POLAR TREC

TEACHERS AND RESEARCHERS EXPLORING AND COLLABORATING

Reeling in CTD Data – Understanding Physical and Chemical Parameters of Ocean Water Using CTD Profiles

Overview

A focus of the PolarTREC Southern Ocean Diatoms expedition was to collect water samples and physical profile data using oceanographic technology. Oceanographers rely on the real-time data transferred from the water column to the ship-based computers using a CTD sensor. The CTD measures conductivity (salinity), temperature and depth (based on pressure) along with additional information based on the oceanographer's scientific questions. These data sets allow oceanographers to make decisions regarding sampling depths and the productivity of the water column. This lesson utilizes CTD profiles from the Southern Ocean Diatoms expedition, as well as open-source data from the California Current Ecosystem Long Term Ecological Research (LTER) database, the Georgia Coastal Ecosystems LTER database and the Hawaiian Ocean Time Series (HOTS) database to encourage analysis and comparison of ecosystems and physical parameters.

Details

- Lesson
- Antarctic
- About 1 period
- Download, Share, and Remix
- Middle School and Up

Materials

CTD data profile sheets – (one per student – color)
CTD Lesson Student Data Sheet (one per student)
Claim/Evidence/Reasoning (CER) Rubric

Objectives

Students will be able to:
- Interpret physical and chemical characteristics of ocean water using CTD profiles from various ecosystems.
- Report findings related to CTD data to peers.
- Compare CTD data from different ocean regions to select regions of productivity.
- Use appropriate strategies to work cooperatively

Lesson Preparation

Students will complete an engaging Jigsaw activity to analyze data from CTD profiles. Each group is assigned one CTD profile for analysis. Upon completion of the Student Data Sheet, students return to original groups to compare four different CTD profiles. Students finish the lesson by completing a claim, evidence and reasoning activity based on a provided research problem/question. This lesson can be used to engage students before covering topics ranging from variations in the ocean to primary productivity/photosynthesis.

Prior to the lesson, teachers may pre-teach the following vocabulary: water column, salinity, thermocline.

Teachers may also show videos of CTD casts (see resources for an example) to introduce the lesson.

Procedure

1. View CTD cast video and ask students to describe the process and predict the importance of this technology.

2. Divide students into ‘home’ groups of four or five students (depending on class size). NOTE: You can also place group numbers at the top of the handouts prior to class to eliminate forming groups twice.
3. Provide each student in the group with a different CTD profile (five are provided with this lesson, but others may be obtained).
4. Distribute one copy of the Student Data Sheet to each student.
5. Ask students to form ‘expert’ groups by finding other students that have the same CTD profile. These ‘expert’ groups should work together to complete Part A of the Student Data Sheet.
6. Students should return to their ‘home’ groups and share their analysis with group members.
7. Students in the ‘home’ groups complete Part B of the Student Data Sheet.
8. As a group or on an individual basis, students complete the claim, evidence, reasoning section.
9. CER rubric available for formative assessment.

Extension

- Contact oceanographers and find out how they utilize CTD data in their research (potential for classroom presentation)
- Analyze CTD profiles that include additional measurements (oxygen, fluorescence, etc.)

Resources

Southern Ocean Diatoms Expedition Journals related to CTD:
September 11, 2016: First Cast https://www.polartrec.com/expeditions/southern-ocean-diatoms/journals/20... (https://www.polartrec.com/expeditions/southern-ocean-diatoms/journals/2016-09-11)
September 24, 2016: CTD https://www.polartrec.com/expeditions/southern-ocean-diatoms/journals/20... (https://www.polartrec.com/expeditions/southern-ocean-diatoms/journals/2016-09-24)
CTD cast video courtesy PolarTREC

Additional CTD profiles: Hawaii Ocean Time Series (HOTS) http://hahana.soest.hawaii.edu/hot/methods/ctdtsod.html (http://hahana.soest.hawaii.edu/hot/methods/ctdtsod.html)

Standards

a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry
a. Structure of the earth system
a. Abilities of technological design
b. Understandings about science and technology
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry
b. Structure and properties of matter
c. Chemical reactions
b. Geochemical cycles
a. Abilities of technological design
b. Understandings about science and technology

Next Generation Science Standards: Science and Engineering Practices

Developing and using models
Analyzing and interpreting data
Constructing explanations
Engaging in argument from evidence
Obtaining, evaluating and communicating information

Assessment

Pre-and post-questions
Jigsaw activity (self and peer assessment/collaboration)
Answers to Student Data Sheet questions
Claim/Evidence/Reasoning rubric

Author/Credits

Cara Pekarcik from North Quincy High School in Quincy, MA created this lesson as a follow-up to the 2016 PolarTREC Southern Ocean Diatoms expedition.
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Dr. Randelle Bundy is a Postdoctoral Scholar at Woods Hole Oceanographic Institution. Dr. Bundy created the CTD profiles using data from the 2016 PolarTREC expedition and other open-source databases.

CTD Profile Data:
Jenkins, Bethany; Chappell, Phoebe Dreux; Buck, Kristen (2016): September-October Southern Ocean Diatom Cruise. (CTD Antarctica 1, 2 and 3)

Di Iorio, Daniela (2004): March 2003 CTD, PAR, oxygen and chlorophyll profiles for the Georgia Coastal Ecosystems Altamaha River transect. Georgia Coastal Ecosystems LTER Project; University of Georgia; Long Term Ecological Research Network. http://dx.doi.org/10.6073/pasta/d199091b14cd71b9f67ad0b93a975b4d (http://dx.doi.org/10.6073/pasta/d199091b14cd71b9f67ad0b93a975b4d) (CTD Georgia Coast)

Goericke, Ralf (2016): Conductivity Temperature Depth (CTD) Log of CTD casts from CCE LTER process cruises in the CCE region, 2006 – 2014 (ongoing).. California Current Ecosystem LTER; SIO; Long Term Ecological Research Network. http://dx.doi.org/10.6073/pasta/9b4fd22f289fcb599f285904929c3e37 (http://dx.doi.org/10.6073/pasta/9b4fd22f289fcb599f285904929c3e37) (CTD California Coast)

Name: _____ Block: _____ Date: _____
Reeling in CTD Data
Student Data Sheet

Part A – Please complete the following questions in your 'expert groups'. All members of the 'expert' group should have the same CTD profile.

1. What color is used to represent the following measurement:
    a. Temperature: _____
    b. Salinity: _____
    c. PAR: _____

2. What is the temperature at the depth of 20m? If your CTD cast does not have a depth of 20m, answer the question using a depth of 5m.

3. Looking at the temperature readings, describe what happens to the temperature as the CTD moves deeper into the water column.

4. A **thermocline** is described as a rapid change in temperature in the water column. Is a thermocline present in the CTD profile? Describe the thermocline below and then mark the thermocline on the CTD cast.

5. What units are used to measure water salinity?

6. Describe the change in salinity as depth increases.

7. Average ocean salt water salinity ranges between 32-36psu. Does the CTD cast appear to be from salt water or from fresh water? Please explain your answer using evidence from the CTD profile.

8. A **mixed layer** is defined as the area of the upper water column where parameters like salinity and temperature do not rapidly change. Is a mixed layer present in this CTD profile? Is the mixed layer shallow or deep? Please explain your answer using information from the profile.

Please return to your 'home' groups to complete Part B

Part B – Please complete the following questions in your 'home' groups. All members of the 'home' group should have different CTD profiles.

1. Explain your CTD profile to the members of your group. Be sure to highlight the changes in temperature and salinity.

2. Identify ONE difference between the CTD profiles (this can be a difference between all or just some of the profiles – please be specific in the answer).

3. What is the deepest depth sampled between all four profiles?

4. Typically, salinity increases with depth. Do all the CTD profiles follow this general characteristic?

Part C – Claim, Evidence and Reasoning. Write a scientific explanation that answers the question below

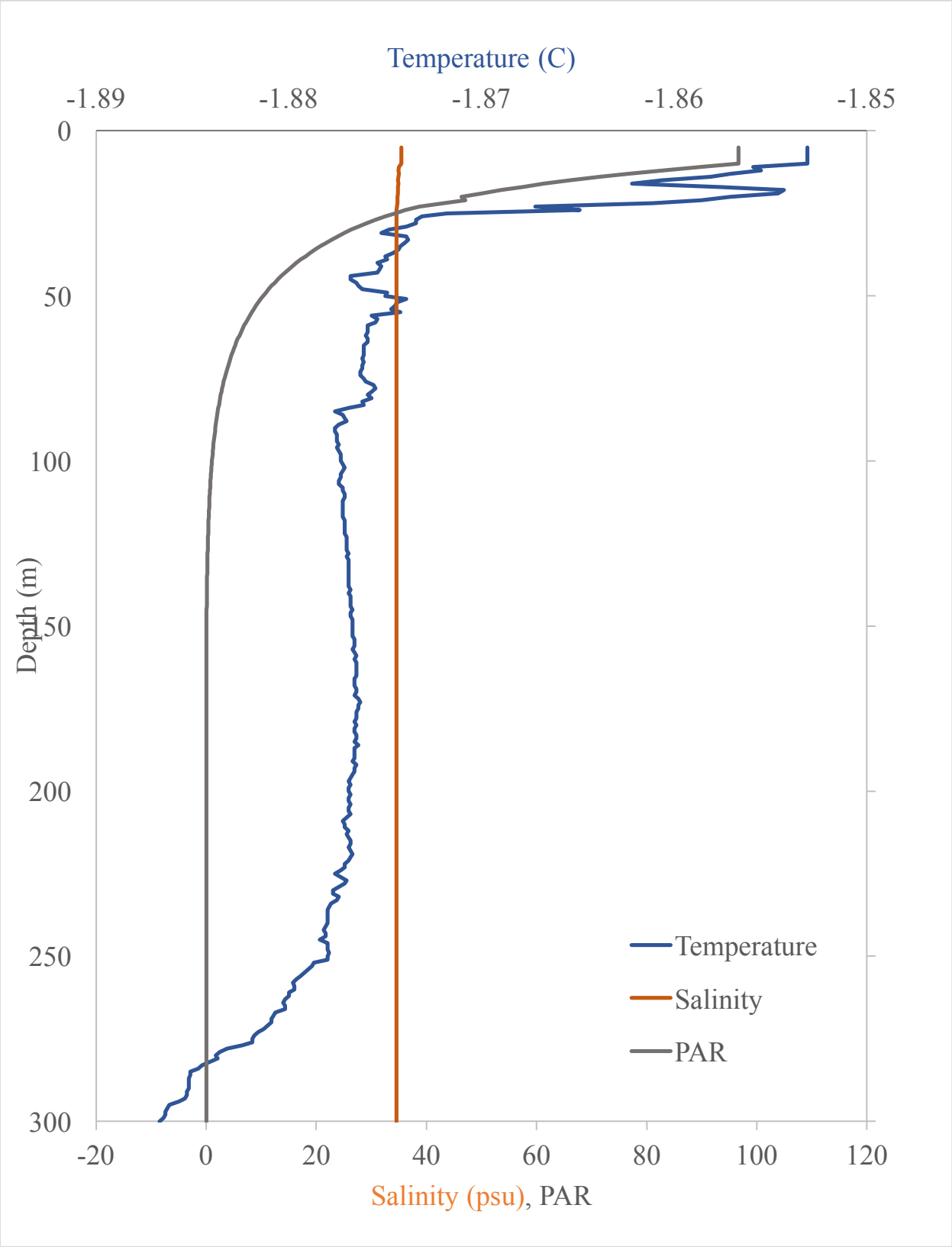
Question: Typically, temperature data decreases with depth. Do all the CTD profiles follow this general characteristic?

Claim (A conclusion that answers the original research question/problem):

Evidence (Scientific data that supports the claim):

Reasoning (Justification that links the claim to the evidence):

Name: _____ Block: _____ Date: _____



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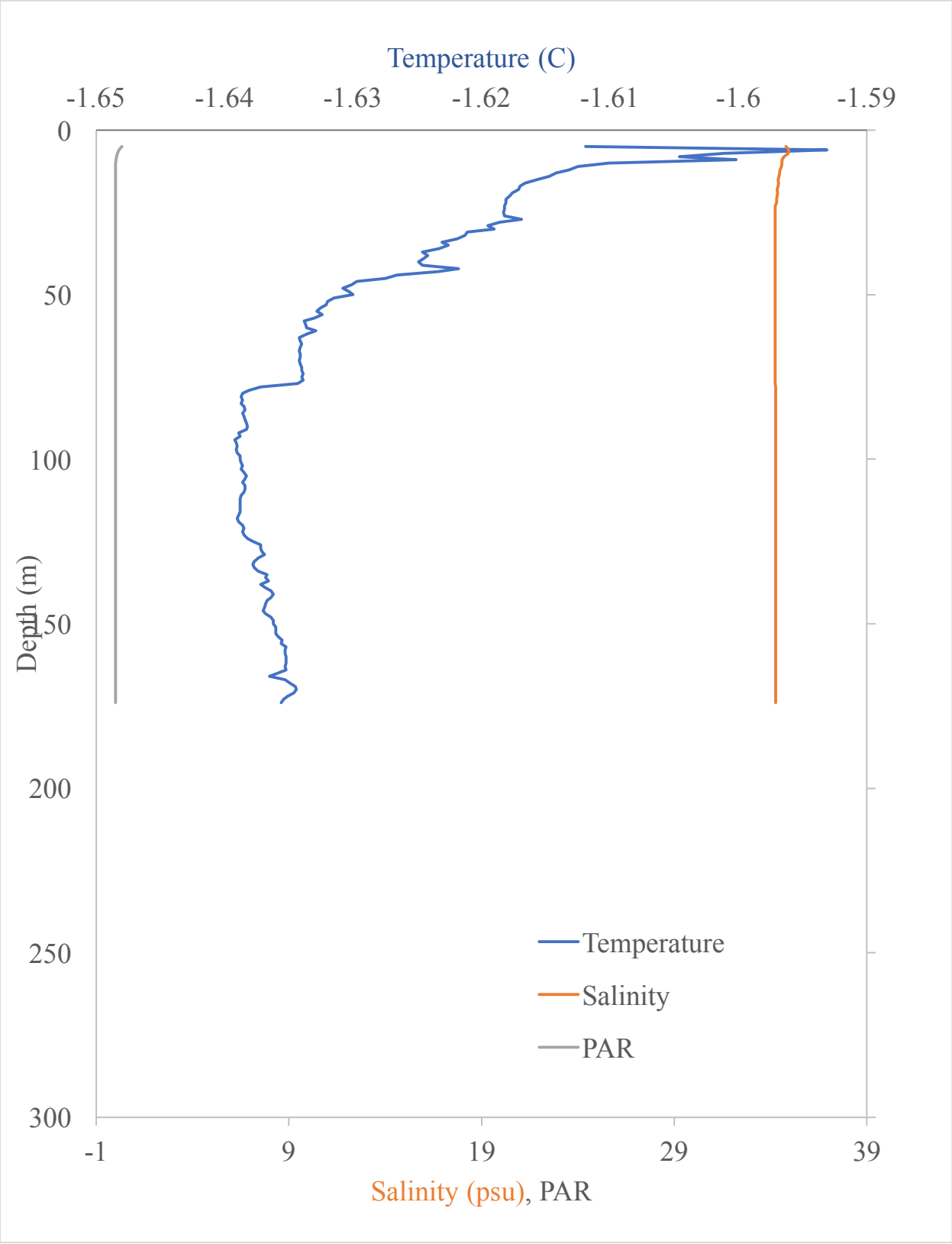

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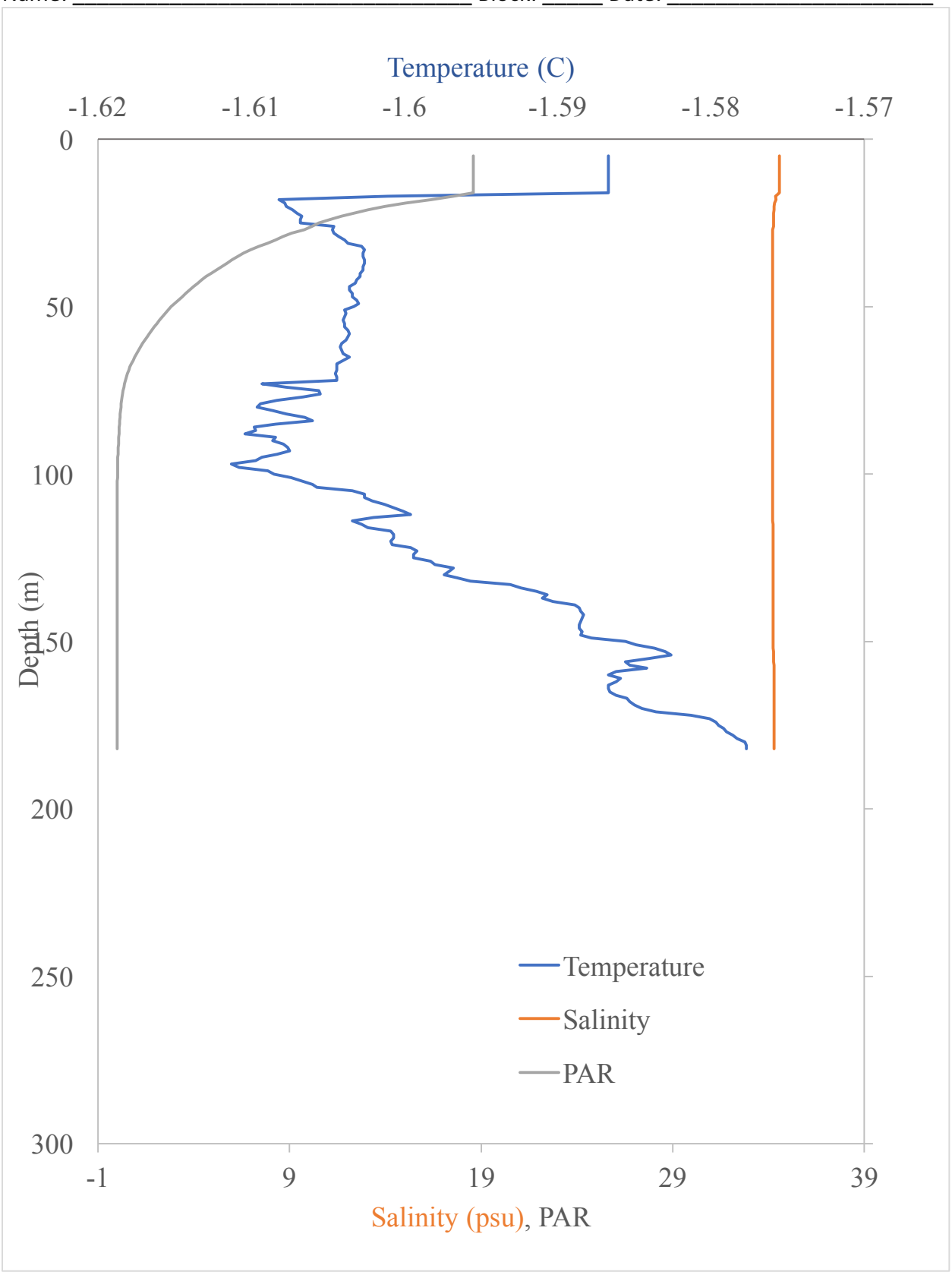

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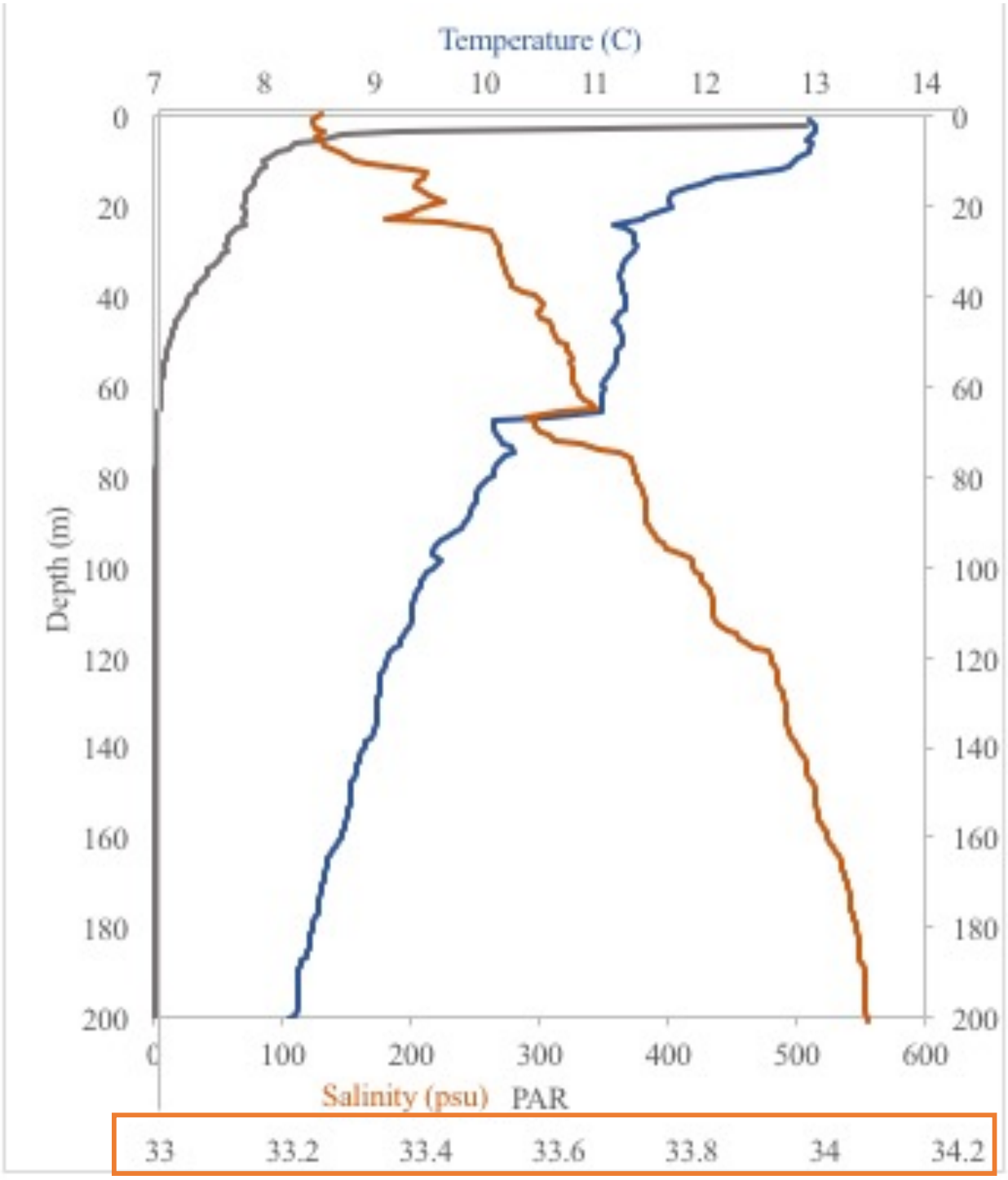

Name: _____ Block: _____ Score: _____/ 7

	0	1	2	3
Claim - A conclusion that answers the original research question/problem	Does not make a claim, or makes a claim that does not relate to the original research question/problem.	Claim is complete and relates to the original research question/problem		
Evidence - Scientific data that supports the claim.	Does not provide evidence.	Provides unrelated evidence	Provides appropriate but insufficient evidence to support the claim or also includes some inappropriate evidence.	Provides appropriate and suffient evidence to support claim.
Reasoning - A justification that links the claim to the evidence.	Does not provide reasoning	Provides reasoning that does not link evidence to claim.	Some attempt is made to relate evidence to underlying priciples, but there are missing pieces. (Repeats evidence and/or insufficient scientific principles).	All of the ideas necessary to link evidence ot the claim are included.