IPCC Scenarios: An Interim Assessment

Hugh Pitcher

American Enterprise Institute

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Battelle

Pacific Northwest National Laboratory

UNIVERSITY OF MARYLAND

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  - Nebojša Nakićenović--IIASA
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  - Jae Edmonds--JGCRI

Four Themes

- IPCC scenarios
- Issues with the SRES scenarios
- Do the issues matter? And if so how? And to whom?
- Uncertainty

IPCC Emissions Scenarios

- 1990 Three IPCC Emissions Scenarios
- 1992 Six emissions scenarios (IS92)
- 1995 Evaluation of Emissions Scenarios
- 1997-2000 SRES
- 2000-2001 WG3 Stabilization Scenarios for TAR
- Next steps
  - Meetings in January and June of 2005
  - Downscaling
  - Uncertainty

Special Report on Emissions Scenarios

- Terms of Reference
  - Represent the literature
  - Account for new developments—critiques
    - Sulfur
    - EIT
    - No economic development
  - Extend users beyond climate models
  - Open process—no one model
  - Results to be available in open literature
  - No additional climate policies

SRES process creates novel demands

- Multiple users
  - Climate Models
  - Impacts and Adaptation
  - Policy Assessment
  - Policy Community
  - Stakeholders
- Multiple models
  - IIASA, RIVM, NIES, MARIA, EPA--ASF, JGCRI
- Full suite of gases & sulfur
  - CO2,CH4,N2O,HFC,PFC,SF6,SO2

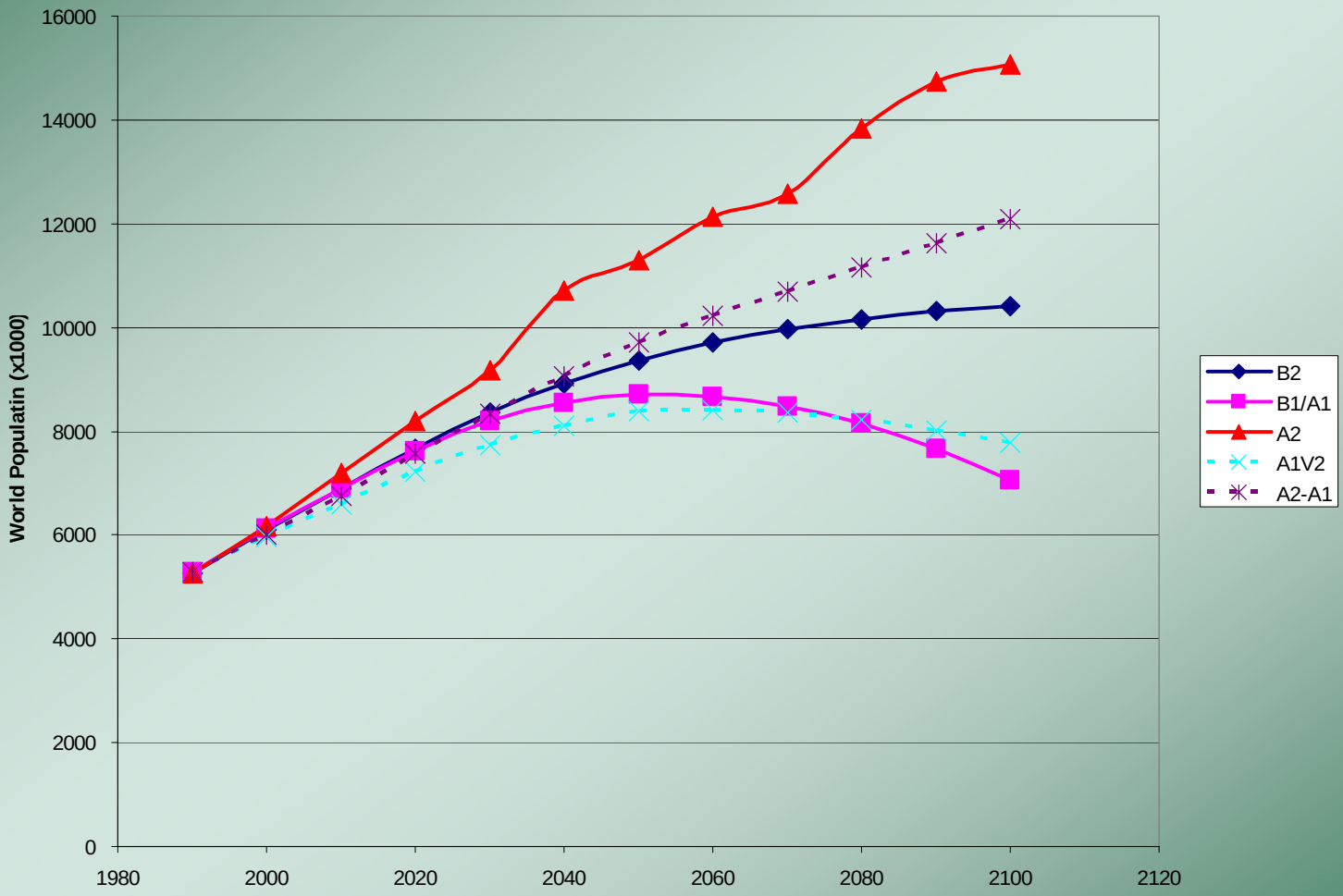
SRES process

- Use Shell scenario process
  - Four scenario families
  - Users not in the room
- Create endpoints for model runs
  - Population
  - GDP (1990 MEX)
  - Final Energy (Ej 10^18j)
- Harmonize model outputs
- Literature review
- Write text in parallel
- 52 authors, 89 reviewers

Results

- Special Report
- 40 scenarios
  - 28 harmonized into 6 families
  - 12 non-harmonized
    - A1V1, A1V2,A2-A1,B1H,B2H
  - Downscaled results for climate modelers
- CIESIN website with revised results

