



PhD thesis :2014-2017

Role of atmospheric input on the stoichiometry of dissolved organic matter in the surface Mediterranean Sea

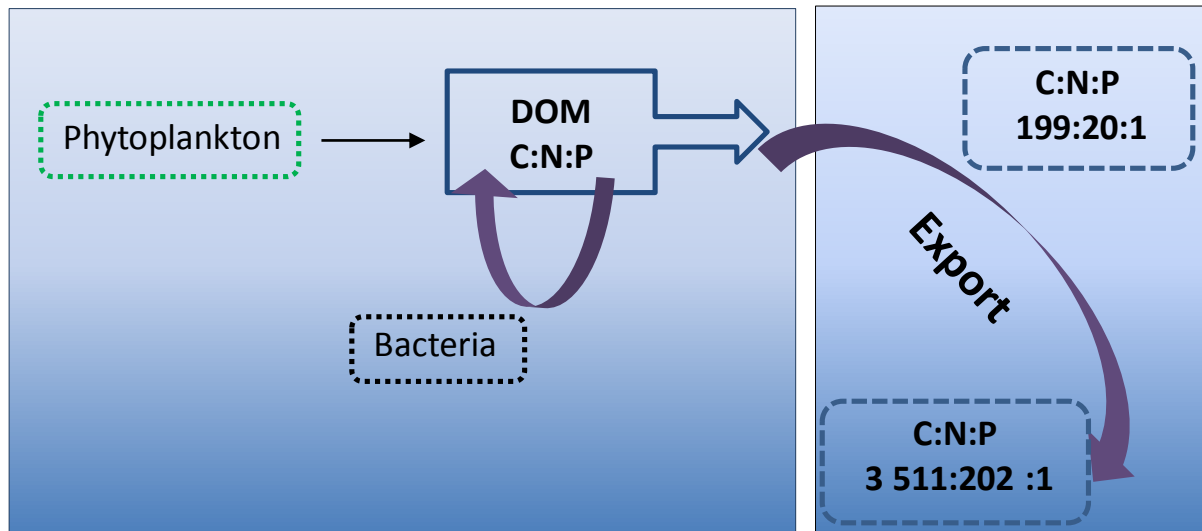
First year results

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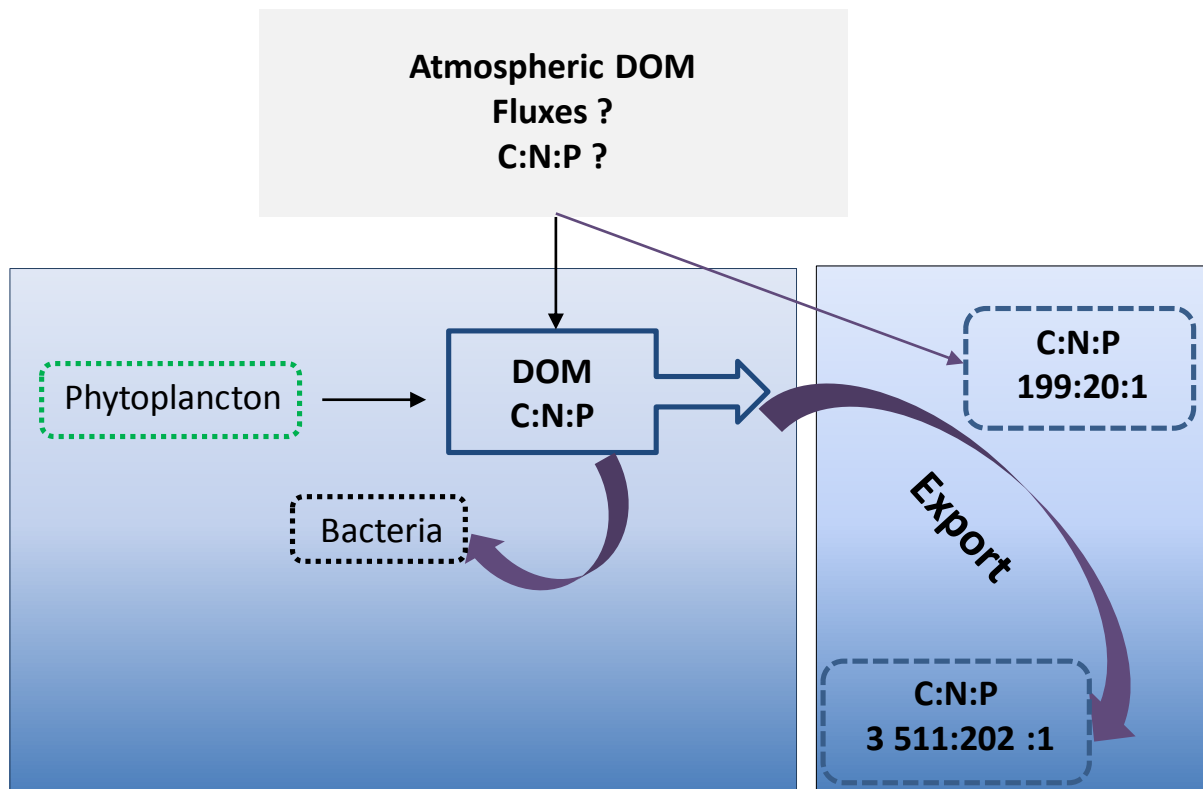
Scientific context

