Probabilistic Integrated Assessment of "Dangerous" Climate Change

Michael Mastrandrea

August 17, 2004

GCEP End-of-Summer Workshop

Outline

- **Probability and Likelihood**
- **“Dangerous” Climate Change (DAI)**
- **Probabilistic Analysis of DAI Potential**
- **Implications for Climate Policy**

Probability and Likelihood

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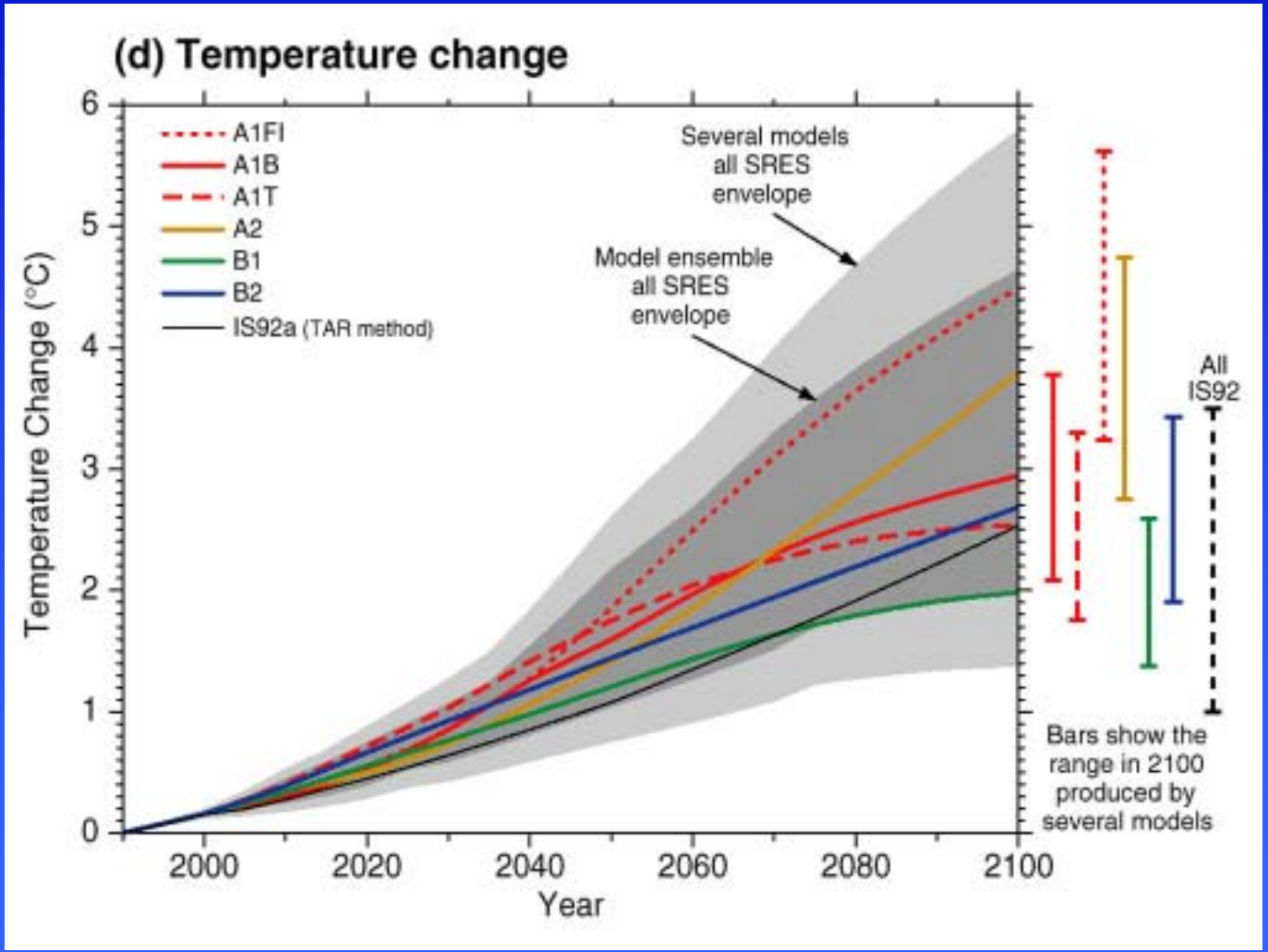
- If likelihoods are not communicated, end-users will create their own
  - Special Report on Emissions Scenarios, e.g.

Probability and Likelihood



IPCC SRES, 2001

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  - Special Report on Emissions Scenarios, e.g.
- Probabilistic ranges vs. point estimates
- Climate policy = risk management

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  - “to ensure that food production is not threatened”
  - “to enable economic development to proceed in a sustainable manner”

“Dangerous” Climate Change

- What is “dangerous anthropogenic interference” (DAI)?
- Potentially “dangerous” climate impacts:

“Dangerous” Climate Change

Species loss and ecosystem disruption

“Dangerous” Climate Change

Sea level rise

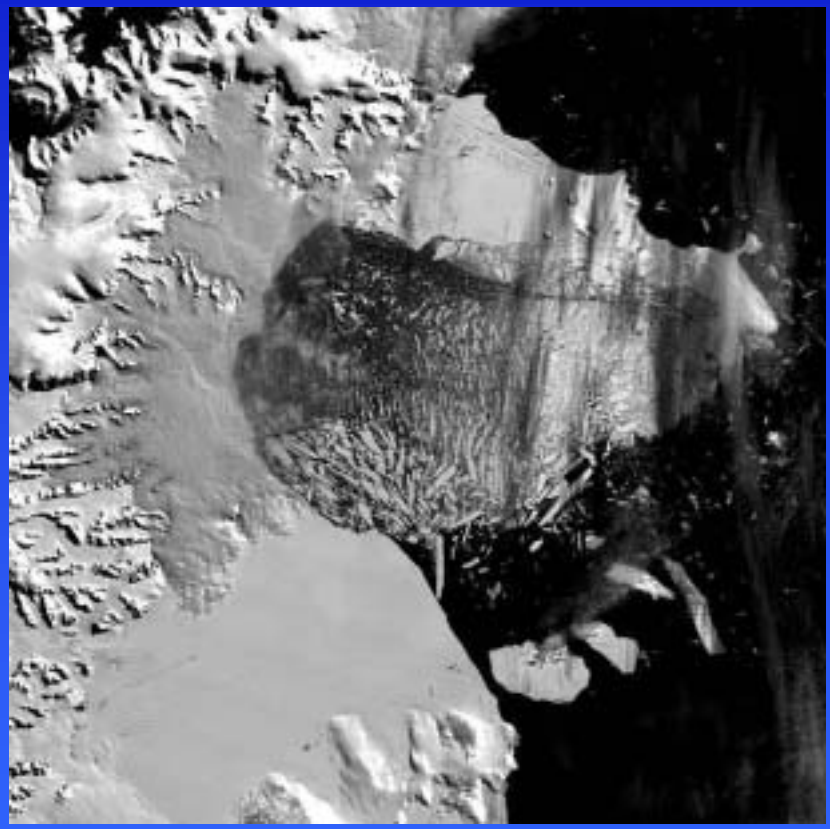
“Dangerous” Climate Change

Increased frequency and intensity of storms

“Dangerous” Climate Change

Agricultural impacts

“Dangerous” Climate Change



NASA

Abrupt climate change

“Dangerous” Climate Change

- What is “dangerous anthropogenic interference” (DAI)?
- Potentially “dangerous” climate impacts:
  - Species loss and ecosystem disruption
  - Sea level rise
  - Increased frequency and intensity of storms
  - Agricultural impacts
  - Abrupt climate change
- Different thresholds

“Dangerous” Climate Change

- Who decides what is “dangerous” in DAI?

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“Dangerous” Climate Change

- Who decides what is “dangerous” in DAI?
  - What geographical scale?
  - What socioeconomic level?
  - What value system?
- Varying importance of impact categories

A Metric for DAI

- Metric Assumptions:

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- Metric Assumptions:
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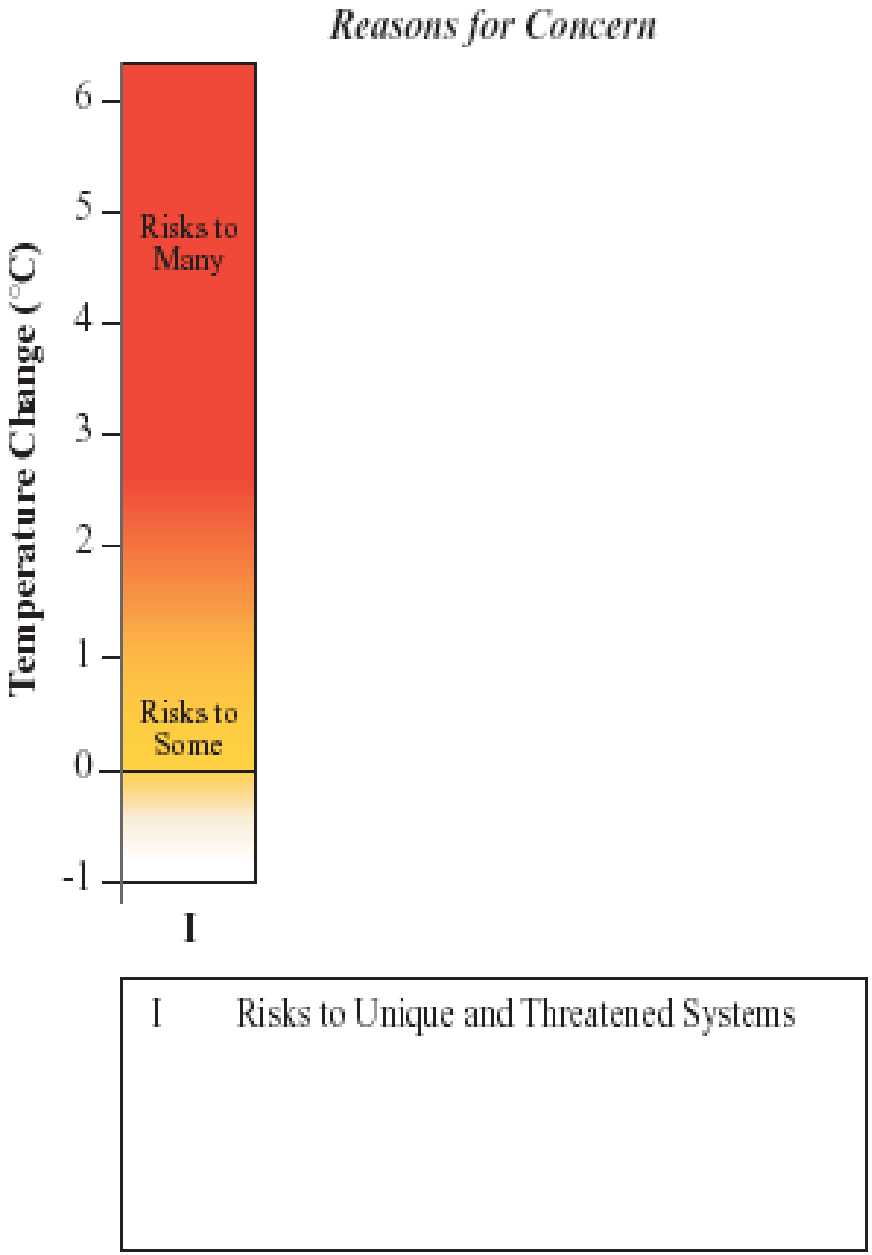
  - All categories of “dangerous” impacts
  - No weighting of categories
  - Link impacts to global average temperature increase
  - Cumulative “danger”
  - Probabilistic metric

Reasons for Concern



(IPCC TAR, 2001)

