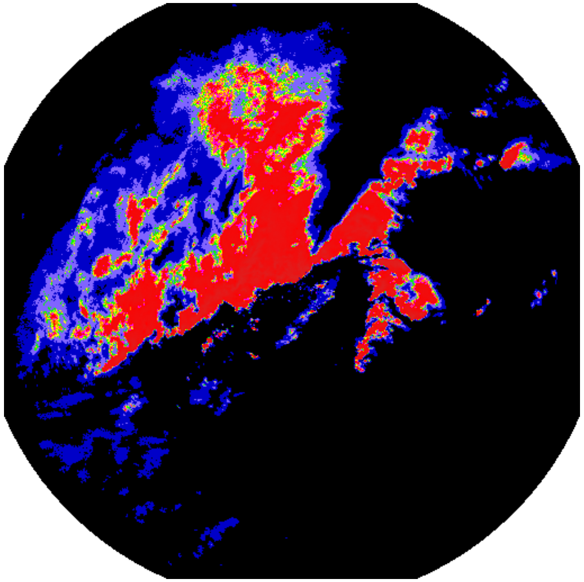
Multi-model simulation of the F4 Haumont tornado



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The Hautmont tornado

- Town of Hautmont, Northern France, August 3rd 2008
- 2030 – 2045 UTC
- F4 intensity (92 – 116 m/s) **(NOT EF4!!)**
- 3 deaths, 18 injuries
- € 1.5M of damage
  - Wesolek, E., and P. Mahieu, 2009 : The F4 tornado of August 3, 2008, in Northern France : Case study of a tornadic storm in low CAPE, high shear environment. *Atmos. Res.*, **93,** 50-65

Hautmont, Northern France

Challenge : simulate tornadogenesis for a real case in Europe

- Strategy
  - Multi-model simulation with WRF and ARPS

Why a multi-model simulation ?

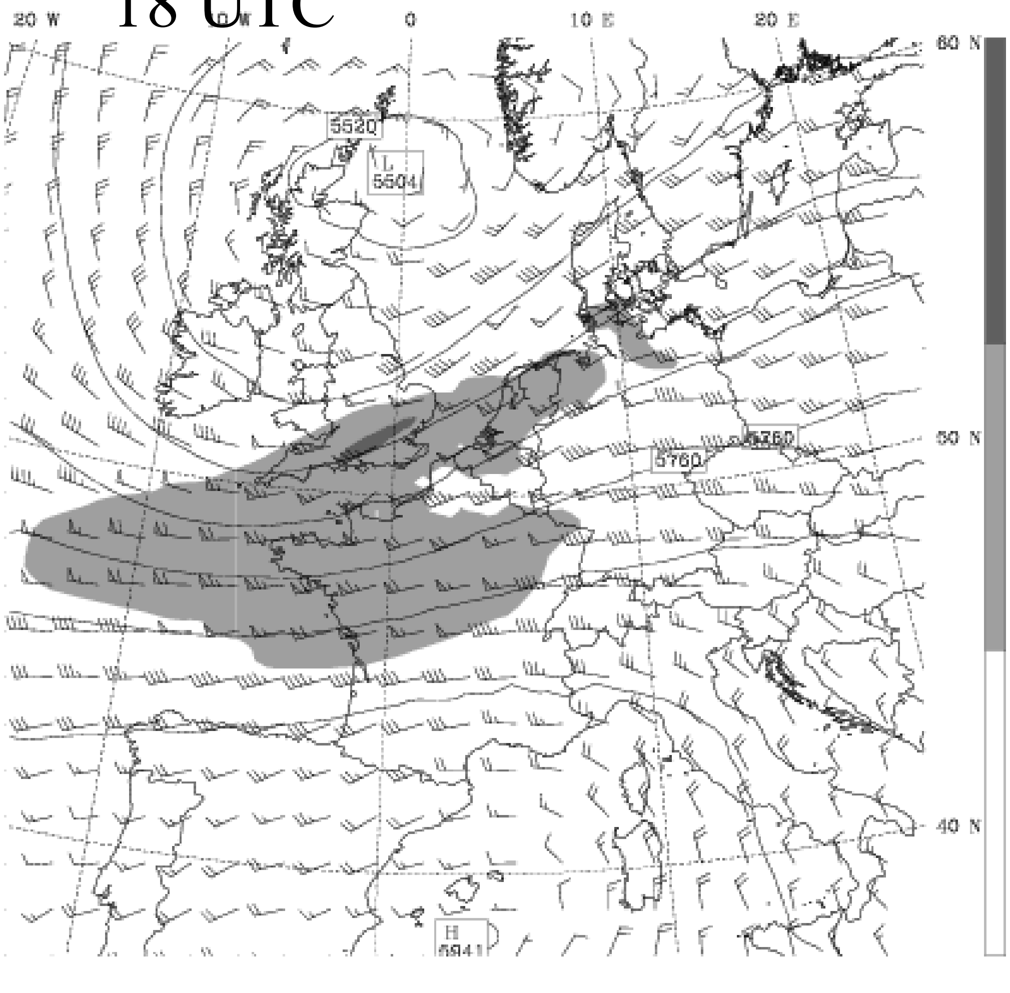
- ARPS less diffusive than WRF
  - WRF more appropriate for synoptic to mesoscale sim
  - ARPS more appropriate for « cloud » scale sim
  - Tornado sims have already been performed using ARPS
- Program suite to export model outputs
- Contribution of both models to the forecast

