

***Climate Change
and the National Water Program:
Tribal Consultation***

**U.S. Environmental Protection Agency
Region IX**

November, 2010

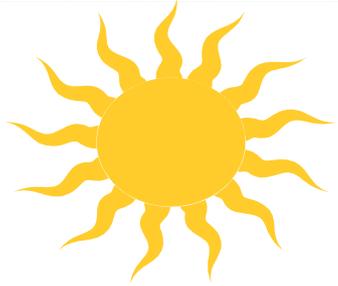
Overview

- Part 1: Climate Change: It's causes and implications
- Part 2: Federal, EPA, and the National Water Program - Climate Change Activities
- Part 3: Consultation



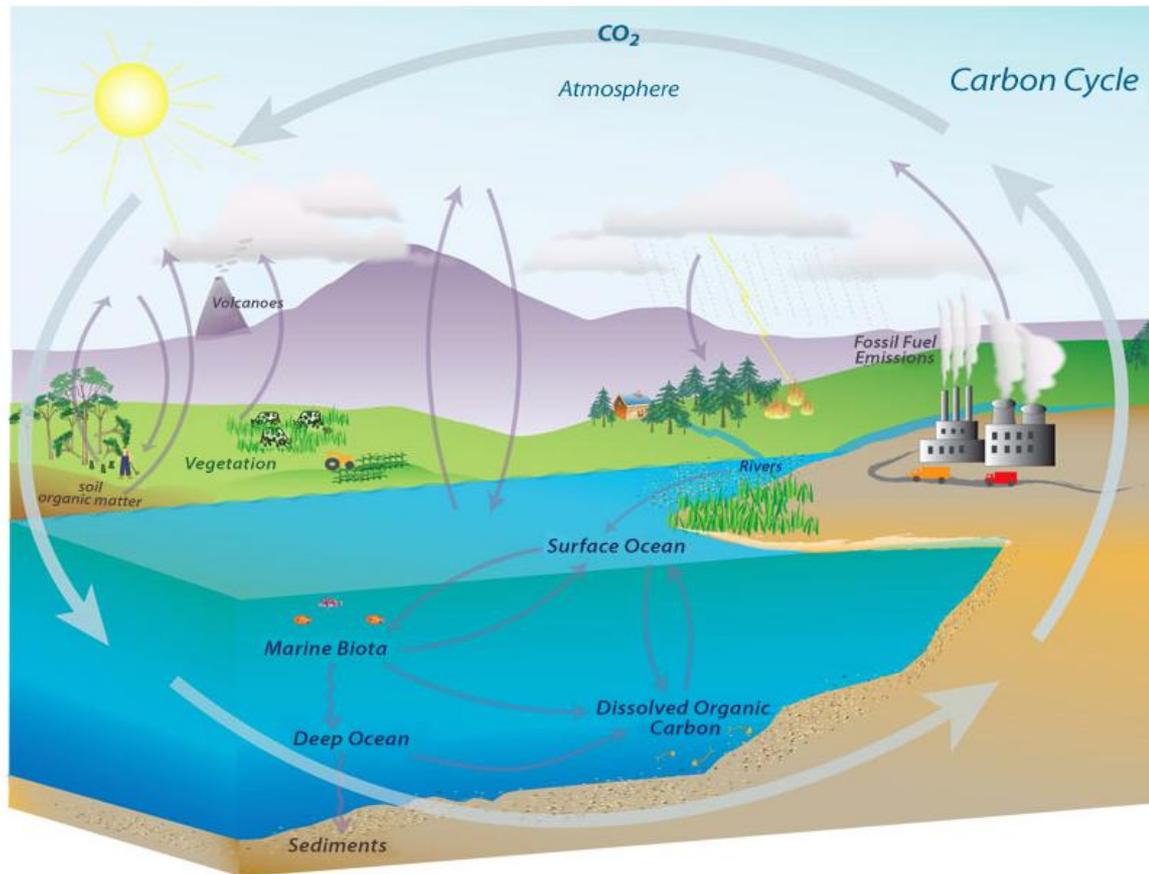
Part 1:

Climate Change: It's Causes and Implications



What is the Cause of Climate Change?

