Climate Change and Materials Management

Where have we come from,

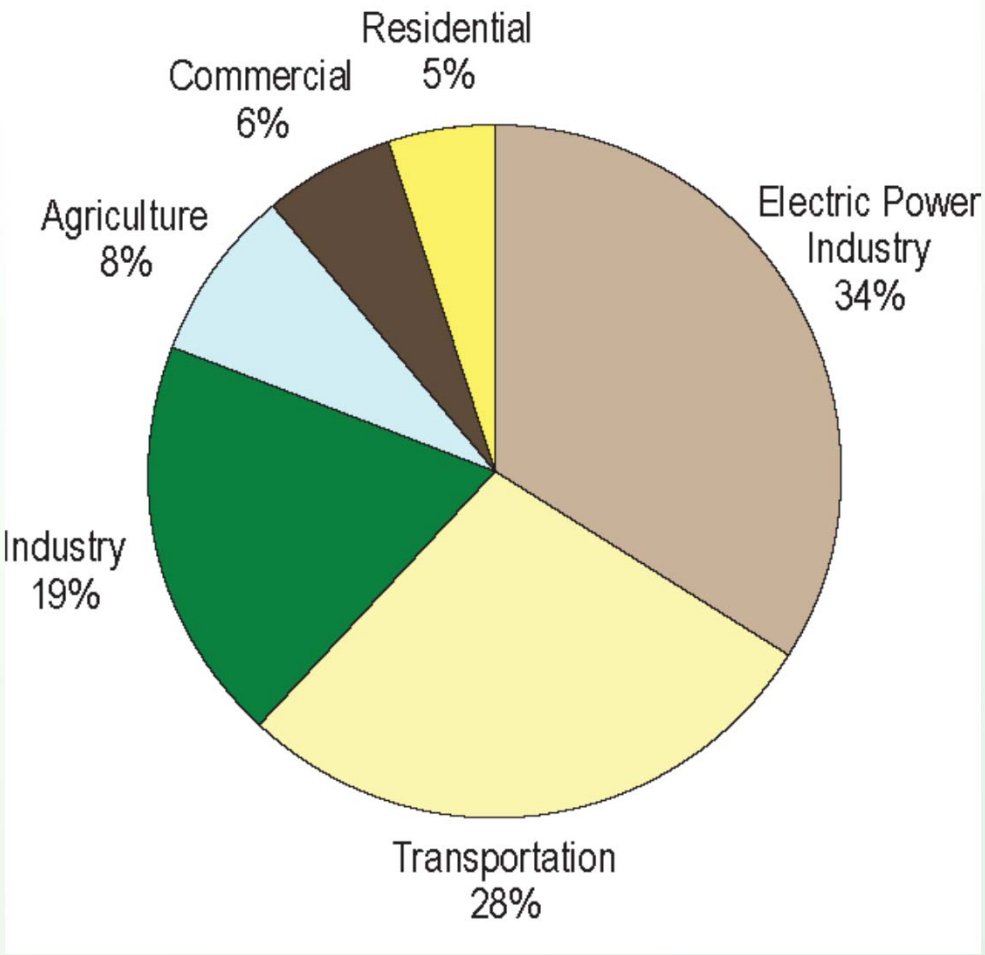
where are we going

Materials Management

- **An approach to using and reusing resources most productively and sustainably throughout their life cycles,**
  - minimizing the amount of materials involved
  - minimizing associated environmental impacts.
- **Can result in significant GHG savings.**

Conventional Accounting: Sector Based

U.S. GHG Emissions (2006)



End-of-pipe focus

Doesn't show role materials management plays in reducing GHG emissions

One set of opportunities

Source: U.S. Inventory of GHG Emissions and Sinks : 1990-2006 (US EPA, 2008)

GHG Emissions Across the Waste and Materials Lifecycle

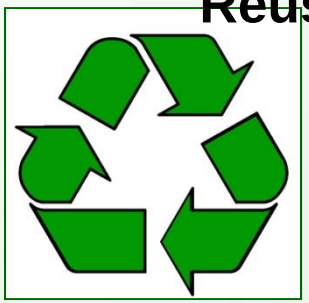
Materials Extraction

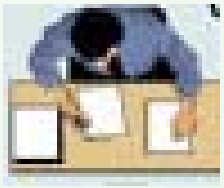
- energy and transportation emissions
- reduction in carbon storage

Manufacturing

- energy, process and transportation emissions

Recycling, Reducing, Reusing





Use

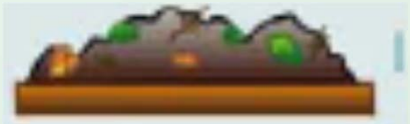
- energy emissions

Landfilling

- landfill gas emissions
- offsets from energy recovery

Waste Management

- transportation emissions

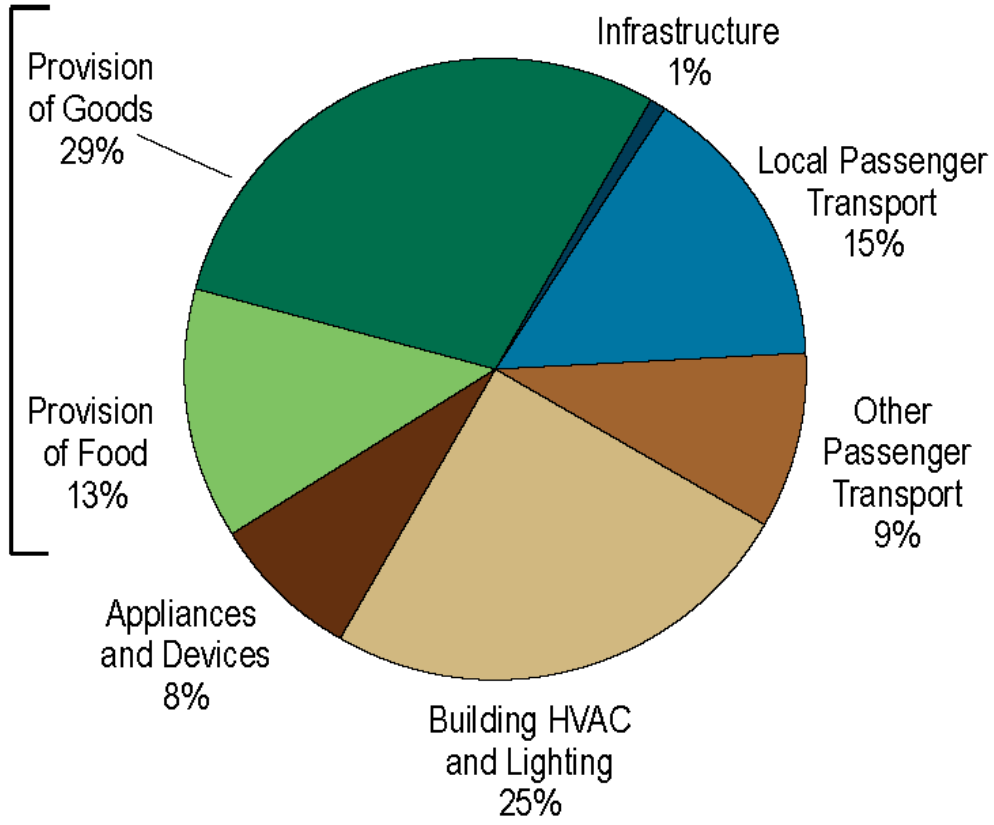


Composting

Systems Based View:
U.S. GHG Emissions (2006)

Same GHG emissions, a new lens.

Identifies new opportunities for GHG reductions



Source: *Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices*. U.S. EPA, September 2009

Opportunity Knocks:

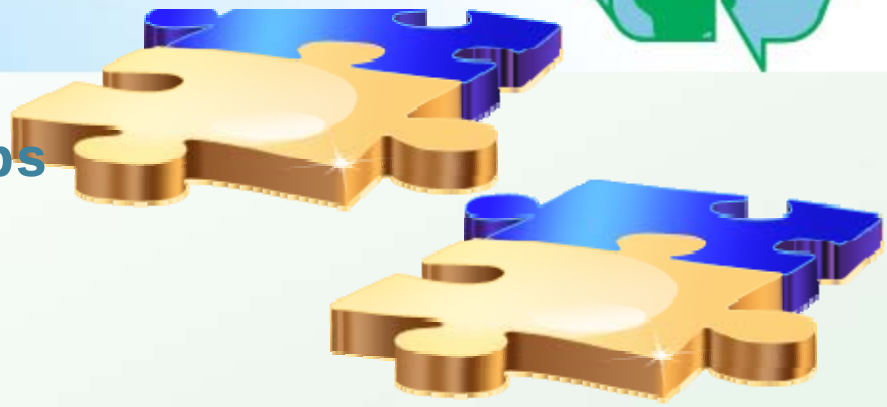
- **In 2006, the U.S. recycled over 80 million tons of municipal solid waste**
  - Equivalent to conserving 182 million metric tons of carbon dioxide equivalent (MMCO2E).
  - Additional 300 MMTCO2E in unrealized opportunities.
    - Source: *Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices*. U.S. EPA, September 2009

- **These opportunities are short term, high impact, lower cost and don't require huge changes in infrastructure.**

West Coast Climate and Materials Management Forum

Where have we come from,
where are we going

We decided:
Create Solutions Together



- **West Coast Government Reps**
- **Get Educated**
- **Make a Plan**
  - identify areas of collaborative effort and strategic actions to reduce greenhouse gas (GHG) emissions through improvements in ***waste prevention, recovery, and disposal***
- **Develop a Joint Statement**
  - 2008 and 2009 Joint Statement
  - 2010 Joint Statement to be developed at Forum [illegible]
- **Work together to develop solutions**

Key Learning:
We can't get from here to there without major changes.

- Measurement matters
  - WARM is a valuable tool and we need to continue improving it – especially around organics (underway)
  - Current inventories and protocols under represent the impact of effective materials management – ICLEI and CARB
  - Emissions accounting under represents the impact the US has on GHG emissions – we consume more than we produce.
  - Measurement is key to having materials become as important as energy and transportation in emission reduction policies..
    - How do we financially motivate producers to use less materials and less GHG intensive materials.

- More targeted research needed
  - We need to move forward with existing knowledge while increasing our knowledge base

Getting from here to there (cont)

- Education and communication are critical tools for success.
  - Stakeholders don't understand the potential benefits.
  - Competition exists between traditional accounting and system accounting.
  - Lack of information a barrier to implementation.

- The old tools are not sufficient
- We need to expand and mandate solutions in partnership with all stakeholders and partners – *voluntary isn't enough*. We need to explore, implement and fund policies like:
  - Aggressive recycling and composting
    - Zero waste and 75-95% recycling goal
  - Product Stewardship and producer responsibility
  - Product standards and labeling
  - Leveraging purchasing/environmentally preferable purchasing
  - Building capacity and infrastructure
  - Addressing high embedded energy materials in landfills
    - C&D, Organics, Paper, Metals, Plastics, Carpet

2010 Priorities
From the December 2009 Forum

- Provide **concrete actionable tools** for policymakers, program managers and elected officials to make informed choices, provide to information to the public, create immediate actions and communicate effectively; *(all)*

- Identifying key opportunities to address the upstream GHG reduction inherent in **reducing and shifting consumption**. *(consumption subcommittee)*

- Develop **communication tools and positive messaging** that reflects our work and reflects the thinking and work of others. *(outreach and communication subcommittee)*

- Work towards the development of state, community and city level **inventories and action plans** that take a consumption based or systems based approach; *(inventory subcommittee)*

2010 Priorities
From the December 2009 Forum

- Engage in innovative and important **materials management projects**, such as carpet and organics management; *(materials management subcommittee)*
- Articulate the connection between strategies such as **product stewardship** and the GHG emissions reductions associated with waste prevention; *(materials management subcommittee)*
- Develop, communicate and coordinate actions around the necessary **research agenda** to support the above priorities. *(research subcommittee)*

Our Opportunity

- To be **bold and strategic** in taking advantage of effective materials management policies and opportunities
- To **support each other** while organizing to act nationally.
- To be **transformational** instead of incremental.
- To **learn from others** who have been successful
- To **lead and add value** across the country on how to reduce GHG emissions through effective materials management.

Getting involved

www.epa.gov/region10/westcoastclimate

- Watch the webinars posted on the website
- Decide if and where you can support the above priorities
- Contact EPA to get engaged with the workgroups
  - Workgroups are lead by forum participants
- Spread the word about the importance of materials management in addressing GHGs.
- Join the Forum Annual Meeting next week by webinar or in person
  - (Seattle, San Francisco, Portland and Los Angeles)

Disclaimer

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Global Climate Change:
A Clear and Present Danger

EPA Webinar: Climate, Materials and Meassurement

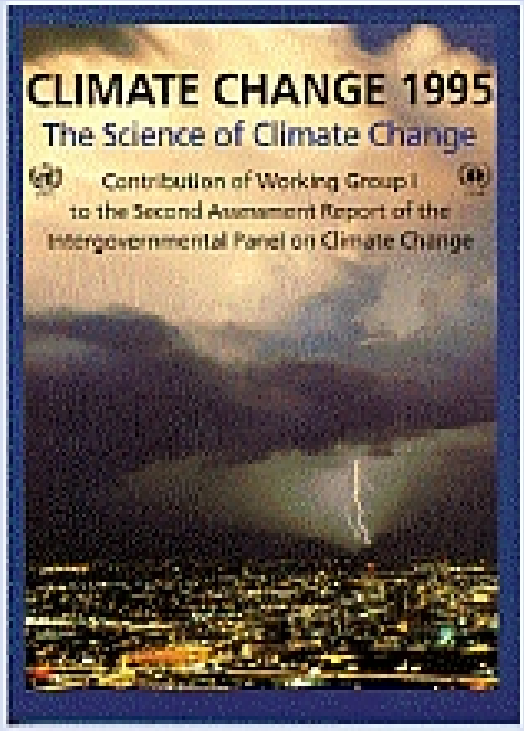
January 6, 2011

Professor Richard Gammon
University of Washington

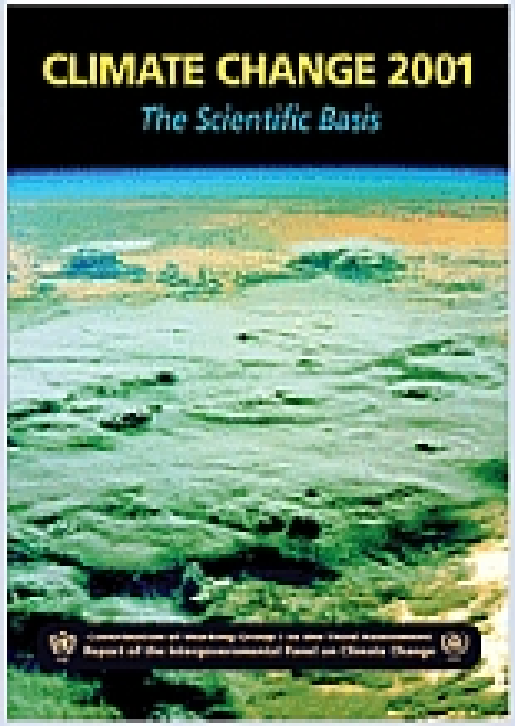
"Let the people know the facts, and the country will be safe."
Abraham Lincoln

Climate scientists express increasing level of concern and certainty:

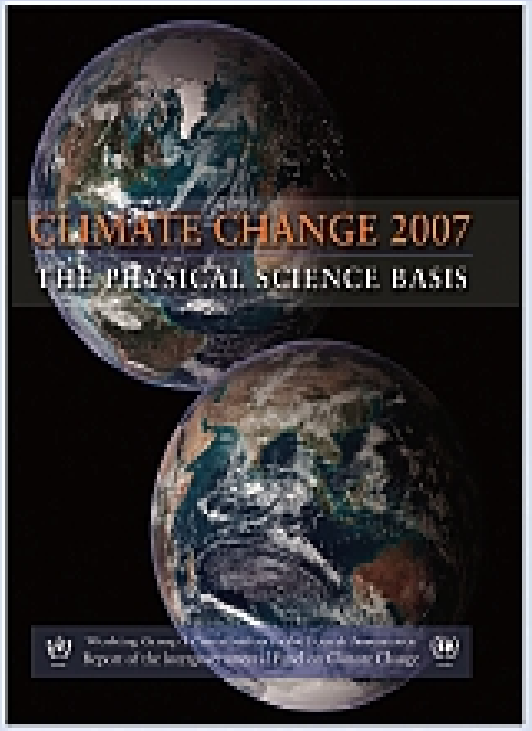
IPCC (1990) IPCC (1995) IPCC (2001) IPCC (2007) ?



"The balance of evidence suggests a discernible human influence on global climate"



"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities"



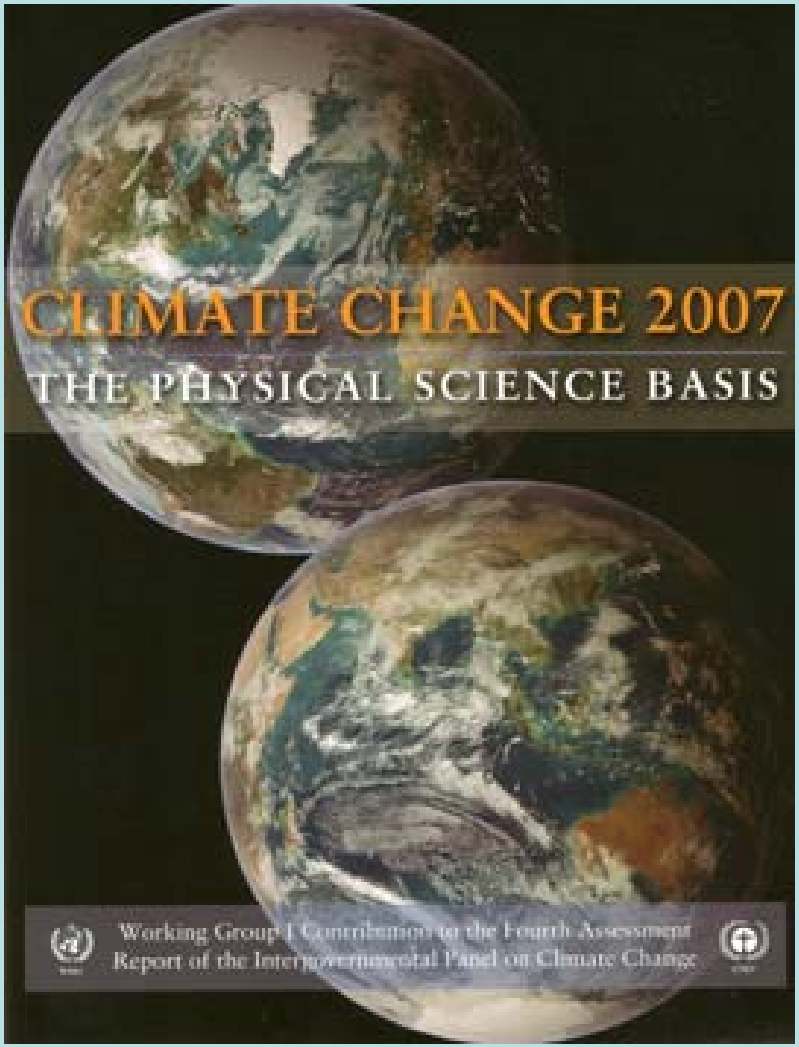
"Most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations"

"Warming of the climate system is **unequivocal…**

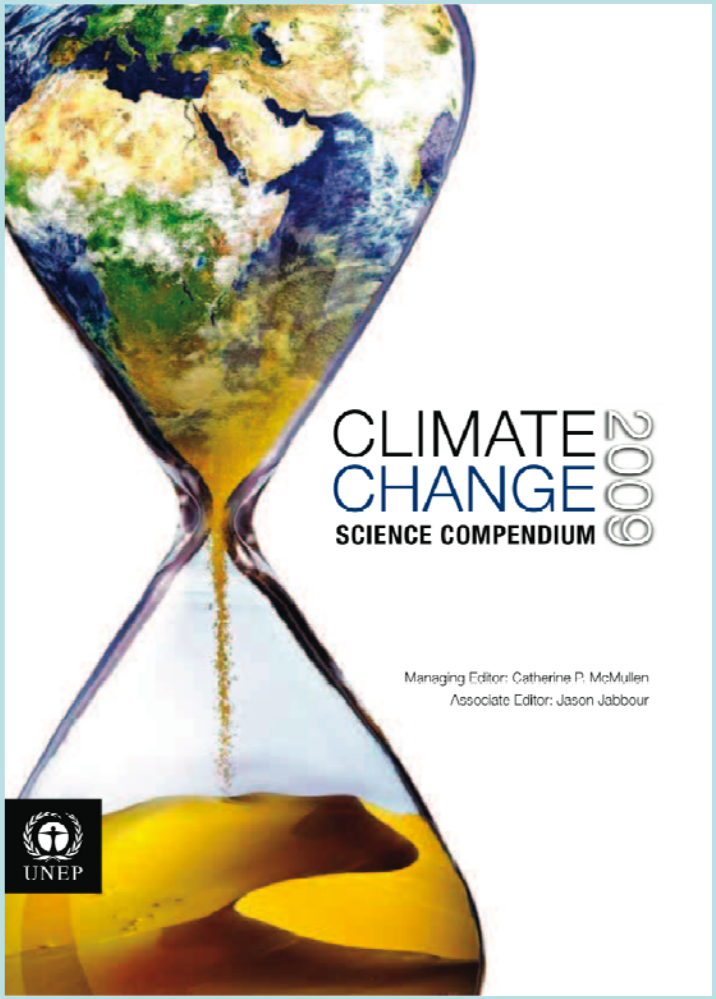
as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea…"

