interTwin

Climate Change Impacts of Extreme Events DTs

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EODC Forum 2023, 9-10 May 2023, Vienna & Online

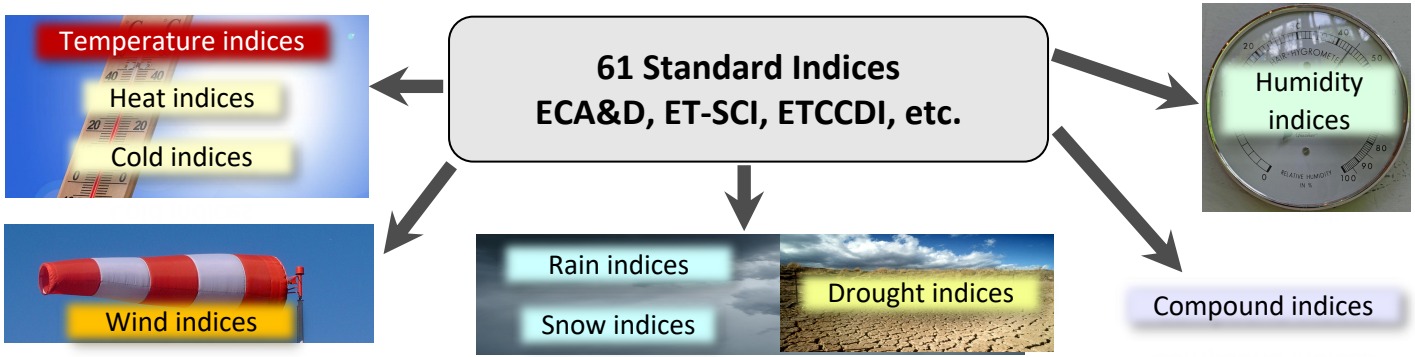
interTwin is funded by Horizon Europe under grant agreement n° 101058386

Why a DT for Climate Change impacts and Extreme Events?

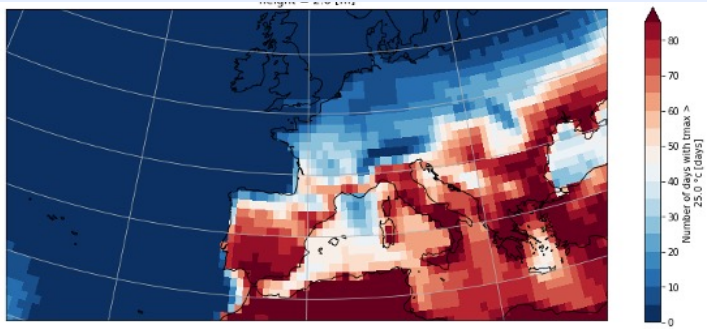
- Needs for users to assess the impacts of different climate change scenarios on extreme events
- Evaluate properly the climate change impacts uncertainties: ensemble approach
- Very large number of scenarios and simulations
  - Large data volumes
  - Overwhelming and requires large computing, bandwidth and storage resources
  - Very time consuming

➢ Efficient, fast and flexible approach is needed

Why a DT for Climate Change impacts and Extreme Events?



- Intra-period extreme temperature range [° C] - **ETR**
- Warm days (days with mean temperature > 90th percentile of daily mean temperature) - **TG90p**
- Summer days (days with max temperature > 25 ° C) - **SU**
- **...**



Scientific overview: Climate Change Impacts Extreme Events

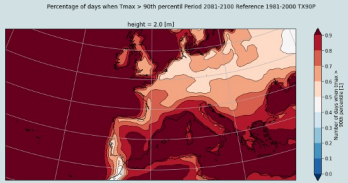
Characterization of the changes of Extreme Events and their impacts

Data-driven approach (based on Unsupervised Machine Learning or Variable Autoencoders) for detecting and assessing the changes of characteristics of extreme events. The following characteristics will be assessed:

- Duration
- Spatial extent
- Intensity (if relevant)
- Frequency of occurrence
- Compound Events

Generic approach

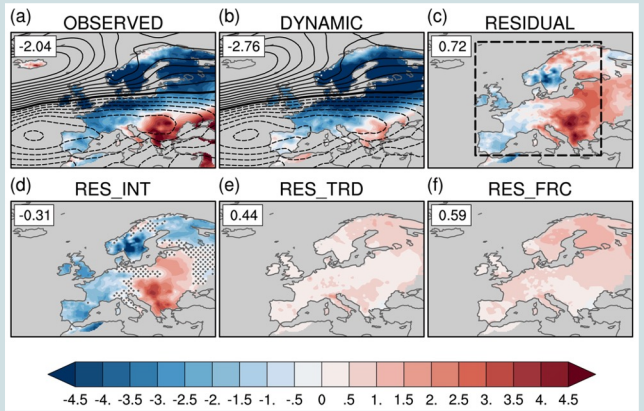
Start simple: heavy rain events



Extreme Event Attribution (EEA)

