Moored Nitrate Monitors

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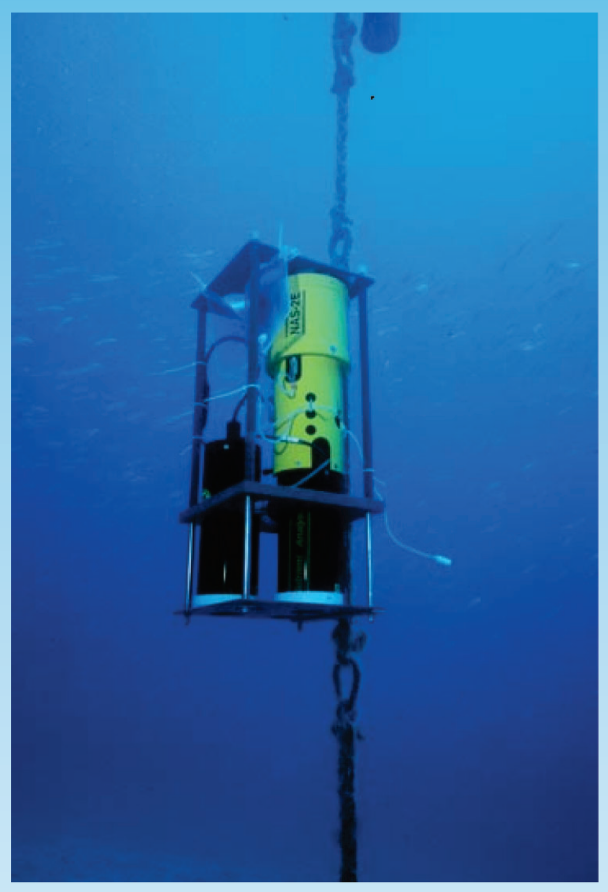


Goals

We have deployed nitrate meters in upwelling (Oregon) and downwelling (Gulf of Alaska) regimes of the Northeast Pacific Ocean to 1) better understand mechanisms of on-shelf nutrient transport, 2) better parameterize nitrate from physical and/or biological parameters, and 3) better understand how declining nutrients in the Northeast Pacific Ocean may impact coastal ecosystems.

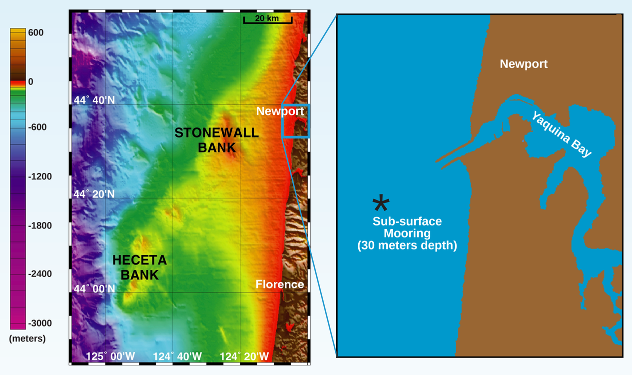
Oregon Coast

Purpose

To examine the temporal variability of subsurface nitrate offshore of Yaquina Bay Channel during seasonal upwelling in relation to wind events and tides.

