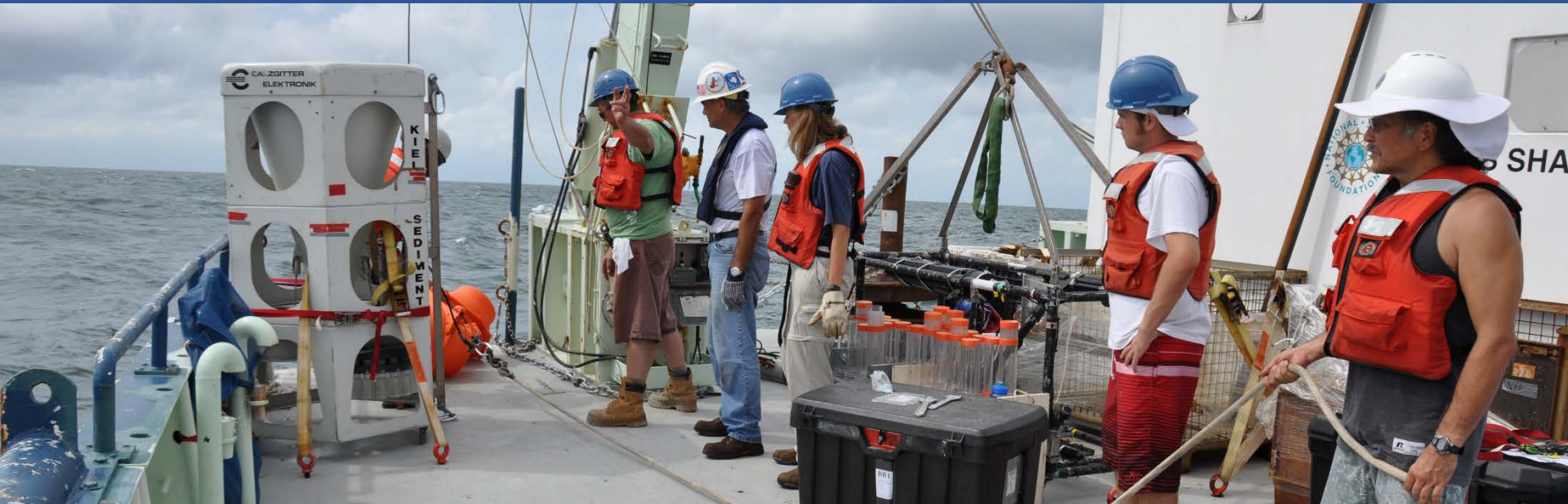


Climate change, phytoplankton export and carbon sequestration

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