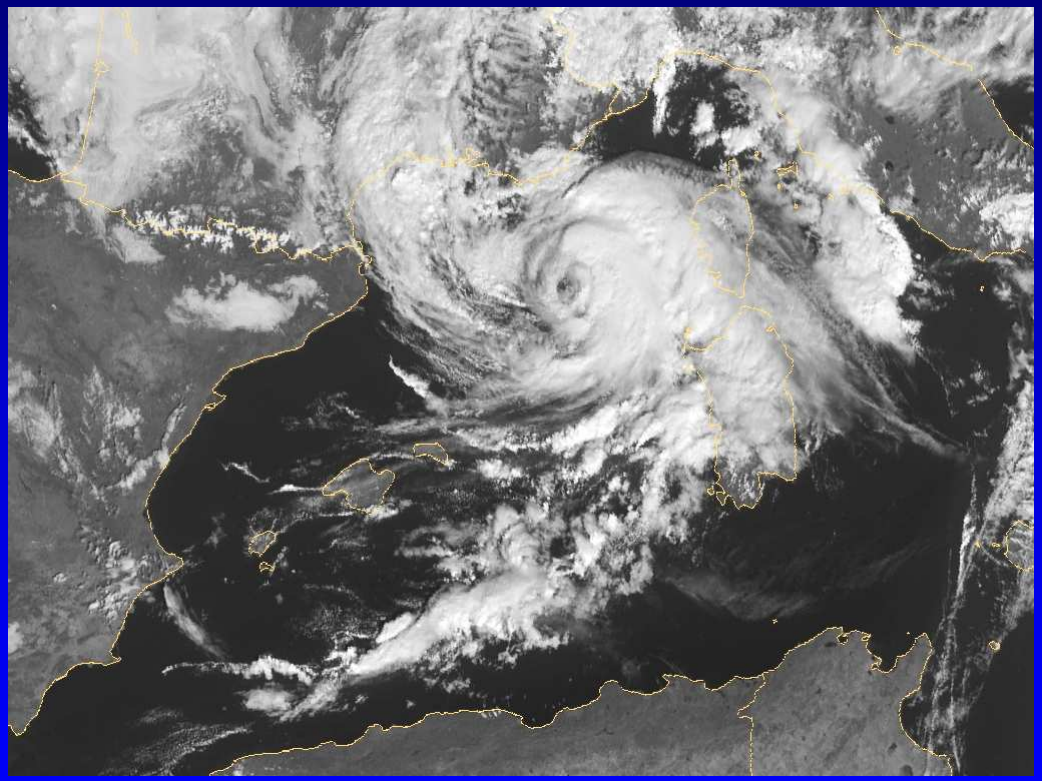
Els huracans mediterranis



Romu Romero, Grup de Meteorologia (UIB)

Curs d'Estiu 2016 "La meteorologia i el clima de les Illes Balears"

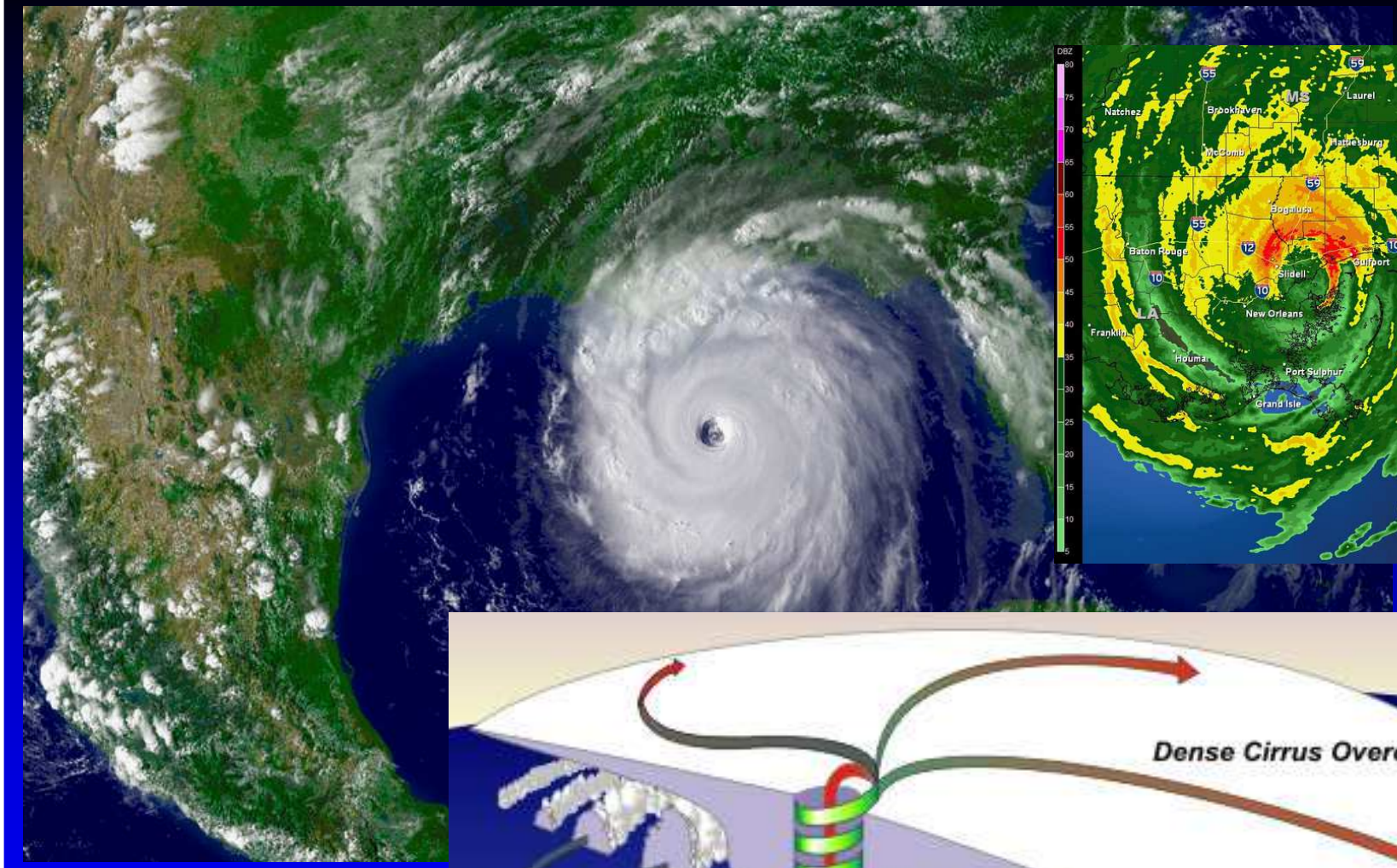
ÍNDEX

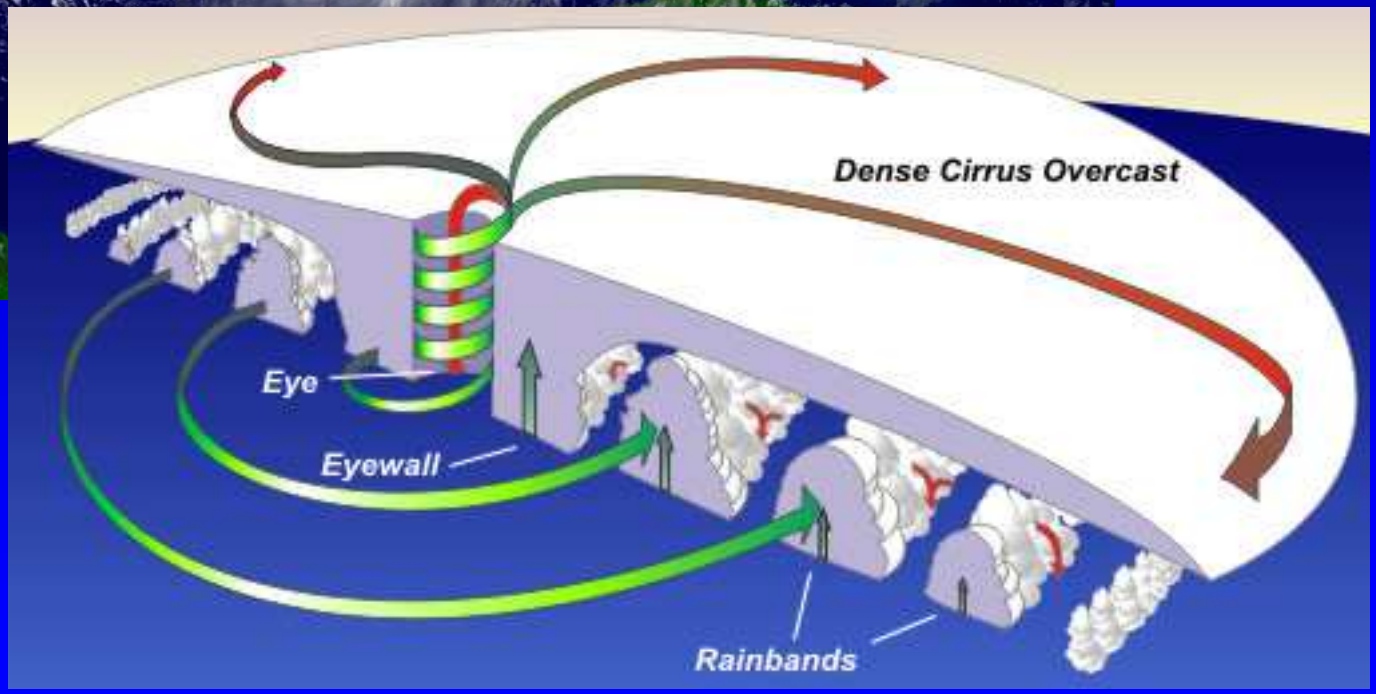
- Ciclons Tropicals: Una Mica de Física
- Medicanes: Observacions i Simulacions
- Medicanes: Efectes del Canvi Climàtic ?

CICLONS TROPICALS:
UNA MICA DE FÍSICA

Tropical Cyclones

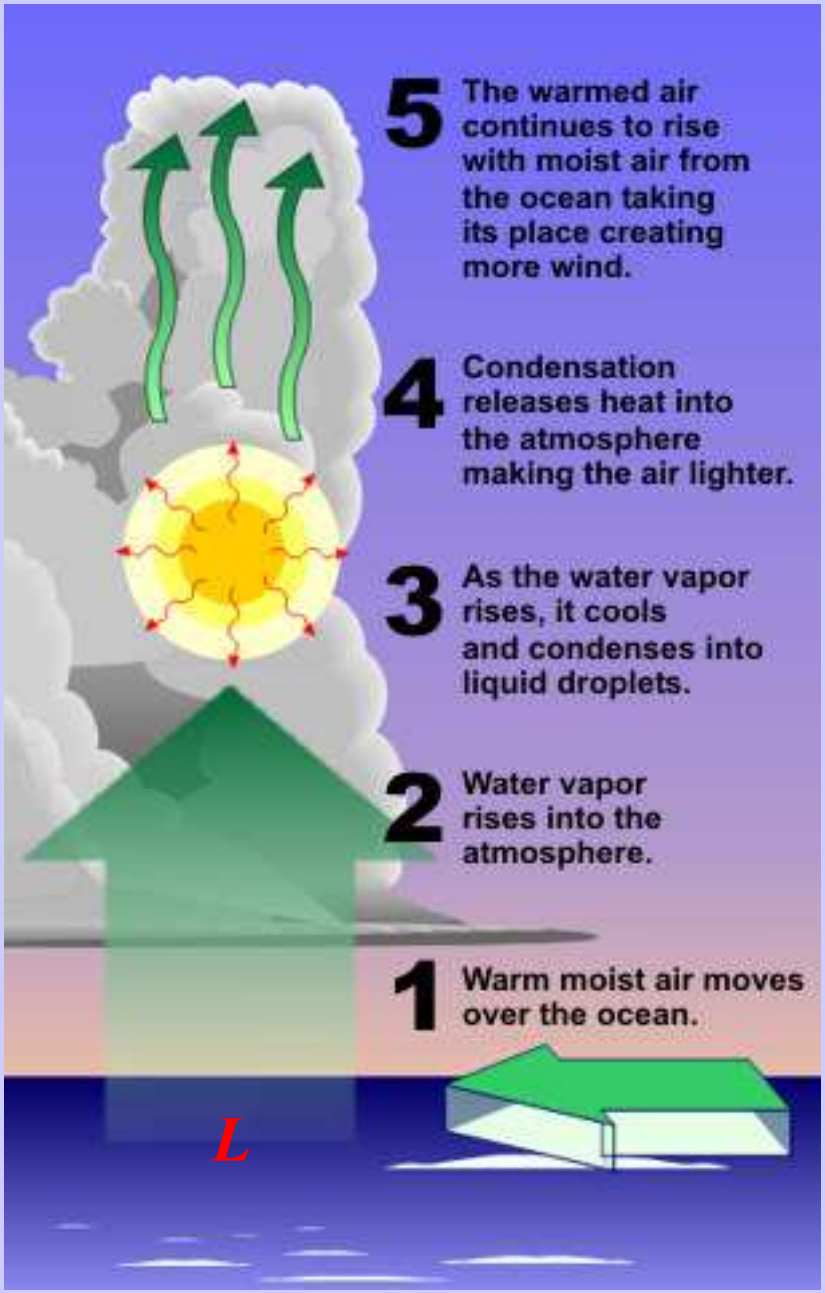
Huracán Sandy
(Octubre 2012)





Huracán Katrina (Agosto 2005)

Mecanismo Físico



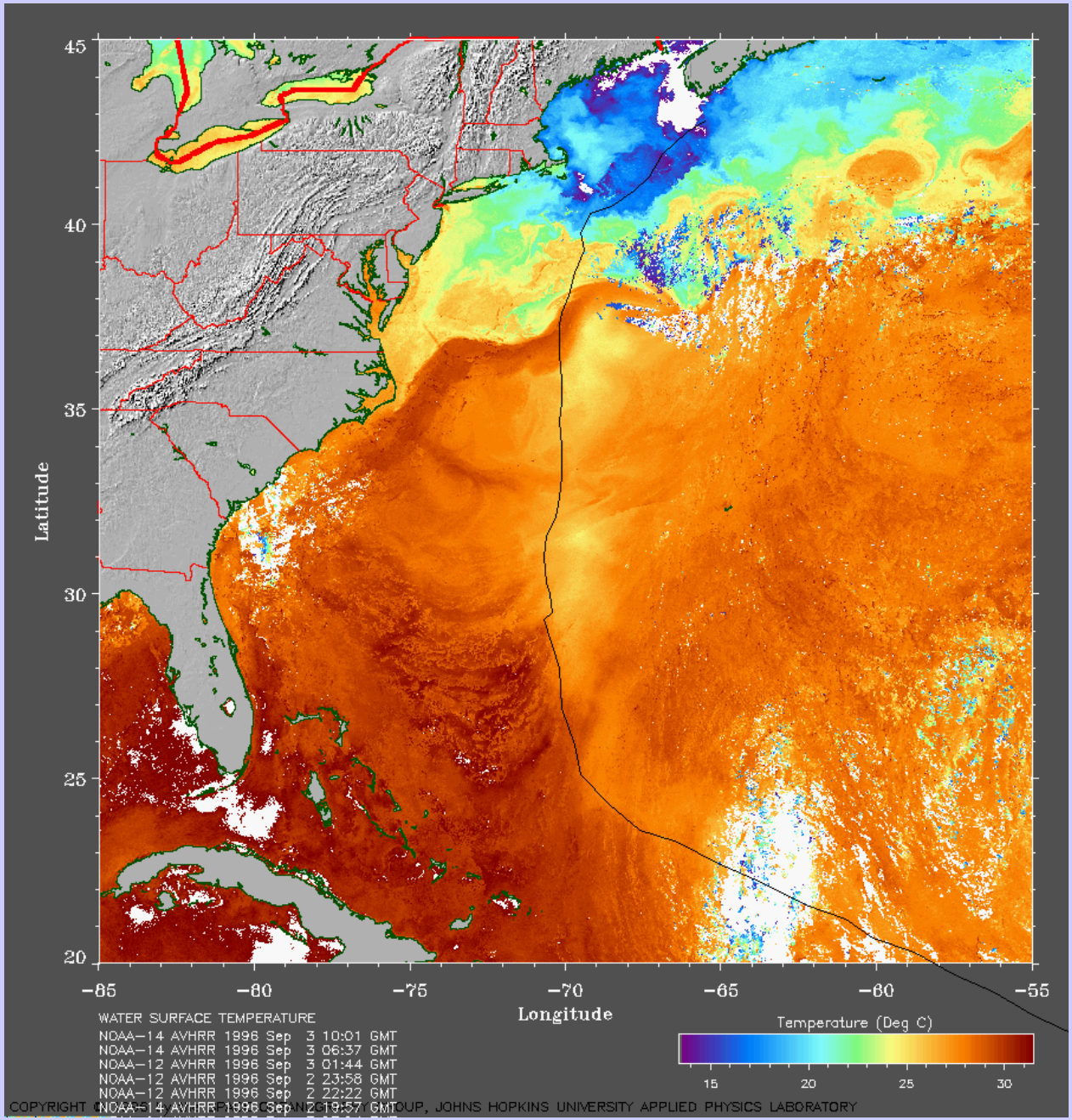
Saffir–Simpson hurricane wind scale

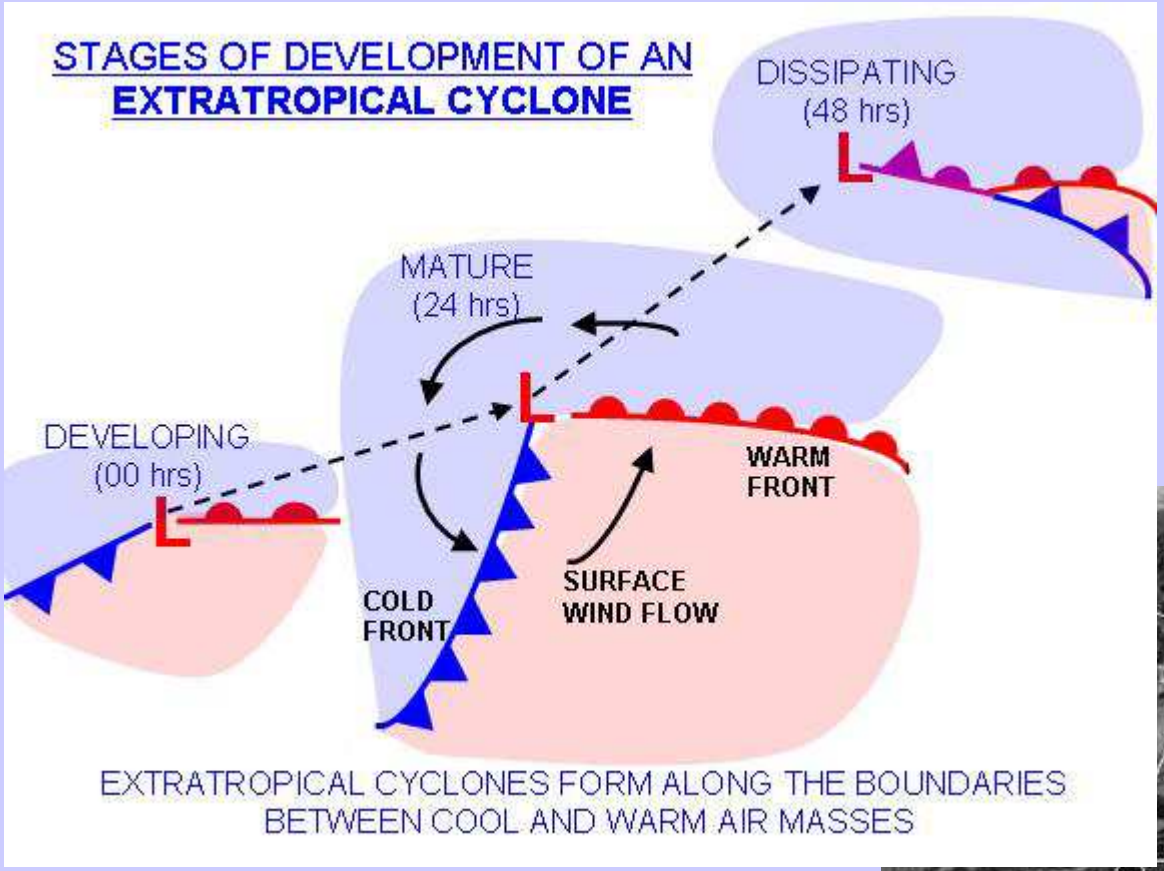
Category	Wind speeds
Five	≥70 m/s, ≥137 knots ≥157 mph, ≥252 km/h
Four	58–70 m/s, 113–136 knots 130–156 mph, 209–251 km/h
Three	50–58 m/s, 96–112 knots 111–129 mph, 178–208 km/h
Two	43–49 m/s, 83–95 knots 96–110 mph, 154–177 km/h
One	33–42 m/s, 64–82 knots 74–95 mph, 119–153 km/h

Related classifications

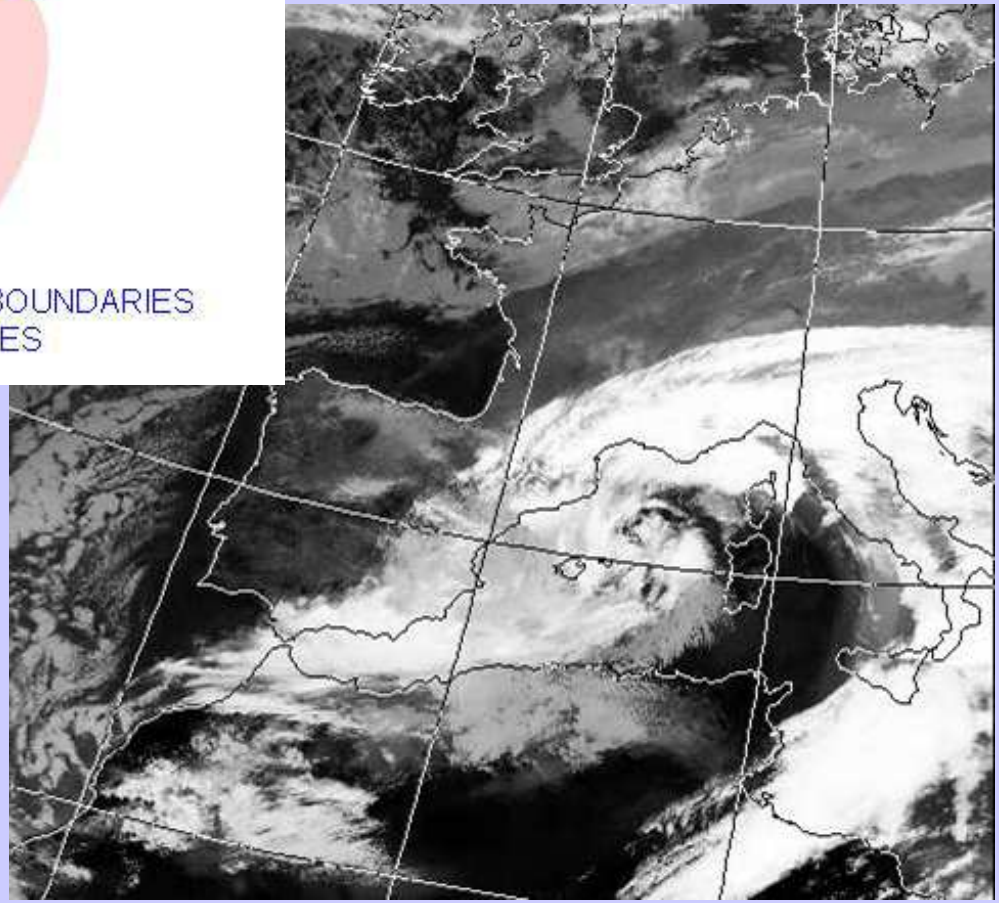
Tropical storm	18–32 m/s, 34–63 knots 39–73 mph, 63–118 km/h
Tropical depression	≤17 m/s, ≤33 knots ≤38 mph, ≤62 km/h

Redistribución de Calor en la VERTICAL





Redistribución de Calor en la HORIZONTAL



Ciclones Extratropicales

TEORÍA: Ciclón Tropical actúa como una Máquina Térmica (Ciclo de Carnot)

$$\rightarrow |V_{\max}|^2 \cong \frac{C_k}{C_D}\frac{T_s - T_o}{T_o}\left(k_0^* - k\right)$$

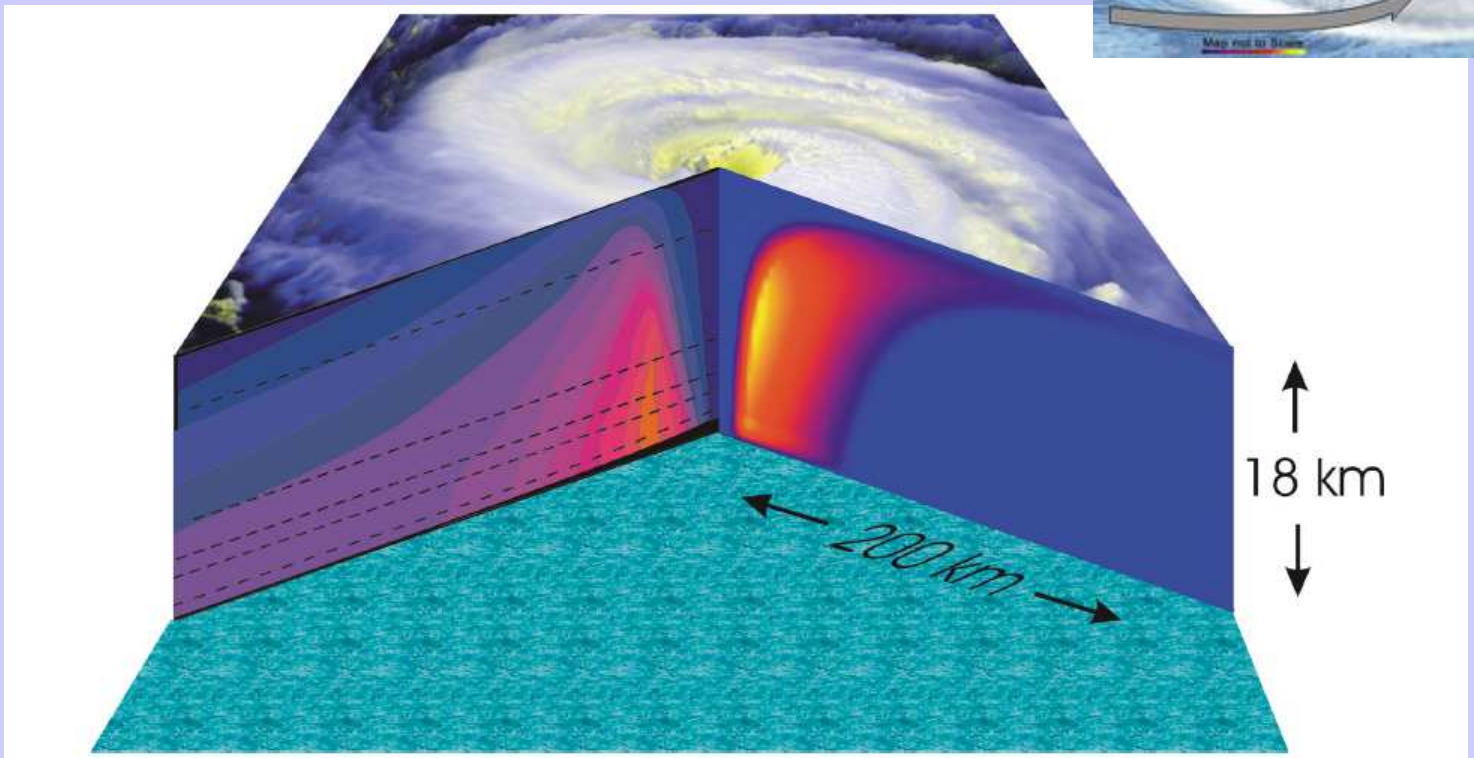
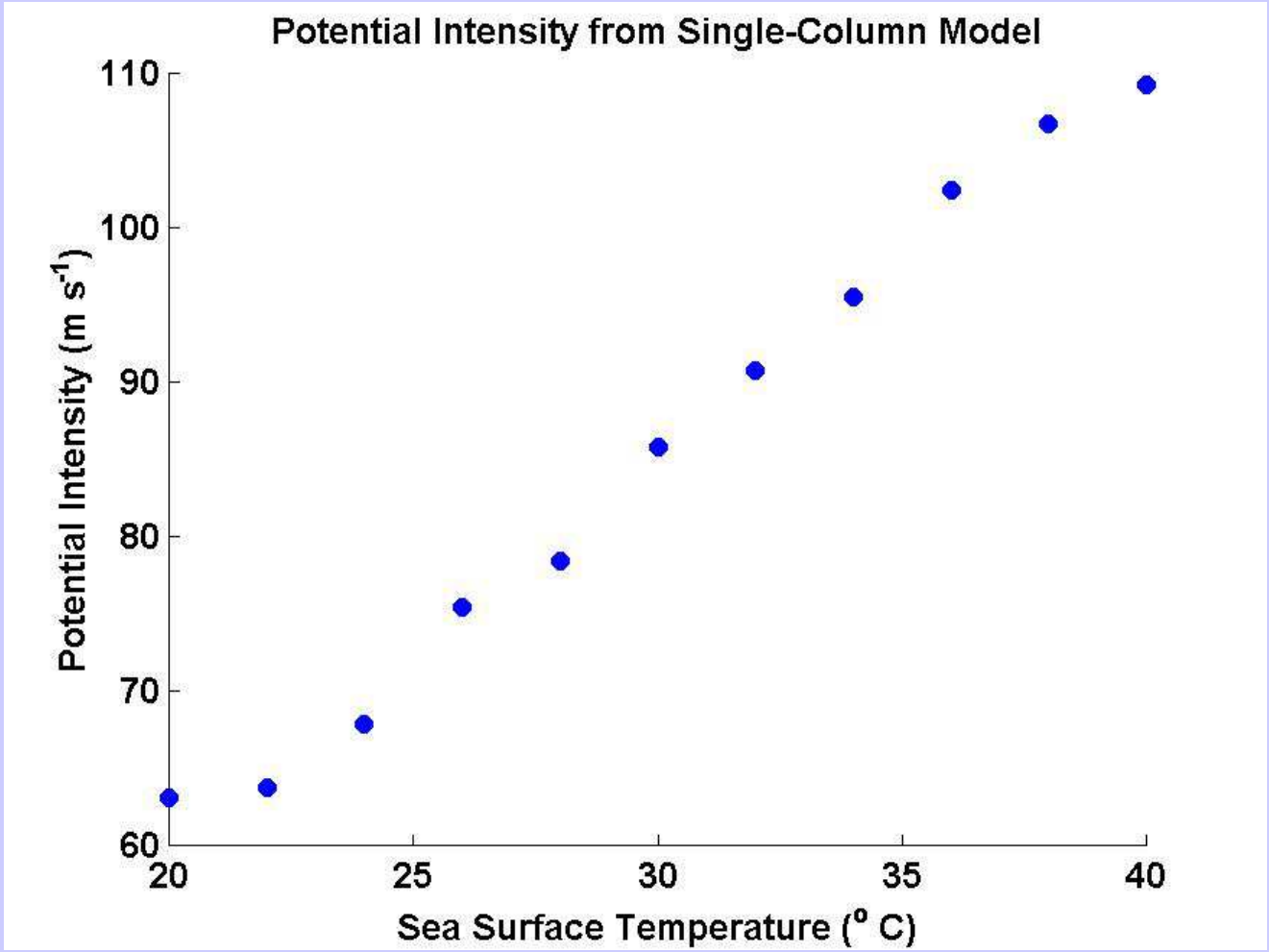


