

# WEATHER FORECAST PRODUCTS

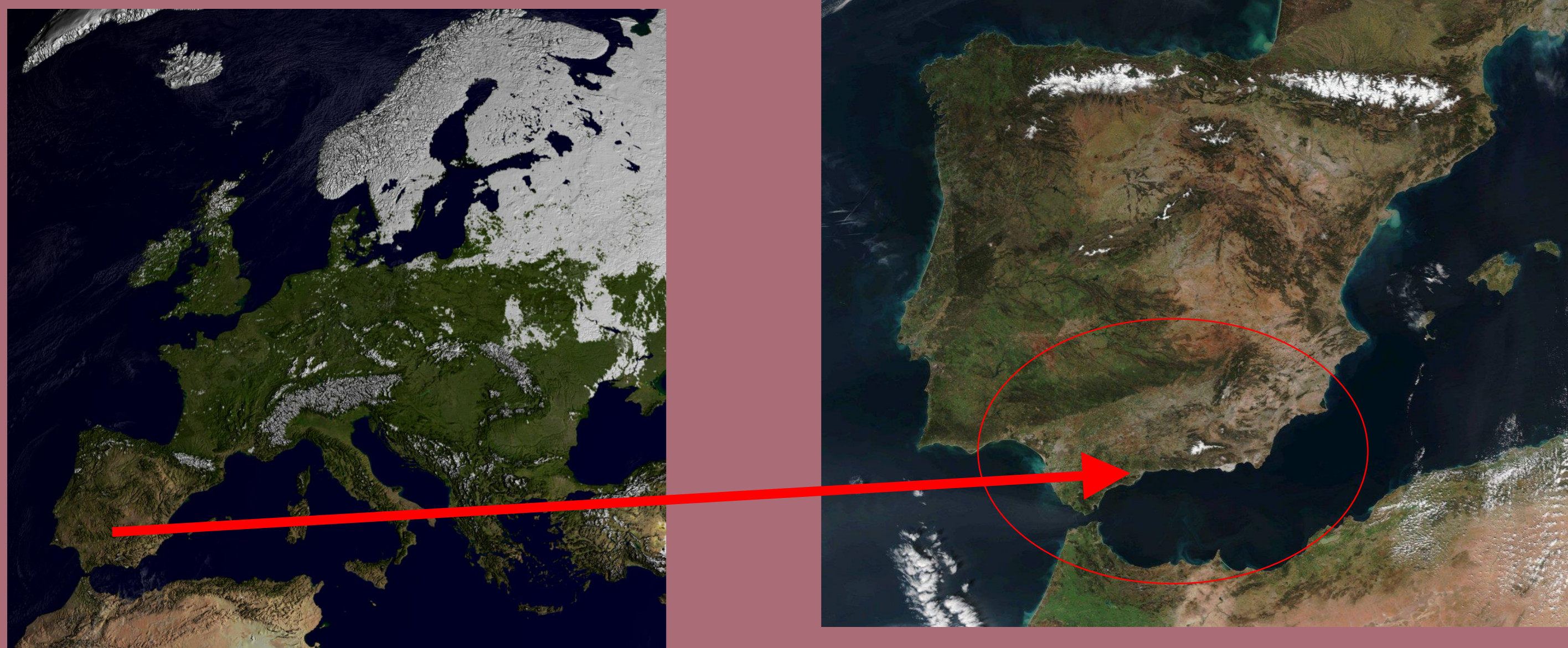
## CASE STUDY: FLOODING IN SOUTH-EASTERN SPAIN, SEP 2019

Carlos Manuel Jiménez Caveró – cjimenezc@aemet.es

AEMET – Spanish National Weather Service – www.aemet.es

### Where we are and what we do

AEMET (Spanish National Weather Service) provides weather forecasts and warnings to protect life and property, monitoring and forecasting of weather hazards. AEMET's operational forecasters are in charge of showing how weather is most likely to evolve. To do this, AEMET makes use of a wide variety of ECMWF products, both high resolution (HRES-IFS) and ensemble forecast (ENS) products. Mainly, ensemble products are used for medium-range forecasts, while high resolution products play a key role in the short-range. AEMET also develops new products based on ECMWF data, both deterministic and probabilistic, focused on Iberian Peninsula and Canary islands.

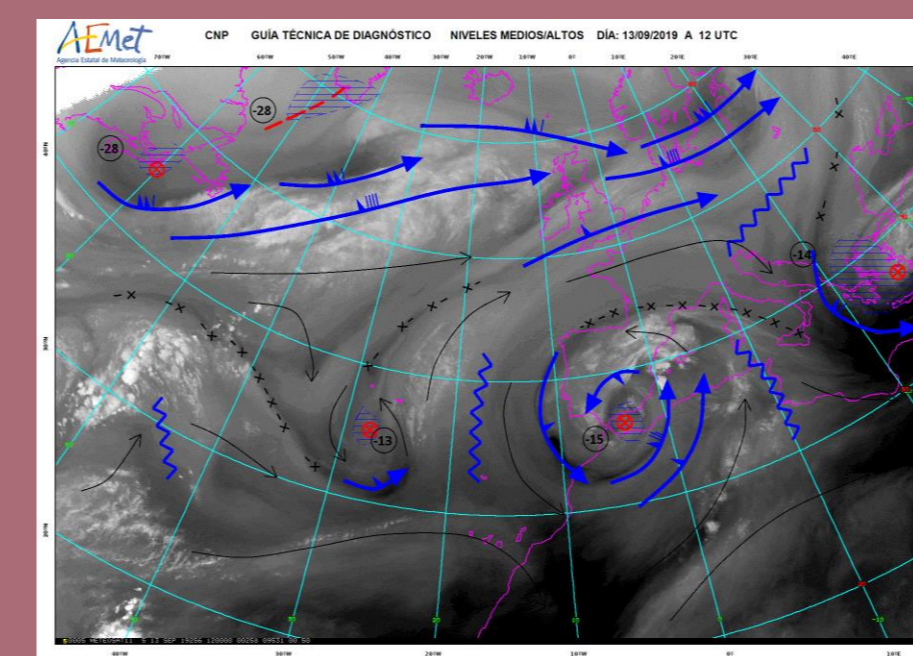


AEMET Málaga Meteorological Centre: provides weather forecasts and warnings for southern Spain. Tasks:

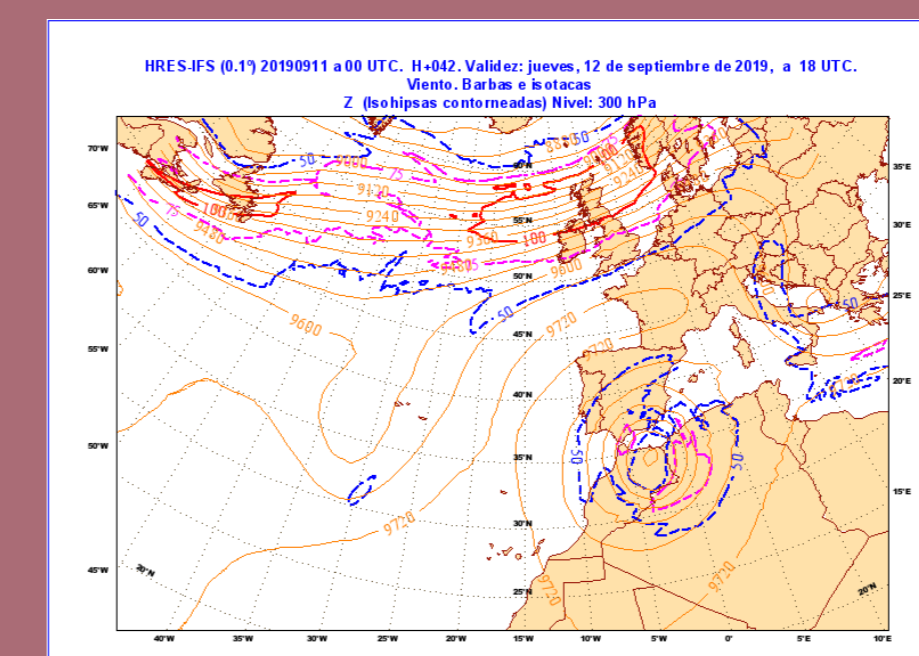
- Weather forecasting regional, provincial and local levels.
- Monitoring and forecasting of weather hazards.
- Information and specialist advisory services for the mass media and the general public.
- Meteorological and climate-related studies and products for applications of social and economic interest.
- Meteorological observation in southern Spain, and data archive.

