A sensitivity test of SST variation in the mainland version of AROME/Portugal

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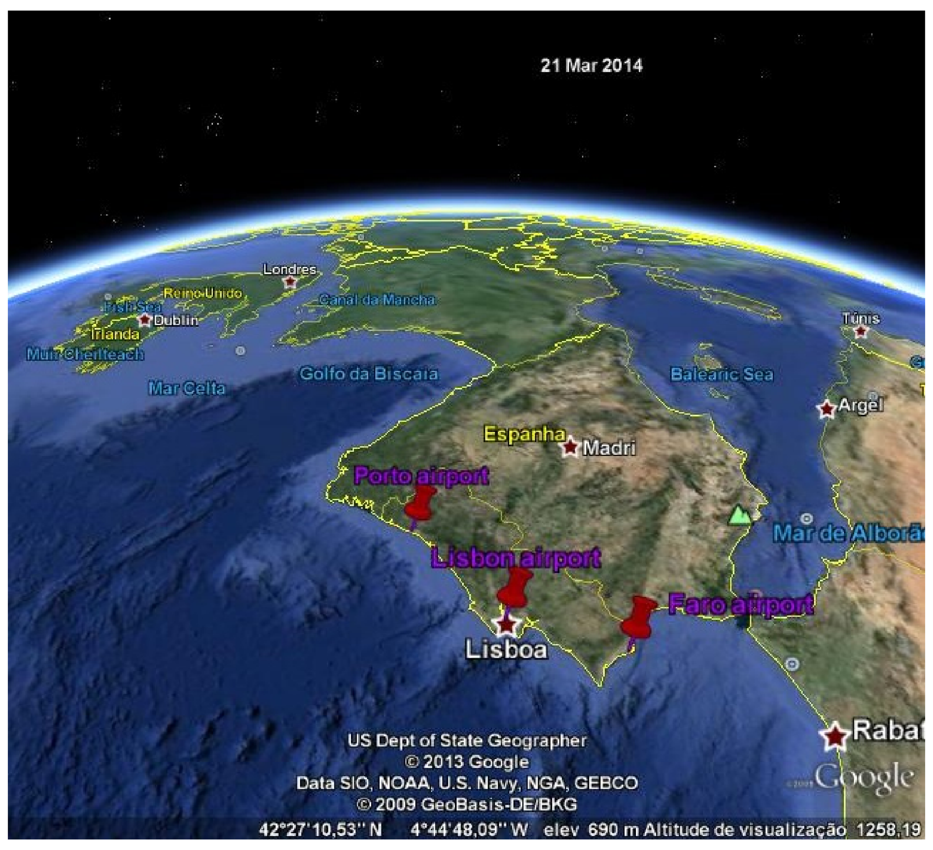
24th ALADIN Workshop & HIRLAM All Staff Meeting 2014, 07-11/04/2014, Bucharest, Romania

Motivation

Fog are among the factors affecting the operations at the main Portuguese airports with significant economic impact. During Summer, Porto's airport may register 30% of occurrences in just one month, often associated to the advection of an air mass over a colder sea surface.

In Portuguese Mainland the main airports are located near the Atlantic coastline where fog is often observed. Any continental warm air mass crossing the Atlantic coast finds an endless moisture reservoir at the ocean. The cooling of the physical surface underneath can force its saturation producing a foggy air mass that is easily advected over the airport's runways [1,2].



These situations are difficult to forecast: fog is not a direct model field. Under favourable synoptic conditions, low level cloudiness, the humidity at 2m, the wind at 10 m and the planetary boundary height are used as predictors. The process genesis of fog near the Atlantic coast of Portuguese Mainland seems to be very much related to the surface temperature and its land-ocean contrast.

In this way, it would be natural to think that a good representation of the surface temperature (ST) along this coastline in the local models could add some value to the fog forecast and a preliminary study on the impact of the SST variation in AROME/PTG forecasts (in particular in the fields used as predictors to the fog forecast) was requested by the aviation meteorology sector. The main conclusions are illustrated in this poster.

