Disturbance of phytoplankton biomass seasonal dynamics in a South Pacific island wake: A biogeochemical-Argo floats-based study

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Aim of the study

The **South Pacific subtropical gyre** is a vast and remote area where biogeochemical *in situ* observations are scarce, leading to large uncertainties on phytoplankton biomass variability. The aim of this study is to investigate **physical** and **biogeochemical** observations from three Biogeochemical-Argo (BGC-Argo) **profiling floats** that collected data in the central **South Pacific Ocean**, near **Tahiti** (17.7°S -149.5°W) between March 2015 and early 2017. **Seasonal** dynamics of phytoplankton biomass is characterized both in the **open ocean** and in the **island wake** generated by Tahiti. Here, we examine if an island mass effect (i.e., biological enhancement) can be evidenced leeward Tahiti.

Data

Data from 3 BGC-Argo floats

Float	Length of the mission	Temporal resolution of data acquisition	Equipment
080b	20 months	5 days	CTD/radiometry/WET Labs ECO Puck Triplet
078d	~3 months	daily	CTD/radiometry/WET Labs ECO Puck Triplet /nitrate sensor/optode
070d	~3 months	5 days	CTD/radiometry/WET Labs ECO Puck Triplet /nitrate sensor/optode

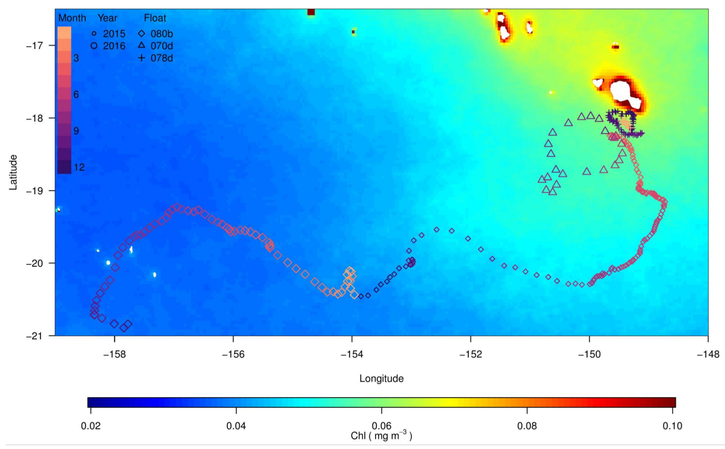

Figure 1: Trajectory of the 3 BGC-Argo profiling floats used in this study as a function of month and year along their deployment. The color in background represents the mean satellite surface chlorophyll a concentration (Chl) from the MODIS Aqua entire mission. Islands are indicated in white.

Seasonal dynamics

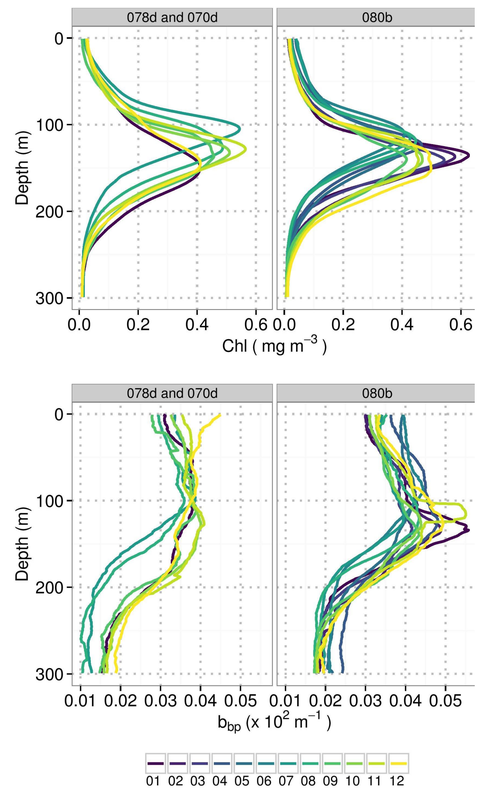

Figure 2: Vertical distribution of monthly average chlorophyll a concentration (Chl, top) and particulate backscattering coefficient (b_{bp}, bottom). The color code represents each month of the year over 2015 to 2017.

