Total water vapour column on the Iberian Peninsula: Satellite vs ground measurements

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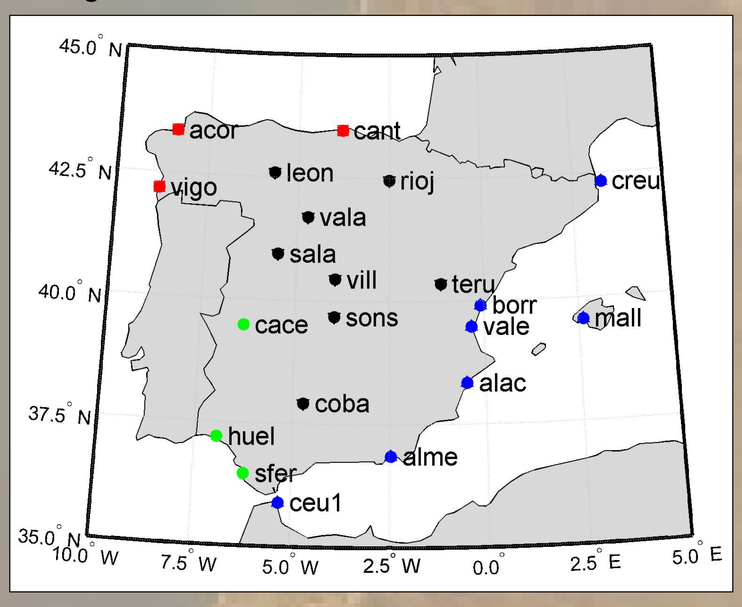
OBJECTIVE

The main aim of this work is the validation of water vapour column (WVC) product of GOME-2 instrument (on board MetOp-A satellite) at the Iberian Peninsula. WVC data from GPS instruments are used to this end. Another target is to study the effect of solar zenith angle (SZA) and cloud fraction (CF) on the accuracy and precision of GOME-2 product.

DATA AND METHOD

The WVC data from GOME-2 (GDP-4.6 version) were obtained at 21 GPS stations located at the Iberian Peninsula (or near) and indicated in the next figure:



The nearest pixels to stations were selected. CF, SZA and albedo flag (AF; "sea"=1, "land"=0) were also obtained from GOME-2. Data period was from 2007 to 2012.

VS.

The accuracy and precision of GOME-2 to estimate the WVC/GPS is studied using the mean (**MBE**) and the standard deviation (**SD**) of the GOME-2 and GPS differences.

MBE and SD at each station "s" (MBE_s and SD_s) were calculated with the available N_s data by:

$$MBE_s = \frac{1}{N_s}\sum_{i=1}^{N_s}\Delta_{s,i}\,;\; SD_s = \sqrt{\frac{1}{N_s-1}\sum_{i=1}^{N_s}\left(\Delta_{s,i}-MBE_s\right)^2}$$

where $\Delta_{s,i}$ is the diffence of the i-data of WVC (w) defined in absolute or relative value by:

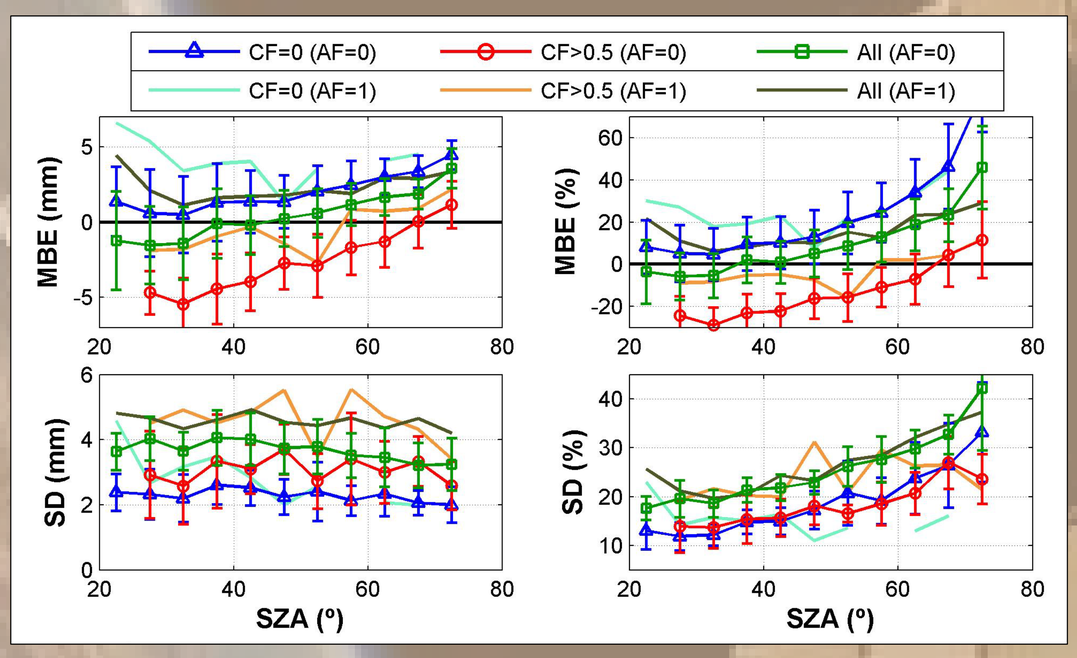
$$\Delta_{s,i} = w_{s,i}^{GOME} - w_{s,i}^{GPS}\,;\; \Delta_{s,i}(\%) = 100\,\frac{w_{s,i}^{GOME} - w_{s,i}^{GPS}}{w_{s,i}^{GPS}}$$

