

+ Scientific Uncertainty and
+ Security Risks of Climate Change

+ Jay Gulledge, PhD

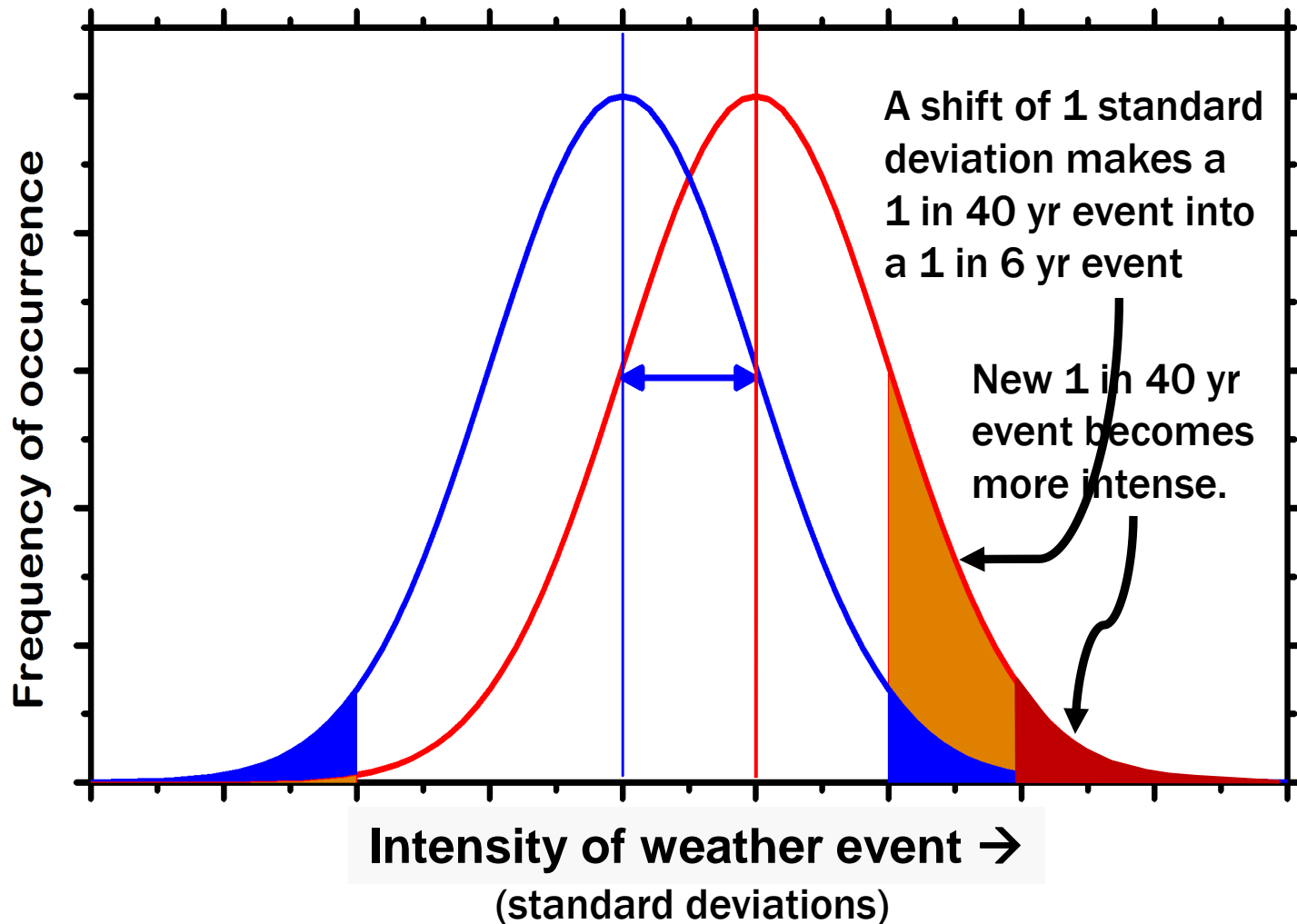
+ Senior Scientist
+ Director, Science & Impacts Program
+ Pew Center on Global Climate Change

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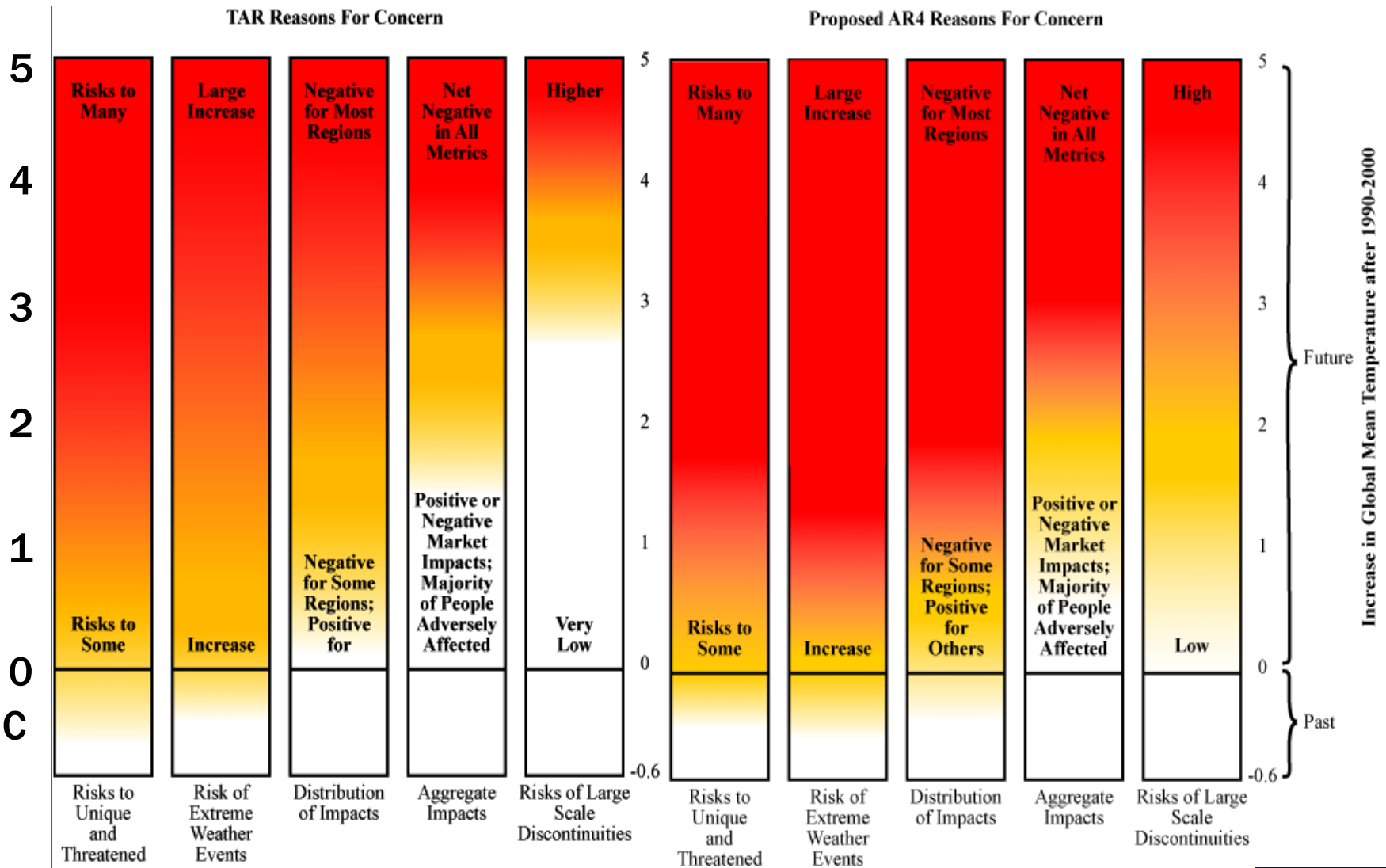
Risk Perception is Key