### Case study – Synoptic framework

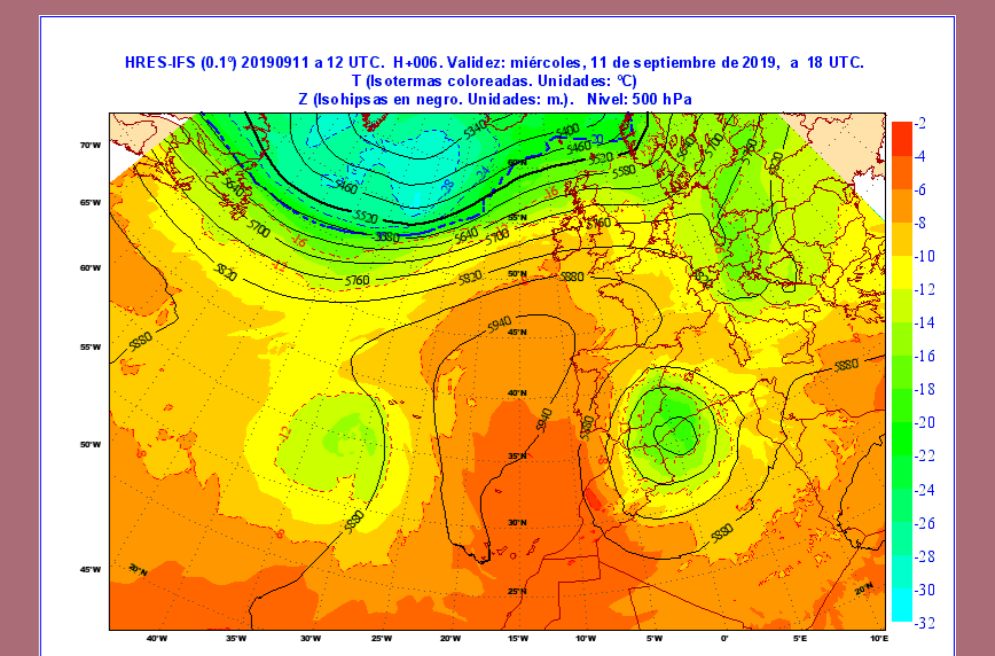
- A disastrous flood event occurred in south-eastern Spain, along the Mediterranean area, on 12-13 September, 2019, with more than 100mm of cumulative rainfall recorded over 1-h period or 200mm of cumulative rainfall recorded over 3-h period, in some points. As a consequence, there was a historical flood event, with Segura river overflow in Murcia and Alicante.
- **Intense cut-off low** as a main character, with a cold-core upper cyclonic eddy of  $-20^{\circ}\text{C}$ , was isolated from the meandering upper-level westerly jet, and moved southern from Cantabrian Sea to western Mediterranean area. It had a 140-150kt jet at 300hPa level, which is very anomalous at the beginning of September in this latitude. It points out how intense this cut-off low was. Besides, it had a surprising slow movement which enhanced large amounts of rainfall during several days.



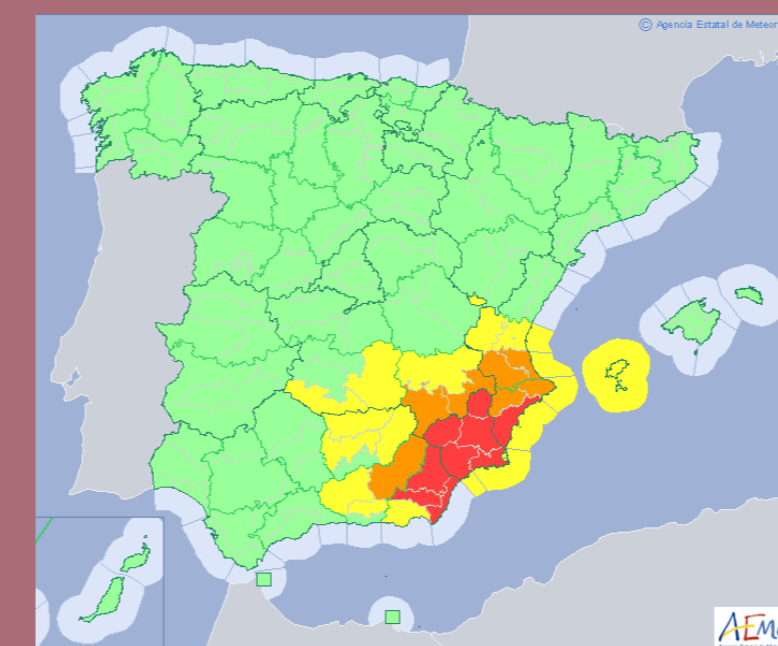
Aemet high levels diagnostic - Sept 13<sup>th</sup> 00 UTC



