



Global Climate Change

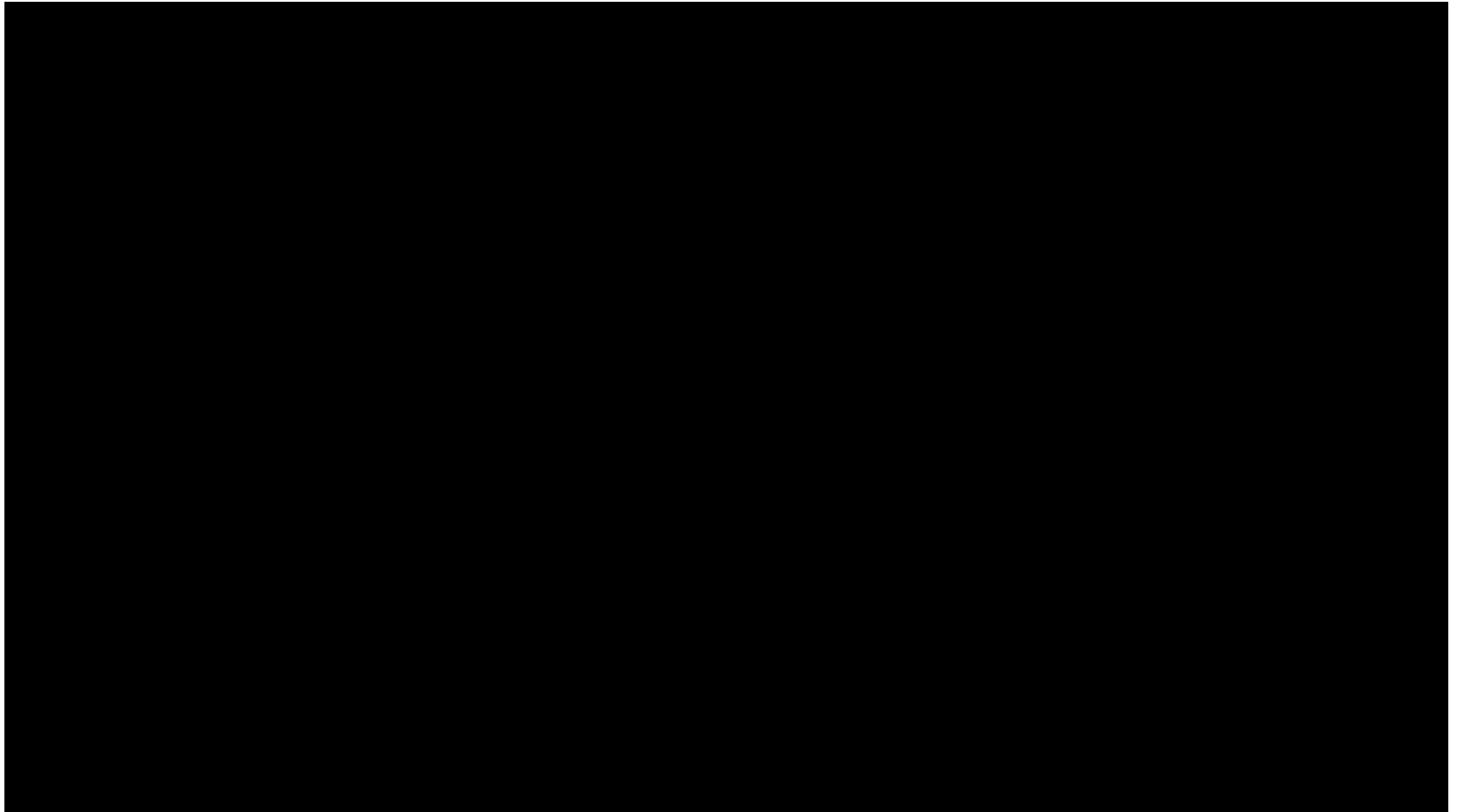
Definitions

- **Climate change:** refers to a change of a climate that is ***attributed directly or indirectly to human activity*** that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (United Nations Framework Convention on Climate Change, UNFCCC).

Definitions

- **Climate change:** refers to a change of Earth's climate, including temperature, precipitations, and other variables.
- **Global warming:** refers to a long-term increase in Earth's average surface temperature.

