

LEARNING FOR THE FUTURE FROM THE OBSERVATION AND MODELLING OF MEDICANES



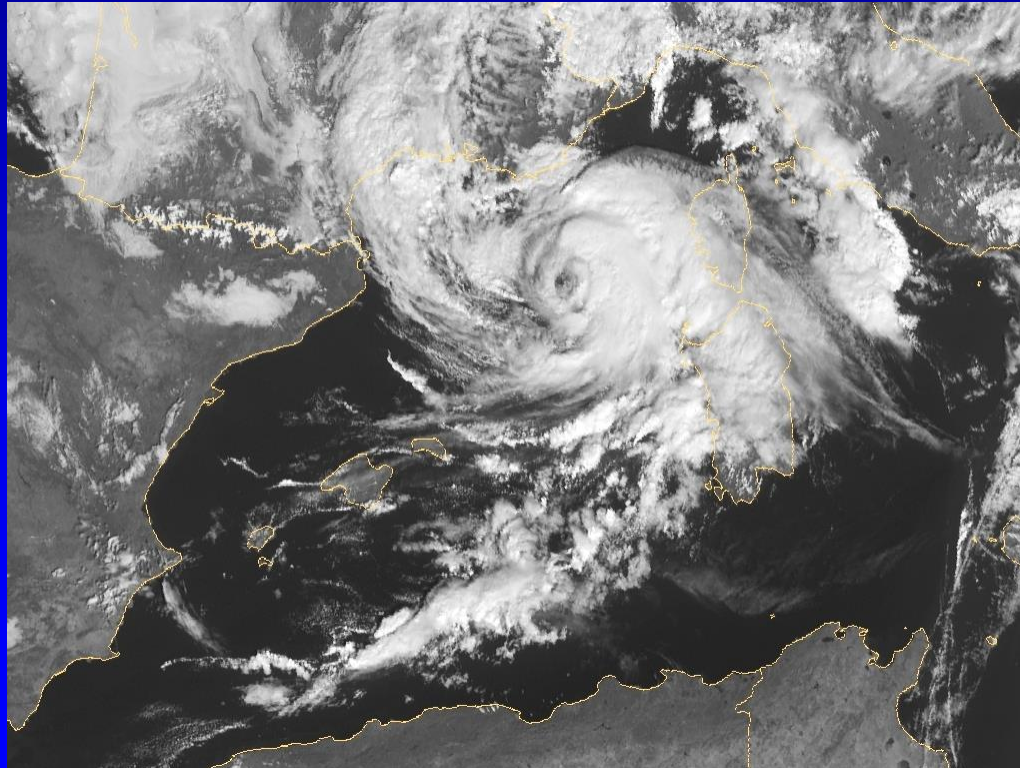
R. Romero

European Climate Research Alliance (ECRA) - General Assembly 2015

MOTIVATION

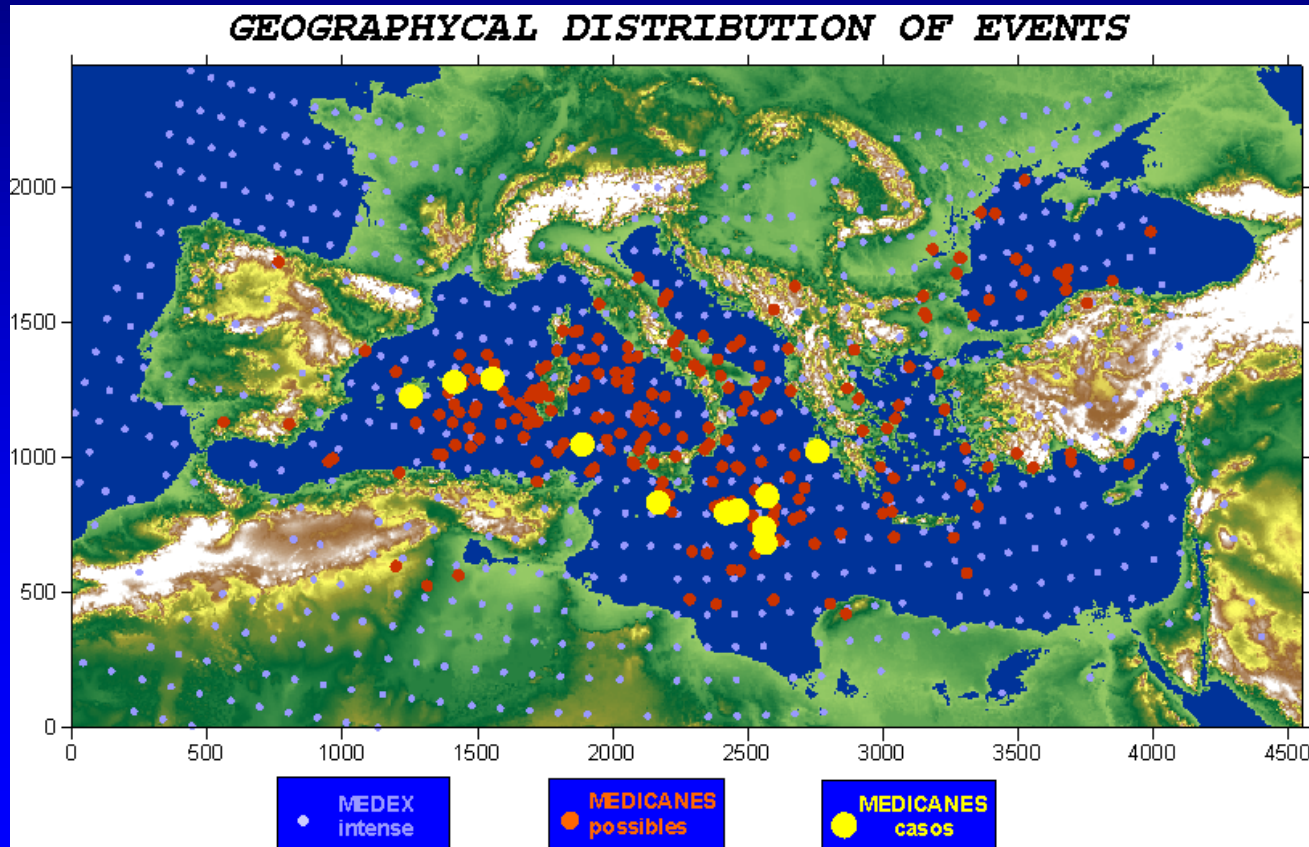
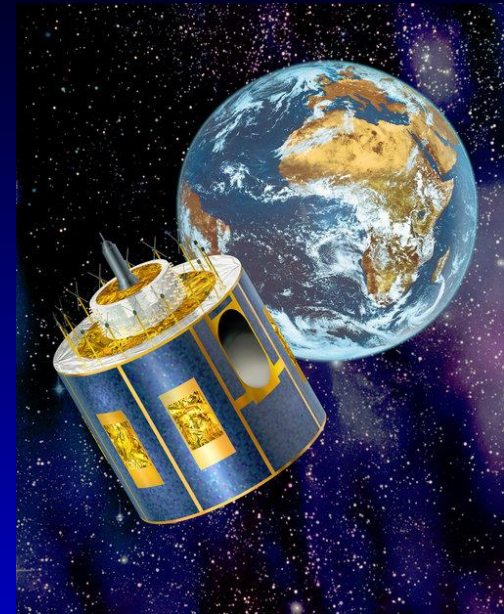
Medicanes or “Mediterranean hurricanes” are **extreme windstorms** potentially threatening the islands and coastal areas:

- Are there favoured locations for medicane development ?
- How intense can they become ?
- How could they react in frequency and intensity to global warming ?



LONG-TERM RISK OF MEDICANES ???

