Representation of deep convection in HARMONIE/AROME

Javier Calvo

Acknowledgments: Carlos Santos, Lisa Bengtson and ES0905 COST Action

Aladin/Hirlam ASM, 7-10 May 2012. Marrakech

Outline

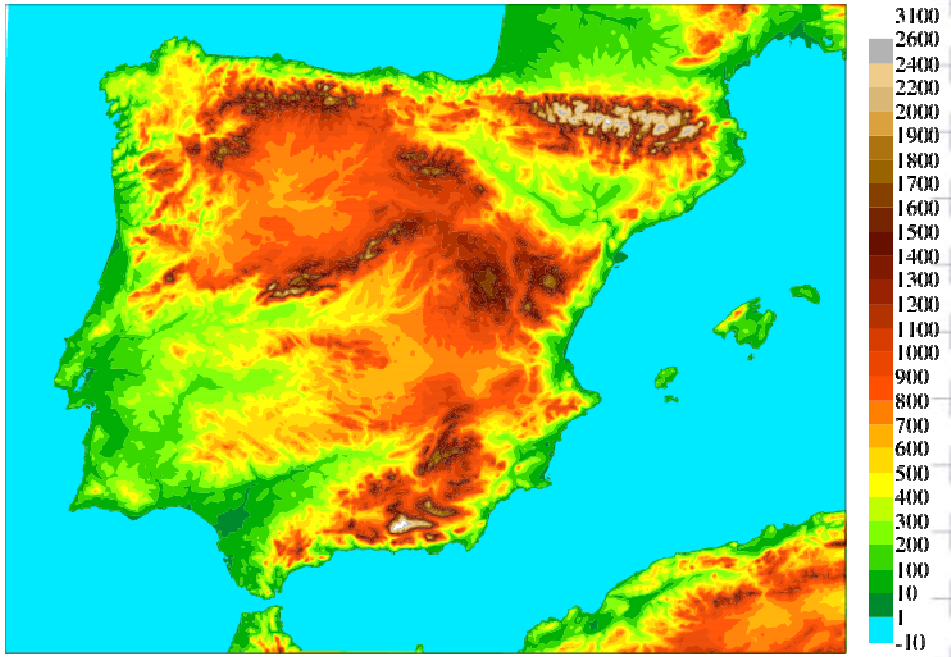
- Model set up
- How does explicit convection work at 2.5 km?
- Some interesting cases
- Sensitivity to the inclusion of a convective parameterization and to SLHD?
- Behaviour without strong dynamical forcing
- Diurnal cycle
- Objective verification
- Conclusions

HARMONIE at AEMET: AROME configuration

Cy36h1.4

- EDMFM
- Explicit convection

- 65 vertical levels
- Δx= 2.5 km
- Run 4 times per day H+30 forecast
- Only SURFEX surface analysis (OI)
  - No clear advantage of 3DVar upper air analysis if we use only convectional observations.
- Direct nesting in ECMWF forecasts



Forecasters are getting familiar with the new model/resolution (training and evaluation). First impression is very good.

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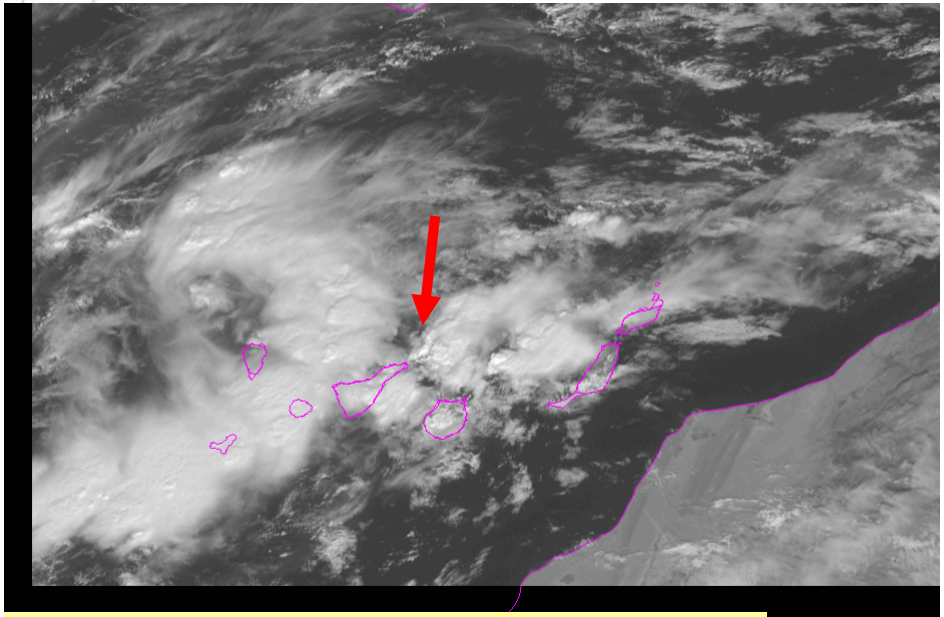
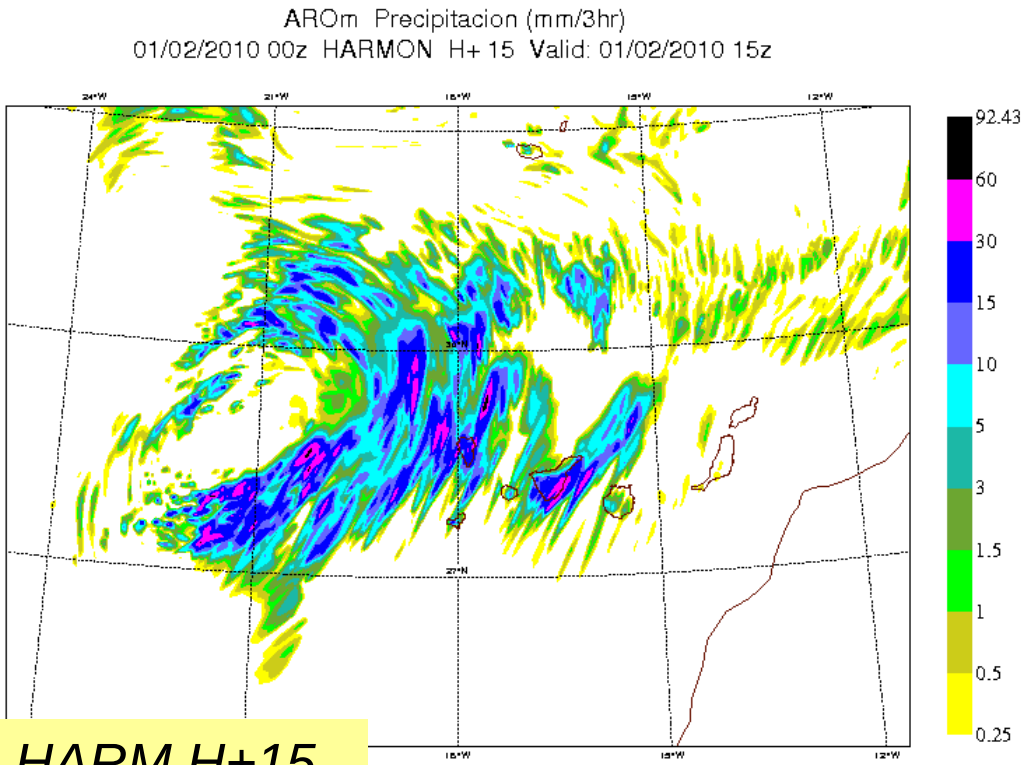
Can we reproduce the local scale?

Hybrid tropical-extratropical low

Over Canary Islands



MSG-2 VIS06 1 feb 12:00

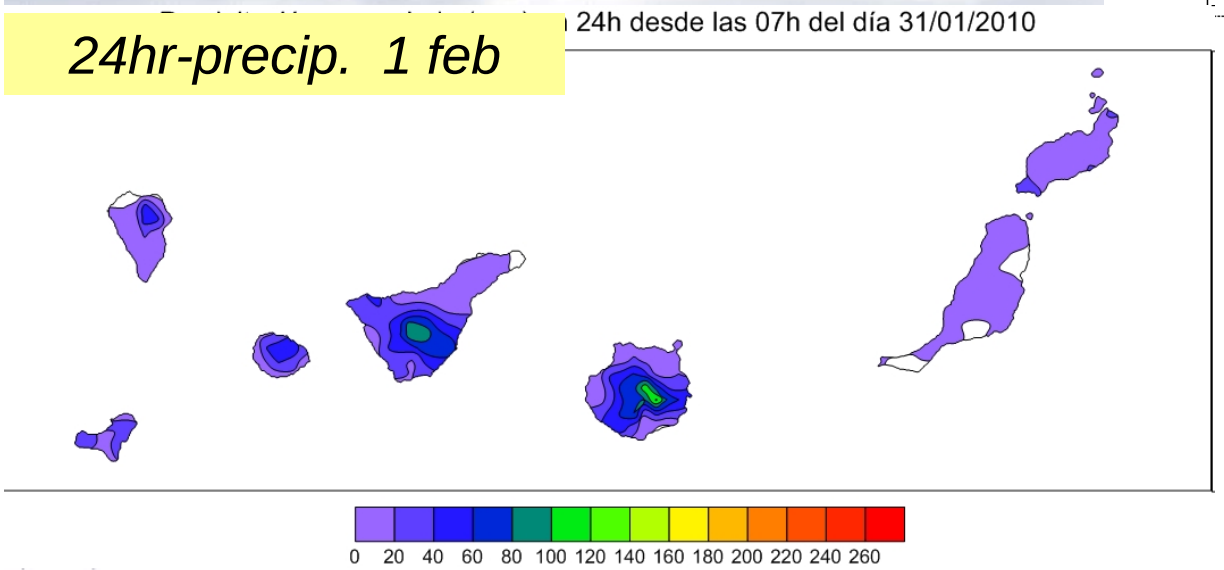


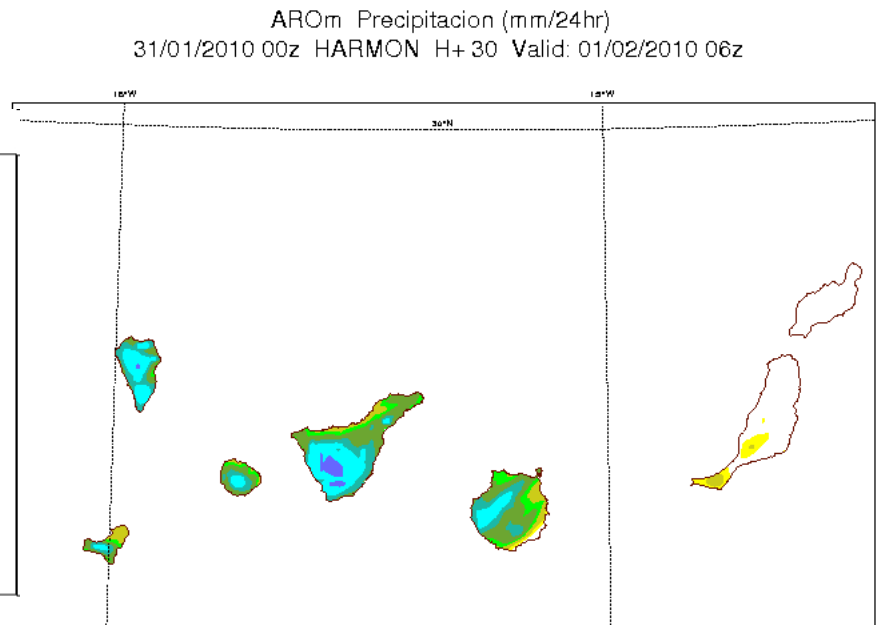
HARM H+15

• During a period of 3 days, 31st January-2 February 2010, gives significant amounts of precipitation which many locations catching amounts above 200 mm. The distribution over the Islands is irregular.

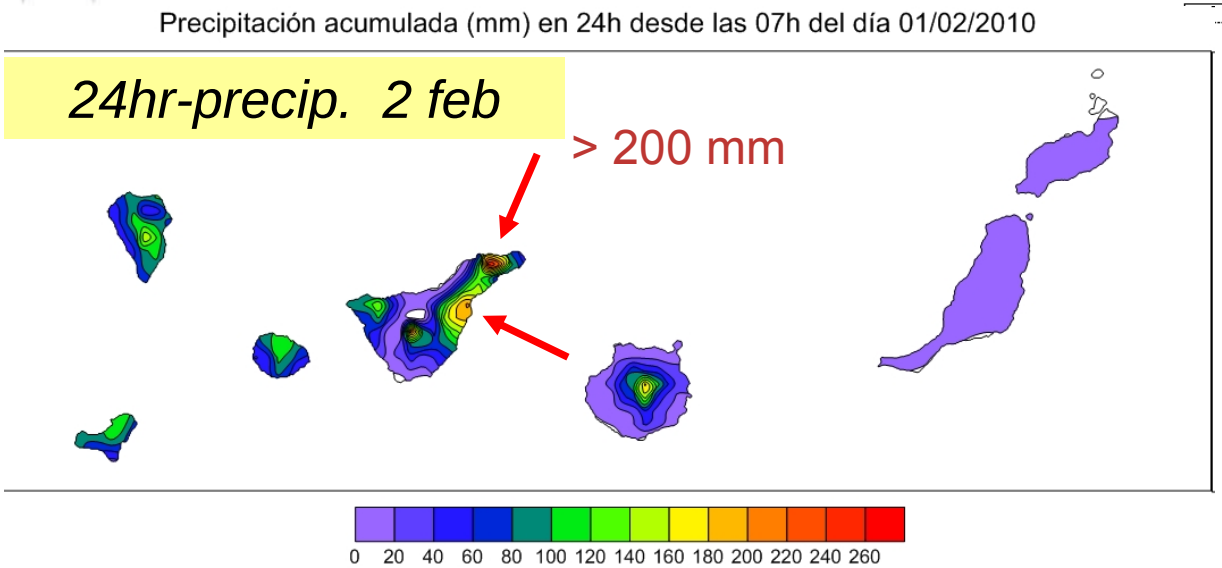
Missing local maxima associated with small scale convection