HRES-IFS Geopotential and wind 300 hPa



HRES-IFS Geop. and temperature 500 hPa



Weather red warnings South-eastern Spain



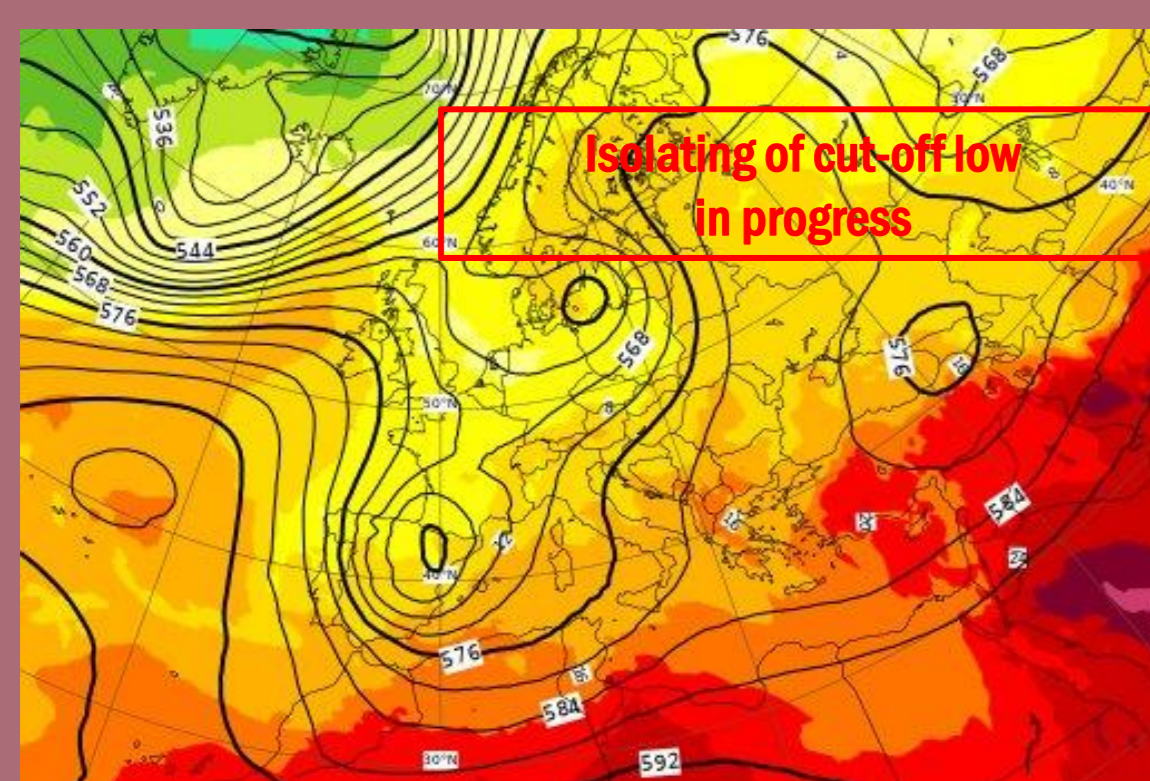
Segura river overflow



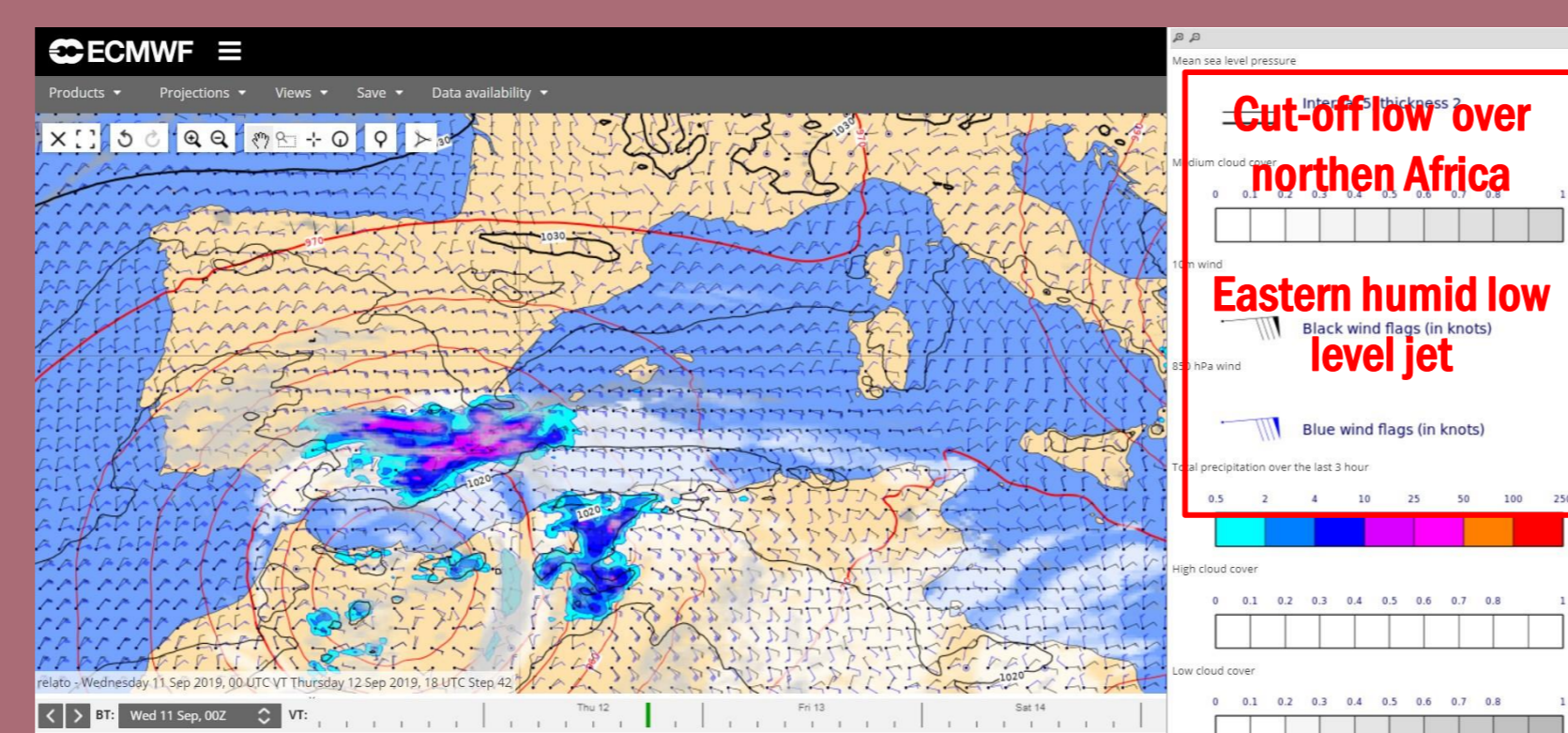
Flooding in Orihuela, Alicante

### Case study - ECMWF products

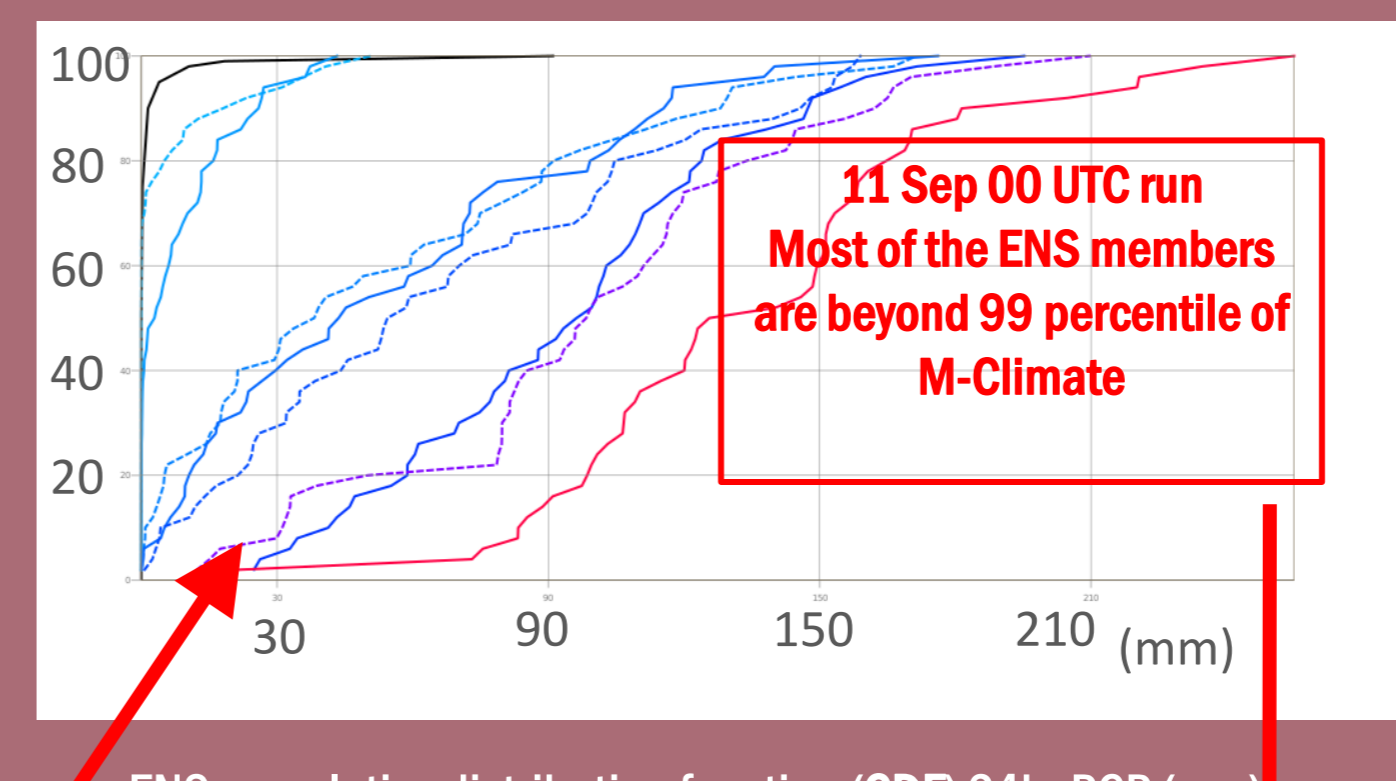
The cut-off low destabilized the atmosphere due to the accompanying upper-level cold air and favoured severe weather events. However, just taking into account the upper low we cannot explain the heavy rainfall registered. Other actors were the warm Mediterranean Sea (typical at the end of summer) which favoured large amounts of precipitable water in low levels, and the still high summer temperatures in land regions. Attending to low level pressure systems, there was a strong high along France and Italy, and a low pressure region along north of Africa. As a result, an intense and very wet westward low level jet was established. It transported large amounts of precipitable water, from the heart of Mediterranean Sea to coastal regions of Spain. We can call this as a **humid Mediterranean atmospheric river** associated with a warm and wet low level advection. Another aspect that always plays a role is the orographic land distribution, with close mountain areas of almost 1500m high.



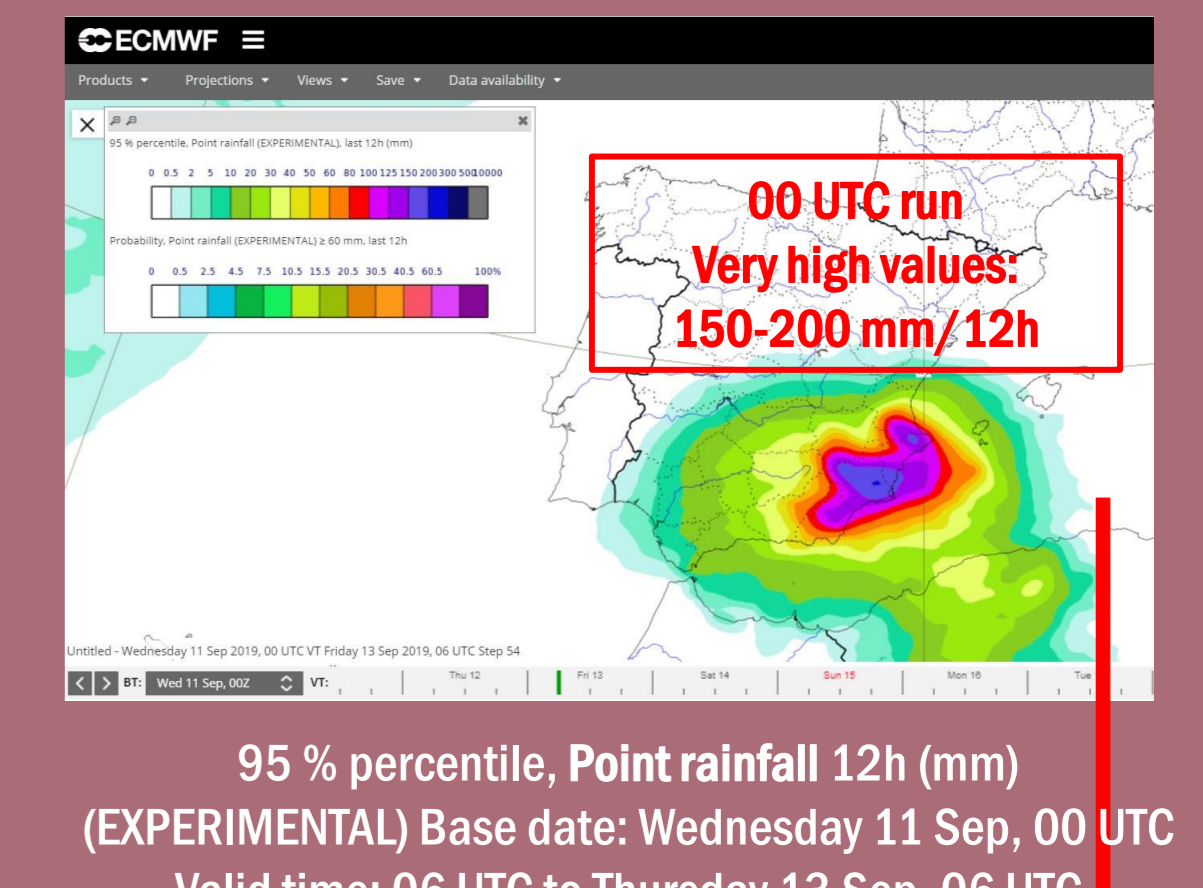
HRES-IFS 850 hPa temperature / 500 hPa geopotential  
Wednesday 10 Sep, 12 UTC T+12 Valid: Thursday 11 Sep, 00 UTC



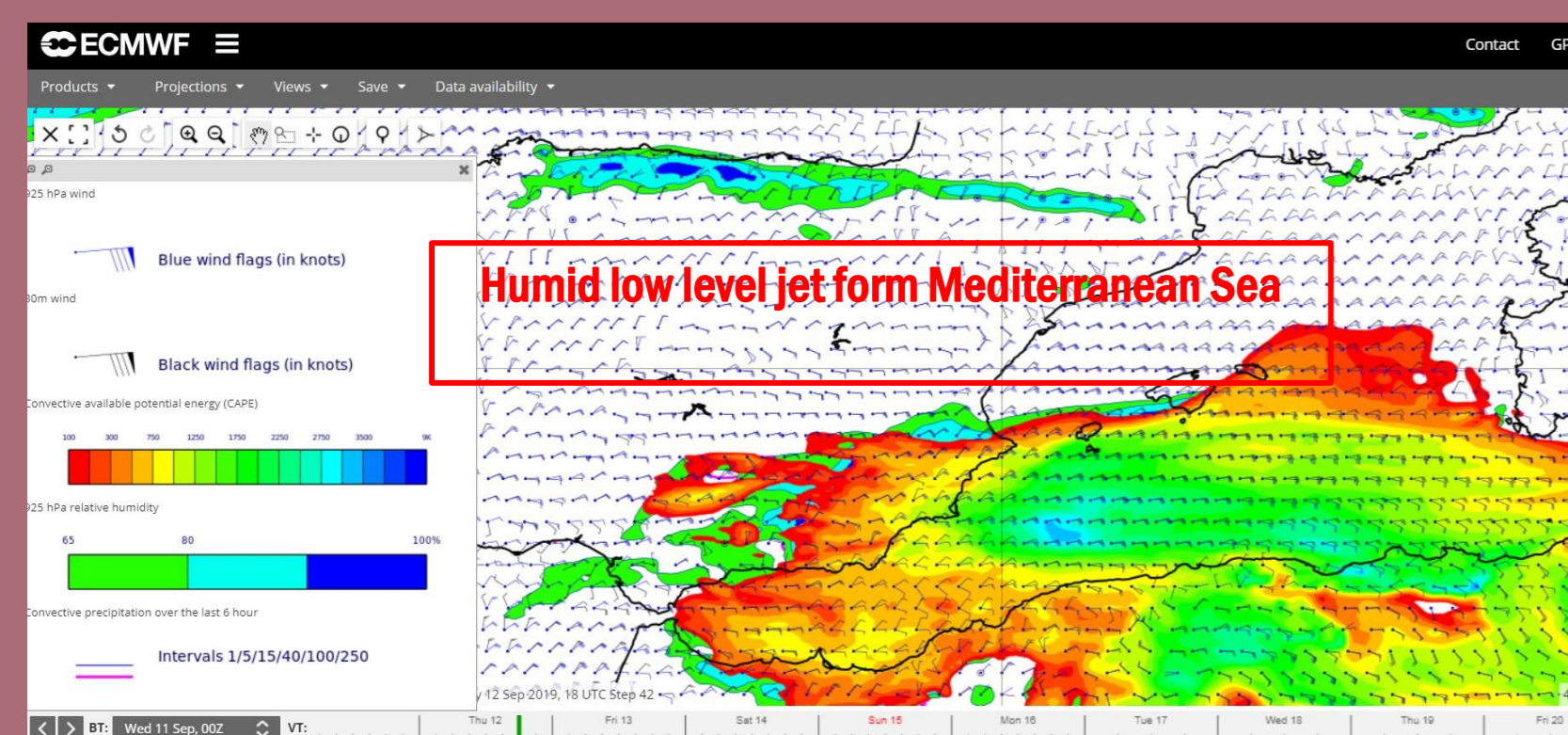
ecCharts. HRES-IFS 300 hPa geopotential / 850 hPa wind / PCP last 3 hour  
Wednesday 11 Sep, 00 UTC T+42 Valid: Thursday 12 Sep, 18 UTC



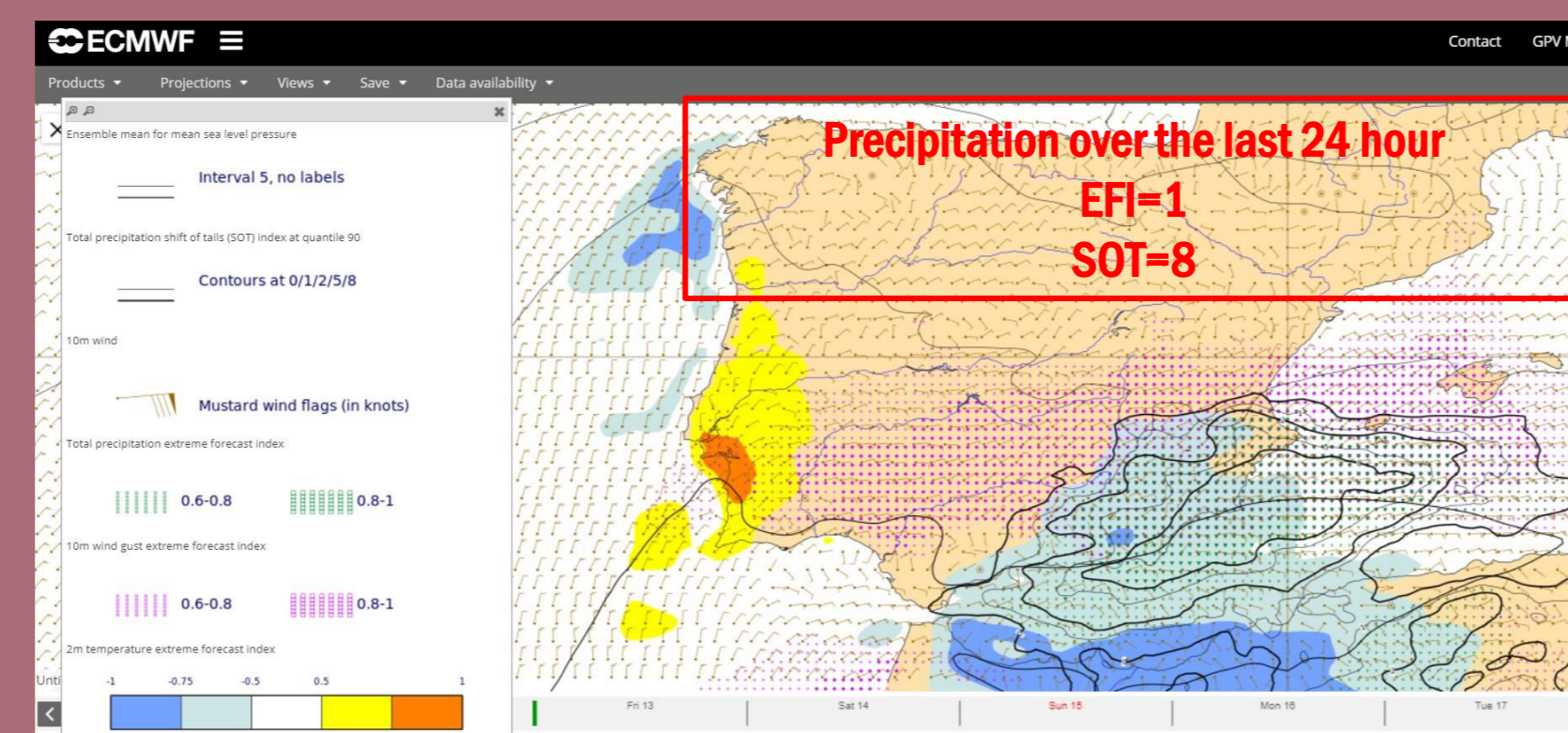
ENS cumulative distribution function (CDF) 24hr PCP (mm)  
Base date: Wednesday 11 Sep, 00 UTC  
Valid time: 00 UTC to Thursday 13 Sep, 00 UTC



