Asset Level Modelling of RISKs In the Face of Climate Induced Extreme Events and ADAPTtation (RISKADAPT)

Climate data and climate change

Risk assessment of structures under Climate Change

Athens
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RISKADAPT
Modeling of Risks and Adaptation

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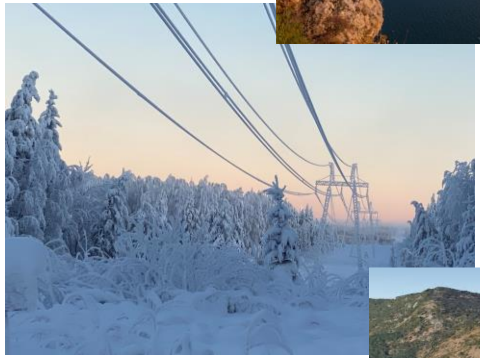
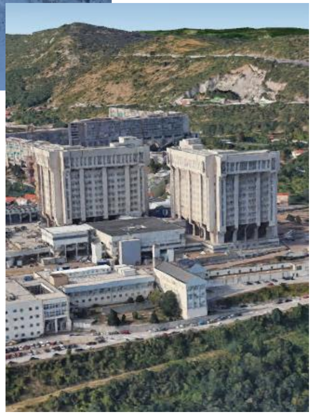
Framework Programme of the EU

RISKADAPT pilot cases

- Pilot 1 - Polyfytos Road Bridge in Region of Western Macedonia, Greece.
  - Climate forcing: Precipitation and river discharges.
- Pilot 2 - Energy transmission grid in a Nordic climate.
  - Climate forcing: Icing and snow load.
- Pilot 3 - Cattinara hospital building in Trieste, Italy.
  - Climate forcing: strong Bora winds.
- Pilot 4 - High-rise buildings with glass facades in Hong Kong.
  - Climate forcing: heavy wind and rain.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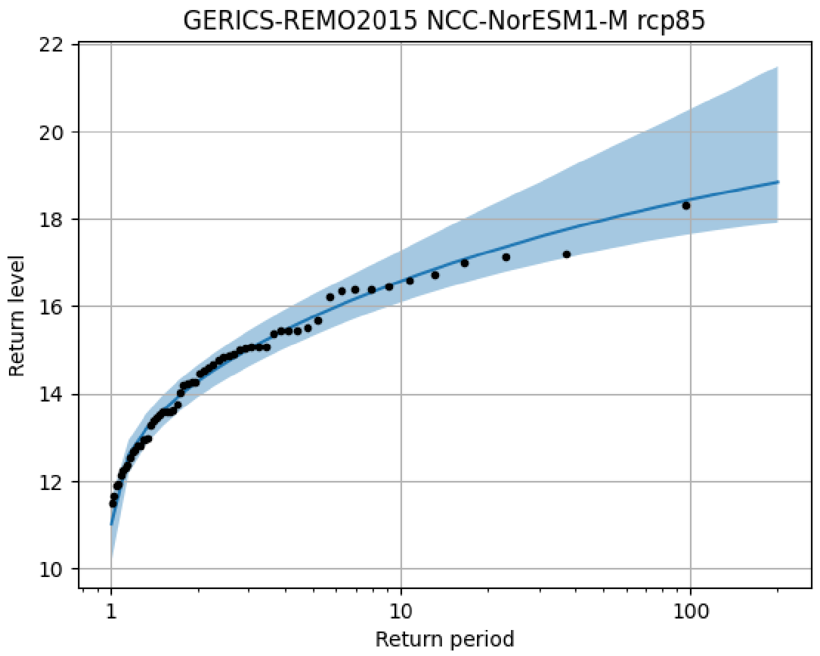
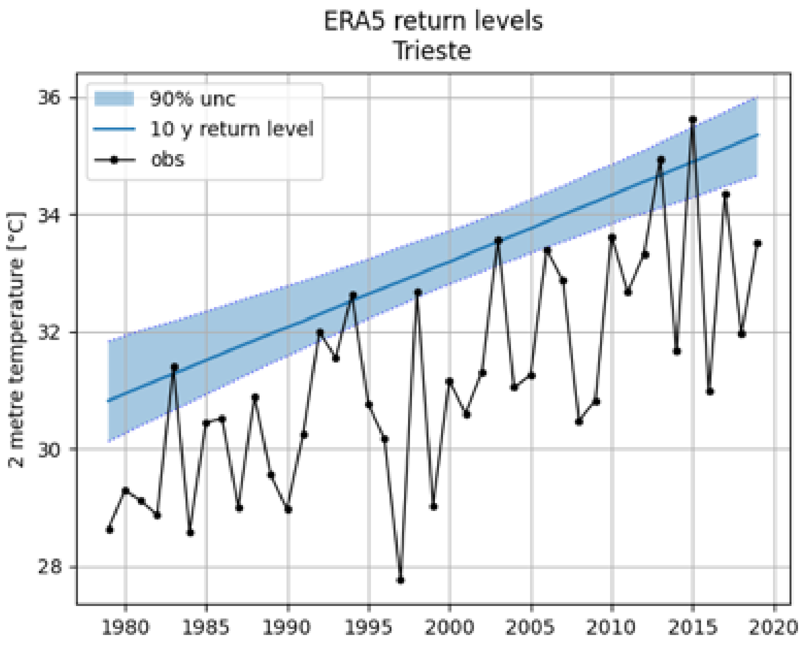
Climate extremes

- Extreme value analysis gives statistical tools to evaluate occurrence probabilities of rare events based on historical or simulated future time series of maxima.
- In rapidly changing climate, the non-stationary nature of the system must be accounted.