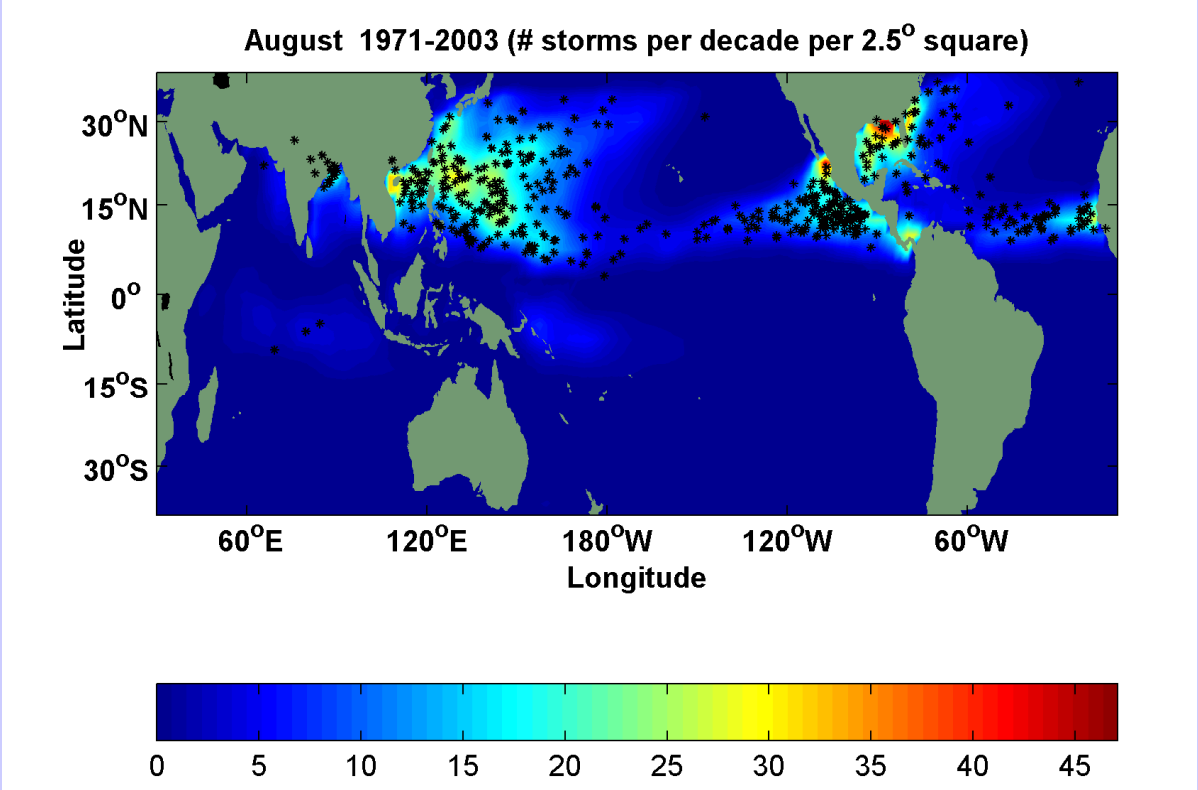
Figure 3 Cutaway view of the structure of a tropical cyclone. The top of the storm is based on a satellite photograph of the cloud structure of Hurricane Fran of 1996. The right-hand cut shows the vertical component of velocity, from a numerical simulation of a hurricane using the model of Emanuel (1995a); maximum values (yellow) are approximately 8 ms^{-1}. The left-hand cut shows the magnitude of the tangential wind component measured in Hurricane Inez of 1966 by aircraft flying at levels indicated by the black dashed lines; from Hawkins & Imbembo (1976). Maximum values are approximately 50 ms^{-1}.

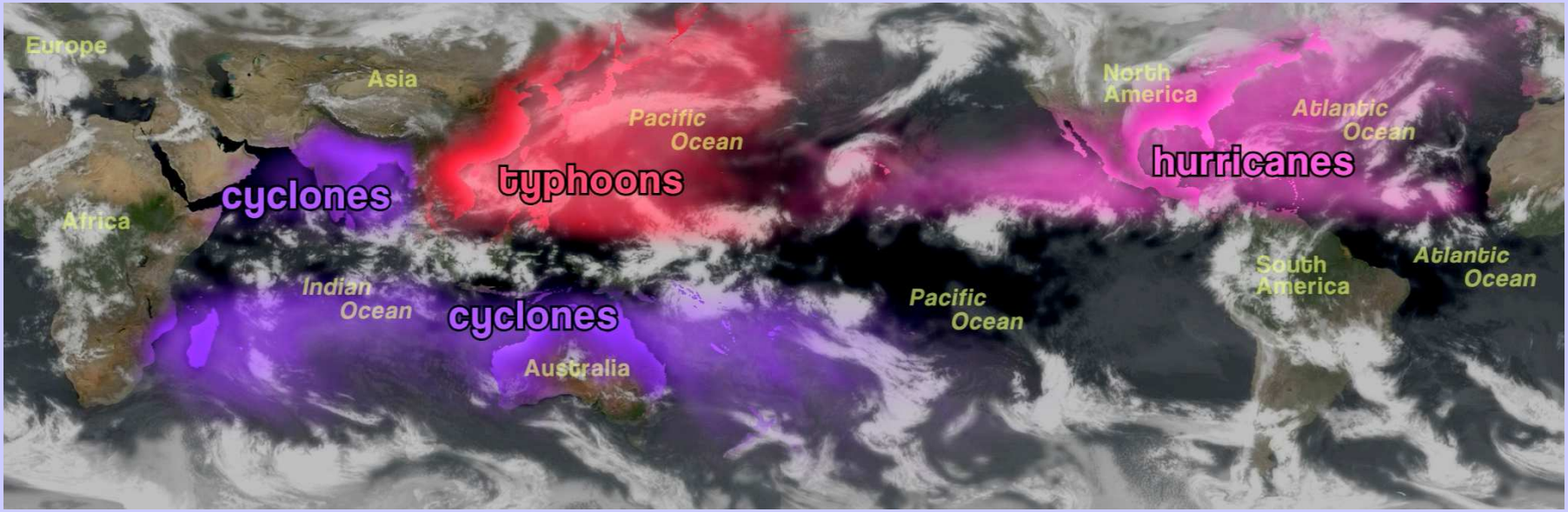
TEORÍA: La Intensidad Potencial Aumenta con la SST (Emanuel, 1987)

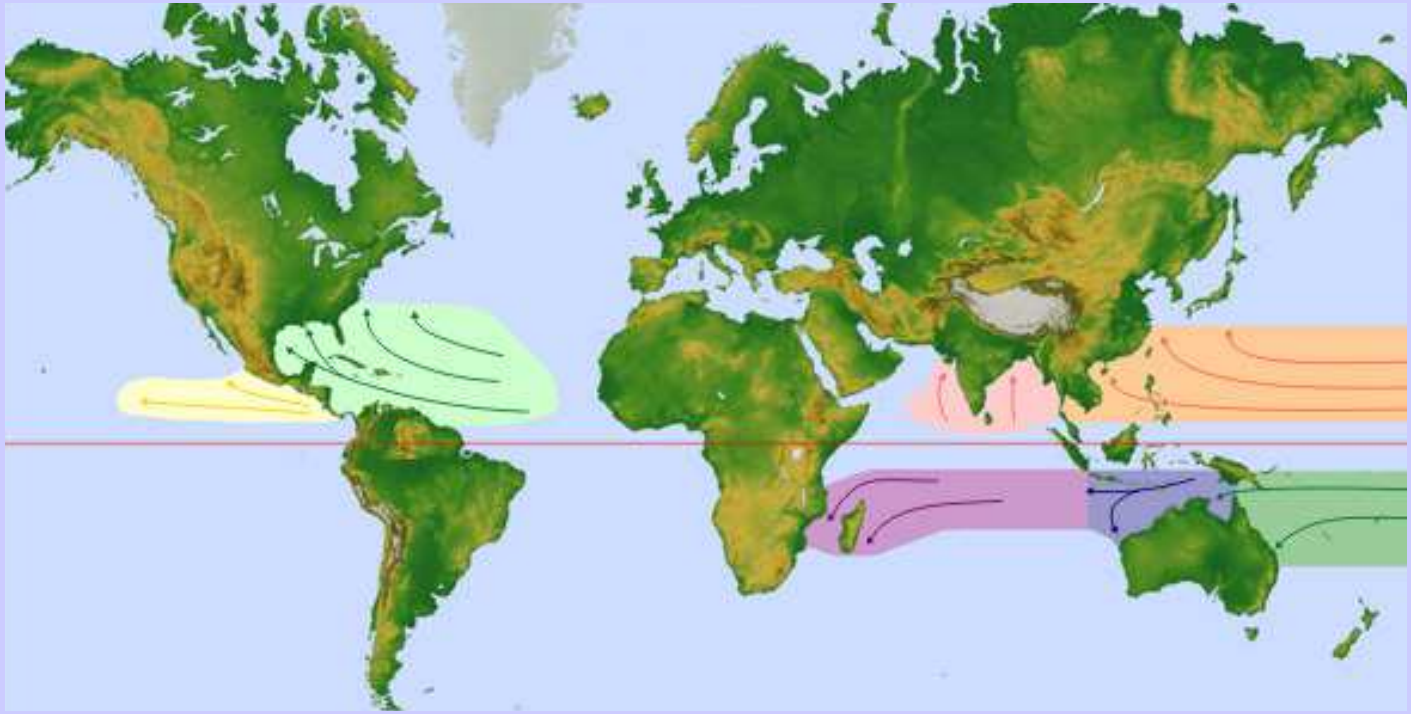


Índice Empírico de Génesis

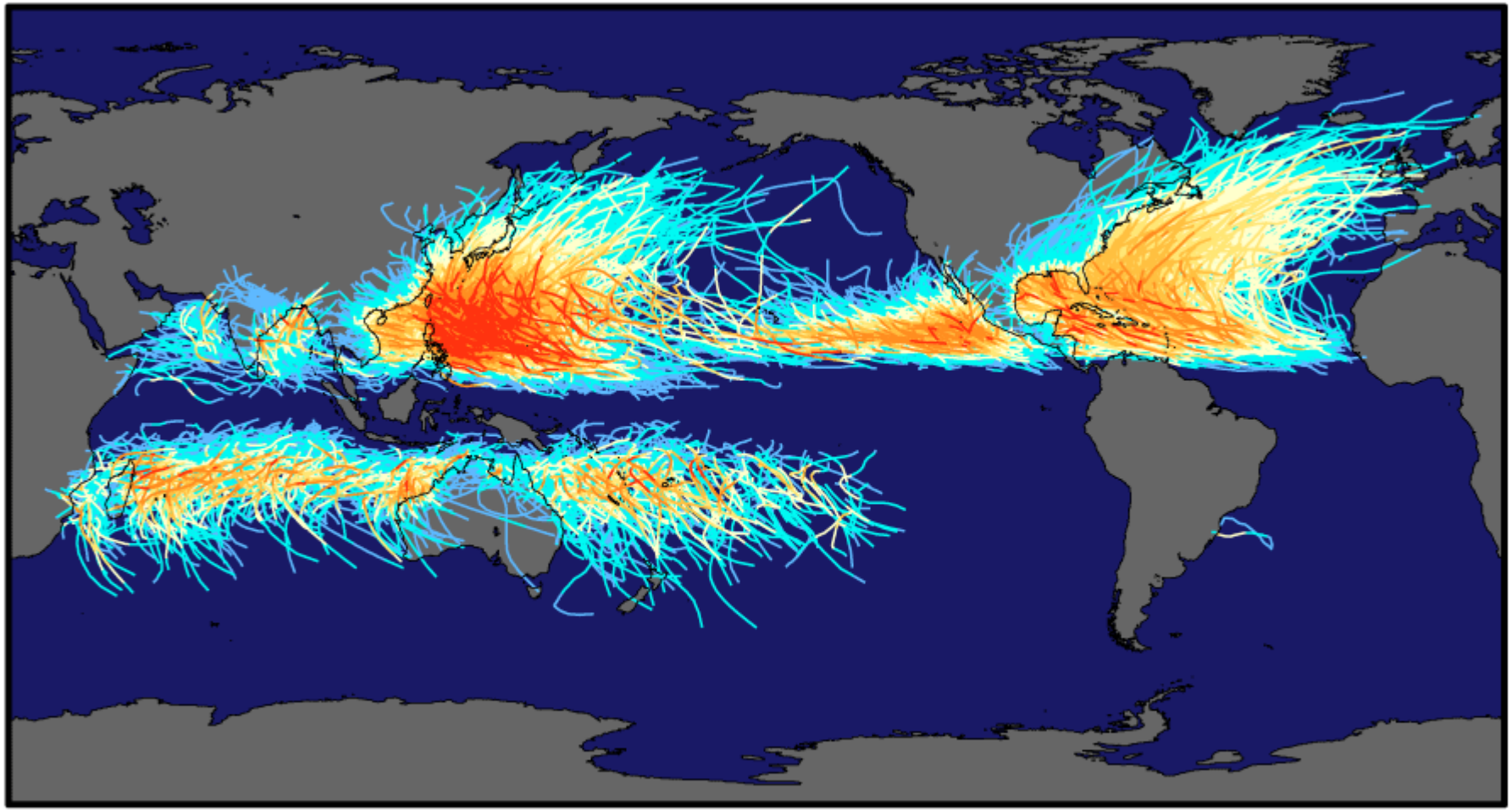
$$I = \left| 10^5 \eta \right|^{3/2} \left(\frac{H}{50} \right)^3 \left(\frac{V_{pot}}{70} \right)^3 \left(1 + 0.1 V_{shear} \right)^{-2},$$




Europe
Asia
Pacific Ocean
North America
Atlantic Ocean
cyclones
typhoons
hurricanes
Africa
Indian Ocean
cyclones
Pacific Ocean
South America
Atlantic Ocean
Australia



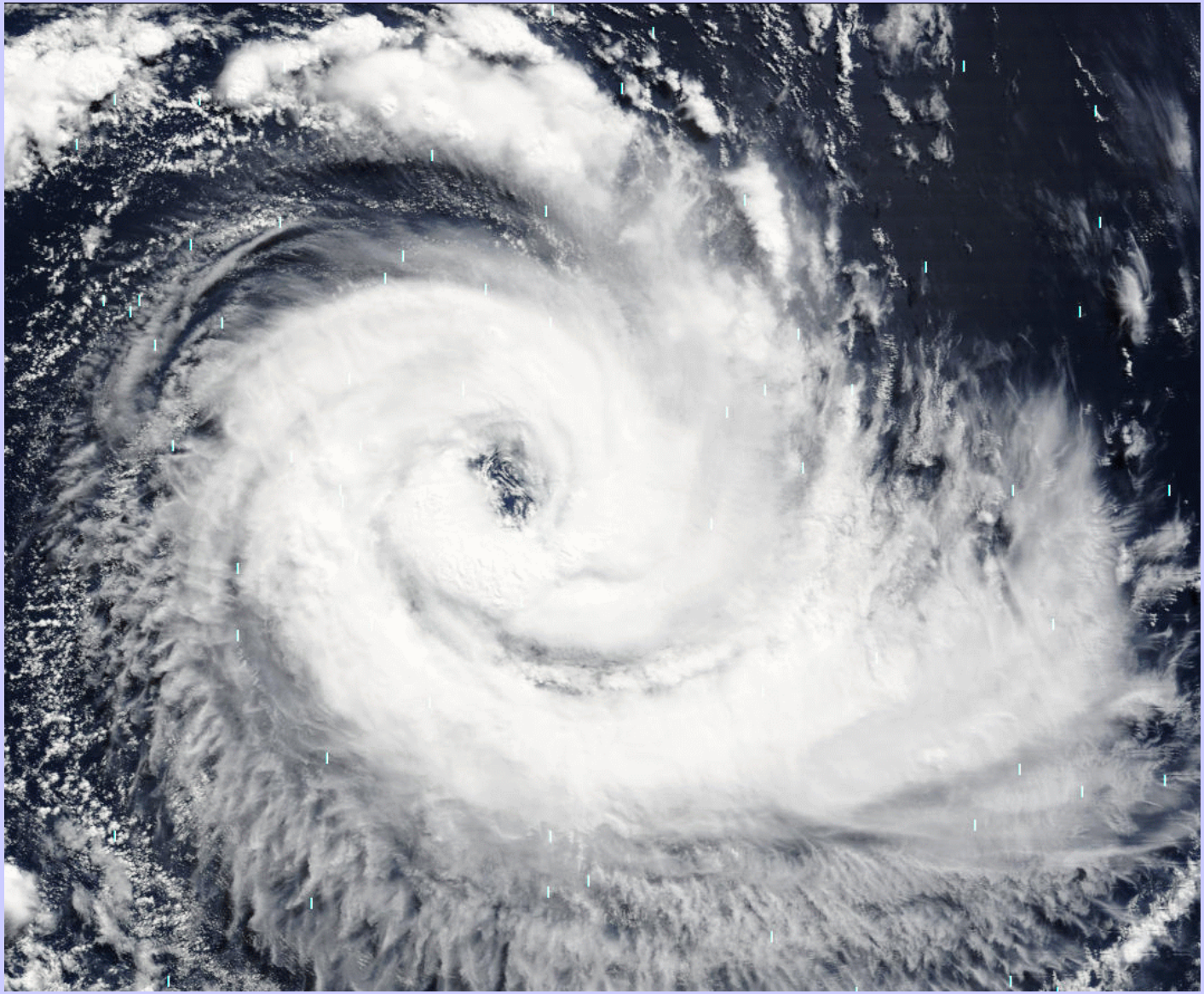
Tracks and Intensity of All Tropical Storms



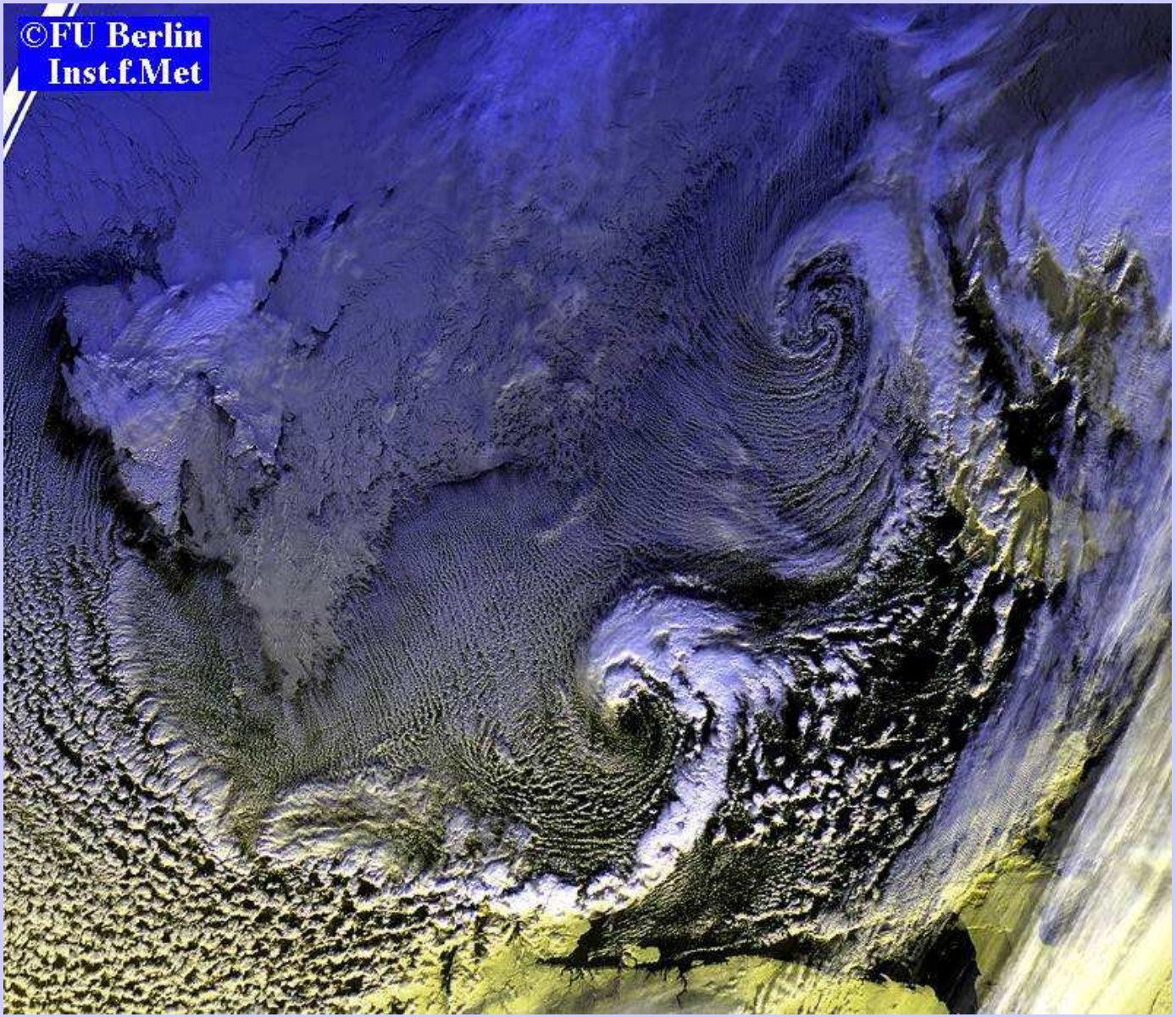
TD | TS | 1 | 2 | 3 | 4 | 5

Saffir-Simpson Hurricane Intensity Scale

Huracán Catalina (Brasil, marzo 2004), formado a partir de una depresión fría en altura



Bajas Polares



MEDICANES

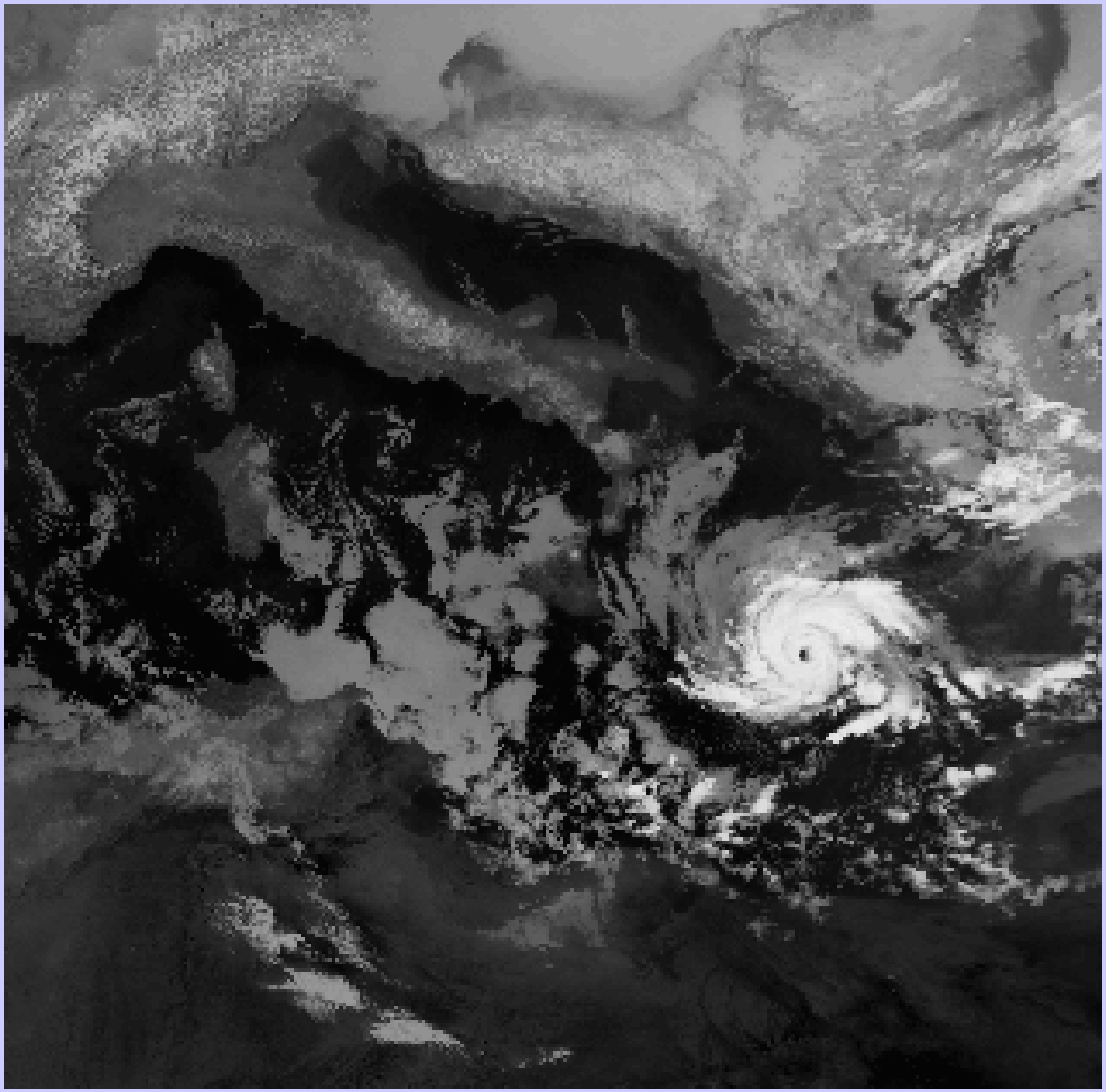
(miniciclones, ciclones cuasi/sub-tropicales …)

- **~1-2 por año** en el conjunto de la cuenca mediterránea, rara vez alcanzando la categoría de huracán (120 km/h).

- Típicamente, se forman bajo el efecto de una **depresión fría y aislada** en los niveles medio-altos de la troposfera.

