Parameterizing Multiple Ligand Classes Improves the Simulation of Dissolved Iron in the Subtropical North Atlantic

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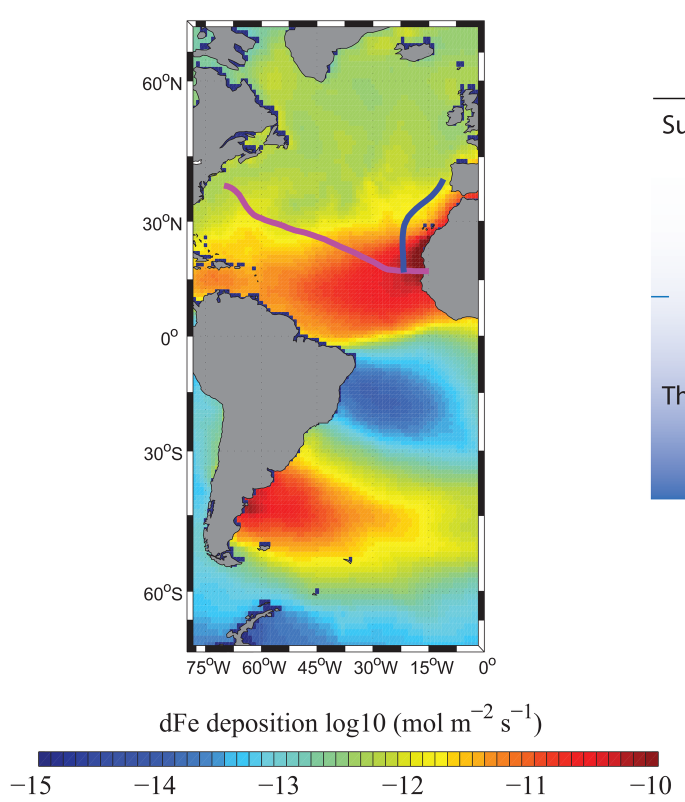
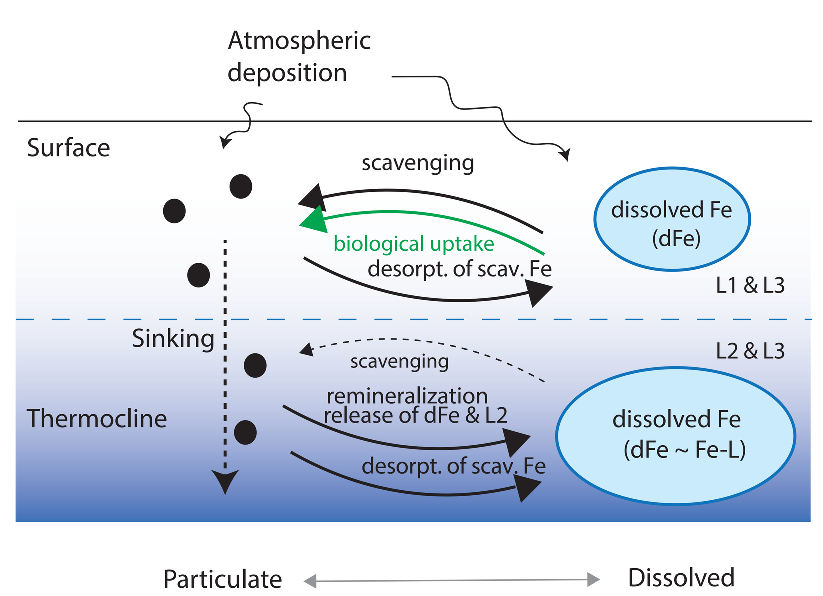
Question and model description

