Marine Turbulence Re^3-visited

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The 8th Warnemünde Turbulence Days

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Universidade Vigo

Grupo de Oceanografía Biolóxica

What is the role of mixing in controlling microphytoplankton community composition?

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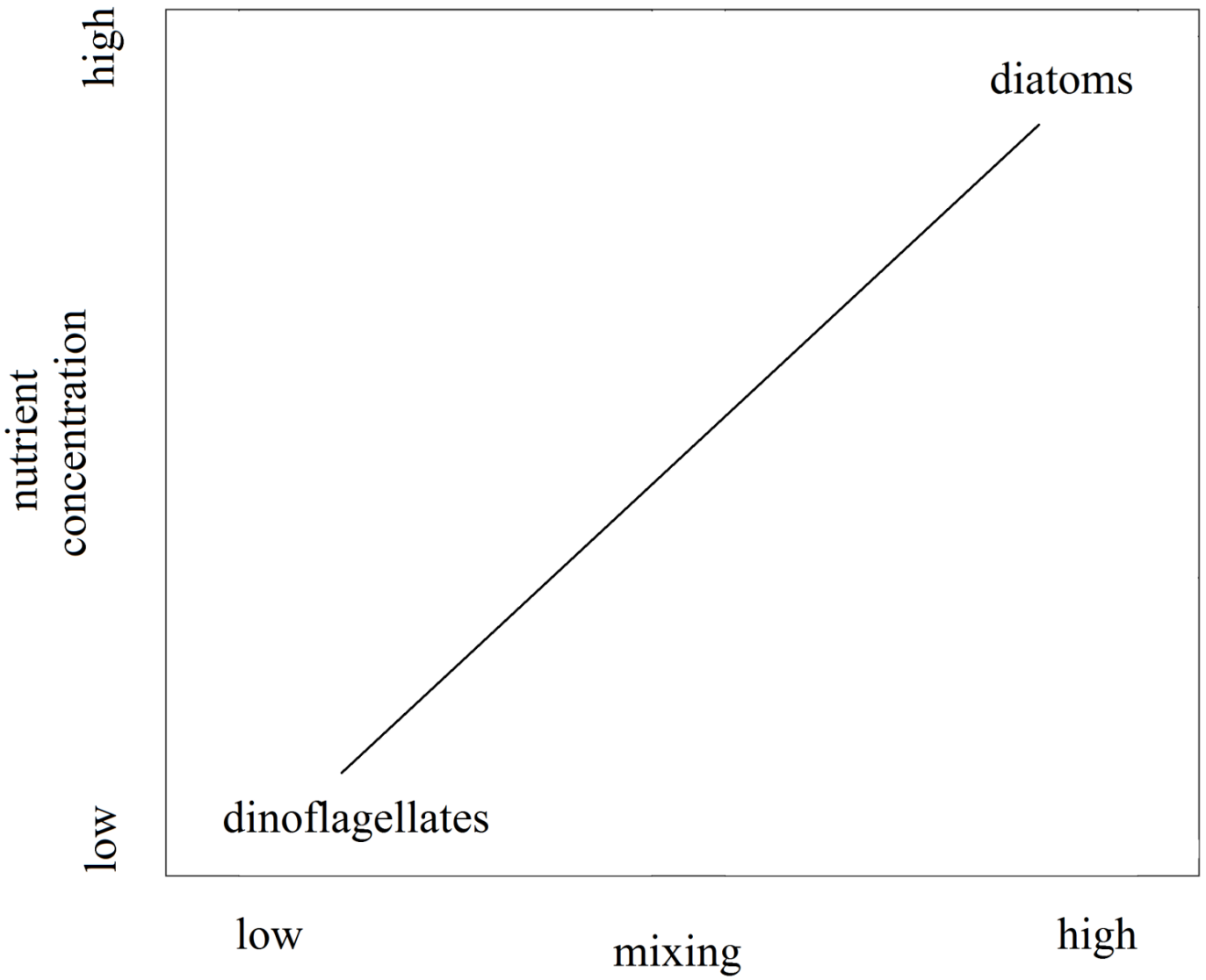
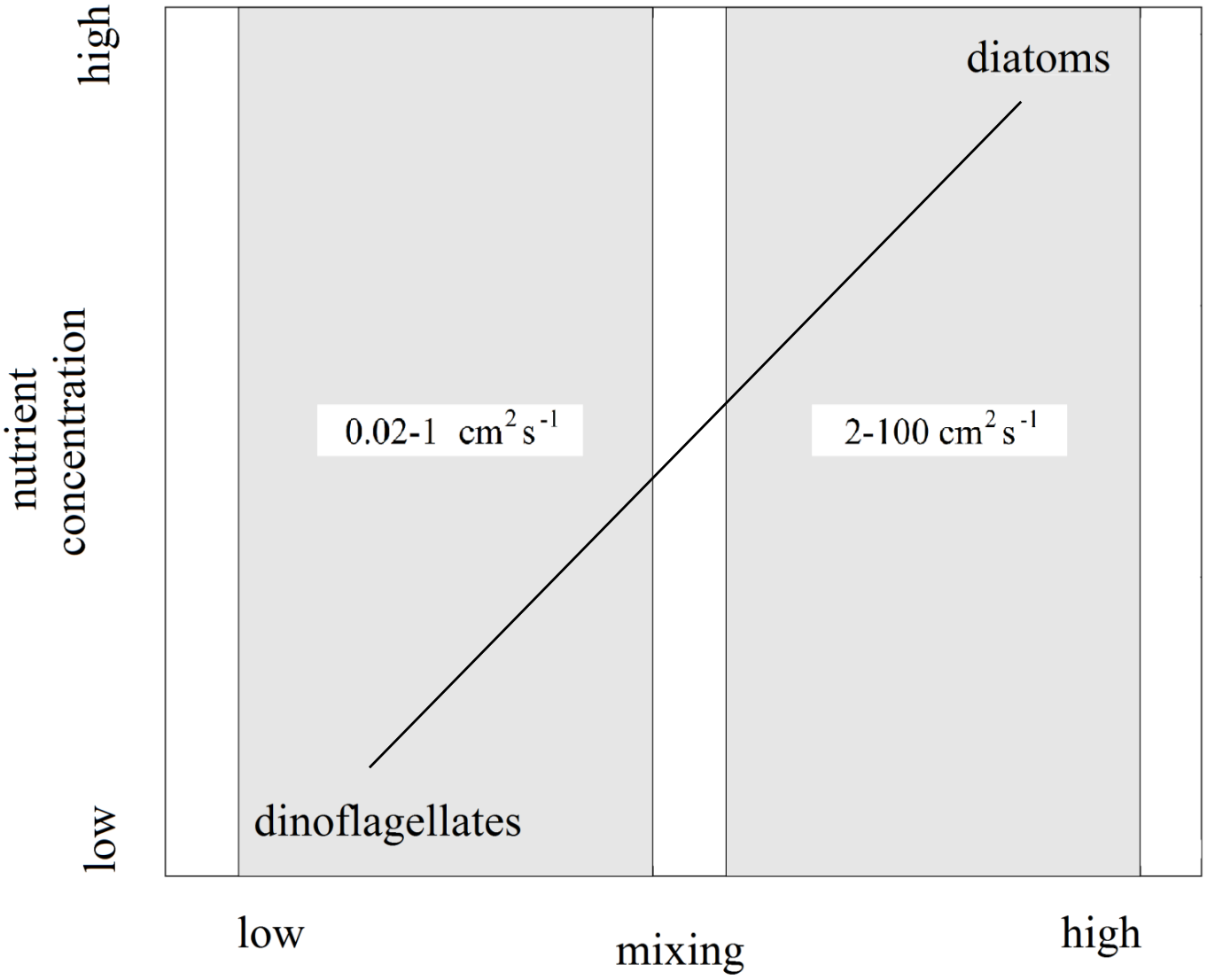
“There is no life without water, and there is no life in water without turbulence in water”

Ambühl (1960) in Margalef (1997)

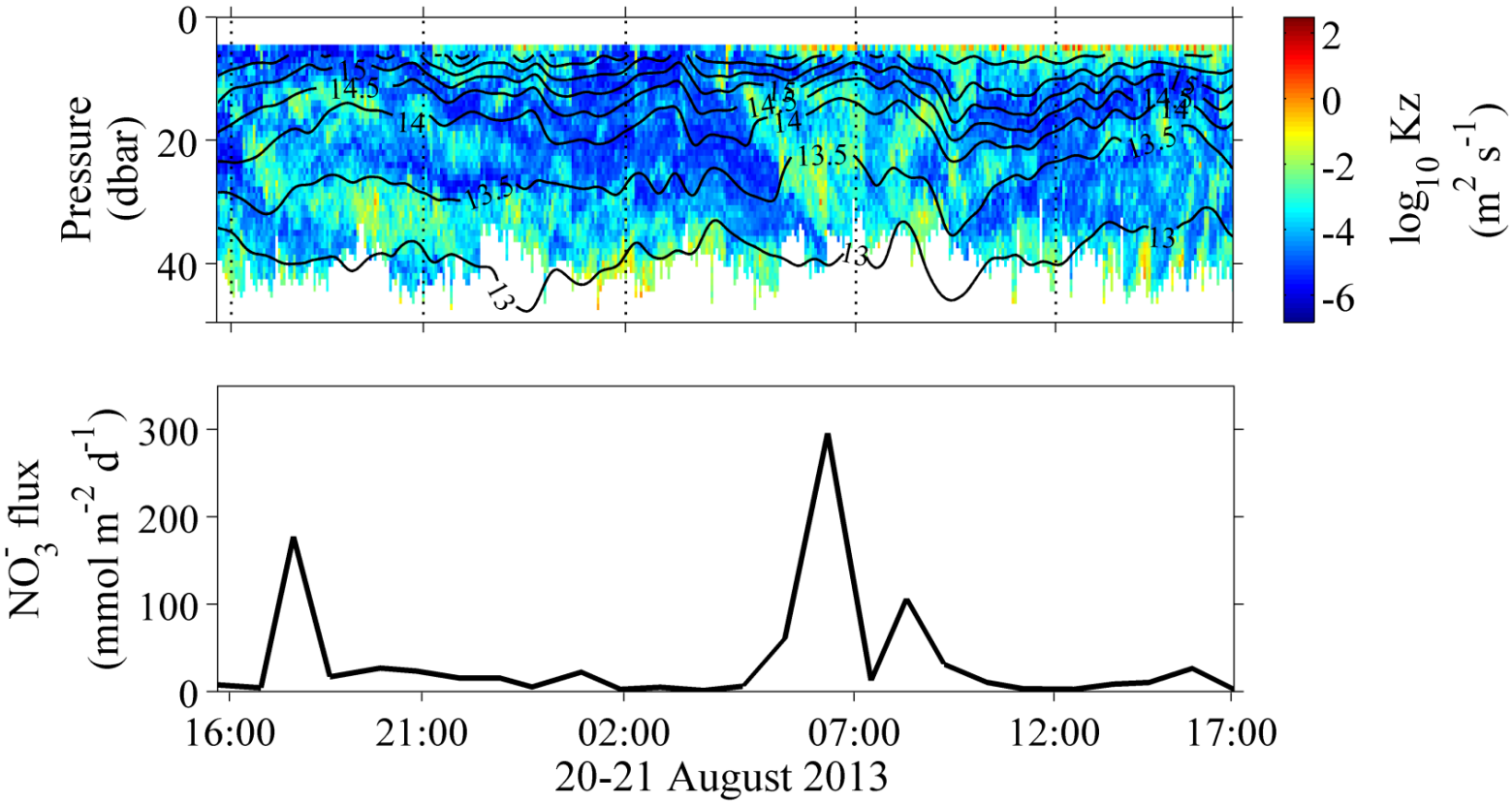
Margalef´s Mandala (1978)



Margalef´s Mandala (1978)



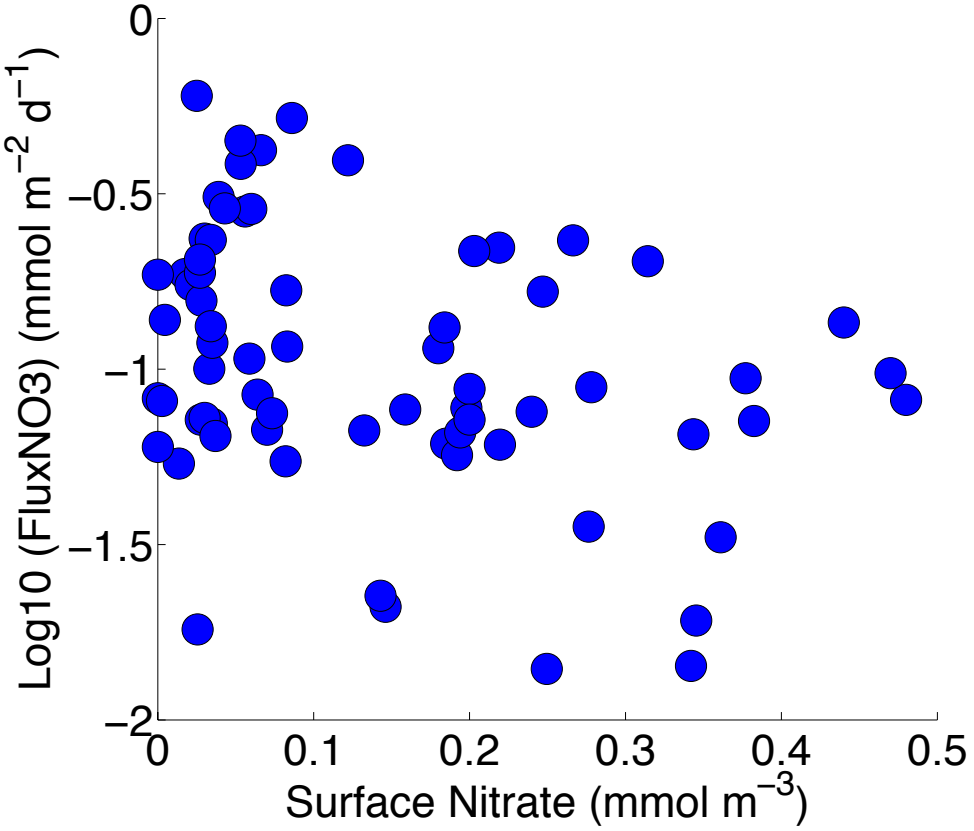
Internal wave mixing and nutrient supply on the Ría de Vigo (NW Spain)



Villamaña et al. (L&O, 2017)

Mixing and stratification: related but not the same

Nitrate flux versus surface nitrate concentration in oligotrophic regions



Mouriño-Carballido et al. (2011, L&O)

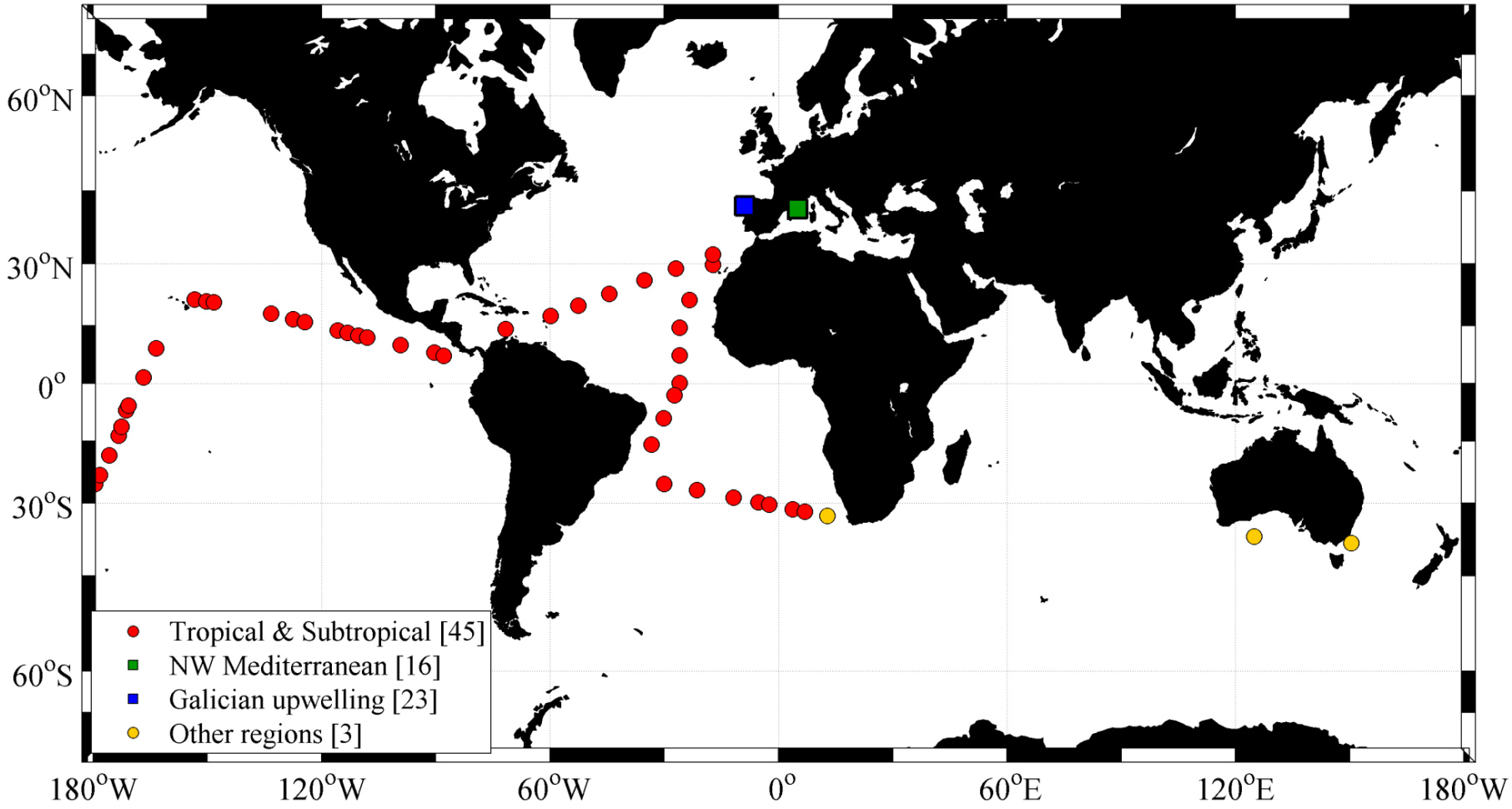
Changes in nutrient concentration can be disconnected from changes in nutrient supply

Do field observations validate the Margalef’s mandala?

Our goal

To investigate the role of mixing and nutrient supply on microphytoplankton community composition

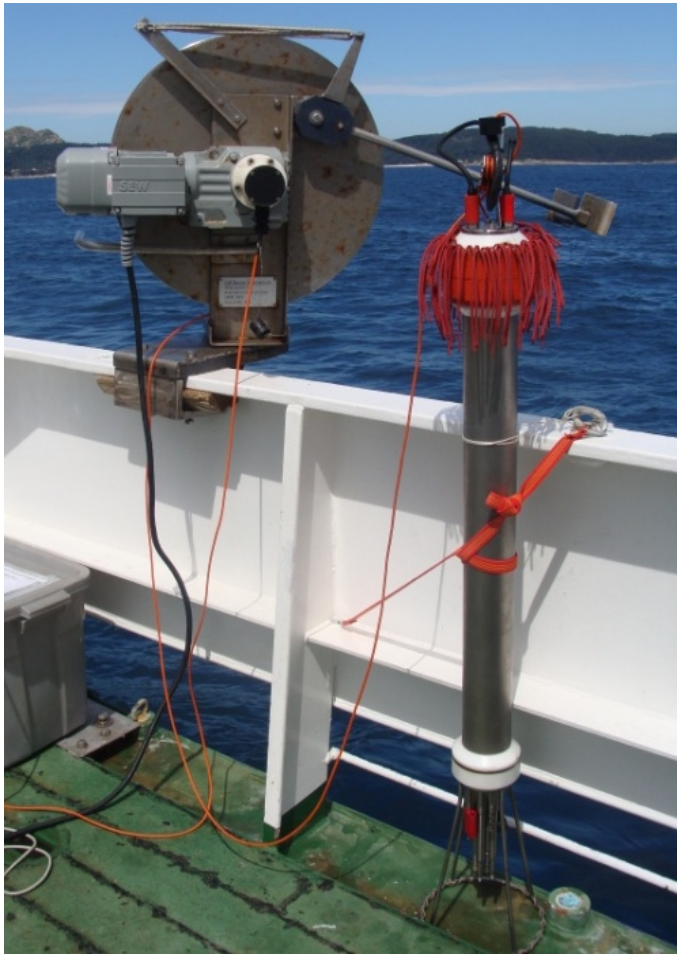
Data set of microturbulence and microphytoplankton



5 cruises - 86 Stations (2009-2013):

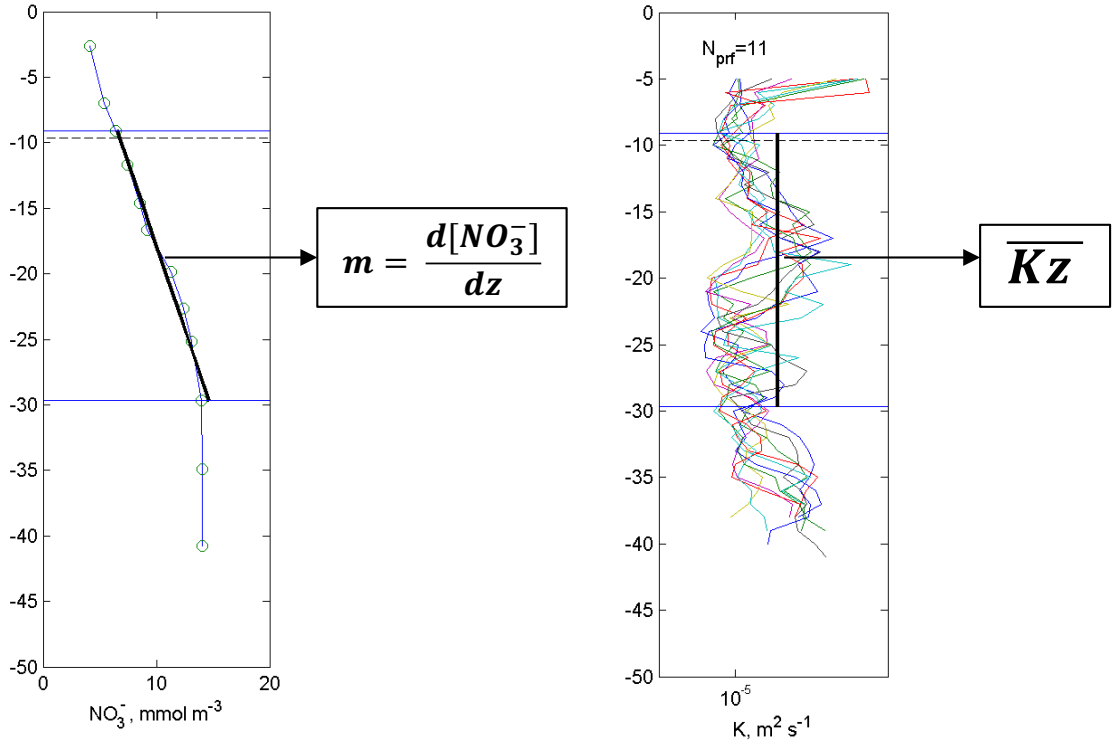
- Microstructure turbulence
- Nitrate concentration
- Microphytoplankton community composition

How do we quantify turbulence and mixing?
Microstructure profiler



Nutrient supply

$$NO_3^- \; diffusive \; flux = \; -Kz \cdot \left(\frac{d[NO_3^-]}{dz}\right)$$



For Galician upwelling region:

$$NO_3^- \; advective \; flux \; = \; \frac{I_W \; x \; D}{A} \cdot \; [NO_3^-]_{bottom}$$

Diatom and dinoflagellate biomass

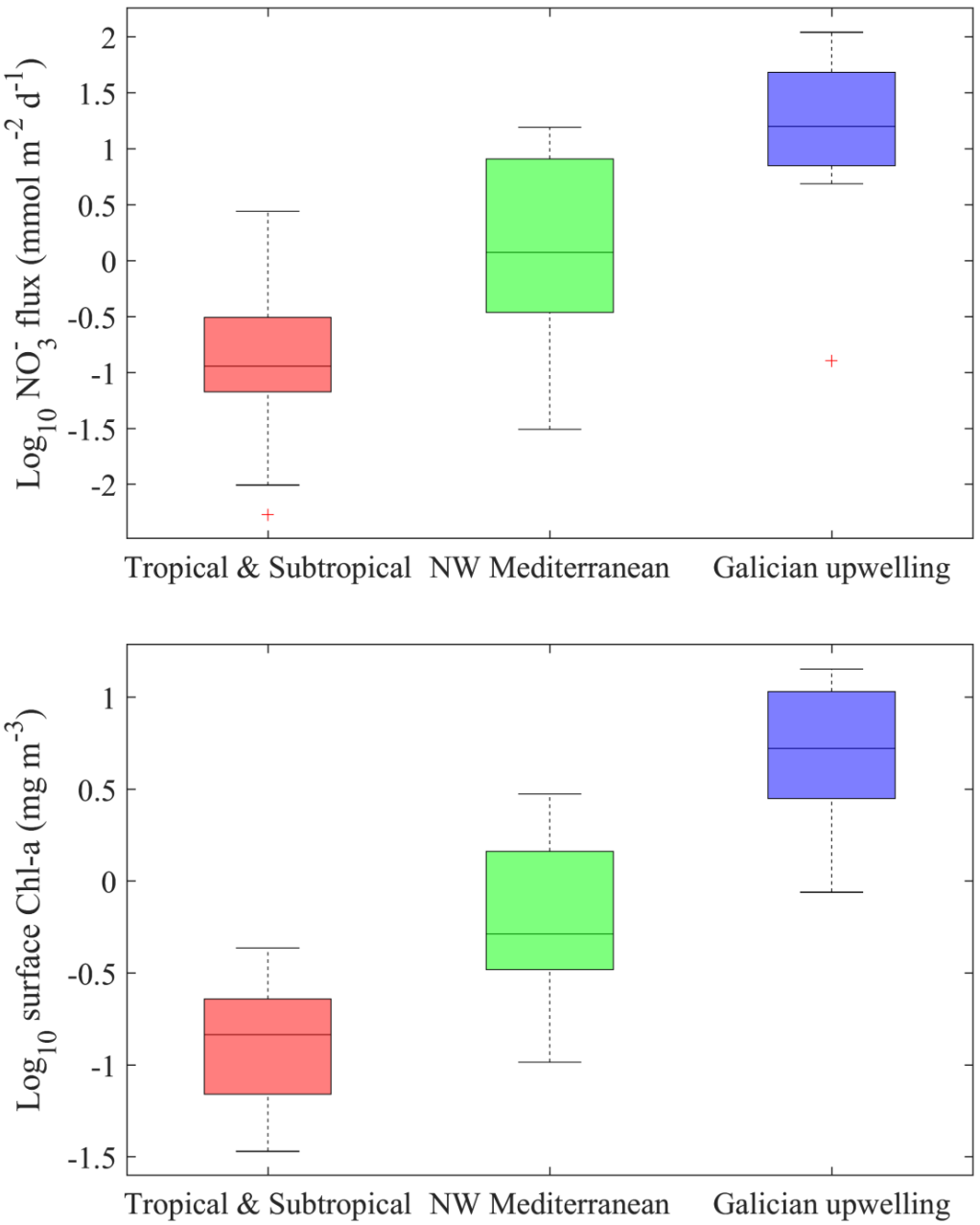
cell abundance → inverted microscope

cell biovolume → dimensions and shapes
Hillebrand et al (1999)

