EXPORTS May 2019 Science Meeting

Re-Introduction to EXPORTS,
Quick review of we did in the NE Pacific and
Goals for this meeting

May 6-9, 2019 Williamsburg, VA

Round the room quick intros??

Announcements??

EXPORTS Goal & Rationale

Goal: Predict the export, fates & C cycle impacts of ocean NPP from satellite (& other) observations

- Advances in remote sensing, genomics, in situ imaging & autonomous tools make achieving this goal possible
- EXPORTS' focus is on quantifying export pathways & NPP fates over a range of ecosystem states
- Emphasize a predictive understanding by measuring & modeling regulating processes

EXPORTS: Three Science Questions

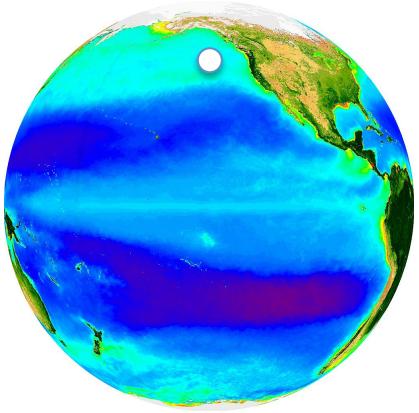
How do upper ocean ecosystem characteristics determine the vertical transfer of organic matter from the well-lit surface ocean?

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

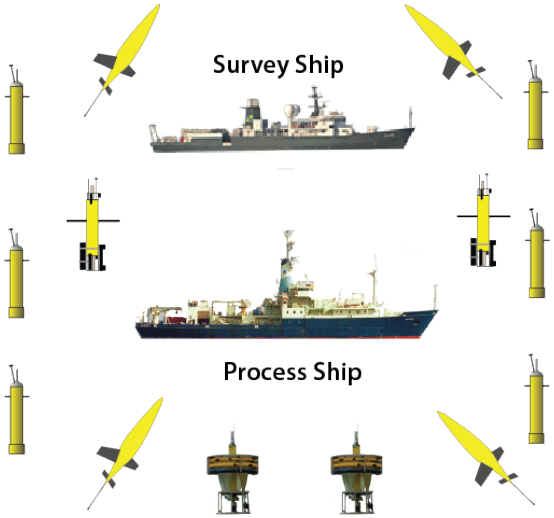
How can the knowledge gained be used to reduce uncertainties in contemporary & future estimates of the export and fates of NPP?

View from satellite orbit…

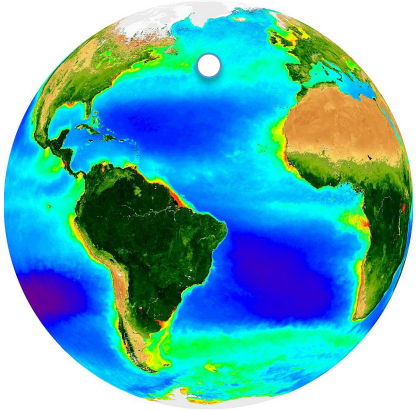
Station P



Cruise: Aug/Sep 2018
Duration: 27 d @ site
Leverage: Line P & OOI



N. Atlantic



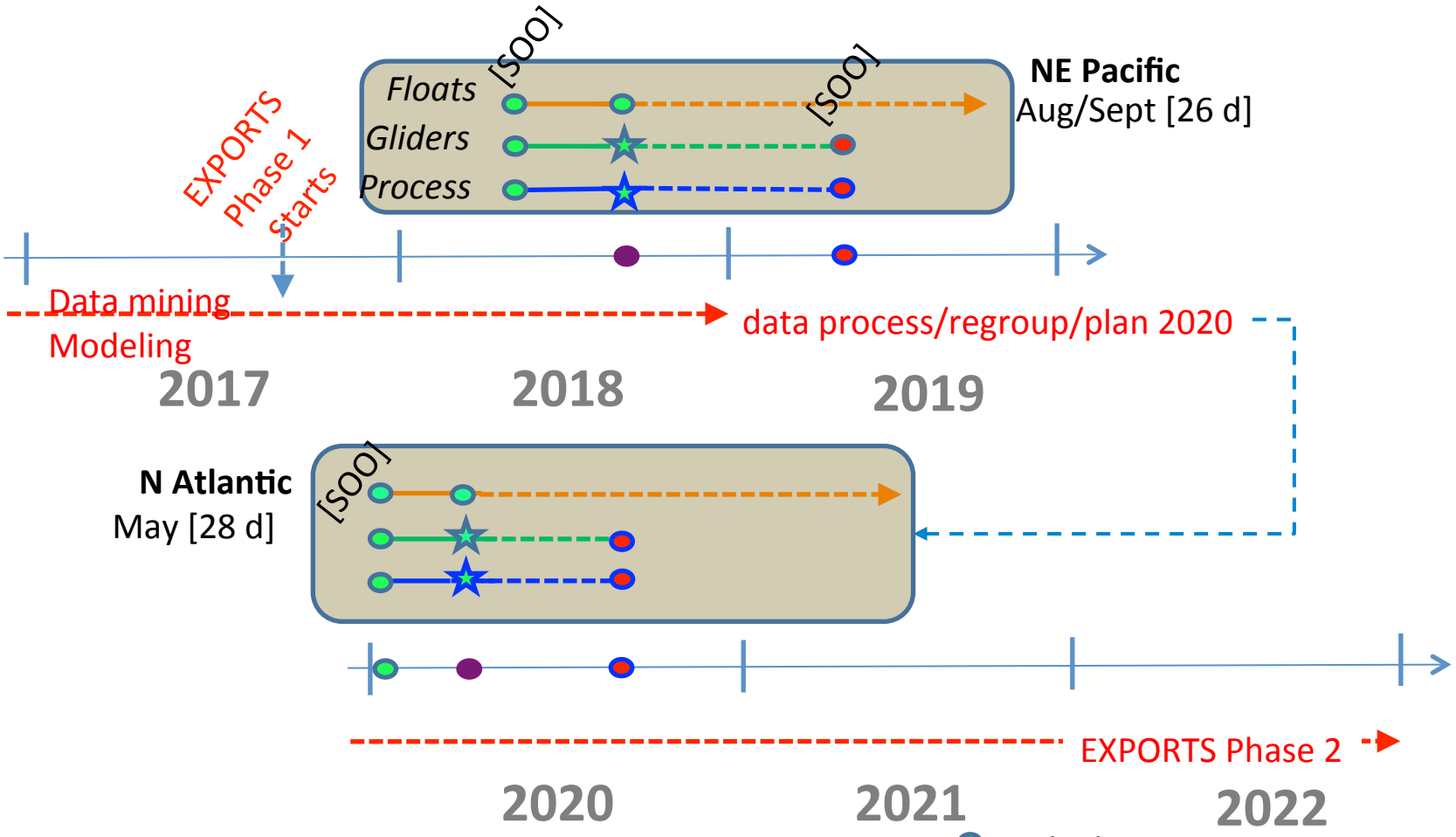
Cruise: Apr/May 2020
Duration: ~28d @ site
Leverage: WHOI's OTZ, internationals, e.g. Biarritz

Will collect ~7 ecosystem / C cycling states

Also OSSE / data mining (NASA ROSES 2015)

and **Phase 2 – Synthesis / Modeling** (ROSES 20??)

