A New MIT Assessment of Climate Change Risk

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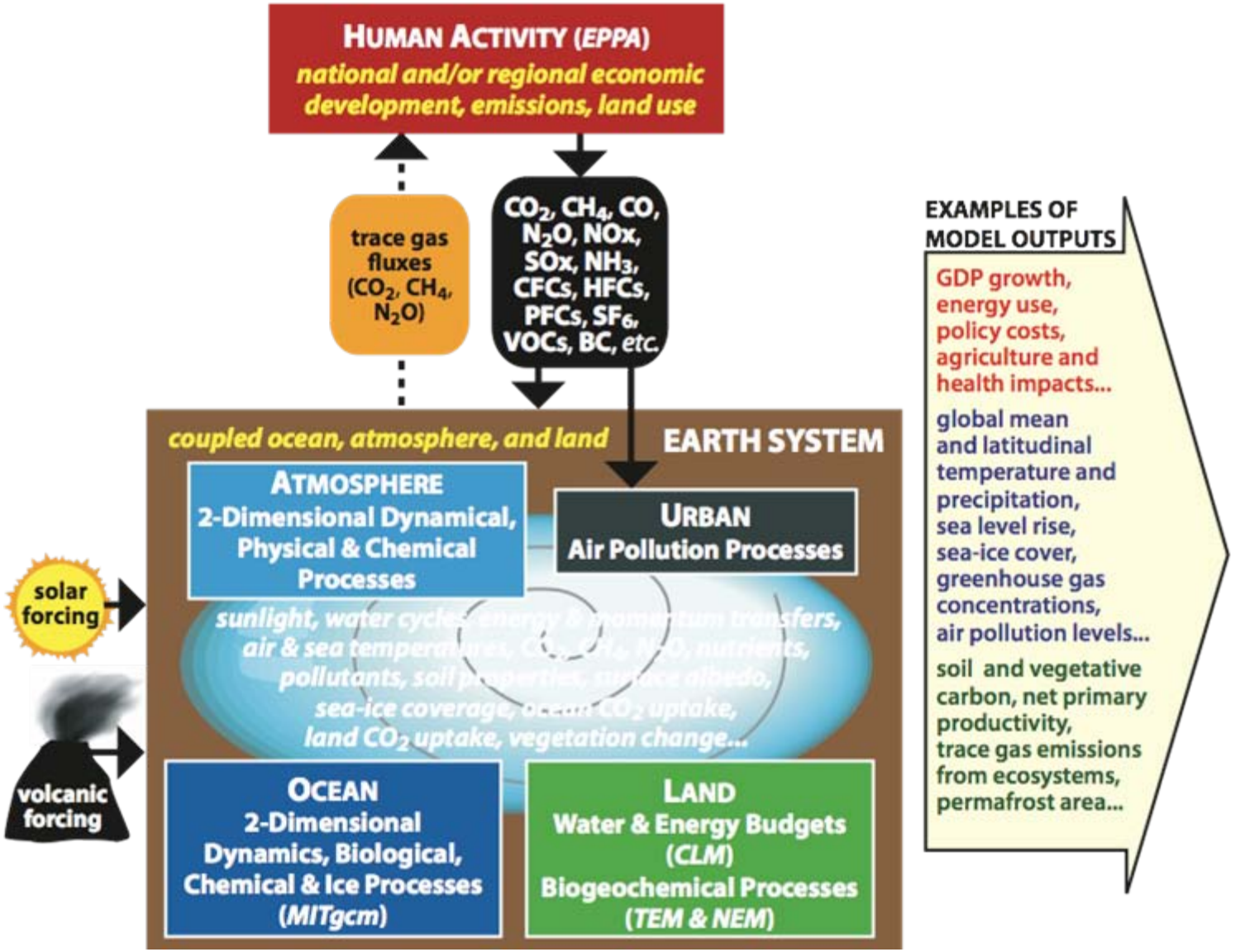
The Message

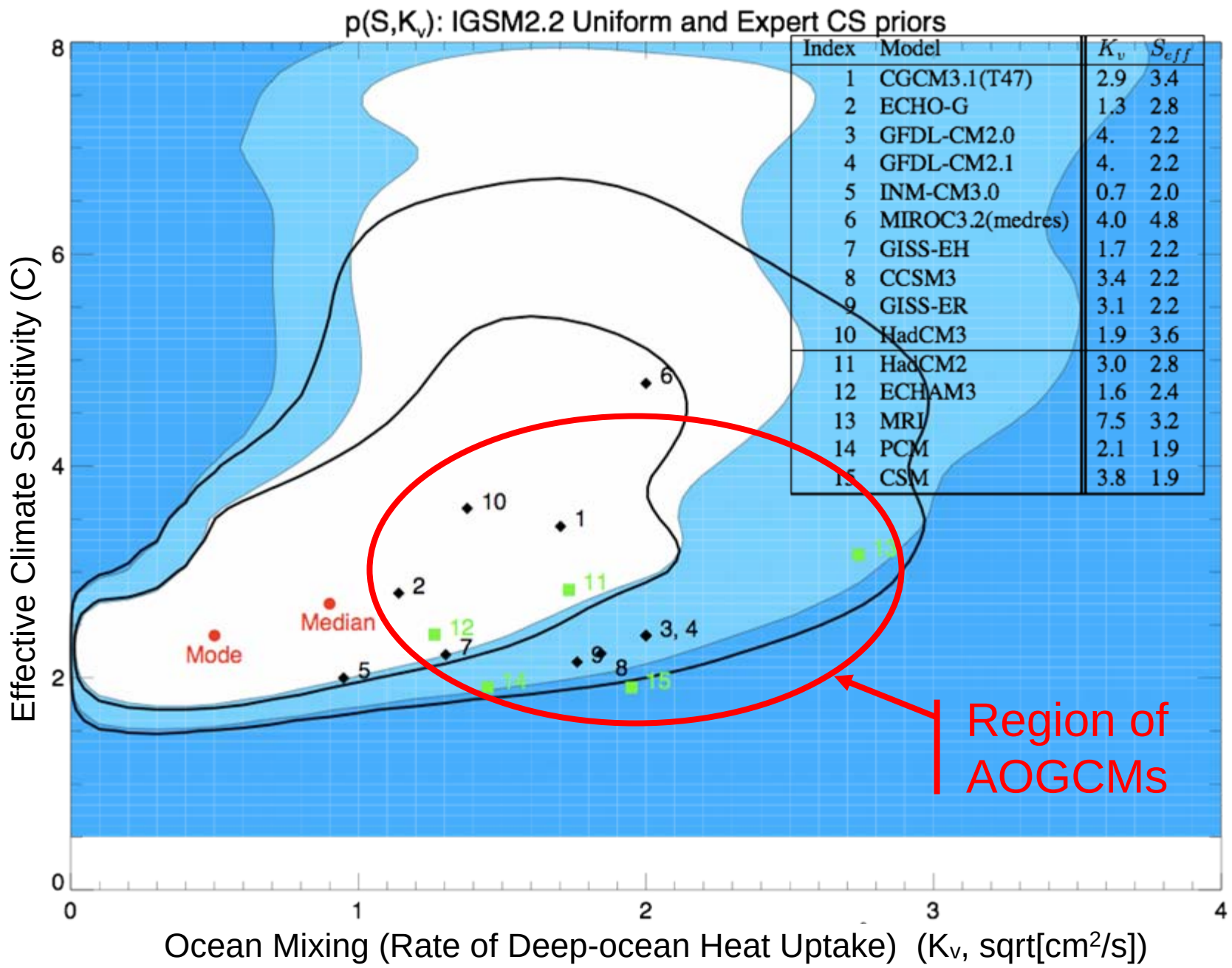
- Existing AOGCMs do not cover the full range of uncertainty in climate sensitivity and ocean heat/CO_2 uptake
- The risk of change in the 21st Century is higher than
  - Our earlier MIT analysis
  - The impression given by IPCC results
- We will continue to learn
  - Results contingent on MIT models
  - But . . . this is a heads-up

