Environmental drivers of the Great Orange Tip population dynamics in different regions

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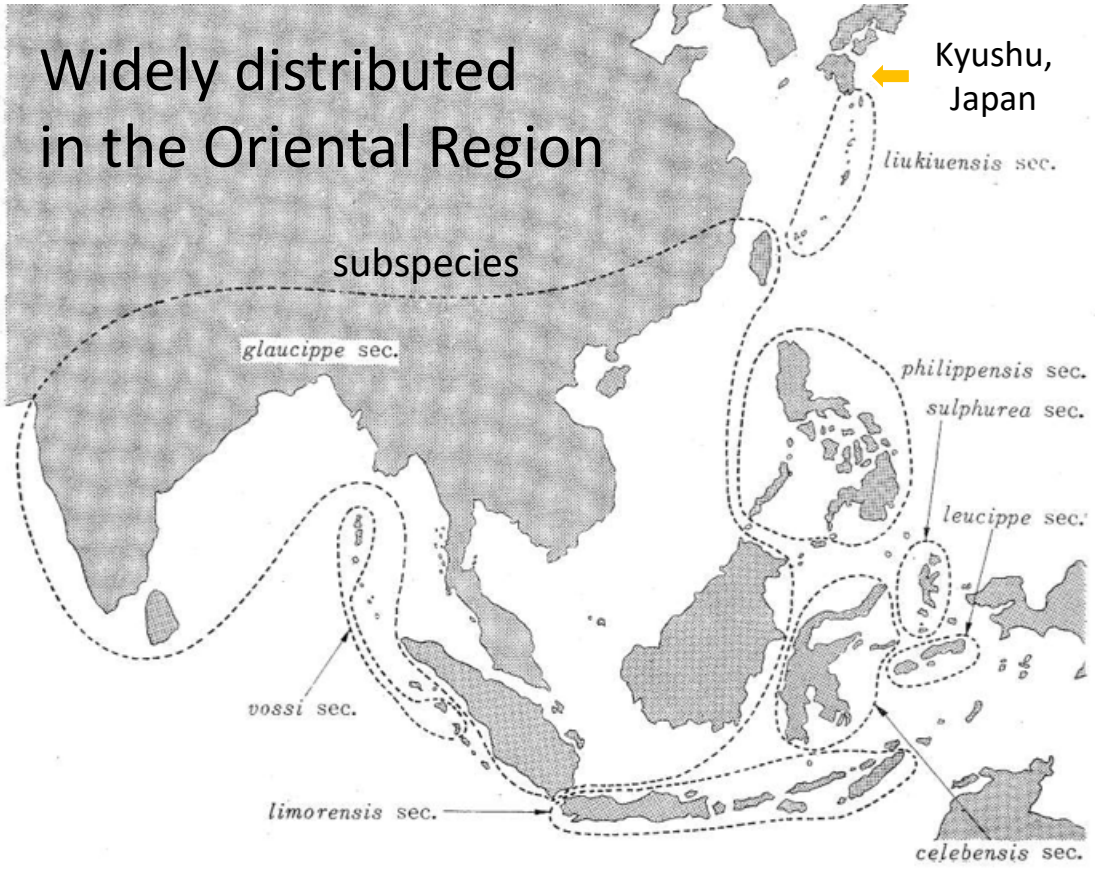
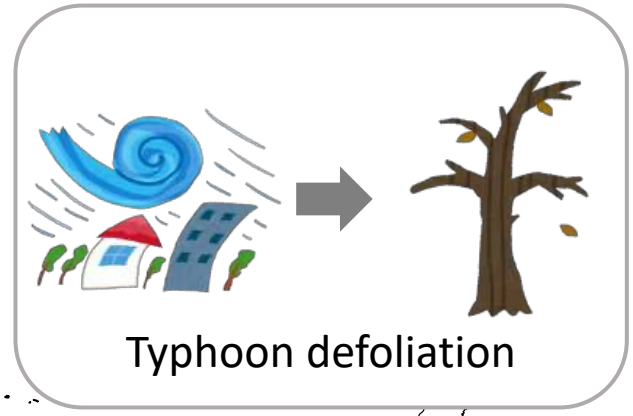
The great orange tip butterfly (*Hebomoia glaucippe*)

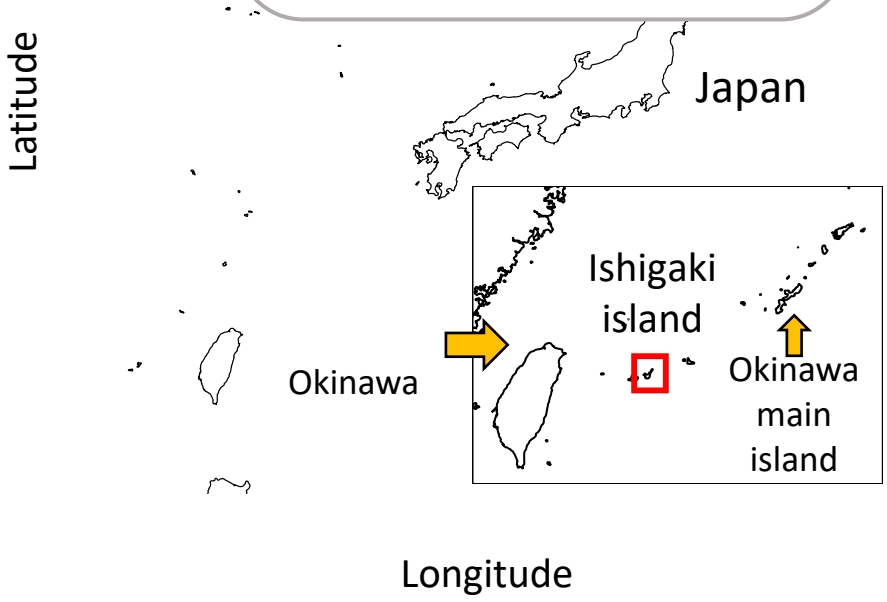


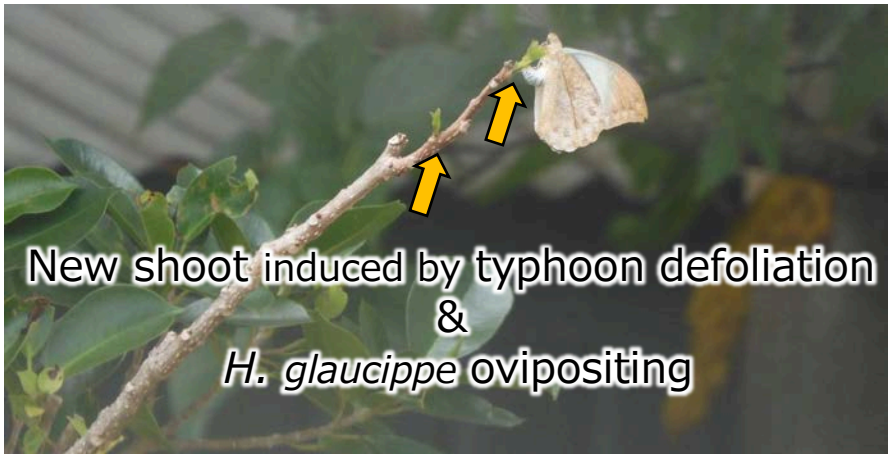
Morishita 1973

←The host tree in Japan

Bud burst & oviposition of *H. glaucippe* after typhoon defoliation on Ishigaki island

