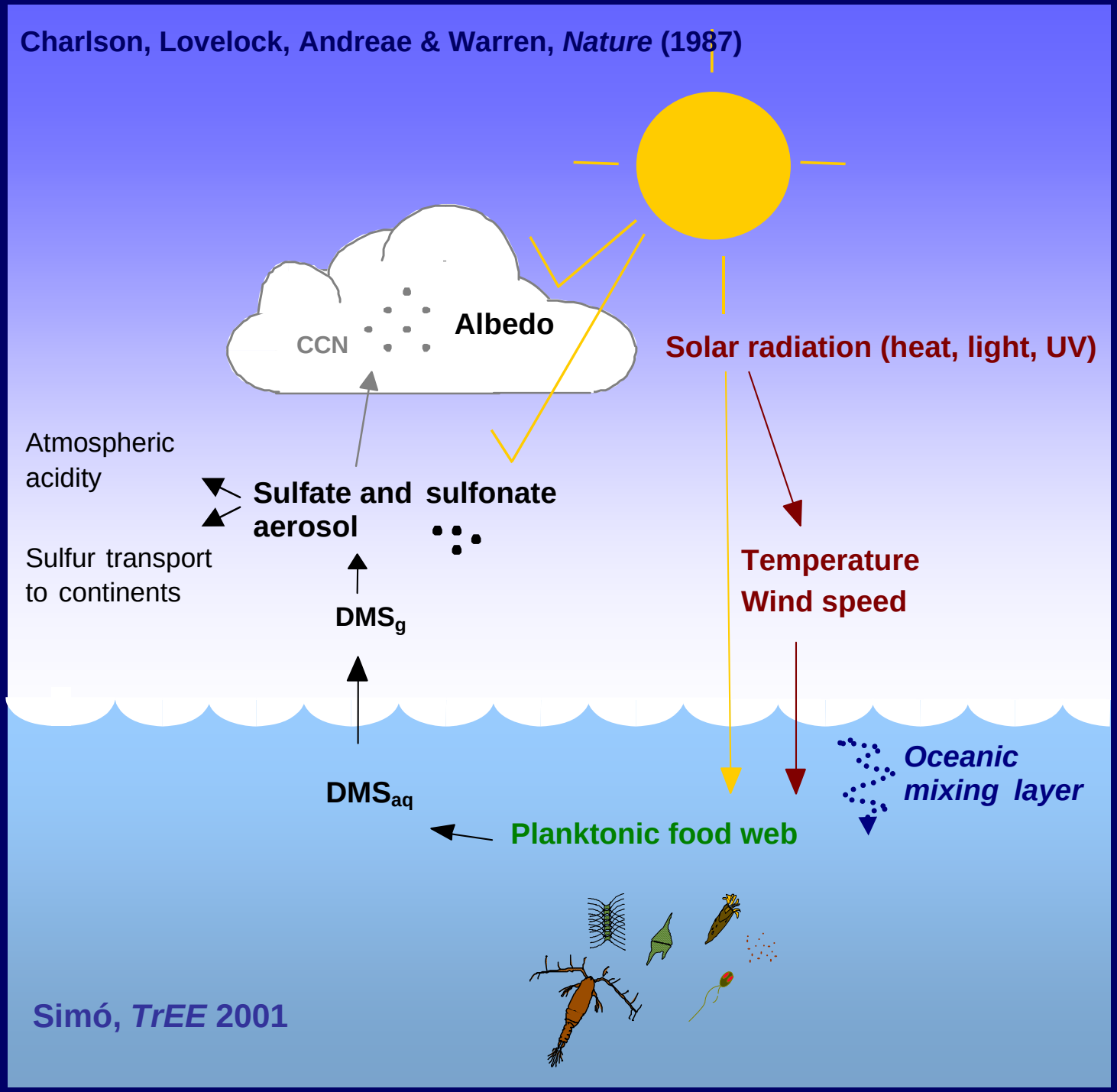
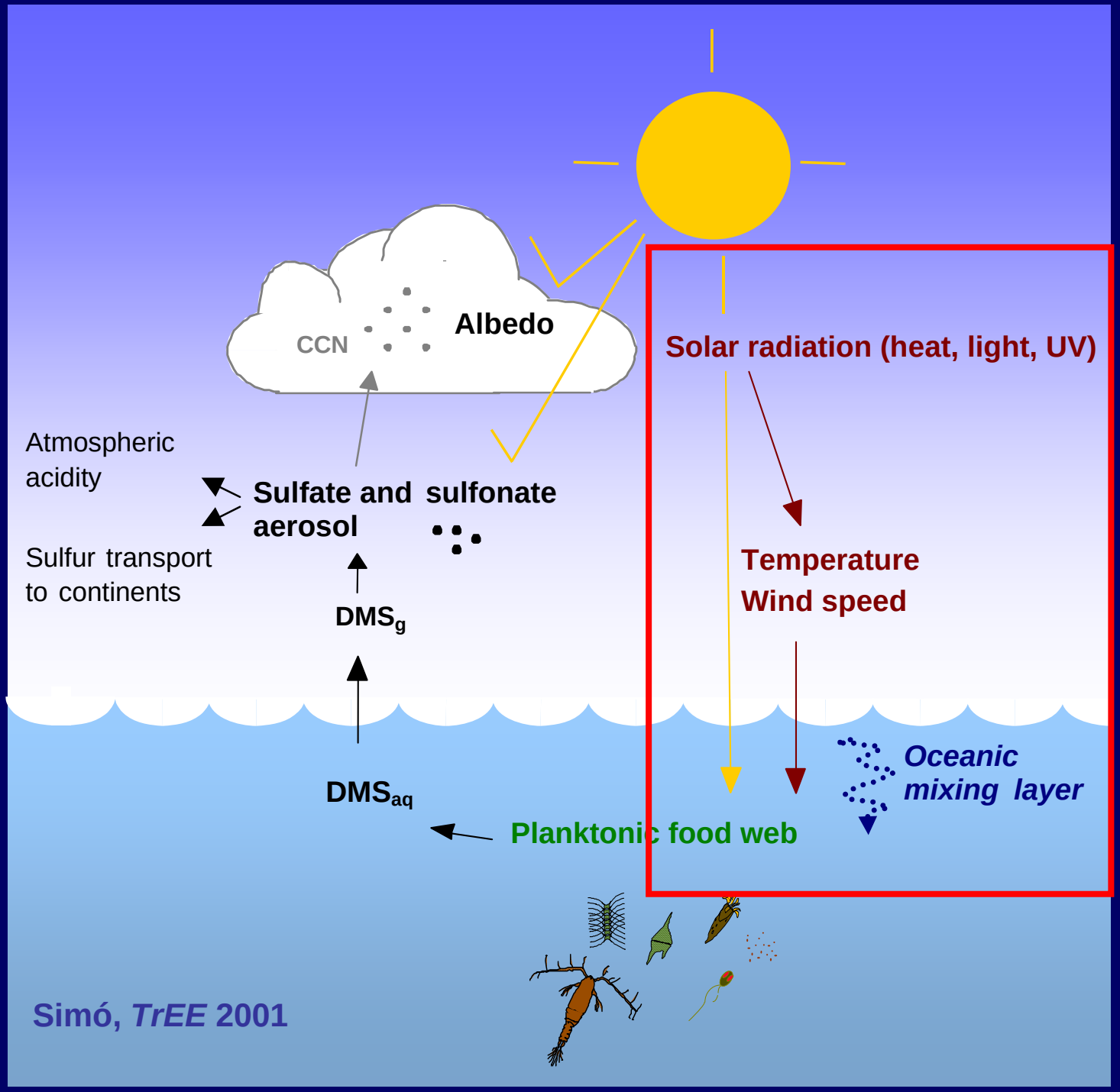
Role of microzooplankton grazing in the DMS cycle: field and laboratory studies

