Maritime convective initiation of the severe thunderstorm of 4th October 2007 in Mallorca: Numerical experiments

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14th October , 5th ECSS

Universitat de les Illes Balears

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Introduction

- **4th october 2007**
  - Maritime short squall line
  - Huge damages on Mallorca island

- **A challenge for mesoscale numerical models**
  - Maritime initiation
  - Interaction between synoptic scale and mesoscale

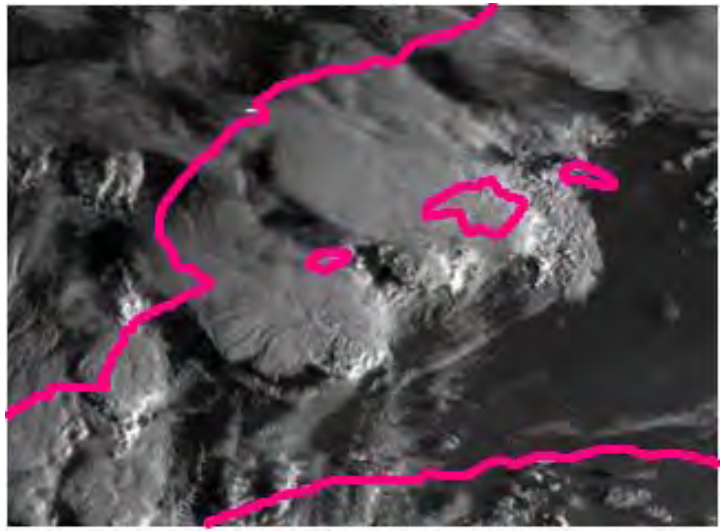
- **Objectives :**
  - Study of case simulations with **3** mesoscale numerical models
  - To assess the impact of pseudo-observation assimilation
  - Better understanding of te squall line environment
  - To analyse squall line structure at fine scale

Contents

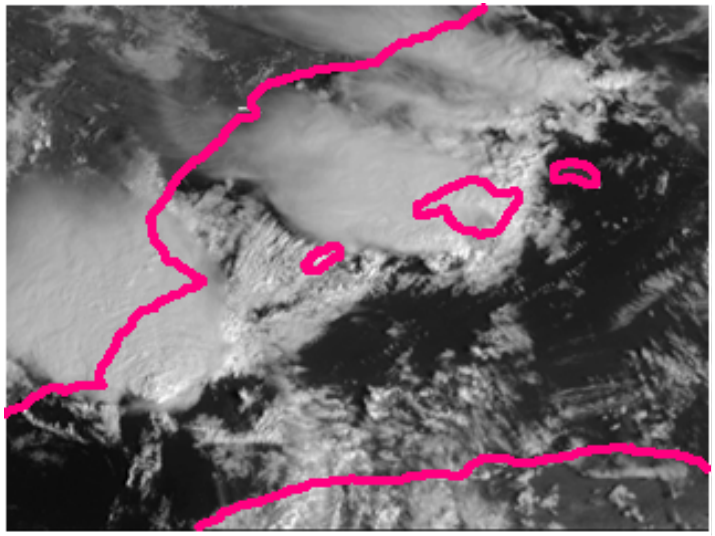
I- Case desciption

HRV images from METEOSAT

7 UTC



9:30 UTC



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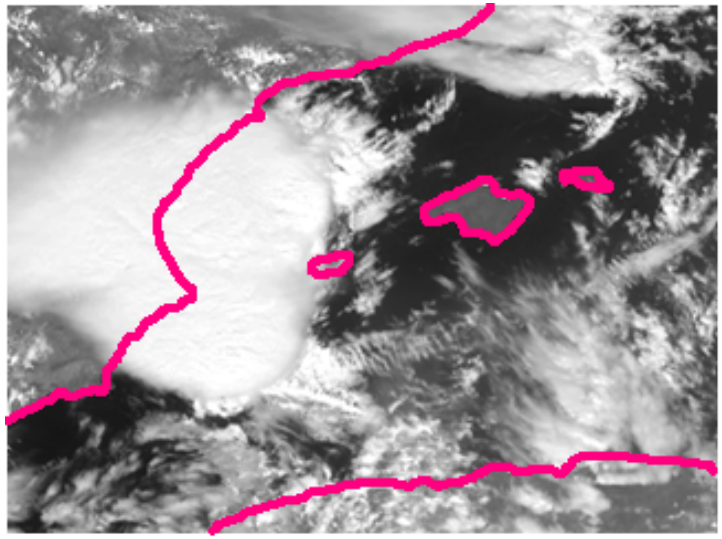

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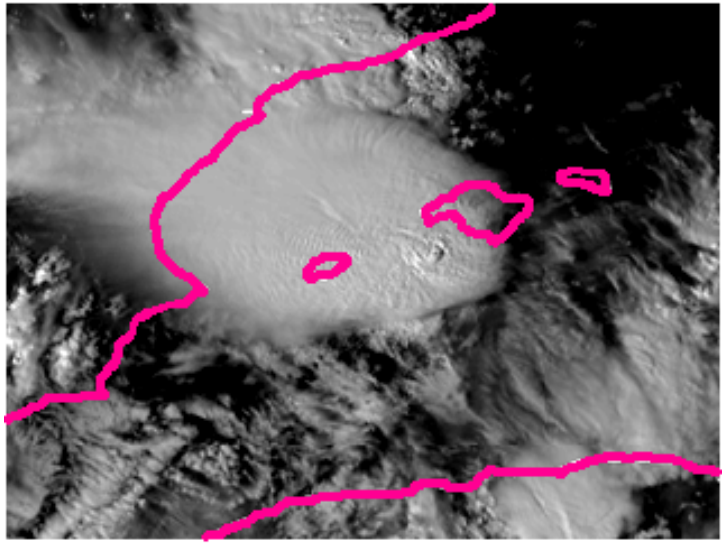
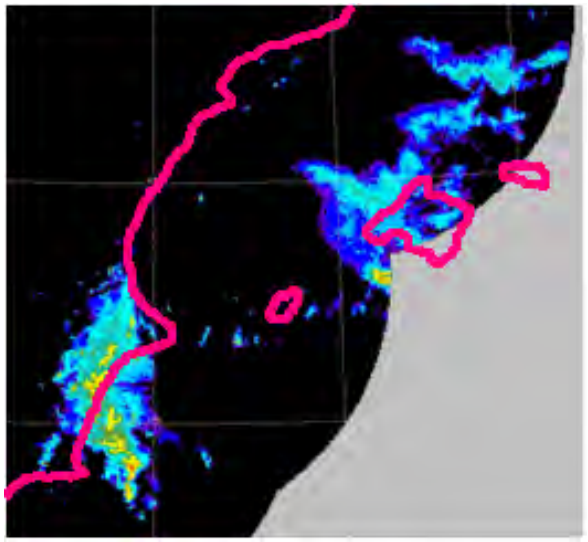


I- Case description

Radar reflectivities

9 UTC



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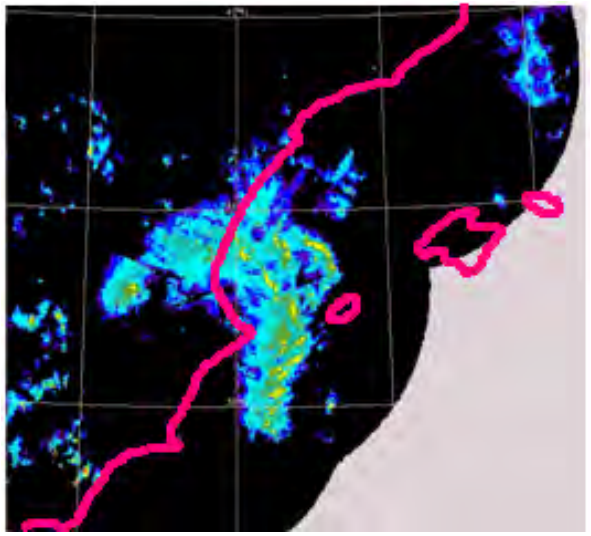

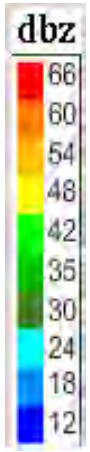

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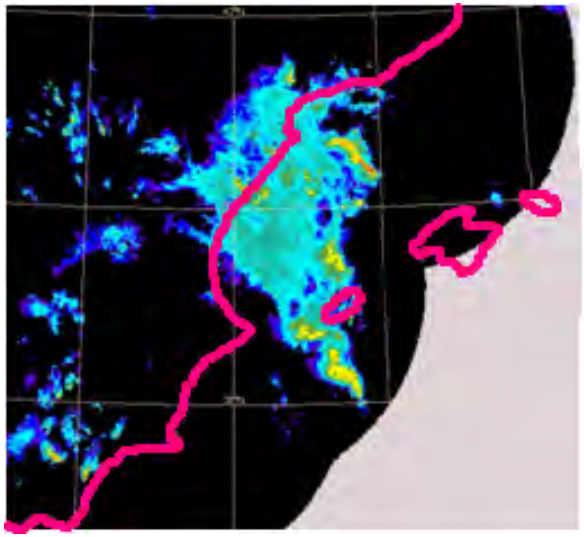

