Spectral Distribution and Spectral Absorption of Suspended particulates in Waters of Sanya Bay

Yang dingtian, Cao wenxi

South China Sea Institute of Oceanography, LED, Guangzhou, 510301, email: dtdang@tom.com

ABSTRACT Optical profile and spectral absorption of suspended solids in waters of Sanya bay was measured on August 8-14, 2003. Optical profile was taken by using MicroPro optical profile. Apparent optical indexes, vertical diffuse attenuation coefficient (K_d) and water leaving radiance (Lw), were calculated. K_d at the blue end of the spectrum was greater than that at the red end of the spectrum in waters near Sanya River mouth, however, in waters near open sea, K_d at the blue end of the spectrum was smaller than that at the red end of the spectrum. Distribution of water leaving radiance was relatively higher in waters near Sanya River mouth, but relatively weaker in near open sea water. Spectral absorption of suspended particulates was also measured. Results showed that the spectral absorption of chlorophyll a was greater in waters near Sanya river mouth, but relatively weaker in waters near open sea, which indicated higher concentration of phytoplankton in waters near Sanya river mouth. Except for water at the 5th sampling station, the ratio of spectral absorption of chlorophyll a to total suspended particulates in surface waters was greater than that in bottom waters at all stations.

Key words Sanya bay, spectral absorption, vertical diffuse attenuation coefficient, suspended solids.

1 INTRODUCTION

Sanya Bay, located to southwest of Sanya downtown, is a planned protection region for coral and bio-diversity, with 118 kinds of zooplanktons and 11 genus (Yin Jiangiang,et al, 2004) of pelagic larva. In recent years, water quality of Sanya Bay to some extent influenced due to the development of tourism. Chl a concentration exceeds 10μg/dm^3 and abundance of total bacterium is 4×10^6/dm^3, among them Escherichia coli is11000/dm^3 (Ning Xiuren, 1999). Some researchers suggested that litter fall of mangrove along Sanya River also contribute to the deterioration of water quality.

Changes of water quality led to corresponding changes of apparent optical parameters, such as water-leaving radiance and vertical light attenuation. Substances in waters, such as chl a, suspended solids and CDOM, can be detected by established bio-optical models. At present, retrieval of these substances with remote sensing in Case-I waters is mature. However, the algorithms in Case II water varied greatly and the parameters showed strongly territorial. Based on the analytical algorithm of case-I waters from Gorden (1988) and Morel (1988), Zhongping Lee et al (2004) used analytical algorithm to retrieve chl a in case-II waters, however, regional parameters still existed. In most offshore regions in China, waters contain high concentration of suspended solids and CDOM, which contributes great differences of optical characteristics from case-I waters. Wenxi Cao et al (2004) studied the spectral absorption of particulates and chlorophyll a in Pearl River mouth and obtained the bio-optical model that fitted the waters there. Suspended solids and nutrients concentration in Sanya Bay is relatively low, which is ideal for analyzing case-II waters by using analytical algorithm. This paper mainly studies the spectral absorption model of particulates and spectral distribution of waters in Sanya Bay. The regional parameters of bio-optic model were calculated. And it also offers some tutorial proposals for establishment of analysis algorithm which works for further optical extraction of substances in waters with high quantity of suspended particulates and CDOM.

2 Material and method

Arrangement of sampling stations was shown in figure 1. No.2 locates at the entrance of Sanya River. Stations 1 to 6 are near the shore, and stations 7 to 12 are far from the bank. Among them, station 11 and 12 are close to open sea. Water samples from surface, middle and bottom were collected using Niskin bathometer. Samples used to determine chl a concentration were filtered with GF/F membrane and froze in refrigerators. Concentration of chl a can be determined by using Turner-Design 10 spectrofluorometer (Cleveland, 1993) and calibrated with standard sample from Sigma company.

Samples, used to determine absorption coefficient of particulate, were filtered with Whatman GF/F membrane. Absorption coefficient of total particulate was determined with spectrophotometer and pigments were extracted by 90% methanol solution. Absorption coefficient of detritus particulate, which sedimented on the membrane, was measured after pigments had been extracted. Absorption coefficient of chl a can be calculated from absorption coefficient of total particulate subtracted by that of detritus particulate.

During the sampling period, apparent optical parameters were determined. *Micropro* optical profiler (Satlantic company) was used to measure incident radiance, downwelling irradiance of water of different depth and upwelling radiance. *Micropro* software was used to calculate K_d , $Lu(0^-)$ (upwelling radiance under surface) and Lw (water-leaving radiance).

