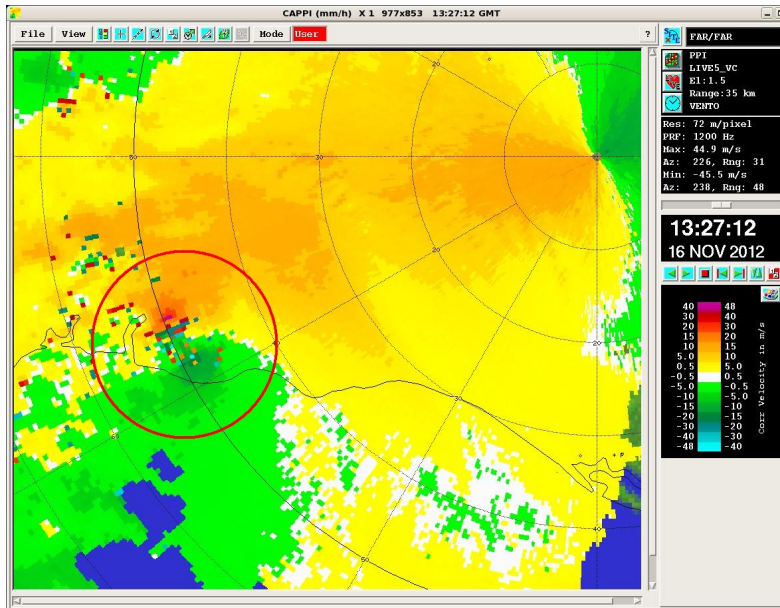# Tornadic
versus
Non Tornadic
Supercell discrimination using Doppler radar in Portugal

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ECSS 2013
7th European Conference on Severe Storms
Helsinki, Finland, 3-7 June
Scandic Marina Congress Center

Tornadic versus Non Tornadic Supercell discrimination using Doppler radar in Portugal

Severe Weather Forecasting for Portugal, in the **Nowcasting** range

(2h ahead)

How many Supercell tornados in Portugal/year ??? ...

Strongly dependent on synoptic scale circulation, mainly in winter

A few years with (maybe!)

7-10 ocurrences ...

Many years with Nil !

In regions where the threat of severe weather is low, producing effective forecasts and responses can be challenging (e.g., Doswell, 2001). Without a large number of events to train upon, forecasters are often poorly prepared to recognize the threat of severe weather (Doswell, 2005, p. 85).

Rauhala and Schultz *in* **Severe thunderstorm and tornado warnings in Europe**, Atmospheric Research 93 (2009)

Severe Weather Forecasting for Portugal, in the **Nowcasting** range

(2h ahead)

Doppler Weather Radar Supercell diagnose criteria based on ...

