

MEDICANE RISK IN A CHANGING CLIMATE:

Results of two methods



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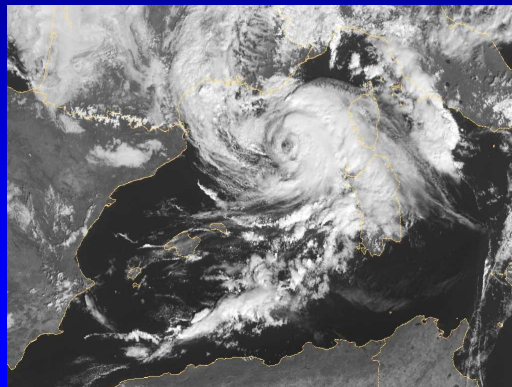
C. Ramis

13th EMS Annual Meeting (Reading, UK, 9-13 September 2013)

MOTIVATION

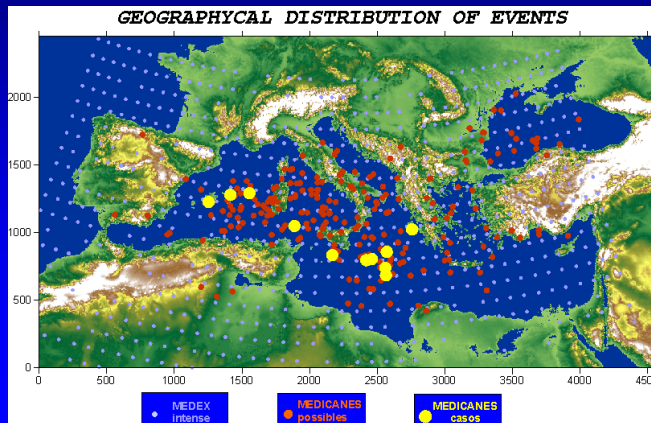
Medicanes are warm-core, surface flux-driven **extreme windstorms** potentially threatening the islands and coastal areas:

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



MEDICANE RISK ???

With an average frequency of **only 1-2 events per year** and given the lack of systematic, multidecadal databases, an objective evaluation of the **long-term risk** of medicane-induced winds is **impractical** with standard methods

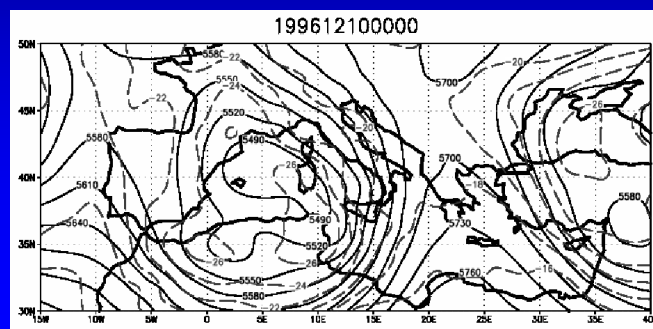


Database from satellite
(Tous and Romero, 2012)

APPROACH: Large-scale environmental proxies

Synoptic analyses of a few studied cases show that an inevitable precursor is the presence of a deep, **cut-off, cold-core** low 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 ...



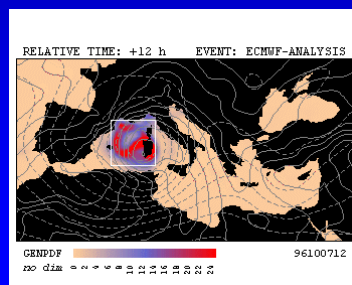
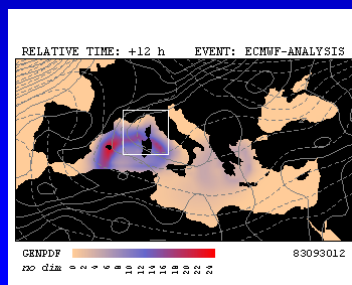
APPROACH: Large-scale environmental proxies

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

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

GENIX parameter
(Emanuel and Nolan, 2004)

