Introduction Java Climate Model, Scenarios to limit global warming to 2°C, +> Implications for Brazilian energy sector

Presentation IVIG 21 June 2011

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in IVIG 14 may-14 august 2011

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... who is this ...?

- 90-93 Univ Edinburgh - focus environmental chemistry +...

- 93-00 PhD UEA Norwich - Air-Sea CO_2 Fluxes, catalysis marine algae
  + European Study of Carbon in Ocean Biosphere Atmosphere
  + project Qingdao Ocean Univ China
  + UNFCCC COP2 (GCI) COP3 Kyoto (SGR)

- 01-02 early development JCM
  Denmark DEA, Norway UNEP-GRID, Switzerland Univ-Bern + COP 6,7 ...

- 02-11 UCL-TECLIM (formerly ASTR - Louvain-la-Neuve Belgium)
  + projects CLIMNEG, ABCI
  + support to IPCC vice-chair, IPCC scenarios process
  + support European UNFCCC science expert groups (SBs, COPs 14-16)
  + MATCH, project INFRAS (swiss), UNEP paper etc.

- now here in IVIG... (until mid august)

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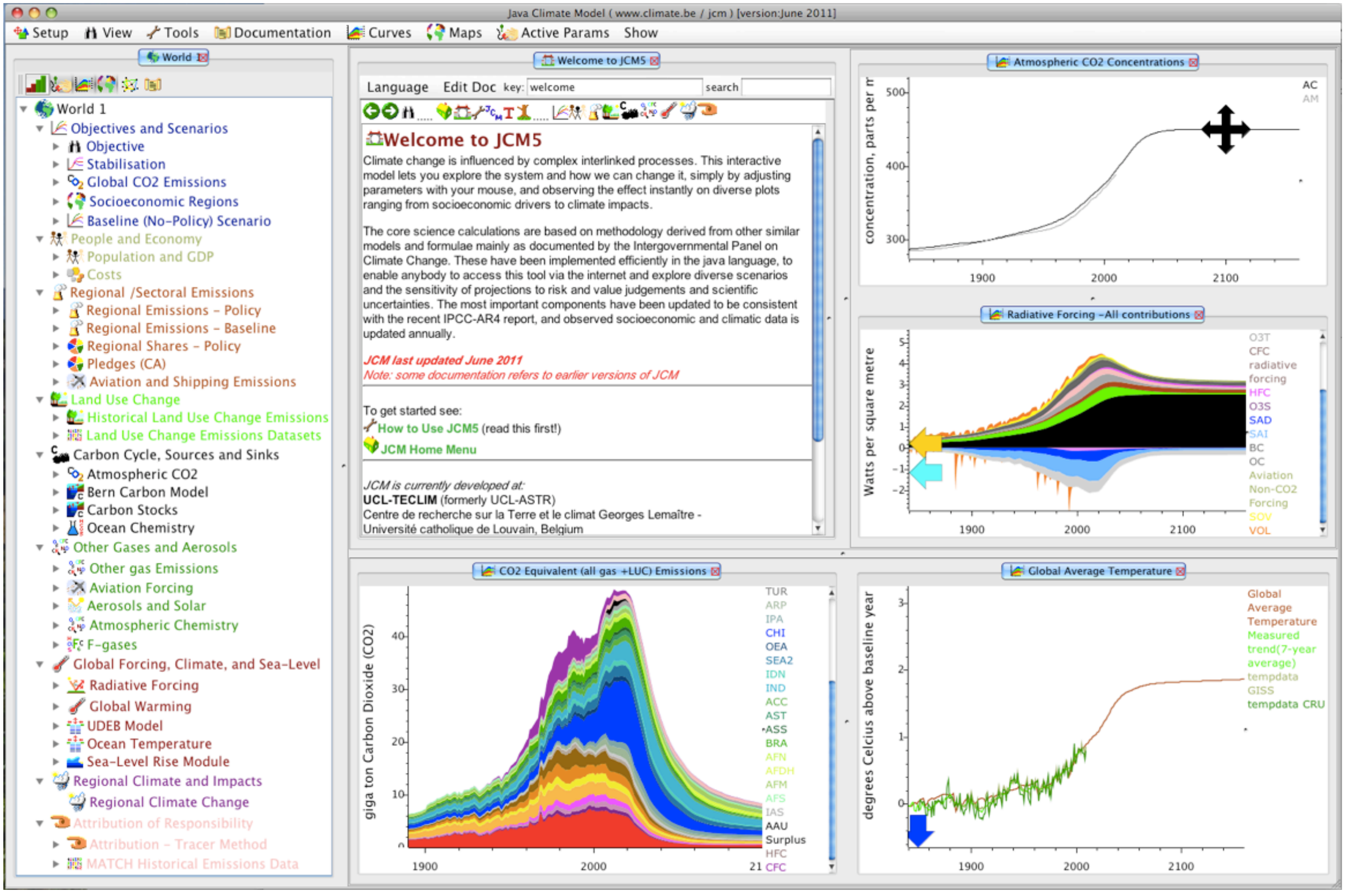
Introducing Java Climate Model



Special focus of JCM

- Global Stabilisation Scenarios (2°C etc.)
  - multi gas, multi-indicator, flexible pathway shapes...
  - sensitivity to climate, & carbon cycle uncertainties
  - sharing of emissions / effort between countries

- Interactive tool for global dialogue - enable people to explore relative sensitivity to policy options and scientific uncertainties:
  "the ultimate integrated assessment model is the global network of human heads"

- Core science copied from other models and IPCC reports.
  Fast, efficient implementation convenient for both:
  - interactive exploration useful for teaching
  - integration over uncertainty - risk analysis

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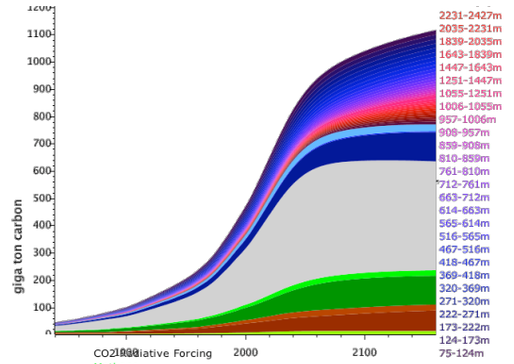
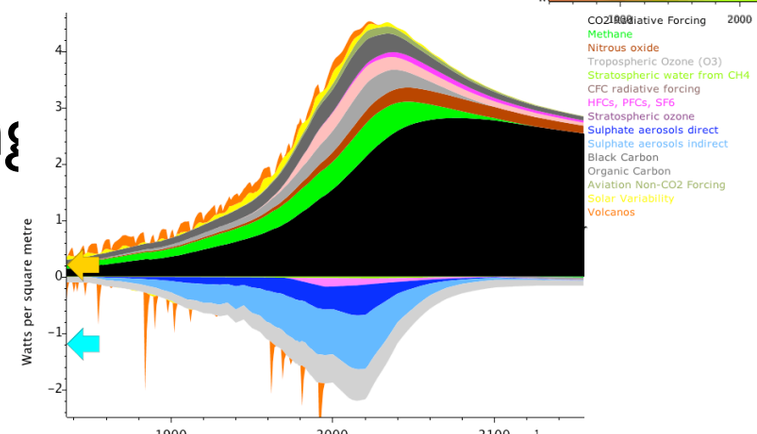
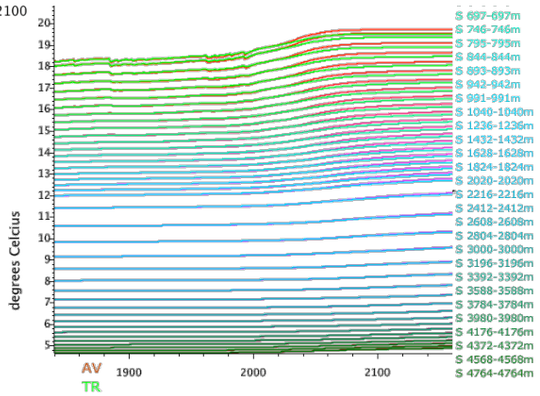
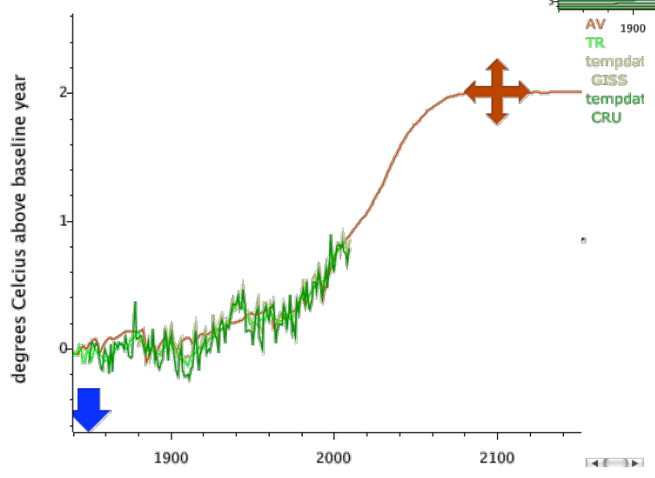
Physical science of JCM

- Bern carbon model including climate feedbacks and ocean chemistry
- Atmospheric chemistry and radiative forcing calculated for >30 gases and aerosols
- UDEB climate model (parameters tuned to GCMs)
- Originally intended to be consistent IPCC-TAR, mostly updated to AR4
- Speciality - inverse calculations to stabilise temperature









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=> Climate Sensitivity ?

