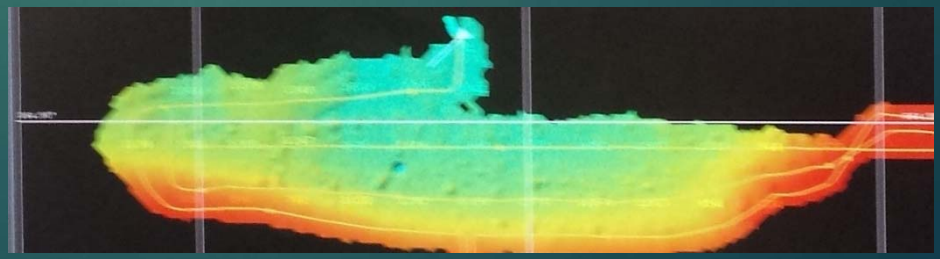
Exploring the Ocean: CTDs

Oceanography

- Oceanography is the study of the ocean.
- It covers a wide range of topics from marine life to the geology of the sea floor to the physical properties of the ocean.



Oceanography

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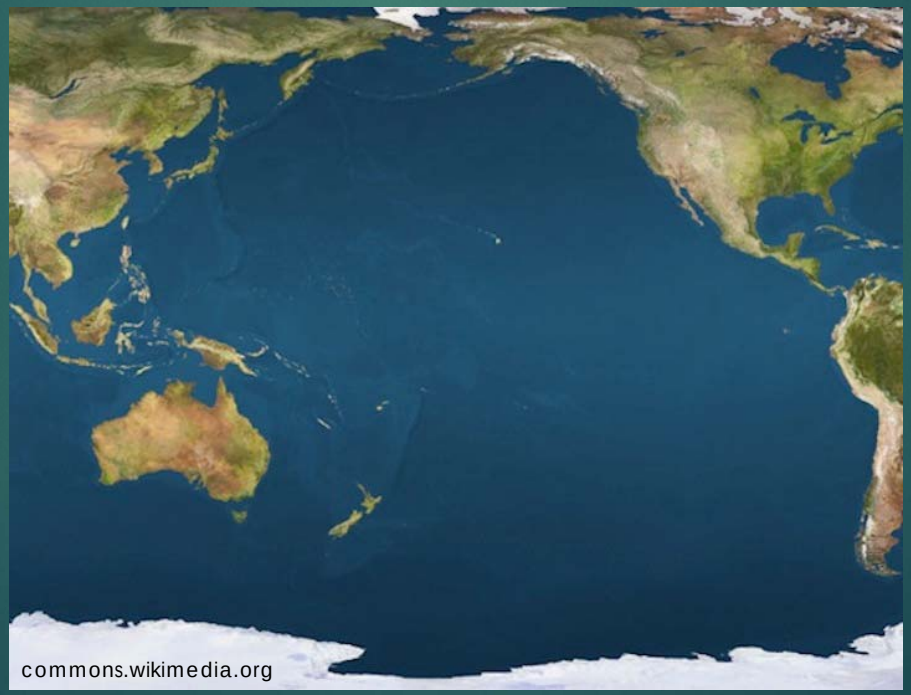
- It covers a wide range of topics from marine life to the geology of the sea floor to the physical properties of the ocean.
- Physical oceanography is the study of the physical components of the ocean including:
  - Light
  - Waves
  - Tides
  - Currents
  - Composition of ocean water

Physical Oceanography

- Are the physical properties of the ocean the same everywhere in the world?



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Physical Oceanography

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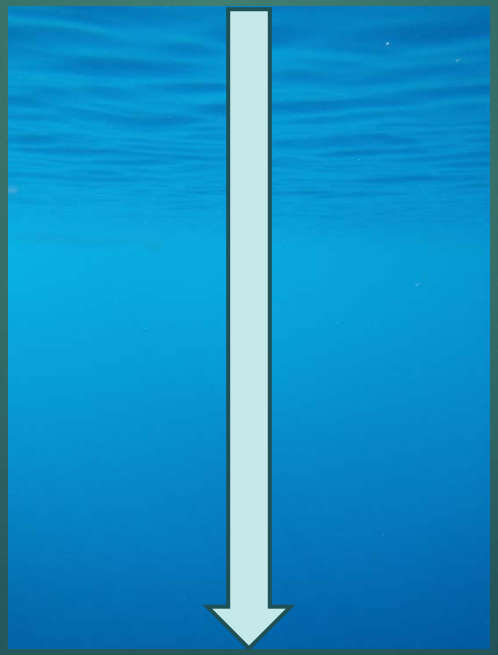
- What are some features of the ocean that can differ across different parts of the world?
  - Depth
  - Salinity
  - Temperature
  - Dissolved oxygen
  - Organic matter/amount of life
  - Et al.