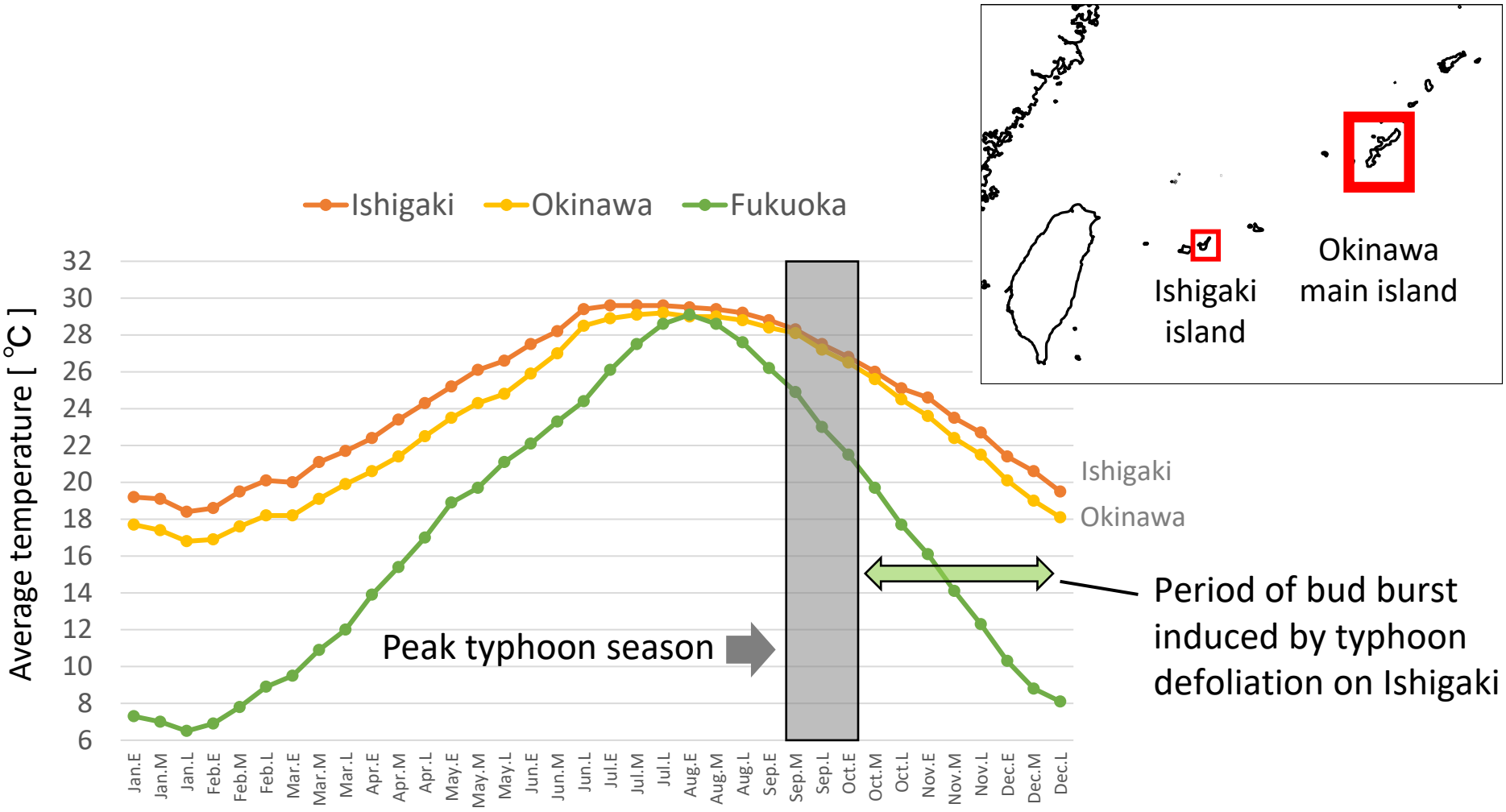






Typhoons can regulate the population dynamics.

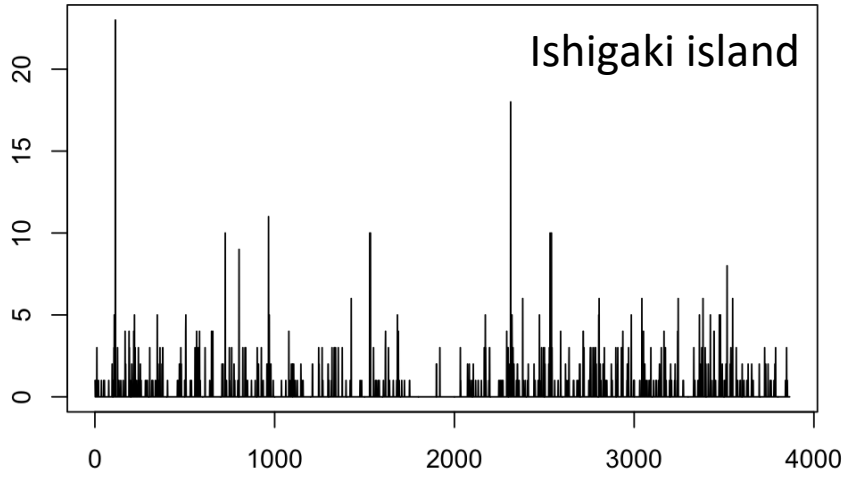
Comparison of Ishigaki island and Okinawa main island

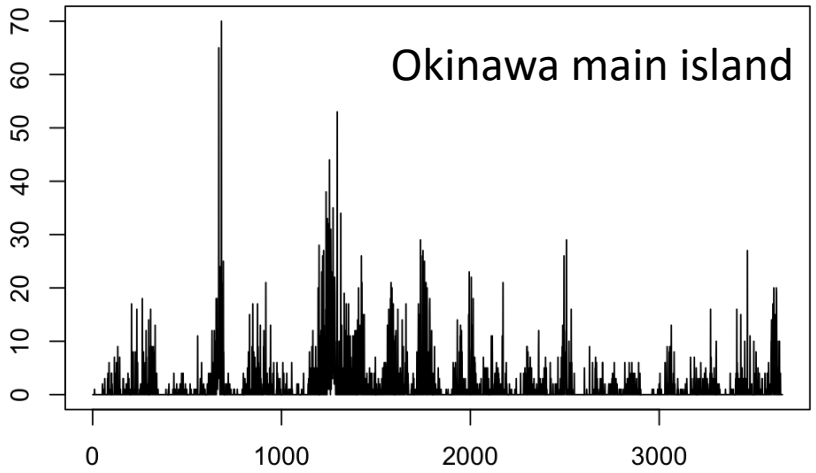


Typhoon defoliation does not induce bud burst on the Okinawa main island.

