A Study on Heavy Rainfall and Flash Floods Using Different Climate Toolboxes

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I. BACKGROUND

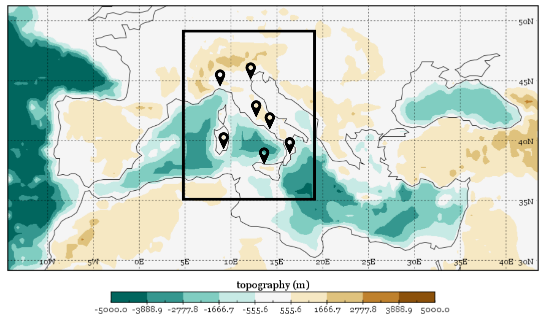
Under the conditions of human-induced climate change, extreme events such as flash floods caused by heavy rainfalls become more frequent and intensified. Inevitably, these events can cause significant human casualties, and socio-economical devastations [1].

These escalations are expected to become higher due to a warming climate that leads to increased water vapor in the atmosphere, and thus, intensified precipitation events.

Recent studies showed that the majority of flood events in Italy constitute flash floods, and therefore, it is projected for the region of Italy to be increasingly affected by flood events caused by the increase in heavy precipitation.

II. MATERIALS AND METHODS

Our study area is Italy. In particular, 7 cities highly affected by flash floods in Italy, namely *Venice*, *Rome*, *Naples*, *Genoa*, *Cagliari*, *Catanzaro*, and *Palermo* are studied.



The **RX1day Index** and **the 95th percentile rainfall** for the historical period (1981-2020) and future projections (-2100) are retrieved using 5th generation ECMWF reanalysis (**ERA5**), and 5th phase of the Coupled Model Intercomparison Project (**CMIP5**) from the Climate Change Service (**C3S**) Climate Data Store (**CDS**) [2].

The **CNRM-CM5 (CNRM-CERFACS, France),** and **EC-Earth 2.3 T159 coupled** (1860-2100) models are used under the high emissions global warming scenario, namely the Representative Concentration Pathway (**RCP**) 8.5".

Copernicus C3S Toolbox, **KNMI Climate Explorer**, and **MATLAB ©** are utilized for analysing and visualising the data.

Non-parametric Mann-Kendall (**MK**) trend test was used for trend detection.

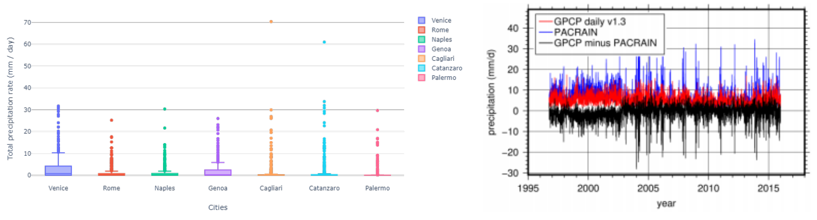
$$\operatorname{sgn}(X_j - X_i) = \begin{cases} 1 & \text{if } X_j - X_i > 0 \\ 0 & \text{if } X_j - X_i = 0 \\ -1 & \text{if } X_j - X_i < 0 \end{cases}$$

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \operatorname{sgn}(X_j - X_i)$$

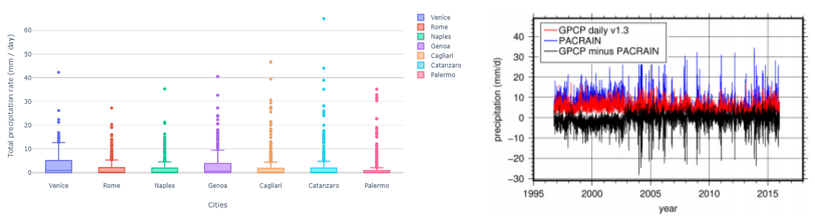
III. RESULTS

- **Precipitation Distribution Box plots**

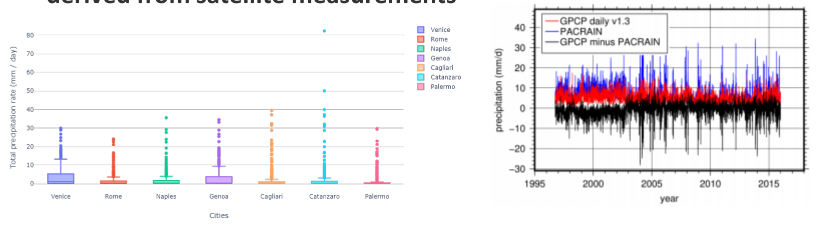
Precipitation daily gridded data for 2017 derived from satellite measurements