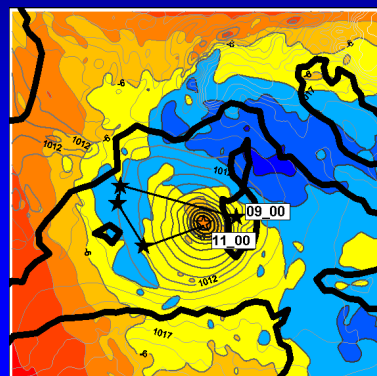
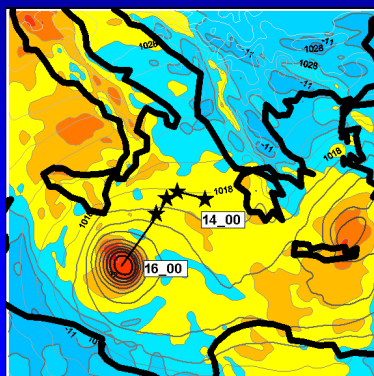
• **But** these environmental proxies behave as **necessary but no sufficient** ingredients for the successful genesis of a medicane ...



FIRST METHOD: Nested climatic simulations

Detection and tracking of symmetric warm-core cyclonic disturbances generated **in mesoscale simulations** forced by Reanalysis and GCM data:

• **But high computational cost**: Limited horizontal resolution; Too few climatic realizations to permit a full sampling of the PDF of storms ...



SECOND METHOD: Statistical-deterministic approach

Developed by Kerry Emanuel and his team in the context of the long-term wind risk associated with tropical cyclones:

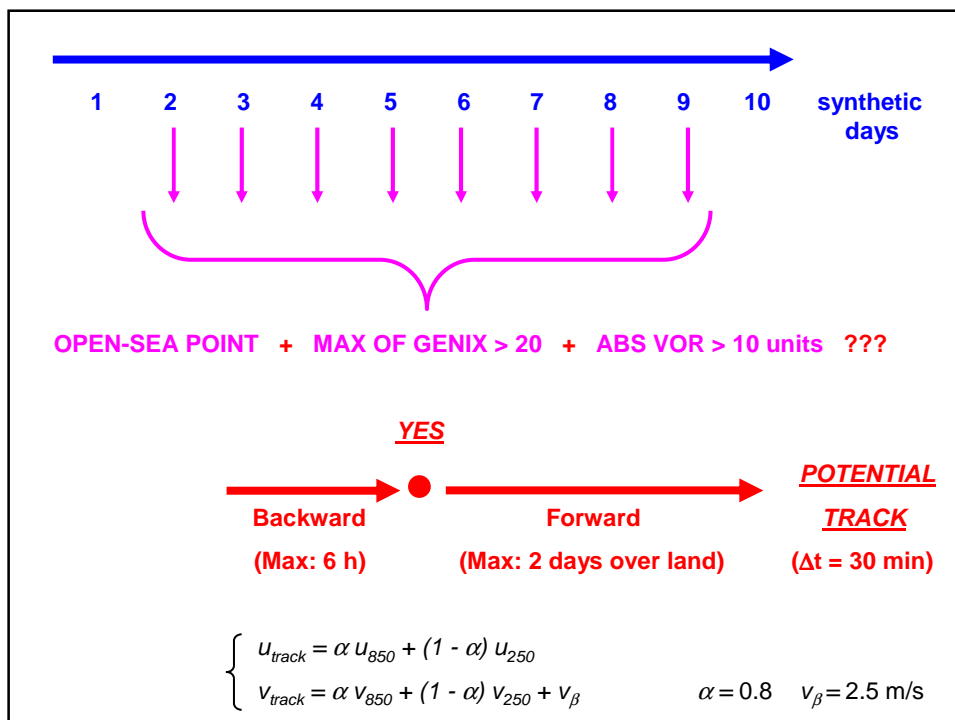
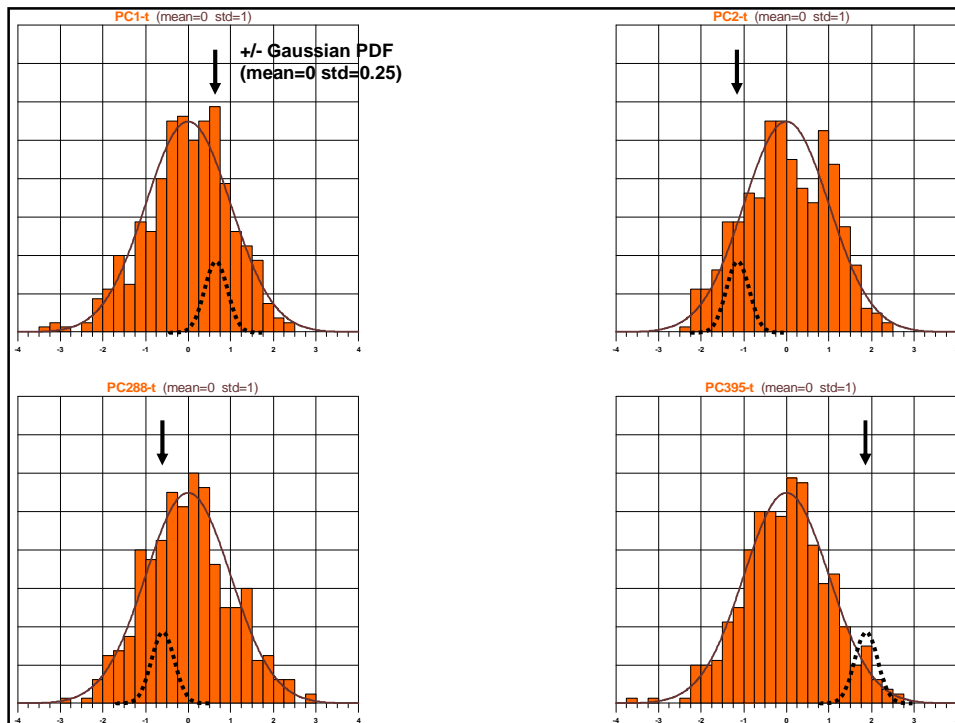
- Low-cost generation of **thousands of synthetic storms**
- **Statistically robust** assessment of risk (e.g. return periods for winds)
- **Genesis**: Random draws from observed PDF or Random seeding
- **Track**: Randomly varying synthetic winds (respecting climatology)
- **Environment**: Previous winds + monthly-mean thermodynamic fields
- **Intensity and radial distribution of winds**: CHIPS model