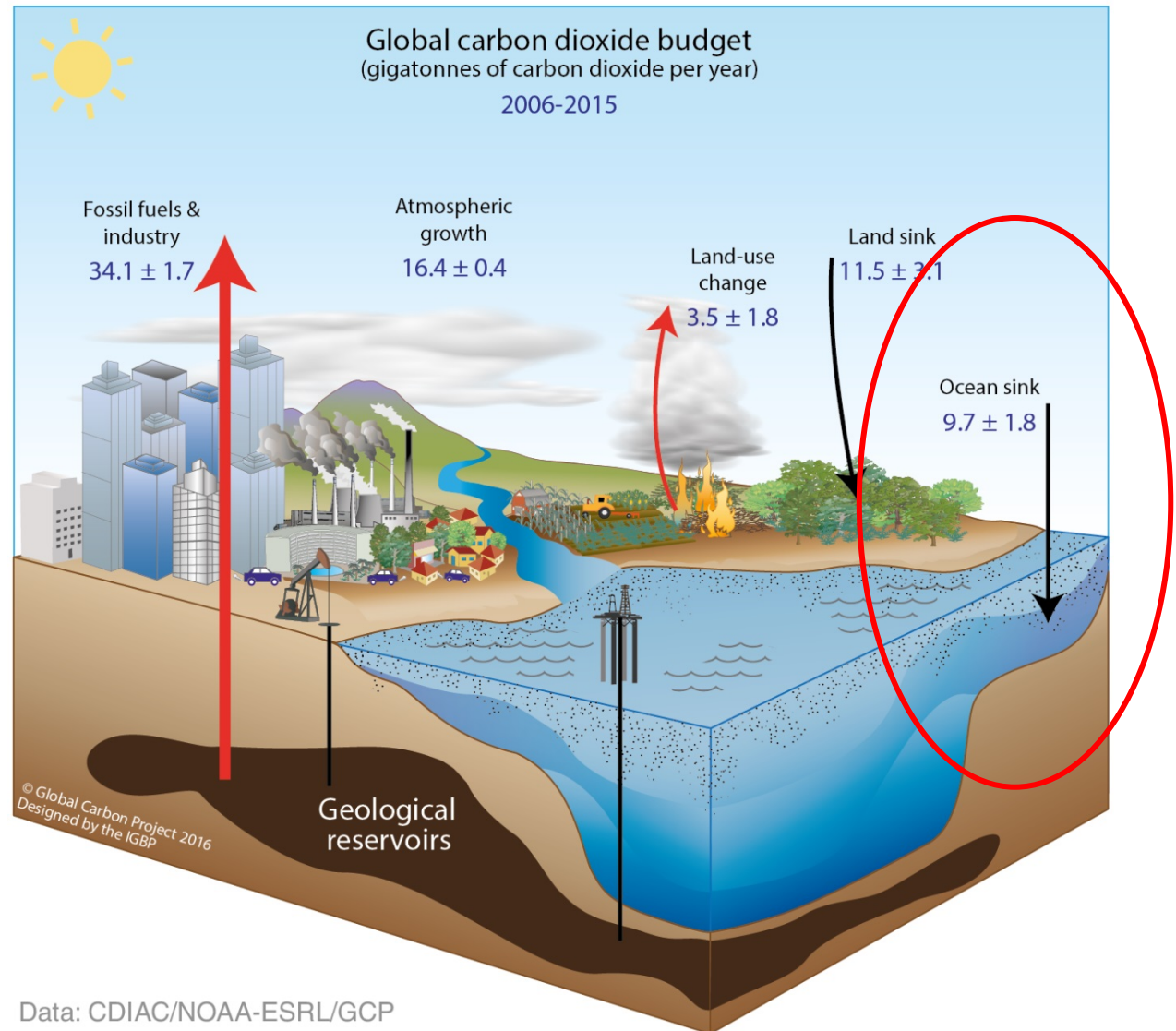
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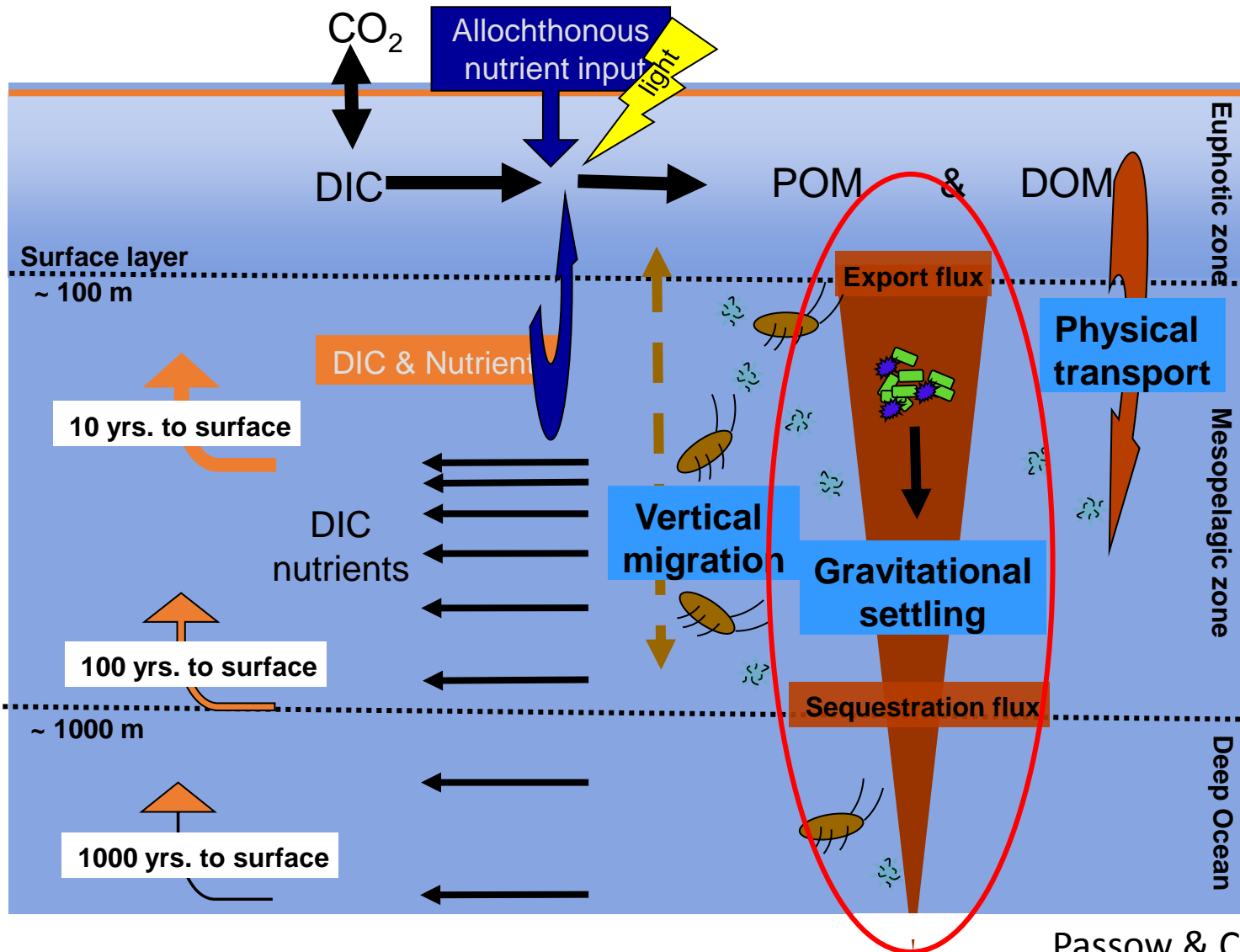