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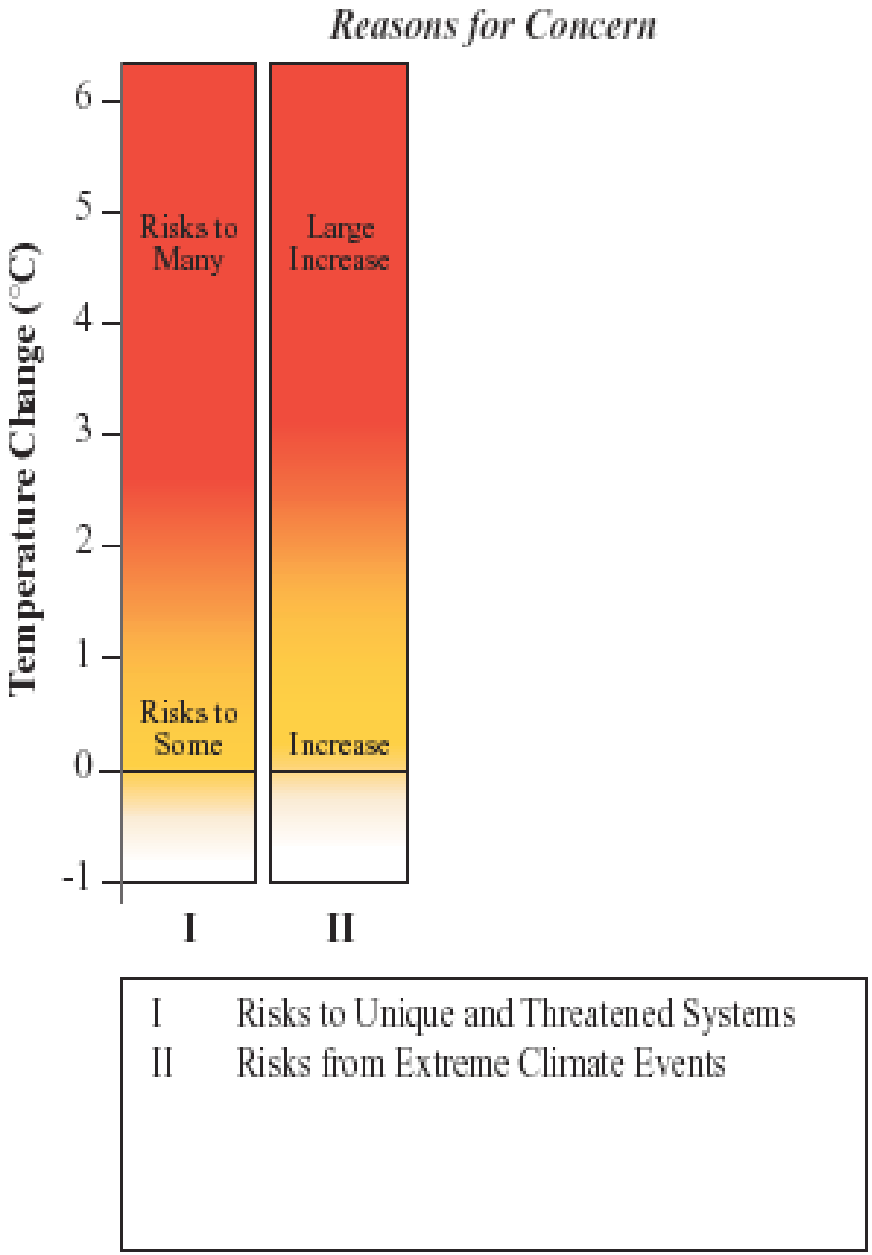

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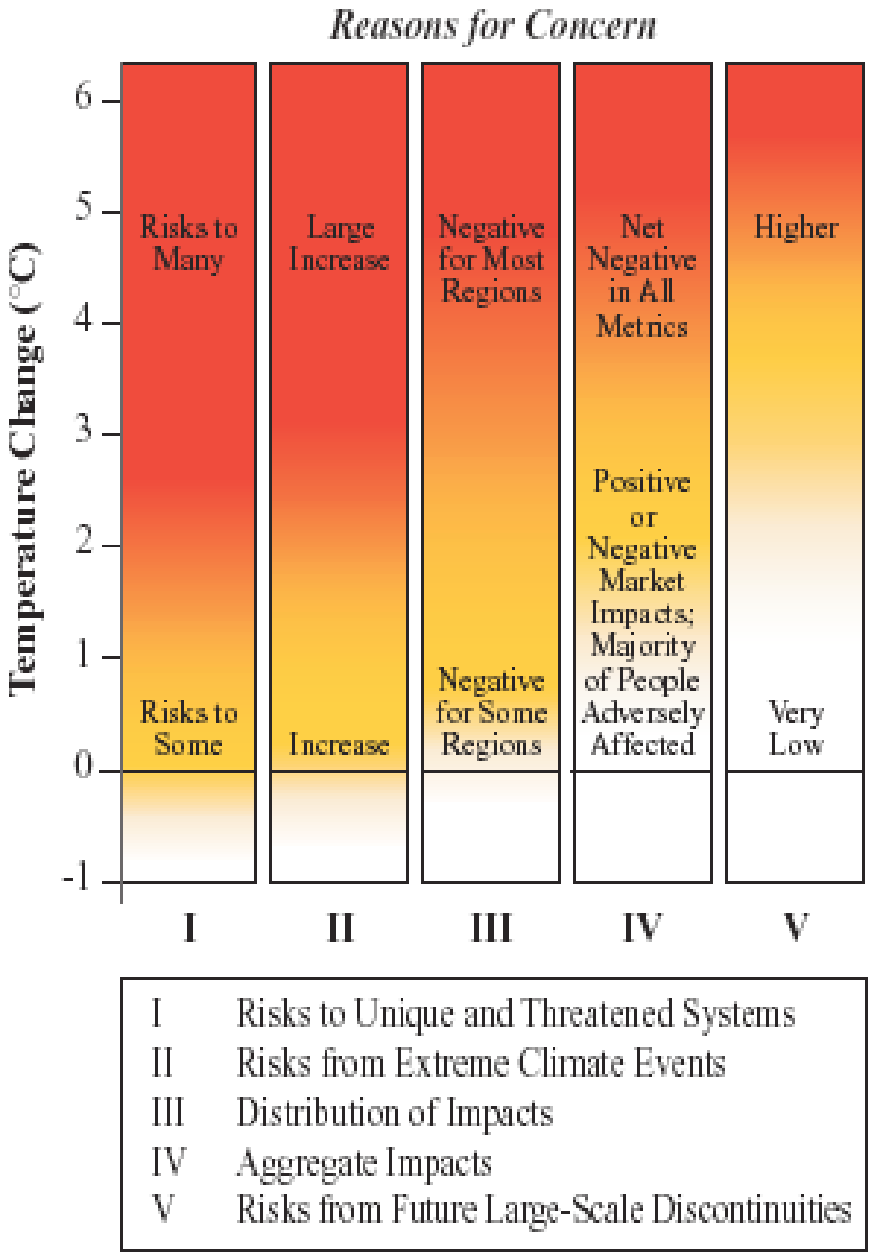

