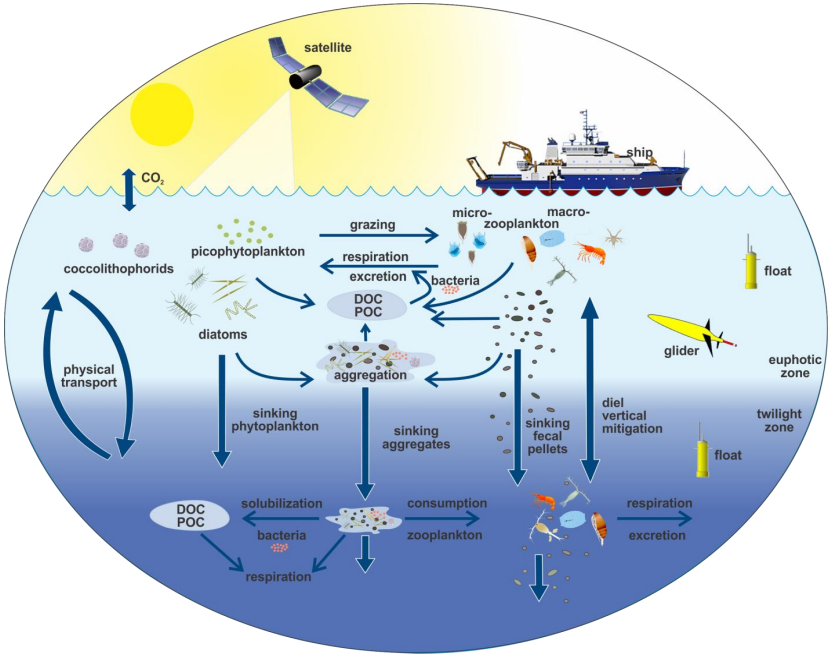
EXPORTS

EXport **P**rocesses in the **O**cean from **R**emo**T**e **S**ensing



Dave Siegel (UCSB) & Ken Buesseler (WHOI)

EXPORTS Writing Team: Mike Behrenfeld (OSU), Claudia Benitez-Nelson (USoCar), Emmanuel Boss (UMaine), Mark Brzezinski (UCSB), Adrian Burd (UGA), Craig Carlson (UCSB), Eric D'Asaro (UW), Scott Doney (WHOI), Mary Jane Perry (UMaine), Rachel Stanley (WHOI), Deb Steinberg (VIMS)

What is EXPORTS?

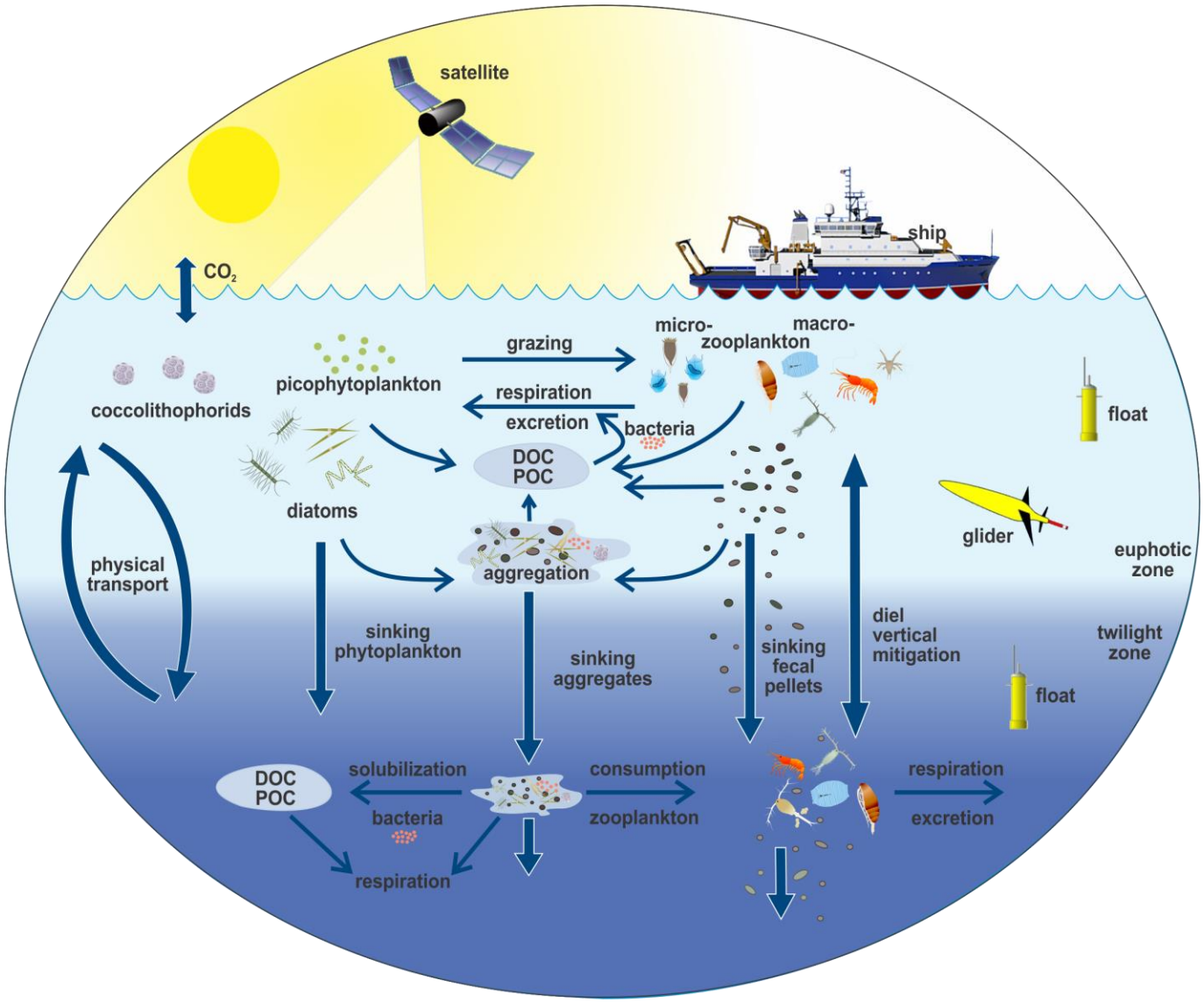
A community-vetted science plan for a NASA field campaign

Predict the **state** of the biological carbon pump from satellite (& maybe other) observations

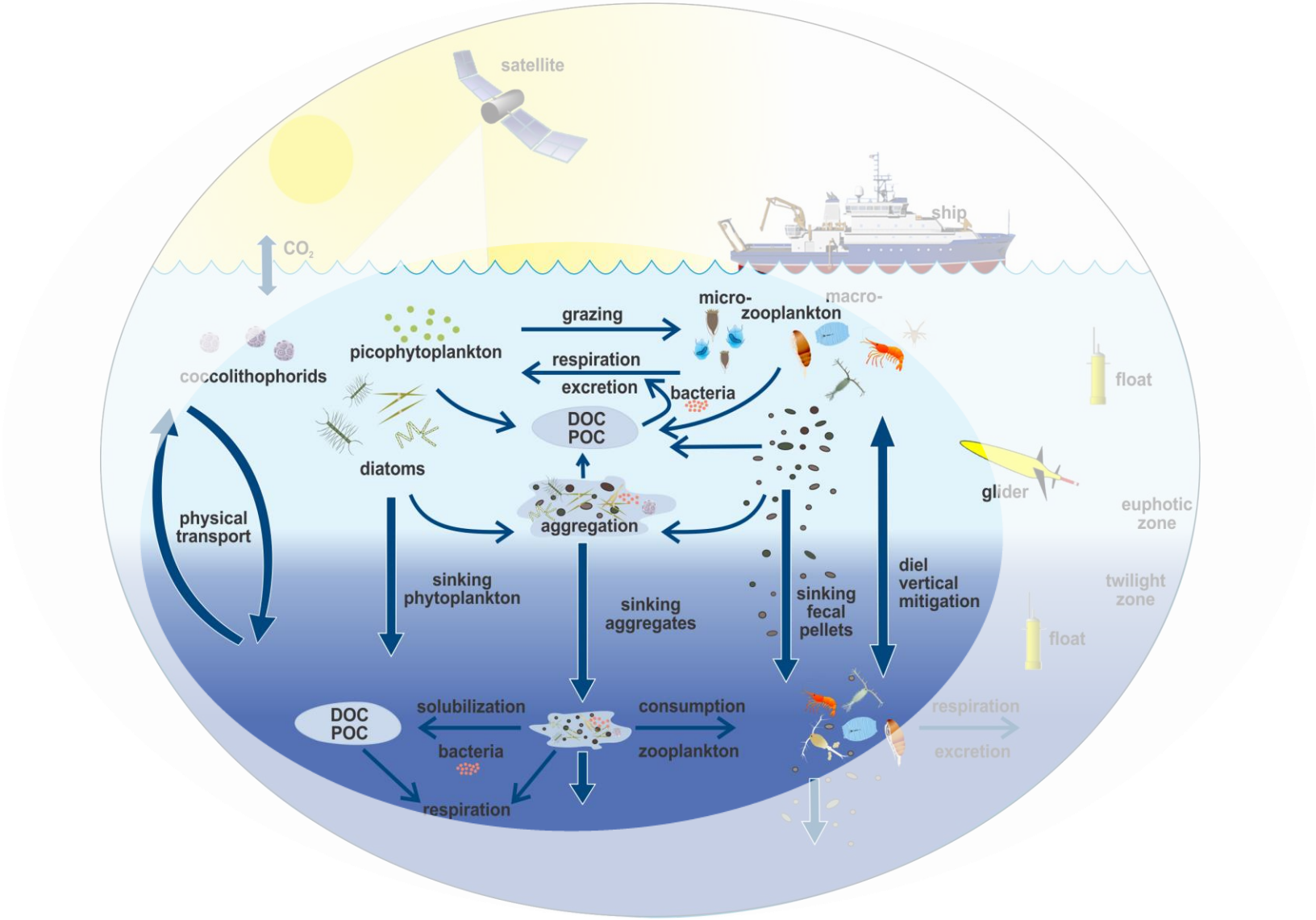
Final Science Plan Submission: June 2014

Projected start date: 2017 (if approved)

