Mediterranean weather and climate; the focus of the Meteorology Group of the UIB

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Joint Meeting of the Climate and Meteorology Group of the Spanish Remote Sensing Society (AET) and the Spanish Ground Validation Group for the Global Precipitation Measurement (GPM) Mission

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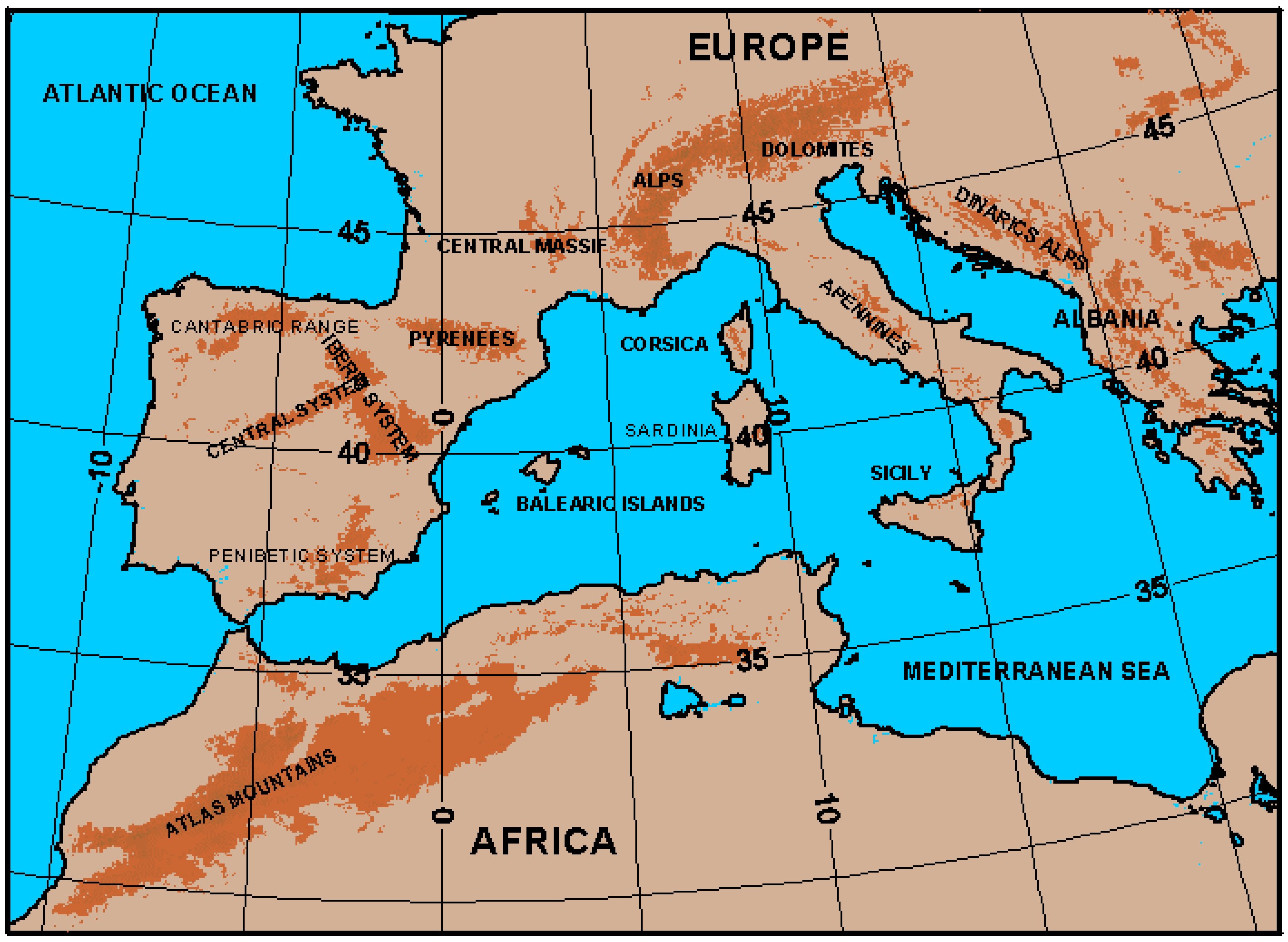
1. General aspects of the Mediterranean regional precipitation



Basic Ingredients in the genesis of severe weather events in the Mediterranean basin:

1) Warm sea s. temperature

2) Wind at low levels

→ Supply of moist and CAPE at low levels

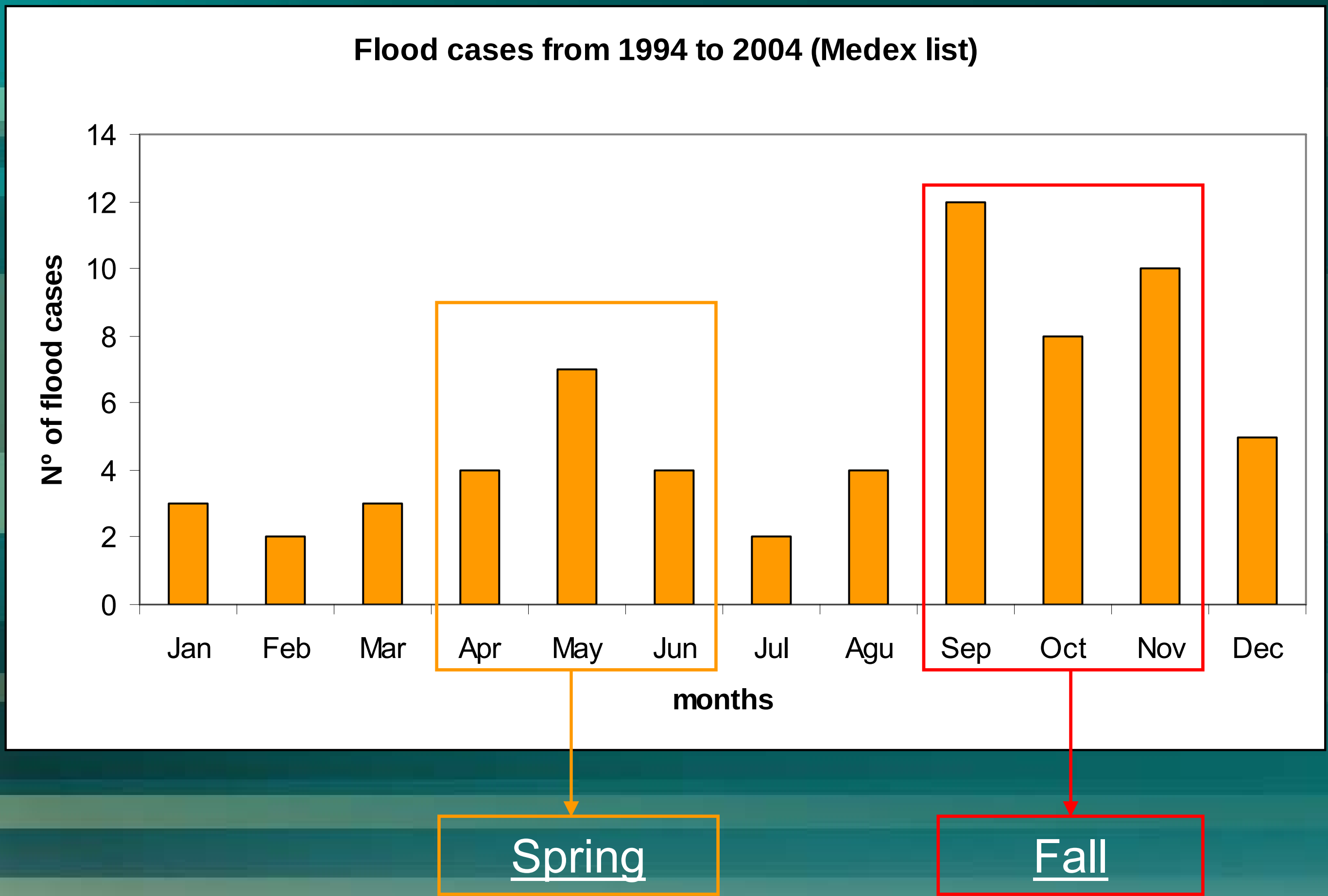
3) Irruption of cold air at different levels

