Mapping Fe limitation in the Ross Sea using *in situ* Fv/Fm

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Working Title: Iron-efficient photosynthetic strategy of phytoplankton in the Ross Sea

Thomas J. Ryan-Keogh, DeLizo, L.M., Walker O. Smith Jr., Peter N. Sedwick, Dennis J. McGillicuddy, C. Mark Moore and Thomas S. Bibby

- In this study the spatial and temporal extent of relative iron limitation is mapped using short-term (24 hr) iron-addition bioassay experiments during PRISM-RS, Dec-Feb 2012

- We also present molecular and physiological data to show that, as phytoplankton draw-down nutrients (iron and nitrate), they modify their photosynthetic strategy to become more Fe-efficient

- This change in photosynthetic strategy is linked to the well-known phytoplankton community progression from *Phaeocystis*-dominated communities early in the growing season to diatom-dominated communities late in the growing season

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Phaeocystis	**Diatoms**
Spring	**Summer**
Well-Mixed	**Stratified**
Low light	**High Light**
High Fe (?)	**Low Fe (?)**

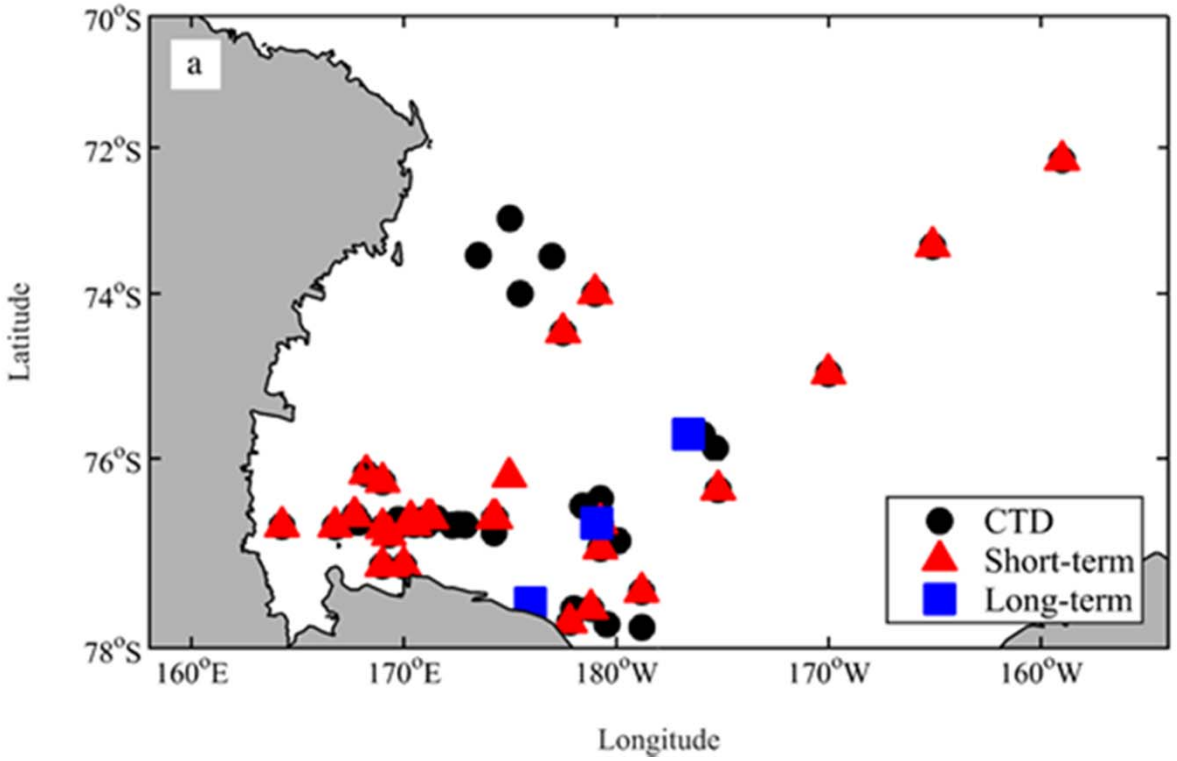

Figure 1

Datasets

- *Phytoplankton physiology*
- *Abundance of photosynthetic catalysts*
- *Iron (dFe), Macronutrients*
- *HPLC – Pigment analysis*
- *In situ bioassay (Fe-addition experiments) 24 (hr) Red, 168 (hr) Blue*

