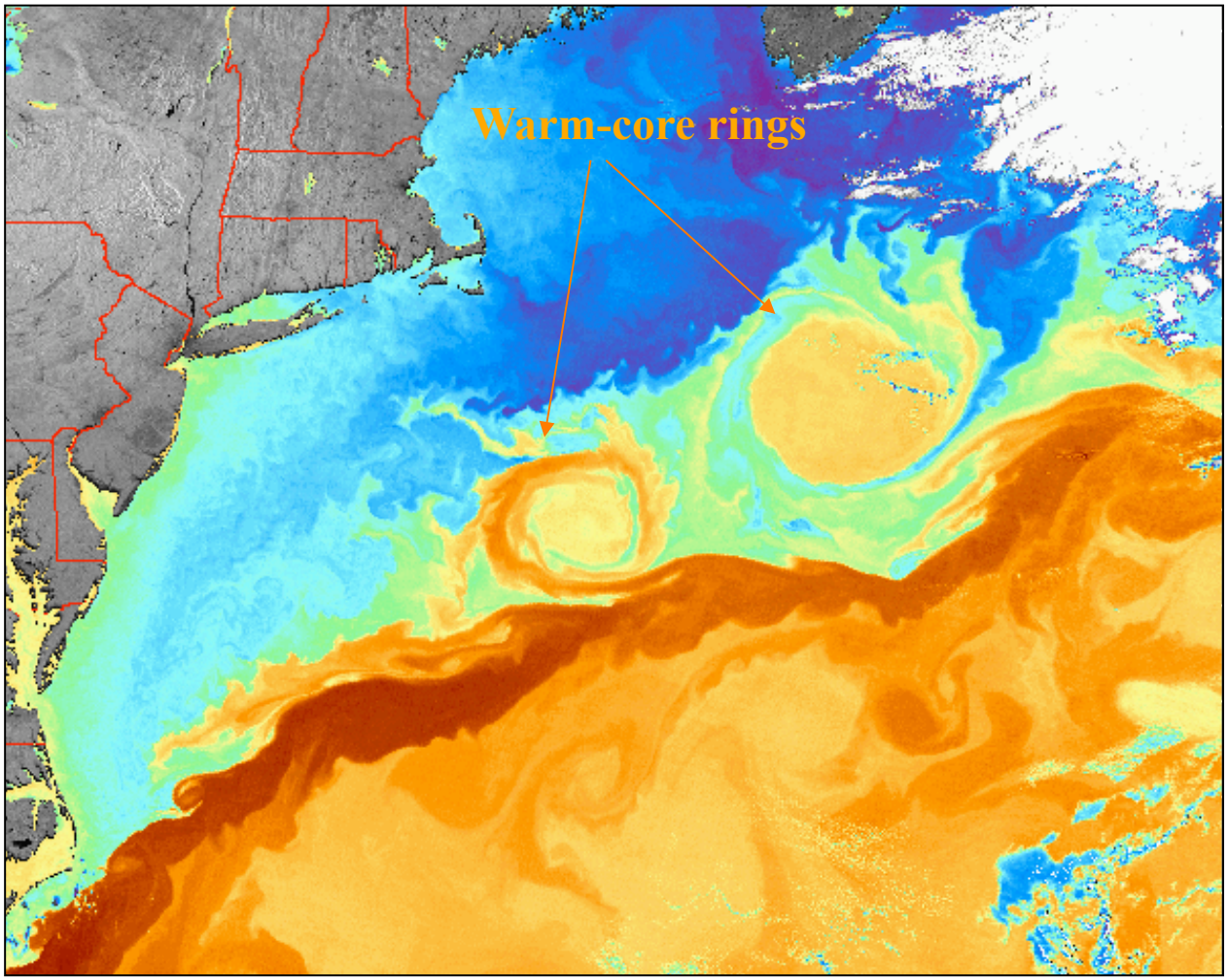
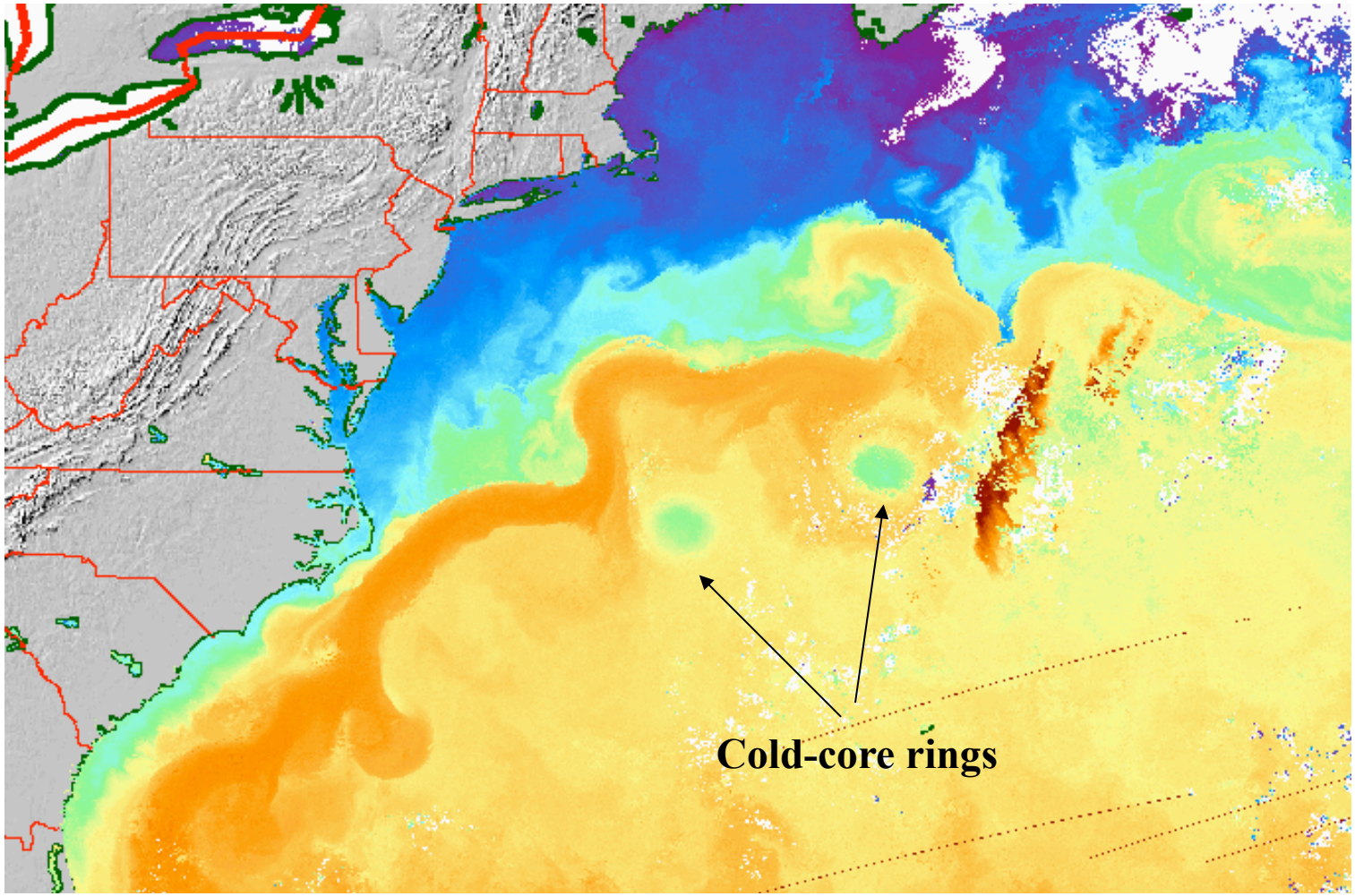
MAR650 Lecture 5: Biological Features of Colds and Warm-Core Rings