The Global Carbon Cycle

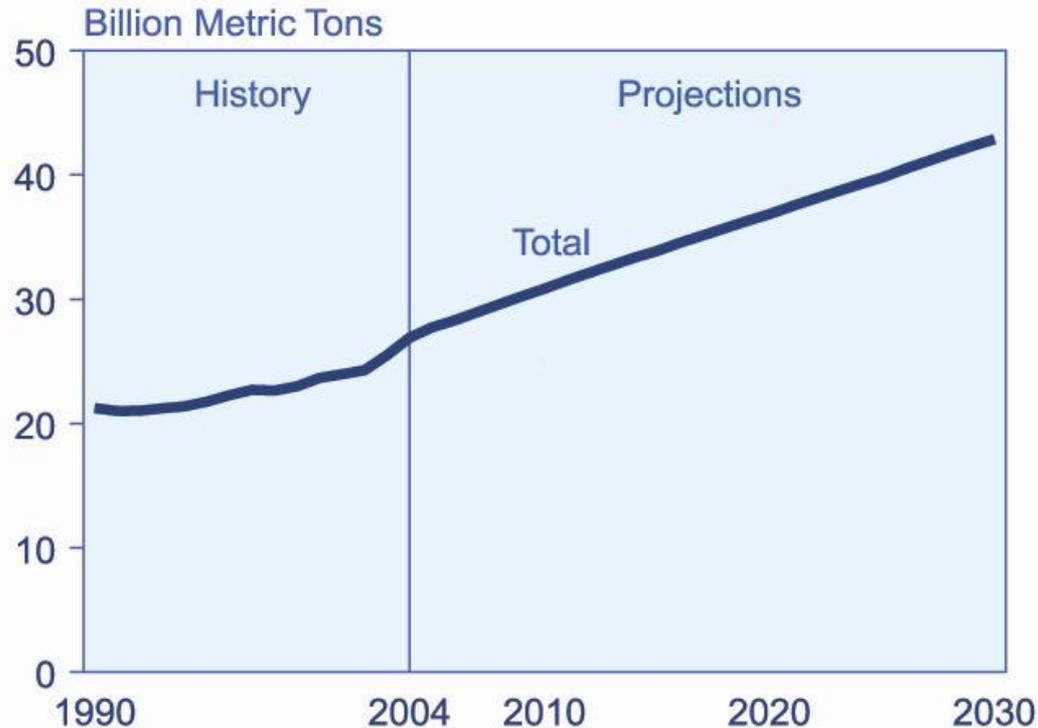


Source: NOAA , www.esrl.noaa.gov

What is the Cause of Climate Change?

Carbon Dioxide & Other Heat Trapping Gases

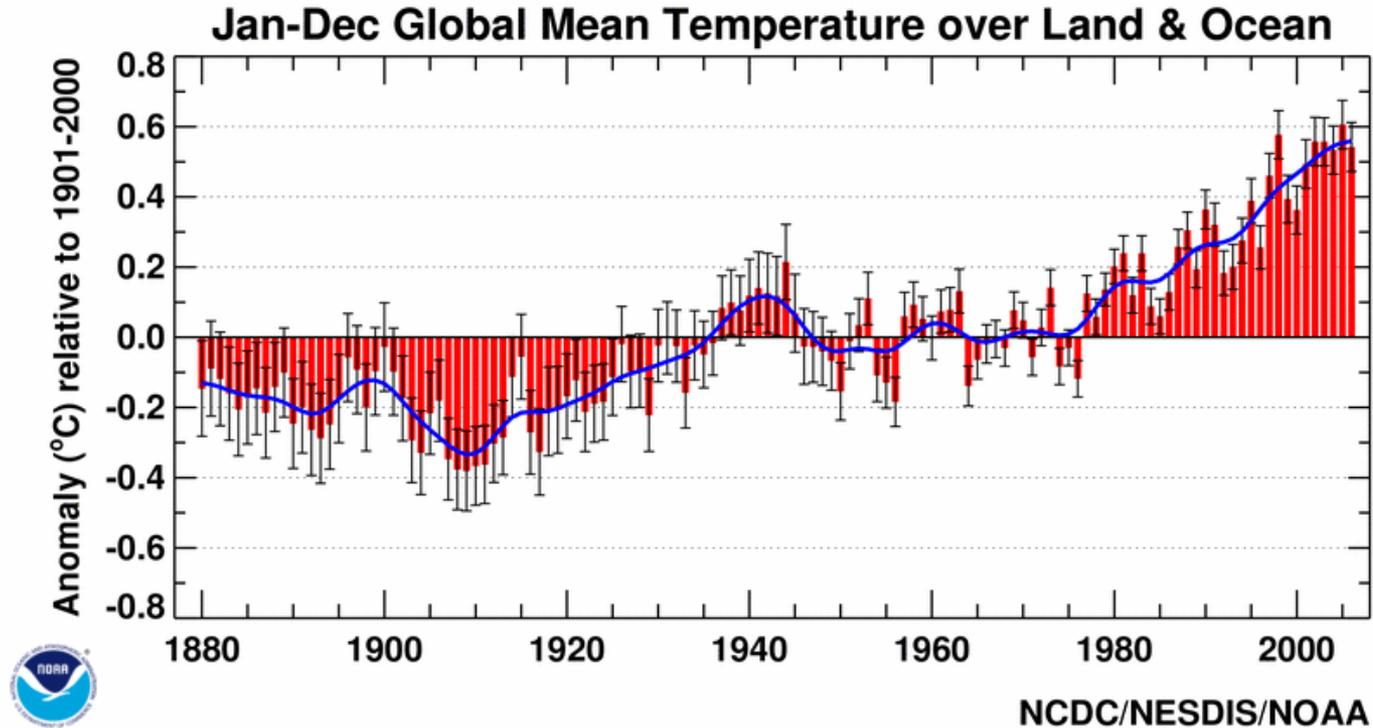
World Energy-Related Carbon Dioxide Emissions



Source: EIA, *International Energy Outlook 2007*

How Is the Climate Changing?

Observed Temperature Changes

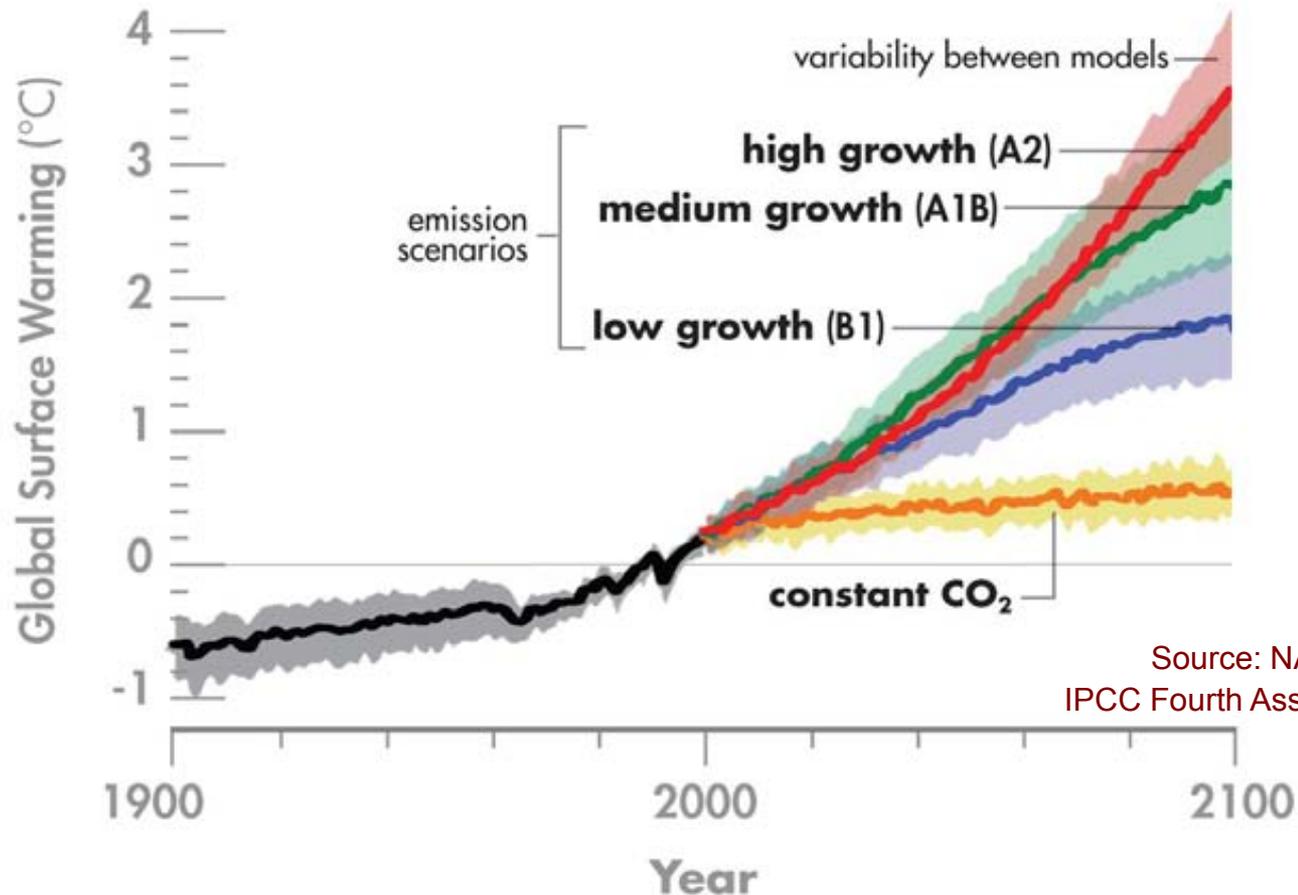


**Annual Average Global Surface Temperature Anomalies
1880-2006**

8 of the 10 warmest years on record have occurred since 2001

How Is the Climate Changing?

Projected Temperature Change