MIT Integrated Global System Model



Model Consistency with 20th C

- Main uncertainties in climate response
  - Climate sensitivity (C)
  - Rate of deep ocean circulation (Kv)
  - Net aerosol forcing (Fa)
- 20th Century data for estimation
  - Temperature: surface, upper air & ocean
  - Solar and volcanic forcings
  - Observations of GHG concentrations
- Estimate joint distribution, indicating realm of values consistent with history



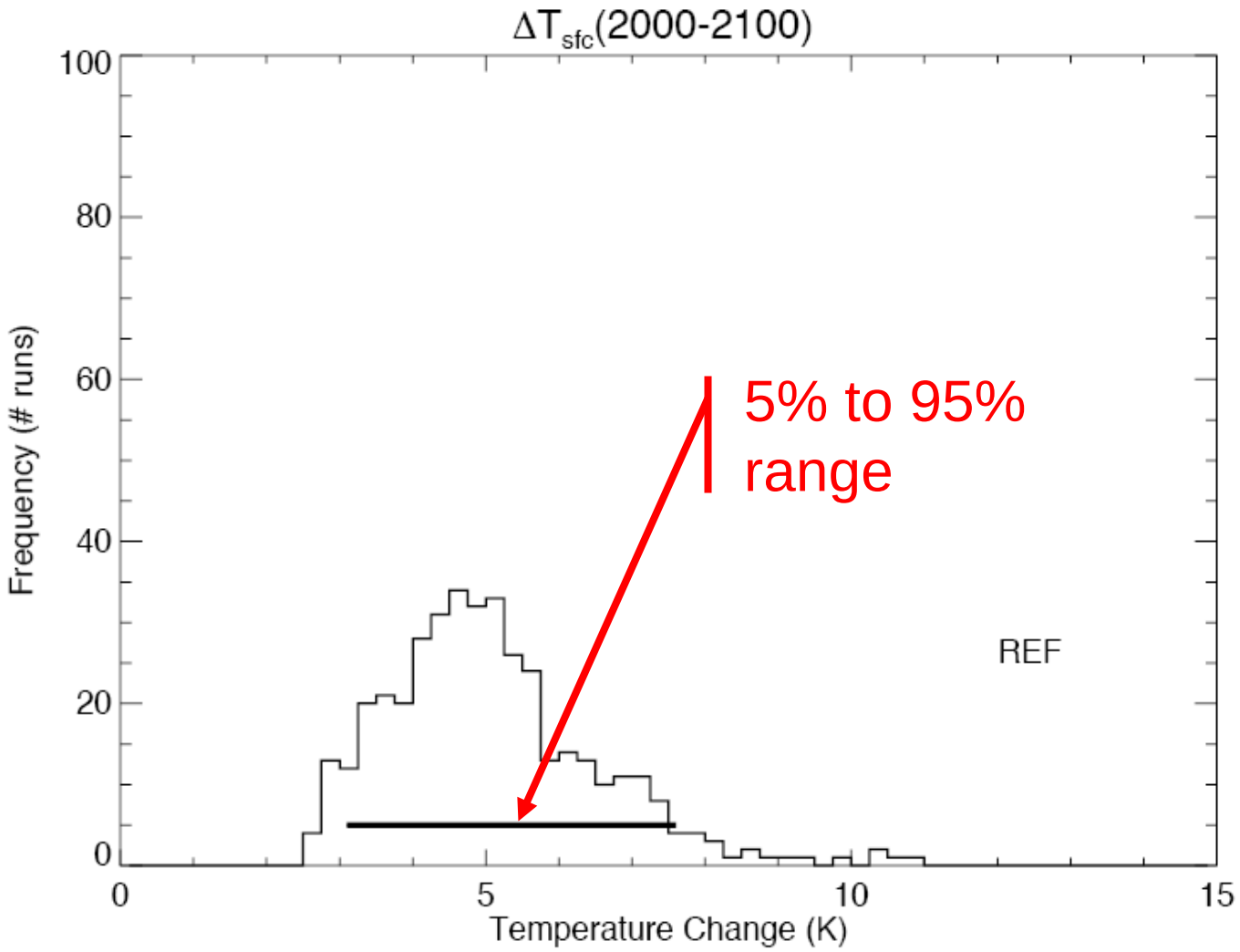
Index	Model	K_v	S_{eff}
1	CGCM3.1(T47)	2.9	3.4
2	ECHO-G	1.3	2.8
3	GFDL-CM2.0	4.	2.2
4	GFDL-CM2.1	4.	2.2
5	INM-CM3.0	0.7	2.0
6	MIROC3.2(medres)	4.0	4.8
7	GISS-EH	1.7	2.2
8	CCSM3	3.4	2.2
9	GISS-ER	3.1	2.2
10	HadCM3	1.9	3.6
11	HadCM2	3.0	2.8
12	ECHAM3	1.6	2.4
13	MRI	7.5	3.2
14	PCM	2.1	1.9
15	CSM	3.8	1.9