→ Instability and rainfalls

4) Irregular topography

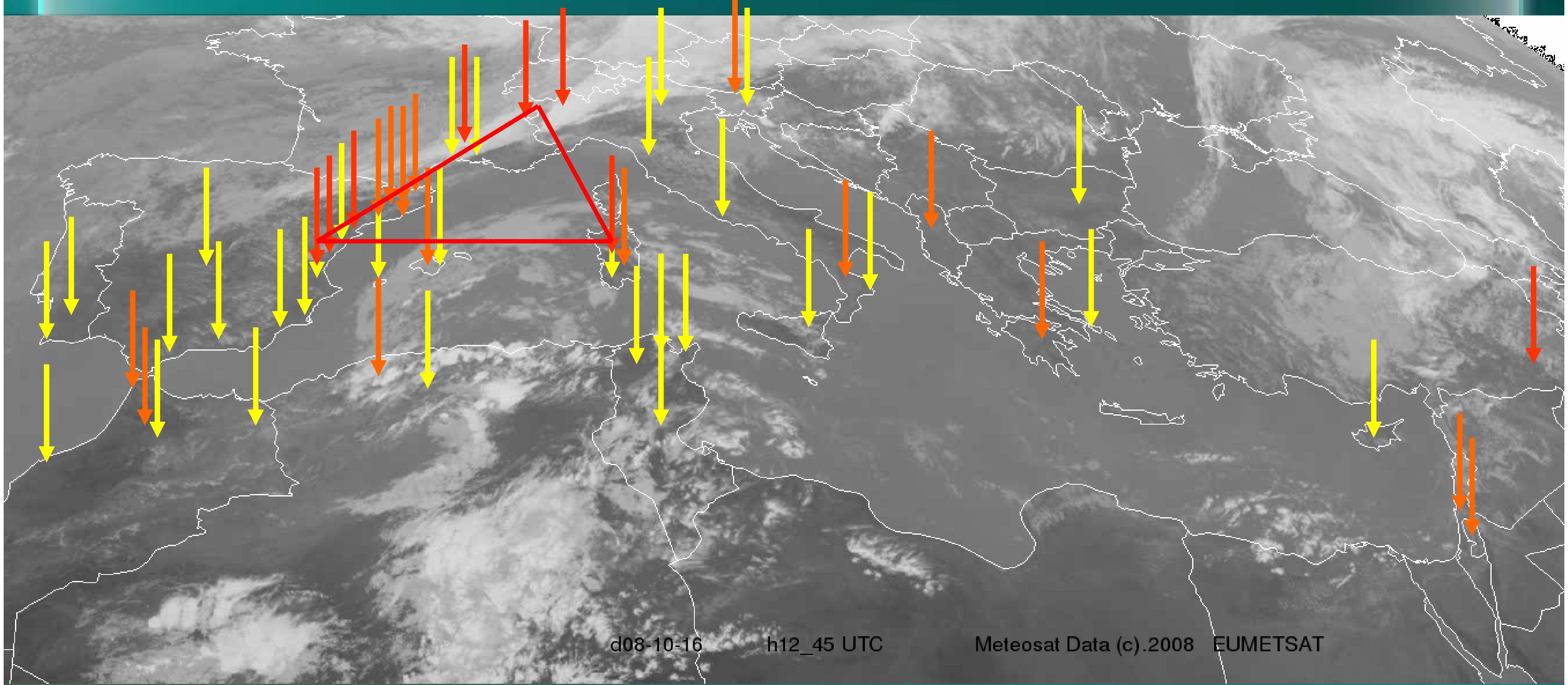
→ Regional or Local reinforce of rainfalls

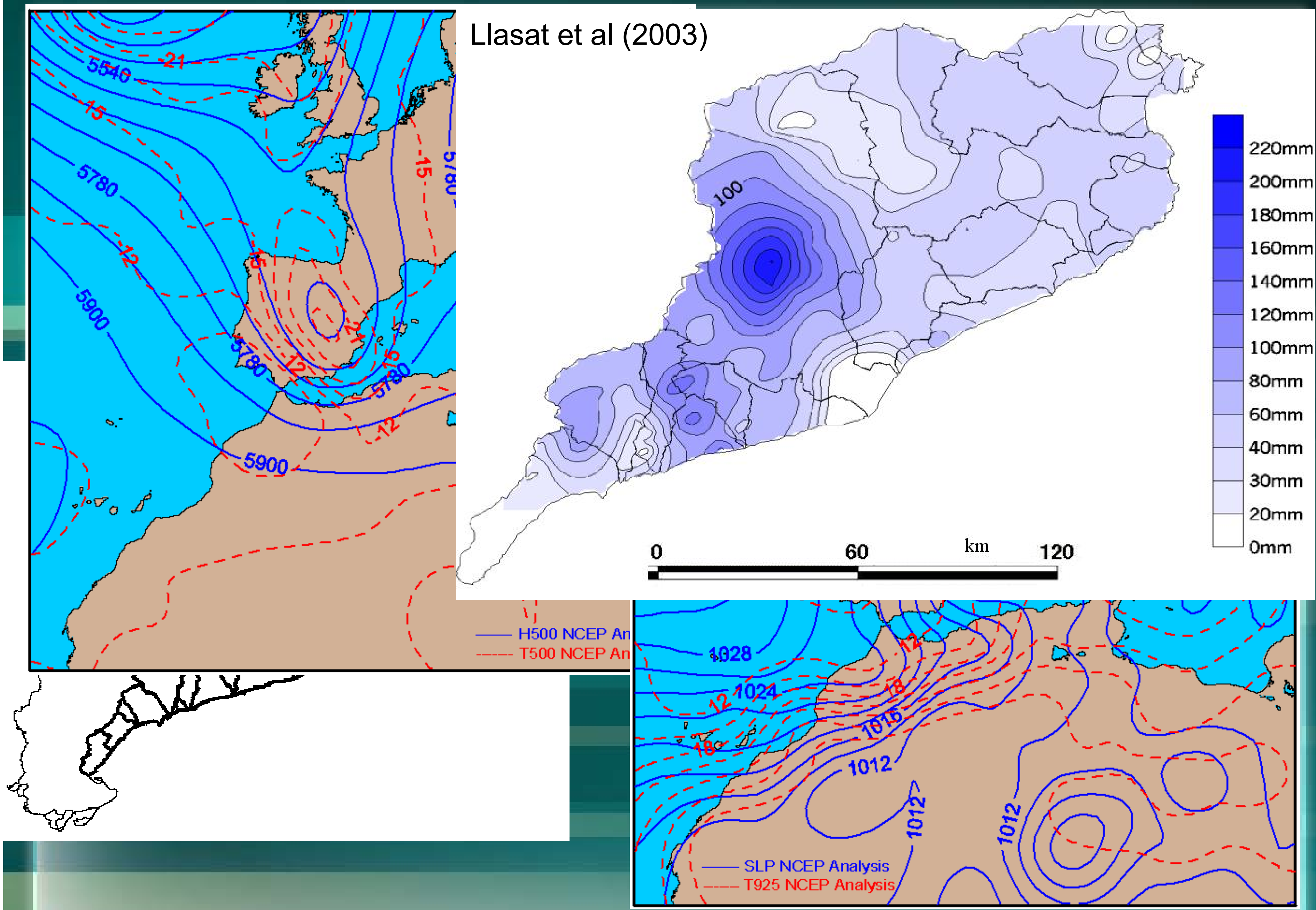
Frequency of cases with precipitation > 80 mm/24h from 1994 to 2004. (source: MEDEX project list in http://medex.inm.uib.es/data/Selection_cases.htm)



Spatial distribution of the most catastrophic cases from 1994 to 2004 (source: MEDEX project list)

- Between 80 and 200 mm/24h: 43 cases
- Between 200 and 400 mm/24h: 15 cases
- More than 400 mm/24h: 8 cases

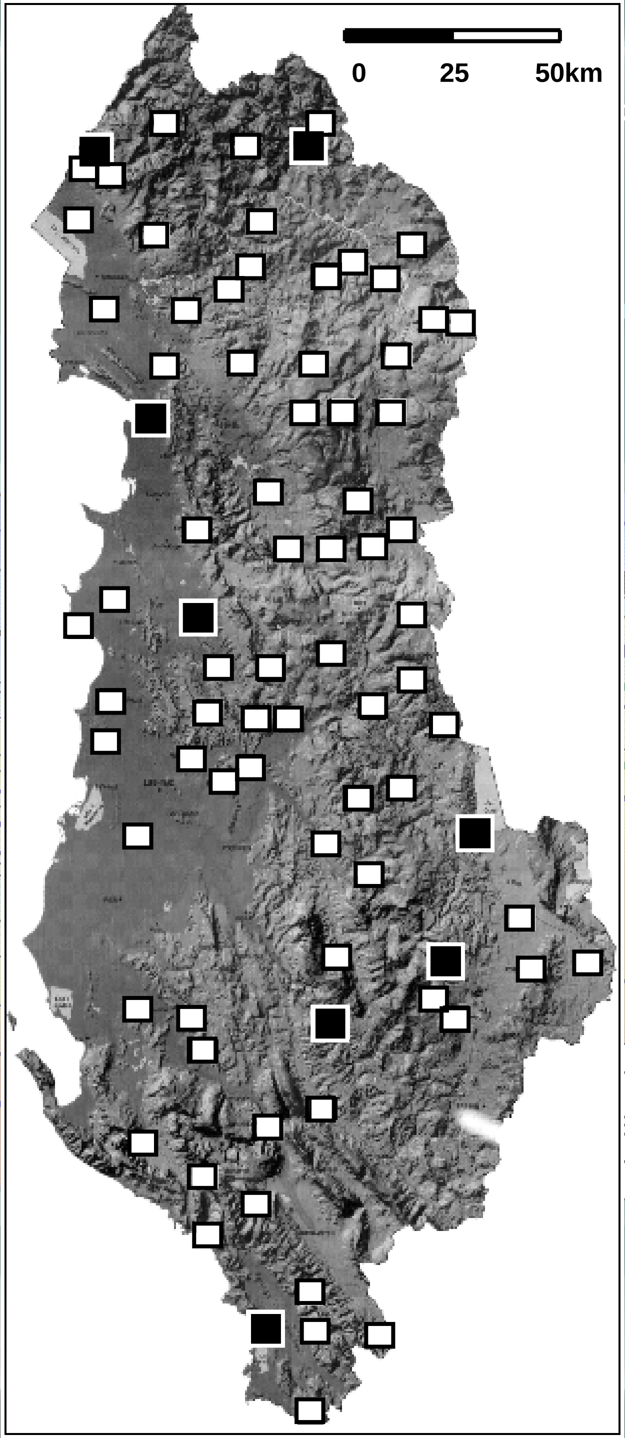




Llasat M. C., Rigo T., and Barriendos M., 2003, The 'Montserrat-2000' flash-flood event: a comparison with the floods in the Northeastern Iberian Peninsula since the 14th century, International Journal of Climatology, 23, 453-469.

