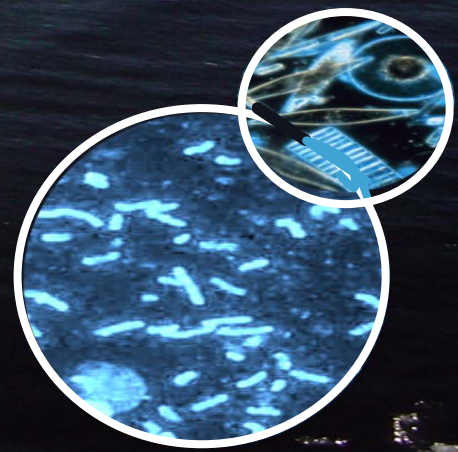
Effects of increasing UV radiation on Arctic phyto- and bacterioplankton biogeochemical activity



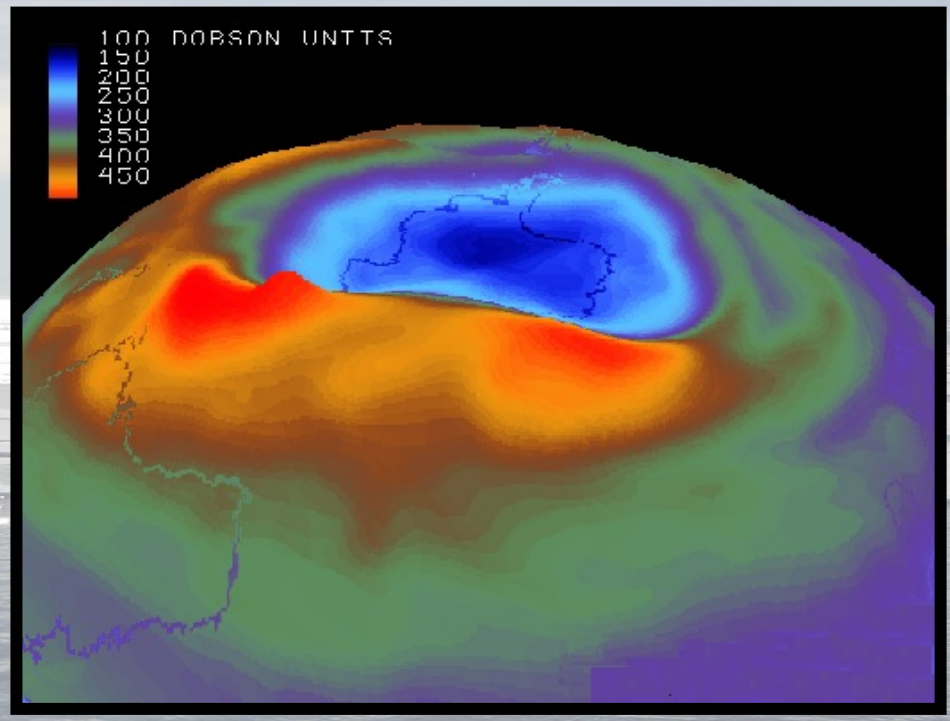
Clara Ruiz-González, Martí Galí, Josep M Gasol & Rafel Simó

Institut de Ciències del Mar (Barcelona, Spain)

Ozone depletion

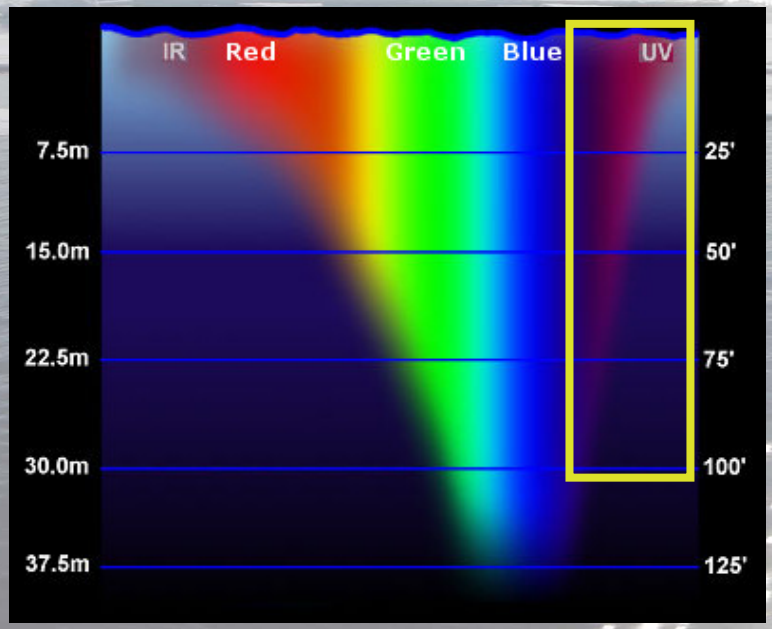
Reduction of Arctic and Antarctic ice cover

Higher doses of UVR in polar regions



UVR (280-400nm) affects microbial activity through:

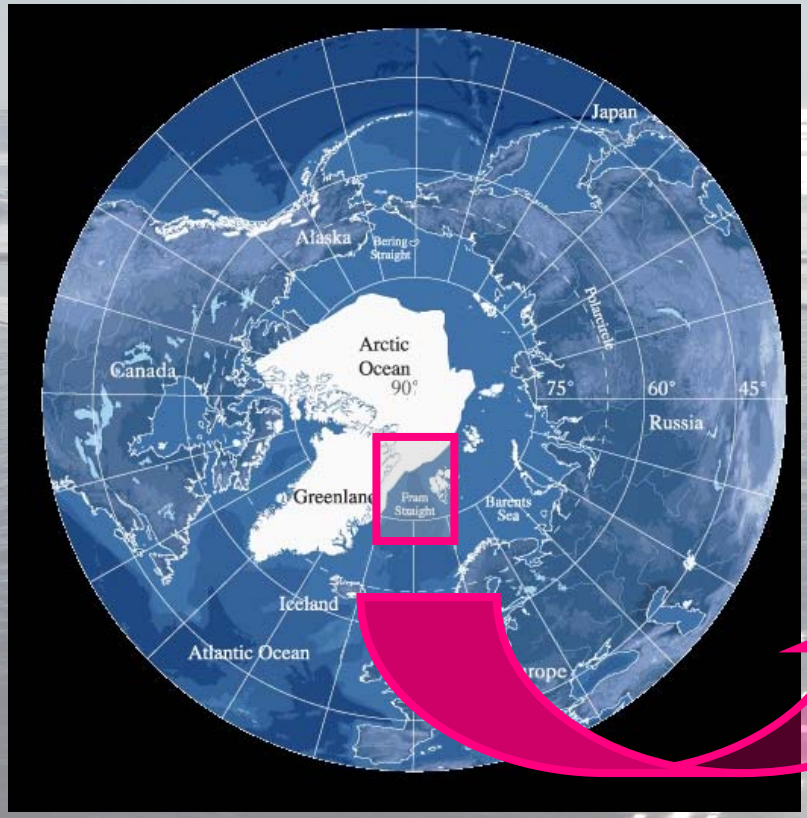
- Photochemical transformations of DOM
- Cellular damage

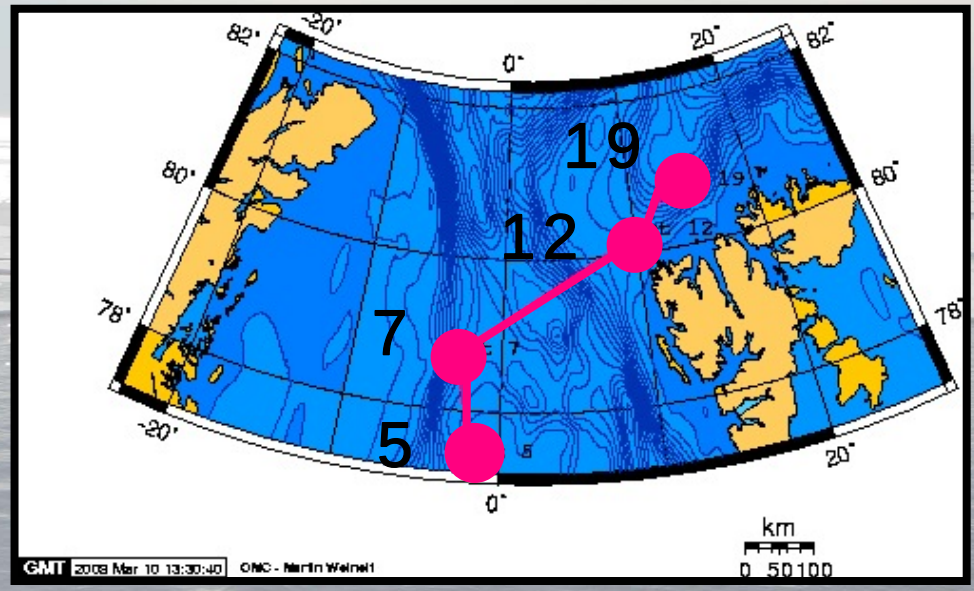


Direct damage	Indirect damage
Direct absortion by biological molecules	Formation of reactive oxigen species or free radicals

Marine bacteria are among the groups of plankton more susceptible to sunlight damage!

AIM: Determine the role of natural sunlight on Arctic phyto- and bacterioplankton biogeochemical activity





ATOS project

July, 2007

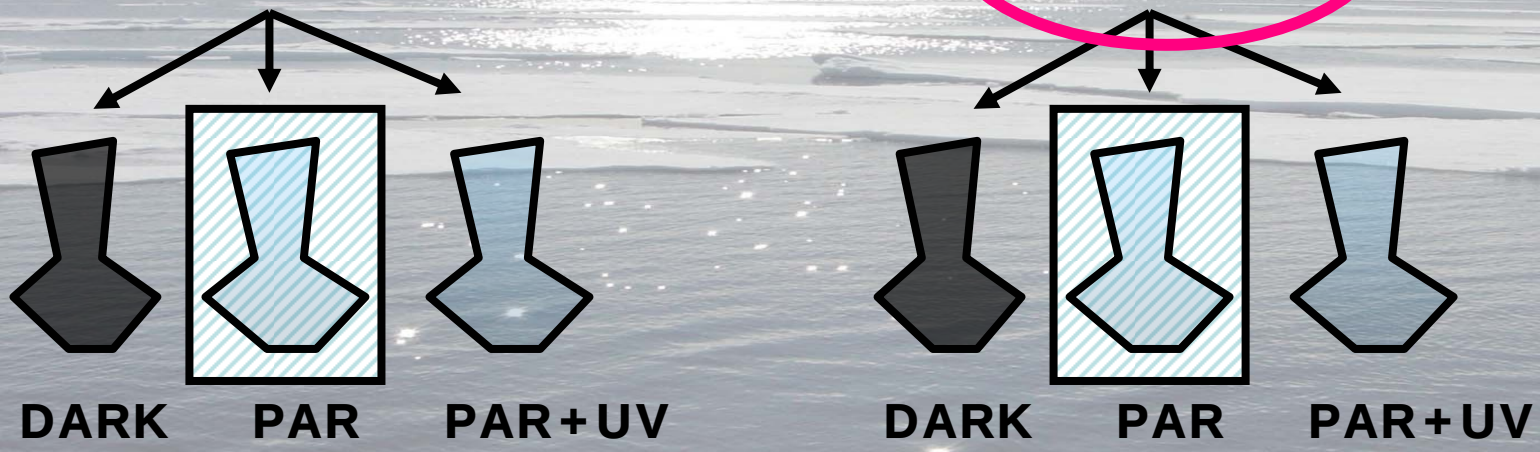
AIM: Determine the role of natural sunlight on Arctic phyto- and bacterioplankton biogeochemical activity