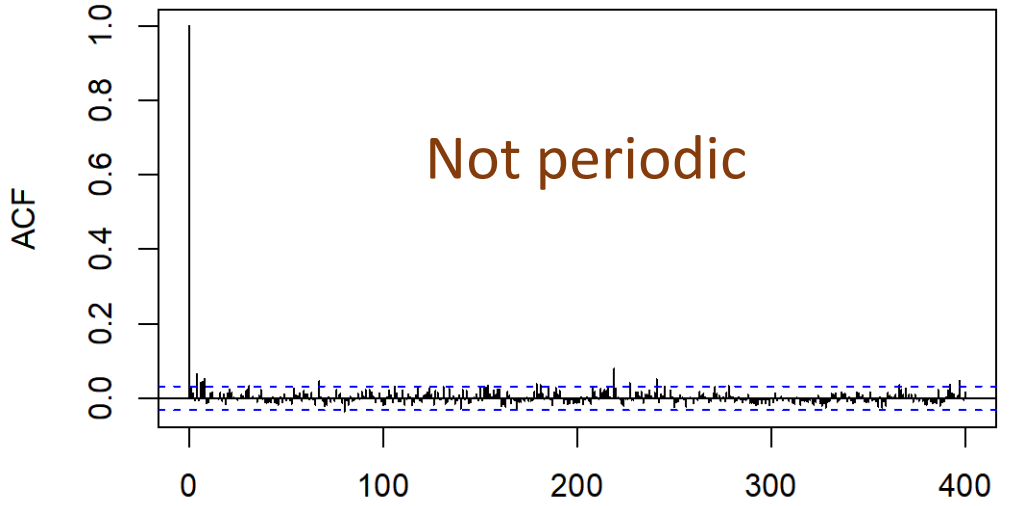
Different periodicity of the population dynamics

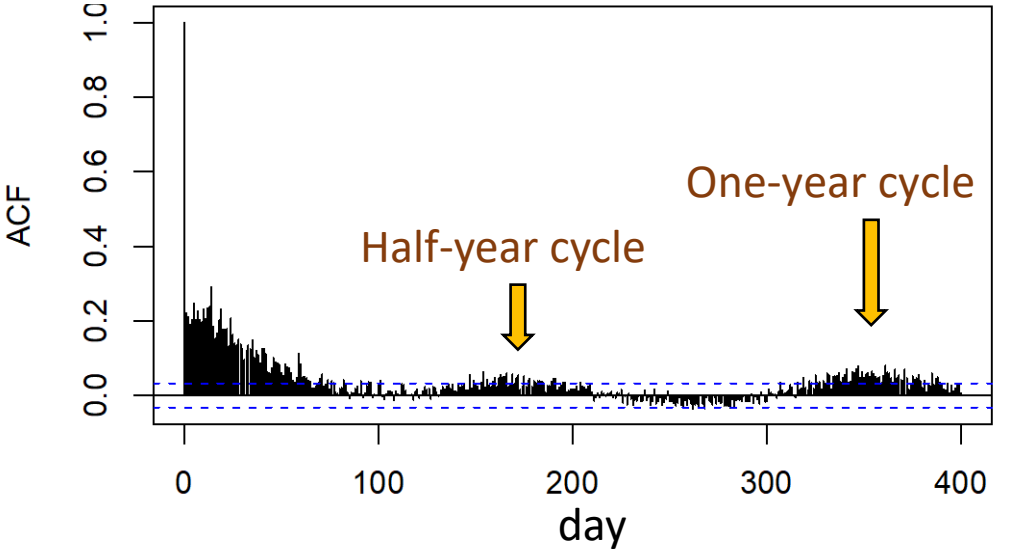
Published data of the Great Orange Tip





ACF: autocorrelation function





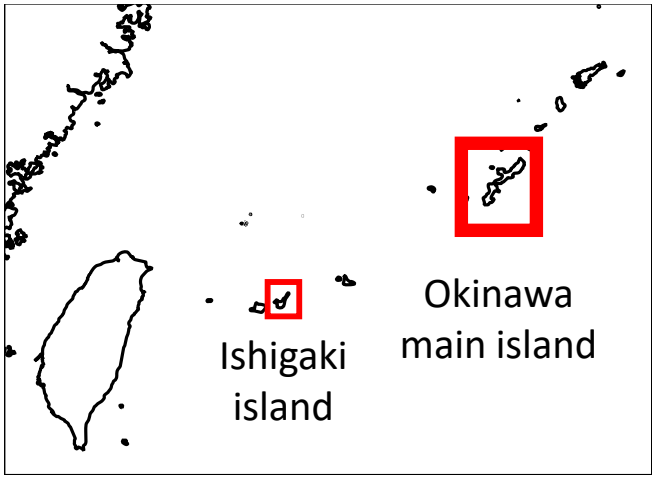
To explore the environmental factors regulating the population dynamics of *H. glaucippe*

Time series constructed from published count data of  at each island

Environmental time series

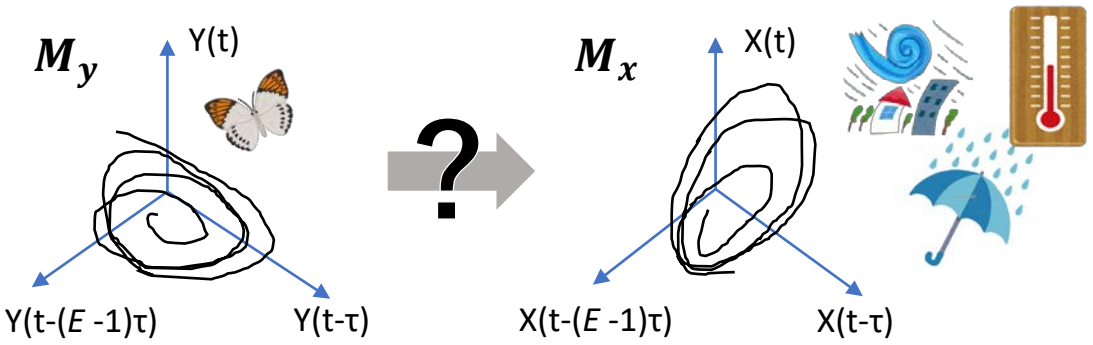


https://okinawakontyou.ti-da.net/e6459479.html



Causal inference used by Convergent Cross Mapping (Sugihara et al. 2012)

Making attractor from time series



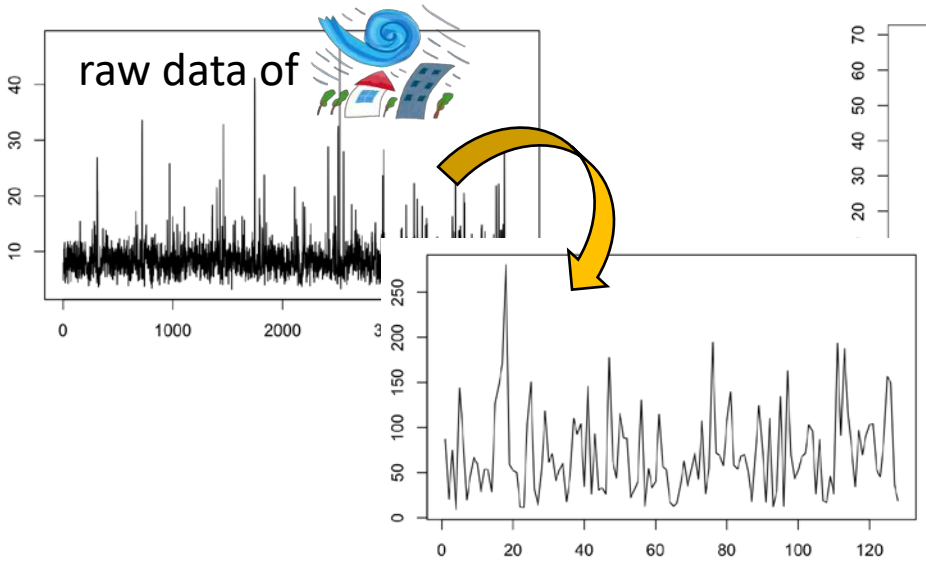
Time series data used for Causal inference

