Seasonal Variability of Phytoplankton Biomass on the Oregon Shelf

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Abstract

Water-column profiles were collected using CTD casts on 10 research cruises on the R/V Oceanus from December 2017 to July 2019. These cruises sampled at an Inner Shelf and a Mid Shelf site on the Newport Hydrographic line in 30 m and 80 m of water, respectively. Water-column profiles from the collected 87 casts have been processed and compared using open-source data processing tools in Python. Variables such as temperature, salinity, density, and fluorescence are compared over different seasons at the two sites. Water-column fluorescence was used as a proxy for phytoplankton biomass, and integration of fluorescence profiles provides insight regarding seasonal variations in phytoplankton biomass off the Oregon coast. Preliminary results suggest total water-column fluorescence cannot be predicted based on season alone. Mean total fluorescence was higher and more variable on the Inner Shelf in spring, while it was highest and most variable on the Mid Shelf in summer. Both sites experienced the lowest mean total fluorescence in winter. Further analysis must be done to understand drivers of total fluorescence and its high variability during the spring and summer on the Oregon Shelf.

Background

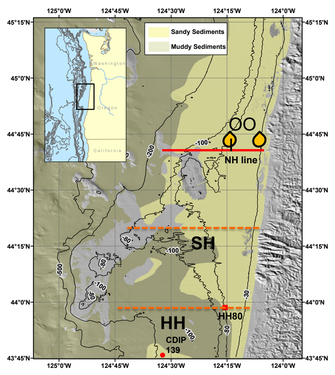

Fig. 1: Study Site on the Oregon coast.

Site Description:

- Part of the Northern California Current System
- Data collection at Inner shelf (30 m) and Mid shelf (80 m) on Newport Hydrographic line

Seasonal Water Column Dynamics :

- Upwelling most prominent May-Sept.
- As a result of the Ekman Transport and consequent upwelling, nutrient rich waters are brought towards the surface
- Large waves from North Pacific storms mix the water column in the winter

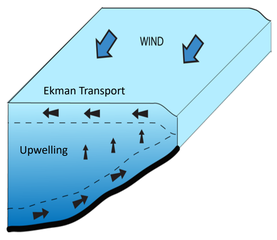

Fig. 2: Schematic of coastal upwelling & Ekman transport on the Oregon coast.

Methods

- 10 cruises from Dec 2017 – July 2019
- 87 CTD casts evaluated over mid (80m) and inner shelf (30m)
- Python
  - Data visualization
  - Fluorescence integration
  - Profiles fitted using PCHIP interpolate
    - Integrated from 2 to 28 m at Inner Site
    - Integrated from 2 to 75 m at Mid Site

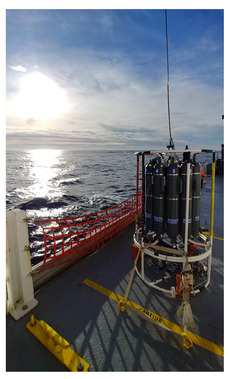

Fig. 3: CTD profiles to measure temperature, conductivity, fluorescence, and pressure.

