
CASIX
Centre for Observation of Air-Sea Interactions and Fluxes

The big Earth System questions are: How is the Earth changing and what are the consequences for life on Earth?

Yes!!!

Atmospheric concentrations of CO_2 continue to rise inexorably

Global temperatures continue to rise

Land and Ocean are increasingly sources of CO_2 to atmosphere

Arctic ice may disappear in summer

Antarctic ice shelf is fragmenting

Increasing desertification?

Increasing tropical storms?

Consequences – more of the same

For the Marine Environment, surface ocean-lower atmosphere, the questions are:

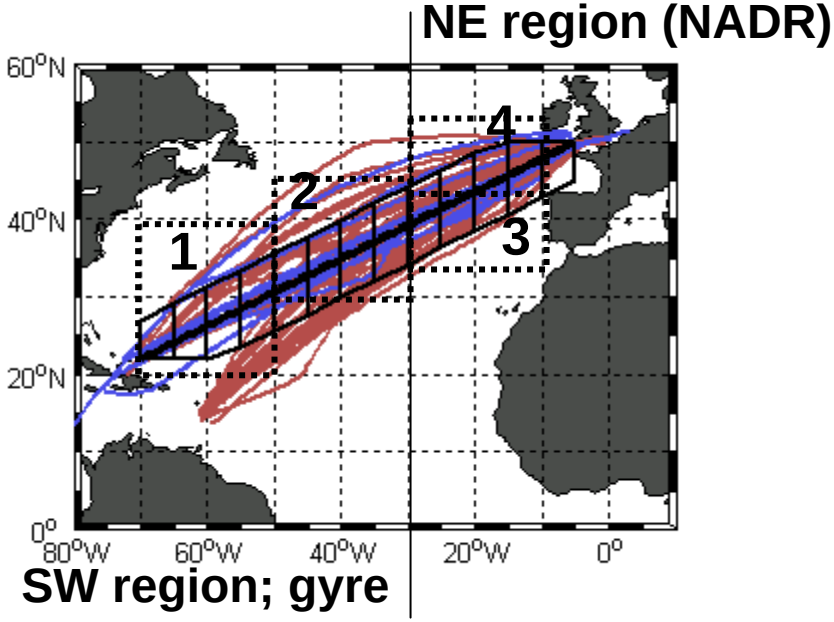
How do marine systems vary with time? (e.g. changes of THC, etc?)
How are marine ecosystems regulated by ocean processes? (physics, structure)
How do marine ecosystems interact with the global carbon cycle? (CO_2 flux)

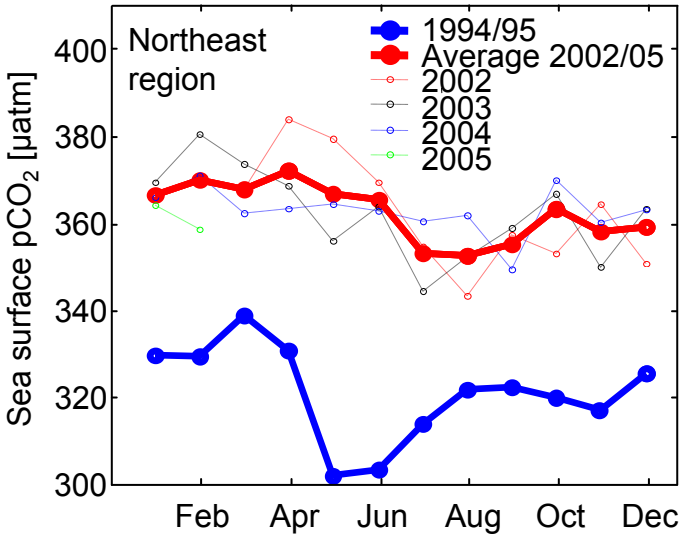
Global Carbon cycle and the climate system are intimately linked with the ocean C-cycle through the air-sea exchange of CO_2

The area of the tropical & sub-tropical gyres is increasing (greater stratification); gyres are important ~ 63% ocean area.
Result - More picoplankton.
Changes of CO_2 sink or source?

Reduced winter mixing at mid to high latitudes (due to greater stratification) - Less nutrient replenishment.
Earlier stratification and earlier spring bloom
Shorter spring bloom – less diatoms – less CO_2 fixed?