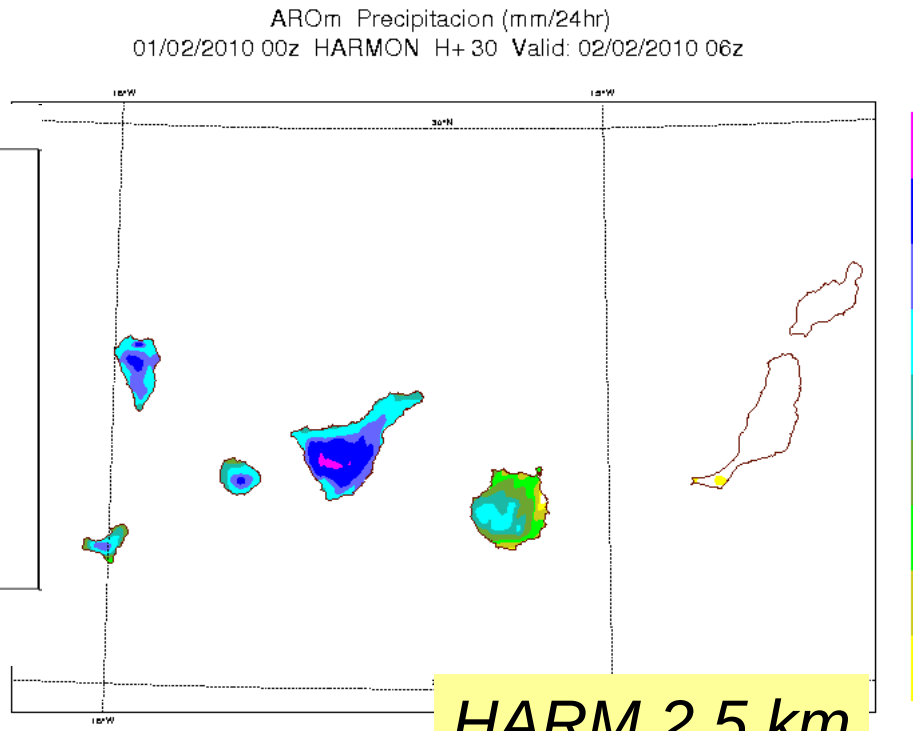
24hr-precip. 1 feb





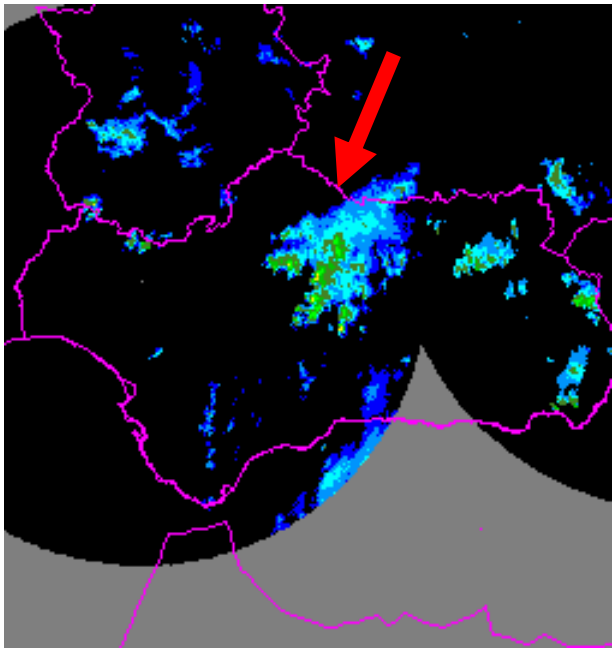
24hr-precip. 2 feb

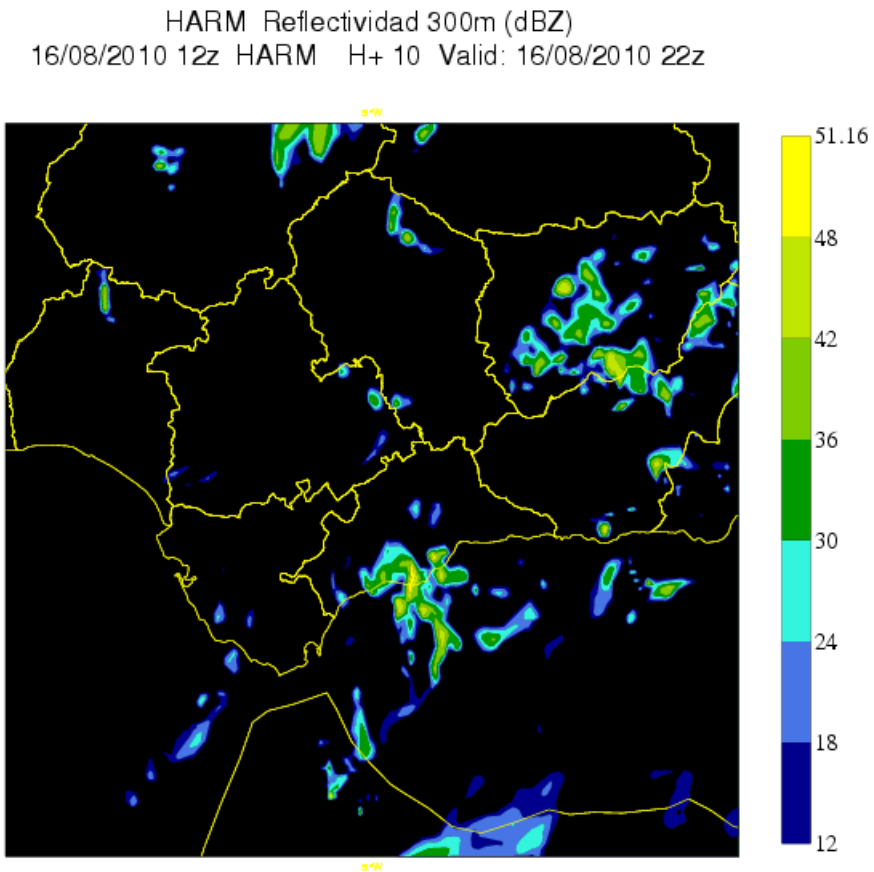




HARM 2.5 km

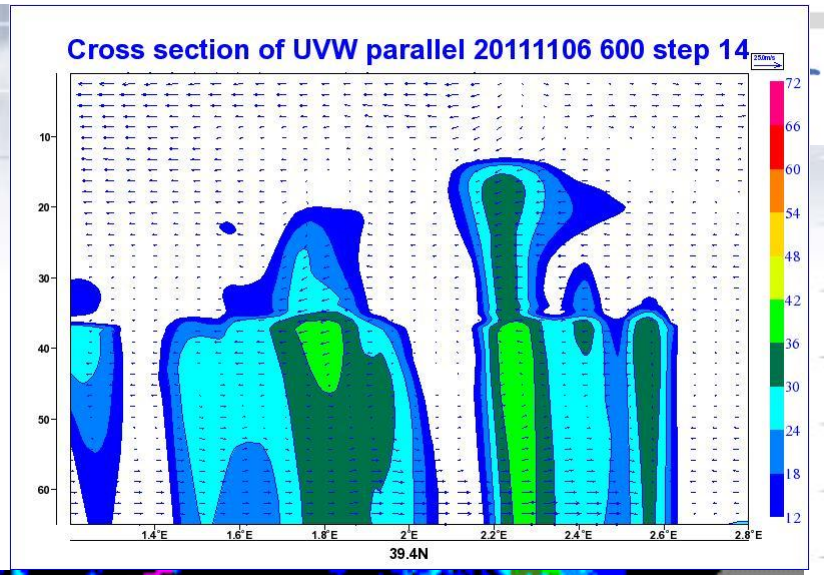
A Super Cell producing more than 200 mm in 4 hour