Violeta Saló, Rafel Simó, Albert Calbet

Institut de Ciències del Mar, CSIC, Barcelona


Charlson, Lovelock, Andreae & Warren, *Nature* (1987)
CCN
Albedo
Solar radiation (heat, light, UV)
Atmospheric acidity
Sulfate and sulfonate aerosol
Sulfur transport to continents
DMS$_g$
Temperature
Wind speed
DMS$_{aq}$
Oceanic mixing layer
Planktonic food web
Simó, *TrEE* 2001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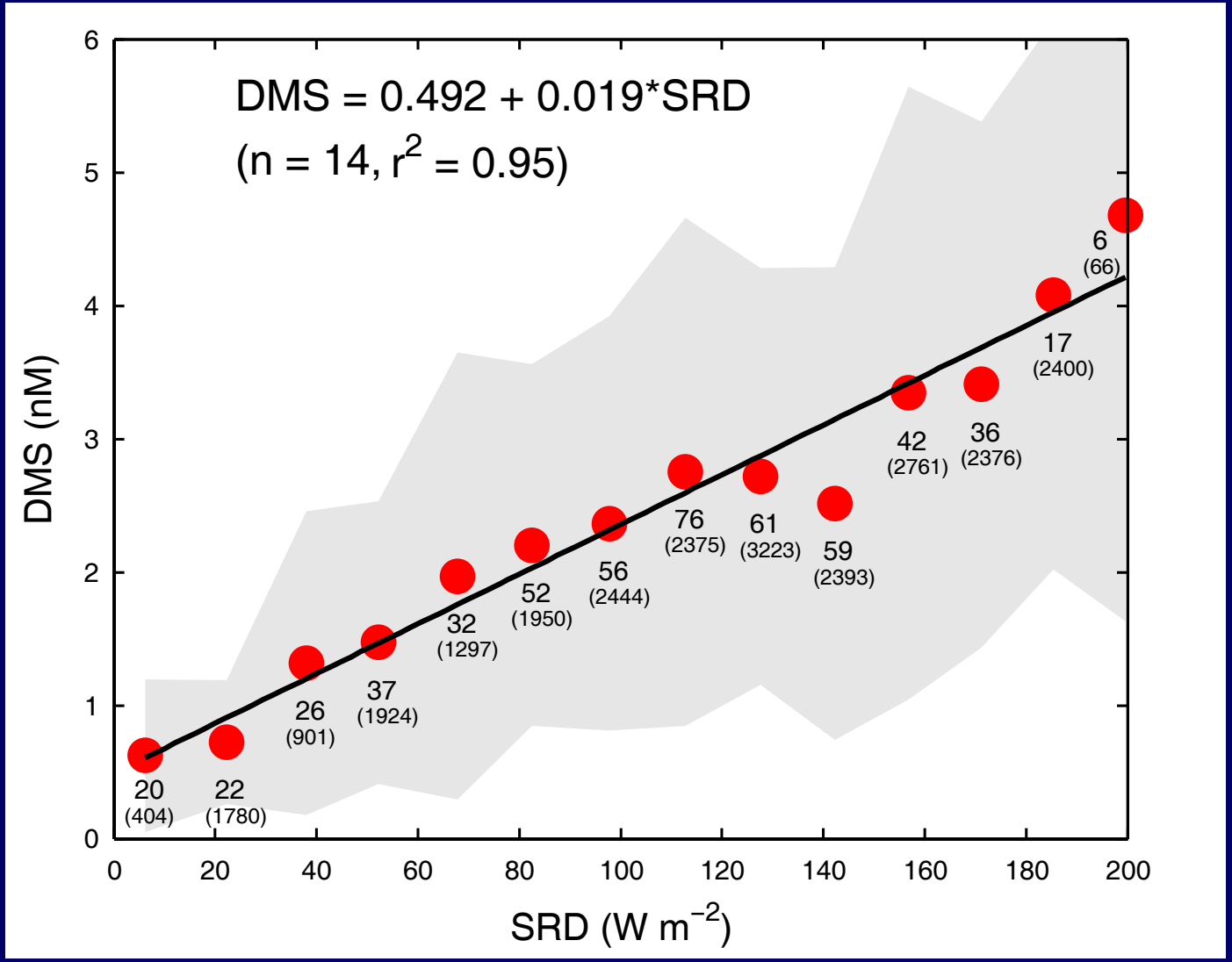
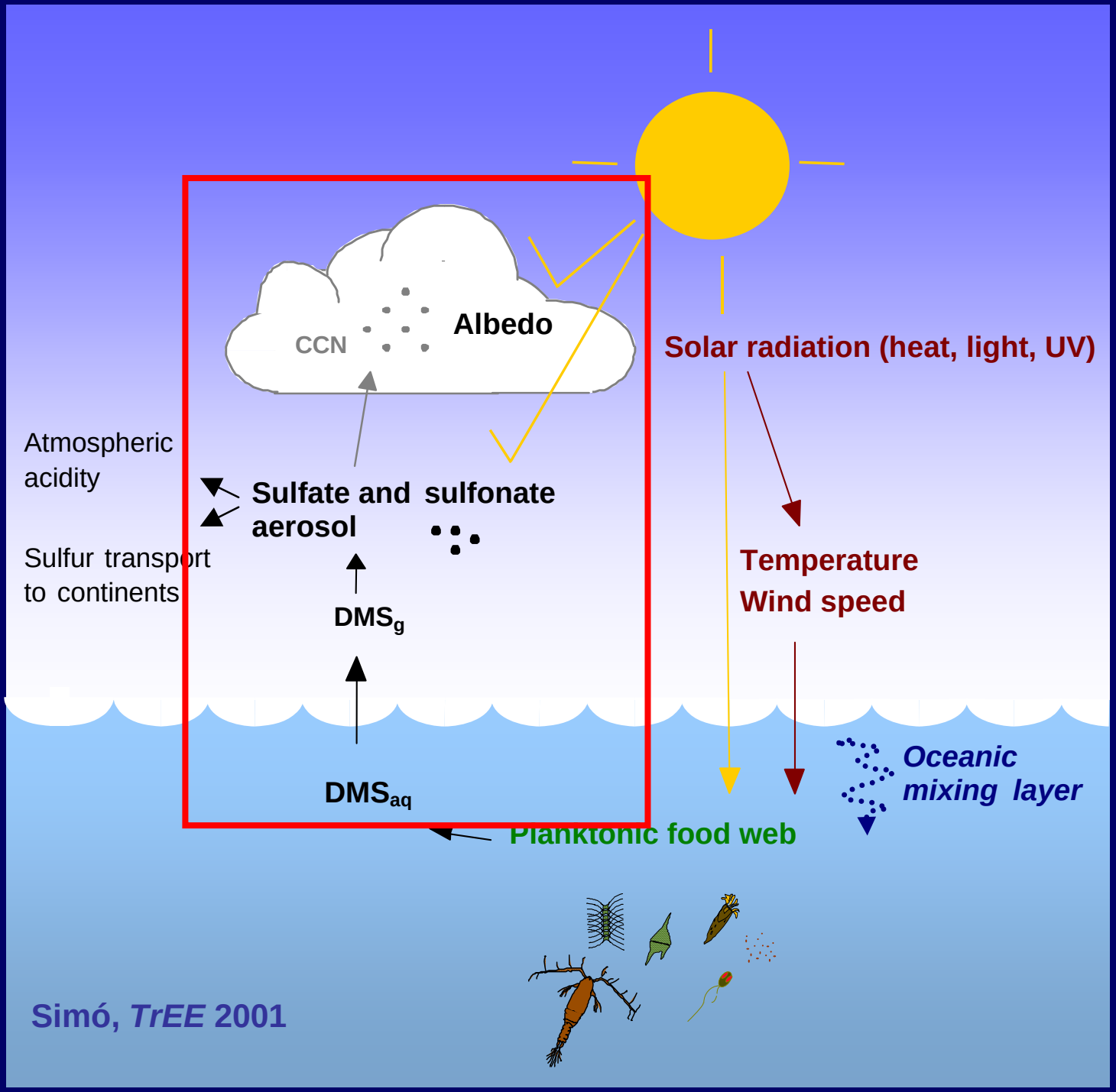
Simó, TrEE 2001

GLOBAL OCEAN

DMS vs. SOLAR RADIATION DOSE

Vallina & Simó, *Science*, 2007

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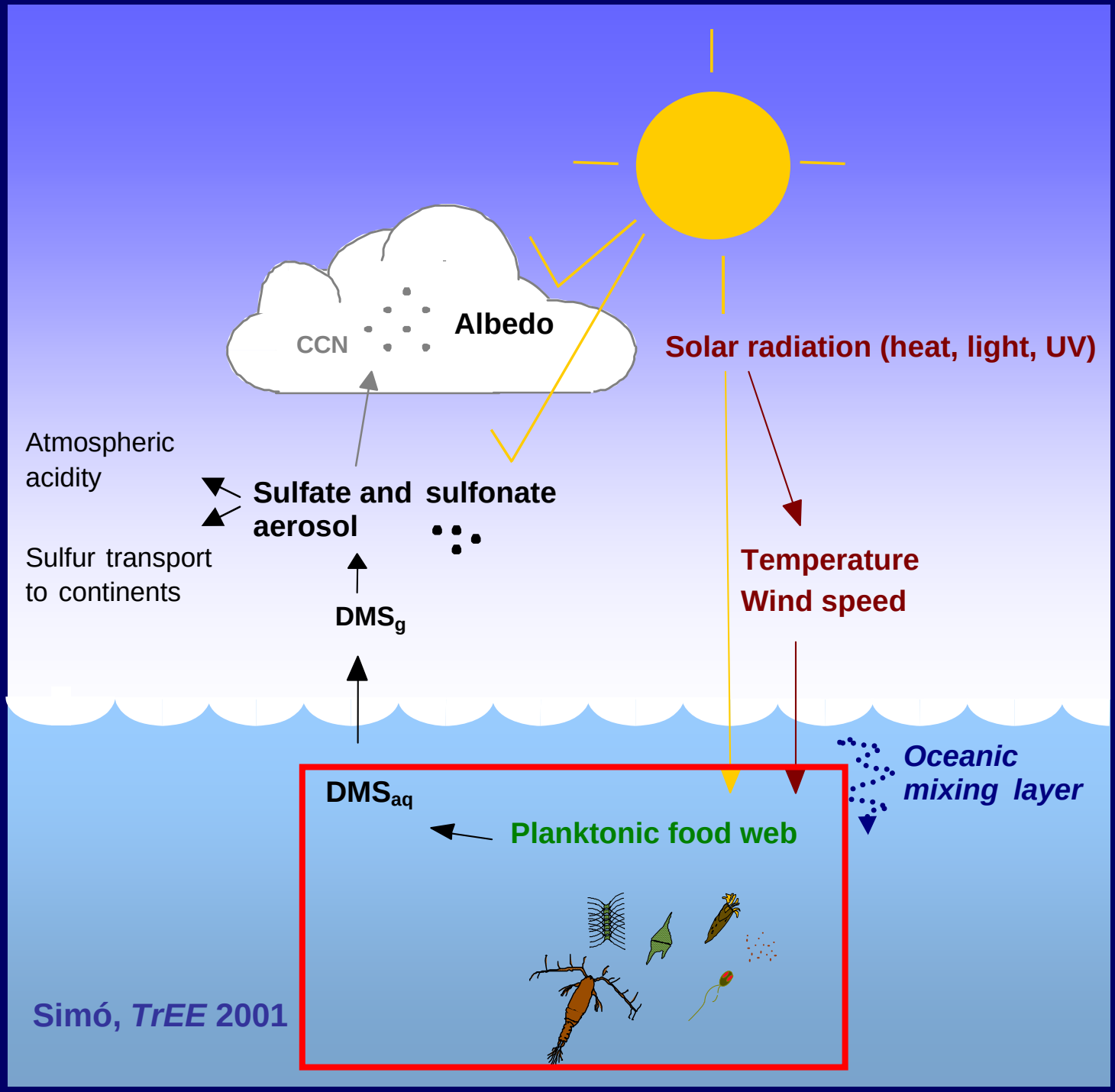
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Simó, TrEE 2001

DMS = f (CHL, MLD)

