Integrating Ocean Observations across the Coastal Shelf Boundary

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Motivation

The ocean is the biggest source of wild or domestic protein in the world. The global fish production exceeds that of cattle, sheep, poultry or eggs. Fish can be produced in two ways: by capture and by aquaculture. The total production has grown 34% over the last decade.

Marine Biodiversity: Over 60% of the world's coral reefs are threatened as a result of pollution, sedimentation and bleaching due to rising water temperatures caused by global warming.

Coastal Infrastructure: Significant percentage of the world population live on the coastal fringes. There are significant infrastructure facilities at the coastal fringes.
Coastal Population

Data shown represent the percentage of a country’s population who live within 100 km of the coast.

Source WRI
Note: for some small island nations where no data was provided, coastal pop. % has been assumed to be 100%.

Legend:
- 0–25%
- 26–50%
- 51–75%
- 76–100%

Displayed areas represent approximate marine areas for coral reef countries. These do not represent official country borders.

Figure 2. Proportion of population living on the coast.
Map source: http://www.seafuse.org/
Near-coastal ocean regions have been divided into 64 Large Marine Ecosystems that cross geopolitical borders. This concept is expected to improve co-operation of countries with regard to international marine conservation. The individual LMEs are coloured to indicate the intensity of fishing from 2000 to 2004. In many marine regions the fishing pressure has not dropped since then. © after www.lme.noaa.gov
Observations across the coastal shelf boundary

Coastal ocean sits between land and open ocean

- Mediates freshwater, carbon and nutrient cycles
- Sustains important ecosystem services (food for people)
- Faces issues of resilience and vulnerability to human activities (population and land-use change) and multi-decadal climate variability
  - e.g. temperature change, acidification, habitat shifts, ecosystem stresses, and changes in productivity and biodiversity

**e.g. Consider the freshwater cycle:**

- Continental shelf circulation connects terrestrial runoff to the open ocean
- Observations of salinity and shelf edge fluxes inform closure of shelf-wide freshwater budgets (in conjunction with land-side inflow data)
- If you can’t close the freshwater/salinity budget, how could you possibly close the budget of land-to-ocean nitrogen flux or carbon export and burial?
The complex ocean – shelf boundary
GOOS Regional Alliances bring to national and regional Ocean Observing System into a forum for discussion and cooperation. Working with GRAs, OOPC is developing a working group to ensure open ocean and coastal ocean Observations are consistent and coordinated across the shelf-open ocean boundary.
GRAs Multi-platform Observing Systems
Study of winter phytoplankton productivity on outer shelf used moorings, gliders & ship surveys in 2012. H. Seim, C. Edward, J. Nelson

Jets and streamers drive exchange of shelf and GS waters via bottom boundary layer, and surface

Studies of shelf/open-ocean interaction processes that fuel coastal productivity should be considered in context with boundary current dynamics that vary on larger and longer space and time scales.

LB3 mooring: Upper slope currents show transition between jet and meander regimes (and distinct from inner shelf moorings)
Open Ocean and Shelf interactions.
Coastal Nutrient Resupply

Wind-driven upwelling event:
6-9°C & 5-10 μmol/l

Wind-driven downwelling event:
1-2°C & 1-2 μmol/l

Current-driven upwelling event:
3-4°C / 3-5 μmol/l
Physical influences on Phytoplankton
OOPC: Sharing information of International Best Practices

Sustained open ocean observing would provide the deep ocean context to complement coastal process studies; each with appropriate technology (coastal: Slocum gliders, moorings, ship-towed profilers, CODAR; deep: Spray gliders, deep mooring, Argo...)

Bottom mixed layer thicknesses up to 100 m at Blake Plateau and Charleston Bump. Can infer vertical water column from glider data.

PEACH Field Campaign observed at Cape Hatteras, to be the object of future observing program.

R. Todd, WHOI
Conclusions

Specific issues that a comprehensive (observations and models) Boundary Current/Shelf Interaction coordination group will address are:

- impacts and influences of large-scale remotely driven variability on boundary currents
- how variability in strength and dynamics of the boundary currents drive shelf-sea/open-ocean exchange, including nutrient forcing, carbon export, and other aspects of productivity of shelf waters
- response of coastal and boundary current dynamics to local and regional wind and buoyancy forcing; impact these have on dynamics at larger scales through teleconnections
- quantifying resolution required to represent coastal and BC dynamics in global climate models
- obtaining basin-wide estimates of meridional transports through a synthesis of coastal, boundary and open ocean observations