SRES Population Scenarios



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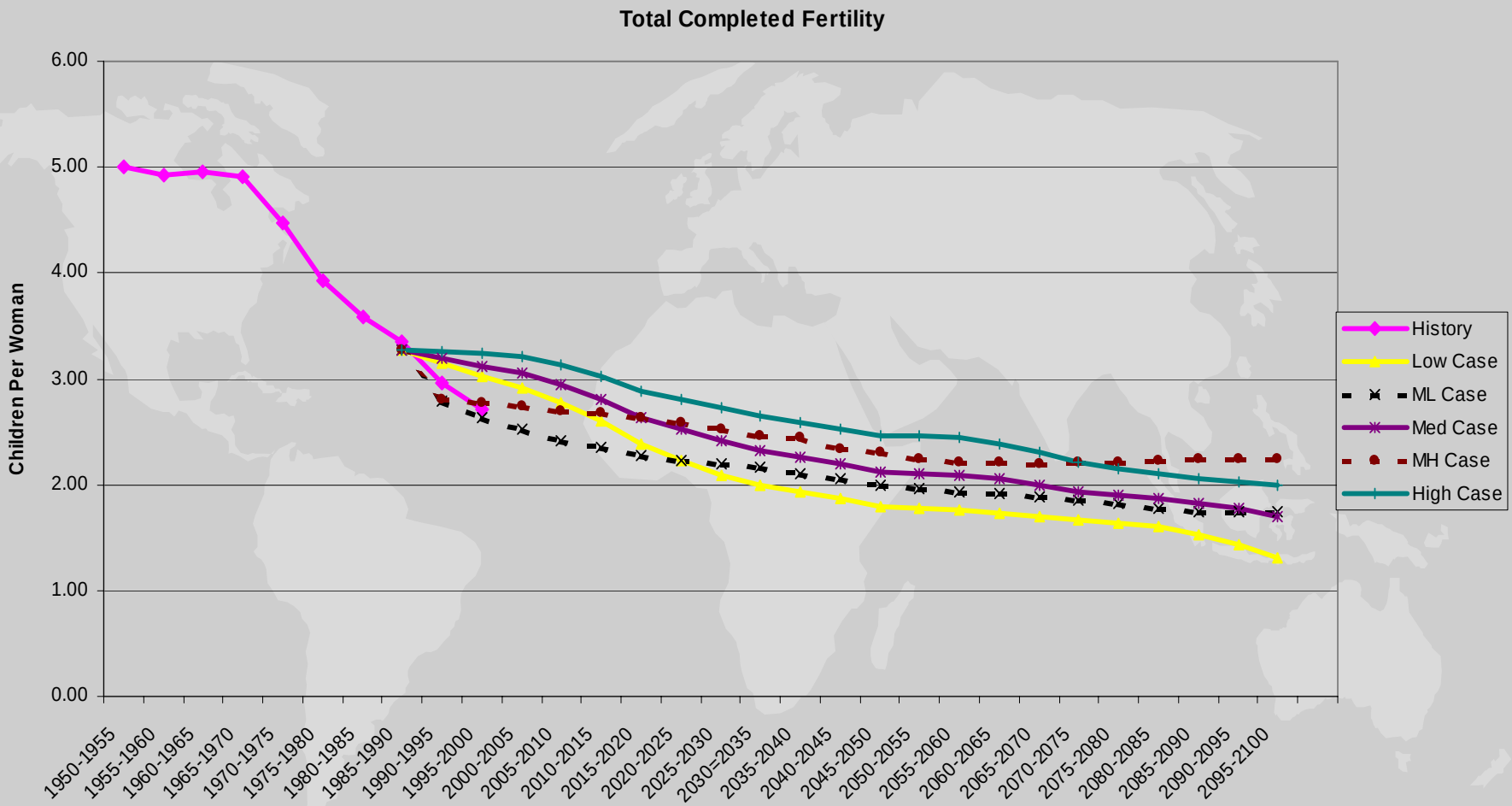
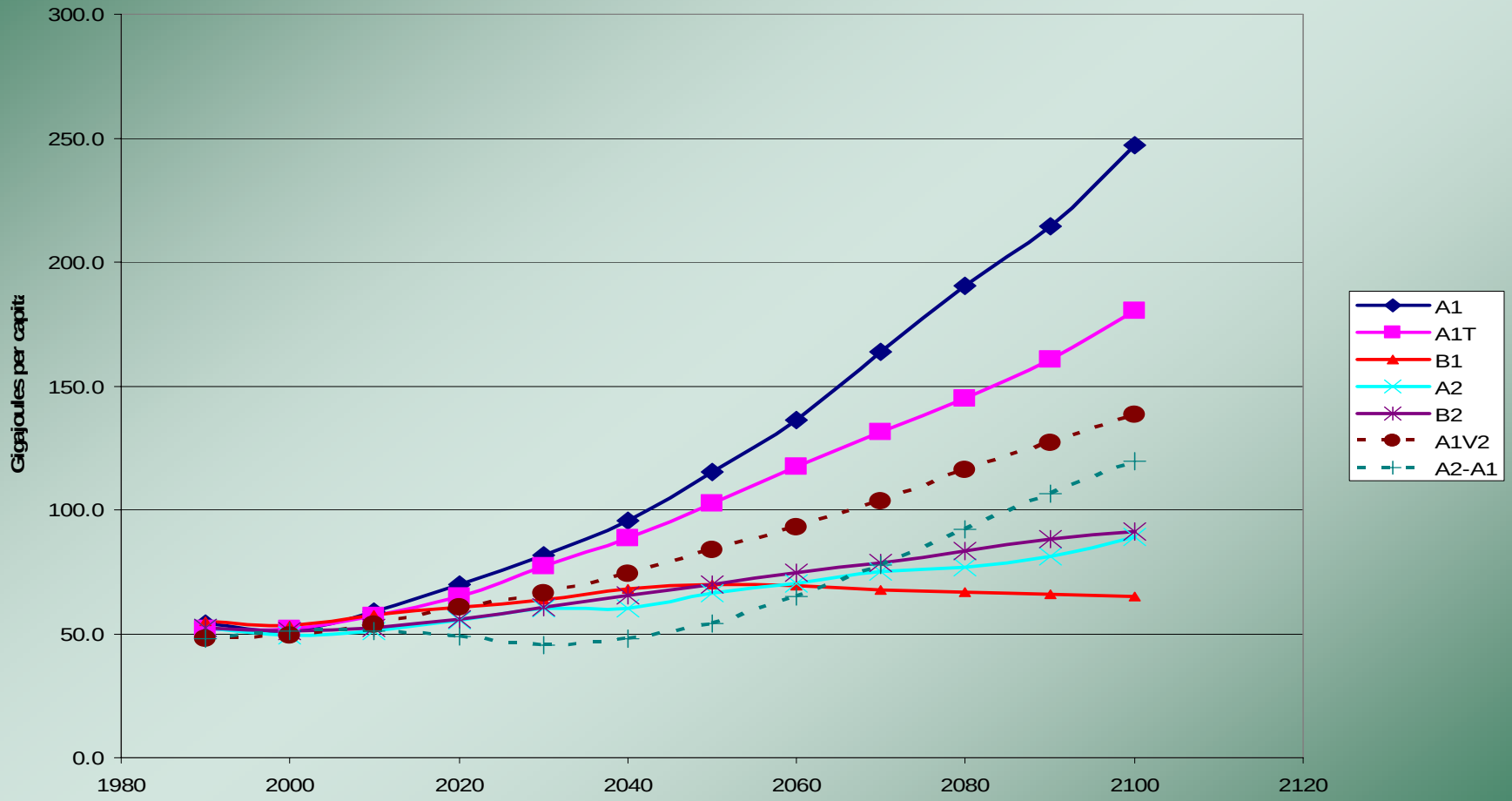
Total Completed Fertility



Per Capita Energy Consumption



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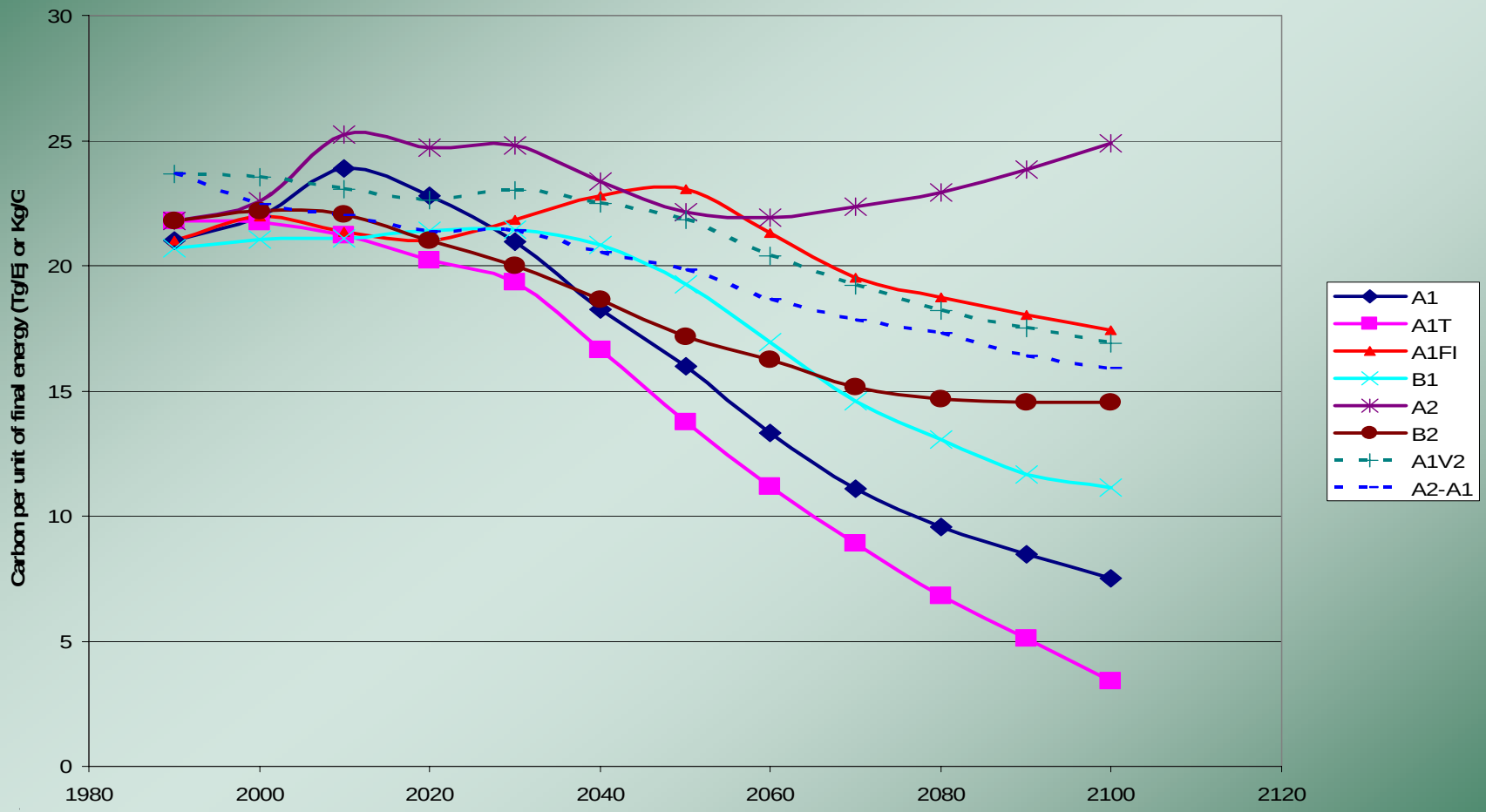
Carbon Intensity (per unit of Energy)



