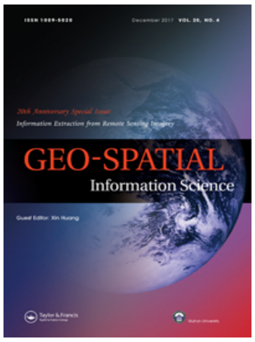

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Retrieval of Brown Carbon based on the aerosol complex refractive indices in the winter of Wuhan

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ABSTRACT

The impact of Brown Carbon (BrC) to aerosol light absorption has been paid more attention recently and there are a large number of studies showing that the influence of BrC on radiative forcing should not be ignored. BrC also acts as an important component of haze pollution which is occurring frequently in Wuhan, China. Therefore, it is essential to estimate their optical properties, composition, and mass concentration. Considering most haze pollution happens during the coldest time, we retrieved BrC columnar content during winter in Wuhan for the first time. Our method bases on the fact that BrC showed the strong spectral dependence on UV-light absorption. Using this method, we found that BrC makes up the small proportions of total aerosol volume (less than 10%). In the winter of 2011, we retrieved the daily-averaged columnar-integrated mass concentration of BrC on clear day is 4.353 mg/m^2 while that of haze day is 12.750 mg/m^2. According to the sensitivity study, we found that the results highly relied on the assumed aerosol refractive index. To reduce the uncertainty of this approach, we need to gain a better understanding of the temporal variability of the radiation absorbing components of these aerosols in the future.

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KEYWORDS
Brown Carbon (BrC); Black Carbon (BC); aerosol complex refractive index

1. Introduction

Aerosols play an important role in global climate through direct and indirect radiative forcing. Combustion-produced carbonaceous particles are the predominant radiation absorbing components of aerosols. Most direct radiative forcing models classify carbonaceous particles into two main types, strong radiation absorbing Black Carbon (BC) or negligibly radiation absorbing Brown Carbon (BrC). In 2001, Jacobson (2001) pointed out that BC might warm the atmosphere and could become the second most important component of climate change after CO_2. Ramanathan and Carmichael (2008) published that the BC forcing of 0.9 W/m^2 could lead to the temperature of 0.5–1.0 °C on a global scale. Later, Alexander indicated that a large amount of BrC existed in East Asian–Pacific outflow and suggested that BrC should be explicitly included in radiative forcing models (Alexander, Crozier, and Anderson 2008). Bahadur found that the BrC absorption at 440 nm was about 40% of that of BC and demonstrated that current climate models treating BrC as non-absorbing were underestimating the total warming effect of carbonaceous aerosols (Bahadur et al. 2012). Using a global chemical transport model and a radiative transfer model, Feng, Ramanathan, and Kotamarthi (2013) estimated the enhanced absorption of solar radiation due to BrC in a global model, and global simulations suggested that strongly absorbing BrC contributed up to 0.25 W/m^2 (19%) of all absorption by anthropogenic aerosols. BrC was also found to be ubiquitous and effectively absorb solar radiation based on observations over East Asia in spring 2001 (Sato et al. 2003). Obviously, the impact of BrC to the aerosol light absorption and its climatic implication cannot be ignored. Thus, it is essential to quantify the optical properties, composition, and mass concentration of BrC to determine accurately the magnitude of radiative forcing. Currently, the sources and formation of BrC and its temporal variability are not well understood. It is difficult to use the traditional thermos method to separate BC and BrC due to similarity of their chemical properties. Lately, the retrieval of BrC based on its optical properties obtained from remote sensing has been proposed.

In 2005, Schuster et al. (2005) was the first to introduce an approach to determine the BC concentration from AERONET data based on the complex refractive indices of aerosol. Later, Dey et al. (2006) applied the same approach, but also included BrC / dust as another absorbing component. Recently, Arola et al. (2011) took advantage of the spectral-dependent properties of BrC to establish a BrC column-integrated concentration all

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