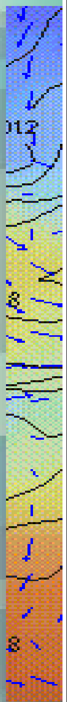
200 mm in 6 hours, 5 people died, 500 people displaced,

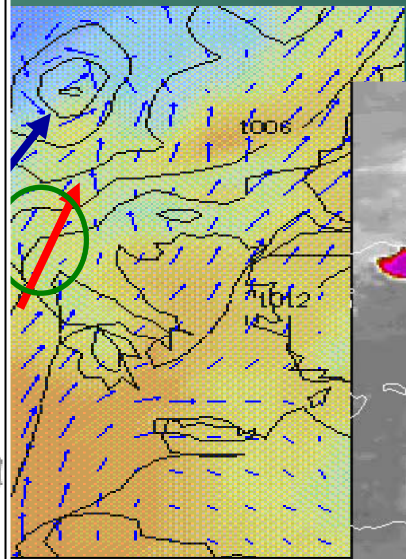
Historical and material damage (more than 65 M€)



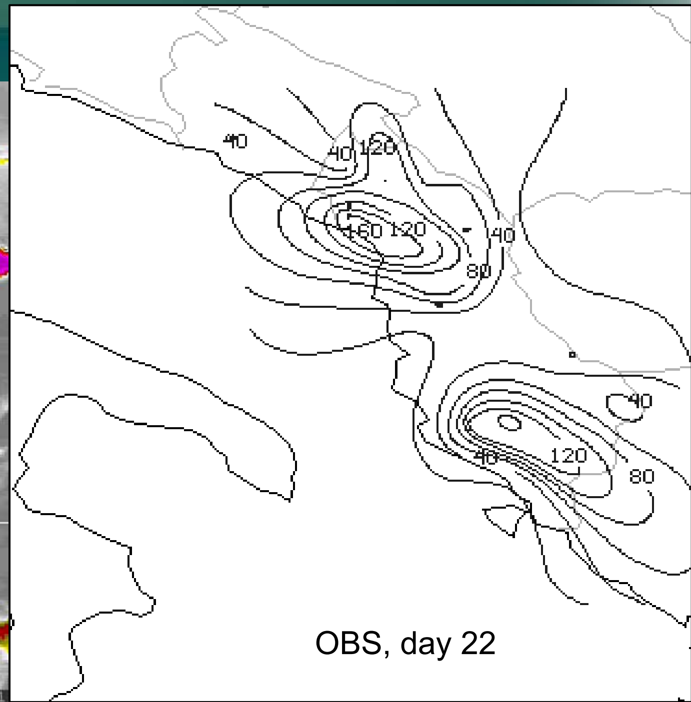
urred the 21-23/Sep/2002

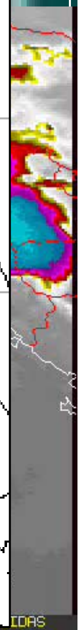
24 hours are registered the day 22 in
valleys.





temperature and the
e sea level pressure c
nber 2002 at 00 UTC

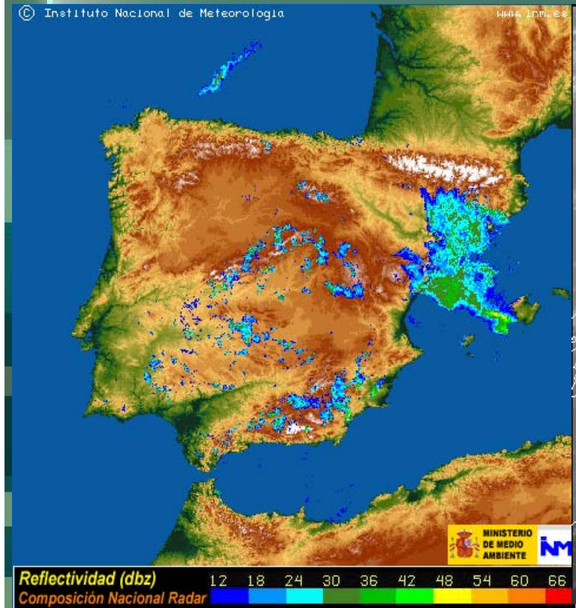


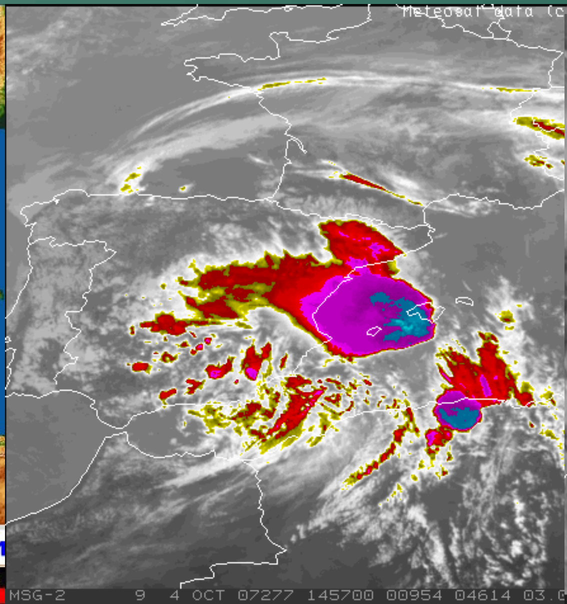


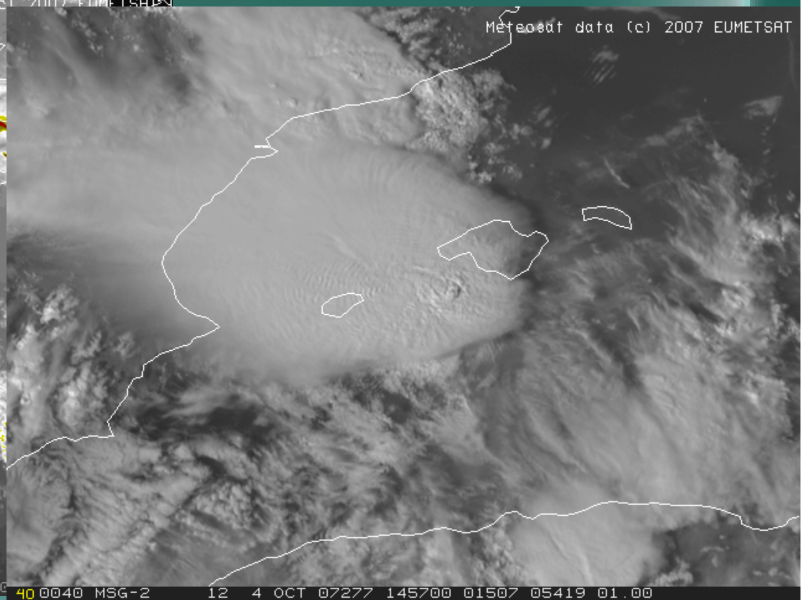
3) Recent cases in the Balearic Islands.

i) Palma de Mallorca the 4/Oct/2007

- A squall line moves from offshore Murcia to Leon Gulf passing over Mallorca at 17:00 (local time).
- Not much rain but very strong winds (max measured of 109 km/h) have affected urban areas producing, 1 death, 19 injuries and huge economical losses.








Sucesos

La tormenta
La tormenta

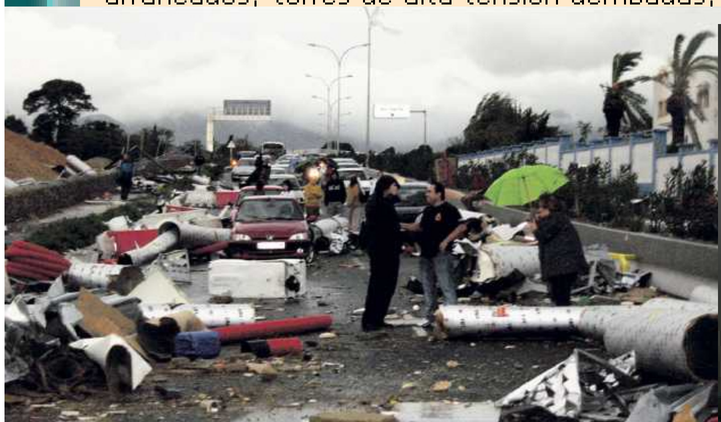
En el´polígono de Can Valero el desastre fue mayúsculo: volaron los tejados de algunas naves y decenas de coches quedaron destrozados. Foto: SEBASTIÀ AMENGUAL

Catastrófico

Una tormenta huracanada trae el caos a Palma en apenas quince minutos y deja un balance desolador

JAVIER JIMÉNEZ

Oscureció. Una gran nube negra entró por la bahía, cubrió Palma y desató el desastre. En Sólo quince minutos la capital balear padeció un calvario. Las consecuencia de la tormenta huracanada han sido catastróficas: una veintena de heridos, uno de ellos crítico; cientos de coches dañados; miles de árboles arrancados; torres de alta tensión derribadas;



Two weeks later, the 17-18/Oct/2007, after a stormy day in Mallorca (more than 60 mm/6 hours in Palma) a Tropical like Mediterranean Storm or Medicane was observed.