- DOM in the ocean is a large reservoir of reduced carbon, **662 Pg C** (Comparable to the atmospheric reservoir, **700 Pg C**)
- DOM is a major pathway of carbon export in the ocean
- The efficiency of carbon export depends, among others, on the stoichiometry of the surface DOM



Scientific context

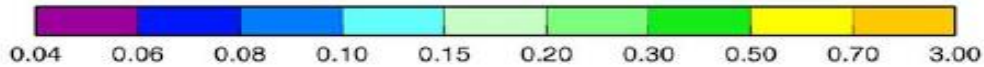
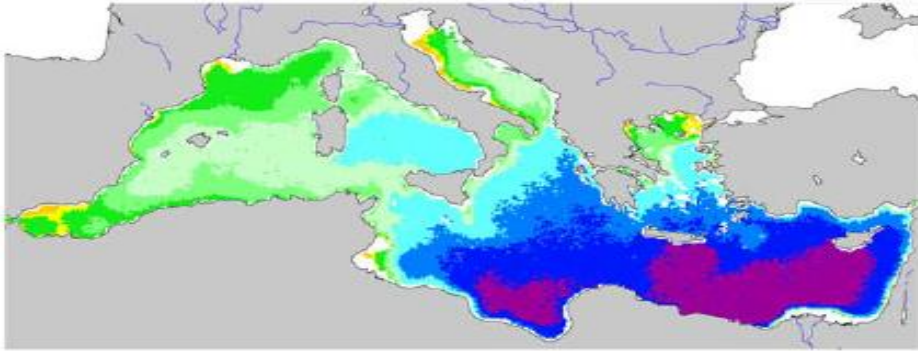
- The stoichiometry of surface DOM in the open ocean is regulated by the relative contribution of bacterial activity and external sources such as atmospheric deposition



