Spatiotemporal Patterns of Dissolved Organic Phosphorus Lability across the Subtropical North Pacific Gyre

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1. Subtropical Ocean Deserts

- Subtropical gyres cover ~**40%** of Earth's surface
- Often termed 'biological deserts' with stratified waters containing very little nutrients to sustain life → largescale downwelling
- Quantifying nutrient transport, utilization, and relation to carbon drawdown is key in understanding how carbon cycles between atmosphere and hydrosphere

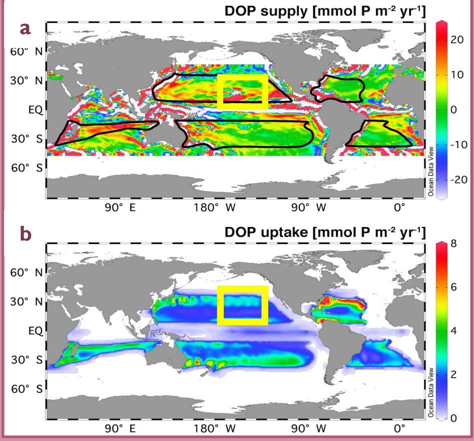

***Fig. 1 (a)** physical flux of DOP supplied by lateral transport and **(b)** biological uptake flux of laterally supplied DOP both integrated over depth. Adapted from Letscher et al. (2016).*

2. Motivation

- Inorganic nutrient PO_4 is known to be key for autotrophic growth
- Subtropical surface-dwelling phytoplankton must depend on alternative methods of nutrient delivery due to the inhibited vertical physical supply within gyres
- Prior studies suggest subtropical nutrient budgets depend on bioavailable DOP
- Model results predict lateral gradients in Ekman surface waters transport DOP from areas of high concentration to low (Fig. 1a)
- Predicted DOP uptake therefore higher at center of NPSG (Fig. 1b)

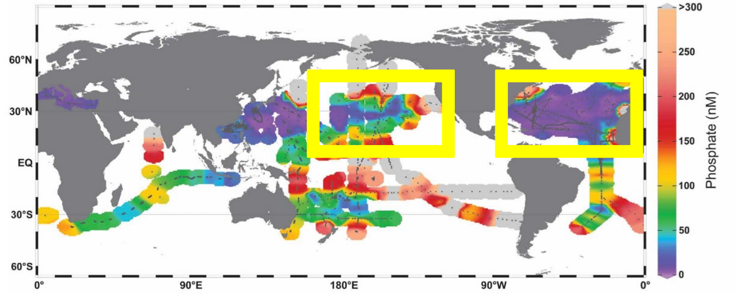

Fig. 2 Global distribution of surface DIP observed using high-sensitivity techniques. Adapted from Martiny et al. 2019.

3. Methods

- 12-day cruise aboard R/V Kilo Moana (June 2021)
- Transect within NPSG running 22.75° – 31°N north of Oahu, HI (Fig. 2a & b)
- CTD Rosette sampler deployed at 10 stations
- Bioassay incubation experiments preformed at either end of transect to quantify the magnitude of heterotrophic DOP remineralization in surface waters (5m) and the shallow mesopelagic (125m)
- 2 treatments used for incubations:
  - Whole = 100% SW
  - Mixed = 20% SW, 80% 0.2 μm filtered SW
- Ash hydrolysis method used to calculate total dissolved phosphorus (TDP)
  - Modified version of Solórzano and Sharp (1980)
- Both ash hydrolysate of TDP method and soluble reactive phosphorus (SRP) measured by standard colorimetric molybdenum blue method
  - Adapted from Strickland and Parsons (1968)
- Dissolved organic phosphorus (DOP) calculated using **DOP = TDP – SRP**
- Incubation experiments conducted to eradicate light
  - Strictly looked at heterotrophic consumption (Fig. 2c)

QUESTIONS TO BE ANSWERED:

1. Can we observe a lateral gradient of DOP concentration in surface waters along cruise track?
2. Is there evidence for DOP consumption within surface waters?
3. Is there evidence for preferential DOP consumption between surface waters and mesopelagic?

