Antarctica for Global Climate

Sea Ice Mass Balance in the Antarctic (SIMBA) International Polar Year 2007: Why was it important

Role of Sea Ice Arctic and Antarctic



(IPCC, 2001) **27.7**

27.6

17.8

17.5

15.5

13.7

13.5

10.4

5.6

10⁶ km²

Total winter sea ice extent in Antarctica, at ~ 20 million km², rivals the extent of the earth's major terrestrial biomes.



Courtesy of Blake Weissling

Major Glaciers and Ice Sheets

 For the last 100 years close to 90% of the glaciers in Europe, North America, South America and Asia have retreated. This has resulted in Europe's Glaciers having only 40% of the mass they had 100 years ago.

Glacier Calving Video

 The continental ice sheets over Greenland and Antarctica account for over 90% of the total fresh water on the earth. Formation and Melting of these and other continental ice sheets (now gone) have been the major factors in sea level change in geologic time.



NGM Maps, National Geographic Magazine

Wilkins Ice Shelf - 2008

220 mi² ~7x the size of Manhattan

Serves Airo III otra Waye Layona'

JIM ELLIOTT/BRITISH ANTARCTIC SURVEY

Sea Ice – Significance to Global Climate

Ice-Albedo feedback

Controls ocean heat flux

Dampens waves and momentum transfer

Brine rejection drives ocean thermohaline circulation

Melting provides fresh water influx



After Gordon and Comiso, 1988



Albedo change

Sea ice reflects 50 – 90 % of incoming solar radiation, the rest is absorbed by the sea ice. What is absorbed is eventually re-radiated to the atmosphere as thermal radiation.



What's the Problem?



The Greenhouse effect

A M -----E E E \mathbf{O} S

Some solar radiation is reflected by the atmosphere and earth's surface Outgoing solar radiation: 103 Watt per m²

Some of the infrared radiation passes through the atmosphere and is lost in space

S

S N H F G EE R G

Solar radiation passes through the clear atmosphere. Incoming solar radiation: 343 Watt per m²

GRIDD

o

Some of the infrared radiation is absorbed and re-emitted by the greenhouse gas molecules. The direct effect is the warming of the earth's surface and the troposphere.

> Surface gains more heat and infrared radiation is emitted again

> > 5 E -

Solar energy is absorbed by the earth's surface and warms it ... 168 Watt per m?

... and is converted into heat causing the emission of longwave (infrared) radiation back to the atmosphere.

Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995. The acience of climate change, combibution of working group 1 to the second assessment report of the interpovernmental panel on climate change, UNICP and WMO, Cambridge university press, 1996.





Partly depending on temperature of the surface water, the oceans can be a source or a sink of CO². Generally, cold waters absorb and warm waters emit.

The Southern Ocean, the body of water that surrounds Antarctica, is the single largest sink of CO² on the planet.

Temperature Prediction for 2xCO2



What's the role of sea ice in a global climate perspective?

Every autumn the ocean freezes over,

every Summer the sea ice melts.



Graphics courtesy of Dr. Sharon Stammerjohn

SEARCE Mass Balance in the Antarctic

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September 26 we arrived at Ice Station Belgica

Latitude 71 South Longitude 90 West

IANIEL B. PALMER

25 days after first departing Punta Arenas

No human has ventured into this region in wintertime since the first Belgica expedition arrived in 1898



Note: they got trapped in the ice for 18 months!

Courtesy of Blake Weissling



Courtesy of Martin VanCoppenelle

SIMBA

- Baseline data from which to monitor future change in Antarctic sea ice:
- Geophysical processes (snow & ice thickness and extent, physical properties, heat flux, energy balance)
 - Biogeochemical processes (biological habitats, DMS production, trace metals, CO₂ Flux)
 - Satellite Remote Sensing (validating tools for long-term monitoring of sea ice / climate systems)

En Route to Final Ice Camp: Ice Observations





En Route to Final Ice Camp: Ice Observations



Grease

First Year

Nilas

Geophysical Studies Conducted on the Sea Ice: Time Lapse Camera

SIMBA Geophysical Assessment



Emperor penguins lined up to assist with measurements

Photo by: Glenn Grant



Courtesy of Blake Weissling and Mike Lewis

Site from bridge of NBP

Surface roughness across Site



Geophysical Studies Conducted on the Sea Ice: Snow Depth and Ice Thickness

View from Transect line 1

Geophysical Studies Conducted on the Sea Ice: Snow Depth and Ice Thickness

Step 4: Drill f

+2 meter = 6 ft drill bit

ill bits

Geophysical Studies Conducted on the Sea Ice: Snow Depth and Ice Thickness

Snow thickness can get up to $\sim 1.5 \text{ m} = \sim 4.5 \text{ ft}$

Geophysical Studies Conducted on the Sea Ice: Snow Depth and Ice Thickness – EM 31

> Concurrent measuring of ice thickness to compare with in situ measurements

Typical Profile of Snow Depth and Ice Thickness

Fabra Site - Line 1B (10/07/07)



Courtesy of Mike Lewis

Geophysical Studies Conducted on the Sea Ice: Snow Pits



Geophysical Studies Conducted on the Sea Ice: Resistivity



Various Teams Required to Each Job



Biogeophysical Studies Conducted on the Sea Ice: Ice Coring

Biogeophysical Studies Conducted on the Sea Ice: Ice Coring



Figure 8 : 1 cm-thick section of the Brusels 4 core clearly showing the descending refrozen brine tubes. Fingers for scale.

Native Animals Tend to be Curious



Current Trends

• The amount of CO2 in the atmosphere affects our planet's temperature. With concentrations of CO2 currently at 383 ppm, the planet is now approximately 0.8 °C warmer than pre-industrial levels.

 Scientists are now forewarning that, at approximately 450 ppm CO2 in the atmosphere, we will trigger potentially irreversible glacial melt and sea level rise "out of humanity's control". Concentrations of 450 ppm corresponds to approximately 2 °C global warming above pre-industrial levels



Antarctic Ice Core Data 1

Sea Level Rise with Ice Sheet Melting

• Based on the new rate of sea level rise, the projected increase in sea level by 2100 is now over 1m (>3 ft) rather than 2 ft. The surprising melting of the Greenland and Antarctic Ice Sheets observed recently is also leading to some estimates of 2m increase in sea level, or greater by 2100 (so the 1m rise would take place much sooner).

Let's get some "Perspective":

If the Greenland and Antarctica ice sheets are melting, What is the potential impact of sea level rise on Texas?

Coastline Change from 1m Rise



"Names on the 1m Face"

- Texas Places that will be under water in 2100
- Port Arthur, Port Isabel, Port Mansfield, Sabine Pass, Sabine, Orange, Lake Charles, La
 South Padre Island, Padre Is Natl Seashore, half of Galveston Island, Matagorda Island (and some mainland coastlines)

Coastline Change from 2m Rise



"Names on the 2m Face"

- Texas Places that will be under water with 2m Sea Level Rise (perhaps by 2100)
- Beaumont, Galveston, Texas City, Port Lavaca, Port Aransas, Rockport, Aransas Pass, Shore Acres, La Porte, Bay Oaks, Clear Lake Shores-SeaBrook and,

New Orleans Louisiana

Credits

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