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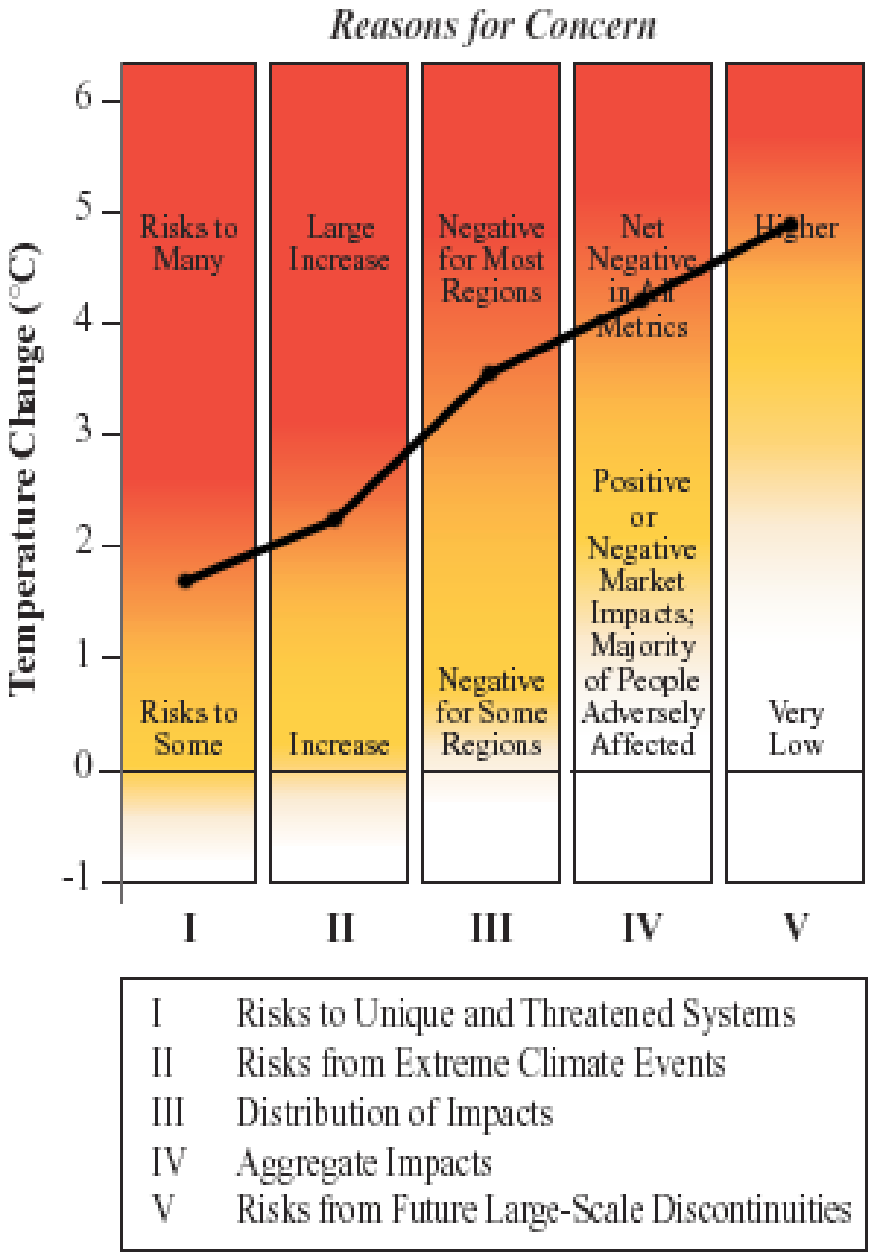

"Dangerous" CDF

20th ‰: 1.8ºC
50th ‰: 2.85ºC
80th ‰: 4.2ºC

(IPCC TAR, 2001)

Metric Application

- How likely is DAI?

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- Apply DAI metric to projections of future climate change

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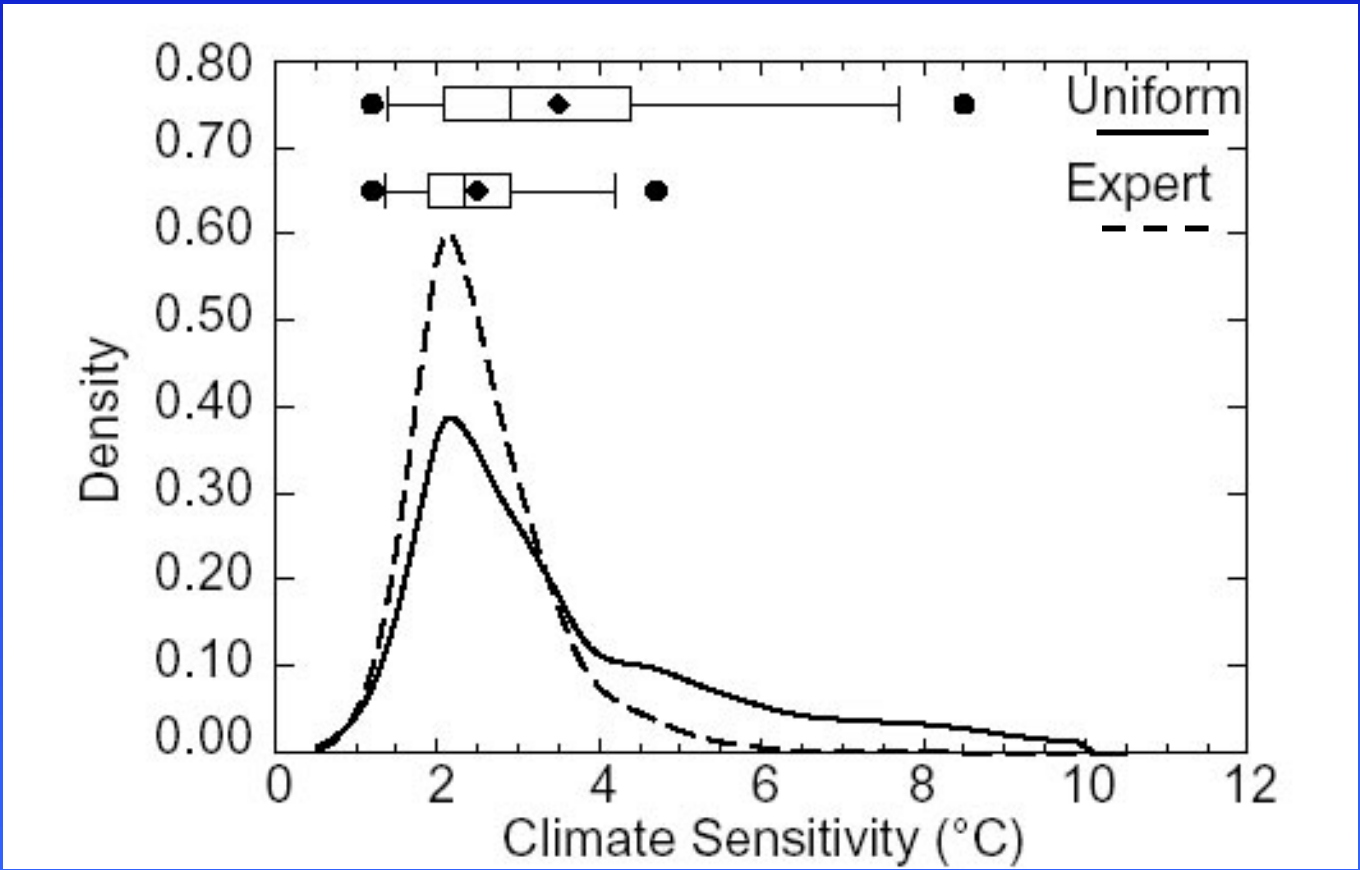
- Dynamic Integrated Climate and Economy (DICE) Model
  - Integrated Assessment Model (IAM)