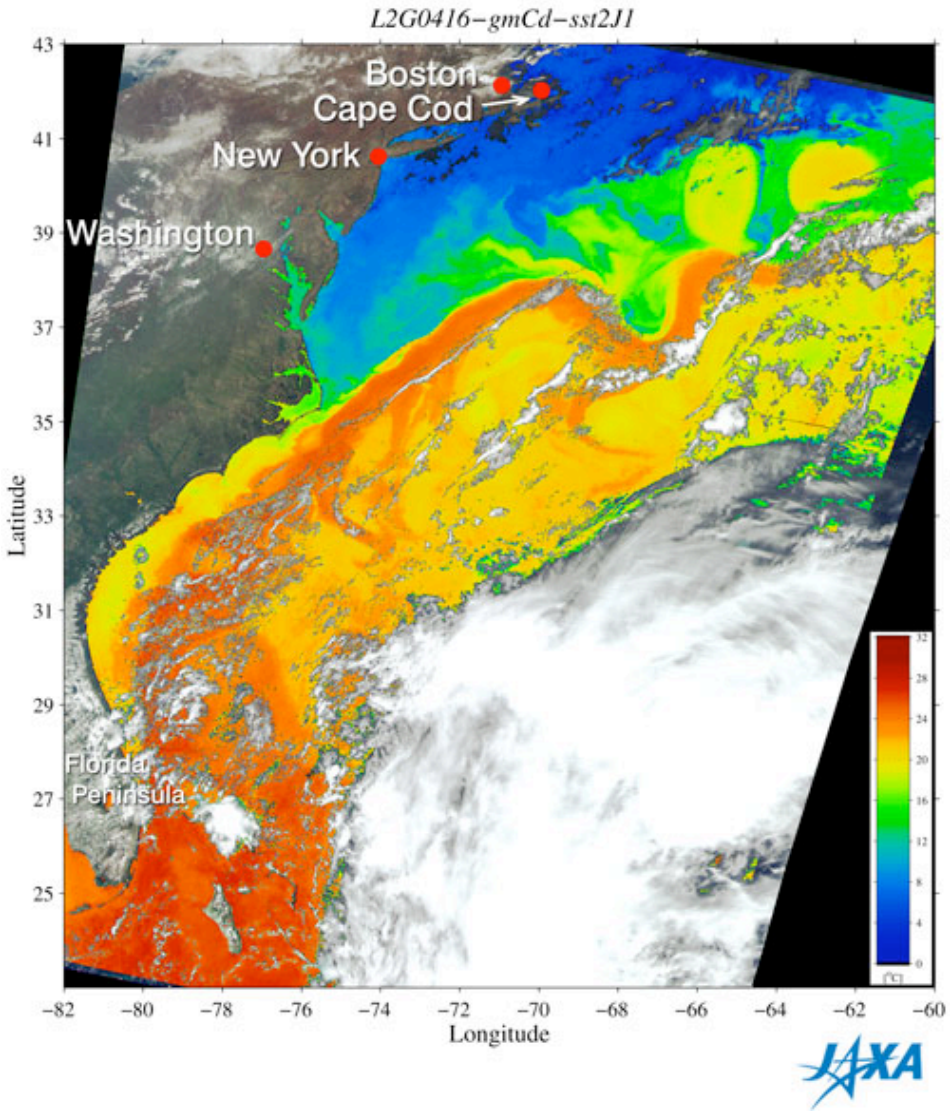
http://fermi.jhuapl.edu/avhrr/gs/averages/index.html

