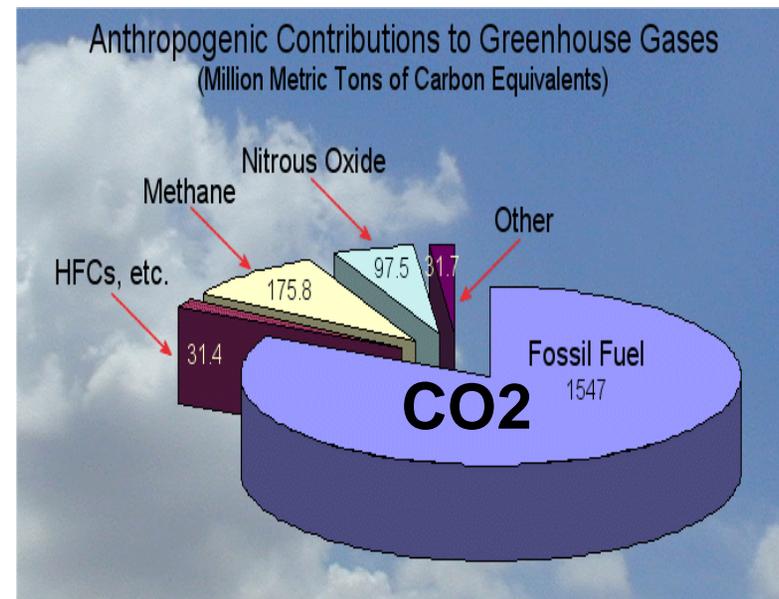
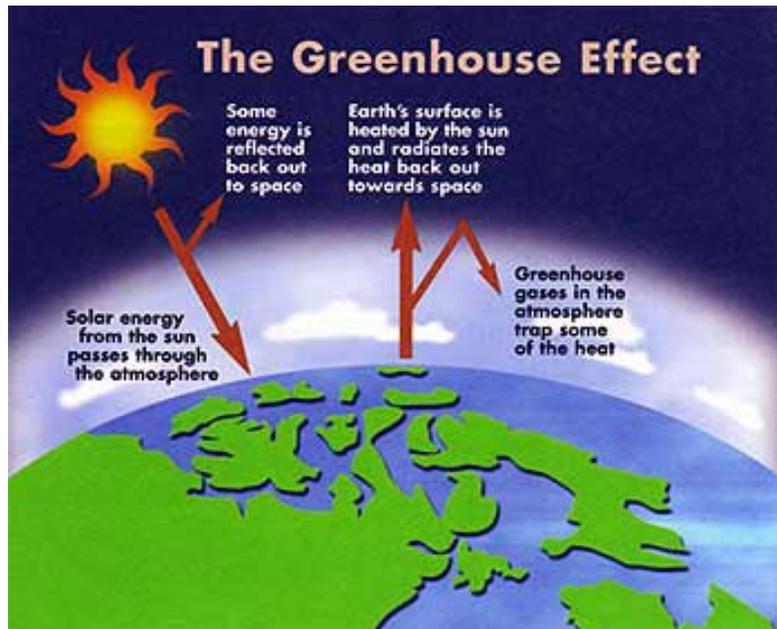


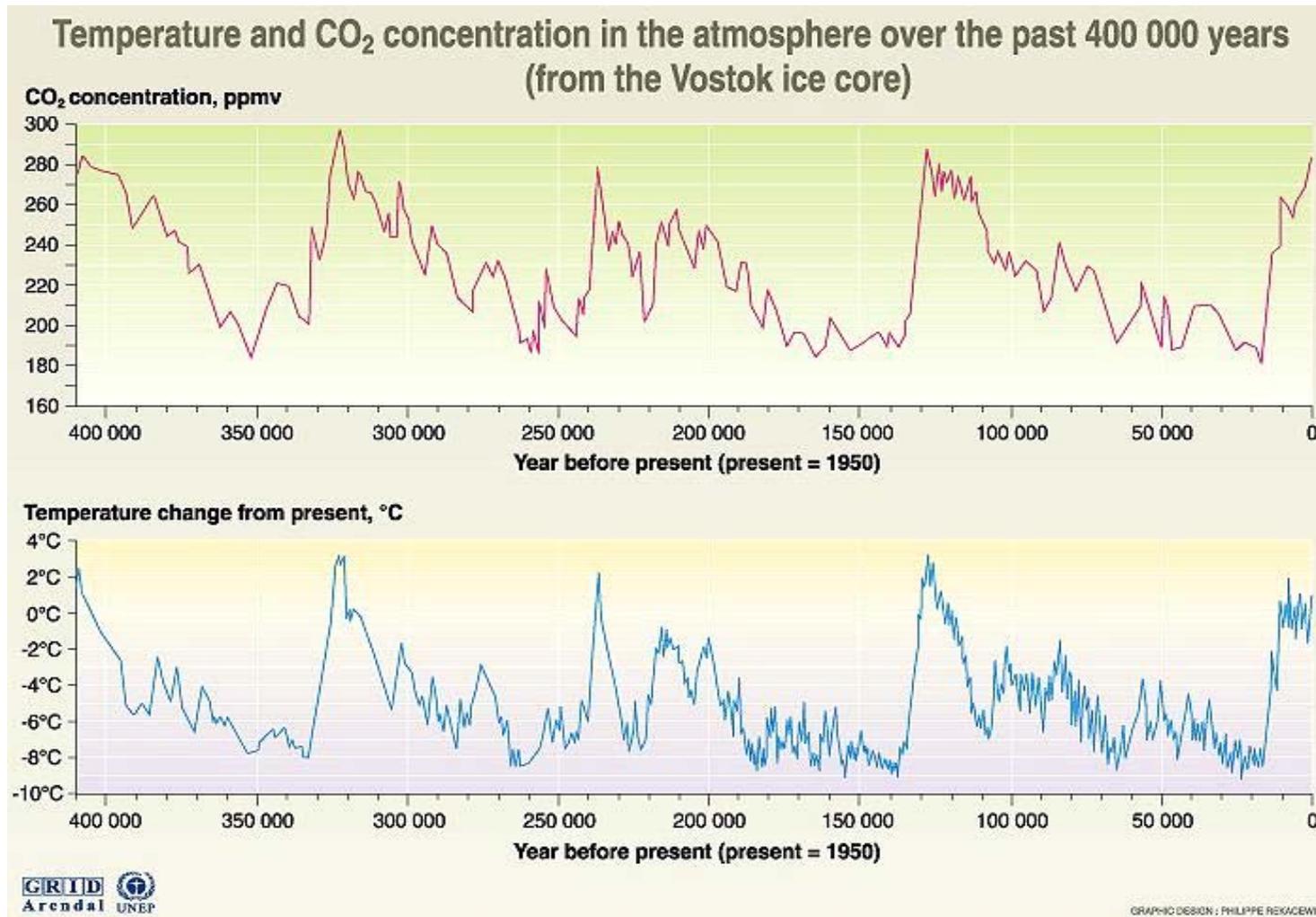
Norman Willard  
U.S. EPA Region I  
Energy Team  
Energy, Climate & Transportation  
Mass Bays Program  
Management Committee Meeting  
December 12, 2007



