Projections of droughts, extreme rainfalls, heat waves and cold spells in Europe using a combination of dynamical and statistical approaches

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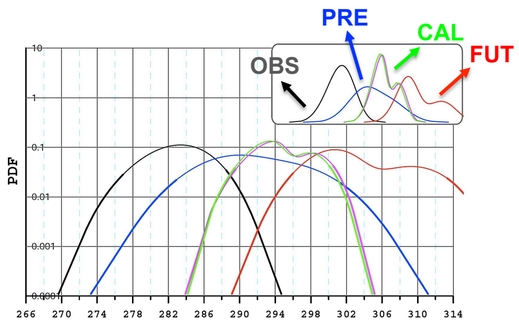
1. MOTIVATIONS

A evidenced in recent years, most of the nature-related economic costs and human losses in many regions of Europe, including the Mediterranean zone, are due to extreme phenomenology (heat waves, colds spells, persistent droughts, heavy precipitations; etc.). Perspectives on the future of these extreme events are here derived by using observed and model projected daily meteorological data from E-OBS and EURO-CORDEX database, respectively. To properly project the regional climate models at local scale, a quantile-quantile adjustment (*Amengual et al. 2012*) has been applied to the simulated regional scenarios. However for our specific purposes dealing with extreme phenomenology, the general method has been adapted to explicitly focus on the tails of the distribution.
Results about future incidence of heat waves, cold spells, heavy precipitation and droughts at annual and seasonal scale are here presented for each emission scenario over Europe.

2. STATISTICAL DOWNSCALING

Quantile-Quantile adjustment *(Amengual et al. 2012)*



The general method, "the global calibration", has been adapted to explicitly focus on the tails of the distribution, instead of deriving the calibration parameters from the general spectrum of CDFs.

Validation task

Evaluation of raw and calibrated data compared against the observations for the 1956-1980 interval. Control period (1981-2005)

- Perkins skill score (Perkins et al. 2007)

Annual	PSS (%) whole PDF		
Variable	Raw	Global	Local
Pr	86,5	86,8	86,7
	PSS(%) over P_{99}		
Pr	62,8	**71,3**	**73,5**

Winter	PSS (%) under P_5			PSS (%) over P_{95}		
Variable	Raw	Global	Local	Raw	Global	Local
Tmin	49,5	**62,4**	**63,6**	47,2	**64,8**	**65,7**

Summer	PSS(%) under P_1			PSS (%) over P_{99}		
Variable	Raw	Global	Local	Raw	Global	Local
Tmax	38	**56,7**	**57**	24,2	**49,1**	**50,3**

3. DATABASE AND METHODOLOGY

- As a observed baseline we have used the E-OBS gridded data set (25 km)
- Regarding the future projections, we use the regional simulations database available from the EURO-CORDEX project. A set of 14 RCM simulations of daily series of 2-m minimum and maximum temperatures and accumulated precipitation has been obtained at grid resolutions of about 12 km driven by different GCMs under the future regional scenarios **RCP4.5 and RCP8.5.**

Climate change projections

Compute changes in calibrated CDFs between a 25-year past (i.e. control/observed; 1981-2005) and successive future 25-year RCM time-slices (2021-2045; 2046-2070; **2071-2095**)

4. RESULTS

- **HEAT WAVES:** a spell lasting 3 or more consecutive days with daily maximum temperature above 95th percentile of observed daily maximum temperature in summer.

Amplitude exceedance: the accumulated thermal stress exceedance for all the days under extreme conditions in a given time interval.

