Probabilistic Assessment of "Dangerous" Climate Change and Emissions Scenarios

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Avoiding Dangerous Climate Change

Exeter, UK

PDF Generation

- $\Delta TEQ = (\Delta F/\Delta F2x) \times \Delta T2x$

- ΔTEQ = Equilibrium temperature increase above pre-industrial
- ΔF = Radiative forcing stabilisation level
- $\Delta F2x$ = Radiative forcing for a doubling of CO_2
- $\Delta T2x$ = Climate sensitivity

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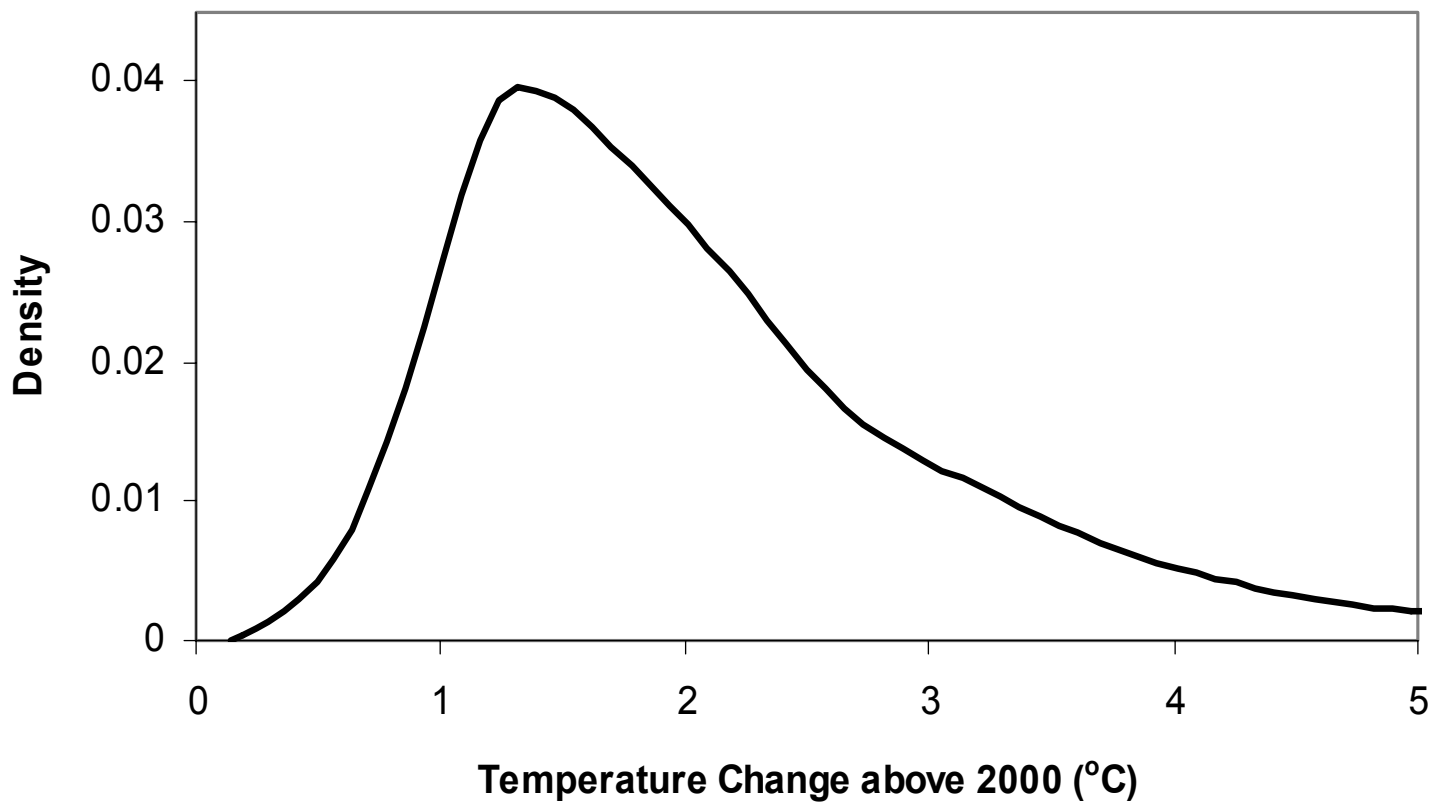
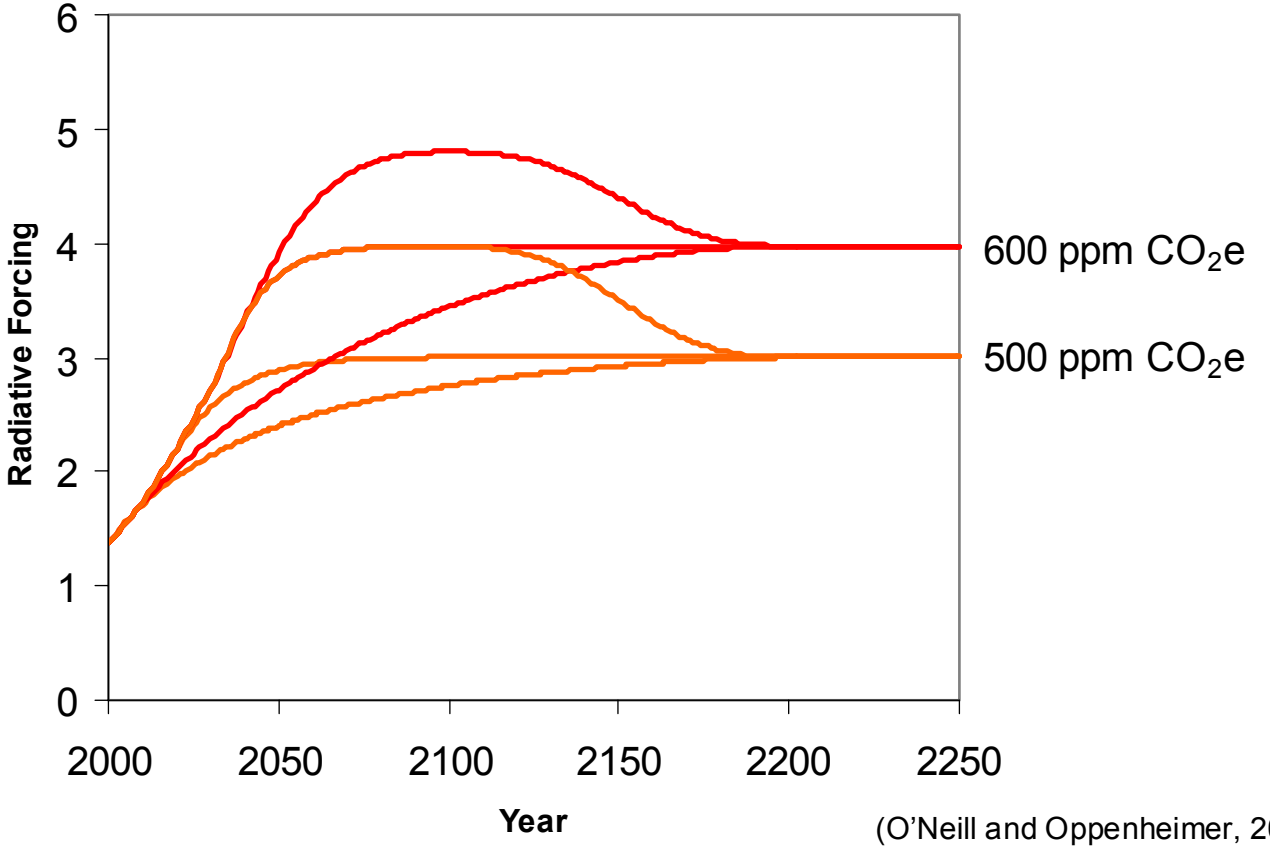
PDF Generation