- Risk is great for high-impact outcomes even if probability is thought to be low
- Uncertainty tempts people, including scientists, to underestimate risk
- Security assessments should contemplate the full range of uncertainty.
- Scientists should conduct *risk* assessment in addition to scientific assessment.

Risk Perception: Climate Extremes



Risk Assessment: "Reasons for Concern"



What We Know

*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 level*

IPCC 2007

What We Know

*Most of the observed increase in global average temperatures since the mid-20th century is **very likely*** due to the observed increase in anthropogenic greenhouse gas concentrations.*

IPCC 2007

*Very Likely: >90% chance

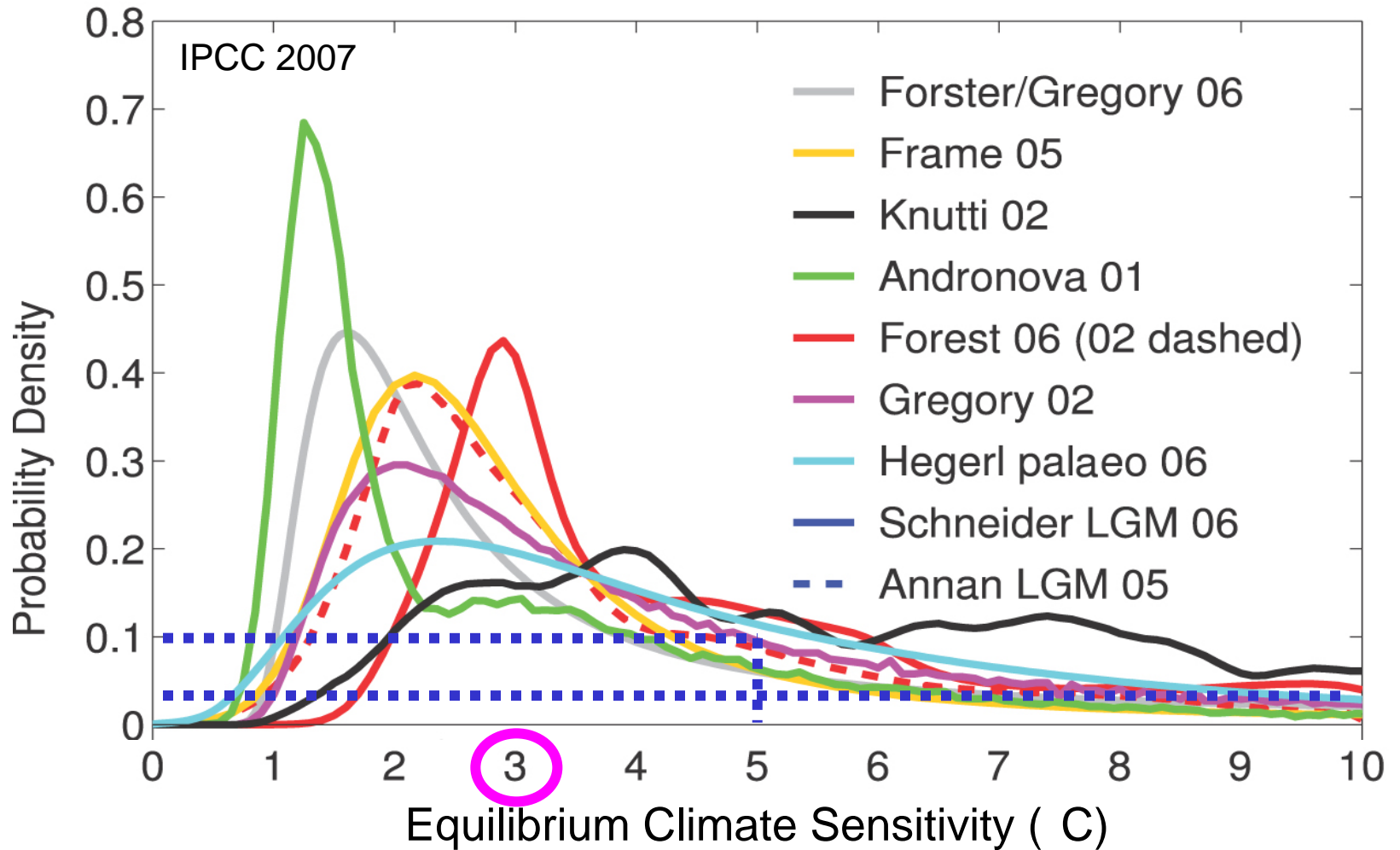
What We Know

- Changes are under way; further change is unavoidable
- 21st century change will be larger than 20th
- Net effects will be negative for most regions
- Damage occurs at the extremes, not the averages
- Sea level, water, weather extremes will affect billions
- Developed and developing countries are vulnerable
- Adaptive capacity can be overwhelmed

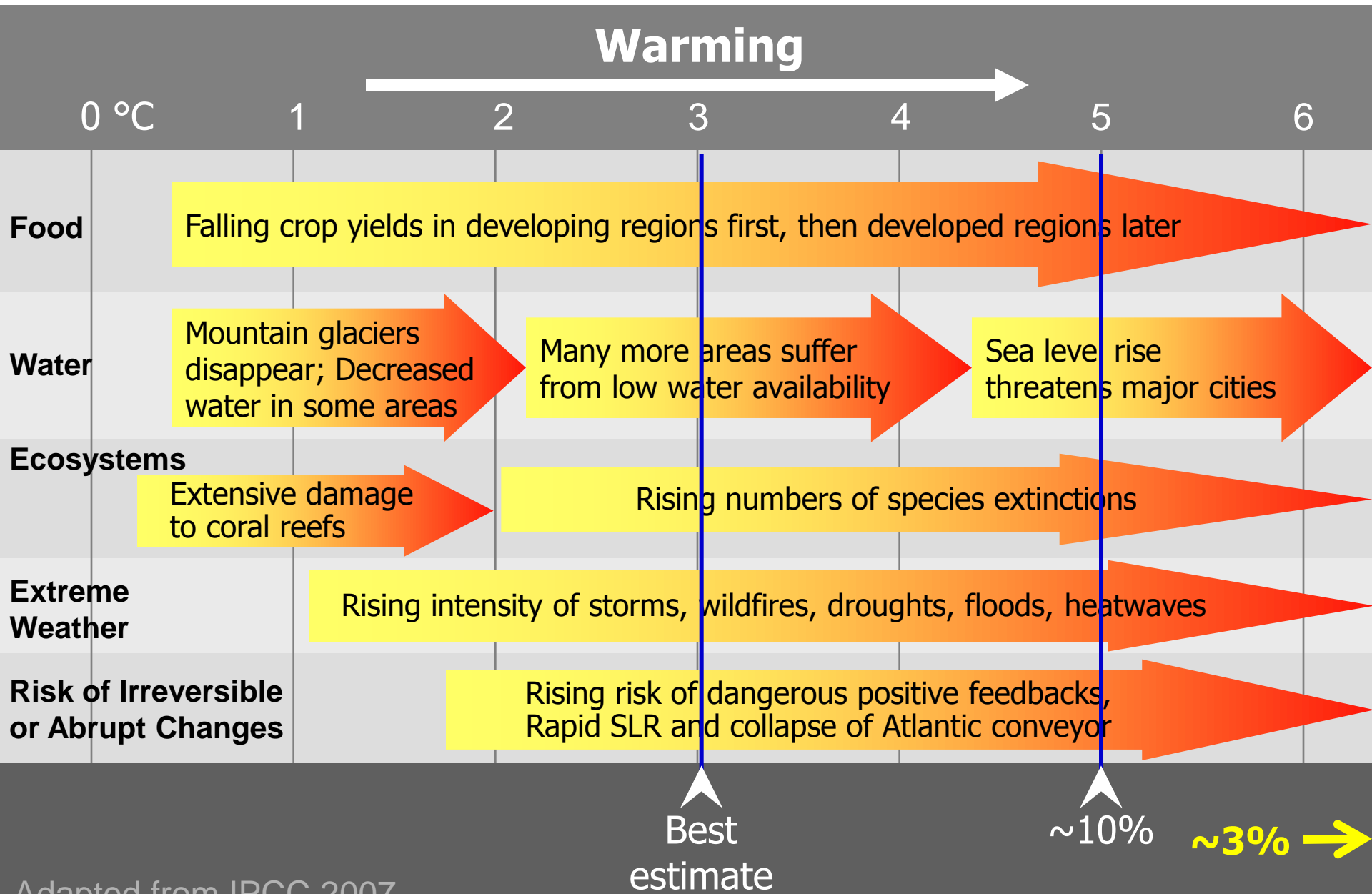
What We **Don't** Know

- Equilibrium climate sensitivity
- Future GHG emissions and other forcings
- Timing and magnitude of future change
- Regional details of future change
- Timing/effect of positive feedbacks
- Thresholds/tipping points/irreversibility

