

CEE 370

Environmental Engineering Principles

Lecture #26

Water Quality Management IV: Estuaries & Oceans

[Reading: Mihelcic & Zimmerman, Chapter 7](#)

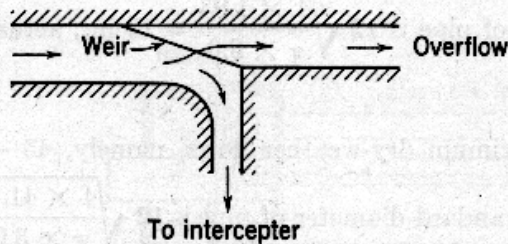
[Reading: Davis & Cornwall, Chapt 5-5 to 5-6](#)

[Reading: Davis & Masten, Chapter 9-5 to 9-6](#)

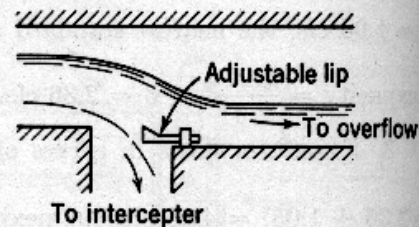
Combined sewer overflows

CSOs

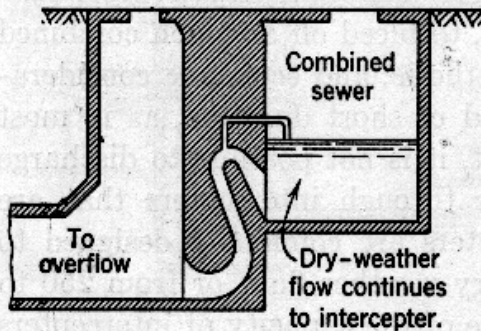
- Intended to protect wastewater systems from high flows
- A major source of contamination in many surface waters



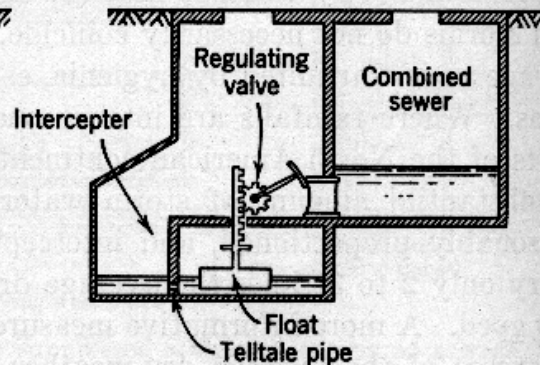
a. Diverting weir—plan



b. Leaping weir—vertical section



c. Siphon spillway—vertical section



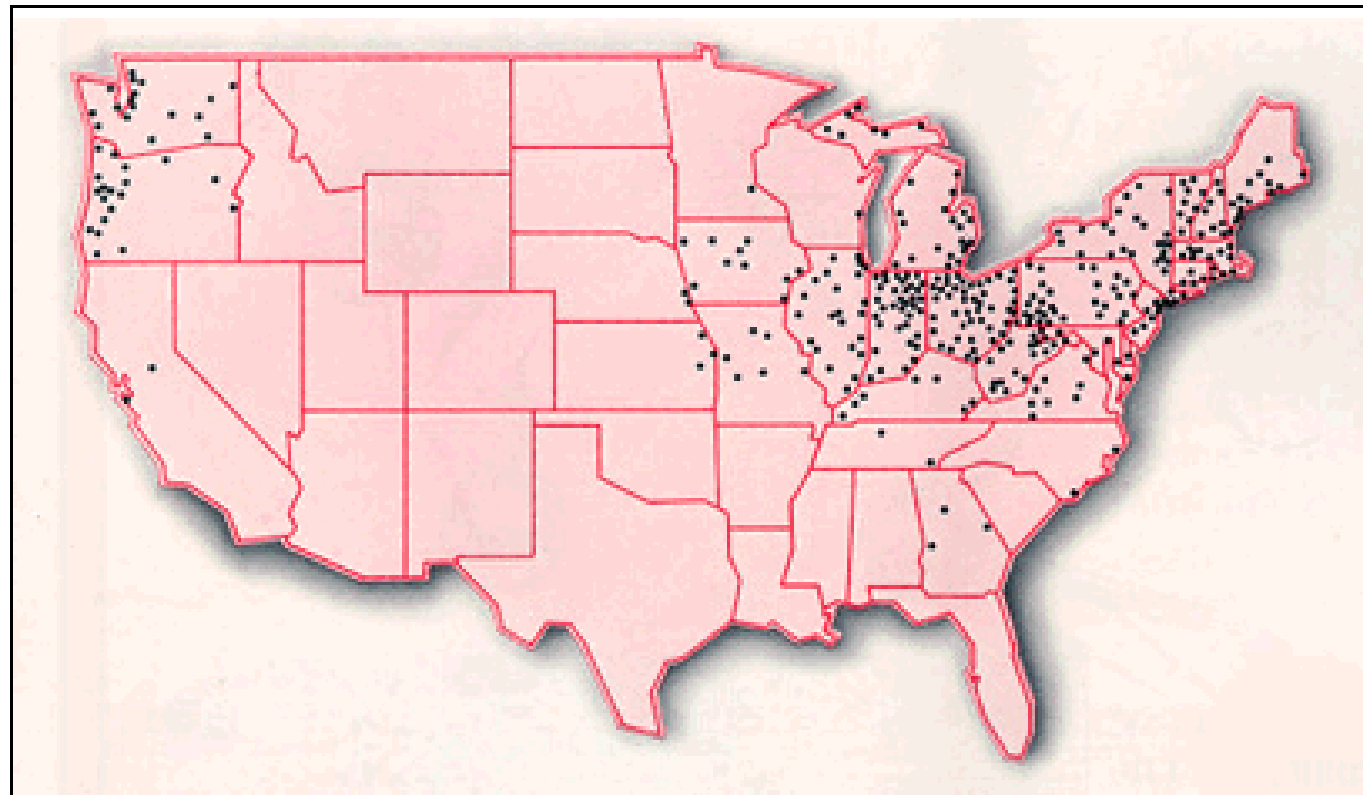
d. Mechanical diverter, or regulator—vertical section; actual mechanisms are more complicated.

Figure 3-6. Regulation of storm-water overflow.

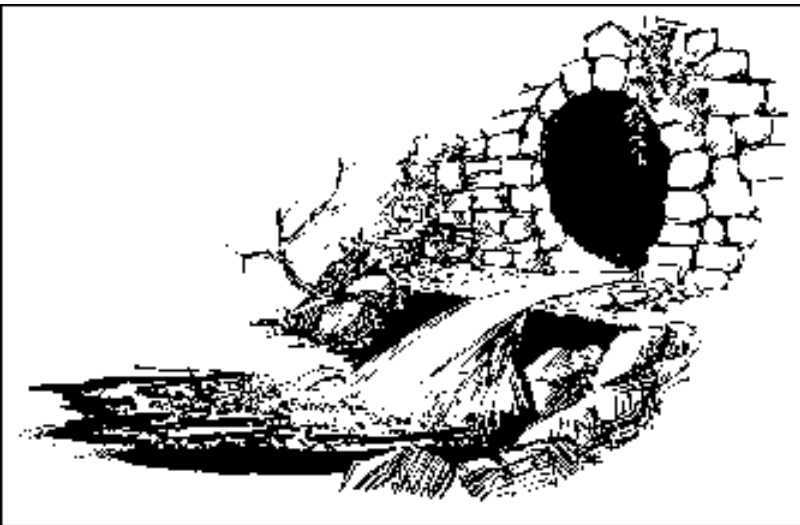
Pg 72, from Fair & Geyer, 1954

Combined Sewer Overflows

- Most CSOs are in the Northeast



Combined Sewer Overflows



City	# outfalls
Agawam	12
Chicopee	40
Erving	1
Holyoke	15
Ludlow	5
Montague	3
Palmer	26
South Hadley	11
Springfield	25

