A DOWNSCALING APPROACH FOR SMOS USING AN ADAPTIVE MOVING WINDOW

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1. ABSTRACT

After more than 8 years in orbit the Soil Moisture and Ocean Salinity (SMOS) satellite is still in good health and several algorithms for improving its spatial resolution have been proposed and validated in a variety of catchments [1] [2]. However, none of them has yet been applied at the continental scale. In this study we present a soil moisture downscaling algorithm which combines the SMOS brightness temperatures (T_B at ~40 km spatial resolution), the Normalized Differenced Vegetation Index (NDVI at 1 km) and the Land Surface Temperature (LST at 1 km), into 1km soil moisture maps. A validation of the resulting maps has been carried out over Spain and Europe.

2. INTRODUCTION

The lower range of the microwave spectrum (1-10 GHz) is optimal for soil moisture (SM) sensing since, at these frequencies, there is a strong relationship between SM content and soil dielectric constant. Recent progress has allowed launching two space missions specifically devoted to globally measuring SM i) the Soil Moisture and the Ocean Salinity (SMOS) and ii) the Soil Moisture Active Passive (SMAP), launched by the ESA in 2009 and the NASA in 2015, respectively. These two missions operate at L-band, which is considered optimal for SM estimation, being less affected by vegetation, soil roughness and atmospheric effect, than higher microwave frequencies [3]. Here we propose an evolution [4] of the optical-based disaggregation algorithm applied to SMOS, originally developed by Piles et al. [1].

3. OBJECTIVE

The objective of this work is to develop a downscaling algorithm to improve the SMOS SM spatial resolution to obtain high resolution soil moisture maps (HR SM) at continental scale. This has been achieved using an adaptive moving window. Although in this poster only results over the Iberian Peninsula and Europe are presented, the algorithm has also been tested over Australia, Brazil and Africa.

4. METHODOLOGY & RESULTS

The main steps for the HR SM generation are:

1. Calculation of the linear equation coefficients (b_i), for each coarse pixel. Appling the adaptive moving window with the information of the NDVI, LST, SM L3 and T_B, at 25 km (LR).
2. HR SM maps generation. Using the b_i obtained in the previous step and the information of the NDVI, LST and T_B at 1 km (HR).

$$SM = b_0 + b_1 \cdot LST + b_2 \cdot NDVI + \frac{b_3}{3}\sum_{i=1}^{3} T_{BH\theta_i} + \frac{b_4}{3}\sum_{i=1}^{3} T_{BV\theta_i}$$

