Atmospheric correction by Spectral Shape Matching Method (SSMM): Accounting for horizontal inhomogeneity of the atmosphere

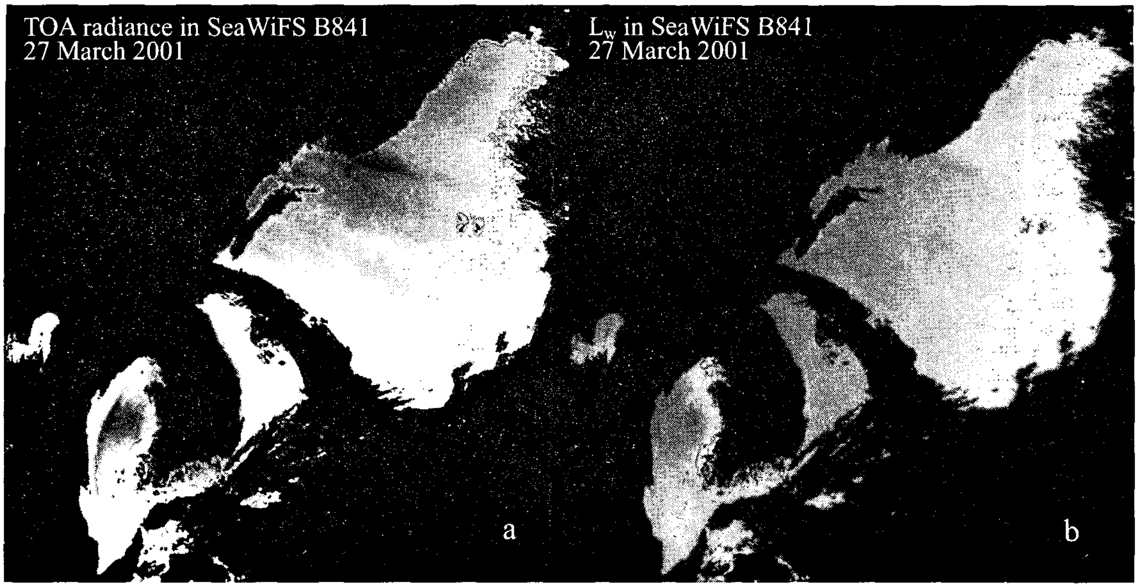
Palanisamy Shanmugam and Yu-Hwan Ahn

Ocean Satellite Research Group

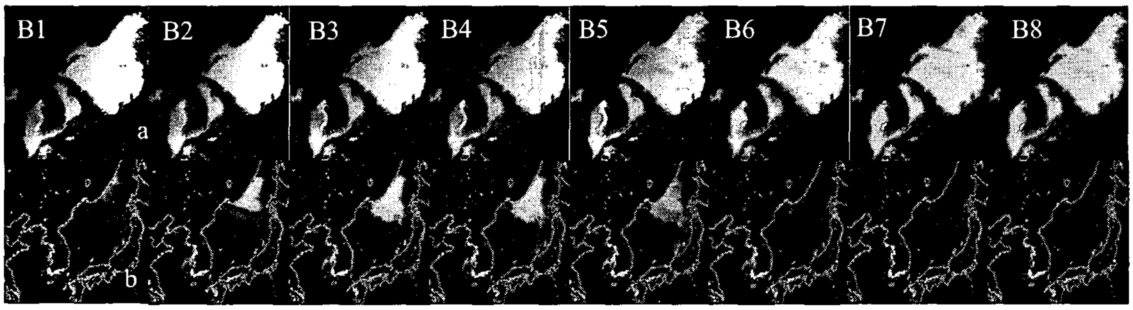
Korea Ocean Research and Development Institute

Email: pshanmugam@kordi.re.kr

Abstract: The current spectral shape matching method (SSMM), developed by Ahn and Shanmugam (2004), relies on the assumption that the path radiance resulting from scattered photons due to air molecules and aerosols and possibly direct-reflected light from the air-sea interface is spatially homogeneous over the sub-scene of interest, enabling the retrieval of water-leaving radiances (L_w) from the satellite ocean color image data. This assumption remains valid for the clear atmospheric conditions, but when the distribution of aerosol loadings varies dramatically the above postulation of spatial homogeneity will be violated. In this study, we present the second version of SSMM which will take into account the horizontal variations of aerosol loading in the correction of atmospheric effects in SeaWiFS ocean color image data. The new version includes models for the correction of the effects of aerosols and Raleigh particles and a method for computation of diffuse transmittance (t_{os}) as similar to SeaWiFS. We tested this method over the different optical environments and compared its effectiveness with the results of standard atmospheric correction (SAC) algorithm (Gordon and Wang, 1994) and those from in-situ observations. Findings revealed that the SAC algorithm appeared to distort the spectral shape of water-leaving radiance spectra in suspended sediments (SS) and algal bloom dominated-areas and frequently yielded underestimated or often negative values in the lower green and blue part of the electromagnetic spectrum. Retrieval of water-leaving radiances in coastal waters with very high sediments, for instance <SS> = > 8g m^{-3}, was not possible with the SAC algorithm. As the current SAC algorithm does not include models for the Asian aerosols, the water-leaving radiances over the aerosol-dominated areas could not be retrieved from the image and large errors often resulted from an inappropriate extrapolation of the estimated aerosol radiance from two IR bands to visible spectrum. In contrast to the above results, the new SSMM enabled accurate retrieval of water-leaving radiances in a various range of turbid waters with SS concentrations from 1 to 100 g m^{-3} that closely matched with those from the in-situ observations. Regardless of the spectral band, the RMS error deviation was minimum of 0.003 and maximum of 0.46, in contrast with those of 0.26 and 0.81, respectively, for SAC algorithm. The new SSMM also remove all aerosol effects excluding areas for which the signal-to-noise ratio is much lower than the water signal.



Figs. 1a and b. Example of Asian dust event (predominantly of absorbing aerosols of desert mineral particles) (a) and effective atmospheric correction by SSMM method (b) over the Korean ocean waters.



Figs. 2a and b. Comparison of the atmospherically corrected water-leaving radiances by SSMM (top) and SAC algorithm (bottom) on SeaWiFS image of 27 March 2001.

Table 1. RMS error deviation for SSMM and standard atmospheric correction algorithms in highly turbid Korean coastal waters.

Wavelength (nm) / Method	412	443	490	510	555	670	765	865
SAC	0.52	0.33	0.28	0.26	0.3	0.5	0.79	0.81
SSMM	0.16	0.42	0.16	0.08	0.08	0.003	0.044	0.46

References

Ahn, Y.H., and P. Shanmugam, 2004. New methods for correcting the atmospheric effects in Landsat imagery over turbid (Case-2) waters. *Korean Journal of Remote Sensing*, 20, 289-305.

Gordon, H.R., and M. Wang, 1994. Retrieval of water-leaving radiance and aerosol optical thickness over the oceans with SeaWiFS: a preliminary algorithm. *Applied Optics*, 33: 443-452.