Adapting to Climate Change for Natural Resources, Food & Fiber

3rd Annual BA-UMD Fall Symposium

Trends in Agriculture

January 23, 2014

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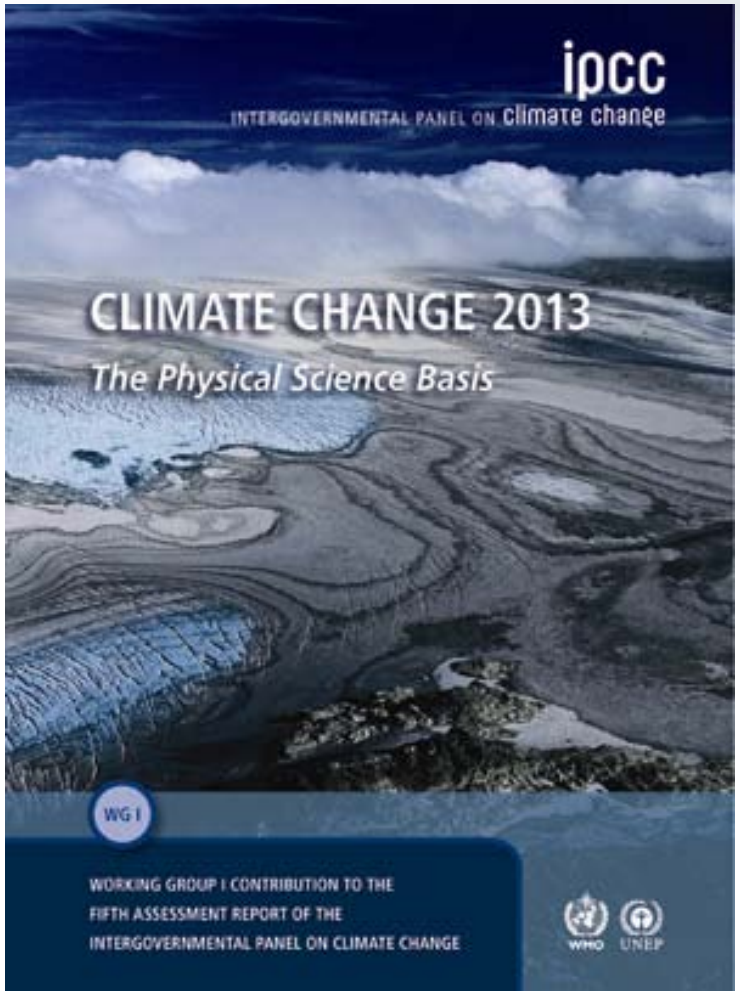
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Public Opinions on Global Warming

	Alarmed	Concerned	Cautious	Disengaged	Doubtful	Dismissive
	Highest Belief in Global Warming Most Concerned Most Motivated					Lowest Belief in Global Warming Least Concerned Least Motivated
US	16%	26%	25%	5%	15%	13%
MD	23%	39%	19%	5%	10%	5%
ES	21%	35%	24%	4%	11%	6%

George Mason University
www.climate changecommunication.org

Intergovernmental Panel on Climate Change 5th Assessment



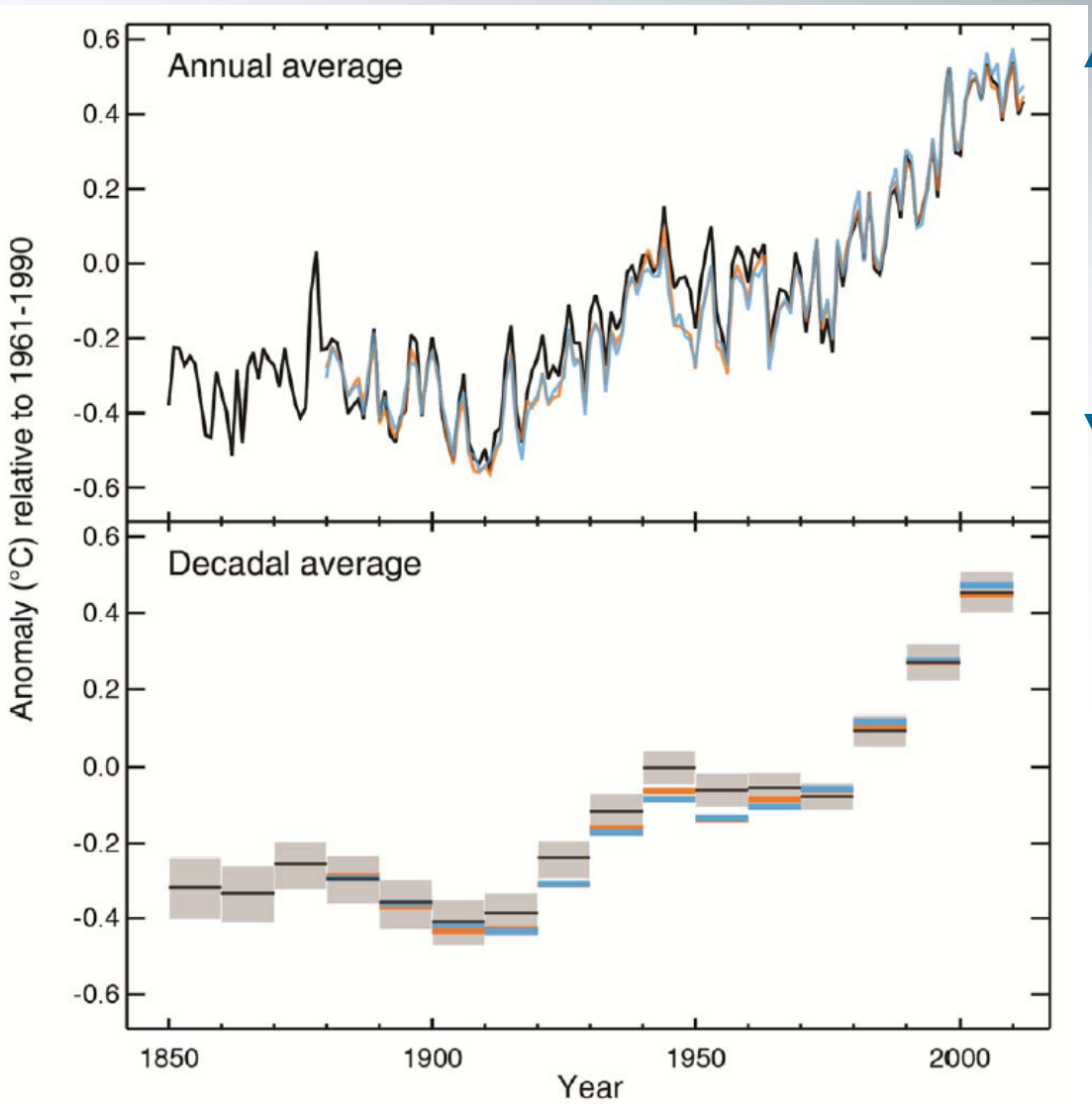
It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century.

Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

www.ipcc.ch

How Much Has It Warmed?

Global average land and ocean temperature



about 0.9 C or 1.6 F

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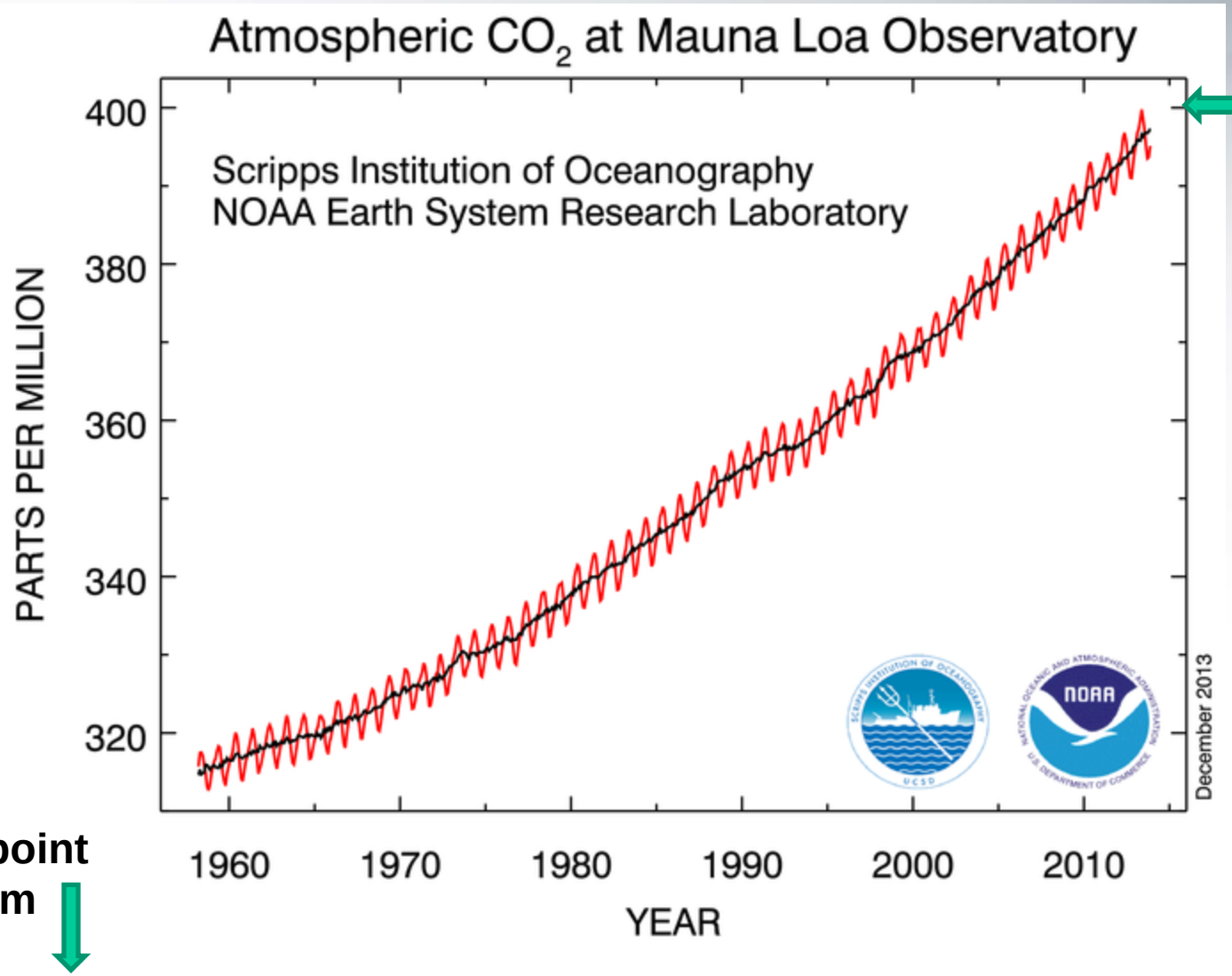
Increase in Atmospheric CO_2

