QUALITY OF THE STANDARD ATMOSTHERIC PRODUCTS FROM THE SEAWIFS AND MODIS SENSORS OVER THE BLACK AND MEDITERRANEAN SEAS

Vyacheslav Suslin, Georgy Tolkachenko*, Sónia Cristina***

*Marine hydrophysical institute of National Academy of Sciences of Ukraine, 2, Kapitanskaya str., 99000, Sevastopol, Ukraine,
**IMAR-FCT-University of Algarve, Campus de Gambelas, 8005139 Faro, Portugal, e-mail: slava.suslin@gmail.com

One of the major determinants of the quantitative description in respect to the nature phenomenon is the accuracy of the measurements. Despite the active use of standard level-2/3 products derived from satellite ocean color measurements in different applications, the attempts of analysis of its accuracy are continued [1, 2]. This is an urgent need of research community to use the satellite-derived data for a clear understanding of its quality.

The goal of this work is to analyze the quality of the standard SeaWiFS- and MODIS-derived products such as aerosol optical thickness, below as τ_a, and Angstrom exponent, below as α. First of all, the Black Sea and eastern Mediterranean are the areas of this study. Both of these sites are specific. They are the closed seas and, therefore, they can be force by dust aerosol. In addition to the understanding of the identified features, other domains were studied too. These are Atlantic Ocean near the southern coast of Portugal (high impact of oceanic aerosol, but it is the same latitude like eastern Mediterranean) and eastern part of the Baltic Sea (far from the equator area, but it is also a closed sea as the Black and Mediterranean Seas). The standard aerosol level-2 products of SeaWiFS (GAC, Version 5.2) and MODIS-Aqua/Terra (LAC, Version 1.1) sensors [3] and *in situ* measurements of four AERONET sites such as Sevastopol, Forth Crete, Gotland and El Arenosillo (Level 2.0 Direct Sun Algorithm, Version 2/ Level 2.0 Almucantar Retrievals, Version 2) [4] were used.

Table. Maximum (τ_a/α) of two-dimensional histograms in Figures 1-5.

region/instrument	***AERONET***	***SeaWiFS***	***MODIS-Aqua***	***MODIS-Terra***
Black Sea	0.084 /1.52*	0.132/0.65[a] 0.121/0.81[b] 0.121/0.81[c]	0.139/0.84[a] 0.113/0.87[b] 0.106/0.89[c]	0.142/0.86[a] 0.112/0.94[b] 0.108/0.96[c]
Eastern Mediterranean	0.096/1.21**	0.139/0.55[a] 0.128/0.60[b] 0.127/0.64[c]	0.150/0.58[a] 0.119/0.65[b] 0.109/0.68[c]	*****
Atlantic Ocean near South Portugal	0.076/1.02***	0.142/0.37[a] 0.107/0.55[b] 0.102/0.59[c]	0.144/0.40[a] 0.111/0.46[b] 0.099/0.48[c]	*****
Western Baltic Sea	0.063/1.29****	0.106/0.52[a] 0.094/0.81[b] 0.092/0.83[c]	*****	*****

Note: */ **/ ***/ **** - Sevastopol/Forth Crete/El Arenosillo/Gotland AERONET stations; ***** - values were not calculated; ***a*** – data where flag 21 sets 1 and flag 4 sets 0; ***b*** – data where τ_a and α values are calculated; ***c*** – data where both flags 4 and 21 set 0.