- likely to be in the range of 2° to 4.5°C (3.6° – 8.1° F)
- best estimate about 3° C,
- very unlikely to be less than 1.5°C

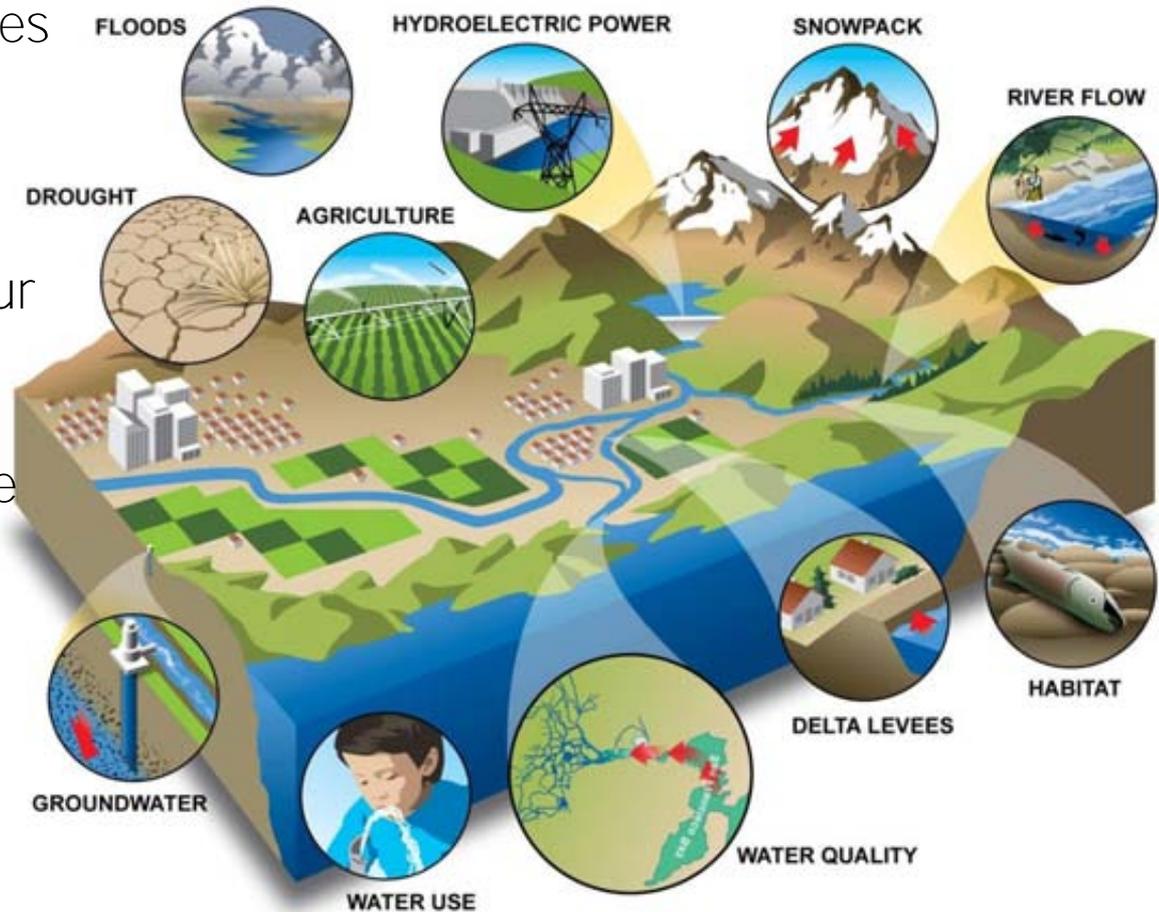
Climate Change and the EPA National Water Program

A changing climate in the years ahead will raise new challenges for protecting and improving the quality of the Nation's waters.



