

A Vine Copula Based Model for European Multi-Hazards

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Using a newly developed vine copula package, the relationships between heatwave, drought, wind and fuel indicators with wildfires are modelled. The vine copula model attempts to generate stochastic events that include potential wildfire footprints. Here we showcase the model setup using Tenerife as a case study. This model setup will also be used to investigate the dependencies between precipitation, earthquakes and landslides.



Sharing is encouraged



Conference Abstract

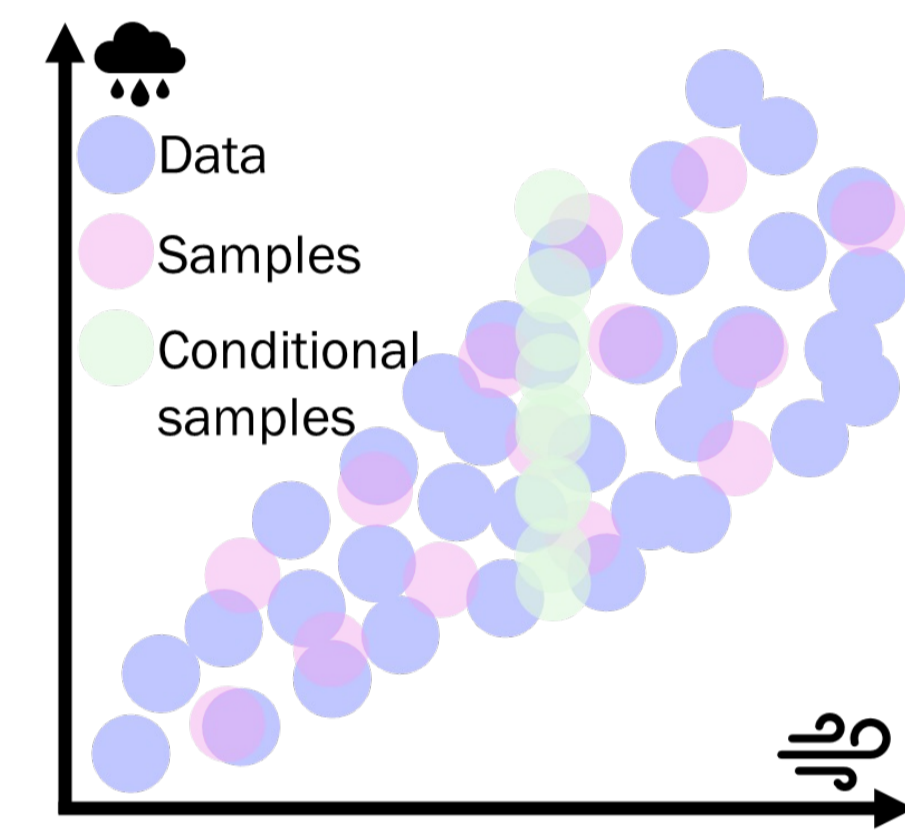


Outstanding Student & PhD candidate Presentation contest

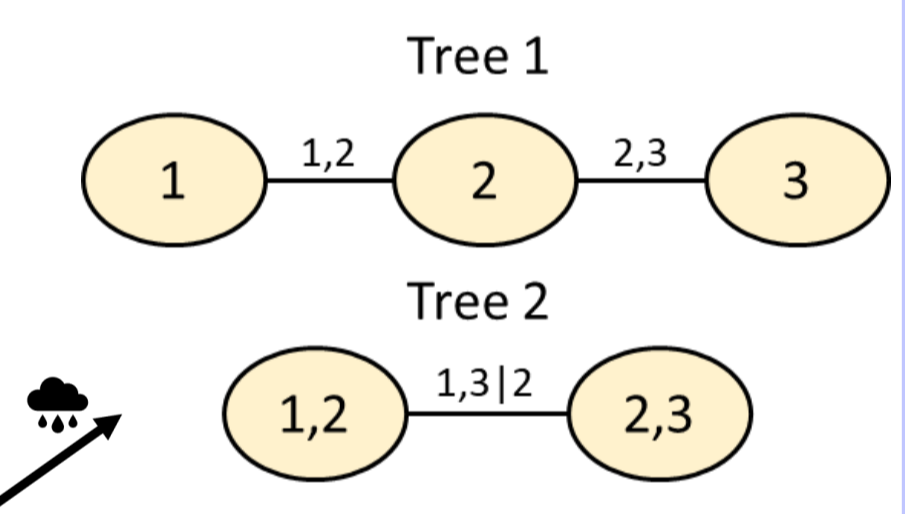
This presentation participates in OSPP

VineCopulas: a Python package

- A bivariate copula method describes the dependency structure between two variables
- Copulas allow for random and conditional samples of the data to be generated
- E.g., a copula between precipitation and wind speed can generate random and conditional samples of both variables




