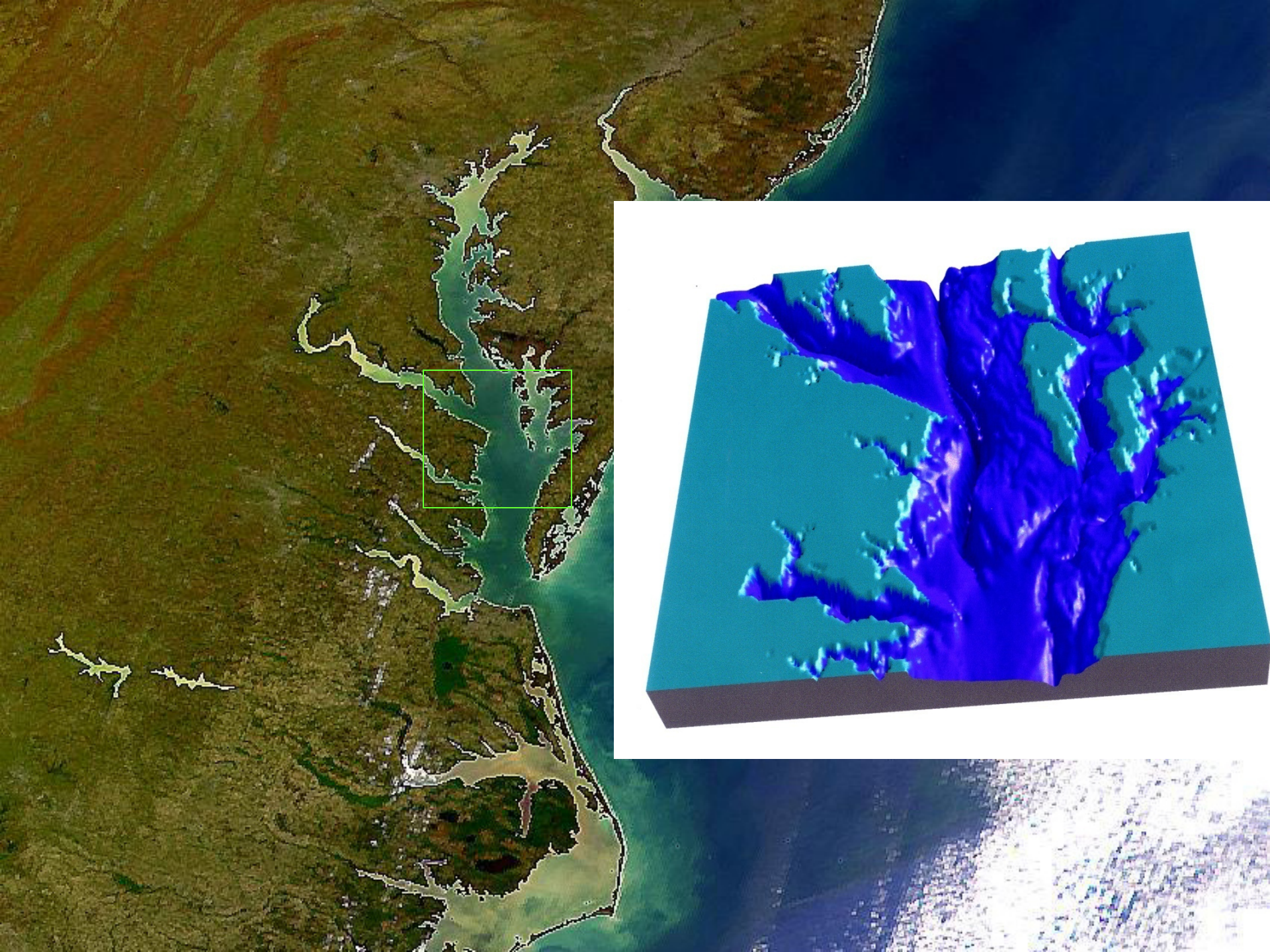
The Coastal Ocean: Estuaries and Continental Shelves:

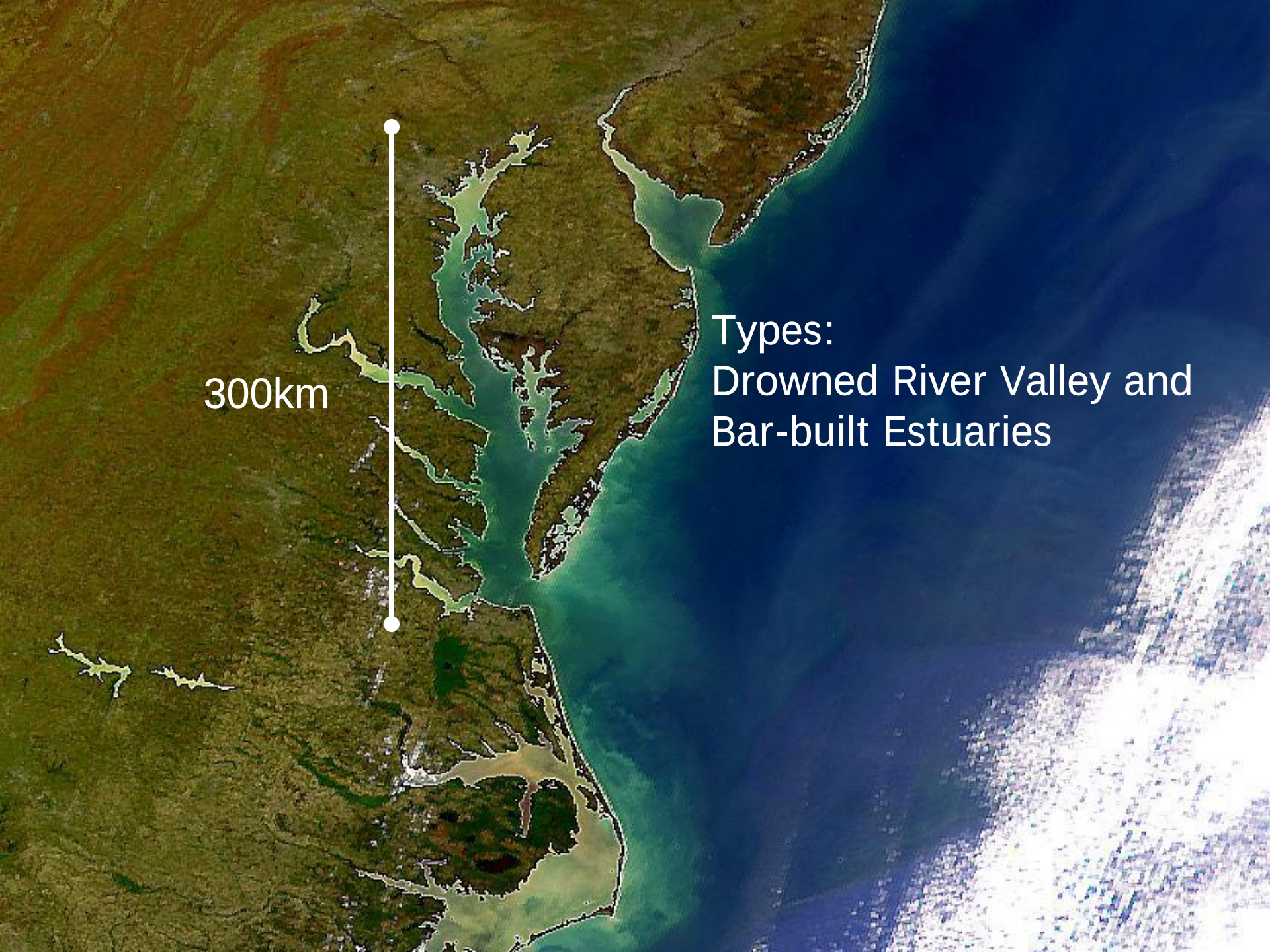
How do they move, and how do we know this, and what's happening in the long run?

W.C. Boicourt
University of Maryland



Estuary

A semi-enclosed coastal body of water having free and open connection to the sea, and in which sea water is measurably diluted by fresh water from land drainage.


300km
Types:
Drowned River Valley and
Bar-built Estuaries

So, how do Estuaries work?

Let's Start with:

Lock Exchange

Lock Exchange

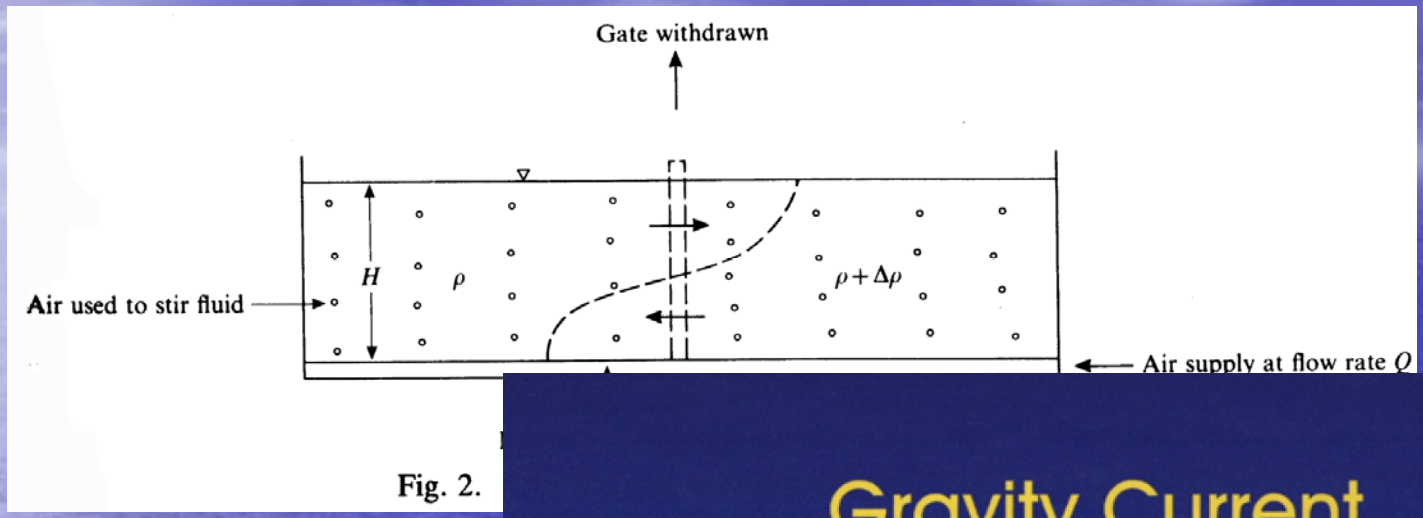
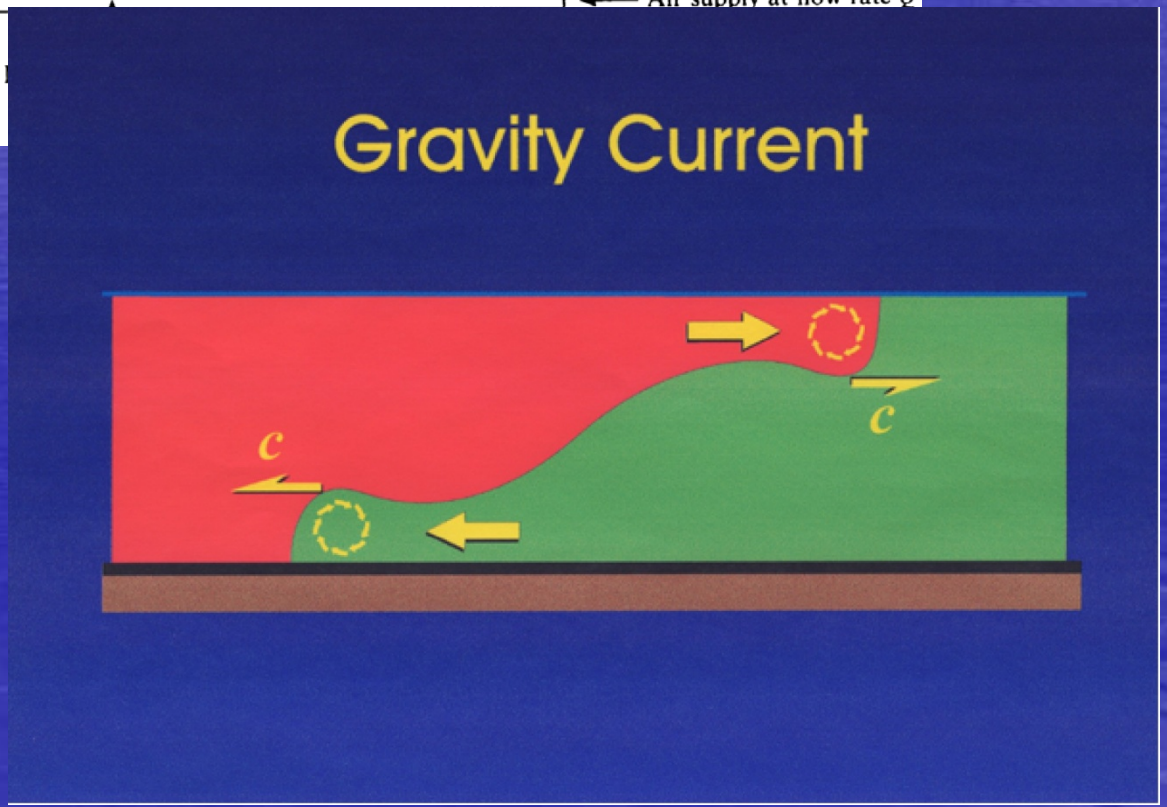


Fig. 2.