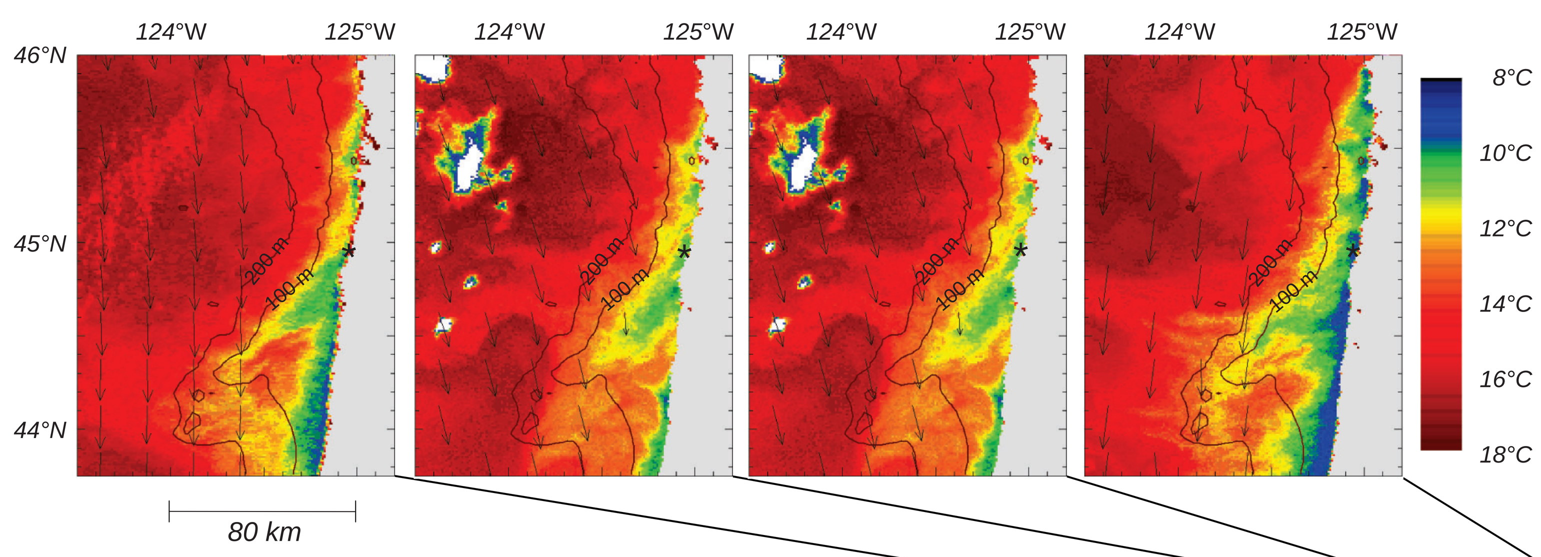
Design

In August, 2000 we moored a W.S. Ocean Nitrate Monitor along withT-S sensors and a current meter offshore of Yaquina Bay.



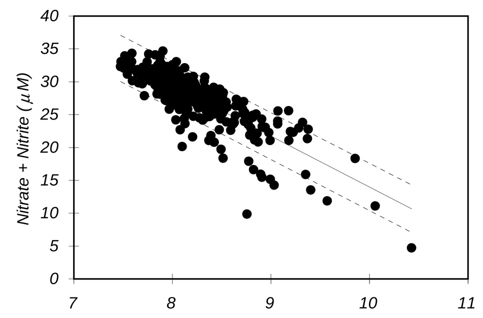
Bathymetry along the central Oregon Coast (left) with the locations of Hecta Head and Stonewall Bank, and the location of the mooring outside of Yaquina Bay Channel (right). Bathymetry compiled from various NOAA data sources.

Results

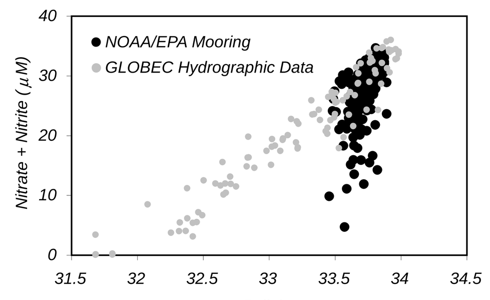


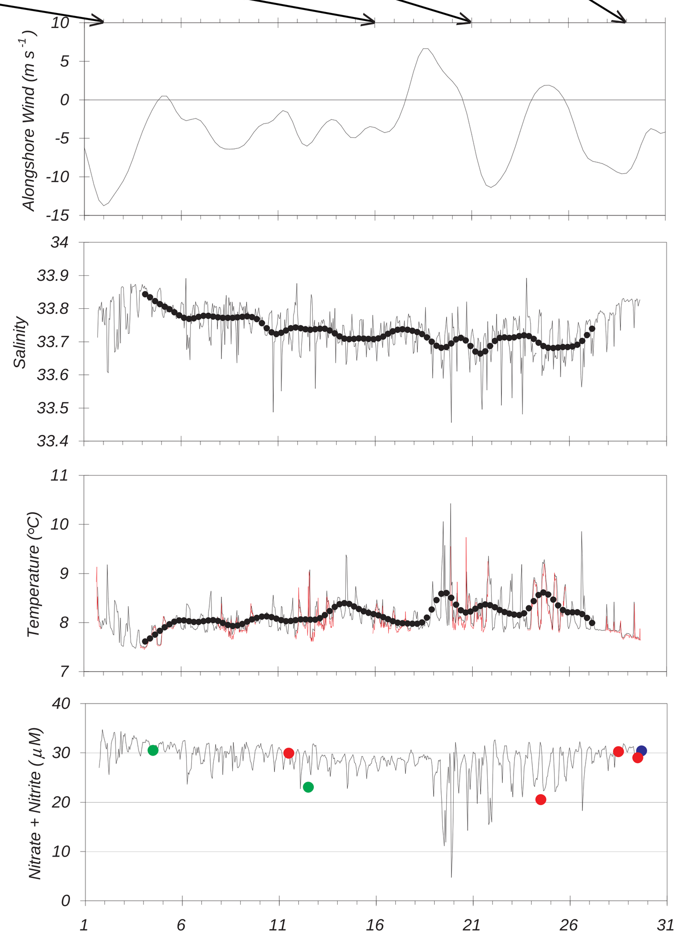
SeaWiFs images of sea-surface temperature (°C) observed during the time-series overlaid with NCEP wind vectors and bathymetry at 100 and 200 meters.

