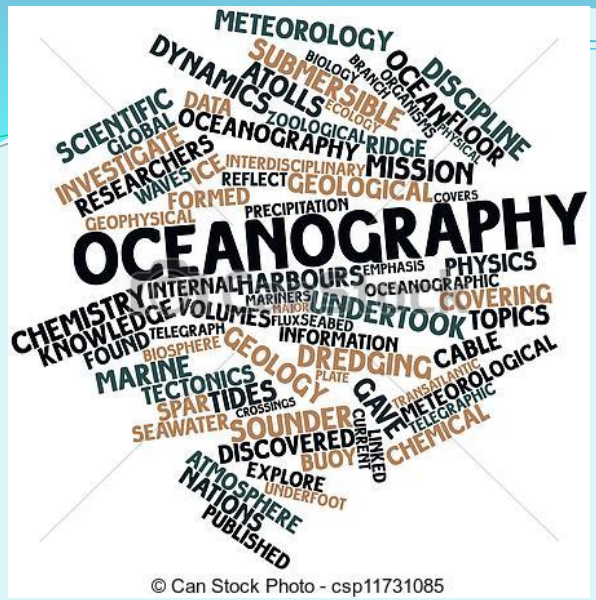


DYNAMIC PLANET OCEANOGRAPHY

Divisions B & C

2025-2026

Event Parameters

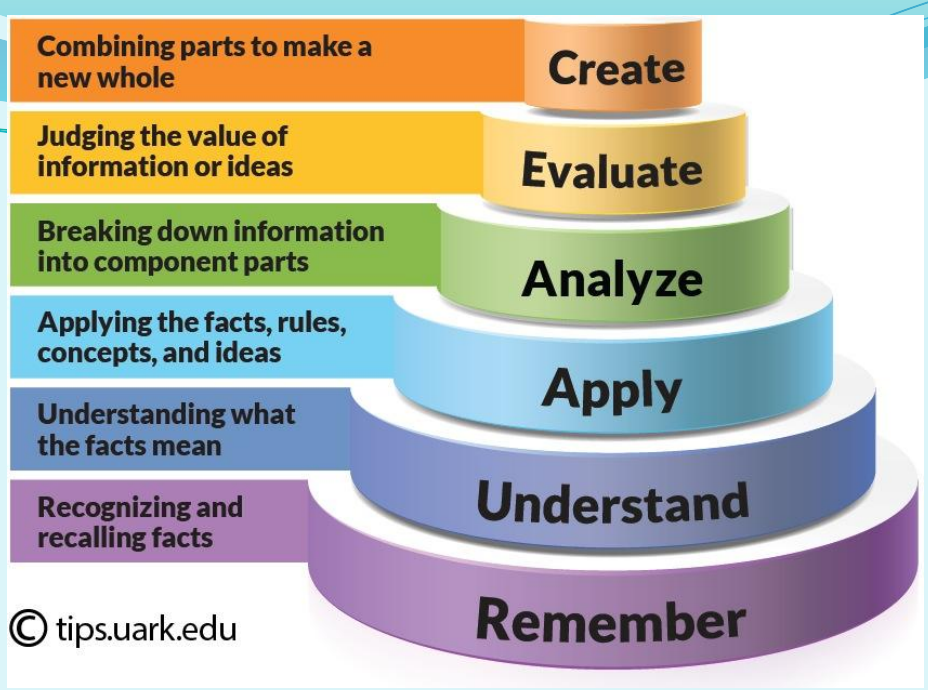
- Topic will be limited to physical oceanography
  - Physics
  - Chemistry
  - Geology
  - Meteorology
  - Biology as it relates to the physical characteristics

- **https://www.soinc.org/dynamic-planet-c**
- **https://miscioly.org/**

Event Parameters

- One or two team members compete
- Any kind of stand-alone calculator (two)
- One Binder of any size is allowed
- If station test, no material may be removed from binder

Event Parameters



- Competition is geared toward analysis and performance rather than strictly knowledge-based questions
- Typically a station-based format, but may be a sit-down test with multiple tasks
- Don't neglect the knowledge and comprehension skills!
  - This is the base upon which the tasks are built
- Teams must understand how to work with the knowledge

