Experimental evidence of dust-induced changes in DOM bioavailability in the surface oligotrophic ocean

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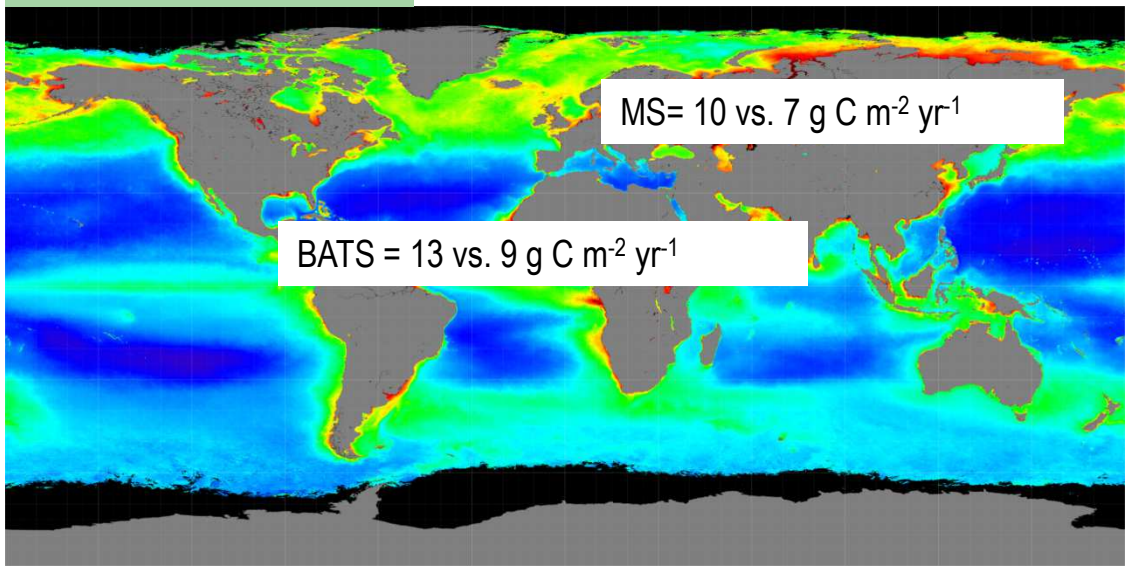
DOC pool in the oligotrophic ocean

DOC is the second largest oceanic C pool (662 ± 32 Pg C)

DOM is a crucial advective/mixing pathway of carbon export, particularly in the oligotrophic ocean

DOC vs. POC export

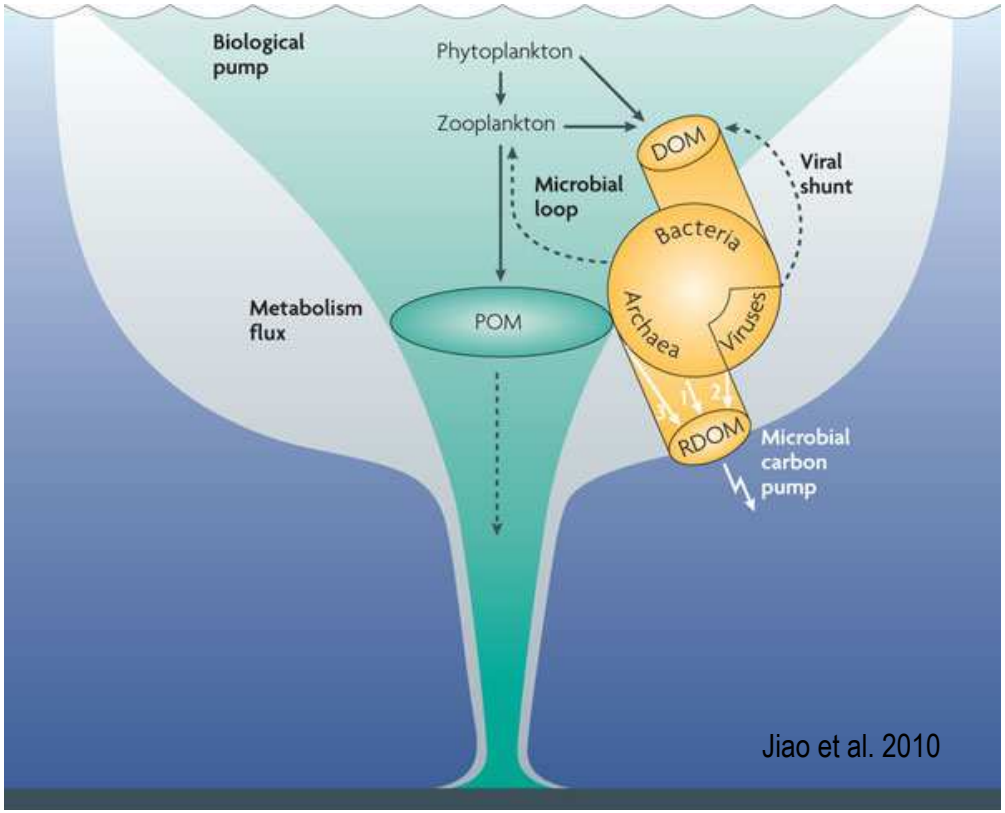


DOC export through vertical mixing results from the decoupling between production and removal processes during the stratification period due to nutrient limitation of bacterial activity

Hansell et al. 2009; Hansell, 2002; Carlson et al. 1994; Avril, 2002; Santinelli, 2015; Thingstad et al. 1998