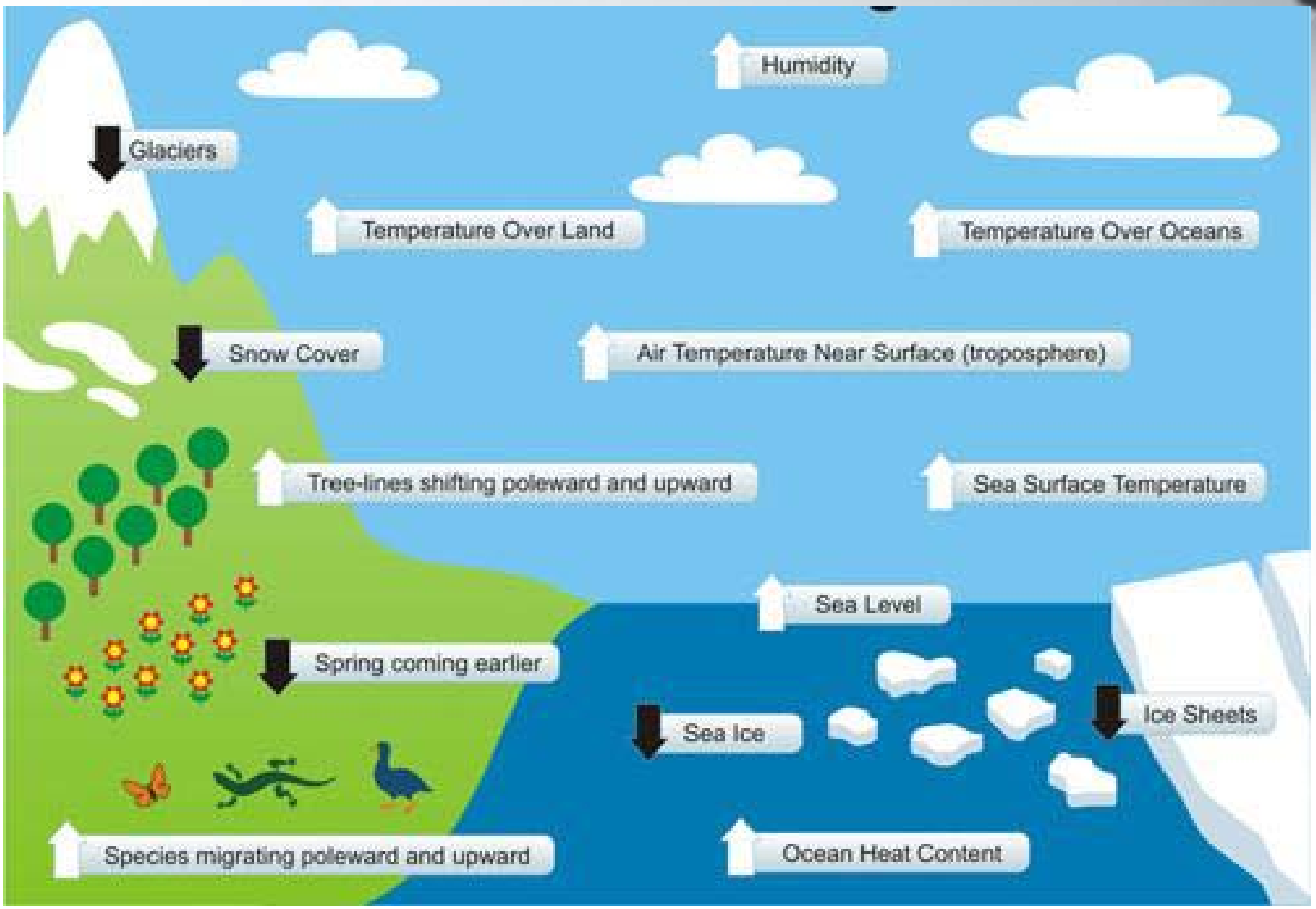


Crossed 400 ppm this May

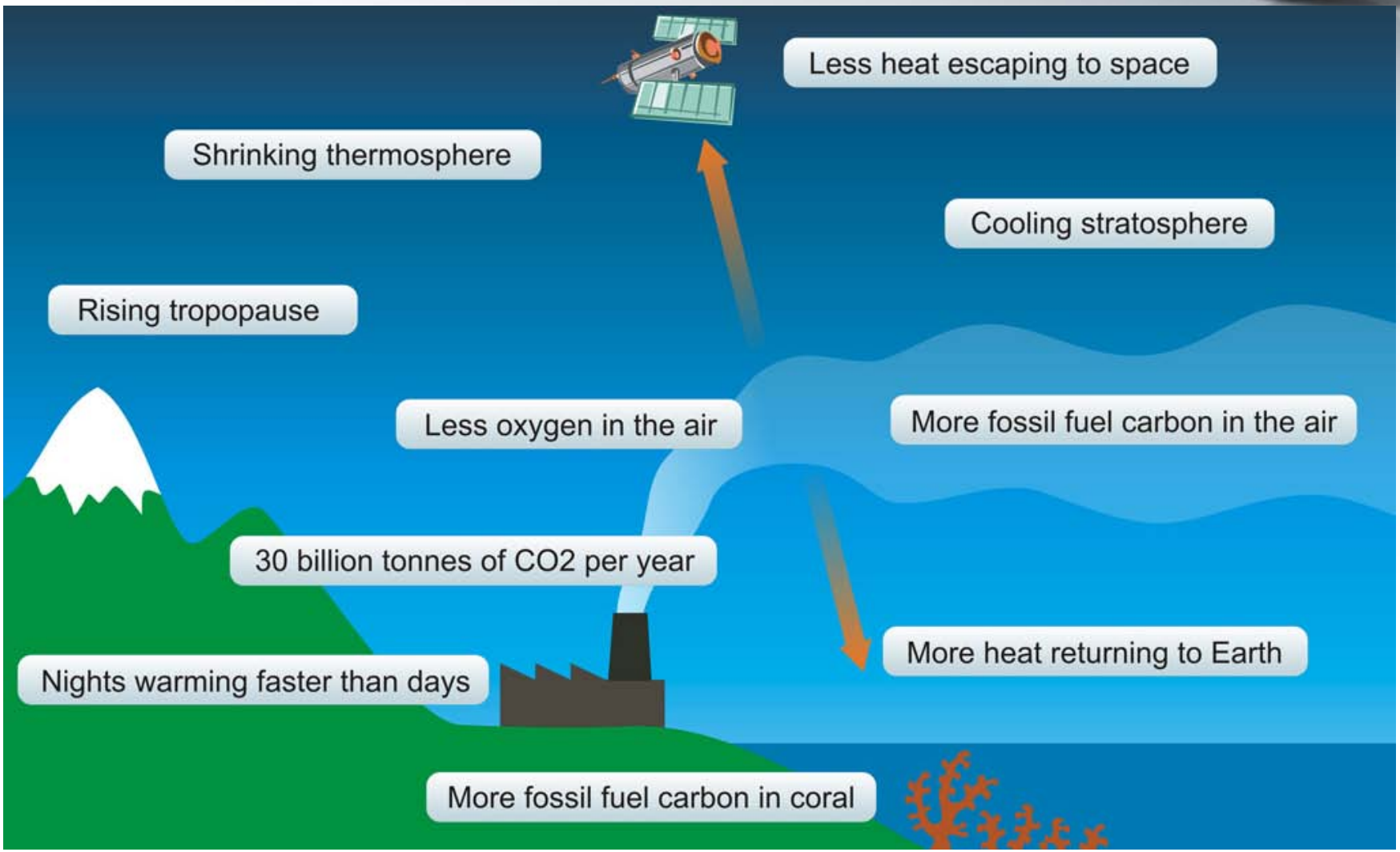
Today 398.8 ppm

Starting point 280 ppm

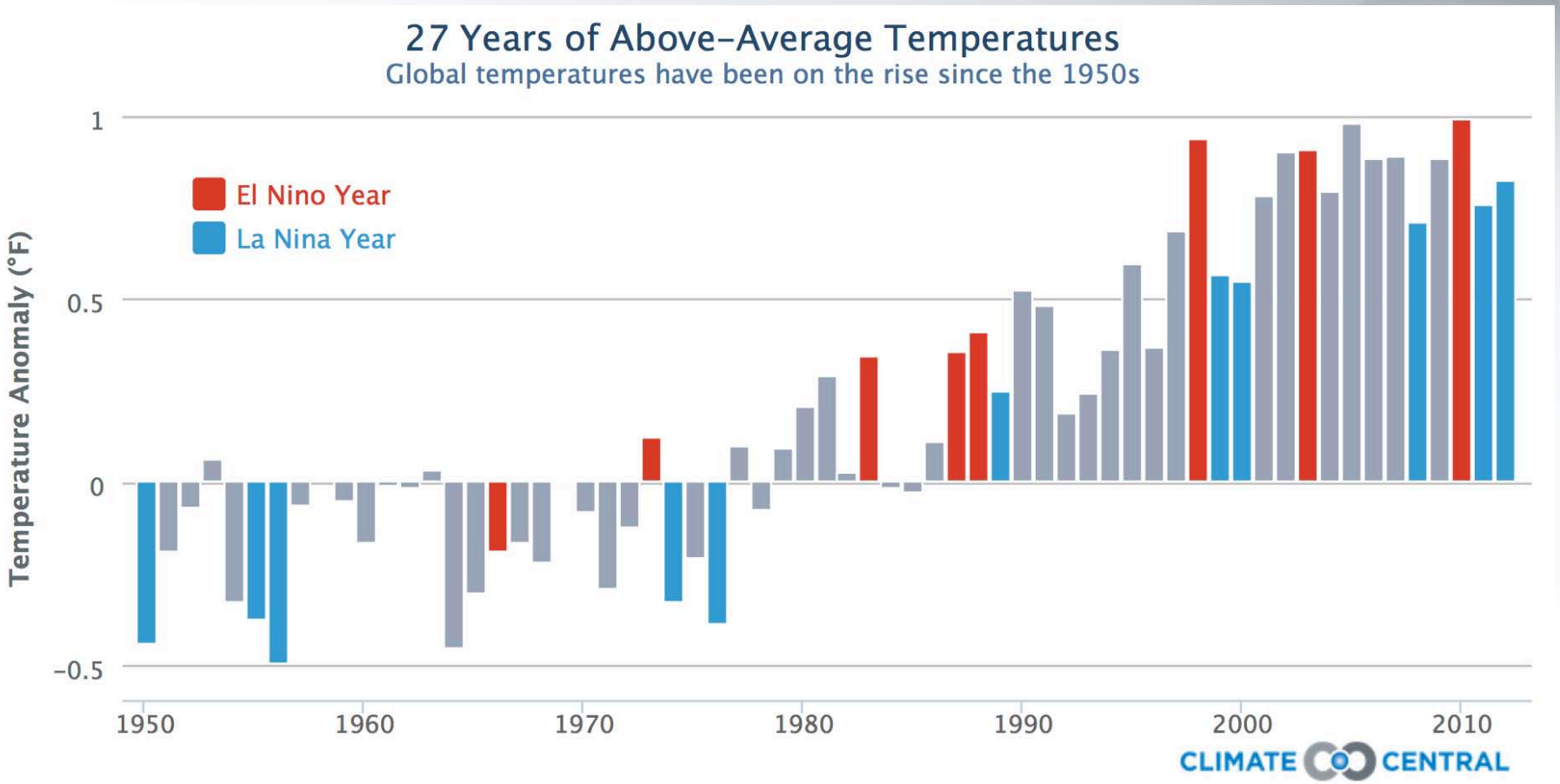
Indicators of a Warming World



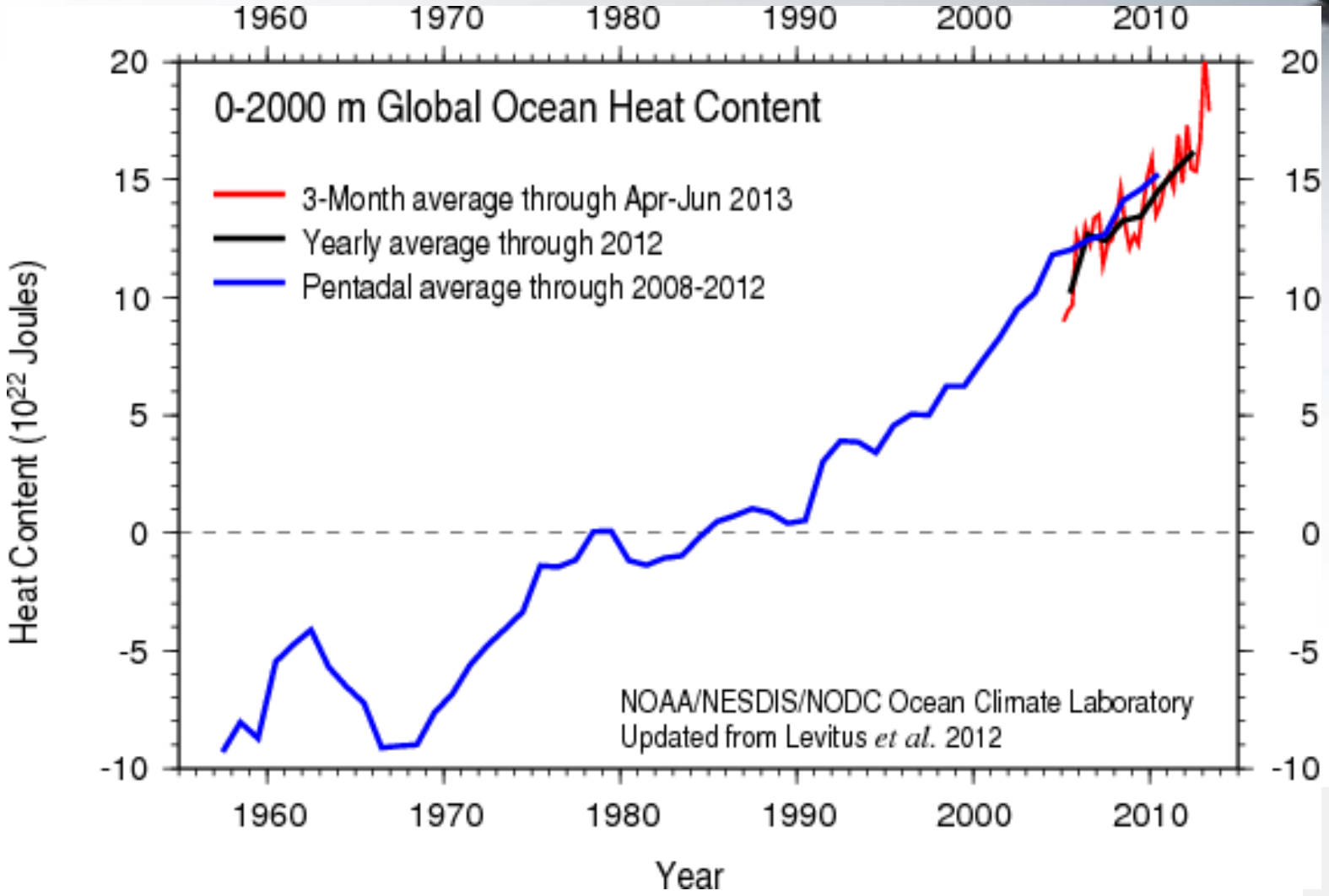
Fingerprints Confirming Human Cause



Has Global Warming Paused?



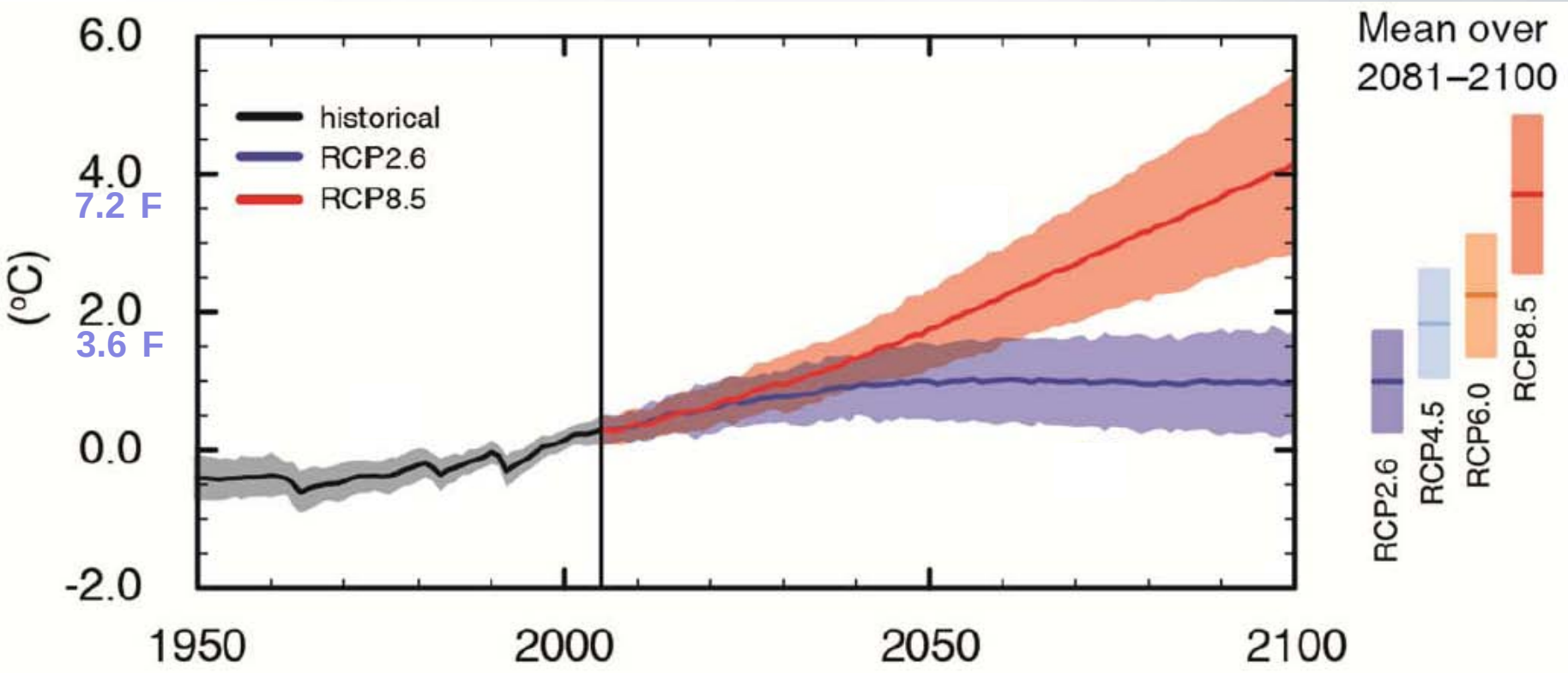