ADAPTATION OF THE SECOND METHOD

The separation of timescales made in the tropics between the synthetic wind field (**fast scale**) and the thermodynamic environment (**slow scale**) is **not appropriate** to represent the movement, growth and decay of **mid-latitude** weather systems. In addition, the history of medicane genesis is far too sparse to form a reasonable **PDF of genesis**, and **random seeding** would be very **inefficient**:

- For each month, decomposition through **PCA** of 10-day synoptic evolutions of **z250, z850, T600, R600 and PINT** into the new space of independent PCs
- Random **selection + random perturbation** of the set of PCs
- This perturbed set of PCs is **converted back into physical space**
- This is tantamount to generating 10-day sequences of spatiotemporal **coherent z250, z850, T600, R600 and PINT synthetic fields** which also respect their mutual covariances
- **Potential Genesis**: Based on the **GENIX** parameter



EXEMPLE FOR A REAL EVENT

(d)

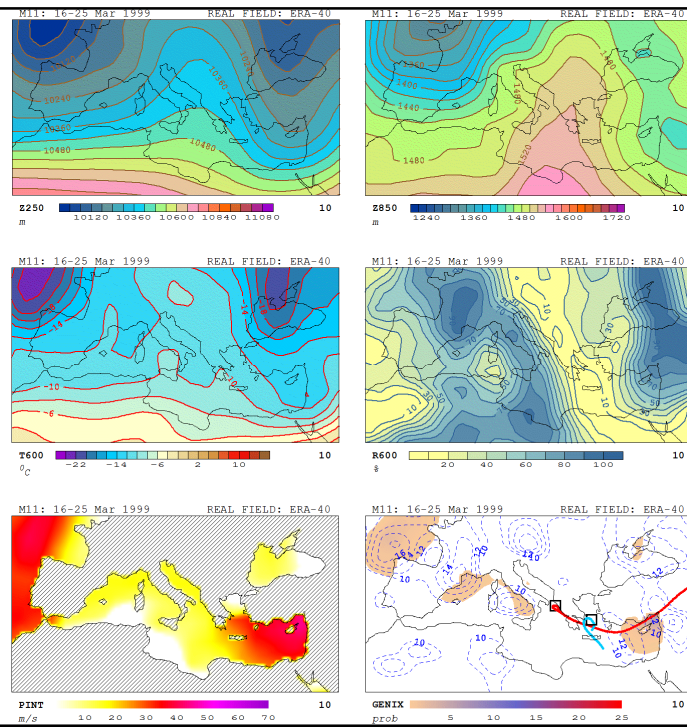
19-March-1999, 18 UTC