SST initialisation in AROME/PTG

The Sea Surface Temperature (SST) at the operational mainland version of AROME/Portugal – here addressed as AROME/PTG - is a field prescribed at the model initial conditions being kept constant along its time integration.

The first step of our work consisted on the subjective analysis of the quality of the SST initialisation in AROME/PTG. Figures 3 and 4 illustrate the successive approximations (and consequent degradation) undertaken from the original *Operational Sea Surface Temperature and Sea Ice Analysis* (OSTIA) [3] analysis shown in Figures 1 and 2: AROME initial conditions are downscaled from ALADIN/Portugal initial conditions which are downscaled from an ARPEGE analysis. The ARPEGE analysis results from a relaxation [4] between an OSTIA analysis and a CANARI analysis [5].

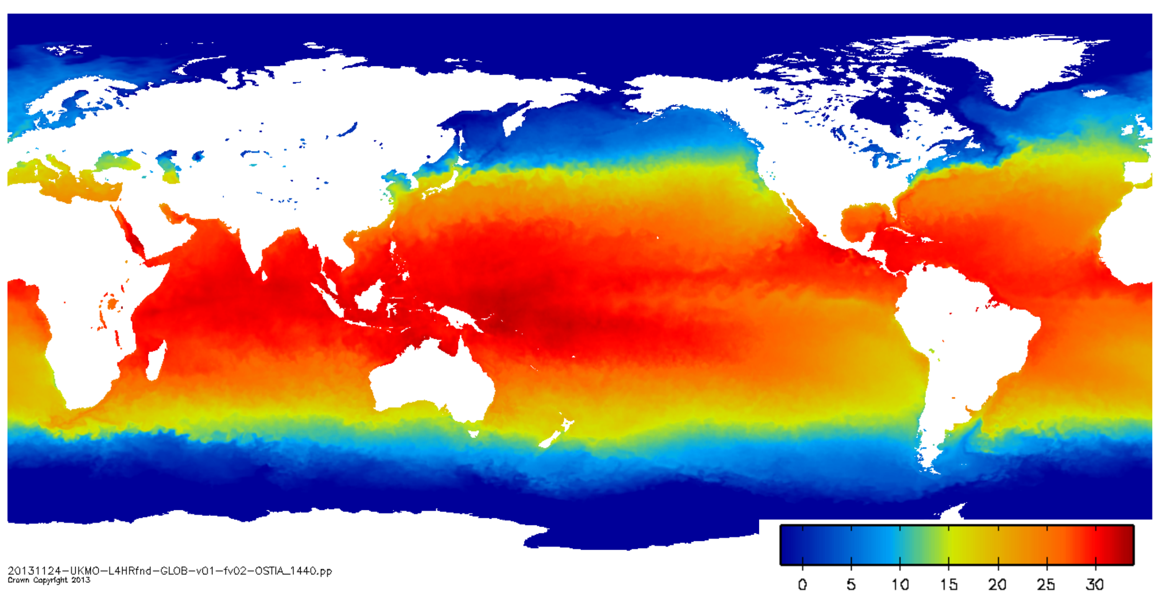


Figure 1 – OSTIA SST analysis on 14 November 2013. It is based on satellite and bouy information and uses as background the anomaly of the persistence. The image shows the spacial variability of SST. It has a relevant gradient along the latitude but also near the continental borders.

