OBSERVATIONS AND FINE-GRID SIMULATIONS OF AN OROGRAPHICALLY-INITIATED CONVECTIVE EVENT IN NORTHEASTERN SPAIN

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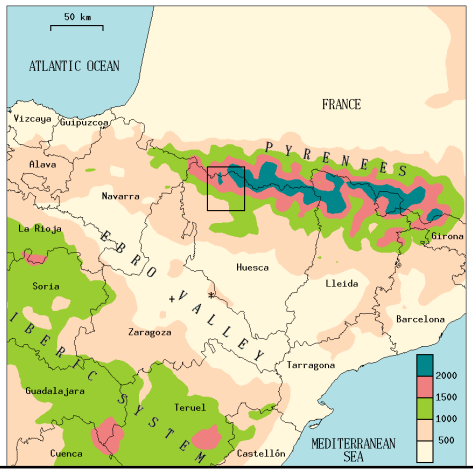
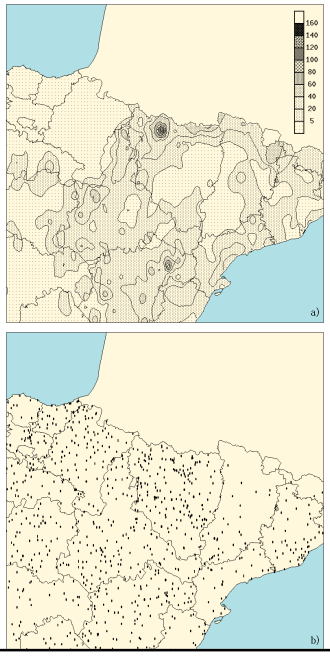


RAINFALL 24 h

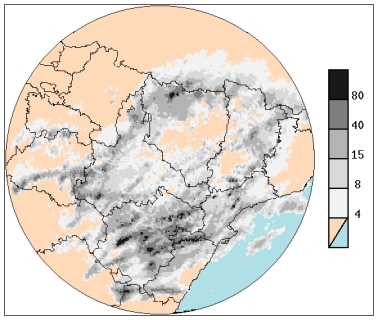
RAINGAUGES NETWORK



07 UTC
7 August 1996

07 UTC
8 August 1996

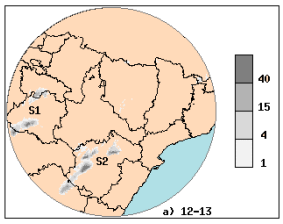
RADAR-ESTIMATED



Significant rainfall along the Pyrenees and Iberic System Connecting corridor across the low lands of Ebro valley

Flash-floods in **Biescas** (>250 mm; 225 mm 15-18 UTC)

