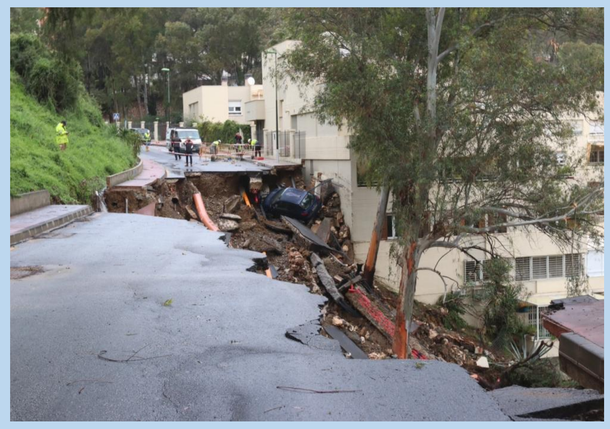
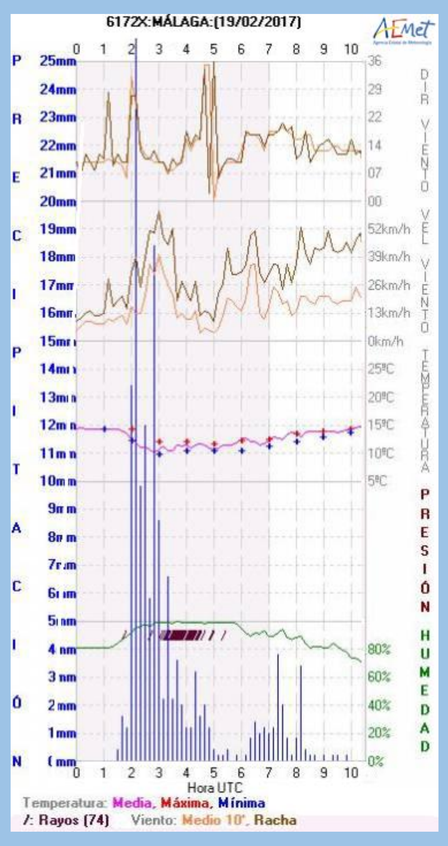
Stationary severe thunderstorms over Malaga on 19 February 2017

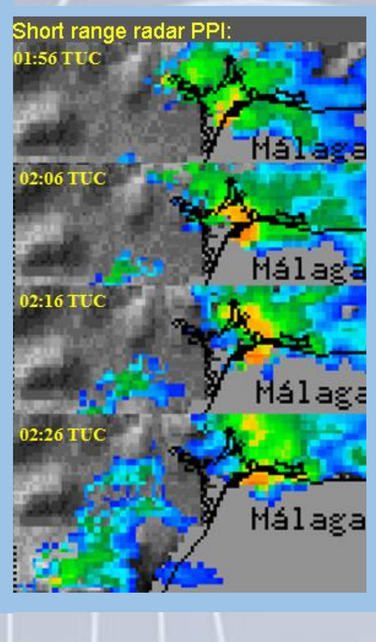
A. Roa, J. Rodríguez, X. Calbet, C. Marcos, M.A. Martínez, F. Polvorinos, J. Riesco, P. Rípodas
AEMET, Spain

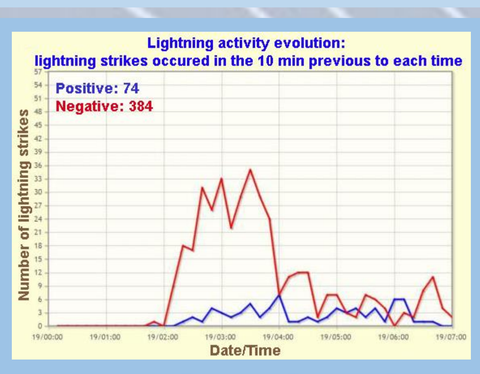
During the dawn of 19 February 2017, a set of intense thunderstorms occurred over south Spain. Malaga city was especially affected by these thunderstorms. Precipitation, that started at about 01:30 UTC (02:30 local time) and lasted around 8 hours, peaked just after 02:00 UTC. The horizontal distribution of precipitation was quite variable, showing some maxima over the center and eastern Malaga city.
This case study, that discusses the highly localized and stationary thunderstorms previously described, is tackled from both scales, synoptic and mesoscale, adding some issues at microscale. To carry out this task, deterministic outputs and convective diagnostic products of the ECMWF model, and remote sensing (radar, lightning and both basic and NWCSAF satellite products) and observation data products are used.