DOC pool in the oligotrophic ocean

Bacterial activity (and microbial loop functioning) also shapes the chemical composition of the DOM pool → **<u>residence time of the DOM pool</u>** (Microbial Carbon Pump, Jiao et al. 2010)

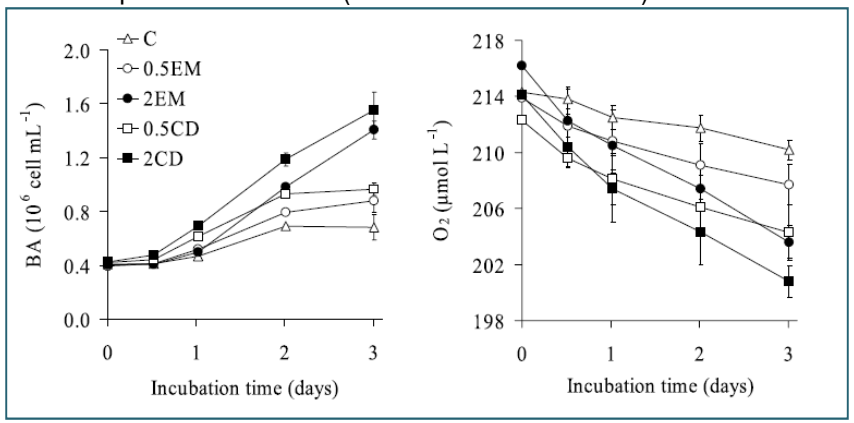


Processes affecting bacterial activity at the surface ocean may modify the residence time of the surface DOM pool → DOC export

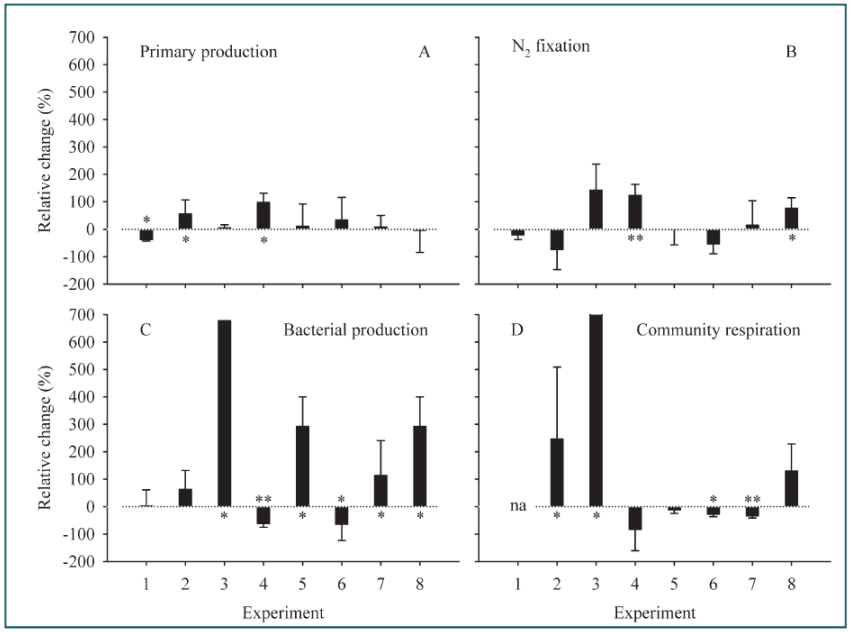
Bacterial response to dust deposition

Nutrient limitation of bacterial activity can be transiently relieved through the pulsed inputs of new nutrients derived from Saharan dust

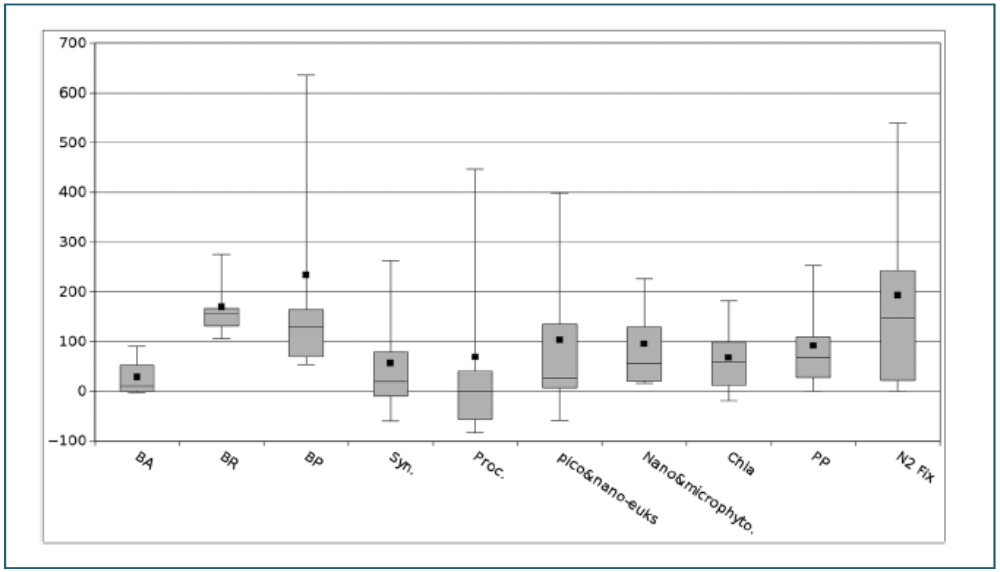
In vitro experiment Med Sea (Pulido-Villena et al. 2008)