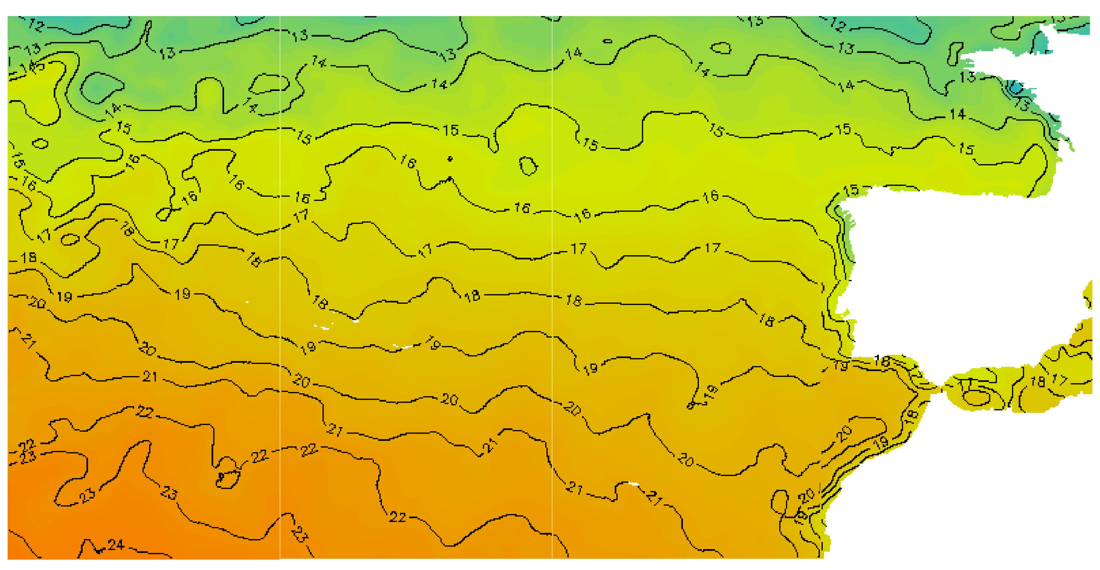


Figure 2 – Zoom of OSTIA SST analysis at 12UTC on 24 November 2013.

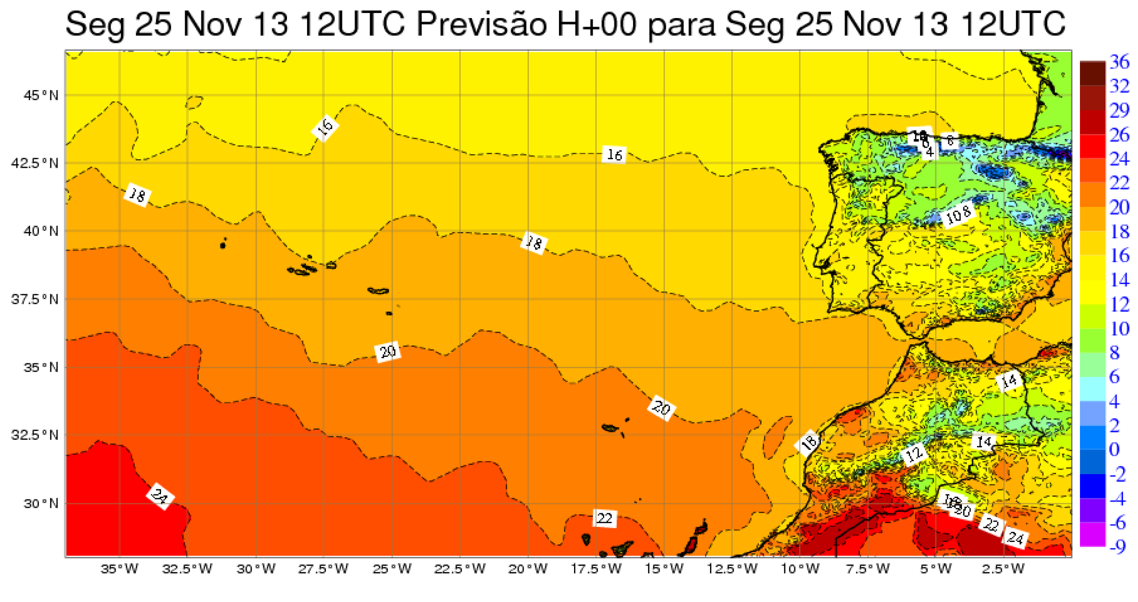


Figure 3 – ALADIN/Portugal ST initial condition at 12UTC on 25 November 2013. Note the coulours legend in Figures 1 and 2 do not correspond exactly to those of Figures 3 and 4.