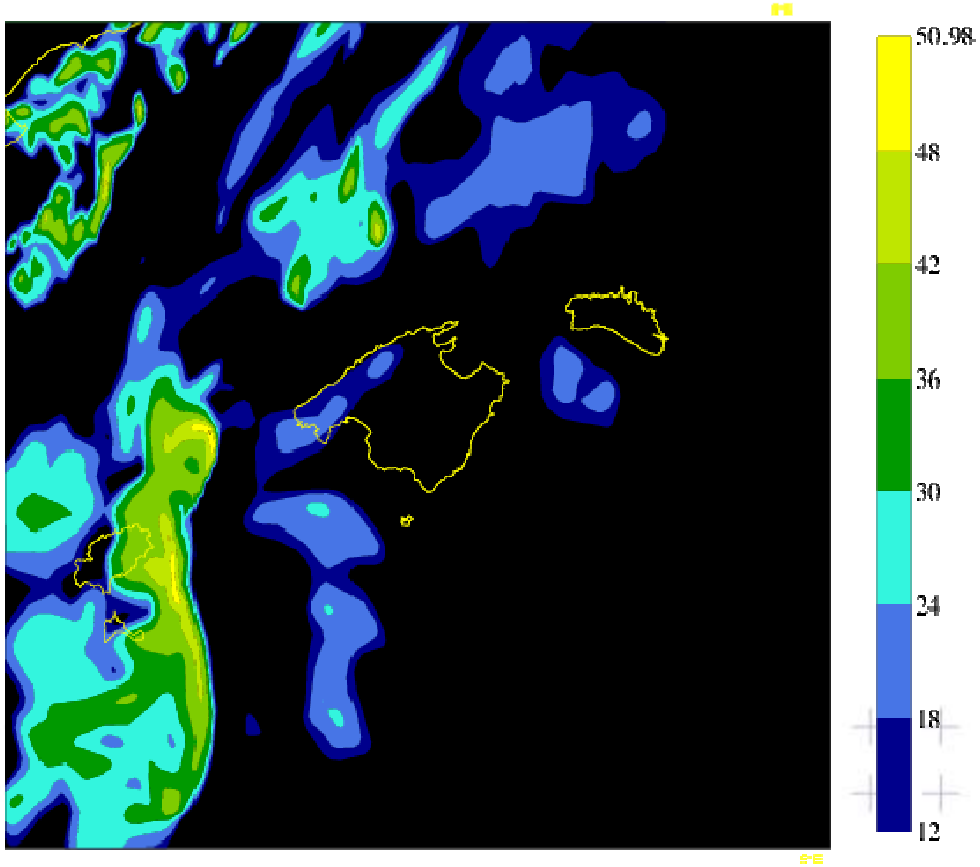


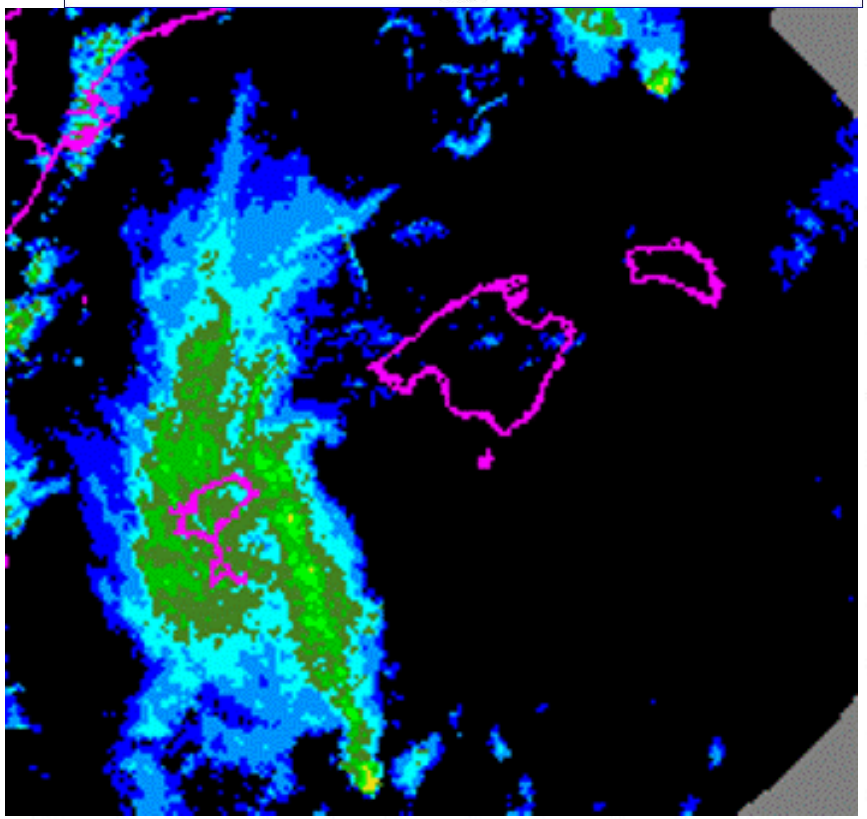


Squall line 04-11-2011 12 UTC

Reflectivity

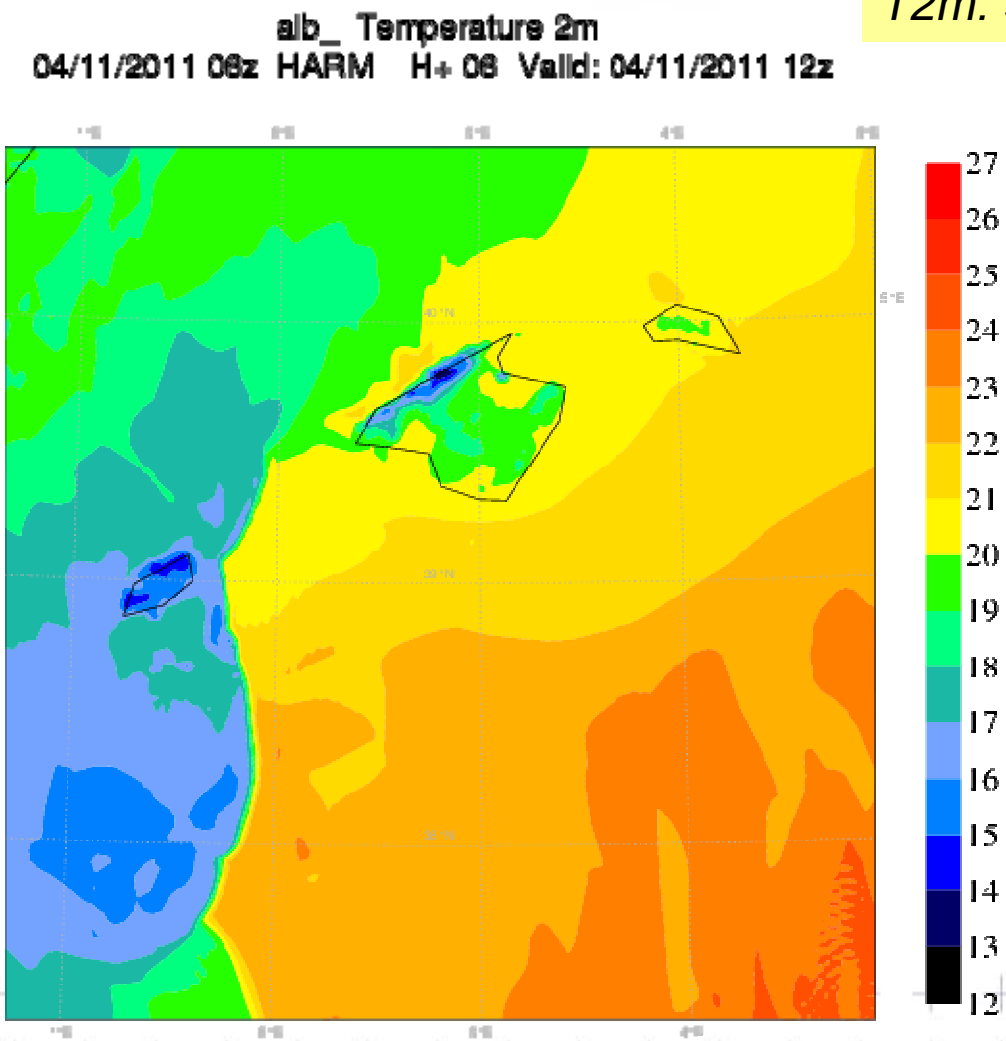






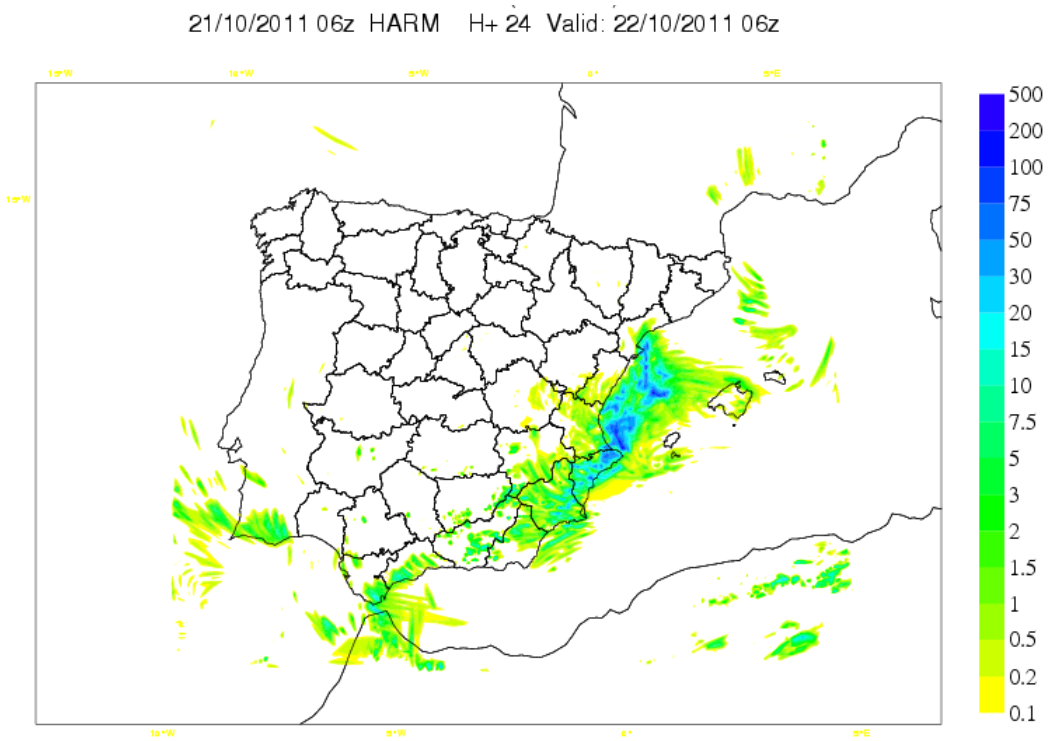
A squall line. Downdrafts

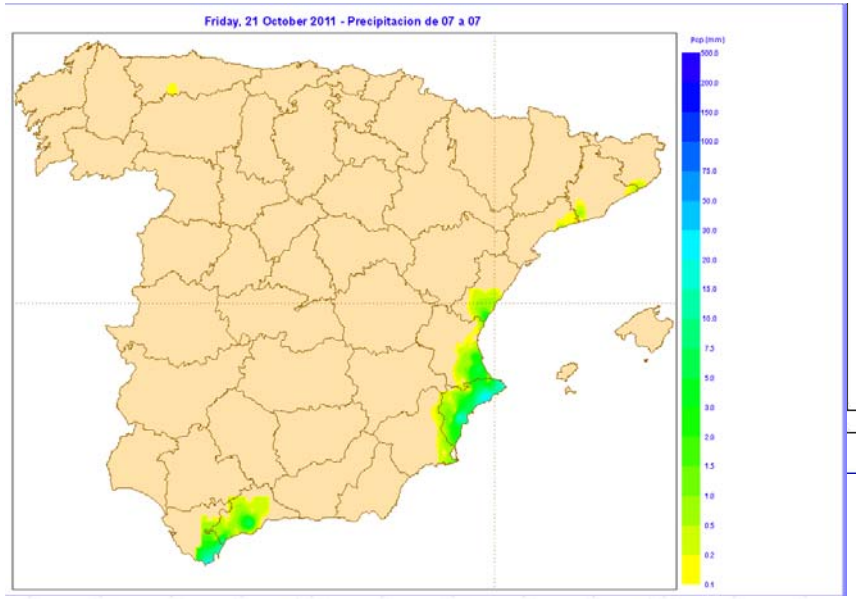
T2m: 5 ºC colder

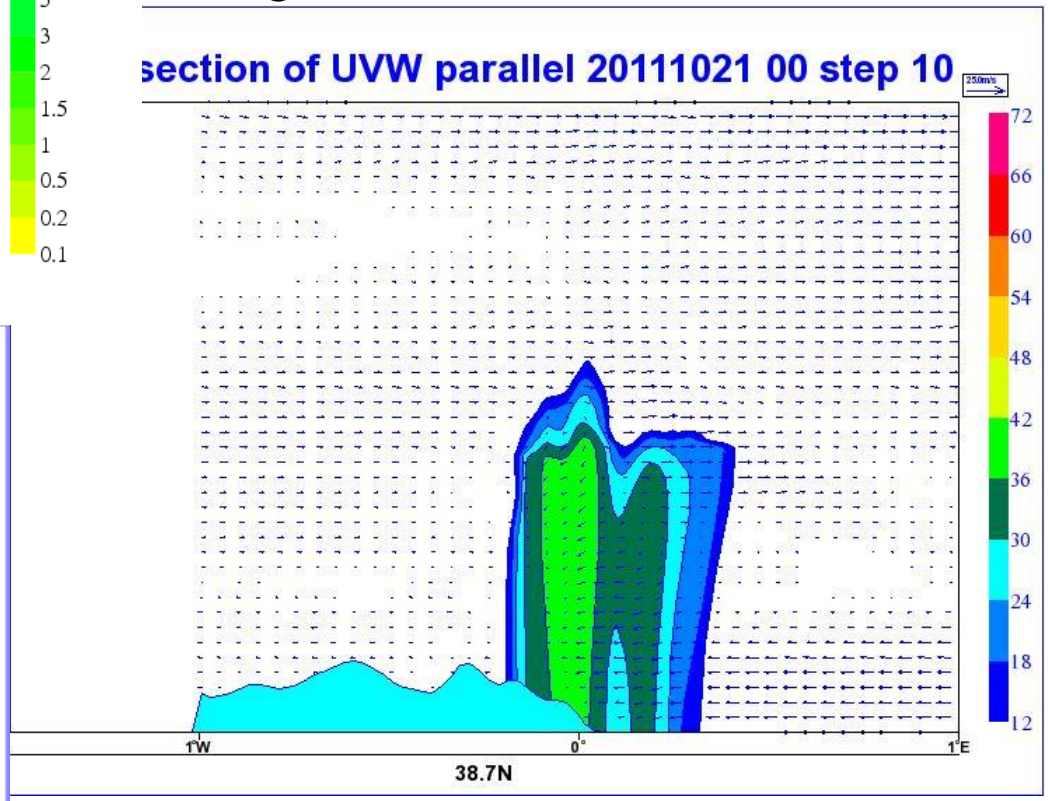


Small large scale forcing Convergence line along the coast

But also significant precipitation amounts in land. Not easy to get it right







Sensitive to the initial conditions

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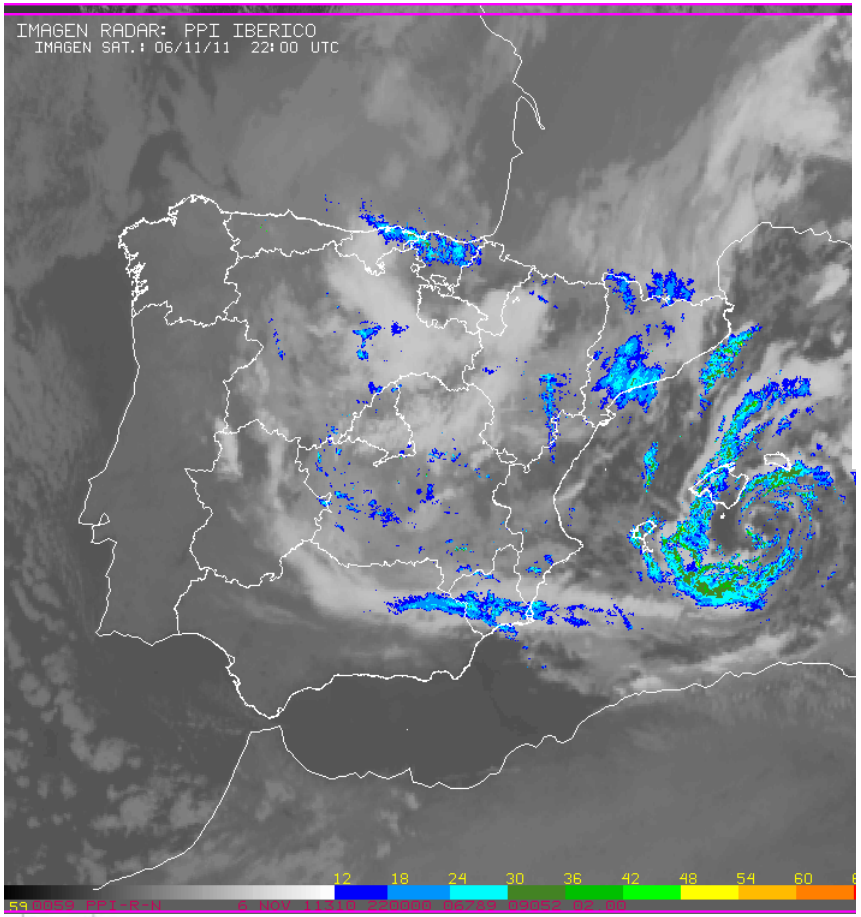
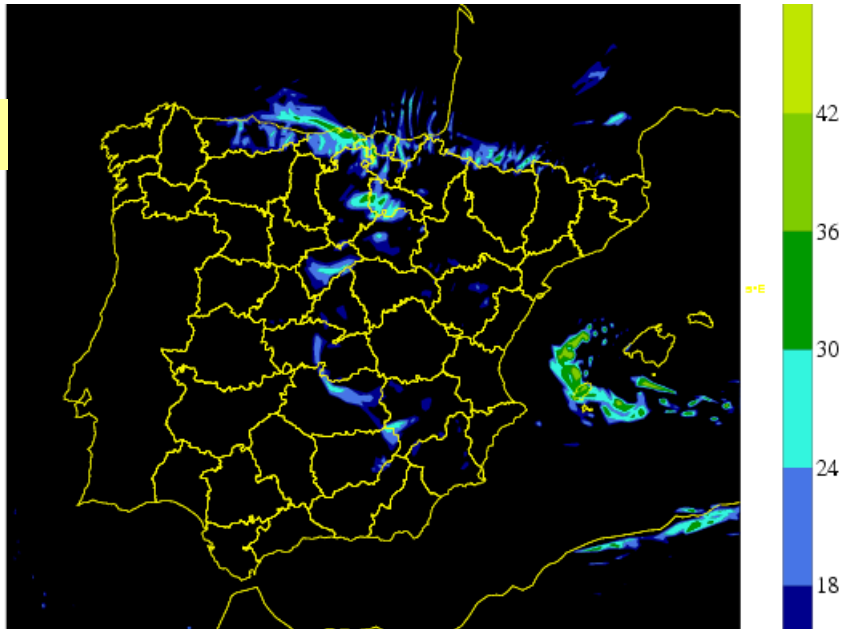
Including a parameterization of deep convection (Kain-Fritsch-Bechtold)