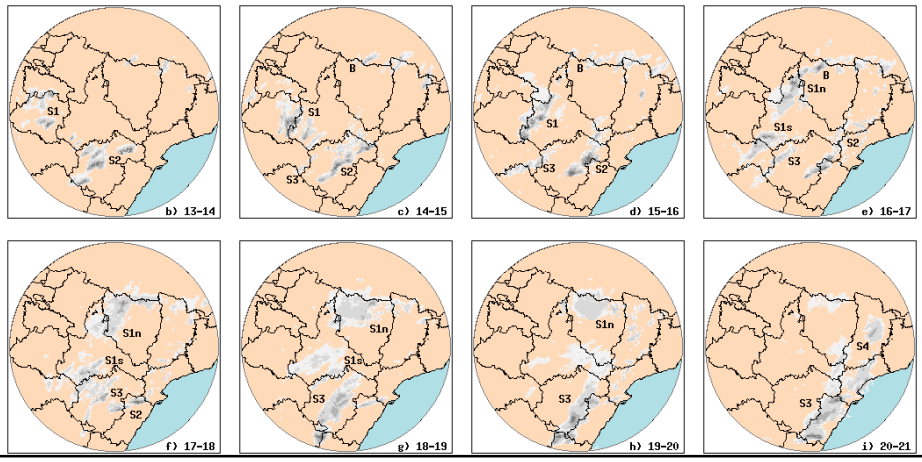
RADAR-ESTIMATED HOURLY RAINFALL



The episode began at 12 UTC over the mountains: **Diurnal heating ?**

Differential movement of the main MCSs **S1** and **S2** after 15 UTC

Merger of **S1n** with the Biescas convective storm **B** at 17 UTC



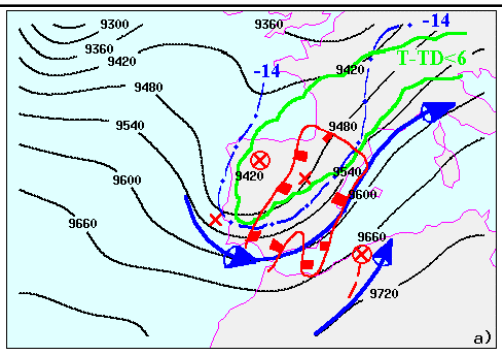
SYNOPTIC ENVIRONMENT

MID-UPPER LEVELS

Advance of a trough and cold front

Upward Q-G forcing in eastern Iberian peninsula

ULJS off the Mediterranean coast

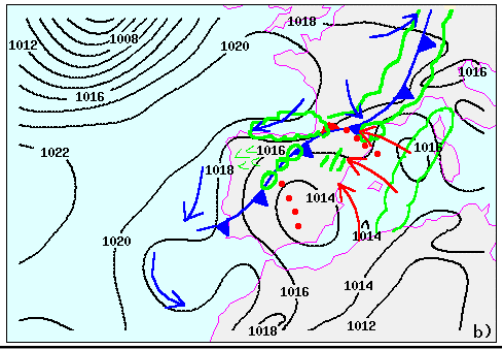


12 UTC

LOW LEVELS

Low in southeastern Spain / Warm-moist advection

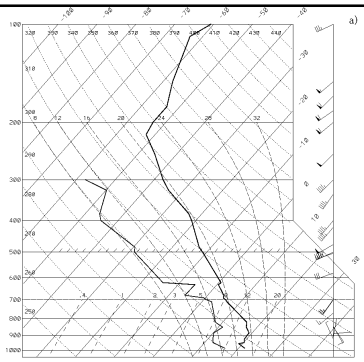
Cold front blocked against the Pyrenees



PRECONVECTIVE SOUNDING AT ZARAGOZA

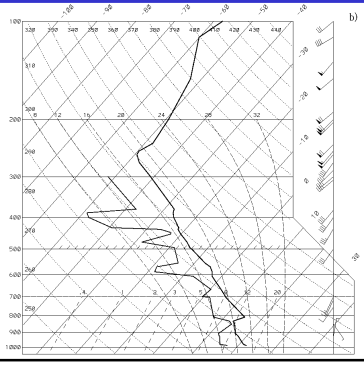
00 UTC

CAPE	31 J / kg
CIN	383 J / kg
TT	51
K	35
LI	+1
PW	33 mm



12 UTC

CAPE	945 J / kg
CIN	165 J / kg
TT	55
K	35
LI	-2
PW	37 mm



SURFACE MESOSCALE COMPOSITES

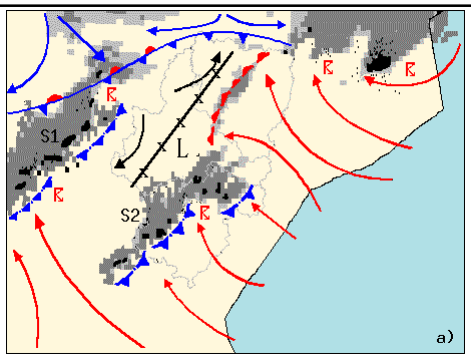
12 UTC

Upslope wind systems

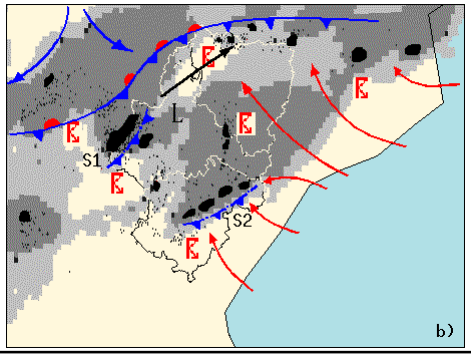
SW-NE oriented deformation zone

Mesolow in the Ebro valley of thermal origin **?**

Outflow boundaries from S1 and S2



15 UTC



MESOSCALE NUMERICAL SIMULATIONS

*** PSU-NCAR mesoscale model (non-hydrostatic version MM5)**

*** Simulations:**

- 3 domains: 82x82x31 (36 and 12 km) / 112x112x31 (4 km)
- Interaction: two-way
- I.C and B.C: NCEP global analysis + Surface and Upper air obs.
- Period: 24 h, from 00 UTC 7 August 1996