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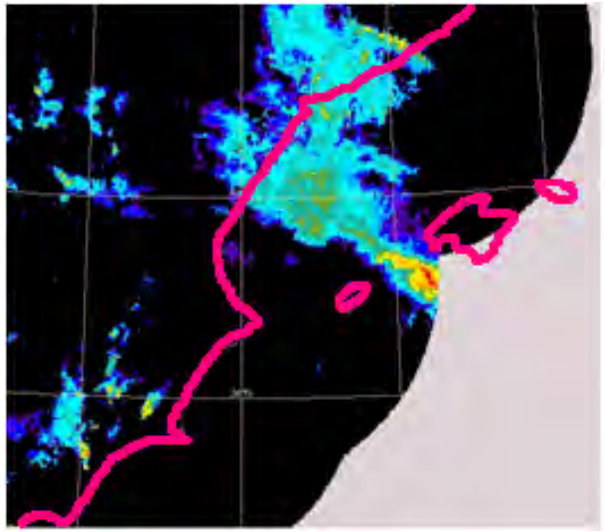


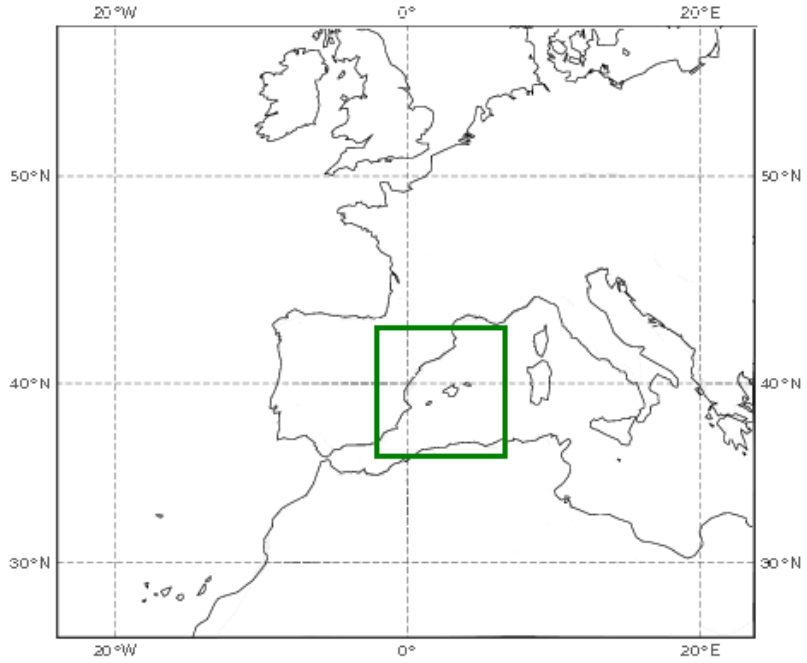
Contents

II- Methodology

Experiments :

Exp.	Model	IC/BC	Resolution
1	Méso-NH	ECMWF	2.4 km
2	WRF	ECMWF	2 km
3	MM5	ECMWF	2 km
4	MM5	ECMWF + nudging	2 km

Domain :



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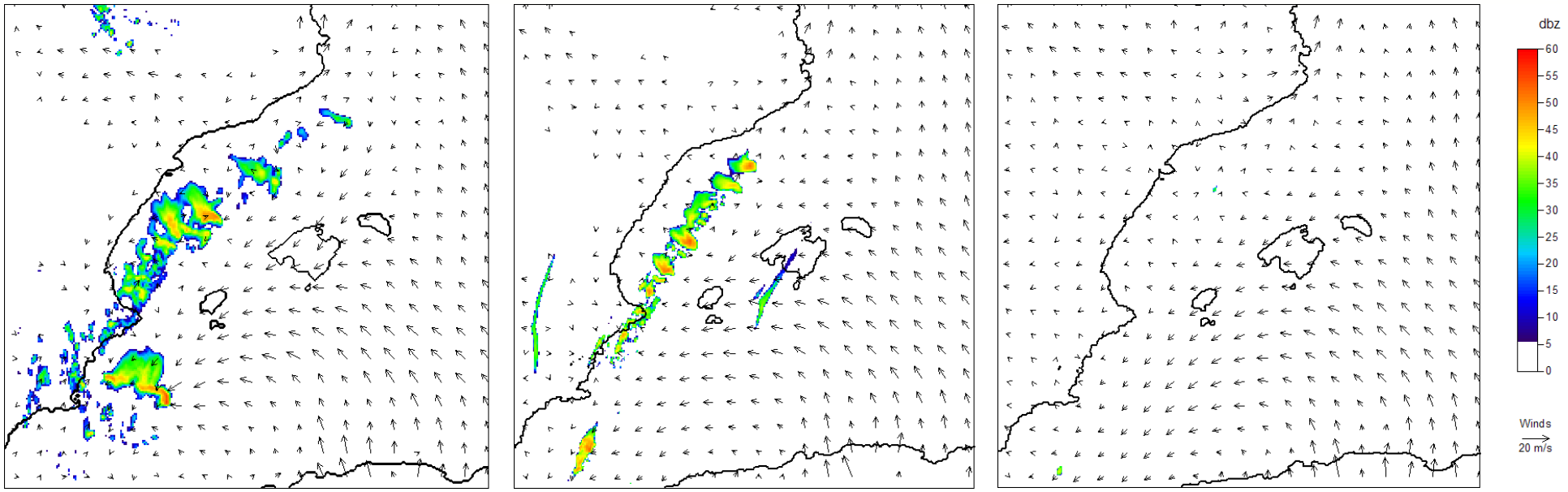
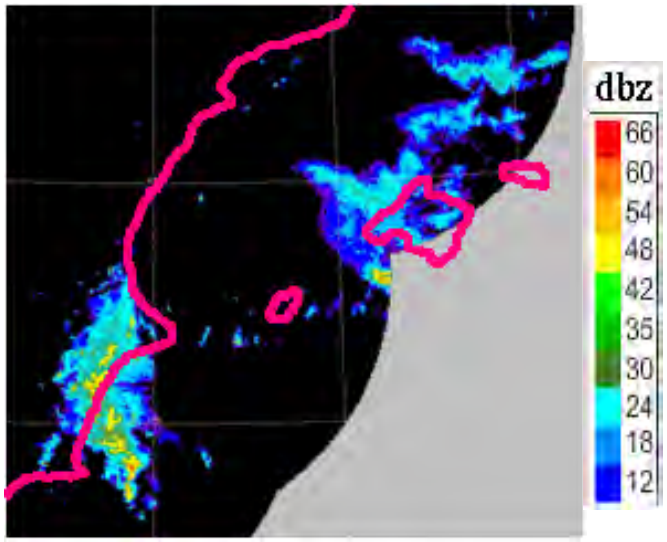
III-a) Model influence

Méso-NH **WRF** **MM5**



Reflectivities and wind at 925 hPa at 9 UTC

Radar reflectivities observed at 9 UTC



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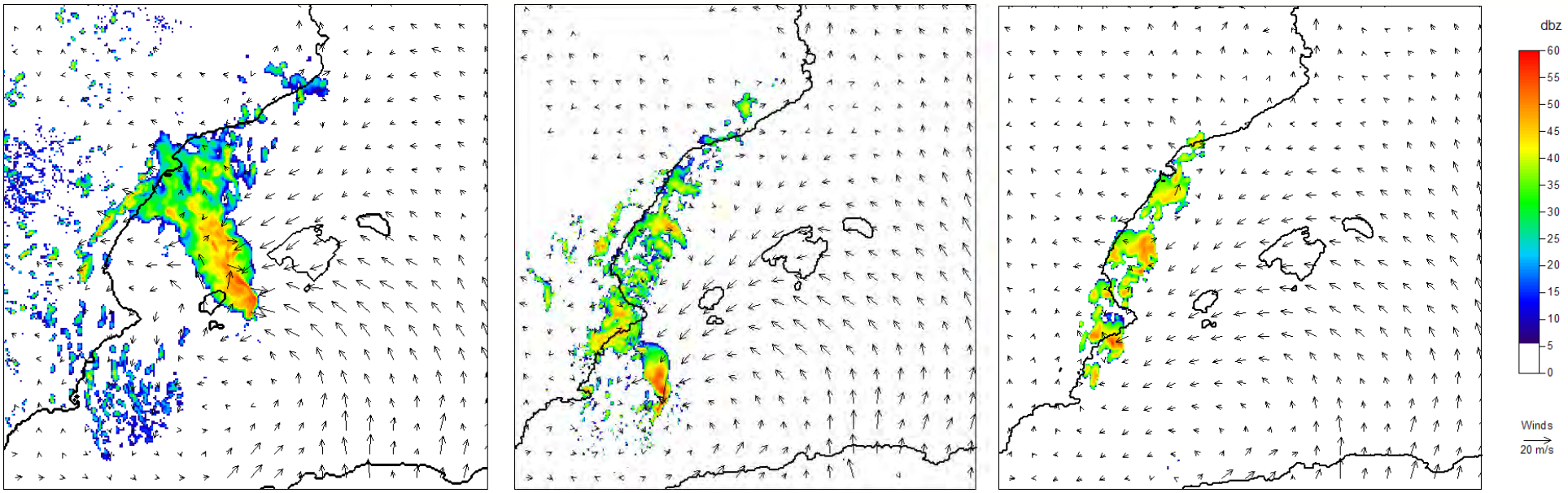
III-a) Model influence

