

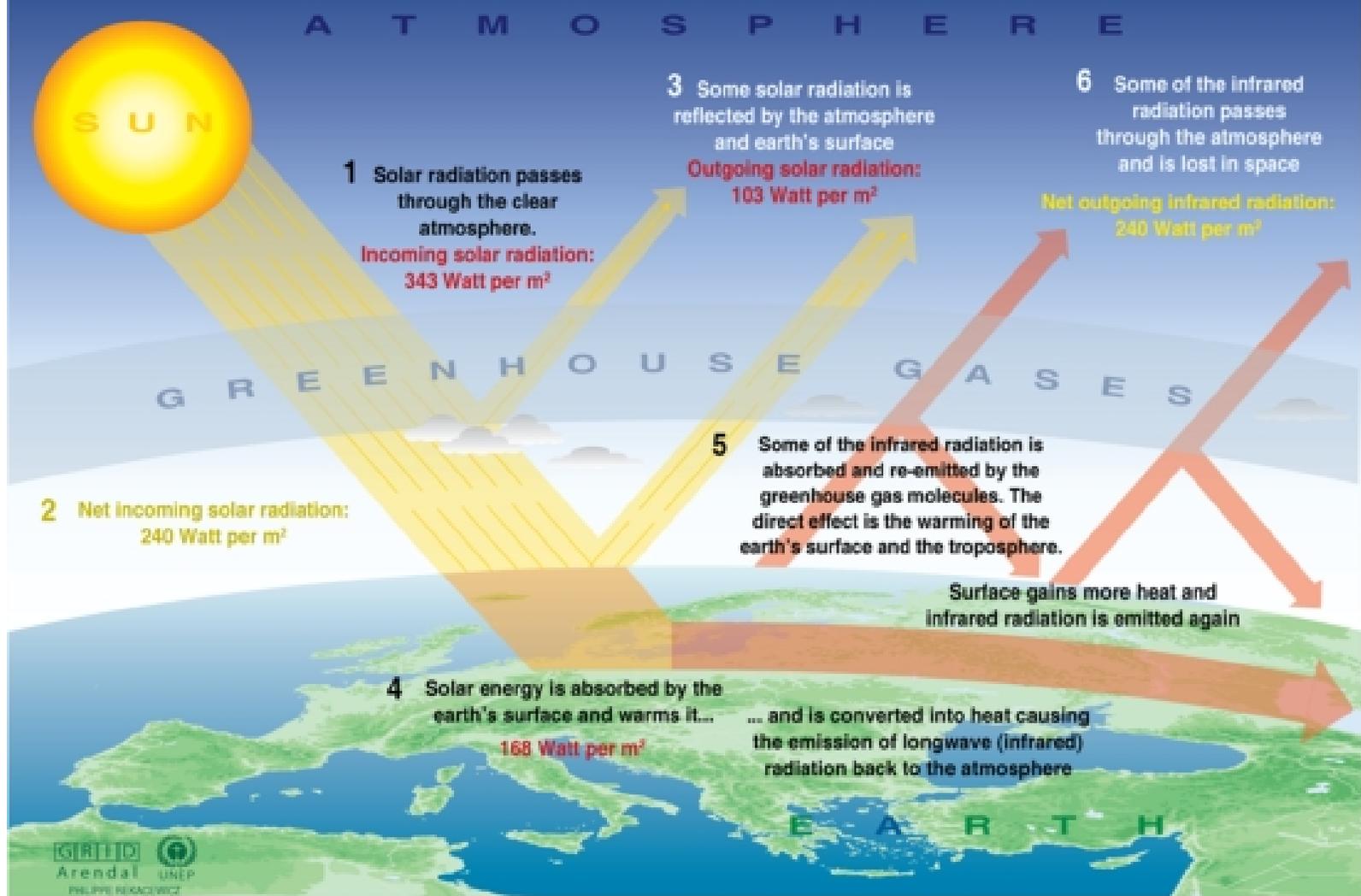
Climate Change and Vermont



Vermont Legislature's Summary of 2007 Exploration of Climate Change Issues in Vermont

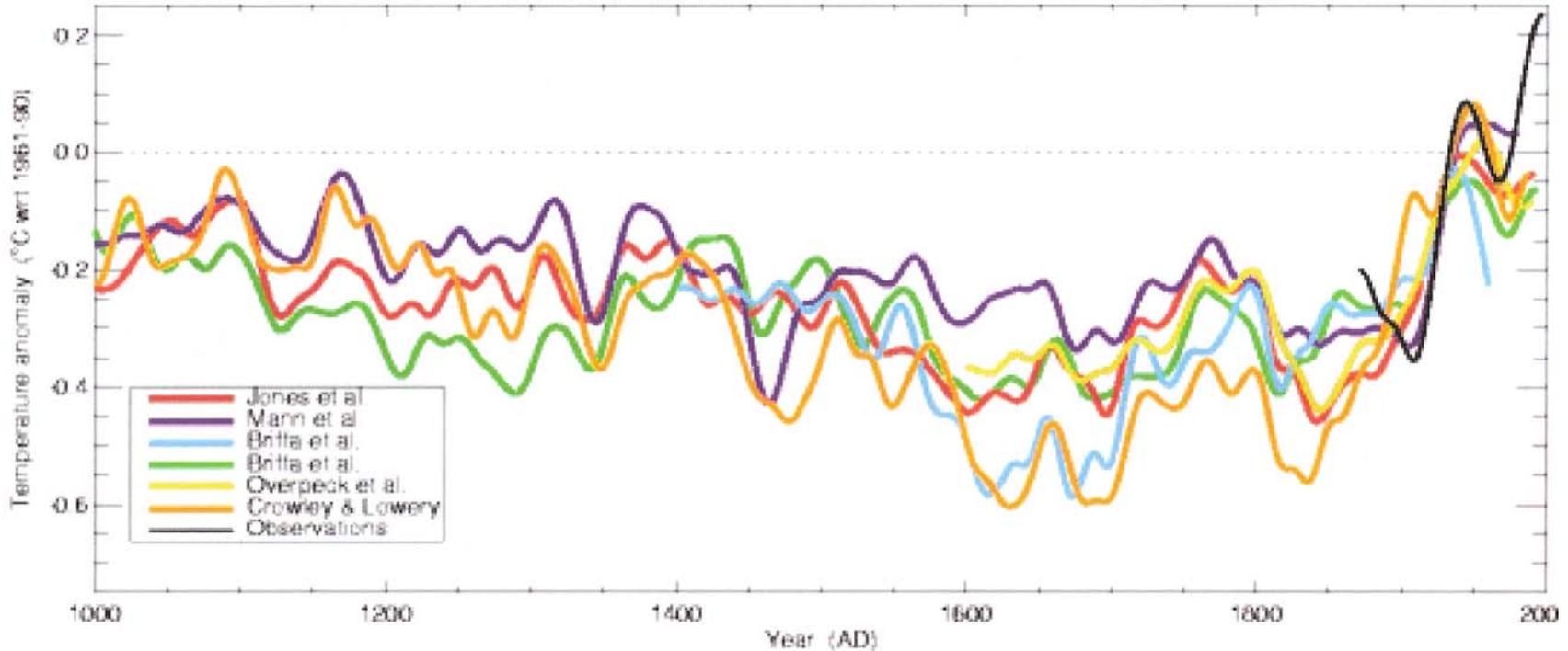
- *At the beginning of the 2007 legislative session, the house and senate committees on natural resources and energy hosted a 3-week deliberative process to investigate climate change and its potential impacts on Vermont.*
- *This presentation is a summary of key testimony and information gathered during this process.*