Projection: Included Uncertainties

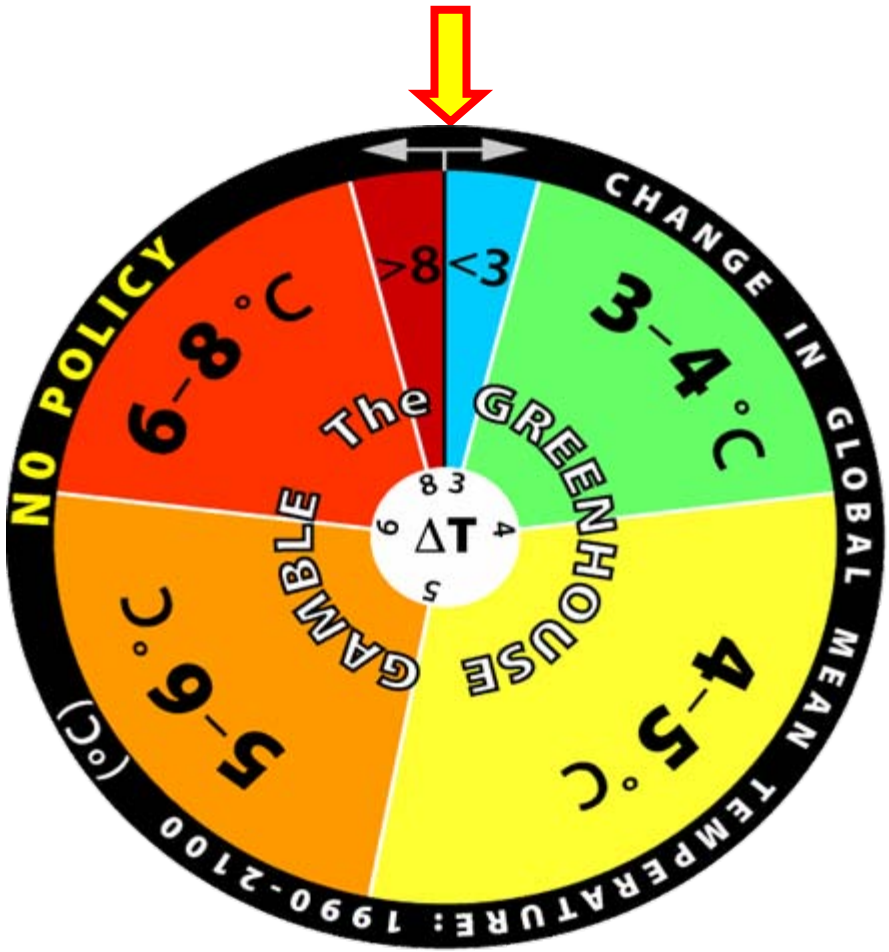
- Emissions uncertainty (from EPPA model)
- Climate system response:
  - Climate sensitivity (C)
  - Rate of deep ocean circulation (Kv)
  - Net aerosol forcing (Fa)
- Carbon cycle uncertainty:
  - Rate of carbon uptake by the deep-ocean
  - CO_2 fertilization effect on ecosystems
- Effect of precipitation frequency on natural emissions of CH_4 + N_2O

400 member ensembles

PDF of Change: No Policy



Another Way to Look at It



No policy case

Why is the Risk Higher than in Previous MIT Estimates?

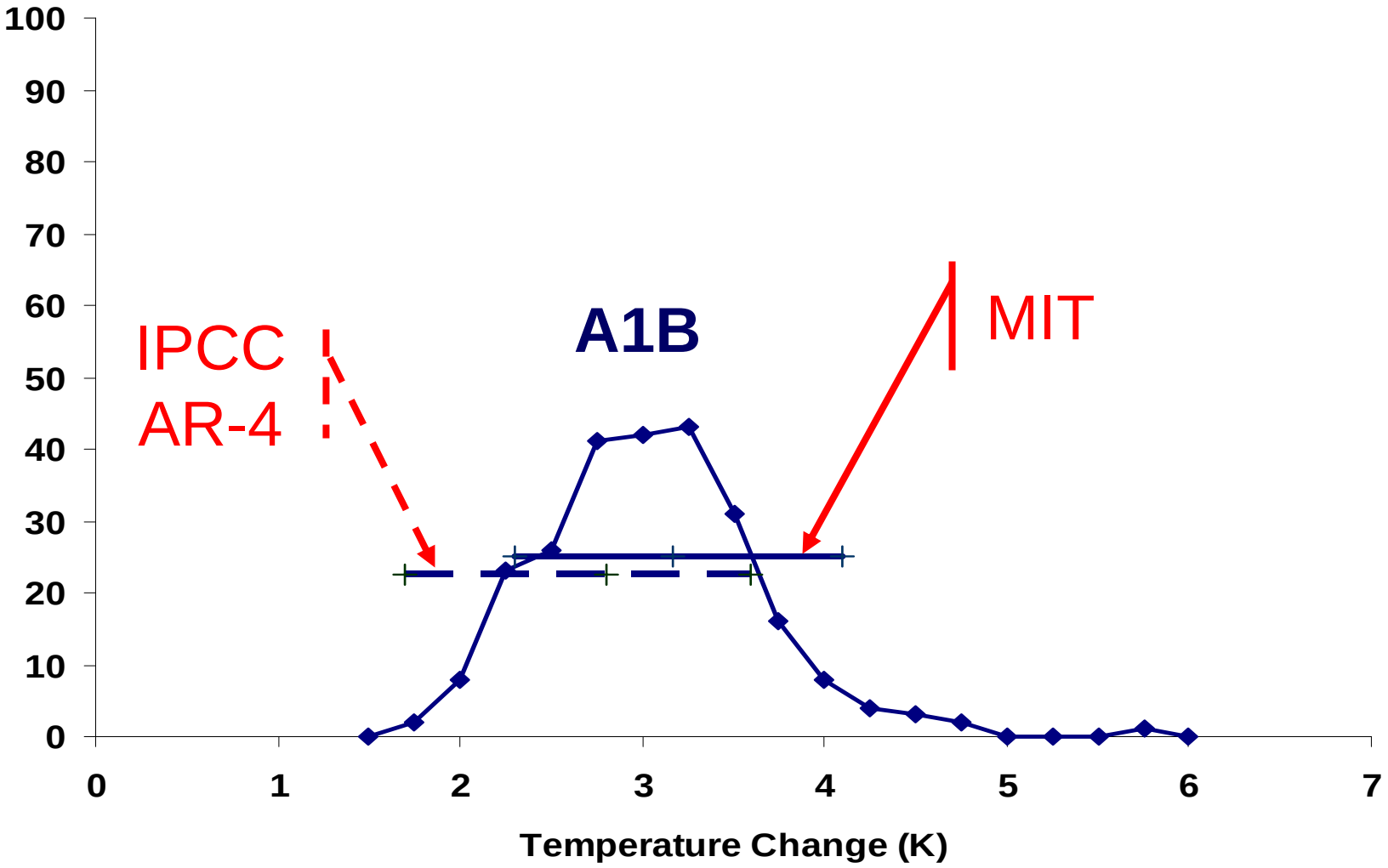
- Radiative forcing
  - Emissions (higher lower bound)
  - Reduced ocean uptake of CO_2
  - Additional forcings (black carbon, ozone)
- Climate model response
  - Slower ocean uptake of heat
- Learning
  - Distributions better defined