Numerical simulation with WRF

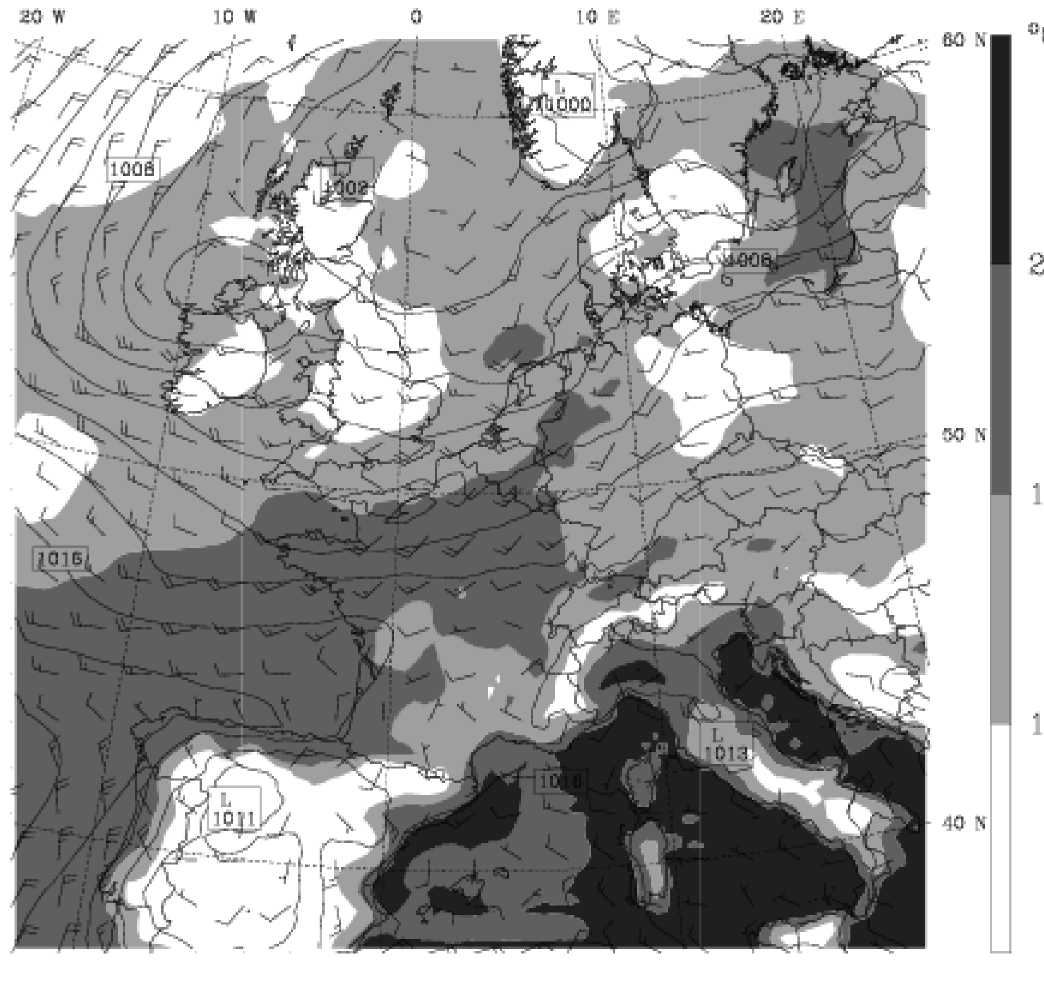
- 3 two-way nested domains
  - dx = 27 km
  - dx = 9 km
  - dx = 3 km
- Initialization
  - NCEP Climate Forecast System Reanalysis 0.5°
- Physics
  - Shafer et al. 2009
- Run from 6 to 24 UTC