Climatic Uncertainty

- Two key sources of uncertainty:
  - Climate Sensitivity (ºC)

Climatic Uncertainty

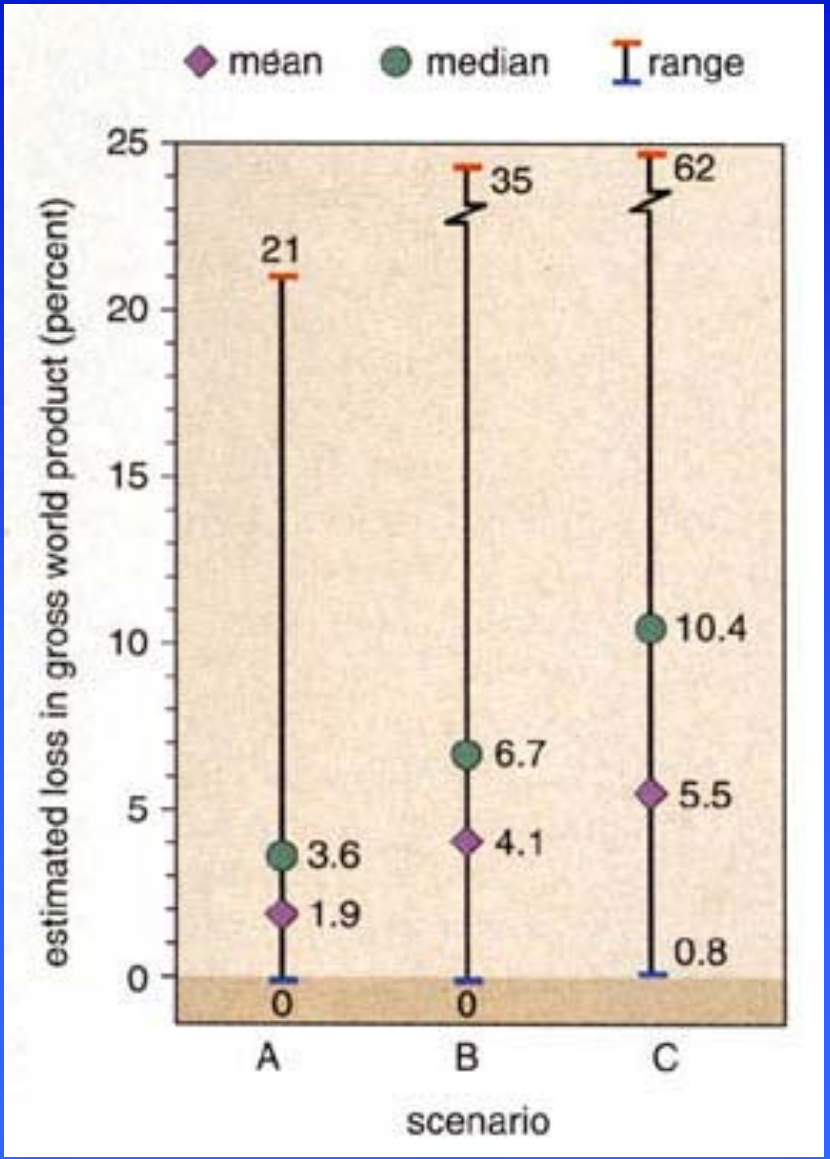


Forest et al., 2001

Climatic Uncertainty

- Two key sources of uncertainty:
  - Climate Sensitivity (ºC)
  - Climate Damages (ºC→% GWP)

Climatic Uncertainty



Scen. A: 3°C in 2090

Scen. C: 6°C in 2090

Methods

- Step 1: Vary climate sensitivity only (no climate damages, low discount rate)

