

The background of the slide is a dramatic landscape. It features a dark, stormy sky with heavy, dark clouds. A bright light source, possibly the sun or moon, is visible on the horizon, creating a strong lens flare and illuminating the scene. The foreground shows a body of water with dark, choppy waves. The overall color palette is dominated by dark blues, greys, and a bright white/yellow light source.

Evidence of Climate Change

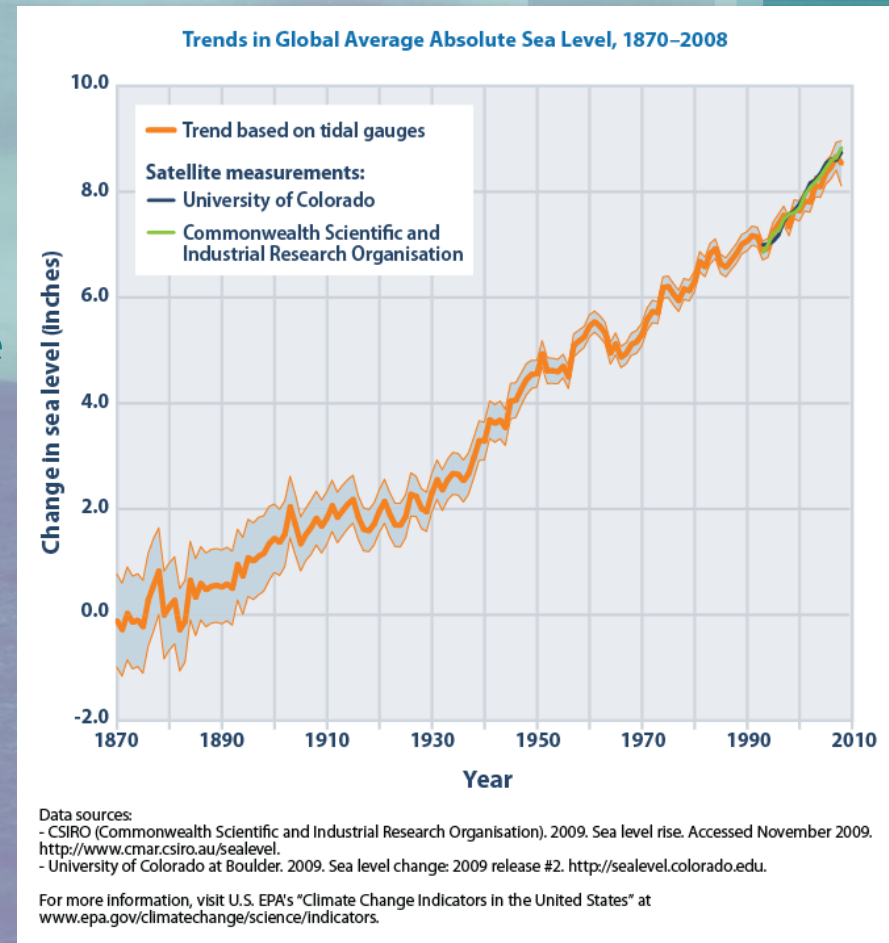
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OVERVIEW

