COMPARISON OF GROUND BASED GLOBAL RADIATION MEASUREMENTS FROM AEMET RADIATION NETWORK WITH SIS (SURFACE INCOMING SHORTWAVE RADIATION) FROM CLIMATE MONITORING-SAF

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ABSTRACT

A comparison of monthly mean values for 2006 of daily global radiation from 31 radiometric stations, which form part of the AEMET (Spanish State Meteorological Agency) Radiation Network, with SIS (Surface Incoming Shortwave Radiation) from Climate Monitoring-Satellite Application Facility (CM-SAF) has been performed. The shortwave solar radiation is the flux reaching a horizontal unit earth surface in the 0.2 – 4μm wavelength band expressed in W/m^2.

SIS product is computed using SEVIRI (Spinning Enhanced Visible and Infrared Imager) and AVHRR (Advanced Very High Resolution Radiometer) data. The surface irradiance SIS is calculated from the incoming solar flux at the top of the atmosphere $E_{0,}$ and the atmospheric transmittance T which is estimated with a radiative transfer model in relationship to the Top Of the atmosphere Albedo (TOA) for different atmospheric and surface states.

The results show very similar data and sometimes near-coincident measurements between both sources of information with discrepancies around ±5%. In this study, a good agreement between monthly SIS data and monthly global radiation from ground based stations is showed for most of the year 2006.

The study reveals very encouraging results for the use of SIS data to elaborate a solar radiation Atlas for Iberian Peninsula region.

AEMET RADIATION NETWORK

Spanish State Meteorological Agency (AEMET) maintains a network of 51 radiometric stations providing ground-based radiation measurements. Figure 1 shows the location and different variables obtained in each station. In order to perform a comparative study of the values registered by SEVIRI and AVHRR radiometers with ground-based measurements, a set of 31 radiometric stations from this network has been selected including monthly global and diffuse radiation data for 2006.

The main radiometric stations measure the following set of variables: Global and diffuse irradiance, infrared radiation and UVB irradiance. Direct, global and diffuse sensors are installed on an automatic solar tracker (see Figure 2). It consists on shading units (the two black balls linked by a dipstick to the tracker) which casts shadows on the diffuse sensors.

