THE MEDEX:
A PROJECT ON MEDITERRANEAN CYCLONES
(SPECIAL PRESENTATION)

Mediterranean School on Mesoscale Meteorology – 1st Edition
(Alghero, Sardinia, June 7-11, 2004)

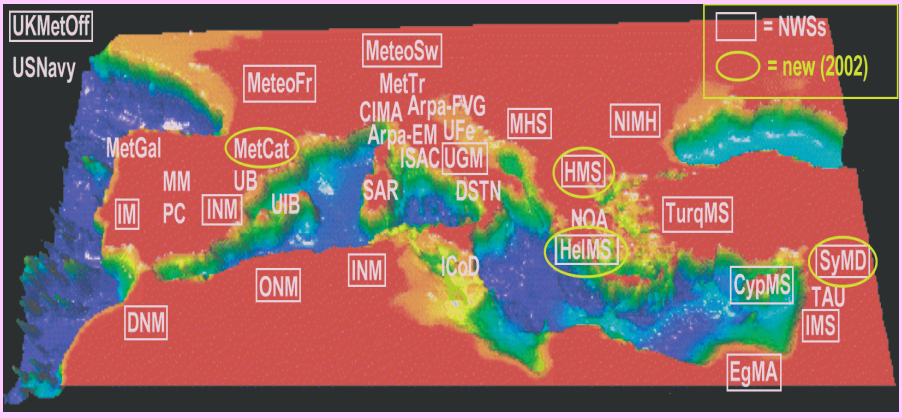
Romu Romero (Lecture 5)

Universitat de les Illes Balears

MEDEX http://medex.inm.uib.es/

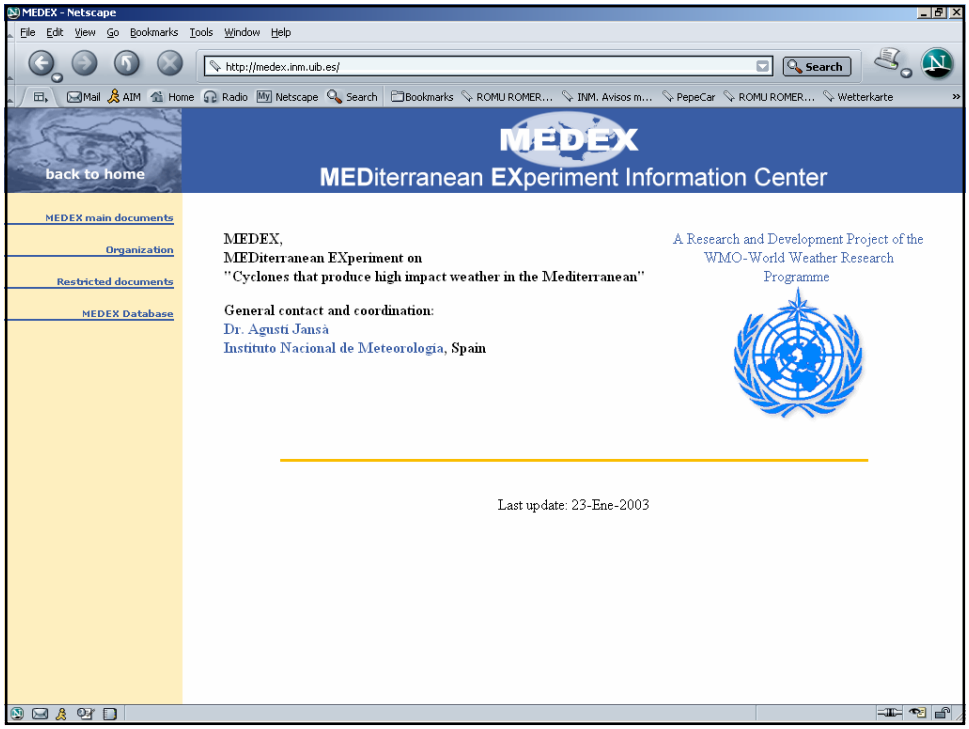
WMO
World Weather Research Programme

MEDiterranean EXperiment on Cyclones that produce High Impact Weather in the Mediterranean



A project coordinated by Dr. Agustí Jansà (Spanish *Instituto Nacional de Meteorología*, INM)

Proposer institutions: INM (Spain), ISAC-CNR (Italy) and IMS/Tel Aviv University (Israel)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MEDiterranean EXperiment on
"Cyclones that produce high impact weather in the Mediterranean"
General contact and coordination:
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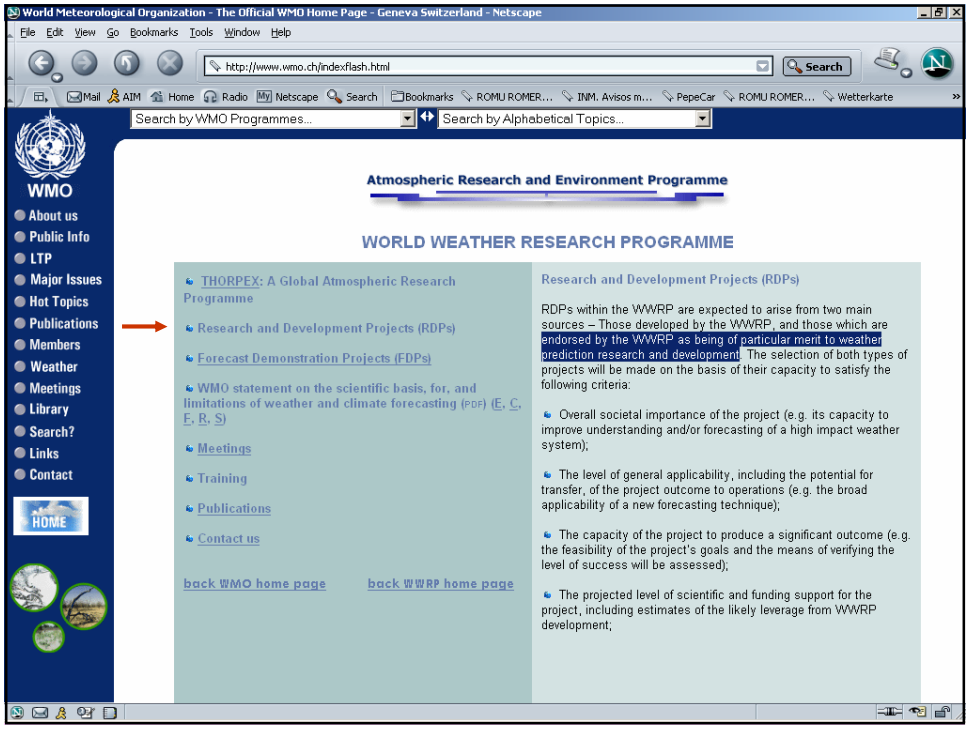
Instituto Nacional de Meteorologia, Spain
A Research and Development Project of the WMO-World Weather Research Programme
Last update: 23-Ene-2003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THORPEX: A Global Atmospheric Research Programme
Research and Development Projects (RDPs)
Forecast Demonstration Projects (FDPs)
WMO statement on the scientific basis, for, and limitations of weather and climate forecasting (PDF) (E, C, F, R, S)
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Research and Development Projects (RDPs)
RDPs within the WWRP are expected to arise from two main sources – Those developed by the WWRP, and those which are endorsed by the WWRP as being of particular merit to weather prediction research and development. The selection of both types of projects will be made on the basis of their capacity to satisfy the following criteria:
Overall societal importance of the project (e.g. its capacity to improve understanding and/or forecasting of a high impact weather system);
The level of general applicability, including the potential for transfer, of the project outcome to operations (e.g. the broad applicability of a new forecasting technique);
The capacity of the project to produce a significant outcome (e.g. the feasibility of the project's goals and the means of verifying the level of success will be assessed);
The projected level of scientific and funding support for the project, including estimates of the likely leverage from WWRP development;

MEDEX HISTORY: A starting point

"The inhabitants of the countries of the Mediterranean basin are quite aware of the frequent occurrence of severe weather in the Mediterranean region, such as heavy rainfall and strong winds associated with extreme weather events. Rainfalls of over 200 mm, and in some extreme cases, in excess of 800 mm, in 24 hours have been known to occur from time to time, while sustained wind speeds in excess of 100 km/h have been recorded in connection with events such as the Mistral, Tramontane, Ethesian and the Bora. As a result of these phenomena, significant losses in life and property are frequently reported in many countries. We recall some of the events which made headline news in the last few years. These include the exceptional and extensive heavy rains which affected wide parts of Egypt, including the Sinai Peninsula, in November 1994. In that event, more than 500 people lost their lives and large areas were inundated; even the famous ancient tombs of Luxor were menaced by flood surges. Fifty people died when a bridge collapsed after heavy rains in northern Algeria in October 1995. Torrential cloudbursts, reported to be the worst in 80 years at some locations, caused severe, widespread flooding and landslides in Southeast France, Corsica and north-western Italy during a four-day period in early November 1994. Over 50 lives were lost and thousands were left homeless in France, while the floods in Italy were even worse than the notorious event of November 1951 when the River Po overflowed its banks. Economic losses in northern Italy were reported at US $9 billion. During 1996 as a whole, several periods of above normal precipitation affected the Mediterranean basin. The drought-prone regions of southern Spain and northern Morocco received annual precipitation between 700 to 900 mm above normal, while 250 to 750 mm above normal were received in other areas on both sides of the western half of Mediterranean. Despite the benefits of the rainfall, excessive amounts resulted in some deaths, dislocation of people and significant crop damage. Notable example is the disastrous flash flood which caused significant loss of life at a camp site in Spain in August last year."

(Prof. Obasi, Secretary-General WMO, *Opening address at the INM/WMO International Symposium on Cyclones and Hazardous Weather in the Mediterranean*, Palma de Mallorca, Spain, 14 April 1997)

MEDITERRANEAN CYCLONES ⟷ HIGH IMPACT WEATHER

MEDEX HISTORY: Weaknesses of the present knowledge

- The connection between cyclones and high impact weather has not yet been analyzed in a coherent, comprehensive and systematic way:
A good dynamically oriented climatology of the cyclones that produce high impact weather in the Mediterranean is needed

- The inaccuracy on the forecasting of a cyclone formation and evolution would imply inaccuracy in the forecasting of the high impact weather itself:
… But to which extent ?

- The limited skill of the NWP models can be due to: (a) inaccuracy of the initial conditions; (b) inappropriate representation of some physical processes or their interactions; (c) intrinsic limitations in the predictability of the atmospheric flow:
The details and relative weight of each contribution should be investigated

MEDEX HISTORY: Weaknesses of the present knowledge

- The identification of relevant factors for the cyclone and high impact weather generation and evolution is a prerequisite for the assessment of the influence of the representation of the physical processes in NWP models on the accuracy of the predictions:
A coordinated and more systematic effort is necessary in this direction

- The characteristic small scale of Mediterranean systems and the scarce density of observations in the Mediterranean and surrounding areas suggest a particularly strong influence of initial conditions on the inaccuracy of some predictions:
The identification of the sensitive areas where better defined initial conditions (i.e. more observations) would most likely lead to improved forecasts becomes an important point in which our knowledge has to improve

MEDEX HISTORY: First proposal (September 1998)

GENERAL AIM

" The main general objective of the MEDEX project is the better understanding of the mechanisms leading to severe weather –heavy rain and strong wind- in the Mediterranean area, as much those related to cyclones as those not related to them, in order to improve the forecasting of this kind of events. Due to the close relationship between severe weather and cyclogenesis in the Mediterranean, the better understanding of the Mediterranean cyclogenesis has to be included as a secondary objective for MEDEX.