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Climate extremes - generalized extreme value distribution GEV

The GEV distribution is defined by three parameters: μ, σ and ξ:

$$G(y;\ \mu,\sigma,\xi) = \exp\left(-\left[1+\xi\left(\frac{y-\mu}{\sigma}\right)\right]_{+}^{-\frac{1}{\xi}}\right),$$

GEV cumulative distribution

which gives quantiles defined by tail probabilities p

$$y_p = \begin{cases} \mu - \frac{\sigma}{\mu}\left[1-\{-\log(1-p)\}^{-\xi}\right], & \text{for } \xi \neq 0, \\ \mu - \sigma\log\{1-\log(1-p)\}, & \text{for } \xi = 0. \end{cases}$$

GEV quantiles

For non-stationarity, we can let the parameters depend on external factors, for example as in
$\mu_t = \mu_0 + \mu_{trend} \cdot (t - t_0) + f(t) + \epsilon_t$.

Our analysis is based on hierarchical Bayesian statistics and MCMC algorithms implemented in Stan statistical language and Python.

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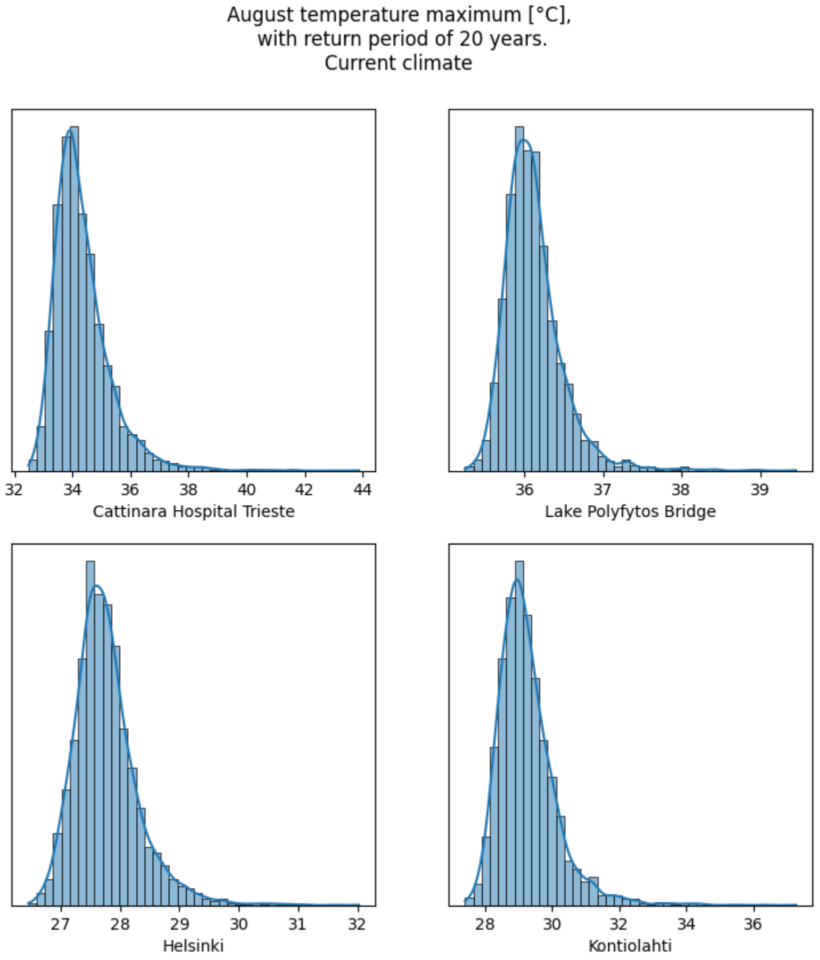
ERA5 reanalysis for historical and the current climate

- **ERA5** is the fifth generation ECMWF reanalysis for the global climate and weather for the past 8 decades.
- It is the best source for global historical analysis of the actual weather based on numerical weather prediction model and wide range of observations.
- Available from 1940 to present.
- Accessible from Copernicus Climate Store (CDS), Google cloud, etc.



