Preliminary Observations on Chlorophyll a and Primary Productivity Distributions Obtained During the Gulf of Alaska GLOBEC Monitoring Program

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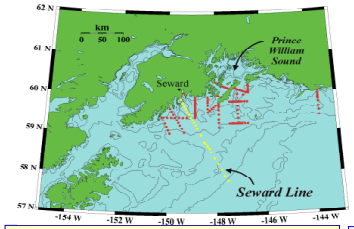

Abstract: As a part of the GLOBEC monitoring program for the Gulf of Alaska, chlorophyll a distributions were monitored from October 1997 through December 2001. These collections were obtained during the months of March, April, May, July or August, October, and December. Collection times were chosen to provide an opportunity to observe the seasonal and inter-annual variations in phytoplankton standing stock associated with changing nutrient concentrations and hydrographic conditions. In addition, nutrient distributions and primary production patterns were also monitored. Fluorescence patterns and chlorophyll a distributions suggest increased phytoplankton concentration in the early spring, extending throughout the water column. In April, phytoplankton concentrations were enhanced over the inner-shelf and shelf-break regimes. By late summer, standing stock estimates were highest in a sub-surface layer extending across the entire shelf. Primary production estimates using conventional stable isotope protocol indicated an unusually high event occurring well beyond the shelf break in May of 2000. Enhanced nitrate concentrations, nitrate uptake rates and elevated phytoplankton biomass (primarily in the > 20 µm fraction) coincide with a doming of density structure and eddy activity. These data provide a preliminary look at the concentrations and distributions of phytoplankton pigments and nutrient concentrations in conjunction with a dynamic down-welling shelf intermittently impacted by eddies.

Introduction:

During the GLOBEC monitoring program for the Gulf of Alaska, samples were collected from the Seward Line to obtain chlorophyll distributions, nutrient concentrations and estimates of primary production on an annual basis. To date, samples have been collected in 1998, 1999, 2000 and 2001 during the months of March, April, May, July or August, October, and December. These collection times provide an opportunity to observe the seasonal and inter-annual variations in the chemical, biological and physical properties over the Alaskan shelf. This data represents the first systematic yearly record of nutrients, pigments and primary production across the Gulf of Alaska shelf.

Figure 1:

Integrated chlorophyll a distributions as shown by size fraction for stations GAK 1, GAK 4, GAK 9, GAK 13 and KIP 2 (mg Chl a m^{-2}). These chlorophyll distributions are for 2001 and are integrated to 50 meters.

GAK 1 represents stations within waters of the Alaska coastal current. Gak 4 is located over the mid-shelf. Gak 9 is representative the shelf-break area. GAK 13 is sea-ward of the shelf break and is occasionally within the Alaskan Steam. KIP 2 is located within Prince William Sound.

Size fractions shown in legend are >20 µm, <20 and >5 µm, and , <5 µm. Note: scales are different for each panel.

KIP-2 (a Prince William Sound station) and GAK 1 both demonstrate the predominance of large (>20 µm) cells although <5 µm cells may account for 50% of the biomass in winter months.

Moving offshore on the Seward line, small cells tend to dominate these stations. The smaller cell component exhibits a lower amplitude oscillation than the >20 µm fraction. Correlations of nitrate uptake rates nitrate concentration and biomass increases in this larger fraction remain to be examined.

Figure 1.

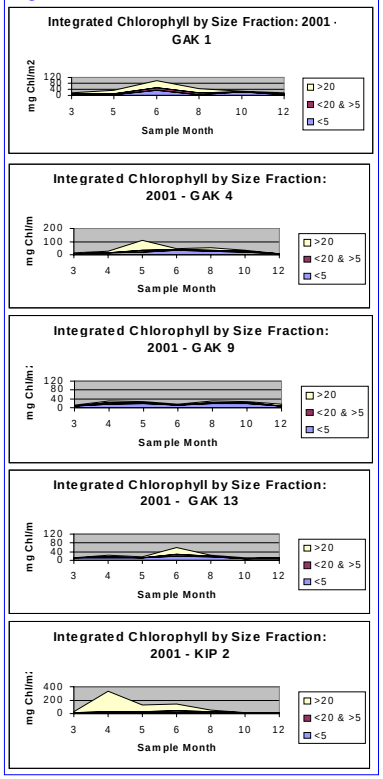

Figure 2.