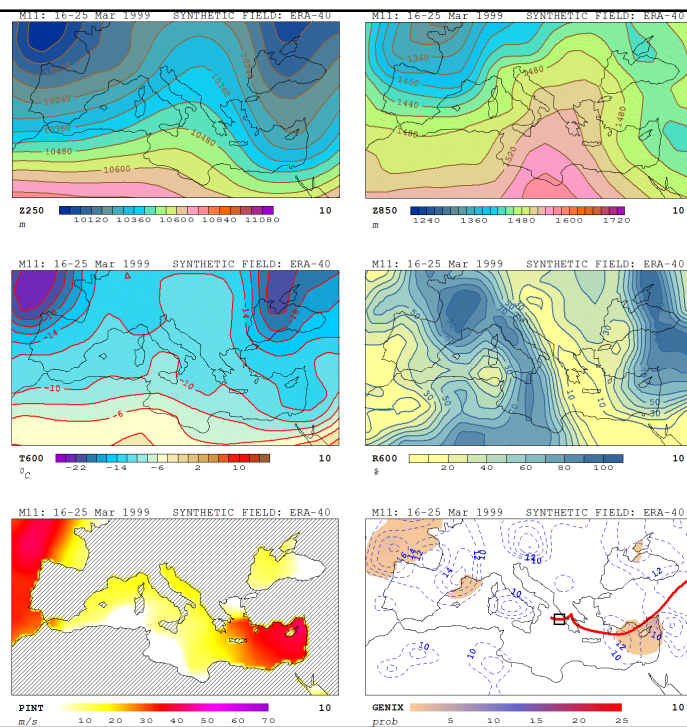
M11



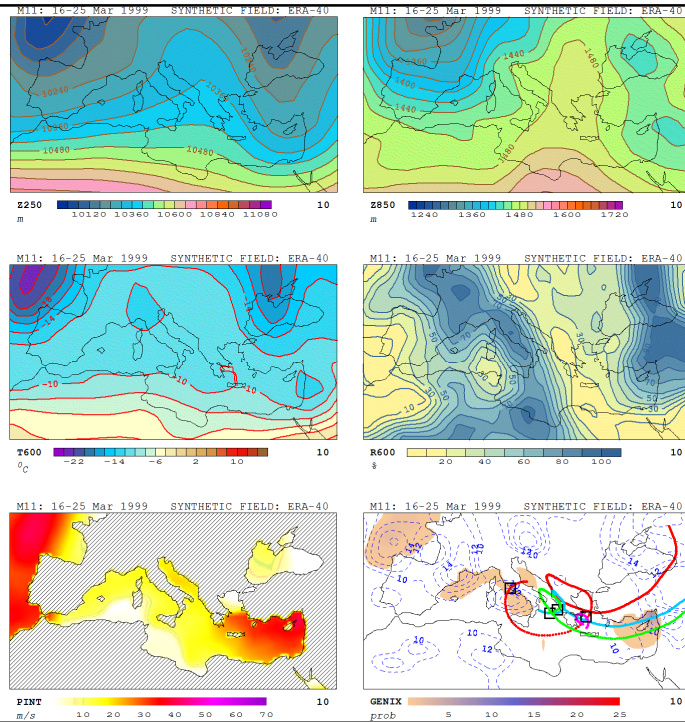
ERA-40
2 tracks



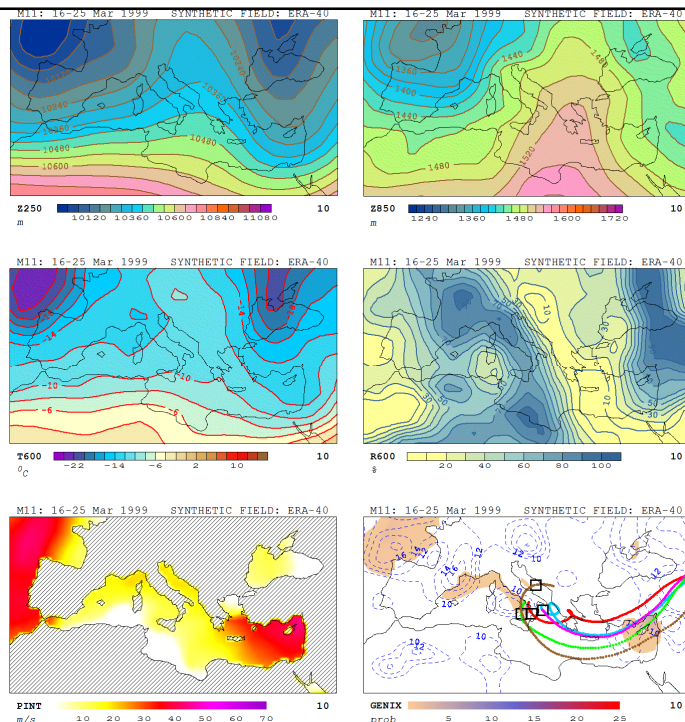
RND 1
1 tracks



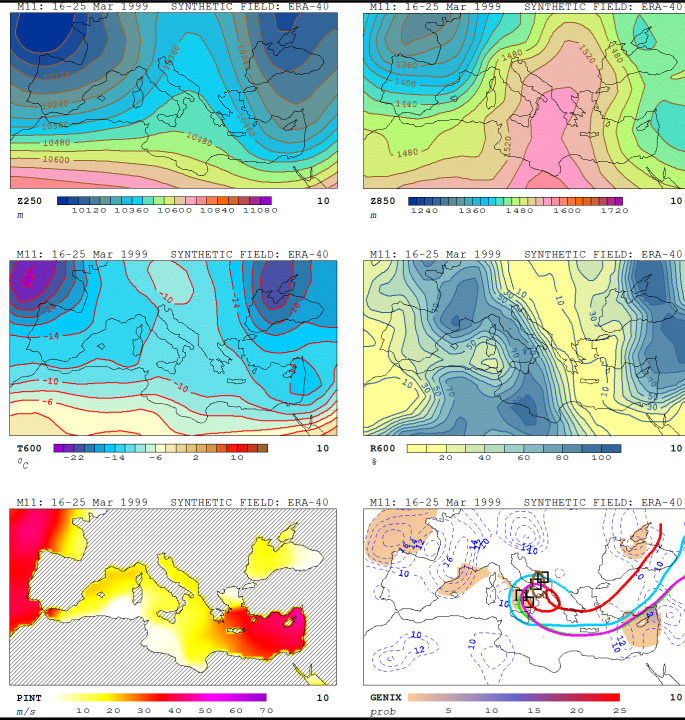
RND 2
4 tracks



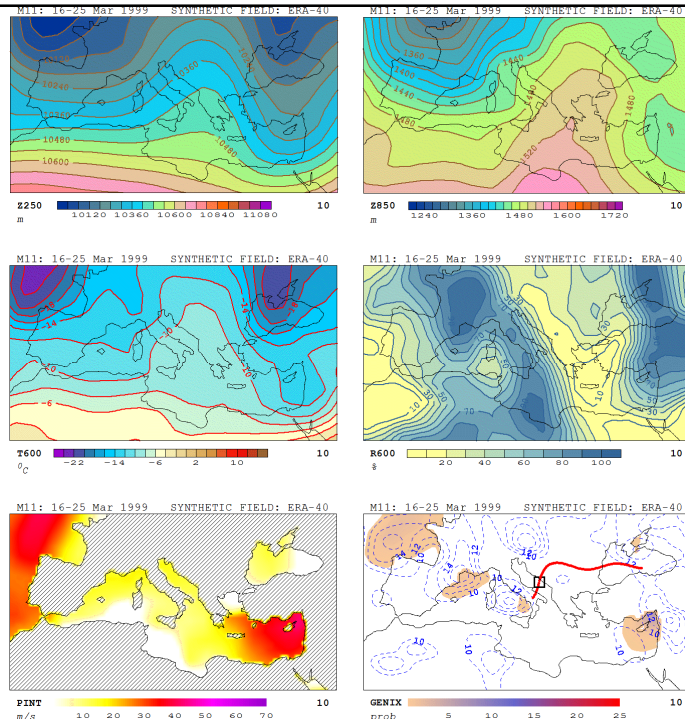
RND 3
5 tracks



RND 4
5 tracks



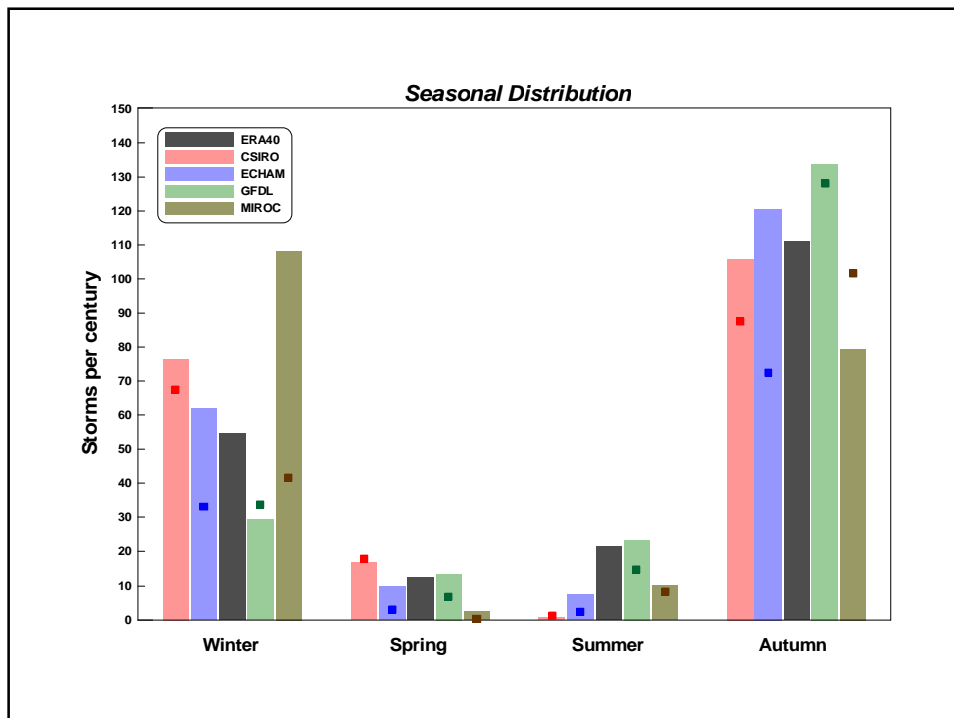
