Aerosol inputs of new nutrients (N, P, Fe) along a zonal along transect (20° S) in the SW Pacific ocean

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OBJECTIVES

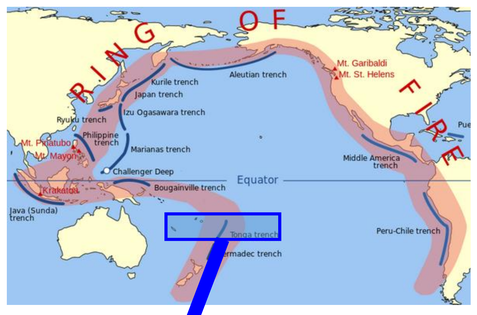
The OUTPACE oceanographic campaign took place in the SW Pacific in 2015 (February 18-April 3; R/V L'Atalante) along a 5000 km transect from New Caledonia to French Polynesia.

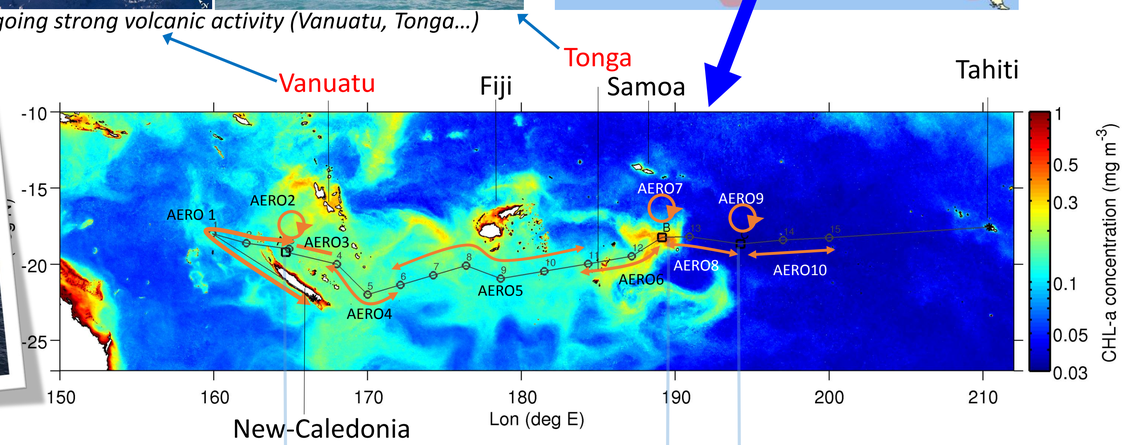
The investigated area, characterized by oligotrophic to ultraoligotrophic regimes, is also characterized by high [Chla] in the vicinity of the numerous archipelagoes present there (Vanuatu, Fiji, Tonga…).

One of the current hypothesis is that those higher [Chla] may be due to inputs of volcanic material from the Islands.

One objective of the OUTPACE cruise was thus to test this hypothesis by measuring simultaneously the release of new nutrients and micronutrients from the aerosols collected during the cruise and the *in situ* stocks and the response of the natural assemblage to aerosols additions.

On going strong volcanic activity (Vanuatu, Tonga…)





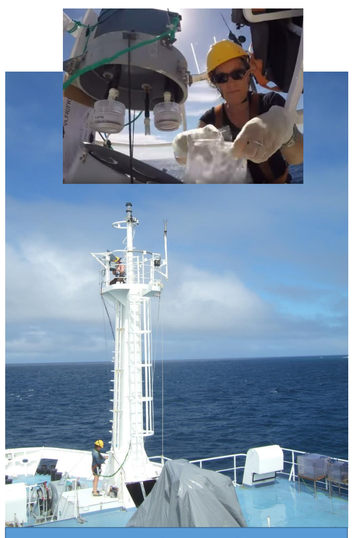
Methodology

Using ultra-clean techniques, we:

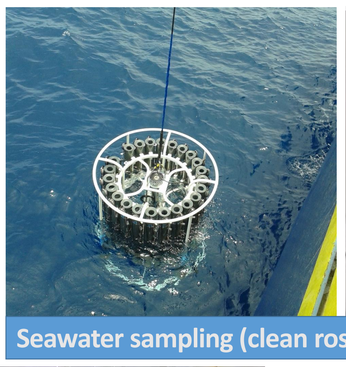
(1) sampled the water column to quantify in situ stocks for nitrate, phosphate and iron,

(2) performed dissolution experiments with both aerosols collected on board and ashes from the Vanuatu Yasur volcano

(3) conducted addition experiments to investigate the impact of atmospheric nutrients on the planktonic assemblage