- Se sustentan en el elevado desequilibrio termodinámico **aire-mar** propiciado por la perturbación primaria. Son más frecuentes en **otoño**.

Medicane del 15-17 Enero 1995



MEDICANES (locals): OBSERVACIONS I SIMULACIONS

www.uib.es/depart/dfs/meteorologia/METEOROLOGIA/MEDICANES

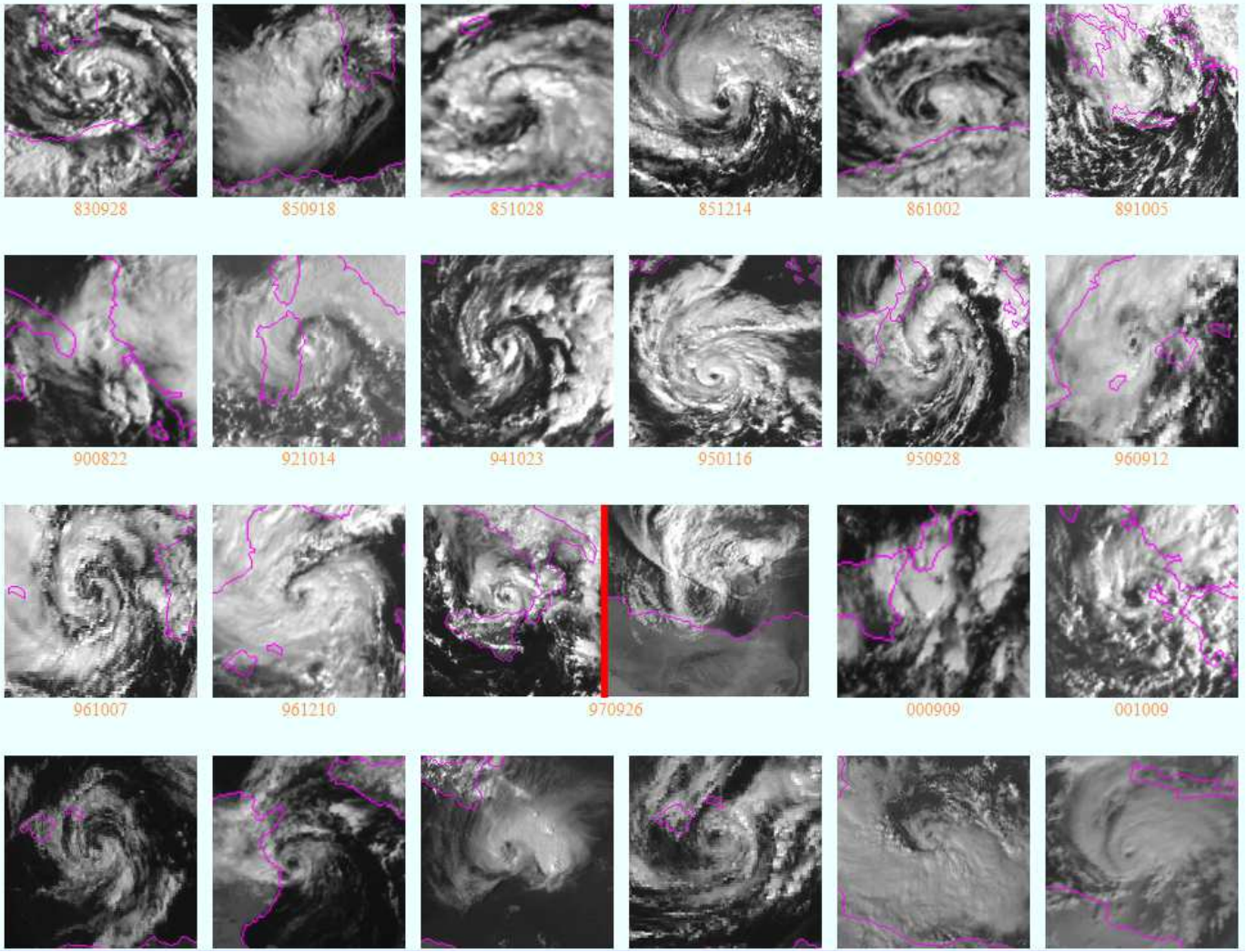
Grup de Meteorologia
Departament de Física

MEDICANES: Mediterranean tropical-like storms

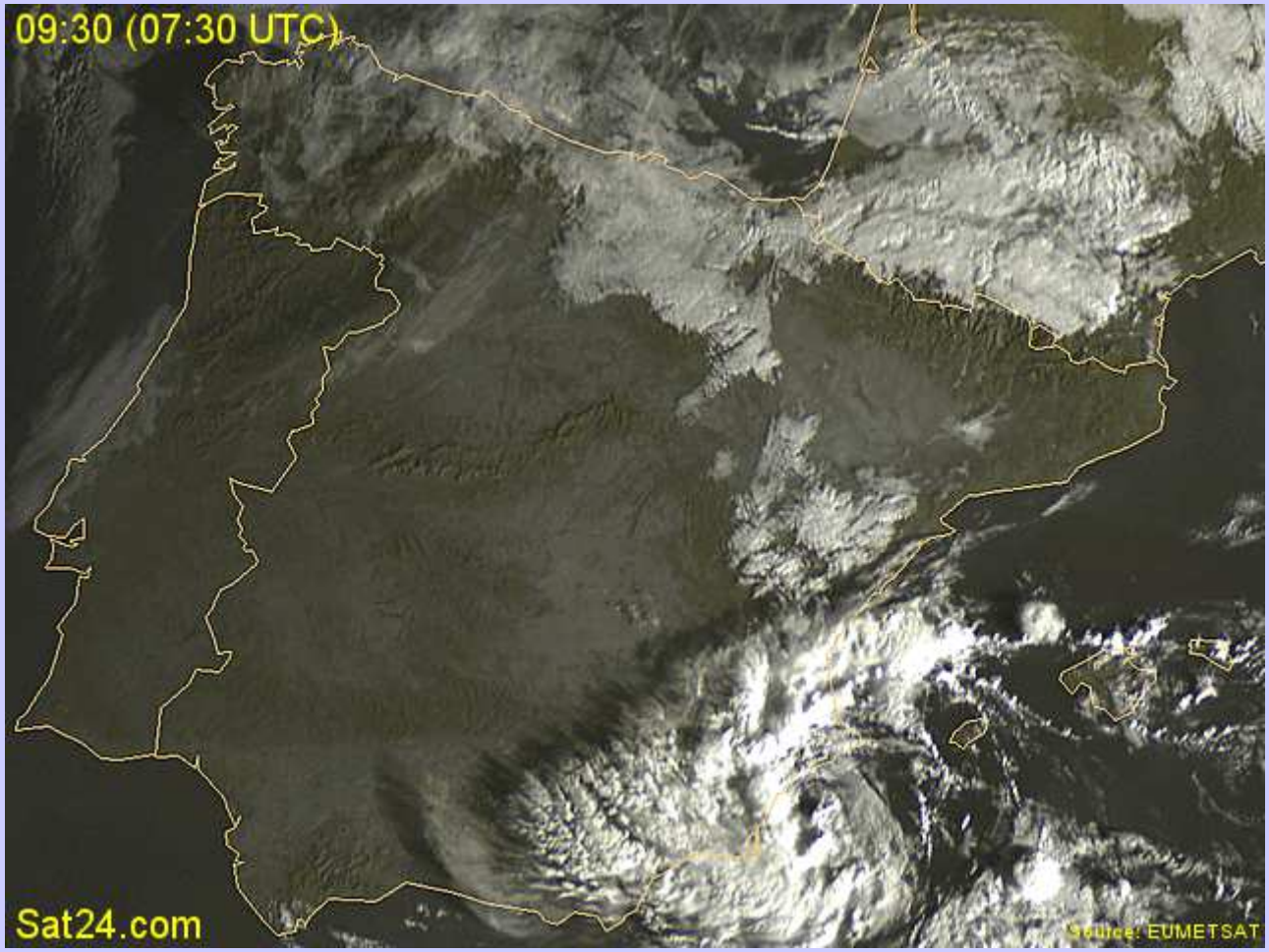
Lluís Fita @

* Satellite images thanks to:
Angel Luque
* List of cases thanks to:
D. Bianchino, K. Emanuel, Iuka Milevoj and Wikipedia
* Schematic-animations thanks to:
Lorena Garcies
* Barographs thanks to:
INM-Centre Meteorològic a les Illes Balears
* QuickScat winds thanks to:
Remote Sensing Systems
* Synoptic environment thanks to:
European Centre for Medium-Range Weather Forecasts (ECMWF)

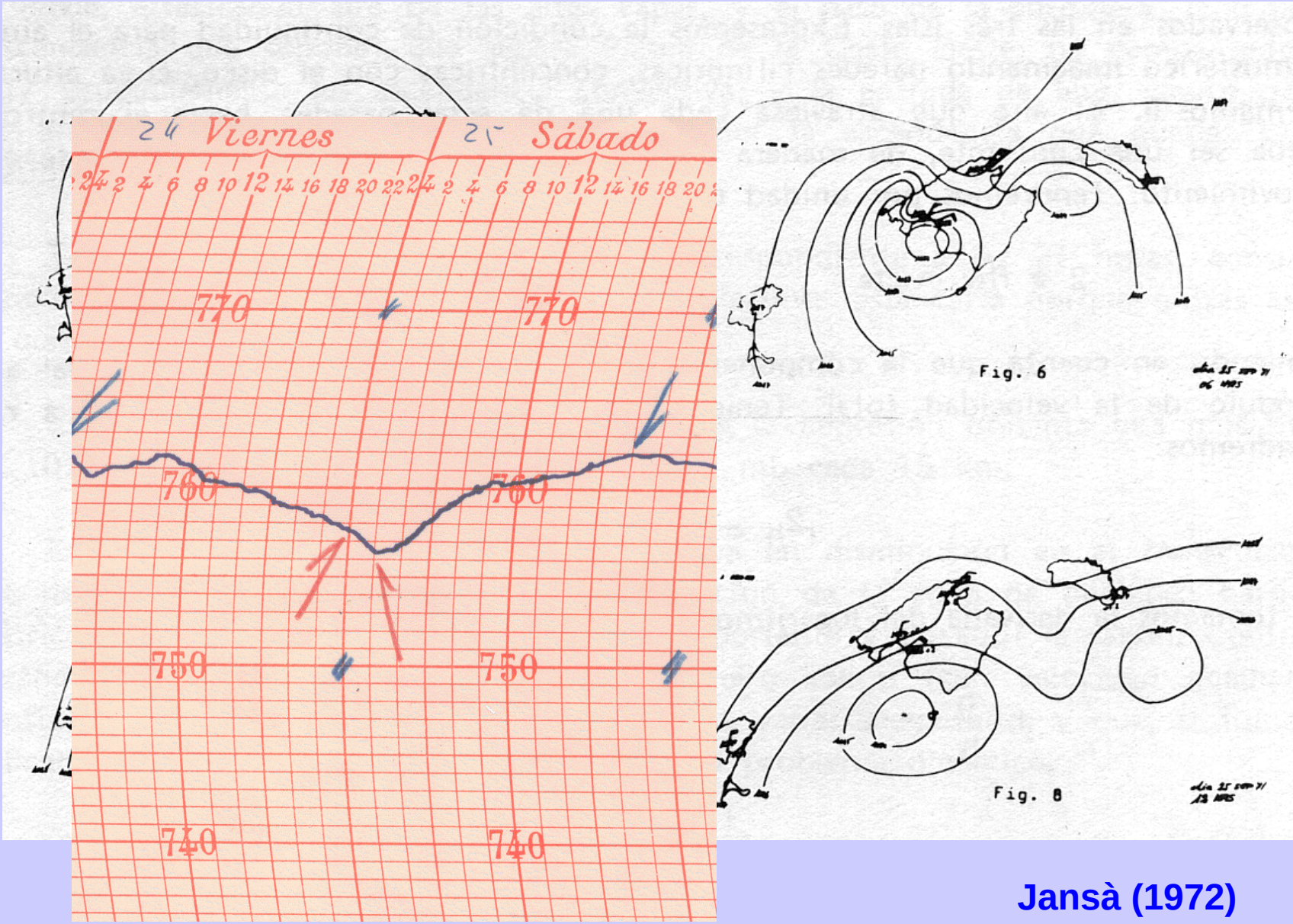
Grup de Meteorologia
Departament de Física



Medicane del 18 Octubre 2007

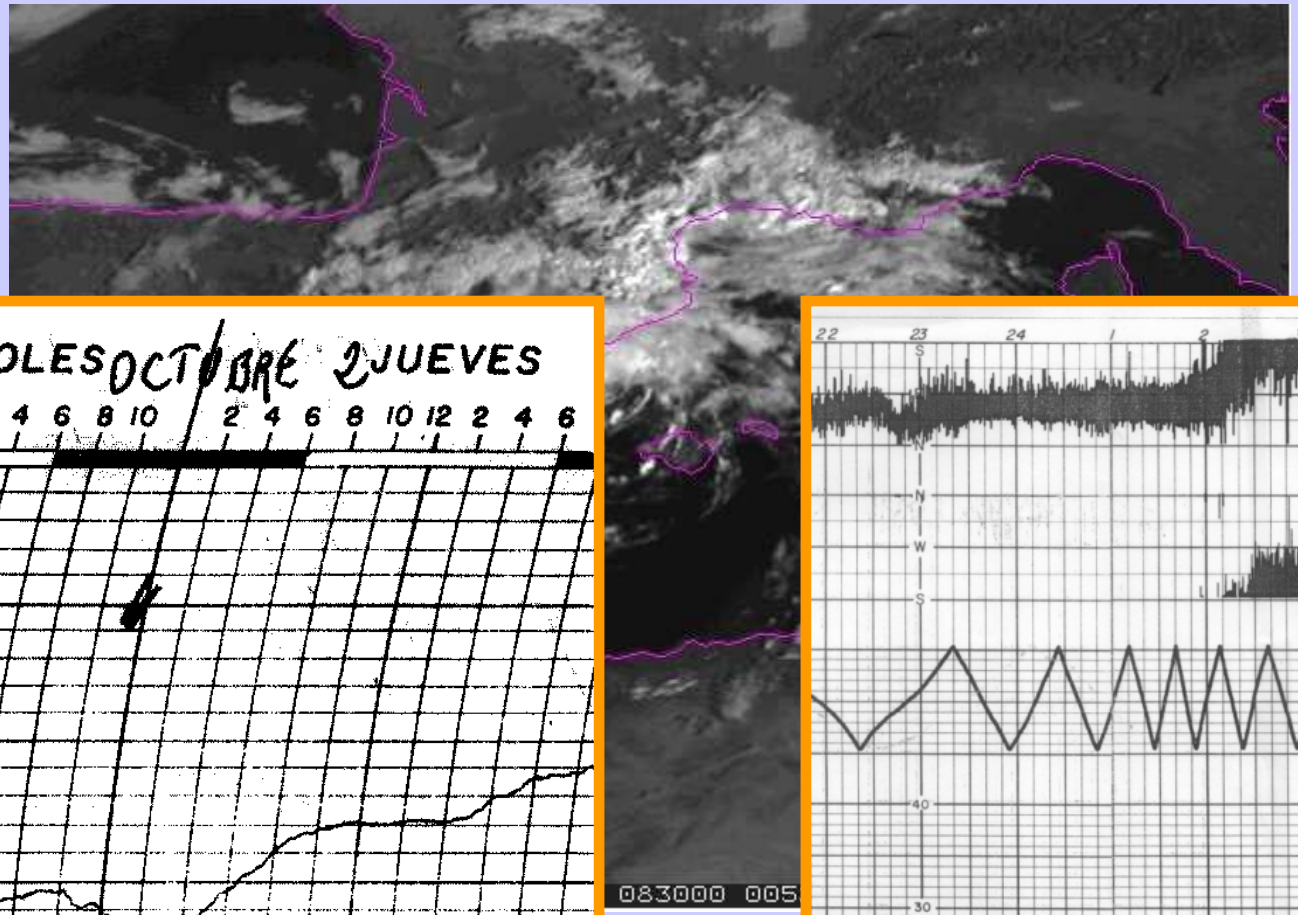


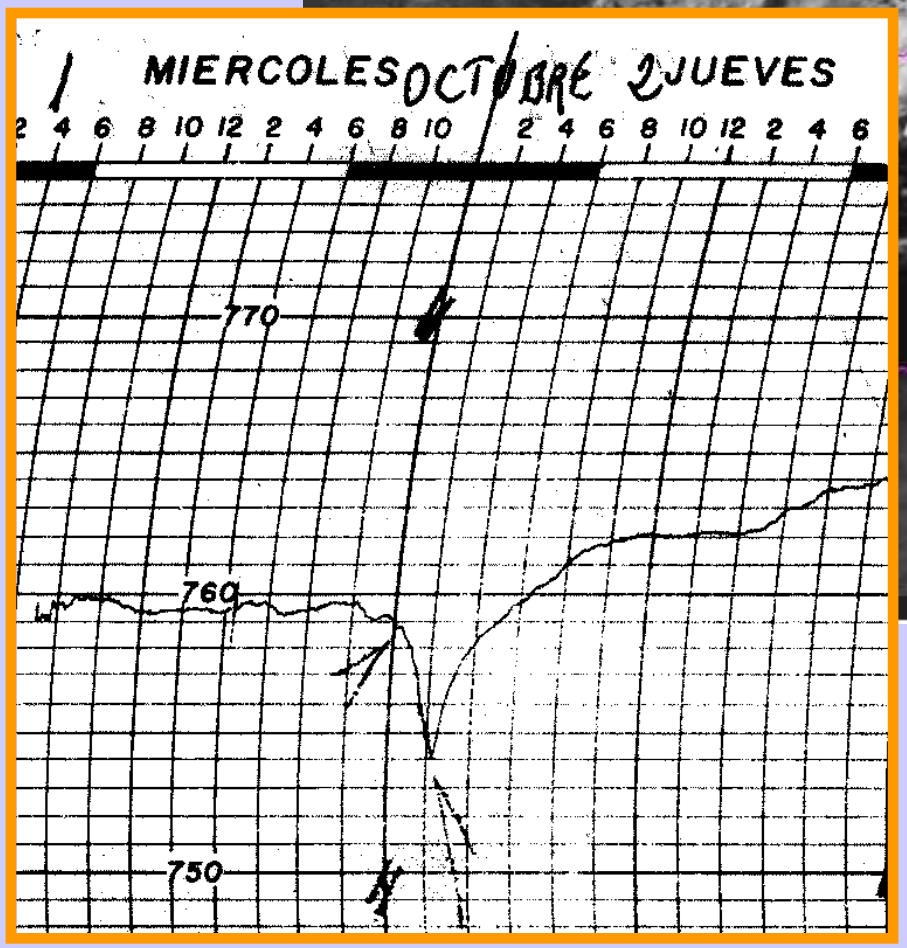
Medicane del 24-25 Septiembre 1971 ???

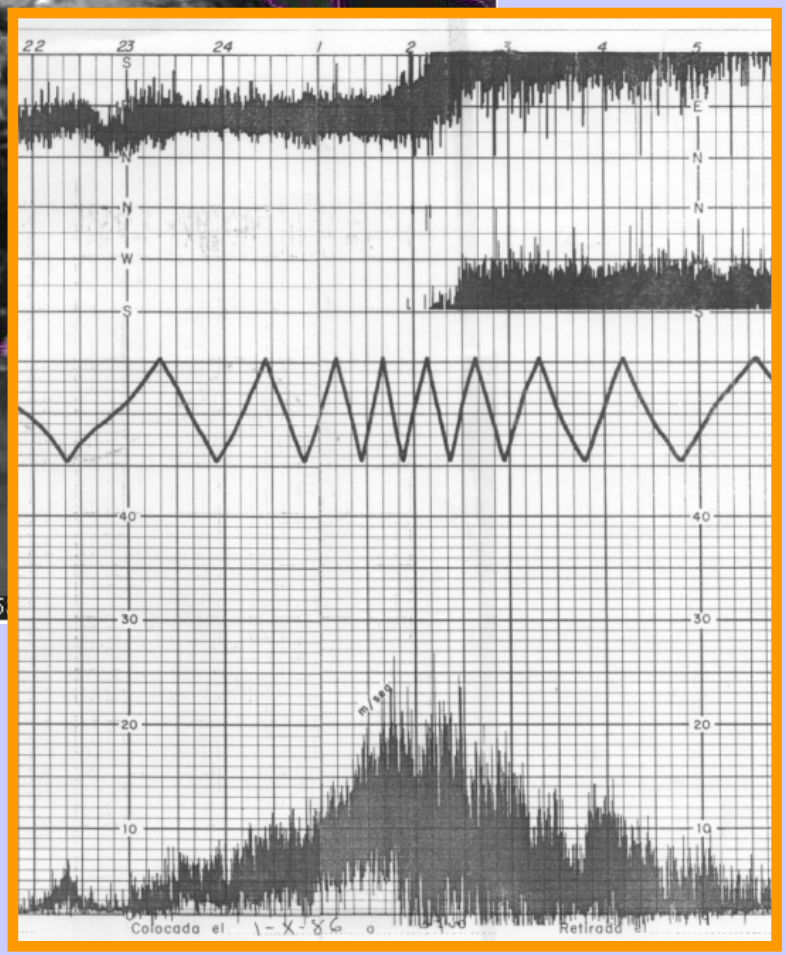


Jansà (1972)

Medicane del 2 Octubre 1986







Medicane del 2 Octubre 1986

Diario de Ma

Palma, viernes 3 de octubre de 1986

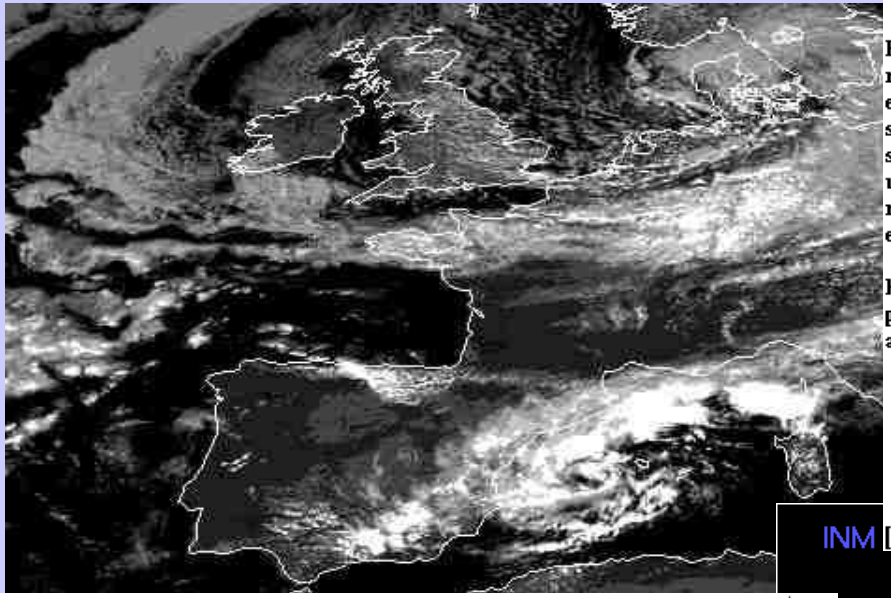
Las pérdidas, aunque no han sido evaluadas, podrían ascender a varios cientos de millones

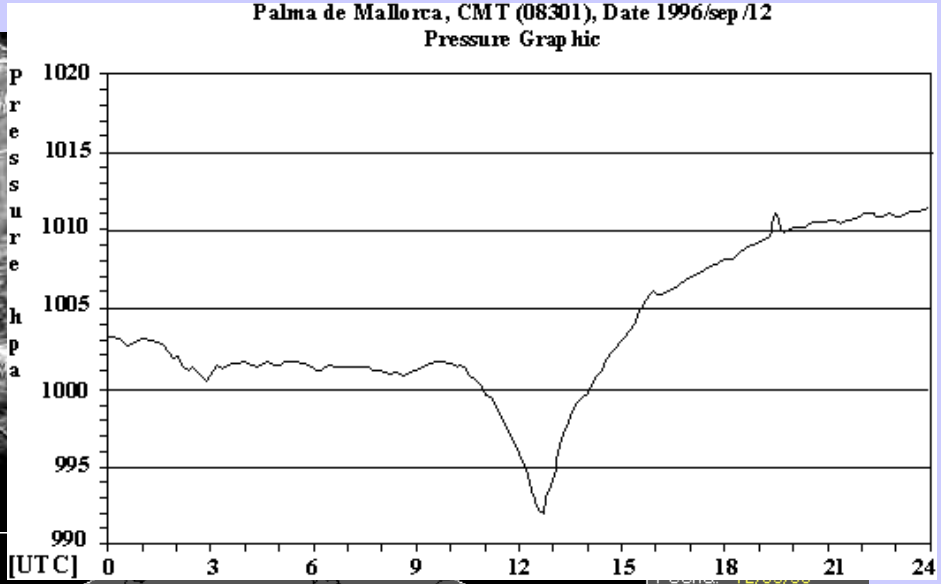
El ciclón destruyó unos veinte barcos de recreo en el Paseo Marítimo

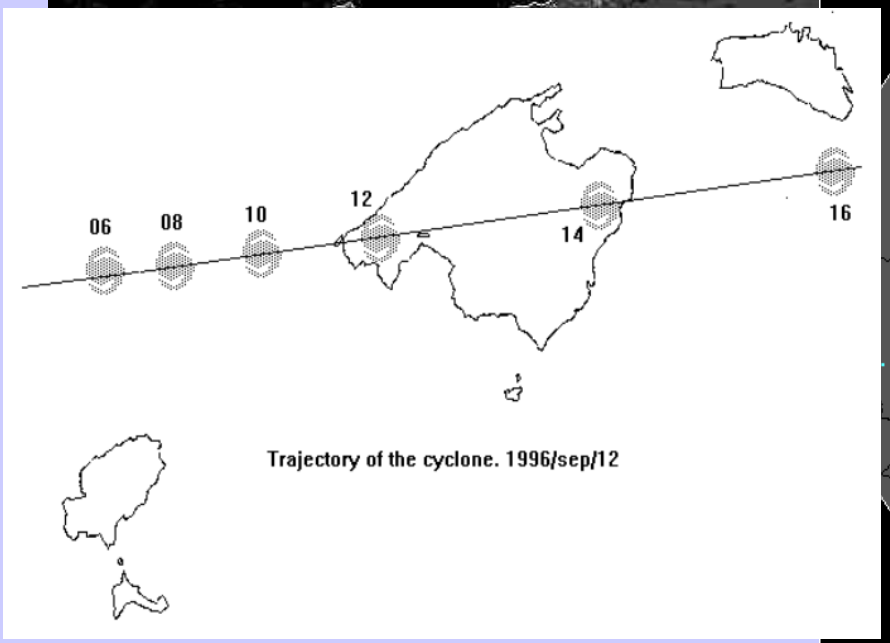
Mallorca se vió ayer sorprendida, a horas de la madrugada, con un viento do que llegó a alcanzar en ocasiones ló lómetros por hora, y que causó serios distintos puntos de la isla, afectando importante al Paseo Marítimo de Palma produjeron numerosos daños a una vei barcos allí amarrados. El viento comen. sar estragos en la isla alrededor de las madrugada. Los daños causados pese ber sido evaluados puden ascender a va tos de millones. El fuerte viento estuvo a acompañado de fuertes precipitaciones garon a alcanzar en la zona de Sóller los por metro cuadrado. Tanto los bomb Palma como los efectivos de la Policía M se vieron obligados a llevar a cabo un trabajo desde las tres de la madrugad bien entrada la tarde. Las previsiones, los bomberos como de la Unidad de Inte Inmediata, se vieron desbordadas, a c fenómeno climatológico. Dentro de P mayor actividad estuvo motivada por la árboles y postes del tendido eléctrico y te que afectaron a doce turismos aparcado cibir sobre sus carrocerías el impacto de ramas. Según las previsiones del Institut nal de Meteorología, la "gota fría" puede afectando a la isla en las próximas horas.