Overall Timeline

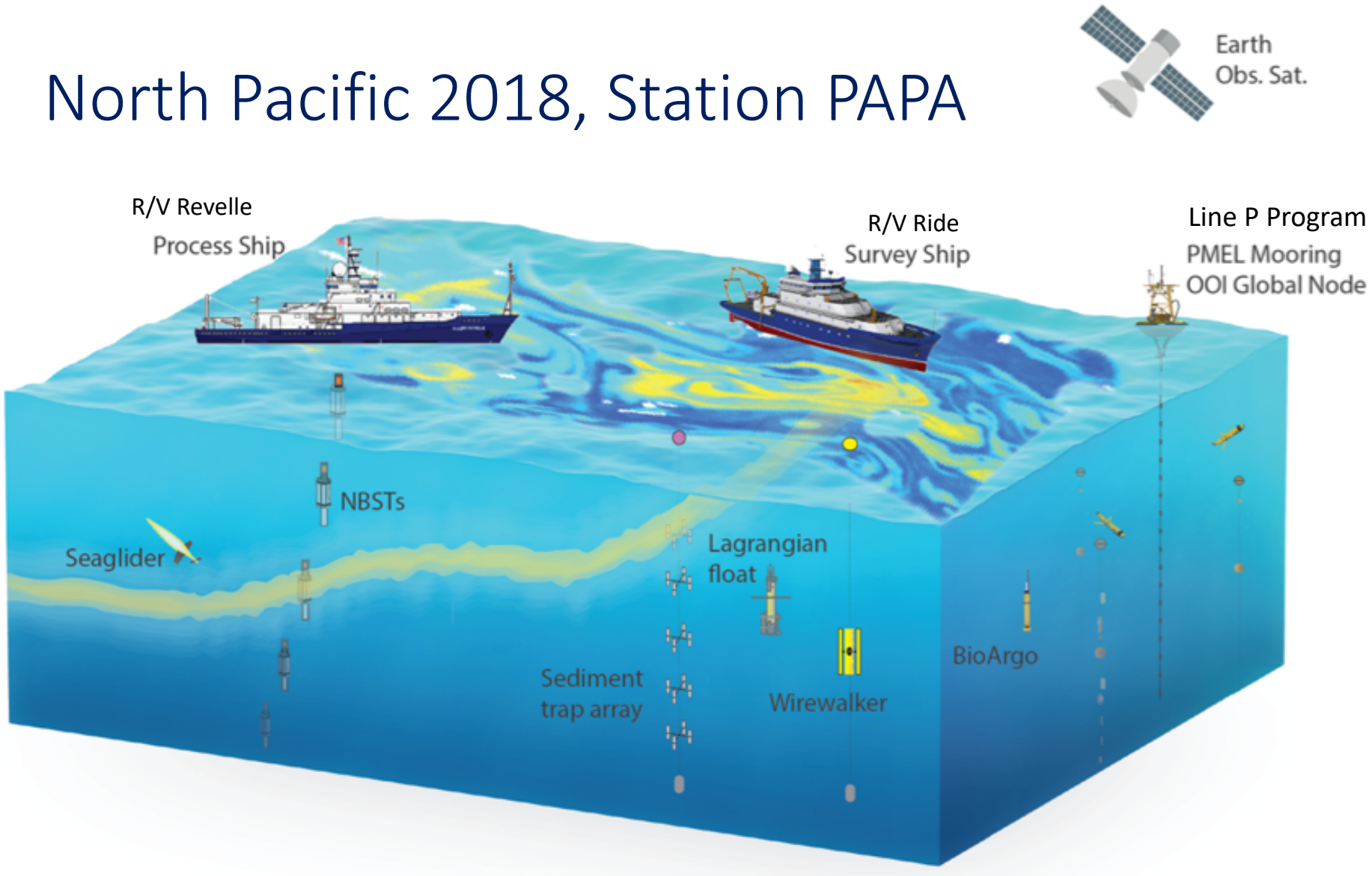


● = ***Process & Survey Cruises*** *- includes multi depth trapping, rates, tow-yo SMS mapping, zooplankton tows, full bio-optics, etc.*