We have built two-dimensional histograms of τ_a and α using data sets obtained during the lifetime of listed above sensors and AERONET sites. The results are presented in Figs. 1 - 5 and the Table. For a fixed area, the principle difference between Aeronet measurements and standard satellite-derived products is in their maximum location in the histograms. An Aeronet maximum has essentially higher value of Angstrom exponent. The Baltic Sea is an exception there is a difference also, but it is minimal. It is reasonable to assume that the statistical properties of Aeronet data are true, then the mentioned above difference can be explained by the impact of glint on the standard satellite-derived products. This statement is confirmed by changes of the maximum location in the histograms for the specially prepared samples of satellite data, in particular, the use of flags of 4 and 21, which increased the contribution glint components in experiments ***c***-> ***b*** -> ***a*** (see Table). As a result, the shift of the histogram maximum is occurred in the direction of higher values of aerosol optical thickness and lower values of Angstrom exponent. It indicates that this shift is an impact of the increasing forcing of glint component. For the MODIS sensor compared with SeaWiFS sensor, this effect is more powerful because of the lack of a tilt (higher values of τ_a in case ***a***).

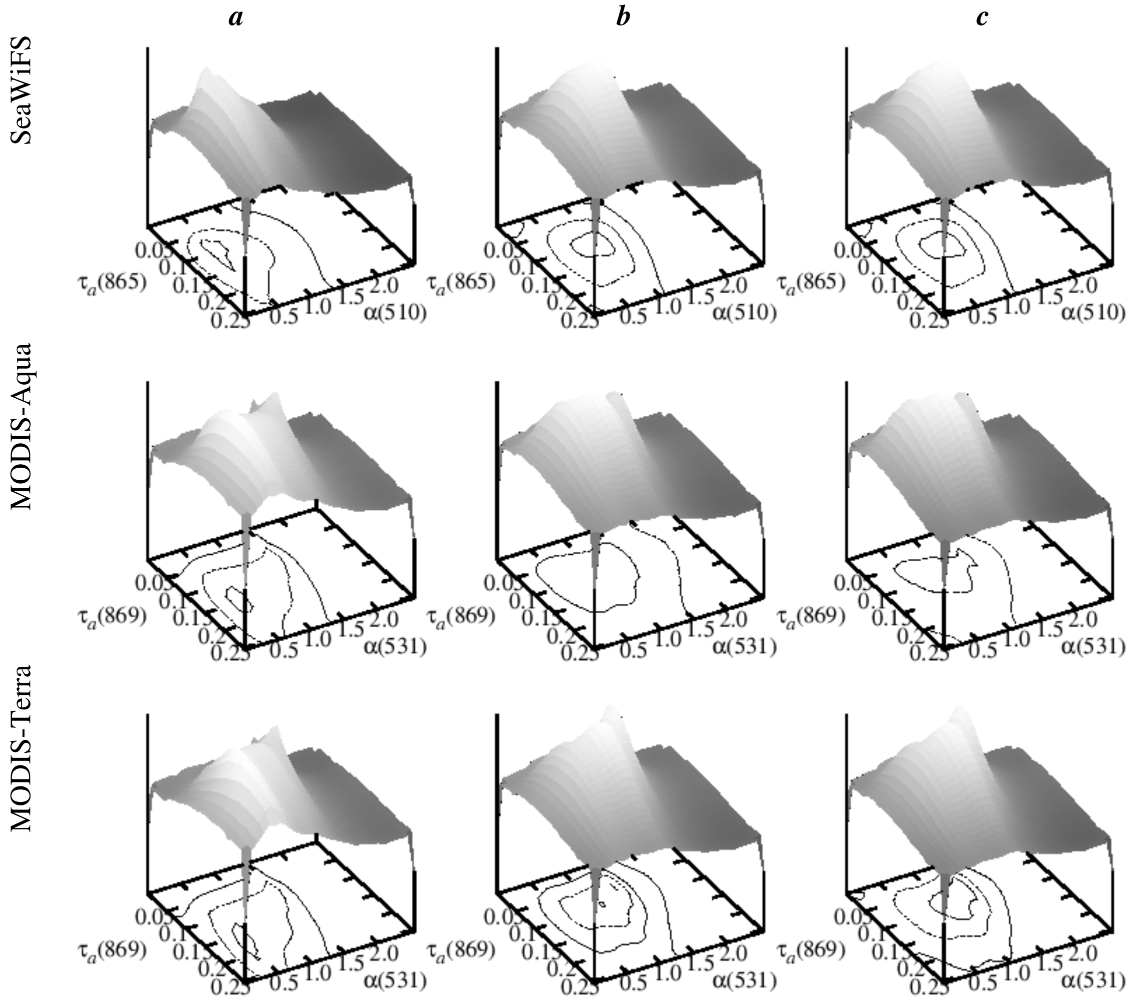

Figure 1. Two-dimensional histograms of τ_a and α over the Black Sea (40.6-47N, 27-42.7E) during lifetime of SeaWiFS and MODIS-Aqua/Terra sensors. Note: *a*, *b*, *c* – see comments in Table.

a ***b*** ***c***

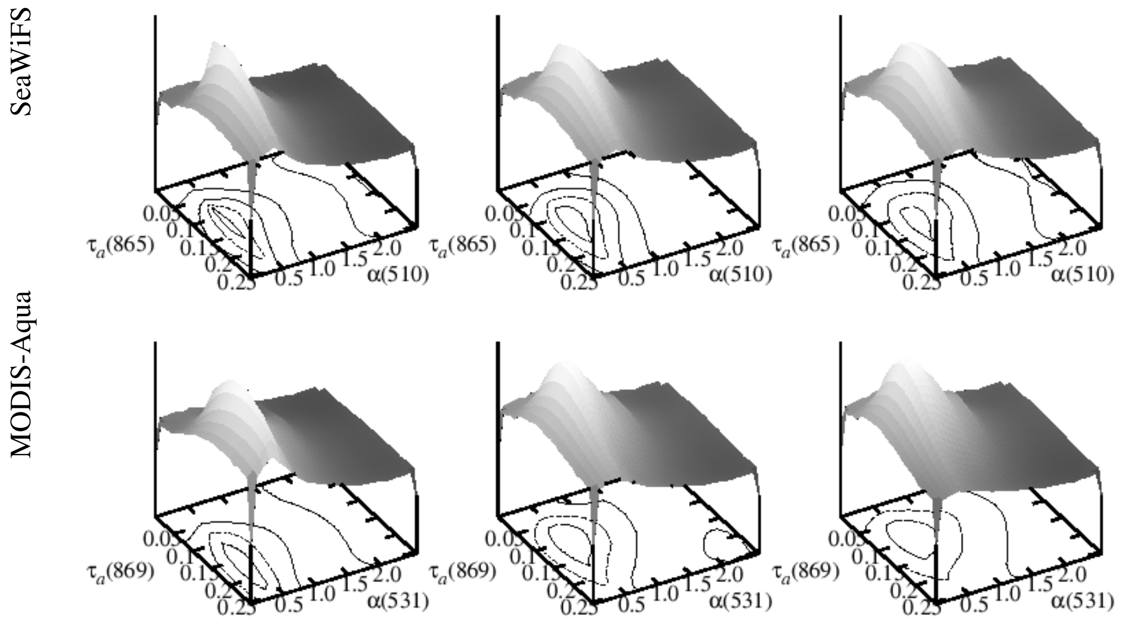

Figure 2. The same as Figure 1 for Eastern Mediterranean (30.6-37N, 21-36.7E). Note: *a*, *b*, *c* – see comments in Table.

