Changes in precipitation extremes over the Eastern Mediterranean during 1961-2012

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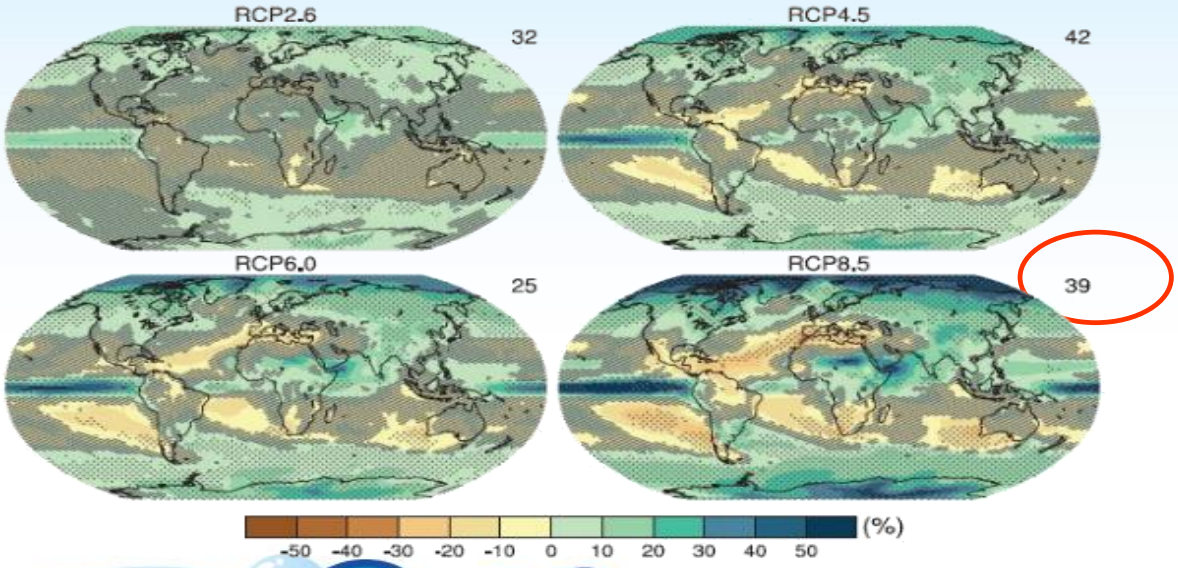
Introduction

Mediterranean region has shown large climate shifts in the past and it has been identified as one of the most prominent "Hot-Spots" in future climate change projections.

Annual mean precipitation change (2081-2100)

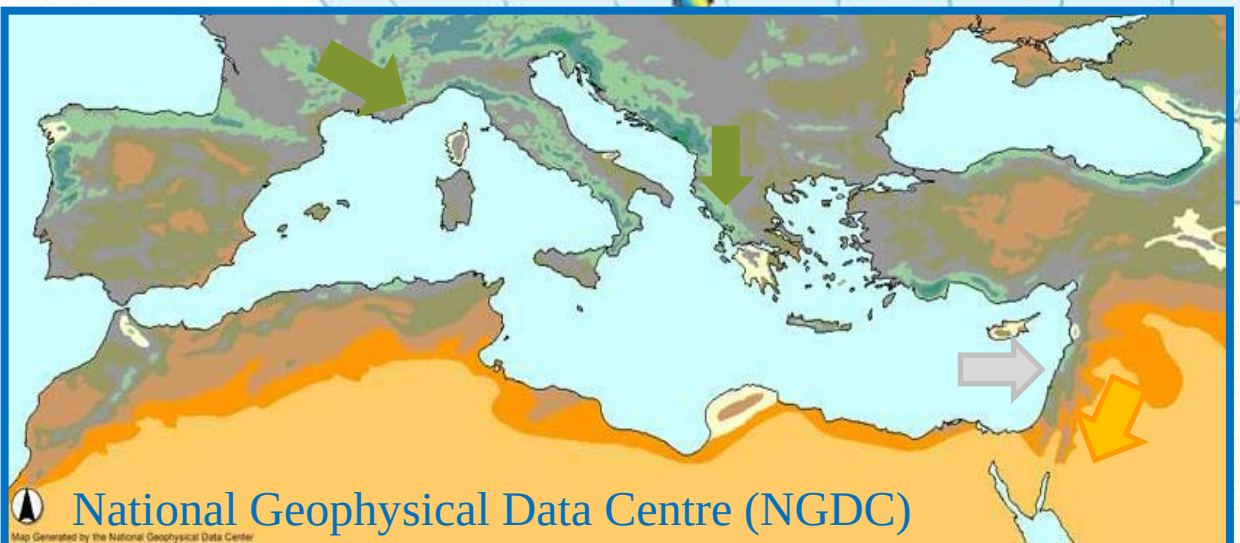


Source: IPCC, 2013, Summary for policymakers

The Eastern Mediterranean (EM) region is located in the area where both mid-latitude and sub-tropical atmospheric processes play significant roles during the rainy season. It is also characterized by substantial differences in the amounts of solar radiation between northern and southern parts. A large part of the EM air moisture originates from the North Atlantic and Arabian Sea areas.