*** Physical parameterizations:**

- PBL: Based on Blackadar (1979) scheme (Zhang and Anthes 1982)
- Ground temperature: Force-restore slab model (Blackadar 1979)
- Radiation fluxes: Considering cloud cover (Benjamin 1983)
- Resolved-scale microphysics:
  - 36 km - Cloud water, rainwater, cloud ice and snow (Zhang 1989)
  - 12/4 km - Mixed-phase model (+ graupel) (Lin et al. 1983)
- Parameterized convection:
  - 36 km: Kain-Fritsch (1990)
  - 12 km: Grell et al. (1991)
  - 4 km: None

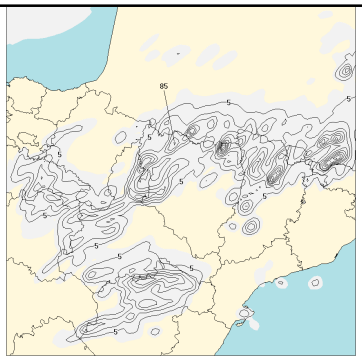
FORECAST

Spatial pattern well captured

Deficiencies along the Mediterranean coast

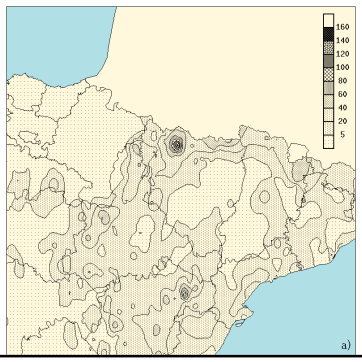
Precipitation maxima generally more intense

