**Objectives:** The availability of nitrogen is one of the main factors controlling primary productivity and carbon sequestration by the ocean. Biological N₂ fixation constitutes one of the major sources of ‘new’ nitrogen for the surface ocean with a net input estimated around 100-200.10¹² g yr⁻¹. The objective of the VAHINE project is to study the fate of nitrogen newly fixed by diazotrophs in the oligotrophic ocean.

**Main results:** To answer these questions, a triplicate mesocosm (55 000 L) experiment was conducted for 25 days in the southwest Pacific (New Caledonia; 22°29.073 S, 166°26.905 E) in Jan.–Feb. 2013. This study, which involved 25 scientists, yielded a comprehensive data set on community-level responses to a diazotroph bloom and its impact on community changes, biogeochemical cycles and export. Two post-cruise meetings were organized in Marseille in Oct. 2013 (16 communications) and July 2014 (10 communications) to present the results of the project. A special issue is in preparation for Biogeosciences (see below).

![Triplicate mesocosms deployed in the framework of the VAHINE project in New Caledonia (Jan.-Feb. 2013). The logistics was performed by the R/V Alis.](image)

![Fig. 1. Triplicate mesocosms deployed in the framework of the VAHINE project in New Caledonia (Jan.-Feb. 2013).](image)

![Fig. 2. Temporal changes in (A) dissolved inorganic phosphate turn over time (T_{DIP}, d), (B) N₂ fixation (nM N d⁻¹), (C) primary production (PP) (µM C d⁻¹) in the mesocosms M1 (red), M2 (blue) and M3 (green) and in surrounding waters (black). The three dots of each color represent the measured values at the 3 sampled depths. (D) POP_{export}, (E) PON_{export} and (F) POP_{export} fluxes (nM d⁻¹) in the mesocosms expressed in equivalent water volume. Solid lines are 3-days running mean value. P1 and P2 denote the two phases of the experiment when the diazotrophic community was dominated by DDAs and UCYN-C, respectively (taken from Berthelot et al., Biogeosciences, in revision).](image)
N₂ fixation was the main driver of new production during the whole experiment. The e-ratio that quantifies the efficiency of a system to export particulate organic carbon (POCₜₐₓₜₜ) compared to PP (e-ratio = POCₑₓₜₜ/PP) was significantly higher (p<0.05, n=57) during P2 (39.7±24.9 %) than during P1 (23.9±20.2 %) indicating that UCYN-C were more efficient at promoting C export than DDAs (Berthelot et al., Biogeosciences, In revision).

Moreover, the succession of diazotrophs inside, outside the mesocosms and in the traps during the experiment provided a unique opportunity to calculate in situ net growth and death rates (Turk et al., submitted). Bonnet et al., studied the transfer of fixed ^15N₂ in the pelagic food web using cell sorting by flow cytometry and nanoSIMS, Leblanc et al. studied the evolution of the phytoplankton community composition using microscopy, flow cytometry and pigments analyses, Hunt et al. studied the zooplankton trophic structure and nitrogen uptake pathways, Van Wambke et al. studied the dynamics of heterotrophic bacterial community and its links with transcriptional changes during the experiment, Pfreundt et al. studied the abundance and transcriptional changes within the microbial community, Spungin et al. studied the dynamics of TEP production and release, the microbial and phytoplankton mortality and targeted Gene Expression in dying blooms of diazotrophs in the mesocosms. Finally, Gimenez et al., investigated the fate of diazotroph derived nitrogen during the VAHINE mesocosms experiment using a mechanistic biogeochemical model approach.

All articles will be submitted in the 2015 in the VAHINE special issue recently accepted in Biogeosciences.

**Future of the project:** the project will stop early 2016 with the end of ANR funding. The VAHINE project allowed to develop and/or adapt techniques to study the fate of fixed N in the pelagic food webs and the impact of N₂ fixation on export that are now used in other projects, such as OUTPACE (PIs: T. Moutin, S. Bonnet, M.I.O, funded by LEFE, ANR, IRD, GOPS, CNES) in a more oceanic perspective including interactions with hydrodynamics. Within this context, w recently performed a 45-days multidisciplinary cruise between New Caledonia and Tahiti onboard the R/V Atalante to work on the fate of biological production and its subsequent fate along trophic gradients, with a specific emphasis on the production sustained by nitrogen fixation during which we used the techniques developed during VAHINE. The modelling part developed during VAHINE will also later be used in the framework of the OUTPACE project.

**Nombre de publications, de communications et de thèses**

**Publications**

Results are currently being published in a special issue of BIOGEO SCIENCES that has just been accepted [http://www.biogeosciences-discuss.net/special_issue153.html](http://www.biogeosciences-discuss.net/special_issue153.html)

**Biogeochemical and biological response to a diazotroph bloom in a low-nutrient, low-chlorophyll ecosystem: results from the VAHINE mesocosms experiment**

**Guest Editors:** S. Bonnet, D. G. Capone, F. Lacan, and E. Marinañ

16 articles are planned, one in under revision, one is submitted (below) and the rest will be submitted in 2015


Kendra A. Turk-Kubo, Ildiko E. Frank, Mary E. Hogan, Anne Desnues, Sophie Bonnet, Jonathan P. Zehr. Diazotroph community composition shifts from diatom-associated Richelia- to Cyanothece-dominated during the VAHINE mesocosms experiment. Submitted to Biogeosciences.

**Ph.D students**

The VAHINE project involves 3 Ph.D students: Hugo Berthelot (MRT fellowship 2012-2015, defense planned on December 2015, Supervisors: T. Moutin, S. Bonnet), Ulrike Pfreundt (University of Friburg, Germany, Supervisor: W. Hess ) and Dina Spungin Bar Ilan University, Israel, Supervisor; I. Berman-Frank)

**Communication to international conferences/workshops**

Gimenez, A., Baklouti, M., Moutin, T., Berthelot, H., Bonnet, S. Investigating the fate of diazotroph derived N during the VAHINE Mesocosm experiment using a mechanistic biogeochemical model. ASLO meeting Granada, Feb. 2015.

Berthelot, H., Moutin, T., Bonnet, S. Fate of nitrogen fixed by diazotrophs in the ocean: Preliminary results from the VAHINE mesocosms experiment in N. Caledonia. “From bloom to gloom”, 29 July -7 August 2014 at Hólar University, Iceland.

Berthelot, H., Moutin, T., Bonnet, S. Fate of fixed nitrogen during a mesocosms experiment in the South Pacific Ocean. International Solas Summer School, August 23rd – September 2nd, 2013, Xiamen, China.

Berthelot, H., Moutin, T., Bonnet, S. Fate of fixed nitrogen during a mesocosms experiment in the South Pacific Ocean. Second EMBO Conference on Aquatic Microbial Ecology: SAME-14, August 23-28 2015, Uppsala, Sweden

**OUTREACH.**

- 20 minutes documentary film ‘Les coulisses de la science’ [https://www.youtube.com/watch?v=s8kRjGoazQw](https://www.youtube.com/watch?v=s8kRjGoazQw)
- 3 TV spots News NC1ère [http://mio.pytheas.univ-amu.fr/?VAHINE-Project](http://mio.pytheas.univ-amu.fr/?VAHINE-Project)
- 3 newspaper articles ‘Les Nouvelles calédoniennes’, 2 radio (RRB, NC1ère) broadcasts