BIDIRECTIONAL FACTOR OF WATER LEAVING RADIANCE FOR GOCI

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ABSTRACT: Geostationary ocean satellite, unlike other sun-synchronous polar-orbit satellites, will be able to take a picture of a large region several times a day (almost with every one hour interval). For geostationary satellite, the target region is fixed though the location of sun is changed always. Thus, the ocean signal of a given target point is largely dependent on time. In other words, the ocean signal detected by geostationary satellite sensor must translate to the signal of target when both sun and satellite are located in nadir, using another correction model. This correction is performed with a standardization of signal throughout relative geometric relationship among satellite – sun – target points. One signal value of a selected pixel point of the target region of Geostationary Ocean Colour Imager (GOCI) would be set up as a standard, and the ratio of all remained pixel point can be calculated. This relative ratio called bidirectional factor, the result of modelling of spatiotemporal variation of bidirectional factor is shown.

KEY WORDS: Bidirectional factor, GOCI, COMS, Water leaving radiance

1. INTRODUCTION

There are many considerations when we want to analysis the change of ocean environment by ocean color remote sensing. Those are the amount of irradiance in ocean surface, the transmittance of air and water, many relative reactions (absorption, scattering, attenuation) of water molecules and water mass, the discounting effect of air until ocean upward reflectance are reached to the ocean colour sensor, and the characteristics and ability of ocean colour sensor. It is same whether polar-orbit sensor or geostationary sensor. But the geostationary ocean satellite, unlike other sun-synchronous polar-orbit satellites, will be able to take a picture of large region (in case of GOCI, 2,500km X 2,500km) several times a day(almost every one hour interval) and the target region is fixed and the relative location of sun is changed every capture times. So, to get more real and accurate result from sensor data, it is necessary that the relative geometry of sun-target point-satellite is considered additionally. In case of sun-synchronous polar-orbit satellite, the geometric angle among sun, target point and satellite is always same and the solar irradiance is considered same amount in anytime. But for geostationary, the geometric angle of sun – target point – satellite is always changed because the solar position is always changed according to the time of picture but both the target region and satellite's position are fixed. This change varies with target points, with times, with wavelengths. We can calculate the ratio of target region's signal and aiming position's signal, that is bidirectional factor, and derive representative value of region.

2. DATA & METHODS

2.1 Assumptions

This bidirectional factor calculation model has many assumptions for computing ocean remote sensing parameters like the geostationary satellite position, the field of view of satellite ocean color sensor, acquisition time and times per day, sensor's wavelength if it is multi-spectral sensor, time zone, atmospheric conditions, ocean water conditions and wind speed.

Satellite position: geostationary position at 127E.

Field of view of sensor: 2,500km x 2,500km target centred on 36N, 130E (the Korean target) or northern hemisphere.

Sensor acquisition time and times: The sensor takes a picture hourly between 9h00 and 16h00.

Time zone: GMT+09 are recommended.

Atmospheric conditions: One mean aerosol type(maritime aerosol with 80% of humidity) is considered, with 3 optical thickness values, namely $\tau_a =$ 0.03, 0.10, and 0.50, corresponding to very clear, average, and turbid atmosphere. The selected atmosphere is spatially homogeneous over the Northern Hemisphere (or the Korean target)

Ocean water conditions: The ocean is spatially homogeneous. The optical properties are those of Case-1 waters with 3 chlorophyll concentrations, namely 0.1, 1, and $10 mg\, m^{-3}$

Wind speed: The wind speed is zero.

Wavelengths of sensor: Eight wavelengths are considered, i.e. 412, 443, 490, 555, 660, 680, 745 and 865 nm.

2.2 Methods

The numeric model (Morel et al, 2001) has been used to generate the irradiance reflectance of the sea (for the 3 Chlorophyll concentrations).

If the environment of Earth (the aerosol concentration for atmospheric condition and the chlorophyll concentration for ocean water) and the wavelength of satellite are defined, the predicted satellite position and aiming position on ground and time will be inputted from user to prepare many geometric information like sun position, sun zenith angle, satellite zenith angle, sun and satellite azimuth angle, calculated point coordinate (latitude and longitude), relative azimuth angle between satellite and sun and the relative distance from aiming point. All the information can be handled as input for calculating the top of atmospheric radiance that is composed of the upwelling radiance from water, reflected radiance by aerosol in air and other fluorescence signal. And then we can estimate normalized water leaving radiance and we can derive bidirectional factor from the ratio of normalized water leaving radiance in Korean sea.

This paper will be considerable of chosen day's variation of normalized water leaving radiance and bidirectional factor. Also, the monthly variation of bidirectional factor in chosen time will be considered.

3. RESULTS & DISCUSSIONS

3.1 Results

We can test this model in the condition of one band (555nm), very clear air and water condition and selected day (21 march 2006, every month's 21 day). The bidirectional factor data is compared with each other.

