

Interactive comment on “Comparison of satellite microwave backscattering (ASCAT) and visible/near-infrared reflectances (PARASOL) for the estimation of aeolian aerodynamic roughness length in arid and semi-arid regions” by C. Prigent et al.

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The manuscript is focussed on the estimation of the aerodynamic roughness length (z_0) in arid and semi arid regions. The potential of two satellite approaches is discussed: visible/near-infrared observations (PARASOL part of the A-Train) and microwave backscattering measurements (ASCAT on board MetOp). The main objec-

C2086

tive of the paper is to derive a global map of z_0 at 6km spatial resolution for arid and semi arid regions. This can be useful for atmospheric dust modelling. The manuscript contains a number of questions regarding the method used to derive z_0 (semi arid regions, winter selected period, interpolation method: : :). These are described below. Also, additional work on the discussion of the z_0 products appears to be necessary (PARASOL z_0 vs ASCAT z_0 in desert areas). Consequently, the manuscript requires important revisions before publication.

p. 2936, l. 20-22: “Our objective here is to find a practical relationship between the : : :”. Over arid regions, z_0 is expected to be stable in time. Is it also the case for semi arid areas (seasonal vegetation, agricultural activities: : :)? How can the temporal variability of the vegetation in semi arid areas and its influence on the z_0 derived from satellite observations be taken into account? Please discuss this point in the paper.

> We agree that the z_0 can undergo some temporal variability, related to vegetation, to agricultural activities, or even to changes in dune patterns or to dust deposition following an aerosol event. Our primary objective in this study is to analyse the complementarity of the two observation types (namely the visible and the active microwave) to provide roughness length. In a previous study using active microwave only (Prigent et al., 2005), we analysed the temporal variability of the roughness length. From our analysis (and from previous work such as Marticorena et al, 2004), it appears that due to atmospheric contaminations (clouds, but also dust events), the visible observations cannot be used on a regular basis to update the roughness estimates. As a consequence, in order to benefit from the high spatial resolution from the visible, we limited our analysis here to November-February, when the atmospheric dust contamination is more limited for the visible observations. Comments have been added in the text, in section 3.1 and in the conclusion.

p. 2938, l. 20: “Figure 1 shows the mean k_1/k_0 coefficient for the 2007-2008 winter: : :”. The median k_1/k_0 was used in previous studies (e.g. Marticorena et al., 2004). For this kind of applications, median values seem to be more relevant than averaged

C2087

values. Why the mean k_1/k_0 coefficient is used here and what would be the results using median values?

> The two solutions have been tested, with very limited differences. In Marticorena et al., 2004, the reviewer is right, it is the median value that is used but there is no clear justification for it.

p. 2939, l. 2-3: Please indicate the location and coordinates of the three different zones (a,b and c).

>Zone a: latitude 18 to 22, longitude 45 to 55 Zone b: latitude 25 to 27, longitude -5 to 0 Zone c: latitude 13 to 15, longitude -17 to 0 This has been added to the caption in figure 1.

p. 2940, l. 10: "For this study, the 865 nm observations during the 2007 winter months will be used". The large variability of the shorter wavelengths is clearly pointed out by the authors (Fig. 2, 443 nm and 565 nm). For the third region (Fig. 2, c, right panel), variations are observed for the 3 wavelengths (670 nm, 765 nm and 865 nm). The use of the 865 nm observations instead of a combination of the observations at the 3 wavelengths is not obvious for me and needs to be discussed more in detail.