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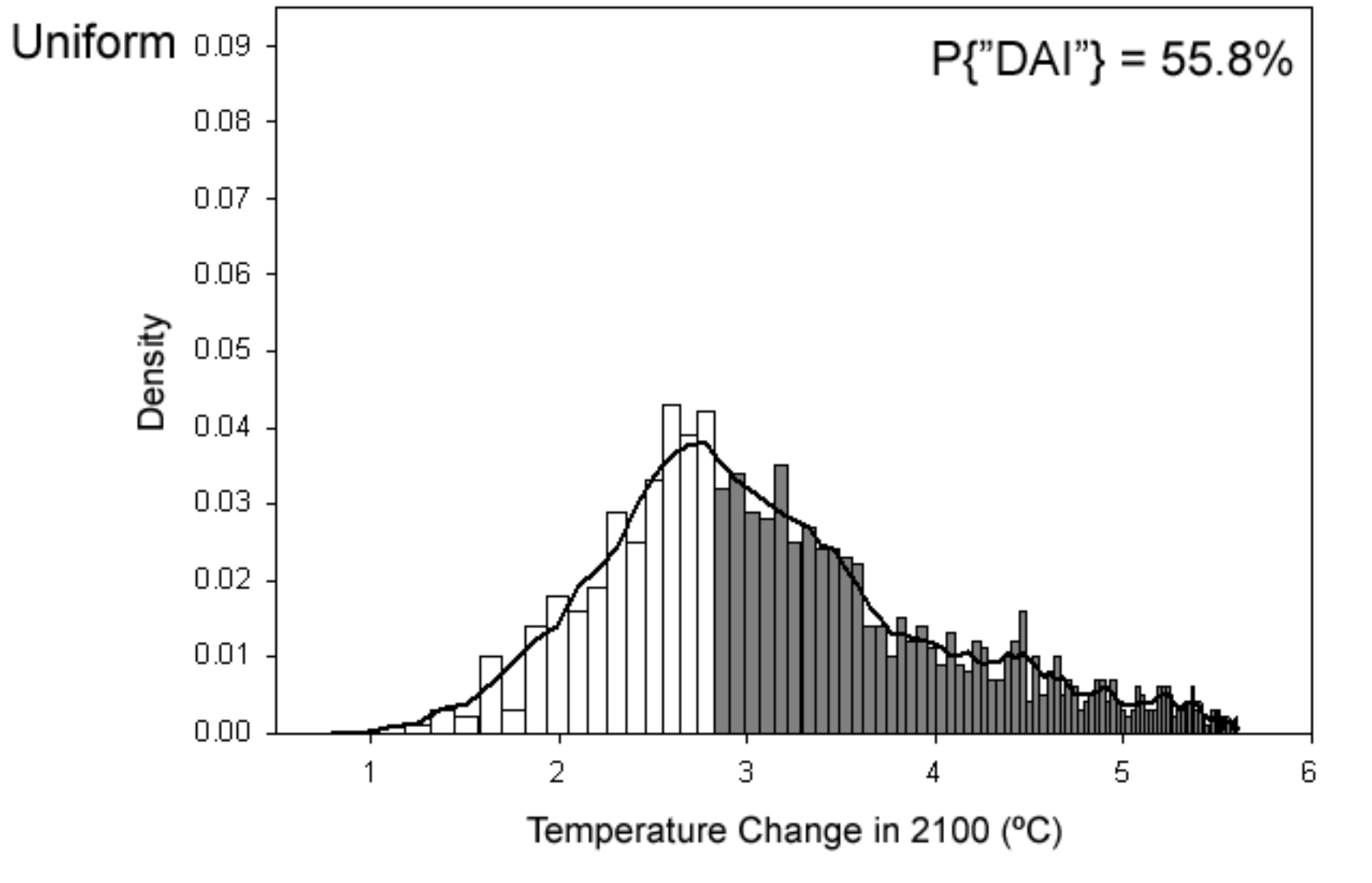
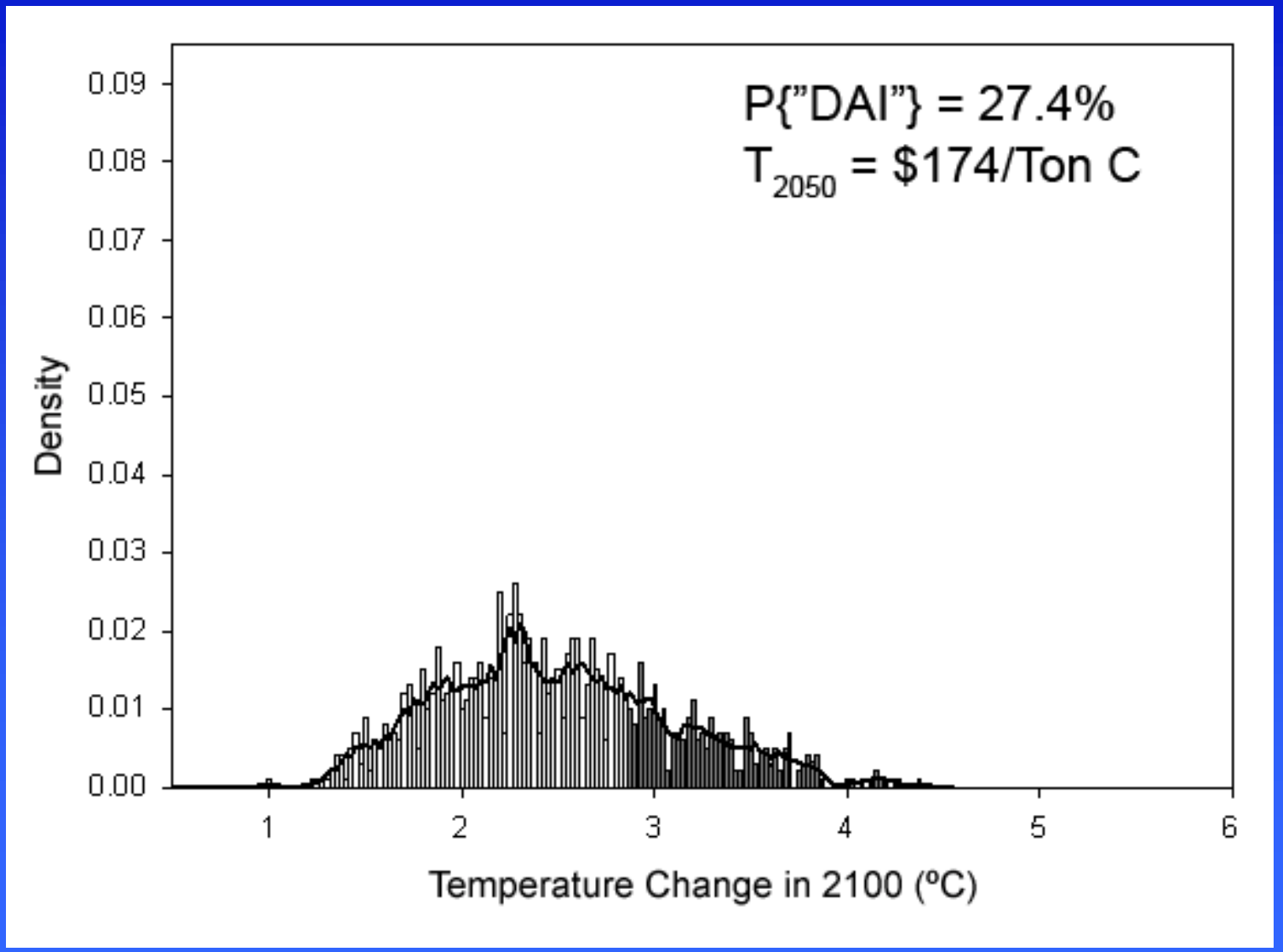
- Step 1: Vary climate sensitivity only (no climate damages, low discount rate)
- Step 2: Vary climate sensitivity and climate damages (low discount rate)
- In each step: Evaluate probability of DAI