Emissions Scenarios



(O'Neill and Oppenheimer, 2004)

Climate Model

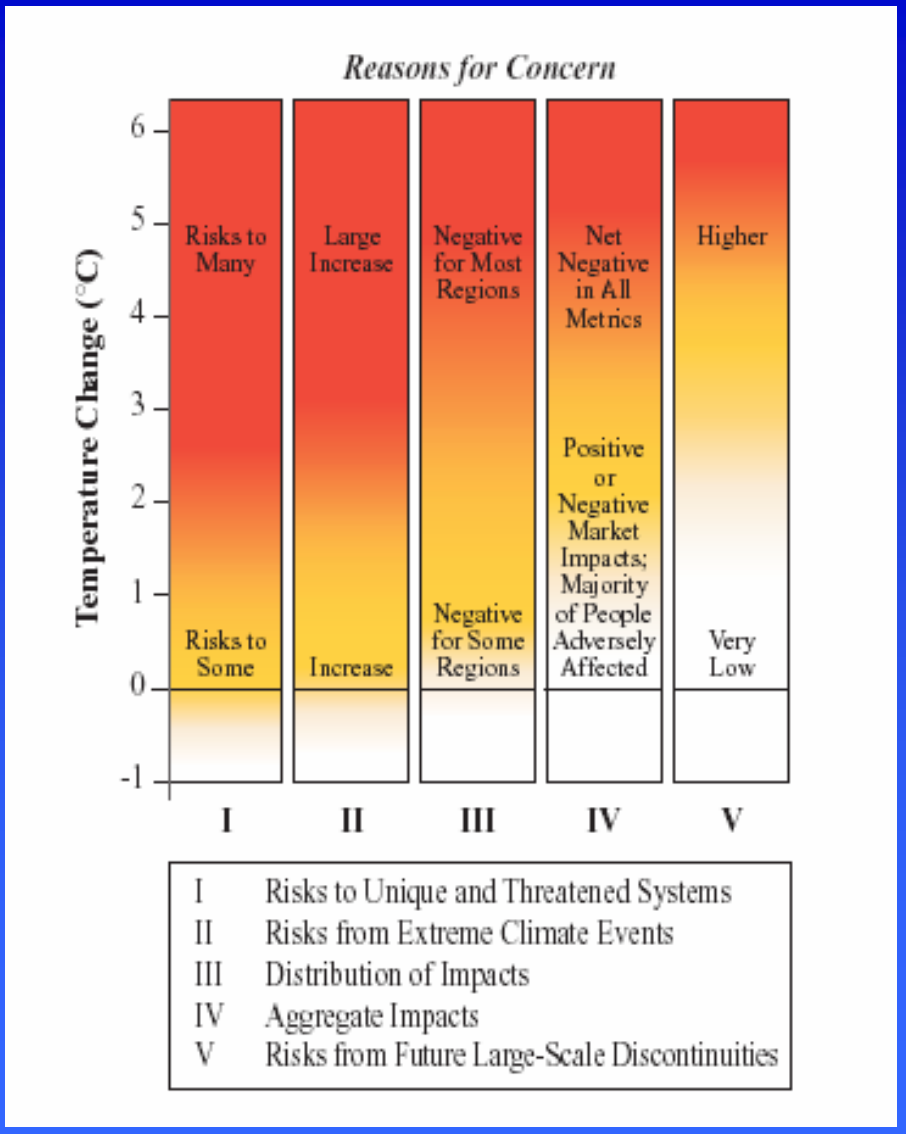
$$T(t) = T(t-1) + \sigma_1\{F(t) - \lambda T(t-1) - \sigma_2[T(t-1) - T_{LO}(t-1)]\}$$