Better understanding and forecasting of hazardous weather in the Mediterranean will positively affect the understanding and forecasting of hazardous weather around the world. The Mediterranean area is a good target region for a project devoted to the hazardous weather knowledge due to the high intensity and frequency of this type of events in it. "

MEDEX HISTORY: First proposal (September 1998)

HEAVY RAIN

" Concerning heavy rain, particular objectives of the project would be:

- To study the instabilisation, triggering and feeding mechanisms, both in the synoptic- and mesoscale, leading to heavy precipitation events and to analyse the ability of the numerical models to reproduce these mechanisms in the short term and of the remote sensing observations to contribute to monitor them.

- To establish the relationship or independence between heavy rain and cyclogenesis or cyclone presence in different kind of cases. "

MEDEX HISTORY: First proposal (September 1998)

STRONG WINDS

" Concerning strong wind, particular objectives of the project would be:

- To establish the relationship between strong wind and cyclogenesis or cyclone presence in different kind of cases.

- To measure or diagnose the acceleration field in strong local winds and to compare them with the accelerations provided by the numerical models. "

MEDEX HISTORY: First proposal (September 1998)

CYCLONES

" Particular objectives of the project concerning cyclone would be:

- To identify different kind of 3D structure in the Mediterranean cylones.

- To identify and to evaluate the main factors involved in the Mediterranean cyclogenesis events (when accompanied by severe weather) and to check the ability of the numerical models to simulate these factors.

- To establish the relationship between cyclones and hazardous weather (heavy rain and strong wind). "

MEDEX HISTORY: Second proposal (July 1999)

GENERAL OBJECTIVE

"The improvement of the knowledge and forecasting of cyclones –in the most general sense of the word- that produce high impact weather in the Mediterranean area"

MEDEX HISTORY: Second proposal (July 1999)

SPECIFIC OBJECTIVES

1) "To construct an exhaustive database of cyclones and high impact weather events, covering a period long enough and all the Mediterranean area, and the exploitation of such database"

2) "To improve the knowledge on the physical mechanisms of the Mediterranean cyclogenesis related to high impact weather and of the mechanisms of this relationship, to identify the insufficiencies of available operational NWP in forecasting cyclones that produce high impact weather and the formulation of recommendations to improve them"

3) "To check the impact on the analysis and forecasting of cyclones (that produce high impact weather) of the introduction of additional conventional (or manageable as conventional) observing systems as well as the criticism of some of the existing observing systems"

MEDEX HISTORY: Second proposal (July 1999)

SPECIFIC OBJECTIVES

4) "To asses the effect on the forecasting of cyclones (that produce high impact weather) of the introduction of variational assimilation schemes and other alternative assimilation procedures to introduce non-conventional or modified conventional sets of data"

5) "To measure the social benefit of the improvement of forecasting of cyclones that produce high impact weather"

6) "The formulation of conceptual models to help the forecasters "

MEDEX: Phase 1 (2001-2004)

GENERAL OBJECTIVE

"The improvement of the knowledge and forecasting of cyclones –in the most general sense of the word- that produce high impact weather in the Mediterranean area"

MEDEX: Phase 1 (2001-2004)

SPECIFIC OBJECTIVE 1

"To implement an initial approach to a dynamically oriented climatology of the cyclones that produce high impact weather in the Mediterranean. Working in a systematic way, we want to know the type of cyclonic structures that appears related to high impact weather events of different kind, in different areas within the Mediterranean area, as well as the percentage of high impact weather events that may or may not be related to cyclones. This is a necessary step to evaluate the potential impact of the improvement of the forecasting of cyclones on the prediction of the high impact weather itself. It is also necessary to know how representative is the work done on the base of a selection of particular cases"

MEDEX: Phase 1 (2001-2004)

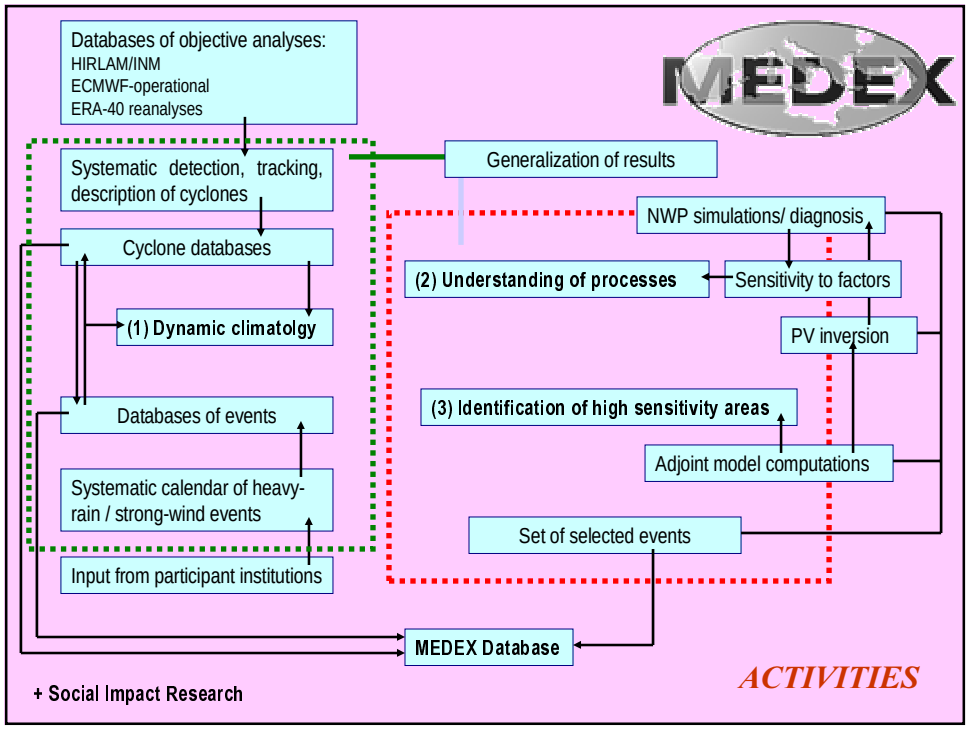
SPECIFIC OBJECTIVE 2

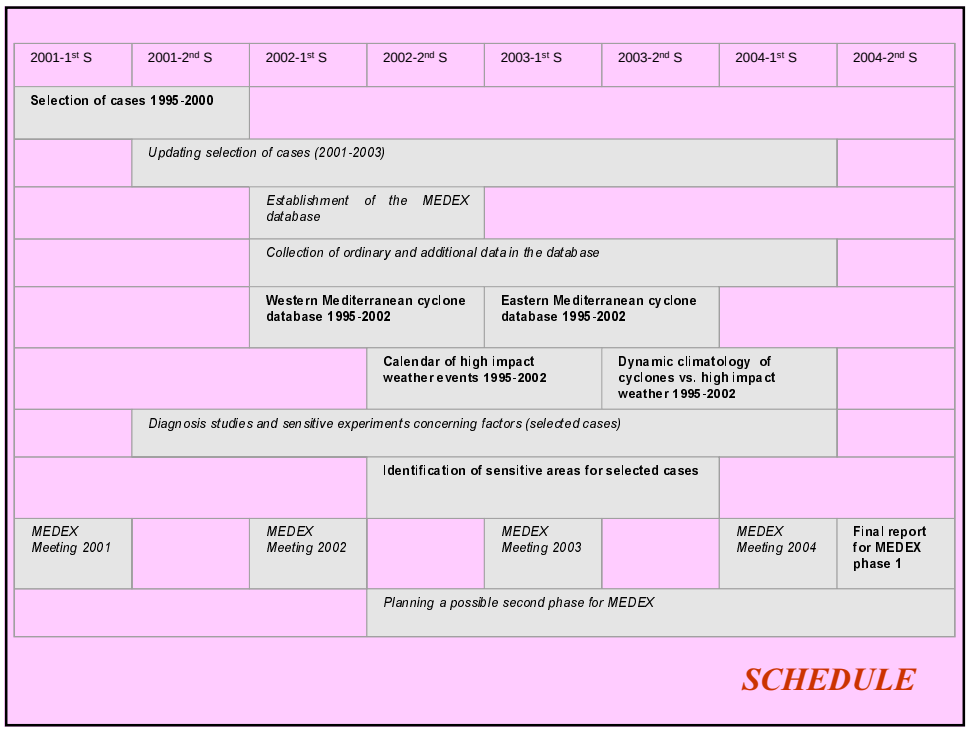
"To determine and rank the multiple geographical and meteorological factors that are acting in the generation and evolution of the different types of cyclones that produce high impact weather in the Mediterranean. The skill of NWP models to predict the Mediterranean cyclones has to be connected with the determined factors"

MEDEX: Phase 1 (2001-2004)

SPECIFIC OBJECTIVE 3

"The identification of sensitive areas where better initial conditions may likely lead to improved forecasts. In general, the inaccuracy in the initial conditions can be a source of error of the numerical prediction. It is necessary to know the areas, levels and magnitudes for which the analysis error produces most significant errors in the prediction of the cyclones. Closely connected with the former objective is an assessment of the impact of better defined initial conditions in sensitive areas"


Databases of objective analyses:
HIRLAM/INM
ECMWF-operational
ERA-40 reanalyses
MEDEX
Systematic detection, tracking, description of cyclones
Generalization of results
Cyclone databases
NWP simulations/ diagnosis
(2) Understanding of processes
Sensitivity to factors
(1) Dynamic climatolgy
PV inversion
Databases of events
(3) Identification of high sensitivity areas
Adjoint model computations
Systematic calendar of heavy-rain / strong-wind events
Set of selected events
Input from participant institutions
MEDEX Database
+ Social Impact Research
ACTIVITIES