Heating Has Continued in Ocean



How Much Will it Warm?

It mainly depends on how much greenhouse gases we emit.

Global average surface temperature



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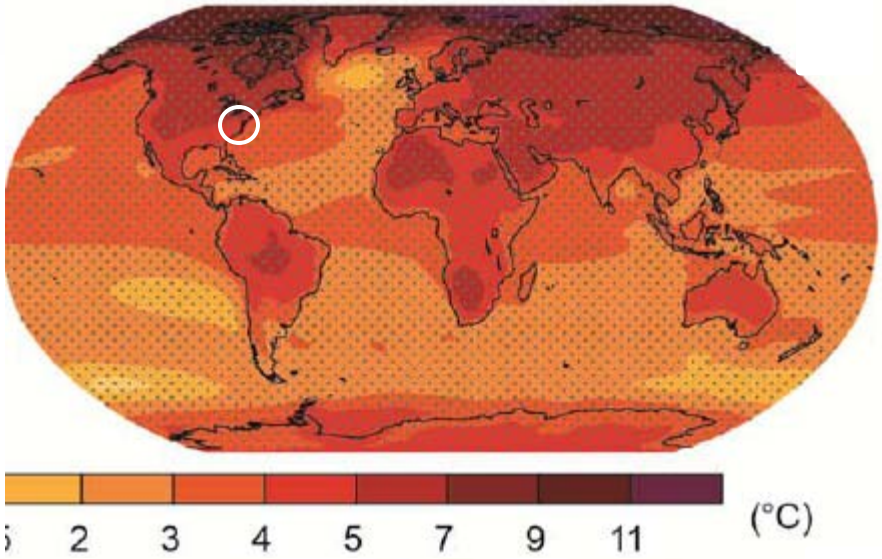
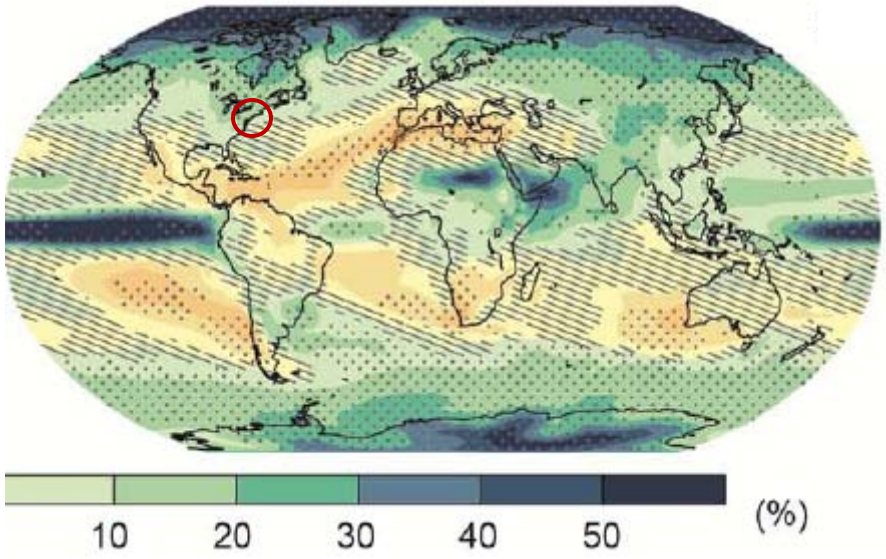
RCP8.5 = 'business as usual' continued growth in emissions