Content

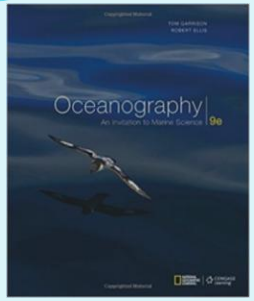
- Teams should understand the ocean as a system
- Ocean systems interact with other Earth systems
  - Lithosphere, hydrosphere, atmosphere, cryosphere, biosphere
- Often certain team members will be expert at their favorite topics
- All team members should have a basic understanding of all topics, and when teams are assembled, make sure their areas of expertise complement each other

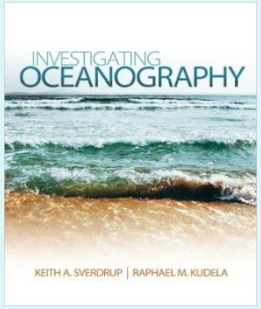
Competition hints

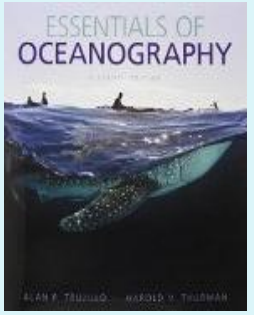
- Everyone should know to study and how to work with their partners
- Practice with the partner before the competition
- If a page is able to be split into parts, partners may divide and conquer, then check each other
- Never skip tie breakers! This happens more than half the time. In every competition, many of the ties are broken because one team didn't bother to do the question at all.

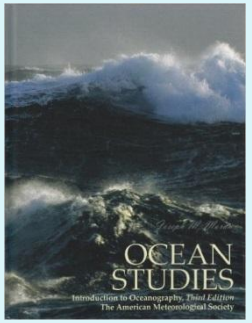
Resources: texts

- Great texts:
  - Oceanography: An Invitation to Marine Science
    - by Tom S. Garrison
  - Investigating Oceanography
    - by Keith A. Sverdrup and Raphael M. Kudela
  - Essentials of Oceanography (newer)
    - by Alan P. Trujillo and Harold V. Thurman
  - Ocean Studies: Introduction to Oceanography
    - by Joseph M. Moran









Resources online

- Texts
- MIT Open Courseware
  - http://ocw.mit.edu/resources/res-12-000-evolution-of-physical-oceanography-spring-2007/textbook-contents-preface-etc/
- Introduction to Physical Oceanography
  - by Robert Stewart, Texas A&M University
  - http://oceanworld.tamu.edu/resources/ocng_textbook/PDF_files/book_pdf_files.html (404, page not found. Try Wayback machine)
  - Now directs to https://sites.google.com/tamu.edu/ocean-world/home
    - (Not a very thorough resource)
- Agencies
  - NOAA
  - NWS
  - Woods Hole Oceanographic Institute
- University websites
- Look for exam questions and quizlets for practice
  - http://science.jbpub.com/oceanlink/index.cfm

Basic topics you need but nobody tells you to study

- Geography!
  - Ocean basins, major bays, rivers, estuaries
- Superlatives
  - Biggest, deepest, fastest, saltiest, warmest, etc.
- Cartography
  - Types of maps, longitude & latitude, topo maps
- History
  - (Very broad and basic), Matthew Fontaine Maury, early navigation, economic uses of oceans
- Vocabulary
  - Prepare an awesome glossary. Don't forget acronyms.

Content suggestions

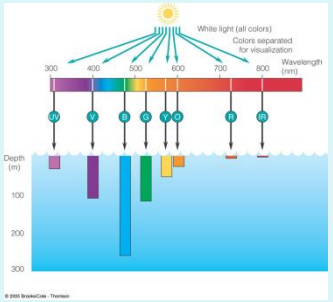
- Each topic is broken down into subtopics
- Essential subtopics are highlighted in maroon
  - B division might want to concentrate on those
  - C division should know all, and go even further!
- This list is a good guideline, but it's not all-inclusive.