$$T_{LO}(t) = T_{LO}(t-1) + \sigma_3[T(t-1) - T_{LO}(t-1)]$$

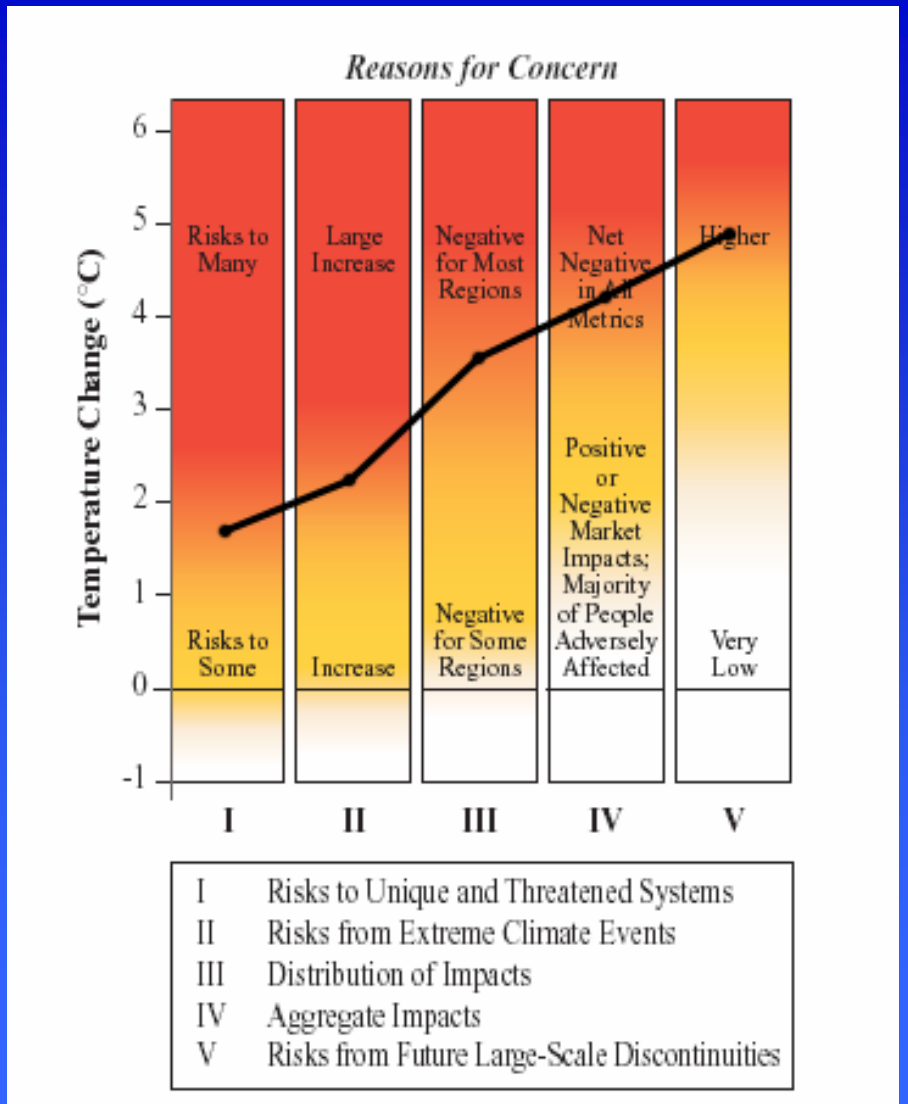
- $T(t)$ = Upper Box temp
- $T_{LO}(t)$ = Lower Box temp
- $F(t)$ = Radiative Forcing

Source: Thompson and Schneider, 1981 as used by Nordhaus, 1994

Reasons for Concern



(IPCC TAR, 2001)