Radar Reflectivity
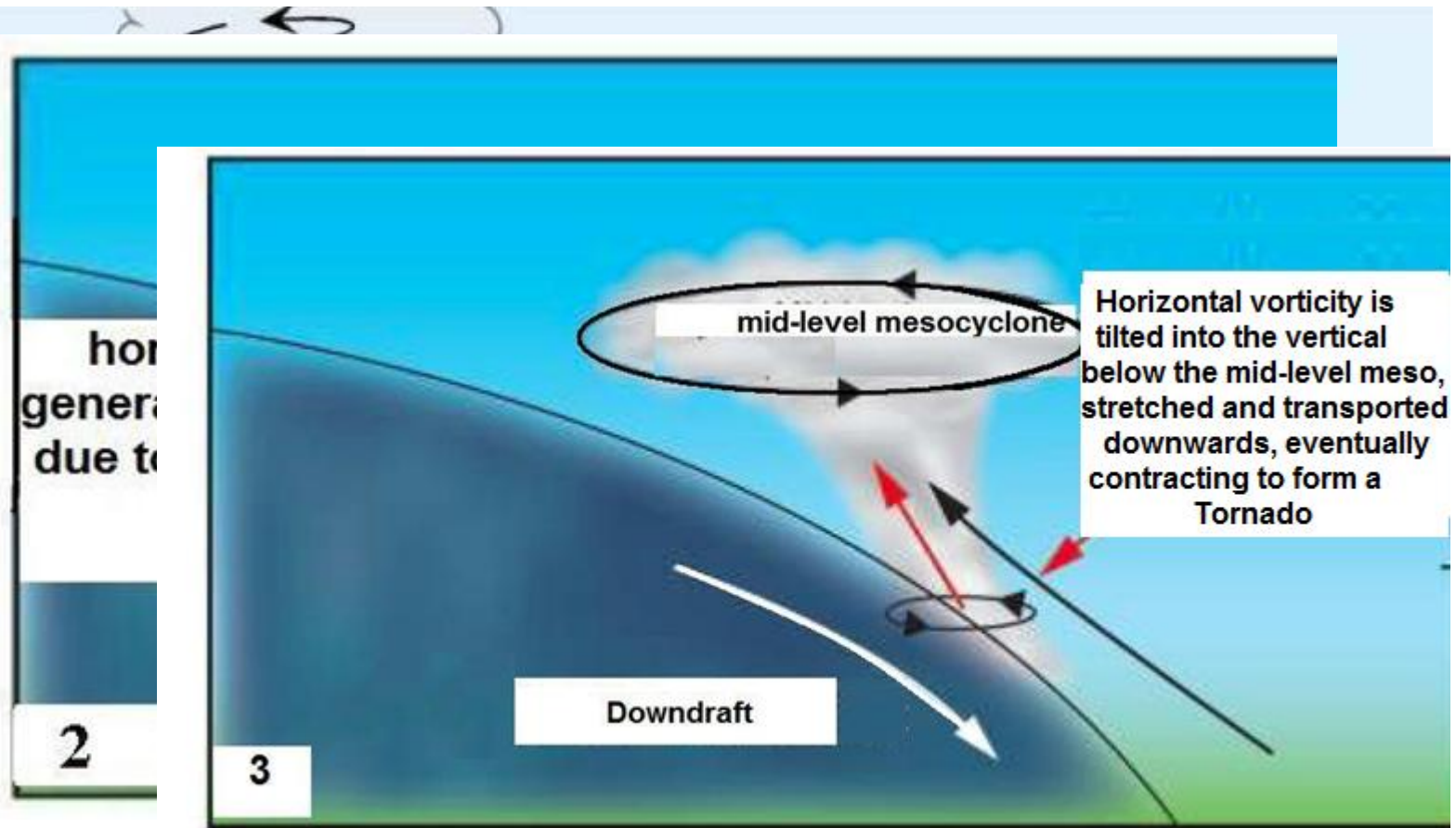
Doppler Velocity

No stringent Supercell definition !

"Tornado Outbreak" on the 16th November 2012, southern Portugal

4 tornadoes, including

1 tornado F3/T6

(Fujita, Torro scales)

Conceptual models and the "**Tornadic Supercell**" idea

(adapted from Markowski and Richardson, 2009; Kendal/Hunt Publishing, 2005)

mid-level mesocyclone

Horizontal vorticity is tilted into the vertical below the mid-level meso, stretched and transported downwards, eventually contracting to form a Tornado

Downdraft

Horizon stre

1

2

3

hor genera due t

Tornadic versus Non Tornadic Supercell discrimination using Doppler radar in Portugal

Conceptual models and the "**Tornadic Supercell**" idea
(adapted from Markowski and Richardson, 2009; Kendal/Hunt Publishing, 2005)

Theory

Observations

Numerical simulations

Portuguese observational climatology

Non tornadic Supercells usually mantain mesocyclone circulation at "mid" levels

More prone to tornado generation Supercells usually extend, and intensify, mesocyclonic circulation to "lower" levels
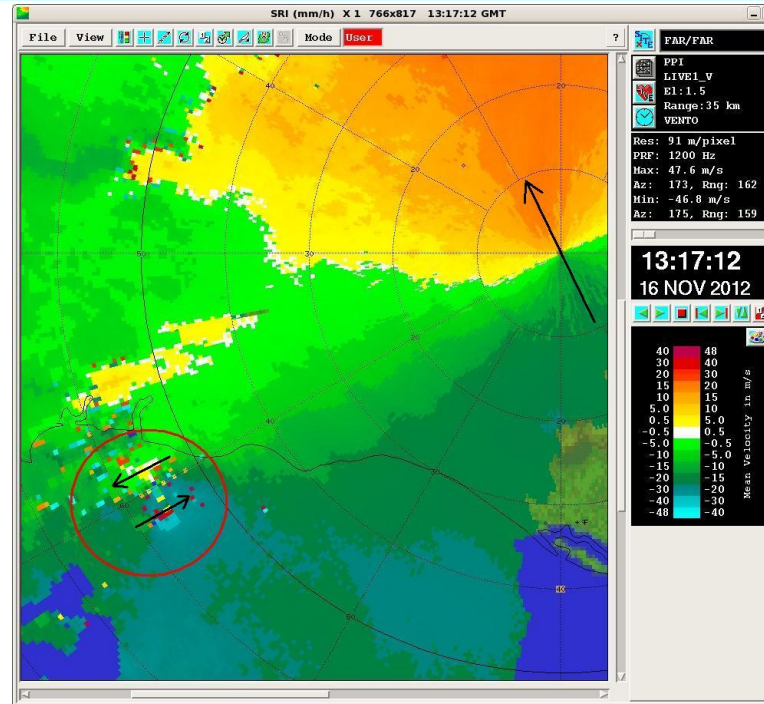
IRIS (*Interactive Radar Information System*, Vaisala) used to configure the Radar Warning products (version 8.12.8)

Algorithmic processing steps

Non Tornadic Supercell ("SC") and Tornadic Supercell ("AVT") Warnings

1 – Storm Relative Velocity: needed!

RAW "Doppler velocity" (Z,V)

100 km range

RAW "Reflectivity" (Z)