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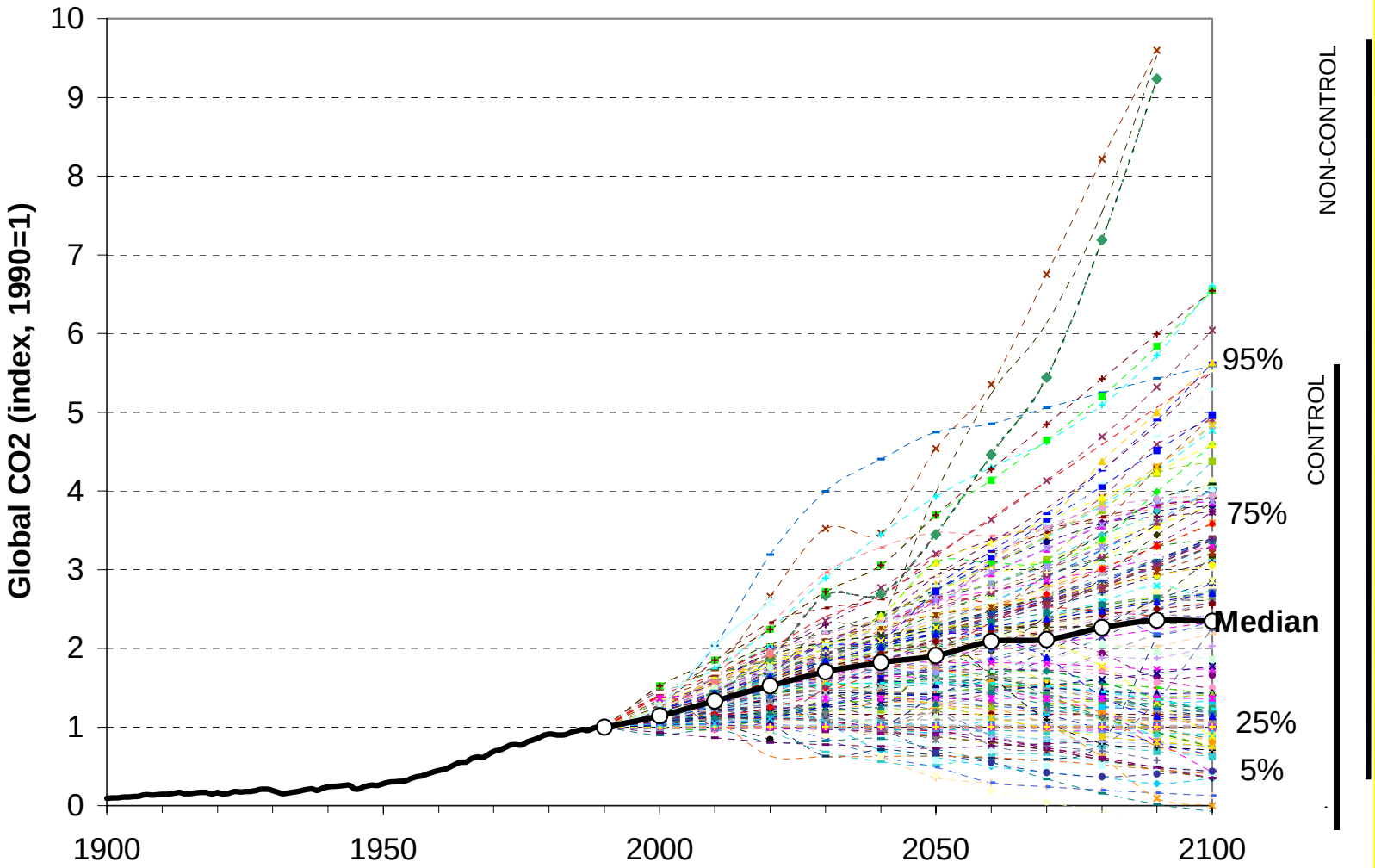
Carbon Dioxide Emissions

Total All Sources

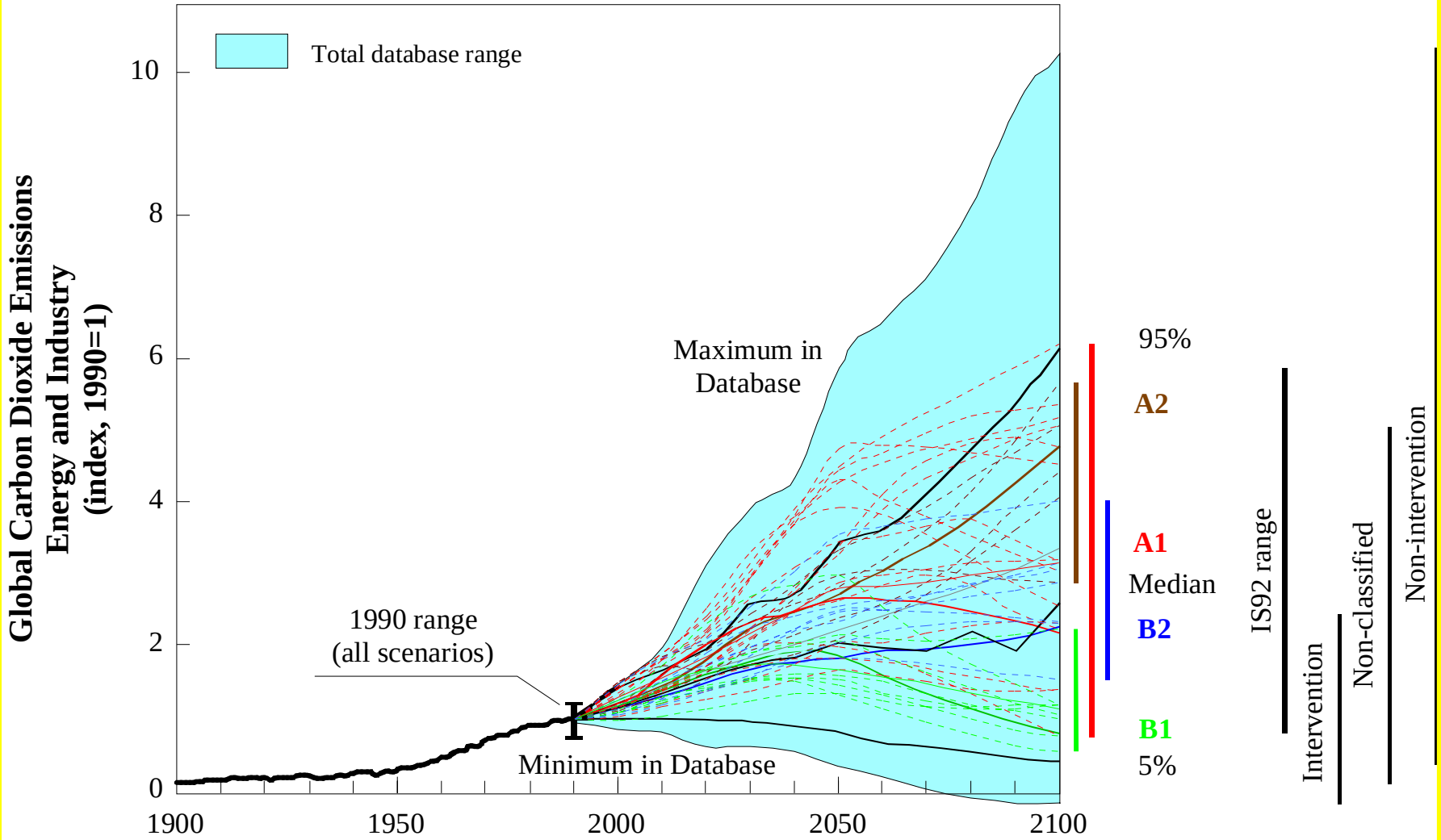


Nakicenovic *et al.*

IIASA 1998

Global Carbon Dioxide Emissions

40 SRES Scenarios and Literature Range



Nakicenovic *et al.*

SRES 2000

Critiques of SRES scenarios

- No scenario likelihoods
- No central case
- No development failure scenario
- Emissions high (or low)
- Sulfur too low
- Non-CO2 Emissions
- Land Use

- Population (TCF, Life Expectancy)
- GDP (MER) too high
- Energy use too high and/or too low
- Improper measurement of income (PPP/MER)
- Insufficiently detailed results (downscaling issues)

Need criteria before we can assess the critiques

- Scenarios are designed to illuminate a (potential) problem or question
- Do the critiques change the way in which the problem is perceived or the question answered?
- Simple structural heuristics are of great value in understanding results

