

A satellite image of the Canary Islands archipelago in the Atlantic Ocean. A large, yellowish-brown dust plume is visible extending from the African continent towards the islands. The text is overlaid on the image.

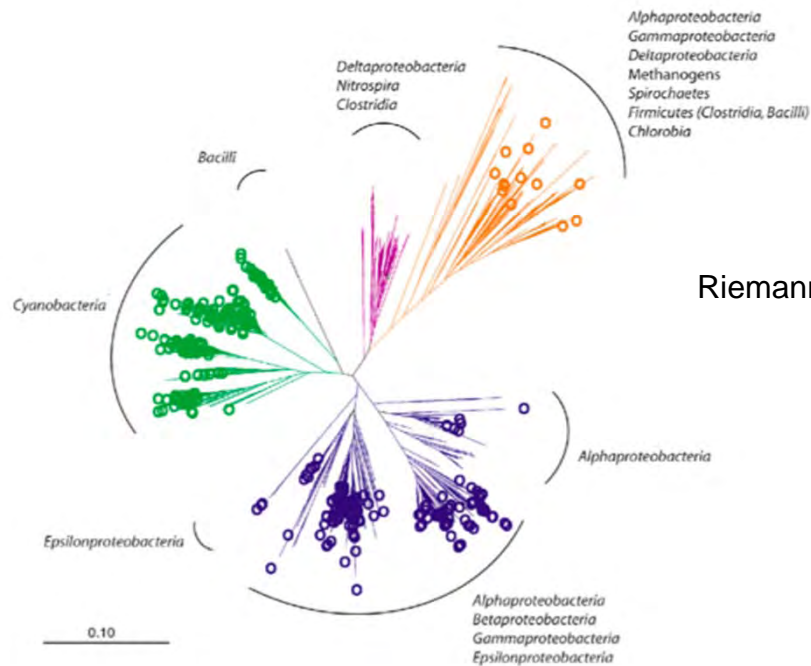
**Enhancement of nitrogen fixation rates by unicellular  
diazotrophs versus *Trichodesmium* after a dust  
deposition event in the Canary Islands**

**Mar Benavides**

# Introduction

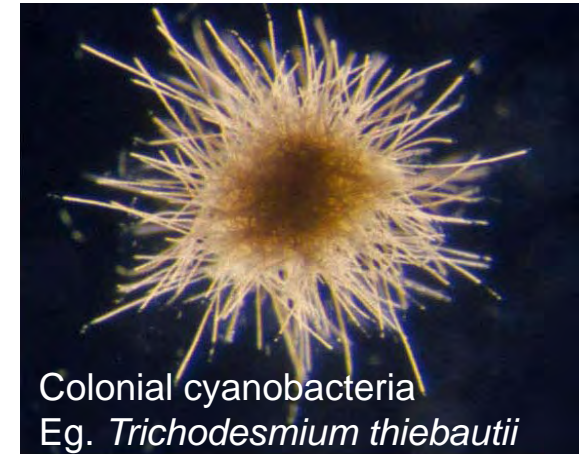
- Reduction of atmospheric nitrogen to ammonium  $N_2 \rightarrow NH_4^+$
- Diazotrophic organisms (diazo = nitrogen, trophykos = nutrition)

## Cyanobacteria, Bacteria, Archaea

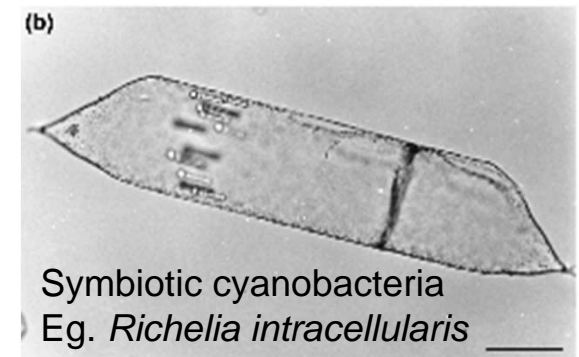


Riemann et al., 2010

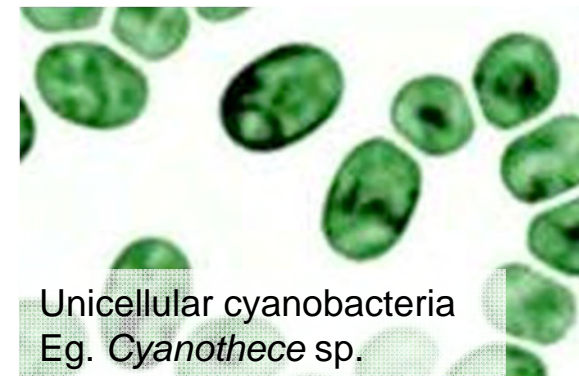
- $N_2$  fixation fuels up to 50% of open ocean primary production (Capone et al., 2005)
- Nitrogenase  $\rightarrow$  *nifH* gene
- Diazotrophs limited by Fe and P



