STATION 5: QUEEN MAUD LAND, ANTARCTICA

Background Information

Watch the *video on Queen Maud Land, Antarctica*.

From the hot, humid equatorial tropics of Africa, you enter a replica of Neumayer Station III, one of five German Antarctic research bases. Although the air is definitely cooler, fortunately, the *Klimahaus* refrained from simulating the bone-chilling temperatures that reach a high of −6º C (21º F) and a low of −30º C (−22º F). Temperatures can dip even lower in other parts of Antarctica, setting a world record at −89º C (−128.2º F).

Neumayer Station III is located 2,000 kilometers from the geographic South Pole. From November 15 to January 27, the sun never sets on the station. From May 21 to July 22, the sun never shines on the station. Because temperatures never rise above the freezing point of water, precipitation is not measured. The coldest temperature ever recorded at the station, −59ºC (−58ºF) occurred on July 8, 2010.

High winds, shifting ice, and drifting snow complicate polar research. The station is powered by wind turbines. Drinking water is obtained by melting snow. Waste generated by personnel working at the station is packed and shipped by icebreaker to the nearest port. Hazardous waste, such as fluorescent bulbs, is shipped back to Bremerhaven for disposal.

Antarctica is covered with a single mass of thick ice with places that never melt. Although surrounded by ocean, the climate is continental with little to no ocean or ocean current effects on weather. Because temperatures at Queen Maud Land remain below the freezing point of water, there is no rainfall. Antarctica has two seasons: summer and winter. Each season lasts 6 months. During the winter months, most of Antarctica is in 24 hours of darkness. During the summer months, in most parts of Antarctica, the sun never drops below

the horizon. It is as if the sun sets one day and rises 6 months later. Extreme changes in hours of sunlight, snow, high winds, blowing snow, and extreme low temperatures explain why Antarctica is unsuitable for human settlement.

Located at 8º 34′ E, 73º 30′ S, Neumayer Station III has a climate designation of polar ice cap because the temperature on average never rises above 0º C (32º F). Neumayer Station III is the southernmost research outpost of the Alfred-Wegener-Institut in Bremerhaven. Scientists at Neumayer Station III have been collecting daily atmospheric and ground weather data since the 1980s. Scientists make daily measurements of atmospheric temperatures and ozone levels, using balloons that carry sensors high into the atmosphere. On the ground, scientists measure incoming and reflected long-wave radiation, temperature, wind speed, relative humidity, and snowfall. An array of infrasound sensors are used to monitor international compliance with the nuclear test ban treaty. Long-term atmospheric data are used to develop models and forecasts of future climate conditions.

Antarctica's ice cores provide evidence of Earth's past climates. All oxygen atoms have 8 protons (positive particles in the center of the atom). Most oxygen atoms have 8 neutrons (neutral particles in the center of the atom), but some oxygen atoms have more or less than 8 neutrons. Atoms with the same number of protons but a different number of neutrons are called isotopes. Isotopes of oxygen may have different masses as a result of having different numbers of neutrons. Water is made of one oxygen atom and two hydrogen atoms. The ratio of heavy and normal oxygen atoms from ancient water that formed ice provides clues to past climates. Carbon dioxide gas can also become trapped in the ice cores, giving scientists insights into ancient atmospheric carbon dioxide concentrations.

Ice in the Arctic and Antarctic regions plays a significant role in regulating global climates. The annual cycles of land and sea ice in polar regions are being studied for understanding of geophysical systems interactions, for monitoring current climate conditions, and for forecasting future climate conditions. Although seasonal changes in ice coverage occur, the general trend in both polar regions has been a loss of ice mass.

The rate of ice loss in western Antarctica has tripled over the past half century. Because the ice sheet extends into the ocean, ice loss may be hidden until a large chunk of ice separates from land and falls into the ocean. Hidden ice melt may cause a collapse or calving. When glaciers calve, large chunks of ice fall into seawater, thus altering the temperature and salinity of the seawater. When ice sheets collapse, the ice becomes a free-floating iceberg drifting in the Antarctic circumpolar current, possibly melting and altering salinity. Scientists from many disciplines are studying the effect of land ice melt and glacier calving on ocean currents and ecosystems.