Comparison with the IPCC

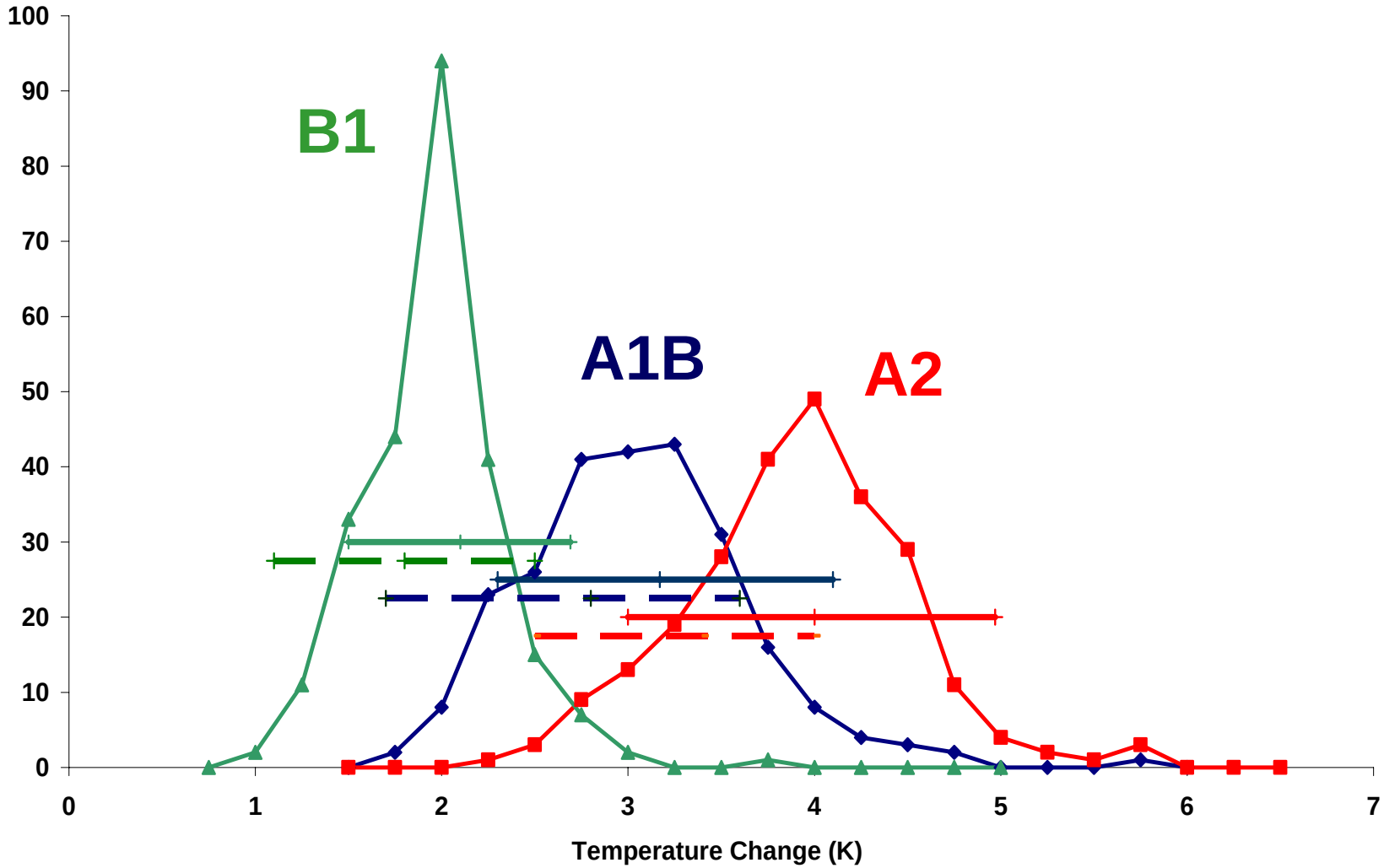
- Simulate results for SRES emissions scenarios
  - MIT estimates of parameters in model of response
  - 250 member ensembles
- Compare with 5% to 95% range published in the AR-4 (Figure TS.27)

PDFs of key parameters from MIT Analysis and AOGCM values from the IPCCC AR-4

Comparison with the IPCC
(MIT PDF & 5% to 95% ranges)