Environment

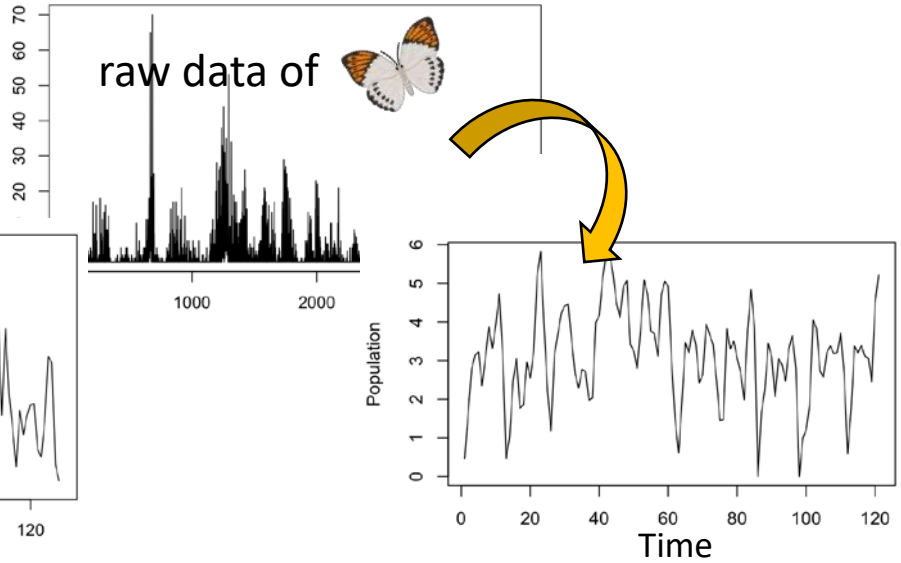
Time lag of n_1 days

H. glaucippe

Cumulative sum over n_2 days



Cumulative sum over 30 days



Different drivers on each island

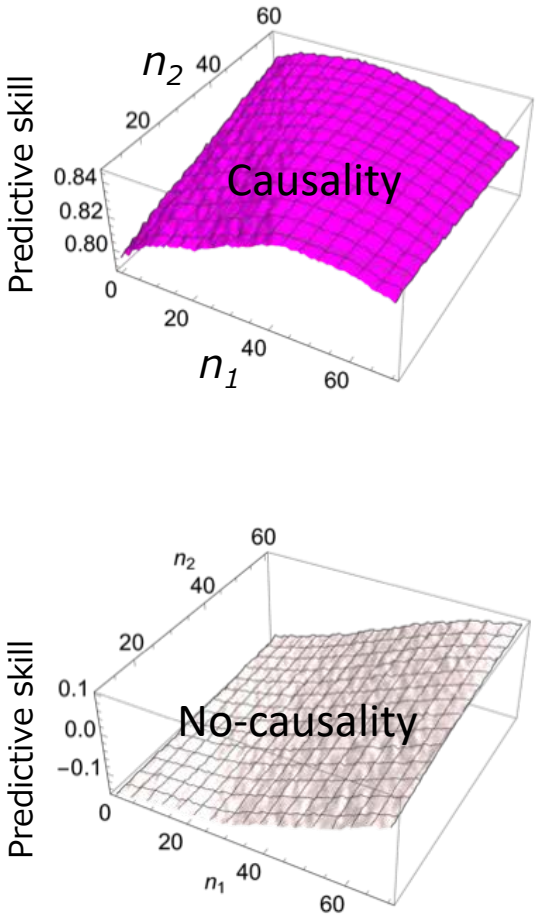
Okinawa main island

Ishigaki island

Average Temperature

Maximum Wind Speed

Rainfall

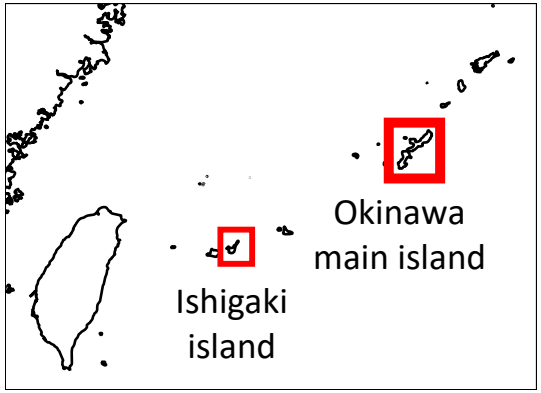


Global warming change the environmental driver of Okinawa

Present

Future (Temperature rise)

New shoots
&
Oviposition



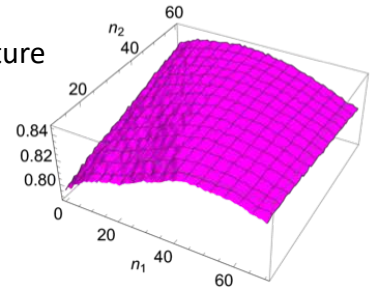
Environmental driver change could occur.

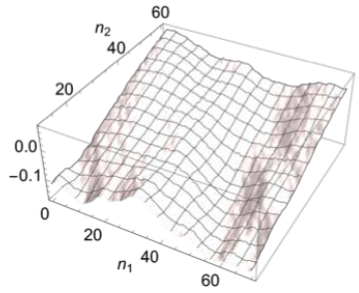
Conclusion

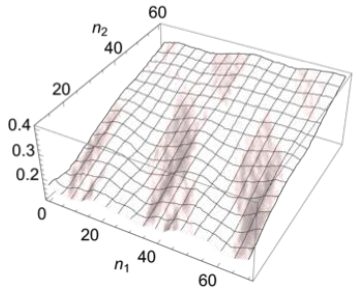
Okinawa:

Annual cycle of temperature regulated the population dynamics.

Average Temperature

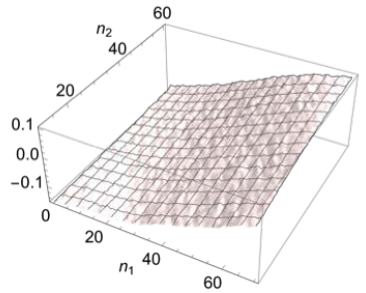




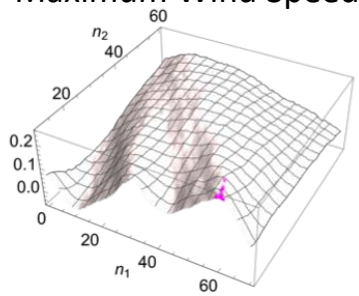


Ishigaki:

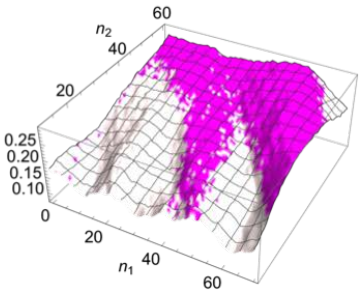
Strong wind and rainfall regulated the population dynamics.