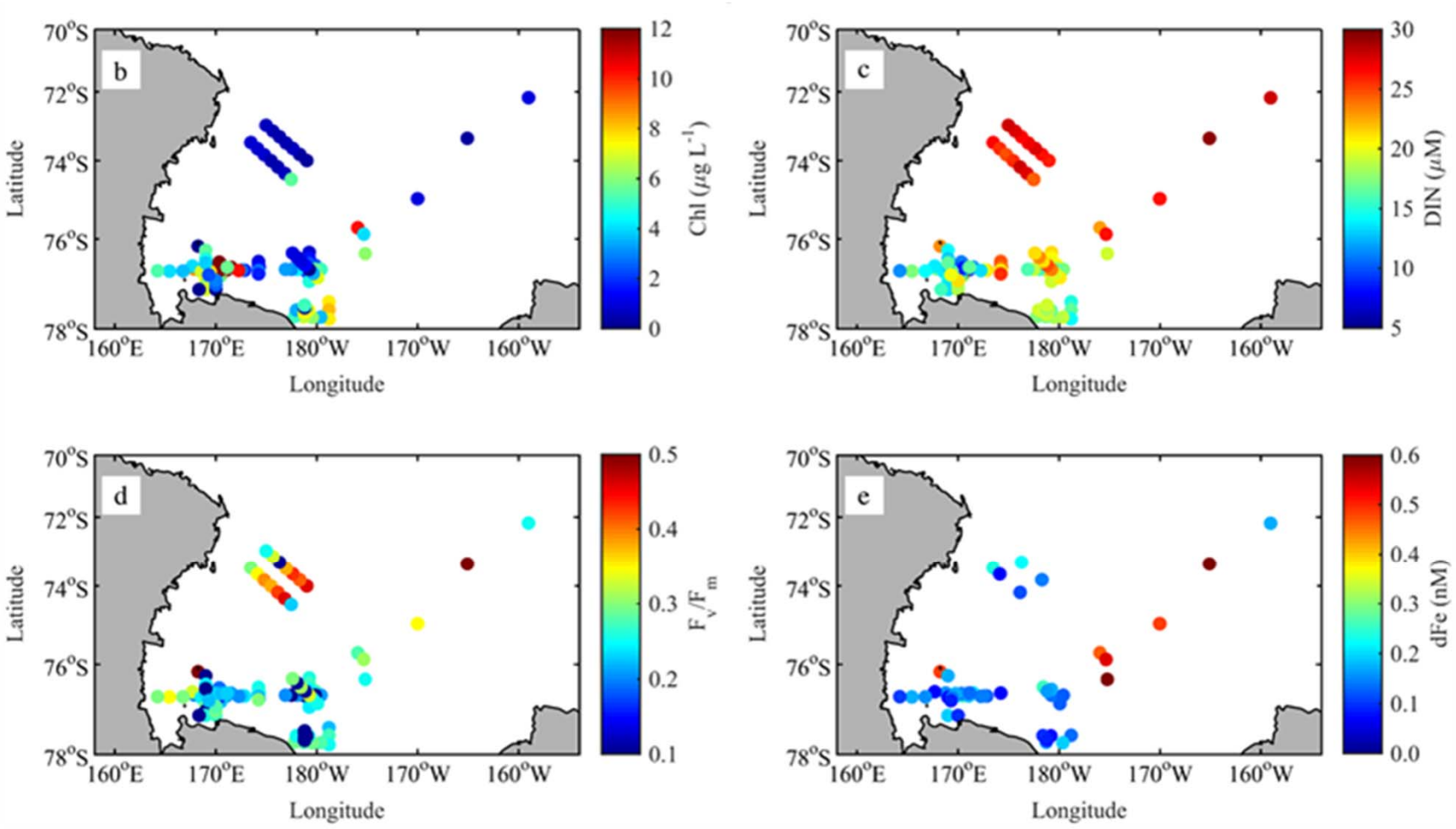

Figure 2 – *In Situ* observations of chlorophyll, nutrients and photosynthetic physiology (Fv/Fm)