Synoptic pattern in WRF

18 UTC

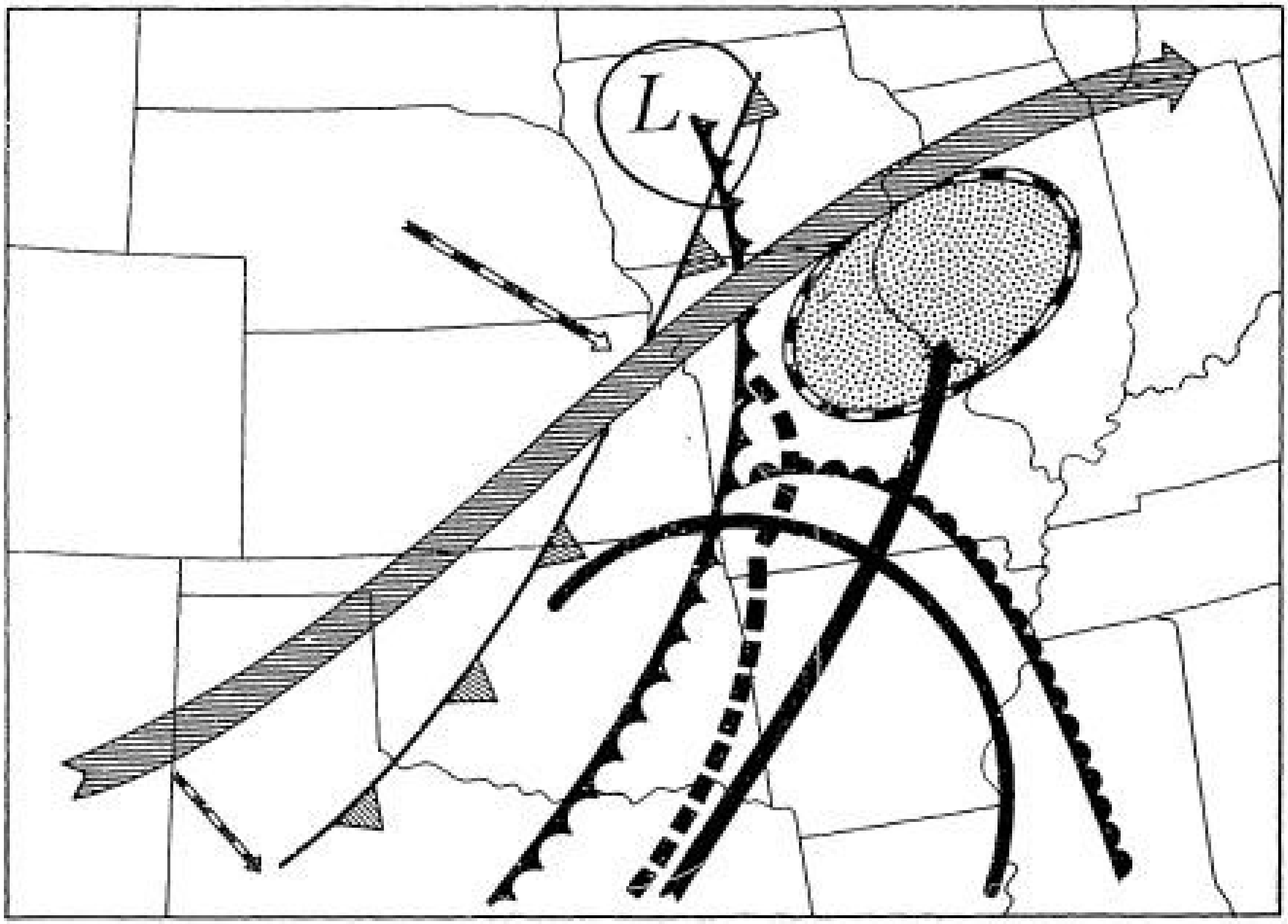


500 mb

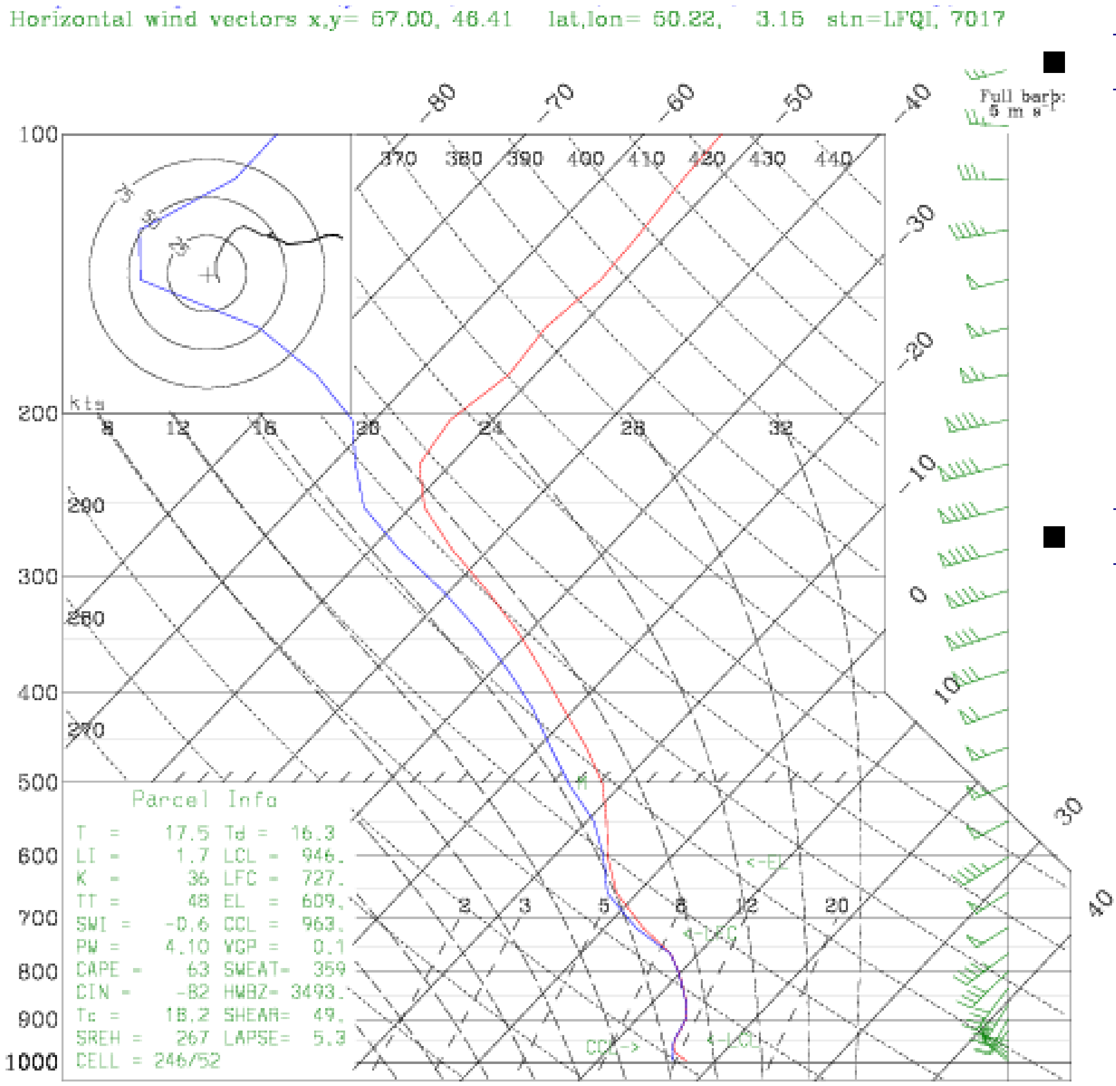


surface

Miller type E synoptic map (designed for the USA, but works for Europe!!)