HWA = HWT−Tth HWF

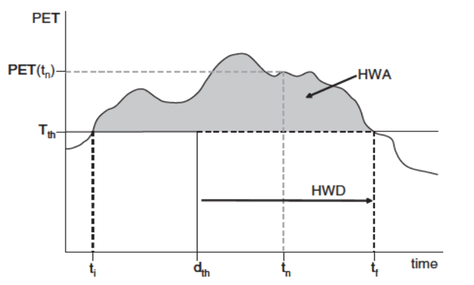
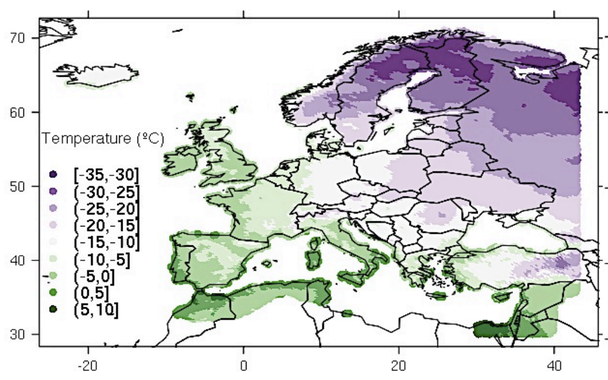


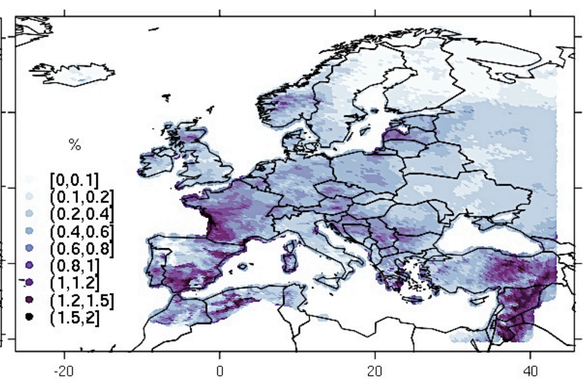
Fig. 1. Graphical sketch of heat wave duration (HWD) and amplitude (HWA, gray shading) exceedances. T_{th} and d_{th} denote the thermal stress and duration thresholds, respectively.

- **COLD SPELLS:** a spell lasting 3 or more consecutive days with daily minimum temperature under 5th percentile of observed daily minimum temperature in winter.

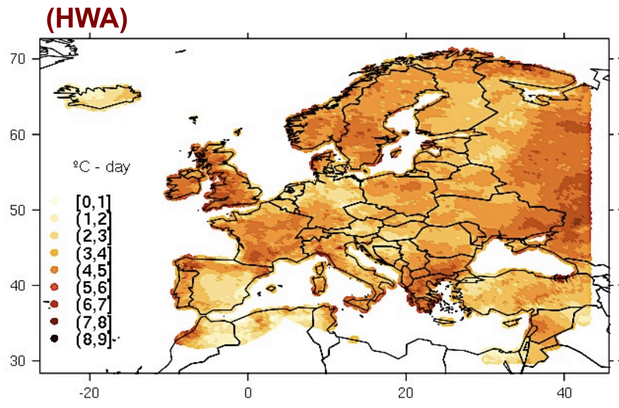
OBSERVED 5th PERCENTILE



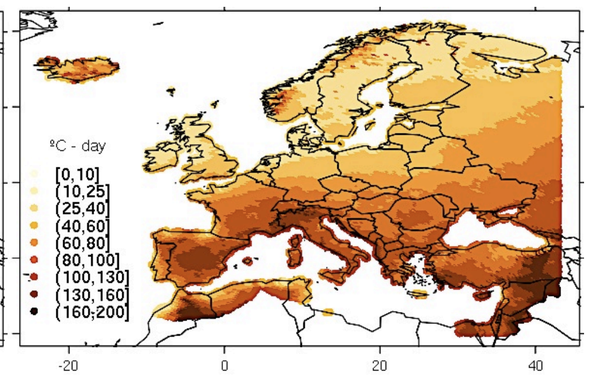
EVENTS UNDER P5 (future)