2001-1st S
2001-2nd S
2002-1st S
2002-2nd S
2003-1st S
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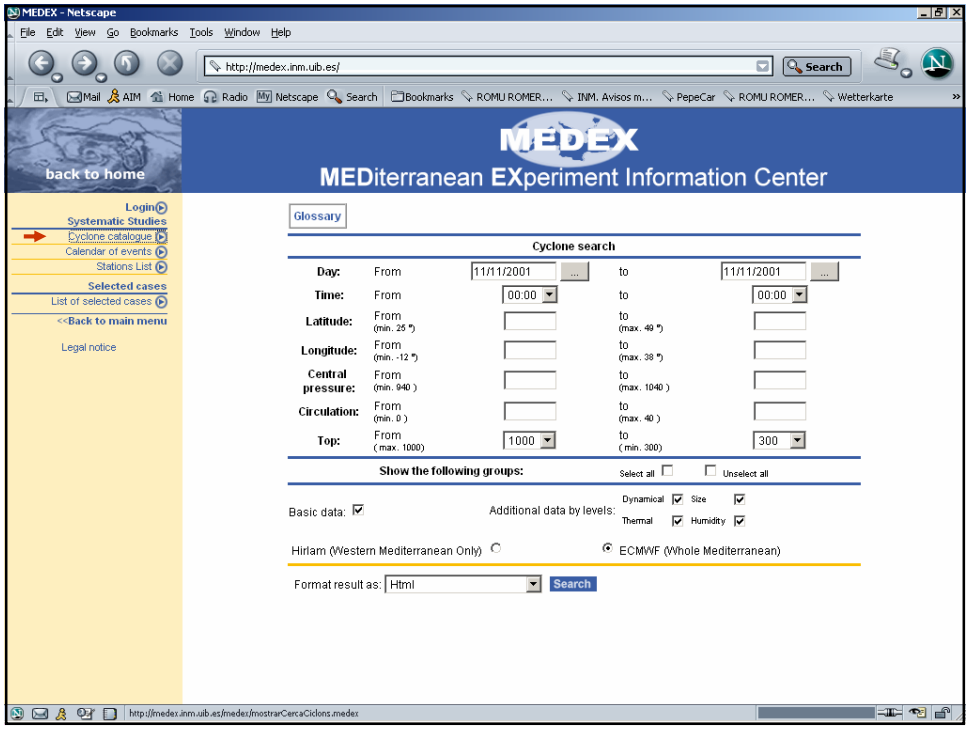
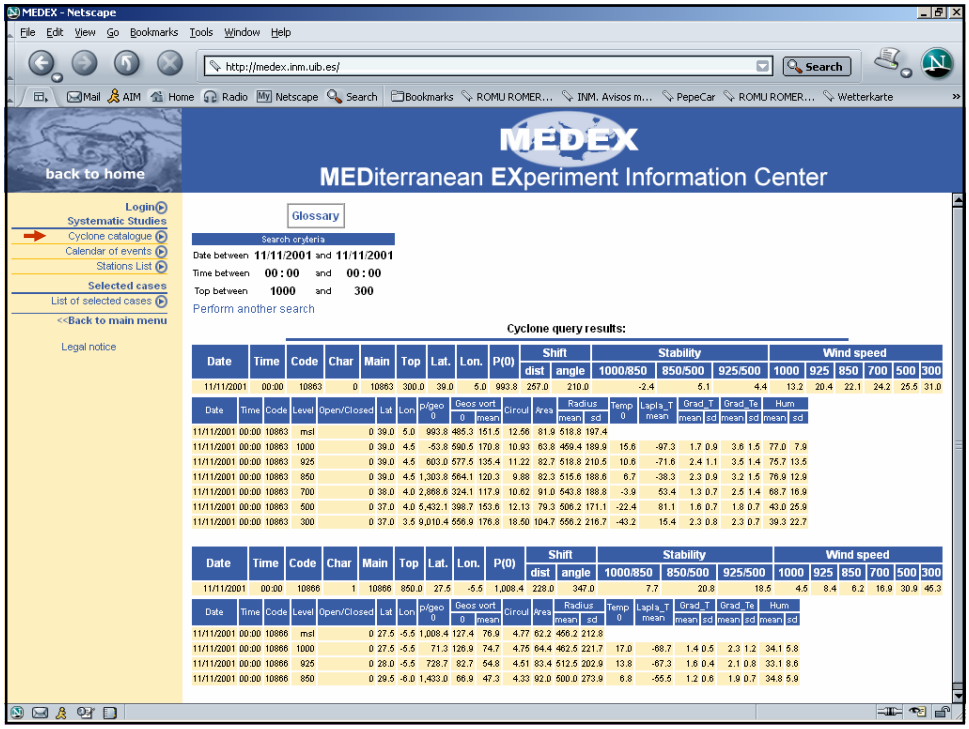
2004-1st S
2004-2nd S
Selection of cases 1995-2000
Updating selection of cases (2001-2003)
Establishment of the MEDEX database
Collection of ordinary and additional data in the database
Western Mediterranean cyclone database 1995-2002
Eastern Mediterranean cyclone database 1995-2002
Calendar of high impact weather events 1995-2002
Dynamic climatology of cyclones vs. high impact weather 1995-2002
Diagnosis studies and sensitive experiments concerning factors (selected cases)
Identification of sensitive areas for selected cases
MEDEX Meeting 2001
MEDEX Meeting 2002
MEDEX Meeting 2003
MEDEX Meeting 2004
Final report for MEDEX phase 1
Planning a possible second phase for MEDEX
SCHEDULE



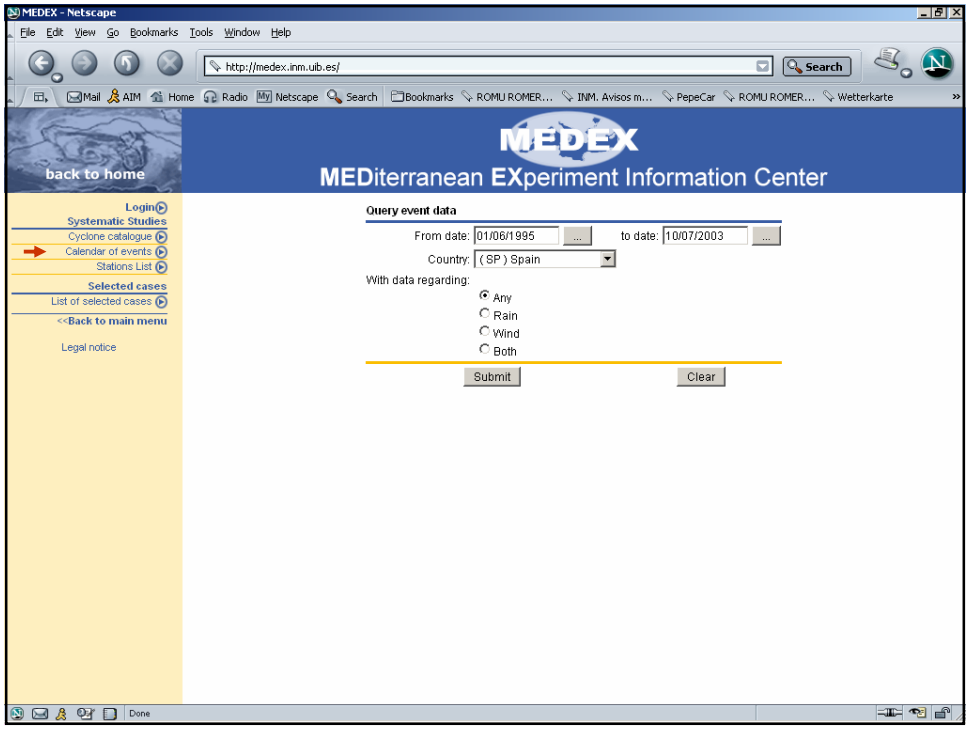


Date	Time	Code	Char	Main	Top	Lat.	Lon.	P(0)	Shift		Stability			Wind speed					
									dist	angle	1000/850	850/500	925/500	1000	925	850	700	500	300
11/11/2001	00:00	10863	0	10863	300.0	39.0	5.0	993.8	257.0	210.0	-2.4	5.1	4.4	13.2	20.4	22.1	24.2	25.5	31.0

Date	Time	Code	Level	Open/Closed	Lat	Lon	p/geo 0	Geos vort 0	Geos vort mean	Circul	Area	Radius mean	Radius sd	Temp 0	Lapla_T mean	Grad_T mean	Grad_T sd	Grad_Te mean	Grad_Te sd	Hum mean	Hum sd
11/11/2001	00:00	10863	msl		0	39.0	5.0	993.8	485.3	151.5	12.56	81.9	518.8	197.4							
11/11/2001	00:00	10863	1000		0	39.0	4.5	-53.8	590.5	170.8	10.93	63.8	459.4	189.9	15.6	-97.3	1.7	0.9	3.6	1.5	77.0	7.9
11/11/2001	00:00	10863	925		0	39.0	4.5	603.0	577.5	135.4	11.22	82.7	518.8	210.5	10.6	-71.6	2.4	1.1	3.5	1.4	75.7	13.5
11/11/2001	00:00	10863	850		0	39.0	4.5	1,303.8	564.1	120.3	9.88	82.3	515.6	188.6	6.7	-38.3	2.3	0.9	3.2	1.5	76.9	12.9
11/11/2001	00:00	10863	700		0	38.0	4.0	2,868.6	324.1	117.9	10.62	91.0	543.8	188.8	-3.9	53.4	1.3	0.7	2.5	1.4	68.7	16.9
11/11/2001	00:00	10863	500		0	37.0	4.0	5,432.1	398.7	153.6	12.13	79.3	506.2	171.1	-22.4	81.1	1.6	0.7	1.8	0.7	43.0	25.9
11/11/2001	00:00	10863	300		0	37.0	3.5	9,010.4	556.9	176.8	18.50	104.7	556.2	216.7	-43.2	15.4	2.3	0.8	2.3	0.7	39.3	22.7

Date	Time	Code	Char	Main	Top	Lat.	Lon.	P(0)	Shift		Stability			Wind speed					
									dist	angle	1000/850	850/500	925/500	1000	925	850	700	500	300
11/11/2001	00:00	10866	1	10866	850.0	27.5	-5.5	1,008.4	228.0	347.0	7.7	20.8	18.5	4.5	8.4	6.2	16.9	30.9	45.3