> We tested several combinations of wavelengths, as well as separately forward and backward reflectances. We found that high correlation between the different parameters, with the 865 nm presenting the lowest noise level. Note that Marticorena et al. also reach similar conclusion.

p. 2940, l. 11: "For this study, the 865 nm observations during the 2007 winter months will be used". The authors well-explain that winter months were chosen because the atmospheric dust contamination is the lowest during this period. The winter months (Nov. to Feb.) were chosen for North Africa and the Arabian Peninsula (p. 2938, l. 15-23). Yet, the seasonal variability of the atmospheric dust load is not the same for the different desert regions. In order to establish a z_0 global map (Fig. 6 A), it needs

C2088

to be pointed out which winter months were considered for the desert regions of the southern hemisphere (Nov. to Feb. are no winter months there). For instance, in Australia, October to March are considered to be the months of maximum atmospheric dust-loadings. Please indicate clearly in the paper which months were chosen for the different desert regions and add references to confirm their low dust periods.

> It has been made clear in the text that the selected winter months correspond to the northern hemisphere. We agree with the reviewer that the seasonality of the atmospheric contamination can be different over the different regions of the globe. With the objective of providing a global estimate of roughness length, we selected the period of time that shows minimum atmospheric contamination in a global sense, and this corresponds to the northern winter months. For detailed regional studies, we agree with the reviewer that the visible observations should be selected during the minimum of atmospheric contamination for that specific region. Note that our study presents the first results of roughness length estimate from visible observations, and our results appear to agree well with other related parameters, at a global scale.

p. 2940-2941, 2.3 In situ data: Please indicate which of the in situ data used correspond to arid regions and which ones correspond to semi arid regions. To derive z_0 for arid and semi arid areas, statistical relationships should be established using in situ data representative of both arid and semi arid regions. Please discuss also if the same relationship can be used to obtain z_0 for arid areas and for semi arid areas.

> Here again, the reviewer has to have in mind that we want to obtain global relationship that can be applied 'practically and operationally' at global scale. This is why we avoid developing specific relationship for specific environments. There is a clear need for globally consistent maps of roughness parameters, and this is what our study provides. We fully agree that for local studies, finer analysis could be conducted, classifying different surface types and establishing different relationship between the roughness length and the satellite observations. It has not been proved however that these cautions would necessary provide better results. For instance, our long experience in

C2089

satellite processing shows that adding pre-classified surface types in the retrieval of land surface parameters can introduce errors due to the selection of the classification mask, as well as to unphysical transitions between the different classes.

p. 2942, l.23: "A good correspondence is obtained between the two satellite products: : :". Please indicate the PARASOL and ASCAT z0 values corresponding to the different locations in Table 1. This can help to discuss quantitatively the correspondence between the z0 datasets derived from the two satellite products.

> The Parasol and ASCAT z0 values have been added in Table 1.

p. 2943, l. 18: "Only regions with z0 lower than 0.1 cm are represented, corresponding to arid and semi arid areas." Could you please explain how this 0.1 value was chosen?

> The FAO [2003] classification allows to isolate the worldwide 'dunes or shifting sands' units (Figure 6 a). The threshold values are obtained by adding the mean and the standard deviation of the z0 computed over this soil unit for each z0 product. The mean value plus one standard deviation of the "dunes and shifting sand" unit is equal to 0.11 cm, consistent with the z0 variation range for bare surfaces by Darnenova et al. (2009) (see Table 2 in their paper).

In Table 1, half the z0 values (14/29) corresponding to desert regions are higher than 0.1 cm. Maps of z0 estimates presented in Fig. 6 should be produced using a relevant threshold value.

> We agree with the reviewer that a significant number of the z0 in situ values used to derive the linear regressions are higher than 0.1 cm. However, our analysis shows that when applying the relationship to all regions, contamination of the observations, both visible and active microwave, by vegetation and topography can lead to results that are not realistic, and a threshold is applied to limit the impact of these contaminations.

p. 2943, l. 19: "For PARASOL, the averaged 2007-2008 winter observations are considered: : :". Please indicate the winter months for the northern and the southern

C2090

hemispheres (see previous comment p. 2940).