- **Open ocean (080b data):**
  The seasonal dynamics of phytoplankton biomass observed by the BGC-Argo float is consistent with previous descriptions of oligotrophic environments (e.g. deepening and intensification of the deep chlorophyll maximum (DCM) from winter to summer, Mignot *et al.*, 2014)

- **Leeward side of Tahiti (078d and 070d data):**
  Differences from the seasonal patterns are observed, such as the decrease of the DCM in austral summer (in yellow and purple)

Time series acquired from the 078d profiling float

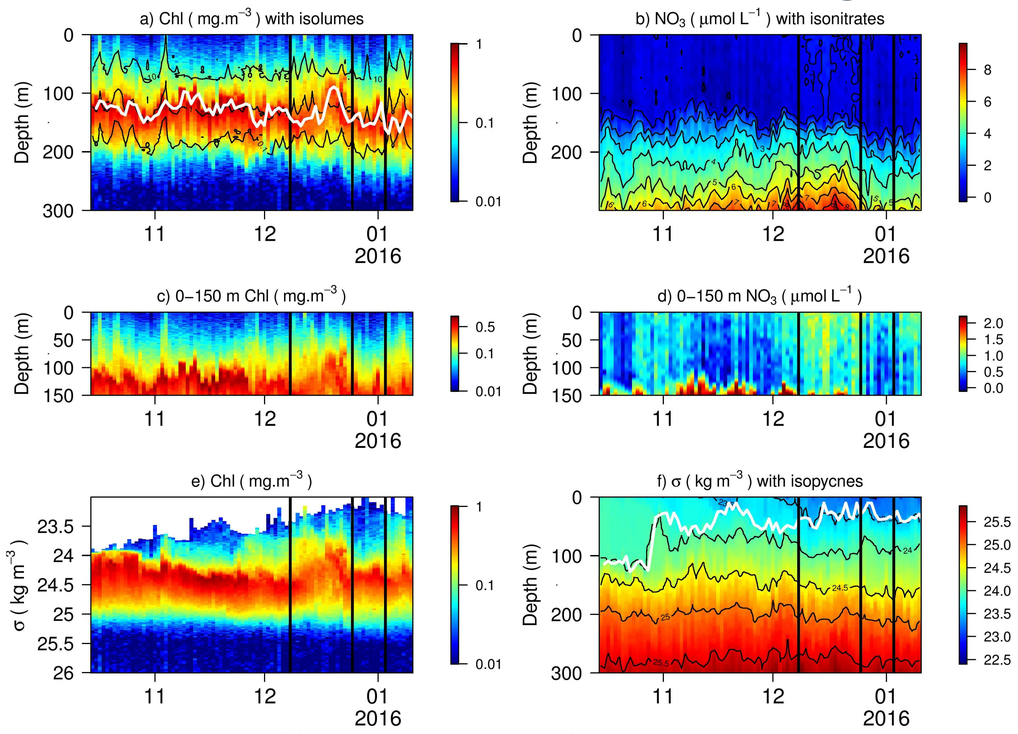

Figure 3: Vertical distribution of (a) Chl along time. Isolumes (mol quanta m^{-2} d^{-1}) are indicated as black lines. (b) Vertical distribution of nitrate concentration with isonitrates as black lines. (c) and (d) are zooms of (a) and (b) over 0-150m. (e) Time series of Chl as a function of density. (f) Vertical distribution of density along time. Isopycnes are superimposed as black lines. The white line represents the DCM and the mixed layer depth in (a) and (f), respectively.