The Greenhouse effect

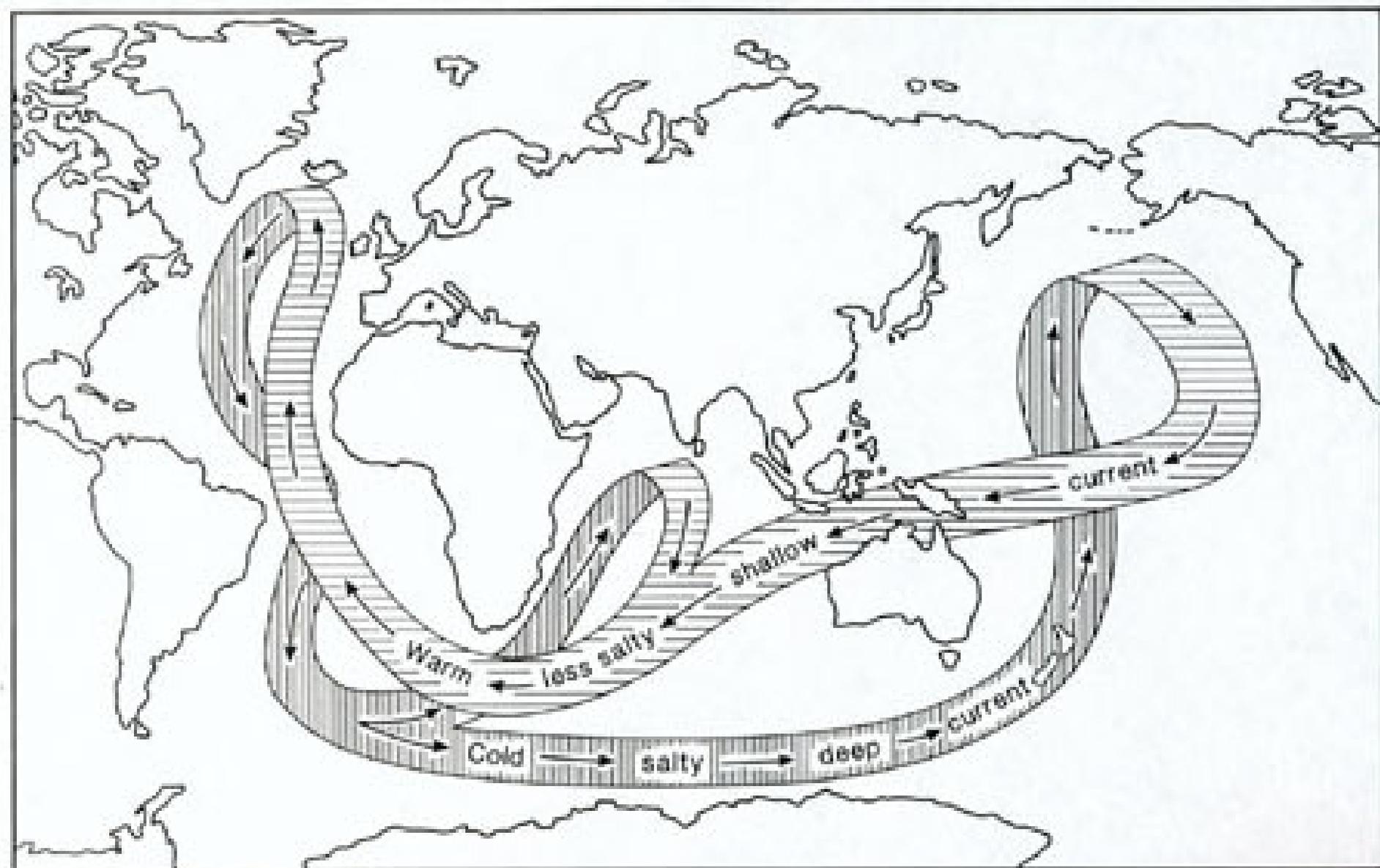


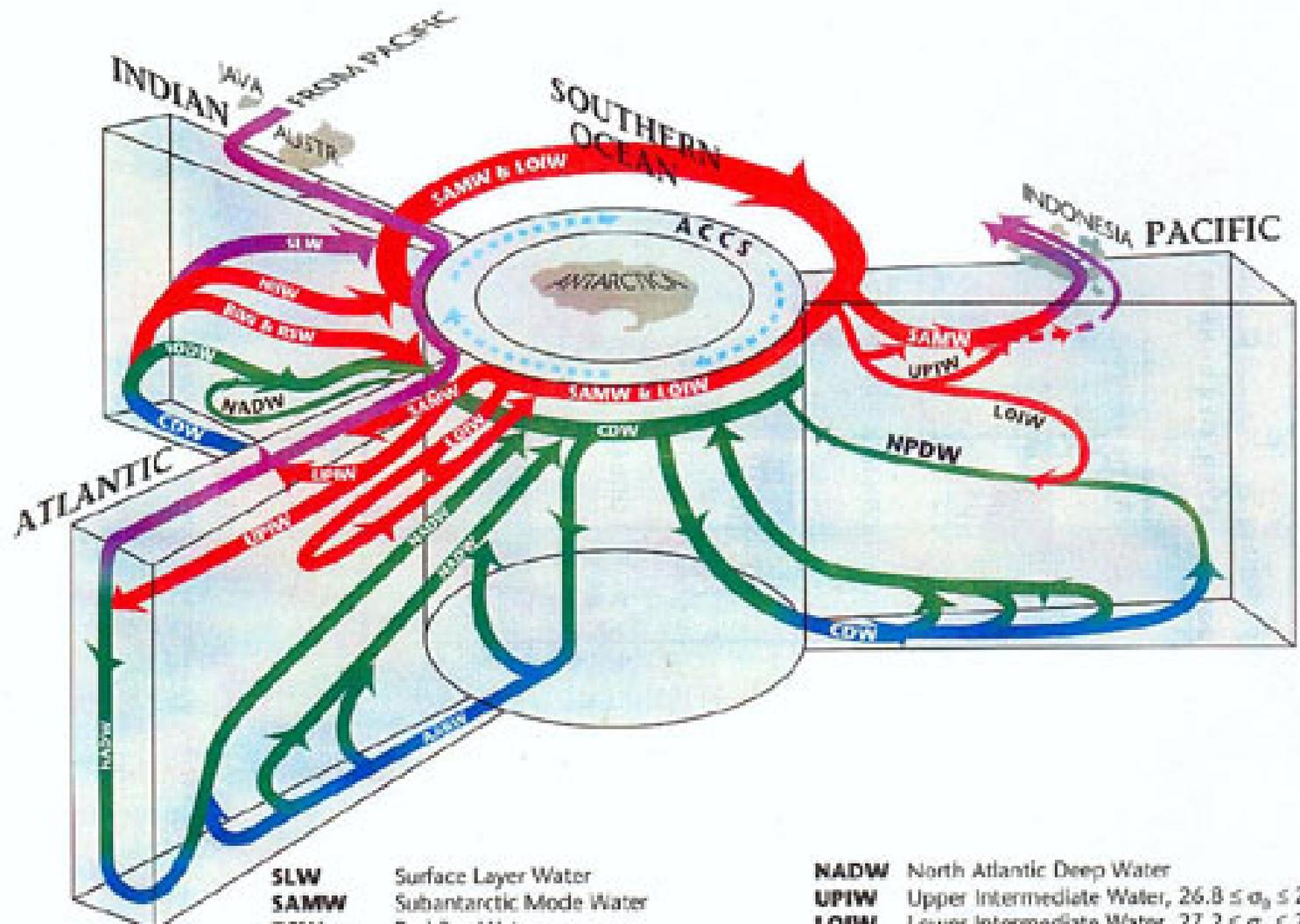
Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the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

The Millennial Temperature Record



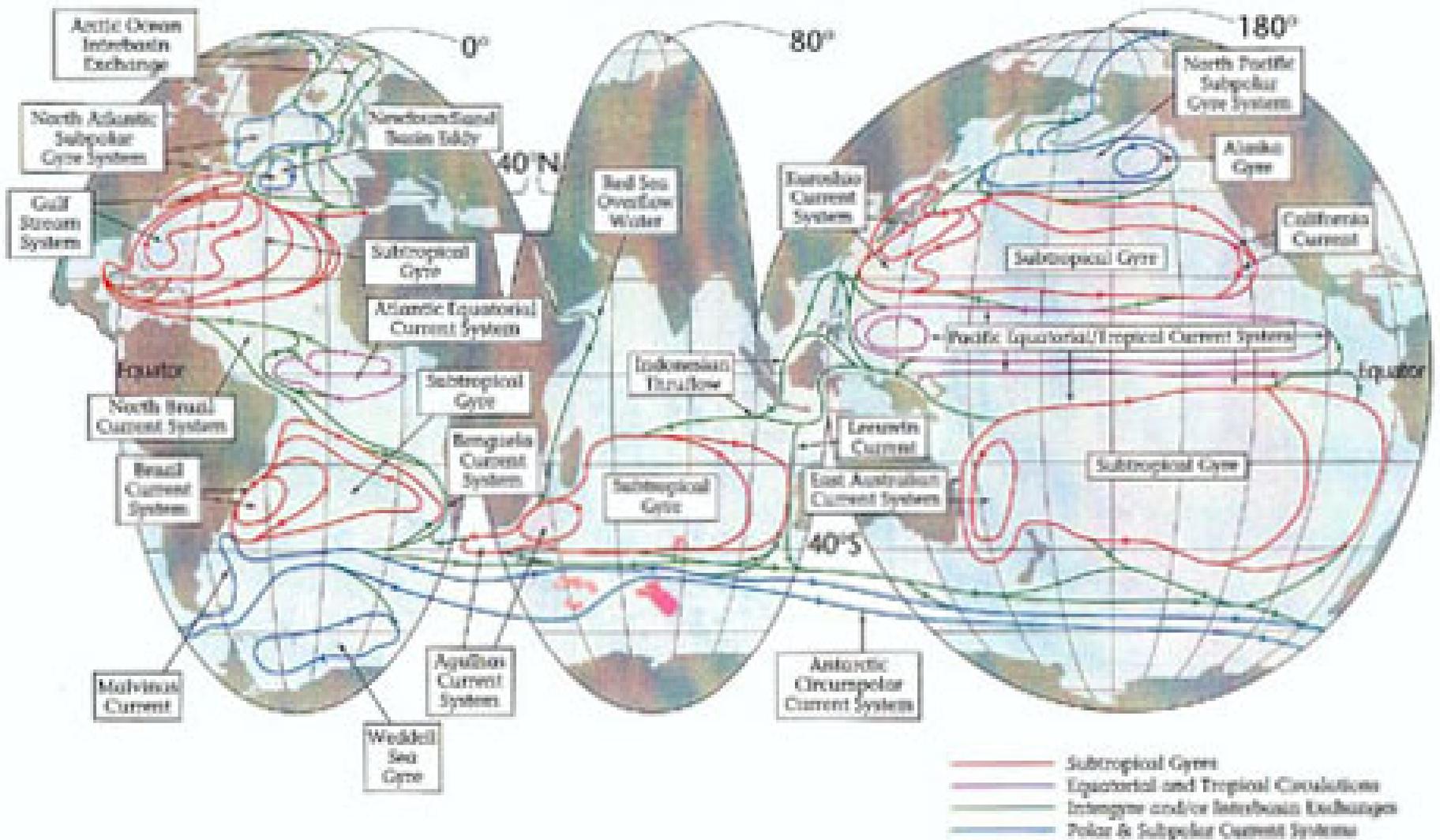
- Before thermometers
‘proxy’ records have large uncertainty
- Jones: <http://www.cru.uea.ac.uk/cru/info/milltemp/>