Colonial cyanobacteria  
Eg. *Trichodesmium thiebautii*



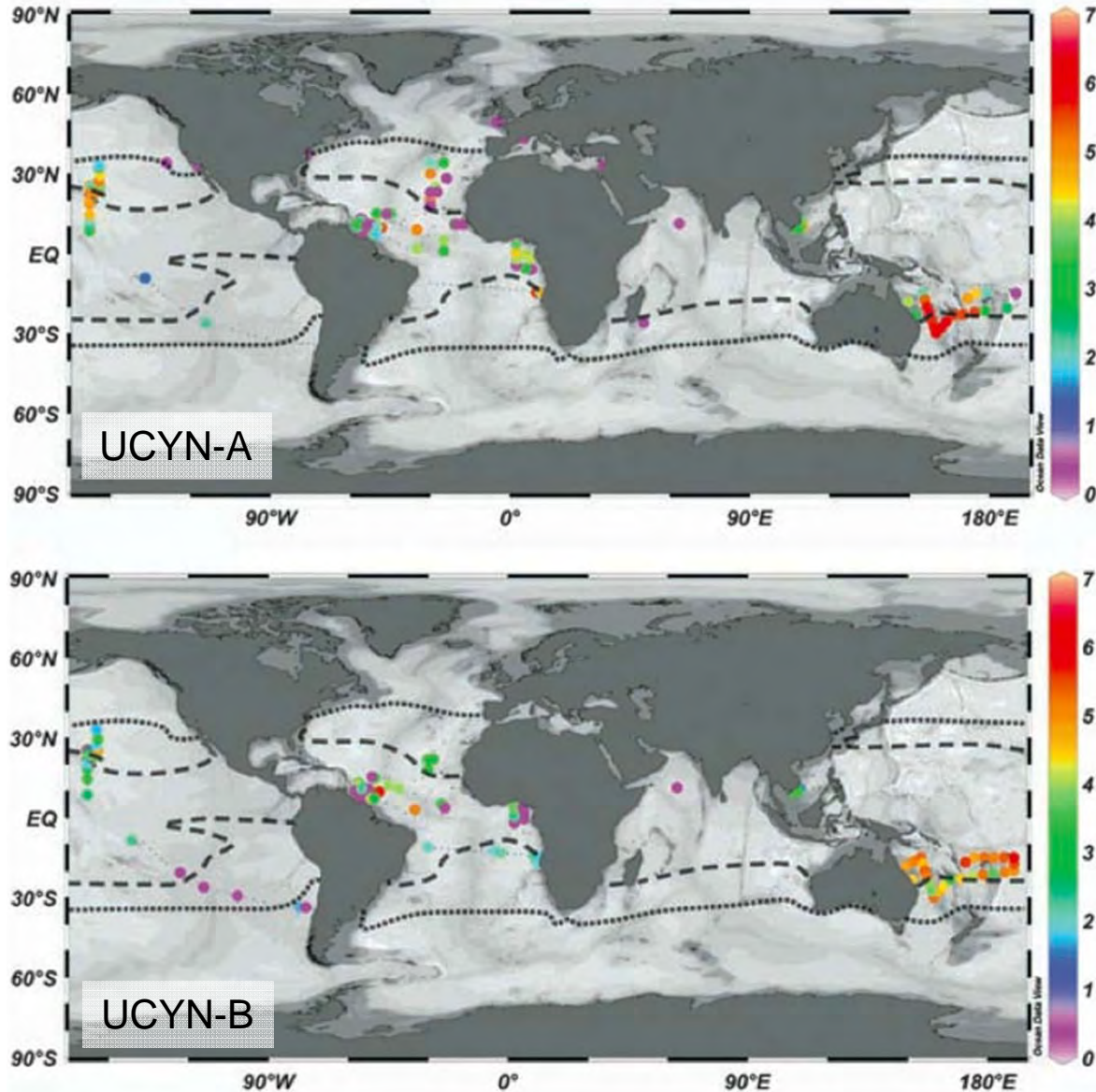
Symbiotic cyanobacteria  
Eg. *Richelia intracellularis*



Unicellular cyanobacteria  
Eg. *Cyanothece* sp.



## The importance of unicellular diazotrophs



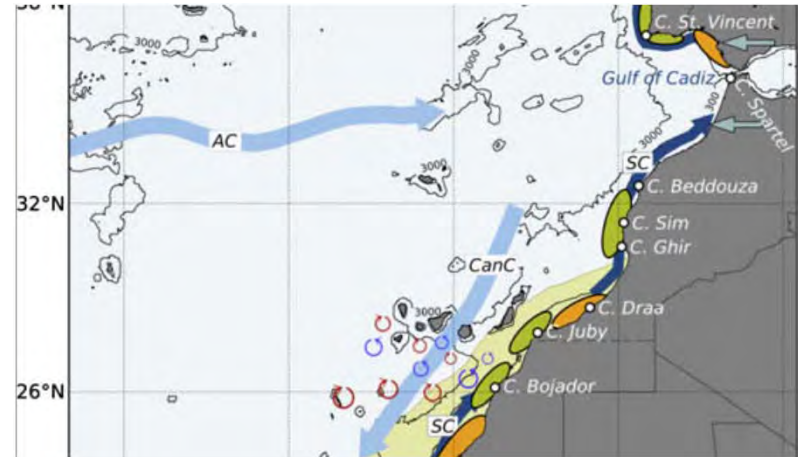
- *Trichodesmium* only appears in tropical and subtropical areas

- Wide distribution of the *nifH* gene but...

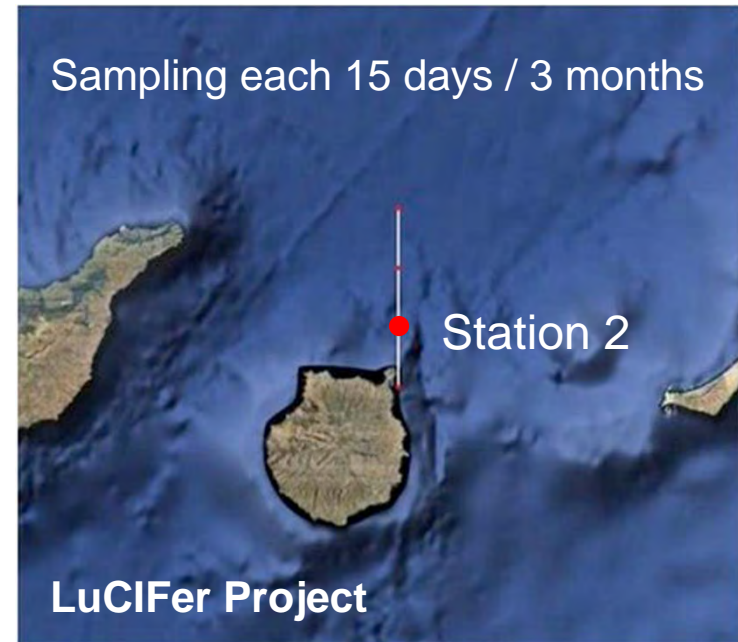
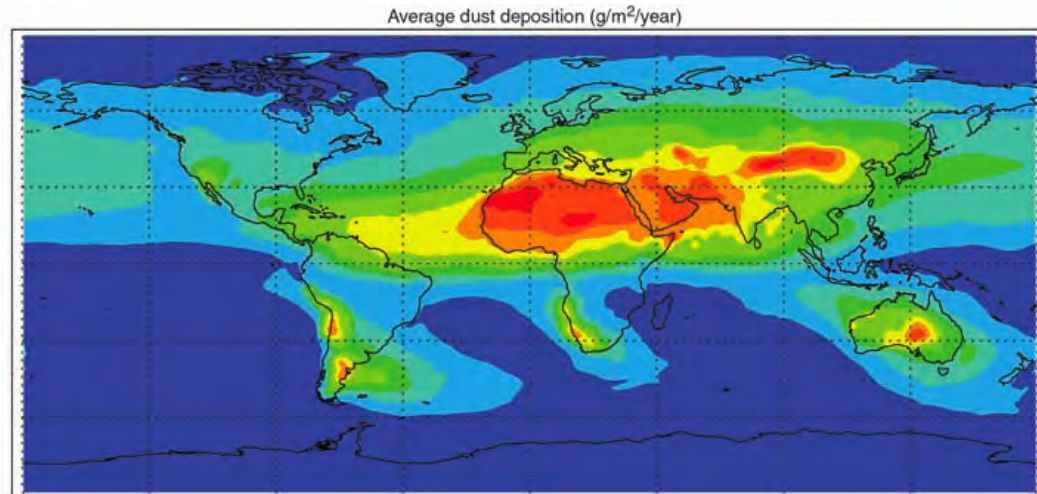
- Lack of N<sub>2</sub> fixation data