Date	Time	Code	Level	Open/Closed	Lat	Lon	p/geo 0	Geos vort 0	Geos vort mean	Circul	Area	Radius mean	Radius sd	Temp 0	Lapla_T mean	Grad_T mean	Grad_T sd	Grad_Te mean	Grad_Te sd	Hum mean	Hum sd
11/11/2001	00:00	10866	msl		0	27.5	-5.5	1,008.4	127.4	76.9	4.77	62.2	456.2	212.8							
11/11/2001	00:00	10866	1000		0	27.5	-5.5	71.3	126.9	74.7	4.75	64.4	462.5	221.7	17.0	-68.7	1.4	0.5	2.3	1.2	34.1	5.8
11/11/2001	00:00	10866	925		0	28.0	-5.5	728.7	82.7	54.8	4.51	83.4	512.5	202.9	13.8	-67.3	1.6	0.4	2.1	0.8	33.1	8.6
11/11/2001	00:00	10866	850		0	29.5	-6.0	1,433.0	66.9	47.3	4.33	92.0	500.0	273.9	6.8	-55.5	1.2	0.6	1.9	0.7	34.8	5.9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Calendar of events
Stations List
Selected cases
List of selected cases
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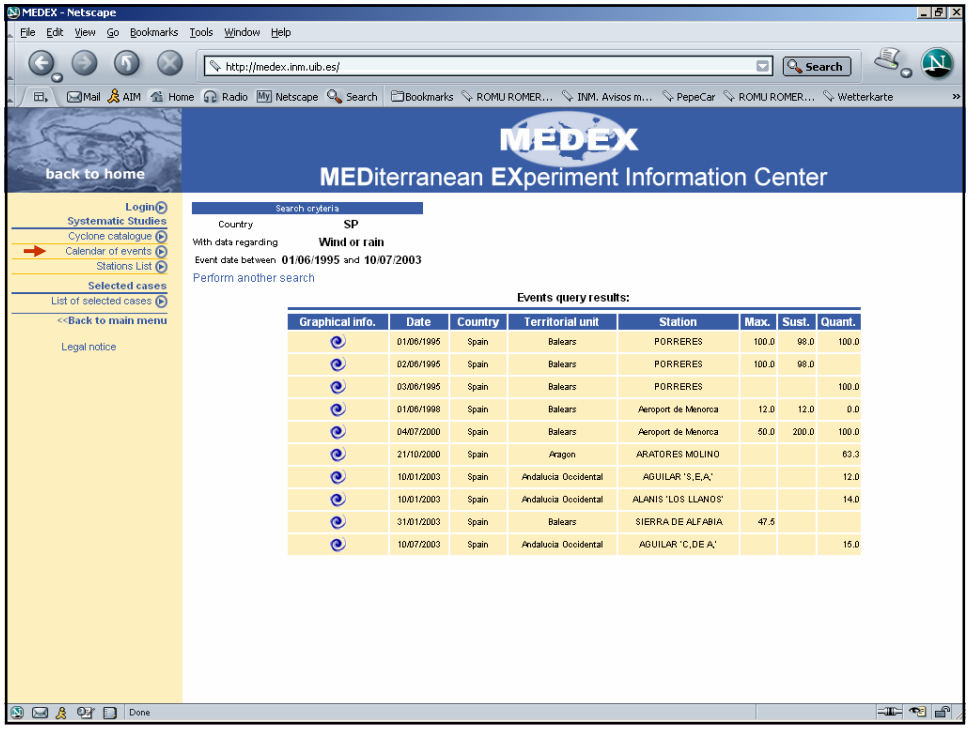
Legal notice
Query event data
From date: 01/06/1995
to date: 10/07/2003
Country: (SP) Spain
With data regarding:
Any
Rain
Wind
Both
Submit
Clear
Done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Search criteria
Country SP
With data regarding Wind or rain
Event date between 01/06/1995 and 10/07/2003
Perform another search
Events query results:
Graphical info. | Date | Country | Territorial unit | Station | Max. | Sust. | Quant.
01/06/1995 Spain Balears PORRERES 100.0 98.0 100.0
02/06/1995 Spain Balears PORRERES 100.0 98.0
03/06/1995 Spain Balears PORRERES 100.0
01/06/1998 Spain Balears Aeroport de Menorca 12.0 12.0 0.0
04/07/2000 Spain Balears Aeroport de Menorca 50.0 200.0 100.0
21/10/2000 Spain Aragon ARATORES MOLINO 63.3
10/01/2003 Spain Andalucia Occidental AGUILAR 'S,E,A,' 12.0
10/01/2003 Spain Andalucia Occidental ALANIS 'LOS LLANOS' 14.0
31/01/2003 Spain Balears SIERRA DE ALFABIA 47.5
10/07/2003 Spain Andalucia Occidental AGUILAR 'C,DE A,' 15.0
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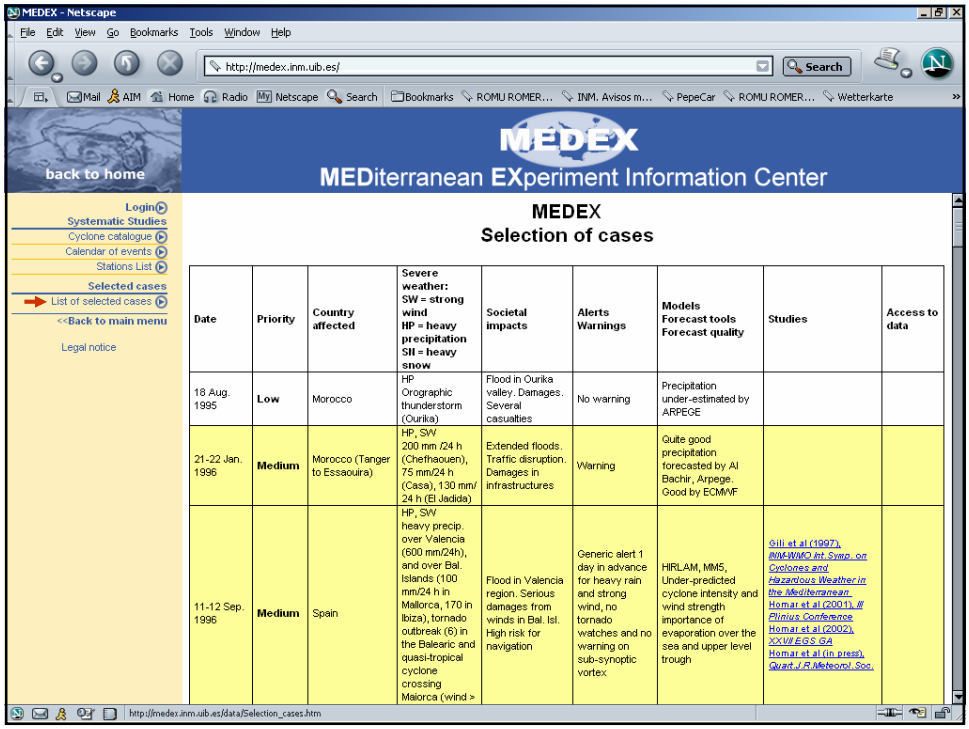
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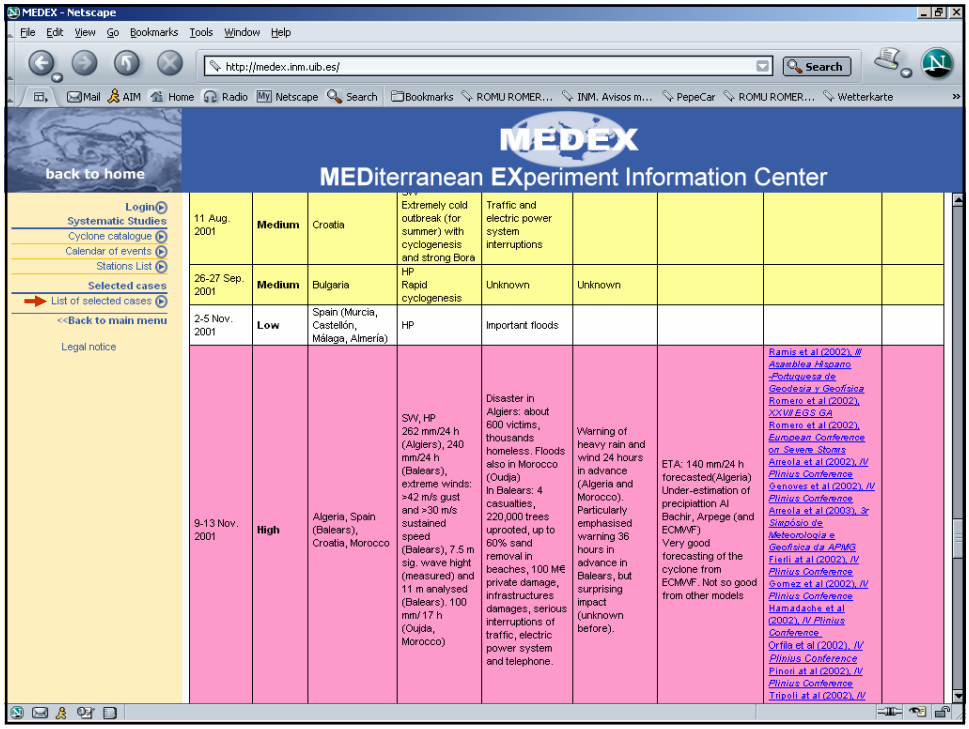
Selection of cases
Date
Priority
Country affected
Severe weather: SW = strong wind HP = heavy precipitation SN = heavy snow
Societal impacts
Alerts Warnings
Models Forecast tools Forecast quality
Studies
Access to data
18 Aug. 1995
Low
Morocco
HP Orographic thunderstorm (Ourika)
Flood in Ourika valley. Damages. Several casualties
No warning
Precipitation under-estimated by ARPEGE
21-22 Jan. 1996
Medium
Morocco (Tanger to Essaouira)
HP, SW 200 mm /24 h (Chefhaouen), 75 mm/24 h (Casa), 130 mm/ 24 h (El Jadida)
Extended floods. Traffic disruption. Damages in infrastructures
Warning
Quite good precipitation forecasted by Al Bachir, Arpege. Good by ECMWF
11-12 Sep. 1996
Medium
Spain
HP, SW heavy precip. over Valencia (600 mm/24h), and over Bal. Islands (100 mm/24 h in Mallorca, 170 in Ibiza), tornado outbreak (6) in the Balearic and quasi-tropical cyclone crossing Maiorca (wind >
Flood in Valencia region. Serious damages from winds in Bal. Isl. High risk for navigation
Generic alert 1 day in advance for heavy rain and strong wind, no tornado watches and no warning on sub-synoptic vortex
HIRLAM, MM5, Under-predicted cyclone intensity and wind strength importance of evaporation over the sea and upper level trough
Gili et al (1997), WMO Int Symp. on Cyclones and Hazardous Weather in the Mediterranean
Homar et al (2001), III Plinius Conference
Homar et al (2002), XXVII EGS GA
Homar et al (in press), Quart J R Meteorol Soc.
http://medex.inm.uib.es/data/Selection_cases.htm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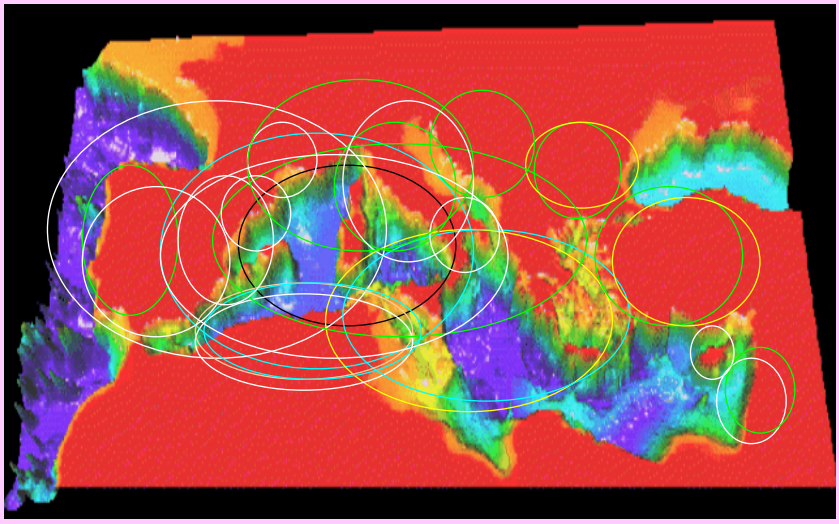
Legal notice
11 Aug. 2001
Medium
Croatia
SW Extremely cold outbreak (for summer) with cyclogenesis and strong Bora
Traffic and electric power system interruptions
26-27 Sep. 2001
Medium
Bulgaria
HP Rapid cyclogenesis
Unknown
Unknown
2-5 Nov. 2001
Low
Spain (Murcia, Castellón, Málaga, Almería)
HP
Important floods
9-13 Nov. 2001
High
Algeria, Spain (Balears), Croatia, Morocco
SW, HP 262 mm/24 h (Algiers), 240 mm/24 h (Balears), extreme winds: >42 m/s gust and >30 m/s sustained speed (Balears), 7.5 m sig. wave hight (measured) and 11 m analysed (Balears). 100 mm/ 17 h (Ouida, Morocco)
Disaster in Algiers: about 600 victims, thousands homeless. Floods also in Morocco (Oudja) In Balears: 4 casualties, 220,000 trees uprooted, up to 60% sand removal in beaches, 100 M€ private damage, infrastructures damages, serious interruptions of traffic, electric power system and telephone.
Warning of heavy rain and wind 24 hours in advance (Algeria and Morocco). Particularly emphassised warning 36 hours in advance in Balears, but surprising impact (unknown before).
ETA: 140 mm/24 h forecasted(Algeria) Under-estimation of precipiattion Al Bachir, Arpege (and ECMWF) Very good forecasting of the cyclone from ECMWF. Not so good from other models
Ramis et al (2002), II Asamblea Hispano -Portuguesa de Geodesia y Geofisica
Romero et al (2002), XXVII EGS GA
Romero et al (2002), European Conference on Severe Storms
Arreola et al (2002), IV Plinius Conference
Genoves et al (2002), IV Plinius Conference
Arreola et al (2003), 3r Simposio de Meteorologia e Geofisica da APMG
Fierli et al (2002), IV Plinius Conference
Gomez et al (2002), IV Plinius Conference
Hamadache et al (2002), IV Plinius Conference
Ortfia et al (2002), IV Plinius Conference
Pinori et al (2002), IV Plinius Conference
Tripoli et al (2002), IV



