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太湖春季水体固有光学特性及其对遥感反射率变化的影响

Analysis of inherent optical properties of Lake Taihu in spring and its influence on the change of remote sensing reflectance

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中文摘要:

吸收特性和后向散射特性是水体重要的光学特性,同时也是建立生物光学模型的基本参数。利用2009年4月太湖春季实测数据,结合生物光学模型推导了太湖春季水体颗粒物后向散射系数,分析了太湖春季水体的吸收特性和后向散射特性,并利用经验正交分解方法对遥感反射率变化的影响因子进行了分析。结果表明:(1)非色素颗粒物是影响太湖春季水体吸收特性的主导因子,色素颗粒物和有色可溶性有机物(CDOM)对总吸收(不包含纯水)的贡献相对较小,且色素颗粒物在梅梁湾湖区的包裹效应明显大于其他湖区。(2)颗粒物后向散射系数与总悬浮物和无机悬浮物具有很强的相关性(相关系数均在0.88以上),与有机悬浮物的相关性相对较弱(相关系数均在0.73以下),且水体中多次散射对水面总辐亮度有较大的贡献,平均贡献率高达93.46%。(3)利用经验正交分解方法将遥感反射率变化光谱分解成3个正交因子,3个正交因子总共解释了约99%的遥感反射率变化信息,其中,第一正交因子解释了93%的变化信息,第二和第三正交因子分别解释了5%和1%的变化信息。通过对各正交因子与水体不同组分的吸收和后向散射系数进行相关性分析得出,颗粒物的后向散射对水面反射光谱的形成具有非常重要的影响,太湖春季水体遥感反射率的变化主要取决于无机颗粒物的吸收和后向散射,有机颗粒物对遥感反射率的变化影响较小。

English Summary:

Absorption and backscattering characteristics are important optical properties and they are also two basic parameters of bio-optical model. Remote Sensing reflectance is the basis for inversing water quality parameters and its character mainly depends on absorption and backscattering of all kinds of optical active substances of water, so it is very important to study absorption and backscattering characteristics of water and its influence on remote sensing reflectance. Lake Taihu is one of the five major freshwater lakes and also a typically shallow inland eutrophic lake in China with an area of 2338 km^2 and an average depth of about 2 m. In this paper the in situ remote sensing reflectance and absorption coefficients measured in April 2009 in Lake Taihu were firstly used to deduce backscattering coefficients of particles combined with bio-optical model. Then we analyzed the absorption and backscattering characteristics of Lake Taihu in spring, and Empirical Orthogonal Function (EOF) was used to decompose remote sensing reflectance in order to analyze the influence of absorption and backscattering characteristics on the change of remote sensing reflectance. The results show that: (1) Non-algal particle is the dominant factor which influences the absorption characteristic of Lake Taihu in spring, and its average contribution rate to the total absorption coefficients (exclusion of pure water) is 66.92%. While the contribution of algal particles and CDOM to the total absorption coefficients (exclusion of pure water) is relatively small and their average contribution rates are 21.83%, and 11.25%, respectively. The specific absorption coefficient and the size of algal particles in Meiliang Bay are all smaller than that in other areas of Lake Taihu, which means the package effect of algal particles in Meiliang Bay is obviously larger than that in other areas. (2) The backscattering coefficients of particles between 400nm and 750nm have a strong correlation with the concentration of total suspended matters and inorganic suspended matters with the correlation coefficients larger than 0.88, but a relatively weak correlation with the concentration of organic suspended matters with the correlation coefficients less than 0.73. The multiple scattering has great contribution to the total radiance of water surface and the average contribution rate can reach 93.46%. (3) The EOF analysis provides three dominant modes which account for about 99% of the total variance of remote sensing reflectance in Lake Taihu in spring, i.e. the first EOF mode accounts for 93% of the total variance, while the second and the third modes only explain 5%, and 1%, respectively. The backscattering coefficients of particles have an important influence on the spectral reflectance, and the change of remote sensing reflectance of Lake Taihu in spring is mainly ruled by absorption and backscattering of inorganic particles while the effect of organic particles is relatively small.

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