Precipitation center at Biescas: 85 mm



TOTAL PRECIPITATION

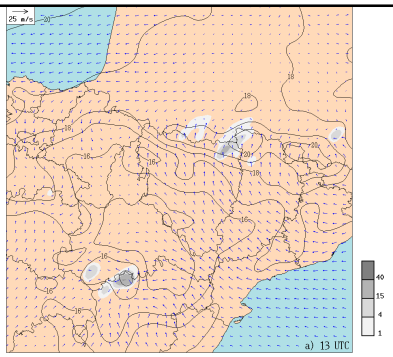
OBSERVED

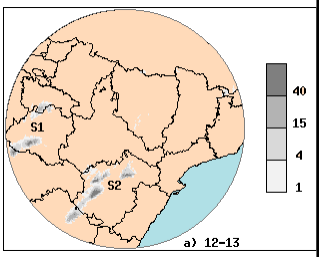


12 - 13 UTC

Orographic triggering

S1, **S2**, **cells** along Pyrenees





TEMPORAL EVOLUTION

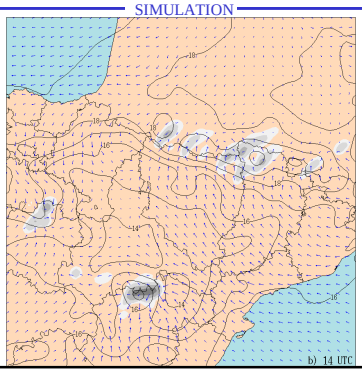
SIMULATION — RADAR

13 - 14 UTC

General **upslope** wind flows

Mesolow in the Ebro valley

Blocking high pressure areas

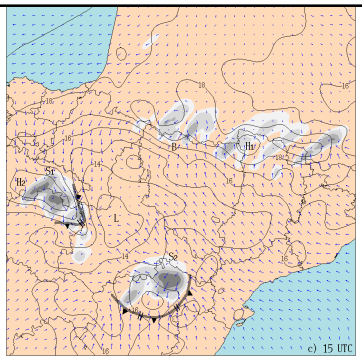


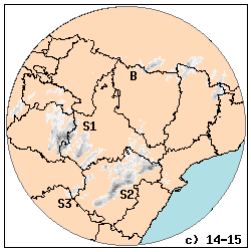
14 - 15 UTC

Deepening of the mesolow

Deformation zone

Storm at Biescas **B**





TEMPORAL EVOLUTION

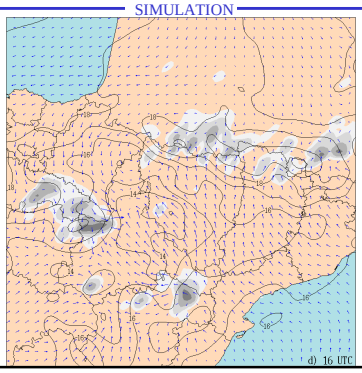
SIMULATION — RADAR

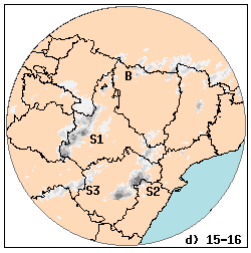
15 - 16 UTC

S1 and **S2** moving **E**-wards

Convective **outflows**

Strong LL **convergence**

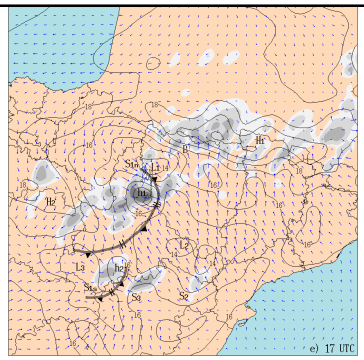


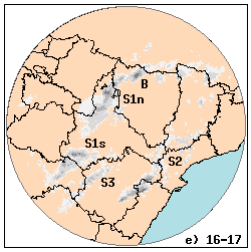


16 - 17 UTC

S1 moving **NE**-wards (**S1n**)

Convective **disruption** of the flow



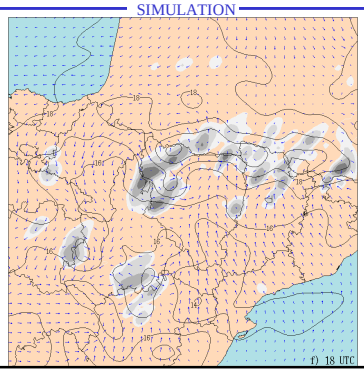


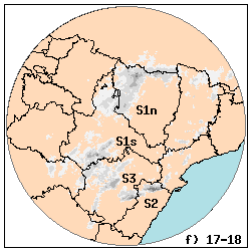
TEMPORAL EVOLUTION

SIMULATION — RADAR

17 - 18 UTC

Connection between **S1n - B**

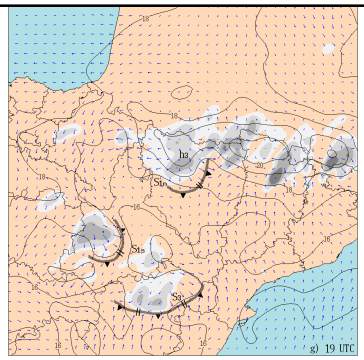


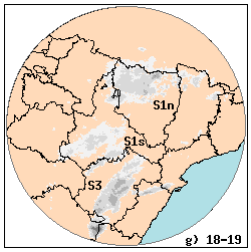


18 - 19 UTC

Extension of the merger

Low-level divergence (**h3**)