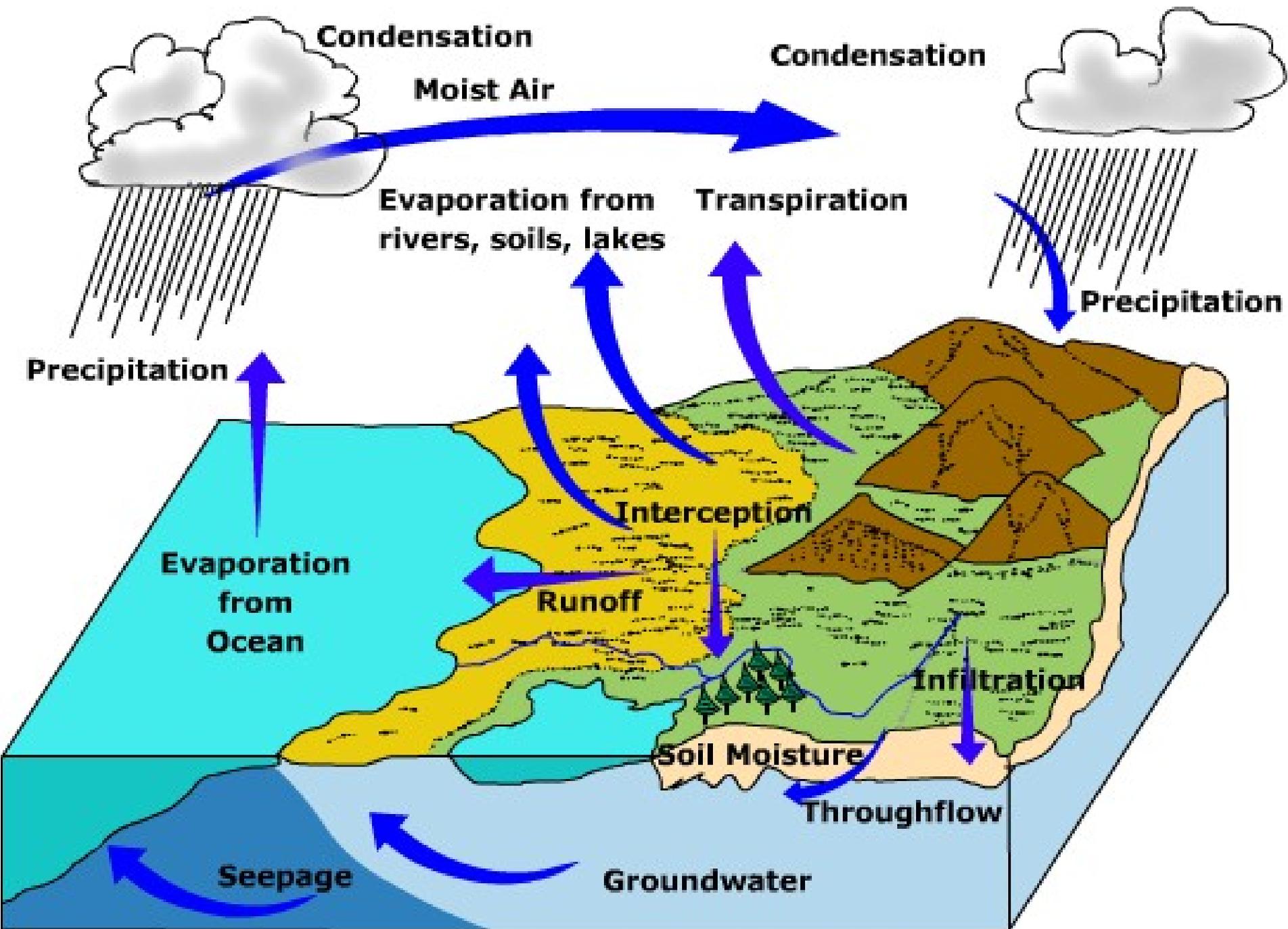




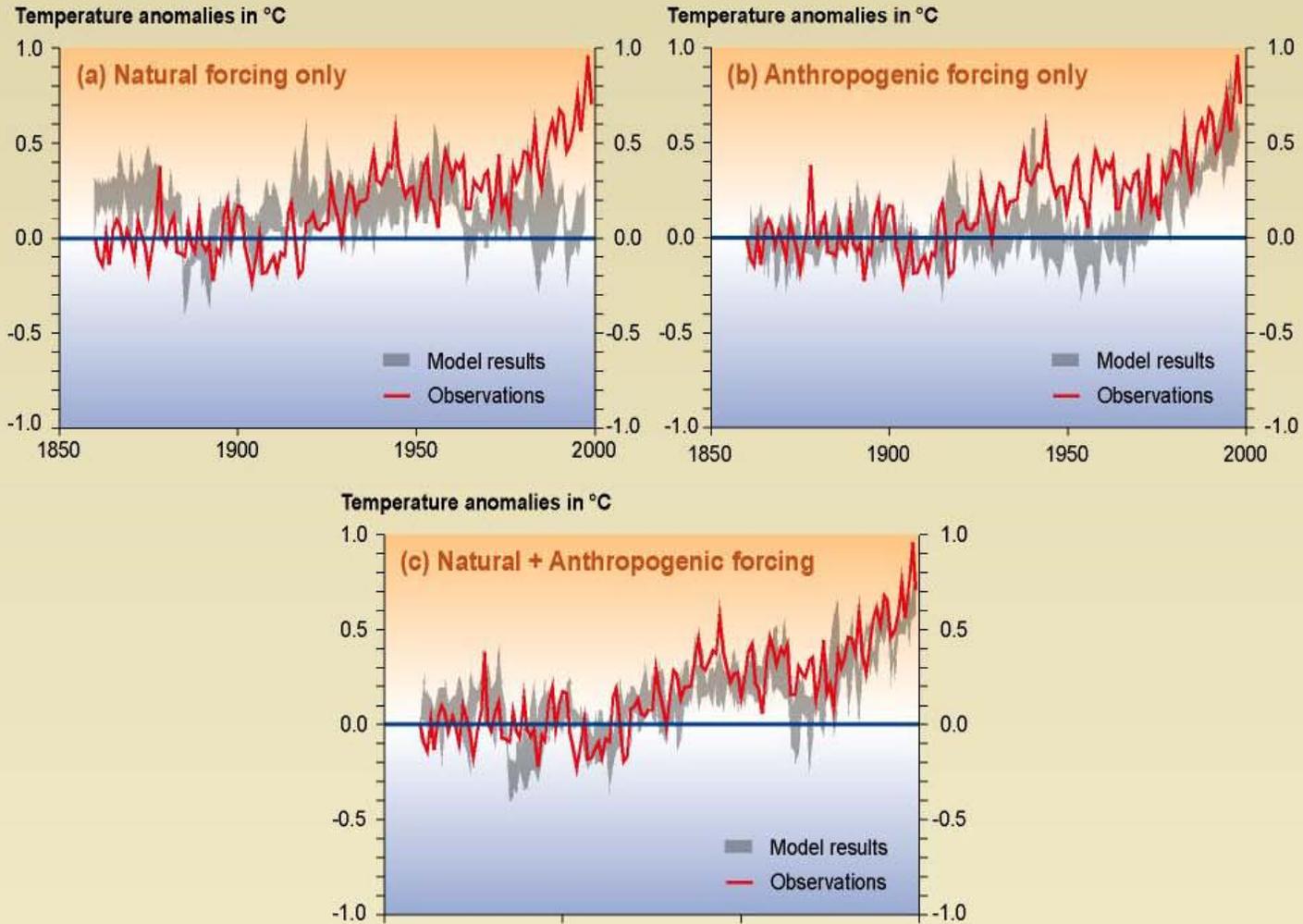
- SLW** Surface Layer Water
- SAMW** Subantarctic Mode Water
- RSW** Red Sea Water
- AABW** Antarctic Bottom Water
- NPDW** North Pacific Deep Water
- ACCS** Antarctic Circumpolar Current System
- CDW** Circumpolar Deep Water