2.The Meteorology Group of the UIB, research lines.

http://www.uib.es/depart/dfs/meteorologia/

–Boundary Layer	PR: Joan Cuxart (joan.cuxart@uib.es)
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–Remote Sensing	PR: Angel Luque (angel.luque@uib.es)
–Severe Weather	PR: Climent Ramis (cramis@uib.es)

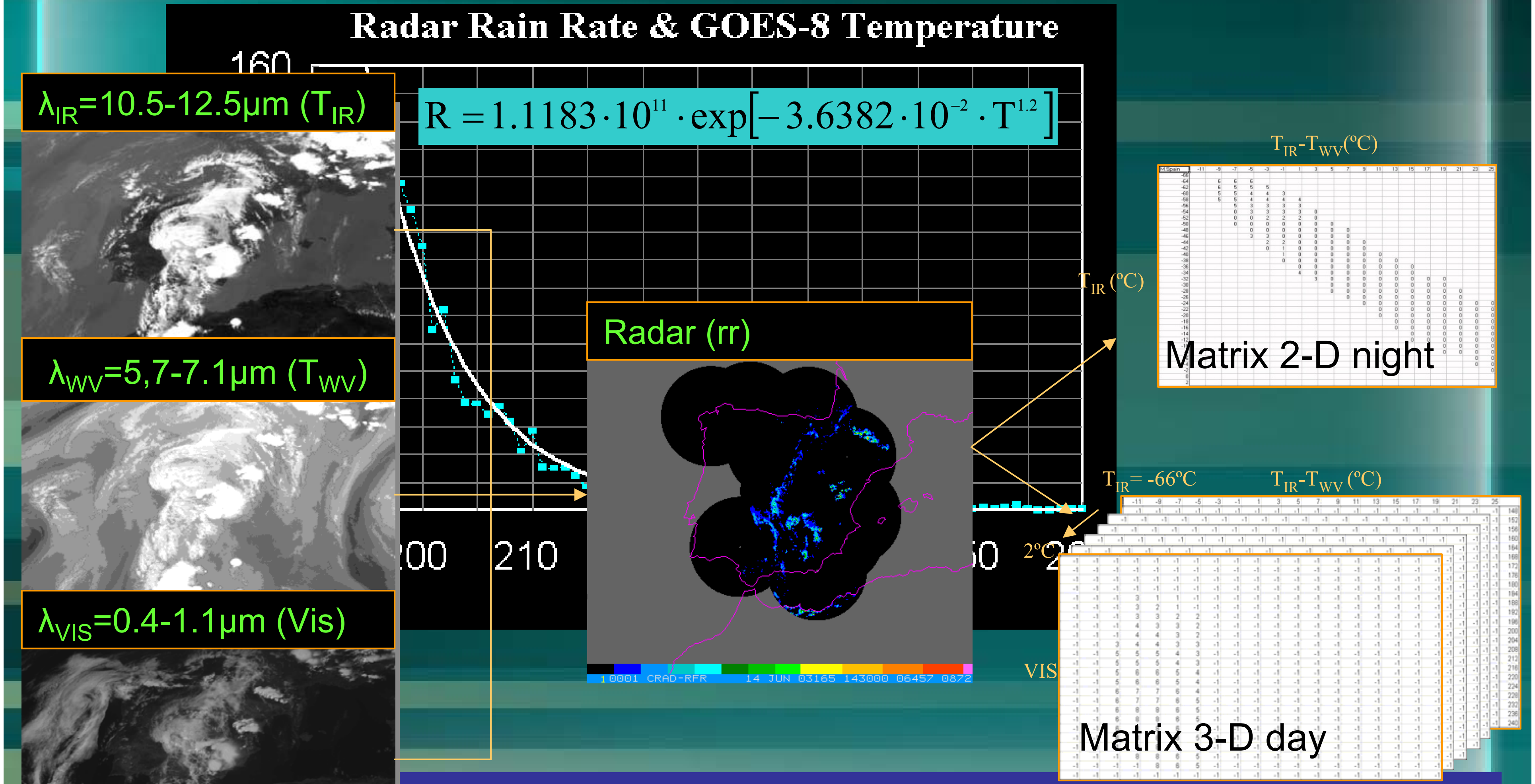
The focus of the Remote Sensing research line

- Estimation of the precipitation from geosynchronous satellites for operational purposes in Mediterranean regions.
  - -Auto-Estimator (Vicente et al., 1998) as a first guess.
  - -Satellite rainfall correction factors (Vicente et al., 1998, 2002).
  - -Convective Rainfall Rate (CRR) (AEMET, SAFNWC)
  - -Calibration with rain gauges, radar and rpms.
  - -Improvement and delineation of new correction factors.
- Analysis of Tropical-like Mediterranean Storms (Medicanes)
  - – Detection of convective/stratiform rain pixels.
  - – Estimation of low level clouds movement.

Vicente G. A., Scofield R. A. and Menzel W. P., 1998, The operational GOES infrared rainfall estimation technique, Bulletin of the American Meteorological Society, 79, 1883-1898.

Vicente G. A., Davenport J. C. and Scofield R. A., 2002, The role of orographic and parallax corrections on real time high resolution satellite rainfall rate distribution, *International Journal of Remote Sensing* 23, 221-230.

- The estimation methods applied by us are:
  - -AE (Auto-Estimator), Vicente et al. (1998)



…and Menzel W. P., 1998, The operational GOES infrared rainfall estimation technique,
…n Meteorological Society, 79, 1883-1898.

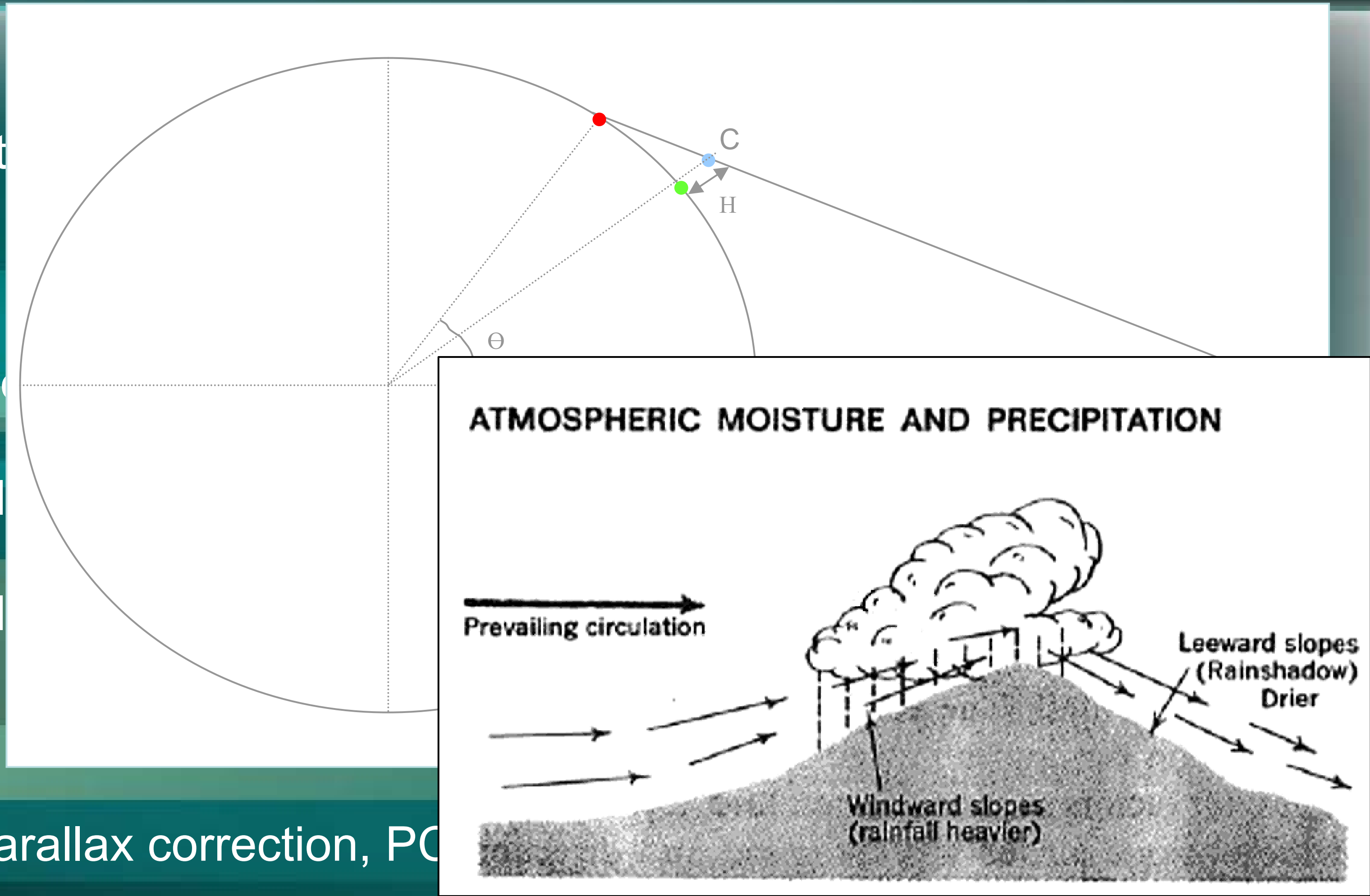
• Correct

Vicente

• 1º M

• 2º Cl

• 3º Cl



Vicente

• 4º Parallax correction, PC

• 5º Orographic correction, OC, winds from MM5

Vicente G. A., Scofield R. A. and Menzel W. P., 1998, The operational GOES infrared rainfall estimation technique, Bulletin of the American Meteorological Society, 79, 1883-1898.

Vicente G. A., Davenport J. C. and Scofield R. A., 2002, The role of orographic and parallax corrections on real time high resolution satellite rainfall rate distribution, *International Journal of Remote Sensing* 23, 221-230.