# The greenhouse effect, the greenhouse gases



# CO<sub>2</sub> concentrations are closely correlated with temperature

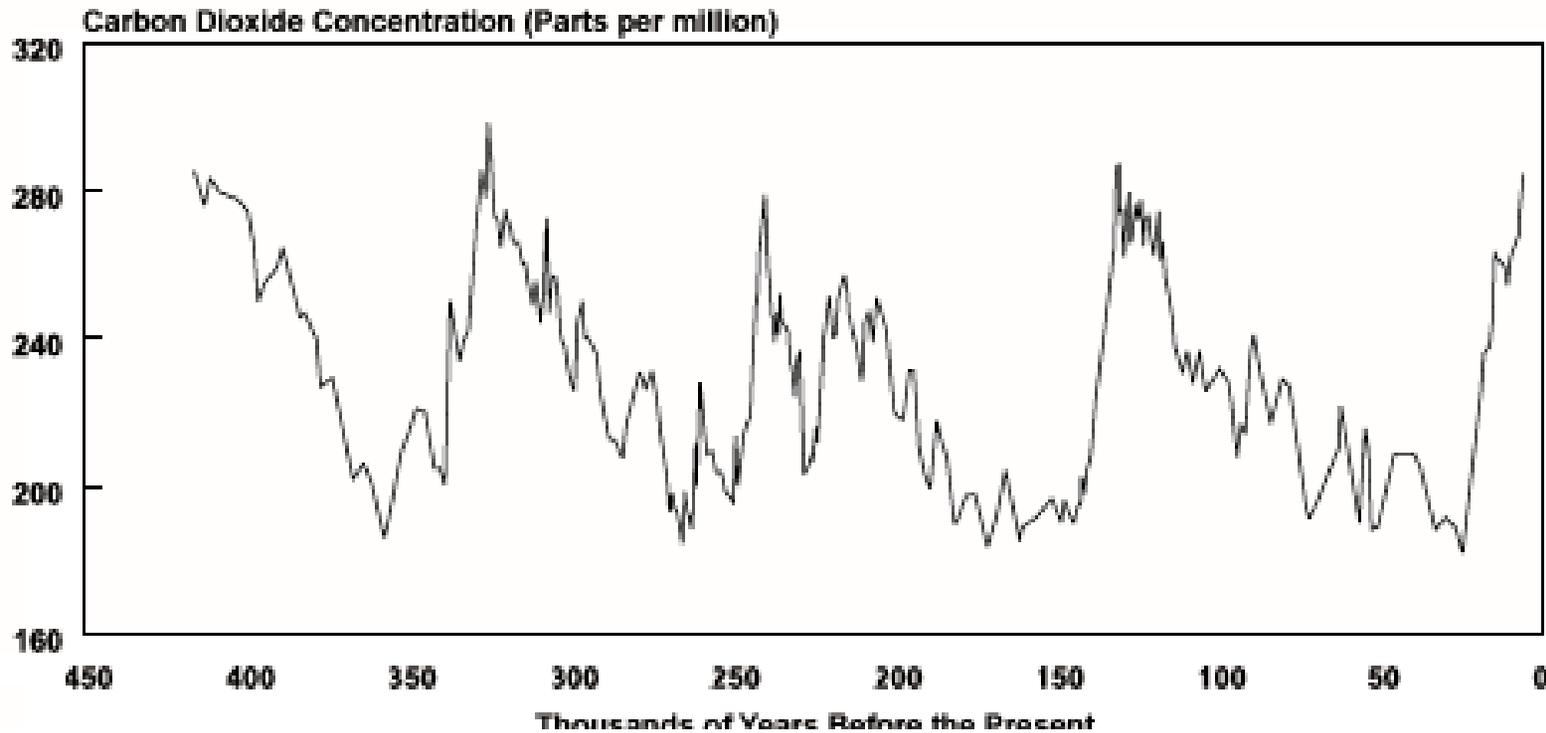


Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3 June), pp 429-436, 1999.

