VERIFICATION OF HIGH-RESOLUTION MESOSCALE SIMULATIONS USING LAND-SURFACE TEMPERATURE FIELDS DERIVED FROM SATELLITES

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OBJECTIVE. Verify high-resolution mesoscale simulations under nocturnal stably stratified conditions (clear skies and weak-synoptic pressure gradient conditions). Further details are found in Cuxart et al. (2007) and in Jiménez et al. (2008). The runs are made with the MesoNH model (Lafore et al., 1998) at 1km resolution in the horizontal and 3m in the vertical close to the surface and stretched above. The runs are computationally very expensive and they typically last 24 hours (from noon to noon).

A) NOCTURNAL MESO-BETA AND KATABATIC FLOWS IN THE ISLAND OF MAJORCA (Fig. 1)

The model outputs show that during the night-time the local effects, such as the topography, are the responsible of the organization of the flow at lower levels.

The air flows down from the mountains to the sea, following the terrain (Fig. 2), in agreement with the observations. The wind over the Island is weak but, at the slopes, katabatic winds are formed (Martínez and Cuxart, 2009).

The coldest temperatures are found in the bottom of the valleys where the air accumulates (Fig. 2).

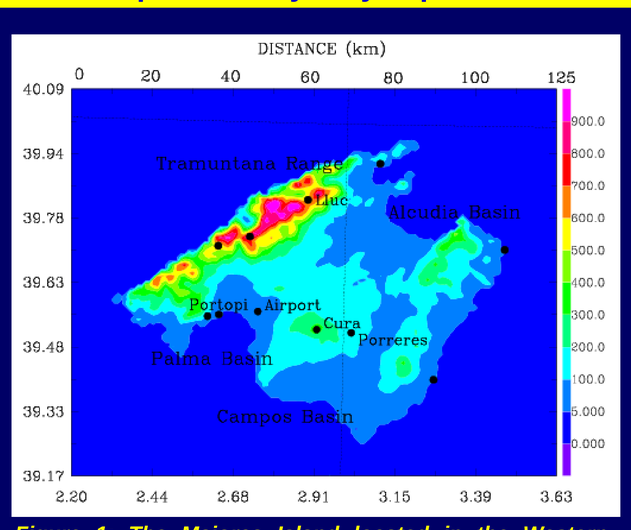
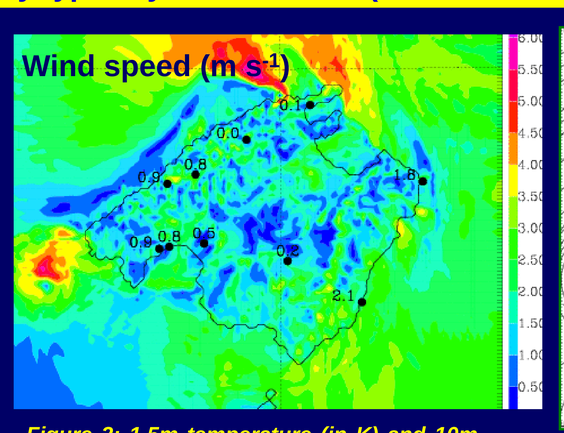


Figure 1: The Majorca Island located in the Western Mediterranean Sea seen by the model at 1km resolution (dimensions 125 km x 100 km). The black points indicate the location of the surface weather stations.



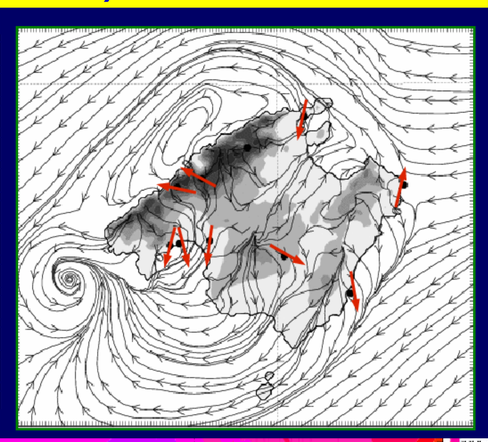
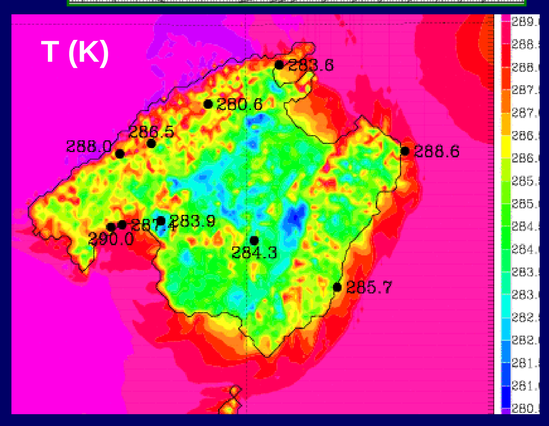


Figure 2: 1.5m temperature (in K) and 10m wind direction and speed (in m/s) at 0000 UTC on April, 29th 2005. The values and the vectors indicate the observations.