a ***b*** ***c***

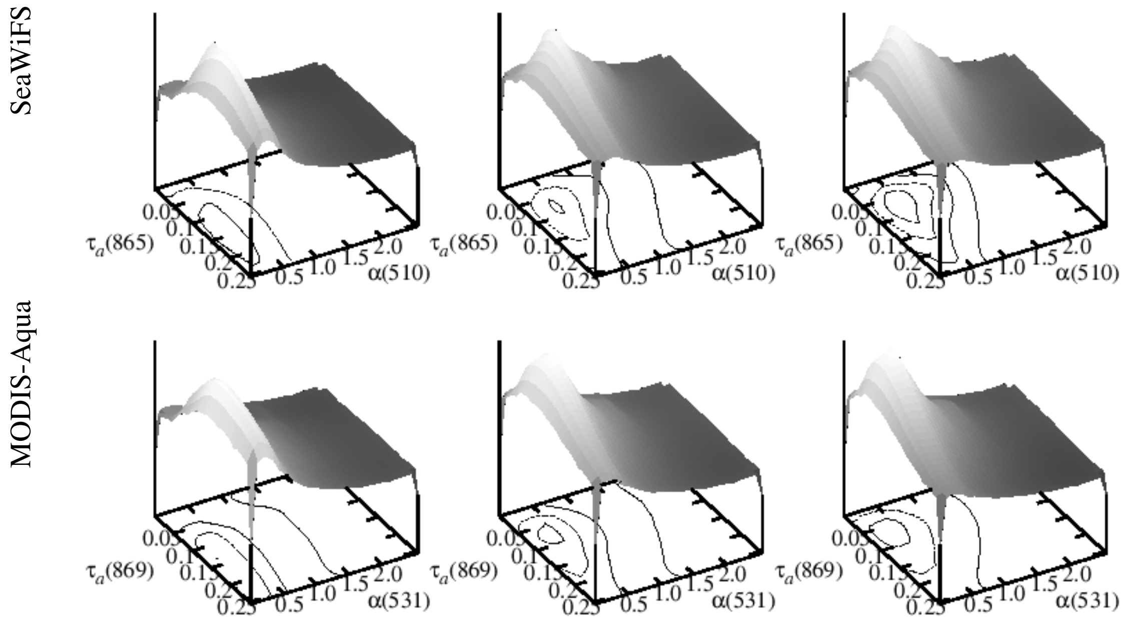

Figure 3. The same as Figure 1 for Atlantic Ocean near south Portugal (33.6-40N, 15W-0.7E). Note: *a*, *b*, *c* – see comments in Table.

a ***b*** ***c***

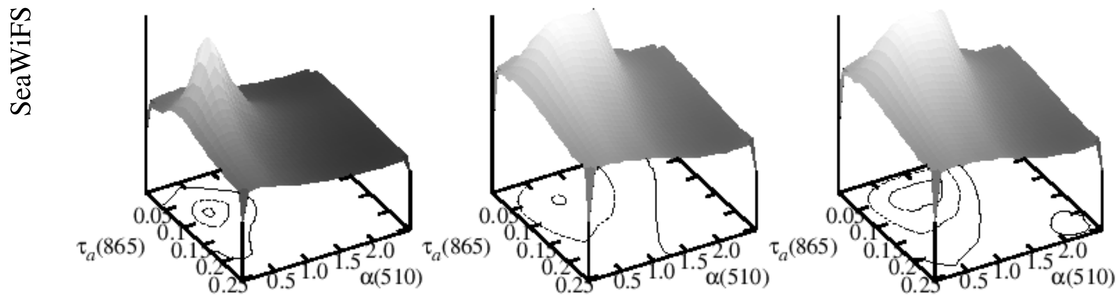

Figure 4. The same as Figure 1 for Eastern Baltic Sea (54.6-61N, 15-30.7E). Note: *a*, *b*, *c* – see comments in Table.

Another mark of the glint influence on the satellite-derived products is the trend of increasing of τ_a maximum with decreasing of region latitude from the Baltic to the Black Sea and further to the Mediterranean Sea, while the value of α is low. An additional experiment with the flag 11 has shown that the effect of high τ_a can not be the result of high backscattering values due to the presence in seawater of small detached coccoliths. This is well shown in the chain experiments from Black Sea to Mediterranean Sea, in which the influence of coccolithophore bloom decreases, but the value of τ_a increases. Module of near-surface wind speed (and, therefore, glint component or flags 4 and 21) is better forecast in the open ocean than in closed seas, especially if they include islands. This follows from comparing the locations of histogram maximum for Atlantic and Mediterranean areas (see Figs. 2-3).

