Climatology of cyclones in Mediterranean Region

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SEEVCCC/NHMS of Serbia

12-14 June 2013, Madrid, Spain
Scoping meeting on Mediterranean RCOF

Mediterranean Basin –

geographical position and characteristics

The Mediterranean Basin consists of the Mediterranean Sea and its surrounding shorelines.

- It also extends inland to the north approximately to the ridge line of the Pyrenees, the Alps, and the Dinaric Alps.
- The Atlas Mountains form a good boundary for the southwestern Mediterranean but in the southeast, the basin fades away somewhere within the Sahara Desert.
- In the west, the Strait of Gibraltar forms the limit of the Mediterranean Sea and basin, and in the east, the central mountains of the Anatolian Peninsula of Turkey separate the Mediterranean from the Black Sea.
- To the southeast, the coastline of the Middle East forms the eastern end of the basin.

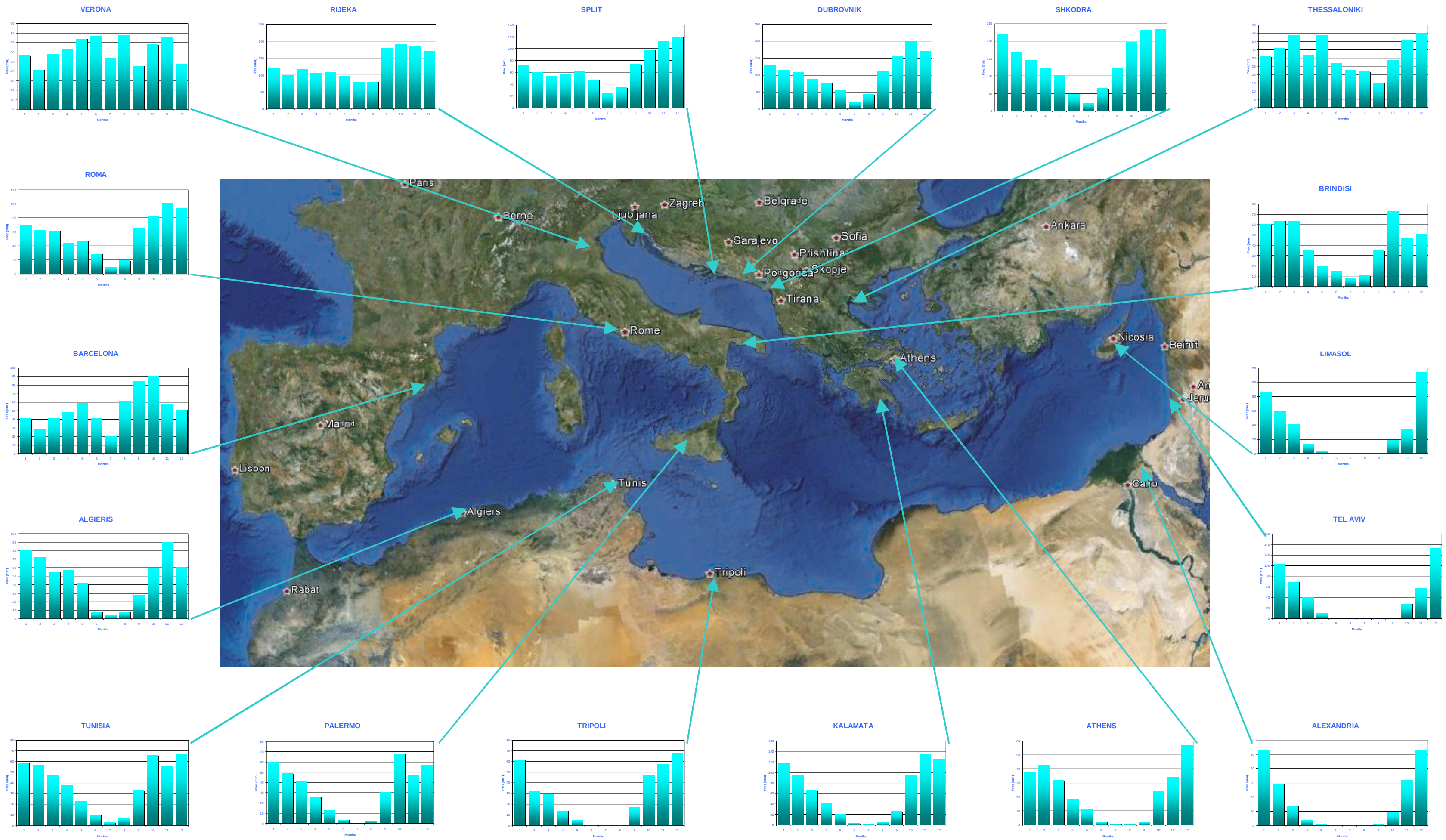
Introduction

Economies of the countries from the region of Mediterranean or of those which are gravitating to it, depend in a large degree, directly or indirectly, on frequency, intensity and tracks of cyclones. Cyclones, which are coming into or developing in the region of Mediterranean, are greatly responsible for mean monthly precipitation totals and their distribution.

Economy branches that are dependant on and vulnerable to the amounts and distribution of precipitation the most are:

- Agriculture
- Water resource management
- Energy sector

Distribution of mean monthly precipitation totals in the Mediterranean region



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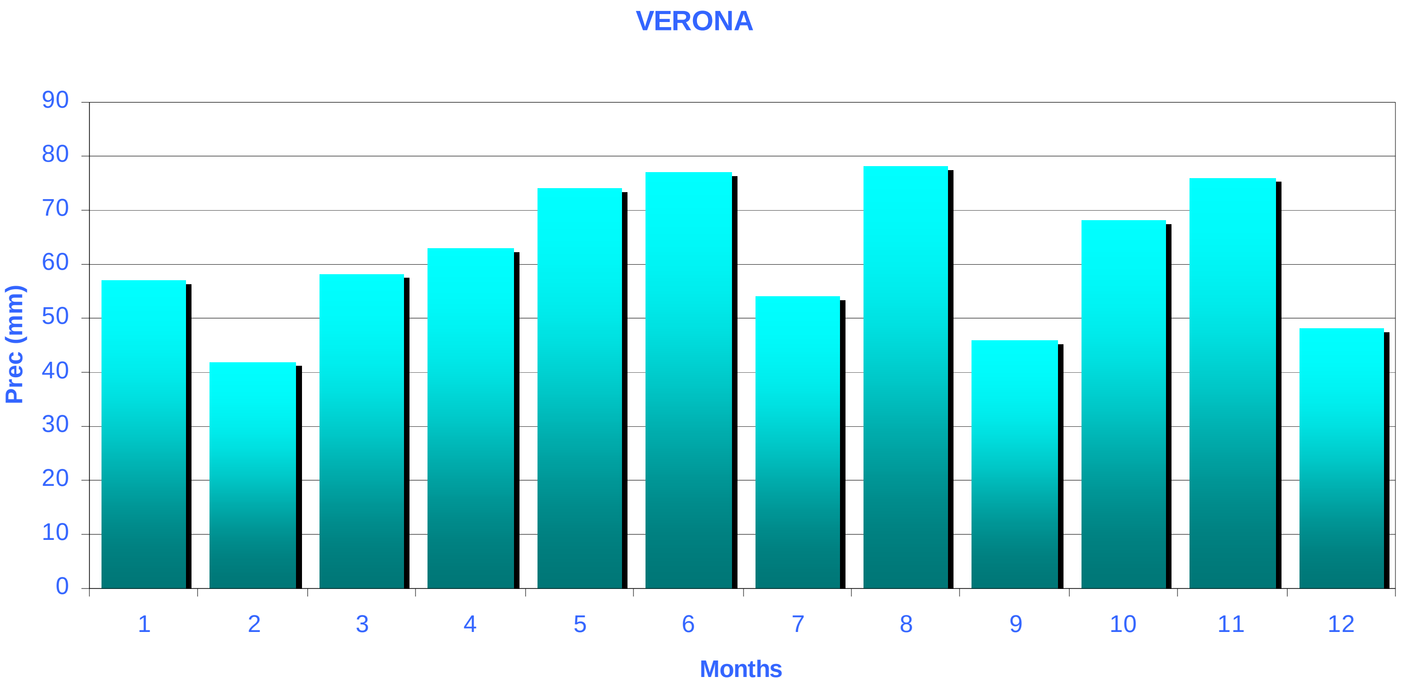
VERONA
Prec (mm)
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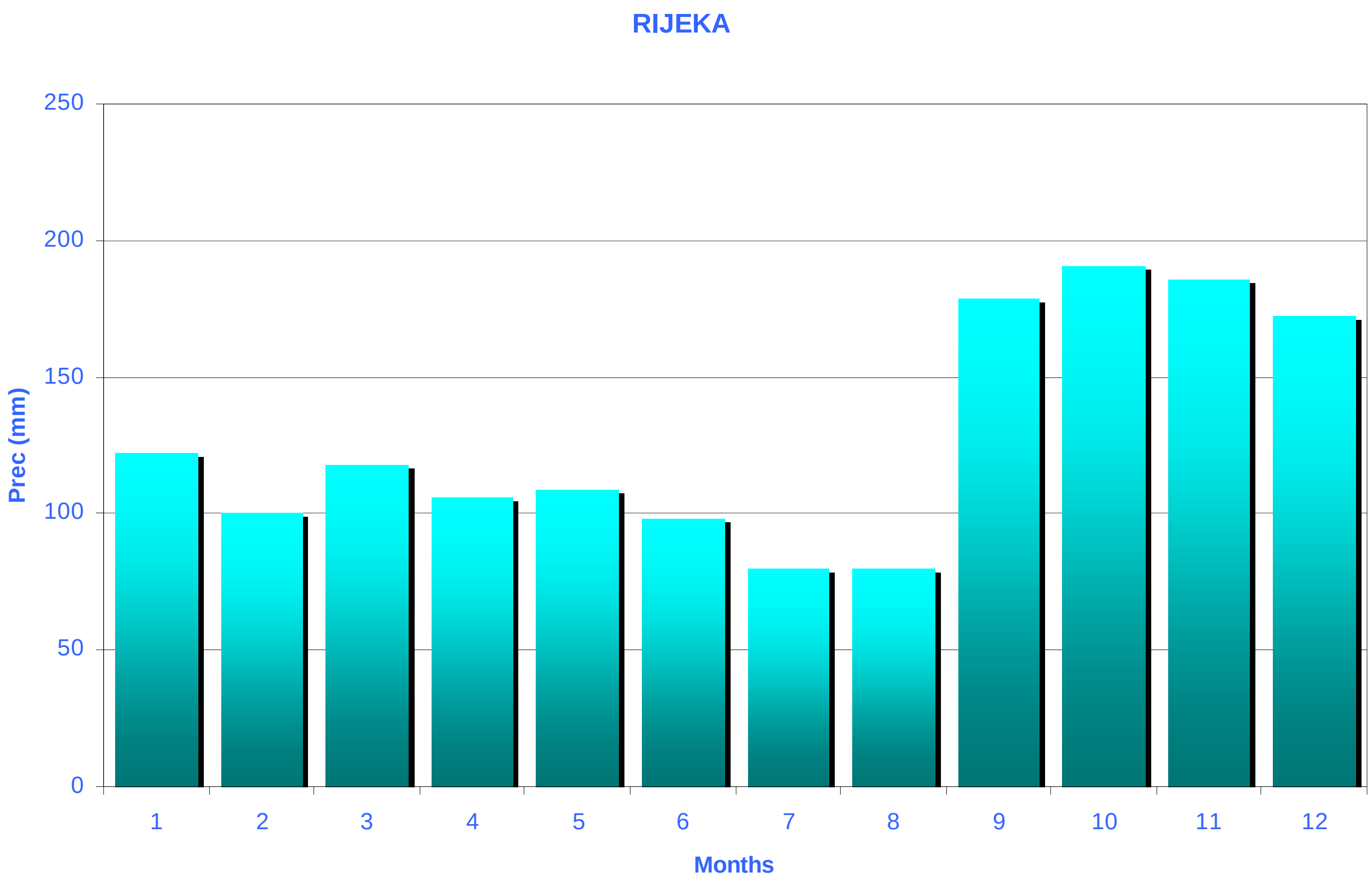
Months