In the EM, the research of precipitation extremes is more complicated, as compared to other Mediterranean areas, due to the complex topographical features and the sparse station data. Recent studies have demonstrated an increasing tendency of dry spell length, decreasing precipitation, as well as a tendency towards drier conditions during the last two decades over the EM

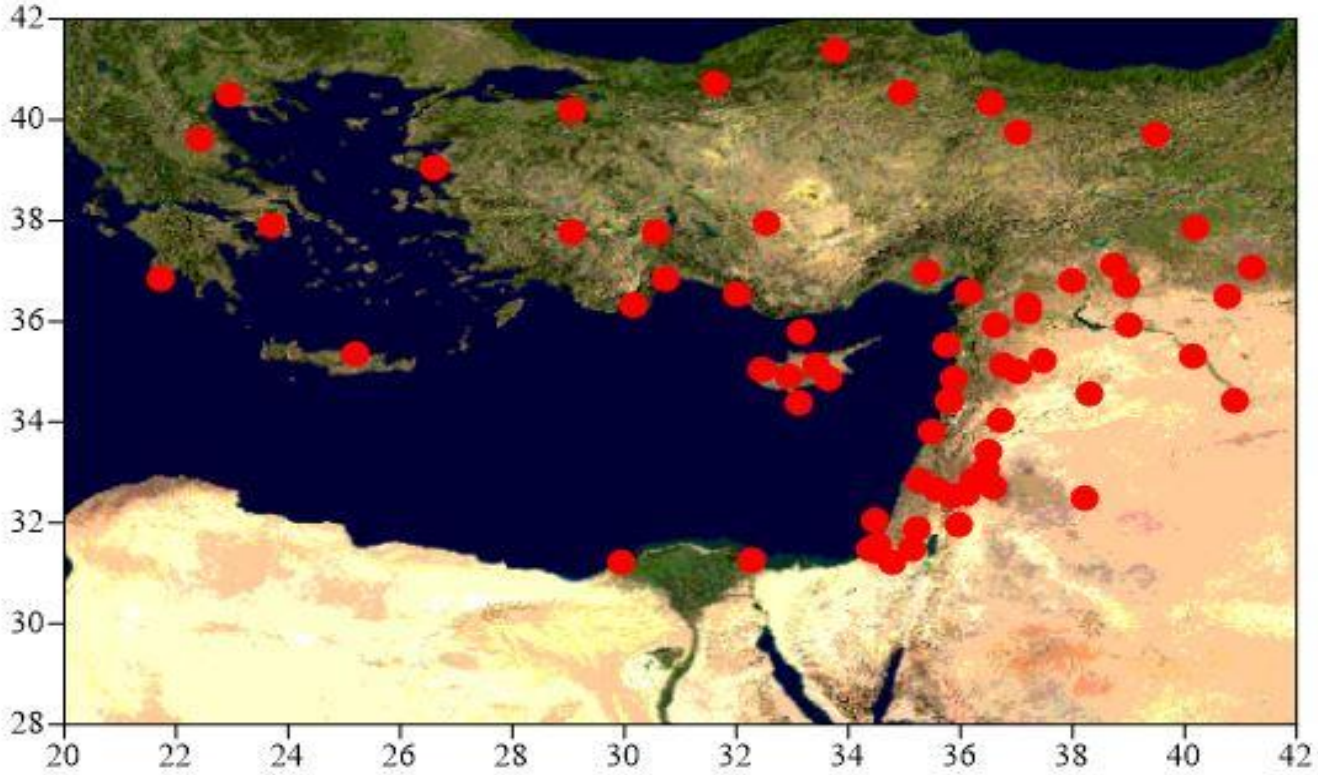
Mean Annual Precipitation
1961-2006



0
100
200
400
600
1,000
1,400 mm

Study Period and Datasets

70 daily series are considered for this study during (1961-2012)



For a better spatial coverage of the Mediterranean region

Daily data of the European Climate Assessment & Dataset (ECA&D) has been used

Daily Global Historical Climatology Network (GHCN-Daily) dataset was also used.

Unpublished data has been obtained by contacting the regional National Hydrological and Meteorological Services.

Monitoring changes in extreme precipitation

Climatic extreme indices recommended by the joint World Meteorological Organization (CCL/CLIVAR/JCOMM) Expert Team on Climate Change Detection and Indices (ETCCDI), as well as from the European research project STARDEX (Statistical and Regional dynamical Downscaling of Extremes for European regions) were calculated to characterize the possible change in extreme of rainfall (floods, drought) over the EM.