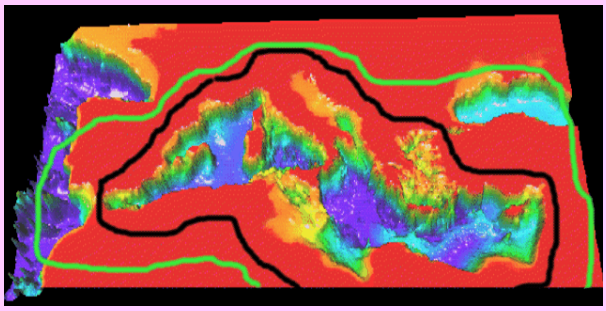
Geographical coverage of the selected events

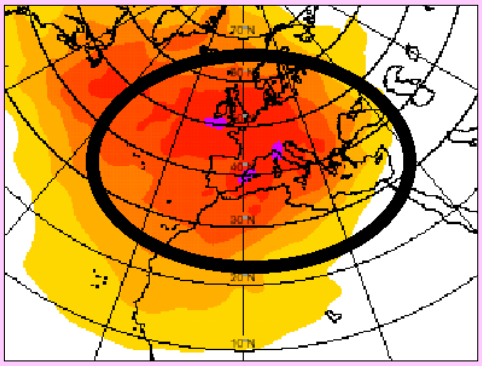
MEDEX objective	*Type of data*	*Area*	*Details*
Dynamical climatology	**Rainfall and wind**	**Inner Mediterranean**	All peak values that overpass defined thresholds, since 1995.
	Analysed fields	**Inner Mediterranean** (at least)	4 daily at standard levels, al least since 1995.
Sensitivity to factors (validation)	**Rainfall and wind**	**Inner Mediterranean**	All data in the affected area for selected events only.
	Radar and other non-conventional	**Inner Mediterranean**	All data in the affected area for selected events only.
Impact of observations	**Upper air data**	**Outer Mediterranean** (Eastern Atlantic incl.)	All data in sensitive areas for selected events only.
	Surface data	**Outer Mediterranean** (mainly inner area)	All data in sensitive areas for selected events only.

Additional possibilities:

- Surface winds from scatterometers
- Data from aircrafts
- Data collected for common events in other projects (MAP, THORPEX, etc.)

DATA REQUIREMENTS

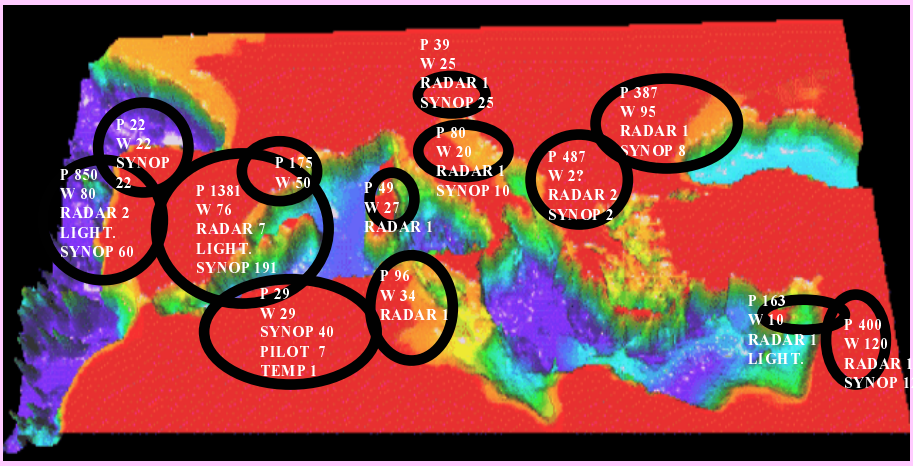




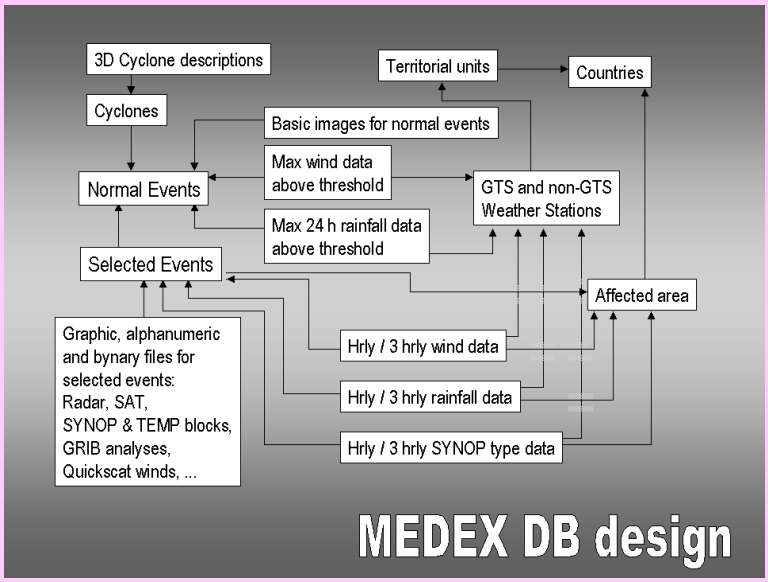
INNER AND OUTER MEDITERRANEAN AREA

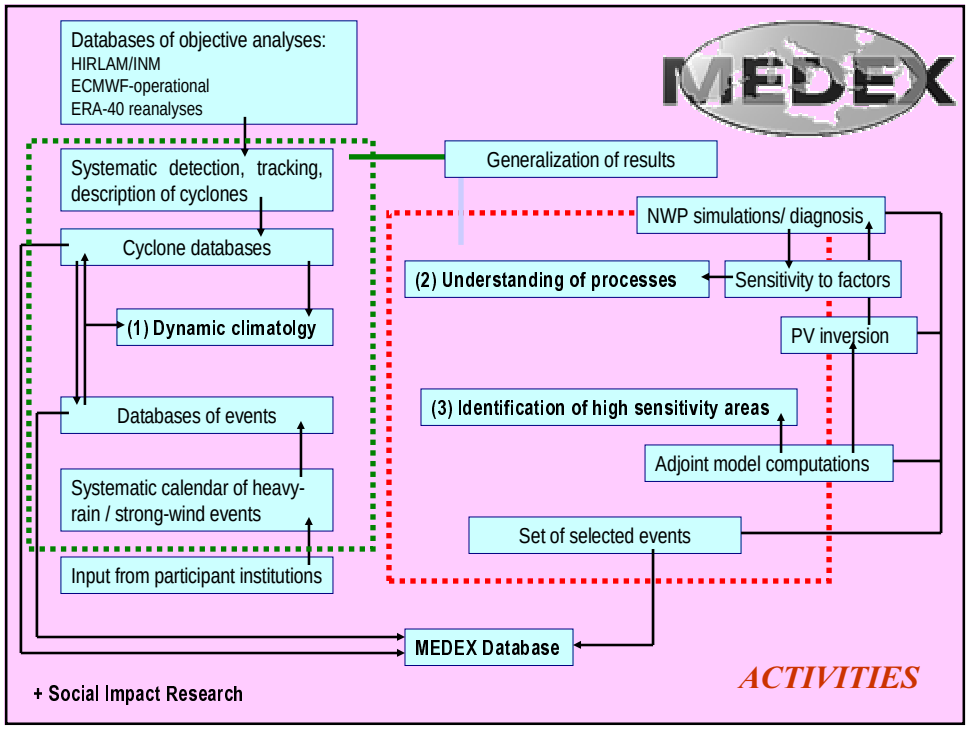
Institution	*Rain. num.*	*Wind num.*	*Radar num.*	*Lightening*	*Synop num.*	*Pilot num.*	*Temp num.*
IM, Portugal	850	80	2	Yes	60		
INM, Spain	1381	76	7	Yes	191		
UB, Spain	175	50					
ONM, Algeria	29	29			40	7	1
SAR, Sardinia	49	27	1				
INM, Tunisia	96	34	1				
ARPA-FVG, Italy	39	25	1		25		
ARPA-ER, Italy	80	20	1		10		
MHS, Croatia	487		2		2		
NIMH, Bulgaria	387	95	1		8		
Cyprus MS	163	10	1	Yes			
IMS, Israel	400	120	1		120		
CITA, Gailicia, Spain	22	22			22		