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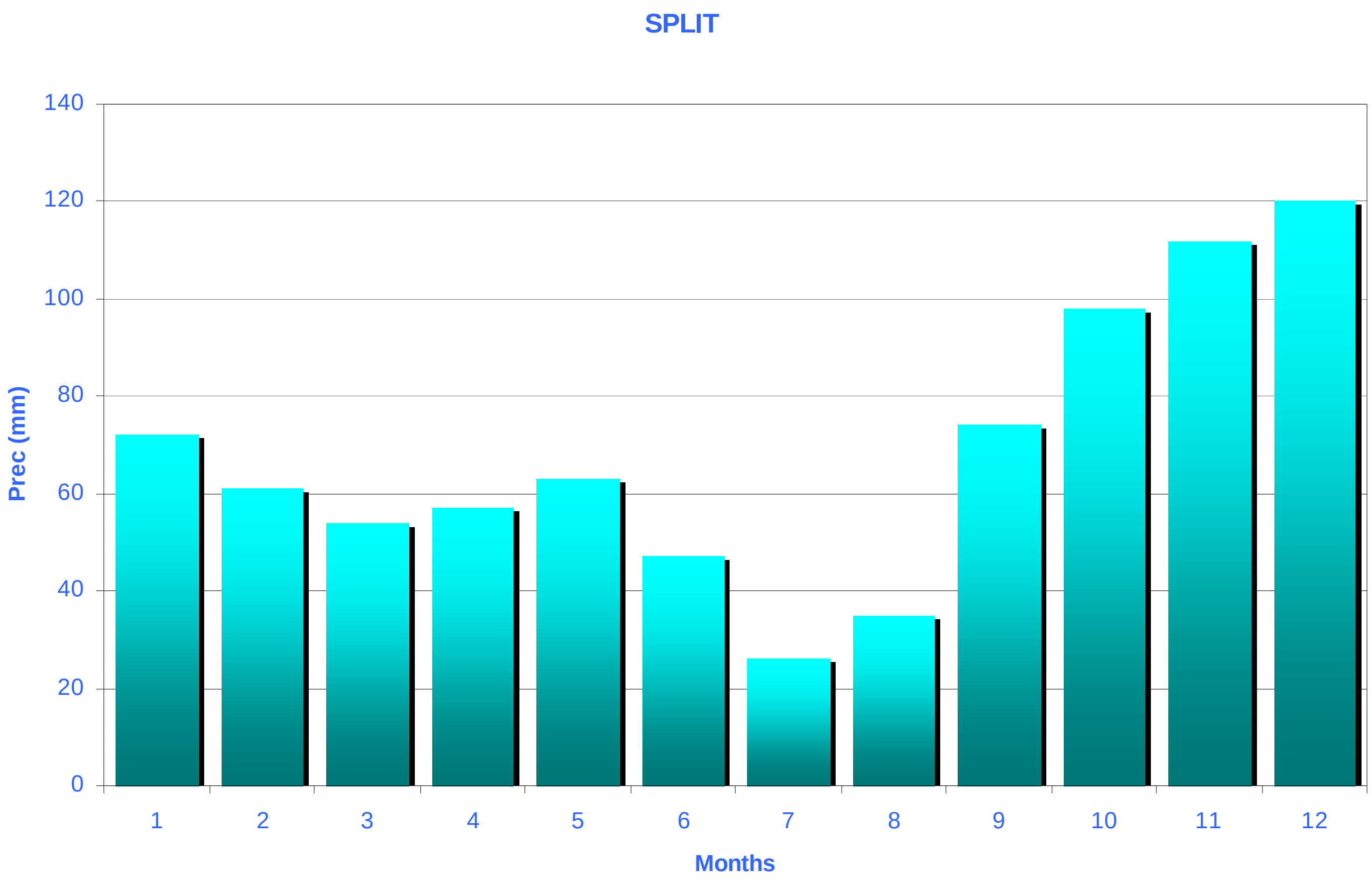
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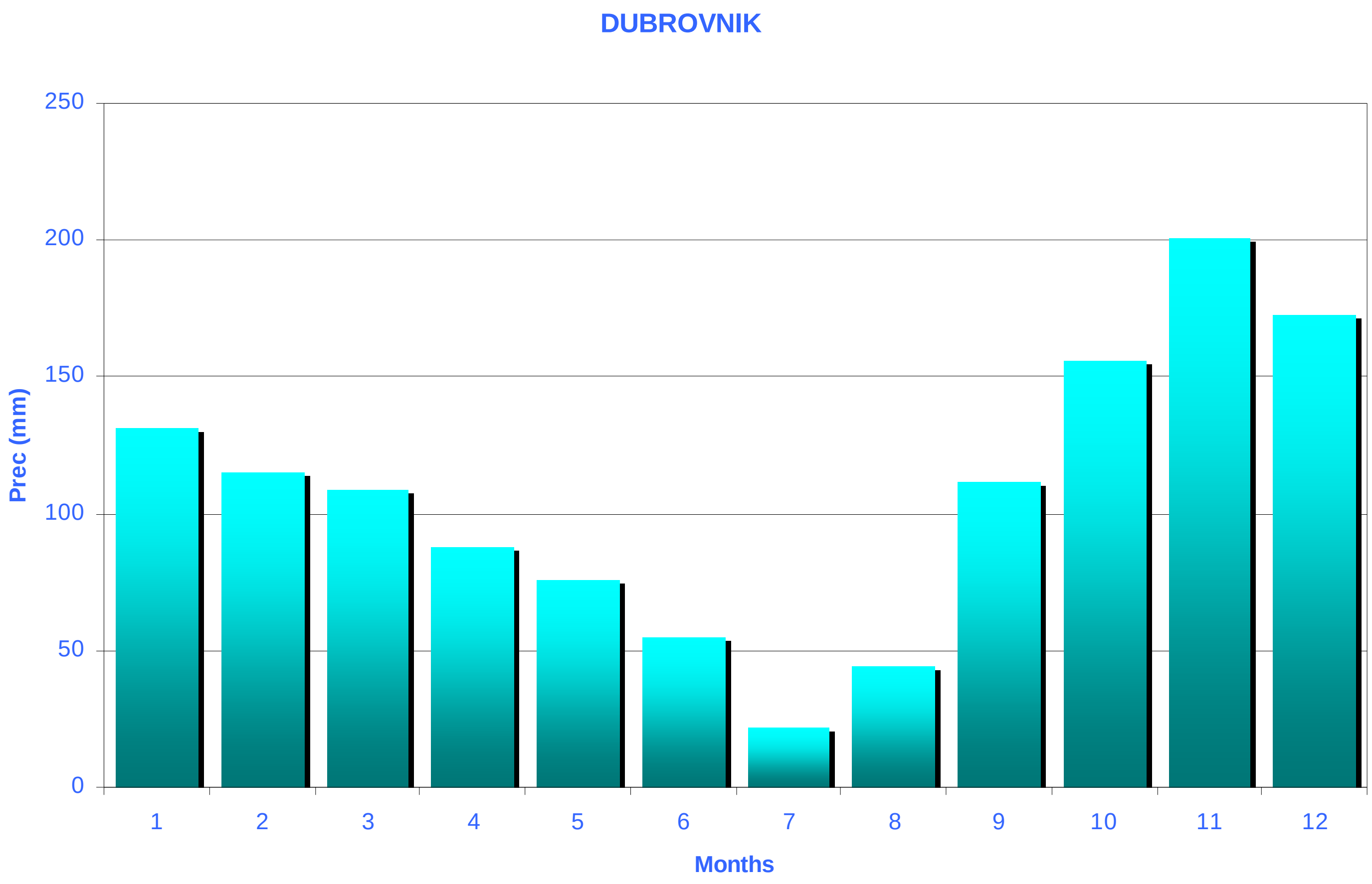
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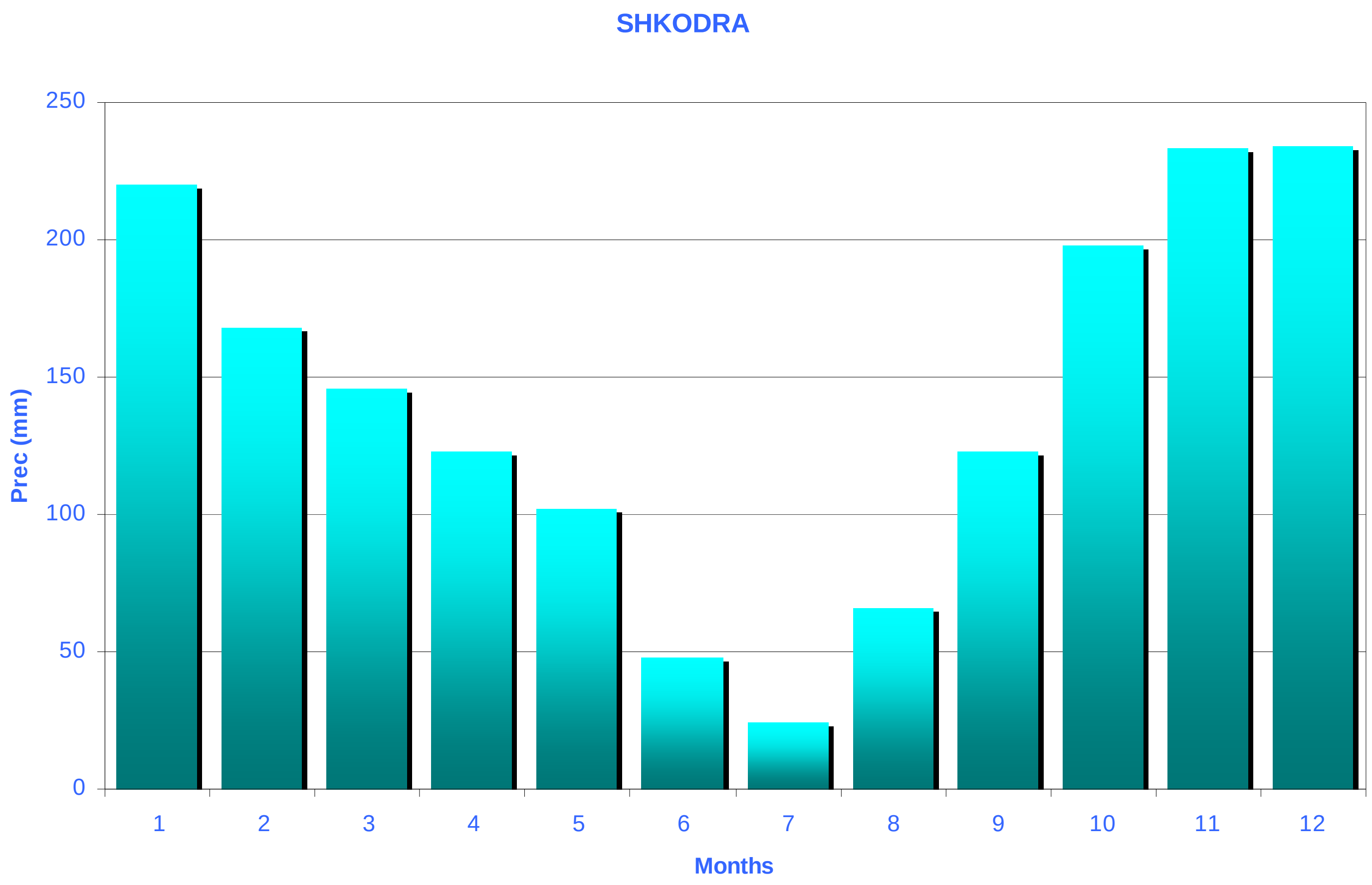
Months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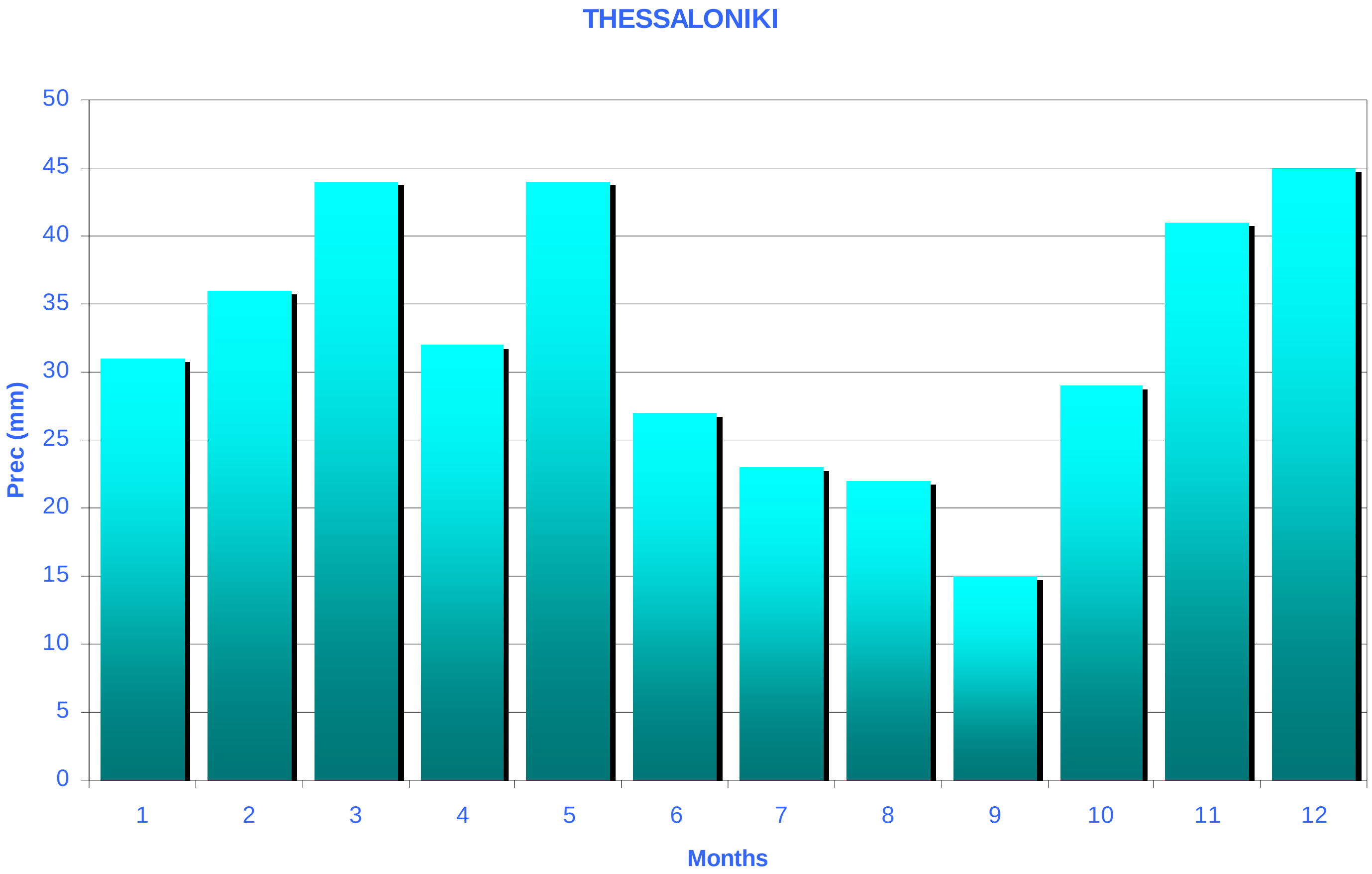
Months