Linden and Simpson (1986, 1988)



Laboratory Experiment—Linden and Simpson (1986, 1988)

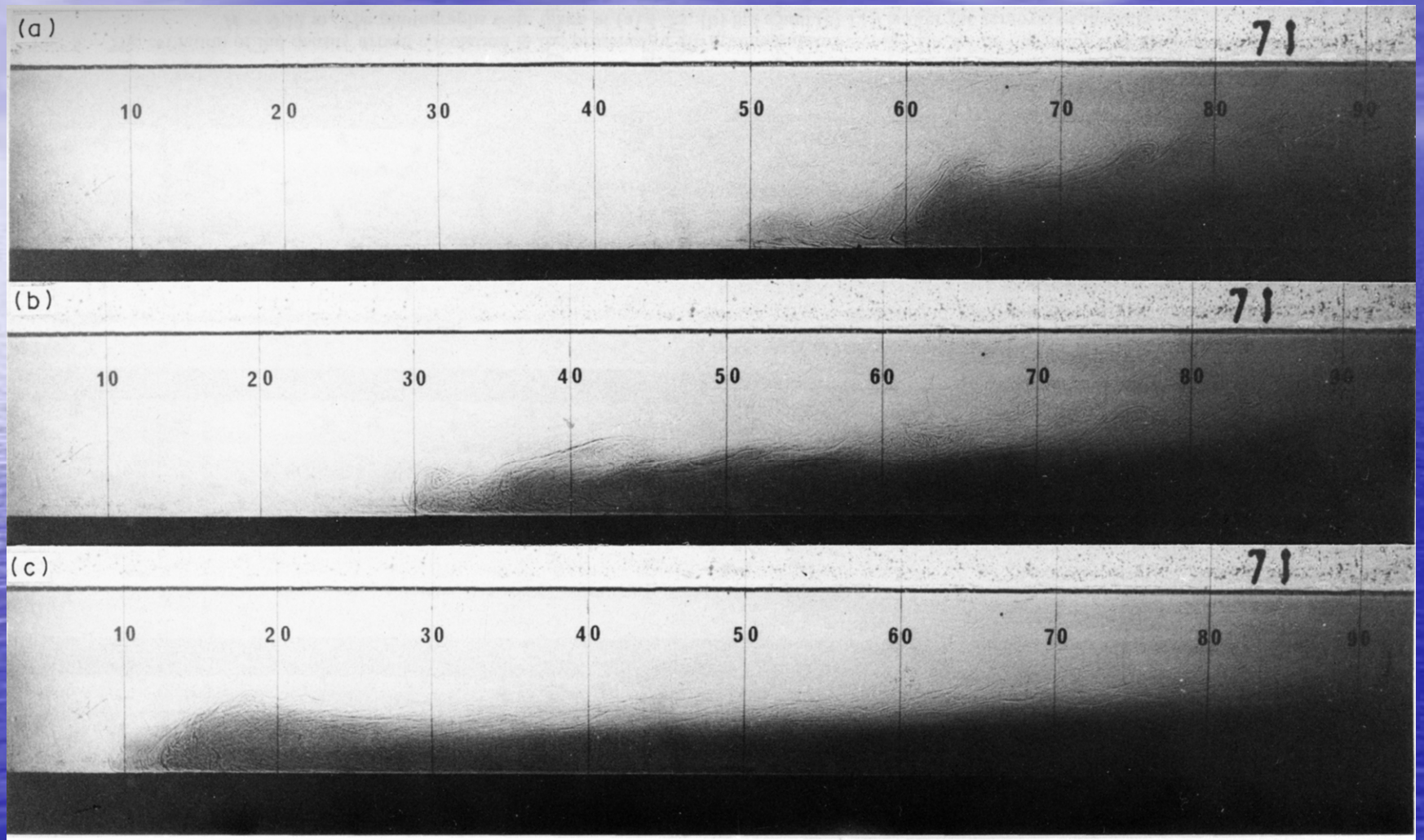
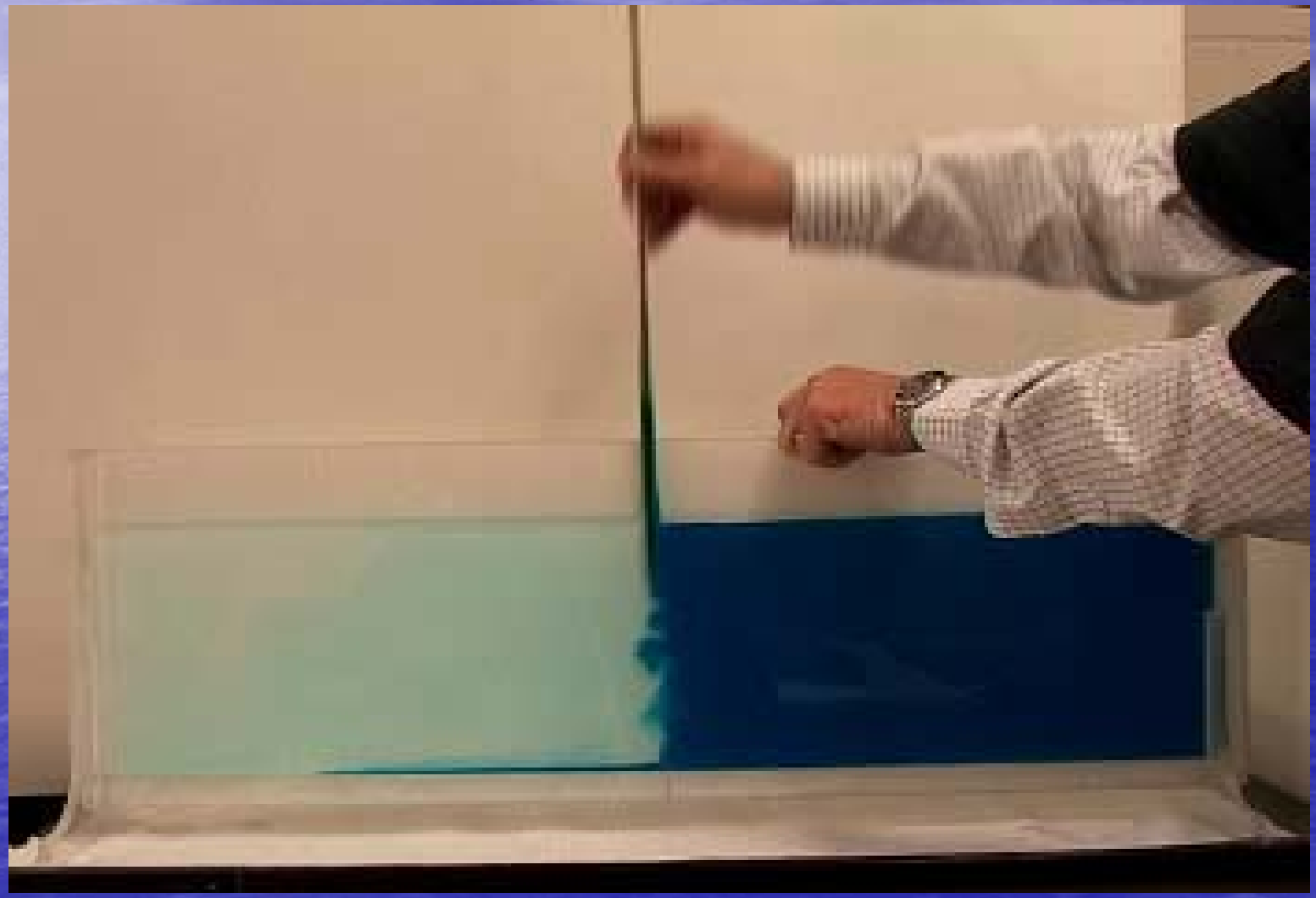


Fig. 4. Frontogenesis, the formation of a gravity current, after the turbulence ceases. In this example the fluid was vertically mixed and the buoyancy difference between the ends of the tank when the bubbles were turned off was $g' = 0.05$ m s^{-2} and the depth $H = 0.12$ m. The photographs were taken at (a) 8.9 s, (b) 10.8 s and (c) 17.4 s after the bubbling ceased.