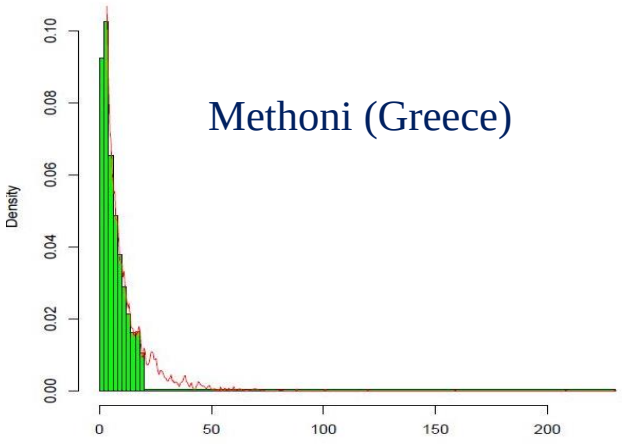
R- based program RClimdex 1.3 software was used to obtain the climatic extremes indices

Climatic extreme indices

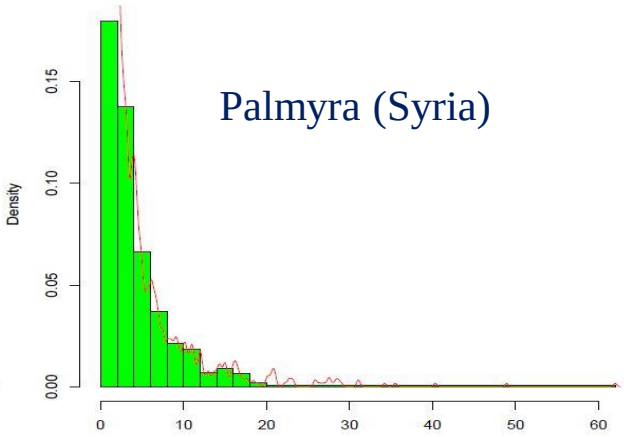
ID	Definition
RX1day	Monthly maximum 1-day precipitation
Rx5day	Monthly maximum consecutive 5-day precipitation
SDII	The ratio of annual total precipitation to the number of wet days (≥ 1 mm)
R10	Number of days per year when precipitation ≥ 10 mm
R20	Number of days per year when precipitation ≥ 20 mm
CDD	Maximum number of consecutive dry days when precipitation <1mm
CWD	Maximum number of consecutive wet days when precipitation ≥ 1mm
R95p	Annual total precipitation from days >95th percentile
R99p	Annual total precipitation from days >99th percentile
PRCPTOT	Annual total precipitation from days ≥ 1mm.

Example of daily precipitation successful quality control procedures using. RClimDex (Histogram (vertical bars) and Kernel- filtered density (line) showing the high density)

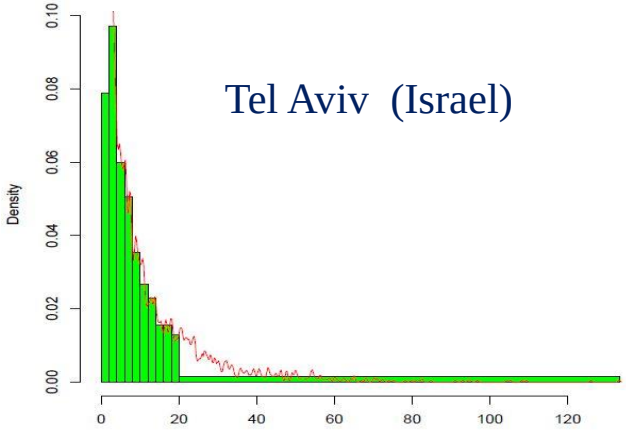
Methoni (Greece)



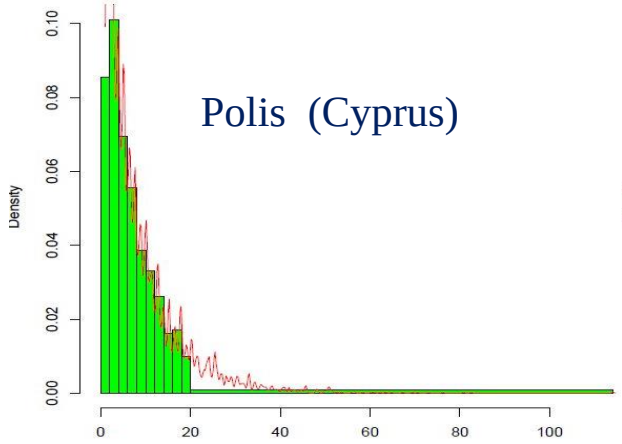
Palmyra (Syria)



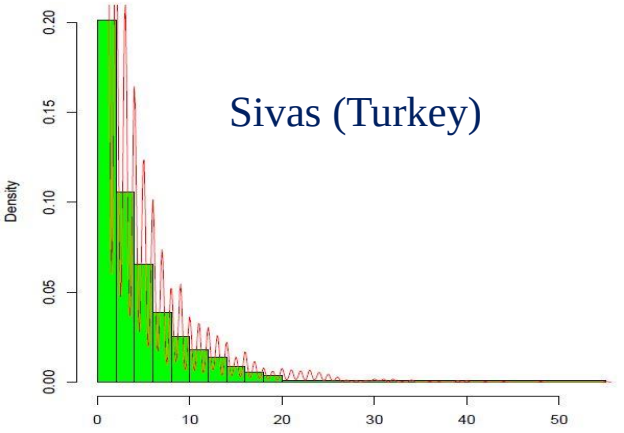
Tel Aviv (Israel)