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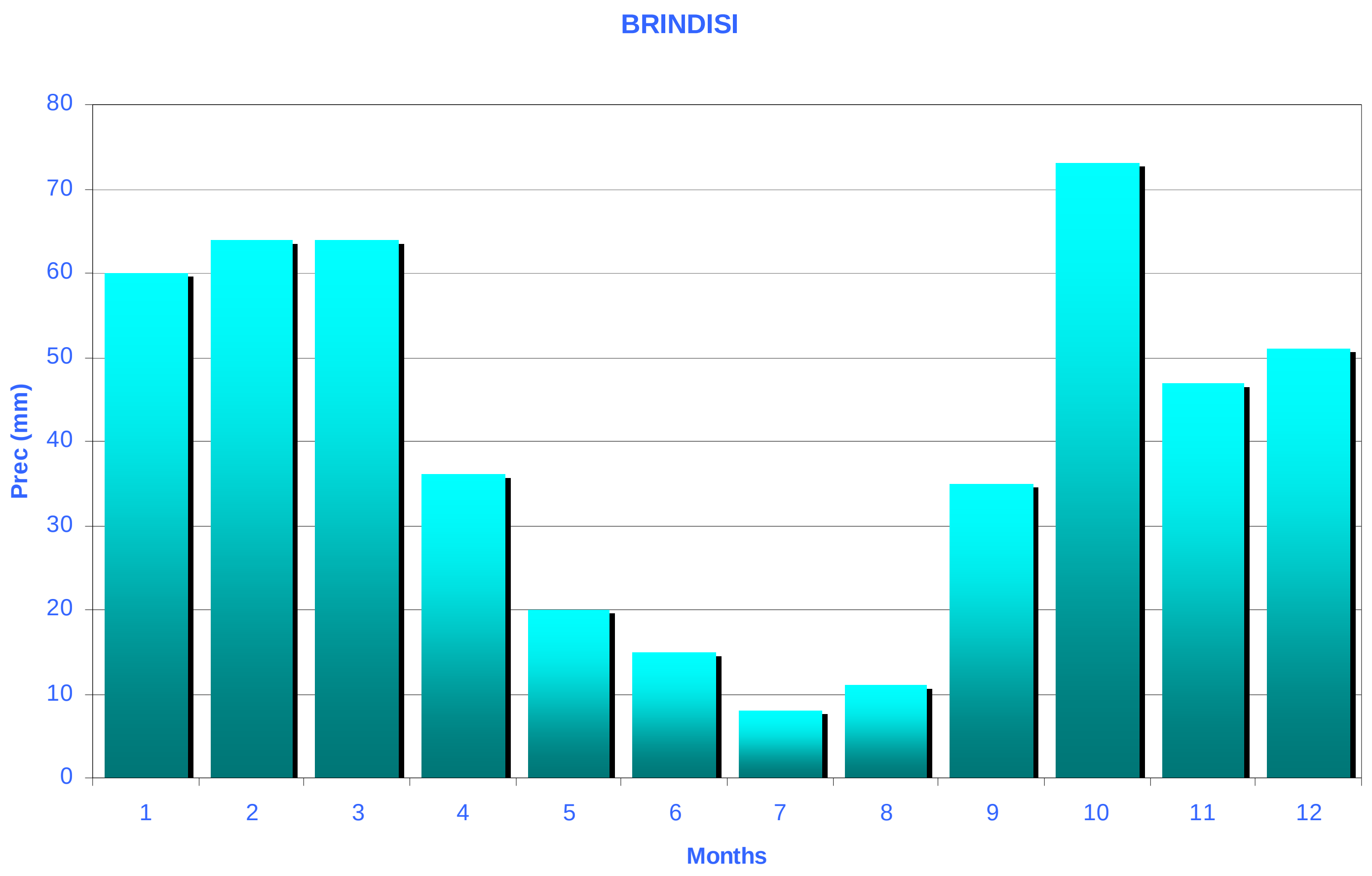

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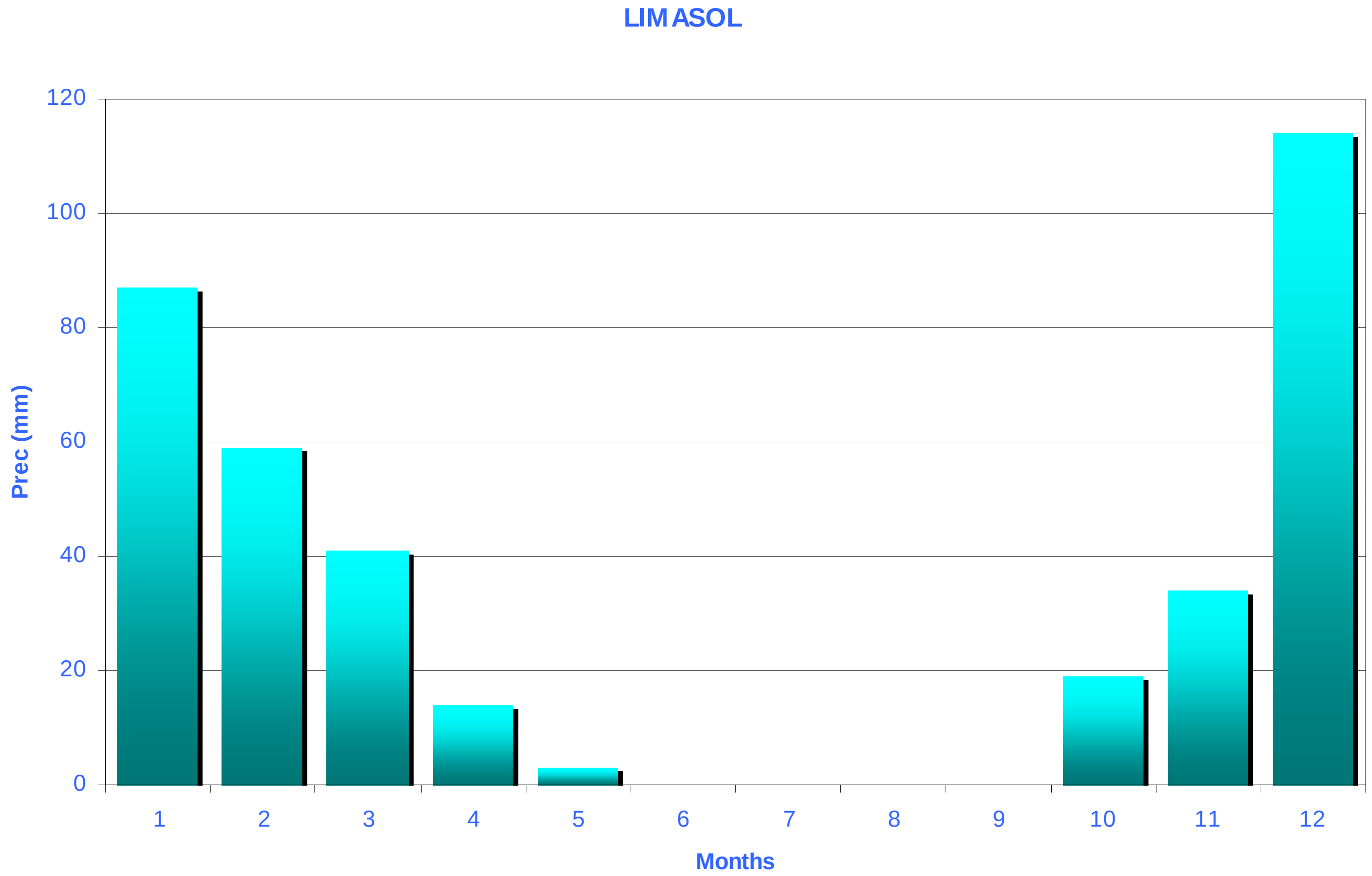

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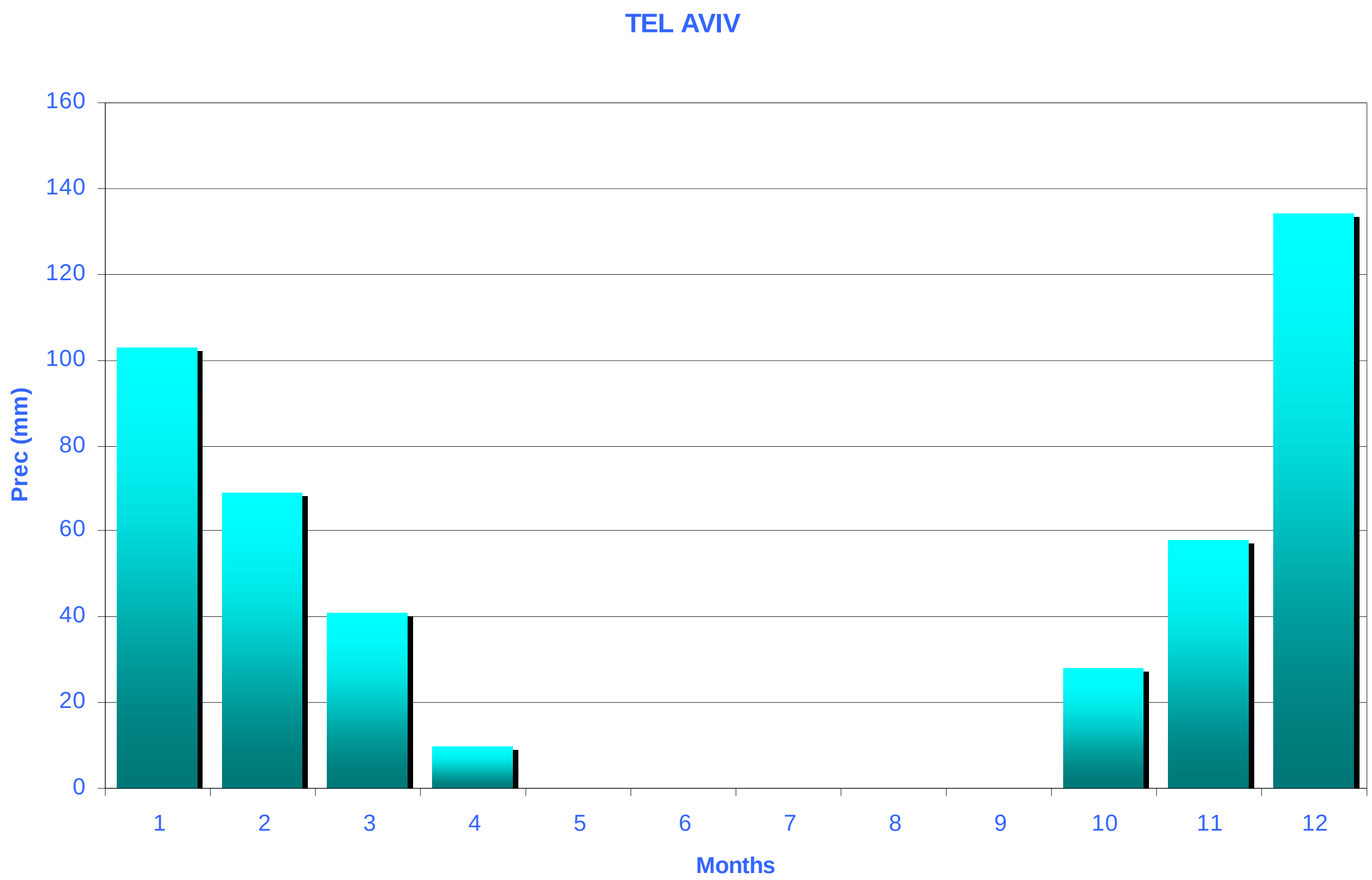