Many Undergraduates

Perturbation of the global carbon cycle caused by anthropogenic activities: Averaged for 2006–2015 (GtCO₂/yr)



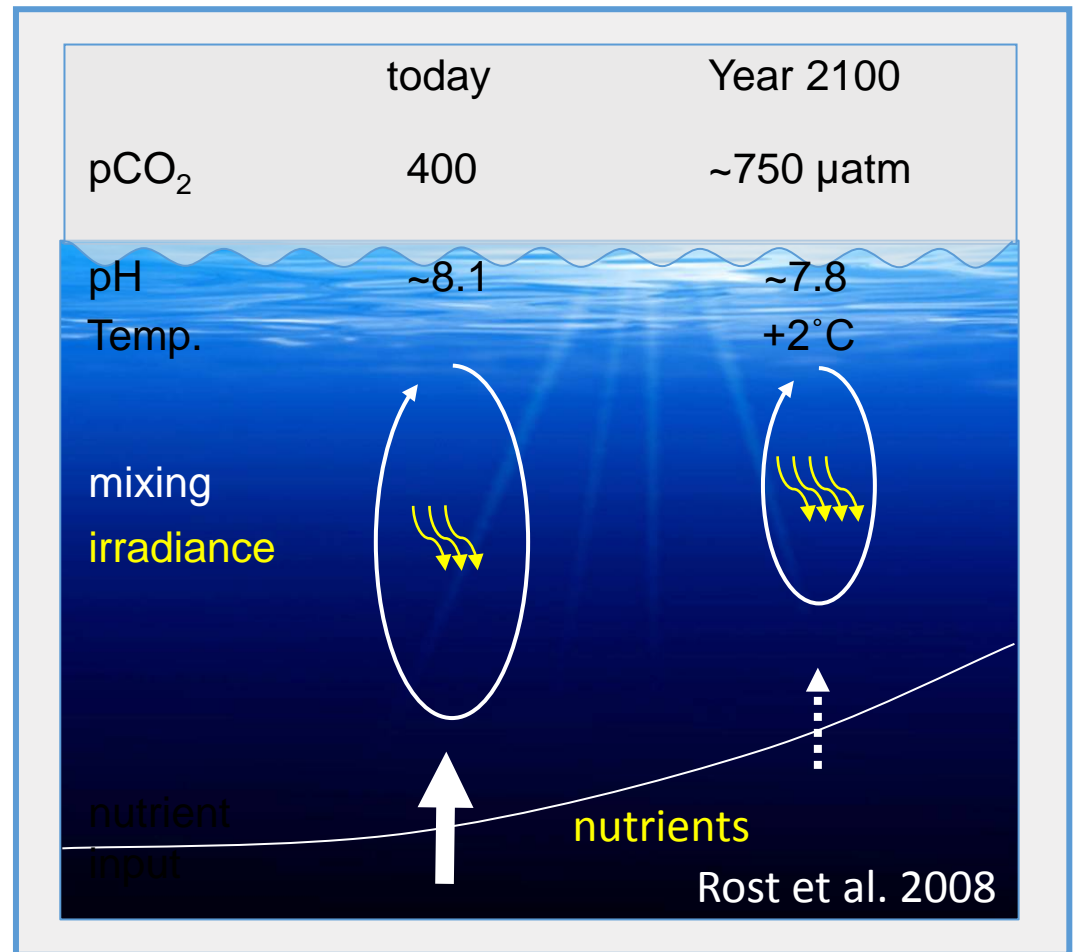
Will the Biological Carbon Pump strengthen with climate change?