Considering a side effect, the results of extrapolation of the histogram maximum for Sevastopol station and SeaWiFS sensor are presented in Fig. 6 (case ***c*** , Black Sea). It is significant that concurrence of lines is in the range of wavelengths from 490-555 nm. It can also explain of well-known fact about more quality of standard level-2/3 products obtained in this spectral range as compared in the blue region [5-6].

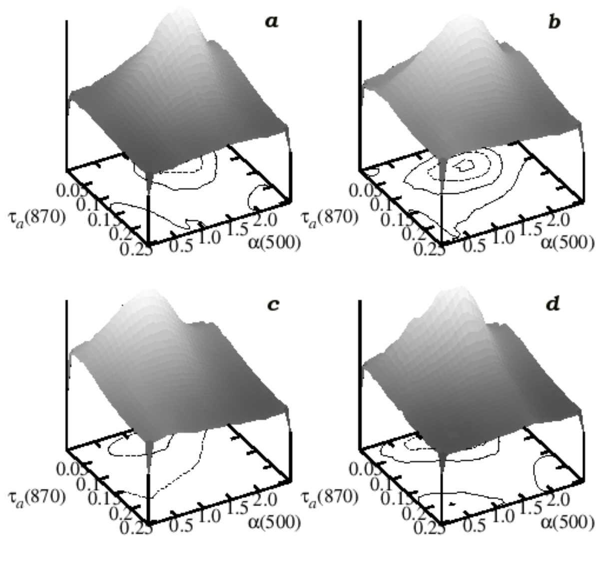

Figure 5. Two-dimensional histograms of τ_a and α for AERONET sites (Version 2, Direct Sun Algorithm): (*a*) – Sevastopol (44N, 33E), (*b*) – Forth Crete (35N, 25E), (*c*) - El Arenosillo (37N, 6W), (*d*) – Gotland (57N, 18E).

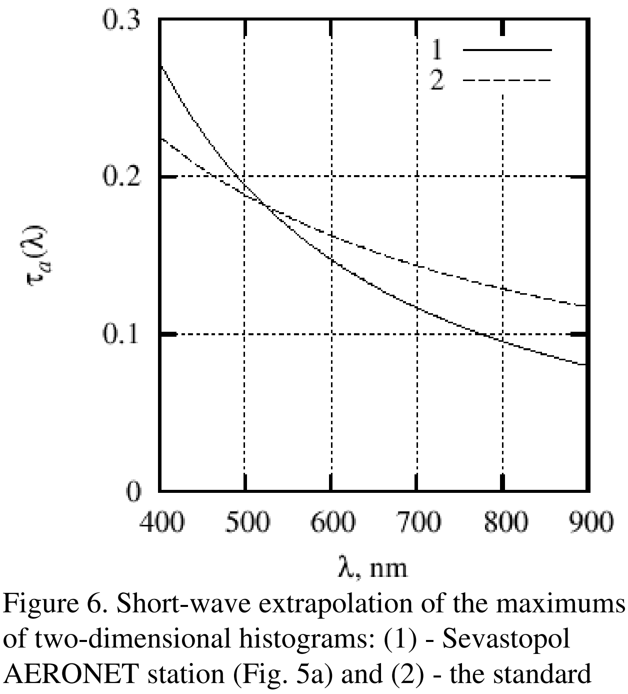

Figure 6. Short-wave extrapolation of the maximums of two-dimensional histograms: (1) - Sevastopol AERONET station (Fig. 5a) and (2) - the standard SeaWiFS atmospheric products (Fig. 1, c) for the case ***c*** in Table.

