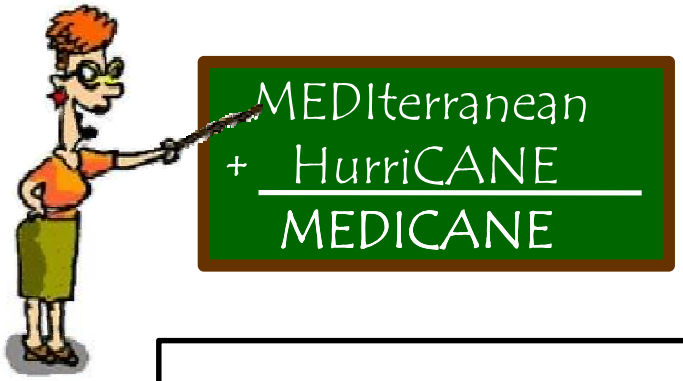
Climate change effects on medicanes based on a dynamical downscaling method

Maria Tous, Romualdo Romero and Climent Ramis

Universitat de les Illes Balears (UIB)



OBJECTIVES

1.- To create medicane risk maps.

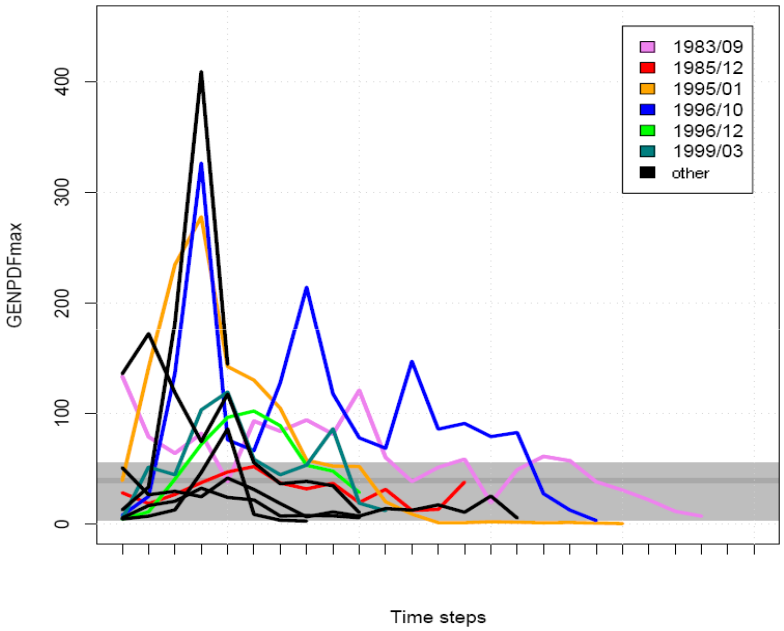
2.- To evaluate changes in medicane future risk maps compared with the present ones.

METHODOLOGY

1.- To identify medicane-prone areas. → **2.- To run a high resolution numerical model.** → **3.- To evaluate the results.**

$$\text{P.I.} \approx \frac{C_k}{C_D}\frac{T_S - T_0}{T_0}(k_0^* - k)$$

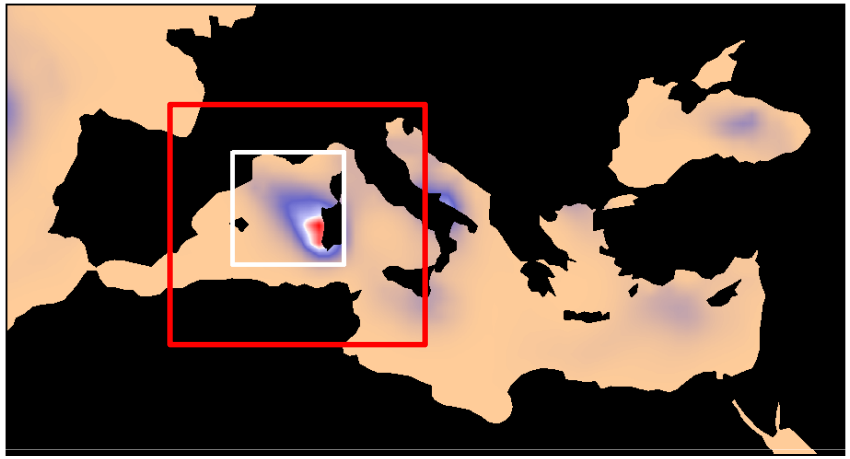
$$\text{GENPDF} = \left|10^5 \eta\right|^{3/2}\left(\frac{\text{H}}{50}\right)^3\left(\frac{\text{P.I.}}{70}\right)^3(1+0.1\,\text{V}_{\text{shear}})^{-2}$$



To identify areas with an adequated pro-development meteorological parameters, detected in ERA-40 and global climate models.

1.- To identify medicane-prone areas. → 2.- To run a high resolution numerical model. → 3.- To evaluate the results.

MODEL	PRESENT	FUTURE (2081-2100)	
ERA-40	1981-2000		
ECHAM5	20C3M	SRESA2	SRESA1B
MIRO	20C3M	SRESA2	SRESA1B
CSIRO	20C3M	SRESA2	SRESA1B
GFDL	20C3M	SRESA2	SRESA1B



To identify areas with an adequated pro-development meteorological parameters, detected in ERA-40 and global climate models.

1.- To identify medicane-prone areas. → 2.- To run a high resolution numerical model. → 3.- To evaluate the results.

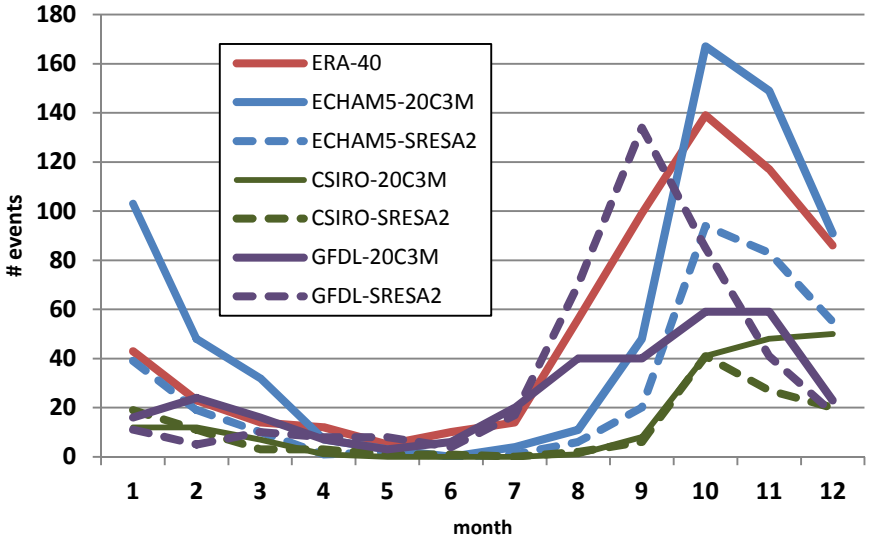
MODEL	PRESENT	FUTURE (2081-2100)	
ERA-40	1981-2000		
ECHAM5	20C3M	SRESA2	SRESA1B
MIRO	20C3M	SRESA2	SRESA1B
CSIRO	20C3M	SRESA2	SRESA1B
GFDL	20C3M	SRESA2	SRESA1B

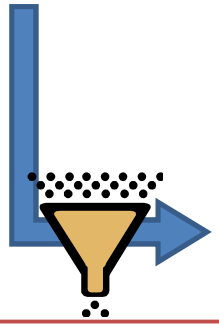
List of events GENPDF>q99 → Criterion: Area >350x350 km^2 → List of pro-development areas

To identify areas with an adequated pro-development meteorological parameters, detected in ERA-40 and global climate models.