A changing ocean

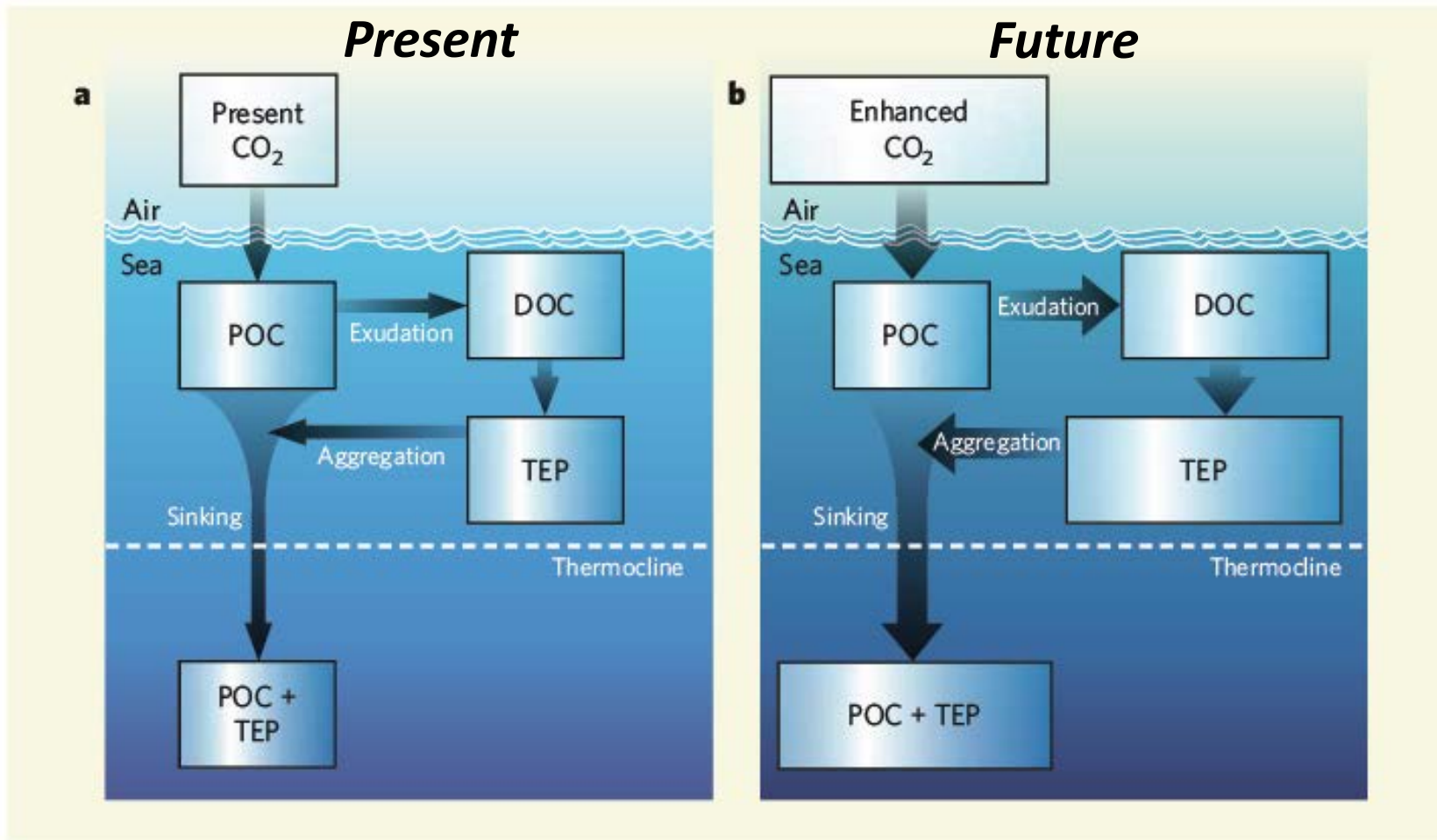
Will export flux increase in future ocean?

- **Ocean acidification**
 - pH and acid-base balance
 - Change in bioavailability of elements
- **Temperature**
- **Stratification change**
 - Light climate
 - Nutrient availability
 - Oxygenation
- **Nutrient input, eutrophication....**



Gravitational settling of marine snow

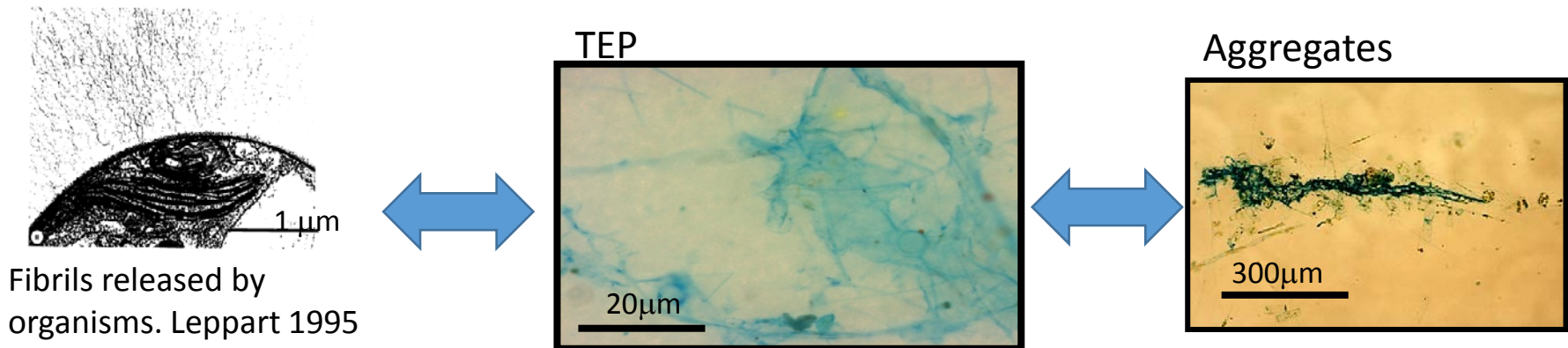
In 2007 the question if particle flux or the Biological Carbon Pump will intensify with climate change was answered with a clear YES !