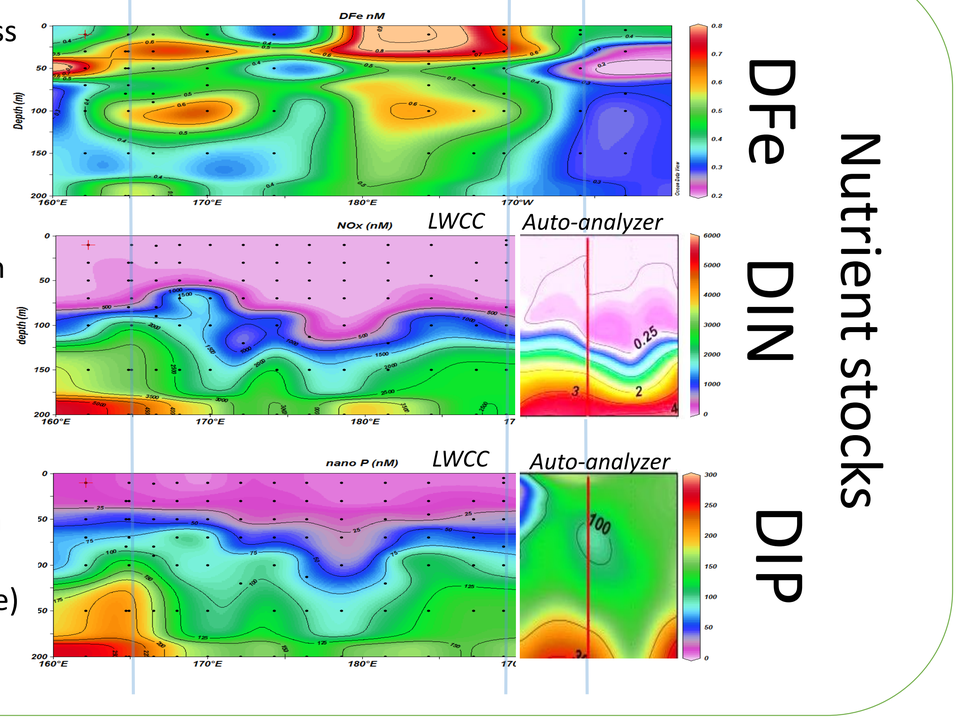
Aerosol sampling



Seawater sampling (clean rosette). Direct filtration inside clean van

Dissolution experiments

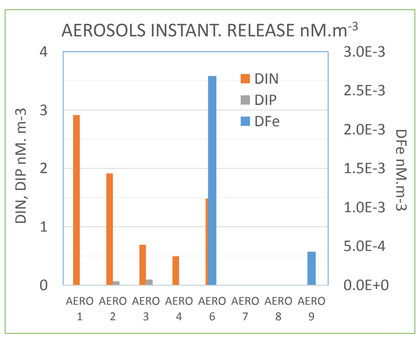
On deck incubations

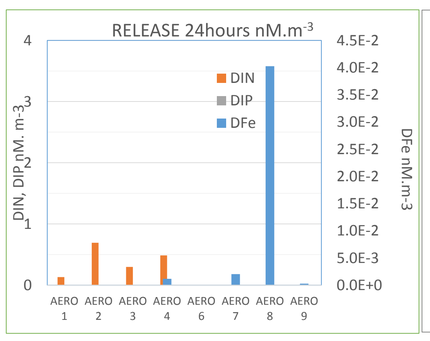


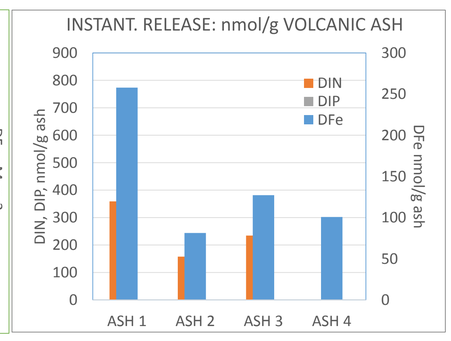
- High [DFe] +patchiness before the gyre
- (Sub)surface enrichments in the vicinity of islands
- DIN ~ 25 nM in 0-50m
- Deepening of the nitracline toward the East (gyre)
- DIP ~ 18 nM in 0-50m
- Strong increase towards the East (gyre)