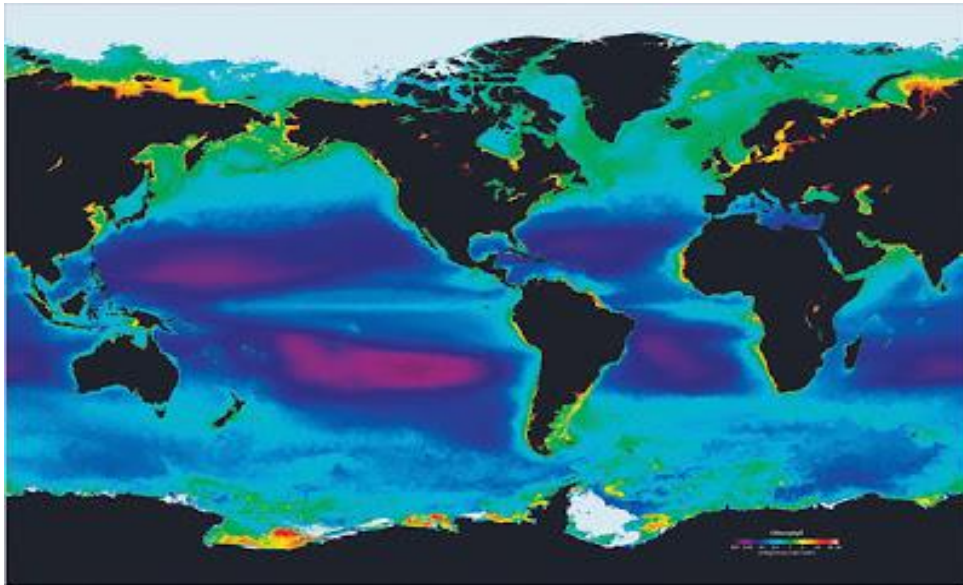
Aims

- To quantify simultaneously atmospheric fluxes of DOC and DOP
- To measure the low concentrations of phosphate in the surface layer for a better evaluation of the surface DOM C:N:P ratio.
- To evaluate the contribution of atmospheric deposition to the phosphate pool in the surface NW Mediterranean Sea

Why The Mediterranean Sea ?



Annual mean of surface chlorophyll concentration (mg m^{-3})
in the Mediterranean Sea (Bosc et al. 2004)



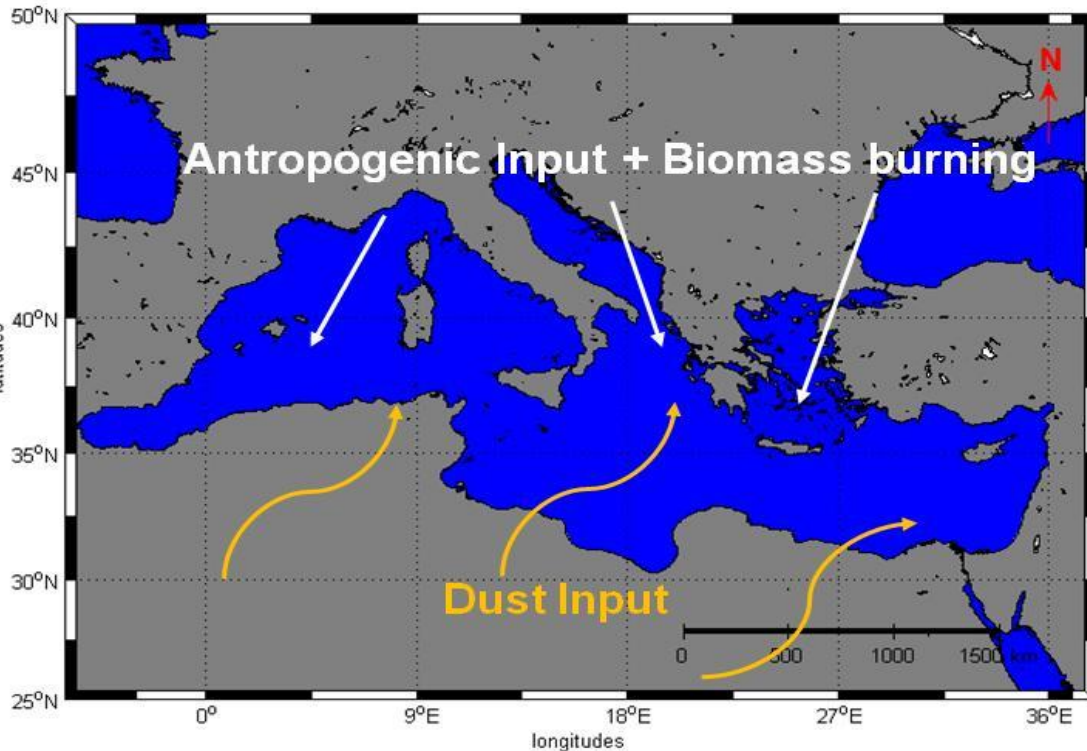
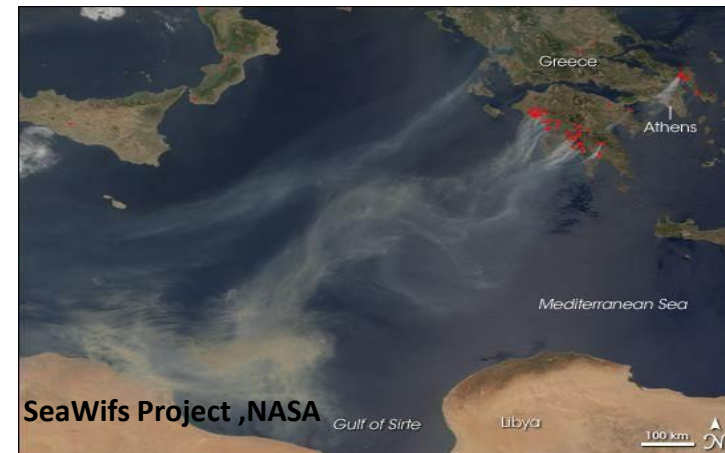
Chlorophyll concentrations in the global ocean
(source: SeaWiFS, NASA)