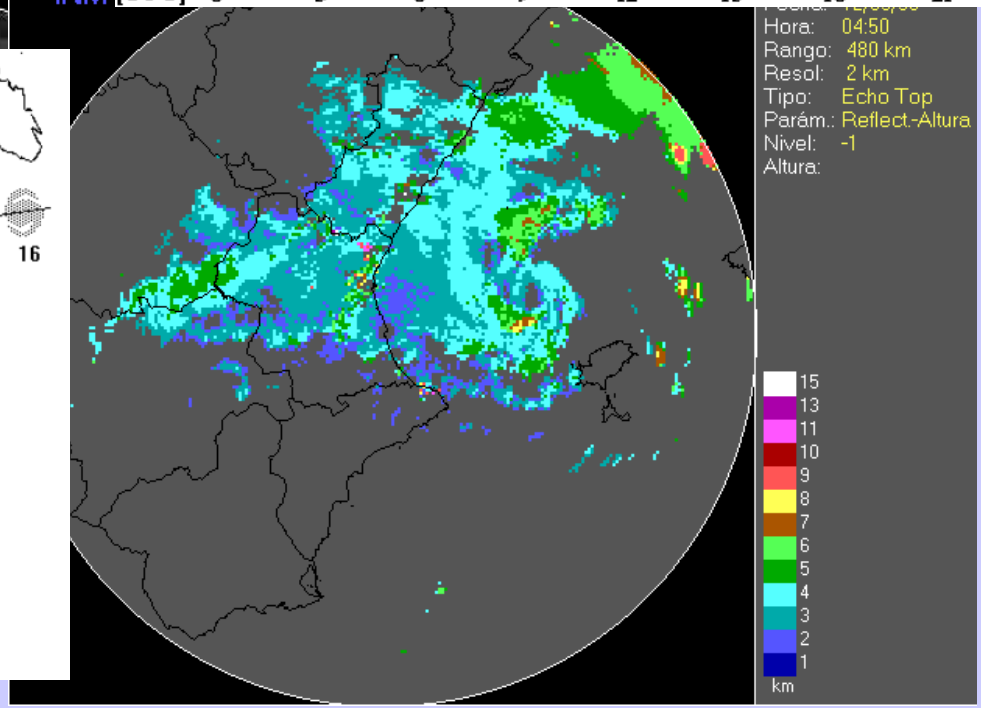
Destrozos en el puerto. – En el puerto el pequeño c causó estragos en embarcaciones. Algunas se hundiera otras, a causa de la fuerza del viento, rompieron amarras sufrir posteriores y violentas colisiones contra los pantalan otros barcos, resultaron seriamente dañadas. Igualmente ron dañadas las instalaciones de "Baleares Náutica", las les quedaron prácticamente desmanteladas. *(Foto Lorenzo)*

Medicane del 12 de Septiembre 1996





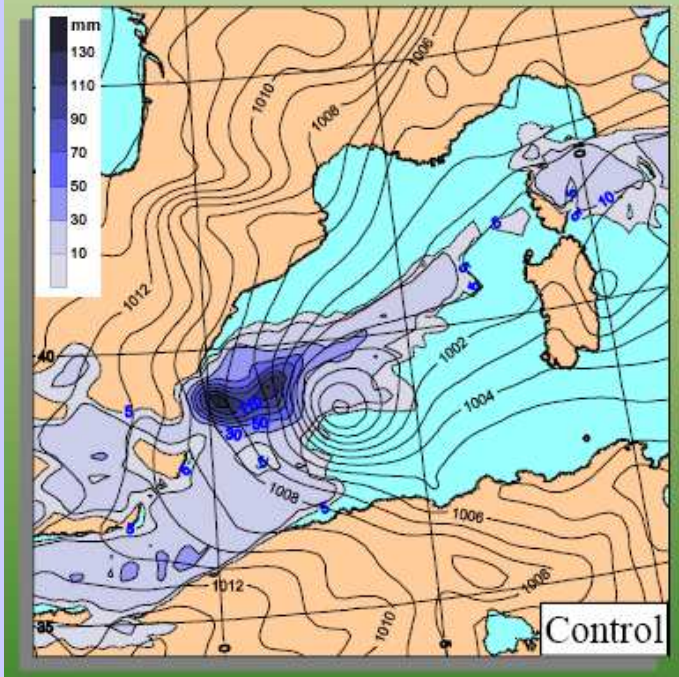


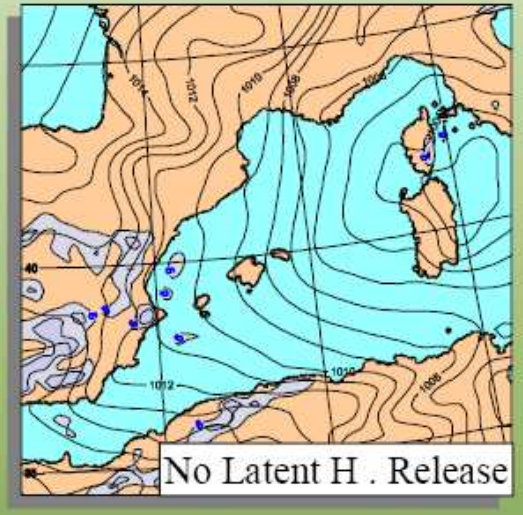


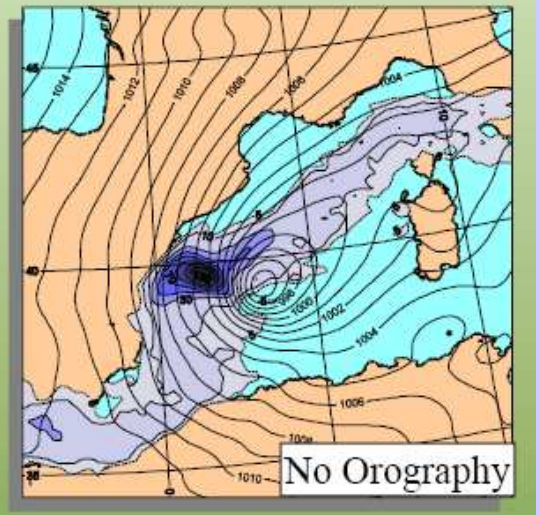
Medicane del 12 de Septiembre 1996

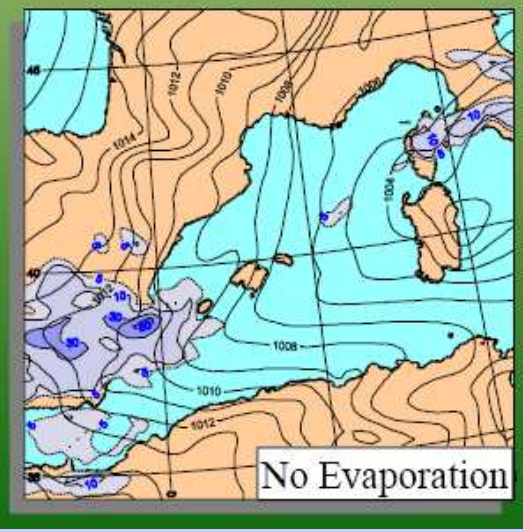
Sensitivity

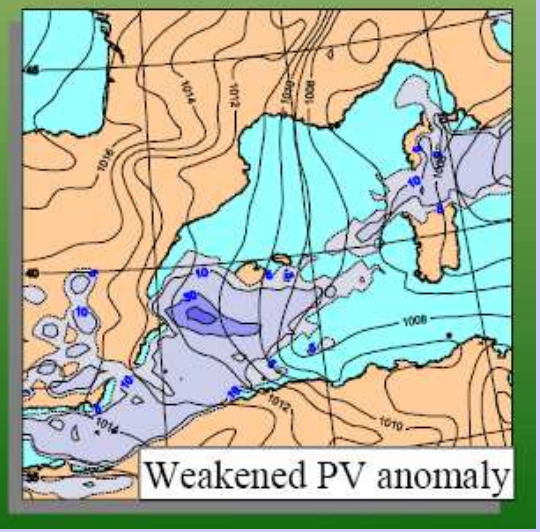
- Results of the sensitivity experiments in terms of surface pressure and accumulated precipitation at 1200 UTC:





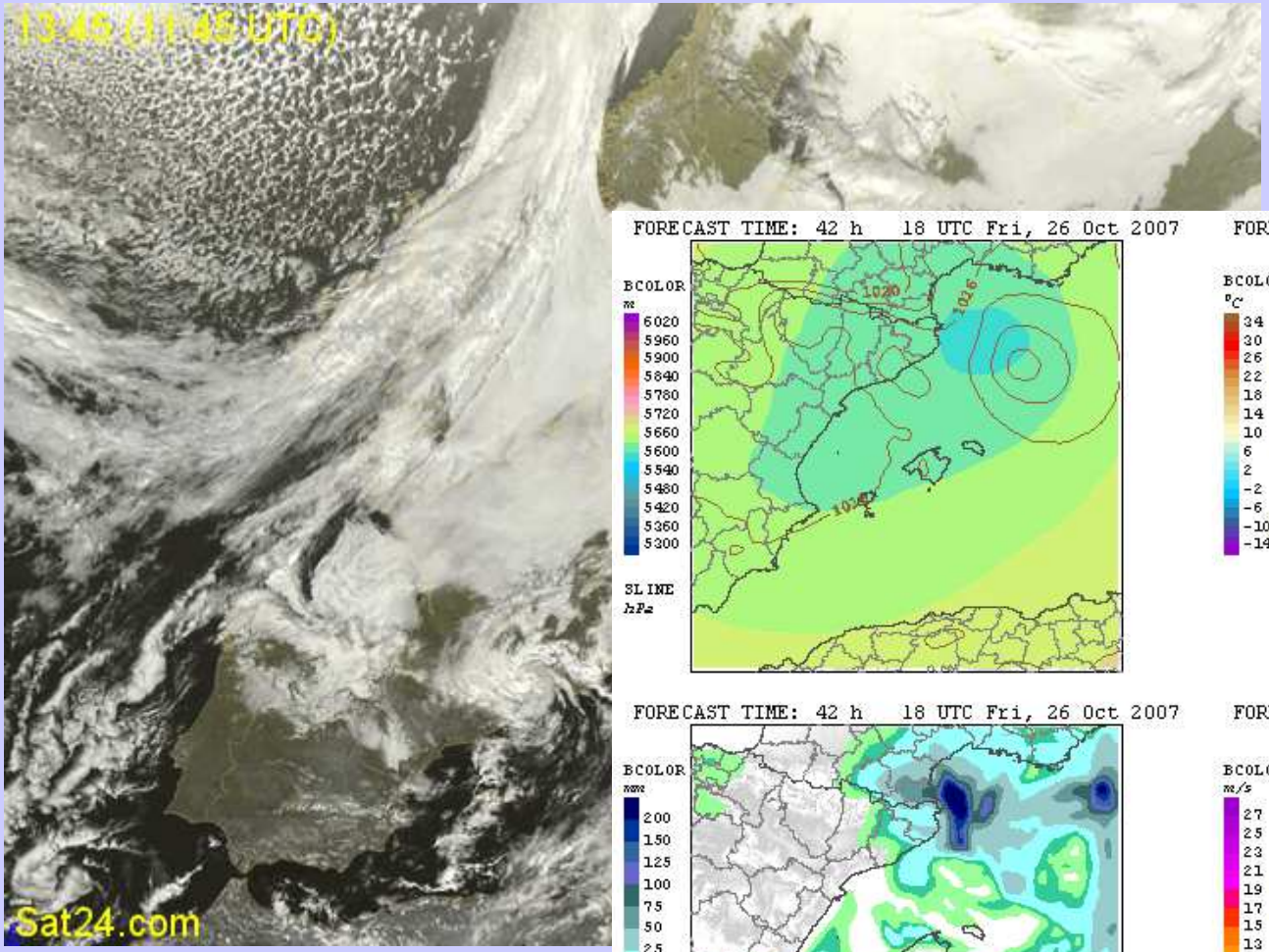


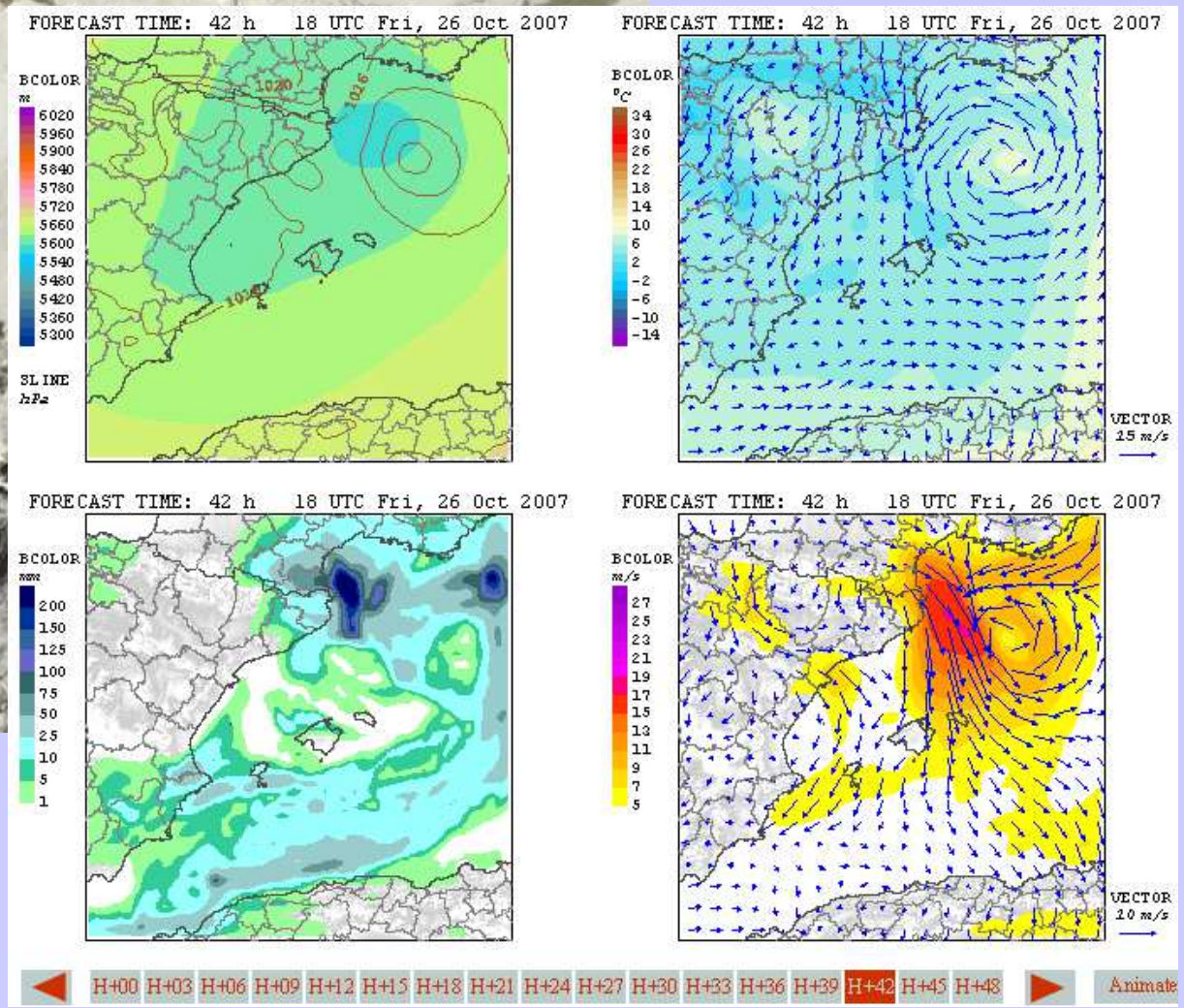




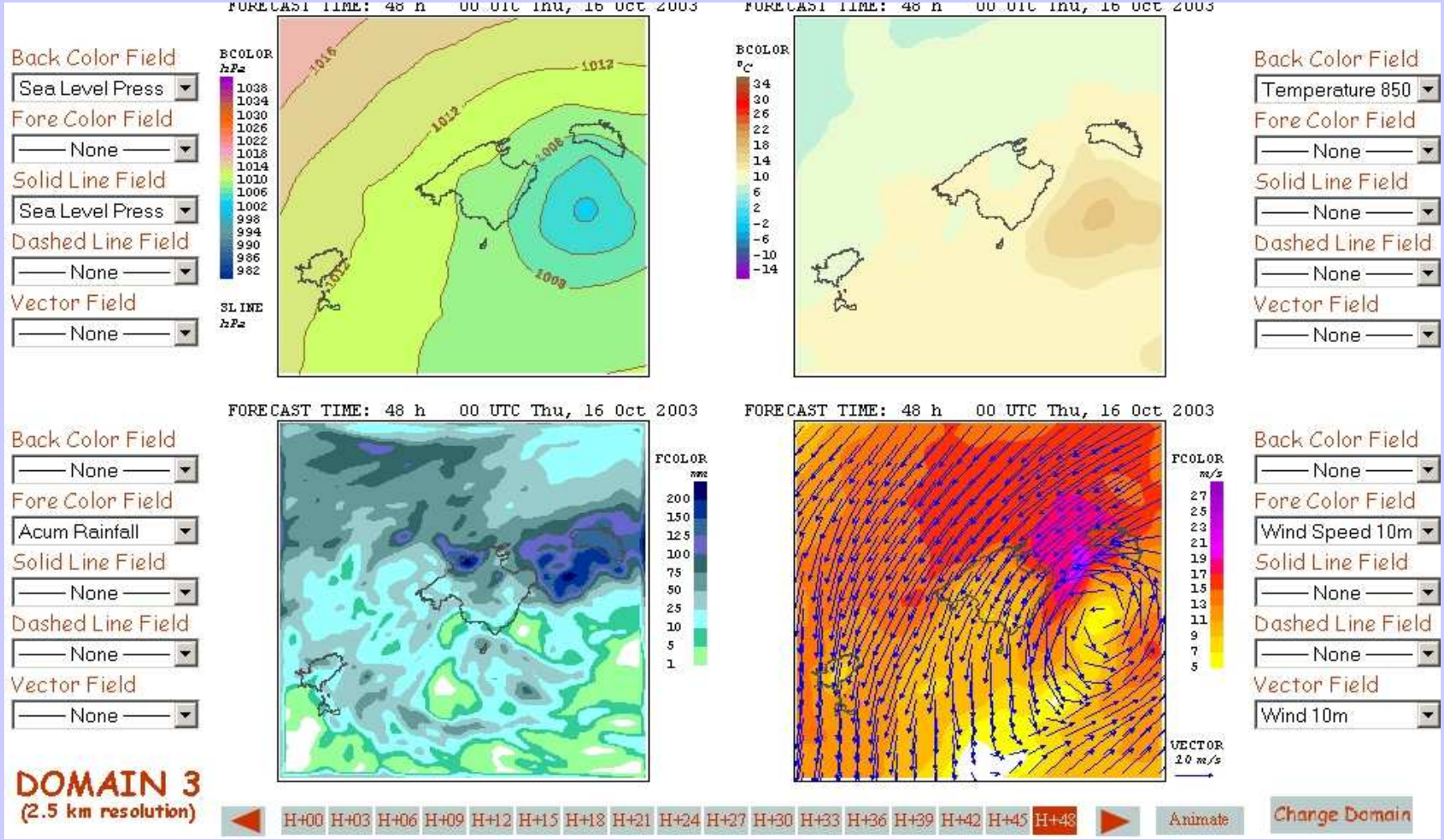
Homar et al. (2003)

Medicane del 26 Octubre 2007

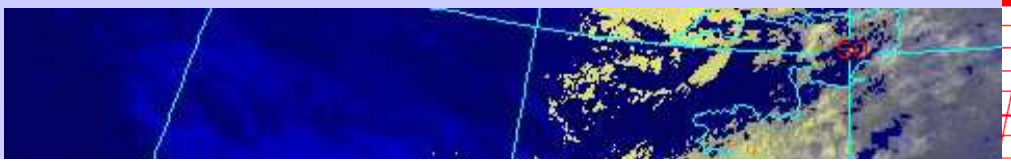


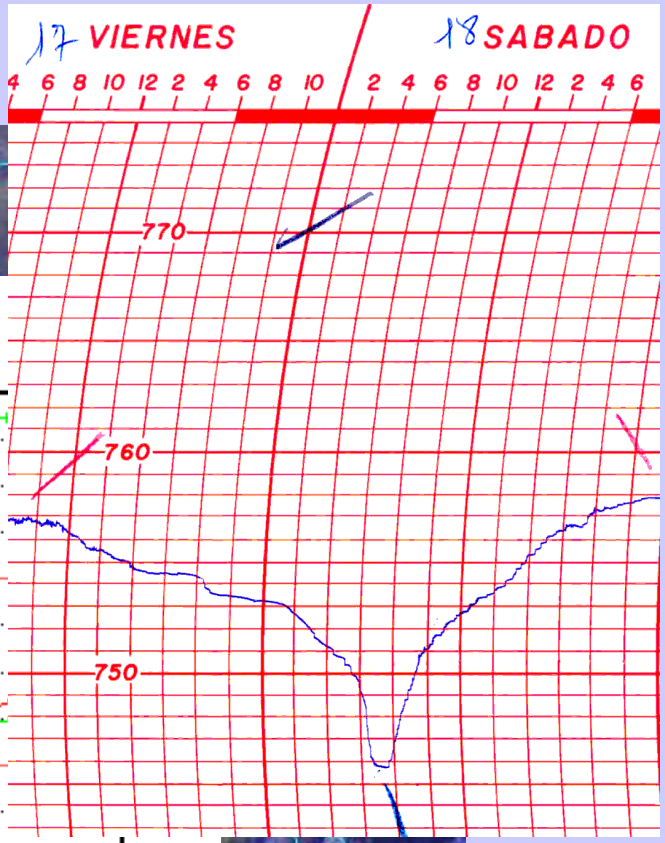


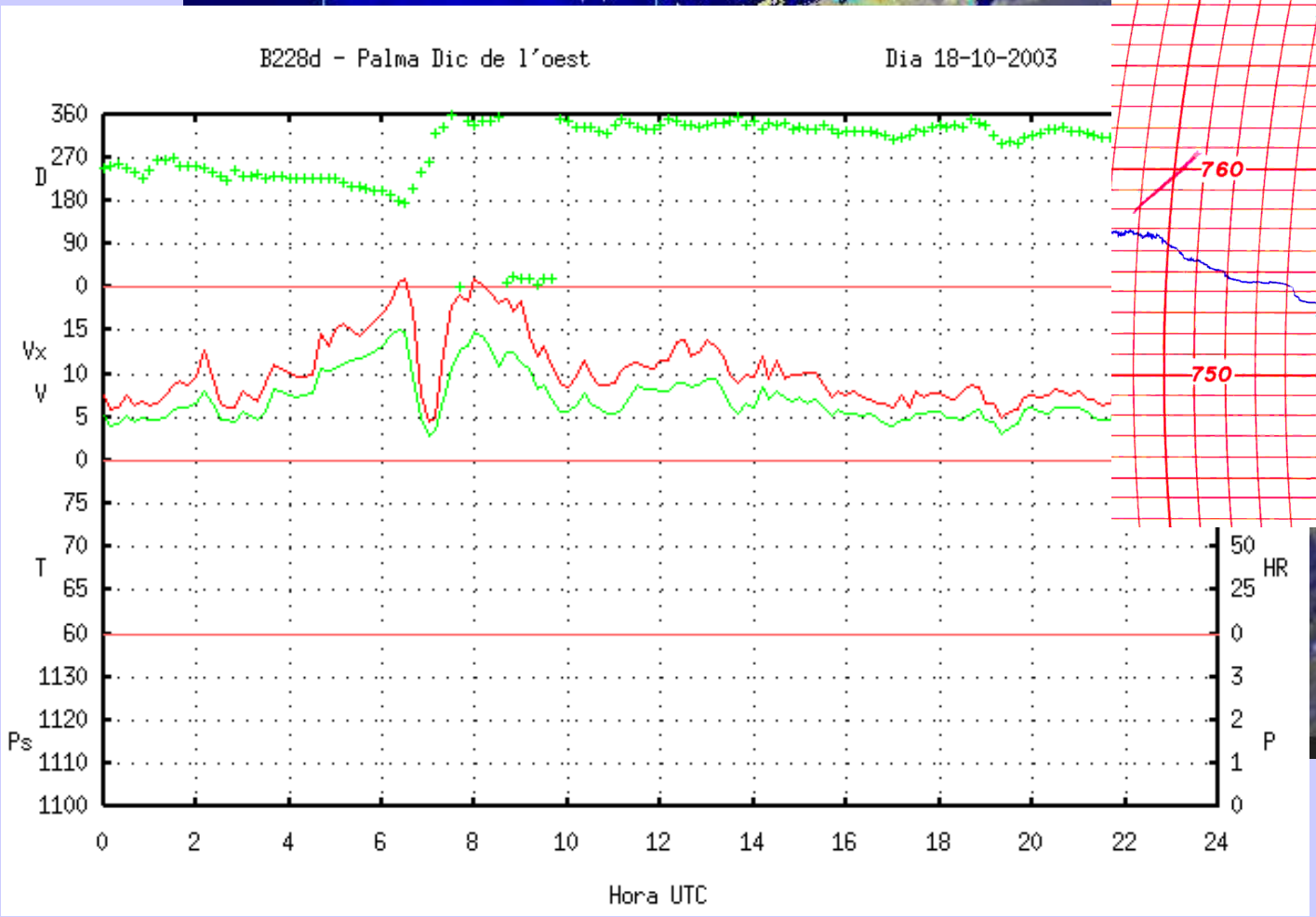
FALSO Medicane del 16 Octubre 2003



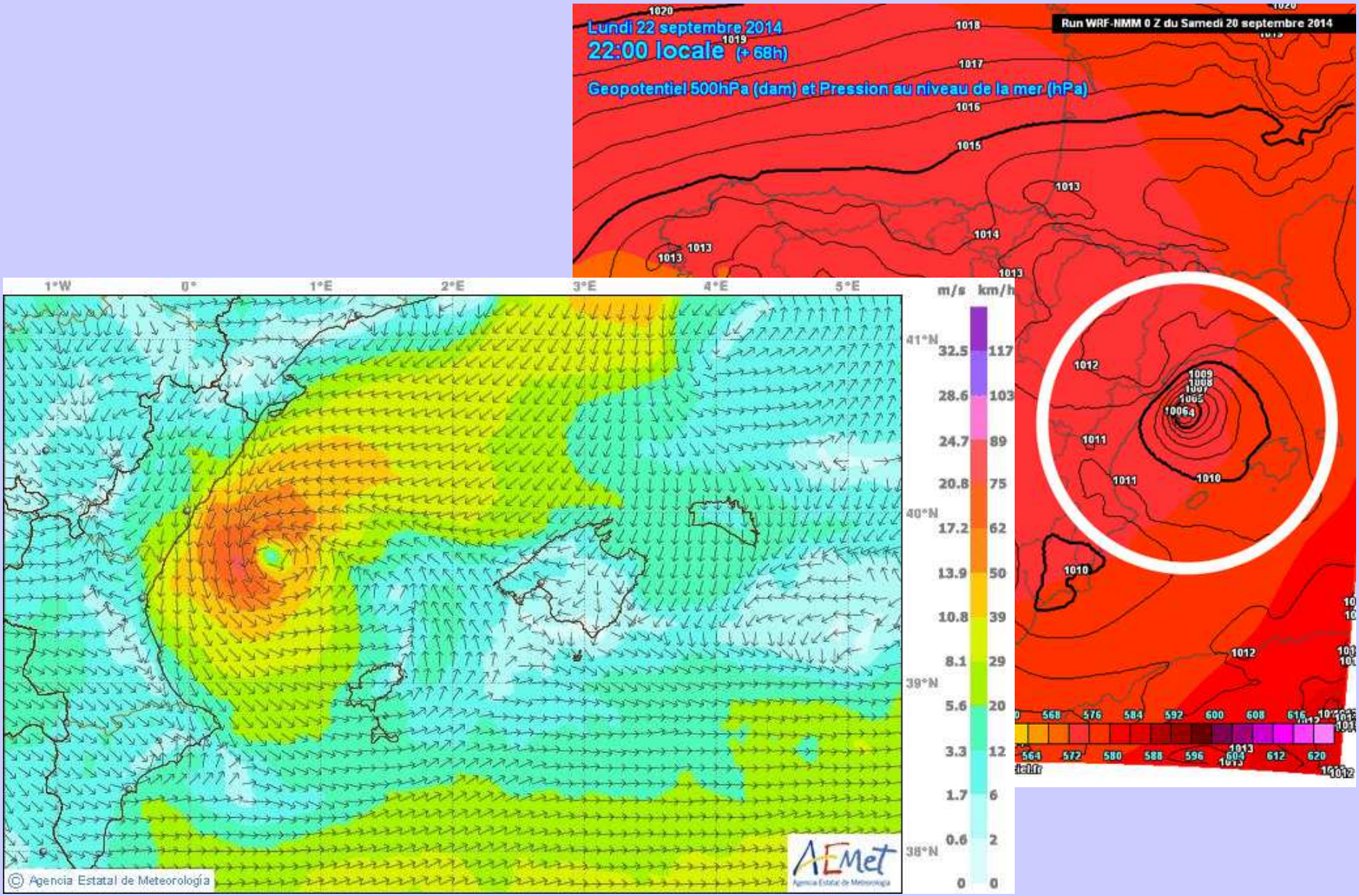
… PERO Medicane el 18 Octubre 2003







FALSO Medicane del 22-23 Septiembre 2014

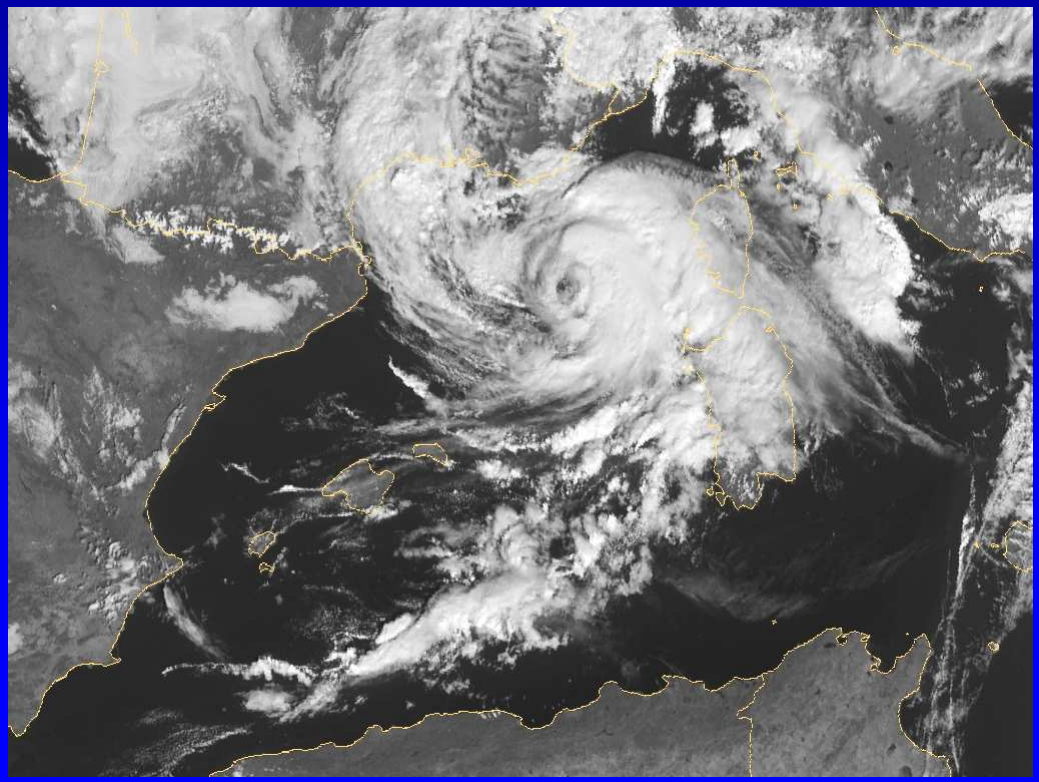


MEDICANES:
EFECTES DEL CANVI CLIMÀTIC ?