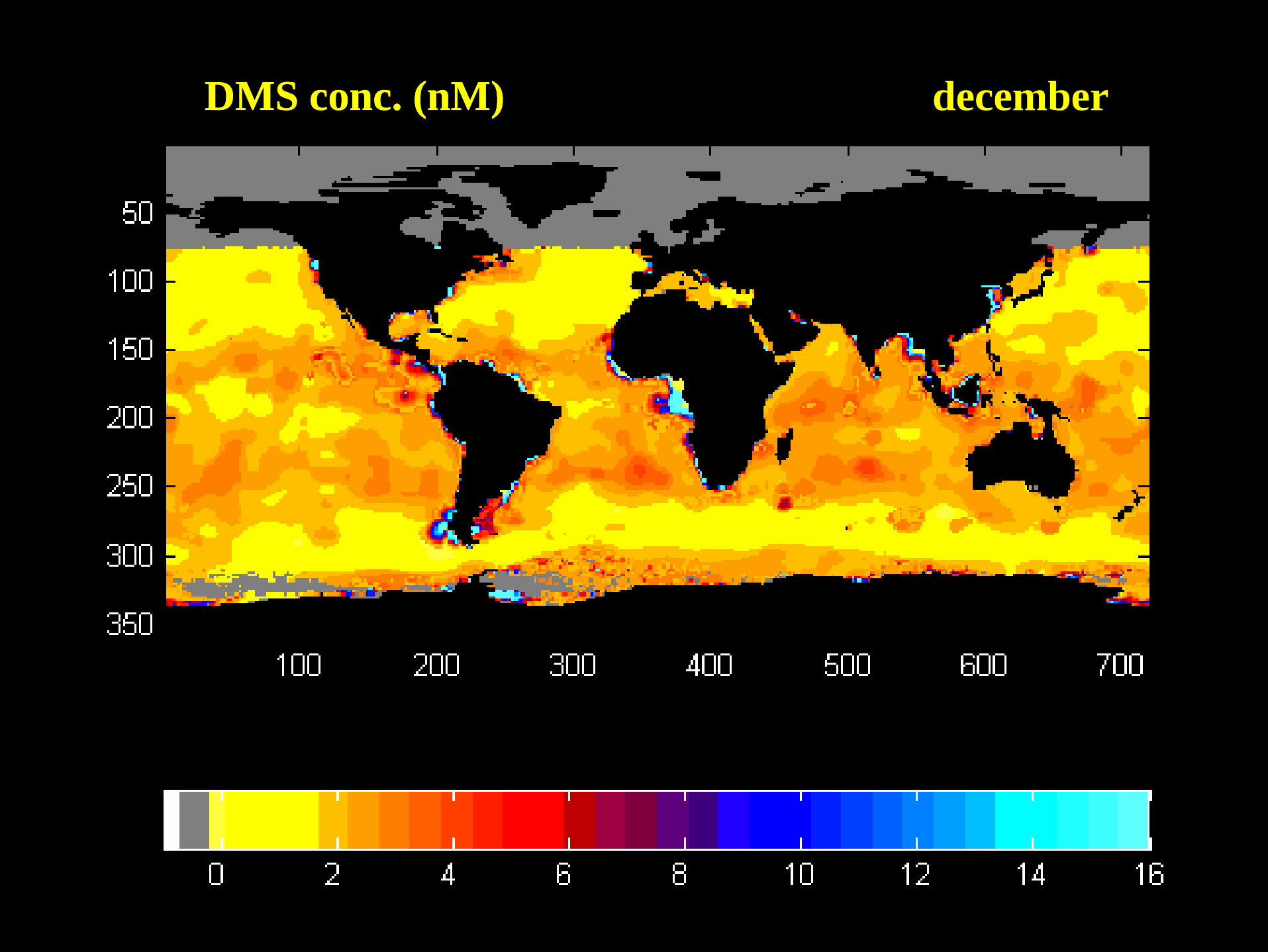
CHL : SeaWiFS

monthly

MLD : de Boyer-Montégut (ΔT = 0.2 ^{o}C from 5 m)

monthly

Simó & Dachs,
Global Biogeochem. Cycles,
2002


DMS conc. (nM)
december
50
100
150
200
250
300
350
100
200
300
400
500
600
700
0
2
4
6
8
10
12
14
16

DMS = f (CHL, MLD)

CHL, MLD : ORCA-LIM / PLANKTOM5 projections

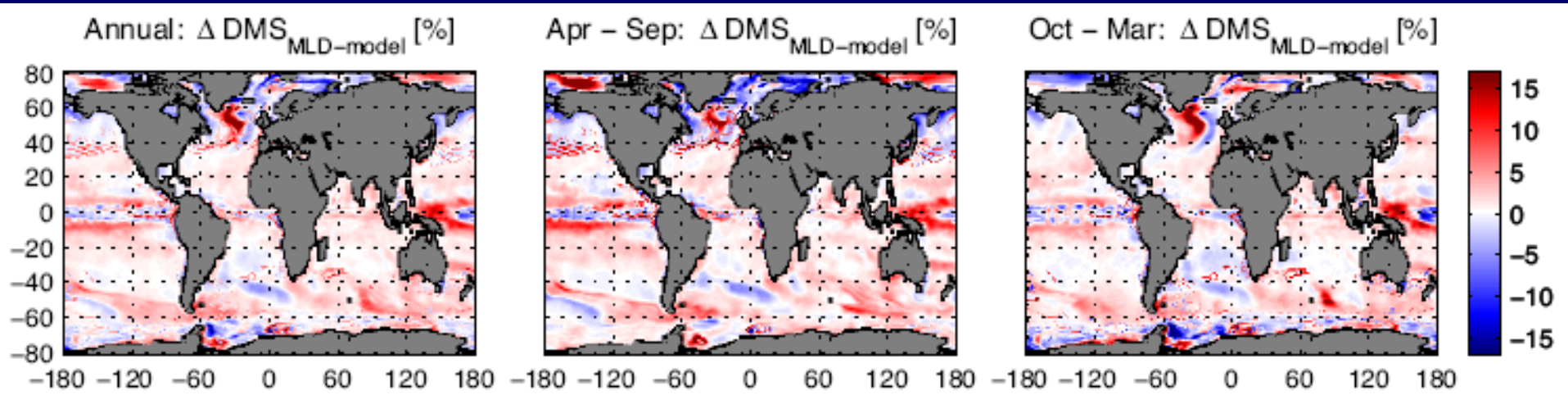
Atmospheric forcing anomalies from IPSL model – IPCC scenario A2

(50% increased CO_2 by 2060)

PREDICTED DMS CONCENTRATIONS

% OF CHANGE IN 2060:

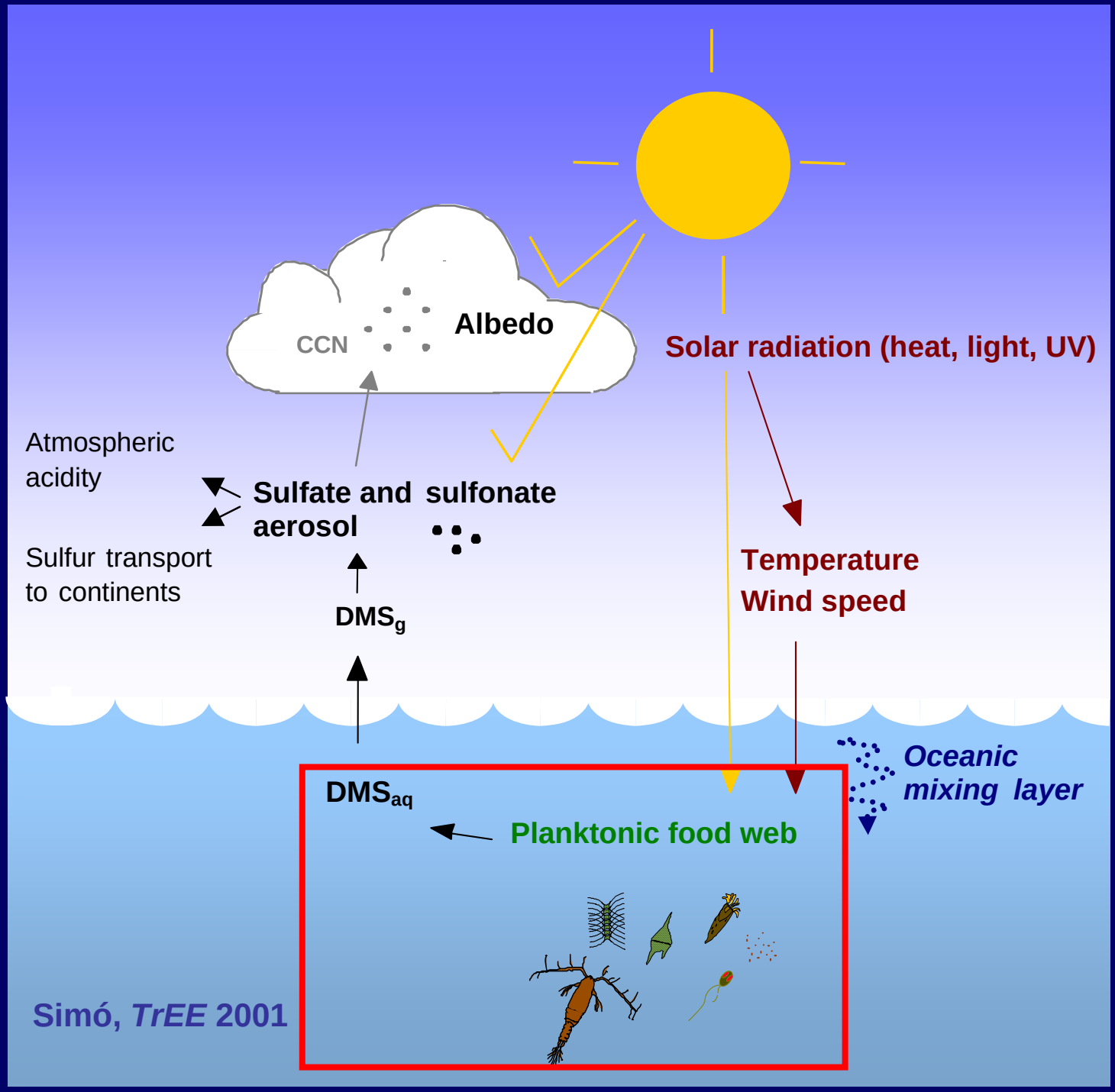
GLOBAL WARMING vs CONTROL



Only 1.2% annual increase,

approx. 2% of CO_2 radiative forcing

Vallina, Simó & Manizza, PNAS 2007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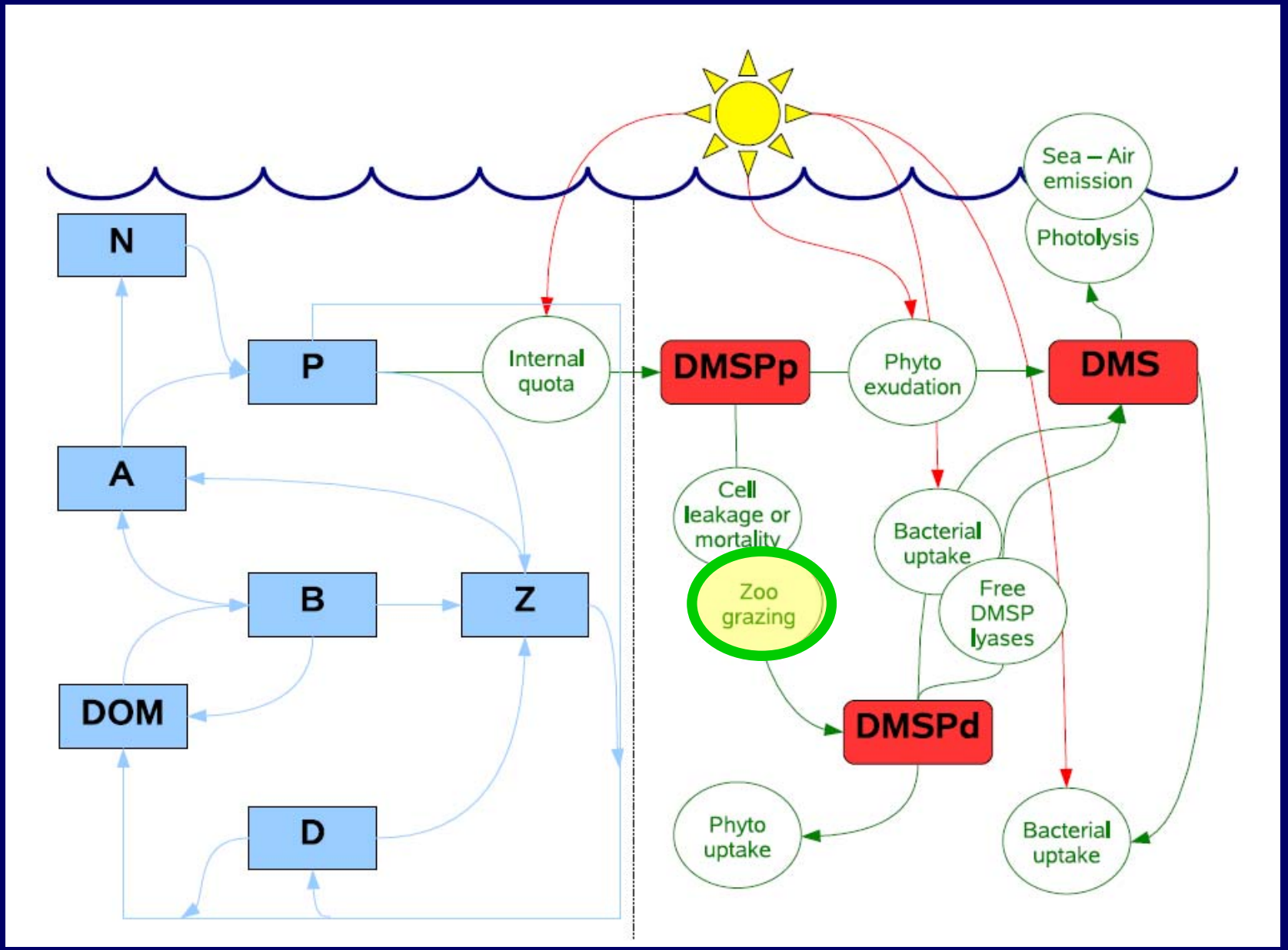
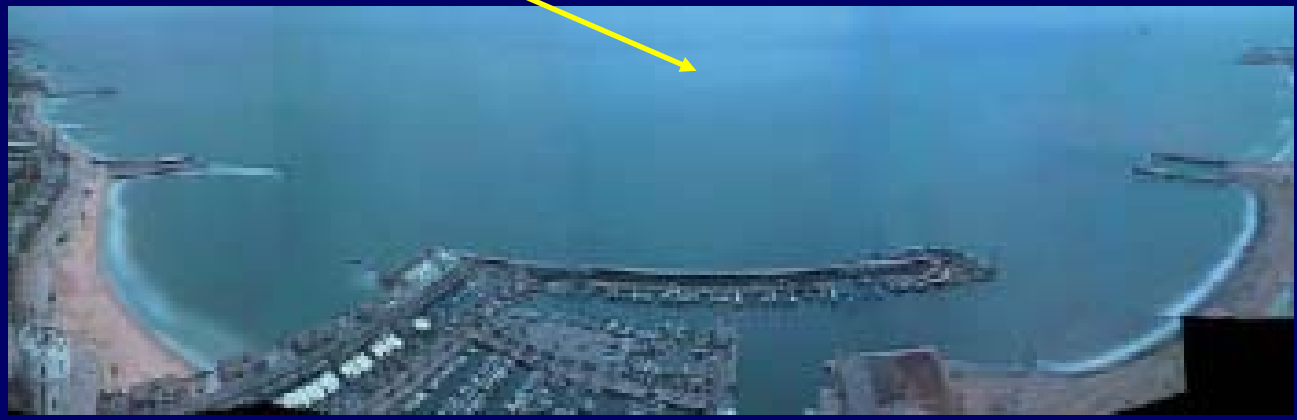


DMOS MODEL

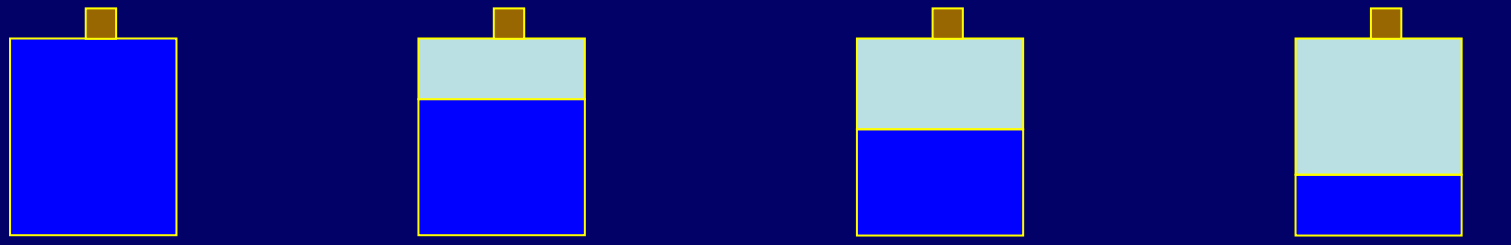
Vallina, Simó et al., *JGR-BGS* 2008

An annual series of dilution experiments

(41.22° 775' N, 02.13° 150'E) NW Mediterranean



An annual series of dilution experiments

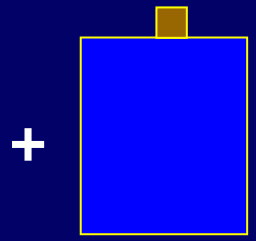


100% whole 75% whole 50% whole 25% whole

Whole seawater from 5m :

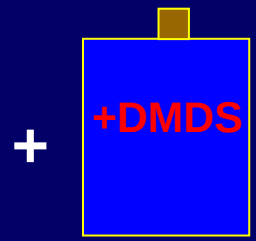
Seawater filtered through 0’22 μm:

+ excess nutrients in all !