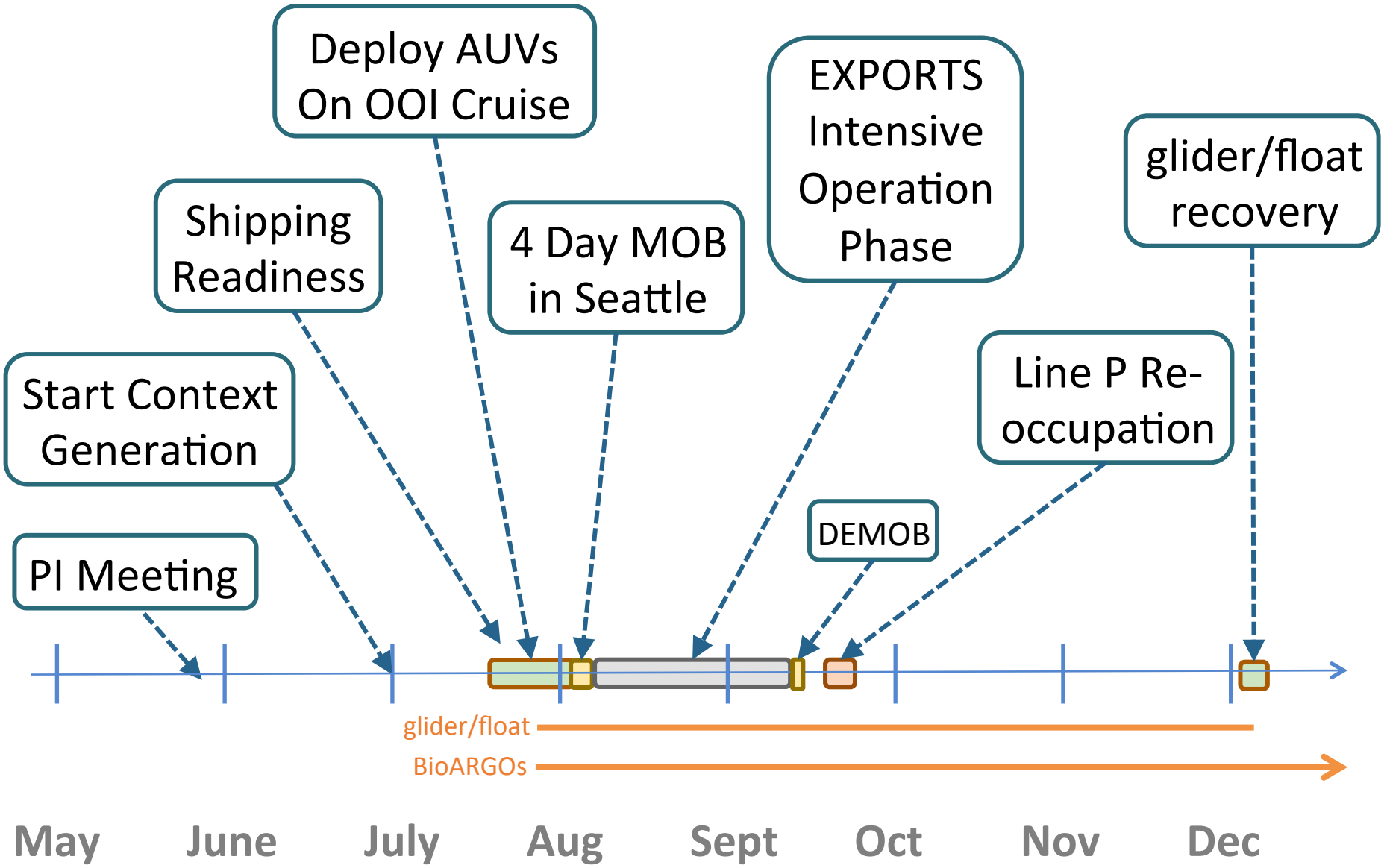
● = *deploy autonomous assets*

● = *recover autonomous assets*

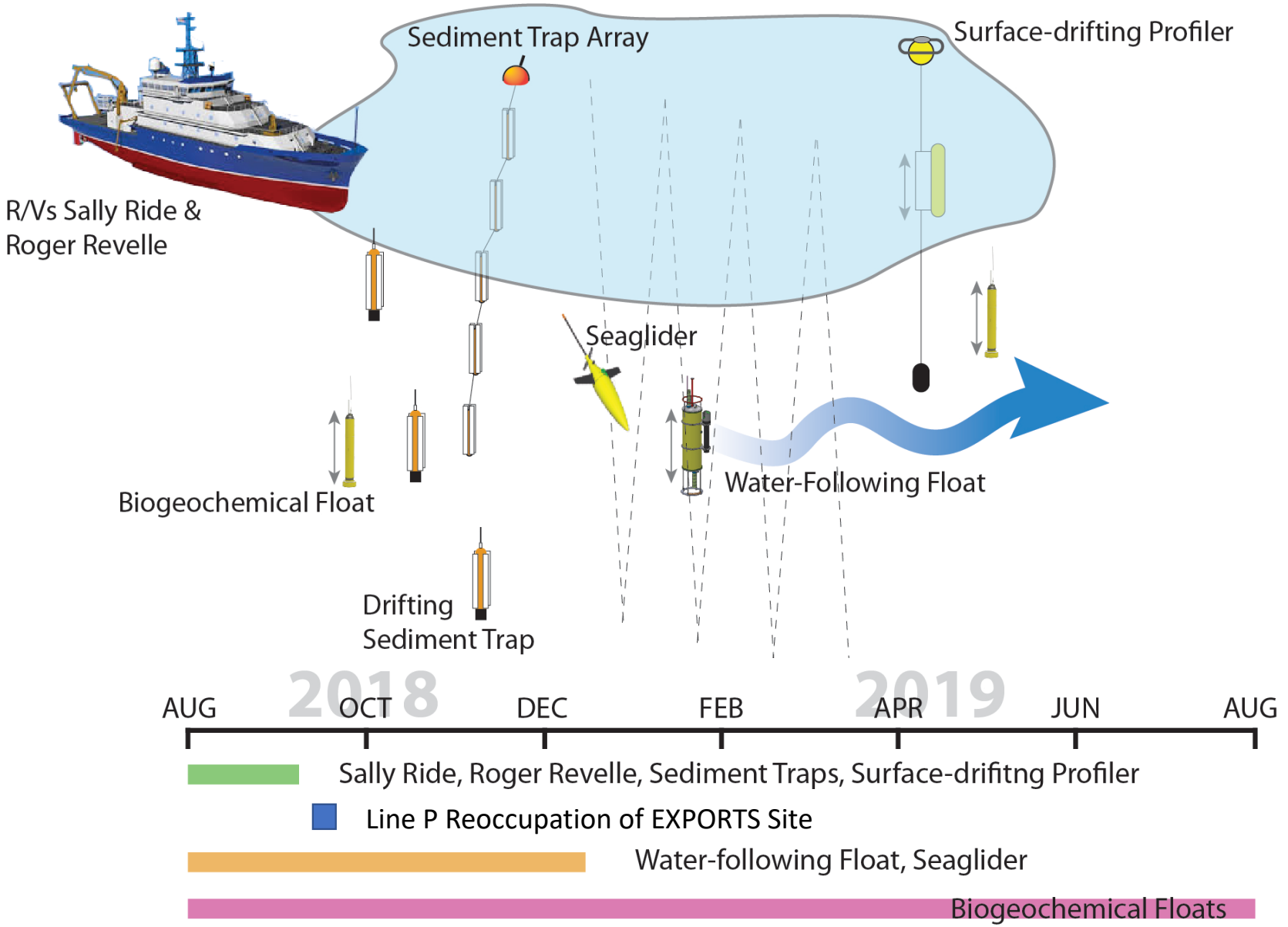
North Pacific 2018, Station PAPA



EXPORTS' 2018 Timeline



EXPORTS Observational Design

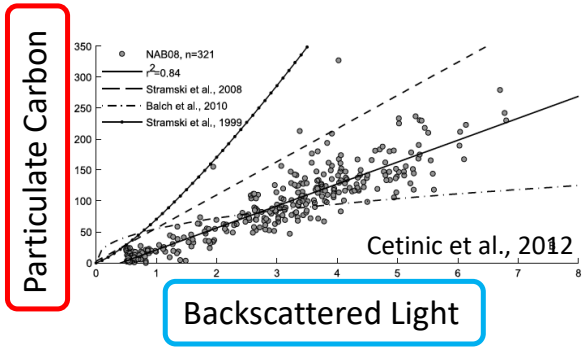


EXPORTS Autonomous Platforms

Craig Lee, Eric D'Asaro (APL-UW), Mary Jane Perry (UMaine), Melissa Omand (URI), David Nicholson (WHOI) and Andy Thompson (CalTech)
Andrea Fassbender, Ken Johnson, Yui Takeshita and Sophia Johannessen (MBARI)