Finally, MBE and SD were obtained as the average of the MBE_s and SD_s of the N_{sta} stations:

$$MBE = \frac{1}{N_{sta}}\sum_{s=1}^{N_{sta}} MBE_s\,;\; SD = \frac{1}{N_{sta}}\sum_{s=1}^{N_{sta}} SD_s$$

RESULTS

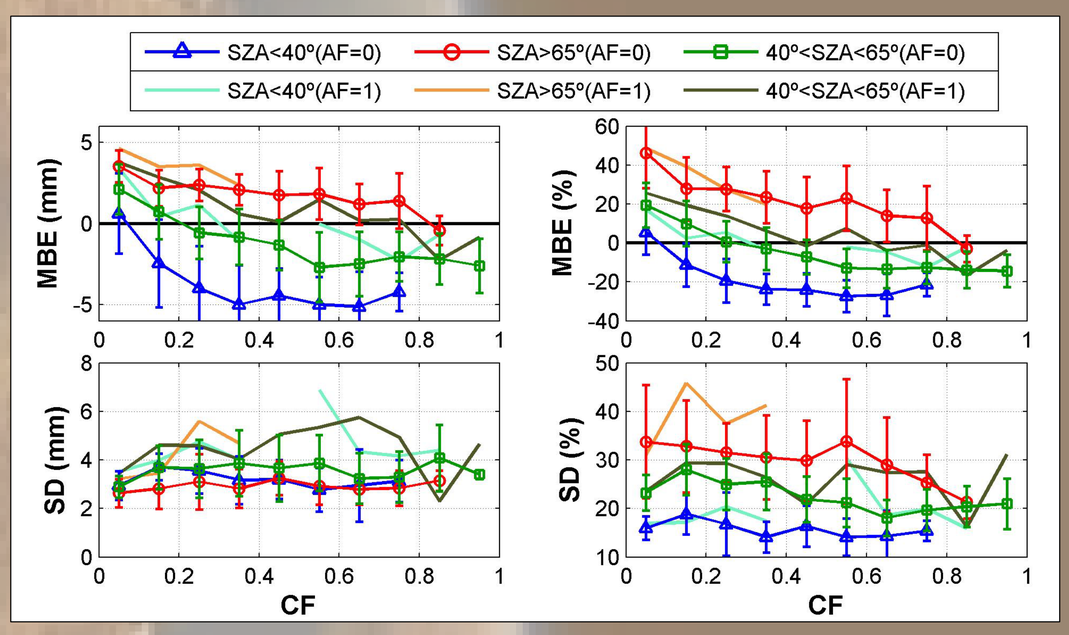
Absolute and relative MBE and SD were calculated at 5º SZA bins from 20º to 75º for AF=0 (land) and AF=1 (sea), and for three different sky conditions: cloud-free (CF=0), cloudy (CF>0.5) and all cases (All). Error bars are the deviation between stations.



For those cases with SZA below 40º under cloud-free conditions, the accuracy of GOME-2 is high for AF=0, while GOME-2 clearly overestimates GPS measurements for AF=1.

By contrast, for the same SZA interval but under cloudy conditions, GOME-2 strongly underestimates GPS for AF=0, while the MBE is near zero for AF=1. These results suggest that GOME-2 retrieval algorithm overestimates WVC data for surface conditions flagged as sea under cloud-free conditions. Regarding the precision given by SD values for SZA lower than 40º, GOME-2 is more precise in land and under cloud-free conditions, followed by cloudy conditions in land and cloud-free in sea (around 2.5 mm; 10-15%). For those cases with SZA above 40º (when number of cloudy data increases), the cloud-free and cloudy GOME-2 data increase the relative overestimation with increasing SZA (for land albedo flag). The MBE values closest to zero are found for sea flag cases under cloudy conditions, which is caused due to the balanced effects over the GOME-2 retrieval algorithm: cloudy cases reduce MBE while the "sea" cases increase it. This balanced effect is not recorded by the SD parameter, reporting values higher than 20% for those conditions.

In order to study the influence of SZA and AF on the CF dependency, Fig. 4 shows the MBE and SD as a function of 0.1 CF bins for different SZA intervals, and for AF=0 and AF=1.



The relative SD shows the lowest values for low SZA values with land flag, being similar for all CF values. Regarding MBE, it is near to zero (good accuracy) for the smallest CF corresponding to SZA below 40º with AF=0.

Additionally, all MBE curves show a sharp decrease with increasing CF up to CF~0.3, and from this value, a slight decrease or stabilization. Furthermore, it must be noted the large difference between the curves corresponding to "land" and "sea" surfaces for SZA values below 40º, with MBE close to zero for "sea" cases. This latter result is associated with a balanced effect between the satellite overestimation related to "sea" surfaces and the underestimation due to low SZA conditions.

CONCLUSIONS

WVC from GOME-2 is very promising, being in a good agreement with the GPS data recorded at the Iberian Peninsula, but this satellite product still needs some improvements in order to reduce the notable geometrical dependence observed for SZA above 40º. The accuracy and precision of GOME-2 to predict WVC depend strongly on SZA and the cloud fraction, presenting better precision for SZA values below 40º and cloud-free conditions. The accuracy and precision of GOME-2 depend also, but weaker, on the type of surface.

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