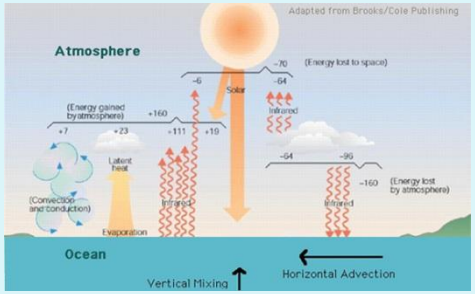
i. Seawater

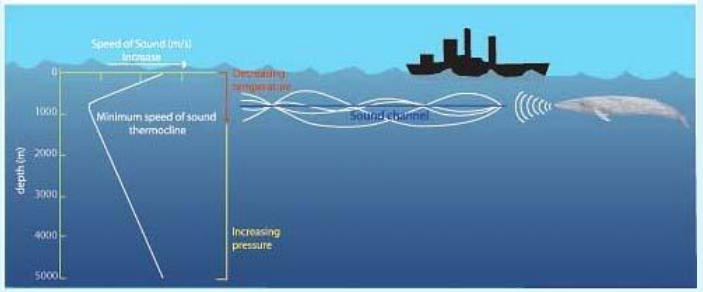
- **Composition, density, variations in salinity, and sources of salts**
- Structure of water molecule and how it acts
  - Phase changes and temperatures, specific heat, polar molecule
- Dissolved solids and dissolved gasses
  - Composition, proportions, how they act when other factors change (i.e. climate change)
- Salinities
  - Typical salinity in ppt, percent, and Practical Salinity Units (psu), calculations (and chlorinity), map of salinities, know why they change, residence times, conservative and nonconservative constituents
- Sources of salts
  - Surface weathering on land, excess volatiles from upper mantle
- Principle of constant proportions (Forchhammer's principle)
- Acid/base balance
  - Typical values in ocean water (and their locations)
  - Ocean water as a buffer
  - Global climate change effects

ii. Radiation and Heat

- **Inputs, outputs, transfers, and conversions**
- Solar energy
  - reflection, refraction, absorption, conversion to heat, albedo, ice vs. water
- Areas of evaporation, freezing and SSTs (sea surface temps)
- Uneven solar heating
- Latent (phase change) and sensible (conduction & convection) heat
- Light transmission
  - Refraction, absorption
  - Percent of frequency with depth
- Sound transmission
  - SOFAR layer
- Effect of ocean proximity on climates
- Hurricanes: purpose, formation, SST
- Geothermal heat

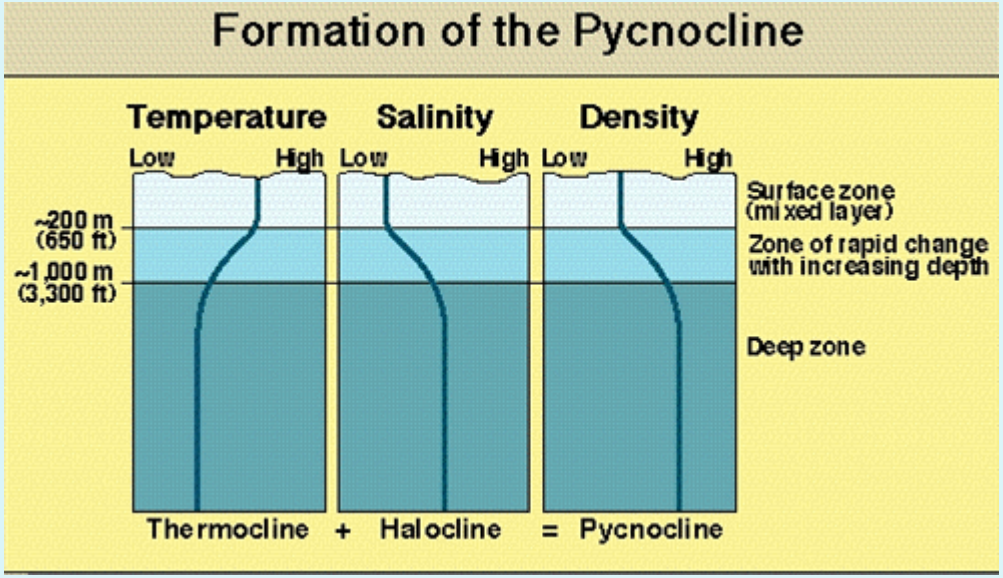


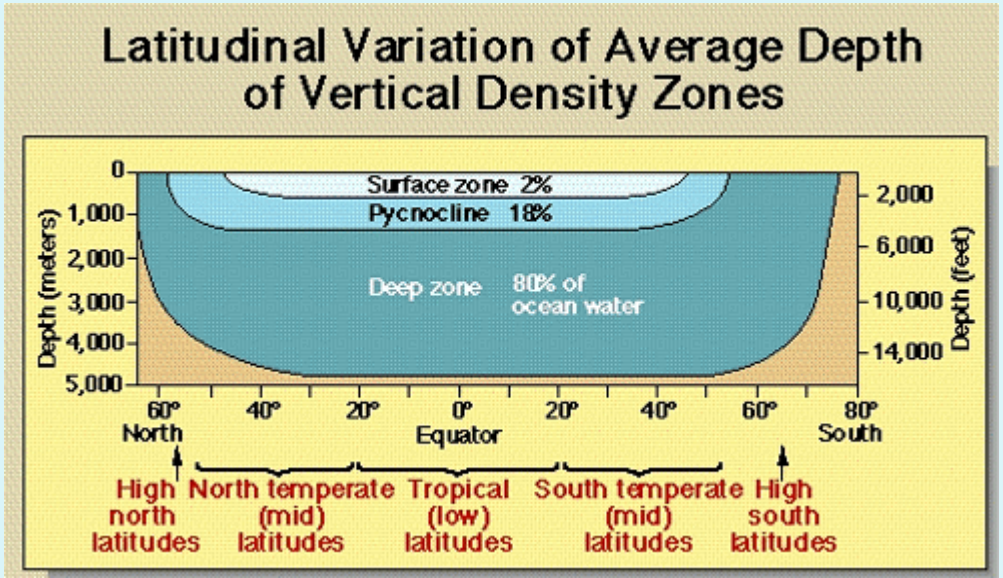




iii. Water profiles

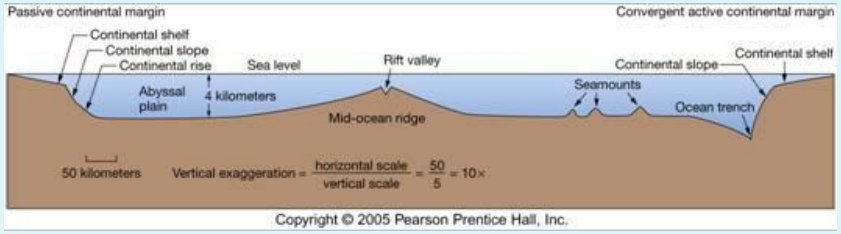
- **Temperature, pressure, three-layer structure**
- Mixed layer (surface characteristics)
- Thermocline, halocline, pychnocline
- Deep water
- Percent of water in each
- Changes in latitude





iv. Topographic features

- **Topographic features found on continental margins, estuaries, ocean basins, and mid-ocean ridges**
- Cross section across an ocean basin, with depths
- Shelf, slope, rise, submarine canyons (causes), abyssal plains, ridges/rises, rift valleys, abyssal hills, seamounts, guyots
- Composition of each feature (including type of crust)
- Percentage of ocean for each major feature and location of largest areas of each
- Types of estuaries and typical examples
  - Drowned river mouth, fjord, bar-built, tectonic
  - Structure and movement of water
  - Economic importance



v. Plate tectonics

- **Processes and features of tectonic plate motion in ocean basins, and patterns of age of the ocean floor.**
- Plate tectonic theory
- Continental drift, evidence for moving plates, relative motion of plates, structure of Earth's interior
  - Mechanism of movement
- Types of plate boundaries (oceanic and continental locations)
  - Convergent = subduction (Ocean->Ocean, Ocean->Continent)
  - Divergent
  - Transform (and relative motion along faults)
- Features that occur at each type of boundary
  - Volcanoes, trenches, hydrothermal vents, earthquakes, Benioff zone
- Paleomagnetism

vi. Distribution of chemicals

- **Distribution of chemicals (nutrients, oxygen, metals) in the ocean, vertical and horizontal structure**
- Overlaps with i. (seawater) to some extent, but more detail
- Sediments; their composition, formation, and distribution
  - Lithogenous, hydrogenous (authigenic), biogenous, cosmogenous
  - Manganese nodules
- Calcite compensation depth (CCD)
- Upwelling and downwelling effects on nutrients and oxygen
- Oxygen isotopes and their use (O16 and O18)
- Chlorophyll distribution

vii. Reefs

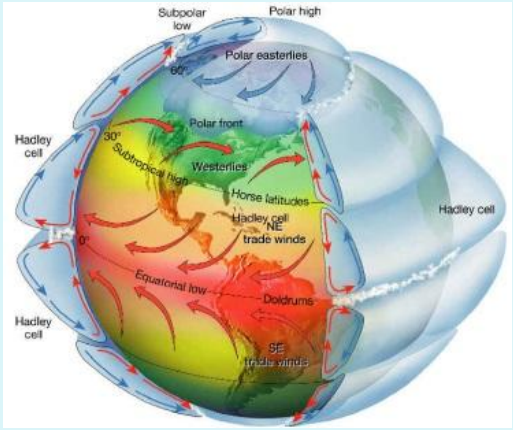
- **Formation of fringing reefs, barrier reefs, atolls**
- Darwin's explanation of atoll formation
- Locations of major reefs
  - Global distribution
  - Don't forget cold water reefs
- Other types of reefs
  - Patch reefs
- Structure of reefs
  - Composition
  - Seaward vs landward differences

viii. Waves

- **Motion, height, wavelength, period, fetch, swell, surf, and tsunamis**
- Motion of water (circular, elliptical) and mass transport
- Breaking plunging, spilling
- Disturbing and restoring forces
- Deep-water, transitional, and shallow-water waves
- Causes of waves (wind, landslides, earthquakes, tidal forces)
- Fetch, seas, wave trains
- Calculations with speed (celerity), wavelength, frequency, and/or period
- Dispersion, reflection, refraction, and diffraction
- Constructive and destructive interference (and rogue waves)
- Internal waves