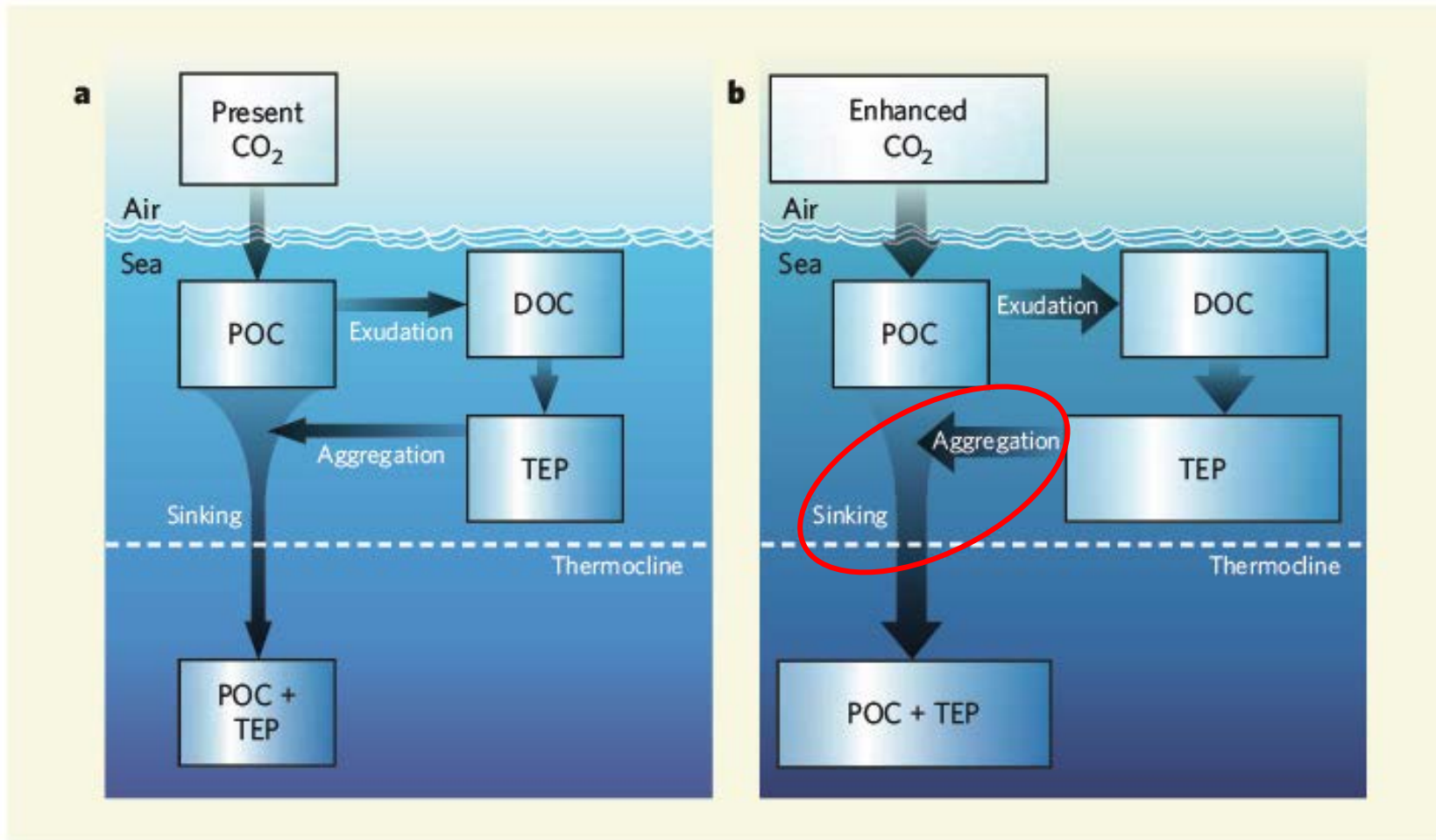
TEP: Transparent Exopolymer Particles

TEP

- are gel-particles
- form from fibrillar precursors released by phytoplankton
- act as glue sticking particles together
- form the matrix of marine snow – **essential for aggregation**
- **are positively buoyant** (Azetsu-Scott & Passow 2004)



