On the role of dust particles for iron cycling in the tropical and subtropical Atlantic

Goldschmidt 2017, Paris

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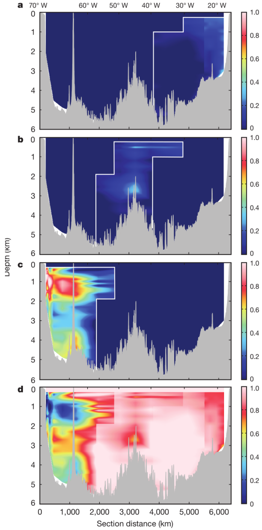
Dust is the major Fe source in the tropical and subtropical Atlantic

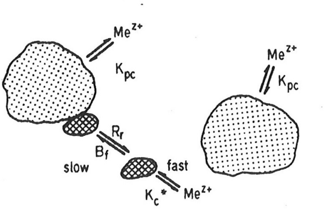


(Conway et al, 2014)

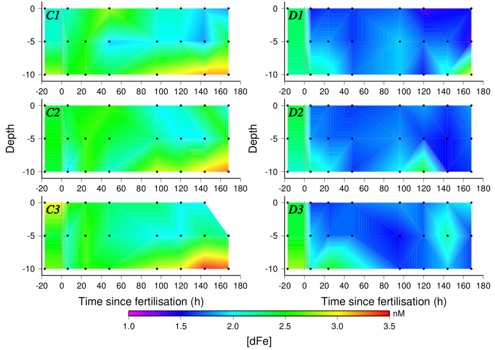
relative role of the different iron sources across the subtropical/tropical Atlantic, estimated from isotopic composition of dissolved iron

- sediment diagenesis
- hydrothermalism
- suspended sediment particles
- saharan dust

Dust is also a source of lithogenic particles



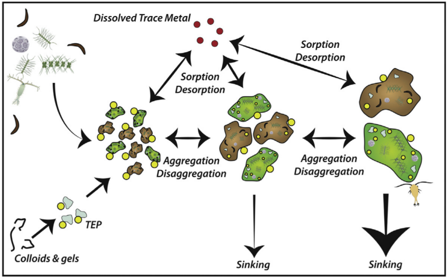
Honeyman and Santschi, 1989



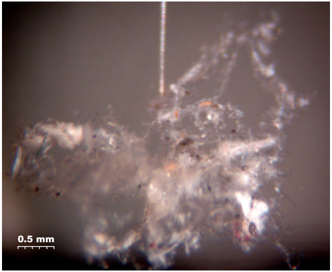
Wagener et al., 2010

→ is that important in the open Atlantic, where often biogenic particles dominate?

Concentration of dust is controlled by particle dynamics



Jackson and Burd 2015



Iversen, pers. comm.

dust brings in mostly micrometer-sized particles

these hardly sink on their own

sinking dominated by larger, mixed organic/inorganic aggregates

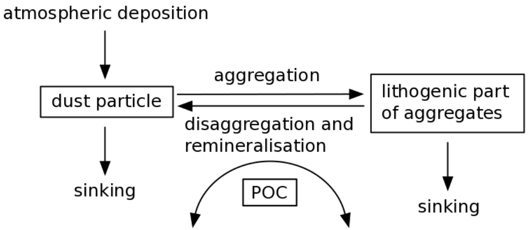
Model setup

iron model:

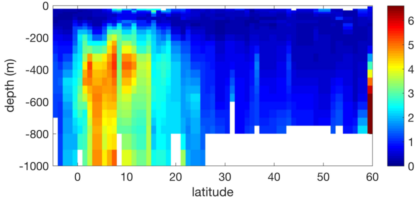
- iron sources: dust and sedimentary input
- biological uptake and remineralisation
- organic complexation (constant ligand)
- scavenging onto particles (dust, organic particles and aggregates)

ecosystem model REcoM2:

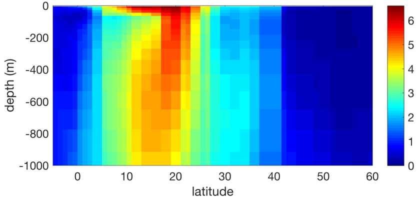
- two phytoplankton classes, one zooplankton and one detritus
- variable cellular stoichiometry
- sinking speed increases with depth



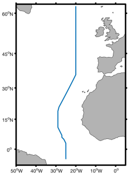
Ye et al. 2017, submitted



measured PFe (nM) (Barrett, pers. comm.)



modelled PFe (nM)



A16N track

+ pFe in the right order of magnitude

+ particle minimum $\sim$ 100m depth

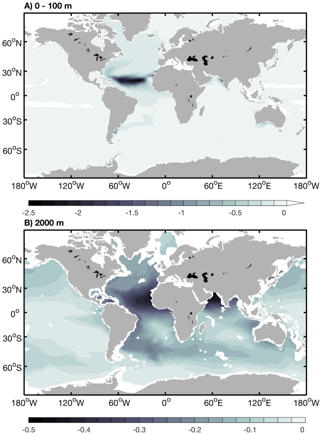
– surface pFe higher
  $\rightarrow$ monthly averaged dust fields and non-linearity of aggregation?

