Revisiting the distribution of diazotrophy in the oceans

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Statistics Consulting Presentation

October 24, 2023

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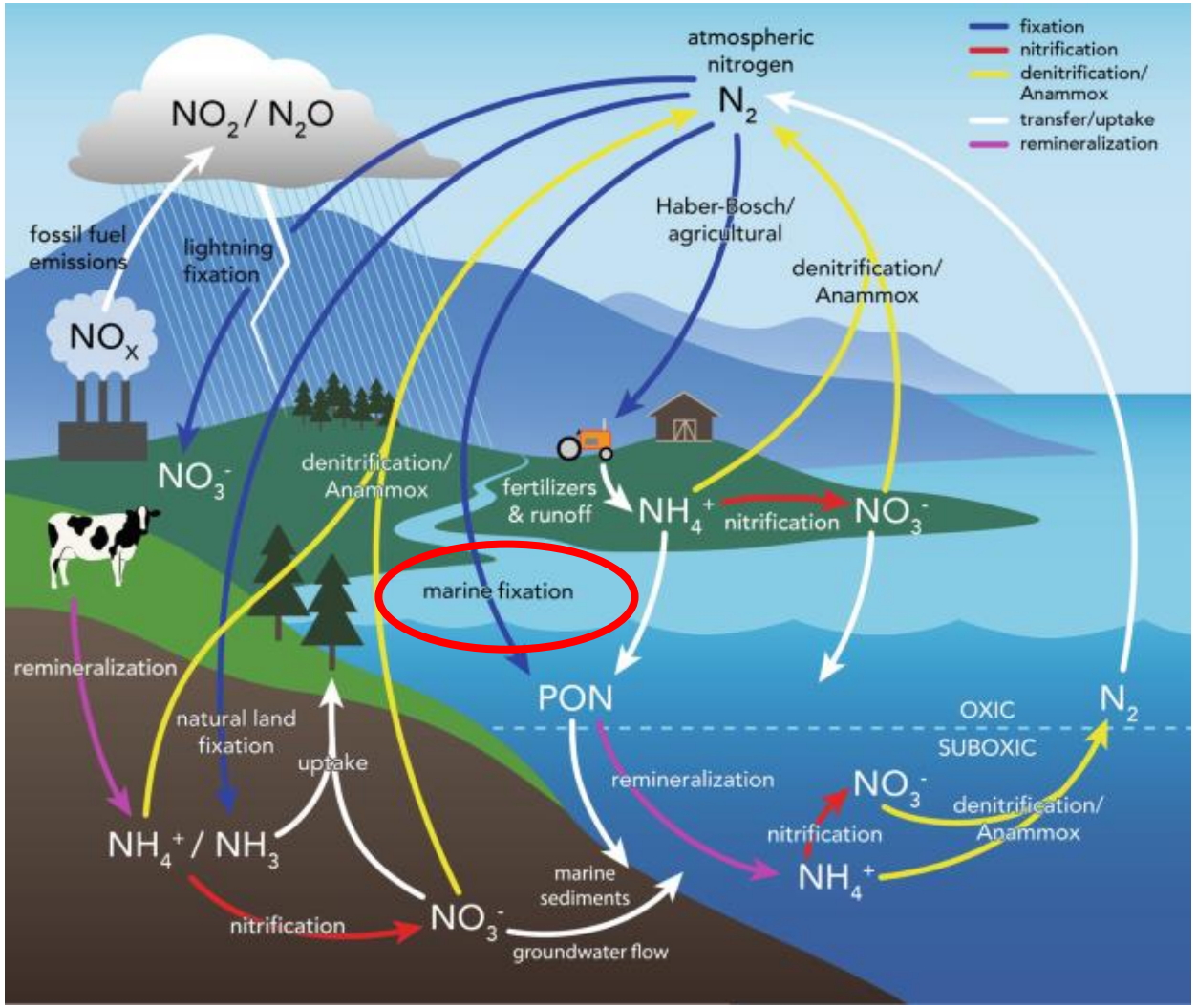
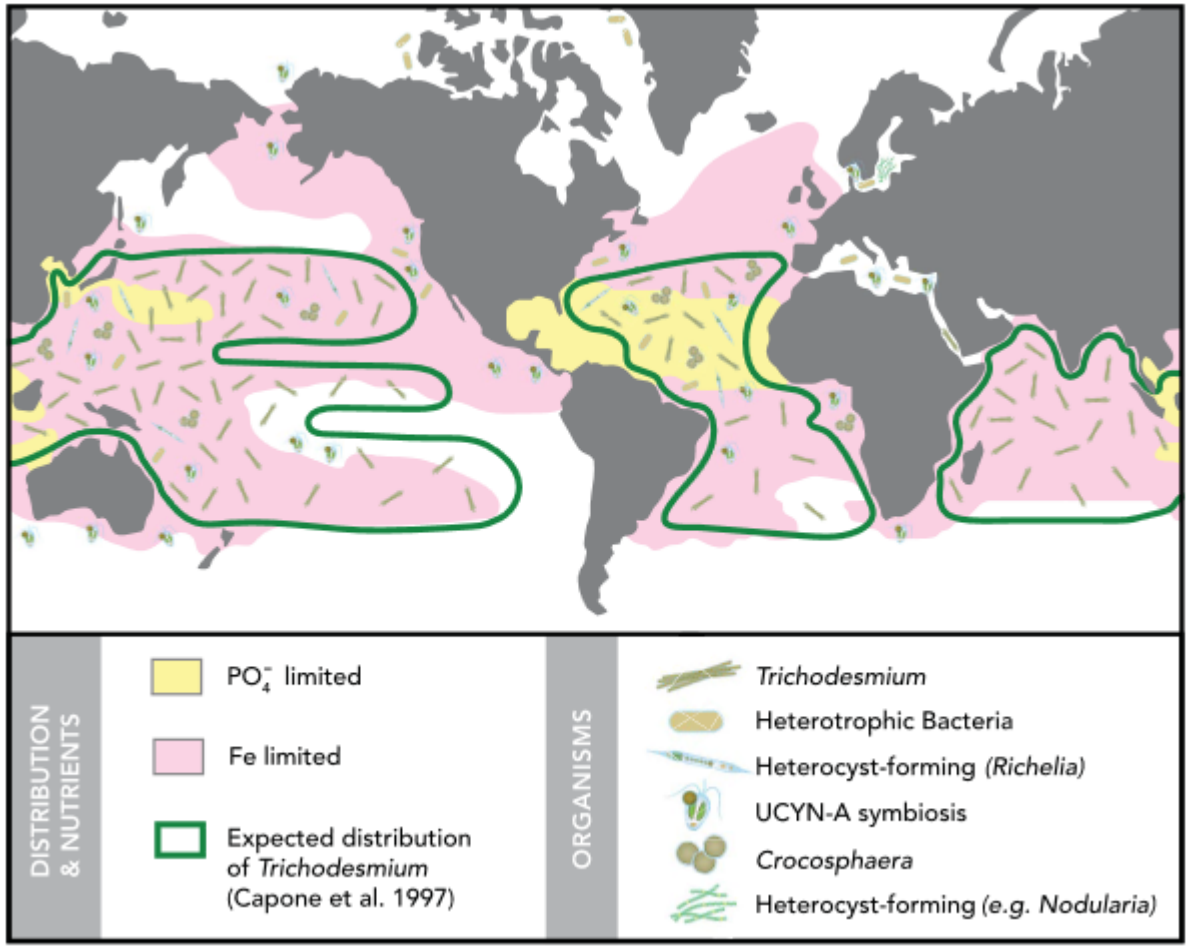
The Nitrogen Cycle



Zehr & Capone, 2021

BNF is limited to open ocean tropical & subtropical regions

Global Nitrogen Fixation

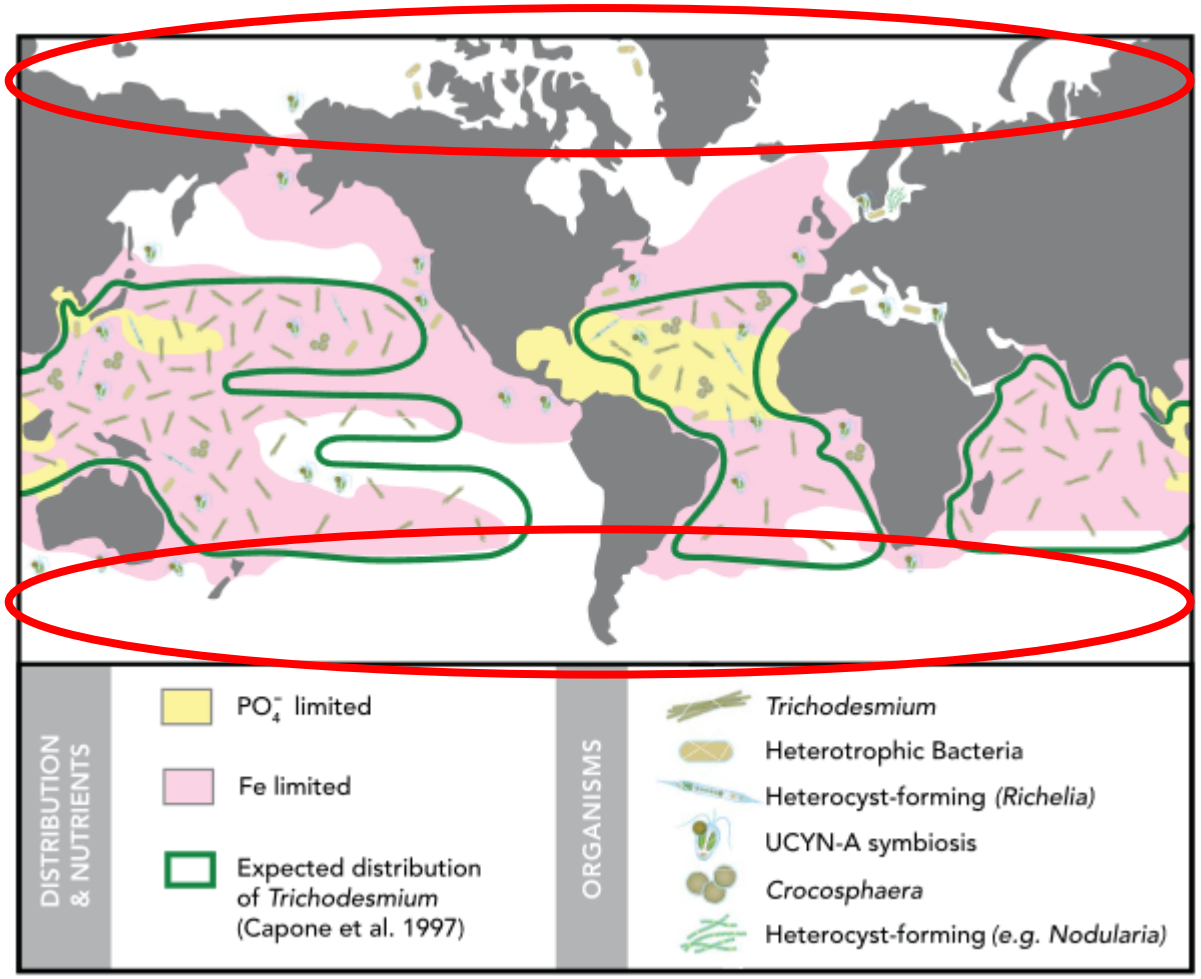


Zehr & Capone, 2020

Historic Hotspots

- Oligotrophic areas
- Tropical regions

Global Nitrogen Fixation



Zehr & Capone, 2020

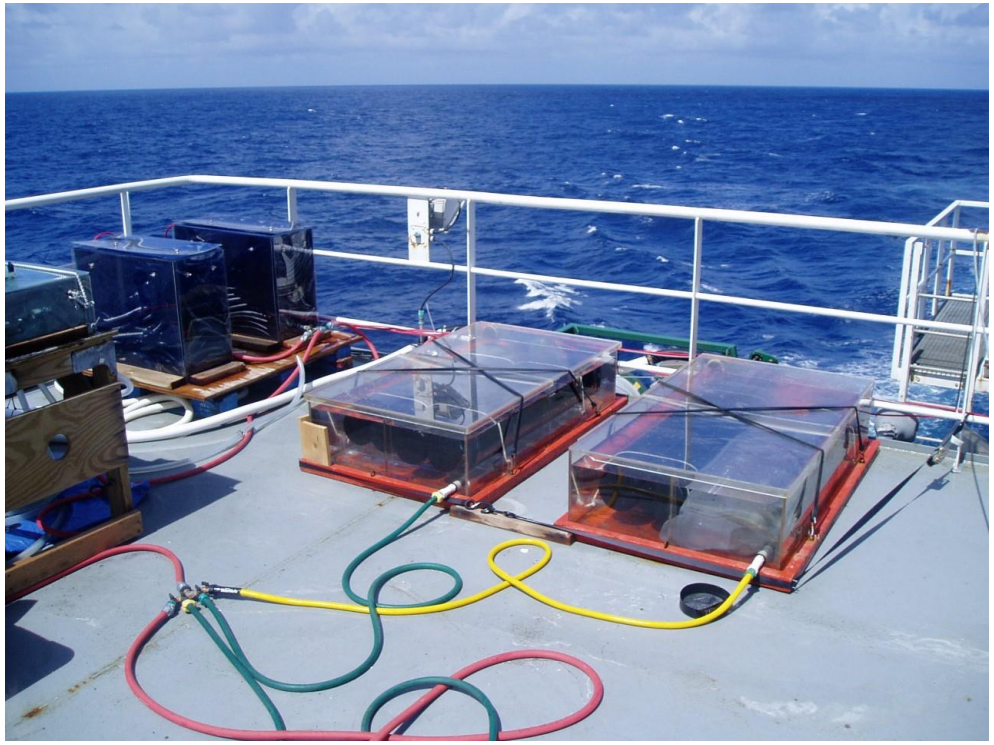
Historic Hotspots

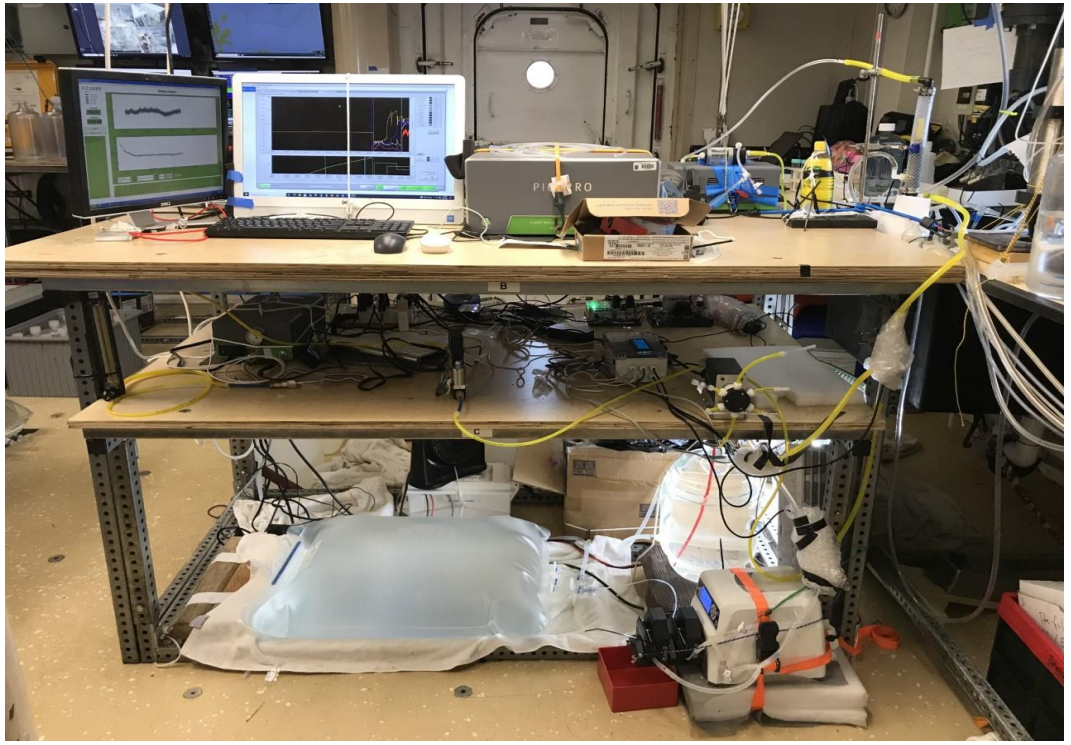
- Oligotrophic areas
- Tropical regions

Understudied and undersampled regions

- **Coastal areas**
  - *Tang et al 2019, Mulholland et al 2012, Grosse et al 2010*
- **Polar areas**
  - Arctic
    - *Shiozaki et al 2018, Shiozaki et al 2012, Sipler et al 2017,*
  - Antarctic
    - *Shiozaki et al 2020, Shiozaki et al 2022, Raes et al 2020*

Current Field Measurement Methods





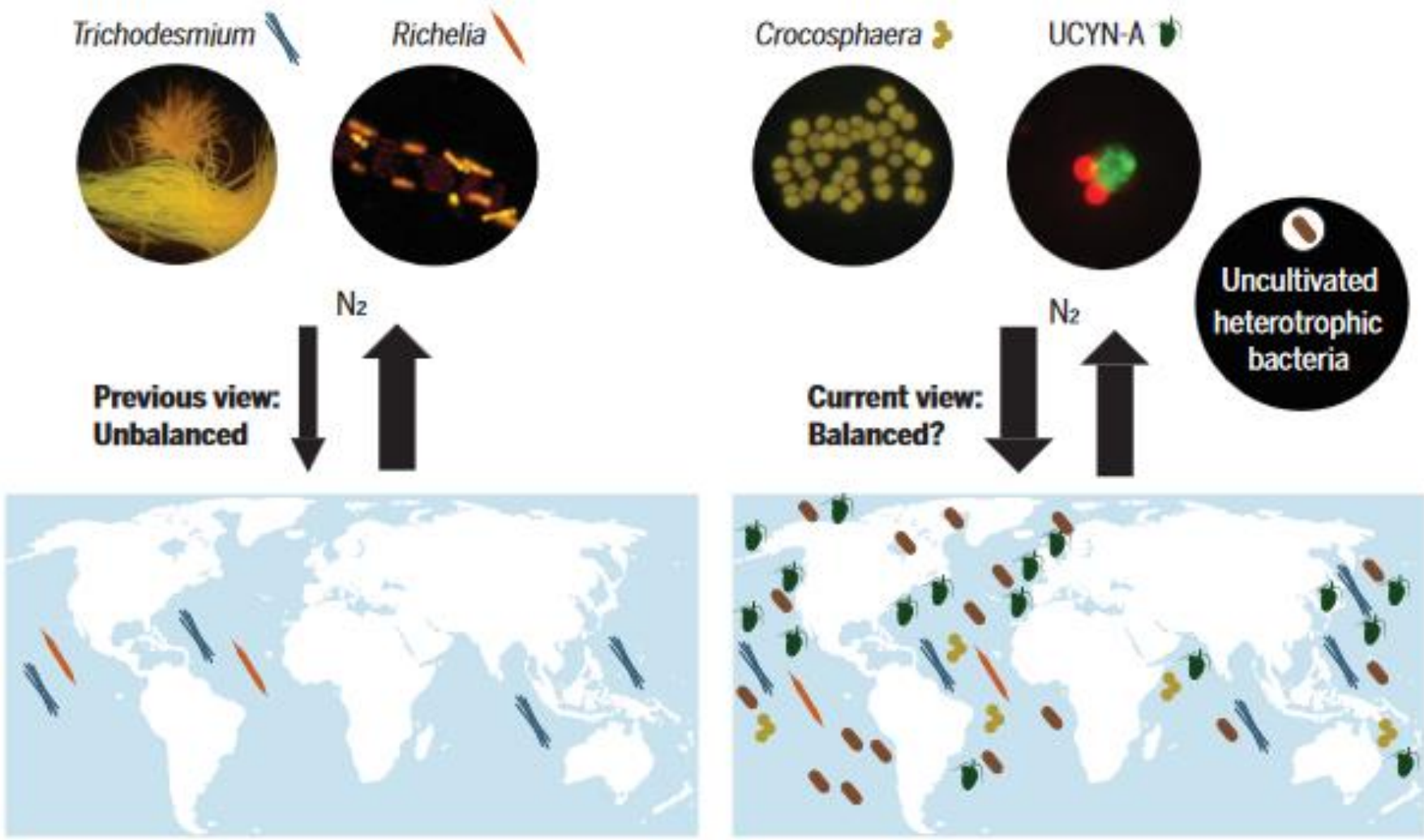
$^{15}N_2$ incubation / Acetylene reduction assay

- Time and labor intensive and discrete
- No immediate results

Flow-Through Incubation Acetylene Reduction Assays by Cavity Ring Down Laser Absorption Spectroscopy (FARACAS)

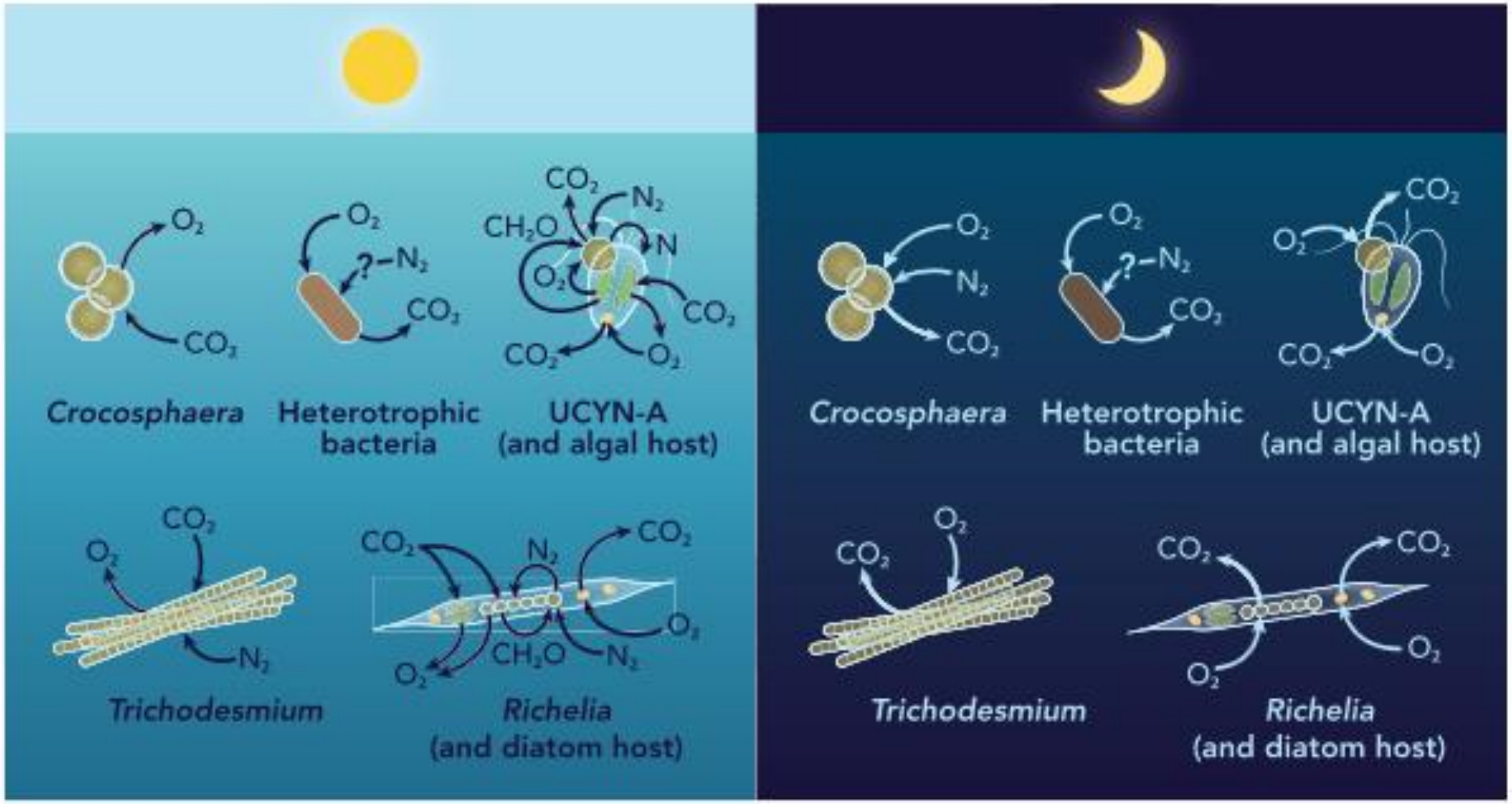
- Continuous measurements, more data
- IMMEDIATE results – can adapt measurements

Diazotroph Diversity



Zehr & Capone, 2020

Diazotroph fixation diel cycling



Zehr and Capone, 2020

Comparing Four Datasets

North Atlantic, 2019

Indian Ocean, 2022

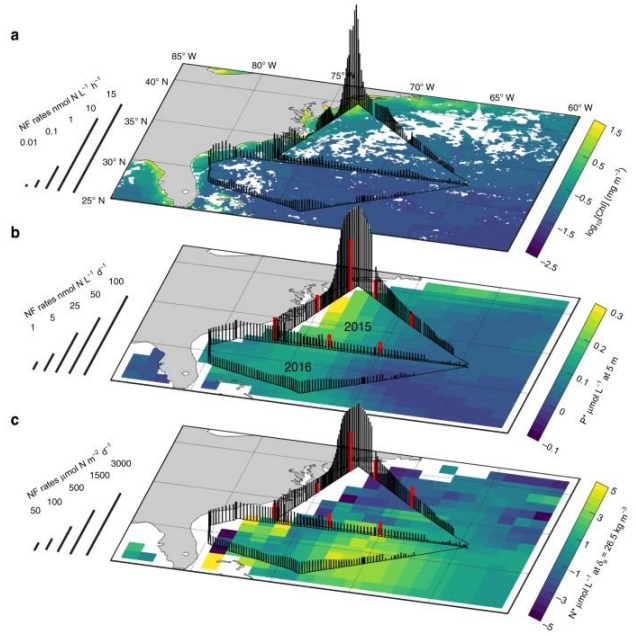
Northwest Passage, 2022

Barents Sea, 2023

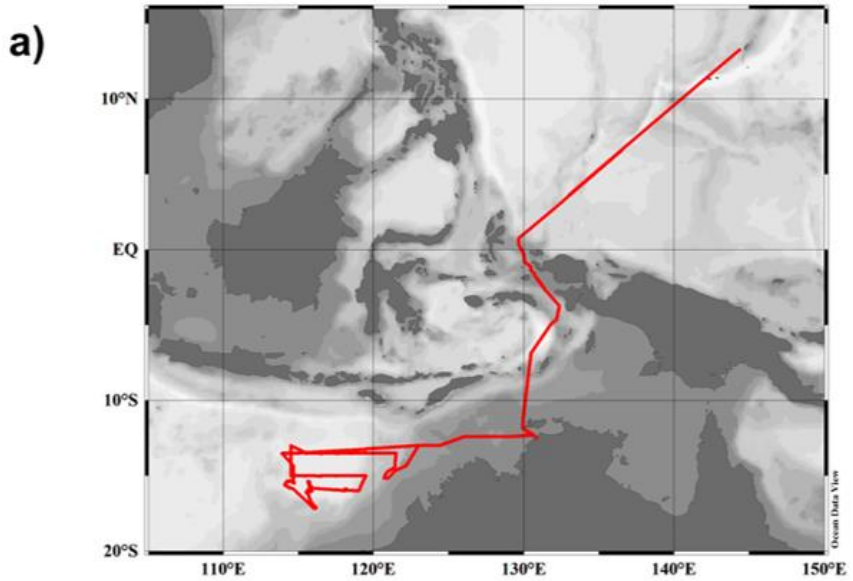
Goal:

Analyze datasets for periodicity in BNF over a diel cycle

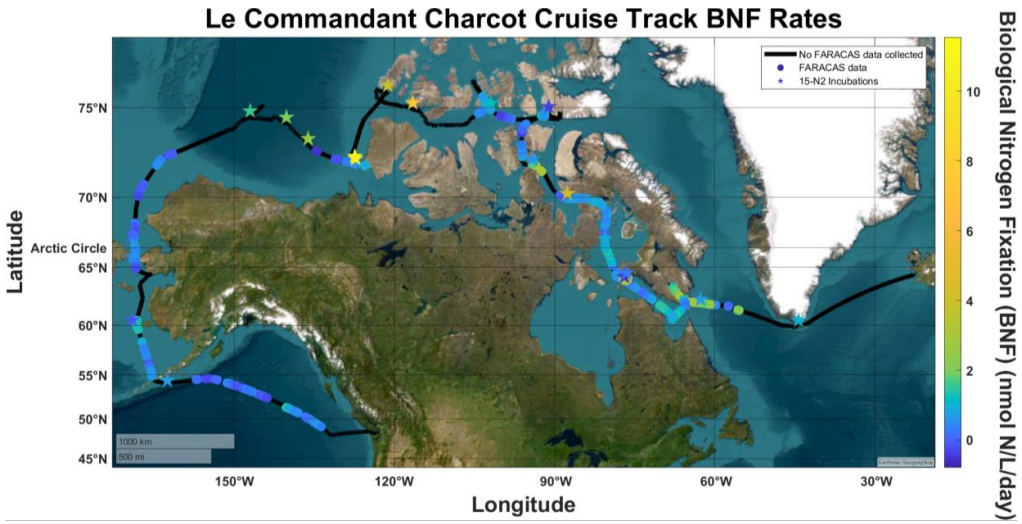
Atlantic Ocean, 2015 and 2016



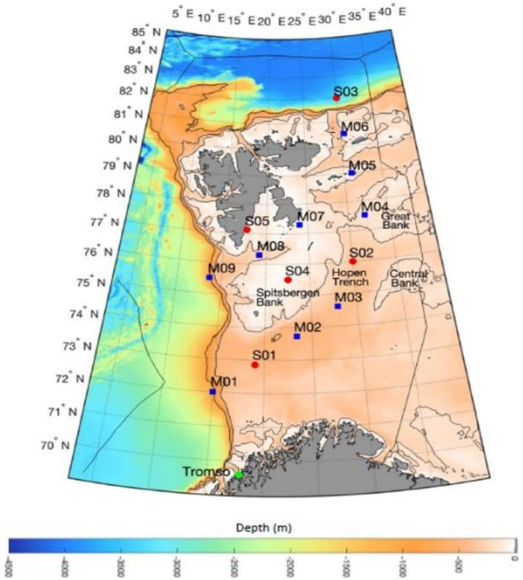
Indian Ocean, 2022



Northwest Passage, 2022

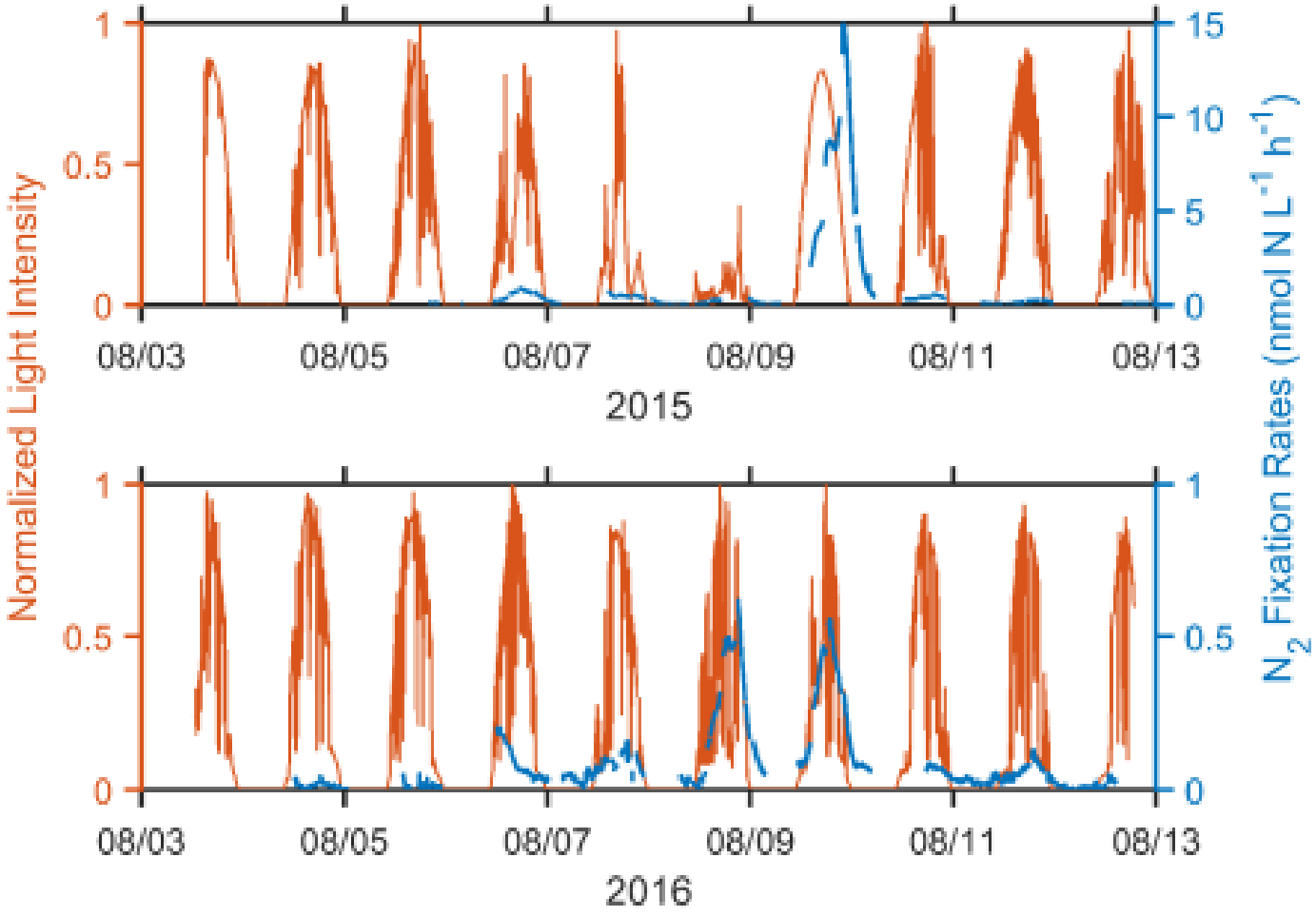


Barents Sea, 2023



(no data from this one yet!)

North Atlantic Ocean (2015 and 2016)



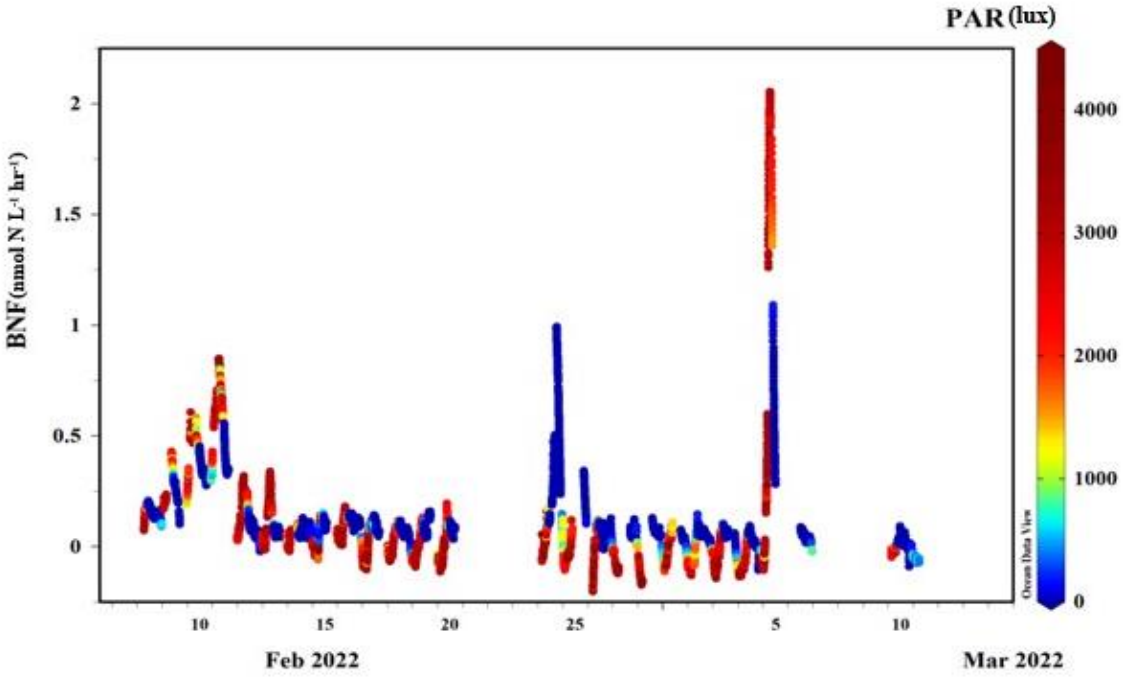
BNF over two North Atlantic cruises

General ideas from visual analysis:

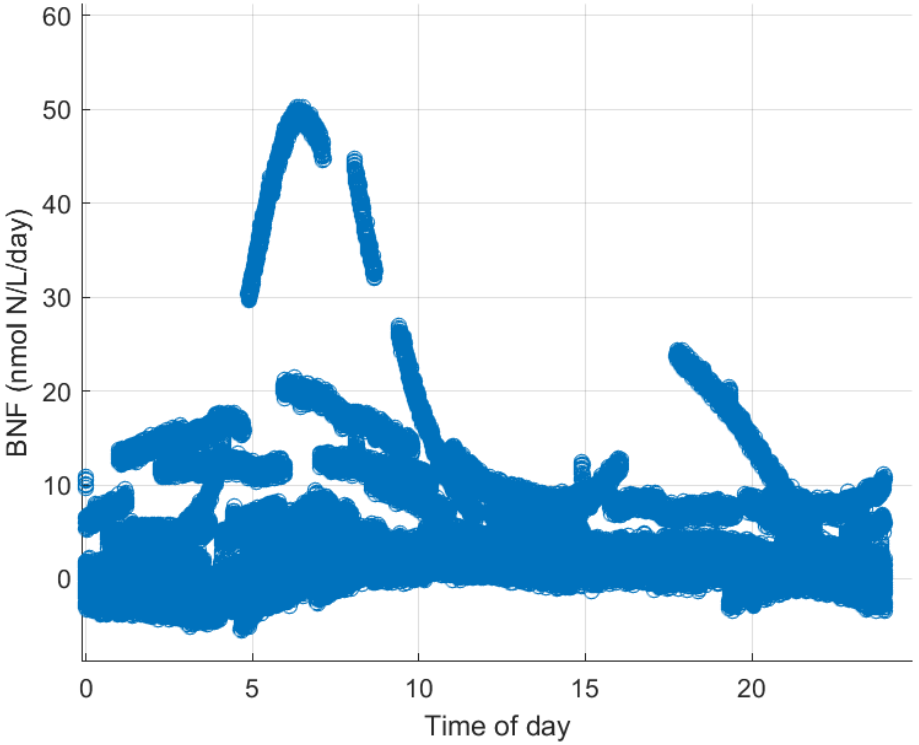
- Higher rates of BNF during high light intensity
- Lower rates of BNF during low light intensity

Tang et al, 2019

Indian Ocean (February -March 2022)



BNF in umol N/L*hour. Color bar demonstrates Photosynthetically Active Radiation (PAR)

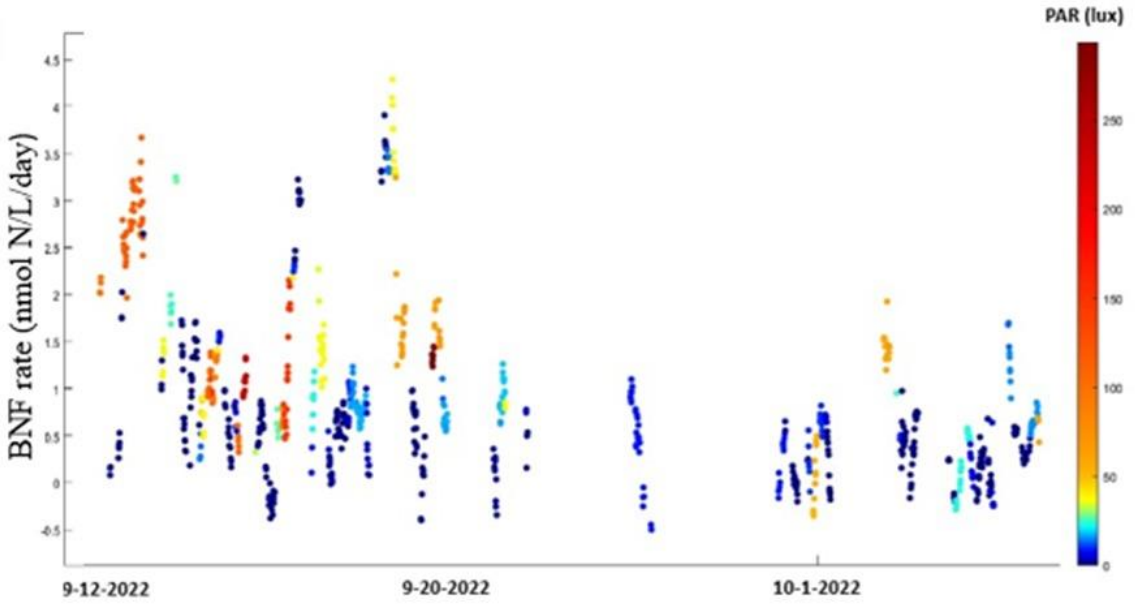


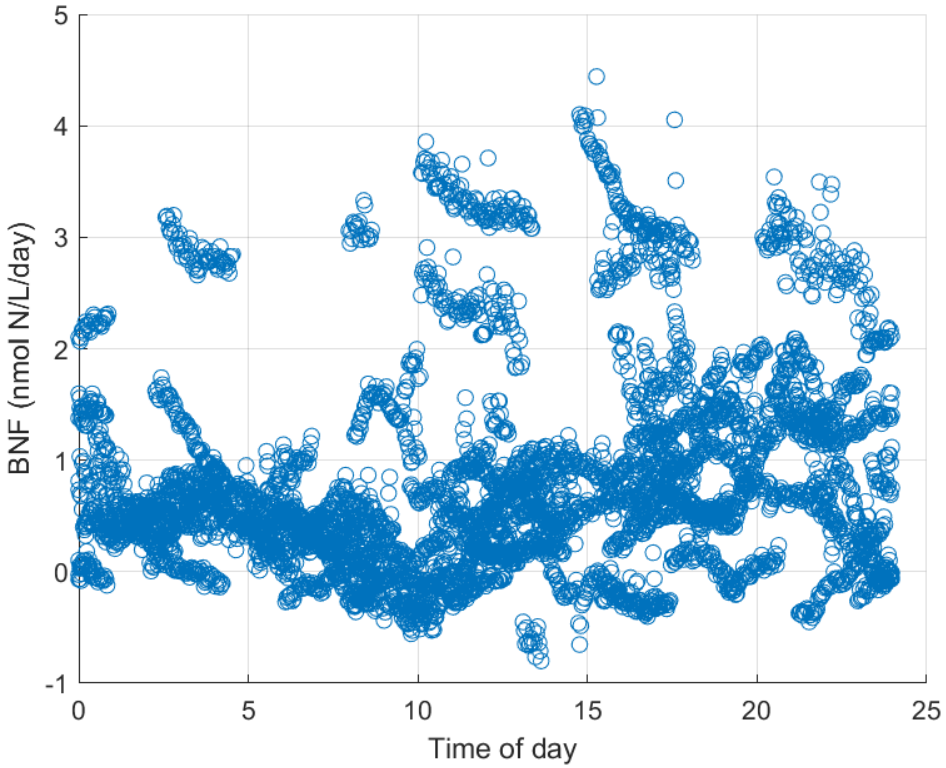
General ideas from visual analysis:

- Higher rates of BNF during low light intensity
- Lower rates of BNF during high light intensity

de Souza et al., in prep

Northwest Passage (September – October 2023)





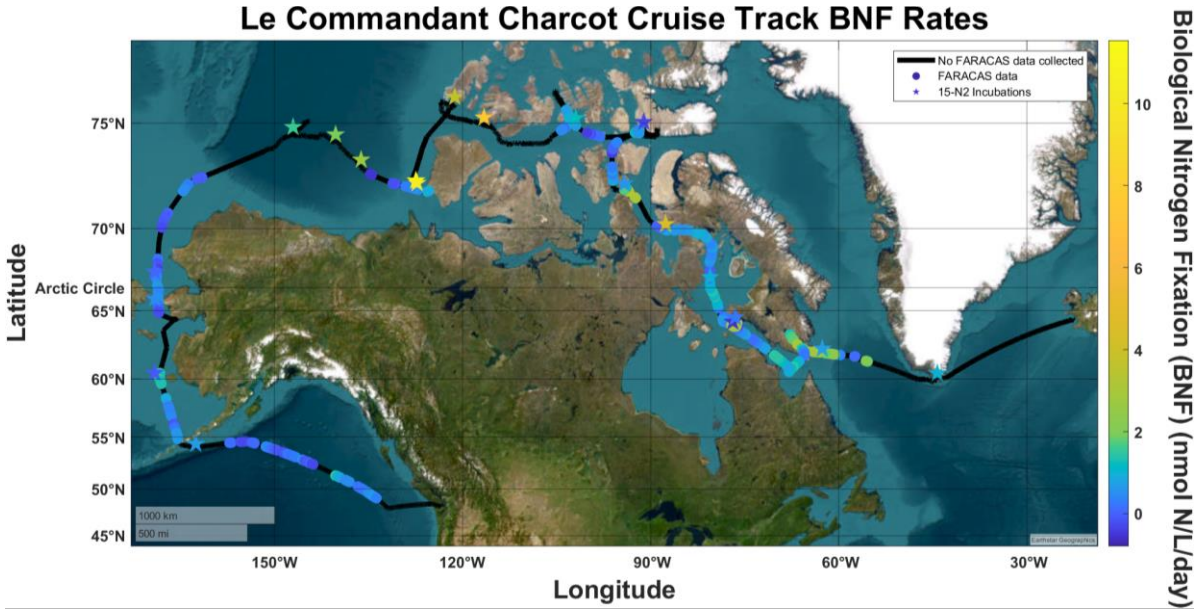
General ideas from visual analysis:

- Higher rates of BNF during high light intensity
- Lower rates of BNF during low light intensity

de Souza et al., in prep

My question for all of you!

What would be the best method to quantify periodicity in these time series?



There are many confounding factors that also could affect BNF

- Light
- Temperature
- Salinity
- Metals and other nutrients
- Proximity to coastline

But I'd like to just focus on light

Additionally, within a dataset, there might be times where periodicity is more significant than others – can I measure that?

Preliminary Ideas

Periodogram Analysis

Autocorrelation

Harmonic Analysis

Lomb-Scargle periodogram

Discrete Wavelet Transform

Fourier Transform