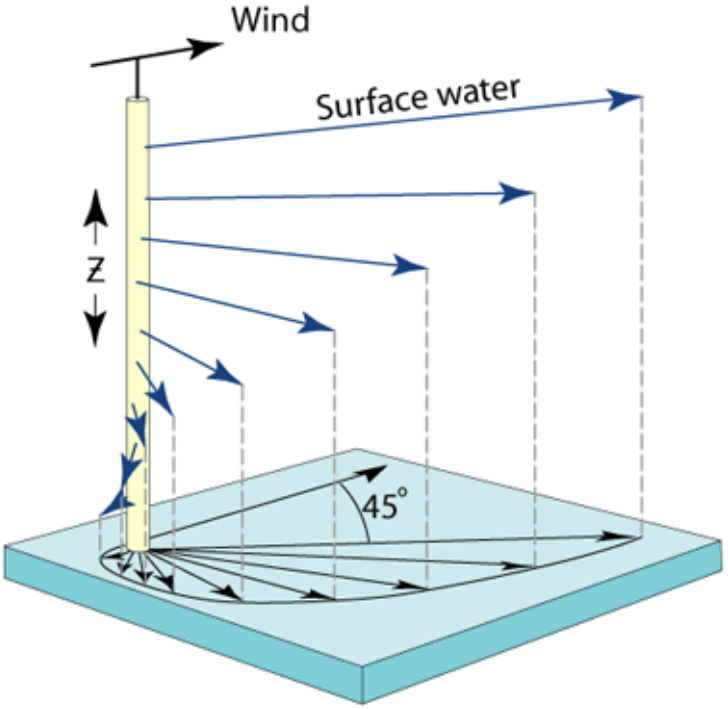
ix. Surface currents

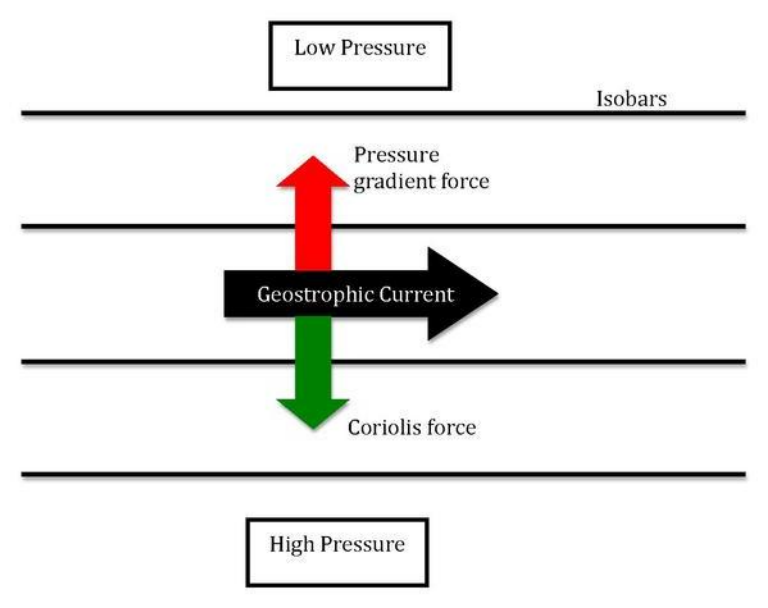
- **Warm and cold currents**
- **Gyres**
- **Coriolis effect**
- Antarctic circumpolar current (West Wind Drift)
- Western and eastern boundary current
  - Names and characteristics
- Countercurrents and undercurrents
- Three cell model of the atmosphere and surface winds
- Warm- and cold-core eddies
- Pacific garbage patch
- El Niño, La Niña, ENSO



x. Division C only

- Ekman spiral
- Geostrophic currents



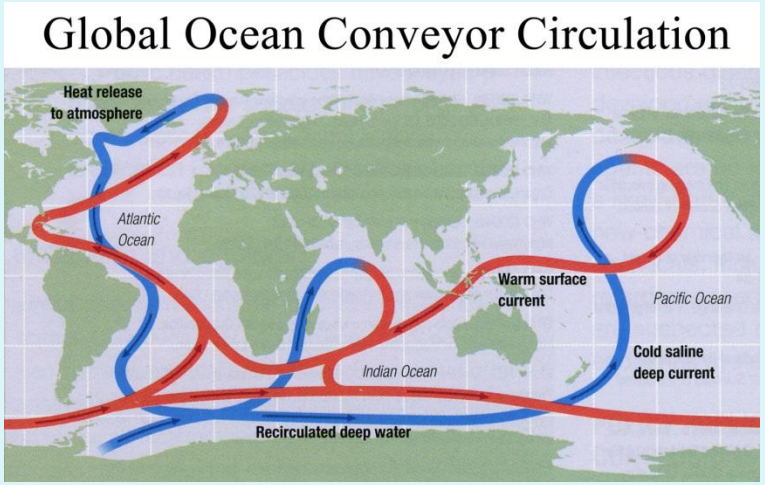


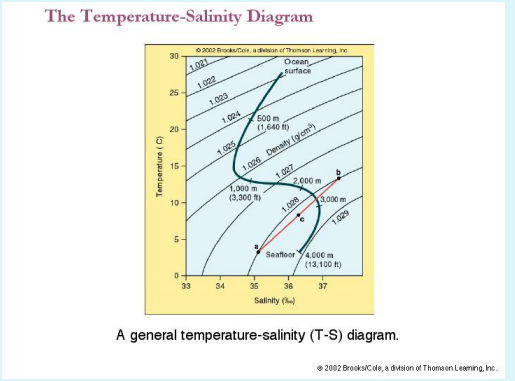
xi. Coastal currents

- **Longshore currents, rip currents, and upwelling**
- Longshore currents
  - Longshore drift
  - Sediment distribution on either side of groins
- Rip currents
  - Cause
  - Recognition
  - How to survive
- Upwelling and downwelling
  - Causes
  - Results of upwelling and downwelling

xii. Deep ocean circulation

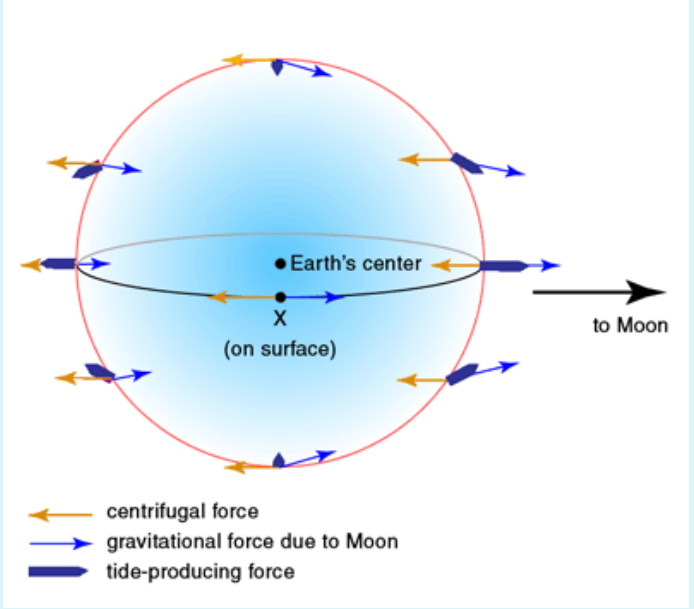
- **Deep ocean circulation, ocean overturning, and water masses**
- Thermohaline circulation
  - Time for complete circuit
- Water masses
  - How (and where) they are formed
  - Major water masses
  - AABW, AAIW, NADW, Mediterranean water
- Temperature-salinity diagrams
  - Isopychnals
- Climate effects





xiii. Tides

- **High and low tides, spring and neap tides, tidal currents**
- Equilibrium theory of tides, dynamic theory of tides
- Phases of the moon
  - Relative positions of Earth, moon, sun
  - Relative strengths of lunar and solar tides
  - Timing
  - Inertial and gravitational force vectors
- Diurnal, semidiurnal, and mixed tides
- Amphidromic points
- Confined basins
  - Tidal bores
  - Flood, ebb, slack waters
  - Bay of Fundy



xiv. Coasts

- **Coastal features and processes, uplift and subsidence**
- Types of coasts
  - Active vs. passive, primary vs. secondary, features of each
- High and low energy coasts
- Shore straightening and wave refraction
- Beaches
  - Zones, types, features, profiles
  - Seasonal changes (summer and winter beaches)
- Barrier islands, spits, bay mouth bars, lagoons
- Sea cliffs, sea caves, sea arches, sea stacks, tombolos
- Human effects on beaches
  - Sea walls, jetties, groins, sand importation, global warming
- Land and sea breezes
- https://www.st.nmfs.noaa.gov/Assets/Nemo/documents/lessons/Lesson_16/Lesson_16-Teacher%27s_Guide.pdf

xv. Tools and technology

- **Oceanic tools used to collect water samples, sediments, cores, track water movement, etc.**
- Conductivity, temperature, depth sensors (CTD)
- Salinometers
- Nansen bottles, Niskin bottles
- Secchi disks
- Box corers, grab samplers, gravity corers, piston corers
- Trawls
- Submersibles
- Buoys and drifters
  - TAO/TRITON data array, DART buoys
  - Rubber ducks and Nike shoes

xvi. Fisheries and ocean circulation

- **Relationships between fisheries and ocean color**
- Satellite imagery determines color
  - Color indicates presence of chlorophyll (and concentration)
  - Chlorophyll tells what phytoplankton is in the area
- Food chain implications
- Conditions affecting fisheries
  - Upwelling, El Niño, Pacific Decadal Oscillation
  - https://www.pmel.noaa.gov/elnino/fish-distribution (north)
- Remote sensing data can support fisheries management
  - Stock assessment, aquaculture, harvesting
- Global marine ecosystem health
- Algal blooms
- Water quality

References

- Used Garrison's text for most lists (see slide 7). These are credits for the illustrations
- http://tips.uark.edu/using-blooms-taxonomy/
- http://www.eduweb.com/portfolio/earthsystems/parent_printable.html
- http://www.bestonlinecollege.org/oceanography-careers/
- http://www.canstockphoto.com/word-cloud-for-oceanography-11731085.html
- http://seawebvoicesinaction.blogspot.com/2011/05/seaweb-in-san-francisco-your-brain-on.html
- http://science.kennesaw.edu/~jdirnber/BioOceanography/Lectures/LecPhysicalOcean/LecPhysicalOcean.html
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