The Ocean in a High-CO_2 World
Ocean Acidification
An international science symposium series
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Climate Change-Driven Multistressor Impacts on a Shelf Ecosystem: The Gulf of Maine

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Poster #89

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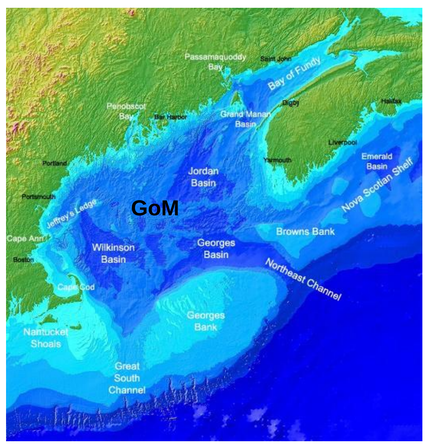
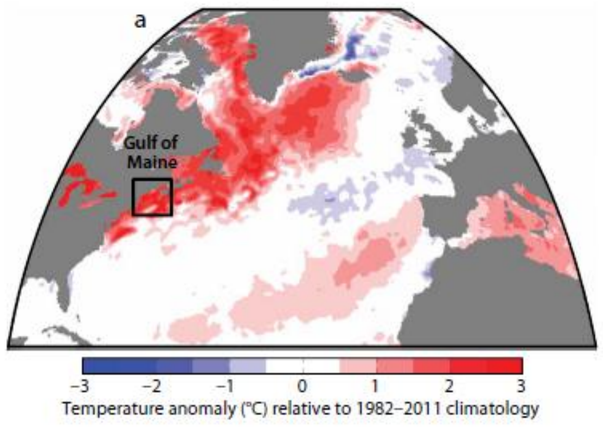
Abstract: The Gulf of Maine on the Northwest Atlantic margin is experiencing substantial decadal changes in water column biogeochemical characteristics and planktonic-benthic ecosystem structure and function. Such transformations are believed to be the result of global anthropogenic forcing with acute effects on the North Atlantic region. In order to examine linkages between drivers, stressors and specific impacts on the biogeochemical system and ecology, multiple chemical and biological data sets collected by numerous Gulf of Maine researchers from time-series moorings, research cruises and satellite surveys over the course of three decades, are integrated and summarized. Recent freshening and warming of the North Atlantic/Gulf of Maine appear to be significant drivers of plankton and fish community regimes shifts, changes in carbon delivery rates, variations in benthic community life cycles and production, as well as driving potential impacts on $CaCO_3$ precipitation/dissolution rates and near-bottom dissolved oxygen levels. Implications are that these trends will continue along their present trajectory into the future as a function of increasing atmospheric carbon dioxide levels and global temperature rise.

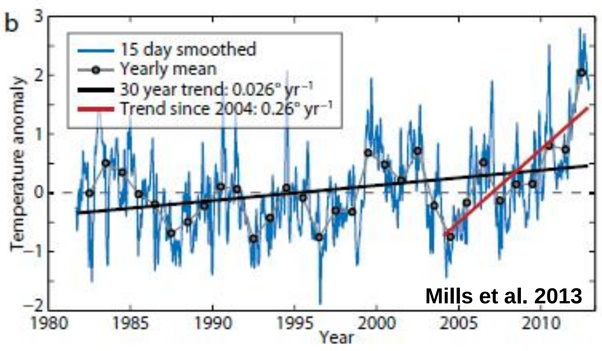
I. Climate-driven changes in Gulf of Maine (GoM)

