One-dimensional modelling of Iron Speciation at the Tropical Eastern North Atlantic Time-Series Observatory

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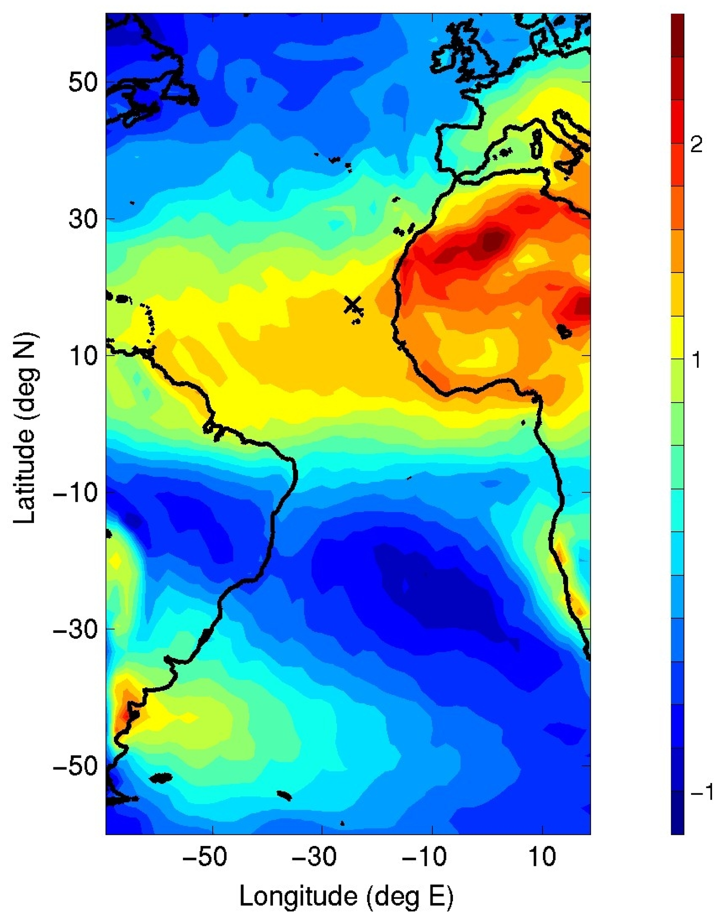
TENATSO site

The Tropical Eastern North Atlantic Time-Series Observatory (TENATSO) is located at Cape Verde Islands (17°N, 24.5°W) which is ideal for investigating dust impacts on marine ecosystems, because:

-Saharan dust events lead to massive dust transport from land into ocean (*right logarithmic dust deposition (g/m2/year) from Mahowald 2003*) ;

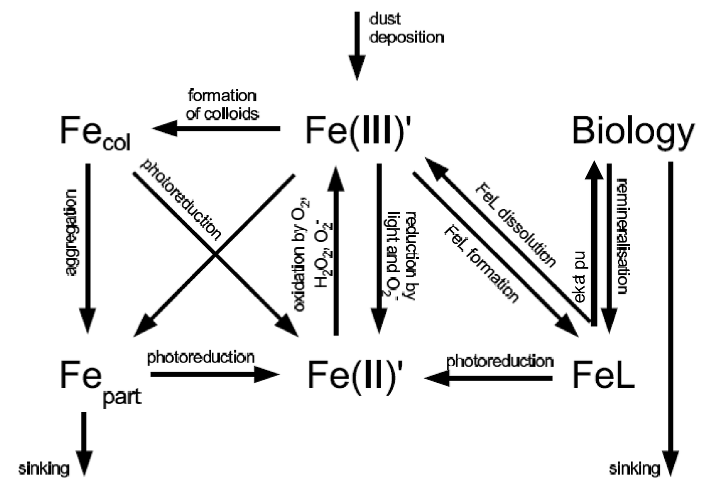
-due to the subtropical climate the mixed layer depth has a relatively low variability (see below);

-blooms of diazotrophic cyanobacteria were observed during and shortly after the dust events.



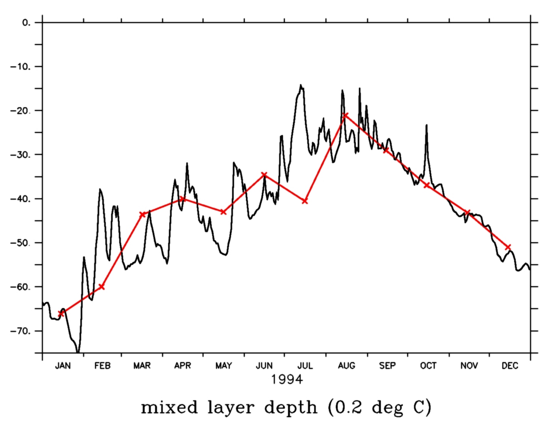
Model of Iron Speciation

A one-dimensional model of the biogeochemistry and speciation of iron is coupled with the General Ocean Turbulence Model (GOTM) ar a NPZD-type ecosystem model.