Physical Ocean Properties

- Are these physical properties of the ocean the same within the same geographical area?
- Are these physical properties of the ocean the same across depth?



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Physical Ocean Properties

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- Are these physical properties of the ocean the same across depth?
- What might cause physical properties of the ocean to vary across depth?
  - Different water masses
  - Currents
  - Fresh-water runoff
  - Evaporation
  - Underwater structures (hydrothermal vents, methane lakes, etc)

Physical Ocean Properties

- Studying physical properties of ocean water can tell us a lot:
  - Fresh water inputs vs Evaporation or salt exclusion
  - Ice formation
  - Thermohaline circulation and Current movement
  - Nutrient and mineral contents
  - Heat transfer
  - Dissolved Oxygen
  - How much life can be supported
  - Presence of underwater features (volcanoes and vents)
  - Much, much more!

Physical Ocean Properties

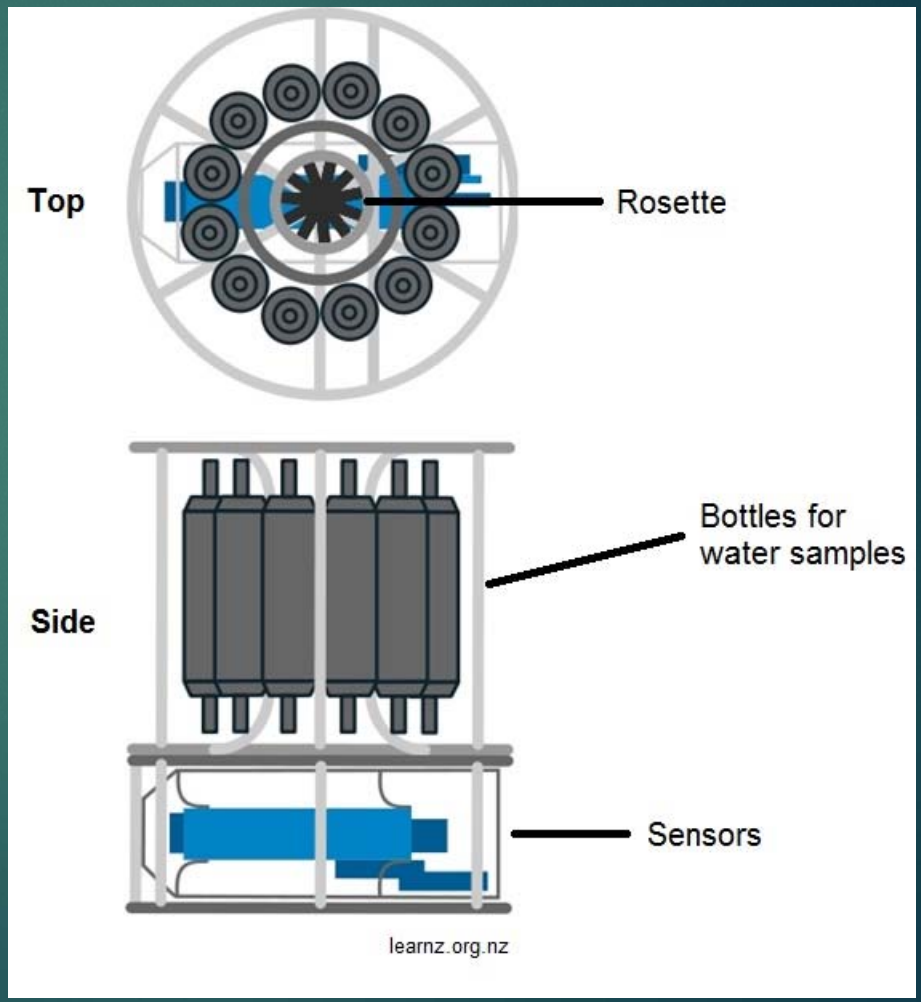
- How can we measure differences in physical properties of ocean water?
  - Across the surface?
  - Across the depth of the ocean?

CTDs

- A CTD is an oceanography instrument used to determine conductivity (directly related to salinity), temperature and depth of ocean water samples.
- CTDs can be used to collect data down to 10,000m (sometimes even deeper). That's over 6 miles deep!

CTDs

- The instrument consists of several sensors which measure CTD and send data back to the ship in real time and a cluster of containers that collect water samples at different depths.
- Extra sensors can be added on to measure things like DO, pH, fluorescence and other properties.

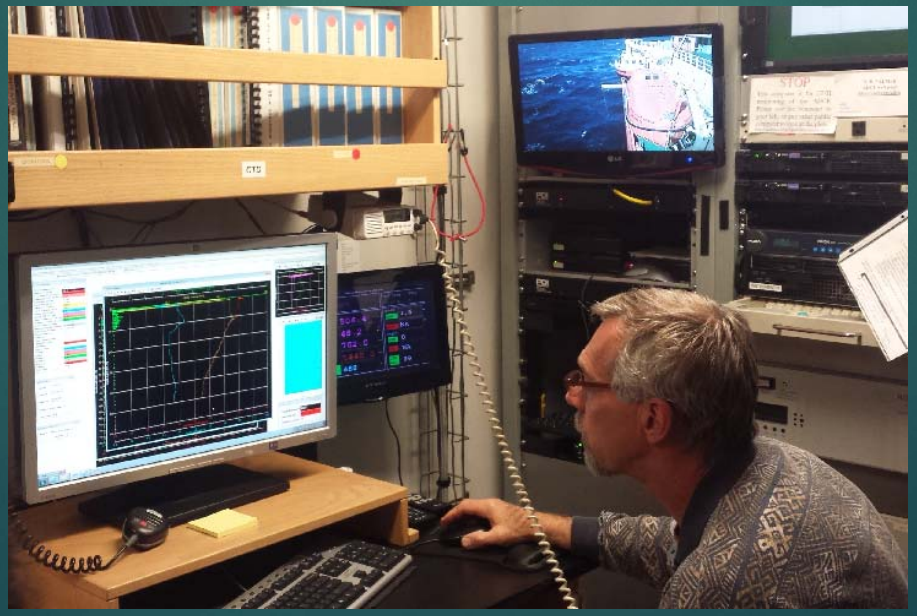


CTDs

- The standard method of sampling is called a vertical cast.
- The ship stays in position and the CTD is lowered through the water, sending back data and collecting samples straight down.

Back on the ship

- As the CTD descends, scientist monitor the data it is sending back from a computer station on the ship.
- They observe this data to determine where they want water samples and manually control where samples should be collected.



Back on the ship

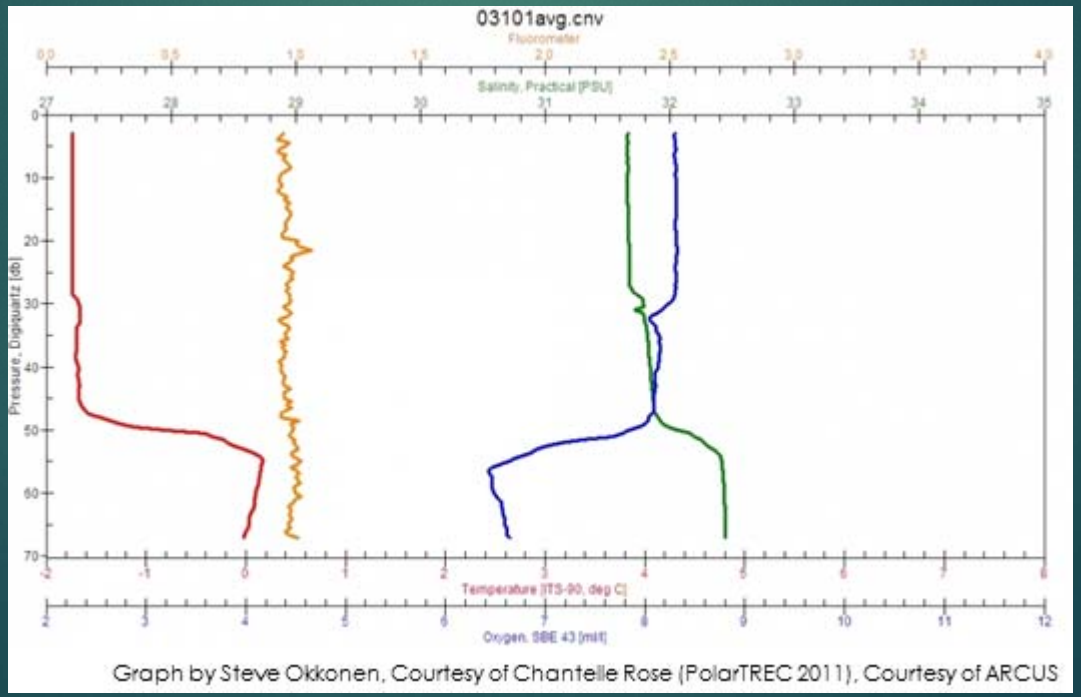
- When the CTD is retrieved, the water samples are collected and analyzed for additional properties.

CAST!

- https://youtu.be/KVd7W4LtIBg

CTD Data

- The data shows real time information the CTD sends back to the ship on its descent and ascent.
- Scientists use these plots to determine where they would like to collect water samples.



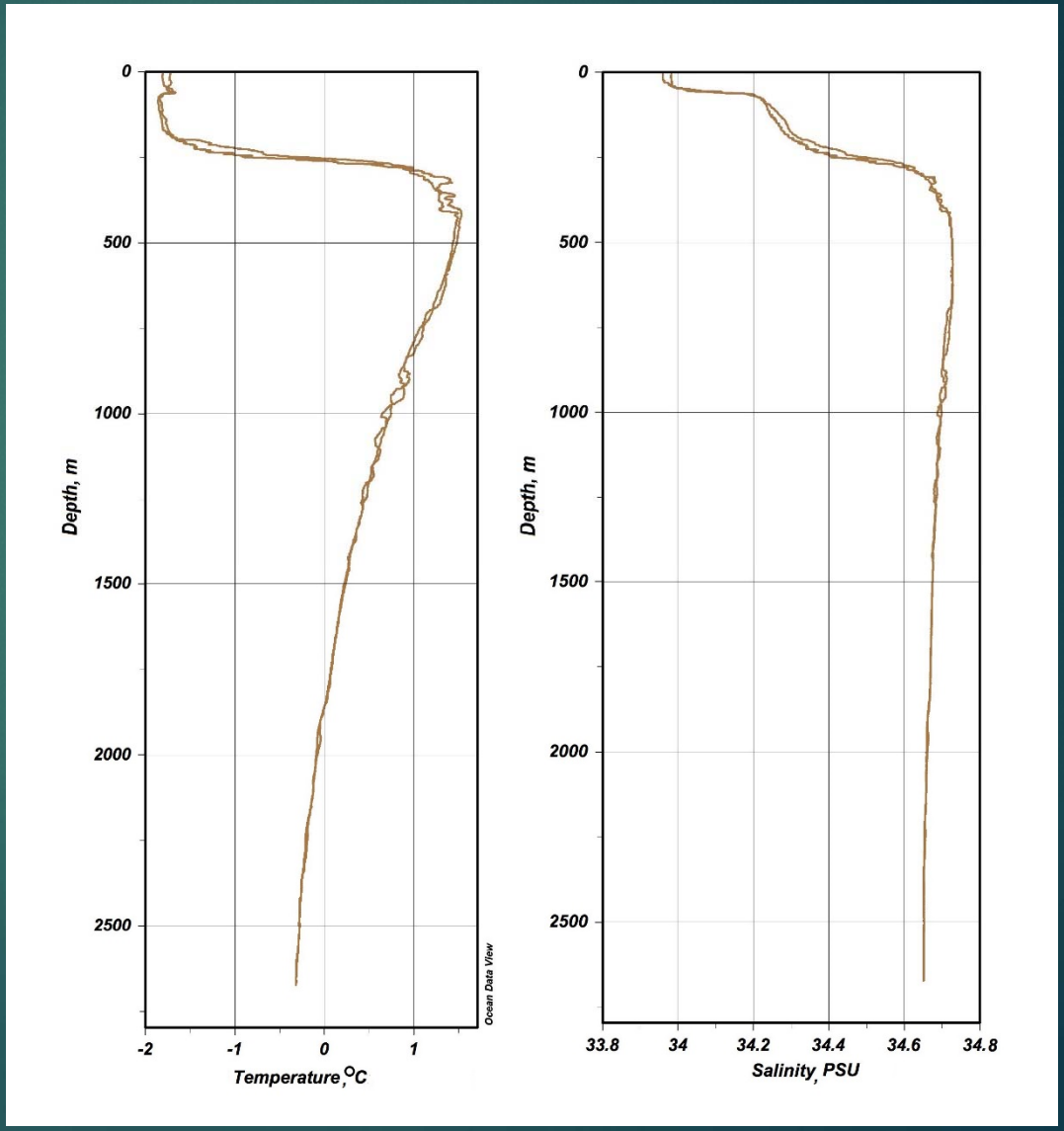
Graph by Steve Okkonen, Courtesy of Chantelle Rose (PolarTREC 2011), Courtesy of ARCUS

CTD Data

- Pressure is measured in decibars, which is used because it is relatively close to depth in meters. Example: 100 m = 100.39 db
- Sudden changes in salinity or temperature over short distances show haloclines or thermoclines and can possibly denote different water masses.
- Dissolved oxygen and fluorescence can provide information on suitability for marine life and photosynthesis rates.

CTD Data

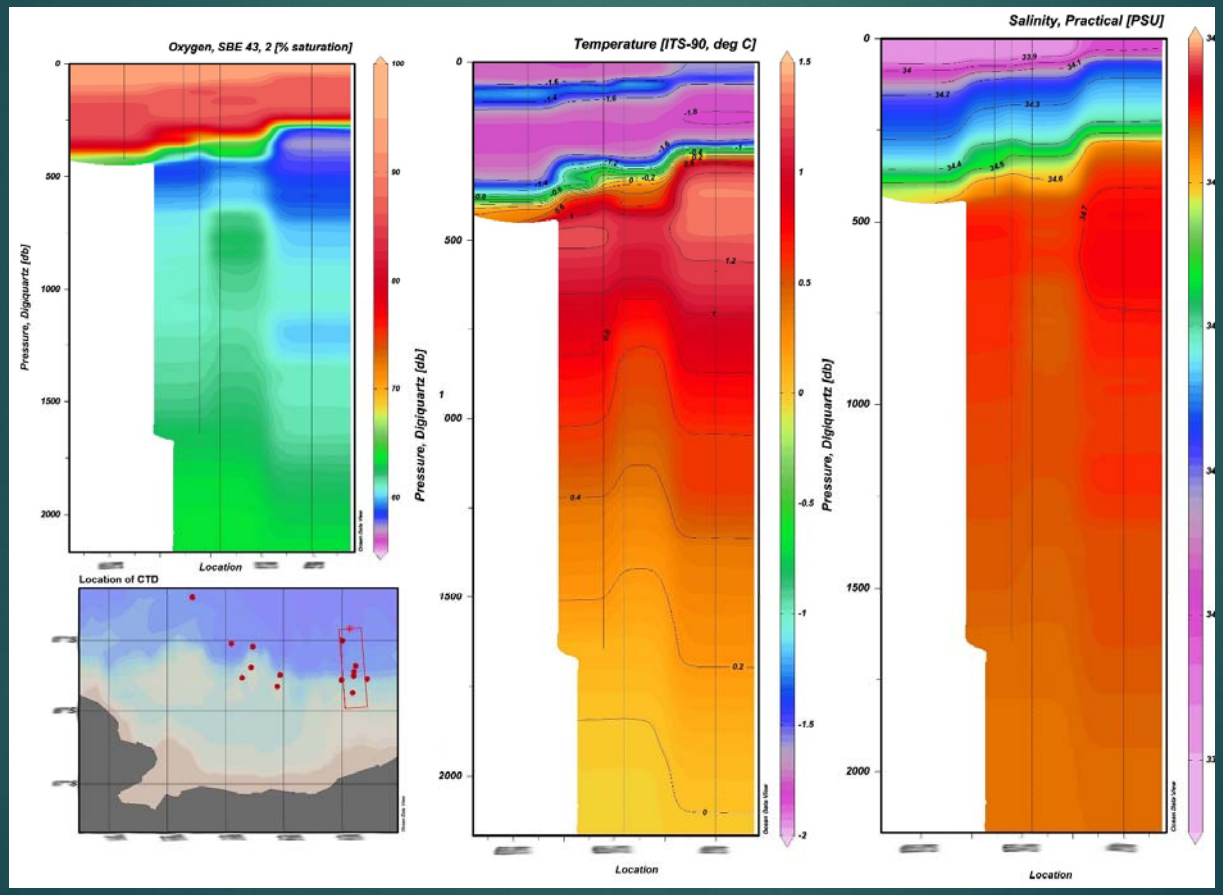
- As you look at the graph:
  - Does temperature always decrease with depth?
  - Does salinity always decrease with depth?



Compiled Profile

- A compiled profile combines many different casts into one image that shows different water masses and their properties over a given distance.
- As a false color graph/image, these graphs use colors to represent different variables rather than the color we would see (true color image/graph).

Example of compiled profile



Compiled Profile

- As you look at the graph:
  - What components contribute to water density? How can warmer water be found below colder water?
  - How many different water masses do you see? Why is this important?
  - How could you tell direction of movement of ocean currents using CTD casts?

Activity

- Try analyzing the data collected from a real CTD cast!
- Then experiment to analyze CTD water samples.

Credits

- NBP1503 Chief Scientist- Frank Nitsche
- Assembled by Dominique Richardson
- Unless otherwise credited, Photos by Dominique Richardson (PolarTREC 2014-2015), Courtesy of ARCUS and NSF
- Graphs and Data courtesy of Frank Nitsche and David Porter