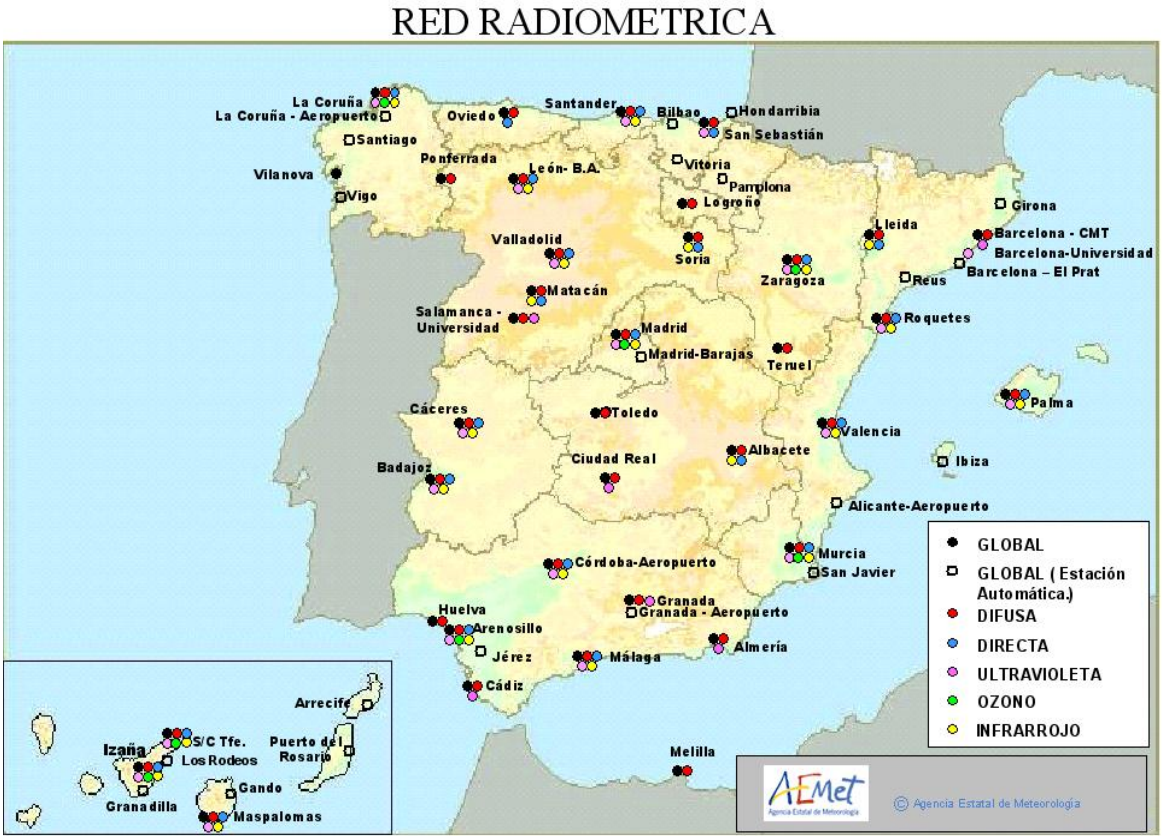

Figure 1: **AEMET radiation network.**

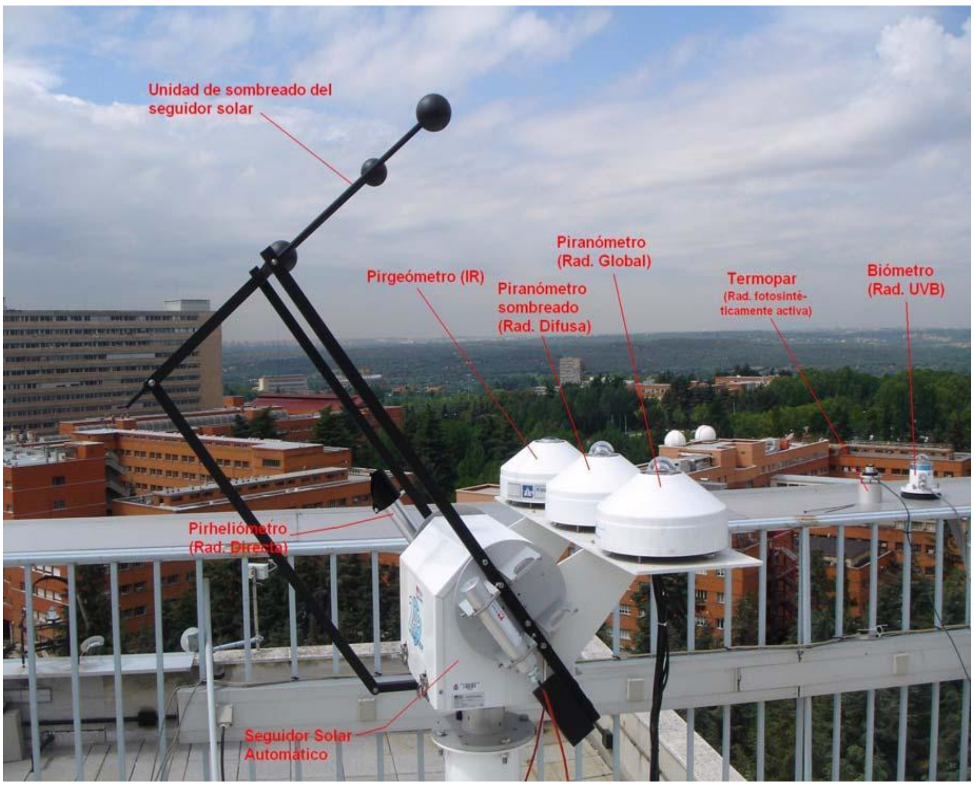

Figure 2: **Sensors placement in a AEMET main radiometric station.**

SATELLITE APPLICATION FACILITY ON CLIMATE MONITORING (CM-SAF)