- We were asked what is the right climate sensitivity?
- IPCC AR4 likely (=66%) 2°C to 4.5°C (could be higher!)
- Must vary together with other parameters
  - ocean mixing, aerosol forcing etc.
  - can weight sets according to fit GCMs or historical data
  - likewise for carbon cycle parameters etc.
- JCM allows to explore sensitivity, or make systematic risk analysis

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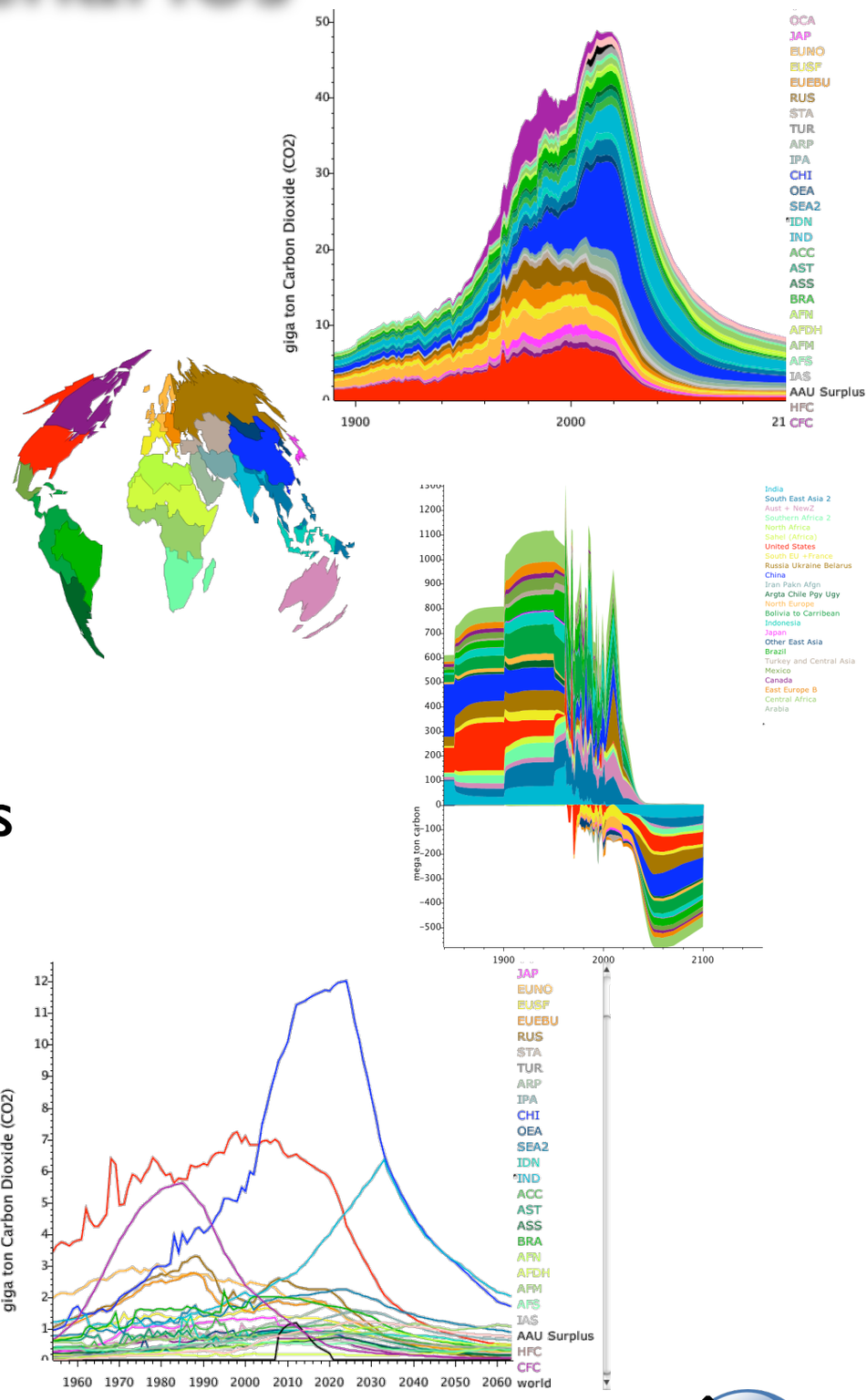
Regional Emissions Scenarios

- Regional data CO_2, CH_4, N_2O, CO_2eq, population, GDP, ...
- Diverse region sets depending application
- Calculates by country 1750-2050, by region thereafter (=> 2300+)



- Calculates LUC emissions from biome changes
- Originally - top-down sharing, convergence, depending population, GDP, etc.
- Recently - added "pledges" to 2020 + gradual participation approach thereafter

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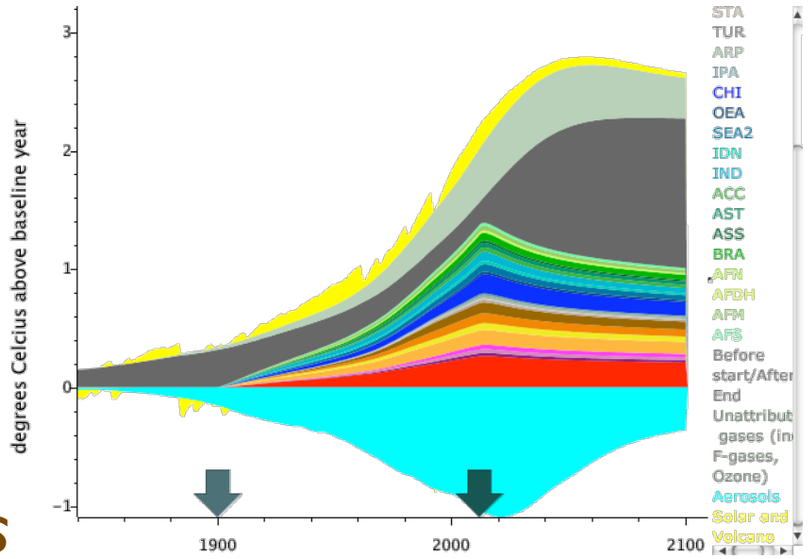
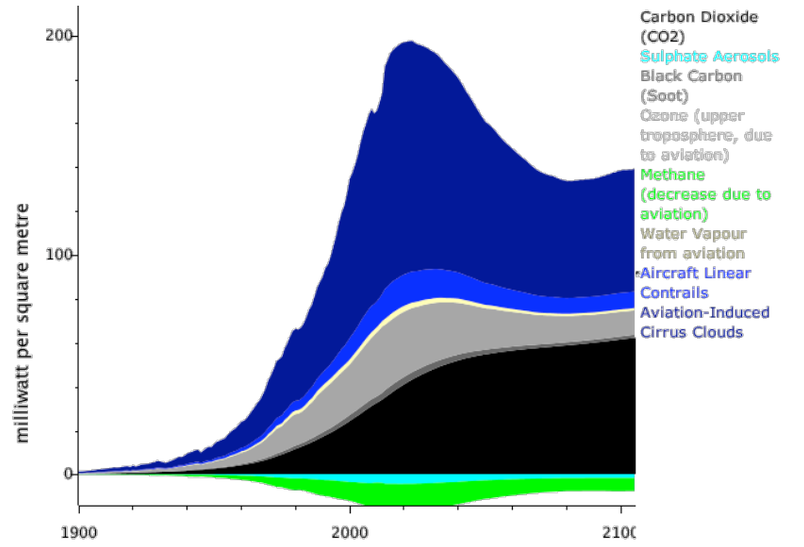
Other applications of JCM

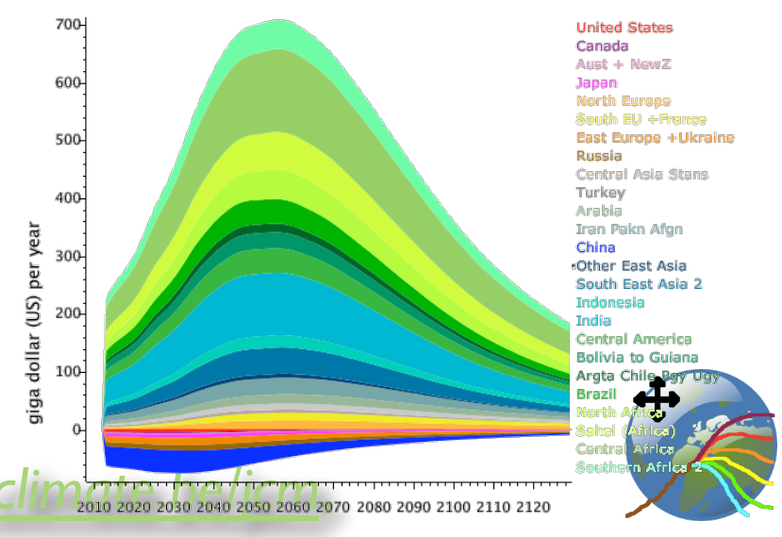
- Historical Contributions to climate change (ACCC/ MATCH) + focus historical landuse change with IVIG *(revisit? compare "carbon space", "equitable access to sustainable development?")*



- Aviation scenarios incl climate impact cirrus clouds/ other gases (ABCI) *(comparison short/long-lived gases - reapply to issue GWP, GTP ?)*



- Economic analyses - sensitivity to scenarios and integration over regions, wealth, time, and uncertainty/risk (Climneg2 project)



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=> Integrating over time / gases

- Interested to explore alternatives to GWP
  comparing short/long-lived gases?
  - depends impact of most concern (eg biodiversity vs sea-level rise)
  - also depends reference scenario - e.g. 2°C not constant conc^{n}s
  - need scientific paper comparing variants for IPCC AR5

- Also interested to explore historical / future contributions
  to climate change, in context sustainable development
  - take into account decay in atmosphere and evolving technology

- but Brazilian "double integral" was misleading,
  atmosphere has little heat capacity to accumulate warming,
  only applies to deep ocean => sea-level rise

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IPCC Scenarios - Old and New

- IPCC SRES scenarios explicitly excluded any climate policy,
  were based on data trends from1995, and had poor regional resolution.
  were used in JCM mainly for comparing climate projections to GCM results,
  and scaling relative reductions in gases and regions etc.

