THE 8th-10th JANUARY 2009 SNOWFALLS
A CASE OF MEDITERRANEAN WARM ADVECTION EVENT

GOBIERNO DE ESPAÑA — MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

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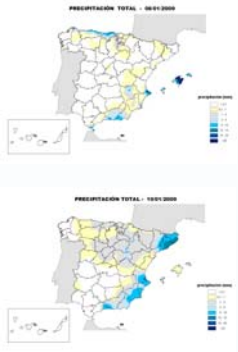
MOTIVATIONS

Heavy snowfalls, up to 20-30 cm, were reported in some places of the Spanish plateau.
Snowfalls led to **road blockade** in the metropolitan zone of Madrid province.
The **airport of Madrid-Barajas was closed** for several hours.

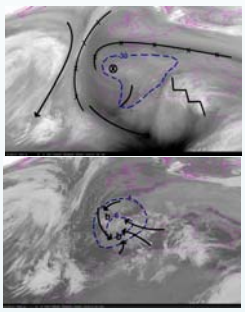
This type of snowfall is called **"warm advection".**
This winter situation is very **efficient** from precipitation point of view, generating significant snowfalls and affecting a lot of areas.
See daily precipitation maps on the left.

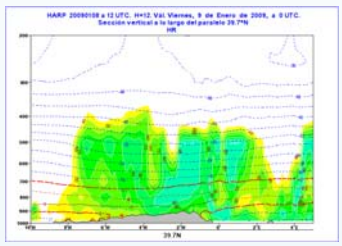


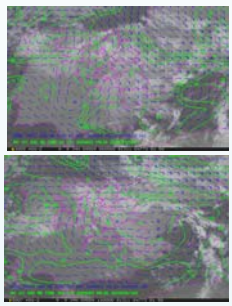
Daily precipitation maps, 00-24h, from the AEMET meteorological basic network

Synoptic and Mesoscale Settings

• The snowstorm was characterized by the previous **irruption of an European continental polar air mass**, that subsequently interacted with a **wet and warm air mass of Mediterranean origin**, all preceded by low level easterly flows. A cut- off low was located over the vertical of the Iberian Peninsula.
• The cut-off low produced the favorable conditions to generate a mesoscale boundary at low-middle levels and a convergence zone to the east of the Iberian Peninsula.
• This mesoscale boundary moved westwards affecting central regions of Spain.
• Heavy snowfalls were reported in Madrid, Castilla-La Mancha and Castilla y Leon autonomic communities.



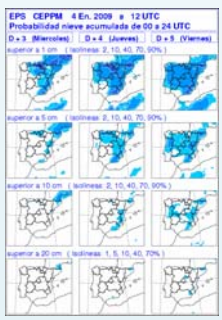


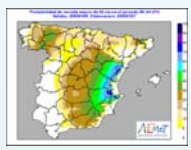


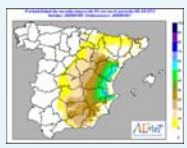
Left panels: MSG WV06.2 (top) and IR10.8 (bottom) images with subjective analyses, 9 Jan. 2009 06 UTC.
Central panel: Vertical cross section across 39.7ºN: Mediterranean sea on the right, the Iberian Peninsula at the middle and Atlantic ocean on the left. 08 Jan. 2009 12 UTC HIRLAM run at 00 UTC, 9 Jan. 2009 Relative Humidity (yellow-green scale, in %) and temperature fields (red dashed line, in ºC).
Right panels: MSG IR10.8 images at 06 (top), 18UTC (bottom) superimposing Relative Humidity (%) at 700 hPa and wind vector (kt) at 850 hPa, using HIRLAM analyses, at the corresponding time.

Medium Range Predictions and Postprocessing Outputs

• Snow probabilistic maps, from ECMWF-VarEPS model, and post processing AEMET maps were very useful. They showed "special signals or call-to-attention" of heavy snowstorms (10-20 cm) in areas of high social impacts, but with low probability values. See left and right operational maps from medium range and short range predictions, respectively.
• The forecasting surface temperatures reached extremely low values. See central figure, for an example.
• T 2m ECMWF EFI (Extreme Forecast Index) charts showed an infrequent very cold air mass at the surface level on the Iberian Peninsula and surrounding areas. Figure not showed.

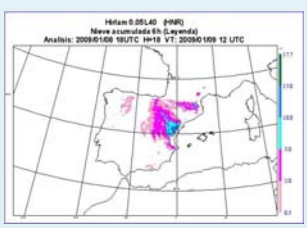


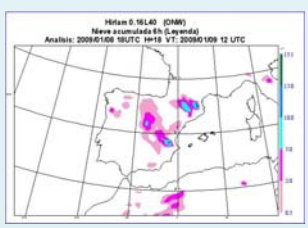


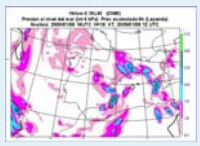


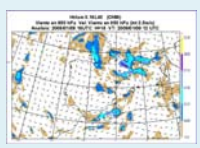
HIRLAM-AEMET Model Simulations

•The operational run HNR (HIRLAM6.2, horizontal resolution 0.05 º) and the suite run ONW (HIRLAM7.0, horizontal resolution 0.16º) are showed and compared.
•The analysis is the main difference between both versions. The version 7.0 uses the blending method. The first-guess is rebuilt using the ECMWF upper-level analysis and the HIRLAM surface analysis.
•The observed values of accumulated snow and the snowfall affected area are better represented by the ONW model, in spite of its resolution, lower than the HNR run. However, the forecasted amounts of snow were smaller than the observed one.
•On the left, ONW and HNR models, 18-hour forecast for the 6-hour accumulated snow. On the right, ONW model 18-hour forecast for the 6-hour accumulated precipitation (upper) and for the 850 hPa wind (bottom). Initial situation 8 January 2009, 18 UTC.

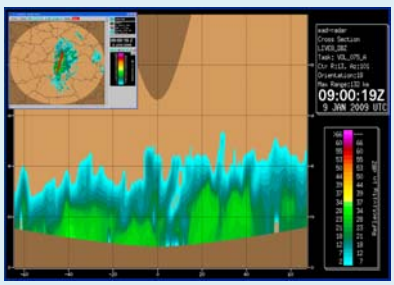






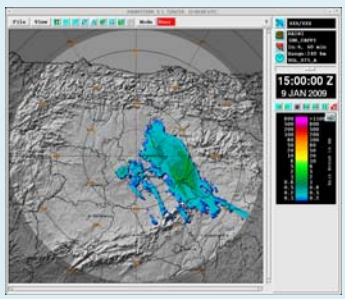


CONCLUSIONS



Vertical cross section, red line, of volumetric Madrid radar data (reflectivity, dBZ), showing precipitation echoes in Madrid and Castilla-La Mancha areas.
9 Jan 2009, 09 UTC

• The snowstorms, affecting the Iberian Peninsula during 8th-10th January 2009, are known as a **warm advection** one. They are associated with easterly flows, wet and relative warm air from Mediterranean sea. They are very **efficient** from precipitation point of view.
• The **ECMWF-VarEPS model** and **derived outputs** pointed out **low probabilities of heavy snowfalls (10-20 cm)** in the middle-range forecasting (D+4, D+5...) but **in the high impact social areas**.
• The determinist models in short-range forecasting underestimated the intensity and locations of the snowfalls.
• These differences appeared mainly due to model underestimations of the intensity of the wind at low levels, 850 hPa.



Lowest level PPI (dBZ, reflectivity) of Autilla del Pino radar (Palencia)
9 Jan 2009 15 UTC