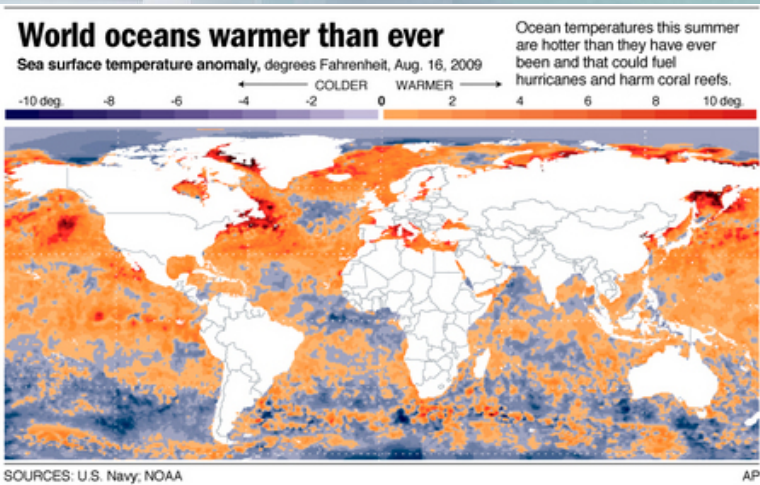
- Indicators:
 - Oceans
 - Sea level rise
 - Warming oceans
 - Ocean acidification
 - Ice
 - Shrinking ice sheets
 - Declining Arctic sea ice
 - Glacial retreat
 - Air
 - Global temperature rise
 - Extreme events
 - Skeptics

SEA LEVEL RISE

- Current Situation:
 - Average global sea level rise in the last century (17 cm=6.7 in)
 - Global rate in last decade double that of last century
 - "Local" or "relative" sea level rise
- Projections:
 - Global rate and rise by end of century (20-39 in)
- Impact:
 - Coastal cities, ecosystems, wetlands at risk
 - Increase salinity of groundwater



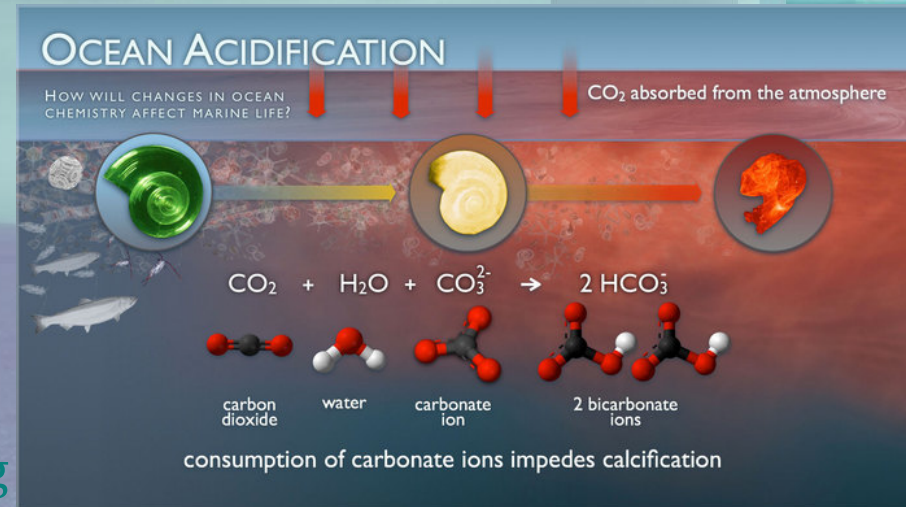
WARMING OCEANS



- Current situation:
 - Top 700 meters (about 2,300 ft) of ocean has warmed 0.302 degrees Fahrenheit since 1969
- Projections:
 - Oceans will warm by as much as 4-8 degrees Fahrenheit in 21st century
- Impact:
 - Northward species movement
 - Introduction of invasive species

OCEAN ACIDIFICATION

- Current Situation:
 - 0.1 pH unit drop, acidity has increased by about 30%
 - Carbon dioxide absorbed by upper layer of ocean increasing by 2 billion tons/yr
- Projections:
 - Ocean acidity could increase nearly 150% by end of century
- Impact:
 - Increase risks of coral bleaching events, coral loss
 - Adverse health effects on marine species