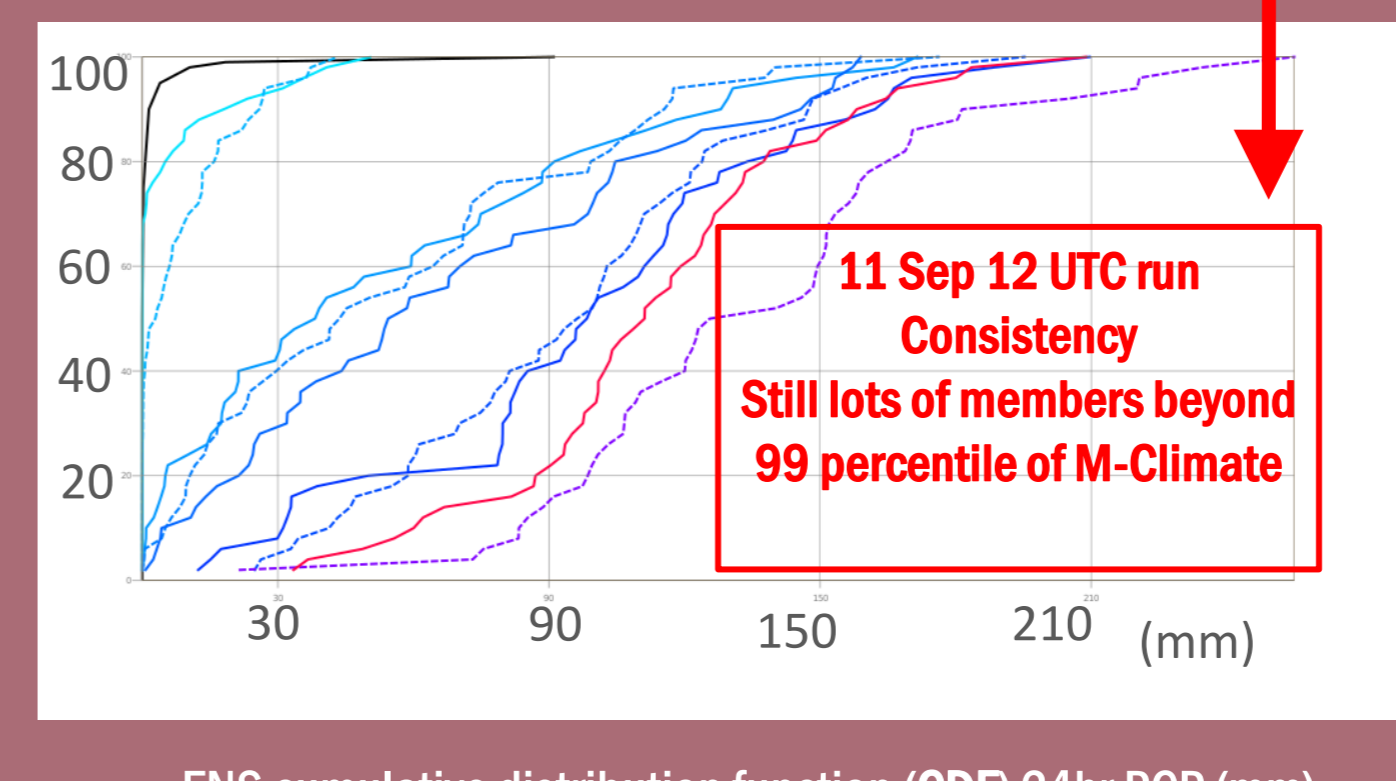
95 % percentile, Point rainfall 12h (mm)  
(EXPERIMENTAL) Base date: Wednesday 11 Sep, 00 UTC  
Valid time: 06 UTC to Thursday 13 Sep, 06 UTC



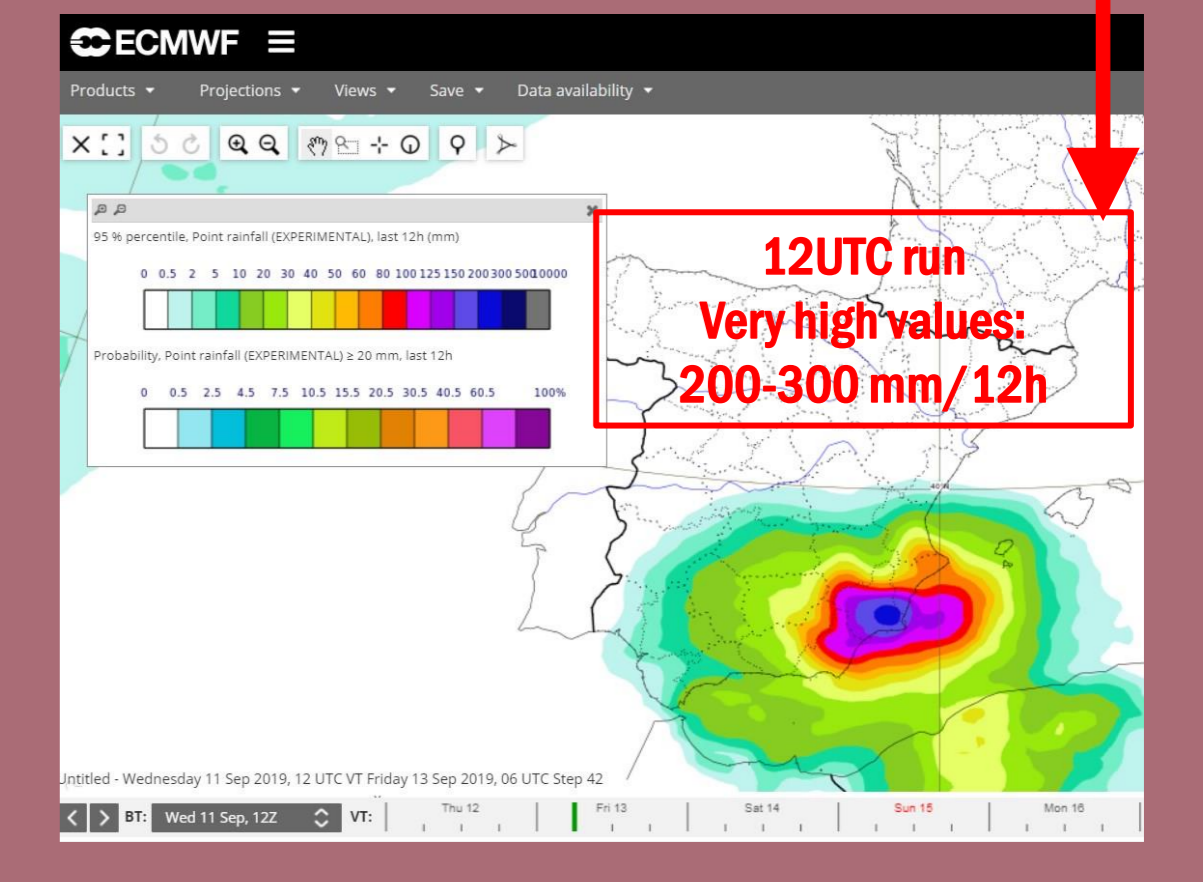
ecCharts. HRES-IFS 925 hPa wind / 925 hPa relative humidity  
Wednesday 11 Sep, 00 UTC T+42 Valid: Thursday 12 Sep, 18 UTC



ecCharts. EFIs: Temperature, PCP, wind gust, SOT: PCP  
Wednesday 11 Sep, 00 UTC T+48 Valid: Friday 13 Sep, 00 UTC

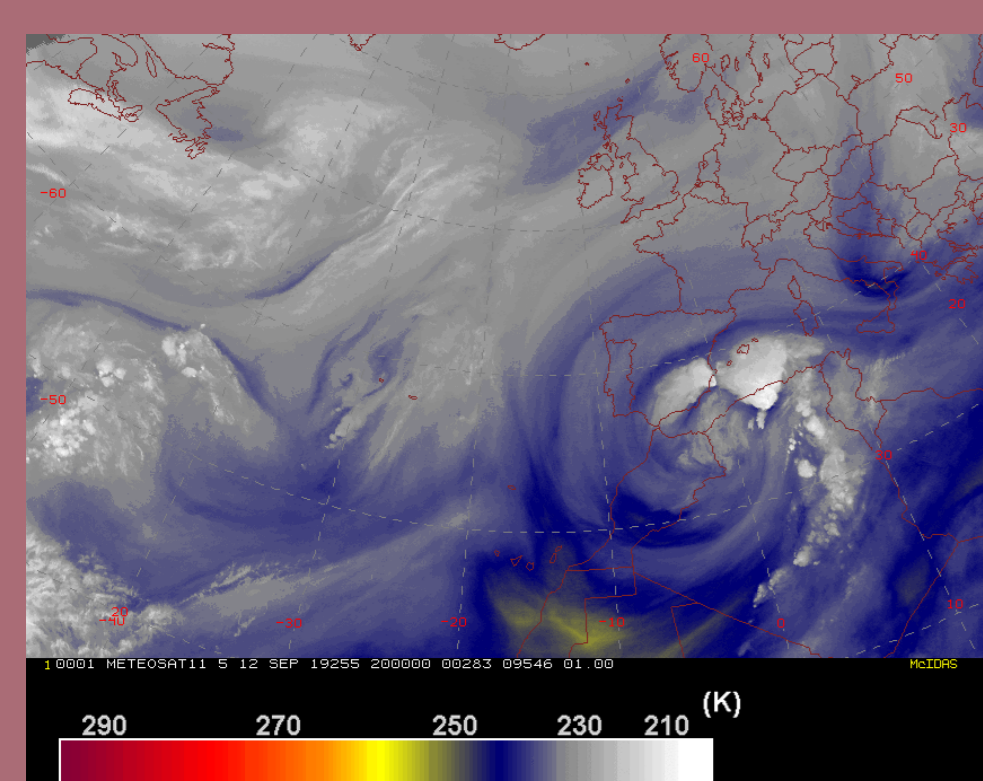


ENS cumulative distribution function (CDF) 24hr PCP (mm)  
Base date: Wednesday 11 Sep, 12 UTC  
Valid time: 00 UTC to Thursday 13 Sep, 00 UTC