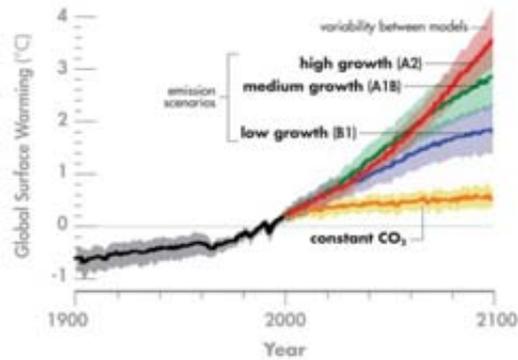
Why Does Climate Change Matter to Water Program Managers?

- Temperature change drives other changes in natural environmental processes that in turn affect the quality and quantity of our water resources.
- Steps taken to reduce the release of greenhouse gases may have consequences for water resources and programs.



Source: California – Department of Water Resources. Climate Change in California Fact Sheet.

Water-Related Effects of Climate Change



Source: NASA Earth Observatory, based on IPCC Fourth Assessment Report (2007)

Warmer water



Precipitation changes



Source: NOAA, www.katrina.noaa.gov

Increases in tropical storm intensity



Source: USEPA, www.epa.gov/cre

Ocean and coastal changes



Source: Maps of Lands Vulnerable to Sea Level Rise as found in EPA 2008u

Sea level rise

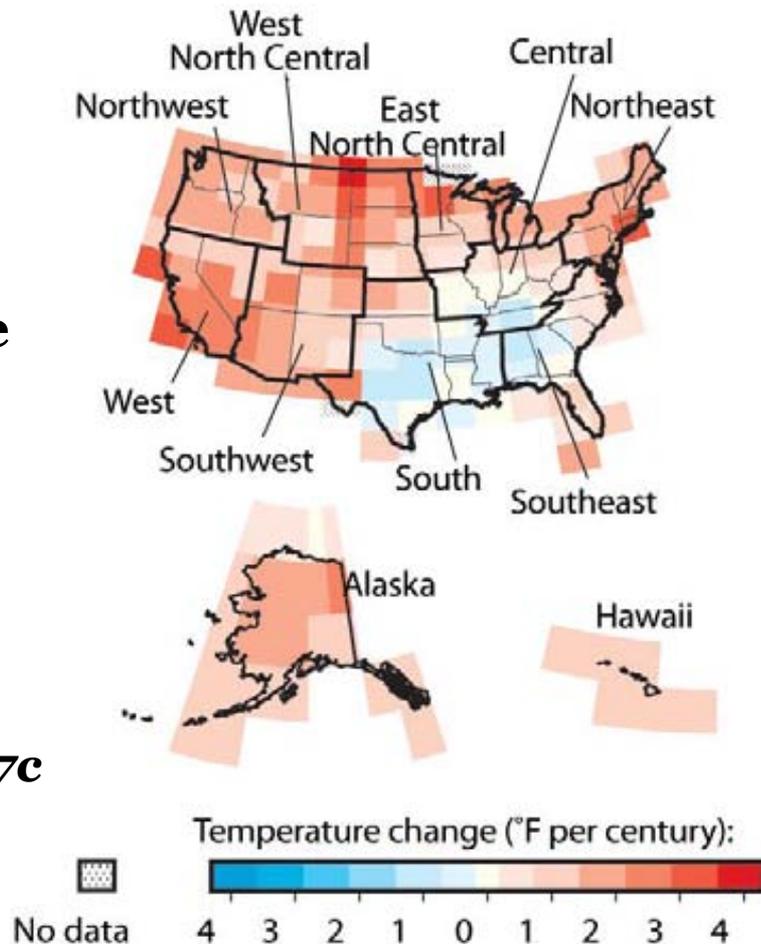
The Effect on Water Resources

Air & Water Temperature Increases

“All of North America is very likely to warm during this century, and the annual mean warming is likely to exceed the global mean warming in most areas...warming in the USA is expected to exceed 3.6 F by nearly all models.”