- Strong upwelling was observed at the start and end of the month, interrupted by a period of weak downwelling winds, and lower nitrate levels in nearshore water.
- Outflow from Yaquina Bay was not evident (no relationship between tidal height and temperature, salinity or nitrate); tidal scale variability resulted from alongshore transport of gradients past the mooring.
- Nitrate and temperature are related ($r^2 = 0.71$) due to the uptake of nitrate by phytoplankton concomitant with warming of recently upwelled water.
- Slope of N+N vs. T
  - 7.7±0.4 μM N °C^{-1} (95%)
  - Surface warming rate
    - 0.52±0.07 °C d^{-1}
    - (Dugdale et al., 1997)
  - GLOBEC hydrographic chl-*a*
    - (10-20 m, Aug 4 & 12)
    - 3.1±1.6 μg l^{-1}
  - *Normalized nitrate uptake rate*
    - 1.3±0.7 μM N d^{-1} chl-*a*$^{-1}$



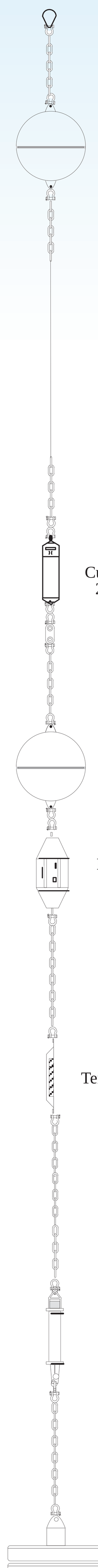
- The normalized nitrate uptake rate compares favorably with estimates made from N^{15} incubations in 1985 under nitrate replete conditions: 1.4±0.4 μM N d^{-1} chl-*a*$^{-1}$ (Kokkinakis & Wheeler, 1987).
- The relationship of nitrate with salinity differs between the GLOBEC hydrographic cruise and the mooring as a result of Columbia/Frasier river water in offshore surface water.

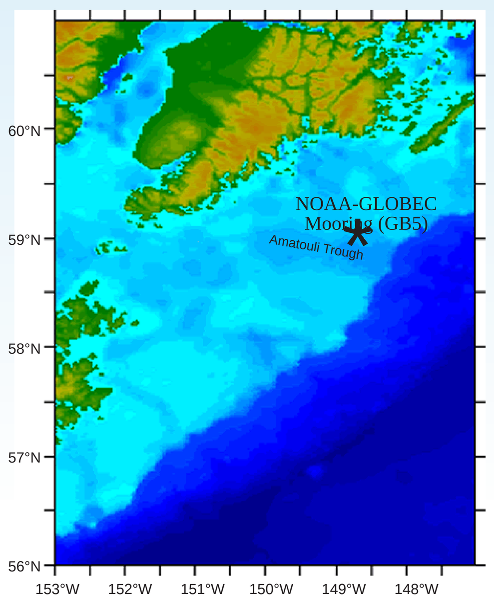




Time series of alongshore wind speed, temperature, salinity and nitrate. The temperature time series includes readings from the SeaCat (black) and sporadic measurements from the RCM9 (red). A 6 hr filter was applied to the data, and both filtered (circles) and unfiltered results are presented for temperature and salinity. Green symbols in the nitrate time series are surface waters at the 1 km station of a concurrent GLOBEC cruise, red symbols are from the surf zone, and the blue symbol is from a surface sample collected during the recovery cruise.

