POLAR WEEKEND

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

SHRINKING ICE SHEETS & RISING SEA LEVEL

TOPIC: Shrinking Ice Sheets and Rising Sea Levels

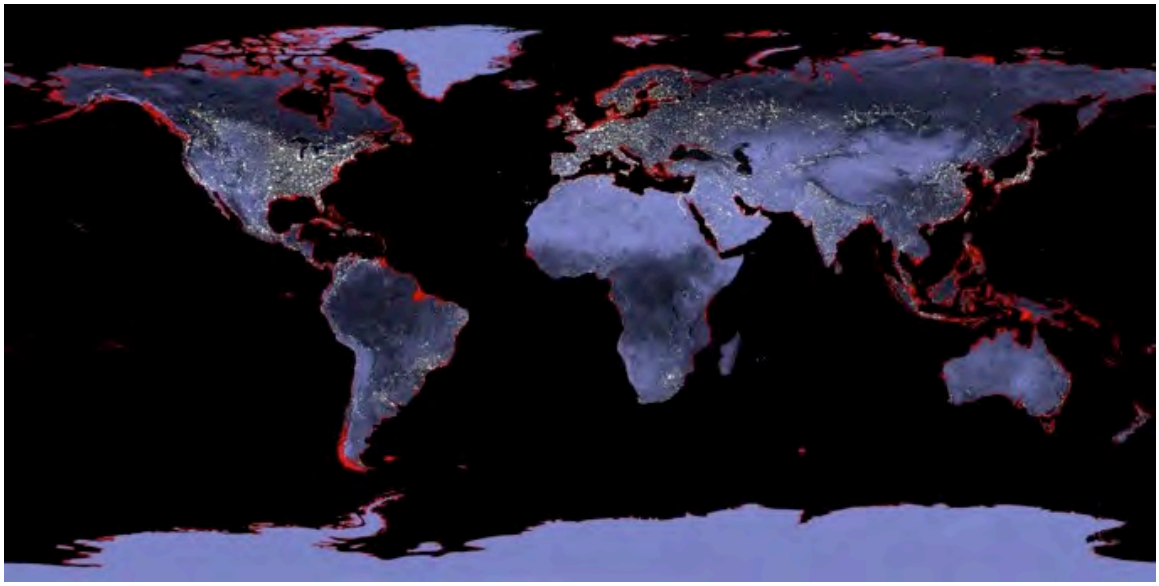
PROJECT PERSONNEL:
Dr. Robert Bindschadler,
Glaciologist, NASA
"Scientists provide information on what they see, measure and record – it is up to the public to be the stewards of the planet."

PHOTO: 'Dr. Bob' dressed in his Antarctic parka in the field on the West Antarctic Peninsula

WHERE ON THE MAP ARE WE?
The Antarctic continent is divided into two main parts - East and West with the Transantarctic Mountains being the dividing line. Dr. Bob's research has focused on the West Antarctic Ice Sheet (WAIS), and specifically during IPY was focused on the Pine Island Glacier (called PIG on this map) the most active glacier anywhere in Antarctica. In fact, he and his team were the first people to actually set foot on the PIG ice shelf! In the winter the temperature drops to -50 degrees C and the winds are fierce! PIG is ~ 2300 km (1400 miles) from McMurdo Station, the U.S. Antarctic Program's main base.

GENERAL BACKGROUND INFORMATION ON THE SUBJECT:
Ice sheets change sea level as they grow and shrink. Humans are vulnerable to rapid changes in sea level because the coasts are developed economically with tourism and trade and 1/3 of the world's population lives within the coastal zone. What kind of threat is Sea Level Rise (SLR)? One of the things we don't understand well is the role of ice sheets and glaciers in SLR. We do know

that Ice Shelves are important because they act like a wall holding back ice streams that bring ice from the glacier flowing off the edges of the continent and into the oceans. Once the ice shelves melt or break away, they release the ice streams the flow behind them causing them to speed up bringing more and more ice to the ocean. Another way to think about it is the ice shelf is like popping the cork out of a bottle. Ice sheets themselves don't add to SLR since they are already floating, but continental ice that starts out on the land once it is added to the oceans WILL contribute to SLR.



Red areas will flood with 1 meter of SLR.

WHAT IS SO IMPORTANT ABOUT PIG?

PIG, a glacier that is ~40 km (25 miles) long and 20 km wide (12 miles), is the most active glacier in Antarctica and is thinning rapidly. Its movement has been measured at a rate of 10 meters a day – (that is more than 1 ft. an hour)! Remarkably you can't feel it move when you are standing on it. This fast moving glacier is moving ice quickly to the ocean. PIG is one of two major glaciers that drain the West Antarctic Ice Sheet, draining an area that could add 1 meter of SLR (see the map above to see what type of impact that could have). Economists estimate this could cost the world economy ~ $1 trillion dollars. But how long will all this take? Scientists are trying to figure this out.