# Historic CO<sub>2</sub> concentrations up 36% since the 1700's

Today  
381 ppm → \*

## Atmospheric Carbon Dioxide

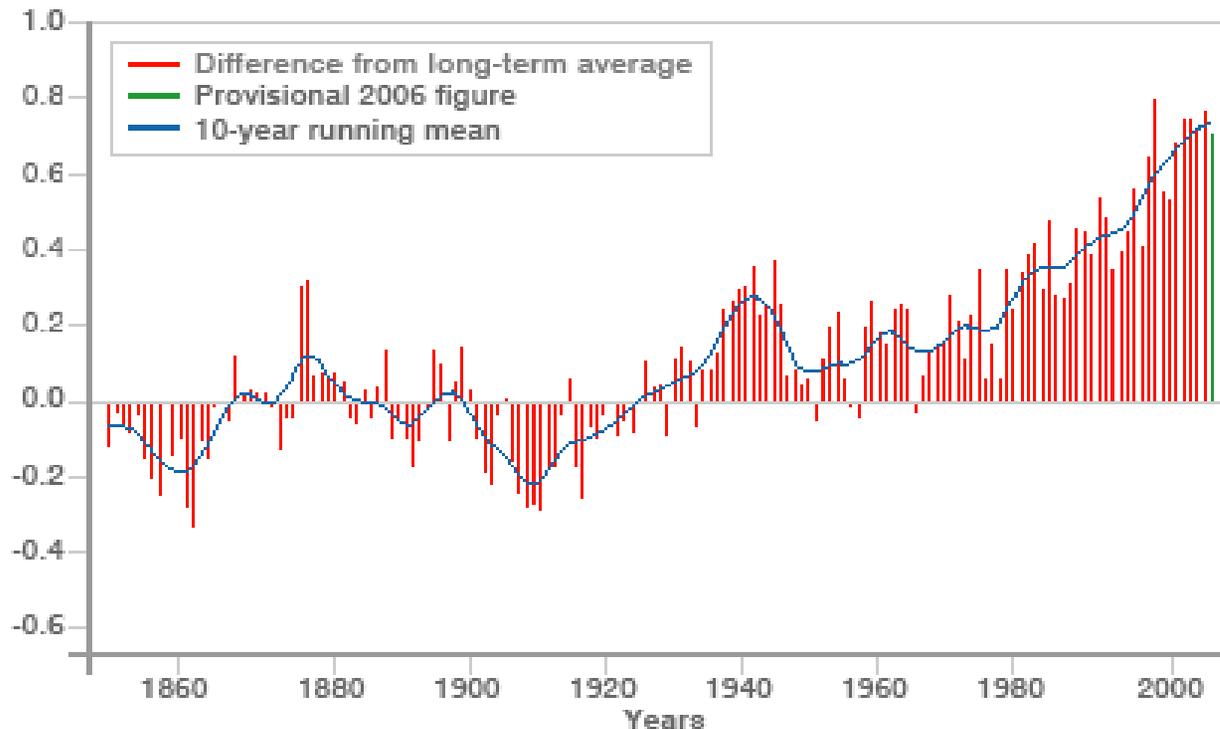


Source: IPCC WGI Third Assessment Report, 2001

# Global temperatures since 1850

- Eleven of the twelve years in the period 1995-2006 rank among the 12 warmest since 1850
- 2006 annual average temperature was warmest on record in U.S.
- Warming since the middle 1970s is now about 1°F

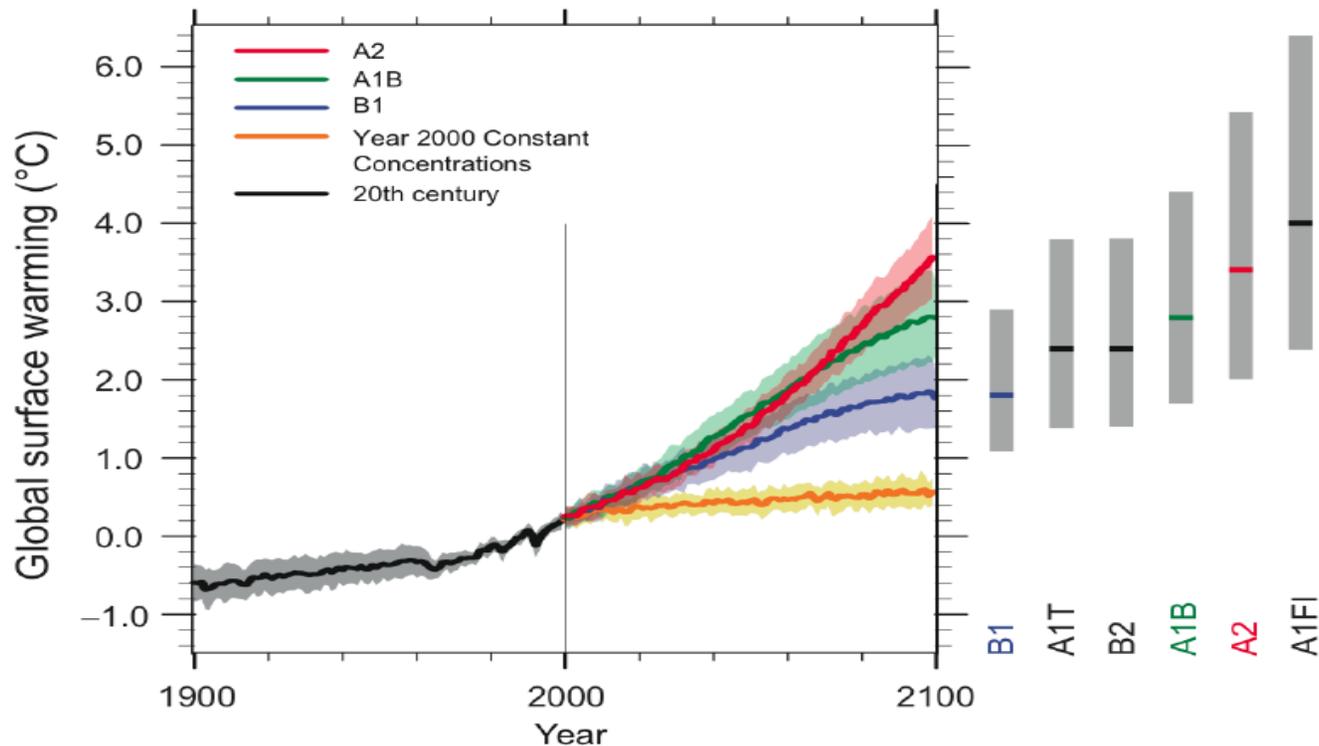
**AVERAGE GLOBAL TEMPERATURES SINCE 1850**  
GLOBAL AVERAGE NEAR-SURFACE TEMPERATURES  
Temp difference (degrees C) from end of 19th century



SOURCE: Met Office/Univ of East Anglia/Hadley Centre

# What about the future?

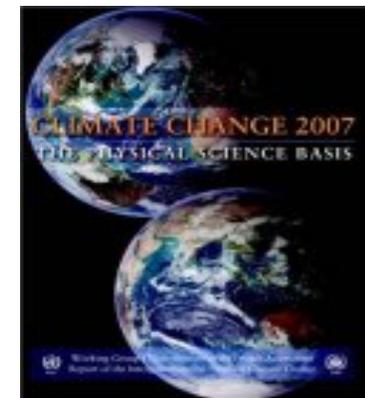
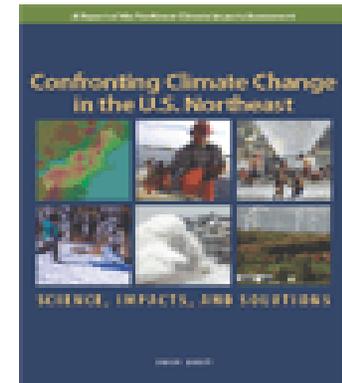
Multi-model Averages and Assessed Ranges for Surface Warming