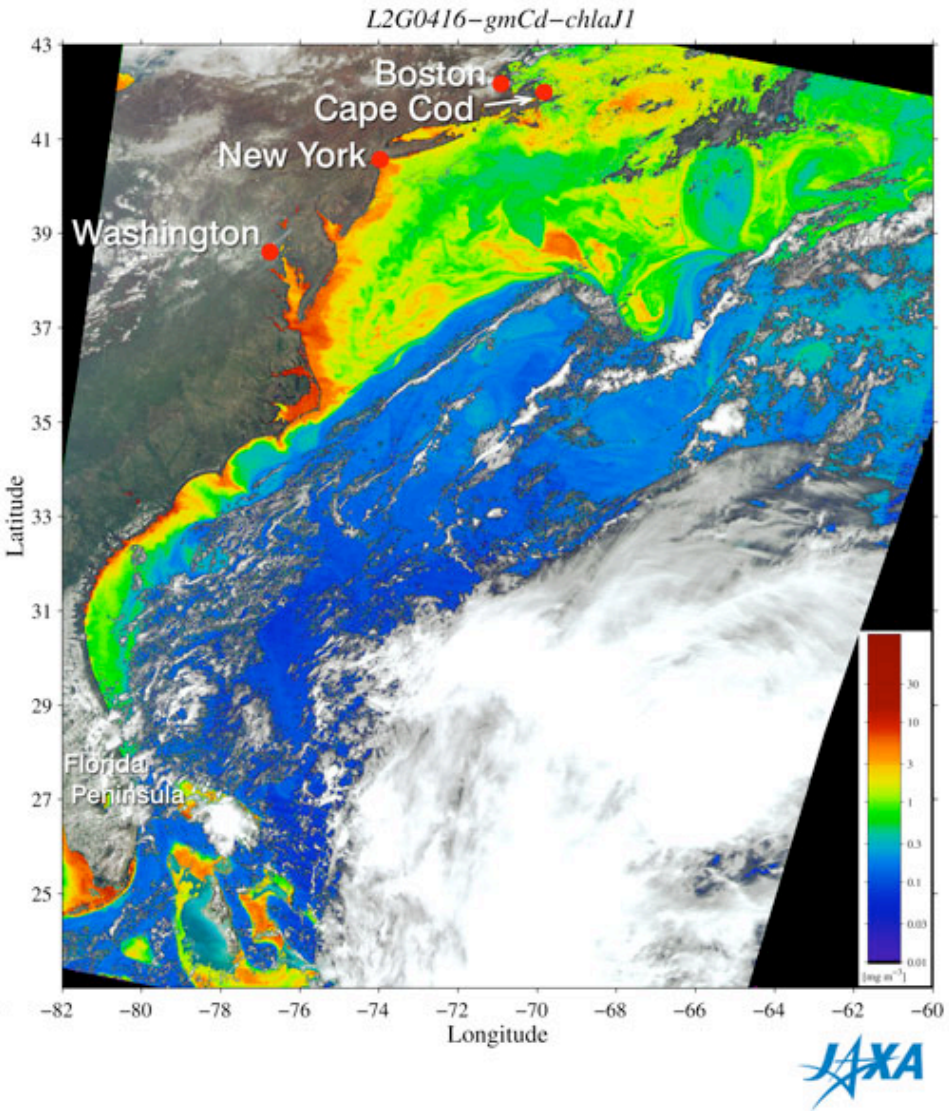
Mixed barotropic/baroclinic instabilities, bottom topography (seamounts)

March 6, 2008



http://fermi.jhuapl.edu/avhrr/gs/averages/index.html


L2G0416−gmCd−sst2J1
Boston
Cape Cod
New York
Washington
Florida
Peninsula
Latitude
Longitude
43
41
39
37
35
33
31
29
27
25
−82
−80
−78
−76
−74
−72
−70
−68
−66
−64
−62
−60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Boston
Cape Cod
New York
Washington
Florida
Peninsula
Latitude
Longitude
43
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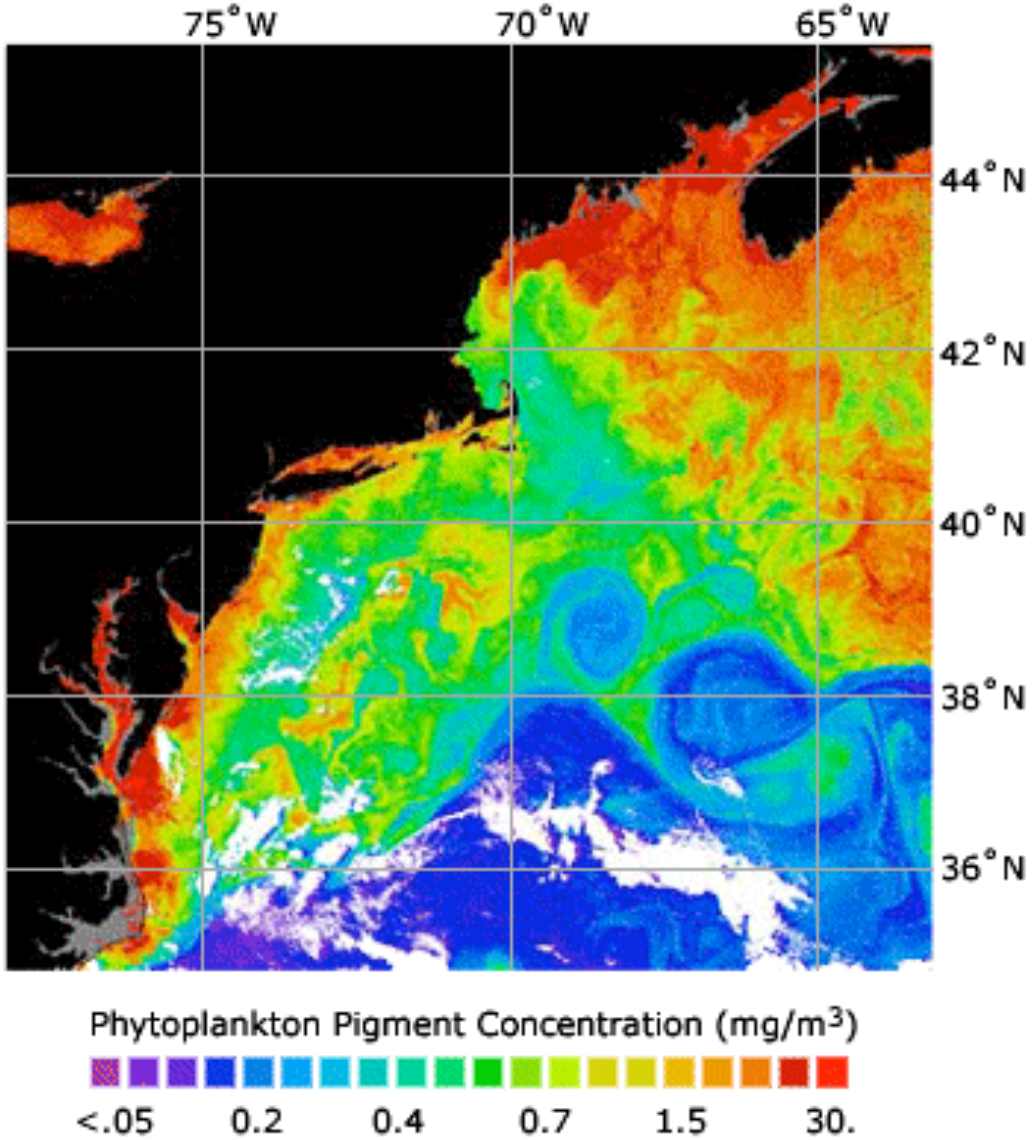