Main impacts:
Fortunately there were no casualties or seriously injured people. On the other hand, many losses and material damages were reported at the centre and eastern Malaga city:
- 203 incidents were managed by the emergency services.
- Important avenues and streets blocked, in some cases, due to more than 1 metre high floods.
- Houses, garages, other private properties and oficial buildings were flooded.
- A partial street subsidence dragged three cars and land slides affected several houses and main roads.
- Some areas suffered from gas and water shortages.

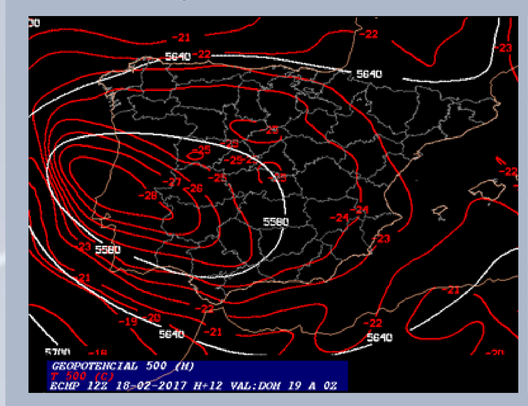


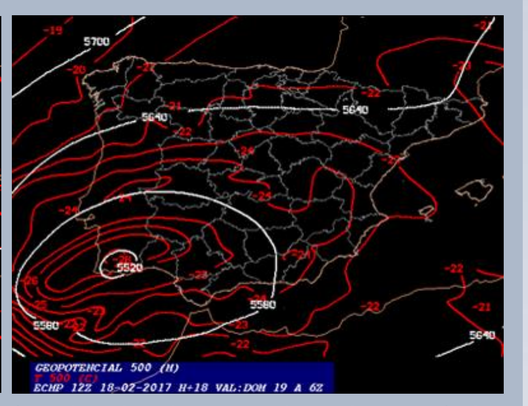




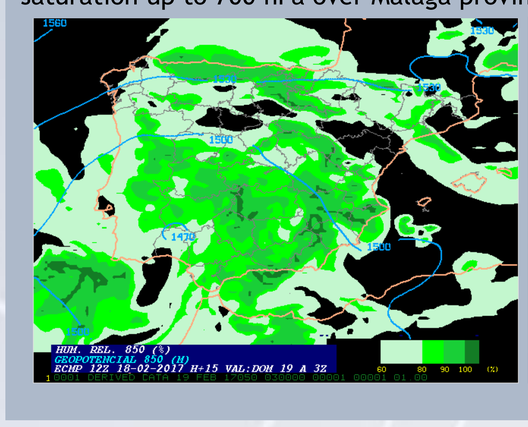
Observed data:
152.6 mm over 7 hours were reported at Malaga-Puerto station, located at the port of Malaga, with a ***87.4 mm hourly accumulation*** just before 2:50 UTC, which is the highest hourly precipitation ever measured at Malaga municipality. However, at the Regional Weather Center, that is barely 5 km away from the port, only 65.2 mm were reported; and at the airport, located at less than 10 km away from the port, only 28.4 mm were reported over the whole period.
It should also be mentioned the high lightning activity that occurred, with **74 lightning strikes** registered at Malaga-Puerto station in a 20 km radius area, most of them, between 02:00 and 04:00 UTC. Also, more than **10 cm of graupel** were accumulated at some places.

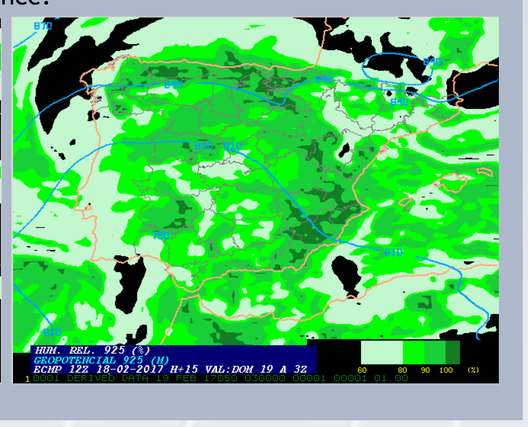
Meteorological analisys on 19 February at 00:00 UTC:
HIGH AND MEDIUM LEVELS: Cut-off low located at the west of the Iberian Peninsula, with its centre between Extremadura and Portugal, and -28º C temperature at 500 hPa. The rear jet stream, with up to 100 kt, moves the cut-off low to the south.
LOW LEVELS: Powerful and large anticyclon over Azores Islands and other one over Central Europe. Low pressures at the southwestern Iberian Peninsula with a small front affecting the southwestern areas.





As a consequence of the surface low location, low level east and southeast winds affected Malaga province coasts during the first half of 19th day. There was moisture saturation up to 700 hPa over Malaga province.