In vitro experiments NASG (Maranon et al. 2010)



Compilation of recently conducted experiments (Guieu et al. 2014)



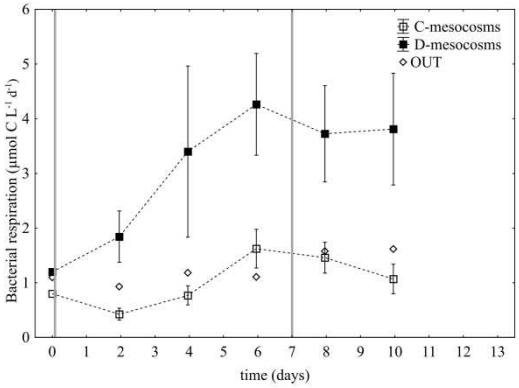
Consistent responses of bacterial community to dust deposition

Response of the microbial food web to dust deposition

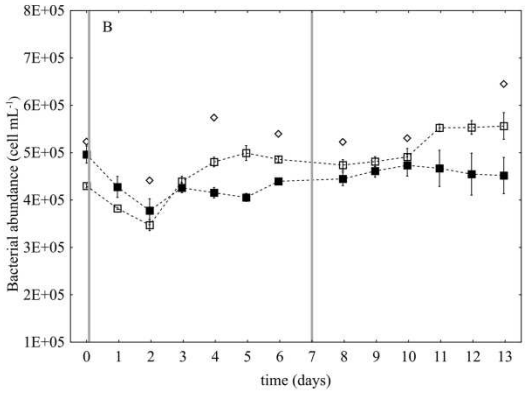
Dust deposition also affects the structure and functioning of the whole microbial food web

(ANR-DUNE, Pulido-Villena et al. 2014)

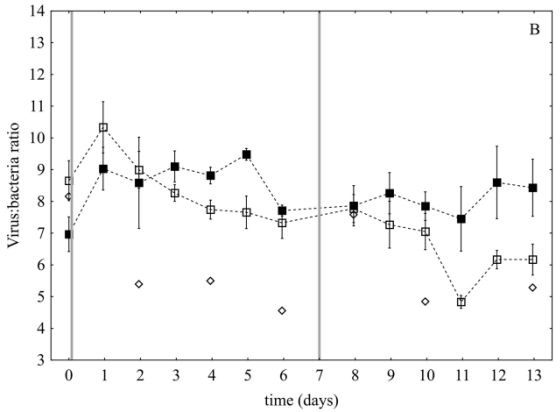
Stimulation of bacterial respiration

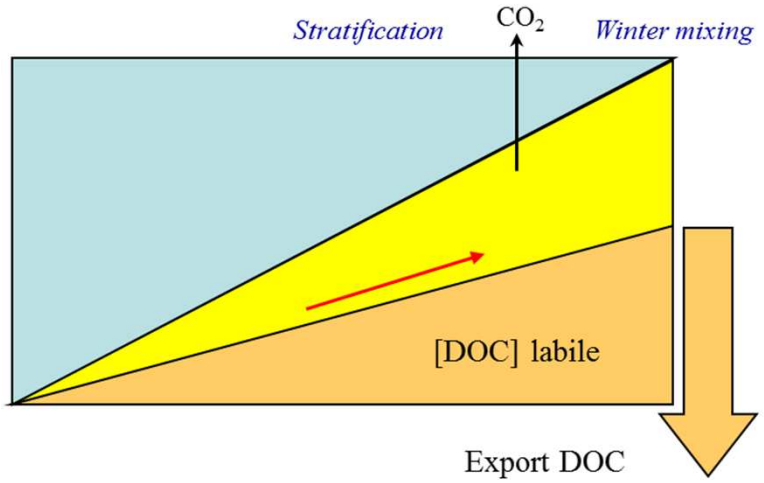


Decrease of bacterial abundance



Increase of viral control





The stimulation of bacterial activity during the stratification period may decrease the amount of DOC exported through winter mixing

→ **<u>'bacterial' link between dust deposition and C cycle</u>**

The DONUT project

The DONUT project aimed at revisiting the 'bacterial' link between dust deposition and C cycle

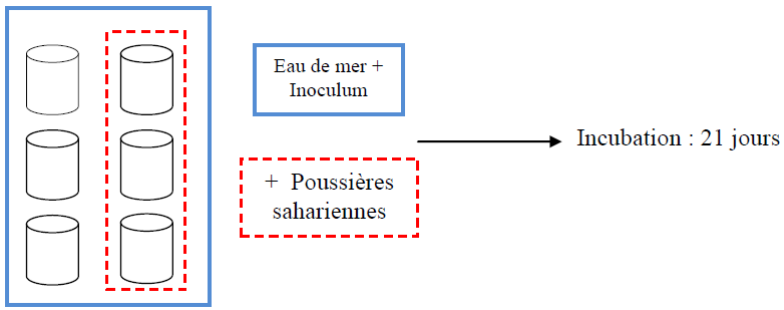
How the bacterial (and microbial loop?) response to dust deposition can shape the DOM pool and modify its residence time: DOM bioavailability

