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High time-resolved measurement of stable carbon isotope composition in water-soluble organic aerosols

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Water soluble organic carbon (WSOC) is a significant fraction of organic carbon (OC) in atmospheric aerosols. WSOC is of great interest due to its significant effects on atmospheric chemistry, the Earth's climate and human health. Stable carbon isotope (δ13C) can be used to track the potential sources and investigate atmospheric processes of organic aerosols. In this study, a method of simultaneously measuring the mass concentration and δ13C values of WSOC from aerosol samples is established by coupling the Gas Bench II preparation device with isotopic ratio mass spectrometry. The precision and accuracy of isotope determination is better than 0.17 ‰ and 0.5 ‰ respectively, for samples containing carbon larger than 5 μg. This method is then applied for the high time-resolution aerosol samples during a severe wintertime haze period in Nanjing, East China. WSOC varies between 3-32 μg m-3, whereas δ13C-WSOC ranges from -26.24 ‰ to -23.35 ‰Three different episodes (e.g., namely the Episode 1, the Episode 2, the Episode 3) are identified in the sampling period, showing a different tendency of δ13C-WSOC with the accumulation process of WSOC aerosols. The increases in both the WSOC mass and δ13C-WSOC values in the Episode 1 indicate that WSOC is subject to a substantial photochemical aging during the air mass transport. In the Episode 2, the decline of the δ13C-WSOC is accompanied by the increase in the WSOC mass concentrations, which was associated with regional-transported biomass burning emissions. In the Episode 3, heavier isotope (13C) is exclusively enriched in total carbon (TC) compares to WSOC aerosols. This suggests that water-insoluble carbon may contain 13C-enriched components such as dust carbonate which is supported by the enhanced Ca2+ concentrations and air mass trajectories analysis. The present study provides a novel method to determine stable carbon isotope composition of WSOC and it offers a great potential to better understand source emission, atmospheric aging and secondary production of water soluble organic aerosols.