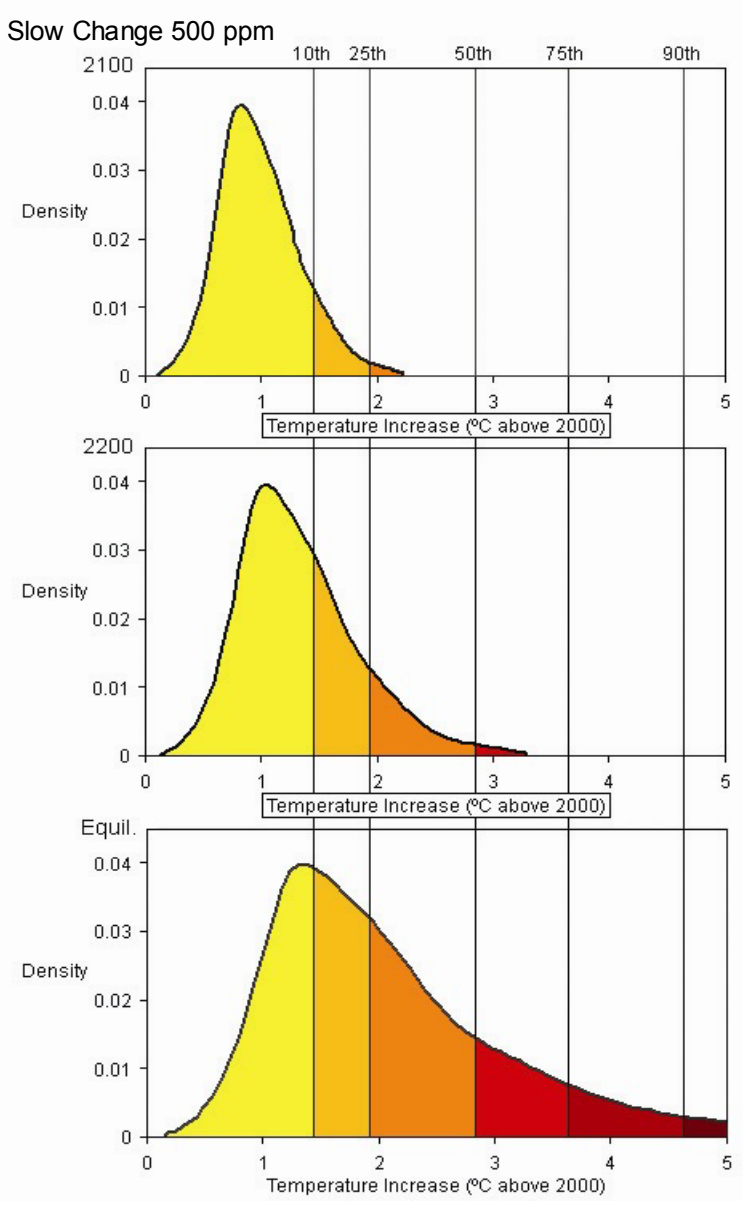


"Dangerous" CDF

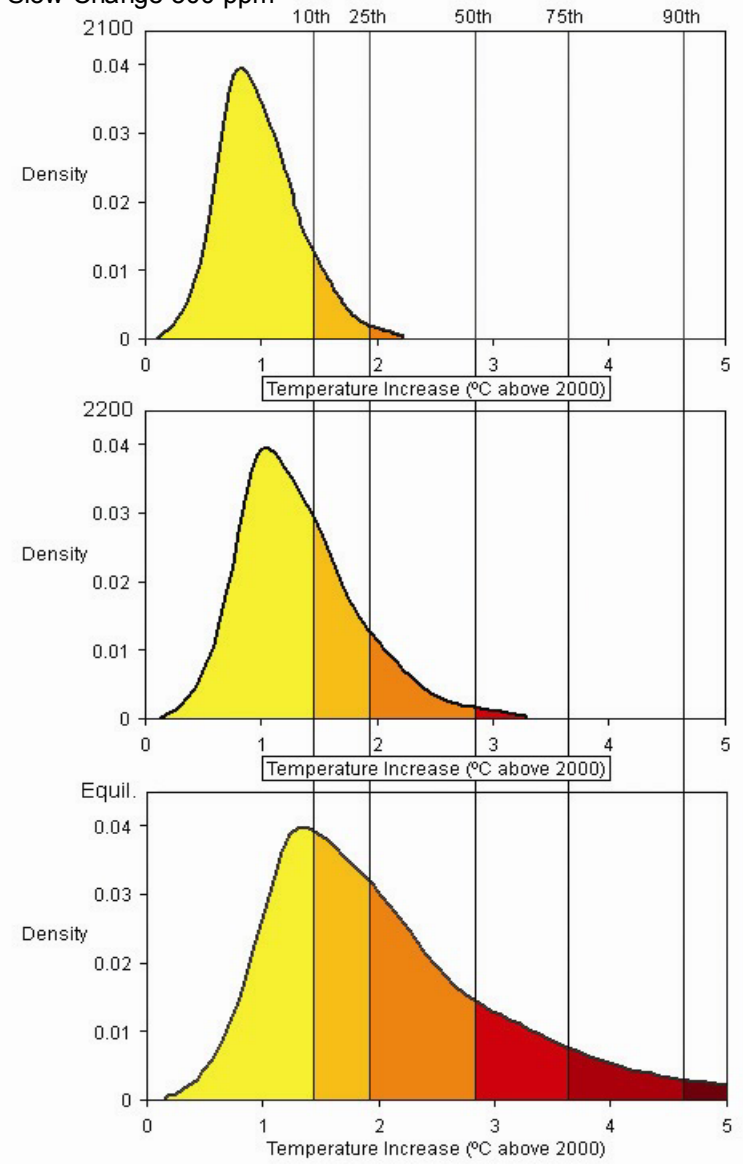
20th ‰: 1.8ºC
50th ‰: 2.85ºC
80th ‰: 4.2ºC

