

FINAL REPORT PROGRAM LEFE

Program LEFE/ action(s) CYBER	Project Title	Years 2019 – 2021
	<u>I</u> mpac <u>T</u> des <u>A</u> ppor <u>t</u> s <u>A</u> tmosph <u>é</u> riques de <u>N</u> utr <u>i</u> ments sur les communaut <u>é</u> s phytopl <u>a</u> nc <u>t</u> oniques du transect <u>O</u> ISO : des zones LNLC à HNLC (ITALIANO)	
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<p><i>Context</i> : Nutrient inputs from the atmosphere to the ocean can impact the carbon cycle (biological carbon pump), and climate at a global scale, and are therefore very important in some regions and at some periods. While nutrient inputs from dust have been the subject of several studies in recent decades, work on the impact of volcanic ash on marine ecosystems is more recent, and mainly concerns iron inputs.</p> <p><i>Objectives / scientific questions</i> :</p> <p>The main objective of ITALIANO is to better understand and quantify the impact of atmospheric inputs of macro- (Si, N, P) and micronutrients (Fe) released from volcanic ash and desert aerosols on the activity and structure of the phytoplanktonic communities in contrasting areas of the South Indian Ocean: Low Nutrient Low Chlorophyll (LNLC), High Nutrient Low Chlorophyll (HNLC), High Nutrient Low Silicate Low Chlorophyll (HN-LSi-LC) and productive system of the Kerguelen plateau.</p> <p><i>Main results</i></p> <p>From microcosms experiments, we have shown that a realistic deposition of desert or volcanic aerosols is an important source of new nutrients to the ocean surface, triggering a significant increase in the photosynthetic activity of phytoplankton (CO₂ fixation) in the contrasting biogeochemical provinces (LNLC, HNLC, HN-LSi-LC, Kerguelen plateau) encountered in the South Indian Ocean (Figures 1, 2). Both aerosol types mitigated iron deficiency occurring in the Southern Ocean during the Austral summer and caused a +24 to 110 % increase in primary production, depending on the station (Fig. 2). The release of dissolved silica potentially also contributed to this response, although to a lesser extent (Fig. 2). On the other hand, the same deposition had no effect on primary production in the eastern subtropical part of the South Indian Ocean, as the local nitrogen limitation was not relieved by the aerosols (Fig. 2b). Some algae groups such as diatoms benefit more from the new atmospheric nutrients (40 to 100 % of the biomass increase in the responding stations), thereby modifying the structure of the planktonic community which could potentially increase the efficiency of the biological carbon pump.</p>		

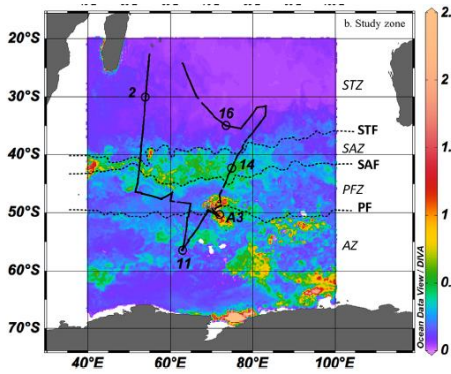


Fig. 1: ITALIANO/OISO-29 cruise transect in January 2019 showing the locations of the five ITALIANO stations (LNLC-2, HNLC-11, Kerguelen-A3, HN-LSi-LC-14 and LNLC-16) where the bioassay experiments (detailed by each bar for each station in Fig. 2) were performed, and satellite-derived chlorophyll-a concentration ($\mu\text{g.L}^{-1}$) averaged over January 2019 (MODIS) (from Geisen et al., 2022).