DATA presently not available on the GTS

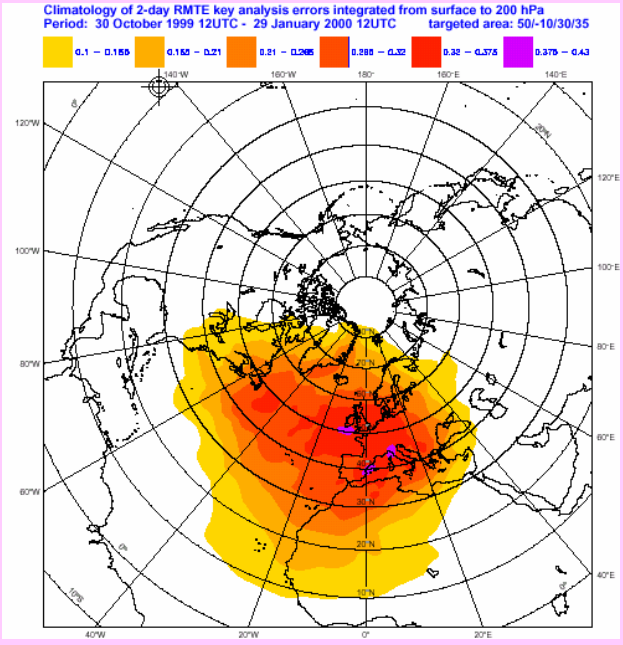


Non-GTS data availability



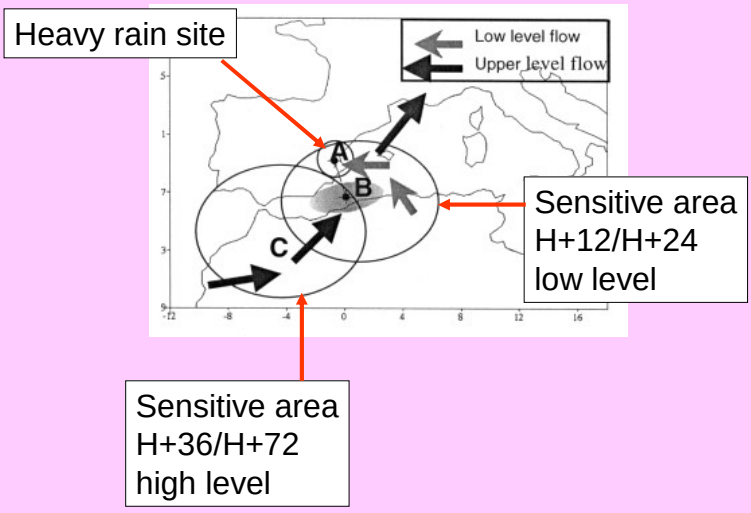


EUCOS study on Climatology of Sensitive Areas for Southern Europe



Too general! … We need to know sensitive areas for specific cases

- **An example**: Hypothesis about sensitive areas and targeted observations for heavy rain in Valencia:



Use of the adjoint modeling system

Schematic view:

Sensitivity fields

- Units of:

$$\frac{[R_f]}{[\text{Init. Cond.}]}$$

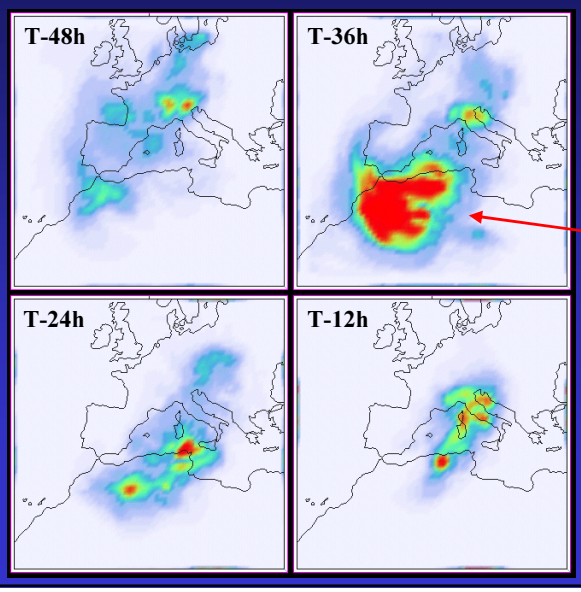
- It shows the sensitivity of R_f to the model initial fields

Response functions (R_f)

- Model error: $X_{obs} - X_{mod}$
- Particular feature of interest
  - Cyclone's central pressure
  - Jet stream location and intensity
  - Temperature at a certain point
  - ...
- Any differentiable function of X_{mod}

Example: Superstorm 10 and 11 November 2001

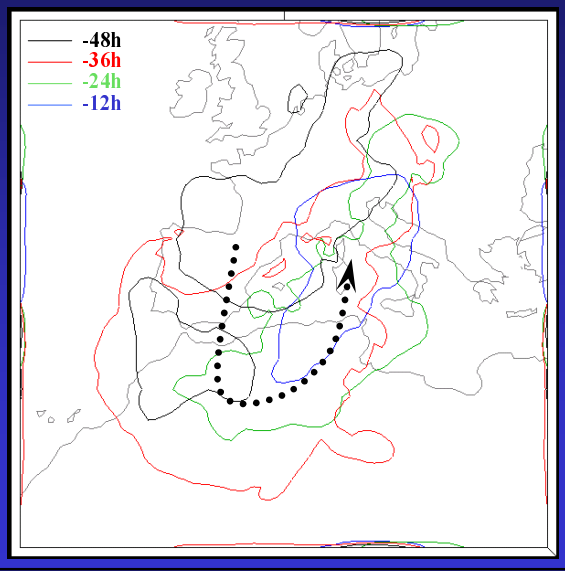
Averaged sensitivity field for the wind maximum over the Balearics:



Close to a critical time?

Example: Superstorm 10 and 11 November 2001

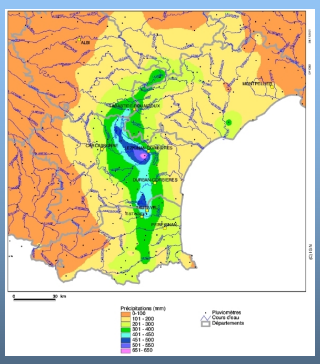
Sensitivity progression backwards:

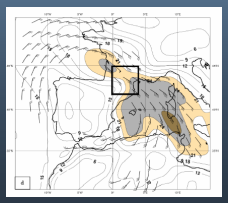


A contribution of Meteo France to MEDEX: case study of the 11-14 November 1999 floods on south-west of France.

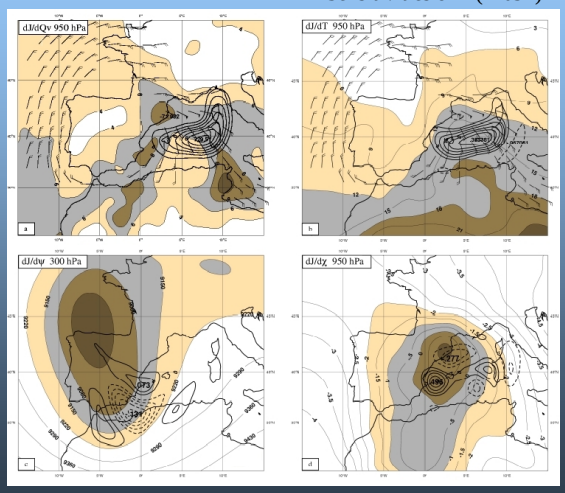
Ph. Lopez, A. Mezdour, Ph. Arbogast, P. Santurette, J. Coier; Edited by B. Joly & A. Joly

METEO FRANCE / CNRM, Toulouse, France (Document for the MEDEX Community)





Sensitivities of **J** (T-09h)



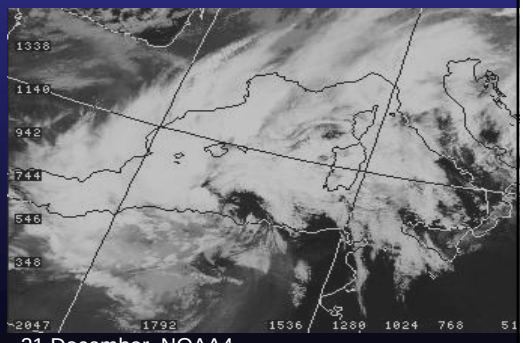
J is the vertically integrated precipitable water in the box

Example Applications:
Targeting (MEDEX)

African Cyclogenesis 79

19-22 December 1979
Balearics and eastern Iberian Peninsula:
78h winds stronger than 35 km h^{-1} (gusts 90 km h^{-1})
-35 hPa in 60 h (Palma) → Bomb

Dr. Víctor Homar
(NSSL, OK, USA)



21 December. NOAA4

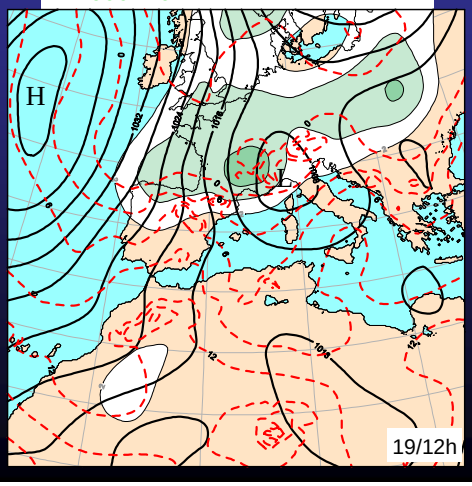
Example Applications:
Targeting (MEDEX)

Analysis

60 — 24 — 0

19 12UTC — 22 00UTC

PV 300hPa PseaL Press. T 900 hPa



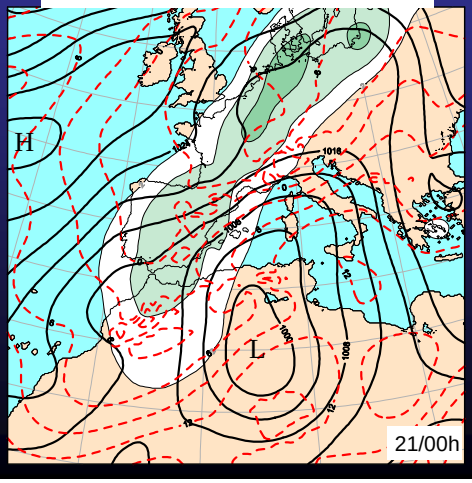
Example Applications:
Targeting (MEDEX)

Analysis

60 — 24 — 0

19 12UTC — 22 00UTC

PV 300hPa PseaL Press. T 900 hPa



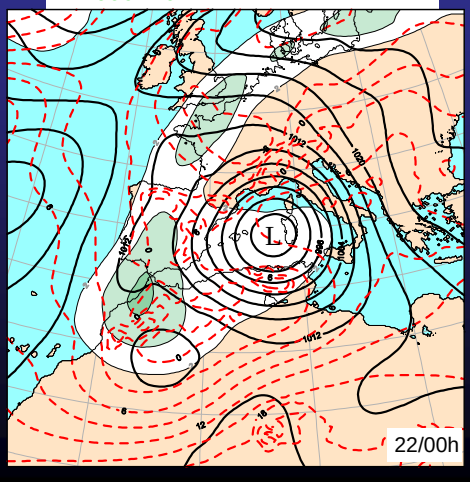
Example Applications:
Targeting (MEDEX)

Analysis

60 24 0

19 12UTC 22 00UTC

PV 300hPa PseaL Press. T 900 hPa



Example Applications:
Targeting (MEDEX)