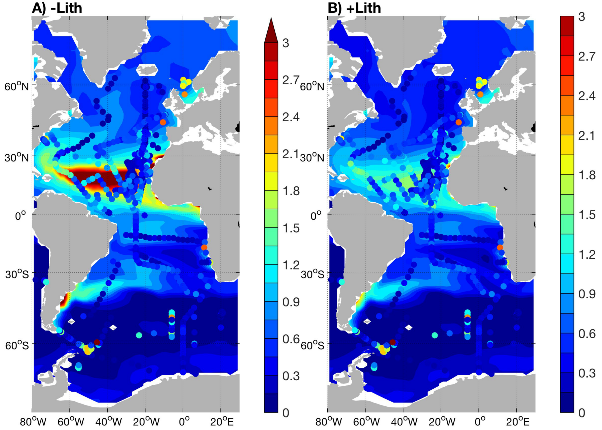
– deep pFe maximum too far north
  $\rightarrow$ location of dust deposition?

– shelf-derived nepheloid layers absent

Ye et al. 2017, submitted

Effect on dissolved iron





dFe difference (nM)

dust only as Fe source

dust as Fe source and sink

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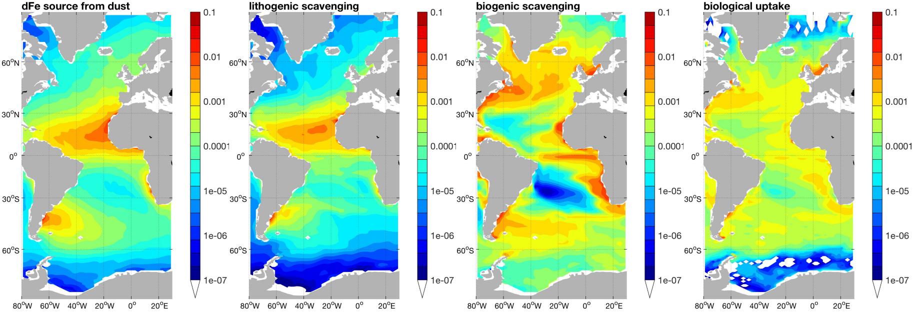
Is dust a source or a sink of dFe?

iron source and sinks in the upper 100m (μmol-Fe m^{-3} day^{-1})



Ye et al. 2017, submitted

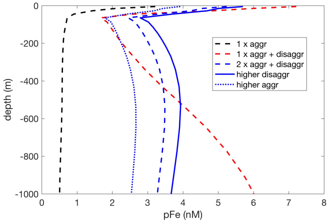
- generally, rather a source than a sink of dFe;
- dust could be a net dFe sink in some regions;
- biogenic scavenging dominates the scavenging loss, except in gyres;
- dFe is rather removed by physical (scavenging) than biological (uptake/export) processes

Thank you!

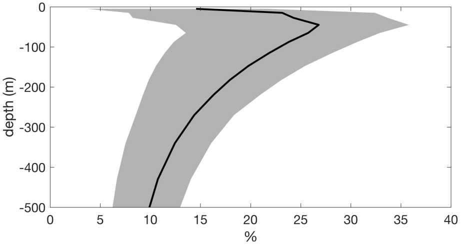
Model equations

$$
\begin{aligned}
\frac{\partial}{\partial t} P_s &= F_d - k_{c_1} \cdot {P_s}^2 - k_{c_2} \cdot (P_l + r_{C:m} D) \cdot P_s \\
&\quad + (k_r + k_{diss}) P_l - \frac{\partial}{\partial z} (w_s P_s) + F_s \\
\frac{\partial}{\partial t} P_l &= k_{c_1} \cdot {P_s}^2 + k_{c_2} \cdot (P_l + r_{C:m} D) \cdot P_s \\
&\quad - (k_r + k_{diss}) P_l - \frac{\partial}{\partial z} (w_l P_l) + F_l
\end{aligned}
$$

pFe Profiles and coarse fraction



at ∼10°N along CLIVAR A16N



near Cape Verde