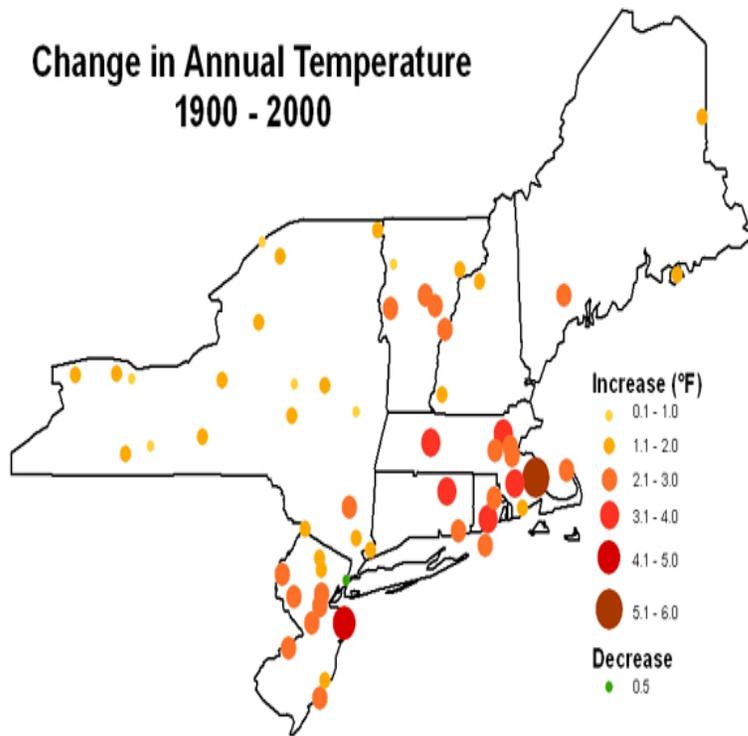
- Greenhouse gases and temperatures will very likely continue to increase
- There are important uncertainties about future emissions and how the climate will respond to them

# Climate Science is “Unequivocal”

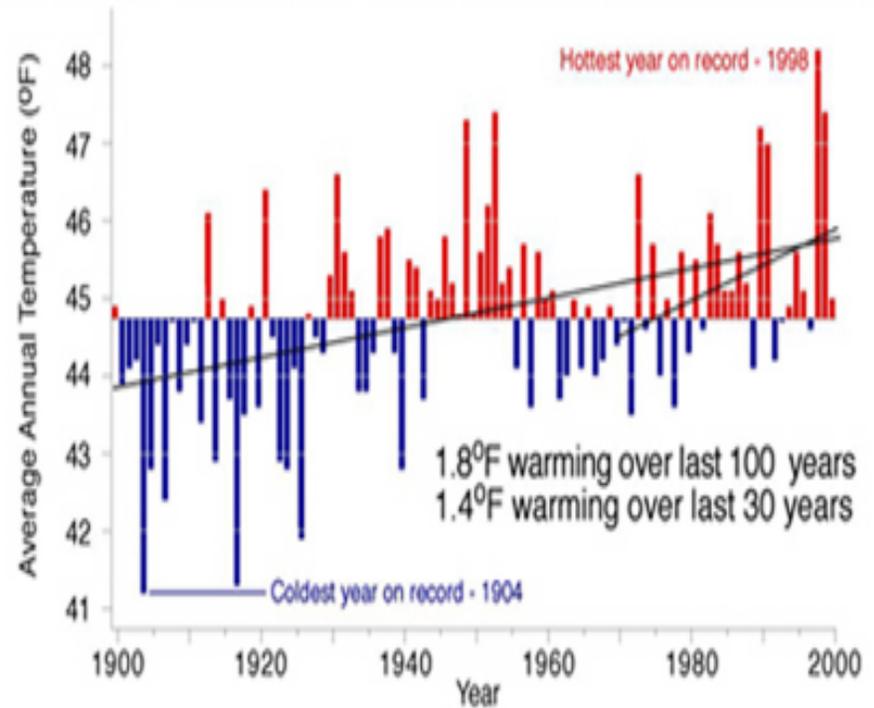
- **World Meteorological Organization** -- 11/2007
  - Atmospheric CO<sub>2</sub> levels are highest ever recorded
  - 381.2 ppm in 2006 is up from 379.2 ppm in 2005 (0.53 percent)
  - 30 percent rise since the late 1700's
- **Union of Concerned Scientists & NECIA** reports -- 2007
  - Northeast states specific future scenerios, vulnerabilities
- **International Panel on Climate Change (IPCC)** reports -- 2007
  - “Evidence unequivocal” – A Summary for Decision Makers 10/2007
  - Increase in storm intensity, erosion & scouring, precipitation dumps, but also droughts
  - Salt water intrusion
  - Wetlands impacts
  - Altered chemistry
  - Ecosystem services, habitat effects



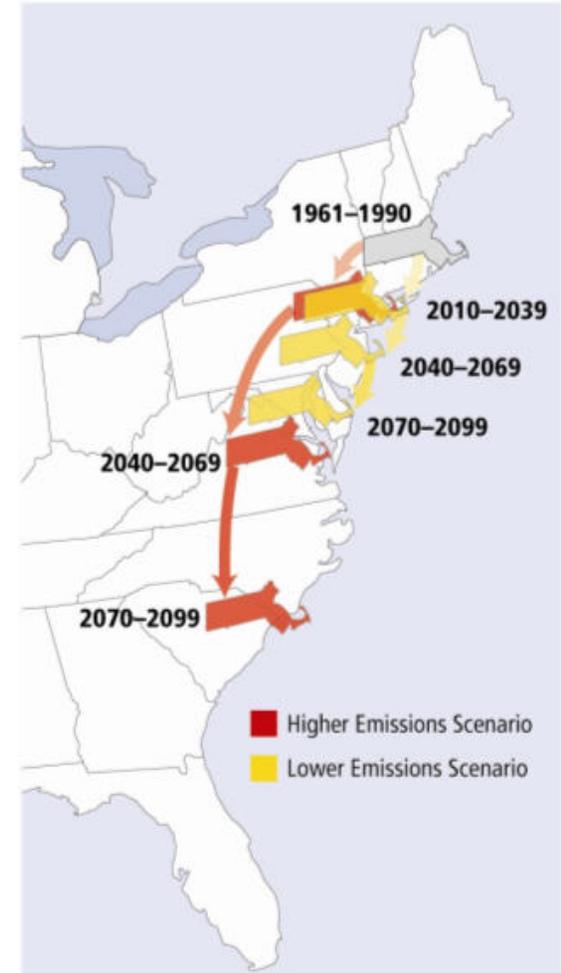
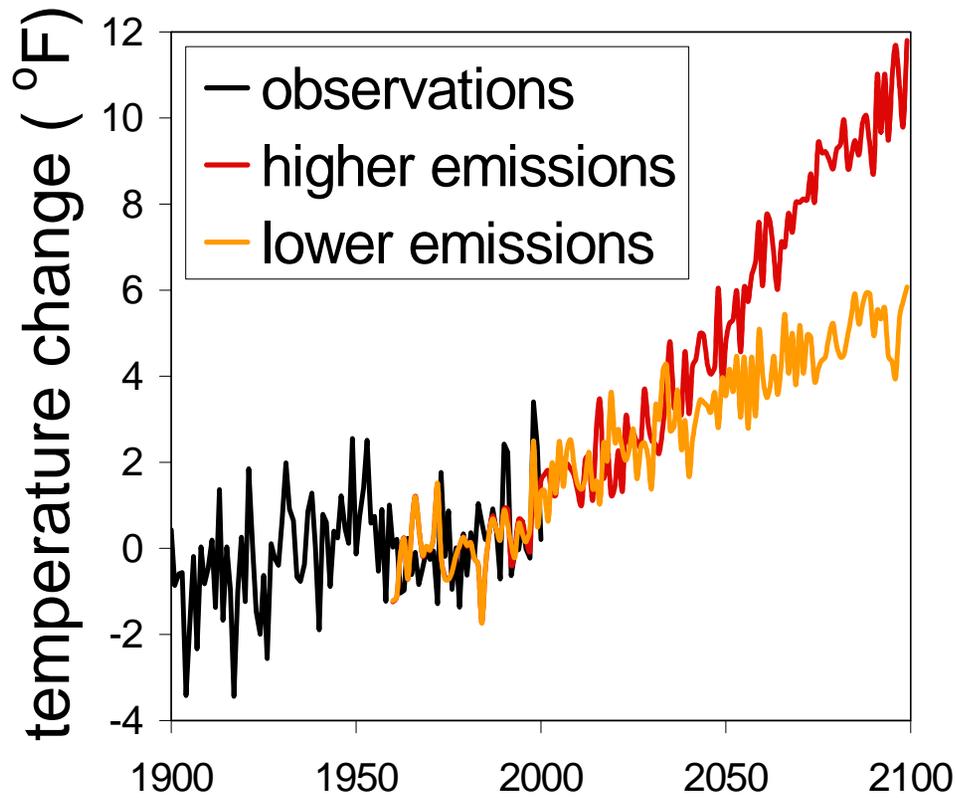
# New England temperatures are rising