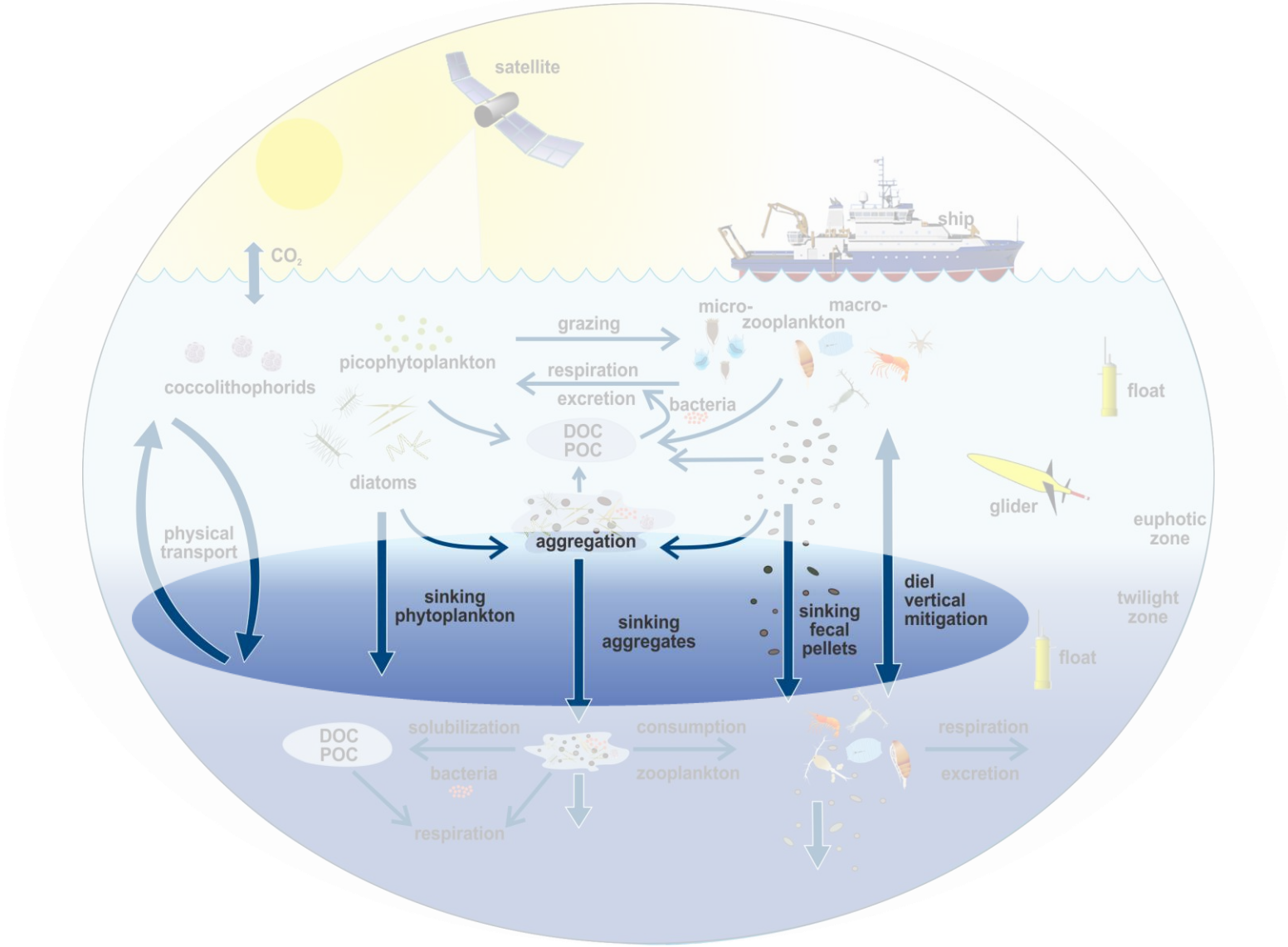
Why EXPORTS?


satellite
ship
CO_2
micro-
macro-
zooplankton
grazing
picophytoplankton
respiration
excretion
bacteria
coccolithophorids
DOC
POC
diatoms
float
glider
physical
transport
aggregation
euphotic
zone
sinking
phytoplankton
sinking
aggregates
sinking
fecal
pellets
diel
vertical
mitigation
twilight
zone
float
DOC
POC
solubilization
consumption
bacteria
zooplankton
respiration
excretion
respiration

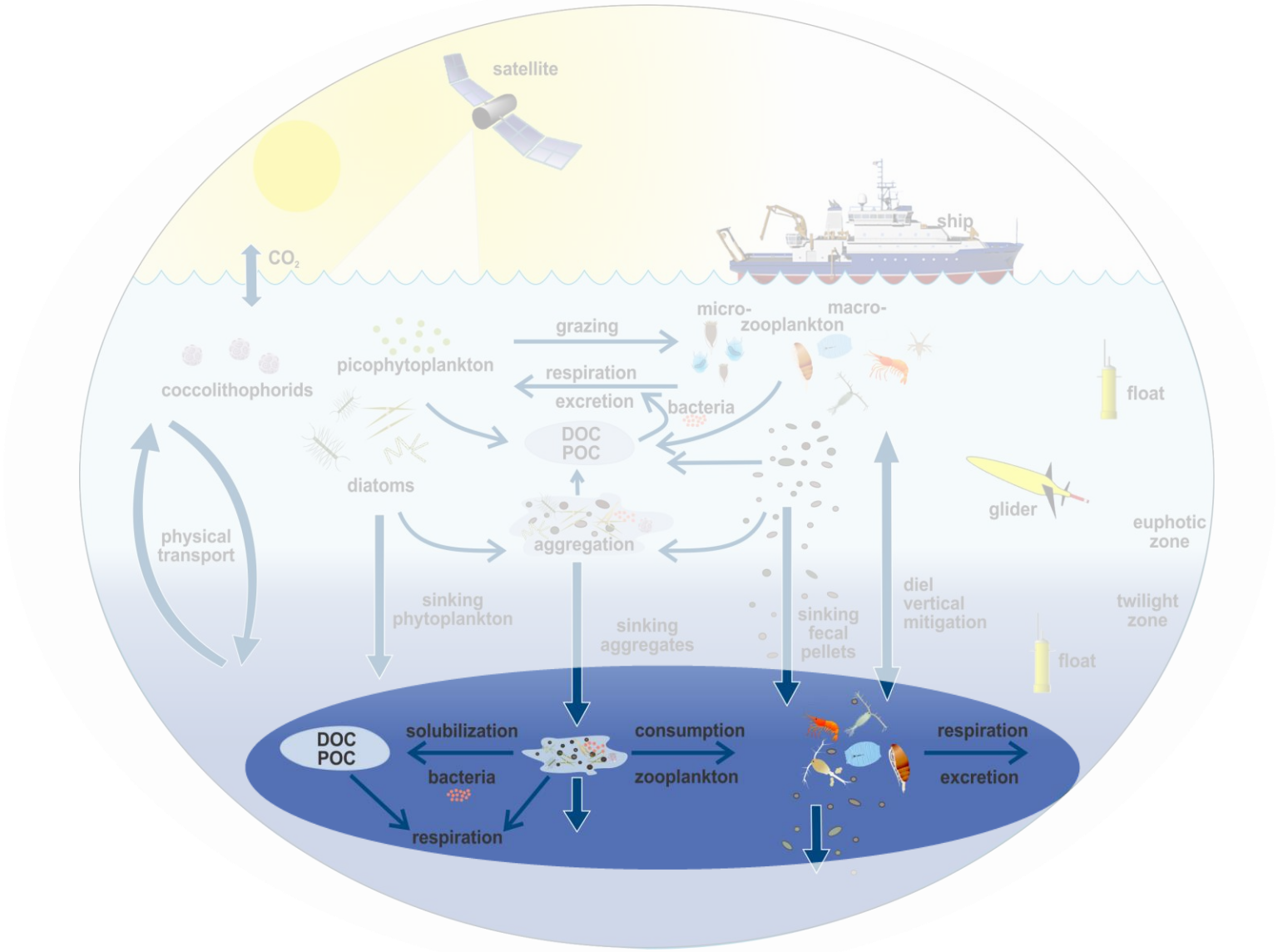
Why? Need to understand, quantify & predict how ecosystem processes transfer organic matter to depth



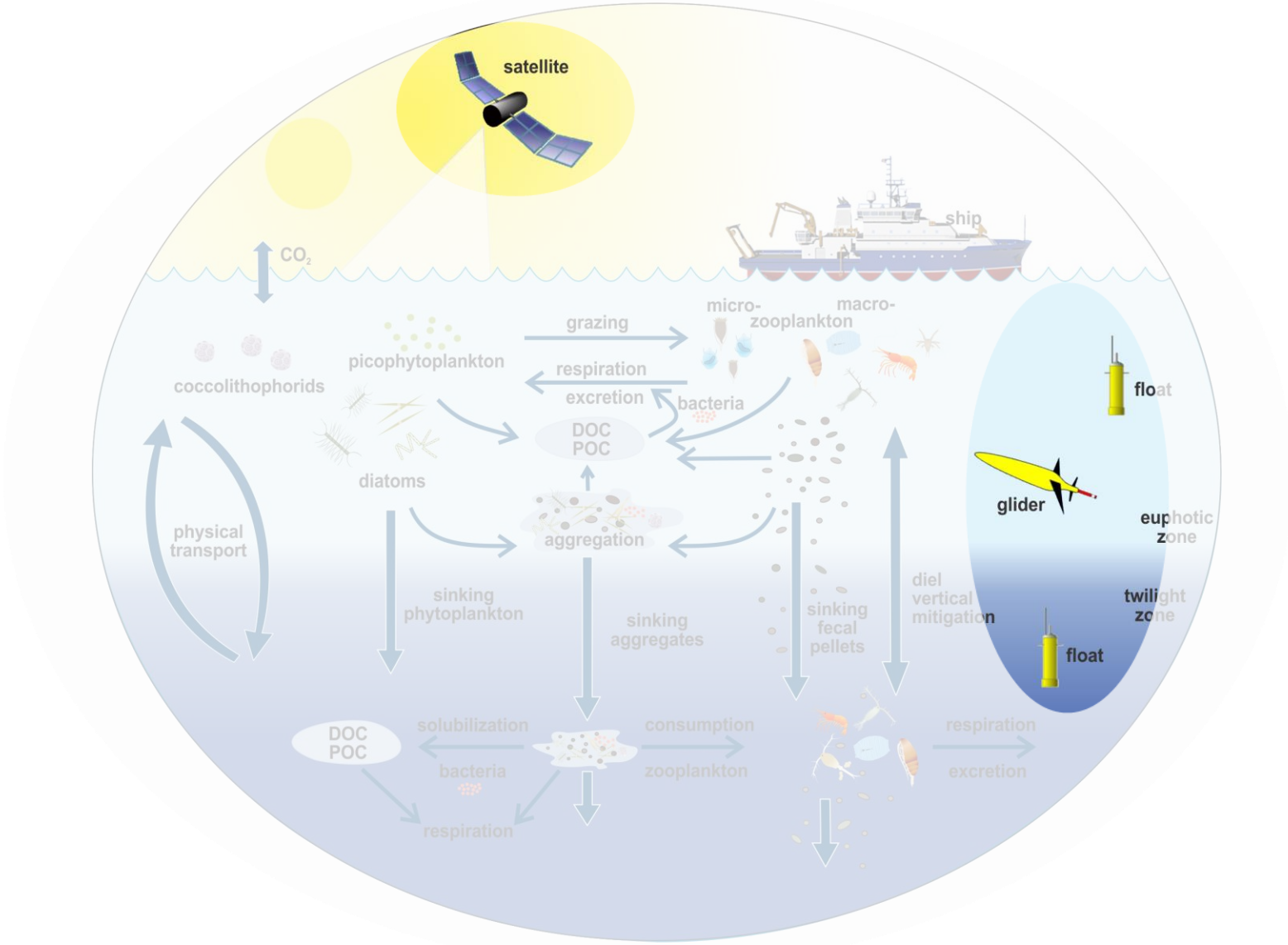
Why? Improve global estimates of carbon export from the euphotic zone (4 to >12 Pg C y^{-1})