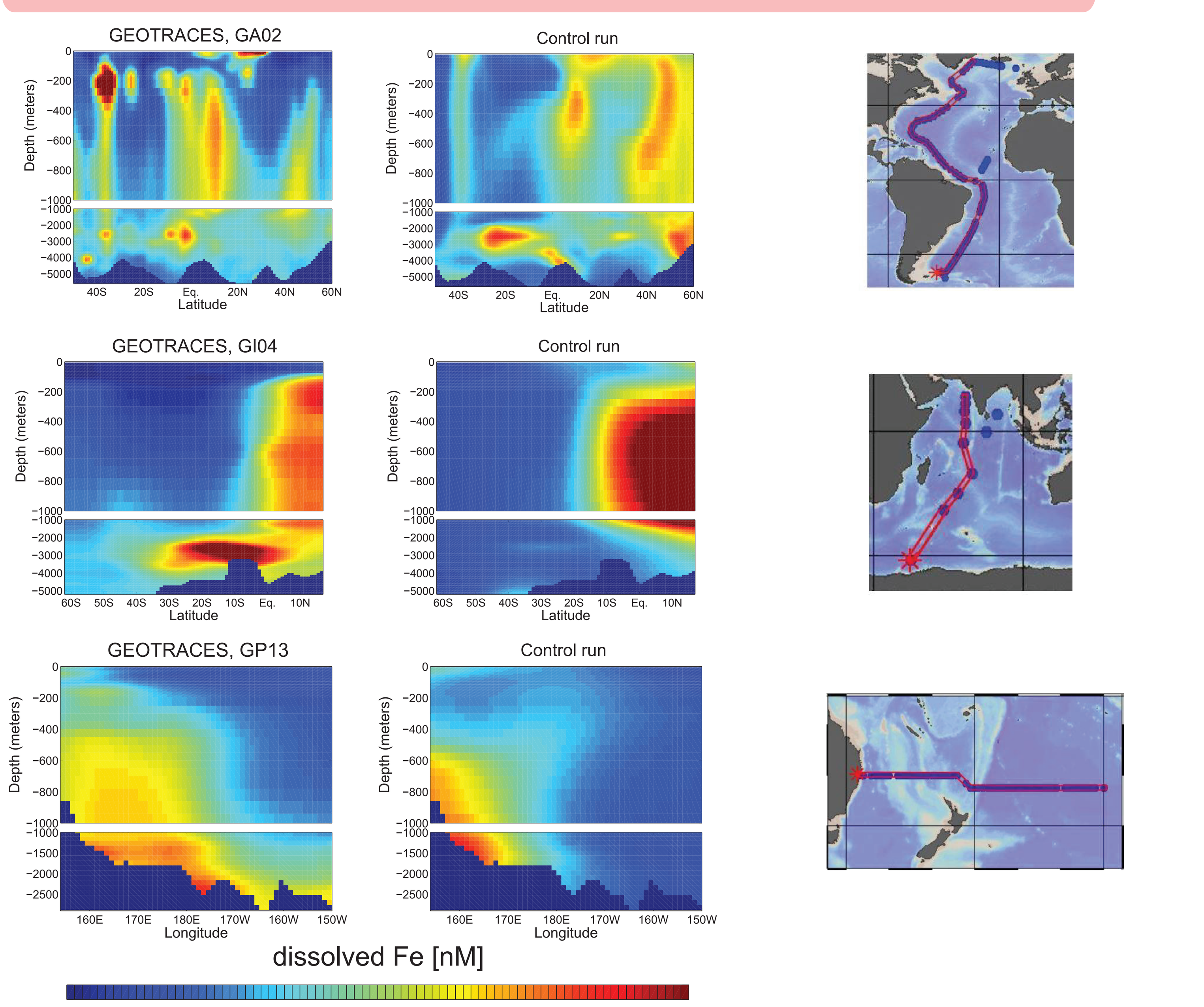
- The subtropical North Atlantic region receives high atmospheric dissoved Fe (dFe) deposition, which comes from Sahara and Sahel deserts
- Relatively low dFe concentration is observed in the surface of the subtropical North Atlantic along the zonal and meridional GEOTRACES GA03 transects
- What controls the dFe distribution in the subtropical North Atlantic?