## Canary Current

- Strong surface heating throughout the year
- Quasi-permanent thermocline → oligotrophic waters
- Mixing January-March → *'late winter bloom'*
- Dust deposition → P and Fe



Arístegui et al., 2009



## *Objectives*



- Short-term variability of N<sub>2</sub> fixation activity in Canary Current waters
- Influence of Saharan dust deposition on diazotrophic activity and diversity

**N<sub>2</sub> fixation**

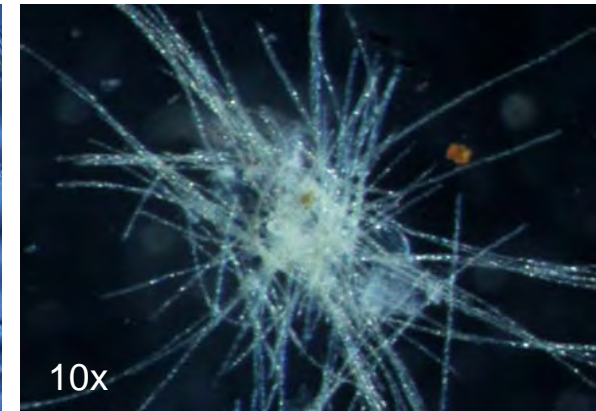
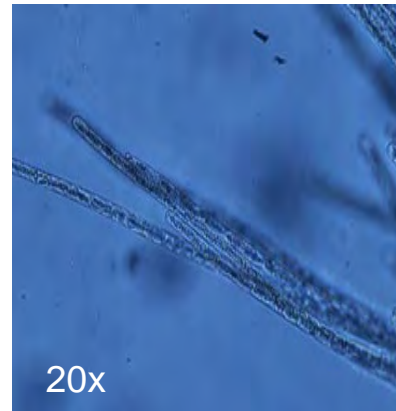
- Acetylene Reduction Assay (ARA) (Stal, 1988)



- Surface water (Niskin 30 L)
- On-deck incubations (light/dark)

**Abundance of *Trichodesmium* sp.**

- Plankton net 50  $\mu\text{m}$
- Vertical casts to 100 m
- ARA >50  $\mu\text{m}$

**>50  $\mu\text{m}$  N<sub>2</sub> fixation rates = *Trichodesmium* N<sub>2</sub> fixation rates**

- Correlations between >50  $\mu\text{m}$  N<sub>2</sub> fixation rates and *Trichodesmium* abundance

$$r^2=0.86 \text{ (light)} \quad r^2=0.69 \text{ (dark)} \quad p<0.05$$

**Surface seawater N<sub>2</sub> fixation rates = Unicellular diazotroph N<sub>2</sub> fixation rates**

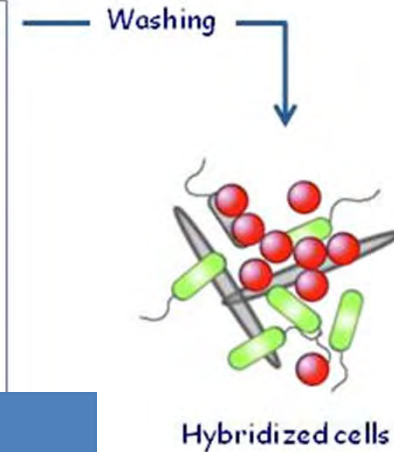
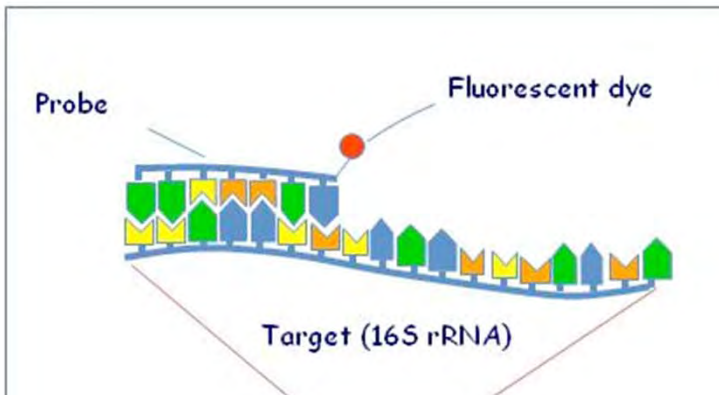
- Low probability of catching *Trichodesmium* with Niskin bottles when its abundance is low (Chang, 2000)