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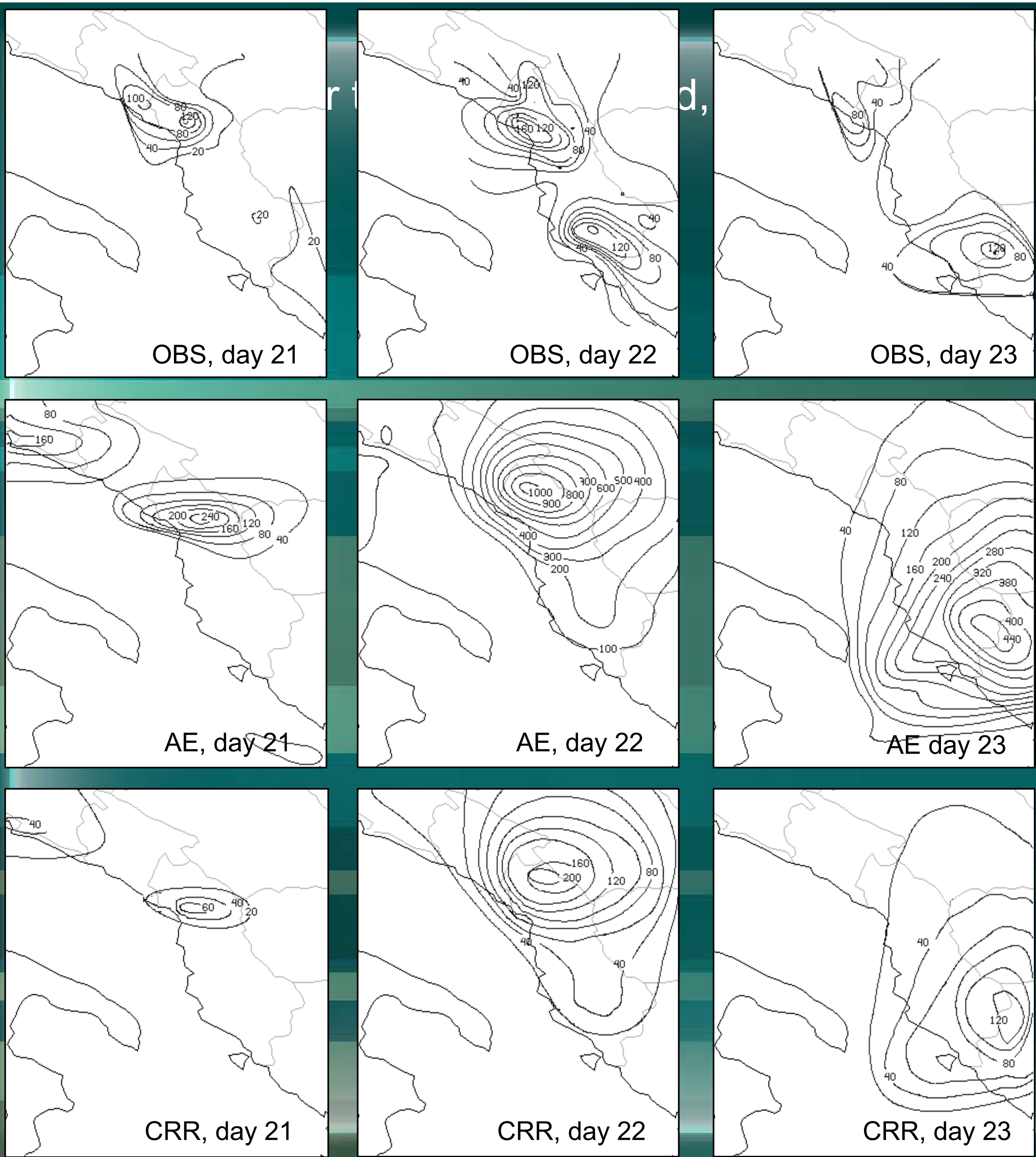


	OBS	AE	CRR	Day
Total Size	6699 (2055+2777+1867)			21, 22, 23
Mean	35.4	172.8	37.4	
SD	33.5	215.3	46.0	
BIAS		137.5	**2.1**	
RMS		246.5	**45.7**	
CORR		**0.39**	0.37	

Results for the sensitivity study of correction factors

– PC, GR2 and OC increase the correlation coefficient in 16%, 9% and 7% respectively.

– These correction factors can work one after another. The optimal order of correction factors we have find is:

Algorithm(AE or CRR) + GR2 + PC + OC   (24% increment in CC)

– This was tested in another flood case occurred in Albania the 7 y 8 nov 2004 using M8 images (T. Porja, 2006), obtaining an increment of the CC about 51%

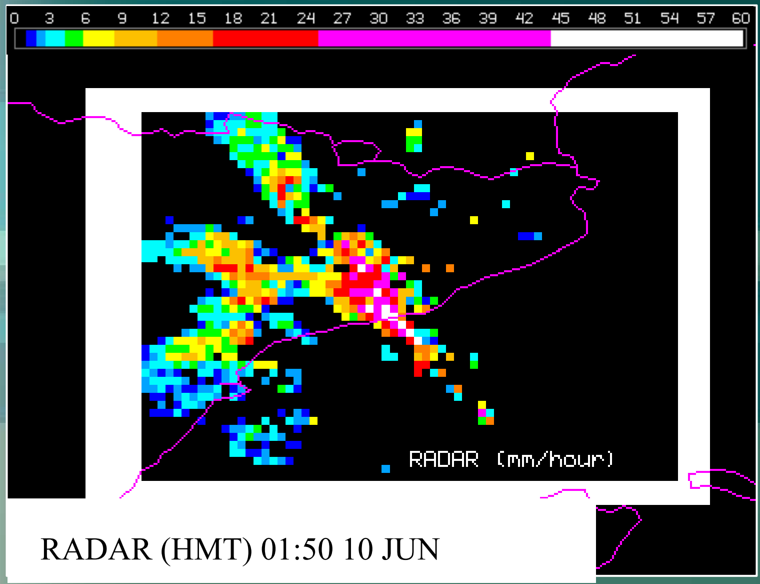
– Both cases in Albania were caused by MCS, therefore by convective clouds.

– However for the Montserrat flood (9-10/Jun/2000) caused by a frontal perturbation the increment in CC was only 5 %

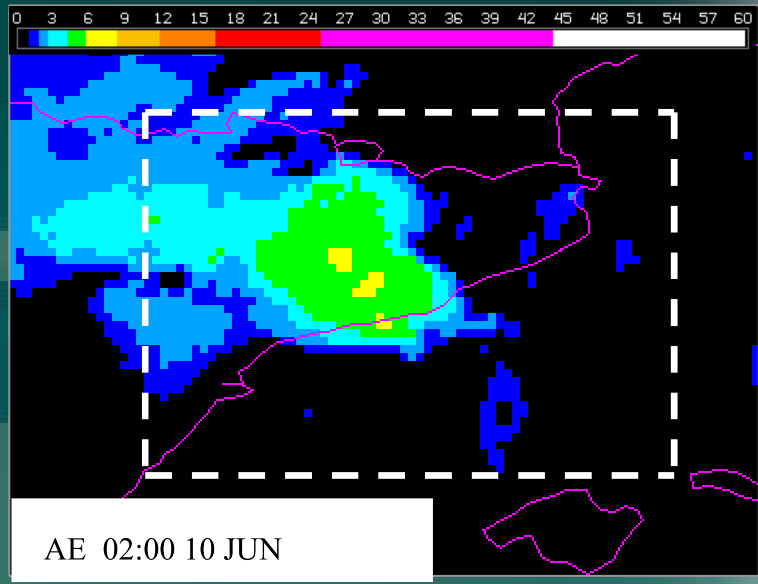
Porja, T.; Luque, A.; Fita, L.; Alonso, S.; Mustaqi, V. Rainfall analysis of flood cases over Albania, using Meteosat imagery, ground rain measurements and passive microwave rain rate. Lecture in the 6th Annual Meeting of the EMS / 6th ECAC. Ljubljana (ESLOVENIA), September, 2006.