C and **N** source

^{3}H-leucine

S source

^{35}S-DMSP

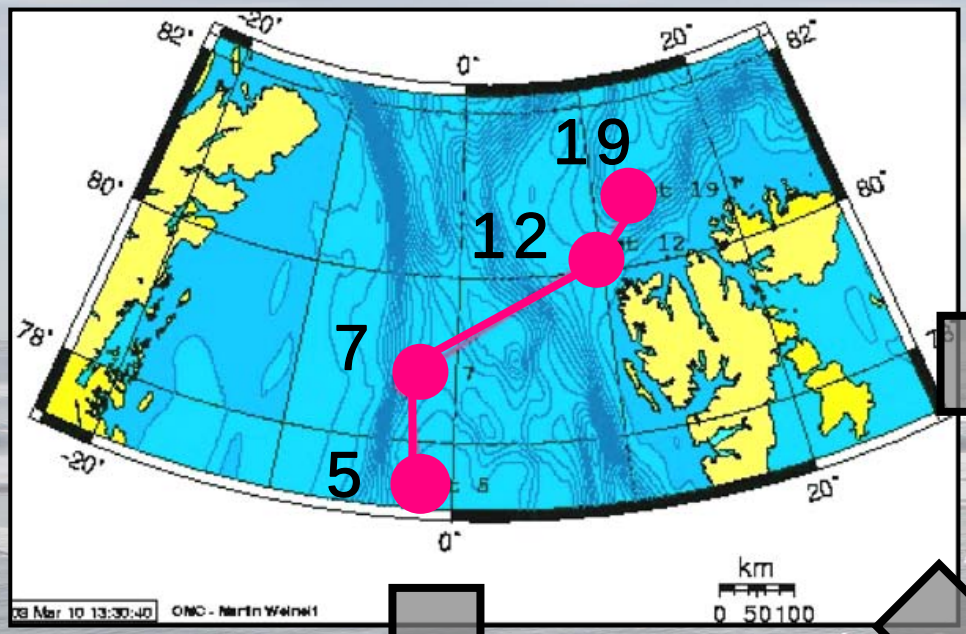


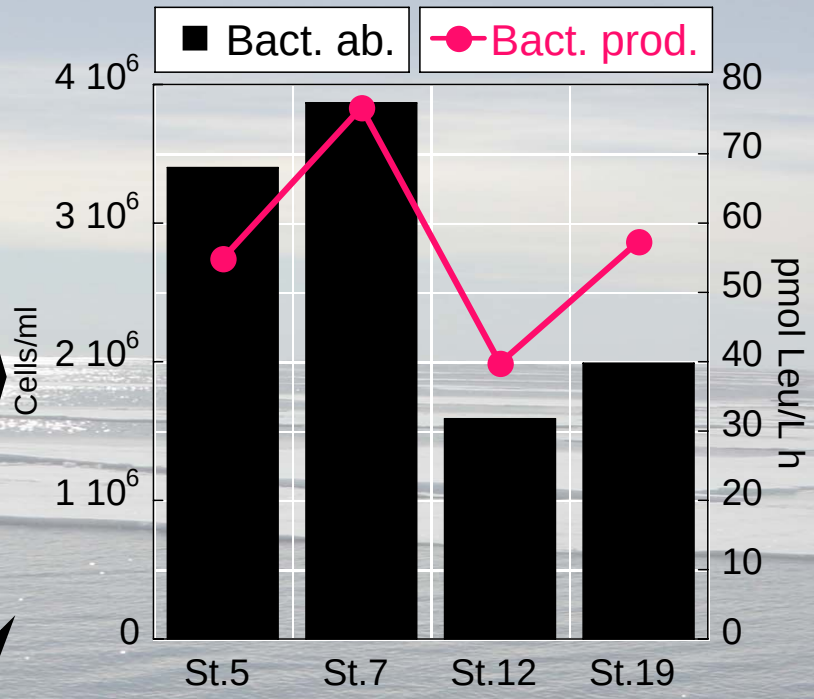
Bacterial production

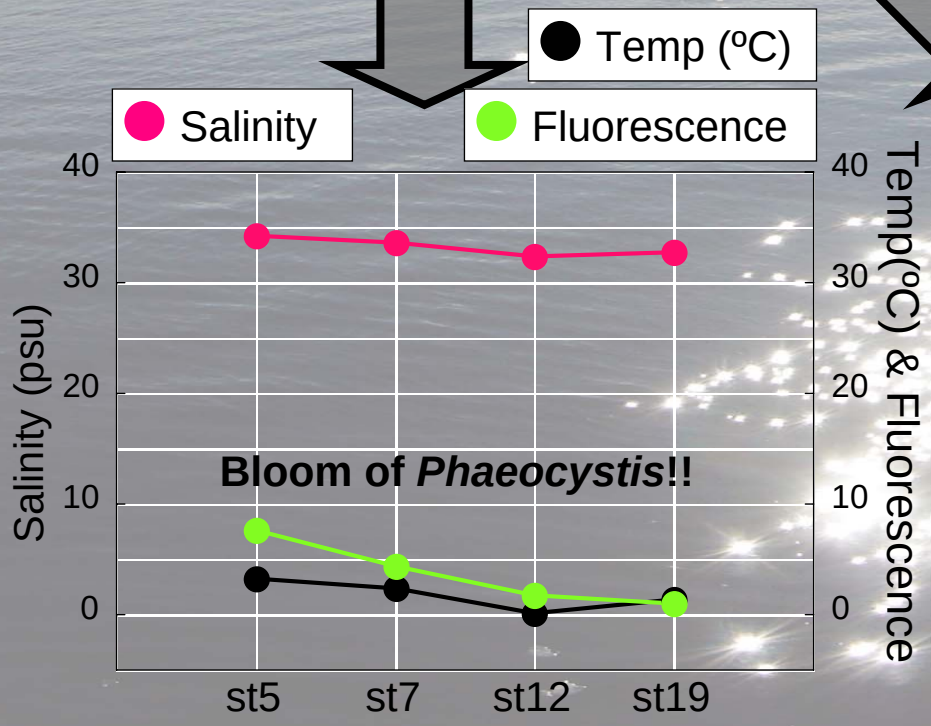
Bacterial abundance

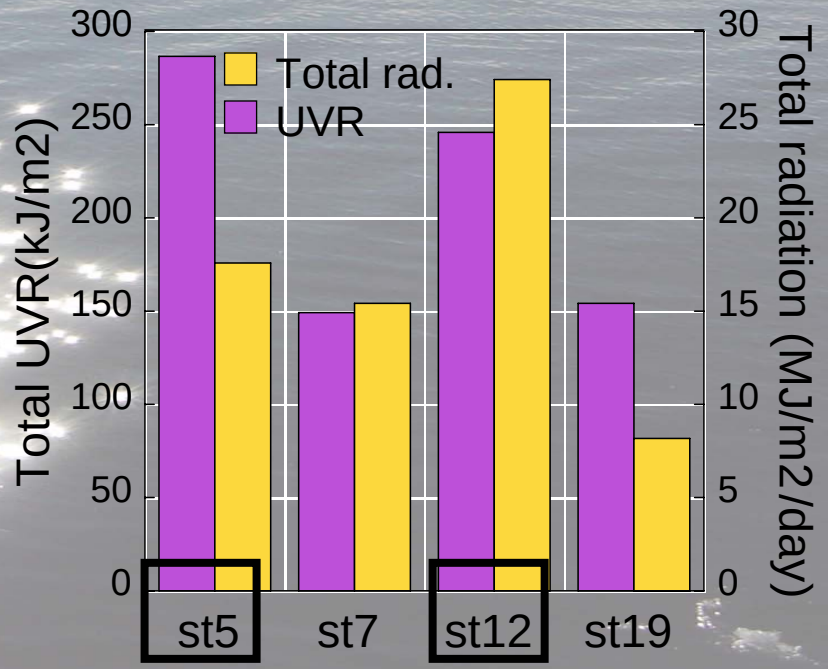