> As previously mentioned, the same northern hemisphere winter months have been used for both hemispheres. This has been made clearer in the text. See comments above.

p. 2943, l. 22: "For ASCAT, z0 is estimated from the yearly average (July 2007-June 2008)". The ASCAT standard deviation for the entire year 2007 was high in the Sahel on the map presented in Fig. 1 F. A yearly average might not be adapted for semi arid regions. Please discuss if the seasonal variability of z0 in vegetated semi arid regions can be problematic (seasonal vegetation, agricultural activities). Please discuss the relevancy of z0 monthly maps for semi arid regions to be used in atmospheric dust models instead of a yearly average.

> The roughness length in semi-arid regions is likely to vary. We are not dust modelers, but our understanding is that so far fixed maps of roughness lengths have been used, taking into account vegetation phenology where and when necessary (based on NDVI usually). From active microwave observations (Prigent et al., 2005) we derived monthly mean climatology of roughness estimates over the globe. In this study, we limit our analysis to the northern winter months because of the atmospheric contamination of the visible observations (see comments above). The interest of the visible information lies in its enhanced spatial resolution as compared to the active microwaves, but with strong limitation in the temporal sampling of the information.

p. 2943-2944: Contrary to the "good correspondence [: : :] obtained between the two satellite products: : :", the z0 maps (a,b) in Fig. 6 present different patterns (location of the higher and lower values: : :). Please discuss the differences observed between the two z0 datasets in the desert areas in details. Merging the two dataset seems tricky.

> There are differences between the data set at local scale that could be discussed. However, with a correlation coefficient of 0.91, the two z0 datasets agree very well, with very consistent patterns at regional and continental scales. Their merging is thus

C2091

legitimate and does not cast specific problems.

p. 2944, l. 1-4: When the PARASOL observations are not present, z_0 retrieved from ASCAT observations should only be at 25 km spatial resolution.

> Even when PARASOL is not present, the ASCAT data have been projected to the PARASOL grid, for the sake of homogeneity of the dataset.

p. 2944, l.6-11: "Regions that are likely rather wet: : ." "This suggest that: : :". The relationship developed here can be used to obtain z_0 for desert areas but may not be easily extended for other regions.

> This is perfectly true. This is the reason why we avoid to extend the roughness calculation to all regions, where the satellite observations can be contaminated by factors (vegetation, wetness, topography. . .) that are not accounted for by the established linear relationships from section 3.

p. 2950, Tab. 1: Please add two columns in Table 1: one for the PARASOL z_0 values and another for the ASCAT z_0 values obtained for these locations. This can be complementary to Fig. 4 and can help to have a quantitative discussion of the differences between the two z_0 datasets in the paper.

> The Parasol and ASCAT z_0 values have been added in Table 1.

p. 2953, Fig. 3: Please rewrite the z_0 equations presented on the plots (z_0 should be in cm). Please also present the bars indicating the standard deviation over the area for ASCAT.

> There is no standard deviation for ASCAT, as only one pixel is taken into account in the comparison with in situ data. The standard deviation for the visible observations essentially correspond to the spatial variability, when the in situ measurements are not point measurements but are representative of a small area that encompasses several PARASOL pixels. z_0 is already in cm.

C2092

p. 2954, Fig. 4: A scatter plot of $\log(z_0)$ would be more relevant to present and discuss the results. z_0 values presented in Tab. 1 range over more than three orders of magnitude (0.002 - 0.873 cm).

> The figure is now in $\log(z_0)$.

p. 2955, Fig. 5: Same comments as for Fig. 3. Please rewrite the z_0 equations presented on the plots (z_0 should be in cm). Please also present the bars indicating the standard deviation over the area.

> We do not understand the problem with the z_0 equation: z_0 is already in cm. There is no standard deviation to be associated to the z_0 estimates directly here (contrarily to what is presented on figure 3, it is not z_0 versus satellite observations, but versus in situ measurements).

p. 2956, Fig. 6: In order to interpret the z_0 maps and discuss the variability of z_0 values over several order of magnitude, $\log(z_0)$ should be mapped. Please make new maps of A, B and C.

>The images are now in $\log(z_0)$.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 2933, 2012.

C2093