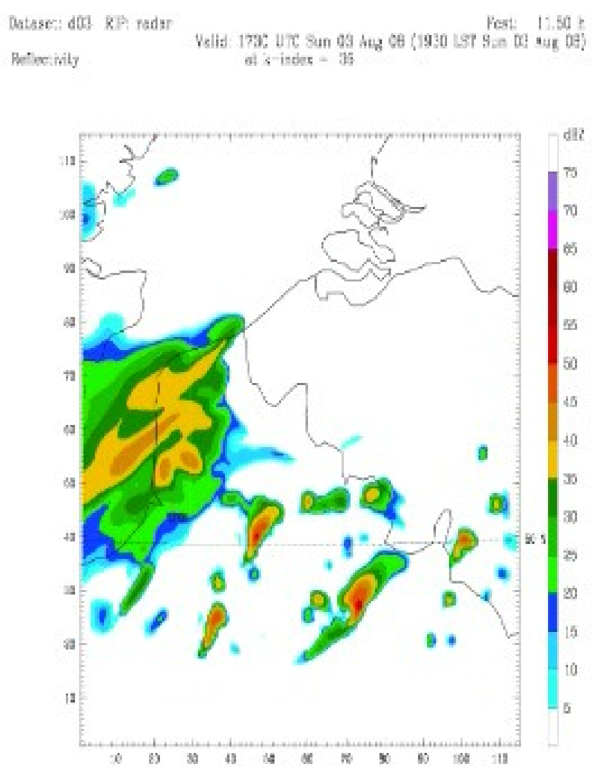
Radiosounding in WRF

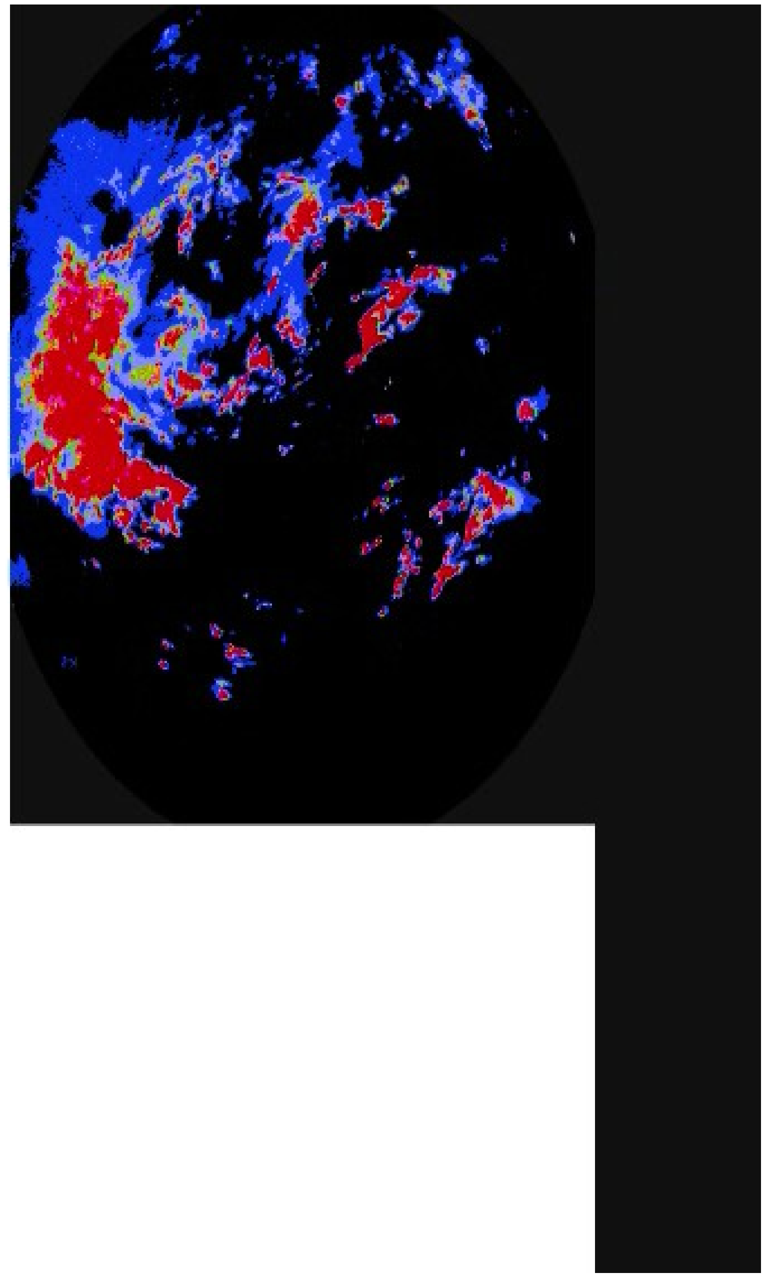


- High shear
  - semi-circular hodograph
  - SREH ~ 300 m2/s2
- Low CAPE
  - ~ 100 J/kg