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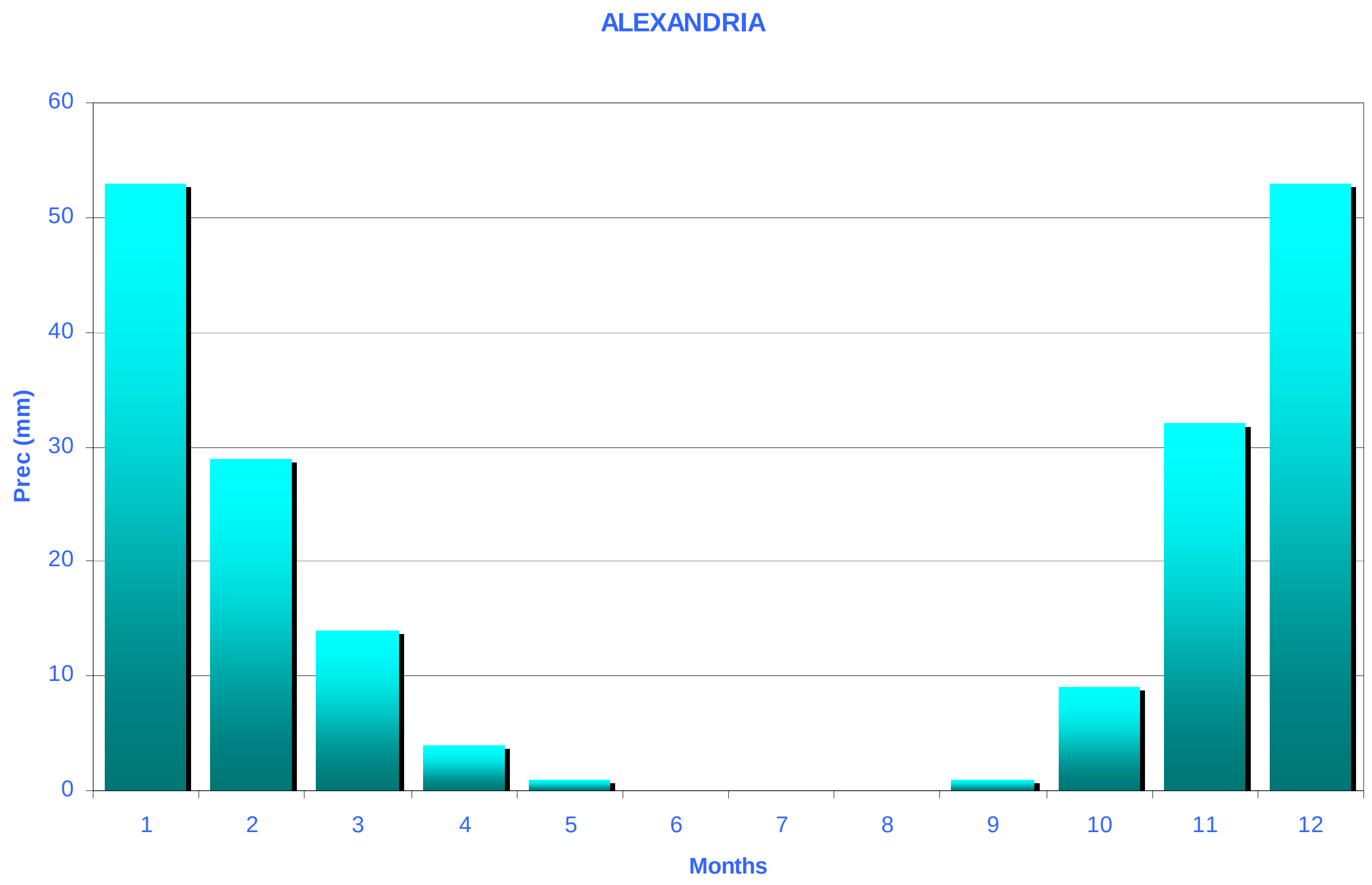

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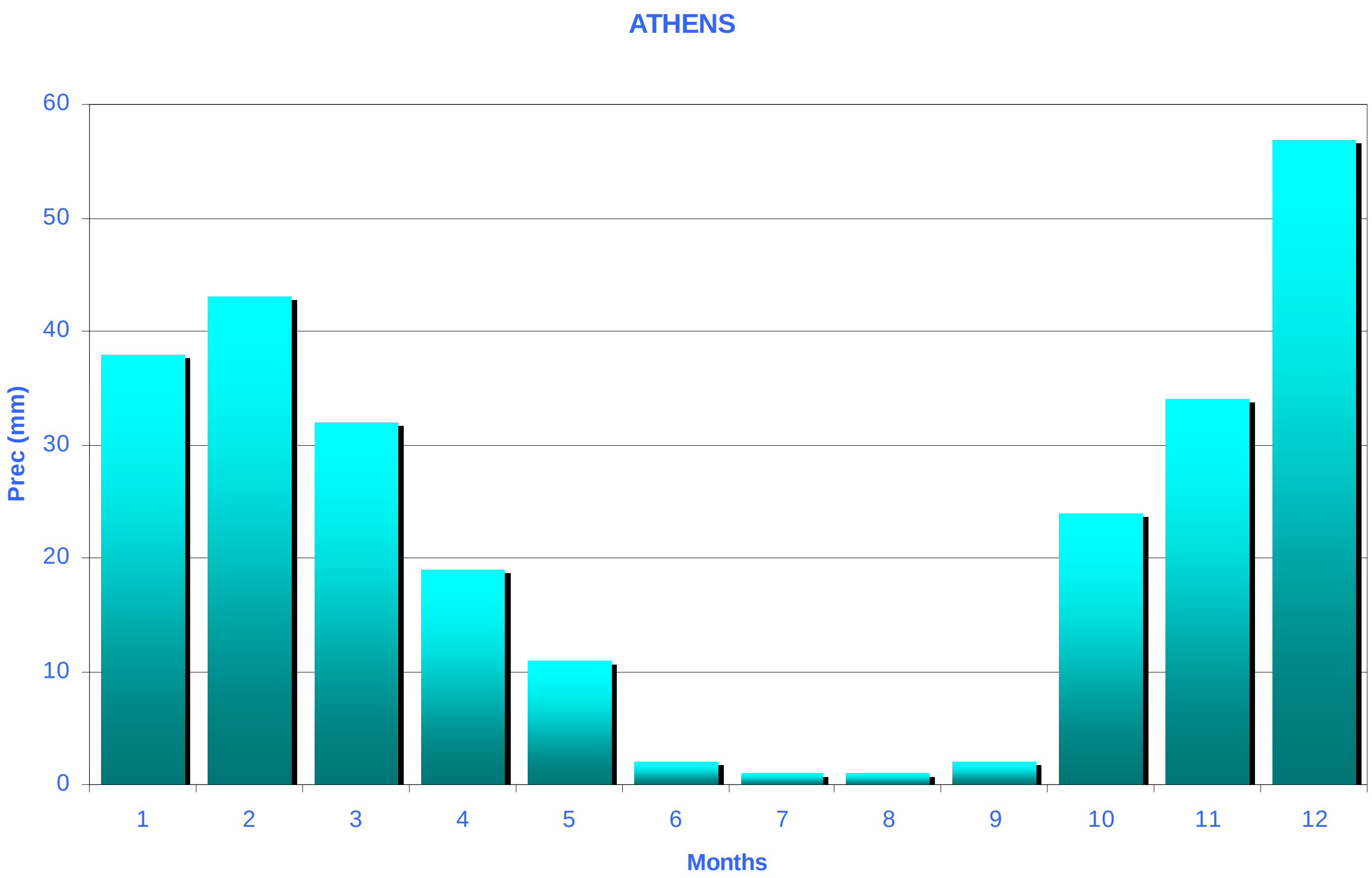

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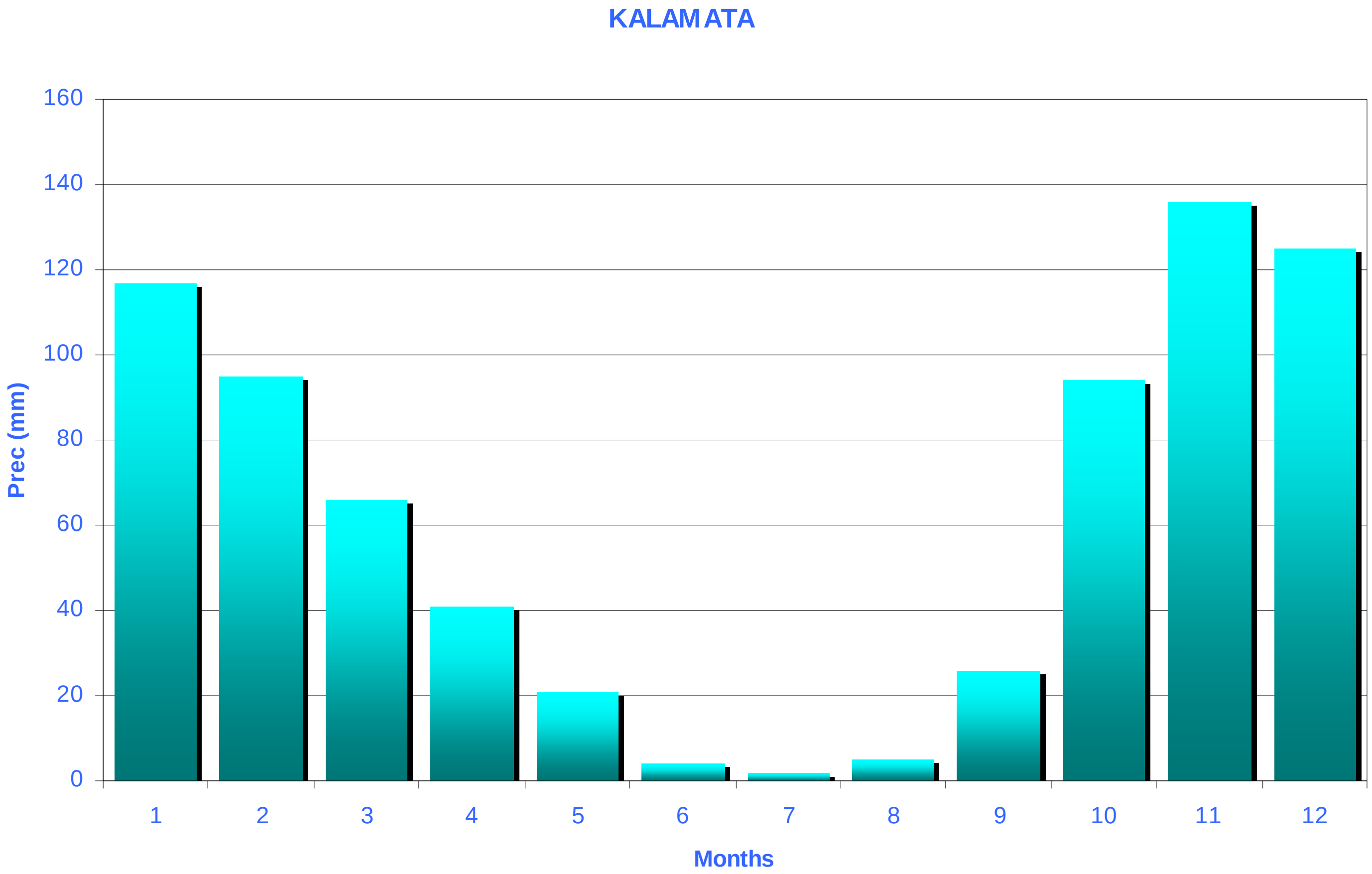
KALAMATA
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Prec (mm)
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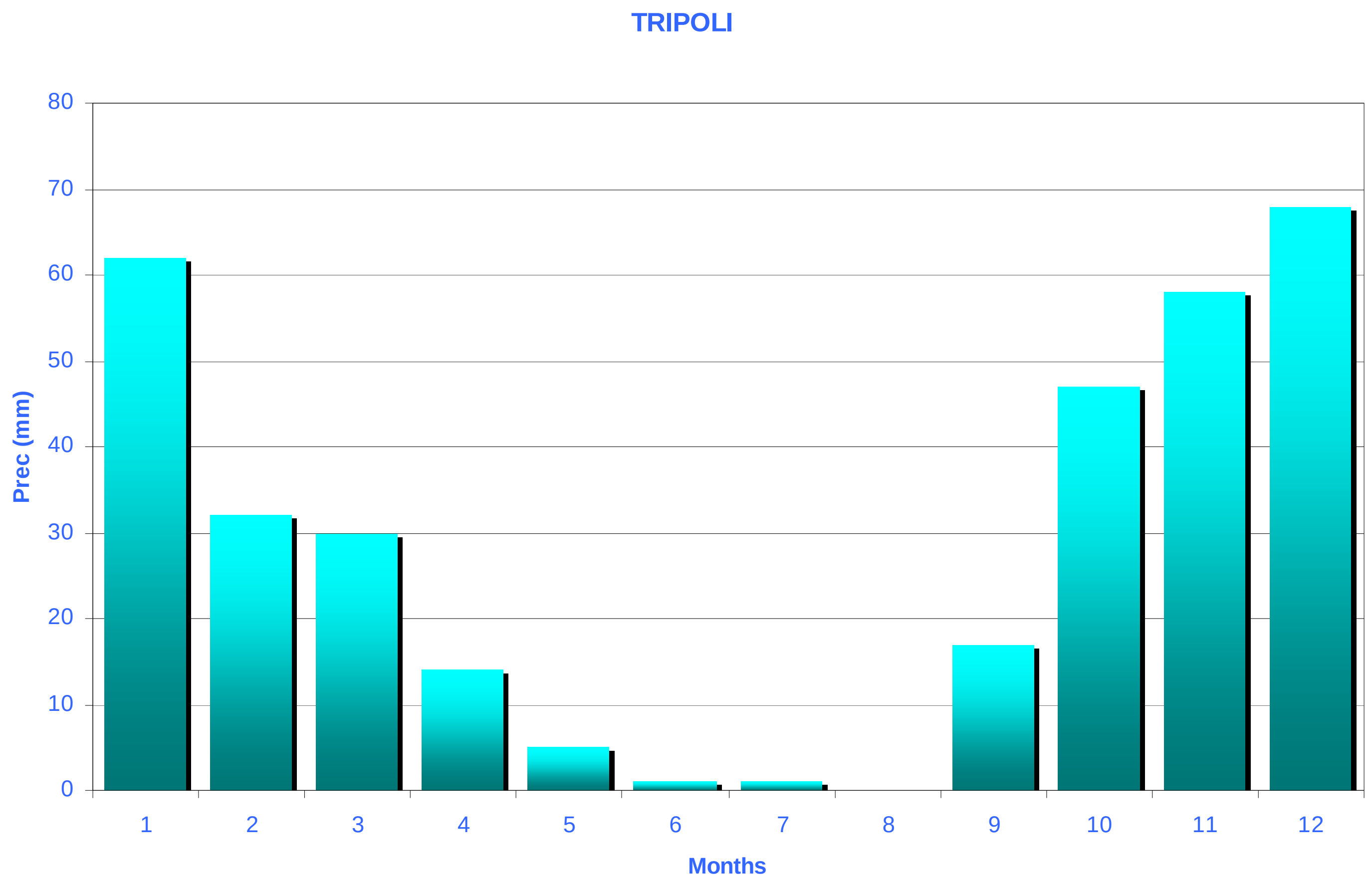
Months