RND 5
1 tracks

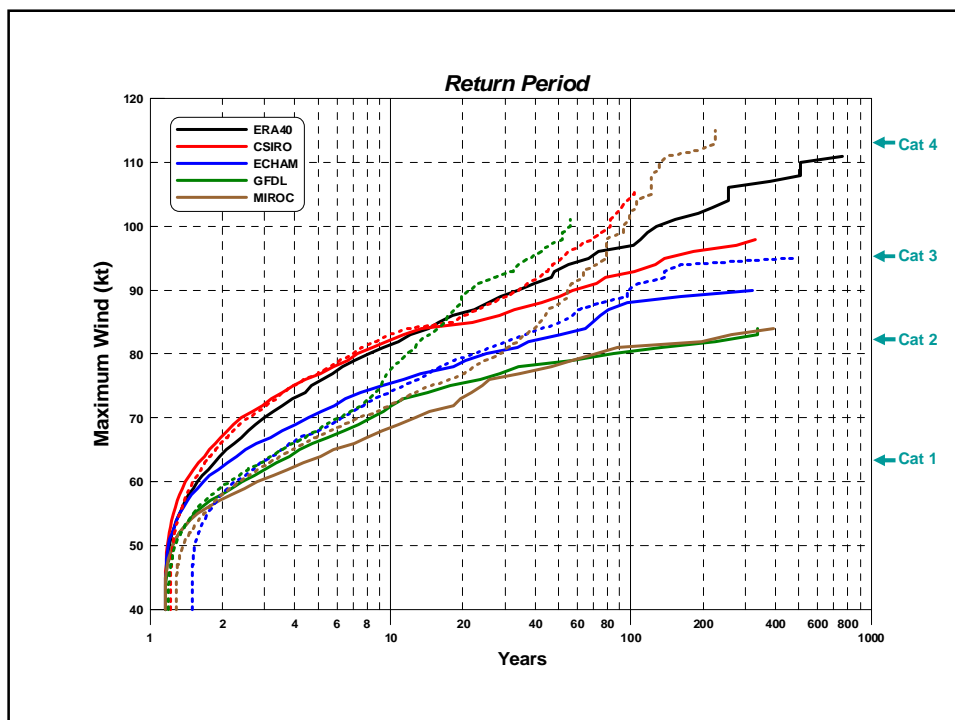
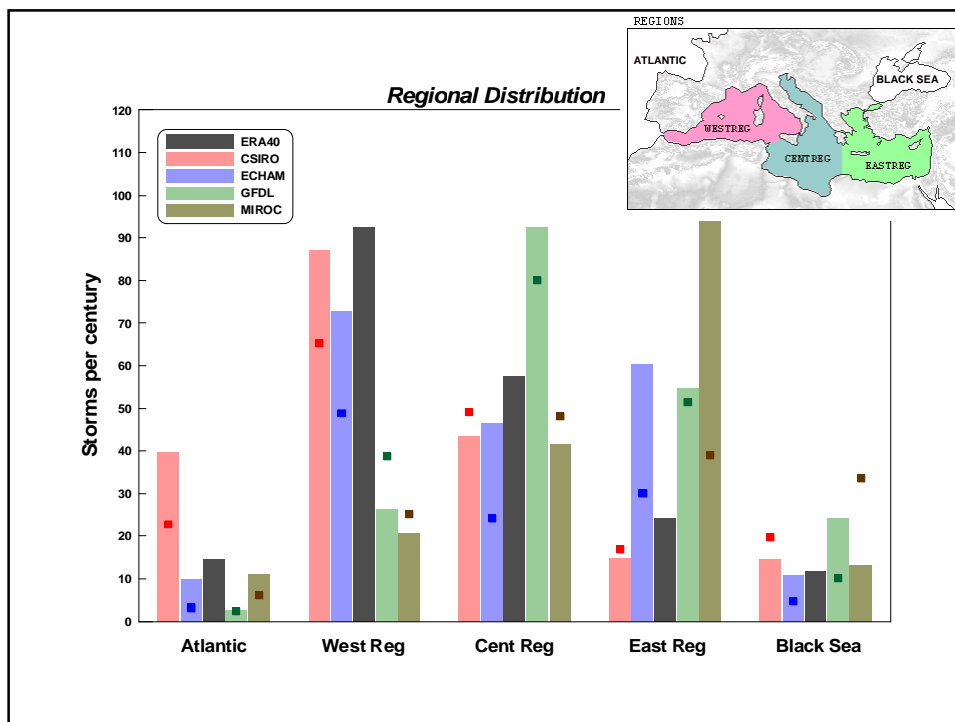


APPLICATION OF THE SECOND METHOD

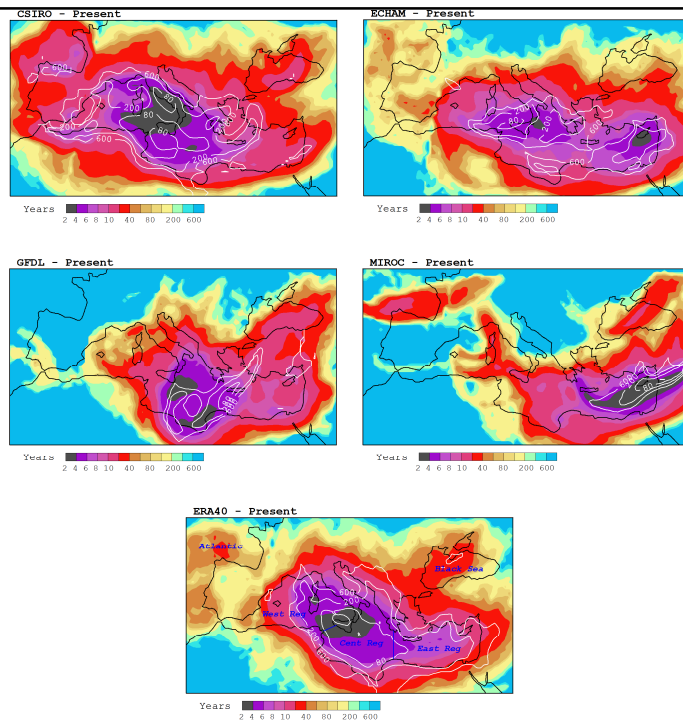
We synthetically generate a total of ~15000 potential tracks for each climate/model. These are simulated with CHIPS and checked for intensification above TS category (34 kt):