Results for the Montserrat flood, occurred the 9-10/Jun/2000

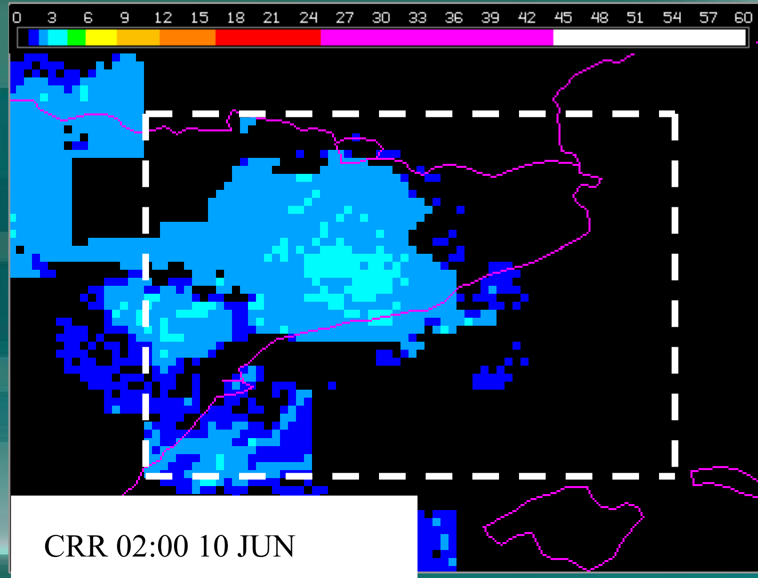
Rain Rates



RADAR (HMT) 01:50 10 JUN



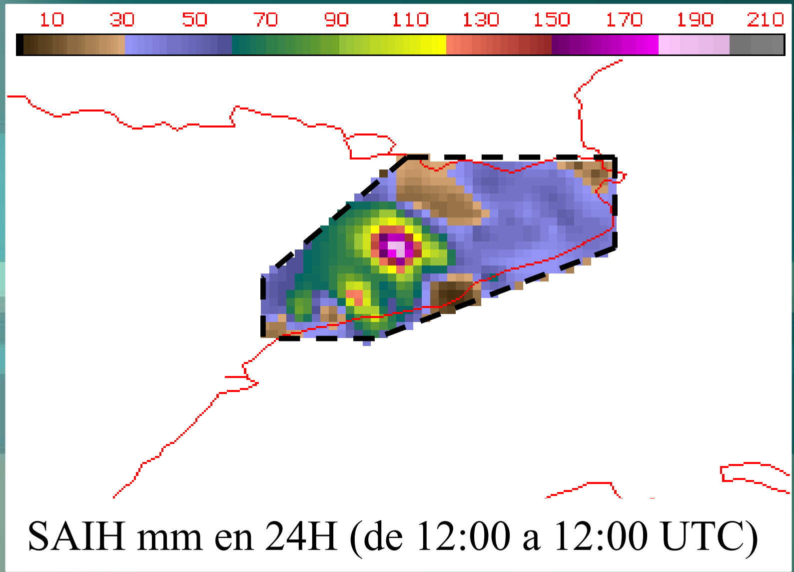
AE 02:00 10 JUN

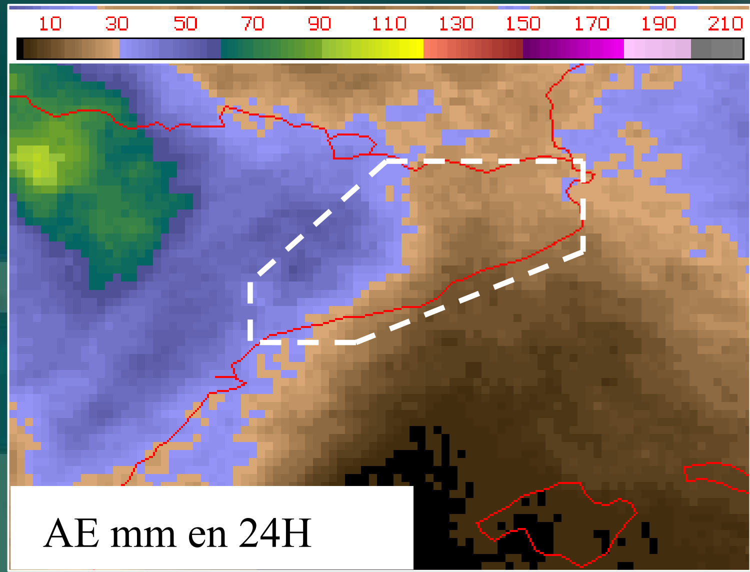


CRR 02:00 10 JUN

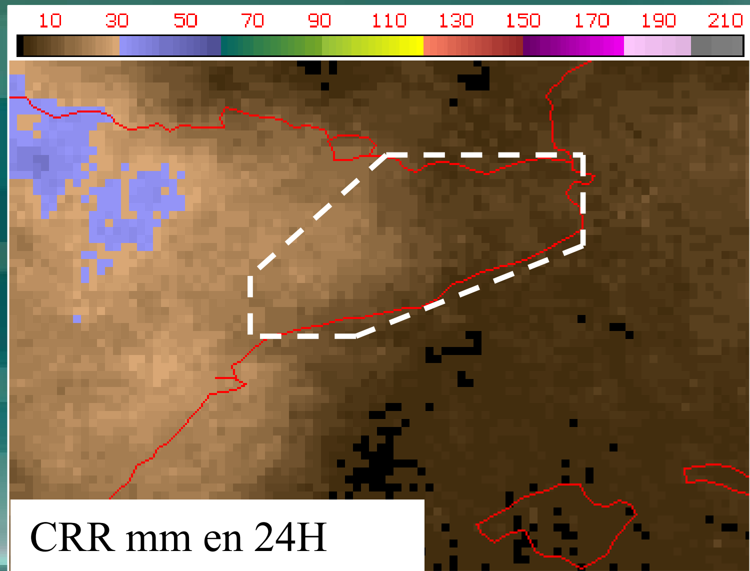
- The verification with respect to radar show that both techniques under-estimate rain rates (more the CRR than the AE).
- Correlation coefficients are: 0.45 for AE and 0.37 for CRR
- Only the parallax correction improve slightly the cc.

Rainfall accumulations in 24 hours





- The under-estimation of both techniques is much more clear.
- Correlation coefficients are: 0.48 for A-E and 0.51 for CRR
- Again only the parallax correction improve slightly the cc.



– Recalibratio ... ain gauges
and Rada

– An IR – ... using data
from

– For CR ... her volume
of da

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AE a ... e
micro

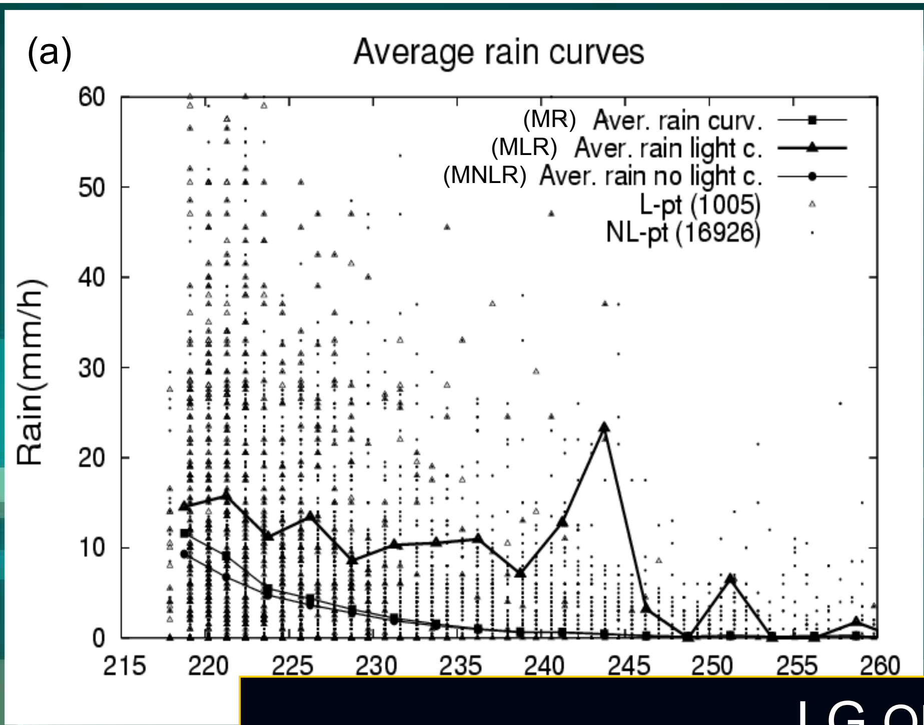
	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25
-66																			
-64																			
-62																			
-60				7	7														
-58			6	7	7	7													
-56		0	5	6	6	7													
-54	0	0	4	5	6	6	2												
-52	0	0	2	5	5	6	3												
-50	0	0	0	3	4	5	4	2											
-48	0	0	0	1	4	5	5	2											
-46	0	0	0	0	2	2	5	5	0	0									
-44			0	0	0	0	2	4	0	0									
-42			0	0	0	0	0	0	0	0									
-40				0	0	0	0	0	0	0	0								
-38					0	0	0	0	0	0	3	0							
-36					0	0	0	0	0	0	0	0							
-34						0	0	0	0	0	0	0							
-32						0	0	0	0	0	0	0	0						
-30							0	0	0	0	0	0	0	0					
-28						0	0	0	0	0	0	0	0	0	0				
-26								0	0	0	0	0	0	0	0				
-24								0	0	0	0	0	0	0	0	0	1		
-22									0	0	0	0	0	0	0	0			
-20									0	0	0	0	0	0	0	0	0	0	
-18										0	0	0	0	0	0	0	0	0	
-16											0	0	0	0	0	0	0	0	0
-14												0	0	0	0	0	0	0	0

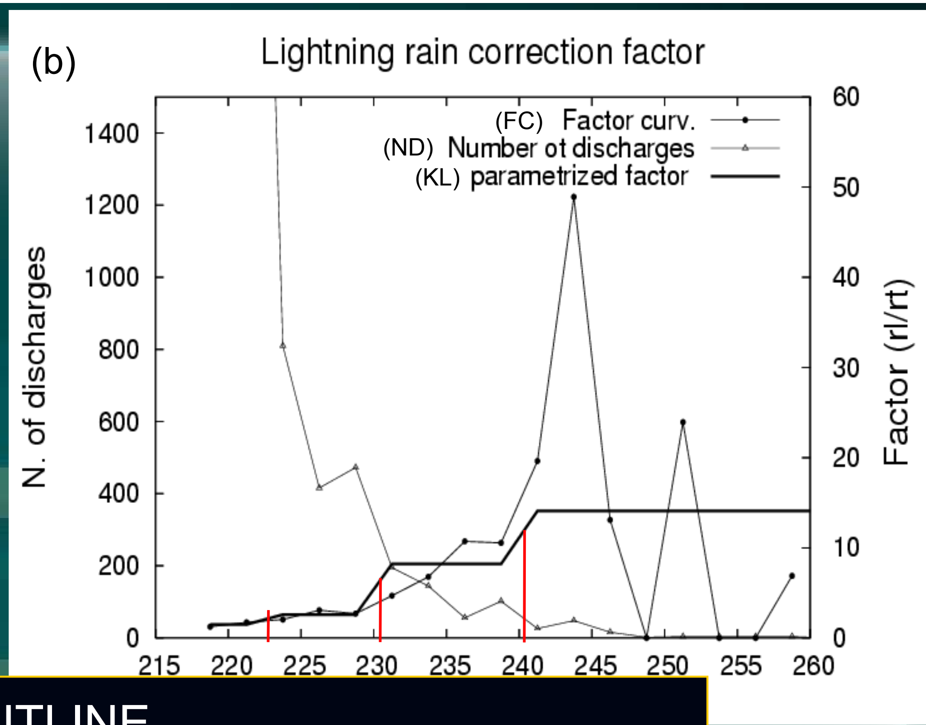
MCRR

	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	13	15	17	19	21	23	25
-66																			
-64		6	6	6															
-62		6	5	5	5														
-60		5	5	4	4	3													
-58		5	5	4	4	4	4												
-56			5	3	3	3	3												
-54			0	3	3	3	3	0											
-52			0	0	2	2	2	0											
-50			0	0	0	0	0	0	0										
-48				0	0	0	0	0	0	0									
-46				3	3	0	0	0	0	0									
-44					2	2	0	0	0	0	0								
-42					0	1	0	0	0	0	0								
-40						1	0	0	0	0	0	0							
-38						0	0	0	0	0	0	0	0						
-36							0	0	0	0	0	0	0	0					
-34							4	0	0	0	0	0	0	0					
-32								3	0	0	0	0	0	0	0	0			
-30									0	0	0	0	0	0	0	0			
-28									0	0	0	0	0	0	0	0	0		
-26										0	0	0	0	0	0	0	0		
-24											0	0	0	0	0	0	0	0	0
-22												0	0	0	0	0	0	0	0
-20												0	0	0	0	0	0	0	0
-18													0	0	0	0	0	0	0
-16													0	0	0	0	0	0	0
-14														0	0	0	0	0	0