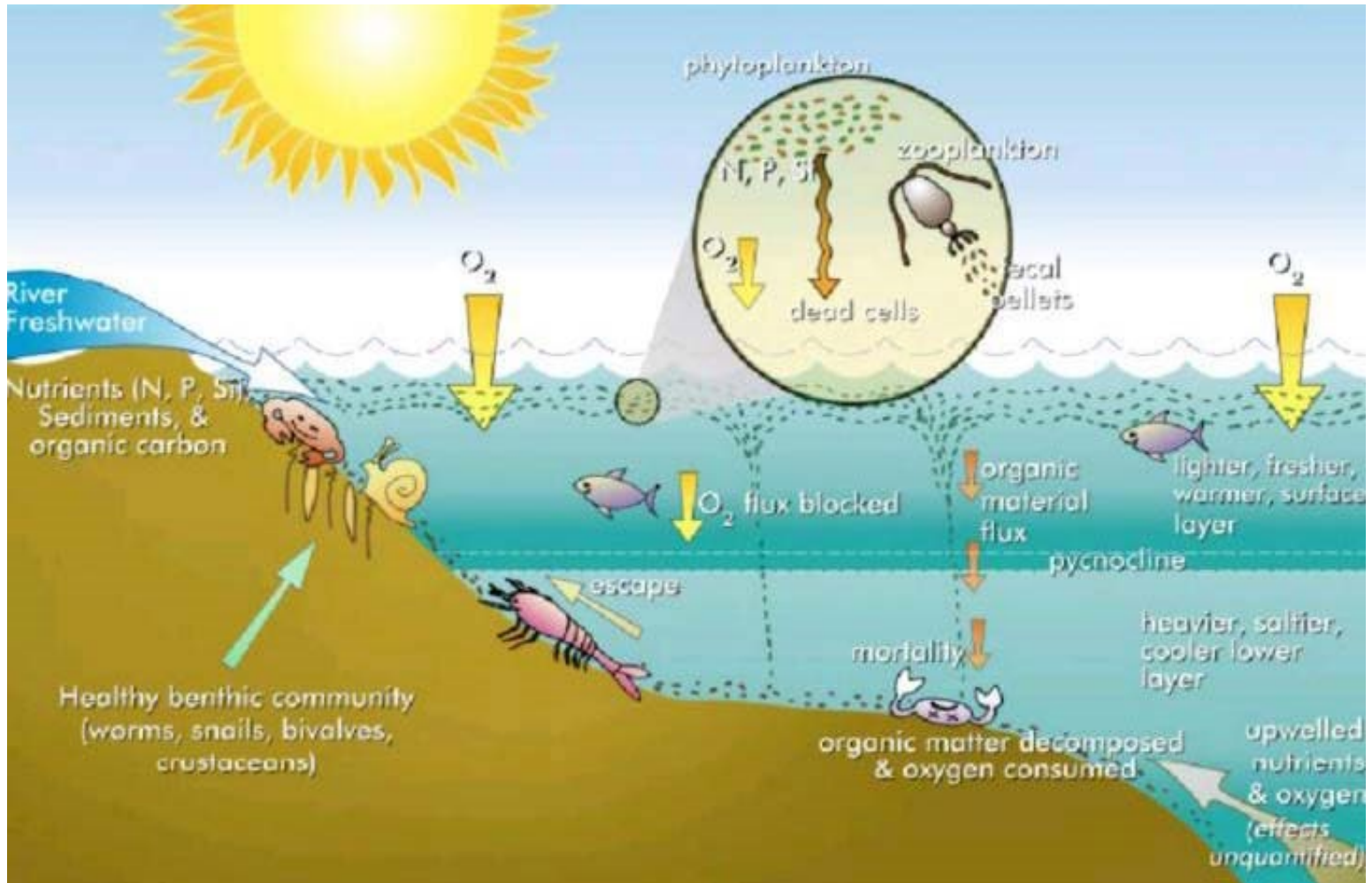
City	# outfalls
Boston	66
Cambridge	13
Chelsea	5
Fall River	19
Fitchburg	27
Gloucester	4
Haverhill	23
Lawrence	2
Lowell	15
Lynn	4
New Bedford	39
Somerville	12
Taunton	1
Worcester	1

Hypoxia in the Gulf of Mexico

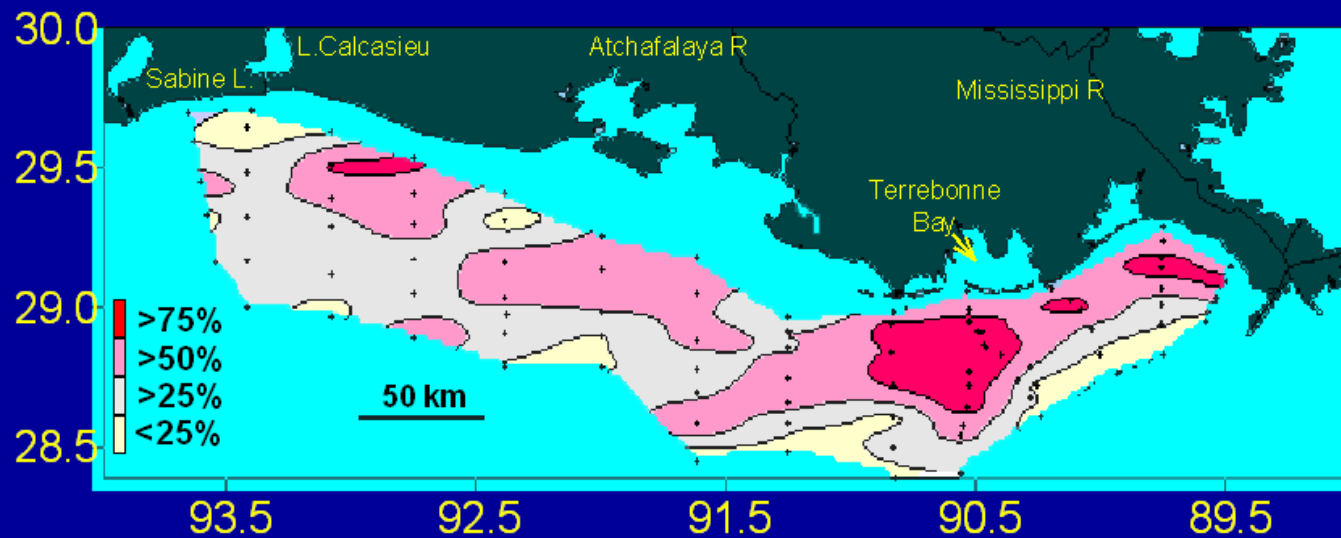


The Dead Zone reached a recorded high of 7,728 square miles in 1999.





Bottom-Water Hypoxia Frequency of Mid-Summer Occurrence 1985 - 1999



(Rabalais, Turner & Wiseman)