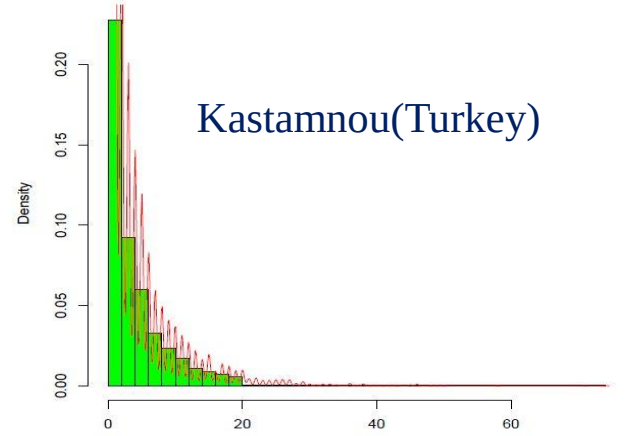
Polis (Cyprus)



Sivas (Turkey)

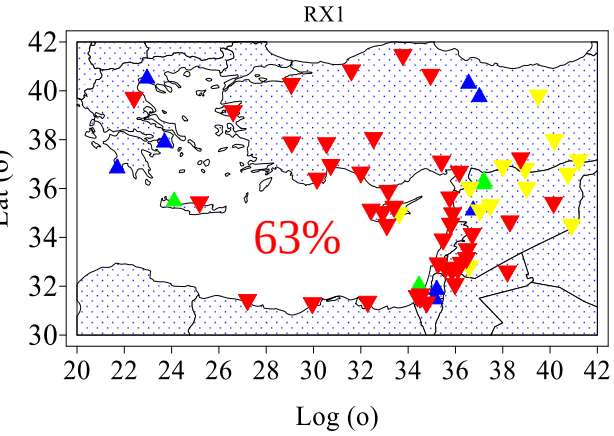


Kastamnou(Turkey)