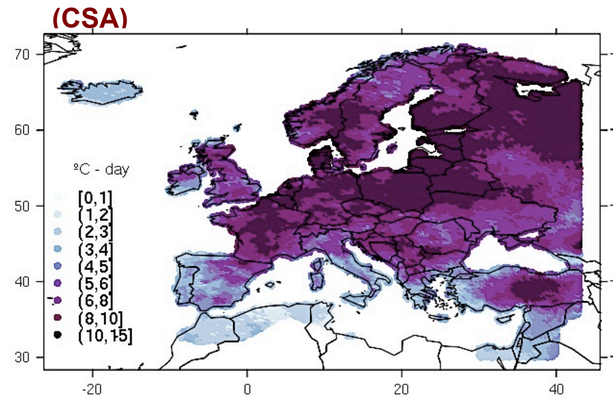
OBSERVED HEAT WAVE AMPLITUDE (HWA)



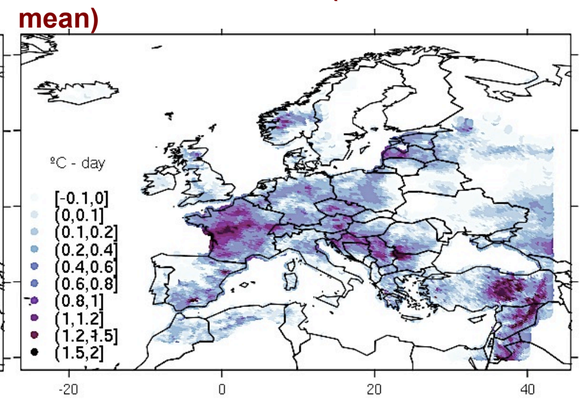
FUTURE CHANGE HWA (multi model mean)



OBSERVED COLD SPELL AMPLITUDE (CSA)

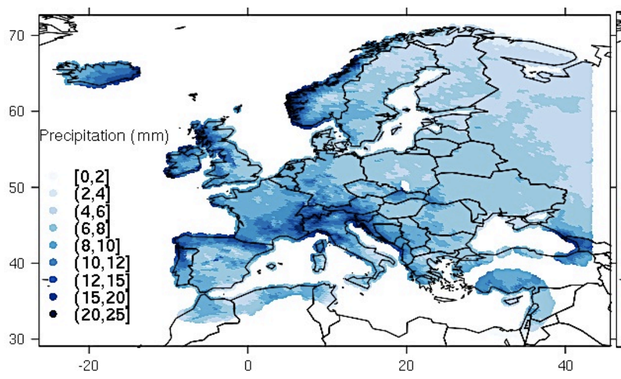


FUTURE CHANGE CSA (multi model mean)

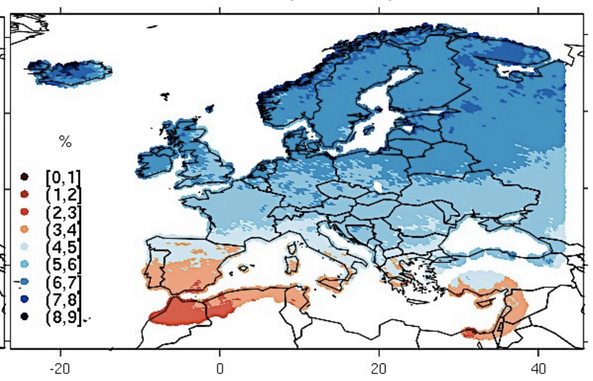


- **HEAVY PRECIPITATION:** a spell lasting dth = 2 or more consecutive days with *daily precipitation (*>= 0.01 mm) above 95th percentile of observed daily precipitation.