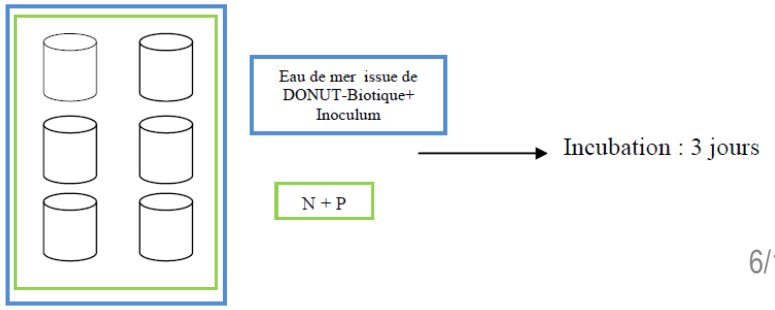
Funded by LEFE-CYBER between 2013-2014
Endorsed by SOLAS
Kahina Djaoudi M2 internship (AMU)

Approach: 2-step in vitro experiment:

1) Classical enrichment experiment (dust + seawater + bacterial inoculum) elarged to 21 days to get DOM changes (DONUT-1)

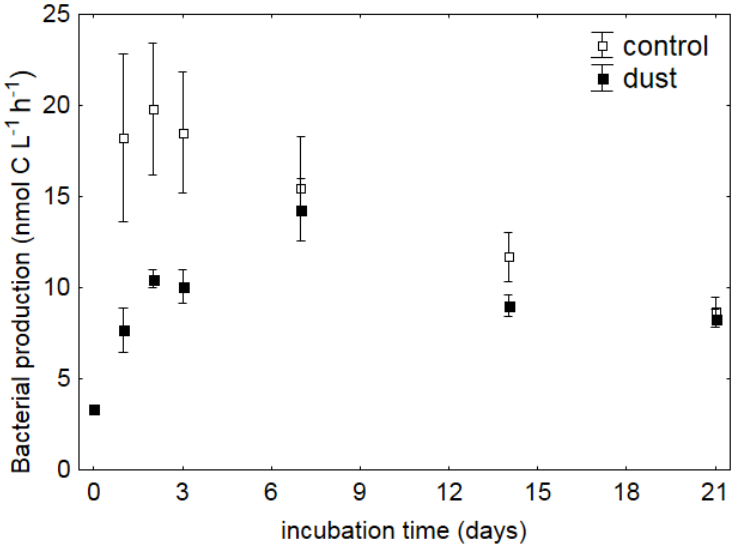
2) Use of the remaining water from DONUT-1 to launch short biodegradation experiments (DONUT-2)

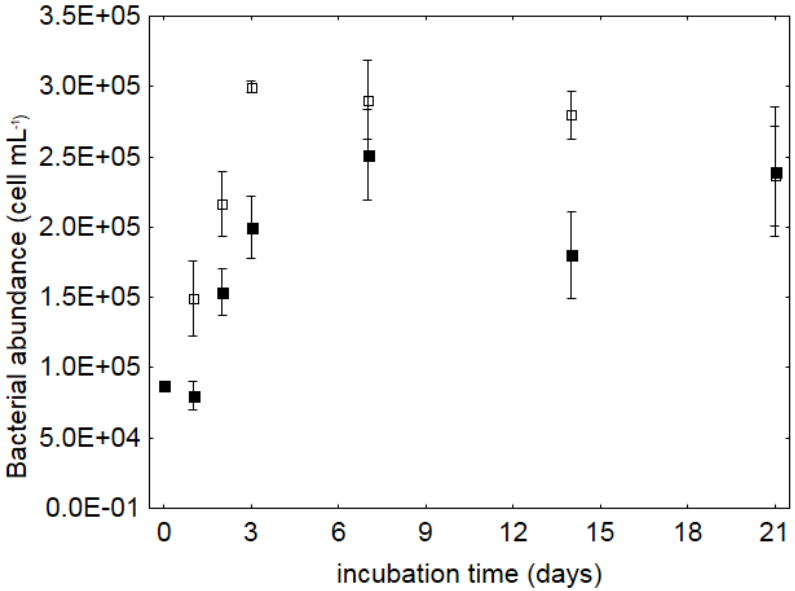




Acknowledegements: SO MOOSE and LISA (DUNE dust)