Why? Need to quantify the attenuation of export below euphotic zone (the twilight zone)

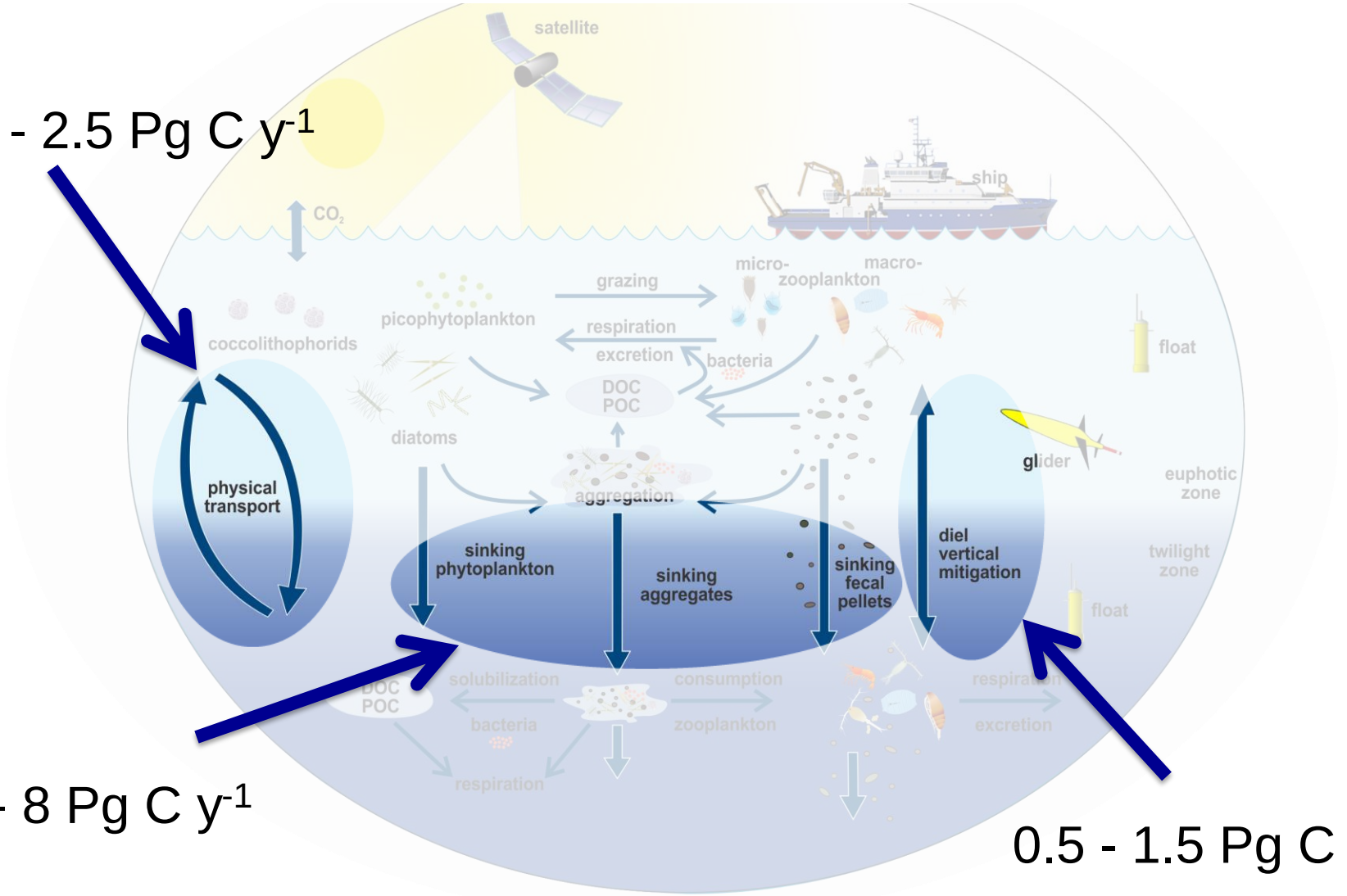


Why Now? Advances in remote sensing (& PACE!!) & autonomous tools make it time!



EXPORTS: Focus on Pathways

Summing over the pathways gets 5 to 12 Pg C y^{-1}



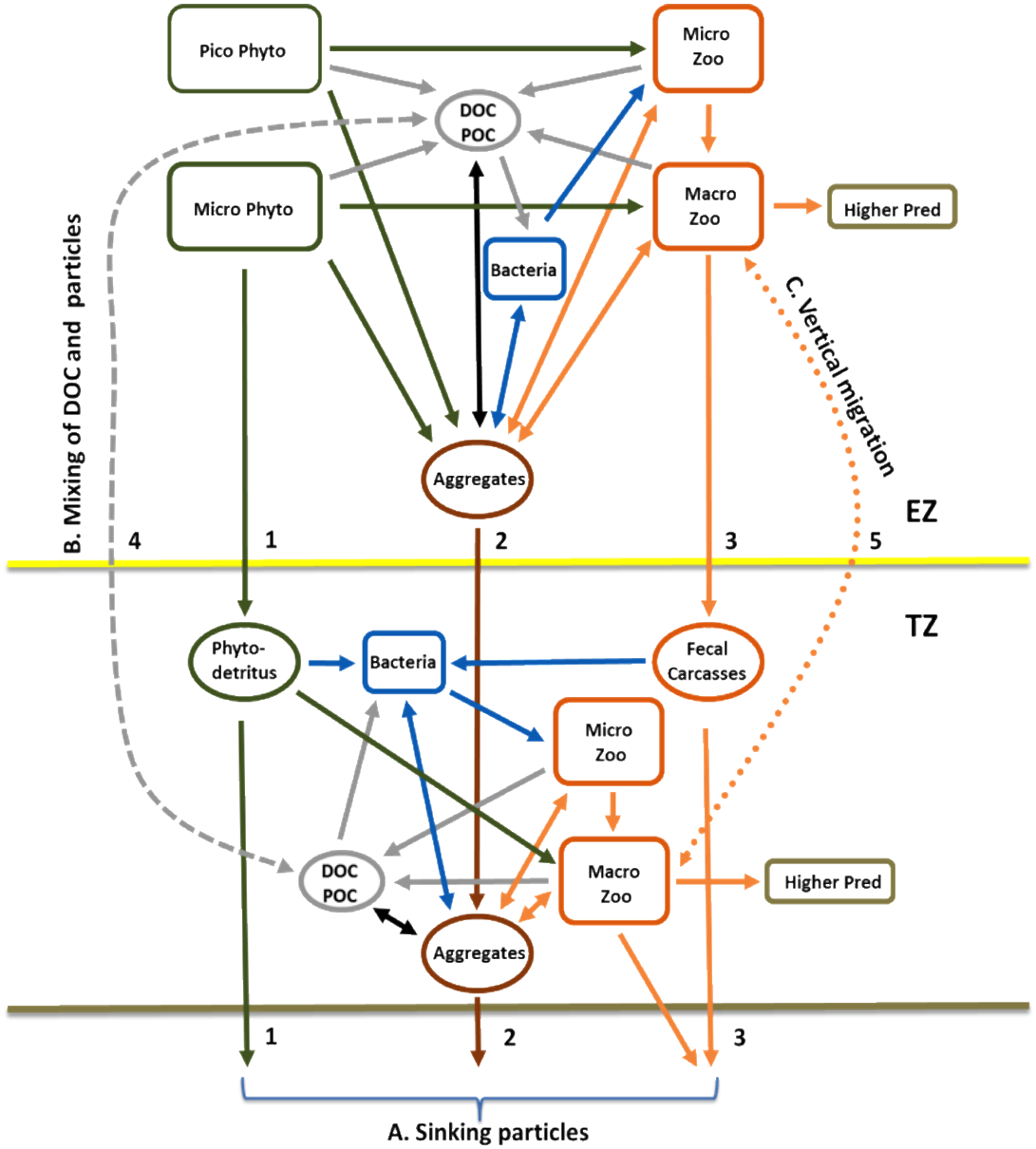
EXPORTS: Observing the Biological Pump's Pathways

Seek a **mechanistic understanding** of the **pathways** driving the biological pump