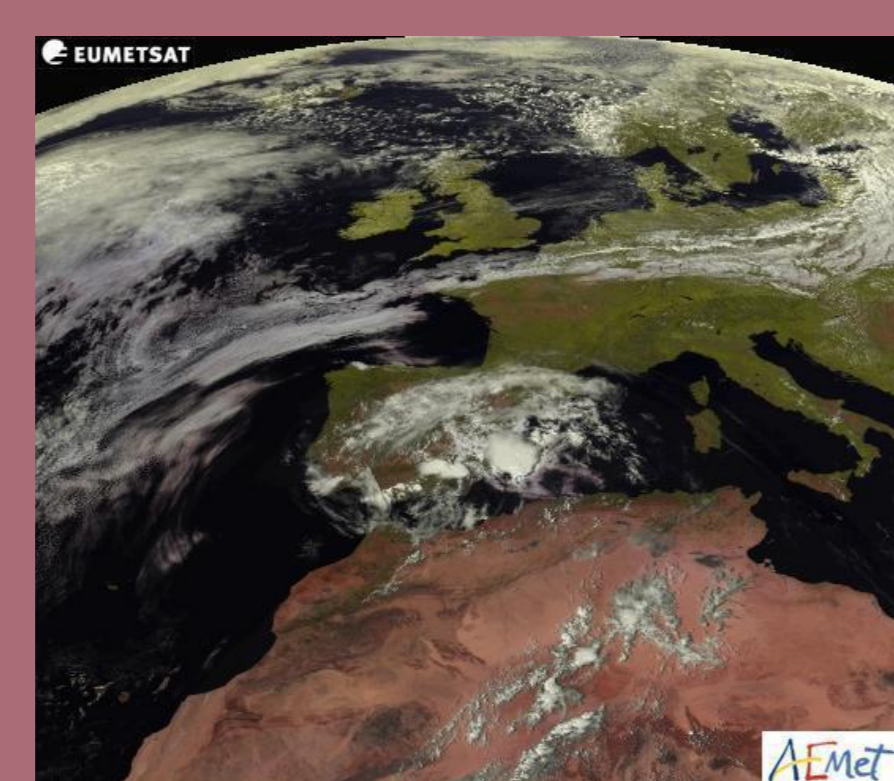


95 % percentile, Point rainfall 12h (mm)  
(EXPERIMENTAL) Base date: Wednesday 11 Sep, 12 UTC  
Valid time: 06 UTC to Thursday 13 Sep, 06 UTC

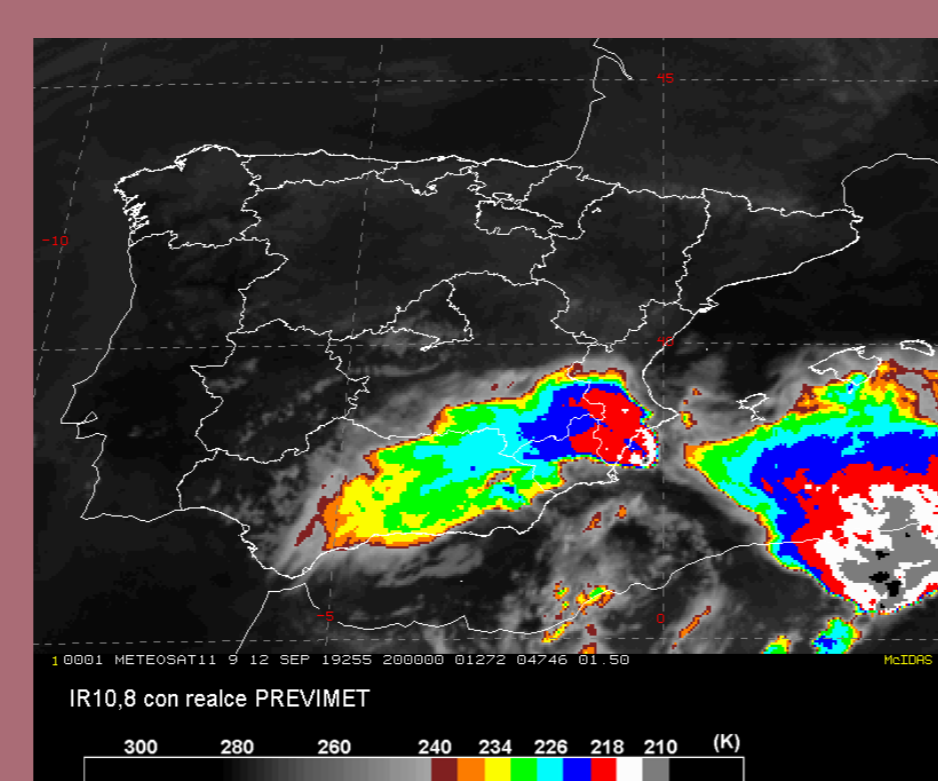
### Case study - Observations



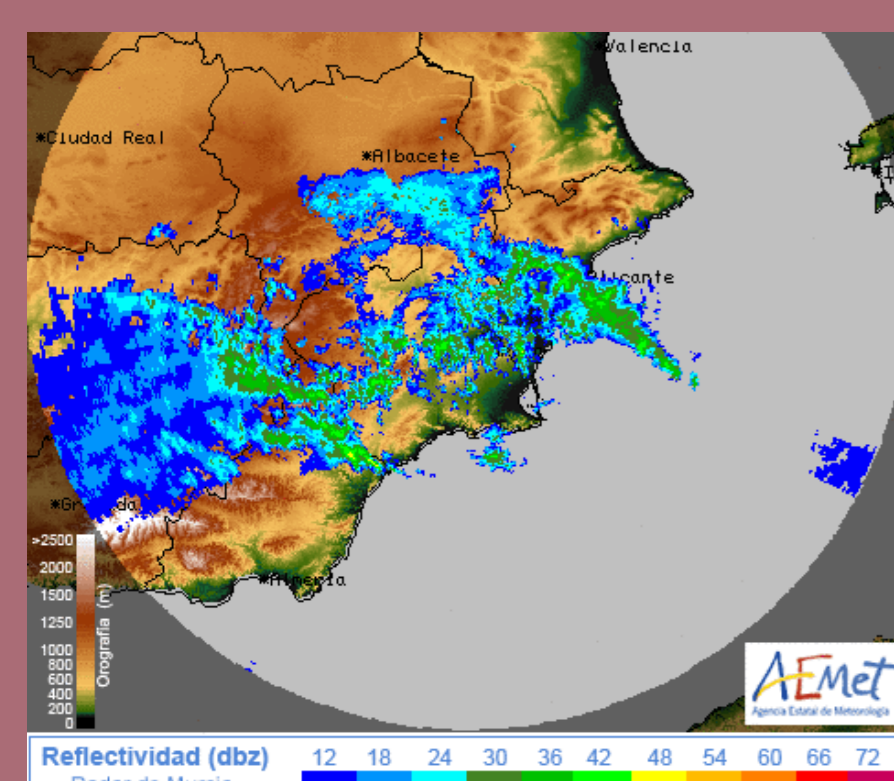
Derived WV 6.2 Satellite image  
Thursday 12 Sep, 20 UTC