- NADW** North Atlantic Deep Water
- UPIW** Upper Intermediate Water, $26.8 \leq \sigma_\theta \leq 27.2$
- LOIW** Lower Intermediate Water, $27.2 \leq \sigma_\theta \leq 27.5$
- IODW** Indian Ocean Deep Water
- BIW** Banda Intermediate Water
- NIIW** Northwest Indian Intermediate Water





Comparison between modeled and observations of temperature rise since the year 1860

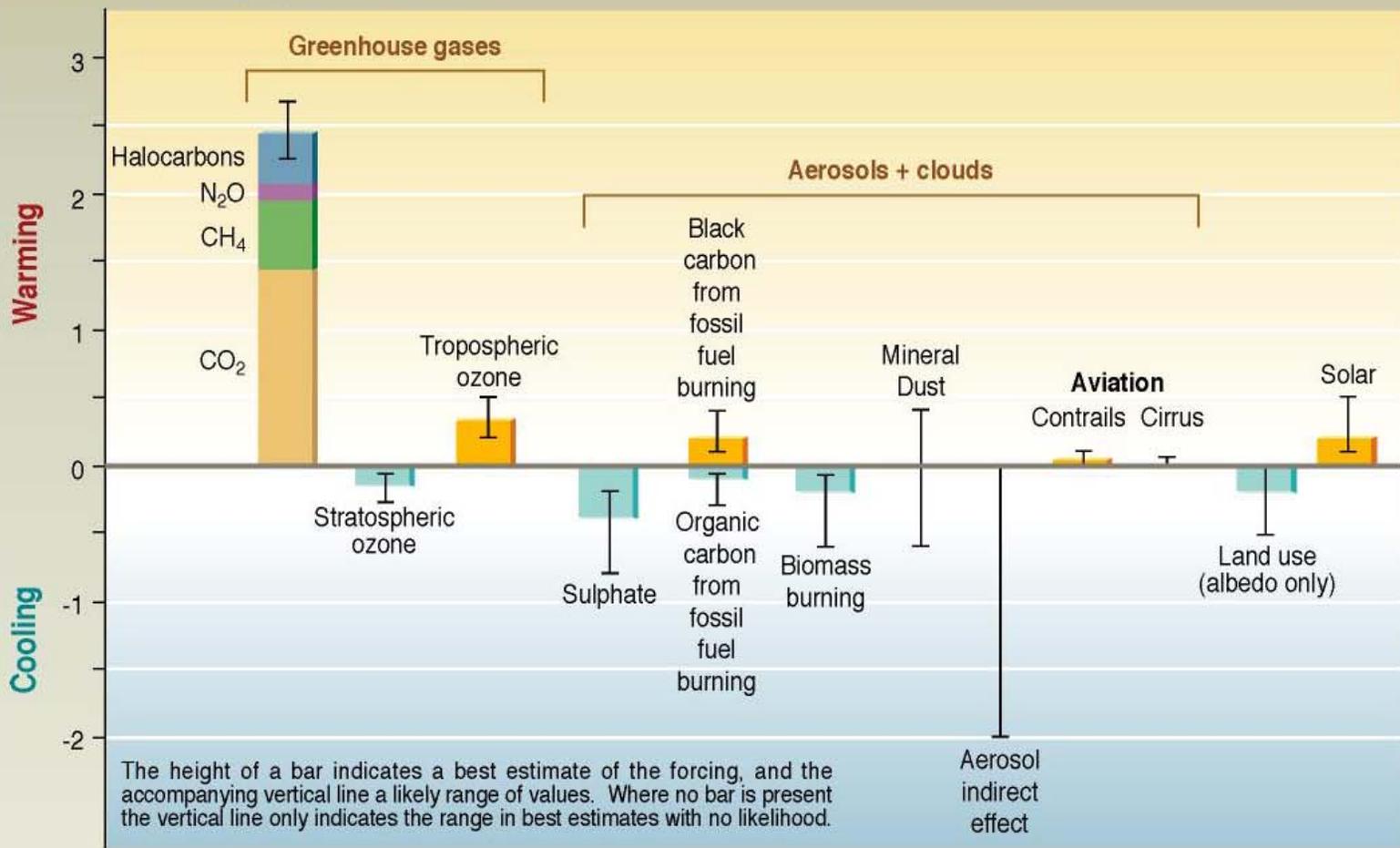


SYR - FIGURE



Anthropogenic and natural climate forcing for the year 2000, relative to 1750

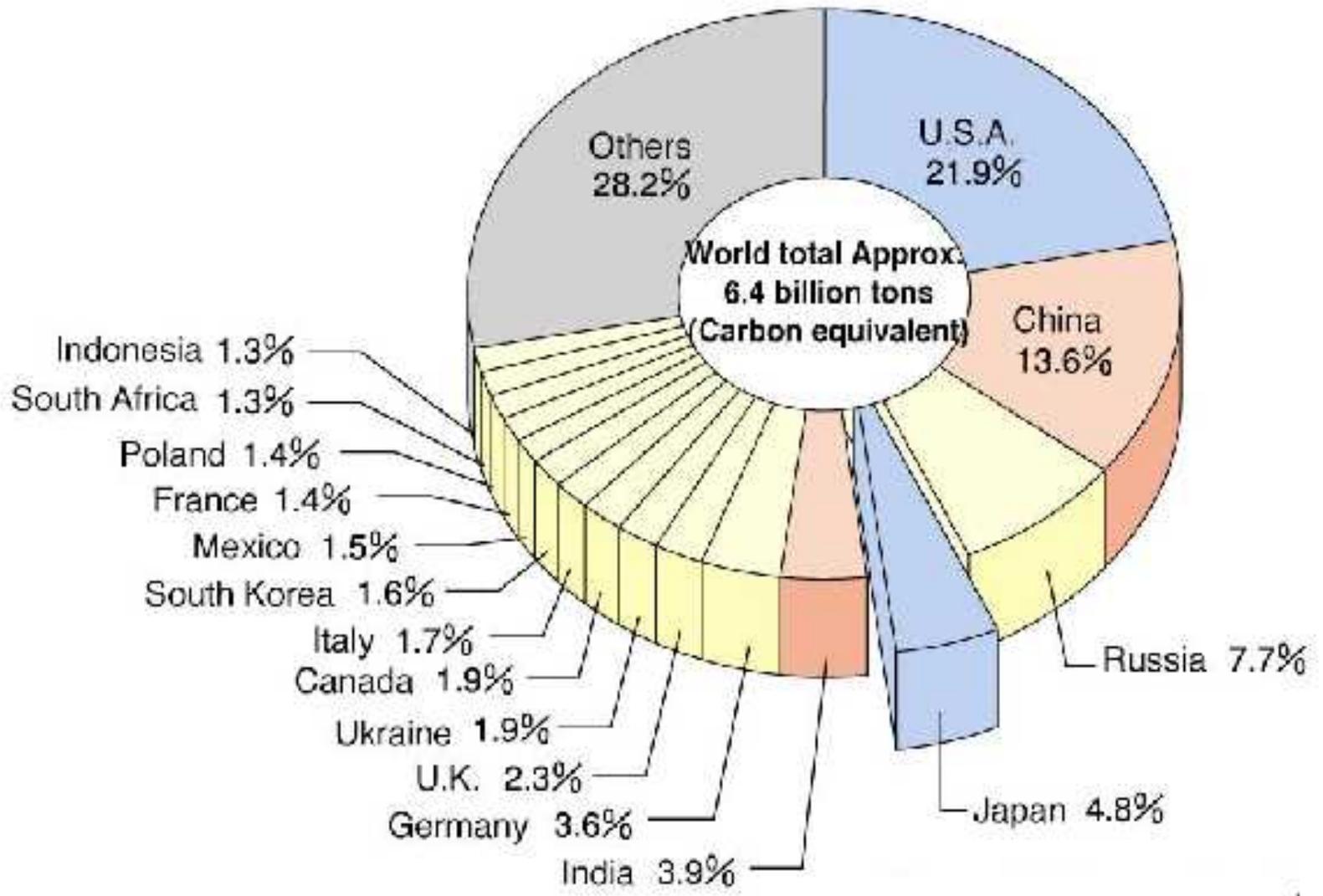
Global mean radiative forcing (Wm^{-2})