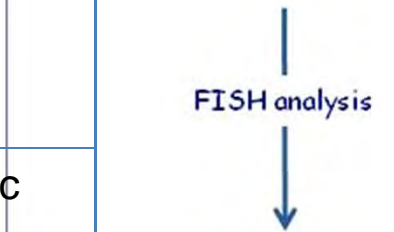
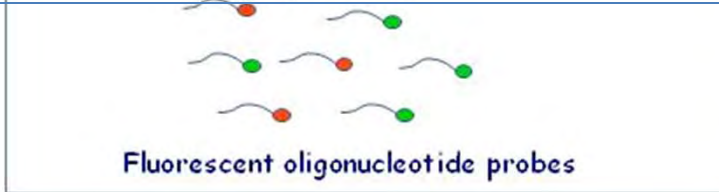
## Unicellular diazotroph abundance

### Tyramide Signal Amplification – Fluorescent In Situ Hybridization (TSA-FISH)

- Filtrate seawater on PC filters
- Probe Nitro821 → *nifH* gene
- Classification



Size	Type
<1 μm Small	Free living containing 16S rRNA Ribosome
>1 - <3 μm Medium	Attached to organic matter Cytoplasm, Nucleoid, Ribosomes, Plasmid 0.5 μm
>3 μm Large	Symbiont Cell wall, Cytoplasmic membrane



## Dust deposition and composition

- Aerosol Optical Depth → Giovanni NASA
- $PM_{10}$ ,  $PM_{2.5}$  → Gobierno de Canarias Calidad del Aire
- Metal analysis