DONUT-1: bacterial abundance and production

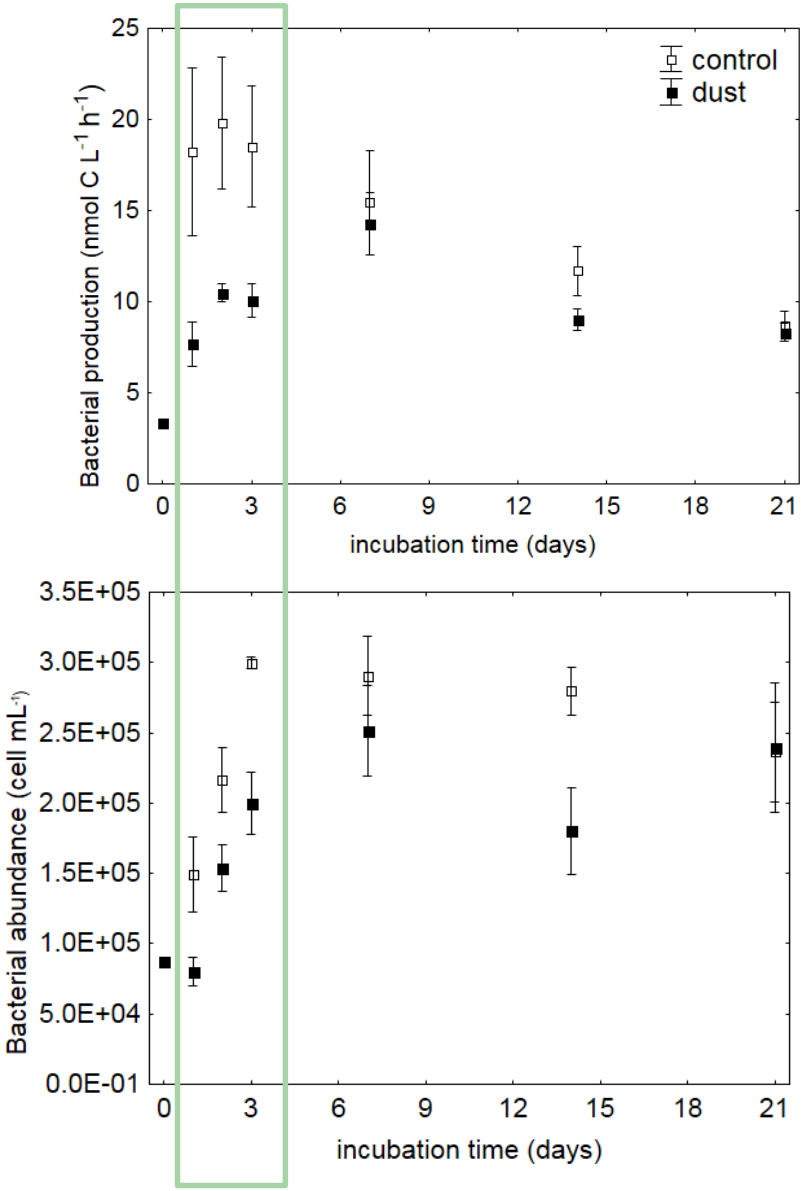




Bacterial activity and growth was inhibited under dust-enriched conditions during the first days of the experiment

Similar values for both treatments at the end of the experiment

DONUT-1: bacterial abundance and production

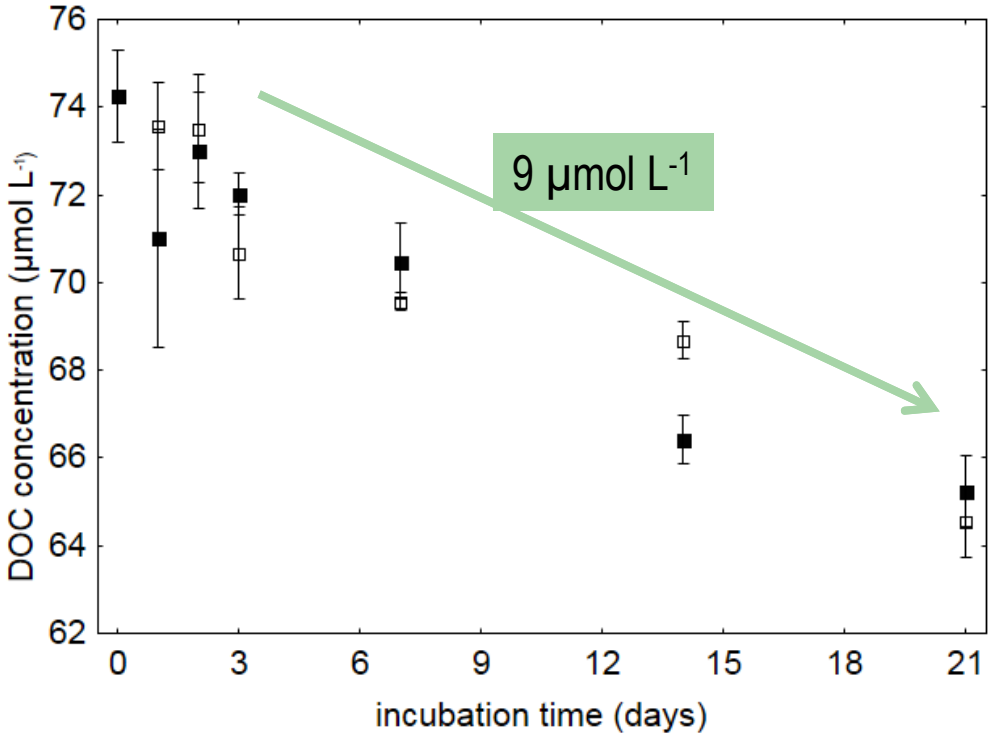


Bacterial activity and growth was inhibited under dust-enriched conditions during the first days of the experiment