A Mediterranean cyclone

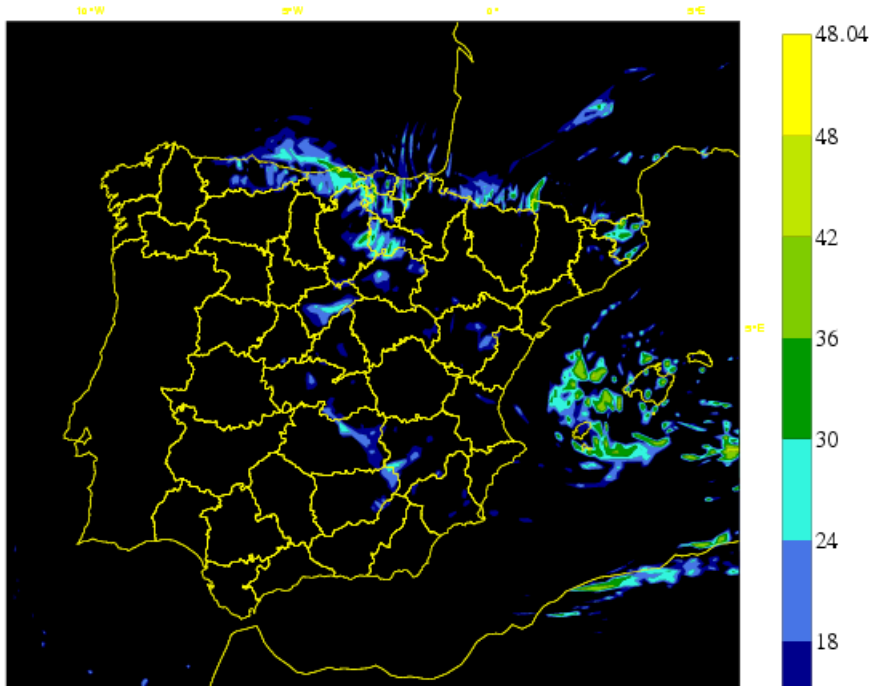
Incl. parameterized convection



KFB+EDMF

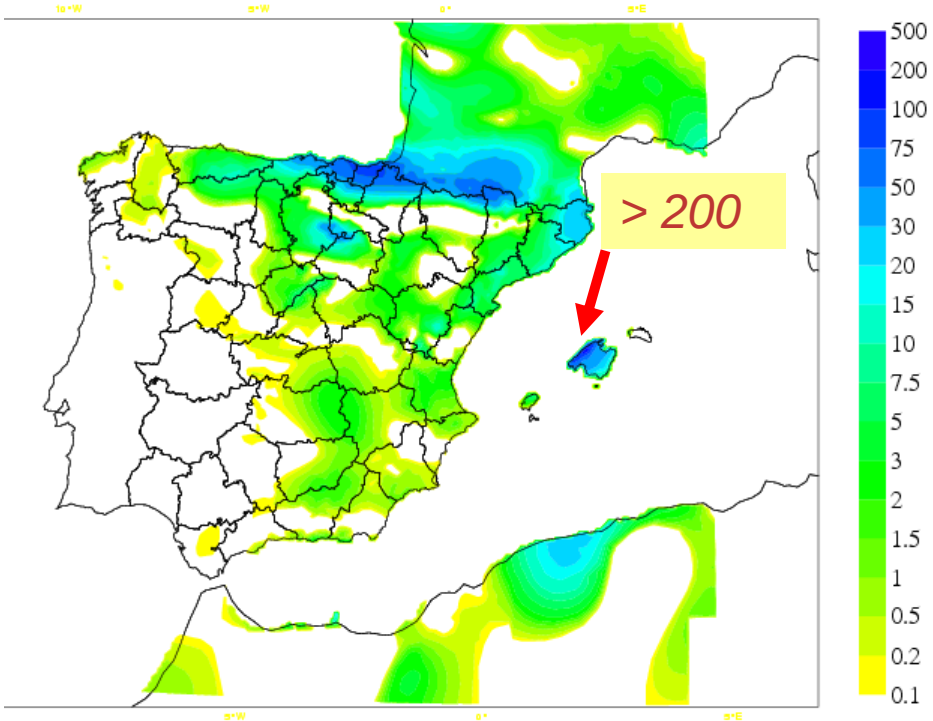


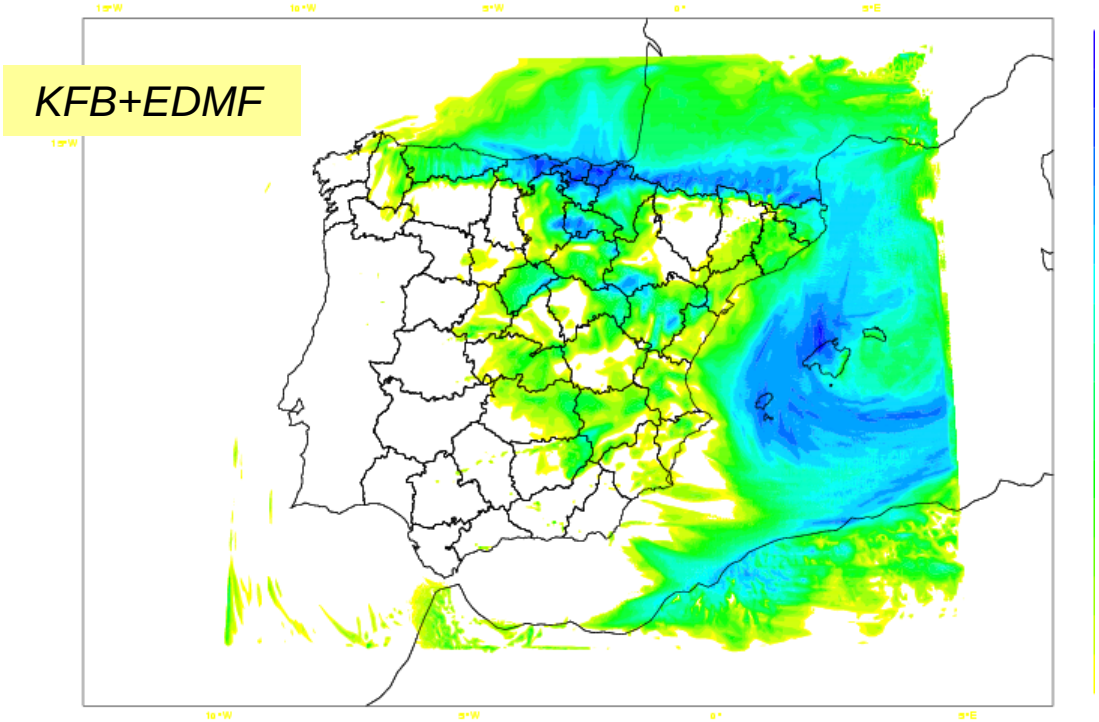
HARM Reflectividad 300m (dBZ)
06/11/2011 06z HARM H+ 16 Valid: 06/11/2011 22z

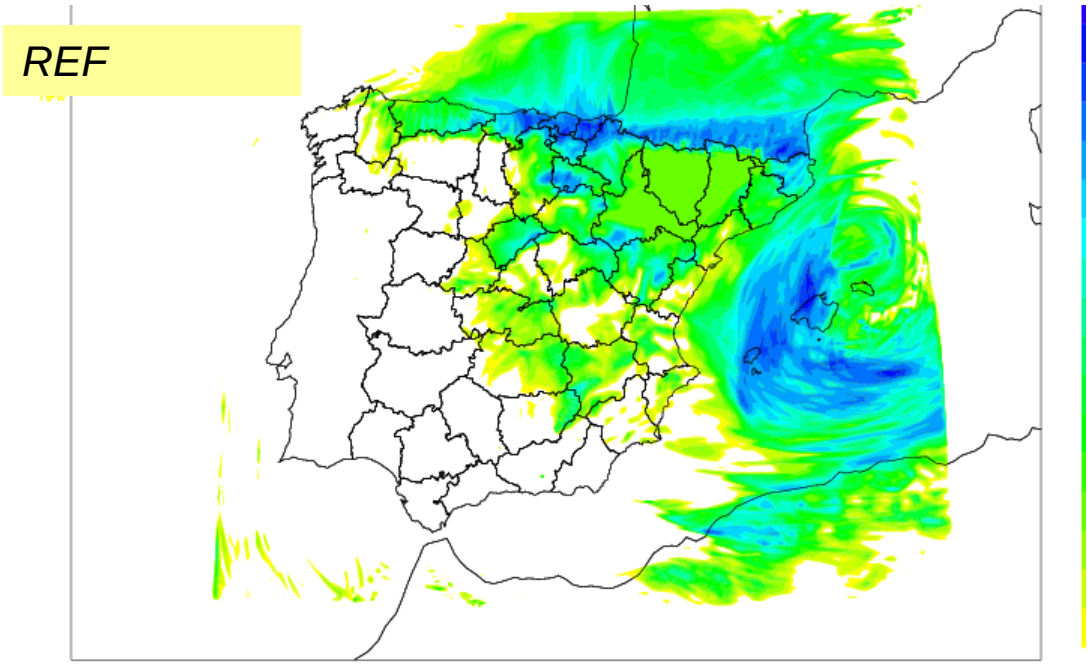


Including parameterized convection

ANpp Analisis precipitacion acumulada (mm/24h)
07/11/2011 06z HARM H+ 00 Valid: 07/11/2011 06z







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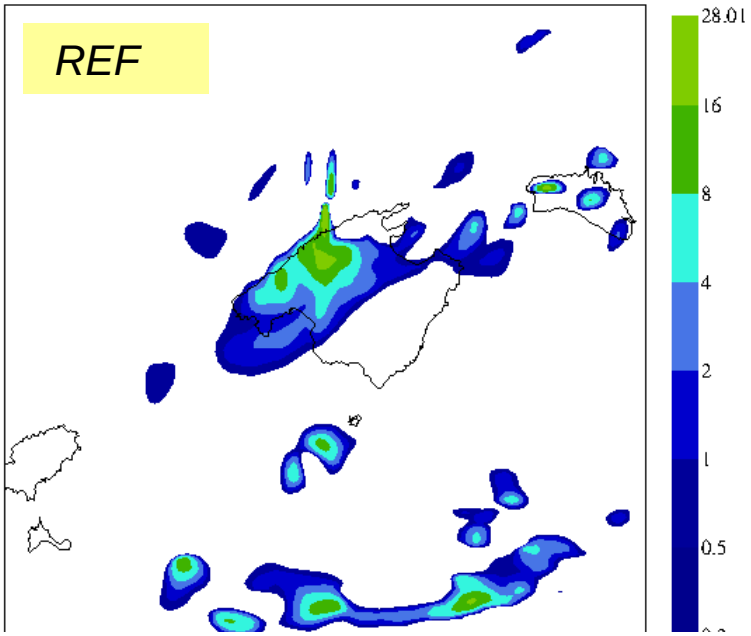
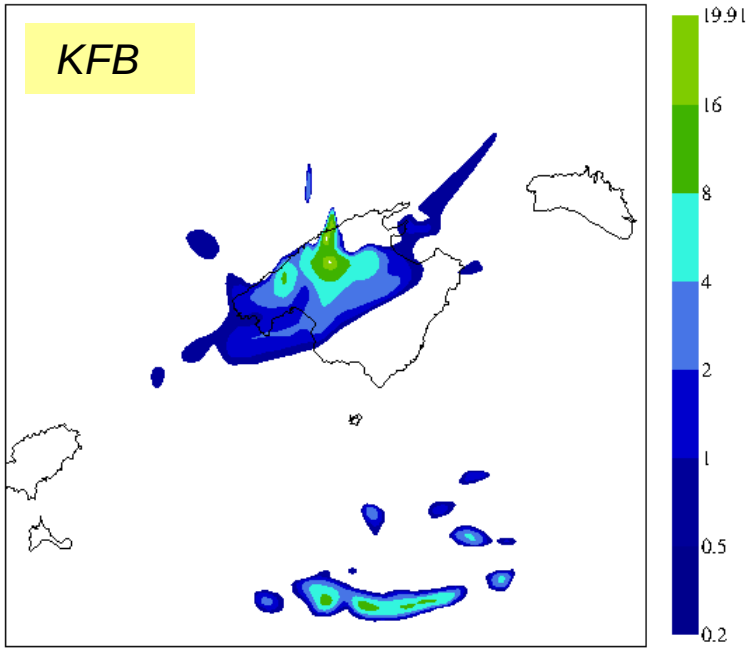
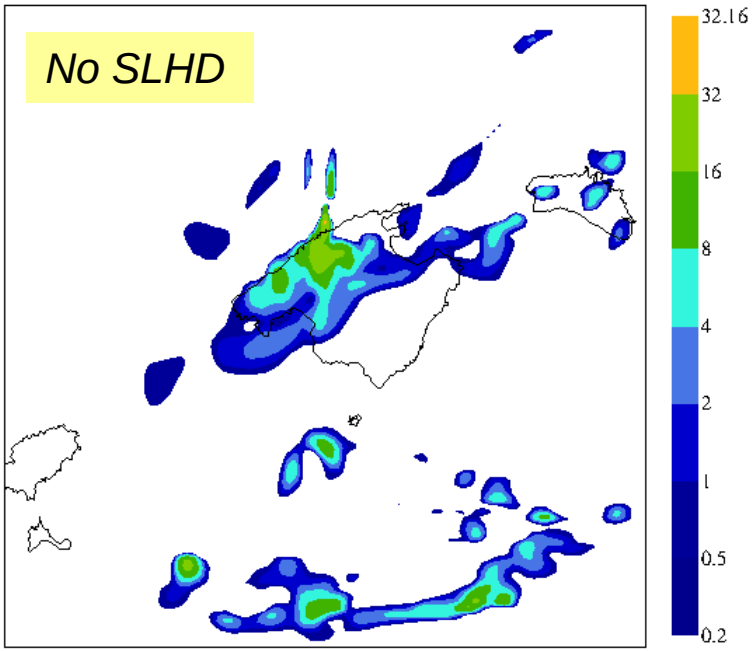
Including a parameterization of deep convection
+
Enable/Disable Semi Lagrangian Horizontal Diffusion

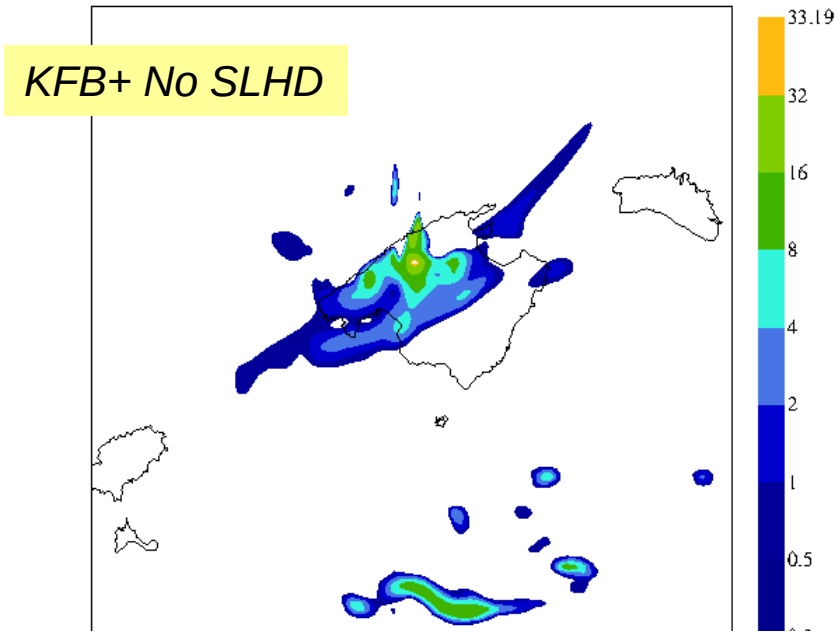


nosl Acc. rain (mm/1hr)
06/11/2011 06z HARM H+ 06 Valid: 06/11/2011 12z



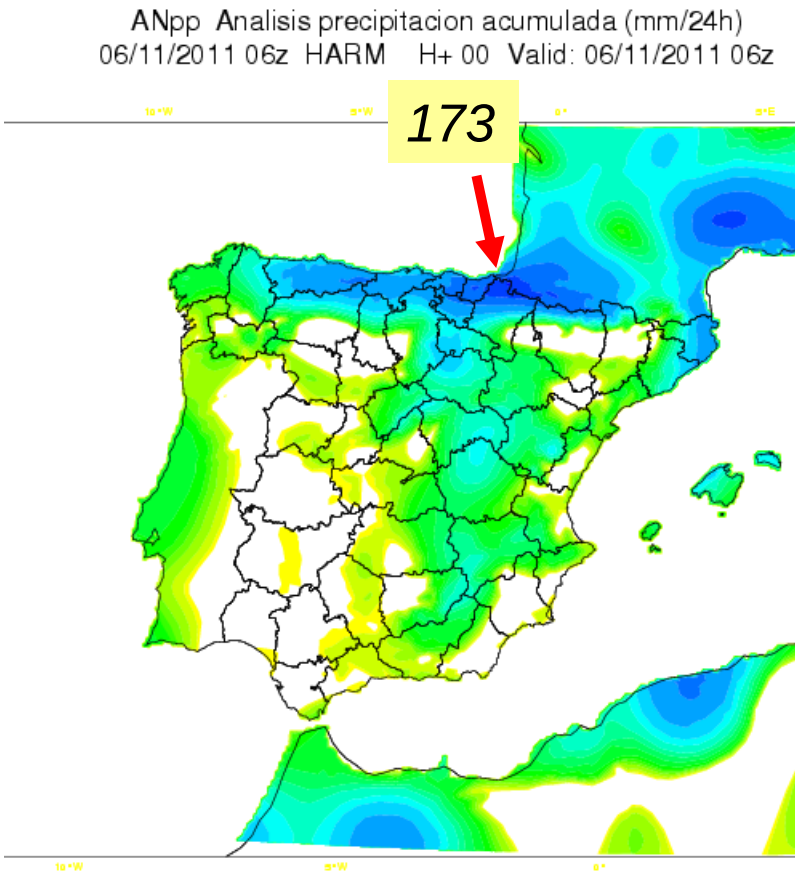
KFBn Acc. rain (mm/1hr)
06/11/2011 06z HARM H+ 06 Valid: 06/11/2011 12z

