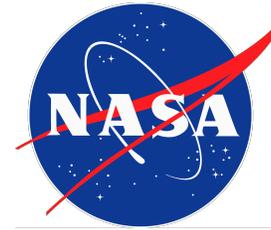


CLEAN webinar on *World Climate*

Juliette N. Rooney-Varga

Thanks to



• John Sterman

• Cecelia Hunt

• