

# ANALYSIS OF THE 12 OCTOBER 2016 FLASH FLOODS IN MARESME, CATALONIA

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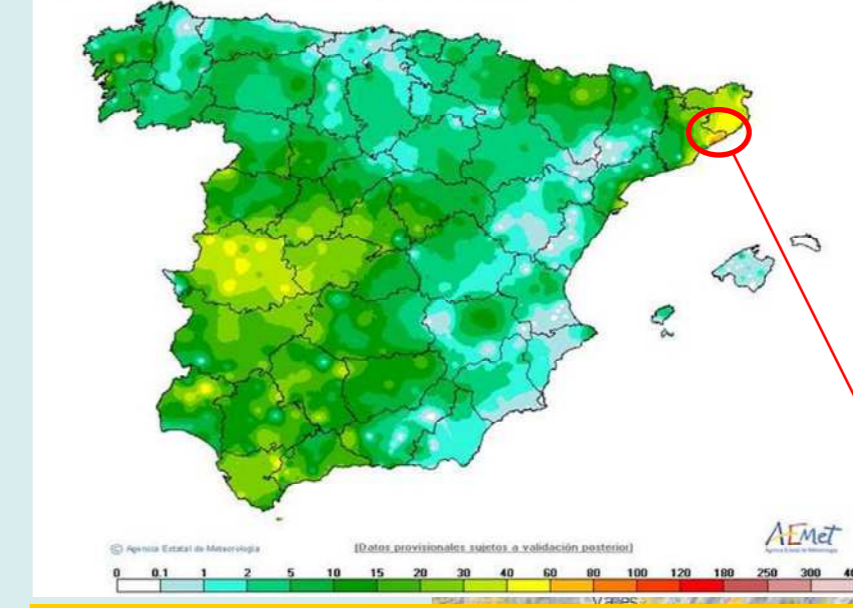
## INTRODUCTION

This study describes an event of heavy rainfall that took place in the Maresme region (located in the northern coast of Barcelona province, in Catalonia). Catalan coastal regions are the most affected by flash-flood events and, in particular, the Maresme is the most impacted area as well as one of the most populated. As a consequence, the natural risk associated to this phenomenon is very high (Llasat *et al.* 2010). During the summer and the beginning of autumn, highly convective episodes usually occur in the western Mediterranean. In Catalonia, flood events occur the most during the autumn season. Generally these events are short-lived and may lead to sudden swelling of rivers born in the Pyrenees and also in coastal streams (Pascual, 1999).

During 12-13 October 2016, an event of heavy and generalized rain took place all over the Iberian Peninsula. An instability line that went across the Catalan coast during Wednesday 12<sup>th</sup> originated a thunderstorm with very heavy showers, even torrential rain, which persisted at some points of the Maresme region, accumulating more than 200 mm at several points in less than 4 hours. This very intense rain caused traffic and railroad cuts, power outage, loss of cars parked at watercourses and, unfortunately, a man died trapped in his car at an underpass.



- Damages and casualties:**
- More than 900 emergency calls during the episode – Flood alert (INUNCAT), 300 emergency calls to the fire brigade.
  - National road N-II and secondary road C-31 were cut off. Train service suspended for several hours.
  - People trapped in N-II road and in flooded underpasses had to be rescued.
  - 24h precipitation/day record in Catalonia since 1943.
  - 1 man died drowned in his car dragged by the rain in Cabriels.
  - Several river overflows and cars dragged by river floods.
  - Power outage affected more than 2000 houses in 4 towns.
  - Important material damage. 3 flooded schools closed in Vilassar.



TOWN	Precipitation (mm) in 24 h
Cabriels	220.9 (SMC)
Vilassar de Mar	203.0 (Meteorological)
Vilassar de D'Alt	159.4 (AEMET)
Premià de Mar	153.0 (Meteorological)
Mataró	122.0 (Meteorological)
Cabrera	102.6 (Meteorological)
Arenys de Mar	98.5 (AEMET)
Alella	94.2 (Meteorological)
Fogars de la Selva	91.1 (SMC)
Santa Susanna	82.8 (AEMET)
Badalona	83.3 (SMC)
Barcelona (CMT)	47.5 (AEMET)



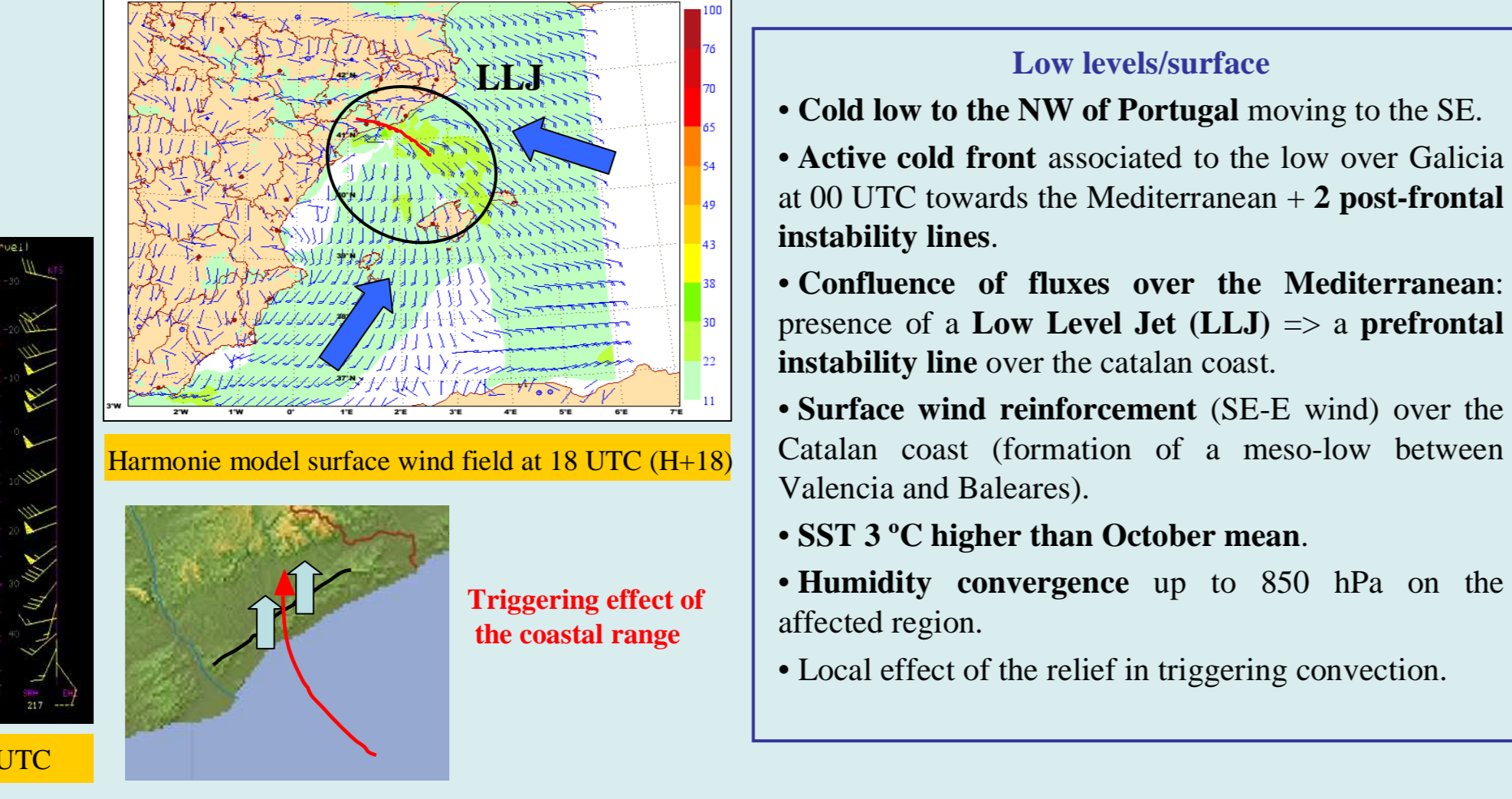
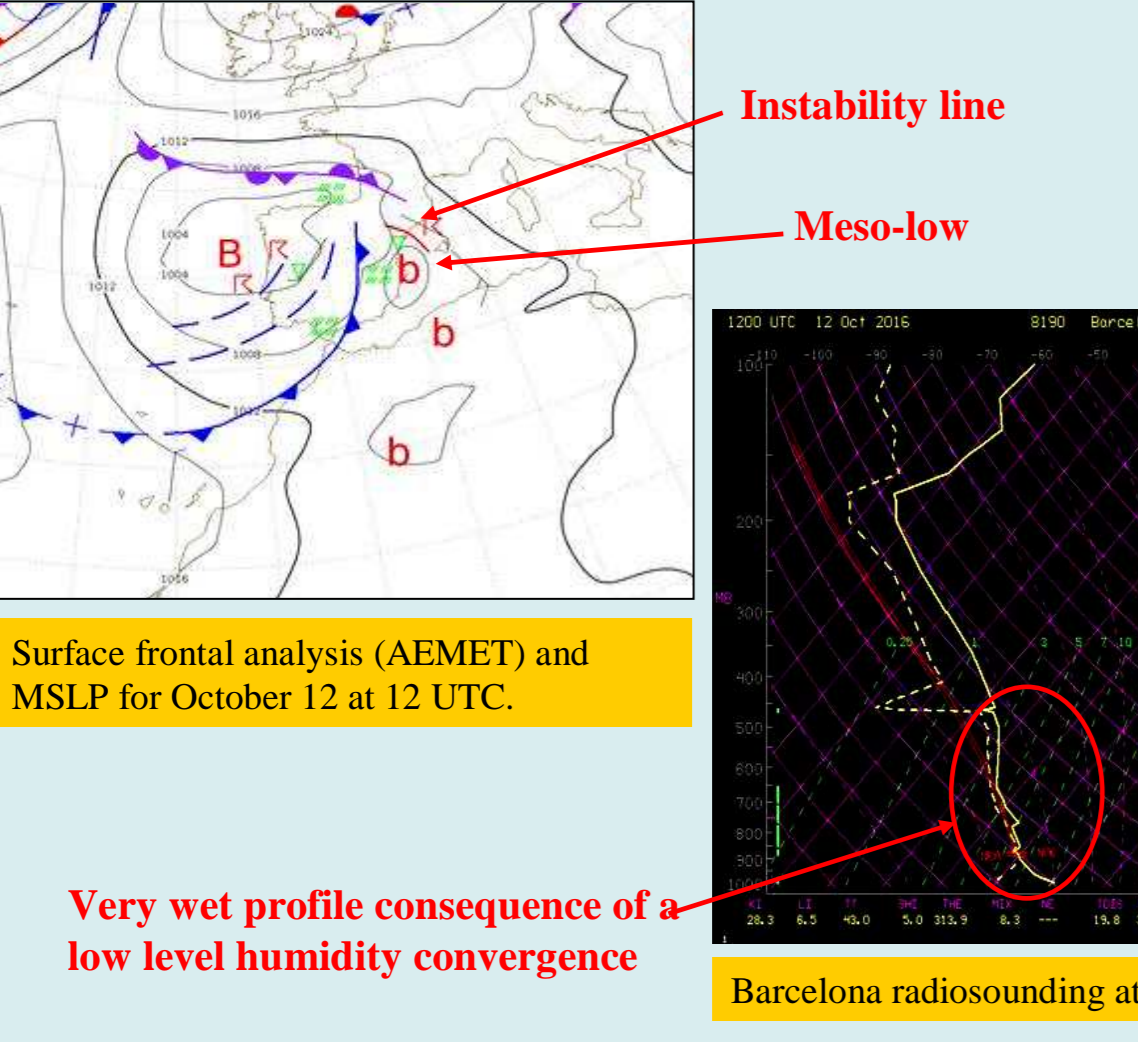
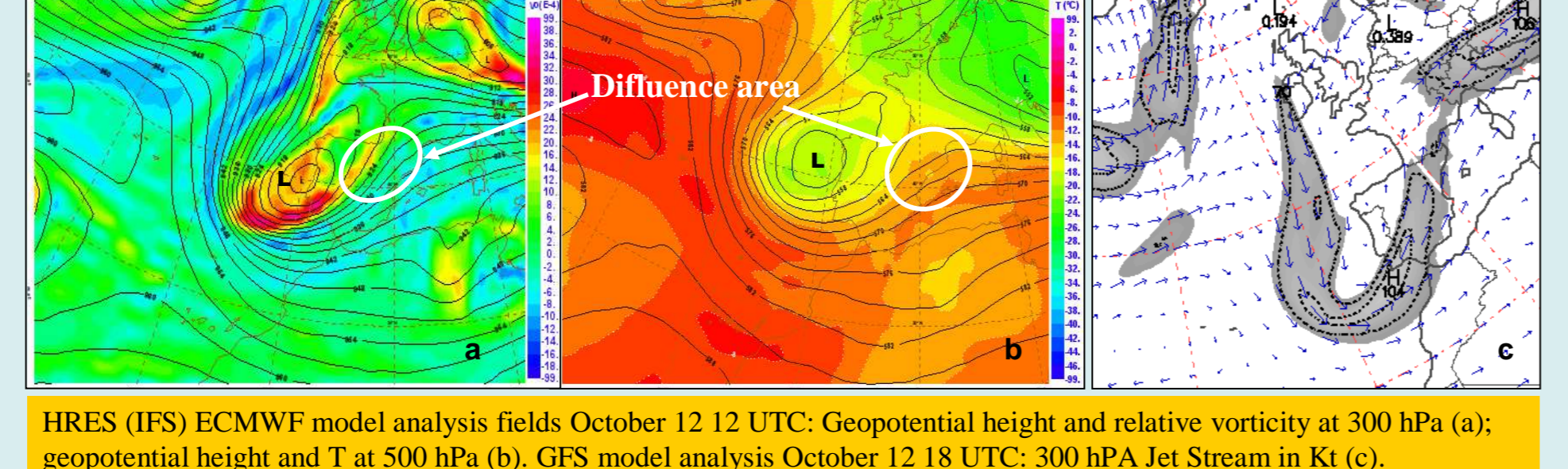
• 5 towns in Baix Maresme registered Pcp > 100 mm in 24 h.

• All-time intensity record in Catalonia in Cabriels (85 mm in 30') = torrential rain!!

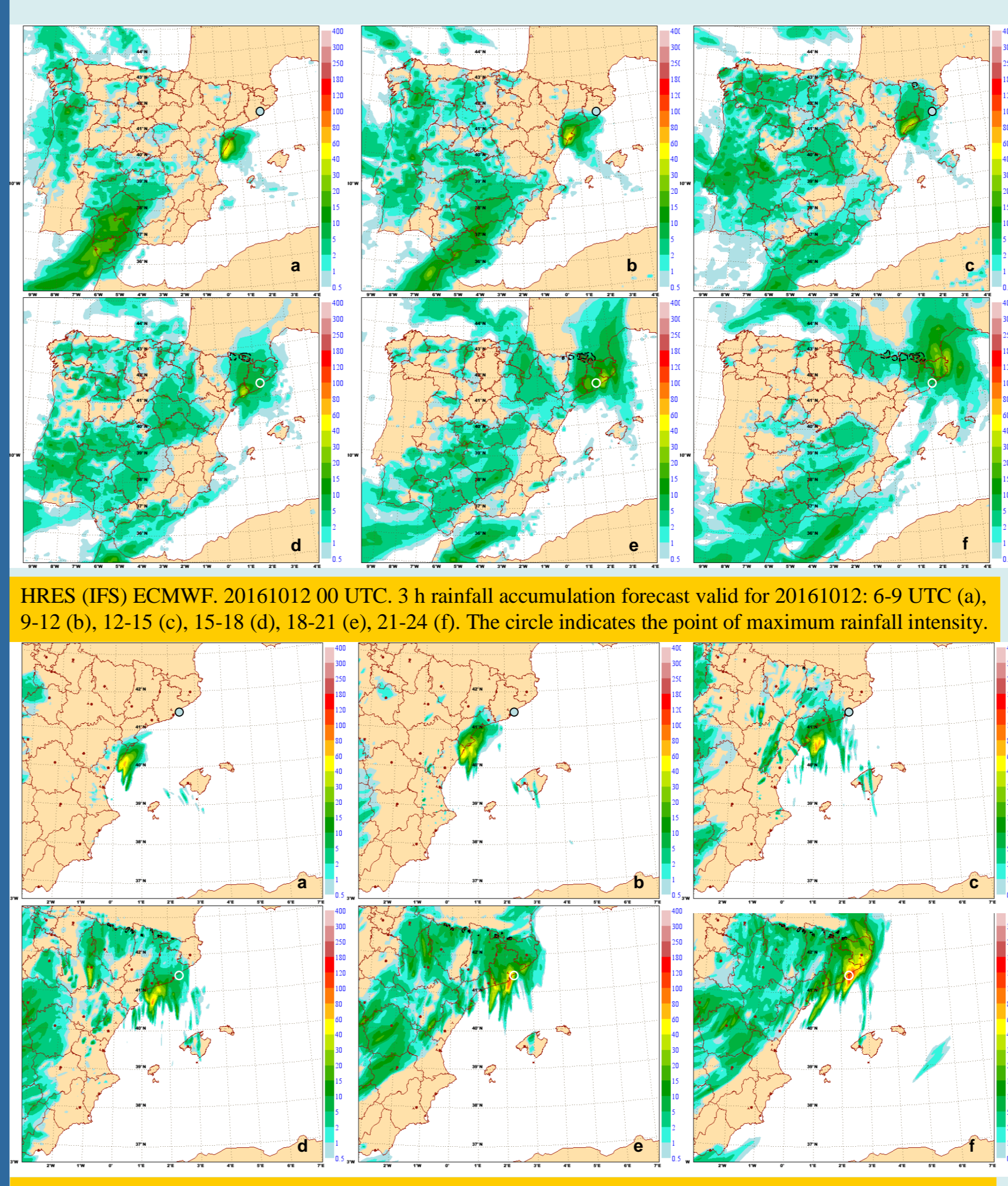
## SYNOPTIC AND MESOSCALE SETTING

The meteorological synoptic framework in south-western Europe on October 12 was governed by the passage of a cold front associated to a cold low centered at the north-west of Portugal. This front went across the Iberian Peninsula followed by two post-frontal instability lines. The passage of these frontal structures caused persistent and occasionally strong downpours at the south-east and centre of the Peninsula. Previous to the crossing of the front, the convergence of fluxes with Mediterranean trajectories originated an instability line that crossed the Catalan littoral during that evening causing the heavy, even torrential rain showers that affected the Maresme area.

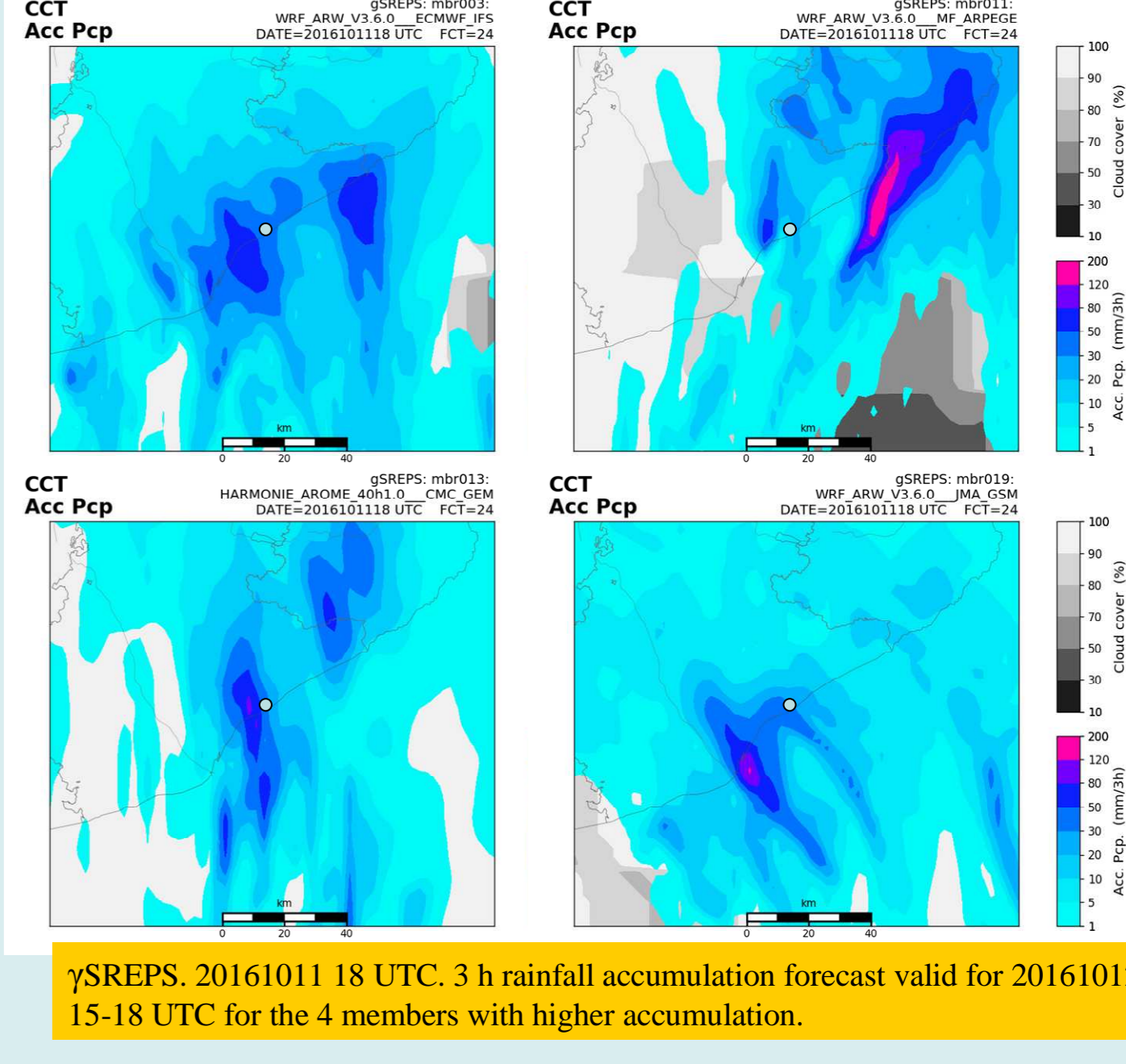
- High levels (500-300 hPa)**
- Weak anticyclonic circulation (small ridge over the Peninsula => South France).
  - Cut-off low over Central Europe.
  - Cold low (<20 °C) at NW of Portugal moving to the SE.
  - Diffuence area over Catalonia (300-500 hPa) => ↑ instability.
  - Jet streak at 300 hPa over the study region at 18 UTC
  - Mean flow from the SW over the Peninsula.