RCP2.6 = rapid reductions in GHG emissions to 0 by 2070

Changes Will Vary Greatly





RCP8.5 Scenario for 2081-2100

Annual mean surface temperature
[Chesapeake region warms more than global average]

Average percent change in annual mean precipitation
[~10% increase in Chesapeake region, mainly winter-spring]

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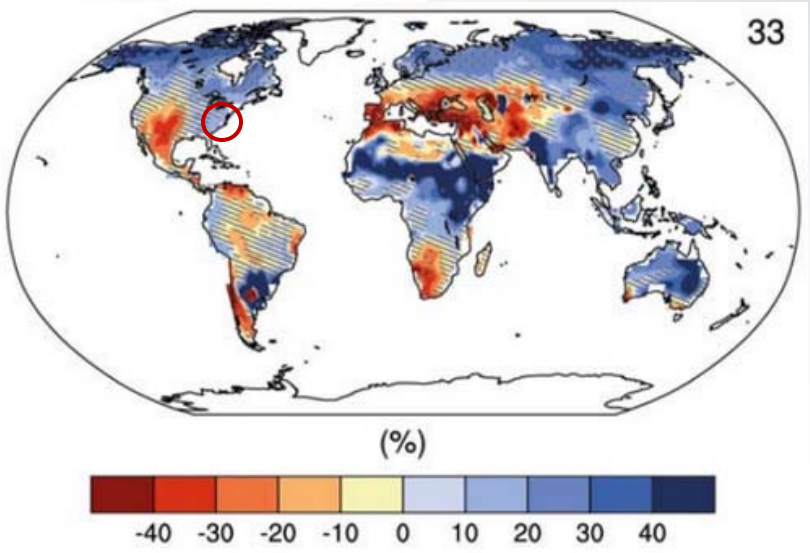
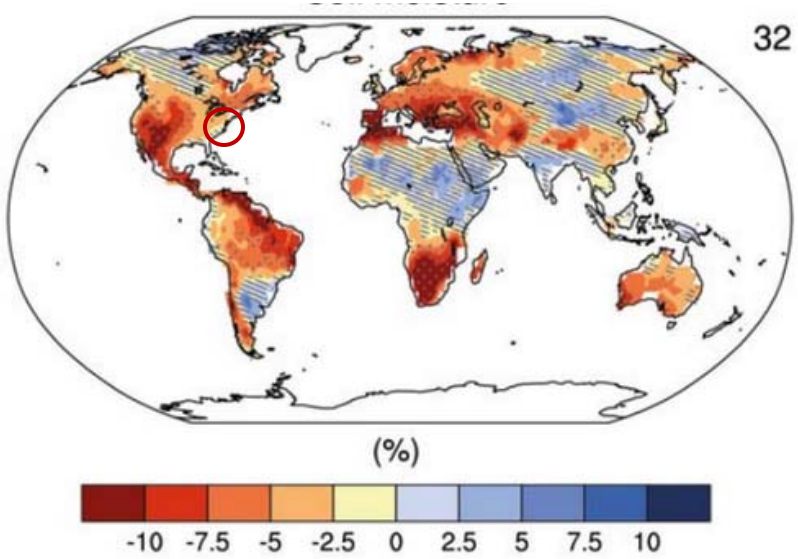
Changes Will Vary Greatly





RCP8.5 Scenario for 2081-2100

Average percent change in runoff
[some increase in runoff to Chesapeake Bay, but models don't agree]

Average percent change in soil moisture
[drier conditions in growing season in Chesapeake basin]

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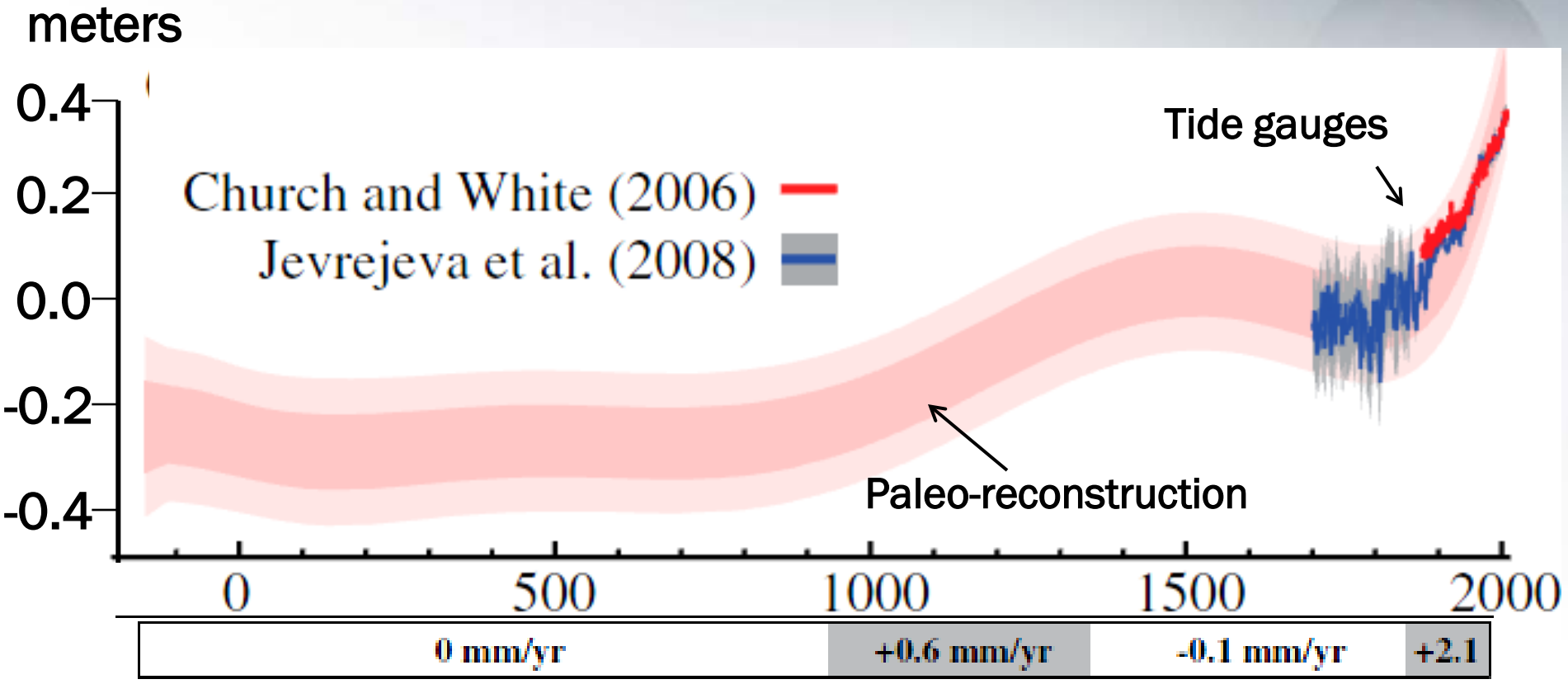
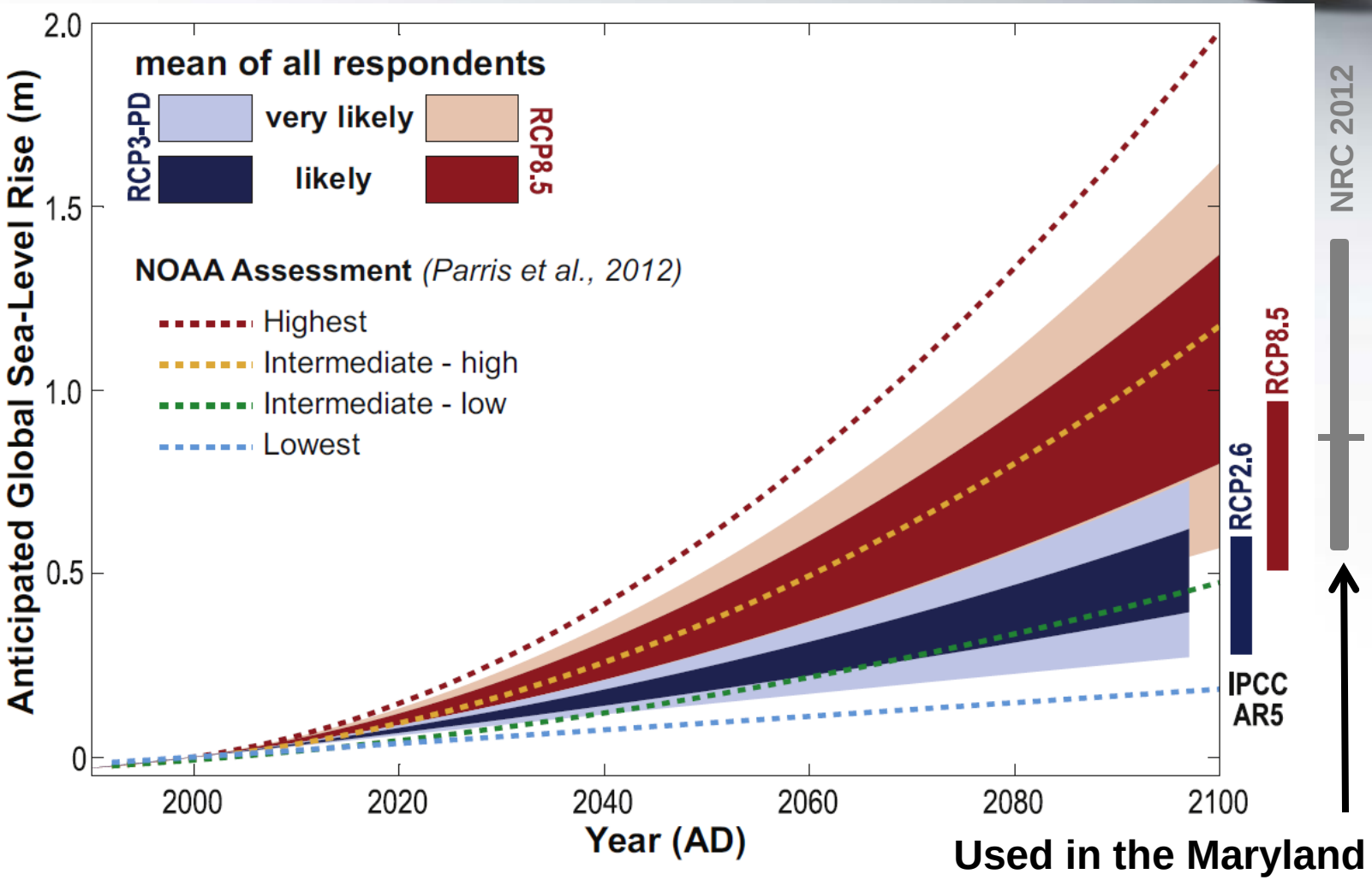
Sea Level Had Been Stable 2000 Years



Kemp et al. 2011. *Proc. National Acad. Sci*

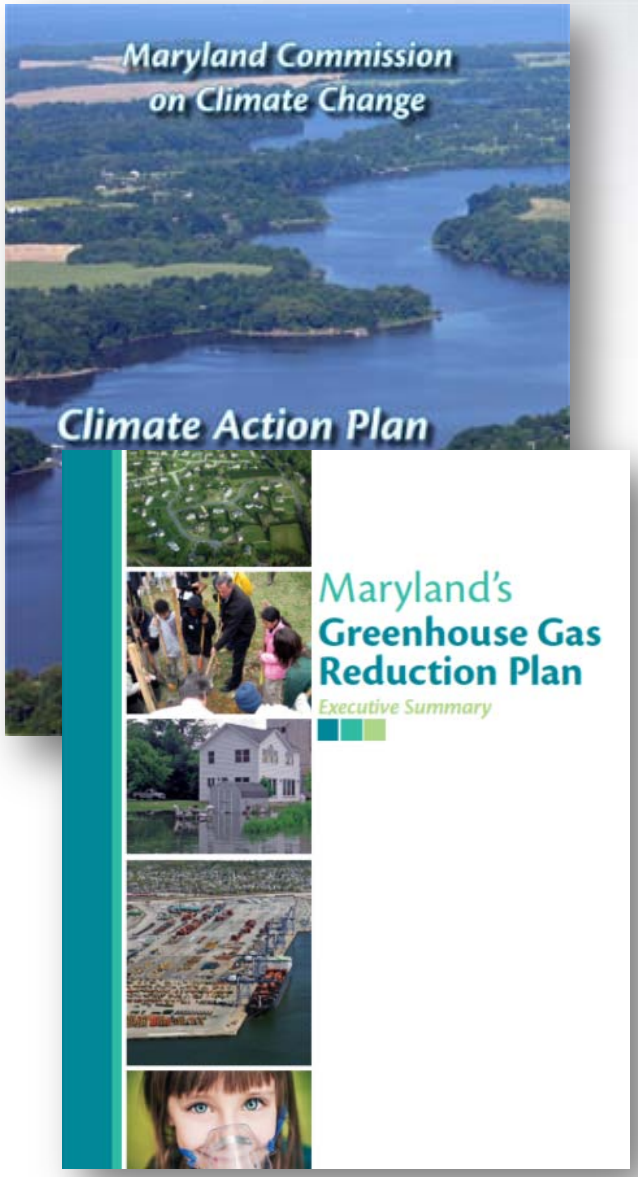
How Much Will the Seas Rise?

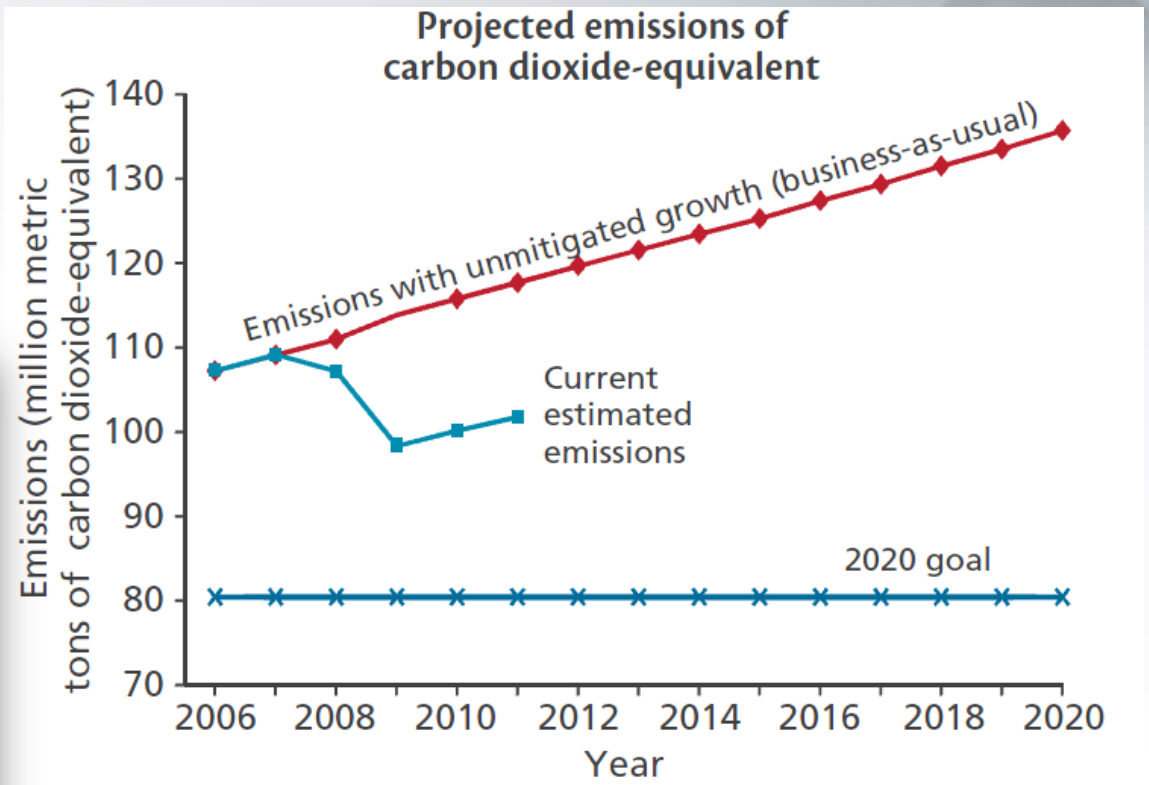


Used in the Maryland sea-level rise update

Horton et al. 2013 *Quaternary Science Reviews* 84:1

Climate Action Plan





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Climate Change Assessments

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Reaching the Public

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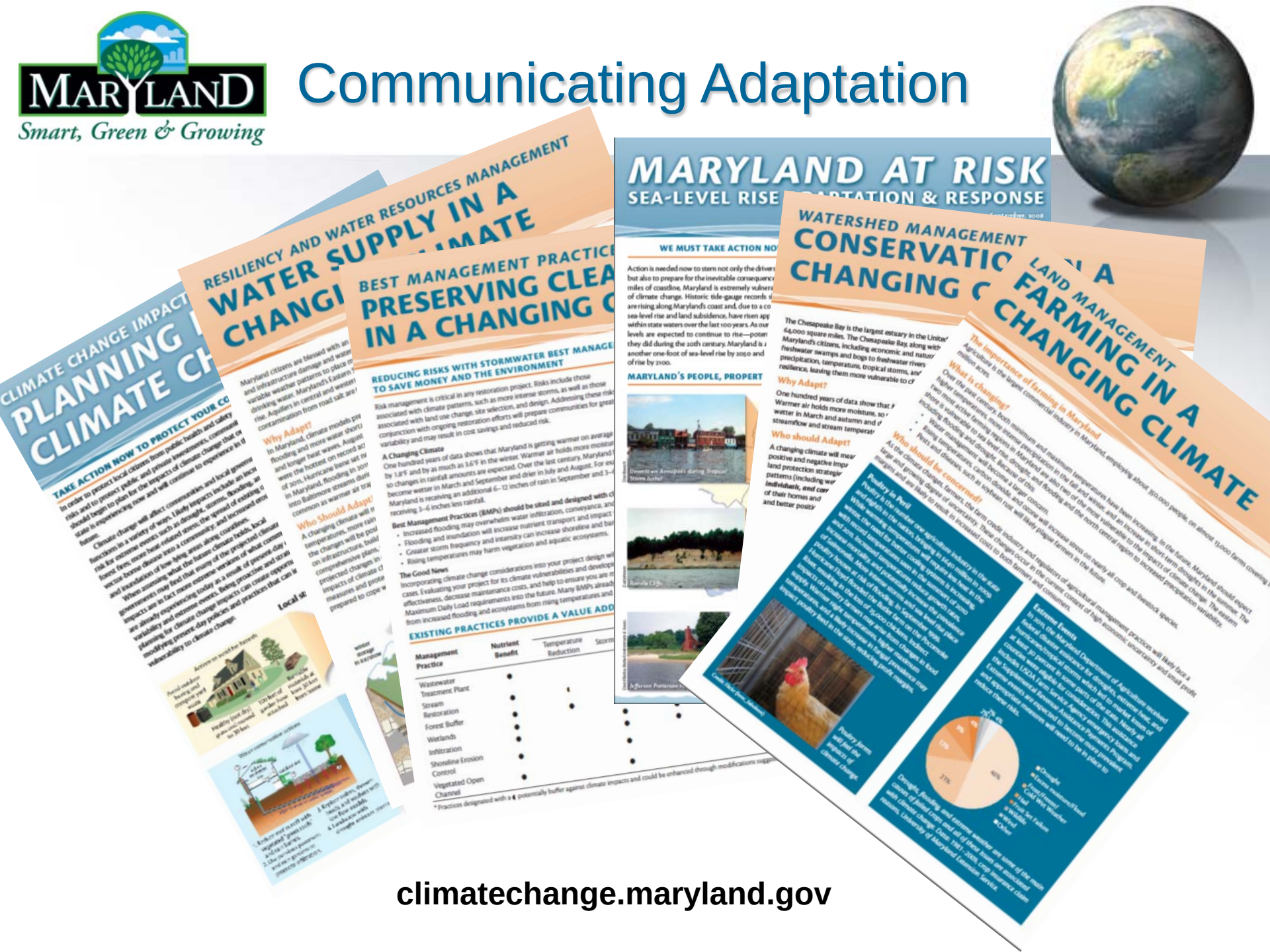
Communicating Adaptation



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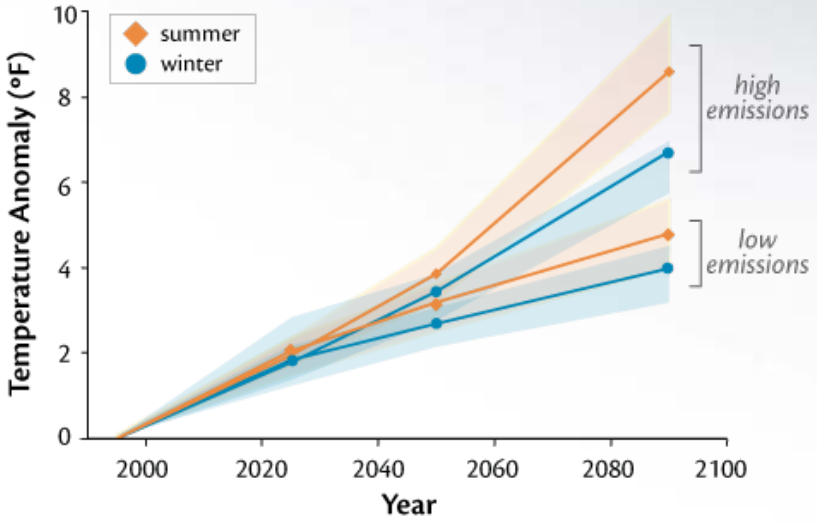
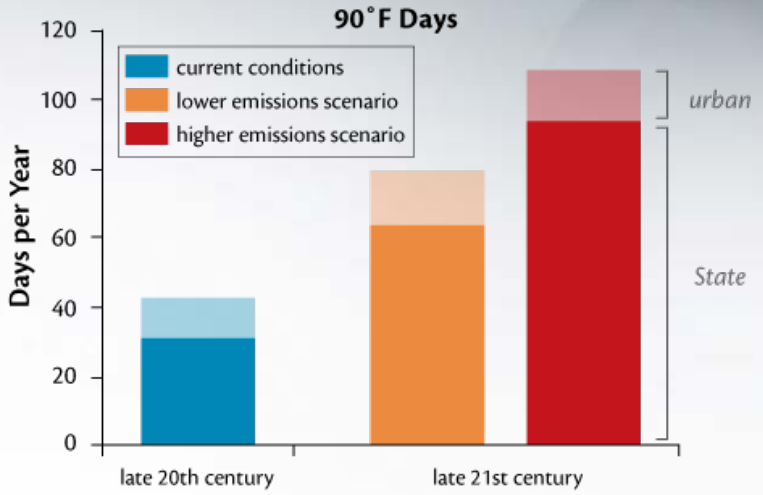
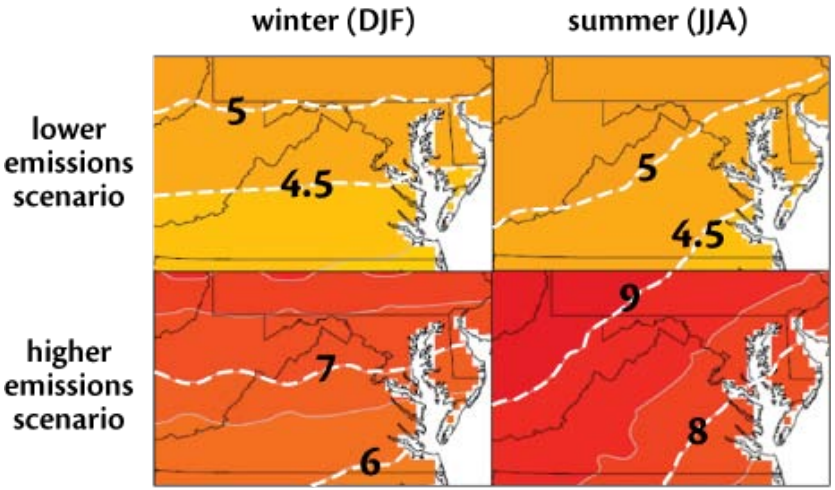
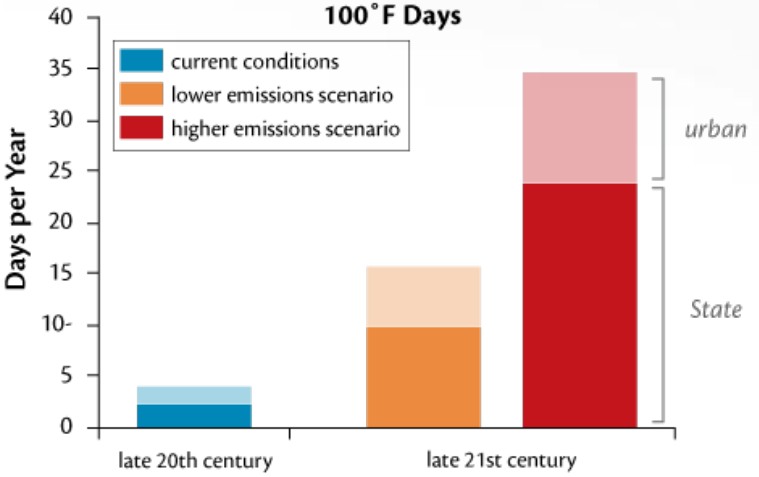
Milder Winters, Hotter Summers



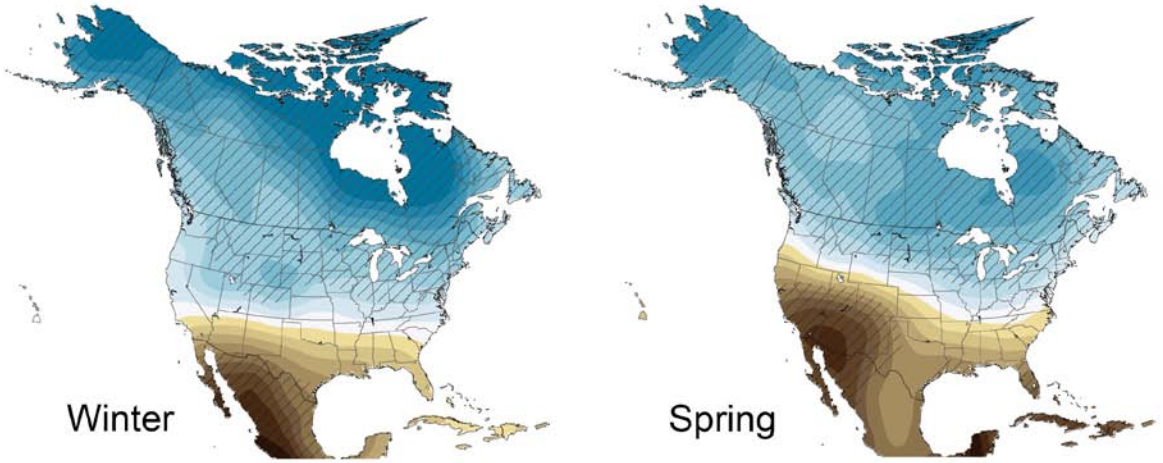




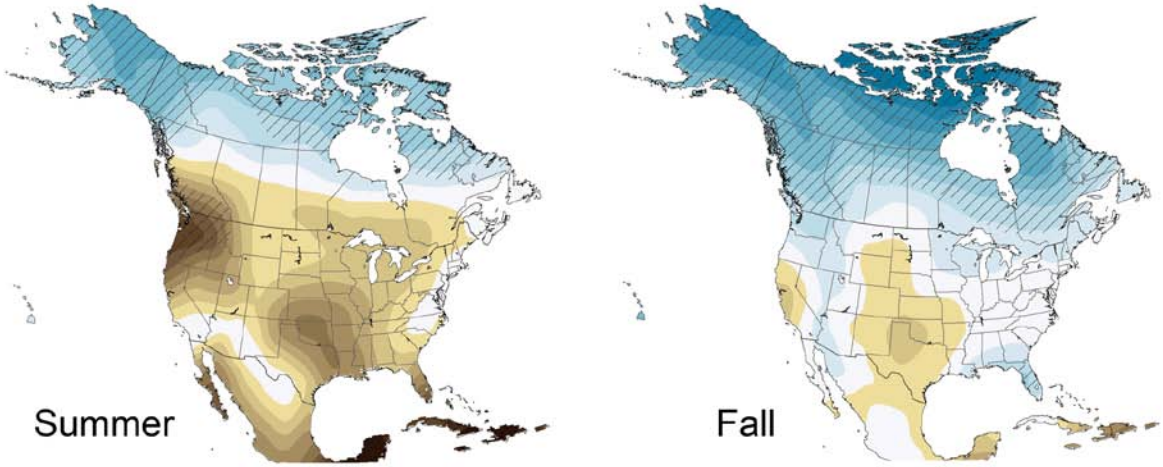


www.umces.edu/applying-science/global-warming-free-state-highlights

Projected Changes in Precipitation



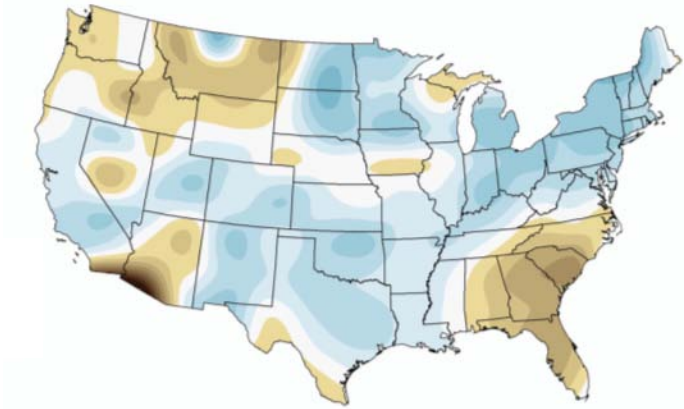
by 2080-90s



Percent Change

<-40 -35 -30 -25 -20 -15 -10 -5 0 5 10 15 20 25 30 35 >40

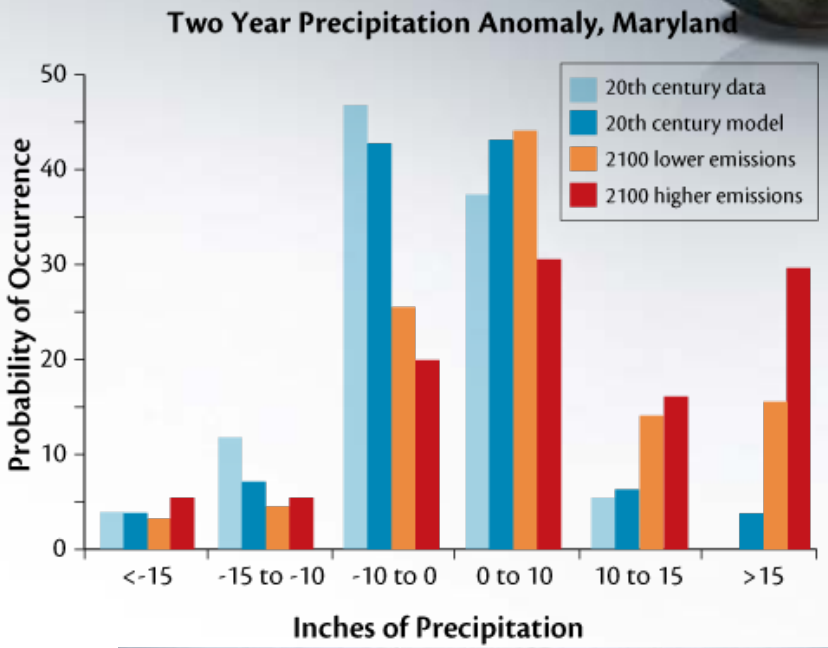
Observed annual change 1950-2008



www.globalchange.gov/

Consequences for Water Resources

- Somewhat more precipitation overall but mostly in winter & spring
- Summer droughts and downpours more frequent
- Soil moisture limiting agriculture; increased irrigation demand
- Baltimore supplies safe, Potomac River uncertain
- Will not alleviate overdrawing of ground water