75°W
70°W
65°W
44°N
42°N
40°N
38°N
36°N
Phytoplankton Pigment Concentration (mg/m3)
<.05
0.2
0.4
0.7
1.5
30.

Cold-core rings: colder water from the continental shelf with rich nutrients and abundant plankton species

↓ Moves into the Sarggaso Sea

Nutrient concentration, phytoplankton biomass and zooplankton abundance is relative higher than the surrounding water

Because of quasi-geostrophic flow field with weak water exchange with surrounding water, surfaces of nutrients and density are overlapped, rising up! Be aware that density field is conservative, but nutrients and phytoplankton fields do not! Phytoplankton has a sinking velocity and also food web cycling makes the biological field more complicated.

Spring: chl-a concentration has a maximum at a depth of 20 m below surface: 4 μg/L, which is 40 times larger than that found in the Sarggaso Sea (0.4 μg/L);

Spring-summer: the near-surface temperature increases in cold-core rings, larger phytoplankton species decreases, while small phytoplankton species increases

Summer: maximum chl-a concentration sinks to 80 m, its value decreases to 0.6 μg/L, causes by mixing with surrounding water, thermoclines limit the upward nutrient supplies, larger phytoplankton's rapid death.

Zooplankton in a cold-core ring originally come from the outer shelf, which are favor for relatively cold water. When solar radiation increases and also temperature increases due to exchange with the Sarggaso Sea, these animals migrate deepward. Zooplankton in the Sarggaso generally are in the upper 100 m, but in a cold-core ring could go to 800 m. But moving deepward could reduce the respiration ability, which reduce in ability of producing eggs, etc, and also could not find enough foods in the deep region, they could die after 17 months.

Warm-core rings: come from the biological desert , characterized with lower nutrients and plankton biomass

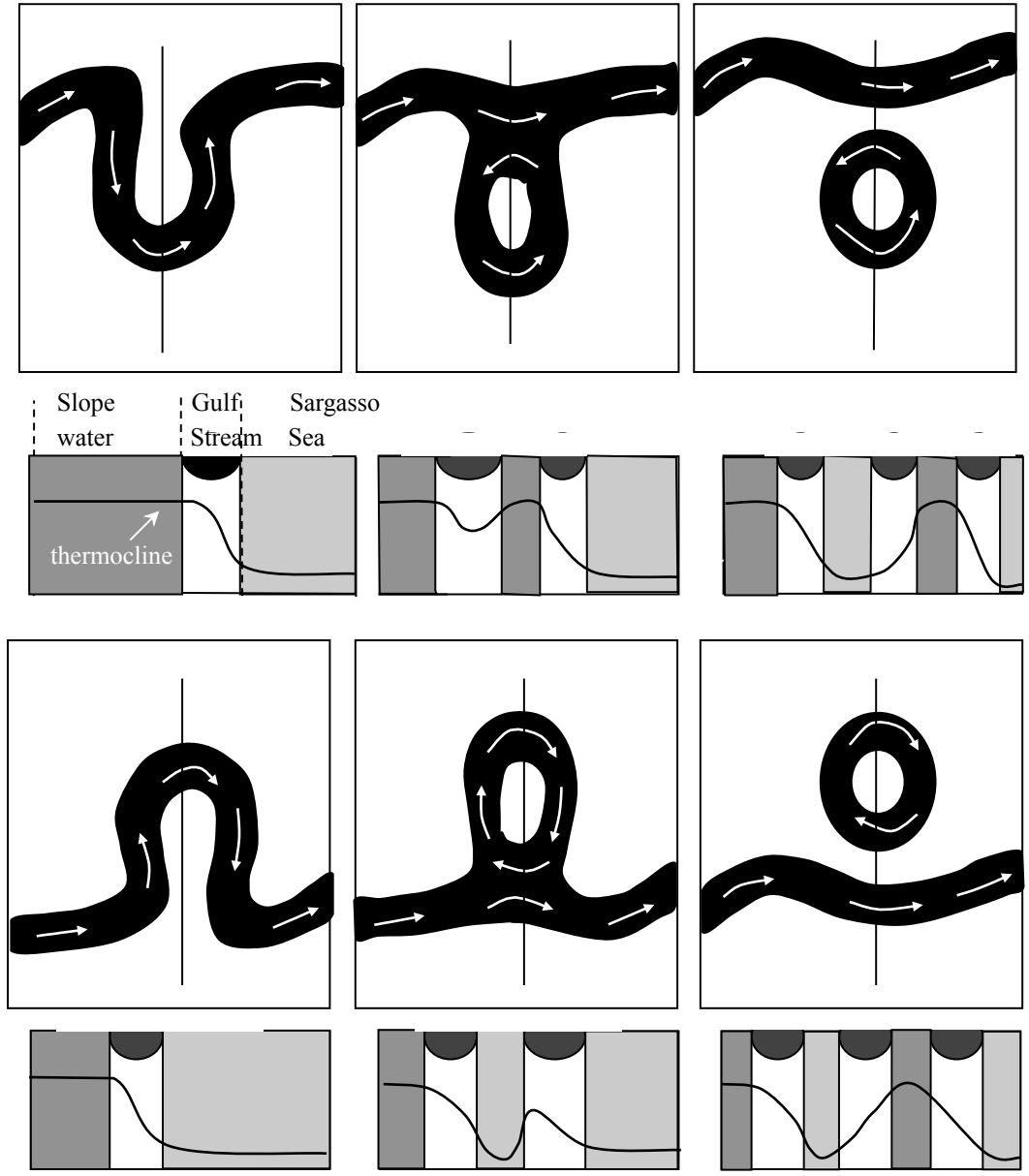
Moves onto the slope

Interaction with the slope could cause upwelling, which could advect the high nutrient water from the deep region to the euphotic layer near the surface. As a result, the chl-a concentration near the surface of a warm-core ring is higher than surrounding water.