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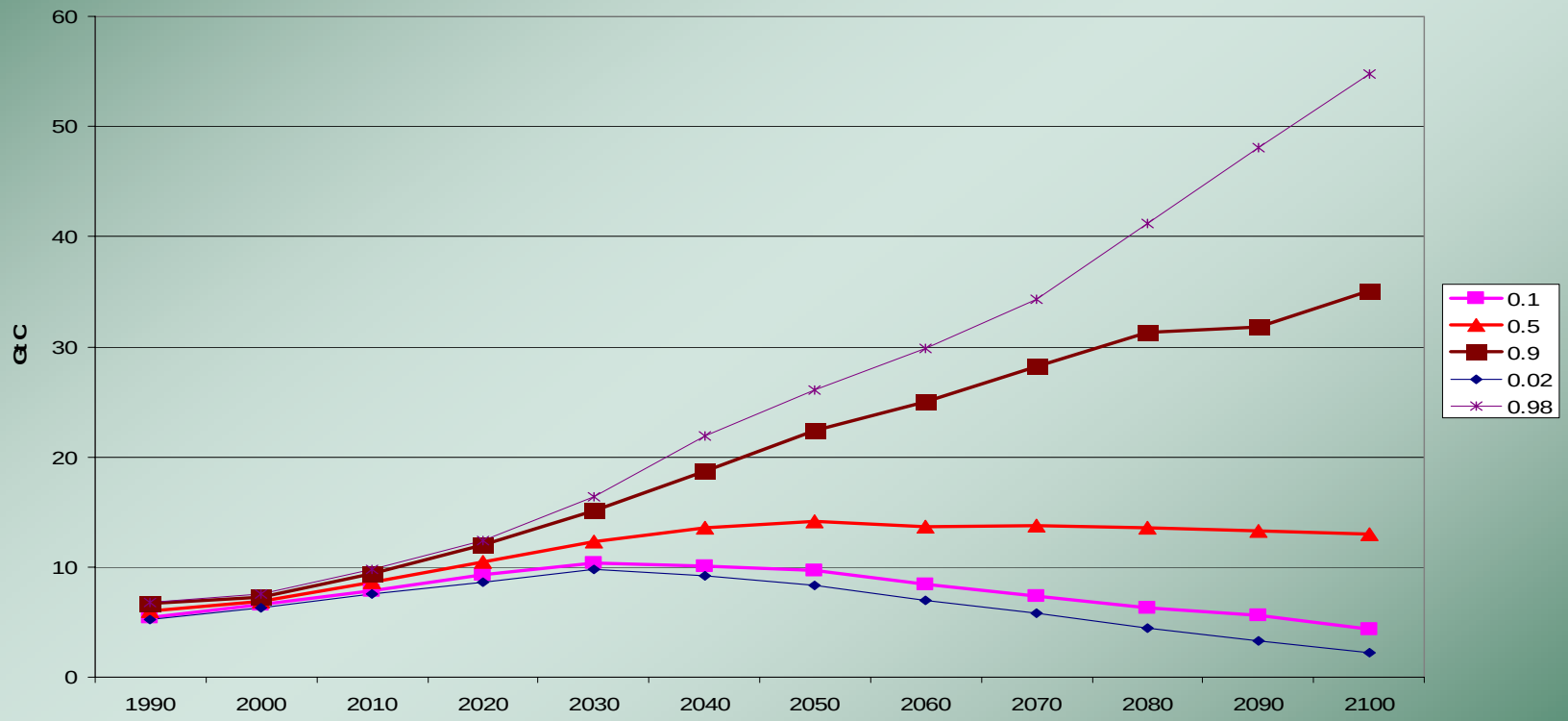
Simple counting (uncertainty?) model

- Instead of Kaya identity
  - C = Population x (GDP/capita) x (energy/GDP) x (C/energy)
- Use
  - C = Population x (Energy/capita) x (C/Energy)
- Run all combinations of 5 population cases x 6 final energy x 6 carbon intensity (180 cases)
- Useful for understanding what changes matter to climate models—which are insensitive below 50 ppmv or 200 Gt C.

The distribution of annual emissions is as wide as what we saw in the literature survey



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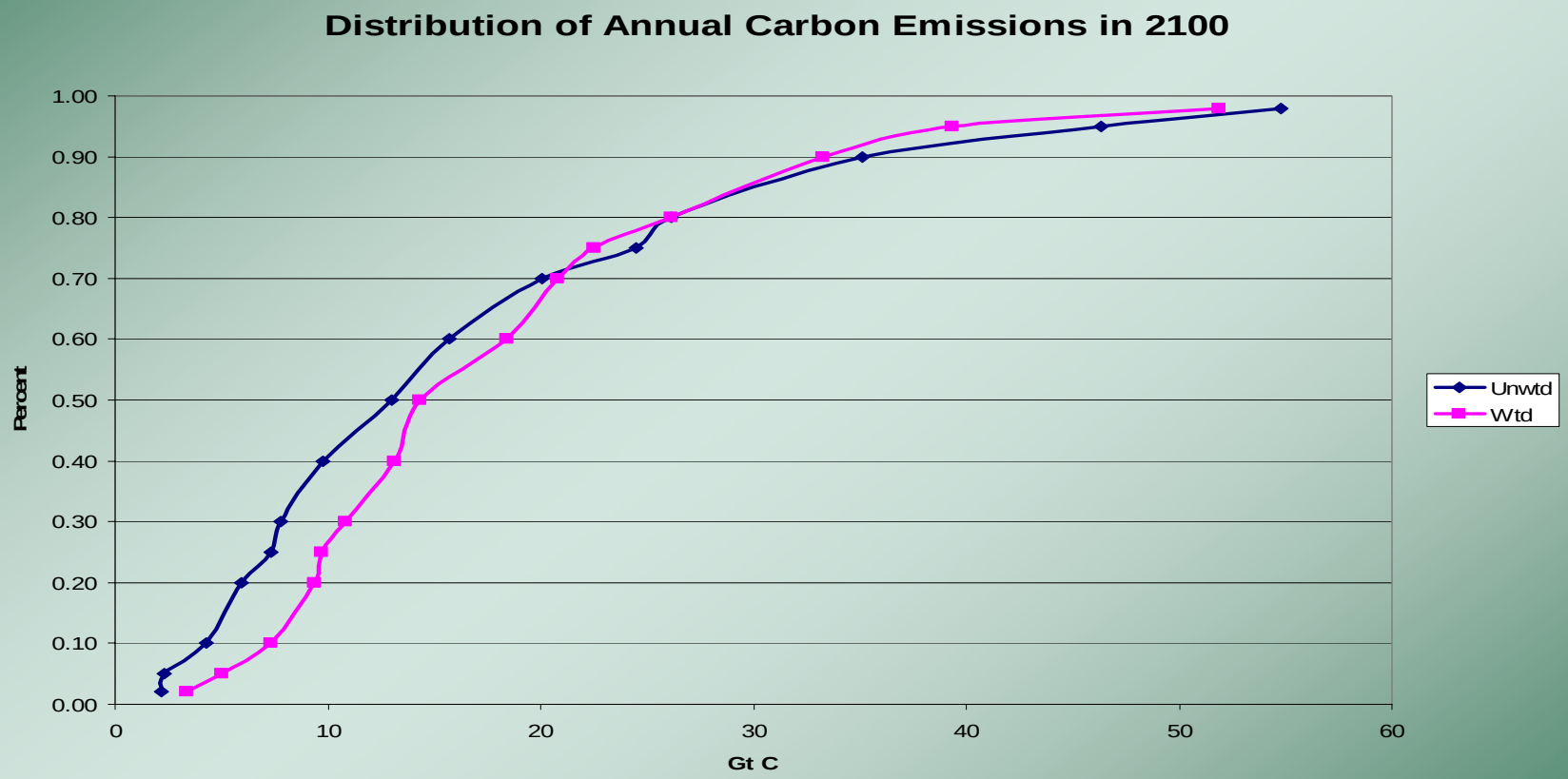
The distribution of cumulative carbon emissions is much narrow than the annual emissions

Cumulative range of carbon emissions is from 1000 to 2300 billion tons.

- Climate modelers are comfortable scaling between runs.
- Five Climate model runs for B1 or A1T, B2, A1, A2 and A1FI will provide sufficient coverage for base cases and a wide variety of potential variation on these cases.