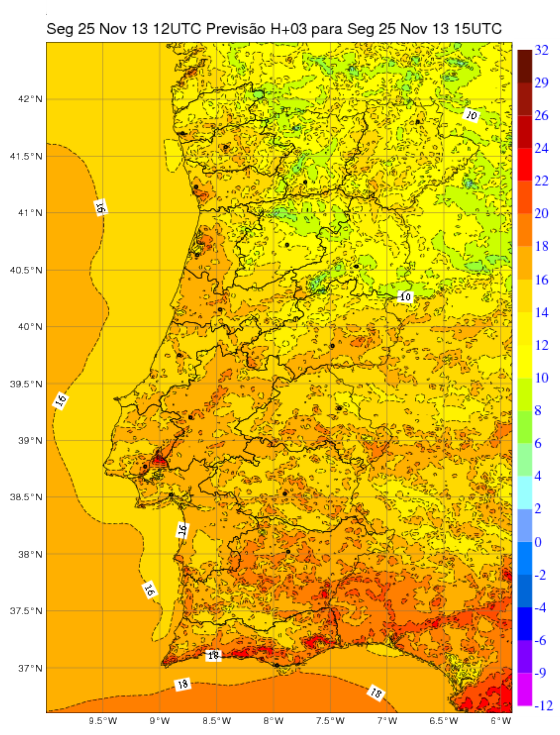
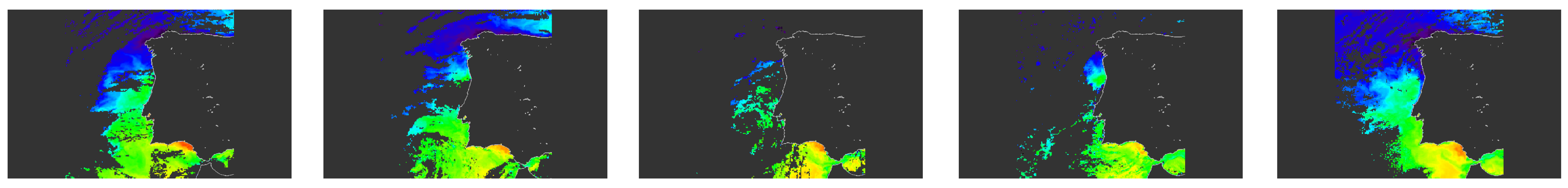


Figure 4 - AROME/PTG ST initial condition at 12 UTC on 25 November 2013.

SST variability at the Atlantic coast of Portuguese Mainland

The second step of this work consisted on the identification of SST real variability inside the domain of AROME/PTG during the actual range of its time integration. A study based on 2,5 years of satellite and buoys data on a period from 2011 to 2013 was used. We could conclude that this variability corresponded to a maximum of 2,5 degrees of temperature in 48 hours along the Portuguese coastline. In particular, near Porto this maximum value corresponded to a decrease in Summer.



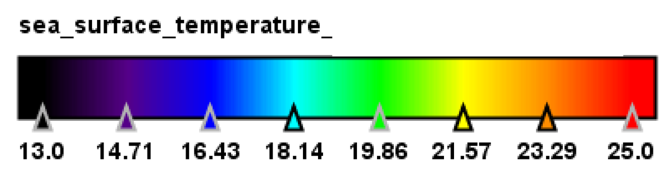


Figure 5 – Daily evolution of GHRSST(*) observation near the Portuguese Mainland coast from 28 May 2011 to 1 June 2011 when a minimum of SST is registered by a buoy located in the north, near Porto. In the Figures the chronology is represented from left to right.

The situation illustrated in Figure 5 seems to correspond to upwelling conditions which are often observed during summer in the Atlantic coast of Portugal Mainland. Some studies (for instance, [6]) have concluded that during Summer, under a certain steady regime of north-western winds (raised by the joint action of the Azores anticyclone position and the Iberian low), there is an outcrop of colder deep sea waters forcing the SST to a decrease of temperature. A typical variability of -2,5 degrees in 3 days can be considered. Other phenomena did not seemed to cause such variability amplitude in the SST [7].