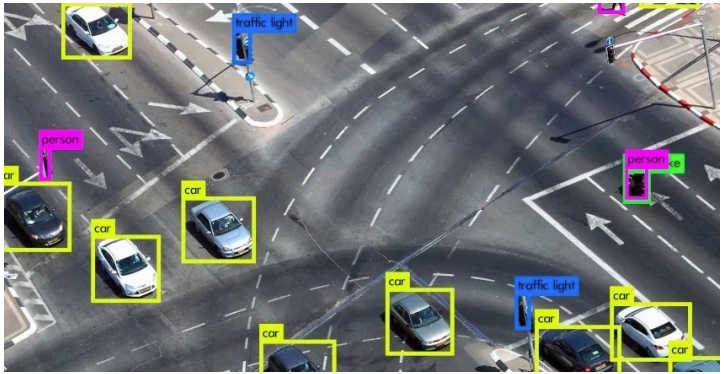
Data-driven approach for a near real-time or projection-based assessment of the attribution of high impacts extreme events to climate change.

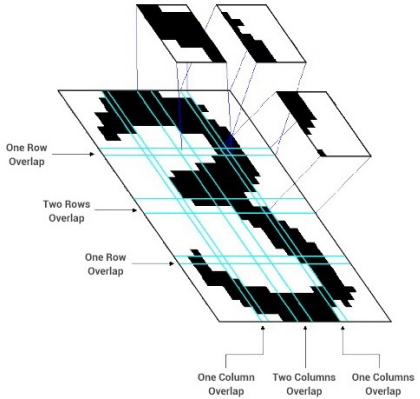
Terray, L.: A dynamical adjustment perspective on extreme event attribution, Weather Clim. Dynam., 2, 971–989, https://doi.org/10.5194/wcd-2-971-2021, 2021.



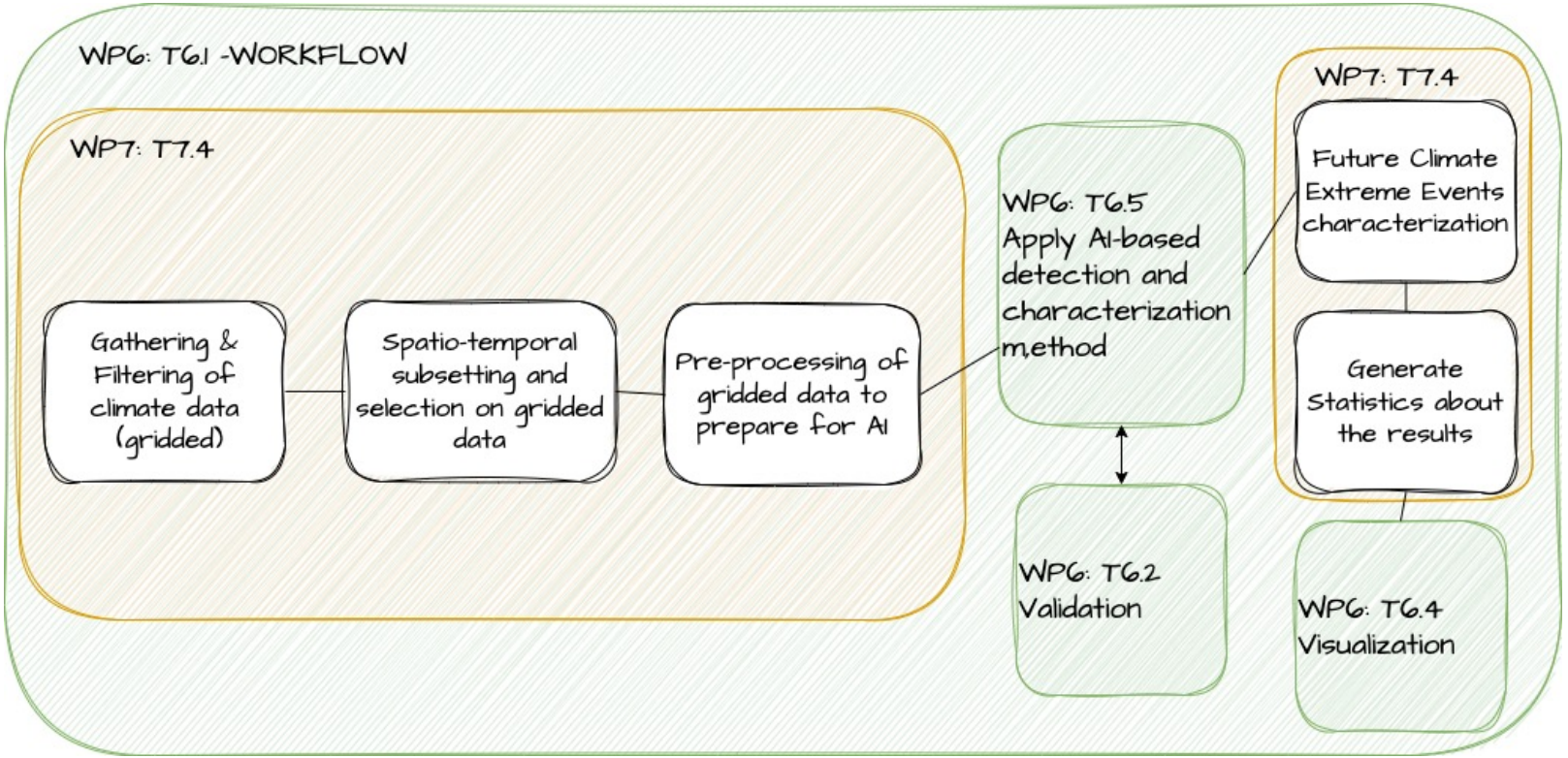
Why use a AI based method?