Alaskan Shelf





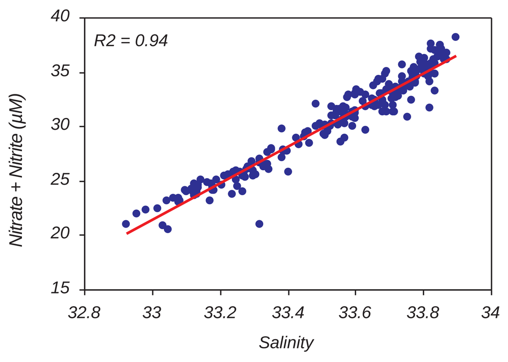
Purpose

To examine the role of role of submarine canyons in supplying nutrients to the Alaskan Shelf, and, to parameterize nitrate from temperature and/or salinity.

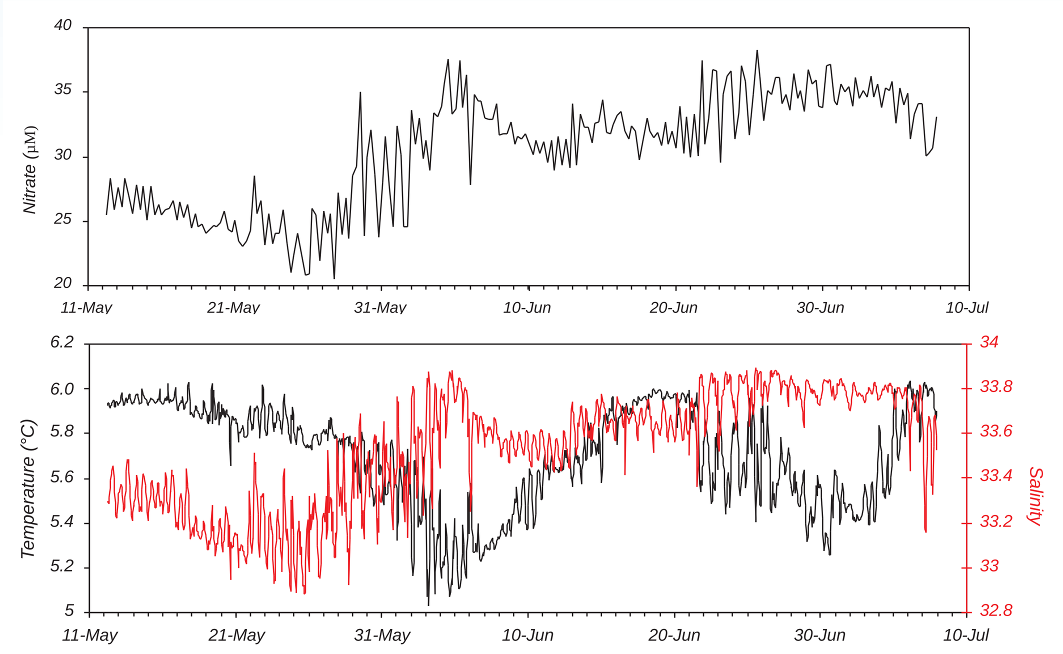
Design

In May, 2001 we moored a W.S. Ocean Nitrate Monitor at 233 m on the northern slope of Amatouli Trough

Results

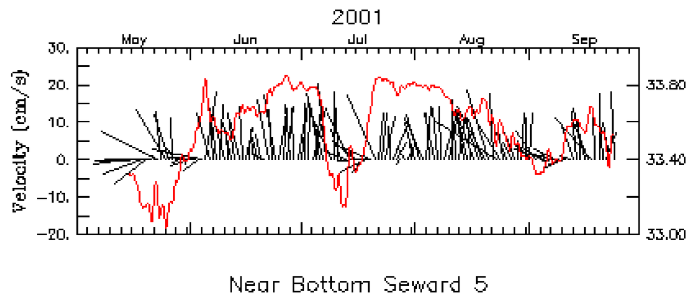


The relationship of nitrate and salinity at the Amatouli mooring.

