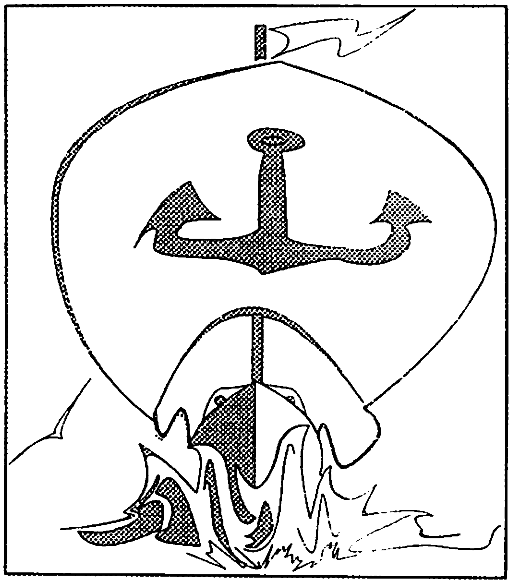
ECONOMETRIC MODELS OF GLOBAL WARMING EMISSIONS SCENARIOS - AN OCEANOGRAPHIC PERSPECTIVE



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Econometric Models of Global Warming Emission Scenarios-an Oceanographic Perspective

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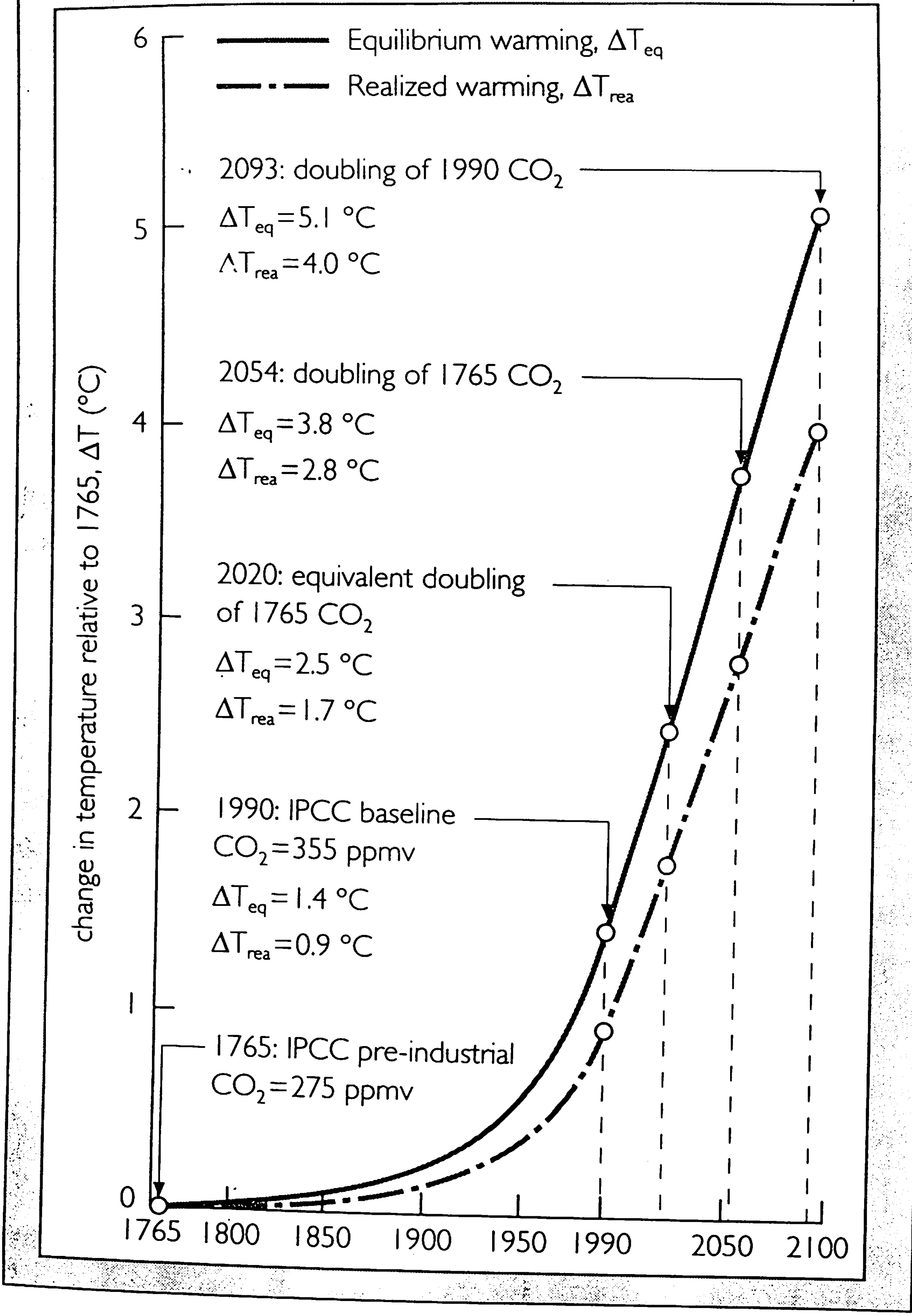
74 econometric models of greenhouse gas emissions (carbon dioxide, methane, nitrous oxide) have been identified by Japanese researchers by Model name, developer/s, type, forecast period, and assumptions. Currently the UN Panel on Climate Change is evaluating various emissions scenarios with respect to (1) non-intervention [no policy action]; (2) effect on environment and climate; (3) costs of mitigation by region and economic sector with time; (4) potential criteria for emission reductions by country and geographic region. Evaluation is needed to suggest the proper inputs to both econometric models and global climate models to assist policy makers/planners to recommend appropriate political action on both a global and local scale. Most of the significant land-based anthropogenic parameters have been identified and even quantified in industrialized countries in temperate regions. However, in the tropics, areally far larger than the temperate and polar regions,significant non-industrial anthropogenic activities, i.e. deforestation and agricultural burning, are poorly understood. Also, the feed-back of the models into climatic "mitigation" suffers from the lack of time series for both natural land and ocean based cycles of the greenhouse gases. Econometric models emphasize industrial inputs and must assume either a neutral or simple natural background signal. Our growing knowledge of natural aperiodic interannual signals such as ENSO suggest that fluctuations in oceanic outgassing and absorption of greenhouse gases may obscure any short term mitigating efforts on land. Thus mitigating strategies only may have local/regional impacts, although commendable, would not seen in the global picture.