Results

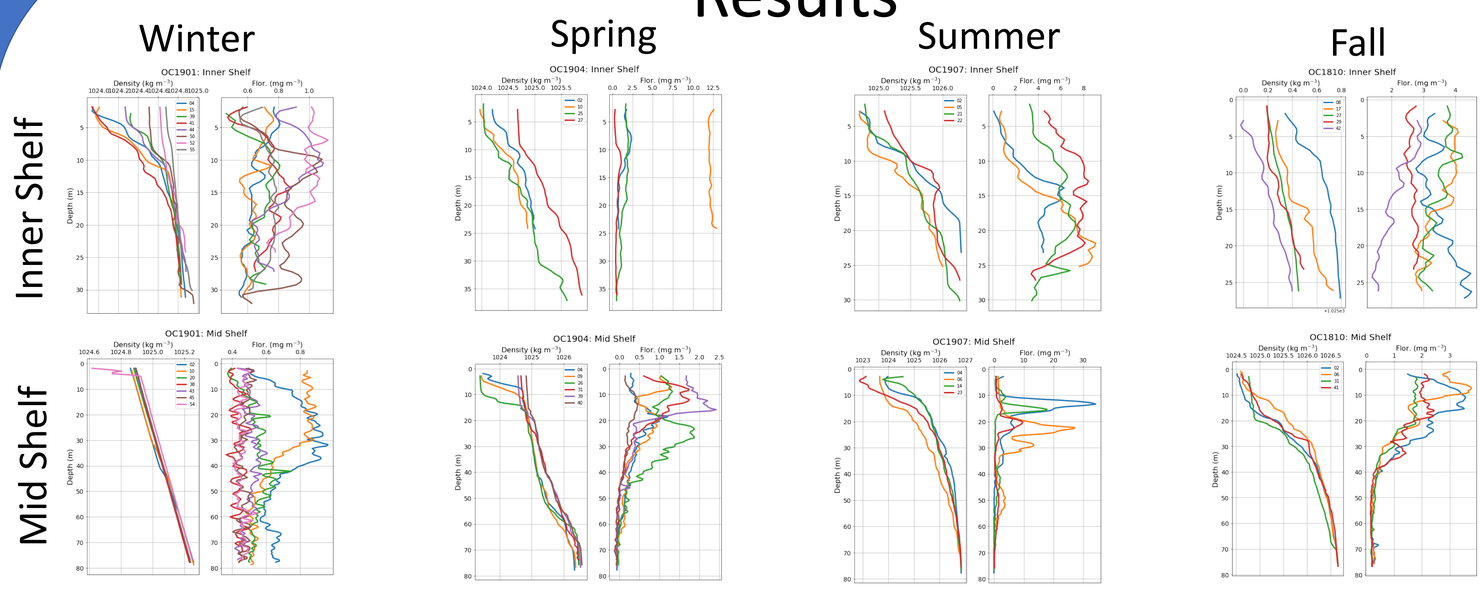

Fig.3: Examples of water-column profiles of density and fluorescence for the Inner and Mid Shelf Sites for each season. The legend corresponds to the event number of the respective cruise ID.

Table 1: Mean total water-column fluorescence (mg m^{-2}) grouped by cruise for the Inner Shelf. N = number of CTD casts. SD = standard deviation.

cruise	N	Mean	SD
OC1712	2	19.47	1.67
OC1801	3	24.88	9.56
OC1805	8	177.71	120.92
OC1807	3	111.03	87.37
OC1808	4	138.10	46.85
OC1810	5	81.71	15.66
OC1901	8	19.62	2.71
OC1904	4	95.26	130.62
OC1907	4	136.85	37.68

Table 2: Mean total water-column fluorescence (mg m^{-2}) grouped by cruise for the Mid Shelf. N = number of CTD casts. SD = standard deviation.

cruise	N	Mean	SD
OC1712	5	38.76	3.27
OC1801	4	43.35	2.60
OC1802	4	105.99	11.34
OC1805	5	56.11	15.14
OC1807	3	103.57	62.95
OC1808	5	60.37	8.17
OC1810	4	72.17	13.40
OC1901	7	39.84	8.40
OC1904	6	30.34	14.15
OC1907	3	201.57	91.33

Table 3:Mean total water-column fluorescence (mg m^{-2}) grouped by season for each site. N = number of CTD casts. SD = standard deviation.

	season	N	Mean	SD
Inner Shelf	**winter**	13	20.81	5.01
	spring	12	150.23	124.92
	summer	11	130.26	52.58
	fall	5	81.71	15.66
	season	**N**	**Mean**	**SD**
Mid Shelf	**winter**	20	53.5	27.8133
	spring	11	42.0518	19.3128
	summer	11	110.6582	79.034
	fall	4	72.1725	13.4016