Size fractionated assimilation

MAR-FISH


19
12
7
5
km
0 50 100


Bact. ab.
Bact. prod.
Cells/ml
pmol Leu/L h
St.5
St.7
St.12
St.19

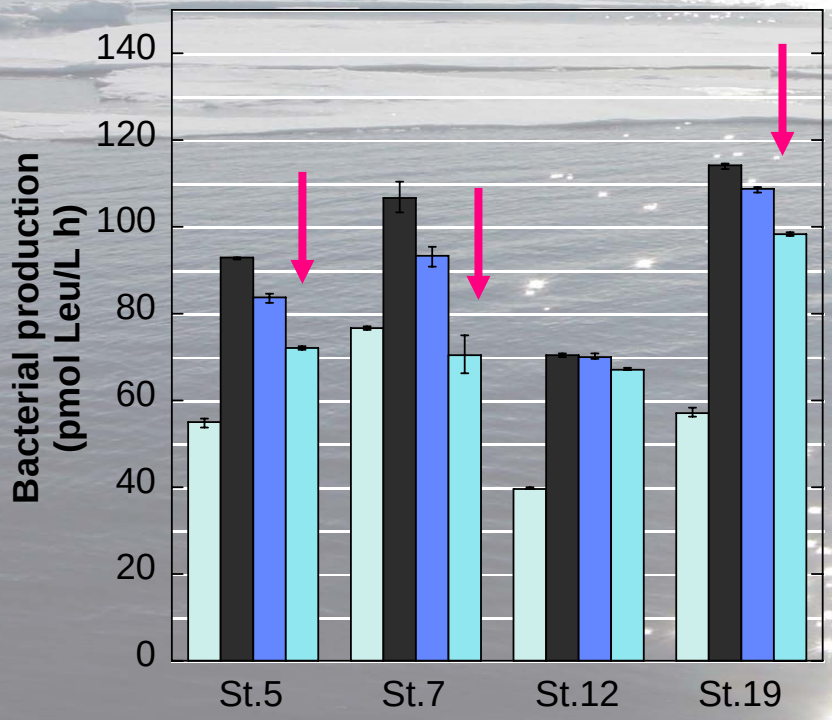

Salinity
Temp (ºC)
Fluorescence
Salinity (psu)
Temp(ºC) & Fluorescence
Bloom of *Phaeocystis*!!
st5
st7
st12
st19