- Vine copulas allow to simulate between more variables
- They use bivariate copulas as building blocks, visualized in a nested sequence of trees





We created **VineCopulas**, a unique python package that can:

- Fit both bivariate and vine copulas
- Allow for both discrete as well as continuous input data
- Draw random and conditional samples for variables of interest



Documentation





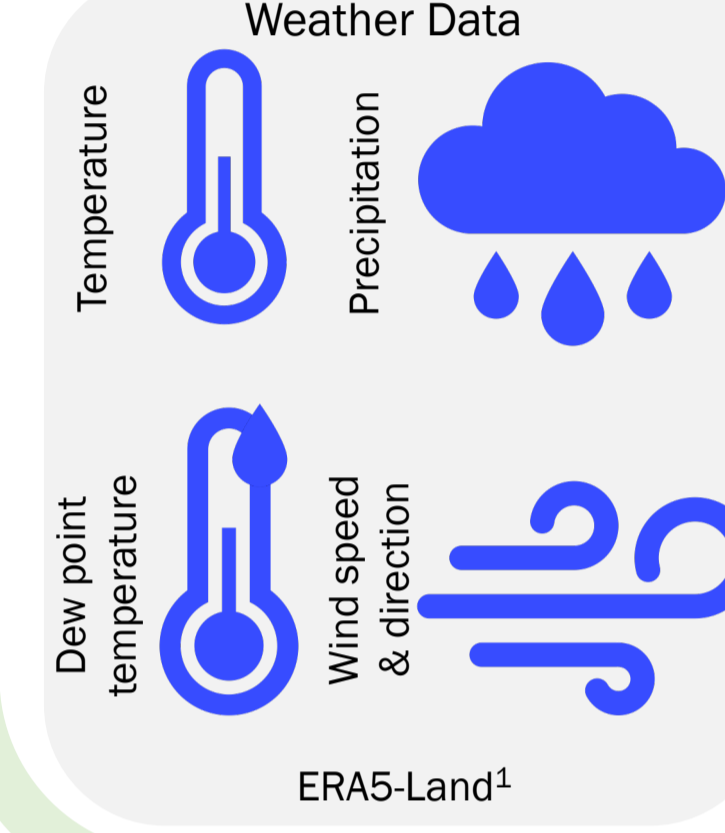
GitHub

Relevance

- The likelihood of a hazardous event can be amplified by the occurrence of a previous event, such as a drought amplifying the likelihood of a wildfire
- This research studies the relationship between drought, wind and heatwave indicators with wildfires