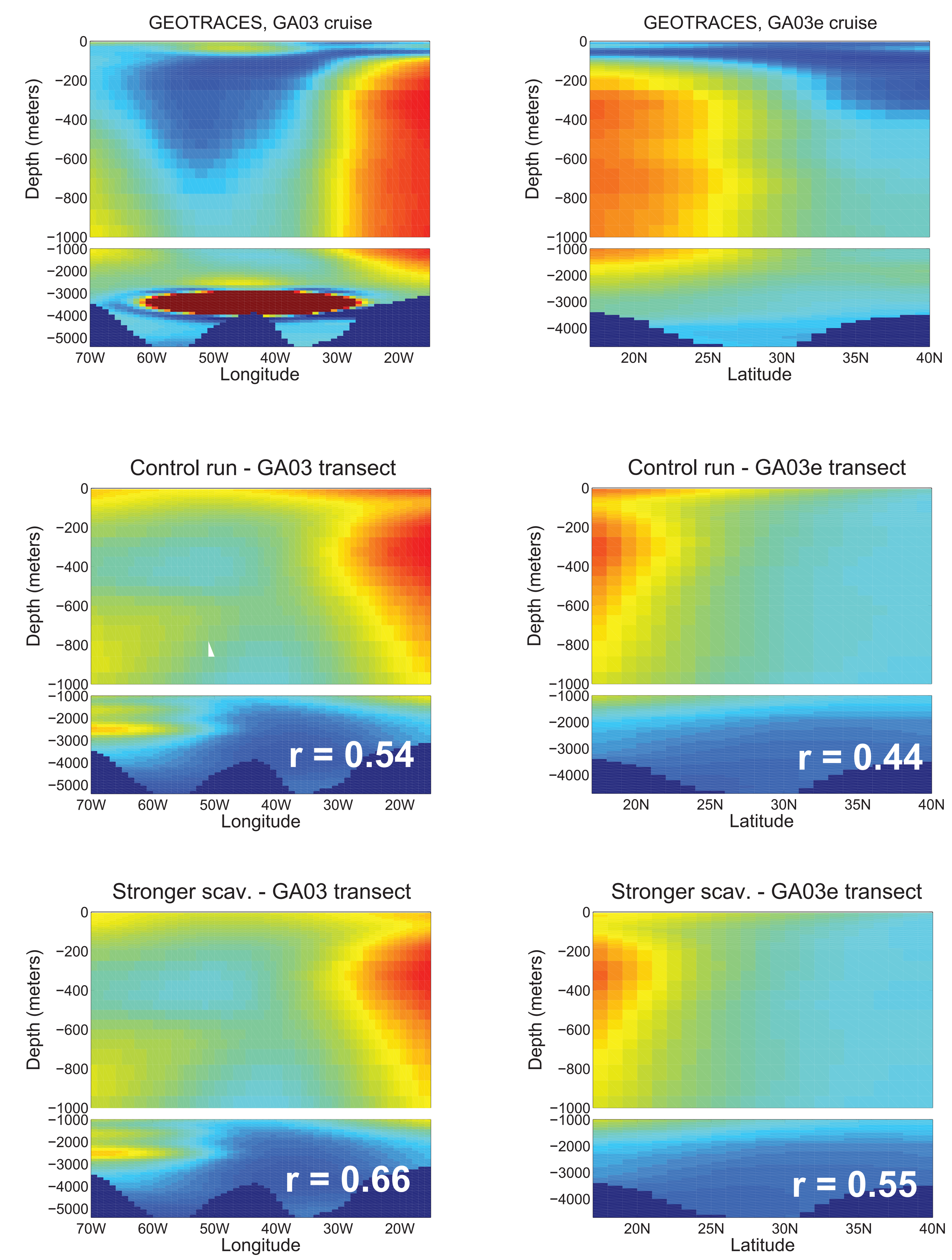
- MITgcm in offline mode: ECCO circulation; 1 degree horizontal resolution; 23 vertical z levels
- Three major sources for dFe (dust, sediment, hydro-thermal). Scavenging/desoprtion of dFe onto/from particles. Remineralization source of dFe
- Three ligand classes protect dFe from scavenging: biologically produced L1, particle remineralized L2, and refractory L3