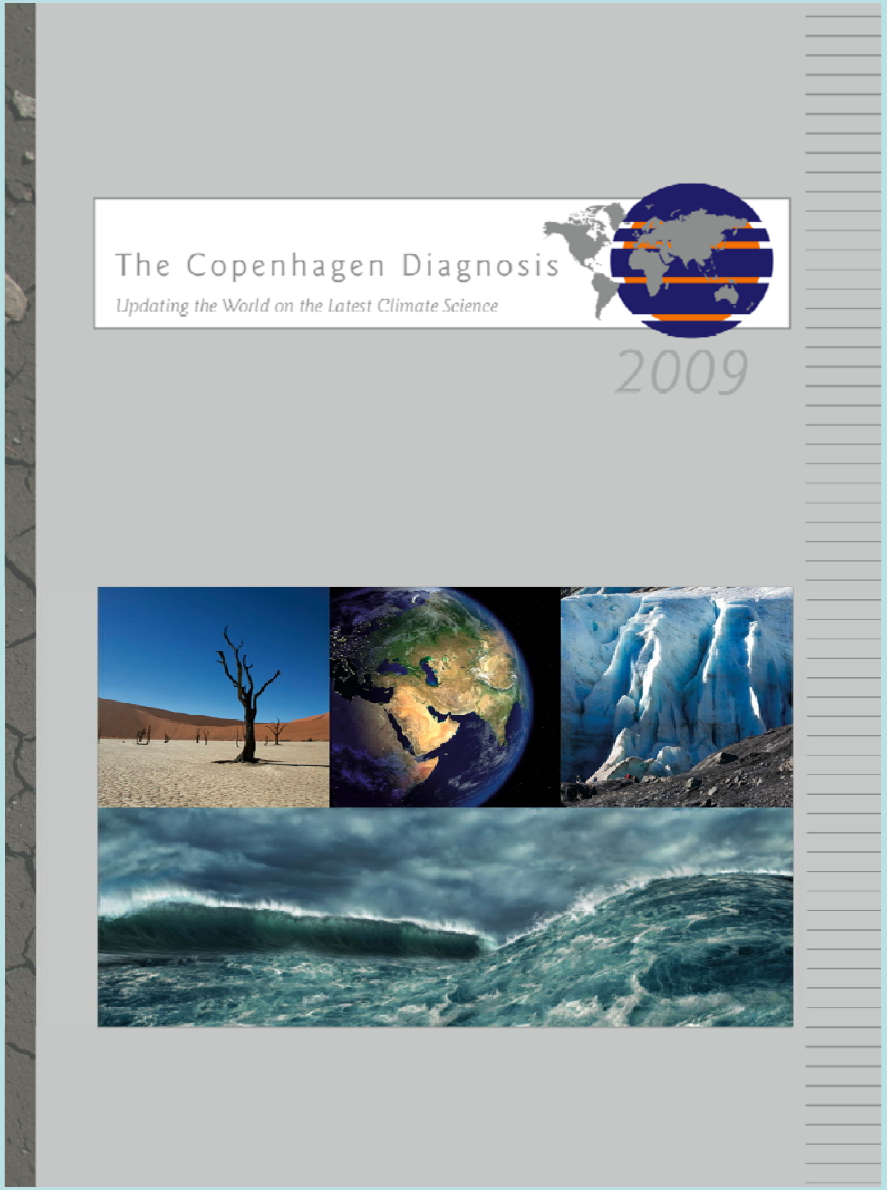
The IPCC ('07) finds that it is "**very likely'**(90 to 95% confidence) that emissions of heat trapping gases from human activities have caused **most** of the observed increase in globally averaged temperatures since the mid 20th century

(IPCC 2007 Summary for Policymakers)



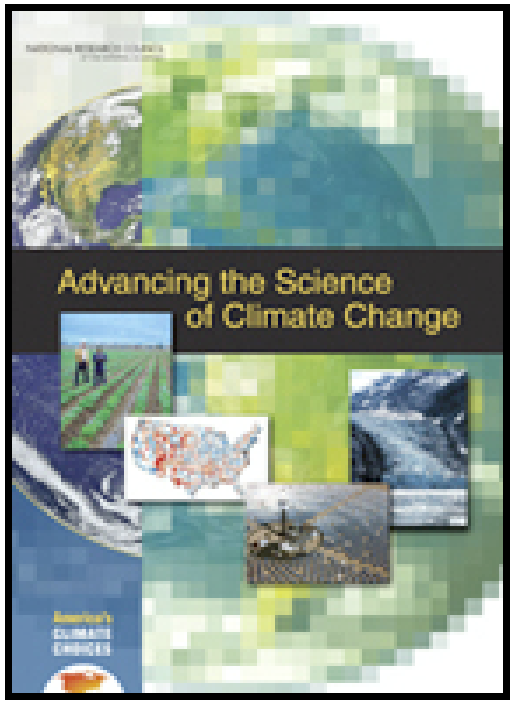
More recent climate science summaries



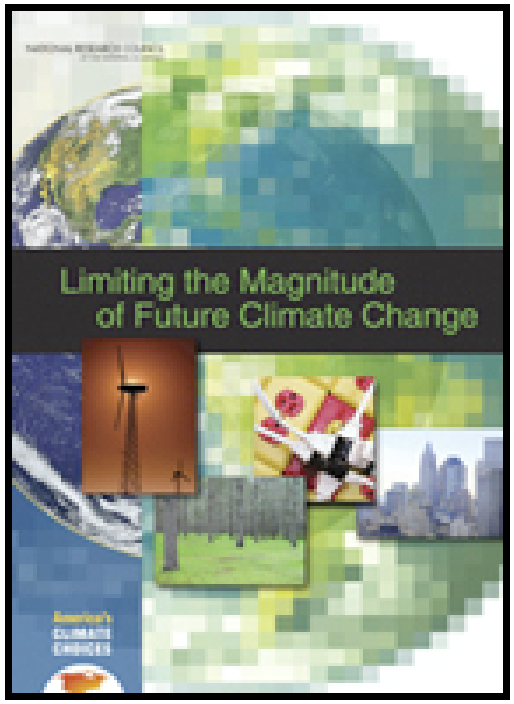


US National Academy of Sciences, 2010

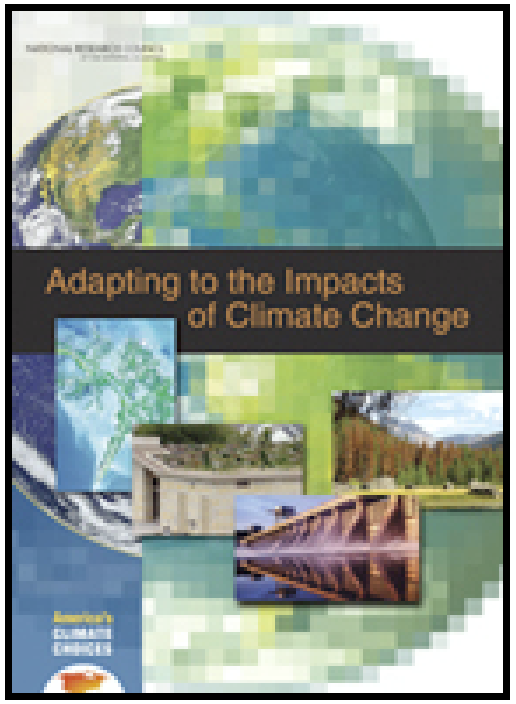
Strong Evidence on Climate Change Underscores Need For Actions to Reduce Emissions and Begin Adapting to Impacts



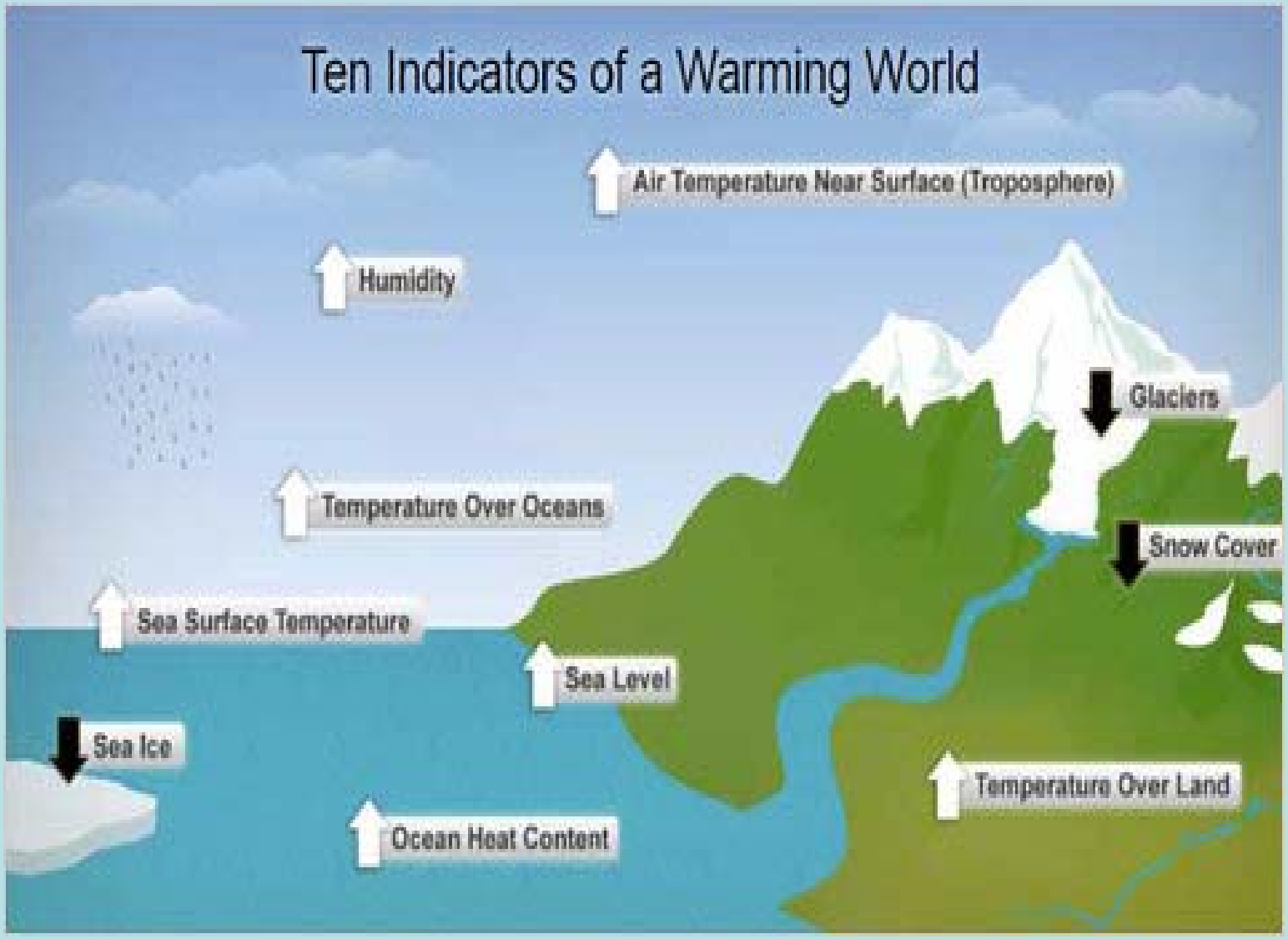
Advancing the Science of Climate Change



Limiting the Magnitude of Climate Change



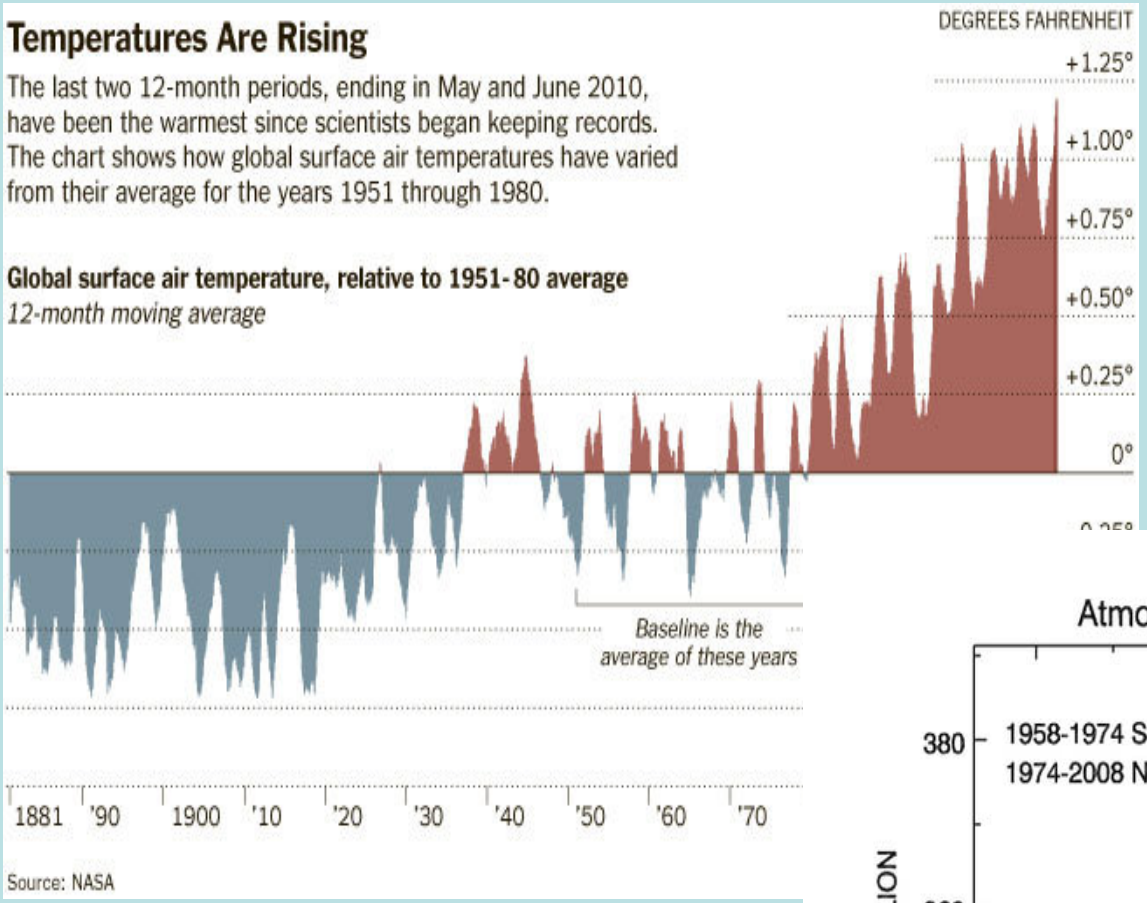
Adapting to the Impacts of Climate Change



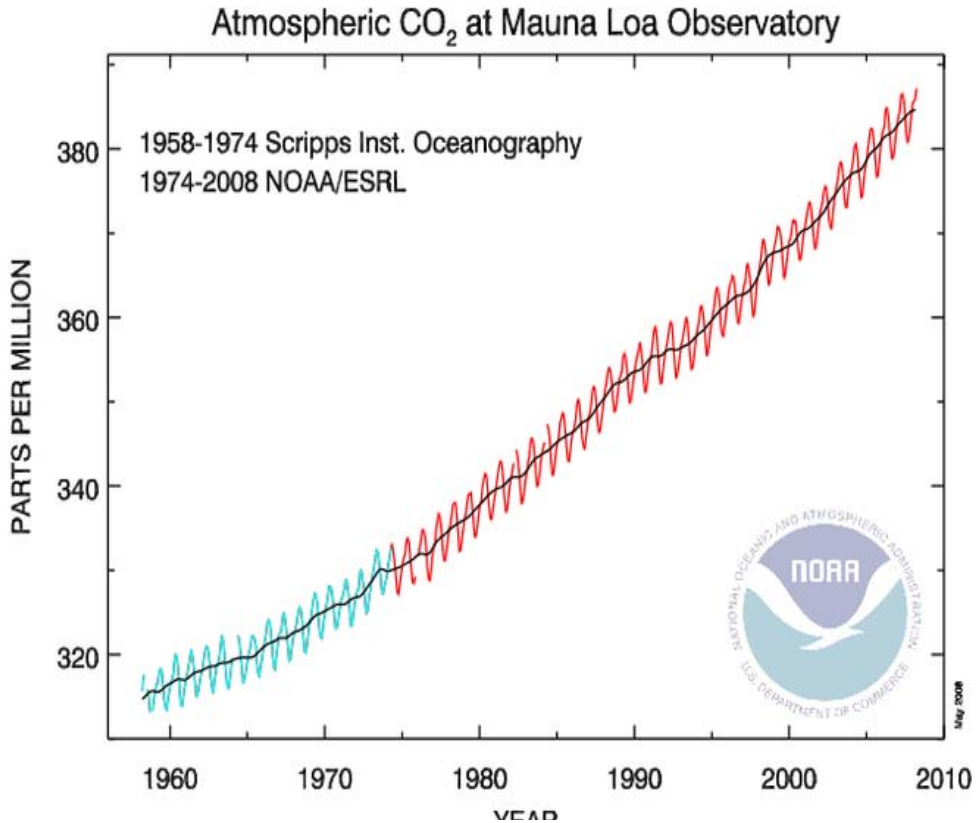
All observations point to a rapidly changing world

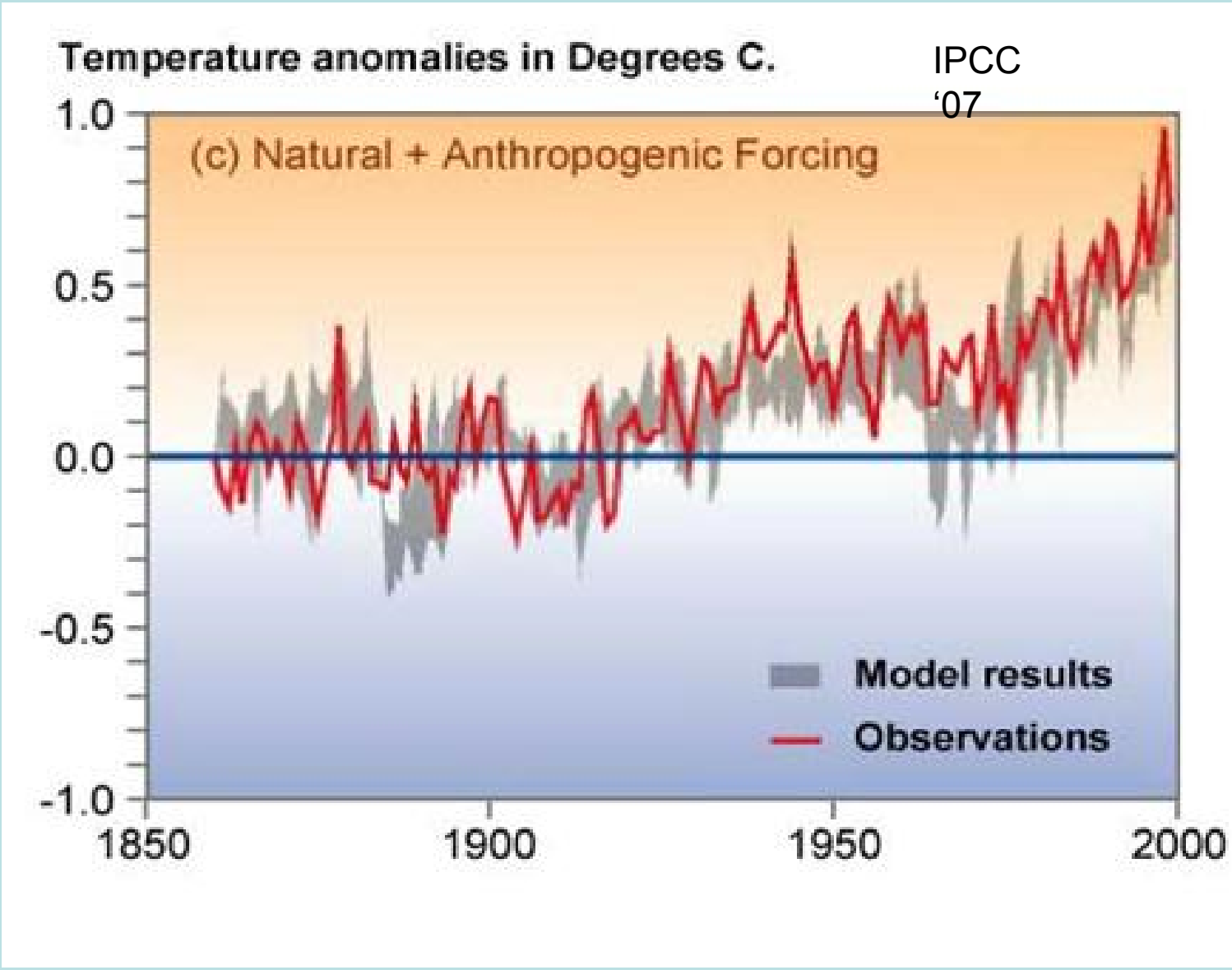
Temperatures Are Rising

The last two 12-month periods, ending in May and June 2010, have been the warmest since scientists began keeping records. The chart shows how global surface air temperatures have varied from their average for the years 1951 through 1980.