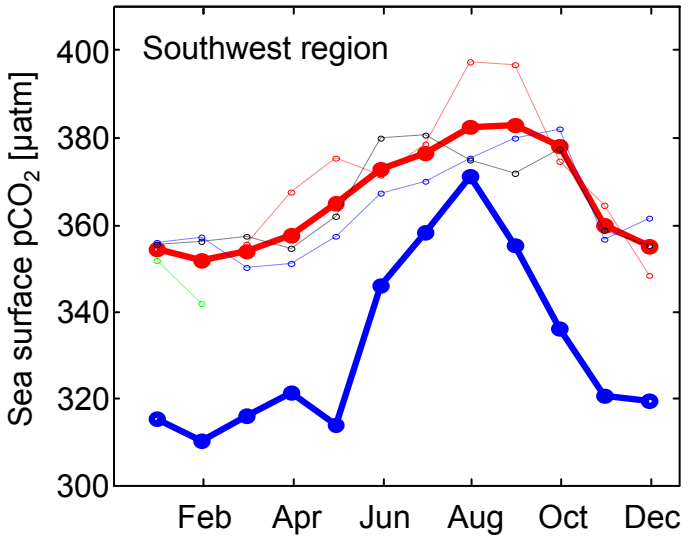
Shuster & Watson paper: NE region,10 – 30 W, > 35N