More Variables
Fewer Measurements

Fewer Variables
More Measurements

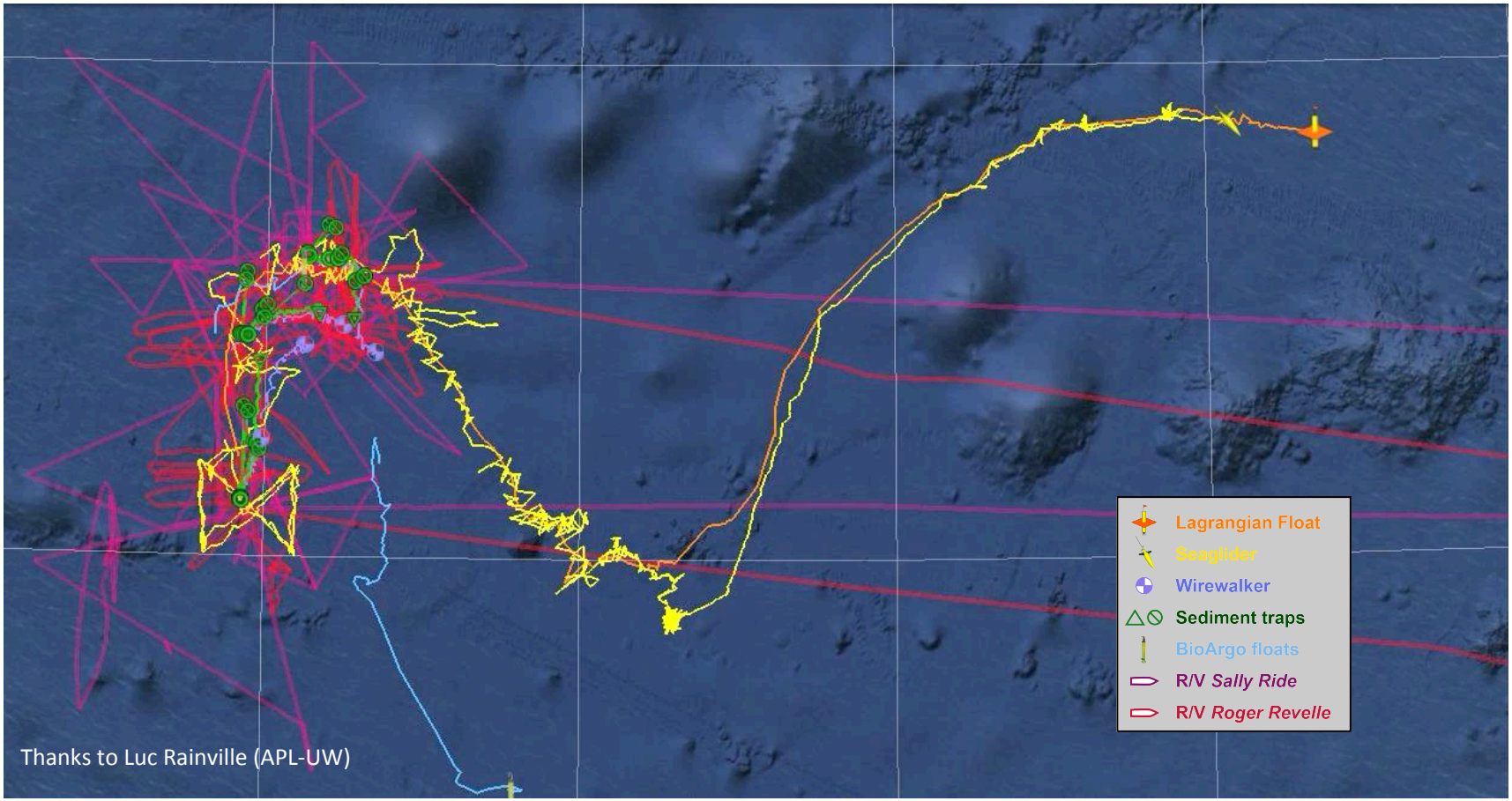


Samples, analyses, sensors

Sensors – electricity, light, sound

- Robots observe scales impractical to measure from ships
- Ships inform interpretation of measurements from robots
- Robots assist with interpretation of satellite sensors
- Lagrangian float provides the experiment's reference center

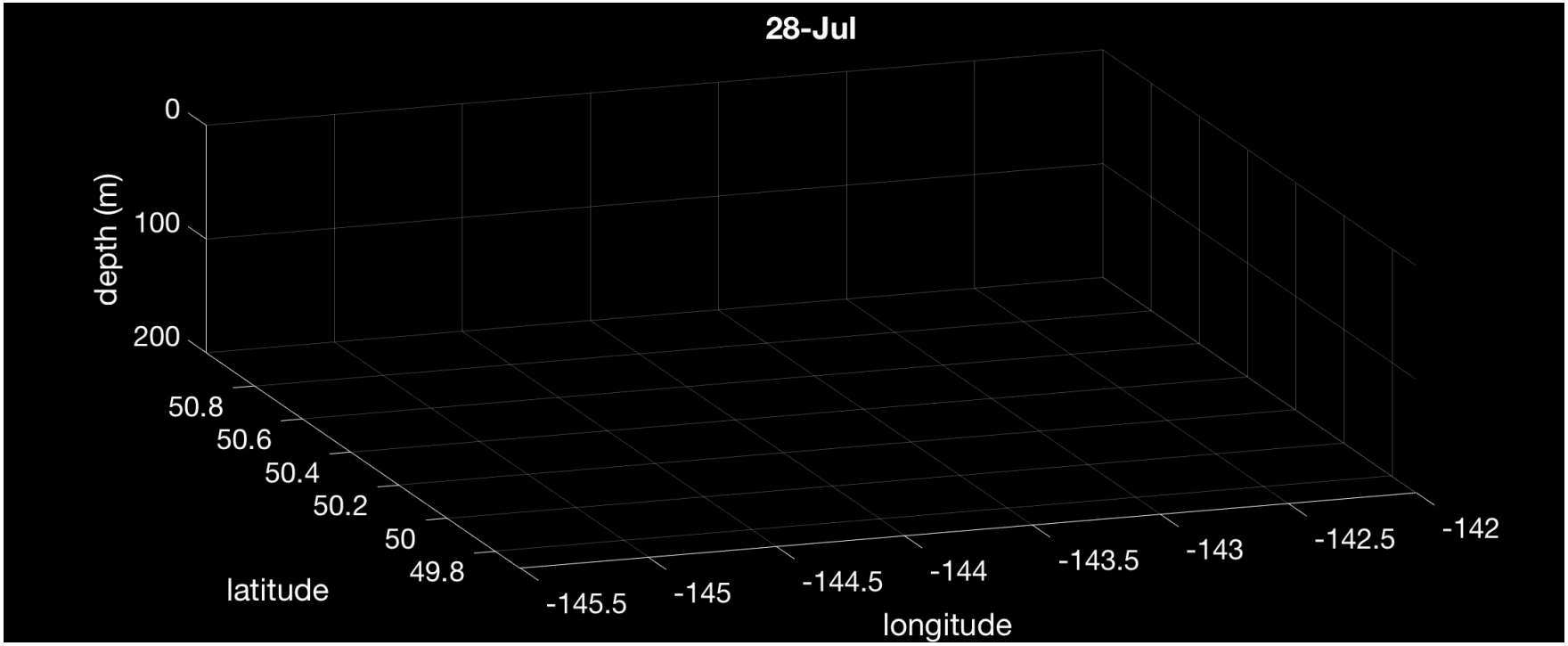
EXPORTS NE Pacific Program – 1 Aug–30 Nov 2018



R/V Roger Revelle
R/V Sally Ride
5 NBSTs + 1 surface-drifting trap
Wirewalker

Long-term Autonomous Measurements
2 BioArgo Float
1 Lagrangian Float
1 Seaglider

Chlorophyll Fluorescence (Seaglider)



- Lagrangian float tracks water parcels below euphotic zone.
- Seaglider collects profiles in butterfly pattern around drifting float.
- Float and glider pair resolves 1D dynamics plus advective contributions at scales larger than the mesoscale (tens of kilometers).
- Two BioArgo floats provide broader context.