1.- To identify pro-development areas. → 2.- To run a high resolution numerical model. → 3.- To evaluate the results.

MODEL	PRESENT	FUTURE (2081-2100)	
ERA-40	1981-2000		
ECHAM5	20C3M	SRESA2	SRESA1B
MIRO	20C3M	SRESA2	SRESA1B
CSIRO	20C3M	SRESA2	SRESA1B
GFDL	20C3M	SRESA2	SRESA1B





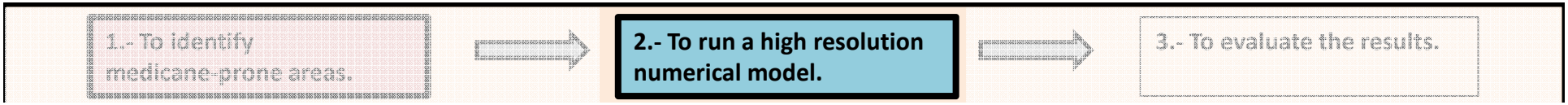
Criteria:
GENPDF>q99
Area >350x350 km^2

pro-medicane development areas

MODEL/MONTH	01	02	03	04	05	06	07	08	09	10	11	12	TOTAL
ERA-40	43	23	14	12	5	10	14	56	99	139	117	86	**618**
ECHAM 20C	103	48	32	7	3	0	4	11	48	167	149	91	**663**
ECHAM A2	39	19	10	1	2	0	1	6	20	94	83	55	**330**
CSIRO 20C	12	12	7	1	0	0	0	1	8	41	48	50	**180**
CSIRO A2	19	11	3	3	1	1	0	2	6	41	27	20	**134**
GFDL 20C	16	24	16	7	3	6	20	40	40	59	59	23	**313**
GFDL A2	11	5	10	8	8	4	17	70	134	85	41	18	**411**

1.- To identify pro-development areas. → 2.- To run a high resolution numerical model. → 3.- To evaluate the results.

To run a high resolution numerical model (in our case, MM5 with a horizontal resolution of 7.5 km) in the identified pro-development areas.



CONTROL

ECMWF
T213 (~ 85 km)
+ obs.

fine GCM res.

ECMWF
(~ 125km)

typical GCM res.

ECMWF
(~ 250 km)

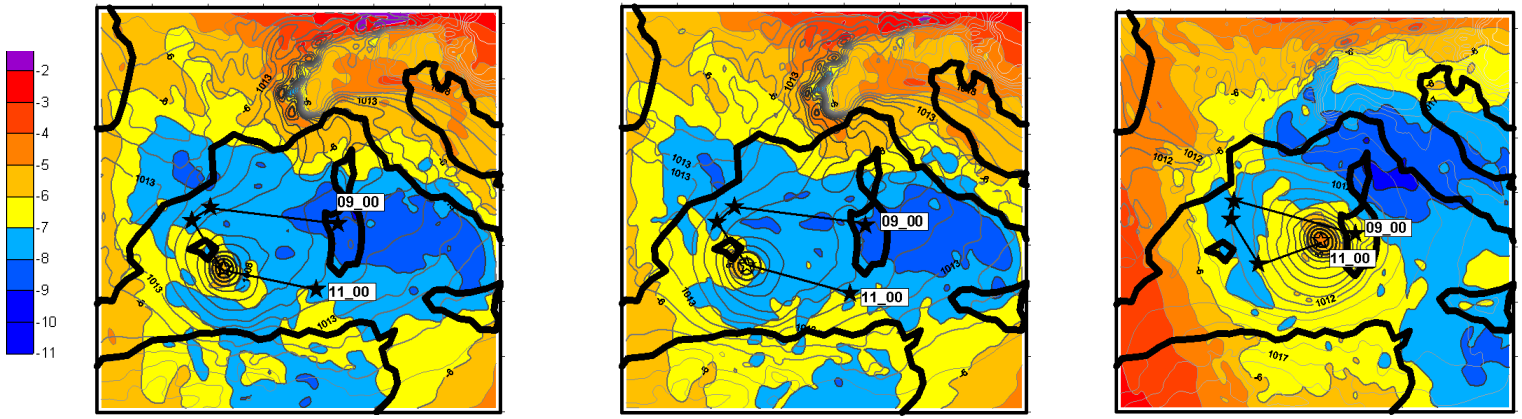
MESOSCALE MODEL SIMULATION

48h

196x196

MM5
7.5 km

Quasi-symmetric intense low-pressure centres at surface with an isolated warm-core structure aloft.



To run a high resolution numerical model (in our case, MM5 with a horizontal resolution of 7.5 km) in the identified pro-development areas.

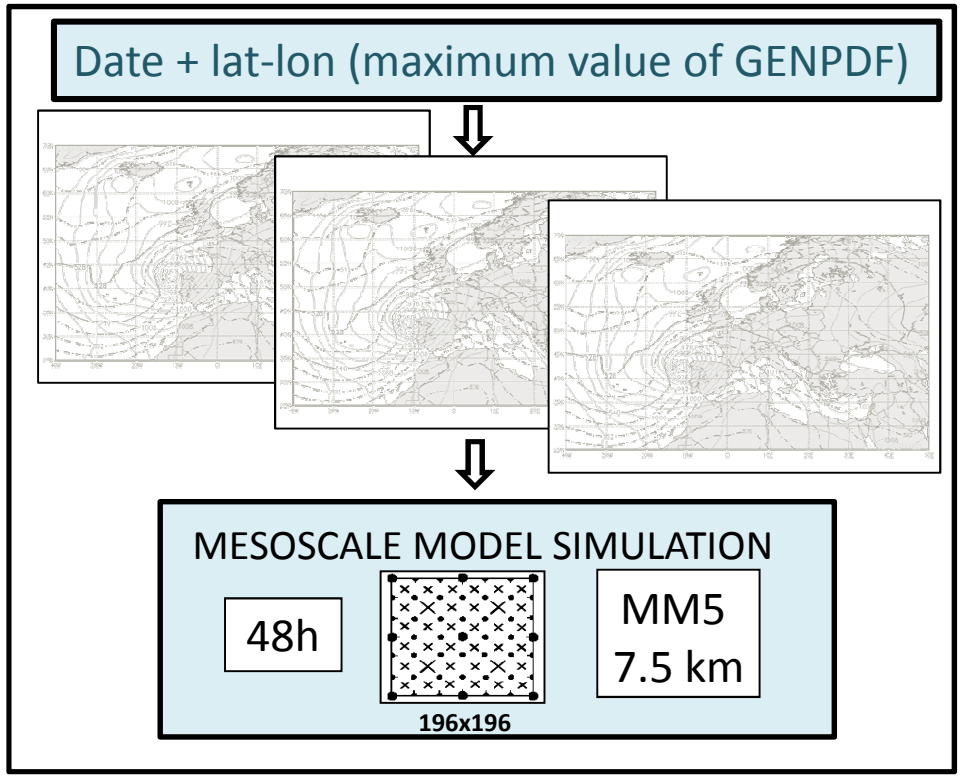
1.- To identify pro-development areas.