- Only 1-2 cases per year !!!
- Impractical evaluation with standard methods



Data base (satellite)
(Tous and Romero, 2012)

FOUR APPROACHES

- ***APPROXIMATION: Large scale ingredients***
-

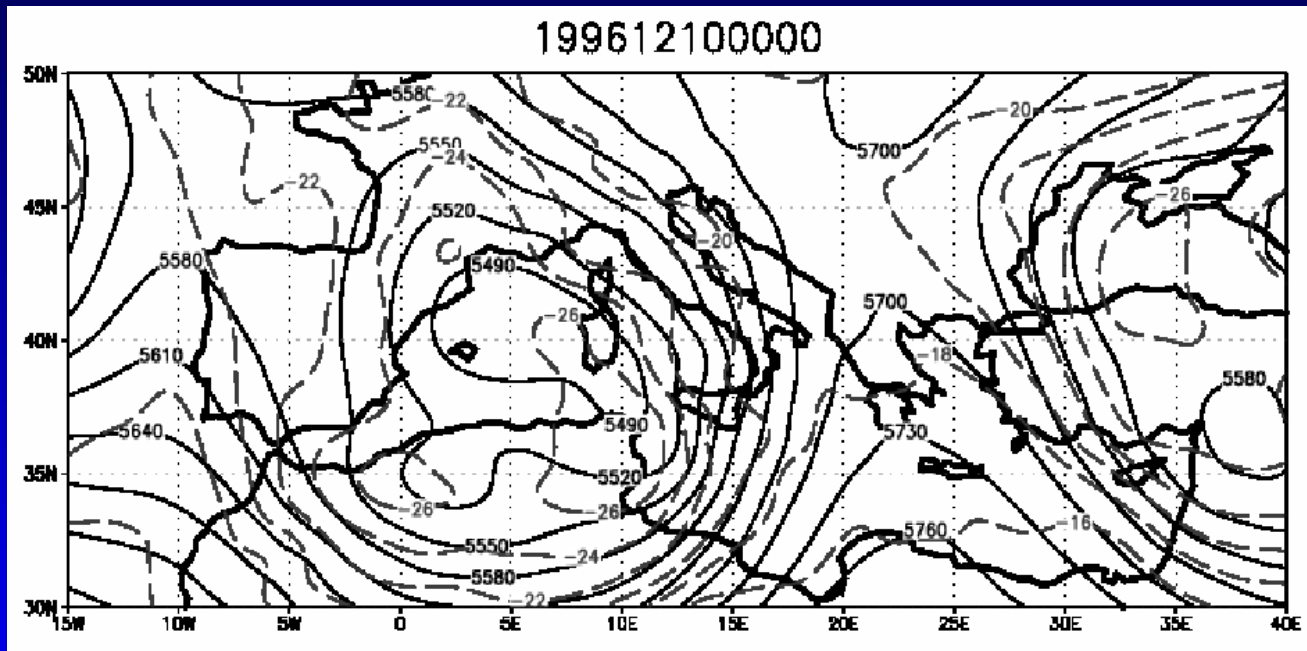
- ***FIRST METHOD: Nested climate simulations***

- ***SECOND METHOD: Global climate simulations (HR)***

- ***THIRD METHOD: Statistical-deterministic approach***

APPROXIMATION: Large scale ingredients

- ***Cut-off, cold-core lows in the upper and middle troposphere:***



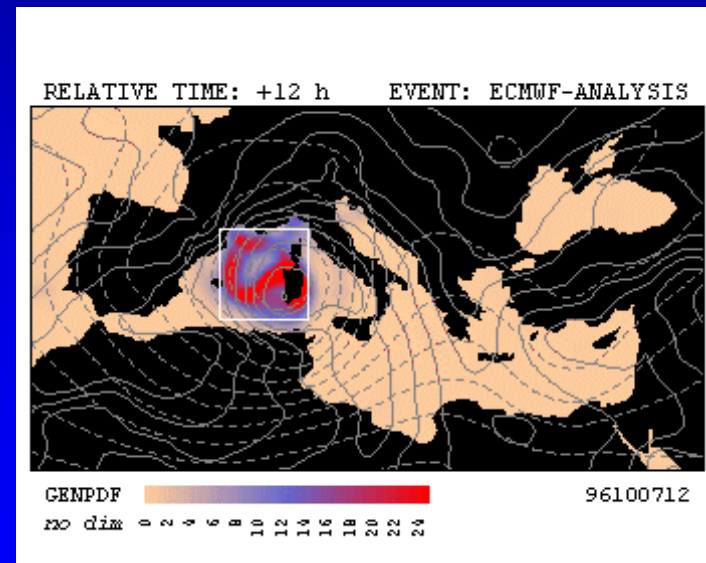
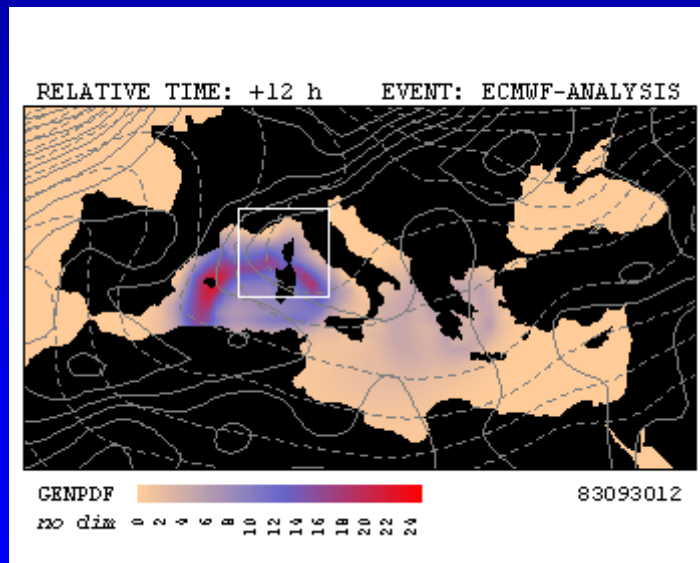
- ***But the infrequent occurrence of medicanes suggests that additional and very special meteorological conditions are necessary for these storms to occur ...***

APPROXIMATION: Large scale ingredients

- Application of an **empirical index of genesis**:

$$I = \left| 10^5 \eta \right|^{3/2} \left(\frac{H}{50} \right)^3 \left(\frac{V_{pot}}{70} \right)^3 \left(1 + 0.1 V_{shear} \right)^{-2},$$

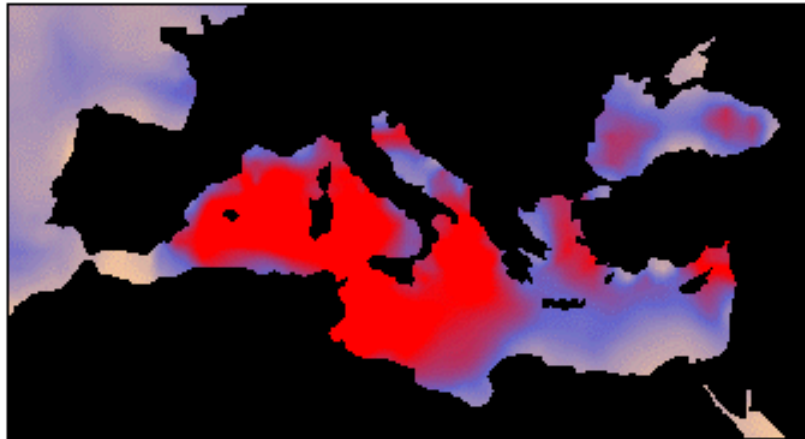
GENIX parameter
(Emanuel and Nolan, 2004)