- IPCC has new RCPs for GCM climate runs, incl peak+decline pathways
  in parallel process develops new library of socioeconomic scenarios
  few results publicly available yet - but any new work should plan to use these
  JCM had peak+decline pathways since 2002...

- Some misleading statements in our (draft) project reports -
  Please do not attribute the faults of SRES to JCM !

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2°C stabilisation scenarios

- Policy compromise to interpret UNFCCC Article 2
  European Policy since 1996, global policy since 2009
  But is it enough to avoid dangerous impacts ?

- What does this imply for emissions pathways?
  What is acceptable risk of passing this level?

- First 2°C probabilistic analysis with JCM in 2003
- New pathways in Swiss (INFRAS) project
- UNEP "Gap" report and other recent papers

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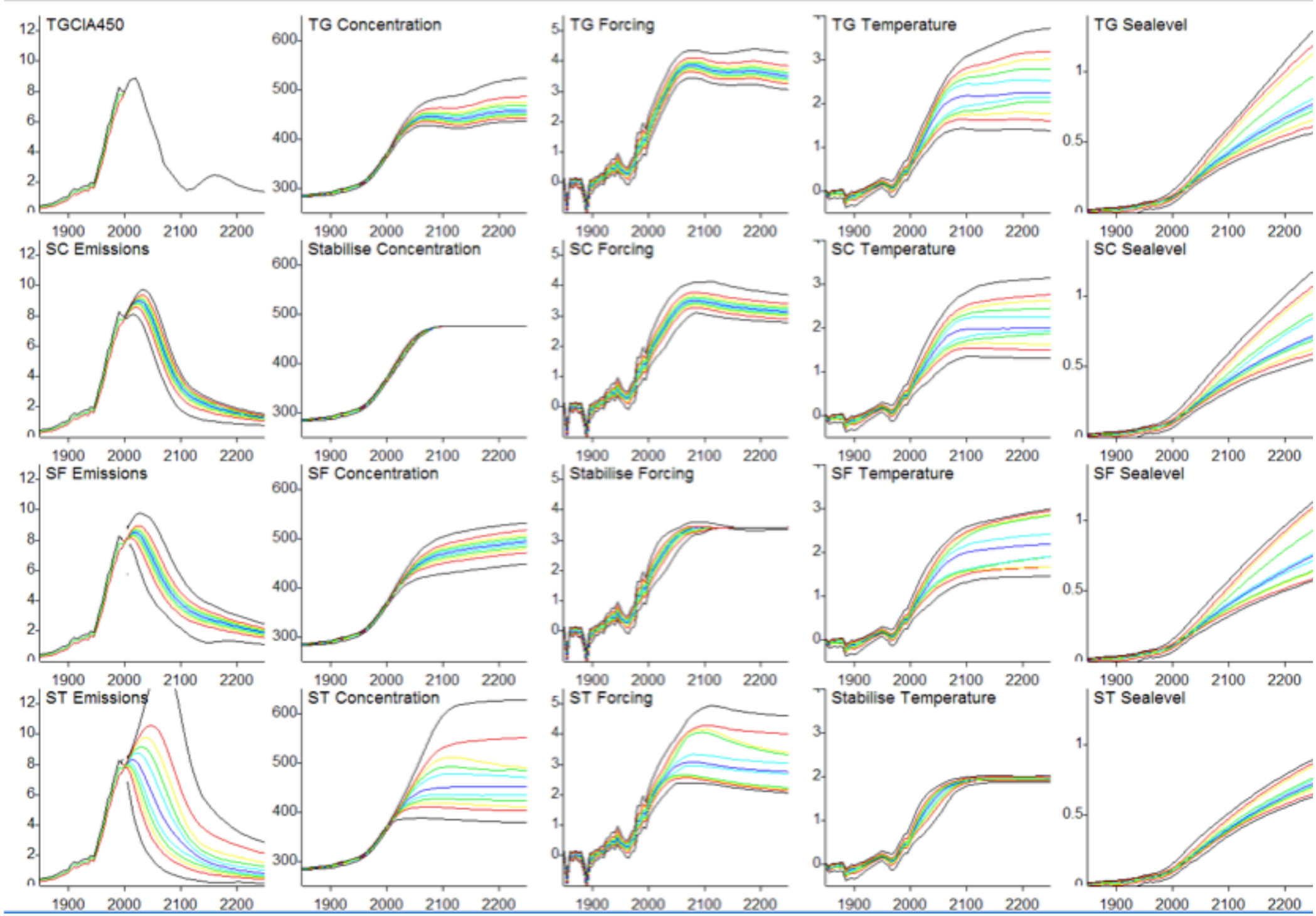
2°C Stabilisation under uncertainty - 2003

Example below from presentation of Matthews & VanYpersele at WCCC 2003 Moscow, also to EU strategy Firenze.
Shifting from concentration to temperature target shifts the burden of uncertainty from impacts to mitigation