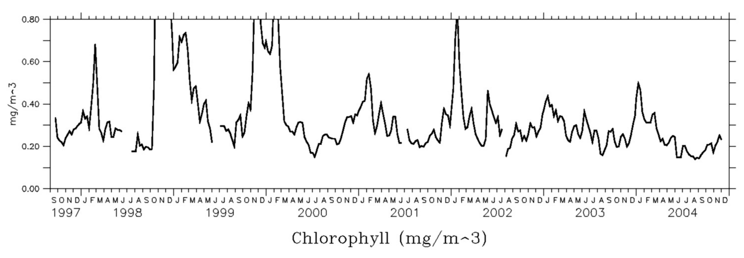
Schematic representation of the iron pools represented in the model and the fluxes between them (Weber&Völker, 2007).

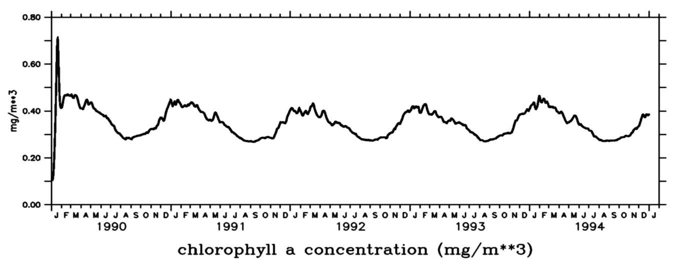
Mixed layer depth and biology



Modelled mixed layer depth (black line) is close to the climatological estimate by DeBoyer (2004) (red line).

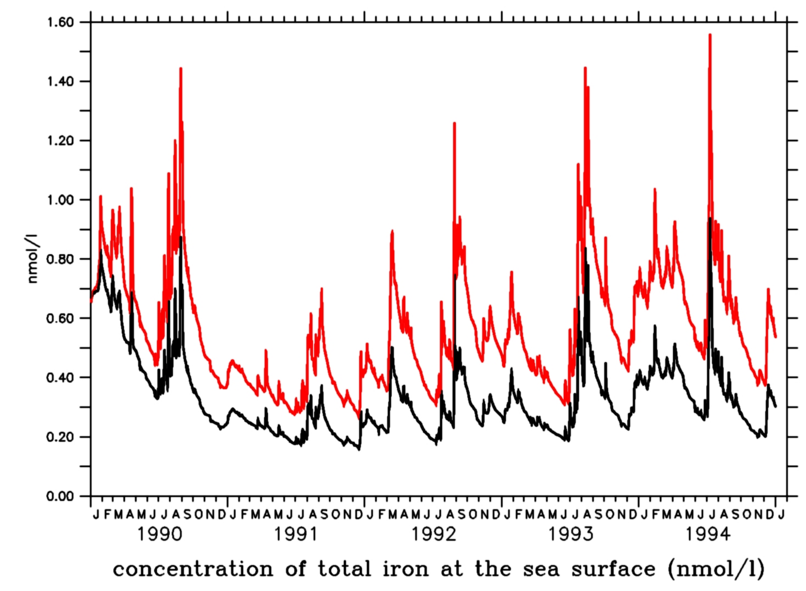
Despite the simplicity of the ecosystem model, comparable chlorophyll *a* concentrations with the satellite data was well reproduced (see below: left: SeaWifs data, right: model run).