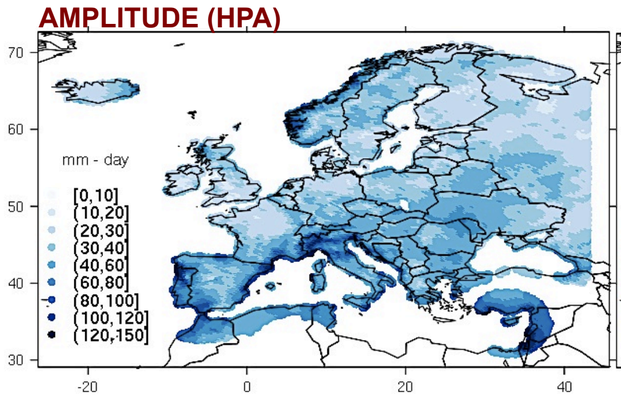
OBSERVED 95th PERCENTILE



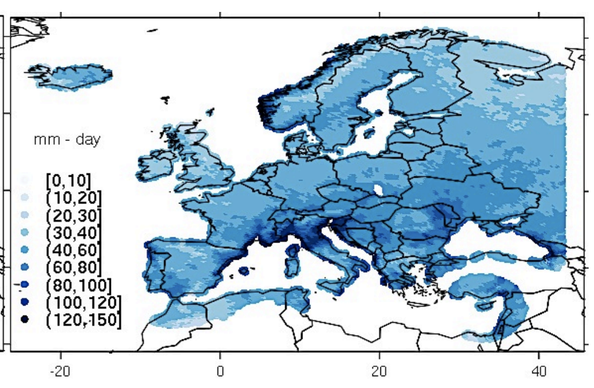
EVENTS OVER P95 (future)



OBSERVED HEAVY PRECIPITATION AMPLITUDE (HPA)



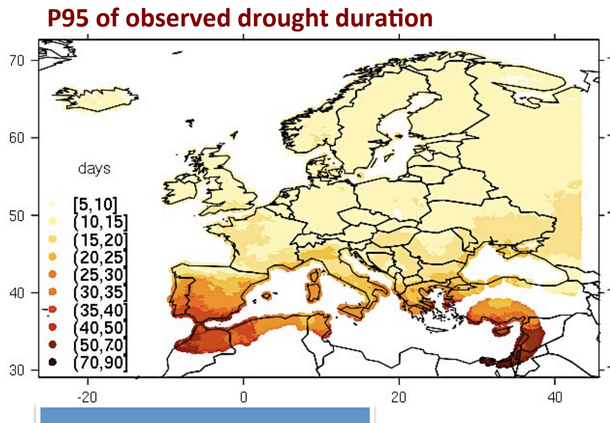
FUTURE CHANGE HPA (multi model mean)



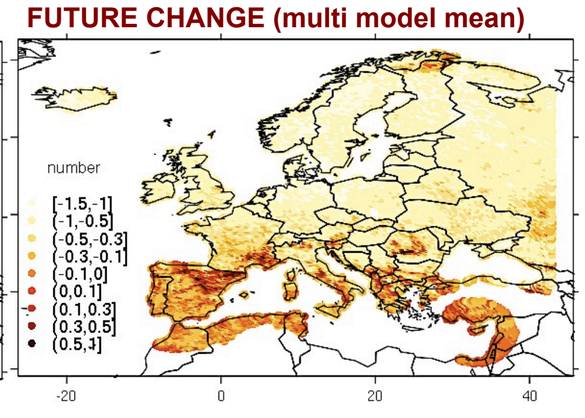
- **DROUGHT:** a spell lasting dth = 3 or more consecutive days with *daily precipitation* <= 0.1 mm

Number of future events with a duration over P95 of observed drought duration

P95 of observed drought duration



FUTURE CHANGE (multi model mean)



CONCLUSIONS

Expected results about the future extreme events for the late twenty first century under the RCP8.5 scenario would indicate:

- An overall increase of the heat wave amplitude in summer, being more marked in the Mediterranean
- A decrease in the future events under the 5th percentile of observed minimum daily temperature in winter. It is expected a general increase of the cold spell amplitude.
- Regarding the annual heavy precipitation results, we observe a rise in the percentage of events over the P95 in the central and northern Europe but a decrease in the Mediterranean. The heavy precipitation amplitude it is expected to increase in the whole domain.
- A rise in number of future events with a duration over the P95 of observed drought duration of up to 1 drought/year in the Iberian peninsula.

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