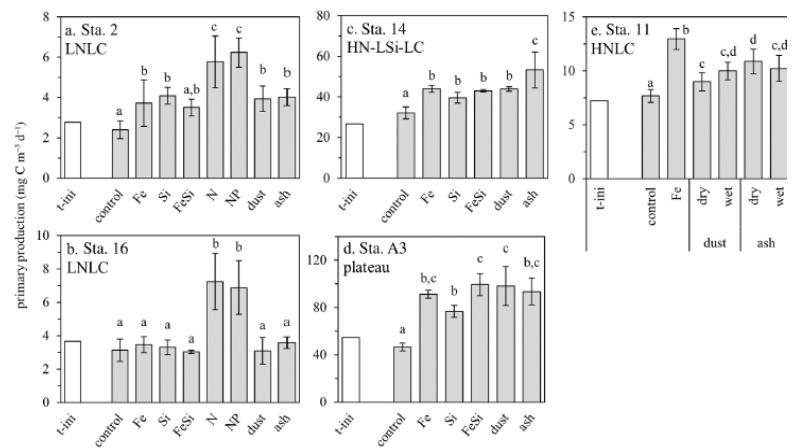


Fig. 2: Primary production ($\text{mg C.m}^{-3}.\text{d}^{-1}$) at the beginning of the experiment (t-ini, white bars) and after 48 h of incubation for each treatment at the stations LNLC St 2 (a) and 16 (b), HN-LSi-LC St 14 (c), Kerguelen plateau St A3 (d) and HNLC St 11 (e). Error bars indicate standard deviation of triplicates. Means that are not significantly different ($p > 0.05$) are labelled with the same letter within a station (from Geisen et al., 2022).

Future of the project :

In relation with ITALIANO, an ANR project in which I am co-PI, has been submitted: SOPHYAC: 'Responses of Southern Ocean phytoplankton to anthropogenic changes, feedbacks to the atmosphere and impact on the trophic chain'.

Number of publications, communications and theses

Publications

Geisen, C., Ridame, C., Journet, E., Delmelle, P., Marie, D., Lo Monaco, C., Metzl, N., Ammar, R., Kombo, J. and D. Cardinal: Phytoplanktonic response to simulated volcanic and desert dust deposition events in the South Indian and Southern Oceans, in rev., *Limnology and Oceanography*, 9999, 1-17, <http://doi.org/10.1002/lno.12100>, 2022.

Geisen, C., Ridame, C., Journet, E., Delmelle, P., and D. Cardinal: A minor dissolvable silicon supply from natural aerosols (desert dust and volcanic ash) to the ocean; to be submitted to GBC

Thèse:

Carla Geisen : 'Macro- and micronutrient dissolution from desert and volcanic aerosols in rain and seawater : Impact on phytoplankton in the Southern Indian Ocean', 235 pp., 2021, SU.

International Communications

Carla Geisen, Céline Ridame, Émilie Journet, Benoit Caron, Dominique Marie, Damien Cardinal, Impact of desert and volcanic aerosol deposition on phytoplankton in the South Indian Ocean, *Blowing South : Southern Hemisphere Dust Symposium*, November 8-10, 2021, on-line event

Carla Geisen, Céline Ridame, Émilie Journet, Benoit Caron, Dominique Marie, Damien Cardinal, Impact of desert and volcanic aerosol deposition on phytoplankton in the South Indian Ocean and Southern Ocean, *EGU*, 3-8 May Vienna, 2020

Carla Geisen, Céline Ridame, Damien Cardinal, Joelle Kombo, Emilie Journet, Rawaa Ammar, Dissolution of Fe and Si from desert and volcanic aerosols and impact on phytoplankton, *IMBER Open Science Conference*, 17-21 June 2019, Brest, France.

Data availability

Geisen Carla, Ridame Céline, Journet Emilie, Delmelle Pierre, Marie Dominique, Lo Monaco Claire, Metzl Nicolas, Ammar Rawaa, Kombo Joelle, Cardinal Damien (2021). Phytoplanktonic Response to simulated Volcanic and Desert Dust Deposition Events in the South Indian and Southern Oceans. SEANOE.

<https://doi.org/10.17882/80825>