Maximum Wind Speed



Rainfall

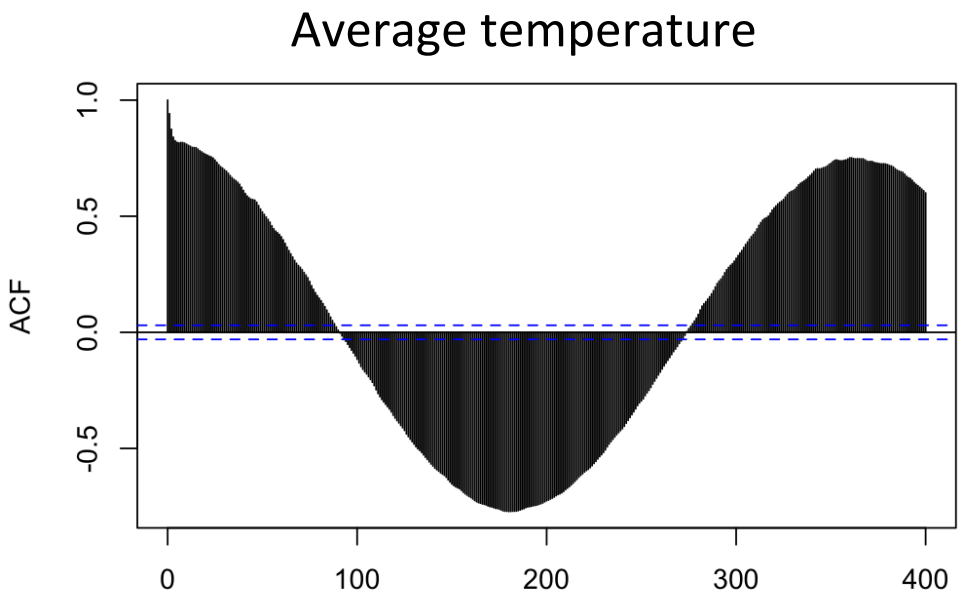


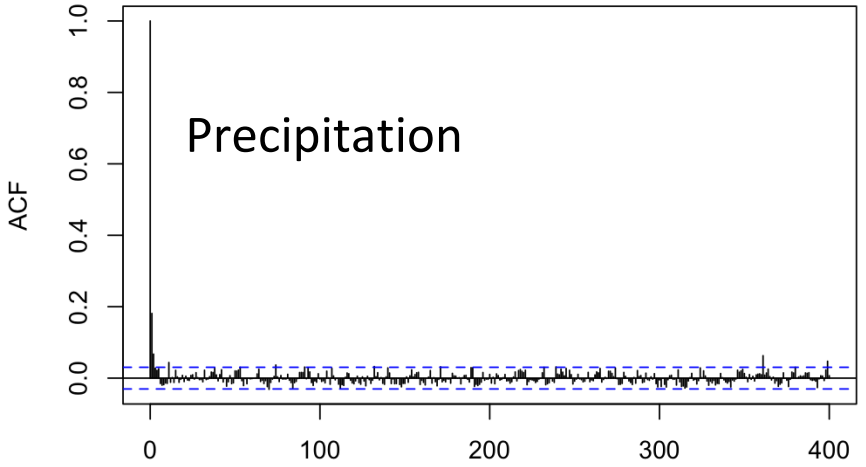
Acknowledgements

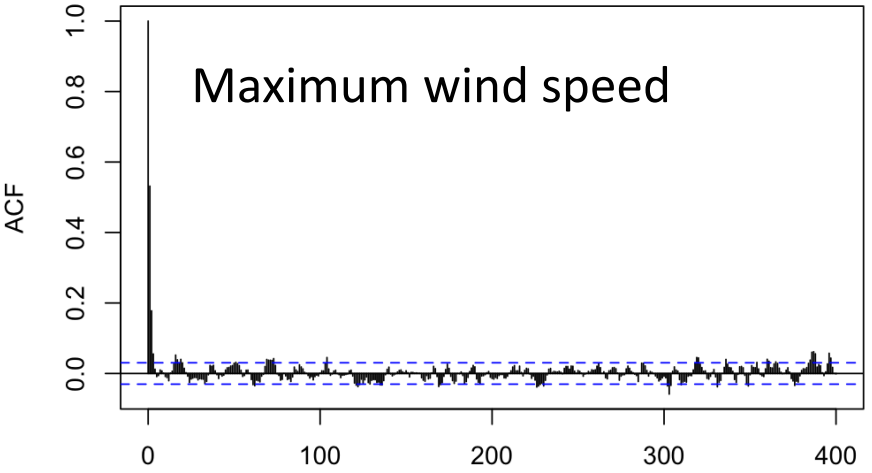
I thank Fukashi Ishiwata for providing the photographs.

Thank you for listening!

Auto correlation function for environmental data







Impacts of typhoon on *C.religiosa* at Iriomote

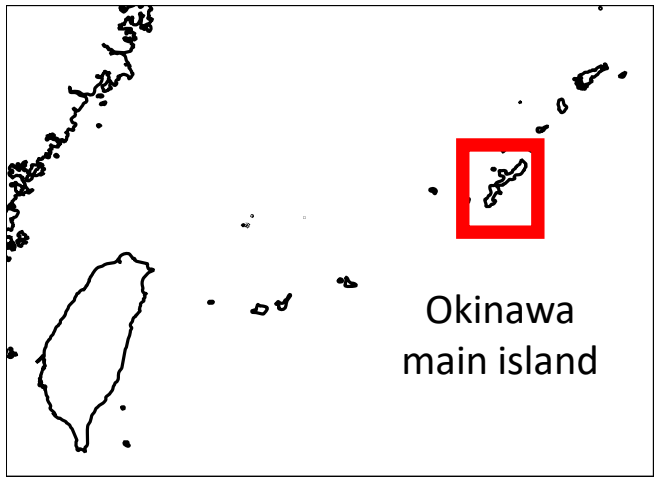
Typhoons in the fall of 2019

Natural defoliation in winter

Typhoon defoliation → Bud burst
in autumn → no leaf shedding in winter

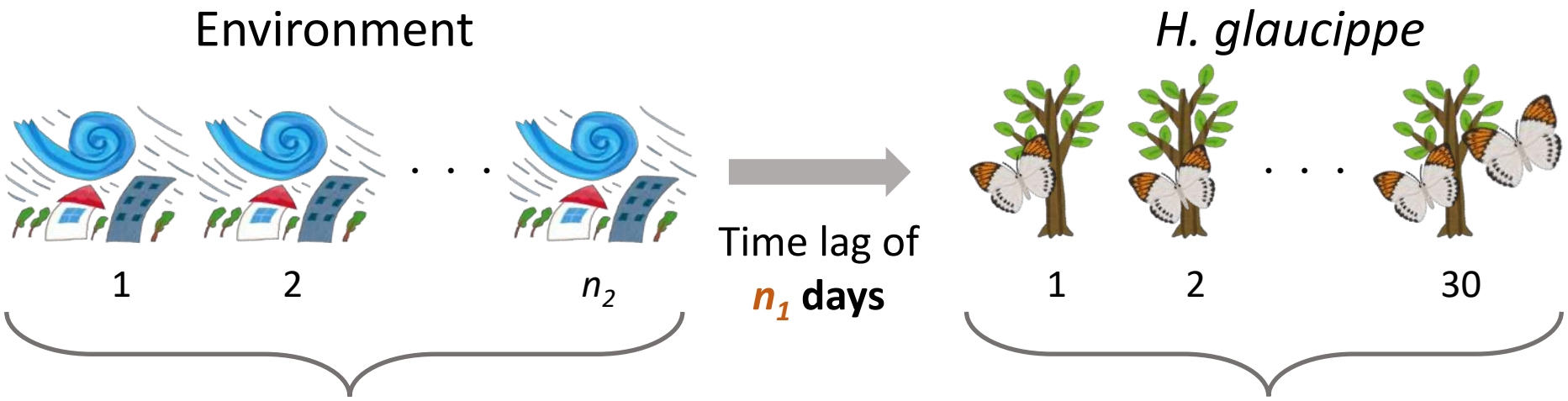
Responses to typhoons are different among trees.