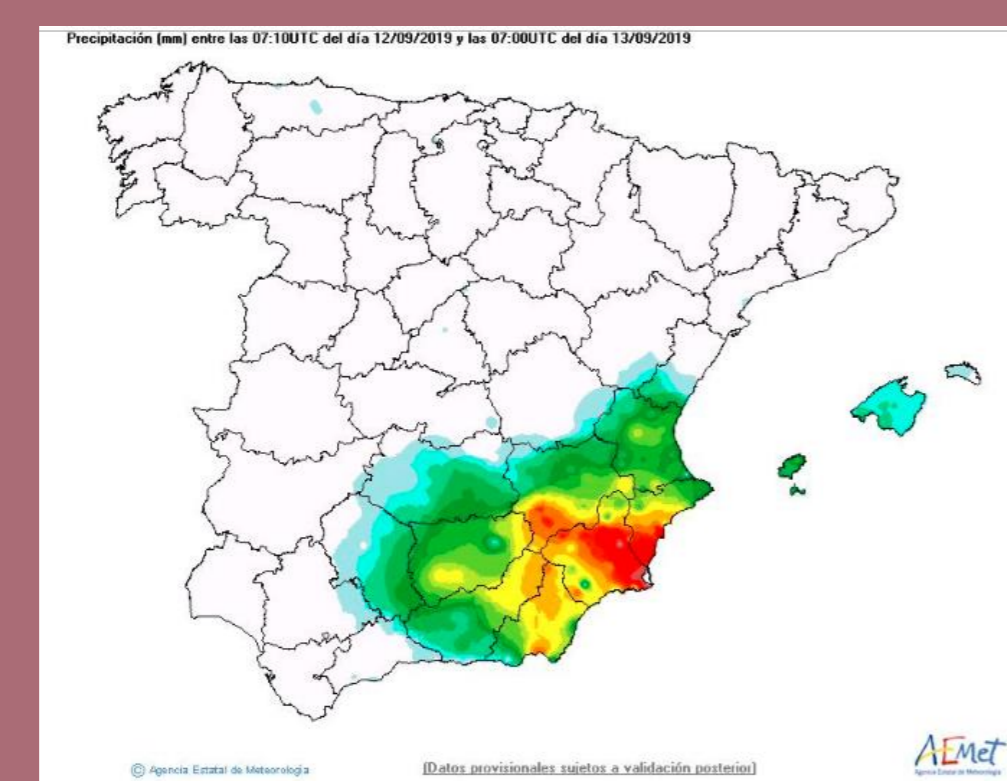
Visible satellite image. EUMETSAT



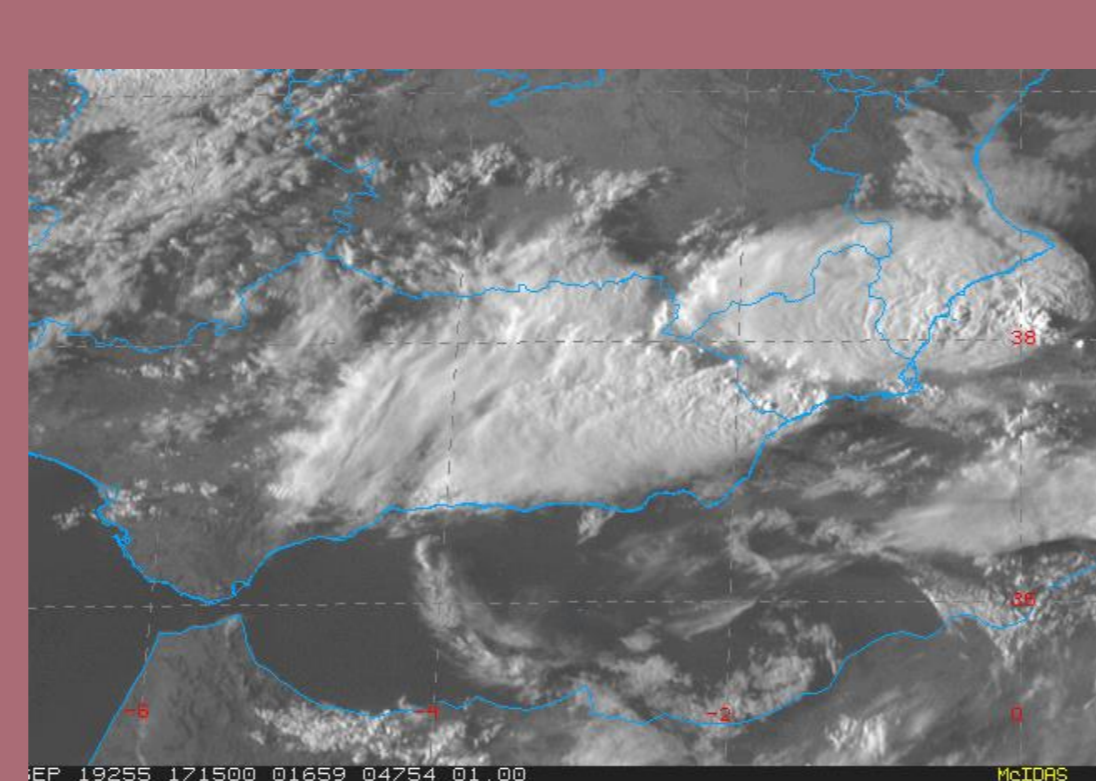
Derived IR10.8 satellite image. PREVIMET enhanced  
Thursday 12 Sep, 20 UTC



Murcia RADAR reflectivity  
Thursday 12 Sep, 19 UTC

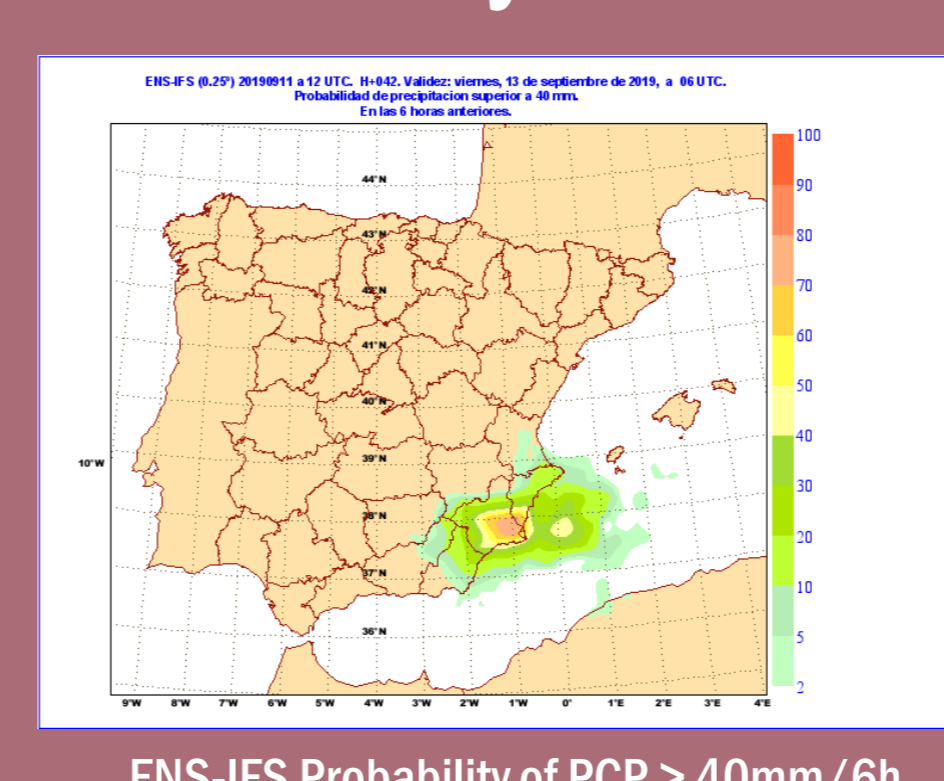


24 hours total rainfall  
From Thursday 12 Sep, 07 UTC to Friday 13 Sep, 07 UTC

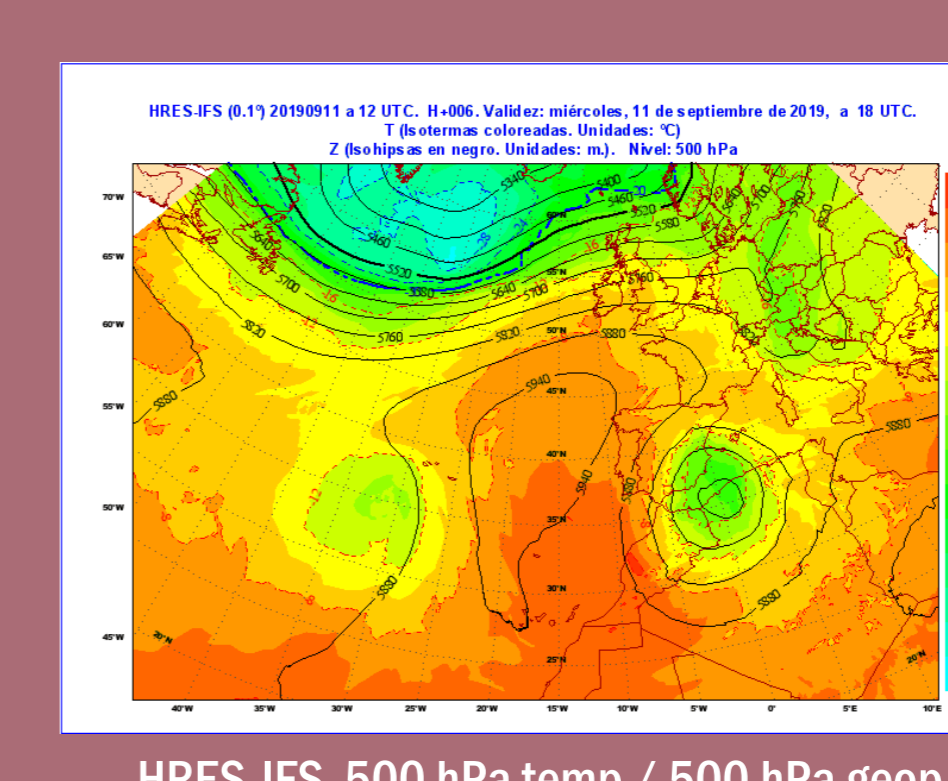


High resolution Visible image satellite  
Southern Spain, Thursday 12 Sep, 17 UTC