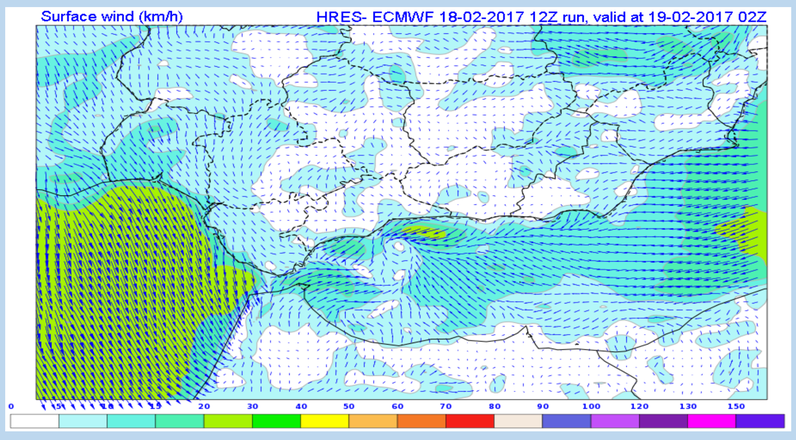




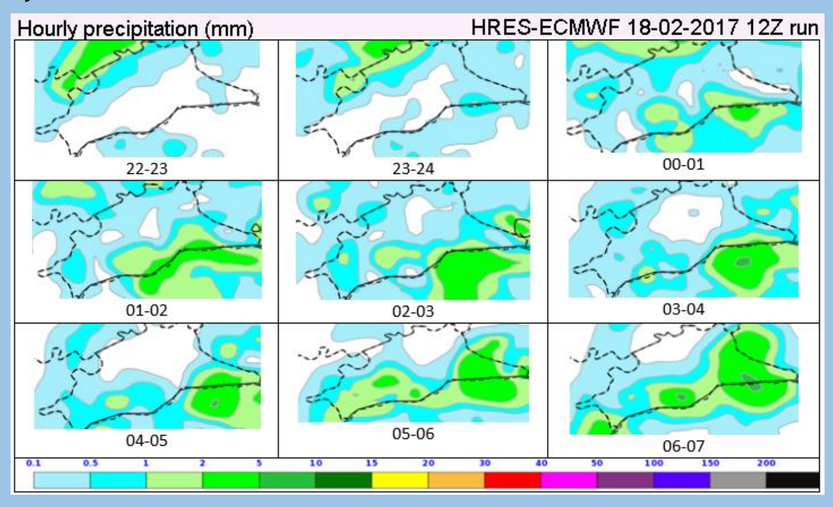
Convective environment:
The cut-off low went down to the inside Iberian Peninsula with a propitious environment to convection from 19 February 00 UTC on, remainig stationary for several hours. Convergence at surface and instability are detected at 03 UTC.

Propitious convection environment product rules:
Slightly propitious:
(LI <= 0 or LI7 <= 0) and CIN <= 200 and PPCO_3h >= 1
Propitious:
(LI <= -1 or LI7 <= -1) and CIN <= 200 and PPCO_3h >= 1
Very propitious:
(LI <= -2 or LI7 <= -2) and CIN <= 200 and PPCO_3h >= 1
Being: LI: Lifted Index leaving at 500 hPa
LI7: Lifted Index leaving at 700 hPa
CIN: Convective inhibition
PPCO_3h: Convective precipitation forecasted for the next 3 hours

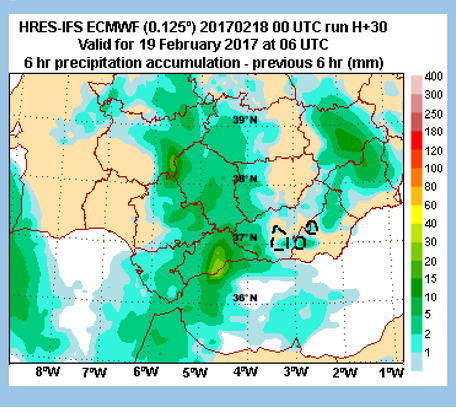
Surface wind (microscale effects / meso-γ scale):
As a consequence of nighttime breeze and the east winds entrance, intense convection began at western Malaga city. The phenomenon moved across the coast to the center and eastern city, intensifying and remainig stationary at the eastern city later on. There was probably some orographic enhancement of precipitation at eastern Malaga.
The surface wind field of 18 February 12 UTC run of HRES-IFS ECMWF model shows a small vortex from 19 February 01 UTC. The model is probably not very accurate catching the surface convergence location in time and space.