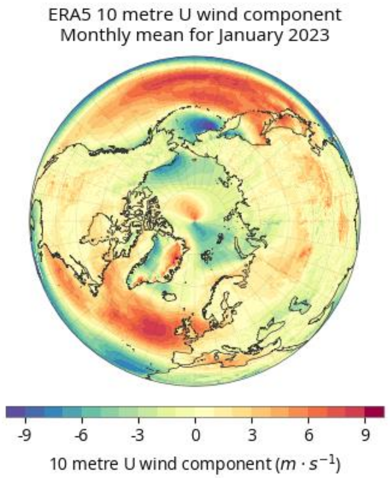


Figure: ECMWF

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Climate modelling

- Climate models are vast computer simulations that numerically solve physics and chemistry equations.
- A numerical description of the climate system, its components, the connections between different parts, and external forcing run on supercomputers.
- Models are used not only to examine future developments but also to enhance the basic understanding of the climate system.
- Concentration scenarios explore different possible futures.
- Climate models use these scenarios to produce climate projections. Climate projections help assess the impacts and risks of climate change.

- RISKADAPT utilises model data available from CDS: the model intercomparison projects, such as **CMIP6** and **Euro-CORDEX**.
- In addition, high resolution **Harmonie-CLIM** model is used over Fenno-Scandinavia.

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Climate modelling: challenges and sources of uncertainties

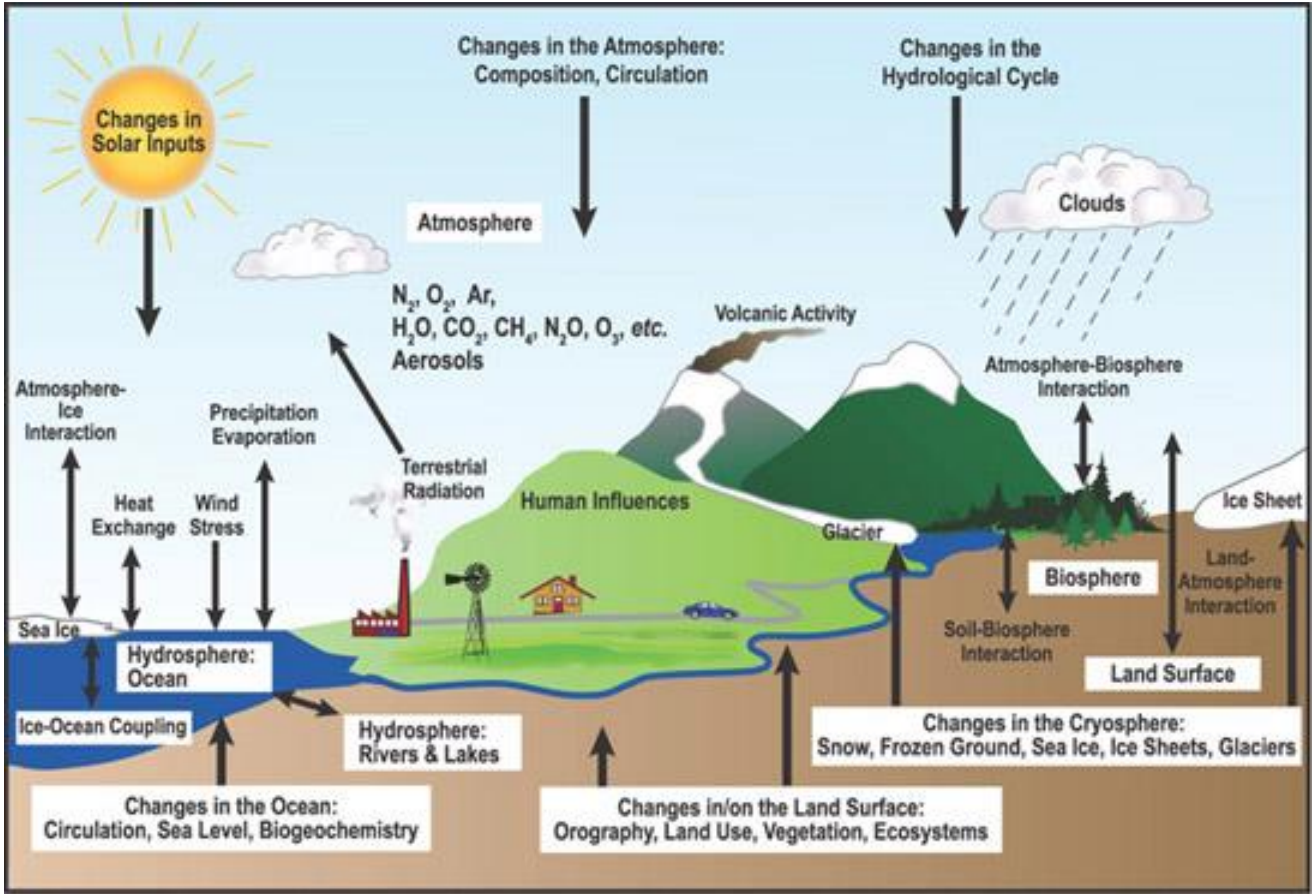

Figure: IPCC (2007)

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Estimating local changes – temperature