- **Necessary but no sufficient ingredients ...**

APPROXIMATION: *Application*

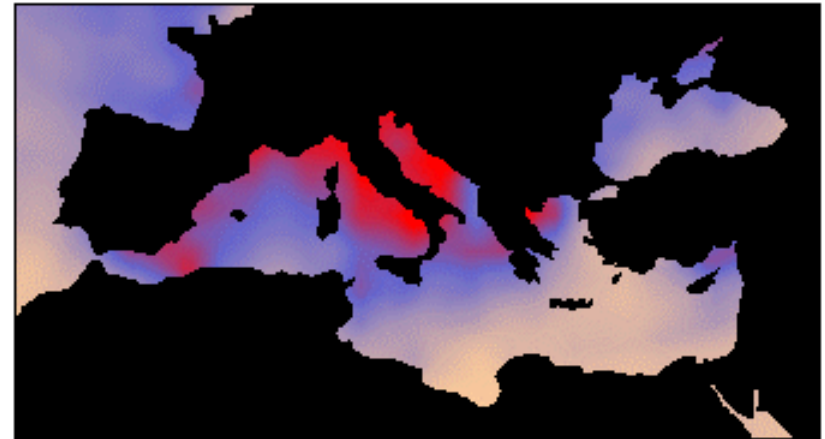
MONTH: Oct REANALYSIS: ERA-40 1981-2000



GEMPDF
no dim 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4

MEAN

MONTH: Oct GCM: CSIRO-20C3M 1981-2000

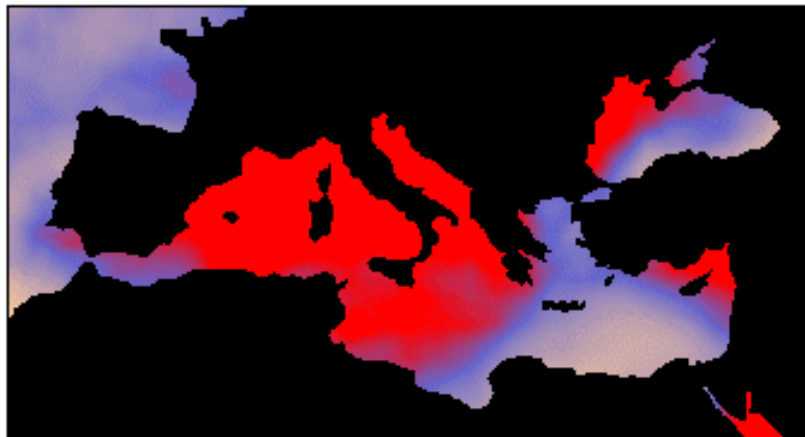


GEMPDF
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MEAN

GENIX Present

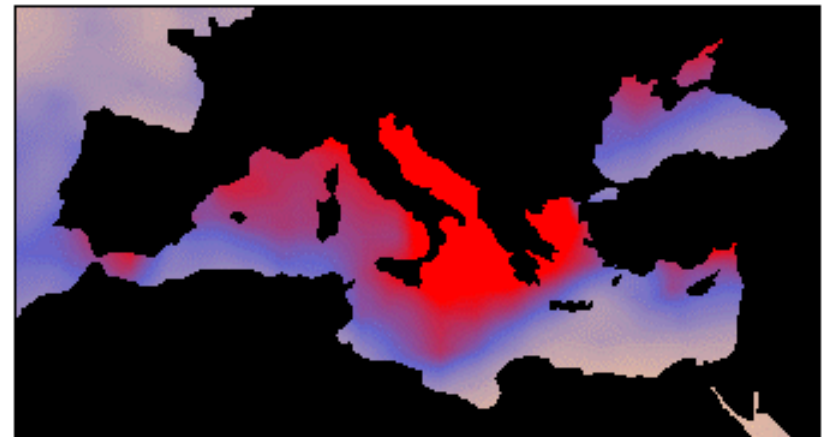
MONTH: Oct GCM: ECHAM5-20C3M 1981-2000



GEMPDF
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MEAN

MONTH: Oct GCM: GFDL-20C3M 1981-2000

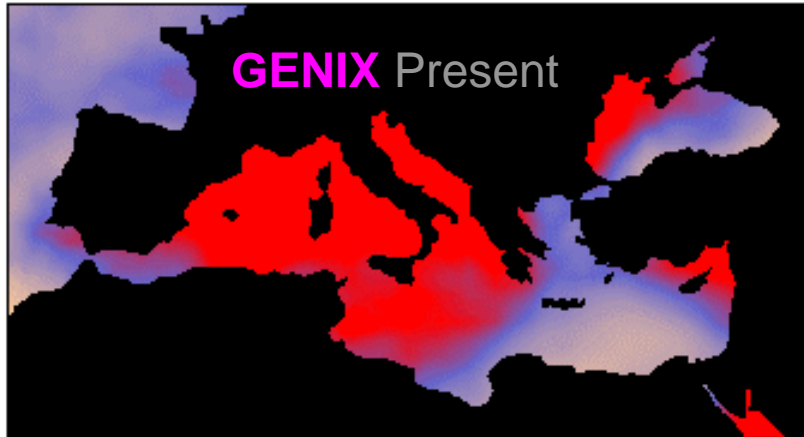


GEMPDF
no dim 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4

MEAN

APPROXIMATION: Application

MONTH: Oct GCM: ECHAM5-20C3M 1981-2000



