POLAR TREC
Learning Resources

Details

Completion Time: Less than a week

Permission: Download, Share, and Remix

Nature's Density Column

Materials

- Laptop computer
- Projector
- Worksheet
- Colored ice cubes with glitter frozen inside
- Salty water (dissolve salt in warm water, allow it to cool)
- Food coloring
- Glassware (for students)

Overview

Nature creates its own density column in marine systems, which is extremely important for the triggering of the spring bloom of phytoplankton. Phytoplankton are an important food source for all organisms- from microscopic zooplankton to large marine mammals such as walrus and whales. The different salinities (and therefore, different densities) of water help to stabilize the water column (by limiting mixing) and keep the phytoplankton near the light, which is one factor necessary for the spring bloom to occur, especially in areas like the Arctic. Students will build their own density columns with different substances and answer questions in a worksheet to reinforce concepts learned.

Objectives

The goal of this lesson is to convey a part of my research to the students, and I want to tie in what they are currently studying to my research. I also want them to see that nature can create its own variations in density. My research is centered in the Bering Sea, and I wanted to have the chance to show students some of what we studied while we were in the Arctic. Students should walk away with the understanding that density columns exist in nature.

Lesson Preparation

Set up projector for PowerPoint presentation and prepare lab materials and worksheets for students. The students can be grouped into teams of four to complete the lesson.

Background information:

Density columns can form in water that has different salinities. These kinds of density columns are extremely important in nature- in the Arctic the ice melts and forms a freshwater layer on top of the saltier ocean water. Inside this ice are phytoplankton that melt out. The water

is in two layers (freshwater on top of salt water). The phytoplankton stay in the freshwater layer because it cannot easily mix with the saltier layer below it. This keeps them at the surface where they are exposed to lots of sunlight, which allows them to expand their numbers. This is important because they are an important food source for other organisms- most of the marine ecosystem depends on the phytoplankton in some way for food.

Procedure

1) Elicitation questions:
Can water exist at different densities? (prior knowledge that water has a density of 1.0g/mL)
Which do you think is more dense, fresh or salt water? Can you think of a way to test which one is more dense?

2) After discussing the above questions with the students, have them create their own density columns using salt and fresh water (in the form of ice). They will do this in groups of four. The salt water will already be prepared (and dyed) for them. Colored ice will be available. Students will put together the column and observe what happens as the ice cube melts (observations will be recorded in a data table).

3) As a class, discuss their observations and what they learned about the density of different types of water. Talk about some real life examples of natural density columns and why they are important- using specific examples from the Bering Sea. Specific topics covered could be:

1. The importance of density in the stabilization of the water column
2. The presence of phytoplankton in the bottom of the sea ice- which are released into the freshwater layer as the ice melts. These phytoplankton help to start the spring bloom in the water column.
3. A stable water column with a freshwater layer keeps the phytoplankton at the top, where they are exposed to more sunlight than if they were in deeper parts of the water column. Since phytoplankton are microscopic plants, being exposed to sunlight helps them to grow in number.
4. Phytoplankton go to feed all other organisms in the marine environment. Using a PowerPoint presentation, students will view graphs of the water column as it goes through different stages of ice cover, and see how as the layers form, the chlorophyll increases in the less dense freshwater layer.

During the PowerPoint, students will be in charge of filling out a worksheet. At the end, students will fill out a couple of short evaluation questions that address some of the concepts covered in the lesson, and bring them back to the discussion that we had at the beginning of the lesson

In the event that your lesson runs short of the allotted time, you can extend the discussion of density in nature and talk about other examples besides the Bering Sea where they might see a density column form.

Learning Resources

If your lesson is running long, you can shorten the discussion about real world density columns.

Extension
ELL/SPED Modifications:
Pictures and diagrams will be used along with discussion, and students will work in groups. The evaluation/lab sheet can be modified to meet the needs of other classrooms if necessary.

Resources
N/A

Assessment
All work will be completed in class. There will be a worksheet for the students to fill out about the lesson and assess their understanding of the concepts covered.

Credits
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Learning Resources

National Science Education Standards (NSES)

Content Standards, Grades 5-8

Content Standard A: Science As Inquiry
a. Abilities necessary to do scientific inquiry
b. Understandings about scientific inquiry

Content Standard B: Physical Science
a. Properties and changes of properties in matter

Content Standard C: Life Science
a. Structure and function in living systems
d. Populations and ecosystems

Content Standard F: Science In Personal and Social Perspectives
b. Populations, resources, and environments

Other Standards

Washington GLE's/EALRS:
1.1.1: Understand how to use physical and chemical properties to sort and identify substances
1.1.5: Understand how to classify rocks, soils, air, and water into groups based on their chemical and physical properties
1.2.1. Analyze how the parts of a system interconnect and influence each other
1.2.4. Understand the components and interconnections of Earth's systems

Nature's Density Column

Procedure/Data Table

1. Get one glass jar for your team
2. Measure 150mL of blue salty water using a graduated cylinder, and place it in the jar.
3. Get a green ice cube and **GENTLY** place it into the water in your jar
4. Observe over a period of 10 minutes, or until the ice cube melts
5. Record your observations in the data table below

Prediction: What do you think will happen to the ice cube in the salty water? Explain why- include a picture if this helps to explain your thinking.

