AN IMPROVED METHOD OF CALCULATING AIR-WATER SURFACE REFLECTANCE OF SKYLIGHT FROM WATER SURFACE MEASURED SPECTRA

Junsheng Li[1] *Bing Zhang*[1] *Qian Shen*[2] *Hao Zhang*[2] *Yuanfeng Wu*[1] *Di Wu*[1]

1. Center for Earth Observation and Digital Earth, Chinese Academy of Sciences, No. 9 Beiyitiao Rd, Haidian District, Beijing, 100080, China;
2. State Key Laboratory of Remote Sensing Sciences, Institute of Remote Sensing Applications, Chinese Academy of Sciences, No 3, Datun Rd, Chaoyang District, Beijing, 100101, China

Email: hrsjsli@163.com

1. ABSTRACT

When calculating remote sensing reflectance from water surface measured spectra, the results are affected by the reflected skylight [1]. To calculate remote sensing reflectance accurately, the contribution of the reflected skylight should be subtracted. The contribution of the reflected skylight is the product of skylight radiance and the air-water surface reflectance of skylight. The skylight radiance can be measured over water surface by spectrometer. But the air-water surface reflectance is affected by multi factors such as the Sun zenith, viewing geometry, wind speed, and air condition. The accurate value of air-water surface reflectance is hard to be determined.

Presently, there are some methods to estimate the value of air-water surface reflectance of ocean waters [1, 2]. But most of these methods are developed for open ocean waters. When calculating the air-water surface reflectance of turbid inland waters, these methods all have some problems.

In this paper, for calculating air-water surface reflectance of skylight over turbid inland waters, we developed an improved method, which was based on the spectral properties of turbid inland waters.

Experiment data are vital for developing and validating the method of calculating air-water surface reflectance of skylight. In this paper, Taihu Lake in eastern China is selected to be the study area [3]. An experiment was carried out in Taihu Lake in January 2007 to measure water surface spectra, water quality parameters, and inherent optical properties on 50 sampling stations [4]. Water surface spectra were measured with an ASD field spectrometer by using the “above water method” [5]. When the boat was anchored, the radiance spectra of light from the reference panel, water, and sky were measured successively.

Firstly, the inherent optical properties of Taihu Lake are analyzed. The scattering coefficient of total suspended matter drops with increasing wavelength: it is big in visible light, small in near-infrared, and almost zero in shortwave infrared. Then, the apparent optical properties of Taihu Lake are analyzed. The spectra of water have similar spectral characteristics with the scattering coefficient of total suspended matter, and almost drop to zero in shortwave infrared. Finally, it comes to the assumption that the water leaving radiance of inland turbid water is zero in shortwave infrared wavelength.

Assuming that the water leaving radiance in shortwave infrared wavelength is zero, the water surface measured radiance in shortwave infrared wavelength is only the reflected skylight. Then the air-water surface reflectance can be calculated by divide the skylight radiance from the water surface measured radiance in shortwave infrared wavelength.

However, there are three atmospheric windows in shortwave infrared wavelength region, which are 1150~1350nm, 1450~1800nm, 2000~2350nm. In which atmospheric window the spectra should be used is a problem. There are two considerations: one is that the signal-to-noise of the spectra in the atmospheric window should be high, so the spectra data in

2000~2350nm were discarded due to its low signal-to-noise ratio; the other is that the assumption that the water leaving radiance in the atmospheric window is zero should be proper. But the two considerations are conflict in some way: the signal-to-noise is higher in shorter wavelength, while the zero assumption is more proper in longer wavelength.

To solve this problem, we develop an improved method. Firstly, the spectra data in 1150~1350nm are used to calculate the air-water surface reflectance. If the calculated value is within reasonable range, then the calculated value is determined to be the final result. Otherwise, the spectra data in 1450~1800nm are used to calculate the air-water surface reflectance. If the calculated value is within reasonable range this time, then the calculated value is determined to be the final result. Otherwise, there might be some problems in the surface measured spectra, and the data had to be checked manually.

The values of air-water surface reflectance on the 50 sampling stations are calculated by the method developed in this paper. Then, the correlations between the calculated values of air-water surface reflectance and wind speed, concentrations of chlorophyll and total suspended matter are analyzed.

The advantages of the improved method developed in this paper are that: it has theoretical basis; it is convenient to be used to calculate air-water surface reflectance automatically; it can compensate the measurement error of skylight radiance. The disadvantages of the method are that it has applicable limitations: the water surface measured spectra should include shortwave infrared wavelength; the signal-to-noise of the measured spectral in shortwave infrared wavelength should be high.

2. REFERENCES

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