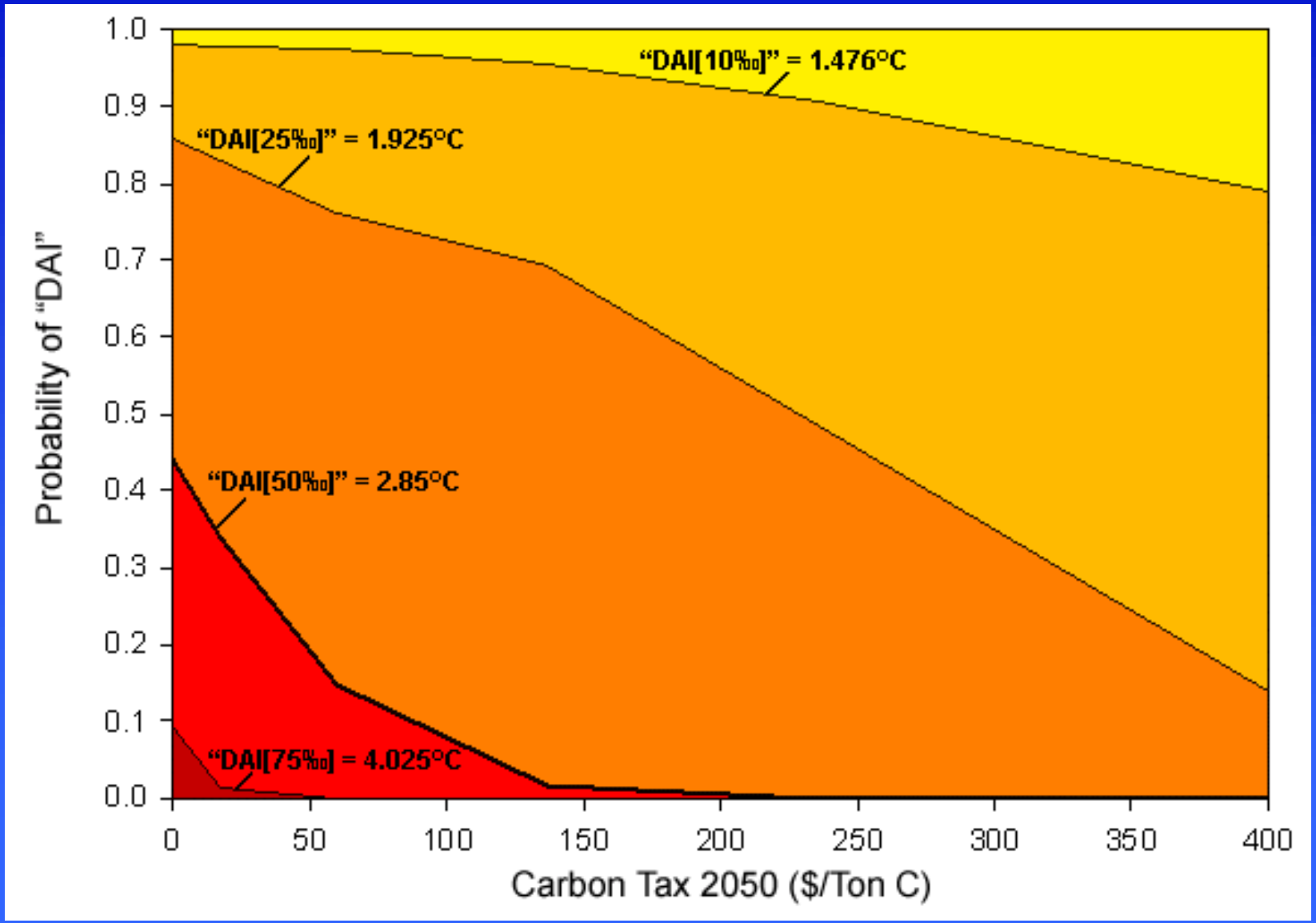
Step 1


Uniform
P{"DAI"} = 55.8%
Density
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1
2
3
4
5
6
Temperature Change in 2100 (ºC)

