

Total Observed Organic Carbon (TOOC): A synthesis of North American observations

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Abstract

Measurements of organic carbon compounds in both the gas and particle phases measured upwind, over and downwind of North America are synthesized to examine the total observed organic carbon (TOOC) over this region. These include measurements made aboard the NOAA WP-3 and BAE-146 aircraft, the NOAA research vessel Ronald H. Brown, and at the Thompson Farm and Chebogue Point surface sites during the summer 2004 ICARTT campaign. Both winter and summer 2002 measurements during the Pittsburgh Air Quality Study are also included. Lastly, the spring 2002 observations at Trinidad Head, CA, surface measurements made in March 2006 in Mexico City and coincidentally aboard the C-130 aircraft during the MILAGRO campaign and later during the IMPEX campaign off the northwestern United States are incorporated. Concentrations of TOOC in these datasets span more than two orders of magnitude. The daytime mean TOOC ranges from 4.0 to 456 $\mu\text{gC m}^{-3}$ from the cleanest site (Trinidad Head) to the most polluted (Mexico City). Organic aerosol makes up 3–17% of this mean TOOC, with highest fractions reported over the northeastern United States, where organic aerosol can comprise up to 50% of TOOC. Carbon monoxide concentrations explain 46 to 86% of the variability in TOOC, with highest TOOC/CO slopes in regions with fresh anthropogenic influence, where we also expect the highest degree of mass closure for TOOC. Correlation with isoprene, formaldehyde, methyl vinyl ketene and methacrolein also indicates that biogenic activity contributes substantially to the variability of TOOC, yet these tracers of biogenic oxidation sources do not explain the variability in organic aerosol observed over North America. We highlight the critical need to develop measurement techniques to routinely detect total gas phase VOCs, and to deploy comprehensive suites of TOOC instruments in diverse environments to quantify the ambient evolution of organic carbon from source to sink.

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