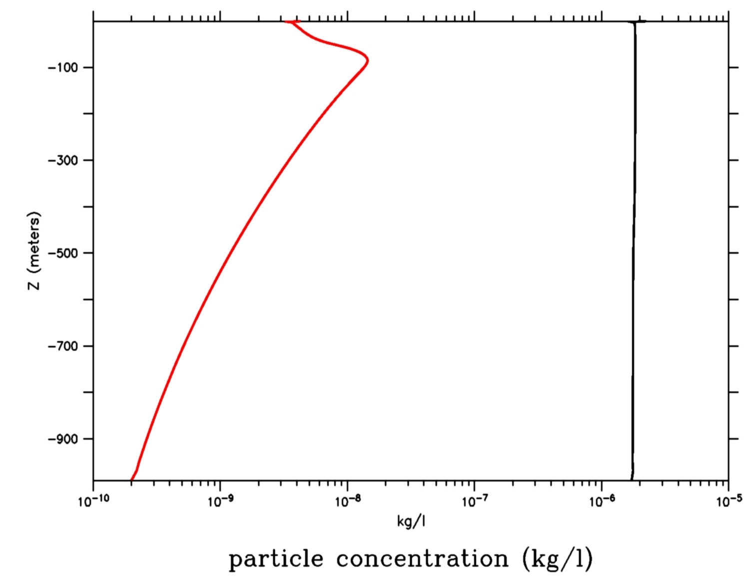


Double role of dust deposition

On the one hand, dust deposition brings considerable input of dissolved iron into the surface waters; on the other hand, it provides inorganic particles for the Fe(III)' absorption and takes dissolved iron out of the system by sinking.



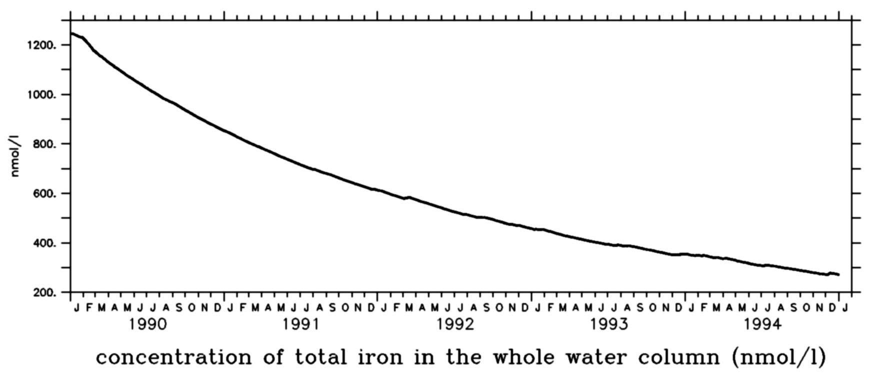
Strength of iron input depends on the values chosen for the iron solubility. (***black***: solubility=0.01, ***red:*** solubility=0.02)



The model run shows much higher concentration of inorganic than organic particles at the TENATSO site. (*left: inorganic—**black**, detritus—**red***)

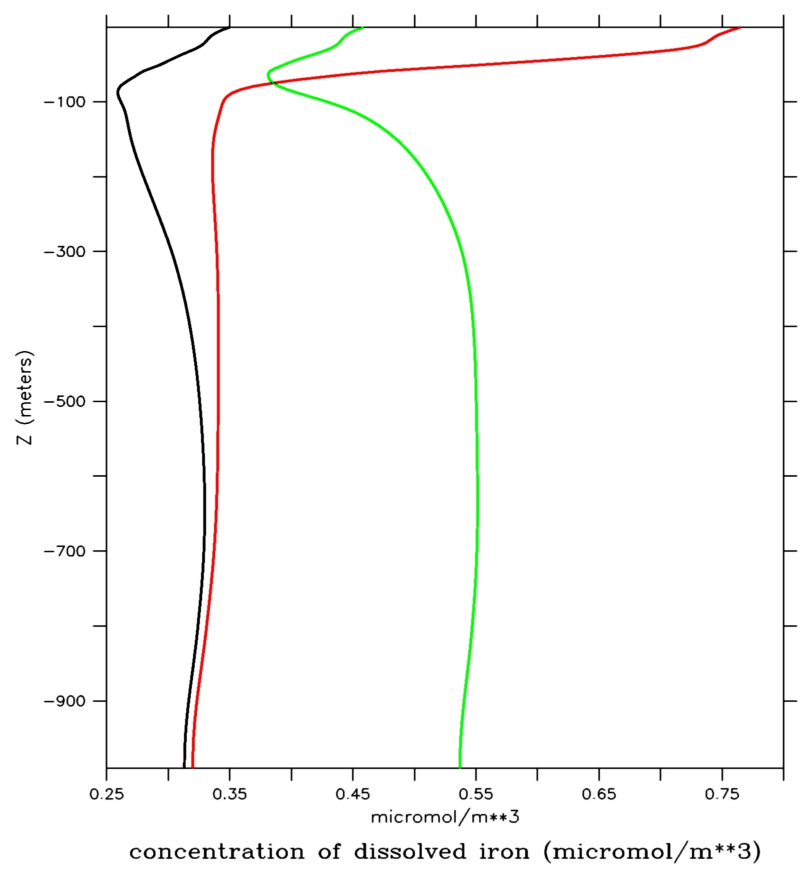
Loss of dissolved iron

Despite the iron input by dust events in surface waters, the model run shows continuous decrease of concentration of total iron in the whole water column (right).