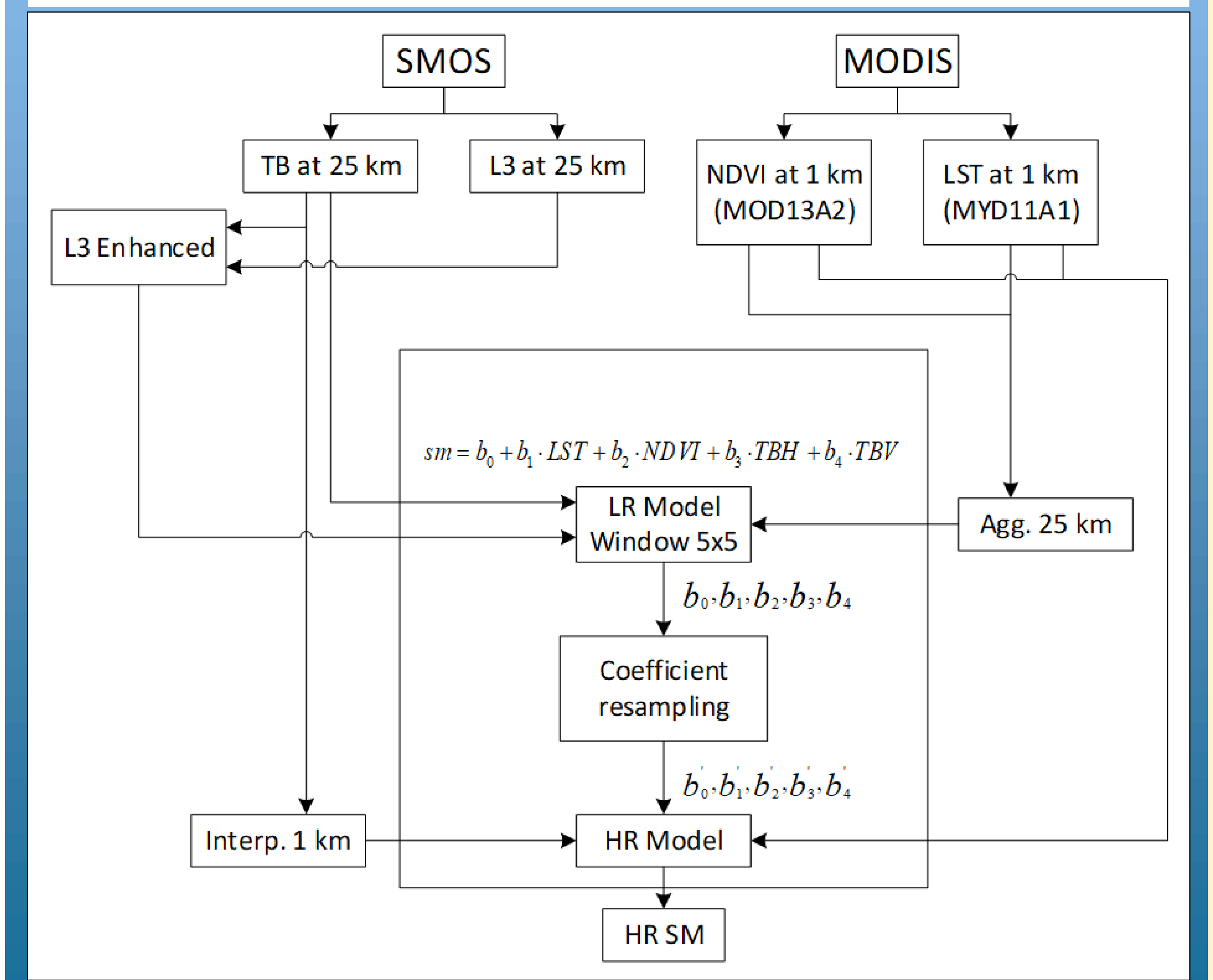

Figure 1. Flowchart with the steps to generate HR SM maps.

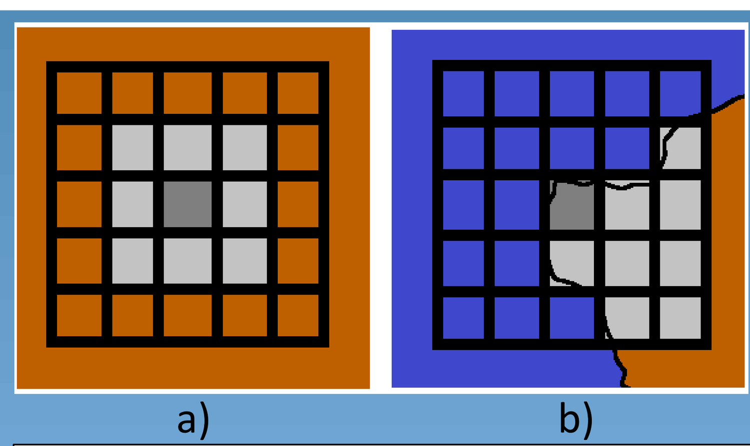

Figure 2. Adaptive moving window. Brown color, available pixels; blue color, unavailable pixels; dark gray color, selected central pixel; and light gray color, the additional pixels which compose the adaptive window. This window is defined independently for each of the pixels of the study area.