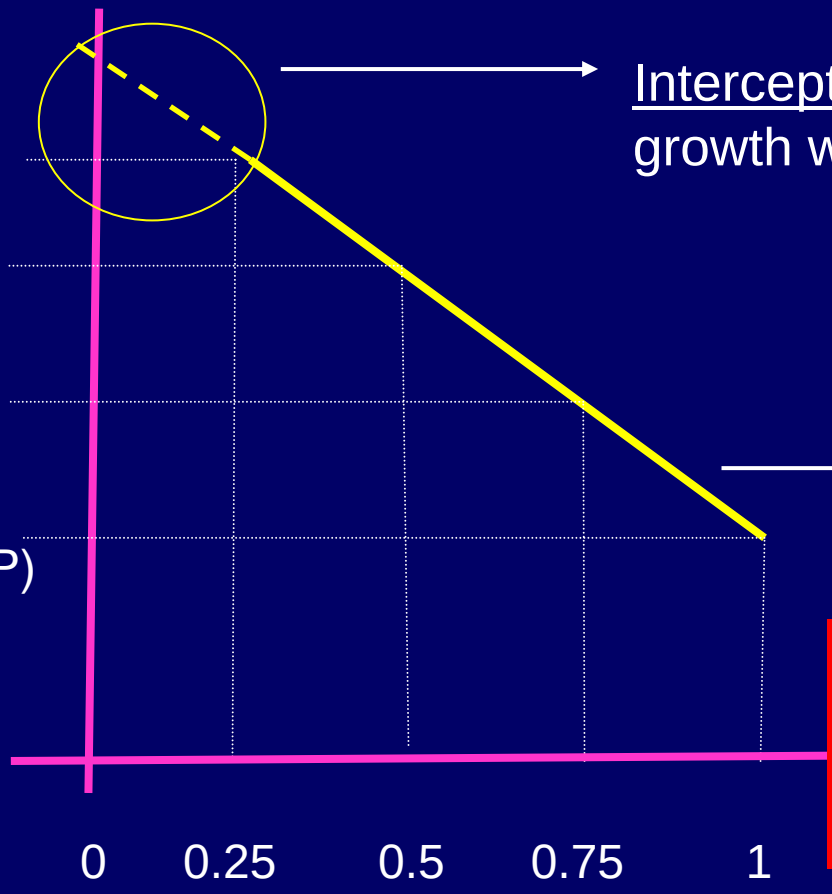
100% whole

no nutrients



100% whole

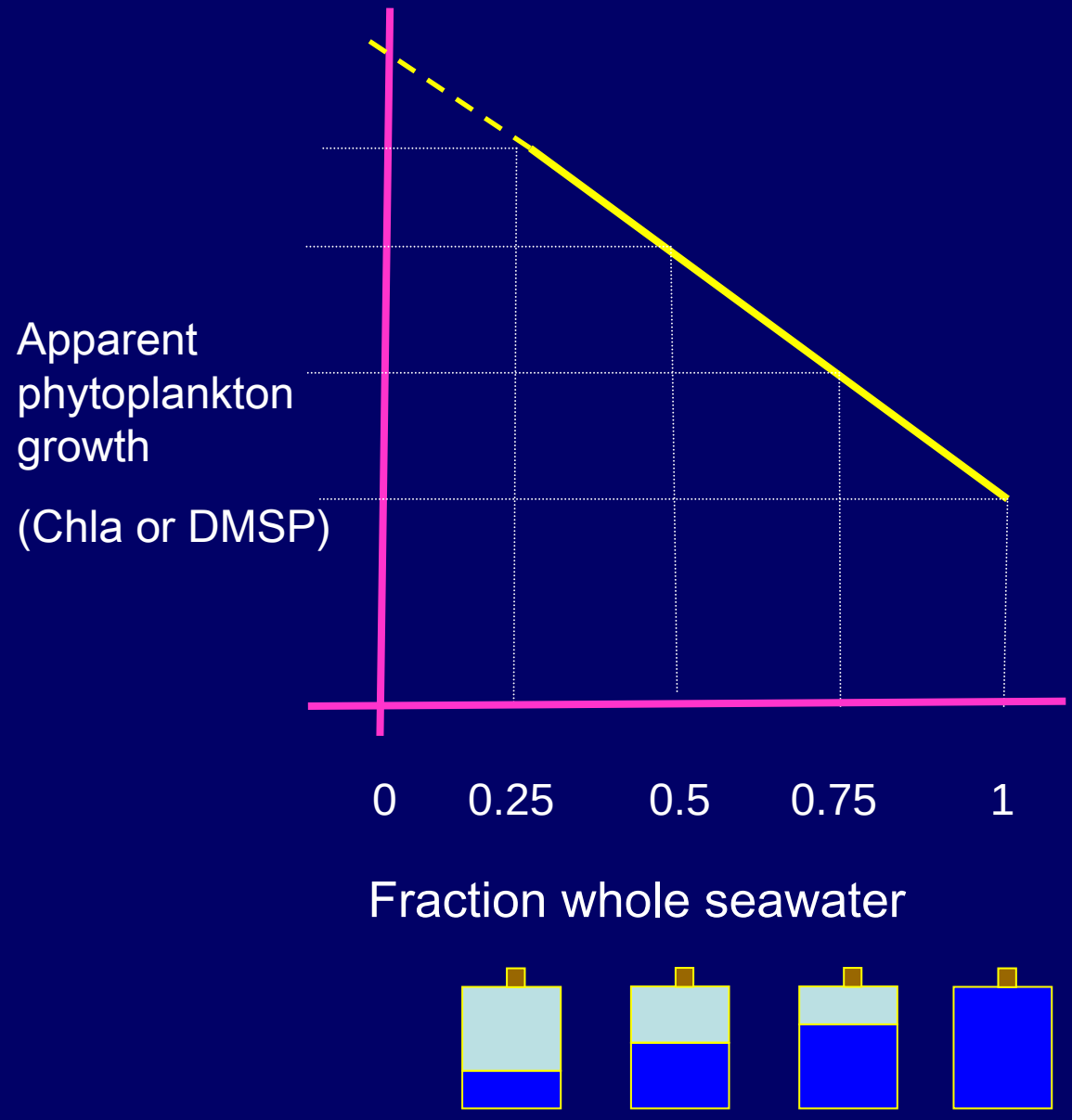
no nutrients



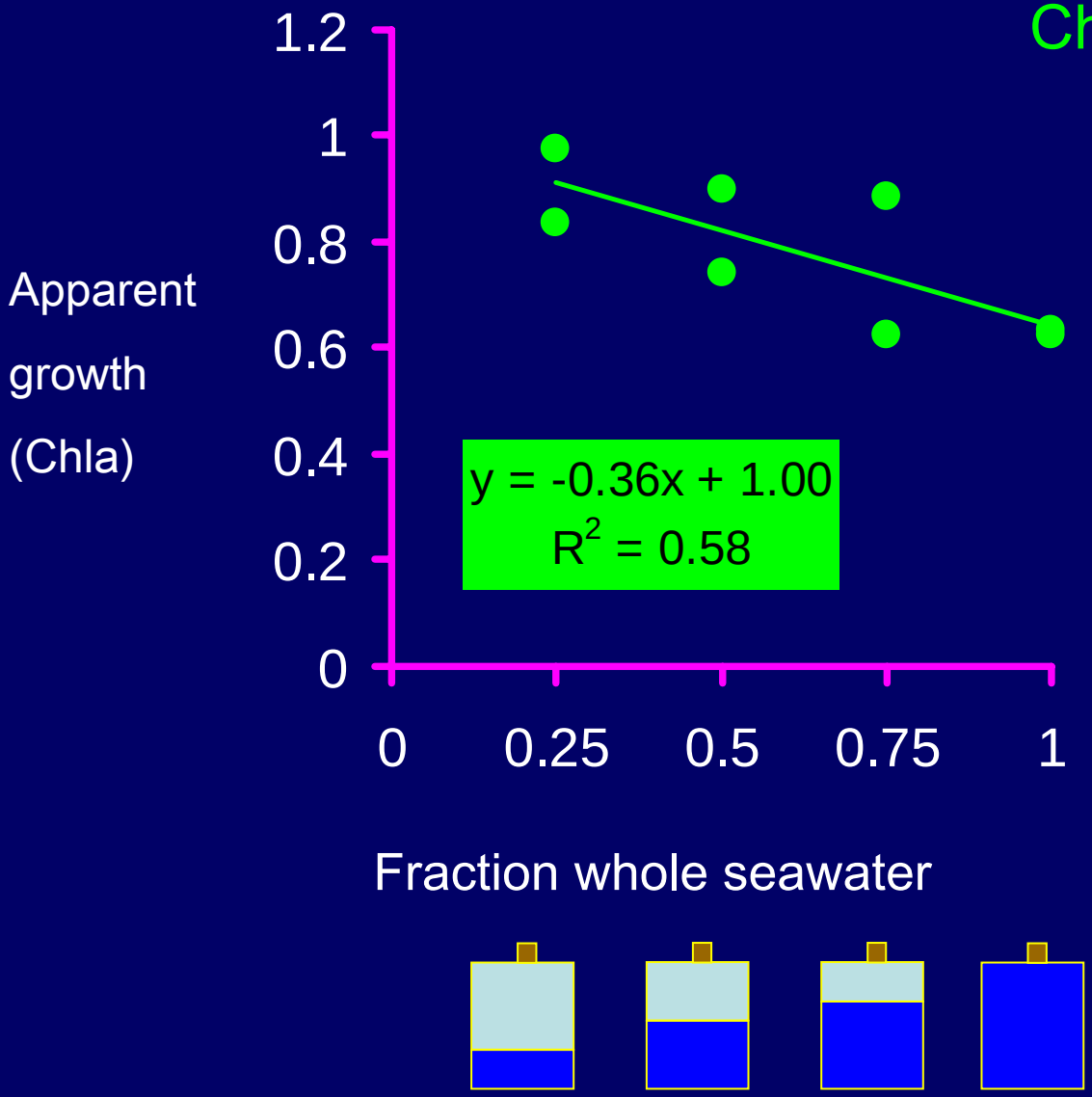
Intercept = gross phytoplankton growth with nutrients, μ (d^{-1})

slope = grazing mortality rate *m* (d^{-1})