GENPDF MEAN
no dim 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4

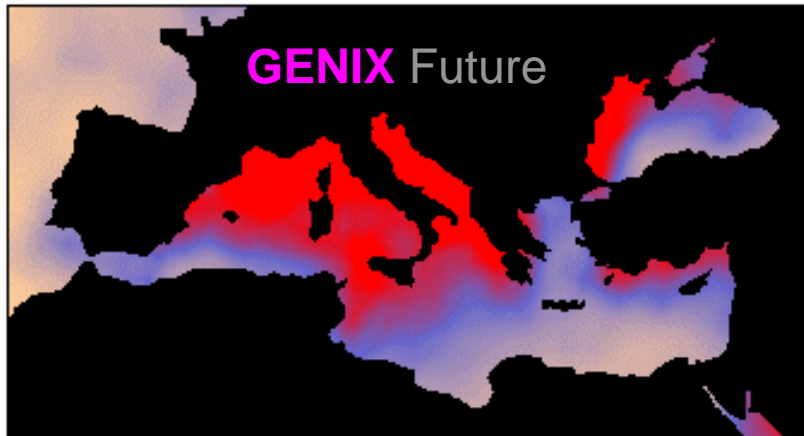
MONTH: Oct GCM: ECHAM5-20C3M 1981-2000



SST MEAN
°C 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

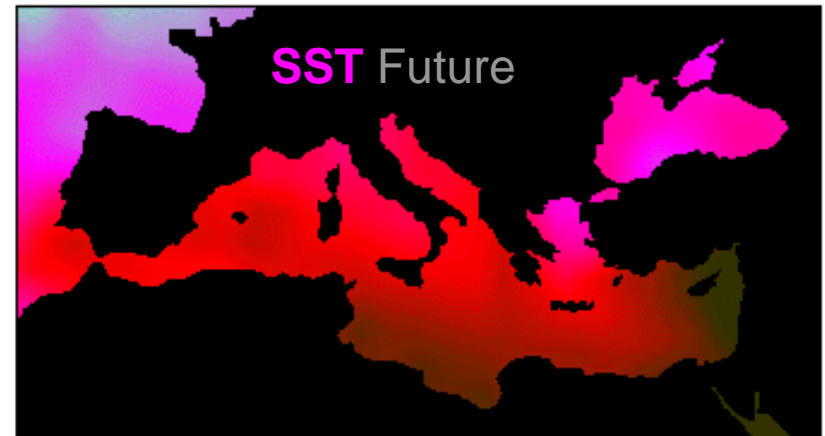
↓ + 3 °C

MONTH: Oct GCM: ECHAM5-SRESA2 2081-2100



GENPDF MEAN
no dim 0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4

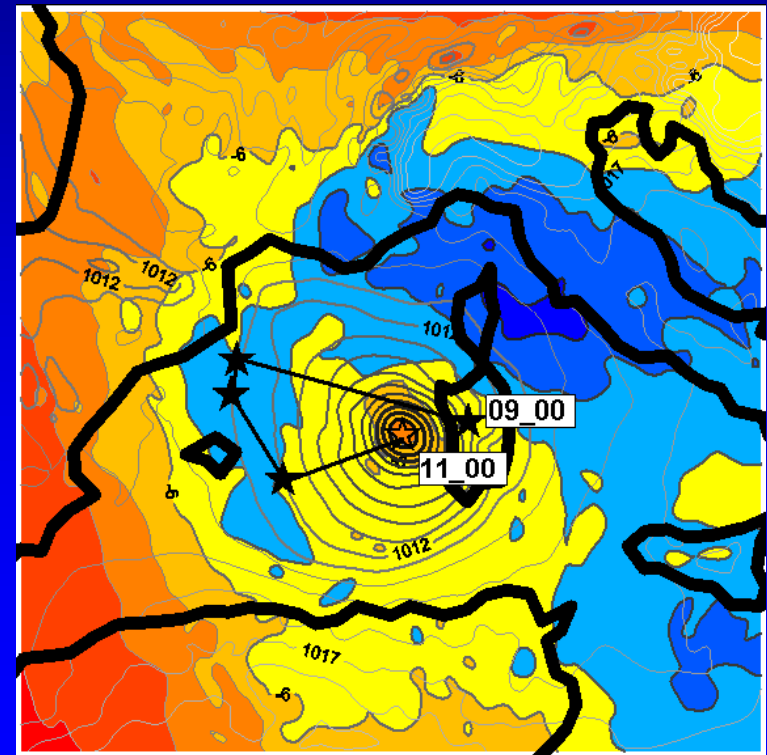
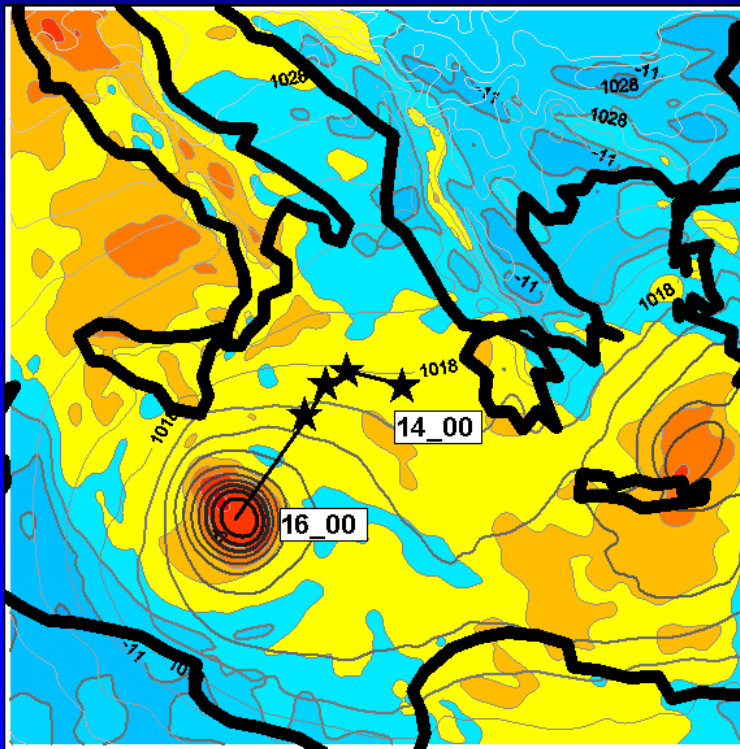
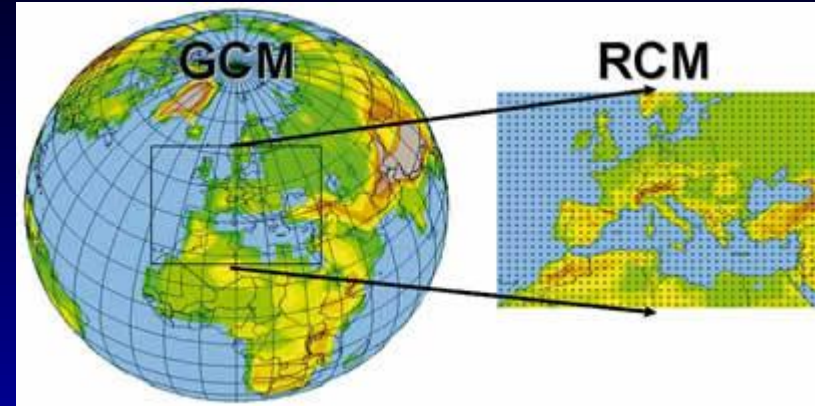
MONTH: Oct GCM: ECHAM5-SRESA2 2081-2100



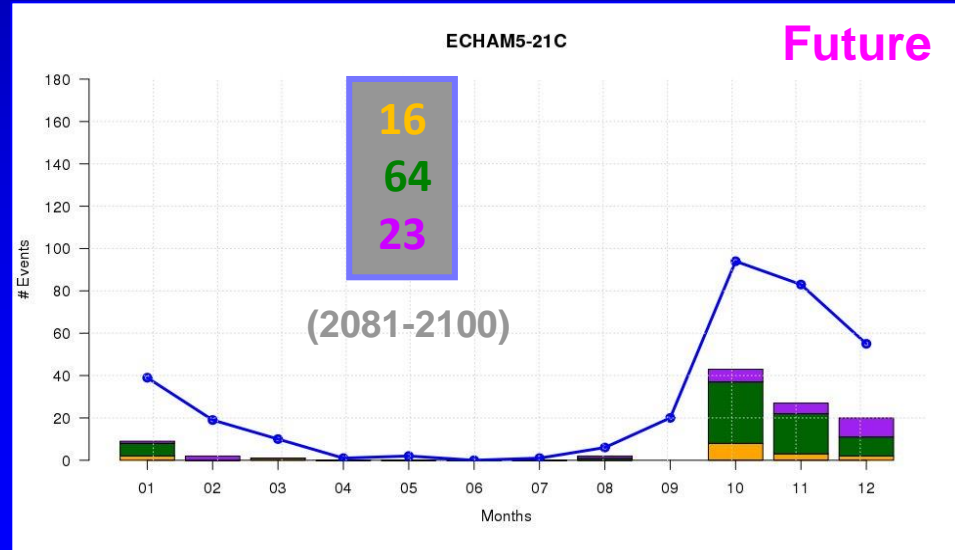
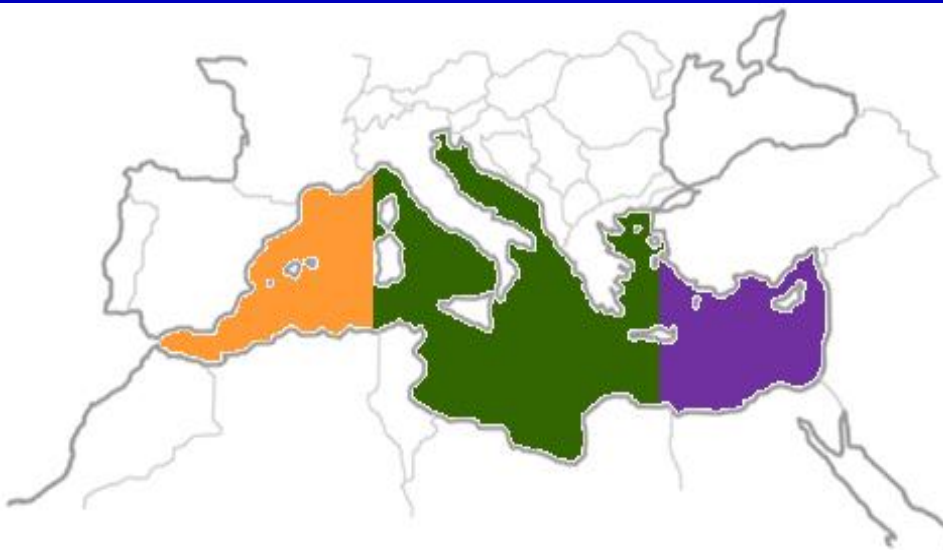
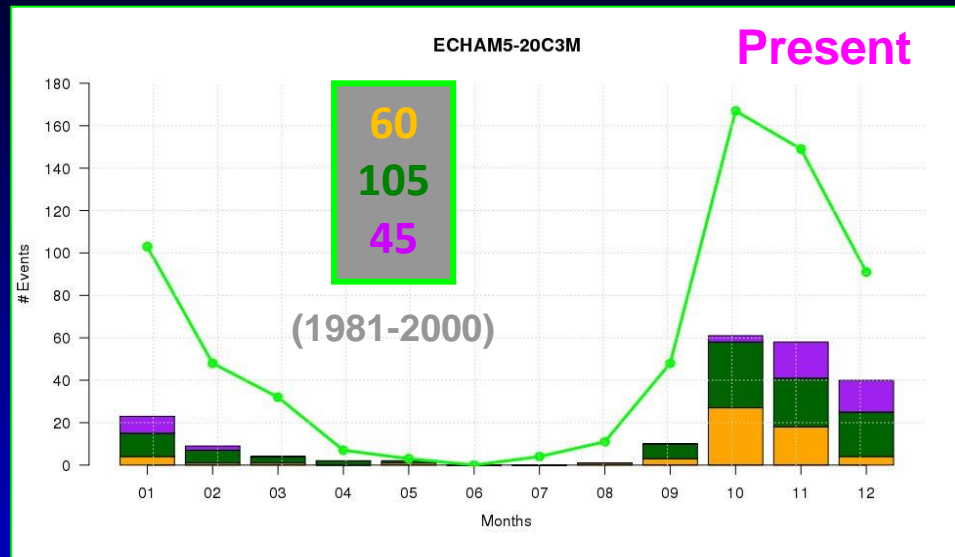
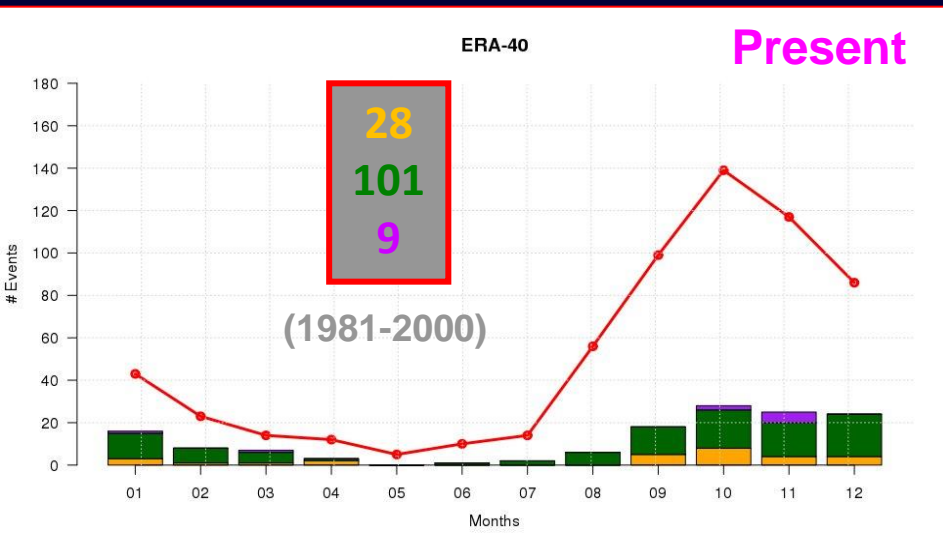
SST MEAN
°C 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

