Grupo 25

Adjoint model, 3DVAR analysis and ensemble generation

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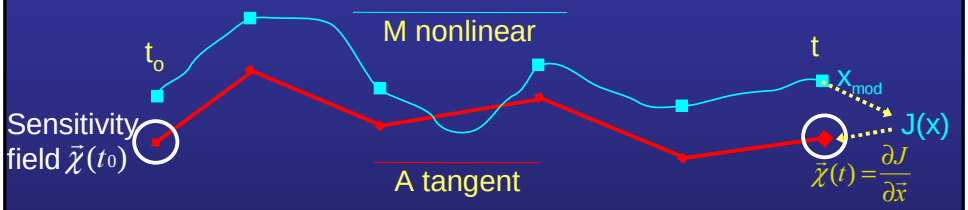
Outline

- Recent achievements
- Plans and projects
- Interaction and offers to other groups
- Discussion

MM5 Adjoint Model

Adjoint integration

- Schematic view of integrations:



Sensitivity fields $\vec{\chi}(t_0)$.

- Units of:

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

- It shows the sensitivity of J(x(t)) to the model initial fields

Response functions J(x(t))

- 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}

Achievements

Available Adjoint system

Reduced number of available options:

- Convection: Kuo, Grell, Arakawa-Shubert (licensed)
- PBL: Bulk, Blackadar
- Explicit moisture: “Stable” precip, Dudhia
- Radiation: simple cooling, surface radiation, cloud-radiation
- No nesting capability

Achievements

Simulations configuration

Domain limitations:

- 2 big (~10Gb) files stores the nonlinear basic state (Whole grid every time step)
- High resolutions incoherent with simplified physics

Typical configuration:

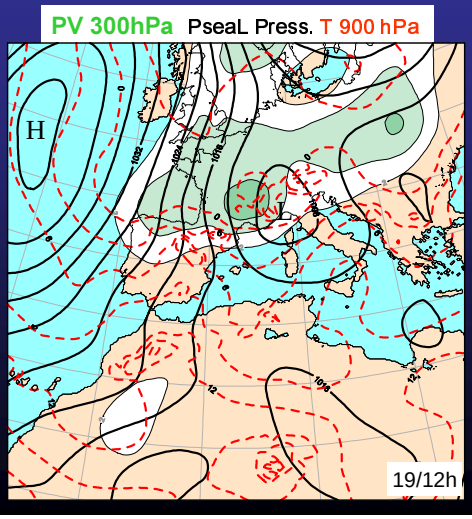
- Grid: 71x71x23 with Δx = 60 km and Δt = 120 s.
- Physics:
  - Cumulus Convection: Grell
  - Explicit moisture: Dudhia
  - PBL: High resolution Blackadar
  - Radiation: Cloud radiation scheme
- IC and BC from the standard MM5 preprocessing package

Example 1:
Targeting contest
19-22 December 1979 Storm

Analysis

60 — 24 — 0

19 12UTC — 22 00UTC



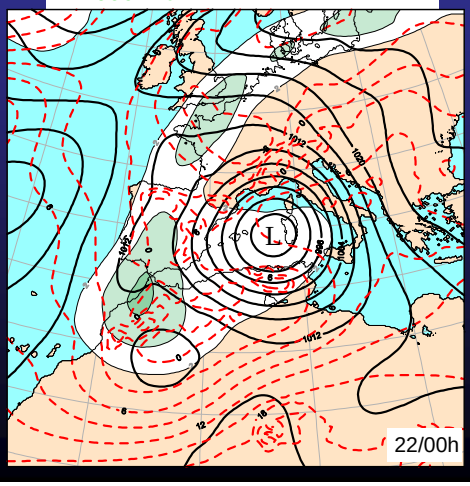
Achievements:
Targeting (MEDEX)

Analysis

60 — 24 — 0

19 12UTC — 22 00UTC

PV 300hPa PseaL Press. T 900 hPa



Achievements:
Targeting (MEDEX)

