Interreg Ελλάδα-Κύπρος
Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης
ERMIS-F

The Cyprus Institute
RESEARCH•TECHNOLOGY•INNOVATION

ΔΕΣΜΟΙ ΑΝΑΠΤΥΞΗΣ

Προσομοίωση κλιματικών αλλαγών για μελλοντικές πλημμύρες στα πλαίσια του έργου ERMIS-F

Modeling climate change for future floods in the framework of ERMIS-F

George Zittis (CYI), Adriana Bruggeman (CYI)

Challenges for ERMIS-F

Our expectations from the climatological/ hydrological point of view are:

- Improve the skill of climate models for the Mediterranean environment
- Create long-range, high-resolution and quality regional climate simulations
- Study impacts of climate change in the hydrological cycle with a focus on precipitation extremes/floods

ΔΕΣΜΟΙ ΑΝΑΠΤΥΞΗΣ

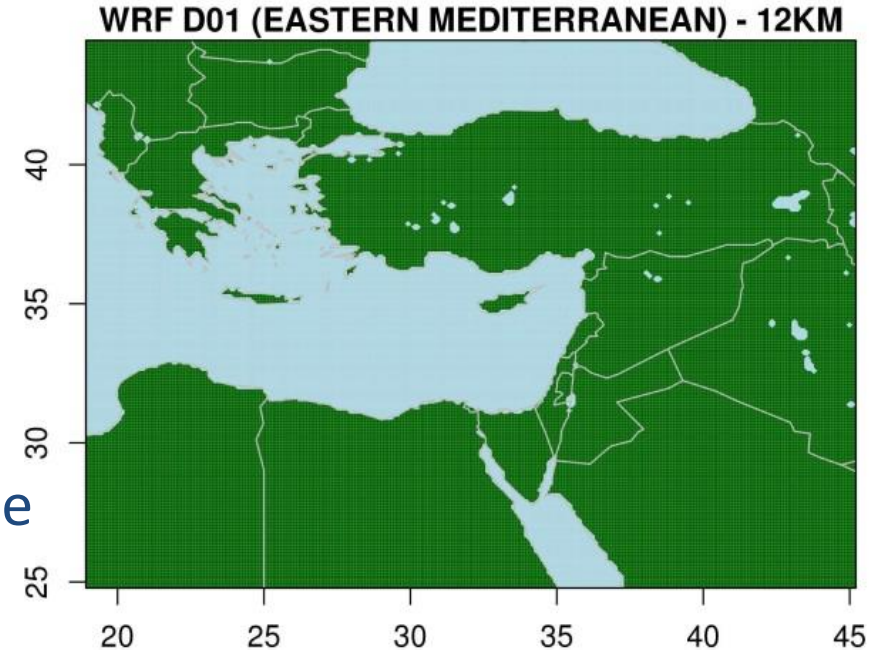
Challenges for ERMIS-F

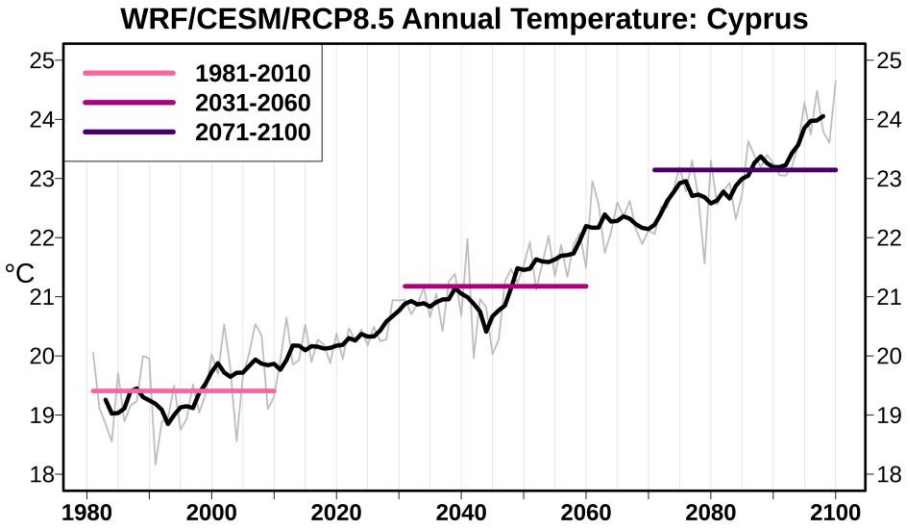
Working on three pillars

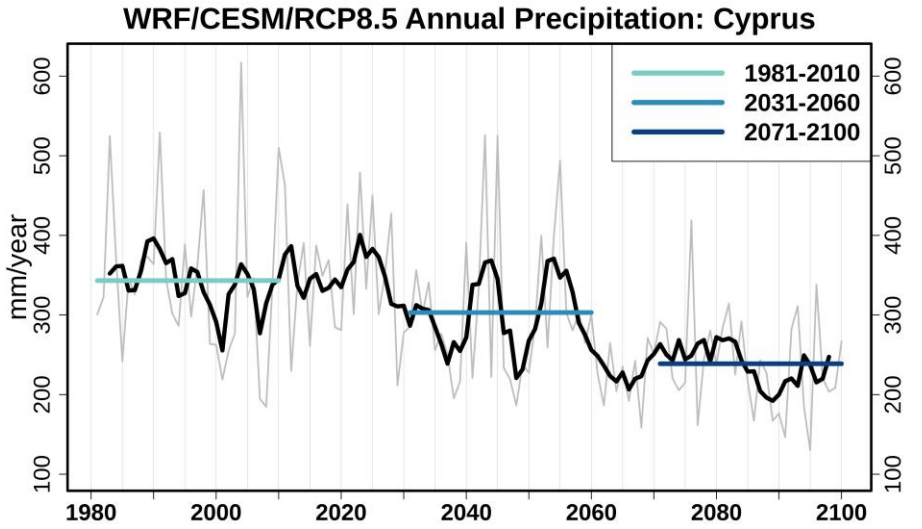
1. Explore trends of extreme precipitation in eastern Mediterranean (ERMIS-F & CORDEX 12-km/6h simulations)
2. Further downscale to 1km/15min for Cyprus for flood modelling (very extreme events for Germasogeia)
3. Analysis of future extremes for Kalloni and Chania (based on the 12-km/6h ERMIS-F simulation)

Trends of future precipitation extremes

- CESM/WRF/RCP8.5
- One-way nesting
- Resolution: 12km/6h
- 40 vertical levels (20 hPa)
- Optimised physics options for the EMME environment