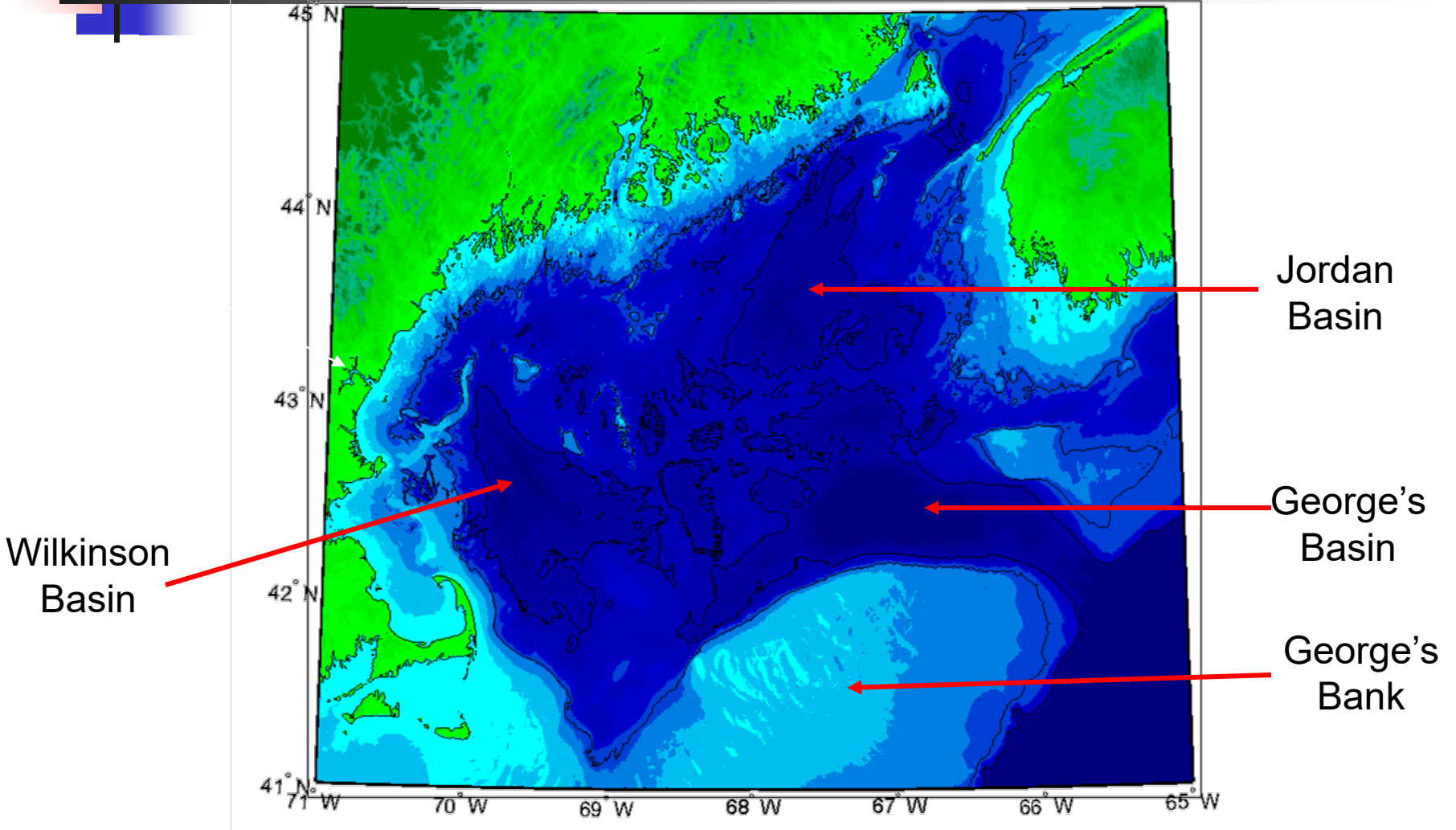
4 Disciplines

- Geological Oceanography
 - Structure of the sea floor
- Chemical Oceanography
 - Chemical composition and properties of seawater
- Physical Oceanography
 - Waves, tides, currents
- Biological Oceanography
 - Oceanic life forms

Physical Characteristics of the Oceans

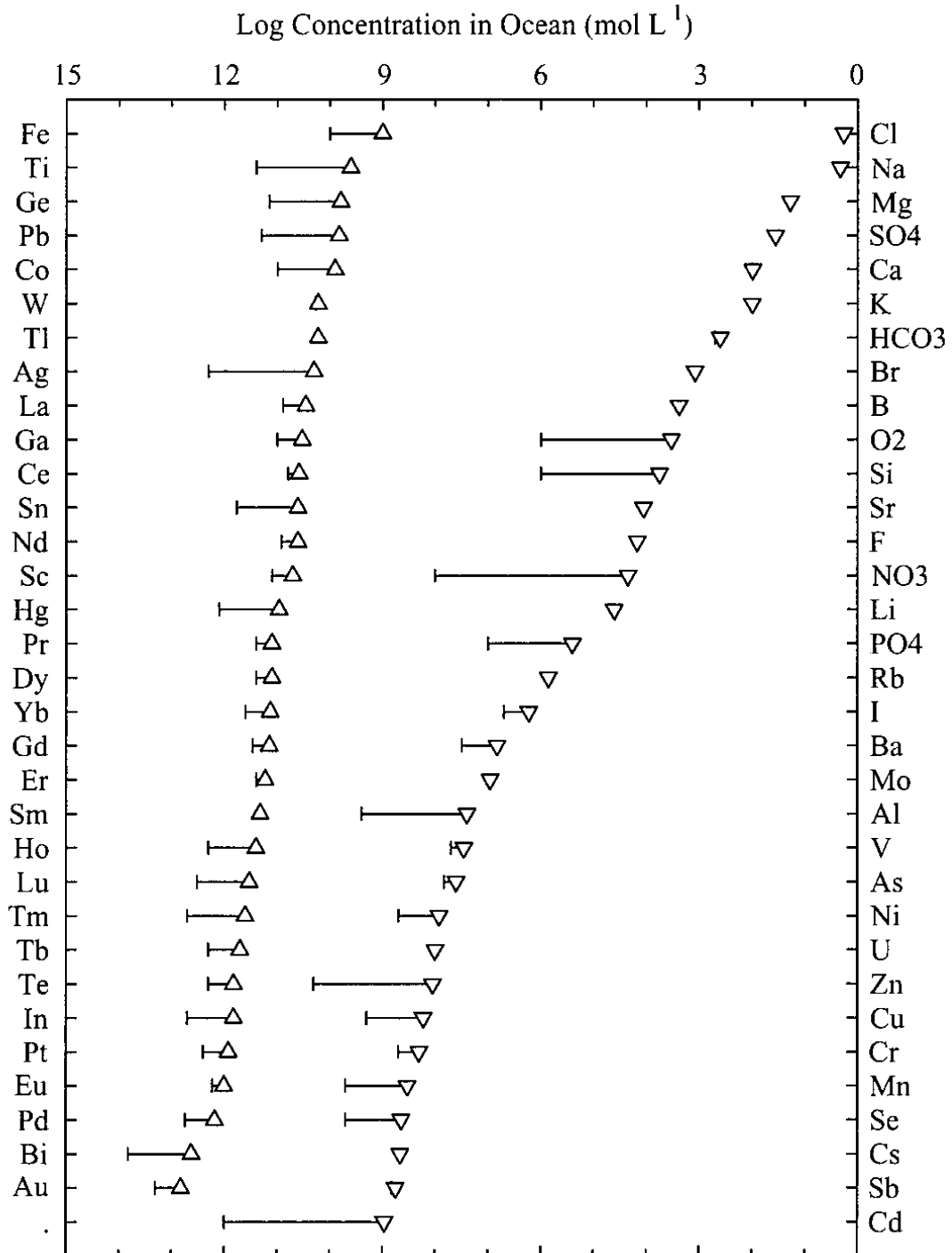
Sea	Area (10^6 km ²)	Volume (10^6 km ³)	Depth (m)	
			ave	max
Pacific	181	714	3,940	11,022
Atlantic	107	351	3,293	9,219
Indian	74	285	3,870	7,400
Total	362	1350	3,729	11,022