2.- To run a high resolution numerical model.

3.- To evaluate the results.

MODEL/MONTH	01	02	03	04	05	06	07	08	09	10	11	12	TOTAL
ERA-40	43	23	14	12	5	10	14	56	99	139	117	86	**618**
ECHAM 20C	103	48	32	7	3	0	4	11	48	167	149	91	**663**
ECHAM A2	39	19	10	1	2	0	1	6	20	94	83	55	**330**
CSIRO 20C	12	12	7	1	0	0	0	1	8	41	48	50	**180**
CSIRO A2	19	11	3	3	1	1	0	2	6	41	27	20	**134**
GFDL 20C	16	24	16	7	3	6	20	40	40	59	59	23	**313**
GFDL A2	11	5	10	8	8	4	17	70	134	85	41	18	**411**

For each **event**, select the **position** of the maximum value of GENPDF

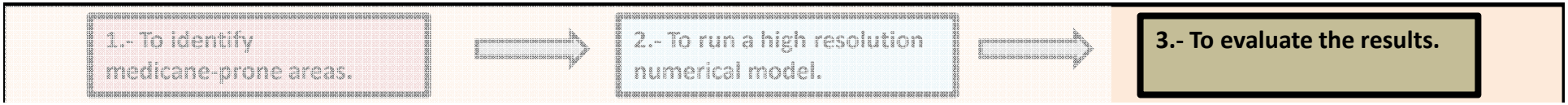


1.- To identify medicane-prone areas.

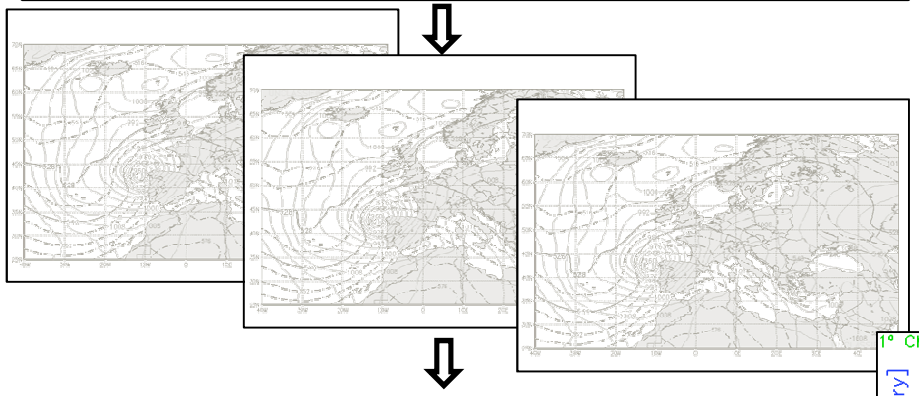
2.- To run a high resolution numerical model.

3.- To evaluate the results.

To evaluate how many medicanes are (intense small scale cyclones with a warm core), and their properties (track, intensity, etc.).

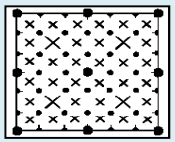


Date + lat-lon (maximum value of GENPDF)



MESOSCALE MODEL SIMULATION

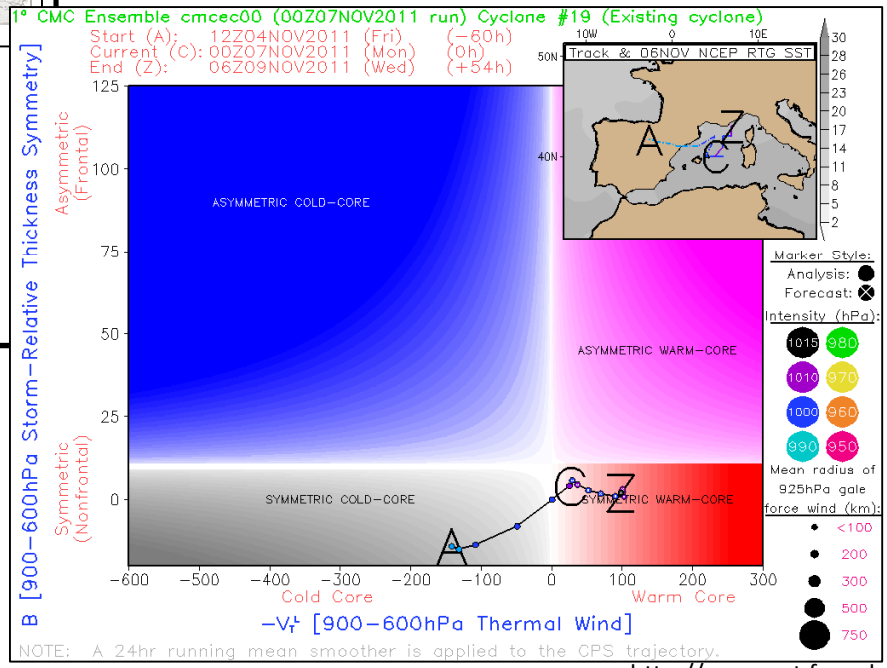
48h



196x196

MM5
7.5 km

Quasi-symmetric intense low-pressure centres at surface with an isolated warm-core structure aloft.



http://moe.met.fsu.edu

To evaluate how many medicanes are (intense small scale cyclones with a warm core), and their properties (track, intensity, etc.).

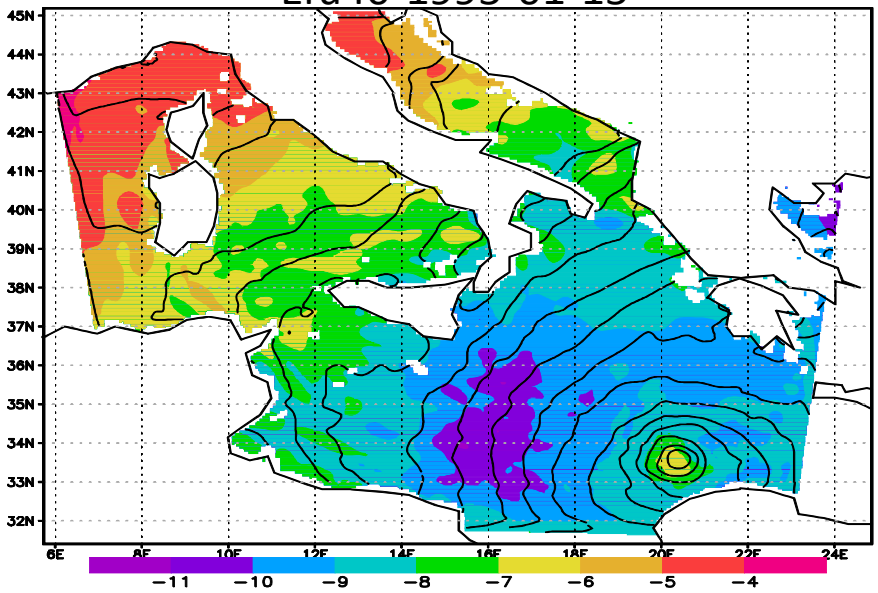
1.- To identify medicane-prone areas.

2.- To run a high resolution numerical model.