The network of stations is generally not very dense and this type of simulations are difficult to verify (Fig. 2). From the satellite images the Land-Surface Temperature (LST) can be directly compared to the one obtained from the model.

LST derived from NOAA and MSG

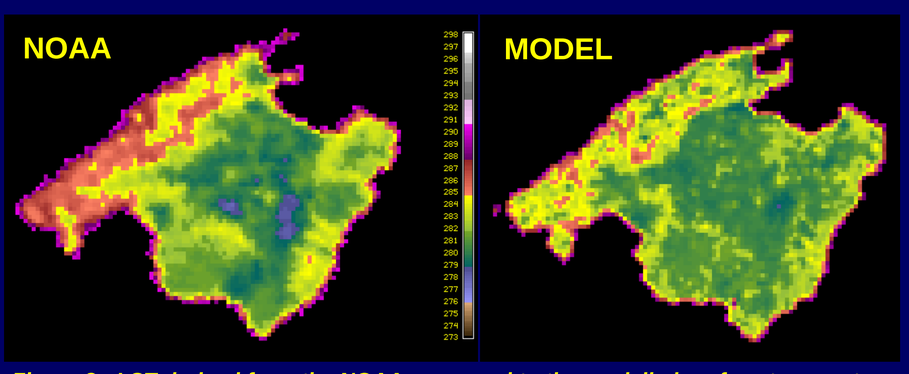


Figure 3: LST derived from the NOAA compared to the modelled surface temperature at 0330 UTC on April, 29th 2009.

The model is able to reproduce the coldest areas in the centre of the basins as it is seen by the NOAA (Fig. 3)

The differences might be related to the representation of the physical processes in the model but also that the frost formation can introduce errors in the satellite-derived LST.

The model outputs agree with the observed temperatures and satellite-derived LST (Fig. 4). However, in the valleys of sizes of about 1 km (Lluc) neither the model nor the LST are able to reproduce the strong observed cooling.

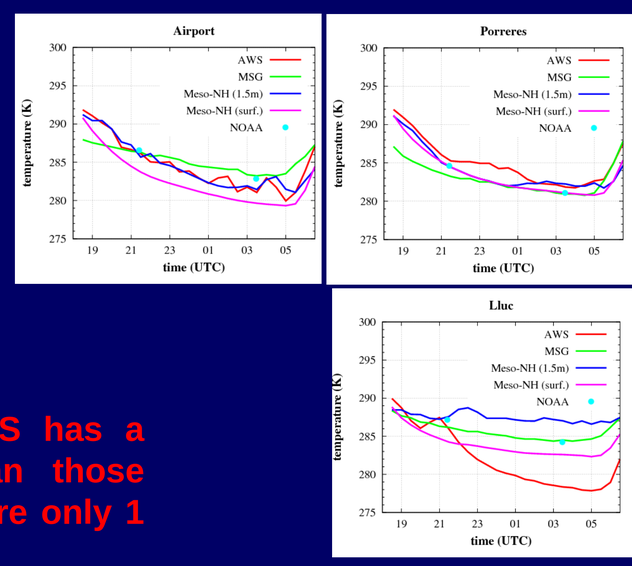
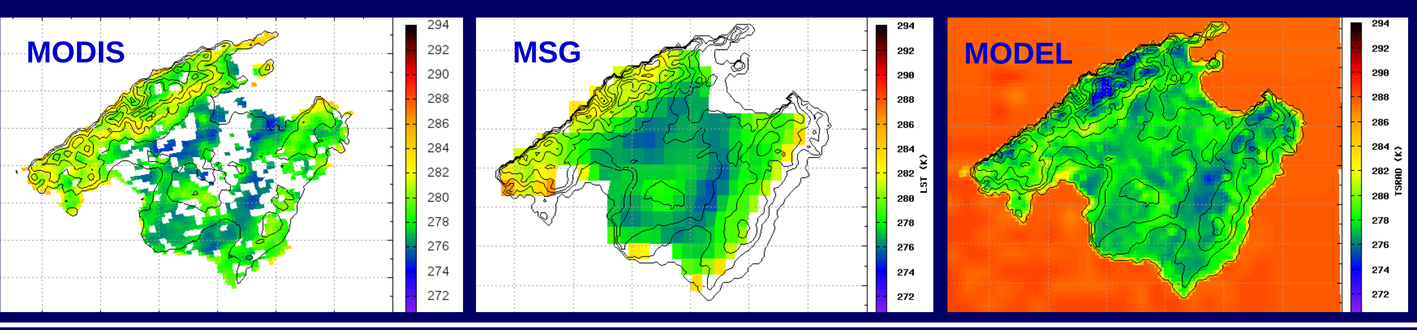


Figure 4: Surface temperature derived from the MSG and NOAA satellites (green line and blue dots, respectively) and the one obtained from the model (purple line). In the same plot, the observed 1.5m is included (in red) as well as the one derived by the model at this height (dark blue). See locations in Fig. 1.