Model validation

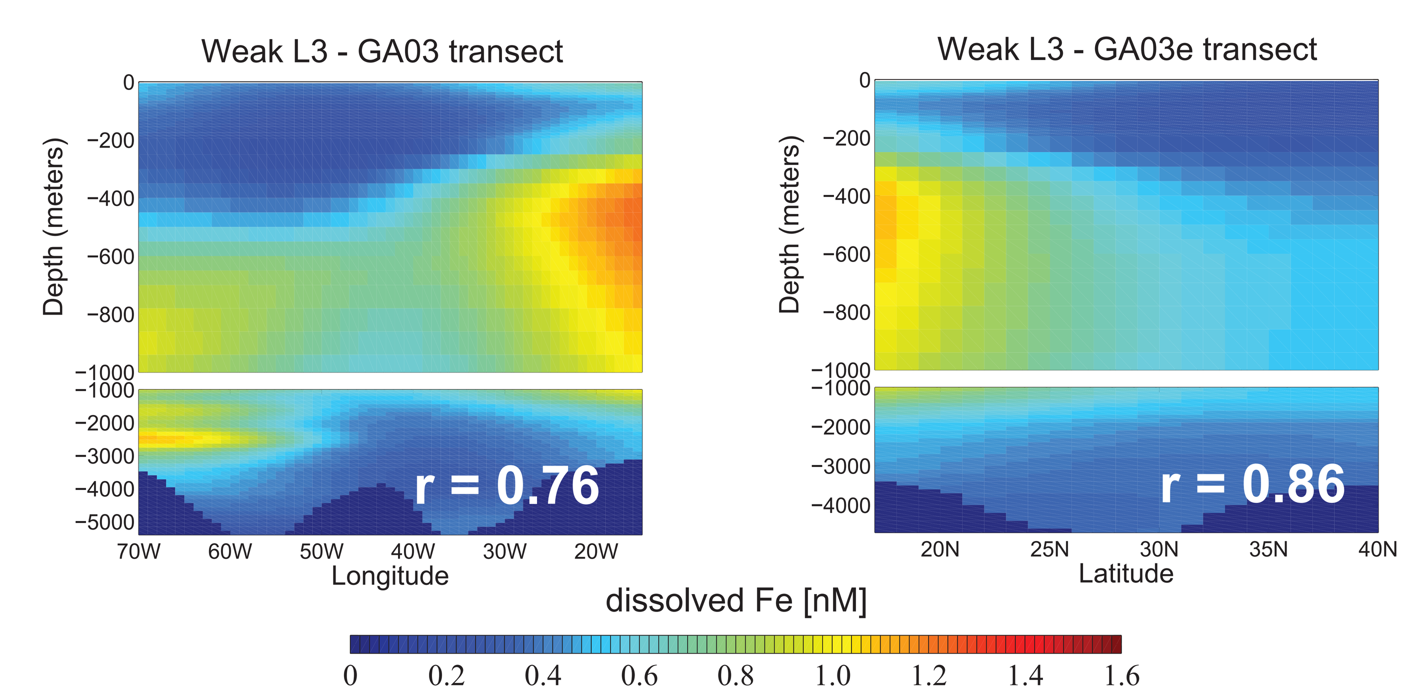


- Model starts capturing some essential features of the dFe distribution in the western Atlantic, Southern Pacific, and Indian Oceans, which revealed by the GEOTRACES transects, especially in the thermocline

