Long-Term Variability of Terrestrial, Terpenoid BVOC Emissions in the Last Millennium

Juan C Acosta[1], Hamish Struthers[1], Eduardo Zorita[2], Annica ML Ekman[3], Alex Guenther[4] and Ilona Riipinen[1]

[1]Applied Environmental Science, Stockholm University , Stockholm, Sweden.
[2]Institute for Coastal Research, Helmholtz-Zentrum Geesthacht, Geesthacht, Germany.
[3]Department of Meteorology, Stockholm University, Stockholm, Sweden.
[4]Atmospheric Chemistry Division, NCAR Earth System Laboratory, Boulder, CO, USA
Keywords: BVOCs, Paleoclimate, Isoprene, Monoterpenes.
Presenting author email: juan.acostanavarro@helsinki.fi

Natural vegetation emits large amounts of volatile organic compounds into the atmosphere. Estimates of the total global source of biogenic volatile organic compounds (BVOCs) in the past millennium range between 1050 and 1100 Tg yr-1 (Adams et al. 2001). BVOCs have multiple impacts on atmospheric chemistry, they alter the concentrations of tropospheric aerosol in continental regions, and affect ozone formation and the oxidizing capacity of the troposphere (Seinfeld & Pandis, 2006). Organic compounds constitute 20-90% of the submicron aerosol mass, depending on location. Most of this contribution is secondary, meaning that the emitted VOCs are oxidized in the atmosphere followed by gas-to-particle conversion of the oxidation products (Jimenez et al., 2009). BVOCs emitted by vegetation are the dominant source of secondary organic aerosol (SOA) in the atmosphere (Guenther et al., 1995). Estimates of the present-day organic aerosol budgets are improving rapidly, but it is unclear how the organic aerosol fraction has evolved in the past. Such information is, however, needed for accurate estimates on the climate forcing caused by aerosols. Understanding the factors that have governed BVOC emissions in the past is a prerequisite for completing this task.

We evaluated the variability of global fluxes of isoprene, monoterpenes and sesquiterpenes over the last millennium using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) (Guenther et al., 2006). MEGAN estimates the emission activity of BVOCs using meteorological conditions and vegetation as input. The model is driven off-line using fields from an Earth System Model millennium simulations (Jungclaus et al. 2010) and reconstructions of the global changes of terrestrial vegetation (Kaplan et al., 2010). We found that compared to preindustrial times (1000-1800 A.D.), global isoprene emissions have decreased 8%, monoterpenes emissions have increased 10% and sesquiterpenes emissions have increased 15% during the time period 1950-1990 A.D.. The results suggest that the variation of isoprene emissions is governed by land-use changes, while monoterpenenes and sesquiterpenes variations are dominated by climate variability.

Adams, J.M. (2001). Chemosphere - Global Change Science, 3, 73-91
Seinfeld, J.H. and Pandis, S. N. (2006). Atmospheric Chemistry and Physics . Wiley, New York
Jimenez, J. L. et al. (2009). Science, 326, 1525-1529
Guenther, A. et al. (1995). J. Geophys. Res., 100, 8873-8892
Guenther, A et al. (2006). Atmospheric Chemistry and Physics, 6:3181–3210
Jungclaus, J. H. et al. (2010). Climate of the Past, 6:723–737
Kaplan, J. O. et al (2010). The Holocene 21(5), 775-791