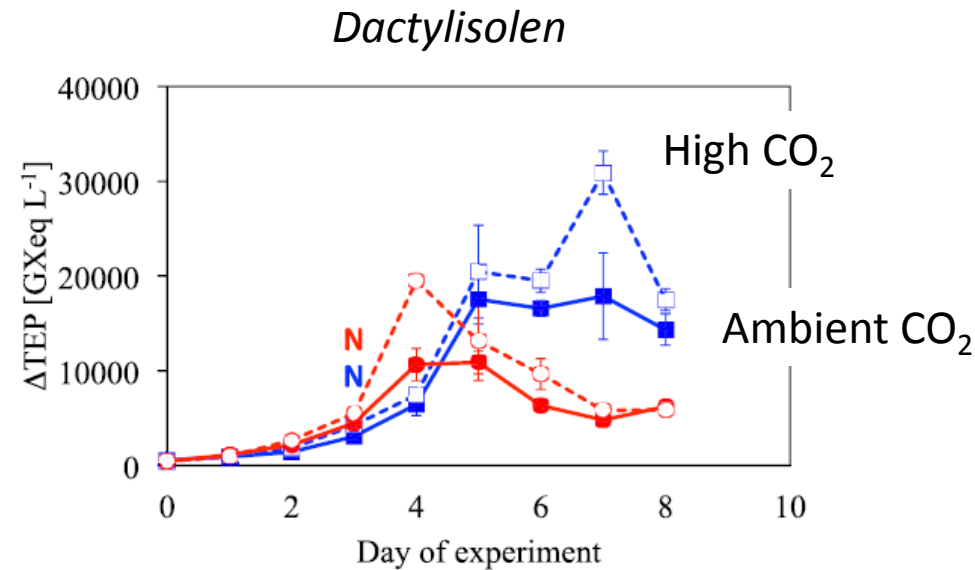
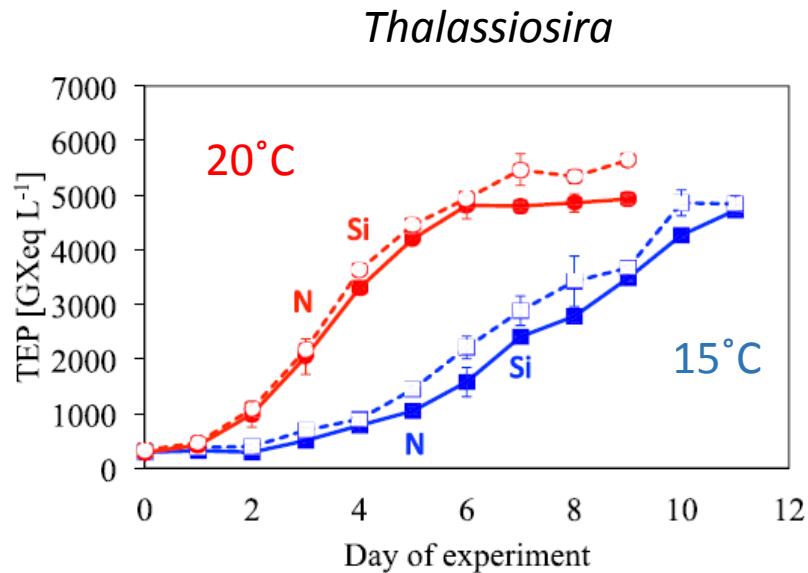
Gravitational settling of marine snow



However:

In 2004 we showed that TEP themselves are positively buoyant (Azetsu-Scott & Passow)