Process Ship

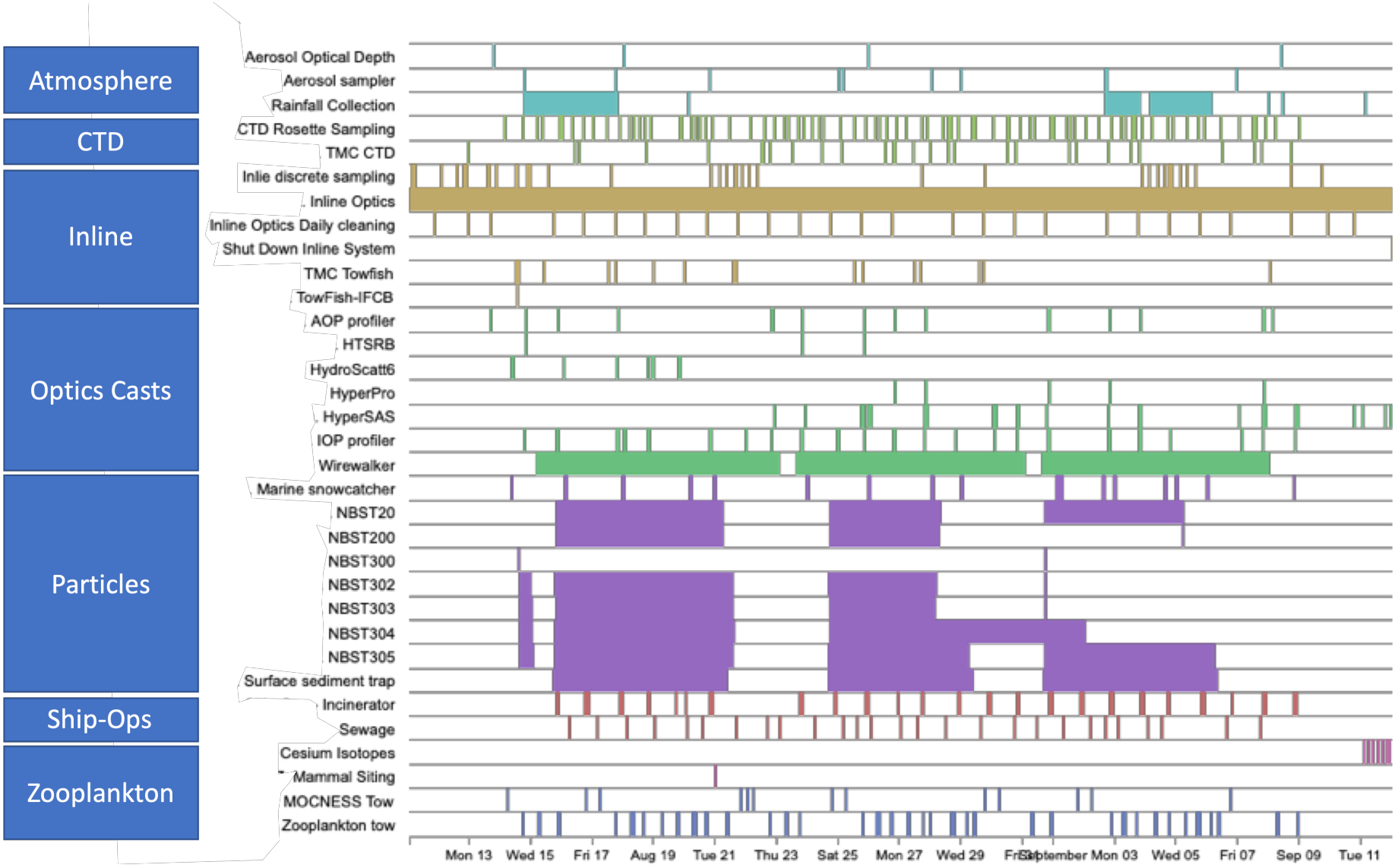
- Optics
  - Profiling & UW IOPs (incl. discrete), C-OPS & HyperSAS reflectance, LISST-Deep PSD, …
- NPP / Rates
  - NPP (^{14}C & ^{15}N), NCP (O_2/Ar), Community resp, Phyto growth / grazing, Zoop resp/grazing, bacterial prod, …
- Taxa & Particle Characteristics
  - MOCNESS, HPLC, iFCB, UVP, FloCam, genomics for Pro's & Euk's, …
- Export pathways
  - Sediment traps, DOM/POM remin, aggregate char, diel zoop migration, …
- BGC stocks
  - Nuts, Chl/HPLC, DOM, POM, Fe, O_2, BSI, PIC, PSD, …

Process Ship

Process Ship	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 1	State 1
Day	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
0000-0100		SIO CTD - 1000 m	SIO CTD - 1000 m	Mocness	SIO CTD - 1000 m	zoo tow	SIO CTD - 1000 m	zoo tow	Mocness
0100-0200		(UVP n, uz, expts)	(UVP n, uz, expts)		(UVP n, uz, expts)	(fp, resp)	(UVP n, uz, expts)	(fp, resp)	
0200-0300		TMC Towfish	TMC CTD 1	Mocness	TMC CTD 1	TMC CTD 1	TMC CTD 1	SIO CTD - 150 m uz	Mocness
0300-0400									SIO CTD - 150 m uz
0400-0500			TMC CTD 2		TMC CTD 2	TMC Towfish	TMC CTD 2		TMC CTD 1
0500-0600									
0600-0700		Deploy Traps							TMC CTD 2
0700-0800		& wire walker		zoo tow (63 um-day)			Poop run	zoo tow	
0800-0900			SIO CTD 150m (NC,expt)	zoo tow	zoo tow	SIO CTD - expts		(fp)	Poop run
0900-1000			TMC CTD- 150m BJ	(fp)	(graze)	zoo tow	SIO CTD 150m (NC,expt)		
1000-1100		TMC CTD- 150m KH	Mocness		TMC CTD- 150m BJ	(fp)	TMC CTD- 150m BJ	Mocness	TMC CTD- 150m BJ
1100-1200		Optics		Optics	Optics	Optics	Optics		Optics
1200-1300	NBST test deploy		Mocness					Mocness	
1300-1400		zoo tow		SIO CTD - 1000 m	SIO CTD - 1000 m	SIO CTD - 1000 m	SIO CTD - 1000 m		SIO CTD - 1000 m
1400-1500		(fp)	Mocness		(UVP d)	(UVP d)		Mocness	(UVP d)
1500-1600	SIO CTD - 500 m	SIO CTD - expts		Mar snow catchr	Poop run	TMC CTD- 150m KH	Mar snow catchr		
1600-1700	(trap water)	SIO CTD - 1000 m	SIO CTD - 1000 m			Poop run		SIO CTD - 1000 m	Recover Wire walker
1700-1800	(expt. water)								
1800-1900	NBST test recover	Mar snow catchr							SIO CTD - 500 m
1900-2000			poop run	poop run	SIO CTD - 500 m (expt)		zoo tow (MSC)	Poop run	(trap water)
2000-2100					Recover 3-day traps	Recover 4-day traps	Recover 5-day traps		(expt. water)
2100-2200	zoo tow		Mocness	zoo tow (63 um-night)				Mocness	zoo tow
2200-2300	(fp ,resp)	Poop run		zoo tow			(incudes STT)		(fp, resp)
2300-2400			Mocness	(fp, resp)				Mocness	