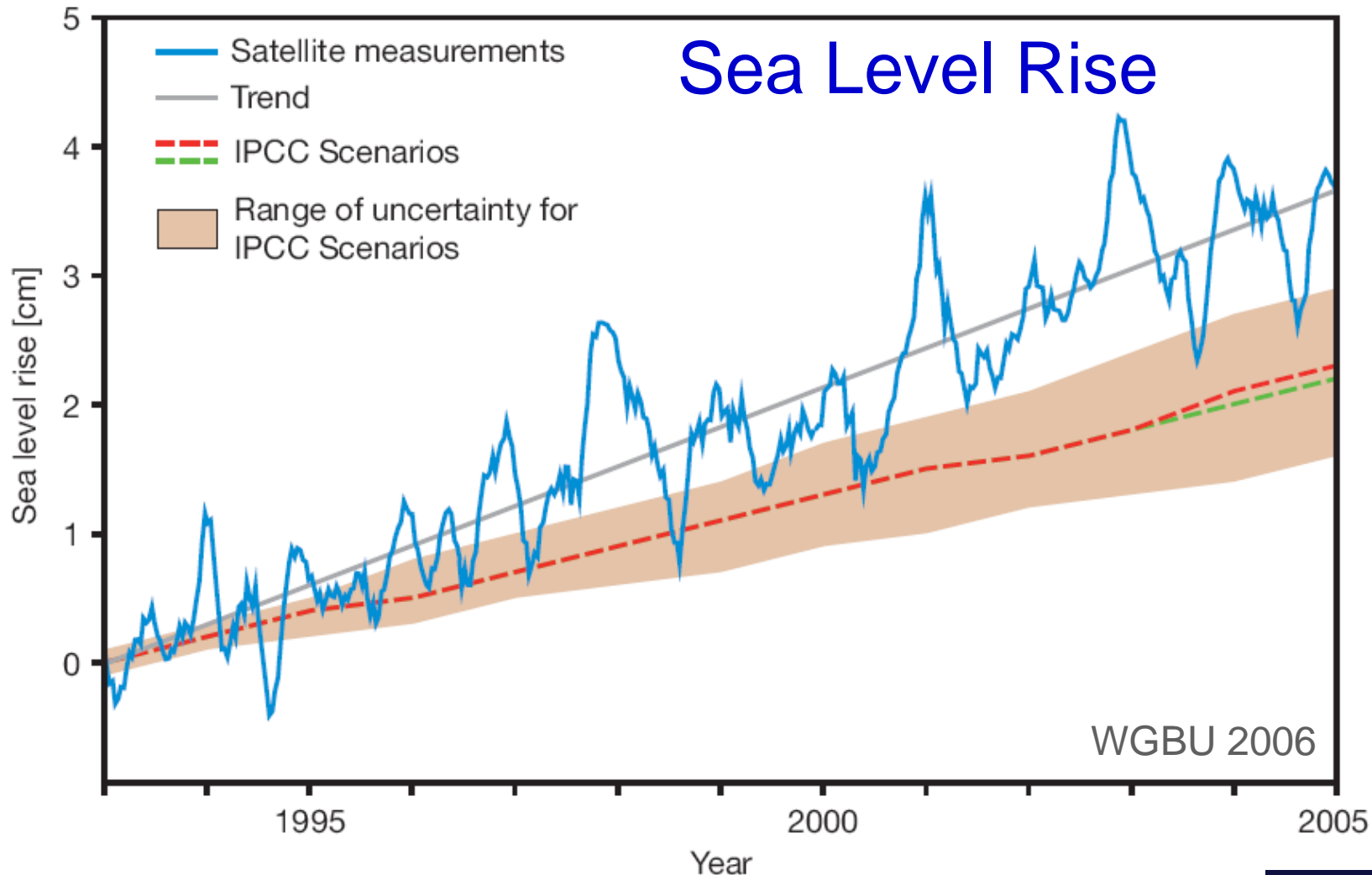
What We Don't Know



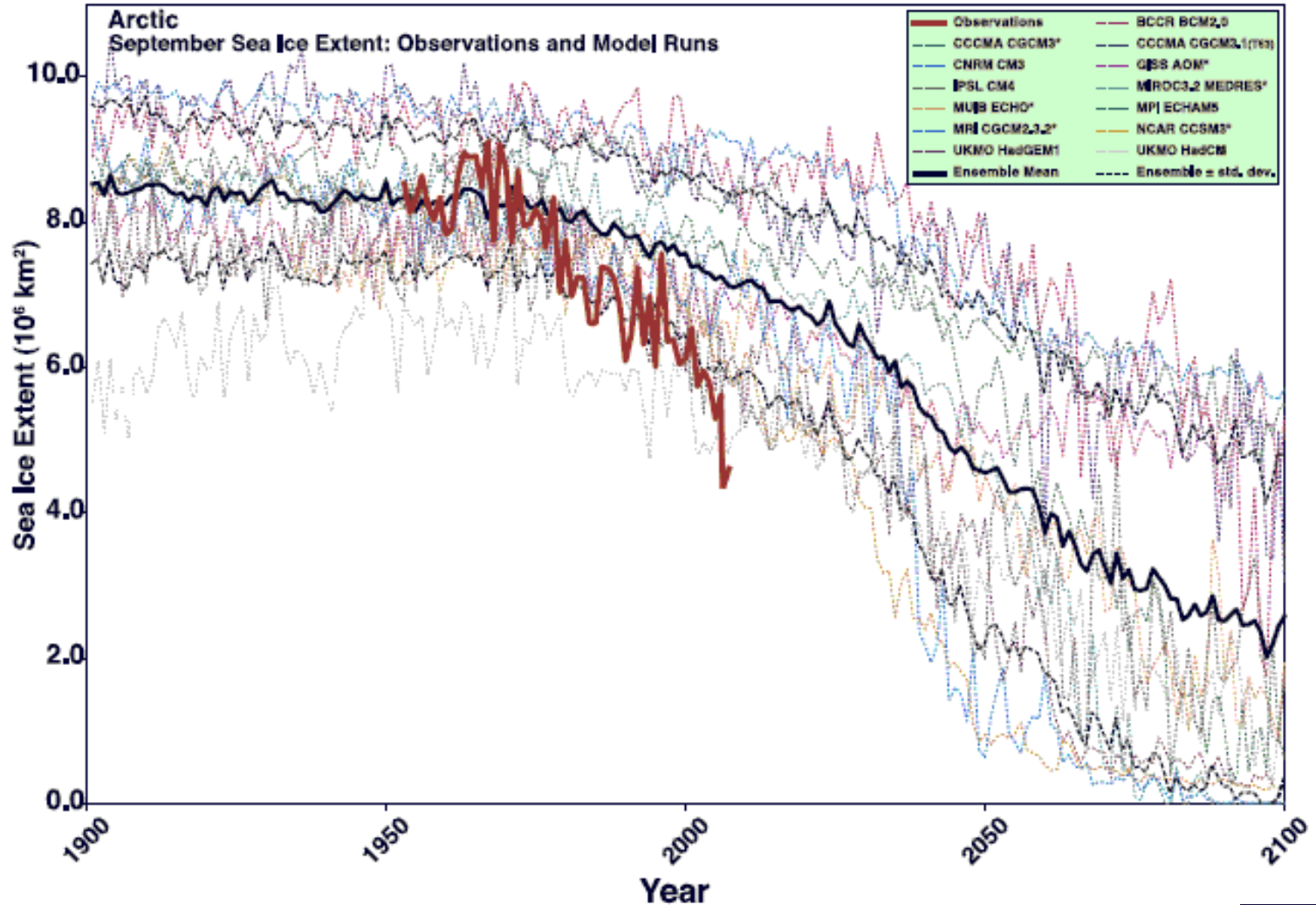
+ Risks Associated with Doubled CO₂



Projections Underestimate Change



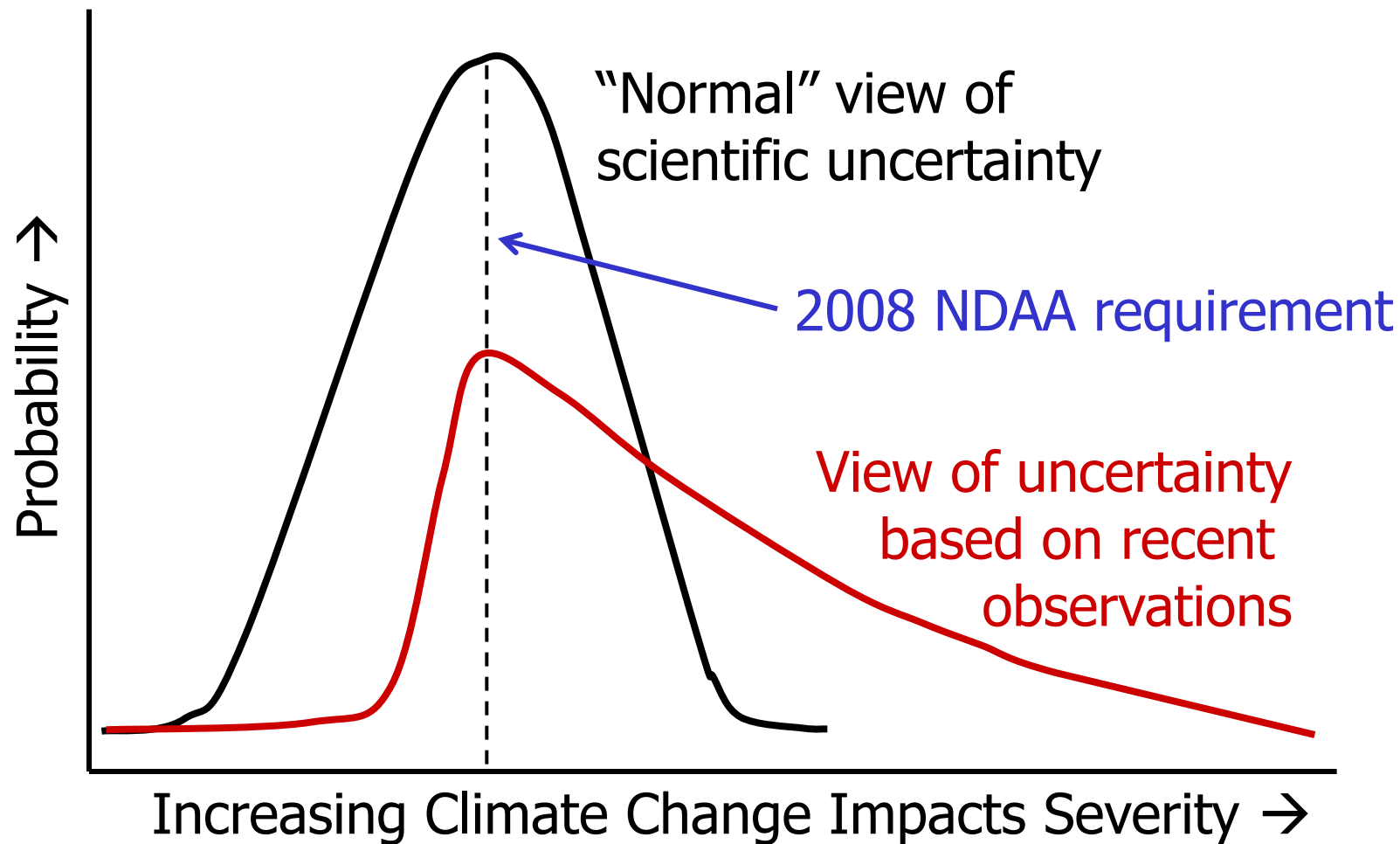
Projections Underestimate Change



Projections Underestimate Change

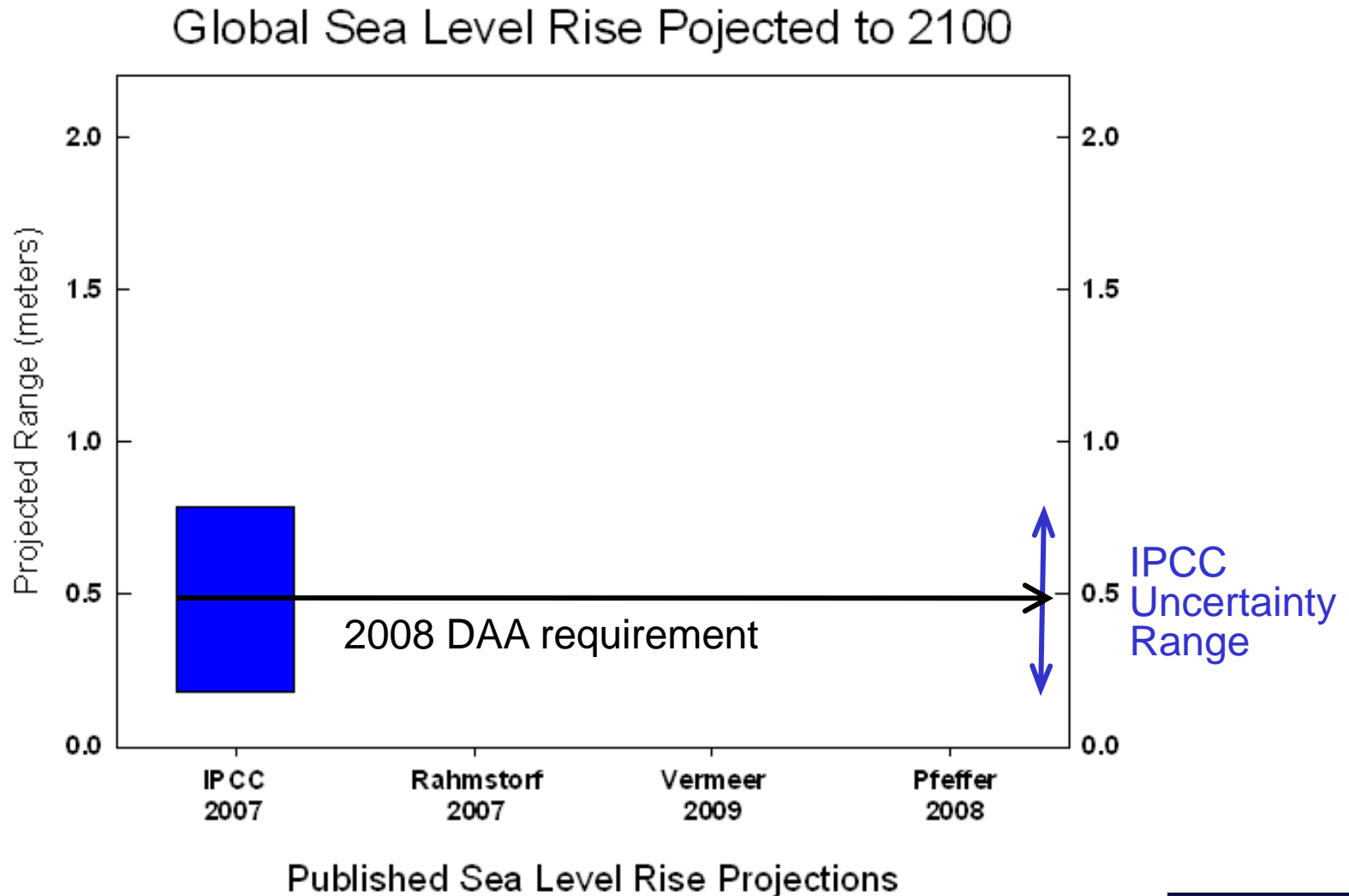
- Sea level rise ~50% faster than projected
(Rahmstorf et al. 2007, *Science*)
- Observed Arctic sea ice loss ~3X faster
(Stroeve et al. 2007, *Geophysical Research Letters*)
- Polar ice sheets losing mass ~100 years early
(IPCC 2007; Shepherd & Wingham 2007, *Science*)
- Small glaciers & ice caps losing ice faster
(Meier et al. 2007, *Science*)
- Global precipitation changing ~2X faster
(Wentz et al. 2007, *Science*; Zhang et al. 2007, *Nature*)
- Tropical belt widening more rapidly
(Seidel et al. 2008, *Nature Geoscience*)