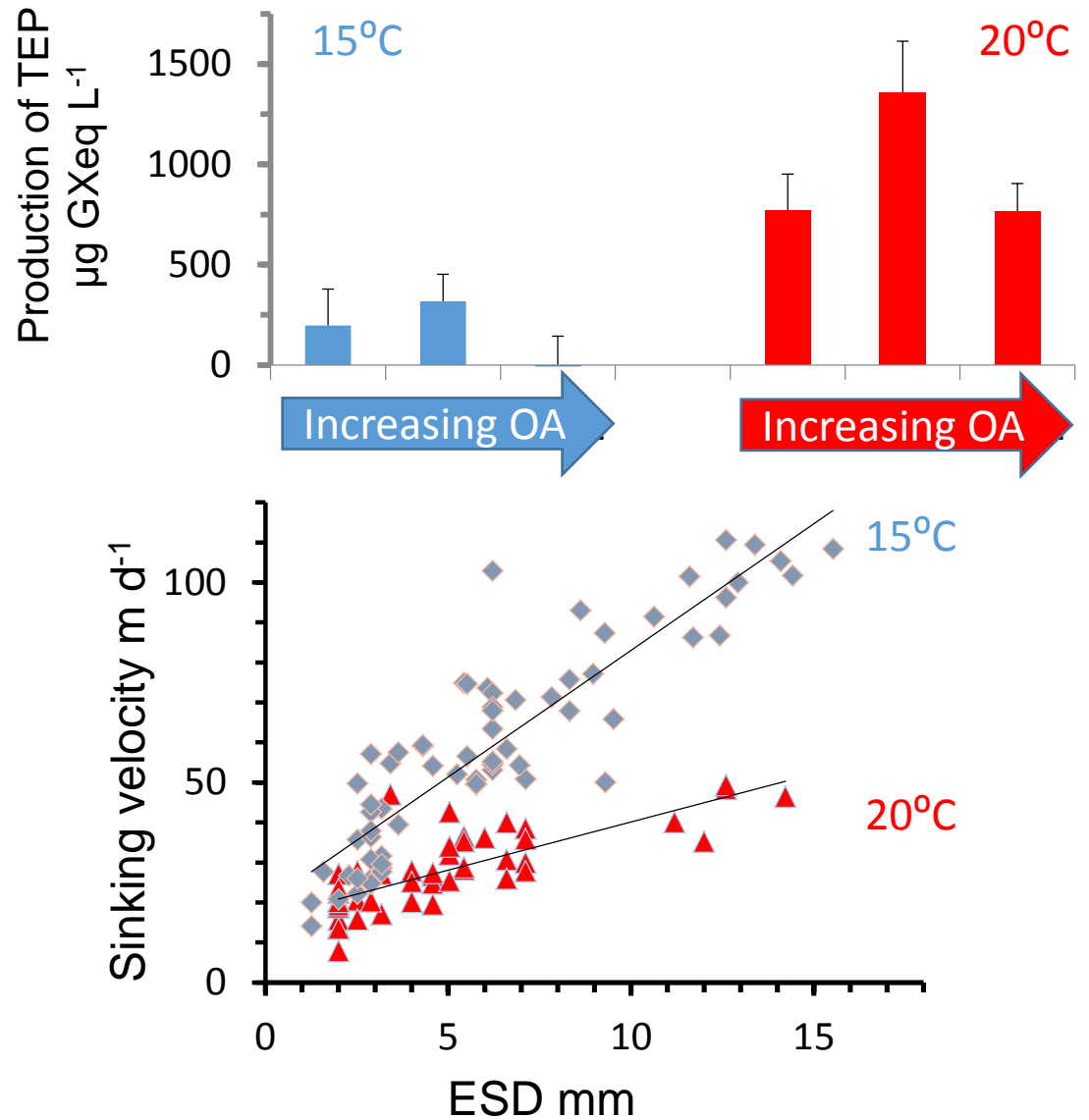
TEP concentration in diatom cultures



- TEP concentrations are sometimes elevated at higher growth temperatures
- TEP concentrations are always slightly elevated at higher $p\text{CO}_2$ (hatched vs solid lines)

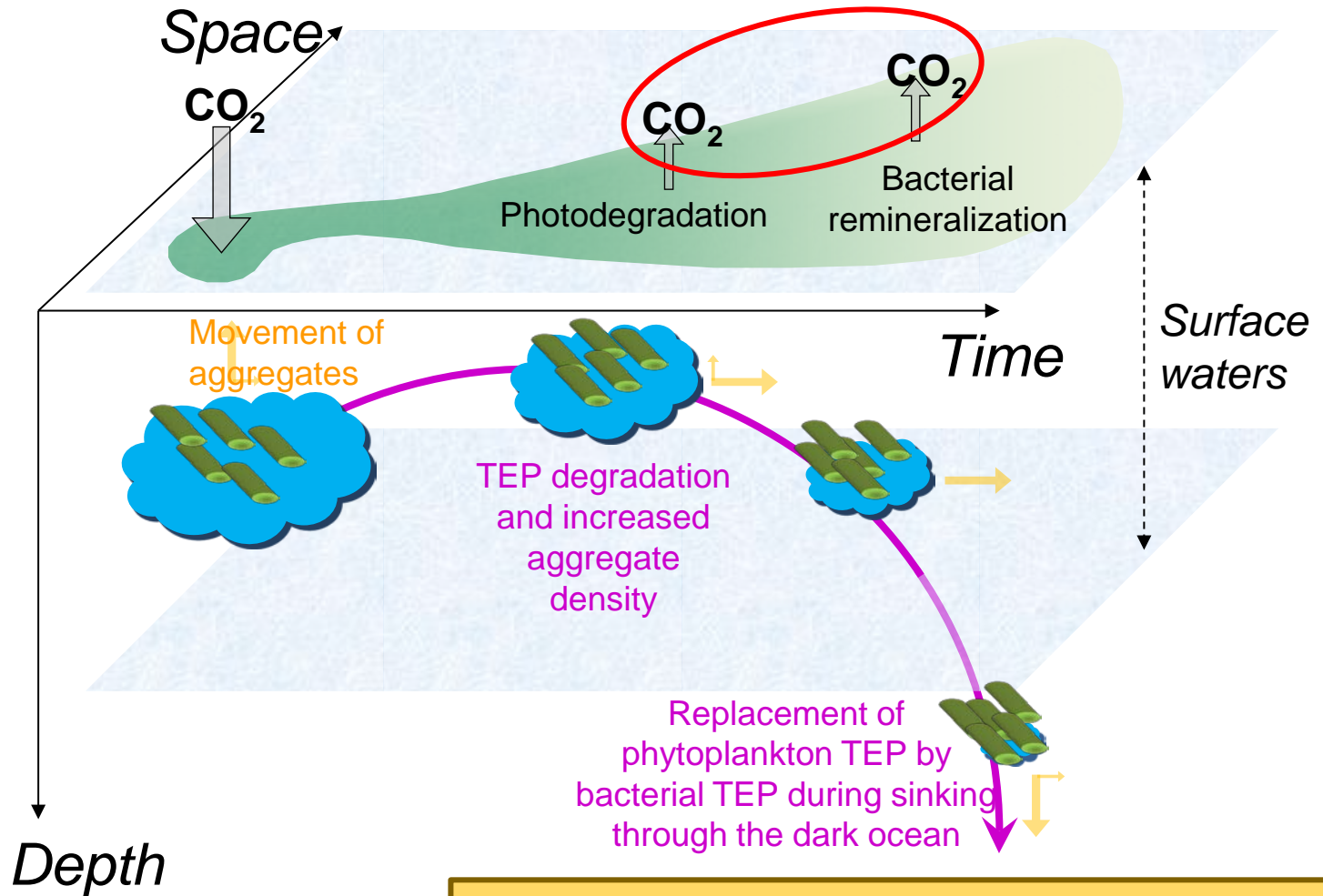
Sinking velocity as a function of TEP or temperature