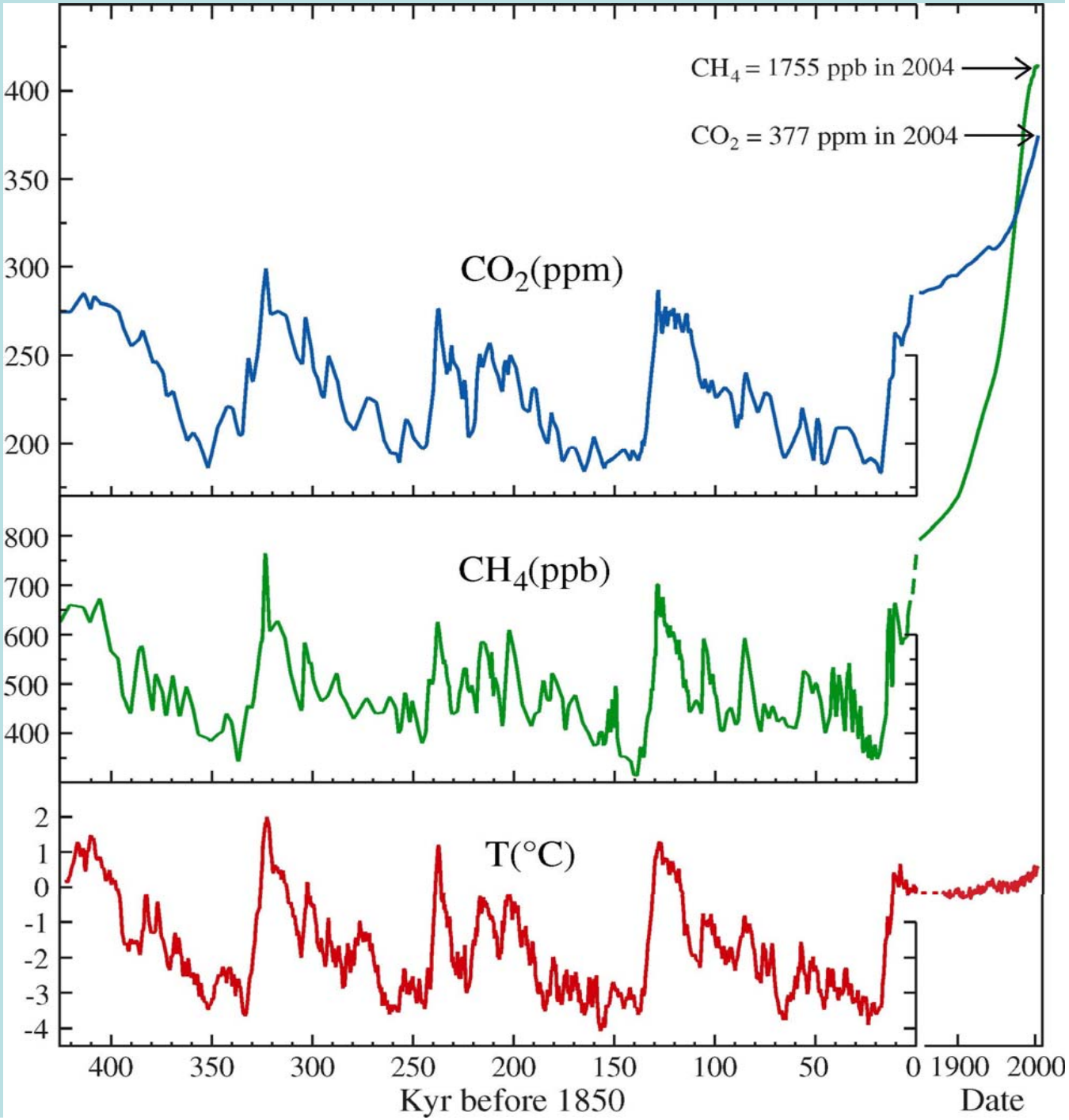
Source: NASA



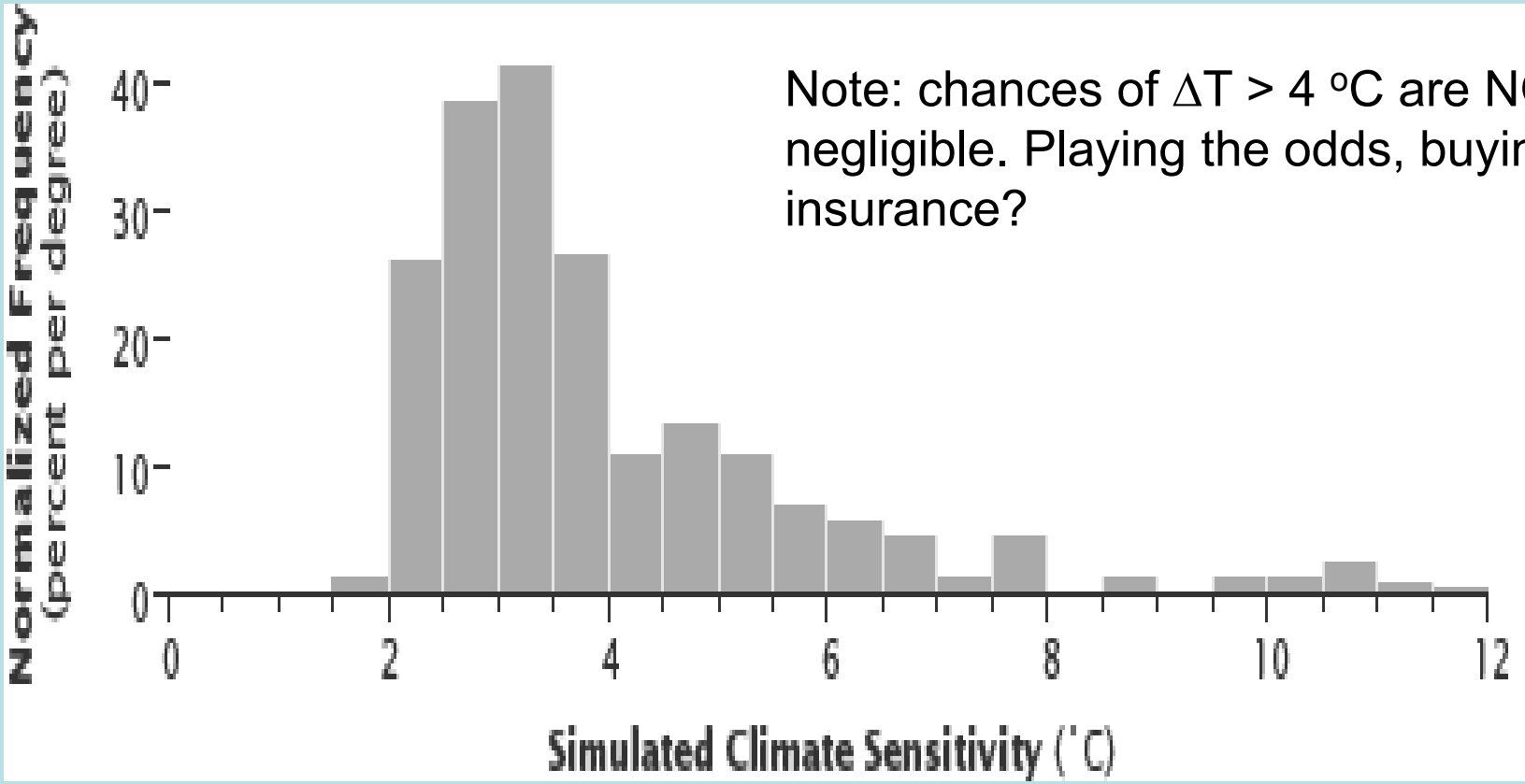


Only greenhouse gases can explain the observed temperature record

CO_2,CH_4 and estimated global temperature (Antarctic $\Delta T/2$ in ice core era) 0 = 1880-1899 mean.

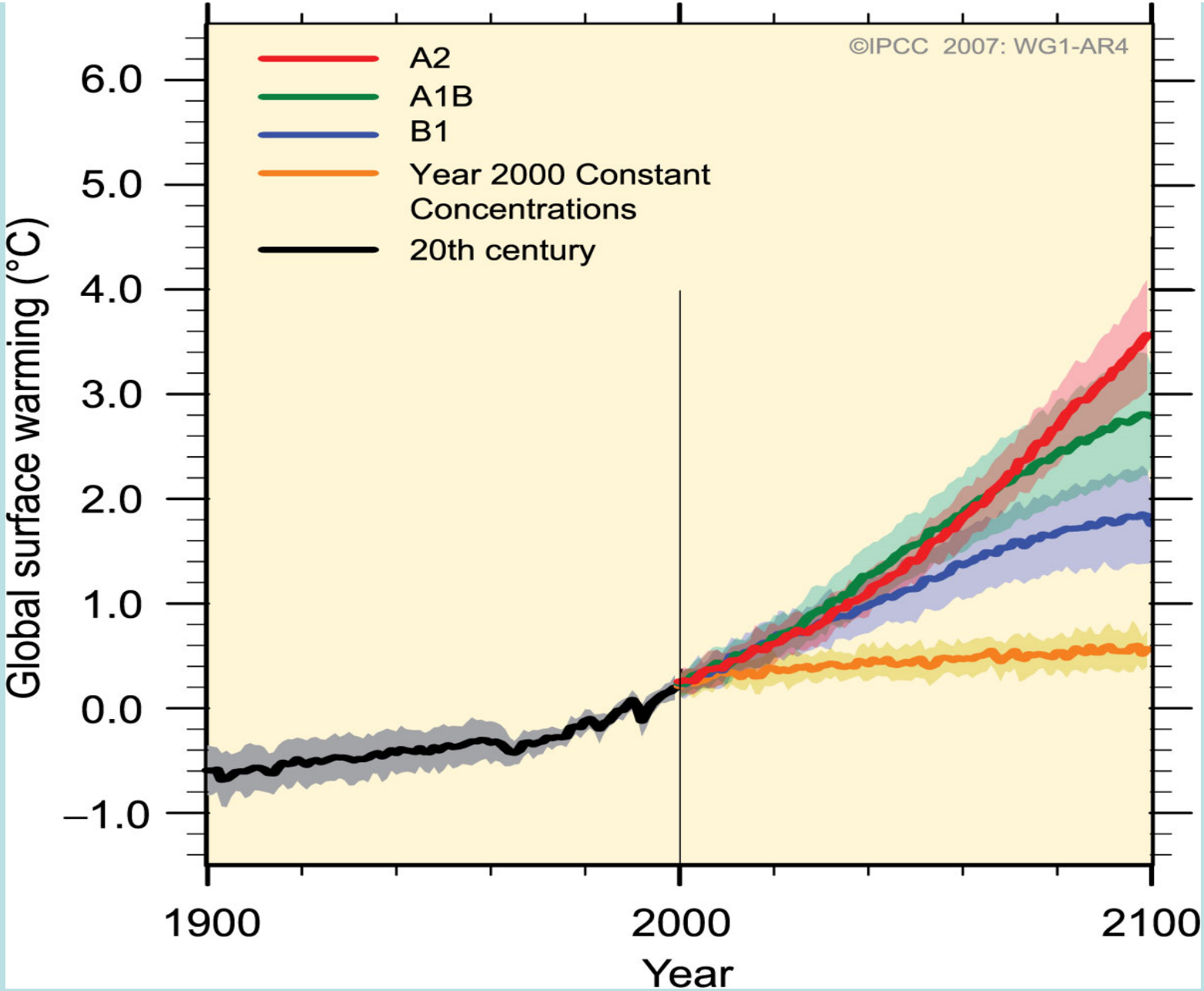


Source: Hansen, *Clim. Change*, **68**, 269, 2005.

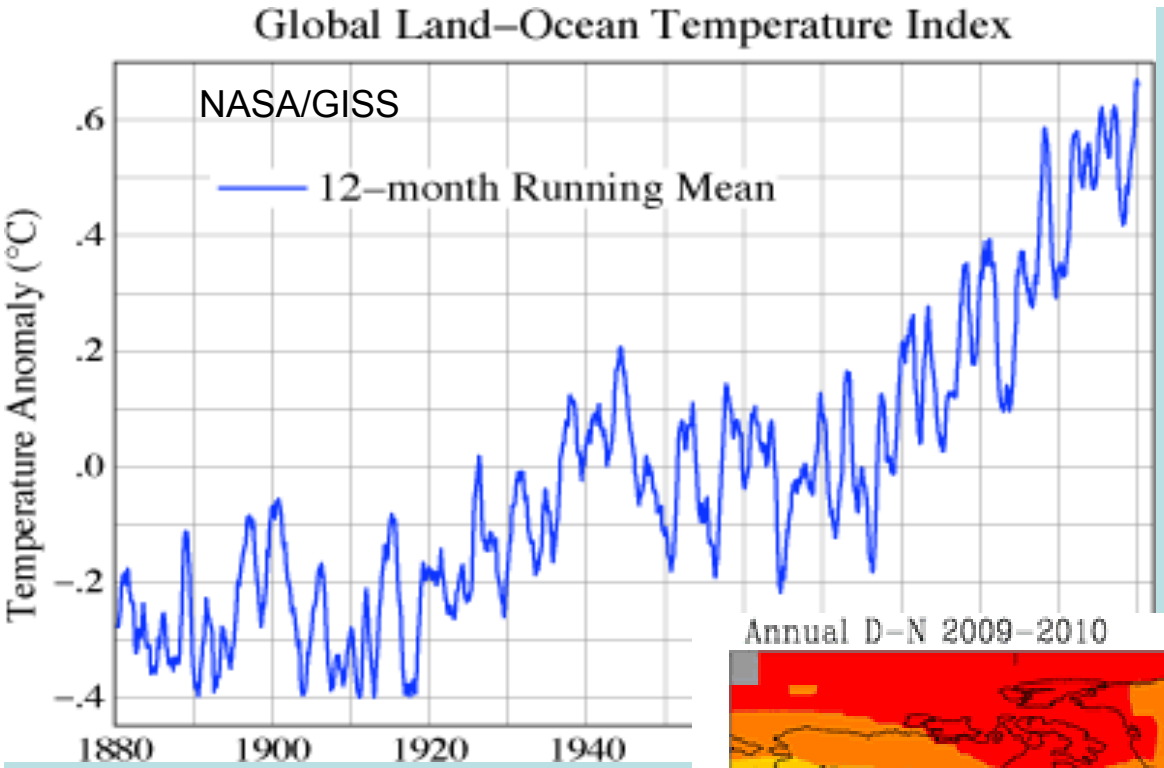


Note: chances of $\Delta T > 4\ ^{o}C$ are NOT negligible. Playing the odds, buying insurance?

How sensitive is the Earth's climate to a doubling of atmospheric CO_2 (from 280 to 560 ppm)?

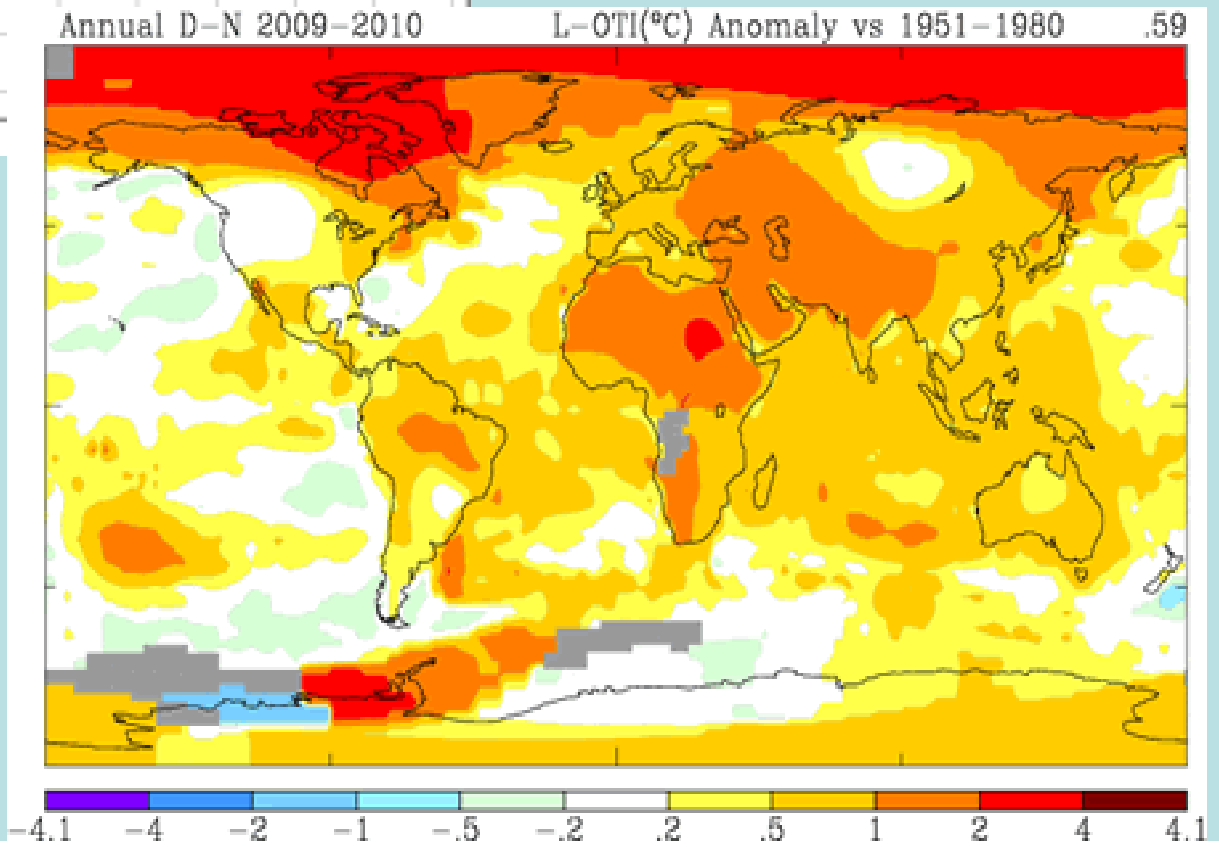


Predicted global warming to 2100 for different emission scenarios (IPCC ‘07)



2010 is the warmest year in the 130-yr global temperature record.

Observed pattern of temp anomalies Dec'09- Nov '10



Pakistan monsoon summer 2010

20 million people displaced

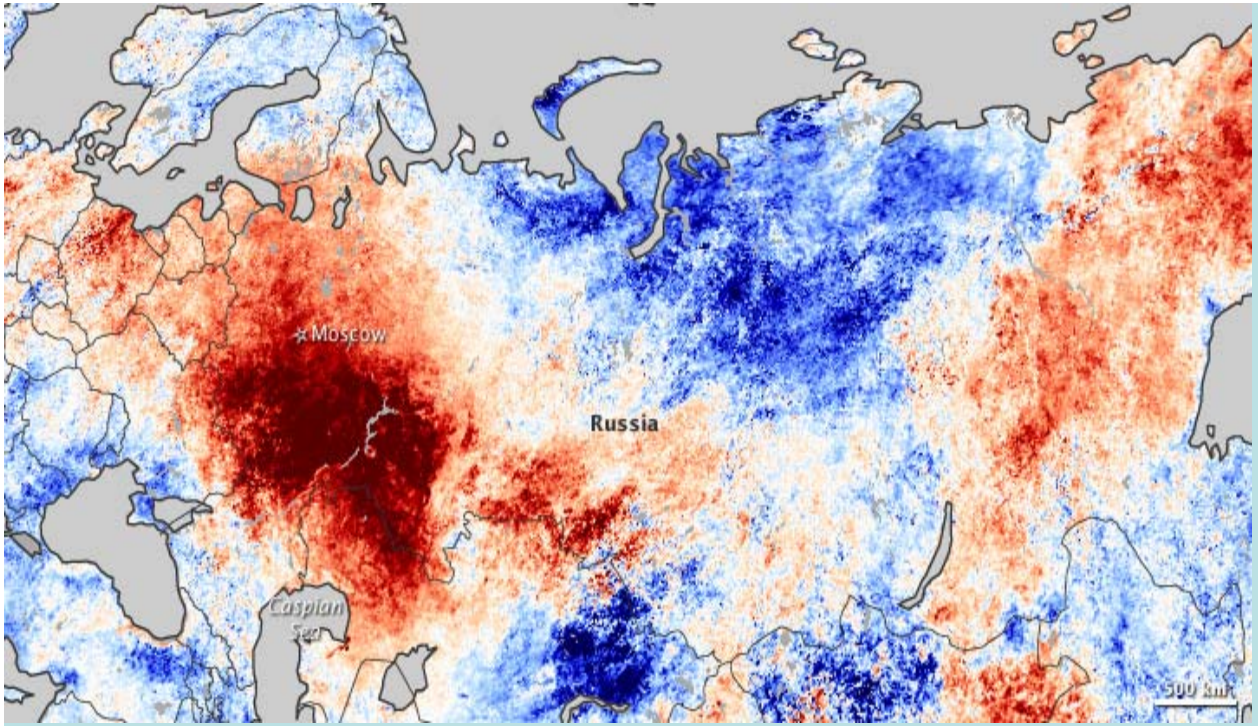
20% of Pakistan flooded.. worst in Pakistani history

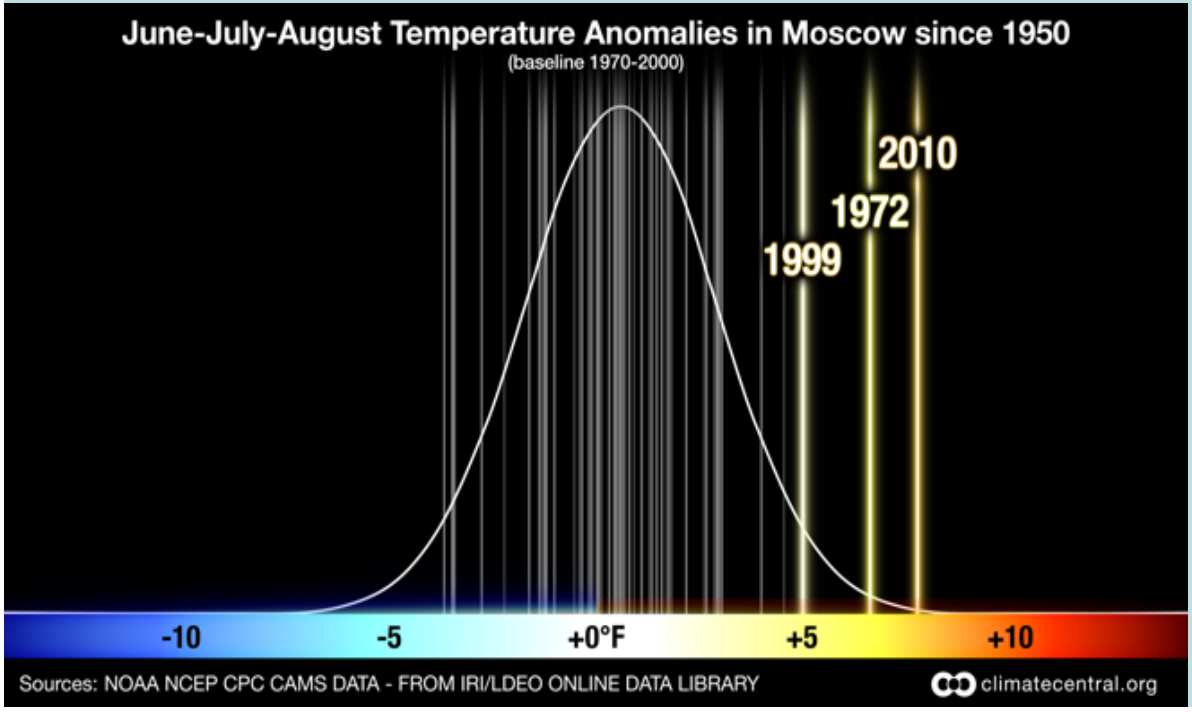
? a dynamical link to….

Russian heat wave July ‘10

25% wheat crop lost, grain exports halted, severe drought, forest fires.