300 km range

INPUT →

FCAST product

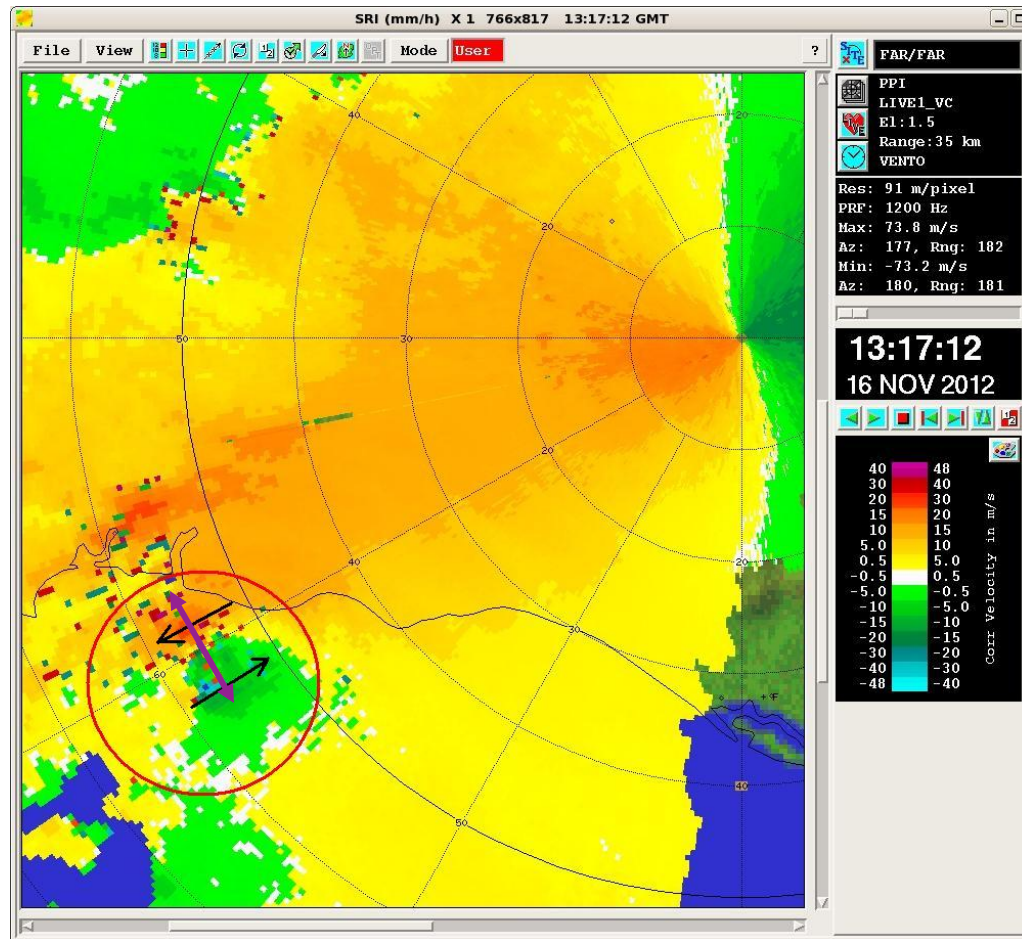**CREATES SRV** →

Mesocyclonic couplet detection enhanced

Tornadic versus Non Tornadic Supercell discrimination using Doppler radar in Portugal

Algorithmic processing steps

Non Tornadic Supercell ("SC") and Tornadic Supercell ("AVT") Warnings
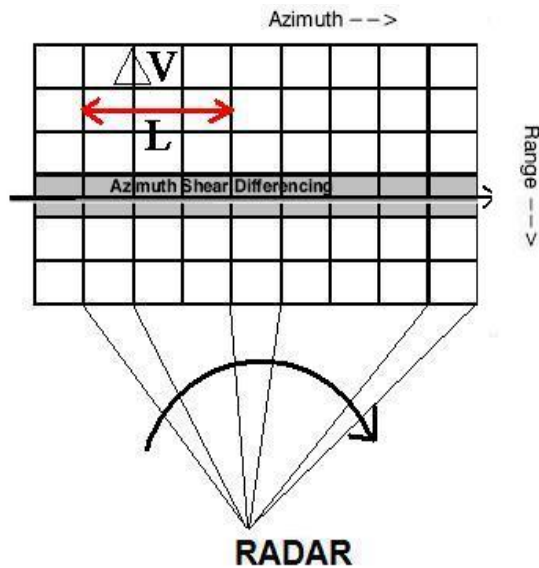
Key parameter: azimuthal shear !

Mesocyclone couplet easier to identify!

(**SRV**)

Automatic Radar Warning products: **tuning** and **performance**

2 - Technical testing and tuning of azimuthal shear

Differencing in azimuth

(L is a filter lenght = admissible gaps between valid info)

Smoothing

Adapted from Vaisala Manual, 2012

Smoothed

3 - Observational testing and tuning of Warning Products

RAW "Doppler velocity" (Z,V,SRV)

100 km range

PCAPPI "Higher" altitude (SRV azimuthal shear)

100 km range

PCAPPI "Higher" altitude (Z)

100 km range

AND

AND

PCAPPI "Lower" altitude (SRV azimuthal shear)

100 km range

Warning Products for **operational** use

Radar Observational Test Series

Ground Truth

Test, Fine tune.. ...maximize **CSI**

Tornadic versus Non Tornadic Supercell discrimination using Doppler radar in Portugal