WHAT DID THE TEAM GET DONE?

The plan was: 1) to set up a camp so that in the future drilling could be done through the ice shelf to install instruments and cameras into the sea below the ice; 2) install 2 GPS receivers to measure movement in the ice sheet to see if it was accelerating; and 3) to set up an automatic weather station (AWS) on PIG since this area is a gap in the weather information. The problem was that the ice sheet was filled with crevasses, and it was too difficult to land the plane and bring all the necessary gear into the area. The GPS was only 3 lbs but the back up battery was 1000 lbs, and then there were the solar panels to run everything! In the end, no camp was built, but a 14 ft. tall weather station was installed and 2 GPS were positioned right next to the ice shelf. The station was installed using a 'dead man' under each foot! WHAT? Check the vocabulary!

TERMS YOU SHOULD KNOW (VOCABULARY):

Ice sheets: Also known as continental glaciers – a mass of glacier ice that provides a continuous cover on the surrounding land area and is greater in size than 50,000 square kms.
Sea level – the average measure of the ocean's surface, used as a way of determining land elevation.
Crevasse –fast moving sections of ice streams cause cracks or fractures in the glacier. These cracks can be tens of meters across, hundreds of meters long and very deep if you fell in.
AND A FUN ONE!
Dead Man: Wood buried in the snow to spread the weight of the feet of an instrument so that the poles don't sink straight down into the snow.

WHY ARE WE STUDYING THIS IN THE POLAR REGIONS?

Ice sheets are remote, but when they change size, their effect on sea level is direct and immediate. Experts expect sea level to rise by one meter (over 3 feet) this century.

HOW DOES THIS AFFECT US HERE IN THE UNITED STATES?

50% of the US population lives near the coast. Globally, 145 million people will have to move if sea level rises one meter.

TO LEARN MORE ABOUT THIS TOPIC:

Find out how much ice is in the ice sheets and how much sea level would rise if all glaciers, or the Greenland ice sheet, or the Antarctic ice sheet flowed or melted away.

ACTIVITES YOU CAN TRY:

Dr. Bob with students at the Polar Fair

Different Folks have Different Coasts:

Intro: Ice sheets matter to people across the globe because ice sheets change size, contributing more or less water to the oceans. This changes sea level and the coastline, where the ocean meets the land. The impact to people at any point along the coastline depends on many factors like whether there are houses or roads at the sea's edge, the erodability of the land there and the range of the tide and strength of the waves. Another factor is the slope of the land and it is that factor that the demonstration focuses on.

Supplies: (see photo for clarification) ***At home alternatives noted in italics***

- Jug of water colored blue
- Ice – cubes or crushed works fine
- Lightweight plastic circular container *(i.e. large mixing bowl)* to be Antarctica – see photo
- Photos printed out to tape around Antarctica and to add around the global oceans
- Toys or props as desired for workers in Antarctica and houses to add to the shorelines
- Any rectangular bin *(i.e. Dishwasher tub, cat litter tray, or casserole dish)* to represent the world's oceans

- Two flat boards to represent shoreline (*i.e. plywood board, cut up plastic to-go containers or Tupperware lids)*
- A prop to go behind the board with the tightest spacing- see photo (*i.e. a brick or a rock)*
- Small ruler (measured in cms preferably)


Dr. Bob and a set up for his activity Different Folks have Different Coasts - SLR Activity

Set up: Coasts with two different slopes are presented along with a distant melting ice sheet that slowly raises sea level. Create samples of two different shorelines – using two sections of thin plywood or thin plastic of equal length set up at two different inclines. Draw lines to exemplify sea level - you can do this in one of two ways: 1) Space lines on the board so that one is twice the difference of the other i.e. 8 mm apart on one board and 16 mm apart on the second board (see photo) or 2) Create both boards with lines the same dimension apart i.e. 5 cm on each board. Number the lines starting with #1 on the bottom line and moving upward to as many lines as you have on the boards. Boards can be decorated with monopoly houses and vegetation to show residences and landscape.

Set the small incline boards in the dish or cat tub. The two boards should be propped at differing inclines to replicate differing shorelines, with one inclined at twice the angle of the other board. This can be done if blocks, with one block twice as high as the other, support the boards. If you spaced your lines with one marked at twice the distances as the other be sure the one with tightly spaced lines is inclined at twice the angle as the other board.
Although not included in the picture, we would suggest you tape a small ruler (marked in cms) onto the inside wall of the tub to serve as a "tide marker". This will show how many cms of water are added to sea level. You can print out images of shorelines to add around the edges of the tube representing the different landmasses that will be impacted by changing sea level.

Create Antarctica: Antarctica is a round plastic tub. A small hole is popped into one corner of the tub with the tub elevated and filled with ice. Use the attached image to create Antarctica! Print out this image, cut and tape it together and wrap it around a plastic tub (you might need to print more than one copy). Place the round Antarctica plastic tub on an elevated surface (several books work) with the small hole set out so that it drains into the dish tub. This represents Antarctica and its continental ice sheet melting into the global oceans. Now fill the Antarctic tube with ice. You are ready to start!

Alternative: if you don't want to drill a hole in the round tub, you can pour the melt water into the rectangular bin every 5 minutes.

Slowly add some of the blue tinted water into the Antarctic display. Watch as it melts some of the ice and flows into the global ocean raising water level. Using the 'tide stick' note how much sea level has risen? What is the effect on the two different shorelines?

Summary: The demonstration shows that the sea moves inland faster along the shore that is shallower. Lines drawn on the two shores emphasize how much more inland intrusion will occur for the shallower shore.

Continental Ice Versus Floating Ice Shelf:

You will need two clear glasses and some ice.
• Put 4 ice cubes in one glass and fill to two thirds full with water. Finish by marking the level of the water on the side of the glass. This will represent your floating ice shelf.
• Fill the second glass with water to two thirds full and mark the level on the outside of the glass.
After marking the water level add 3 to 4 ice cubes. This represents your continental ice.

Make a prediction: Once it melts, which ice loss will change the water level? Why?

Recall what Dr. Bob said about the problem with the loss of a melting ice shelf. What purpose did he say the ice shelf was serving?

Pull it all together: What is the concern with loosing Continental Ice? What is the concern with loosing an Ice Shelf?

Experiment with Ice Flow:

Make a recipe of Flubber to experiment with ice flow
(see http://lima.nasa.gov/mysteries/q1/index.php?page=2)

FILMS YOU CAN WATCH:

You can watch Dr. Bob in the field and learn a lot more at the following locations:

http://passporttoknowledge.com/polar-palooza/video/pig01.mp4
http://passporttoknowledge.com/polar-palooza/video/pig02.mp4
http://passporttoknowledge.com/polar-palooza/video/pig03.mp4
http://passporttoknowledge.com/polar-palooza/video/pig04.mp4

SHRINKING ICE

RISING SEAS

with Dr. Bob

Dr. Robert Bindschadler

ICE and WATER

Ice sheets are made of

ice

Oceans are made of

water

Same stuff; different form (or "phase") solid vs. liquid

GAIN and LOSS

Ice sheets grow by snowfall

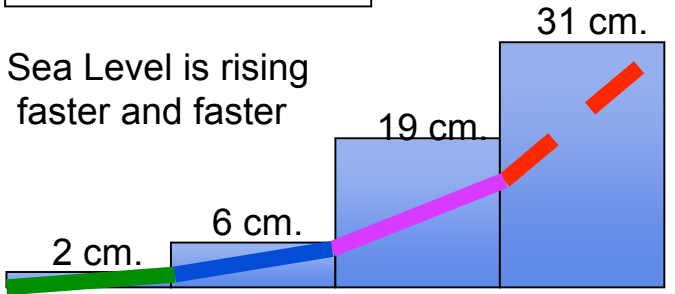
Ice sheets shrink by

melting & flow

Warmer ice sheets flow faster into the ocean

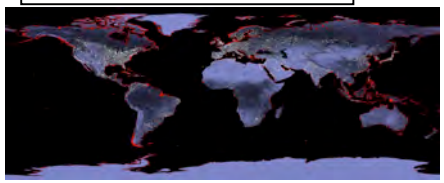
PAST and FUTURE

Sea Level is rising faster and faster



Extra water added to the oceans each century

GLOBAL IMPACT

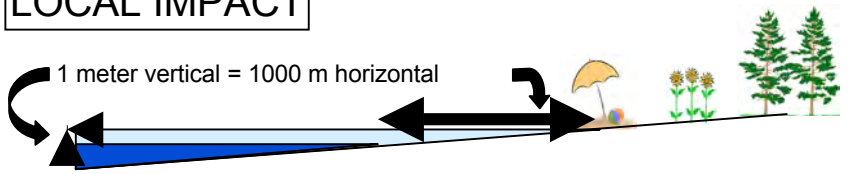


Red areas will flood with 1-meter rise in sea level

Impact of 1-meter rise:
2,200,000 sq. km will flood;
145 million people must move;
$944,000,000,000 will be lost

1-meter rise in sea level is likely by 2100

LOCAL IMPACT



A small rise in sea level moves the shoreline A LOT!!