SAF on Climate Monitoring (CM-SAF) was developed under the leadership of Deutscher Wetterdienst, the German Meteorological Service and entered its Continuous Development and Operations Phase in 2007 [Schulz et. al. 2009]. CM-SAF aims to provide and archive data that can be used to assess the current climate and its variability.
A thorough study has been carried out for 2006 using the product SIS (Surface Incoming Shortwave Radiation) monthly average daily values (15 km resolution), and comparing them with the corresponding global radiation data from the AEMET radiometric ground-based stations (see Figure3).
The shortwave solar radiation is the flux reaching a horizontal unit earth surface in the 0.2-4μm band expressed in W/m^2.
For the calculation of the surface incoming shortwave flux (SIS) an algorithm similar to the one developed by Pinker et. al. (1992) was developed. The basic idea for the algorithm is that a relationship between the broadband (0.2-4.0μm) atmospheric transmittance T and the reflectance R at the top of the atmosphere does exist. The reflectance R can be directly obtained from satellite measurements and the transmittance T is calculated in relationship to the broadband TOA albedo for a variety of atmospheric and surface states using a radiative transfer model (RTM). RTM calculations were carried out using 24 spectral bands and different atmospheric states, covering a wide range of values for water vapor, ozone, aerosol optical thickness and surface albedo.
It is important to note that ice clouds are not consider at the moment in the RTM calculations which could be a source of error to take into account in SIS estimations.