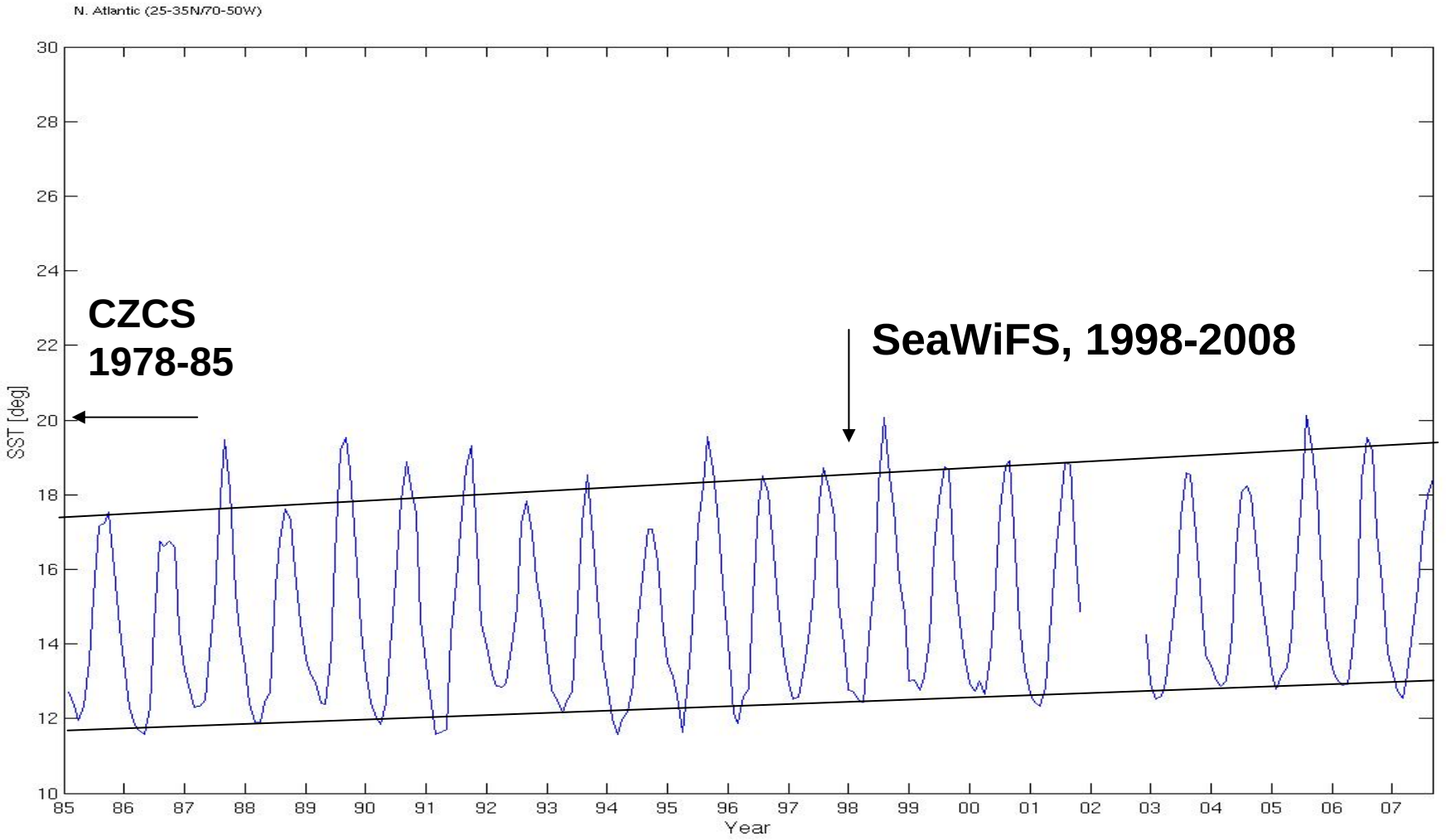


Surface pCO_2 >2002-05 than 1994/95 mean.

Significant seasonal changes in NW region different



SST, NE Atlantic (Box 4), 23 year trend, 1985 - 2008

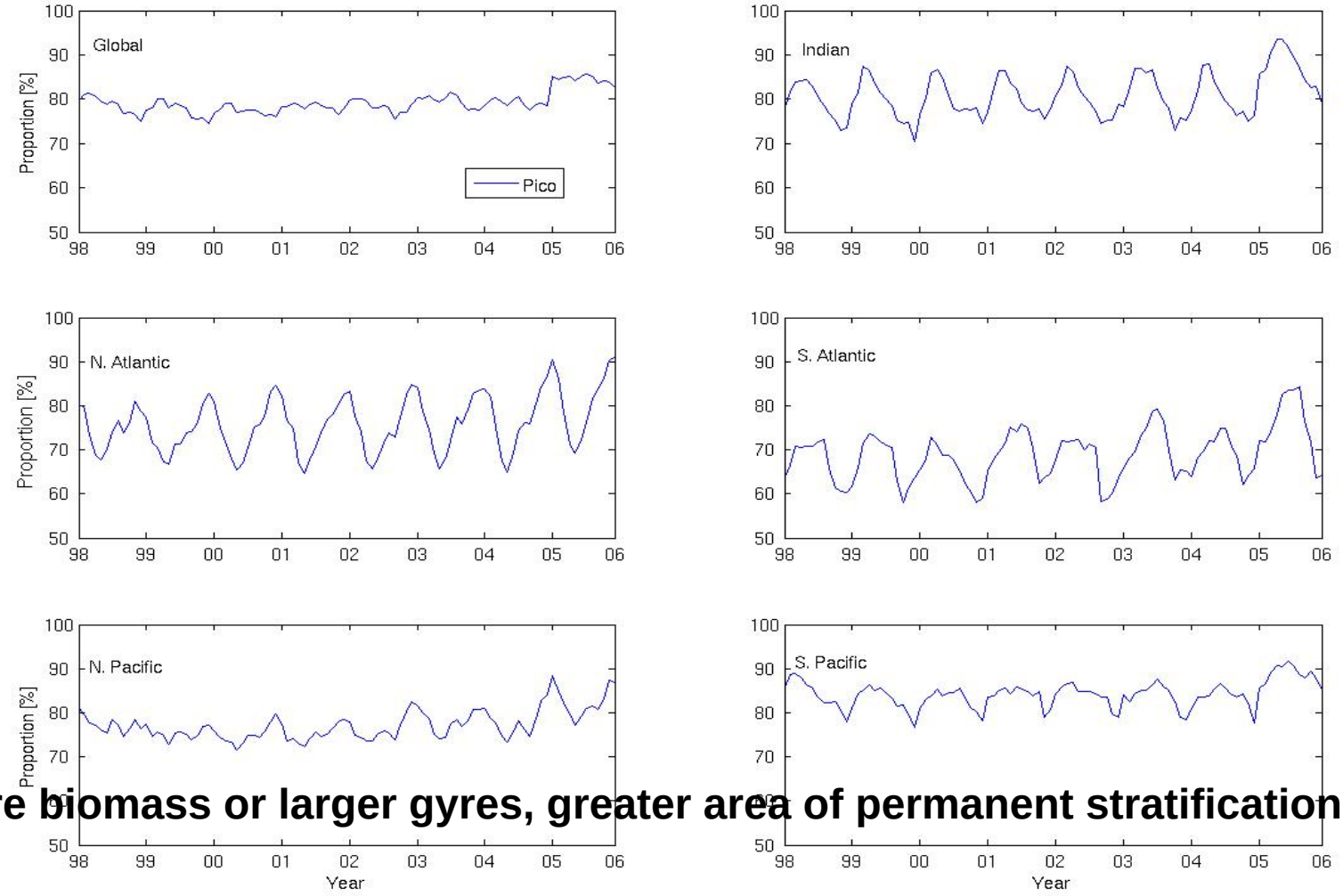


How are global marine ecosystems changing?