CRR

– Use of the e ... areas
– We hav ... called LG





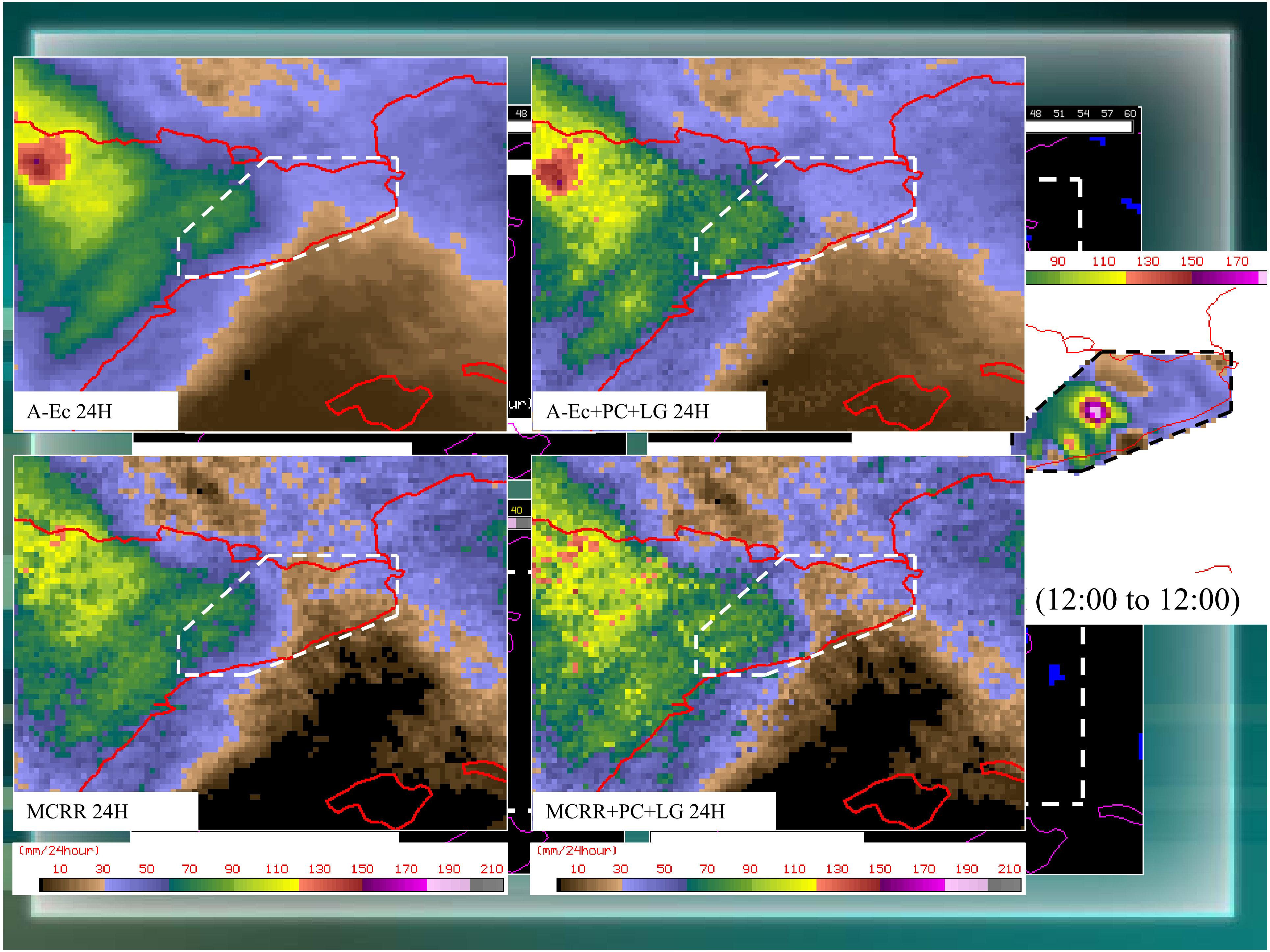
LG OUTLINE

- For satellite rainy electrified points:

- If $T_{IR} < 222.5$ K MF=1.5
- If 222.5 K $\leq T_{IR} < 230$ K MF=2.6
- If 230 K $\leq T_{IR} < 240$ K MF=8.2
- If $T_{IR} \geq 240$ K MF=14.1

- For satellite rainy non-electrified points:

- MF ≤ 1.00 (~0.90) so that Arr (cl area) = constant


A-Ec 24H
A-Ec+PC+LG 24H
MCRR 24H
MCRR+PC+LG 24H
(12:00 to 12:00)
(mm/24hour)
10 30 50 70 90 110 130 150 170 190 210
(mm/24hour)
10 30 50 70 90 110 130 150 170 190 210
90 110 130 150 170

PC, LG evaluation

– PC and LG increase the correlation coefficient in 2% and 8% respectively for rain rates and 3% and 15% for accumulations in 24 hours.

– The optimal order of correction factors we have find is:

Algorithm (AE or CRR) + PC + LG (9% increment in CC for rr and 17% in accumulations in 24h)

– The LG can help to match the highest satellite rain rates with the radar ones but it has to be tested in more study cases.

More information in: http://www.tesisenxarxa.net/TDX-0505108-125013/

3. Medicanes as observed from satellite.

- One or two Tropical-like Mediterranean storms or Medicanes (Emanuel, K. A., 2005) are observed as much every year in satellite images.
- They are warm cores formed typically under the effects of a cold and isolated depression at the medium and high levels of the atmosphere.
- The factors that impulse the formation of a Medicane instead of an ordinary depression are still not well known (Fita et al, 2007).
- Documented Medicanes have not usually achieved hurricane intensity (120 km/h=33.3 m/seg=64.8 knots).

- Some important study cases:

case	Beginning	Ending	Eye initial	eye end
950116	14/01 12^{00}	18/01 20^{00}	15/01 07^{00}	18/01 06^{30}
960912	11/09 21^{00}	13/09 02^{30}	12/09 05^{00}	12/09 12^{00}
961007	06/10 03^{30}	11/10 03^{00}	07/10 06^{30}	07/10 05^{30}
			08/10 12^{00}	10/10 06^{00}
030527	25/03 12^{00}	28/05 04^{30}	27/05 08^{30}	27/05 15^{30}
031018	17/10 00^{00}	19/10 04^{00}	18/10 05^{30}	18/10 13^{30}
051027	26/10 20^{30}	29/10 14^{30}	28/10 10^{00}	28/10 12^{00}
051215	13/12 05^{00}	16/12 12^{15}	14/12 08^{00}	14/12 15^{15}
			15/12 06^{00}	15/12 14^{15}

IR VIS WV (960912)

IR VIS WV (950116)

IR VIS WV (031018)

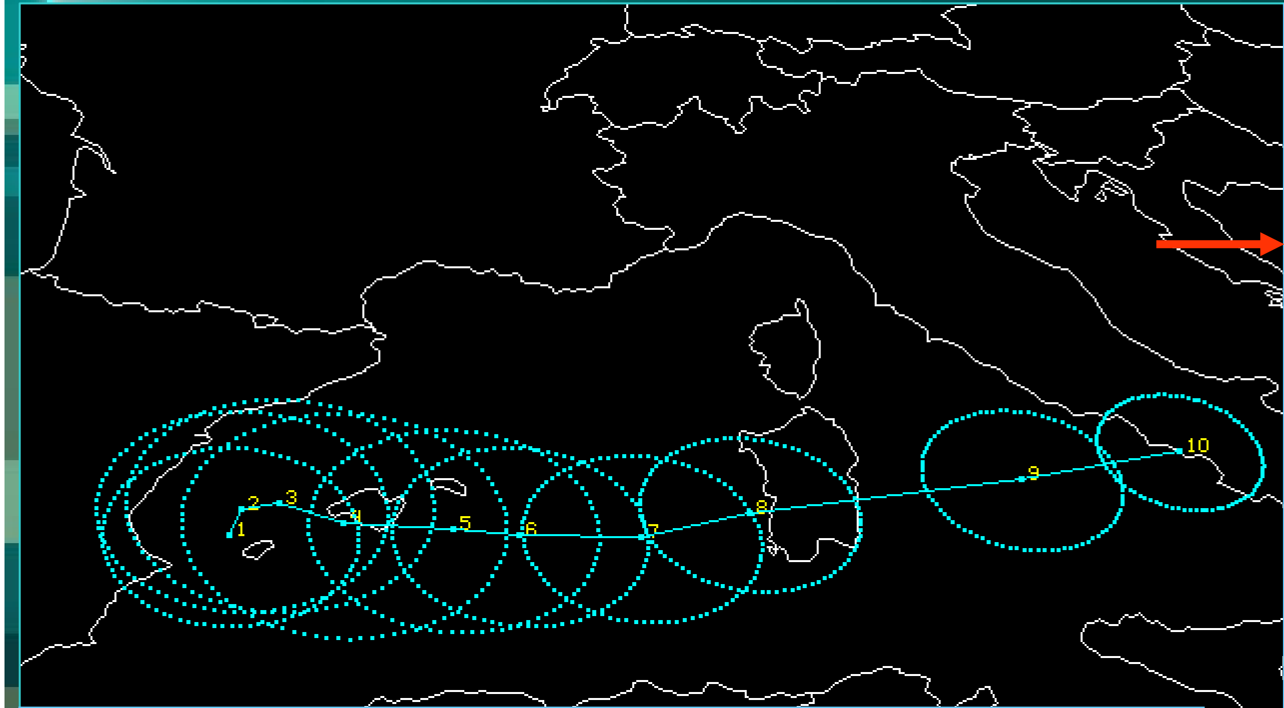
IR VIS WV (051215)