40 km west of tornado location – 2030 UTC

Near surface reflectivity in WRF





Abbeville Radar
15 – 24 UTC

Delay between WRF and radar obs

Numerical simulation with ARPS

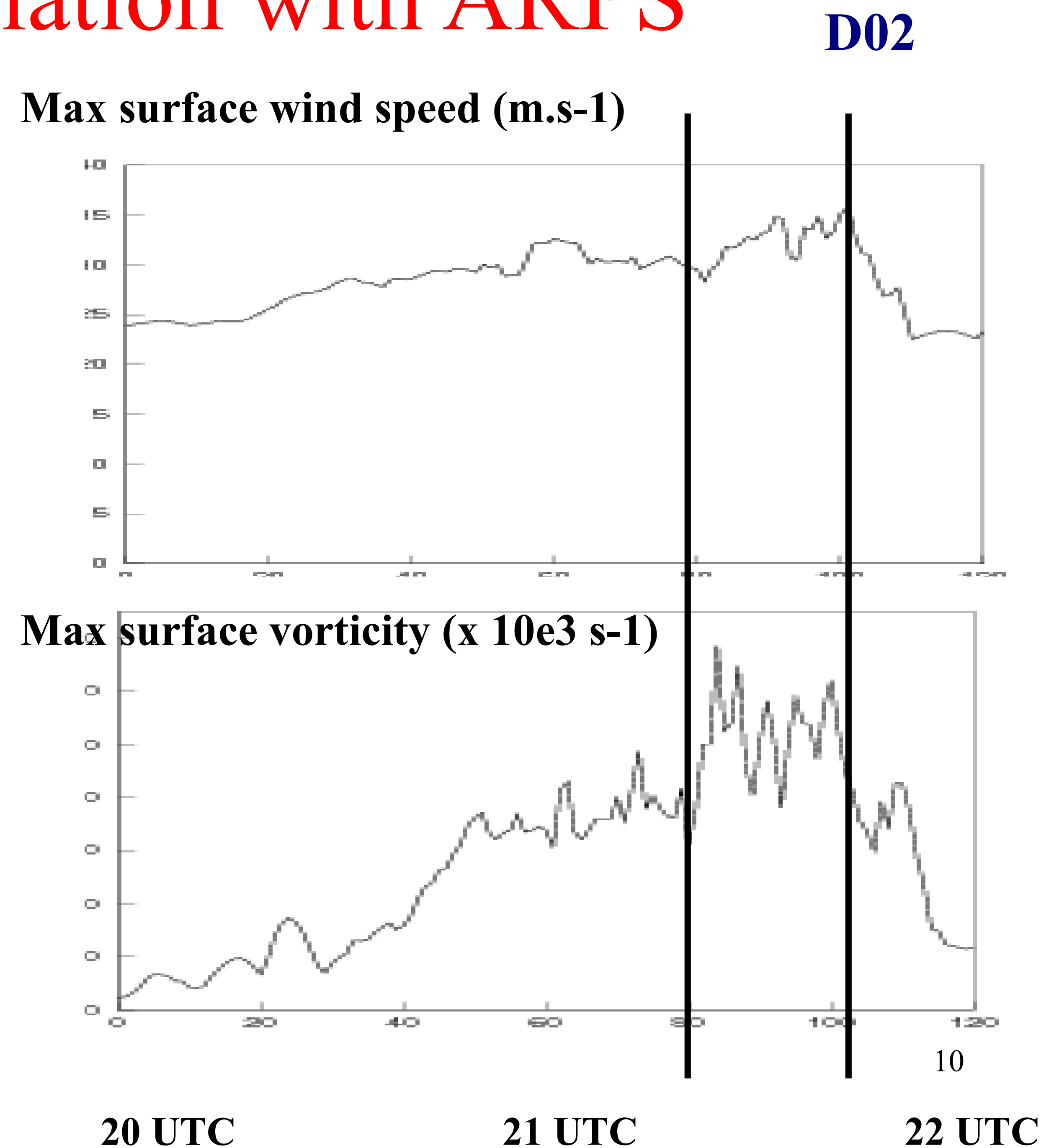
- 3 one-way nested domains centered on max vorticity
  - dx = 1 km
  - dx = 350 m
  - dx = 110 m