Regional Oceanography



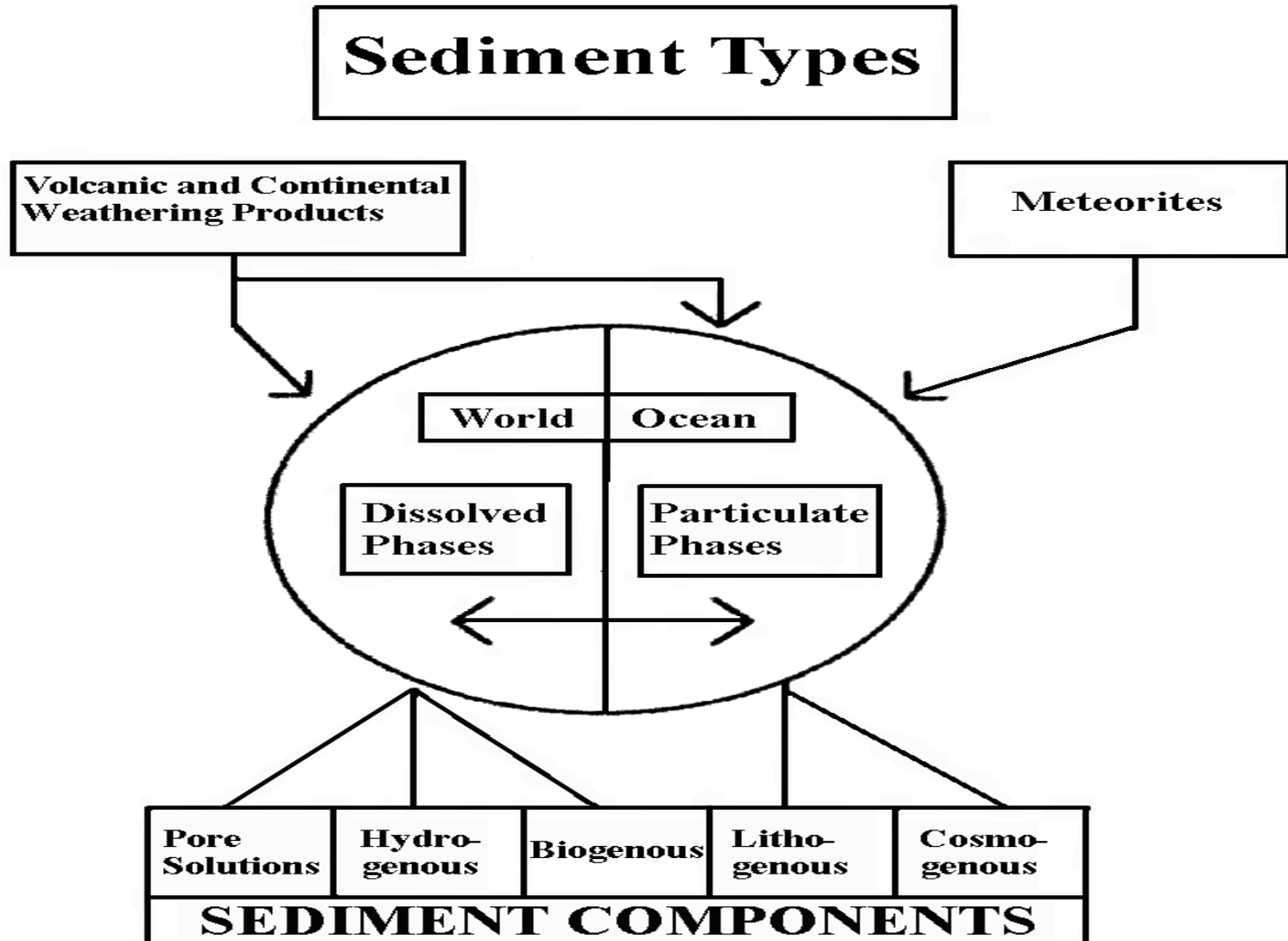


■ Composition of sea water



From Johnson et al., 2000

Sediment Types

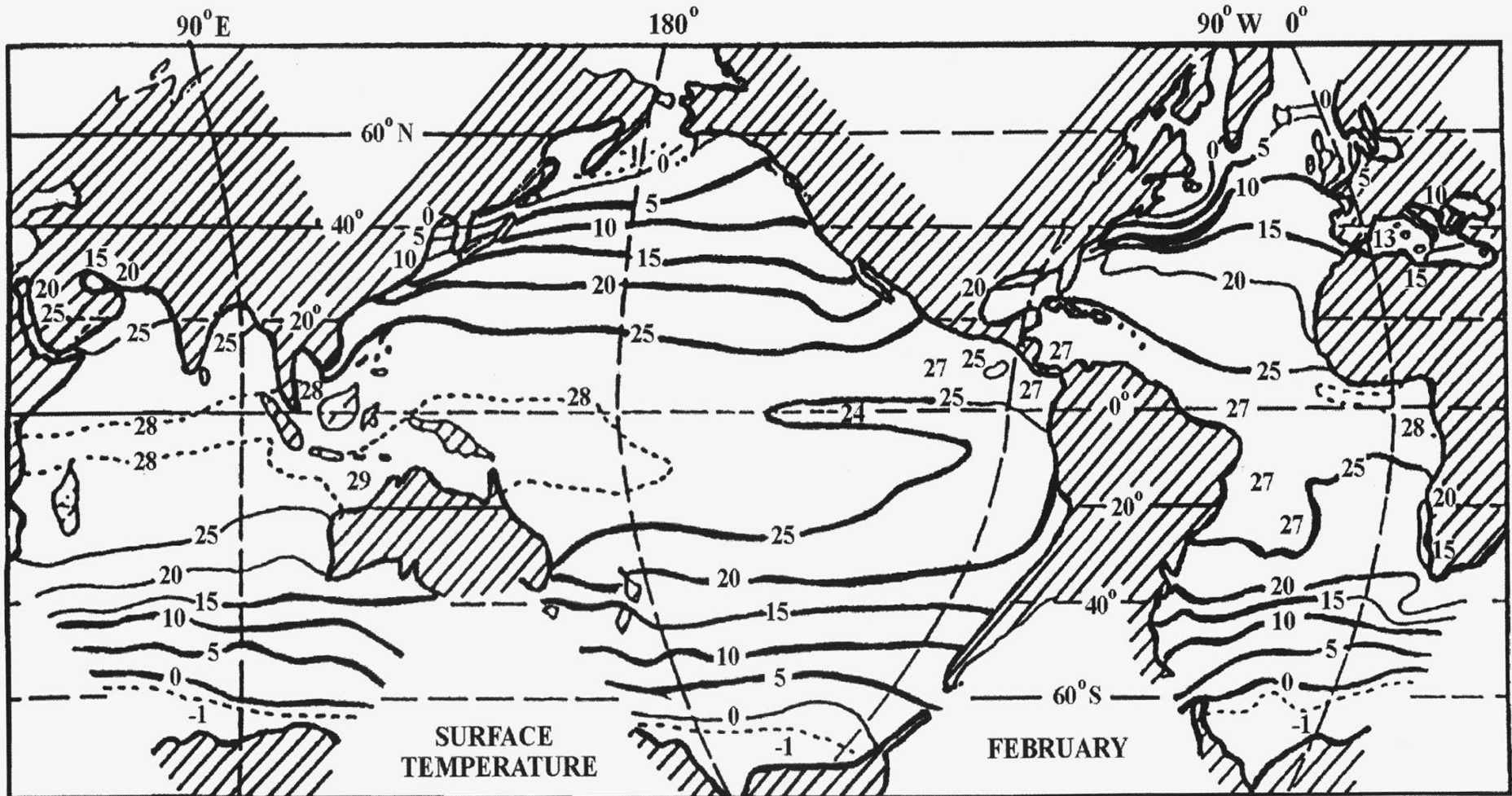




Descriptive Oceanography

- **Distribution of t, S and density**
- **Currents in the World Oceans**
- **Water Masses in the Oceans**
- **Use of Chemical Tracers**
 ^{14}C , Tritium, ^3He , CFC
- **Age of Water Masses**
- **The Ocean Conveyor Belt**