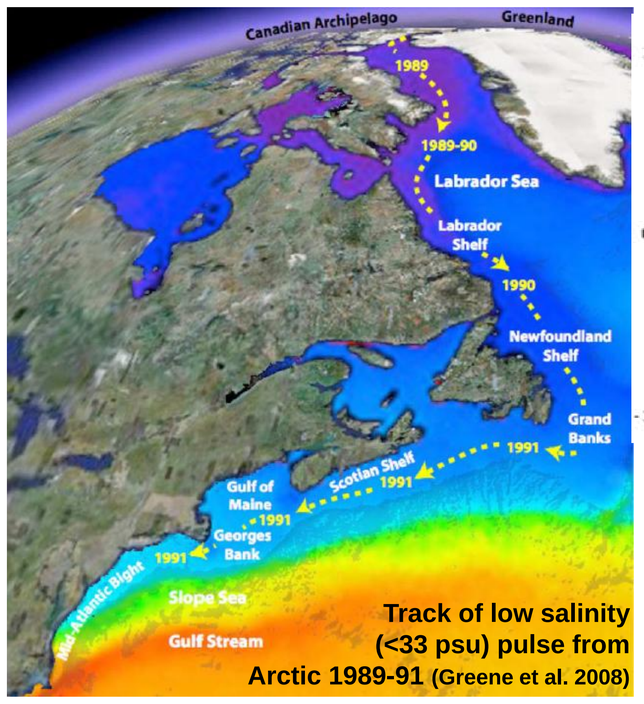


Intense warming of Arctic and No. Atlantic → 10-fold increase in GoM SST over past decade.

June-Aug. 2012 SST

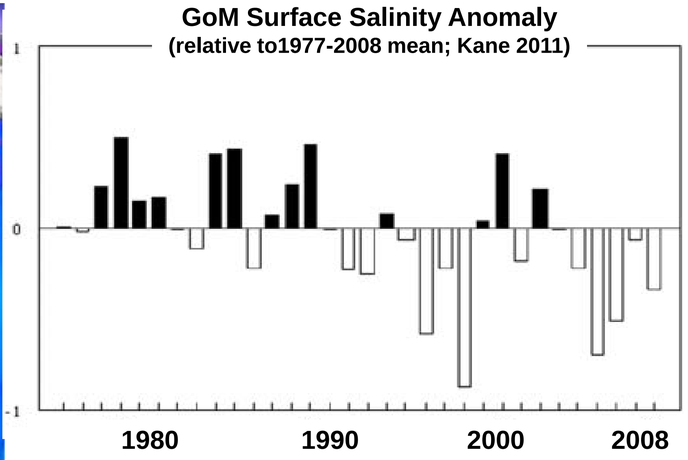






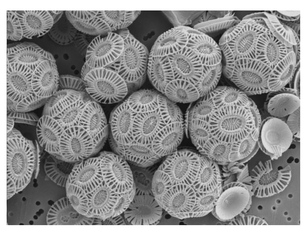
Track of low salinity (<33 psu) pulse from Arctic 1989-91 (Greene et al. 2008)

GoM Surface Salinity Anomaly
(relative to1977-2008 mean; Kane 2011)

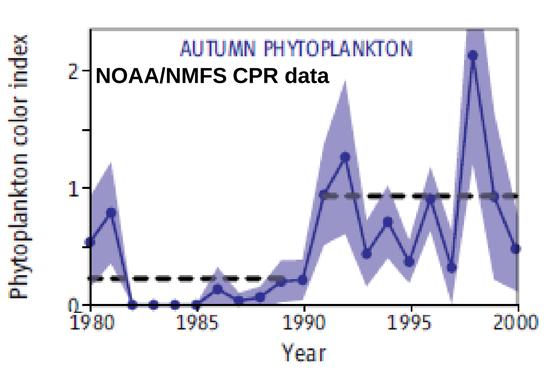


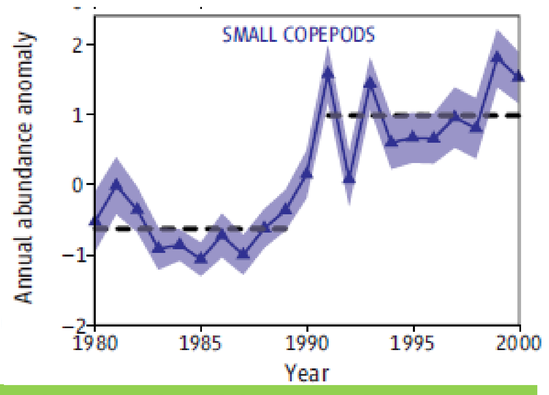
Warming-induced acceleration of Arctic ice melt → Increasing volumes of low salinity/low alkalinity water moving southward into NW Atlantic and GoM since 1990's.

