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^{13}C signatures of aerosol organic and elemental carbon from major combustion sources in China and worldwide

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Isotopic source apportionment is commonly used to gain insight into sources and atmospheric processing of carbonaceous aerosols. Since elemental carbon (EC) is chemically stable, it is possible to apportion the main sources of EC (coal/biomass burning and traffic emissions) using a dual ^{14}C-^{13}C isotope approach. However, dual-isotope source apportionment crucially relies on accurate knowledge of the ^{13}C source signatures, which are seldom measured directly for EC. In this work, we present extensive measurements of organic carbon (OC) and EC ^{13}C signatures for relevant sources in China. The EC ^{13}C source signatures are provided first time using the optical split point in a thermal-optical analyzer to isolate EC, which can greatly reduce the influence of pyrolyzed organic carbon (pOC). A series of sensitivity studies (pOC/EC separation) were conducted to investigate the reliability of our method and its relation to other EC isolation methods. Meanwhile, we summarized and compared the literature ^{13}C signatures in detail of raw source materials, total carbon (TC) and EC using a variety of thermal methods. Finally, we recommend composite EC ^{13}C source signatures with uncertainties and detailed application conditions. There are two points worth noting. First, the traffic ^{13}C signatures of raw materials and EC are separated into three groups according to geographical distribution. Second, the EC ^{13}C signature of C4 plant combustion can be influenced greatly if pOC and EC are not well separated, so the thermal-optical method is necessary. Using these EC ^{13}C source signatures in an exemplary dual-isotope source apportionment study shows improvement in precision. In addition, some interesting distinct and repeatable patterns were discovered in ^{13}C source signatures of semi-volatile, low-volatile, and non-volatile primary OC fractions.