Surface Temperatures





Temperature Distribution

Solar Radiation

Waters are colder in Polar regions

Waters are warmer in Equatorial Regions

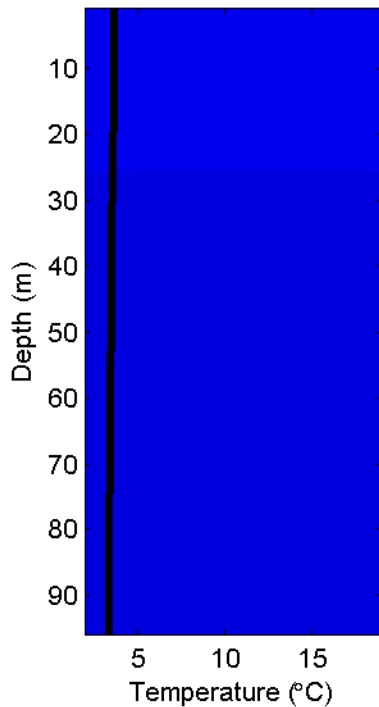
Upwelling

**Waters are colder off the Western Coasts
of continents**

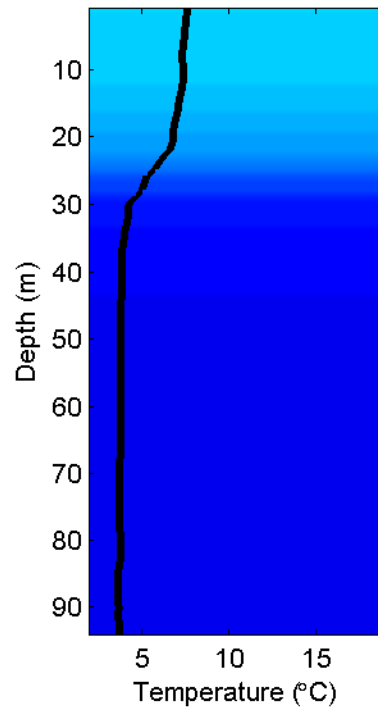
Temperature Depth Profiles

Seasonal: North Atlantic

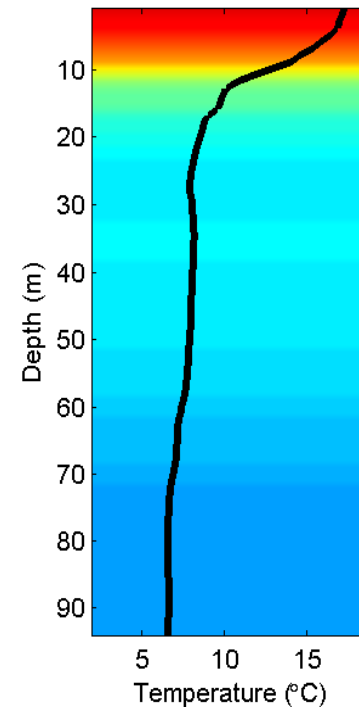
Winter



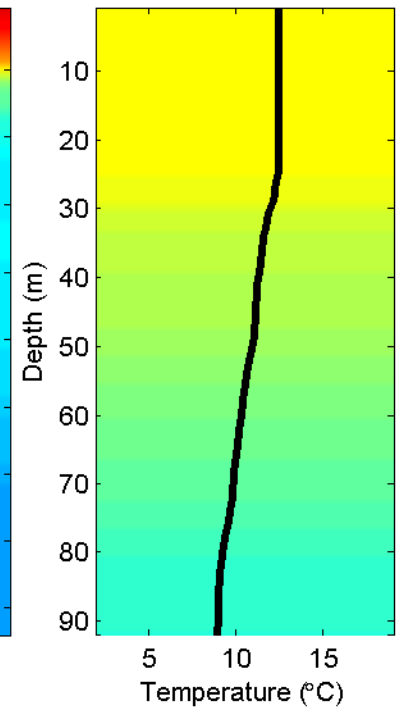
Spring



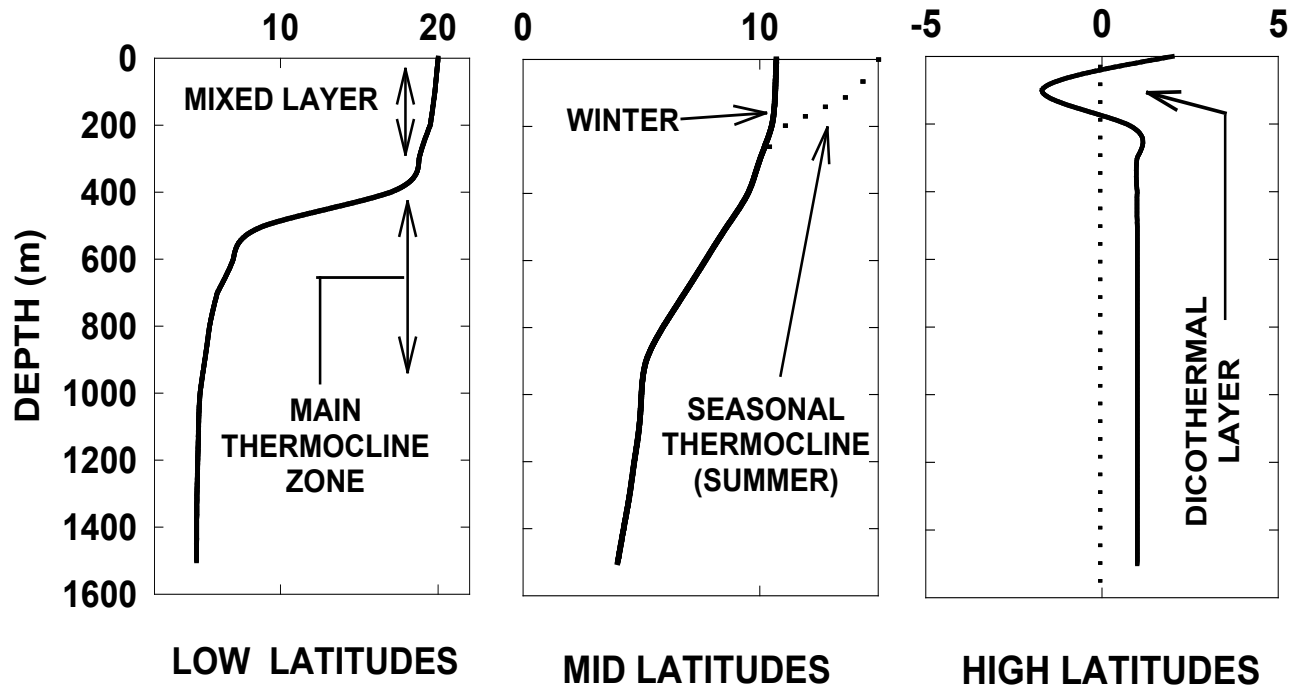
Summer



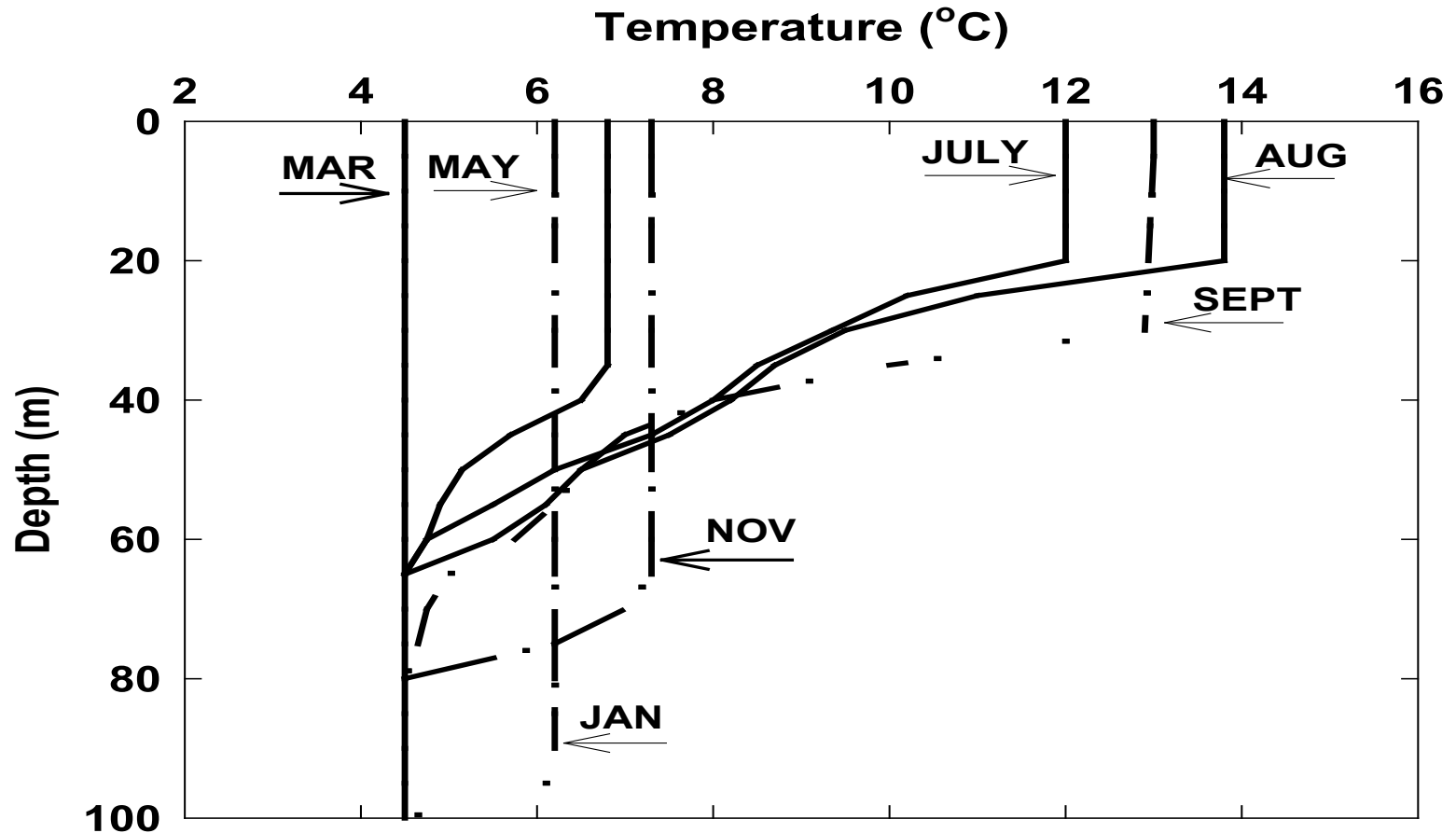
Fall



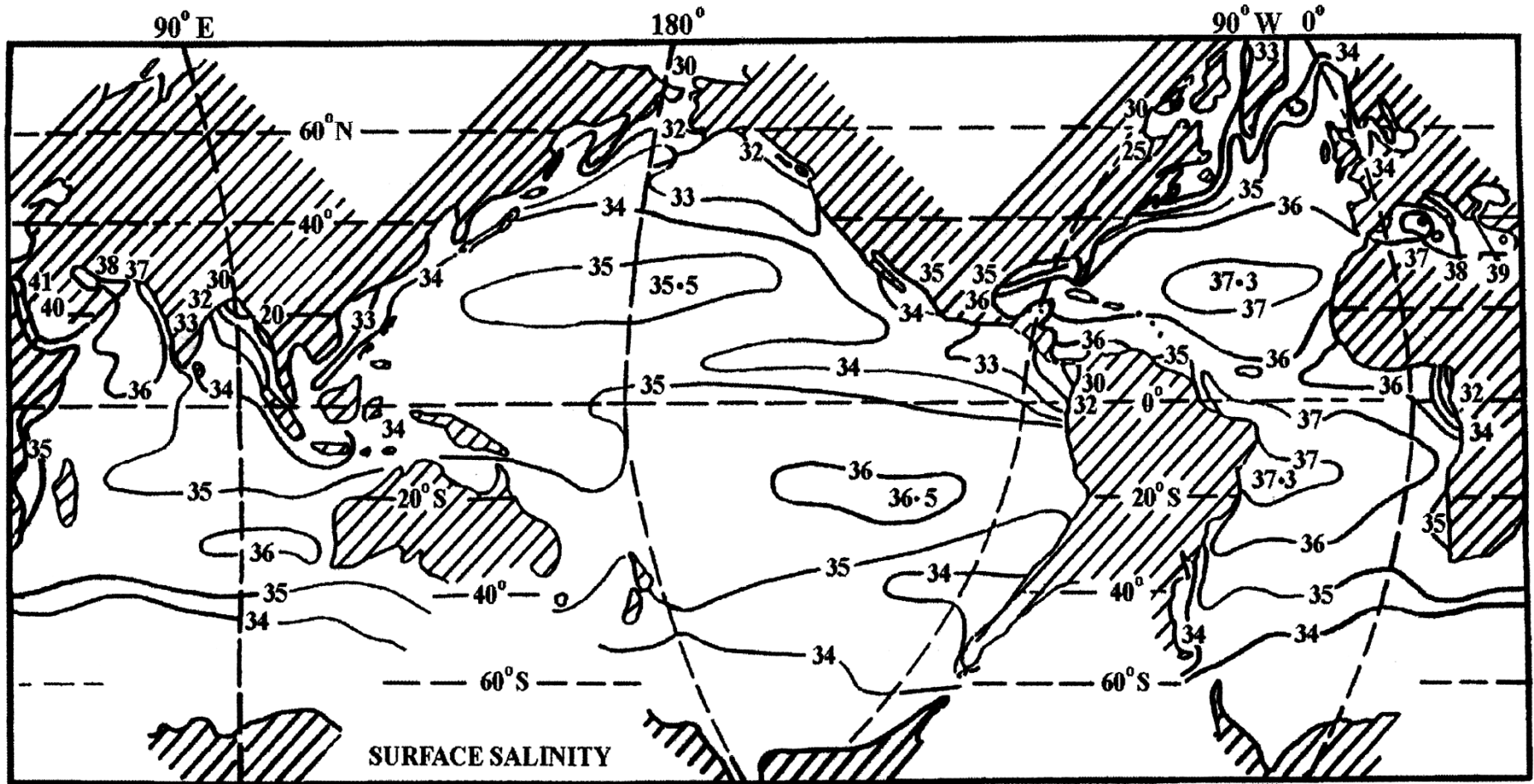