Penguin populations are being studied because penguins are indicator species of ecosystem energy flows in Antarctica. Antarctica peninsula penguin colonies are under stress and showing sharp declines in population. Warmer temperatures have caused rainfall instead of snowfall, which is affecting the rate of successful egg hatching and chick survival in some penguin species. Other species are affected by losses in food sources caused by changes in ocean temperature and salinity from glacial melt and calving.

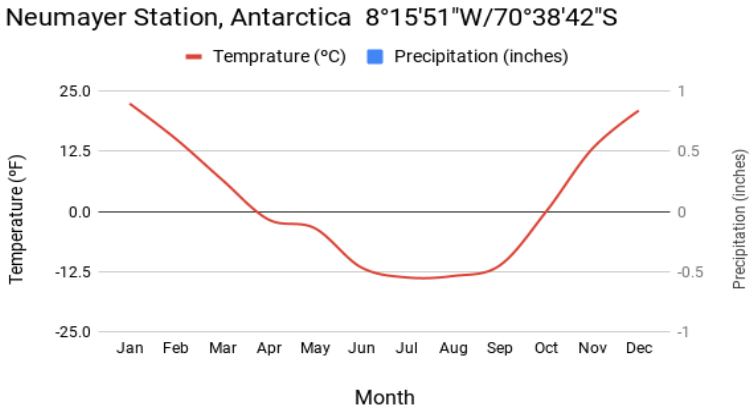
Modeling ocean systems, atmospheric systems, and ecosystems requires data. The Alfred-Wegener-Institut is committed to continuing the Antarctica research begun four decades ago and to contributing to global understanding of climate systems and climate change.

Text by Lori Chen

Perhaps as he shivered in his tent in Antarctica, Axel Werner wondered how turning on a light bulb in Bremerhaven is connected to ice loss in Antarctica.

Explore Queen Maud Land

1. Use Google Earth to develop a sense of place.
2. View the video *Eindrücke aus dem Ewigen Eis: die NEUMAYER-STATION III* (Alfred-Wegener-Institut, 2015).
3. Use the data and information on the climograph to observe the patterns in temperature.



4. Read "Study: 'Major Decline' in Antarctic Penguin Population" (Muller, 2016).
5. Identify factors that influence climate.
6. Identify sources of carbon dioxide and other greenhouse gas emissions.

Learn more about the role of *ice sheets* at NASA Global Climate Change.

Browse the Alfred-Wegener-Institut website for more information.

Predicted Climate Change	Climate Change Threat	Climate Change Impact
Warmer temperatures	Loss of ice mass	Changes in global atmospheric circulation
		Changes in ocean salinity and ocean currents
		Changes in ecosystem energy flow

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Modeling Land Ice Melt

Evaluate the evidence of ice mass loss, and explain how freshwater entering the ocean can affect global climate systems.

Materials Needed

- Ice cube tray
- Distilled water
- Blue food coloring
- 1-liter plastic bottle
- Salt
- Access to a freezer

Instructions

1. Fill an ice cube tray with distilled water. Add blue food coloring to the water. Place the tray in the freezer until solid.
2. Make a saltwater solution using 35 grams of sodium chloride (salt) per 1,000 ml of distilled water. Place the water in the refrigerator.
3. Cut a 1-liter clear plastic bottle to form a funnel from the top one-quarter of the bottle and a container for water from the bottom three-quarters of the bottle.
4. Test common objects to find one that floats in the cold saltwater, but sinks in freshwater. The object needs to be small enough to fit in your bottle. The object's buoyancy will be used to observe a change in density due to a change in salinity. Consider criteria and constraints that affect your design options.

Text by Lori Chen

5. When the ice and saltwater are ready, fill the bottom of the bottle with 250 ml of cold saltwater. Mark the water level using a permanent marker. Measure the temperature of the water. Leave the thermometer in the water for later temperature readings.
6. Add the object you will use to observe changes in density due to changes in salinity.
7. Invert the top of the bottle and place it so it rests neck down on the rim of the bottom of the bottle. Place the blue-colored ice cubes in the funnel shaped bottle top. The ice cubes will be playing the role of land ice.
8. Observe and record what happens as the freshwater ice cubes melt into the saltwater below.
9. Use your observations to describe the effect of melting land ice on oceans.

Text by Lori Chen