LST derived from MODIS and MSG



The LST derived from MODIS has a better spatial resolution than those derived from MSG but there are only 1 or 2 pictures per night (Fig. 5)

Figure 5: LST derived from MODIS and MSG compared to the modelled surface temperature at 2200 UTC on January, 28th 2008.

B) LOCALLY-INDUCED FLOWS AND FOG FORMATION IN THE EBRO RIVER VALLEY (Fig. 6)

Several mesoscale runs have been performed over the Ebro river basin, in the north-eastern part of the Iberian Peninsula (model domain at 2km resolution in Fig. 6), to further study climatologically weak-winds and clear-sky nights conditions close to the city of Lleida.

The model outputs are verified using the dense network of surface observations, satellite-derived LST and a WindRASS profiler located close to Lleida. Further details are found in Cuxart and Jiménez (2012) and in Cuxart et al. (2012).

Fog radiation episodes are very common in this region during winter time and they can last for several days. The fog event from 10th to 12th December 2009 is taken here. Some surface observations are shown in Fig. 7 and the comparison of the modelled surface temperature to the satellite-derived LST is seen in Fig. 8.

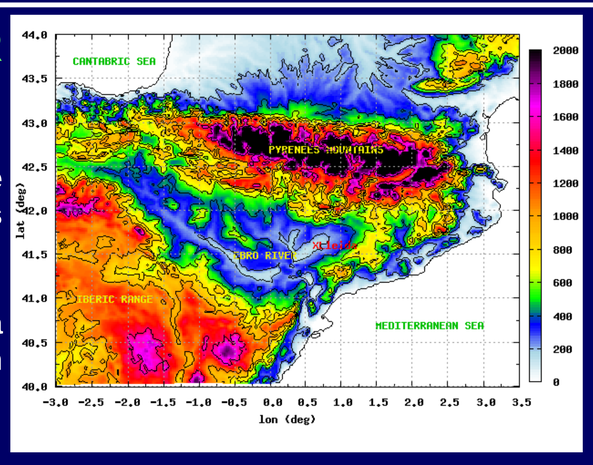


Figure 6: Topography of the Ebro river basin and location of the city of Lleida.

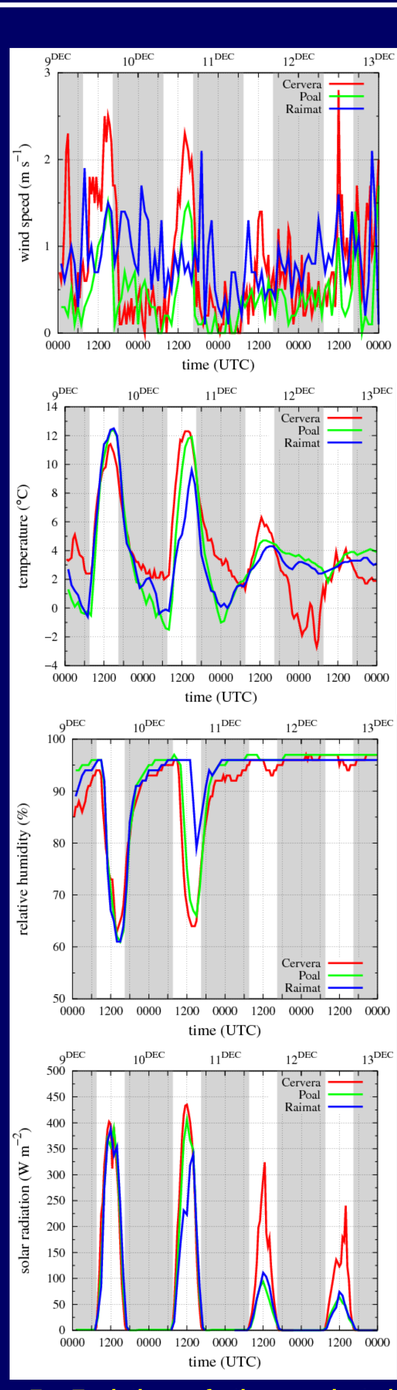
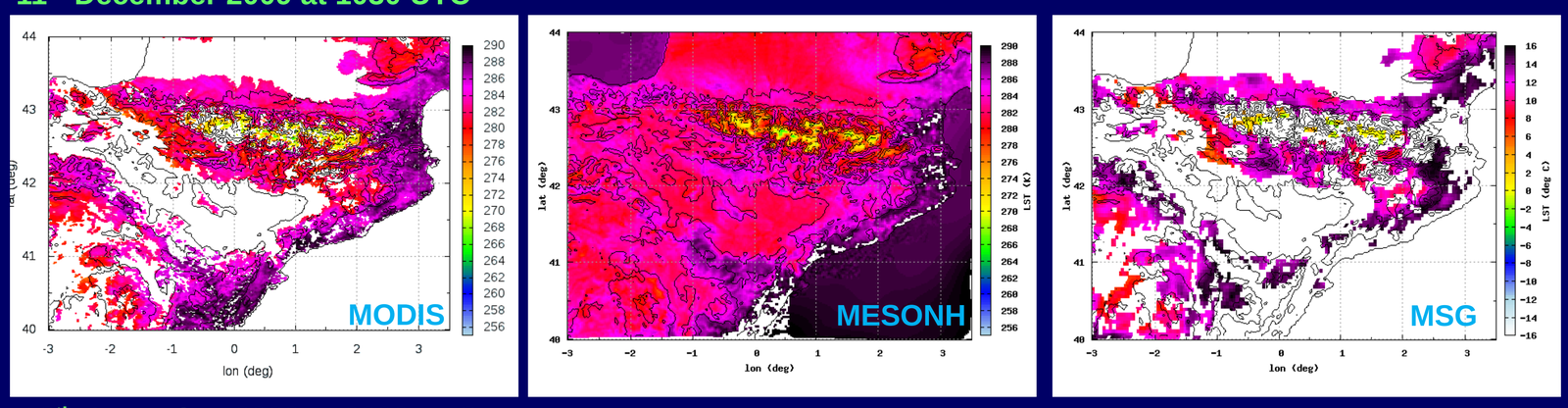