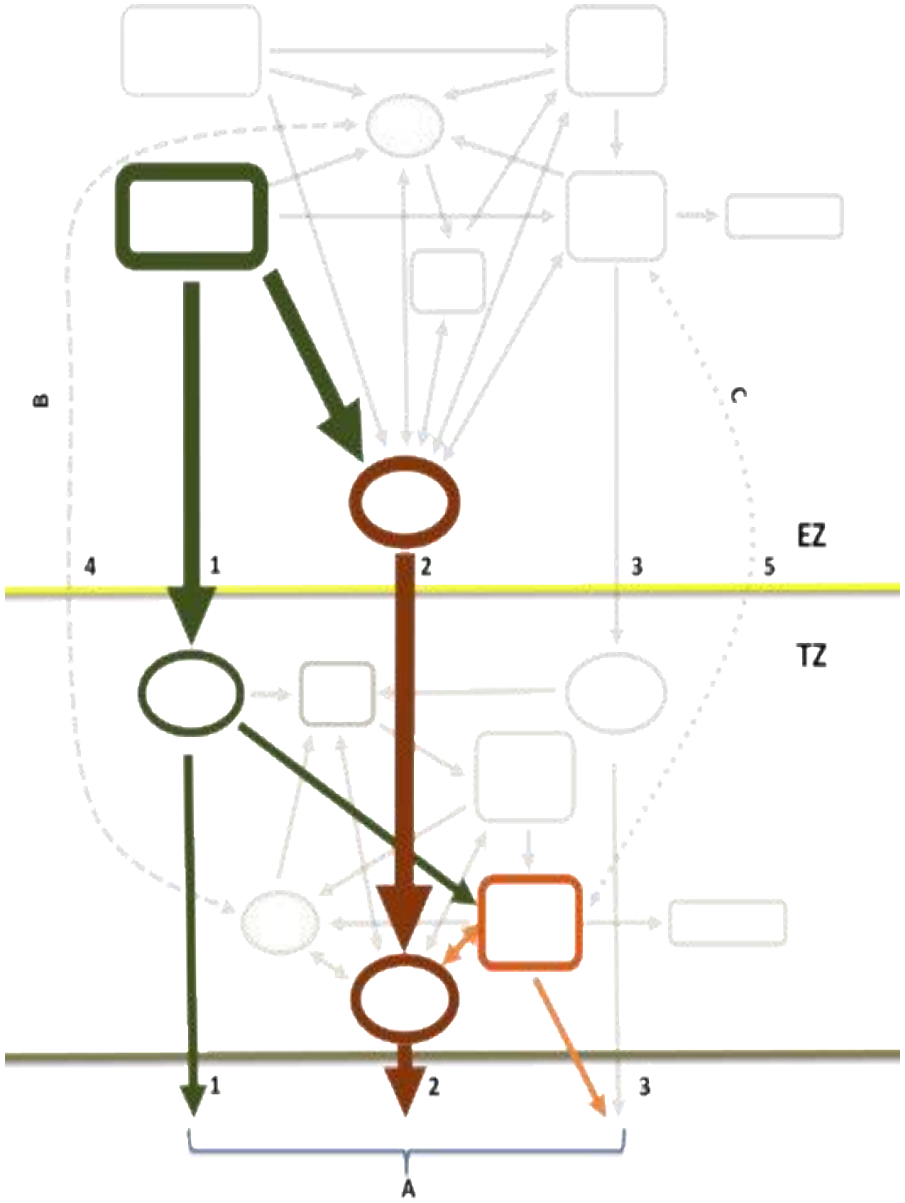
Needed for **building models and predicting** present & future states of the biological pump

Goal: Predict the state of the biological pump given surface ecosystem characteristics

EXPORTS: Focus on Pathways



Different Pathways for Different States



North Atlantic Bloom

Large phytoplankton

Large export flux from the Euphotic Zone

Weak flux attenuation in the Twilight Zone

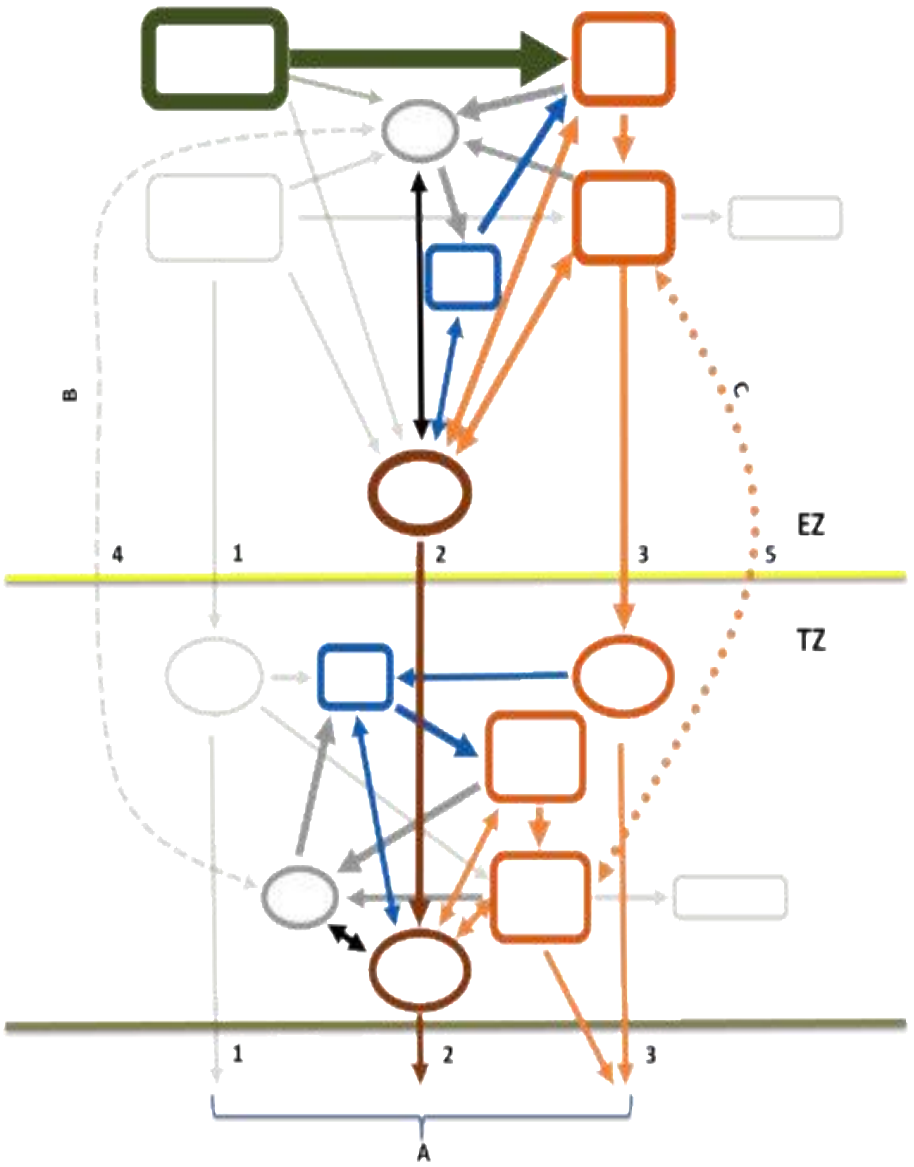
Different Pathways for Different States

Northeast Pacific Summer

Small phytoplankton & microbial loop dominance

Weak export from the Euphotic Zone

Strong flux attenuation in the Twilight Zone



EXPORTS: Three Science Questions

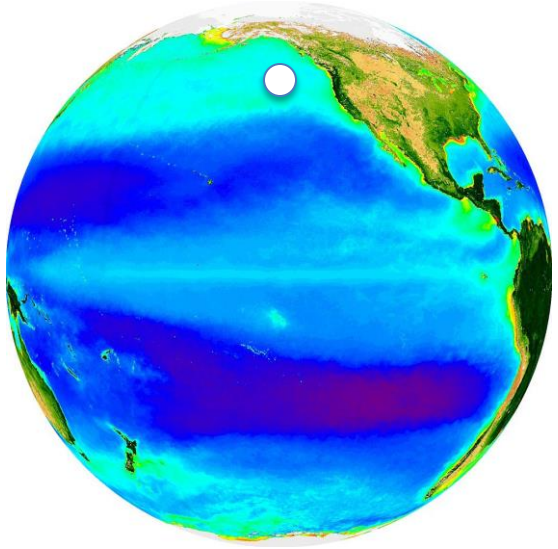
How do plankton community composition & ecological-physical interactions determine the vertical transfer of organic matter from the well-lit surface ocean?

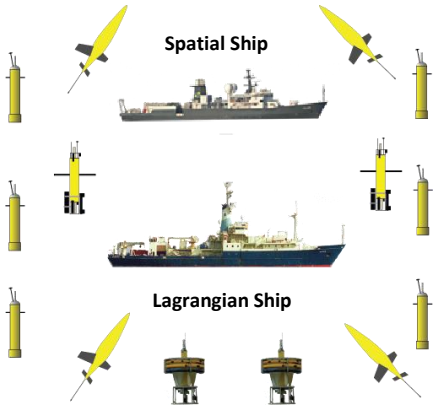
What controls the efficiency of vertical transfer of organic matter below the well-lit surface ocean?

How can the knowledge gained be used to reduce uncertainties in contemporary & future estimates of the biological pump?

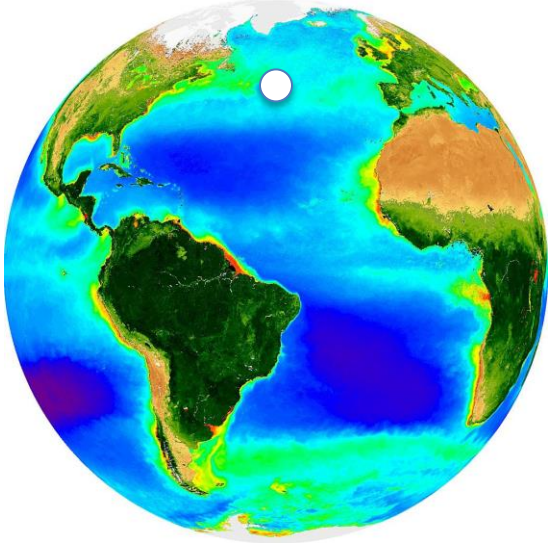
EXPORTS: Experimental Plan

Station P





North Atlantic

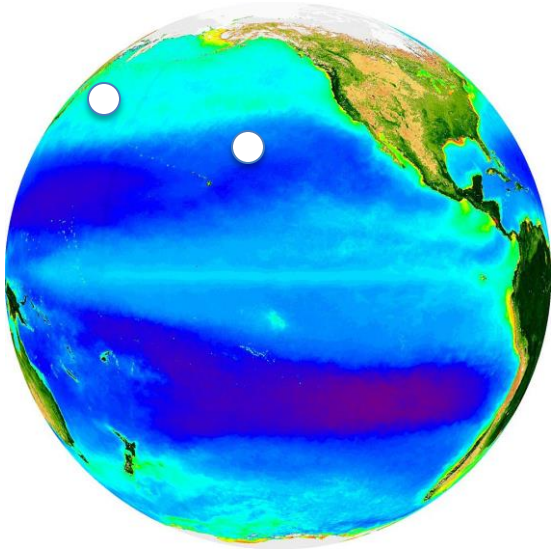


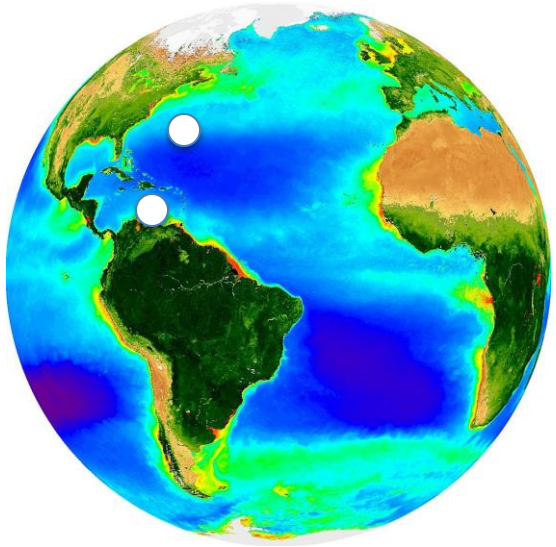
Cruise 1: April/May 30d
(40d survey)
Cruise 2: Aug, 30d
Leverage: OOI node, LineP

Bloom: April/May 45 d
Non-bloom: Aug, 30d
Leverage: PAP & other international partners

Will collect up to 8 states of the biological pump

EXPORTS: Experimental Plan





Data Mining

Compile secondary datasets of more biological pump states from other sites

Extends the number of “states” available for modeling building

Examples include:
BATS, HOT, CARIACO, VERTIGO, MAREDAT etc.