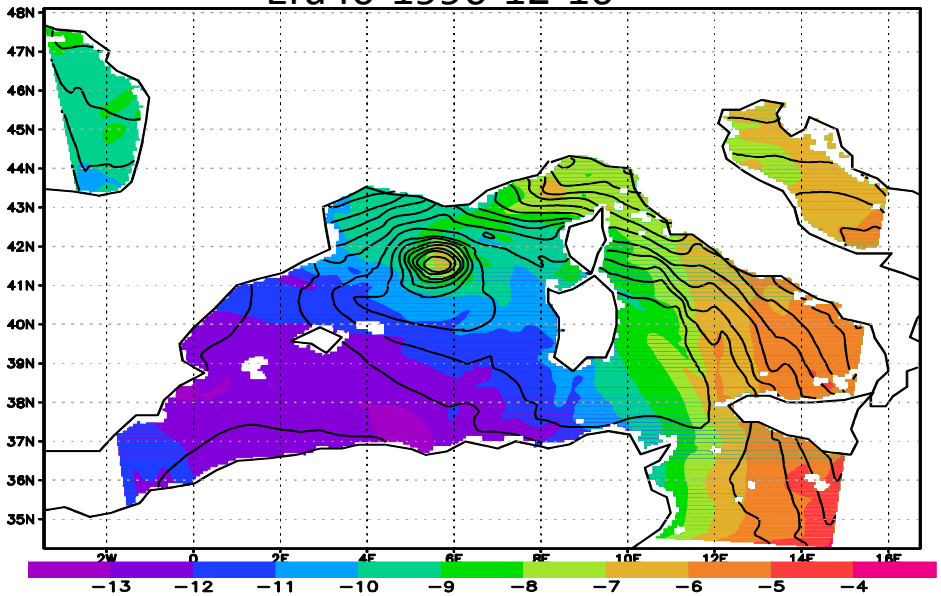
3.- To evaluate the results.

Checking well-known medicanes

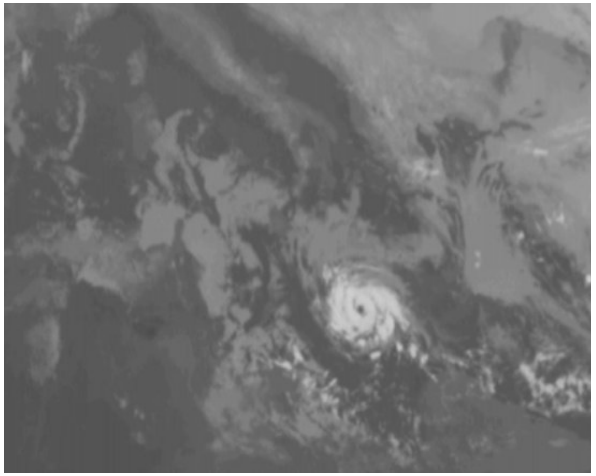
Era40-1995-01-15

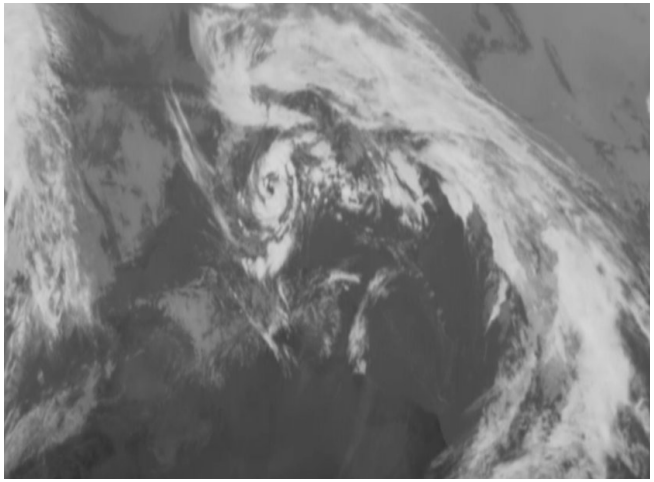


Era40-1996-12-10



Contour: SLP, Shaded: T(700hPa)





1.- To identify medicane-prone areas.

2.- To run a high resolution numerical model.

3.- To evaluate the results.

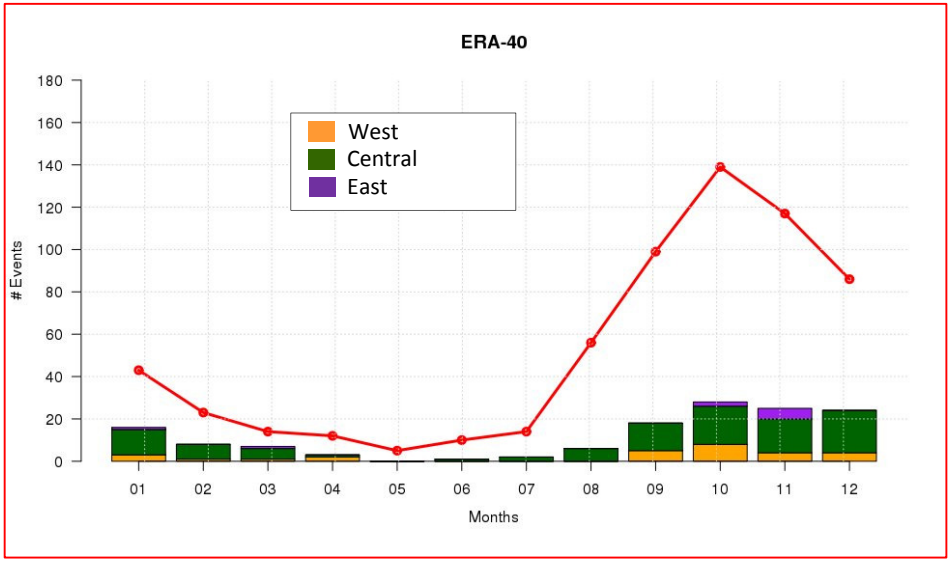
	ERA-40 (618)				ECHAM5-20C (663)				ECHAM5-21C (330)			
	W	C	E	sum	W	C	E	sum	W	C	E	sum
01	3	12	1	**16**	4	11	8	**23**	2	6	1	**9**
02	1	7	-	**8**	1	6	2	**9**	-	-	2	**2**
03	1	5	1	**7**	1	3	-	**4**	1	-	-	**1**
04	2	1	-	**3**	-	2	-	**2**	-	-	-	**-**
05	-	-	-	**-**	1	1	-	**2**	-	-	-	**-**
06	-	1	-	**1**	-	-	-	**-**	-	-	-	**-**
07	-	2	-	**2**	-	-	-	**-**	-	-	-	**-**
08	-	6	-	**6**	1	-	-	**1**	-	1	-	**1**
09	5	13	-	**18**	3	7	-	**10**				
10	8	18	2	**28**	27	31	3	**61**	8	29	6	**43**
11	4	16	5	**25**	18	23	17	**58**	3	19	5	**27**
12	4	20	-	**24**	4	21	15	**40**	2	9	9	**20**
sum	**28**	**101**	**9**	**138**	**60**	**105**	**45**	**210**	**16**	**64**	**23**	**103**