- Elevated temperature leads to increased TEP production, but not OA
- Aggregates formed in treatments grown at elevated temperature, sank slower



Flux depends on ratio between TEP and solid particles

Temporal decoupling between production and sinking of POM (weeks to months)



More TEP, relative to total particle numbers, would lead to decreased flux potential

TEP across an OC-gradient in the N. Atlantic

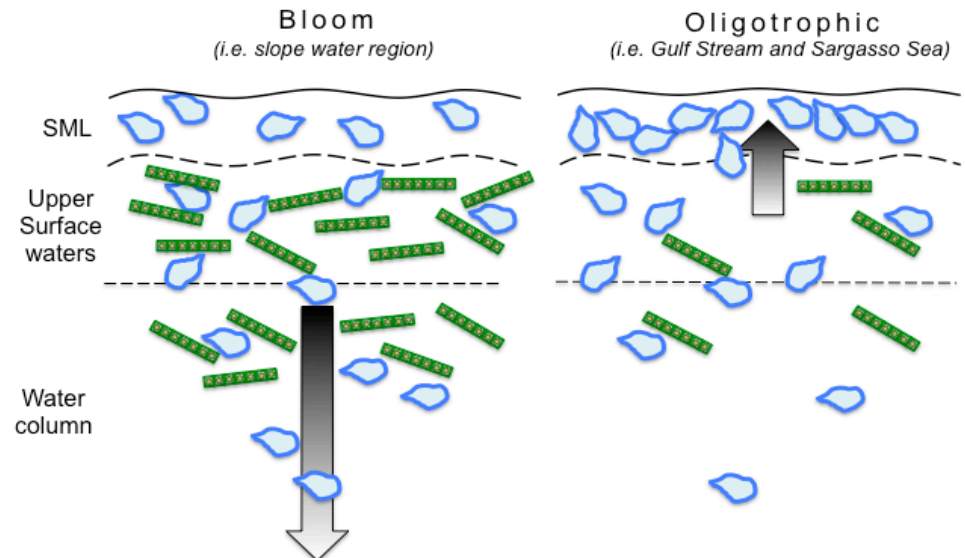
Surface Water	Coastal	Slope water	Gulf Stream
POC ($\mu\text{mol L}^{-1}$)	18	20	9
TOC ($\mu\text{mol L}^{-1}$)	94	83	72
POC/TOC (%)	23	24	13
TEP-C ($\mu\text{mol L}^{-1}$)	33	18	10

← Organic Carbon gradient in SSW

Sea surface Microlayer	Coastal	Slope water	Gulf Stream
TEP ($\mu\text{mol L}^{-1}$)	94	241	405
% TEP	40	60	80
EF_{TEP}	3	13	34

TEP gradient in SML →

On a scale of water masses TEP are more enriched in the sea surface microlayer (SML) if solid particle concentrations in the SSW are low.



Will the Biological Carbon Pump strengthen with climate change?

*Changes in environmental conditions will interactively affect primary production including exudation and TEP formation in a currently unpredictable direction, but there is a **tendency towards increased TEP production under future climate scenarios.***

*The ratio between gel-particles (TEP) and “solid” particles determines flux vs. retention, not the absolute amount of TEP. **Increased TEP production does not imply increased sedimentation, on the contrary!***

A dramatic sunset over the ocean. The sun is a bright yellow-orange orb just above the horizon, casting a shimmering path of light across the dark, choppy water. The sky is filled with large, dark, billowing clouds that are illuminated from below, creating a range of colors from deep purple and blue to bright orange and yellow. The overall mood is serene and powerful.

Thank you!