Few bud burst after typhoon defoliation in Okinawa island.



Typhoons are not expected to have much effect on the population dynamics in Okinawa main island.

Time series data used for Causal inference



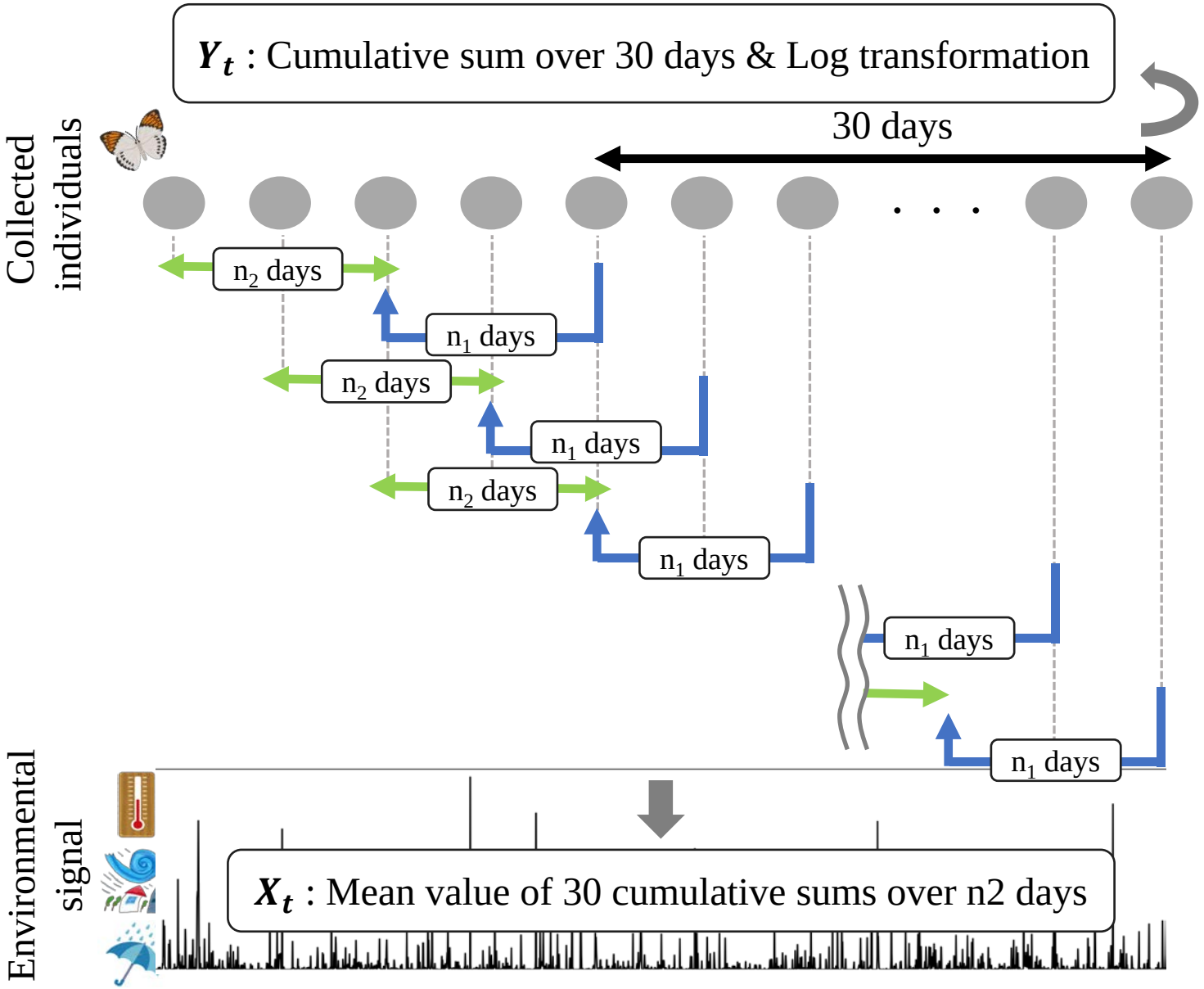
X_t : Cumulative sum over n_2 **days**

Y_t : Cumulative sum over 30 days

X_t corresponds to Y_t by (n_1, n_2)

n_1 : 1 ～ 70　n_2 :11 ～ 60 → 3500 ways

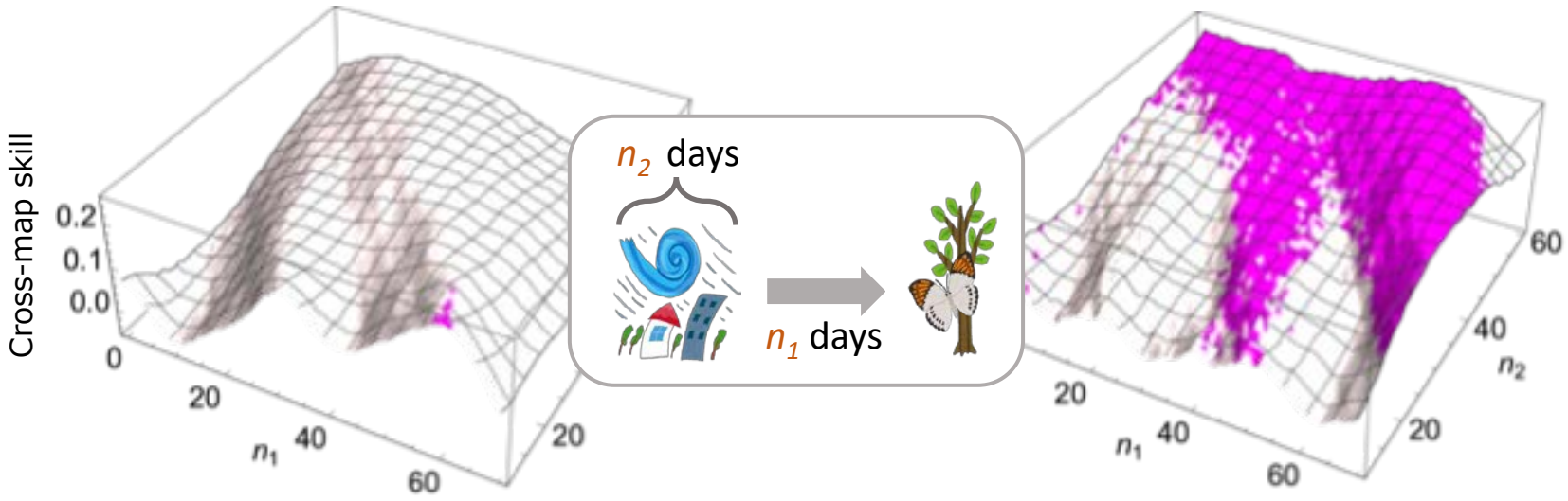
Environmental time series used for CCM



Maximum wind speed and Rainfall regulated the population dynamics in Ishigaki

Maximum Wind Speed

Rainfall



Optimal Parameters : (n_1, n_2) = (60, 12)

(n_1, n_2) = (55, 57)

Long-term wind and rain affect the population dynamics.