MOTIVACIÓN

Los Medicanes son tempestades marítimas potencialmente violentas y que pueden afectar a las islas y zonas costeras del Mediterráneo:

- ***Existen zonas preferentes para el desarrollo de medicanes ?***
- ***Qué intensidad pueden llegar a alcanzar ?***
- ***Cambiará su frecuencia e intensidad con el cambio climático ?***

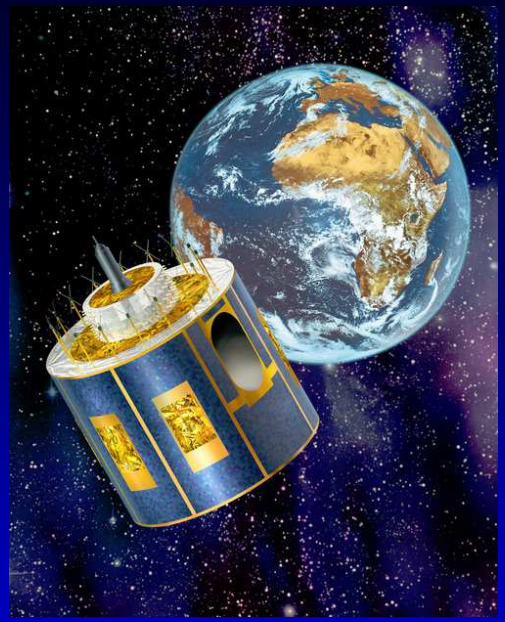


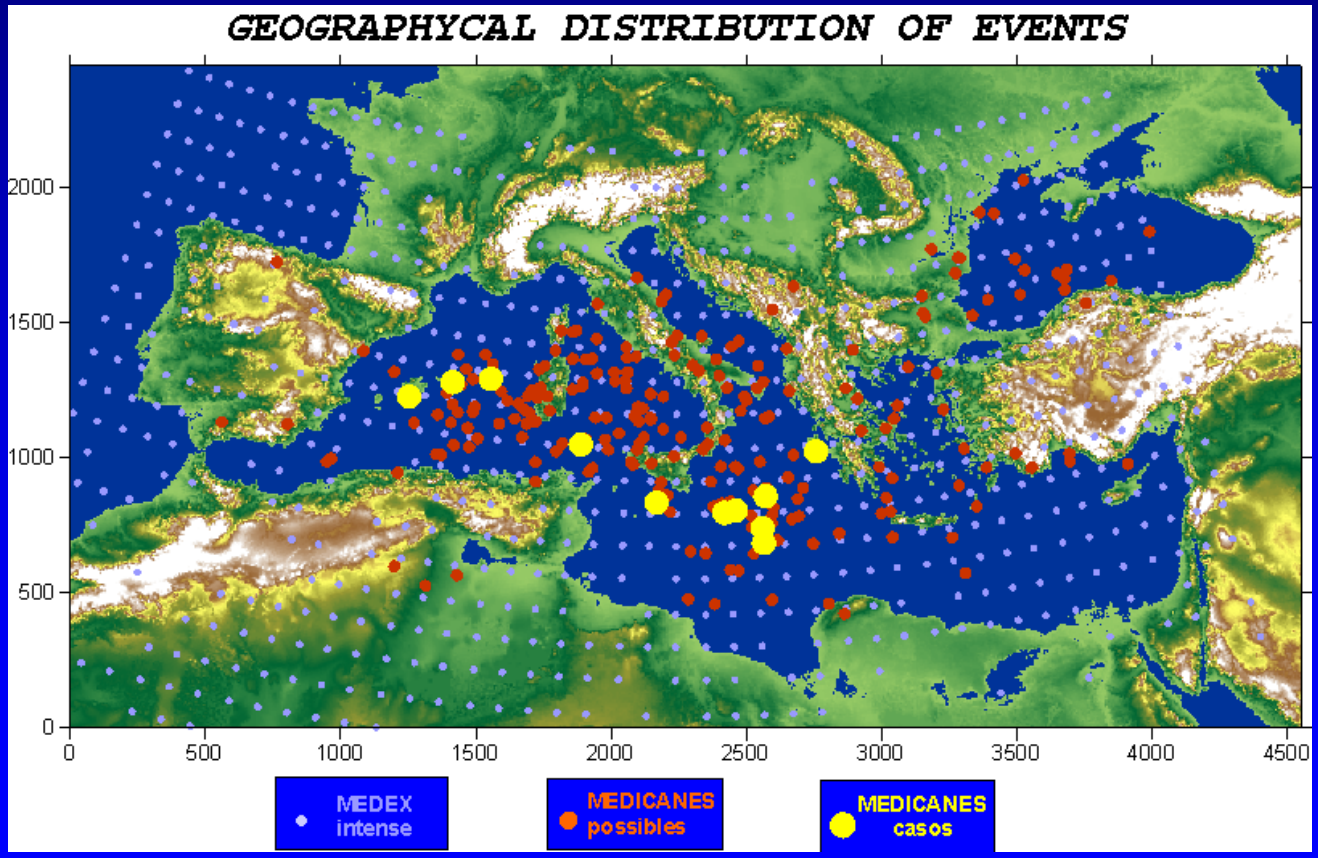
8 Noviembre 2011

(NOAA: INVEST 01M)

RIESGO DE MEDICANES ???

- Solo *1-2 casos por año !!!*
- Cuantificación *difícil* con métodos clásicos



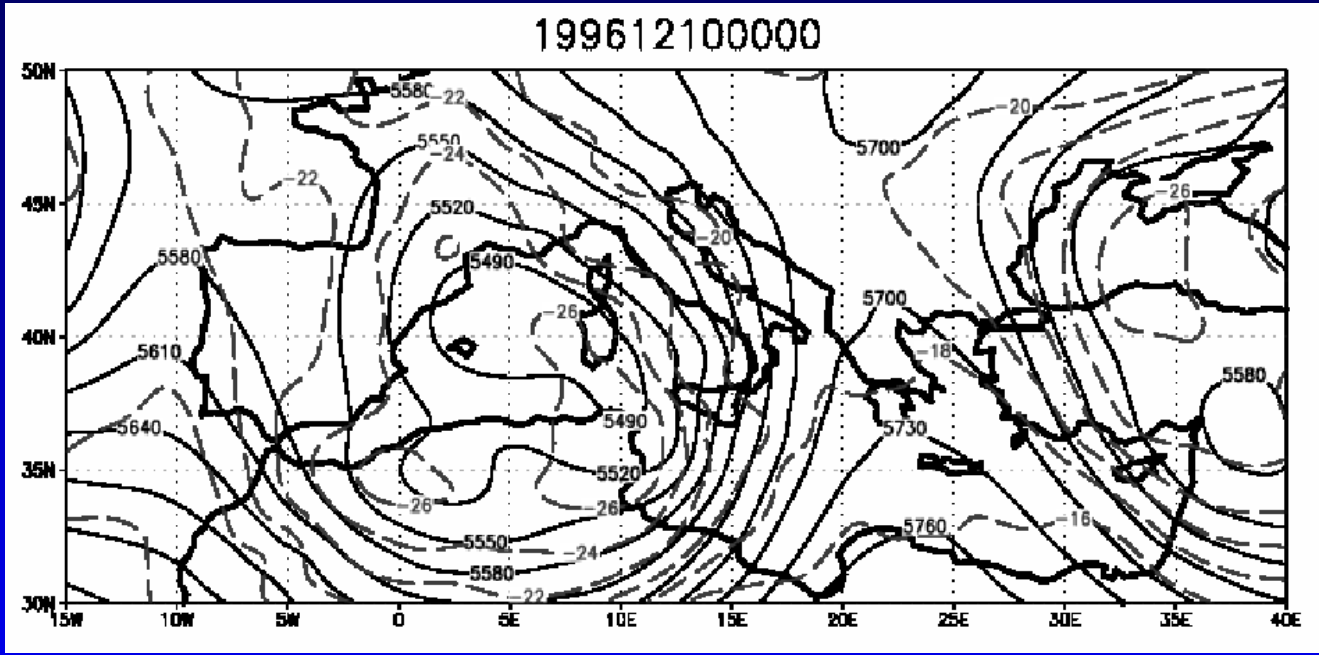


Base de datos (satélite)

(Tous and Romero, 2012)

APROXIMACIÓN: Ingredientes de gran escala

- ***Bajas aisladas y frías** en la media y alta troposfera:*



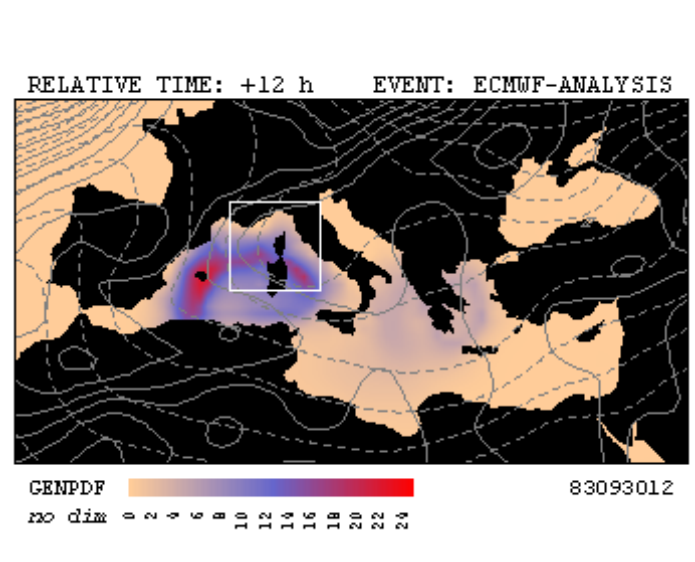
- ***Pero** dada la rareza del fenómeno, deben existir **otras condiciones** meteorológicas adicionales y muy especiales …*

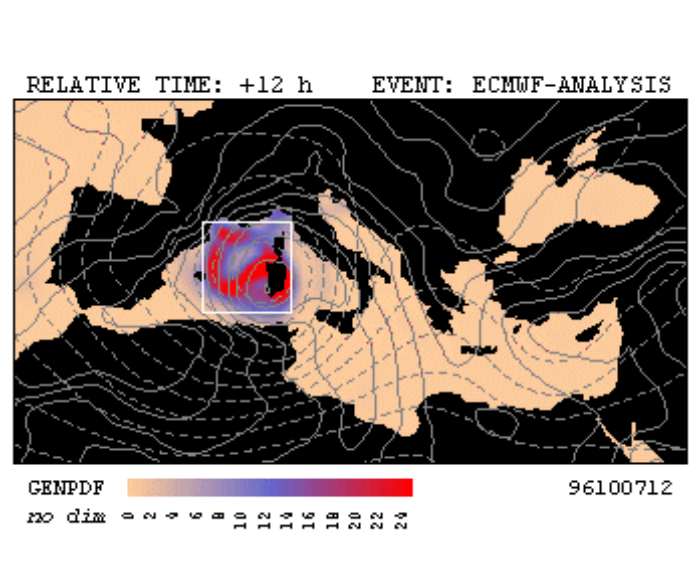
APROXIMACIÓN: Ingredientes de gran escala

- Aplicación del índice empírico de génesis:

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

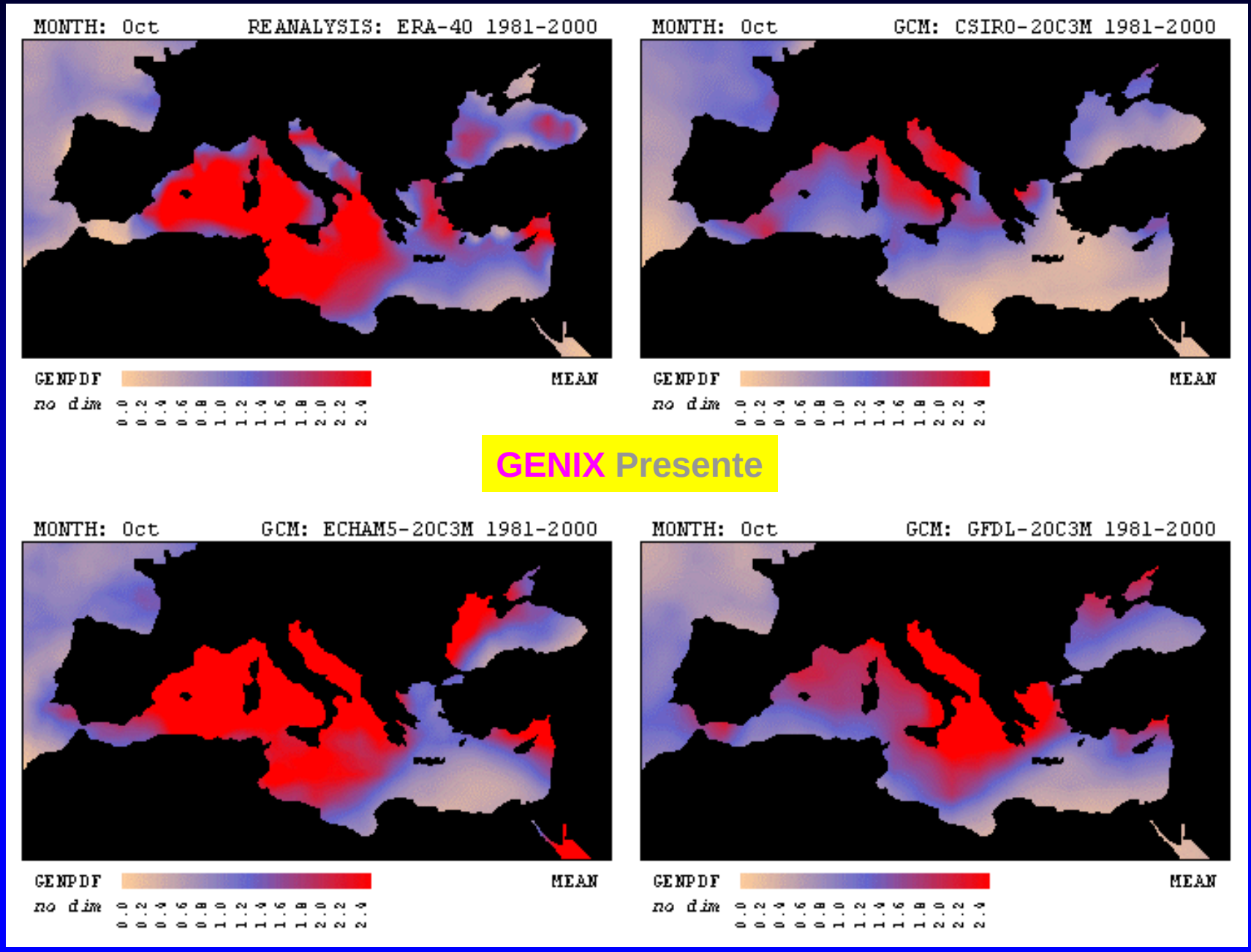
Parámetro GENIX
(Emanuel and Nolan, 2004)



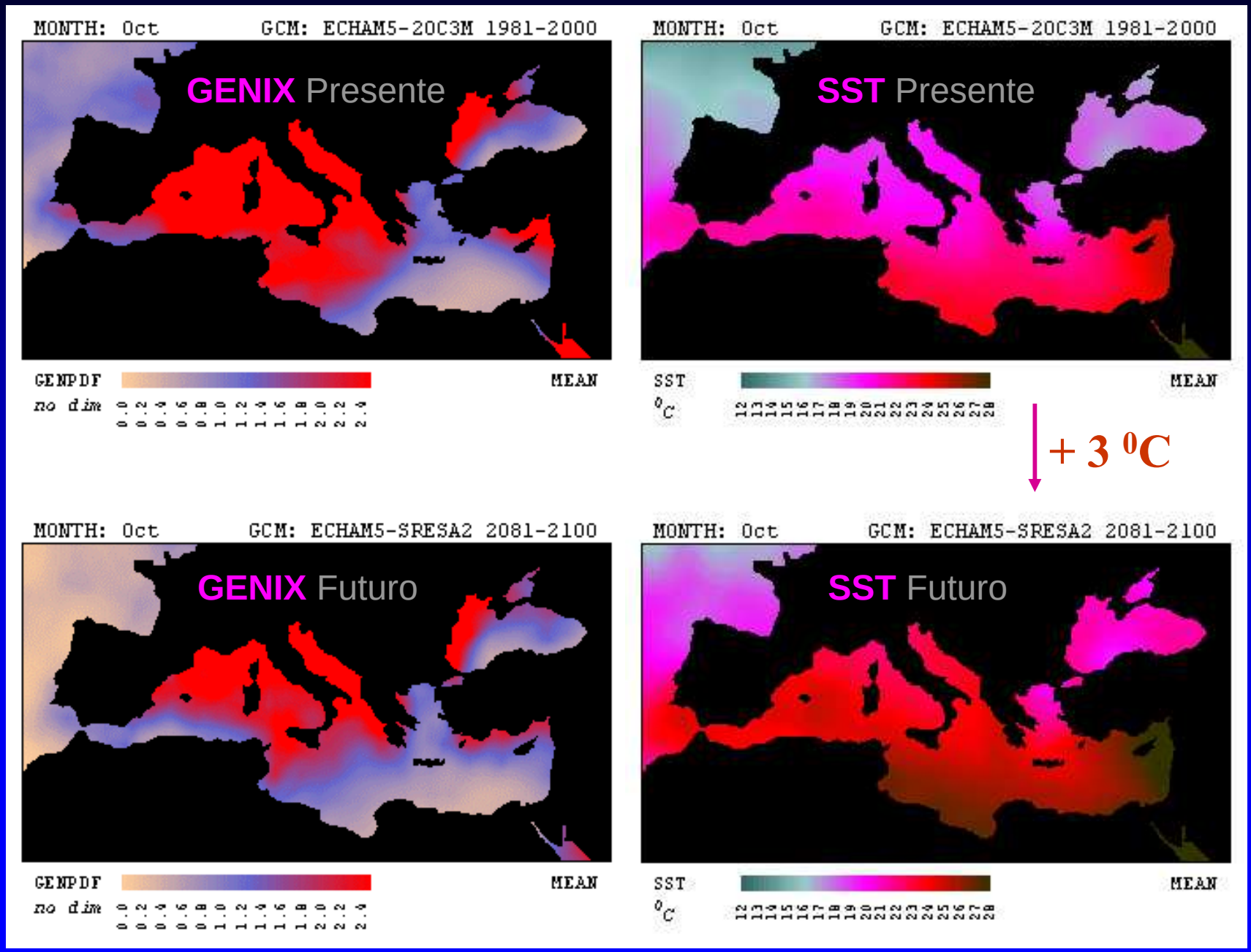


- Ingredientes necesarios pero no suficientes …

APROXIMACIÓN: Aplicación



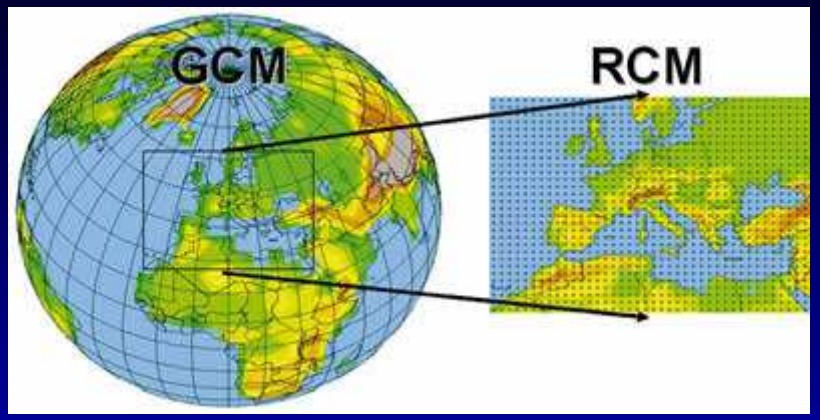
APROXIMACIÓN: Aplicación

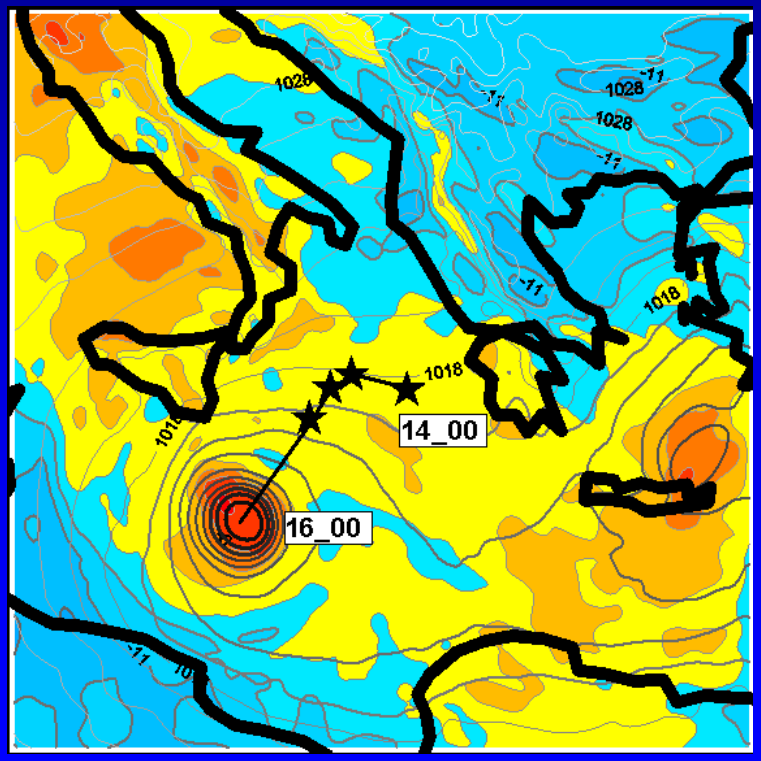


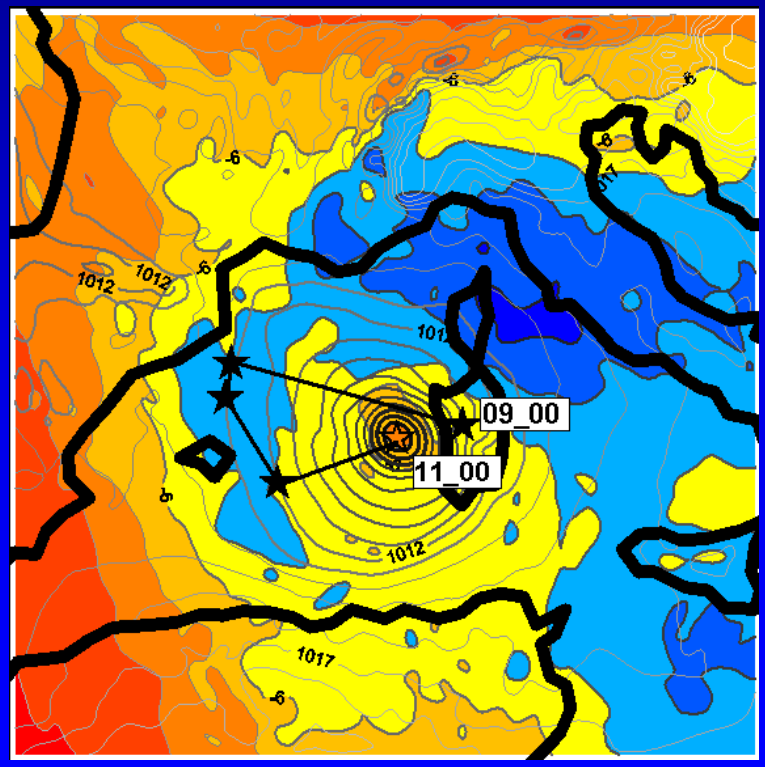
PRIMER MÉTODO: Regionalización climática

- *Alto coste computacional !!!*
(incluso para simulaciones guiadas)

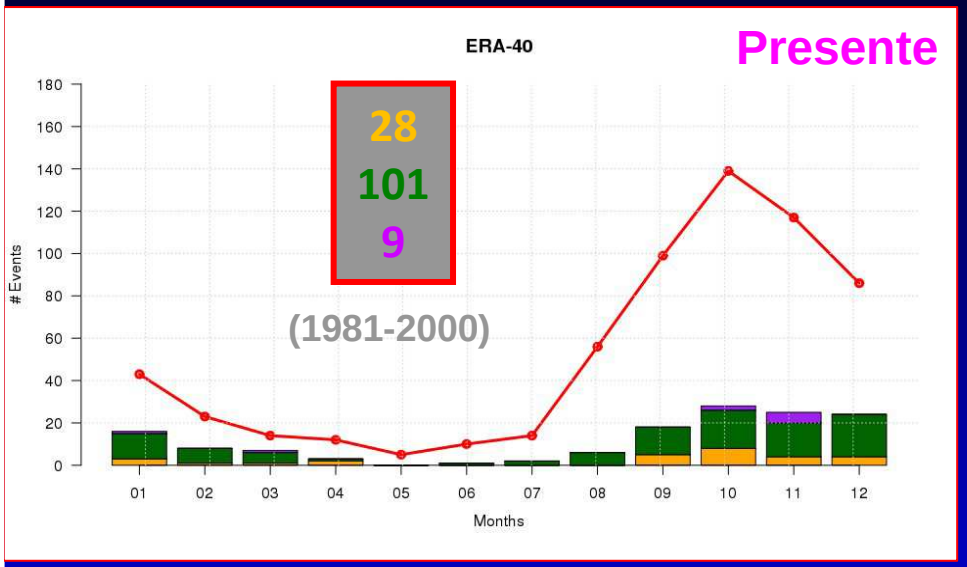
- *Solo un número limitado de casos*
(aunque varios GCMs y escenarios)