Méso-NH **WRF** **MM5**



Reflectivities and wind at 925 hPa à 12 UTC

Conclusions : Further studies

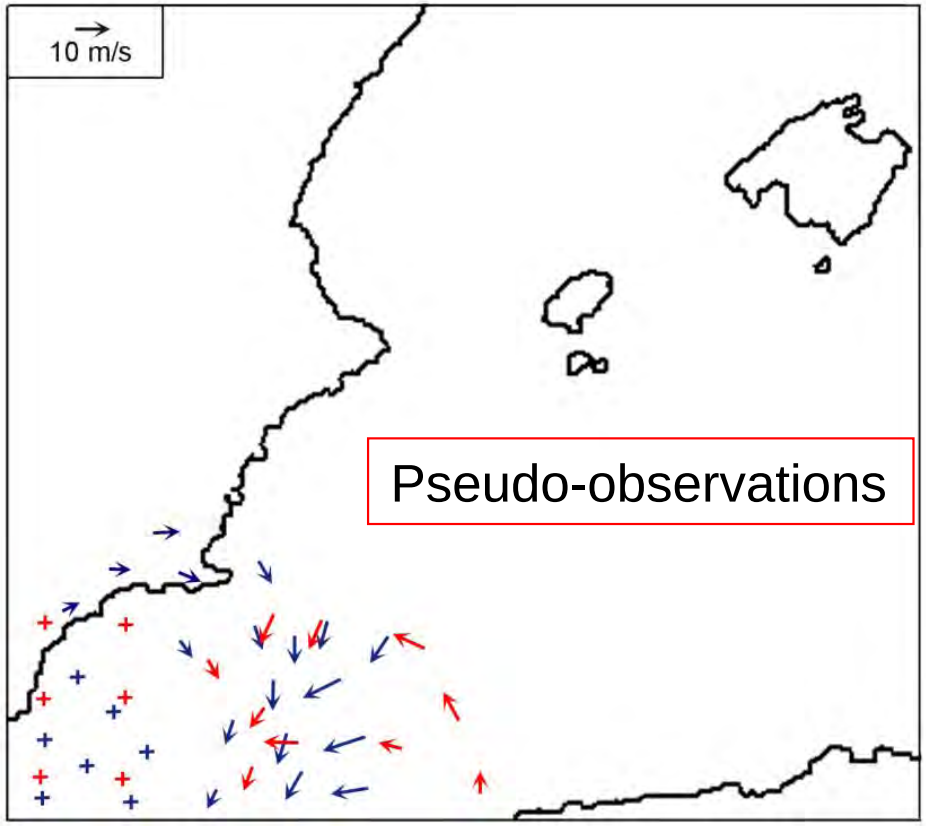
Méso-NH	**WRF**	**MM5**
Convection Structure	Squall line environment	?

III-b) Why MM5 fails ?

Hypothesis : Lack of low-level convergence

- **Pseudo-observations** : To create a convergence line
- **Nudging** : To relax model solution towards observations

↳ Relaxation terms are added to the wind pronostic equation



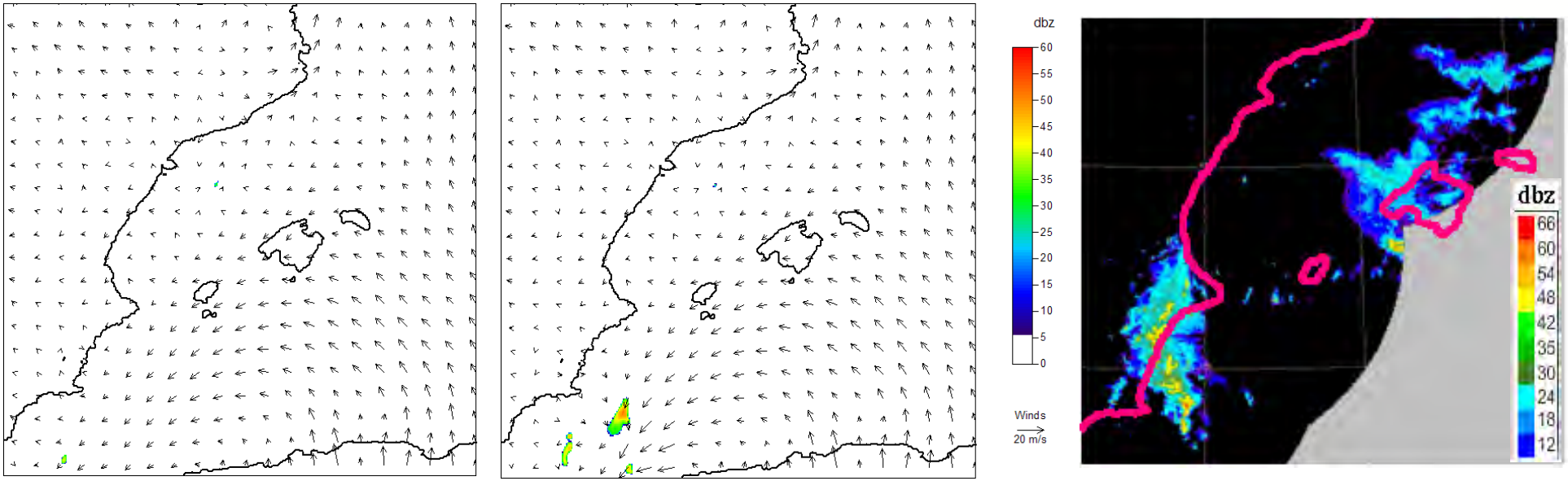
- **At 8 UTC**
  - → levels 982, 942 et 906 hPa
  - → level 866 hPa
- **At 9 UTC**
  - The same 30 km eastwards

III-b) Why MM5 fails ?

Results of nudging:

Reference MM5 | With nudging | Radar reflectivities

9 UTC



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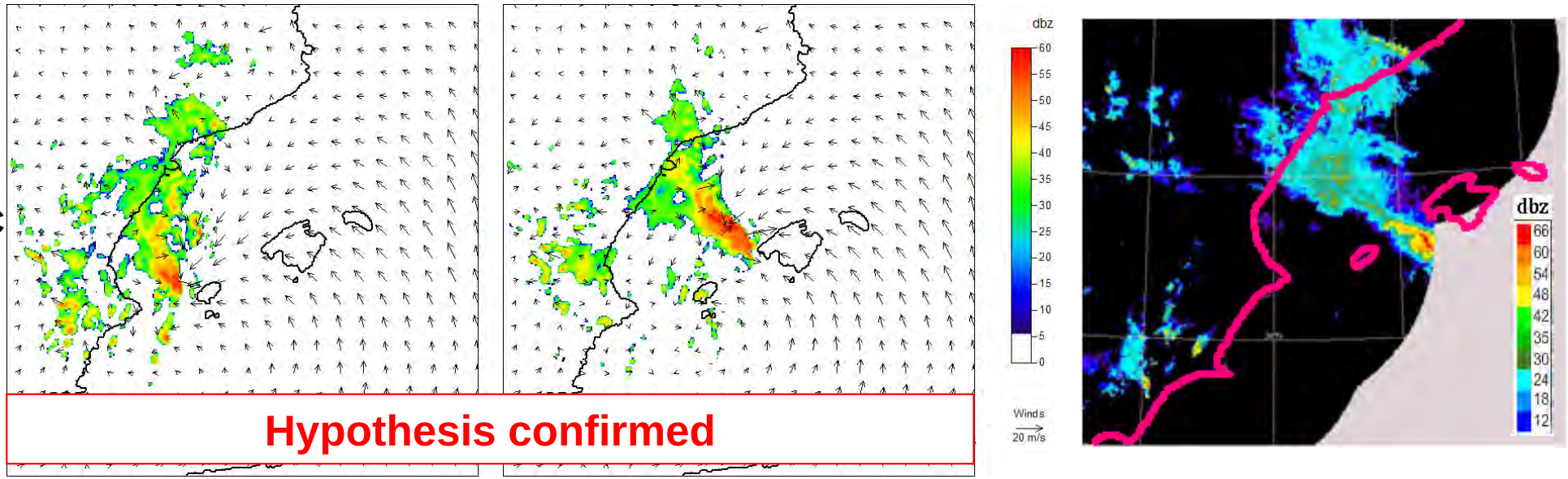
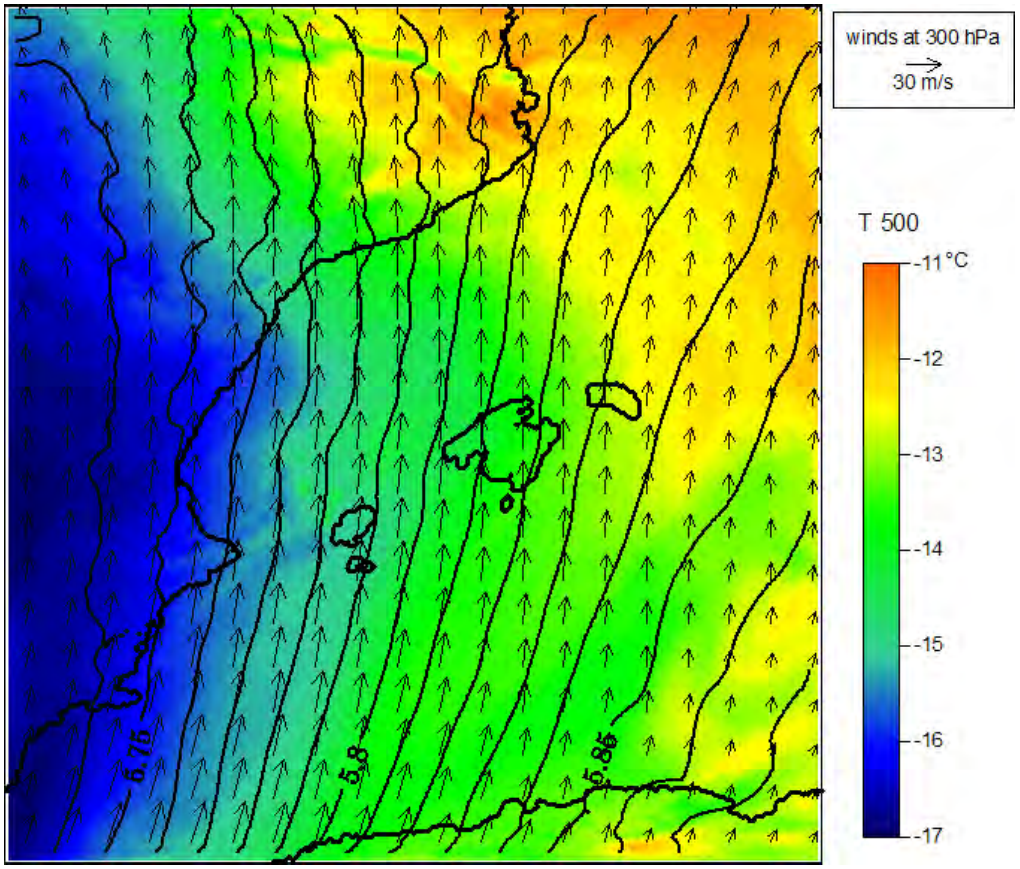