Weighting to reduce unlikely combinations narrows the range of annual emissions



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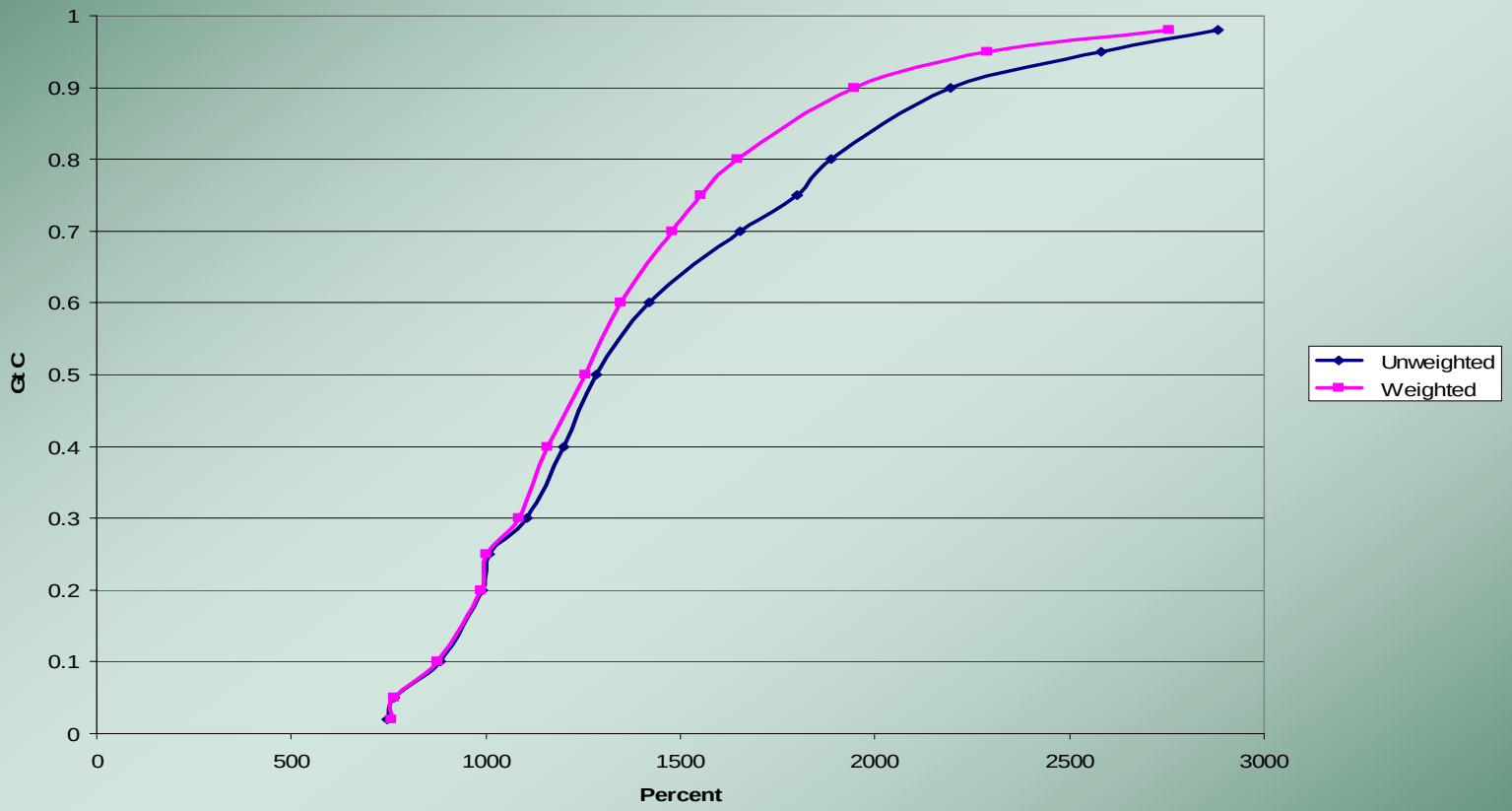
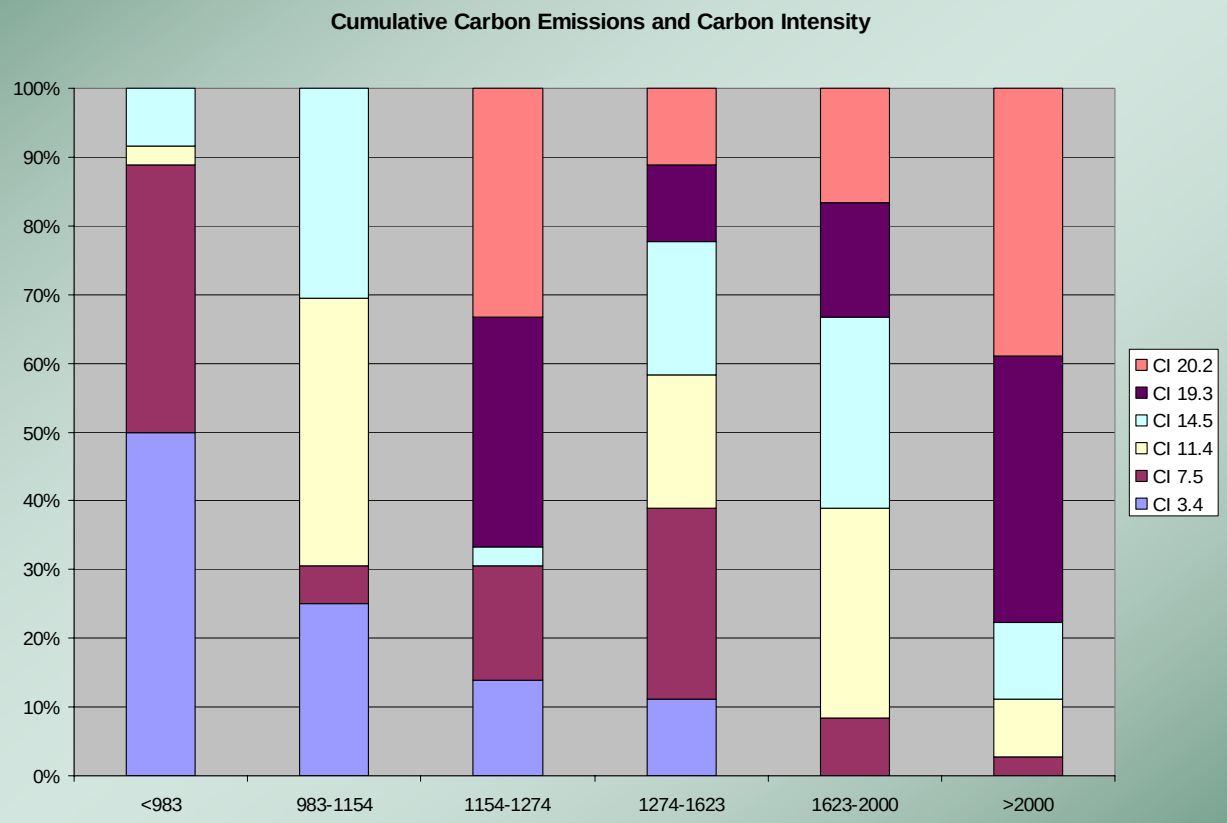
Eliminating combination of high population and high energy use shifts the high end of the cumulative distribution down moderately



Under a no new policy assumption changes in scenario drivers are most likely to narrow the range—not increase it.

- Population range is likely to narrow
- High and low ends of energy use explore less likely outcomes for strategic reasons
- Low end of carbon intensity assumptions explores major changes in energy production and transformation—again for strategic reasons
  - But—major mitigation strategies such as carbon capture and geologic storage are not included

Low cumulative carbon emissions cases require major reductions in carbon intensity



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Other Gases

- Sulfur matters
  - Declining levels reveal warming due to greenhouse gases
- Black carbon remains as a major aerosol research topic
  - emissions
  - likely local air pollution control levels
- Best estimate of net effect of aerosols is negative
- Tropospheric ozone
  - Emissions of precursors have not been subject to control due to air pollution concerns
- Work on Non-CO2 gases has made great progress—led by EPA and EMF studies
  - SRES results were model—not scenario--specific

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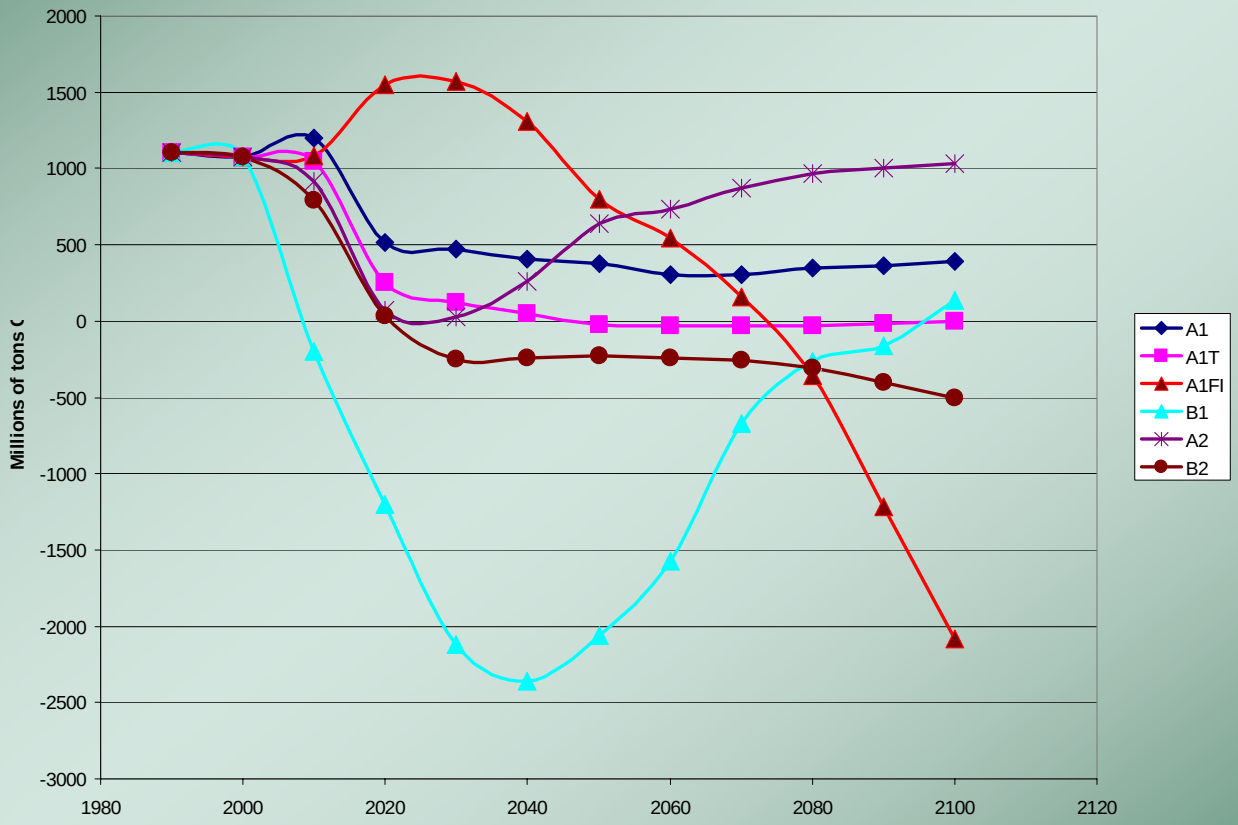
Land use changes are a significant source of carbon emissions—still poorly understood