(*) *Group for High Resolution Sea Surface Temperature*

SST sensitivity test

A sensitivity test to a decrease of SST was performed on AROME/PTG: a fog summer situation observed along the coastline of Portuguese Mainland was considered. METEOSAT specialised products, shown in Figure 6, allowed to indentify a low cloud/fog situation on the early hours of 11 August 2011. A decrease of 2 degrees in was then artifitially introduced in AROME/PTG initial conditions at 00UTC on the 10 August 2011 as shown in Figure 7. The idea was lower the surface temperature underneath the moist air mass to see an eventual enlargment of the geographical area covered by low clouds in the forecast after 30 hours of integration.

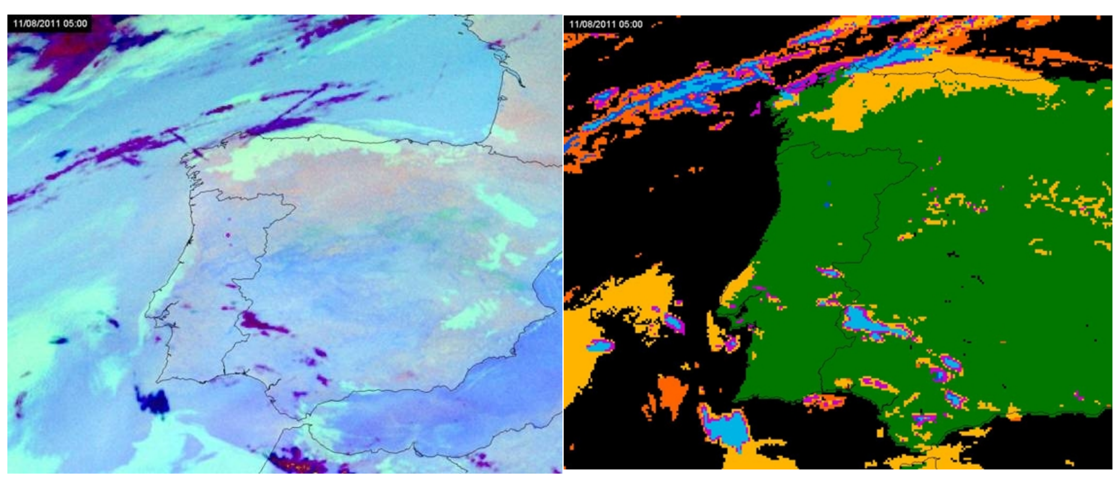


Figure 6 – Low clouds/fog situation observed on the 11 August 2011 at 05UTC: METEOSAT RGB Micro Fog product (region depicted in light blue along the west coast of Portugal, in the left panel) and NWC SAF Cloud Type product (region depicted in orange, in the right panel).

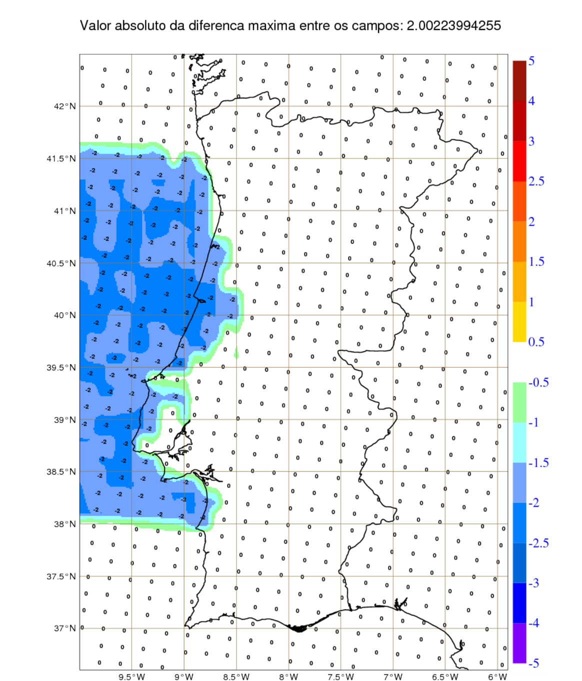


Figure 7 – Spatial distribution of the 2 degrees of decrease of SST initial conditions of AROME/PTG at 00UTC on 10 August 2011.