~11,000 heat-related excess deaths reported in Moscow alone in July

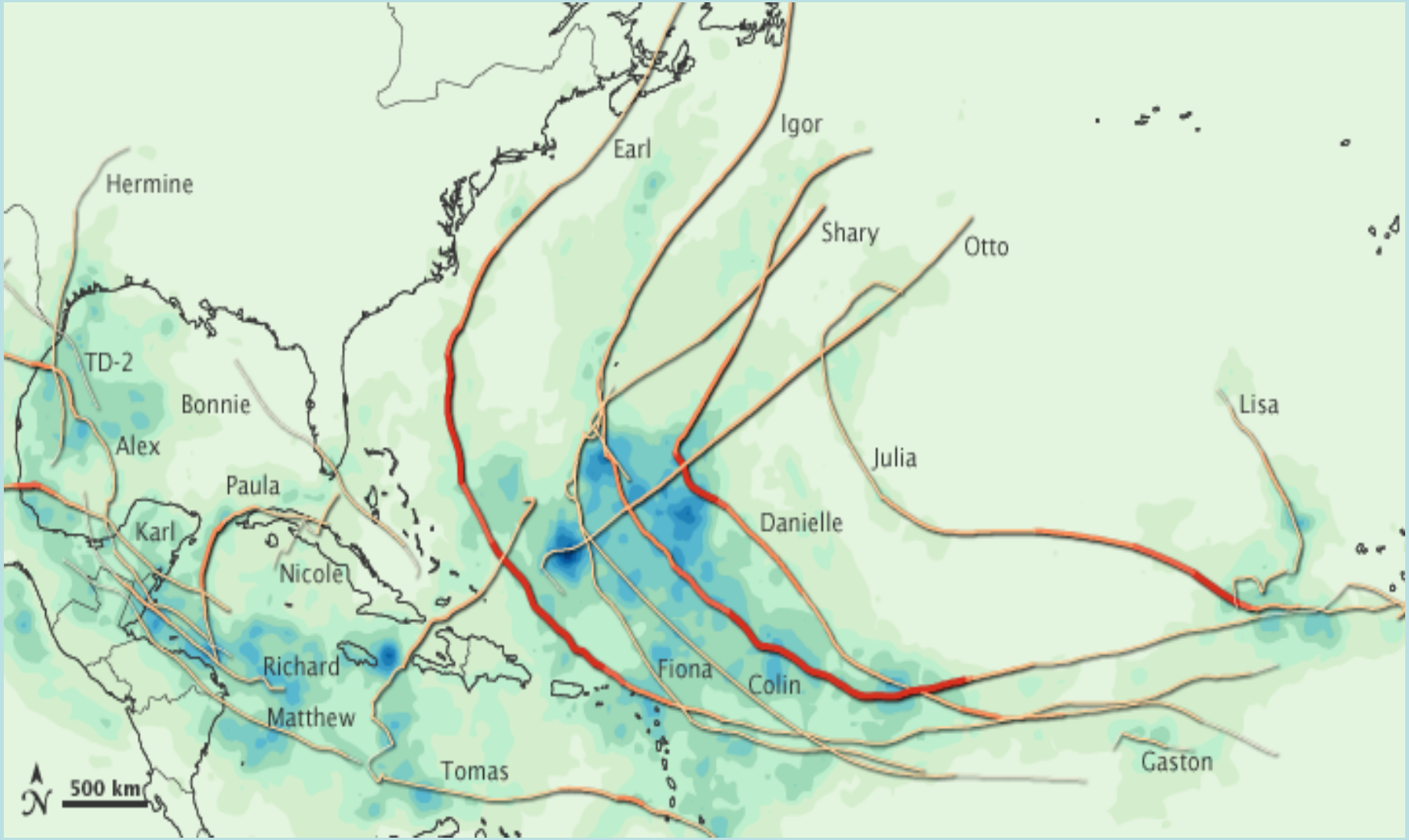




Russian President Medvedev (July, 2010)

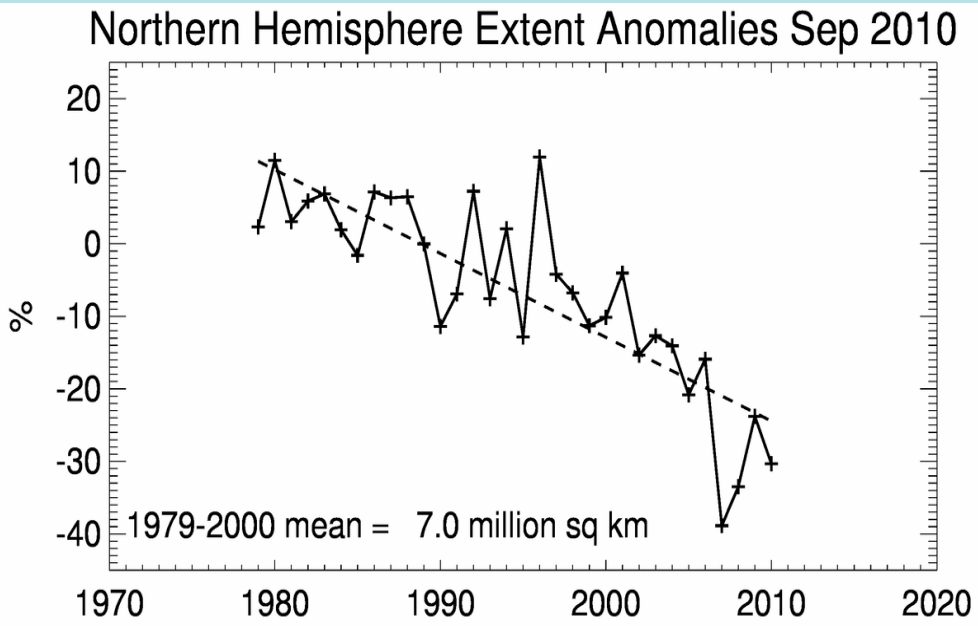
"Practically everything is burning. The weather is anomalously hot. *What is happening with the planet's climate right now needs to be a wake-up call to all of us, meaning all heads of state, all headsof social organizations, in order to take a more energetic approach to countering the global changes to the climate.*"

Moscow reaches >100°F in July 2010, the hottest summer in Russia ever.



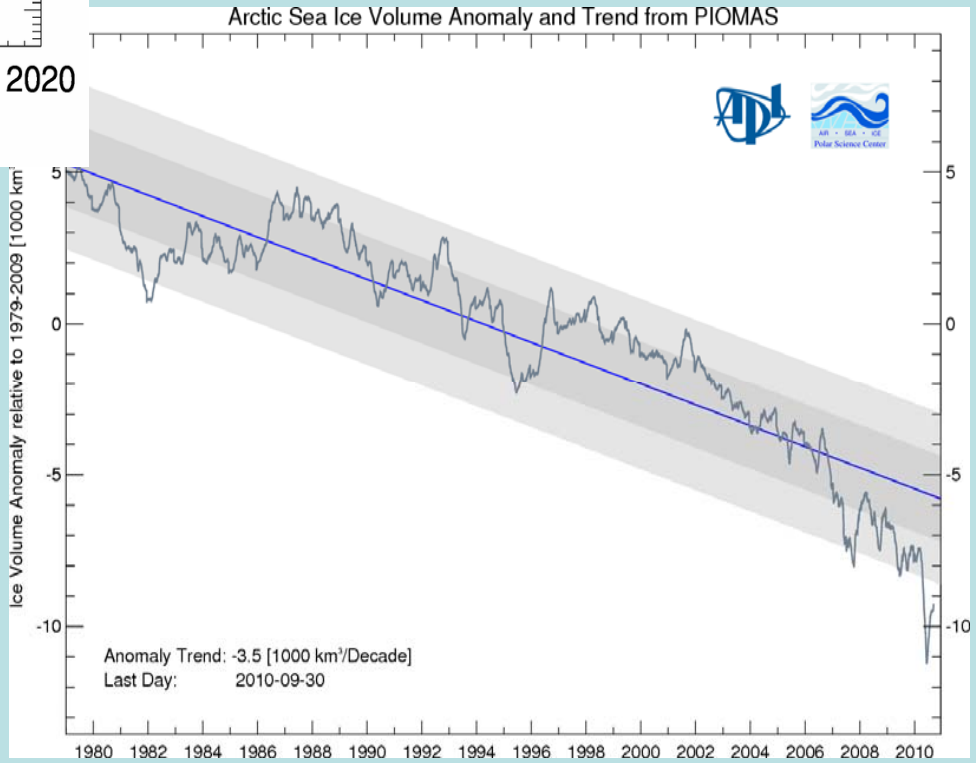
2010 was a very active hurricane year in the North Atlantic, USA dodged a bullet (no landfall), other nations in the Caribbean were not so lucky.

Arctic sea-ice extent continues down in 2010



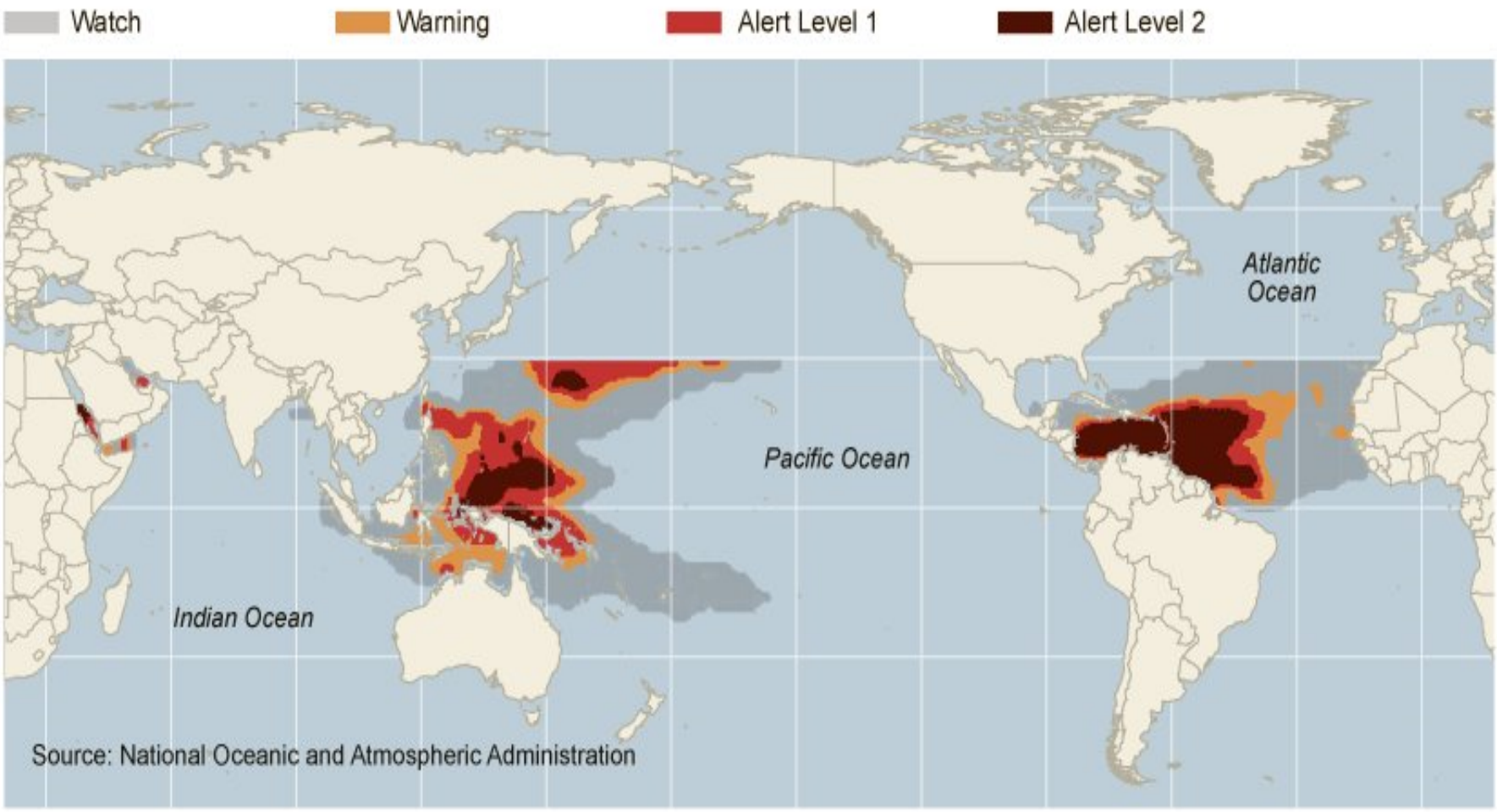
Lacking ice,walrus come ashore

Record low Arctic sea-ice volume in 2010



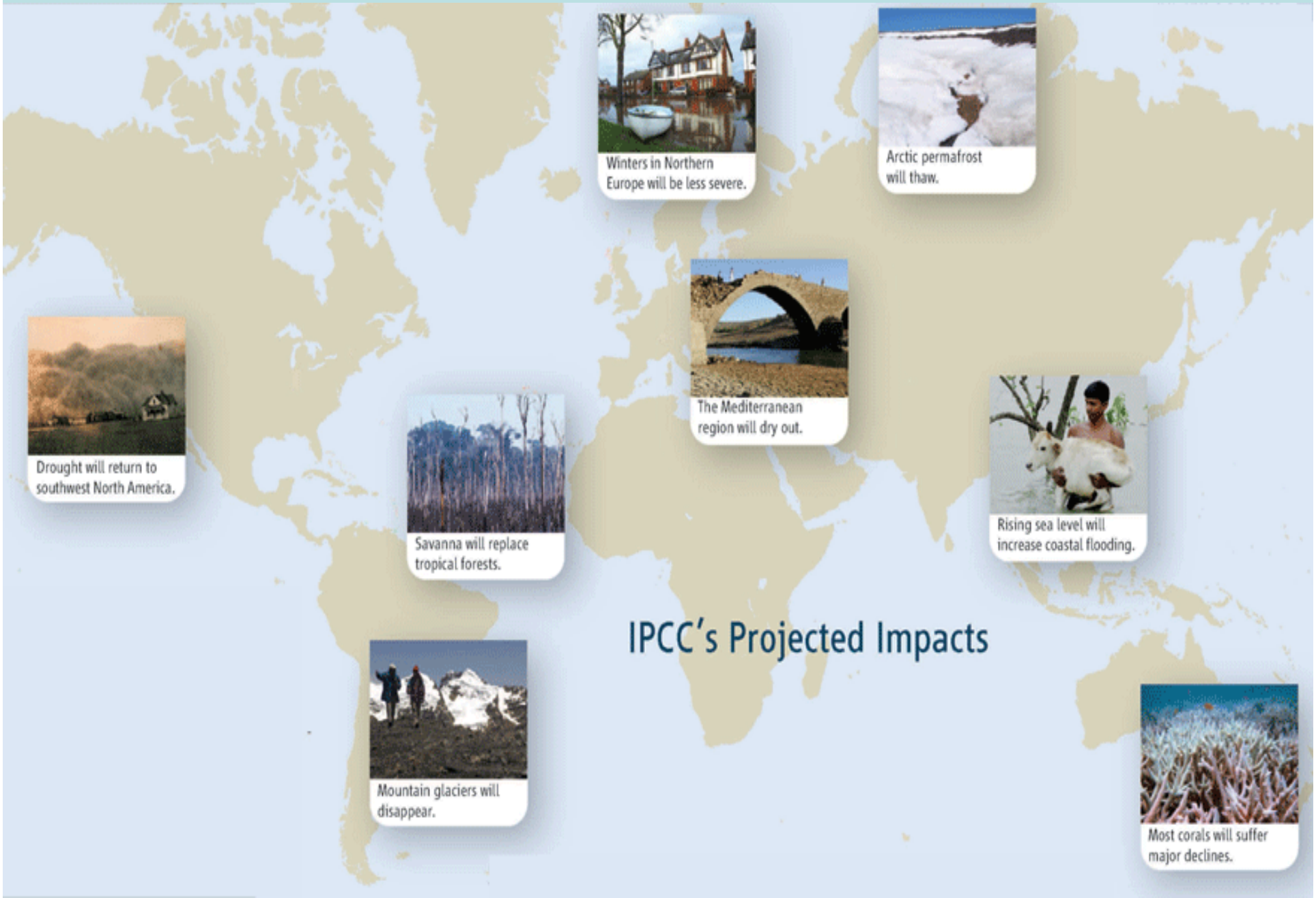
Potential for Coral Bleaching

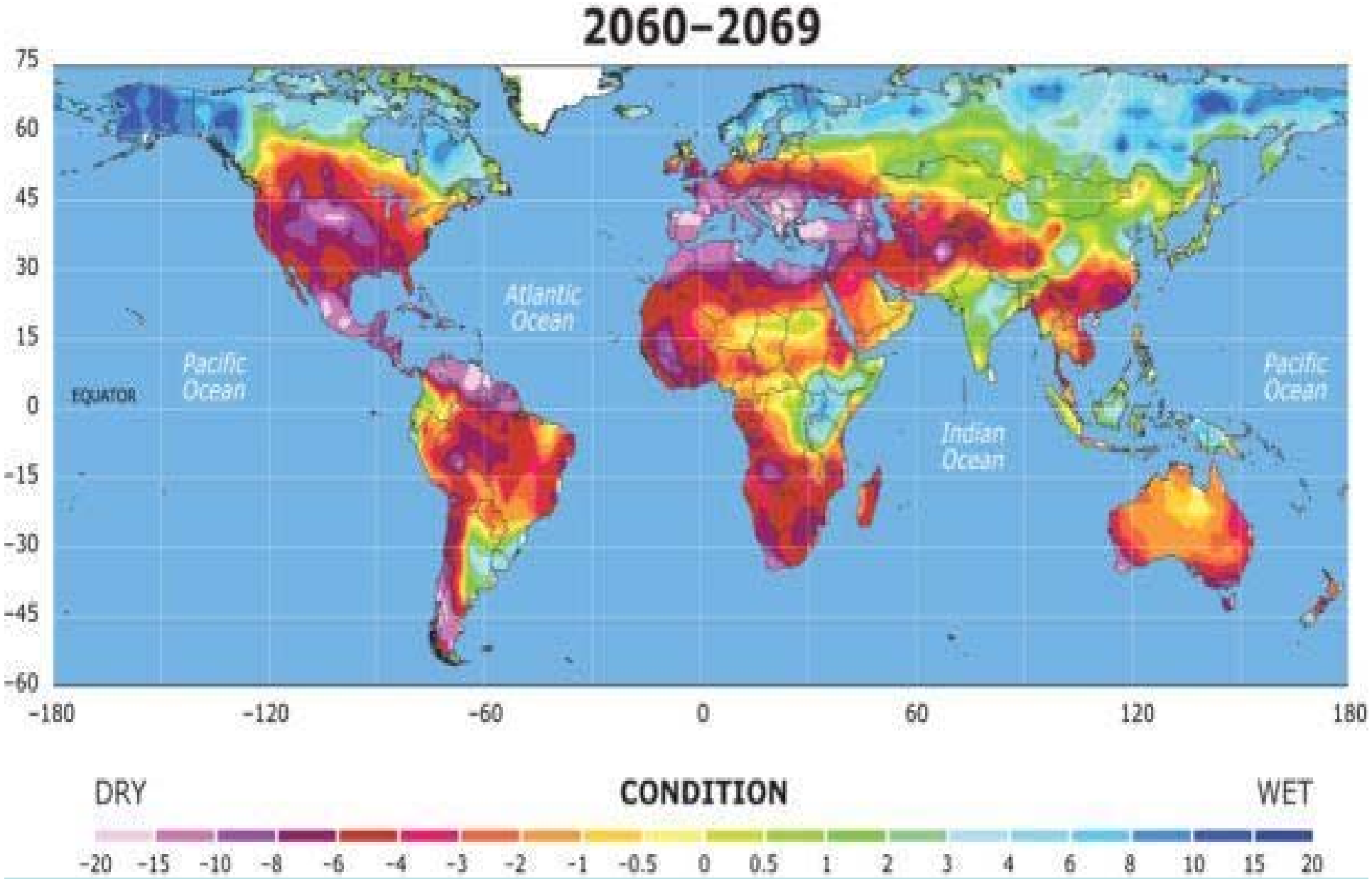
The map below shows areas where the National Oceanic and Atmospheric Administration expects conditions that may cause coral bleaching from September through December. NOAA uses satellite imagery and algorithms based on water temperature over a specific range of time to determine the categories.



A prediction in early ‘10-- observed bleaching was at least as bad as in 1998

Projected global impacts of climate change (IPCC '07)

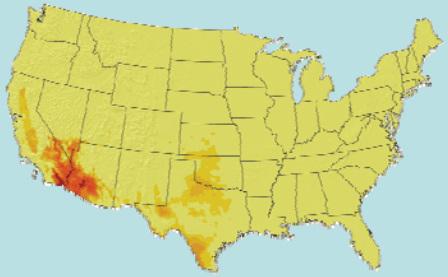




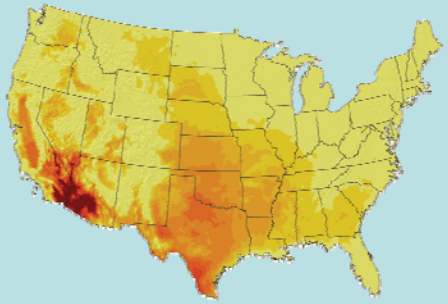
Drought severity prediction (Dai et al, NCAR, ‘10)

Number of days over 100 °F (2080-99)

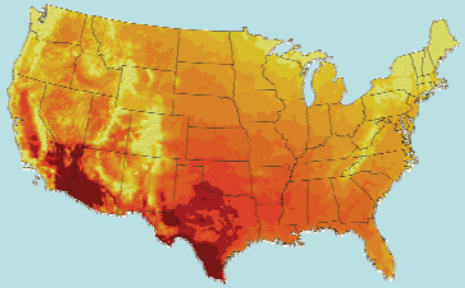
Recent past 1961-79

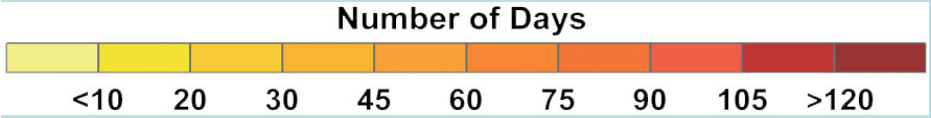


Lower emission scenario



Higher emission scenario



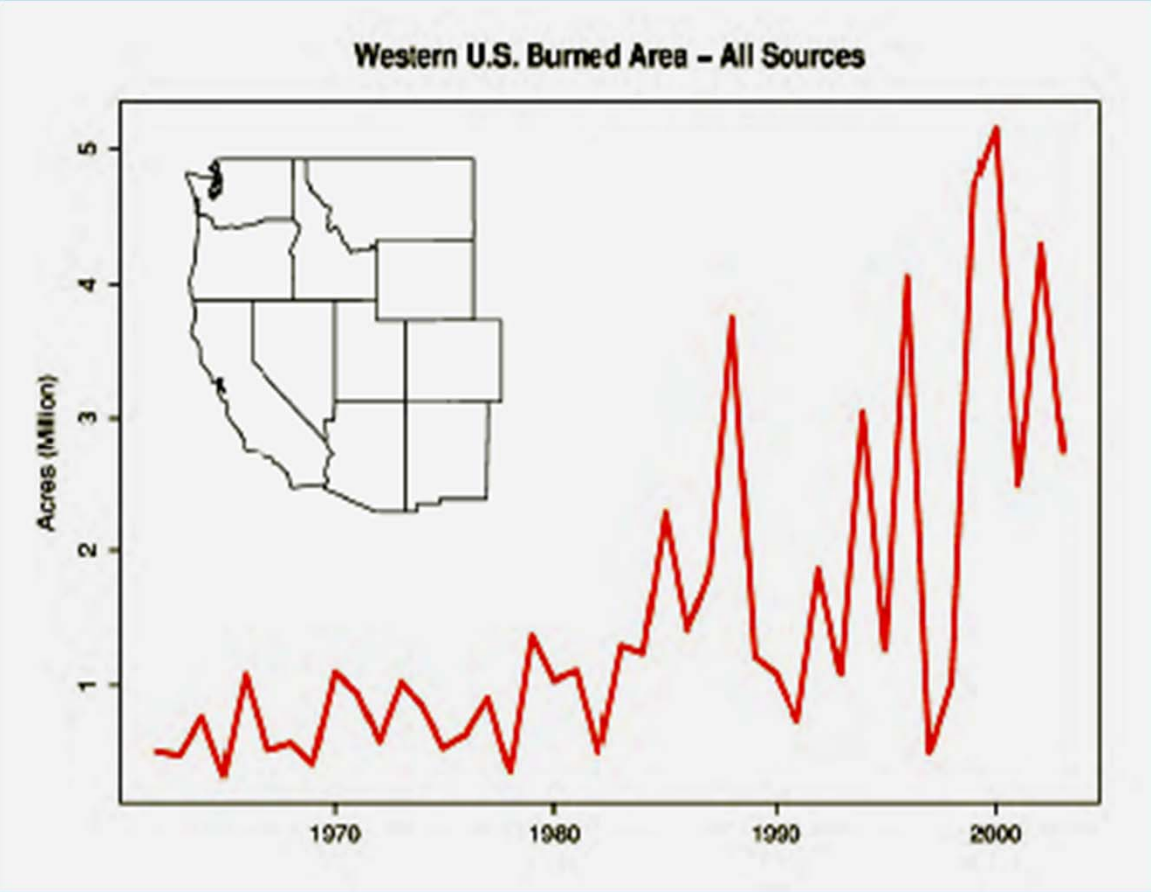


"The United States and many other heavily populated countries face a growing threat of severe and prolonged drought in coming decades, possibly reaching a scale in some regions by the end of the century that has rarely, if ever, been observed in modern times…"