Zooplankton in warm-core rings are directly related to water exchanges with the shelf water due to interaction with the slope and friction as well as mixing due to surface cooling. When a warm-core ring just forms, it is characterized with low phytoplankton and zooplankton biomasses. When it moves onto the slope, shelf phytoplankton and zooplankton species are wrapped into the ring and causes significant increase of phytoplankton and zooplankton biomasses.

Importance:

A warm-core ring's horizontal scale is 100-300 km, which could carry 20-30 Sv water. Although it only lasts for 6 months, it is significant sources to carry the nutrients up to the euphotic layer at the shelf break.



Cold-core ring:

Cyclonic,
200-300 km, 2000 m, north of Bermuda
1 year (up to 4 years)

5-8 per year
10 co-existing at once time

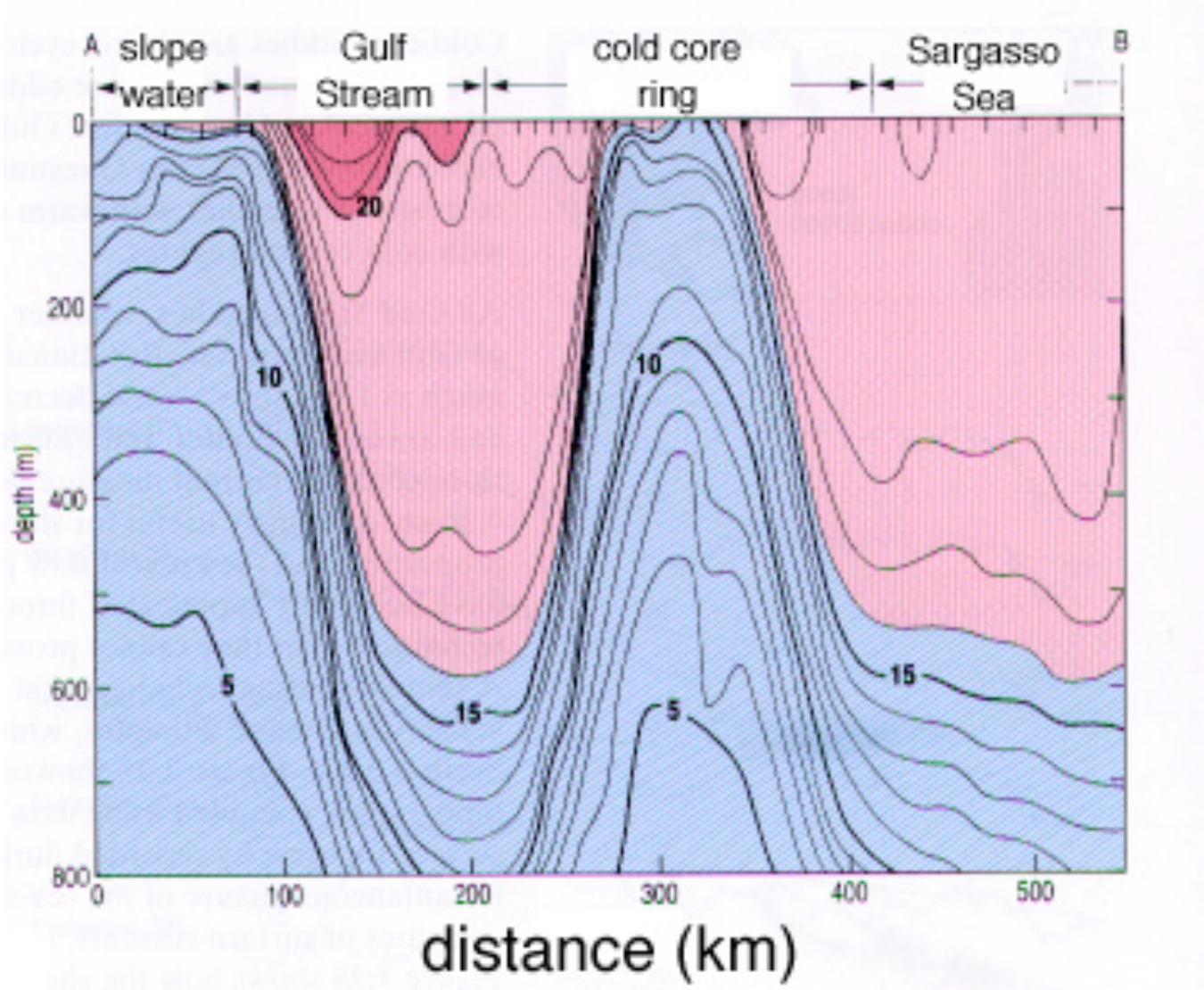
Surface height: depressed (0.5 to 1 m)

Warm-core ring:

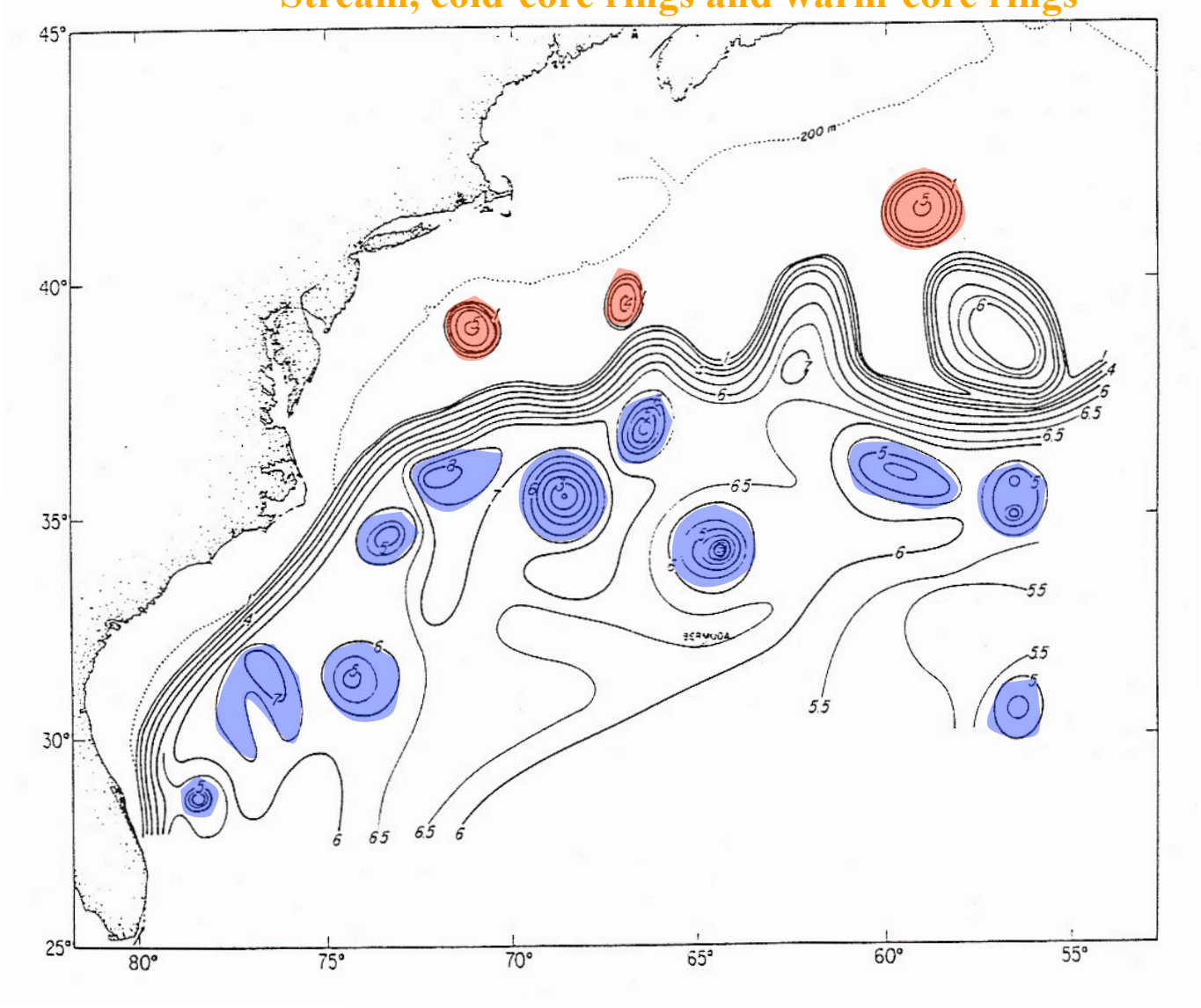
Anticyclonic;
100 km west of Georges Bank
200-300 km east of Georges Bank
6 months