Hypothesis confirmed

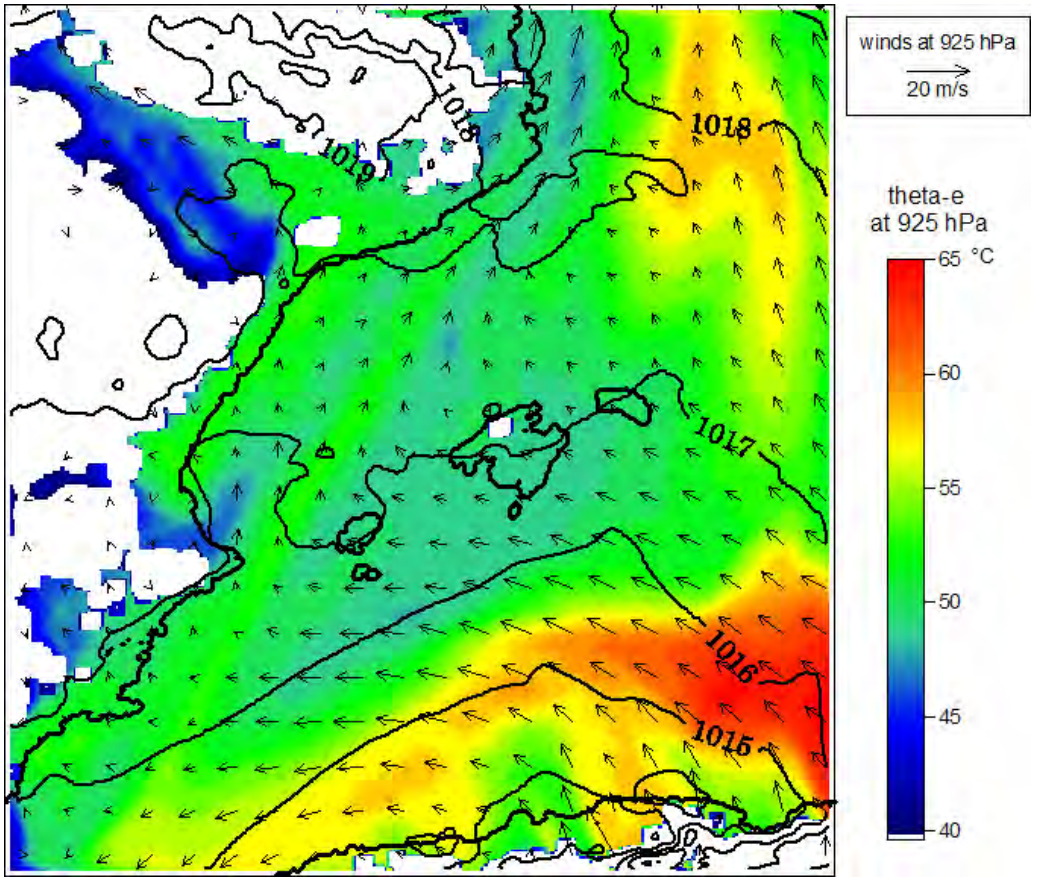
Contents

IV-a) Squall line environment

WRF simulation : Weathers patterns at 6 UTC



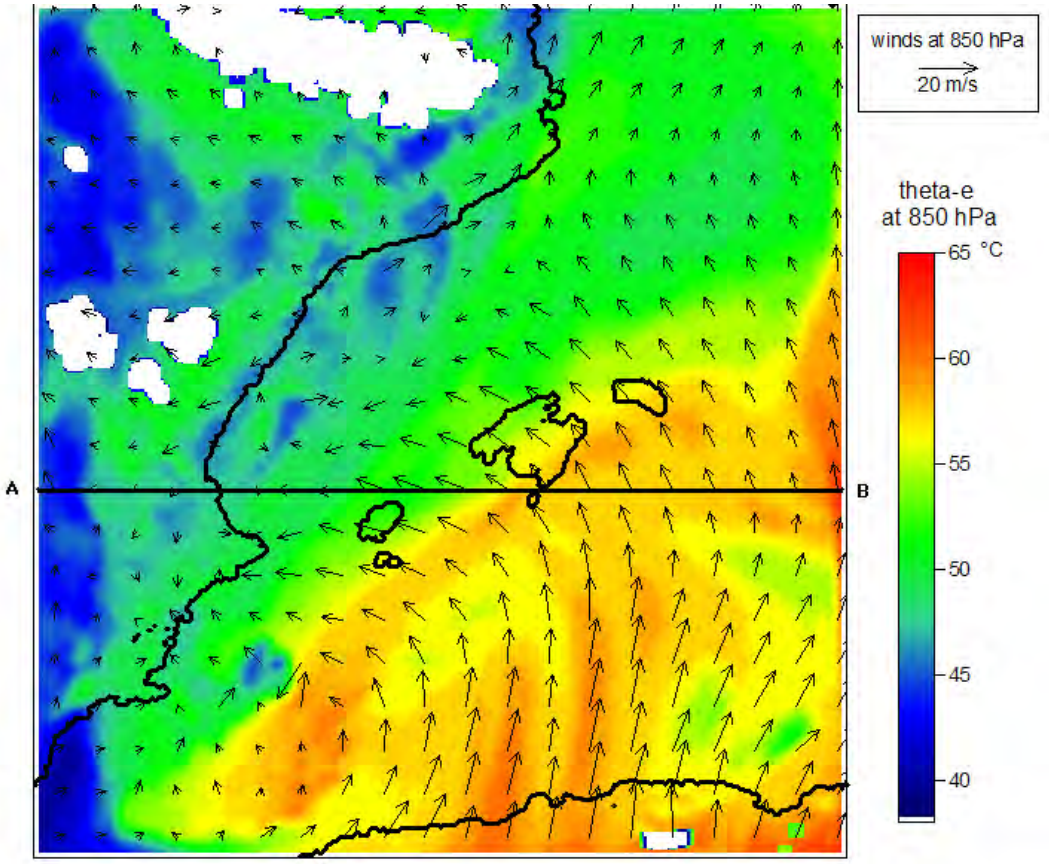
ZT500 + jet at 300 hPa



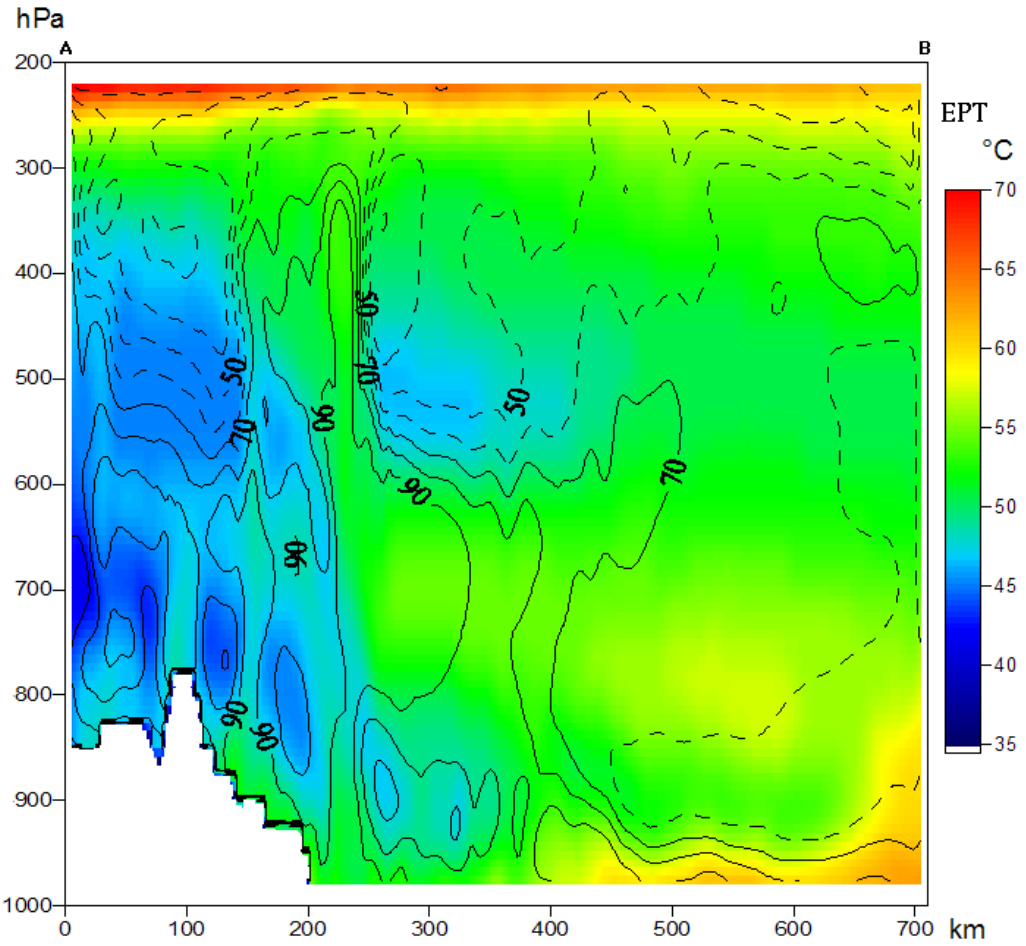
SLP+ Θe + wind at 925 hPa

IV-a) Squall line environment

WRF : Front structure at 12 UTC



Θe à 850 hPa



Θe vertical section A-B

→ A katafront

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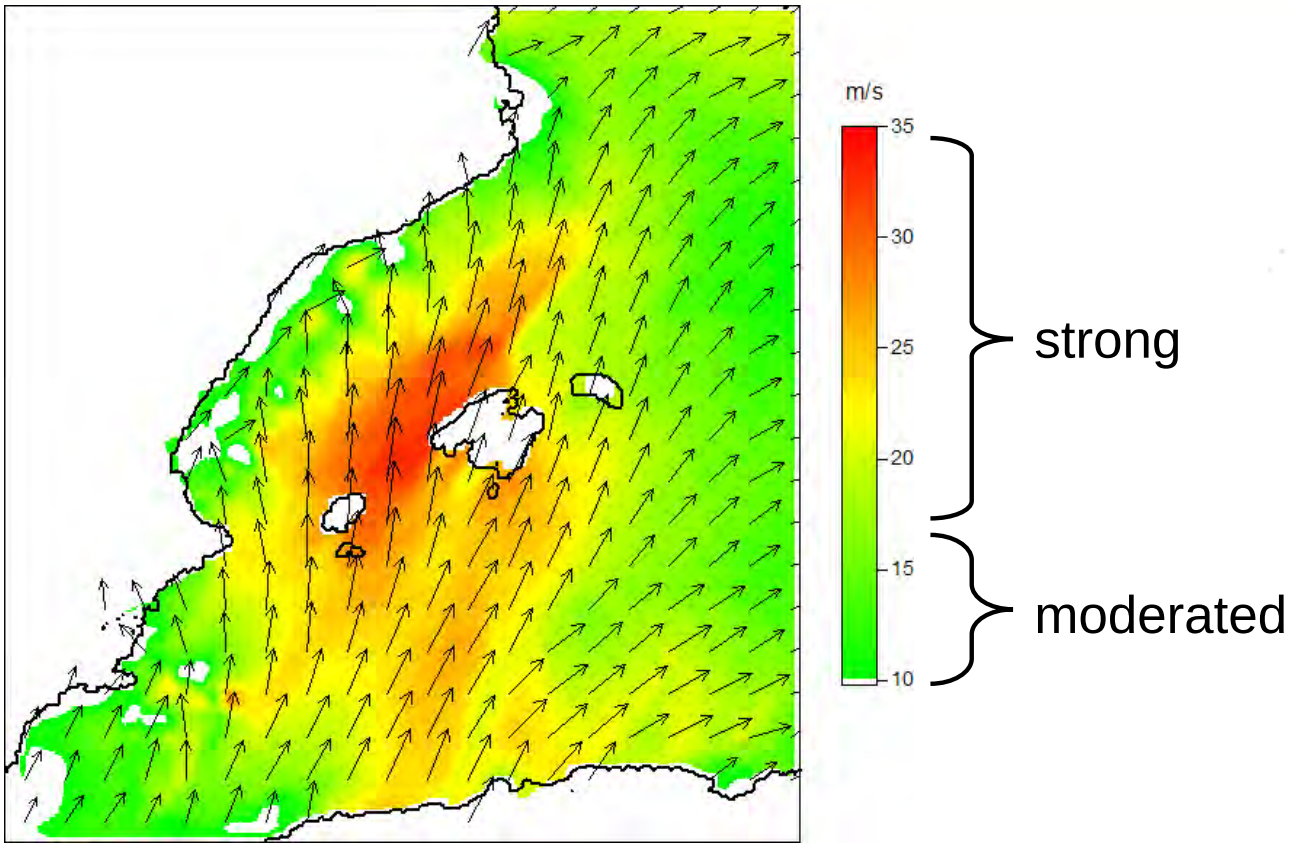
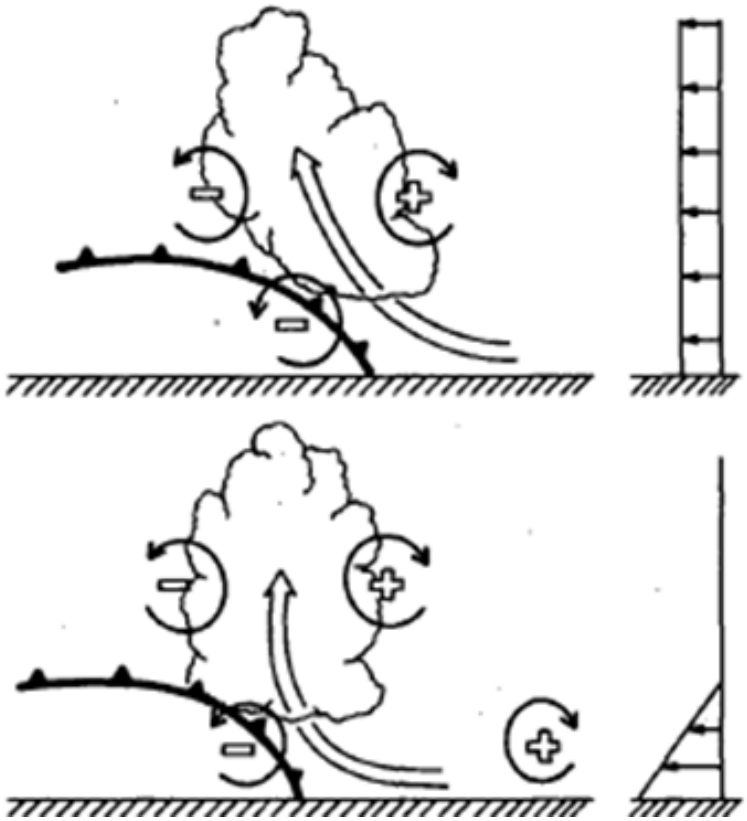
IV-a) Squall line environment

