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Working group report

WG8: Biogeochemical Hotspots, Choke Points, Triggers, Switches, and Non-Linear Responses

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Key Themes:

I. Understanding hotspots and choke points

1) What regions in the global ocean are likely to be the most sensitive to global change (hot spots) or are likely to regulate the ocean's response to global change (choke points) and therefore need to be more carefully studied and monitored?
    a) Marginal seas (e.g. Black Sea)
    b) Coastal margins (e.g. Bering Sea Shelf)
    c) Straits and passages (e.g. Straights of Gibraltar)
    d) Monsoonal regions (e.g. South China Sea)
    e) High latitude oceans (e.g. Southern Ocean, polynias)

2) What biogeochemical processes are likely to be the most sensitive to global change (hot spots) and therefore need to be more carefully studied and monitored?
    a) Processes responsible for HNLC regions (e.g. Sub-arctic Pacific)
    b) Biogeochemical and ecosystem responses to changes in water mass formation rates (e.g. North Atlantic)
    c) Biogeochemical and ecosystem responses to changes in upwelling (e.g. Equatorial Pacific)
    d) Organic remineralization processes responsible for maintenance of oxygen minimum zones in the oceans (e.g. Arabian Sea)

3) Are there hot spots or choke points that need to be protected either from a conservation standpoint (e.g. coral reefs) or because of the potential negative consequences of their response to climate change (e.g. thermohaline circulation)?

II. Understanding the controls, triggers and switches on biogeochemical cycling and ecosystem structure

1) What controls ocean productivity (e.g. sub-surface chl. max, critical depth and macro- and micro-nutrient limitation)?
2) How can changes in stratification or riverine inputs to the oceans affect biogeochemical cycles (e.g. coastal production, rain ratio, N_2O fluxes)?
3) What are the controls that regulate whether a bloom is dominated by diatoms, coccoliths, phaeocystis, or other phytoplankton species?
4) What allows the decoupling of growth and grazing?
5) Do climate regime shifts act as a trigger for changes in ocean ecosystem structure and biogeochemistry (e.g. ENSO, PDO)?
6) What can the past (e.g. glacial/interglacial changes) tell us about controls and triggers?

III. Identifying natural and human induced reversible and irreversible changes on time scales relevant to human induced global change

1) What are the non-linear controls on the trophic levels and can changes in trophic structure be reversed?
2) What are the effects of the timing and duration of seasonal cycles on ocean productivity and biogeochemical cycles?
3) What ecosystem and biogeochemical changes could result from changes in aerosol (Fe) deposition to the ocean or changes in ocean pH and are these changes reversible?
4) What biological feedbacks affect CO_2 fluxes?
5) What can we learn about reversible and irreversible responses to climate change from the paleo-records?

IV. Identifying thresholds

1) What biogeochemical and physical shifts might result from the release of methane hydrates?

2) What can studies of deep water regulation processes for DOC and Fe tell us about possible threshold controls on these parameters?
3) Which processes exhibit true threshold effects as opposed to strong non-linear trends?
4) Which complex biogeochemical models and experimental studies are suitable for systematic studies of poorly understood or undiscovered thresholds?

Approaches/Strategies for Research:

1. Benthic and paleo studies over relevant time scales (hotspots and triggers)
2. process studies over a range of time scales (Choke points)
3. Satellite measurements (identifying functional groups)
4. modeling (more sophisticated diagnostics for processes that we are currently studying by indirect measurements - what is limiting primary production?; modeling of critical processes and hot spots and rapid response of measurement community to test controls proposed by models)
5. application of molecular probes for nutrient transporters as diagnostics for limitation of phytoplankton growth; characterization of genomes for species that can not be cultured and proteomics once these genomes are characterized; micro arrays for highlighting previously unrecognized relationships between genes
6. kinetic studies for metabolic processes
7. Time-series studies (multi-decadal in hot spots and choke points)
8. studies to optimize experimental design
9. Regional surveys (in hot spots and choke points)
10. Autonomous measurements (including in the seasonal sea-ice areas)
11. Laboratory studies (e.g. culturing of key indicator species like *Tricho*)

Impediments

- How to “measure” thresholds processes (DOC in the deep ocean)
- How to determine nutrient controls versus ecosystem structure controls on productivity
- How to interpret the paleo record and the inability of the models to reconcile all of the information available
- Understanding the relationship between paleo records and time series water column observations
- Understanding how micro nutrients “limit” functional groups within the non-phototrophic microbial community (e.g. nitrifiers, methanotrophs)
- Reconciling molecular studies with large-scale ecosystem structures and geochemical signatures
- How to study the Southern Ocean given the extreme environmental conditions

Key Collaborations and Linkages:

need close interactions between physical, biological and geochemical oceanographic communities; interactions between in situ, satellite, and modeling communities; and between ocean community and other relevant disciplines (e.g. molecular biology community)
PAGES
IMAGE
CLIVAR
LOICZ
SOLAS
numerus relevant national programmes
center for environmental bio-inorganic chemistry (CEBIC)