18 ──────────► 24

20 ──────► 22

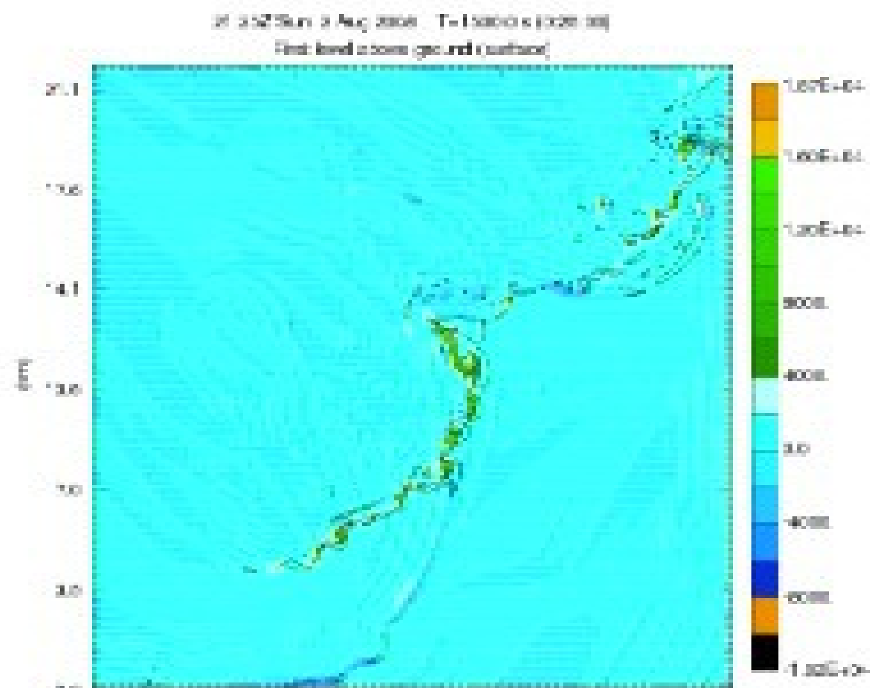
21 ───► 22

- Initialization
  - WRF fine output



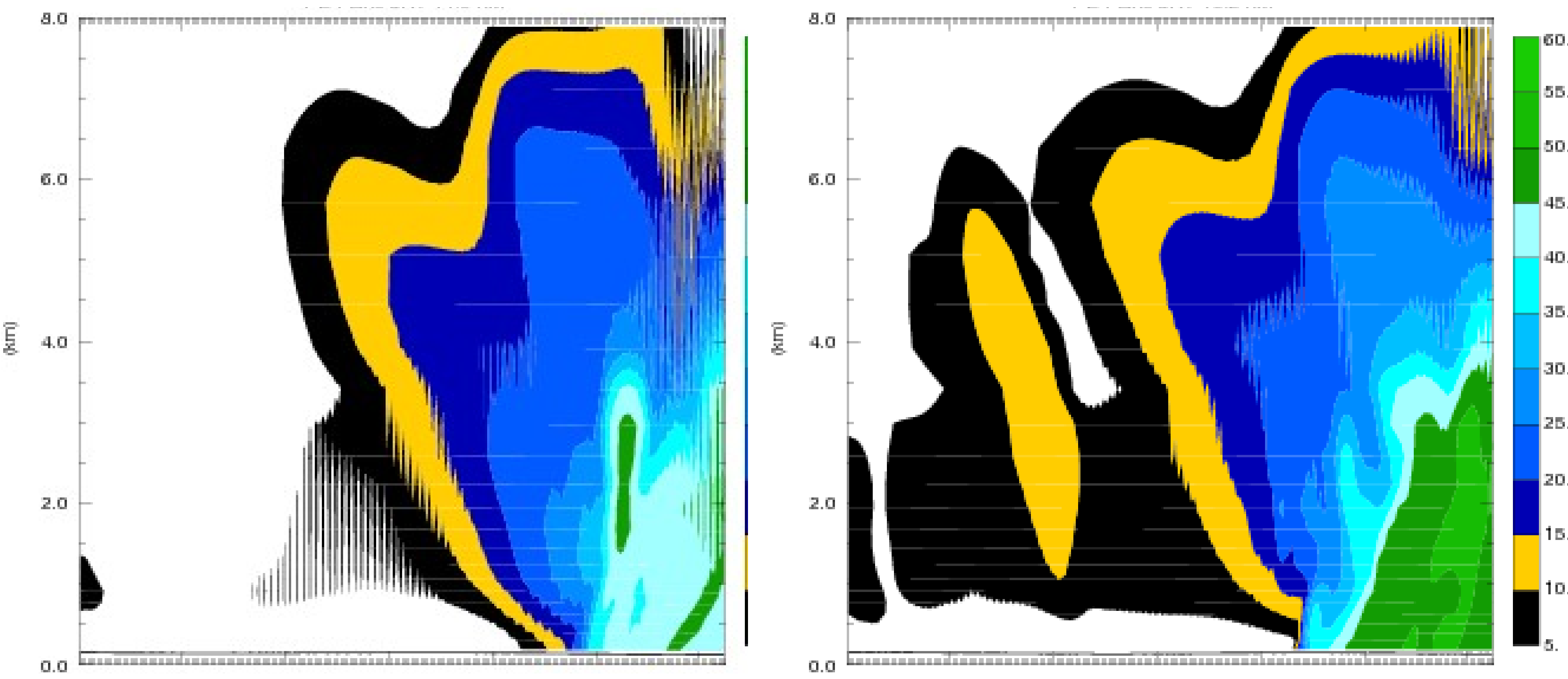
Surface vorticity animation in ARPS

2110-2250 UTC



Descending reflectivity core

« Tornadic circulation » precedeed by DRC descent



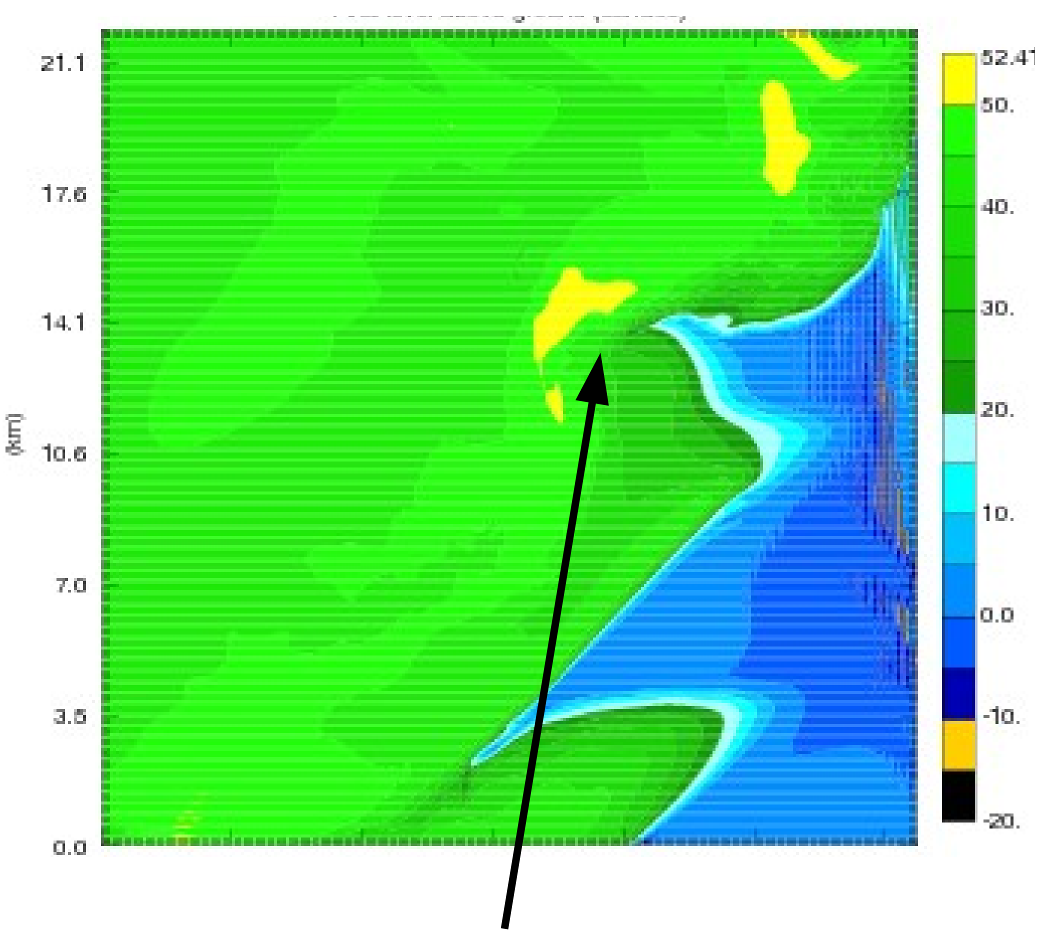
2115 UTC **2125 UTC**

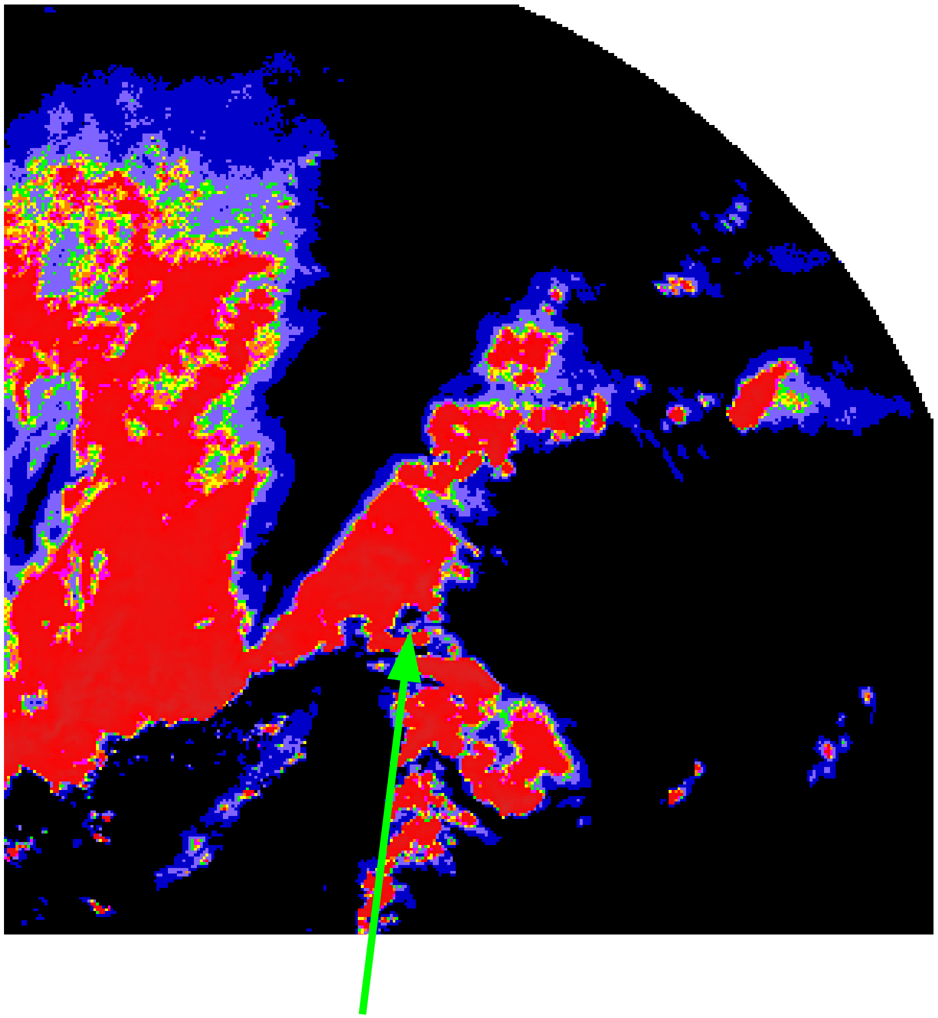
Surface reflectivity

not 2035 but 2130 UTC !

2035 UTC

Supercell circulation embedded in the squall line