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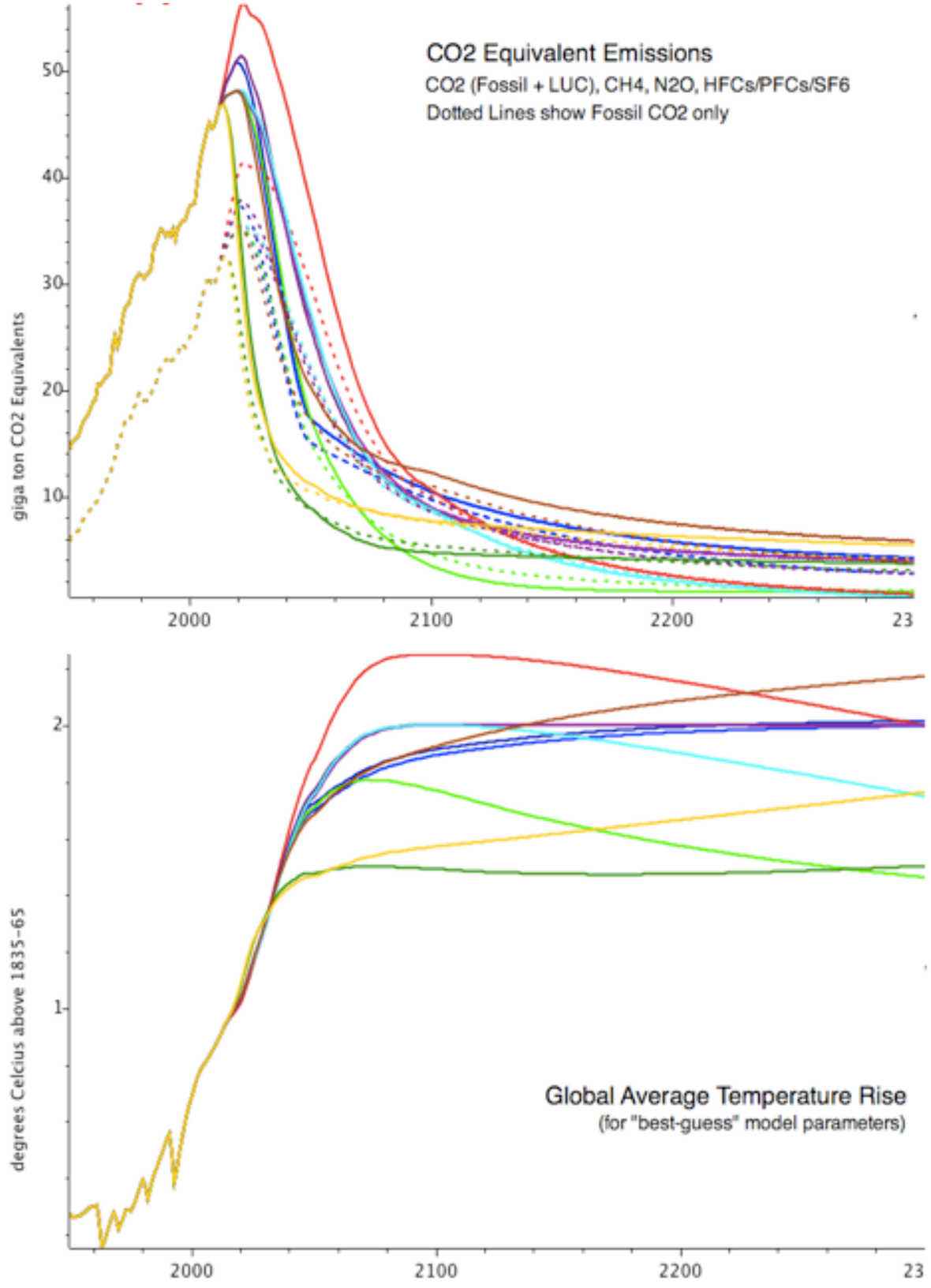
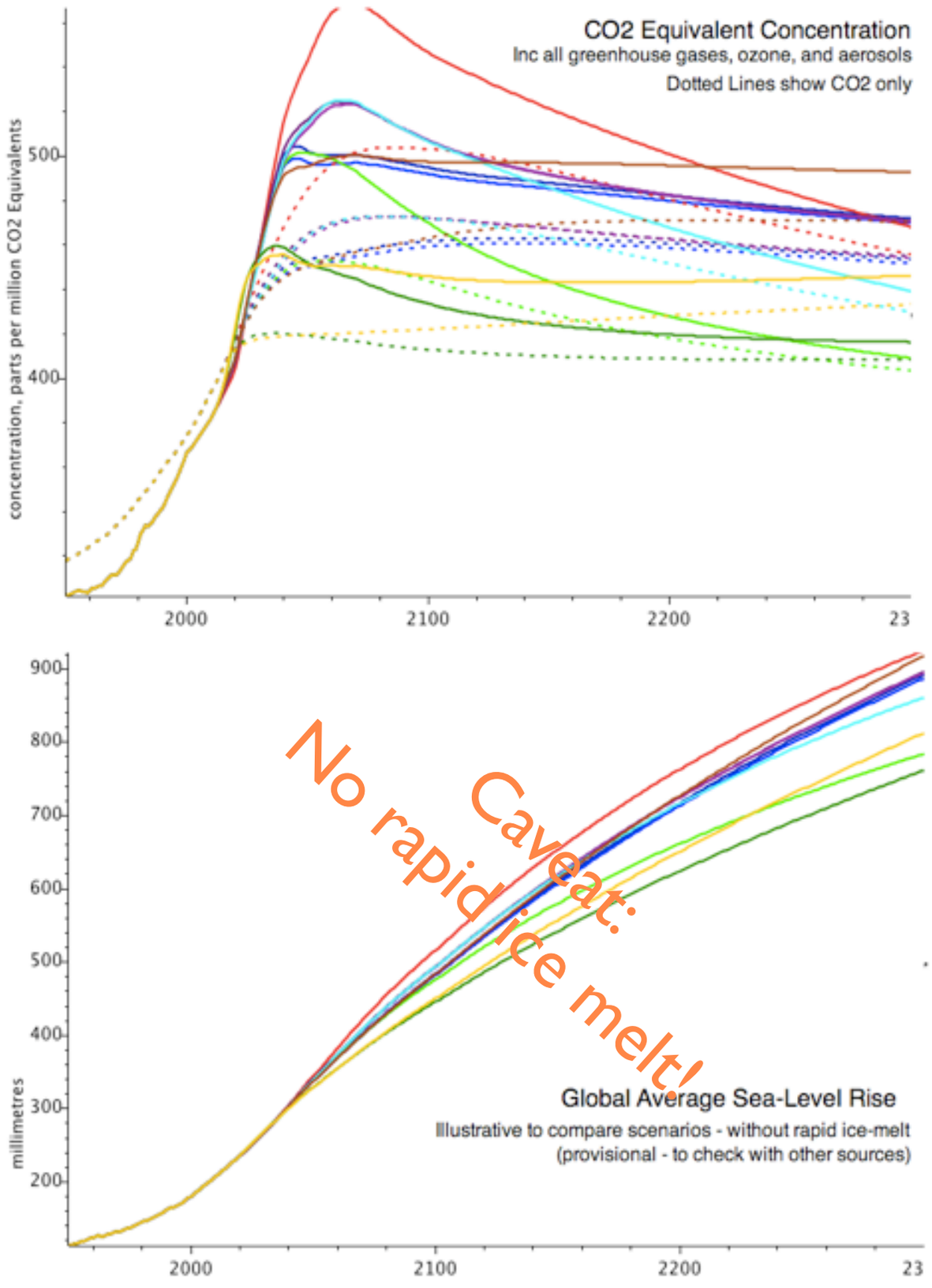
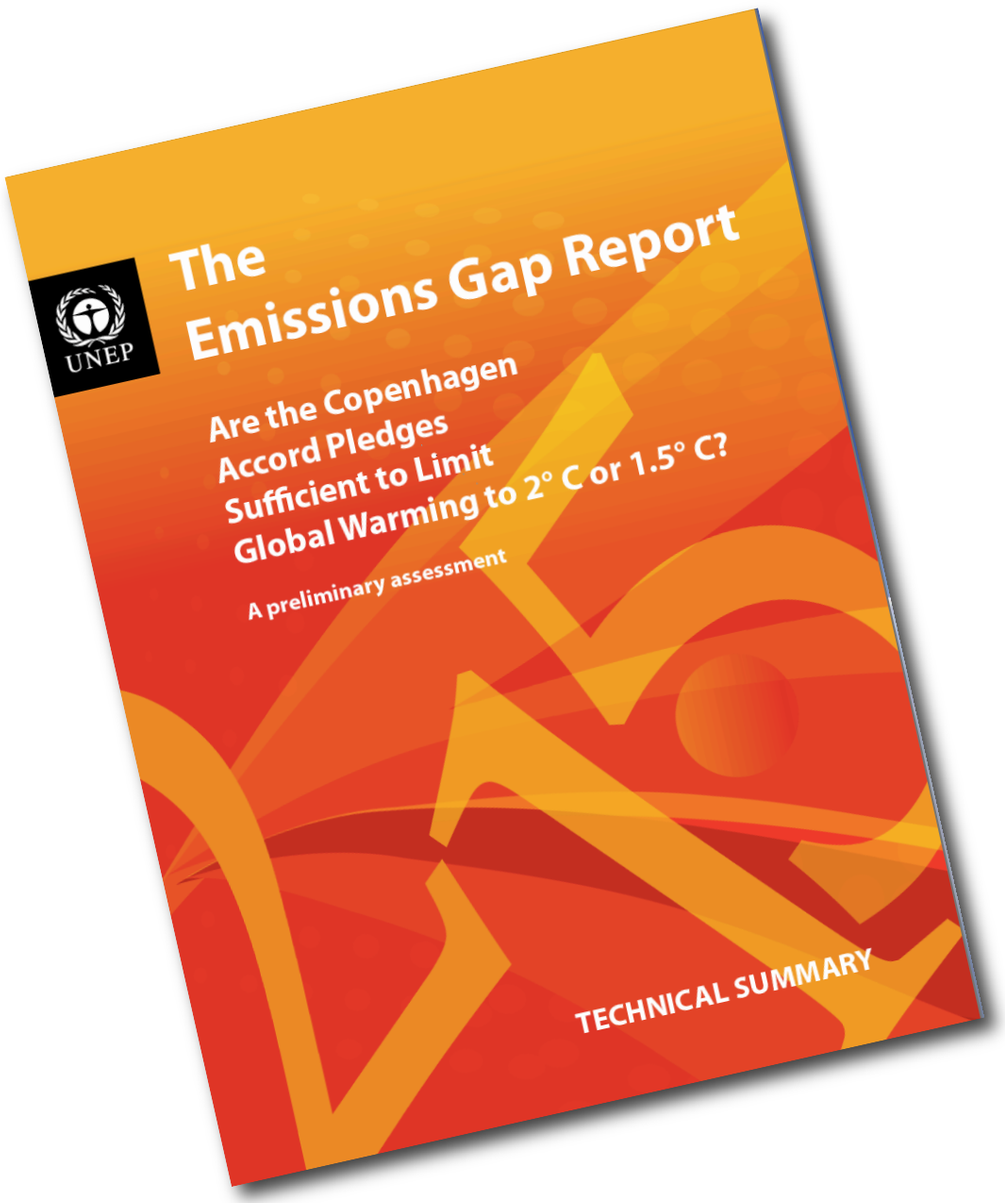
JCM: 2°C / 1.5°C pathways after the 2020 pledges





Caveat:
No rapid ice melt!

UNEP "Gap" report, EGSci paper (Cancun)



Both apply probabilistic approach (>66% chance <2°C), compare many IAM scenarios

Key message: 2020 pledges are not enough, about half-way there.

If emissions peak higher, they decline at unfeasible rates later.

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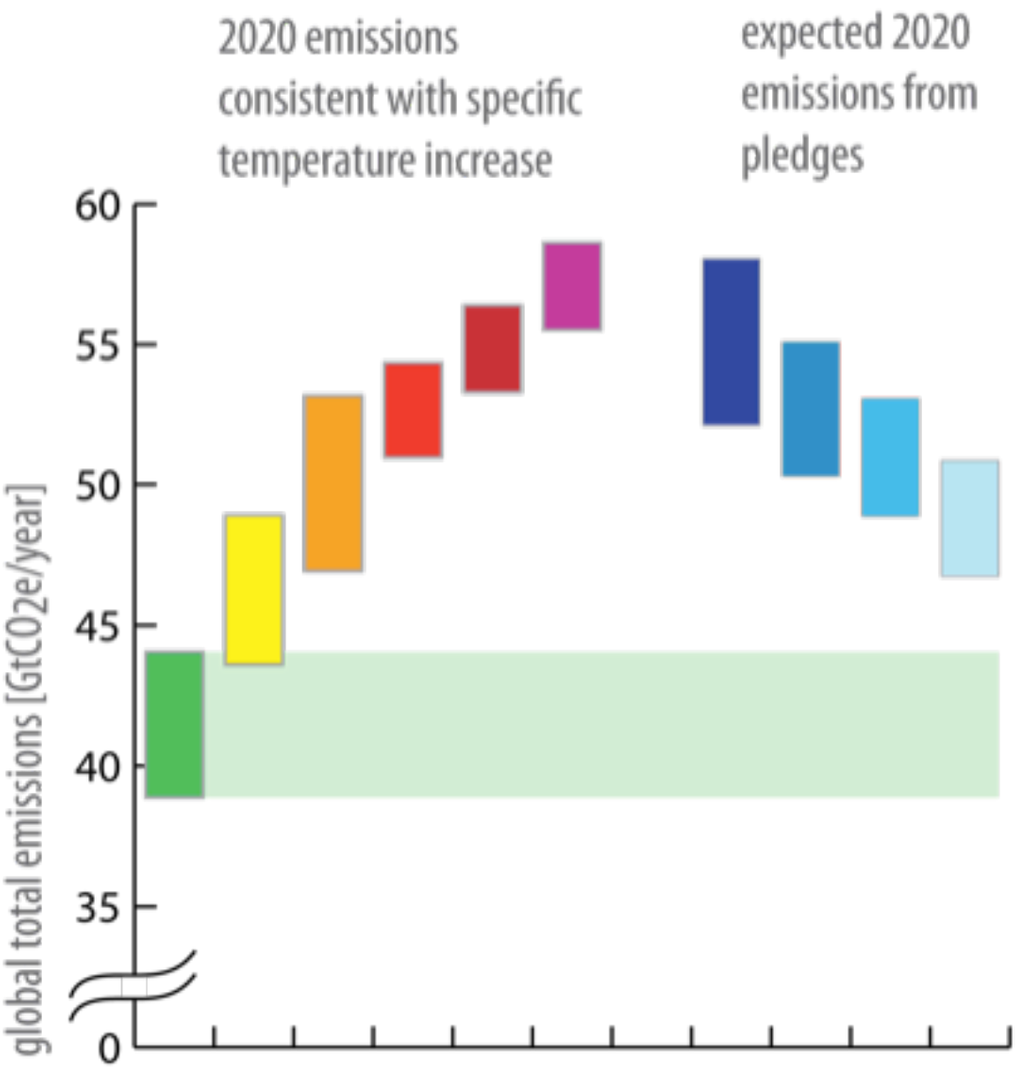
21st century temperature projections