EXPORTS: Experimental Plan

Water-following
follow instrumented mixed layer float(s?)

Follow Particles
from production to trap
Measure C cycling fluxes from 0 to 500 m (over 10 d)

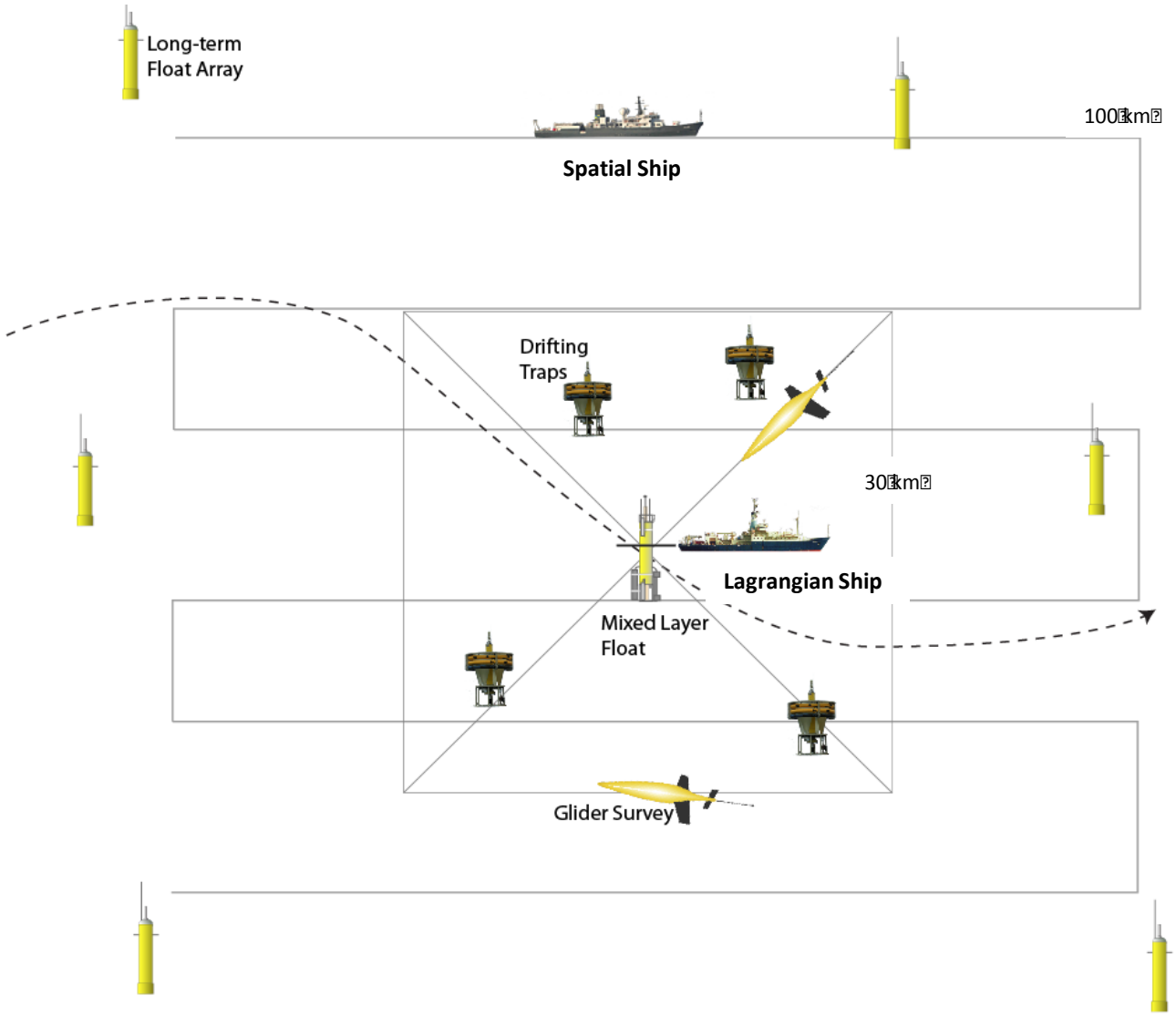
Lagrangian Ship
Measure rates & transformations

Spatial Ship
Submeso- & meso-scale surveys (5-200 km)
Deploy short-term assets

Long Term Presence
Profiling floats (& Satellites)
BioARGO, PSD & export proxy
Annual BGC budgeting
O_2, NO_3, DOC, DIC, etc.

Optimize Spatial Sampling
Gliders surveying (5-100 km)
Bio-optical proxies
Satellite sampling
Ocean color & supporting

EXPORTS: Experimental Plan



Two Ships

"Lagrangian"

