Physico-chemical characterisation and tracing of dust deposition in snow from Dronning Maud Land, NE Antarctica

Aubry Vanderstraeten*†[1], Steeve Bonneville[1], Karine Deboudt[2], Pascal Flament[2], Steven Goderis[3], François De Vleeschouwer[4], Gael Le Roux[4], Reto Gieré[5], Morgane Philippe[1], Jean-Louis Tison[1], Vinciane Debaille[1], and Nadine Mattielli[1]

[1]Département des Géosciences, Environnement et Société, Université Libre de Bruxelles (ULB) – Avenue FD. Roosevelt, 50 1050 Bruxelles, Belgium

[2]Laboratoire de Physico-Chimie de l'Atmosphère (LPCA) – Université Littoral Côte d'Opale – Bâtiment MREI 2 189A Avenue Maurice Schumann F-59140 Dunkerque, France

[3]Analytical, Environmental, and Geo-Chemistry – Vrije Universiteit Brussel (VUB) Pleinlaan 2 BE-1050 Brussels, Belgium

[4]EcoLab, Laboratoire d'Ecologie Fonctionnelle et Environnement, ECOLAB, Université de Toulouse, CNRS, INPT, UPS, Toulouse – CNRS : UMR5245 – 31326 Castanet Tolosan, France

[5]University of Pennsylvania (UPenn) – 240 S. 33rd Street, Hayden Hall Philadelphia, PA 19104-6316, United States

Abstract

Mineral dust is a major source of micronutrients (e.g. Fe) in open oceans and "High Nutrient Low Chlorophyll" (HNLC) zones. The southern Ocean is by far the largest of all HNLC regions and thus has the potential to greatly enhance the biological CO2 pump at the global scale. As the aerosol fluxes in the southern ocean are not well constrained and the potential impact of anthropogenic airborne particles may be larger than expected, a multidisciplinary study is being carried out on dust-bearing snow samples collected in NE Antarctica.

Samples were collected at the coast and 200km inland, near the Sør Rondane Mountains. Particulate and dissolved phases were separated by filtration on 0.2μm poresize membranes. These samples were investigated to (i) characterize the size, morphology, chemistry and mineralogy of dust by single particle analyses (automated-FEG-SEM-EDS), (ii) trace the origin, the geographical variability and the relative contributions of natural and anthropogenic sources from particulate and dissolved phases, through trace element analysis (HR-ICP-MS), (iii) approach the iron bioavailability via the determination of the Fe(II)/Fe(III) speciation at the particle scale by synchrotron analysis.

Samples exhibit a fine particle-size distribution ($>$ 98% of particles $<$ 5μm, n=2500) and $>$ 70% of the particles contain Fe, either in mineralogy, coating or both. Coastal samples indicate a finer grain size and a much higher Fe content in coatings. While the mineralogy suggests a substantial contribution from local Sør Rondane Mts., high Cr, Zn, Cu, Cd & Pb enrichment factors (x10 to x100 relative to upper continental crust) indicate an important

*Speaker

†Corresponding author: auvdstra@ulb.ac.be

anthropogenic contribution at the coast. Furthermore, the dissolved phase has much higher enrichments in transition metals, up to 10x the particulate phase. Finally, rare earth element profiles strongly suggest local (Sør Rondane Mts., Southern Ocean sea spray) and distant (Patagonia) sources.

Keywords: Dust, Antarctica, SEM, EDS, Sources tracing, Fe bioavailability