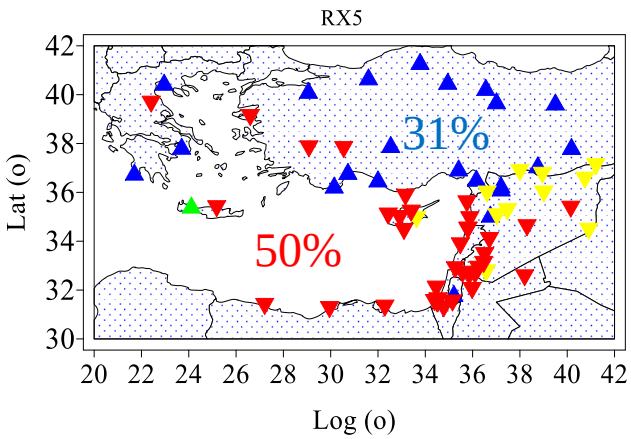


Spatial patterns trend in the annual indices of precipitation during 1961-2012

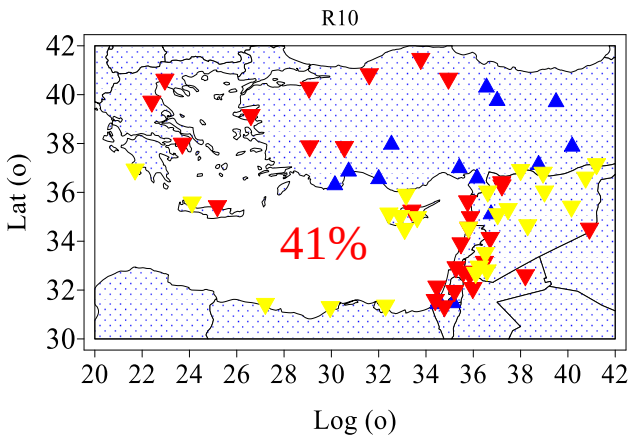
Max 1-day precipitation amount



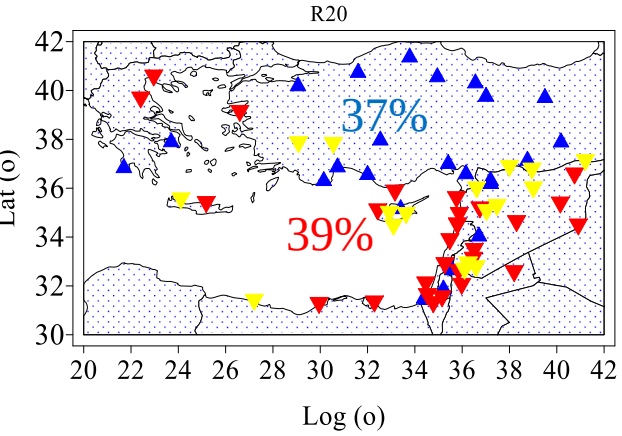
Max 5-day precipitation amount



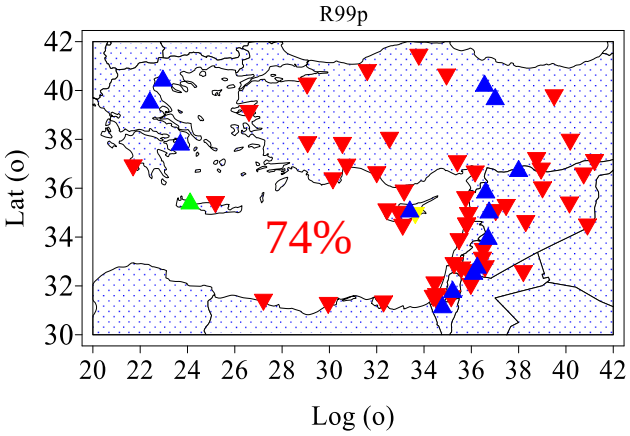
Number of heavy precipitation days



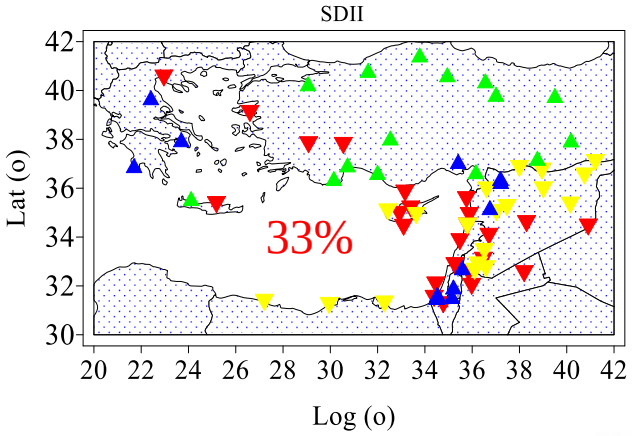
Number of very heavy precipitation days



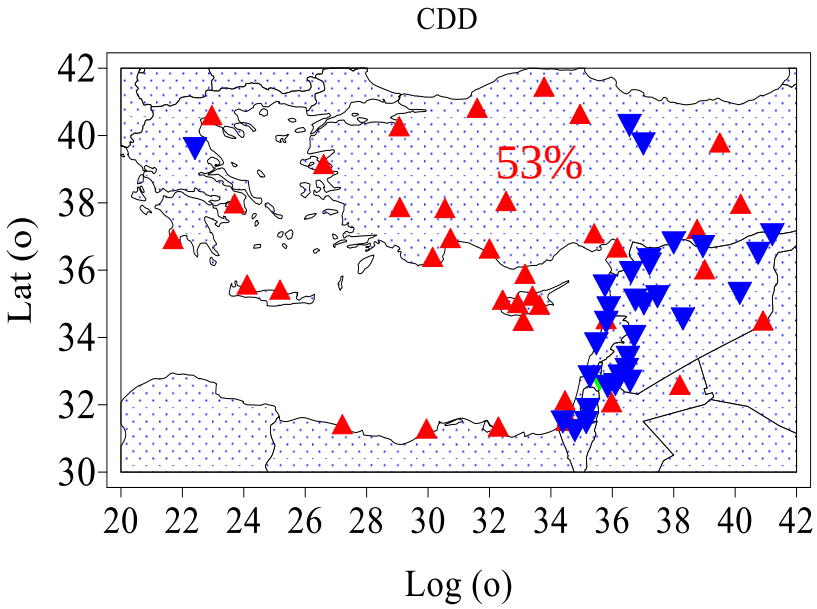
Extremely wet days



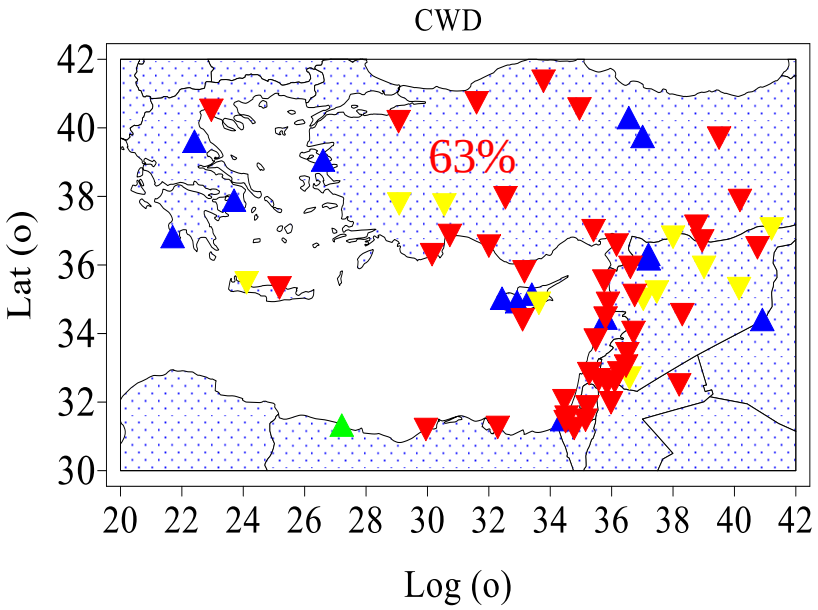
Simple Daily Intensity Index



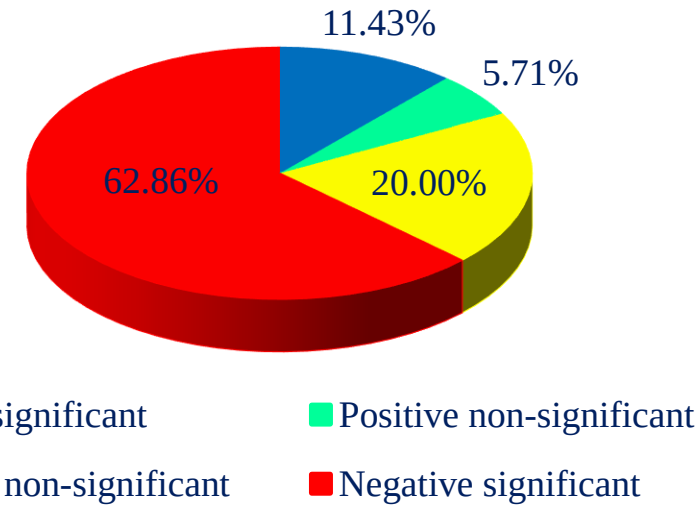
Consecutive dry days



Consecutive wet days



Frequency of the 10 extreme precipitation indices trends