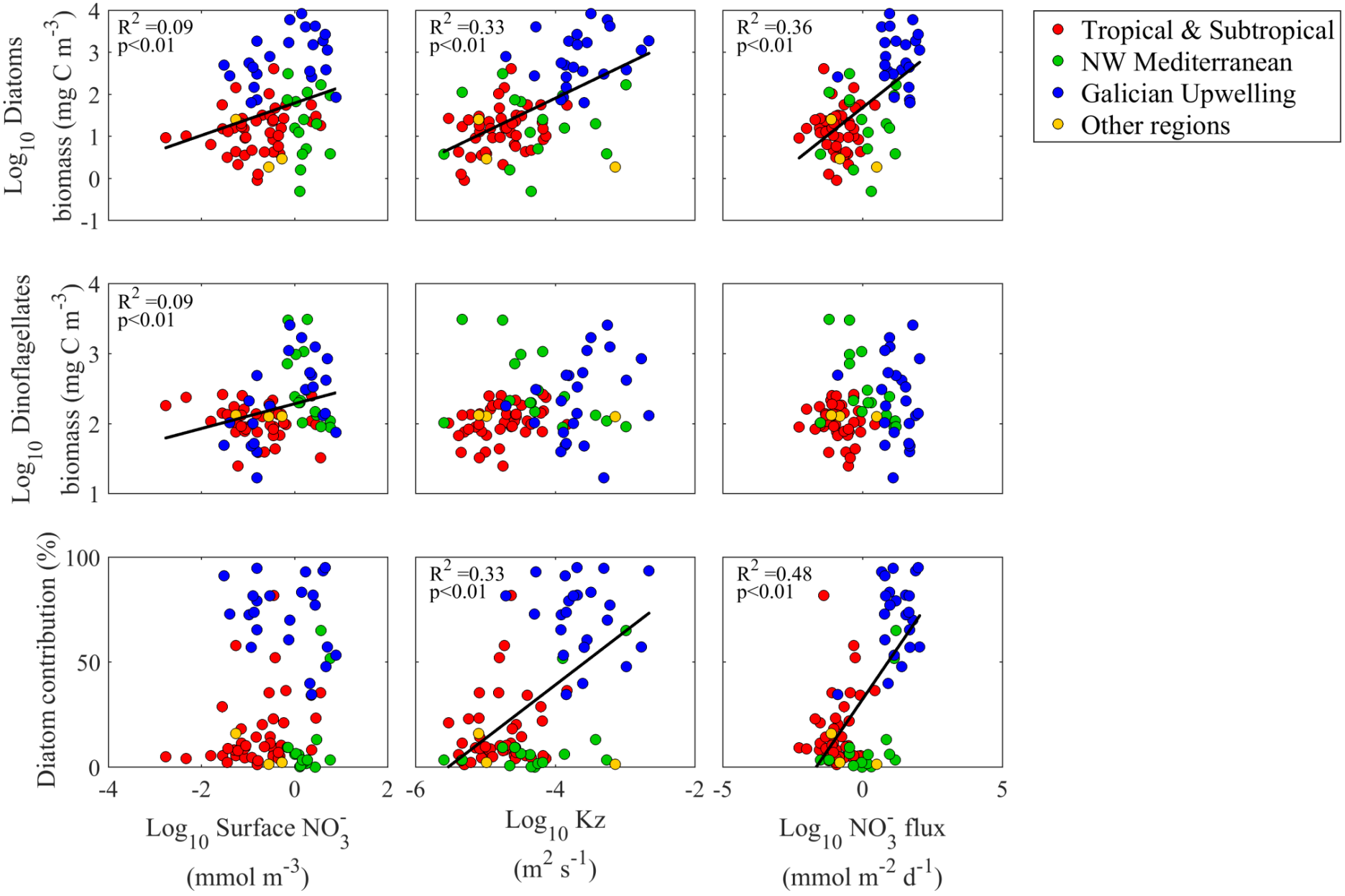
cell carbon → volume-to-carbon conversion factor
Menden-Deuer and Lessard (2000)

C biomass = cell abundance x cell carbon

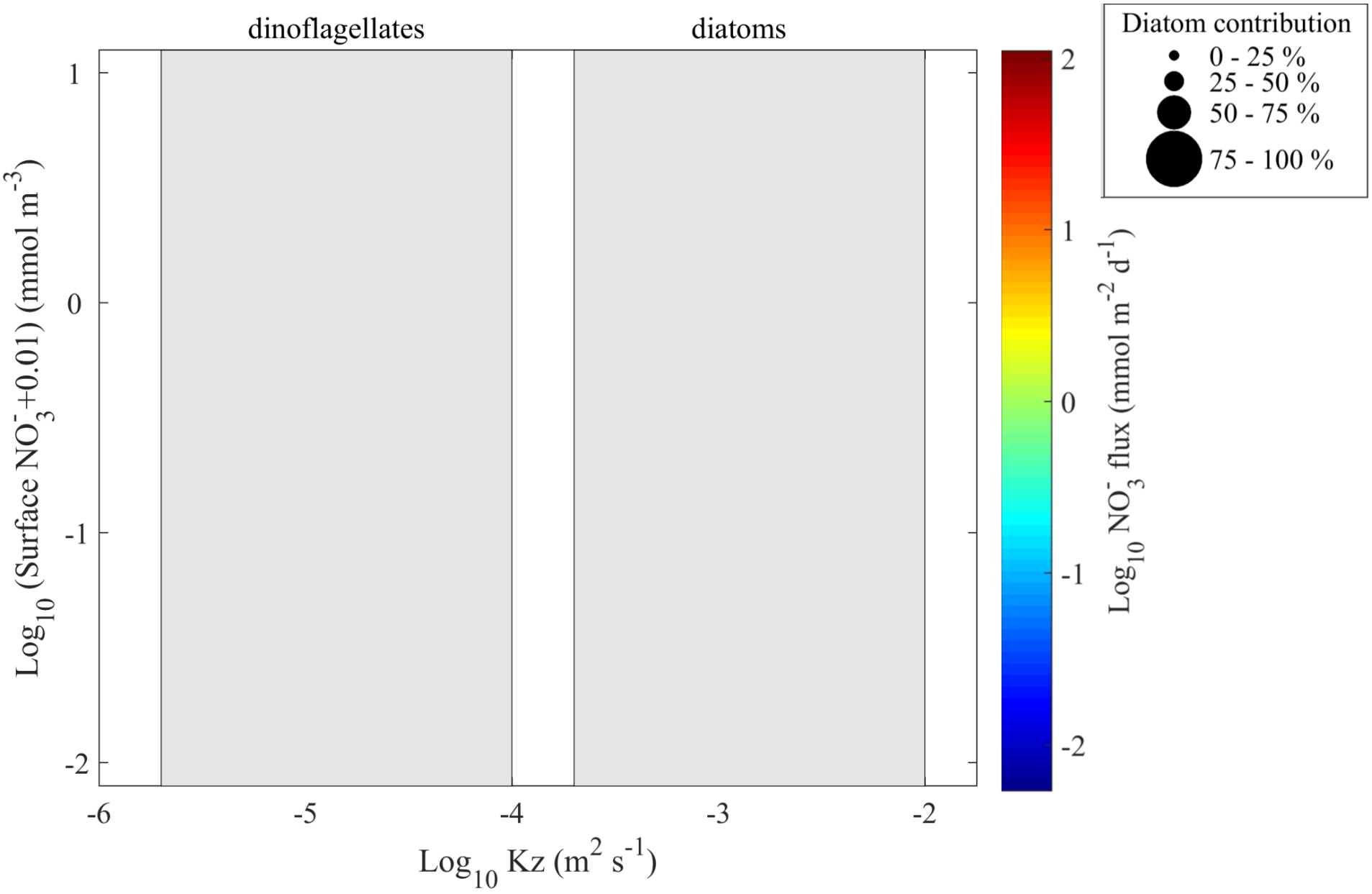
Variability in nitrate fluxes and surface Chl-a