Analysis of PSCs (pico, nano, micro) by Hirata et al; RSE 2008

SeaWiFS 8-year time series, 1998-2006 for 6 ocean basins:

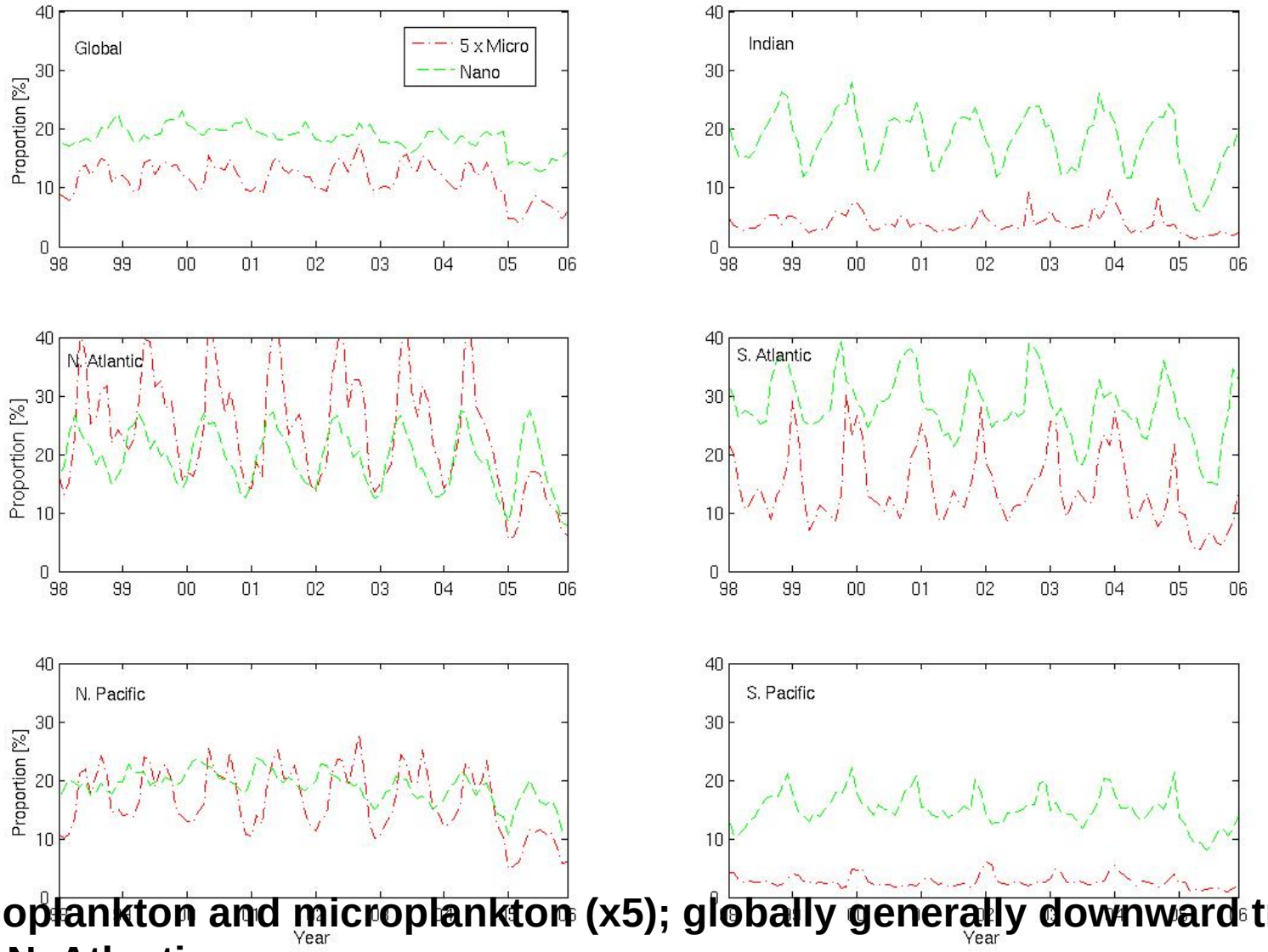
Pico plankton shows upward trend generally; NB N Atlantic.