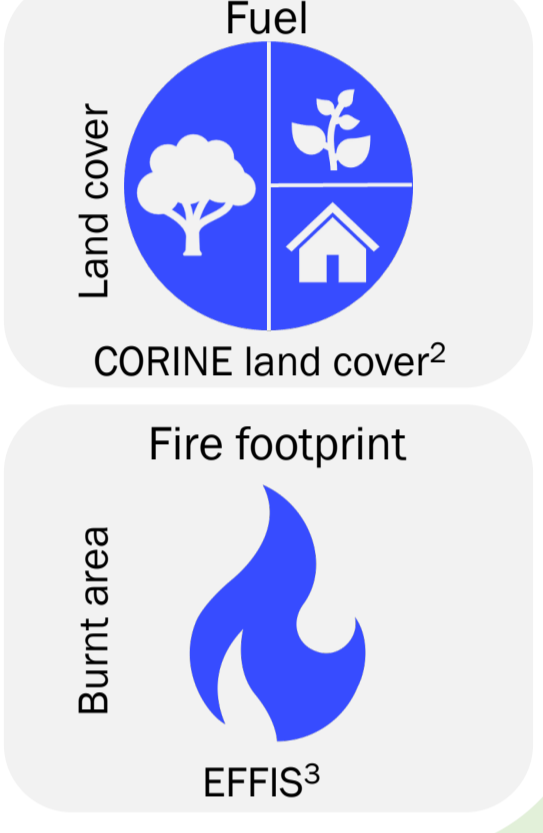
Data

Weather Data



ERA5-Land¹

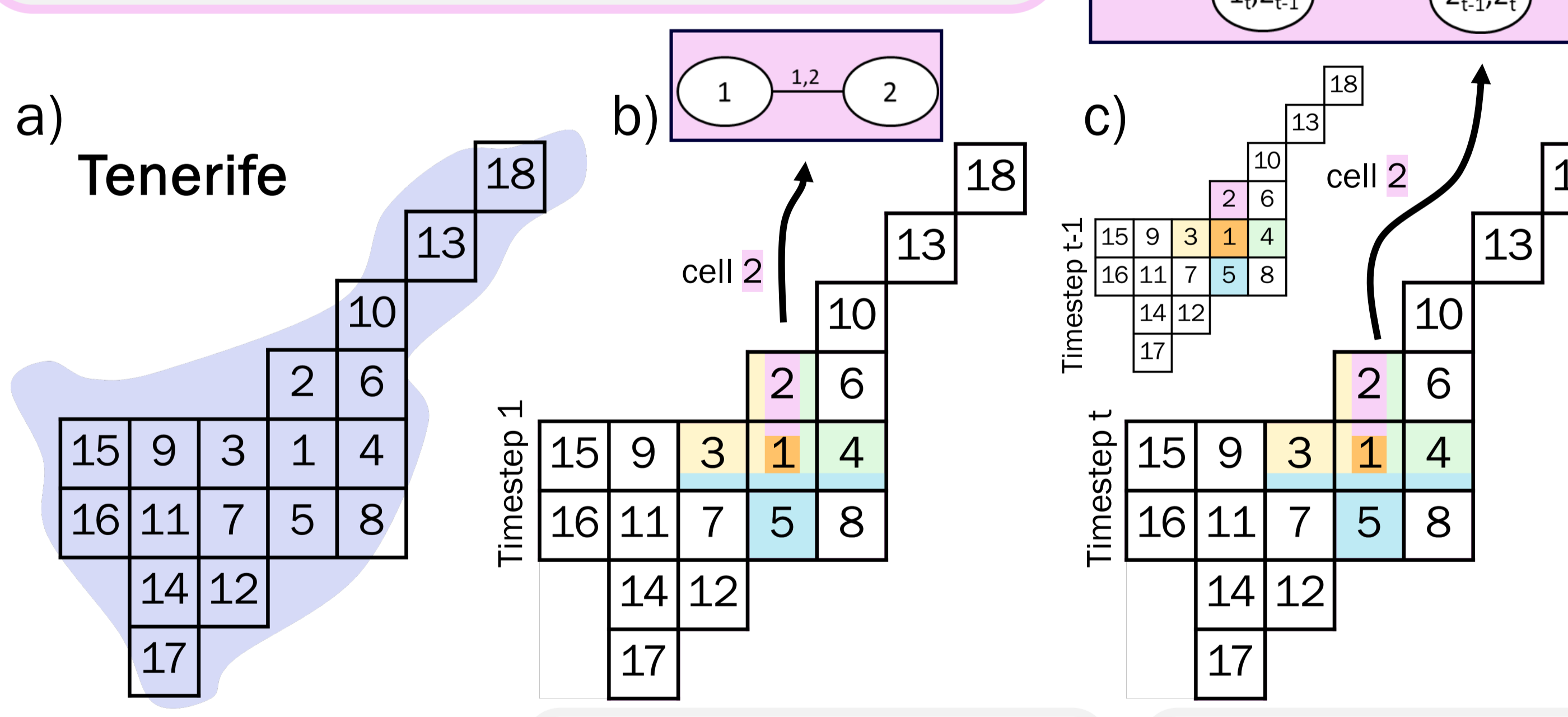
Fuel



CORINE land cover²
EFFIS³

Model Setup: spatiotemporal dependencies

- Using **VineCopulas**, stochastic data is generated for all the different indicator variables
- The Canary Island Tenerife is used as an example case