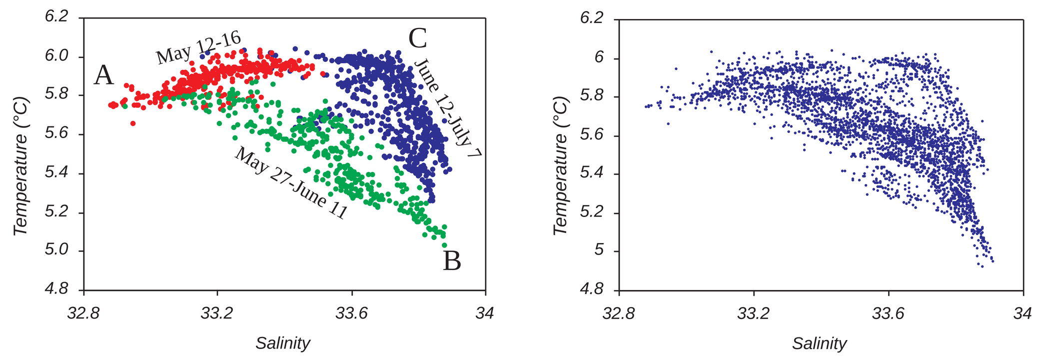


Time series of nitrate (top panel), temperature and salinity (bottom panel) at 233 m in Amatouli trough

- Nitrate and salinity were closely related while the relationship of nitrate and temperature was especially poor ($r^2 = 0.31$, small range of temperature).
- On tidal scales, nitrate varied by about 2-10 μM.
- Nitrate concentrations increased by about 10 μM from May to June/July in conjunction with increased salinity.
- Current vectors showed down-slope flow in early May, and along-slope (up-canyon) flow in late May to mid-July which was associated with high salinity (and high nitrate). Up canyon flow contributes to the on-shelf transport of nitrate.

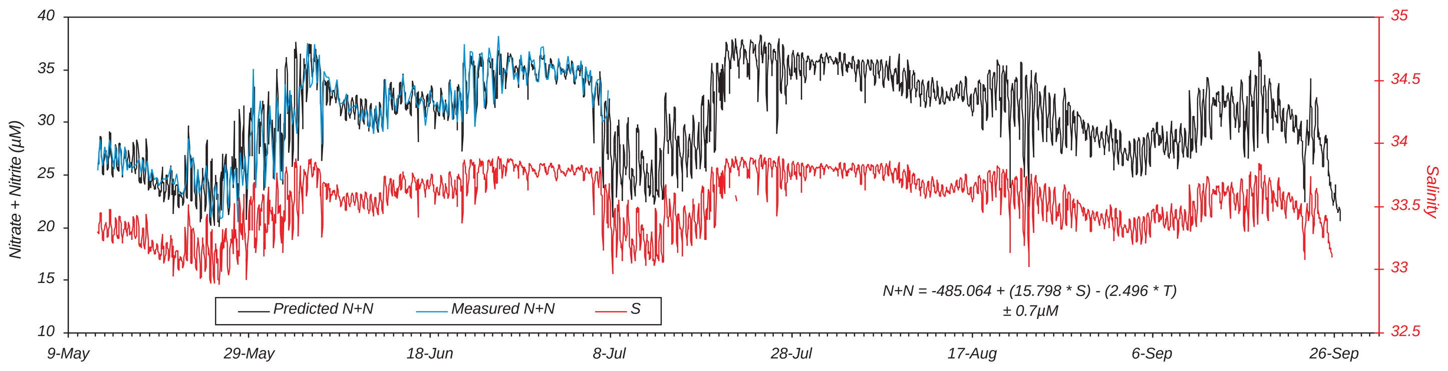


- The nutrient meter was only operational from May 12 to July 7, and not for the entire mooring deployment.
- The T-S diagram from May 12 to July 7 suggested three modes of mixing (red, blue, and green) for three different watertypes (A, B, and C).
- The T-S diagram of all the mooring data (May-September) shows no other watertypes present. Hence, using temperature and salinity to predict nitrate for the entire deployment appears valid.



Temperature-salinity diagrams of mooring data from May 12-July 7 (left) and for May 12-September 25 (right).

- Nitrate was predicted to decrease by 5-10 uM in mid-July and early Sep. due to weaker of along-slope flow.



Conclusion

By continuning to deploy moored in situ nutrient analyzes, we will obtain a better understanding of the interannual variability of nutrients in the Northeast Pacific Ocean, and the variability of mechanisms transporting nutrients onto the shelf. Nitrate timeseries provides an understanding of temporal variability which cannot be achieved from “synoptic” hydrographic data. In addition, predictions of nitrate from regional hydrographic data may be skewed by watertypes outside the study area.

Acknowledgements

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