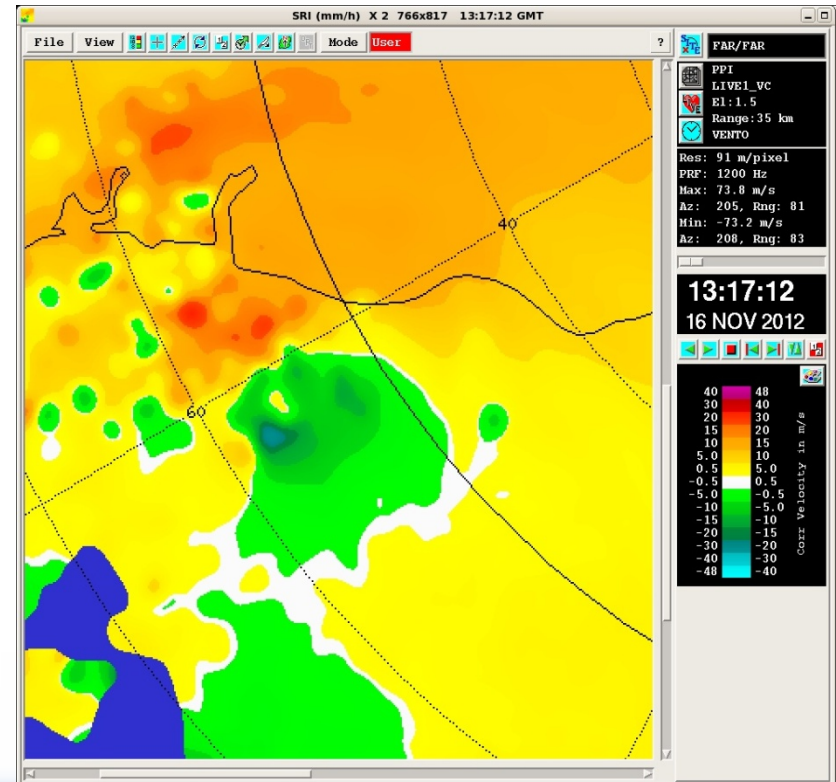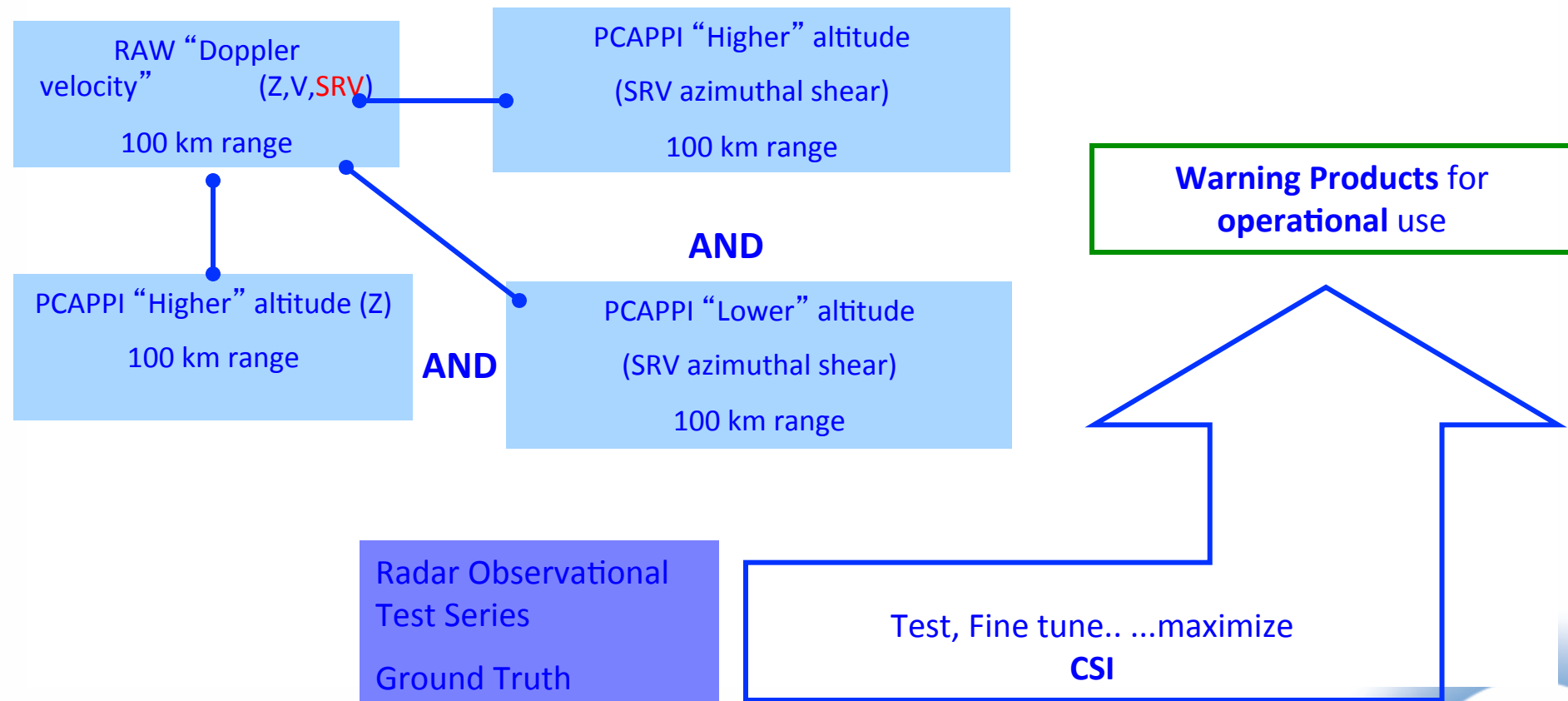## Automatic Radar Warning products: **tuning** and **performance**