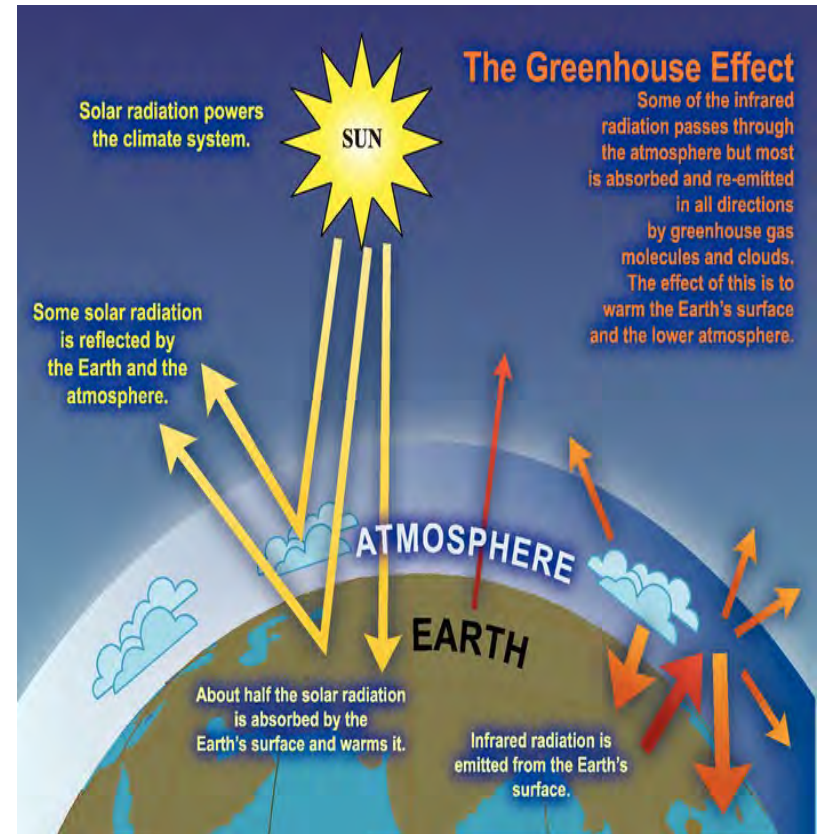
The Greenhouse Effect



Source: <http://www.epa.gov/climatestudents/basics/today/greenhouse-effect.html>

The Greenhouse Effect

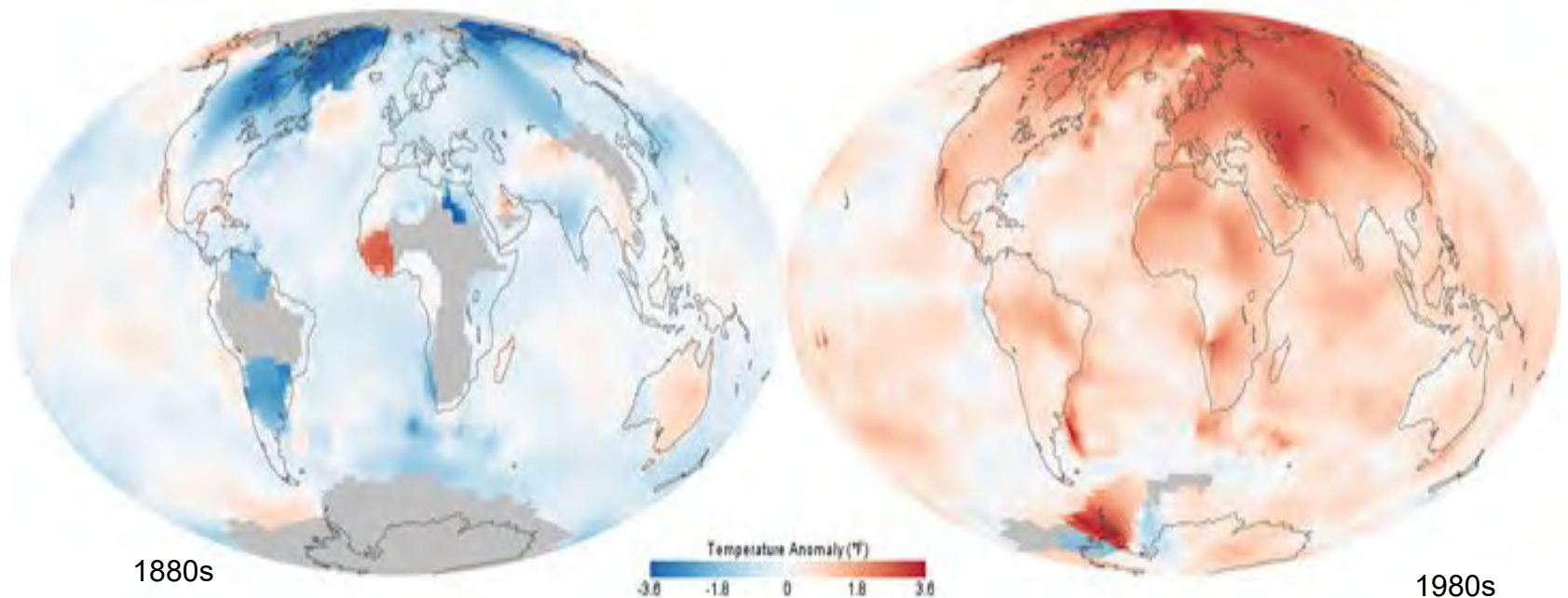
- The greenhouse effect is a process where energy from the sun penetrates into the atmosphere and onto the surface of Earth. To balance the absorbed incoming energy, the Earth radiates the same amount of energy back to space. Much of this thermal radiation emitted by the land and ocean is absorbed by the atmosphere, and re-radiated back to Earth.
(Definition adapted from the IPCC)