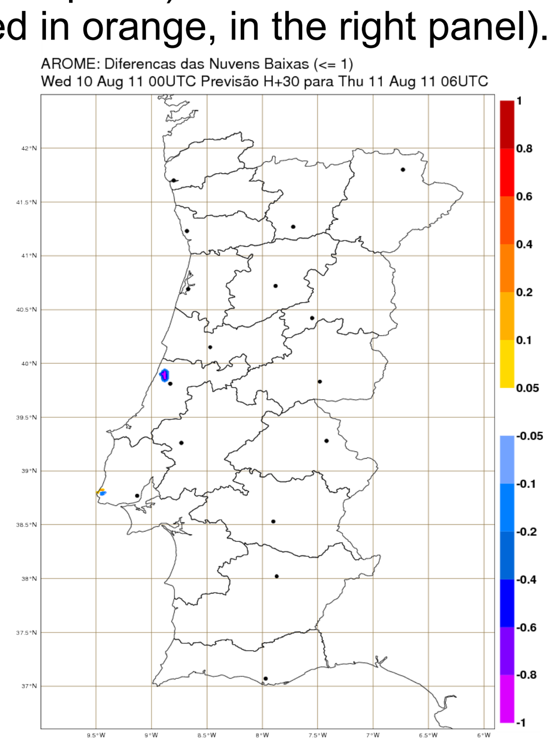


Figure 8 – Low clouds increment in AROME/PTG when compared to the operational forecast at 06 UTC on the 11 August 2011, when a SST decrease of 2 degrees is considered in the initial conditions of AROME/PTG (after 30 hours of integration).

Fog forecast is not a direct model output. It depends on many other factors than just sea surface temperature which should be well represented by the model in orther to achieve a good score. In this way, an investment on a better discretisation inside the planetary boundary layer, like the increase of the number of levels as well as the implementation of a local land surface temperature analysis instead of the actual initialisation by dynamical adaptation was recomended.

Bibliography

[1] Jacinto, J., Mateus C. e Rei, F. (2013), Modelo conceptual de formação de nevoeiro de radiação no estuário do Tejo e sua advecção para o aeroporto. Nota Técnica MET-AERO.33 (edição 01), IPMA, I.P., Lisboa.

[2] Fernando Rei (2012), "Análise climatológica do nevoeiro no aeroporto Francisco Sá Carneiro (Porto)", Tese elaborada na disciplina de Projecto no âmbito da licenciatura em Meteorologia, Oceanografia e Geofísica, FCUL, Lisboa.

[3] Stark, J. D., et al. (2007), *OSTIA : An operational, high resolution, real time, global sea surface temperature analysis system.*, Oceans '07 IEEE Aberdeen, conference proceedings. Marine challenges: coastline to deep sea. Aberdeen, Scotland.IEEE.

[4] Bouyssel, F. (2013), Comunicação Pessoal.

[5] Taillefer, F. (2002), CANARI (based on ARPEGE cycle CY25T1 for ALADIN), GMAP/CNRM Technical Documentation, Météo-France, Toulouse, France.

[6] Oliveira, P., Nolasco, R., Dubert, J., Moita, T., e Peliz, A. (2009), Surface temperature, chlorophyll and advection patterns during a summer upwelling event off central Portugal, Continental Shelf Research, 29, 759-774.

[7] Sykes, P., While, J., Sellar, A., Martin, M. (2011), Diurnal Variability in Sea Surface temperature: Observation and model assessment., Forecasting Research Techinal Report 556, Met Office, UK.

Acknowledgements are due to François Bouyssel, Ludovic Auger, Tomas Kral and Alena Trojakova

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