Analysis

60 24 0

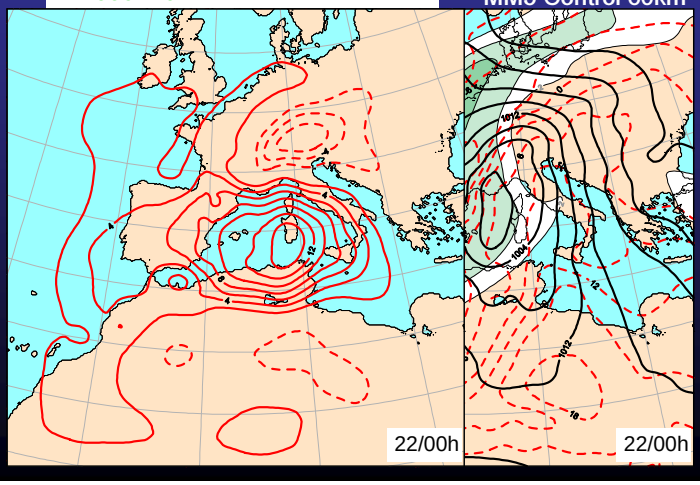
19 12UTC 22 00UTC

Analysis

+60h

PV 300hPa PseaL Press. T 900 hPa

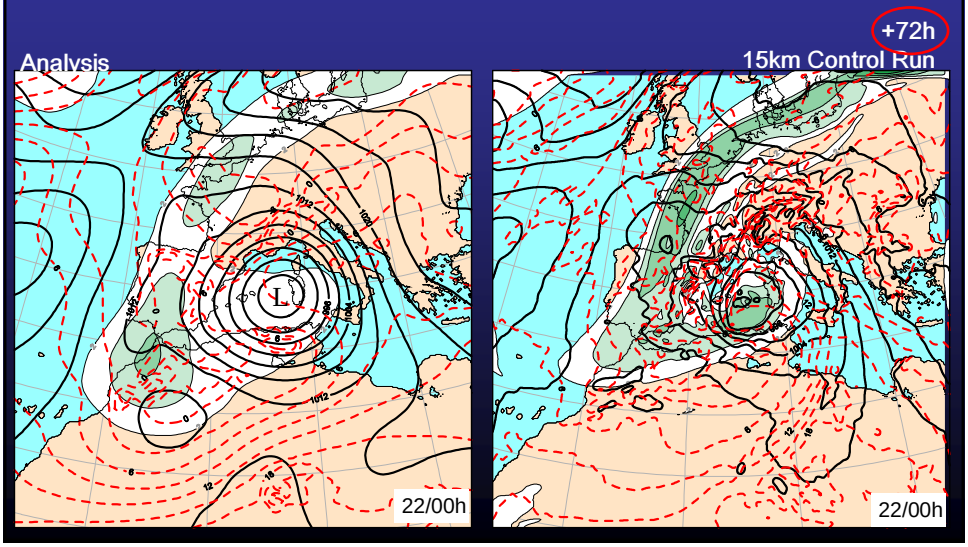
MM5 Control 60km



Example Applications:
Targeting (MEDEX)

ECMWF run

- Better simulation with ECMWF re-analysis fields:

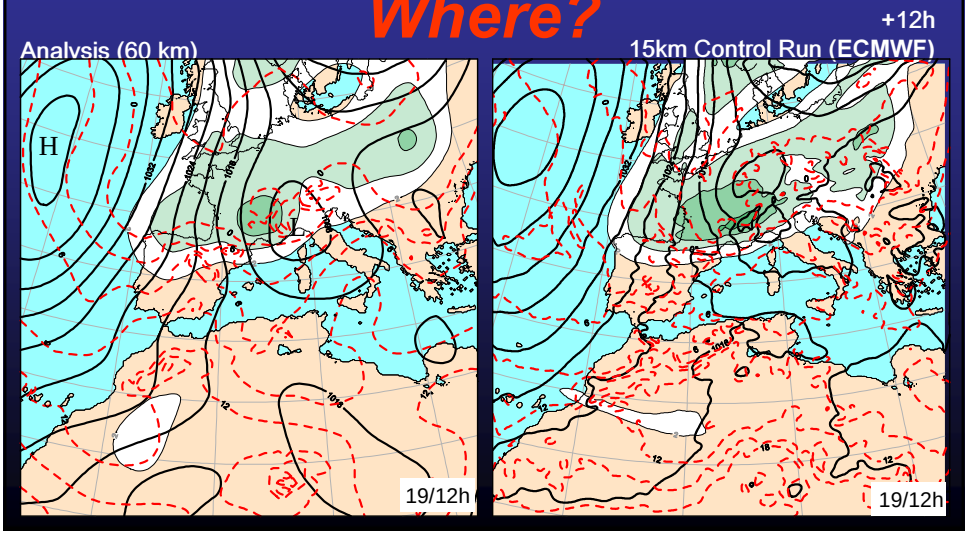


Example Applications:
Targeting (MEDEX)

OSSE run

- Observation System Simulation Experiments:
  Create artificial observations from a successful run

Where?



Example Applications:
Targeting (MEDEX)

Sensitivity estimates

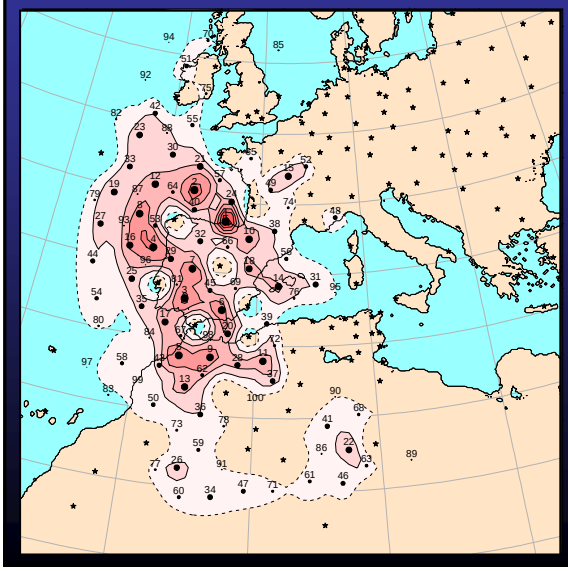
Open Competition! Come and sign in!!

- Finalists:
  - MM5 Adjoint model 60h 60km
  - Human manual I
  - Human manual II
  - Gradients in the IC (upper PV, lower T, V, Q)
  - Sum of Adjoint and Gradients estimates

Example Applications:
Targeting (MEDEX)

Adjoint sens. estimate

- Response Function at 22 00 UTC: SL Pressure at center of observed cyclone

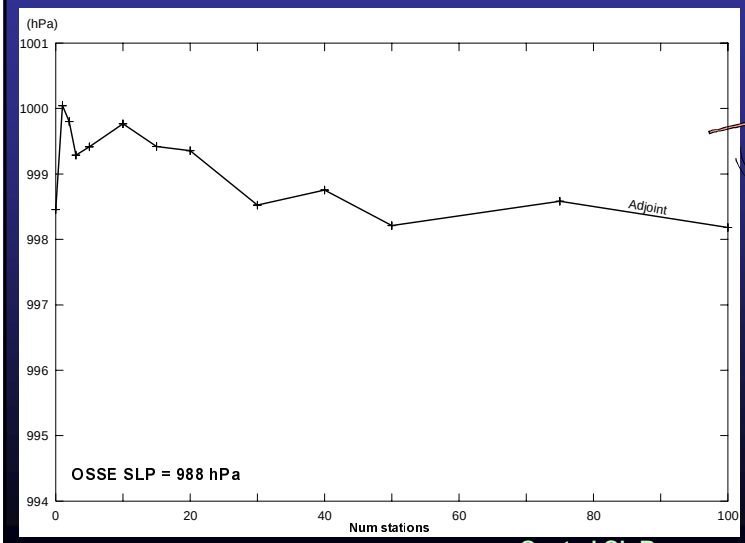


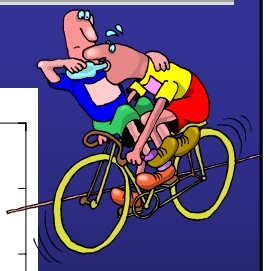
- Gaussian kernel stations
- 100 stations ranked using effective sensitivity
- 100 new simulations, each with an additional artificial sounding
- Actually “only” 12 runs: 1,2,3,5,10,15,20,30,40,50, 75,100

Example Applications:
Targeting (MEDEX)

Adjoint sens. estimate

- First competitor scores:



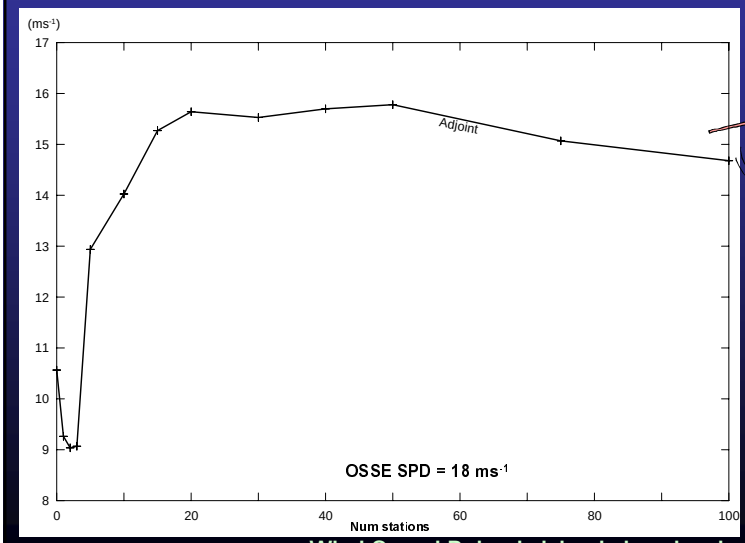


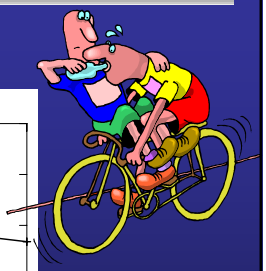
Central SL Pressure

Example Applications:
Targeting (MEDEX)

Adjoint sens. estimate

- First competitor scores:

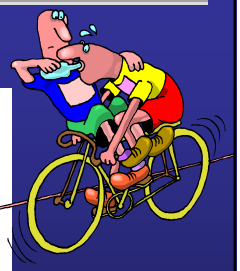




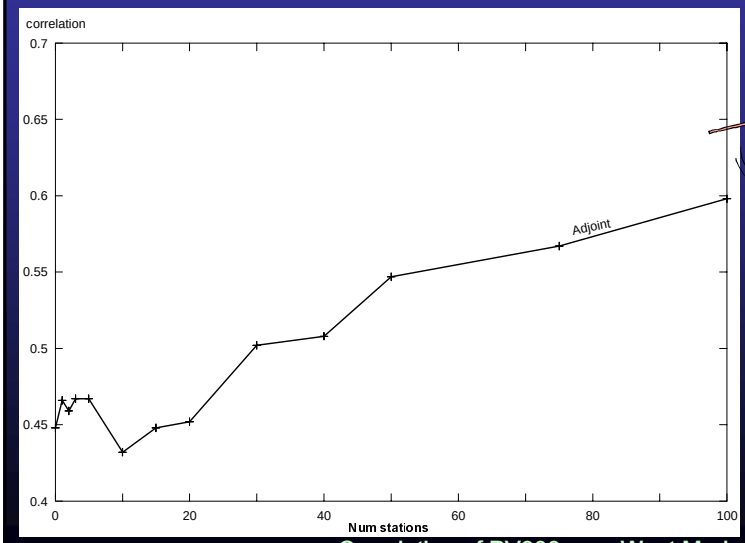
Wind Speed Balearic Islands Low levels

Example Applications:
Targeting (MEDEX)

Adjoint sens. estimate



- First competitor scores:



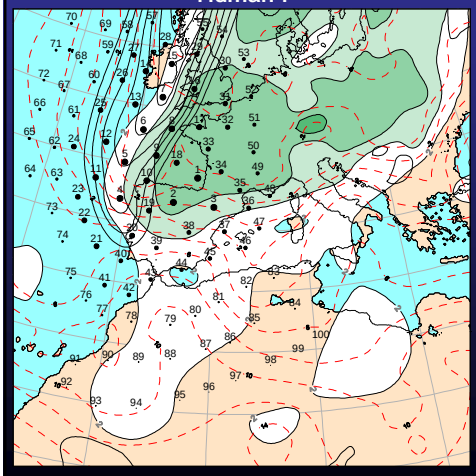
Correlation of PV300 over West Med.