II. Impacts on GoM plankton community and POC & PIC export



1990's → 2000's:
****Decadal decrease in surface water calcification rates and***
****10-fold decrease in surface productivity maxima (Balch et al. 2012) .***



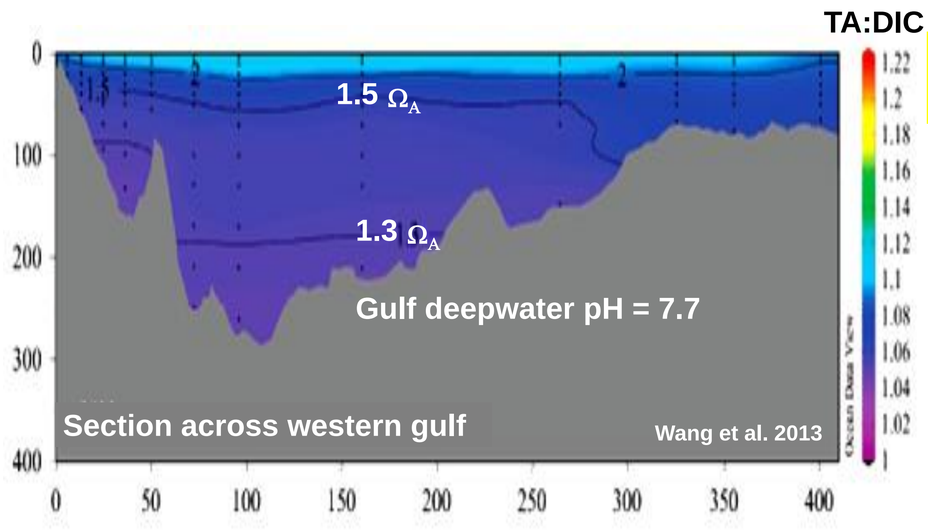


1990's → 2000's: Shorter duration spring blooms; longer autumn blooms; decreasing large copepod species abundance; increase in smaller species (Greene & Pershing 2007).

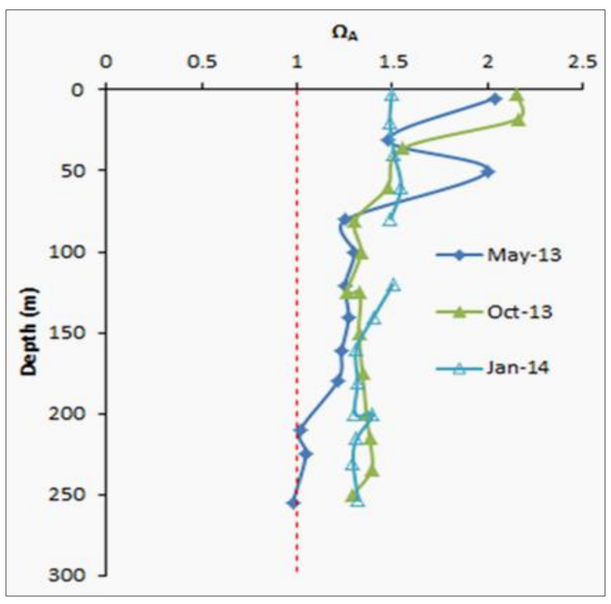
Times-series trap measured POC fluxes: 1990's → 2000's 20-50% decrease in sub-euphotic POC mass export.