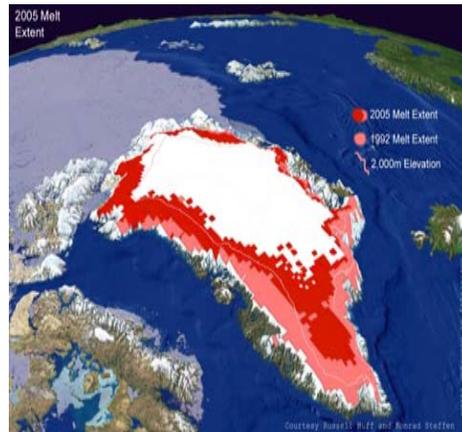
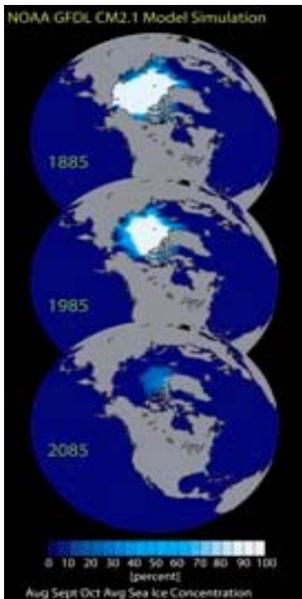
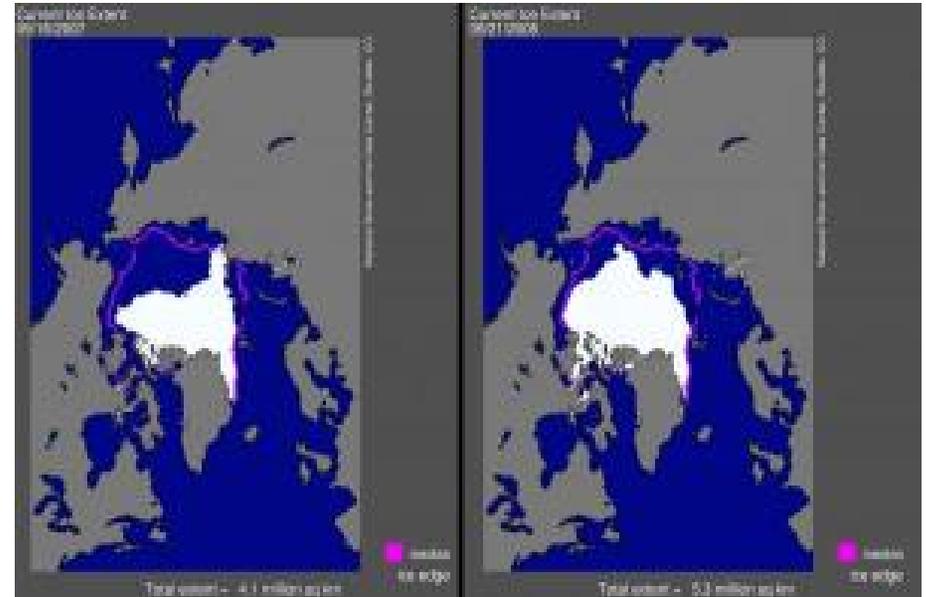
## Average Annual Northeast Temperature



# Future temperatures in the Northeast under 2 scenerios – high & low emissions



Record sea ice melt in 2007, possibly 50% since 1950's. A 2-7 degree F increase in temperatures across the Arctic.