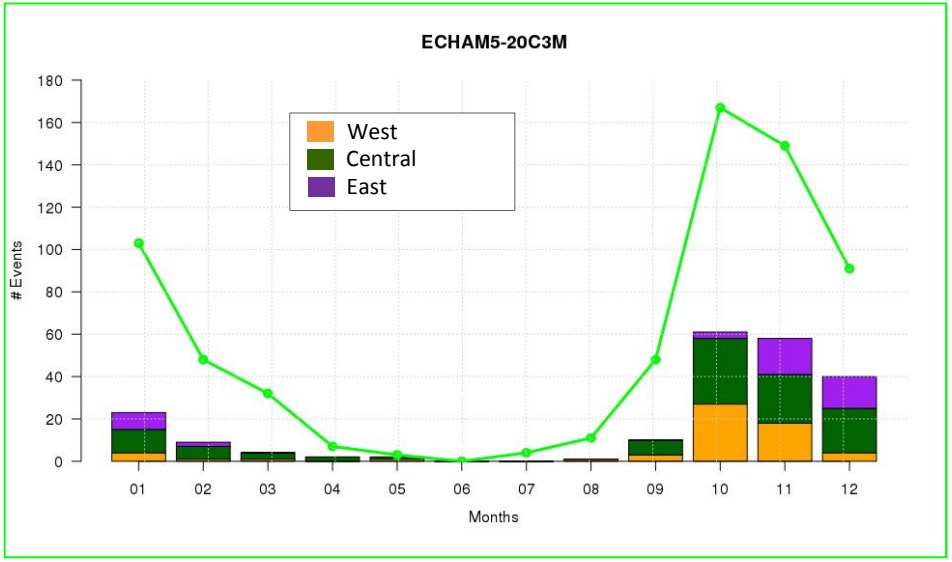
1.- To identify medicane-prone areas. → 2.- To run a high resolution numerical model. → **3.- To evaluate the results.**

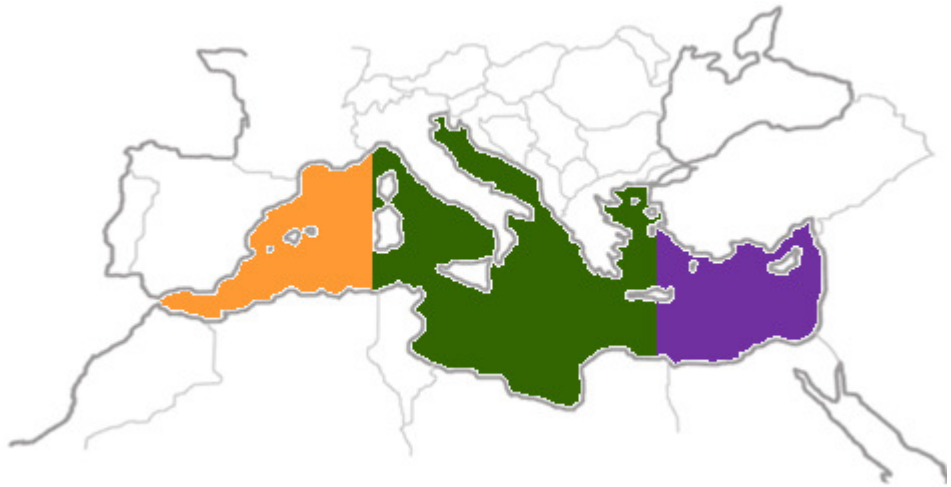
	ERA-40 (618)				ECHAM5-20C (663)				ECHAM5-21C (330)			
	W	C	E	sum	W	C	E	sum	W	C	E	sum
01	3	12	1	**16**	4	11	8	**23**	2	6	1	**9**
02	1	7	-	**8**	1	6	2	**9**	-	-	2	**2**
03	1	5	1	**7**	1	3	-	**4**	1	-	-	**1**
04	2	1	-	**3**	-	2	-	**2**	-	-	-	**-**
05	-	-	-	**-**	1	1	-	**2**	-	-	-	**-**
06	-	1	-	**1**	-	-	-	**-**	-	-	-	**-**
07	-	2	-	**2**	-	-	-	**-**	-	-	-	**-**
08	-	6	-	**6**	1	-	-	**1**	-	1	-	**1**
09	5	13	-	**18**	3	7	-	**10**				
10	8	18	2	**28**	27	31	3	**61**	8	29	6	**43**
11	4	16	5	**25**	18	23	17	**58**	3	19	5	**27**
12	4	20	-	**24**	4	21	15	**40**	2	9	9	**20**
sum	**28**	**101**	**9**	**138**	**60**	**105**	**45**	**210**	**16**	**64**	**23**	**103**

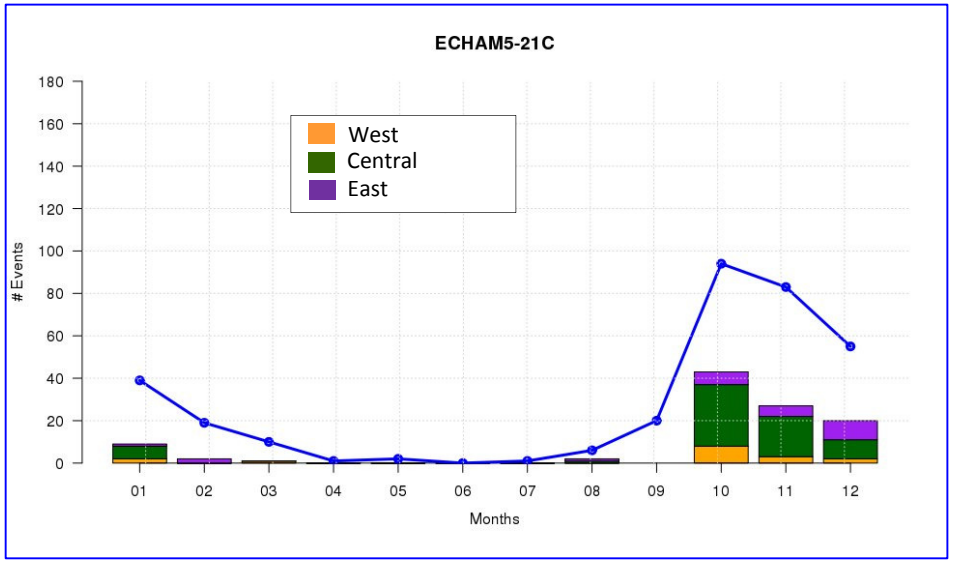
1.- To identify medicane-prone areas. → 2.- To run a high resolution numerical model. → **3.- To evaluate the results.**