FIRST METHOD: Nested climate simulations

- High **computational cost !!!**
(even for guided simulations)
- And only a **limited number** of cases
(although several GCMs / scenarios)

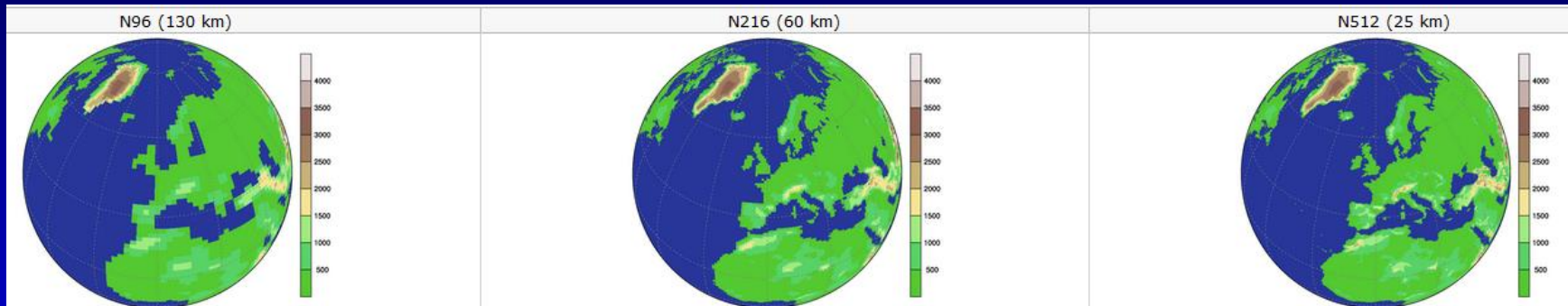


FIRST METHOD: *Application*

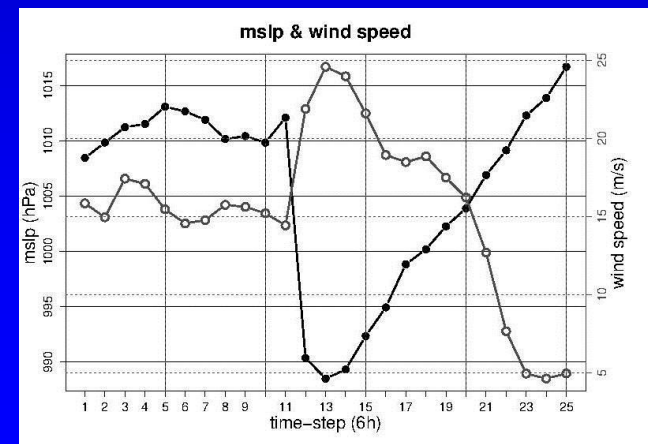
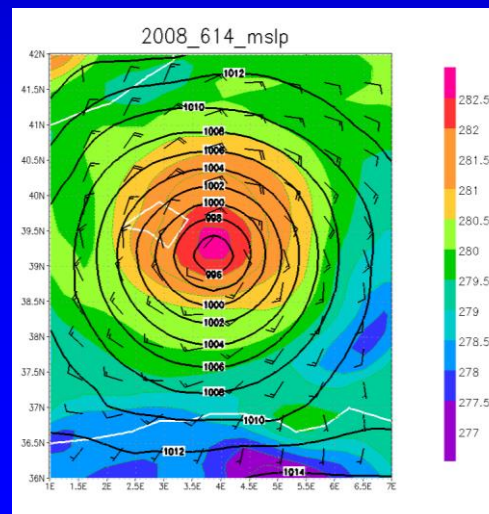
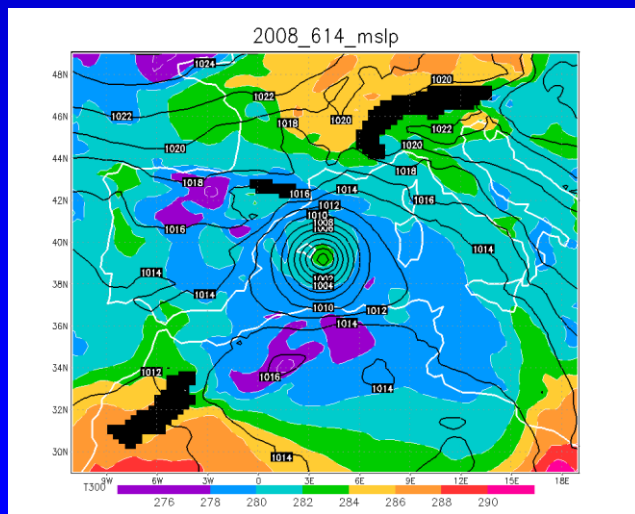


SECOND METHOD: Global climate simulations (HR)