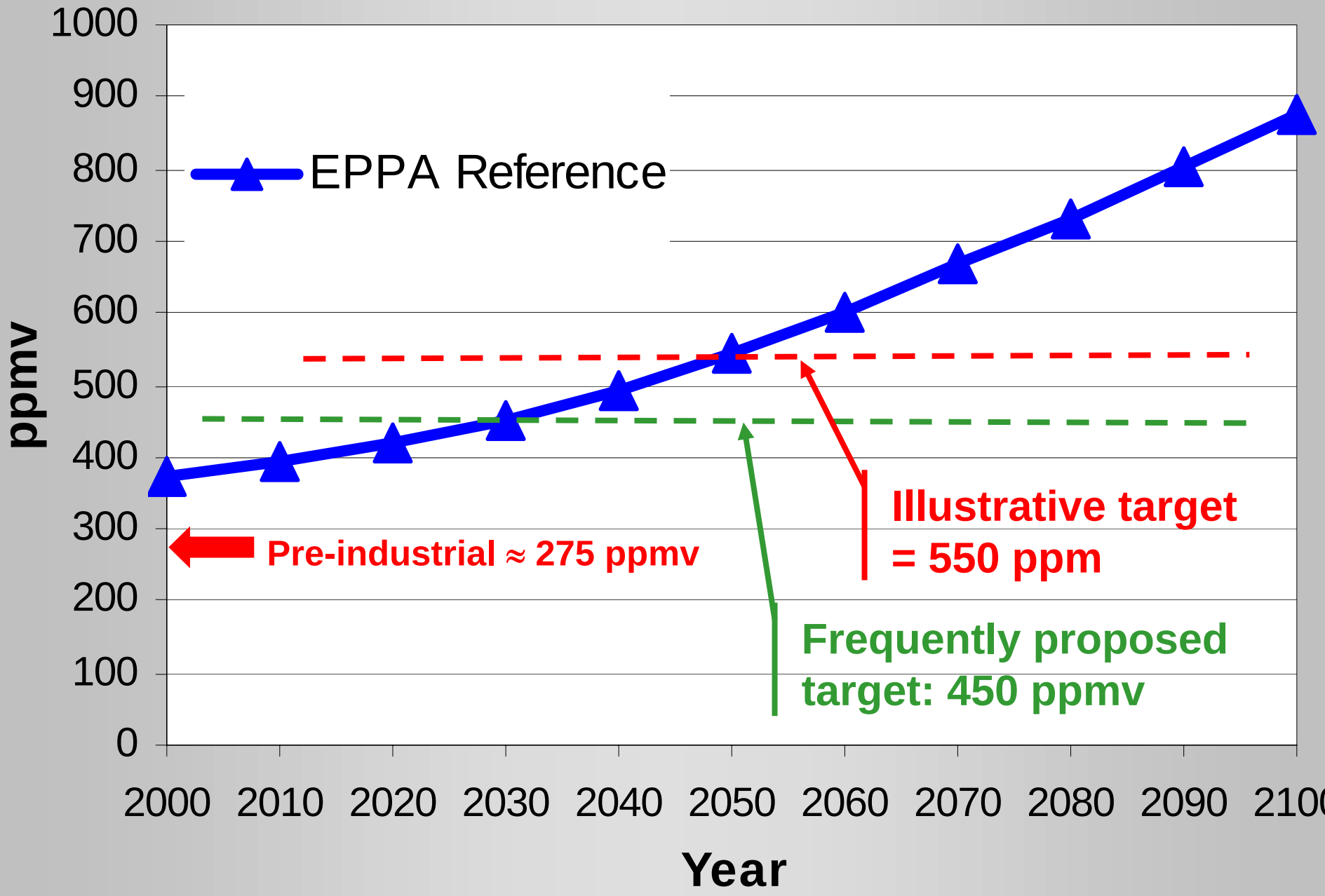
Comparison with the IPCC



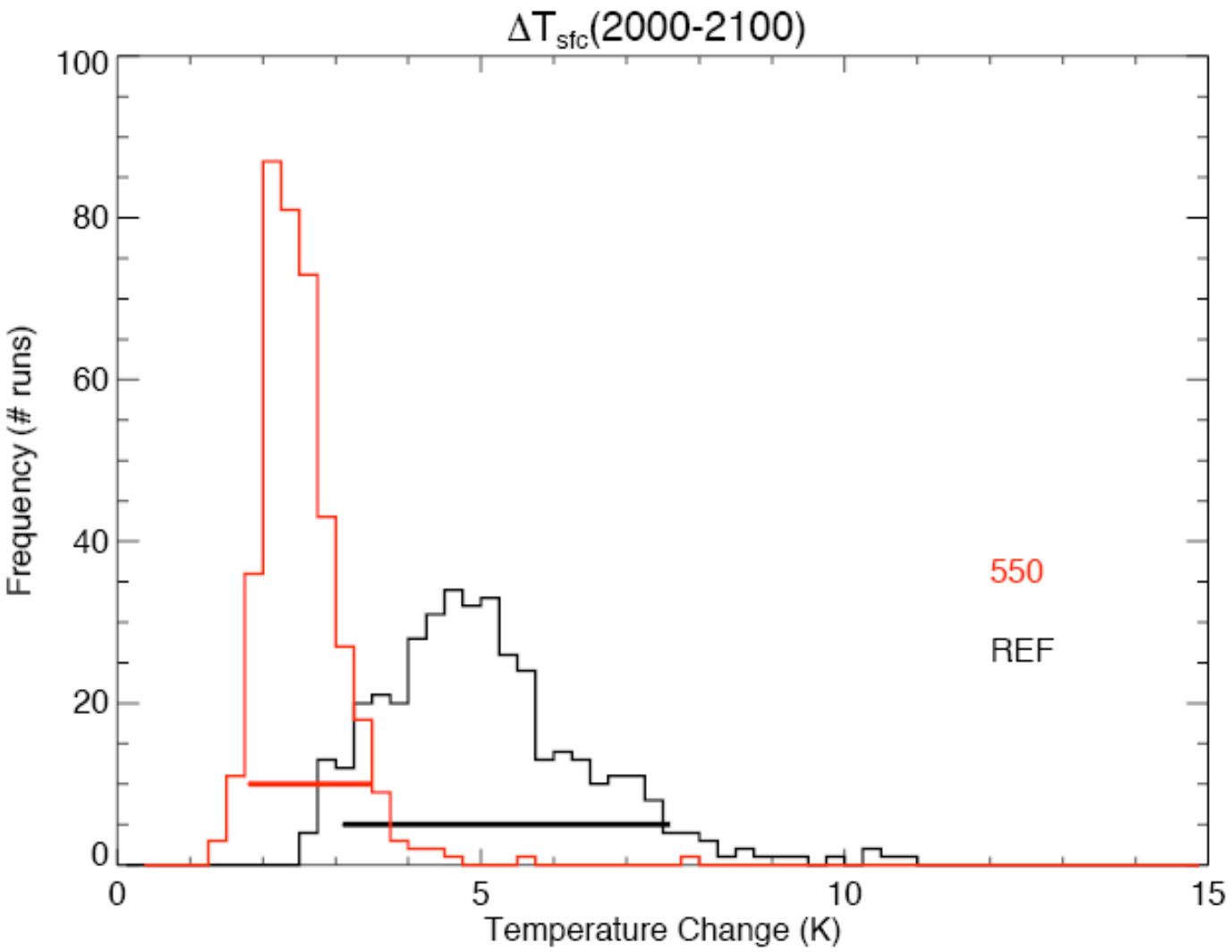
What Effect of Climate Policy?