Simulated small-scale warm core cyclones







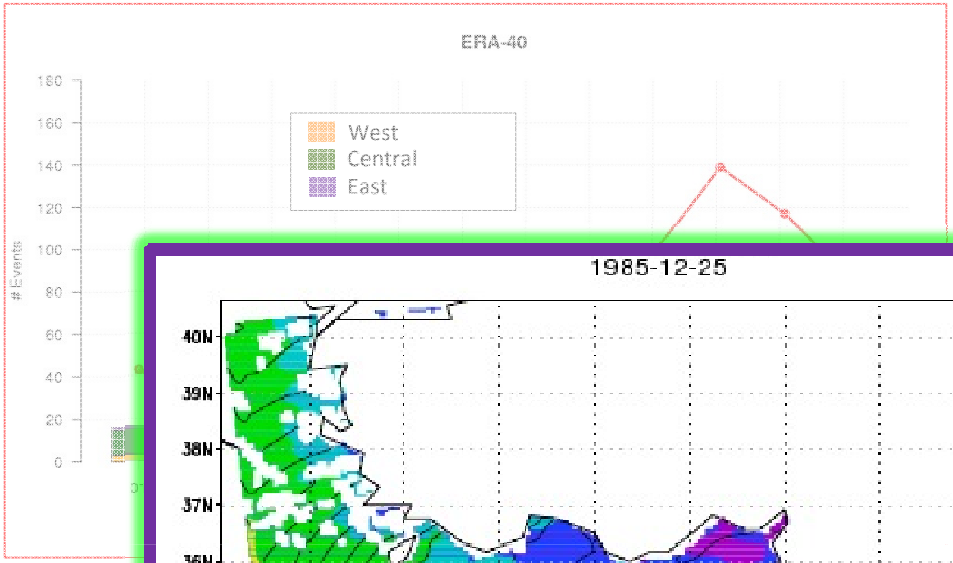


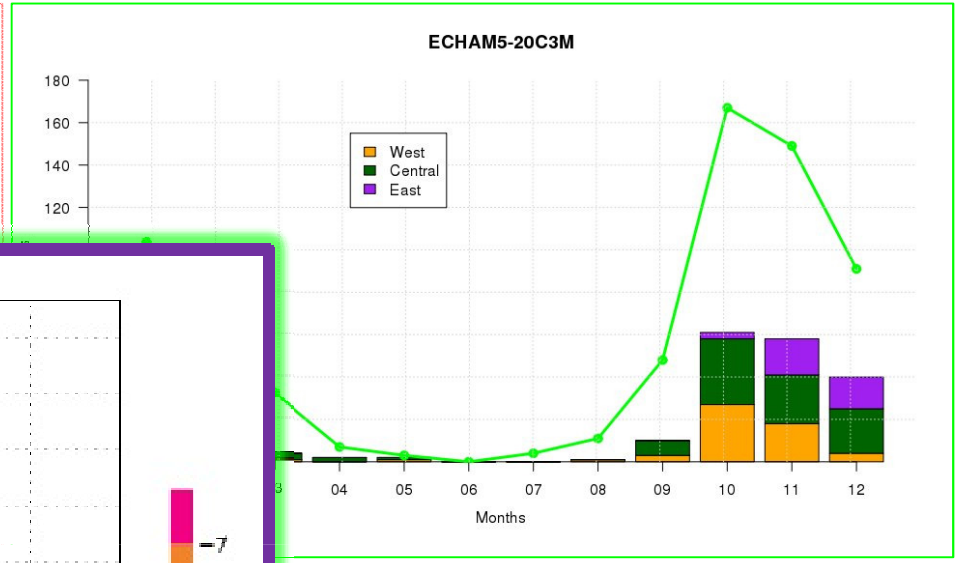
1.- To identify medicane-prone areas.

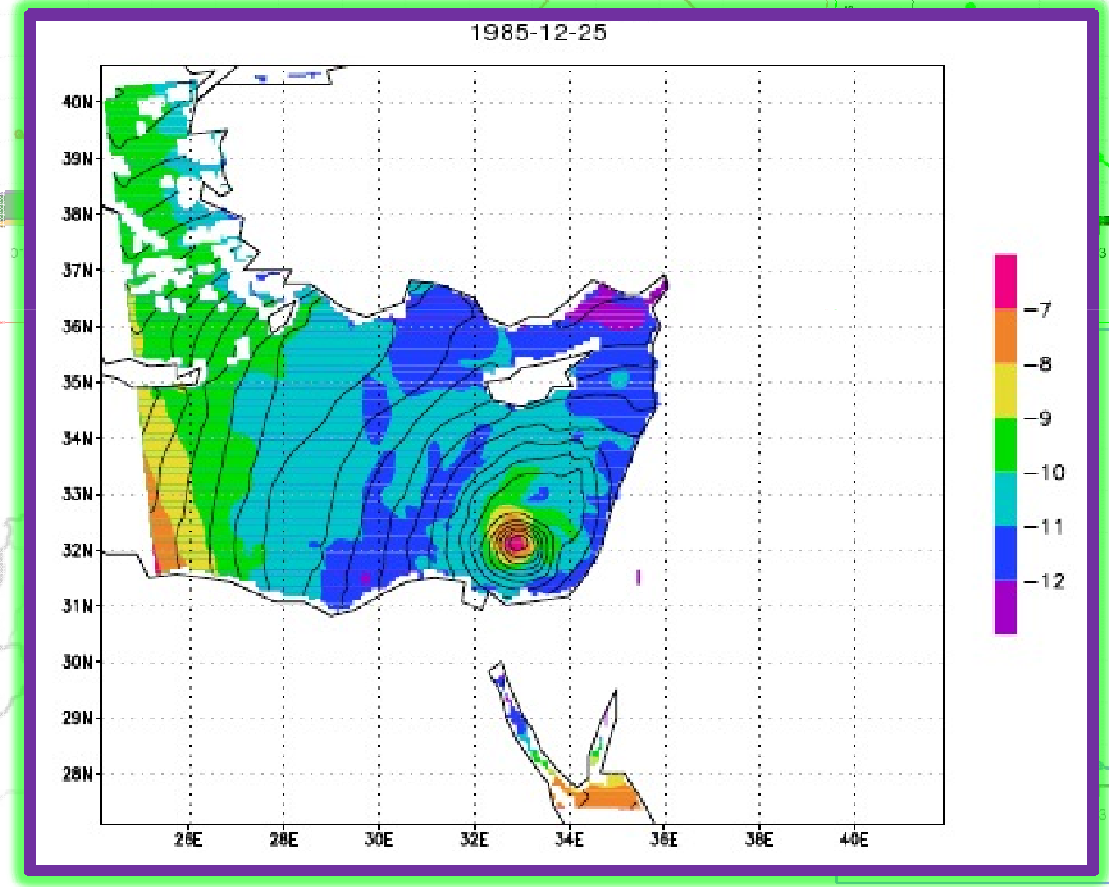
2.- To run a high resolution numerical model.

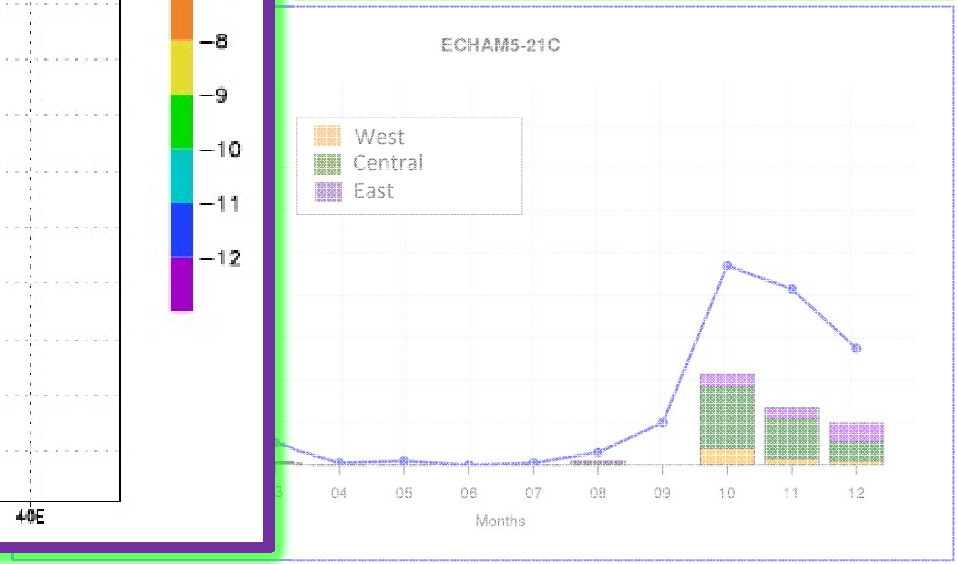
3.- To evaluate the results.