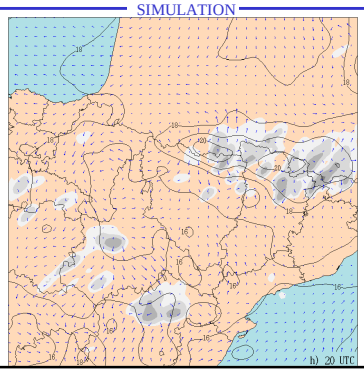
TEMPORAL EVOLUTION

SIMULATION — RADAR

19 - 20 UTC

Weakening of the mesolow

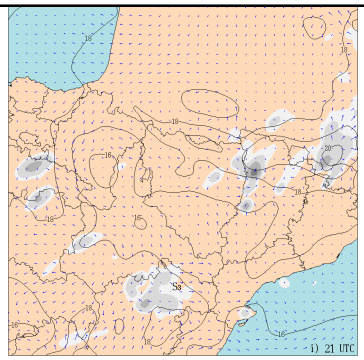
Weak, disorganized LL flow



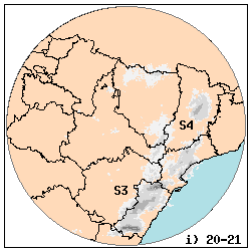
20 - 21 UTC

Dissipation convective systems

TEMPORAL EVOLUTION



SIMULATION



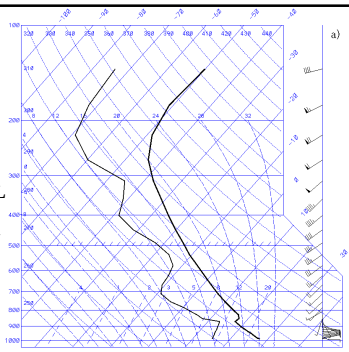
RADAR

FULL SIMULATION

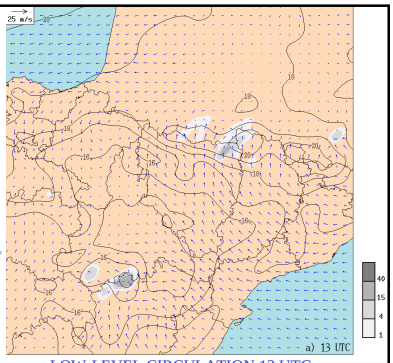
Convective, well-mixed **PBL**

Mesolow in the Ebro valley
Upslope wind systems

IMPORTANCE DIURNAL FORCING



SOUNDING ZARAGOZA 13 UTC

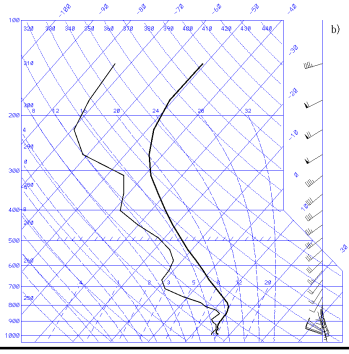


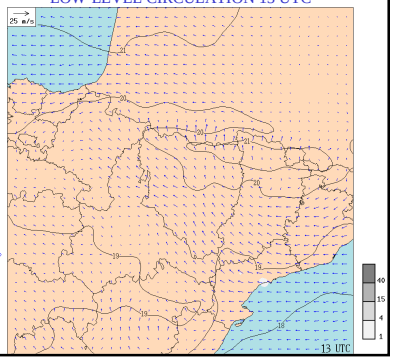
LOW-LEVEL CIRCULATION 13 UTC

NO SOLAR RAD.

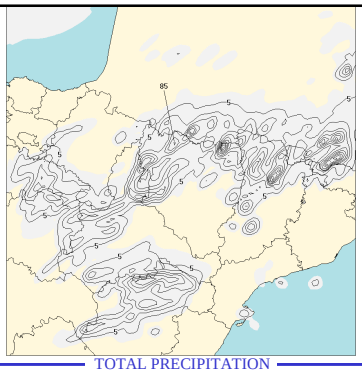
Cooler, more **stable** PBL

No mesolow
No upslope wind systems





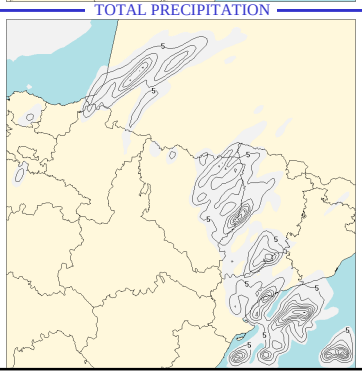
FULL SIMULATION



TOTAL PRECIPITATION

IMPORTANCE DIURNAL FORCING

NO SOLAR RADIATION



Convection develops **later** and farther **east**

CONCLUSIONS

*** Importance of mesoscale components of the flow for the initiation, movement and life cycle of convection**

*** Moderately fine horizontal grid resolution (4 km) + conventional initialization provides valuable information of the convective event and the simulated timing is remarkable**

*** The strong orographic influences typical of the region and the leading role of diurnally-forced circulations (mesolow in the Ebro valley and upslope winds) well-handled by the mesoscale model**

*** Most of the warm season convection that regularly affects northeastern Spain depends critically on the above two factors for its initiation and spatial localization**

ACKNOWLEDGEMENTS

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