Full-depth warming → higher rates of respiration & remineralization

III. Impacts on carbonate system parameters

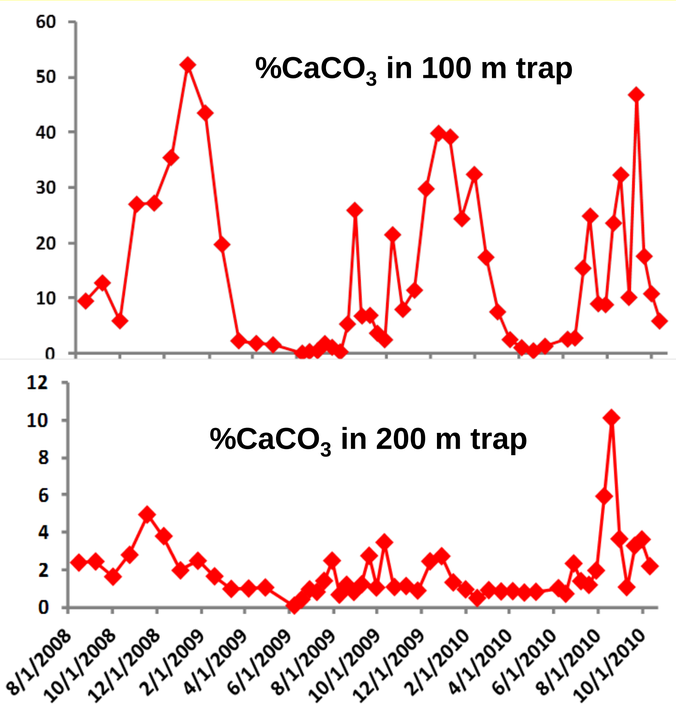


Low buffer capacity (TA:DIC), aragonite saturation state, and pH in deep GoM



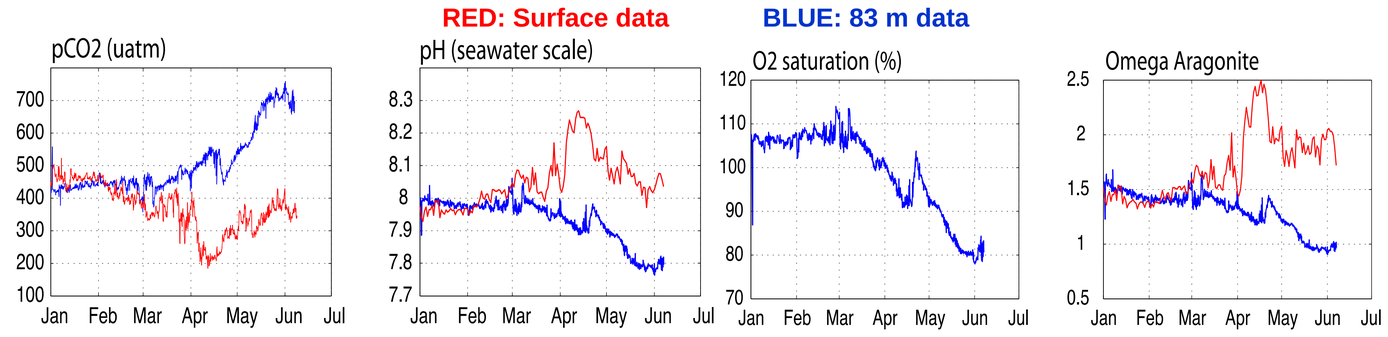
Aragonite pteropod shells dissolve; calcite foram tests survive.

Reflected by %$CaCO_3$ in sinking particulates: decreases significantly 100 m → 200 m.



Evidence of seasonal aragonite loss in relatively shallow GoM water column

RED: Surface data **BLUE: 83 m data**



SUMMARY:

Seasonal aragonite dissolution is coupled with POC remineralization in the lower shelf water column.

With continued warming and freshening of gulf waters, TA, pH and Ω_A expected to decline throughout the Gulf of Maine.

Projected negative impacts on shellfish and crustacean fisheries.