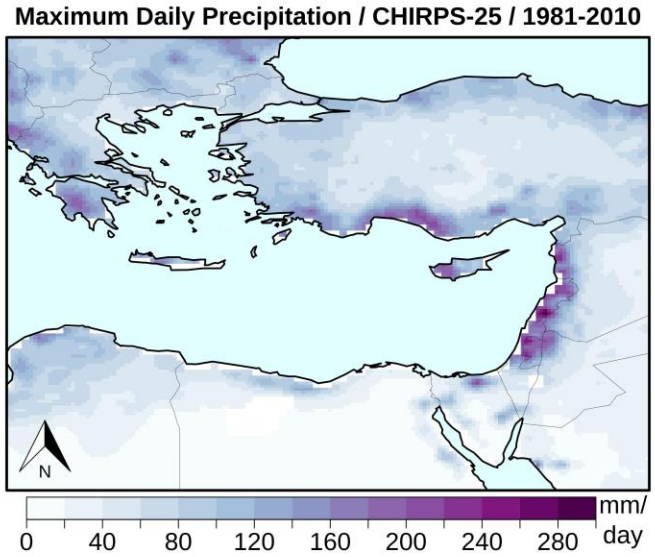






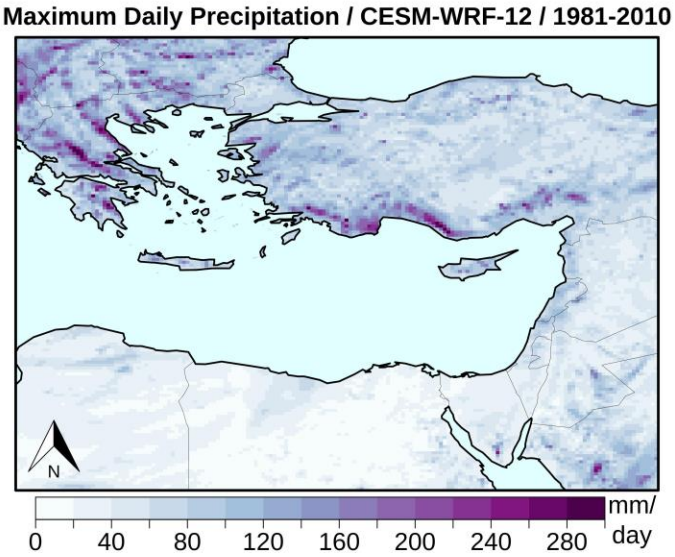
Trends of future precipitation extremes

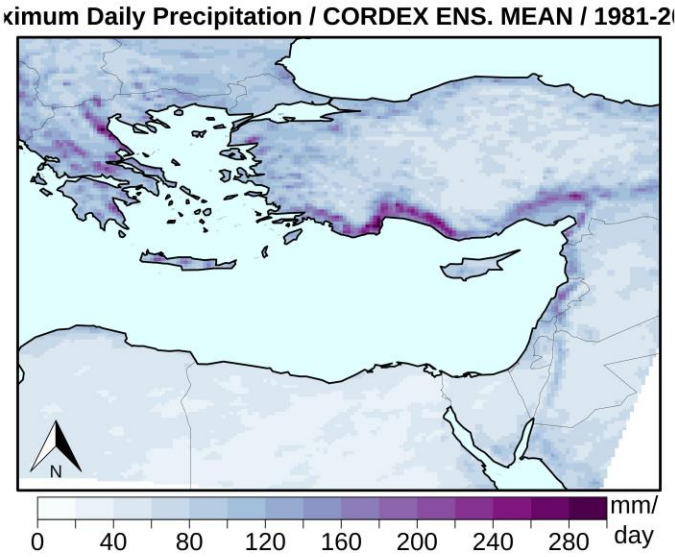
CHIRPS (25-KM)



- Validation for recent past
- Maximum daily precipitation
- 1981-2010

CYI-WRF (12-KM)

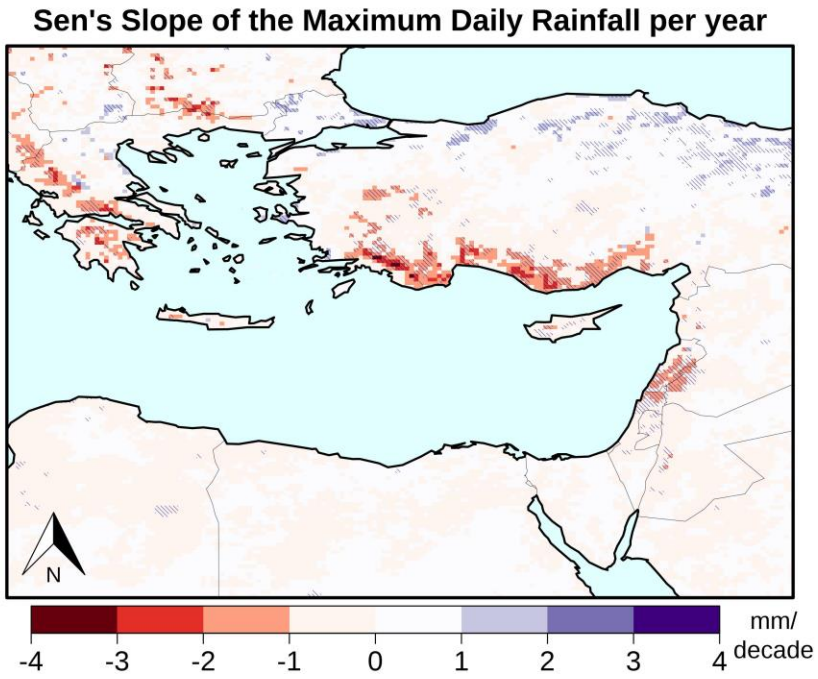




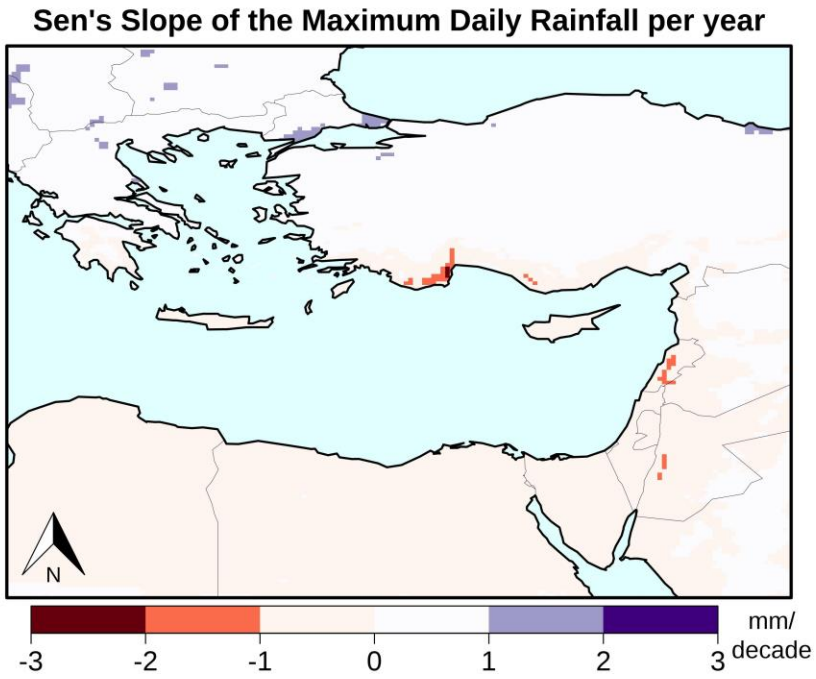
ENS. MEAN (25 EURO-CORDEX SIMS)