An idealized model of natural greenhouse effect (Source: IPCC)

Climate Change

- The average temperature increased by more than 1.3°F over the last century



Greenhouse Gases

- Contribute to intensify the greenhouse effect.
- Prevent the heat to escape from the atmosphere which consequently warming the earth.
- Greenhouse gases: Carbon dioxide (CO₂), methane, sulfur dioxide, nitrous oxide, chlorofluorocarbons (CFCs), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).

Greenhouse Gases



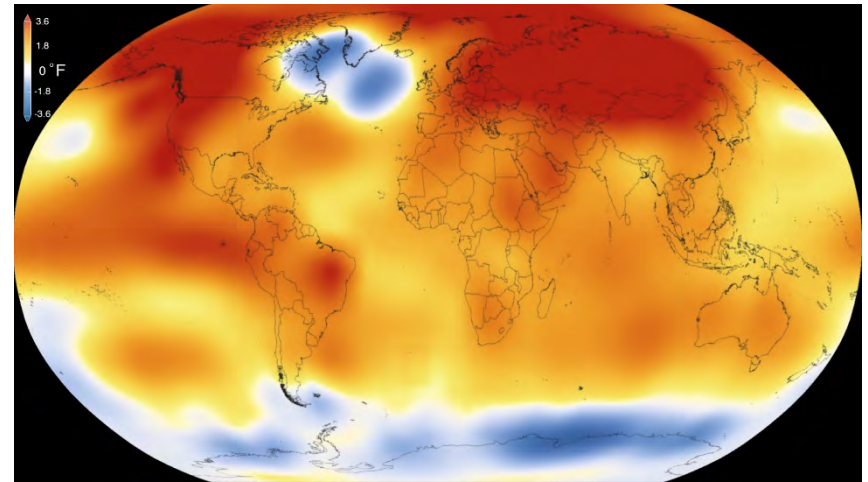
Increases in greenhouse gases are the result of human activities: industrial processes, fossil fuel combustion (coal, oil, and gases), changes in land use such as farming and deforestation.

Greenhouse Gases

- Global greenhouse gases emissions:
 - Net emissions of greenhouse gases from human activities increased by 35% from 1990 to 2010.
 - Emissions of CO₂ account for about $\frac{3}{4}$.
 - Result for electricity generation, transportation, and other forms of energy generation and use.