Dai, (NCAR, '10)

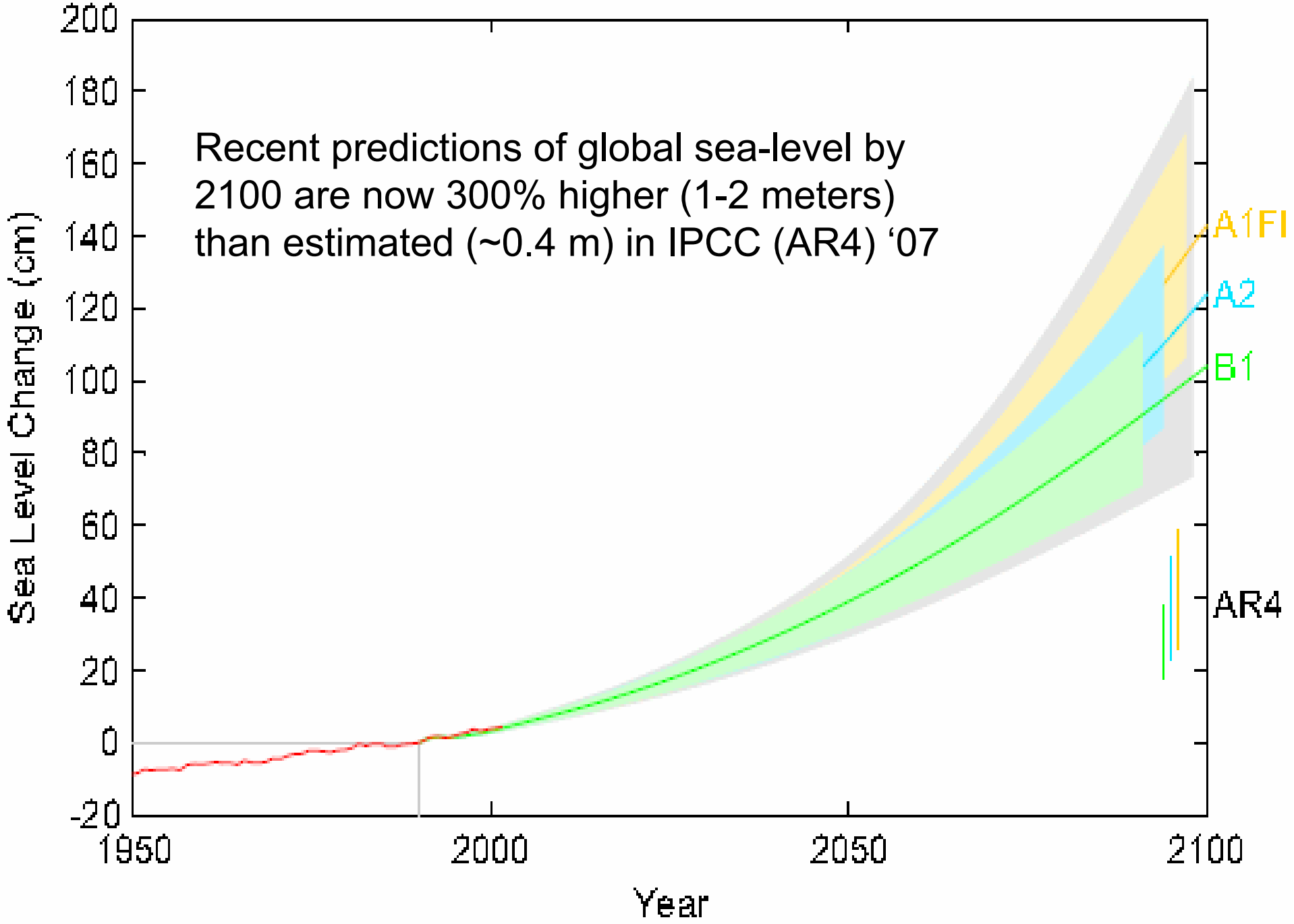
(US Global Change Research Program)

Wildfires have increased 400% in the western USA in the past 30 years



Westerling et al, Science 2006

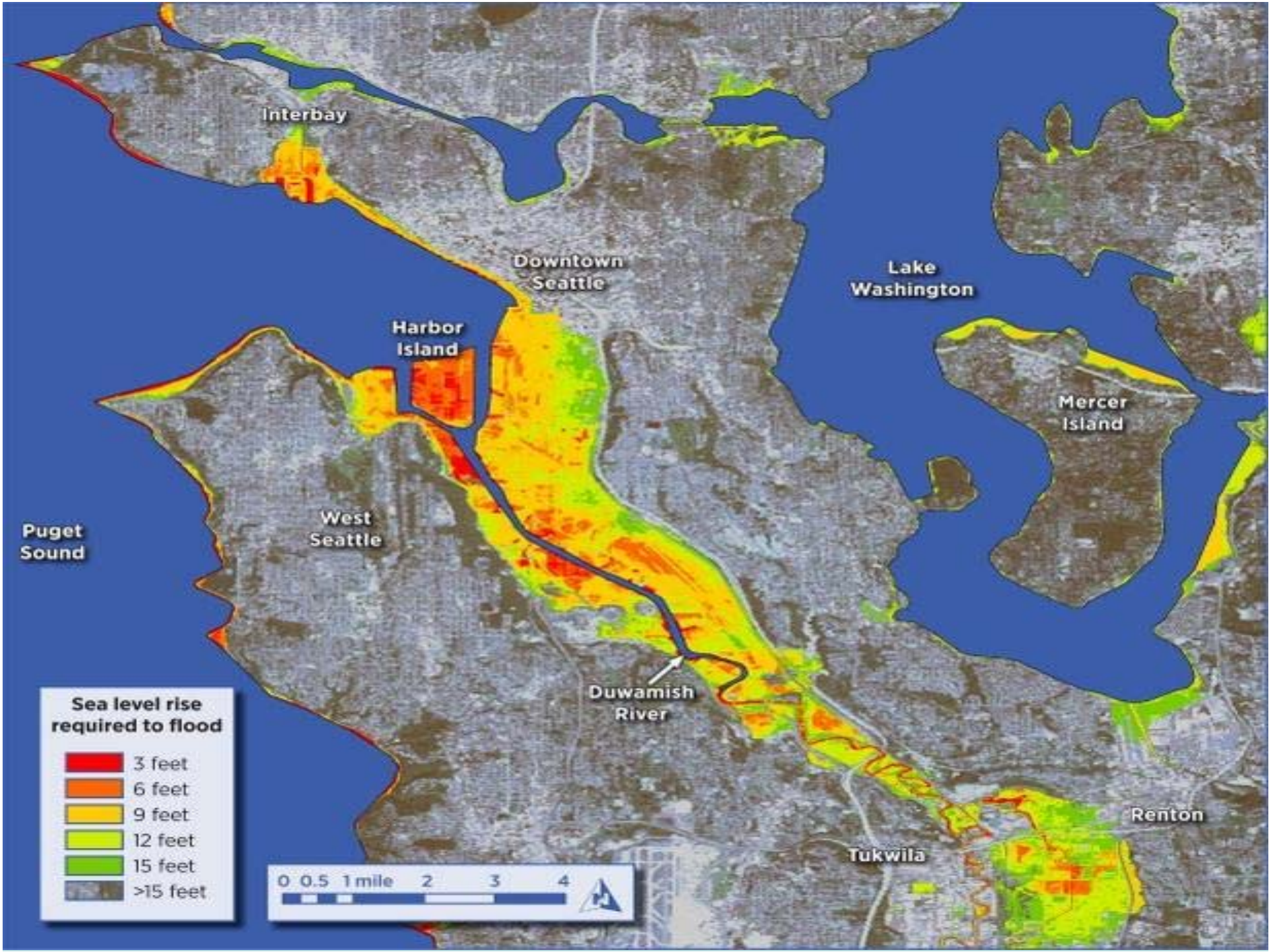
Lake Mead is now at the lowest level since 1937, within 8 feet of rationing threshold for Las Vegas

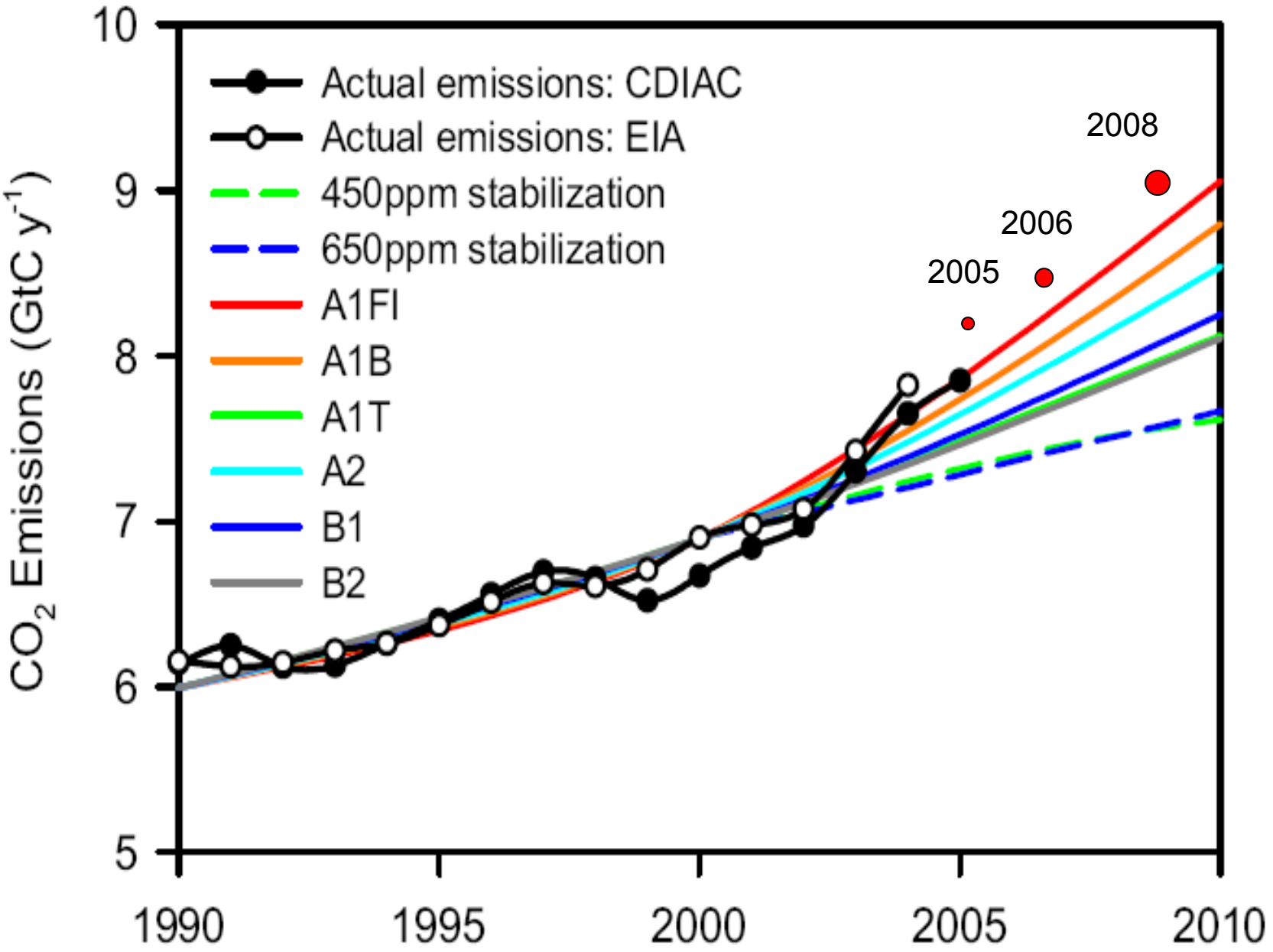

Recent predictions of global sea-level by 2100 are now 300% higher (1-2 meters) than estimated (~0.4 m) in IPCC (AR4) '07
Sea Level Change (cm)
200
180
160
140
120
100
80
60
40
20
0
-20
1950
2000
2050
2100
Year
A1FI
A2
B1
AR4

Each meter of global
sea-level rise will displace
~100 million climate refugees

Fence built by India on the
border with Bangladesh


Predicted loss of US coastline for:
(red) 2 meter S-L rise --possible by 2100
(yellow) 25 meter S-L rise-- later?
Traffic
More...
Billings
Minnesota
Sudbury
South Dakota
Wisconsin
Michigan
Maine
Vermont
New Hampshire
New York
Massachusetts
Wyoming
Iowa
Nebraska
Connecticut
Pennsylvania
Ohio
New Jersey
Denver
Colorado
Maryland
West Virginia
Delaware
Kansas
Missouri
Kentucky
Virginia
Tennessee
North Carolina
Oklahoma
Arkansas
New Mexico
South Carolina
Wilmington
Mississippi
Alabama
Georgia
El Paso
Texas
Austin
Louisiana
Jacksonville
Houston
New Orleans
San Antonio
Chihuahua
Tampa
Florida
Gulf of Mexico
Miami
La Paz
Culiacán
©2009 Google - Map data


Interbay
Downtown Seattle
Lake Washington
Harbor Island
Mercer Island
West Seattle
Puget Sound
Duwamish River
Renton
Tukwila
Sea level rise required to flood
3 feet
6 feet
9 feet
12 feet
15 feet
>15 feet
0 0.5 1 mile 2 3 4

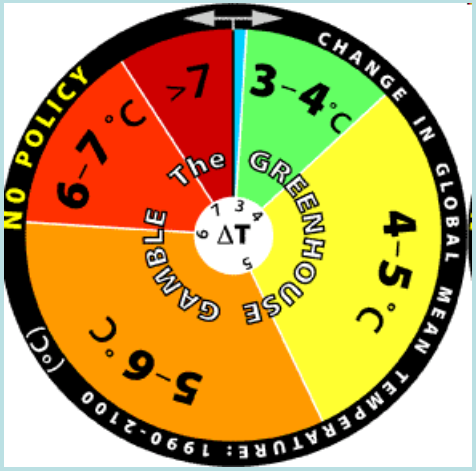


Global CO_2 emissions are rising faster than predicted

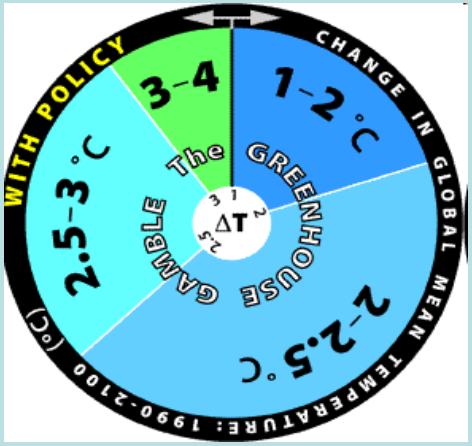
The Greenhouse Roulette Wheel:

Estimated warming by 2100

Business as usual



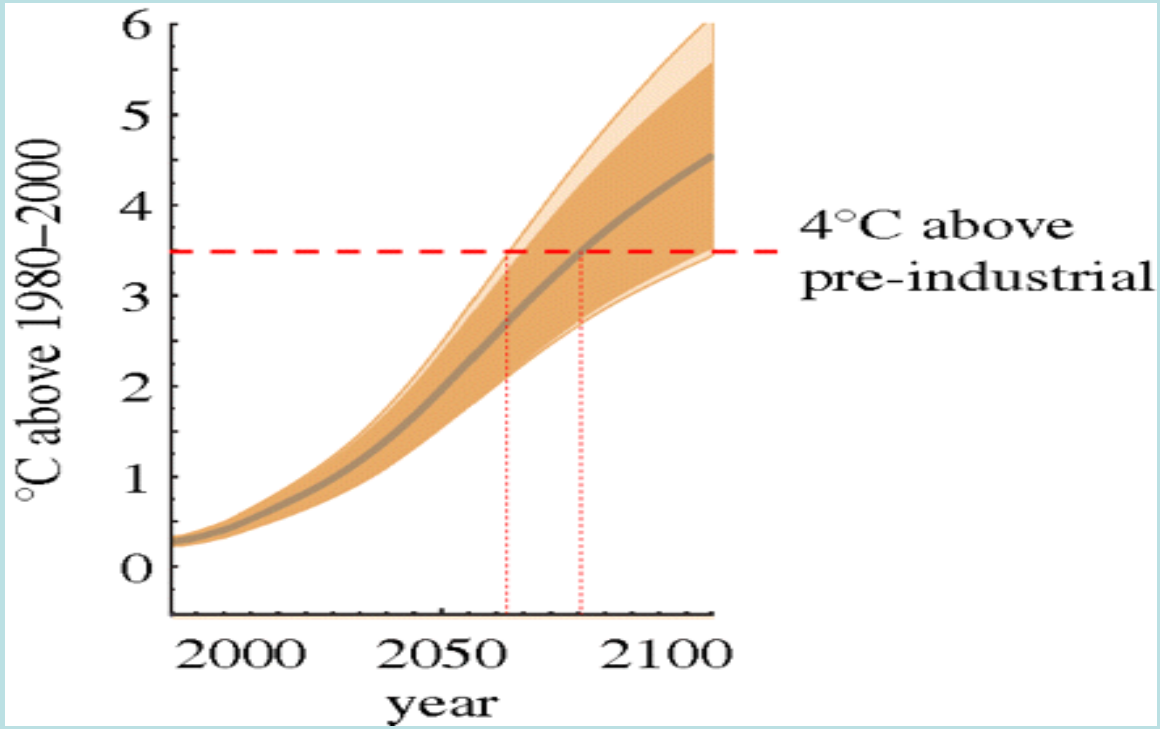
Strong climate policy



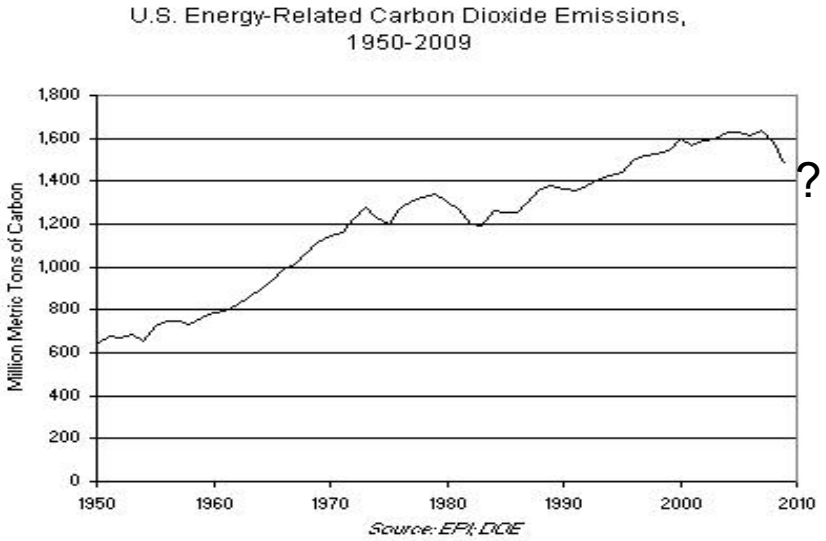
MIT Center for Global Change Studies (2009)