Radar **Observational Test Series**

Constraints:

Doppler velocity quality (dynamical filtering) …

"Events" within 100 km range (2 radars) …

Reliable ground truth

Nº ordem	Data		Período (UTC)	Área de cobertura (LIS/FAR)
1	7/10/09	1T	1 - 4	LIS
2	4/01/10	1T	10 – 13	LIS
3	14/11/11	1T	2 – 5	LIS
4	14/11/11	1T	12 - 16	LIS
5	2/5/12	1T	9 – 15	LIS
6	25/10/12	1T	9 – 16	LIS
7	16/11/12	4T	8 – 15	FAR

374 Non tornadic SC

"NO TORNADO PRODUCER"

418 "Supercells" detected on a subjective basis

(no stringent criteria)

44 Tornadic SC

"TORNADO PRODUCER" at some stage of their life cycle

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Tornadic versus Non Tornadic Supercell discrimination using Doppler radar in Portugal

Automatic Radar Warning products: **tuning** and **performance**

Input Product type	Threshold value	Warning issued
PCAPPI of SRV azimuthal shear (0.8 km)	<= 4.5 m/s/km	
PCAPPI of SRV azimuthal shear (2.2 km)	> 2.0 m/s/km	Non Tornadic Supercell (SC)
PCAPPI of Z (3.0km)	> 30 dBZ	

Input Product type	Threshold value	Warning issued
PCAPPI of SRV azimuthal shear (0.8 km)	> 4.5 m/s/km	
PCAPPI of SRV azimuthal shear (2.2 km)	> 2.0 m/s/km	Tornadic Supercell (AVT)
PCAPPI of Z (3.0km)	> 30 dBZ	

FAR = 31.6 %

POD = **91.2 %**

CSI = 64.1 %

FAR = 68.2 %

POD = **47.7 %**

CSI = 23.6 %

Very few cases !