- The Mediterranean sea is an environment comparable to a model of the global ocean

- Oligotrophic waters (low nutrient low chlorophyll) represent 75 % of the global ocean and the Mediterranean Sea is considered as such

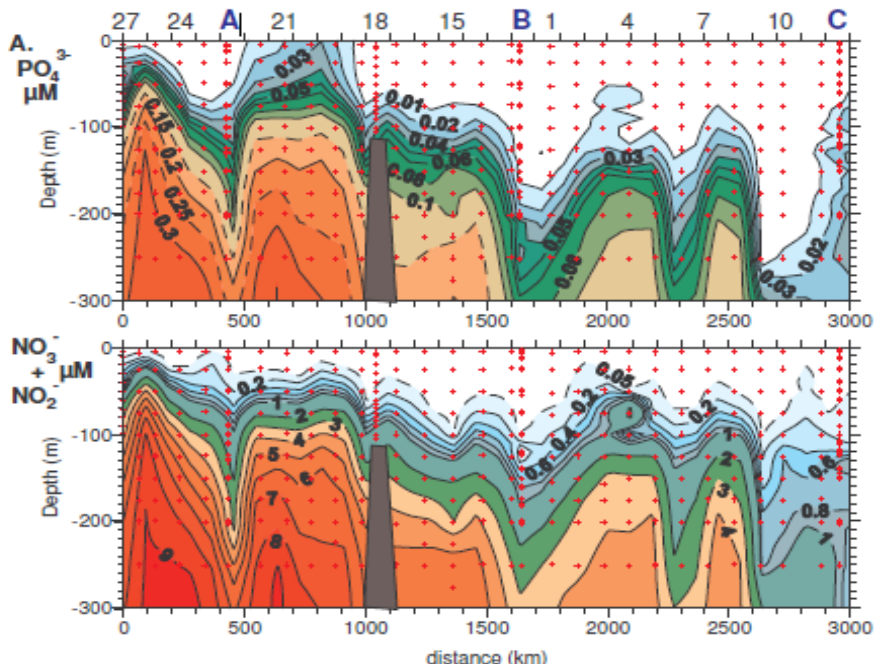
Why The Mediterranean Sea ?

- The Mediterranean sea is strongly influenced by atmospheric inputs. This atmospheric deposition affects the marine biogeochemistry.



Technical challenge

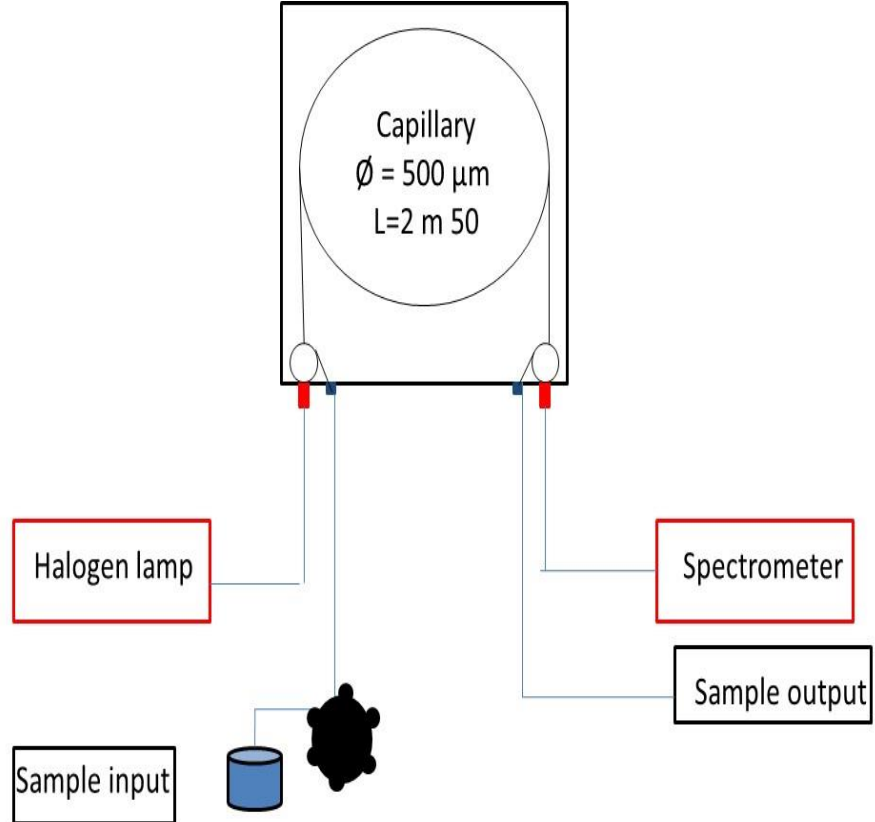
One alternative to detect this low concentrations is to **increase the length of the optical path.**



Phosphorus and nitrogen concentrations along the BOOM transect (Pujo Pay et al, 2011)



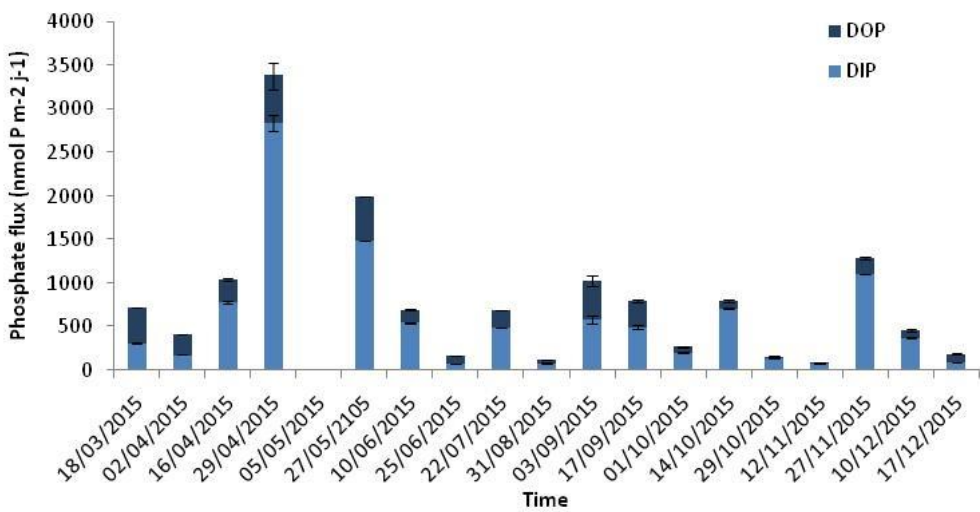
Beer Lambert Law:
$$A(\lambda) = \epsilon(\lambda) * L * C$$



Liquid Waveguide Capillary Cell (LWCC)

Results

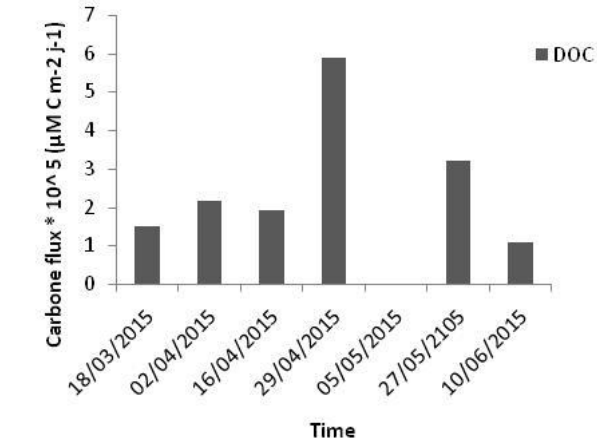
1) Atmospheric fluxes of DOP and DOC



Average flux of DOP ~ 207 nmol m⁻² d⁻¹ and it contributes to ~ 26 % of the total fraction