Trends of future precipitation extremes

CYI-CESM/WRF



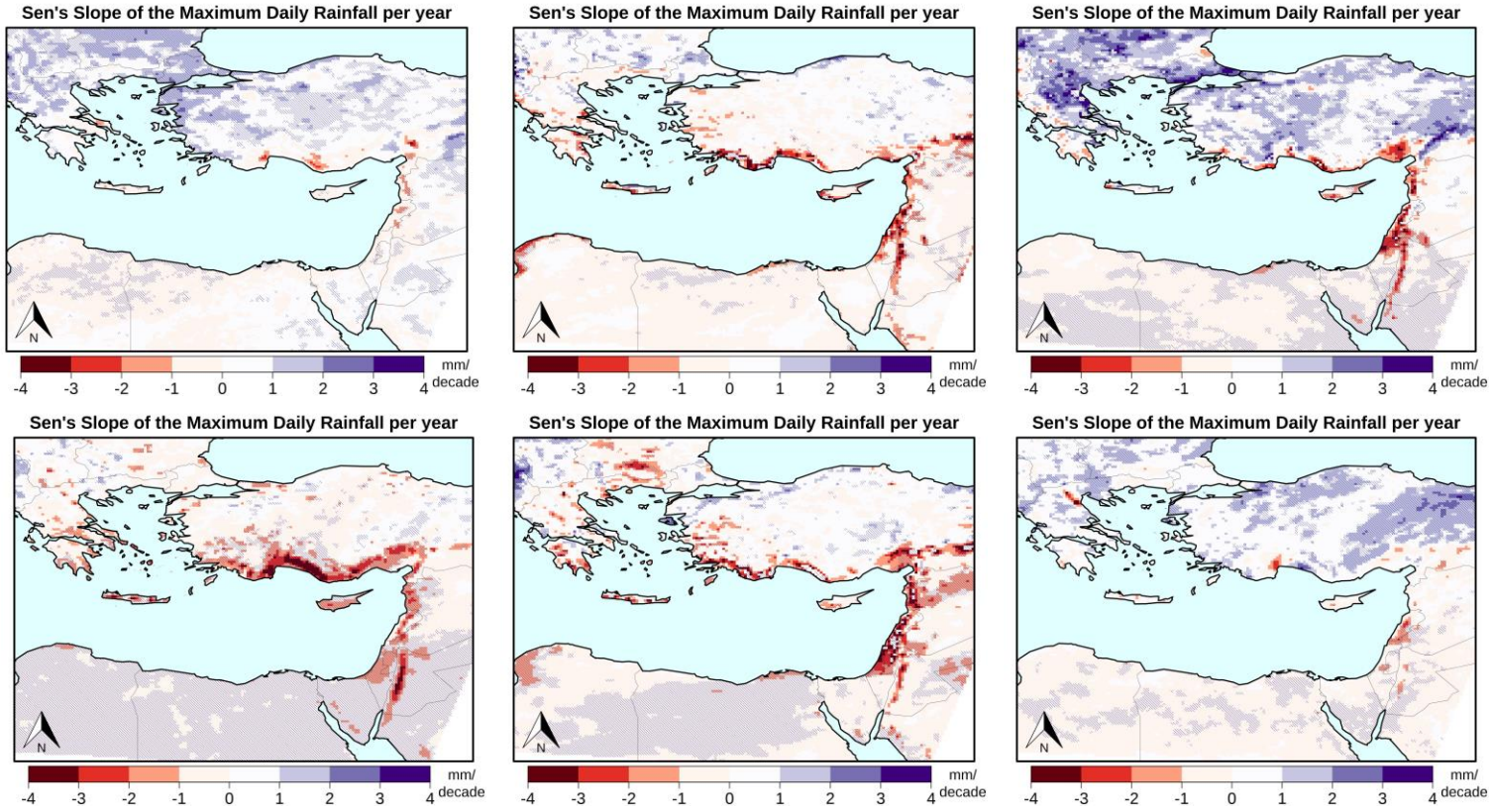
ENS. MEAN (25 EURO-CORDEX SIMS)



- **Maximum daily precipitation / year**
- **2001 – 2100**
- **Sen's Slope Estimator for trends**
- **Mann-Kendall test for significance**

Trends of future precipitation extremes

EURO-CORDEX INDIVIDUAL MODELS



- Maximum daily precipitation / year
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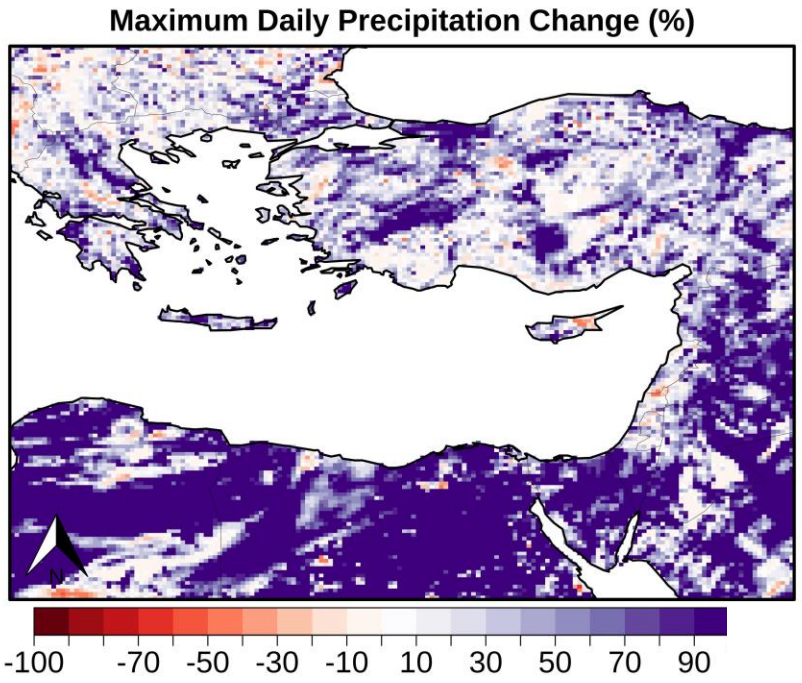
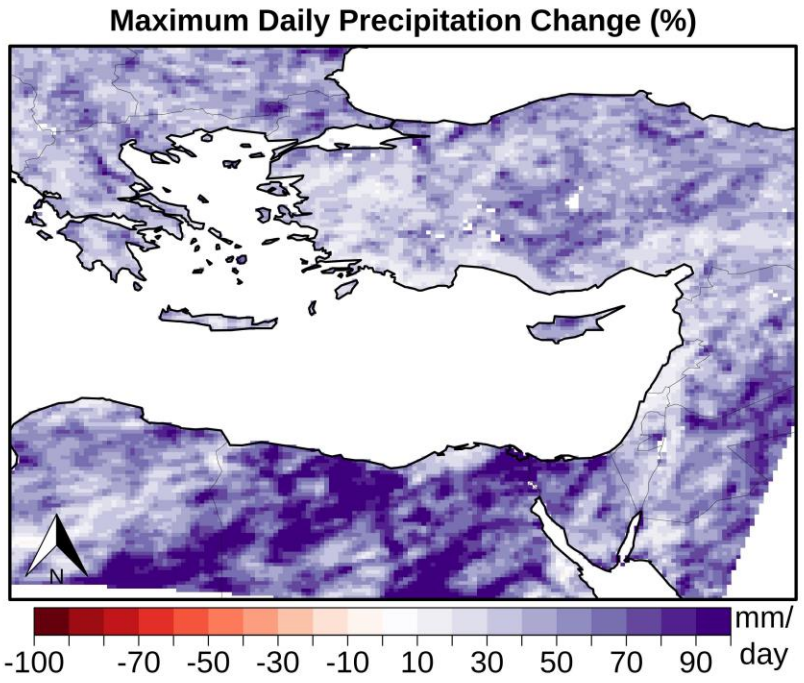
Trends of future precipitation extremes