Top-down control by heterotrophic nanoflagellates

x2 HNF abundance in dust amended treatment

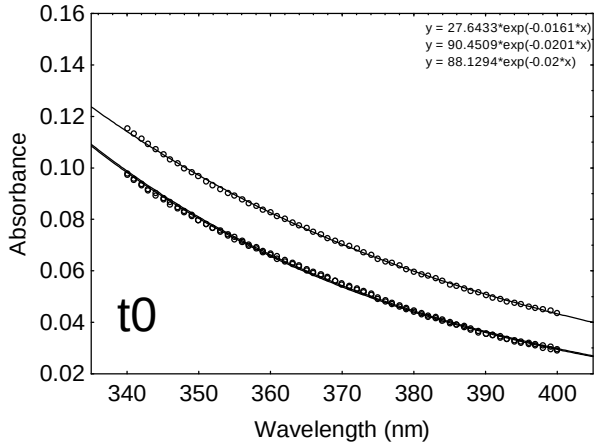
DONUT-1: DOC concentration

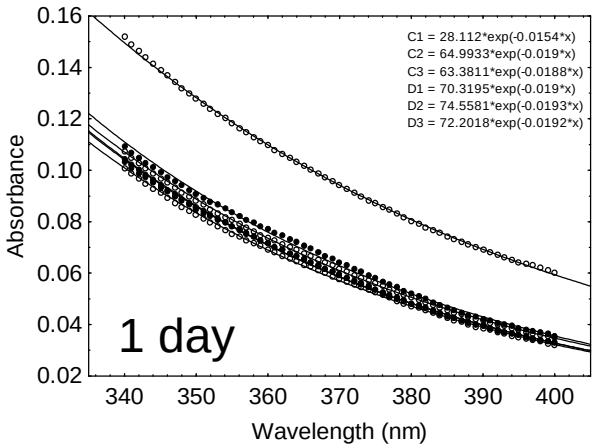


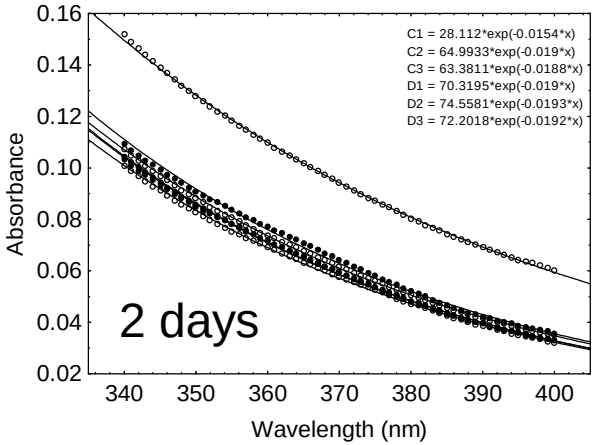
DOC concentration decreased linearly by 9 µmol L^{-1} over the course of the experiment under both control and dust-enriched conditions

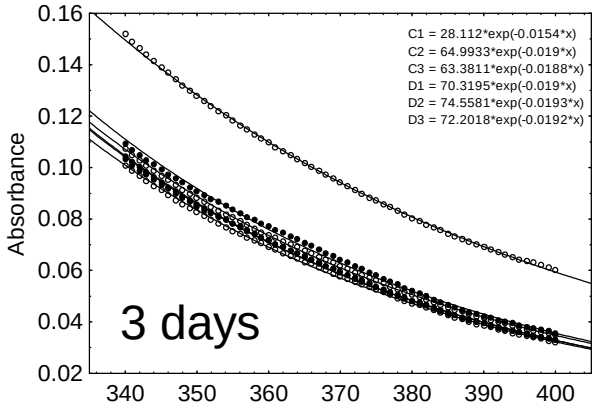
Dust addition did not modify the amount of DOC potentially available for export