Precipitation daily gridded data for 2018 derived from satellite measurements

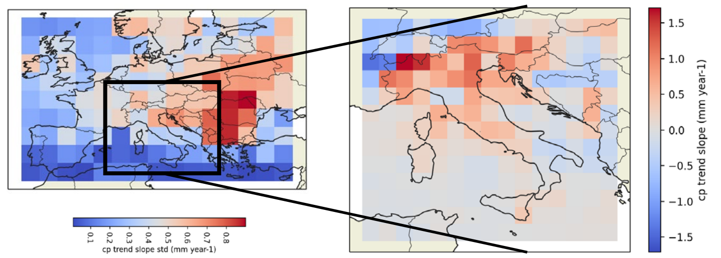


Precipitation daily gridded data for 2019 derived from satellite measurements

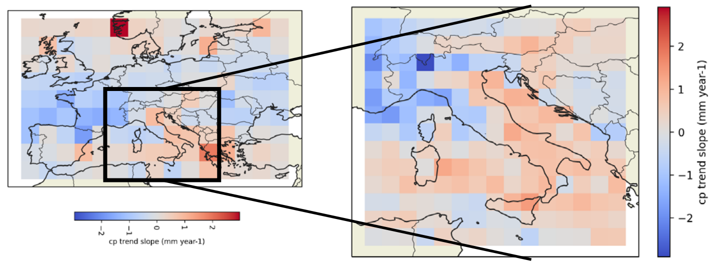


- **Near Surface Convective Precipitation Trends for the ERA5 monthly averaged reanalysis (1991 to 2020)**

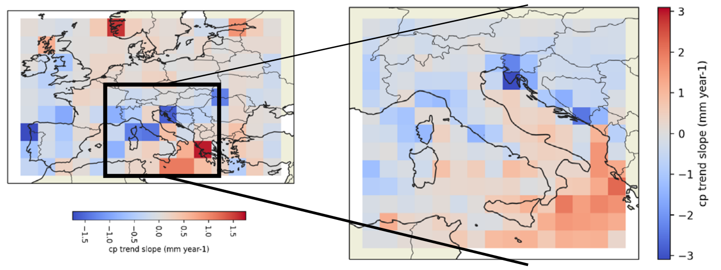
July



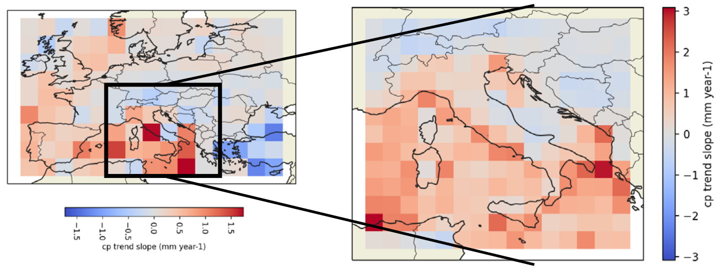
September



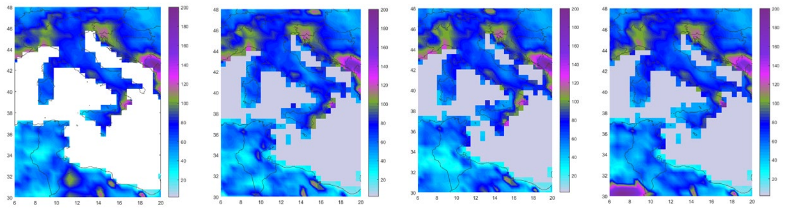
October



November



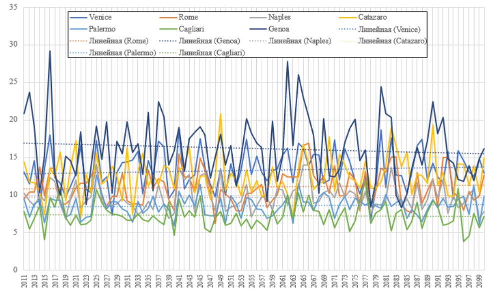
- **RX1day index retrieved from 18 bias-adjusted general climate models (GCMs) from CMIP5**



2011-2020 **2021-2030** **2051-2060** **2091-2100**

RX1day	2011-2020	2021-2030	2031-2040	2041-2050	2051-2060	2061-2070	2071-2080	2081-2090	2091-2100
Venice	72,3	72,3	72,3	72,3	69,5	69,5	72,3	72,3	72,3
Rome	67,3	62,5	67,3	67,3	67,3	67,3	53,4	62,5	67,3
Naples	53,1	46,7	85,5	78,5	51,1	85,5	85,5	53,1	85,5
Genoa	107,3	107,3	107,3	107,3	107,3	107,3	107,3	107,3	107,3
Cagliari	54,0	54,0	40,5	54,0	51,3	54,0	54,0	54,0	54,0
Catazaro	128,8	103,4	95,6	128,8	73,9	122,5	128,8	128,8	85,6
Palermo	48,2	60,2	55,5	47,0	47,0	67,5	55,5	67,5	47,0

- **95th percentile retrieved from 18 bias adjusted Global Climate Models (GCM) from CMIP5**



IV. CONCLUSION

- RX1day index shows different trends depending on the climate models and database used.
- For the 95th percentile rainfall even negative trends are obtained for three of the regarding cities in Italy and slightly positive ones for other cities.
- In the historical data positive trends in precipitation are witnessed. The most significant increases in convective precipitation are obtained in July for Northern Italy, in September for Southern Italy, and in November for the west coast zone.

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References:

[1] Mazzoleni, M., Odongo, V. O., Mondino, E., & di Baldassarre, G. (2021). Water management, hydrological extremes, and society: Modeling interactions and phenomena. *Ecology and Society*, *26*(4). https://doi.org/10.5751/ES-12643-260404

[2] Hersbach, H., Bell, B., Berrisford, P., et al. (2019): ERA5 monthly averaged data on single levels from 1979 to present. Copernicus Climate Change Service (C3S) Climate Data Store (CDS).