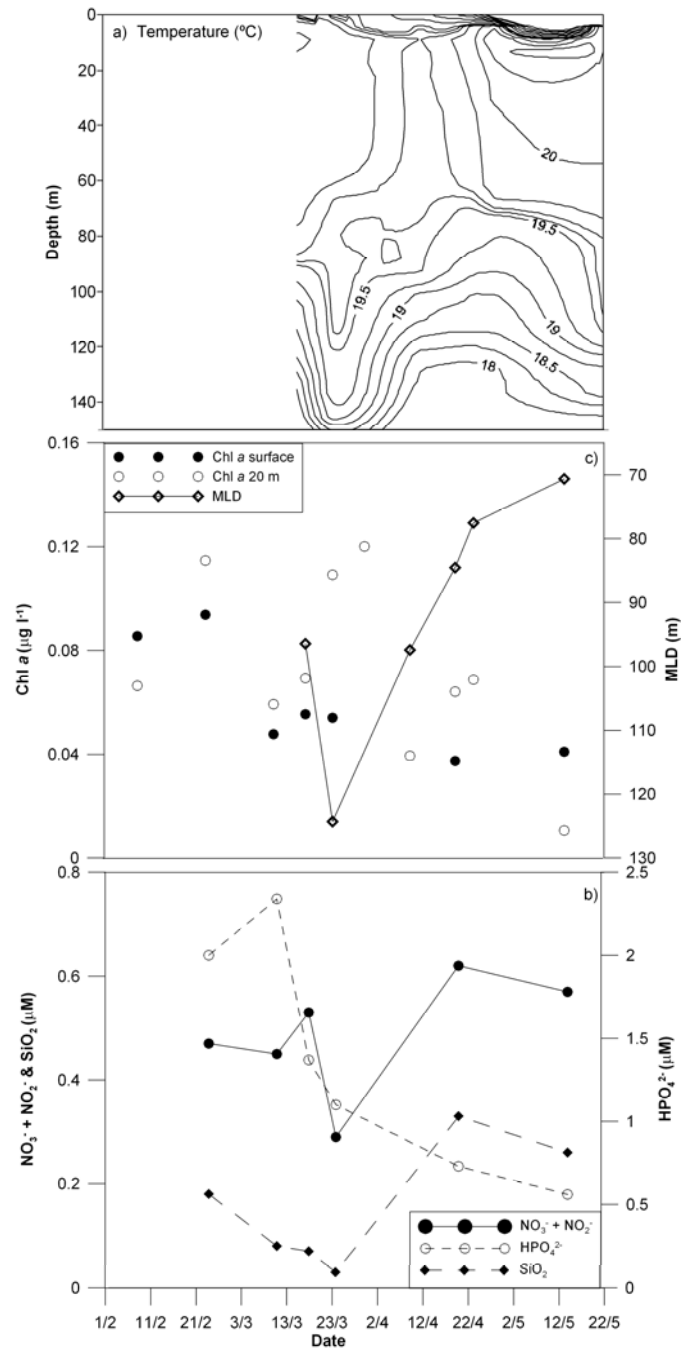
## Hydrography and Chl a

- CTD SBE 25
- Turner AU-10  
Fluorometer





## Results & Discussion



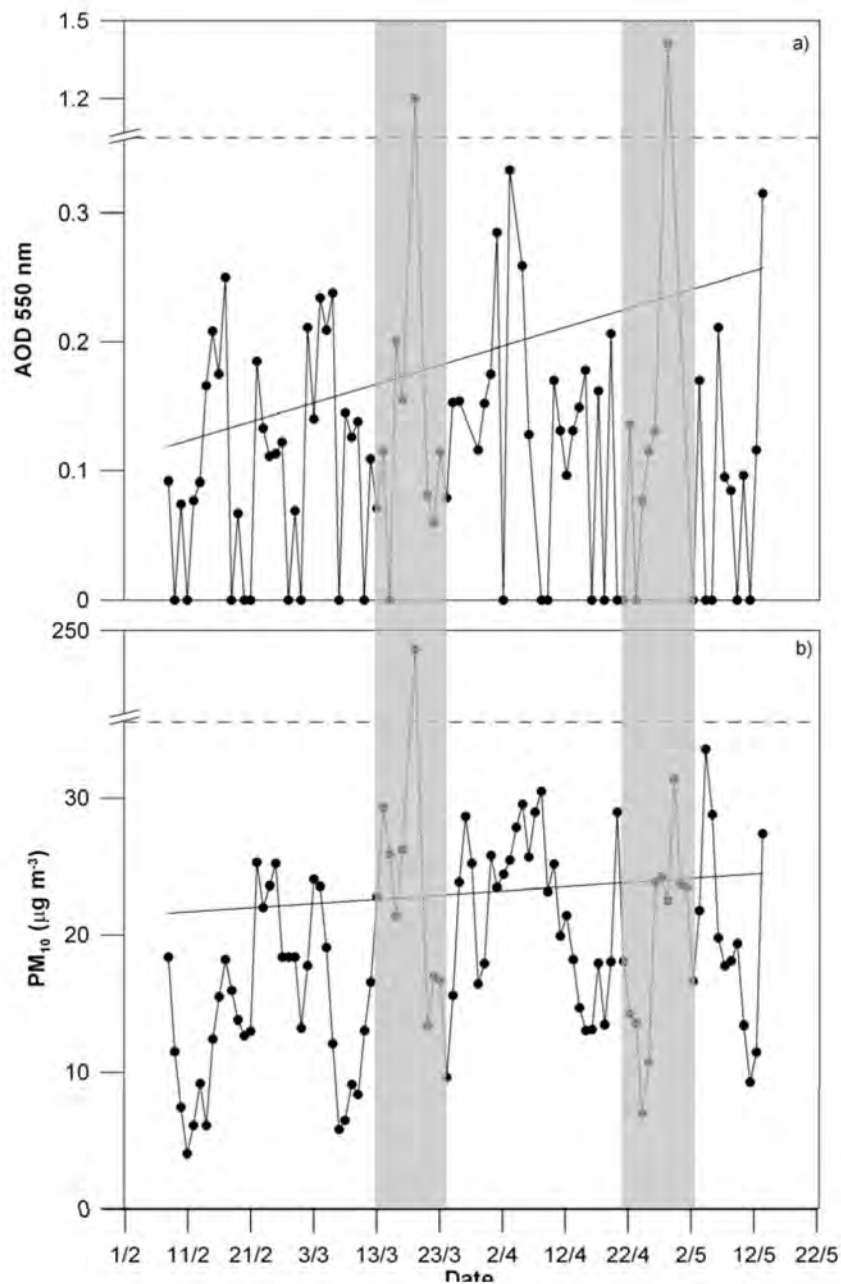
### Temperature, MLD, Chl a, nutrients

- Higher temperatures than previous years
- Stratification
- Lower Chl a
- Low nutrient concentrations

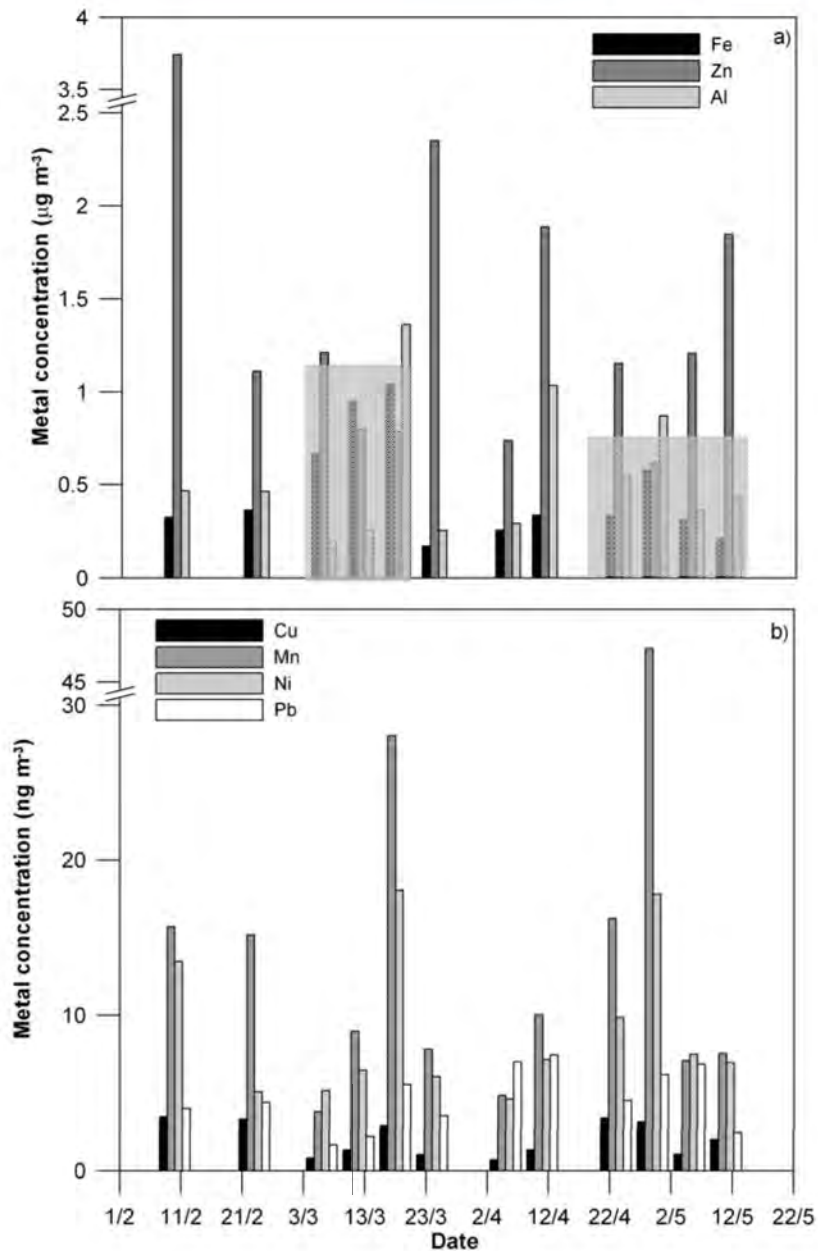
→ No clear 'late winter bloom'