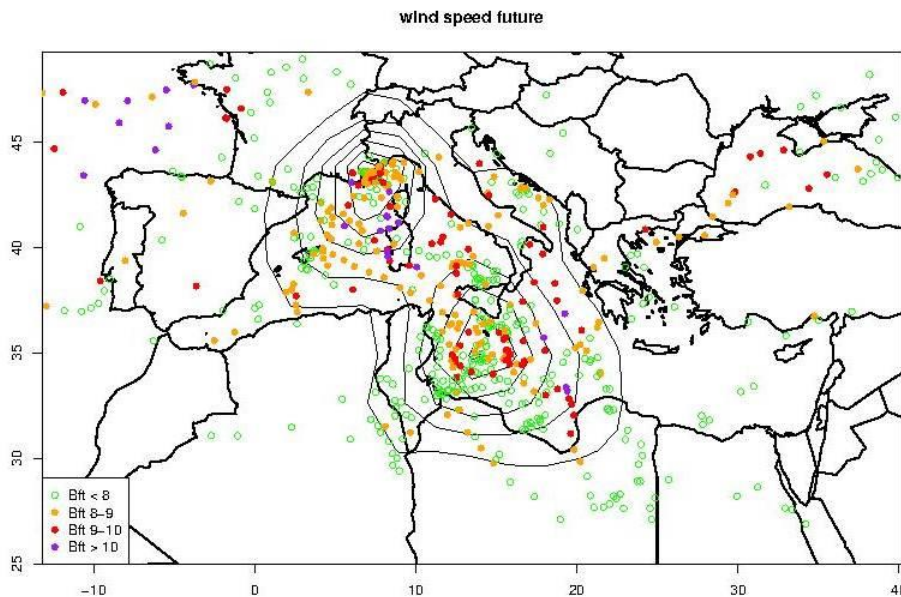
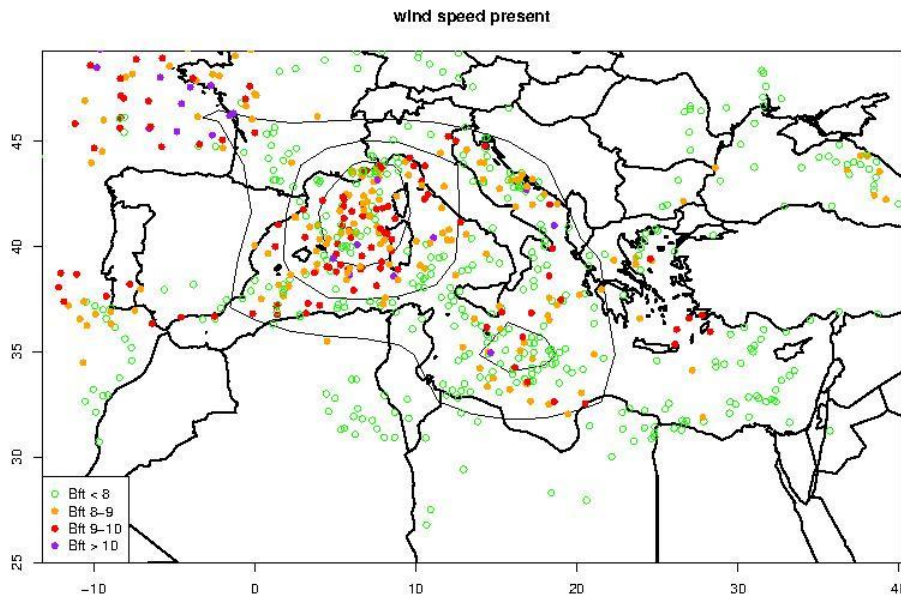
- **Detection and tracking** of intense, symmetric, warm-core cyclonic disturbances (i.e. **medicanes**) generated in the weather-resolving global simulations by **HadGEM3 N512 (25 km)** (UPSCALE project)



- In spite of the **HR**, only “**big**” **medicanes** can be captured ...

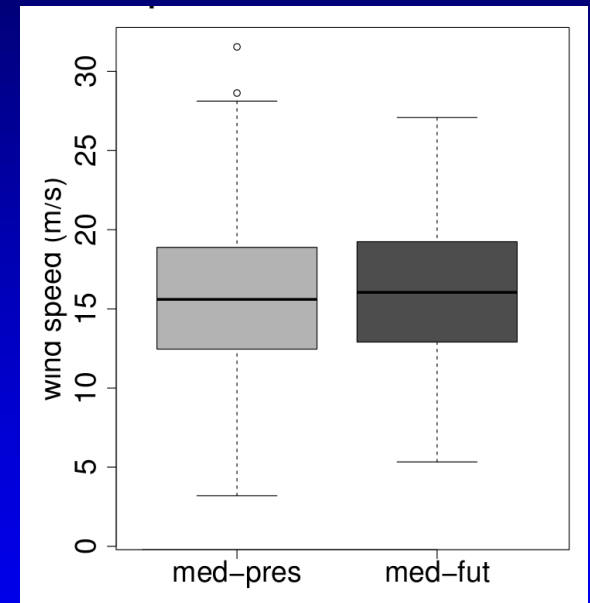


SECOND METHOD: *Application*



PRESENT

65 med / 26 yr



FUTURE

44 med / 26 yr

THIRD METHOD: Statistical-deterministic approach

- Adaptation of the pioneering method of **Kerry Emanuel** (MIT, USA)
- Low-cost generation of **thousands of synthetic storms !!!**
- **Statistically robust** assessment of the spatio-temporal risk function (e.g. calculation of **return periods** for extreme winds)