WRF : the shear



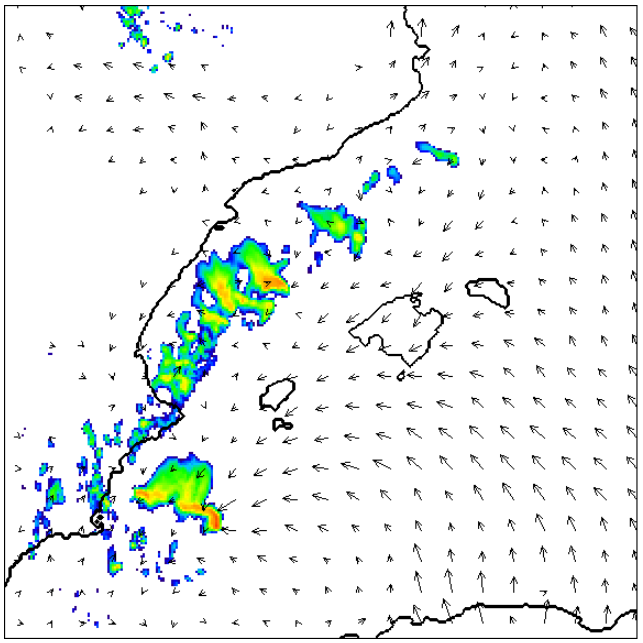
Shear between 1000 and 700 hPa
(11 UTC)



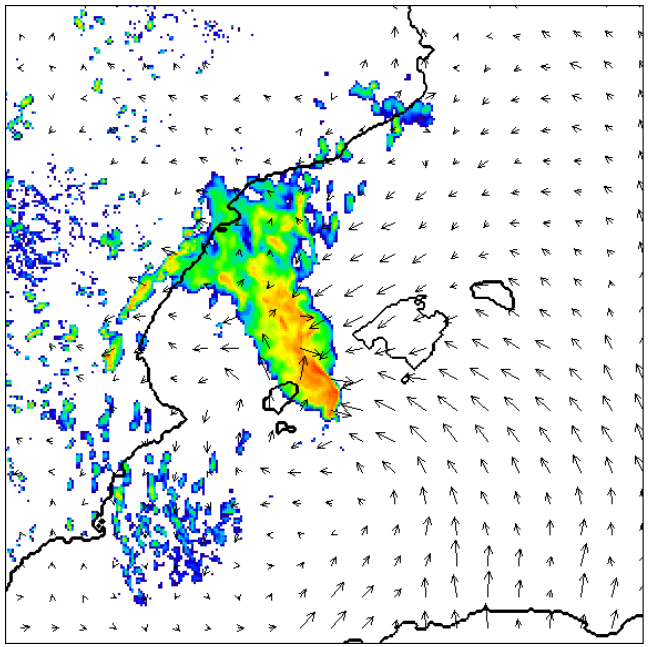
(Rotunno et al. 1988)