(IPCC TAR, 2001)

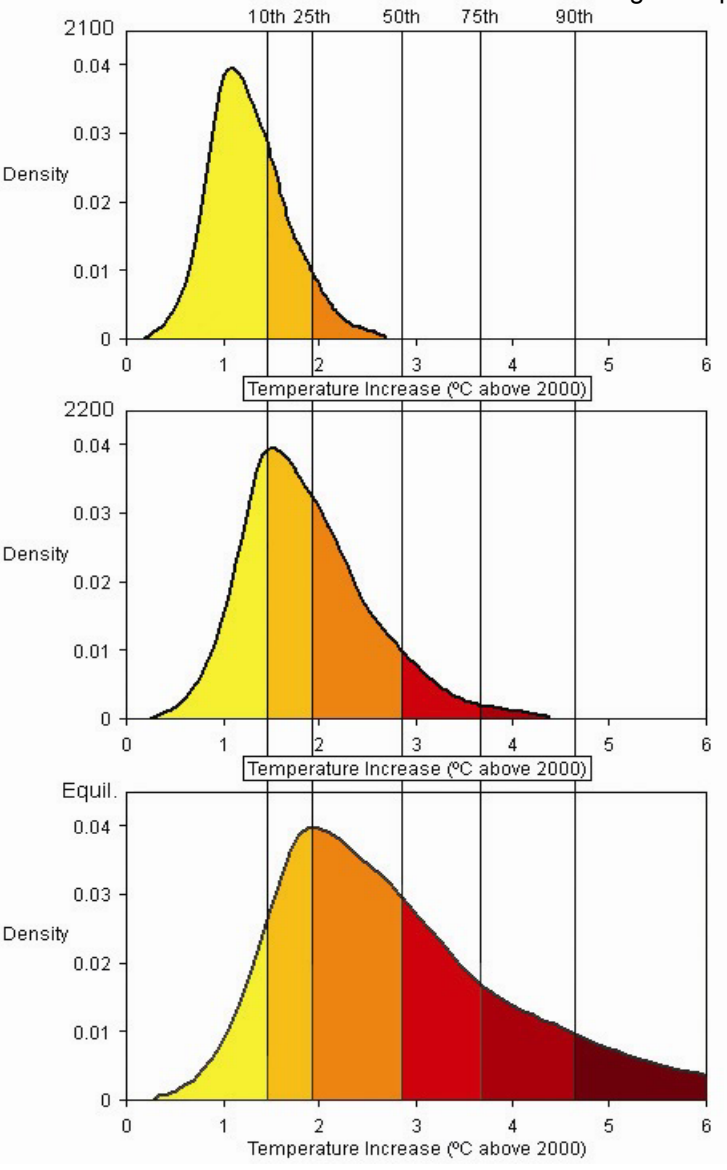
Slow Change 500 ppm



Slow Change 500 ppm



Slow Change 600 ppm



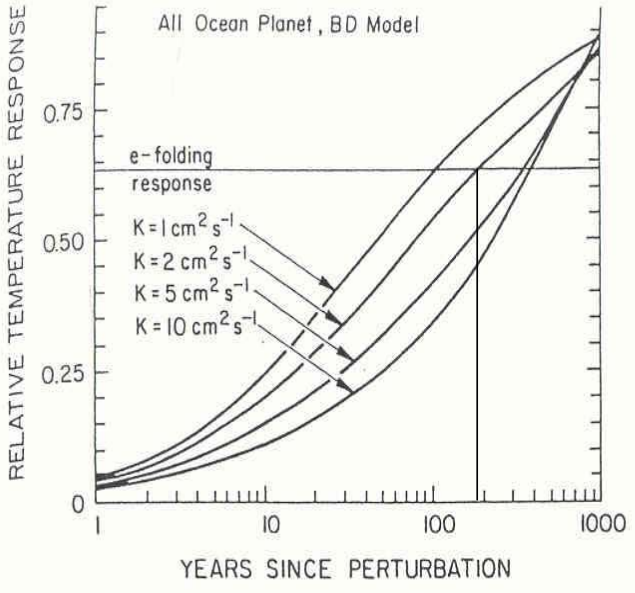


Fig. 1. Transient response of a BD model for an all-ocean planet, with an equilibrium mixed layer sensitivity for CO_2 doubling of 4.2°C, as the ocean diffusivity K varies from 1 to 10 $cm^2 s^{-1}$.