Total rad.
UVR
Total UVR(kJ/m2)
Total radiation (MJ/m2/day)
st5
st7
st12
st19

Before and after 10 h exposure…

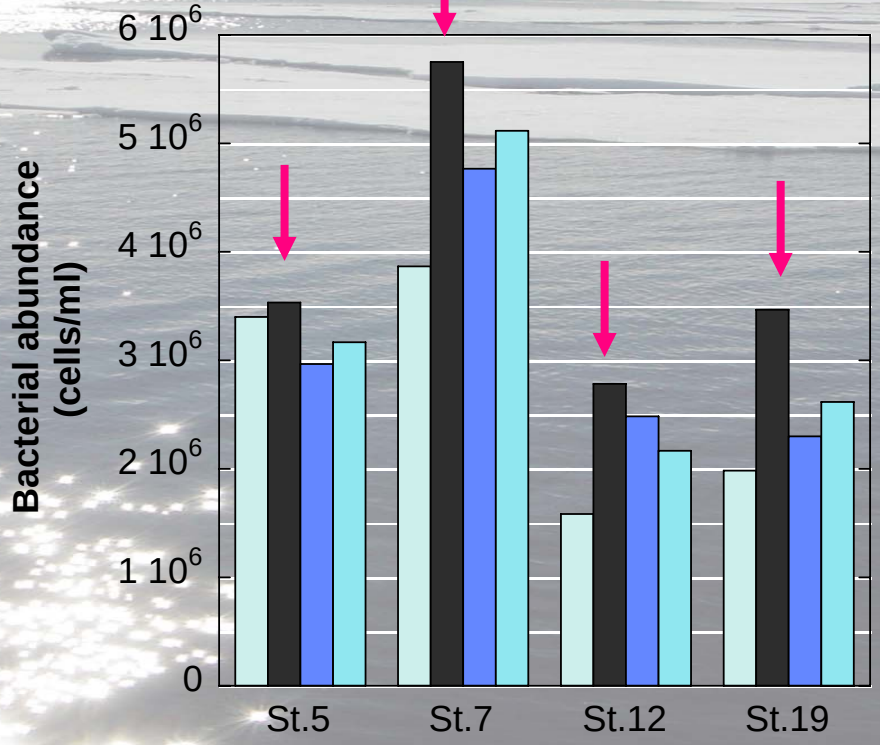
Time 0
DARK
PAR
FULL

Bact. production



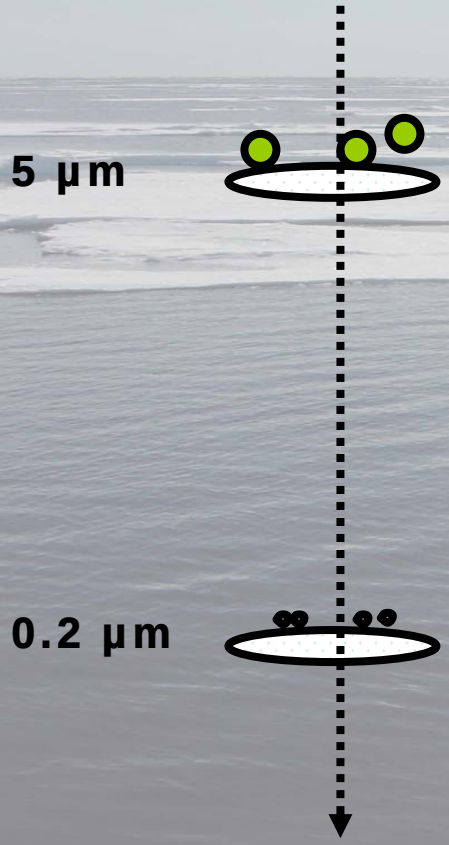
Higher inhibition after exposure to full light

Bact. abundance



Higher cell concentration after DARK incubation

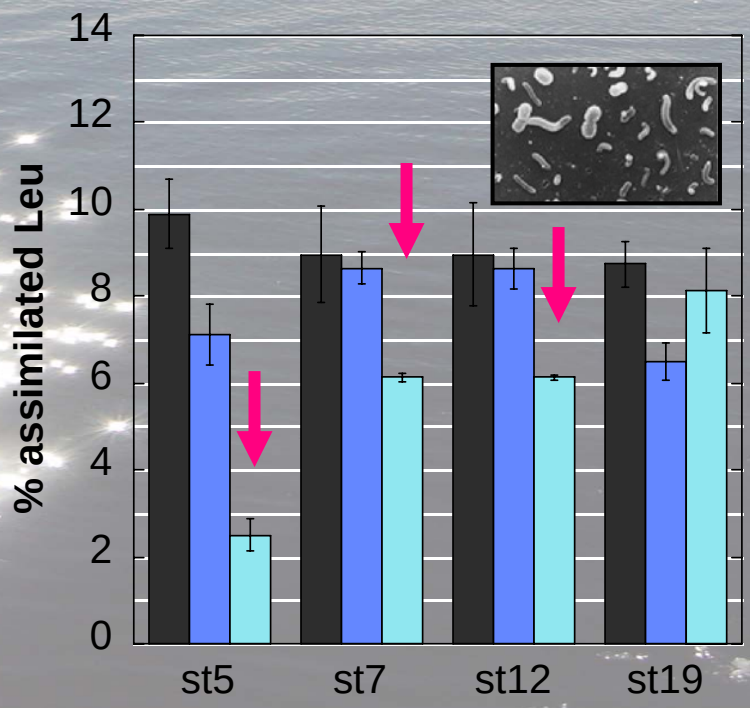
Size fractionated **leucine** assimilation