UNEP "Gap" 2010

Copenhagen Accord pledge estimates

inconsistent with 1.5°C or 2°C (both medium and likely chance)

are more consistent with global temperature increases of **2.5°C to 5°C**



UNEP thanks Joeri Rogelj (ETHZ) for graphics

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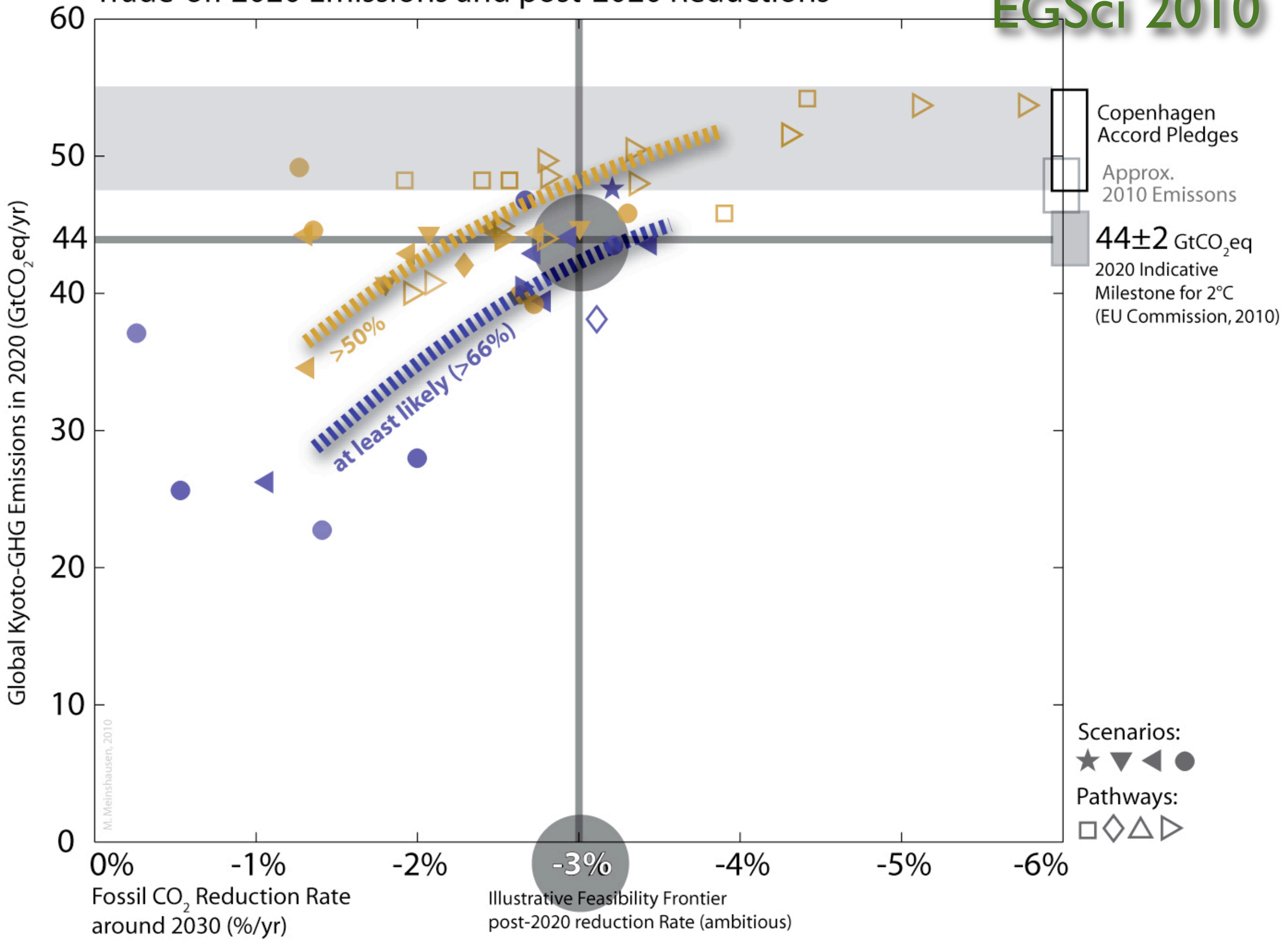
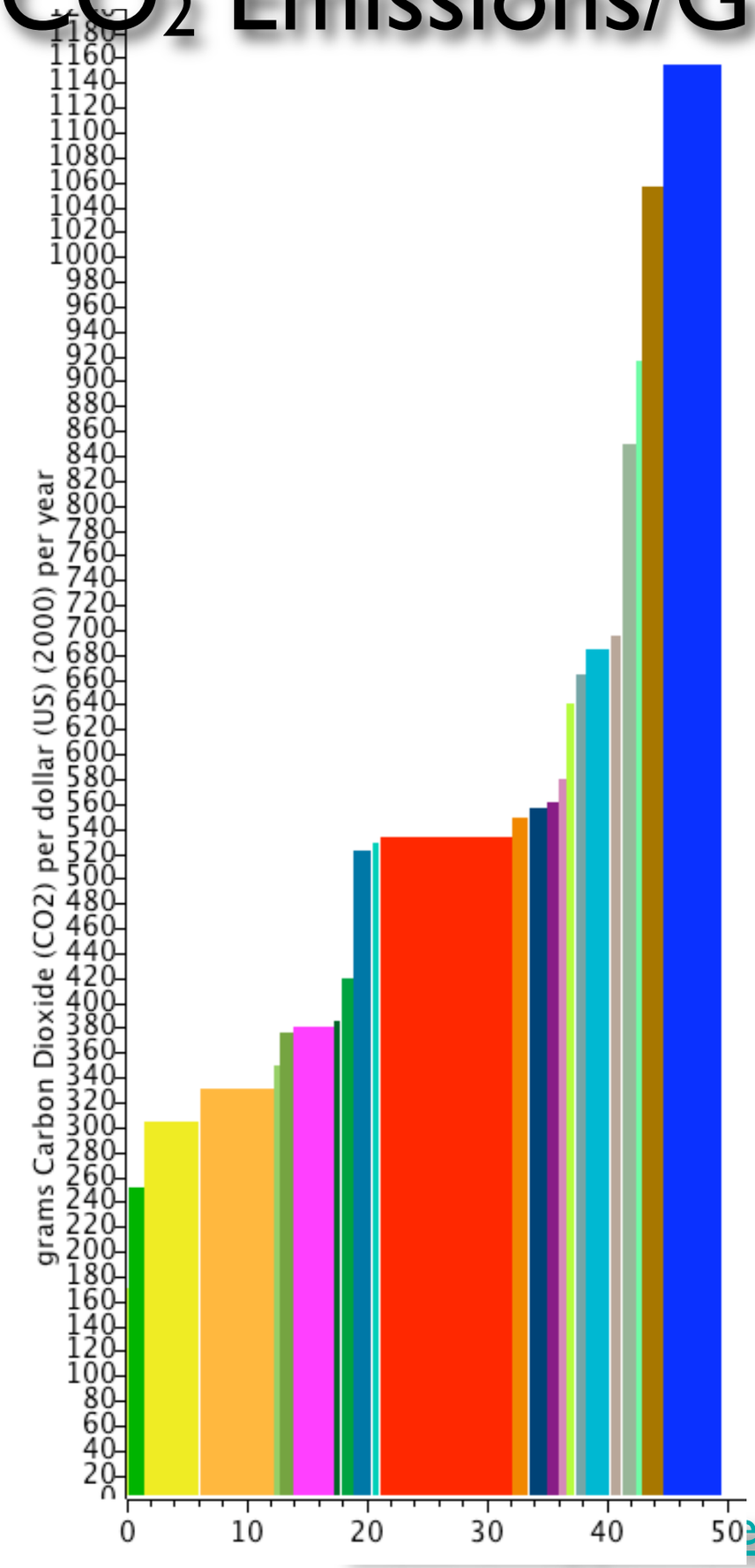
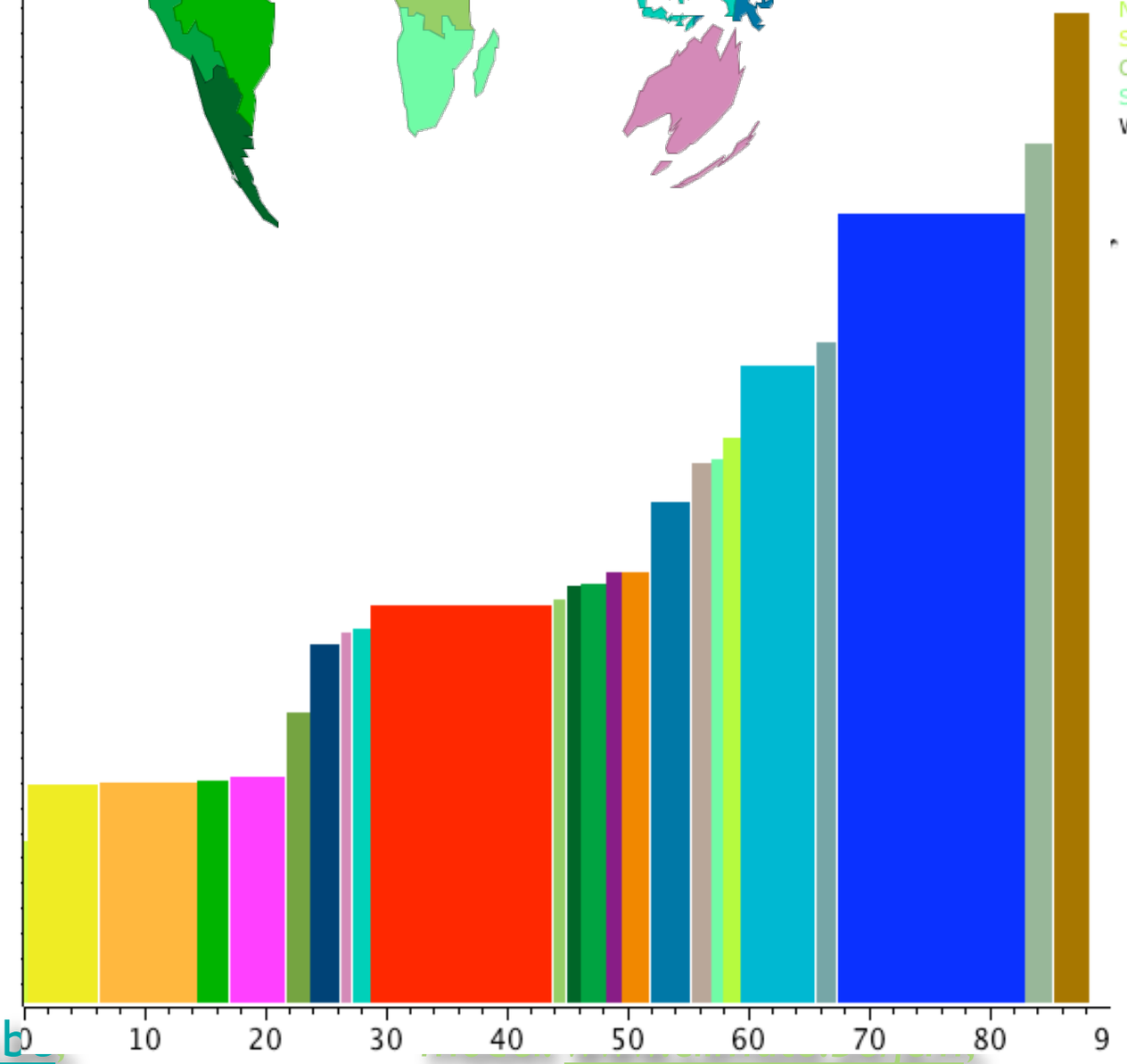
Trade-off 2020 Emissions and post-2020 Reductions