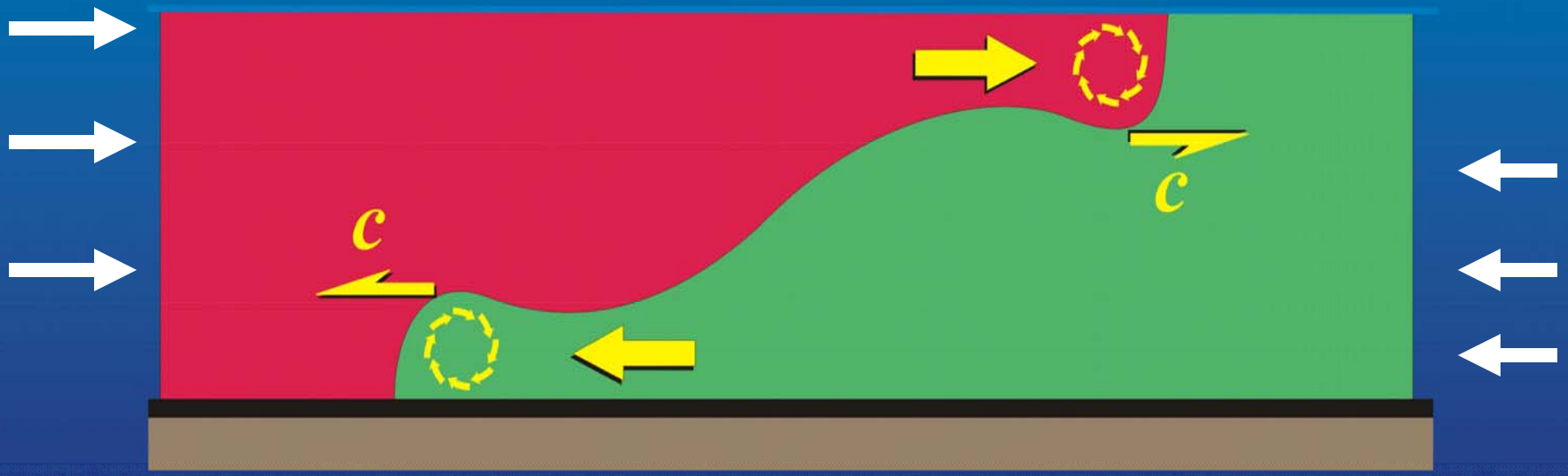
Lock Exchange



Gravity Current

River

Sea

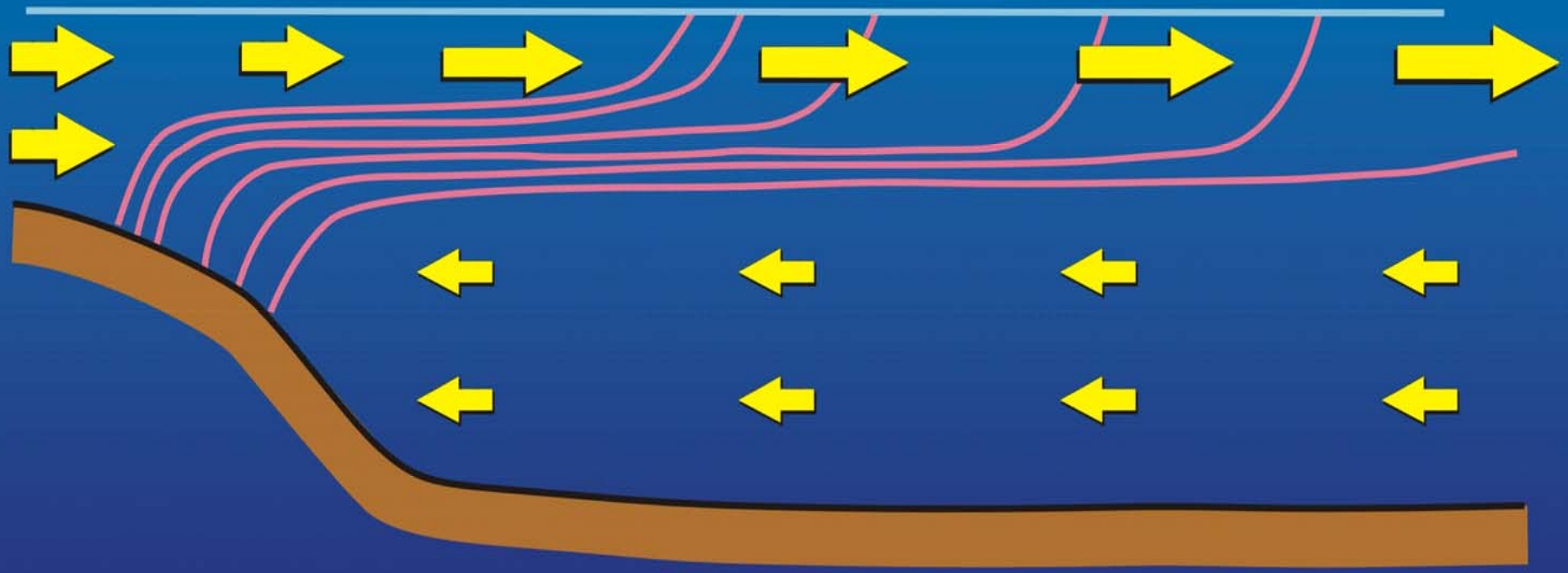


Now, continuously add fresh water and salt water at the ends--

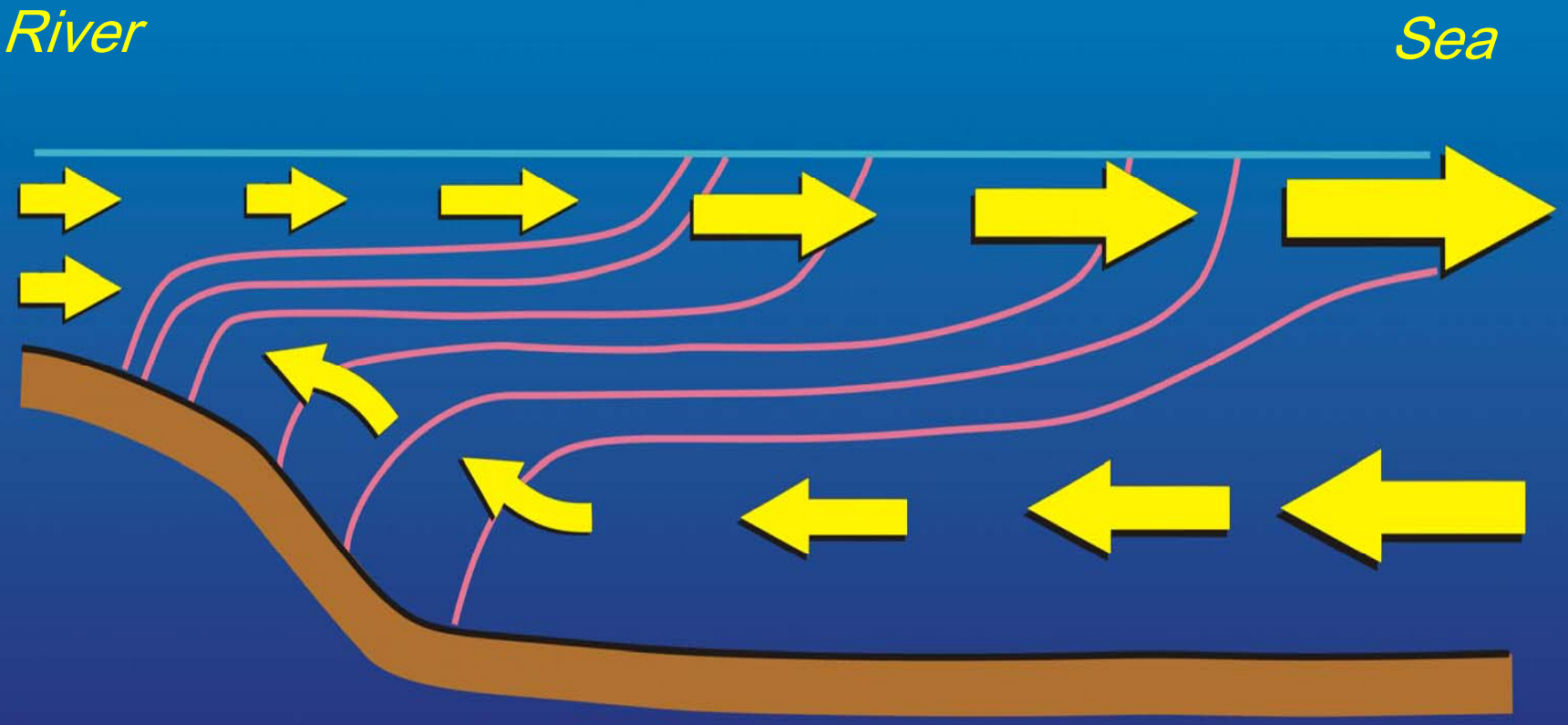
Salt Wedge

River

Sea

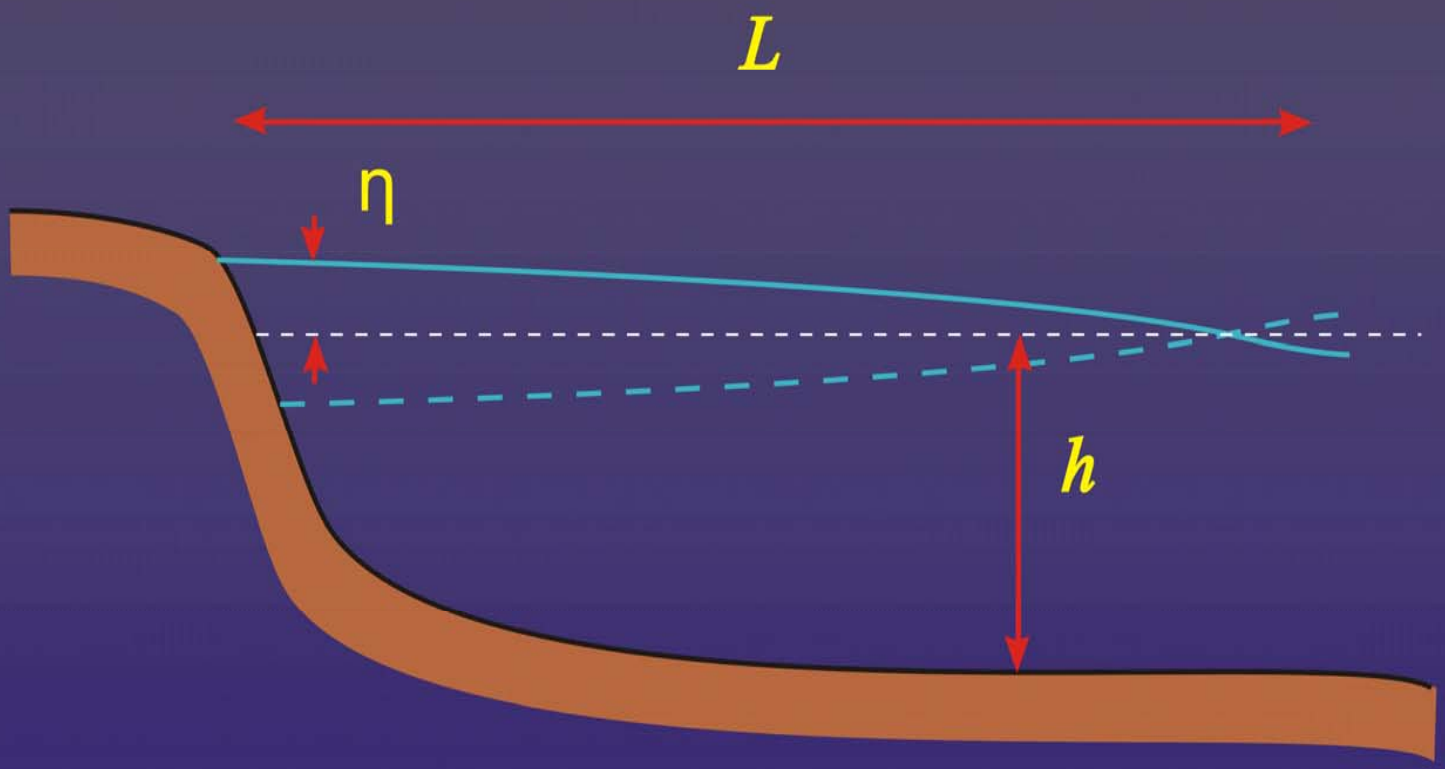


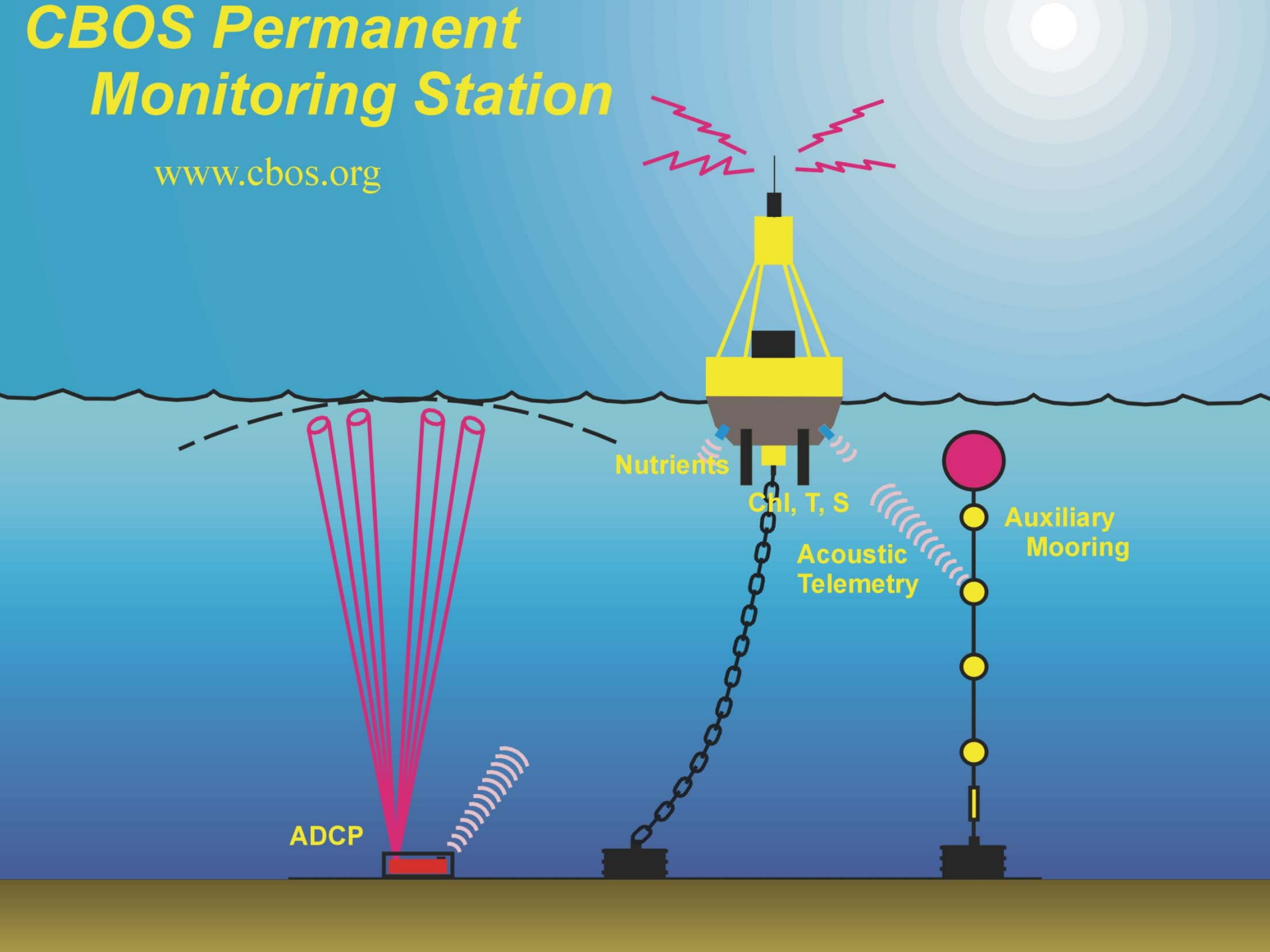
Partially Mixed Estuary



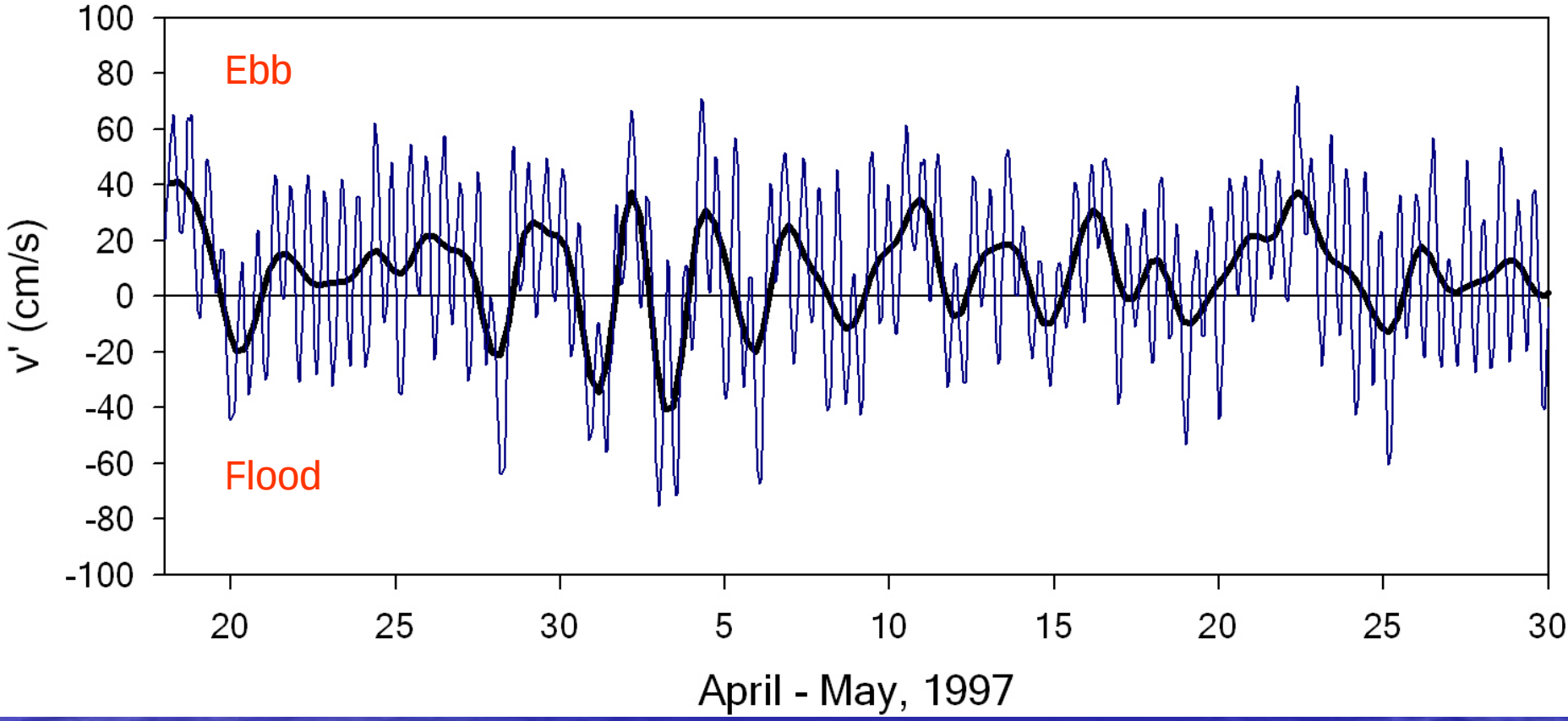
Wind Forcing: many response modes, the simplest of which is:

Quarter-Wave Seiche

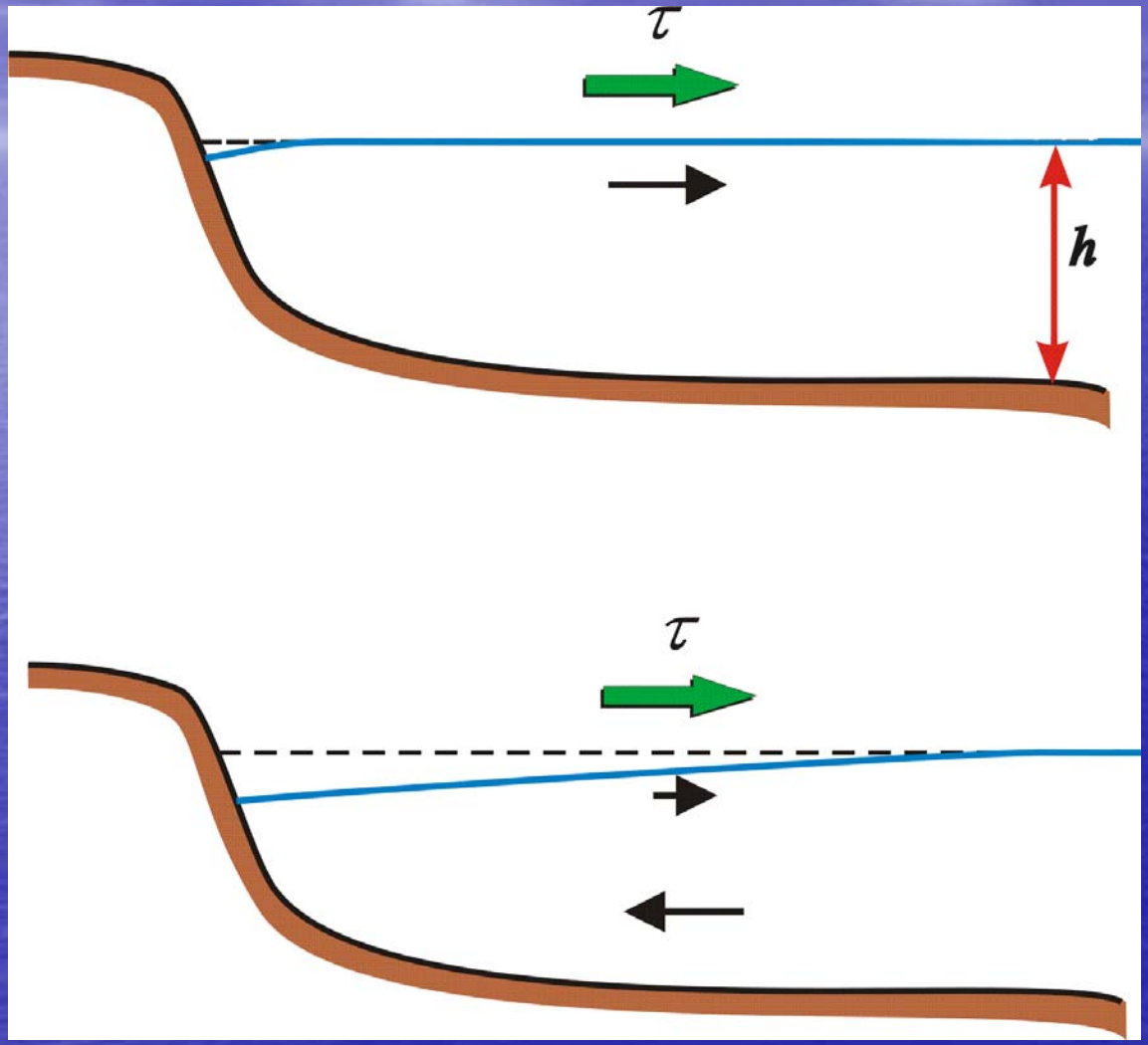


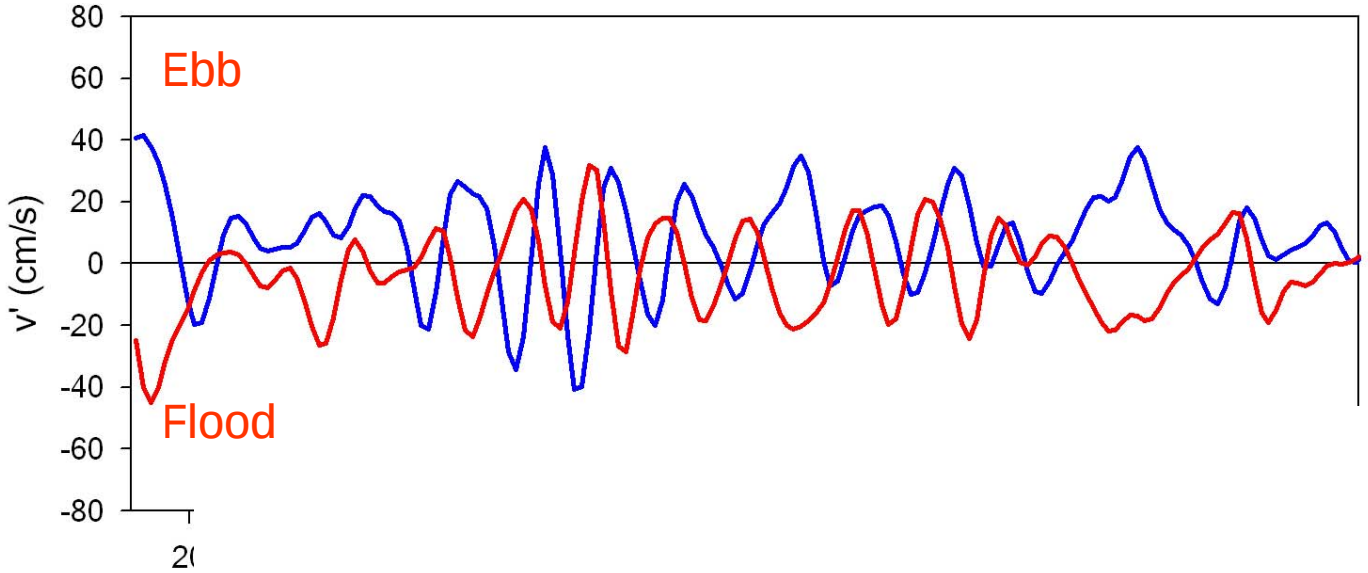

CBOS Permanent
Monitoring Station
www.cbos.org
Nutrients
Chl, T, S
Acoustic
Telemetry
Auxiliary
Mooring
ADCP