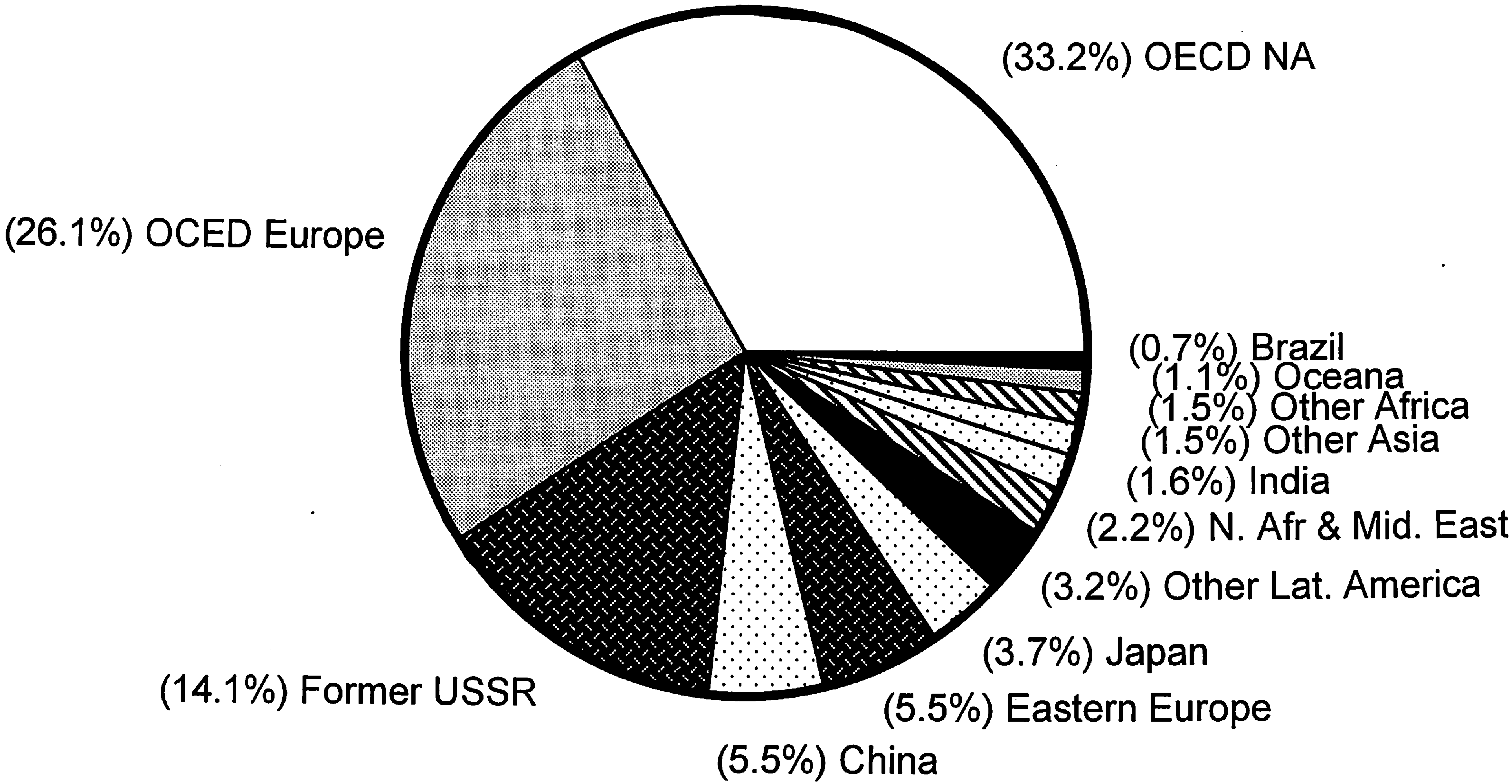
- **UN International Panel on Climate Change (IPCC) Working Group III evaluating emissions scenarios with respect to**:

    - non-intervention [no policy action]
    - effect on environment and climate
    - costs of mitigation by region and economic sector with time;
    - potential criteria for emission reductions by country and geographic region


Equilibrium warming, ΔT_{eq}
Realized warming, ΔT_{rea}
2093: doubling of 1990 CO_2
ΔT_{eq}=5.1 °C
ΔT_{rea}=4.0 °C
2054: doubling of 1765 CO_2
ΔT_{eq}=3.8 °C
ΔT_{rea}=2.8 °C
2020: equivalent doubling of 1765 CO_2
ΔT_{eq}=2.5 °C
ΔT_{rea}=1.7 °C
1990: IPCC baseline
CO_2=355 ppmv
ΔT_{eq}=1.4 °C
ΔT_{rea}=0.9 °C
1765: IPCC pre-industrial
CO_2=275 ppmv
change in temperature relative to 1765, ΔT (°C)
0
1
2
3
4
5
6
1765
1800
1850
1900
1950
1990
2050
2100

Industrial CO_2

Past Contributions 1800-1988 in percent



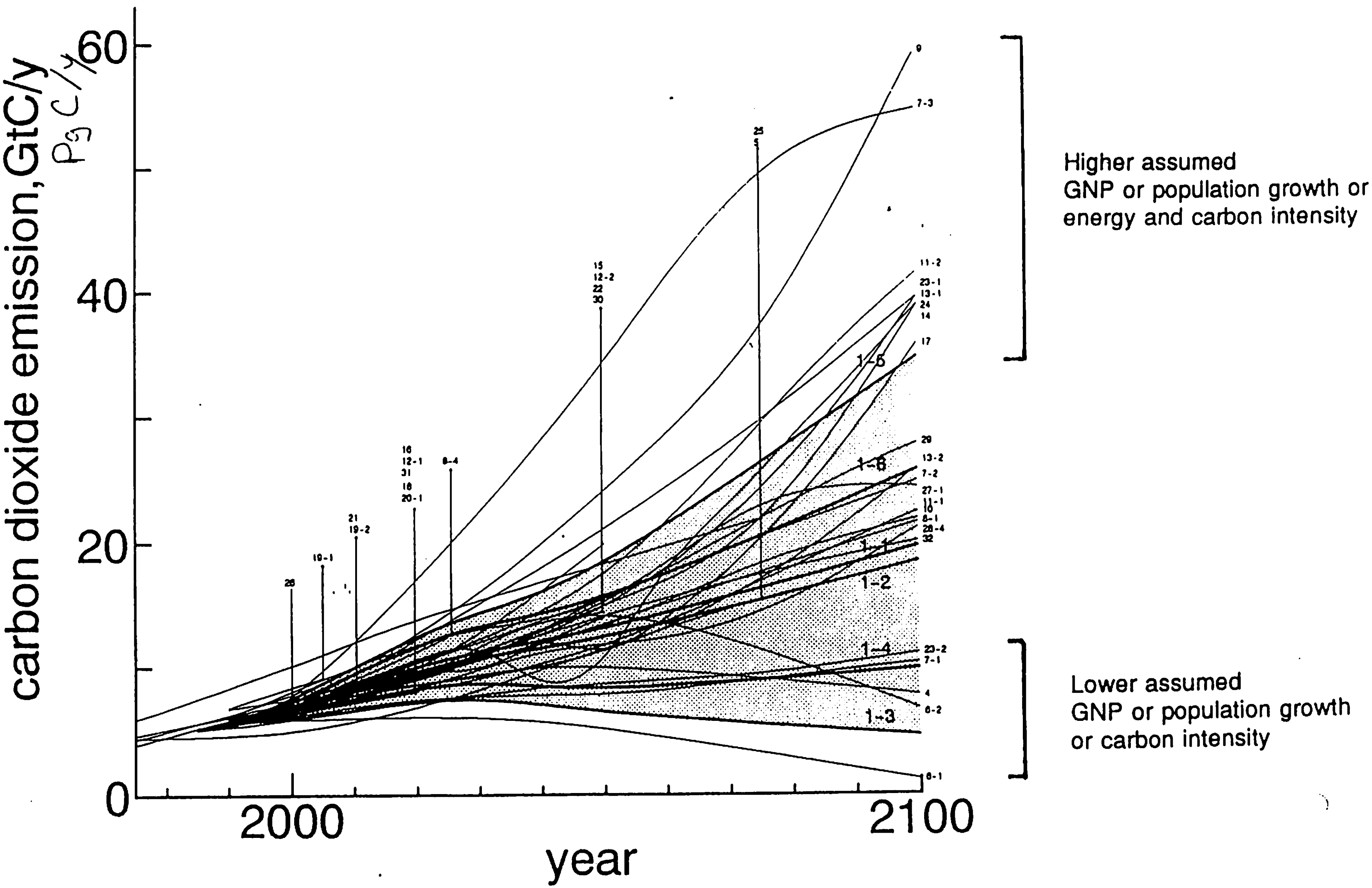


Figure 6.1: Trends of energy-related global CO_2 emissions of various scenarios. Shaded area indicates coverage of IS92 scenarios. Numbers correspond to list of scenarios in Appendix 6.1.

- Most industrial emissions have been quantified

- **POORLY UNDERSTOOD**, however:
  - non-industrial anthropogenic emissions

    agricultural activities (deforestation, burning, tilling *etc.)*
    animal husbandry (*e.g.* manure *etc.*)

  - land-based natural sources, sinks, fluxes

  - oceanic sources, sinks, and fluxes

- Natural components: large and significant

- Ocean:
  Areally: 70% globe
  Photosynthesis: 60%

- Lack of time series for both natural land- and ocean-based cycles of the greenhouse gases makes evaluation of efficacy of models and mitigation strategies difficult

1. Rate of CO2 increase at Mauna Loa decreasing
2. Rate of CH4 increase globally decreasing from 11 ppb (1993-1990 avg) to 4.7 ppm (1992)

TIME SCALES

NATURAL

CO2

- ~~ 7 years in Atmosphere
- ~~ 400 years in Upper Ocean
- ~~35 Years Record Atm at Mauna Loa*

Radiation

- ~~ 11 years: Sun Spot Cycle

Temperature

- ~~ 20,000 to 30,000 Glacial/Interglacial cycles
- ~~ 1,000 Interglacial perturbations
  (mini-Ice ages ~~ 100 year duration)
- ~~ 100 year: of Global Weather Records*
- ~~ 15 years of Satellite Global Weather Records*
- ~~ 10 years Equatorial Kelvin Wave

