Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 2007-2025, 2008
www.atmos-chem-phys.net/8/2007/2008/

Total observed organic carbon (TOOC) in the atmosphere: a synthesis of North American observations

C. L. Heald[1,23], A. H. Goldstein[1], J. D. Allan[2], A. C. Aiken[3,9], E. Apel[4], E. L. Atlas[5], A. K. Baker[6], T. S. Bates[7], A. J. Beyersdorf[6], D. R. Blake[6], T. Campos[4], H. Coe[2], J. D. Crounse[8], P. F. DeCarlo[3,9], J. A. de Gouw[10], E. J. Dunlea[9], F. M. Flocke[4], A. Fried[4], P. Goldan[10], R. J. Griffin[11], S. C. Herndon[12], J. S. Holloway[10], R. Holzinger[13], J. L. Jimenez[3,9], W. Junkermann[14], W. C. Kuster[10], A. C. Lewis[15], S. Meinardi[6], D. B. Millet[16], T. Onasch[12], A. Polidori[17], P. K. Quinn[7], D. D. Riemer[5], J. M. Roberts[10], D. Salcedo[18], B. Sive[11], A. L. Swanson[19], R. Talbot[11], C. Warneke[9,10], R. J. Weber[20], P. Weibring[4], P. O. Wennberg[8], D. R. Worsnop[12], A. E. Wittig[21], R. Zhang[22], J. Zheng[22], and W. Zheng[4]

[1]Department of Environmental Science and Policy Management, University of California, Berkeley, CA, USA
[2]School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Manchester, UK
[3]Department of Atmospheric and Oceanic Science, University of Colorado, Boulder, CO, USA
[4]Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, CO, USA
[5]RSMAS, Division of Marine and Atmospheric Chemistry, University of Miami, Miami, FL, USA
[6]Department of Chemistry, University of California, Irvine, CA, USA
[7]NOAA/PMEL, Seattle, WA, USA
[8]California Institute of Technology, Pasadena, CA, USA
[9]Cooperative Inst. for Research in Environmental Sciences (CIRES), University of Colorado at Boulder, Boulder, CO, USA
[10]Chemical Sciences Division, NOAA Earth System Research Laboratory, Boulder CO, USA
[11]Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, Durham, NH
[12]Aerodyne Research, Inc., Billerica, MA, USA
[13]Institute for Marine and Atmospheric Research (IMAU), Utrecht University, Utrecht, The Netherlands
[14]Forschungszentrum Karlsruhe, IMK-IFU, Garmisch-Partenkirchen, Germany
[15]Department of Chemistry, University of York, Heslington, York, UK
[16]Department of Soil, Water and Climate, University of Minnesota, St. Paul, MN, USA
[17]Department of Civil and Environmental Engineering, University of Southern California, Los Angeles, CA, USA
[18]Centro de Investigaciones Químicas, Universidad Autónoma del Estado de Morelos, Av. Cuernavaca, Mexico
[19]Northrop Grumman Space Technology, Chemistry Technology Department, Redondo Beach, CA, USA
[20]School of Earth and Atmospheric Sciences , Georgia Institute of Technology, Atlanta, GA, USA
[21]Department of Civil Engineering, City College of New York, New York, NY, USA
[22]Department of Atmospheric Sciences, Texas A and M University, College Station, TX, USA
[23]now at: Department of Atmospheric Science, Colorado State University, Fort Collins, CO, USA

Abstract. Measurements of organic carbon compounds in both the gas and particle phases made upwind, over and downwind of North America are synthesized to examine the total observed organic carbon (TOOC) in the atmosphere 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 μgC 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 ketone 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.

Final Revised Paper (PDF, 1775 KB) Discussion Paper (ACPD)

Citation: Heald, C. L., Goldstein, A. H., Allan, J. D., Aiken, A. C., Apel, E., Atlas, E. L., Baker, A. K., Bates, T. S., Beyersdorf, A. J., Blake, D. R., Campos, T., Coe, H., Crounse, J. D., DeCarlo, P. F., de Gouw, J. A., Dunlea, E. J., Flocke, F. M., Fried, A., Goldan, P., Griffin, R. J., Herndon, S. C., Holloway, J. S., Holzinger, R., Jimenez, J. L., Junkermann, W., Kuster, W. C., Lewis, A. C., Meinardi, S., Millet, D. B., Onasch, T., Polidori, A., Quinn, P. K., Riemer, D. D., Roberts, J. M., Salcedo, D., Sive, B., Swanson, A. L., Talbot, R., Warneke, C., Weber, R. J., Weibring, P., Wennberg, P. O., Worsnop, D. R., Wittig, A. E., Zhang, R., Zheng, J., and Zheng, W.: Total observed organic carbon (TOOC) in the atmosphere: a synthesis of North American observations, Atmos. Chem. Phys., 8, 2007-2025, 2008. Bibtex EndNote Reference Manager