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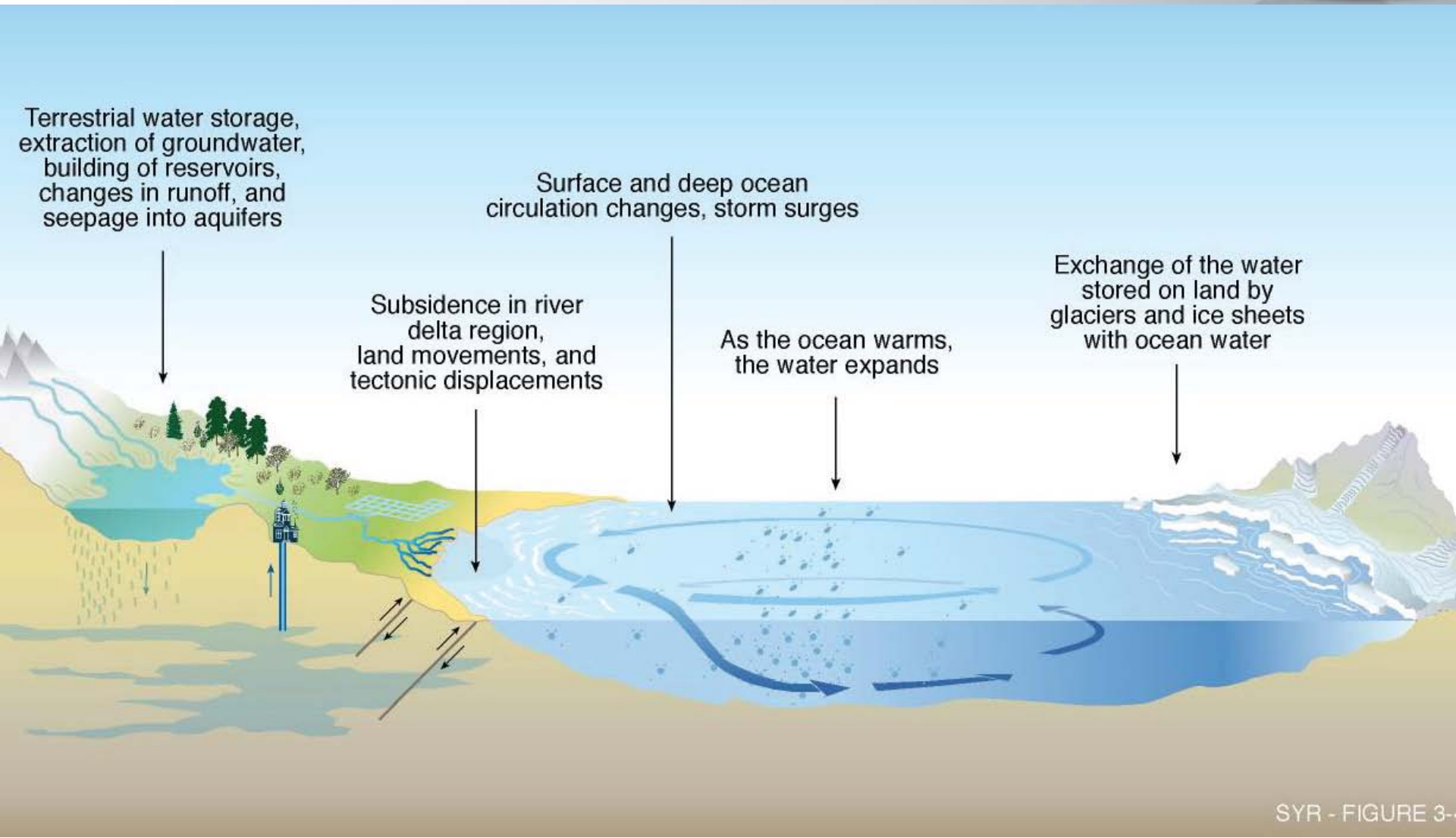
Factors Influencing Sea-Level



SYR - FIGURE 3-

How Much Will Sea Level Rise in the Maryland?

Maryland Relative Sea-level Rise	Thermal (m)	Glaciers (m)	Greenland (m)	Antarctica (m)	Dynamic (m)	VLM (m)	Relative SLR meters	Relative SLR feet
2050 best	0.10	0.05	0.03	0.09	0.09	0.075	0.4	1.4
2050 low	0.04	0.05	0.02	0.04	0.07	0.065	0.3	0.9
2050 high	0.19	0.06	0.05	0.16	0.10	0.085	0.7	2.1
2100 best	0.24	0.13	0.10	0.30	0.17	0.15	1.1	3.7
2100 low	0.10	0.12	0.08	0.10	0.13	0.13	0.7	2.1
2100 high	0.46	0.17	0.17	0.58	0.19	0.17	1.7	5.7
Land ice change fingerprint scale factors		0.9	0.5	1.25				

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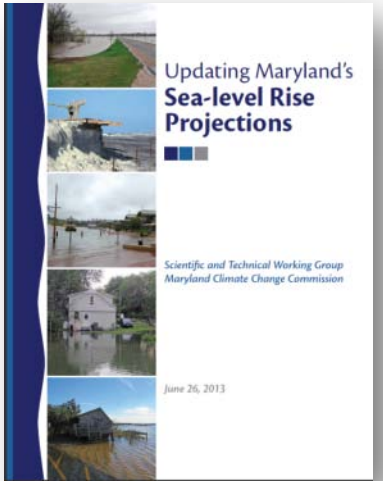
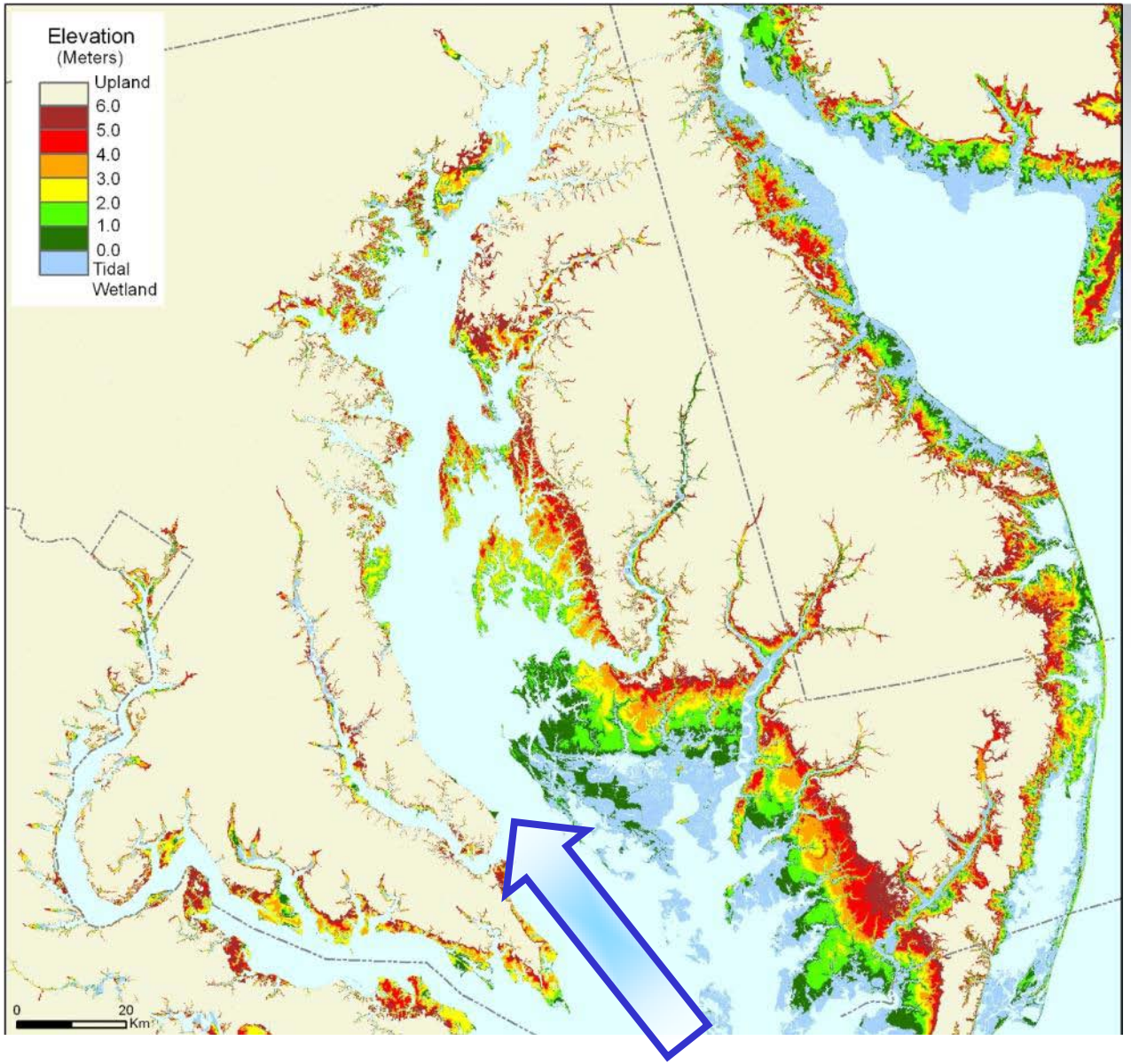