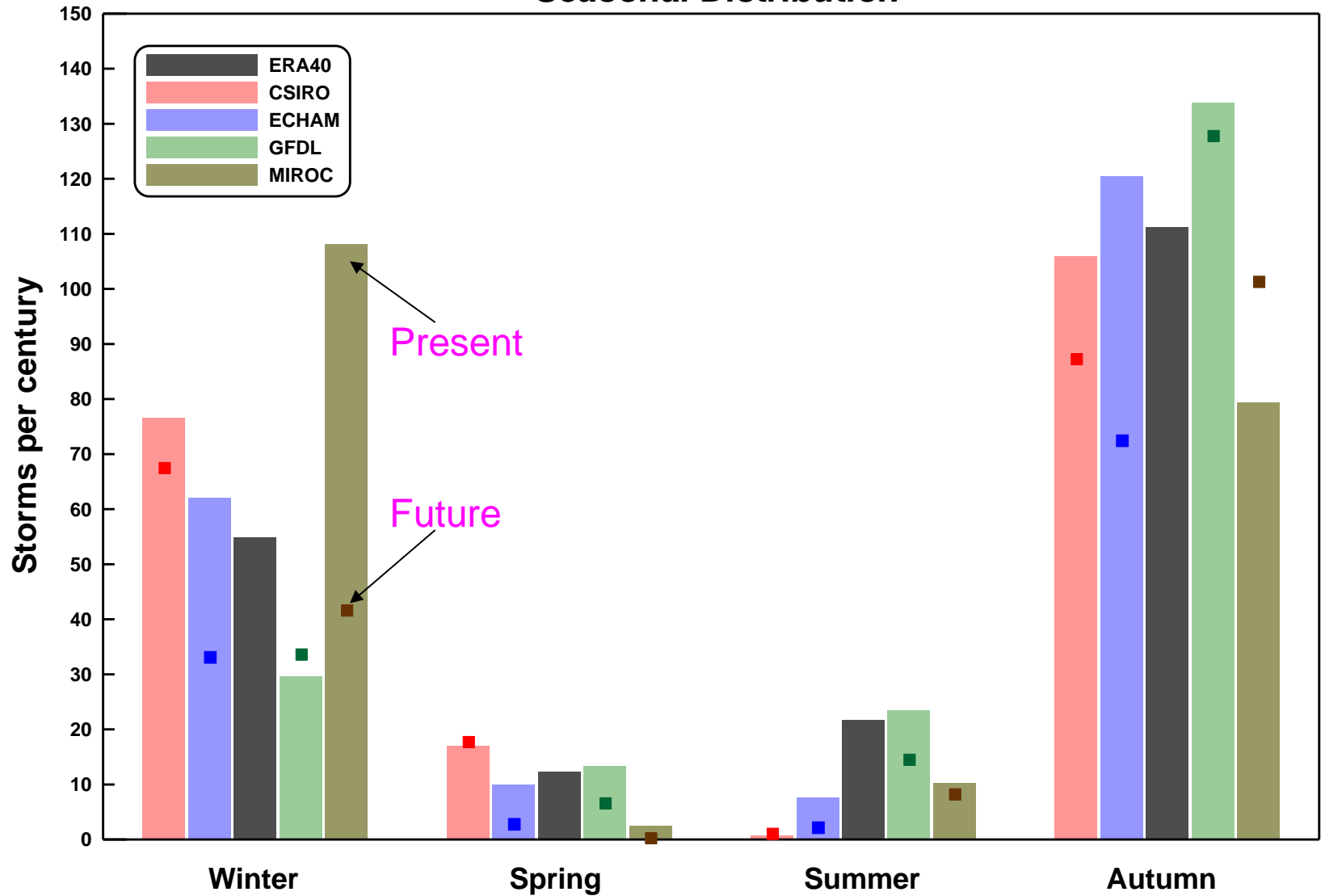


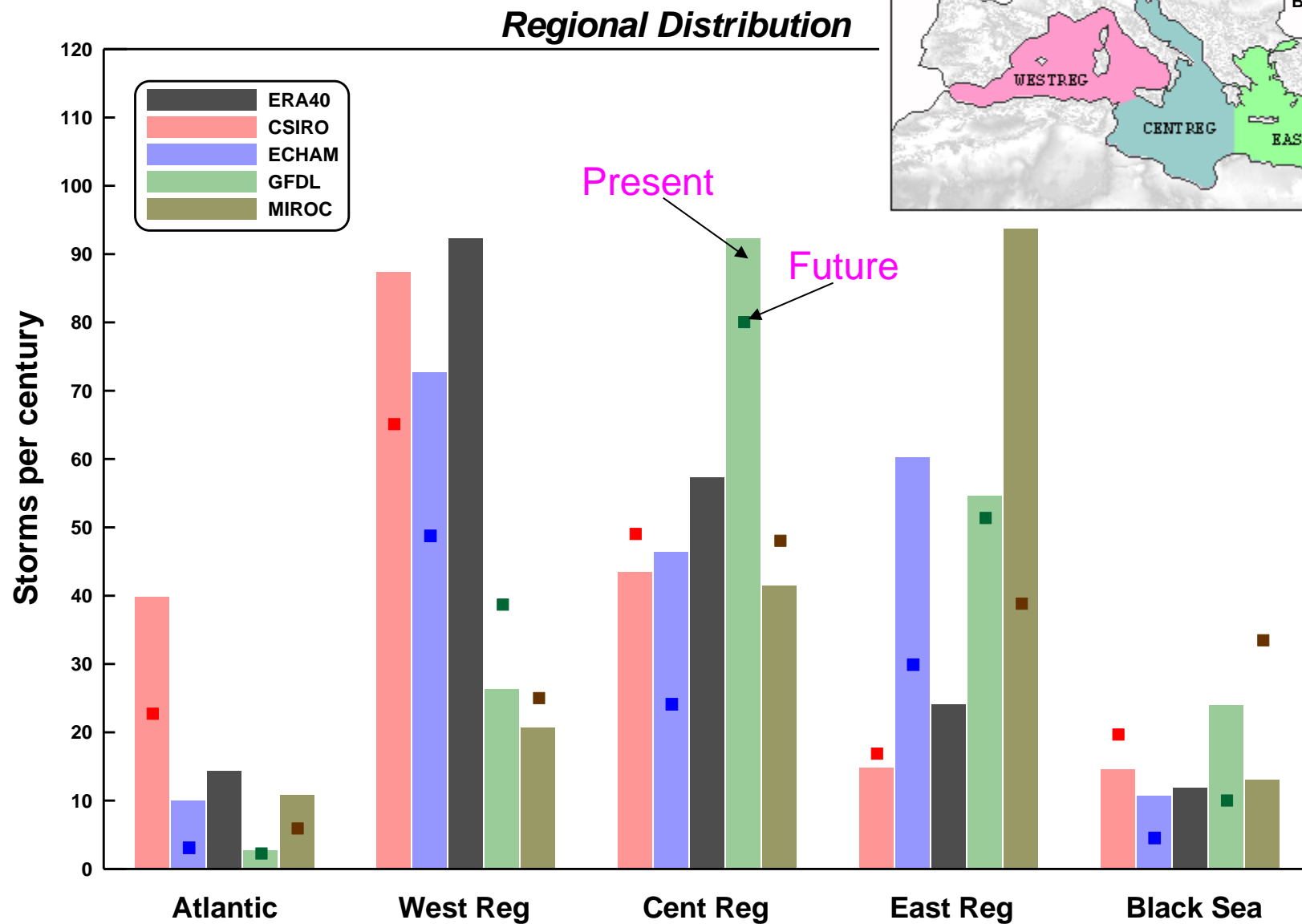
THIRD METHOD: *Application*

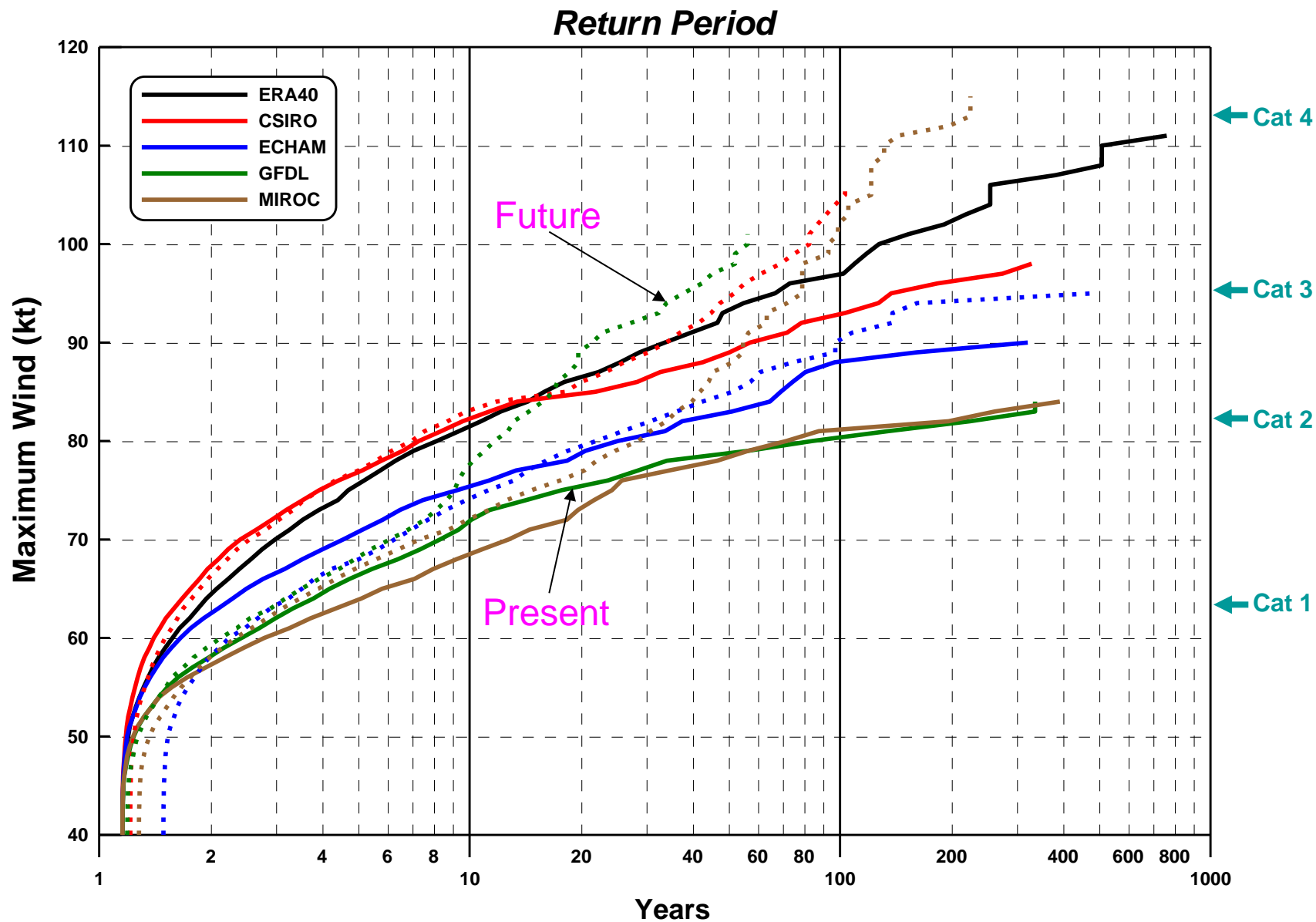
We ***synthetically*** generate a total of ***~15000 potential tracks for each climate/model***. These are simulated with a fast atmosphere-ocean coupled model ***and checked for intensification***:

<i>Climate Scenario</i>	<i>Reanalysis or GCM</i>	<i>Successful Storms</i>	<i>Storms per century</i>
<i>PRESENT</i> <i>1981 – 2000</i>	<i>ERA40</i>	3048	200
	<i>CSIRO</i>	3286	200
	<i>ECHAM</i>	1924	200
	<i>GFDL</i>	1343	200
	<i>MIROC</i>	1567	200
<i>FUTURE</i> <i>2081 – 2100</i> <i>SRES A2</i>	<i>CSIRO</i>	2857	174
	<i>ECHAM</i>	1072	111
	<i>GFDL</i>	1226	183
	<i>MIROC</i>	2389	152