LEVEL OF SCIENTIFIC UNDERSTANDING

High	Medium	Medium	Low	Very low							
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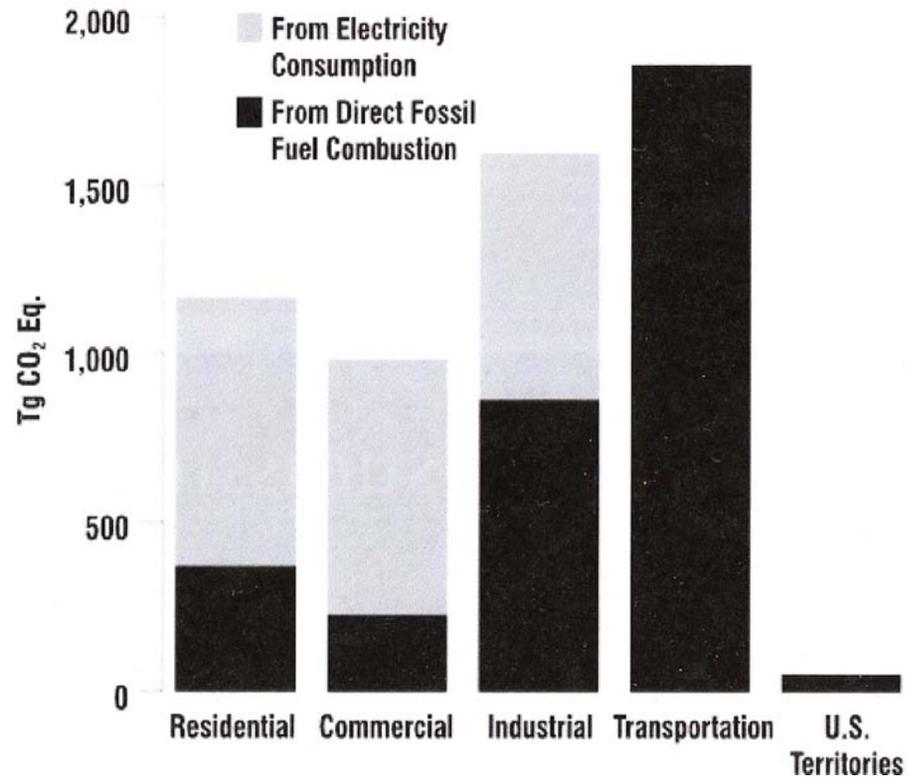
SYR - FIGURE





Main Sources of CO₂

2004 End-Use Sector Emissions of CO₂ from Fossil Fuel Combustion



“Burning 1 gallon of gasoline puts more than 19 lbs. of CO2 into the atmosphere, where it will remain for a hundred years, and buying it provides over 40 cents to countries that hate the United States”.

–Paul MacCready

Implications

- *Sea Level Rise*
 - *Traditionally, when large ice-sheets break up, sea level has risen as fast as 3 feet every 20 years for centuries at a time*
 - *Potential for Ice-Free Arctic Summers by 2040*
 - *"We have already witnessed major losses in sea ice, but our research suggests that the decrease over the next few decades could be far more dramatic than anything that has happened so far". (Holland et al.)*

What causes the sea level to change?

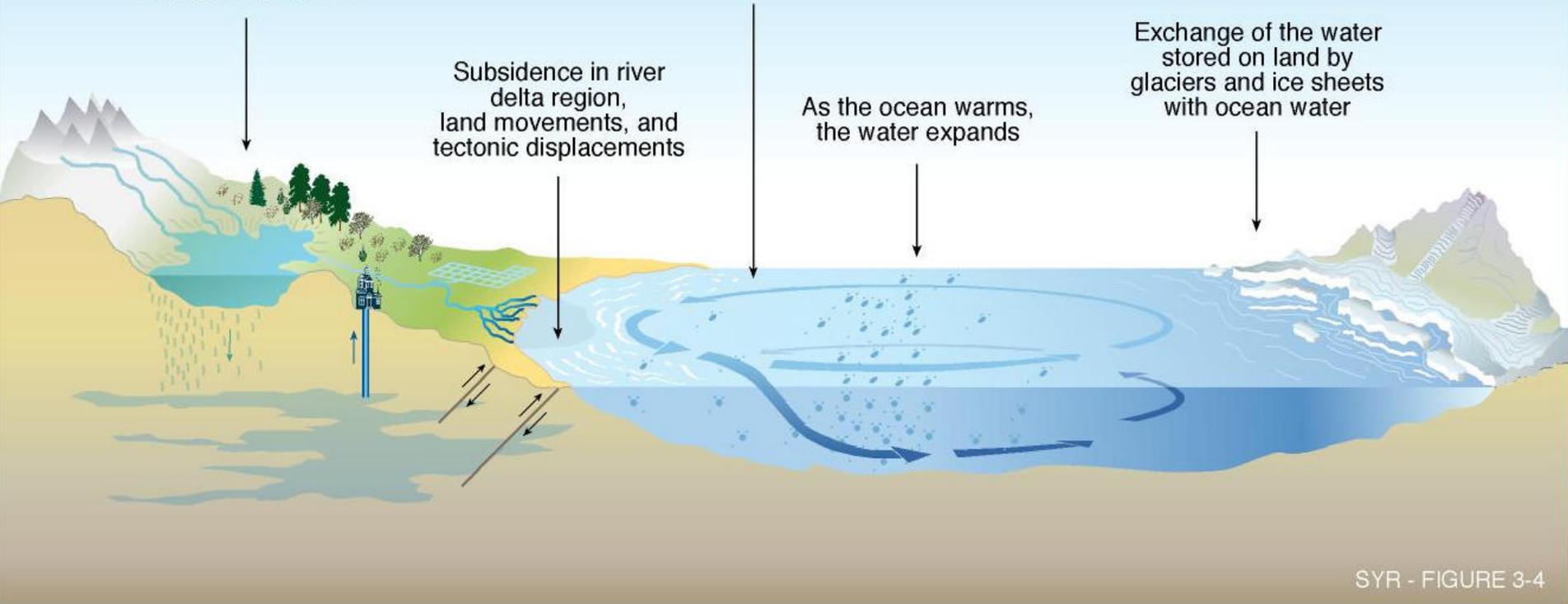
Terrestrial water storage, extraction of groundwater, building of reservoirs, changes in runoff, and seepage into aquifers

