INFLUENCE OF SUN PHOTOMETER FILTER FUNCTION ON RETRIEVING AEROSOL OPTICAL DEPTH

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Ⅰ. INTRODUCTION

The Beer-Lambert-Bouguer attenuation law (Beer's law) is used when direct beam radiation is measured by sun photometer. The aerosol optical depth (AOT) is obtained after subtracting the Rayleigh and ozone and other absorption gas optical depth from total optical depth. Strictly, Beer's law only holds for monochromatic radiation; it can be approximately holds for narrow band pass such as the channel of CE318. So, the band filter function will cause at least three questions in the process of retrieving AOT: 1) the uncertainty of AOT retrieval from CE318 measurements. The measured transmittance is the band weighted transmittance calculated by integrating the channel filter function and each component's spectral transmittance. So, the unknown aerosol band transmittance or AOT can be obtained by calculating other components' band weighted transmittance such as Rayleigh, ozone, etc, which can be calculated by the products of each component's weighed transmittance or by the weighted transmittance of the products of each component's spectral transmittance. The difference between these two retrieval processes we called the uncertainty of AOT retrieval. 2) Is filter function can be ignored when calculating Rayleigh optical depth? It is necessary to analyze the influence of filter function on band weighted Rayleigh optical depth under different zenith angles. 3) The band weighted coefficients of absorption gases may change with the zenith angle as the path gas amounts change.

As a case study, the filter functions of three CE318s identified as 'IRSA-N', 'IRSA-P' and 'CEODE' were used in this paper. The uncertainty of AOT retrieval was analyzed for each channel of three CE318s. To analyze the influence of filter function on band weighted Rayleigh optical depth, we compared the results with the values calculated at the central wavelength of each channel. Besides, we calculated the band absorption coefficients of ozone (O3) and dioxide nitrogen (NO2) under different zenith angles based on the measured fine spectral absorption cross sections (~0.2nm) of SCIAMACHY PFM Satellite Spectrometer[1, 2]. Through above simulation study and analysis, the following conclusions were drawn:

1) The Rayleigh scattering optical depth, the absorption gases' optical depths or transmittances can be calculated respectively by integration of filter function.

2) The filter function is very important for retrieving AOT, especially in short wavelength region such as at 340nm. For example, the uncertainty of AOT retrieval at 340nm channel of 'IRSA-N' CE318 is relative large, about 0.005. The reason is that filter function of 'IRSA-N' CE318 at 340nm channel was not perfect (Figure1); more or less transmittance exists in the wavelength region of far less than 340nm and the ozone absorption strengthens greatly(Figure 2), so the uncertainty of retrieving AOT is relative large.

3) Under large zenith observation condition, it may introduce non-neglected errors if Rayleigh scattering optical depth is calculated directly at central wavelength without filter function considered. About 0.01 errors would appear when zenith angle exceed 75° at 340nm channel. So, we suggest that filter function should be considered when calculating the band Rayleigh scattering optical depth.

4) Through calculation under different gas amounts, the band weighted absorption coefficients of O3 and NO2 almost hold constant when gas amounts increase, except for 'IRSA-N' CE318 at 340nm channel. However, the gas absorption coefficients have differences among different CE318s. So, the band weighted absorption coefficients should be

calculated for a new CE318. The absorption coefficients of 'IRSA-N' CE318 at 340nm channel changes greatly because of the imperfect designed filter function as described in 3) and Figure 1.