- Return to MIT analysis alone
- Comparison
  - Reference (no policy) case, as above
  - Stabilization case that corresponds to 550 ppmv atmospheric CO2 stabilization (from study for US Climate Science Research Program)
- Again, 400 member ensembles

CO2 Concentrations

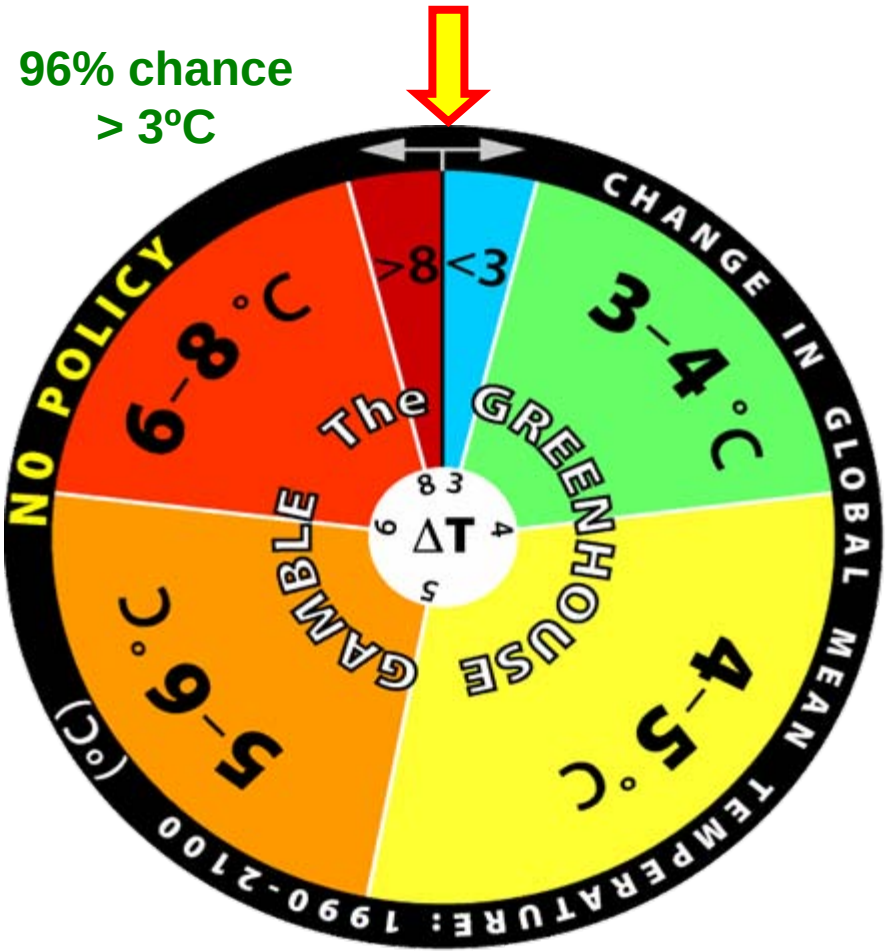


PDF of Change: No Policy & 550 ppm

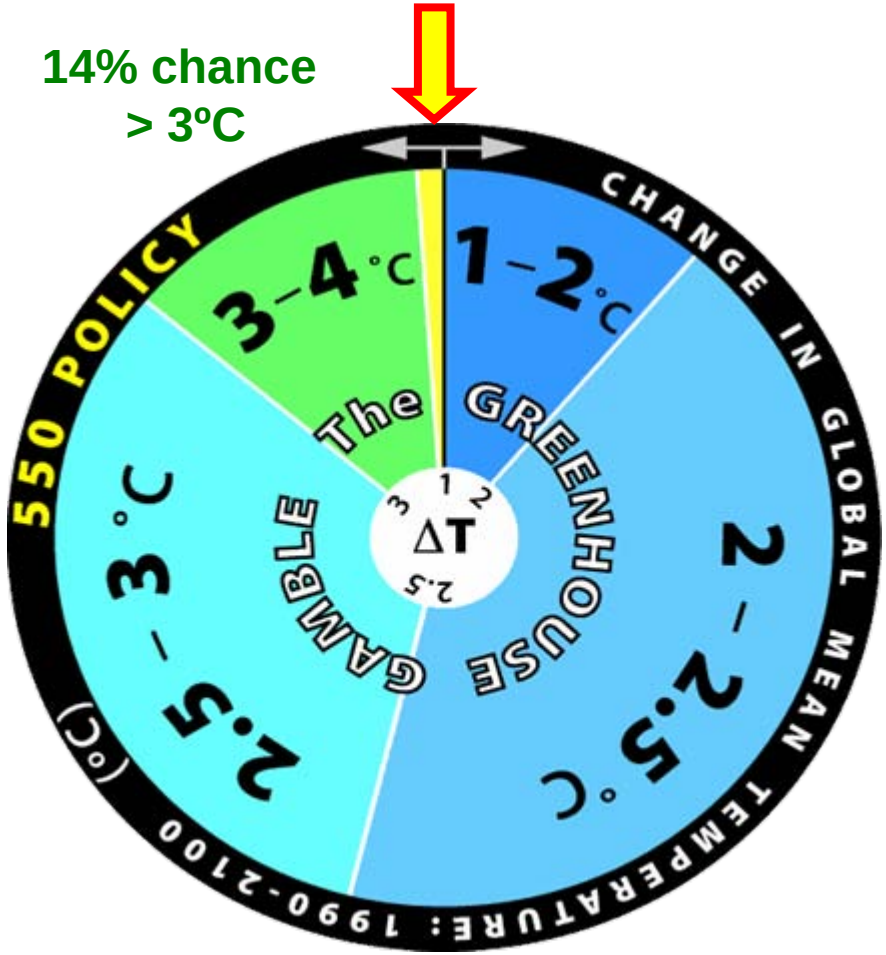


The Greenhouse Gamble

96% chance