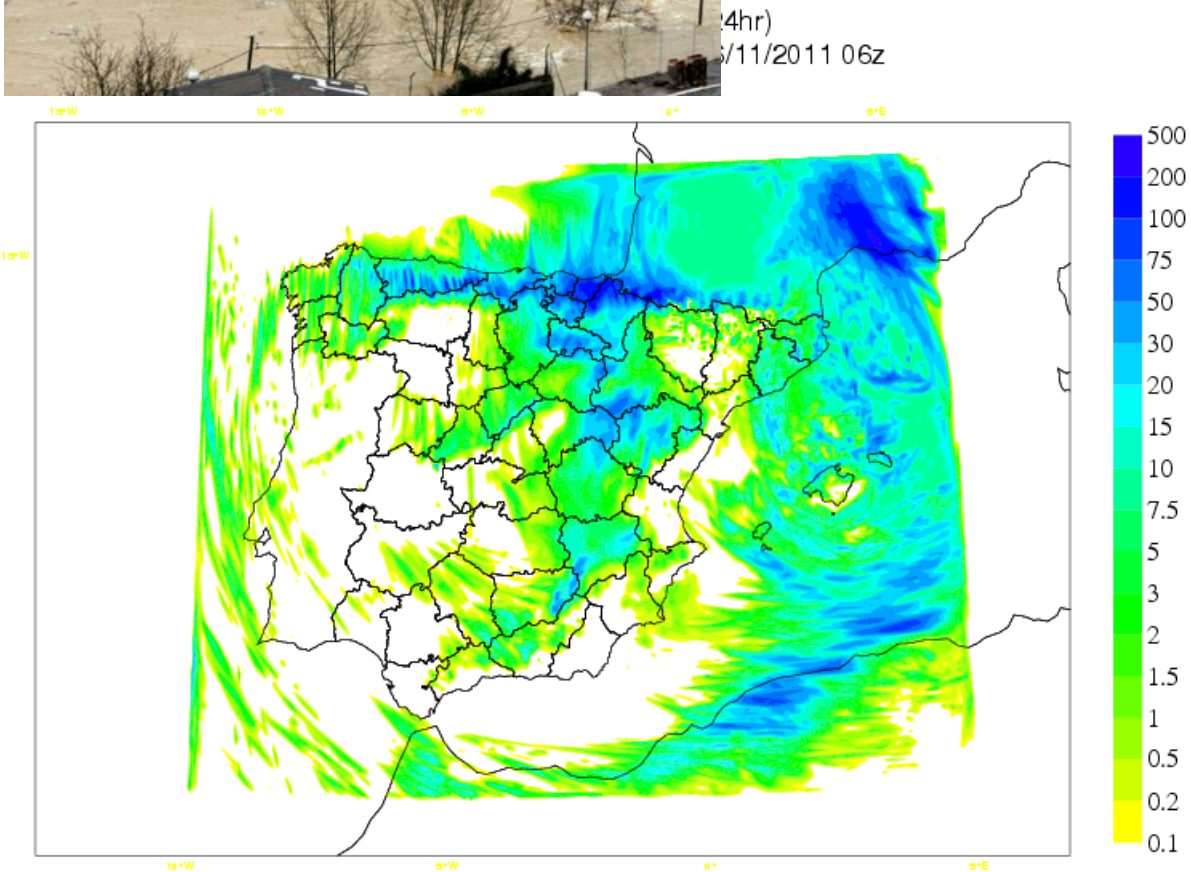




Autumn 2011: 24-hr acc. precipitation

*

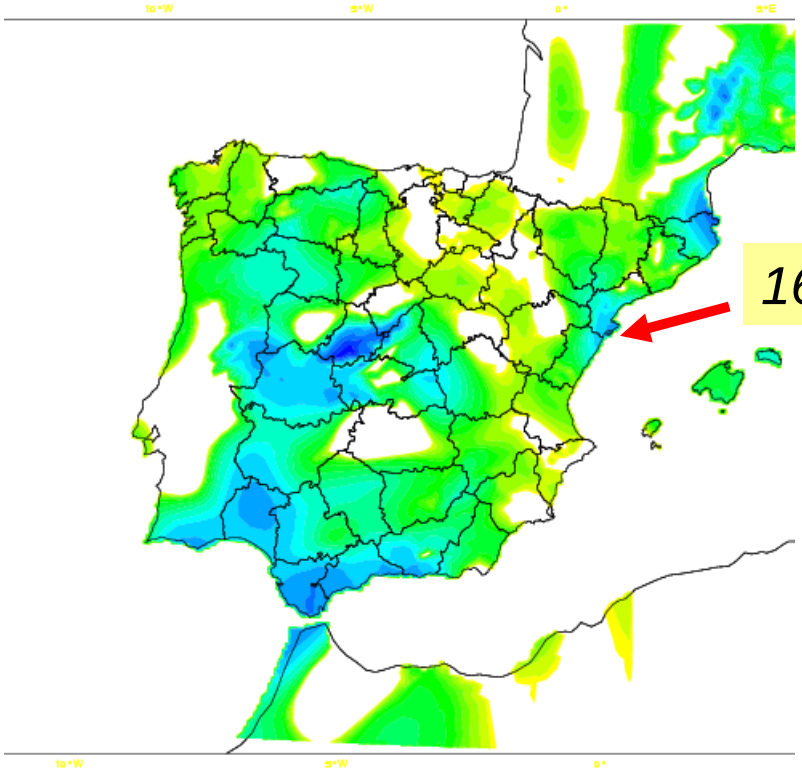




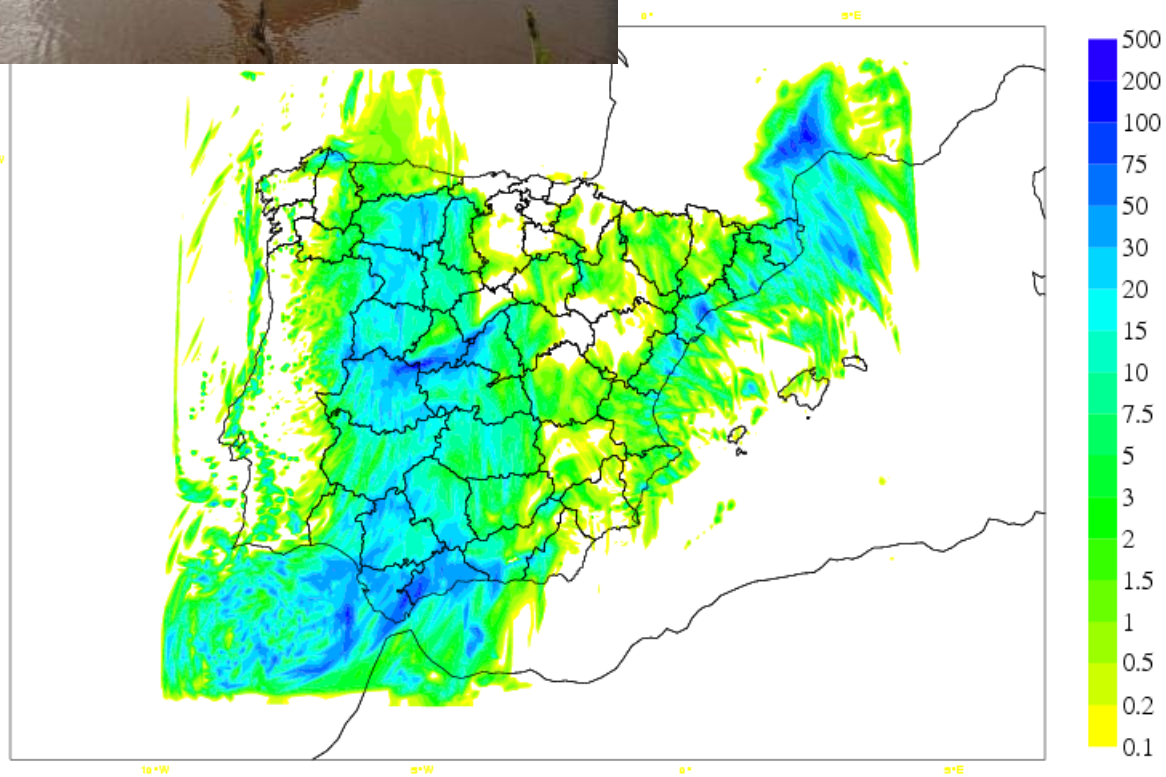
Observation analysis

Forecast

ANpp Analisis precipitacion acumulada (mm/24h)
20/11/2011 06z HARM H+ 00 Valid: 20/11/2011 06z

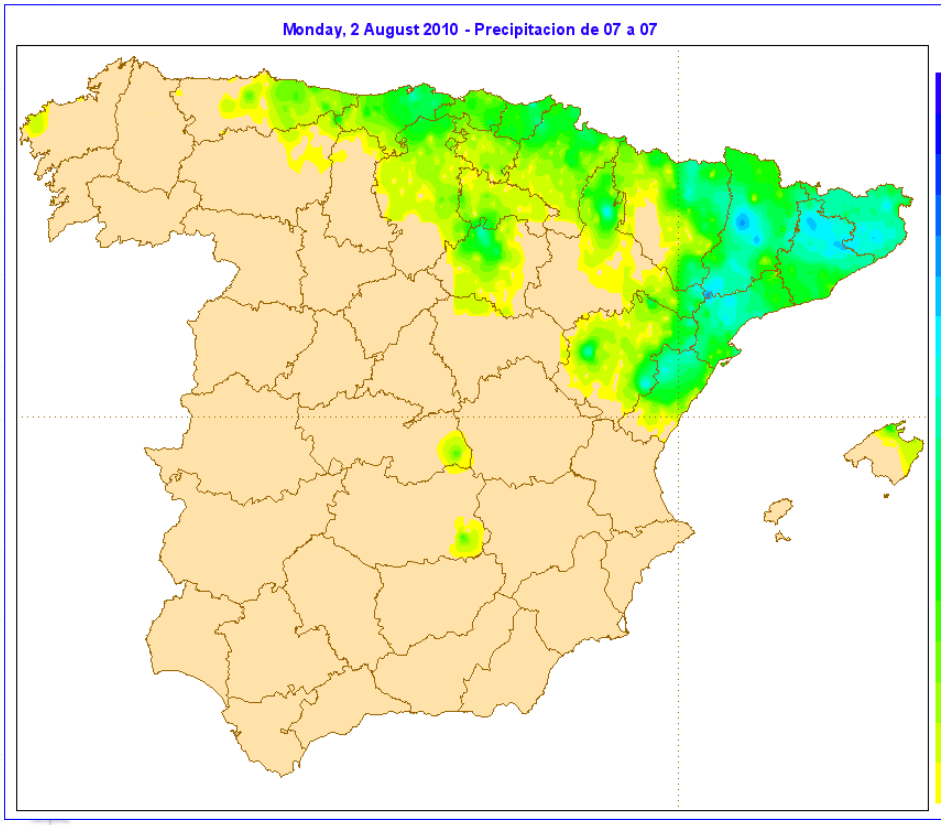


(mm/24hr)
alid: 20/11/2011 06z

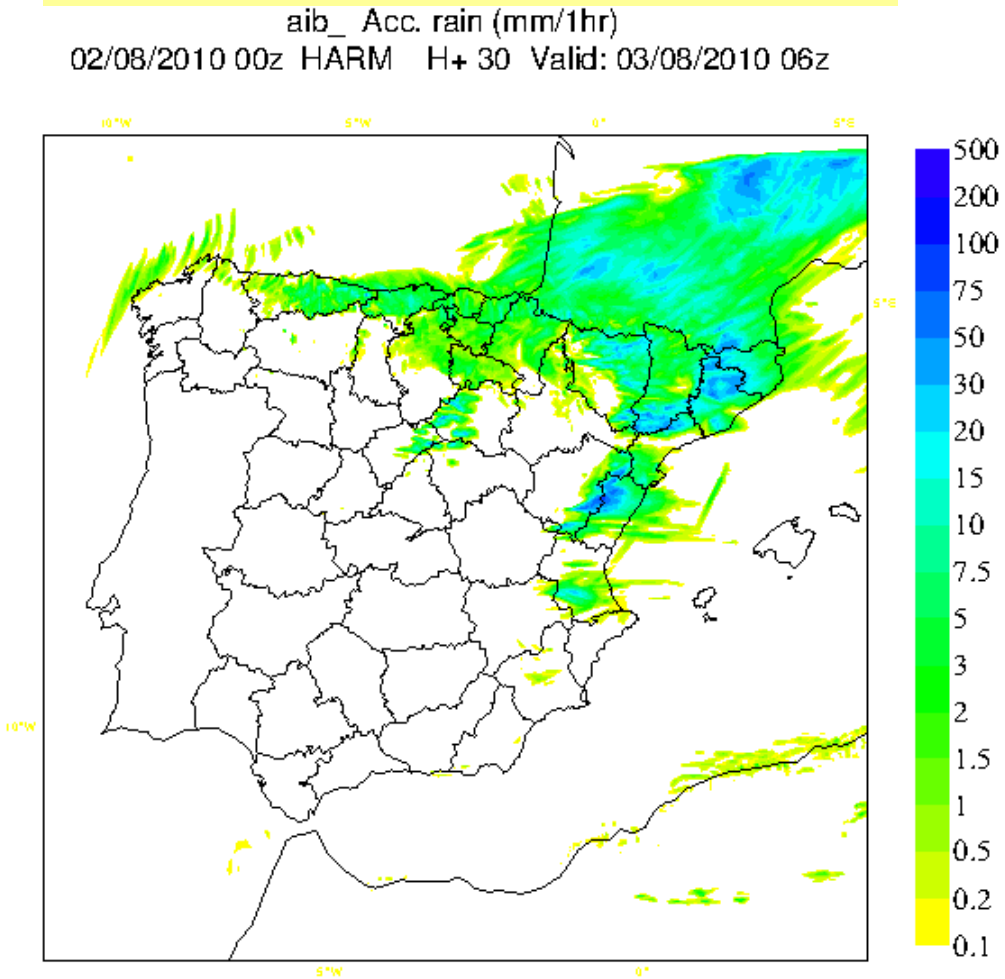


Summer convection (weaker forcing)