TRIPOLI
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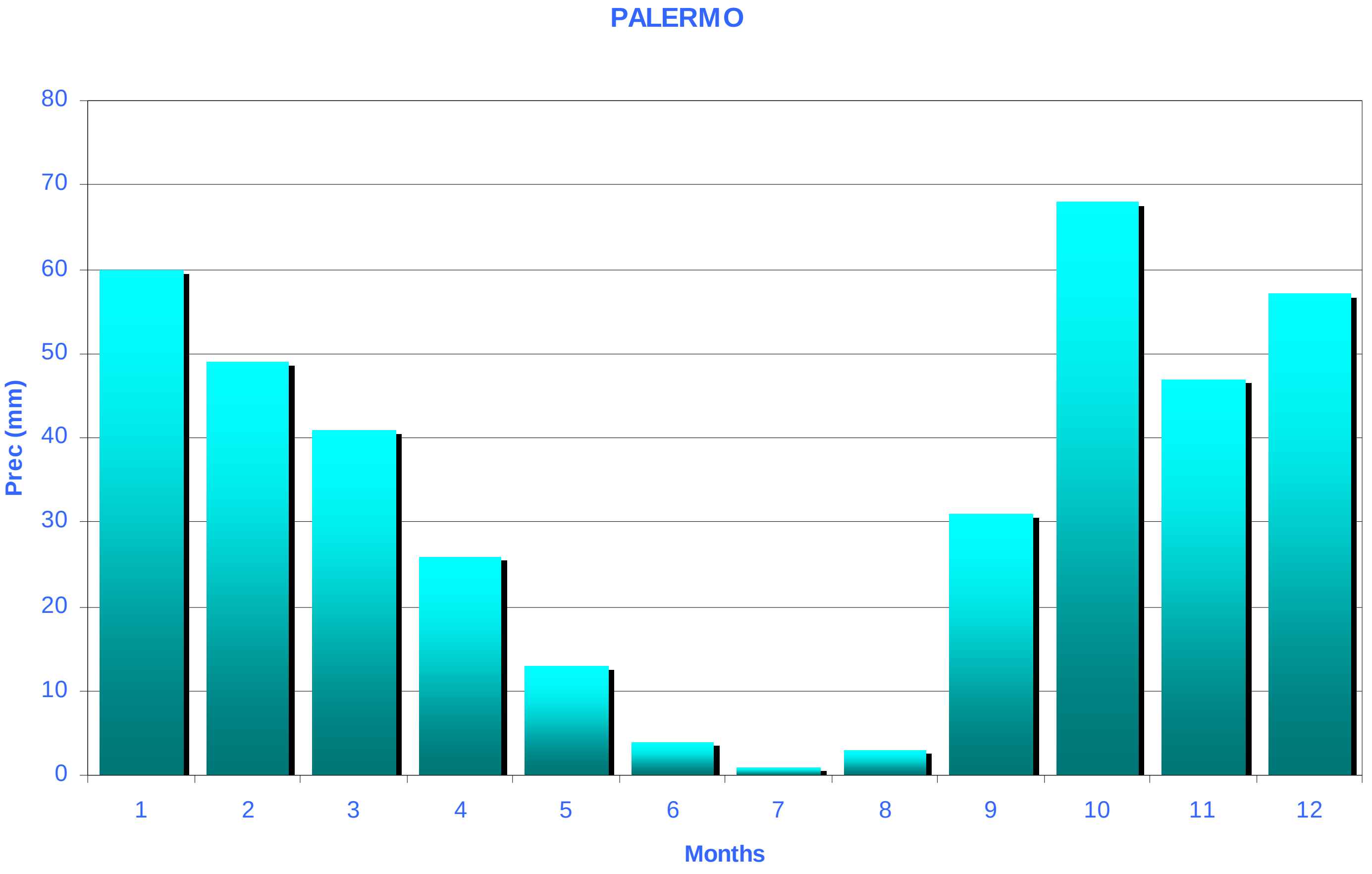
Months



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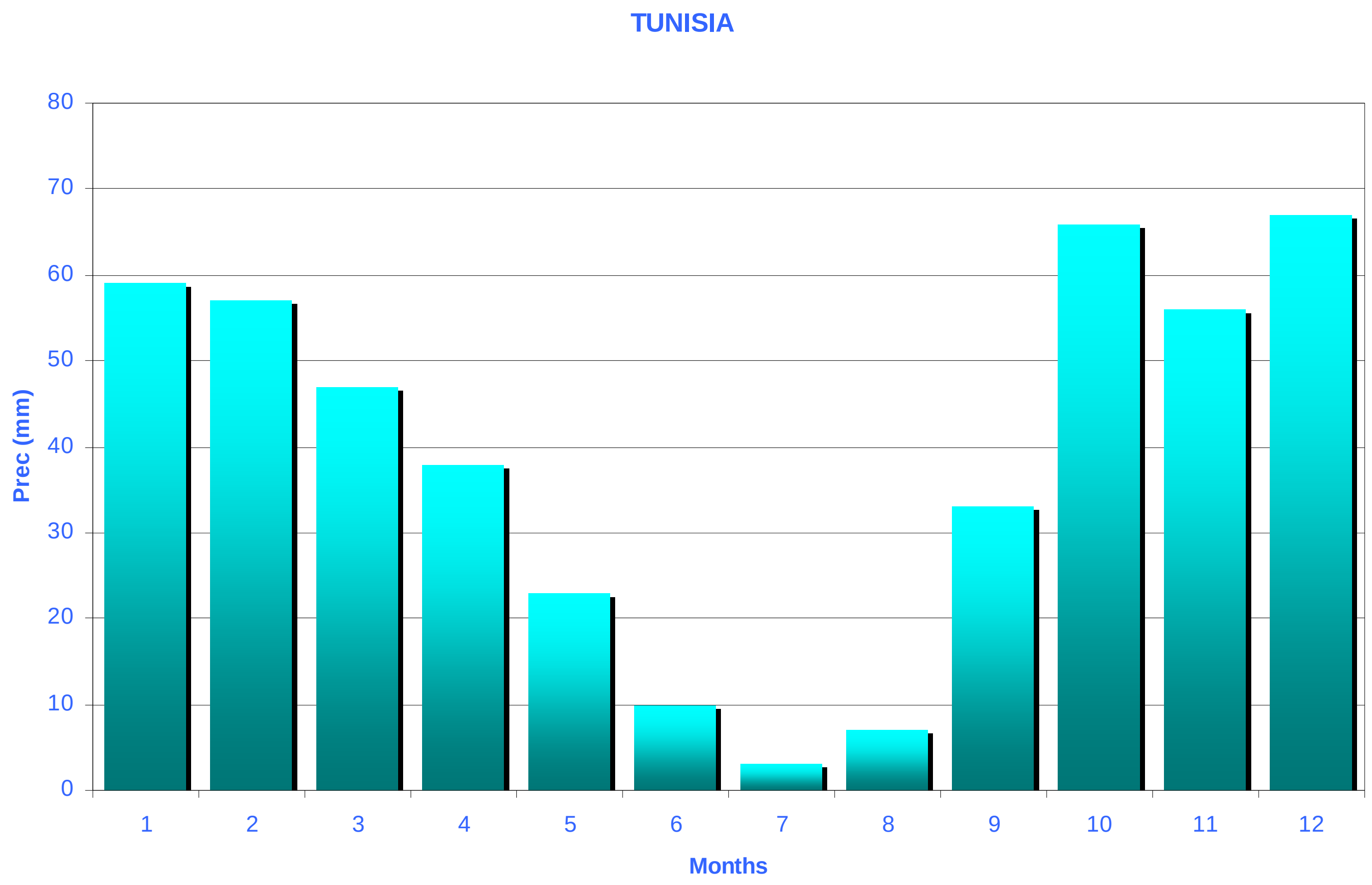
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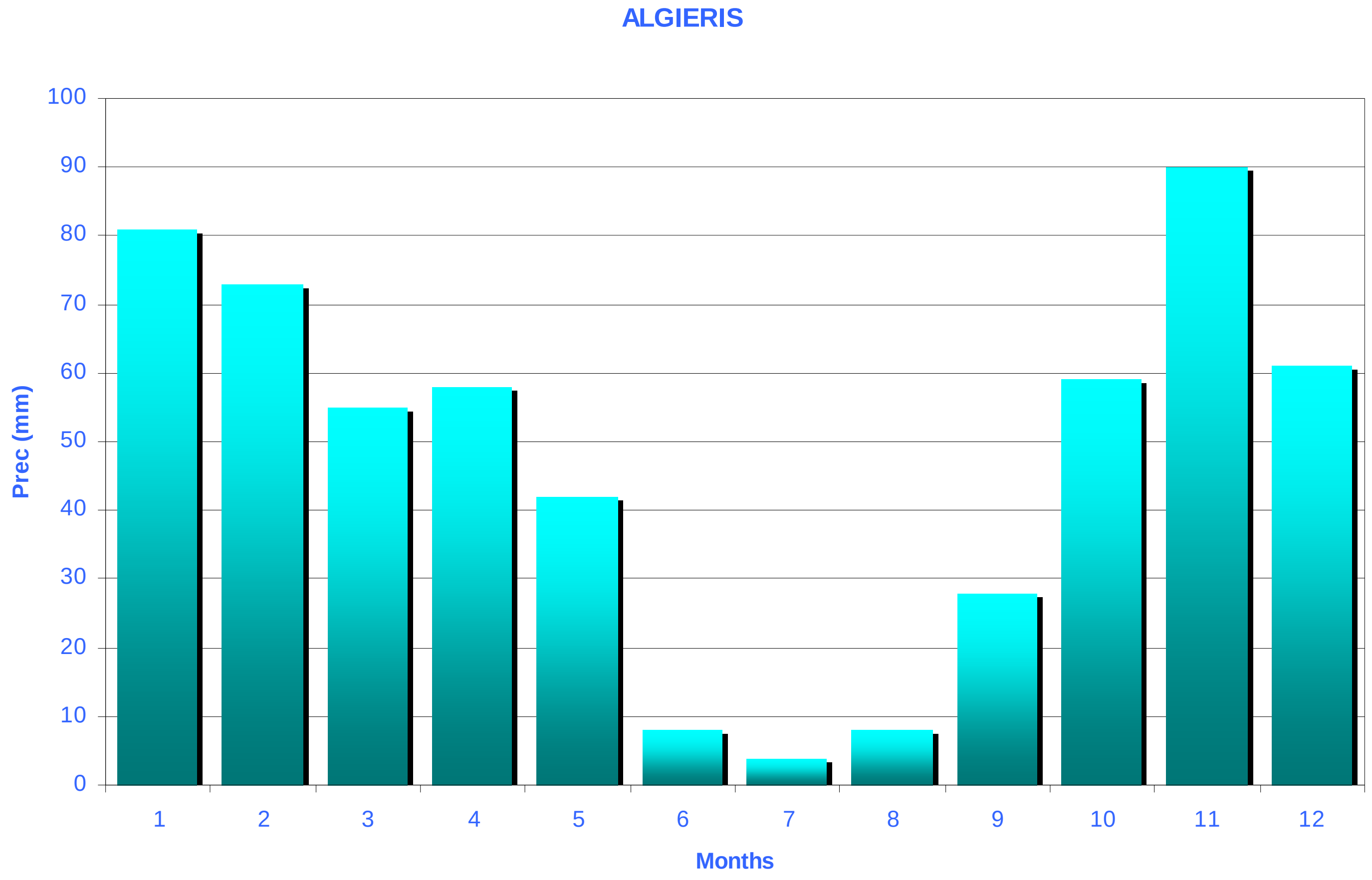