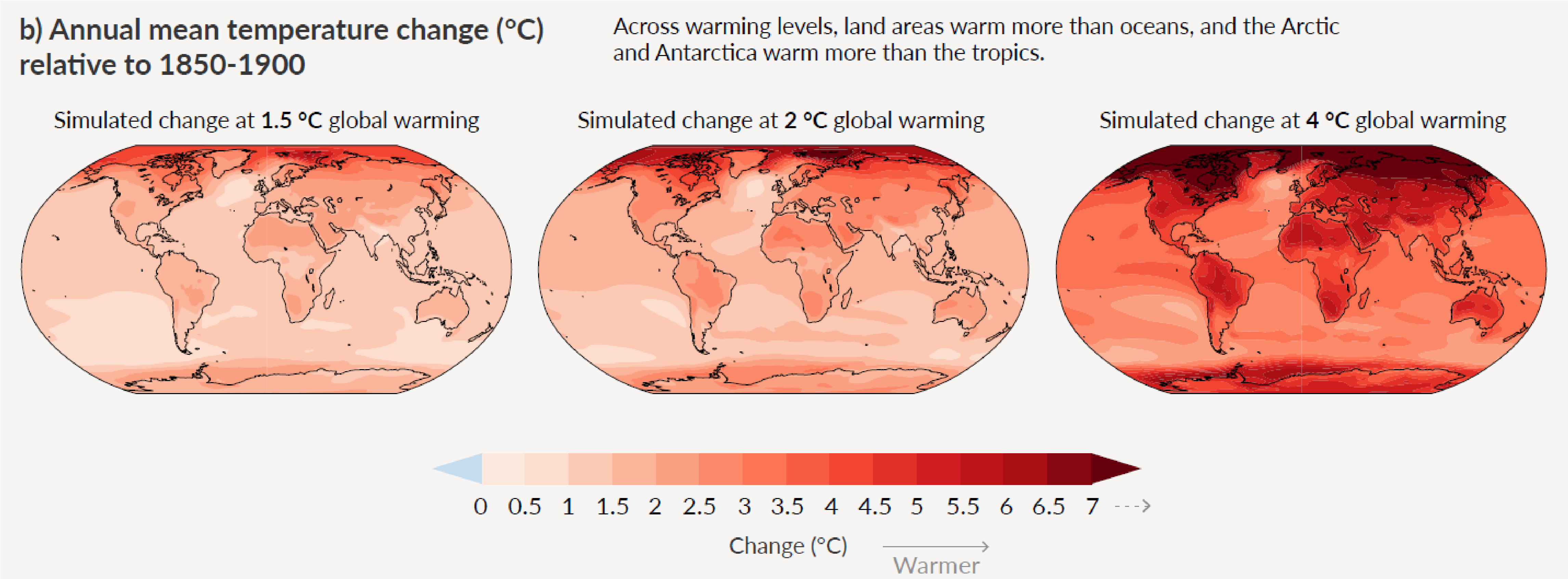

Figure: IPCC

Estimating local changes – precipitation

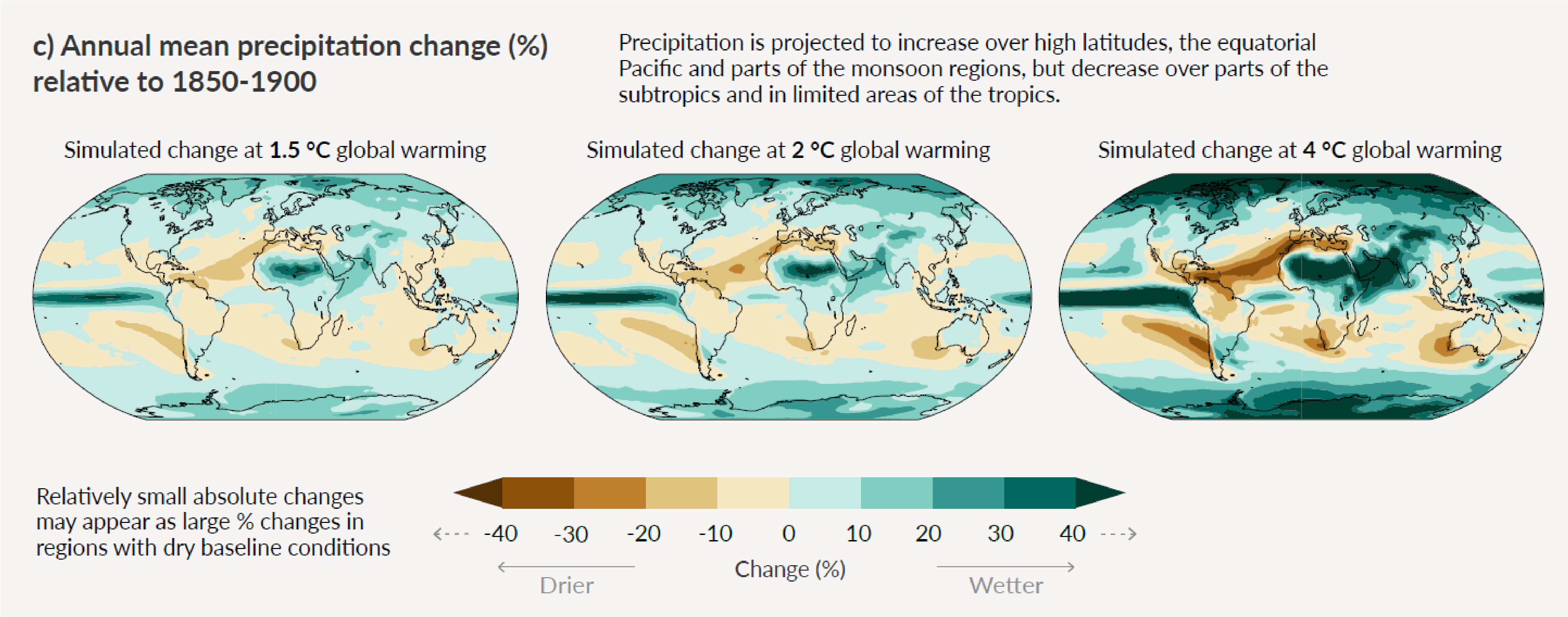

Figure: IPCC

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