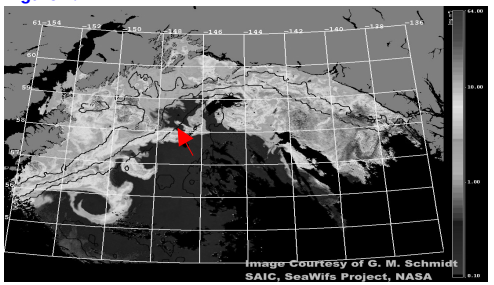

Figure 2:

May 2000 SeaWifs false-color image of near surface chlorophyll pigment suggesting eddy-induced cross-slope exchange in the Gulf of Alaska (Okkonen *et al.*, Nov. 2001 GLOBEC poster). Swirls of enhanced color (increased chlorophyll concentrations marked by red arrow) occur in the vicinity of GAK 13. This region shows enhanced nitrate concentrations, elevated nitrate uptake rates and high carbon uptake rates.

Table 1.

STATION	INTEGRATED ^{15}C-UPTAKE	INTEGRATED $^{15}NO_3$-UPTAKE	INTEGRATED $^{15}NH_4$-UPTAKE	INTEGRATED CHL a
GAK 1	1.087	2.658	2.727	559.65
GAK 4	0.544	0.396	0.441	498.65
GAK 9	1.771	2.983	1.479	632.74
GAK 13	2.066	5.898	1.225	318.14

STATION	CARBON/CHL	NO_3-N/CHL	NH_4-N/CHL	f-RATIO
GAK 1	1.80	4.75	4.87	559.65
GAK 4	1.11	0.81	0.90	498.65
GAK 9	2.71	4.57	2.57	632.74
GAK 13	6.49	18.02	3.85	318.14

STATION	INTEGRATED NO_3	INTEGRATED NH_4
GAK 1	122.80	37.28
GAK 4	644.03	21.42
GAK 9	283.91	14.82
GAK 13	379.64	05.76

Table 1. 2001 integrated primary productivity (g C m-2 d-1), integrated $^{15}NO_3$-uptake (g NO_3-N m^{-2} d^{-1}), integrated $^{15}NH_4$-uptake (g NH_4-N m^{-2} d^{-1}), integrated chlorophyll a (mg Chl m^{-2}), carbon:chl ratio, nitrate:chl ratio, ammonium:chl ratio, f-ratio, integrated nitrate concentration (uM NO_3) and integrated ammonium concentration (uM NH_4). All integrated values determined to 1% light level.

Figure 3.

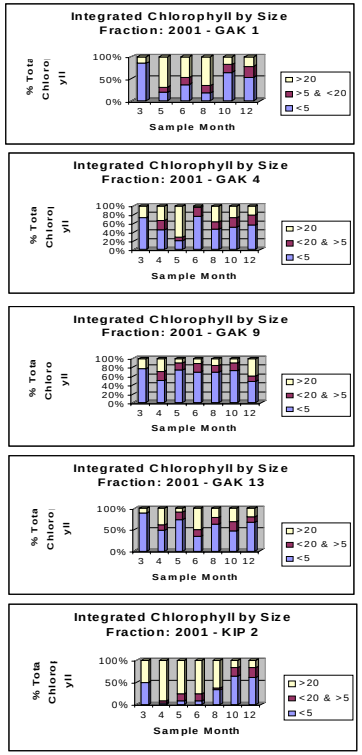

Figure 4.

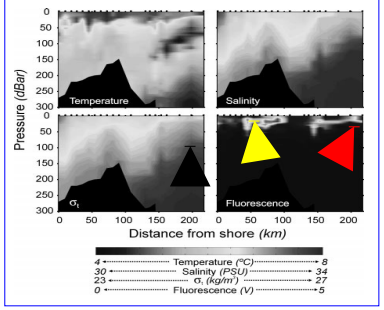

Figure 4. Distributions of temperature, salinity, sigma-t and fluorescence along the Seward line, May 2000. Note the doming of isopleths at approximately 200 km offshore (black arrow). Coincidental with this doming are increases in upper water column nitrate concentrations, fluorescence (red arrow), enhanced $^{15}NO_3$-uptake rates, and enhanced ^{13}C-uptake rates.

Figure 3. Distributions of integrated chlorophyll a by size fraction for stations GAK 1, GAK 4, GAK 9, GAK 13 and KIP 2. Sample period March through December 2001. Large diatom populations dominate inshore stations GAK 1, GAK 4 and KIP 2. Offshore stations are characterized by a large percentage (about 60-80% < than 5 µm cells). These smaller fractions are dominated by smaller Crytomonads and *Synecoccus* spp.

Summary Note: Chlorophyll concentrations along the Seward line typically display a decreasing offshore gradient, dominated by smaller sized cells. The dynamic influence of eddies are displayed by the increased biomass and productivity of large cells as nitrate is delivered to offshore waters. This nutrient delivery mechanism across Alaskan shelf waters may greatly enhance shelf productivity.