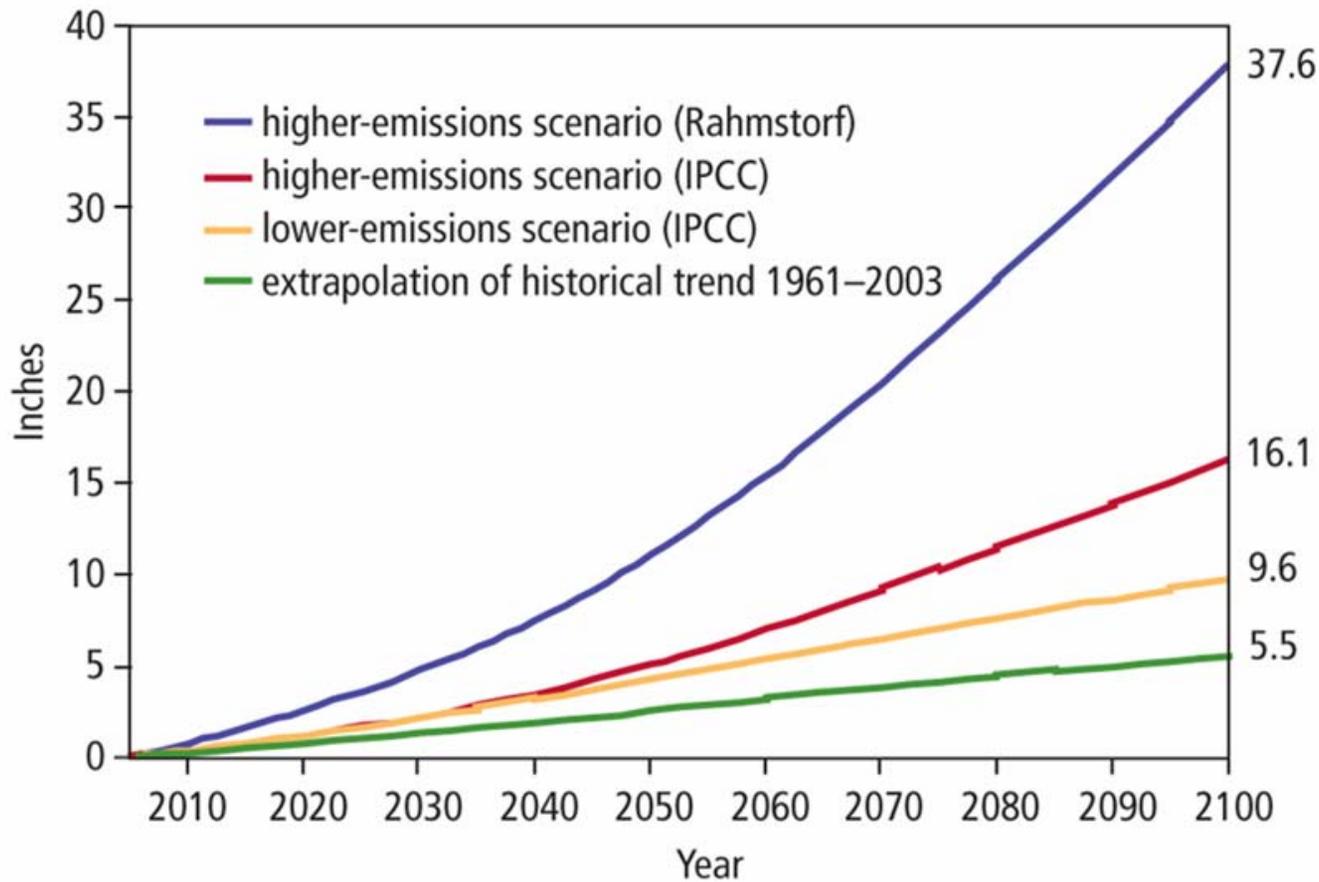
# Tropical and temperate mountain glaciers are melting



- In Montana's Glacier National Park, 27 glaciers remain of 150 in 1850
- Researchers have documented rapid mountain glacier retreat in Greenland, the European Alps, the Himalayas, Ecuador, Peru, Venezuela, New Guinea, and East Africa, among other places
- Coastal warming of Greenland up 4 degrees C since 1992 – AGU 12/11/07

Qori Kalis Glacier, Quelccaya Ice Cap, Peru, are shown between 1978 (top) and 2002. The glacier retreat during this time was 1,100 meters.

# Projected rise in global sea level relative to 2005



# The importance of our coasts

- 14 of the nation's 20 largest cities are coastal
- > 50% of U.S. population w/in 50 miles of the coast, 19 of 20 most populated counties are on the ocean
- 35 million people NC to TX coast alone
- Coastal population will grow by 27 million within 8 years
- \$ 6.8 trillion -- value of insured coastal property exposed to hurricane threat Gulf coast to Maine
- 1938 hurricane thru New England today would cost \$200 billion today (a Category 3 storm)
- Katrina -- \$70+ billion



# Climate vulnerabilities of our coasts are real and significant



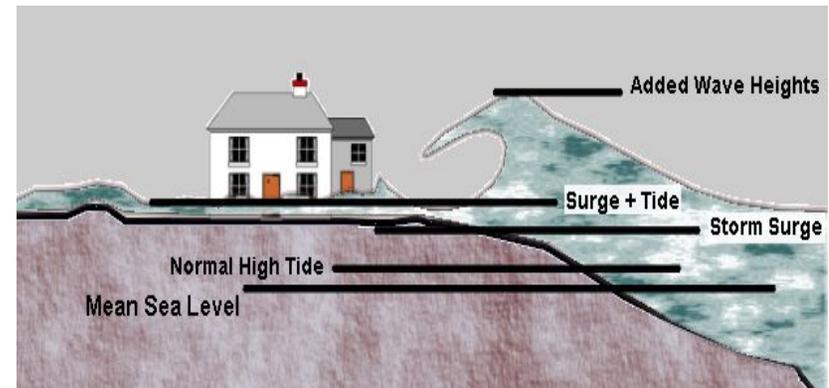
- **Ecosystem stresses** -- habitat, bio-systems like wetlands, water-based species changes
- **Economic** -- tourism, beaches, recreation, flood protection, dry land inundation
- **Wetlands, estuaries** -- natural systems, food source, “nursery” to the world
- **Economic** -- near shore/coastal, marine commercial fisheries
- **Human infrastructure** -- physical damage to housing stock, roads, bridges, ports, CSO’s, POTW’s, industry, cities and communities
- **Drinking water supply** -- salt water intrusion
- **Human toll** -- morbidity, mortality, dislocations, job loss
- **Costly property damage** -- loss, repair, replacement, rebuilding, disaster relief, compensation,
- **Energy** -- supply disruptions, rigs, power plants, pipelines, cost increases