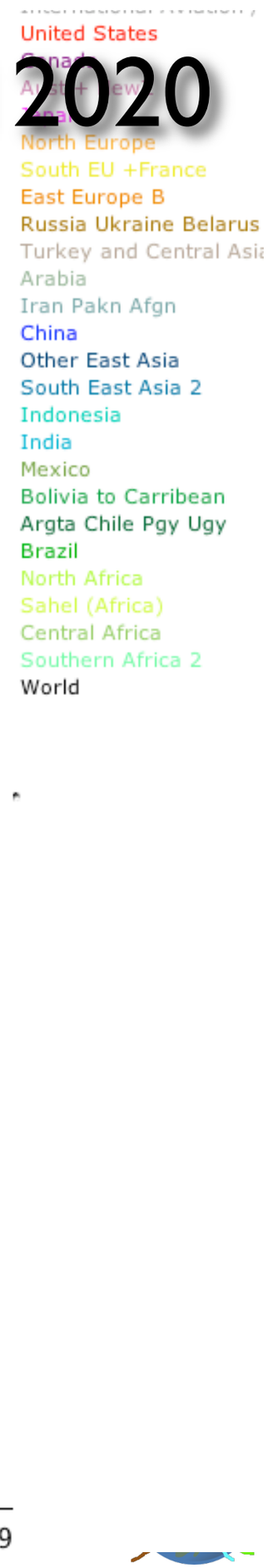
EGSci 2010



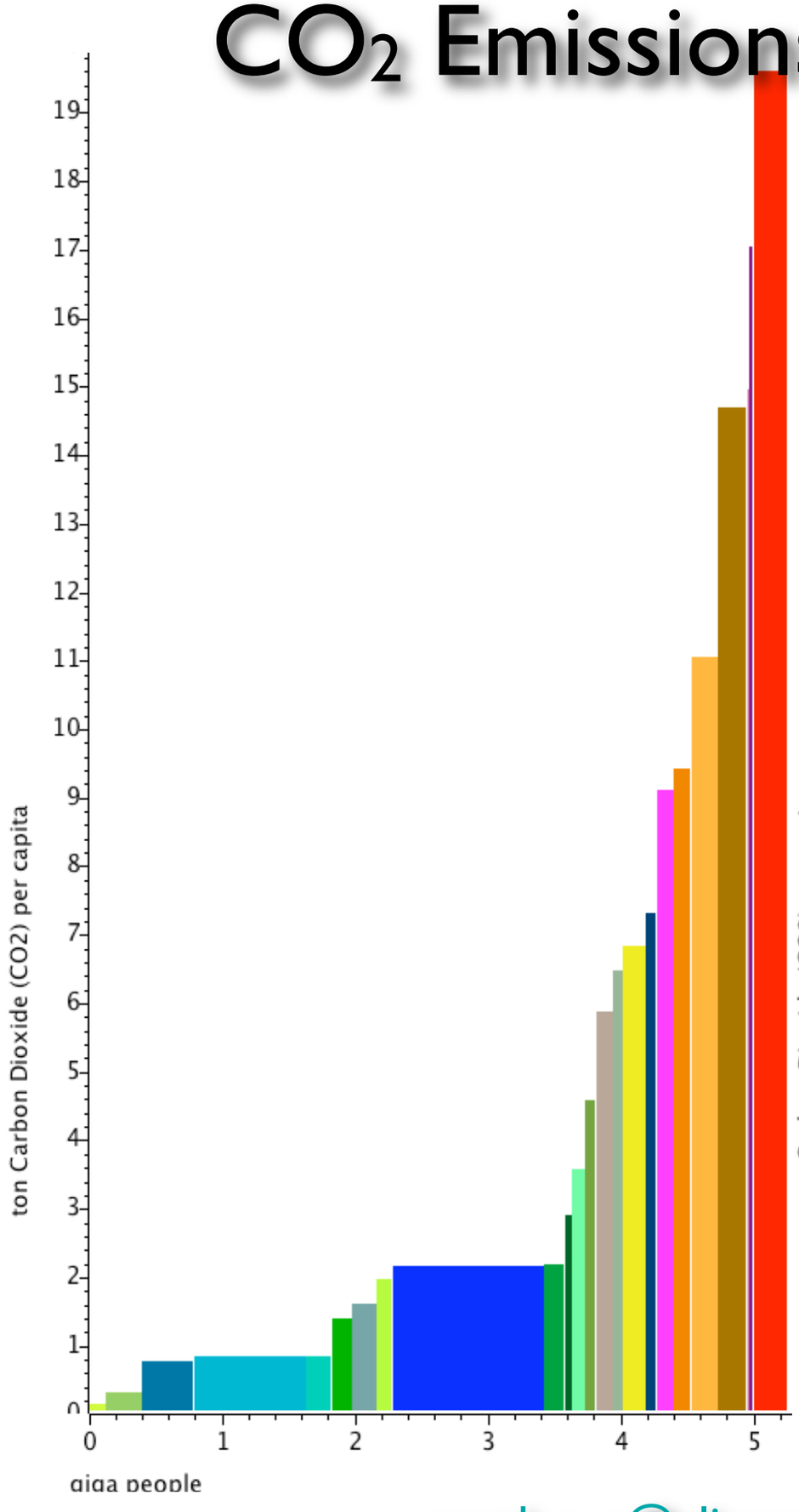
CO_2 Emissions/GDP (intensity) - 2005 and 2020