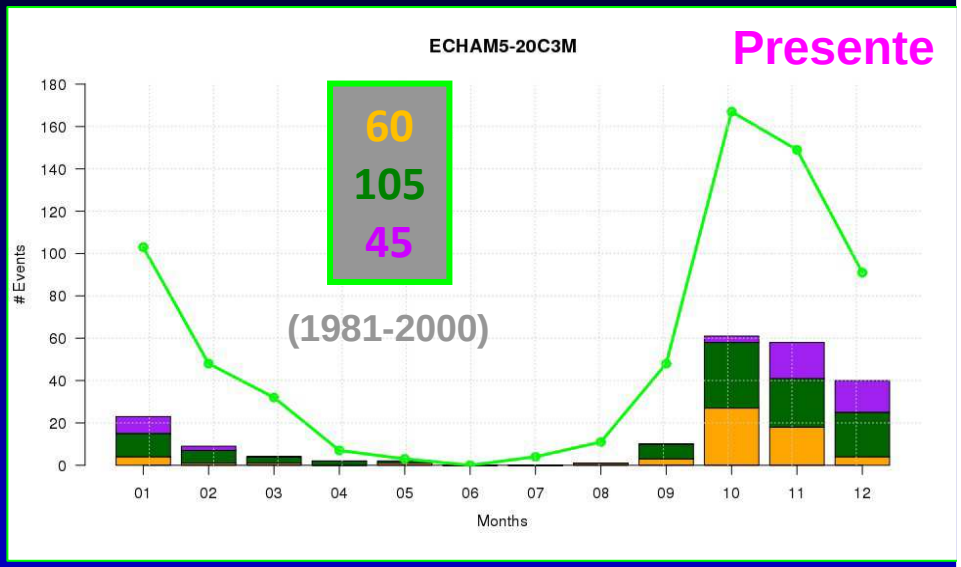


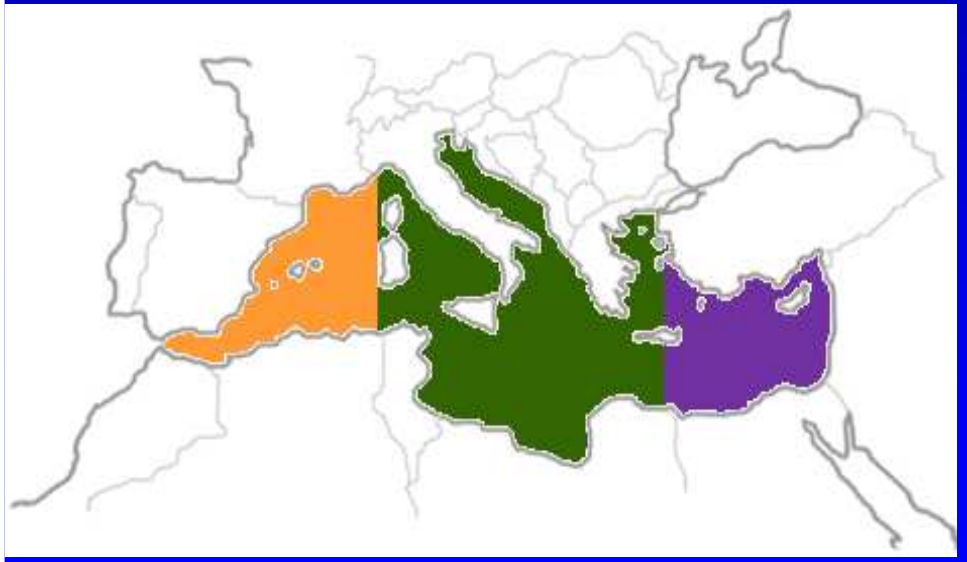


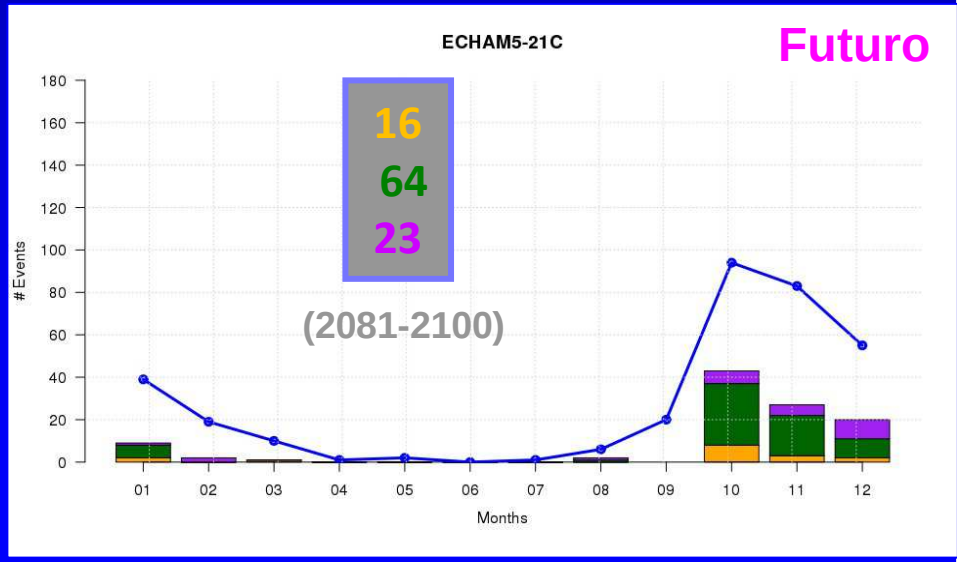


PRIMER MÉTODO: Aplicación



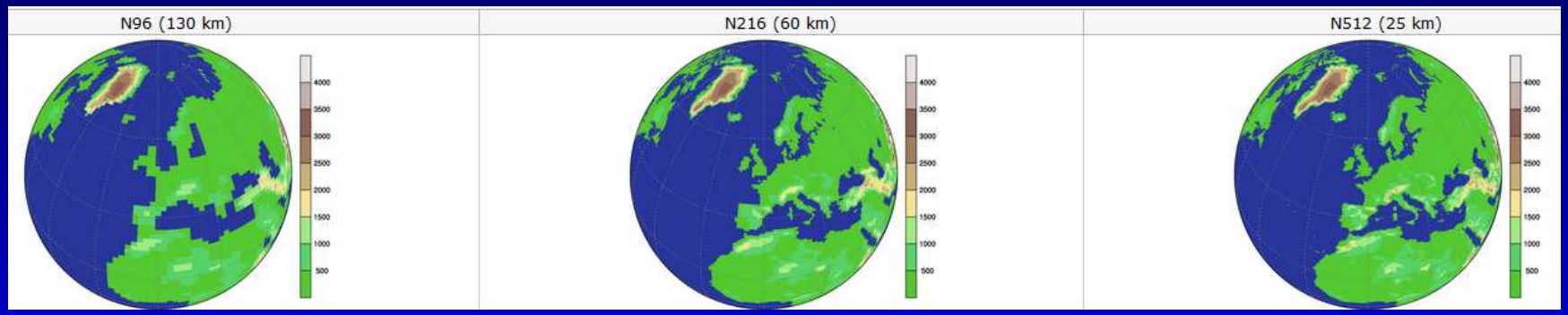




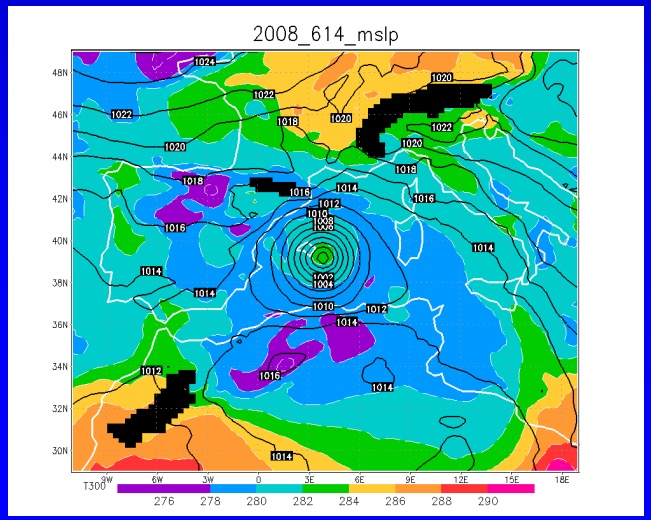


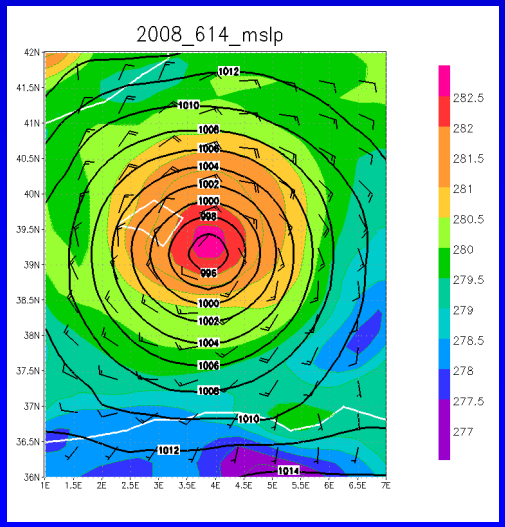
SEGUNDO MÉTODO: Simulaciones climáticas globales (HR)

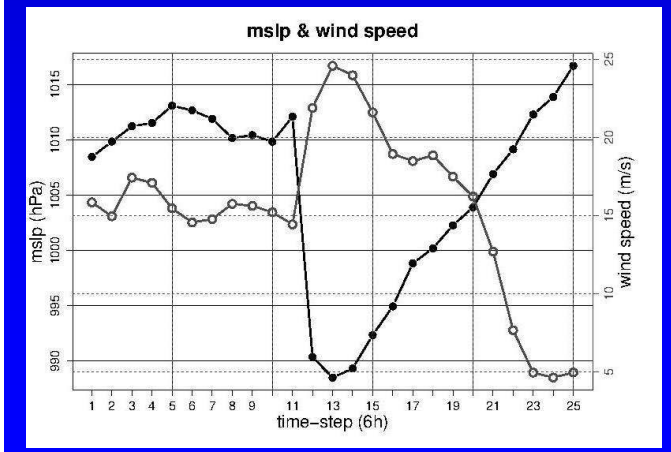
- **Detección** de perturbaciones ciclónicas intensas, simétricas y con núcleo cálido (i.e. **medicanes**) generadas en las simulaciones globales del modelo **HadGEM3 N512** (**resolución 25 km**) (proyecto UPSCALE)



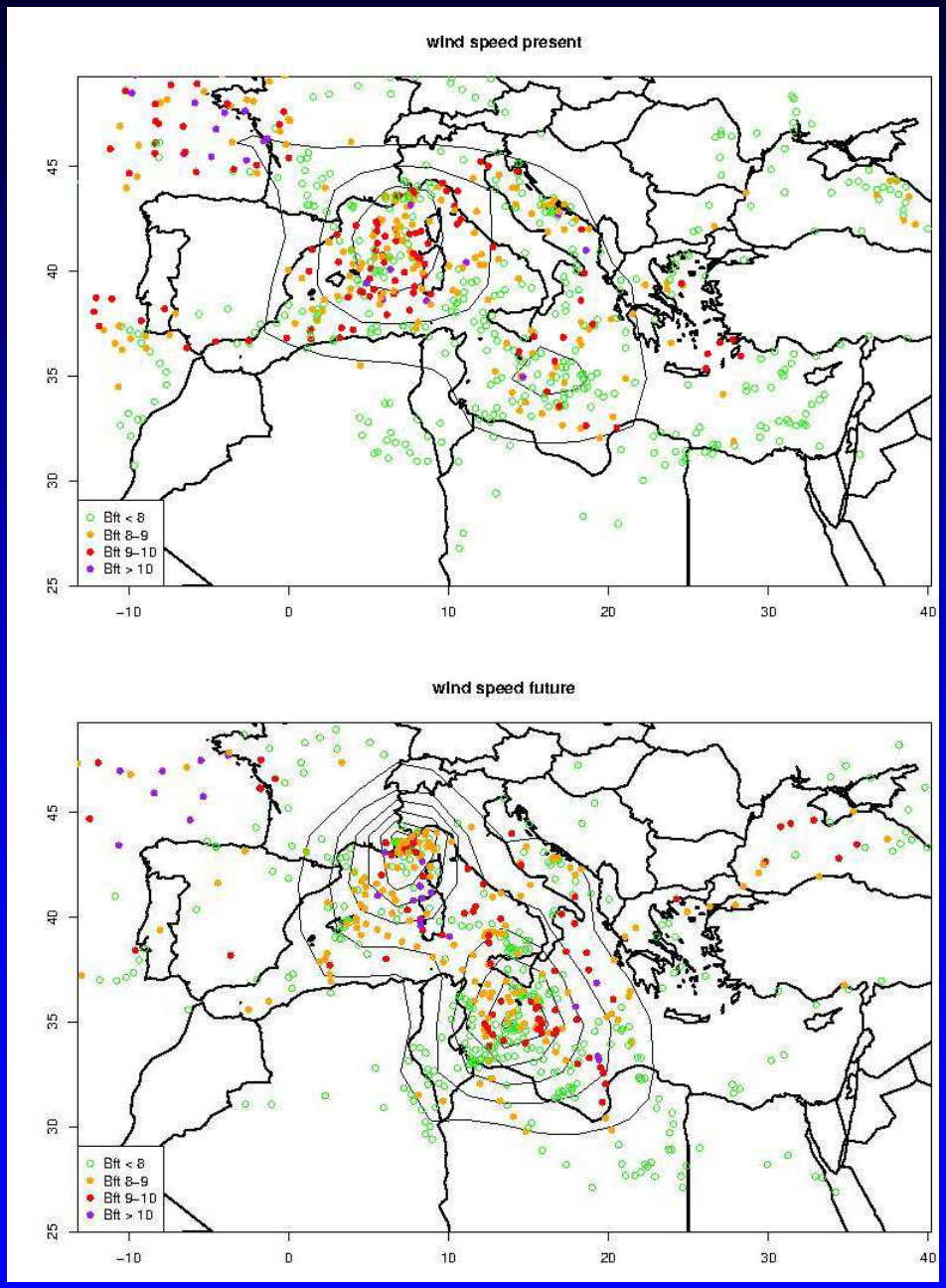
- **A pesar de la HR, solo se capturan medicanes grandes/potentes …**





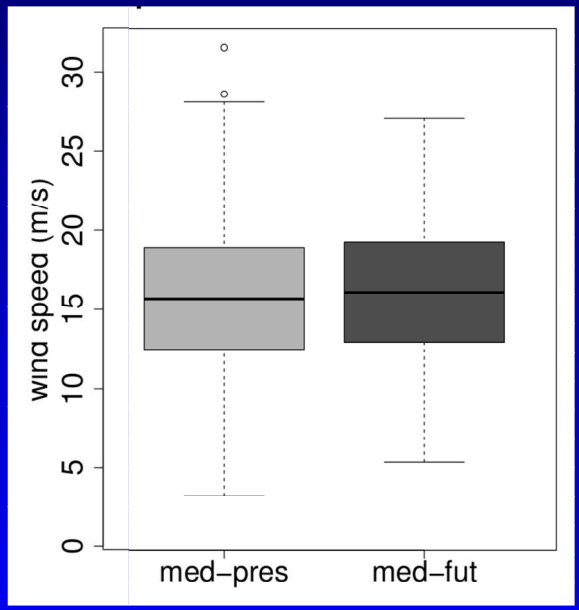


SEGUNDO MÉTODO: Aplicación



PRESENTE

65 med / 26 yr



FUTURO

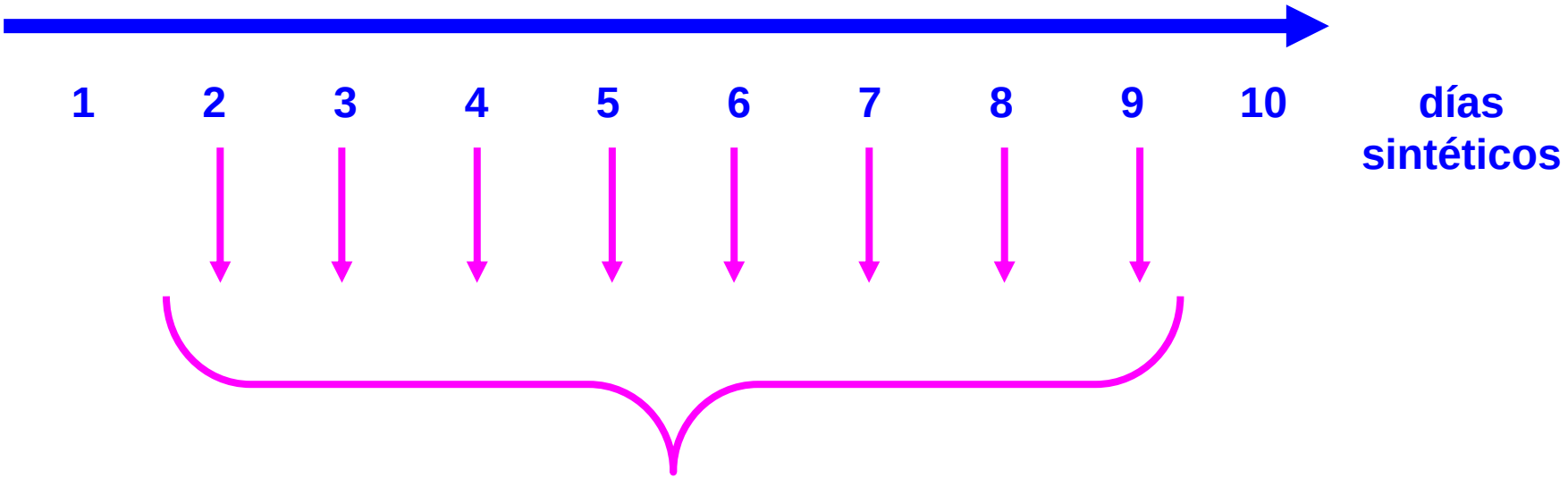
44 med / 26 yr

TERCER MÉTODO: Método dinámico-estadístico

- *Adaptación del método pionero de Kerry Emanuel (MIT, USA)*

- *Generación de miles de huracanes sintéticos a bajo coste !!!*

- *Evaluación del riesgo con gran robustez estadística (p.e. períodos de retorno viento extremo)*



MAR ABIERTO + MAX DE GENIX > 10 + VOR ABS > 10 unidades ???

SÍ

Hacia atrás

(Max: 12 h)

Hacia adelante

(Max: 12 h sobre tierra)

TRAYECTORIA POTENCIAL

(Δt = 30 min)

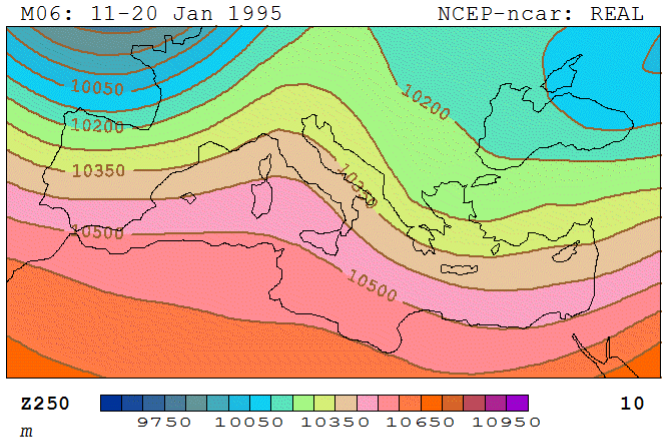
$$\begin{cases} u_{track} = \alpha\, \underline{u}_{850} + (1 - \alpha)\, \underline{u}_{250} \\ v_{track} = \alpha\, \underline{v}_{850} + (1 - \alpha)\, \underline{v}_{250} \end{cases}$$

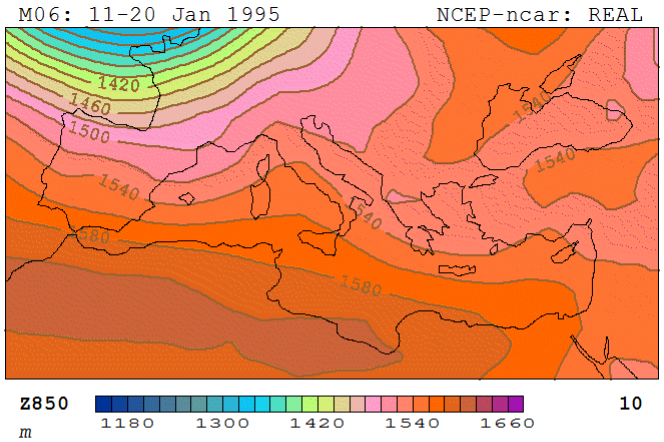
$\underline{AVG}_{time\text{-}space}$

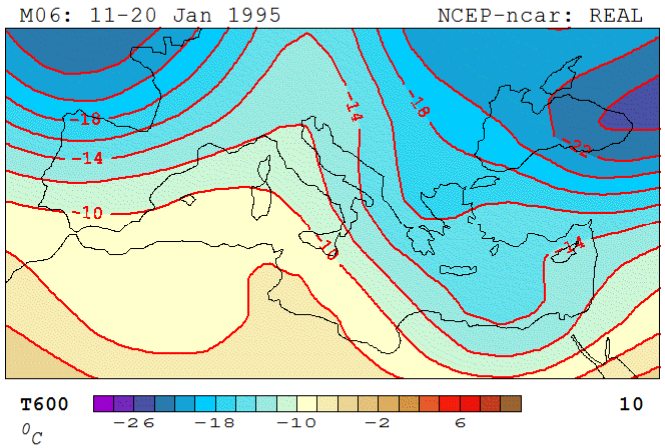
$\alpha = 0.8$

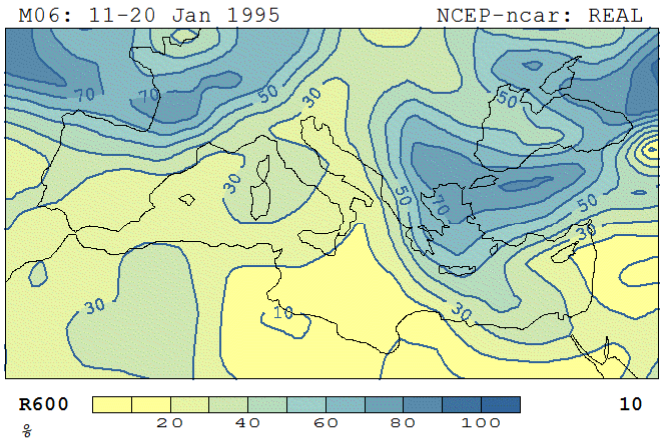
“LYBIAN” MEDICANE
Central Mediterranean, 15-16 January 1995

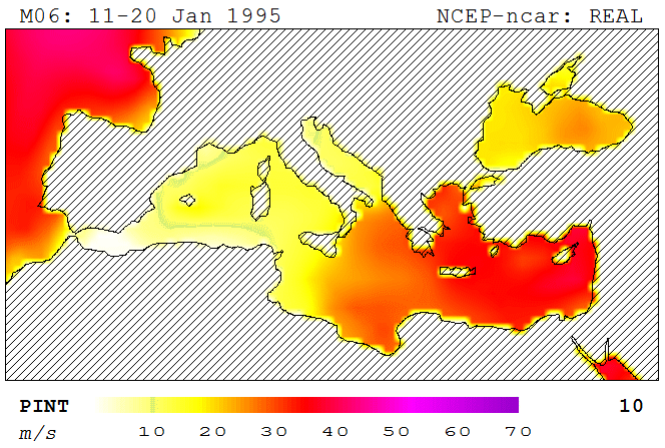
TRACKING method

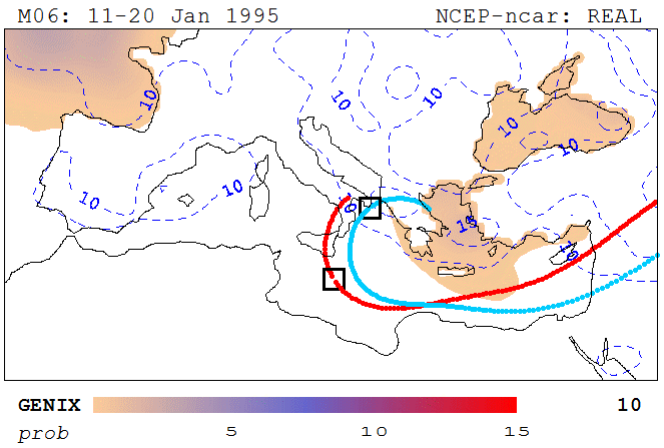




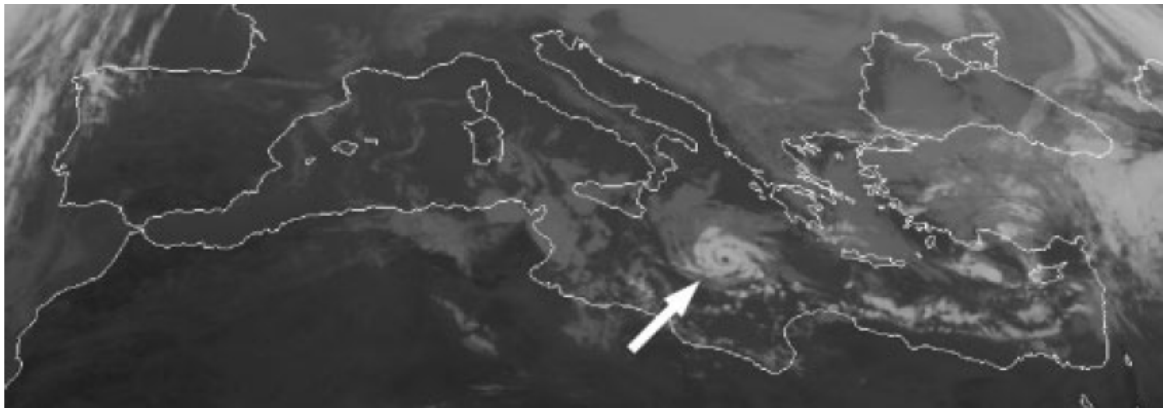


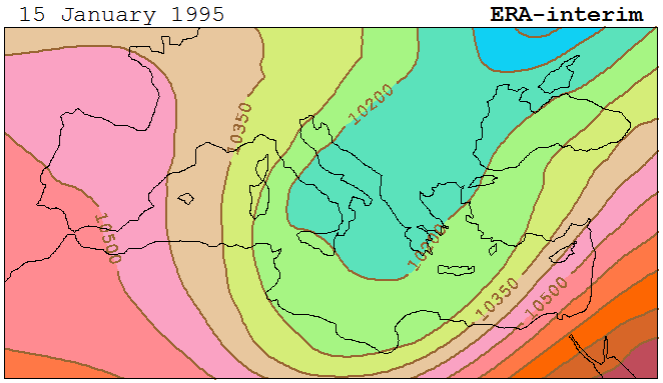




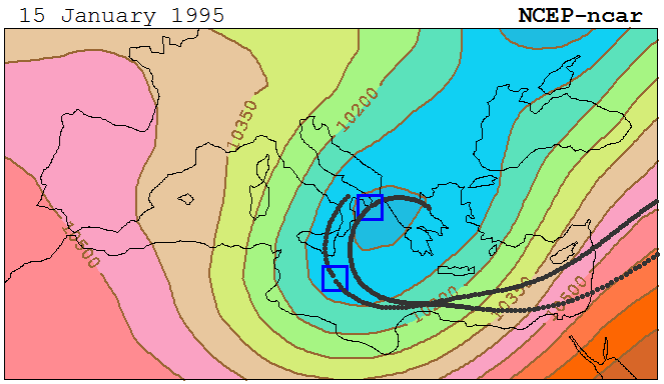


SYNTHETIC analogues

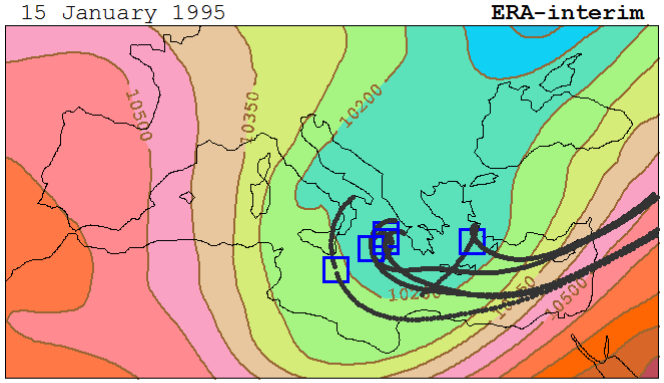




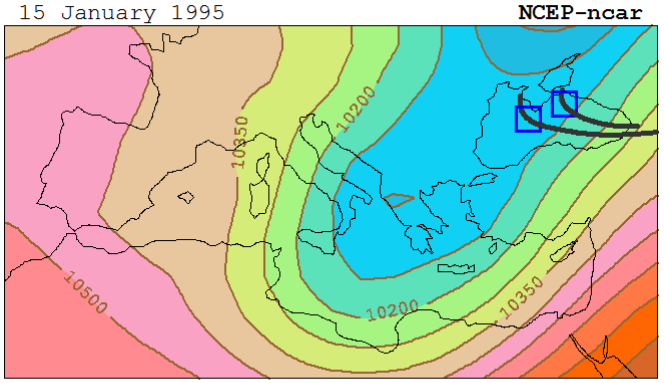
REAL



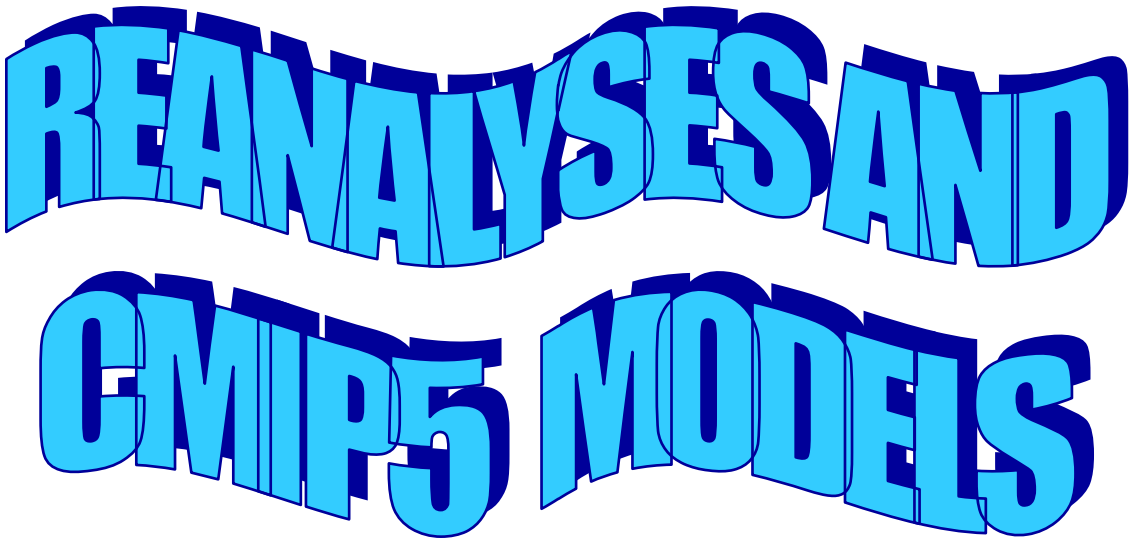
REAL



SYNTHETIC



SYNTHETIC


REANALYSES AND
CMIP5 MODELS

REANALYSIS 1

ERA-interim

ECMWF
(Europe)