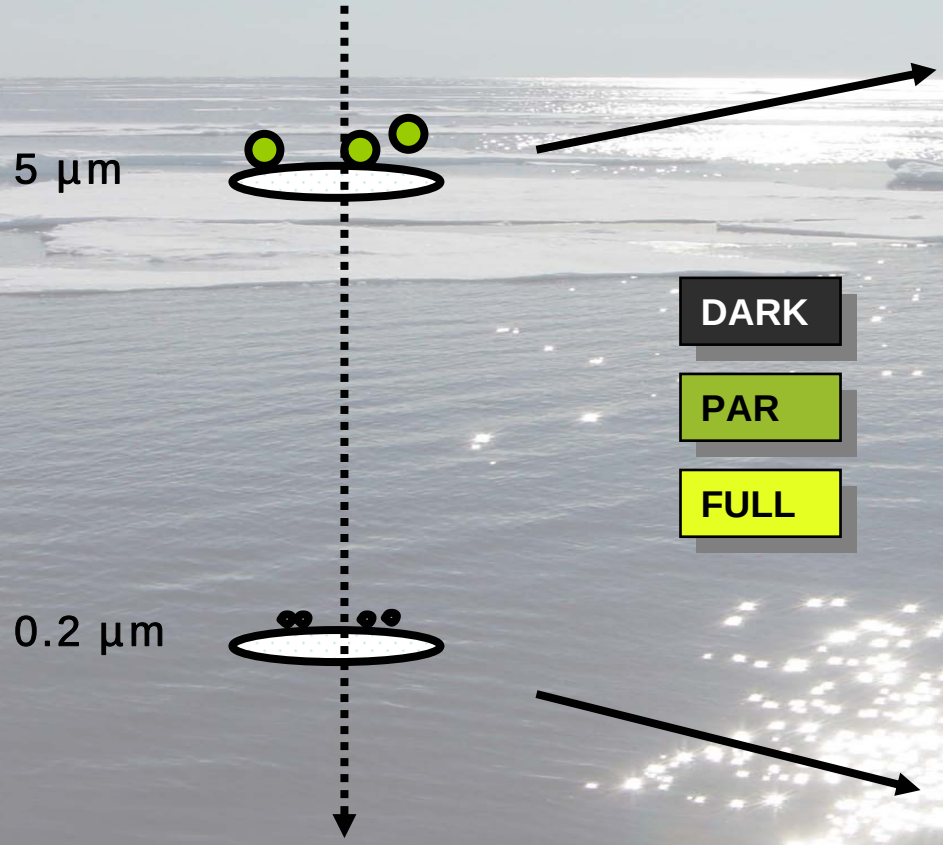
DARK

PAR

FULL



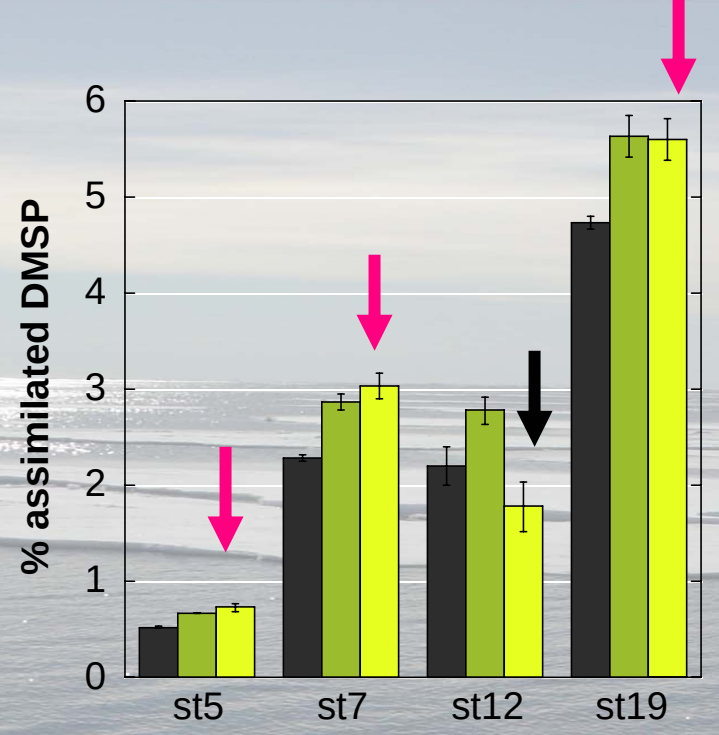
Size fractionated **DMSP** assimilation

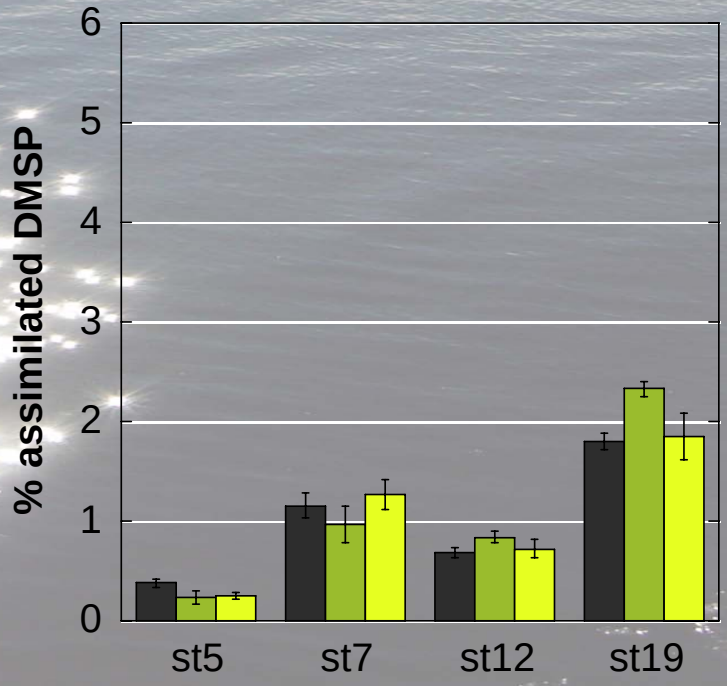


DARK

PAR

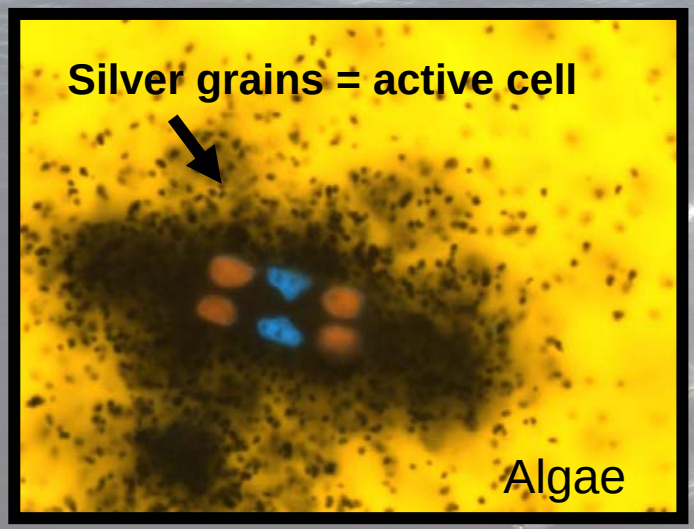
FULL





… What is going on at the **single cell level**?

MICROAUTORADIOGRAPHY: detection of single cells active in the uptake of one radiactive substrate