a) Tenerife

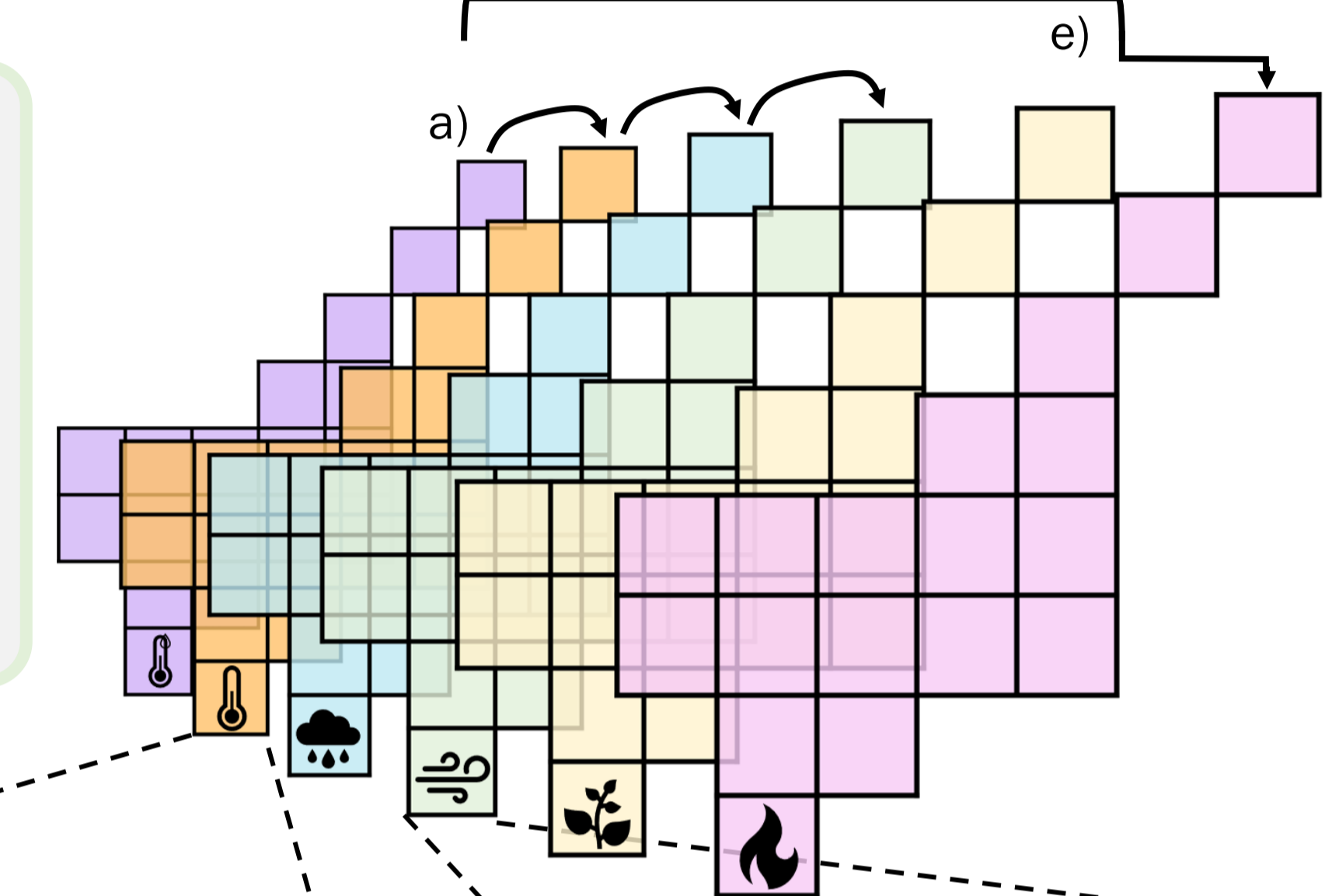
To simulate gridded data, the grids on the area of interest are numbered. This numbering determines the order in which the data is sampled.

b) In timestep 1 (t=1), grid cell 1 will be a random sample. The subsequent steps are sampled based on their neighboring grid cells that have already been sampled. For example, cell 2 is sampled based on 1 using a bivariate copula.