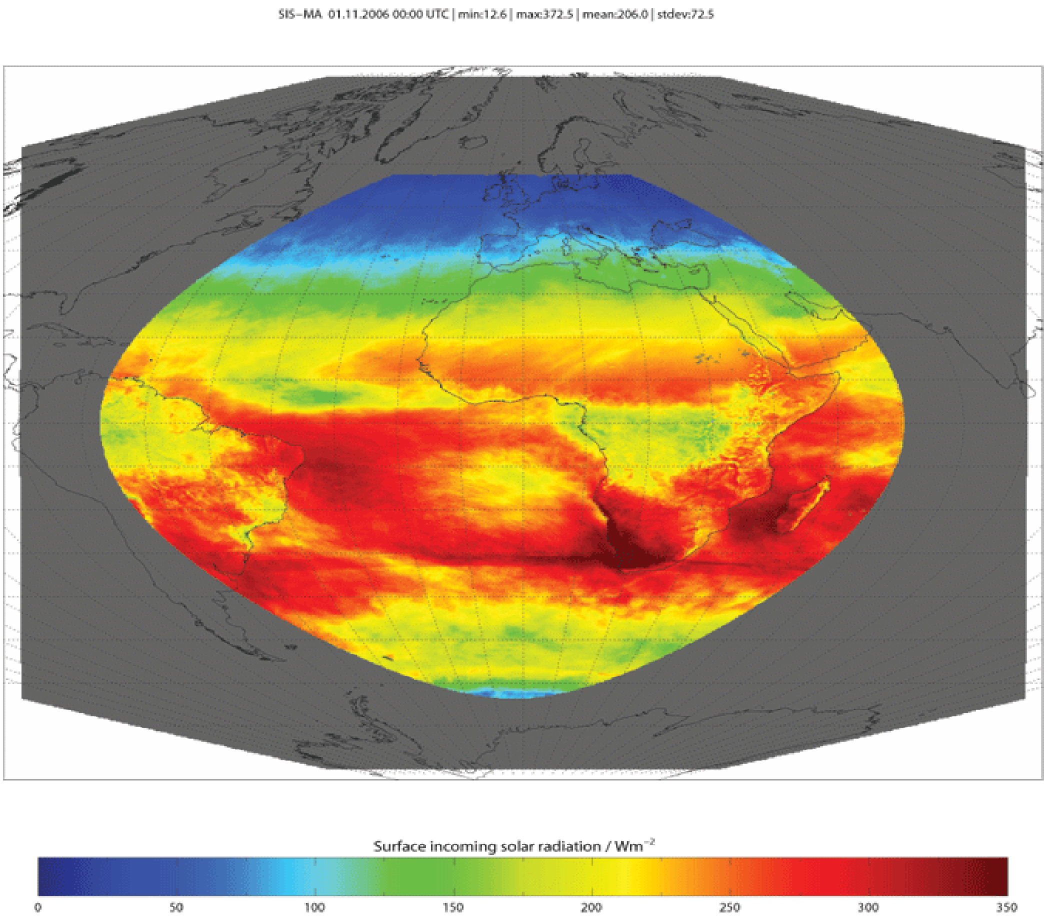

Figure 3: **Example of SIS product image.**

COMPARISON OF GROUND BASED GLOBAL RADIATION MEASUREMENTS FROM AEMET RADIATION NETWORK WITH SIS FOR 2006

In order to evaluate the reliability and precision of the algorithm used to estimate SIS values and the convenience of using SAF-CM SIS data to complement the ground based data from the radiometric stations, a comparison of SIS monthly mean daily data and the corresponding values from 31 selected AEMET stations, has been performed focusing on 2006. In Figures 4, 5 and 6, SIS values are shown in the first column, global radiation from radiometric stations in the second column and percentage differences between global radiation values from the stations and SIS in addition to the locations of the stations in the third column.

A good agreement between both sources of information is remarkable in general, with great similarities in the observed latitudinal global radiation gradients and even reproducing the same data contouring structures. The dominant green colour in the percentage difference fields (third column) indicates very low difference values even during the months with maximum insolation (may, june and july) in which the latitudinal radiation gradients are also more important. Maybe the only exception is october when an appreciable difference should be noted, probably due to disregard ice clouds in SIS calculations in RTM model. It is planned to later also include results for ice clouds.