IV-b) Squall line structure

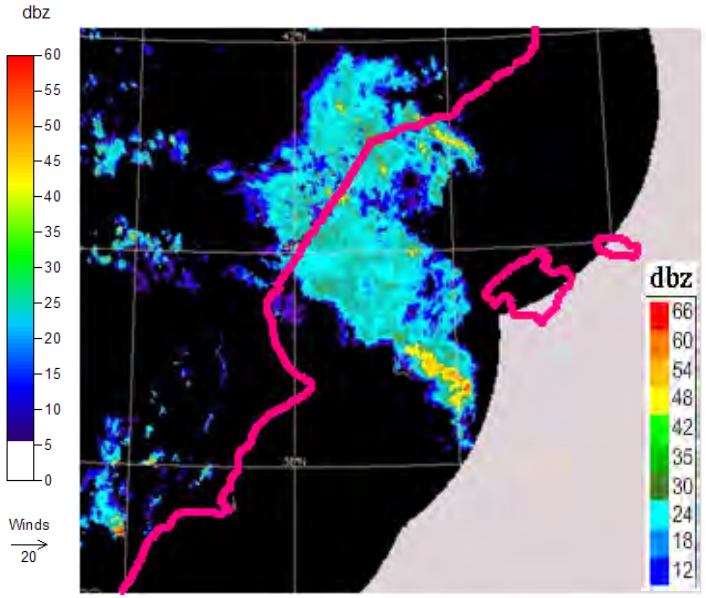
The reference : Méso-NH



9 UTC



12 UTC

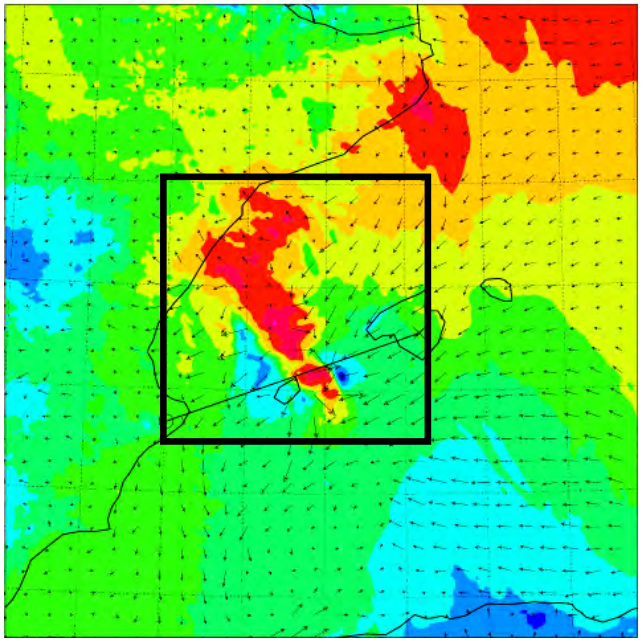


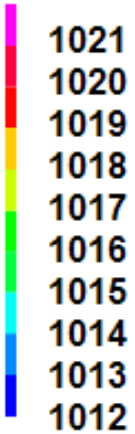
14:30 UTC

IV-b) Squall line structure

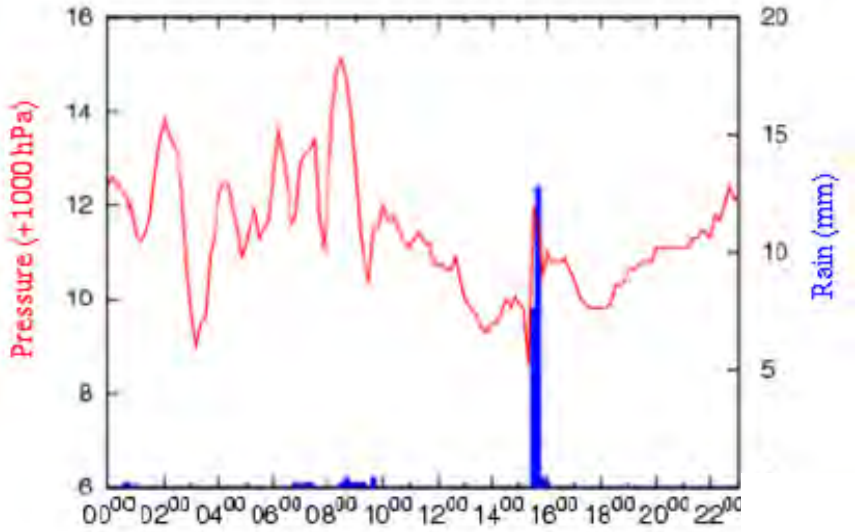
Internal structure, 12 UTC

SLP

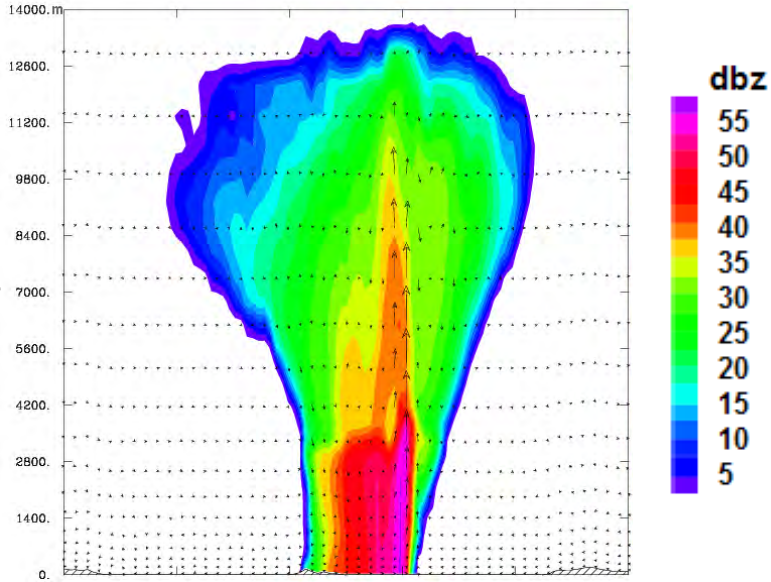




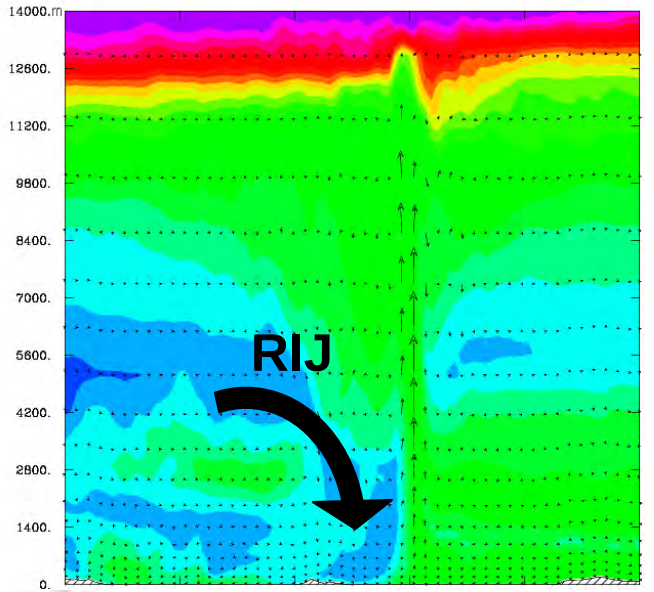
Observations in Mallorca

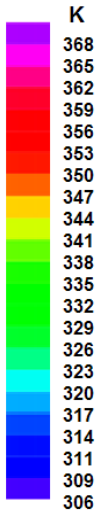


Reflectivities



Θe

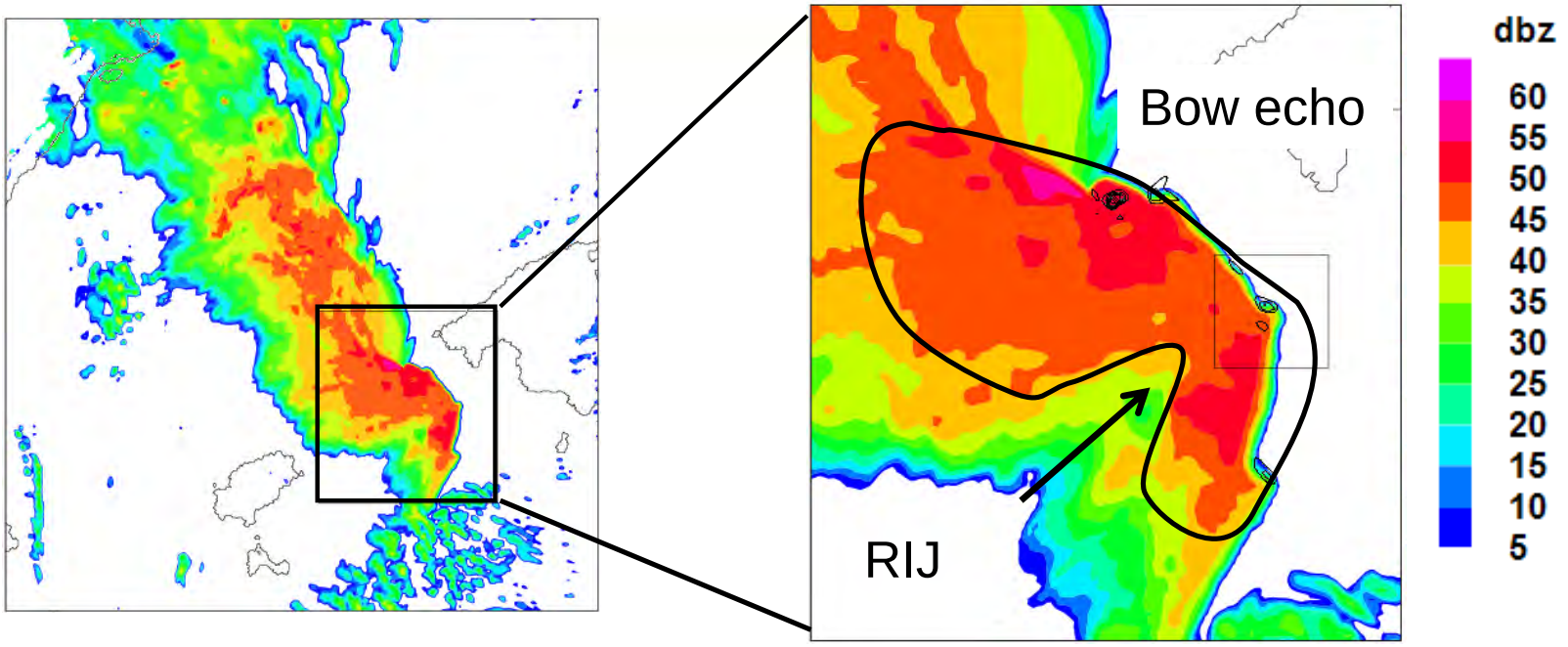




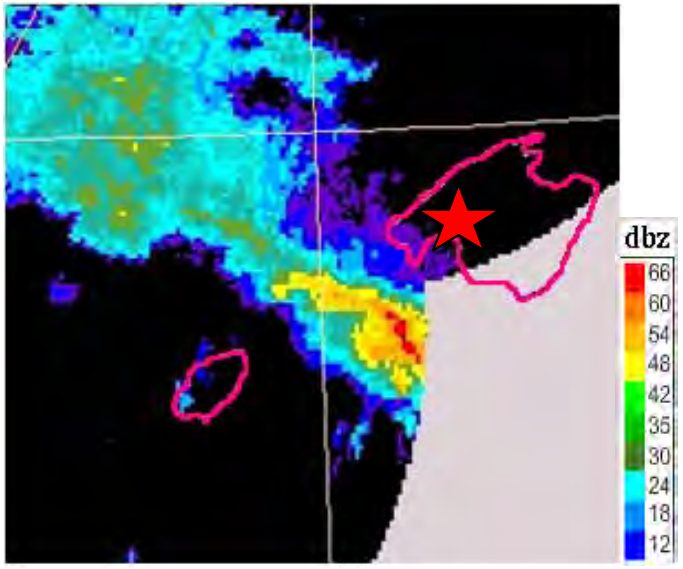
IV-c) Tornadoes tracking

Situation at 12:30 UTC :

Reflectivities :