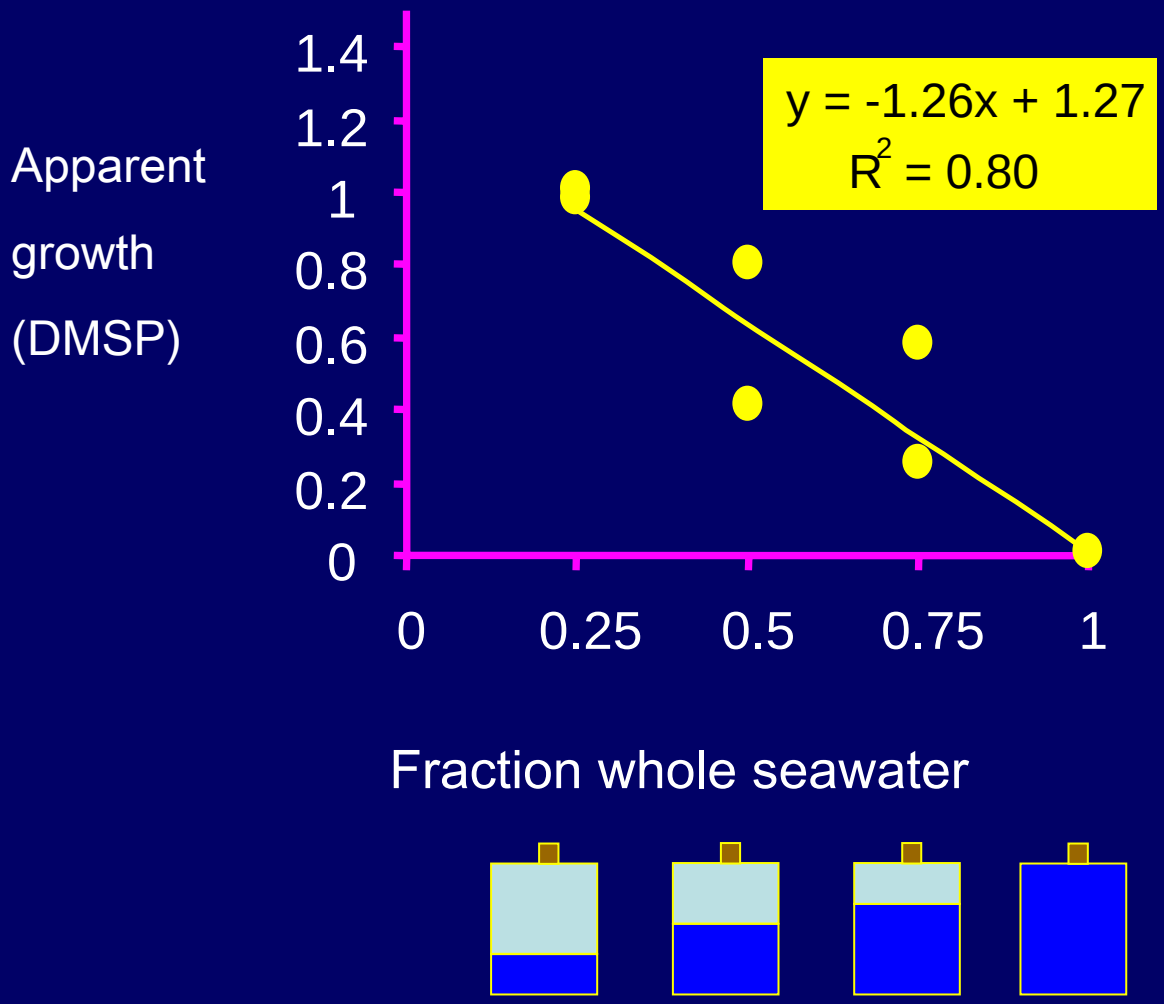
How much Chla or DMSP is grazed per day

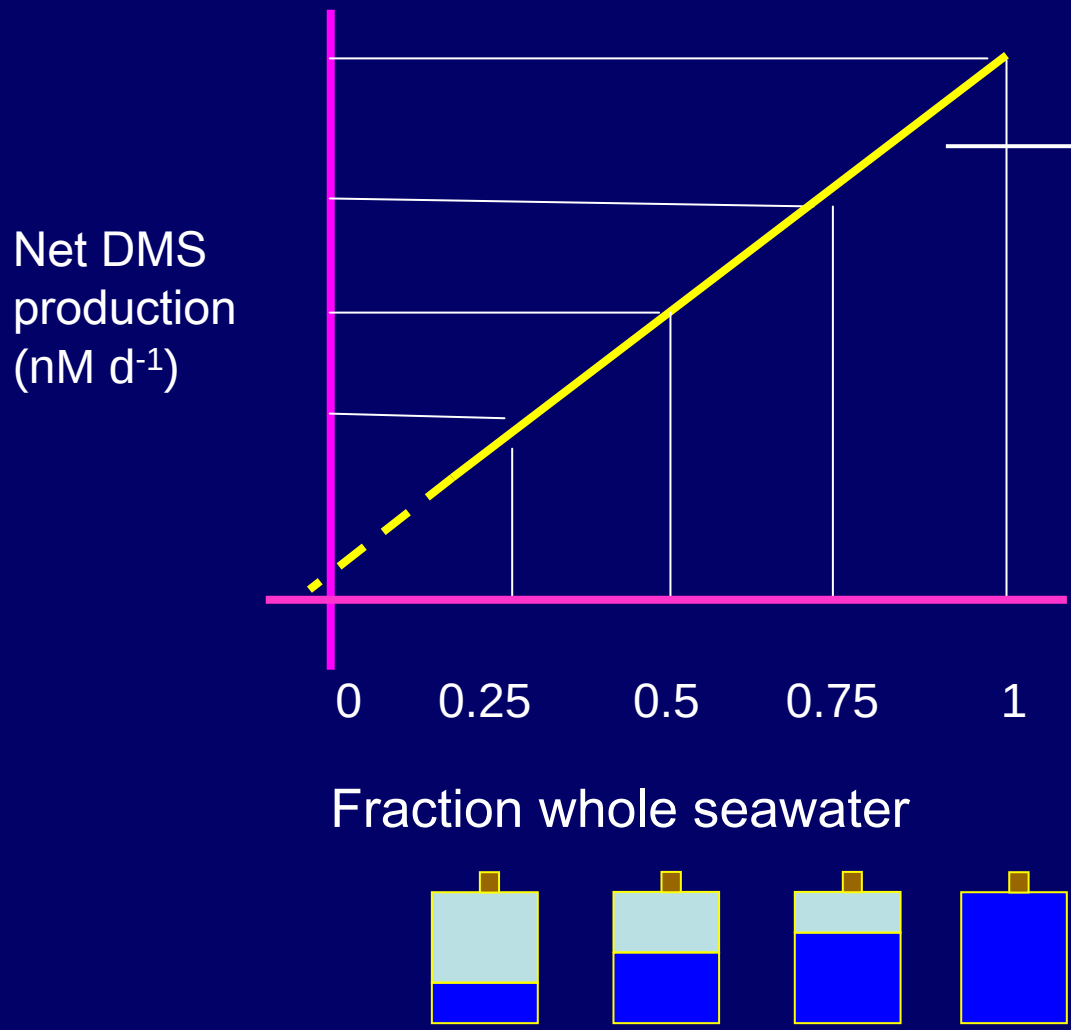

Apparent phytoplankton growth
(Chla or DMSP)
0
0.25
0.5
0.75
1
Fraction whole seawater

Chlorophyll *a*



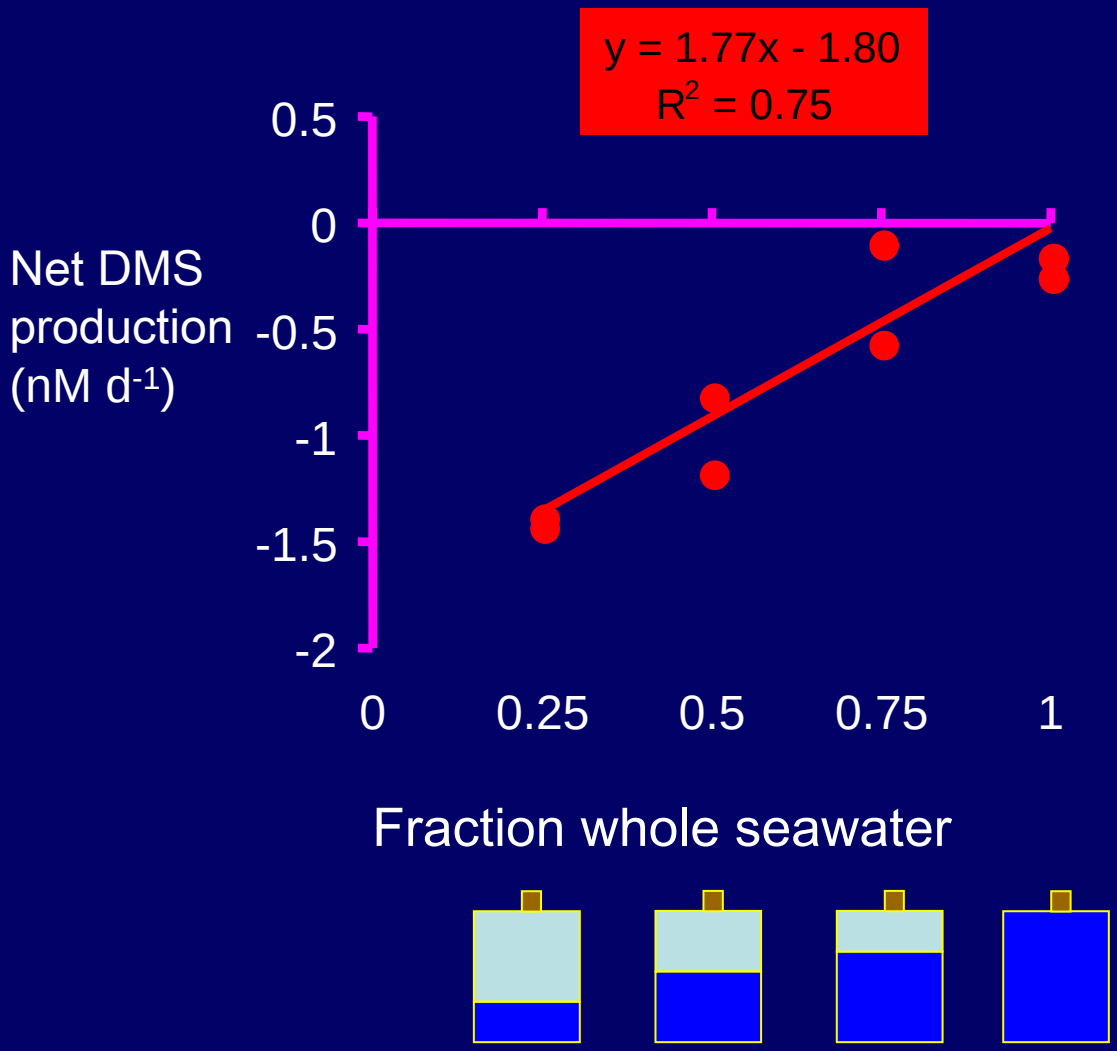
DMSP


Apparent growth (DMSP)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
y = -1.26x + 1.27
R2 = 0.80
0
0.25
0.5
0.75
1
Fraction whole seawater



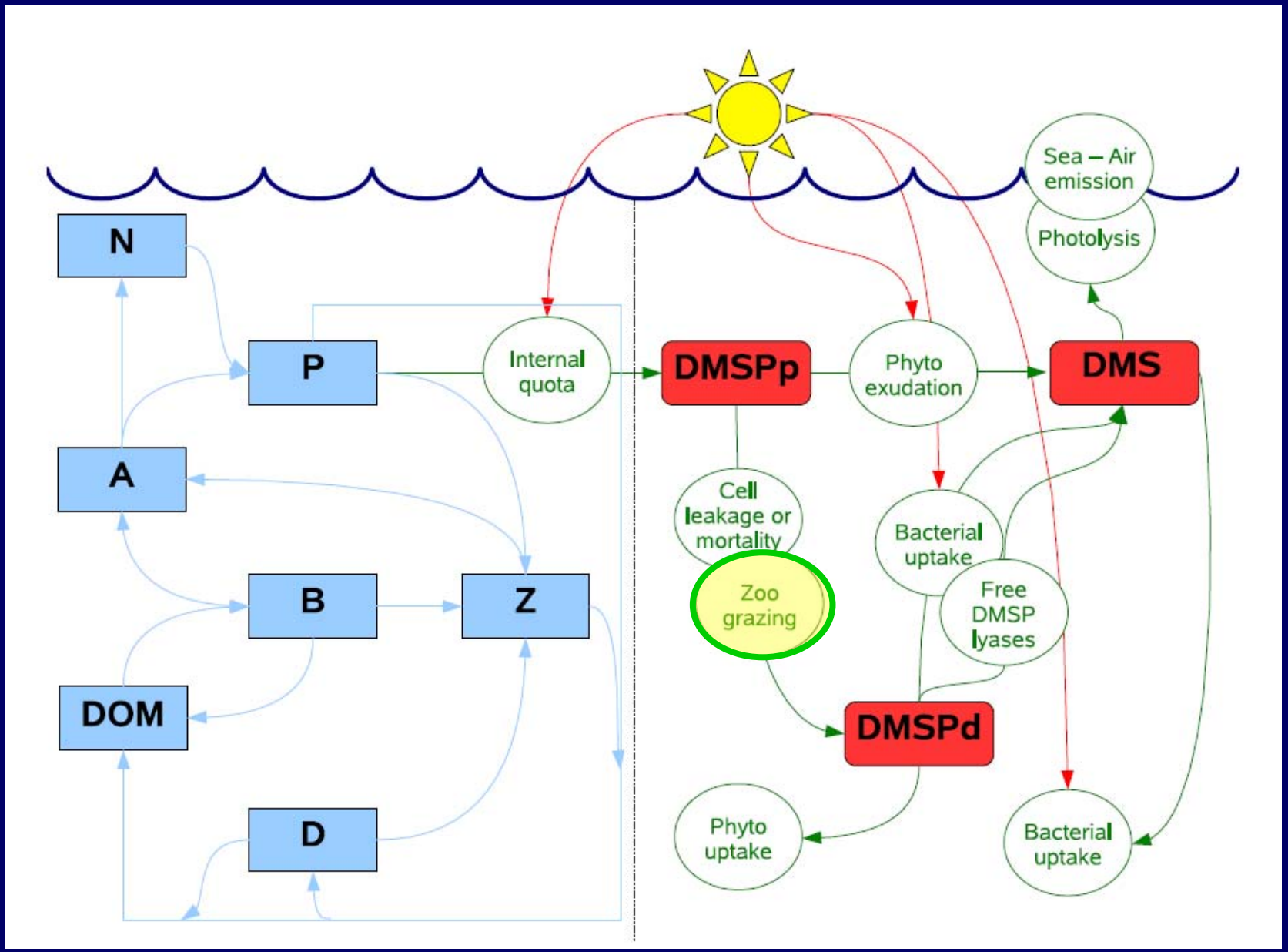
How much DMS is produced by grazing per day