Method

We performed S-map analysis when causality was detected

S-map (Sequentialy locally weighted global linear map) :

We evaluate the interaction strength of the environmental factors and the population dynamics of *H. glaucippe*

ex. S-map between maximum wind speed and the population →

S-map coefficients > 0

Maximum wind speeds ↗↗

⬇

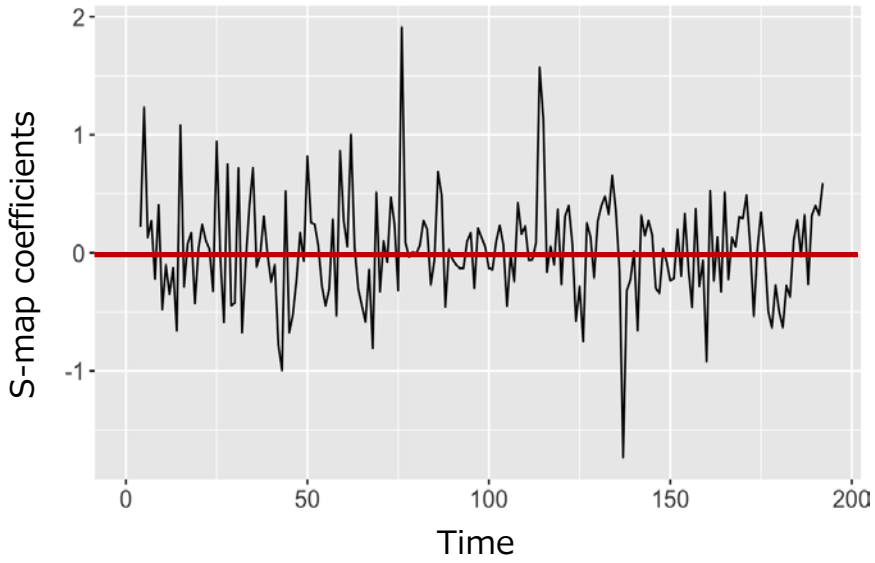
Number of individuals ↗↗

S-map coefficients < 0

Maximum wind speeds ↗↗

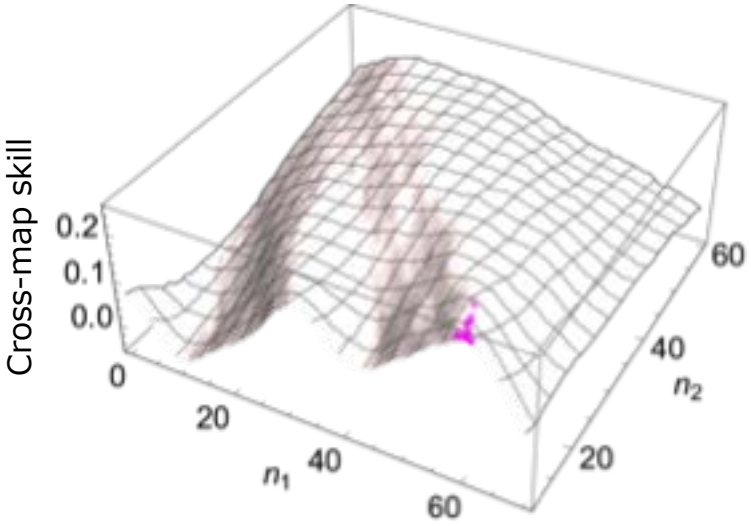
⬇

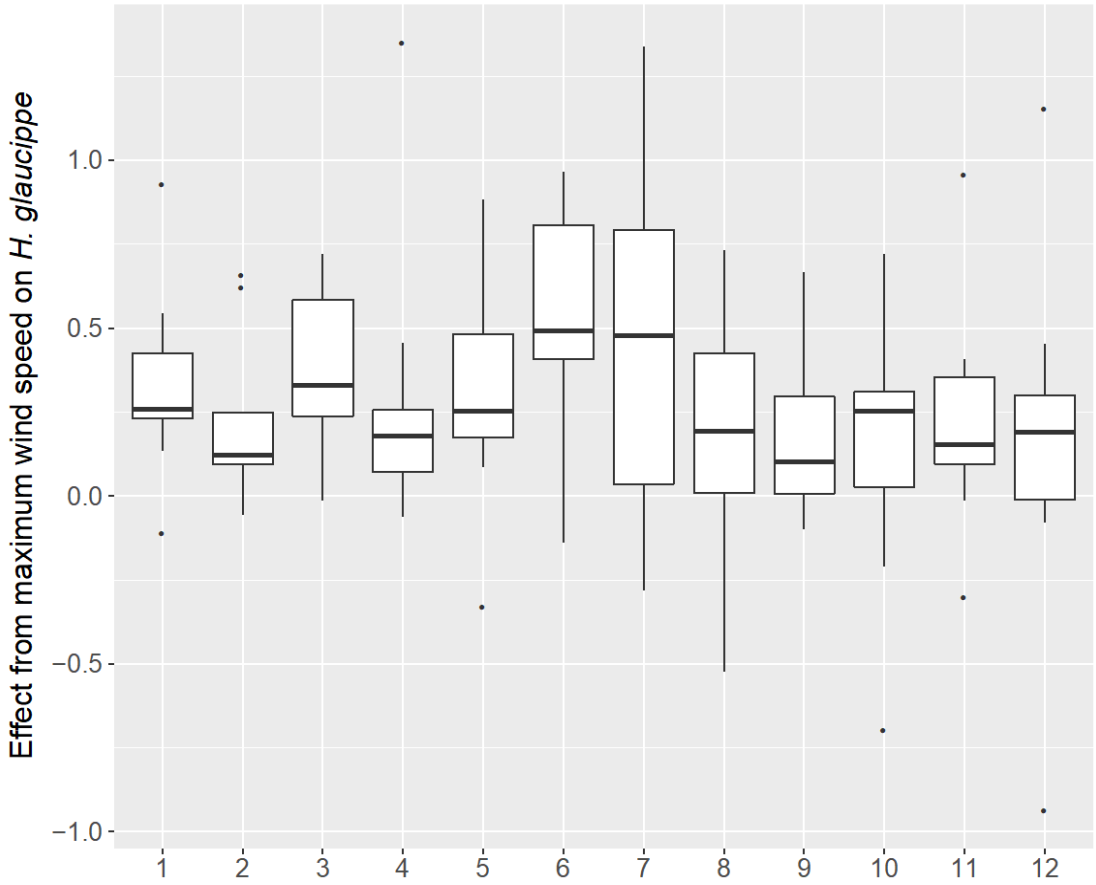
Number of individuals ↘↘



Result

Maximum wind speed had positive effect on the population dynamics in Ishigaki