Diatom and dinoflagellate biomass vs. surface NO_3^- concentration, Kz and NO_3^- flux



Diatom contribution vs. surface NO_3^- concentration, Kz and NO_3^- flux



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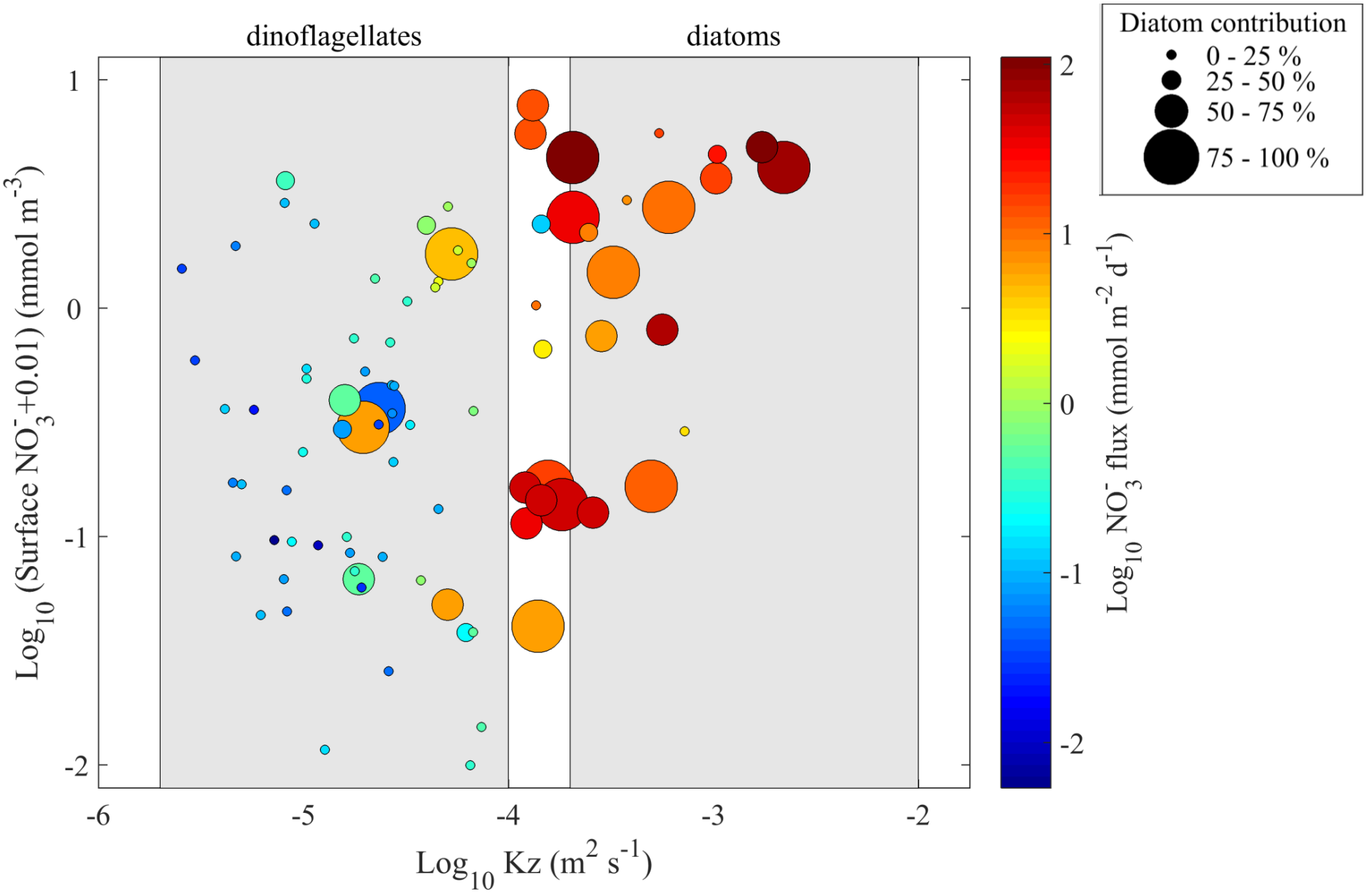
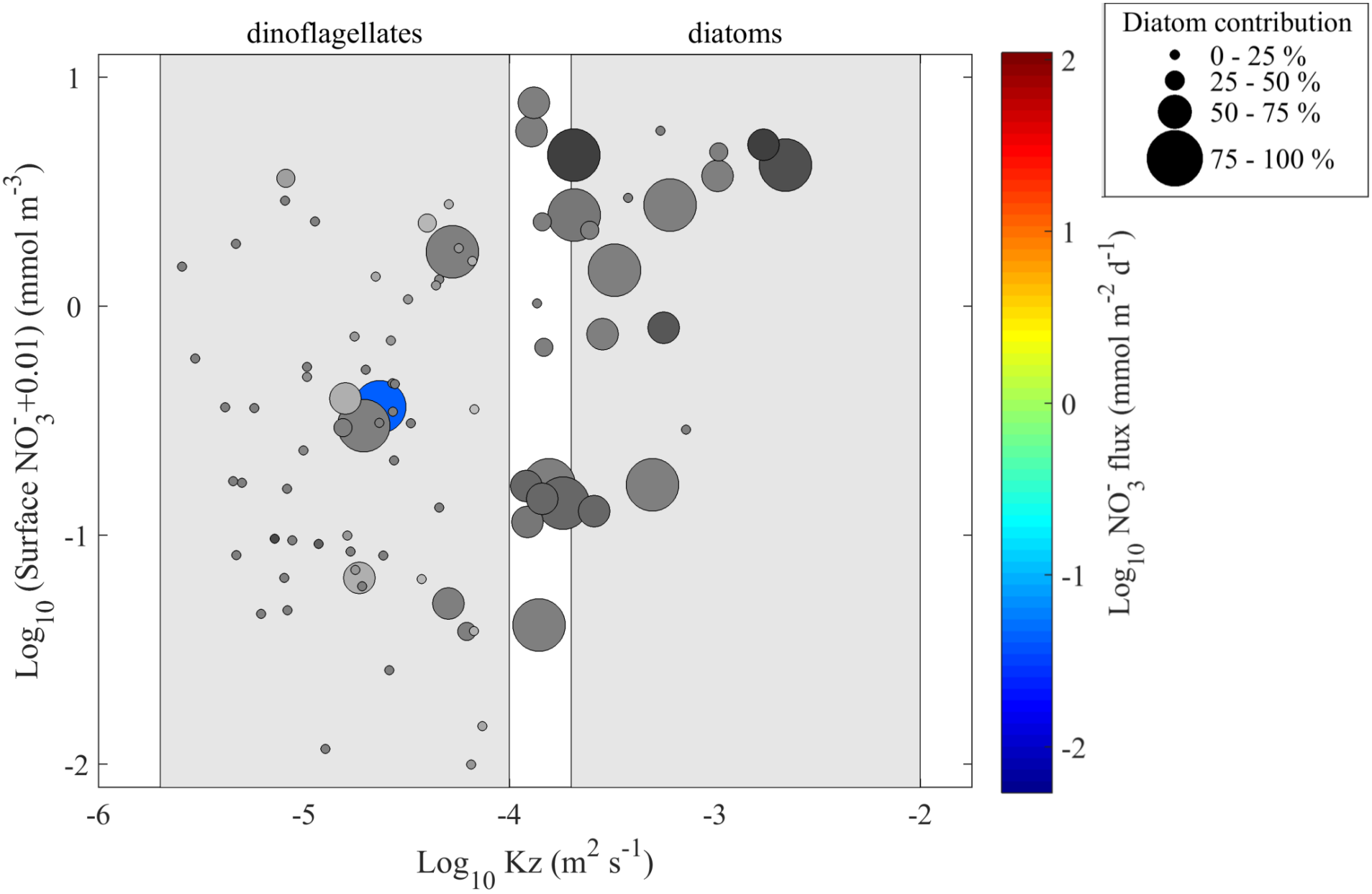
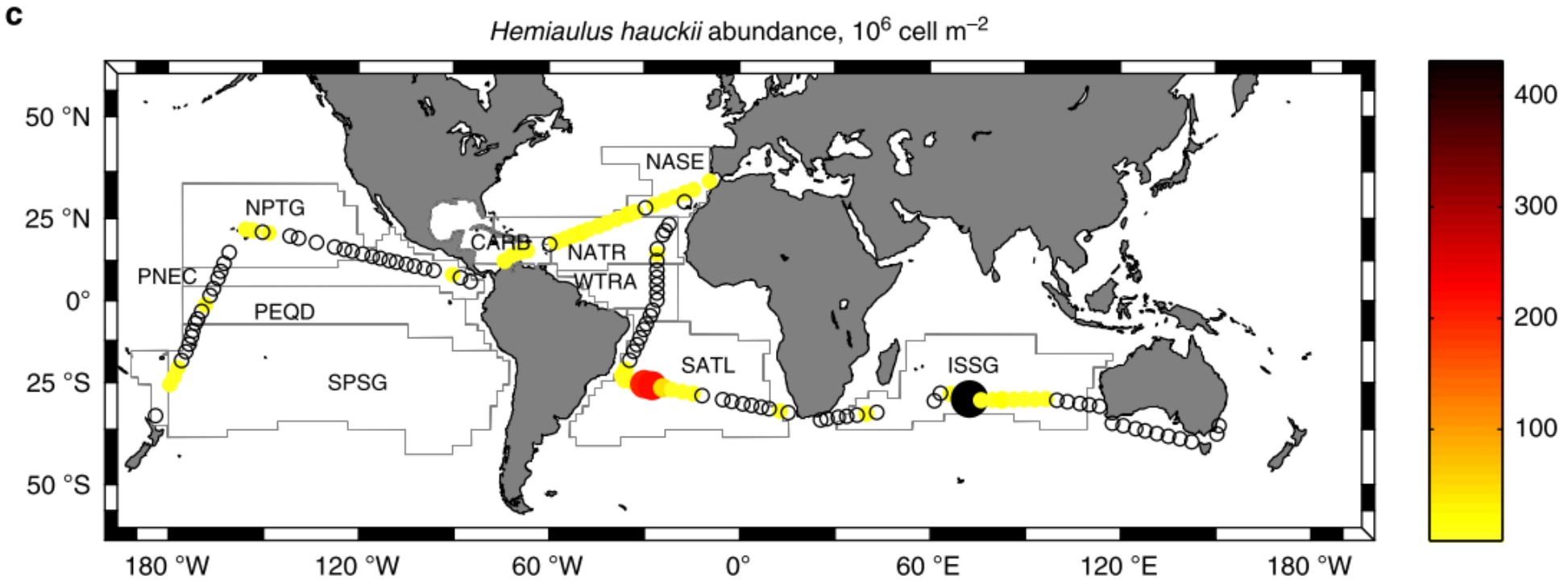