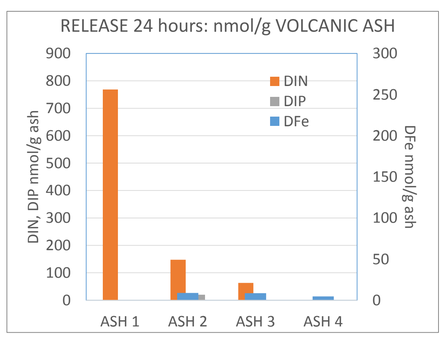
Nutrient stocks DFe DIN DIP

Aerosols and volcanic ashes dissolution





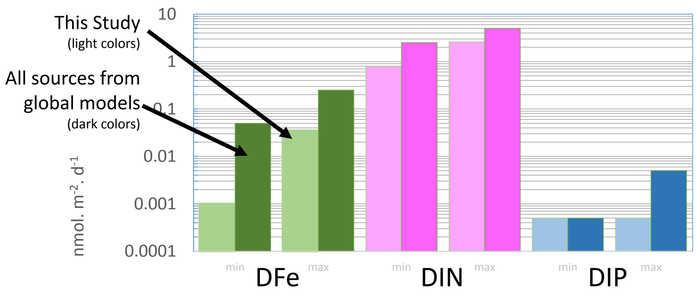




- All samples provided dissolved N and Fe to the surface ocean
- Samples did not release DIP
- DIN release instant >> 24h
- No clear pattern for DFe. Seawater with high DFe: dissolution signal difficult to depict → dissolved flux underestimated

- Volcanic ash from Vanuatu also released DIN and DFe but no DIP
- Mainly instant release for DFe
- Same ash but different effect → different biogeochemical conditions of the seawater used. Ex. LD_A more Fe binding ligand?

Estimated dissolved fluxes from the atmosphere using 0.1 $cm.s^{-1}$ and comparison with modeled fluxes from Luo et al., 2008; Mahowald et al., 2008



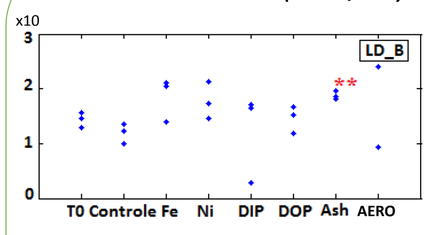
- DFe: up to 70 % of the current estimates
- DIN: up to 100% of the current estimates
- DIP: in agreement with current estimates

→ Important contribution of volcanic source to dissolved deposition of DFe and DIN in the area?

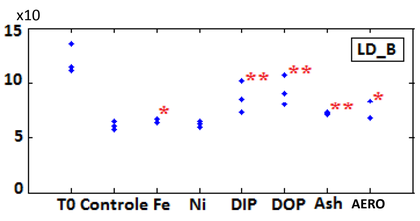
Impact of atmospheric nutrients on plankton

- No significant response for Chla, PP and N_2fixation
- But impact on pico-phytoplankton, bacteria abundances and BP

Prochlorococcus (cells/ml)

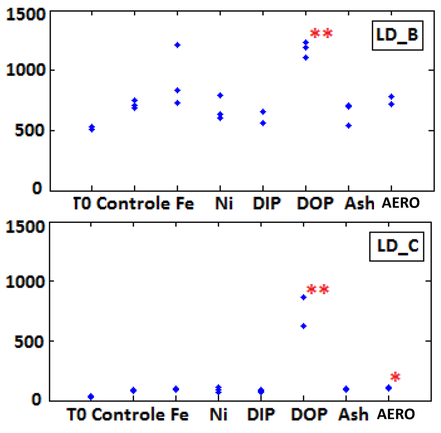


Synechococcus (cells/ml)

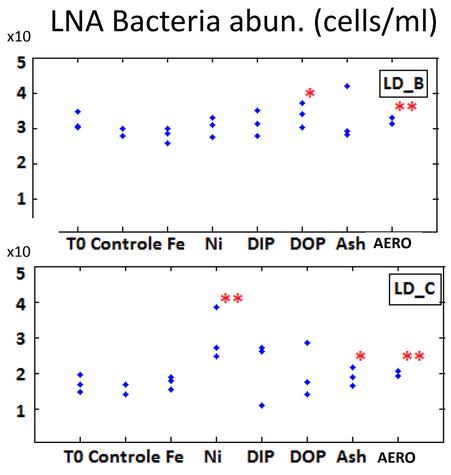


- Response to ash addition: Fe and N limitation
- Limited by Fe and DIP

Bacterial Production ng $C.L^{-1}.h^{-1}$



LNA Bacteria abun. (cells/ml)



On-going and future work

- complete analysis!
- Start a deposition time series in the Vanuatu (Dec. 2015)
- 2 cruises planned around the Vanuatu Archipelago in 2016: dissolution experiments and enrichment experiments with low DFe seawater
- Better investigate the marine source (both massive marine and atmospheric eruption of volcano in 2015, Tonga)

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