

CMECS California Workshop  
The Water Column (WCC)  
*A Work in PROGRESS*  
and with apology to Kathy and Chris

Toby Garfield  
SF State

- March 30, 2011
- State Building, Oakland, CA

# WATER COLUMN COMPONENT ISSUE TEAM



Water Column Component



Benthic Biotic Component



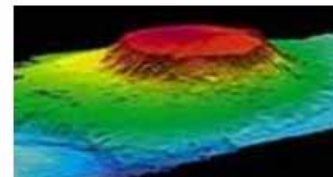
Surface Geology Component

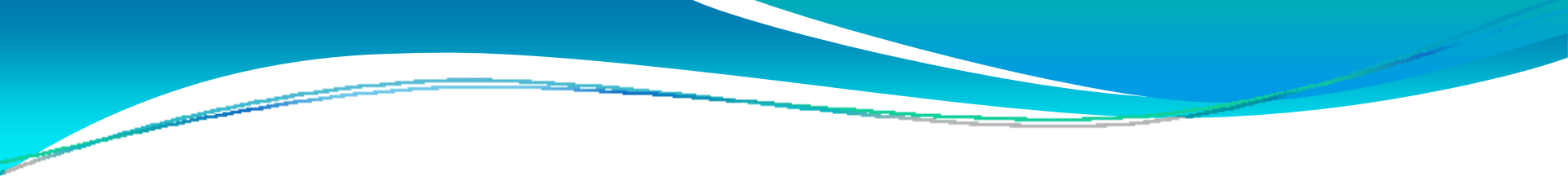


Sub-Benthic Component



GeoForm Component





Systems: three major based on salinity and enclosure  
subsystems are based on “distance from shore” and “depth”  
layers are based on depth  
hydroforms are based on “physics”

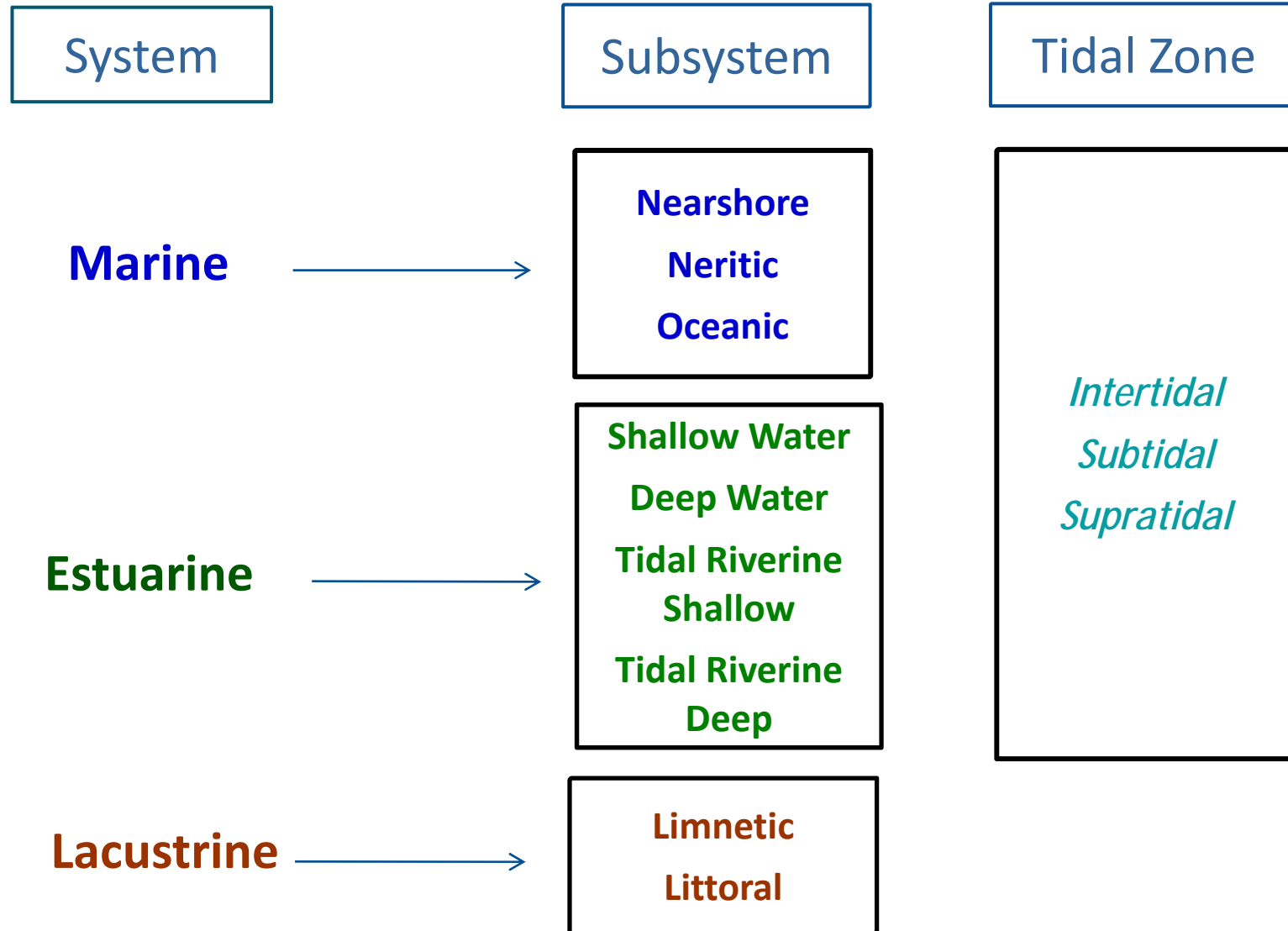
Systems:  
lacustrine (riverine)  
**estuarine**  
**marine**

Subsystems: (think distance from shore and total water depth)  
these are different for the different systems, but want boundaries  
to “match”

Layers:  
again, different for different systems and subsystems, but again want  
a degree of matching

Hydroforms:  
these are the physical modifiers which describe the water column.

# System and Subsystem: Distance from Shore



# Tidal Zones

## Subtidal

- substrate continuously submerged
- below Mean Lower Low Water (MLLW)

## Intertidal

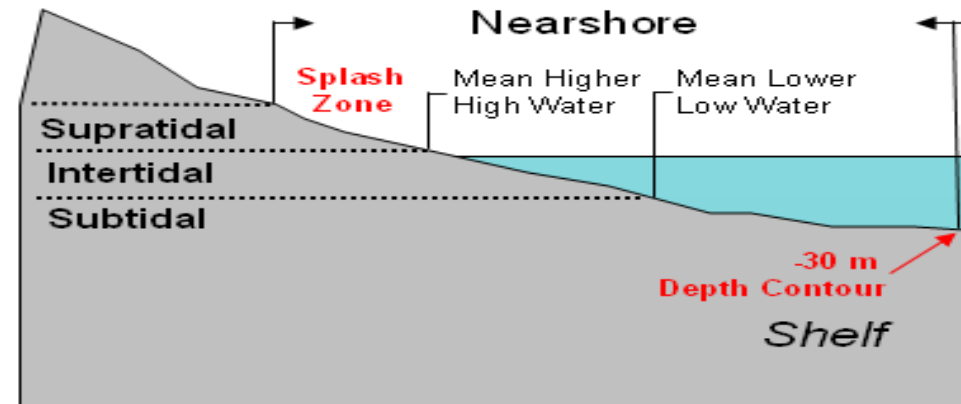
- substrate regularly and periodically exposed and flooded by tides
- from MLLW to the extent of tidal inundation, (i.e., the extreme high water of spring tides)
- exposed regularly to the air by tidal movement

## Supratidal

- areas above the extreme high water of spring tides that are affected by wave splash and overwash
- does not include areas affected only by wind-driven spray

## Examples

- Marine Nearshore Supratidal
- Estuarine Shallow Water Intertidal

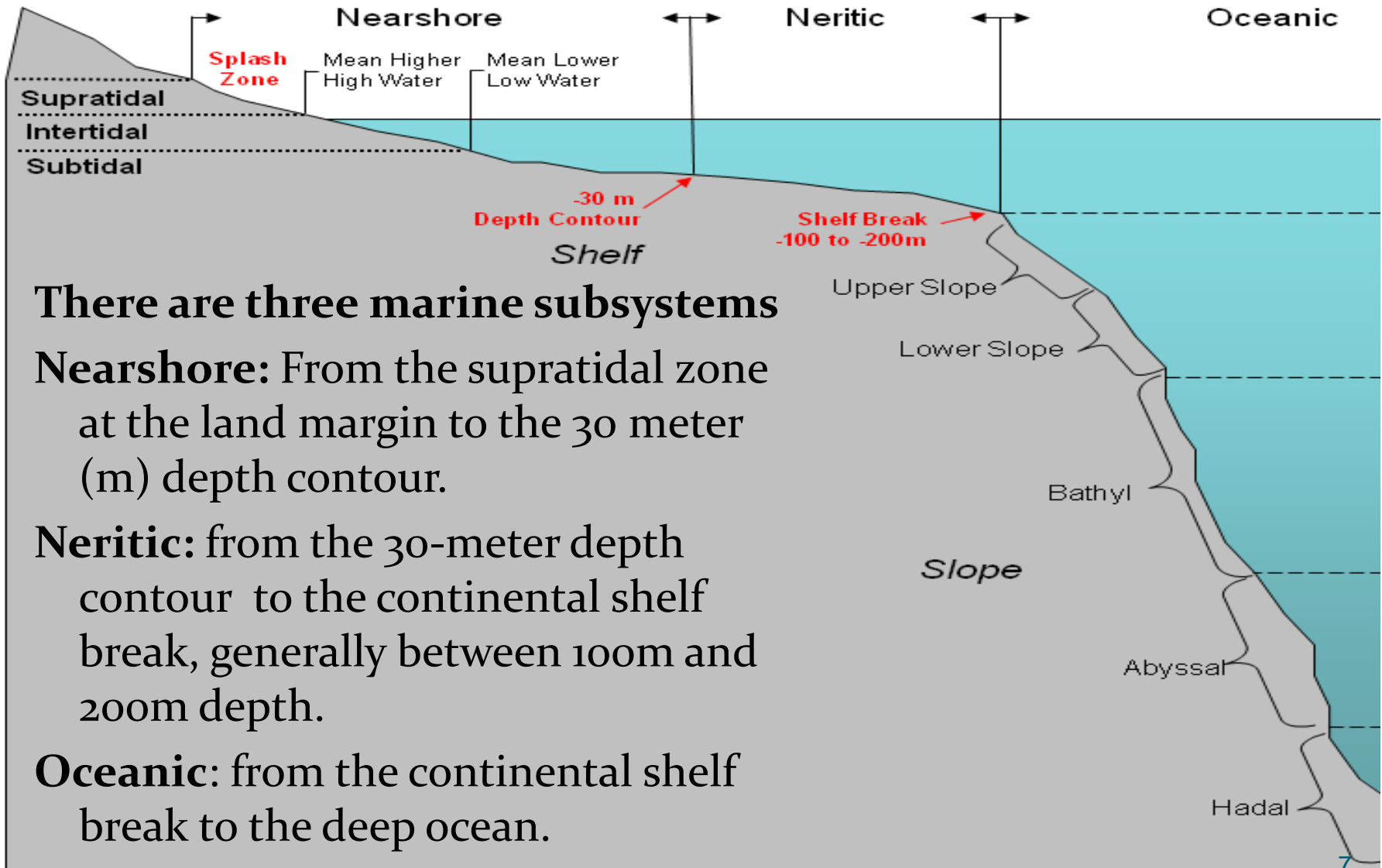


# Marine System

- All waters from the coastline to the open ocean
- **Landward limit:** Extreme high water of spring tides, including the supratidal splash zone
- **Estuarine limit:** From the mouth of estuaries seaward
- **Salinities:** typically exceed 30, often with little or no dilution except outside the mouths of estuaries
- **Includes:**
  - Shallow coastal indentations or bays without appreciable freshwater inflow
  - Coasts protected by rocky islands
  - Freshwater plumes, seeps, lenses (identified w' modifiers)



# Marine Subsystems



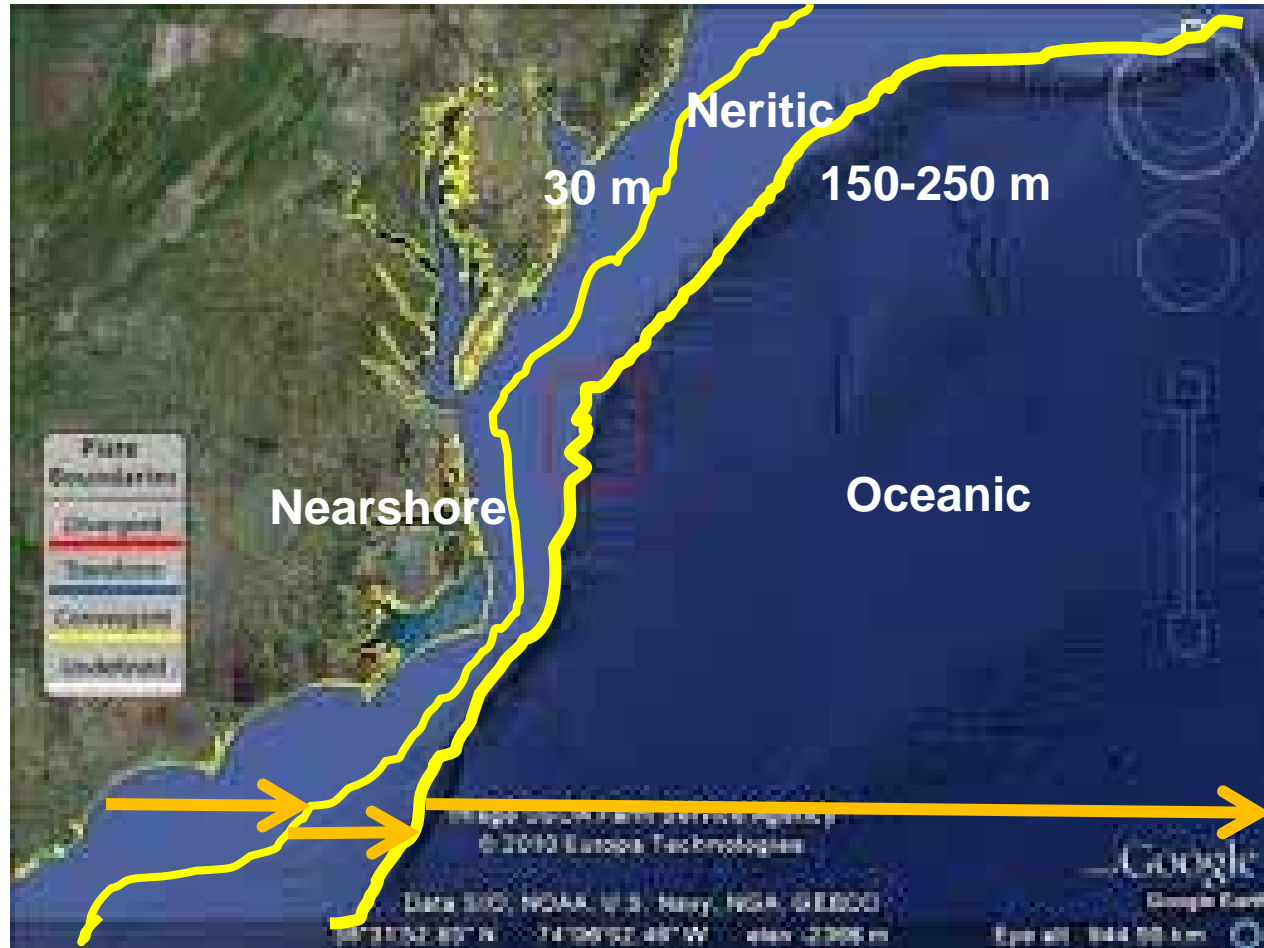
**There are three marine subsystems**

**Nearshore:** From the supratidal zone at the land margin to the 30 meter (m) depth contour.

**Neritic:** from the 30-meter depth contour to the continental shelf break, generally between 100m and 200m depth.

**Oceanic:** from the continental shelf break to the deep ocean.

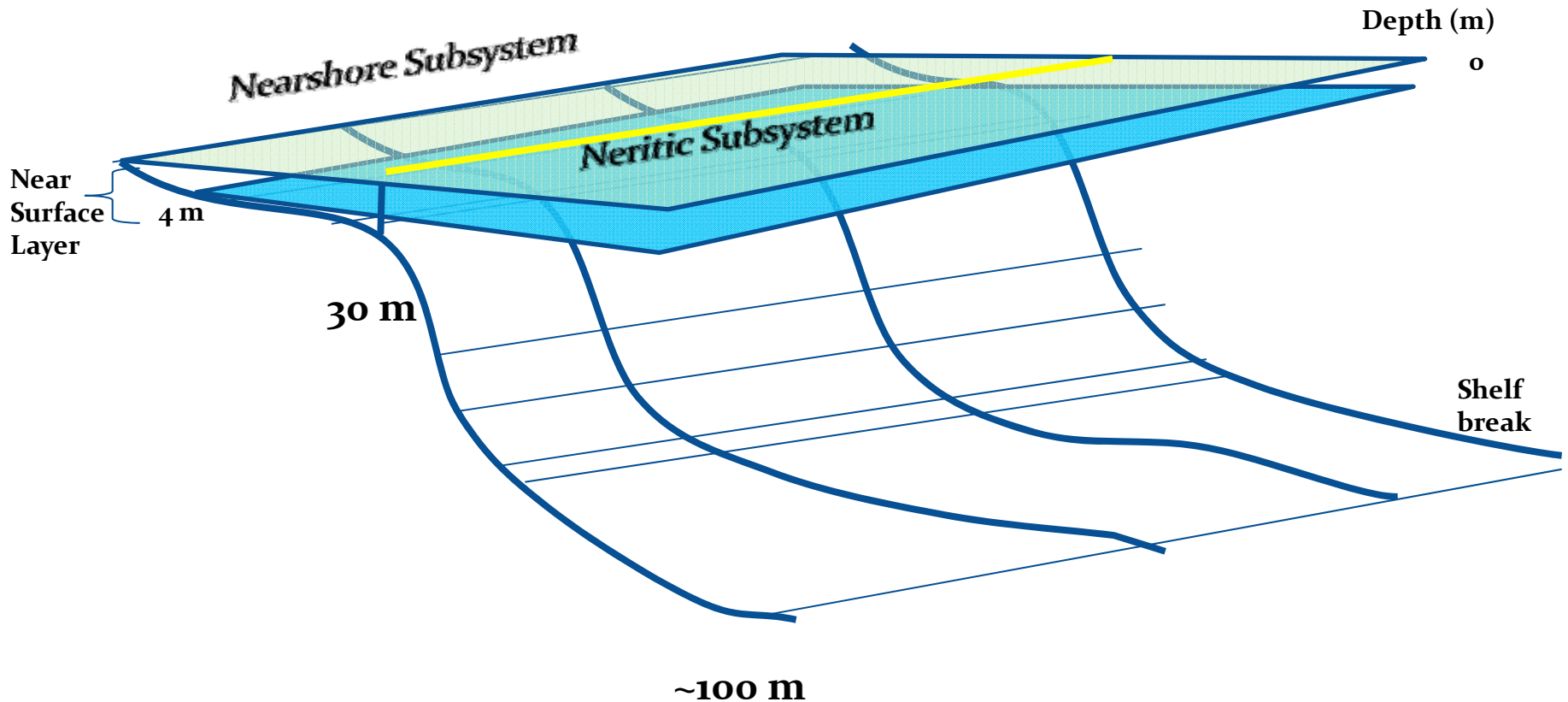
# Marine Subsystems Horizontal Structure





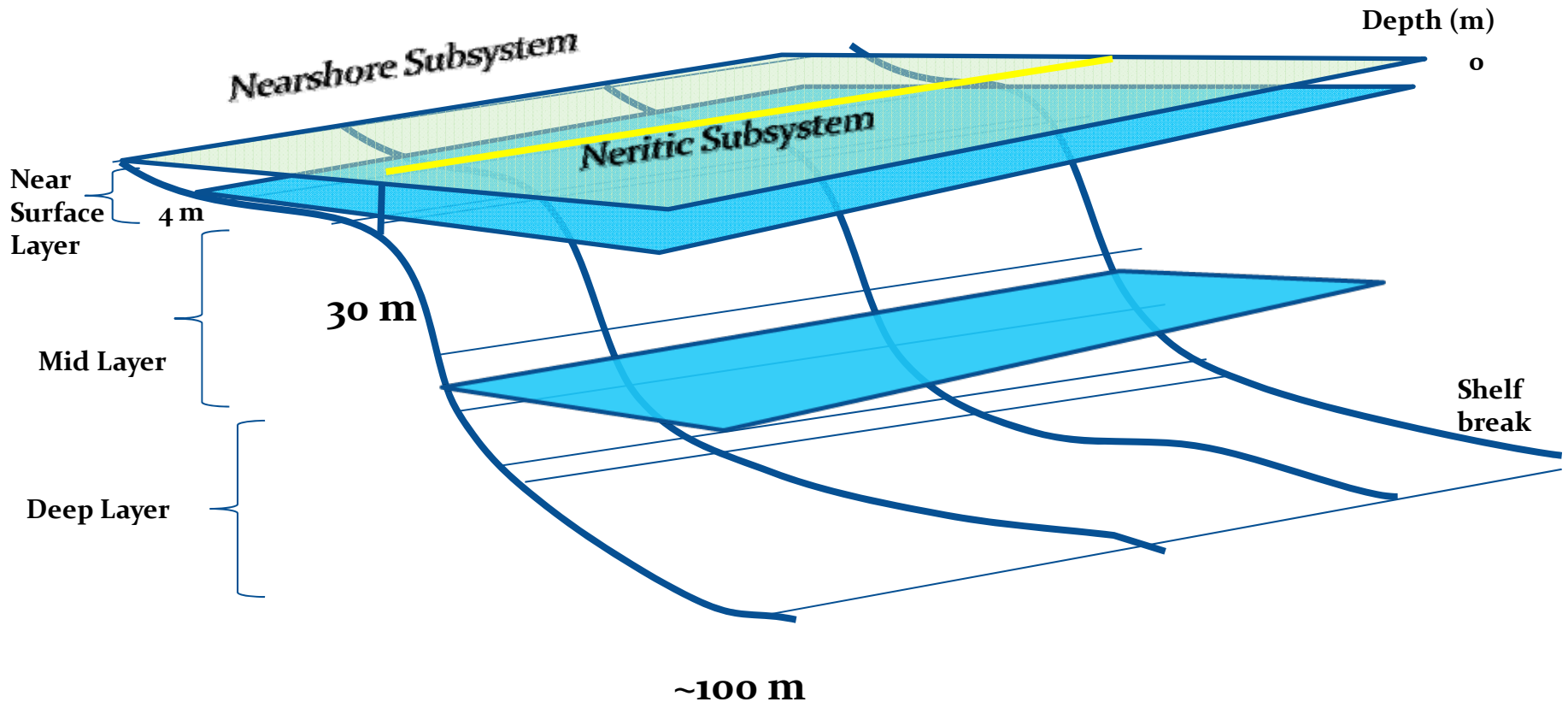
# WATER COLUMN COMPONENT STRUCTURE

## Nearshore and Neritic Layers



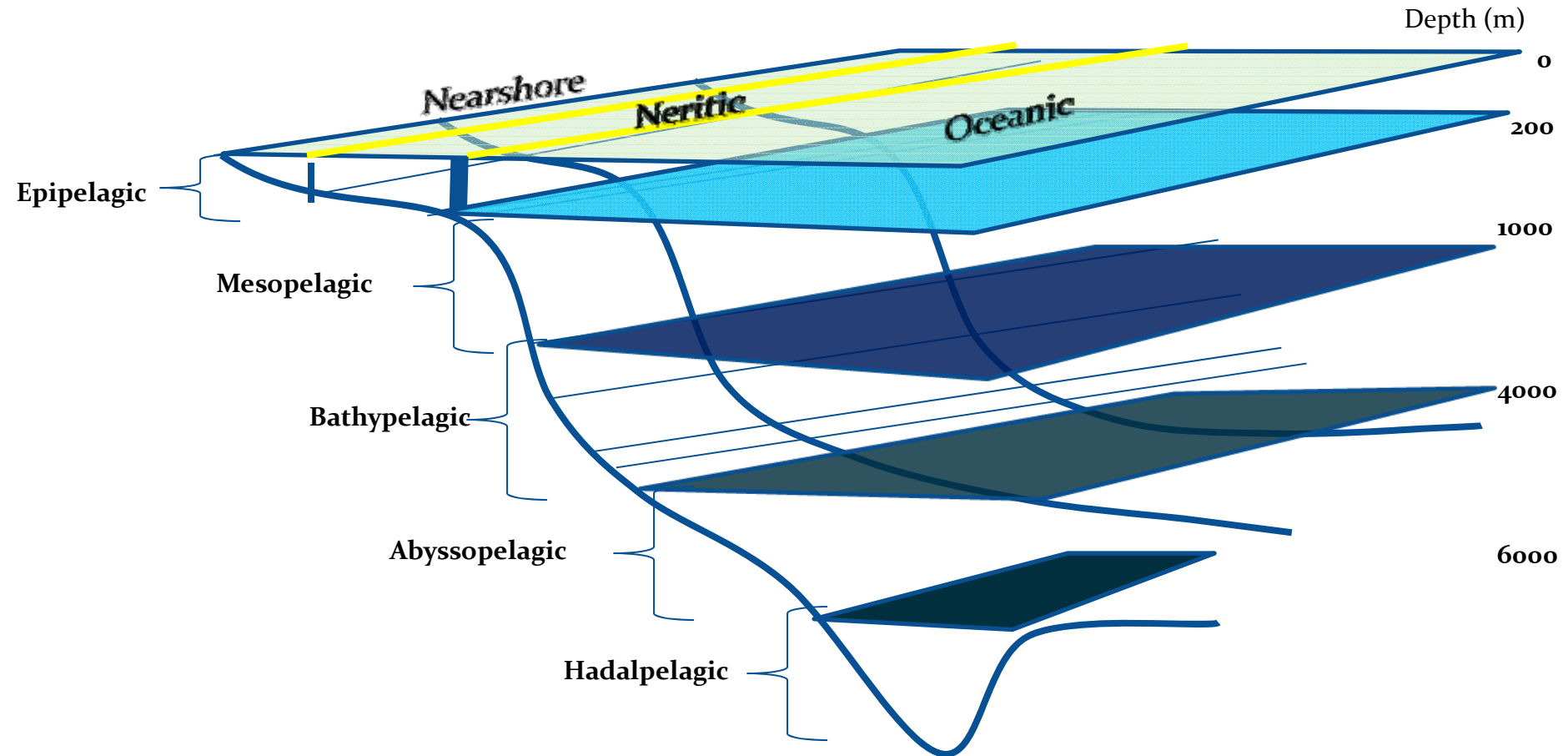
# WATER COLUMN COMPONENT STRUCTURE

## Nearshore and Neritic Layers



# WATER COLUMN COMPONENT STRUCTURE

## Oceanic Layers



# Water Column Component (WCC)

- Describes the structures, patterns and processes of the water column
- Three Subcomponents
  - Depth zones
  - Hydroforms and subforms
  - Biotic Groups & Biotopes
- Modifiers
  - salinity, temperature, etc.





# Hydroforms and Subforms

- Coherent, definable hydromorphic structure with identifiable boundaries and characteristic physical properties
  - Plumes
  - Gyres
  - Eddies
  - Currents
- They vary extensively in size, volume, areal extent, persistence, and ecological significance.



# Original WCC Hydroforms

- Eddy [ED]
- Gyre [GY]
- Downwelling [DW]
- Upwelling [UW]
- Intrusion [IN]
- Current [CT]
- Wave [WV]
- Frontal Boundary [FB]
- Horizontal Layer [HL]
- Ice [IC]
- Surf Zone [SZ]
- Water Mass [WM]




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## Water Column (WCC) Component

Drill down to browse hierarchy. Click link for description.

<ul style="list-style-type: none"> <li>- WCC Depth Zone             <ul style="list-style-type: none"> <li>- Marine Nearshore (Subsystem)                 <ul style="list-style-type: none"> <li>... Marine Nearshore Shallow Zone</li> <li>... Marine Nearshore Deep Zone</li> </ul> </li> <li>- Marine Neritic (Subsystem)                 <ul style="list-style-type: none"> <li>... Marine Neritic Shallow Zone</li> <li>... Marine Neritic Deep Zone</li> </ul> </li> <li>- Marine Oceanic (Subsystem)                 <ul style="list-style-type: none"> <li>... Marine Oceanic Epipelagic Zone</li> <li>... Marine Oceanic Mesopelagic Zone</li> <li>... Marine Oceanic Bathypelagic Zone</li> <li>... Marine Oceanic Abyssopelagic Zone</li> <li>... Marine Oceanic Hadalpelagic Zone</li> </ul> </li> <li>+ Estuarine Shallow Water (Subsystem)</li> <li>+ Estuarine Deep Water (Subsystem)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- WCC Hydroform             <ul style="list-style-type: none"> <li>+ Current</li> <li>... Downwelling</li> <li>- Eddy                 <ul style="list-style-type: none"> <li>... Cold Core Ring</li> <li>... Mesoscale eddy</li> <li>... Warm Core Ring</li> </ul> </li> <li>+ Frontal Boundary</li> <li>+ Gyre</li> <li>+ Horizontal Layer</li> <li>- Ice</li> <li>- <b>Intrusion</b> <ul style="list-style-type: none"> <li>... Freshwater Plume</li> <li>... Fumerole</li> <li>... Hydrothermal Plume</li> <li>... Seep</li> <li>... Turbidity Plume</li> </ul> </li> <li>... Surf Zone</li> <li>... Downwelling</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- WCC Biotic Group             <ul style="list-style-type: none"> <li>... Demersal Fish (Schools)</li> <li>... Floating Microbial Mat</li> <li>... Floating Vascular Vegetation</li> <li>... Floating/Drift Macroalgae</li> <li>... Jellyfish Aggregations (Smacks)</li> <li>... Kelp Forest (Water Surrounding Stipe and Blades)</li> <li>... Pelagic Fish (Schools)</li> <li>... Phytoplankton Bloom</li> <li>... Seagrass Meadow (Water Surrounding Grass Blades)</li> <li>... Surf Foam/Surface Foam</li> <li>... Vent Community</li> <li>... Whale Aggregations (Pods)</li> <li>... Zooplankton Aggregation</li> </ul> </li> </ul>
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# Proposed Hydroform Arrangement

- Current
  - Wind-driven
  - Tidal front and gyre
  - Buoyancy flow (river plumes, winter water masses)
  - Wave-driven current (longshore, rip currents, undertows)
- Wave
  - Surface wind waves
  - Surface swell
  - Internal waves
  - Surf zone
  - Edge waves
  - Storm surge
  - Tsunami
- Tide
  - Tidal range
  - Tidal type (semi-diurnal, diurnal, mixed)
- Water Mass (with descriptors)
  - Temperature
  - Salinity
  - DO
  - Light





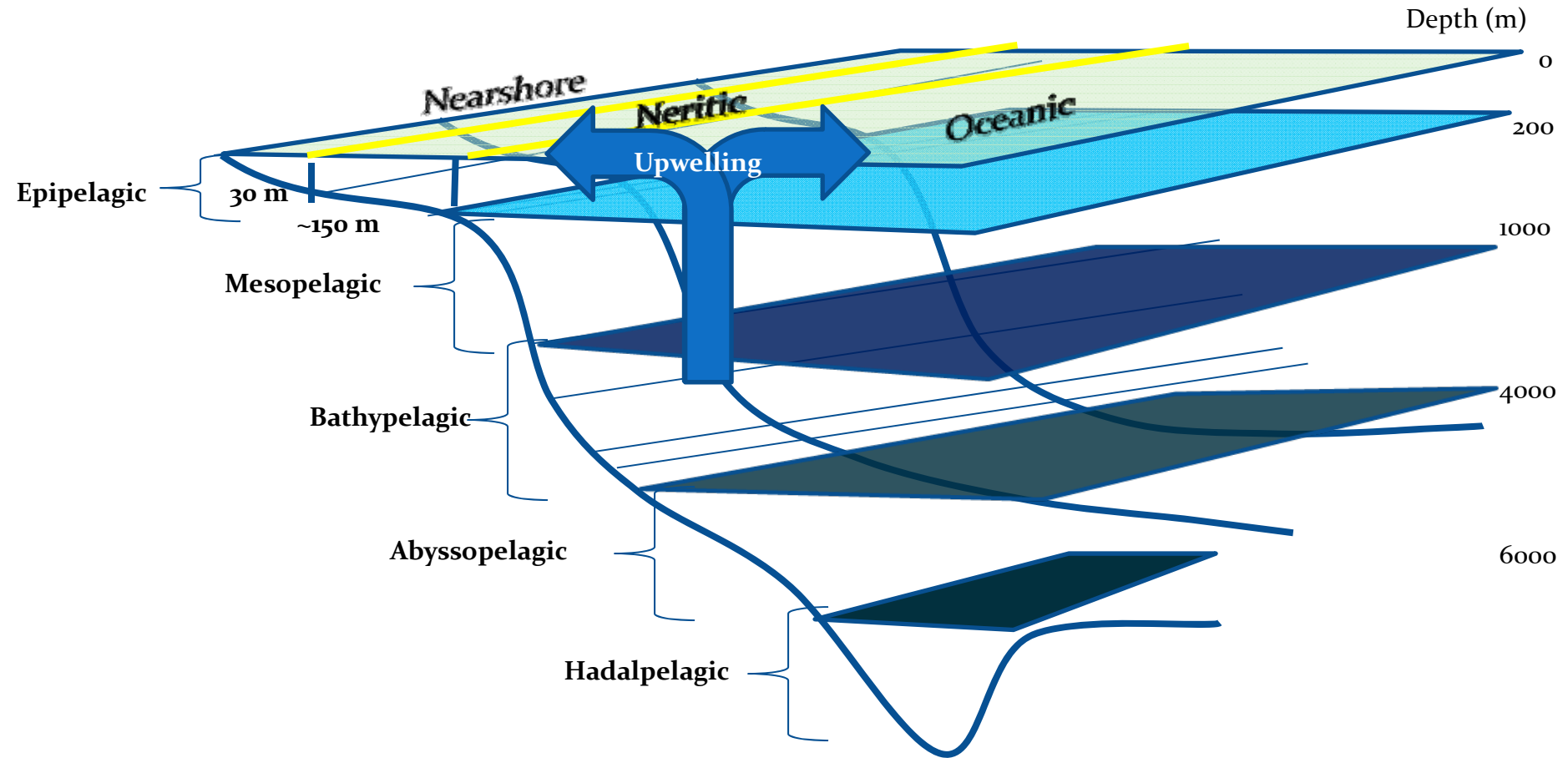
# Hydroform Proposed Rearrangement

## NEARSHORE

- Current
  - Wind-driven
  - Tidal front and gyre
  - Buoyancy flow (river plumes, winter water masses)
  - Wave-driven current (longshore, rip currents, undertows)
- Wave
  - Surface wind waves
  - Surface swell
  - Internal waves
  - Surf zone
  - Edge waves
  - Storm surge
  - Tsunami
- Tide
  - Tidal range
  - Tidal type (semi-diurnal, diurnal, mixed)

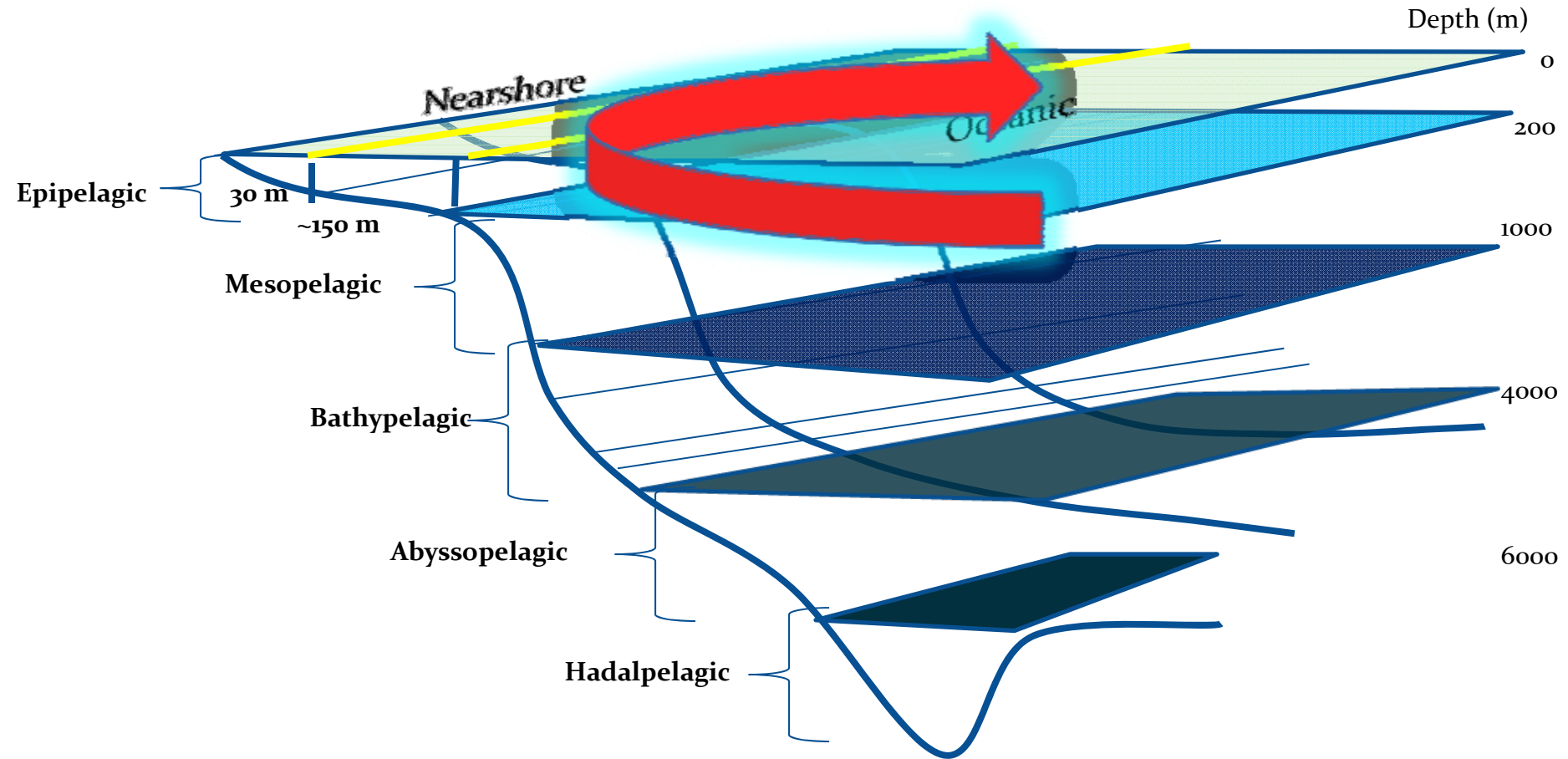
# WATER COLUMN COMPONENT STRUCTURE

## Hydroforms and Subforms



# WATER COLUMN COMPONENT STRUCTURE

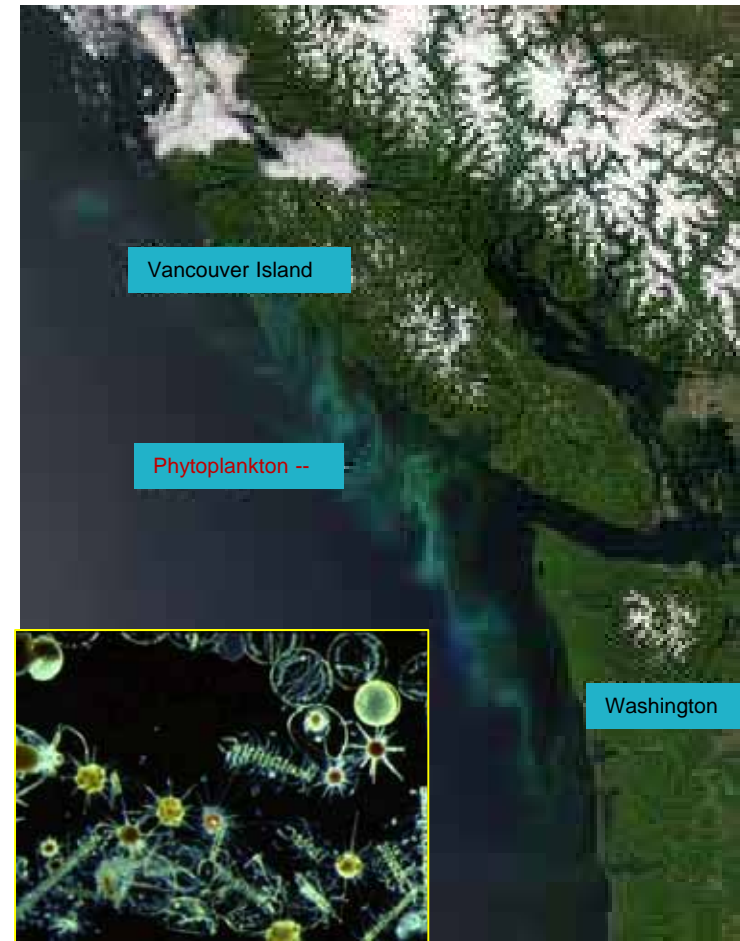
## Hydroforms and Subforms



# WCC Biotic Group

Floating or suspended aggregations of biota defined by the dominant life form or informal taxonomic or functional groupings. Patterns and distributions are determined by and associated with water column structure and dynamics and the physico-chemical components of the water column.

- *Phytoplankton Bloom*
- *Zooplankton Aggregation*
- *Floating Microbial Mat*
- *Floating/Drift Macroalgae*
- *Floating Vascular Vegetation*
- *Jellyfish Aggregations (Smacks)*
- *Vent Community*
- *Surf Foam/Surface Foam*
- *Whale Aggregations (Pods)?*
- *Pelagic Fish (Schools)?*
- *Demersal Fish (Schools)?*
- ~~*Seagrass Meadow (Water Surrounding Grass Blades)*~~
- ~~*Kelp Forest (Water Surrounding Stipe and Blades)*~~



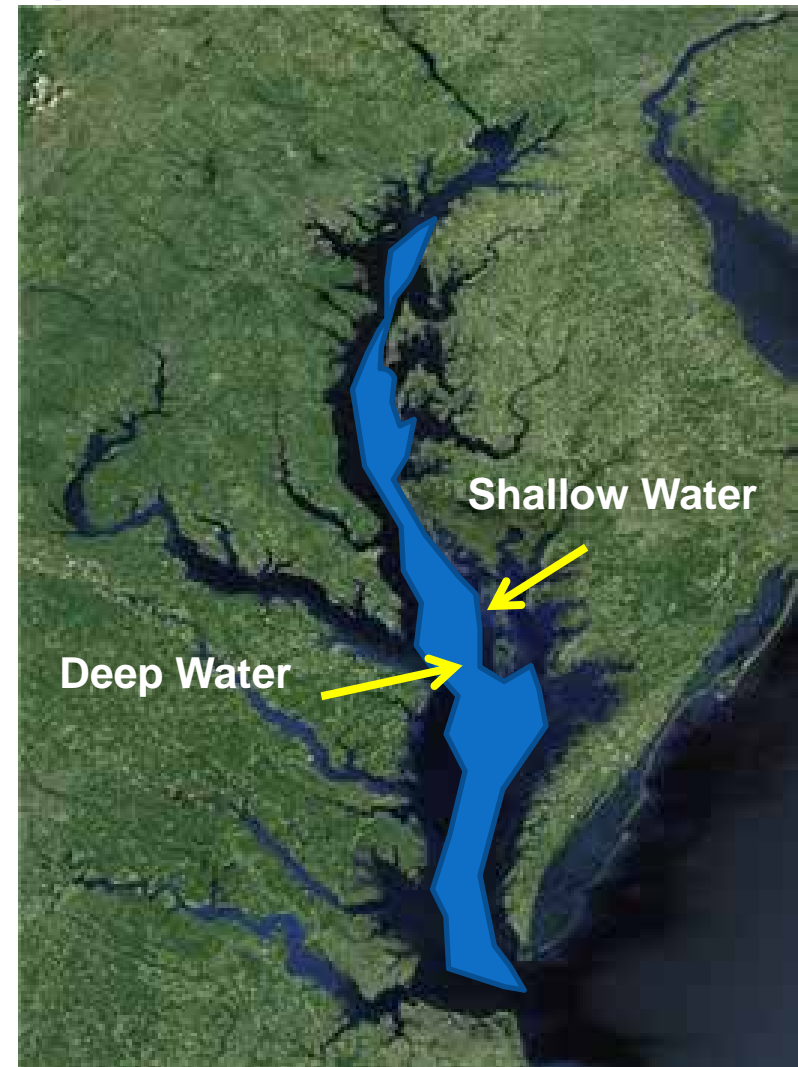
# Estuarine System

- Tidally influenced
- Surface hydrological connection to the sea
- Diluted by freshwater runoff from the land
- Some degree of enclosure by land
- **Upstream Limit:** Head of tide (point where mean range  $< 0.2$  ft)
- **Seaward Limit:** Imaginary line closing the mouth of the estuary at the most seaward geomorphological extent.
- **Landward limit:** Supratidal zone
- **Salinity:** 0 to  $>30$



# Estuarine Subsystems

- **Estuarine Shallow Water**
  - from the supratidal zone to the 4 m depth contour
  - excluding fresh waters (<0.5) designated Tidal Riverine.
- **Estuarine Deep Water**
  - deeper than 4 m
  - excluding fresh waters (<0.5) designated Tidal Riverine.



# Estuarine Subsystems cont.

- **Estuarine Tidal Riverine Shallow Water**
  - from the supratidal zone to the 4 m depth contour
  - influenced by astronomical tides
  - salinity  $< 0.5$  during the period of average annual low flow
  - extending upriver to the head of tide
- **Estuarine Tidal Riverine Deep Water**
  - deeper than 4 m depth contour
  - influenced by astronomical tides
  - salinity  $< 0.5$  during the period of average annual low flow
  - extending upriver to the head of tide



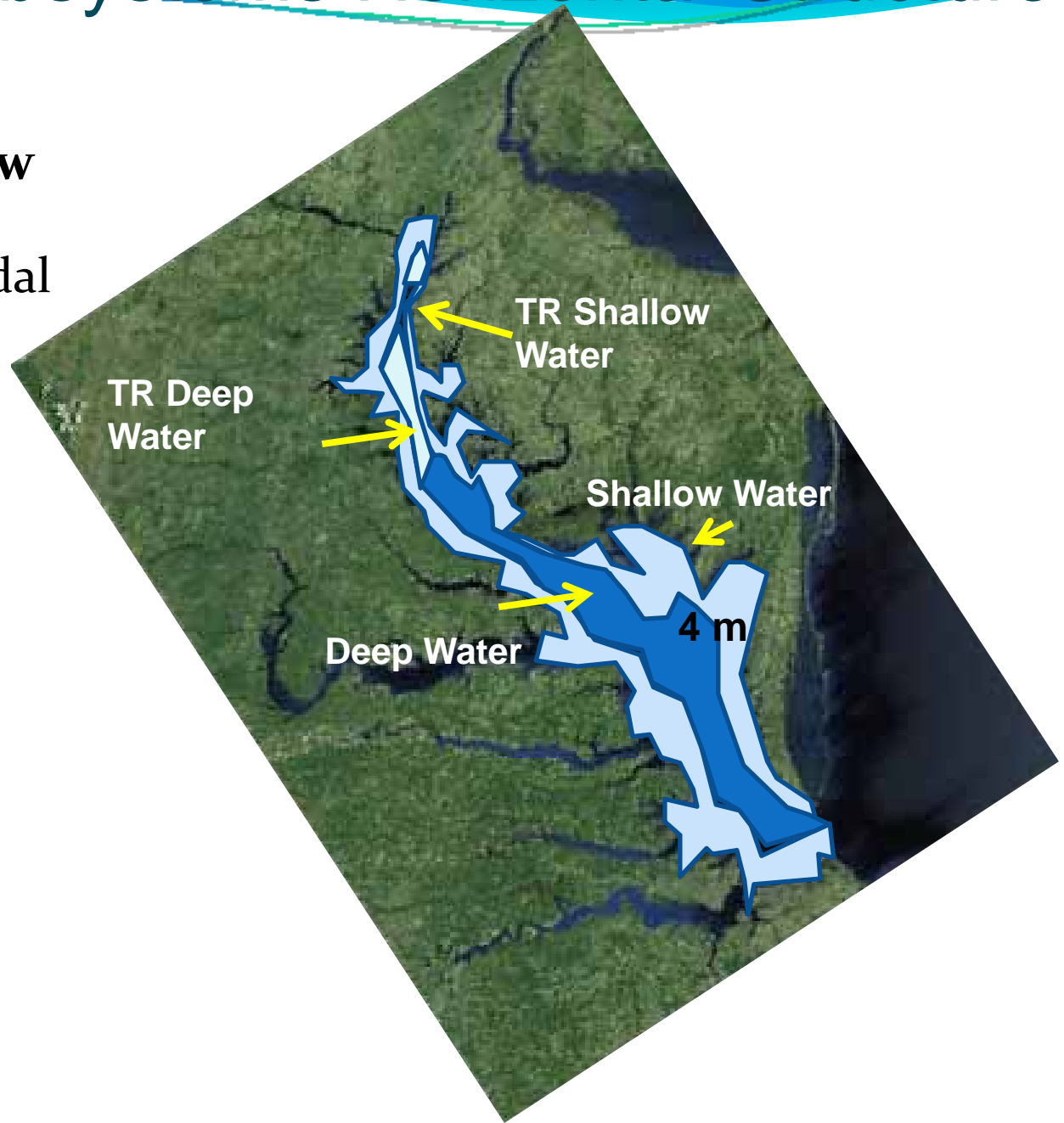
# Estuarine Subsystems Horizontal Structure

- **Estuarine Shallow Water**

- from the supratidal zone to the 4 m depth contour
- excluding fresh waters (<0.5) designated Tidal Riverine.

- **Estuarine Deep Water**

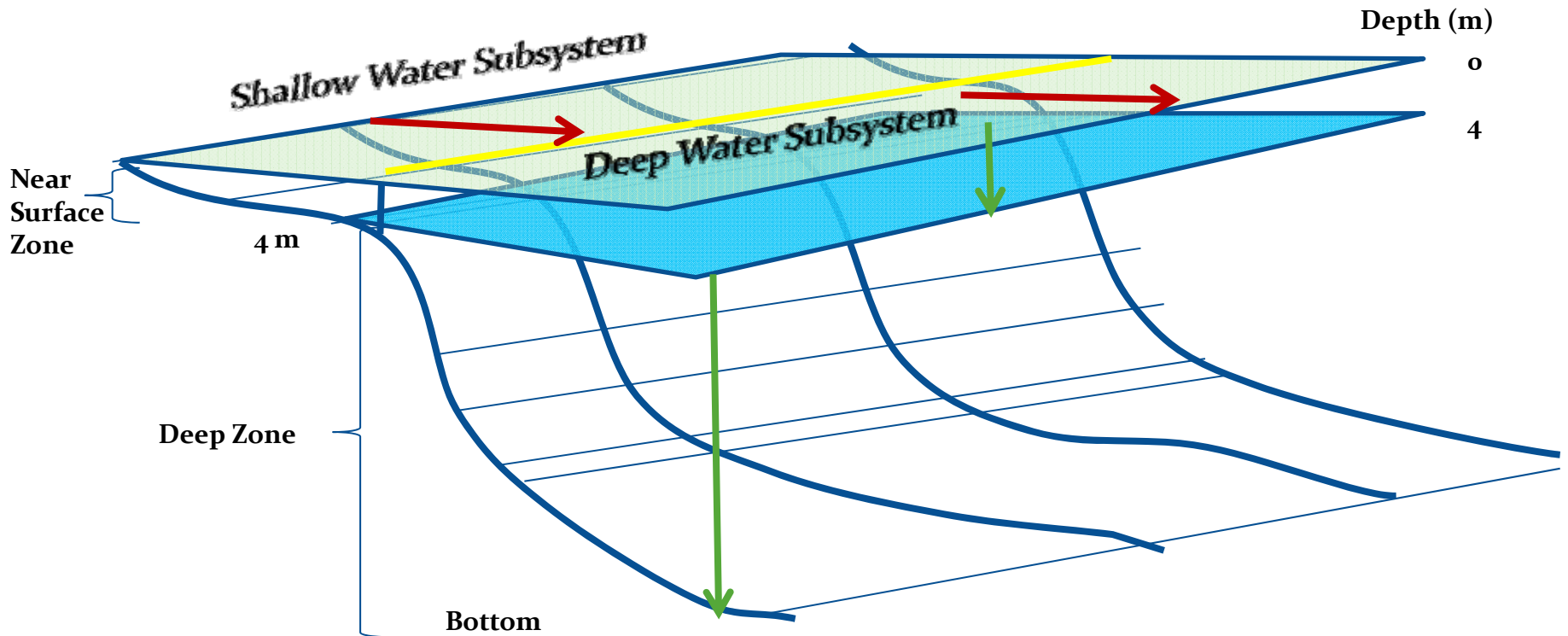
- deeper than 4 m
- excluding fresh waters (<0.5) designated Tidal Riverine.





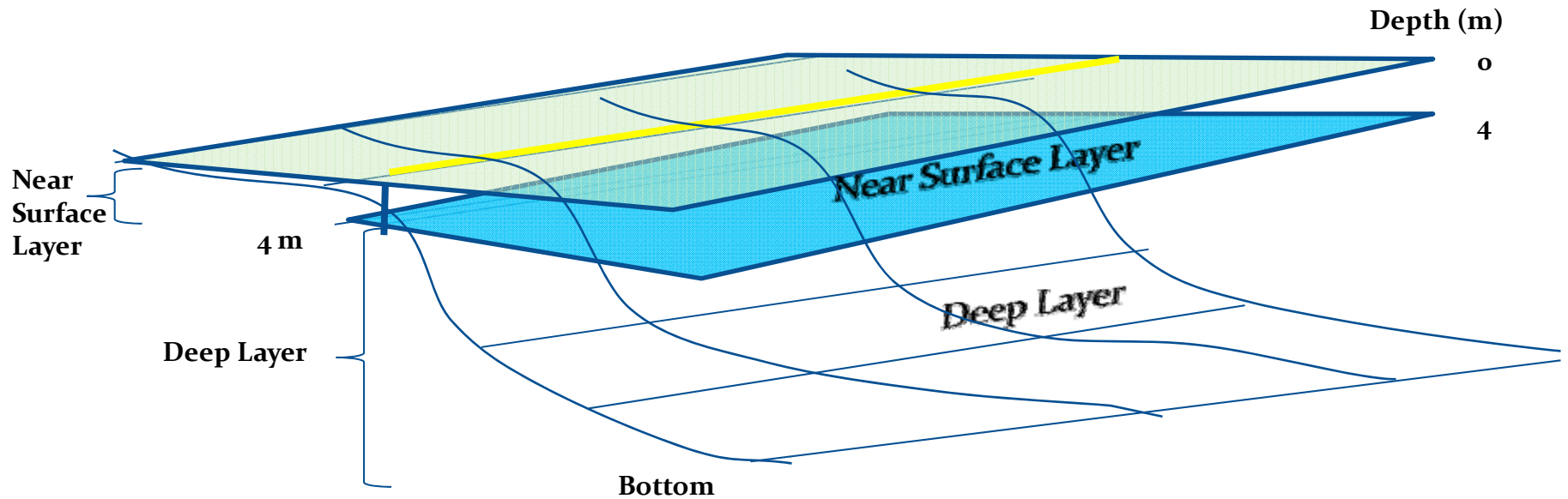
# WATER COLUMN COMPONENT STRUCTURE

## Estuarine Subsystems And Strata



# WATER COLUMN COMPONENT STRUCTURE

## Estuarine Layers





# WATER COLUMN LAYERS/CELLS

*Estuarine Tidal Riverine Shallow Water Near Surface Layer*

*Estuarine Tidal Riverine Deep Water Near Surface Layer*

*Estuarine Tidal Riverine Deep Water Deep Layer*

*Estuarine*

*Estuarine Shallow Water Near Surface Layer*

*Estuarine Deep Water Near Surface Layer*

*Estuarine Deep Water Deep Layer*

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*Nearshore Near Surface Layer*

*Nearshore Deep Layer*

*Neritic Near Surface Layer*

*Neritic Deep Layer*

*Marine*

*Epipelagic Layer*

*Mesopelagic Layer*

*Bathypelagic Layer*

*Abyssopelagic Layer*

*Hadalpelagic Layer*

## Major Issues Status

- SUBSYSTEM
- Consensus on subsystems based on depth contour
- Consensus on a shallow Estuarine Subsystem – based on ?
- Consensus on a Marine Nearshore Subsystem based on total depth
- Consensus on Nearshore/Neritic cutoff at 30m
- Consensus on Neritic/Oceanic cutoff at shelf break
- Possible name change for Neritic Subsystem

## Major Issues Status (cont.)

- LAYERS
- Consensus on an upper layer; based on ?
- Need ecological justification- rationale
- Possible consensus on a surface (neustonic layer) designation
- HYDROFORMS
- Consensus on their importance
- Proposed hierarchical structure
- Need ecological justification
- BIOTOPES
- Include/exclude fish, attached vegetation

# Stommel Diagram (space-time diagram):

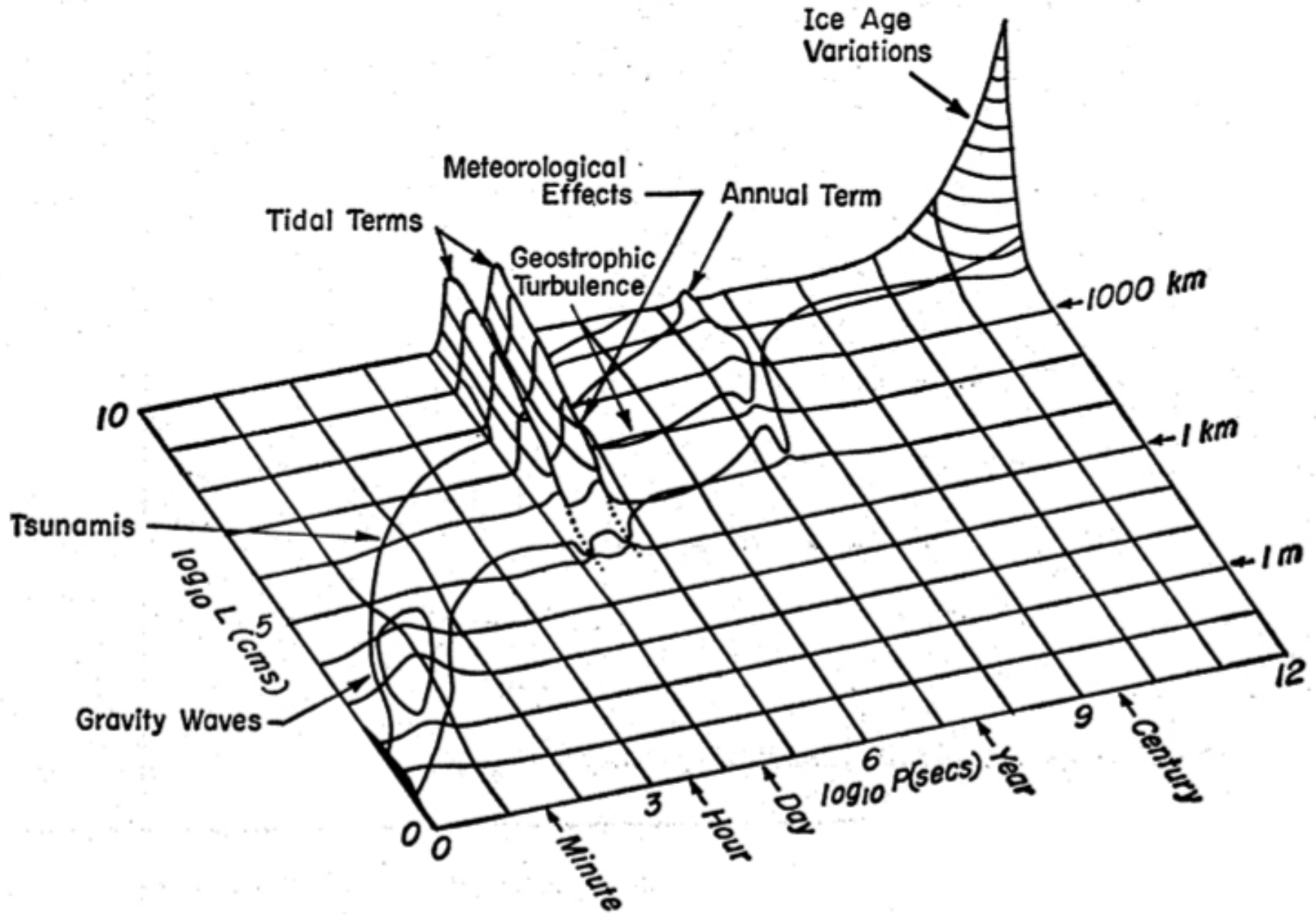
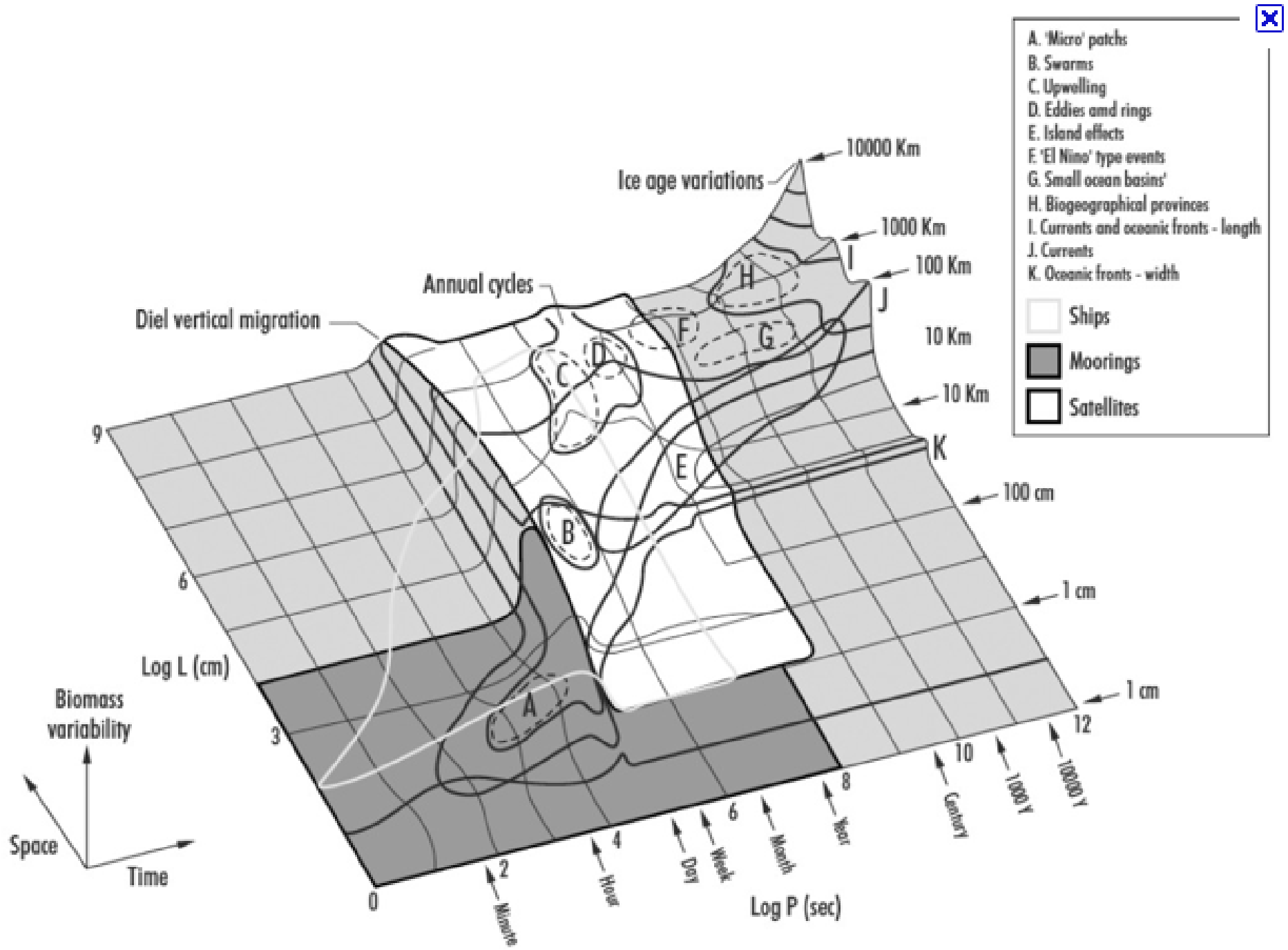


Fig. 1. Schematic diagram of the spectral distribution of sea level.



# WCC Summary

- This is a good place to stop.
- Any questions?
- Apologies to Kathy Goodin and Chris Madden for totally messing up their very nice slides and slide order. All mistakes and misrepresentations are completely mine.