Exceptions to the model

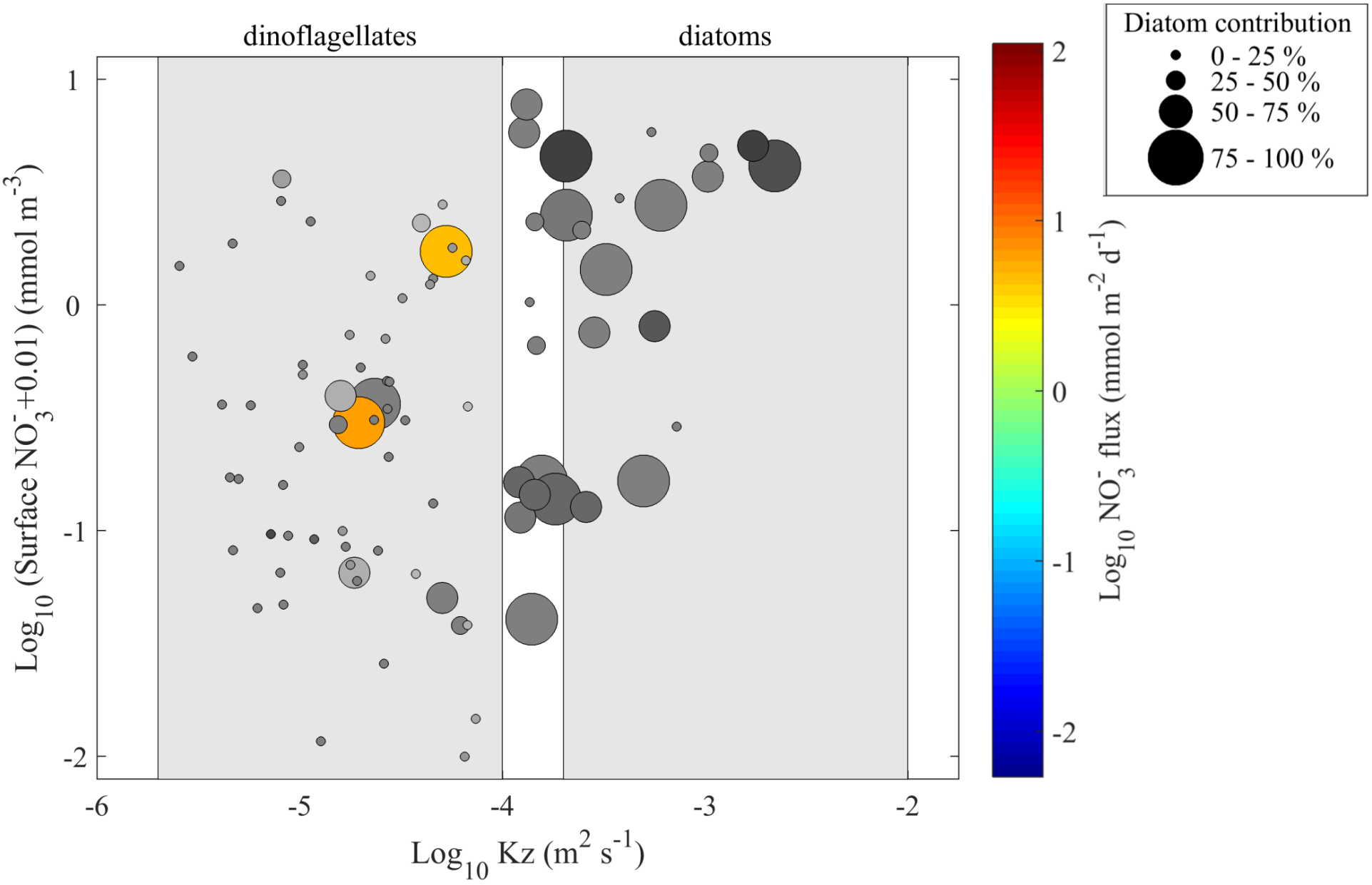


Exceptions to the model: N_2 fixation

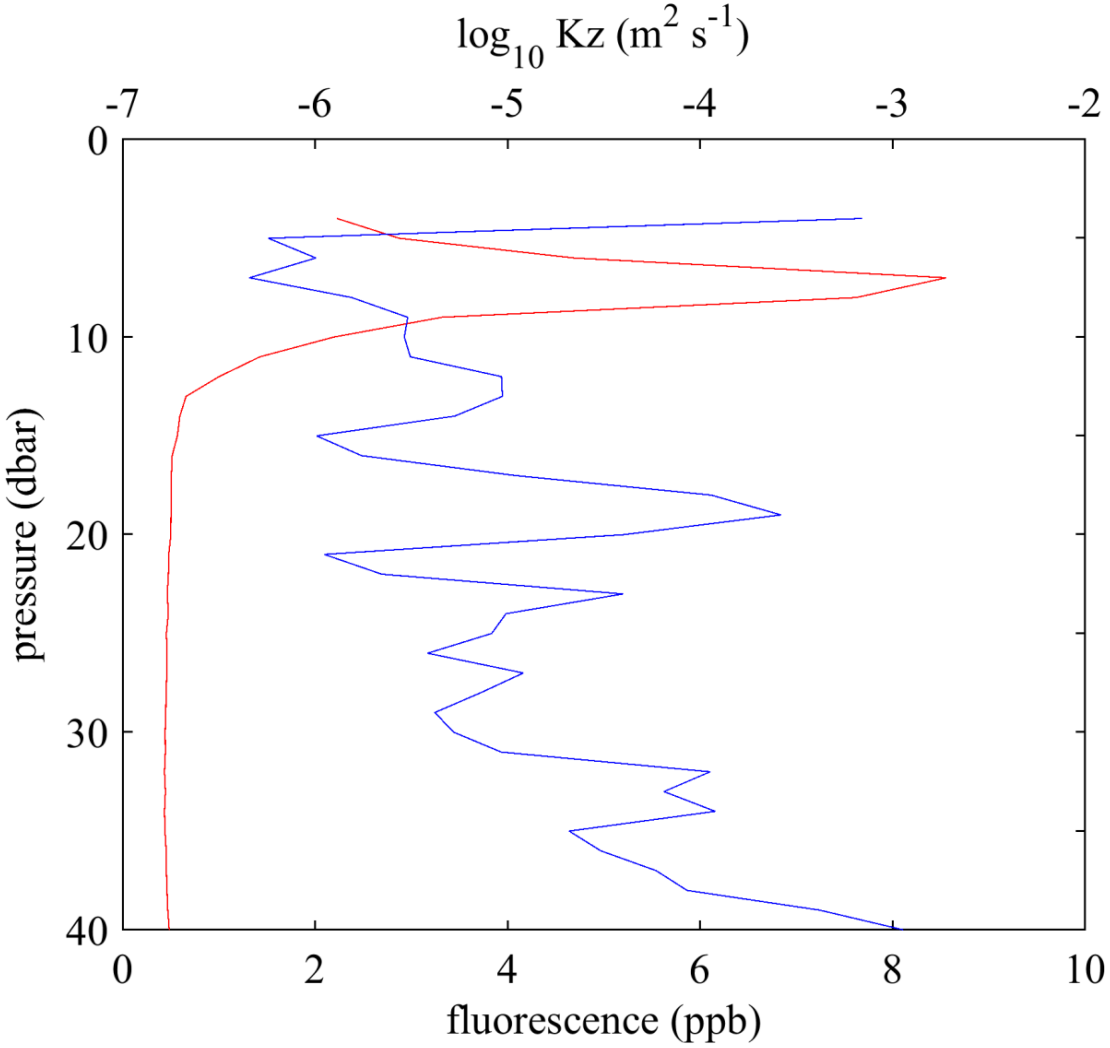


Fernández-Castro et al. (2015, Nat. Comm.)

Exceptions to the model



Exceptions to the model: Thin phytoplankton layers



Conclusions

1. In general, mixing regimes for diatoms and dinoflagellates were 2-100 and 0,02-1 cm^2 s^{-1}, respectively.

2. The contribution of diatoms to biomass enhances with increasing nitrate flux.

3. Nitrate flux was a better proxy for nutrient availability than nitrate concentration

Do field observations validate Margalef’s mandala?

Thank you!

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