Time (minutes)	**Observations (What is the ice doing? What is the saltwater doing? Include a picture of what you observe)**
0	
2	

4	
6	
8	
10	

Draw a picture of what your density column looks like:

Which is more dense- the freshwater from the ice **OR** the saltwater? Explain how you know this.

_____
_____
_____
_____
_____
_____

Nature's Density Column

Part Two

Where do you find density columns in nature?

How do density columns form in places like the Bering Sea/Arctic?

What are phytoplankton? Why do they need sunlight?

How does a density column help phytoplankton to bloom?

Why are phytoplankton SO important in places like the Bering Sea/Arctic?

Nature's Density Column

Nature creates its own density column

Example: The Bering Sea

- As you discovered in your experiment, when ice melts it forms a less dense layer of freshwater on top of the more dense layer of saltwater

- These types of density columns exist in nature, especially in areas like the Arctic (Bering Sea)

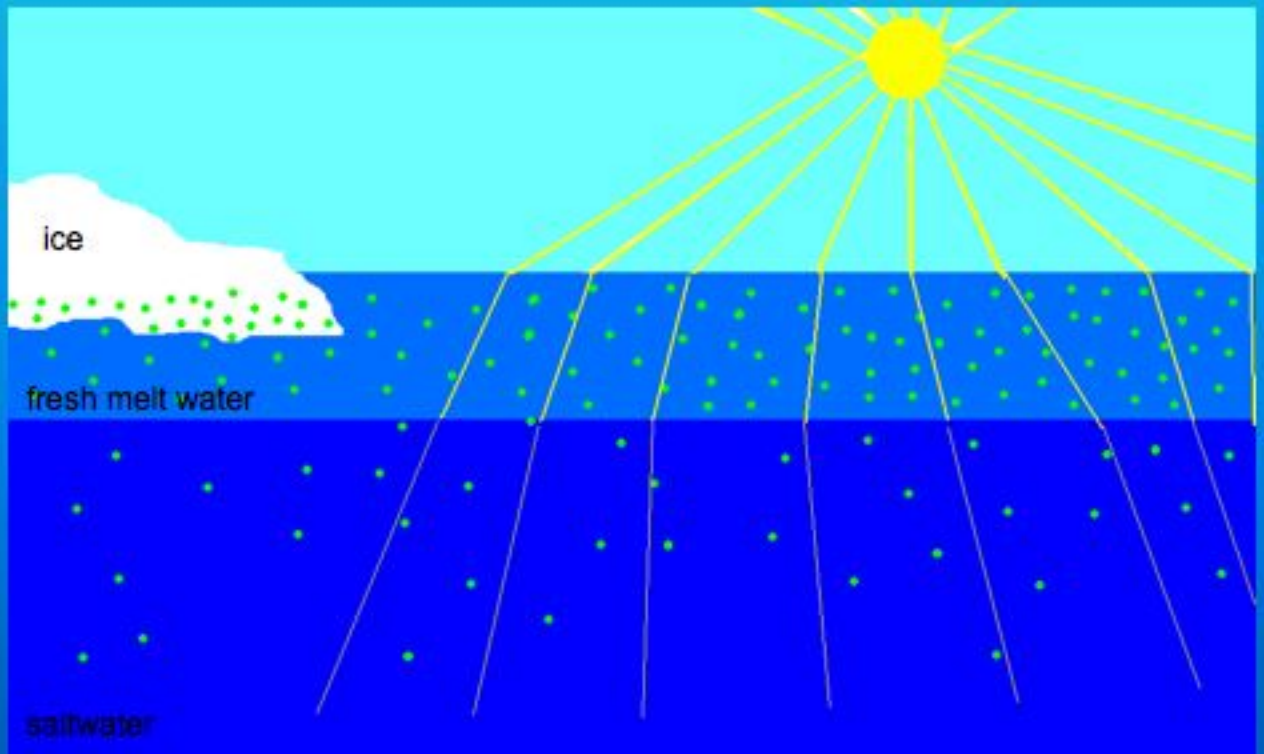
Can you think of other areas where freshwater and saltwater meet?