–IPCC, 2007c

Annual Mean Temperature Anomalies
1901-2005



Source: NOAA/NESDIS/NCDC, as found in EPA 2008v

The Effect on Water Resources

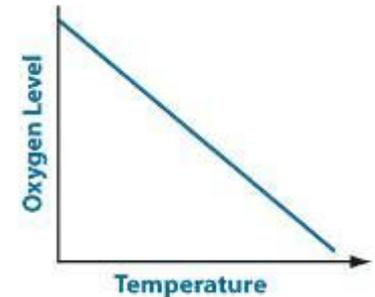
Water Temperature Increases



Changes in the distribution and survival of aquatic species



Algal blooms



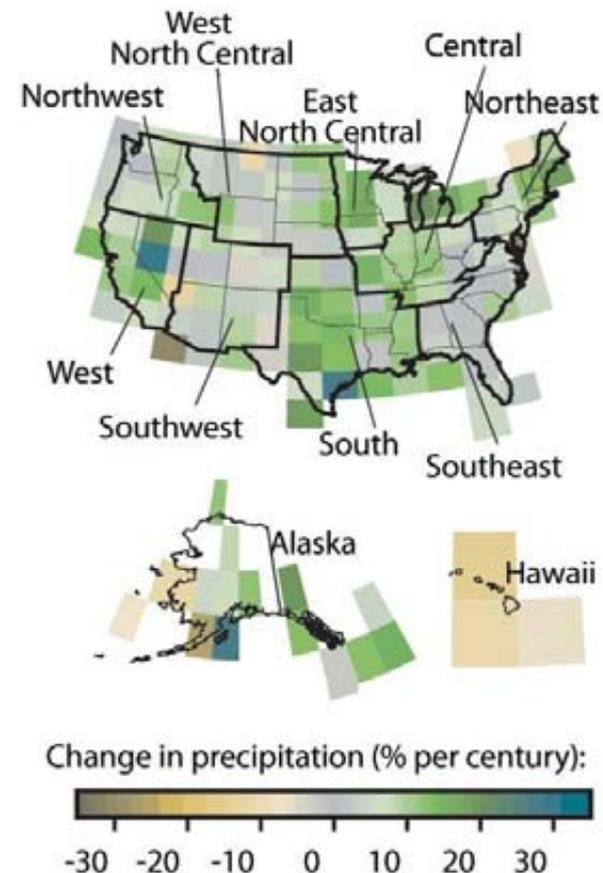
Lower dissolved oxygen levels

The Effect on Water Resources

Precipitation Changes

- Annual average precipitation is expected to increase in the northeast and decrease in the southeast
- Greater variation in precipitation, including more intense drought and extreme rainfall events
- More precipitation falling as rain instead of snow, resulting in changes in the amount of snow cover
- Changes in size and location of waterbodies and wetlands

Annual Precipitation Trends 1901-2005



Source: NOAA/NESDIS/NCDC

The Effect on Water Resources

Precipitation Changes

Water quantity

- Reduced ground water and surface water supply in some areas
- Reduced reliability of snow pack as a water „reservoir’
- Increased water demand due to higher temperatures



Water quality

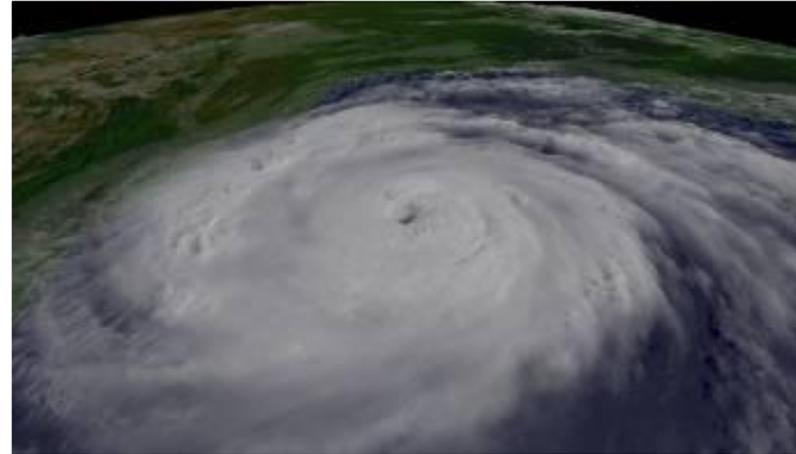
- Increased runoff resulting in erosion and sedimentation
- Overwhelmed water infrastructure due to flooding