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

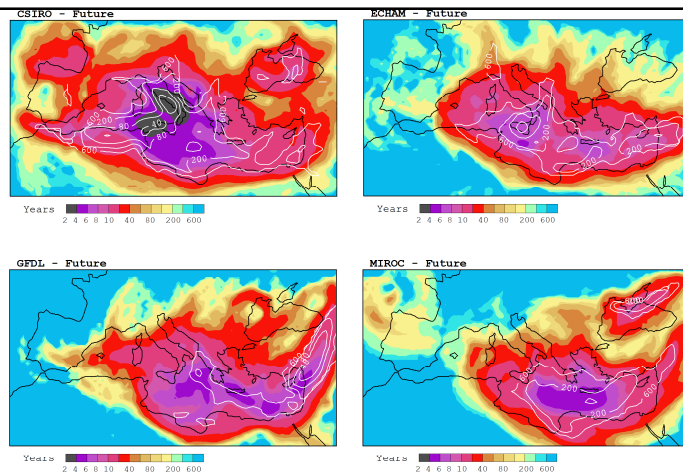




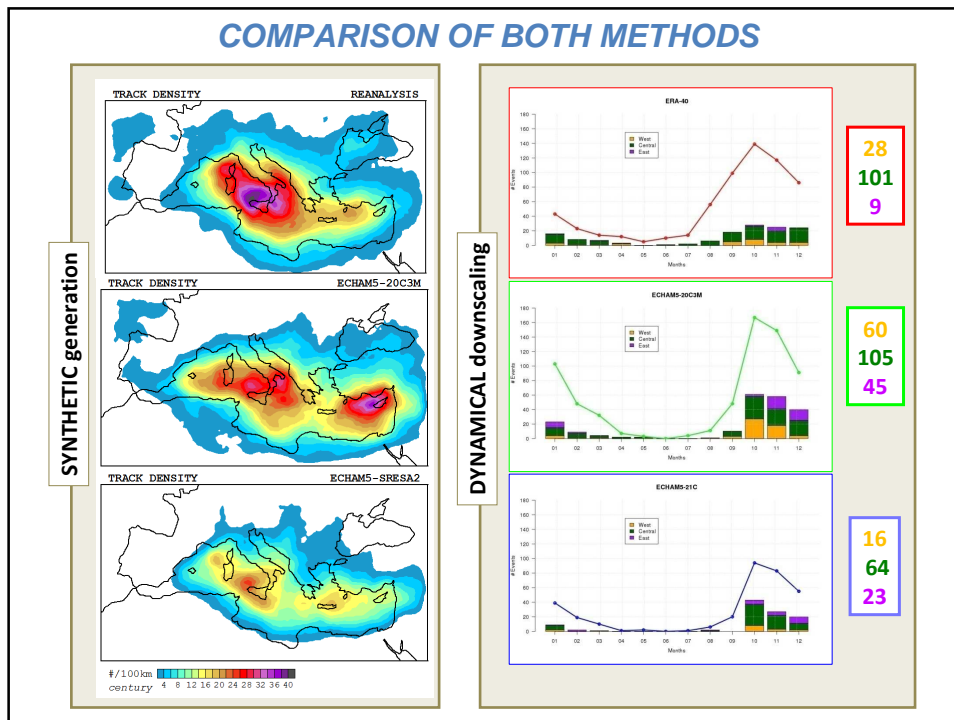
**20C3M
scenario**



**SRESA2
scenario**



COMPARISON OF BOTH METHODS



CONCLUSIONS

- The statistical-deterministic approach is a **good alternative** to **computationally** expensive classical methods (e.g. dynamical downscaling of medicanes), with the extra benefit of producing **statistically large populations** of events
- We attained **unprecedented** medicanes-wind **risk maps** for the Mediterranean region
- General **agreement** with the “known” phenomenology of medicanes in the **current climate** (e.g. maximum in the cold season and central Mediterranean) **and between both methods**
- In spite of some **geographical uncertainties**, GCMs tend to project **fewer medicanes at the end of the century** compared to present but a **higher number of violent storms**, suggesting an increased probability of major economic and social **impacts** as the century progresses