Step 2

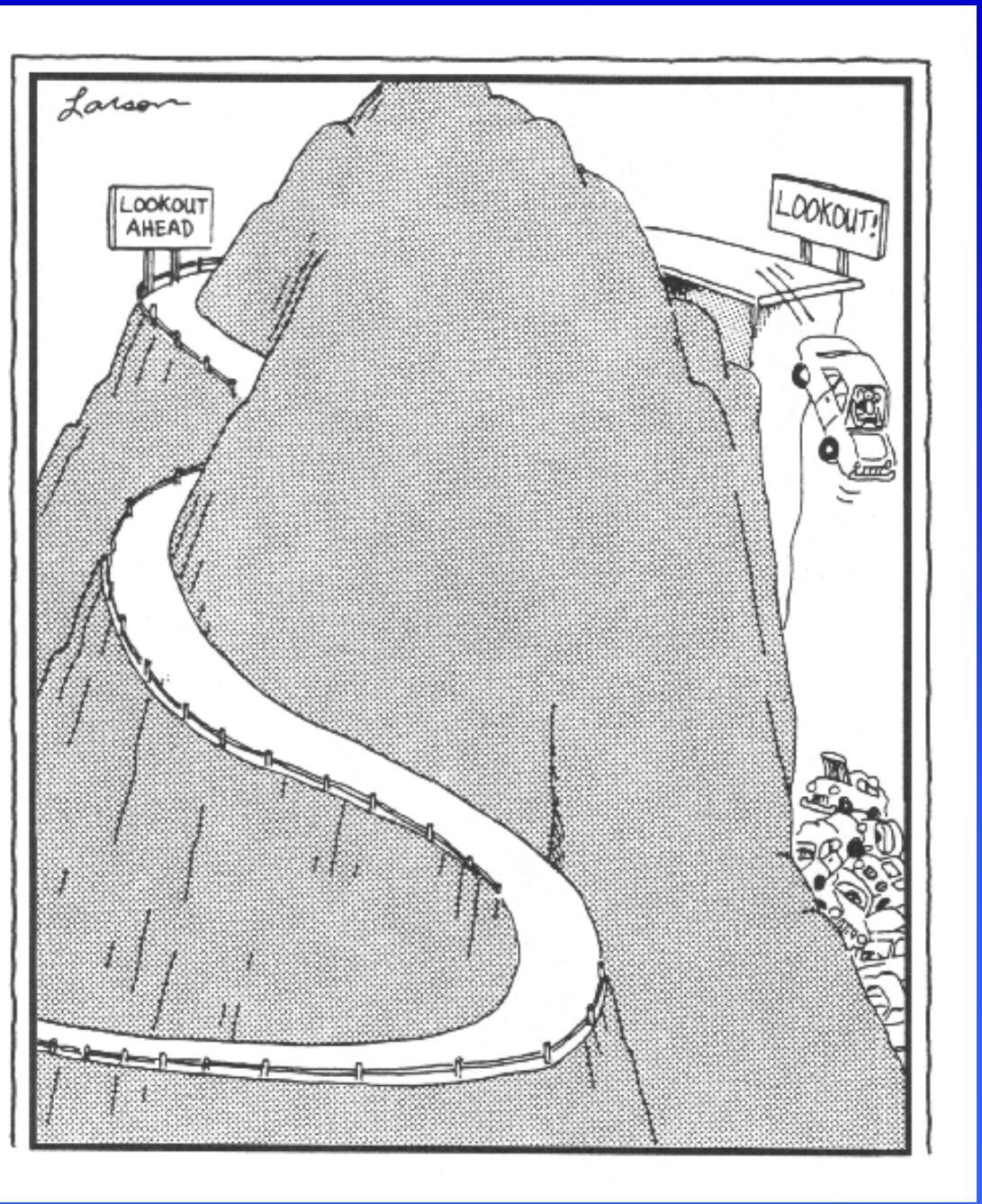

P{"DAI"} = 27.4%
T_{2050} = $174/Ton C
Density
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
1
2
3
4
5
6
Temperature Change in 2100 (ºC)

Step 2

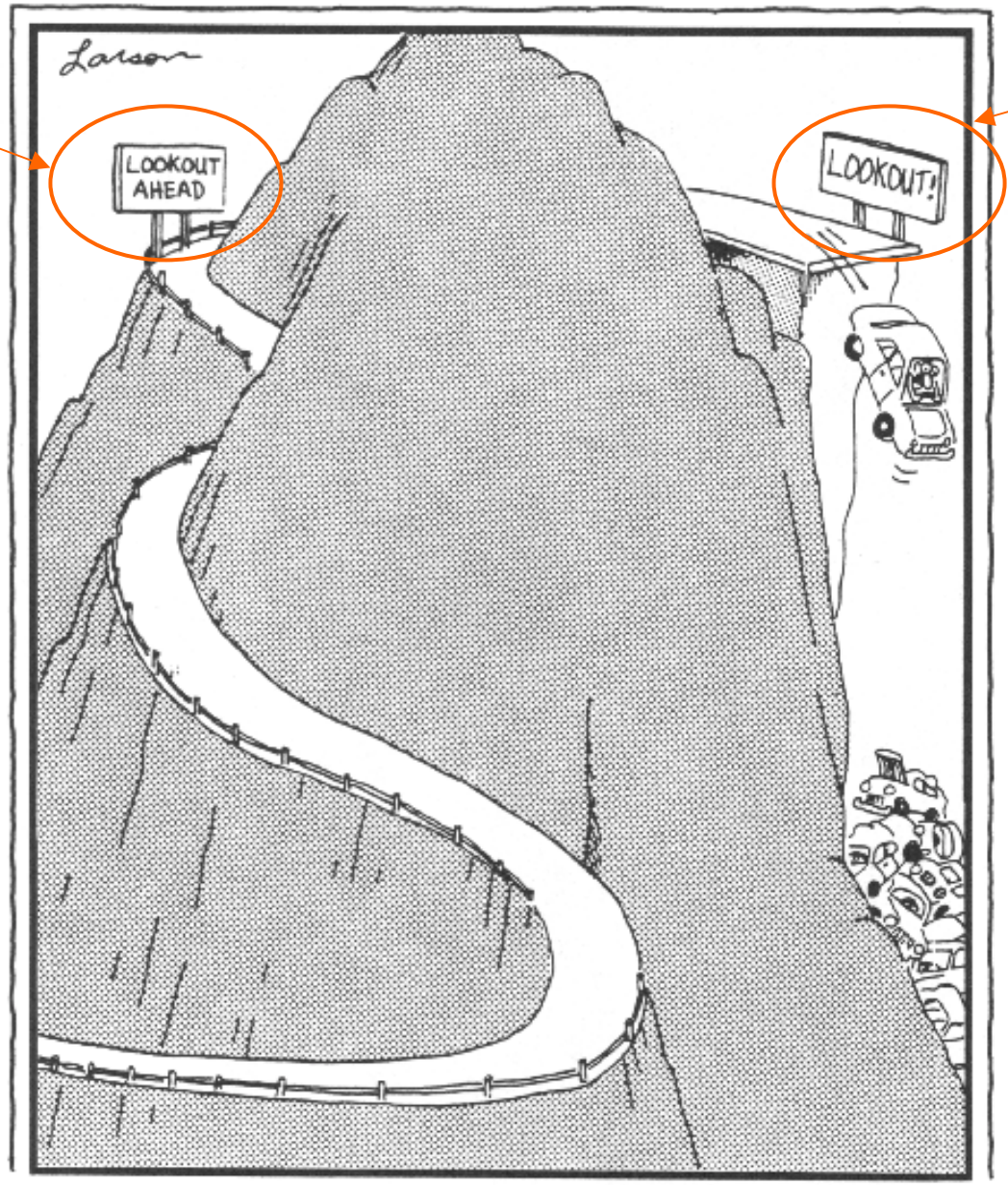

"DAI[10‰]" = 1.476°C
"DAI[25‰]" = 1.925°C
"DAI[50‰]" = 2.85°C
"DAI[75‰] = 4.025°C
Probability of "DAI"
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
50
100
150
200
250
300
350
400
Carbon Tax 2050 ($/Ton C)

What Does it all Mean?

- What is an “acceptable risk” of “dangerous” climate change?
- ~45% risk of “dangerous” climate change?
- “Climate insurance” will reduce risk to acceptable level



Current Information



"Dangerous" Change Threshold

Thank You!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