- All the satellite animations within a numerical analysis (Fita et al, 2006) can be found in:

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

Dynamic Analysis of the case 960912

Centre trajectory, size and mean storm speed are measured using Meteosat5 and SSM/I images



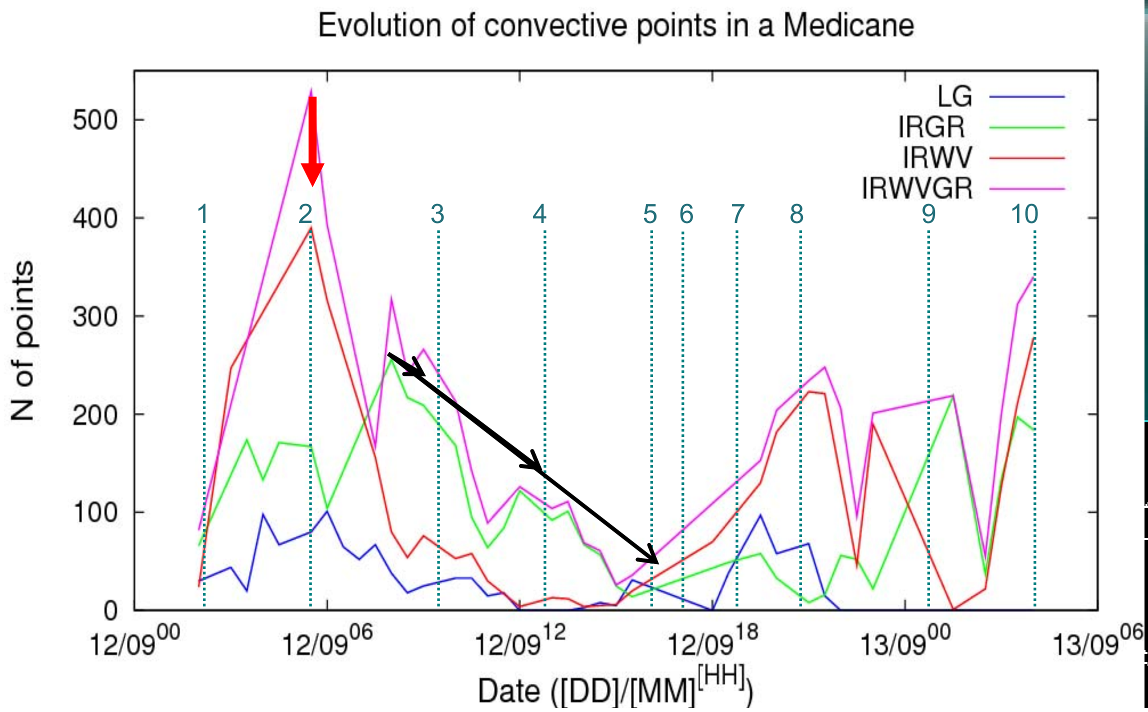
	DAY	Time (UTC)	Radius (km)
1	96/09/12	01:30	130
2	" / " /12	05:00	150
3	" / " /12	09:30	160
4	" / " /12	12:30	180
5	" / " /12	16:00	160
6	" / " /12	17:00	140
7	" / " /12	19:00	130
8	" / " /12	20:30	120
9	" / " /13	02:00	110
10	" / " /13	04:30	100

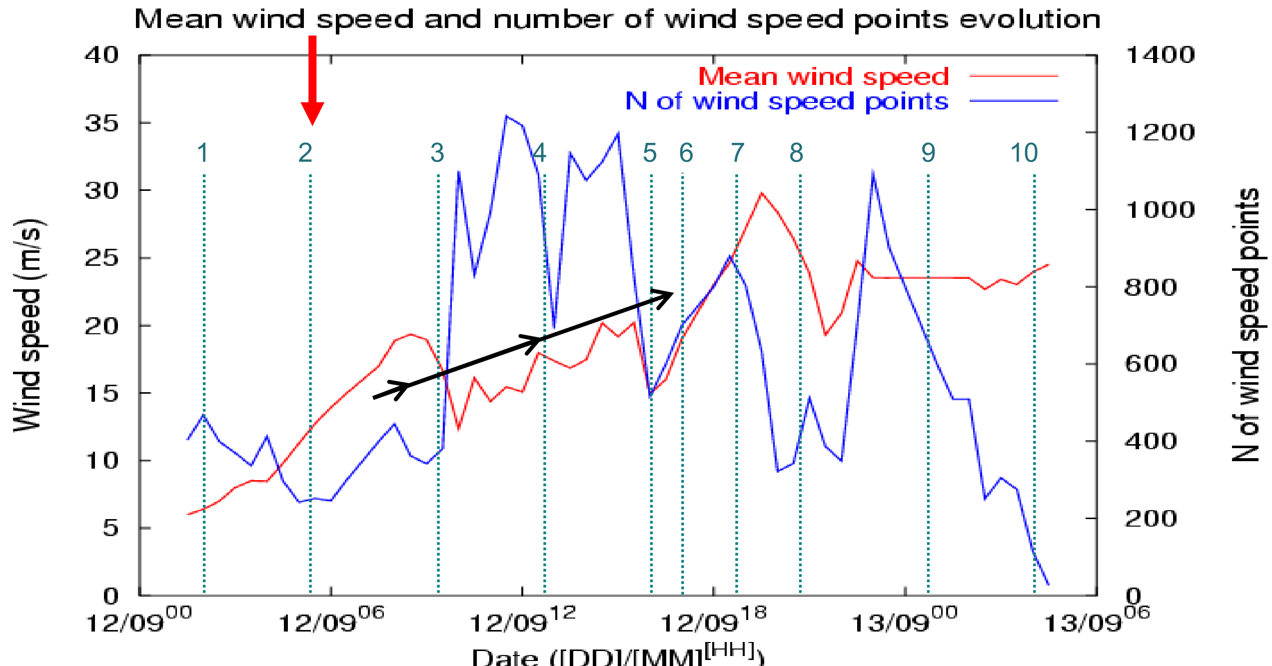
Total-time(HH:MM)= 27:00 = 27 hours

Mean A of I (radius)= 137 km

Total-dist= 1212 km Max winds = 60 knots

Speed of displacement= 44.89 Km/h = 24.24 knots


Evolution of convective points in a Medicane
N of points
Date ([DD]/[MM]^[HH])
LG
IRGR
IRWV
IRWVGR
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10
12/09^00 12/09^06 12/09^12 12/09^18 13/09^00 13/09^06


Mean wind speed and number of wind speed points evolution
Mean wind speed
N of wind speed points
Wind speed (m/s)
N of wind speed points
Date ([DD]/[MM]^[HH])
40 35 30 25 20 15 10 5 0
1400 1200 1000 800 600 400 200 0
1 2 3 4 5 6 7 8 9 10
12/09^00 12/09^06 12/09^12 12/09^18 13/09^00 13/09^06

General Conclusions

- Medicanes have a cloud round structure of 115 km (mean radius).
- They can travel more than 2500 km at a mean speed of 20 knots.
- They can provoke maximum surface winds greater than 55 knots (from SSMI and QuikScat images)

- Three phases in the live of a medicane were observed:
  - **Pre-medicane**: Strong convection before the eye appears.
  - **Stationary phase**: The medicane moves slowly. An eye is observed for the first time, convection decays and horizontal speed of low clouds began to increase (mean 12 m/s).
  - **traveller phase**: The medicane moves fast in a clear direction (at 20 knots), clouds speeds continue increasing (mean 18 m/s).

More information in:
http://www.eumetsat.int/Home/Main/Publications/Conference_and_Workshop_Proceedings/SP_1196354659081?l=en

Thank you

Special thanks to the institutions that have provided data for this work: *EUMETSAT, Remote Sensing Systems (RSS) and Spanish Weather Service (AEMET)*

Other collaborators: L. Fita, A. Amengual, A. Martin (UIB)
T. Porja (HMI of Albania)
A. Mira (Televisió de Mallorca)

Medex list of cases in: http://medex.inm.uib.es/data/Selection_cases.htm

Meteorology Group UIB: http://www.uib.es/depart/dfs/meteorologia/

A. Luque thesis work: http://www.tesisenxarxa.net/TDX-0505108-125013/

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Work about medicanes presented in EUMETSATCONF2007:
http://www.eumetsat.int/Home/Main/Publications/Conference_and_Workshop_Proceedings/SP_1196354659081?l=en