SHRINKING ICE SHEETS

- Why are ice sheets important?
- Climate Change & Ice Sheets

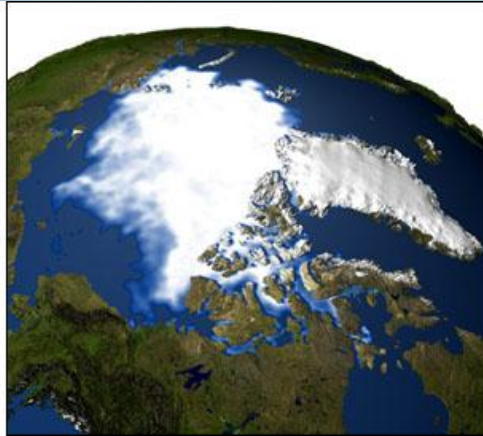


Greenland & Antarctic ice sheets have decreased in mass

- Greenland
 - from 1979 to 2006, summer melt increased 30%
 - winter snow hasn't offset summer ice loss
- Antarctica

- Outlooks
 - at present trends, sea level is likely to be significantly higher than sea levels projected by the UN Intergovernmental Panel on Climate Change in 2007
 - 4mm per year
 - 0.22- 0.44 m by 2090

Declining Arctic Sea Ice

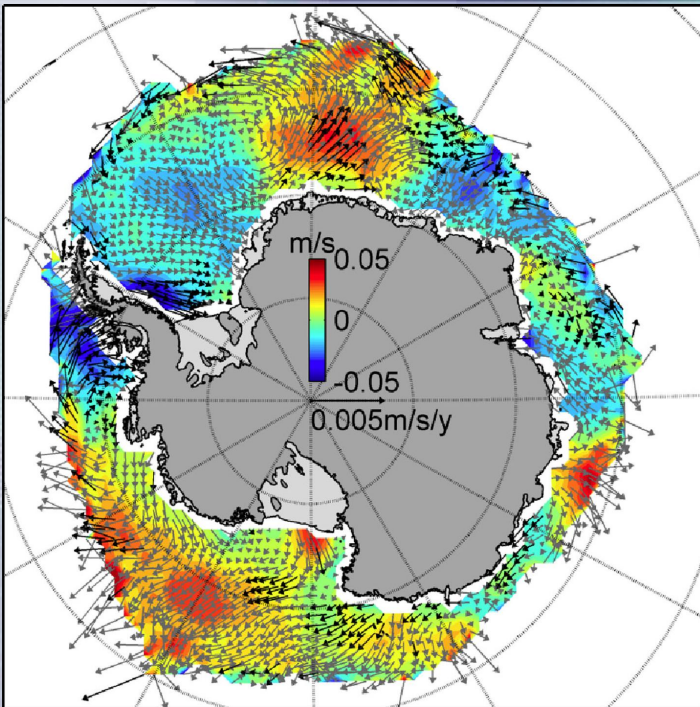


Left: images showing min. arctic sea ice concentration 1979 and 2003.

Source: NASA

- Importance
- extent & thickness of Arctic sea ice declined rapidly over last several decades
 - average ice extent for Oct 2012 was 7 million square km
 - 2nd lowest satellite record
 - 2.29 million square km below the 1979-2000 average
- Poles are the most sensitive regions to climate change on Earth

Antarctic Sea Ice



- new NASA study reports sea ice increase
 - 19-year long study
 - changes to Antarctic sea drift ice
 - changing wind
 - increases in sea ice in past 20 years
 - in contrast--Arctic Ocean is surrounded by land
 - changed winds cannot cause Arctic ice to expand in the same way

Glacial Retreat



definition: body of snow and ice that is dynamic (moves), changing in response to temperature and precipitation

- glaciers store 75% of world's freshwater
- Current Situation
 - glaciers are retreating almost everywhere--Alps, Himalayas, Andes, Rockies, Alaska & Africa
 - substantial retreat since 1995
- Reasons for retreat
 - lost due to melting
 - climate change
- Future concerns
 - water supply in alpine regions
 - changes in streamflow, stress on man and nature



Above: Qori Kalis Glacier (Peru)--1978 (top) and 2002.



