



Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients

Alex Baker (1), Manmohan Sarin (2), Robert Duce (3), Tim Jickells (1), Maria Kanakidou (4), Stelios Myriokefalitakis (4,5), Akinori Ito (6), David Turner (7), Natalie Mahowald (8), Rob Middag (9), Cecile Guieu (10), Yuan Gao (11), Peter Croot (12), Rachel Shelley (13), and Morgane Perron (14)

(1) University of East Anglia, School of Environmental Sciences, Norwich, United Kingdom (alex.baker@uea.ac.uk, t.jickells@uea.ac.uk), (2) Physical Research Laboratory, Ahmedabad, India (sarin@prl.res.in), (3) Texas A & M University, College Station, USA (robertduce@hotmail.com), (4) University of Crete, Heraklion, Greece (mariak@uoc.gr, stelios@uoc.gr), (5) Institute for Marine and Atmospheric Research (IMAU), Utrecht University, (6) JAMSTEC, Tokyo, Japan (akinorii@jamstec.go.jp), (7) University of Gothenburg, Gothenburg, Sweden (david.turner@gu.se), (8) Cornell University, Ithaca, USA (mahowald@cornell.edu), (9) Netherlands Institute of Sea Research (NIOZ), Netherlands (rob.middag@nioz.nl), (10) CNRS, Villefranche sur Mer, France (guieu@obs-vlfr.fr), (11) Rutgers University, New Jersey, USA (yuangaoh@andromeda.rutgers.edu), (12) University of Galway, Galway, Ireland (peter.croot@nuigalway.ie), (13) LEMAR/IUEM, Brest, France (rachel.shelley@univ-brest.fr), (14) University of Tasmania, Hobart, Australia (morgane.perron@utas.edu.au)

The atmospheric deposition of nutrients to the ocean is known to play a significant role in the marine carbon cycle. The impact of such deposition is dependent on the identity of the nutrient in question (e.g., N, P, Fe, Co, Zn, Ni, Cd), the location of the deposition, and the bioavailability of the deposited nutrient. Bioavailability is largely governed by the chemical speciation of a nutrient and, in general, insoluble species are not bioavailable. For Fe and P (and perhaps the other nutrient trace metals) solubility increases during transport through the atmosphere. The causes of this increase are complex, but interactions of aerosol particles with acids appears to play a significant role. Emissions of acidic (SO_2 and NO_x) and alkaline (NH_3) gases have increased significantly since the Industrial Revolution, with a net increase in atmospheric acidity. This implies that Fe and P solubility may also have increased over this time period, potentially resulting in increased marine productivity. More recently, pollution controls have decreased emissions of SO_2 from some regions and further reductions in SO_2 and NO_x are likely in the future. Emissions of NH_3 are much more difficult to control however, and are projected to stabilise or increase slightly to the end of this century. Future anthropogenic emissions are thus likely to change the acidity of the atmosphere downwind of major urban / industrial centres, with potential consequences for the supply of soluble nutrients to the ocean.

To address these issues UN/GESAMP Working Group 38, The Atmospheric Input of Chemicals to the Ocean, is convening a workshop on this topic at the University of East Anglia in February, 2017. The goals of this workshop are to review and synthesize the current scientific information on the solubility of aerosol-associated key biogeochemical elements, the biogeochemical controls on aerosol solubility, and the pH sensitivity of those controls; to consider the likely changes in solubility of key species into the future and the potential biogeochemical consequences of such changes; and to identify the key future research needs to reduce uncertainties in predictive capability in this area. The results, conclusions, and recommendations of this workshop will be presented.