> 3ºC



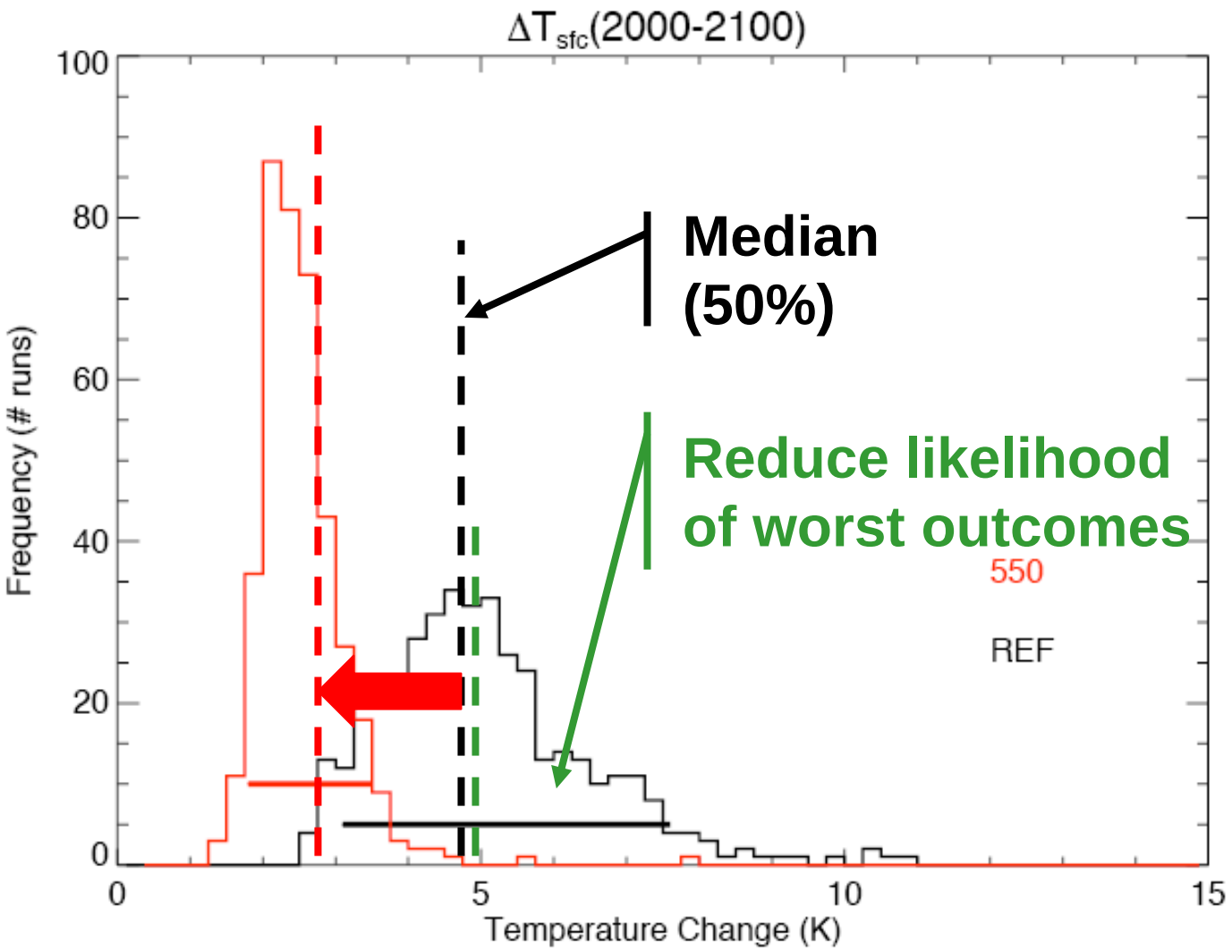
14% chance
> 3ºC



No policy case

550 ppmv stabilization

Focus on the Tails!



Prefer to Think in Terms of Odds?

- A century-scale risk management problem
- The risk builds with time
- Modest mitigation reduces odds of worst outcomes

INCREASE OVER PRE-INDUSTRIAL	WITHOUT POLICY	550 ppm	650 PPM	750 ppm
>4 °C	4 in 5	1 in 20	1 in 5	3 in 5
>6 °C	1 in 3	<1 in 400	1 in 200	1 in 50