Above: Trift Glacier (Switzerland)--1948, 2002, 2004

Below: Pedersen Glacier & Muir and Riggs Glaciers in Alaska

Pedersen Glacier

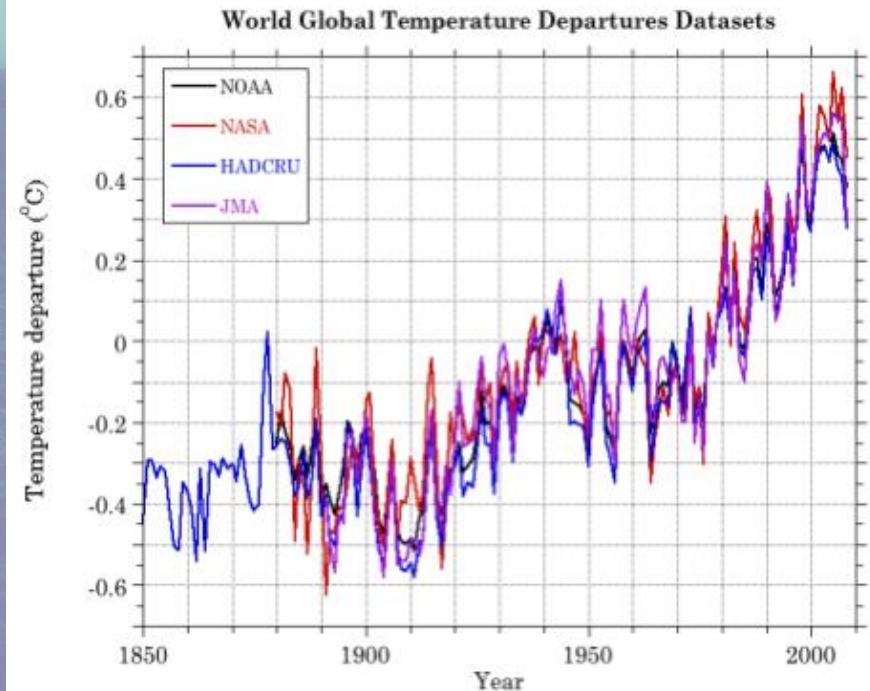
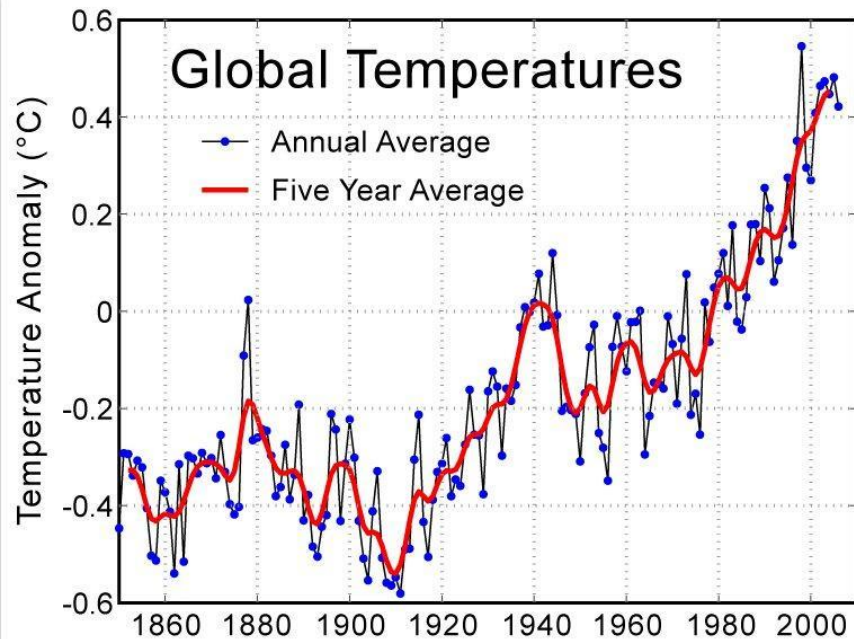
Muir and Riggs Glaciers



Above: Upsala Glacier (Argentina)--1929 vs. 2004

Global Temperature Rise

- The Earth has warmed since 1880; most of this warming has occurred since the 1970s
 - The 20 warmest years have occurred since 1981
 - All 10 of the warmest years have occurred in the past 12 years
- Currently: Surface temperatures continue to increase



Global Temperature Rise

Huffington Post: Nov 9, 2012

A study finds that future temperature rises due to global warming will probably be on the high end of projections, as much as a potentially catastrophic 8 degrees warmer than now by the end of the century.