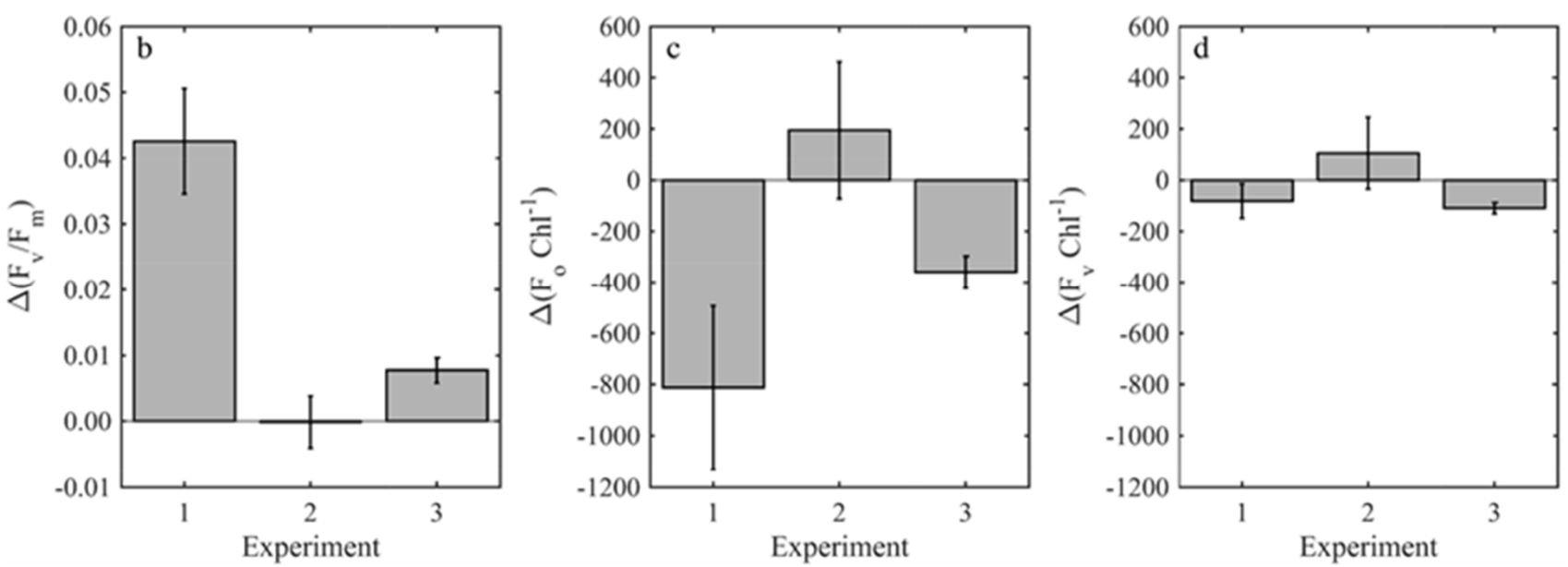

Figure 3 Long-term Fe-addition experiments: (1) Ross Ice Shelf, (2) Ross Bank, (3) Anti-cyclonic eddy
(b) ΔFv/Fm - Relative response to Fe addition
(c) ΔFo Chl^{-1} - How much chlorophyll is active
(d) ΔFv Chl^{-1} - How damaged is PSII

- Evidence for iron limitation of phytoplankton physiology (*but not everywh*ere)
- Iron-stress physiology is a result of inactive chlorophyll rather than damaged PSII – *implications for remote sensing*.