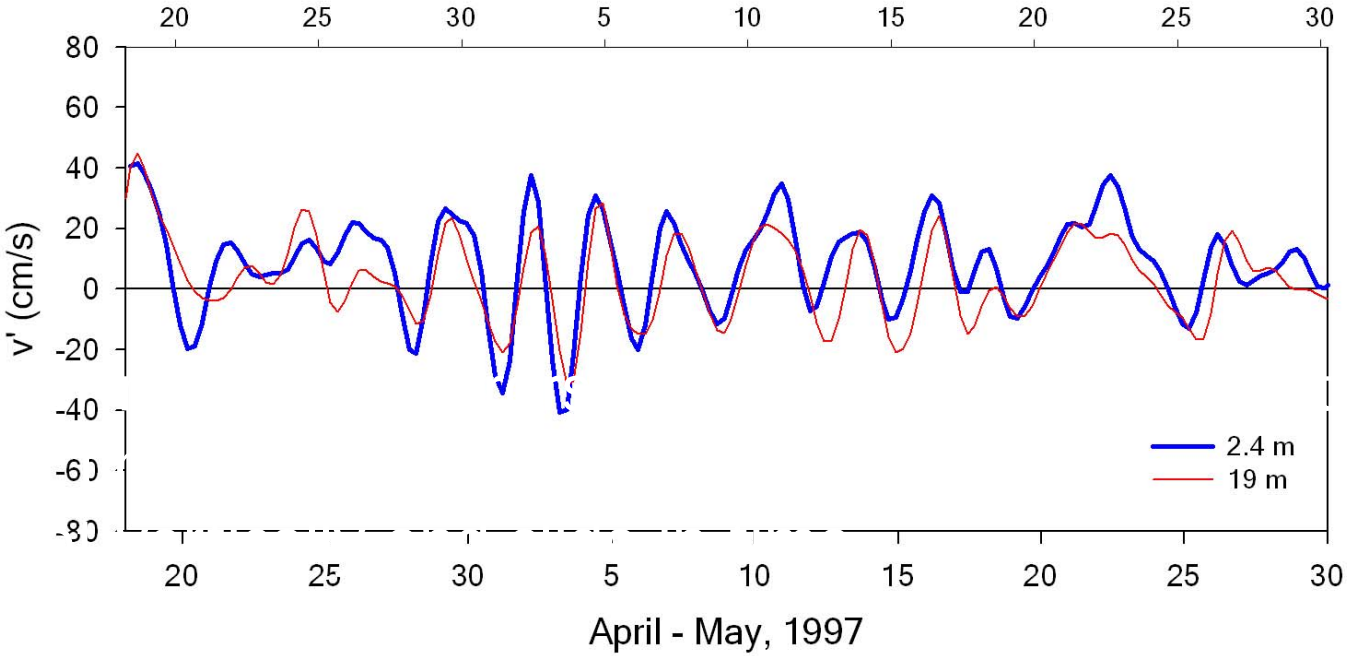
Tidal and Subtidal Flow



Wind Forcing: two-layer response





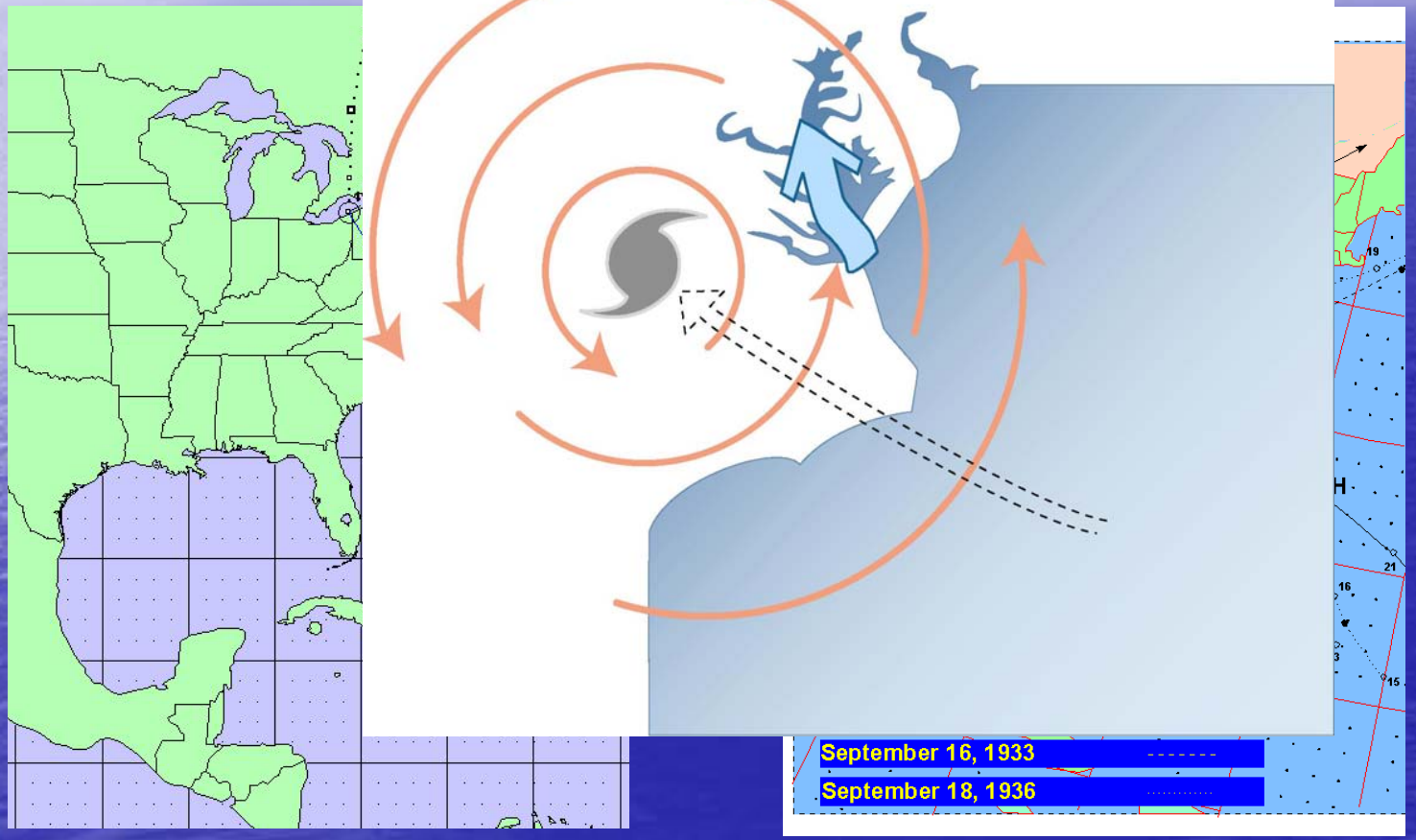


The lowe
a slightly
lower lay

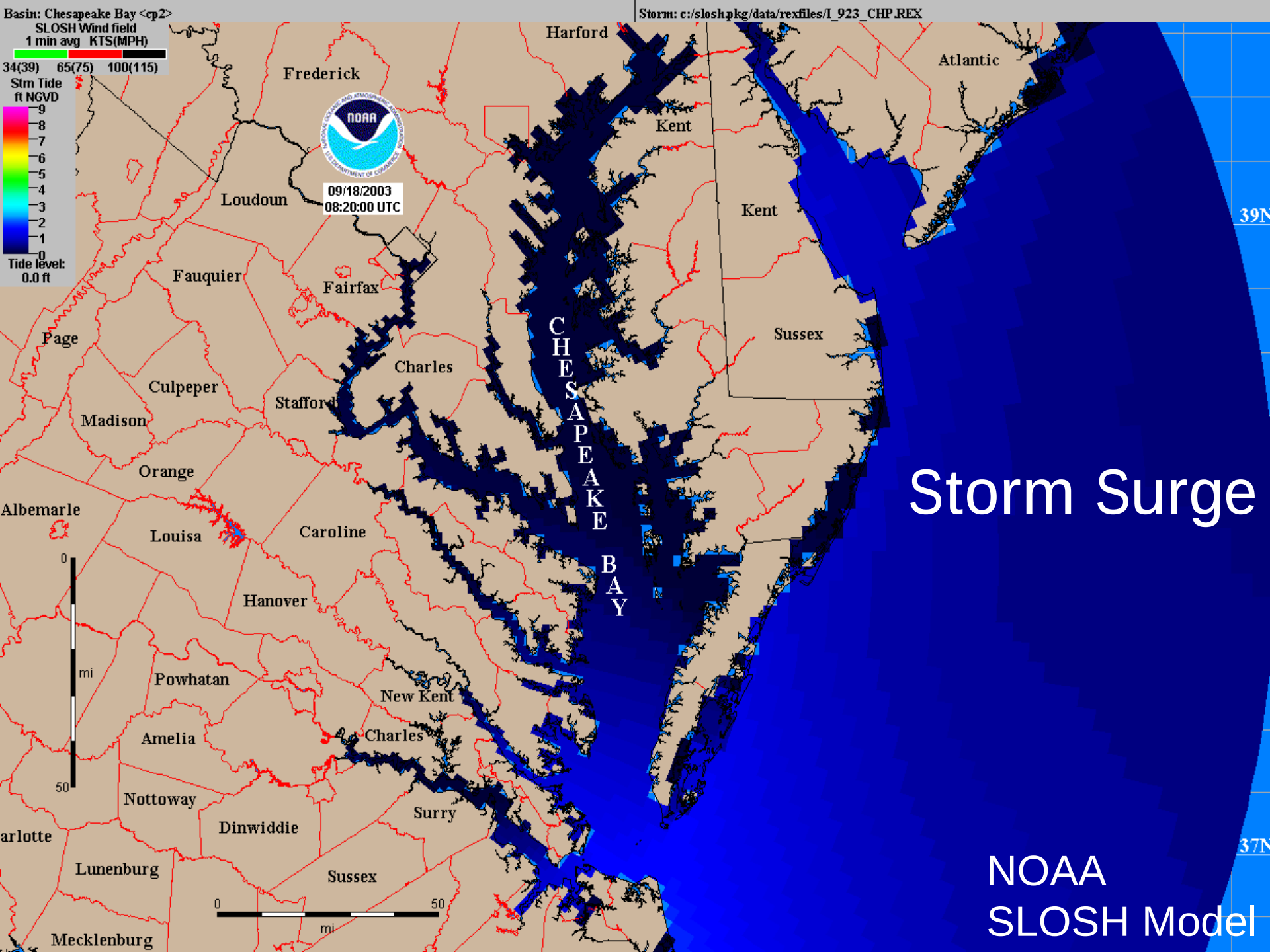
1933,2003; Trend?

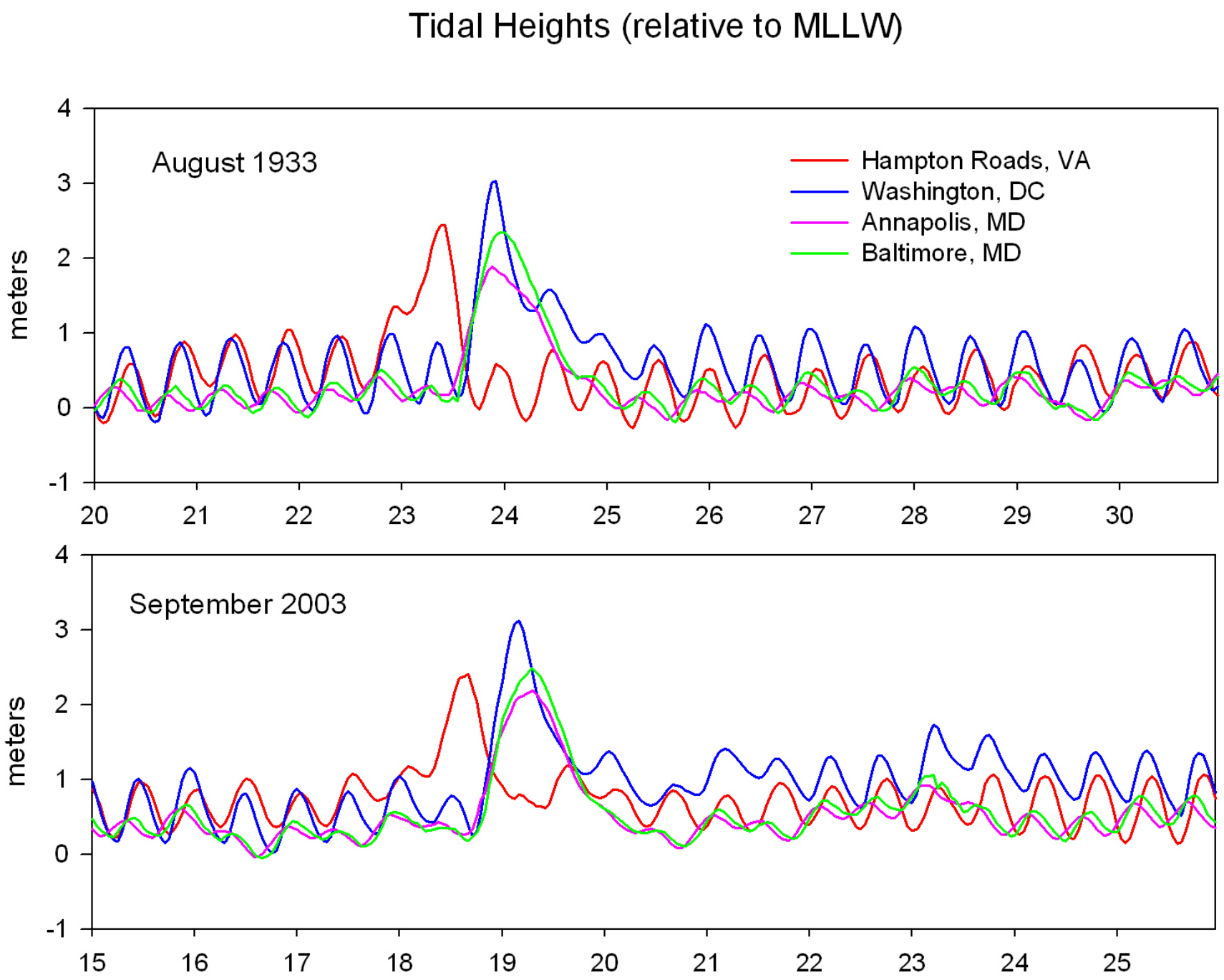
Isabel

August 1933

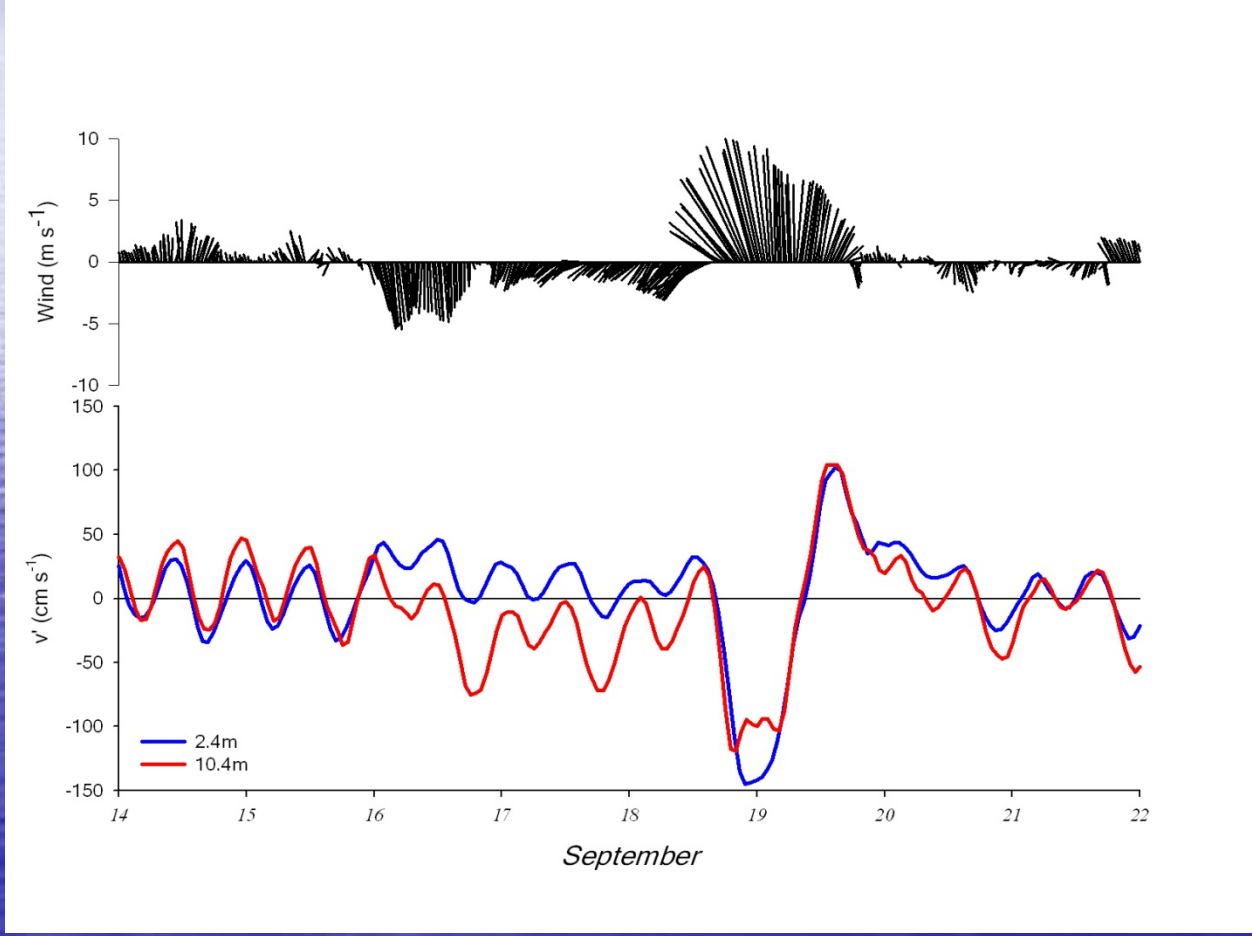


NOAA

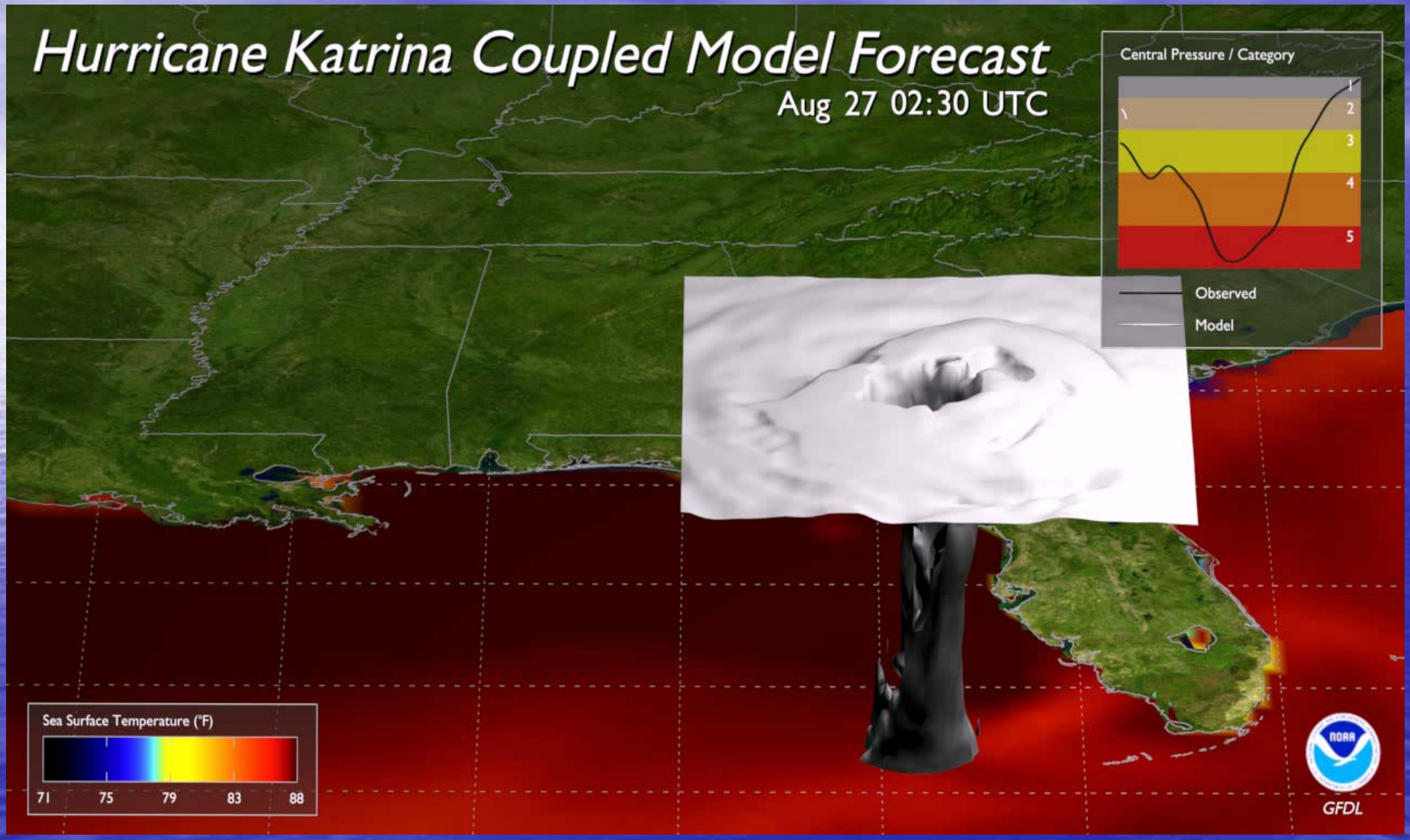

Basin: Chesapeake Bay <cp2>
Storm: c:/slosh.pkg/data/rexfiles/I_923_CHP.REX
SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)
Stm Tide
ft NGVD
9
8
7
6
5
4
3
2
1
0
Tide level:
0.0 ft
NOAA
09/18/2003
08:20:00 UTC
Harford
Frederick
Atlantic
Kent
Loudoun
Kent
Fauquier
Fairfax
Sussex
Page
Charles
Culpeper
Stafford
Madison
Orange
Albemarle
Louisa
Caroline
Hanover
Powhatan
New Kent
Amelia
Charles
Nottoway
Surry
Dinwiddie
arlotte
Lunenburg
Sussex
Mecklenburg
CHESAPEAKE BAY
0
mi
50
0
50
mi
39N
37N
Storm Surge
NOAA
SLOSH Model