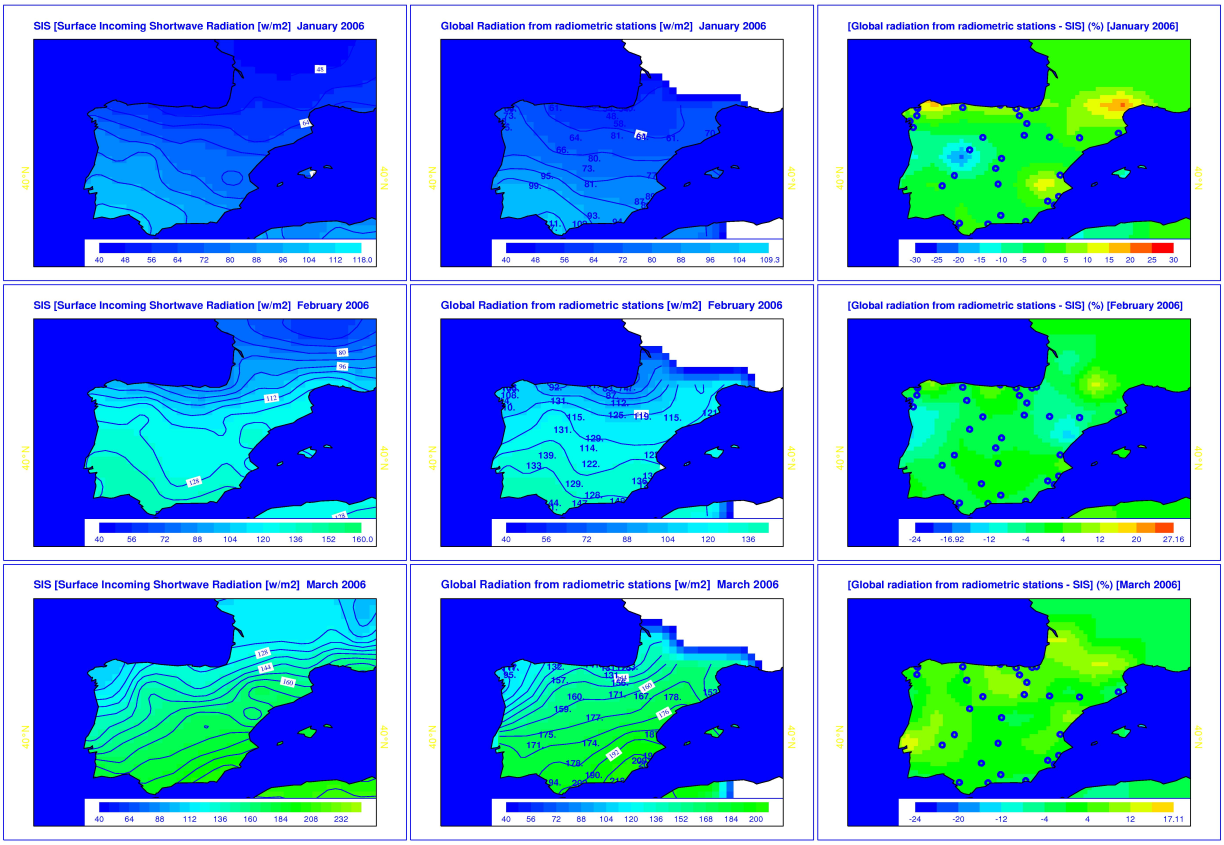

Figure 4: **Comparisons of SIS product and in-situ measurements for January, February and March (2006).**