Extreme Events

- Since 1950:
 - The number of record high temperature events in the US has been increasing.
 - The number of record low temperature events in the US has been decreasing.
 - The number of intense rainfall events in the US has been increasing.
- Hurricane Sandy
- NASA, Aug 6, 2012: *Research Links Extreme Summer Heat Events to Global Warming*
 - *"Our analysis shows that, for the extreme hot weather of the recent past, there is virtually no explanation other than climate change."* - James Hansen, NASA Scientist

Skeptics

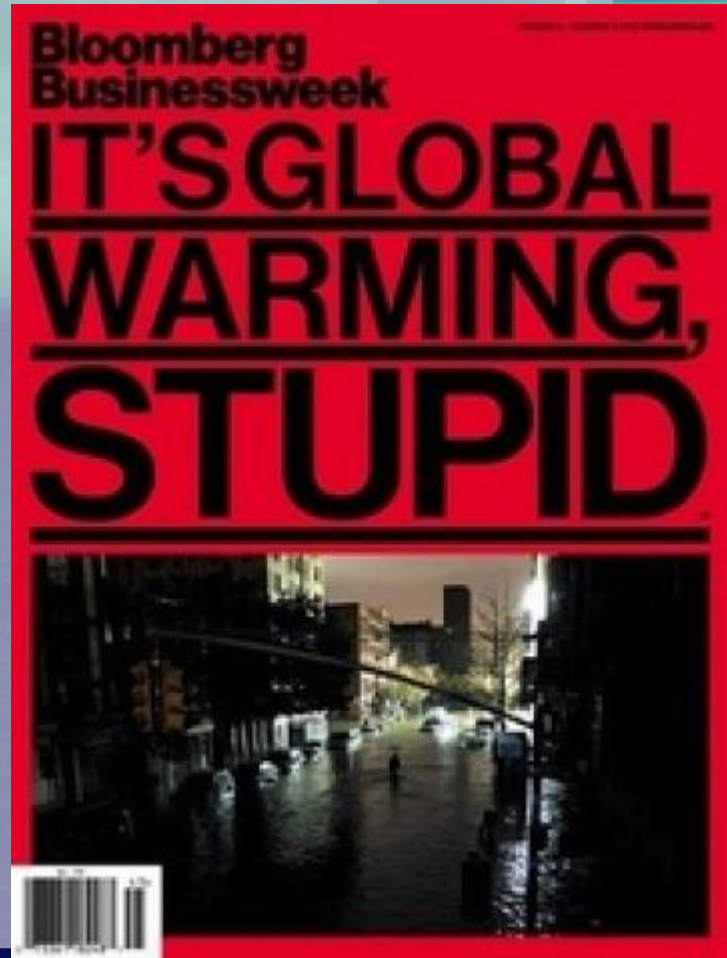
Primary issues concerning the existence/ cause of climate change:

- Different reasons for the increase in temperature.
- Whether the warming trend is unprecedented.
- Whether humankind is responsible.
- Whether the increase is due to poor measurements.

Bloomberg

- Post-Sandy

NY Times, July 2012: *The Conversion of a Climate-Change Skeptic*



Literature Cited

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- http://www.nrmsc.usgs.gov/research/glacier_retreat.htm
- <http://nsidc.org/arcticseaicenews/>
- <http://www.nasa.gov/topics/earth/features/arctic-antarctic-ice.html>