Model experiments



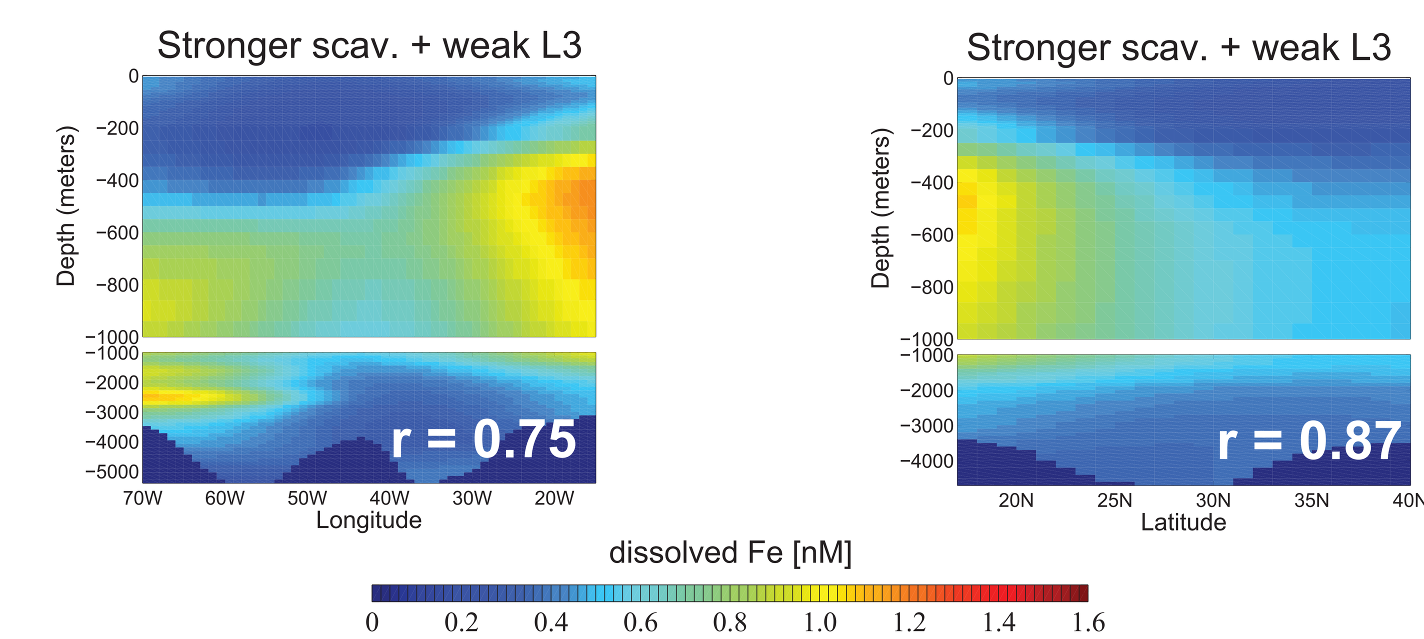
Stronger scav run increases the scavenging rate under the high dust plume by 1000 times relative to the **control** run



Weak L3 run decreases the conditional stability constant of the refractory L3 by 10 times relative to the **control** run

Discussion

- The **control** run overestimates the surface dFe by ~ 0.7 -0.8 nM and underestimates the vertical and horizontal extension of the mid-depth dFe maximum
- The **stronger scav.** run slightly decreases the surface dFe concentration by ~ 0.3 nM, moderately increasing the pattern correlation with observation
- The **weak L3** run significantly decreases the surface dFe (~ 0.8nM) and deepens the subsurface dFe maximum
- The pattern correlation between the model and observation is greatly improved in the **weak L3** run
- Combination of both mechanisms (**stronger scav. + weak L3** run) further decreasesthe surface dFe concentration compared to the **weak L3** run



Conclusions

- An ocean biogeochemistry model is used to examine the observed dFe distribution in the GA03 North Atlantic transects.
- The model tends to overestimate the surface dFe while underestimate the subsurface dFe concentration
- A **stronger scavenging** rate slightly decreases the surface dFe concentration
- Including **weaker refractory ligand** class decreases the surface dFe and deepens the subsurface dFe peak, significantly improving the pattern correlation with obs.

References and Acknowledgement

Hatta et al. (2015), An overview of dissolved Fe and Mn distributions during the 2010–2011 U.S. GEOTRACES north Atlantic cruises: GEOTRACES GA03, Deep Sea Research Part II: Topical Studies in Oceanography, Volume 116, 2015, 117-129, 0967-0645, doi.org/10.1016/j.dsr2.2014.07.005.

Pham and Ito (2018), Formation and maintenance of the GEOTRACES subsurface dis-solved-iron maxima in an ocean biogeohcemistry model, Global Biogeochemical Cycles, 32, doi.org/10.1029/2017GB005852

Tagliabue et al. (2016), How well do global ocean biogeochemistry models simulate dis-solved iron distributions?, Global Biogeochemical Cycles, 30(2), 149–174,-doi:10.1002/2015GB005289

Ye, Y., and C. Völker (2017), On the role of dust-deposited lithogenic particles for iron cy-cling in the tropical and subtropical atlantic, Global Biogeochemical Cycles, 31(10), 1543–1558, doi:10.1002/2017GB005663

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