5 per year
3 co-existing at once time

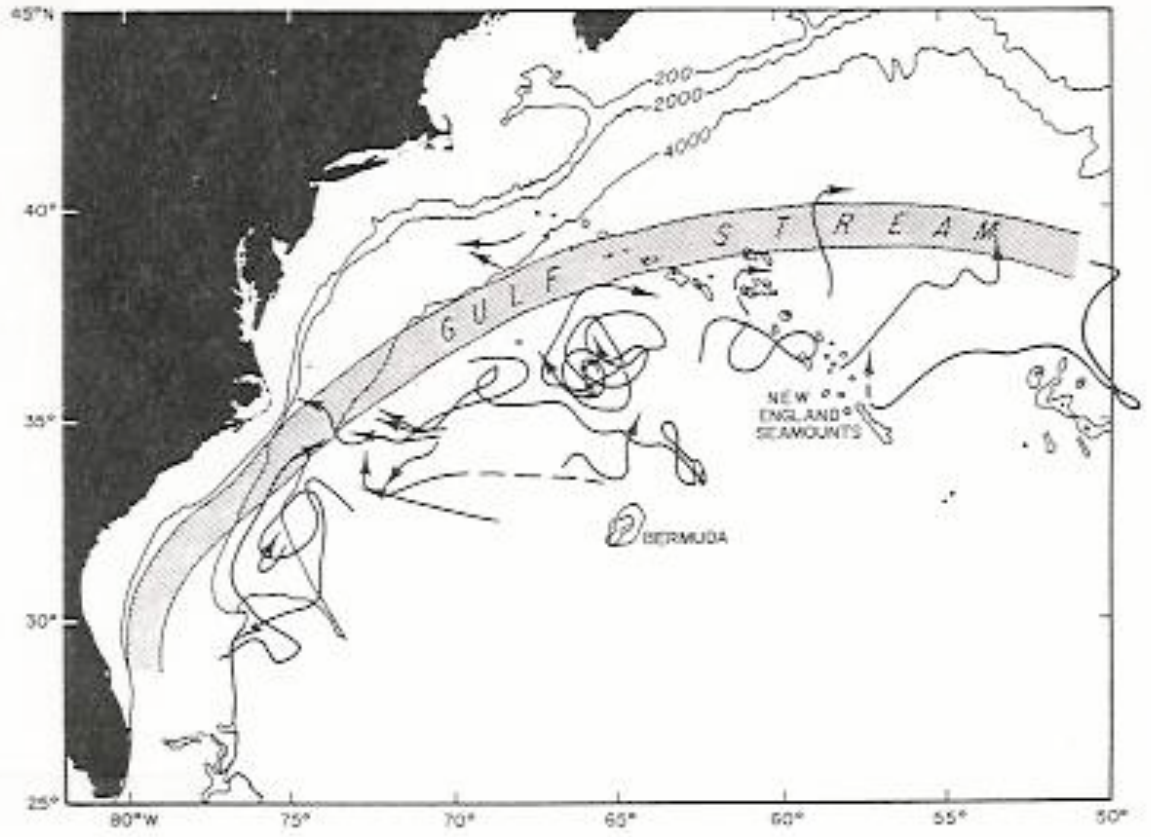
Surface height: elevation

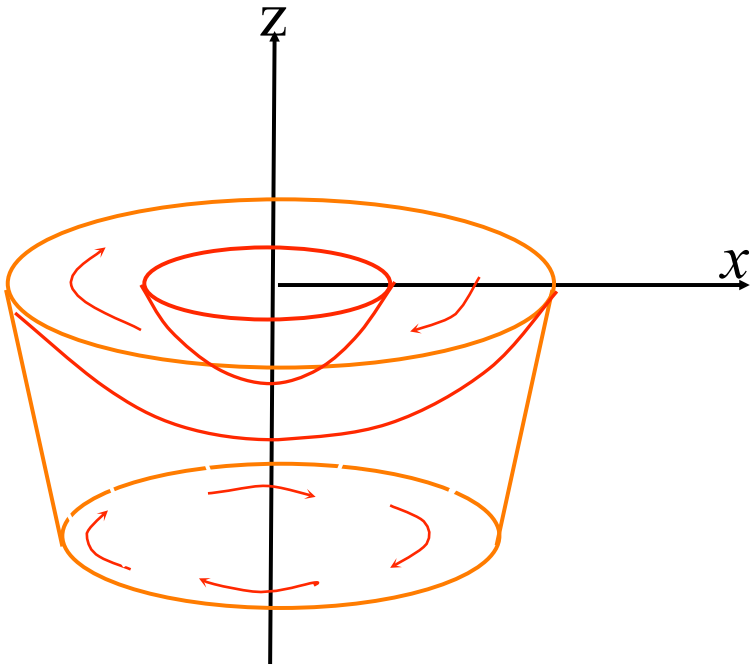

A
slope
water
Gulf
Stream
cold core
ring
Sargasso
Sea
B
0
200
400
600
800
depth (m)
20
10
10
5
15
5
15
0
100
200
300
400
500
distance (km)

A chart of the topography of the 150 isothermal surface showing the Gulf Stream, cold-core rings and warm-core rings