SIO CTD - 500 m (trap water)	To fill sediment traps (500 L from 500m). Could use Marine Snow catcher instead, or combo of the two; also collect incubation water for expts
SIO CTD - 150 m (uz)	Water for microzooplankton grazing incubations
SIO CTD - expts	water needed for incubations/experiments- quick CTD casts to get mixed layer water (Steinberg), also some water needed at 10m and 200 m (Carlson, Gifford); some of these can be done on existing casts
TMC CTD - 150 m - TMC	w/ TMC rosette- morning PP cast, plus water for many people (see CTD water budget list); 2 casts likley needed to get enough water
TMC CTD- 150m BJ/KH	to bottom of euphotic zone (light depedent gene expression)- B. Jenkins group and Kim Halsey; TMC rosette
SIO CTD - 1000 m	Water for many people (see CTD water budget list); also Day vs. night deployments of UVP and ADCP; sometimes water for experiments too
Mar snow catchr	3 casts per state, @same time of day, 3 depths per cast: mixed layer, at depth of export flux (below the mixed layer, trap depth) and deep – e.g. 500; request prior to CTD cast that will have bacteria respiration & production
zoo tow	tows for live animals for experiments day vs. night; usually 200 um mesh; fp=fecal pellet production;resp=respiration&excretion; graze=added bottles to S M-D expt; MSC= marine snow grazing
zoo tow (63 um)	small mesh zoo tow (for 63-200 um size fraction)
Mocness	paired Day vs. night; beginning and end of state
Trap recoveries	best at night so can see the light when they pop up
trap/WW deploy/rec	at beginning and end of state
optics casts	mostly hand-lowered instruments
Towfish	water collection for Jenkins large volume incubations (this done 2x in any two states)
NBST test deploy	do earlier in day if get there in time
Poop run	dump sewage, gray water from ship's tanks away from traps; once traps are recovered, don't have to run as far ; need 1x every 24 hr.