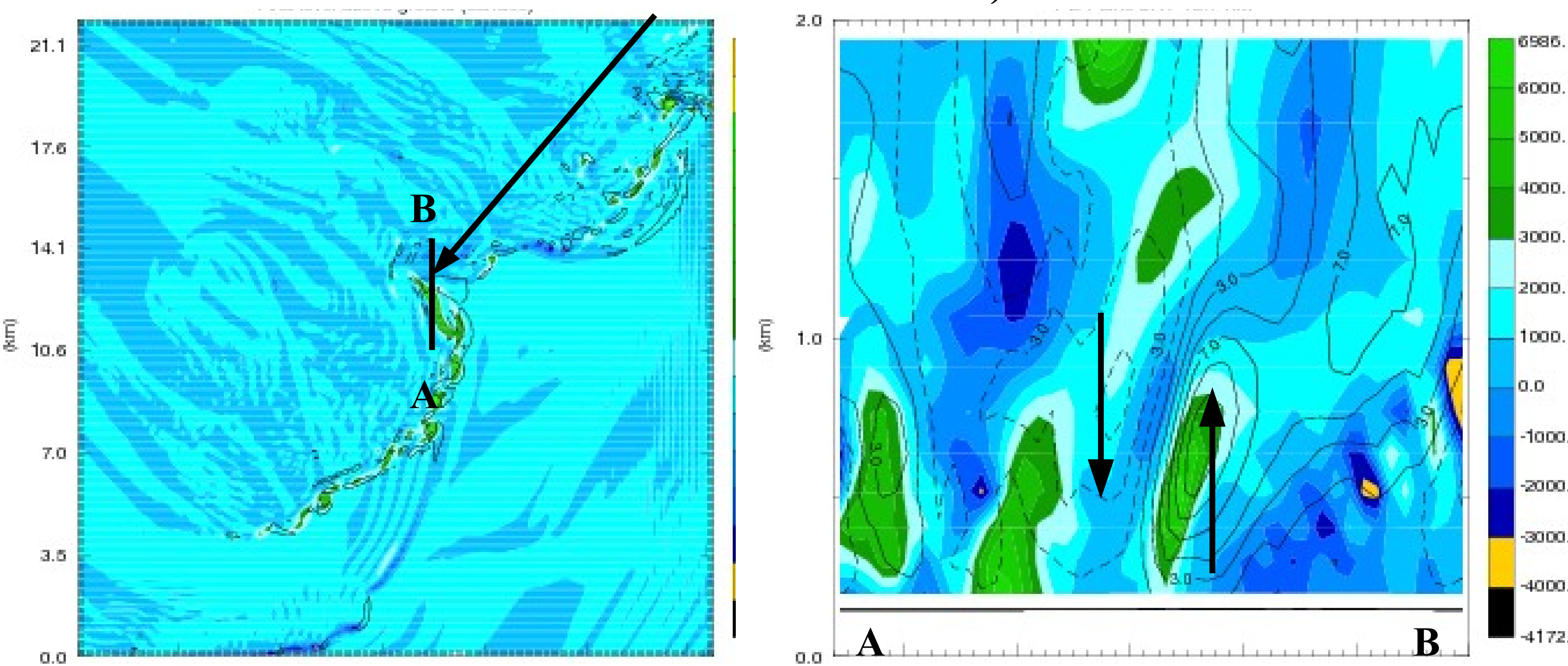
Tornado vortex

Tornado vortex

Surface vorticity

2130 UTC

Tornado vortex (top of the occluded front)



Sensitivity to horizontal resolution

	D01 1 km	D02 350 m	D03 110 m
Max surface vorticity (s-1)	0.03	0.14	0.3
Max surface wind speed (m/s)	30	35	40
Calculated width (m)	4000 unrealistic for a tornado	1000	500 matches the obs

Summary and discussion

- Intensity, lifespan and structures consistent with a tornado
- Lower intensity due to horizontal resolution
- Timing can be improved
  - 1h of delay compared to the observations

Perspectives

- Assimilation of radar reflectivity and radial velocity
- Increase horizontal resolution
- Sensitivity to microphysics scheme

Acknowledgements

Météo France, Bernard Urban (MF), Olivier Caumont (MF), Riwal Plougonven (my PhD advisor) and Juan José Ruiz (CIMA, Argentina)

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Radar packages used

- Opera BUFR software
  - www.knmi.nl/opera