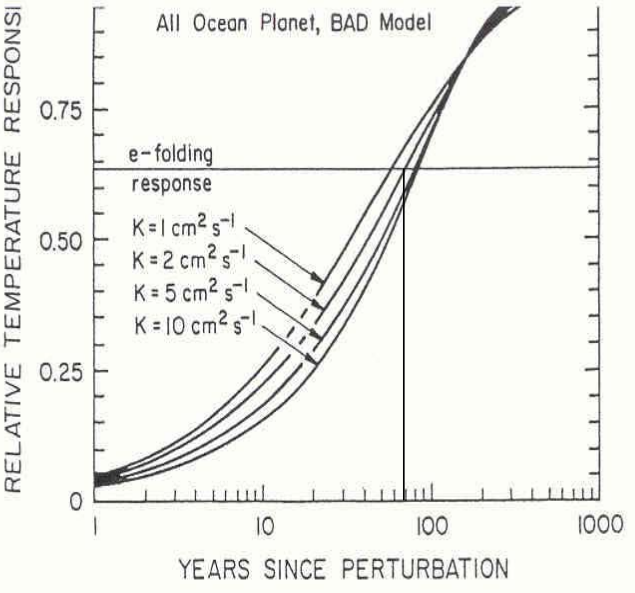
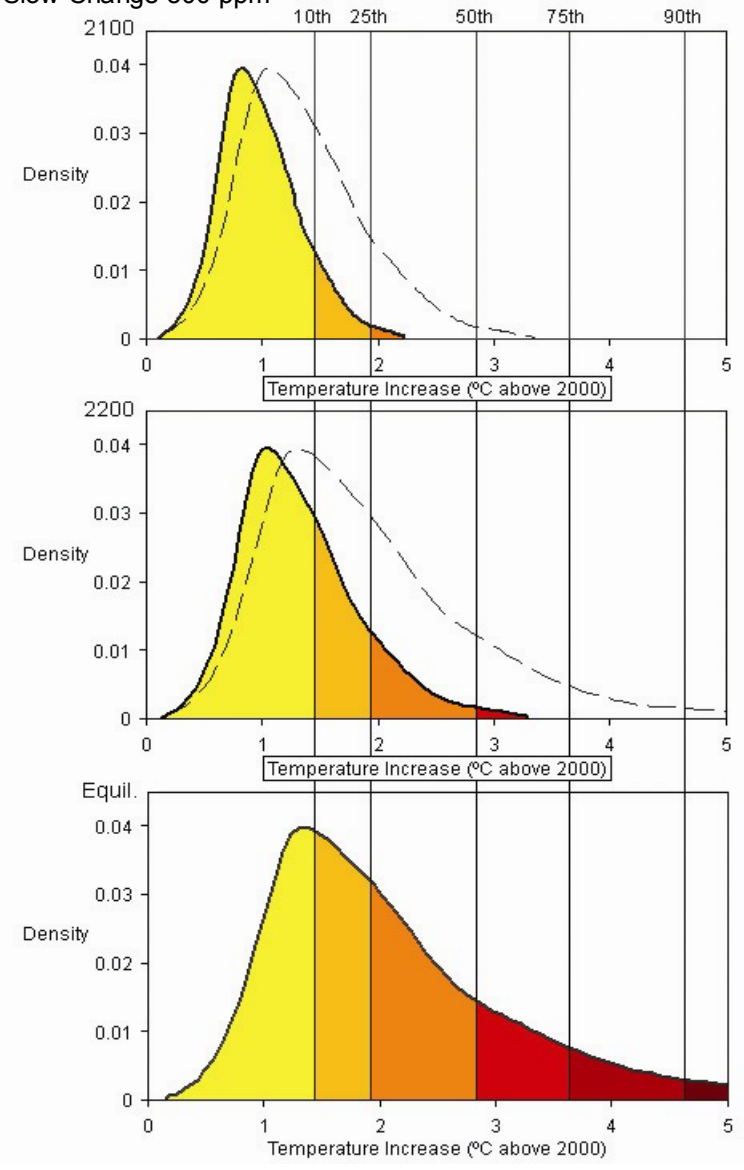