ANTHROPOGENIC

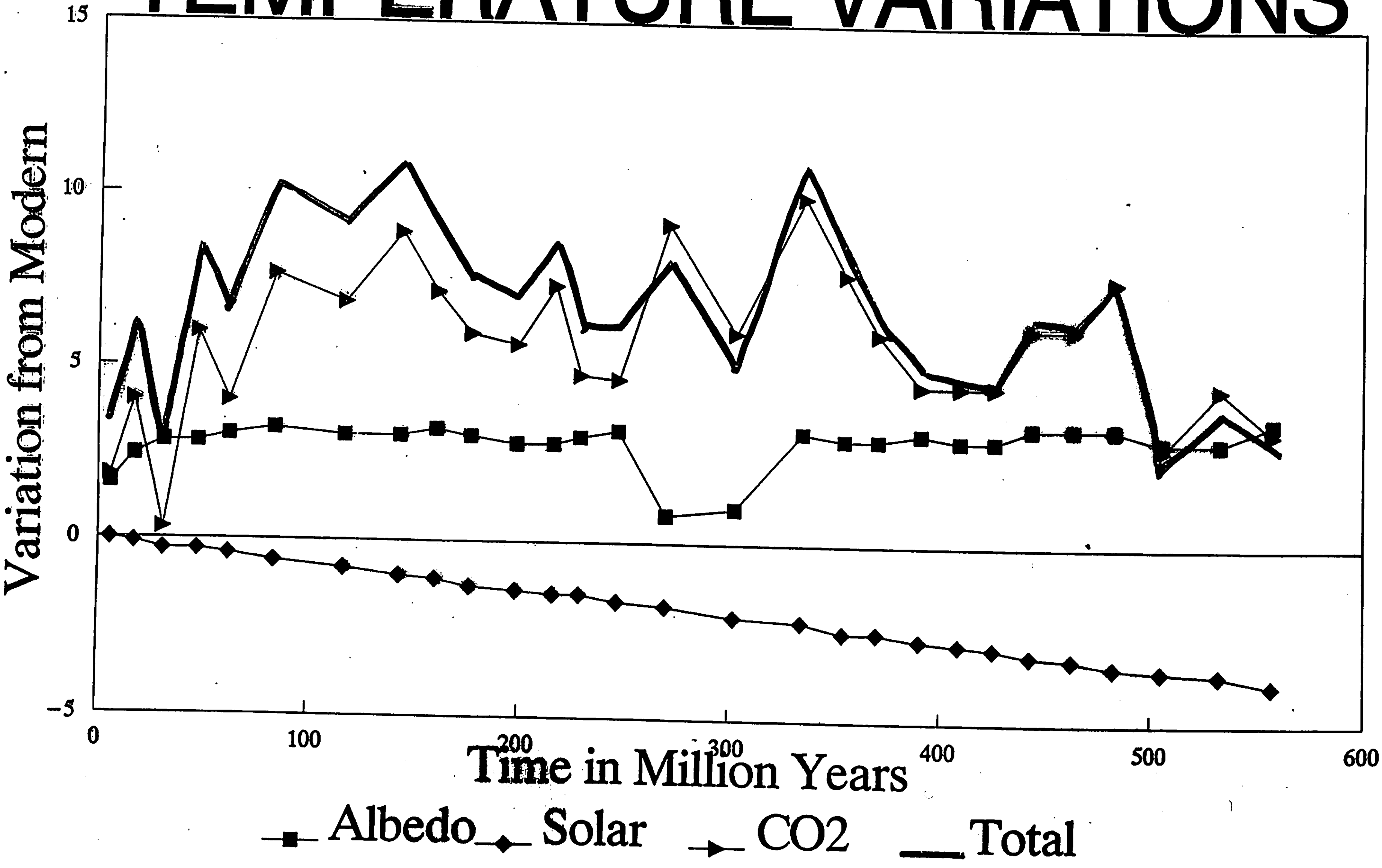
Economic/Engineering life: discount rate variable

- ~~150 years of Industrial Revolution
- ~~ 50 years major projects
- ~~ 5 years computer equipment

Political life:

- ~~2 to 5 years governments

TEMPERATURE VARIATIONS



OCEANIC/ATMOSPHERIC FACTORS

- Greenhouse Gases in the Oceans
  Absorption ➜ Cooling
  Outgassing ➜ Warming

PERIODIC FACTORS

- Equatorial Kelvin Wave cycle ~~ 10 years
  - effects rate of outgassing in Warm Pool

APERIODIC FACTORS

- El Nino: Warming "CHAOTIC?"
- La Nina: Cooling "CHAOTIC?"
- Equatorial ash Volcanism:
  e.g. Pinatubo/Vulcan: Cooling

CONCERNS

- Oceanic factors affecting climatic variability too often discounted
- Fluctuations in natural signature may make scenarios unrealistic
- Non-intervention baseline models must consider natural fluctuations developing policies and strategies for a sustainable future