The Effect on Water Resources **Increases in Storm Intensity**

Warming air and sea surface temperatures are expected to result in greater intensity of tropical storms, accompanied by:

- Stronger peak winds
- Increased rainfall
- Larger storm surges



Intensified hurricanes and tropical storms

The Effect on Water Resources Increases in Storm Intensity



Contaminated Waters



Damaged wetlands



**Flooded Wastewater
Treatment Plant**



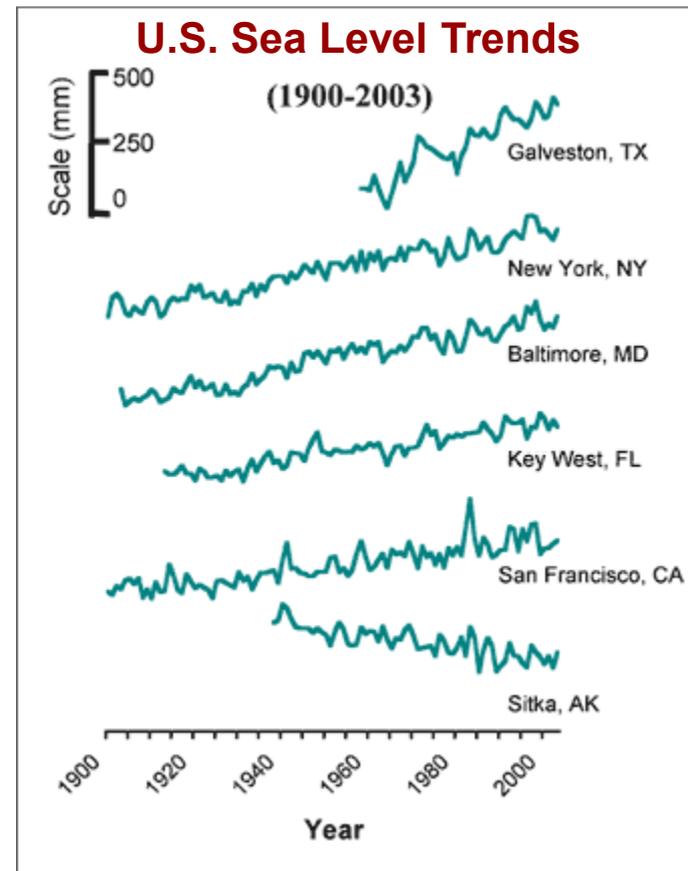
High wind damage

The Effect on Water Resources

Sea Level Rise

“Sea levels are rising worldwide and along much of the U.S. coast.”

- IPCC, 2007



Source: Monthly and Annual Mean Sea Level Station Files from the Permanent Service for Mean Sea Level (PSMSL) at the Proudman Oceanographic Laboratory

The Effect on Water Resources

Sea Level Rise

- Displacement of coastal wetlands and habitat
- Increased coastal erosion
- Salt water intrusion in drinking water supplies
- Inundation of wastewater treatment infrastructure



The Effect on Water Resources

Ocean and Costal Changes

Biological habitat changes are expected in the oceans as the air temperatures increase:

- Estuarine waters become more saline as sea levels rise
- Ocean temperatures increase
- Ocean acidification



What Is the Relationship Between Energy, Water Resources and Climate Change?

- Reduced water flows could limit hydropower and power plant cooling
- Geological sequestration of CO₂ from coal-fired power plants could pose a risk to underground sources of drinking water
- Demand for biofuels could lead to increased agricultural nutrient runoff
- Water collection, treatment and distribution accounts for 4% of energy use in the U.S.



Coal-fired electric power plant

But do we know enough to take action now?

- Global Circulation Models (GCMs)
 - grid cells of typically 100+ kilometers across
 - simulate large geographic areas and timescales better than smaller areas and timescales
 - simulate temperature better than precipitation
 - precipitation is better modeled over large geographic areas than small areas
- “Uncertainty” is with local-scale projections
- Meaning: we must adopt risk management approaches that don't assume „stationarity’



Thank you!

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Water

Impacts Relative to Temperature Change