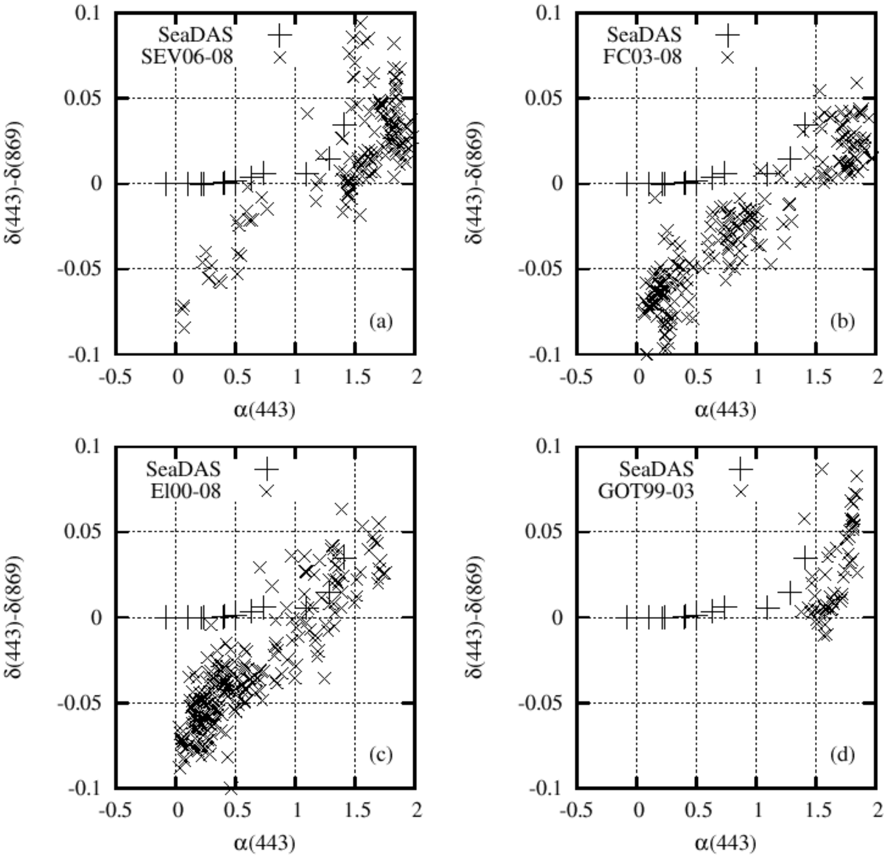

Figure 7. Angstrom exponent vs difference of single scattering albedo, δ , at two wavelengths for 12 standard aerosol models from SeaDAS and aerosol inversion product (Level 2.0 Almucantar Retrievals, Version 2) from AERONET sites: (a) – Sevastopol, (b) – Forth Crete , (c) - El Arenosillo, (d) – Gotland.

Of course, we have idealized the data obtained in the framework of AERONET project. Because Aeronet stations are located on land, one can not exclude the influence of dust aerosol on their measurements. On the other hand, for the coastal station, it would be logical to expect the dual-mode type of histogram. However, for all four Aeronet stations, one mode is dominated. Another factor, it is inadequate description of the aerosol optical properties of standard aerosol models (or their linear combination) used in the atmospheric correction. Two differences between the standard aerosol models [7] and Aeronet measurements are shown in Fig. 7. First, there are no models with the Angstrom exponent value higher than 1.5 throughout 12 standard aerosol models. Second, it is the absorption of aerosols in the blue region of the spectrum, which occurs in nature, δ (443) - δ (869) <0, and is absent in standard atmosphere set. In the eastern Baltic, the forging of absorbing aerosols is weak, but the shift in locations between the maxima of histograms *in situ* measurements and satellite-derived products is kept. Therefore, the absorbing aerosols are also subject to weak influence on the maximum location of our histograms. Thus, the most probable reason of the differences between standard products and atmospheric *in situ* measurements is the result of the influence of sun glint on the standard satellite-derived products. Despite the use of flags of 4 and 21 to remove glint component from level-2 products, the residual contribution of glint component (Figs. 1-4, ***c*** and Fig. 5) is kept what is most likely the result of the difference between the model [8] and real wind during the satellite overpass.

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