Simulated small-scale warm core cyclones







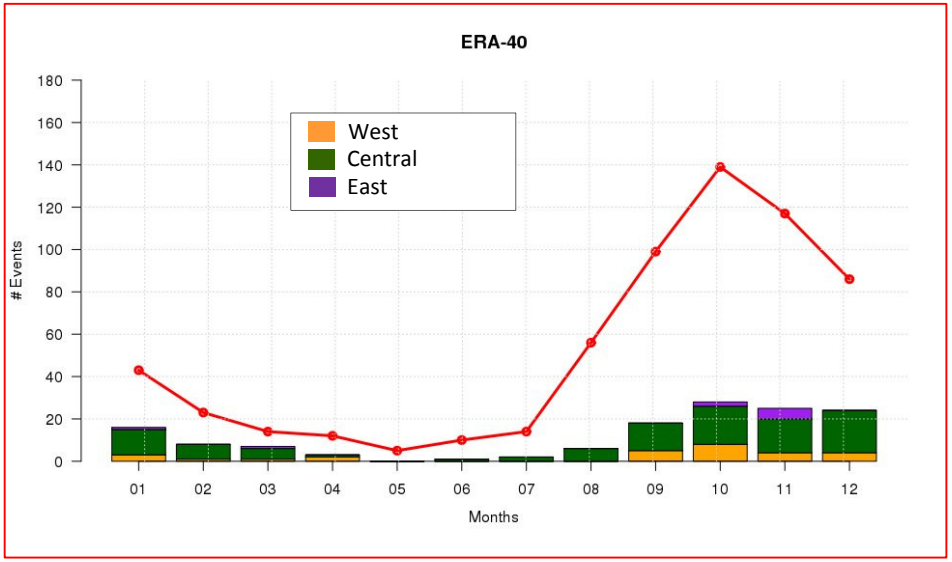


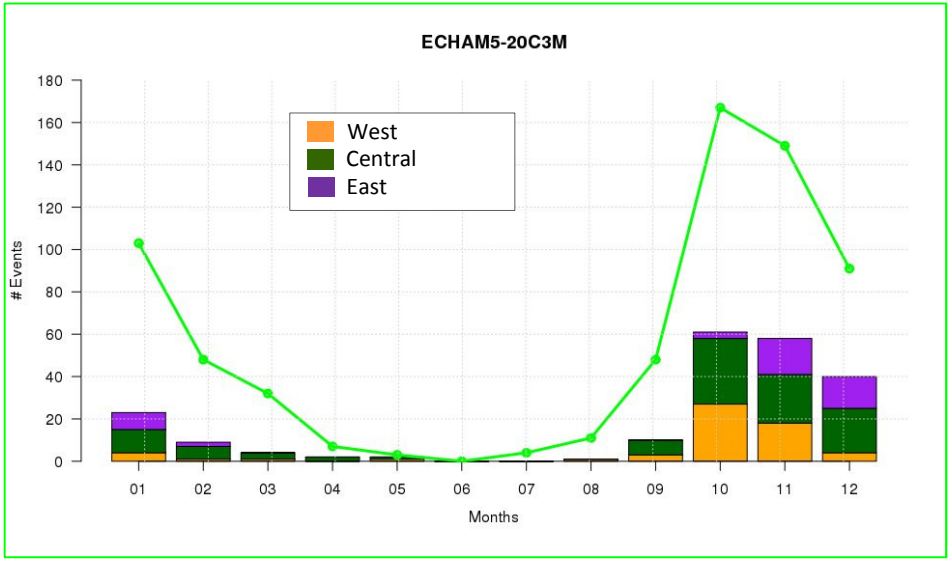
1.- To identify medicane-prone areas.

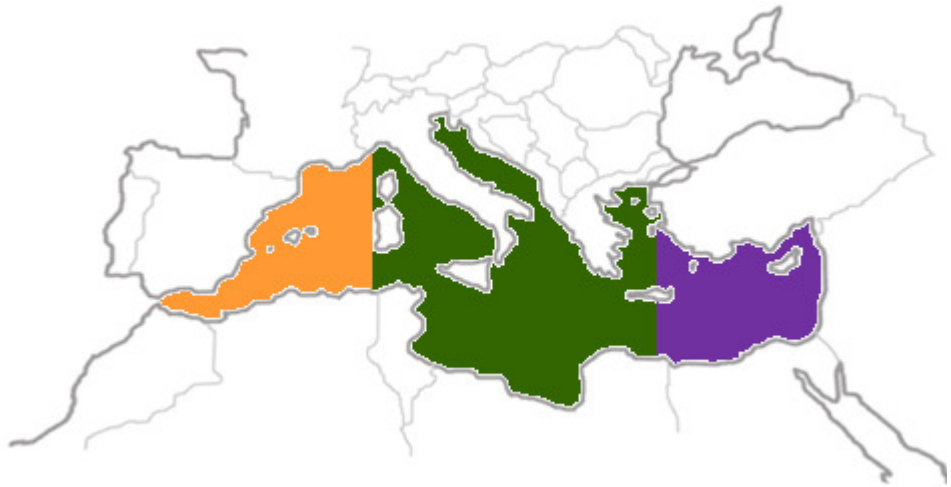
2.- To run a high resolution numerical model.

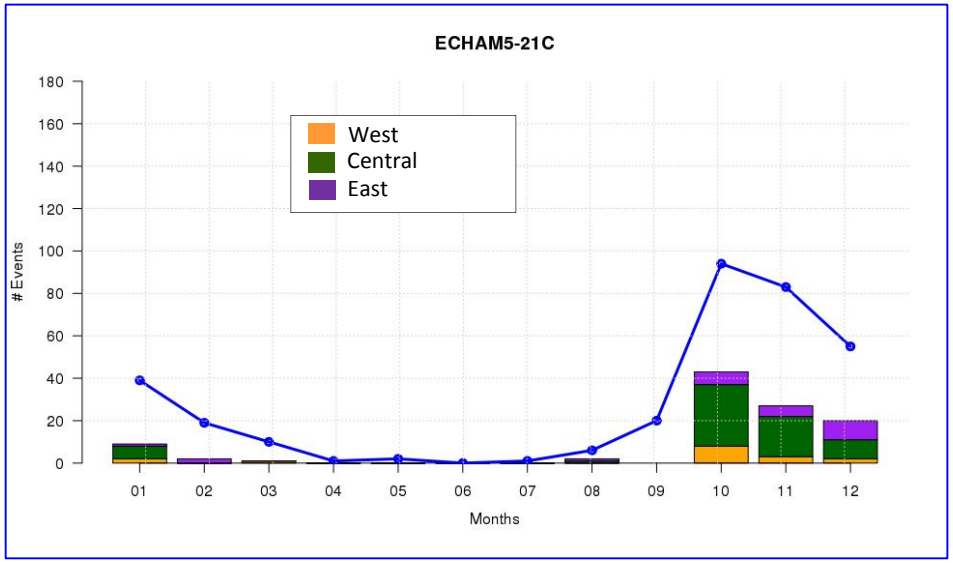
3.- To evaluate the results.