Subsidence in river delta region, land movements, and tectonic displacements

Surface and deep ocean circulation changes, storm surges

As the ocean warms, the water expands

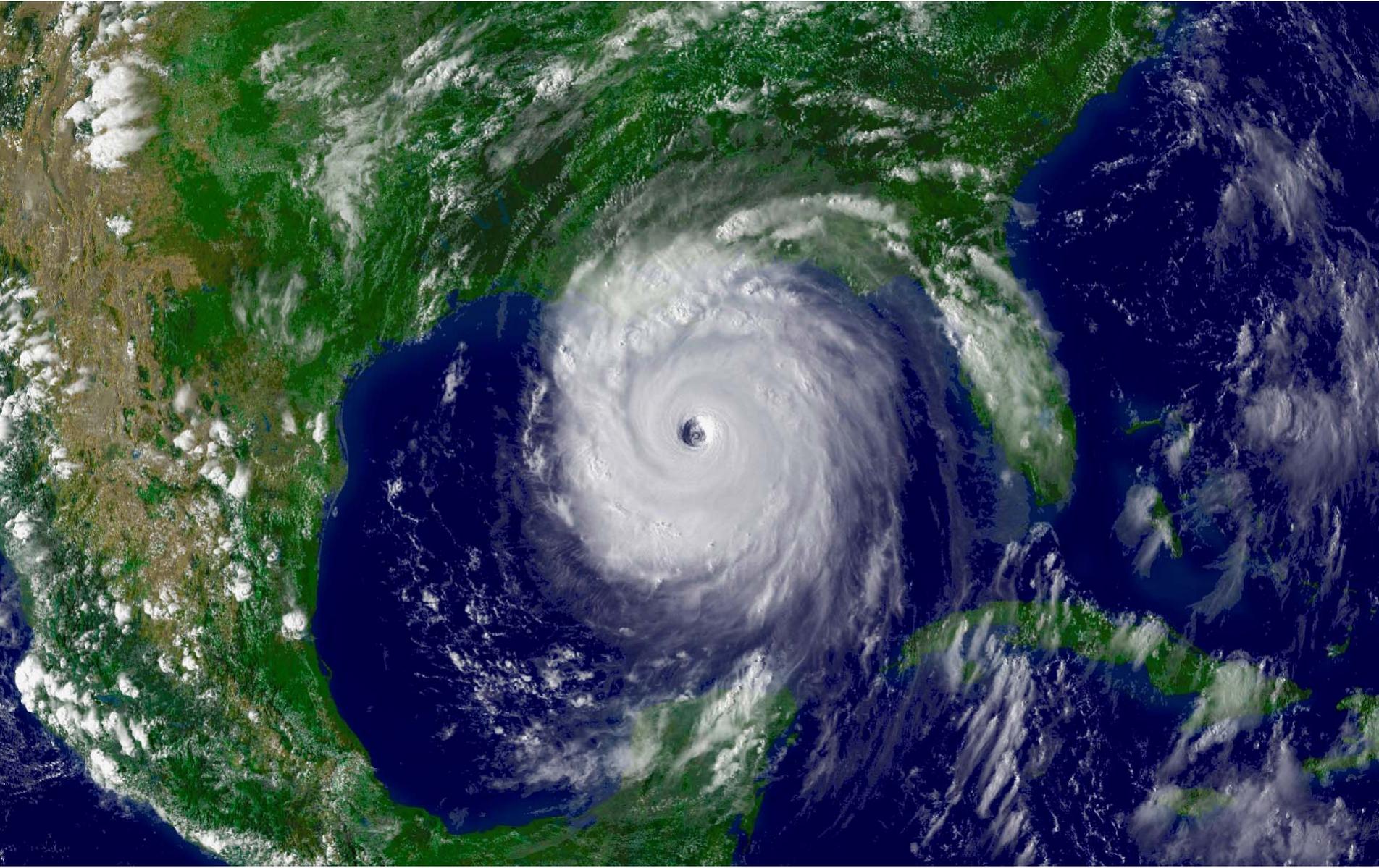
Exchange of the water stored on land by glaciers and ice sheets with ocean water



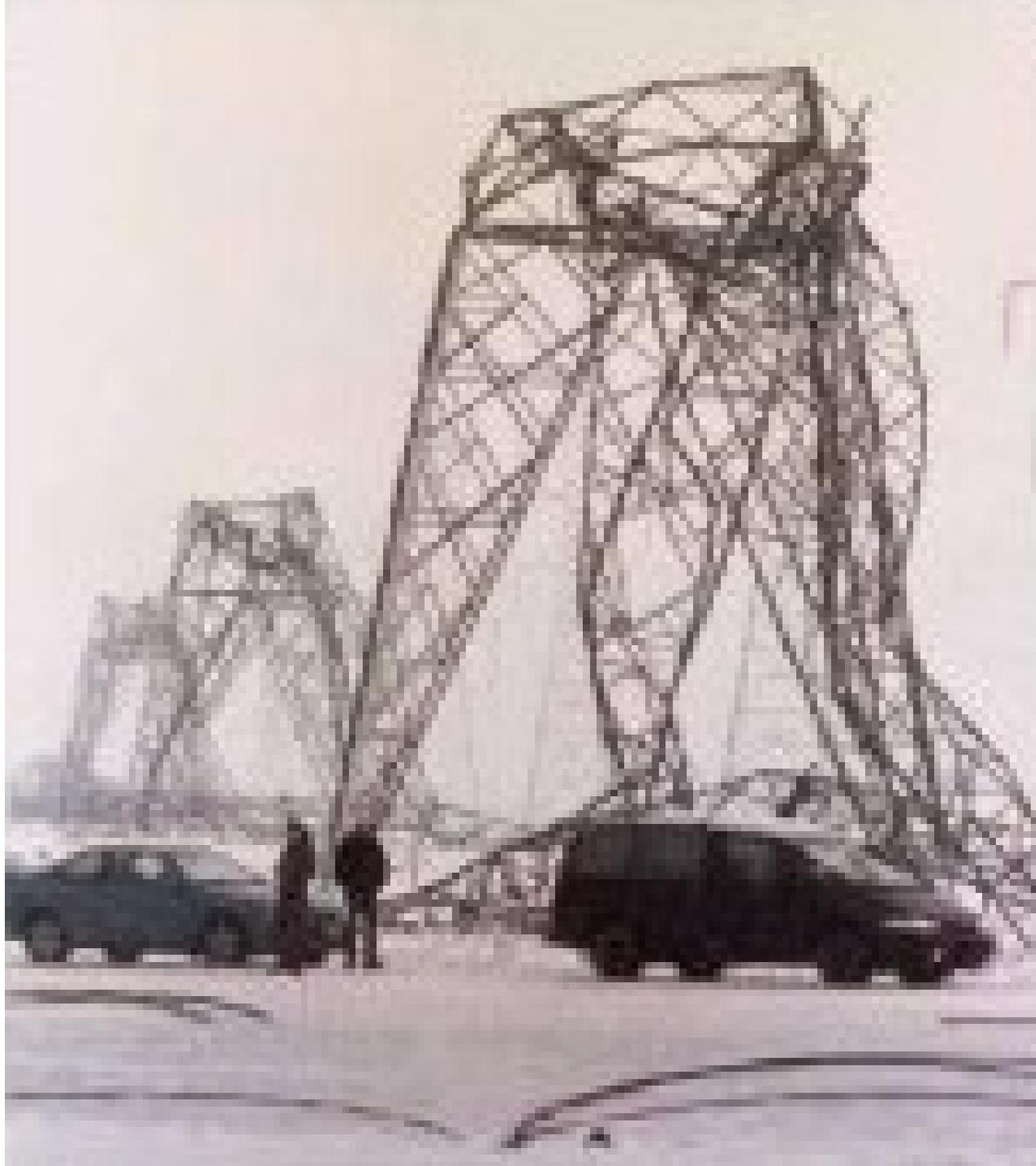
Extreme Weather Events

- *Heavier rain; more flooding*
- *Ice storm in warmest winters on record*
- *Heat wave (eg. Europe 2003)*
- *More powerful Hurricanes (Katrina, Rita 2005)*









New England Implications

- *Loss of maple Forests, replaced with Oak, Hickory, Jack Pines*
- *More winter rain and freezing rain*
- *Summer agriculture boom*
- *Loss of maple industry and ski industry to Quebec*
- *Loss of major tourist income from fall and winter seasons*

Vill we lose the maple forest

Forest Types

Jack Pine

Slash Pine

Shortleaf Pine

Spruce

Cypress

White Pine

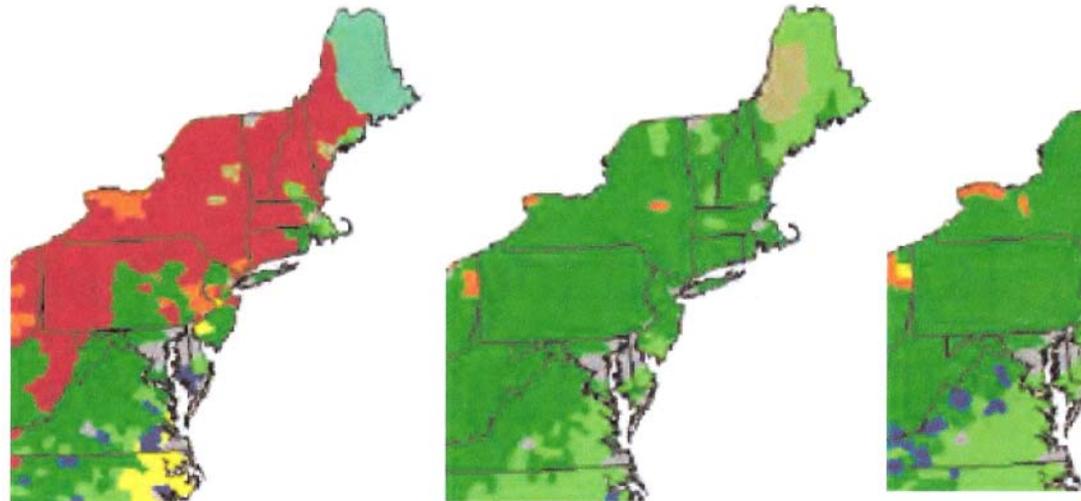
Beech-Birch

Maple

Current -
1960-1990

Hadley Scenario -
2070-2100

Canadian Scenario -
2070-2100



The maps show current and projected forest types for the Northeast, based on the DISTRIBmodel (see Forest sector).
-Beech-Birch, currently a dominant forest type in the region, is completely displaced by other forest types in both Canadian climate scenarios.