$$0,026 - 1,53 * 10^{10} \text{ g P y}^{-1}$$



Average flux of DOC ~ 263 µmol C m⁻²d⁻¹



$$1,17 - 6,43 * 10^{12} \text{ g C y}^{-1}$$

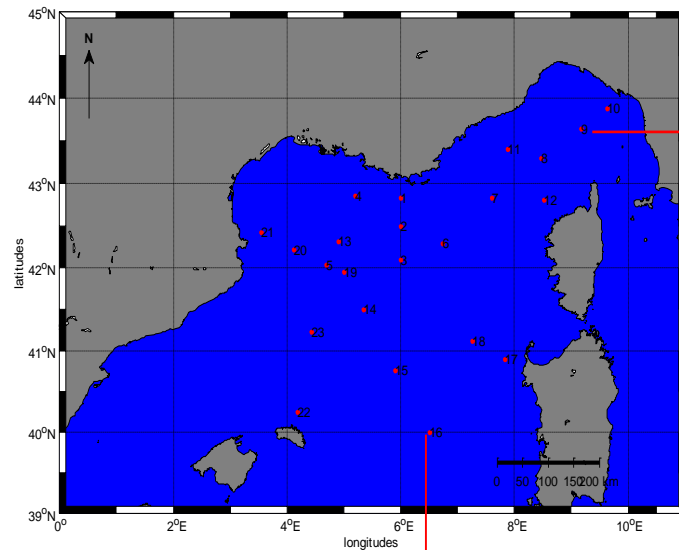
River Flux : 0,644 - 0,712 * 10¹² g C y⁻¹
(Santinelli et al, 2015)

Djaoudi, K., Barani, A., Hélias-Nunige, S., Van Wambeke F., Pulido-Villena, E. Atmospheric fluxes of organic matter to the Mediterranean Sea: contribution to surface dissolved organic matter cycle (in preparation for MERMEX Special Issue)

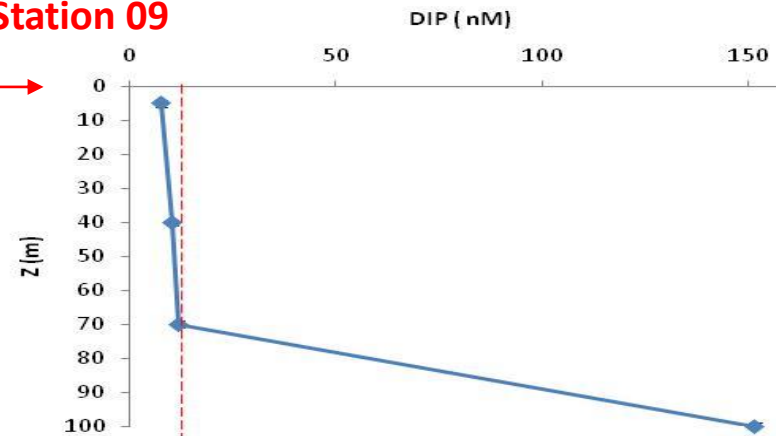
Results

2) Phosphate concentration in the surface layer (0-100 m)

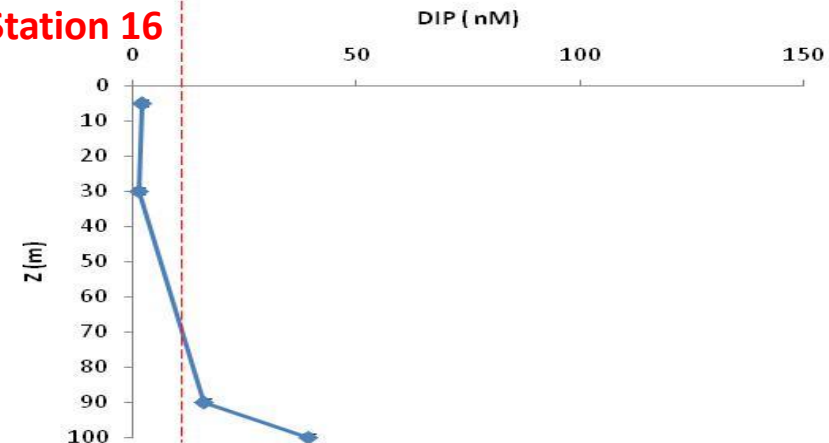
25 stations were sampled in the framework of MOOSE GE cruise (July, 2015) in the NW Mediterranean Sea