Control Analysis

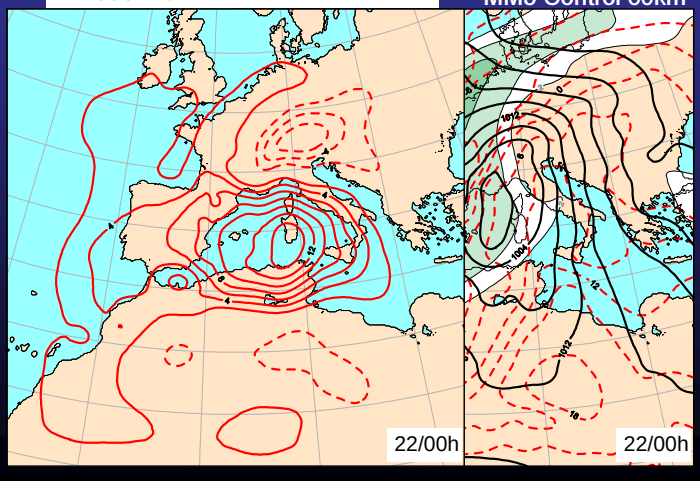
60 — 24 — 0

19 12UTC — 22 00UTC

Analysis

PV 300hPa PseaL Press. T 900 hPa

+60h
MM5 Control 60km

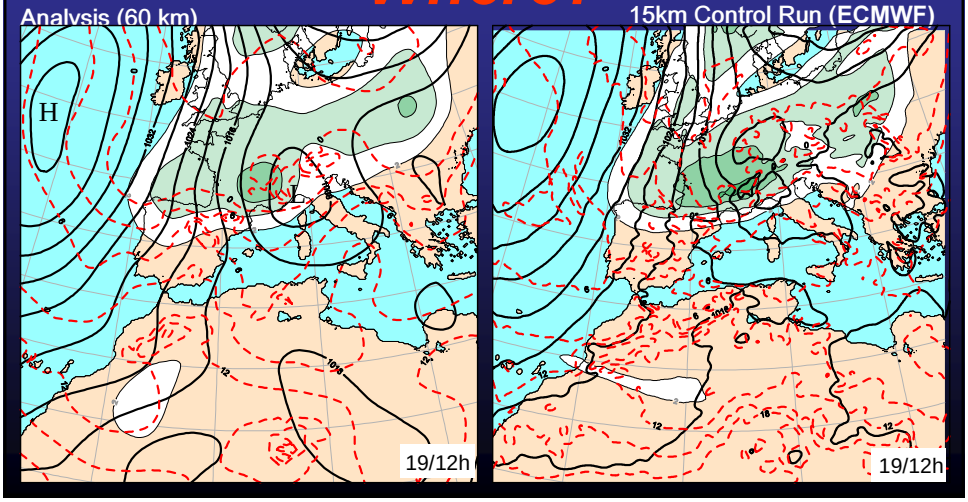


Achievements:
Targeting (MEDEX)

OSSE run

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

Where?



Achievements:
Targeting (MEDEX)

Sensitivity estimates

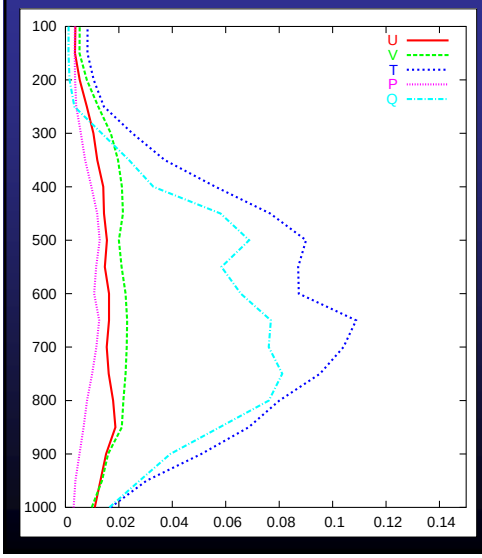
Open Competition! Come and sign in!!