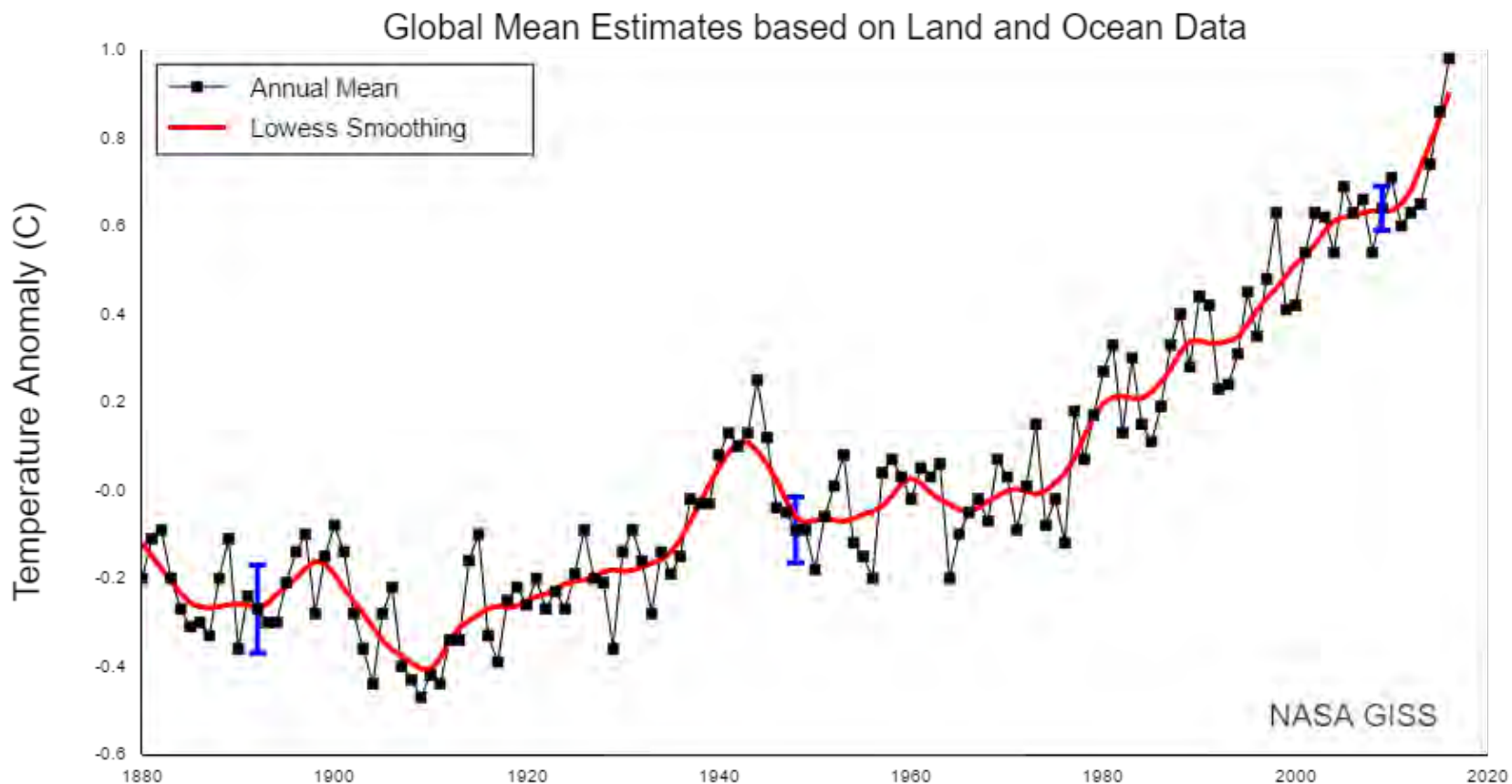
Global Climate Change Effects

- Weather and climate:
 - Average global temperatures have risen about 1.8 degrees Fahrenheit (1.0 degree Celsius) since 1880-1899.
 - 15 of the 16 warmest years on record have occurred since 2001.



