Improved assimilation of SEVIRI radiances over land in meso-scale models using Land Surface Temperature retrievals.

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Infra-red satellite data gathered from the SEVIRI[1](Schmetz et al., 2002) radiometer, which is onboard the geostationary satellite MSG, are operationally assimilated in the AROME[2] and ALADIN[3] limited area models (Montmerle et al., 2007). Measurements come from 12 spectral channels with an unprecedented spatio-temporal resolution (1 image every 15 minutes with a 3km horizontal resolution). These measurements bring useful information about the state of the atmosphere (temperature and humidity) over several layers and of the surface.

Nowadays, SEVIRI observations that are sensitive to atmospheric low-levels are rejected over land partly because of an inappropriate description of the Land Surface Temperature (LST) and of the Land Surface Emissivity (LSE) in the model. Out of the constraints of data assimilation, many studies were carried out to improve our understanding of the LST (Qin et al., 2001; Sobrino et al., 2004 …) and the LSE (Trigo et al., 2008; Borbas and Ruston., 2010) variability.

The potential reduction of these uncertainties which presently restrict the assimilation of surface-sensitive channels over land has been evaluated (1) when the LST is deduced from SEVIRI window channels using a single-channel method and (2) when the LSE atlases produced by the EUMETSAT LSA-SAF[4] replace the static default value of 0.98 used in the radiative tranfer model RTTOV.

First, retrieved LST (called LST-SEV hereafter) were evaluated against independent observations/products: LST-MODIS[5], LST-Land-SAF, T2M (2 m temperature), LST-ALADIN which is the land surface temperature analysed by the ALADIN model. Some differences due to instrumental specifications were found between LST-MODIS and LST-SAF. The LST-SEV and LST-SAF products were found in good agreement over Europe. Cold (warm) biases were observed during day-time (night-time) when comparing LST-SEV, retrieved from channels IR8.7 and IR10.8, with LST-ALADIN which seems to be due to an under-estimation of the diurnal cycle in the model. Then, an emissivity atlas has been combined with these different LST-SEV to simulate SEVIRI brightness temperatures. The simulations were compared to SEVIRI observations. The comparison shows that SEVIRI channel IR10.8 is the most suitable one for LST retrieval (Guedj et al., 2011).

These developments were then tested in a data assimilation context, thus enabling to use more SEVIRI data over land. Two assimilation experiments were run over a 3-month period during summer 2009, one of which is representative of the operational model (CTL) while the other differs by the assimilation of more SEVIRI data over land through a better representation of the emissivity and surface temperature (EXP). We show that the forecast impact is generally neutral to positive over Europe with some positive impact over Southern Europe. SEVIRI data also improve the quality of analyses, particularly those of Total Column Water Vapour (TCWV, see figure 1), and this is substantiated through comparisons with independent GPS measurements (figures 2), (Guedj et al., 2012). These developments should be implemented soon in operations version.

[1] Spinning Enhanced Visible and Infrared Imager
[2] Application de la Recherche à l'Opérationnel à Méso-Echelle
[3] Aire Limitée Adaptation Dynamique Initialisation, développement International
[4] European Organisation for the Exploitation of Meteorological Satellites - Land Surface Analysis - Satellite Application Facility
[5] MODerate resolution Imaging Spectroradiometer

Figure 1: Mean analysis difference in TCWV between EXP (with SEVIRI over land) and CTL (without SEVIRI over land) at 12UTC. TCWV maps are averaged over 45 days (1 September - 5 October 2009). Red (blue) colours means that EXP contribute to decrease (increase) moisture in the analysis as regard to the CTL.

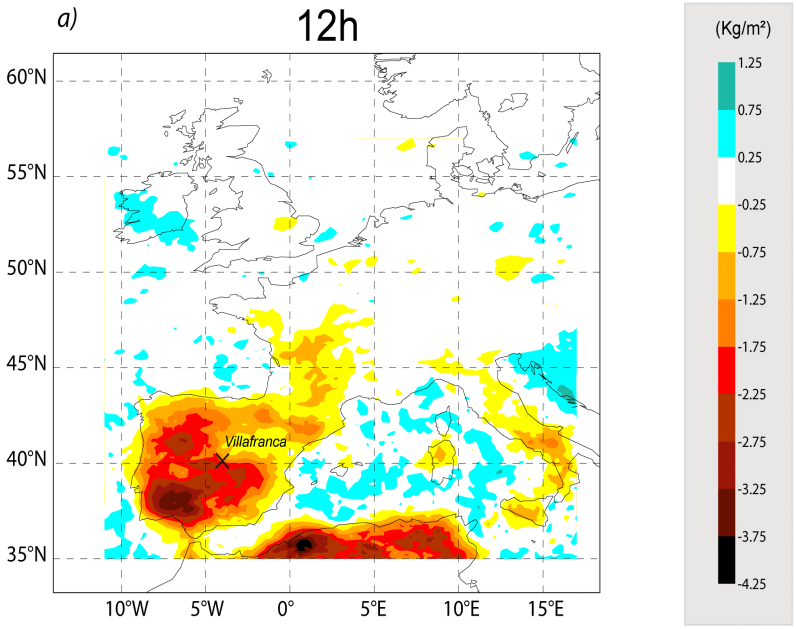
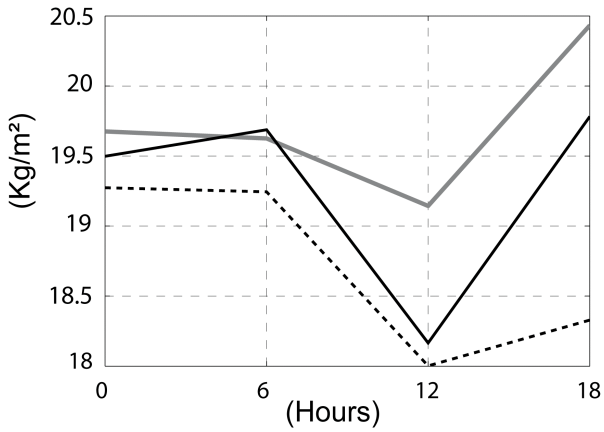


Figure 2: Average values of TCWV from GPS (Villafranca)(dotted black line), EXP (black thin line) and CTL (grey line) according to the assimilation cycle (0-6-12-18 UTC).TCWV values are averaged over 45 days (September 1 to October 15 of 2009)



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