Asymmetry of Uncertainty = Added Risk

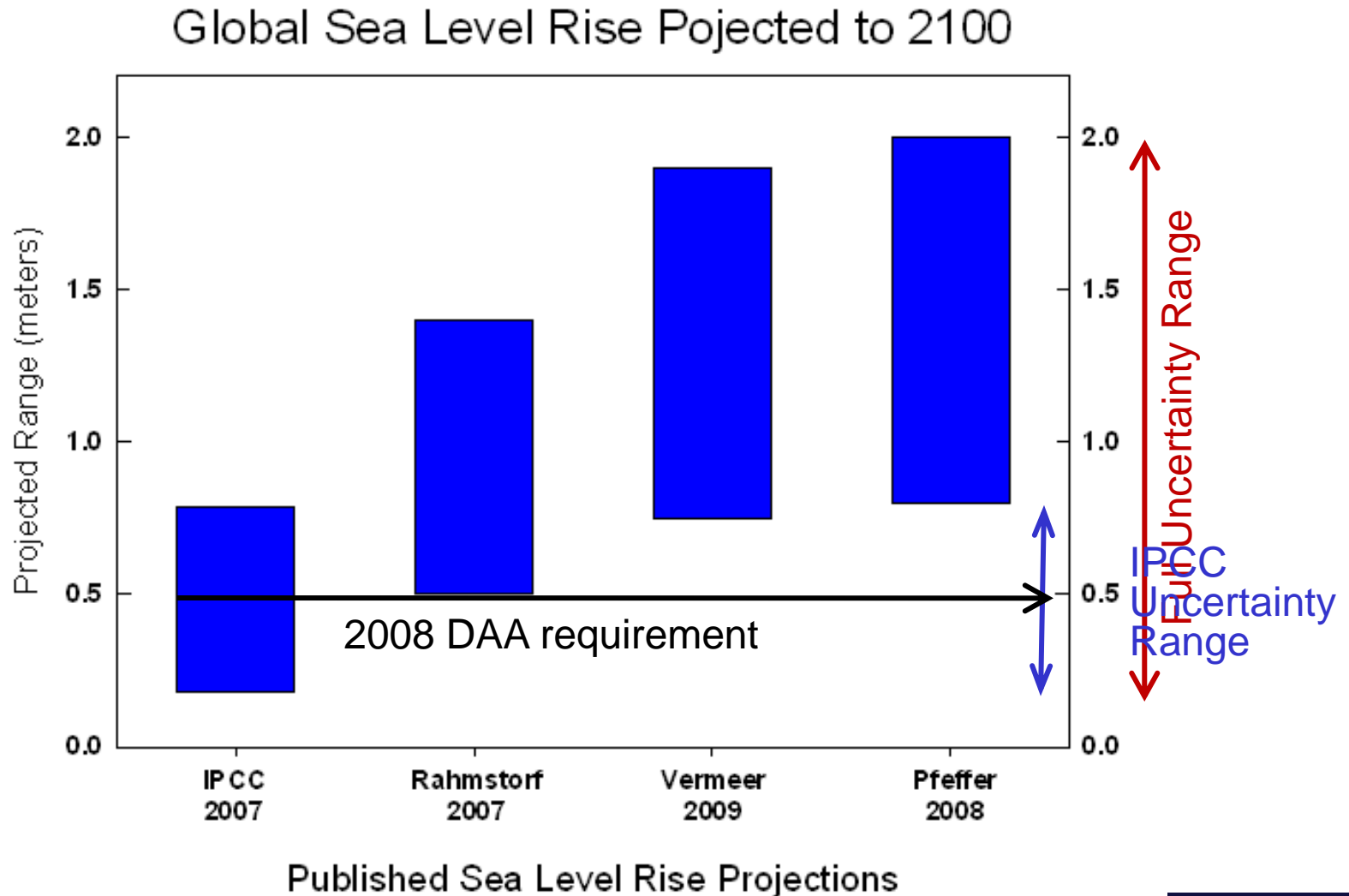


Risks are biased toward more damage.

Uncertainty: Sea Level Rise



Uncertainty: Sea Level Rise



Example: Mekong Delta



1 meter

Legend

- 1-meter rise
- cities
- rivers
- international borders
- High: 146668
- Low: 0

Mekong Delta

Vietnam's "rice bowl"