Operational performance

Animation loop PPZ

14:36-16:06 UTC

5/Mar/13
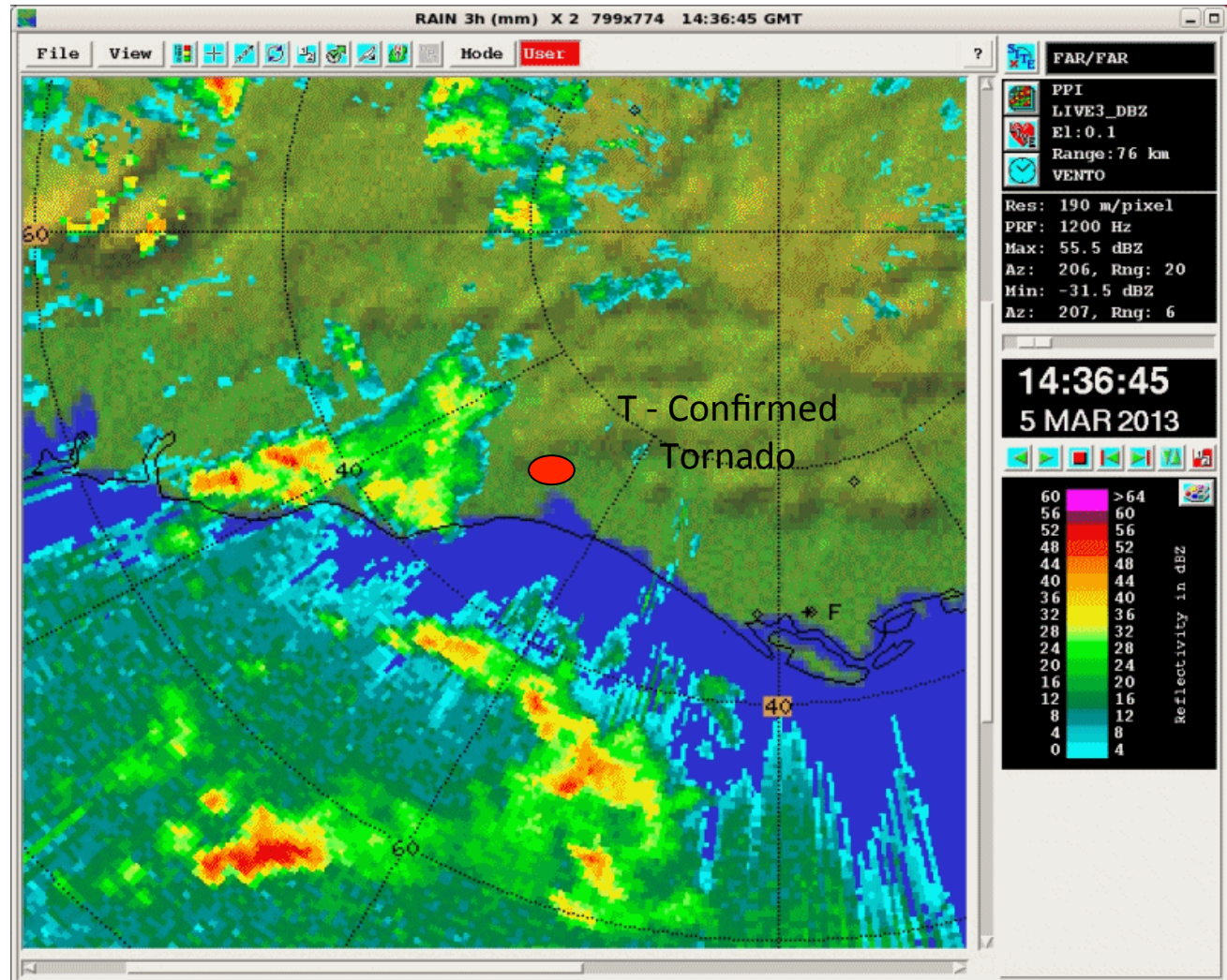
ECSS 2013 - 7th European Conference on Severe Storms