## DETERMINISTIC AND PROBABILISTIC PRECIPITATION FORECASTING

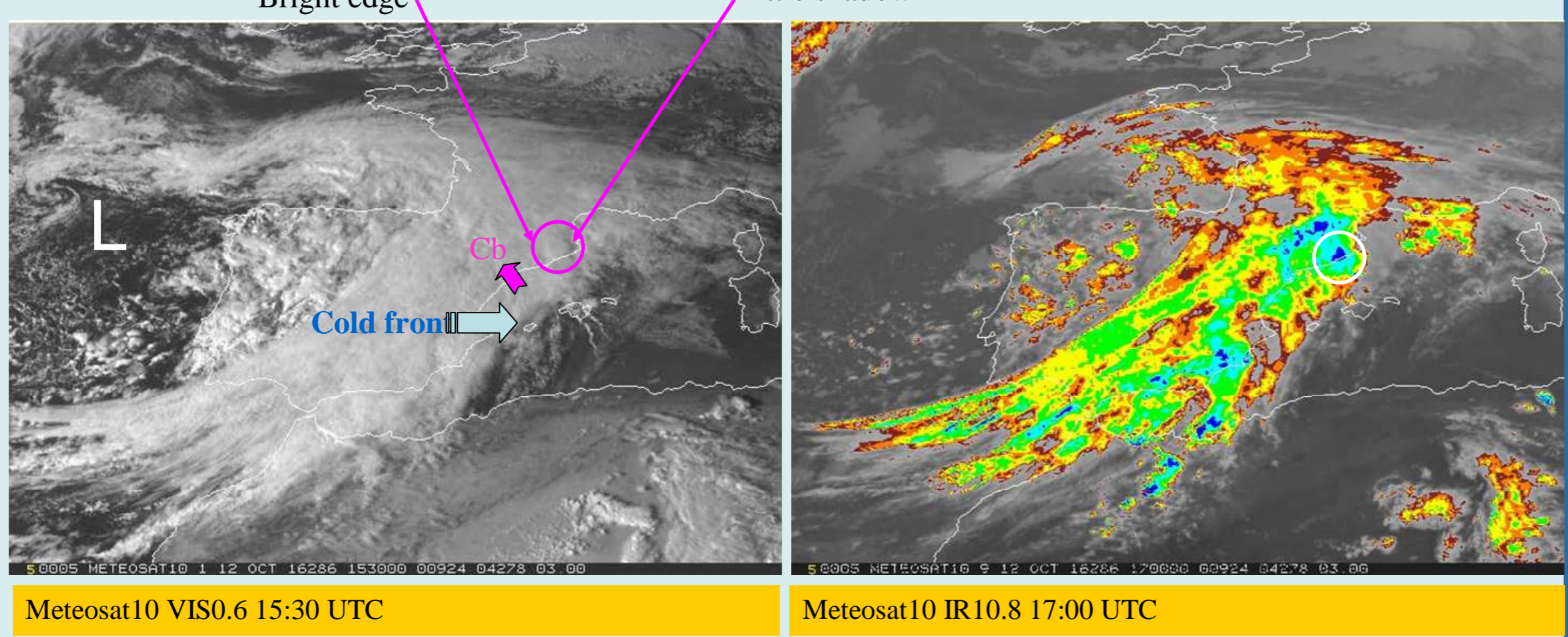


- Deterministic HRES ECMWF (9 km hor. res.) and HARMONIE-AROME (cycle 38) (2.5 km hor. res) fields are operationally used.
- Both HRES ECMWF and HARMONIE-AROME models show a heavy precipitation area moving north-eastward following the coastline.
- Both models show a delay greater than 3 h with respect to the period of observed maximum rainfall intensity in the area of interest.
- ECMWF model reaches a maximum of 40 mm/3h in the area of interest and HARMONIE-AROME 120 mm/3h (more realistic value) but both values are much lower than the observed ones.
- 4 members of γSREPS show 3 h accumulated rainfall > 50 mm and two of them > 120 mm/3h. All of them take place in coastal area north to Barcelona city.