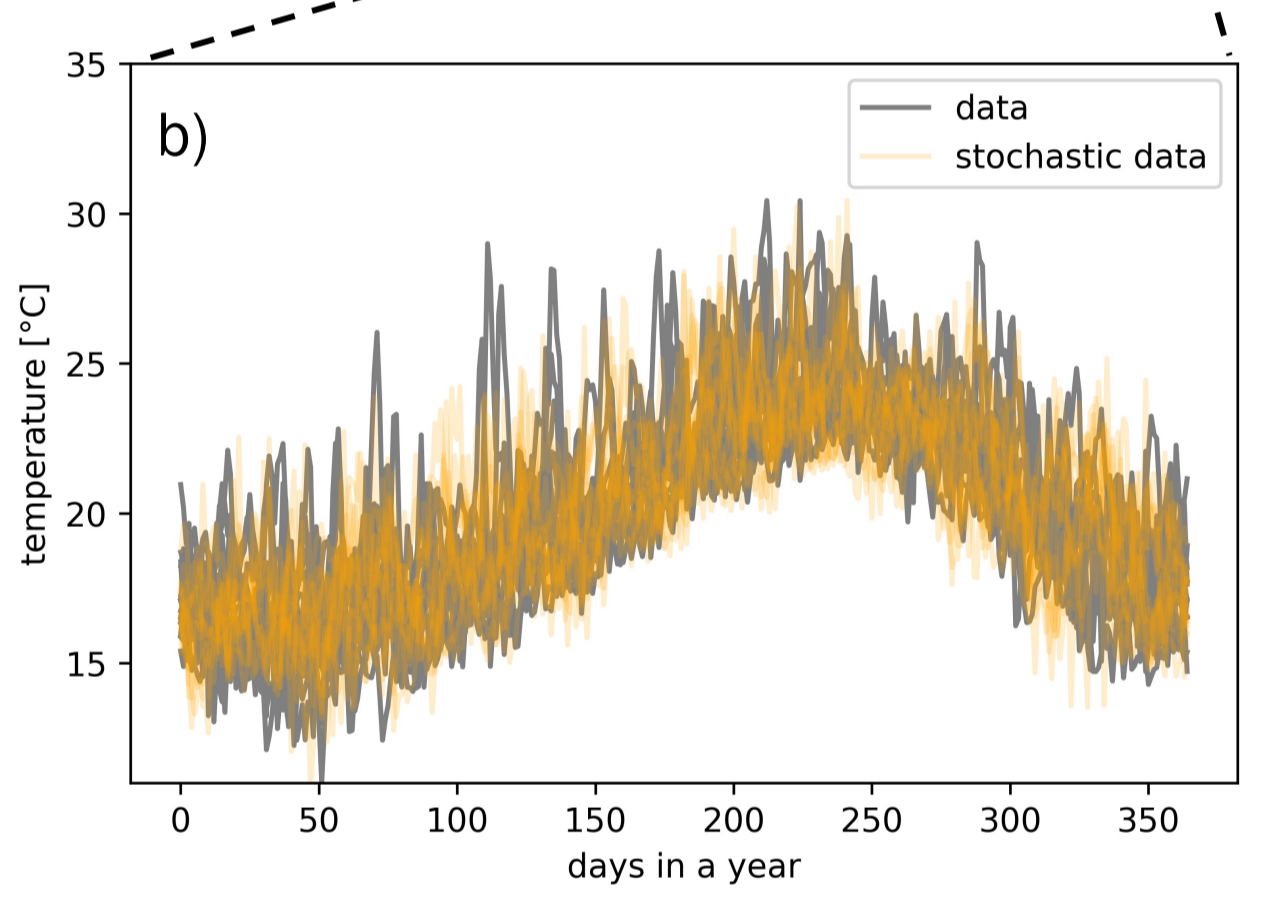
c) In the subsequent timesteps, each grid cell is sampled using the same order as in t = 1, and their value in the previous timestep. For example, cell 2_t is sampled based on 1_t and 2_{t-1}, using a vine copula.