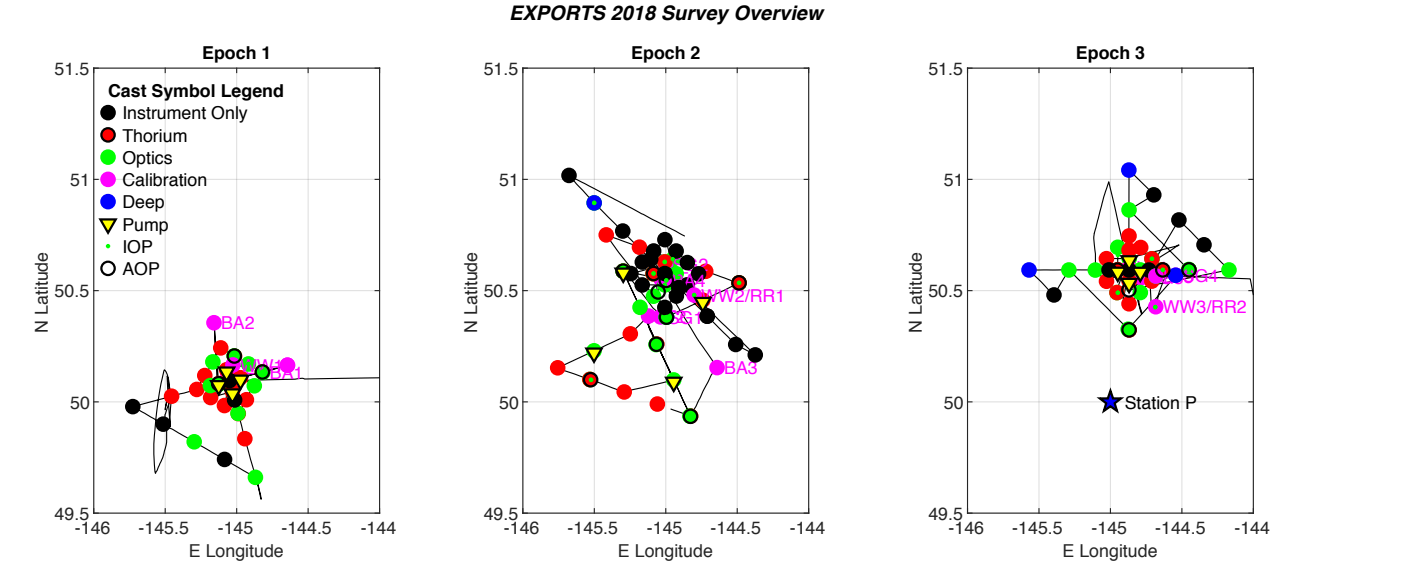
Process Ship

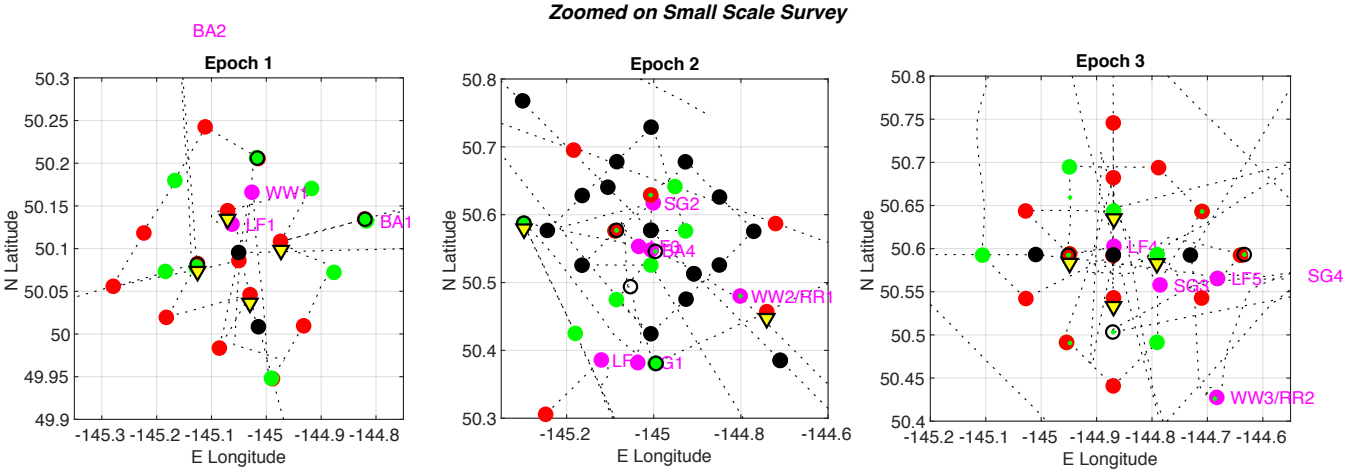


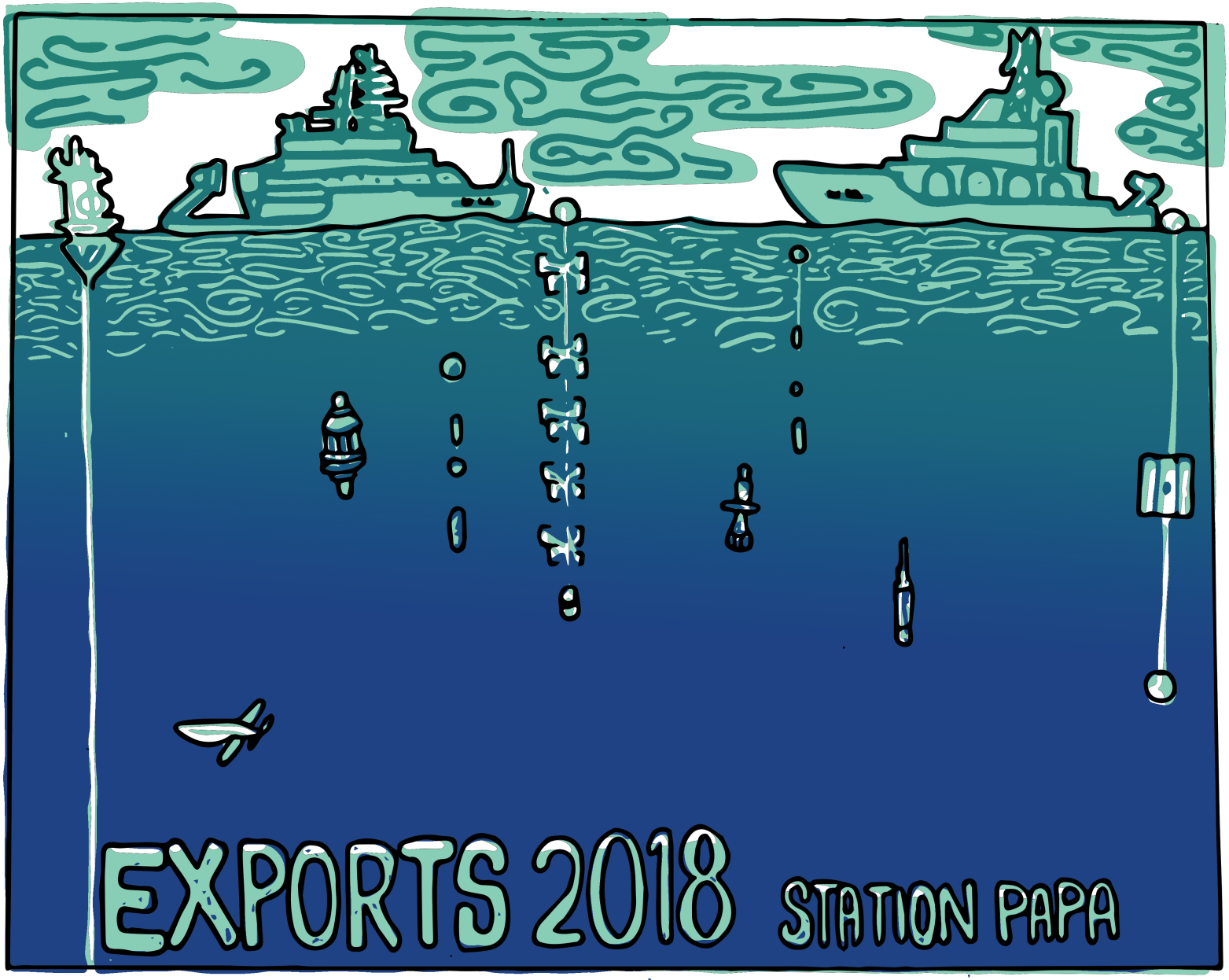
Survey Ship

- Optics
  - Multispectral / multi angle scattering, nanoparticle PSD, profiling & UW IOPs (incl. discrete & size frac), HyperSAS reflectance, submicron PSD, C-OPS & LISST-Deep, …
- NPP / Rates
  - NCP (by O_2/Ar)
- Taxa & Particle Characteristics
  - iFCB, UVP, HPLC, acoustics for zoop, genomics for Pro's & Euk's, …
- Export pathways
  - ^{234}Th export, UVP-sinking flux
- BGC stocks (also act as the calibration link to AUVs…)
  - Pump & Niskin POC/N/PIC/Bsi/etc. profiles, Nuts, Chl/ HPLC, DOC/N, O_2, PSD, …

Survey Ship


EXPORTS 2018 Survey Overview
Epoch 1
Epoch 2
Epoch 3
Cast Symbol Legend
Instrument Only
Thorium
Optics
Calibration
Deep
Pump
IOP
AOP
BA2
BA1
WW2/RR1
BA3
WW3/RR2
Station P
N Latitude
E Longitude
51.5
51
50.5
50
49.5
-146
-145.5
-145
-144.5
-144


Zoomed on Small Scale Survey
BA2
Epoch 1
Epoch 2
Epoch 3
WW1
LF1
BA1
SG2
WW2/RR1
LF5
SG4
WW3/RR2
N Latitude
E Longitude
50.3
50.25
50.2
50.15
50.1
50.05
50
49.95
49.9
-145.3
-145.2
-145.1
-145
-144.9
-144.8
50.8
50.75
50.7
50.6
50.5
50.4
50.3
50.65
50.55
50.45
-144.7
-144.6



EXPORTS
EXport Processes in the Ocean from RemoTe Sensing

North Atlantic 2020 Cruise…

- Contrasting endmember to the 2018 NE Pacific Deployment
- Big signals in biomass, export & low flux attenuation
- Zooplankton and DOM signals should lag phytoplankton blooms
- Larger phytoplankton types & diatoms?
- High mesoscale & sub-mesoscale energy driving patchiness in biomass & NPP and substantial advective vertical C fluxes
- Global & Ocean class R/Vs on station for 28 days (3 epochs with 4 weather days) with 4 day MOB & 2 day deMOB leaving same port
- Focus on long-lead time issues (not berthing, water budgets, etc.)

Meeting Objectives

- Push our NE Pacific data forward towards pubs
  - Work with other groups & with our data managers
  - Get data into SeaBASS!!
- Move forward the Synthesis Working Groups
  - Where are we, what's next?
  - Identify capstone papers we can push forward
- North Atlantic cruise planning
  - What can we do better?
  - Expected differences from NE Pacific & start that planning
  - Partnership with WHOI's OTZ project & a third ship…
  - Focus on long-lead time issues (not berthing, water budgets, etc.)