Example Applications:
Targeting (MEDEX)

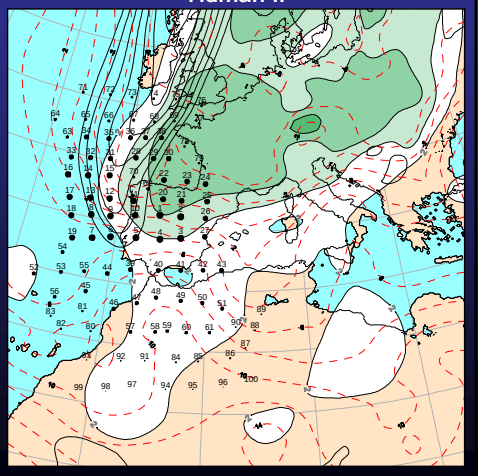
Human sens. estimate

- Forecast run information provided to human

Human I



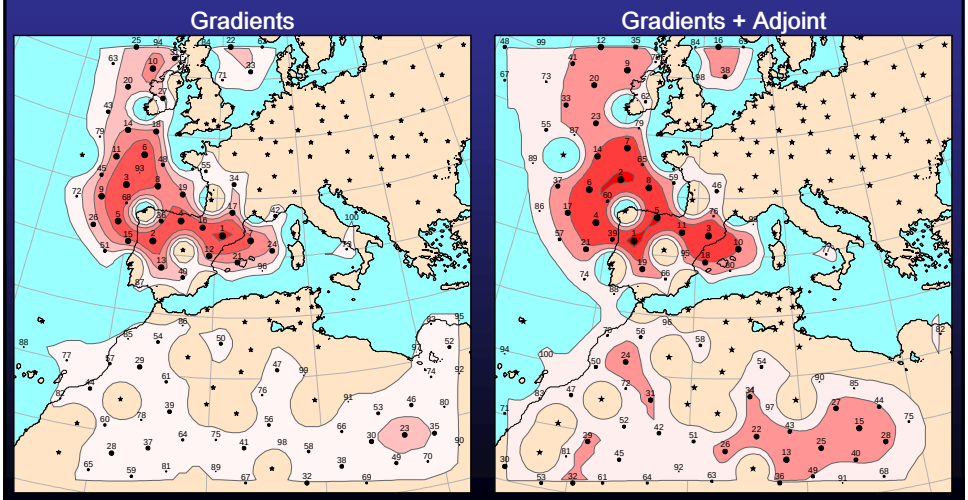
Human II



Example Applications:
Targeting (MEDEX)

Subjective sens. estimate

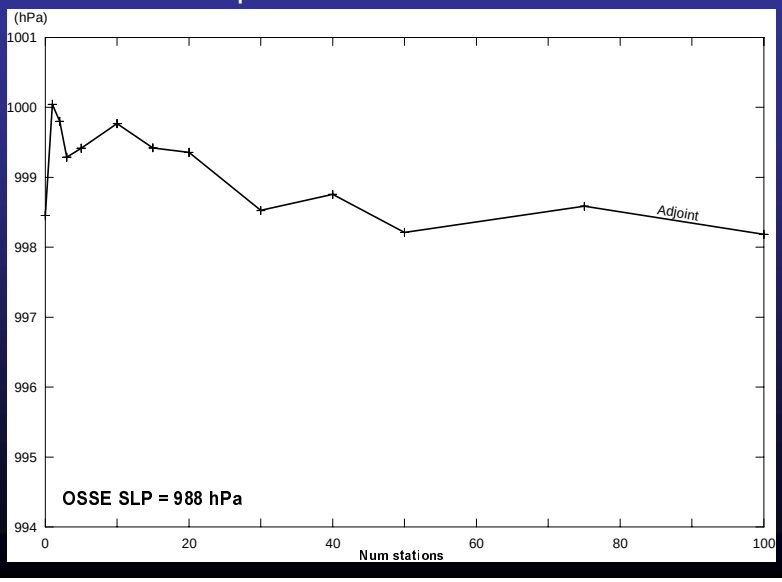
- Subjective rules on IC fields:



Example Applications:
Targeting (MEDEX)

Score board

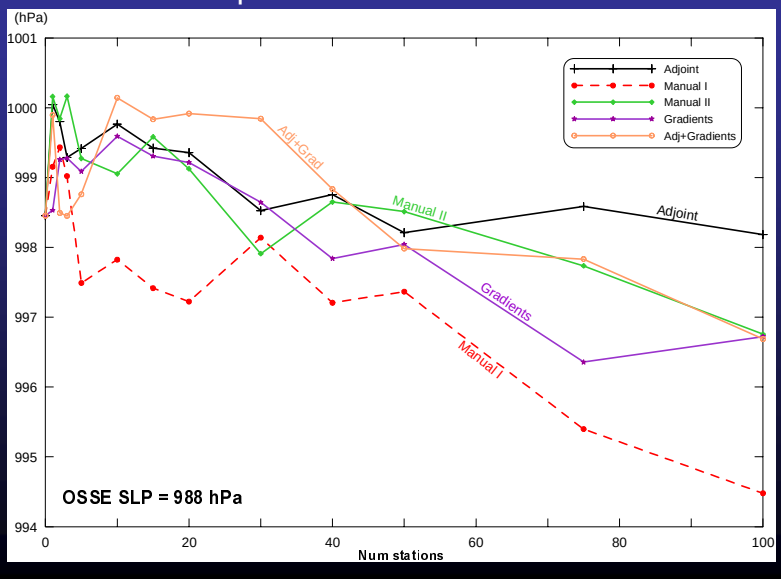
- Central Sea Level pressure:



Example Applications:
Targeting (MEDEX)

Score board

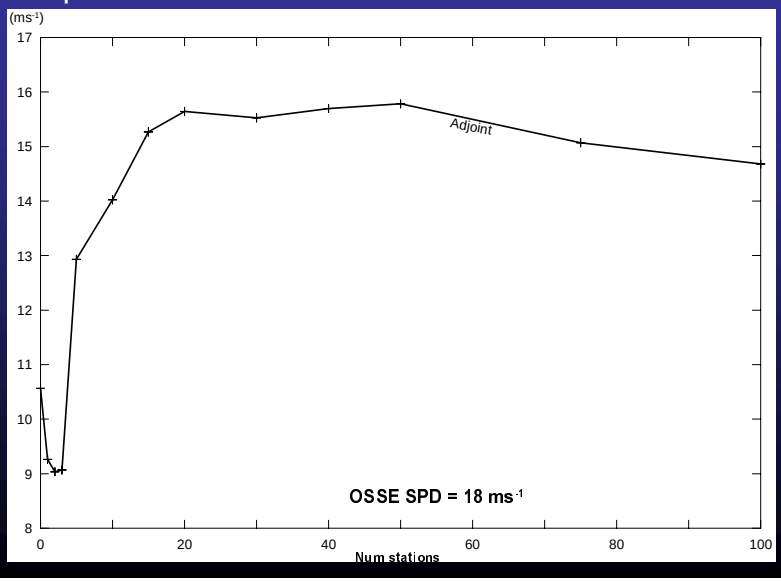
- Central Sea Level pressure:



Example Applications:
Targeting (MEDEX)

Score board

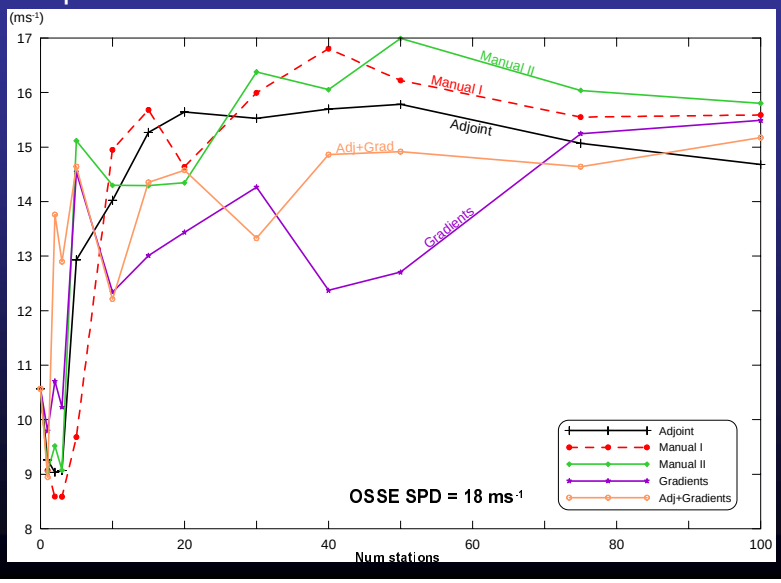
- Wind speed Balearics low levels:



Example Applications:
Targeting (MEDEX)

Score board

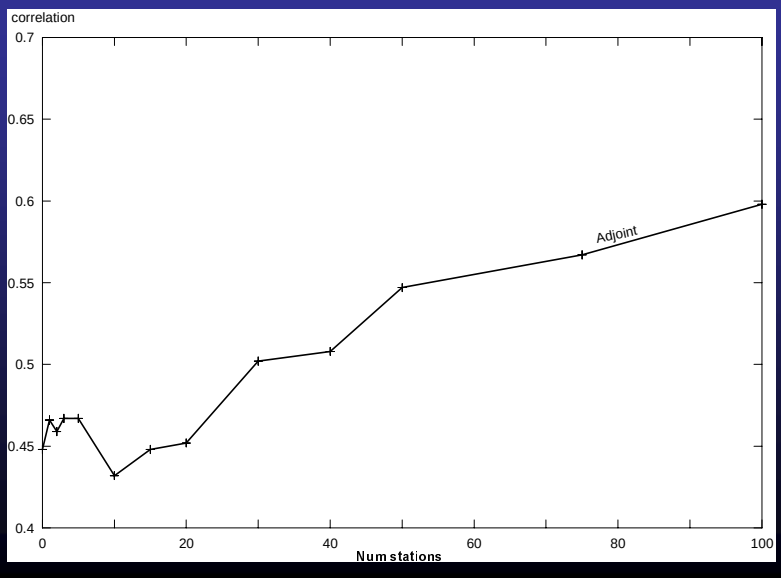
- Wind speed Balearics low levels:



Example Applications:
Targeting (MEDEX)

Score board

- Correlation PV300:



Example Applications:
Targeting (MEDEX)

Score board

- Correlation PV300: