EBS566/666: Lecture 18

Topics

-review

-discussion of article

Overview of class

- Part I.
  - Ocean observatories
  - Introduction to modeling
  - Tides, river plumes, and estuaries
- Part II.
  - Light in the marine environment
  - Bacteria and Archaea
  - Benthic habitats and inhabitants
  - The pelagic zone and its organisms
  - Fish and fisheries
- Part III.
  - Phytoplankton & primary production
  - Zooplankton
  - Biological-physical coupling

Ocean observatories

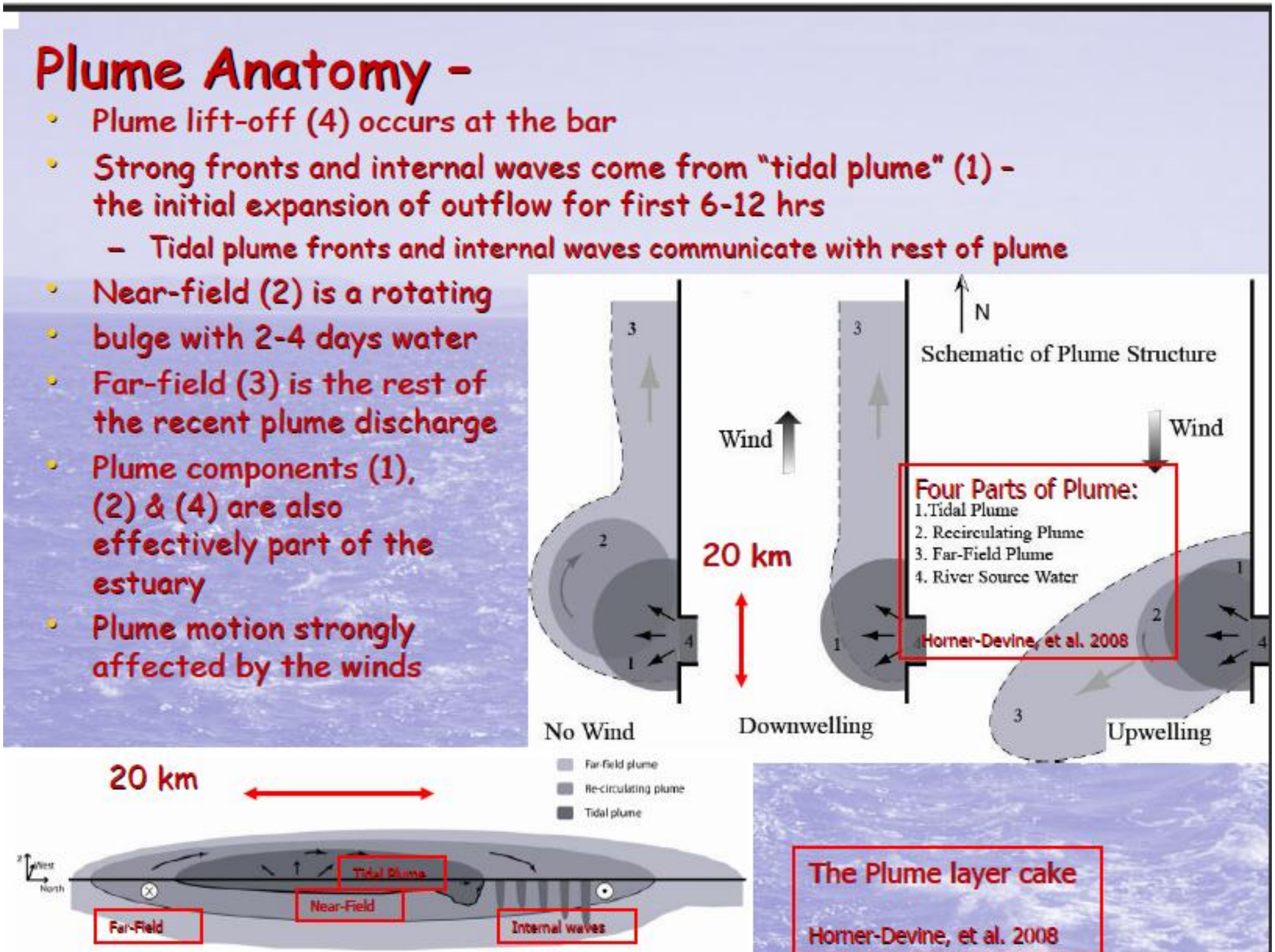
- Infrastructure to allow a continuous presence in the aquatic environment for science & society
- Global, regional scales
- pioneer, endurance arrays
- SATURN & its components

Introduction to modeling

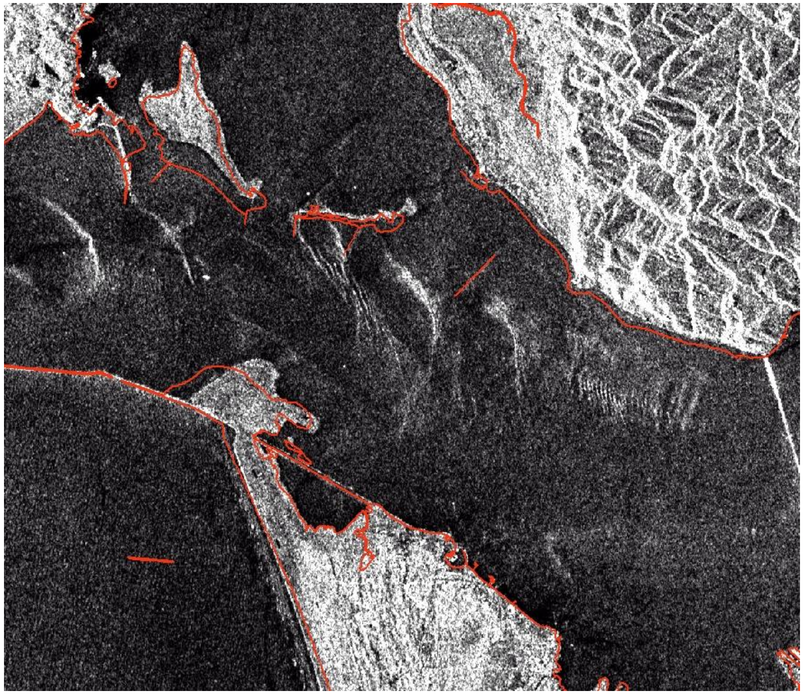
- Variables
- Discretization
  - grids
- Governing equations
  - Conservation of mass, momentum
- Skill assessment

Plume regions

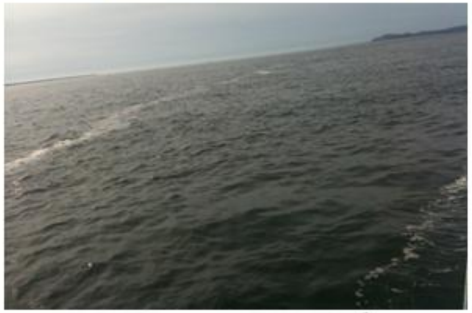
Summary by David Jay of research by A. Horner-Devine et al.

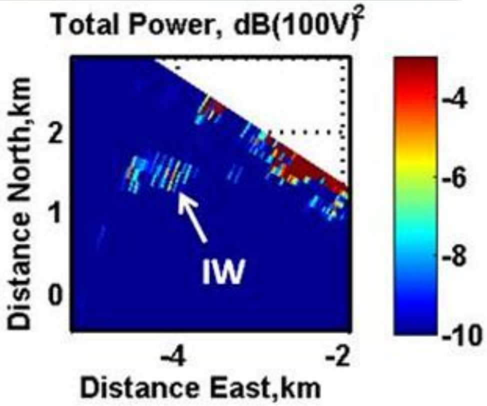


Internal waves



A SAR image taken at 01:56:27 GMT, July 8, 2007 showing the surface roughness as a manifestation of IWs in the Columbia River estuary

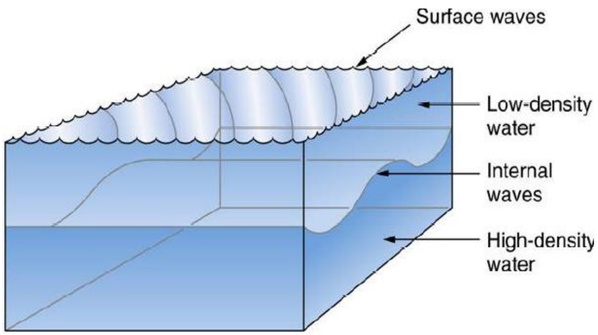


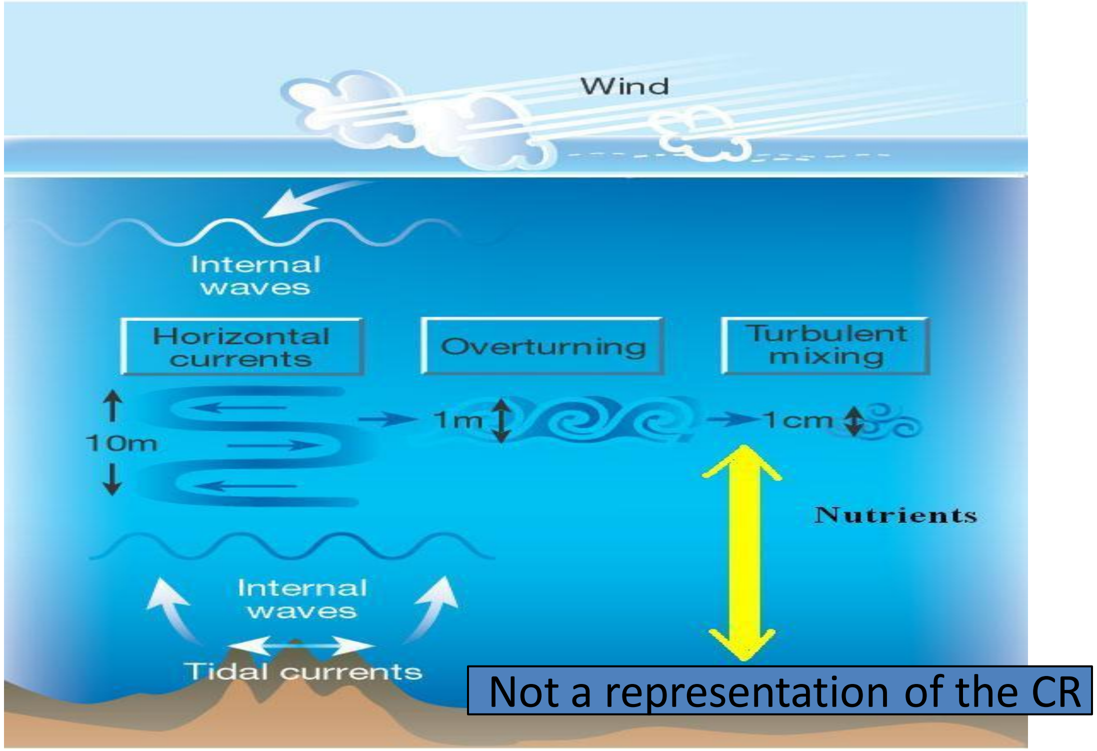


Spatial coverage of the radar from the bridge (right) to the river mouth (left) (background courtesy of Google Earth). The red rectangle shows the approximate location of the internal waves. Middle: Photo of the internal waves taken from the deck of the R/V Pt. Sur at 1600 PDT on September 8, 2009 (courtesy of Craig McNeil). Bottom: image produced from radar data showing the internal waves at 1740 PDT on the same day. The intensity [dB $(100V)^2$] is related to internal wave amplitude while the spacing indicates wavelength.

Why are estuarine internal waves important in the CR?

Internal waves can cause vertical velocity shear, which can intensify vertical mixing process





Through vertical mixing in the North Channel, internal waves may be quite important for the ecology of the Columbia River Estuary (CRE). In particular, internal waves may substantially modulate ocean influences, which are felt predominantly through the North Channel

Slide by Jiayi Pan

Part II

- – Light in the marine environment
- – Bacteria and Archaea
- – Benthic habitats and inhabitants
- – The pelagic zone and its organisms
- – Fish and fisheries

Light

- Drives photosynthesis
- Decays exponentially with depth
- Wavelengths attenuate differently with depth
- Radiance used to detect patterns on the surface using remote sensing
- Different pigments adapted to capture different wavelengths

Light

Different kinds of light emission

- Incandescence
- Fluorescence
- Phosphorescence
- Luminescence
  - Chemiluminescence
    - Bioluminescence (luciferin/luciferase)

Bacteria & Archaea

- The ocean as a microbial world
- Adaptations to environmental conditions → high diversity
- Temperature, light, oxygen, pressure, nutrients, salinity all affect microbial processes

Benthic habitats & organisms

- Habitats of the ocean
- Life on the bottom influenced by:
- Substrate, depth, temperature, oxygen, food, mechanical energy
- Organisms live on the bottom (epifauna) as well as within sediments on the bottom (infauna) – highly diverse, mostly invertebrate, mostly small
- Records of surface or mid-water processes can be preserved on the bottom

Pelagic habitats

- Largest environment on earth
- Big, deep, mostly dark
- Surface currents, deep currents (thermohaline circulation) – drive by different processes and operate on different time scales
- Wide variety of organisms adapted to ‘floating’ or swimming lifestyles
- Feeding, escape from predators

Fish and fisheries

- Important resource; cultural, human health
- Management is a huge challenge
- Size of the stock (how many fish) is influenced by environmental factors, life history of fish, mortality rates, but also by fishing pressure (fishing effort)
- Life history is important
- Stock definitions (for management vs for science)
- Catch per unit effort
- Maximum sustainable yield (MSY)
- Marine Protected Areas (MPA)

Phytoplankton

- Classification
  - Size, pigments, biogeochemistry
- The Spring Bloom
- Sverdrup's Critical Depth Theory
- Criticisms of CDT
- Major classes of phytoplankton
- Bacteria
  - Cyanobacteria
- Eukarya
  - Archaeplastida
  - Chromalveolata
  - Excavata

Zooplankton

- Many kinds; wide size range life habits
- Secondary production
- Physiologic method
  - Growth depends on assimilation, respiration, ecdysis, mortality
- Direct growth measures (growth x biomass)
  - Vidal: growth depends on some limiting factor (food) and slope of growth curve (temperature, individual size)
  - Jenkins: growth is what it is – direct observations
- Controls on 2^oP
  - Huntley-Lopez: temperature
  - Hirst and others: not temperature

Zooplankton

Behavior

- Phenology
- Vertical migration
- Accumulation at fronts
- Feeding

Scales of variability

- < 1 km
  - Viscosity, drag, feeding, swimming, vertical migration
- 10-100's of km
  - Mesoscale eddies, river plumes, upwelling
- > 1000 km
  - Basin-scale circulation
    - Surface, thermohaline

Biological-physical coupling

- Many examples, but we used mesoscale eddies
- Common in the oceans
- 2 types characterized by different features
- Same principles as Spring Bloom, nutrient availability, circulation
- Environment dictates type of plankton present and type of plankton influences geochemical processes (e.g. nutrient cycling)

Final thoughts

Common themes:

- Adaptation
- Exploration & discovery
- Practical applications (e.g. modeling, fisheries)
- Use of new tools to explore, discover, and better manage oceans and estuaries