Heading for a 4 °C warmer world

Estimated warming for A1F1 emission path

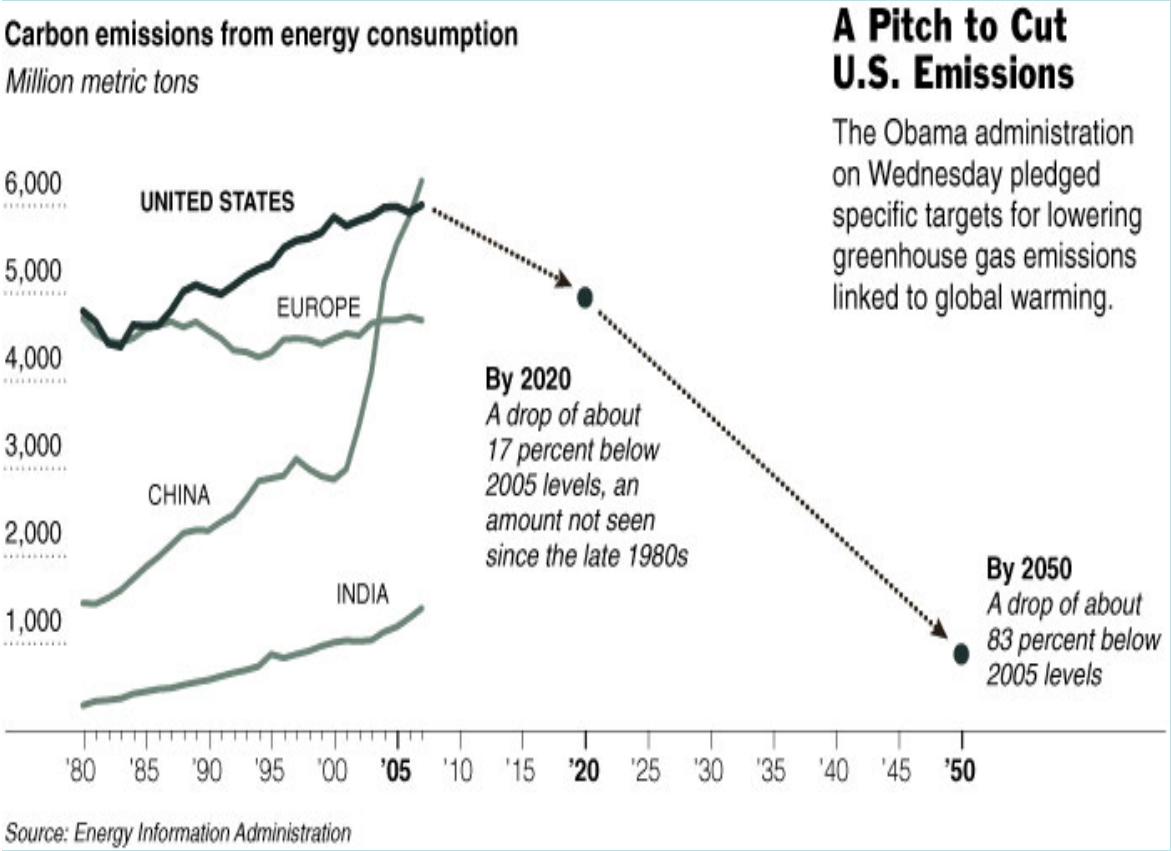


J. Royal Society (2010)

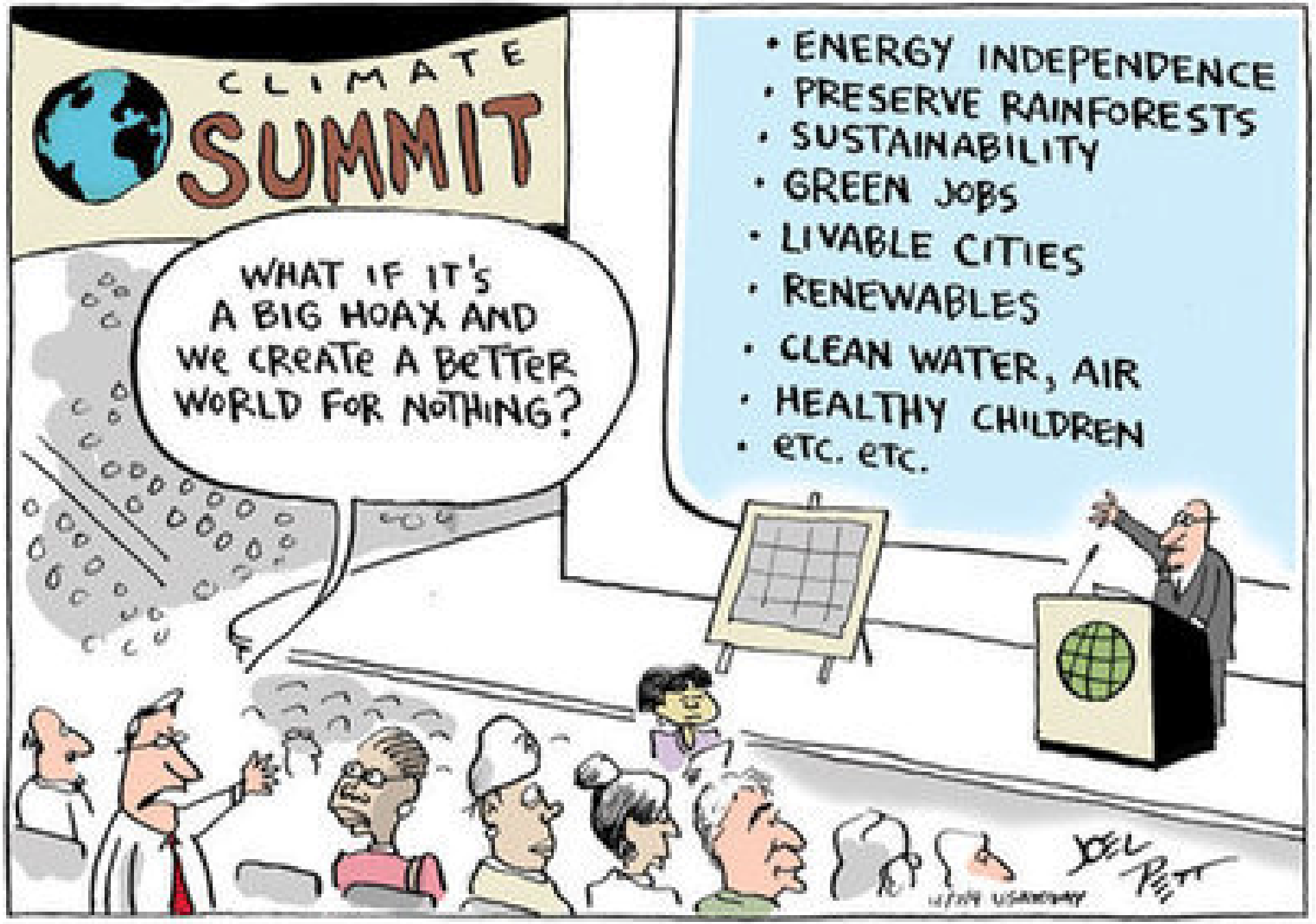


?

Will the USA follow this proposed downward path?



Have we started down, or is this just the recession?



no regrets policy

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Materials Management as a Climate Mitigation Strategy

Prepared for the West Coast Climate and Materials Management Forum

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January 6, 2011

Overview

- Materials management: what is it?
  - Waste/discards management as a subset of materials management
- The climate impact of materials and waste
- Waste/discards management
  - Benefits of recycling
- The importance of materials management and the limitations of the “waste management” framework

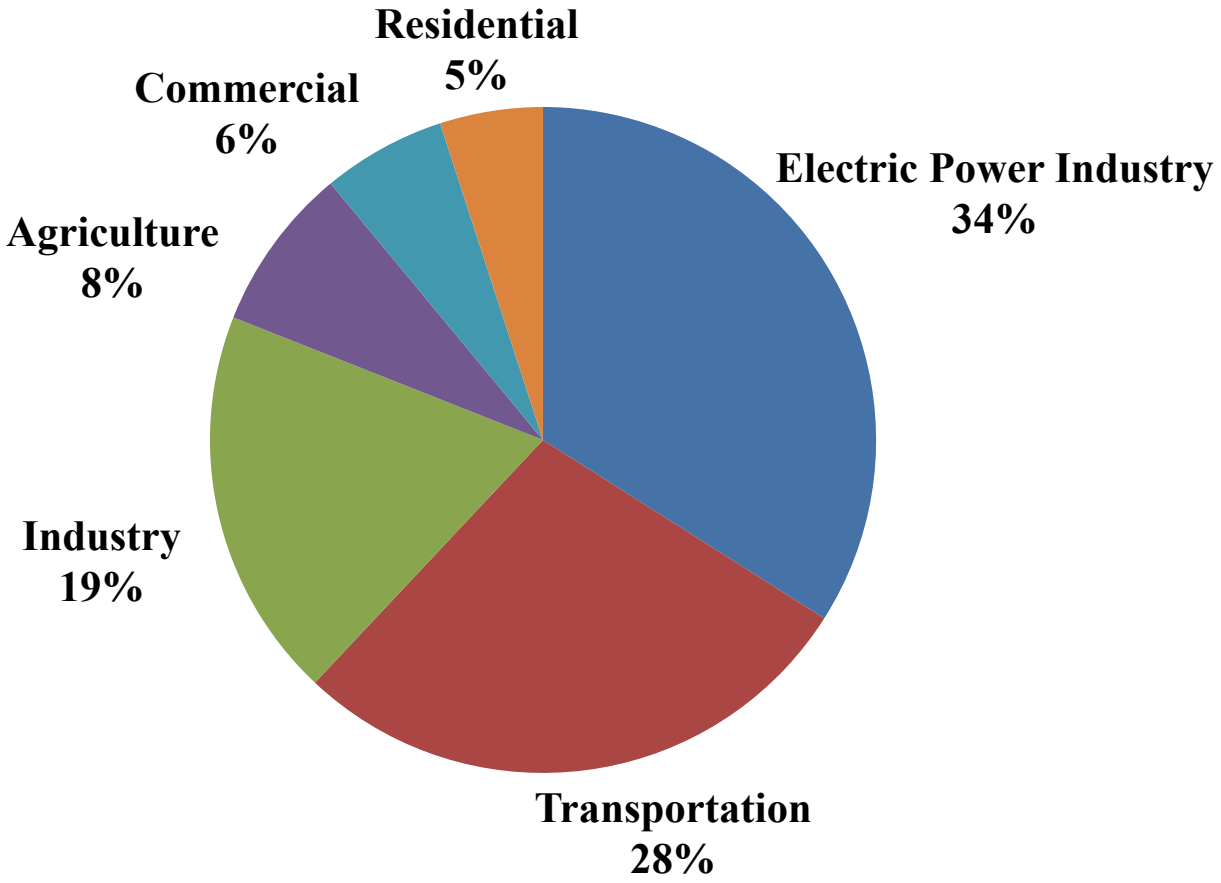
Materials Management: A Working Definition

- *"Materials management is an approach to using and reusing resources most efficiently and sustainably throughout their lifecycles. It seeks to minimize materials used and all associated environmental impacts."*
  - From EPA, Opportunities to Reduce Greenhouse Gas Emissions through Materials and Land Management Practices (PDF) (98pp, 1.5MB)

"Waste Management"/"Discards Management" is a Subset of Materials Management

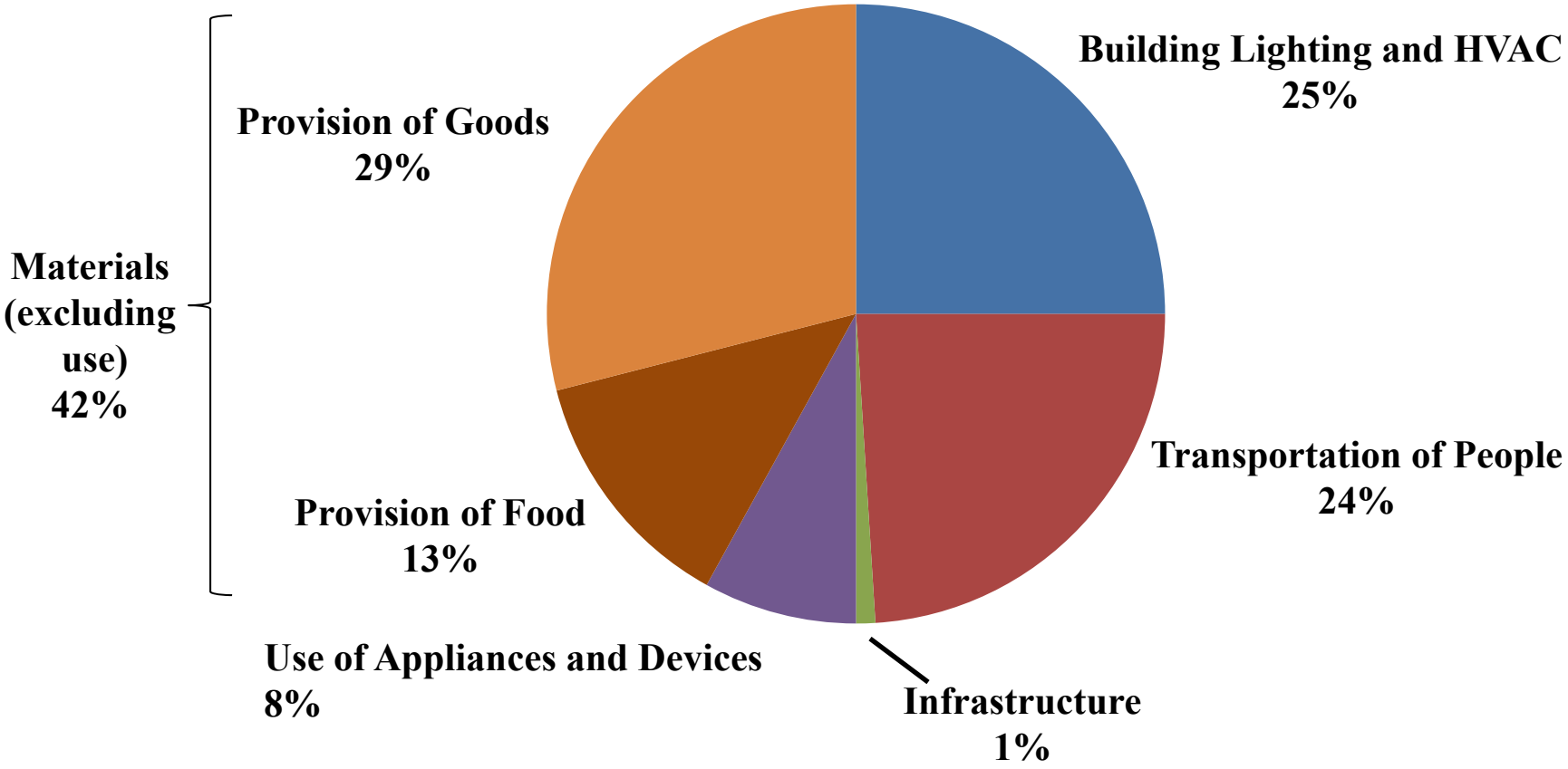
Carbon Goggles

Traditional Sector-Based View of U.S. Greenhouse Gas Emissions (2006)



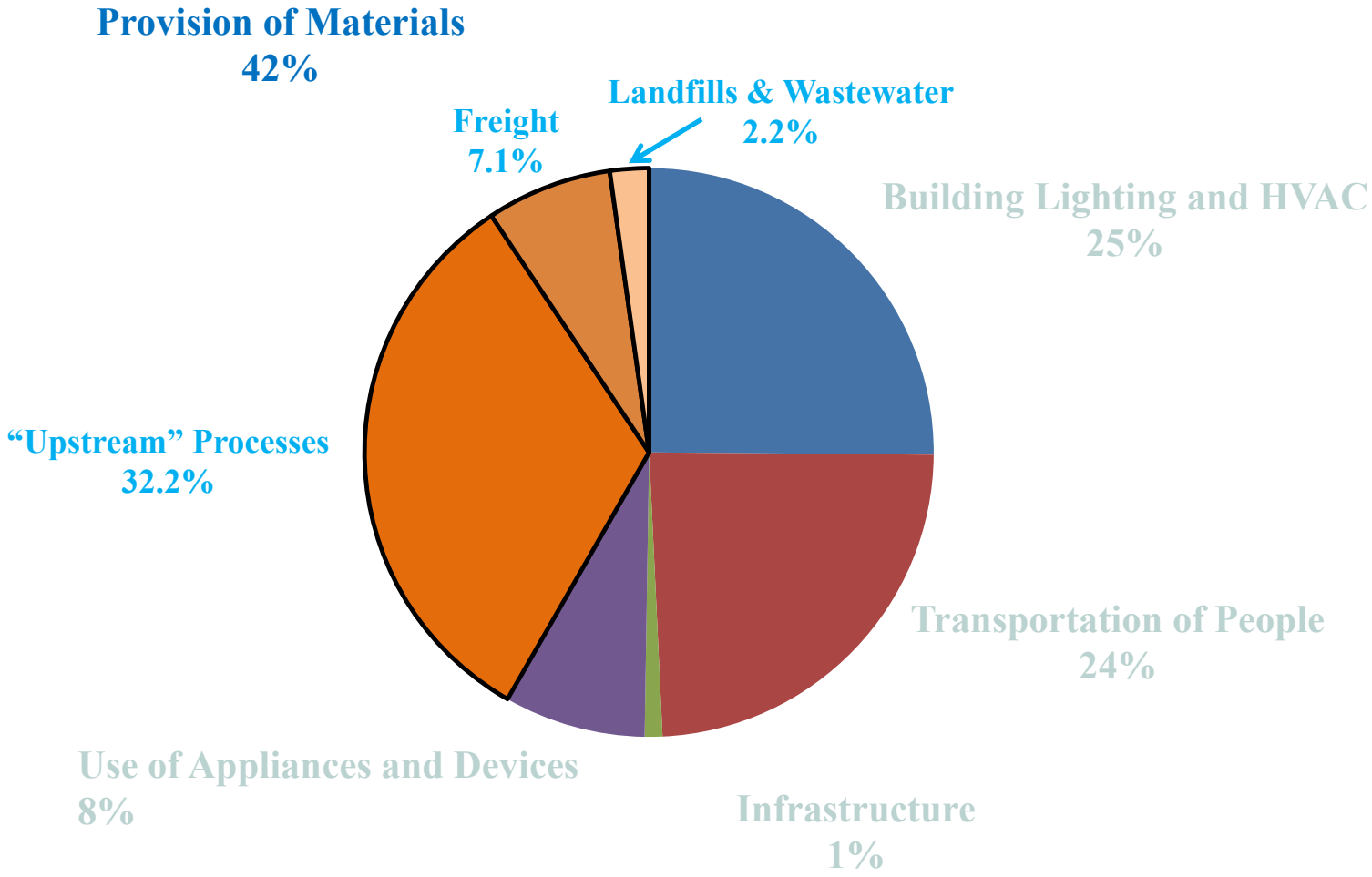
Source: US EPA (2009)

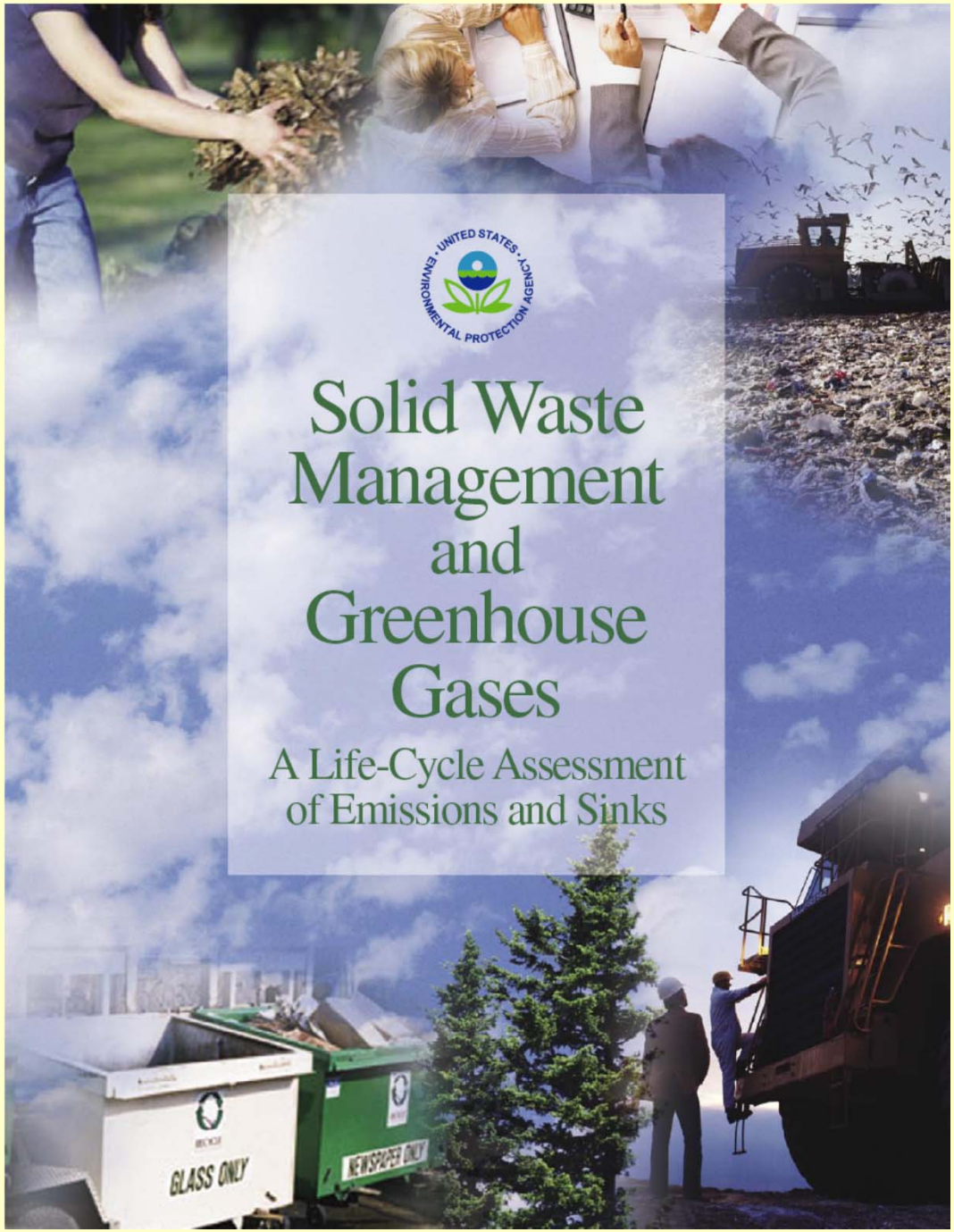
Materials Matter: Systems-Based Geographic Emissions Inventory (2006)



Source: US EPA (2009)

For Materials, "Upstream" Emissions Dominate



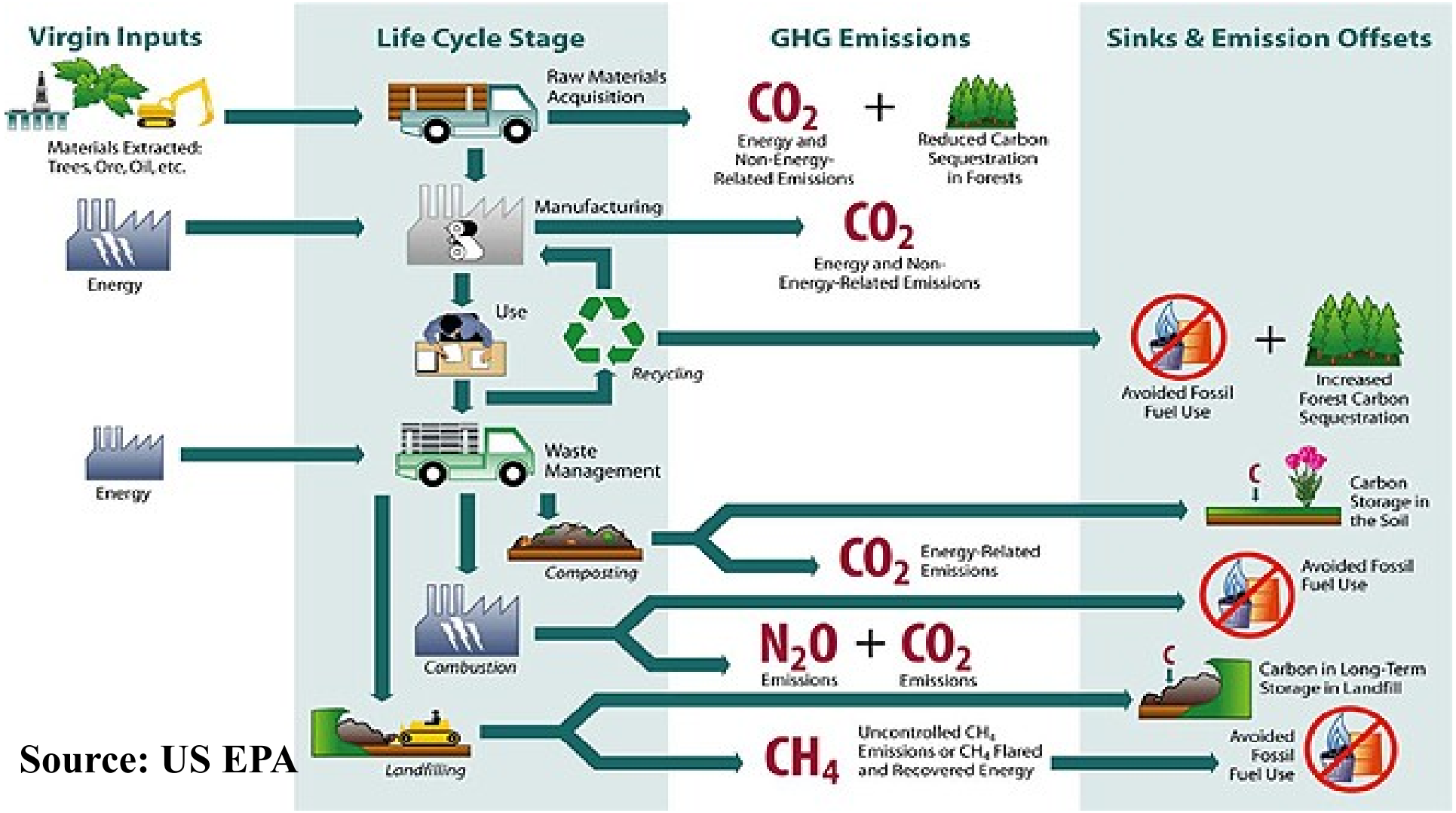


EPA Climate Change and Waste Resources:

Report:
http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html

WARM (WAste Reduction Model) and other tools:
http://epa.gov/climatechange/wycd/waste/tools.html

Greenhouse Gases Over the Product Life Cycle – EPA's WARM Tool



Source: US EPA

Greenhouse Gas Benefits of Recycling

- Recovery in Oregon in 2009 reduced greenhouse gas emissions by ~2.8 million metric tons of CO2e
  - ~3.9% of total statewide emissions
  - Equivalent of 570,000 “average” passenger cars
  - Benefits are dominated by “upstream” processes (not disposal avoidance)

Curbside Recycling (Portland, Oregon)

- For every 100 tons of mixed recyclables collected from households (curbside):
  - 6 $MTCO_2e$ in greenhouse gas emissions from on-route vehicles (including diesel production)
  - 232 $MTCO_2e$ greenhouse gas savings (net) when these recyclables displace virgin feedstock in production

Long-Haul Is Not a Limiting Factor

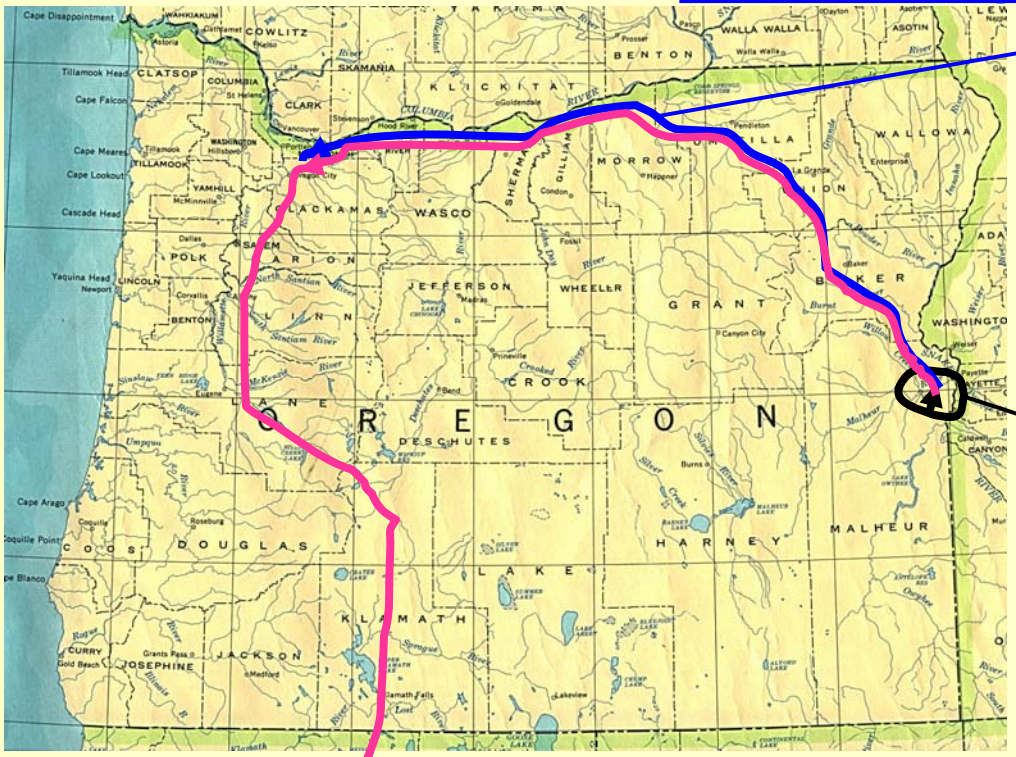
Material	Production & Forestry Savings (MTCE/ton collected)	"Break-Even Point" (miles) Truck	Rail	Freighter
Aluminum	3.44	116,000	451,000	524,000
Corrugated	0.79	27,000	104,000	120,000
Newspaper	0.68	23,000	90,000	104,000
Steel	0.48	16,000	63,000	73,000
LDPE	0.36	12,000	47,000	55,000
PET	0.33	11,000	43,000	50,000
HDPE	0.30	10,000	39,000	45,000
Glass (to bottles)	0.07	2,000	9,000	11,000

"Break-Even Point" is where GHG emissions transporting the recyclables equals GHG emissions avoided when the recyclables displace virgin feedstocks.

Avoided disposal-related emissions are not included.

End Markets Matter! (sometimes)

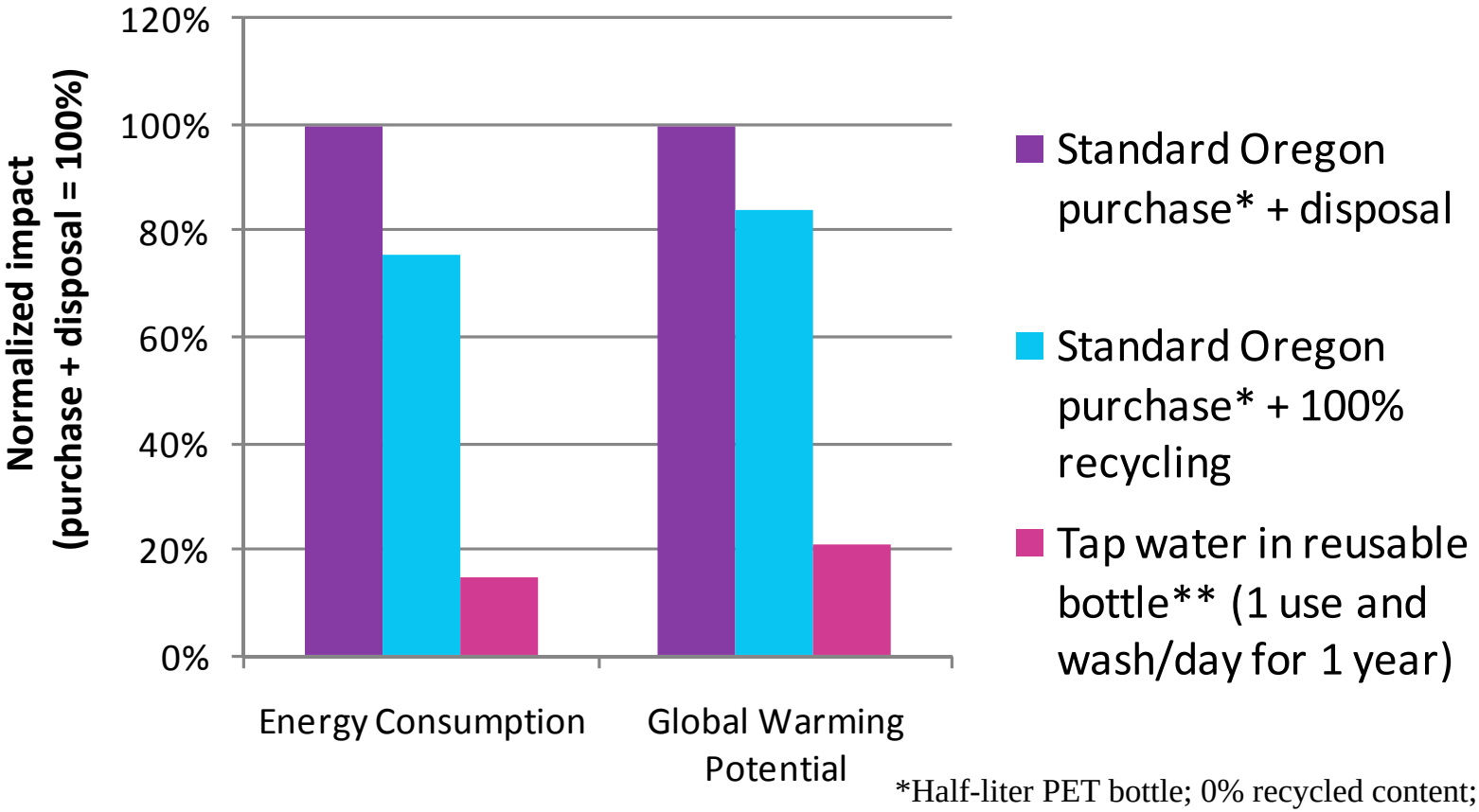
Cullet to Bottle Recycling (Portland)
Net Energy Savings: ~2.1 MMBTU/ton



Cullet to Aggregate Recycling (Local)
Net Energy Savings: ~0.2 MMBTU/ton

Cullet to Fiberglass Recycling (California)
Net Energy Savings: ~3.2 MMBTU/ton

Disposal vs. Recycling vs. Prevention (Drinking Water Example)

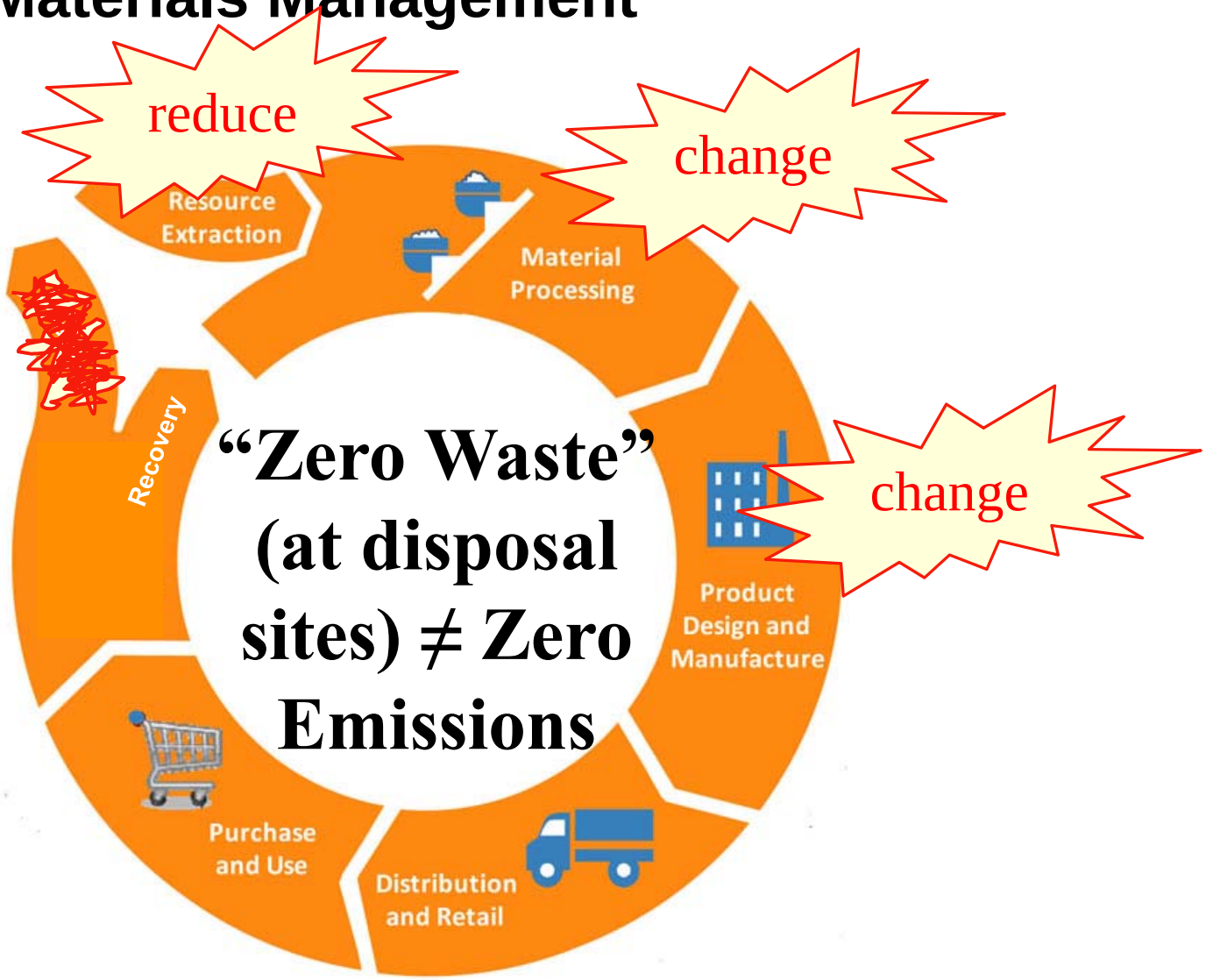


*Half-liter PET bottle; 0% recycled content; 13.3 grams; local water

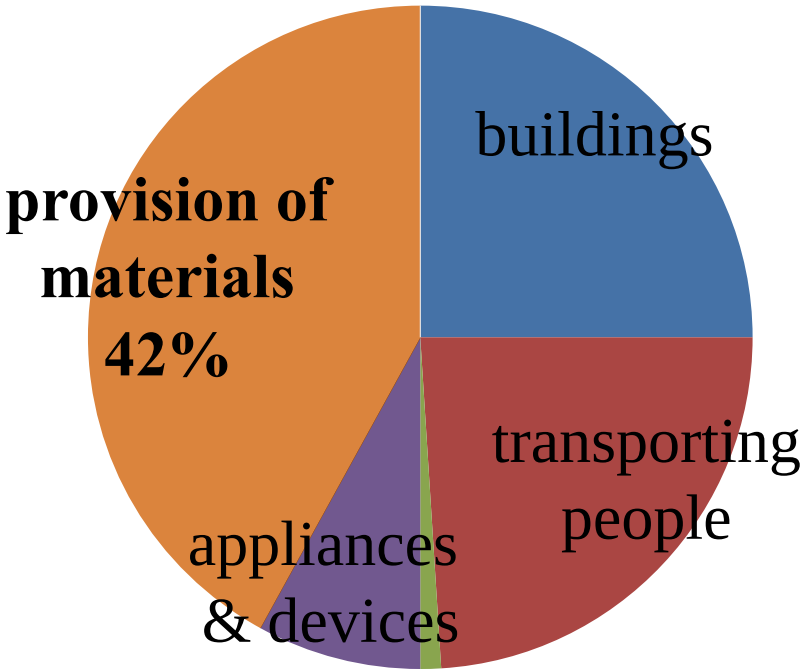
**Average of aluminum/PET/steel; no recycling; high-water use dishwasher

From "Discards Management" to "Materials Management"

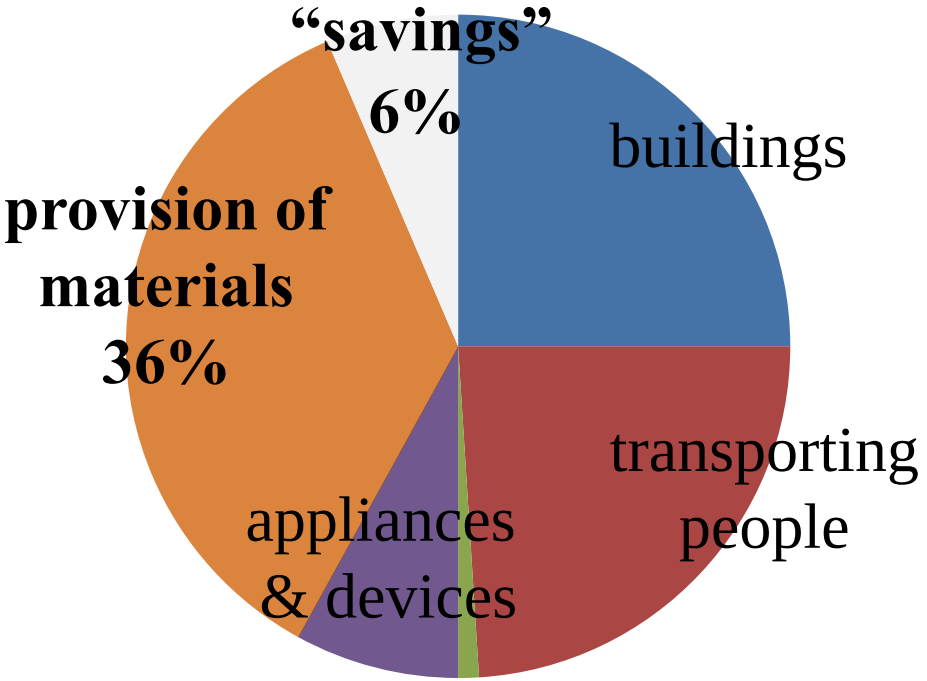
ZERO WASTE



The importance . . . and limitations . . . of waste recovery (recycling, composting)

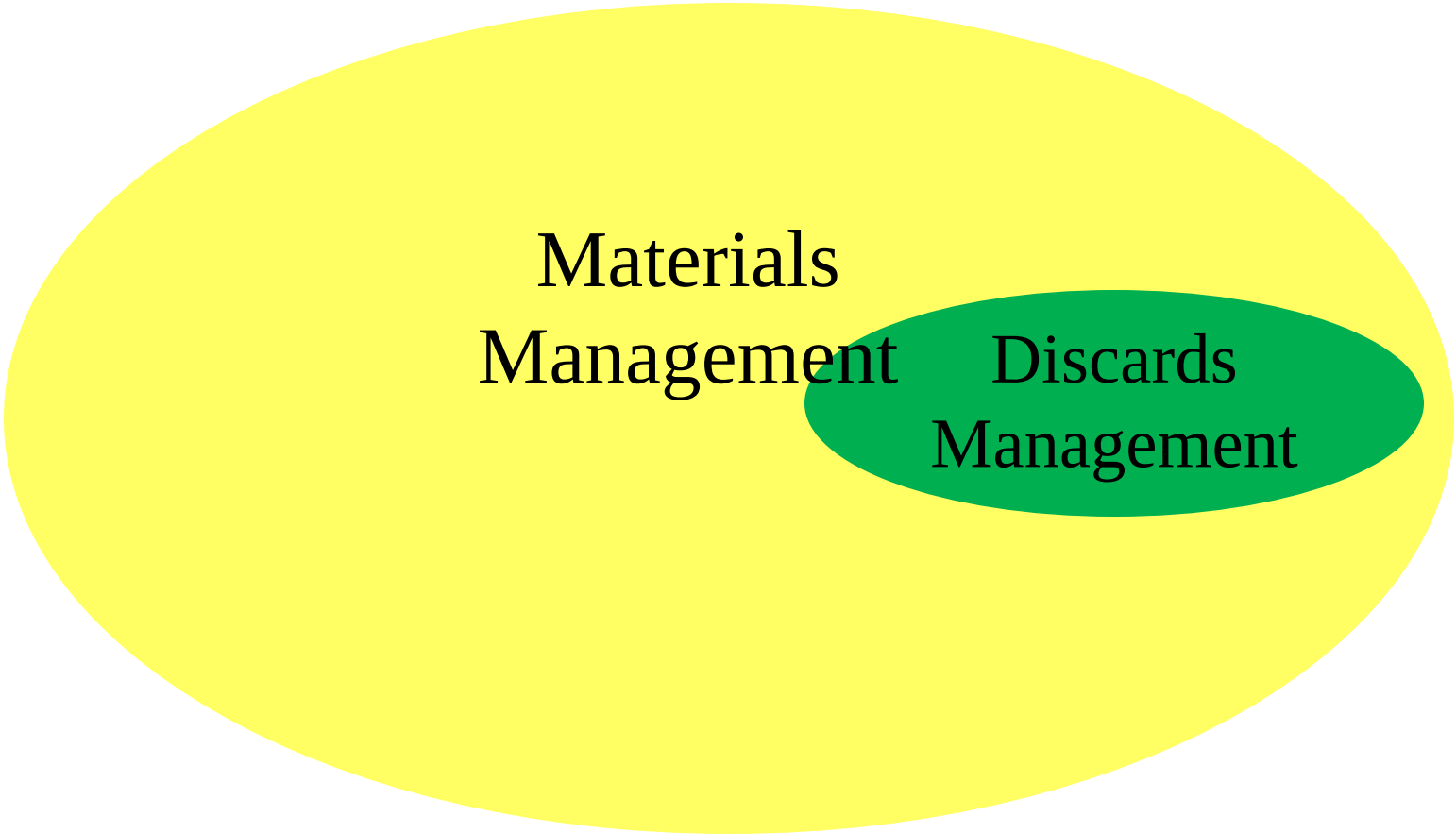


2006 U.S. GHG inventory with 32% recovery (MSW)



2006 U.S. GHG inventory with very high recovery rate (~95% MSW + >70% C&D)

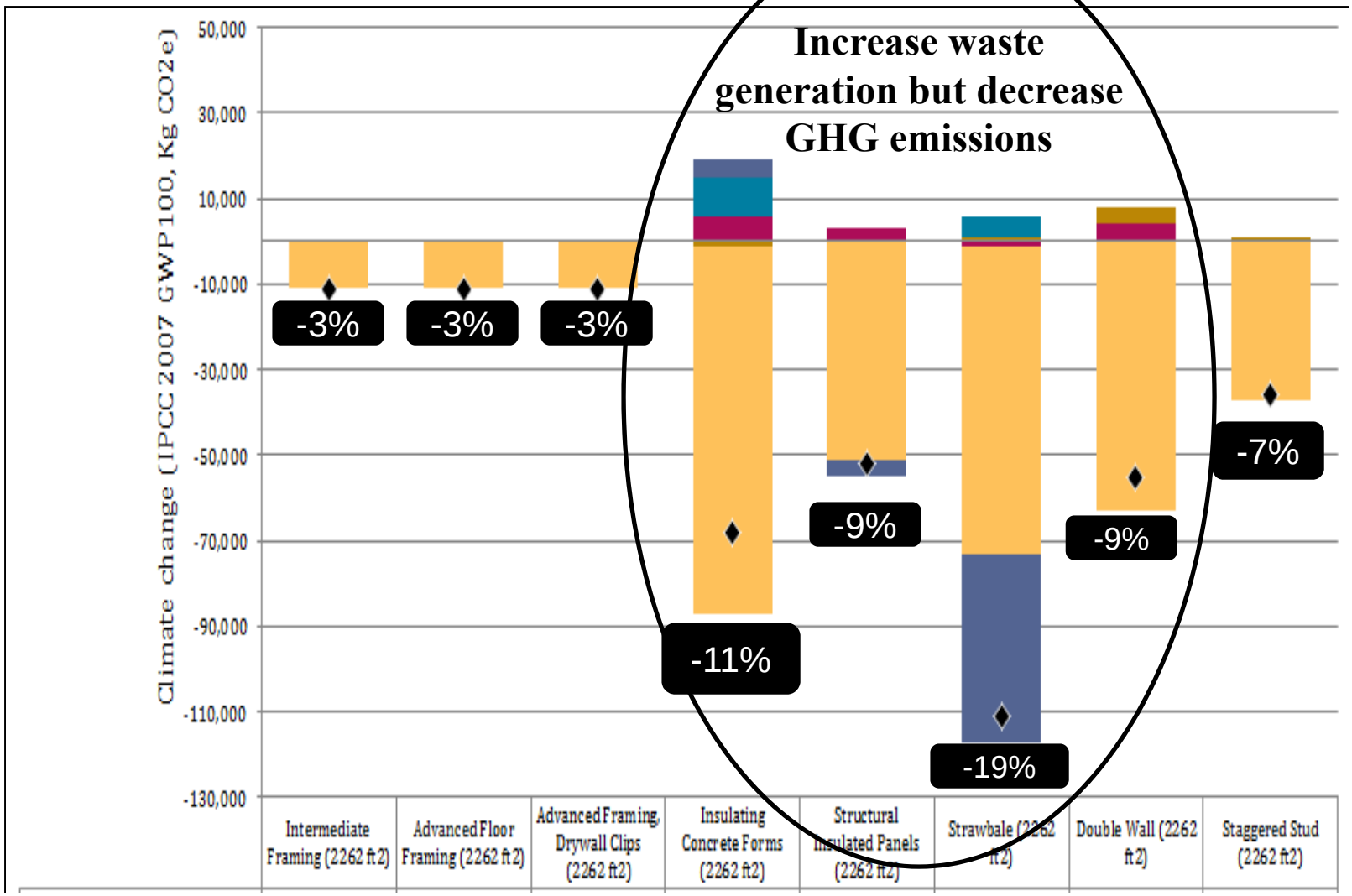
Discards Management is a Subset of Materials Management



The Importance of a Materials Management Perspective - Examples

- Recycling glass
  - Glass to aggregate and glass to containers are both viewed as “recycling” (disposal avoidance)
  - But the GHG benefits of glass to containers may be ~10 times higher
- Building practices and materials
  - Is recyclable/recoverable material always best?
  - Is using less materials (waste prevention) always best?

