Impact of Saharan dust deposition on dissolved-colloidal-particulate nutrient distribution in seawater

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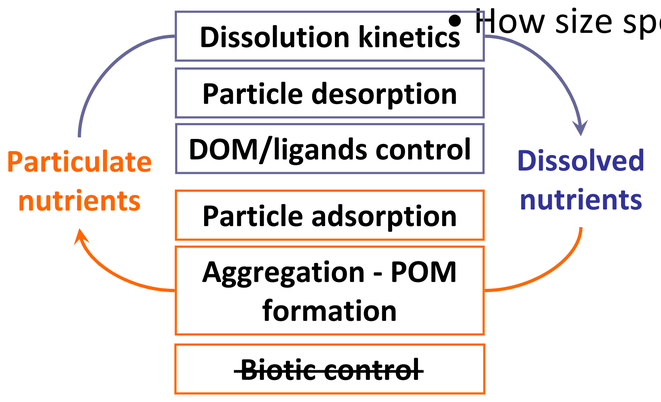
Objectives

- Quantify dissolution and adsorption processes in **abiotic condition** with settling of particles representative of dynamic in natural system

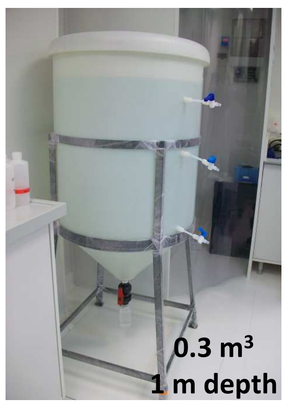


- How size speciation of nutrients is affected by the Sinking lithogenic particles?

- **Dissolved organic matter (DOM)** = positive feedback between dust and ocean biogeochemistry?

- **Seasonal variation**: net effect of atmospheric deposition dependent of **seawater characteristics**?

Methods



- 300 L of seawater collected and filtered (0.2 µm) at 3 periods: **bloom – post-bloom – winter mixing**
  MAY OCTOBER FEBRUARY
- Seeding: wet deposition (10 g.m^{-2}) of processed Saharan dust (Guieu et al. 2010)
- Sampling and handling under ultra-clean conditions

Discrete measurements at 3 depths (0.1 – 0.3 – 0.6 m)
PSD = 0.7 – 250 µm (Coulter Counter + LISST-100)
P – Fe : analysis after filtration at 0.2 and 0.015 µm
a_{CDOM} – TEP – (DOC)

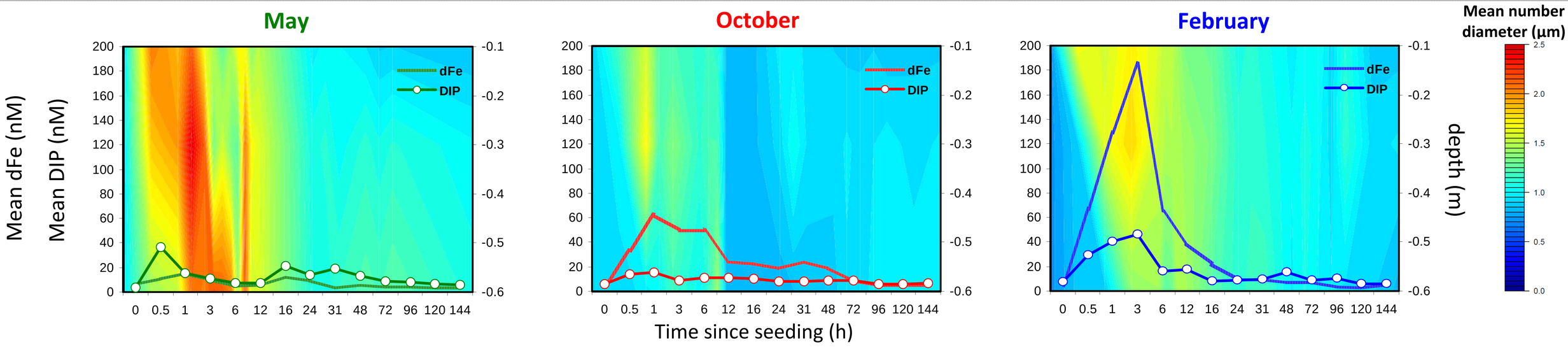
Contrasted initial DOM conditions

	MAY	OCTOBER	FEBRUARY
TEP [µmol/L]	27.1	16.3	2.7
a_{CDOM}(300) [m^{-1}]	0.403	0.357	0.312
dFe [nM]	3.7	3.7	3.9
DIP [nM]	3.5	6	9

TEP and a_{CDOM} values reveal different initial quantities and qualities of DOM: **May** > **October** > **February**

What is the role of the DOM in the dissolution of atmospheric Fe and P after a Saharan dust event?
(colloids – aggregation process?)

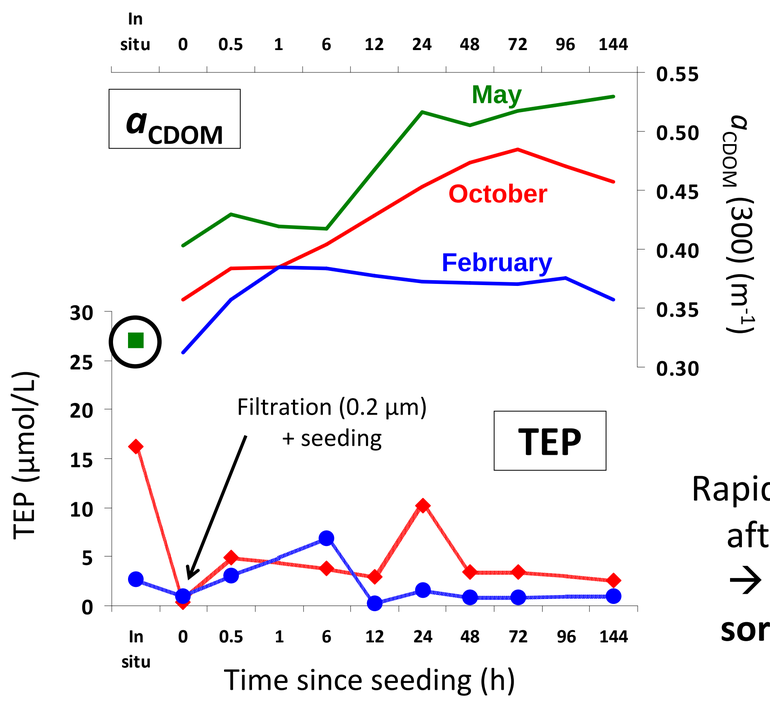
Seasonal Variability of atmospheric Fe and P Dissolution: RESULTS



Seasonal variation of DOM → Variation in the dissolution of Fe and P ("easily" dissolvable Fe and P fraction) - after one week: same situation
Evidence of aggregation → in May and October, number of collisions with colloids (DOM) was higher leading to significantly lower net dissolution
Very fast kinetic processes → few hours (6 – 12 h) after seeding, the decrease of [dFe] and [DIP] corresponds to scavenging (no biological uptake) (Wagener et al. 2010)

Saharan dust event when high *in situ* DOM → lower supply of new dissolved nutrients to the system

What control the fate of atmospheric Fe and P?



May and October: Abiotic formation of colloids and aggregates after seeding

TEP formed from filtered precursors (< 0.2 µm)
(data not available in May after seeding)

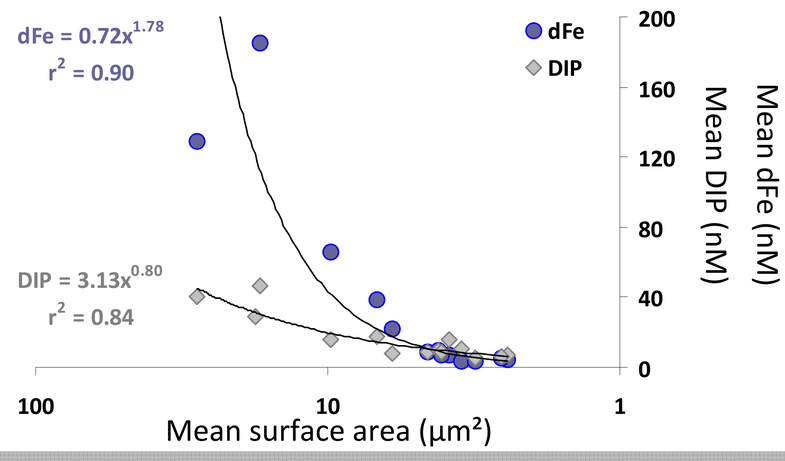
+ increase of CDOM

→ important role in initiating aggregation
→ **accelerating the scavenging and the particulate export of atmospheric Fe and P**

Rapid kinetic of formation of colloidal Fe and P (0.015 – 0.2 µm) after seeding but short residence time in surface (not shown)
→ **preferential loss of colloidal Fe and P by transfer of the sorbed species from the colloidal pool to larger aggregates**

February: Submicron particles active in Fe and P adsorption

Once equilibrium of the dissolution process reached
→ **Hyp**: submicron particles represent an important **substrate for adsorption** as they settle



Conclusions and Perspectives

✓ Consideration of short time scale very important for experimental evidence of dissolved-particulate exchanges

✓ Atmospheric nutrients inputs must be considered along with the settling of the atmospheric particles

✓ Dust deposition events may have different responses as a function of seawater characteristics

✓ Colloidal pumping plays a crucial role in the fate of atmospheric new nutrients

✓ Depending on *in situ* conditions (DOM), submicron lithogenic particles could have a "cleaning effect" for atmospheric nutrients

✓ Toward a better consideration of the dynamic and characterization of the colloidal pool (TEP – Size speciation of nutrients)

References cited
Guieu C, Dulac F, Desboeufs K, Wagener T, Pulido-Villena E, Grisoni JM, Louis F, Ridame C, Blain S, Brunet C, Bon Nguyen E, Tran S, Labiadh M, Dominici JM (2010) Large clean mesocosms and simulated dust deposition: a new methodology to investigate responses of marine oligotrophic ecosystems to atmospheric inputs. Biogeosciences 7:2765-2784
Wagener T, Guieu C, Leblond N (2010) Effects of dust deposition on iron cycles in the surface Mediterranean Sea: results from a mesocosm seeding experiment. Biogeosciences 7:2799-2830