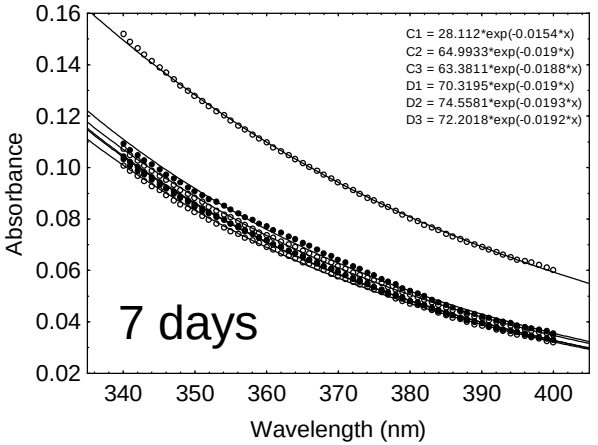
DONUT-1: CDOM dynamics

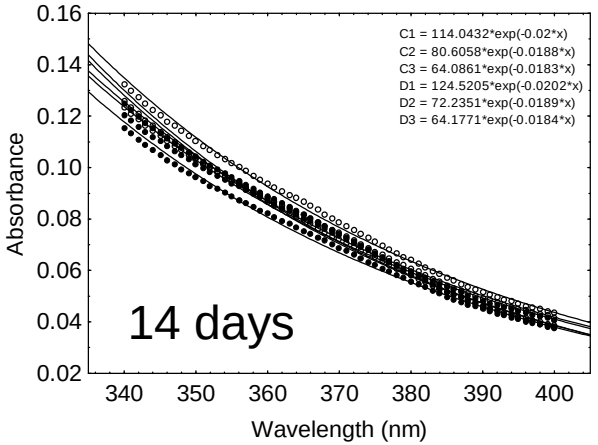


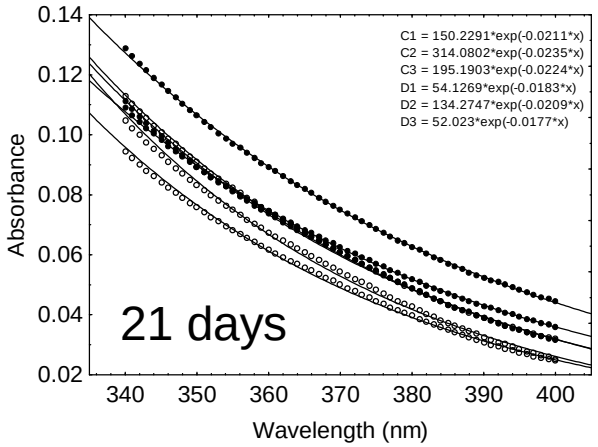






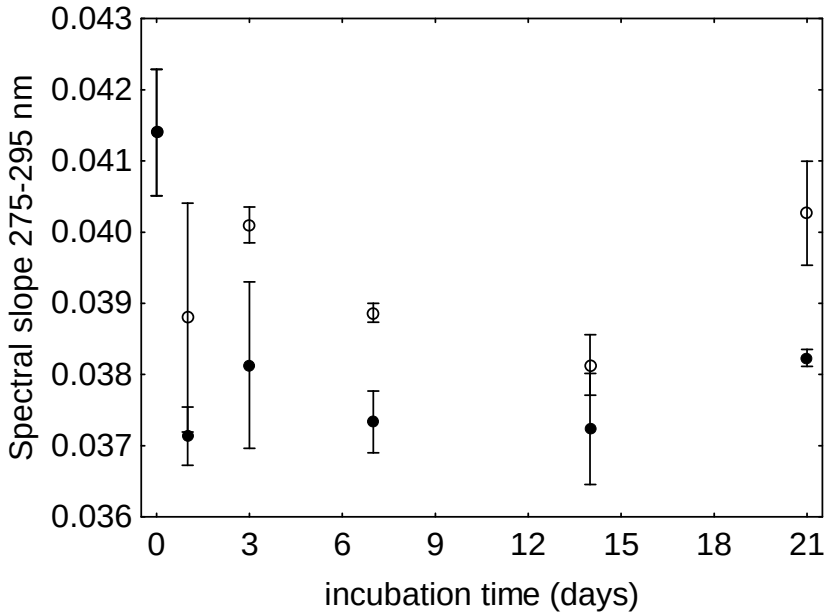


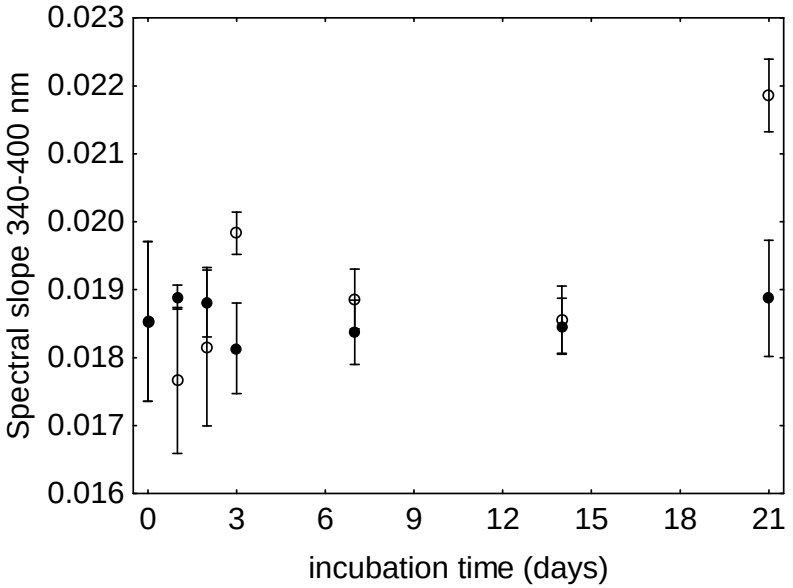




DONUT-1: CDOM dynamics

Spectral slope as an indicator of molecular weight of DOM → lower slope indicates accumulation of HMW DOM (Helms et al. 2008)





These results agree with recent experimental evidence of an effect of nutrient availability on quantity and quality of optically active DOM (Loginova et al. 2015)

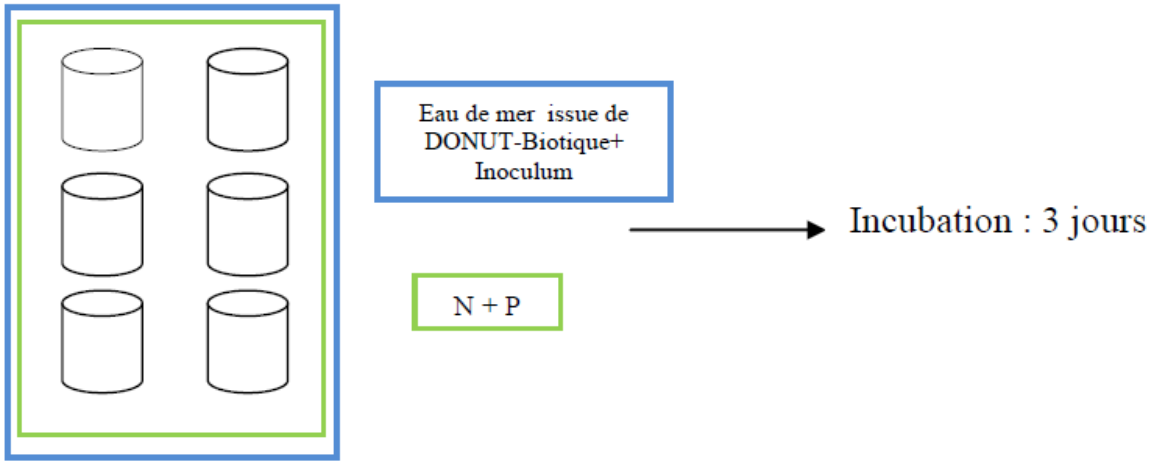
Changes in DOM bioavailability (DOM residence time)??