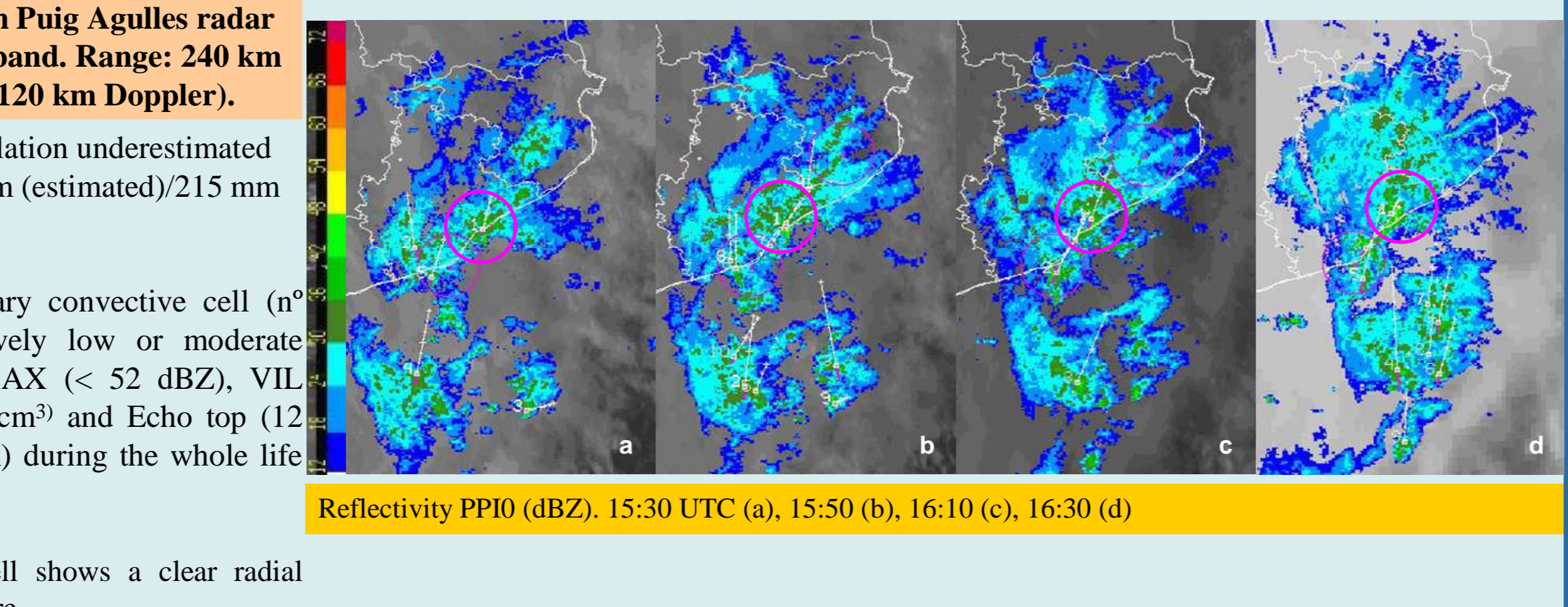


## CLOUDINESS, PRECIPITATING SYSTEMS AND THUNDERSTORMS

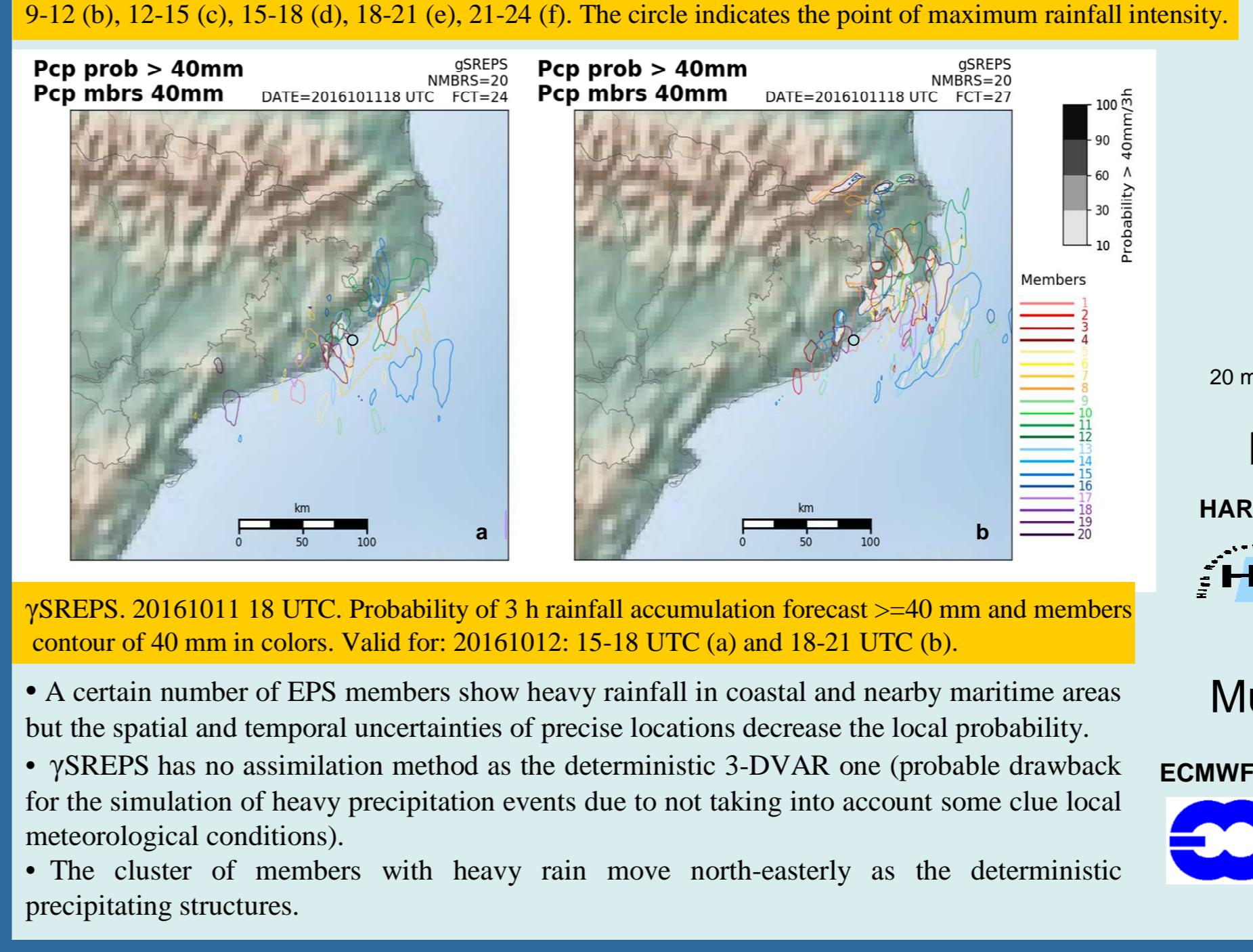
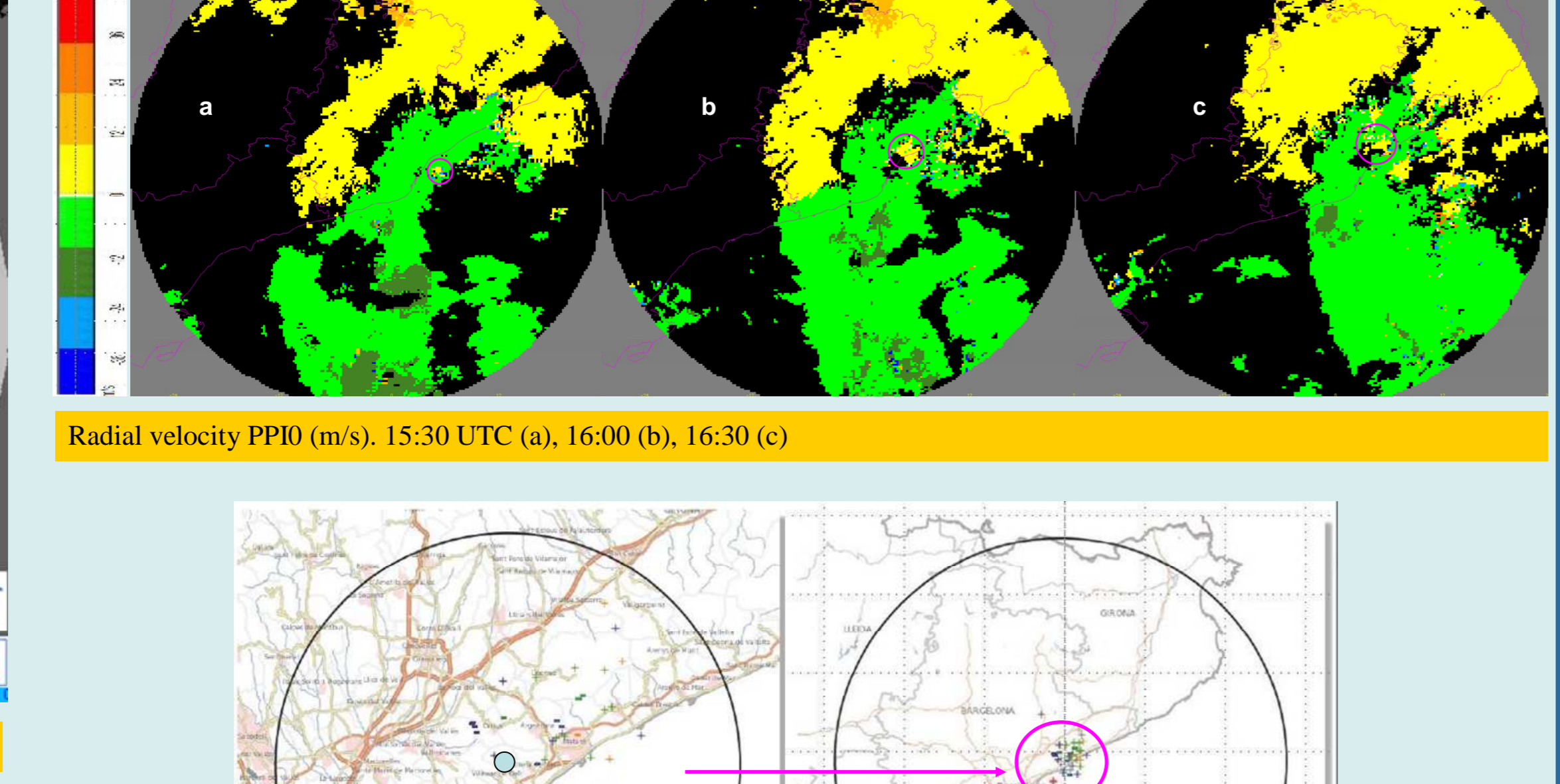
- Cloud band associated to eastward advancing cold front. Clouds displacement from SW to NE.
- Cumulonimbus cloud over northeast Catalonia embedded in the frontal cloud band. Difficult to identify.
- Quasi-stationary Cb or with very slow displacement from SE to NW.
- Not very low brightness temperature of the Cb top comprised between -52 and -56 °C. Not very deep Cb. Difficult to identify.