→ **The DCM shallows during late austral spring (in Dec) and is associated with an increase of Chl in the upper layer. This increase of Chl is associated with a supply of nitrate, not related with an isopycnal uplift.**

Island mass effect observed from the 078d profiling float

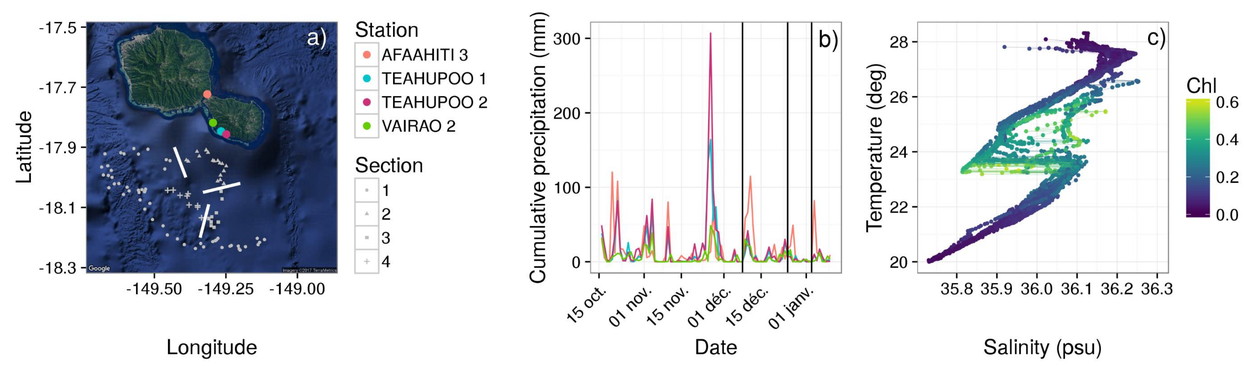

Figure 4: (a) 078d trajectory with sections as defined in Figure 3. The localizations of the Météo France meteorological stations are indicated. (b) Time series of daily cumulative precipitations measured at the 5 stations. (c) TS diagrams (i.e. Salinity as a function of Temperature) for profiles acquired during section 2.

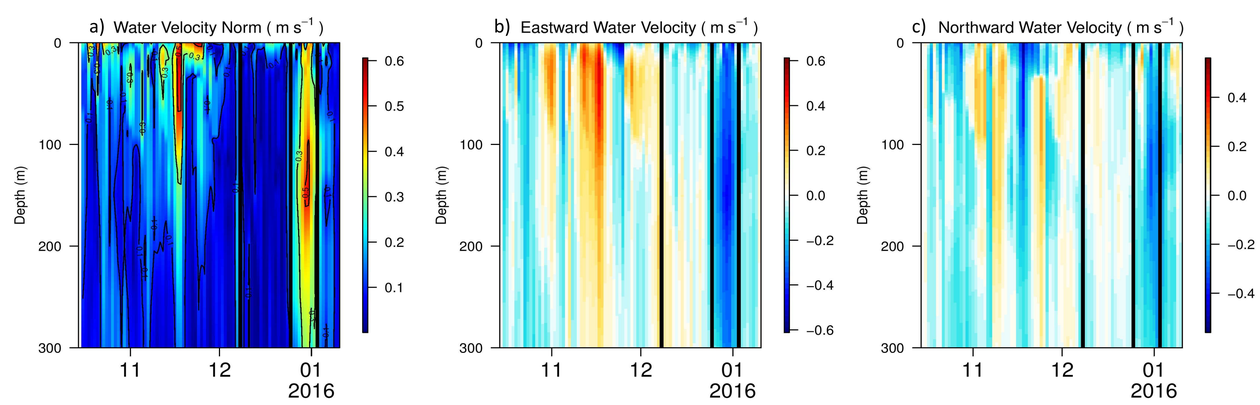

Figure 5: HYCOM-modelled velocity along the 078d float track: (a) the ocean current amplitude, as well as the (b) zonal and (c) meridian components.

→ **The concomitant occurrence of land drainage induced by strong precipitations and a shadow zone of current behind Tahiti shows the increase of nitrate concentration and the phytoplankton biomass enhancement in the upper layer.**

Conclusion

→ **For the first time, an island mass effect on phytoplankton biomass dynamics is evidenced by observations from BGC-Argo floats. We also highlight how local physical processes can strongly disrupt phytoplankton seasonal variability.**

Reference: Mignot A., Claustre H., Uitz J., Poteau A., D'Ortenzio F. and Xing X. (2014), Understanding the seasonal dynamics of phytoplankton biomas and the deep chlorophyll maximum in oligotrophic environments: A Bio-Argo float investigation, Global Biogeochemical Cycles.

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