Discussion

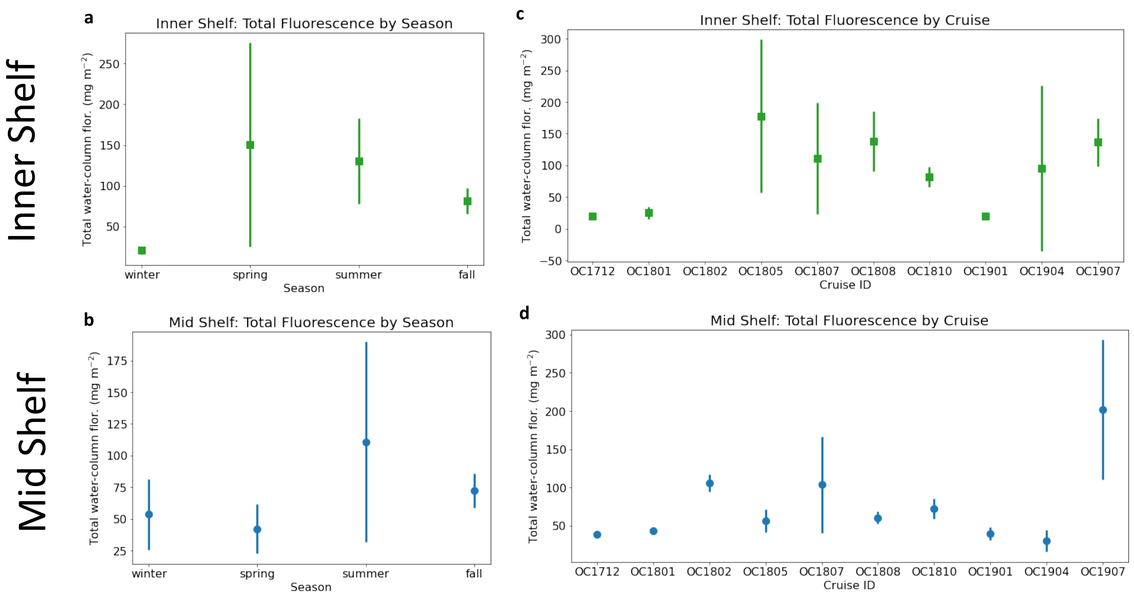

Fig. 4: Mean and standard deviation of total water-column fluorescence (mg m^{-2}) by (**a**) season for the inner shelf (**b**) season for the mid shelf (**c**) cruise ID for the inner shelf, and (**d**) cruise ID for the mid shelf.

- Summer data demonstrates large fluctuations in recorded fluorescence
- Winter months display consistent values, with very little deviation
- Inner Shelf and Mid Shelf report substantially different fluorescence values
- Categorization of data by cruise seemed to be the best approach for data visualization analysis
- Unable to conclude with statistical confidence that one season is different from another

Future Work

- Exploration of other variables that may be resulting in the variability or consistencies that we see in this data analysis
- Obtain more samples for a more even distribution in effort to complete statistical analysis of data using T test and the total water-column integrations for fluorescence
- Statistical analysis
- Use scientific literature and collected water column samples to convert fluorescence into phytoplankton biomass
- Further analysis using OOI Data as cross reference for events that may explain oddities in apparent trends and put our cruises into larger context

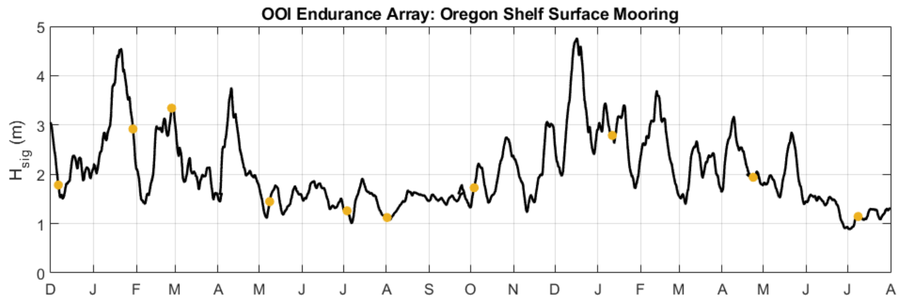

Fig. 5: Significant wave height (Hsig) at the Mid Shelf site for December 2017-July 2019 (Data from Ocean Observatories Initiative)

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