Tidal Heights (relative to MLLW)
August 1933
Hampton Roads, VA
Washington, DC
Annapolis, MD
Baltimore, MD
meters
4
3
2
1
0
-1
20
21
22
23
24
25
26
27
28
29
30
September 2003
meters
4
3
2
1
0
-1
15
16
17
18
19
20
21
22
23
24
25

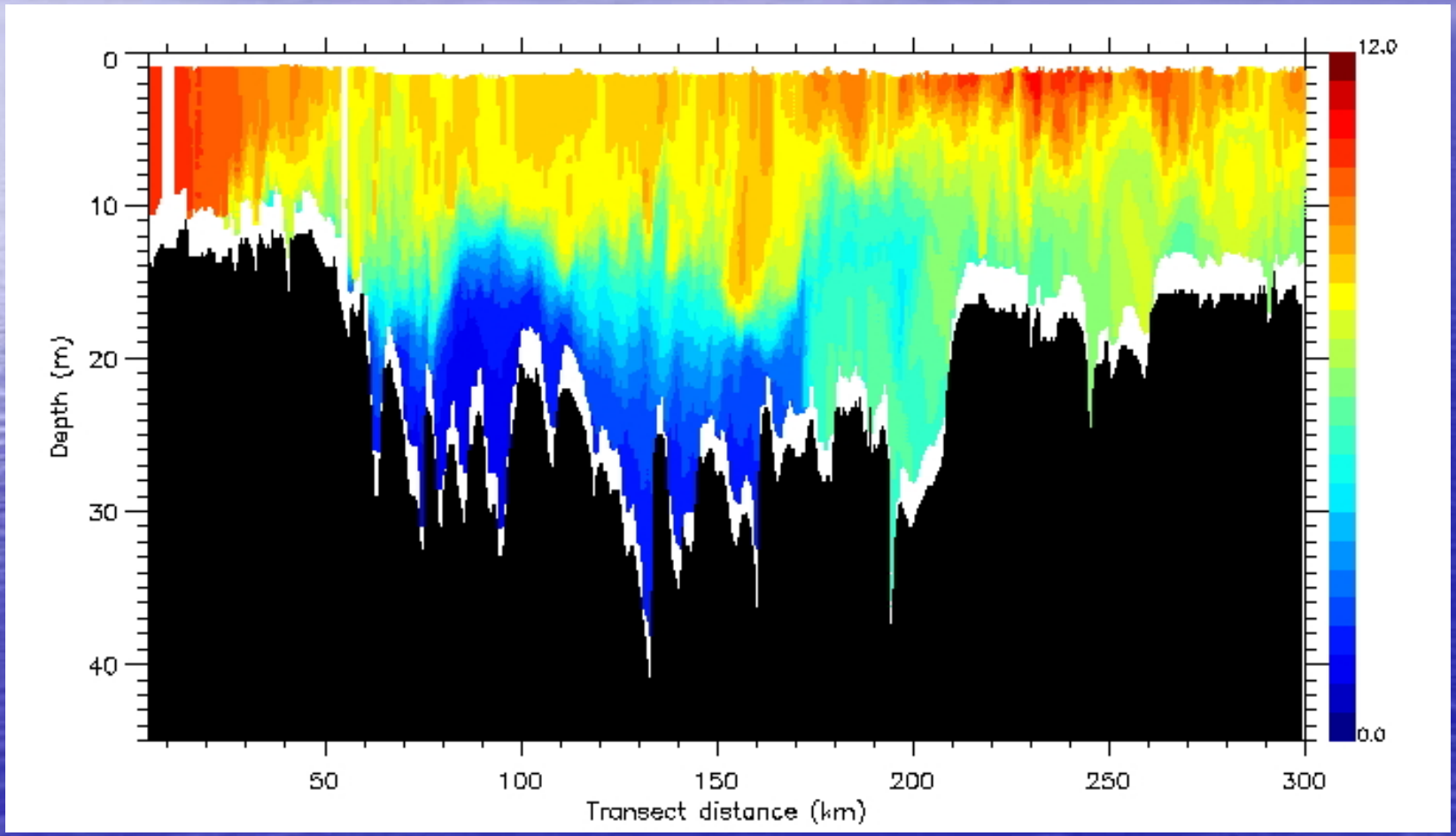
CBOS Mid-Bay Station

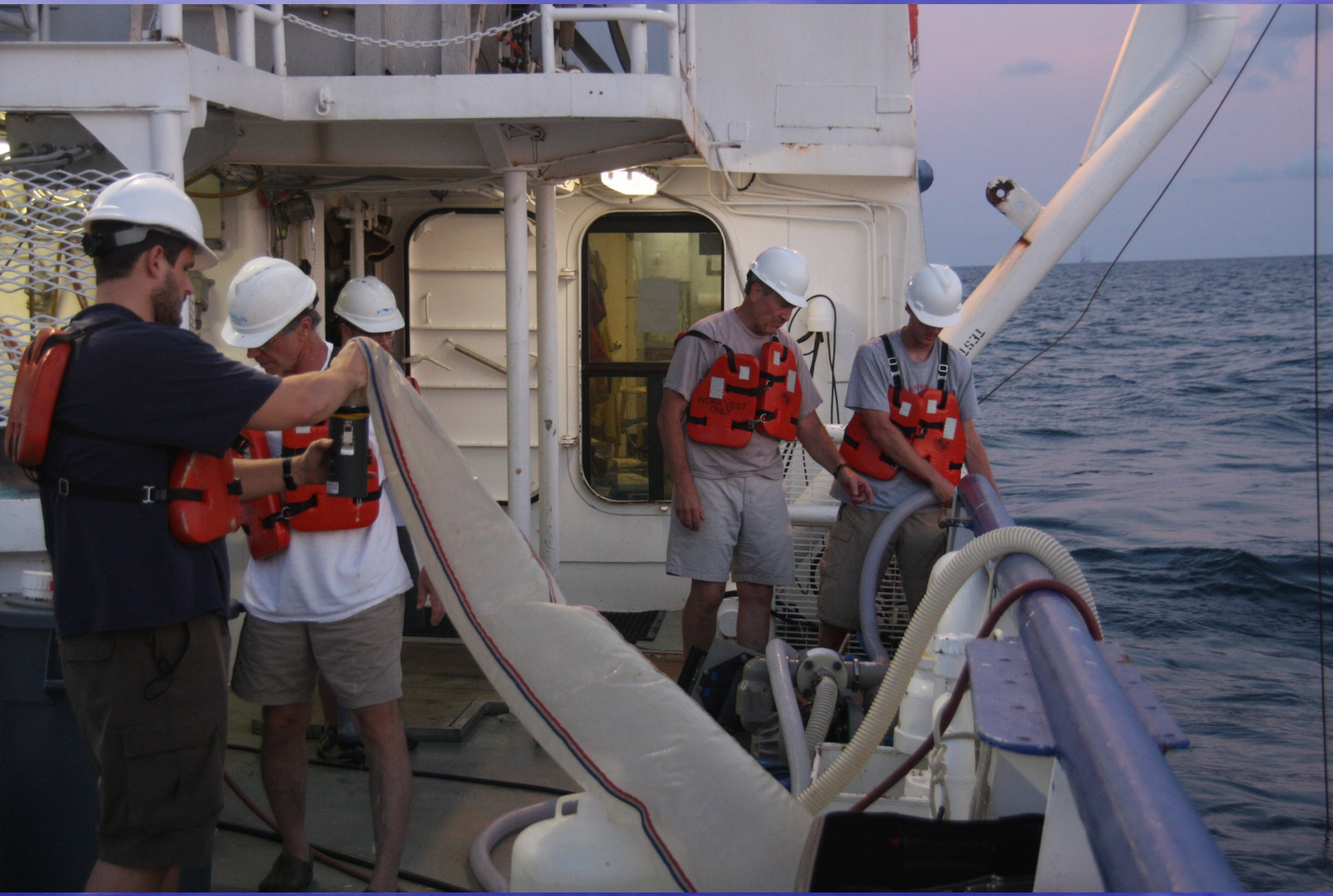


Hurricane Katrina 2005



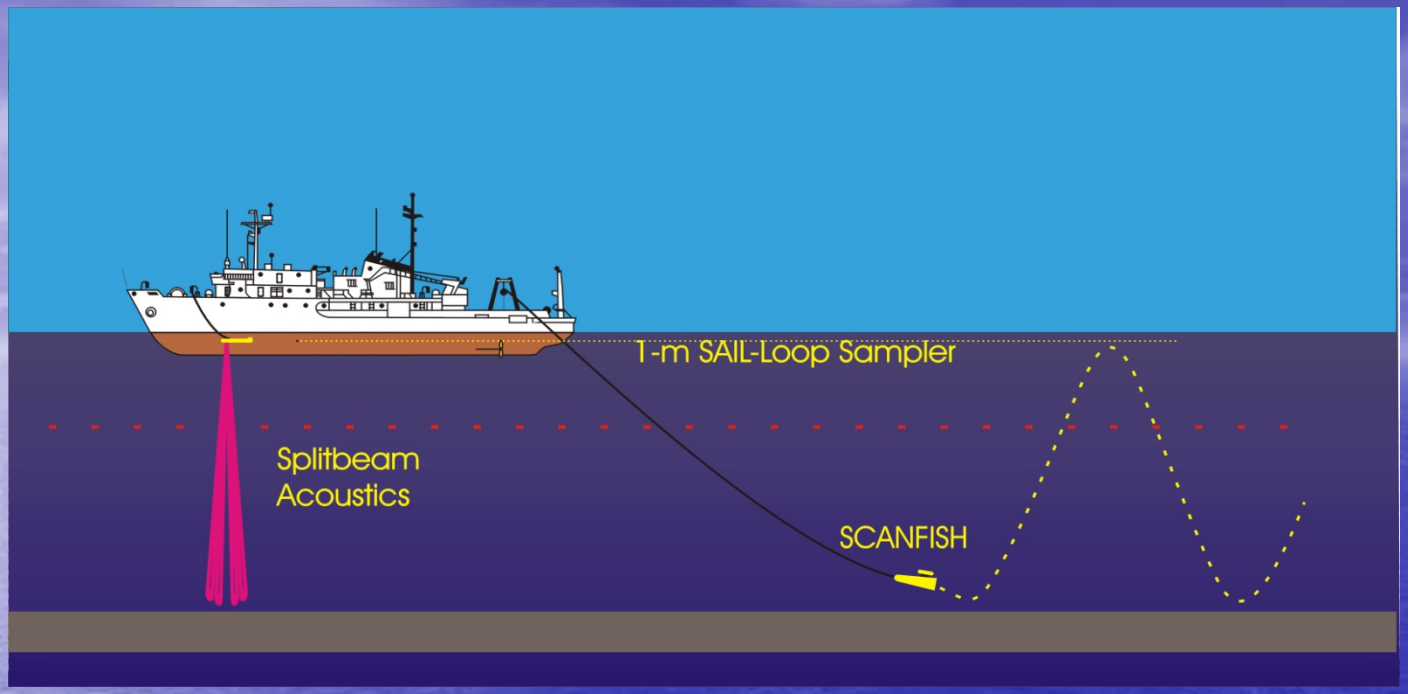
Oxygen Depletion: 5-6 October 03, two weeks after Hurricane Isabel