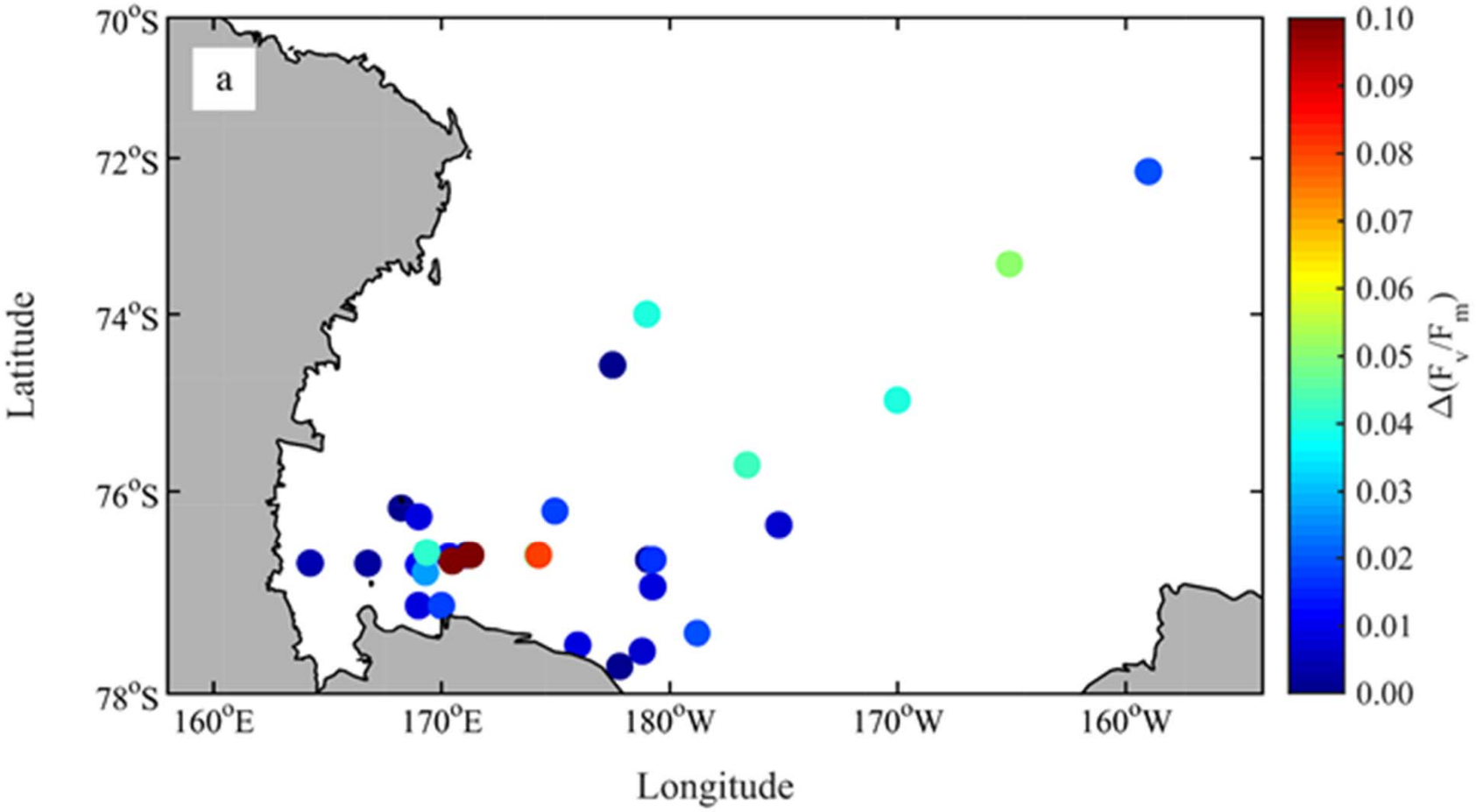

Figure 4 – Short-term Fe-addition bioassay experiments give higher spatial sampling.