2015 was the warmest year since modern record-keeping began in 1880
Source: NASA. Gov

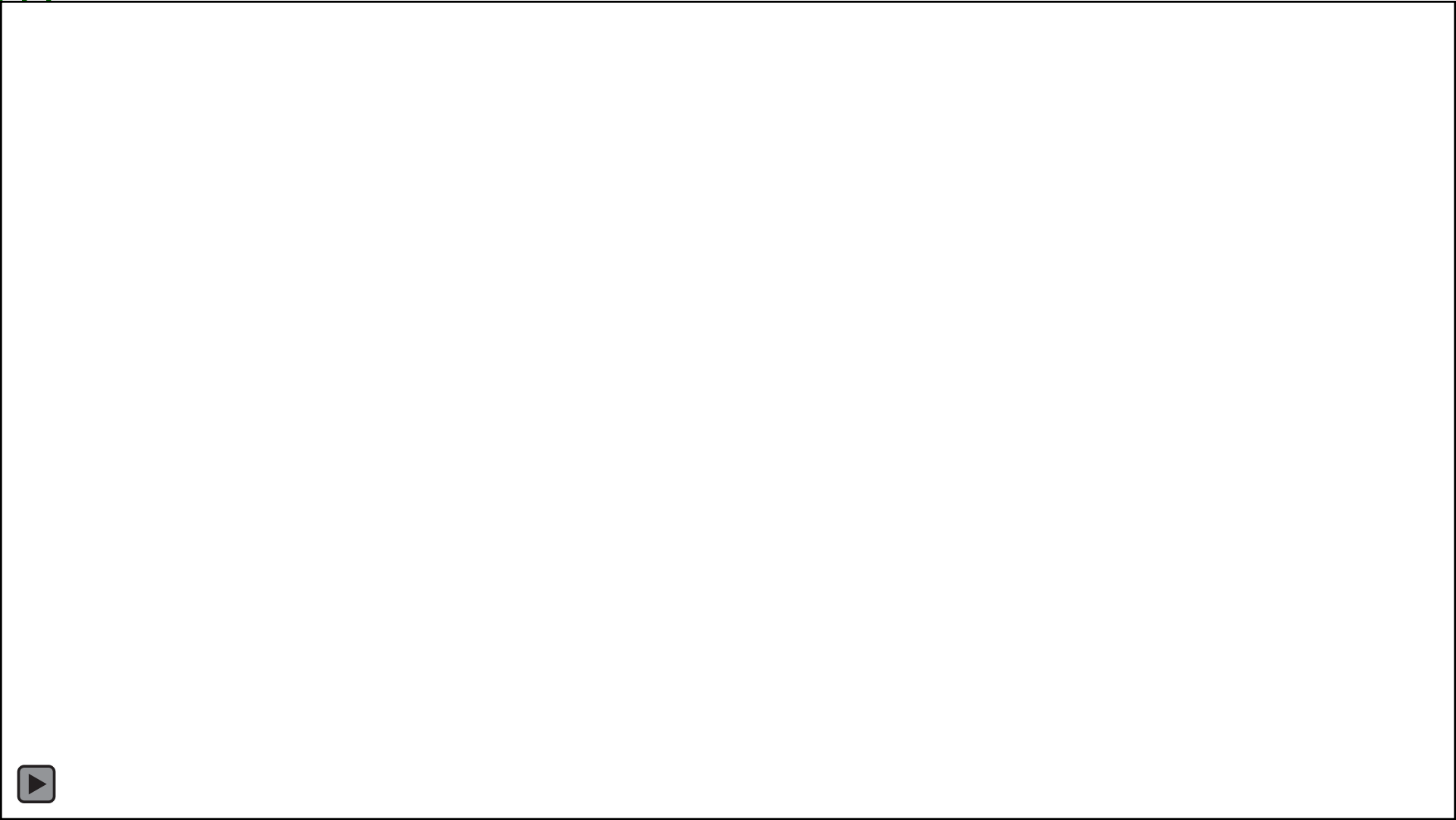
Global Surface Temperature



2016: 0.98°C - 2015: 0.86°C - 2014: 0.74°C - 2013: 0.65°C - 2012: 0.63°C

RANK 1 = WARMEST PERIOD OF RECORD: 1880–2015	YEAR	ANOMALY °C	ANOMALY °F
1	2015	0.90	1.62
2	2014	0.74	1.33
3	2010	0.70	1.26
4	2013	0.66	1.19
5	2005	0.65	1.17
6 (tie)	1998	0.63	1.13
6 (tie)	2009	0.63	1.13
8	2012	0.62	1.12
9 (tie)	2003	0.61	1.10
9 (tie)	2006	0.61	1.10
9 (tie)	2007	0.61	1.10
12	2002	0.60	1.08
13 (tie)	2004	0.57	1.03
13 (tie)	2011	0.57	1.03
15 (tie)	2001	0.54	0.97
15 (tie)	2008	0.54	0.97