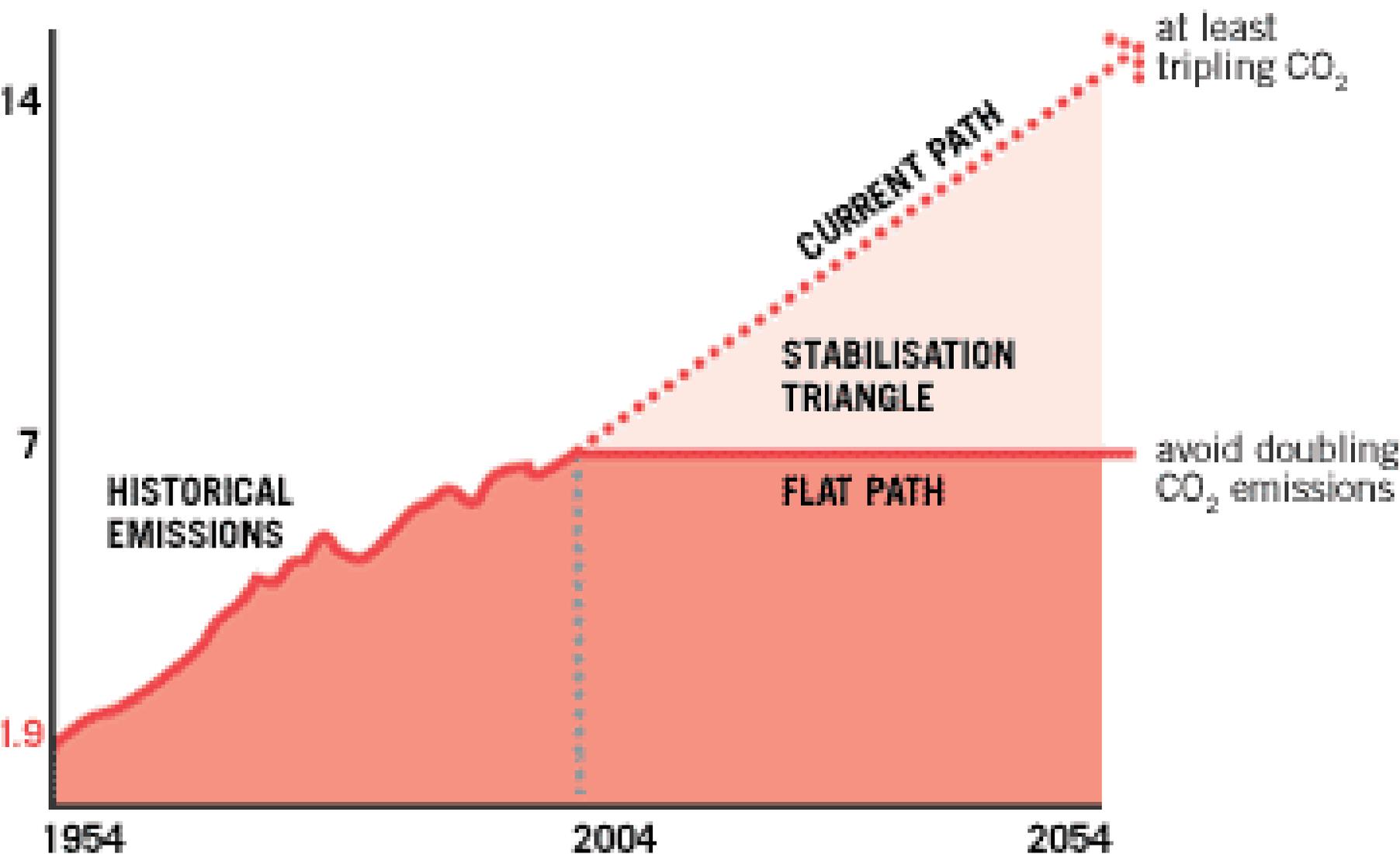


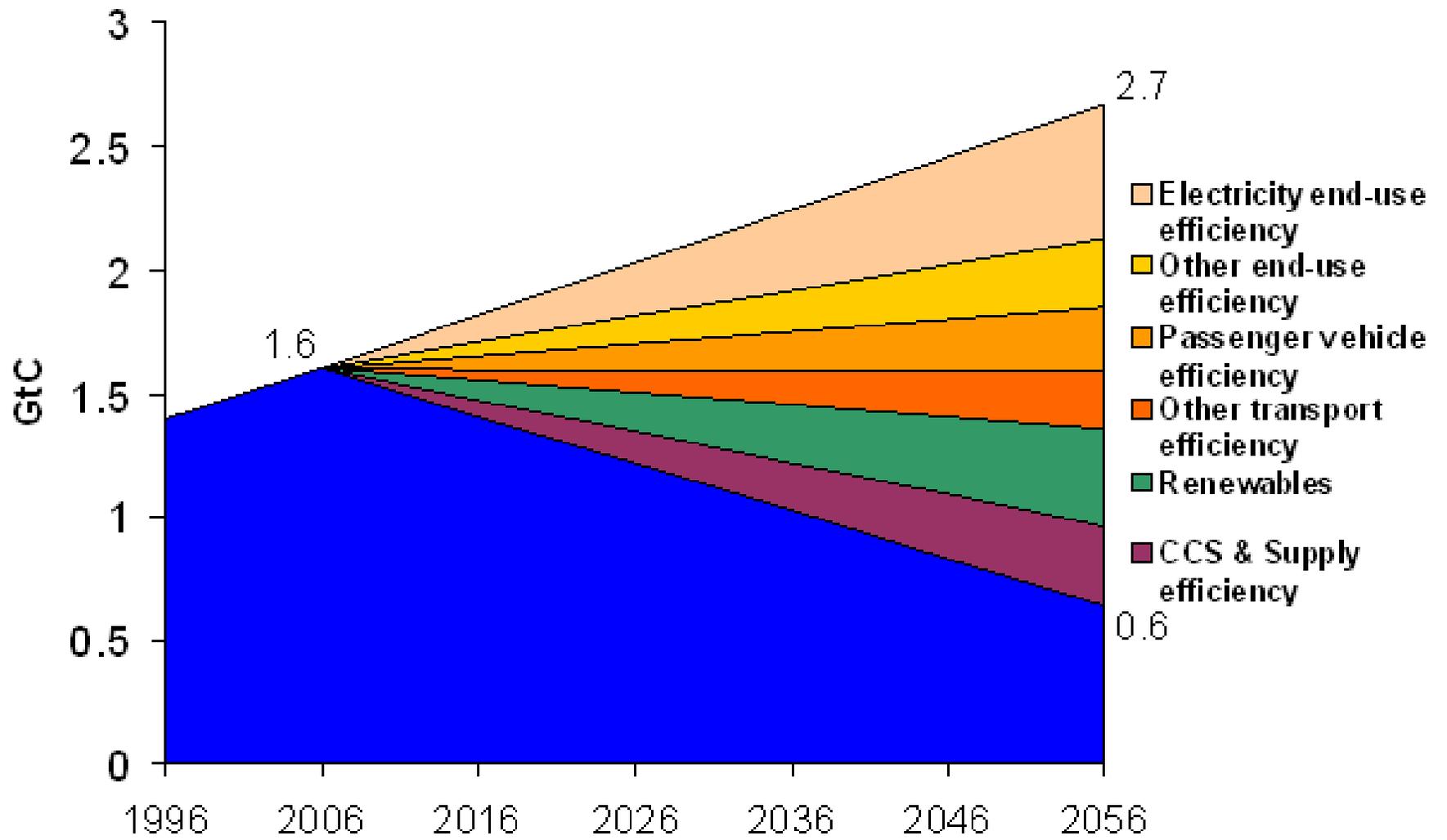
Solutions

Temperature Stabilization

- *To limit global temperature rise to 2C (3.6F) above present day: CO₂ in atmosphere (now 380ppm) would need to be stabilized in range of 490ppm to 670ppm*