Density columns are extremely important in the Arctic

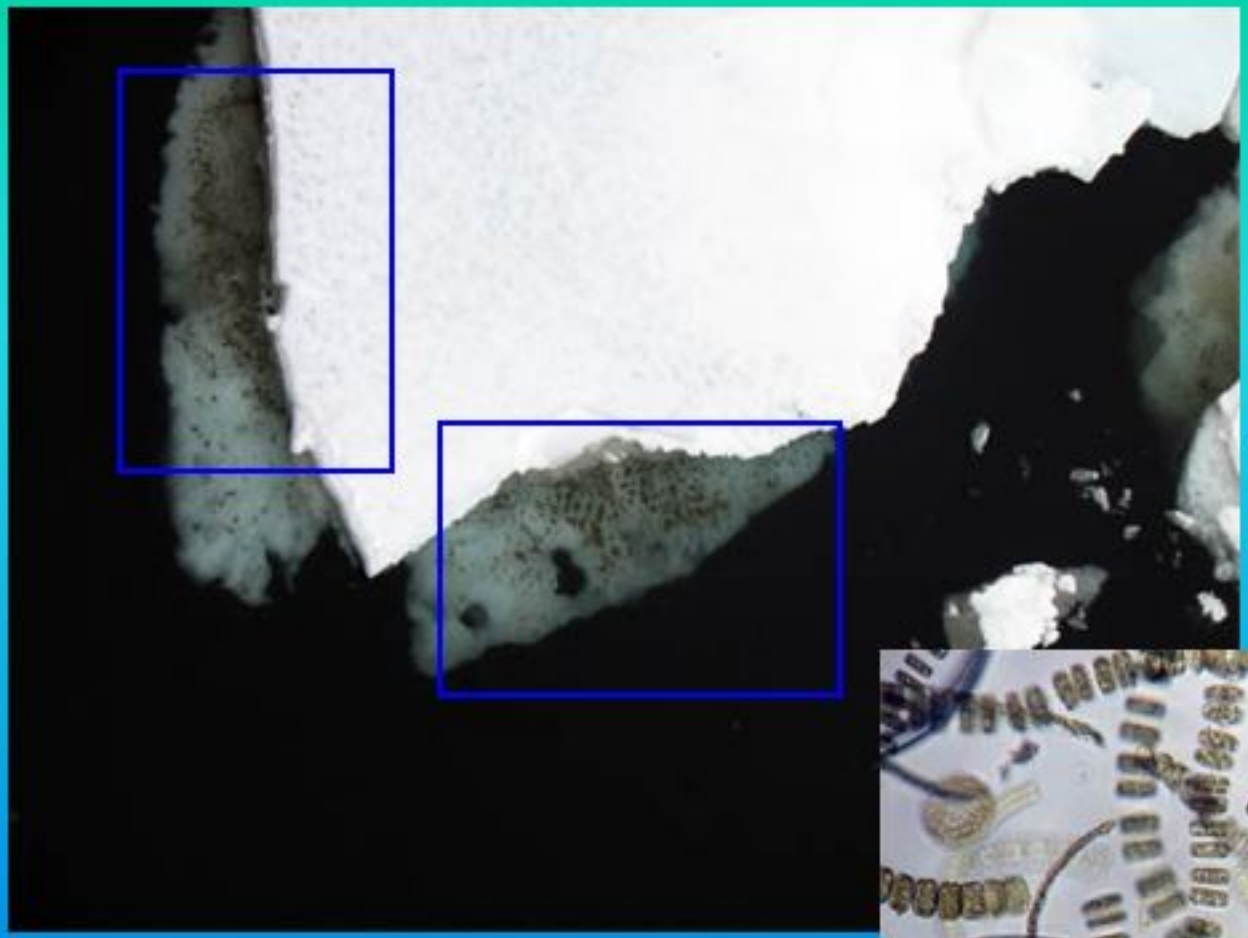
- The two layers of different density water have a hard time mixing together- it usually takes a storm or lots of wind to mix the two layers.
- Phytoplankton (**microscopic plants**) live in the ice. When the ice melts, the phytoplankton are released into the water.
- The phytoplankton mostly stay in the freshwater layer because it cannot mix easily with the more dense, salty water below it.

Why is this so important?

- The phytoplankton depend on sunlight to create their food- using chlorophyll
- Sunlight can only go so deep into the water before it runs out.
- By staying in the freshwater layer, the phytoplankton get more light than they would if they could travel to the saltwater layer.



- More sunlight means more food for the phytoplankton.
- Like all plants, the sun helps them to grow and multiply their numbers very quickly. When they do this, it is called a "bloom"
- Phytoplankton are a **very important** food resource for all other organisms in the water.
  - They get eaten by microscopic animals (zooplankton)
  - They are also eaten by organisms that live on the bottom of the ocean (benthic organisms)
  - Zooplankton and benthic organisms are then eaten by large animals such as fish, birds, walrus, whales, etc
- **Without phytoplankton, most life in the water would not exist.**



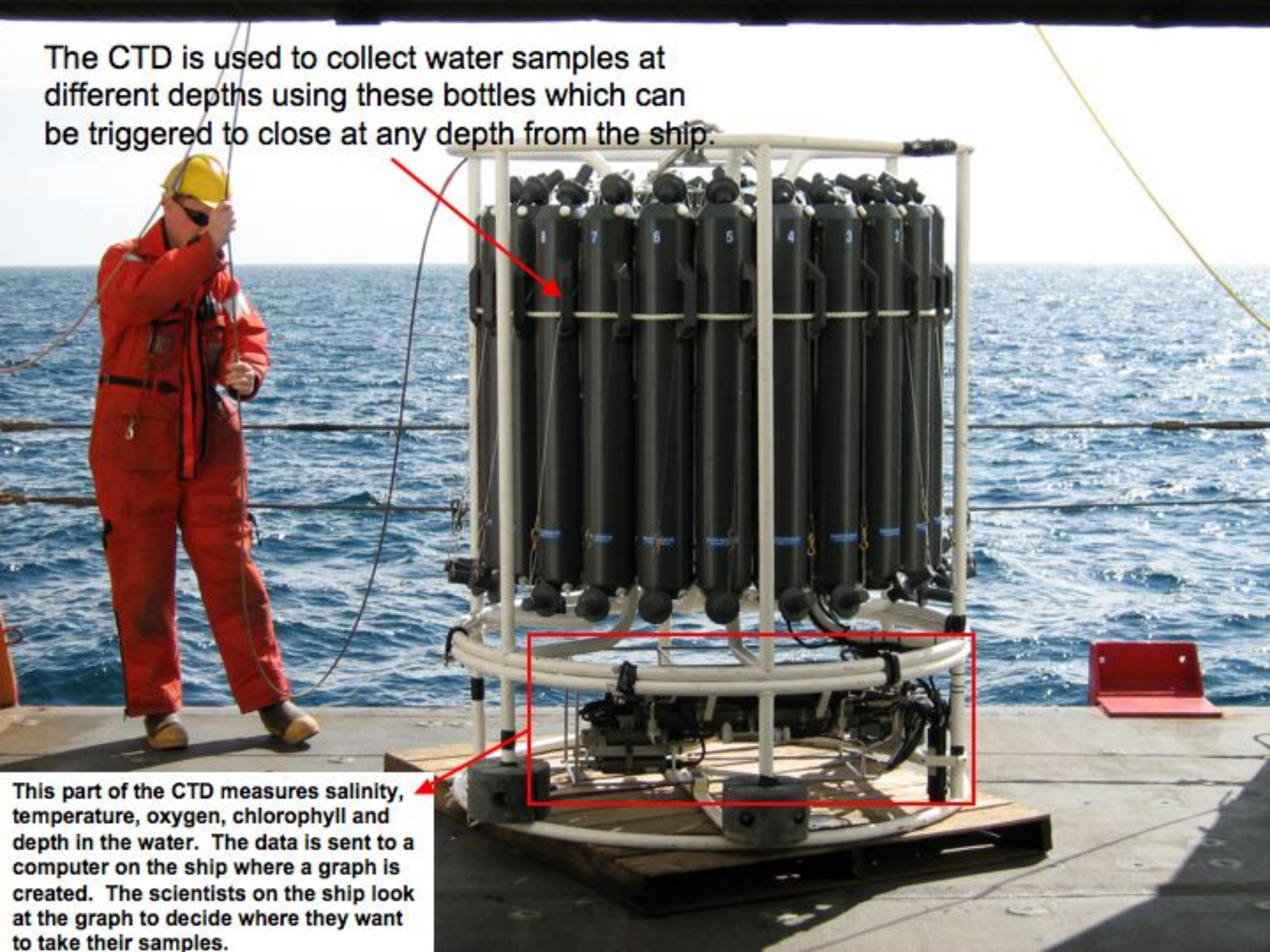
ABOVE: Sea ice with phytoplankton living inside it (see all the brown?)

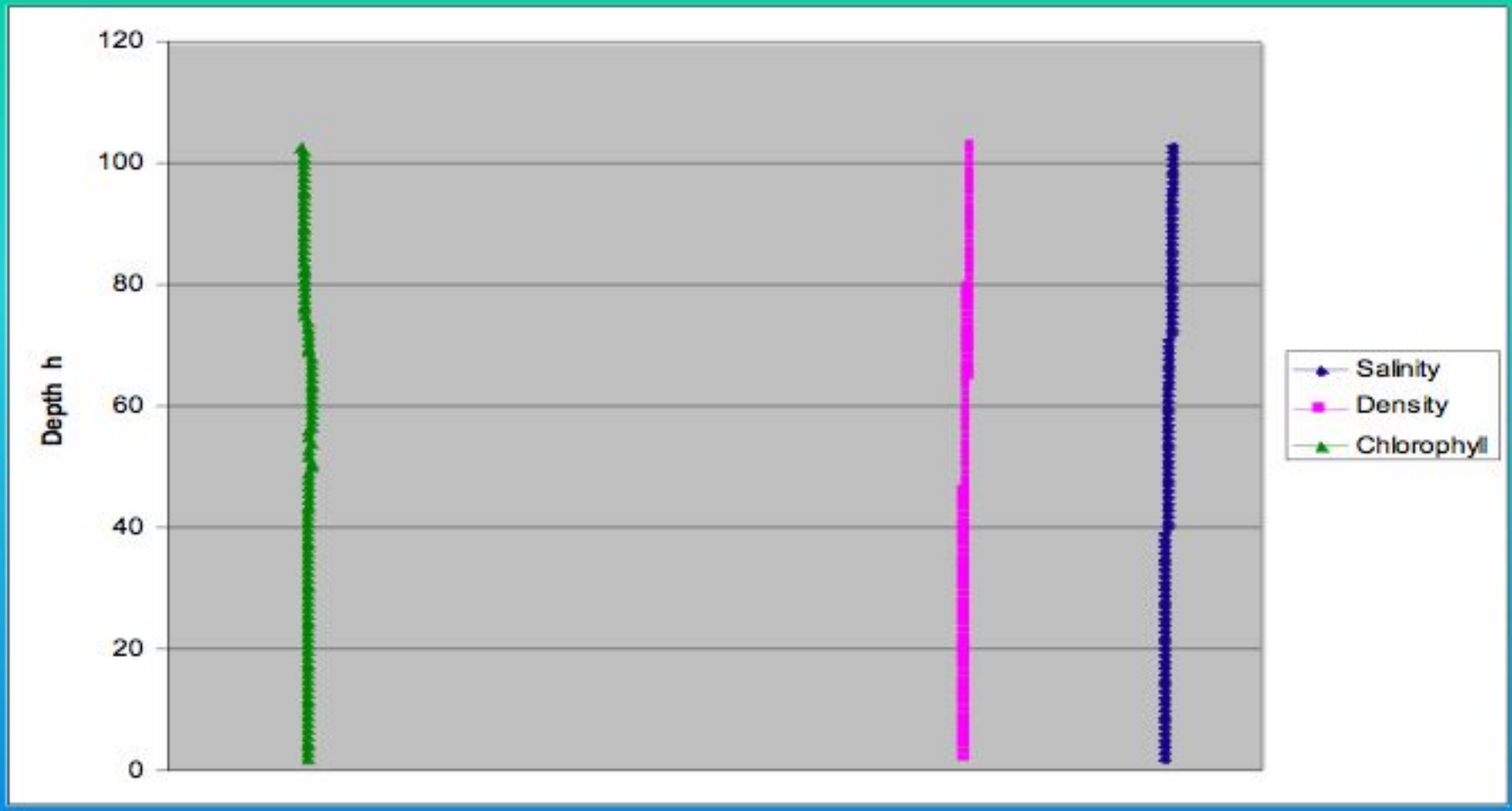
BELOW: The phytoplankton (viewed with a microscope) found in the ice and water. Millions and millions of these tiny cells in long chains make up a phytoplankton bloom

Definitions

- **Chlorophyll:** What plants use to create their food, using energy from the sun.
  - Oceanographers measure the amount of chlorophyll in the water, which gives them a good idea of how much **phytoplankton** are in the water.
- **Salinity:** A word used to describe how much salt is in the water.
- **CTD:** An instrument that collects water from different depths in the water, as well as measures things like salinity, temperature, depth, oxygen, and chlorophyll in the water.

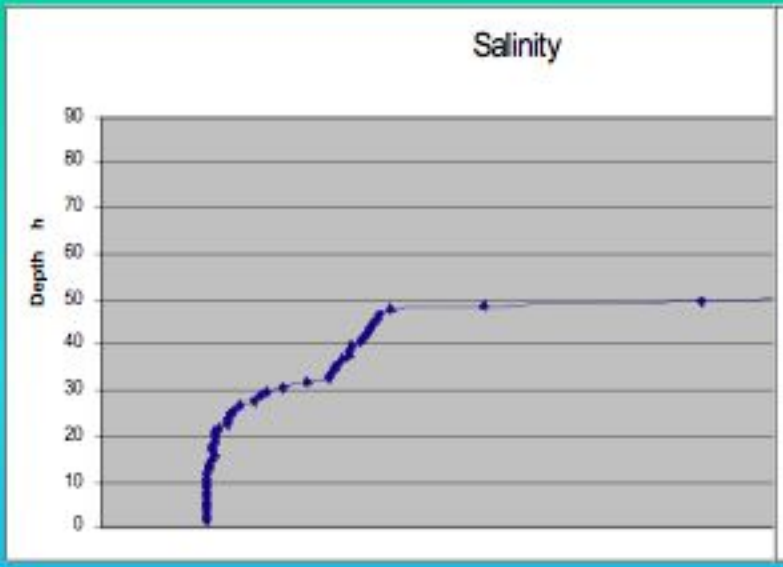
…In the next few slides, we will look at the **salinity, density** and **chlorophyll** data collected on this year's Bering Sea cruise…

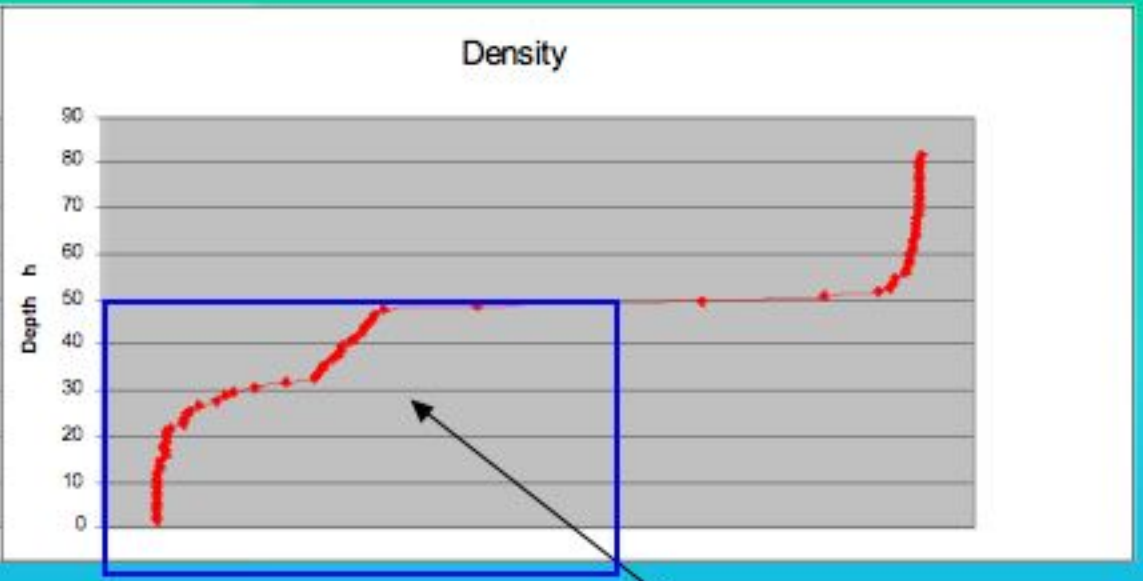

The CTD is used to collect water samples at different depths using these bottles which can be triggered to close at any depth from the ship.
This part of the CTD measures salinity, temperature, oxygen, chlorophyll and depth in the water. The data is sent to a computer on the ship where a graph is created. The scientists on the ship look at the graph to decide where they want to take their samples.

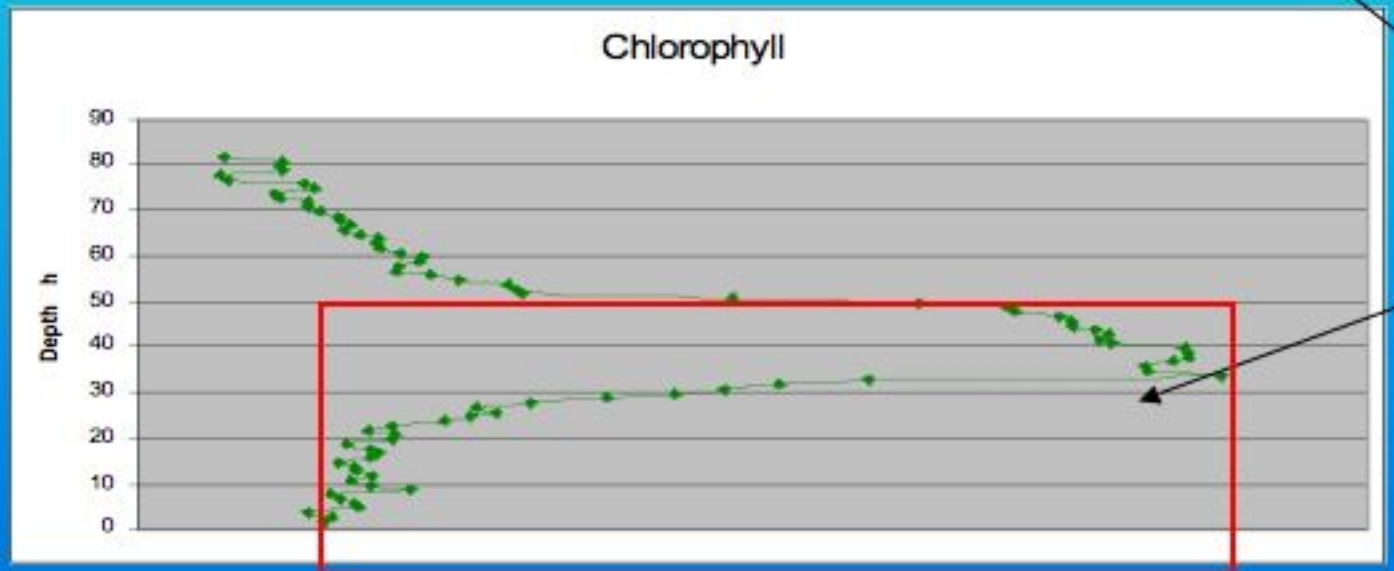


Station 5- Ice covered station

What do you notice about the salinity, density and chlorophyll at this station?



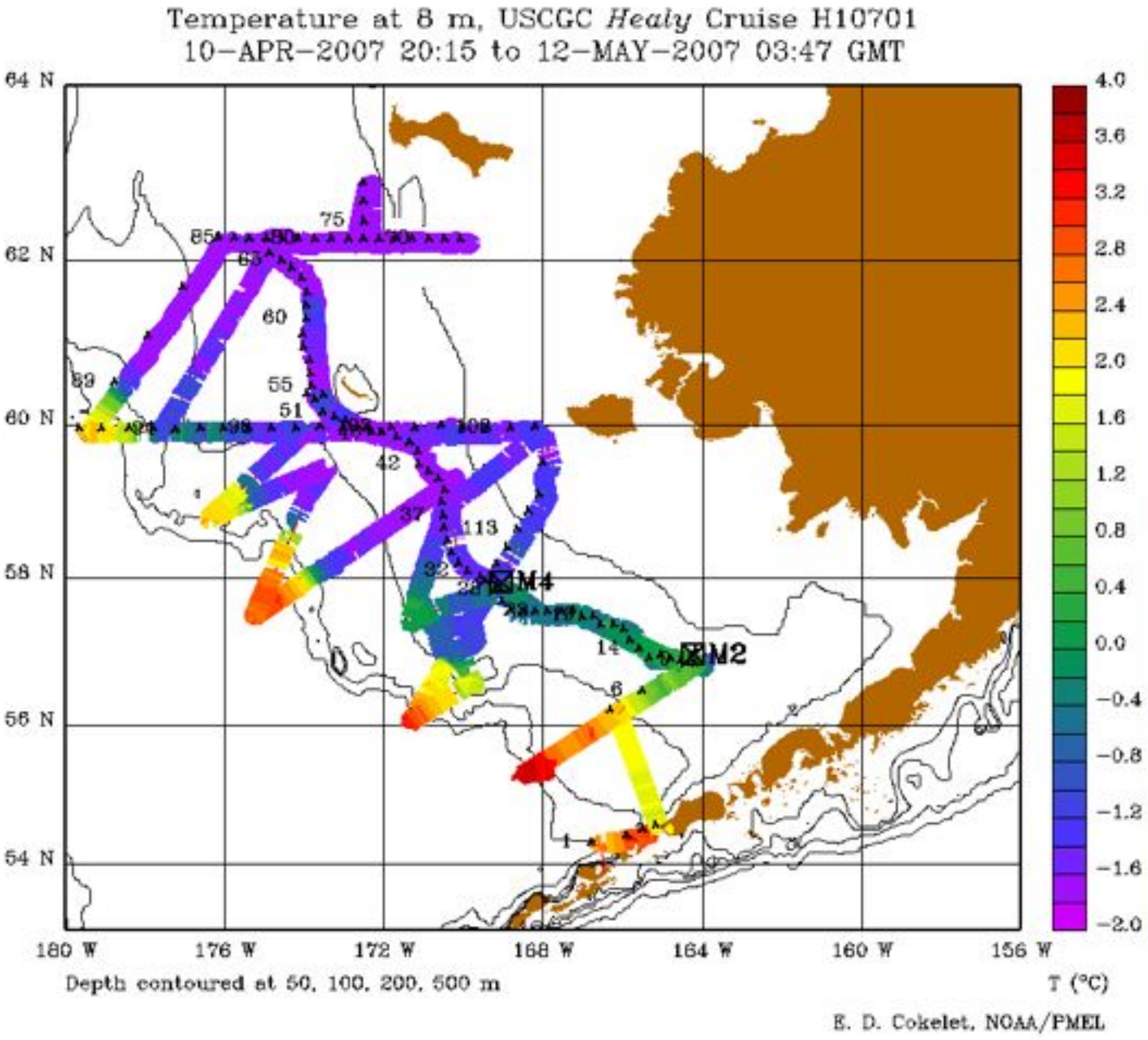


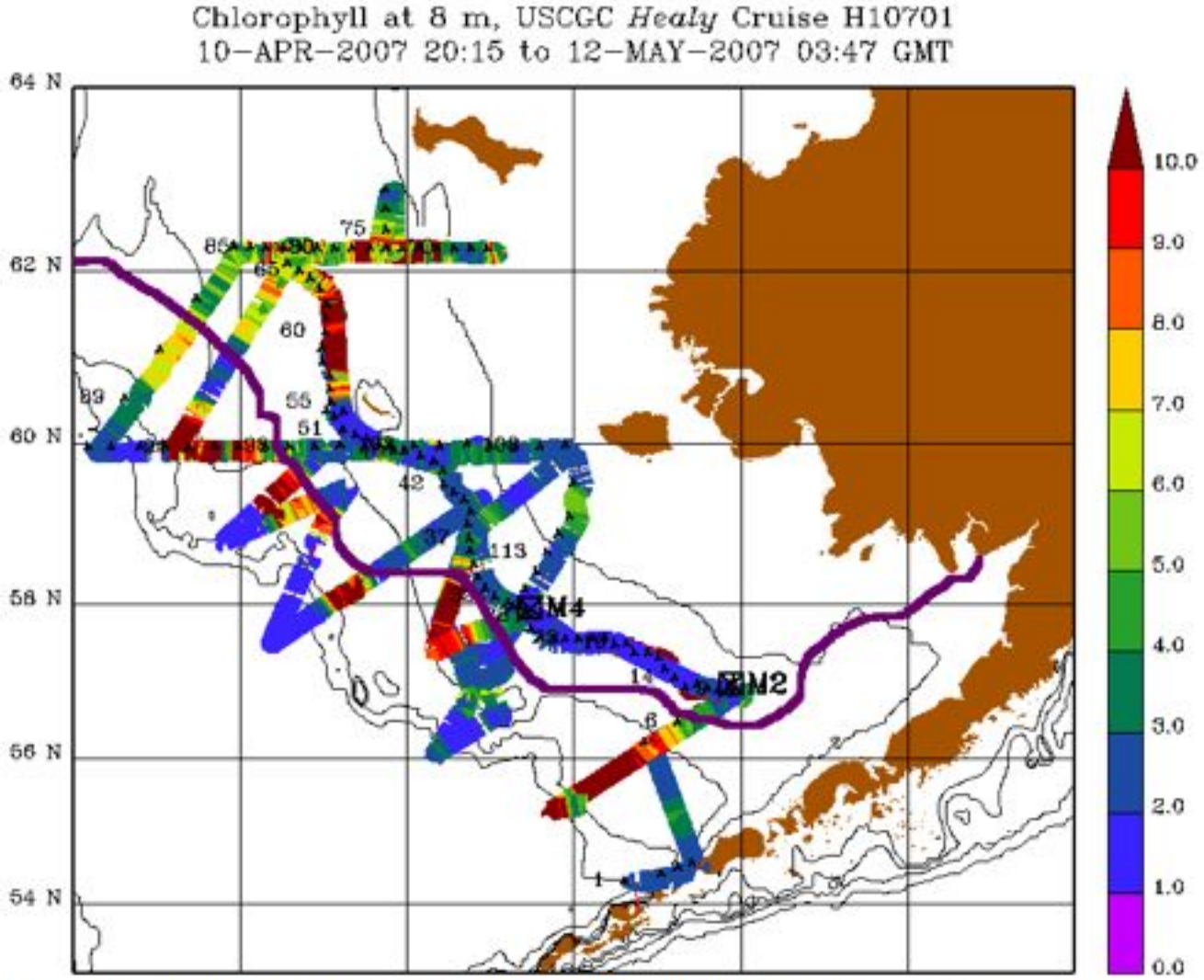


What does the density look like where the most chlorophyll occurs?

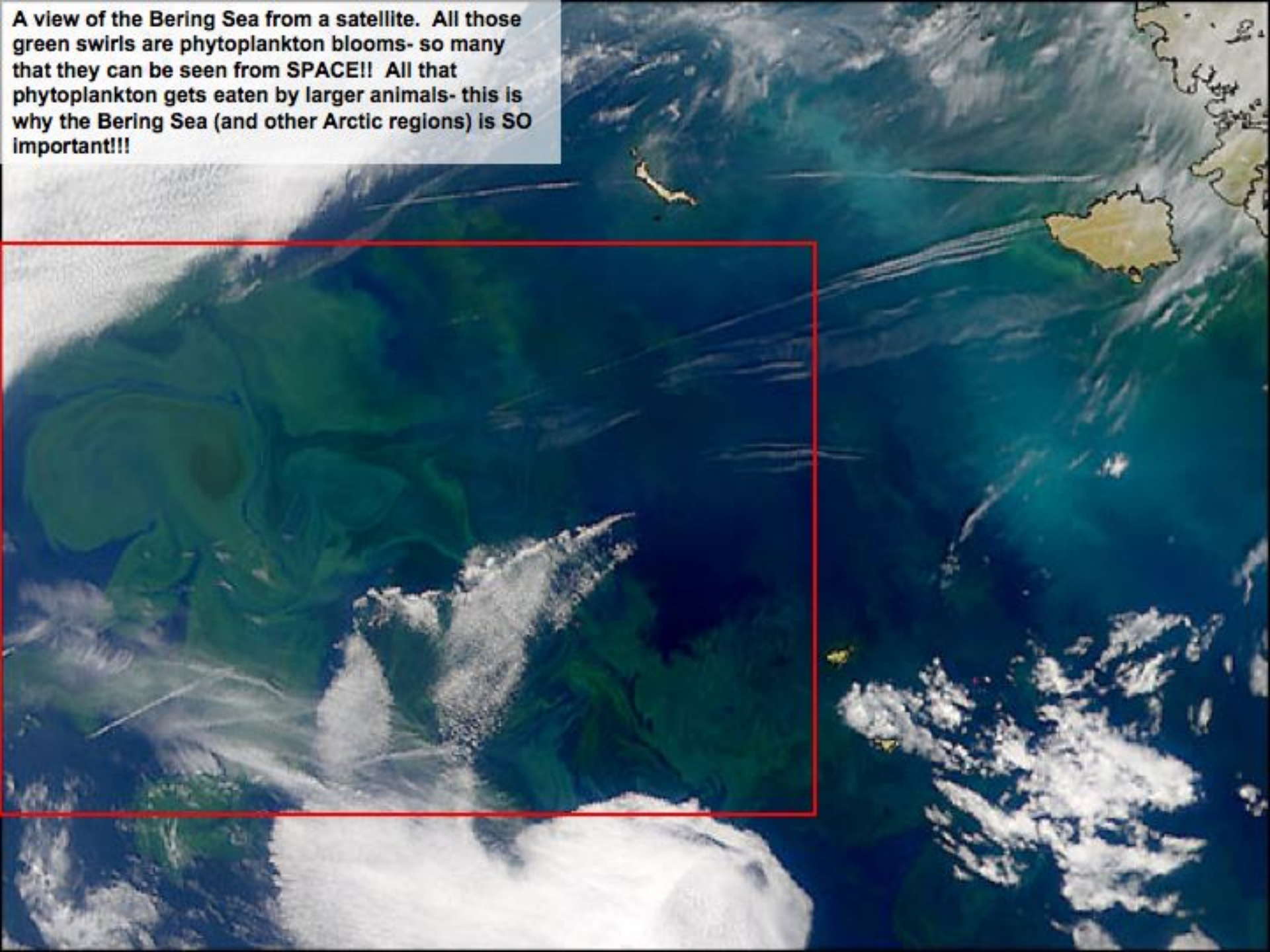
What causes the low density?

Station 133: Located at the edge of the ice


Temperature at 8 m, USCGC Healy Cruise H10701
10-APR-2007 20:15 to 12-MAY-2007 03:47 GMT
64 N
62 N
60 N
58 N
56 N
54 N
180 W
176 W
172 W
168 W
164 W
160 W
156 W
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
−0.4
−0.8
−1.2
−1.6
−2.0
DM4
DM2
Depth contoured at 50, 100, 200, 500 m
T (°C)
E. D. Cokelet, NOAA/PMEL



The dark purple line shows where the ice edge is. What do you notice about the amount of chlorophyll (phytoplankton) that are in the water at the ice edge?


A view of the Bering Sea from a satellite. All those green swirls are phytoplankton blooms- so many that they can be seen from SPACE!! All that phytoplankton gets eaten by larger animals- this is why the Bering Sea (and other Arctic regions) is SO important!!!


QUESTIONS?