Source: NOAA. Global Analysis – Annual 2015



Global Climate Change Effects

- Weather and climate:
 - Global precipitation has increased an average of 0.2% over land areas worldwide since 1901.
 - Tropical storm activity in the Atlantic ocean has increased during the past 20 years.



Hurricane Sandy. Photo Bob Bowne Yahoo

Global climate change effects

- Increased water stress and food insecurity: droughts and floods.
- Extreme weather and increased frequency and intensity of hurricanes.
- Changing disease patterns: outbreaks of infectious disease.
- Changing ecosystems: 20-30 percent of the world's species may face extinction.

Global climate change effects

- Rising sea level:
 - Since 1900: rising at a rate 1 to 2.5 millimeters per year (0.04 to 0.1 inches).
 - Since 1992; rate of rise of 3 millimeters (0.12 inches) per year.
- Rising sea level consequences:
 - Flood river and coastal deltas.
 - Displacing millions of people who live in low-lying delta regions.
- Feeling the effects of climate change.
<http://www.pbs.org/video/1939995285/>

Deforestation

- The major causes for releasing CO₂ in the atmosphere: by cutting trees, carbon are released to the atmosphere and then mixes with oxygen to create CO₂.
- Produces 15 percent of the world's greenhouse gas emissions.
- “Every year, 20 million hectares of rainforest are cut down releasing millions of tons of carbon into the atmosphere.” (Nature Conservancy)

Purposes of Deforestation

- Commercial logging (legal or illegal)
- Clearing land for agriculture
- Creating space for housing and commercial development
- <http://www.pbs.org/video/2099465986/>

Deforestation



Effects of deforestation

- Carbon emissions: contribute to global climate change.
- Loss of species:
 - Destruction of ecosystems: destruction of natural habitats of thousands of animals and plant species.
 - Loss of habitat can lead to species extinction.
- Soil erosion
- Health hazards: soil erosion can contaminate water sources.

Global Environmental Challenges: Water

- The access to clean water is increasingly difficult for many people
- Water consumption and availability may emerge as source of conflict
- More than 50 countries on five continents might be soon involved in water disputes, unless they establish agreements on how to share reservoirs, rivers, and underground water (Global Policy Forum)

Global Environmental Challenges: Water

- Why water might be a as source of conflict?
 - Only 2.5% of the Earth's water is fresh water, and 2/3 of that is locked in ice caps and glaciers
 - 97% of freshwater available for human use is in underground basins
 - Water usage has tripled between 1950-1990
 - Growing world population
 - By 2025, 2/3 of world's population may live in countries experiencing water scarcity

Global Environmental Challenges: The Largest User of Water

- Agriculture: 65% of all the water removed from rivers, lakes, and aquifers
- Industry: 22%, cooling water (in thermal power generation), water for energy (hydro-projects: irrigation, energy, drinking water), process water (processing plants)
- Households and municipalities: 7%

Aral Sea's Eastern Basin is Dry



Aral Sea's Eastern Basin is Dry



In 2000 (left), Asia's Aral Sea had already shrunk to a fraction of its 1960 extent (black line). Further irrigation and dry conditions in 2014 (right) caused the sea's eastern lobe to completely dry up for the first time in 600 years.

Global Environmental Challenges: Air Pollution

- Rapid deteriorating air quality in urban areas
 - Caused by rapid urbanization, car exhaust, and industry emissions
 - Health issues: chronic respiratory tract inflammation, changes in brain tissue



Shanghai, China

Global Environmental Challenges: Desertification

- Desertification refers to the process whereby a desert expands and claims hectares of previously arable land.
- Causes: deforestation, slash and burn agriculture, overgrazing, and climate change
- One quarter of the earth's land is threatened by desertification (UN Environmental Program)

Desertification Vulnerability of Africa