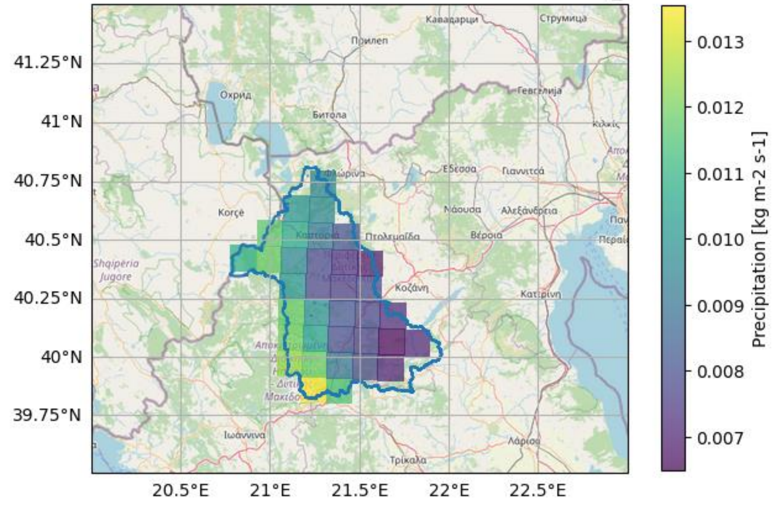
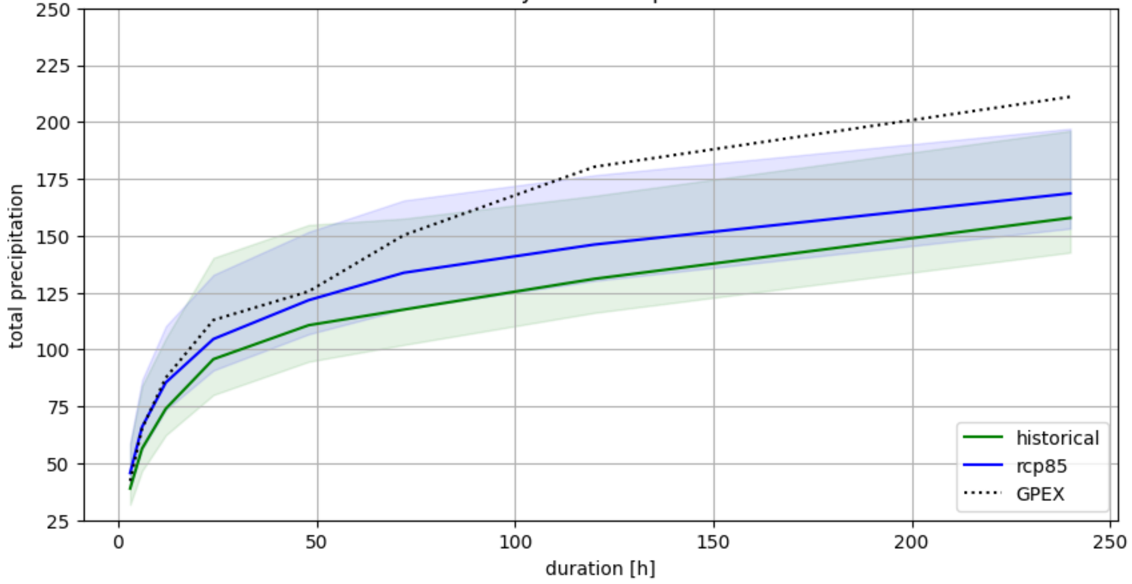
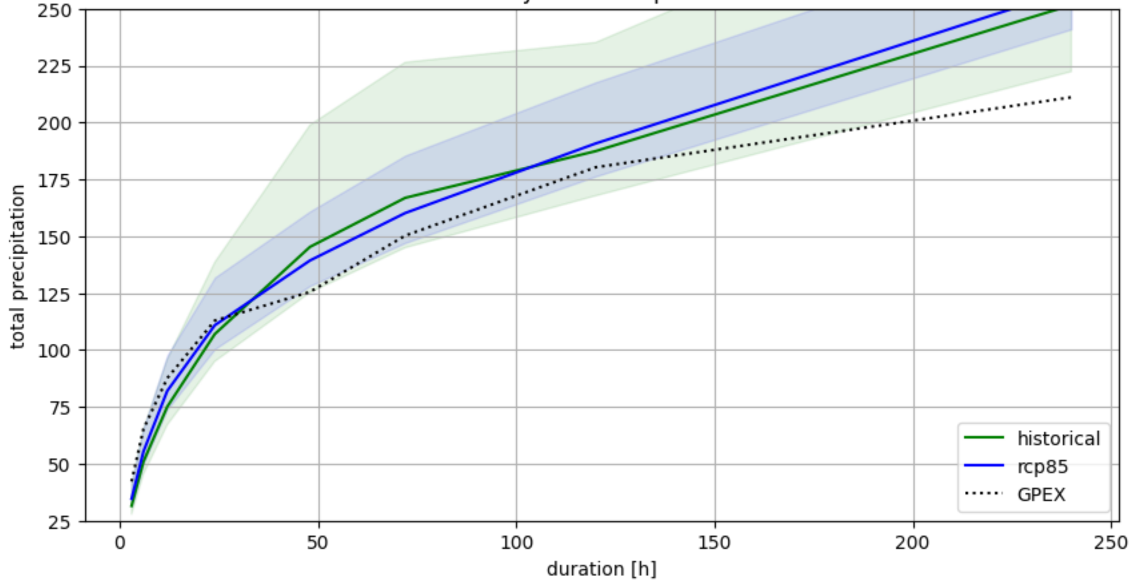
RISKADAPT Pilot 1 – Polyfytos road bridge