- Reflect diet and dietary changes
  - Limits to wild fisheries
  - Ruminant livestock are a very inefficient source of protein
- Water is perhaps the critical input and water availability and quality are still poorly understood
- Technical change and GMO issues remain

There are large variations in the pattern of Carbon emissions from Land Use



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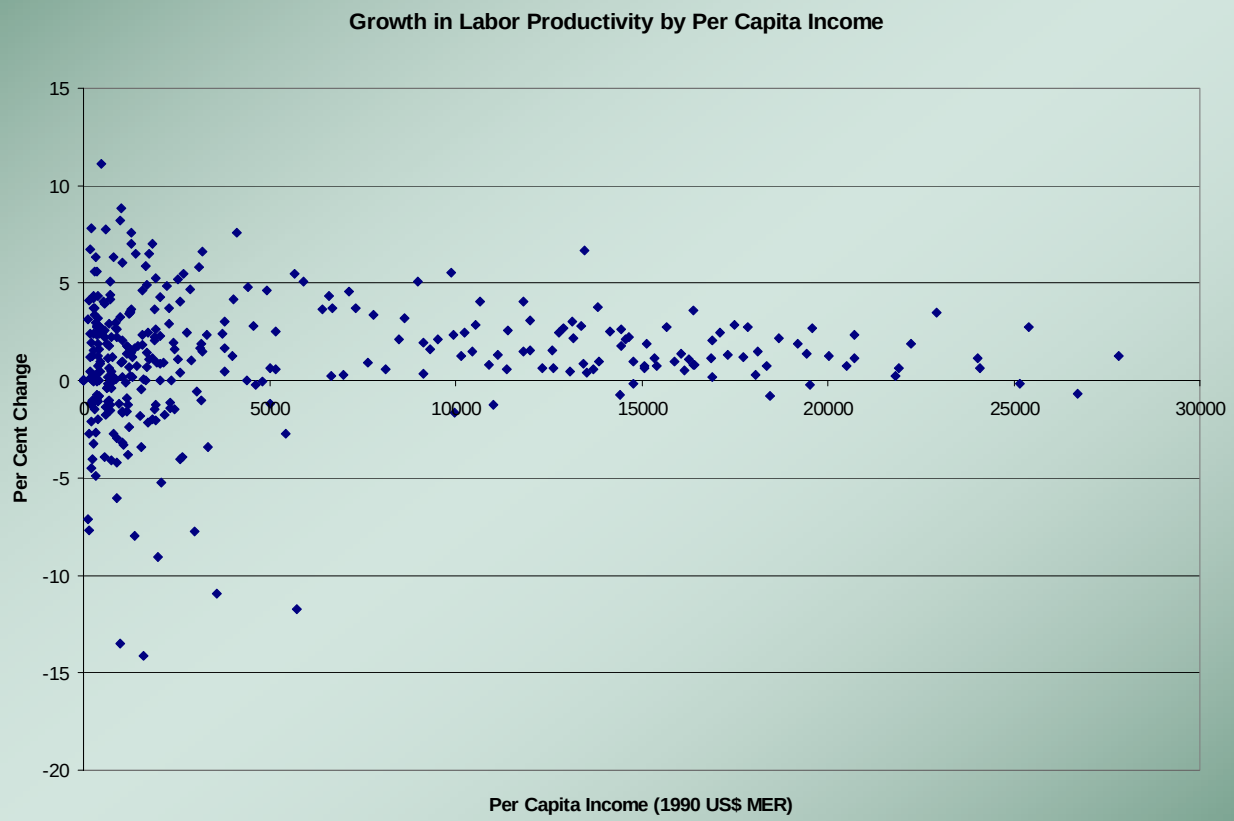
SRES non-harmonized MiniCAM scenarios explore alternative population, GDP and energy use paths

- A1V1: lower energy use
- A1V2: Higher population, lower GDP growth, lower energy use
- A2-A1: Slower economic growth in developing countries, lower population, higher per capita energy use
- B1H: high energy use
- B2H: high coal—high emissions

Core data for driving MiniCAM economic growth paths



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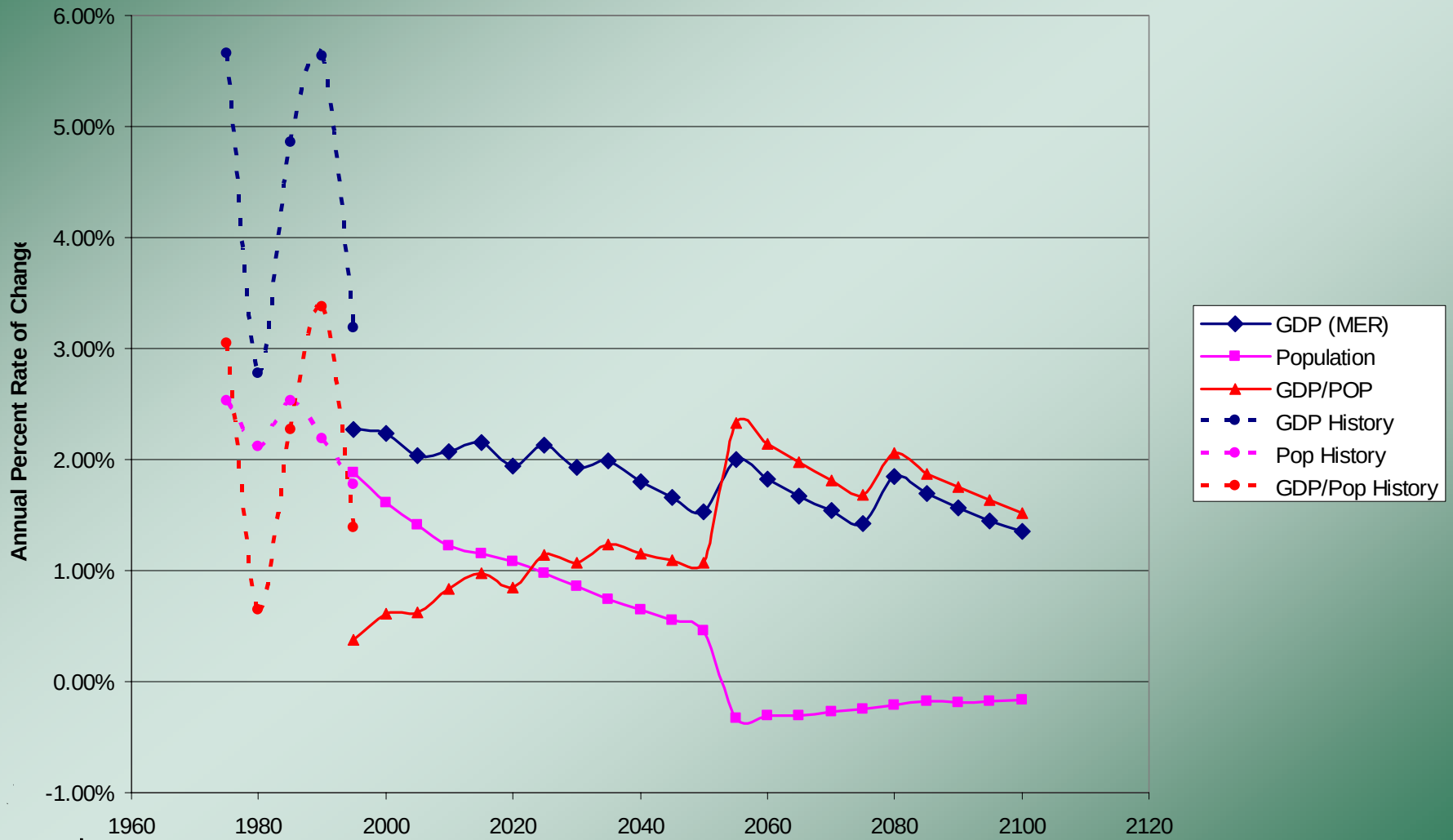
SRES models ran at 9 to 20 region scales Results were aggregated to four regions