Radar reflectivities at 15 UTC

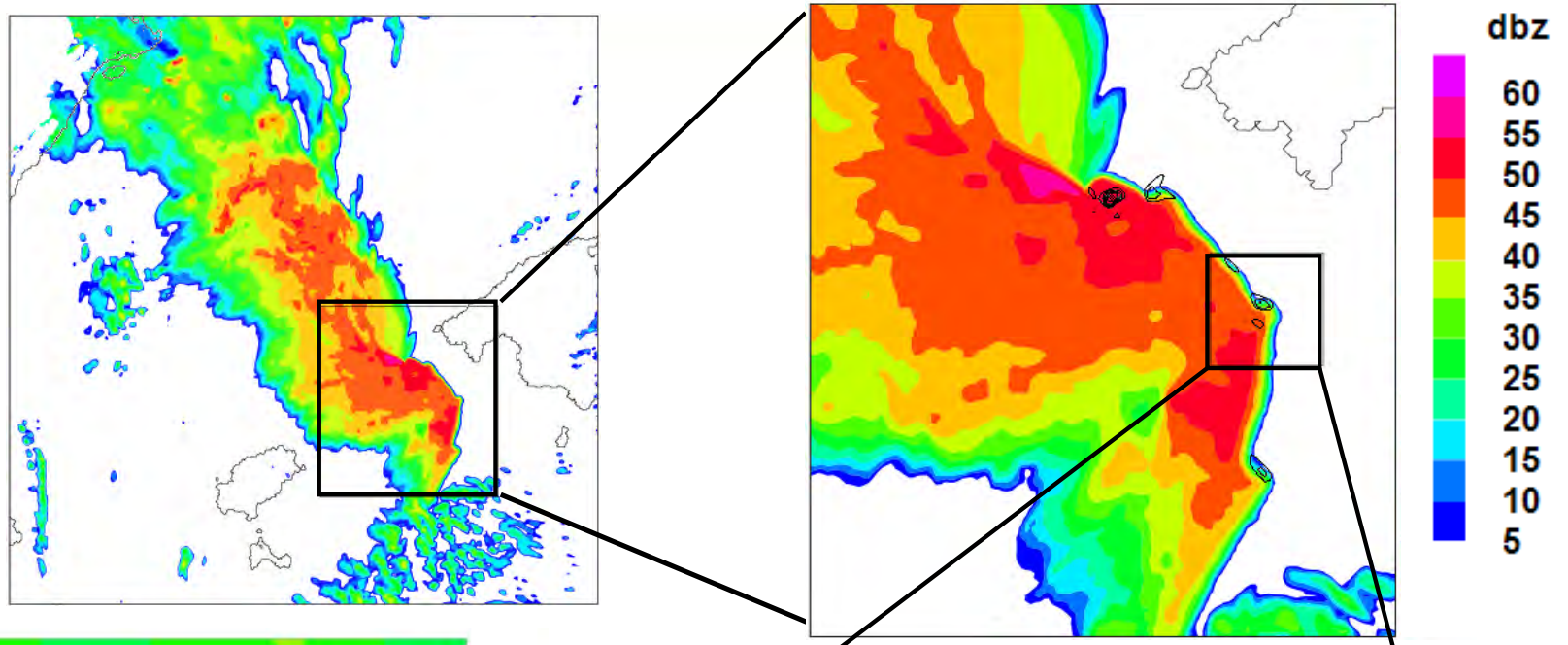


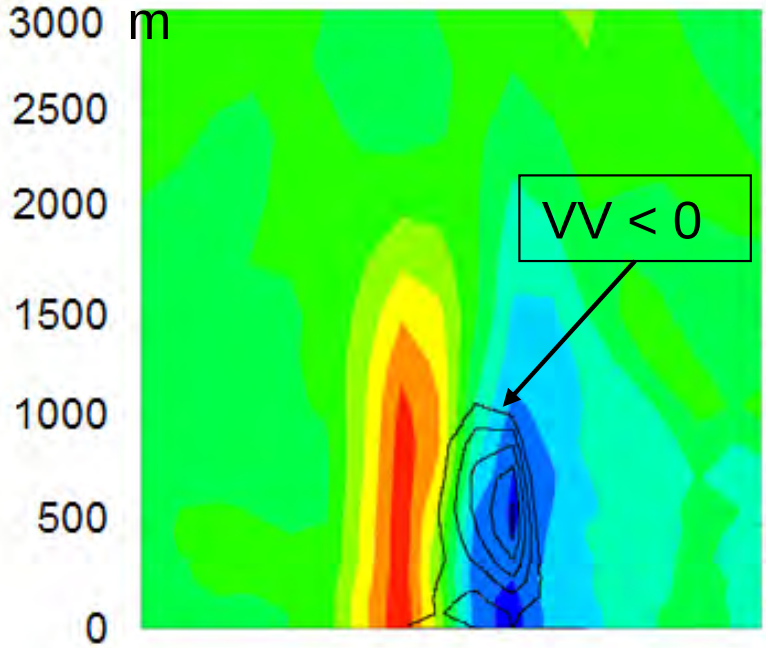
Bow echo : tornadoes risk

IV-c) Tornadoes tracking

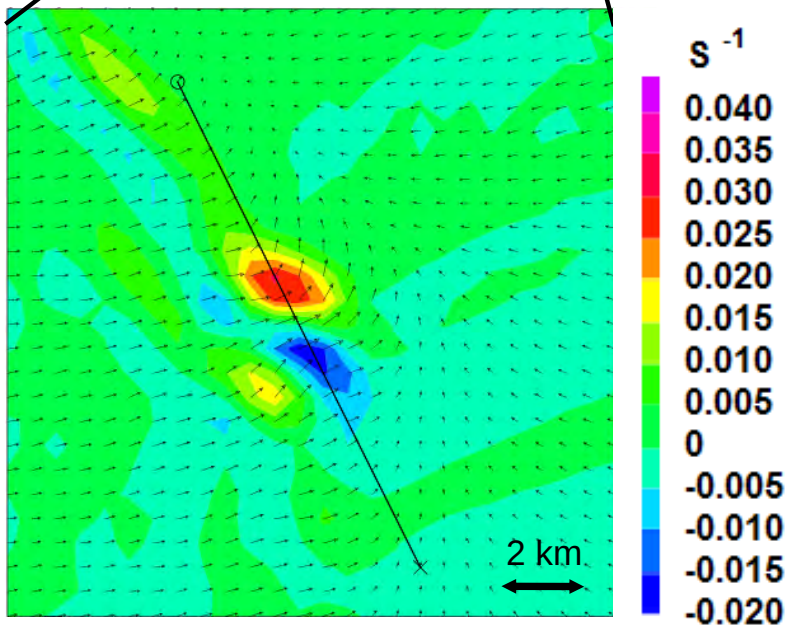
Situation at 12:30 UTC :

Reflectivities at 200m :



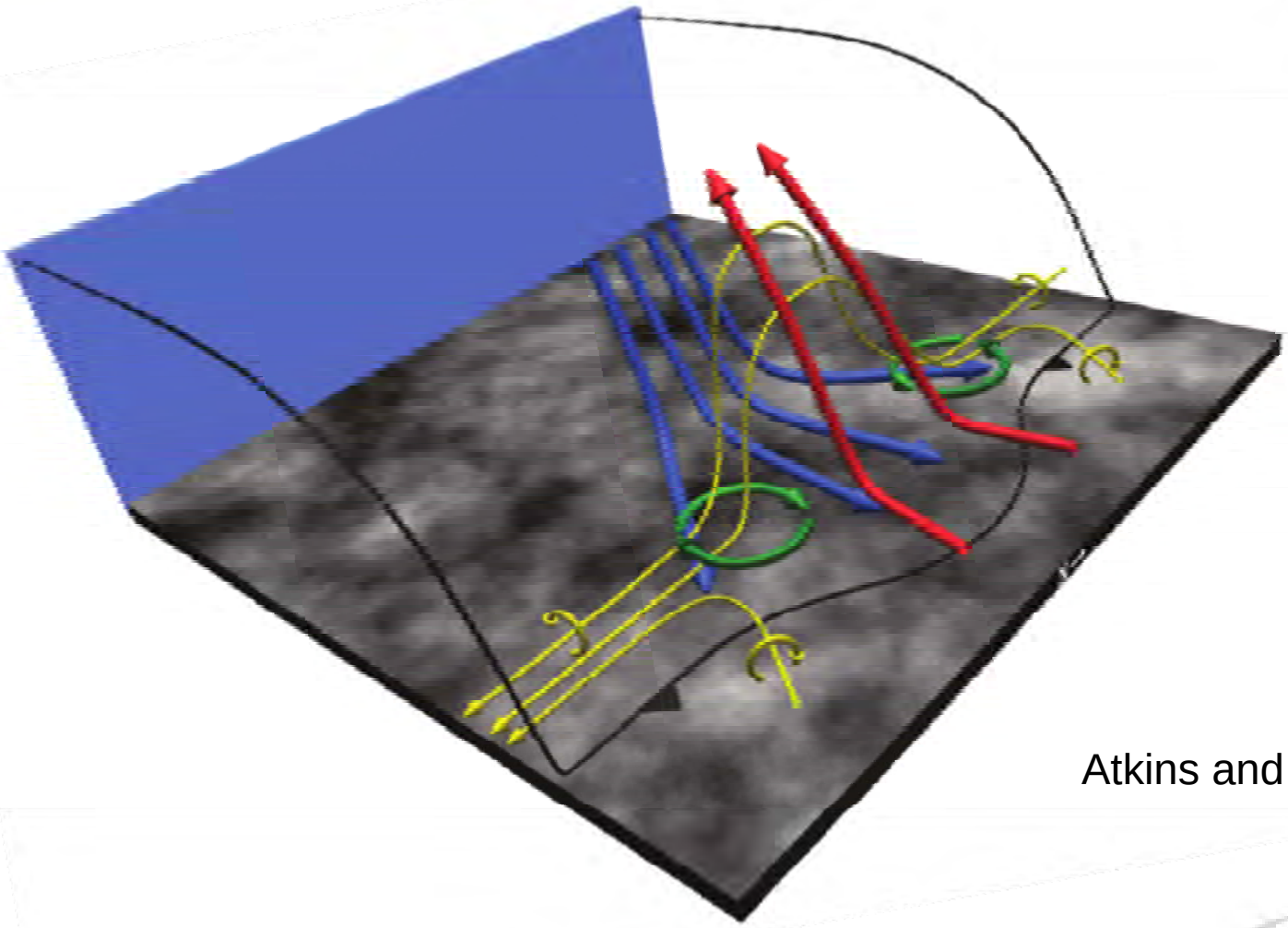


Vertical vorticities at 200 m :



IV-c) Tornadoes tracking

Conceptual scheme of mesovortices formation by updraft



Atkins and St Laurent (2009)

Contents

V) Conclusions and outlooks

- **4th Ocober 2007: a favourable environment**

- **Proof of the fundamental role exerted by the convergence line to iniitate the convection.**

  ↳ **Need of observations over the Mediterranean sea to improve initial conditions quality.**

- **Ability of mesoscale numerical model to simulate bow echo and its associated mesovortices .**

  ↳ **Interest for a mesoscale model on the Mediteranean sea**

- **Illustration of the new theory of mesovortices genesis**

Thank you for your attention