More biomass or larger gyres, greater area of permanent stratification?

Global Trends – Ecosystem change?

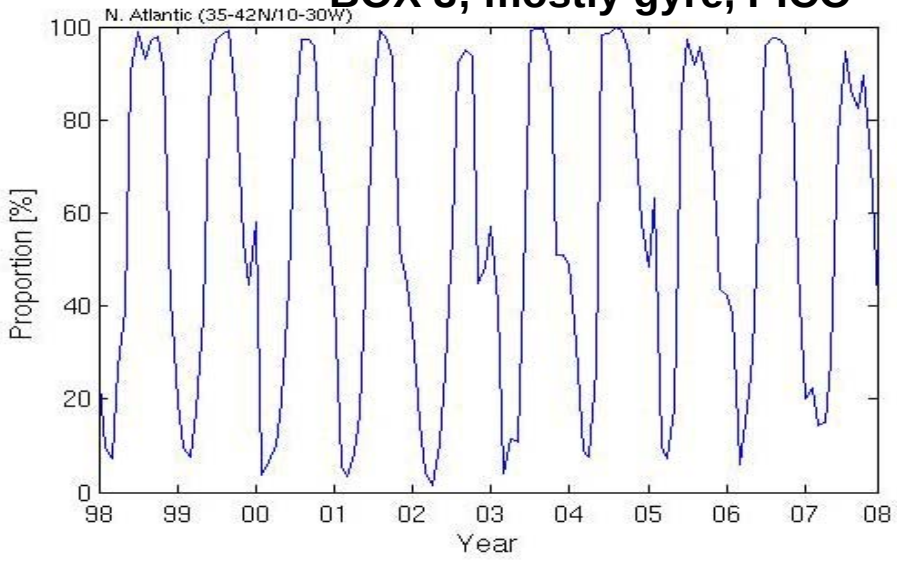
SeaWiFS 8-year time, 1998-2006 for ocean basins; Hirata et al RSE, 2008.



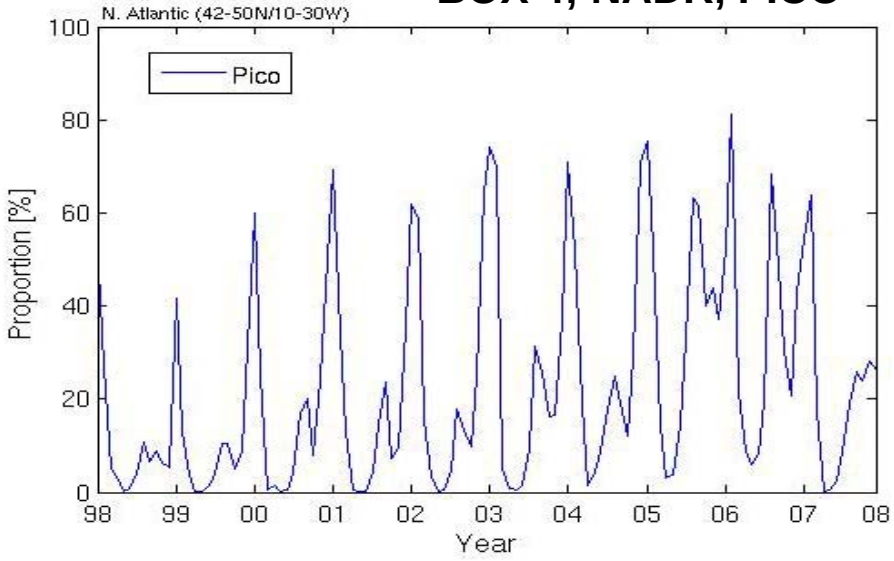
Nanoplankton and microplankton (x5); globally generally downward trend??
NB, N. Atlantic

Trends, NE Atlantic 10 years, 1998 – 2008; ref Watson et al pCO2.