- Regional data at CIESIN
- Four region data not sufficiently detailed for impacts work
- Climate model results also at problematic scale
- TGCIA requested that CIESIN construct downscaled data for population and GDP (MER) at both country and grid scale levels using TGCIA suggested algorithm
- Recent assessment of the results has uncovered major flaws in algorithm
- New algorithm developed at IIASA: results to be available soon

Annual Rates of Change for GDP, Population and Per Capita Income for Turkey: History and Draft Downscaling Projections



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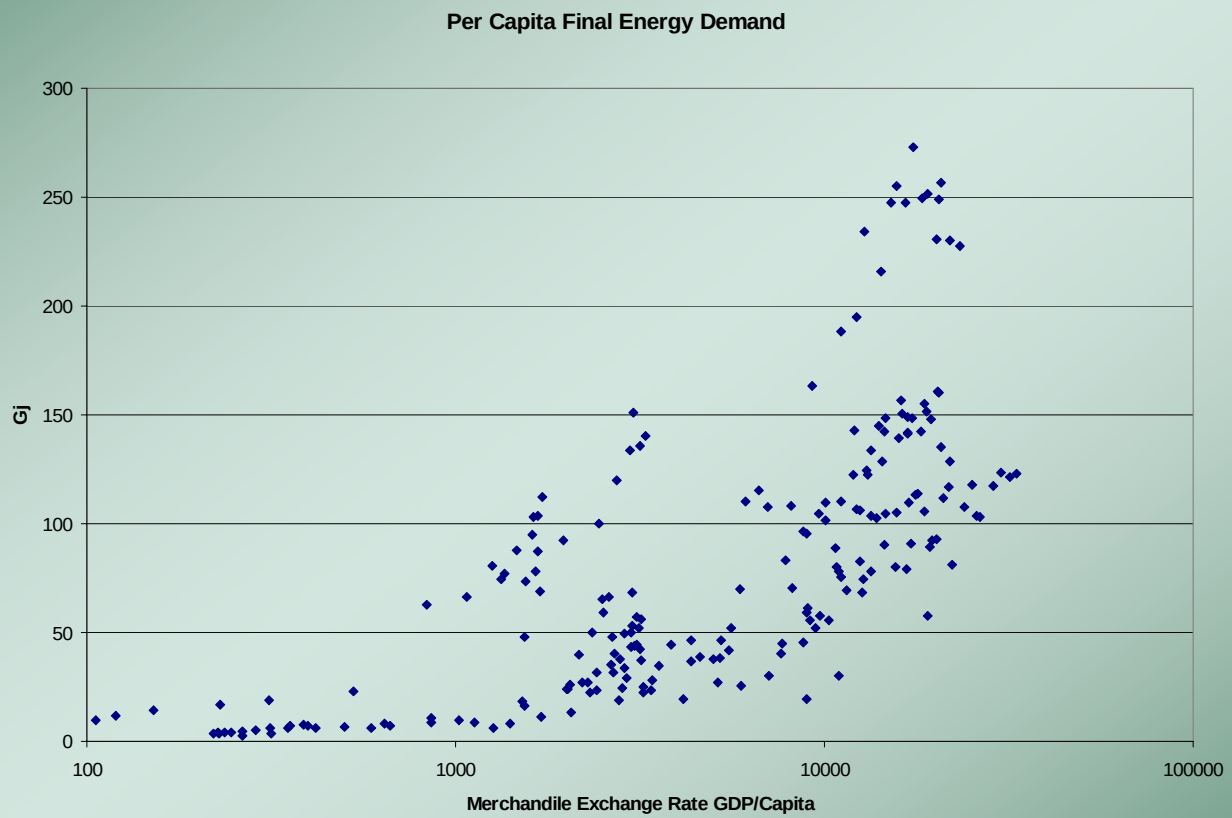
PPP/MER

- SRES models impose cross section PPP/MER relationship on time series results.
- PPP/MER differences driven by relative prices, especially for labor
  - Relative prices in developing countries favor services—typically untraded—results in low cost bundle for domestic consumption
  - Successful economic development must imply increase in price of labor
  - Therefore one would expect convergence and slowing in PPP measured rates of economic growth
  - This pattern does not show up in the data
  - Is it a data issue or a model issue?

Historical data on per capita energy consumption imply where countries end up is most critical



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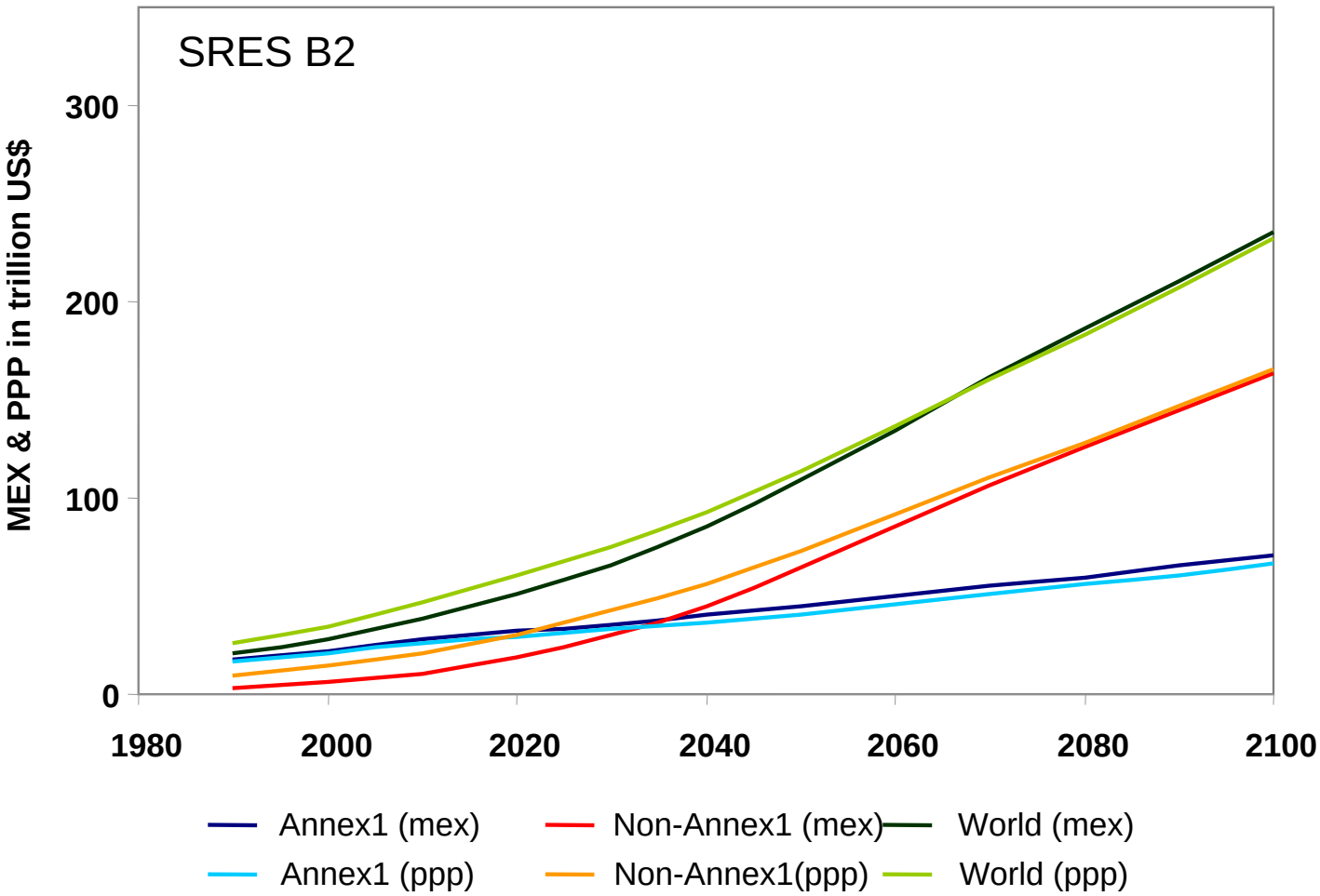
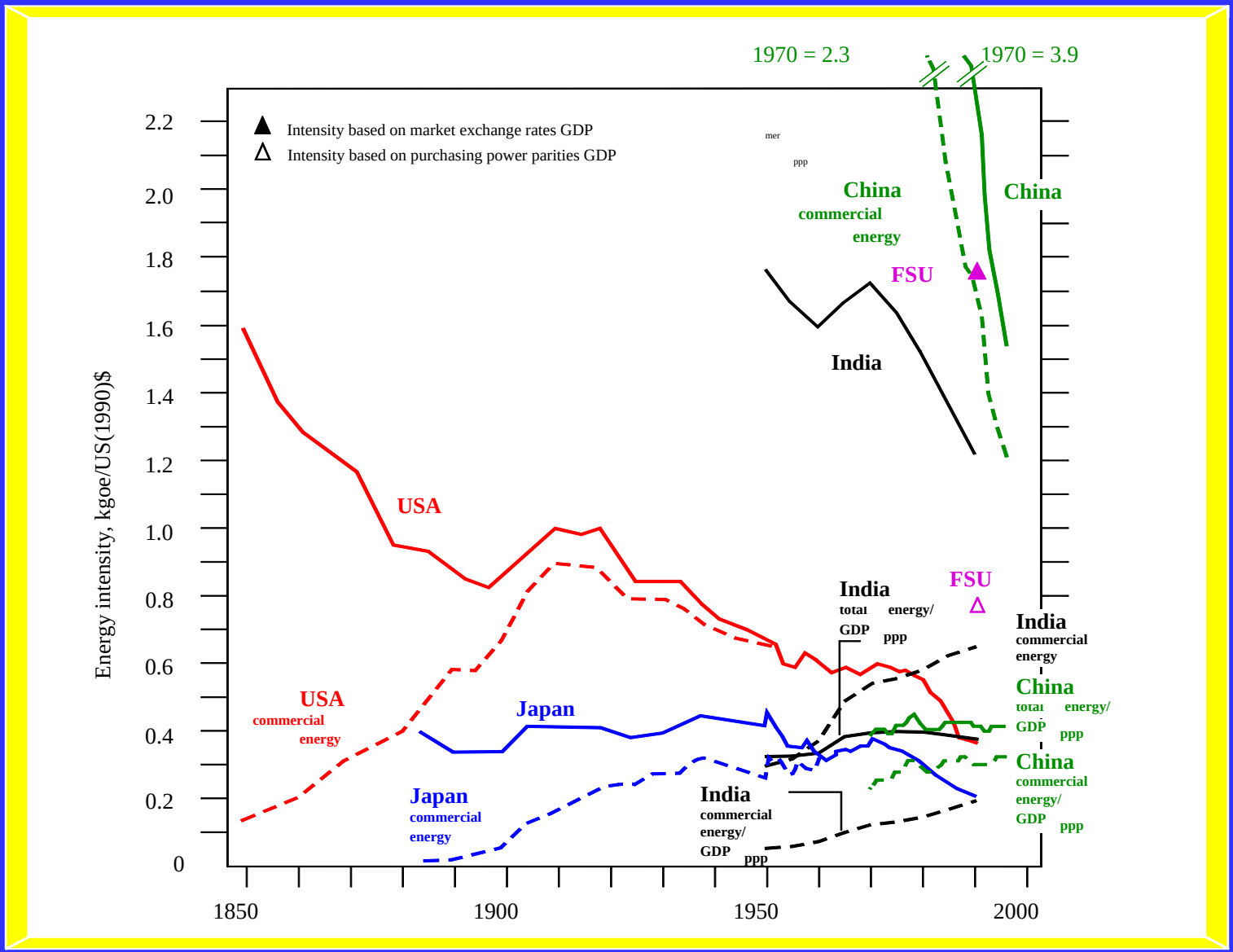
Gross World Product in MEX and PPP