Model: generating data

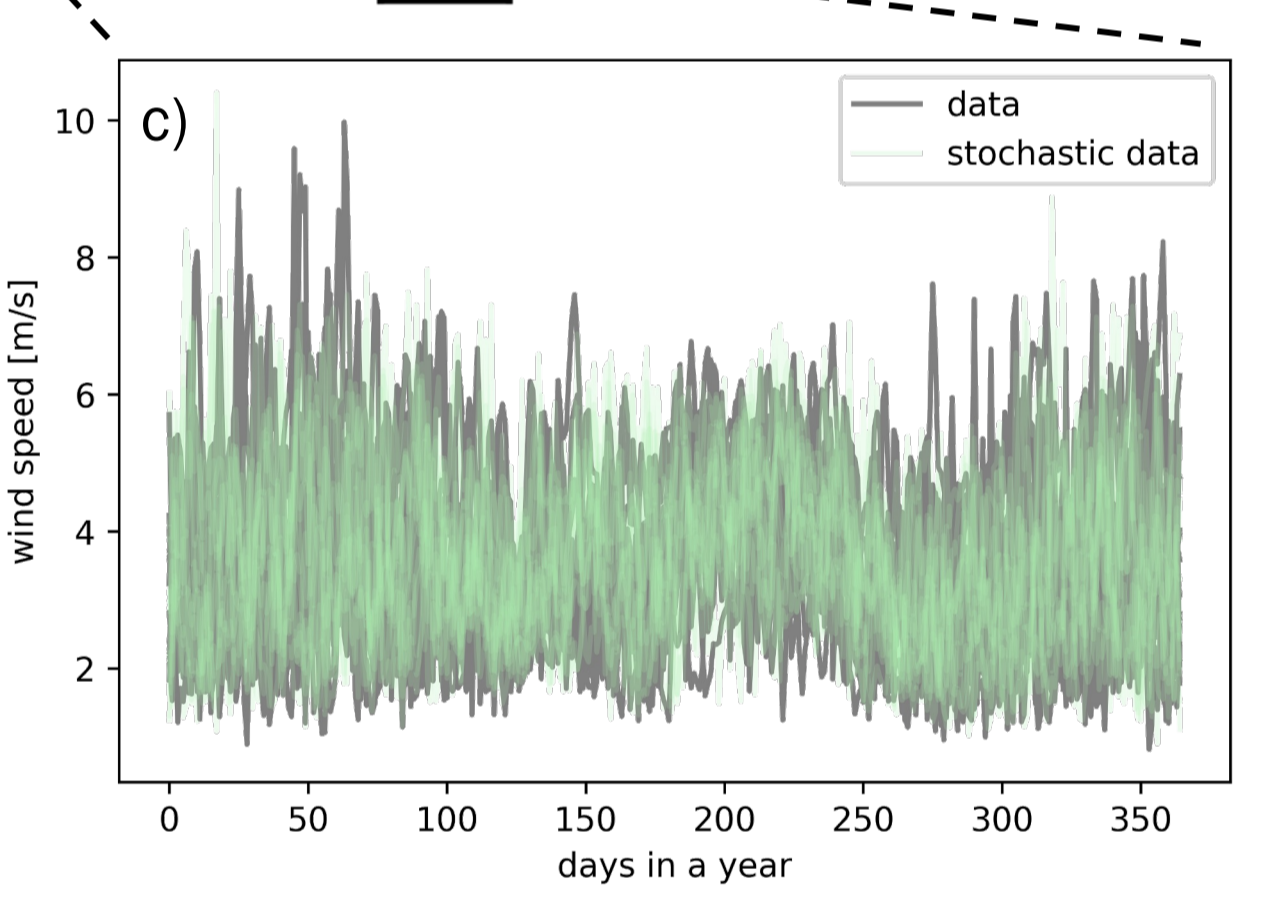
a) To model the dependencies between the unique variables, the spatiotemporal data is simulated by conditionalizing on all the different variables using a vine copula.



b) 14 years of real and stochastic data of temperature (°C) vs days in a year.