4. Results

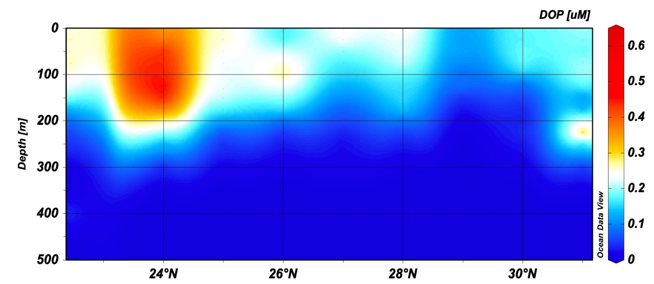

Fig. 3 Concentration of DOP within the upper 500 m of the water column across the cruise track from 22.75°N – 31°N.

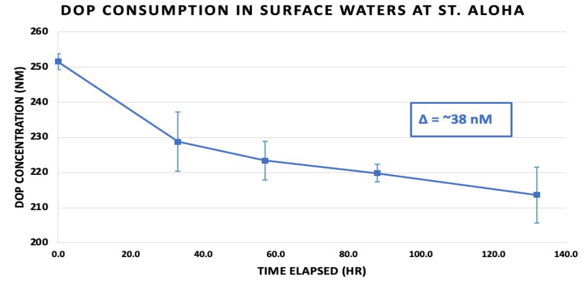

Fig. 5 Bioassay incubation results of DOP consumption within surface waters at St. ALOHA.

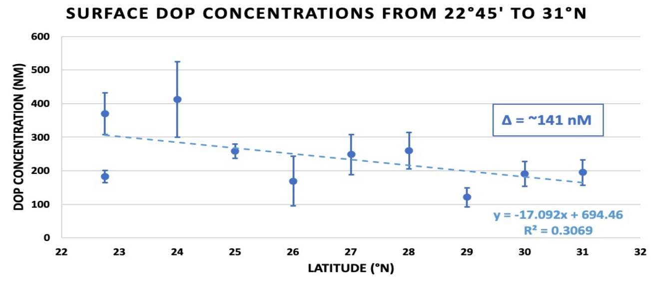

Fig. 4 Decreasing DOP concentrations with increasing latitude, diagnosed via trendline (blue dash) R^2 = 0.3069. Note: samples were collected at St. ALOHA twice on either end of the 12-day cruise.

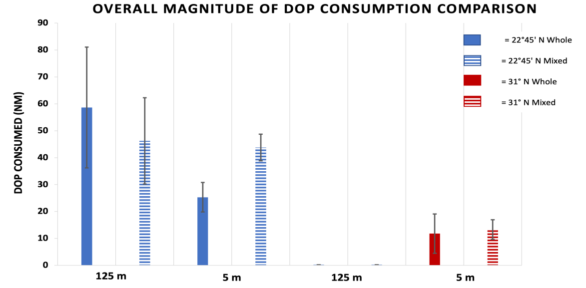

Fig. 6 Net change in bioassay incubation experiments over course of incubation time period. Blue color indicates samples collected at 22.75° N while red color those collected at 31°N. Solid columns represent the whole SW treatment and dashed represent mixed.

- Overall gradient in surface DOP concentrations across the transect
  - Decrease of~141 nM between St. ALOHA and 31°N (Fig. 3 & 4)
- Incubation results support evidence for bioavailable DOP pool at ~5 m depth near southern edge of NPSG (Fig. 5)
  - ~ 38 nM DOP consumed in ~5 days (132 hrs)
- Substantially higher DOP consumption at St. ALOHA than at 31°N
- No measurable consumption within the mesopelagic at 31°N
- Some evidence of DOP consumption by the mesopelagic microbial community present at Station ALOHA (large error bars)
- Lack of support for any preferential consumption of DOP by depth comparing 5m and 125m

5. Conclusions

1. **Lateral gradient of DOP concentration in surface waters was observed from St. ALOHA – 31°N ✓**
2. **Evidence for a measurable pool of bioavailable DOP in surface waters at St. ALOHA ✓**
3. **Sufficient evidence was not found for preferential DOP consumption between surface water depths and the mesopelagic zone X**
4. **Previous experiments that have looked at DOC and DON have found appreciable consumption when released from grazer control (ie. mixed water treatment)**
   - **→ Our results did not suggest this requirement**
   - **→ Higher phosphorus lability?**

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Acknowledgments and Literature Cited

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