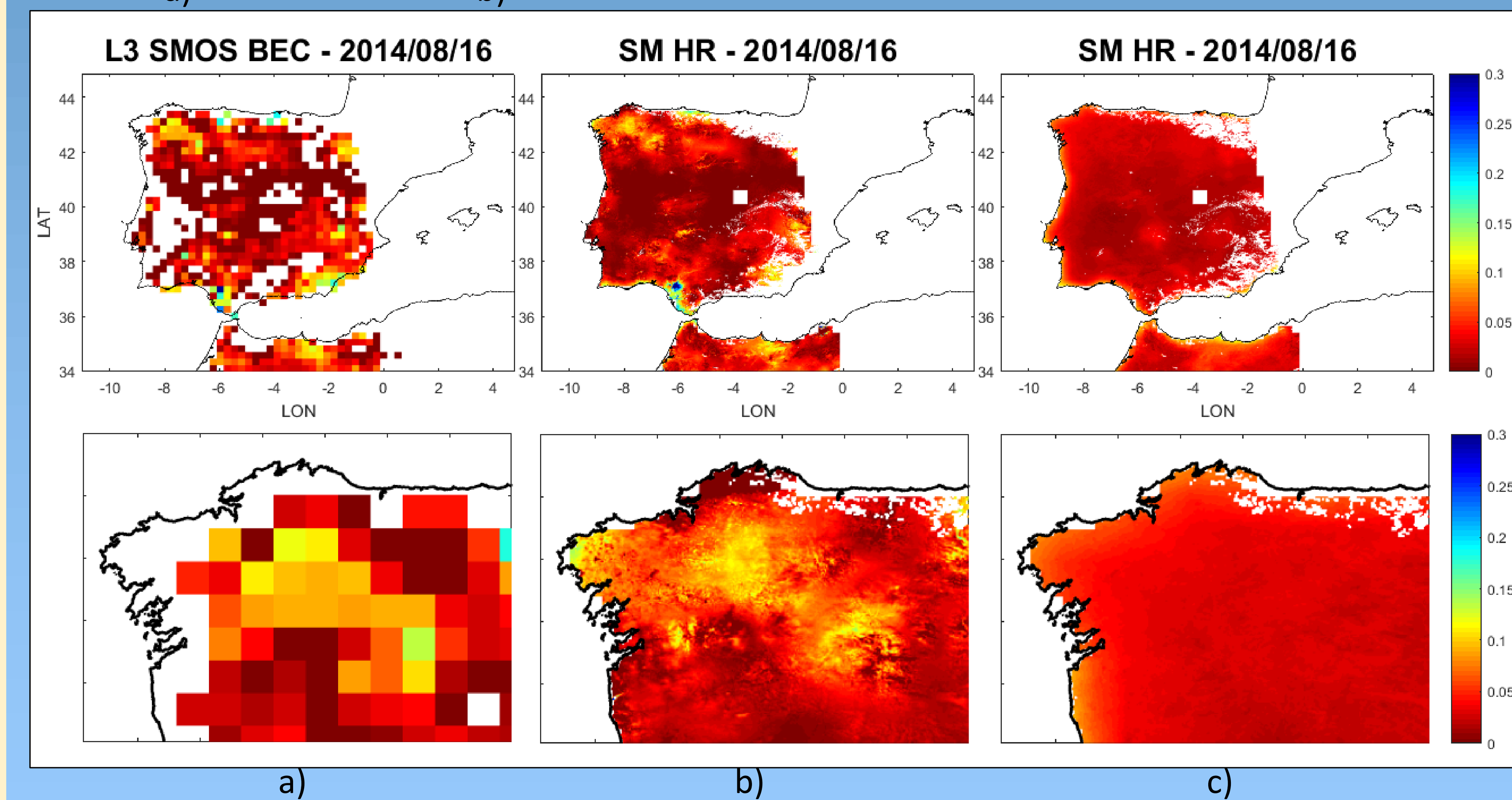

Figure 3. SM products over the Iberian Peninsula for 16-08-2014. a) LR SM map (SMOS BEC L3), b) and c) HR SM maps (1 Km) after applying the new downscaling algorithm using the optimal size of the adaptive moving window and using an excessively large window, respectively.