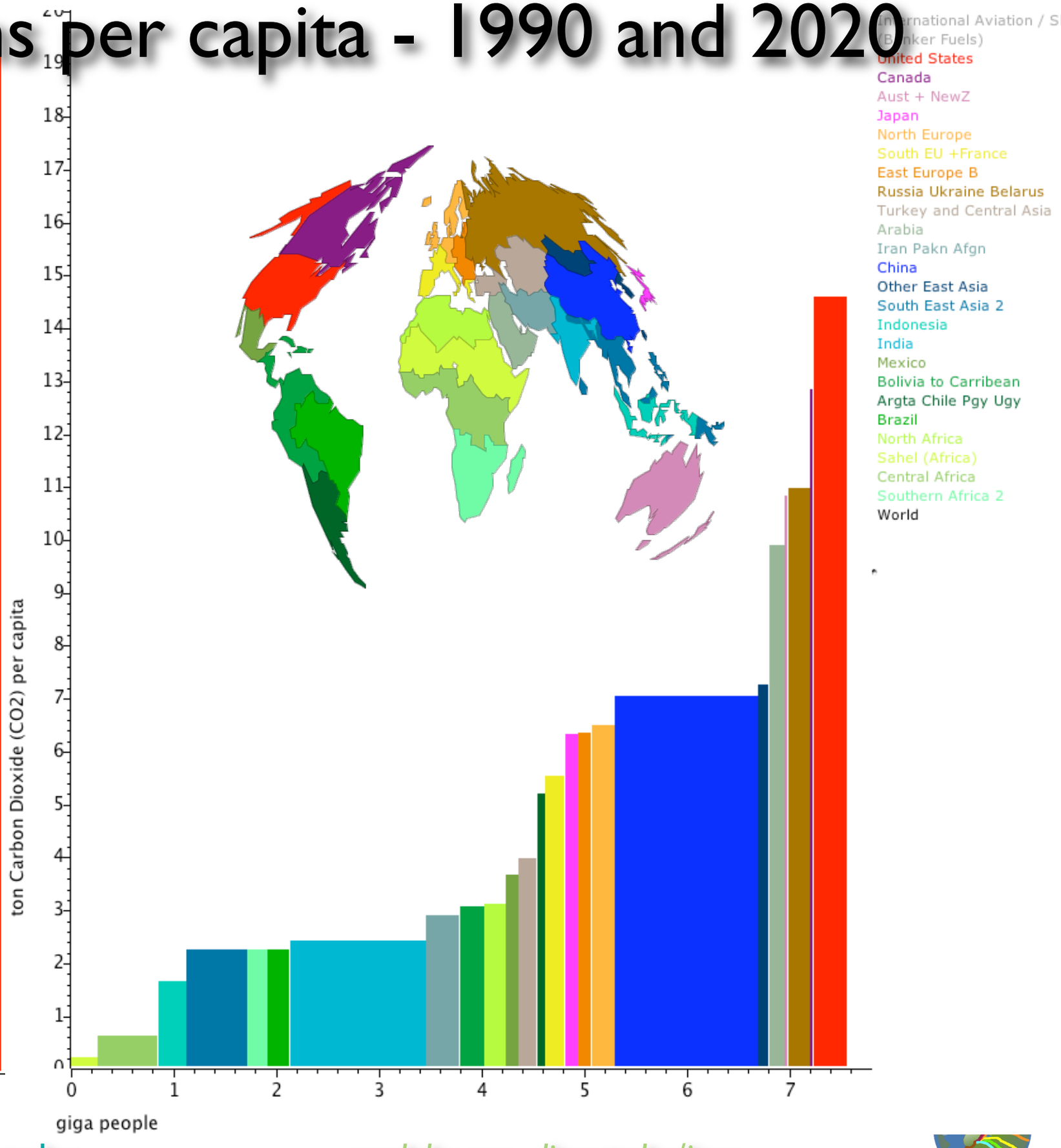






CO_2 Emissions per capita - 1990 and 2020





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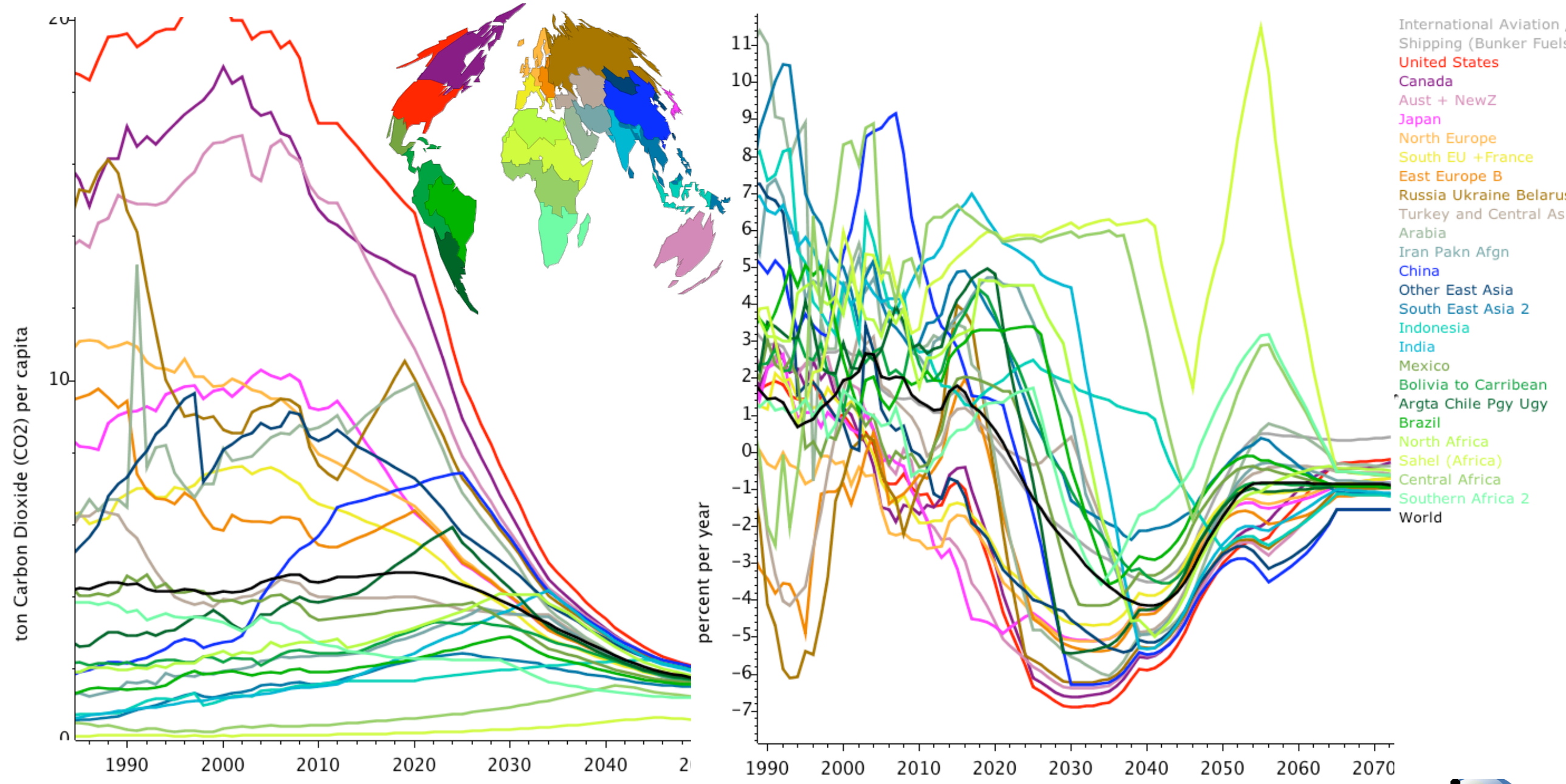
- Should adapt previous slides to include LUC and other gases !

- 2010 CO_2 emissions data suggests we are heading far above the pledges
  China up 10.4%, Brazil 11.4% / year !

Emissions Pathways 2020-2050 (JCM)

Per capita CO2 emissions (left) and rate of decline %/year (right)

Scenario -50% wrt 1990 by 2050, multiple participation / sharing criteria



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2050 emissions and peaking

- Cancun mandate to COP17, Durban 2011:
  to agree 2050 global emissions goal and peaking timeframe
  - crucial to give signal for longterm infrastructure investments
- global total constrains China more obviously than Brazil
- of course, peaking is earlier in some countries than others...
- integral of emissions may be better indicator for avoiding 2°C

