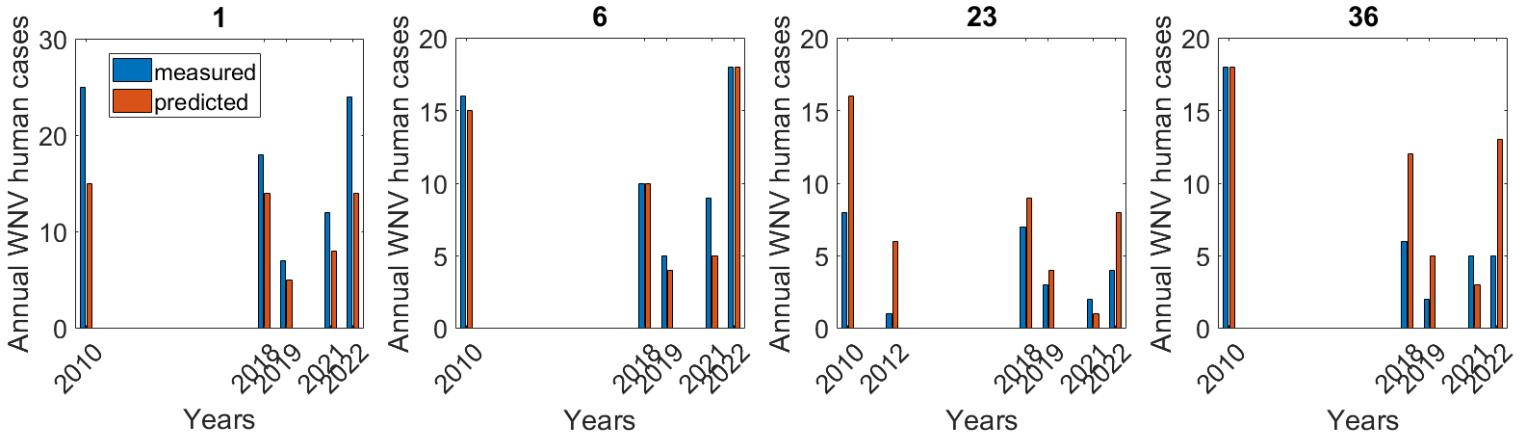
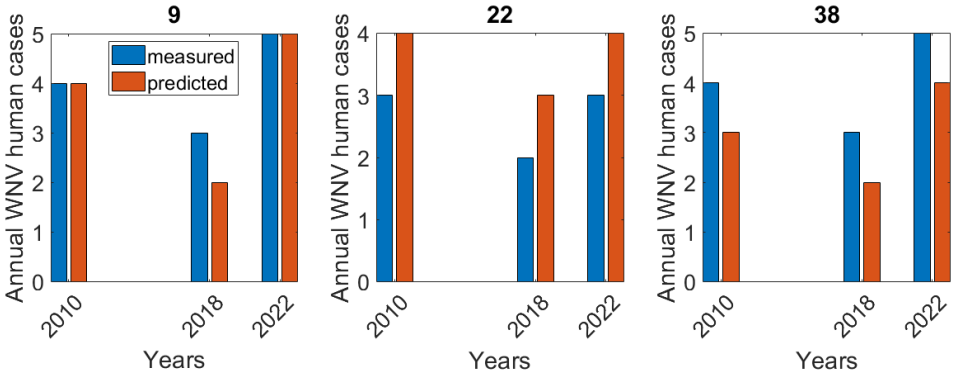
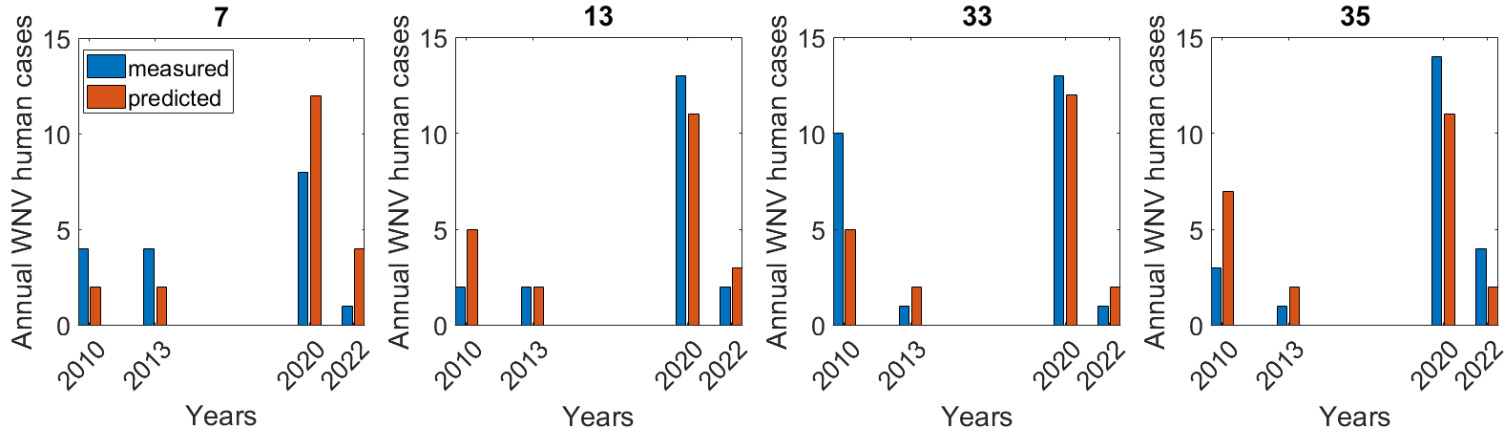
Cluster 1, Critical parameters: T Anomaly of May_y & TP Anomaly of $March_y$



