

Organic aerosol speciation with in-situ thermal desorption gas chromatography: a brief history of the TAG instrument

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Speciation at the molecular level is necessary to more fully understand the sources, sinks, transport and transformation of organic matter in the atmosphere. The thermal desorption aerosol gas chromatograph (TAG) is a mature instrument successfully deployed in five distinct field campaigns and offers a proven method for in-situ, hourly speciation of organic aerosols.

Multiple versions of this evolving instrument will be reviewed but all have in common the use of chemical separation using gas chromatography following thermal desorption. The first TAG to be deployed relied on inertial impaction to collect particulates and filter blanks to estimate vapour adsorption. Figure 1 illustrates the ability to acquire hourly time series of useful aerosol markers (primary norhopane and secondary phthalic acid) in the LA basin as part of the SOAR campaign (Williams et al., 2010). A subsequent deployment in the California Sierra Foothills (Worton et al., 2011) provided important information about the interaction of biogenic primary gases with anthropogenic pollutants that dominates secondary organic aerosol production.

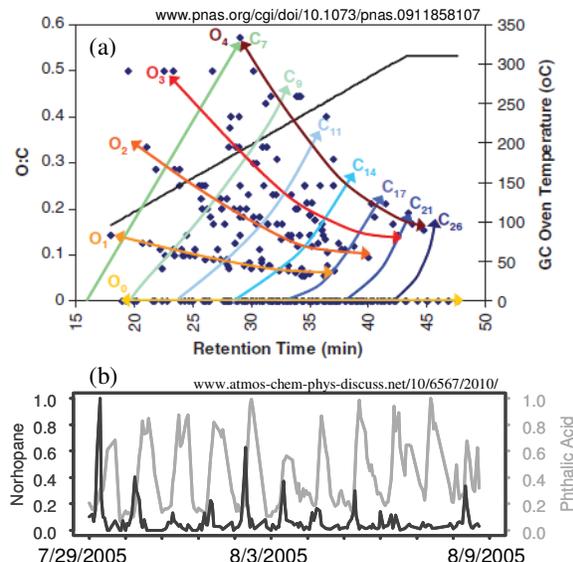


Figure 1. (a) O:C ratio, carbon and oxygen numbers vs. volatility as indicated by column retention time for ~300 compounds and (b) time series of representative source markers as measured in Riverside, CA in 2005.

To measure semi-volatile organics, which are important to secondary aerosol formation, a new version of the instrument has been developed to collect both particle and semi-volatile vapor phases (Zhao et al., 2013). Using a high efficiency carbon-based gas phase denuder and a new collection system with a reusable metal-fiber filter, alternate samples with and without the denuder provide direct partitioning measurements of organic compounds.

A parallel development has focussed on adapting the TAG instrument to function as a parallel collection system to be added to the Aerodyne Aerosol Mass Spectrometer (AMS; Canagaratna et al., 2007). This hybrid instrument (Williams et al., 2013) shares a detector to provide simultaneous size-dependent bulk and speciated organic aerosol information in one instrument. Comparing measurements from these separate instruments has proven the utility of being able to identify individual marker species corresponding to traditional AMS organic classes based on oxygen to carbon ratios such as HOA, OOA etc. (Williams et al., 2010; Worton et al., 2011).

Current efforts are directed towards expanding the range of compounds that can be analysed using in-situ derivatization of highly polar species. A dual cell version of the semi-volatile oriented instrument for initial deployment as part of a southeast US summer of 2013 field campaign seeks to ascertain the origin and fate of the large secondary organic aerosol levels present throughout the region. The paired filter cells provide simultaneous collection of denuded and undenuded aerosol streams for unique hourly measurements of derivatized SOA markers stemming from the oxidation of isoprene and other (bio-)anthropogenic precursors.

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