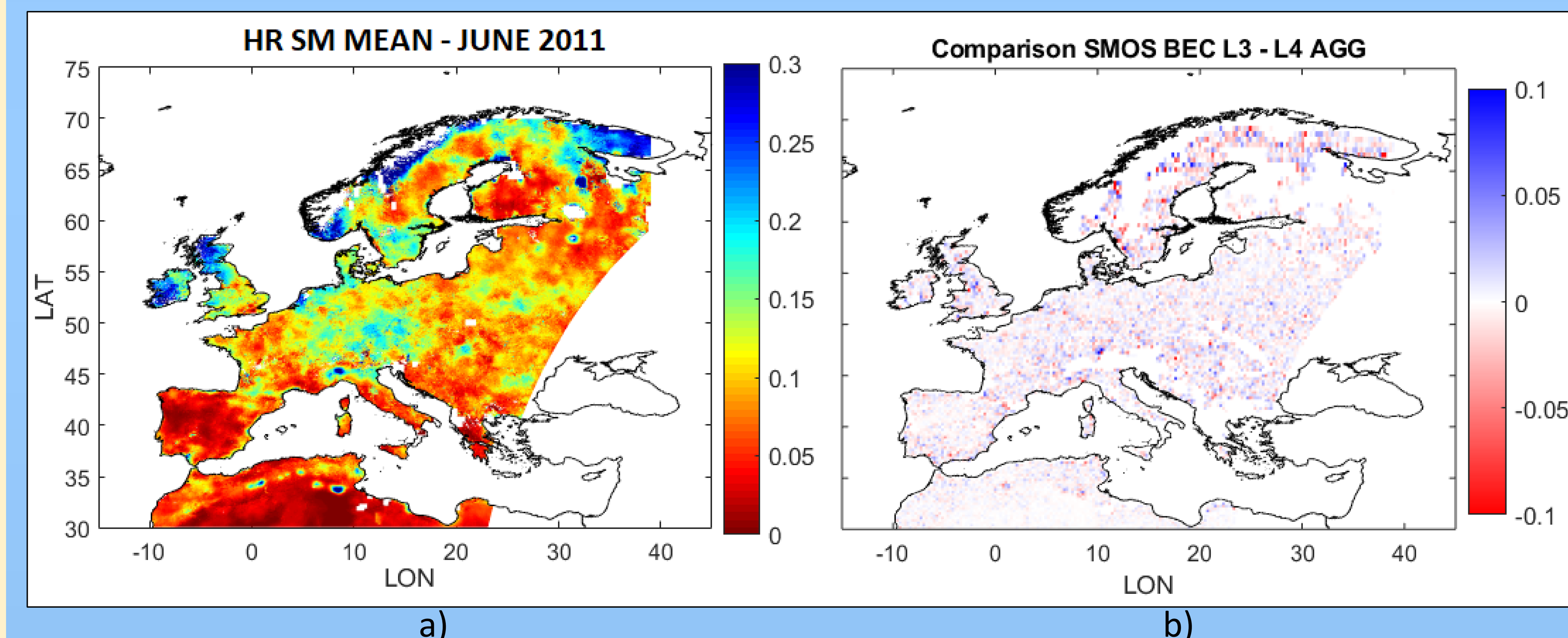

Figure 4. a) Continental HR SM and b) map of the differences between the SMOS BEC L3 SM and the HR SM (1 km) aggregated to 25km.