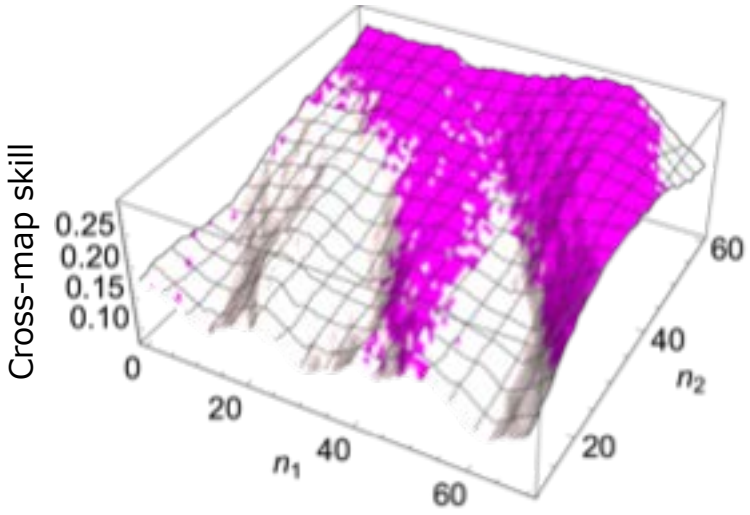




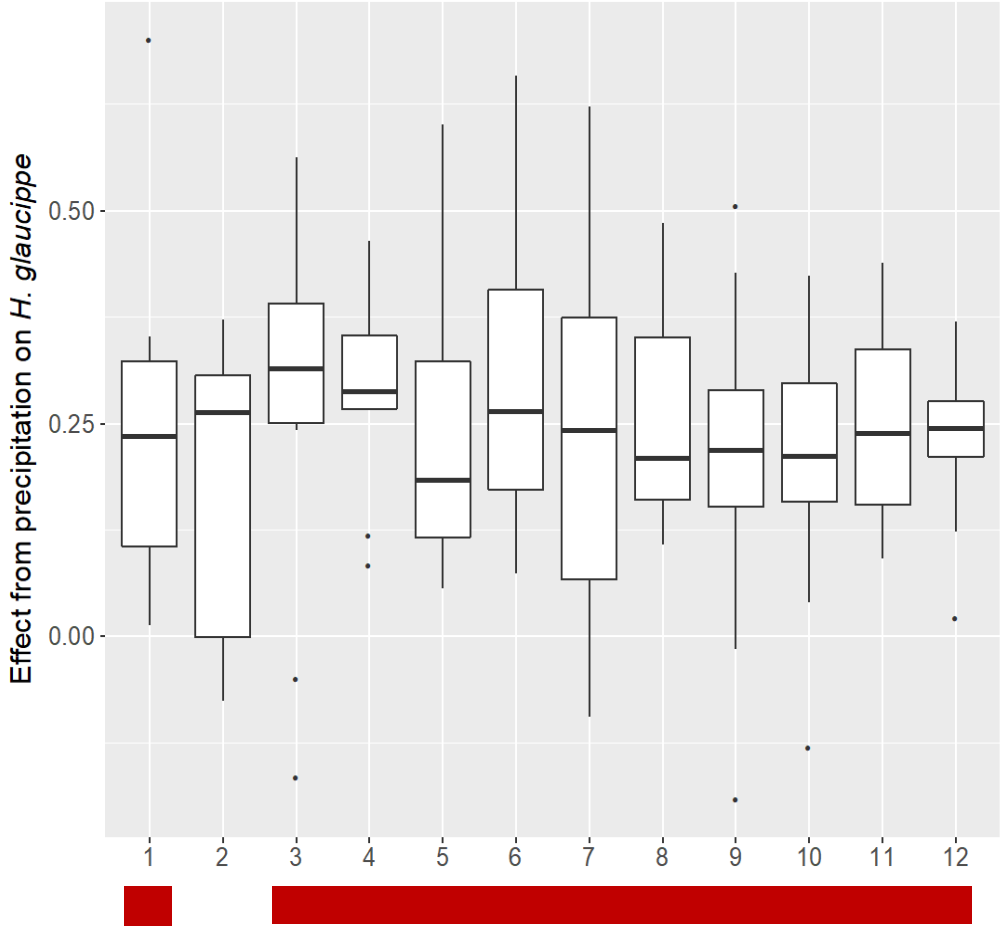
Optimal Parameters : (n_1, n_2) = (60, 12)

Result

Rainfall had positive effect on the population dynamics in Ishigaki

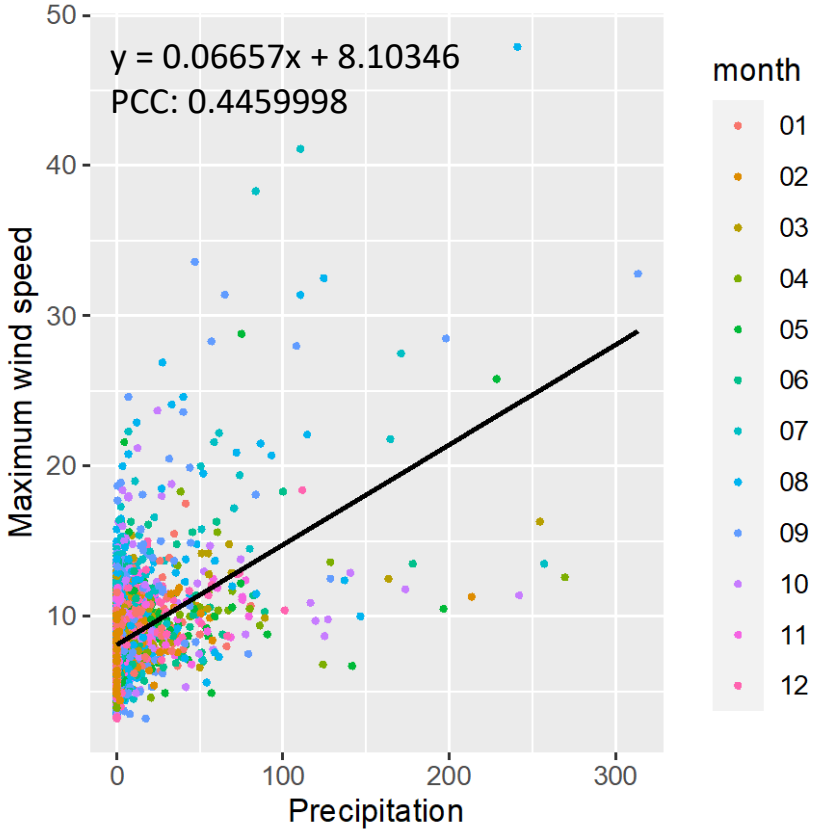


Optimal Parameters : (n_1, n_2) = (55, 57)



Lower 95% CI > 0

CCM results reflect the impact of typhoons



Large value points for precipitation and maximum wind speed are colored blue.

→ Caused by typhoons

Strong wind and rainfall caused by typhoons affect the population dynamics in Ishigaki

Too strong typhoons have a negative impact