But no clear spatial pattern

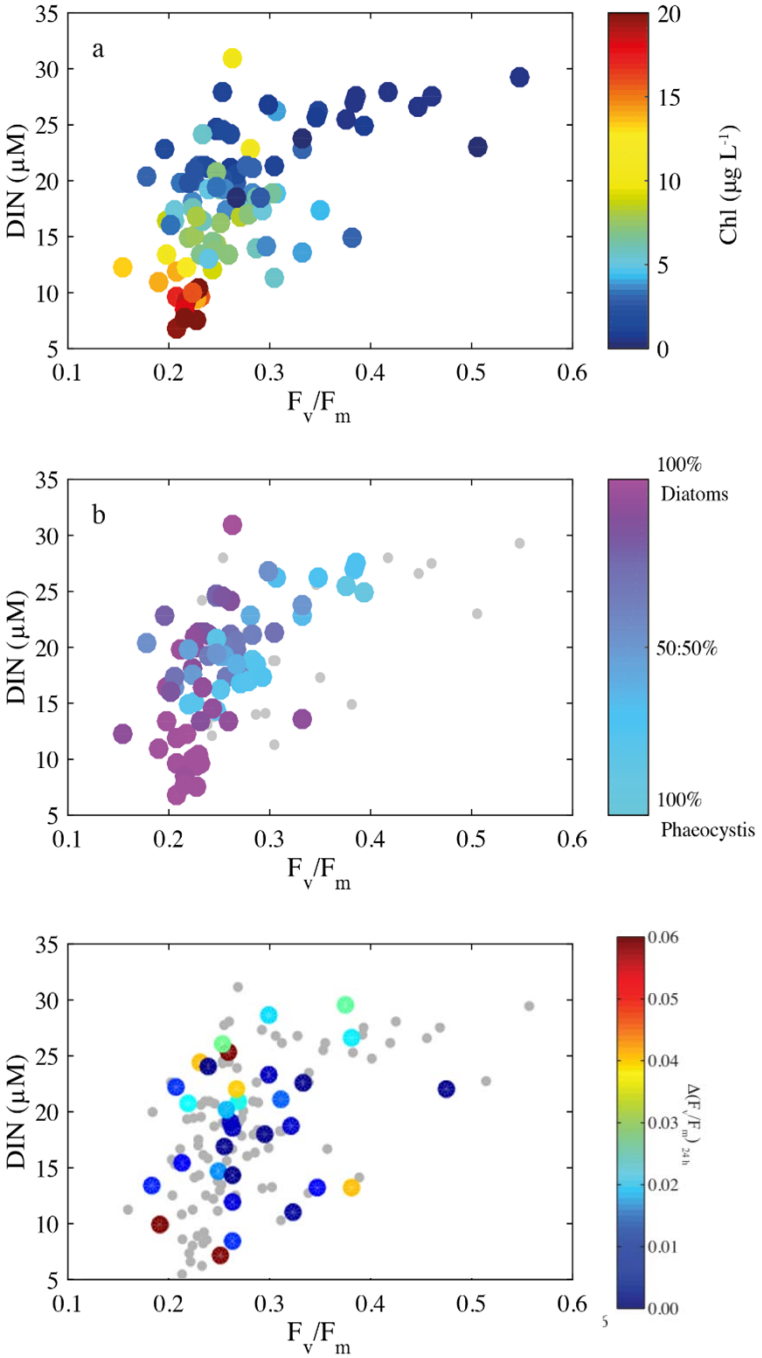

Figure 5

Idealized model plot of surface Nitrate against photosynthetic efficiency (Fv/Fm)

(a) Phytoplankton biomass accumulates

(b) Community shift from Phaeocystis to diatoms

(c) Largest Fe-addition responses observed at (i) lowest nitrate concentrations and (ii) transition in community structure.

