

Name:

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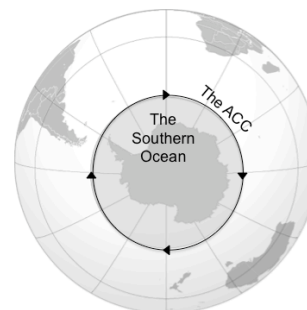
## The Southern Ocean

### Guiding Question:

- What are the seasonal environmental characteristics of the Southern Ocean?

### Introduction

The Southern Ocean surrounds the continent of Antarctica, and has been recognized as an independent 'ocean' since 2000 due its unique features. One important defining feature of the Southern Ocean is the Antarctic Circumpolar Current (the ACC), which is the world's biggest ocean current, and flows eastward.



Due to the pattern of circulation of the ACC, the Southern Ocean is somewhat isolated from the waters of the Atlantic, Pacific, and Indian Oceans. At the same time, it acts as a connecting link in the circulation of the world oceans. In terms of area, the Southern Ocean is the fourth largest ocean after the Pacific Ocean, Atlantic Ocean, and Indian Ocean, but before the Arctic Ocean.

In the Southern Ocean, sea surface temperature (SST) varies from about ten degrees Celsius to about two degrees Celsius. Storms travel eastward around the Antarctic continent and frequently are intense due to the temperature contrast between ice and open ocean. The area from the edge of Antarctica to the Antarctic Circle has, on average, the strongest winds found anywhere on Earth. In the winter the ocean freezes outward in the Pacific and Atlantic sectors. Although the air temperatures goes below zero degrees Celsius, some coastal areas are kept ice-free throughout the winter because of the intense and persistent winds from the interior of Antarctica.

The Southern Ocean has several different patterns of variability. Distinct "fronts" (areas in which variables change rapidly) can be seen in both SST and chlorophyll data. The chlorophyll concentration is a measure of the growth of phytoplankton (microscopic ocean plants), or their productivity. The seasonal patterns are also quite distinct, due to the large differences in the amount of sunlight the area receives between winter and summer, and partly due to the movement of the sea-ice boundary.

### *Part 1: Reading questions*

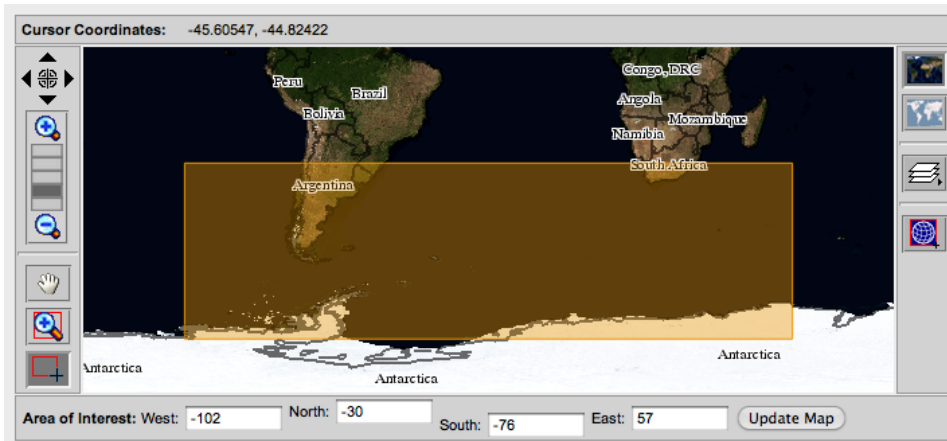
Where is the Southern Ocean?

What is the ACC?

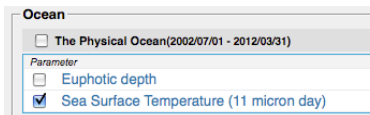
What causes seasonal patterns in sea surface temperature and chlorophyll concentration?

## Part 2: Temperature patterns

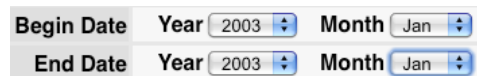
1. From the Student Climate Data website (<http://studentclimatedata.unh.edu>), click on the 'Ocean Data' tab at the top of the page.
2. Under 'Tools and Data' in the left panel, click 'DICCE Portal' to bring you out to the NASA DICCE data portal.
3. Click on the map, and drag your mouse across the screen, or use the Area of Interest box, to create a box that encompasses the Southern Ocean in the Atlantic zone.



4. Under the 'Physical Ocean' parameter section, click the box next to 'Sea Surface Temperature.'



5. In the 'Temporal' section, set both the Begin and End Date years to '2003' and months to 'Jan.'



6. Using the 'Select Visualization' drop-down menu, select 'Lat-Lon map, Time-averaged.'
7. Click [Edit Preferences](#) and under the **Color Bar** section click 'Custom.' Set the **Min value** to 4 and the **Max value** to 20.
8. Click [Generate Visualization](#)

- As the image is loading, use a map, atlas, or online tool (such as Google Maps) to label the following landmarks on the map below: Cape Town, the Falkland Islands, Antarctica. Identify the following ocean-marks: the Atlantic Ocean, the Pacific Ocean, the Indian Ocean, the Drake Passage, the Ross Sea, the ACC.



- Observe the pattern of sea surface temperature from South America (left side of the image) to Africa (right side of the image). At what latitude range (remember, latitude lines run east-west, or horizontally) do you see the biggest temperature change? (*This would be the approximate boundary between the Southern Ocean and the Atlantic*). What are the values above and below this range?

- Return to the data portal page by clicking the [Home](#) tab on the top-left of the page.
- Keep all parameters the same, except in the **Temporal** section, change the end month to 'Dec' (leaving the starting month as 'Jan').
- Using the '**Select Visualization**' drop-down menu, select 'Animation'. Check Edit Preferences to see that the Color Bar Min is set to 4 and the Max to 20.
- Click [Generate Visualization](#)
- How does sea surface temperature change over the course of a year?

- Does the position of the ACC change? How can you tell?

### Part 3. Patterns of chlorophyll

- Return to the data portal page by clicking the [Home](#) tab on the top-left of the page.
- Click *off* the Sea Surface Temperature box, and click *on* the box next to 'Chlorophyll a concentration.'

<input type="checkbox"/> Ocean Biosphere(1997/09/01 - 2014/12/31)		
Parameter	Data Product Info	
<input checked="" type="checkbox"/> Chlorophyll a concentration	SWFMO_CHLO.CR	SeaWiFS
<input type="checkbox"/> Chlorophyll a concentration	MAMO_CHLO_9km.CR	MODIS-Aqua

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3. Keep Animation selected, and under [Edit Preferences](#) set the **Color Bar Min** to 0.05 and the **Max** to 1.5.
4. Repeat the animation generation for 2003 for chlorophyll.
5. Describe the chlorophyll pattern in January. How does this compare with the patterns for SST in January?
  
6. As you progress through the months, what is happening to the pattern of chlorophyll in the images? What do you think is causing this?
  
  
  
  
  
  
  
  
  
  
7. Which months do you see the highest values of chlorophyll in the Southern Ocean?

#### **Part 4. Light**

1. Return to the data portal page by clicking the [Home](#) tab on the top-left of the page.
2. Click *off* the Chlorophyll a concentration box, and click *on* the box next to 'Photosynthetically Available Radiation' (PAR, or sunlight) under 'The Energy and Radiation System'.
3. Repeat the animation generation for 2003 for PAR. *\*Note: Ocean areas that are white represent areas with no data available.*
4. Describe the patterns in light intensity for January.
  
  
  
  
  
  
  
  
  
  
5. What is the brightest month? When is the darkest month?
  
  
  
  
  
  
  
  
  
  
6. Is there a relationship between patterns in PAR and Chlorophyll concentration? If so, why?