- 20 million people
- Grain exporting region

Susceptibility to Sea Level Rise

Weiss & Overpeck
The University of Arizona



Example: Niger Delta

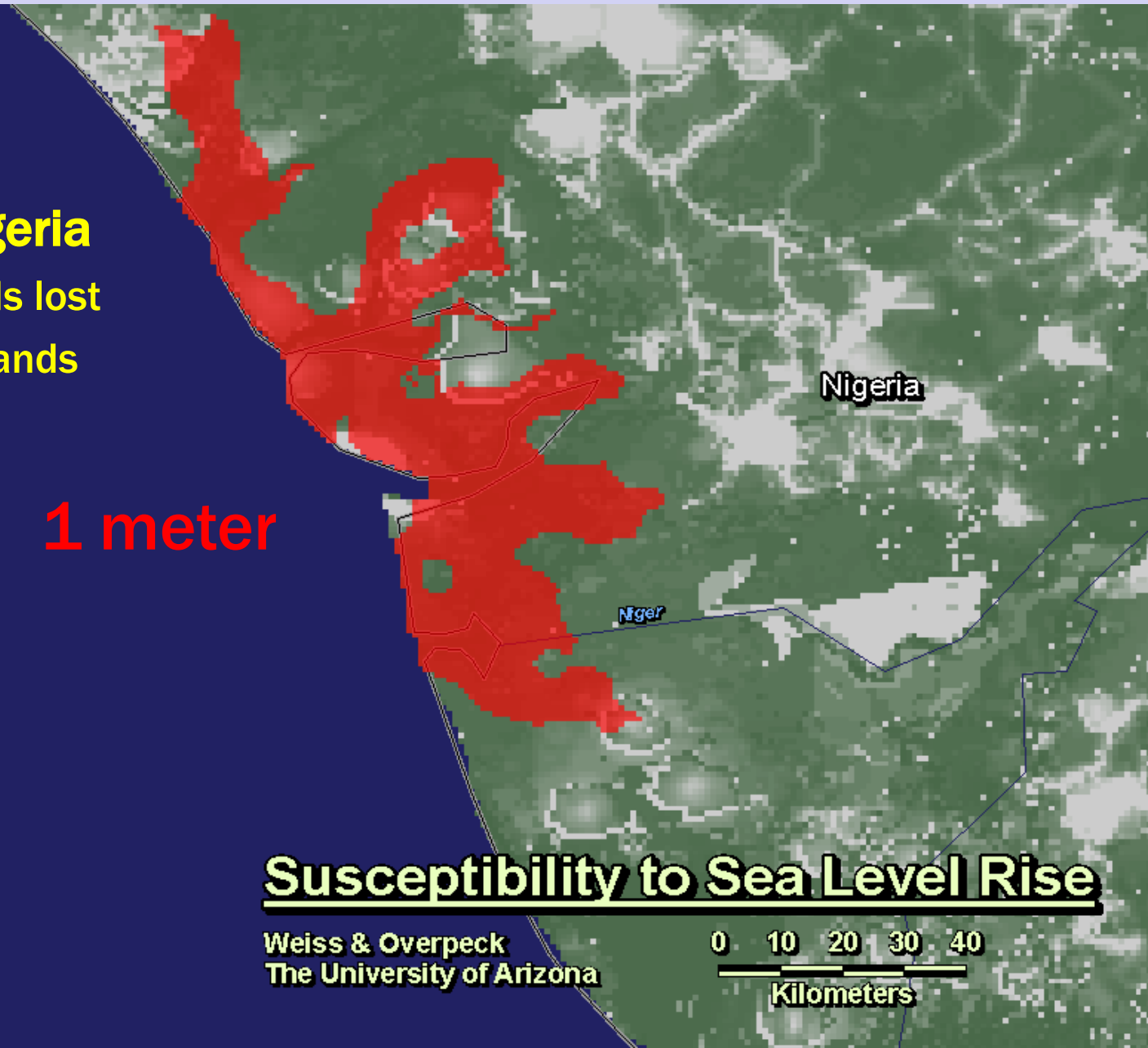
Niger Delta, Nigeria

- Massive wetlands lost
- 6000 km² croplands
- 250 oil fields

1 meter

Legend

-  1-meter rise
-  cities
-  rivers
-  international borders
-  High: 146668
Low: 0



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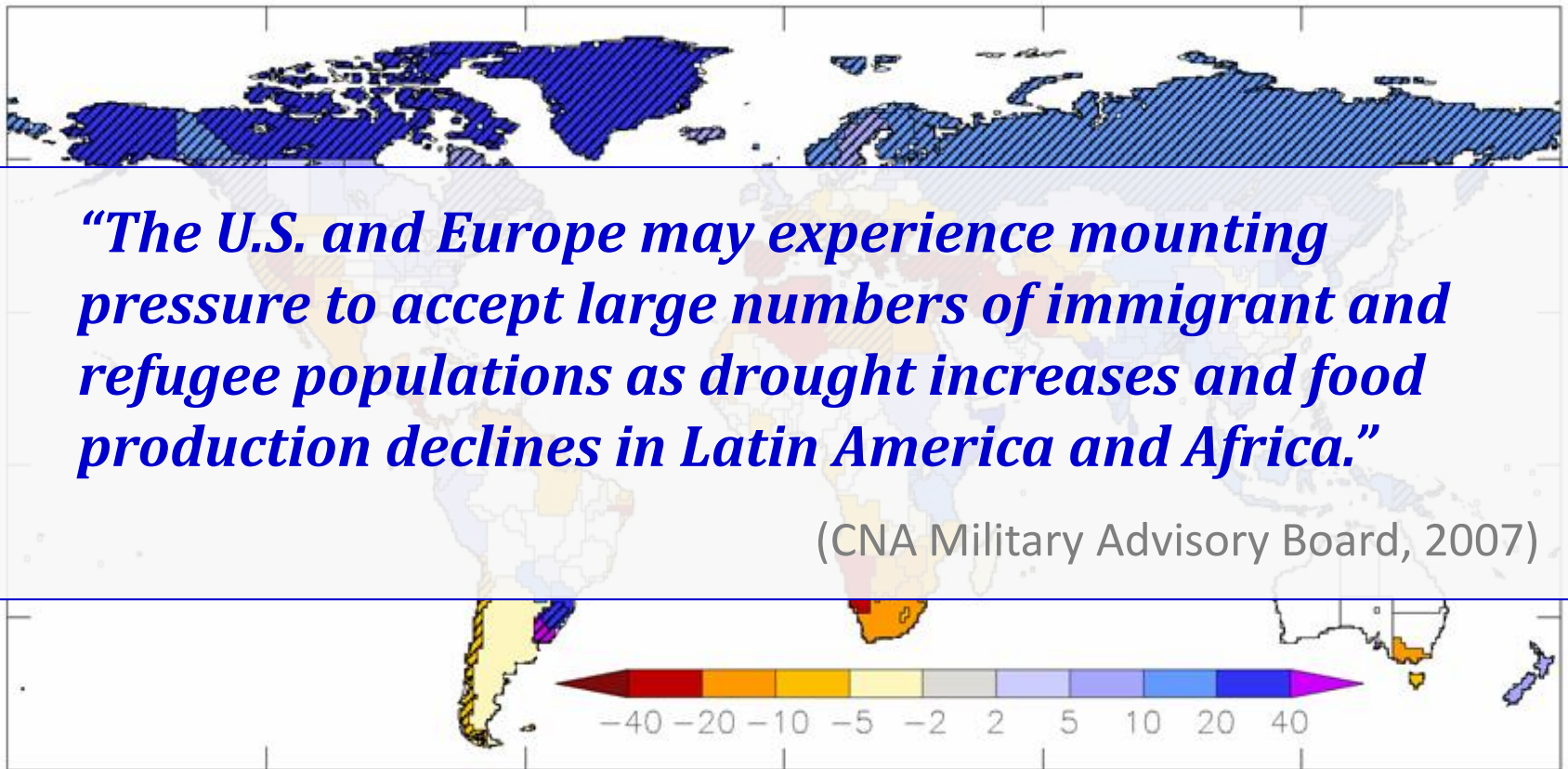