CYI-CESM/WRF

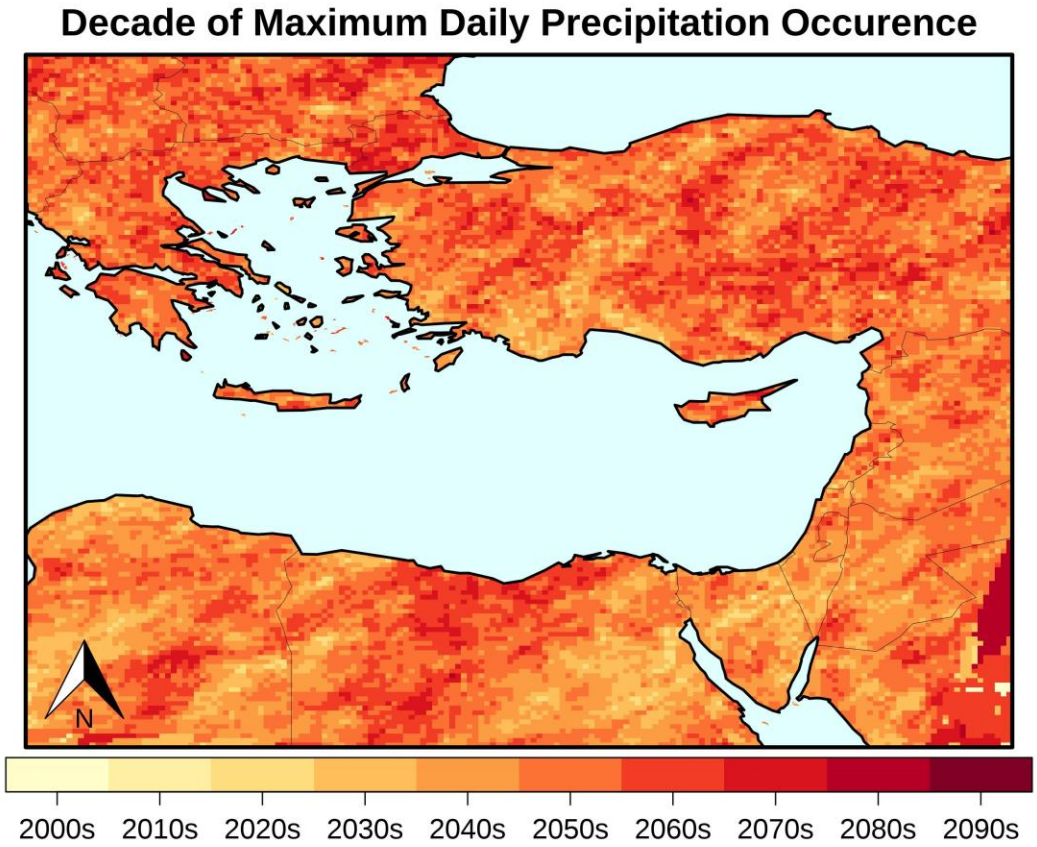


ENS. MEAN (25 EURO-CORDEX SIMS)



Projected changes in the absolute maximum daily rainfall (2001-2100) – (1981-2010)

Trends of future precipitation extremes



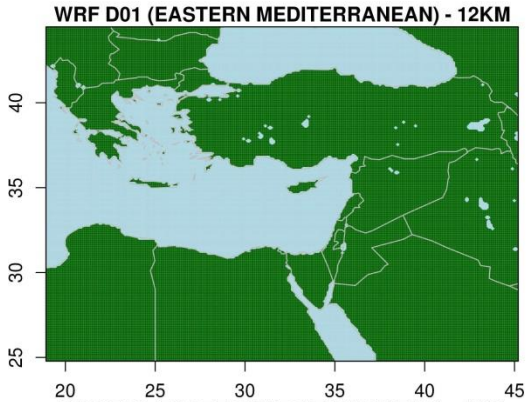
ENS. MEAN (25 EURO-CORDEX SIMS)

The most extreme events expected near 2050s for most of the EMME region

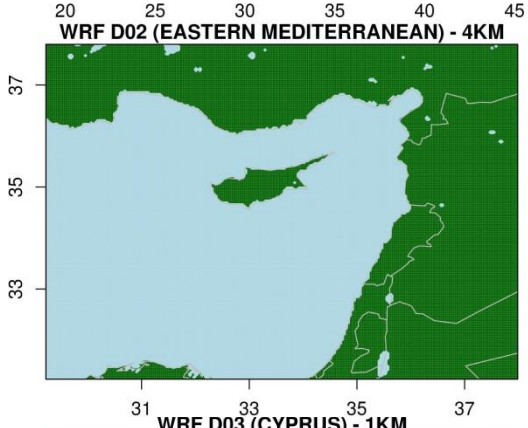
A ”hybrid” approach for simulating future precipitation extremes

- Convection Permitting (CP) simulations reproduce better extreme events
- We cannot afford 120 years of 1km/sub-daily output
- Select sufficient number of extreme events to reproduce present day statistics
- Further downscale the most extreme future events to 1-km

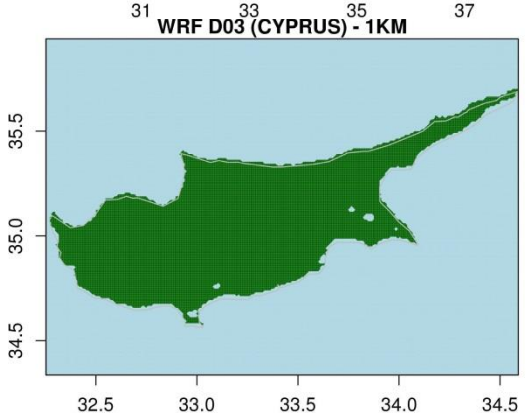
*No parameterization of convection at 4-km / 1-km nests



Eastern Mediterranean (12 km)



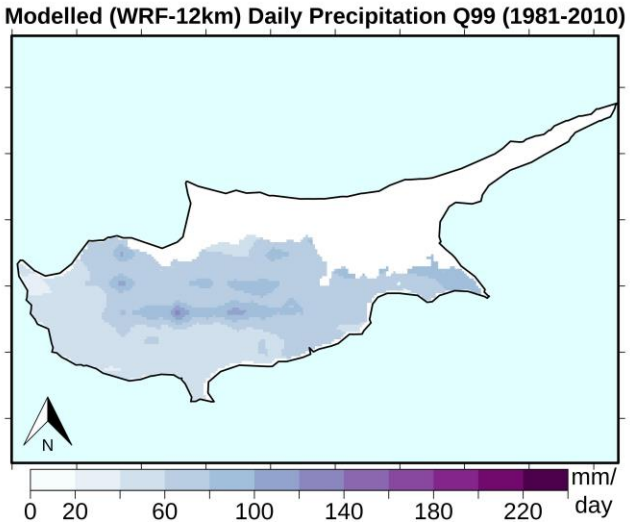
Levant (4 km)



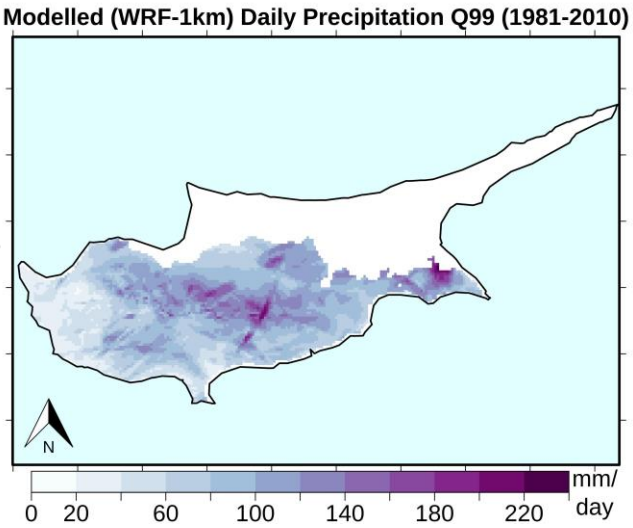
Cyprus (1 km)

A ”hybrid” approach for simulating future precipitation extremes

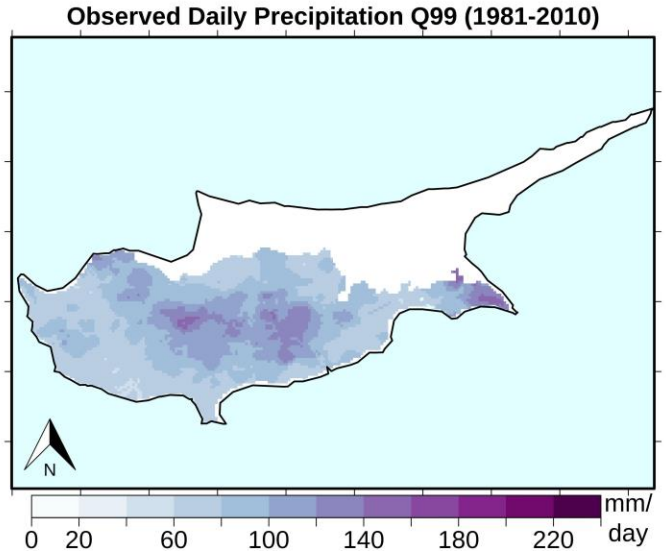
WRF-12 km
Full 1981-2010
time-series



WRF-1 km
32 selected events
(1981-2010)