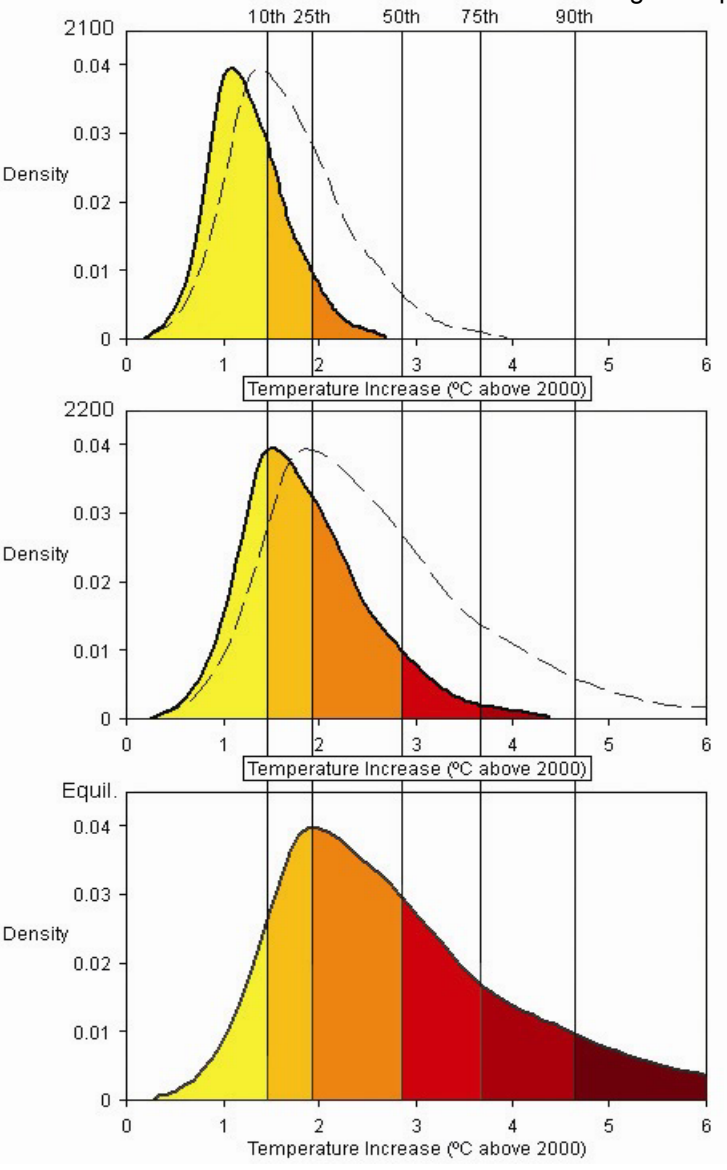
Fig. 2. Same as Figure 1, except for a BAD model, with the advection velocity varying from 2.11×10^{-7} to 2.11×10^{-6} m s^{-1}, in proportion to K, so as to maintain a constant deep ocean temperature profile.

(From Harvey, 1986)