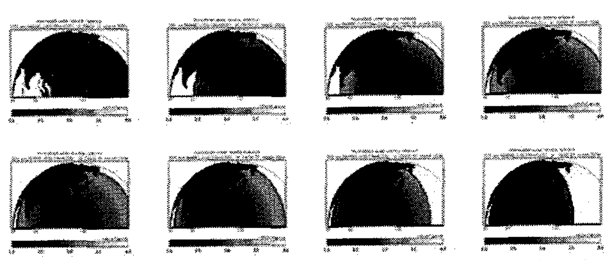

Fig1. The daily variation of normalized water leaving radiance in 21 march 2006 (09h~16h)

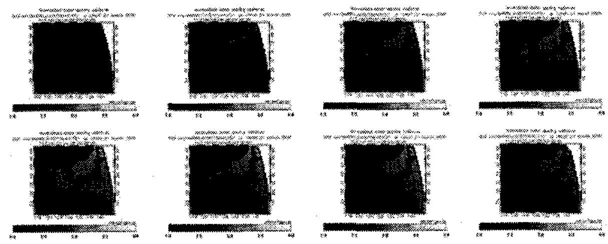

Fig2. The daily variation of normalized water leaving radiance in 21 march 2006 at Korean target (09h~16h)

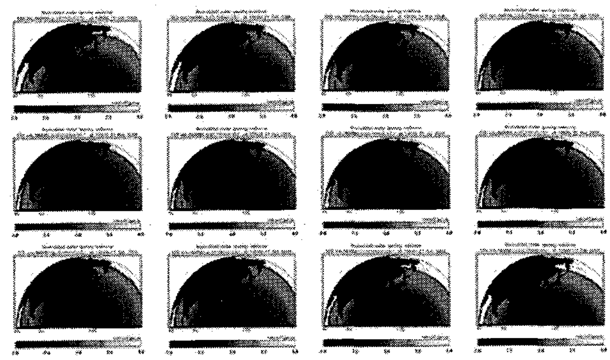

Fig3. The monthly variation of normalized water leaving radiance (each month 21th day)

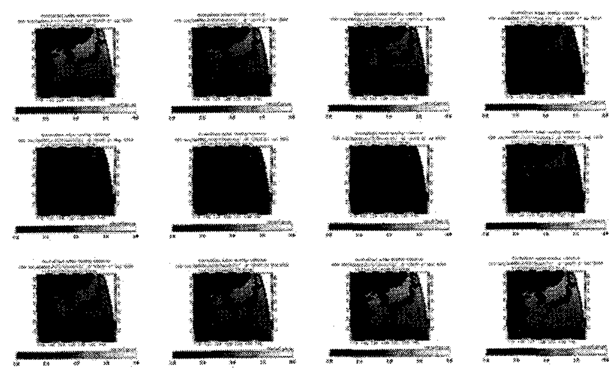

Fig4. The monthly variation of normalized water leaving radiance at Korean target(each month 21th day)

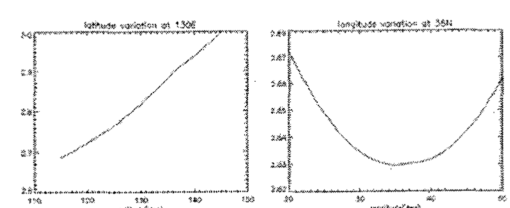

Fig5. the latitude variation of normalized water leaving radiance. (left) and longitude variation of it (right). This show 2^{nd} degree equation form, but in small boundary it can be approximated just a line that can be interpolated.

3.2 Discussions

Normalized water leaving radiance of selected day is spread between 2~4 mW/cm2/um/sr. the bidirectional factor can be obtained by dividing that value to aiming point's value.

In one day analysis results (Fig 1, 2), the amount of input solar irradiance is going larger before 13 hour but is going smaller after that time. The eastern longitude change more than western longitude before 13hour and the western longitude do after 13hour. The location changes of sun have affected ocean water reflecting signal in every times for taking a picture of target region. This result says that we have to get a bidirectional factor lookup table for estimating normalized water leaving radiance of ocean water.

The monthly analysis result says that the signal of spring (Apr. ~ Jun.) is weaker than other month. (Fig 3,4)

The one value of bidirectional factor can cover 1 degree square area and it can be interpolated for target point. (Fig 5) And it can be stored look up table style for wavelength, day, time, chlorophyll concentration, aerosol condition, target area.

4. CONCLUSTIONS

In here, we can see the effect of bidirectional factor and variation of the factor. This result can be used as a factor of bidirectional correction after atmospheric correction and normalization of water leaving radiance in GOCI. Hereafter we need more data simulation and analysis for optimizing this factor.

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