Station 09



Station 16

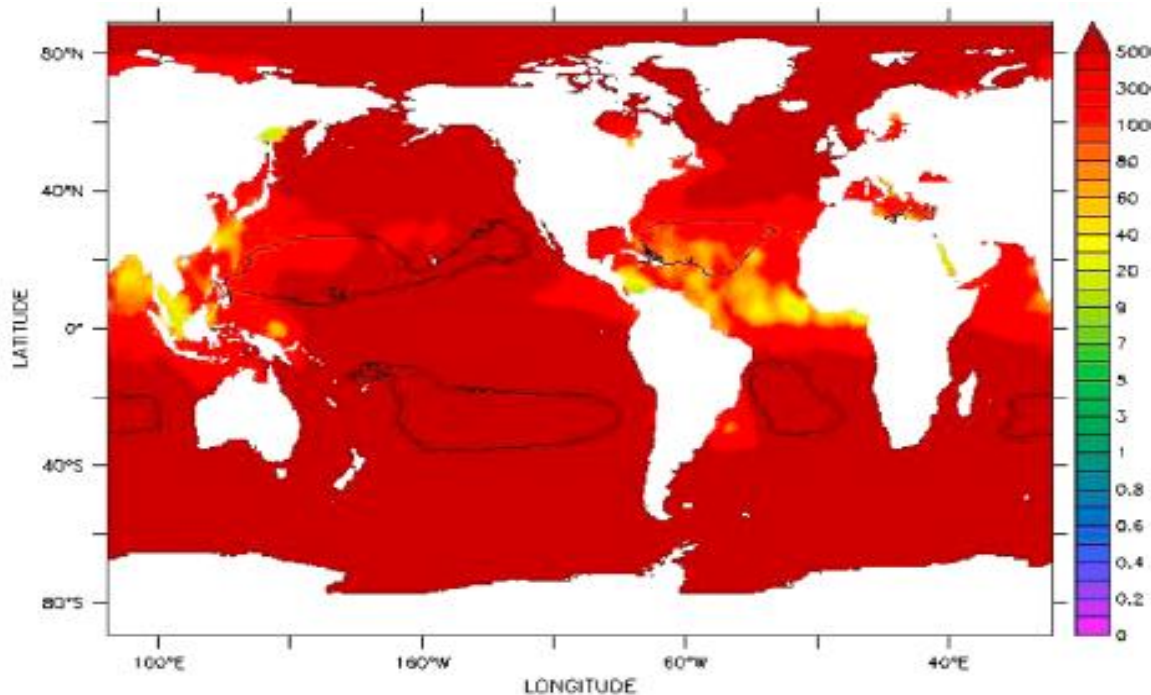


Very low phosphate concentration was observed at selected stations

3) Contribution of atmospheric deposition of DIP to phosphorus pool in the surface NW Mediterranean Sea

TTDA (Turnover Time relative to Atmospheric Deposition): Time to replace the surface mixed layer nutrient inventory by atmospheric deposition.

$$\text{TTDA (years)} = \frac{[\text{DIP}]_{\text{ML}}}{[\text{DIP}]_{\text{ATM}}} \quad (\text{Guieu et al. 2014})$$