"Spatial

Autonomous Array

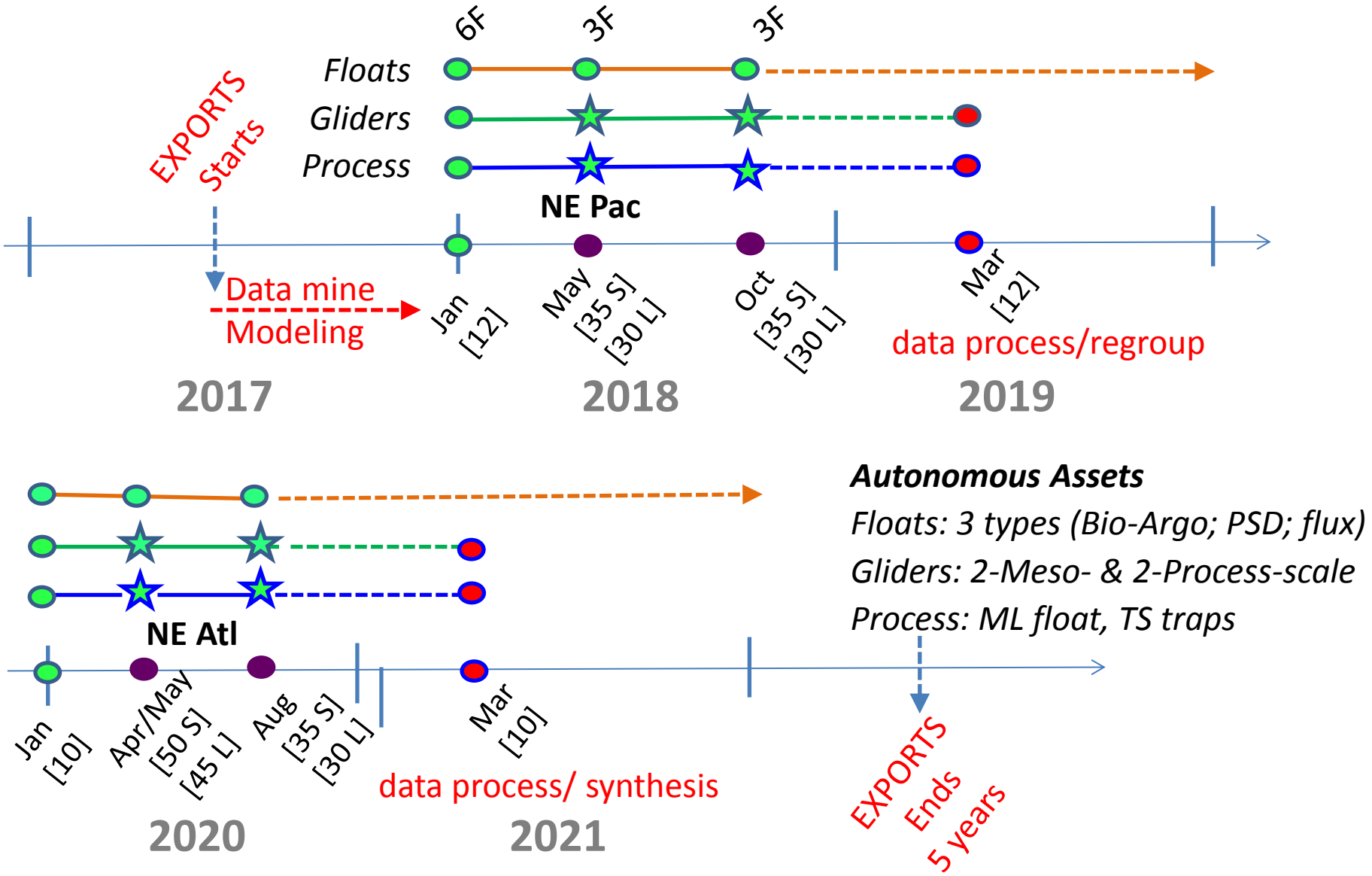
Mixed layer float

Glider surveying

Drifting traps

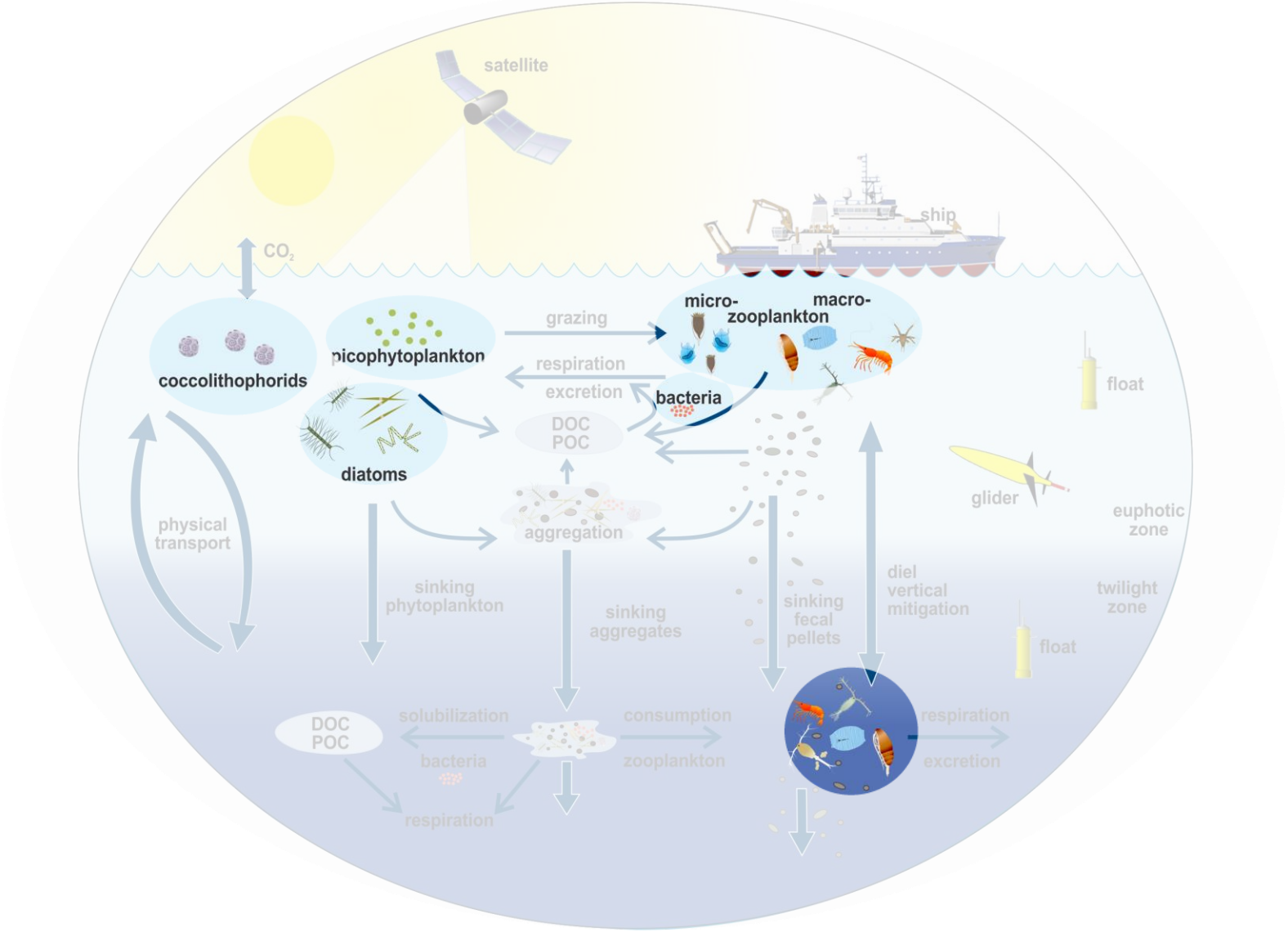
Multiple floats

Bio-Argo, PSD, export


6F
3F
3F
Floats
Gliders
Process
EXPORTS Starts
NE Pac
Data mine
Modeling
Jan [12]
May [35 S] [30 L]
Oct [35 S] [30 L]
Mar [12]
data process/regroup
2017
2018
2019
NE Atl
Jan [10]
Apr/May [50 S] [45 L]
Aug [35 S] [30 L]
Mar [10]
data process/ synthesis
2020
2021
EXPORTS Ends 5 years
Autonomous Assets
Floats: 3 types (Bio-Argo; PSD; flux)
Gliders: 2-Meso- & 2-Process-scale
Process: ML float, TS traps
= Process & Survey Cruises - includes multi depth trapping, rates, tow-yo SMS mapping, zooplankton tows, full bio-optics, etc.
= deploy autonomous assets
= recover autonomous assets