DMS


y = 1.77x - 1.80
R2 = 0.75
Net DMS production (nM d-1)
0.5
0
-0.5
-1
-1.5
-2
0
0.25
0.5
0.75
1
Fraction whole seawater

An annual series of dilution experiments

		Chla		DMSP		DMS		
	T (ºC)	(mg m^{-3}) Chla	(d^{-1}) grazing rate	(nM) DMSP	(d^{-1}) grazing rate	(nM) DMS	(nM d^{-1}) DMS production by grazing	% of gross DMS production
Sep-05	23.5	0.18	0.36					
Oct-05	21.5	1.54	0.38					
Nov-05	16.1	0.97	0.27					
Jan-06	13.0	0.47	0.08					
Mar-06	12.5	1.70	0.23					
Apr-06	14.2	1.13	0.38					
May-06	18.1	1.00	0.21					
Jun-06	21.1	0.50	0.82					
Jul-06		0.36	0.7					
Jul-06	24.4	0.40	0.99					
Aug-06	24.4	0.31	0.5					
Sep-06	22.2	0.73	0.36					
average			**0.44 d^{-1}**		**1.30 d^{-1}**		**2.48 nMd^{-1}**	**45%**
std err			*0.08*		*0.17*		*0.53*	*8*



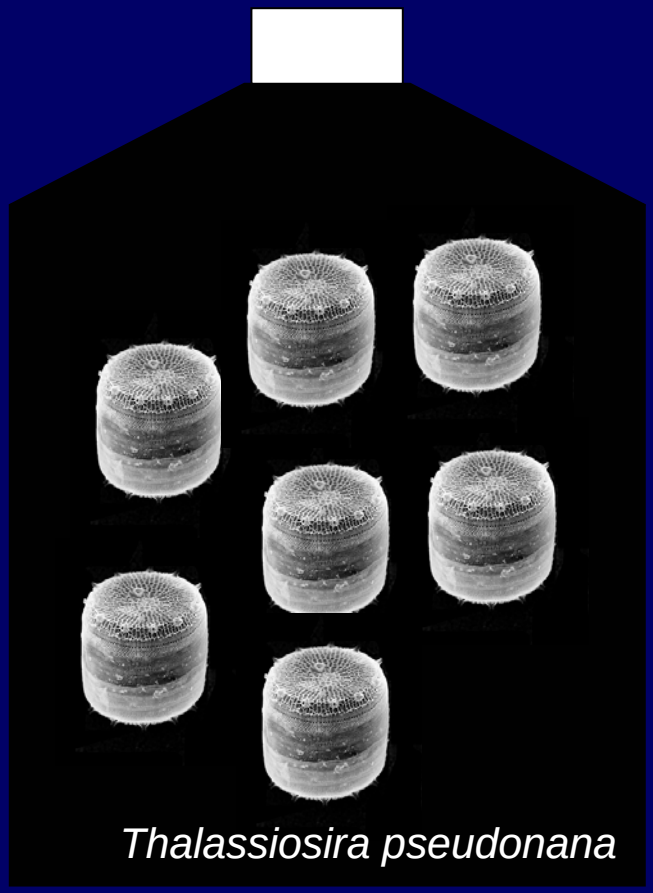
DMOS MODEL

Vallina, Simó et al., *JGR-BGS* 2008

DMSP assimilation by micrograzers? A lab experiment

DMSP assimilation by micrograzers? A lab experiment

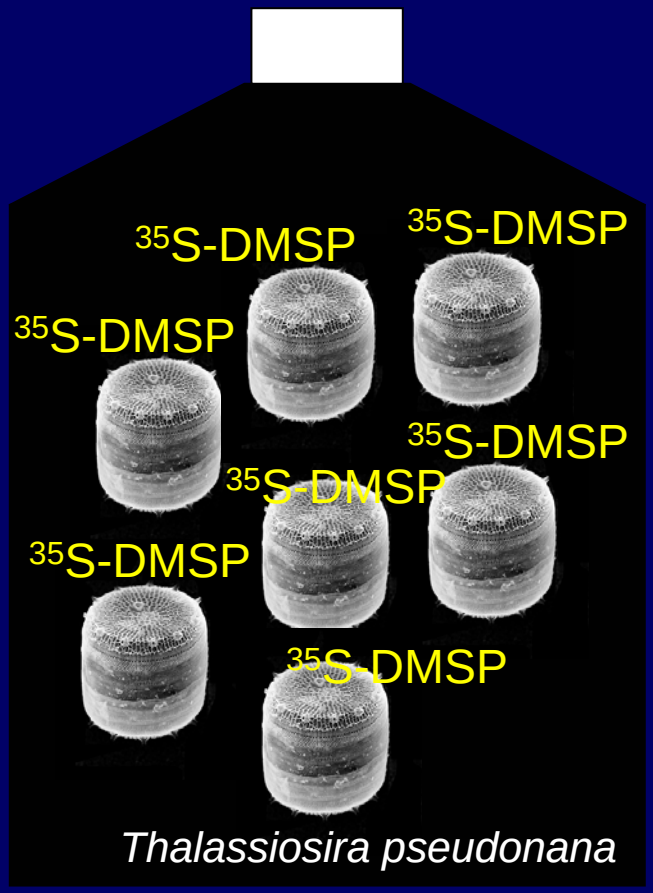
^{35}S-DMSP



Thalassiosira pseudonana

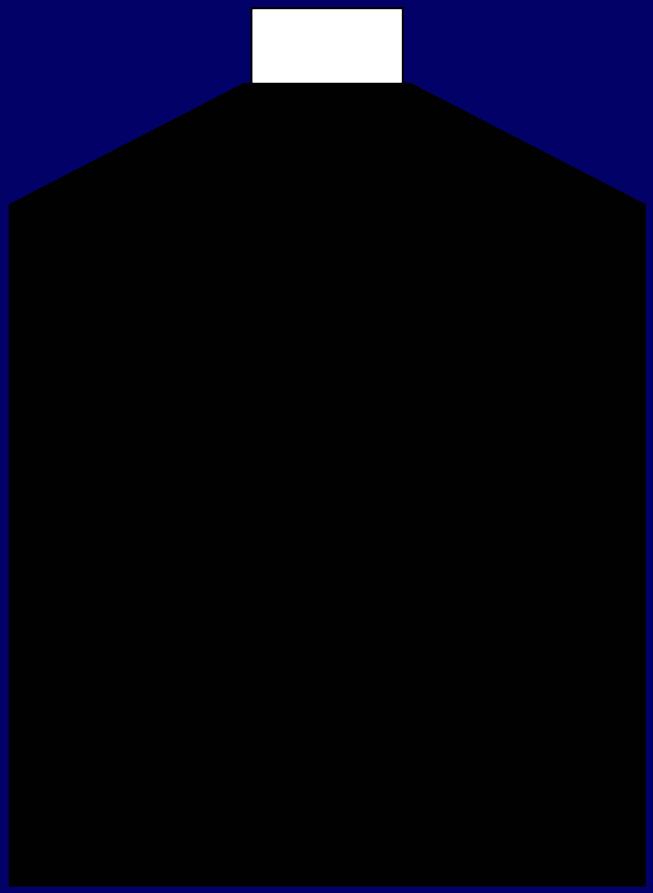
Oxhyrris marina

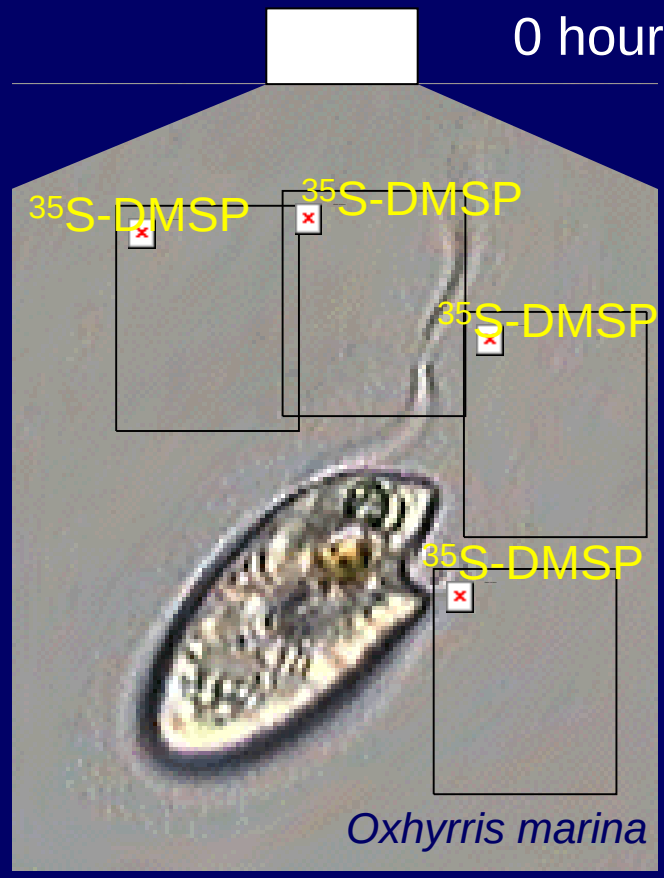
DMSP assimilation by micrograzers? A lab experiment



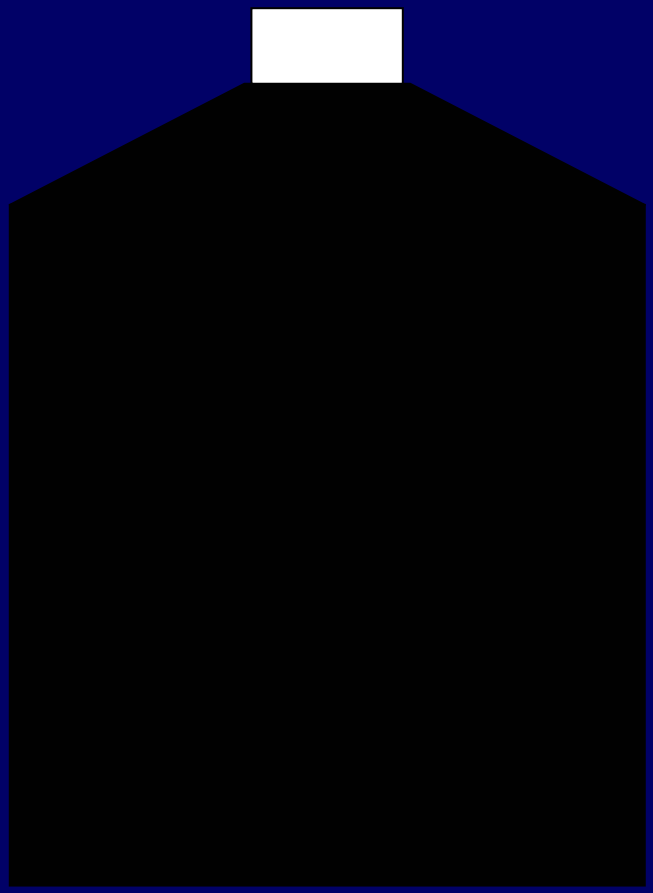
Vila-Costa, Simó et al., *Science* 2006

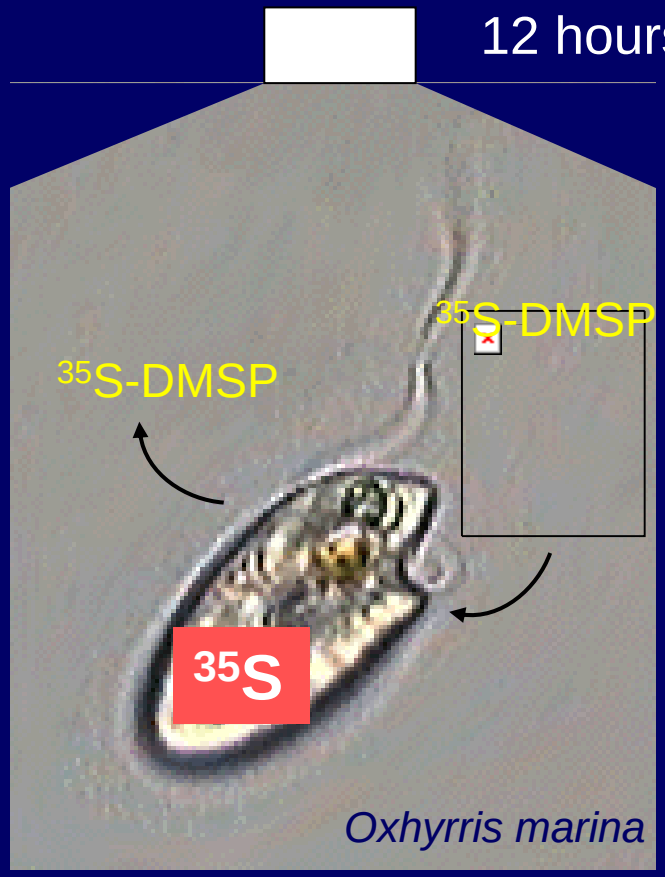
DMSP assimilation by micrograzers? A lab experiment



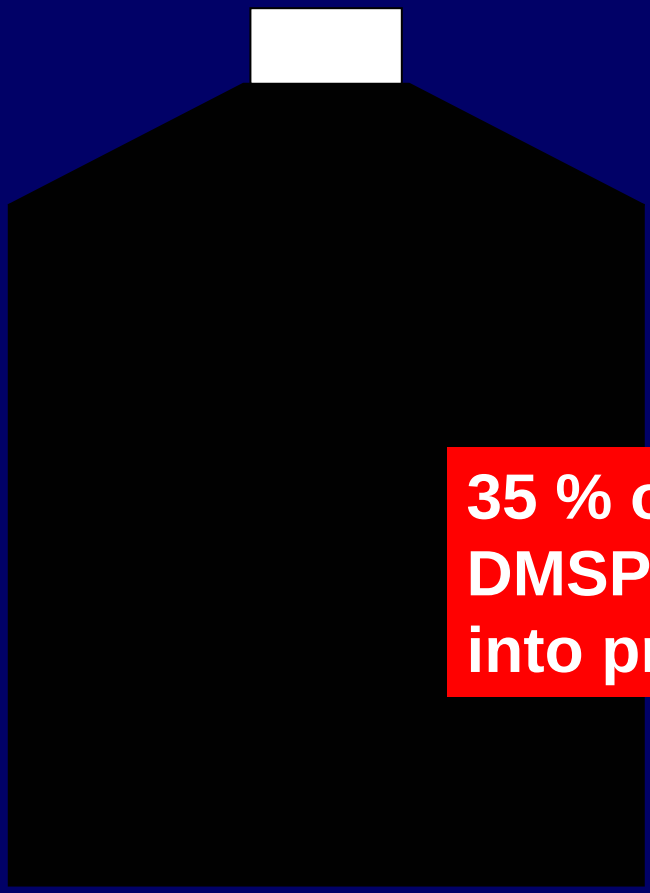


DMSP assimilation by micrograzers?
A lab experiment

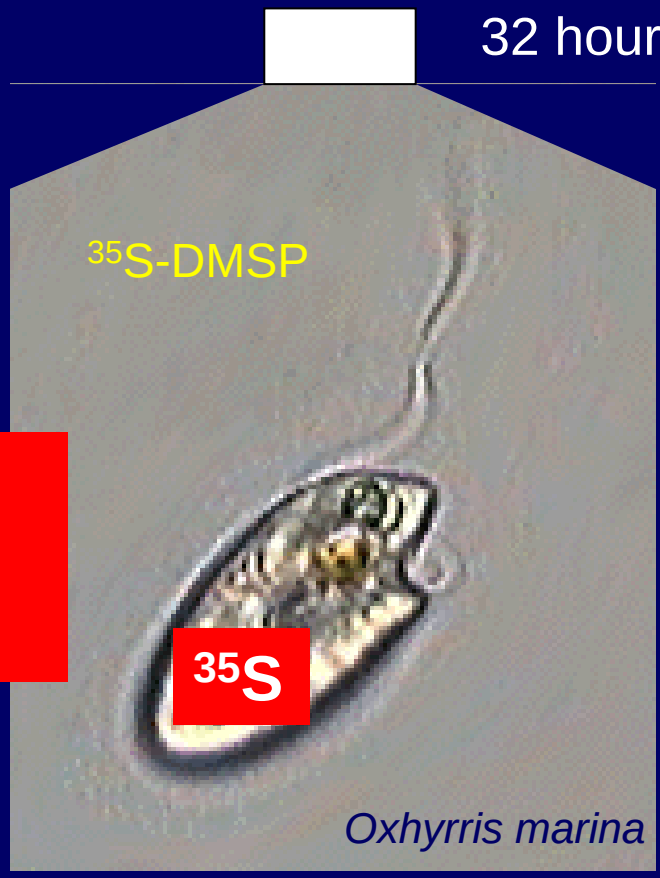




DMSP assimilation by micrograzers? A lab experiment



35 % of ingested DMSP assimilated into proteins

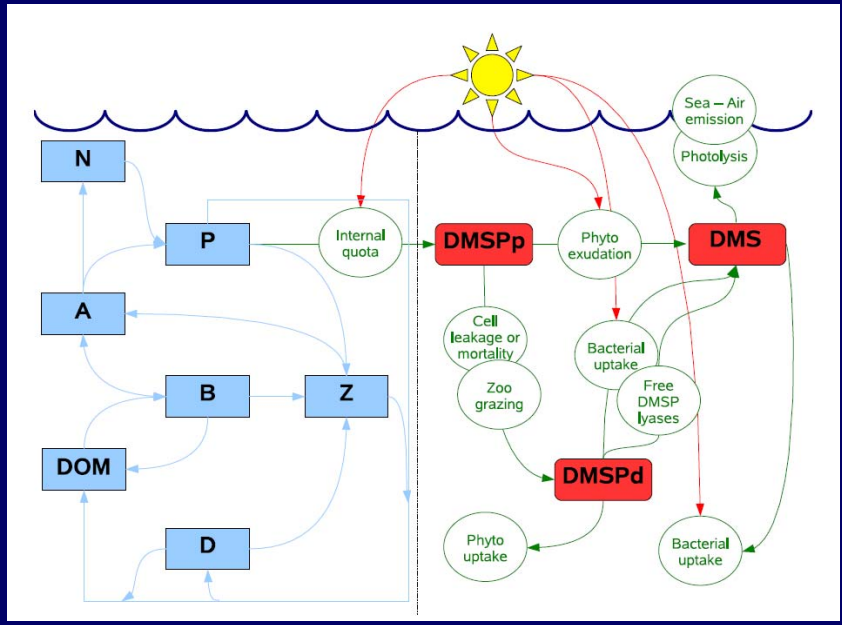


Saló, Simó & Calbet, in prep.

Conclusions

1) Microzooplankton grazing is an important source of DMS (~50% of gross production),

but…



2) Microzooplankton assimilate a large fraction of ingested DMSP thus diverting it from further transformation into DMS.