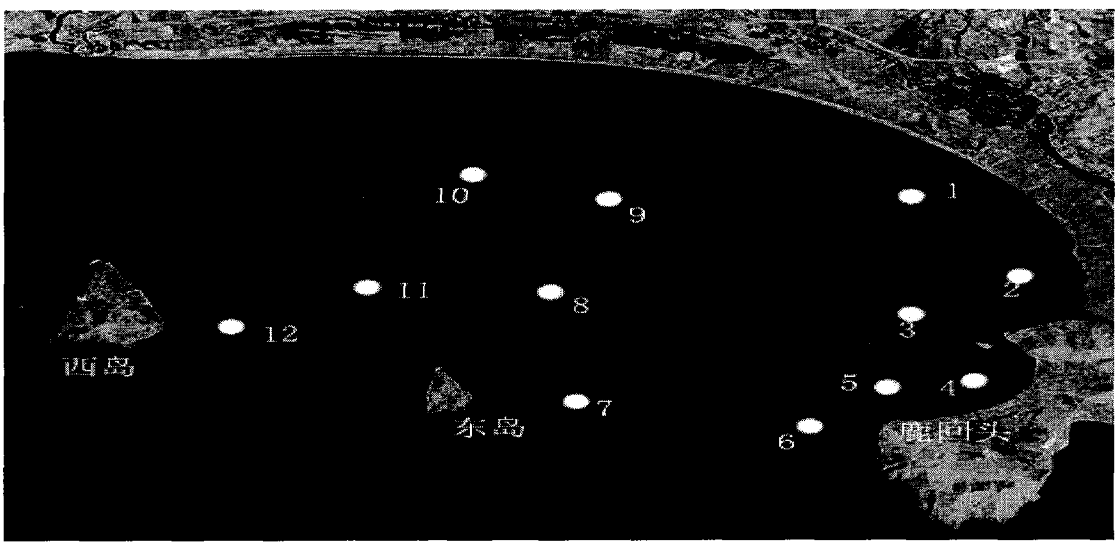

Fig. 1 Sampling stations in Sanya Bay

3 Results and discussions:

3.1 Distribution of K_d

K_d is diffuse attenuation coefficient of downwelling irradiance, and can be expressed as follow(Kirk J T O., 1994):

$$K_d = \frac{1}{z} \ln \frac{E_d(0)}{E_d(z)} \qquad (1)$$

E_d is downwelling irradiance, Z is water depth.

Based on the obtained results, K_d value of all stations was calculated (Figure 2). In near shore waters (such as 1 to 5), K_d is greater. K_d in waters at the 5th sampling station was near 1 m^{-1}, due to the effect of cultivation sites established by Sanya Luhuitou ecosystem station of SCSIO(South China Sea Institute of oceanology, Chinese academy of Sciences). At second sample station, content of organic matter was high, so was chl a concentration, and $K_d(490)$ was correspondingly high. K_d of the 3rd site was also greater, for the influence of the estuary. K_d at the blue end of he spectrum was high due to the strong absorption of CDOM (colored dissolved organic matter) and detritus. At 12 sampling site, Chlorophyll a and K_d were low for little influenced by continental substances. K_d at the blue end of the spectrum was smaller, however, at the red end of the spectrum was greater.

3.2 Distribution of water-leaving radiance

Distributions of water-leaving radiance and diffuse attenuation coefficient showed high similarity. At No. 7,8,10,11, and 12 sites, the values of upwelling radiance($L_u(0^-)$) were relatively low, and at the green end of the spectrum were relatively greater, but at the red and blue end of the spectrum were smaller (figure 3). Concentrations of chlorophyll a were relatively low, and showed typical optical characteristics that were similar with that of case-I waters. At No.2 and No.5 sites, water-leaving radiance was relatively greater, and that at the red end of the spectrum was larger than that at the blue band. The situation may be related with the high concentration of chl a that absorbed greater at the blue end of the spectrum.

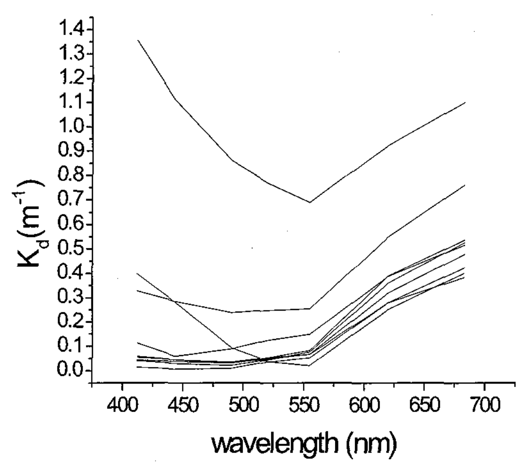

Fig 2 K_d at different stations

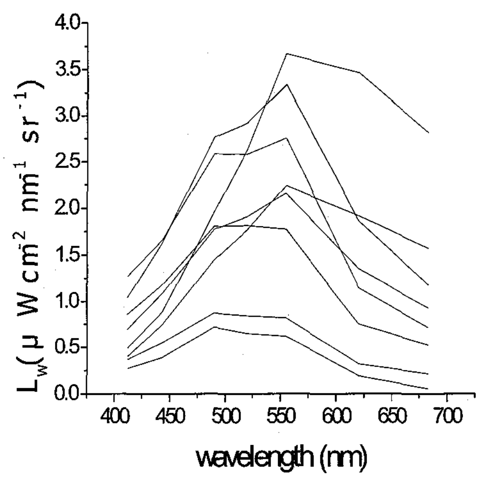

Fig 3 Water-leaving radiance at different stations

4.Conclusion:

1. Water-leaving radiance of waters close to Sanya River a was comparatively large, and at the red end of the spectrum was greater than that at the blue end of the spectrum, for water quality in Sanya Bay was greatly influenced by Sanya River. K_d was also greater, and K_d at the blue end of the spectrum wasgreater than that at the red end of the spectrum. In waters close to the mouth of Sanya Bay, K_d of red band was

larger than that blue band.

2. Absorption of total suspended particulates at the blue end of the spectrum showed negative exponential relationship with wavelength. Absorption of suspended particulates in surface layer was larger than that at bottom.

3. In waters close to the estuary of Sanya River and continent, absorption of chl was high. But in waters close to the mouth of Sanya Bay, chl a absorption was comparatively small.

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