	5/6 MONDAY	5/7 TUESDAY	5/8 WEDNESDAY	5/9 THURSDAY	5/10 FRIDAY
8:00 AM					
8:30 AM					
9:00 AM	Welcome / Updates	Parameter WGs + Data management	Synthesis BO (WG1/WG4/ WG5)	plenary report outs	plenary report outs
9:30 AM		Data Management		Synthesis BO (WG1/WG2/ WG3)	Wrapups - next steps
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12:00 PM	Lunch		plenary report outs	Lunch	Fin
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4:00 PM					
4:30 PM	Flash early career presentations				
5:00 PM		Posters / chit chat time	Posters / chit chat time	Posters / chit chat time	
5:30 PM	Posters - cocktails??				
6:00 PM					
6:30 PM	Dinner at Deb's house!!!!			Something fun - still pending	

Morning session 1	Morning session 2	Afternoon session 1	Afternoon session 2	Afternoon session 3
Jason	Norm	Mary Jane	Debbie	Craig
Craig Lee: *Autonomous Investigation of Export Pathways from Hours to Seasons*	***Alyson Santoro:*** *Surface Versus Subsurface Controls on Microbial Attenuation of Sinking Particulate Flux in the Mesopelagic Ocean*	***Ken Buessler:*** *Elucidating Spatial and Temporal Variability in the Export and Attenuation of Ocean Primary Production using Thorium-234*	***Collin Roesler:*** *Phytoplankton community structure, carbon stock, carbon export & carbon flux: What role do diatoms play?*	***Hilary Close:*** *Isotopic Indicators for Mechanisms of Organic Matter Degradation in the Northeast Pacific*
Andrea Fassbender: *Constraining Upper-Ocean Carbon Export with Biogeochemical Profiling Floats*	***Adrian Marchetti:*** *Quantifying the Export Potential of the Marine Microbial Community: Coupling of Biogenic Rates and Fluxes with Genomics*	***Phoebe Lam:*** *Estimation of particle aggregation & disaggregation rates from the inversion of chemical tracer data*	***Mike Behrenfeld:*** *First Step - Linking Remotely-Detectable Optical Signals, Photic Layer Plankton Properties, and Export Flux*	***Craig Carlson:*** *Evaluating the Controls of DOM Accumulation, Availability, Diagenetic Alteration & Contribution to Export*
Meg Estapa: *Linking sinking particle chemistry & biology with changes in the magnitude & efficiency of carbon export*	***Bethany Jenkins:*** *Diatoms, Food Webs & Carbon Export - Testing the Role of Diatom Physiology in the Biological Carbon Pump*	***David Siegel:*** *Synthesizing Optically and Carbon Export-Relevant Particle Size Distributions for the EXPORTS Field Campaign*	***Xiaodong Zhang:*** *Optically Resolving Size & Composition Distributions of Particles in the Dissolved-Particulate Continuum from 20 nm to 20 mm*	***Ben Van Mooy:*** *Environmental Lipidomics of Suspended and Sinking Particles in the Upper Ocean*
	Susanne Menden-Deuer: *Quantifying Plankton Predation Rates, & Effects on Phytoplankton NPP & Community Composition, PSD & Potential for Export*	***Debbie Steinberg:*** *Zooplankton-Mediated Export Pathways: Quantifying Fecal Pellet Export & Active Transport by Diel and Ontogenetic Vertical Migration*	***Antonio Mannino:*** *In Situ Optics and Biogeochemistry in Support of EXPORTS Science*	

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Synthesis WGs

WG 1	WG 2	WG 3	WG 4	WG 5
Export pathways and flux attenuation and the roles of community structure and time scales (hours to seasons)	**Food webs - convolve biomass, rates, geochemistry, genomics & optics approaches**	**Optics and diagnosing biogeochemical parameters & processes**	**Deconvolving space vs. time and physical vs. biological controls on observed biogeochemical patterns**	**Biogeochemical budgets and C export / remin rates**
Meg Estapa	**Tatiana Rynearson**	**Jason Graff**	**Andy Thompson**	**Roo Nicholson**
Karen Stamieszkin	Amy Maas	Emmanuel Boss	Laure Resplandy	Andrea Fassbander
Uta Passow	Scott Gifford	Norm Nelson	Melissa Omand	William Haskell
Adrian Burd	Sasha Kramer	Andrew McDonnell	Ivona Cetinić	Ken Buesseler/ Muntsa Roca Marti
Ken Buesseler/ Muntsa Roca Marti	Adrian Marchetti	Adrian Burd		Nicolas Cassar

Charges to the Synthesis WGs

- Goals - What are the 3-5 goals that the WG will achieve, how do they relate to the EXPORTS SQ's, & how does achieving these goals relate to project time horizon?
- Process - What do we need to do? What data need to be synthesized and how? What modeling has to occur? Etc. etc.
- Data - What data need to be assembled, known time constraints and what can we do to help things along?
- Deliverables - Synthesis papers, cross-group papers on specific topics, synthesized data sets and on what time scales?
- Goals for this meeting:
  - Make sure we all understand what each WG is doing
  - Present progress made to date and what you hope to make into the future
  - Use the break outs to share data / ideas and make progress on Goals

Potential WG Breakout Topics

WG#	Topic
1	*Flux units, measurement-measurement closure*
1	*Comparing different flux pathways: Zooplankton vs aggregates vs small particles vs physical mixing*
1	*Physical and biological context for flux measurements*
2	Defining Landscape- samples, separating EZ/TZ food webs
2	Refining food webs group goals
2	complete goals discussion if necessary, Defining steps moving forward- products, timelines etc
3	Intercalibration status, proxy conversions - EXPORTS specific vs. existing - status of POC/HPLC, data status/needs
3	Application frontiers in optics - PFTs, particle distributions, export flux, NPP models - mini breakouts after group discussion
3	Integrating products into other working groups - potential papers and products
4	Calibration and comparison of observations across platforms
4	Active dynamical(?) processes: surface forcing, mixed layer depths, scales of variability
4	Link between physical and biological variability
5	Euphotic Zone mass balances -- PP intercomparison, O2/Ar, NCP, F_ez, POC/DOC production
5	Mesopelagic mass balance -- flux attenuation w/ depth, Bulk/Zoo/Microbial Respiration
5	Steady-state, vs Non-steady-state, Stoichiometry C/O/N

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Publish or perish…

- Numbered List of EXPORTS Publications
  - Pub list & PDFs in General/Publications and the public website (oceanexports.org/publications)
  - Let Ivona / Dave know acceptances
- Promoting our EXPORTS Publications
  - One-page PPTs for agency folks (examples in Publications)
  - Let Ivona / Dave know about Press Releases
- Any EXPORTS data published MUST be in SeaBASS
- List of Planned EXPORTS Publications
  - In General/Publications
  - Want to identify potential conflicts…

Publish or Perish…

- Line P collaborations
  - Reach out to your doppelgänger(s?)
  - Need to work toward shared publications
- NE Pacific Special Issue
  - AGU Virtual Journal?? Frontiers in Marine Science?
- NE Pacific Cruise Summary Paper
  - Summarize NE Pacific cruise logistics & basic results
  - Publish as NASA Tech Memo or ??
  - Outline in North Pacific 2018 folder
- 2020 Ocean Sciences Meeting
  - We will propose an “EXPORTS-ee” session(s?)