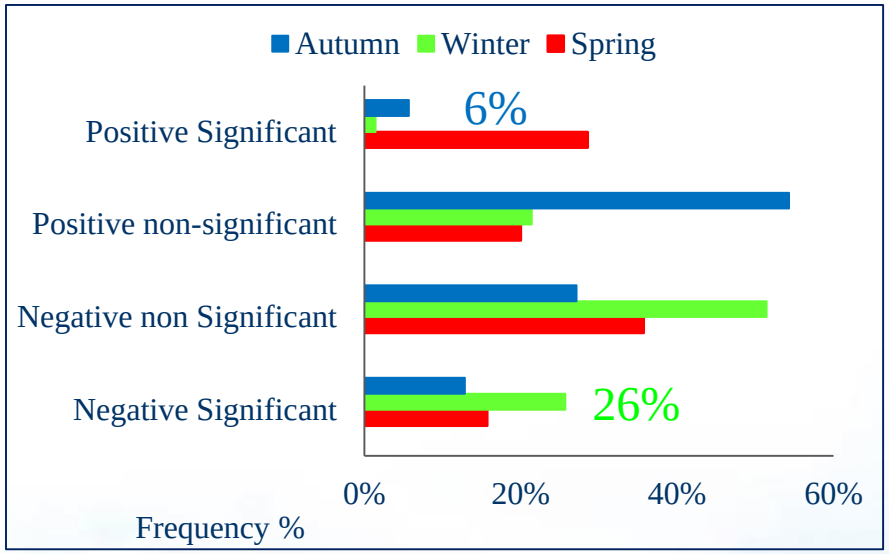
Correlation cofficients between precipitation extreme indices

	PRCPTOT	SDII	RX1 day	RX5 days	R95	R99	R10	R20	CDD	CWD
PRCPTOT	1.00									
SDII	0.66 [a]	1.00								
RX1 day	0.53 [a]	0.63 [a]	1.00							
RX5 days	0.55 [a]	0.68 [a]	0.77 [a]	1.00						
R95	0.72 [a]	0.74 [a]	0.72 [a]	0.73 [a]	1.00					
R99	0.50 [a]	0.57 [a]	0.82 [a]	0.70 [a]	0.70 [a]	1.00				
R10	0.82 [a]	0.59 [a]	0.31 [a]	0.44 [b]	0.52 [a]	0.27	1.00			
R20	0.74 [a]	0.66 [a]	0.45 [a]	0.53 [a]	0.72 [a]	0.42 [b]	0.80 [a]	1.00		
CDD	-0.15	0.06	-0.05	-0.01	-0.06	-0.05	-0.12	-0.07	1.00	
CWD	0.51 [a]	0.04	0.08	0.20	0.15	0.07	0.50	0.18	-0.18	1.00

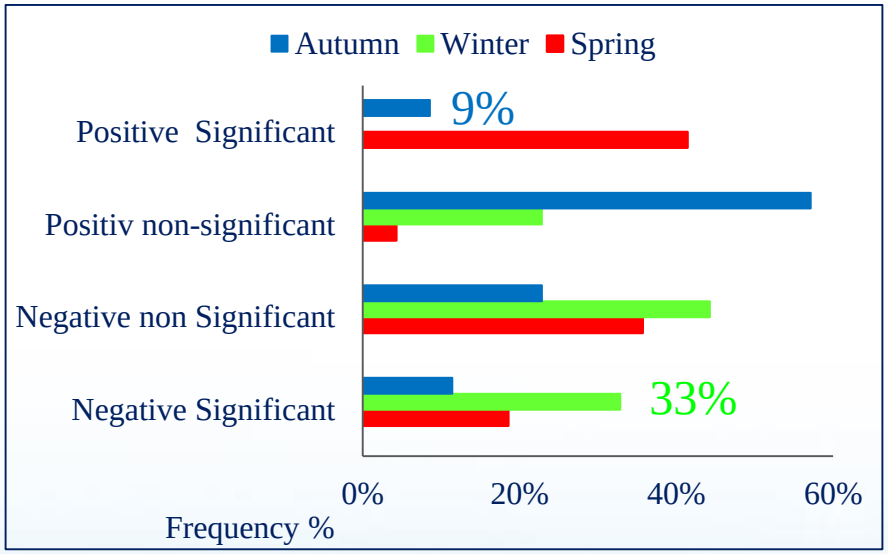
a Significant at the 0.01 level
b Significant at the 0.05 level

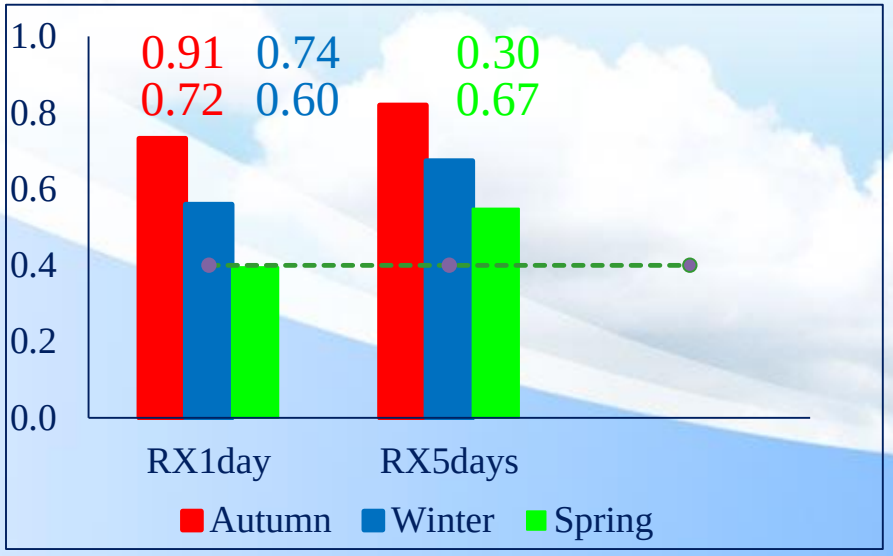
Frequency of seasonalRX1 day and RX5 day trends type in the EM over 1961-2012

RX1day



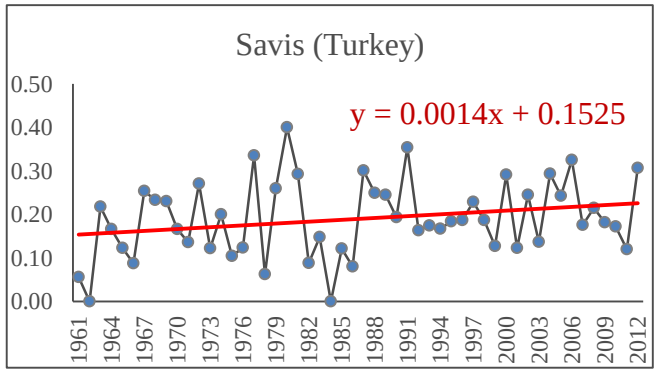
RX5day

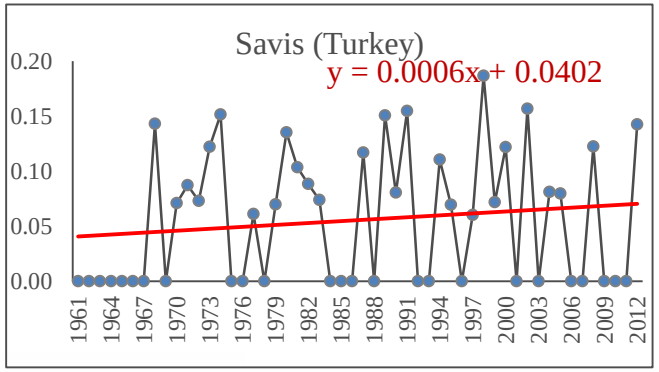


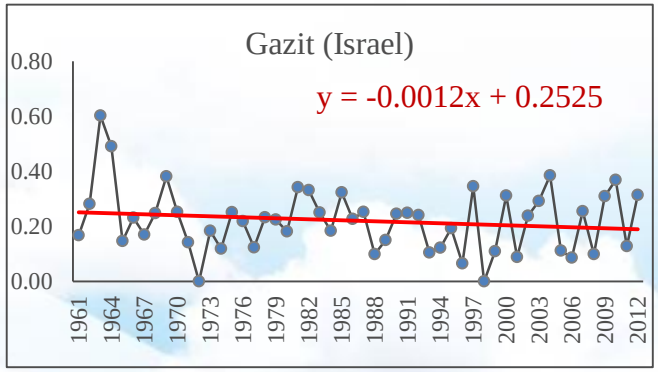


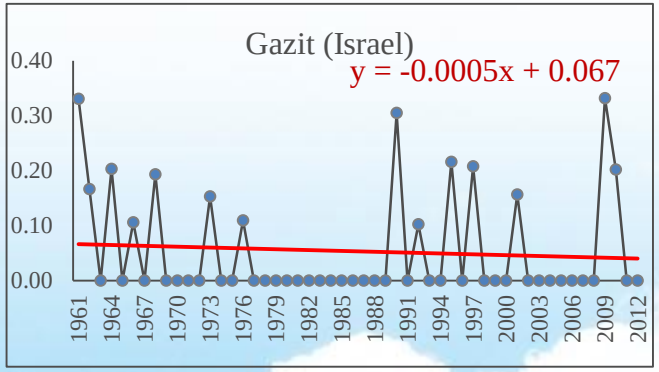
Mean correlations between the RX1day and RX5day indices and total precipitation for three rainy seasons (autumn, winter and spring) over the EM during 1961-2012 (green dashed horizontal line indicates where the 95% statistical confidence level starts)

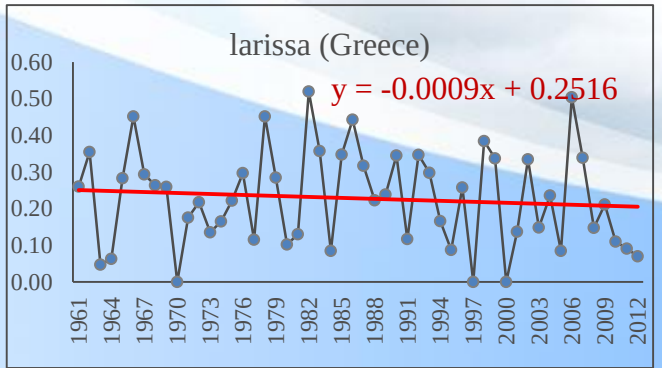
The average contribution of extreme and heavy wet days to total precipitation in some selected stations over 1961-2012.
(Left) very wet days (R95p) and (right) extremely wet days (R99p)

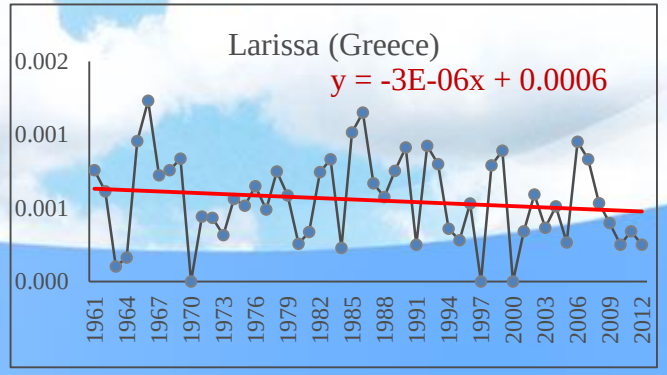








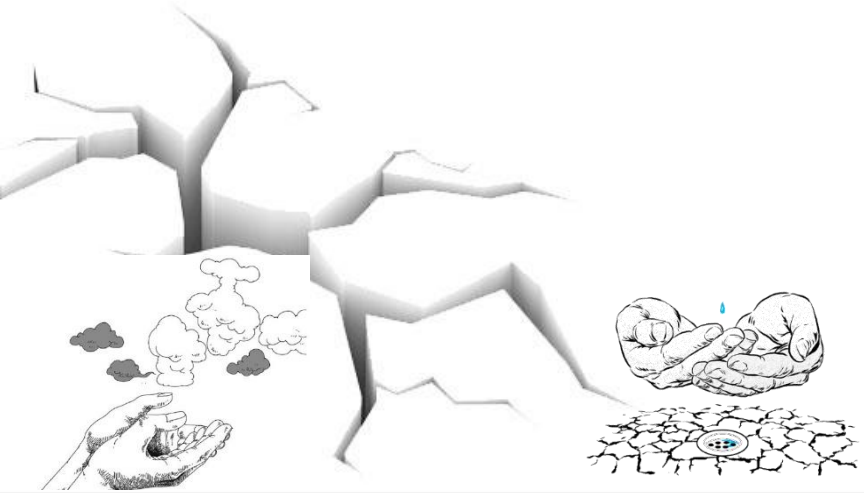




Conclusions

- The pattern of trends for the extremes was generally the same as that for total annual rainfall, with a change to drier conditions with a significant decreasing trend in the annual total precipitation amount (PRCPTOT) in 46% of total stations (3.1% per decade) in Syria, Israel, Jordan, north Libya and north Egypt.
- Some areas of the EM displayed significant decreasing trends in extreme precipitation across the seasons, particularly in winter (DJF) .These results are in line with previous ones which concluded that extreme wet spells in the EM will become shorter in all seasons, except in autumn (Oikonomou *et al*, 2008).

- Significant increasing trend in the maximum number of consecutive days (CDD index) in 53% of total stations was also detected especially in north and northwest Turkey, Cyprus, Greece, north Libya and north Egypt.



Rain can be seen as both the giver and the taker of life.