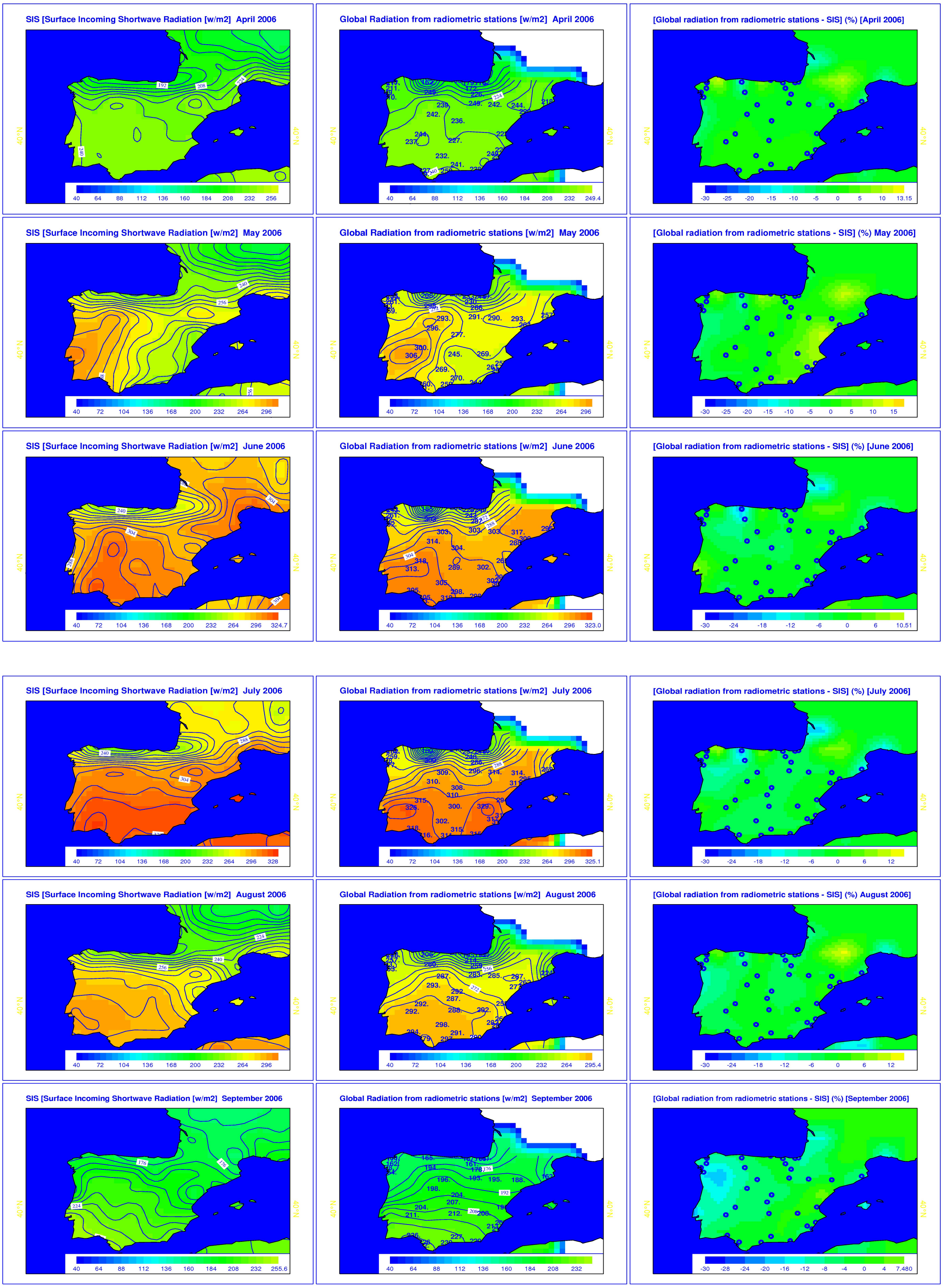

Figure 5: **Comparisons of SIS product and in-situ measurements for April, May, June, July, August and September (2006).**