CY-OBS 1 km
Full 1981-2010
time-series



A ”hybrid” approach for simulating future precipitation extremes

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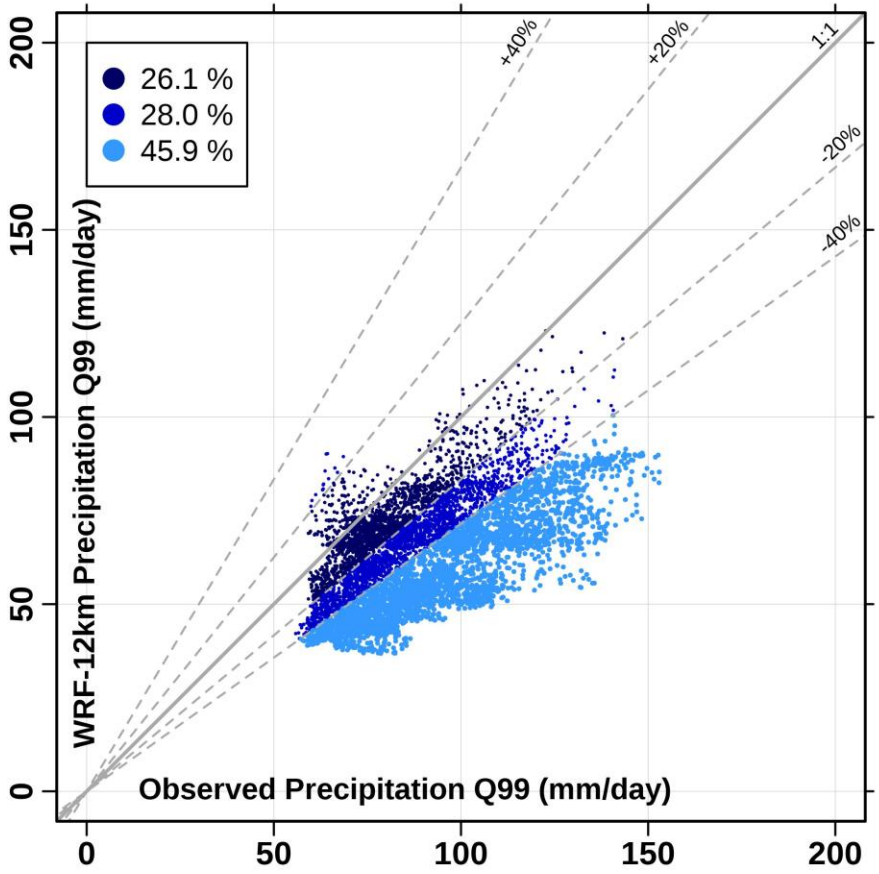
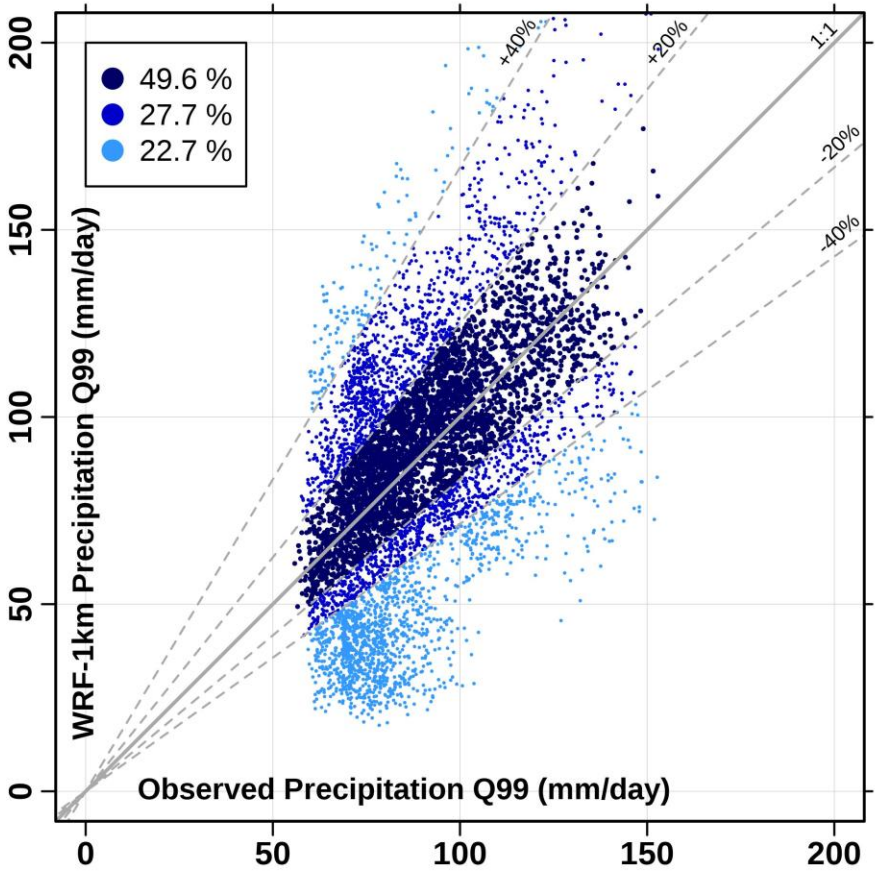
CY-OBS vs. WRF-12 km