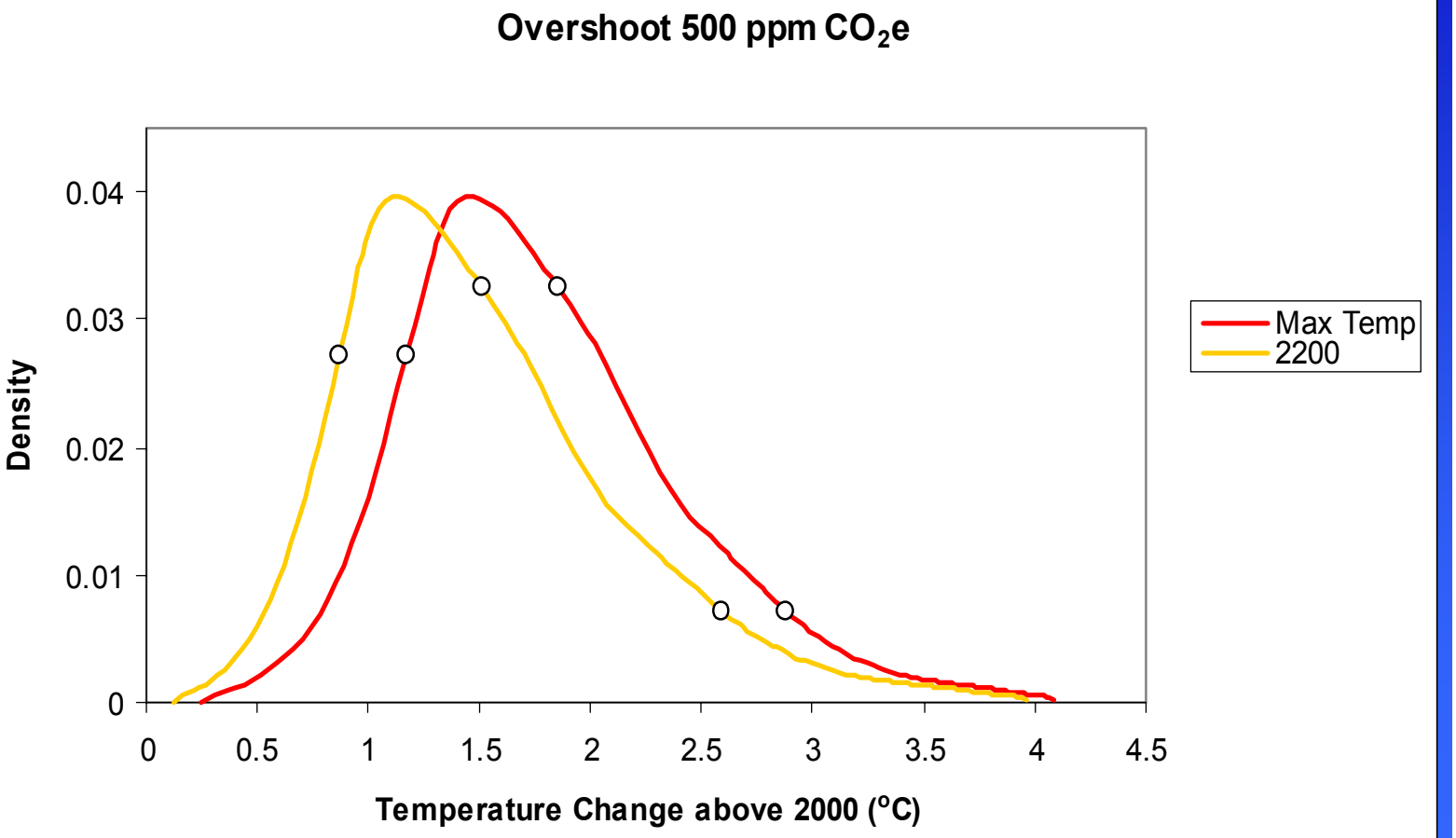
Slow Change 500 ppm



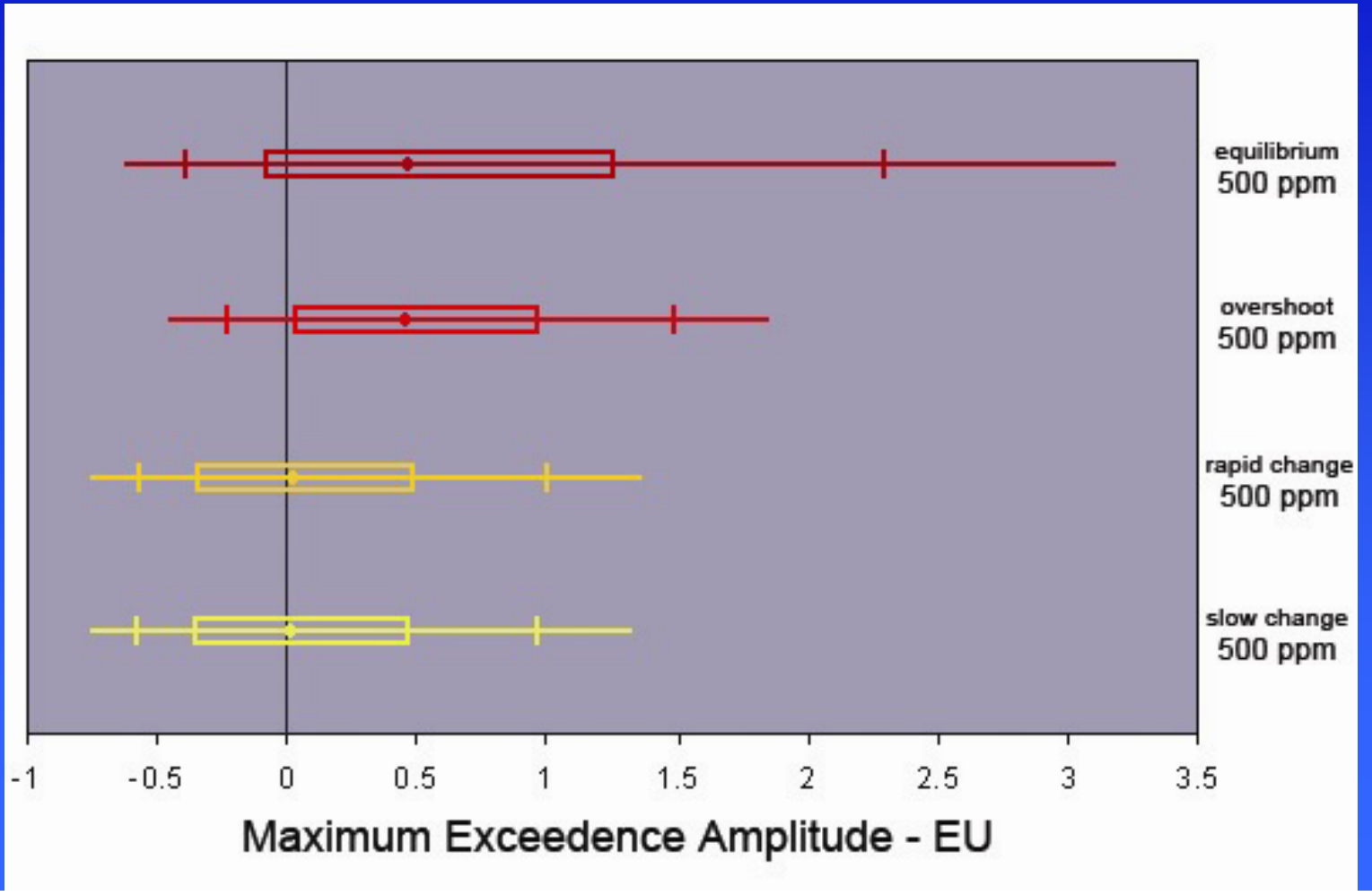
Slow Change 600 ppm



Overshoot Analysis



Maximum Exceedence Amplitude - EU



Conclusions

- Climate system uncertainty precludes one-to-one linkage of stabilisation level and temperature increase.
- Probabilistic analysis of potential for threshold exceedence necessary in stabilisation decision making.
- Shape of emissions profile important in determining risk of dangerous climate impacts.
- Modeled transient response to emissions profile sensitive to ocean model formulation.

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