by precipitation of silver grains from a photographic emulsion around them



+ FISH

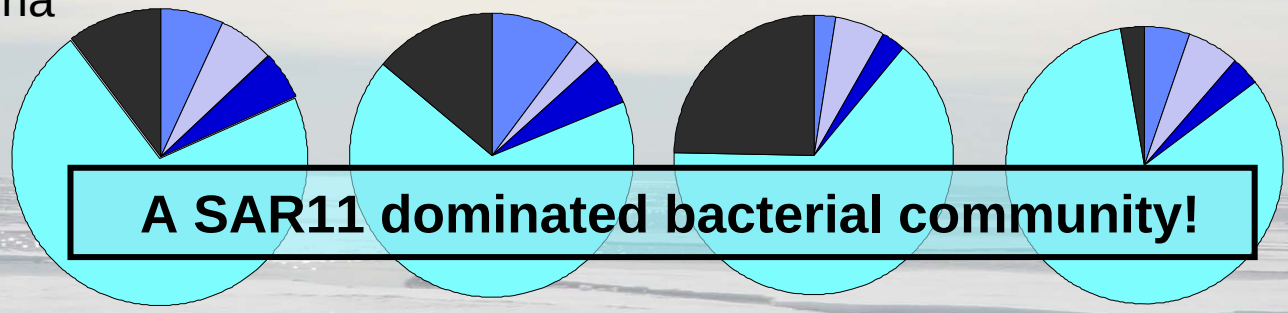
Specific hybridization of bacteria with RNA-targeted oligonucleotide probes which label cells fluorescently

MAR-FISH

(Alonso & Pernthaler, 2005)

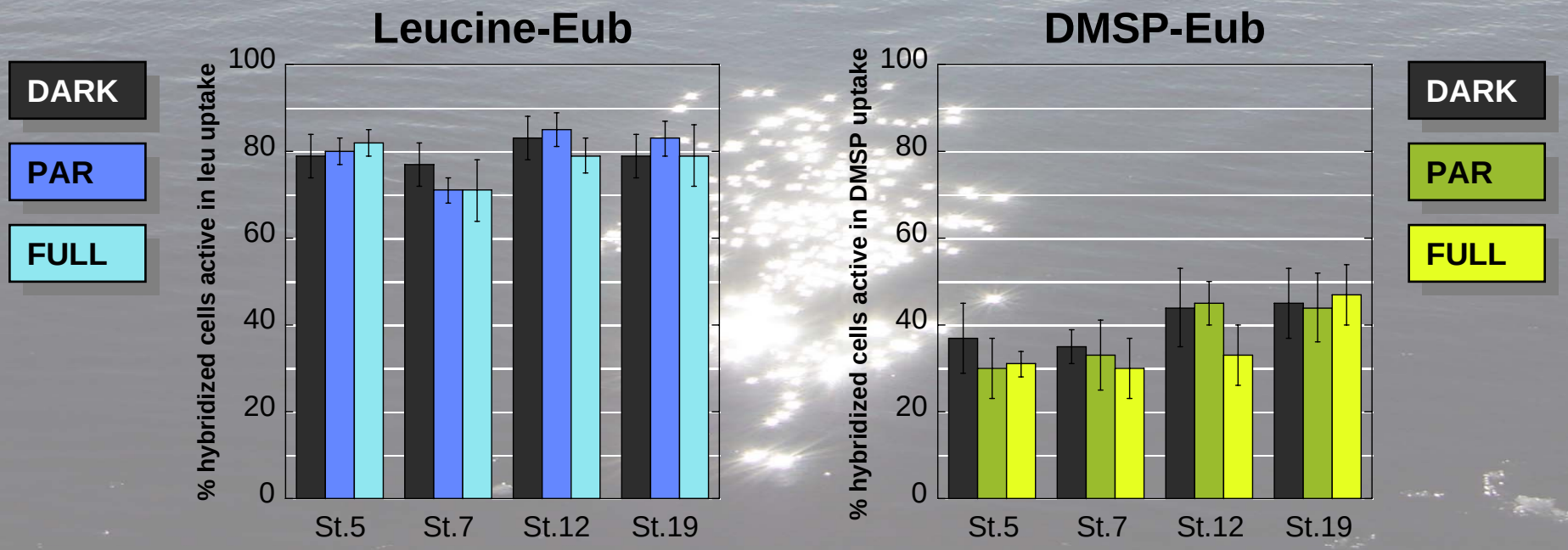
Bacterial community composition (Fluorescent *in situ* hybridization- FISH)