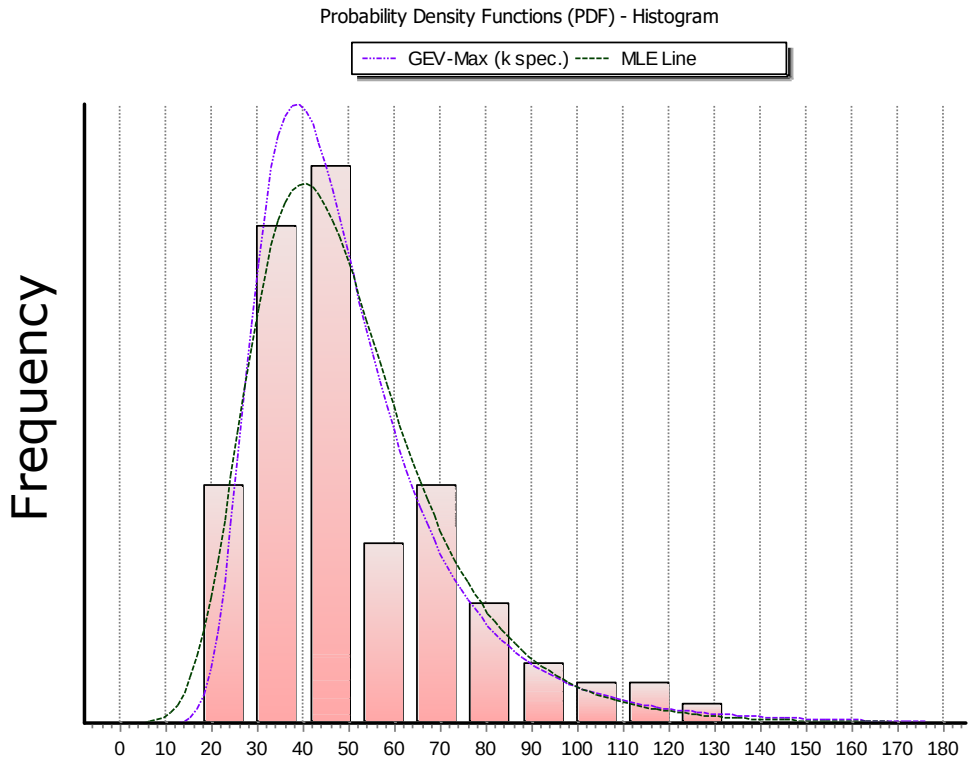


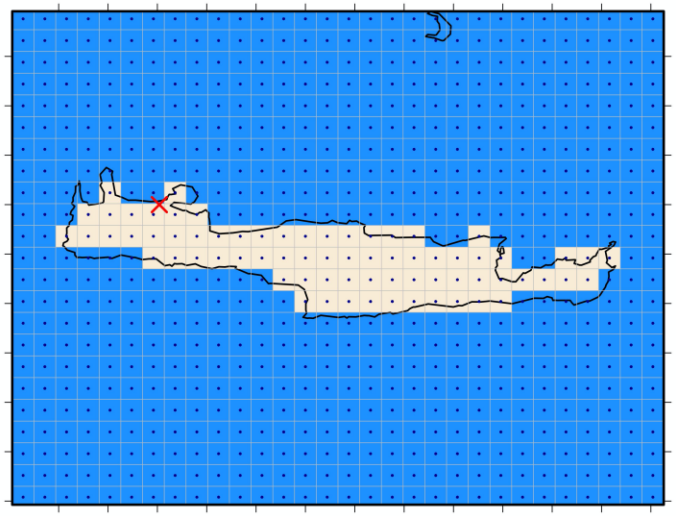
CY-OBS vs. WRF-1 km

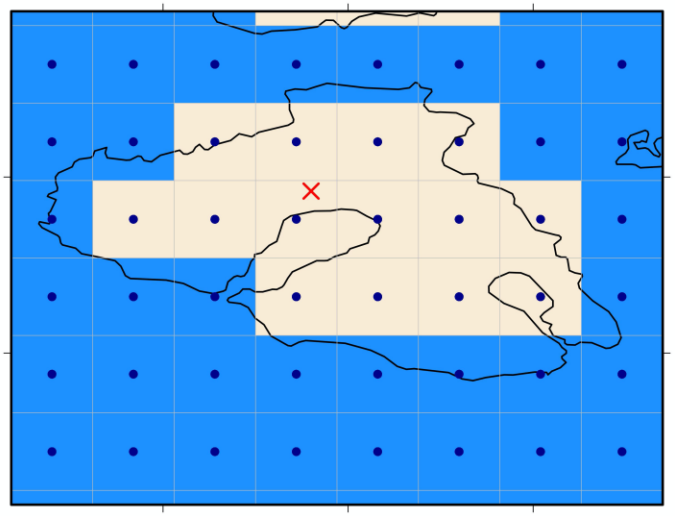


Comparison over 6500 land grid points

Generalized Extreme Value Distributions for past and future time periods







- Data extracted from WRF-12km/6h simulation
- Nearest grid-point to the pilot areas
- Daily maximum rainfall for each year (1981-2100)

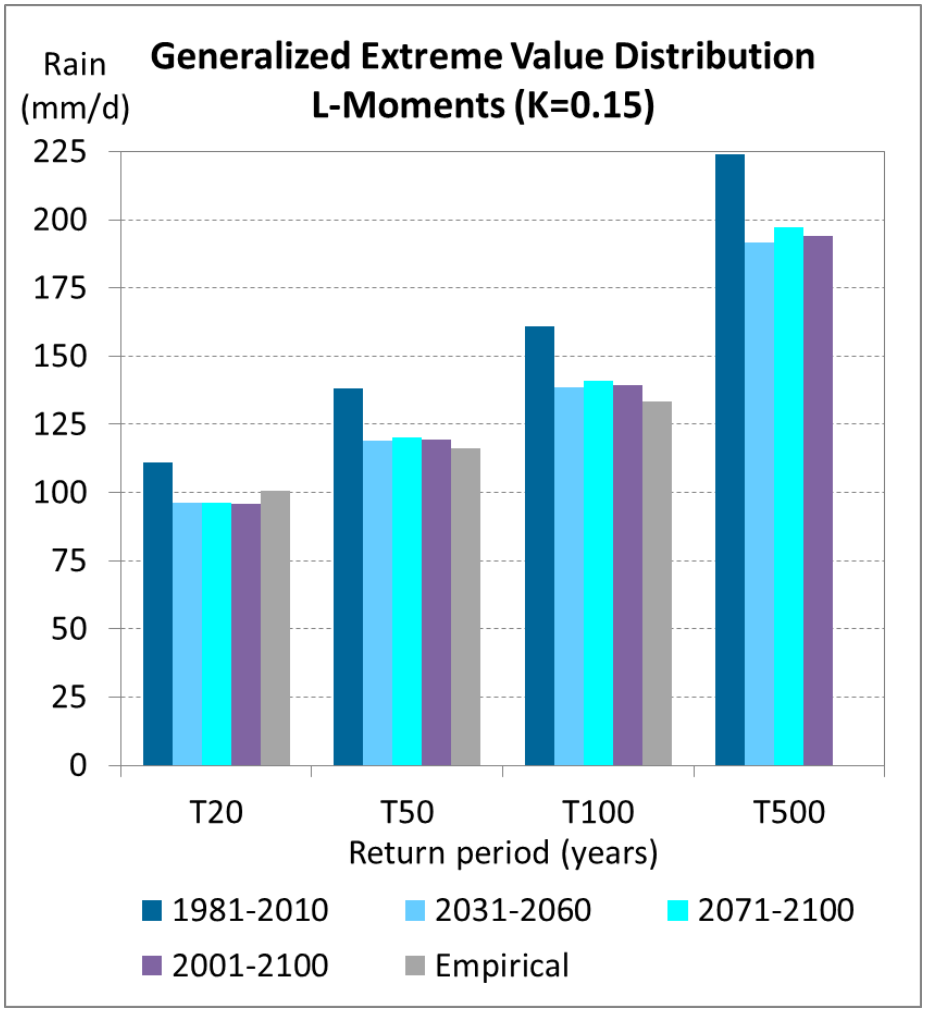
Generalized Extreme Value Distributions for past and future time periods