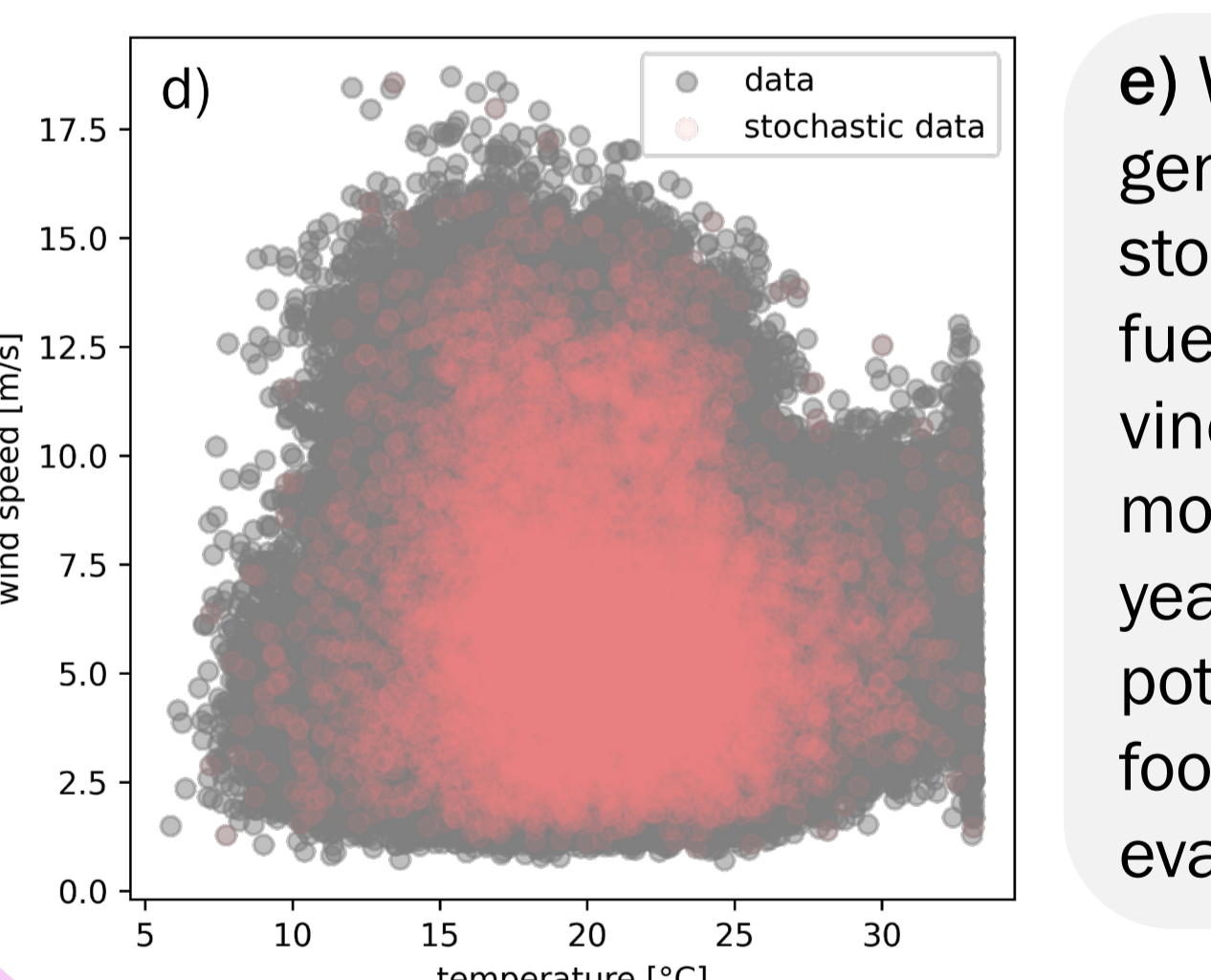


c) 14 years of real and stochastic data of wind speed (m/s) vs days in a year.