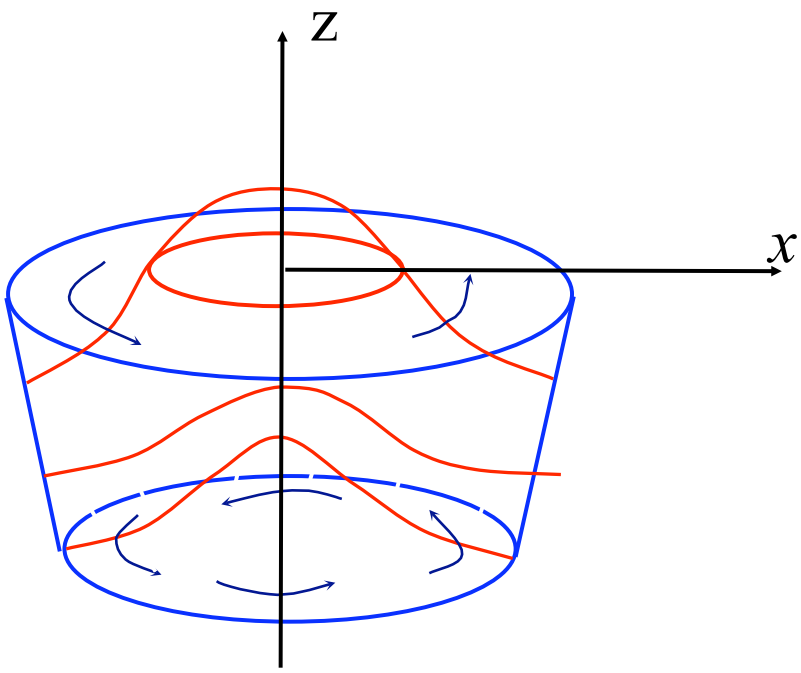


5 km/day, westward; 20 Sv





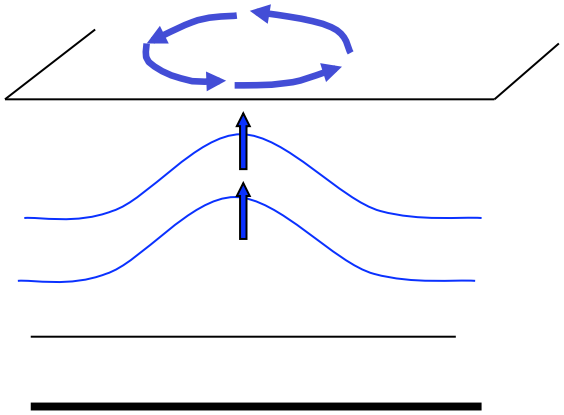
Warm-Core Ring



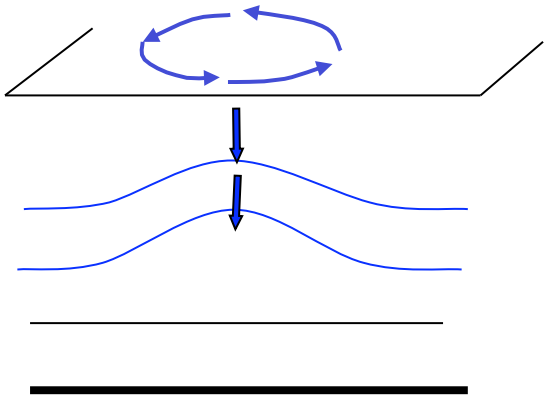
Cold-Core Ring

Cyclone

Formation and intensification

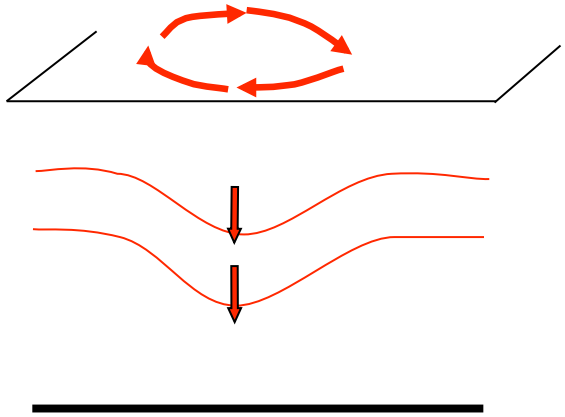


Decay and relaxation

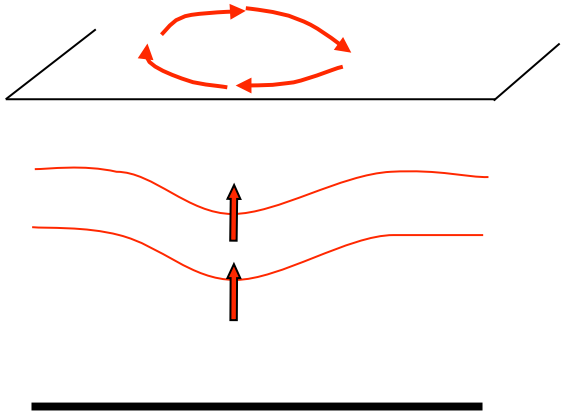


Anti-cyclone

Formation and intensification

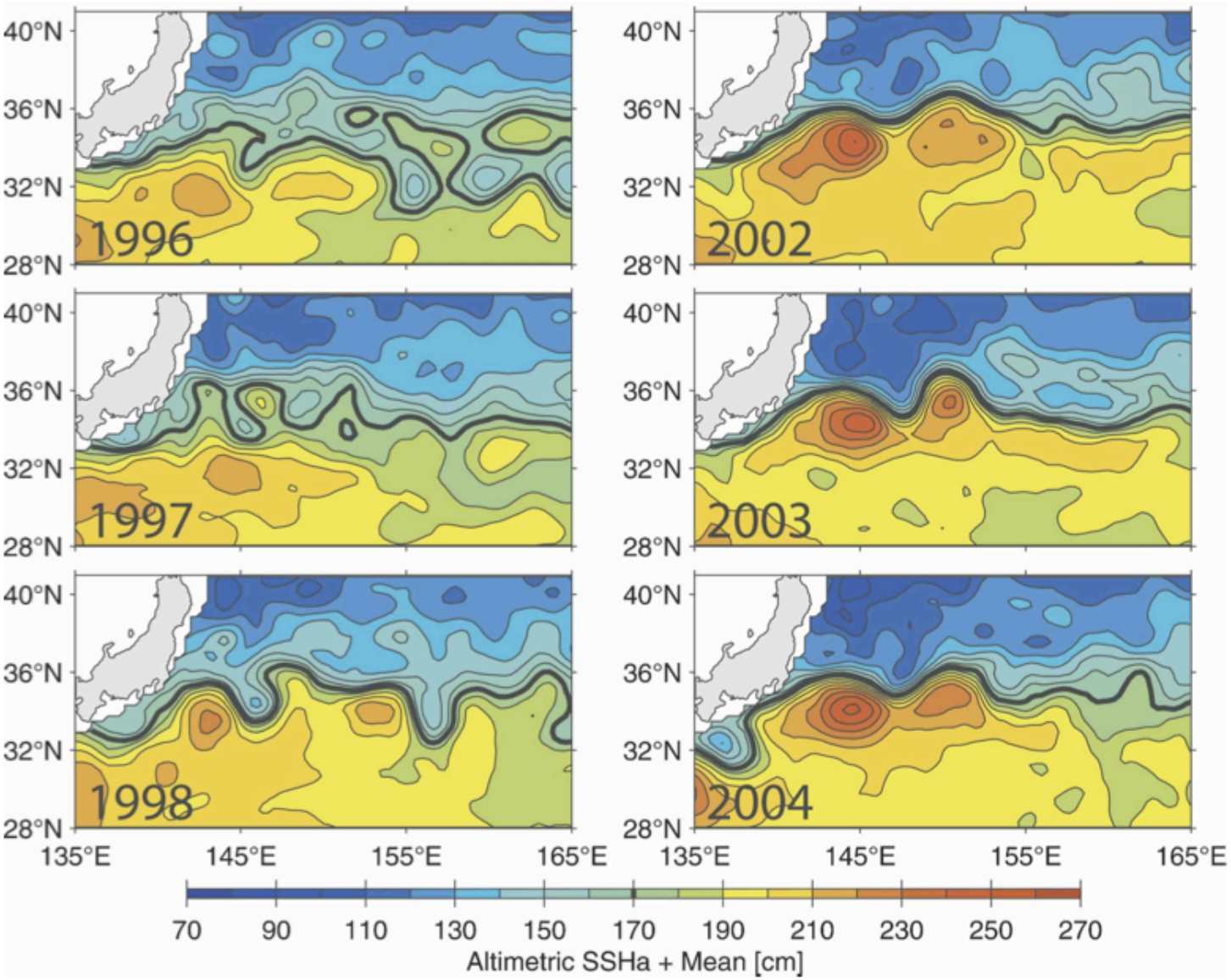


Decay and relaxation



Modified from Flierl and McGillicuddy (2002): In: The Sea.

Maps of yearly averaged sea surface height field. Contour intervals are 10 cm with the thick lines denoting the 170-cm contours (from Qiu and Chen, 2005-JPO)



Yearly paths of the Kuroshio and Kuroshio Extension defined by the 170-cm contours in the weekly Sea Surface Height (SSH) fields (from **Qiu and Chen, 2005-JPO**)