Temperature Profiles



Growth and Decay of Thermocline



Surface Salinity of Ocean Waters

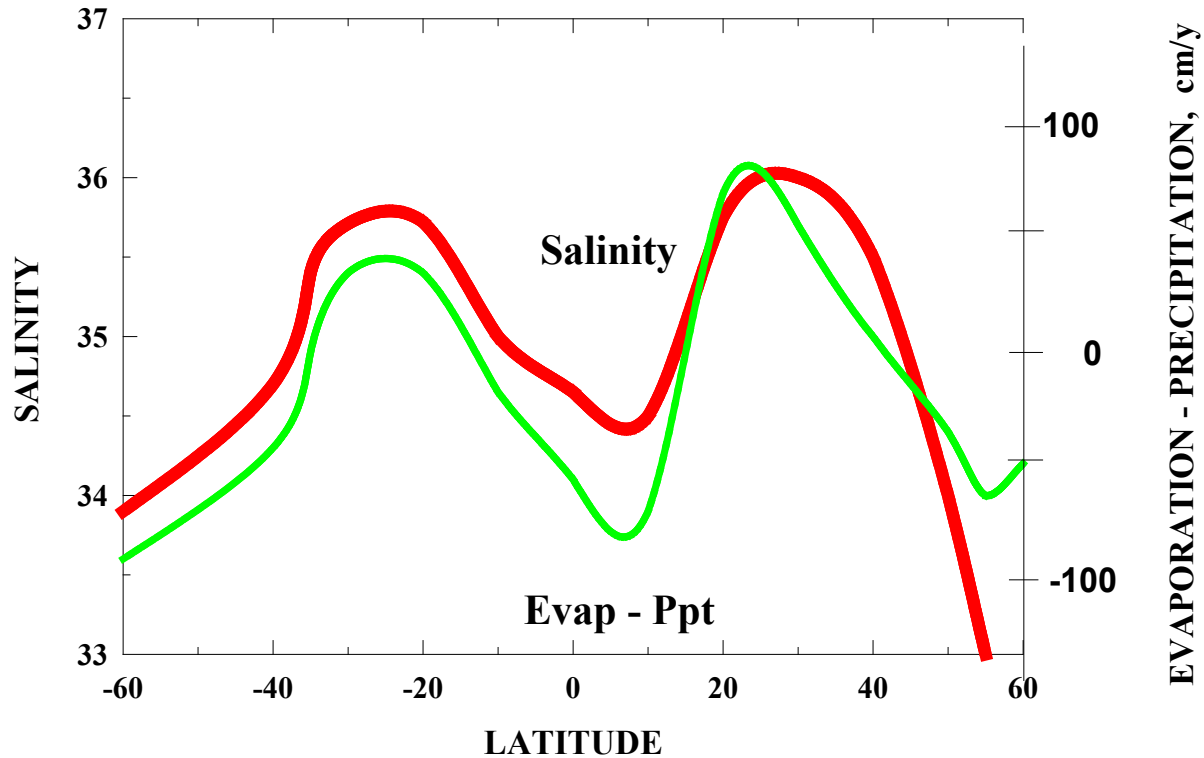




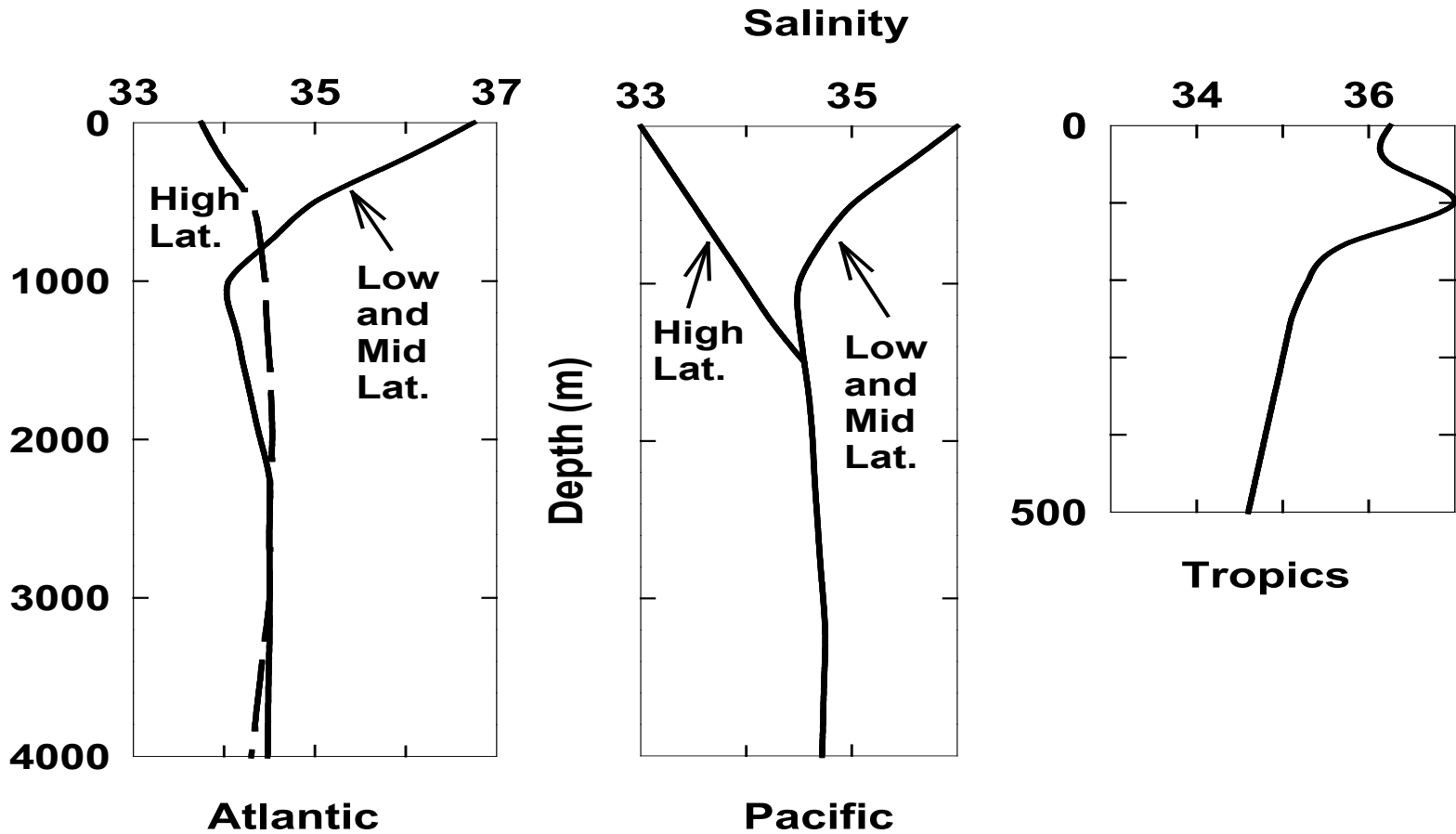
Salinity Distribution

- **Precipitation and Melting of Ice**
 1. **Salinity is lower in Polar Regions**
 2. **Salinity is lower in Equatorial Regions**
 3. **Salinity is lower in Estuarine Regions**
- **Evaporation and Freezing**
 1. **Salinity is higher in mid-Latitudes**
 2. **Salinity is higher in Med. and Red Seas**
 3. **Salinity is higher in the Atlantic than the Pacific**