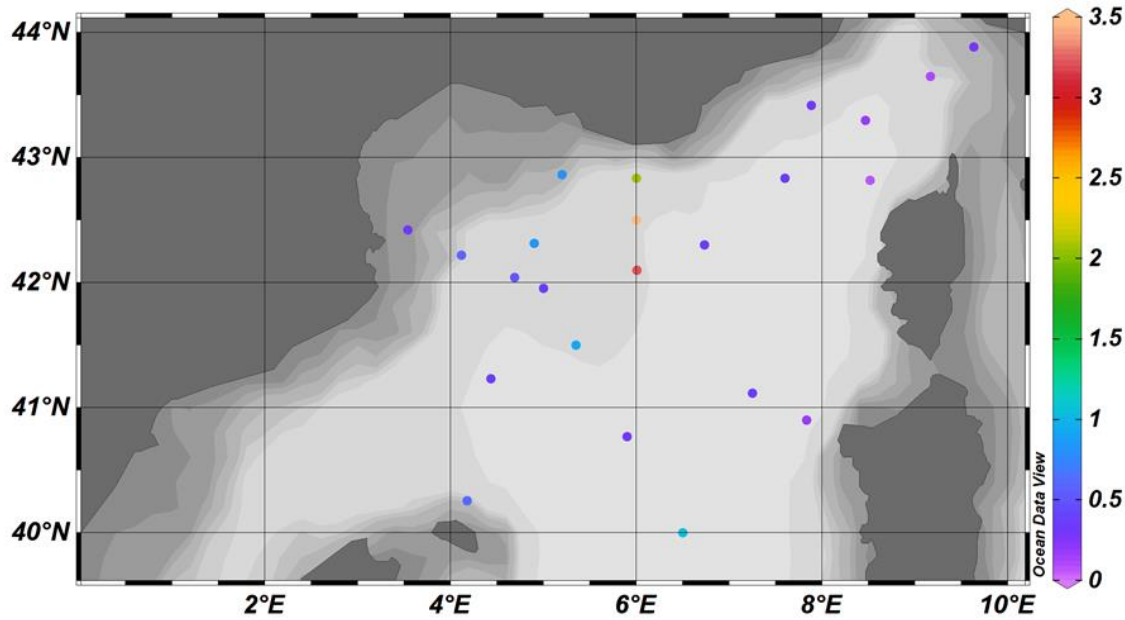


TTDA for P in oligotrophic regions is higher than for N or Fe.

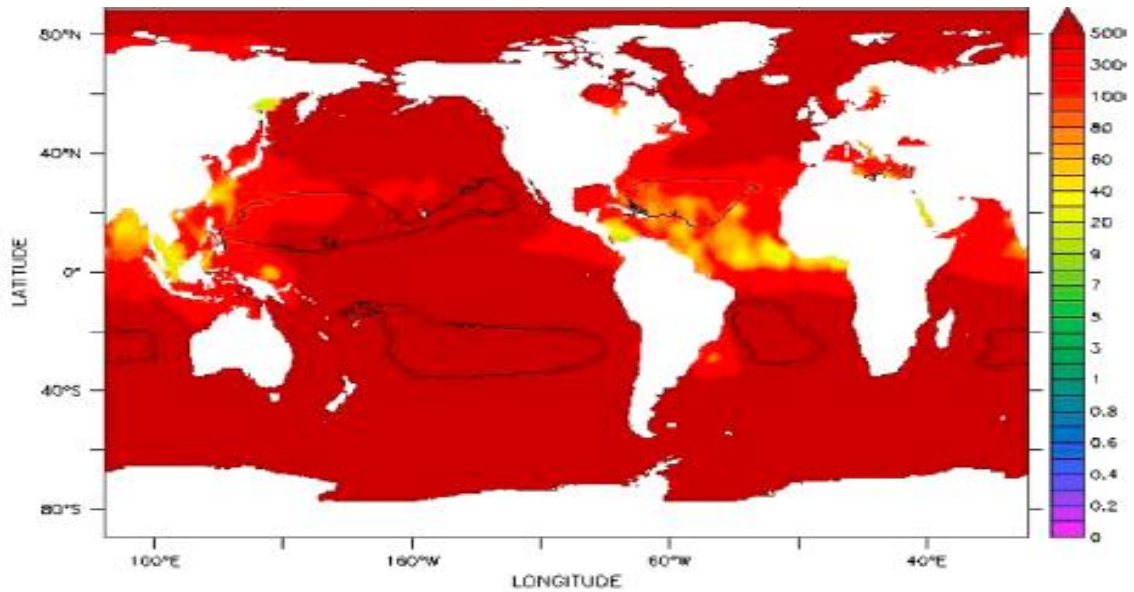


Phosphate climatologies are poorly constrained in surface oligotrophic waters leading to an overestimation of the TTDA

Results



By measuring real phosphate concentrations, we obtain a mean TTDA in the surface NW Mediterranean water of **< 1 year**



Atmospheric supply play an important role in maintaining phosphorus concentrations in the Mediterranean Sea

Atmospheric deposition turnover time (years), Guieu et al (2014).

What else!

- In parallel to the atmospheric survey, a marine survey was set up in MOOSE Antares site where DOC, DON and DOP stocks as well as bacterial activity are quantified (analysis in progress).
- Laboratory experiments will be conducted in order to:
 - 1) asses the bioavailability of the organic fraction of atmospheric deposition.
 - 2) parametrize the variations of marine C:N:P ratio forced by atmospheric deposition.

Part of the work will be conducted in the Istituto di Biofisica (CNR, Italy) in the frame of the PHC-Galileo ADORE project (collaboration with Chiara Santinelli)