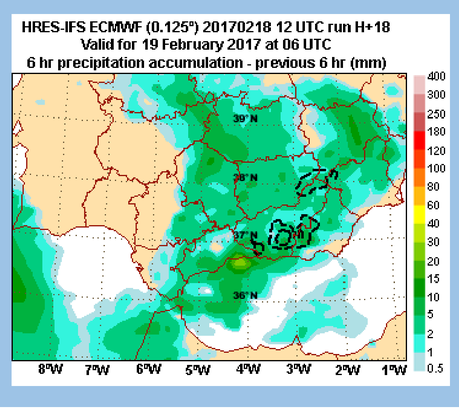


Model forecasted precipitation:
18 February 12 UTC run of HRES-IFS ECMWF model shows how precipitation reaches the coast at midnight and remains at some coastal areas for some hours. However, precipitation intensities were infraestimated even at the shortest ranges.
The local non-hydrostatic HARMONIE-AROME model nor detected the event accurately.

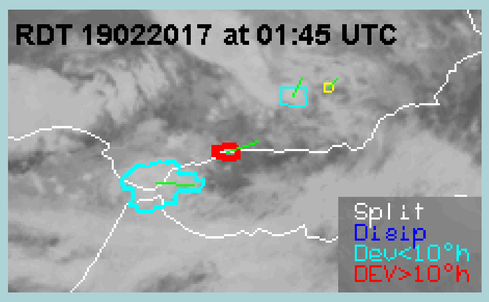


The 19 February 00-06 UTC accumulated precipitation forecasted by 18 February 0 and 12 UTC runs of HRES-IFS ECMWF model shows the maximum close to Malaga city (with a slight difference in location), but the total amount is infraestimated in both cases.

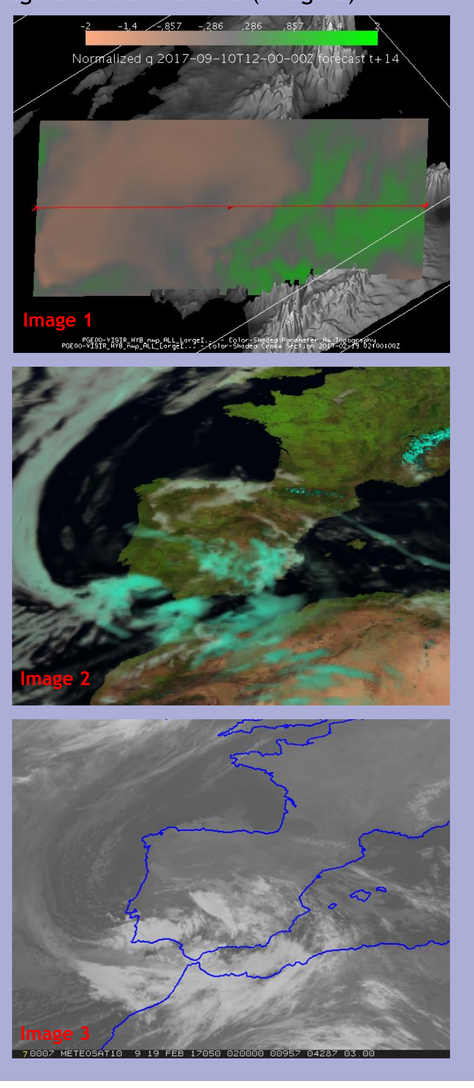




NWCSAF:
The RDT (Rapid development thunderstorms) NWCSAF product detected the thunderstorm over Malaga for the first time at 01:45 UTC, showing the cell in a rapid development stage. This product is derived mainly from SEVIRI (on board MSG satellites) data and also uses some HRES-IFS ECMWF model fields.



Other model applications:
Using the model as a starting point and through some time-space interpolations, model fields can be obtained at the SEVIRI time-space resolution. The first two images of this section are based on HRES-IFS ECMWF model and are valid for 19 February at 02:00 UTC. Image 1 shows a vertical sheet of the three dimensional normalized moisture field. Besides interpolations, model fields can be used, together with a radiative transfer model, simulating satellite radiances. This allows to obtain forecasted satellite pseudoimages, even for the solar channels during the night. With this information, among other things, RGB images can be obtained. Image 2 is a Natural RGB computed for 2:00 UTC, which is compared to the observed IR10,8 SEVIRI image at the same time (Image 3).



Conclusions:
- The event that analyzes this case study caused many losses and material damages over Malaga city.
- A located thunderstorm, that remained stationary for a short period of time, was the one that caused the damages.
- It was very difficult to forecast the magnitude of the thunderstorm.
- HRES-IFS ECMWF model, was able to forecast quite well the structure and location, but hourly intensities, and thus, total amount of precipitation, were really underestimated.
- Small local effects are very difficult to be reproduced by the model.
- Nor the local non-hydrostatic AEMET NWP model was able to forecast the even accurately.
- NWP data together with radiative transfer model can be used to simulate very useful forecasted satellite derived products.
- Further studies should be made regarding the different scales interactions.

e-mail: frodriguezm@aemet.es
www.aemet.es