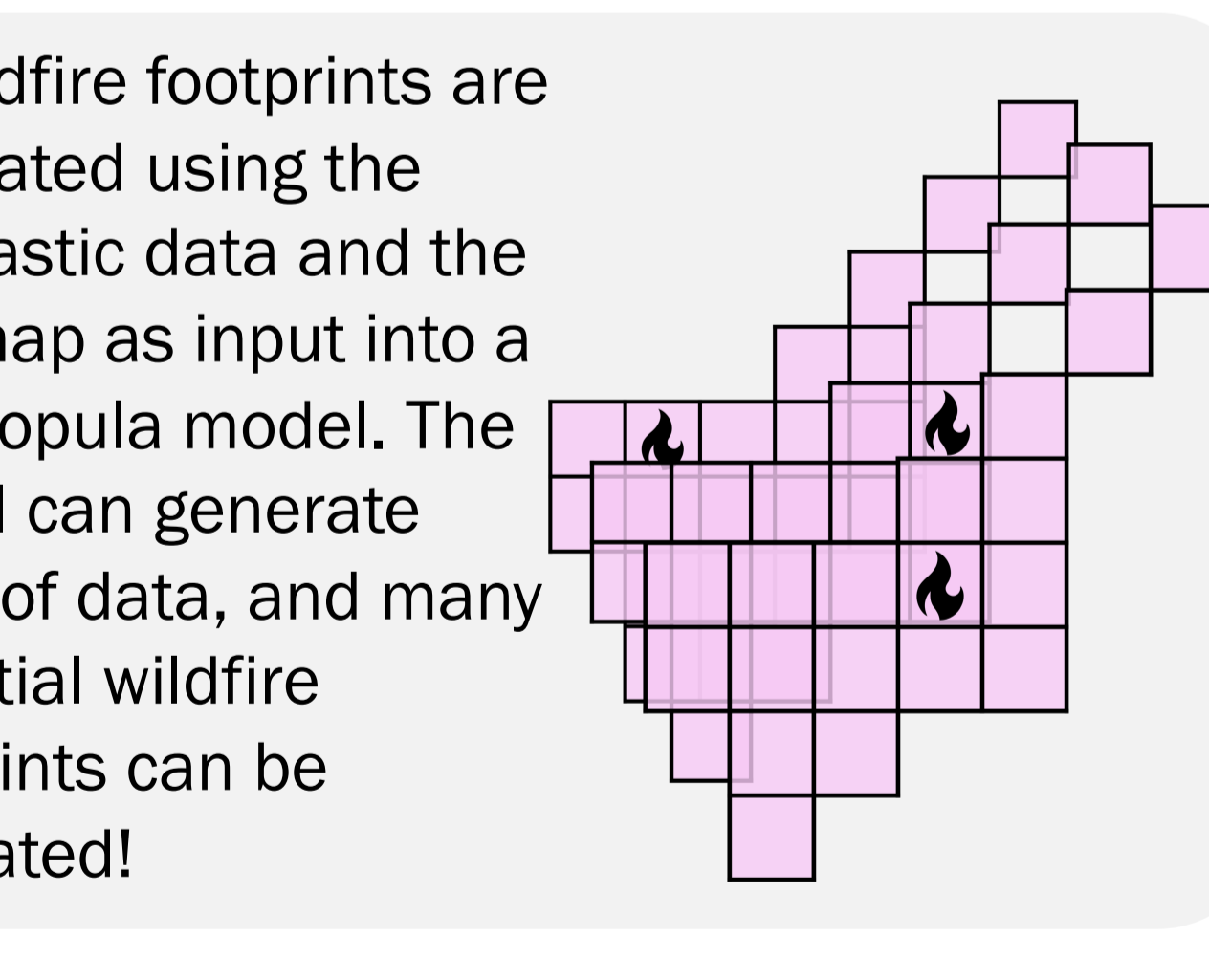


14 years of real and stochastic data of b) temperature, and c) wind speed. d) 10000 stochastic data points showcasing that the relationship between variables is preserved.

d) Scatter plot of wind speed (m/s) vs temperature (°C) showing data points (blue) and stochastic data points (orange).





e) Wildfire footprints are generated using the stochastic data and the fuel map as input into a vine copula model. The model can generate years of data, and many potential wildfire footprints can be evaluated!



Get in touch

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Future Outlook

The model will be openly available for all of Europe by the end of 2024. The model will also include an application of the same method to generate landslide footprints based on extreme rainfall and earthquake data.



1. Muñoz-Sabater, J. et al. ERA5-Land: a state-of-the-art global reanalysis dataset for land applications. *Earth System Science Data* 13, 4349–4383 (2021).
2. CORINE Land Cover. land.copernicus.eu <https://land.copernicus.eu/en/products/corine-land-cover>.
3. Fire Database in the European Forest Fire Information System (version 2-3-1). data.jrc.ec.europa.eu (2018).
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