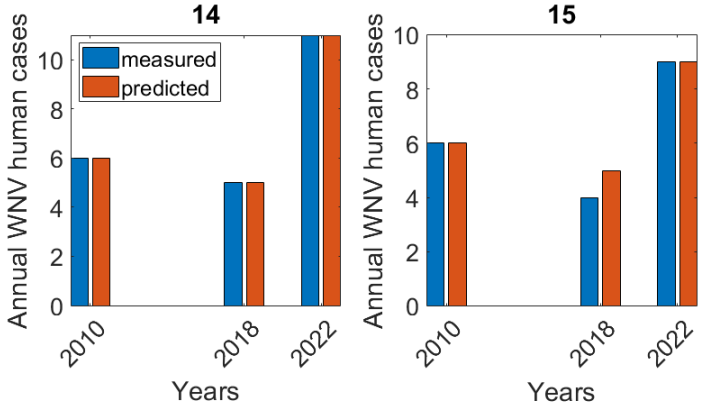
Cluster 2, Critical parameters: T Anomaly of May_y & TP Anomaly of $March_y$

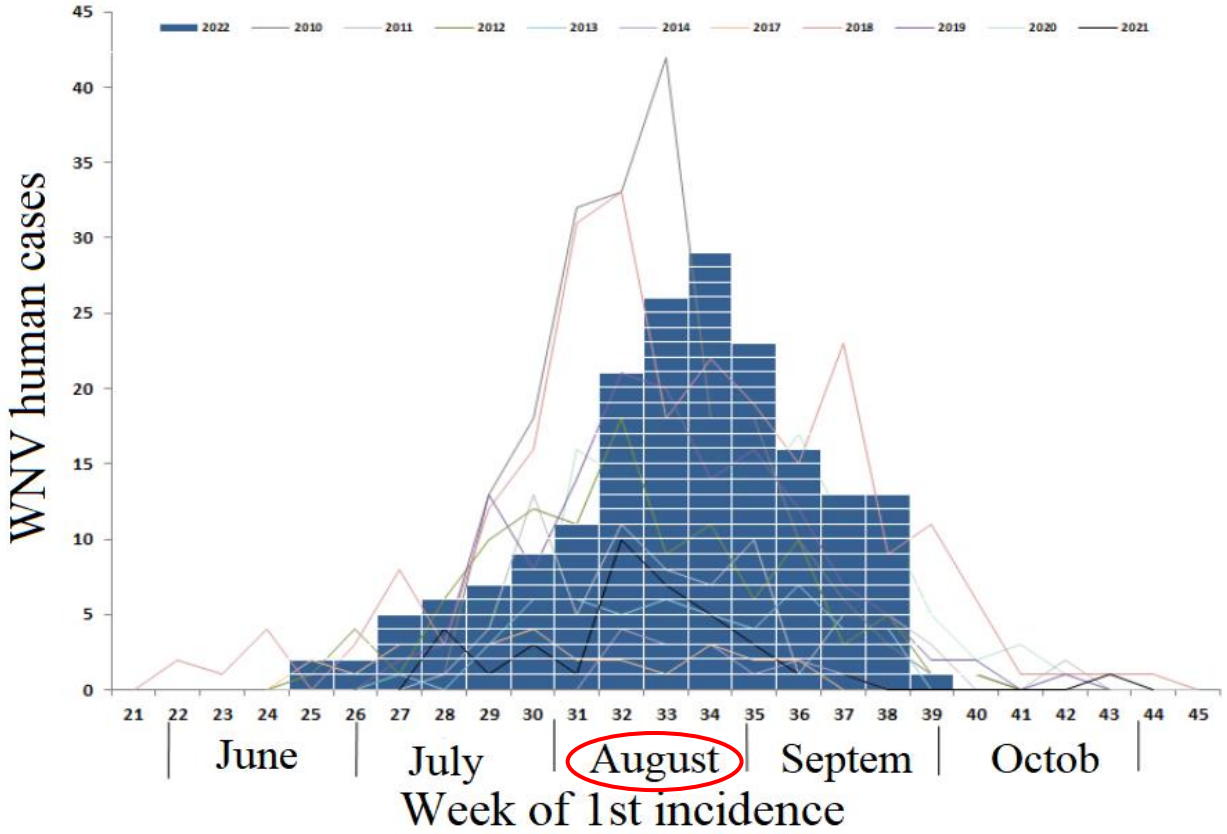


Cluster 3, Critical parameters: T Anomaly of $June_y$ & TP Anomaly of $April_y$



Cluster 4, Critical parameters: T Anomaly of May_y & TP Anomaly of $March_y$





↑TP Anomaly March or April + ↓T Anom 2 months later ⇒ ↑WNV human cases this year

- The month of onset of symptoms for most patients is August.
- For 13 of the 38 municipalities (34%) of the region Central Macedonia, knowing the temperature and total precipitation anomalies at least two months before August, we can predict the number of annual WNV human cases.

- In most of these municipalities, several human cases have been recorded for at least 5 years in the period 2010-2022 (Remember the period 2014-2017 when no cases were recorded in the region).

For the thorough prediction of the intensity of WNV cases, it is proposed to utilize additional parameters such as the degree of infectivity of the mosquito-carriers circulating in the area, as well as the use of indicator organisms such as sentinel chickens.

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Thank you for your attention!

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