- Products from Puig Agulles radar (AEMET). C band. Range: 240 km (normal)/ 120 km Doppler.**
- Total accumulation underestimated by radar: 64 mm (estimated)/215 mm (registered).
  - Quasi-stationary convective cell (n° 1) with relatively low or moderate values for ZMAX (< 52 dBZ), VIL Density (< 1g/cm³) and Echo top (12 dBZ) (< 8 km) during the whole life cycle.
  - Convective cell shows a clear radial velocity signature.



- Echo top (12 dBZ) (km), 17:00 UTC**
- Convective cell with a low number of CG discharges: 40 between 15:23 UTC and 18:05 UTC. Low lightning frequency: 0.33/min between 15:23 UTC and 17:13 UTC.
  - Very high percentage of positive CG lightnings: 68 %.
  - Very isolated thunderstorm: The nearest thunderstorm is located at 90 km southeast over the sea.
  - Quasi-stationary thunderstorm with a slight displacement northward.



## WARNINGS: A VERY CHALLENGING EVENT

In this event some severe weather warnings were issued by the forecasting group of the Spanish National Weather Service located in Barcelona city.

Two kinds of warnings were issued for **Barcelona Littoral area**: rainfall accumulation greater than fixed thresholds in 12 hours (P2) and in 1 hour (P1).

Warnings sequence in local time (warning level: **yellow, orange, red**).

**11th October 11:23 H P2 : 80 mm/12h and P1 : 40 mm/1h from 10 to 20 H 12<sup>th</sup>. Probability > 70 %.**

**11th October 22:04 H P2 : 100 mm/12h (warning level was raised) and P1 : 40 mm/1h from 10 H 12<sup>th</sup> to 00 H 13<sup>th</sup>. Probability > 70 %.**

**12th October 09:03 H P2 : 100 mm/12h and P1 : 40 mm/1h from 14 H 12<sup>th</sup> to 06 H 13<sup>th</sup> (estimated time interval for heavy rain occurrence was delayed and extended). Probability 40-70 %.**

➡ **AFTER SOME HOURS WITHOUT HEAVY RAINS OR THUNDERSTORMS WARNINGS ARE REASSESSED**

**12th October 16:33 H P2 : 100 mm/12h and P1 : 20 mm/1h (warning level was lowered) from 16 H 12<sup>th</sup> to 06 H 13<sup>th</sup>. Probability 40-70 %.**

**BUT...**

➡ **!!1730-1830 L.T. A LOCAL THUNDERSTORM WITH VERY HEAVY RAIN HAS BEEN RECORDED AT SOME PLACES IN THE AREA!!**

**12th October 19:19 H P1 : 80 mm/1h (warning level was raised during thunderstorm) from 19:19 to 20 H 12<sup>th</sup>. Probability 40-70 %.**

**12th October 19:19 H P2 : 180 mm/12h (warning level was raised during thunderstorm) from 19 to 20 H 12<sup>th</sup>. Probability 40-70 %.**

**12th October 19:19 H P2 : 100 mm/12h (10-40 %) from and P1 : 20 mm/1h (40-70 %) (warning levels were lowered after thunderstorm) from 20 H 12<sup>th</sup> to 06 H 13<sup>th</sup>.**

## REFERENCES

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