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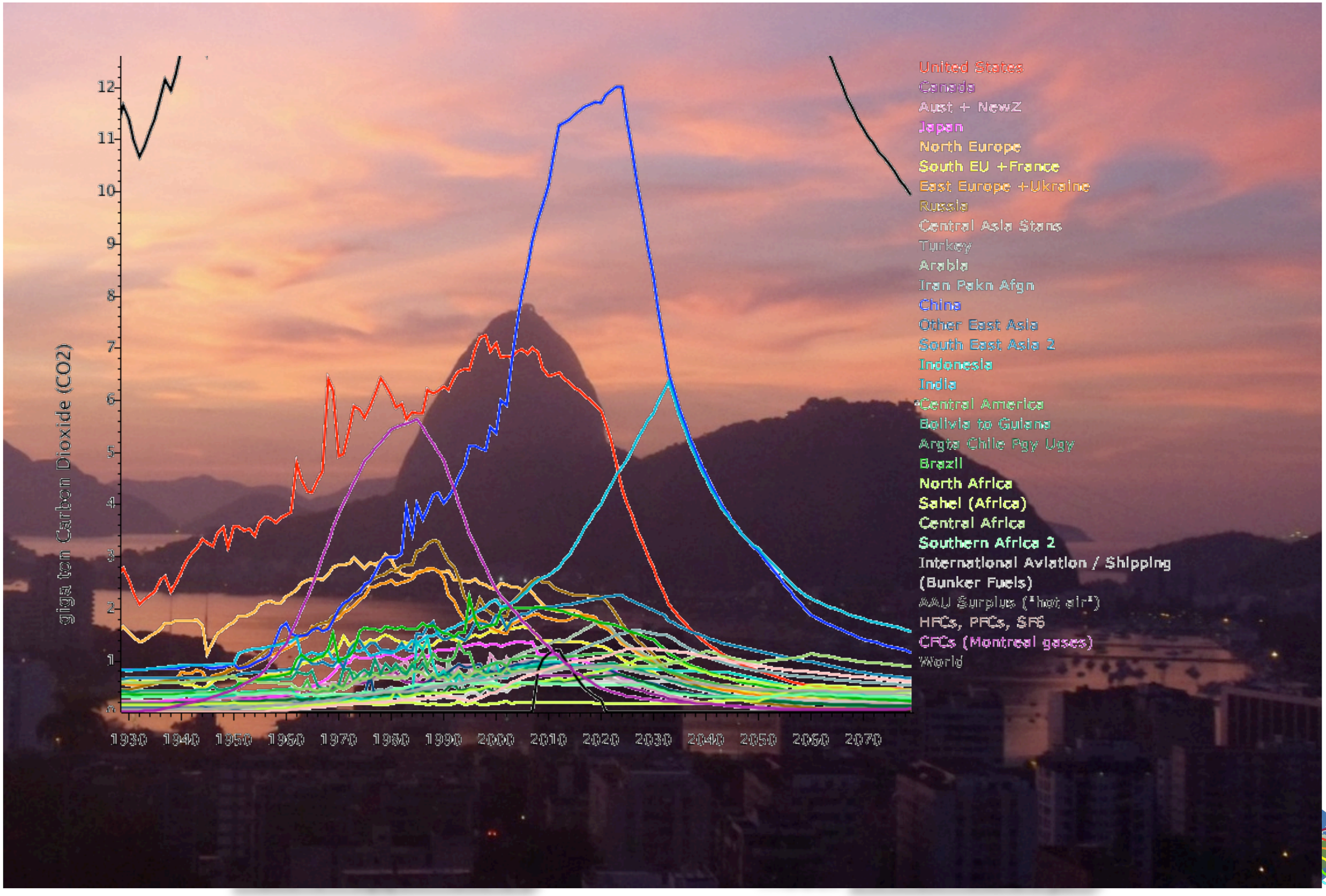
Comparing China, India, Brazil ?



Equity concerns ?

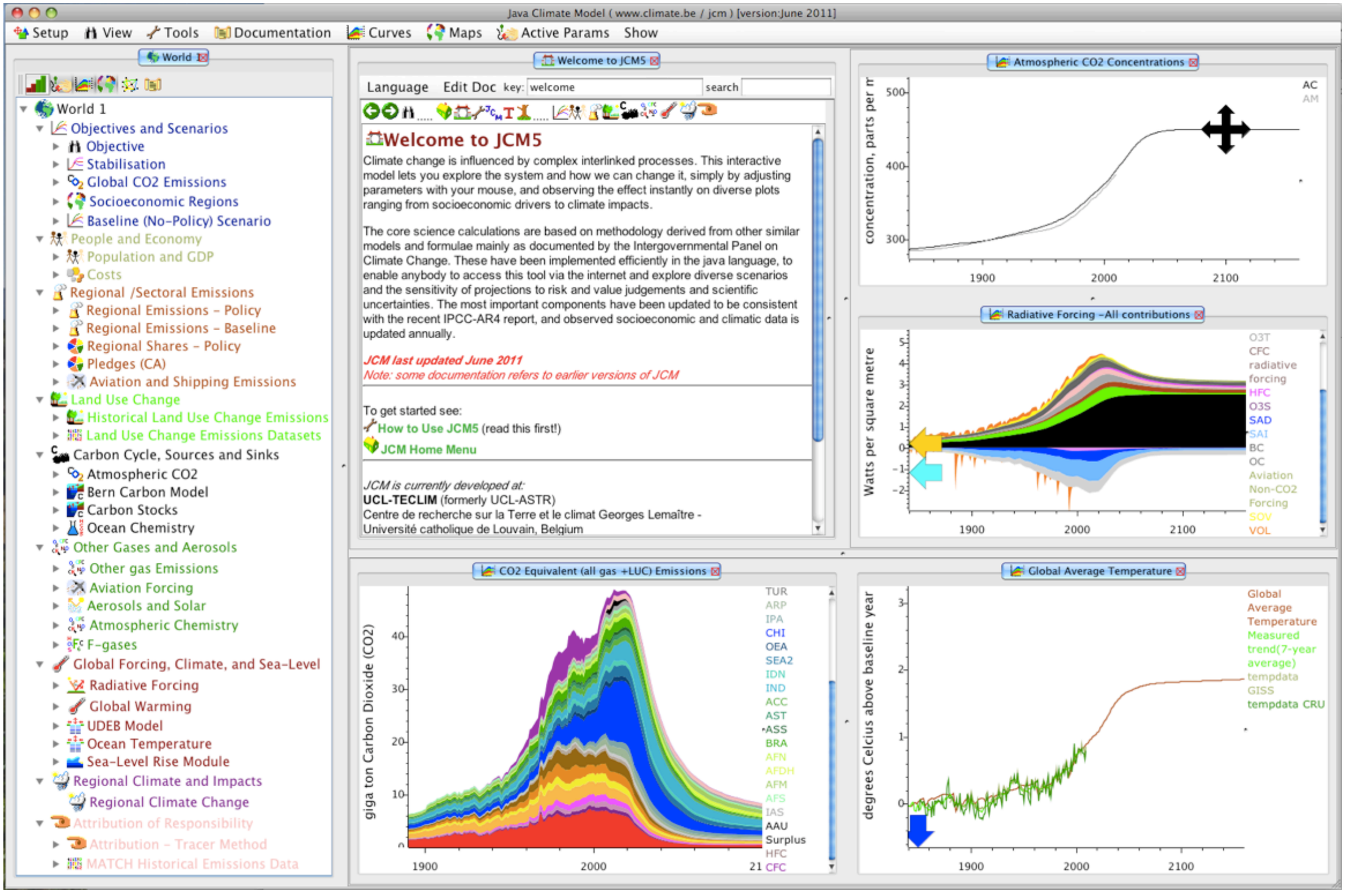
- For agreement of China, India, Brazil etc., equity seems essential

- Global 2050 target - Annex 1 target => implied developing country limit?
  Equal per capita: Ax1 approx -86% if global -50%
  European position: Annex-1 -80 to -95% wrt 1990 by 2050

- "*Equitable Access to Common Atmospheric Space*" ?
  (equal cumulative emissions / contributions to temperature)
  consensus Cancun: "*Equitable Access to Sustainable Development*" = ?

- Greatest *Inequity* is the distribution of climate change impacts
  (concern of vulnerable countries - equity should not be an excuse for delay)

JCM - Demonstration



Issues to fix soon

- Update LUC emissions data and projections
  - especially Brazil + Indonesia

- Assumptions about LUC and other gases in 2020 NAMAs

- Update 2010 emissions, better data for CH_4, N_2O etc.

- Smoother national pathways (shares) ? focus peaking years ?

- more setup examples, documentation, translations?

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To develop here: Sectoral / Energy module

- *(last year: experimental module of fuels, scale to Brazil total)*
- Incorporate PB scenario tables for sectors and fuels to 2030 ?
- How to differentiate extra reductions by sector / fuel?
  - shift towards lower-carbon energy, some options cheaper / more capacity
  - could use MACs but lack investment / learning
- Not only energy supply - what about changing demand?
  energy efficiency, buildings, transport infrastructure planning etc.
- Relation energy / land-use change?
  - distribution of effort energy vs LUC, implications of biofuels for landuse, capacity...
- *Depends on suggestions from you !*

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To develop here: sensitivity analysis 2°C=> Brazilian energy sector

inverse calculation, automated to explore many variants - what makes most difference?

- Starting from 2°C stabilisation scenarios

(various pathway shapes - approaching 2°C faster or slower)

- + Varying physical climate parameters => Concentrations GHGs

(climate sensitivity, ocean mixing, aerosols etc. - probabilistic weighting of sets as 2003 ?)

- + Varying carbon cycle parameters => Global CO2 emissions

(ocean sink, CO2 fertilisation, climate feedback on soil respiration, etc.)

- + Varying sharing of national emissions /effort => Brazilian emissions

(convergence, gradual participation, ... starting from pledges + higher and lower?)

- + Varying distribution between sectors => Brazilian energy sector

(uncertainty in LUC will make a big difference for Brazil)

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To develop later...

- Incorporate new IPCC RCP scenarios and GCM results,
  to test and re-calibrate physical climate system, feedbacks...
- Bottom-up socioeconomic scenarios, demographics, local data...
  + *compare / connect scenarios in new IPCC socioeconomic scenario library?*
- 1.5°C scenarios? *(decline after peak - interest many countries)*
- Alternative metrics for integrating gases (GWP, GTP etc.)
- Synthesis of regional & sectoral impacts of climate change
  - new functions based on AR5 WG2?
- Re-develop optimisation module
  for cost-effective solutions / re-calibration ?
- Simpler versions for teaching, for smaller screens, ...?
- Recall concept democratisation of climate science-policy interface:
  "*ultimate integrated assessment model is the global network of human heads*"

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How to use JCM + Course

- JCM website: www.climate.be/jcm *Updated June 15*
  (also with link to source code by SVN)

- Variant on IVIG intranet: 10.0.0.45/jcm
  (for setups specific to this project, development of sectors module and sensitivity analysis script etc.)

- Course: how to apply JCM ?
  Please indicate suitable dates soon ?

- This was opening presentation - another for new "results" (when?)

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Scenarios to limit global warming to 2°C,
+> Implications for Brazilian energy sector

Obrigado - Perguntas ?

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