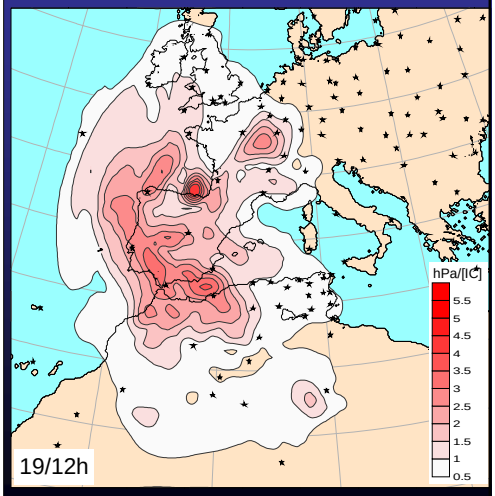
- Finalists:
  - MM5 Adjoint model 60h 60km
  - Human manual I
  - Human manual II
  - Gradients in the IC (upper PV, lower T, V, Q)
  - Sum of Adjoint and Gradients estimates

Achievements:
Targeting (MEDEX)

Adjoint sens. estimate

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

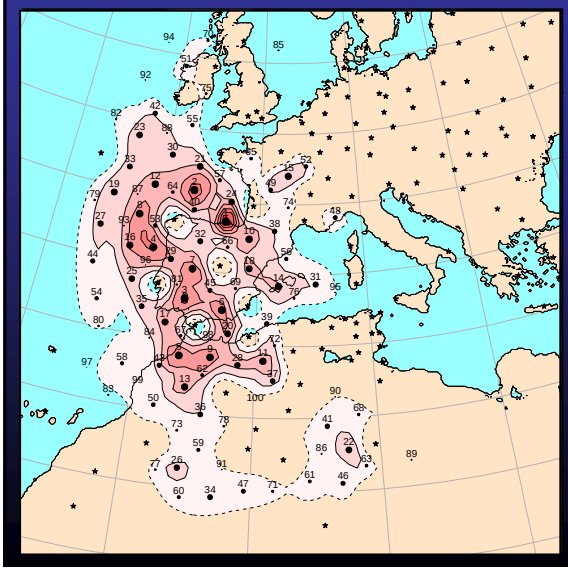




Achievements:
Targeting (MEDEX)

Adjoint sens. estimate

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



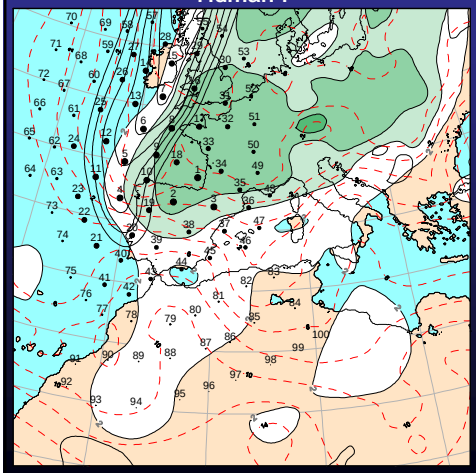
- Gaussian kernel stations
- 100 stations ranked using effective sensitivity
- 100 new simulations, each with an additional artificial sounding
- Actually “only” 12 runs: 1,2,3,5,10,15,20,30,40,50, 75,100

Achievements:
Targeting (MEDEX)

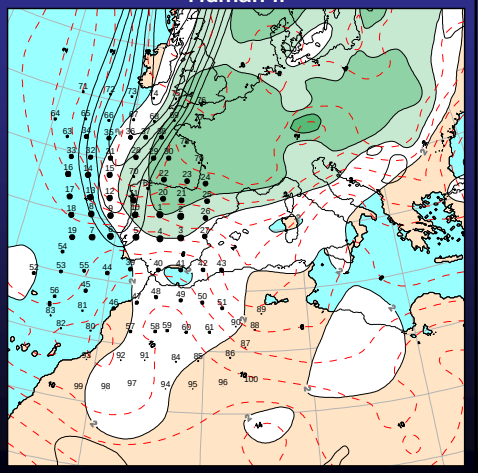
Human sens. estimate

- Forecast run information provided to human

Human I



Human II

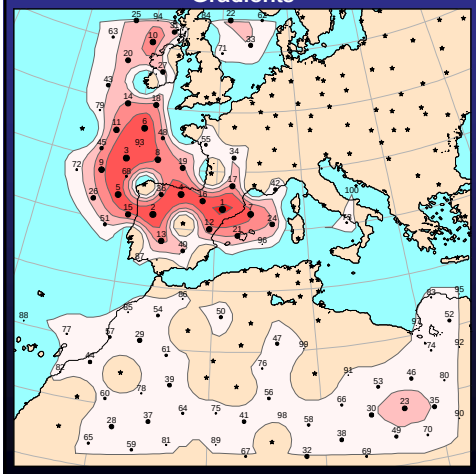


Achievements:
Targeting (MEDEX)