- Hydrological and hydrodynamical modelling by University of Ljubljana based on estimated changes if precipitation.
- Intensity–duration–frequency analysis for Euro-CORDEX model simulations.







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RISKADAP Pilot 2 - icing in Fenno-Scandinavia

- Ice and snow loads of transmission towers.
- Structural risks analysis by ERRA.
- Corona losses in power transmission.
- Effects on wind power production.
- High-resolution Harmonie CLIM model.

Years	1985–2005	2040–2060	2080–2100
Scenario	historical	RCP8.5	RCP8.5
Boundary model	EC EARTH or GFDL-CM3	EC EARTH or GFDL-CM3	EC EARTH or GFDL-CM3

FMI research station in Pallas, Finland
(67°58’ N, 24°07’ E) Photo Ahti Ovaskainen

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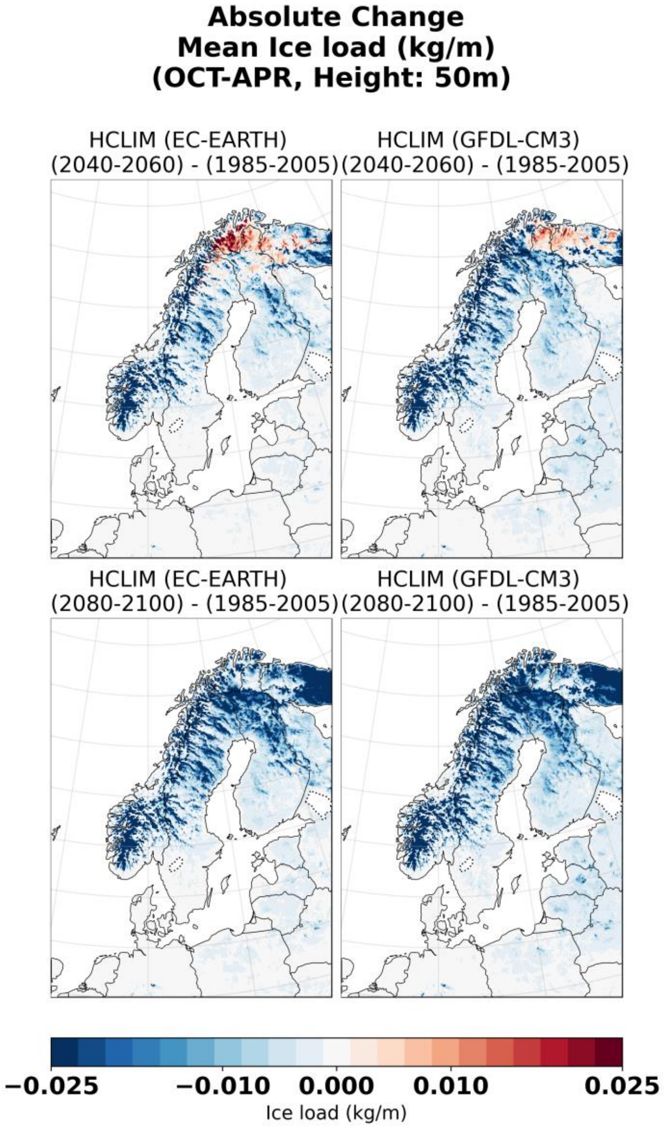
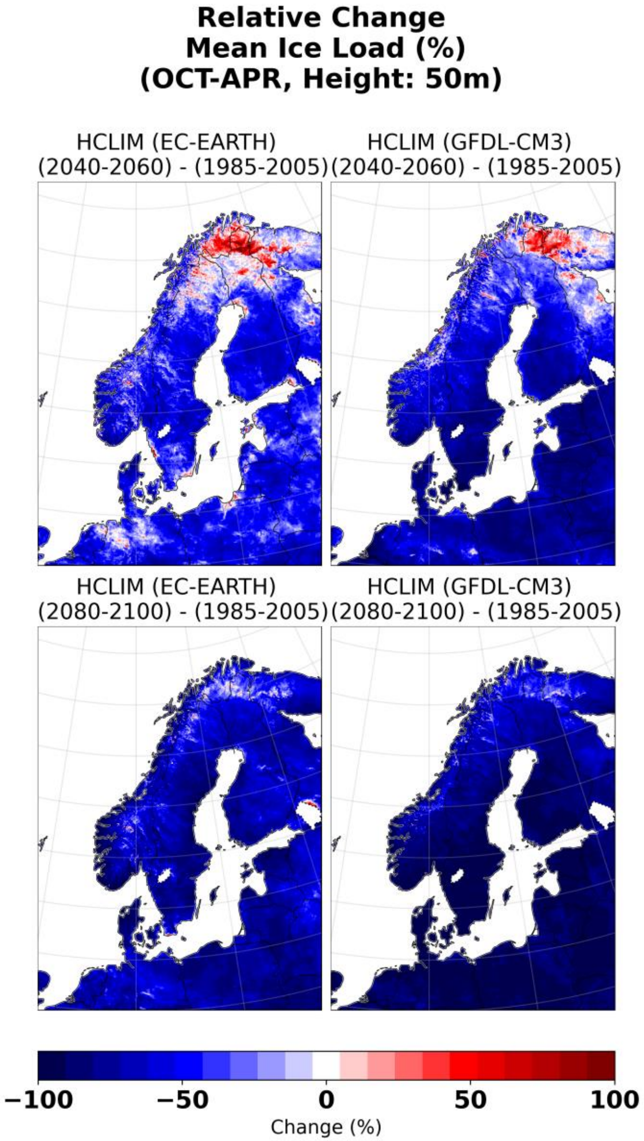
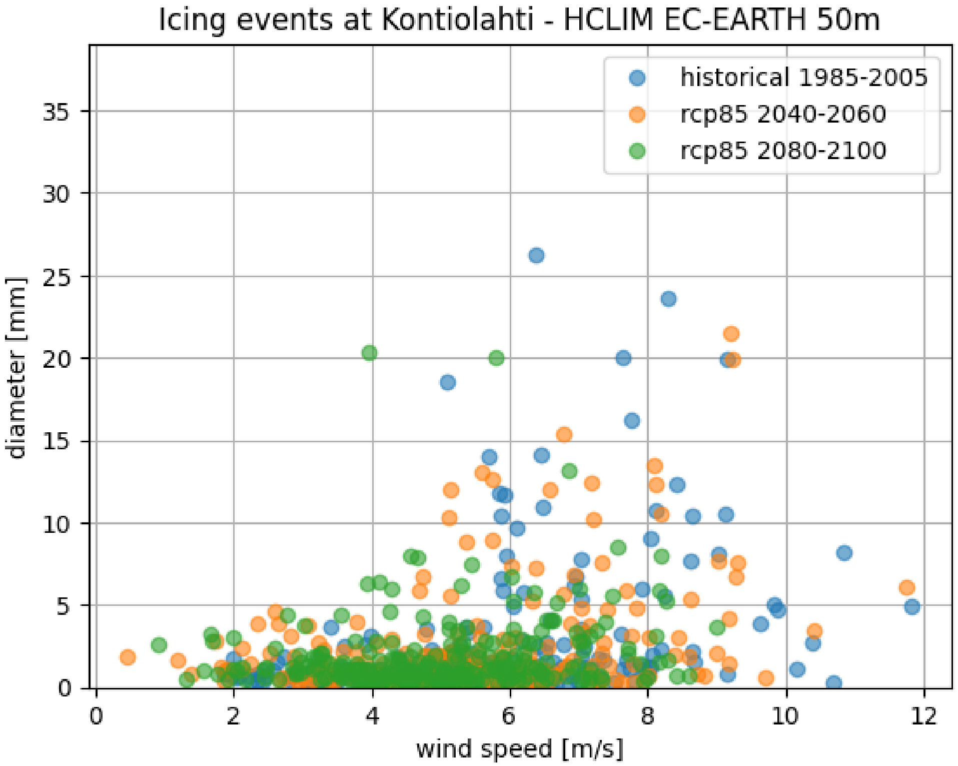
RISKADAP Pilot 2 - icing in Fenno-Scandinavia