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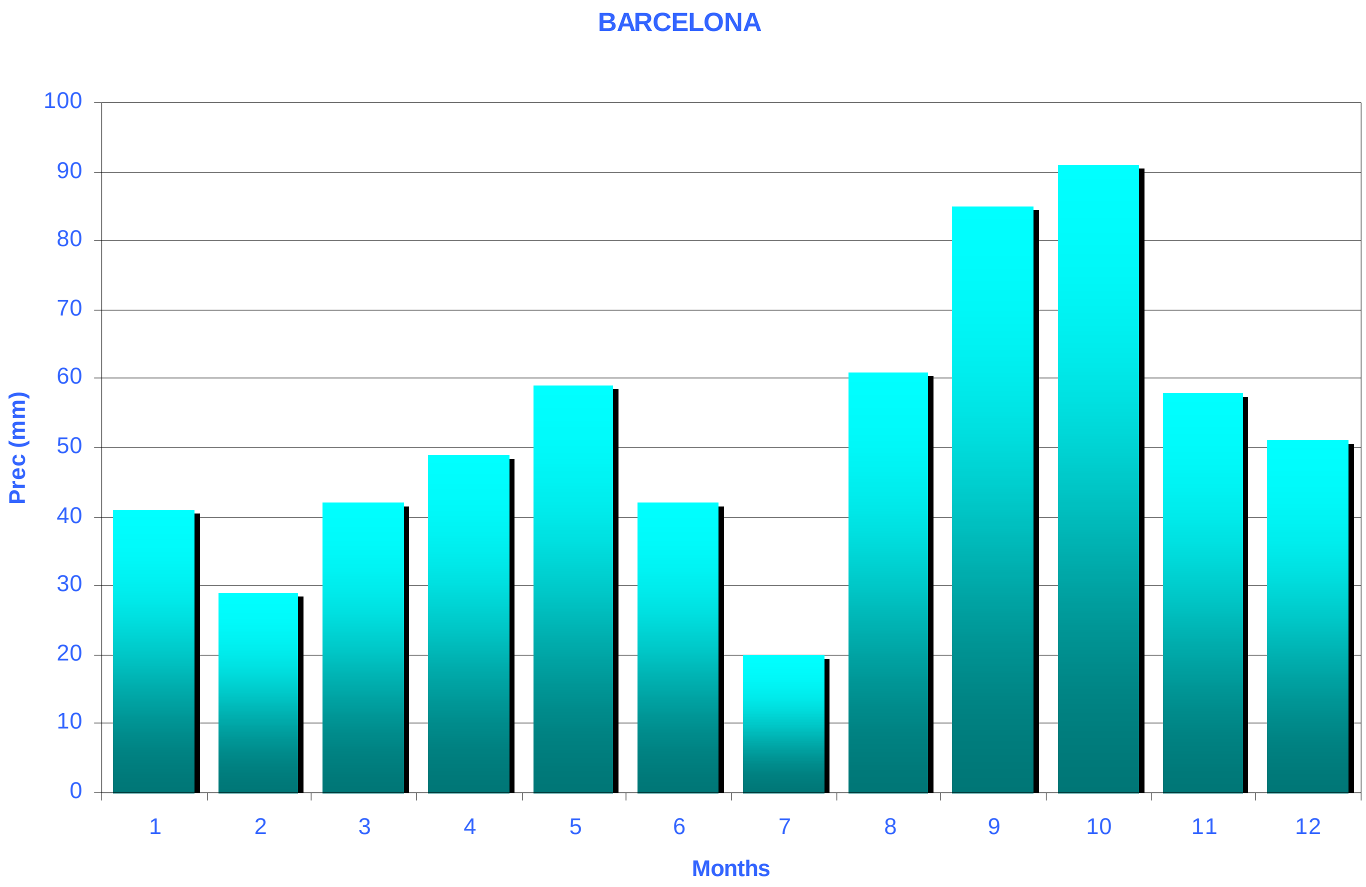
BARCELONA
Prec (mm)
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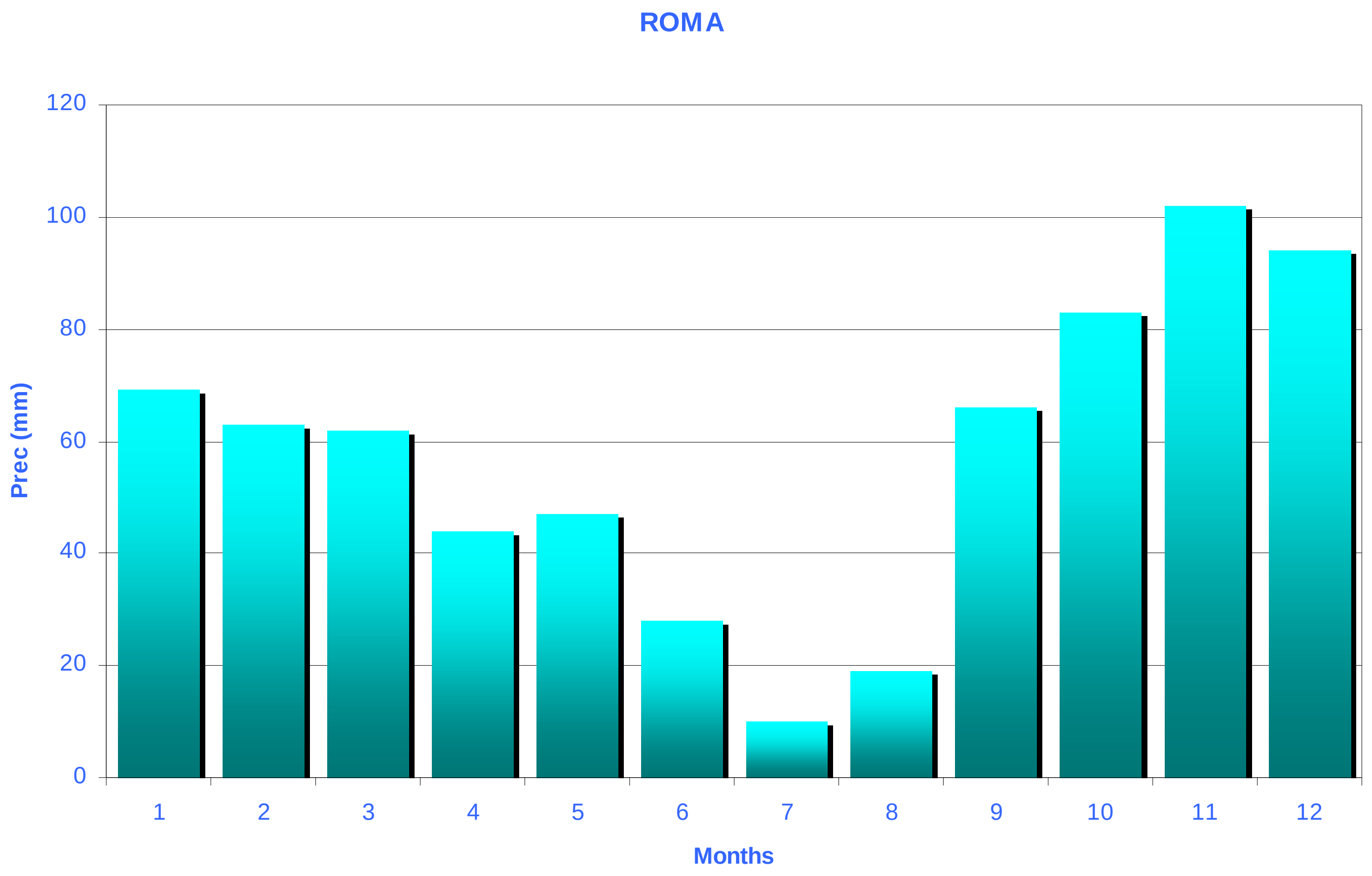
Months



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Basic information about the climatology of cyclones in the Mediterranean region

Subjective climatology of cyclones issued by Dr. Radinović et al. (1965,1987)	Objective climatology of cyclones issued by Trigo, Davis and Biggs (1998)
MSLP charts for the 1951-1969 period for the area of the West Mediterranean, Apennine and Balkan Peninsula, Adriatic and Ionian Sea	MSLP data from ERA in the period 1979-1997 In the area from 24.75ºN to 50.625ºN and 15.75ºW to 45ºE
Space resolution - boxes 1º x 1º	High spatial resolution - 1,125º x 1,125º
High temporal resolution – 00, 06, 12, 18 UTC	High temporal resolution - 00, 06, 12, 18 UTC
Criteria: Cyclones with the scale from ~ 100 to ~1000 km	**Criteria**: Cyclones with lifetime > 12 hours Local Z_{1000} minimum over 3x3 grid points area Minimum must fulfill 2 conditions: - Maximum value of 1020 hPa is required for central sea level pressure evaluated as: p_{cen}(hPa)= 0.121 Z_{1000}(gpm) +1000 - Mean pressure gradient estimated for the area of 9ºlat x 11.25ºlong around minimum pressure, must be at least 0.55 hPa/100 km Filter for the elimination of weak and small troughs which were probably spurious artifacts of the high-resolution data.

Duration (lifetime) of cyclones in the Mediterranean region

Subjective climatology Frequency of cyclones with lifetime	Objective climatology Frequency of cyclones with lifetime
75% < 24 hours	60% < 12 hours
8.5% > 48 hours	
3 % > 72 hours	

Objective climatology:
~ 55 cyclones/month, which last more than 12 hours.
~ 28 hours - average lifetime of cyclones in the Mediterranean region

Over 65% of cyclones have a maximum radius of less than 550 km (mesoscale or subsynoptic-scale range).

Time required for the maximum development of cyclones

➢ Time for reaching the maximum of cyclones depends on the season of the year.

➢ During summer season – only 3% reached their maximum development 24 hours from the start of cyclogenesis.