WORK VEST
ONLY

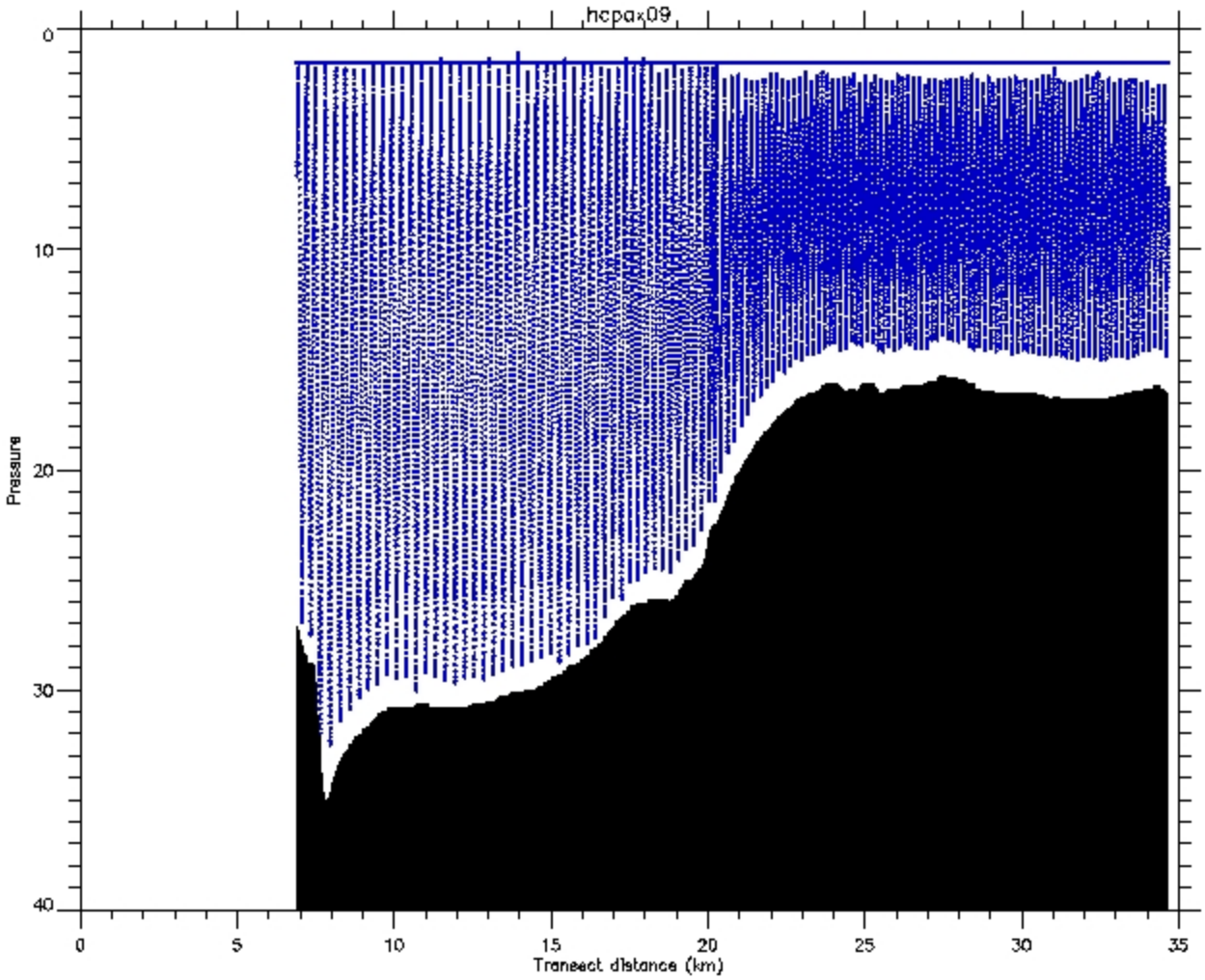
How do we observe the coastal ocean?

- Shipboard measurements
- Moored Platforms
- Autonomous Vehicles
- Satellites
- Coupled Models

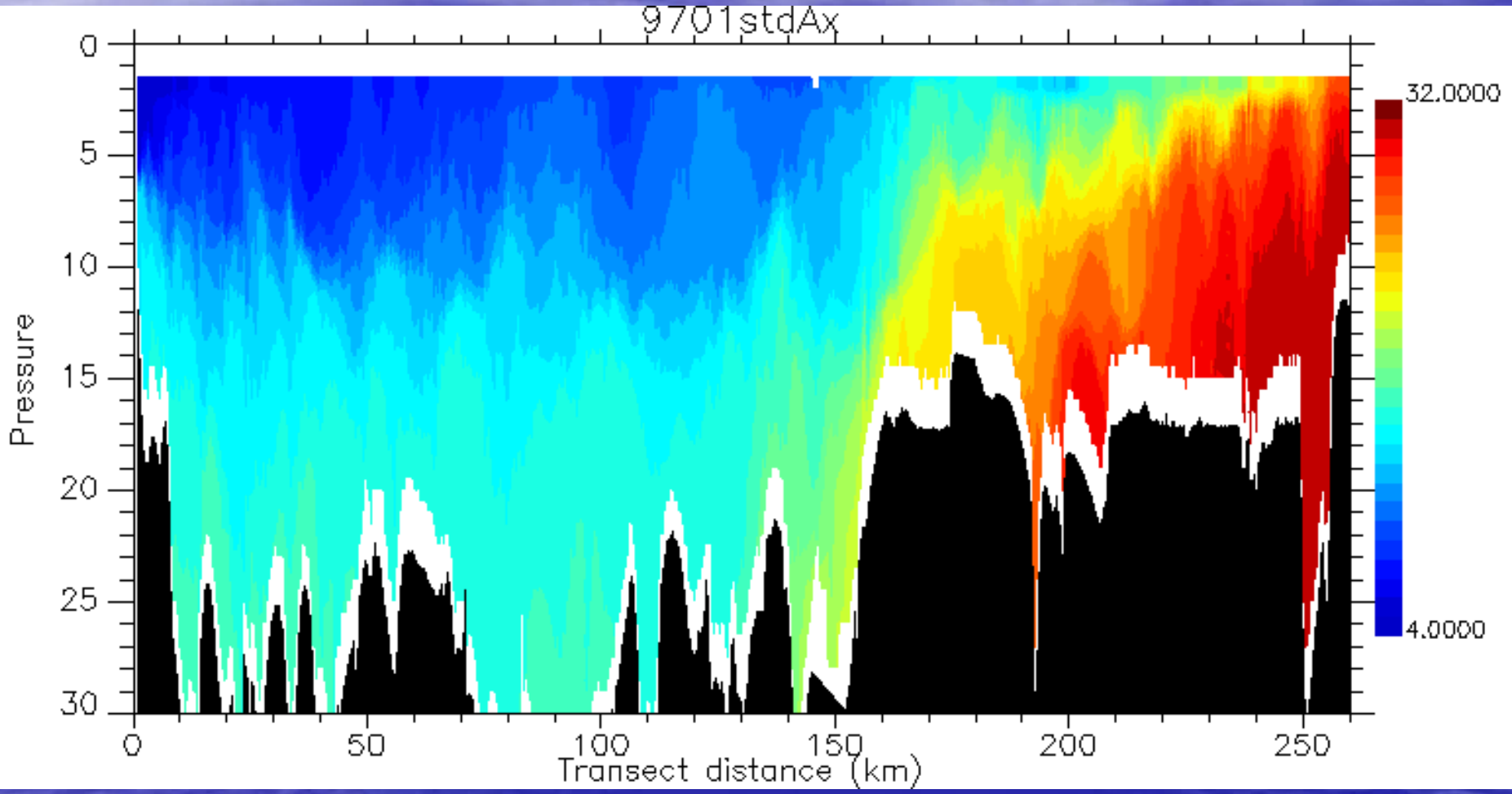


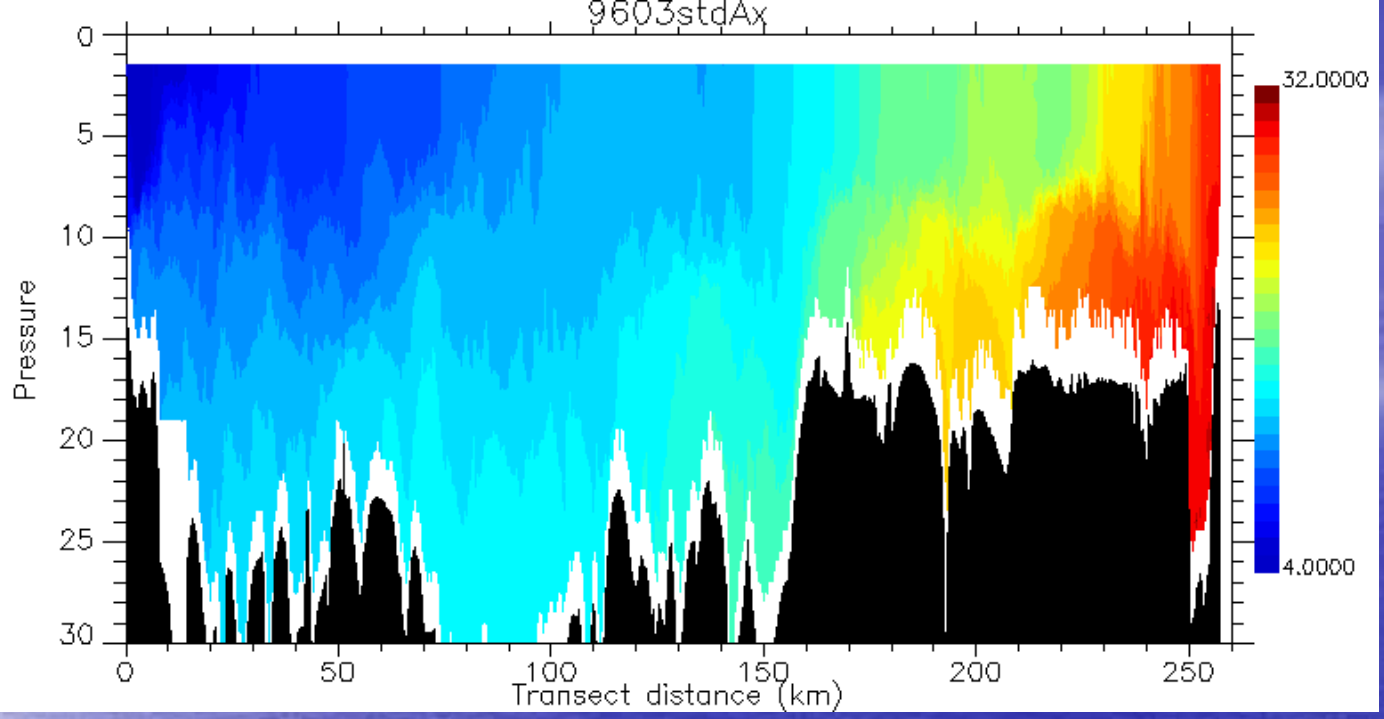
High-Resolution Sampling


APPLETON
S015794
TESTED 8,200LBS 1-16-2007

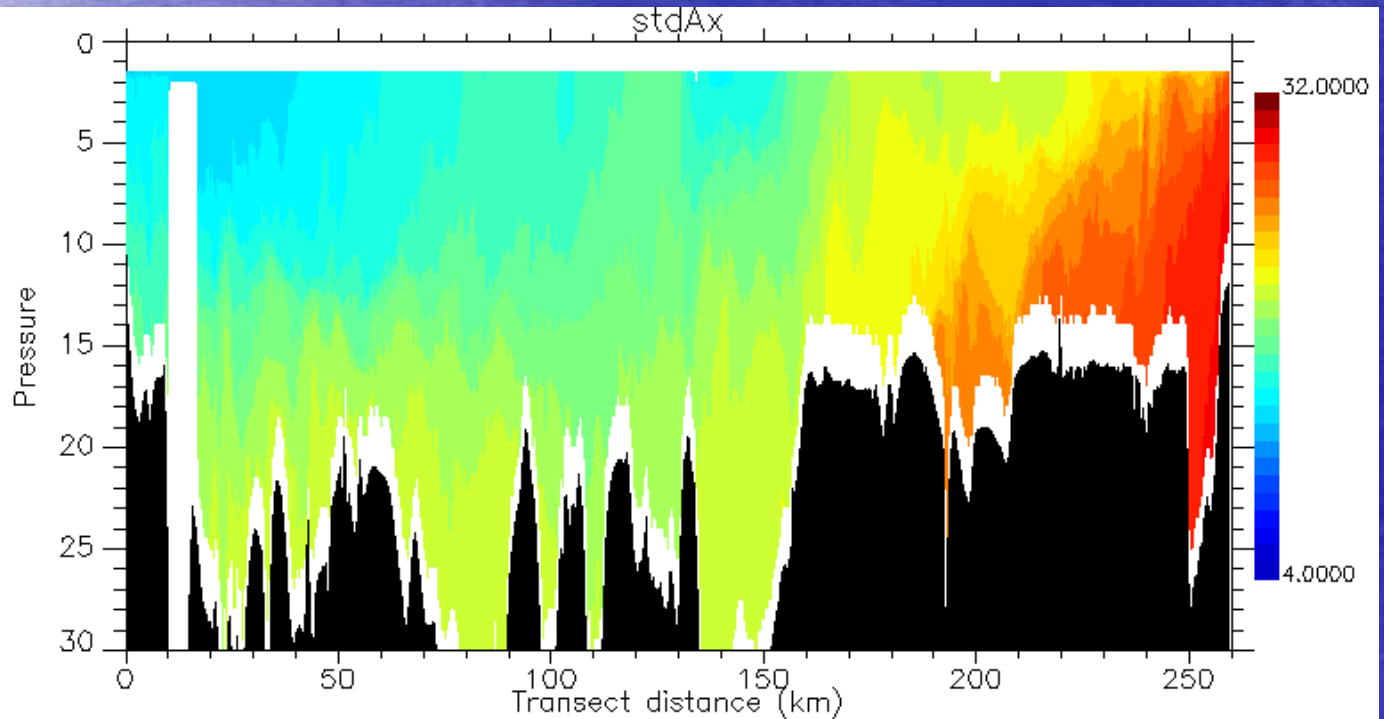

hcpa09
Pressure
0
10
20
30
40
0
5
10
15
20
25
30
35
Transect distance (km)