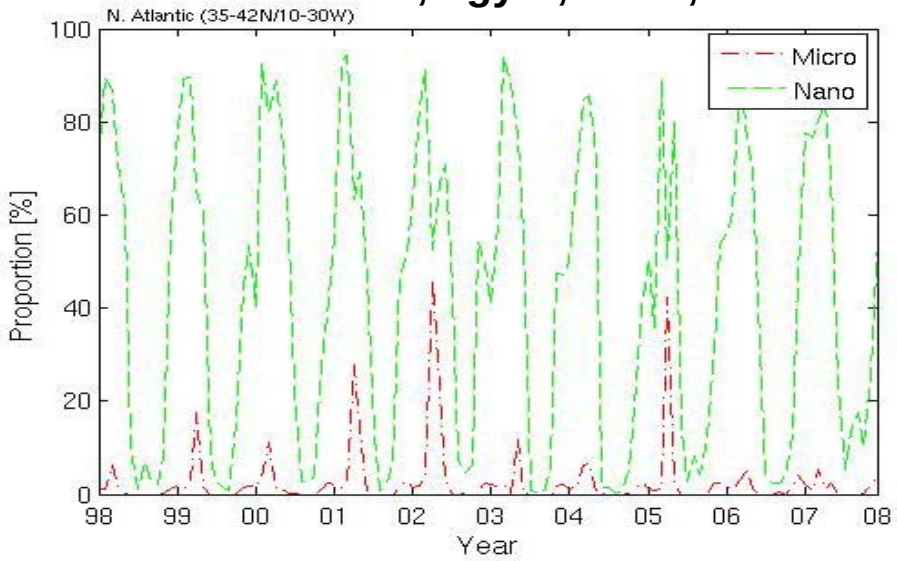
BOX 3; mostly gyre, PICO



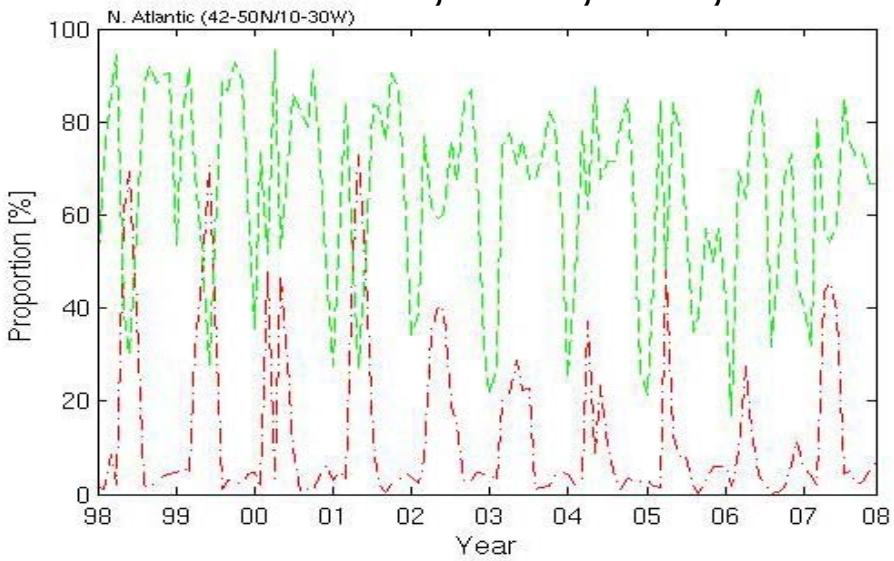
BOX 4; NADR, PICO



Box 3; ~gyre, Nano, Micro



Box 4; NADR, Nano, Micro



Box 4: patterns change, microplankton decline?

POLICY

To reduce atmospheric CO_2 we can do 2 things:

1. Burn less Carbon (fossil fuels):
Economise;
Nuclear power generation;
alternative power sources, solar, wind and waves;
[alternative power sources are episodic
and transmission is inefficient]

2. Capture CO_2 from atmosphere and store.

Be smart:
Use alternative sources to capture and store CO_2
when energy sources are available.
Make H_2 – exploit H_2 cycle technology;
Exploit efficient Stirling cycle technology.

POLICY

Are marine ecosystems changing? – YES!

We need to monitor and model change in marine ecosystems – implications are still largely unknown.

Essential we monitor CO_2 in atmosphere and oceans and air-sea fluxes of CO_2

We can understand change in marine systems from:

1. Observations – observatories, WCO, AMT, time series, seasonal measurements of CO_2 and ecosystem variables.

2. Remote sensing observations of pCO_2 from space & biology – interpretations of Phytoplankton Community Structure.

3. Modelling: coupled circulation-ecosystem models with realistic ecosystems, having representative PFTs and PCS.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