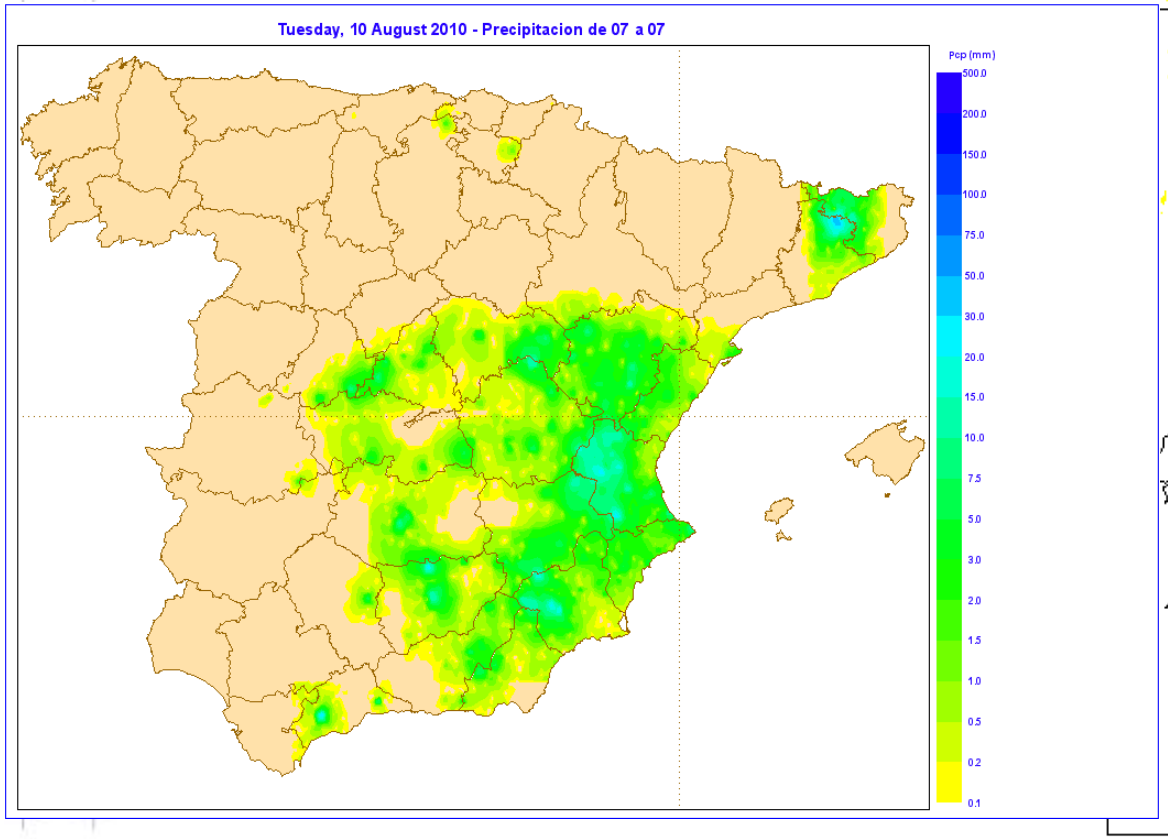
Observation analysis



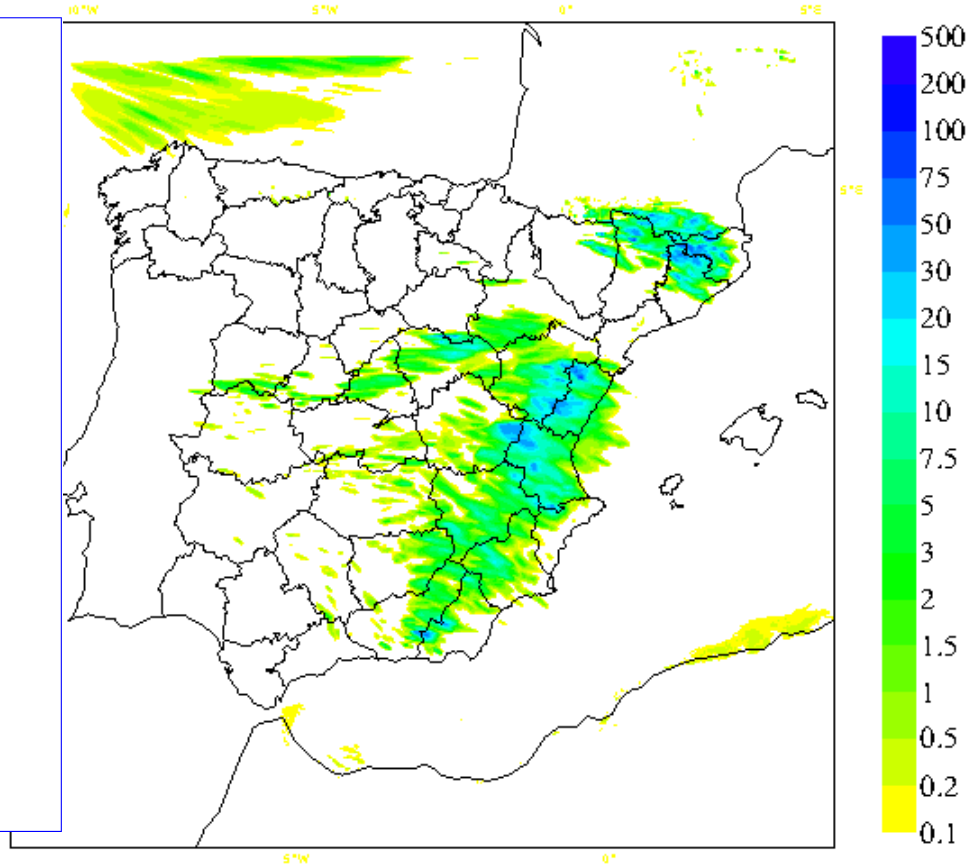
Forecast



Summer convection



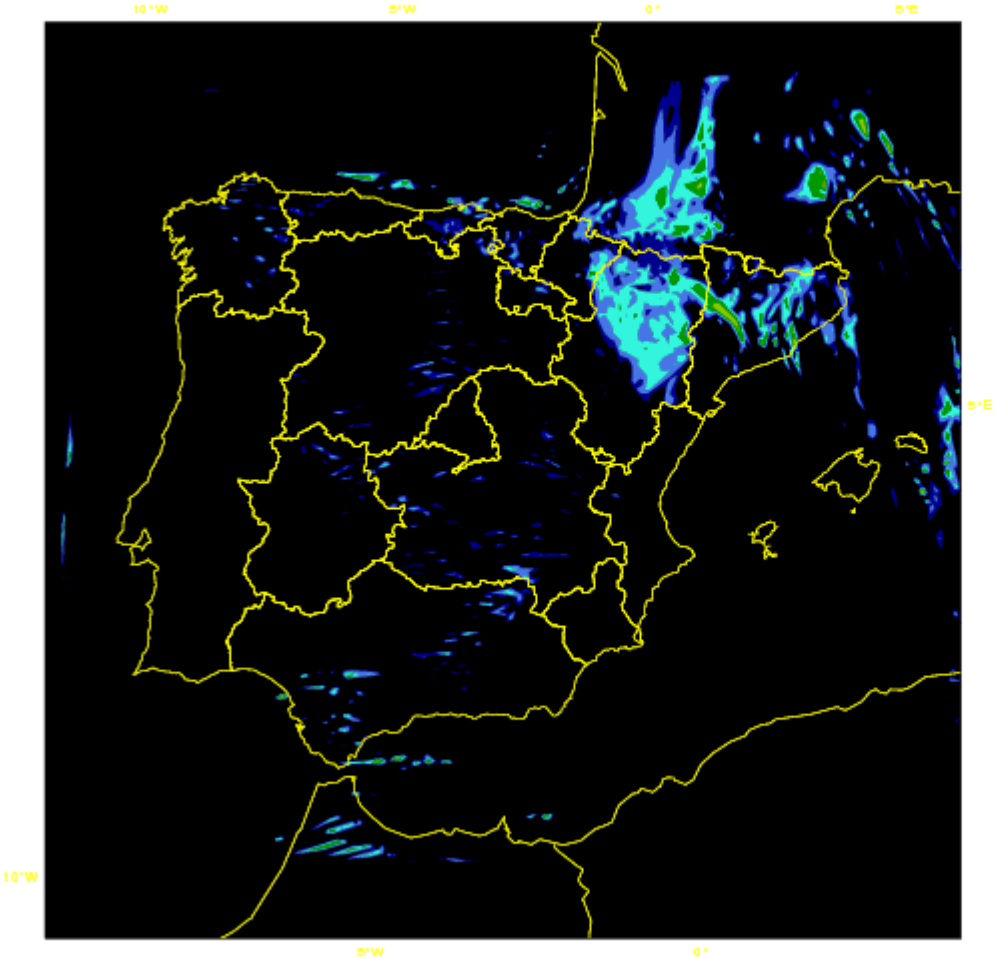
aib_ Acc. rain (mm/1hr)
10/08/2010 00z HARM H+ 30 Valid: 11/08/2010 06z

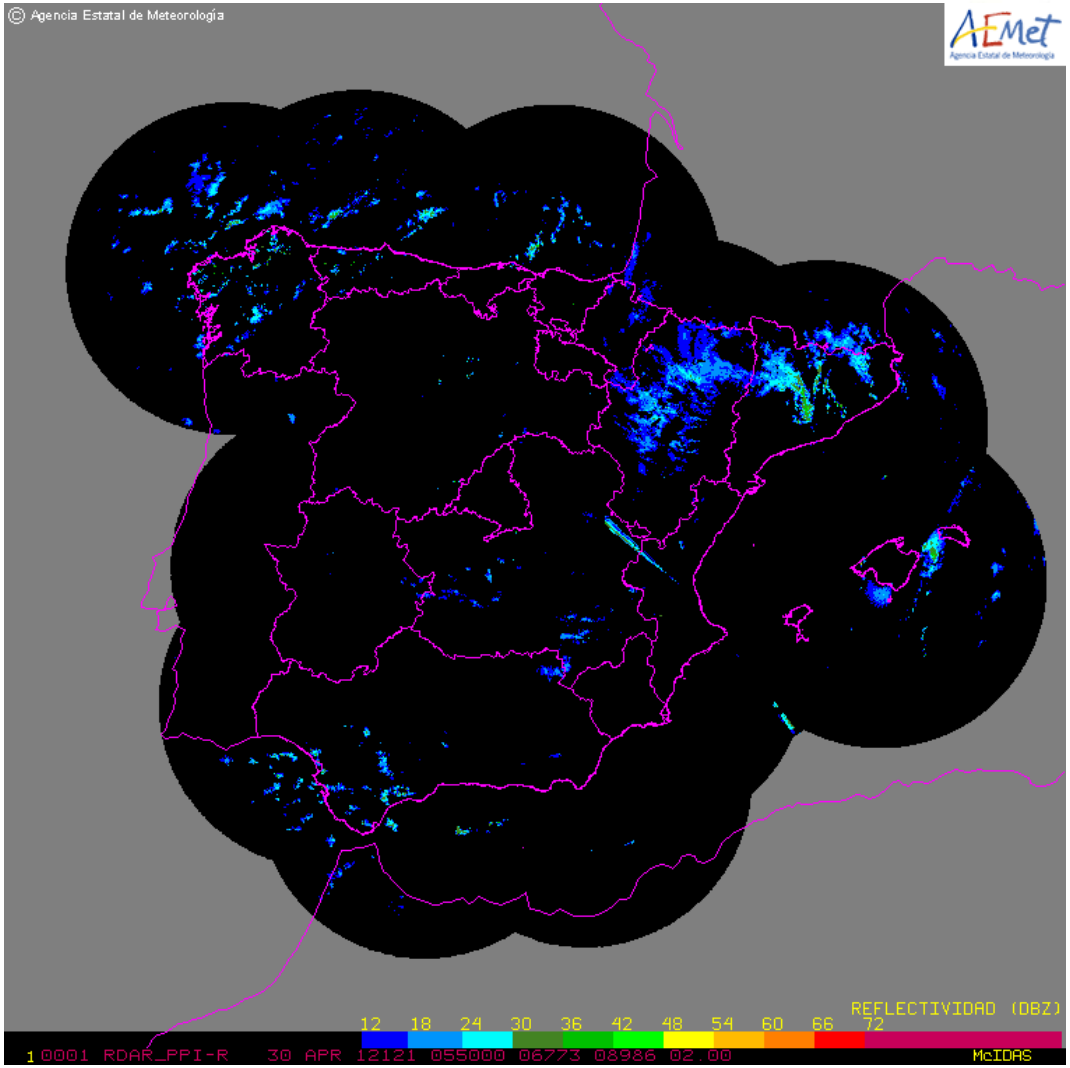


Diurnal cycle of convection: 06 UTC

- Not very deep convection develops within a cold air mass showing a clear diurnal cycle

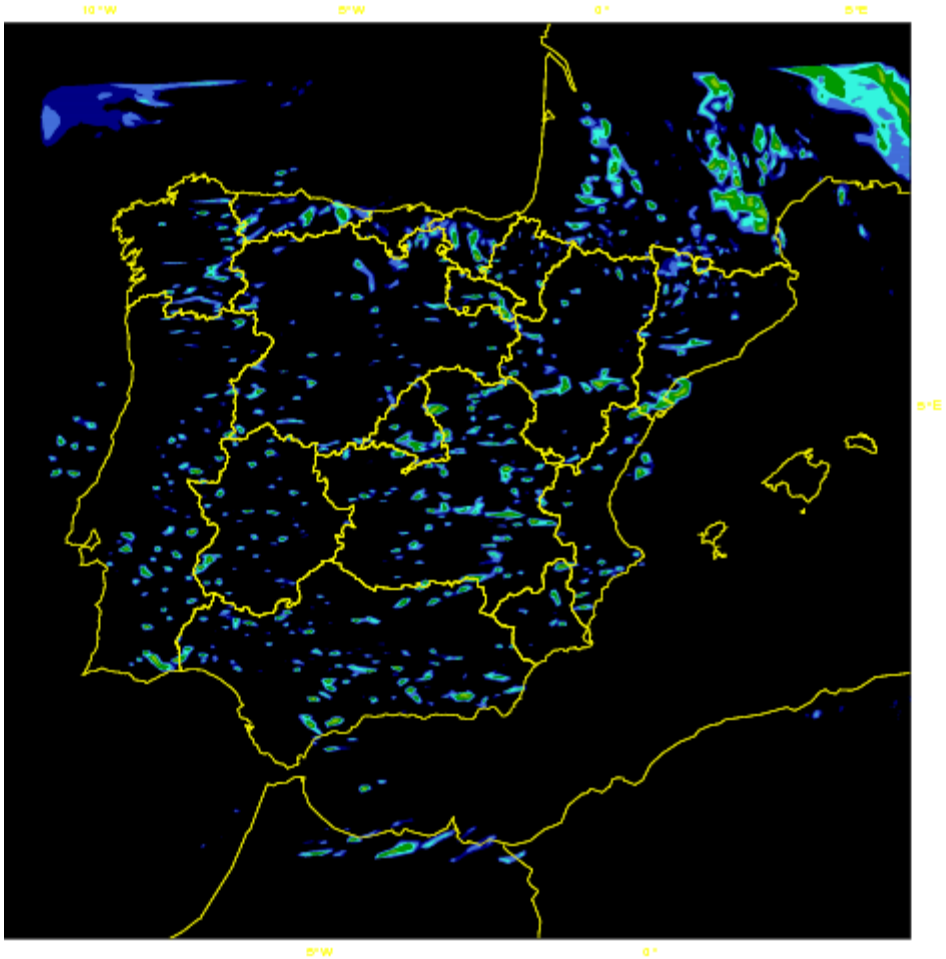
HARM Reflectividad 300m (dBZ)
30/04/2012 00z HARM H+ 06 Valid: 30/04/2012 06z

