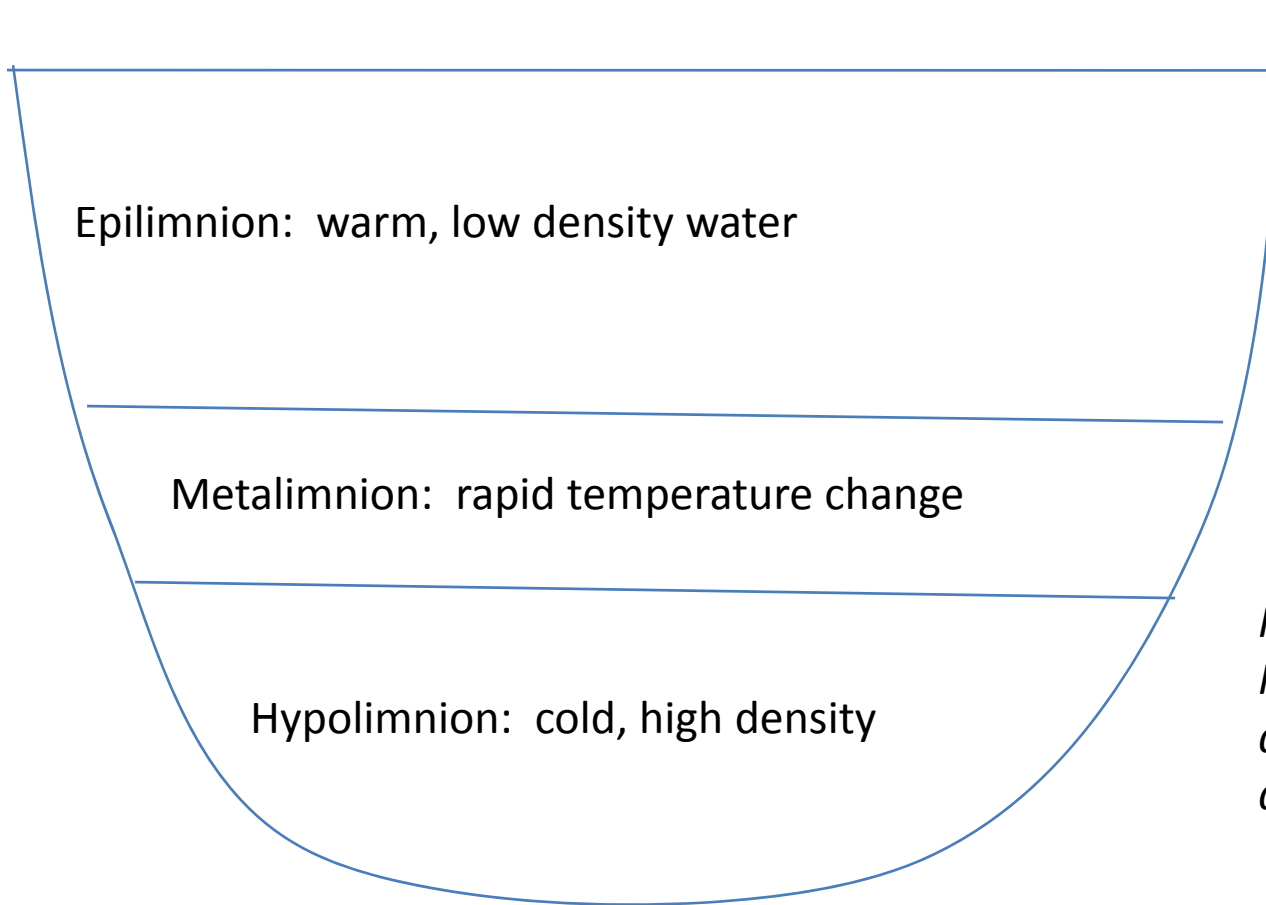


## Summary to this point:

### PHYSICAL PROCESSES

- Pooled water (lakes)
- Running water (streams)
- In between (ground and wetlands)
- Heat and light

# Lakes “in depth” (pun)

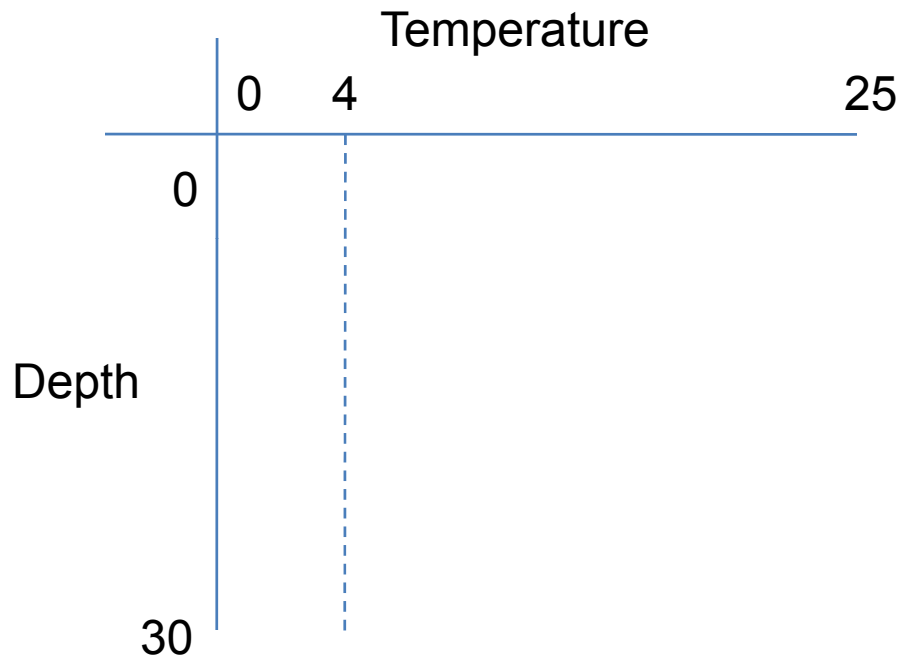
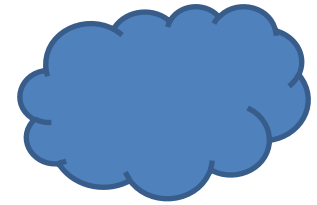


*Note:  
Not the same  
as photic and  
aphotic!!!!!!*

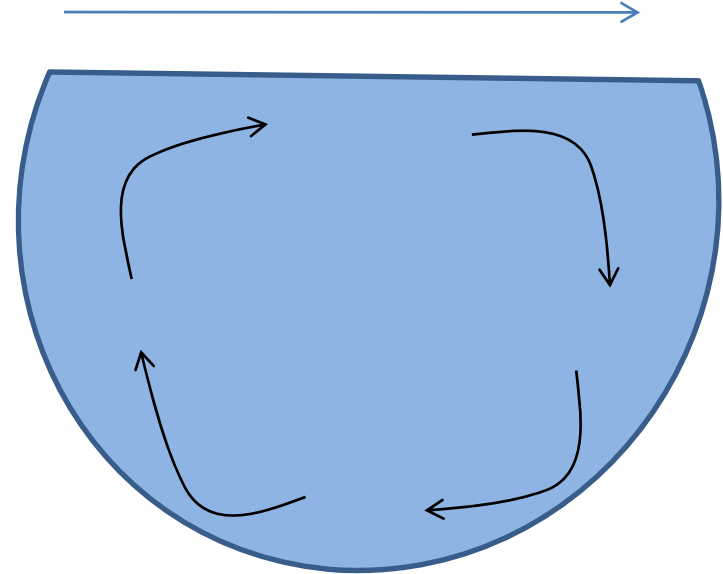
# Thermal Mixing

- Wind is primary mechanism
- Density gradient determines mixing between layers
  - 4°C difference requires some energy to mix
  - 24°C difference requires 30 x as much energy

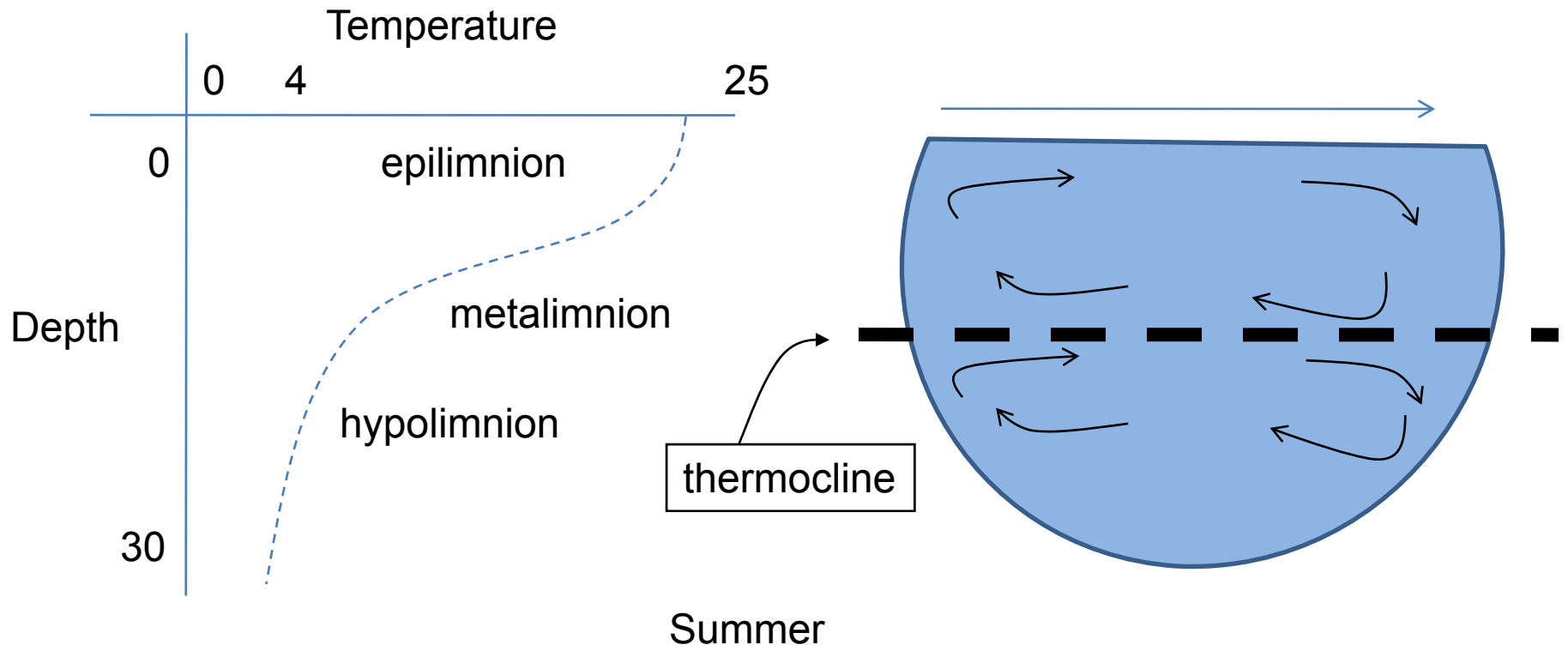
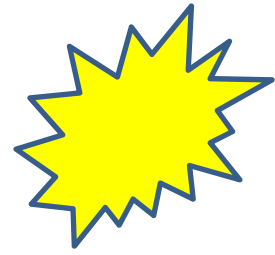
# Thermal Mixing