An Emerging Litany

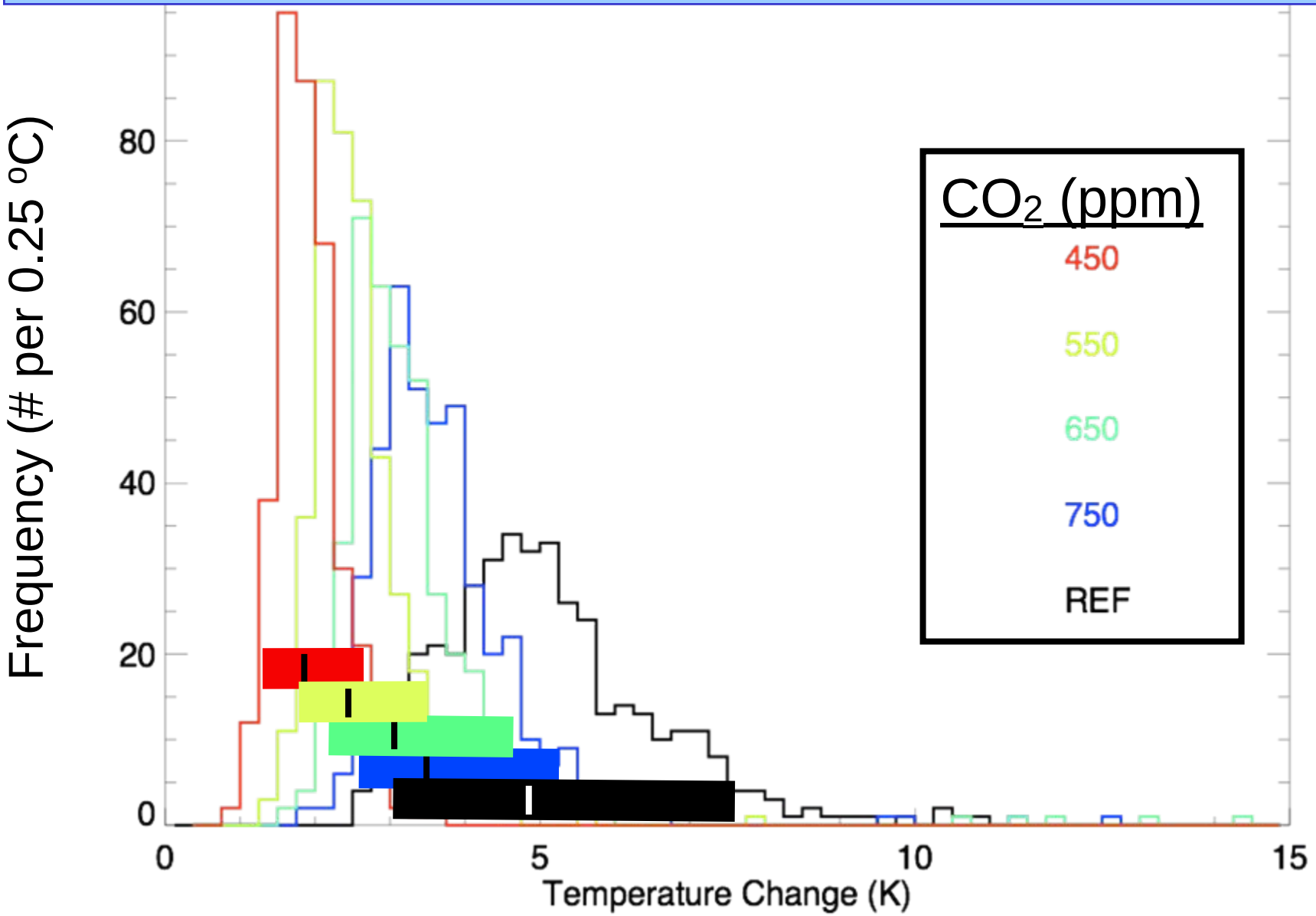
- It's not "proven"
  - Wrong concept! Not a true/false question, but an issue of climate change risk
- It's not that serious
  - At any level, it is serious for some, and high risk for many
- It's too expensive to correct
  - Methods to manage cost risk are available
- It's too late. Can't "solve" in any case
  - Only for arbitrary targets, not for efforts to manage worst social/environmental risks

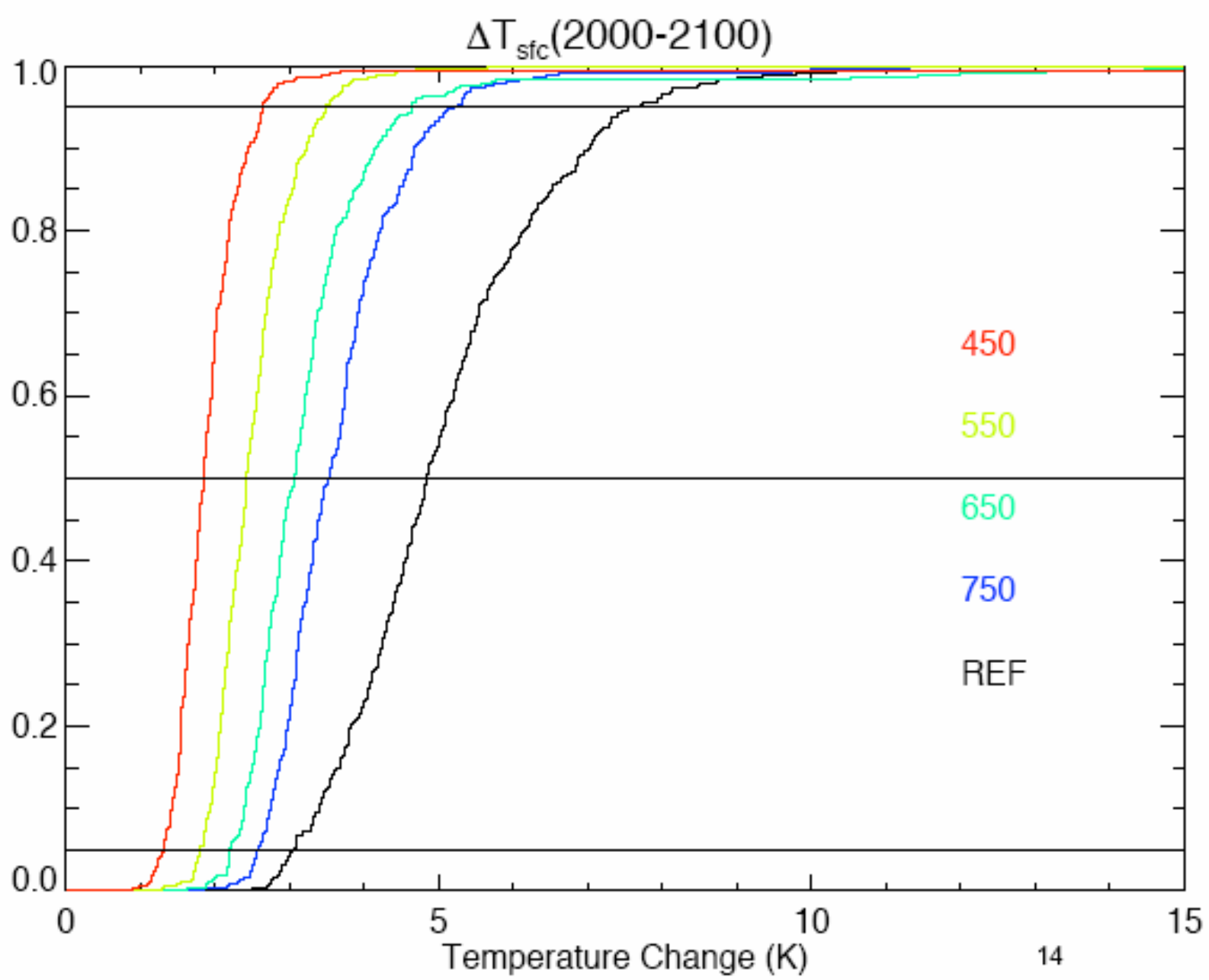
Thank You!

For more on these analyses, see

web.mit.edu/globalchange/

Frequency Distributions for Temperature Change, 2000 to 2100, under **No Policy** and **Stabilization** Scenarios




ΔT sfc (2000-2100)
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
Temperature Change (K)
450
550
650
750
REF