EGU2020-20767
https://doi.org/10.5194/egusphere-egu2020-20767
EGU General Assembly 2020

Impact of desert and volcanic aerosol deposition on phytoplankton in the South Indian Ocean and Southern Ocean

Carla Geisen[1], Celine Ridame[1], Emilie Journet[2], Benoit Caron[3], Dominique Marie[4], and Damien Cardinal[1]
[1]LOCEAN – IPSL, Sorbonne Université, Paris, France
[2]LISA – IPSL, Université Paris Est Créteil, Paris, France
[3]ISTeP, Sorbonne Université, Paris, France
[4]ADMM – SBR, Roscoff, France

The Southern Ocean is known to be the largest High Nutrient Low Chlorophyll (HNLC) area of the global ocean, where algal development is mainly limited by iron (Fe) deficiency, except in few naturally Fefertilized areas (e.g. around Kerguelen plateau). The availability of different nutrients is unevenly distributed in this area. Thus, northwards the polar front, nitrogen and phosphorus (N and P) concentrations are high, but the scarcity of silicon (Si) limits the growth of diatoms (HN-LSi-LC). Further North, the Southern Indian Ocean is characterized by macronutrient limitation and low primary production (LNLC).

In these areas, atmospheric input could play a major role in the nutrient supply of primary producers. The main aim of this study is to assess the biological response of local phytoplankton communities to a deposition of two types of natural aerosols: desert dust and volcanic ash. Preliminary trace-metal clean laboratory experiments enabled us to quantify the abiotic dissolution of main macro- and micronutrients in dry and wet deposition mode of different natural aerosols of these types that yield us to choose Patagonia dust and ash from the Icelandic volcano Eyjafjallajökull for our experiment at sea.

We set up a series of on-board trace-metal clean microcosm experiments in the contrasted biogeochemical conditions of the South Indian Ocean and Southern Ocean with addition of realistic amounts of dust and ash of respectively 2 and 25 $mg.L^{-1}$. Experiments ran over 48 hours to evaluate the triggered primary production and cell abundances. Primary production was estimated by ^{13}C spike and biogenic Si (bSi) uptake rates were assessed by ^{30}Si spike. Parallel experiments with nutrient addition (dFe, DIP, DIN and dSi) along with flux cytometry for estimation of pico- and nanophytoplankton cells enabled us to determine which element(s) dissolved from the aerosols was responsible for the enhanced algal growth.

The highest CO_2 fixation rate of 50 $mg.m^{-3}.day^{-1}$ was found at the natural Fe fertilized Kerguelen plateau station. Dust, ash and Fe addition triggered primary production, and CO_2 fixation doubled in these treatments. We recorded an enrichment of b^{30}Si, indicating an increase of Si uptake rate, mostly stimulated by Fe addition. At the different HNLC stations (high N - low Si and high N - high

Si), Fe and aerosol addition induced as well increased CO_2 fixation. In the northern LNLC stations, algal growth was stimulated by nitrogen addition as expected, but Fe, Si and aerosol addition also triggered a biological response from *Synechococcus* cyanobacteria and pico- and nanoeukaryotes.

Noteworthy, in most experiments the two contrasted aerosol types (desert dust and volcanic ash) at particle charges which varied over more than an order of magnitude triggered very similar biological responses in all of the sampled areas, even with distinct elementary and mineral compositions (e.g. the Icelandic volcano ash is 64 % amorphous and contains roughly twice the amount of Fe, P, Mn and
Zn compared to the Patagonian desert dust which is only 48 % amorphous).

How to cite: Geisen, C., Ridame, C., Journet, E., Caron, B., Marie, D., and Cardinal, D.: Impact of desert and volcanic aerosol deposition on phytoplankton in the South Indian Ocean and Southern Ocean, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-20767, https://doi.org/10.5194/egusphere-egu2020-20767, 2020