- To analyze a large database of climate scenarios with a good performance
- Use efficiently new architectures (GPUs)
- Scalability in cloud-based environments
- Extreme Events spatial structures are similar to pattern recognition in images or series of images





High level workflow: DT for Climate Change Impacts Extreme Events



High level workflow: DT for Climate Change Impacts Extreme Events

Database of climate indices (CMIP6)

ML models training on historical CMIP6 simulations on selected extreme events types

Pre-calculated

Store & Share

Selected CMIP6 future projections & subset

Apply ML model on future projections for selected extreme event type

Characterize the changes of high impacts extreme events in future projections

Visualization

DT User

Selected Extreme Event Type

High level workflow: DT for Climate Change Impacts Extreme Events (Advanced version for event-based climate indices)

CMIP6 Simulation Data

Subset & Calculate specific climate indices using icclim

ML models training on historical CMIP6 simulations on selected extreme events types

Store & Share

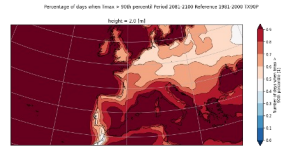
Pre-calculated

Selected CMIP6 future projections & Parameters for specific climate indices & subset

Apply ML model on future projections for selected extreme event type

Characterize the changes of high impacts extreme events in future projections

Visualization



DT User

Selected Extreme Event Type

High level workflow: DT for Climate Change Impacts Extreme Events: Extreme Events Attribution

ERA5 Re-analysis Near Realtime

Select dates and data of extreme event

DT User

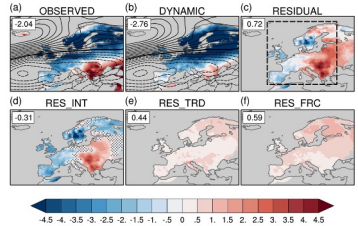
Selected Extreme Event Type

Extreme Event Attribution Standard Data Analytics

Calculate Residuals

Visualization

Store & Share



Requirements: DT for Climate Change Impacts Extreme Events

Repositories	CMIP6	CMIP6 Climate Indices	ERA5
Data types	Projections-Gridded	Historical and Projections of Climate Indices - Gridded	Reanalysis-Gridded
Data formats	NetCDF	NetCDF or zarr	NetCDF
Spatial resolution and coverage	~0.25°x0.25°/global	~0.25°x0.25°/global	~0.25°x0.25°/global
Temporal resolution and extent	6-hourly up to daily /1850-2014 (historical) and 2015-2100 (projections)	Annual 1850-2014 (historical) & 2015-2100 (projections)	Daily (near realtime data, seasonal or event based)
Update frequency	Very rarely	Very rarely	Daily with 5-day latency
Storage Requirements	O(1) TB (under evaluation)	O(300) GB (under evaluation)	O(100) GB
Usage	Model training and calculations	Model training and calculations	Data Analysis execution
APIs/Tools	Synda	wget/curl	Copernicus CDS
DT Application	Generic Extreme events characterization and identification	Generic Extreme events characterization and identification	Extreme events attribution

DT for Climate Change Impacts Extreme Events

- **Summary**
  - On-demand assessment of characteristics changes of extreme events due to climate change
    - Frequency of occurrence
    - Duration
    - Spatial extent
    - Intensity (if relevant)
    - Compound Events

- Machine Learning Model and Method(s) to be used are in development
  - Probably Variable autoencoders type of method
  - GPU+CPU (large RAM usage expected)
  - Training on a subset of the whole DB with standard analytics to select events and train ML Model

- Unlock the use of all relevant climate scenarios for impact studies

THANK YOU!

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Discussion