Simulated small-scale warm core cyclones









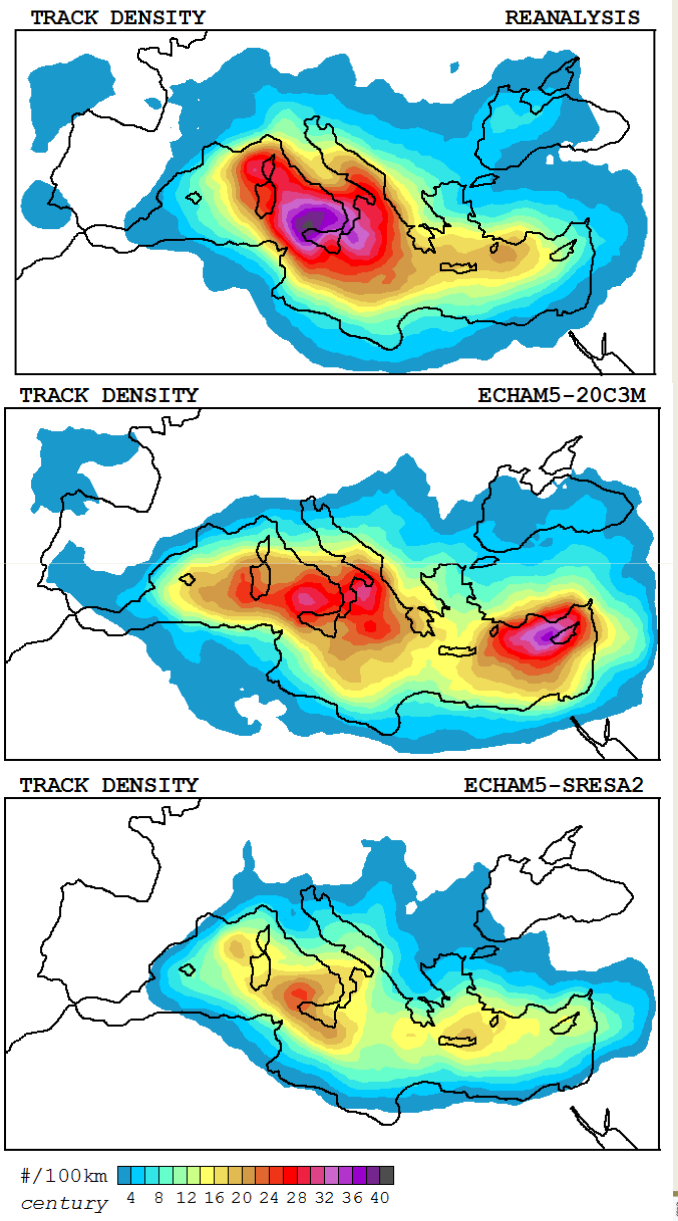
1.- To identify medicane-prone areas.

2.- To run a high resolution numerical model.

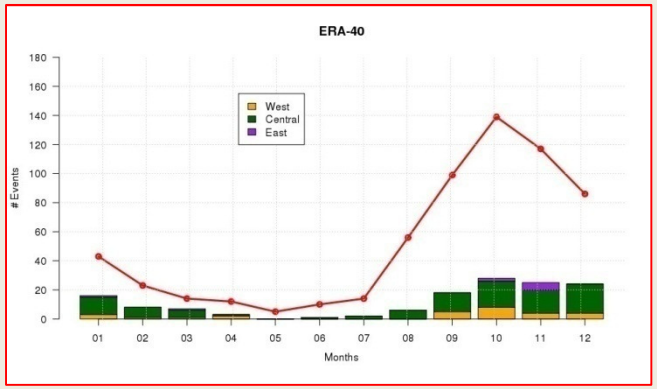
3.- To evaluate the results.

Comparing methodologies

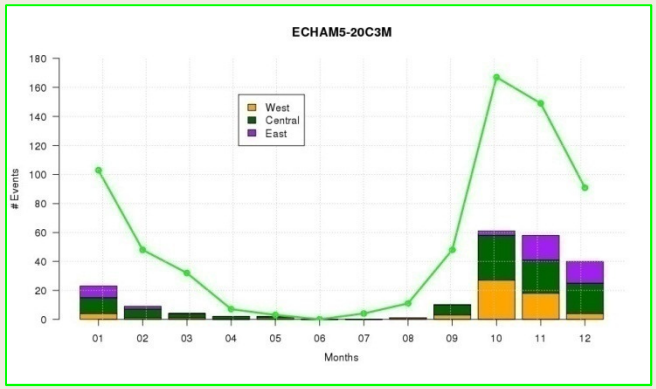
CHIPS model



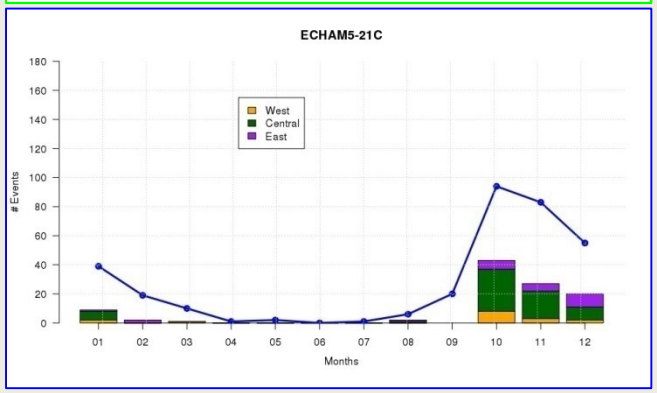
OUR method



28
101
9



60
105
45



16
64
23

medicane-prone areas.

numerical model.

OBJECTIVES

1.- To create medicane risk maps.

2.- To evaluate changes in medicane future risk maps compared with the present ones.

CONCLUSIONS (1)

- Most medicanes occur from October to January and are located in the Central Mediterranean, followed by the Western basin. Very few events are simulated in the Eastern Mediterranean.

- These temporal and spatial distributions are in agreement with our previous work on medicane detection using satellite imagery.

-The spatial distribution is consistent with the risk maps derived from the synthetic generation of events (last talk).

OBJECTIVES

1.- To create medicane risk maps.

2.- To evaluate changes in medicane future risk maps compared with the present ones.

CONCLUSIONS (2)

- ECHAM-5 downscaling tends to overestimate the number of medicanes for the present climate, particulary for Eastern (500%) and Western (200%) regions.

- Future results using ECHAM-5 show a reduced frequency of medicanes compared to present: Western (25%), Central (50%) and Eastern (50%).

OBJECTIVES

1.- To create medicane risk maps.

2.- To evaluate changes in medicane future risk maps compared with the present ones.

FURTHER WORK

-An automatic tracking and characterization of medicanes (e.g. application of the cyclone phase space).

-Running the other models and emission scenarios, and calibrate the results with respect to the actual climatology of medicanes as derived from satellite images.

-To pay special attention to possible changes in medicane intensity.