Salinity vs Evaporation minus Precipitation

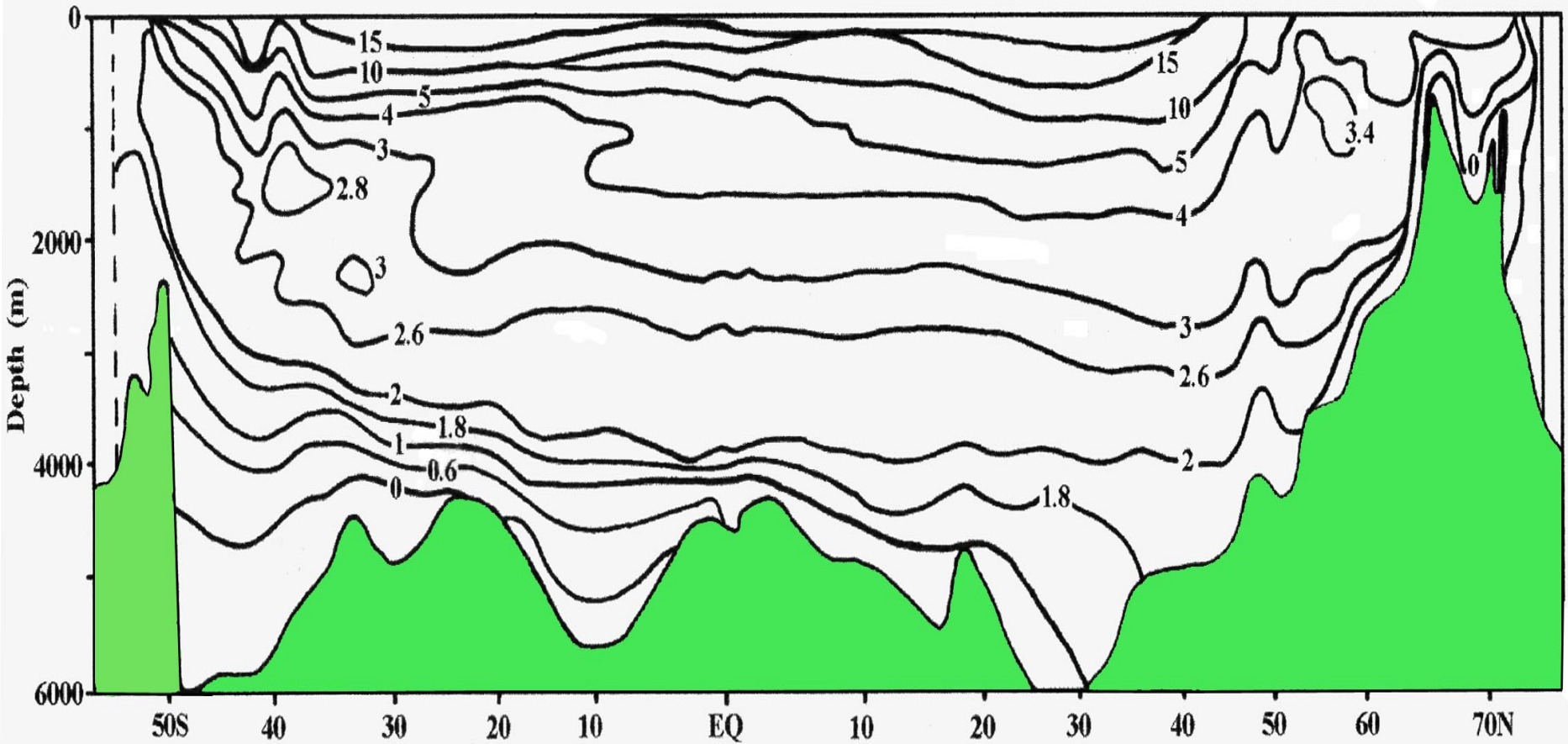


Salinity of Ocean Waters

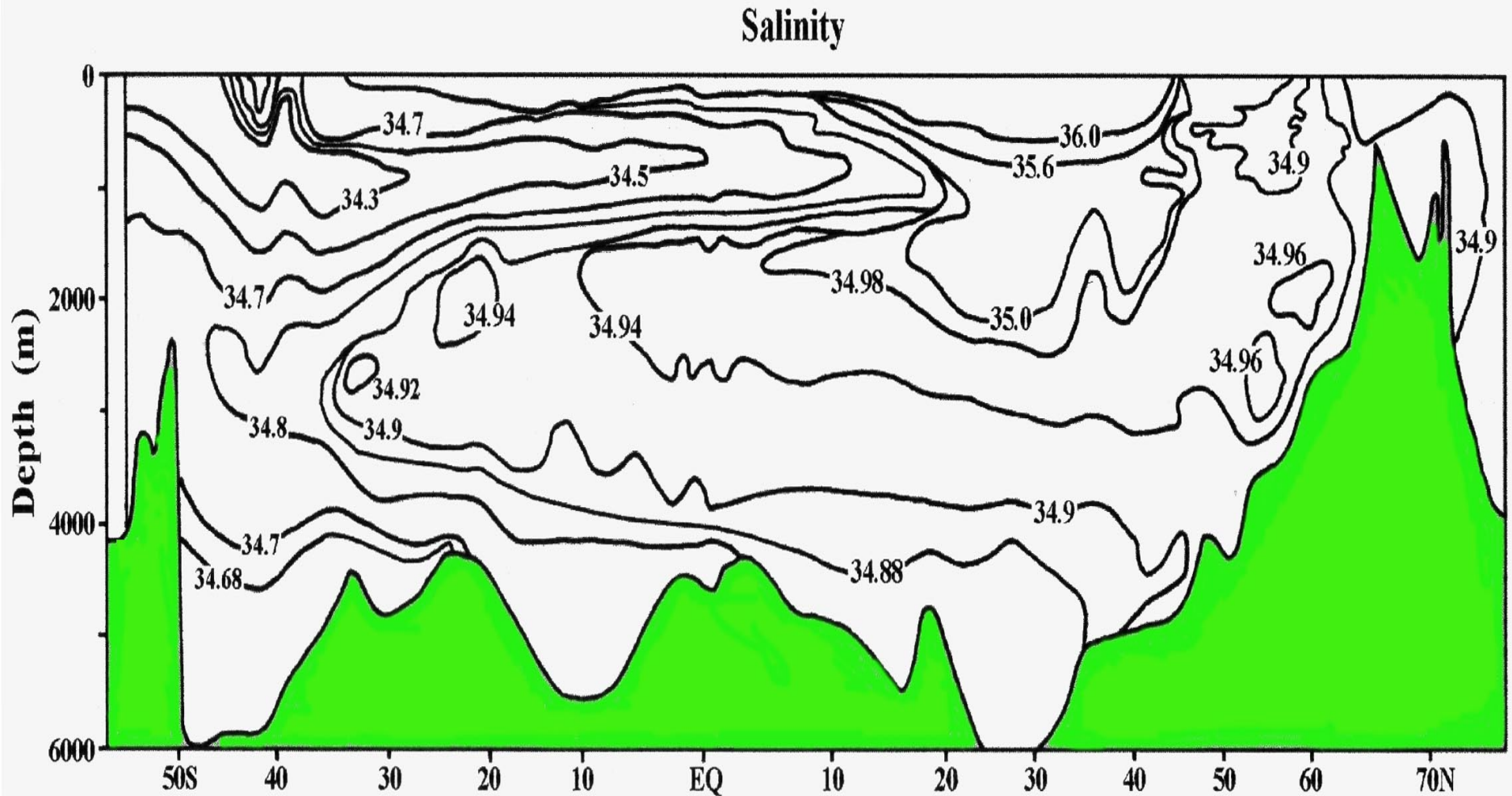


Temperature in Atlantic Ocean

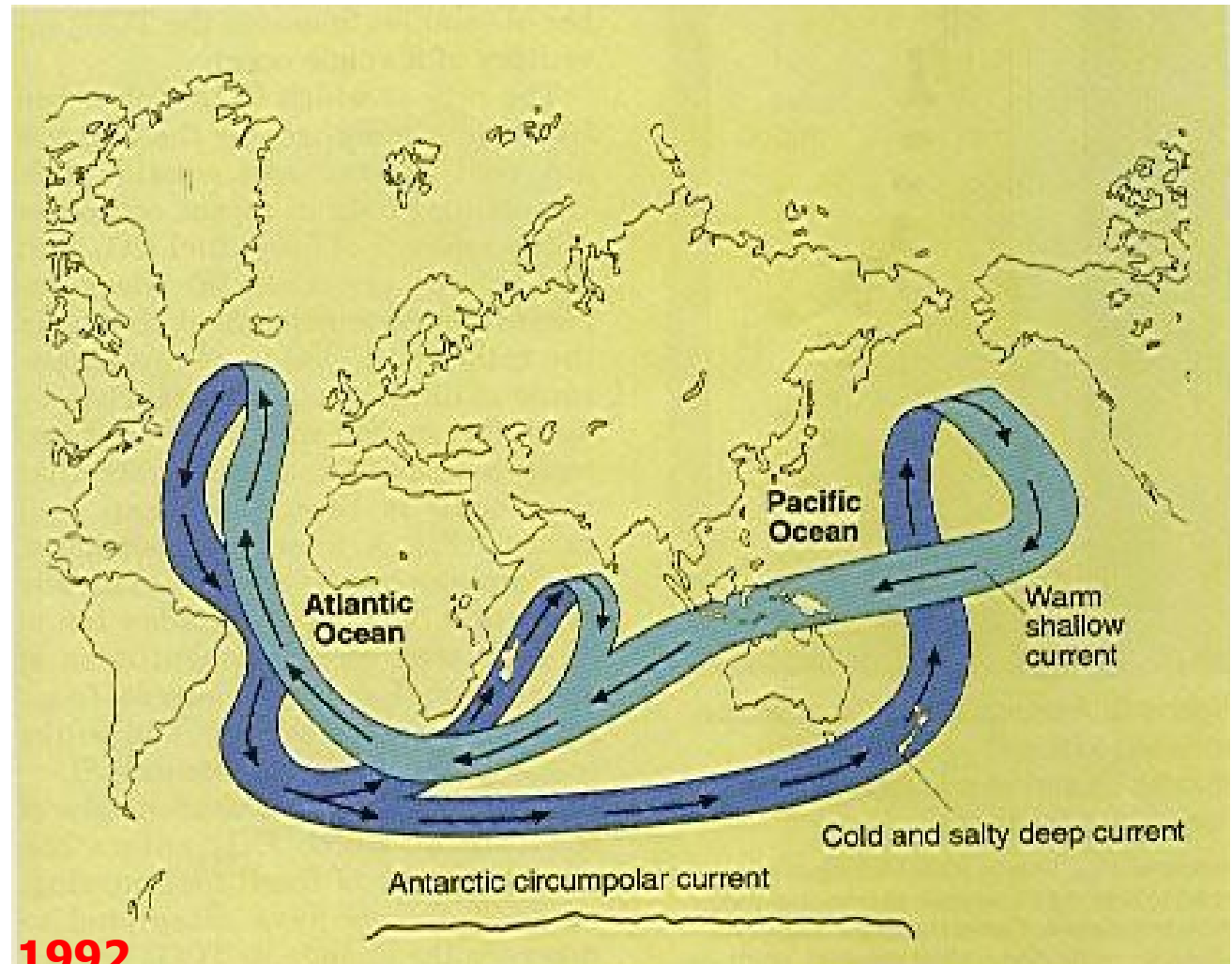