Gammaproteobacteria
Bacteroidetes
SAR11
Roseobacter
Other bacteria

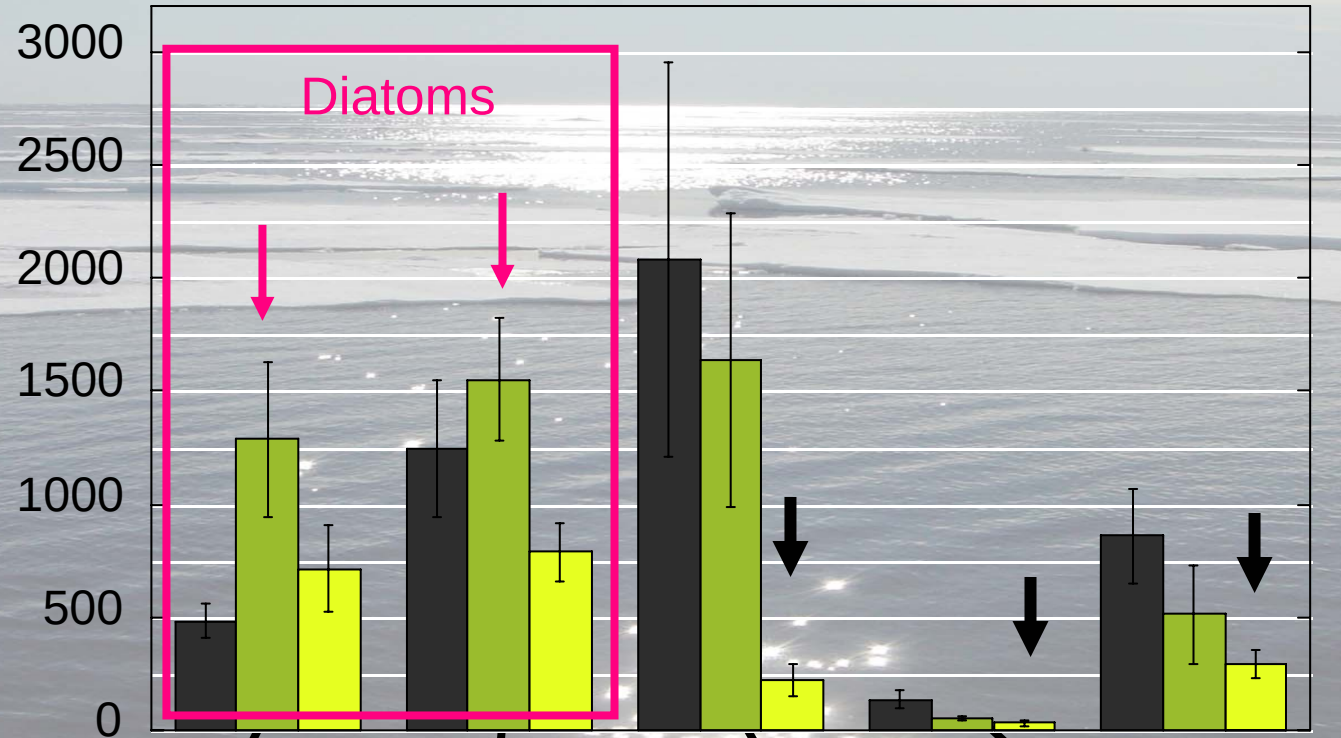


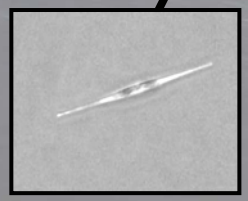
A SAR11 dominated bacterial community!

Single cell activity (FISH + microautoradiography = MAR-FISH)



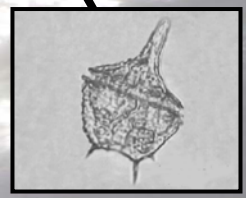
DMSP assimilation in terms of silver grain area: different light responses!



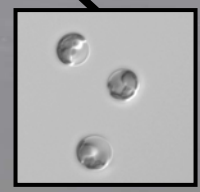


Pseudonitzschia spp.

Navicula spp.



Dinoflagellates



Phaeocystis sp.

DARK

PAR

FULL

Main conclusions

- **UVR** inhibited **leucine uptake** by bacteria either **during** exposure of **after** exposure to full sunlight
- **No changes** in bacterial **community composition** were found, but probably after continued exposure phototolerant species would be selected
- Results on light effects on **single cell** bacterial **activity** were **not conclusive** probably due to early labeling of most of the cells:**silver grain area quantification needed!**
- Most of the **algae** were very **active** in the uptake of the **organic** compound DMSP!! (osmoheterotrophy)
- **Light affected DMSP uptake** by algae (PAR activation in diatoms and UV inhibition in the rest of the groups)

Implications…

- In a global warming scenario, ozone depletion, ice cover reduction and stronger stratification might all lead to increases in the UVR doses of the surface oceans

- Since most of the energy and nutrients are channelled through bacteria and algae, any potential effect of UV on them will lead ultimately to changes in the productivity and elemental fluxes of the overall system

Implications…

- In a global warming scenario, ozone depletion, ice cover reduction and stronger stratification might all lead to increases in the UVR doses of the surface oceans

- Since most of the energy and nutrients are channelled through bacteria and algae, any potential effect of UV on them will lead ultimately to changes in the productivity and elemental fluxes of the overall system

- Understanding and even predicting these changes requires gaining knowledge of the sentitivity of microorganisms and their associated biogeochemistry to increased UVR doses

THANK YOU!

ACKNOWLEDGMENTS

- Carlos Duarte (chief scientist of ATOS)
- Crew of R/V Hespérides
- Gerhard Herndl & Eva Sintes
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