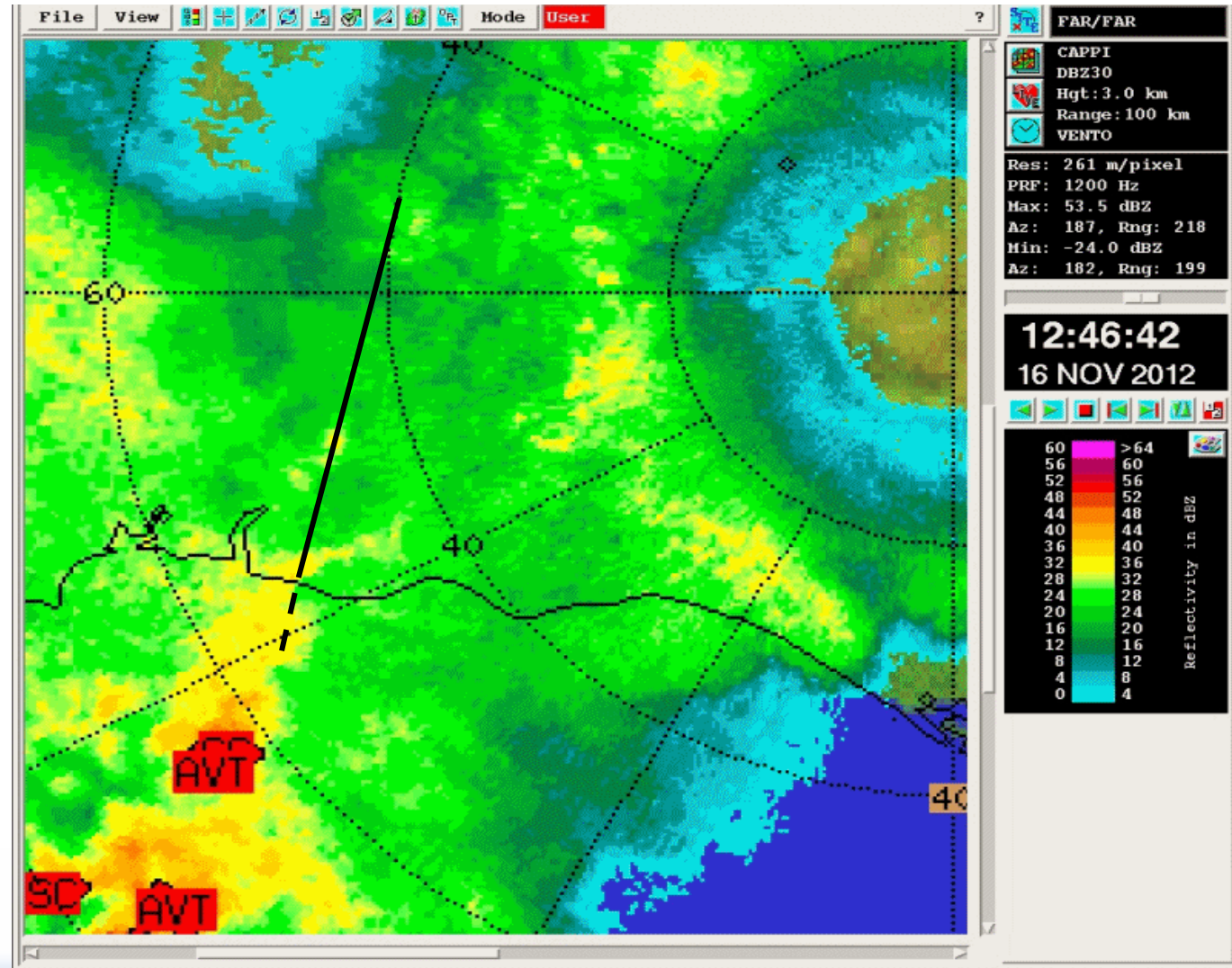# Tornadic versus Non Tornadic Supercell discrimination using Doppler radar in Portugal

Performance example

Observational Test Series

Animation loop CAPPI(Z)

12:46-14:06 UTC

16/Nov/12

F3/T6 Tornado path signed

(13:20-14 UTC over land)

Final considerations

• **Tornadic Supercell** Warning (**AVT**):

DID TARGET the Tornadic Supercell at some instant in **7** out of **10** tornado events

DID TARGET the Tornadic Supercell for several times **before** tornado touchdown in **5** of those **7** tornado events (in 3 of them, EF2 and EF3 damage tornados)

DID TARGET the Tornadic Supercell approximately **on** tornado touchdown in **1** of those **7** tornado events

DID TARGET the Tornadic Supercell **after** tornado touchdown in **1** of those **7** tornado events

• Events with more **AVT** warnings issued (even with false alarms) were the ones with atmospheres theoretically more favourable to organized convection

• Some **AVT** false alarms were issued on top of the radar sites or associated with wind mills spurious echoes

• **Remark: AVT** Warning is based on a Tornado Vortex signature, thus it cannot be strictly considered to be a tornado warning, but a "higher" potential tornado Supercell warning