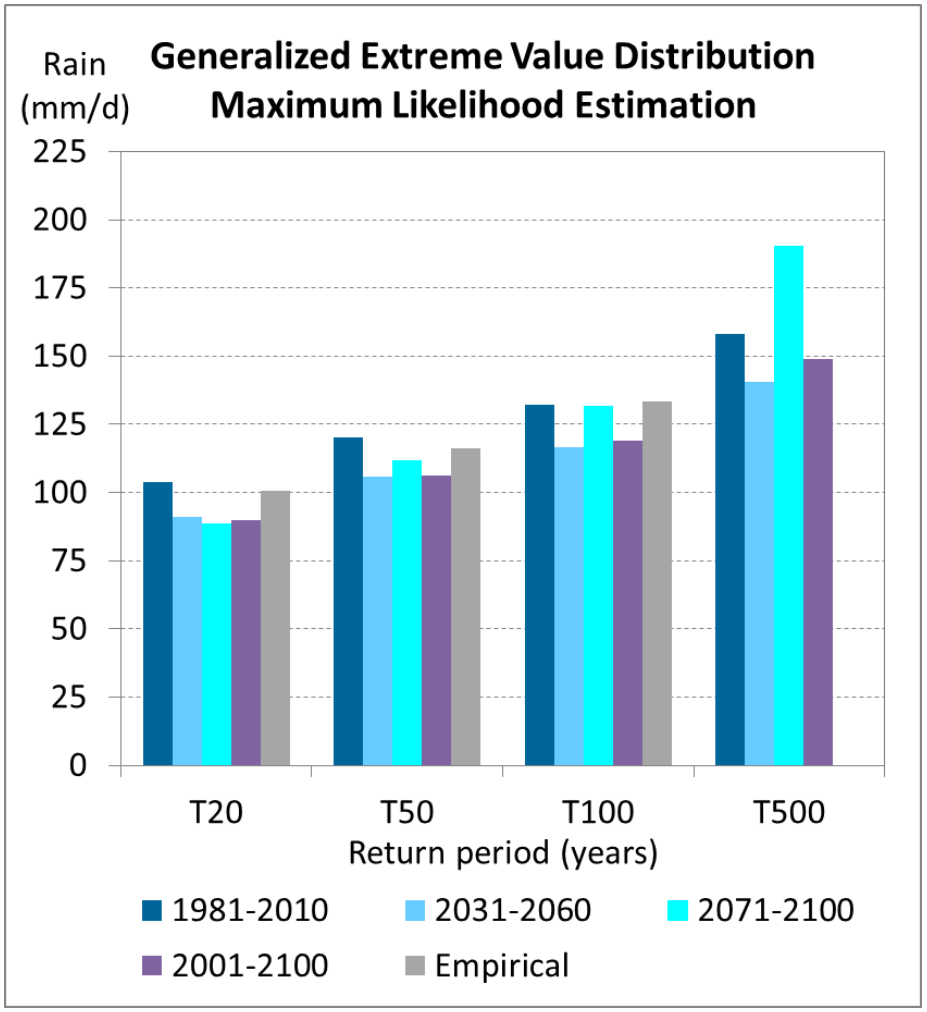
Chania

Period	Distribution parameters			Goodness of fit	
	Shape	Scale	Location	X2-alpha	KS-alpha
	L-Moments (K-0.15)				
1981-2010	0.15	17.31	2.68	0.51	0.99
2031-2060	0.15	14.65	2.82	0.26	0.66
2071-2100	0.15	15.53	2.44	0.43	0.96
2001-2100	0.15	15.06	2.64	0.42	0.92
	Maximum Likelihood Estimation				
1981-2010	-0.03	19.64	2.47		
2031-2060	-0.02	16.76	2.56		
2071-2100	0.19	12.64	3.00		
2001-2100	0.03	15.78	2.58		

Maximum daily rainfall for four return periods T and for past and future time periods

Chania





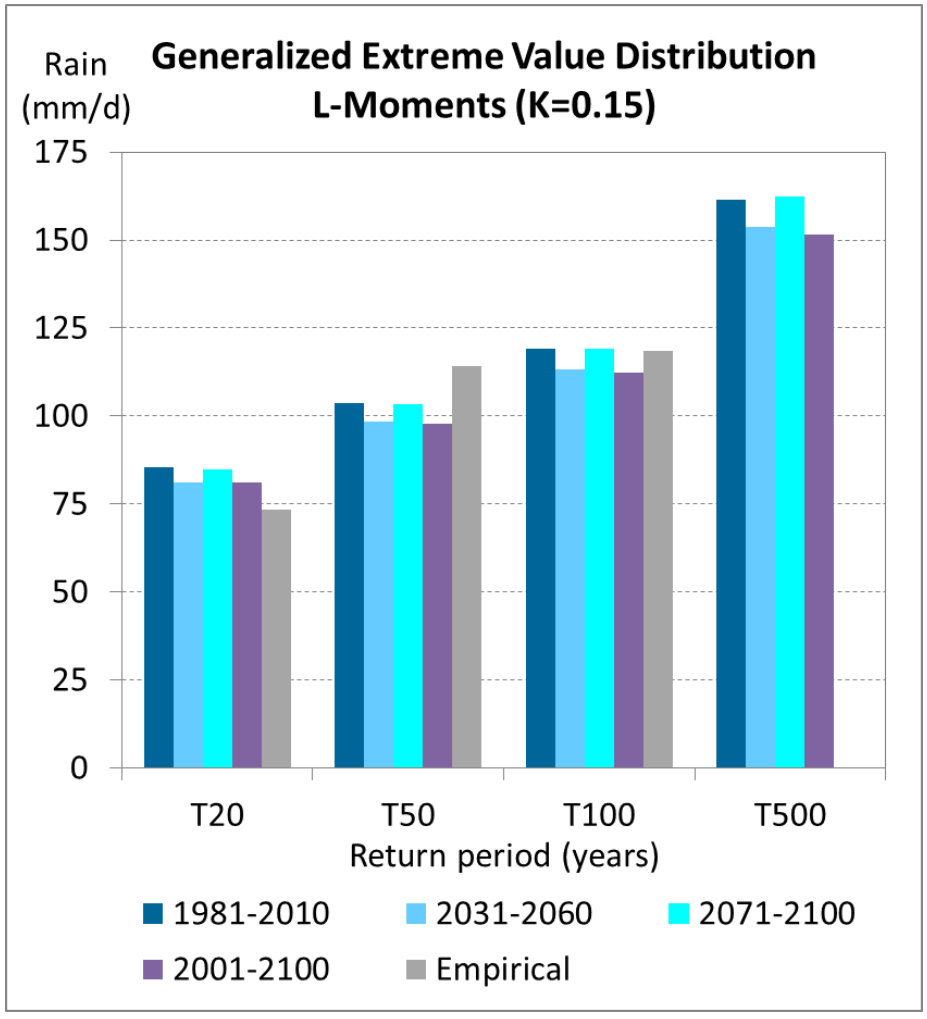
Generalized Extreme Value Distributions for past and future time periods

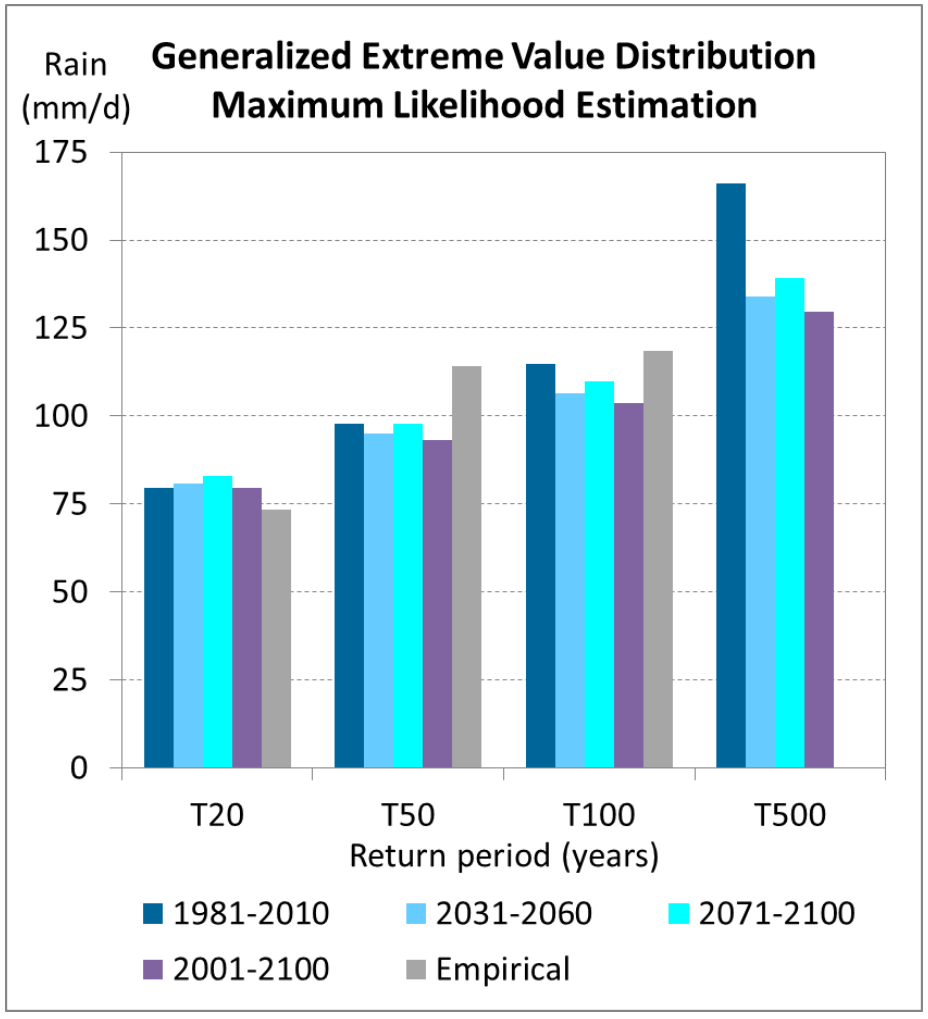
Kalloni

Period	Distribution parameters			Goodness of fit	
	Shape	Scale	Location	X2-alpha	KS-alpha
	L-Moments (K-0.15)				
1981-2010	0.15	11.68	3.57	0.07	0.56
2031-2060	0.15	11.11	3.55	0.61	0.54
2071-2100	0.15	11.90	3.38	0.26	0.92
2001-2100	0.15	10.83	3.74	0.42	0.97
	Maximum Likelihood Estimation				
1981-2010	0.24	8.82	4.71		
2031-2060	0.06	12.62	3.17		
2071-2100	0.06	12.88	3.17		
2001-2100	0.05	12.01	3.41		