LON 0.75º x LAT 0.75º

REANALYSIS 2

NCEP-ncar

NOAA
(USA)

LON 2.5º x LAT 2.5º

HISTORICAL scenario

1986-2005

GCM-01 ***ACCESS1.0*** CSIRO and BOM (Australia) LON 1.88º x LAT 1.25º	**GCM-02** ***ACCESS1.3*** CSIRO and BOM (Australia) LON 1.88º x LAT 1.25º	**GCM-06** ***CanESM2*** Cent. Clim. Mod. Anal. (Canada) LON 2.81º x LAT 2.79º	**GCM-07** ***CCSM4*** NCAR (USA) LON 1.25º x LAT 0.94º	**GCM-11** ***CNRM-CM5*** CNRM and CERFACS (France) LON 1.41º x LAT 1.40º	**GCM-12** ***CSIRO-Mk3.6.0*** QCCCE and CSIRO (Australia) LON 1.88º x LAT 1.86º
GCM-03 ***BCC-CSM1.1*** Beijing Climate Center (China) LON 2.81º x LAT 2.79º	**GCM-04** ***BCC-CSM1.1(m)*** Beijing Climate Center (China) LON 1.13º x LAT 1.12º	**GCM-08** ***CMCC-CESM*** Cent. EuroMed C.Clim. (Italy) LON 3.75º x LAT 3.71º	**GCM-09** ***CMCC-CM*** Cent. EuroMed C.Clim. (Italy) LON 0.75º x LAT 0.75º	**GCM-13** ***EC-EARTH*** EC-Earth Consortium (Europe) LON 1.13º x LAT 1.12º	**GCM-14** ***FGOALS-g2*** LASG-CESS (China) LON 2.81º x LAT 2.81º
GCM-05 ***BNU-ESM*** Beijing Normal University (China) LON 2.81º x LAT 2.79º	***HISTORICAL scenario*** **1986-2005**	**GCM-10** ***CMCC-CMS*** Cent. EuroMed C.Clim. (Italy) LON 1.88º x LAT 1.86º	***RCP85 scenario*** **2081-2100**	**GCM-15** ***GFDL-CM3*** NOAA GFDL (USA) LON 2.50º x LAT 2.00º	
GCM-16 ***GFDL-ESM2G*** NOAA GFDL (USA) LON 2.50º x LAT 2.00º	**GCM-17** ***GFDL-ESM2M*** NOAA GFDL (USA) LON 2.50º x LAT 2.00º	**GCM-21** ***IPSL-CM5A-MR*** IPSL (France) LON 2.50º x LAT 1.27º	**GCM-22** ***IPSL-CM5B-LR*** IPSL (France) LON 3.75º x LAT 1.89º	**GCM-26** ***MPI-ESM-LR*** Max Planck Int. Meteor. (Germany) LON 1.88º x LAT 1.86º	**GCM-27** ***MPI-ESM-MR*** Max Planck Int. Meteor. (Germany) LON 1.88º x LAT 1.86º
GCM-18 ***HadGEM2-CC*** Met Office Hadley Cent (UK) LON 1.88º x LAT 1.25º	**GCM-19** ***INM-CM4*** Rus. Inst. Num. Math. (Russia) LON 2.00º x LAT 1.50º	**GCM-23** ***MIROC5*** U.Tok-NIES-JAMSTEC (Japan) LON 1.41º x LAT 1.40º	**GCM-24** ***MIROC-ESM*** U.Tok-NIES-JAMSTEC (Japan) LON 2.81º x LAT 2.79º	**GCM-28** ***MRI-CGCM3*** Meteor. Res. Inst. (Japan) LON 1.13º x LAT 1.12º	**GCM-29** ***MRI-ESM1*** Meteor. Res. Inst. (Japan) LON 1.13º x LAT 1.12º
GCM-20 ***IPSL-CM5A-LR*** IPSL (France) LON 3.75º x LAT 1.89º		**GCM-25** ***MIROC-ESM-CHEM*** U.Tok-NIES-JAMSTEC (Japan) LON 2.81º x LAT 2.79º		**GCM-30** ***NorESM1-M*** Nor. Clim. Cent. (Norway) LON 2.50º x LAT 1.90º	


RESULTS

REANALYSIS 1

ERA-interim

20349 tracks
7918 survivors

200 storms/century

REANALYSIS 2

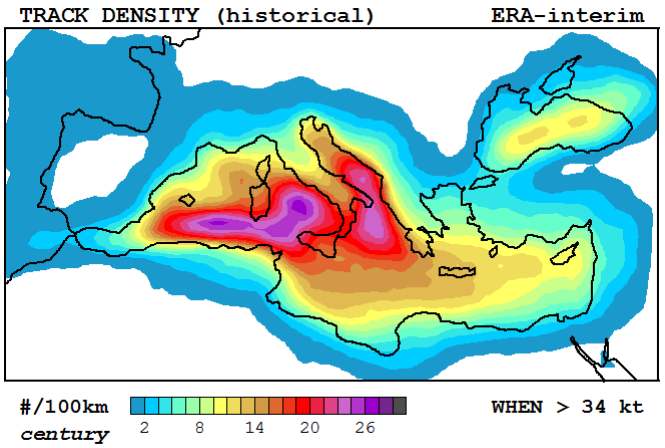
NCEP-ncar

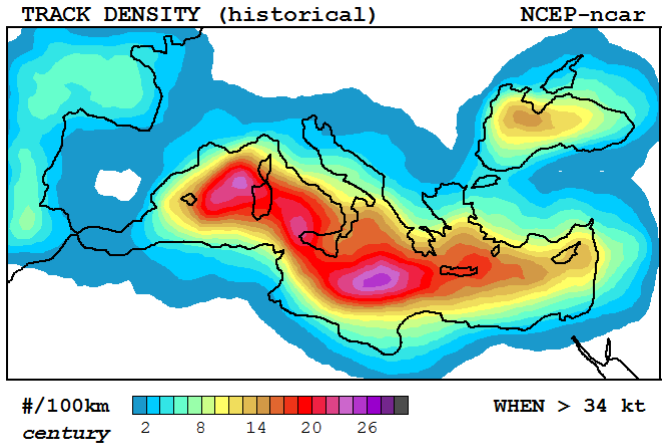
20276 tracks
6379 survivors

200 storms/century

HISTORICAL scenario

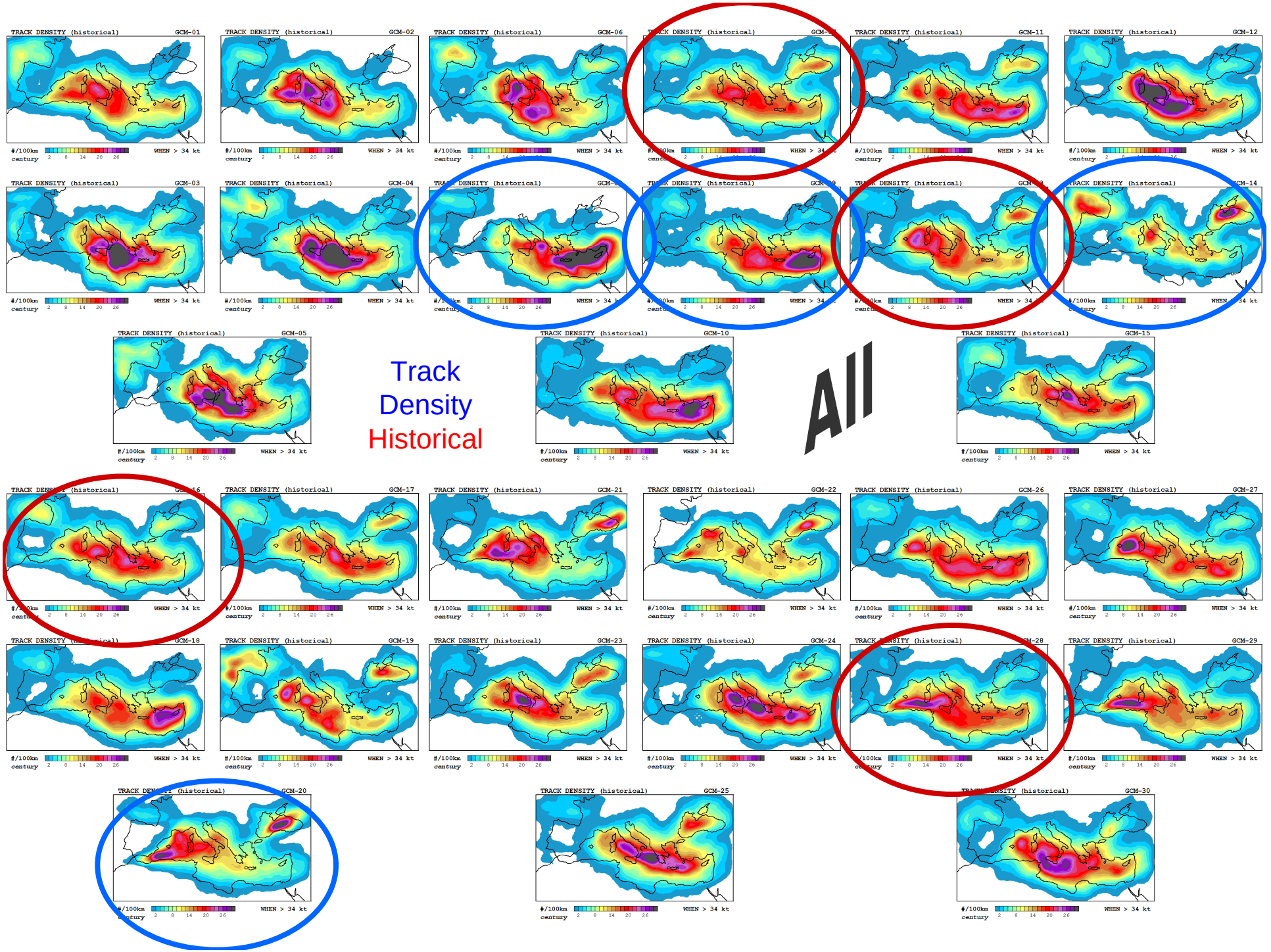
200 storms
(per century)

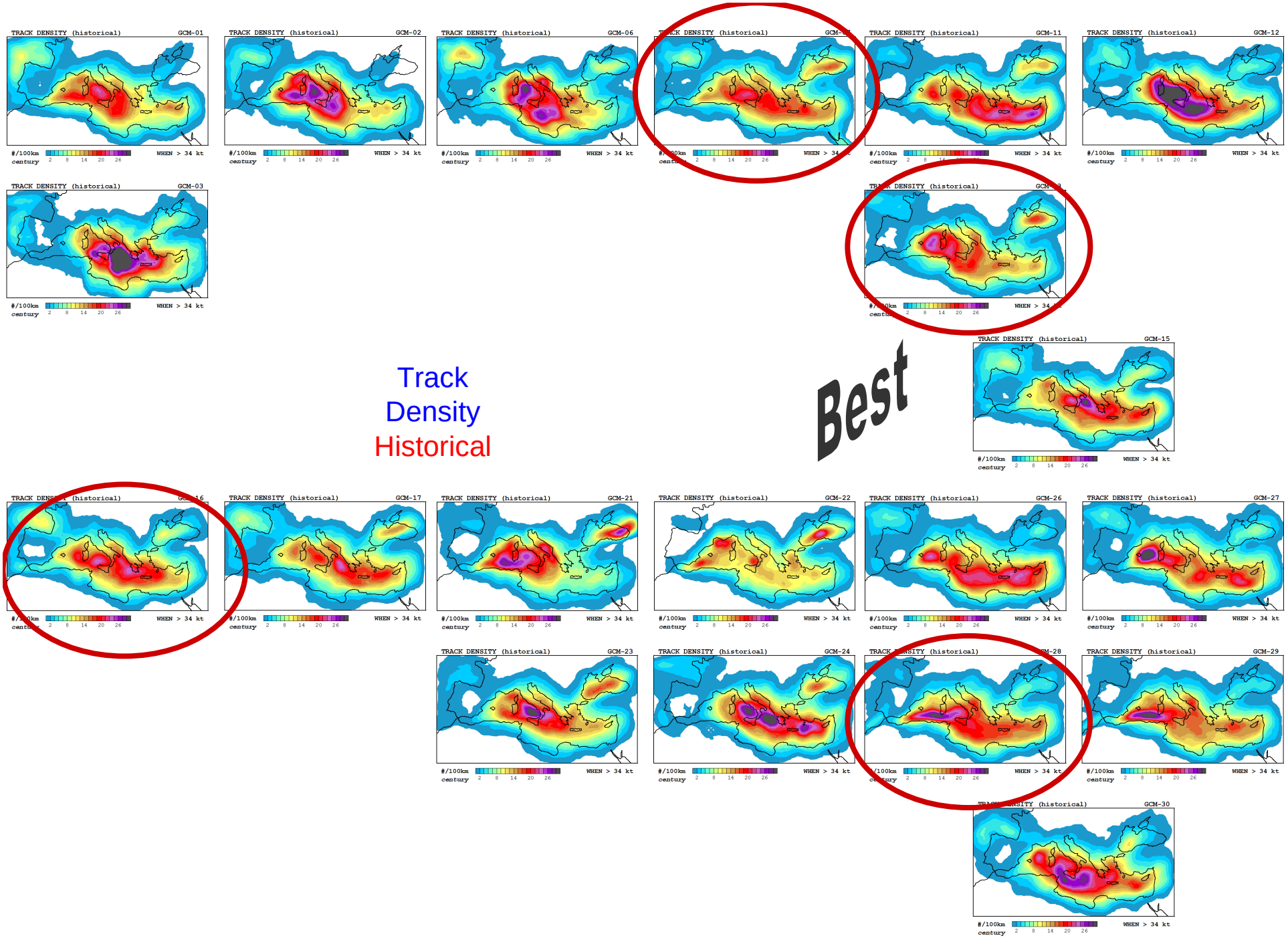




GCM-01 ***ACCESS1.0*** 20325 tracks 7188 survivors 200 storms/century	**GCM-02** ***ACCESS1.3*** 20086 tracks 7281 survivors 200 storms/century	**GCM-06** ***CanESM2*** 20097 tracks 5268 survivors 200 storms/century	**GCM-07** ***CCSM4*** 20405 tracks 7012 survivors 200 storms/century	**GCM-11** ***CNRM-CM5*** 20329 tracks 6535 survivors 200 storms/century	**GCM-12** ***CSIRO-Mk3.6.0*** 20048 tracks 6034 survivors 200 storms/century
GCM-03 ***BCC-CSM1.1*** 20083 tracks 3045 survivors 200 storms/century	**GCM-04** ***BCC-CSM1.1(m)*** 20142 tracks 5167 survivors 200 storms/century	**GCM-08** ***CMCC-CESM*** 20106 tracks 4733 survivors 200 storms/century	**GCM-09** ***CMCC-CM*** 20085 tracks 6368 survivors 200 storms/century	**GCM-13** ***EC-EARTH*** 20180 tracks 7793 survivors 200 storms/century	**GCM-14** ***FGOALS-g2*** 20481 tracks 1925 survivors 200 storms/century
GCM-05 ***BNU-ESM*** 20071 tracks 2946 survivors 200 storms/century	***HISTORICAL scenario*** **200 storms (per century)**	**GCM-10** ***CMCC-CMS*** 20119 tracks 5738 survivors 200 storms/century	ALL	**GCM-15** ***GFDL-CM3*** 20475 tracks 5307 survivors 200 storms/century	
GCM-16 ***GFDL-ESM2G*** 20444 tracks 5309 survivors 200 storms/century	**GCM-17** ***GFDL-ESM2M*** 20374 tracks 5596 survivors 200 storms/century	**GCM-21** ***IPSL-CM5A-MR*** 20178 tracks 4919 survivors 200 storms/century	**GCM-22** ***IPSL-CM5B-LR*** 20592 tracks 5681 survivors 200 storms/century	**GCM-26** ***MPI-ESM-LR*** 20082 tracks 6015 survivors 200 storms/century	**GCM-27** ***MPI-ESM-MR*** 20745 tracks 5678 survivors 200 storms/century
GCM-18 ***HadGEM2-CC*** 20392 tracks 7860 survivors 200 storms/century	**GCM-19** ***INM-CM4*** 20018 tracks 5047 survivors 200 storms/century	**GCM-23** ***MIROC5*** 20651 tracks 6651 survivors 200 storms/century	**GCM-24** ***MIROC-ESM*** 20268 tracks 5709 survivors 200 storms/century	**GCM-28** ***MRI-CGCM3*** 20541 tracks 5647 survivors 200 storms/century	**GCM-29** ***MRI-ESM1*** 21203 tracks 5898 survivors 200 storms/century
GCM-20 ***IPSL-CM5A-LR*** 20176 tracks 5064 survivors 200 storms/century		**GCM-25** ***MIROC-ESM-CHEM*** 20026 tracks 5517 survivors 200 storms/century		**GCM-30** ***NorESM1-M*** 20022 tracks 6558 survivors 200 storms/century	

GCM-01 ***ACCESS1.0*** 22539 tracks 7521 survivors **209.27** storms/century	**GCM-02** ***ACCESS1.3*** 28304 tracks 8335 survivors **228.95** storms/century	**GCM-06** ***CanESM2*** 14750 tracks 3843 survivors **145.90** storms/century	**GCM-07** ***CCSM4*** 20560 tracks 6236 survivors **177.87** storms/century	**GCM-11** ***CNRM-CM5*** 30505 tracks 8689 survivors **265.92** storms/century	**GCM-12** ***CSIRO-Mk3.6.0*** 12085 tracks 2382 survivors **78.95** storms/century
GCM-03 ***BCC-CSM1.1*** 20439 tracks 2932 survivors **192.58** storms/century	**GCM-04** ***BCC-CSM1.1(m)*** 13761 tracks 3523 survivors **136.37** storms/century	**GCM-08** ***CMCC-CESM*** 17277 tracks 3772 survivors **159.39** storms/century	**GCM-09** ***CMCC-CM*** 22778 tracks 7300 survivors **229.27** storms/century	**GCM-13** ***EC-EARTH*** 32781 tracks 12359 survivors **317.18** storms/century	**GCM-14** ***FGOALS-g2*** 29286 tracks 2730 survivors **283.64** storms/century
GCM-05 ***BNU-ESM*** 27750 tracks 3820 survivors **259.34** storms/century	***RCP85 scenario*** **198.52 storms (per century)**	**GCM-10** ***CMCC-CMS*** 20675 tracks 6194 survivors **215.89** storms/century	ALL	**GCM-15** ***GFDL-CM3*** 17779 tracks 4171 survivors **157.19** storms/century	
GCM-16 ***GFDL-ESM2G*** 20348 tracks 4686 survivors **176.53** storms/century	**GCM-17** ***GFDL-ESM2M*** 16884 tracks 3996 survivors **142.82** storms/century	**GCM-21** ***IPSL-CM5A-MR*** 14172 tracks 2382 survivors **96.85** storms/century	**GCM-22** ***IPSL-CM5B-LR*** 23922 tracks 6328 survivors **222.78** storms/century	**GCM-26** ***MPI-ESM-LR*** 19684 tracks 6708 survivors **223.04** storms/century	**GCM-27** ***MPI-ESM-MR*** 21590 tracks 6969 survivors **245.47** storms/century
GCM-18 ***HadGEM2-CC*** 24510 tracks 7503 survivors **190.92** storms/century	**GCM-19** ***INM-CM4*** 12250 tracks 2844 survivors **112.70** storms/century	**GCM-23** ***MIROC5*** 29654 tracks 9216 survivors **277.13** storms/century	**GCM-24** ***MIROC-ESM*** 27239 tracks 5499 survivors **192.64** storms/century	**GCM-28** ***MRI-CGCM3*** 22758 tracks 5993 survivors **212.25** storms/century	**GCM-29** ***MRI-ESM1*** 23950 tracks 6432 survivors **218.11** storms/century
GCM-20 ***IPSL-CM5A-LR*** 23722 tracks 5438 survivors **214.77** storms/century	**15 models** ▼▼▼	**GCM-25** ***MIROC-ESM-CHEM*** 26010 tracks 5283 survivors **191.52** storms/century	**15 models** ▲▲▲	**GCM-30** ***NorESM1-M*** 22427 tracks 5914 survivors **180.36** storms/century	


Track
Density
Historical
All


TRACK DENSITY (historical) GCM-01
TRACK DENSITY (historical) GCM-02
TRACK DENSITY (historical) GCM-06
TRACK DENSITY (historical) GCM-11
TRACK DENSITY (historical) GCM-12
TRACK DENSITY (historical) GCM-03
TRACK DENSITY (historical) GCM-15
#/100km century
2 8 14 20 26
WHEN > 34 kt
Track
Density
Historical
Best
TRACK DENSITY (historical) GCM-17
TRACK DENSITY (historical) GCM-21
TRACK DENSITY (historical) GCM-22
TRACK DENSITY (historical) GCM-26
TRACK DENSITY (historical) GCM-27
TRACK DENSITY (historical) GCM-23
TRACK DENSITY (historical) GCM-24
TRACK DENSITY (historical) GCM-29
TRACK DENSITY (historical) GCM-30

GCM-01
ACCESS1.0
22539 tracks
7521 survivors

209.27 storms/century

GCM-02
ACCESS1.3
28304 tracks
8335 survivors

228.95 storms/century

GCM-06
CanESM2
14750 tracks
3843 survivors

145.90 storms/century

GCM-07
CCSM4
20560 tracks
6236 survivors

177.87 storms/century

GCM-11
CNRM-CM5
30505 tracks
8689 survivors

265.92 storms/century

GCM-12
CSIRO-Mk3.6.0
12085 tracks
2382 survivors

78.95 storms/century

GCM-03
BCC-CSM1.1
20439 tracks
2932 survivors

192.58 storms/century

GCM-13
EC-EARTH
32781 tracks
12359 survivors

317.18 storms/century

RCP85
scenario

198.09 storms
(per century)