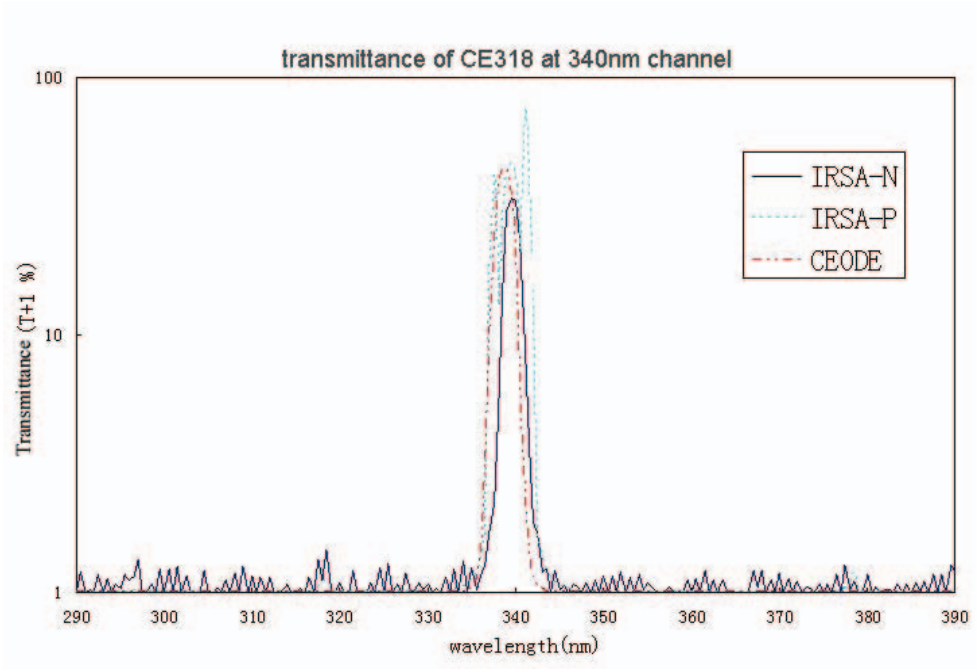

Figure1. The transmittance of three CE318s at 340nm channels

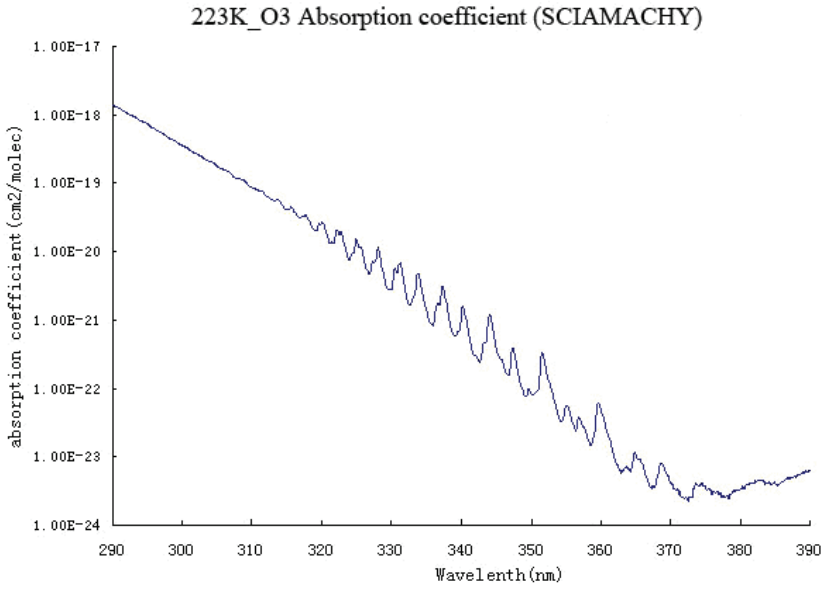

Figure2. The ozone absorption coefficient measured by SCIAMACHY PFM satellite spectrometer under the temperature at 223K

Ⅱ. REFERENCES

[1] Burrows, J. P., Richter, A., Dehn, A., Deters, B., Himmelmann, S., Voigt, S. and Orphal J., "Atmospheric remote -sensing-reference data from GOME: 2. Temperature-dependent absorption cross sections of O3 in the 231-794 nm range", *JQSRT*, 61, 509-517, 1999.

[2] Burrows, J. P., Dehn, A., Deters, B., Himmelmann, S., Richter, A., Voigt, S. and Orphal, J., "Atmospheric Remote-Sensing Reference Data from GOME: Part 1. Temperature-Dependent Absorption Cross-sections of NO2 in the 231-794 nm Range", *JQSRT*, 60, 1025-1031, 1998.