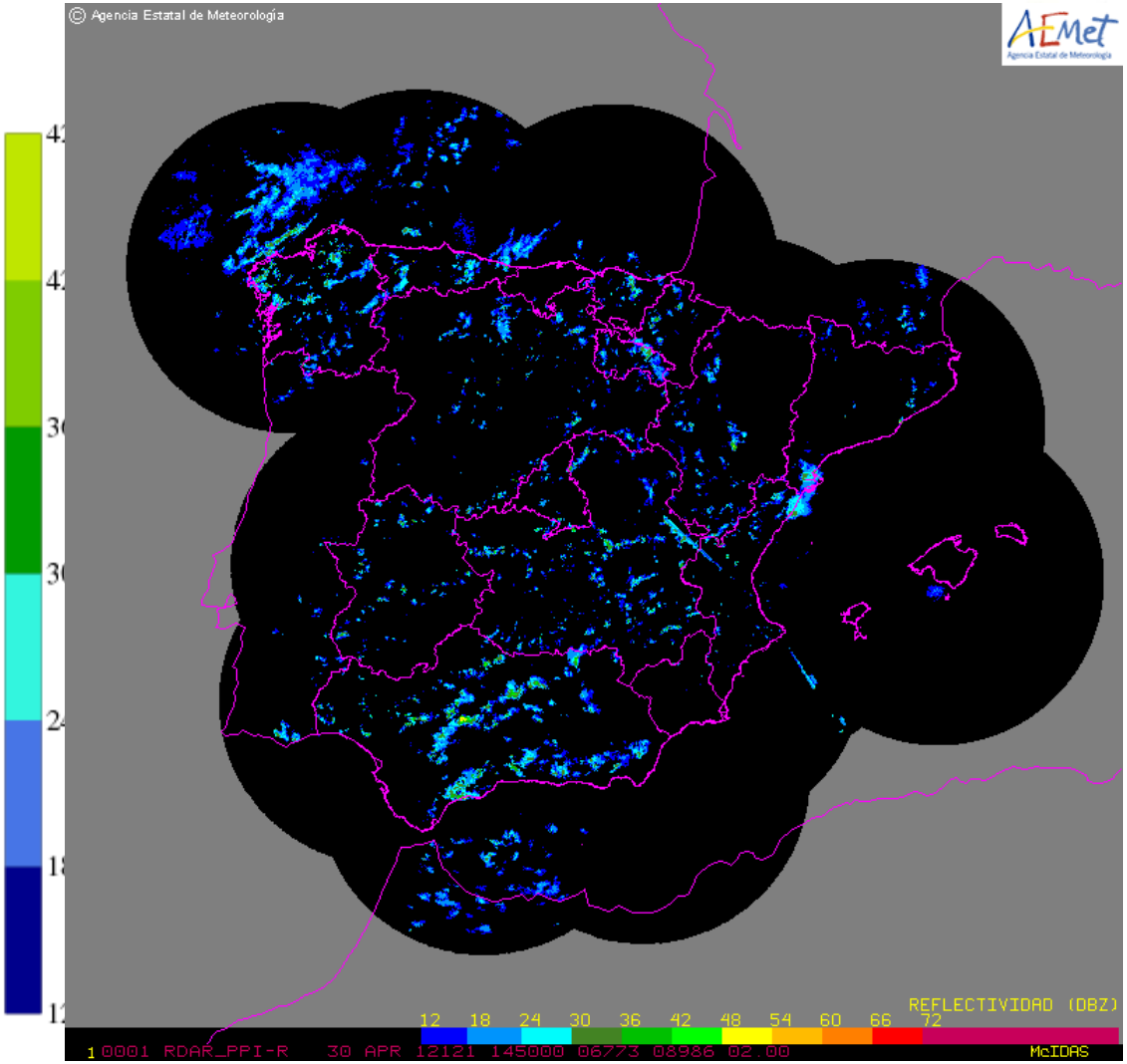




Diurnal cycle of convection: 15 UTC

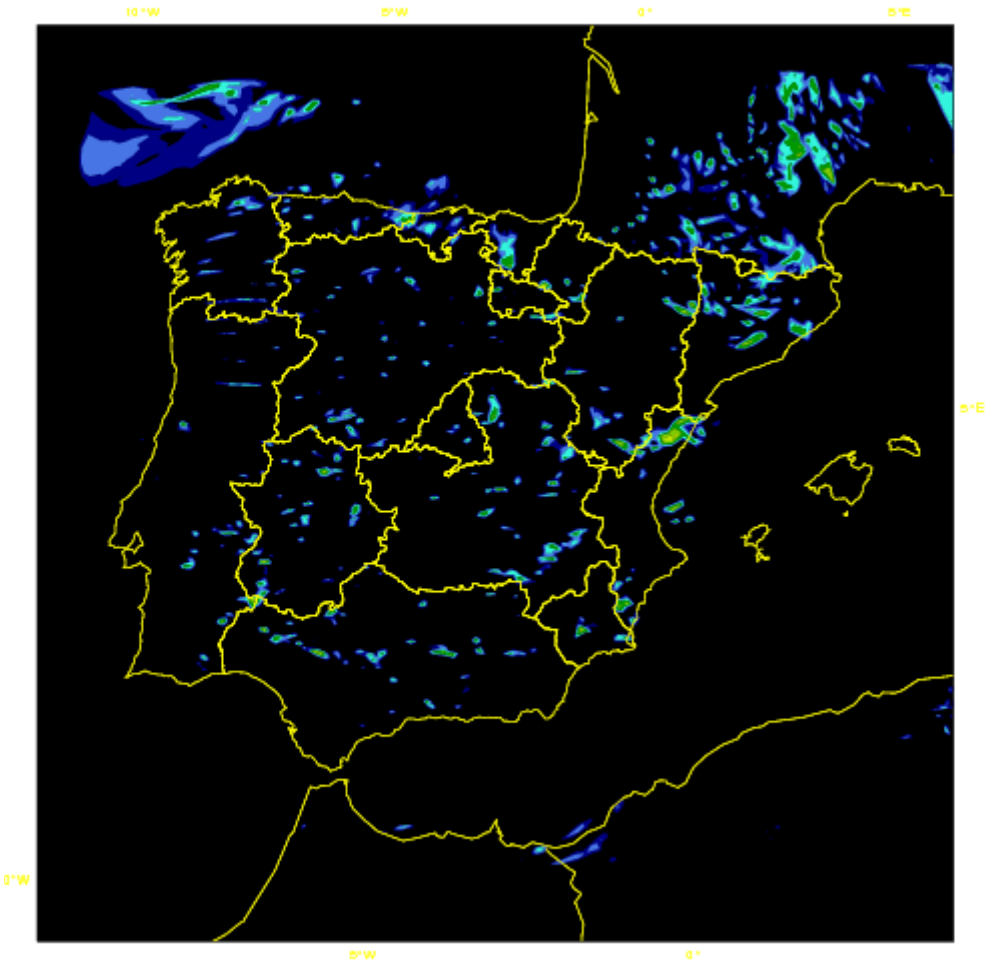
HARM Reflectividad 300m (dBZ)
30/04/2012 00z HARM H+ 15 Valid: 30/04/2012 15z

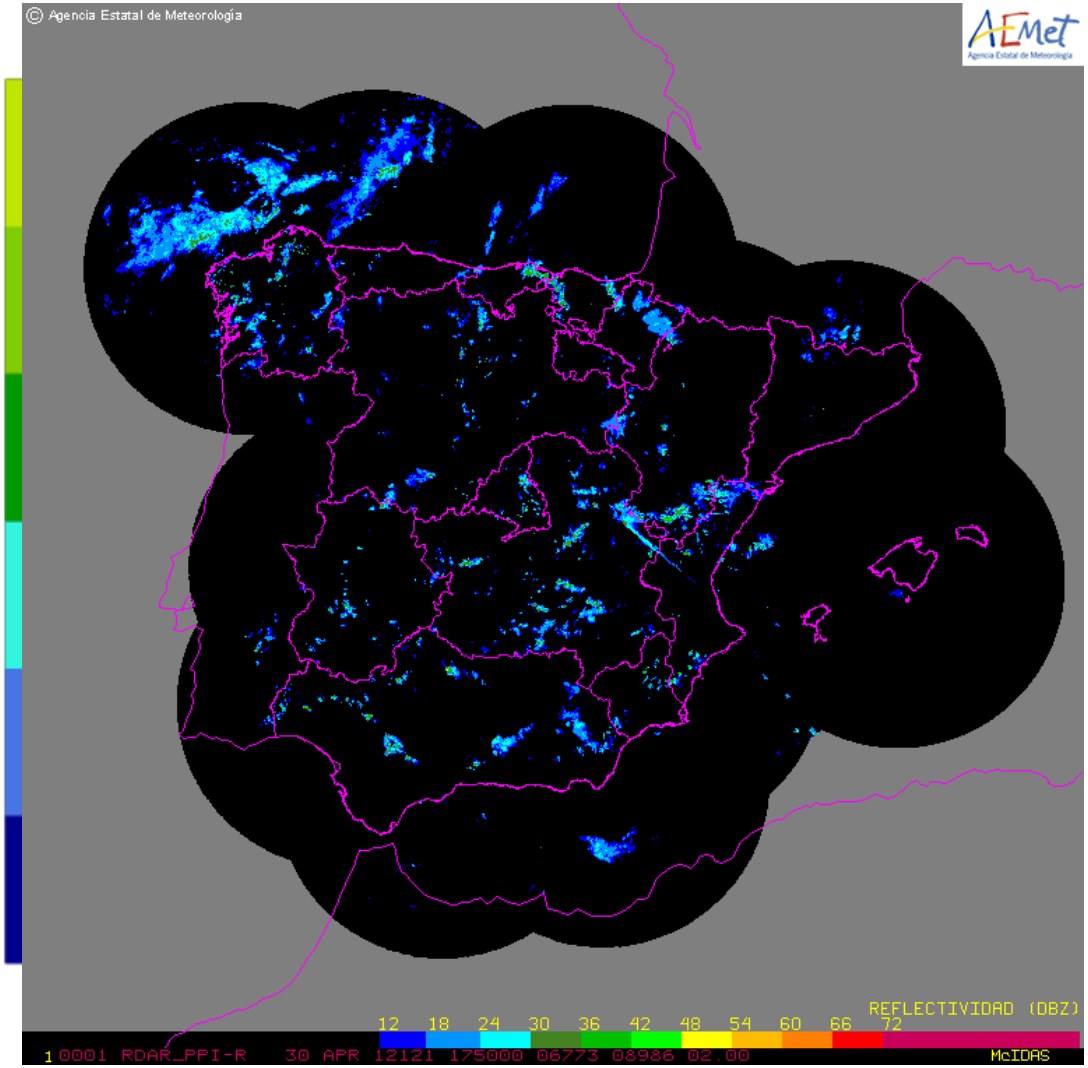




Diurnal cycle of convection: 18 UTC

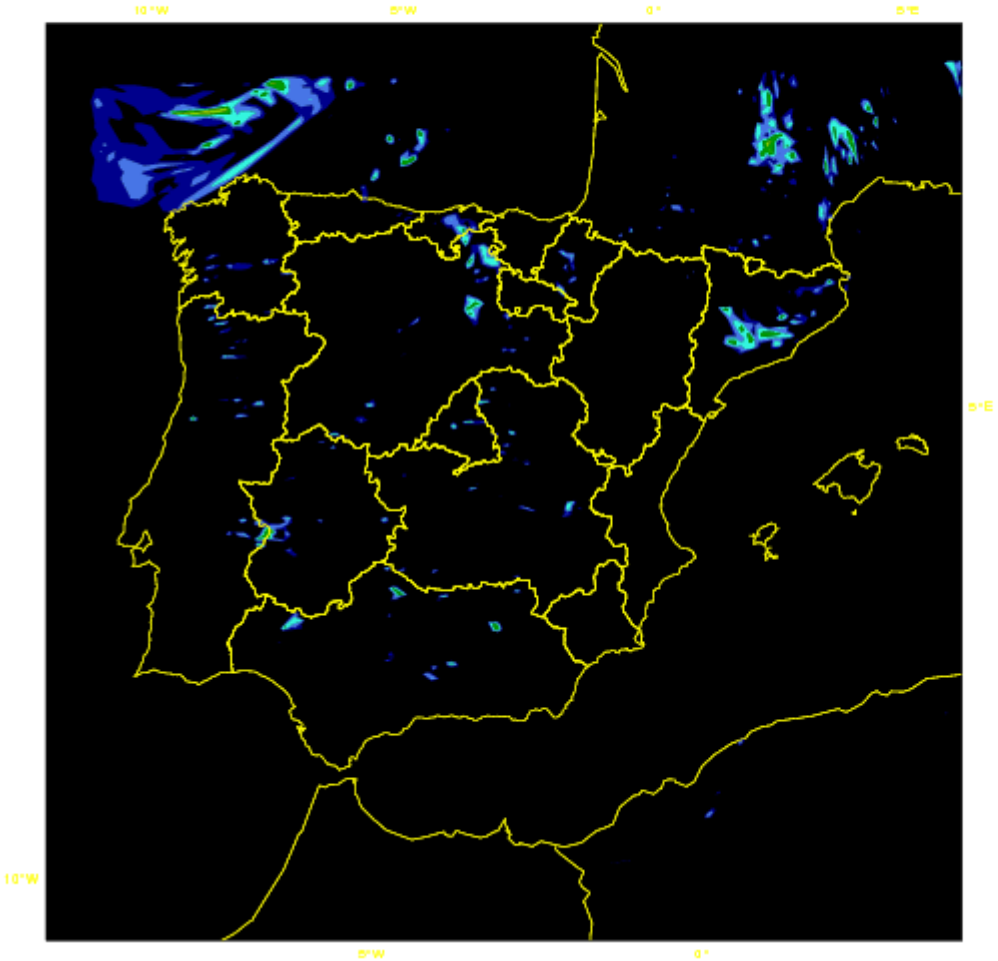
HARM Reflectividad 300m (dBZ)
30/04/2012 00z HARM H+ 18 Valid: 30/04/2012 18z