# Results & Discussion

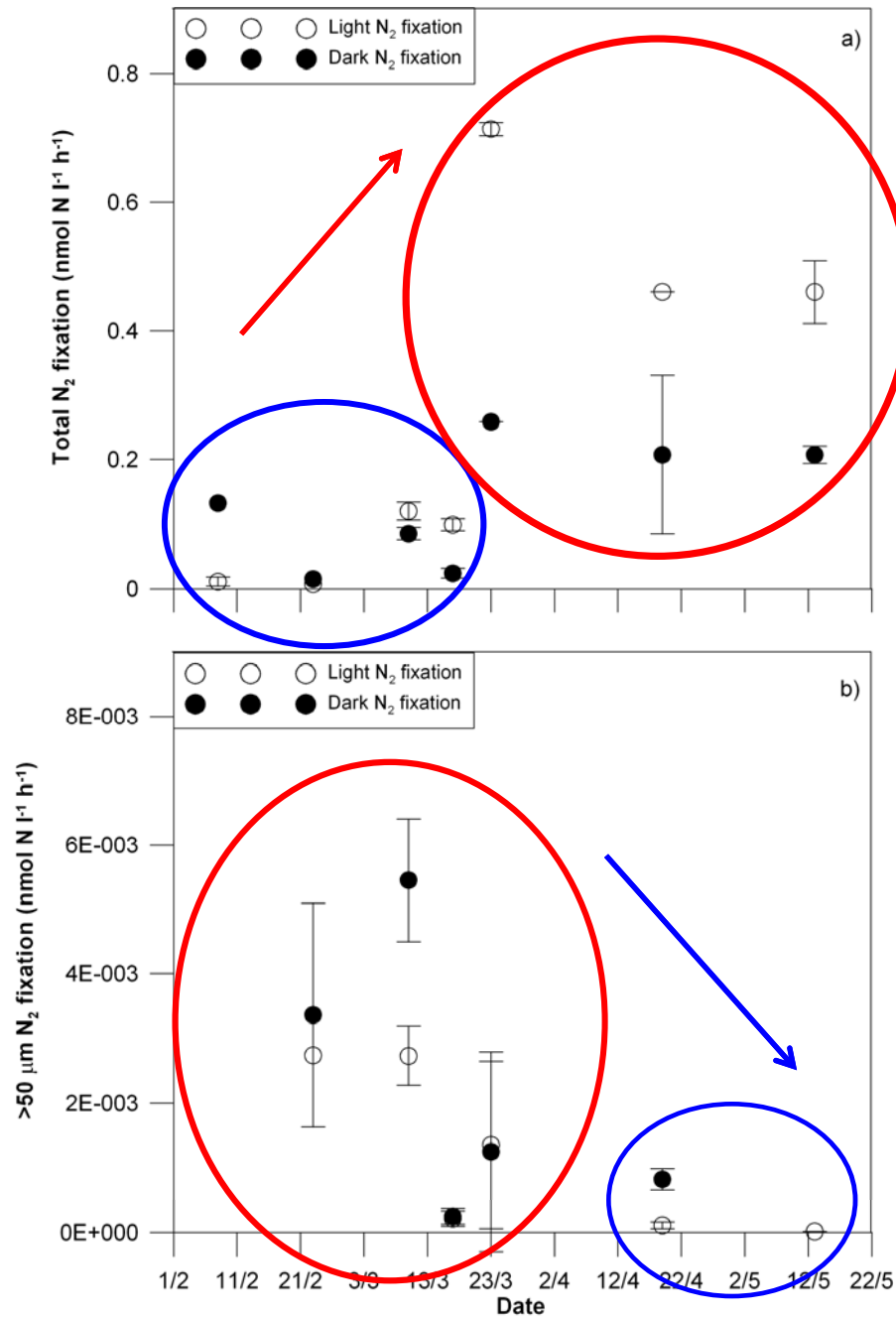
## Dust deposition



## Dust composition



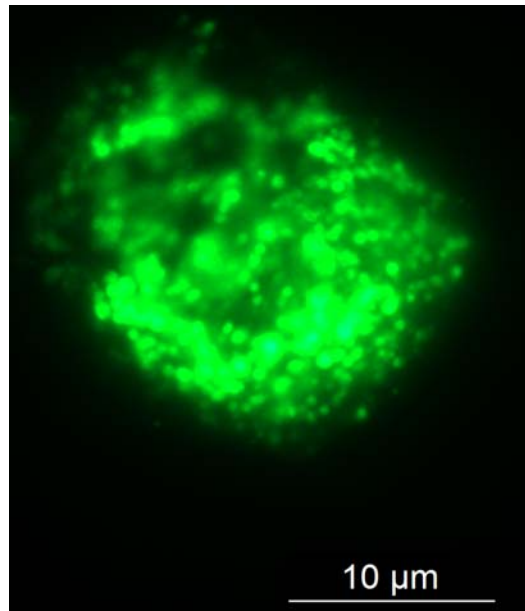
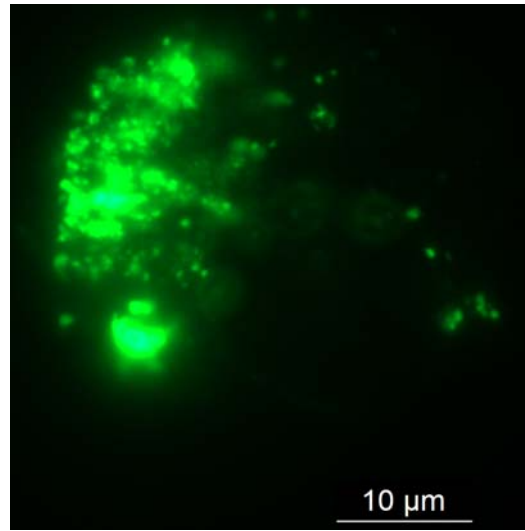
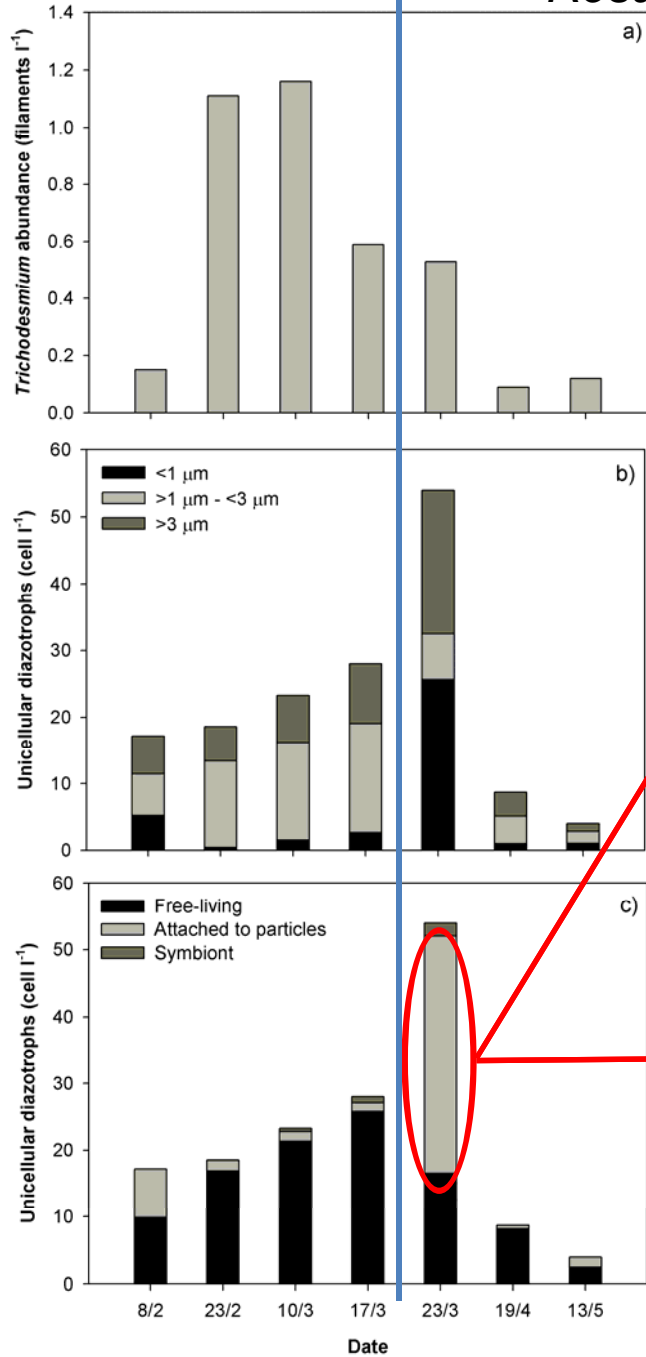
## Results & Discussion