Potential Temperature



Salinity in Atlantic Ocean



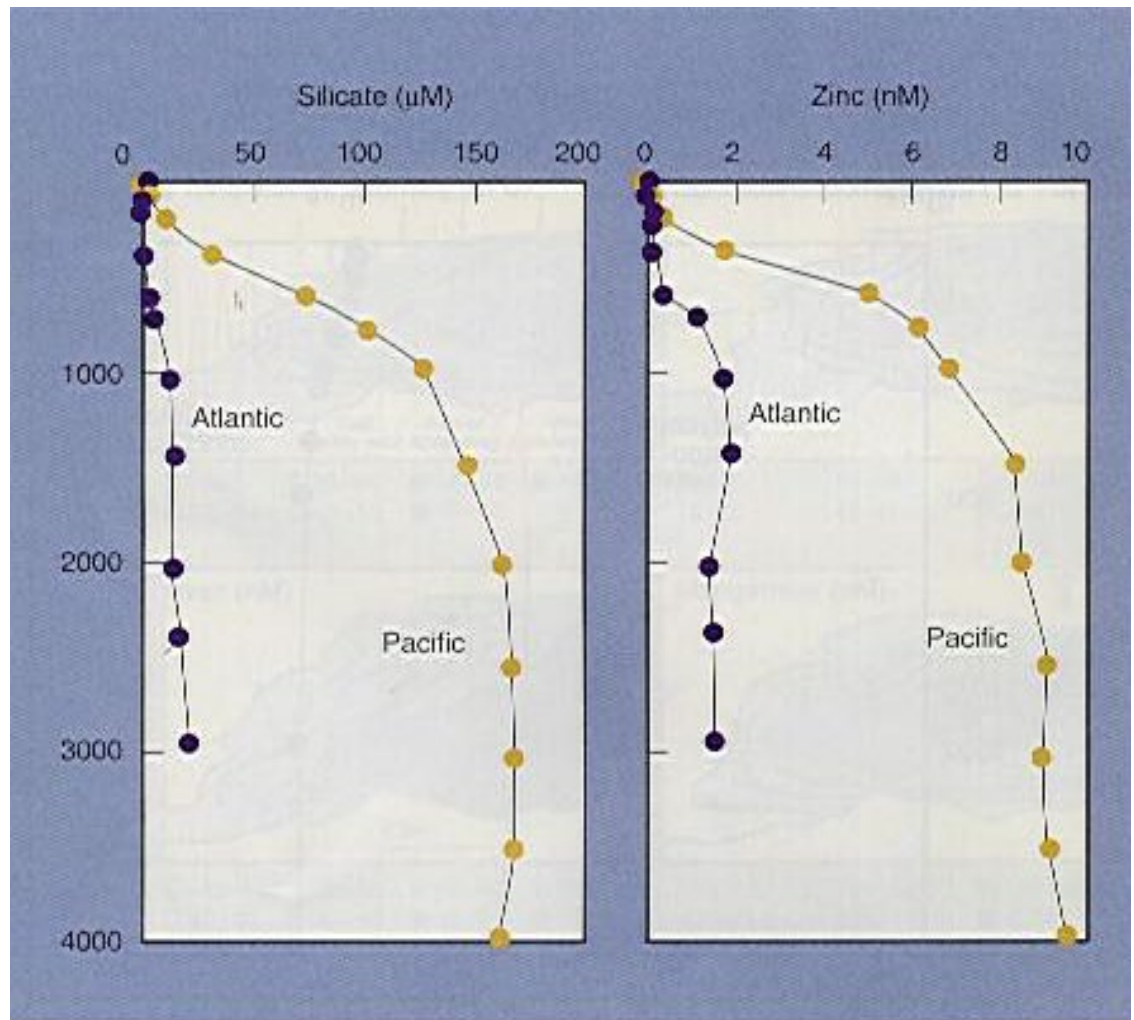
Ocean Currents



From Johnson et al., 1992

Depth profiles

- Atlantic vs
- Pacific



- 
-
- To next lecture