DONUT-2: experimental design

Approach: 2-step in vitro experiment:

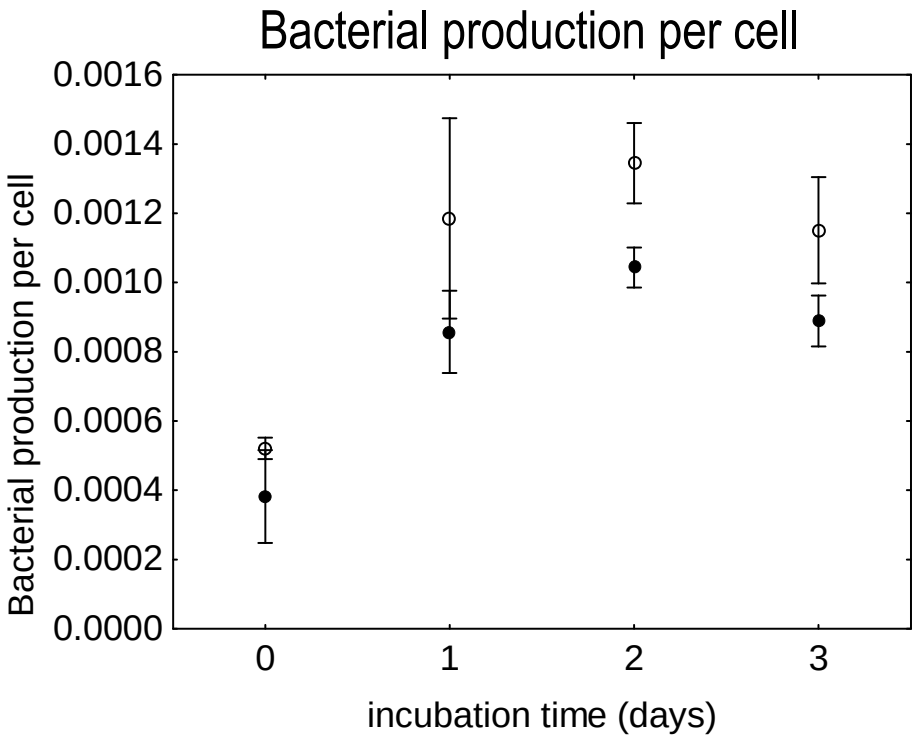
1) Classical enrichment experiment (dust + bacterial inoculum) elarged to 21 days to follow DOM changes (DONUT-1)

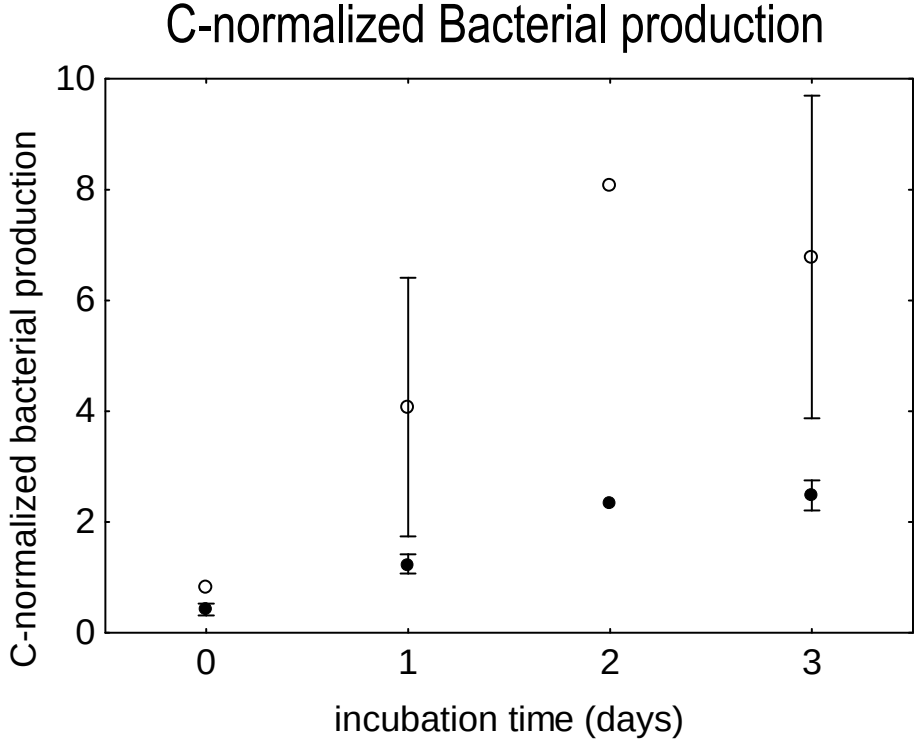
2) **Use of the remaining water from DONUT-1 to launch short biodegradation experiments (DONUT-2)**



Remaining seawater from DONUT-1 was filtered through 0.2 µm
N and P addition to avoid nutrient limitation
New bacterial inoculum added

DONUT-2: bacterial activity





Bacterial production per cell and per unit of available DOC was significantly lower under (previously) dust-enriched conditions

Direct experimental evidence of a decrease in DOM bioavailability induced by dust addition

Dust deposition may have an effect on the residence time of oceanic DOM pool → new link between dust and ocean C cycle?