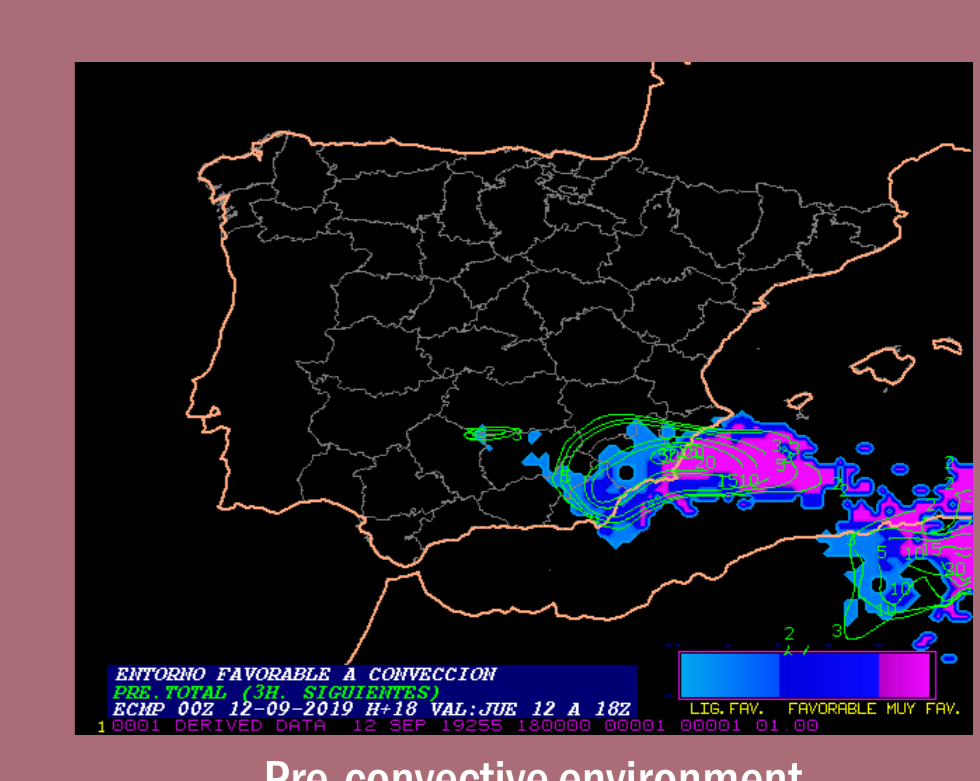
### Case study - AEMET products based on ECMWF data



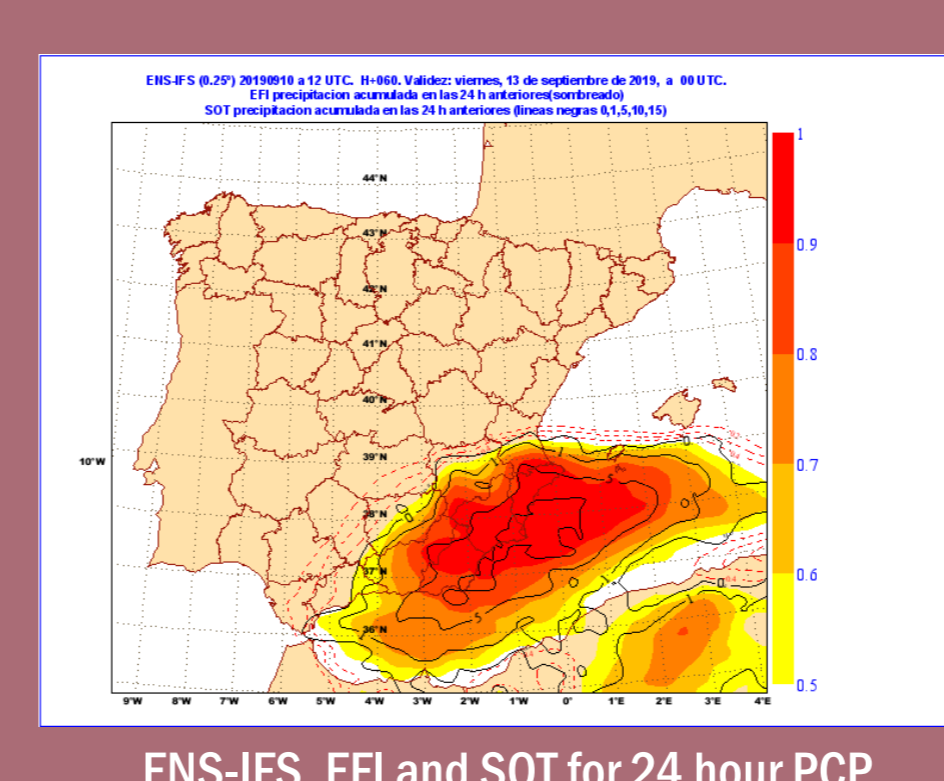
ENS-IFS Probability of PCP > 40mm/6h  
Wednesday 11 Sep, 12 UTC T+42  
Valid: Friday 13 Sep, 06 UTC



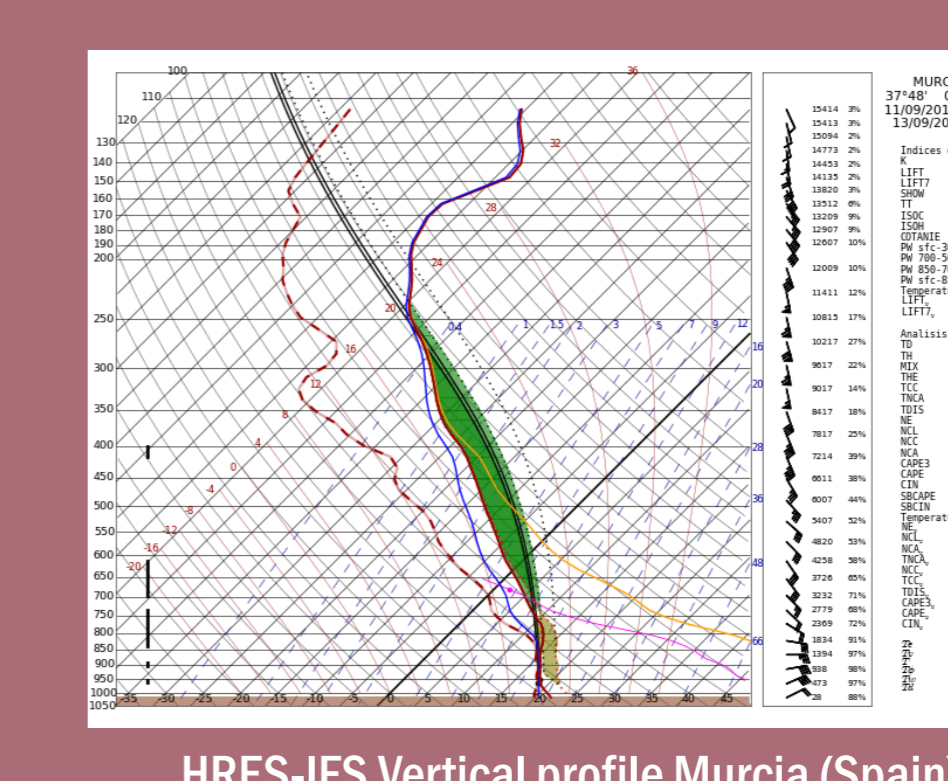
HRES-IFS 500 hPa temp / 500 hPa geop  
Wednesday 11 Sep, 12 UTC T+06  
Valid: Wednesday 11 Sep, 18 UTC



Pre-convective environment  
Wednesday 12 Sep, 00 UTC T+18  
Valid: Wednesday 13 Sep, 12 -18 UTC



ENS-IFS. EFI and SOT for 24 hour PCP  
Tuesday 10 Sep, 12 UTC T+60  
Valid: Friday 13 Sep, 00 UTC



HRES-IFS Vertical profile Murcia (Spain)  
Wednesday 12 Sep, 12 UTC T+36  
Valid: Friday 13 Sep, 00 UTC

This derived product has been developed in order to detect favorable areas for convection, either shallow or deep. The empirical conditions are based on the following ECMWF parameters:

- 500 hPa and 700 hPa lifted index
- Convective Inhibition (CIN)
- Convective Precipitation in 3 hour