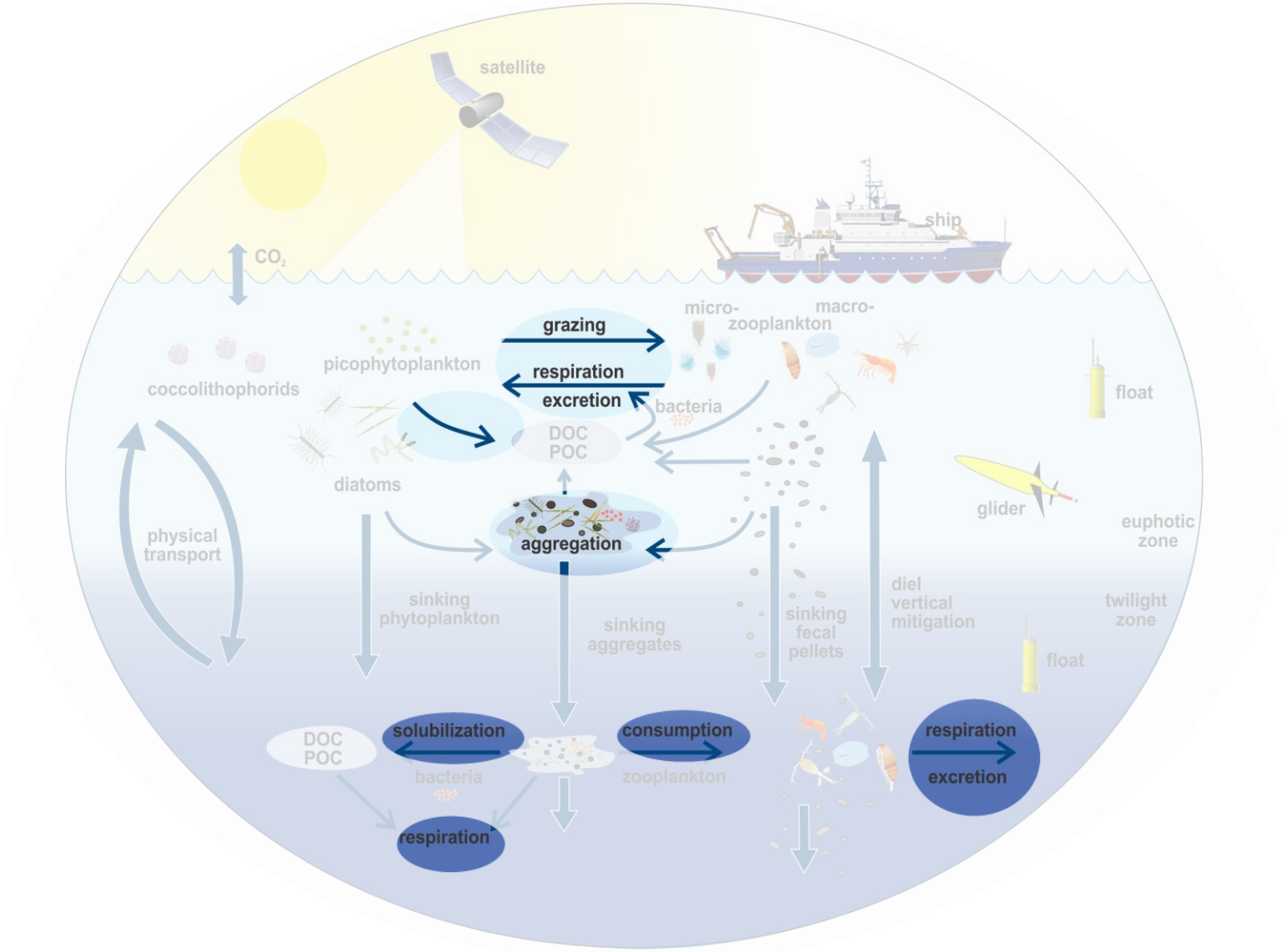
EXPORTS: Observables

Ecosystem Structure: Community Characteristics



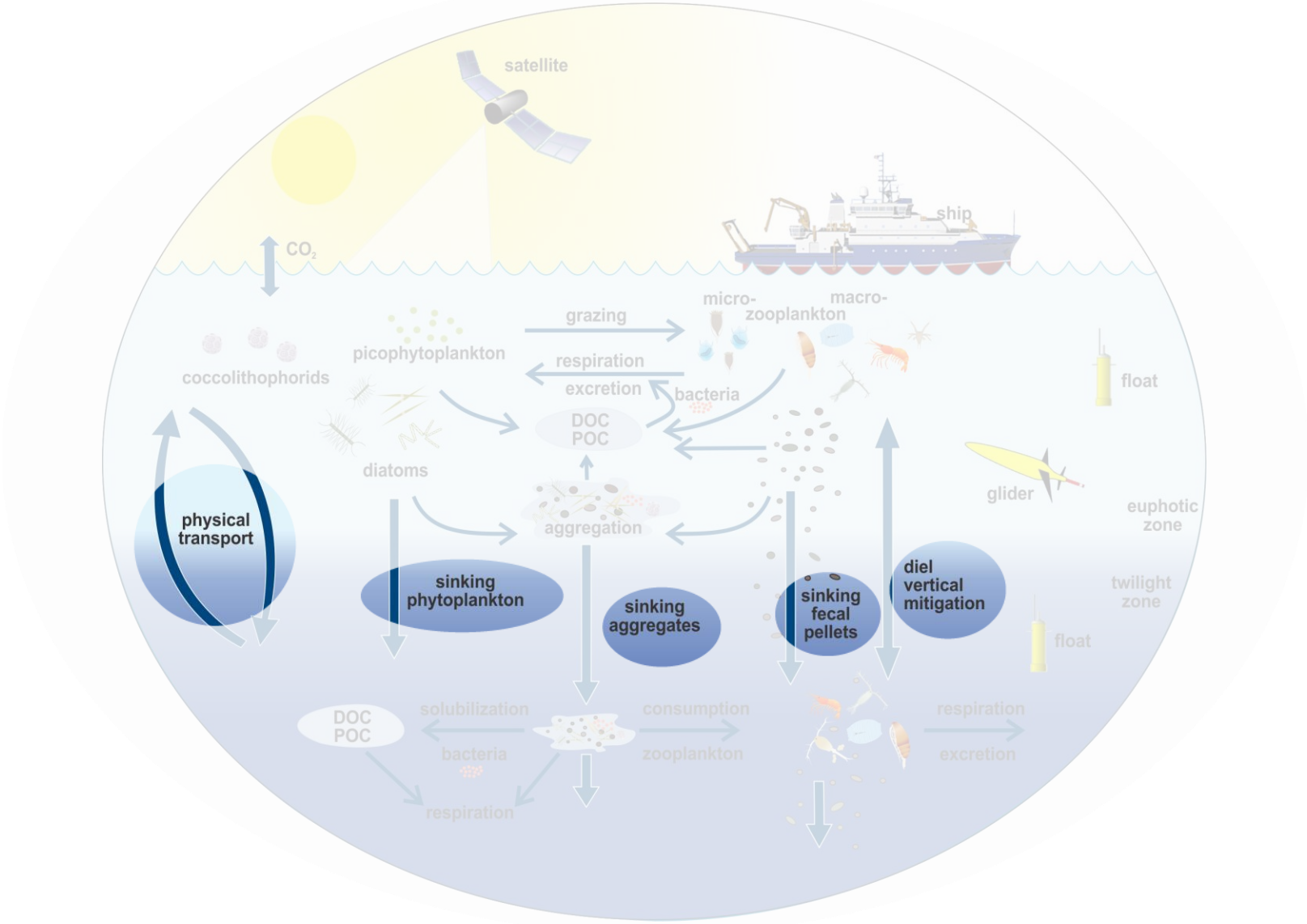
EXPORTS: Observables

Ecosystem Function: Physiology, rates, processes



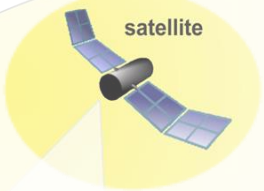
EXPORTS: Observables

Multiple paths to export & its attenuation with depth



EXPORTS: Observables

Water Column Characterization



Ocean Optics:

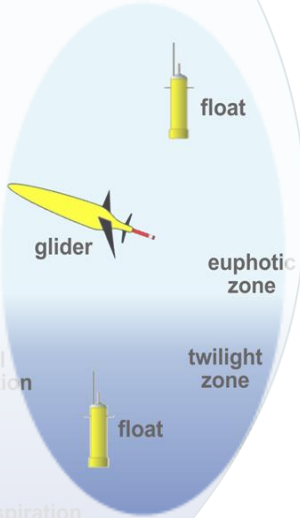
$R_{rs}(\lambda)$, $E_d(z,\lambda)$, IOP's, PSD, etc.

Biogeochemistry:

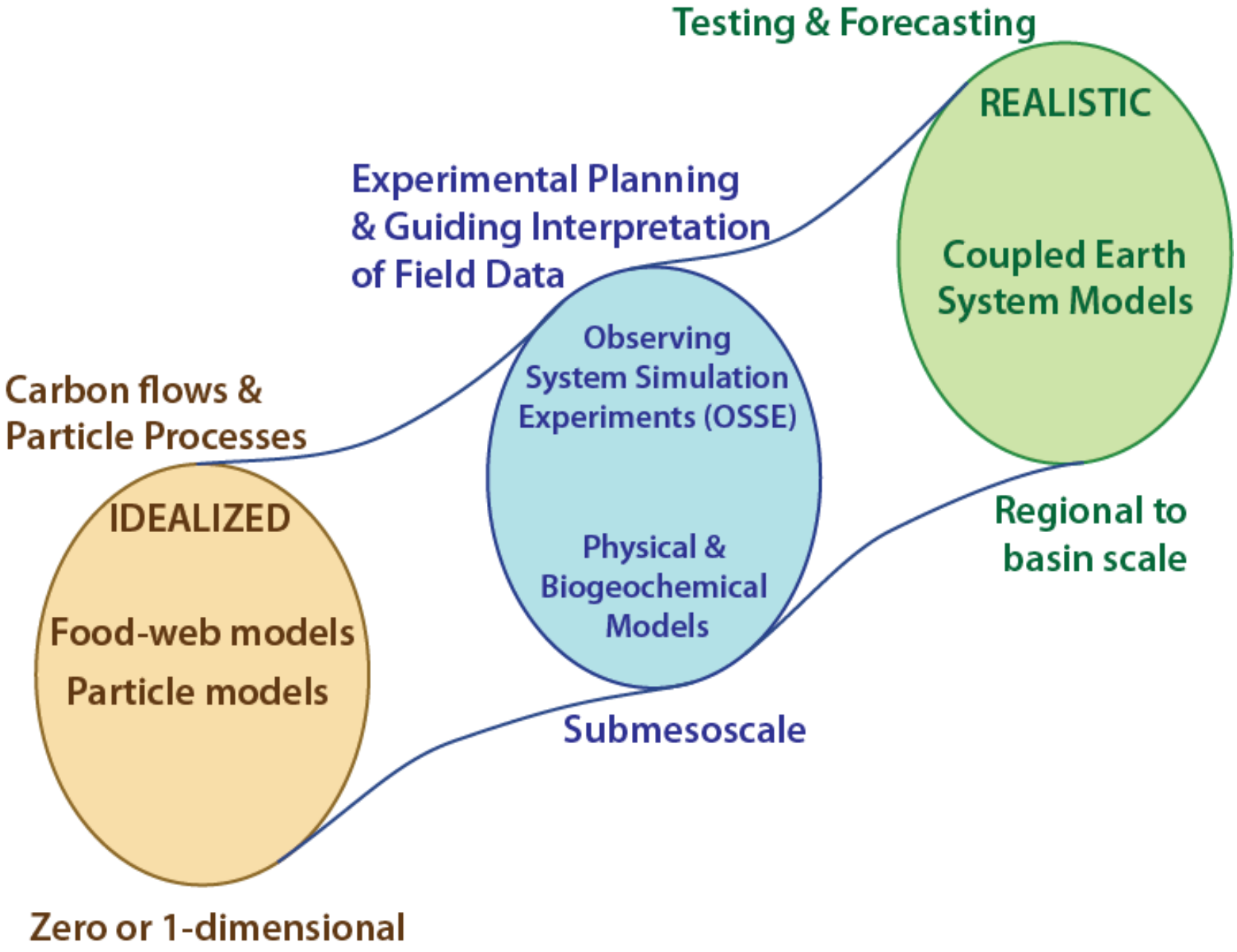
Nuts, DIC, DOC, POC, PIC, etc.

Physical Oceanography:

T, S, horizontal velocity, etc.



EXPORTS: Numerical Modeling



EXPORTS: Technical Readiness

EXPORTS **can** answer its science questions with present technology

Improvements that would be nice…

Experimental Logistics:
OSSE's & tools for coordinating sampling, etc.

Rapid Plankton Characterization:
-omics, imaging, acoustics, cell sorting, etc.

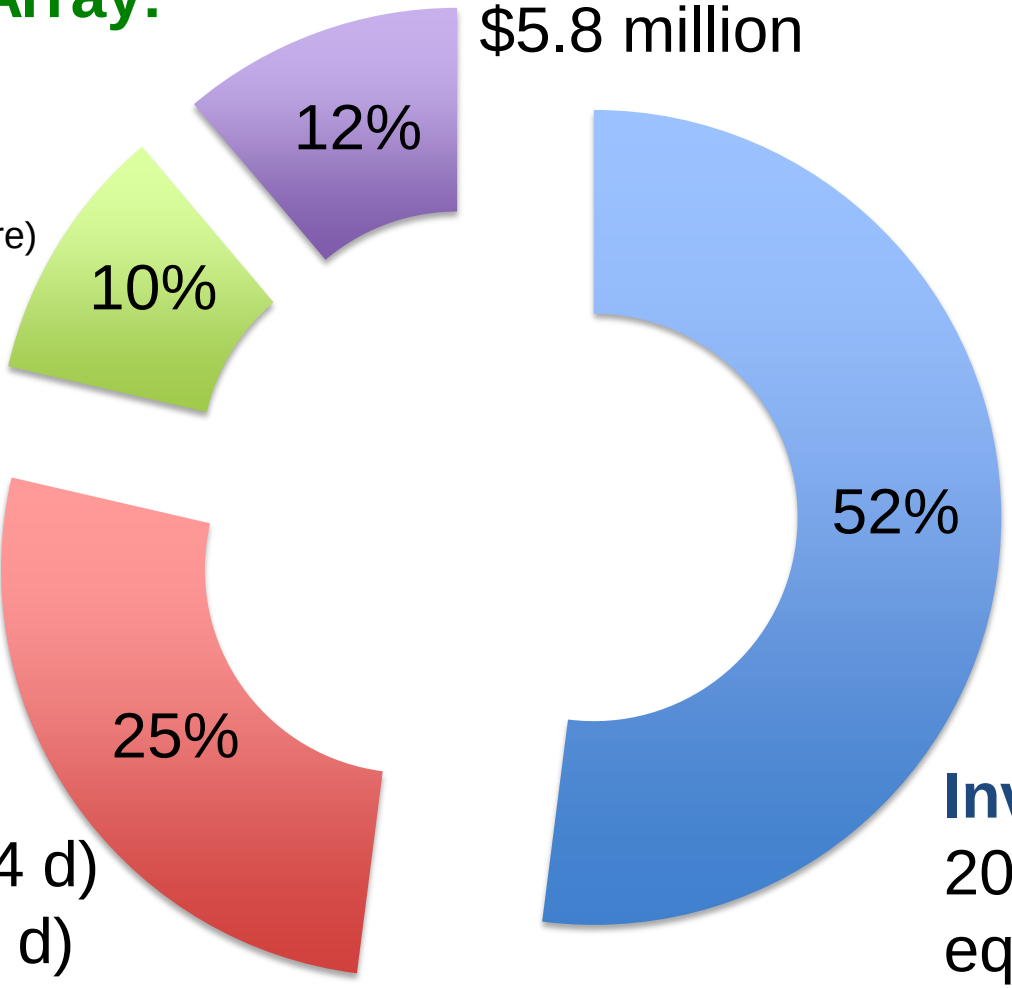
Sensors for Autonomous Platforms:
Zooplankton abundance/composition, DIC, DOC, PSD, etc.

Optical Instrumentation (aimed for PACE):
Hyperspectral reflectance, UV IOP's, etc.