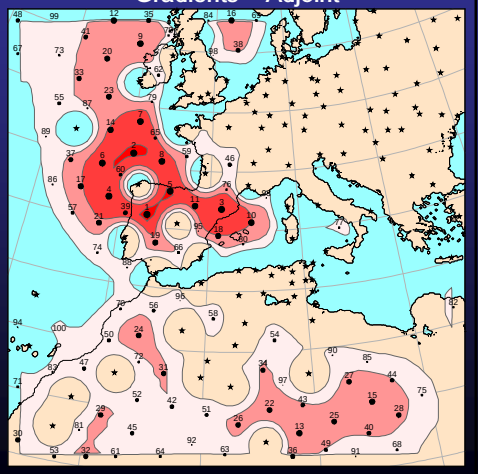
Subjective sens. estimate

- Subjective rules on IC fields:

Gradients



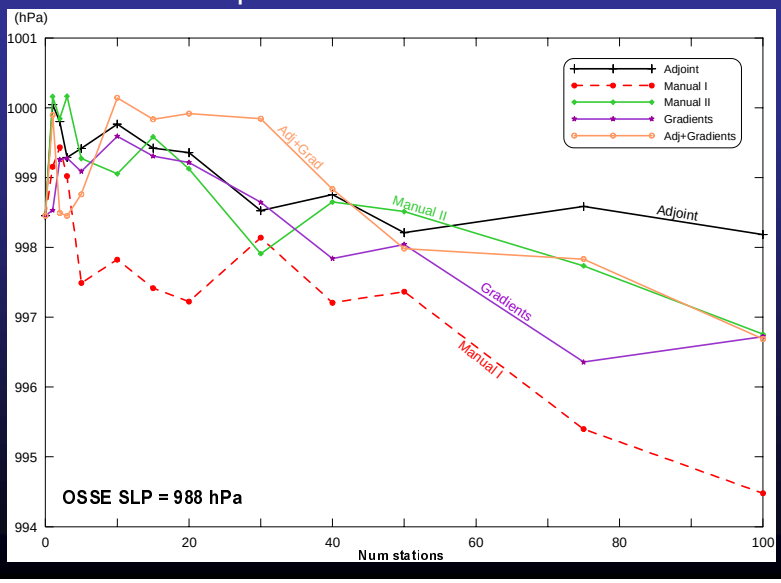
Gradients + Adjoint



Achievements:
Targeting (MEDEX)

Score board

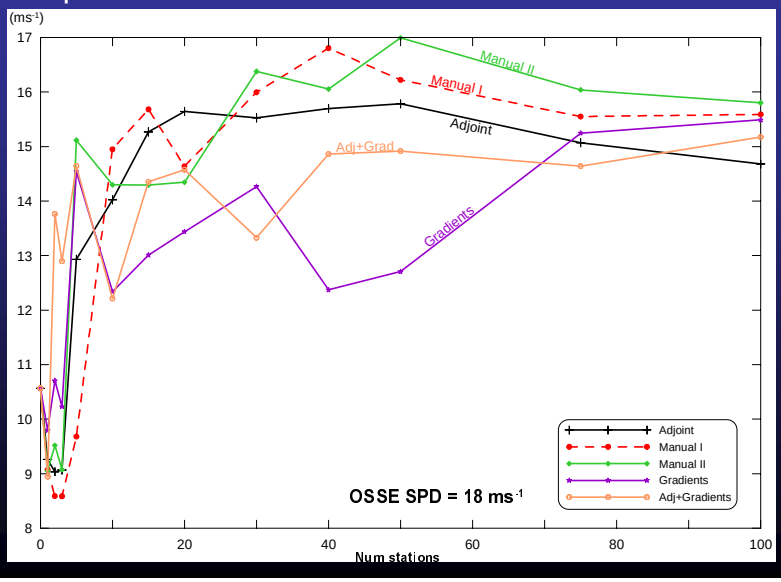
- Central Sea Level pressure:



Achievements:
Targeting (MEDEX)