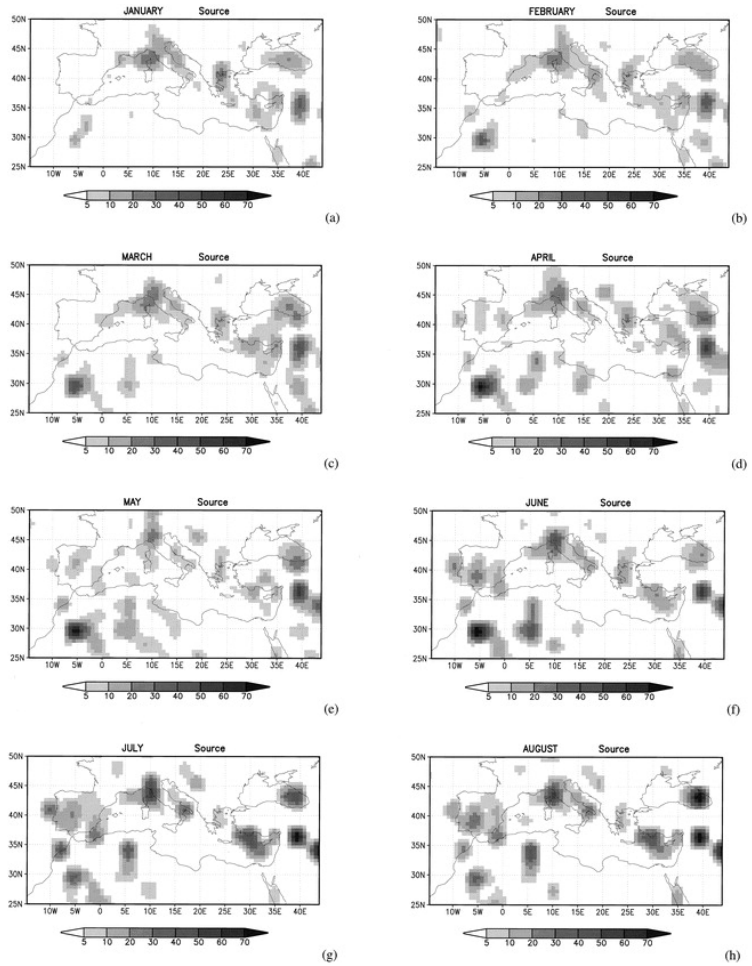
➢ During winter season – 18% of cyclones reached their maximum development 24 hours from the start of cyclogenesis.

Frequency distribution of cyclogenesis events in Mediterranean (1)

Subjective climatology of cyclones by traditional seasons	Objective climatology of cyclones
DJF (Winter)	Between October - March (Winter) (season representative – January)
MAM (Spring)	Between March – June (Spring) (season representative – April)
JJA (Summer)	Between June – October (Summer) (season representative – August)
SON (Autumn)	**Remark:** October has a rather sudden transition between the summer spatial pattern (still observed in September) and the winter spatial pattern (already settled in November)

Frequency distribution of cyclogenesis events in Mediterranean (2)

Subjective climatology of cyclones	Objective climatology of cyclones
The Gulf of Genoa (the area of the Liguria Sea, northern part of the Apennine Peninsula with maximum frequency in the gulf of Genoa Bay)	The Gulf of Genoa – major cyclogenesis region in the whole Mediterranean and one of the most persistent through the year.
The Adriatic Sea with 2 centers with high frequency: - in the North Adriatic Sea - in the South Adriatic Sea	Saharan cyclones (Sharav depressions) seem to be dominant feature of spring, as the area south of Atlas Mountains becomes major source of cyclones. The Western North African maximum reach its peak in period May-June.
	Thermal lows over the Iberian Peninsula from late spring through summer.
The Tyrrhenian Sea and the Aegean Sea	The Aegean Sea – one of major winter and spring cyclone sources.



Cyclones intensity

The criterion used for the subjective statistics of the intensity of cyclones was the average gradient of mean seal level pressure between the periphery and the center of a cyclone in the moment of its maximum development.

Cyclone intensity	Average MLSP gradient (hPa/per 100 km)	Frequency (%)
Weak	1	43
Moderate	1-2	47
Intensive	> 2	10

Big seasonal sensitivity of cyclone intensity – decreasing toward summer.

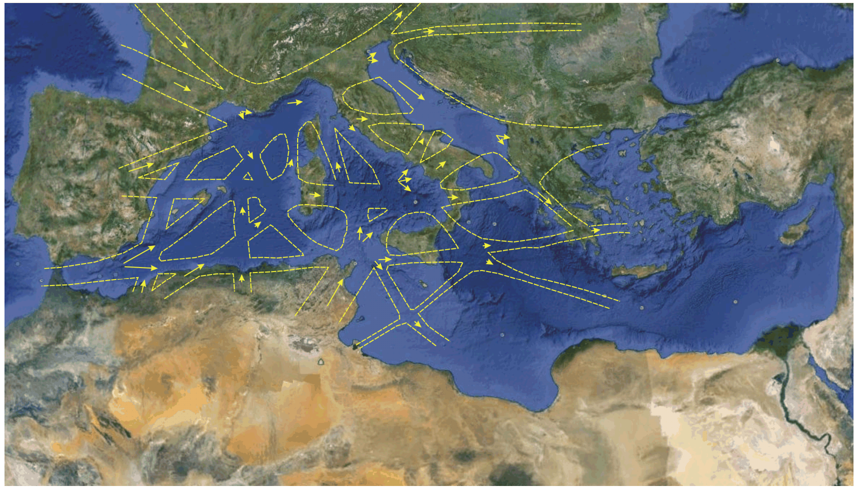
	Month of frequency cyclones maxima	Month of frequency cyclones minima
Weak cyclone	August	February
Moderate cyclone	April	October
Intensive cyclone	February	August

Distribution of cyclone tracks – subjective climatology of cyclones

The width of the cyclone tracks on the picture is proportional to the number of cyclones which passed by during the period 1949-1958.

2 maxima of the frequency of the cyclones passing by are emphasized in:

- the Genoa bay
- the South Adriatic



Distribution of cyclones tracks during the period 1949-1958 (Radinovic, Lalic 1959).

Average number of cyclones – 116 per year in the Mediterranean region

- 10% of cyclones come into
- 90% of cyclones develop

  - 50% from North Africa
  - 50% from other directions

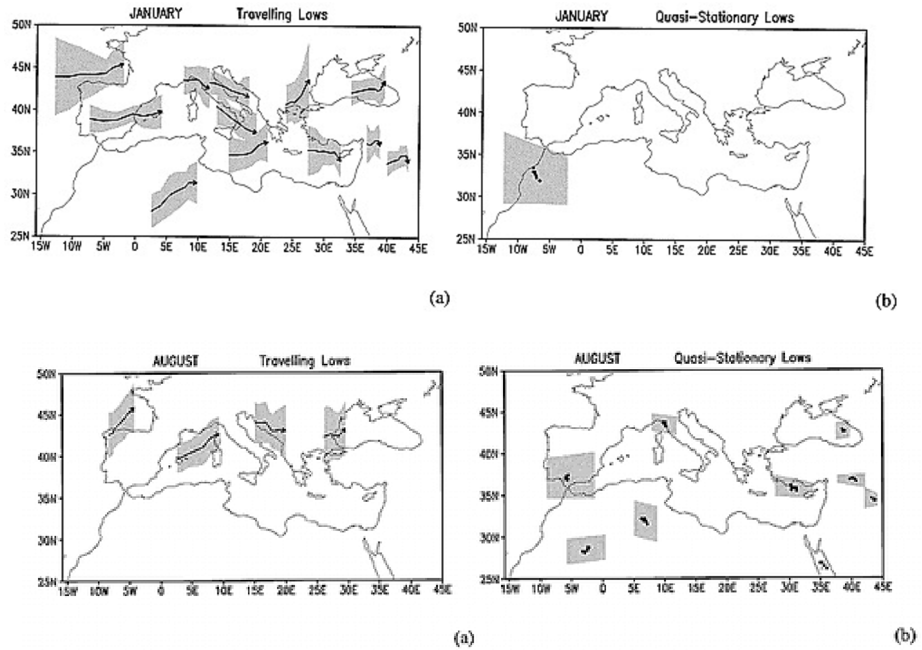
Distribution of cyclone tracks – objective climatology of cyclones (1)

The criteria for cyclones which are considered by k-means algorithm:

- duration – minimum 36 hours
- persistent cyclones skipped

Result: 10% of cyclones were considered ~ between 200 and 370 tracks per month.

There are minor inter-monthly cyclone route variations within each season with slow transitions between three most pronounced Mediterranean seasons: winter, spring and summer (represented with January, April and August)



Distribution of cyclone tracks – objective climatology of cyclones (2)

➢ The Bay of Biskay and central Iberia are 2 main routes of January Atlantic depressions into the Mediterranean, and later in the year the Biscay route tends to tilt to the northeast.

➢ The Gulf of Genoa has a more complex net of routes. In winter there prevails the southeastward direction, extending through Italy, down to the Greek coasts. In spring and summer there is a trajectory cluster associated with cyclones moving out of the Adriatic Sea into the Balkans.

➢ As Atlantic troughs move over the African coast, baroclinic waves are formed south of the Atlas Mountains, resulting in the quasi-stationary Saharan depression area during all months. The southward shift and decreasing of area is probably associated with the predominance of thermally driven processes. There is a pronounced increase of cyclone routes over northern Africa in spring, when eastward and northeastward paths appear roughly between 0º and 30ºE. Most of the depressions moving northeastward are reinforced as they move to the Mediterranean Sea, causing large rainfall over the Greek region.

Possible sources of predictability in the MEDCOF region

- NAO pattern
- Atlantic ridge
- Blocking regime
- EAWR pattern (during winter ???)

Examples:

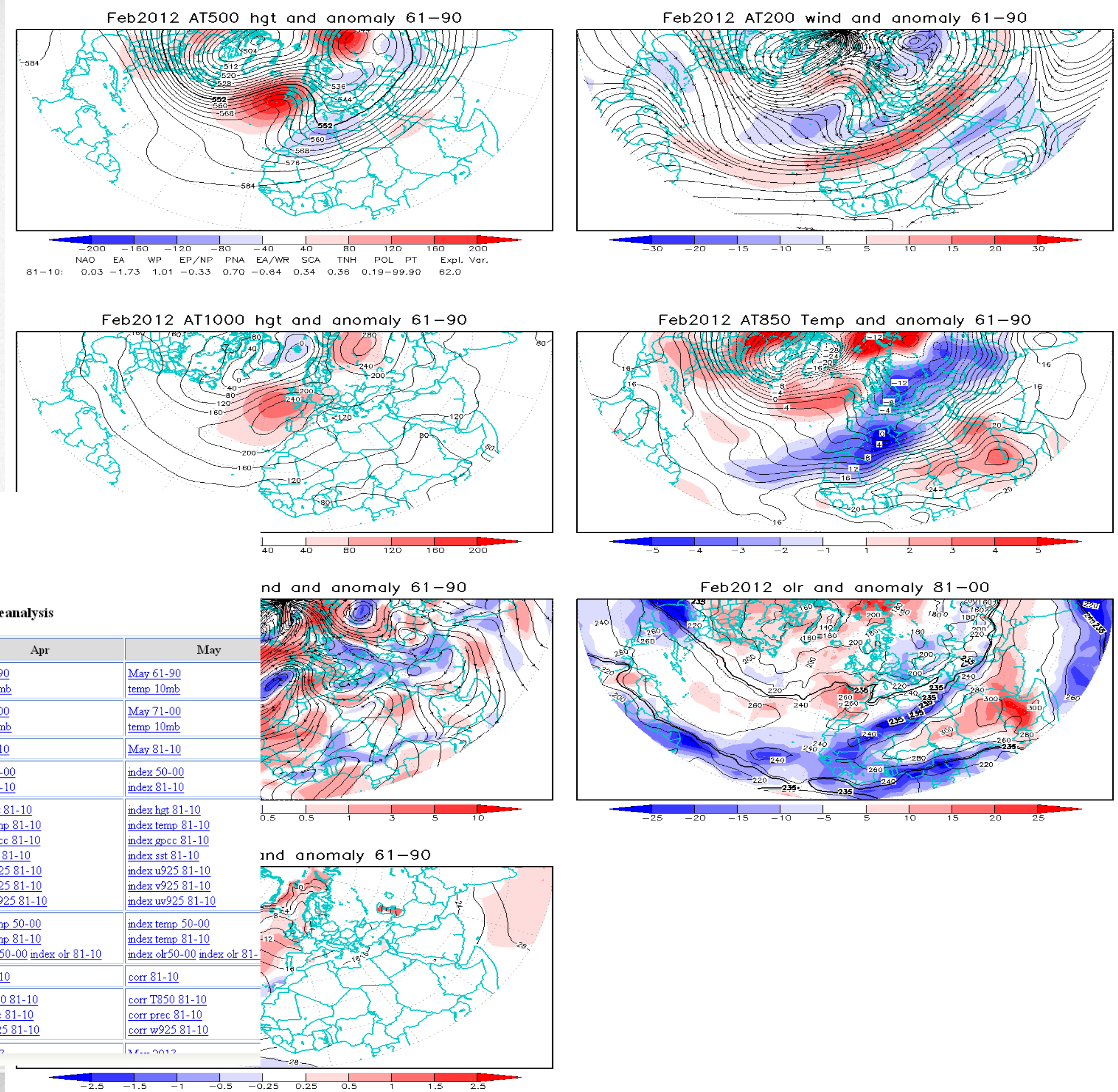
- Cold spell in Europe in late winter 2011/2012
- Precipitation totals above normal during JFM 2013

Cold spell in Europe in late winter 2011/2012
Monitoring – NCAR/NCEP reanalysis accumulated in SEEVCCC

- **Daily and monthly available**

  Available at the beginning of each month

Z500; u,v200; T850; SST; olr…



SEE VCCC

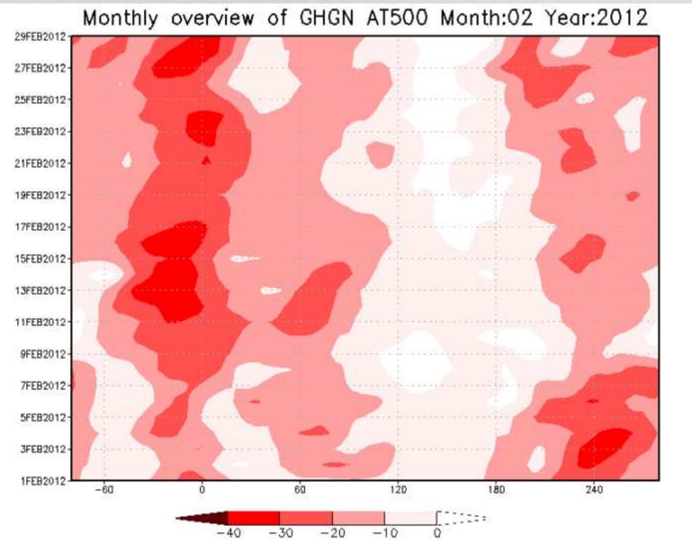
NOAA(sst,olr) and NCEP/NCAR(T,hgt,wind)Reanalysis

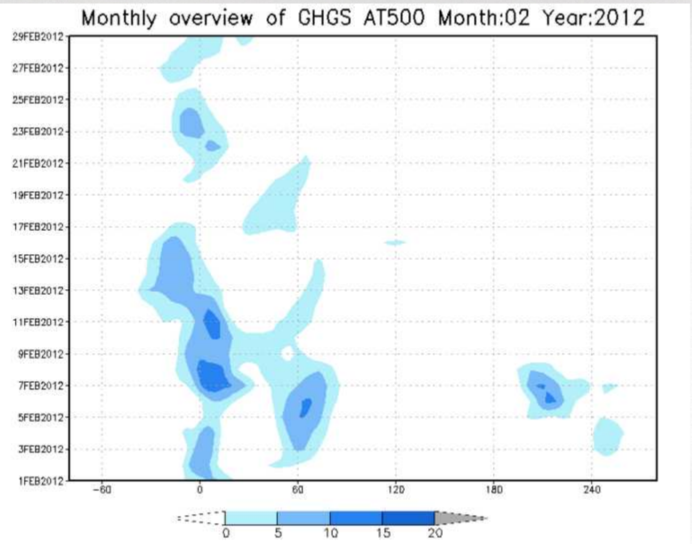
seevccc	Jan	Feb	Mar	Apr	May
1961-1990	Jan 61-90 temp 10mb	Feb 61-90 temp 10mb	Mar 61-90 temp 10mb	Apr 61-90 temp 10mb	May 61-90 temp 10mb
1971-2000	Jan 71-00 temp 10mb	Feb 71-00 temp 10mb	Mar 71-00 temp 10mb	Apr 71-00 temp 10mb	May 71-00 temp 10mb
1981-2010	Jan 81-10	Feb 81-10	Mar 81-10	Apr 81-10	May 81-10
indices	index 50-00 index 81-10	index 50-00 index 81-10	index 50-00 index 81-10	index 50-00 index 81-10	index 50-00 index 81-10
indices2 phase	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10	index hgt 81-10 index temp 81-10 index gpcc 81-10 index sst 81-10 index u925 81-10 index v925 81-10 index uv925 81-10
extreme indices	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-10	index temp 50-00 index temp 81-10 index olr50-00 index olr 81-
indices5-corr	corr 81-10	corr 81-10	corr 81-10	corr 81-10	corr 81-10
indices7-corr	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10	corr T850 81-10 corr prec 81-10 corr w925 81-10

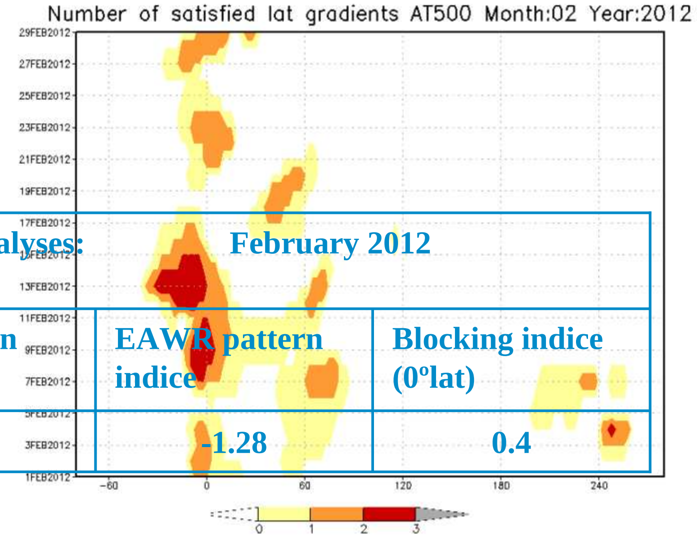
www.seevccc.rs/IDX/imgsrc/Aprindex2.png

Cold spell in Europe in late winter 2011/2012
Monitoring – blocking (Tibaldi & Molteni, 1990)

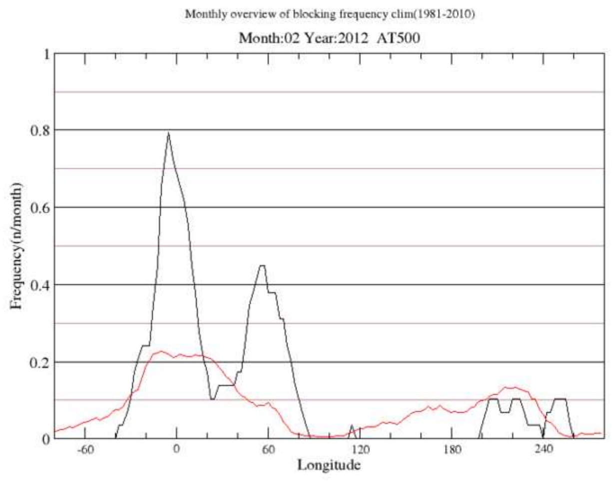
Daily data





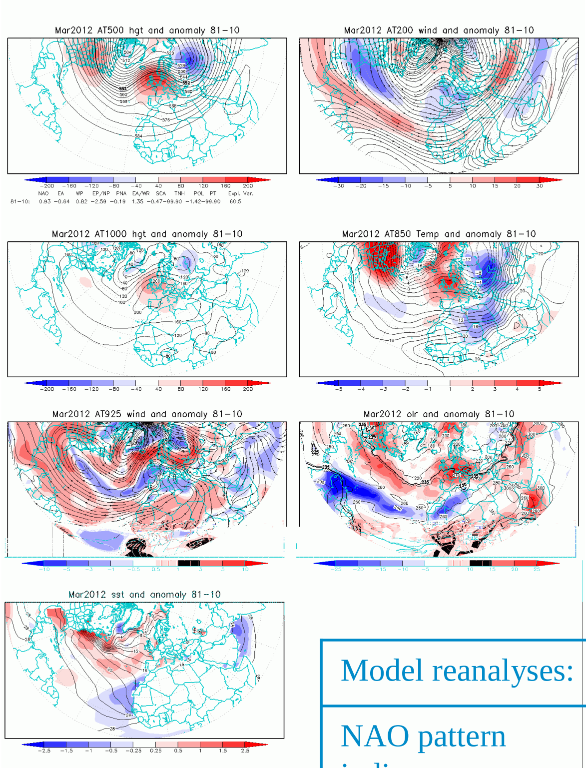


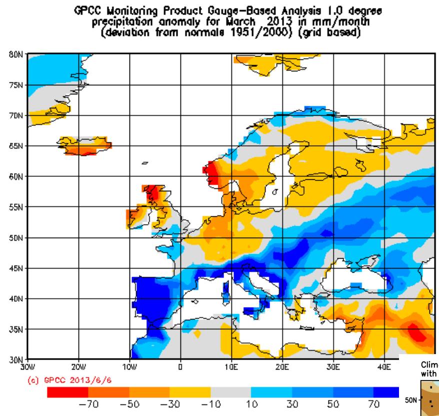
Model reanalyses:	February 2012	
NAO pattern indice	EAWR pattern indice	Blocking indice (0ºlat)
-0.96	-1.28	0.4

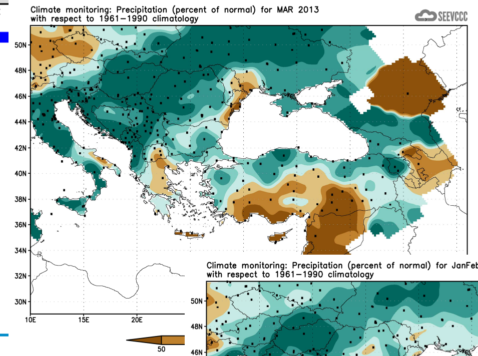


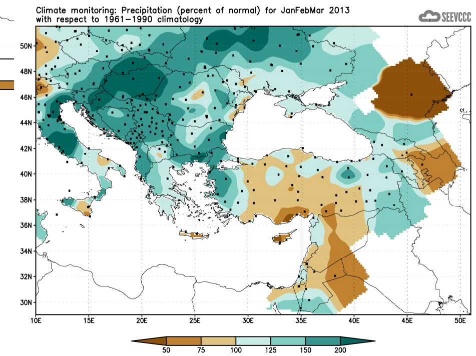
Monthly data + climatology (in red)

Precipitation totals above normal during JFM 2013





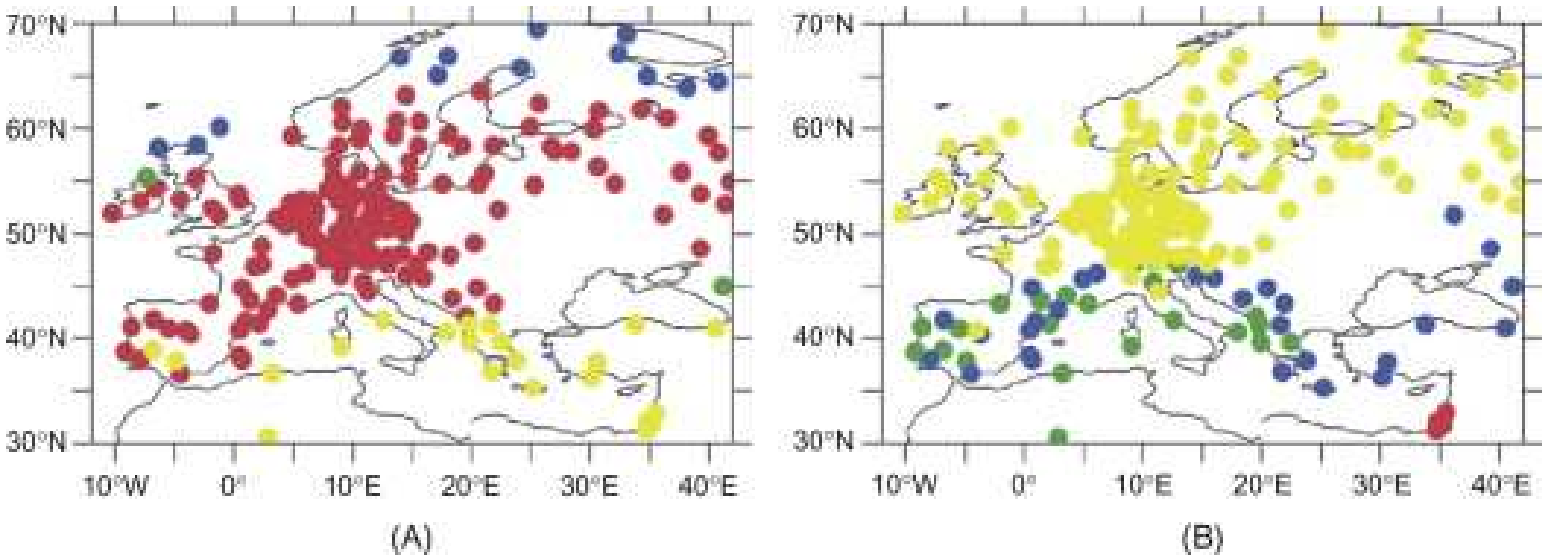




Model reanalyses:	Mart 2013	
NAO pattern indice	EAWR pattern indice	Blocking indice (0ºlat)
-2.09	2.31	0.6

Thank you for your patience and attention !

Relationship between weather regimes and temperature anomalies



Weather regimes favoring the occurrence of warm (A) and cold (B) temperatures. Red is associated with the positive NAO, yellow with the negative NAO, green with the Atlantic ridge, and blue with the blocking.