Assessing Risks: Megadeltas



Assessing Risks: Water Availability

Projected Surface Water in 2050 Relative to 1900-1970



Milly et al. *Nature* 2005, updated

+ For More Information



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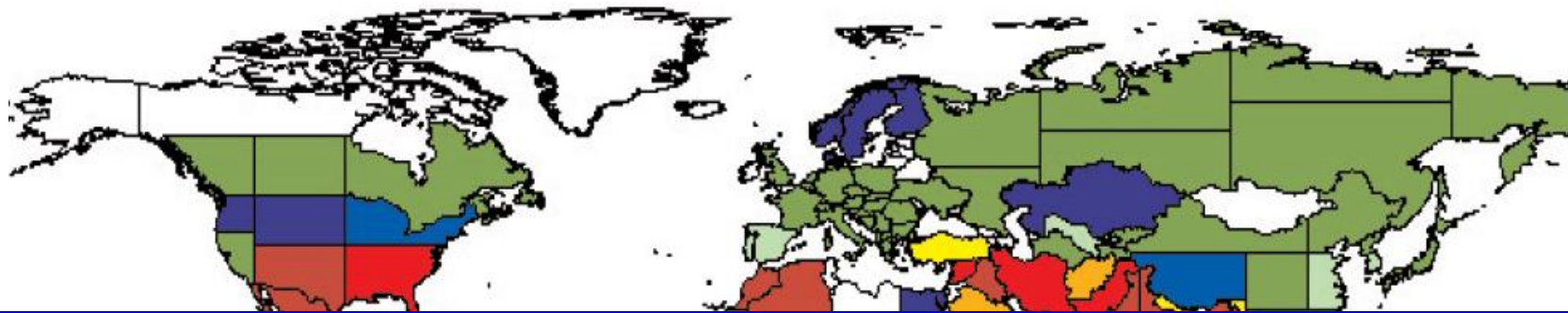
Reserve Slides



Science to Inform Risk Assessment

- Assess risks, not just scientific understanding (e.g., model extremes, climate sensitivity uncertainty)
- Integrate social sciences into assessments
- Identify key vulnerabilities and sensitive regions
- Improve regional/temporal predictions for some aspects of climate change
- Study available but unexploited data
- Identify/monitor key risk indicators
- Provide scenarios on potential surprises

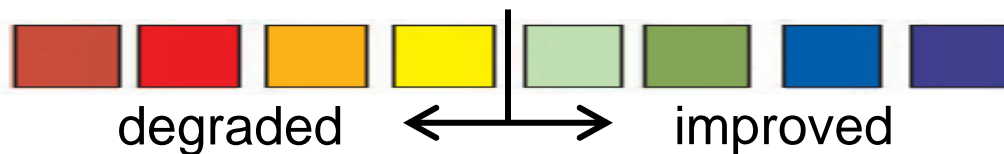
Assessing Risks: Food Security



“The U.S. and Europe may experience mounting pressure to accept large numbers of immigrant and refugee populations as drought increases and food production declines in Latin America and Africa.”

W.R. Cline (2006) *Global Warming: Impact Estimates by Country*, Center for Global Development, Washington D.C.

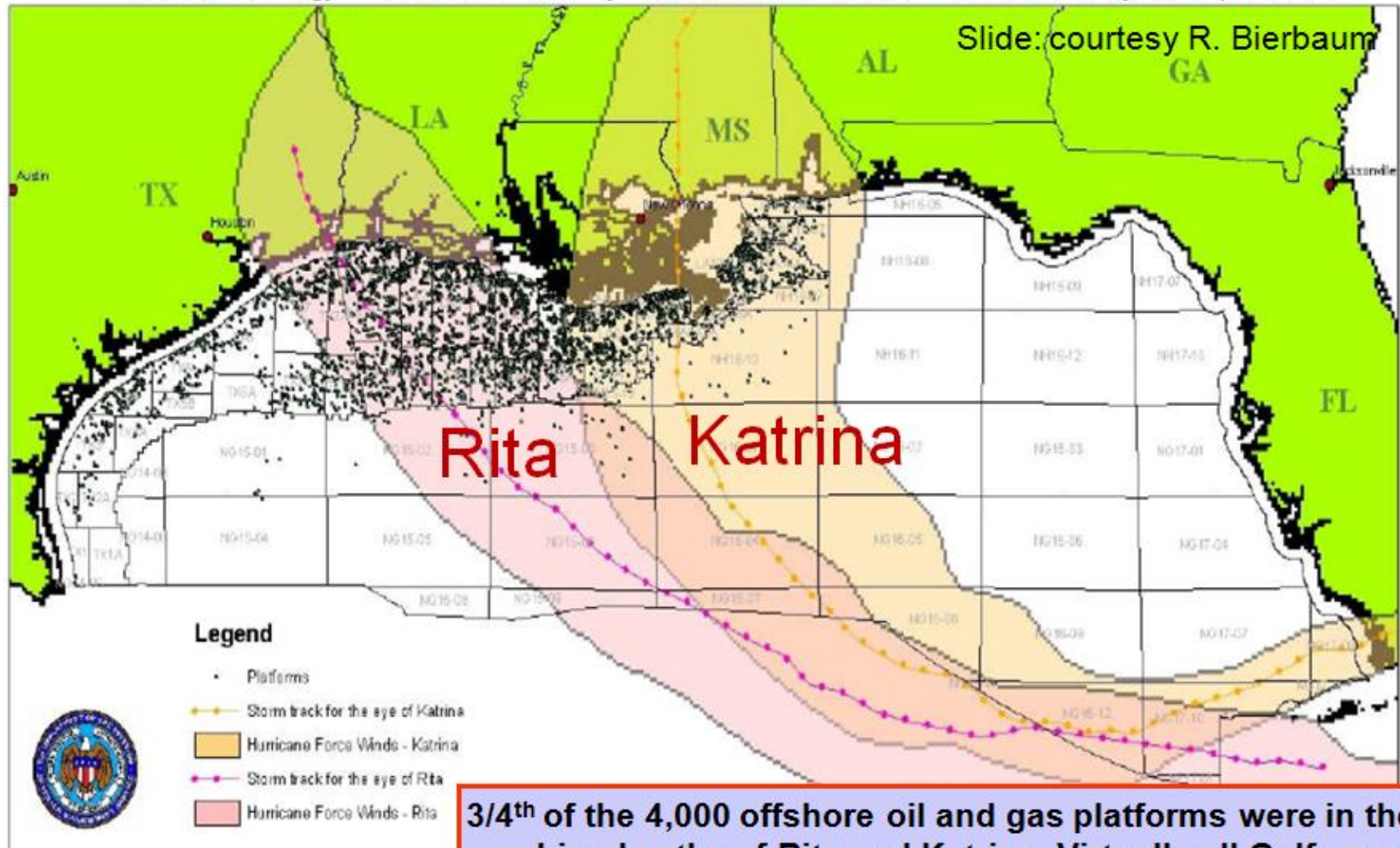
(CNA Military Advisory Board, 2007)



Projected crop production changes

Assessing Risks/Adaptation Priorities

P. Hibbard, "US Energy Infrastructure Vulnerability – Lessons From the Gulf Coast Hurricanes," Analysis Group, March 2006



3/4th of the 4,000 offshore oil and gas platforms were in the combined paths of Rita and Katrina. Virtually all Gulf coast production and import facilities and many refining facilities were evacuated or operations were suspended.

What We Don't Know

Equilibrium Temperature – Sea level Relationship