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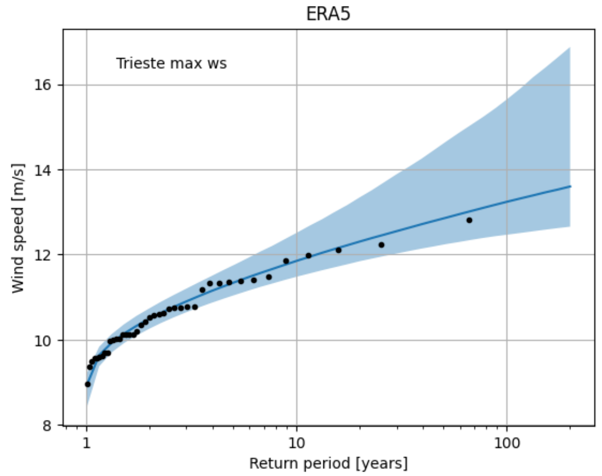
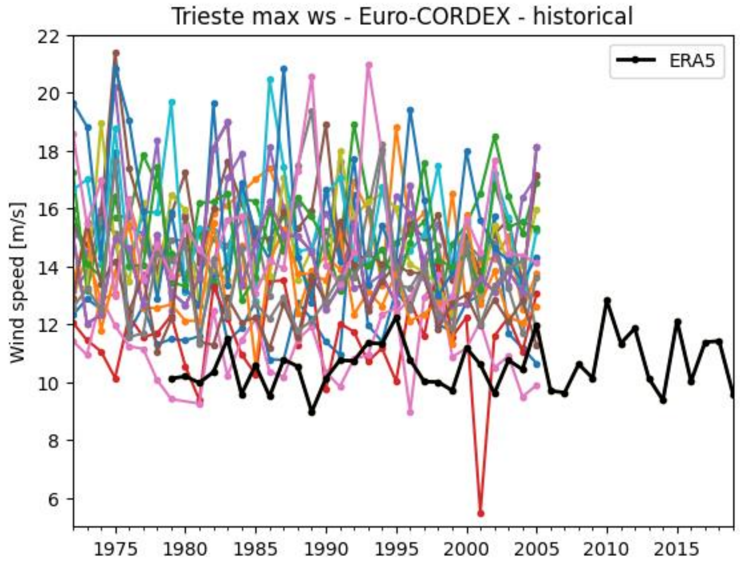
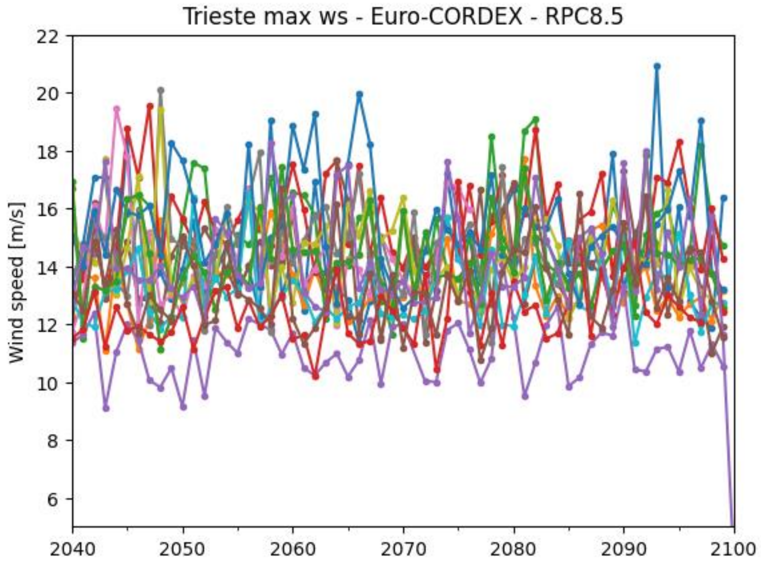
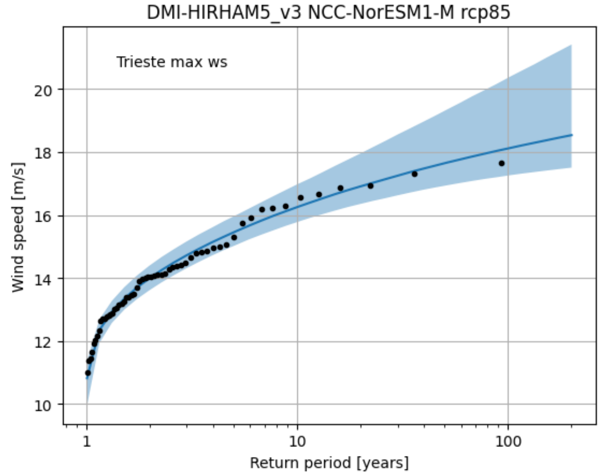
Pilot 3: wind speed near Trieste hospital

- Small-scale modelling by University of Bologna.
- Background: Bora wind.
- Not fully resolved by Euro-CORDEX or ERA5?









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Thank you!

See you at EGU General Assembly 2025, Vienna, 27 April–2 May 2025.

Session ITS4.10/NH13.6:

Impact of climate change-induced extreme events: risk assessment and damage modeling for infrastructure and assets.

https://meetingorganizer.copernicus.org/EGU25/session/54115

EGU General Assembly

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