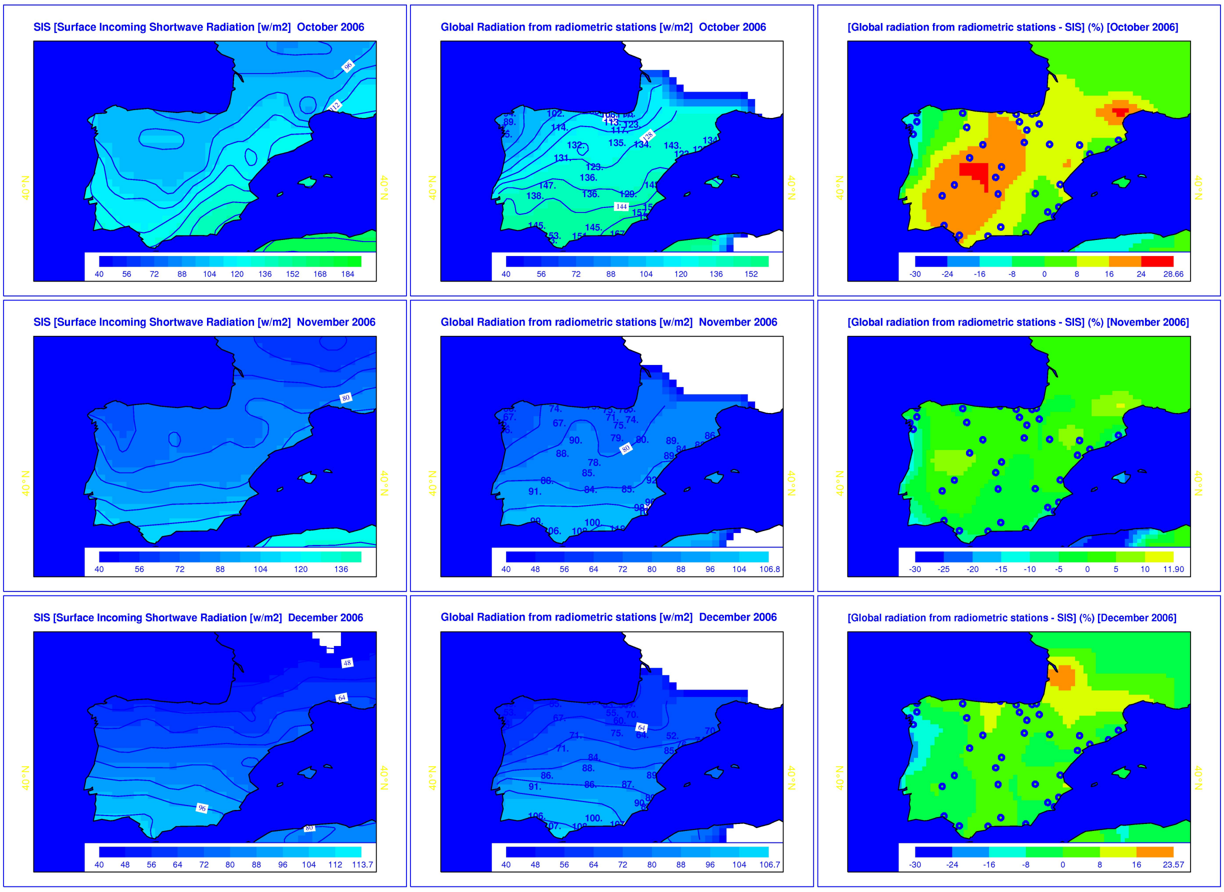

Figure 6: **Comparisons of SIS product and in-situ measurements for October, November and December (2006).**

Figure 7 shows the monthly mean daily irradiance values for 2006 for two AEMET radiometric stations and the corresponding SIS values interpolated at the locations of each location. The results show again a great similarity in the data even during the months with maximum variation in global irradiance (dates near the equinoxes from march to may and from september to november). On the other hand, neither systematic underestimation nor overestimation is revealed throughout the year with the exception of october, when SIS data are a bit lower than radiometric data from the stations. Global irradiance data show a higher rate of decline in autumn months than the rate of increase during spring months.

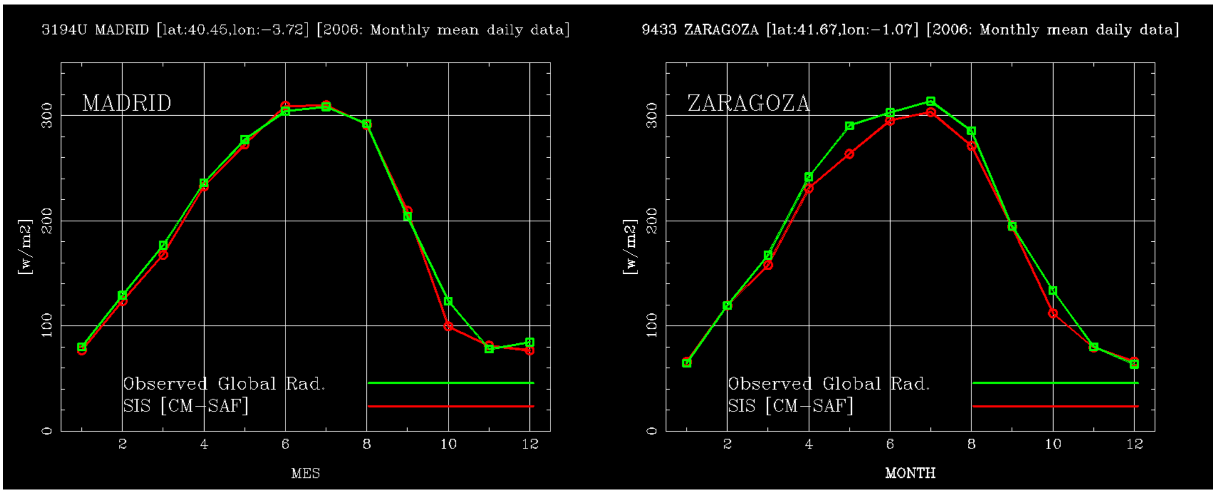

Figure 7: **Comparisons of SIS product and in-situ measurements for Madrid and Zaragoza stations during 2006.**

CONCLUSIONS

A comparison of SIS (Surface Incoming Shortwave radiation) monthly mean daily data from Climate Monitoring CM-SAF and the corresponding values from 31 selected AEMET radiometric stations has been performed focusing on 2006. A good agreement between both sources of information is remarkable in general with discrepancies in the order of ±5%. Great similarities in the observed latitudinal global irradiance gradients, even reproducing the same data contouring structures have been found. In general, nearly coincident data is revealed when comparing throughout the year the in-situ data and the SIS interpolated values for different stations.

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