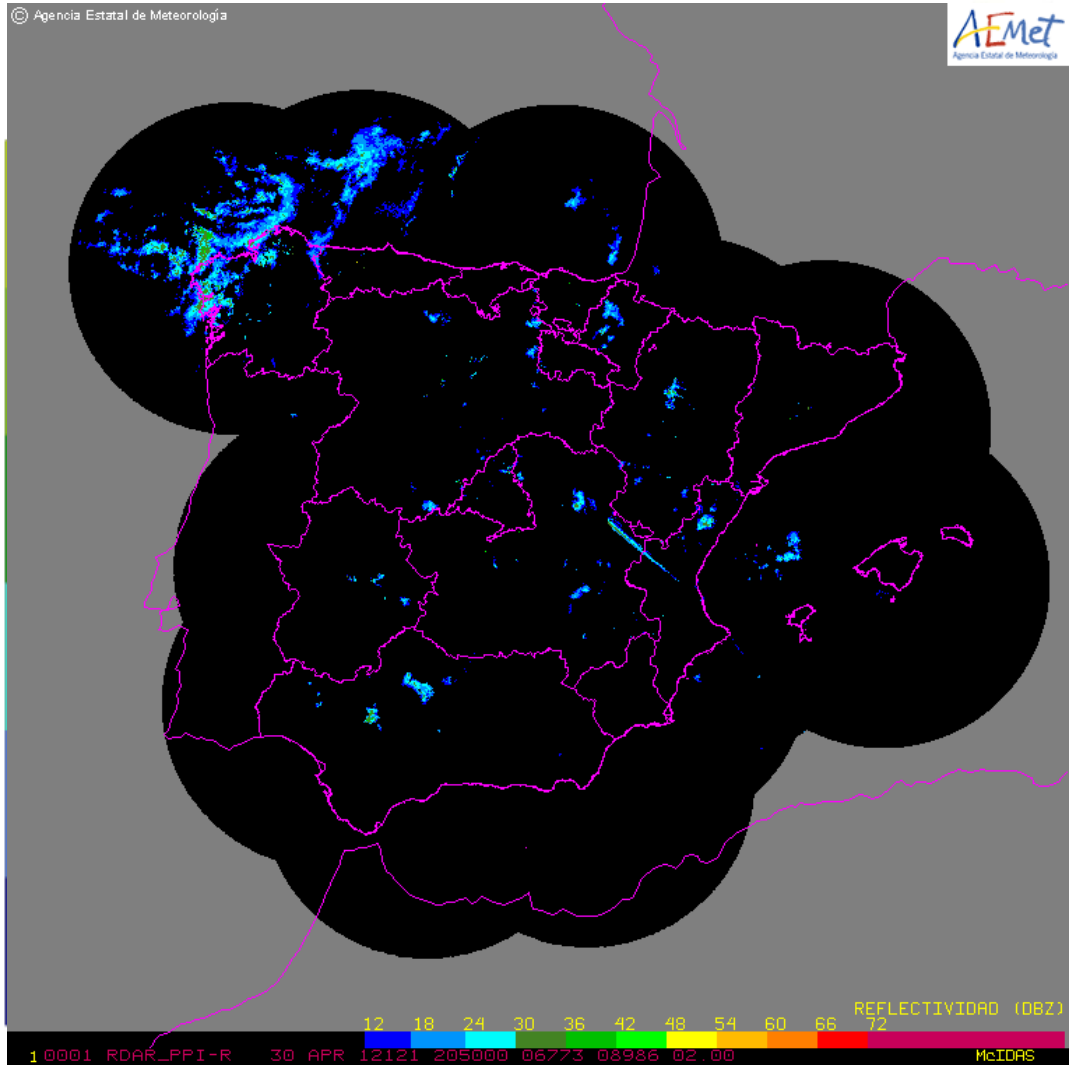




Diurnal cycle of convection: 21 UTC

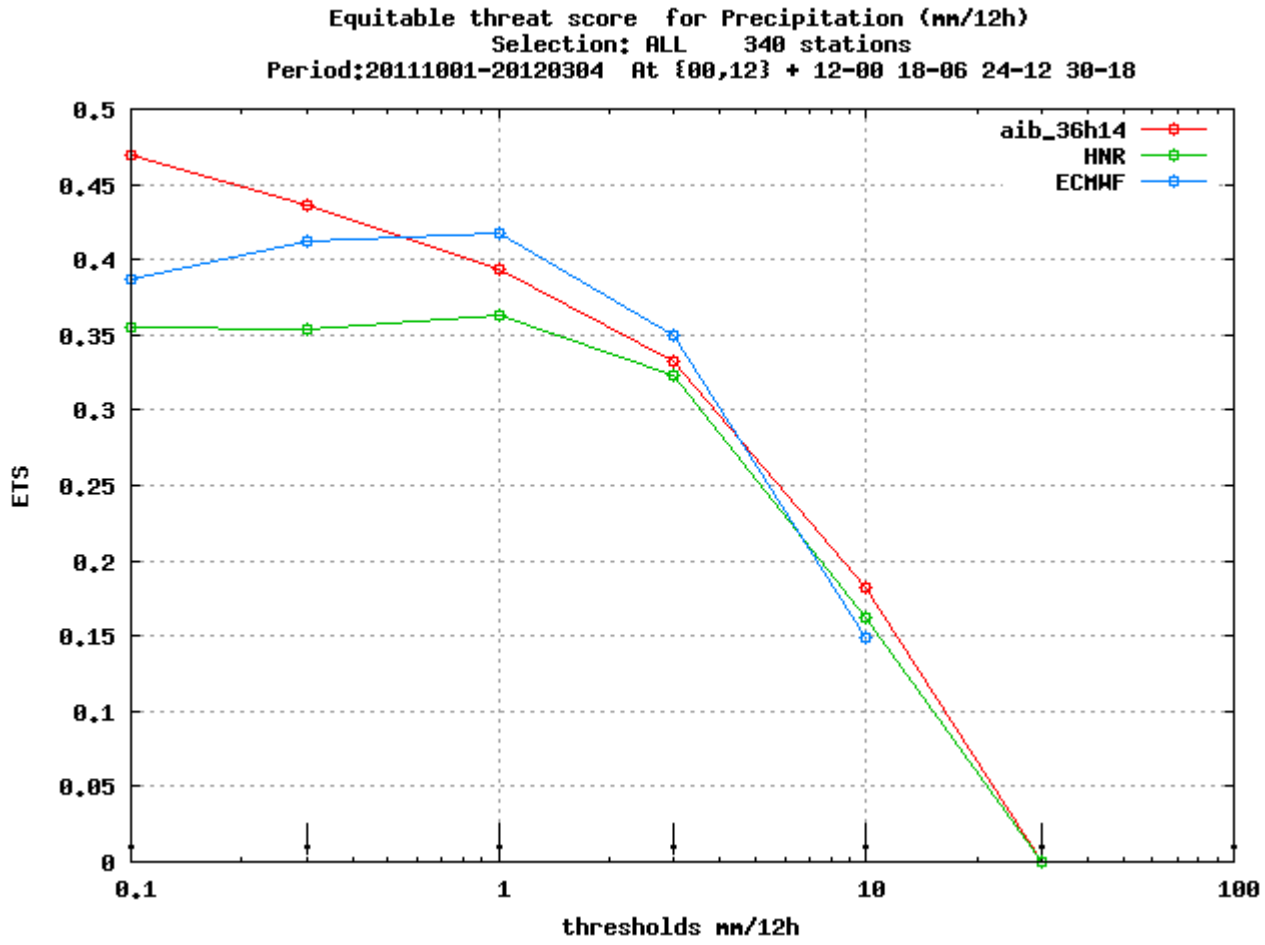
HARM Reflectividad 300m (dBZ)
30/04/2012 00z HARM H+ 21 Valid: 30/04/2012 21z





Verification of precipitation: Equitable Threat Score

5 months. Point verification



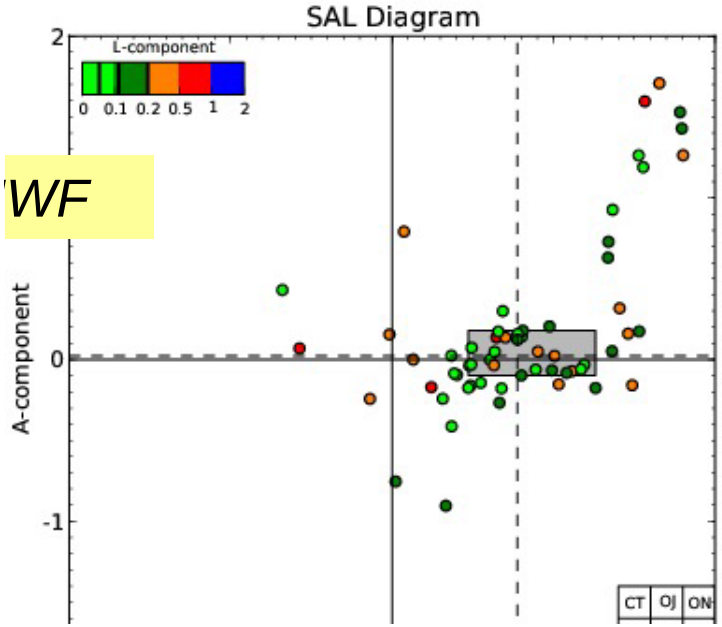
Feauture-Based verification: SAL

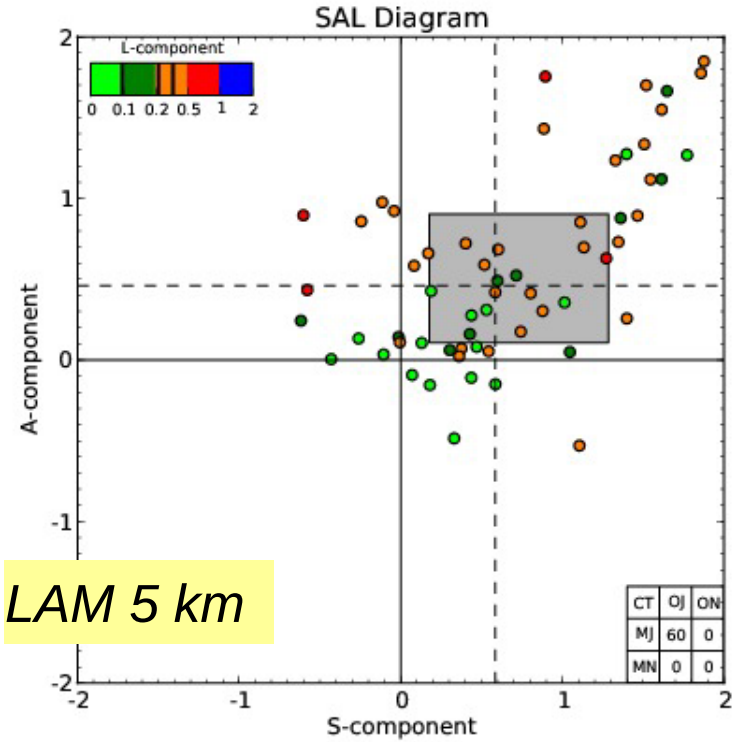
Courtesy of Carlos Santos

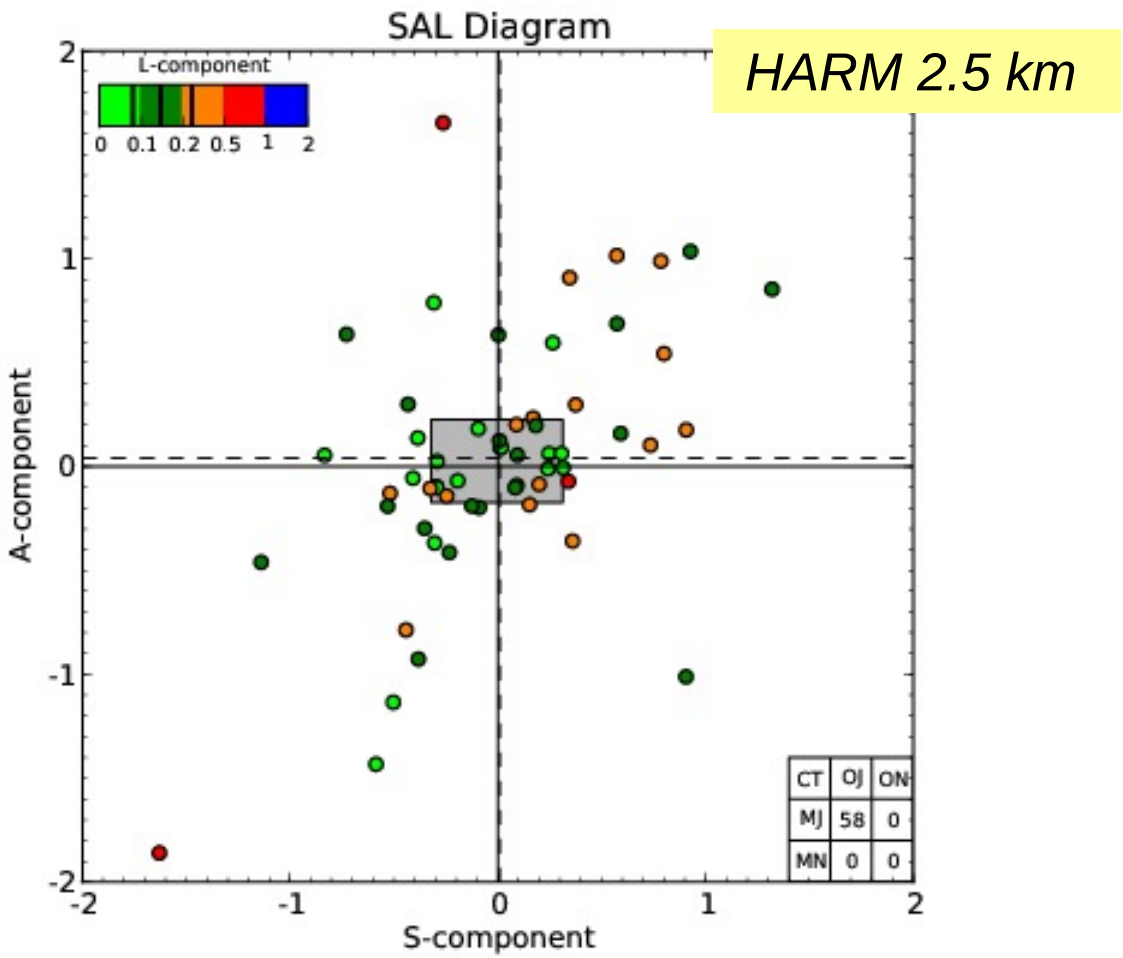
- Define objects based on a threshold
- Use observations up-scaled to model grid (network of 3000 stations over Iberian Peninsula)
- Try to quantify
  - Structure errors
  - Location errors
  - Amplitude errors

- Allows to compare models of different resolutions without double-penalty problems

S:	Structure	-2 … objects too small or too peaked	0 … Perfect	+2 objects too large or too flat
A:	Amplitude	-2 … averaged QPF under-estimated	0 … Perfect	+2 averaged QPF over-estimated
L:	Location		0 … Perfect	+2 wrong location of Total Center of Mass (TCM) and / or of objects relative to TCM







- S ≈0 Very good structures
- A ≈0 Very small and positive bias
- L Good location

Conclusions

- Harmonie with AROME physics is run 4 times a day at AEMET at 2.5 km
- Quite good performance adding value to other models of lower resolution (HIRLAM and ECMWF)
- Including a parameterization of convection smoothes the fields but with little added value although the parameterization used wasn't designed for this resolutions
- A slight diffusion, SLHD, is applied to hydrometeors that smoothes a little precipitation field.
- Large and mesoscale scale patterns are very well represented but the model is not able to represent local scale (space and time) as super cells.
- Predictability problems are very important at these resolutions. Generally updates of the initial state improve the forecast
  - RUC approach and increasing the number of observations
  - Some cases are more predictable than others but in general it is important to have more than 1 forecast: Importance of EPS at convection-permiting scales.