# Coastal storms & storm surges

A 1950's storm in New England



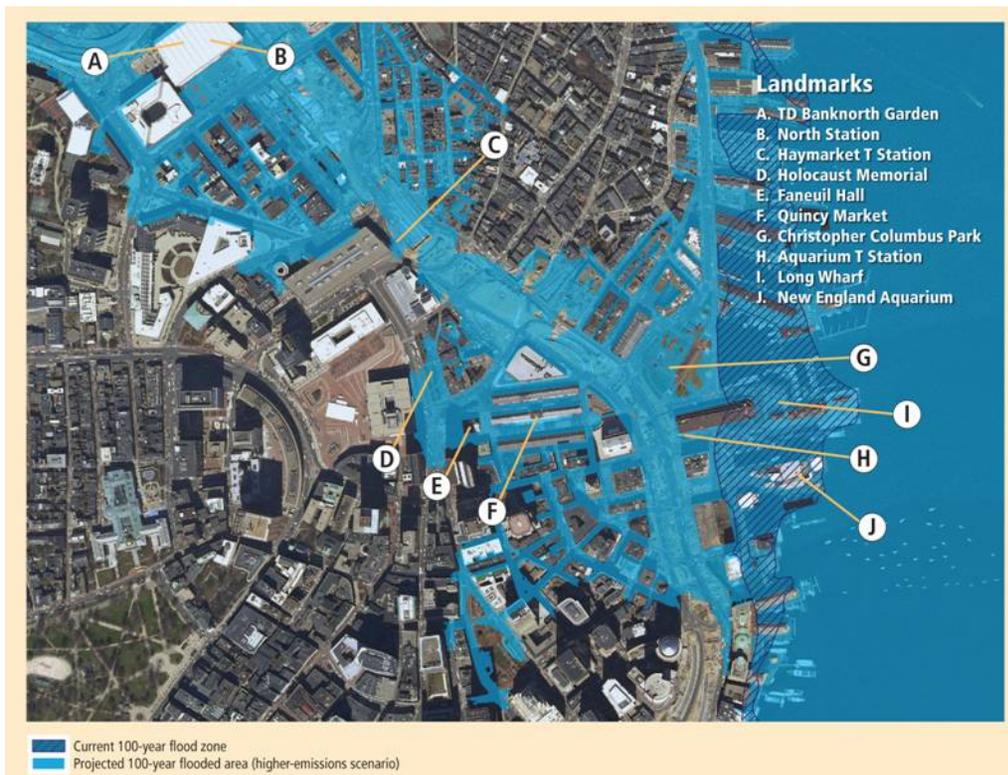
Surges magnify impacts



With climate change  
more intense storms are  
predicted here and worldwide



# Community infrastructure impacts: Boston - future 100 year flood under a high GHG emission scenerio, roads



# Effects on water resources in New England



- **Water Quality**
  - Ambient Water Quality standards, monitoring, reporting,
  - Drinking Water SDWA, surface & ground water protection
  - Pollutant Controls NPDES, CSOs, NPS, TMDL, wastewater
- **Aquatic Ecosystems**
  - Streams & rivers
  - Lakes & reservoirs
  - Wetlands: multiple types
  - Estuaries & other coastal ecosystems

# Climate effects on aquatic ecosystems

- **Ecosystems are affected by**
  - Water quality  
nutrients, sediments, toxics
  - Hydrology  
Streamflow (quantity & timing),  
Lake levels, stratification, ice-over,  
Water tables, salinity, mixing
  - Temperature  
Direct effects, decomposition rates,  
dissolved oxygen concentrations
  - Sea level rise & storm surges
  - UV radiation
  - Riparian habitat
- **Climate changes are affecting**
  - Rivers & streams
  - Lakes & reservoirs
  - Wetlands
  - Estuaries



# Climate impacts on wetlands

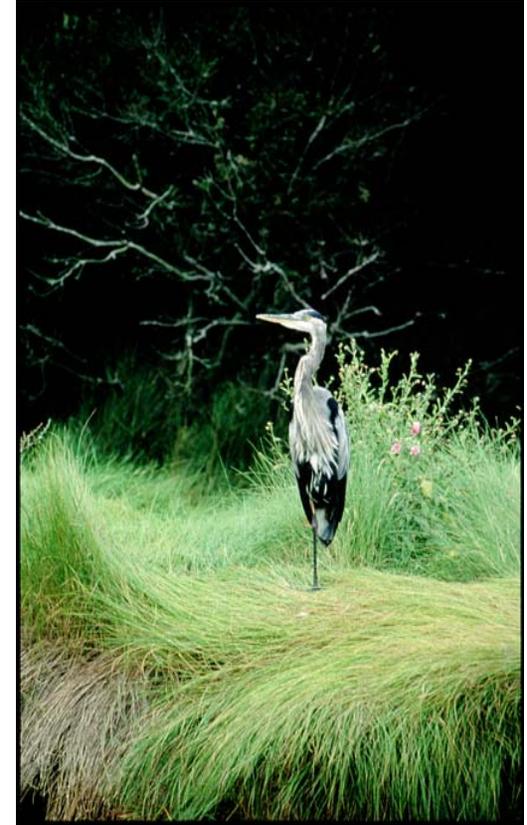
**Many sources of water** in wetlands, all of which are sensitive to climate change:

- Coastal waters (ocean, estuaries)
- Surface water
- Groundwater
- Rain

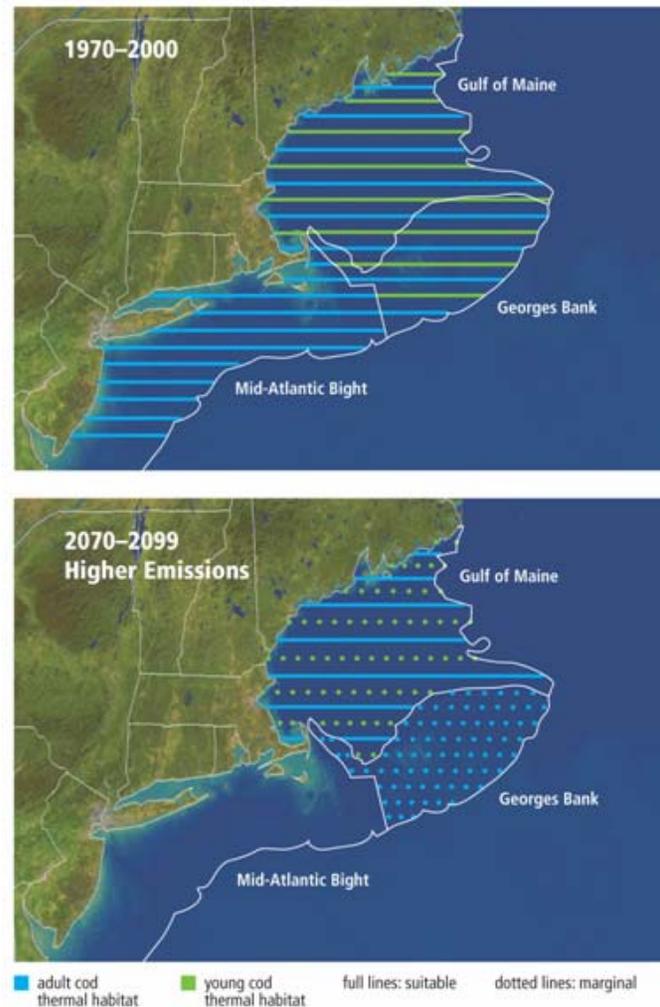
**Risks to wetlands** include:

- Inundation by rising seas
- Wetter (more source water)
- Drier (less water +/- or more evaporation)
- Altered temps, seasonality
- Pollutant loads

**Effects** could include: habit impacts, changes in species composition, susceptibility to invasive species, functioning



# Natural resource impacts. An example: The cod fishery and changing habitat conditions



# Responding: Regional & state climate activity

- **NEG/ECP - New England Governors/Eastern Canadian Premiers' - Climate Action Plan**

- 6 New England states plus QE, PEI, NS, NB & NF
- Goals: 1990 by 2010, 10% below 1990 levels by 2020, 75-80% of 2001 levels by 2050
- 110+ New England college & university presidents support goals
- New workgroup: transportation & air quality, assess bio-fuels potentials
- Strong support by governors continues – How will we achieve 75-80% goal ?