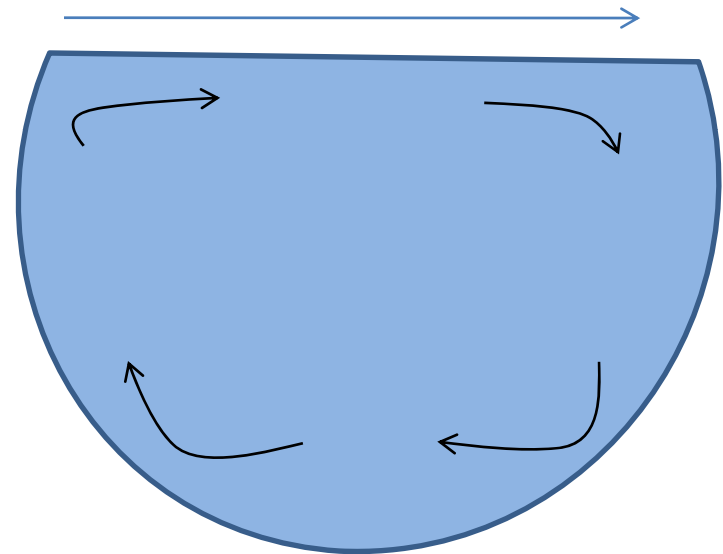
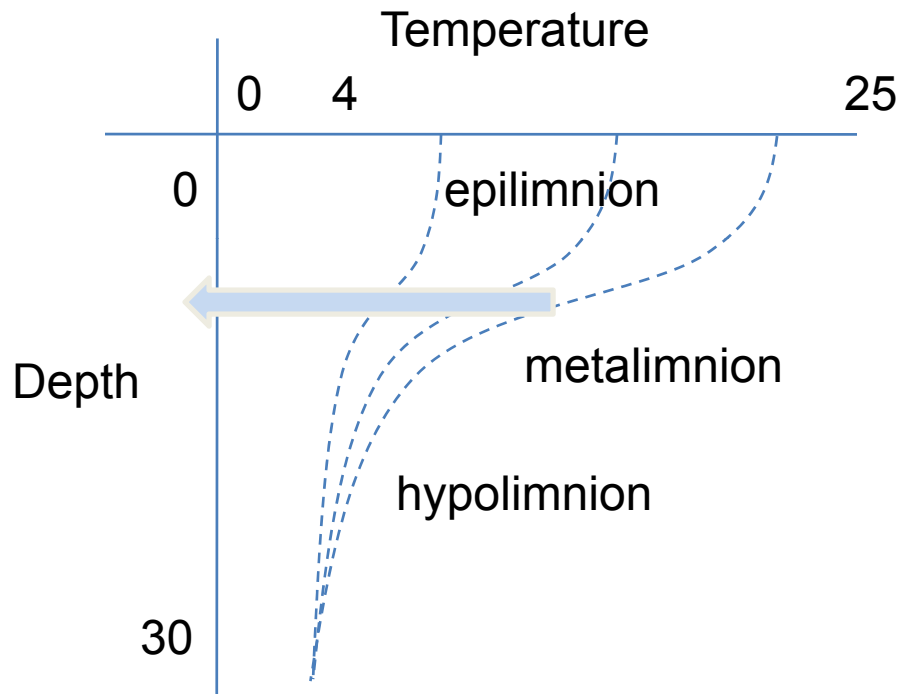
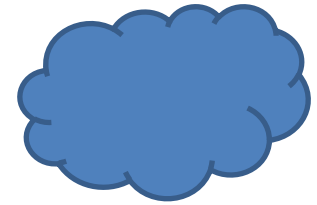
Spring



# Thermal Mixing

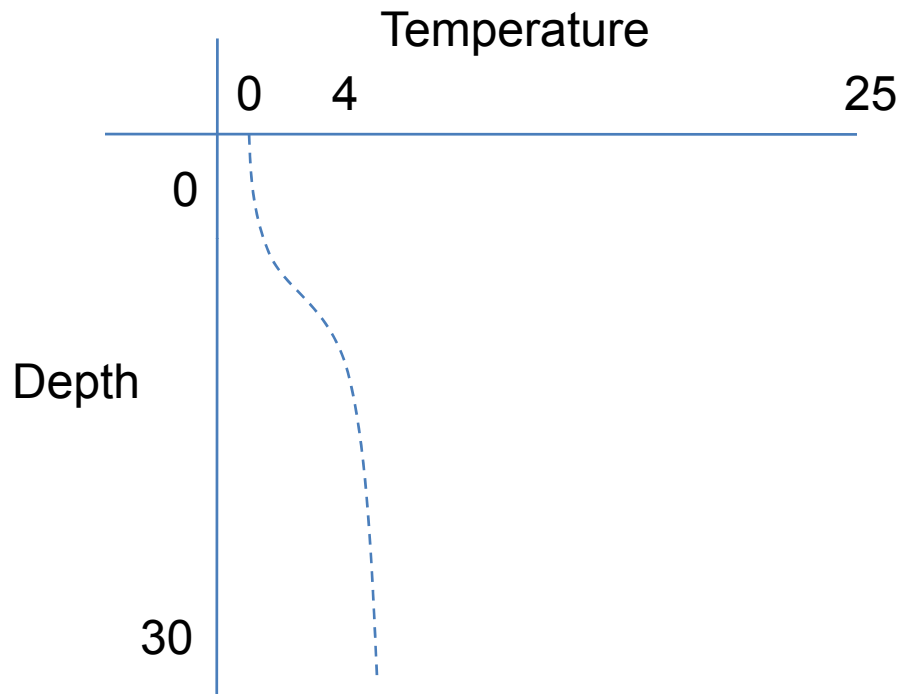
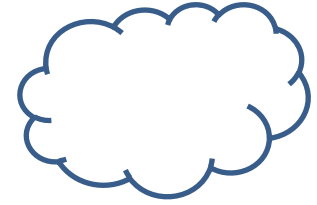


# Thermal Mixing

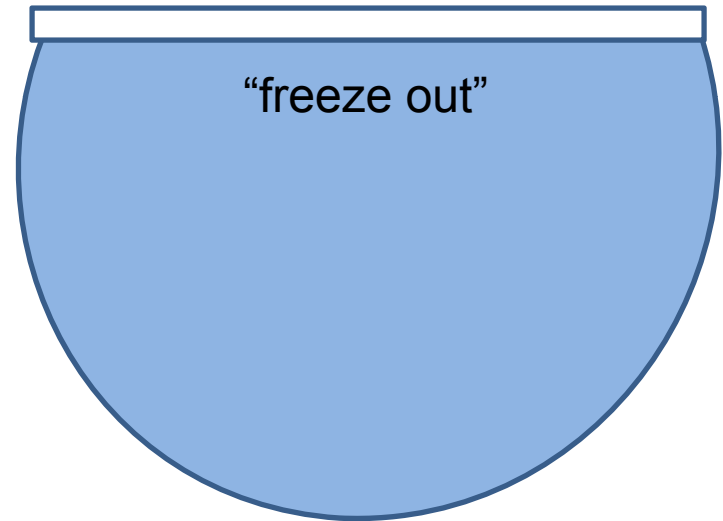


Fall

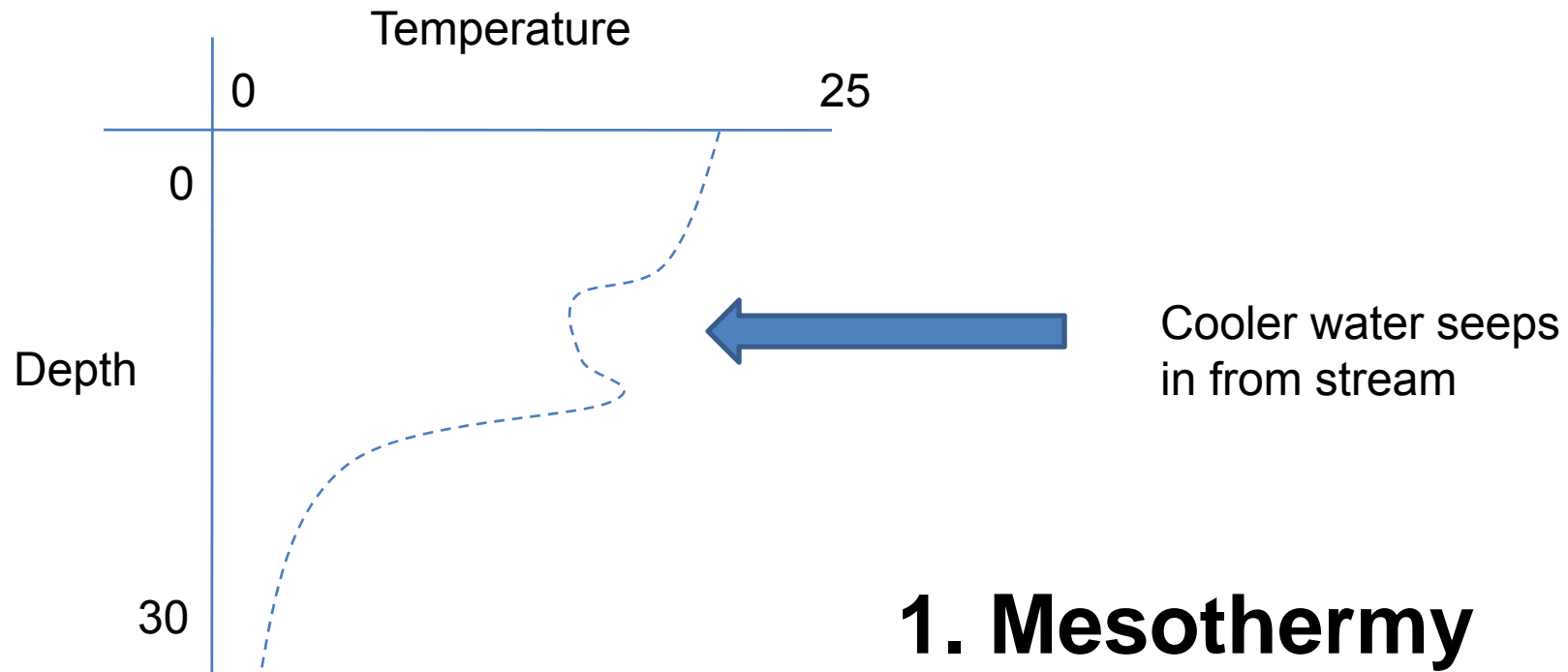
# Thermal Mixing



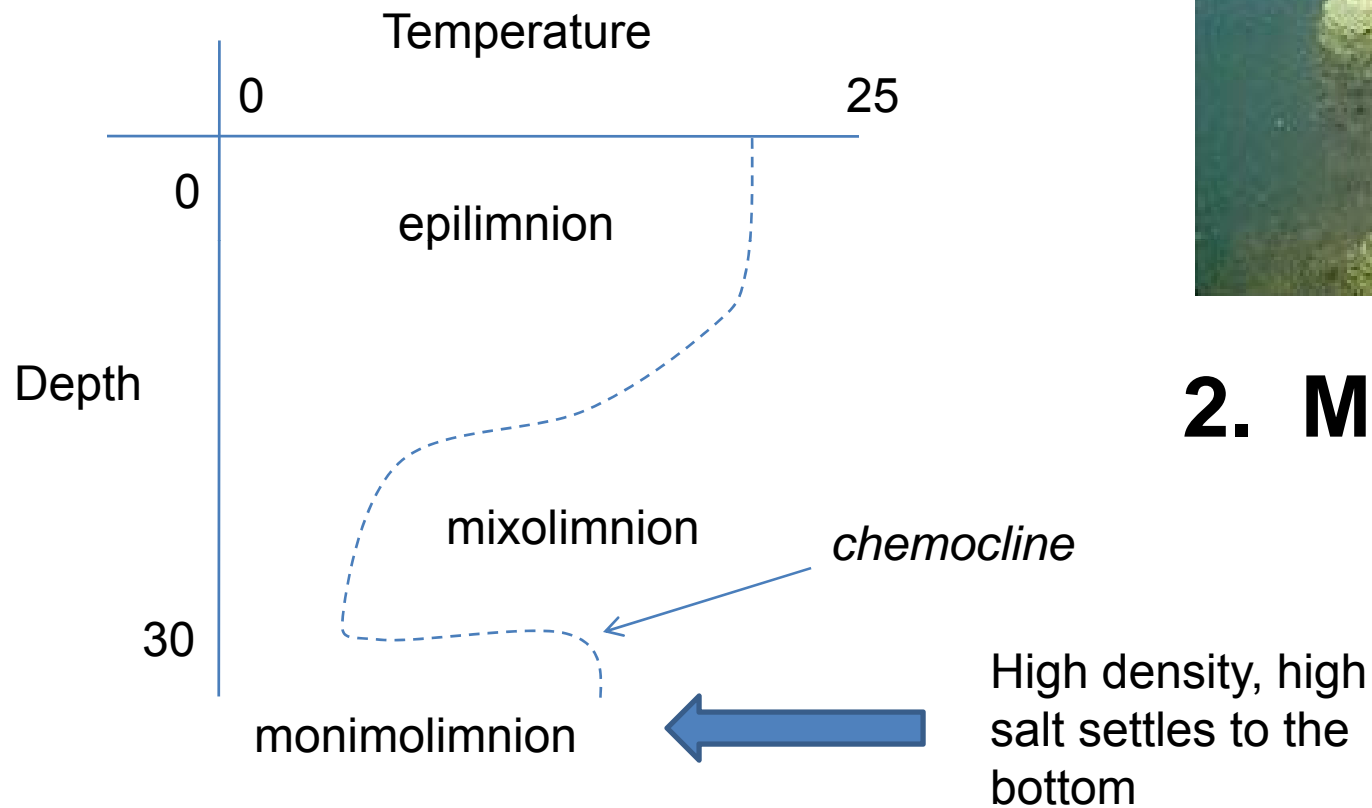
Winter



# Other Mixing



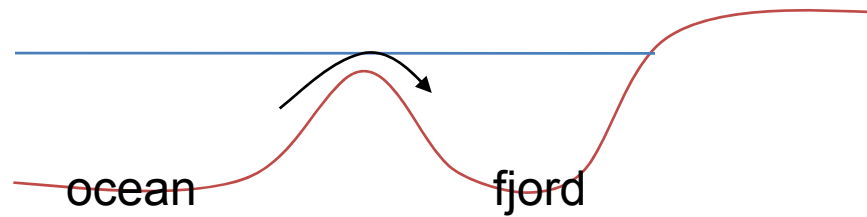
# Other Mixing



## 2. Meromixis

# Meromixis

## 1. Ectogenic Meromixis



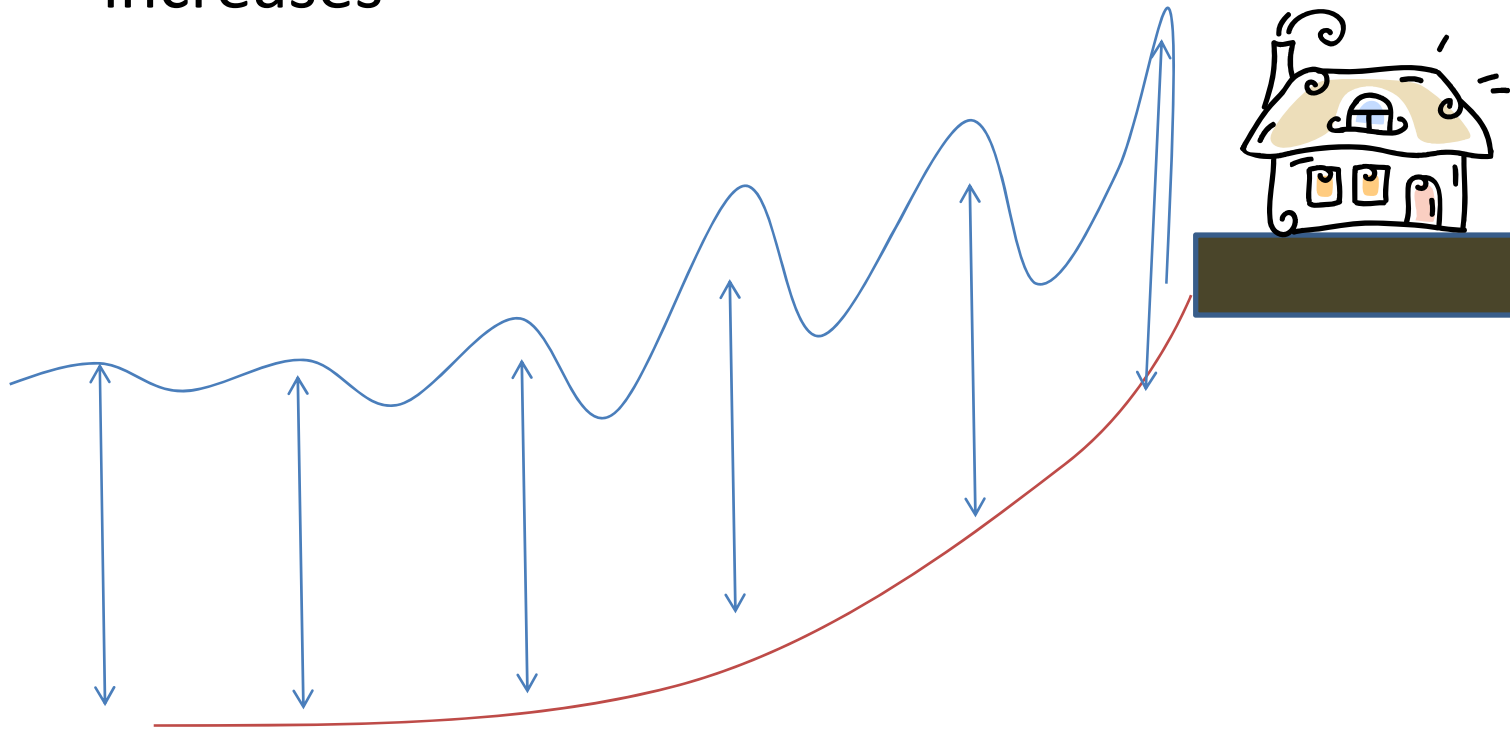
## 2. Crenogenic Meromixis (groundwater)

## 3. Biogenic Meromixis (decomposition)

## 4. Cryogenic Meromixis (freeze out)

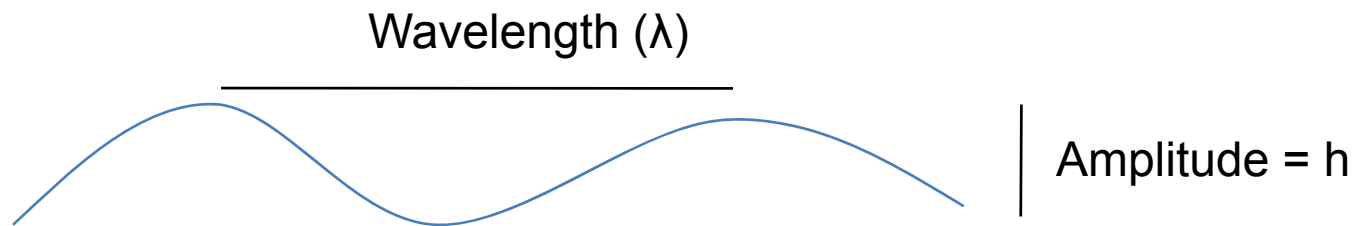
# Water Motion

- Surface Waves – interact with change in depth
  - As depth declines, the wave amplitude (height) increases



# Water Motion

- Surface waves



1. Gravity Wave  $\lambda \geq 6.28$  cm
2. Capillary Wave (Ripple)  $\lambda < 6.28$  cm
3. White Cap ratio of  $h:\lambda > 1:10$

# Water Motion

Height of highest wave:

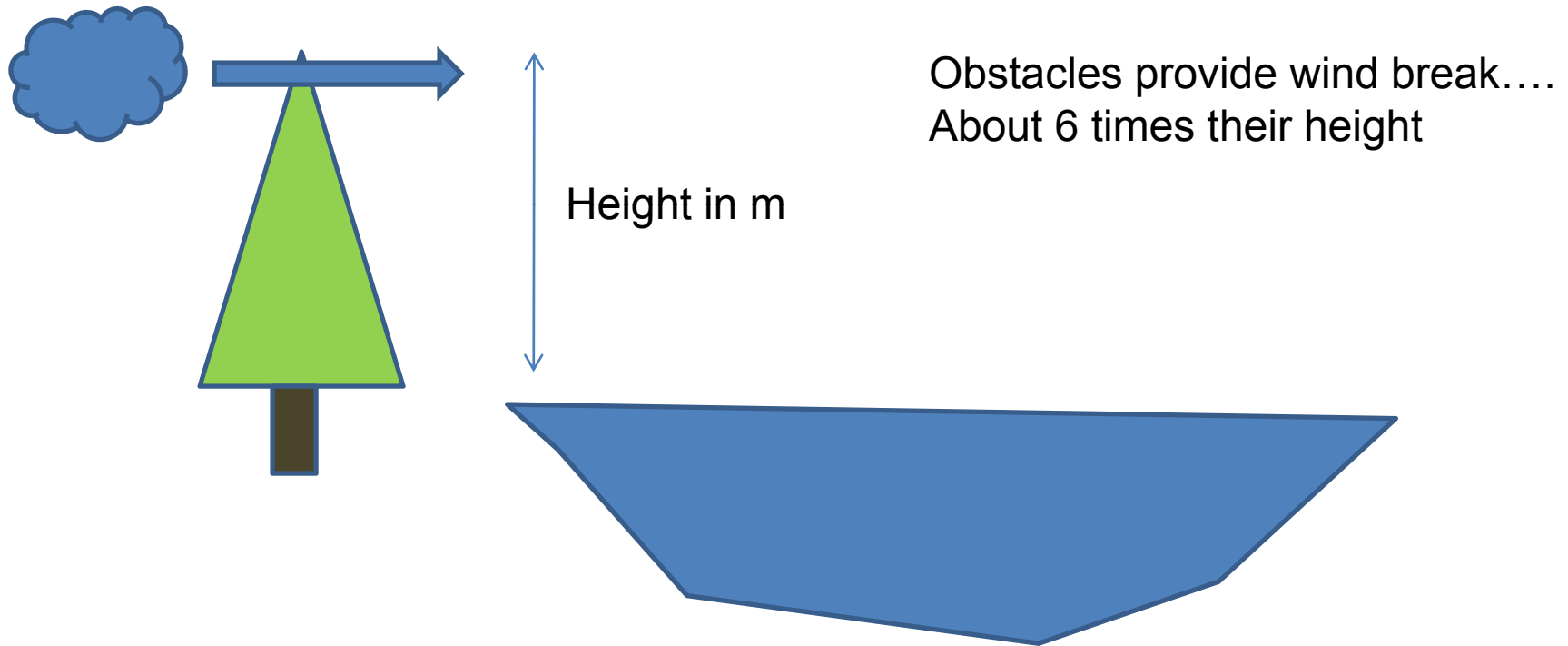
$$h = 0.105\sqrt{\textit{fetch}} \quad (\text{in cm})$$

Lake Superior

487 km fetch (or  $4.82 \times 10^7$  cm)

So 7.3 m theoretical maximum wave amplitude

# Water Motion



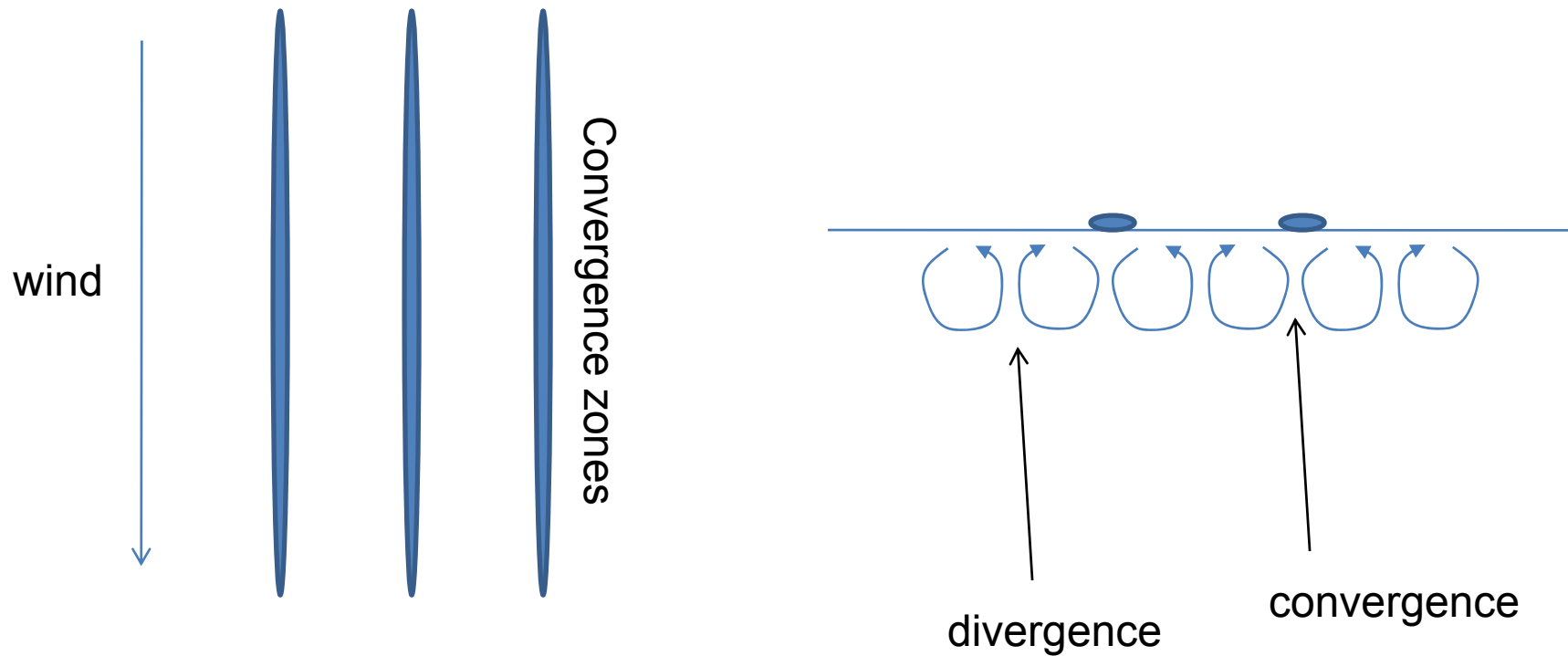
# Surface Dynamics

- What happens at the surface?
  - Wind - water velocity is about 2% of the wind velocity
  - Wind (and water) blows in predictable direction
    - Coriolis Effect (BIG SCALE)
      - 45° right in northern hemisphere (clockwise)
      - 45° left in southern hemisphere (counterclockwise)



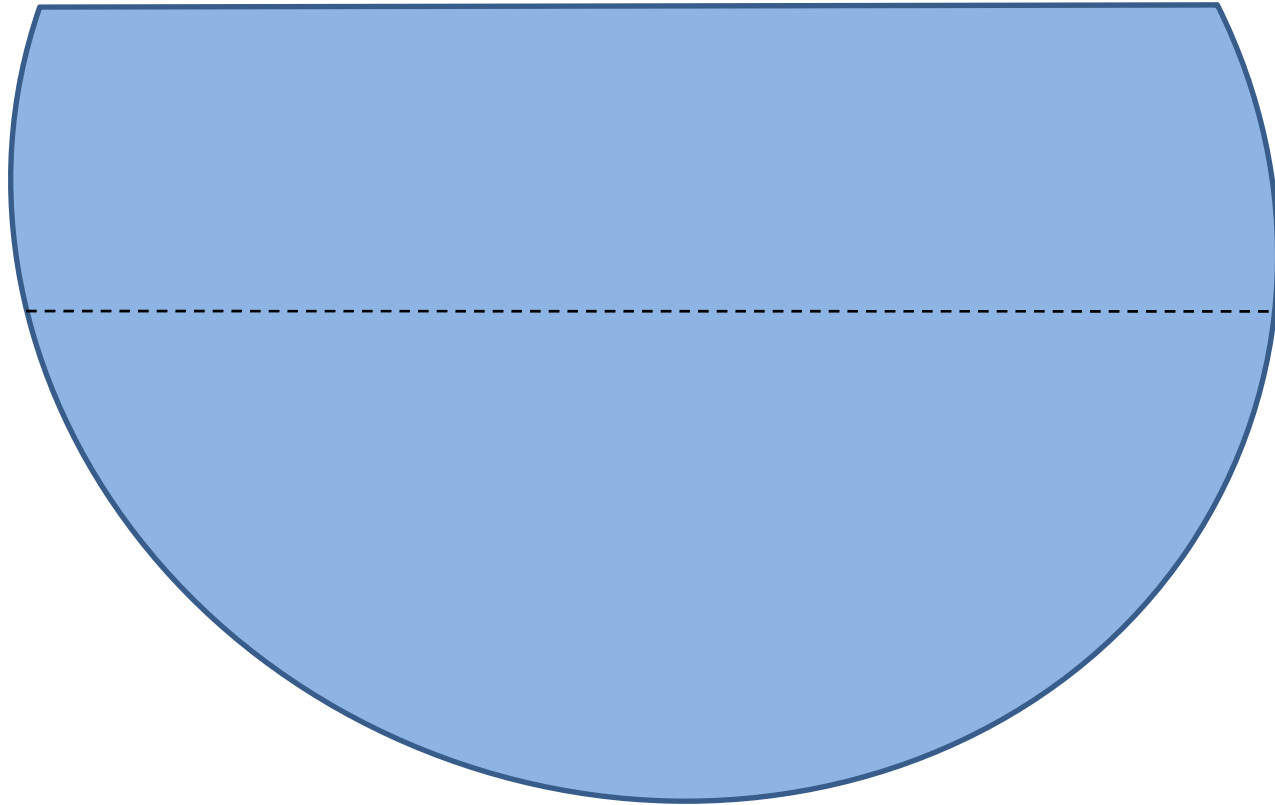
# Surface Dynamics

- Langmuir spirals (scale of meters)
  - Sustained wind in one direction



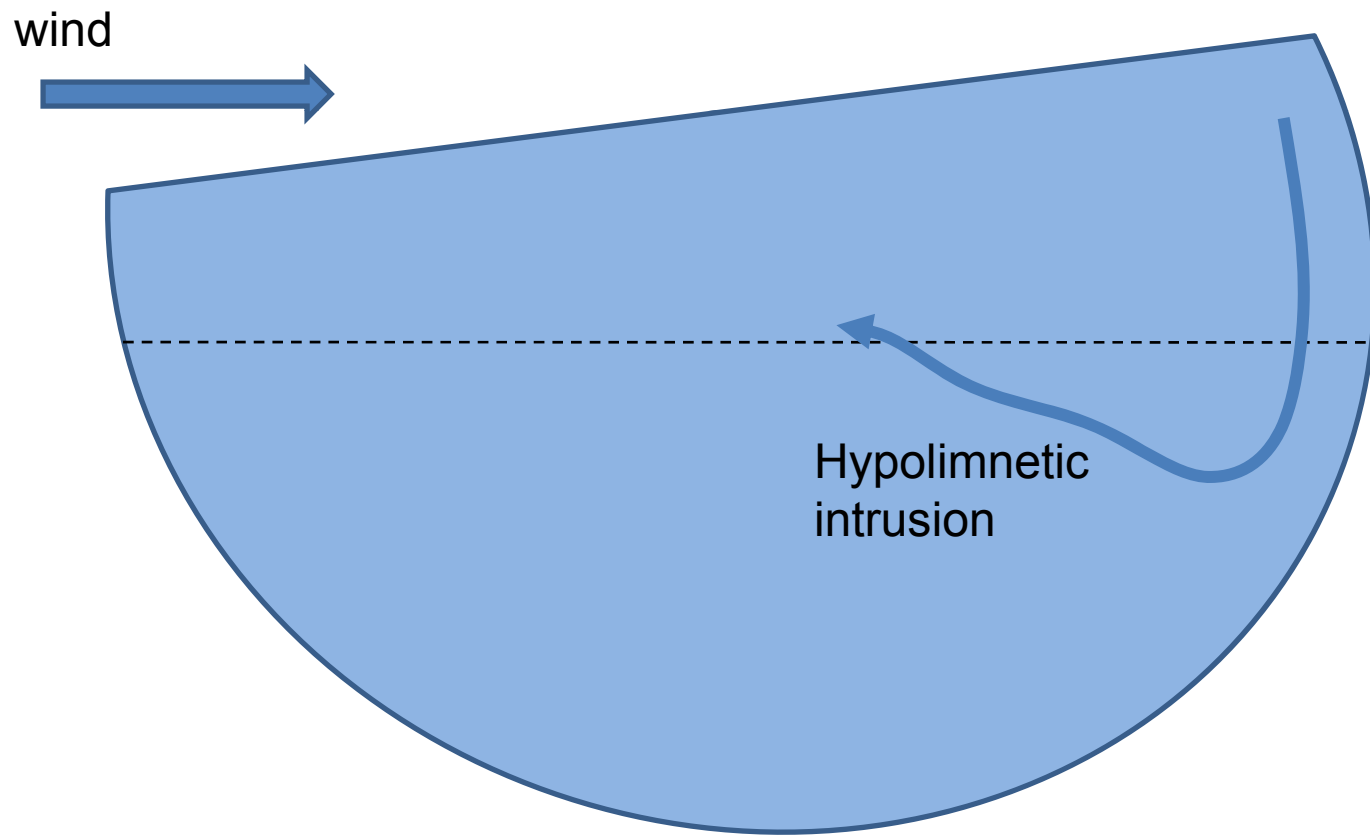
# Surface Dynamics

- The seiche



# Surface Dynamics

- The seiche

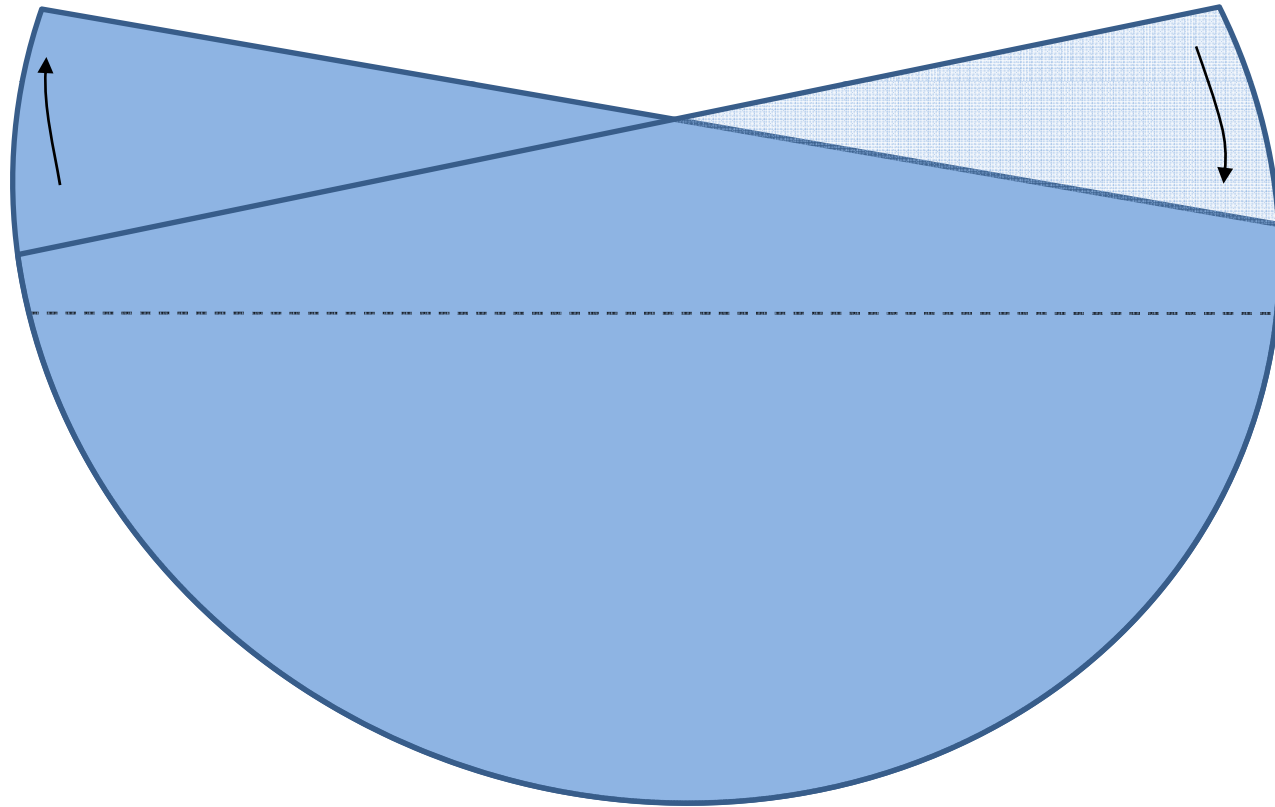


# Surface Dynamics

- The seiche

The surface will rock along central node

Wind  
stops



# Seiche

- Under some circumstances seiche can occur internally (not obvious at the surface)
- Seiche can influence nutrient dynamics and distribution of organisms