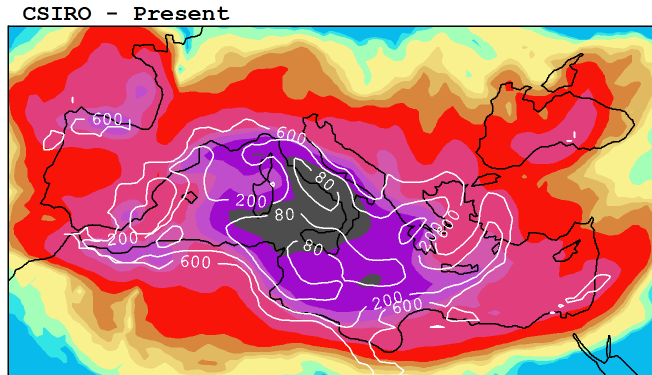
Seasonal Distribution



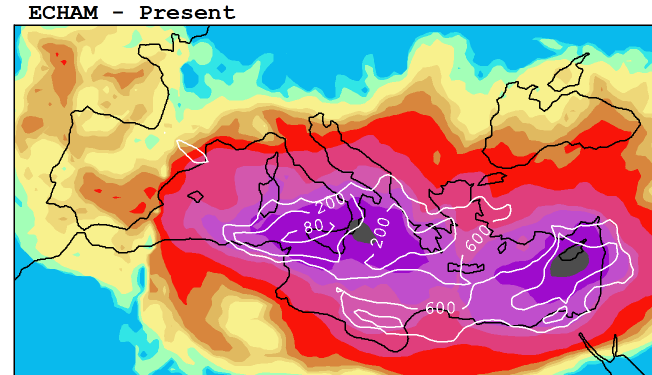




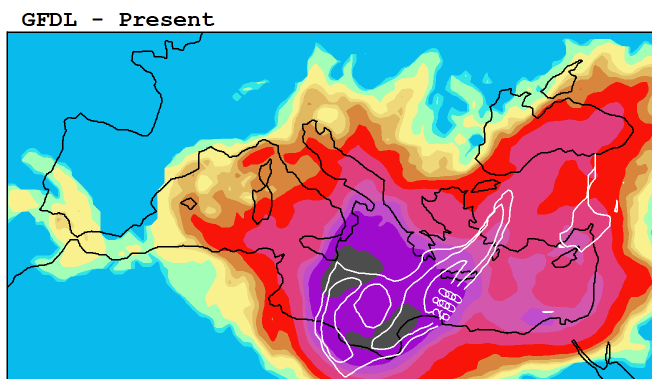
P R E S E N T



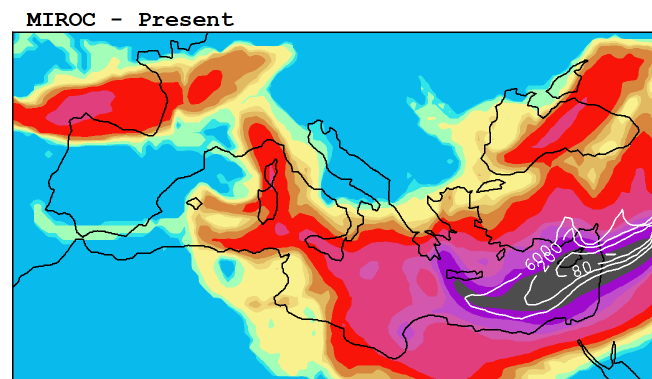
Years 2 4 6 8 10 40 80 200 600



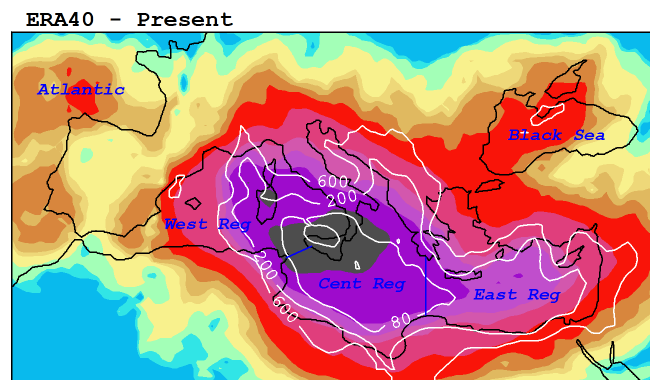
Years 2 4 6 8 10 40 80 200 600



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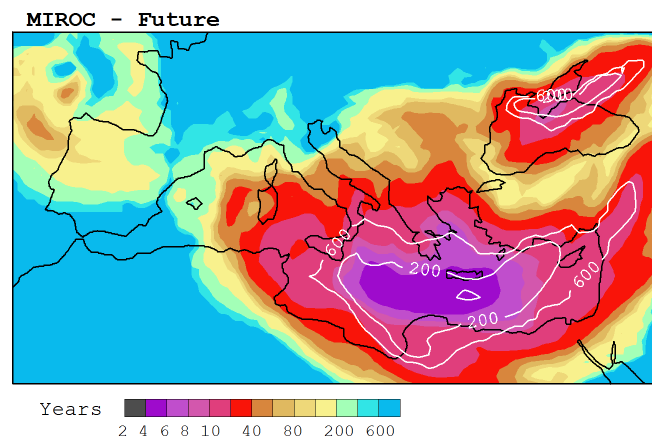
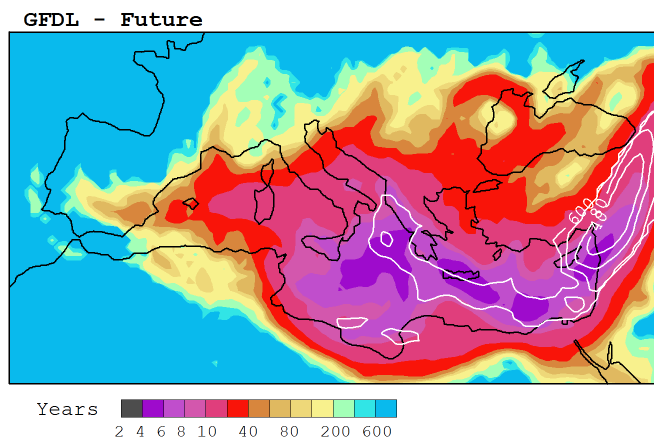
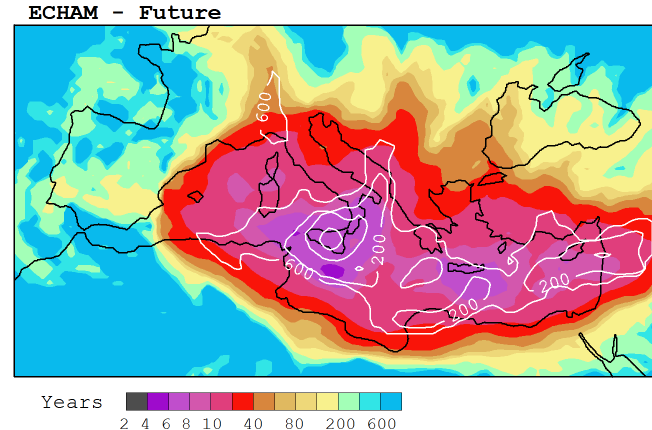
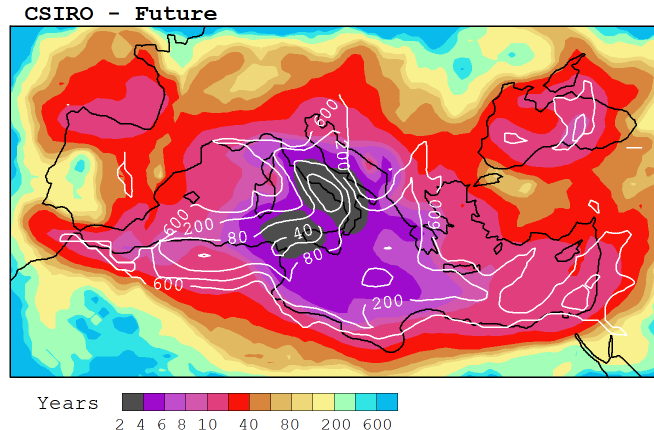


Years 2 4 6 8 10 40 80 200 600

> 34 kt

> 60 kt

FUTURE



> 34 kt

> 60 kt

SUMMER 2015 ...

- Results for MEDICANES will be updated using 30 CMIP5 models (uncertainty?)
- We will apply the “same” method to investigate the future of POLAR LOWS

A satellite image of a hurricane, likely Hurricane Katrina, over the Gulf of Mexico. The hurricane's eye is clearly visible in the center. The text "THANK YOU FOR YOUR ATTENTION !!!" is overlaid in yellow, bold, serif font.

**THANK YOU FOR
YOUR ATTENTION !!!**