Figure 7: Evolution of three selected surface stations: Raimat (at the WindRASS site), El Poal (at a low part of the basin) and Cervera (at the slopes, in the limit of the fog deck). Shaded areas indicate night-time.

11th December 2009 at 1030 UTC



12th December 2009 at 0200 UTC

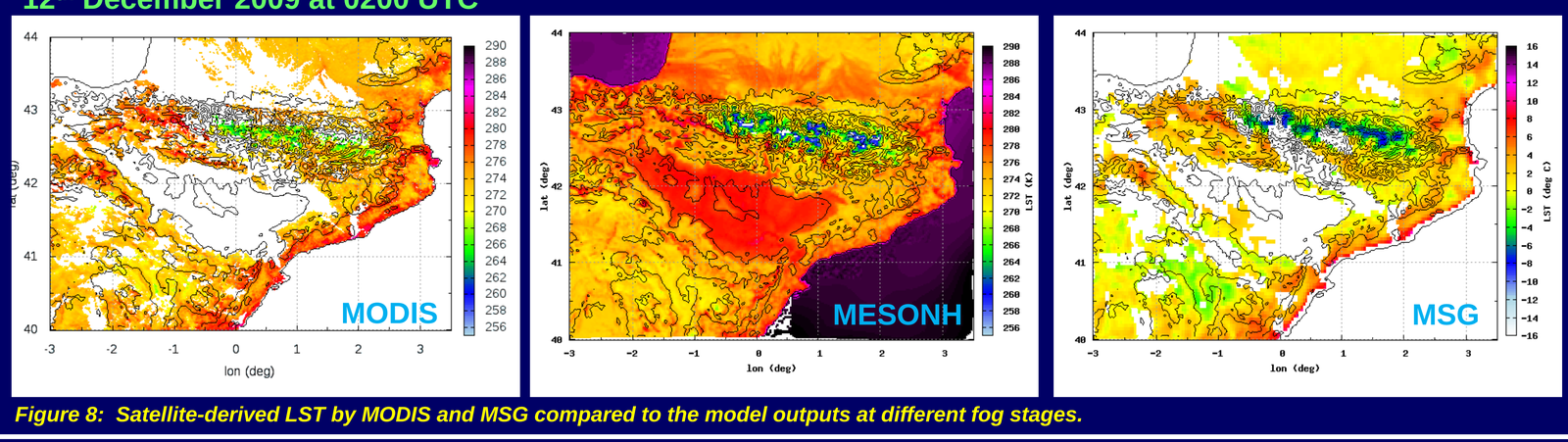


Figure 8: Satellite-derived LST by MODIS and MSG compared to the model outputs at different fog stages.

The fog started during December, 10th 2009 but it covered the whole basin during December, 11th (weak winds, no diurnal cycle in the temperature, humidity close to 100% and reduced solar radiation, Fig. 7).

The fog extension can be estimated from the satellite observations. The white areas of the satellite-derived LST (Fig. 8) are missing values that are identified as fog or cloud areas, in this case.

The MSG LST fields are colder than those derived by MODIS because no water vapour correction is applied in MSG.

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