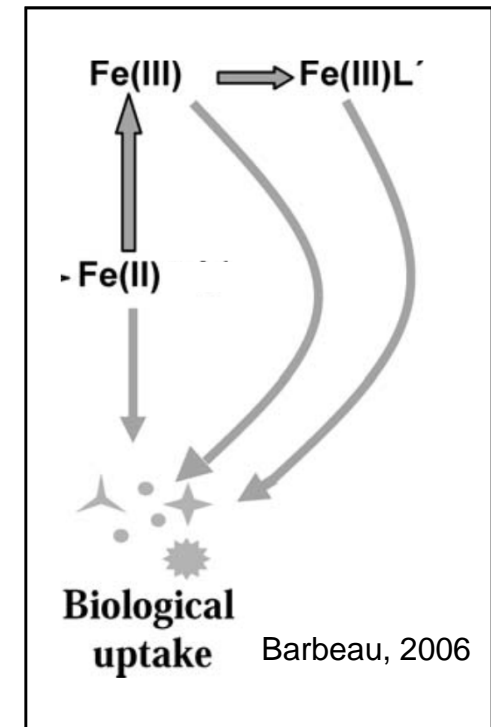
- Unicellular diazotrophs' N<sub>2</sub> fixation rates increase after the dust deposition event
- *Trichodesmium* N<sub>2</sub> fixation rates decrease after the dust deposition event