EXPORTS Budget: $53M, 5 years

Other:
Logistics, project/data man, etc.
$5.8 million

Autonomous Array:
6 × 4 floats
6 gliders (4 spares)
2 ML floats (1 spare)
9 traps (3 spares)
$5.3 million



Ships:
NE Pacific (154 d)
N Atlantic (180 d)
$13.8 million

Investigators:
20 PI groups & equipment
$27 million

EXPORTS: Budget

Yes, this is a large request. **BUT** $53 million is in line with most NASA field campaigns & U.S. JGOFS process studies

Descoping & Rescoping: Modularity of the EXPORTS science plan makes this easier

Partnering will be critical: Both within the U.S. and internationally

EXPORTS: Next Steps

Draft comment period has ended and ~30 written comments are being assimilated into final report

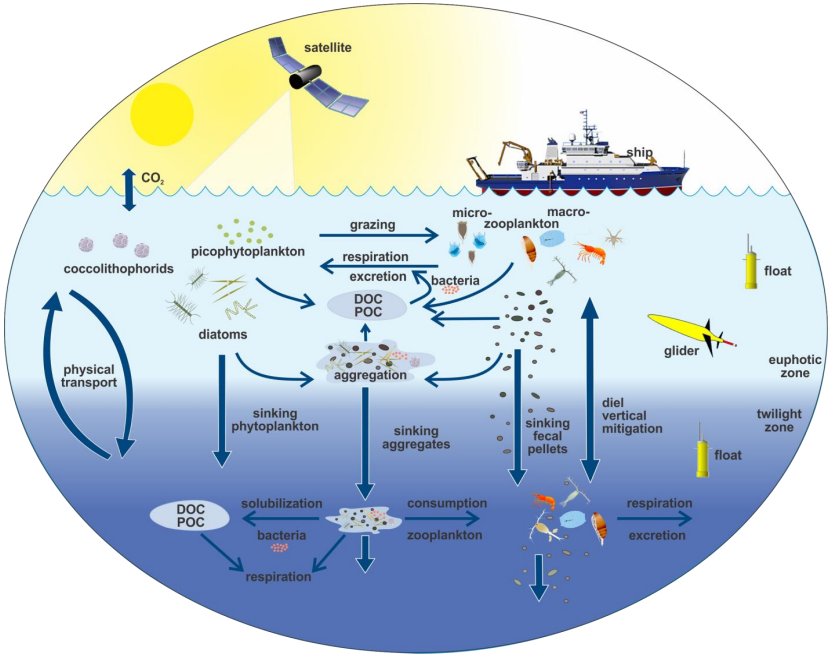
Final Science Plan will be submitted to NASA in June followed by formal comment period (60 d) & panel review

If selected: A Science Definition Team will be competed (late-2014) to write the Implementation Plan with the EXPORTS field campaign starting 2017

Important: Every role in EXPORTS will be competed!!

EXPORTS

EXport Processes in the Ocean from RemoTe Sensing



http://exports.oceancolor.ucsb.edu

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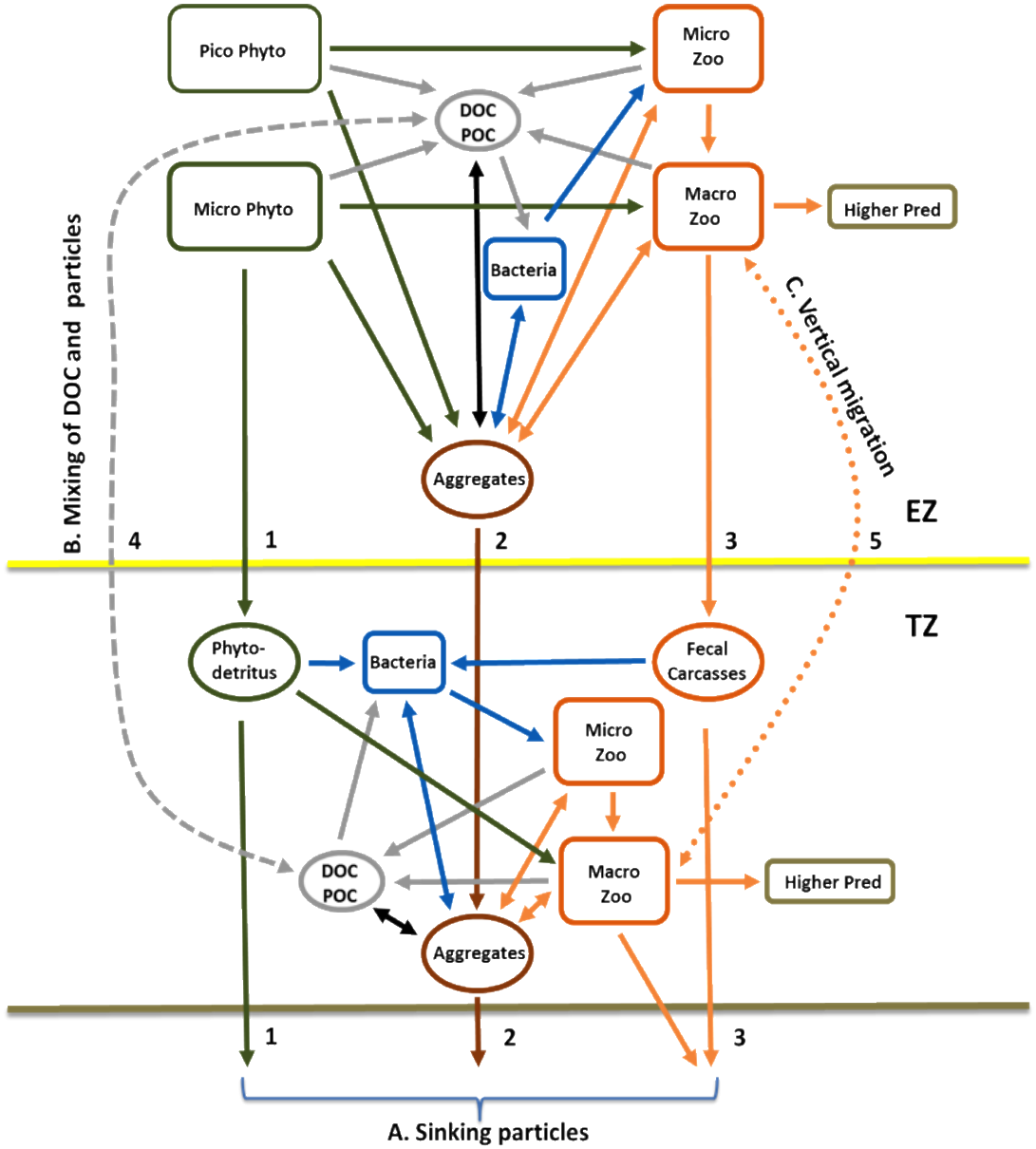
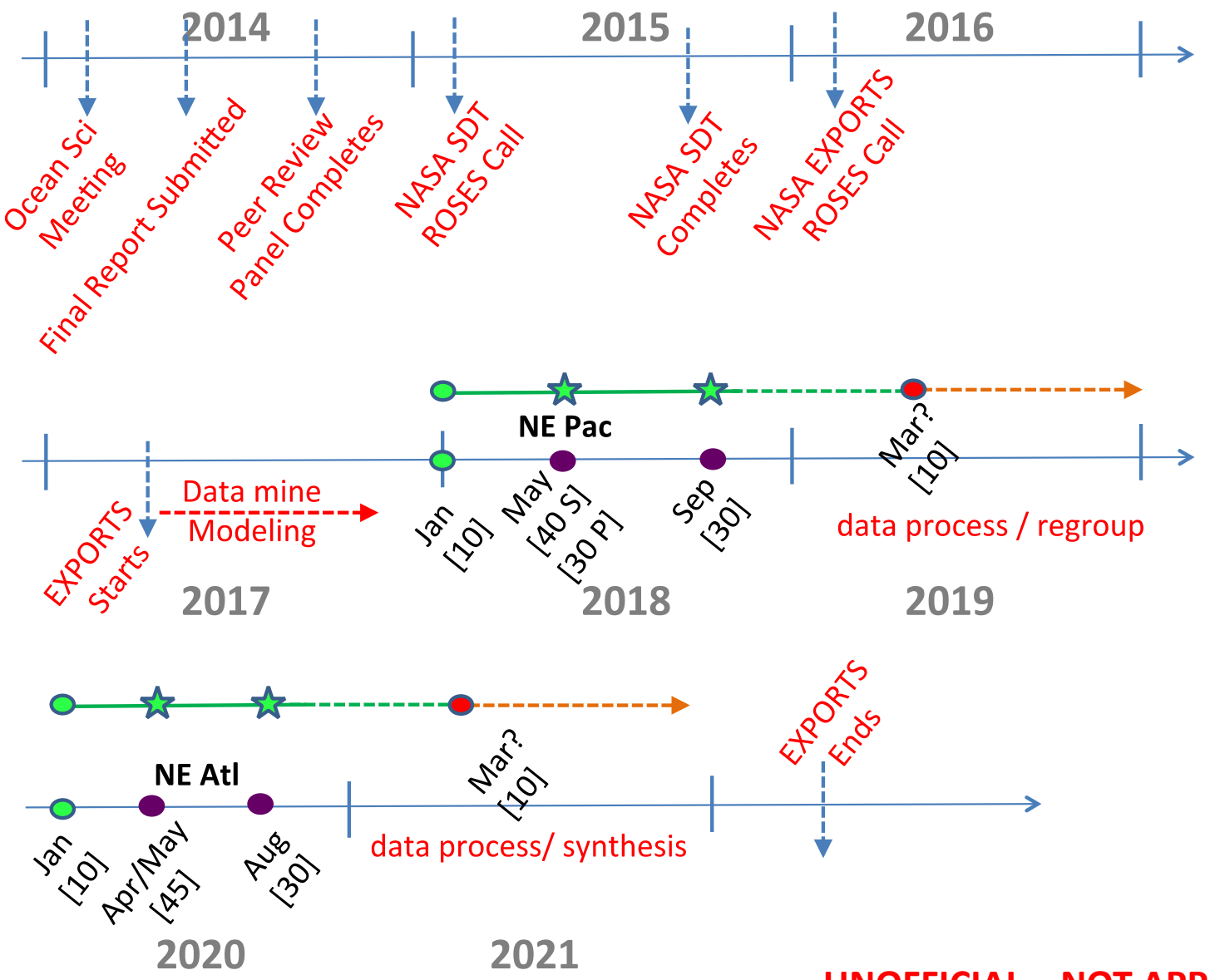
EXPORTS: Focus on Pathways



EXPORTS: *Notional* Timeline



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