- **RGGI - Regional Greenhouse Gas Initiative – a CO2 ‘Cap and Trade’ program**

- A model for a national climate program
- Power plants only (for now)
- Began 2003 – moving ahead strongly – starts Jan 1, 2009
- Goal: 10% GHG reduction by 2019
- 10 states have joined: ME, NH, VT, MA, RI, CT, NY, NJ, MD & DE
- Will yield \$\$\$ for energy efficiency and clean energy
- Additional carbon offsets being studied, e.g. forests
- Western Governors’ analog “WGGI” - CA, OR, WA, UT, AZ, NM & BC



- **The Climate Registry – Building climate response “infrastructure”**

- 39 states, 3 Tribes, 3 Canadian provinces, 2 Mexican states
- “Credit” for early action to reduce GHG
- Voluntary, policy neutral, 3<sup>rd</sup> party verification, transparency
- Sets rigorous standards & uniform methodologies for states, communities, businesses universities, others to 1) inventory GHG emissions and 2) report GHG reductions
- Starts Jan 1, 2008



# More regional & state climate activity

- All of our New England states have prepared GHG emission inventories
- All of our New England states have prepared climate action plans and are implementing them
- New England states contributed to a regional GHG inventory and are working together closely on specific actions to reduce GHG, promote energy efficiency, clean & renewable energy, transportation & clean fuels
- An active NGO and foundation community
- A savvy public and an engaged media
- An economic opportunity for new jobs in New England



# Northeast Regional Oceans Council

- NEG/ECP climate action plan: directive to agencies to engage on coastal science, policies, adaptation, mapping, emergency management re-climate impacts on coasts
- NORC created by New England Governors in 2005, now with wider Canadian participation along with state CZMs, EPA, NOAA, Interior, FEMA, Gulf of Maine Council
- 4 areas of concentration, one was “making the region coastal hazards response ready” i.e. sea level rise, storms
- 2007 Congress, annual Report to NEG in August 2007
- Meeting at EPA NE offices in October, 2007

# The Massachusetts Climate Action Plan

[www.mass.gov/dep/air/climate](http://www.mass.gov/dep/air/climate)

- **MA Exec.Office Energy & Environmental Affairs & MA DEP**
- **Action items to reduce GHG:**
  - Transportation
  - Energy efficiency
  - Renewable and clean energy
  - Smart Growth
  - State fleet
  - Energy performance in state buildings
  - Procurement
  - CO2 and power plants
  - RGGI
  - NEG/ECP Climate Action Plan
  - MEPA process
  - Climate action state funding
  - Community development grants based on a GHG criterion



# The Massachusetts Climate Action Network

- Helping communities work on climate change
- 36 MA communities – case studies, mentoring, sharing expertise, experiences, best management practices



# ICLEI Local Governments for Sustainability Cities for Climate Protection program



- 300 communities in the U.S., 800 in the world
- 62 communities in New England
- Linked to the New England Governors & Eastern Canadian Premiers climate action plan and state climate plans

# ICLEI Local Governments for Sustainability Climate Resilient Communities (new)

5 step methodology for communities

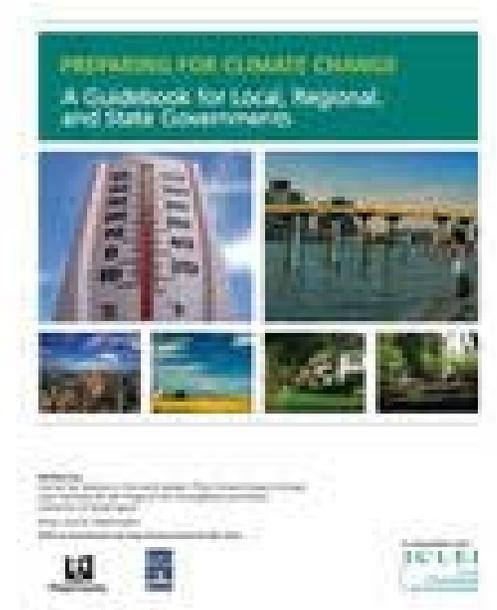
Conduct a Climate Resiliency study

Prioritize areas for action and set goals

Develop a Climate Resilient Action Plan

Implement the Plan

Monitor and reevaluate



# Climate action in other branches: the Congress, the U.S. Supreme Court

- **CONGRESS**

- A crowded field of bills filed 12+
- A national cap and trade program ?
- A carbon tax ?
- Economy-wide or just some sectors ?



- **U.S. SUPREME COURT**

- EPA has the authority and responsibility to regulate CO<sub>2</sub> from vehicles under the Clean Air Act
- Rulemaking process underway, draft rules by January 1, 2008
- Final rules by summer 2008
- Applicability of CO<sub>2</sub> as a “pollutant” to other EPA environmental programs ?

# U.S. Climate Science Program (CCSP) Synthesis & Assessment Products (SAPs) relating to coasts are in the works

- **CCSP Goal 4:** “Understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes”
- **SAP: # 4.1** due: 12/2007 Coastal elevation and sensitivity to sea level rise Lead: EPA Contributing: USGS / NOAA / NASA / DOE
- **SAP: # 4.4** due: 12/2007 Preliminary review of adaptation options for climate-sensitive ecosystems and resources Lead: EPA Contributing: USDA / NOAA / NASA / USGS / DOE

# “Adapting” to climate change

- **EPA’s Office of Water:** A National Strategy for Climate Change
- **EPA’s Office of Research & Development:** Air Quality and Climate Change
- **NEPA:** environmental impact reviews to consider GHG implications



# EPA New England's Community Energy Challenge

- **Purpose:** Stimulate energy efficiency in New England, reduce CO<sub>2</sub> from energy use
- Spring 2007 launch
- 57 communities now participating
- 18% of the New England population – 2 million people
- 10 largest cities in New England
- EPA collaborating with states, MA DEP, utilities, ICLEI, CT Clean Energy Fund, NGO's
- Benchmark:
  - Municipal buildings, e.g. schools, etc.
  - Waste water treatment plants
  - Drinking water facilities



# EPA national programs

Clean, efficient energy use is key to mitigation

**Clean Energy-Environment Partnership** program

- Best management practices for local government
- Calculators

**EnergyStar** voluntary energy efficiency programs

**Green Power Partnership** program

**WasteWise** program for solid waste and recycling

**Transportation** programs

**WaterSense** program



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