Score board

- Wind speed Balearics low levels:



Competition results

- Adjoint sensitivity estimations:
  - Provide an indication of sensible areas (~synoptic)
  - This information is already available by classical subjective or objective estimate of sensitivity (diagnosis)
  - Tests to determine the effective resolution of the adjoint estimates suggest no estimative skill at the mesoscale, perhaps at lower synoptic scale

  - Causes: Simple physics, tangent linearization (60h integrations), …

Example 2:

Ensemble member generation

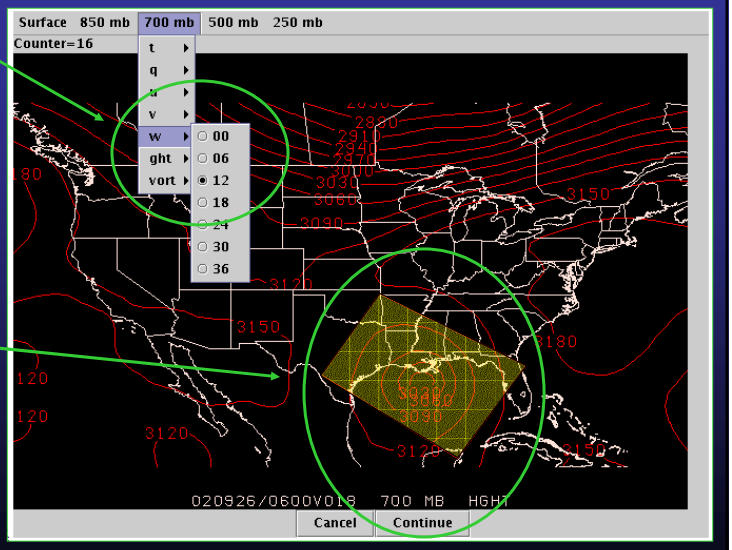
Spring Program SPC 2003

Achievements:
Ensemble members generation

SPC Spring P. 2003

Forecaster chooses level, field, and time

A box is drawn around interest area, process continues until counter is at zero

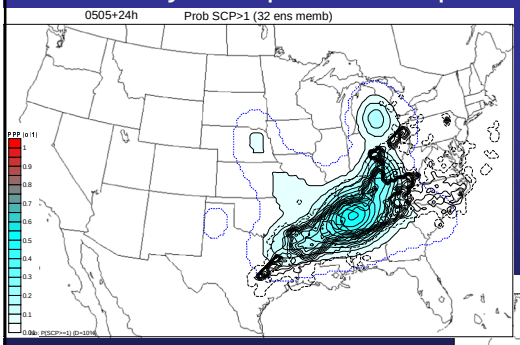


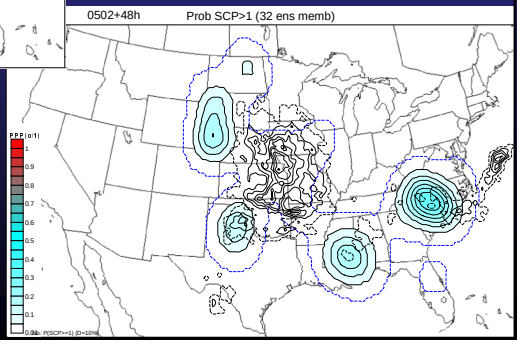
Thanks to J. Levit

Achievements:
Ensemble members generation

SPC Spring P. 2003

- Probability of Supercell Composite > 1:





Plans and projects

- Test of the most adequate response functions (adjoint limitations) and climatology of quantitative sensitivity fields.
- Further exploration of adjoint methods in an ensemble framework for high impact weather in the Western Mediterranean.
- Comapre MM5 adjoint to other models

Interactions and offers

- Sensitivity calculation for case studies. Past experience with groups 1 and 21
- Use of MM5 3DVAR analysis system (background error?)
- Ensemble generation and interpretation
- General support for MM5 installation and use Past experience with groups 21 and Uni. La Laguna

Discussion

- Congratulations current management of the MM5 network. Great success!
- Suggestions for next Steps:
  - Installation/Set-up problems: database of configurations (files?), computer info, benchmarks?
  - Common projects: Poor man's real-time ensemble on a web page? (or even standard ensemble?),…