CO₂ EMISSION IN BILLIONS OF TONNES FROM 1954-2054

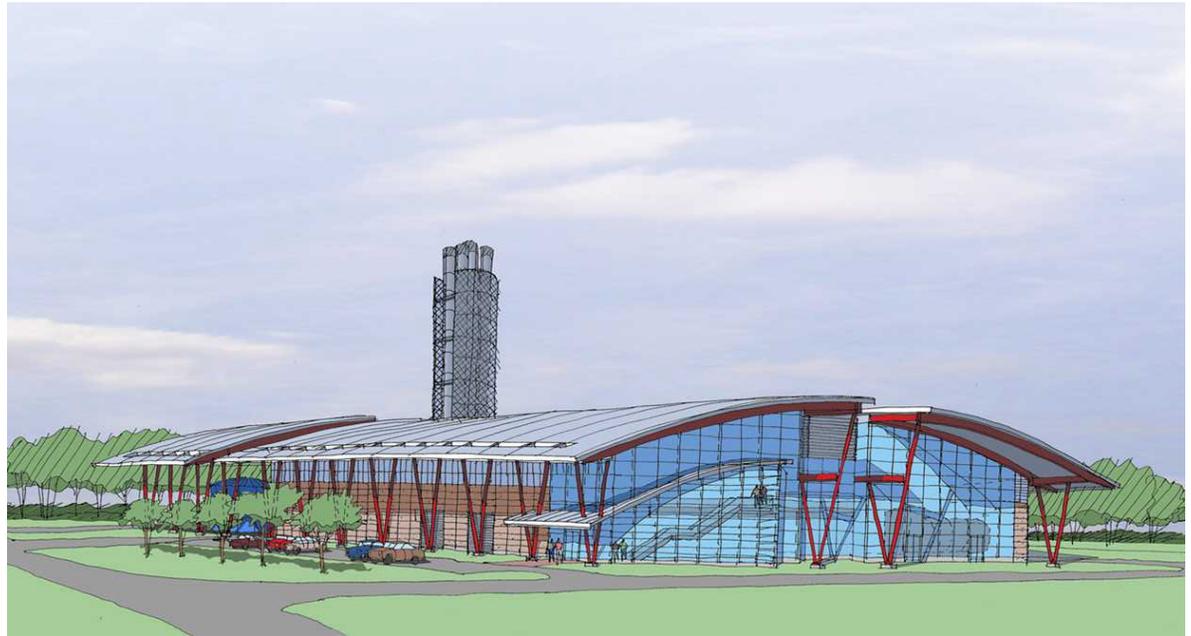




Home Heating

- ***Technology***

- *Wood/grass pellets for stoves, residential and commercial*
- *District heating of towns with co-generation*
- *Better building codes and retrofits*
- *"-47 to 115 F with no heating/cooling equipment, less construction costs"*



Transportation

Policies

– *Change Behavior*

- Cash/Tax incentives for fuel efficiency
- Ride Sharing
- Excessive use fees



Transportation

Policies

– Change Technology

- Bio-fuels
- Incentives to Manufacturers
- Advanced vehicles
- Incentives to consumers
- Develop markets
- Use requirements



Transportation

Technology

- *Bio-diesel from crops/waste*
- *Ethanol from cellulose: perennial grasses, shrubs, wood*
- *More efficient cars*



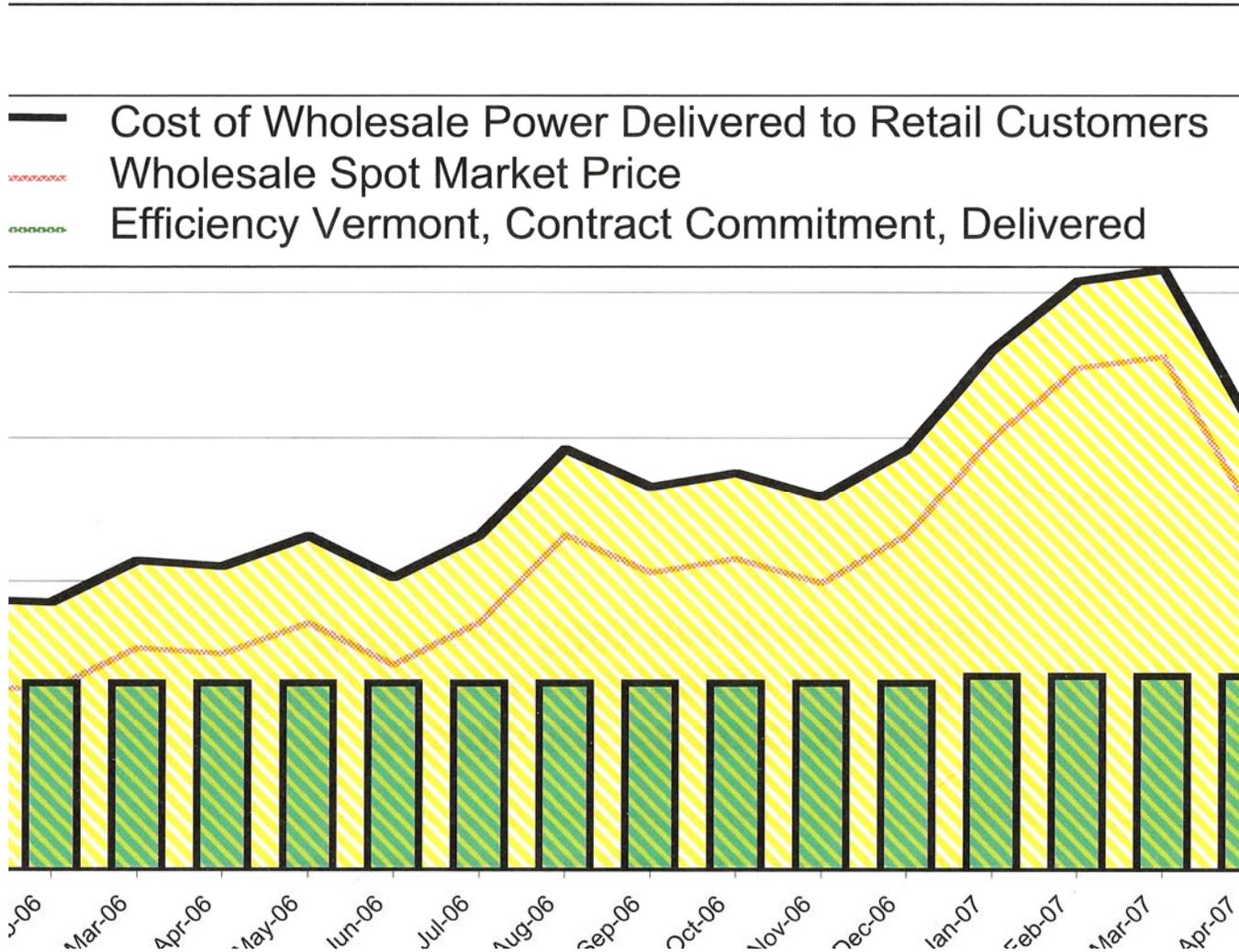
Electricity

- *Policies*

- *Put climate at the center of state utility/energy policy*
- *Keep encouraging and expanding Efficiency Vermont*
- *Fair competition for saving and making electricity*
- *Rewards for cutting bills not selling more electricity*
- *No institutional barriers to self-generation and co-generation*
- *Help utilities create negawatt (energy savings) markets*
- *Break down barriers to capturing negawatts (energy savings)*

Efficiency is cheap and stable,

Power Costs vs. Efficiency Vermont Costs for 2002 & 2003 NE-ISO Average Monthly Price

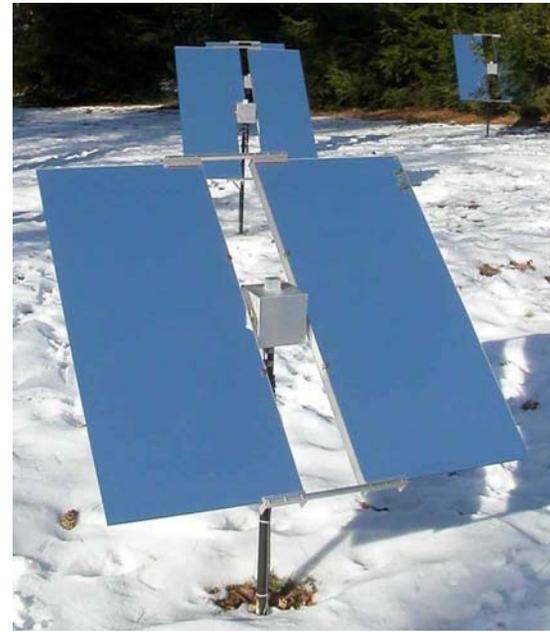
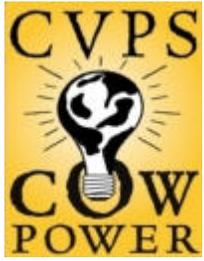


Electricity

- *Technology*

- *Renewables*

- Solar
 - Wind and Hydro-electric
 - Methane from manure and landfills
 - Wood chips



Personal Reflection on Climate Change

- *Photos, stories, etc.*

The Election
Leonard Nathan

How did the stones vote
this time?

They voted for hardness
and few words

as the trees voted
for slow growth
upwards and a shedding
of dead dependents.

And the men?

They voted against
themselves again
and for fire
which they thought they
could control,
fire

which voted for blackened stumps
and no more elections.

(Nathan, 1980)