There are three ways to control the loss of dissolved iron in the model: biological uptake, scavenging onto particles and colloid aggregation.

Model runs show that concentration of dissolved iron and relationship between colloidal and organically complexed iron depend strongly on the value of the colloid aggregation rate and redissolution of colloidal iron.



***black**: high colloid aggregation rate (Wen et al.,1997) without redissolution of colloidal iron;*

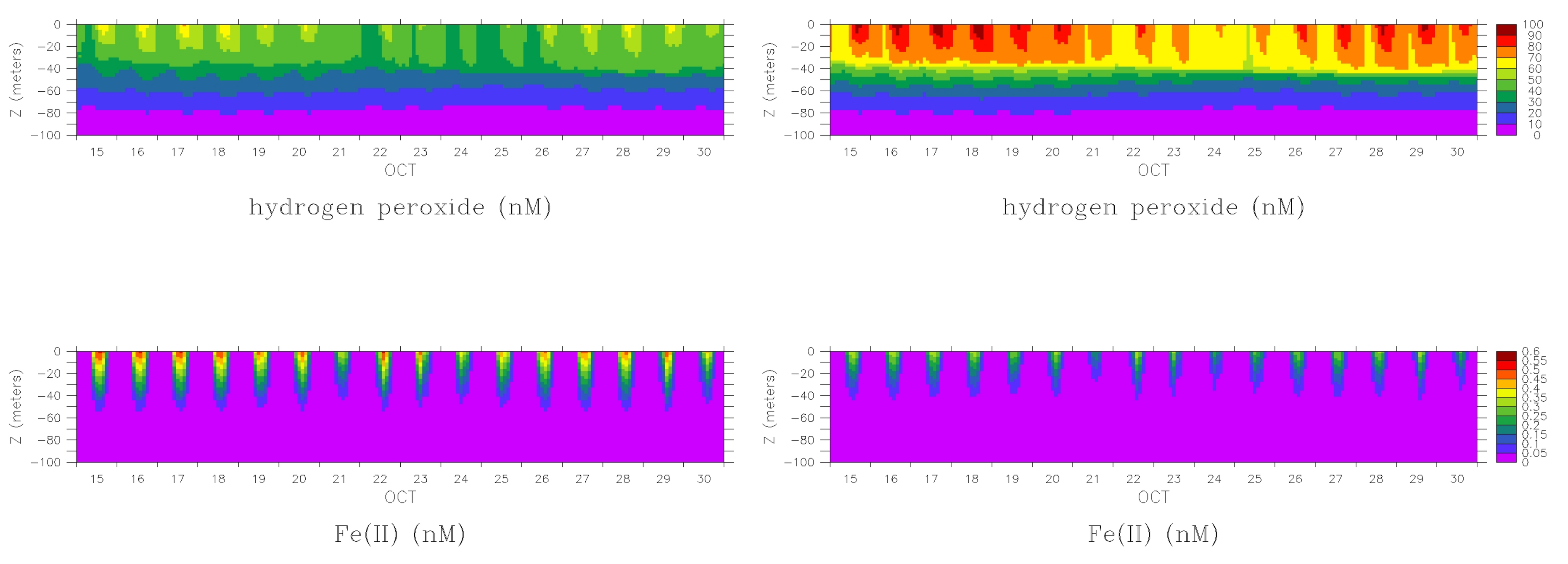
***red**: low colloid aggregation rate (Wen et al.,1997) without redissolution of colloidal iron;*

***green**: high colloid aggregation rate with redissolution of colloidal iron.*

Photochemical cycling

The modelled iron speciation shows a strong daily cycle. The amplitude of the daily cycle is controlled by the concentration and speciation of dissolved copper. Choosing 1nM copper concentration the modelled H2O2 concentration is in agreement with the vertically integrated data from Steigenberger 2008.

left: total copper concentration =1nM; right: total copper concentration = 5nM.



Conclusions and outlook

A model of iron biogeochemistry developed for the BATS site is applied at the TENATSO site with observed or estimated values of dust deposition, salinity and temperature at Cape Verde Islands.

Photochemical cycle of H2O2 can be reproduced reasonably.

Due to higher dust deposition than at the BATS site, the scavenging of dissolved iron is dominated by inorganic particles compared to organic particles.

The sensitivity study shows that the role of the colloidal pumping mechanism depends strongly on colloid aggregation rate and redissolution of colloidal iron.

Lacking data on iron speciation in this area, we could not do more comparisons with observations. Therefore, modelling of iron biogeochemistry at TENATSO requires more data on concentration of different iron species.

References
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