Lifecycle GHG Benefits of Wall Framing Options



The Importance of a Materials Management Perspective – More Examples

- Appliances
  - The waste hierarchy says: “reuse” is better than “recycling”
  - But replacing (and destroying) inefficient appliances (+ cars, windows, etc.) may be better than reuse
- Packaging
  - Does recyclable packaging necessarily have a lower carbon footprint than non-recyclable packaging? For example:
    - Readily recyclable steel or glass vs. harder-to-recycle aseptic containers
    - E-commerce order fulfillment: cardboard boxes vs. plastic shipping bags

DEQ's E-Commerce Life Cycle Assessment (LCA): Materials Evaluated

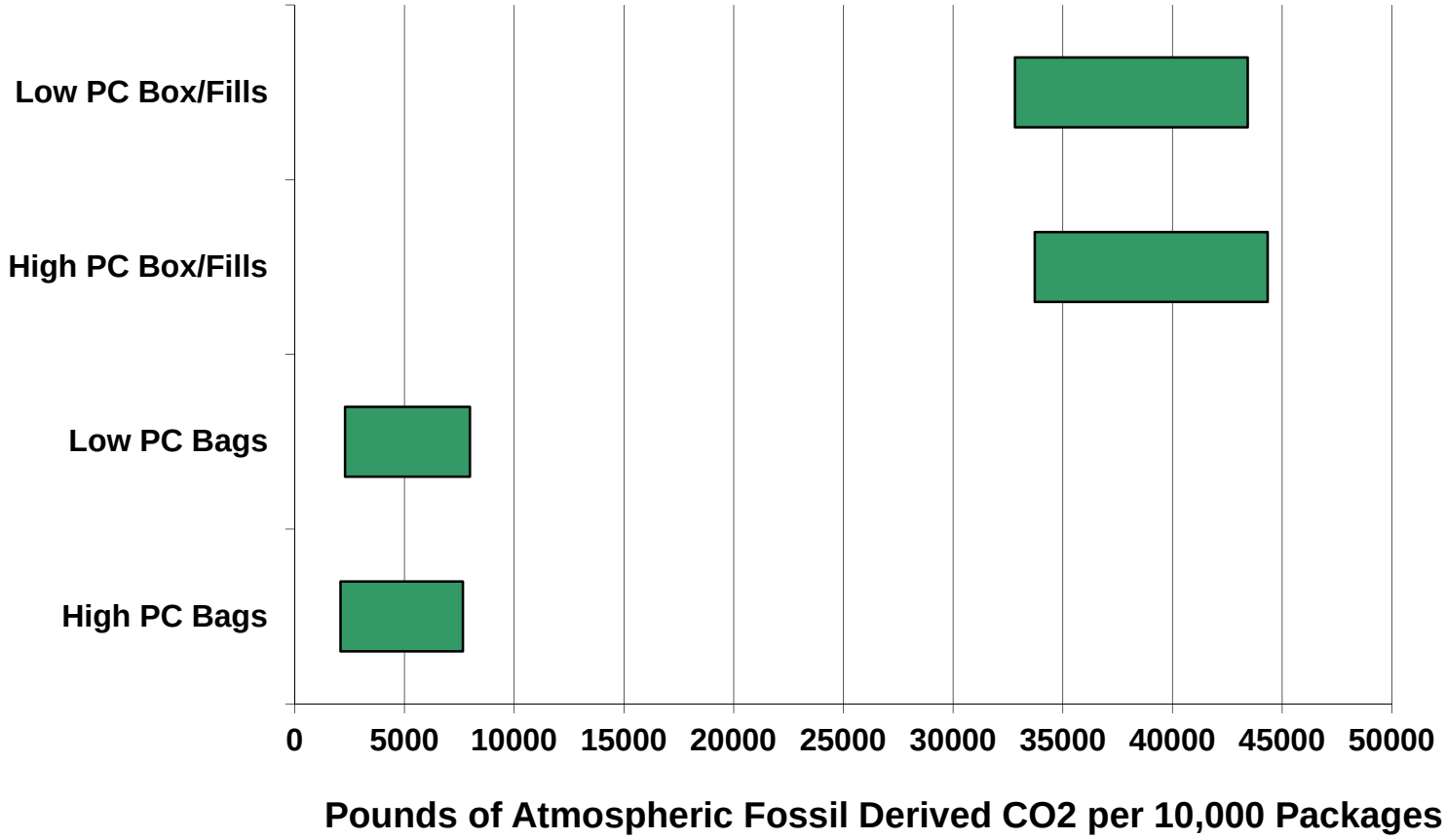
Corrugated box*

Void Fill (for boxes)
Polystyrene loose fill*
Corn starch loose fill
Molded paper loose fill
Inflated "air pillows"*
Newsprint dunnage*
Kraft dunnage*
Shredded office paper
Shredded boxes

Shipping Bags
Unpadded all-kraft mailer*
Unpadded all-poly mailer*
Kraft mailer with ONP padding*
Kraft mailer with poly bubble padding*
Poly mailer with poly bubble padding*

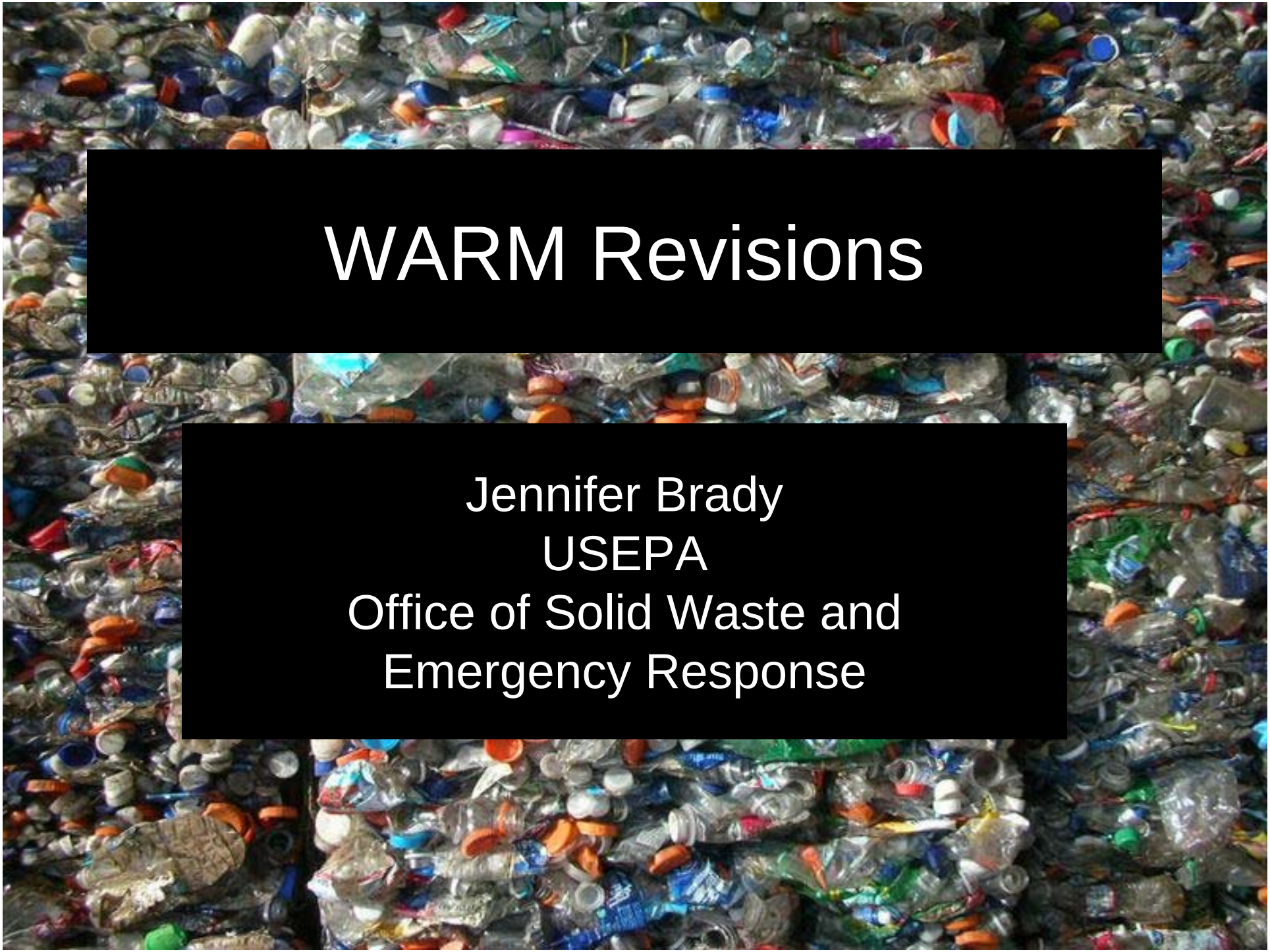
*Different levels of post-consumer content also evaluated.

E-Commerce Results: Fossil-Derived CO2 Emissions



"Upstream" materials management options

- Producer responsibility – redesign of products, cleaner (lower carbon) production
- Supply chain management (e.g., WalMart)
- Carbon footprinting, labeling
- Low-carbon purchasing
- "Sustainable consumption"
- Putting a price on carbon (e.g., carbon tax and/or cap-and-trade)
- Others



WARM Revisions

Jennifer Brady
USEPA
Office of Solid Waste and
Emergency Response

Background

- Calculations begin at a “waste generation” reference point
- Focus on GHGs emitted, carbon stored, or utility energy displaced at following stages:
  - Waste management (downstream)
  - Raw material acquisition (upstream)
  - Manufacturing (upstream)
  - Transportation of raw material and waste

Model Design

1. Describe the baseline generation and management for the MSW materials listed below.
   If the material is not generated in your community or you do not want to analyze it, leave it blank or enter 0. Make sure that the total quantity generated equals the total quantity managed.

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Generated
Aluminum Cans				NA	0.0
Steel Cans				NA	0.0
Copper Wire				NA	0.0
Glass				NA	0.0
HDPE				NA	0.0
LDPE				NA	0.0
PET				NA	0.0
Corrugated Containers				NA	0.0
Magazines/Third-class Mail				NA	0.0
Newspaper				NA	0.0
Office Paper				NA	0.0
Phonebooks				NA	0.0
Textbooks				NA	0.0
Dimensional Lumber				NA	0.0
Medium-density Fiberboard				NA	0.0
Food Scraps	NA				0.0
Yard Trimmings	NA				0.0
Grass	NA				0.0
Leaves	NA				0.0
Branches	NA				0.0
Mixed Paper (general)				NA	0.0
Mixed Paper (primarily residential)				NA	0.0
Mixed Paper (primarily from offices)				NA	0.0
Mixed Metals				NA	0.0
Mixed Plastics				NA	0.0
Mixed Recyclables				NA	0.0
Mixed Organics	NA				0.0
Mixed MSW	NA			NA	0.0
Carpet				NA	0.0
Personal Computers				NA	0.0
Clay Bricks	NA		NA	NA	0.0
Concrete[1]			NA	NA	0.0
Fly Ash[2]			NA	NA	0.0
Tires[3]				NA	0.0
Asphalt Concrete			NA	NA	0.0
Asphalt Shingles				NA	0.0
Drywall			NA	NA	0.0
Fiberglass Insulation	NA		NA	NA	0.0
Vinyl Flooring	NA			NA	0.0
Wood Flooring	NA			NA	0.0

2. Describe the alternative management scenario for the MSW materials generated in the baseline.
   Any decrease in generation should be entered in the Source Reduction column.
   Any increase in generation should be entered in the Source Reduction column as a negative value.
   (Make sure that the total quantity generated equals the total quantity managed.)

Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
				NA
				NA
				NA
				NA
				NA
				NA
				NA
				NA
				NA
				NA
				NA
				NA
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NA	NA			NA
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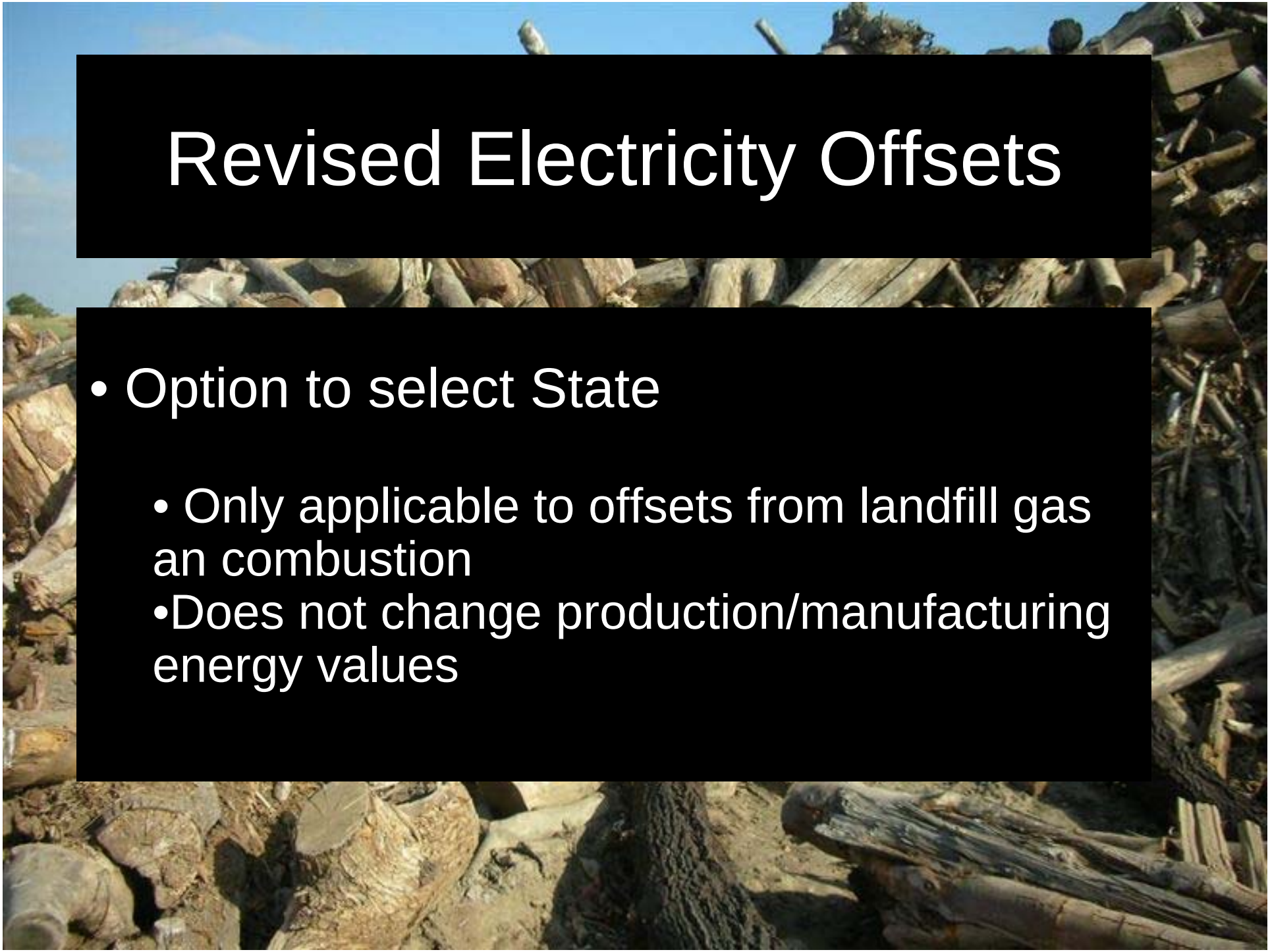
				NA
	NA		NA	NA
NA			NA	NA
NA			NA	NA
				NA
			NA	NA
				NA
			NA	NA
	NA		NA	NA
	NA			NA
	NA			NA

New Categories

C&D Materials

- Drywall
- Fiberglass insulation
- Asphalt concrete
- Asphalt shingles
- Vinyl flooring
- Wood flooring

Tires now open-loop



Revised Electricity Offsets

- Option to select State
  - Only applicable to offsets from landfill gas an combustion
  - Does not change production/manufacturing energy values

New Analysis

- Revised assumptions regarding capture of landfill gas based on system installation
- Incorporated decay rate for organic materials

New options

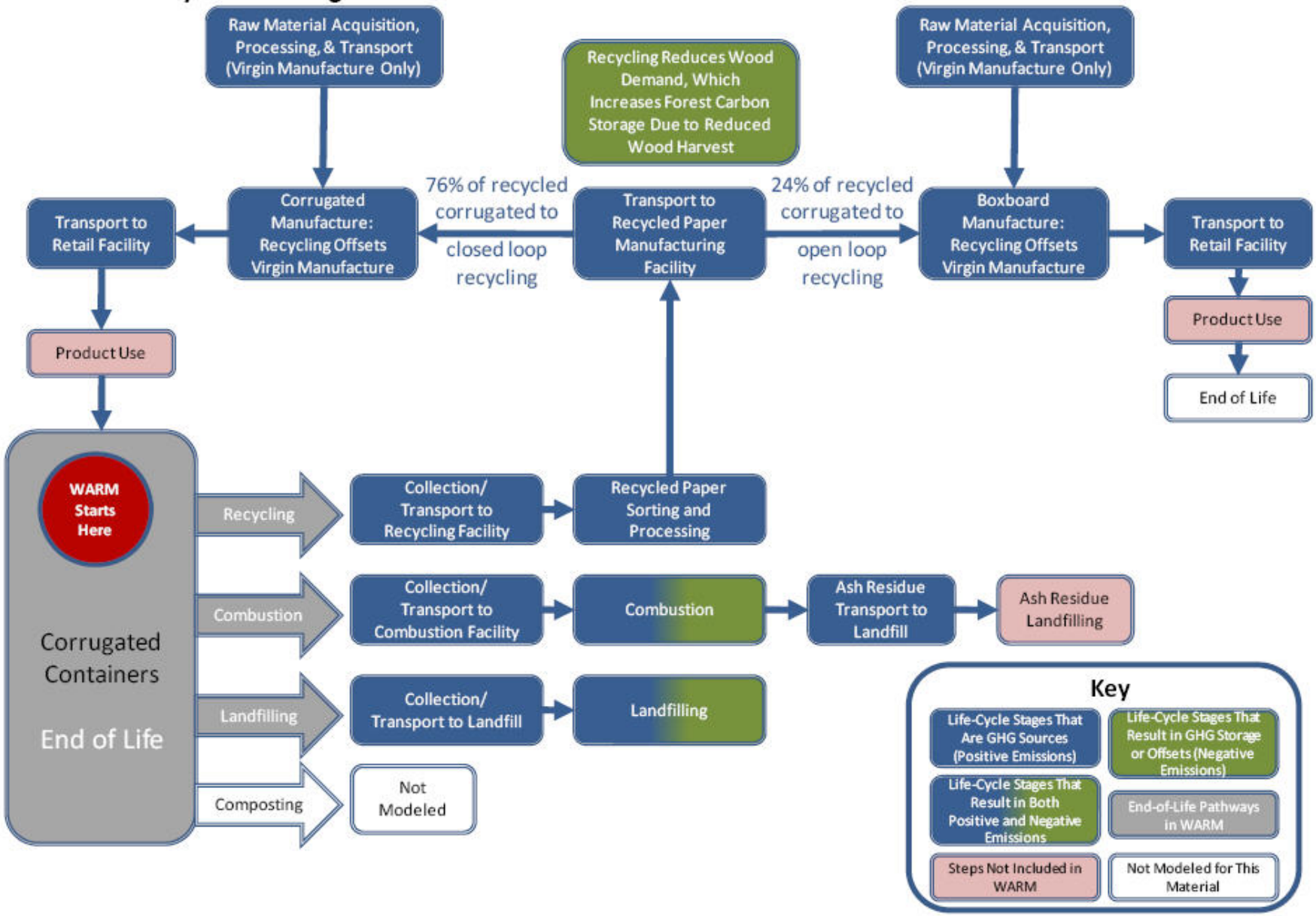
- 6a. Which of the following moisture conditions and associated bulk MSW decay rate (k) most accurately describes the average conditions at the landfill . . . [Select dry, average, wet, or bioreactor]
- 6b. For landfills that recover landfill gas, the landfill gas collection efficiency will vary throughout the life of the landfill . . . [Select typical, worst-case, or aggressive]
  - For example. Typical equates to:
    - 0 % for years 0-2
    - 50% for year 3
    - 75% for years 4-7
    - 95% for years 8-100

New Documentation

- Individual chapters for management practices, materials, and special topics (e.g. carbon storage)
- Tables with emissions data for each stage of life cycle included
- C&D materials have separate chapters

New Documentation

Exhibit 1: Life Cycle of Corrugated Containers in WARM



New Documentation

Exhibit 3: Composition of Mixed Paper Categories

Paper Grade	Mixed Paper (General)	Mixed Paper (Primarily Residential)	Mixed Paper (Primarily from Offices)
Corrugated Containers	48%	53%	5%
Magazines/Third-Class Mail	8%	10%	36%
Newspaper	24%	23%	21%
Office Paper	20%	14%	38%
Total	**100%**	**100%**	**100%**

Which format to use?

- Excel version
  - Additional options for energy grid and landfill conditions
- Web version
  - Same options as previous version

Contact Information

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Jennifer Brady

Email: brady.jennifer@epa.gov

EPA's Waste Reduction Model http://www.epa.gov/warm