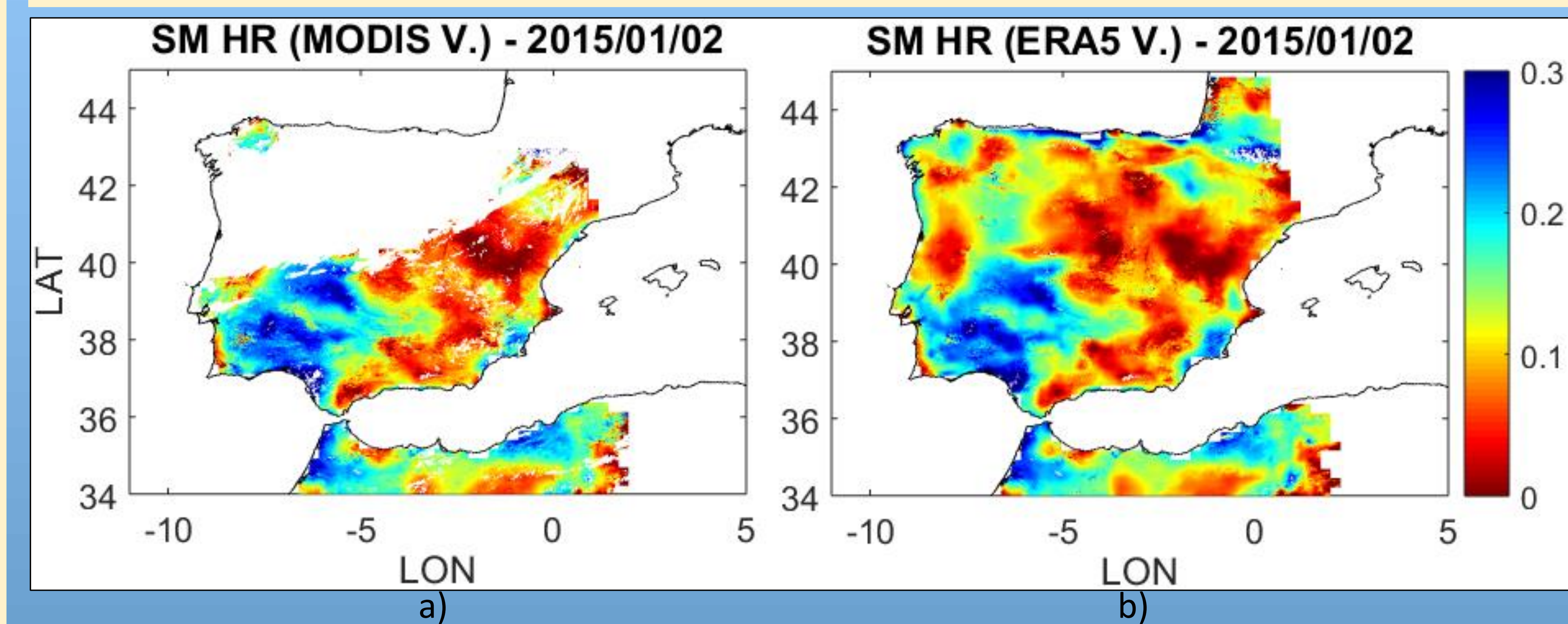

Figure 5. HR SM maps using as an input parameter for the downscaling algorithm a) the MODIS LST and b) the ERA5 LST (Cloud Free).

5. CONCLUSIONS AND FUTURE WORK

- A spatially consistent downscaling algorithm for SMOS using an adaptive moving window has been presented.
- When HR maps are aggregated to 25 km from 1 km, the energy keeps almost the same with respect to the original coarse grid cell.
- The downscaling algorithm generates results which are consistent regardless of the size of the study area.
- Two versions of the algorithm developed: the cloud free and the SMOS MODIS.
- Future Work: Analyze the possibility of using Sentinel 1 data to improve the HR SM maps.

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[2] O. Merlin et al., "Disaggregation of SMOS Soil Moisture in Southeastern Australia," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 50, no. 5, pp. 1556-1571, May 2012.
[3] T. J. Jackson and T. J. Schmugge, "Passive microwave remote sensing system for soil moisture: some supporting research," *IEEE Transactions on Geoscience and Remote Sensing*, vol. 27, no. 2, pp. 225-235, Mar 1989.
[4] G. Portal et al., "A Spatially Consistent Downscaling Approach for SMOS Using an Adaptive Moving Window," *IEEE Journal of Sel. Topics in Applied Earth Obs. and Remote Sens.*, vol. 11, no. 6, pp. 1883-1894, June 2018.