Nakicenovic & Slentoe

IIASA 2003

Energy Intensity Improvements



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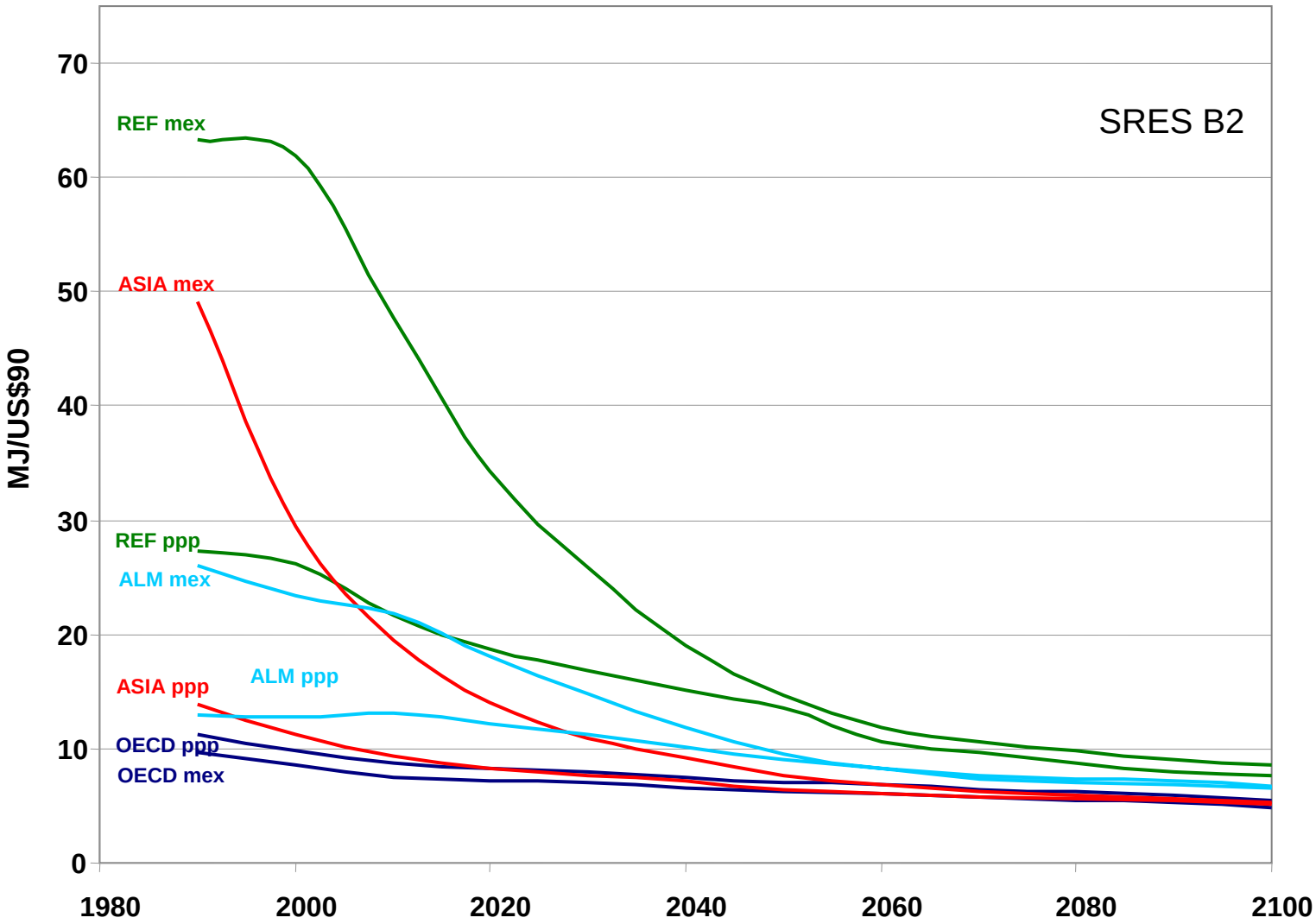
IIASA 1998

Primary Energy Intensity of GDP MEX and PPP



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SRES—despite repeated requests—has not been willing to assign probabilities

- Rational for no probability assessments
  - Do not pick one case and collapse analysis to this case
  - Role of human intervention in changing outcomes
  - Scenarios do not come from common modeling framework or common assessment of the future
  - Role of scenarios is to explore strategy
  - Uncertainty is too large to risk minimize—need robust strategies

Scenario structure and use

- SRES Scenarios do not have a common motivation
  - A1 explores a high-growth, market oriented future with three alternative energy futures
  - B1 explores a high-growth, global commons oriented future with high energy efficiency
  - B2 is dynamics as usual—a reasonable successor to IS92A
  - A2 explores a slow developing, regionally heterogeneous world with slow energy technology development

No central case or starting point for constructing policies

- One could argue that the greatest weakness of SRES is the failure to develop and communicate a strategy for using marker scenarios in a policy framework
- Developing methods for working at the uncertainty levels that characterize the climate problem is of high priority
- Learning how to consider politically unpalatable futures is a key part of the process

Conclusion

- Harry Truman would have fits
  - On the one hand—we can plausibly argue that under low climate sensitivity and low dynamics as usual emissions we do not have a problem that requires immediate action
  - On the other hand—under high climate sensitivity and high emissions—we need to be making major changes now to avoid significant impacts such as large rises in sea level
    - Range of climate sensitivity (1 to 9 not 1.5 to 4.5)
    - Four degree C threshold for melting Greenland ice sheet
- Decision making under deep uncertainty is critical