Consequences of Sea-Level Rise



Light blue: salt marshes

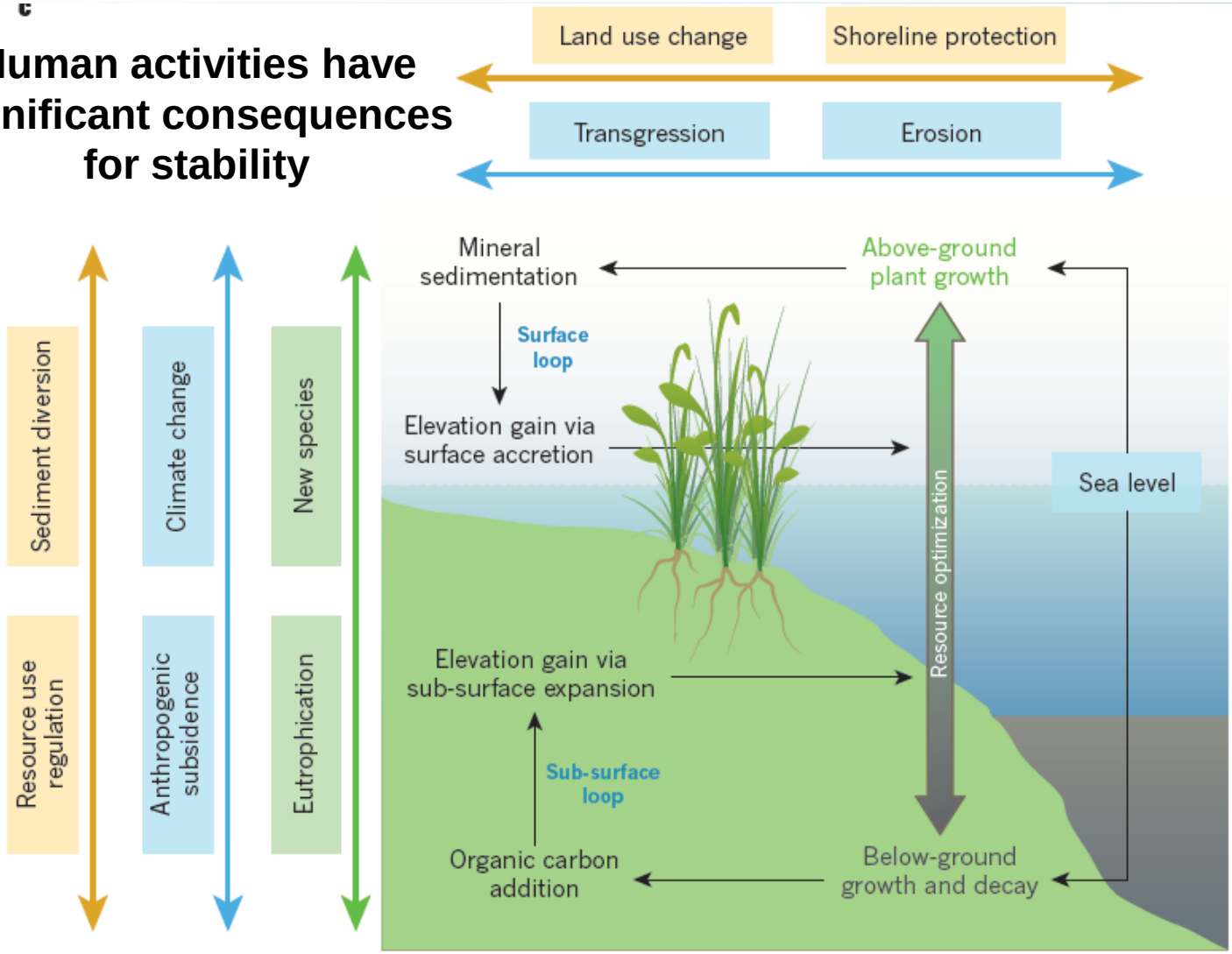
Greens: < 2 m, susceptible to innundation

Orange-yellow: 2-4 m, susceptible to storm surge

Greater Bay volume, ocean influence

Tidal Wetlands and Sea-Level Rise

Human activities have significant consequences for stability



Kirwan & Megonigal *2013. Nature* 404:53

National Assessment Key Messages

Agriculture

1. Climate disruptions increasingly negative by mid-century.
2. Declines in crop & livestock productivity due to weeds, diseases, insects & other stresses.
3. Degradation of soil & water assets by increasing extremes in precipitation challenges rain-fed and irrigated agriculture w/o innovative conservation.
4. Rising incidence of weather extremes increasingly have negative effects on productivity
5. Increase innovation needed to ensure pace of adaptation.
6. Consequences for food security in US and globally.

From public review draft, subject to change. www.globalchange.gov

National Assessment Key Messages

Forestry

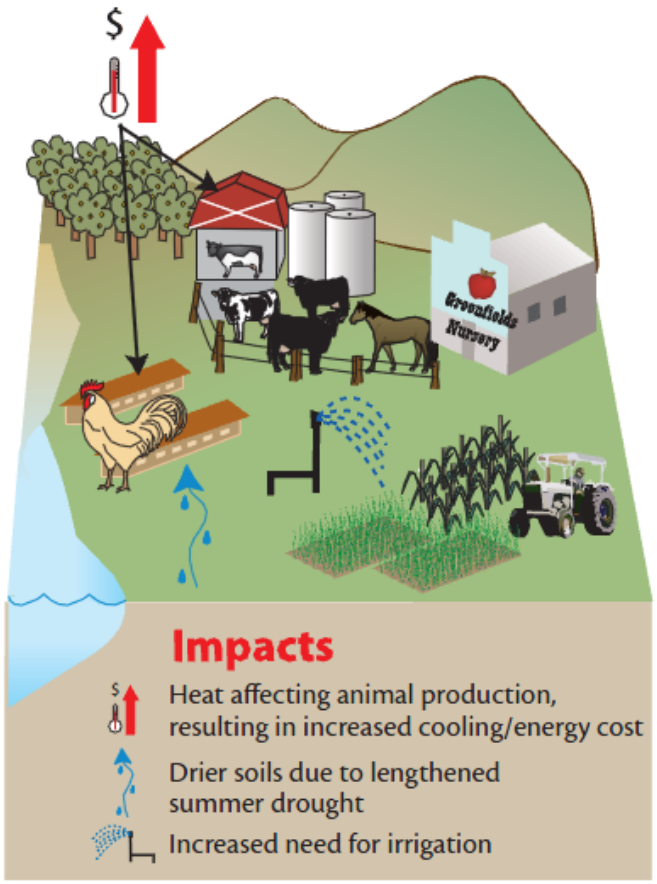
1. Climate change increasing vulnerability through fire, insect infestations, drought & disease outbreaks.
2. US forests absorb 13% of CO2 emitted in US, but reductions projected.
3. Bioenergy is emerging new market, could finance salvage & restoration.
4. Changes in ownership, globalization, bioenergy markets and US climate change policy will influence forest management.

From public review draft, subject to change. www.globalchange.gov

Limiting Climate Change & Agriculture

- Reduce GHG emissions related to production & transportation.
- Waste reduction.
- Generate renewable energy.
- Carbon sequestration.
- Food security.

Impacts & Adaptation for MD Agriculture



Product (ranked by 2007 market value, USDA Census)	Climate impact	Adaptation strategy
Poultry	Increased cooling costs; decreased production; changing disease presence	Improve energy efficiency of housing; bioenergy use; improve ability to monitor disease and quarantine
Grains, oilseeds, dry beans, peas	Water stress: increased irrigation use; winter flooding; changes in crop yield quantity and quality	Diversify cultivar and crop types; improve water management systems; improve pest forecasting
Nursery, greenhouse, floriculture, sod	Increased cooling costs; water stress	Establish emergency response systems; improve energy efficency of housing
Milk and dairy	Decreased milk productivity; changing disease presence; low-quality pasture during drought	Increase shade and cooling; improve ability to monitor disease and quarantine; manage pastures for drought
Cattle and calves	Changing disease presence; heat stress; low-quality pasture during drought	Increase shade and cooling; improve ability to monitor disease and quarantine; manage pastures for drought; farm heat-toleant breeds
Vegetables, melons, potatoes, other crops, hay	Water stress: increased irrigation use; winter flooding; changes in crop yield quantity and quality	Diversify cultivar and crop types; improve water management systems; improve pest forecasting
Horses, ponies, mules, burros, donkeys	Heat stress; low-quality pasture during drought	Increase shade and cooling; manage pastures for drought education about heat stress
Fruit trees, nuts, berries	Water stress: increased irrigation use; increased pest damage	Diversify cultivar and crop types; improve water management systems; improve pest forecasting

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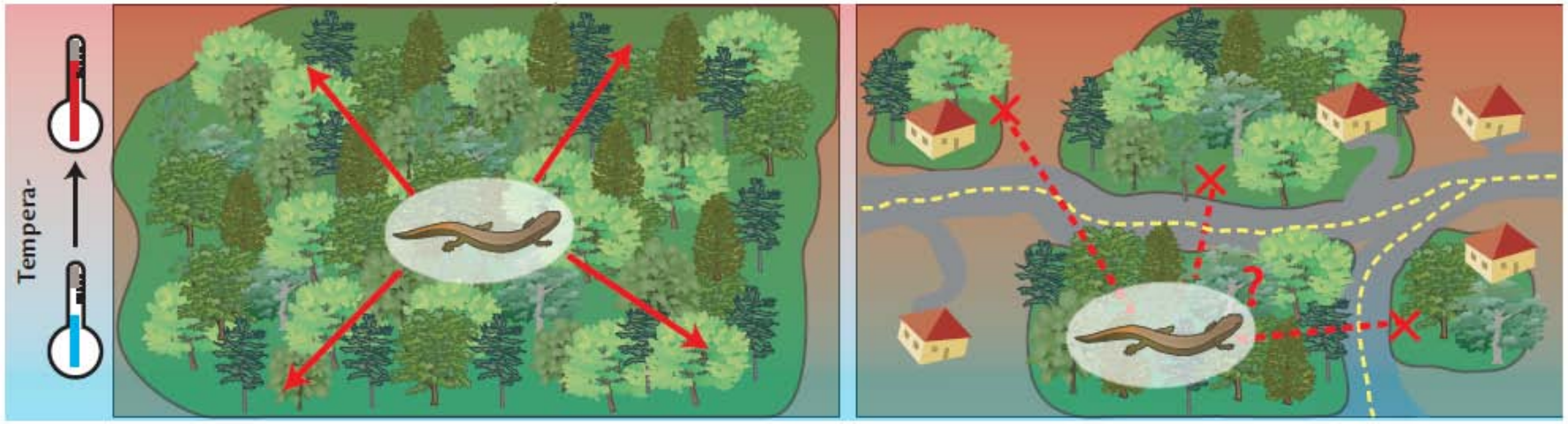
Managing Forests for Migration



Contiguous Forested Landscape **Fragmented Forested Landscape**

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Climate Change Education

Maryland and Delaware Climate Change Education Assessment and Research

- K-12 Education (integrated with Next-Generation Science Standards, and Environmental Literacy Requirements)
- Higher Education (sustainability literacy, teacher preparation, pipeline)
- Informal Education (museums, aquaria, outdoor centers, media)

www.madeclear.org/

Questions or Comments?

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- www.umces.edu/people/president