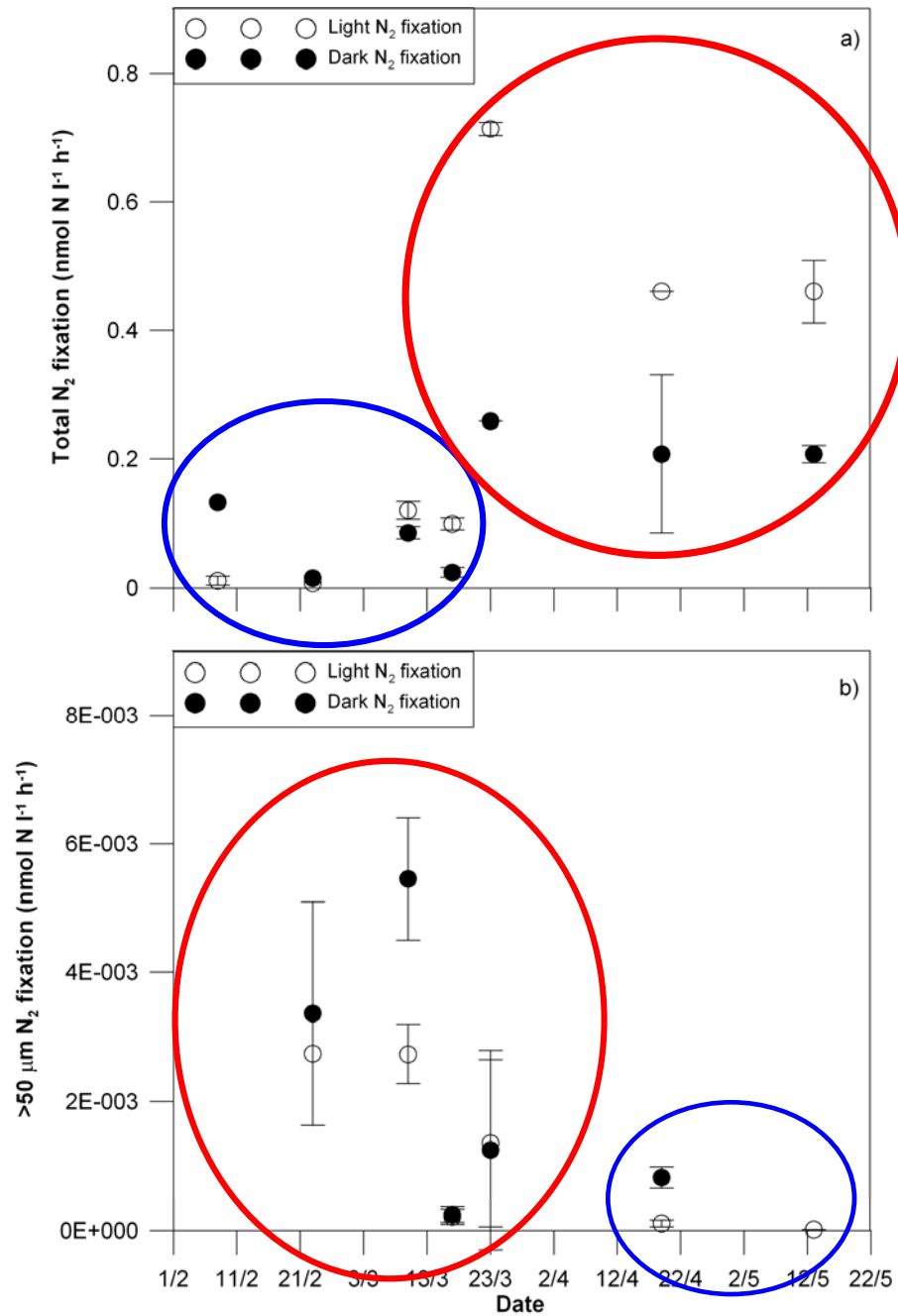
# Results & Discussion



**Unicellular diazotrophs complexed to organic matter particles**



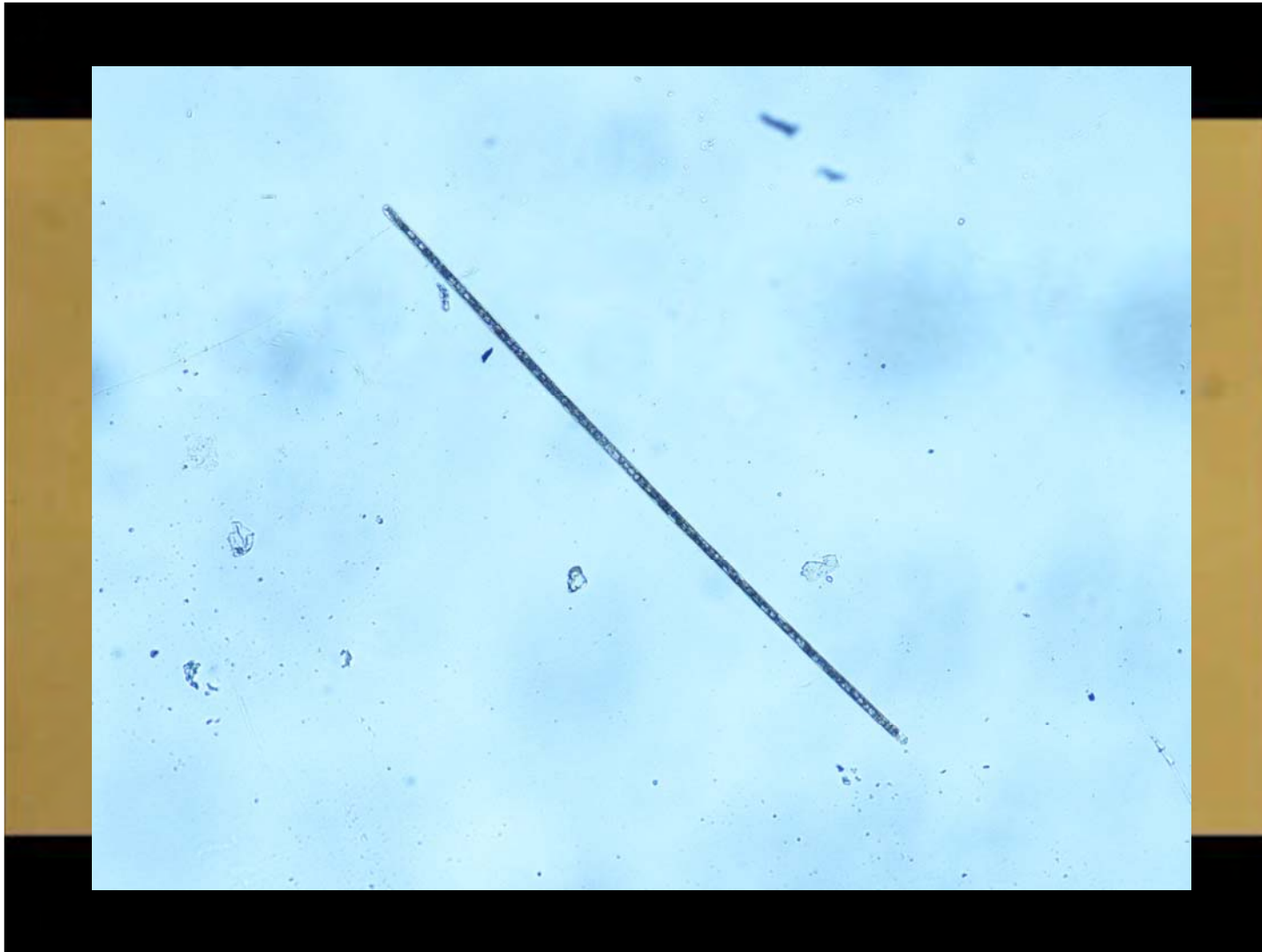
## Results & Discussion



- *Trichodesmium* N<sub>2</sub> fixation rates decrease after the dust deposition event

## Results & Discussion

- *Trichodesmium* colonies can take advantage of dust particles
- Free *Trichodesmium* filaments cannot





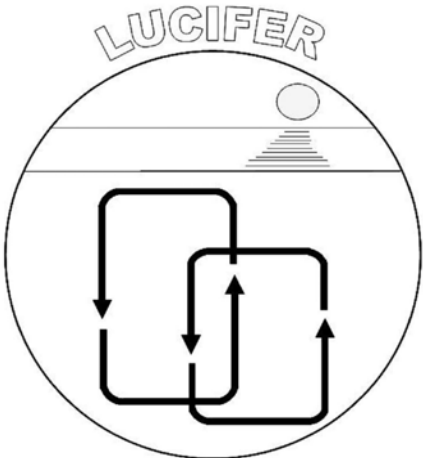
## Conclusions



- Dust deposition enhances unicellular diazotrophs' N<sub>2</sub> fixation rates when they are attached to organic matter particles
- Free *Trichodesmium* filaments do not seem to be able to uptake the Fe in atmospheric dust
- N<sub>2</sub> fixation rates may change greatly in short-term periods: importance of monitoring programmes



**Gracias!**



**Ciclo de Ciencia**  
**Compartida**