BEST

GCM-15
GFDL-CM3
17779 tracks
4171 survivors

157.19 storms/century

GCM-16
GFDL-ESM2G
20348 tracks
4686 survivors

176.53 storms/century

GCM-17
GFDL-ESM2M
16884 tracks
3996 survivors

142.82 storms/century

GCM-21
IPSL-CM5A-MR
14172 tracks
2382 survivors

96.85 storms/century

GCM-22
IPSL-CM5B-LR
23922 tracks
6328 survivors

222.78 storms/century

GCM-26
MPI-ESM-LR
19684 tracks
6708 survivors

223.04 storms/century

GCM-27
MPI-ESM-MR
21590 tracks
6969 survivors

245.47 storms/century

GCM-23
MIROC5
29654 tracks
9216 survivors

277.13 storms/century

GCM-24
MIROC-ESM
27239 tracks
5499 survivors

192.64 storms/century

GCM-28
MRI-CGCM3
22758 tracks
5993 survivors

212.25 storms/century

GCM-29
MRI-ESM1
23950 tracks
6432 survivors

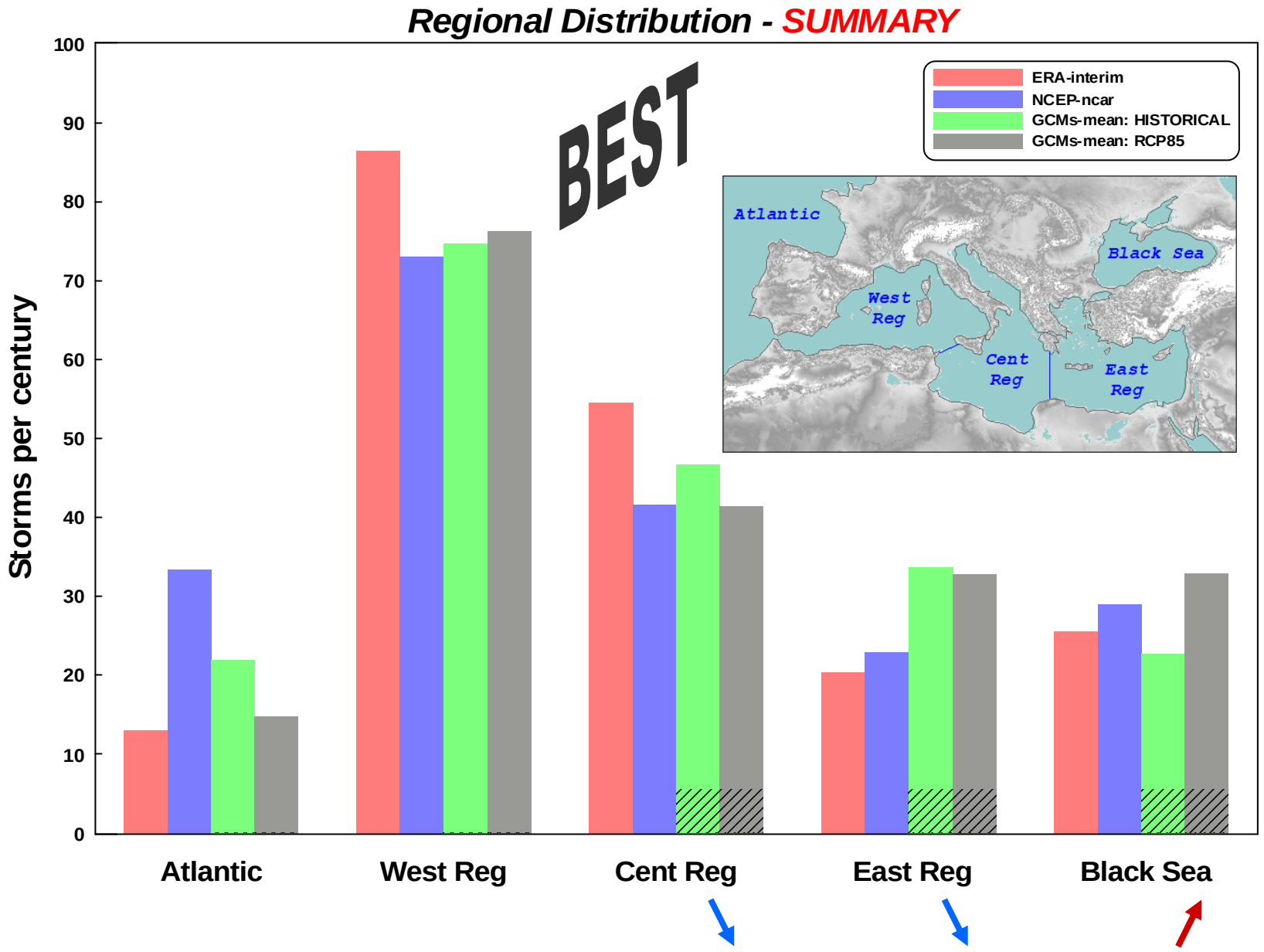
218.11 storms/century

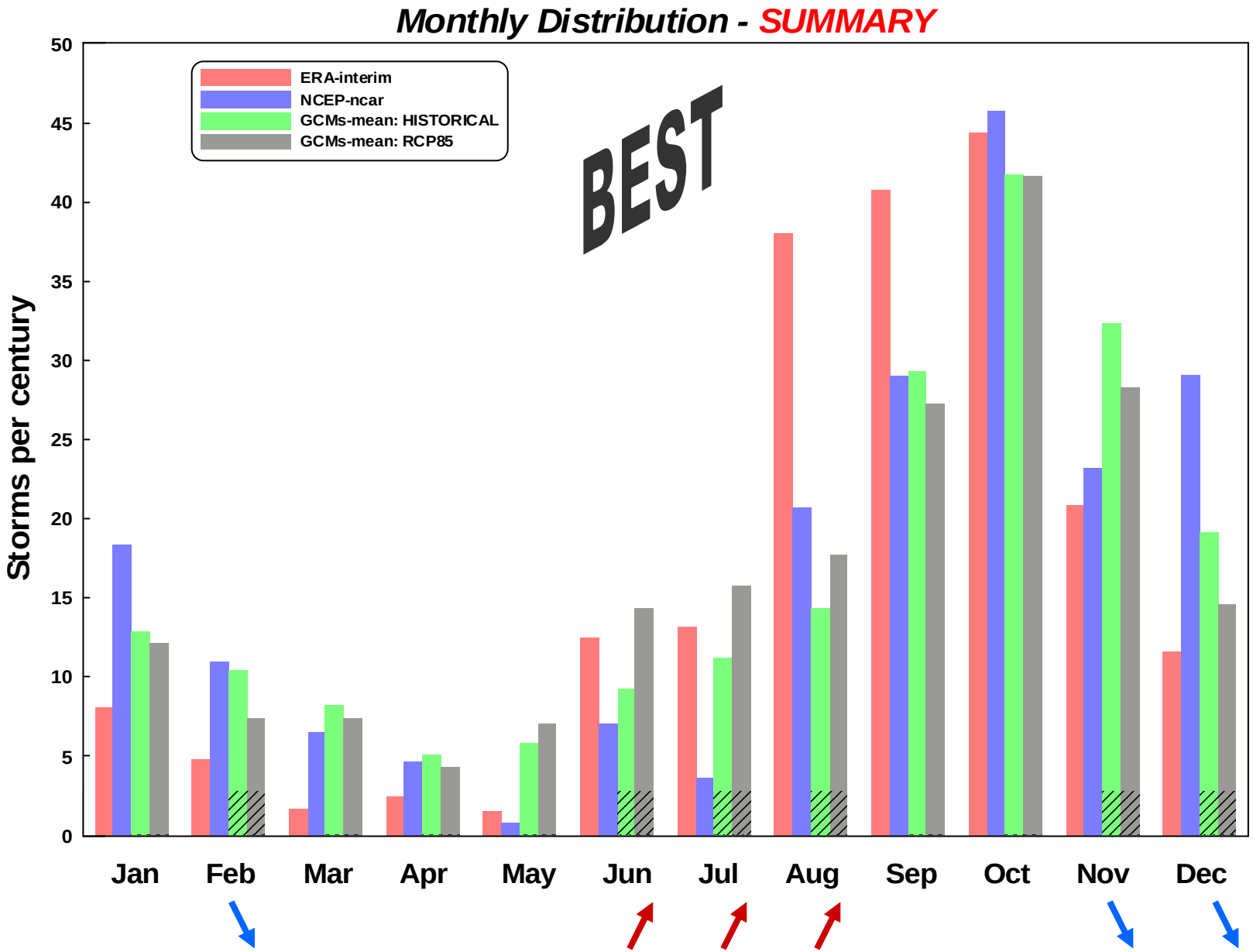
10 models
▼▼▼

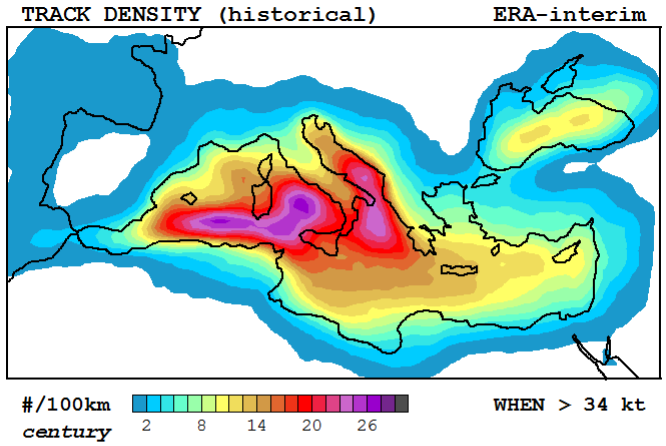
10 models
▲▲▲

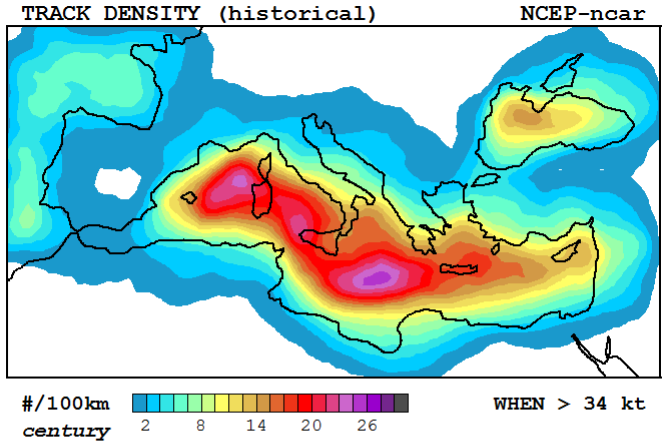
GCM-30
NorESM1-M
22427 tracks
5914 survivors

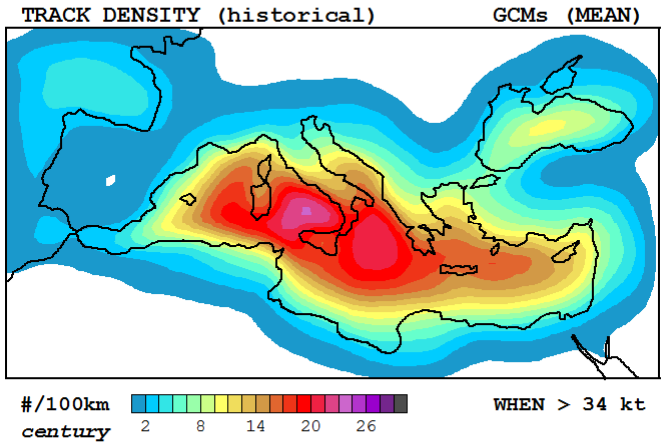
180.36 storms/century

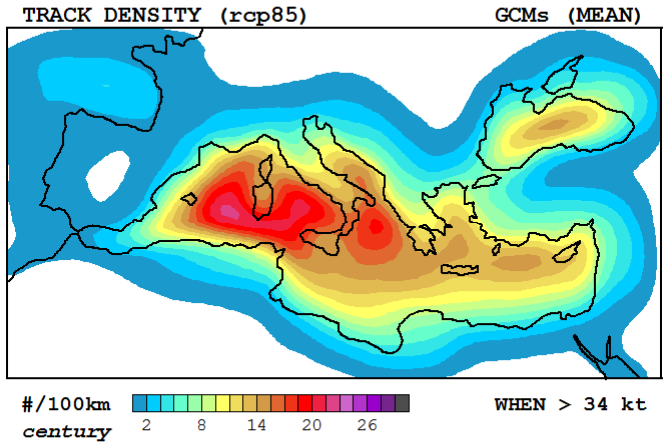

Regional Distribution - SUMMARY
BEST
ERA-interim
NCEP-ncar
GCMs-mean: HISTORICAL
GCMs-mean: RCP85
Atlantic
Black Sea
West Reg
Cent Reg
East Reg
Storms per century
100
90
80
70
60
50
40
30
20
10
0
Atlantic
West Reg
Cent Reg
East Reg
Black Sea


Monthly Distribution - SUMMARY
ERA-interim
NCEP-ncar
GCMs-mean: HISTORICAL
GCMs-mean: RCP85
BEST
Storms per century
0
5
10
15
20
25
30
35
40
45
50
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec







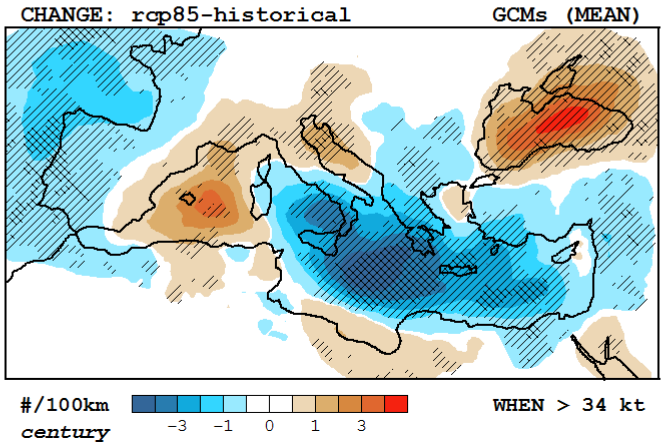


CORR

REAn01 = 0.948
REAn02 = 0.942
MEAN = **0.945**

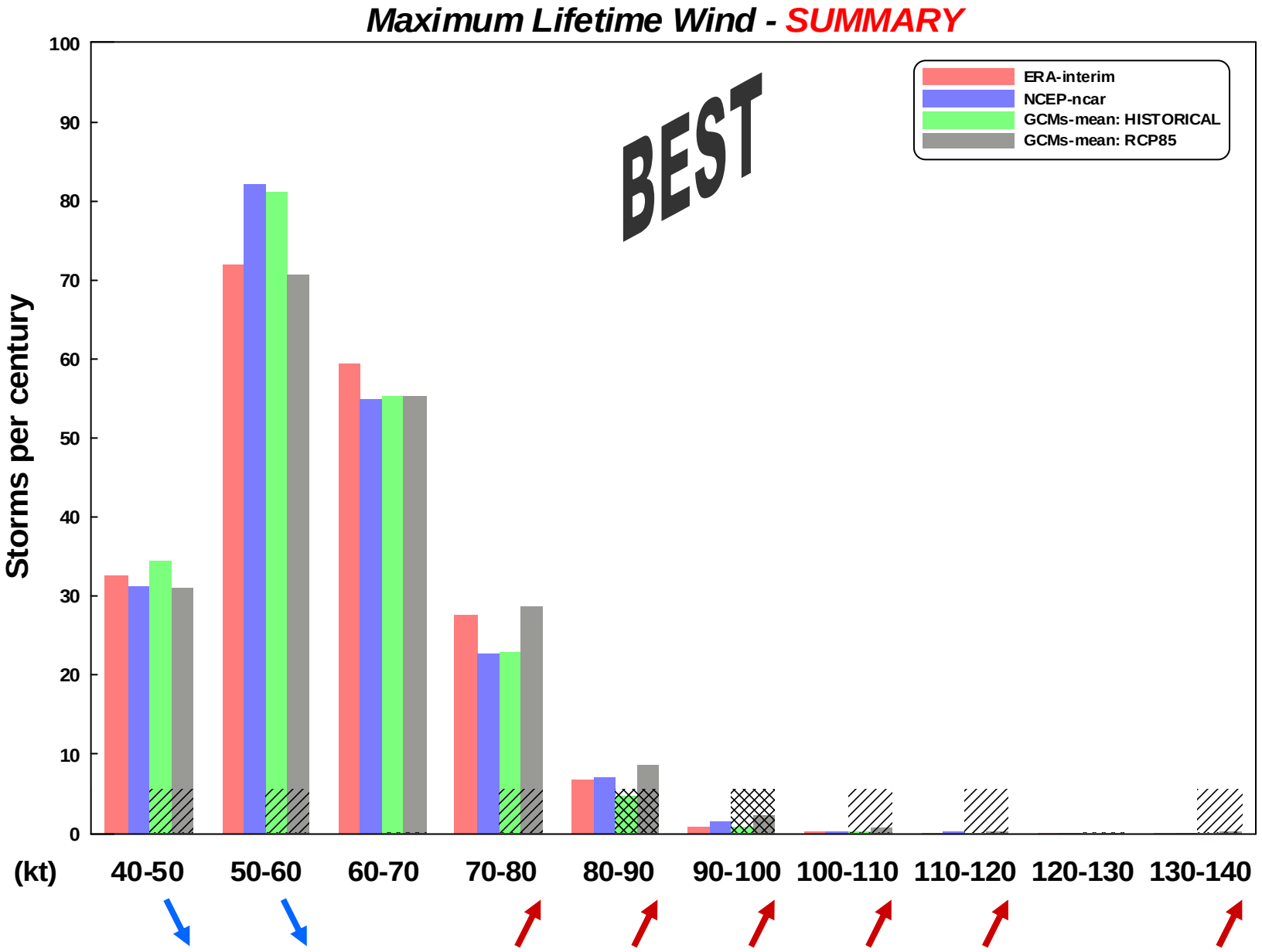
RMSE

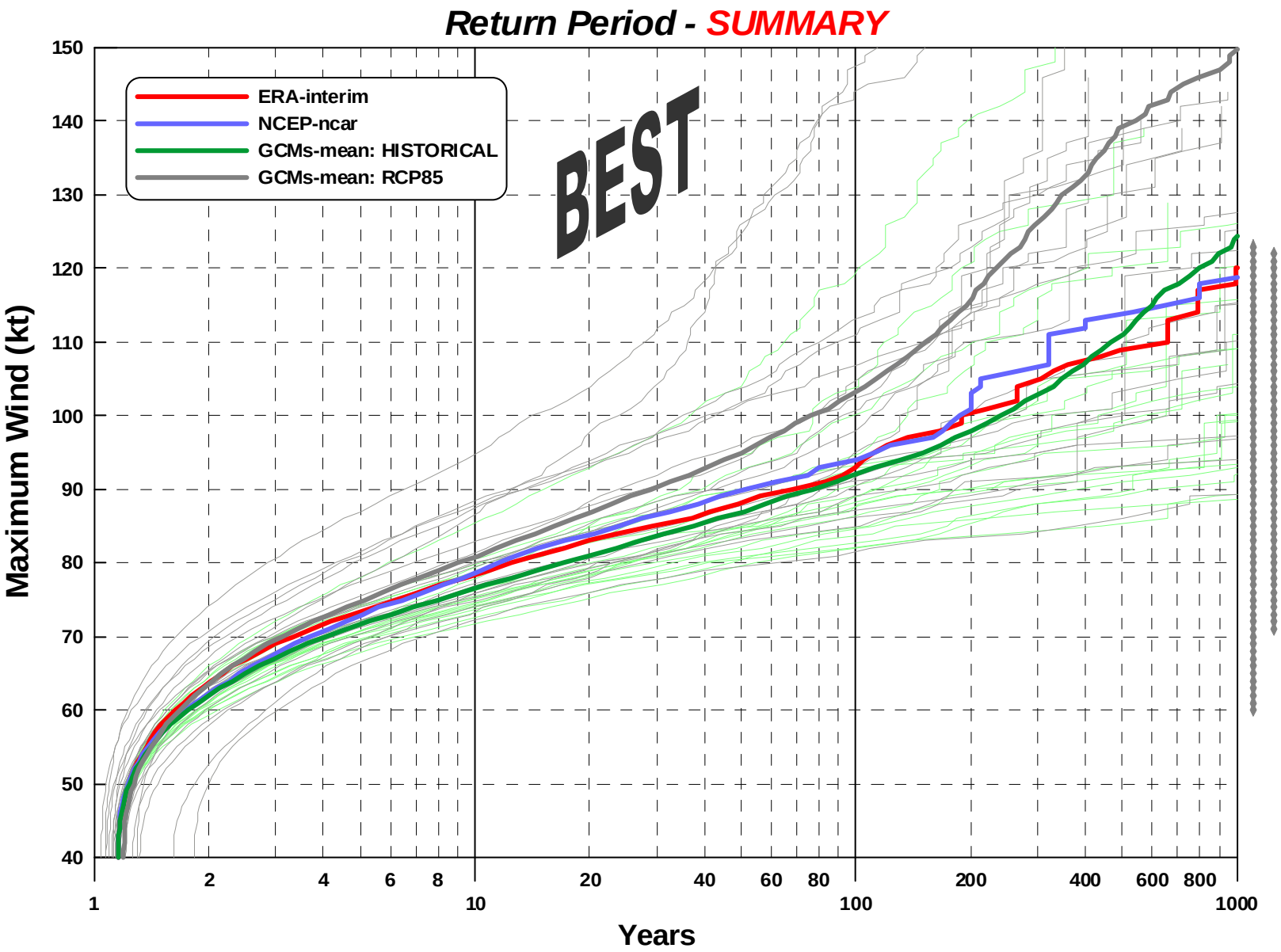
REAn01 = 1.907
REAn02 = 1.930
MEAN = **1.918**

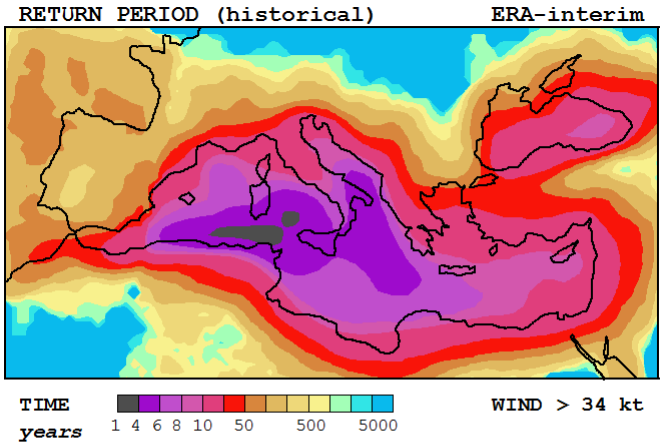


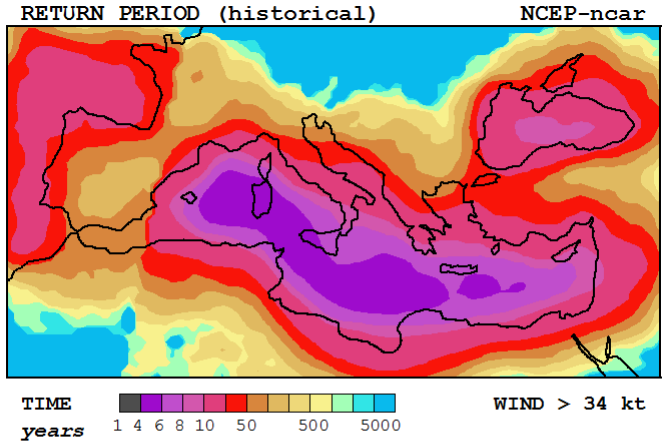
Track
Density
Summary

BEST


Maximum Lifetime Wind - SUMMARY
BEST
ERA-interim
NCEP-ncar
GCMs-mean: HISTORICAL
GCMs-mean: RCP85
Storms per century
100
90
80
70
60
50
40
30
20
10
0
(kt)
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140


Return Period - SUMMARY
ERA-interim
NCEP-ncar
GCMs-mean: HISTORICAL
GCMs-mean: RCP85
BEST
Maximum Wind (kt)
150
140
130
120
110
100
90
80
70
60
50
40
1
2
4
6
8
10
20
40
60
80
100
200
400
600
800
1000
Years



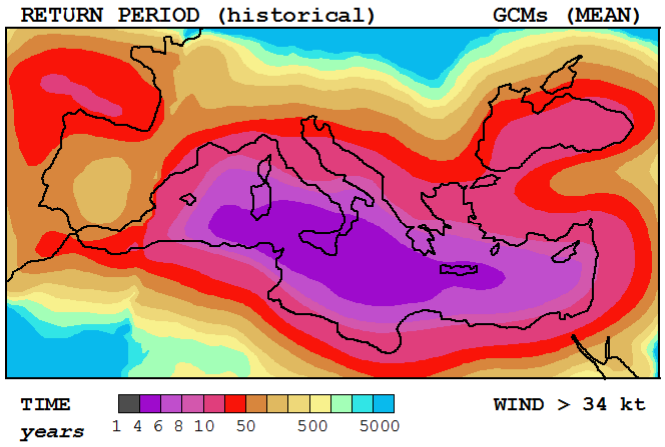


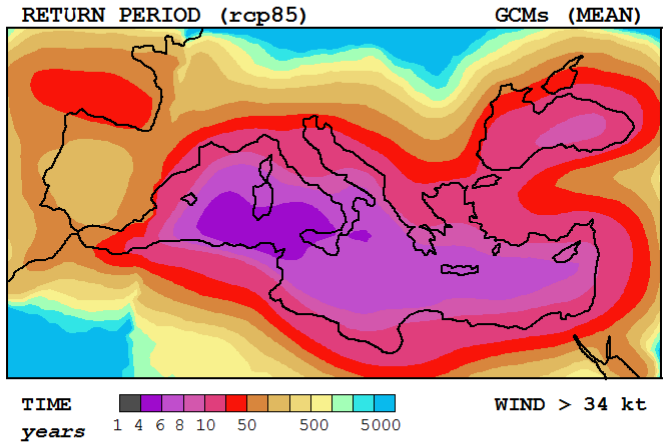
CORR

REAn01 = 0.768

REAn02 = 0.742

MEAN = **0.755**



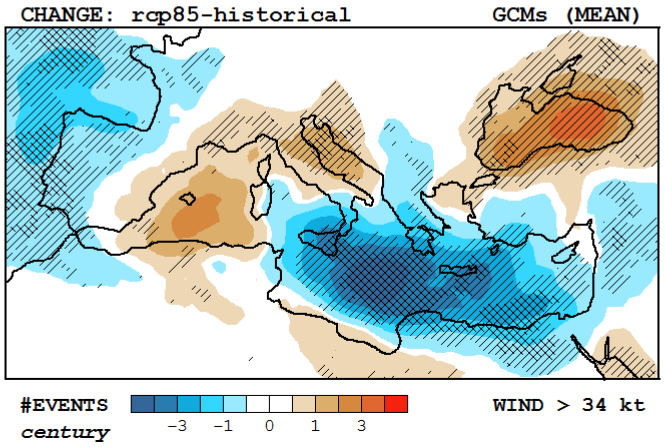


RMSE

REAn01 = 2.157

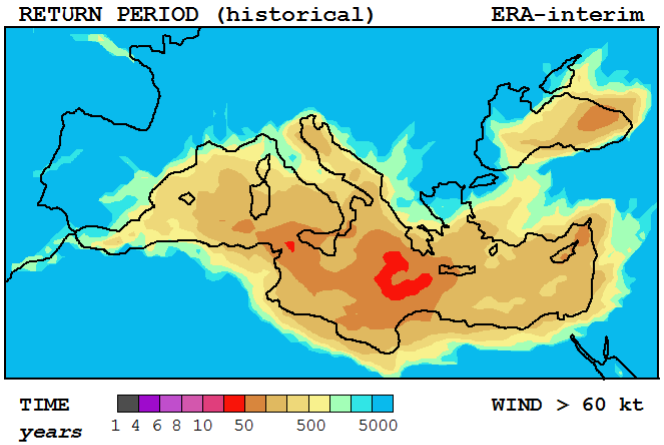
REAn02 = 4.131

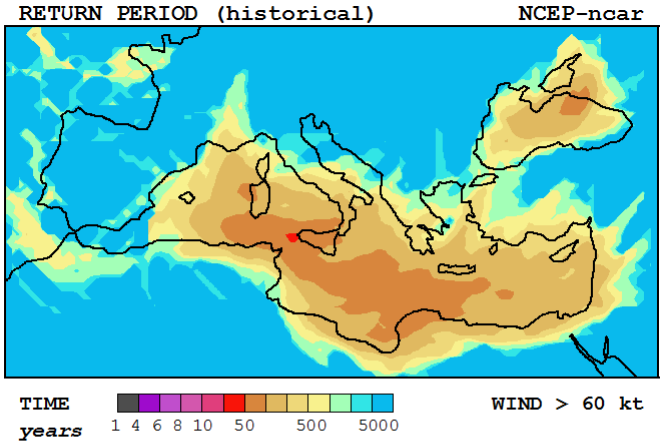
MEAN = **3.144**



Return Period 34 kt Summary

BEST





CORR

REAn01 = 0.604

REAn02 = 0.649

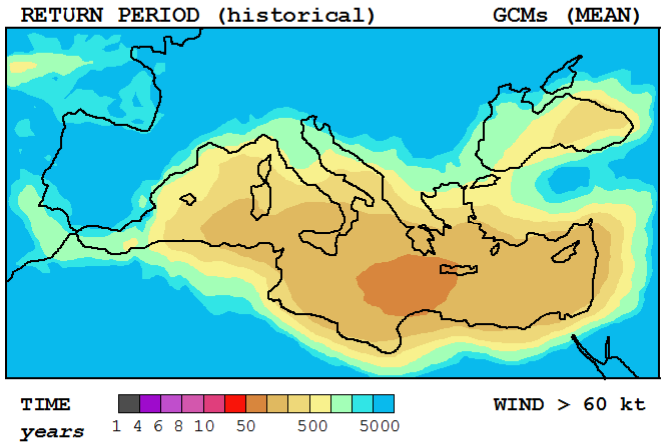
MEAN = **0.626**

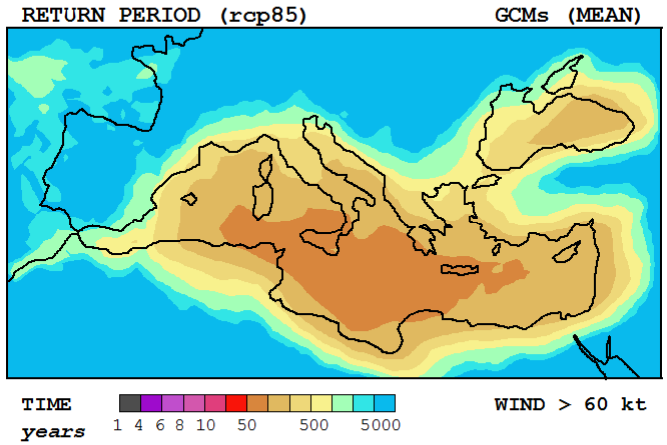
RMSE

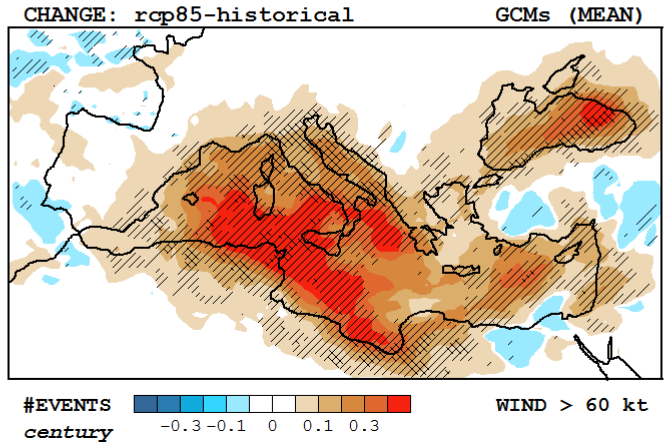
REAn01 = 4.972

REAn02 = 8.418

MEAN = **6.695**







Return Period 60 kt Summary

BEST


GRÀCIES PER
LA VOSTRA ATENCIÓ !!!

POSSIBLES TREBALLS PRÀCTICS

1. El centre de predicció i seguiment de **ciclons tropicals** de major prestigi al món és el **National Hurricane Center** de la NOAA (http://www.nhc.noaa.gov/). **Investigar** a partir d'aquesta pàgina web la **mecànica de funcionament del NHC i els diferents productes meteorològics específics que elabora per a la conca de l'Atlàntic i del Pacífic nordoriental**. Al no haver començat encara l'època d'huracans en l'hemisferi nord, es recomana il·lustrar l'informe utilitzant casos d'estudi de l'arxiu.

2. No existeix de moment una base de dades exhaustiva de **medicanes** amb una descripció detallada de la seva **formació** i **evolució** i molt menys dels **seus efectes** (pluges o vents registrats, danys sobre la població o les infraestructures, etc...). No obstant això, es poden trobar alguns casos ben documentats dispersos en diferents fòrums de la web. **Es demana elaborar un informe el més complet possible que reculli alguns casos notables -i probablement recents- de medicane**.