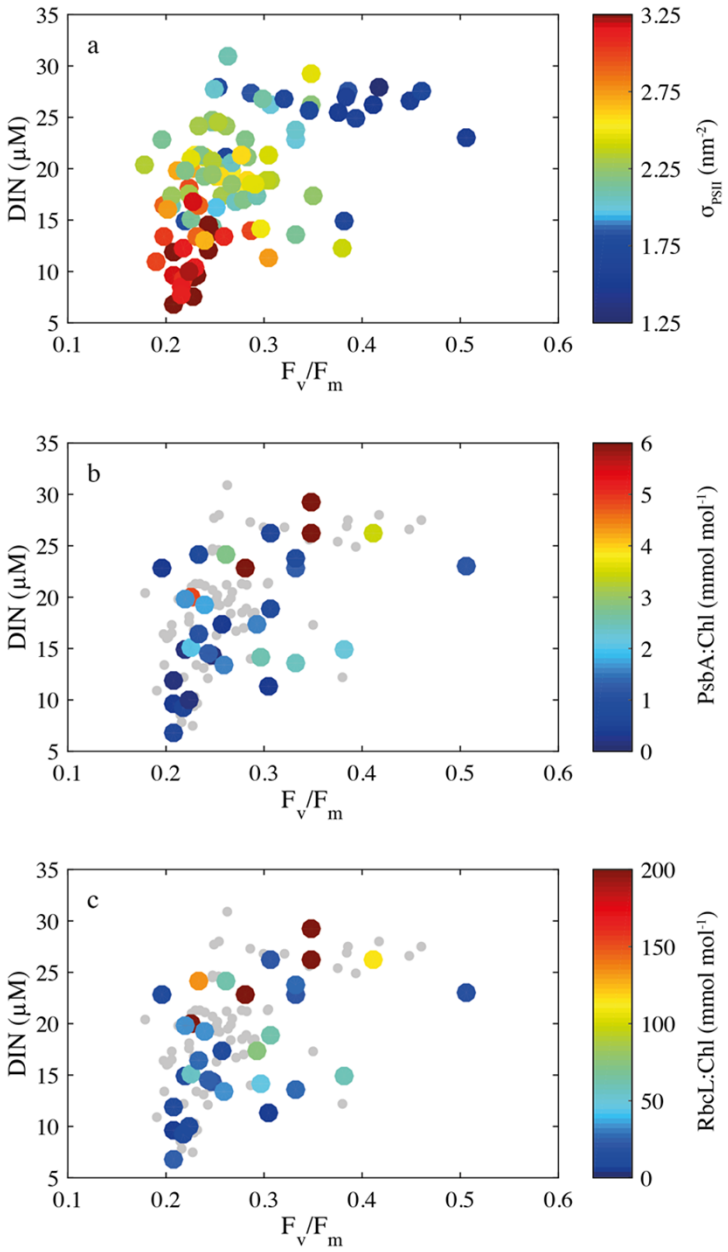

Figure 6

Change in photosynthetic strategy

How do Ross Sea phytoplankton do photosynthesis?

(a) Larger light-harvesting antenna.

(b) and (c) Less photosynthetic catalysts per chlorophyll.

‘Sigma-Type’ photosynthetic strategy that is Fe-efficient is selected as nutrients are removed from the system.

Consequence for diatoms is *photoinhibition*.

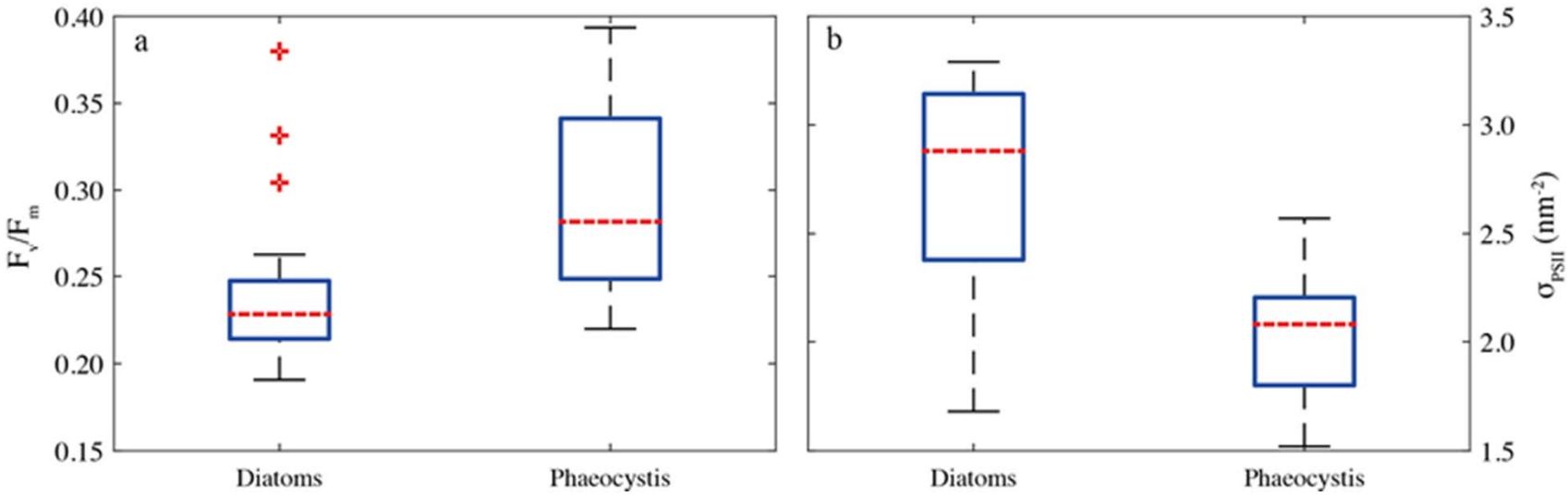

Figure 7

Ross Sea Diatoms – Low photosynthetic Fe requirement

May be an adaptation enabling diatoms to continue to draw down nitrate as *Phaeocystis* becomes limited.

Implications of Chl:Fe ratios and productivity estimates from Satellite in Ross Sea