Axial Salinity Distribution, Spring 1997

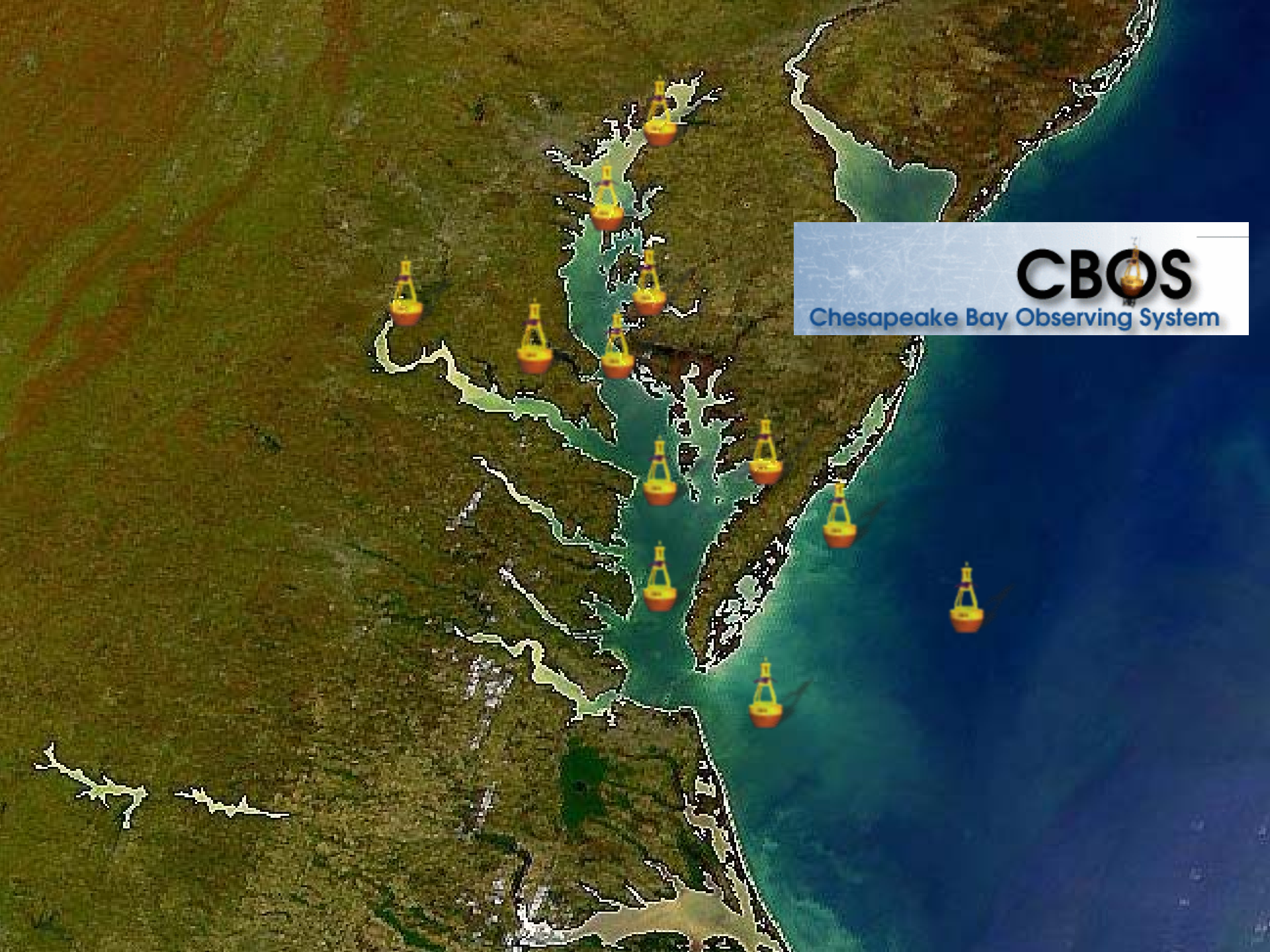




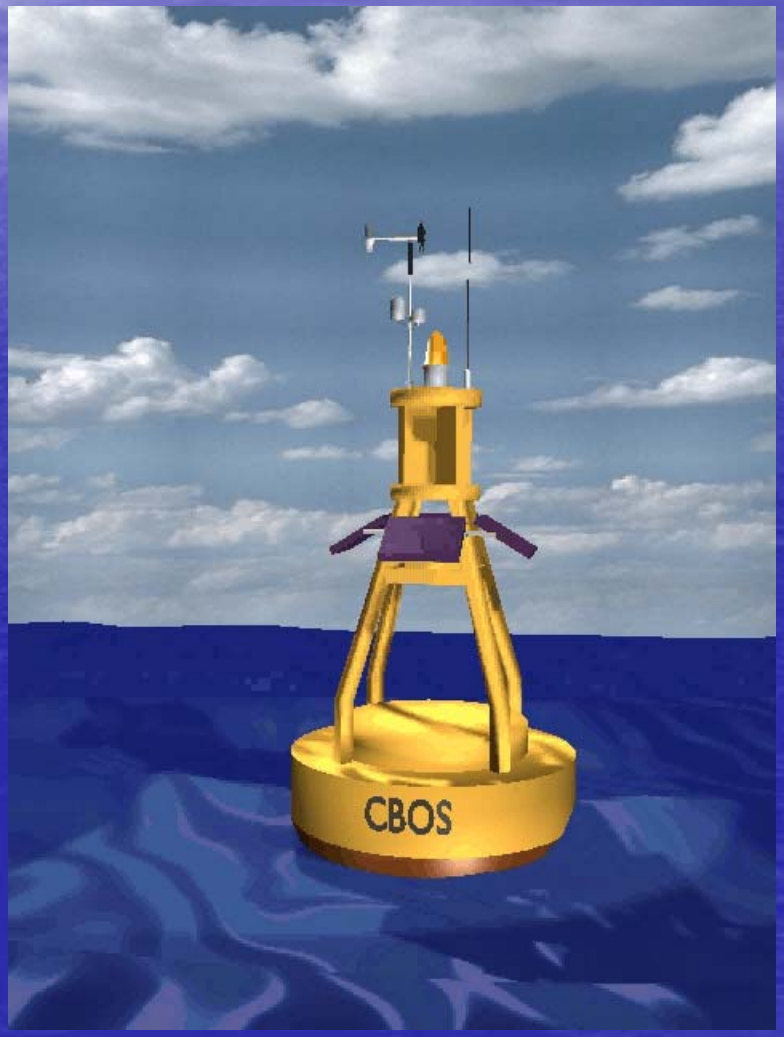
Wet Year
1996



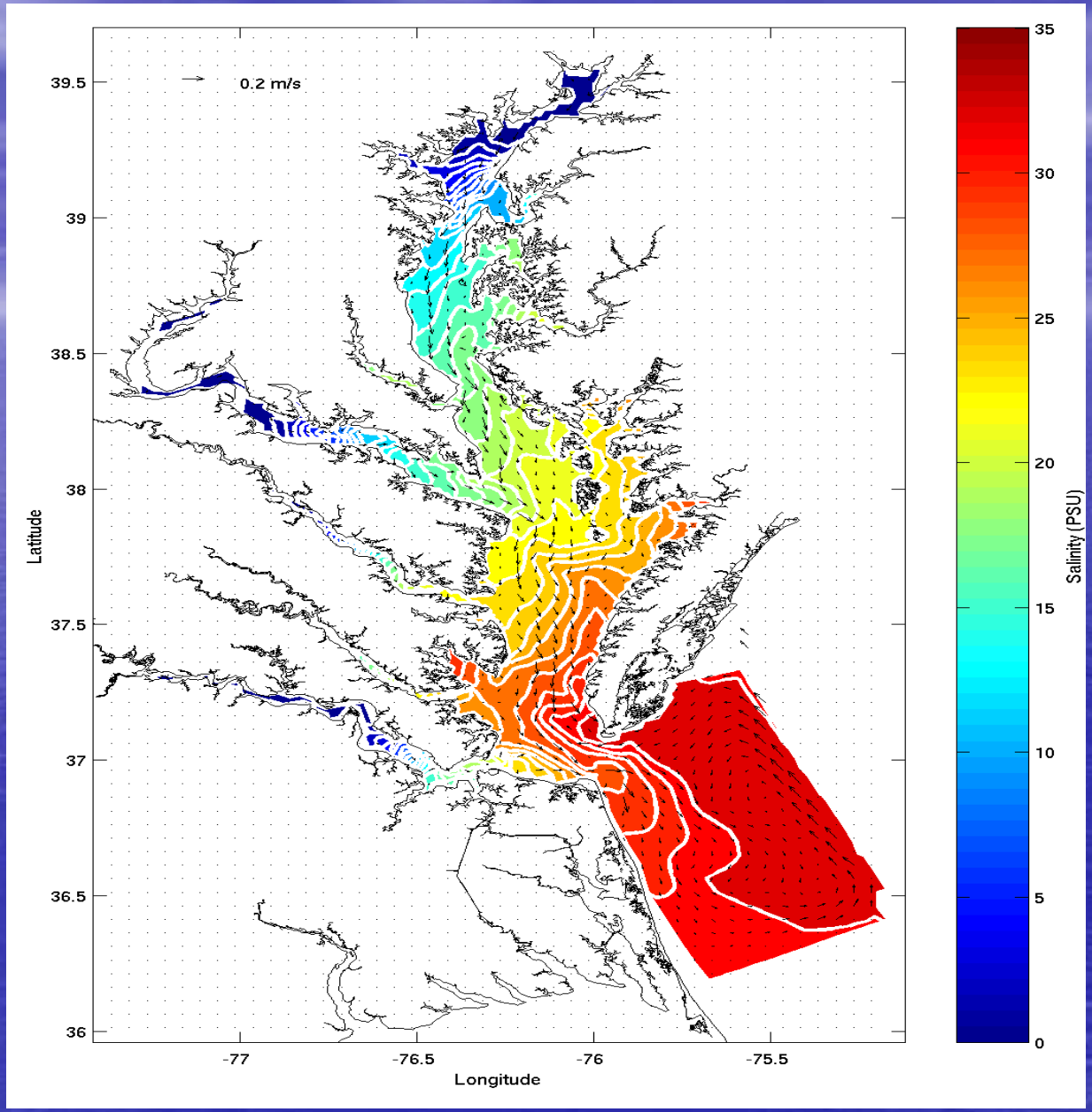
Dry Year
1997


CBOS
Chesapeake Bay Observing System

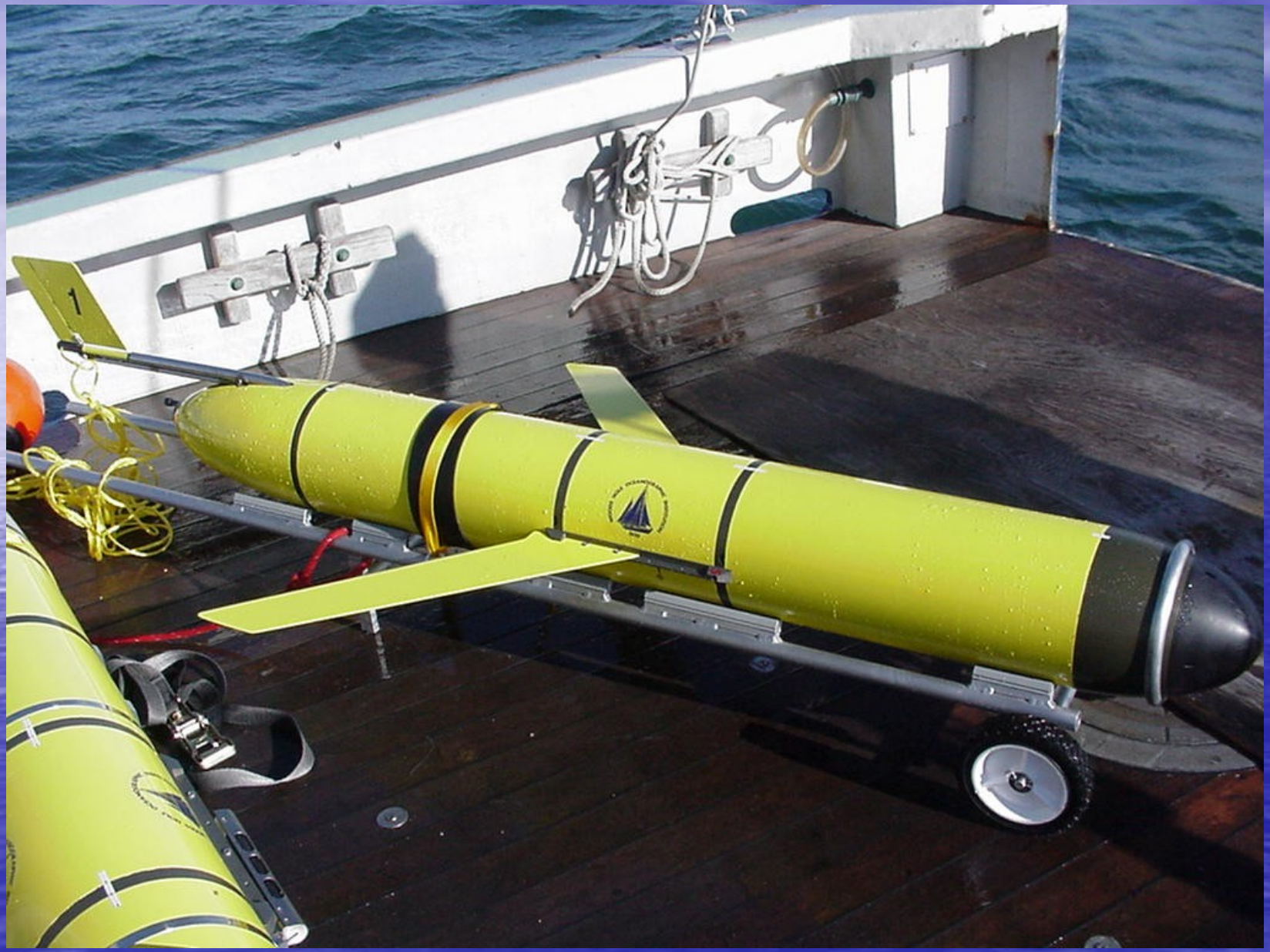
CBOS Buoy Mark III



Numerical Models



Li, Zhong, and Boicourt (2005)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