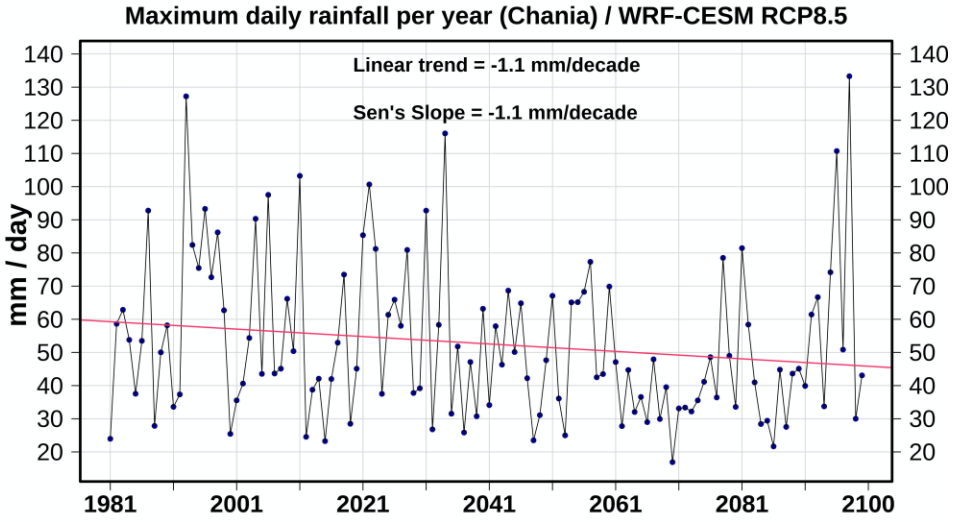
Maximum daily rainfall for four return periods T and for past and future time periods

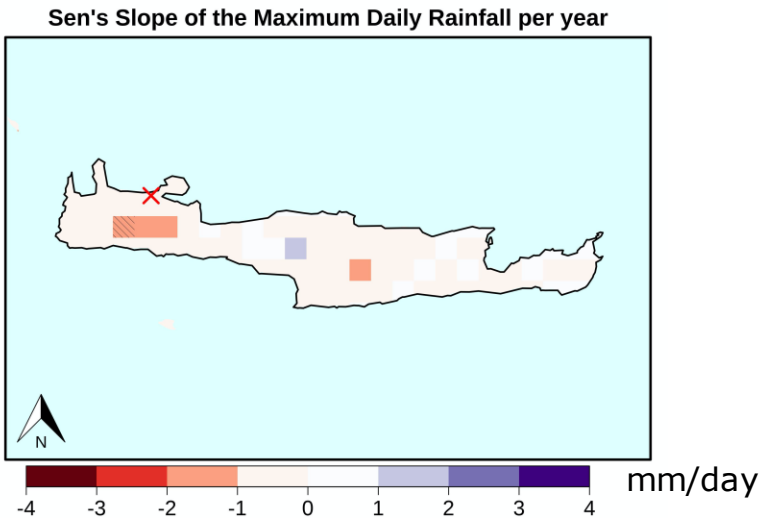
Kalloni

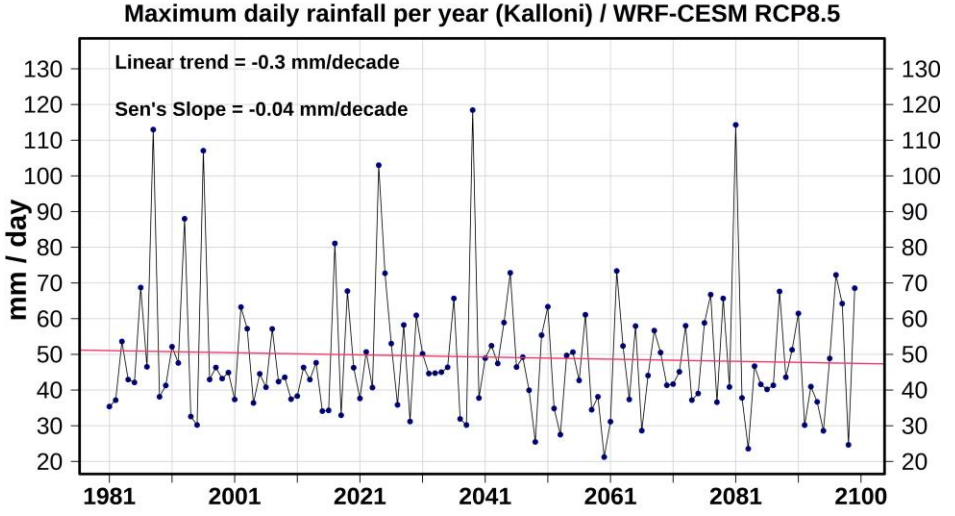


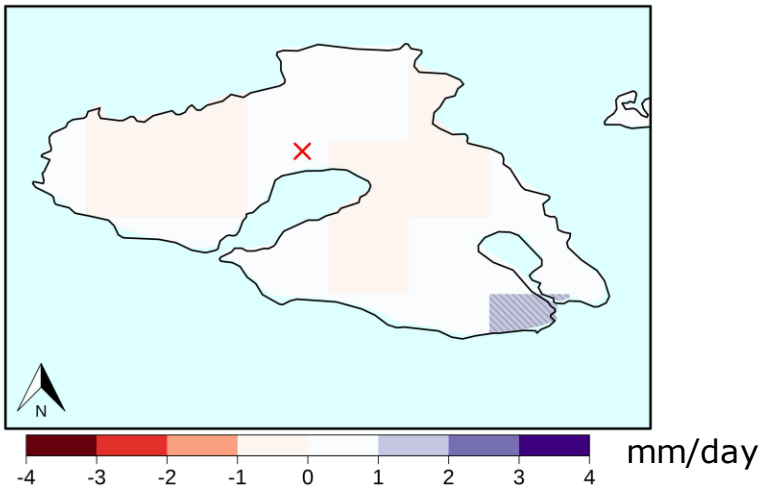


Trends of future precipitation extremes









Summary

- The 12-km data tend to underestimate daily rainfall extremes, but can be used to analyse trends/changes in extremes.
- Our simulations and CORDEX data indicate negative trends for most of the eastern Mediterranean.
- Analyzing climate change extremes is a complex combination of dynamical downscaling and hydrological statistics.
- The occurrence of extremes remains highly variable during 2001-2100.
- The fitting of the extreme value distribution functions affects the estimation of the extremes, indicating that 30-years is not a sufficient long period for fitting GEVs.
- This makes it extremely difficult to isolate the effect of climate change on extremes for flood modeling.
- For both Kalloni and Chania, the 1980-2010 period shows more extreme behaviour than the 2001-2100 period.

Thank you for your attention!

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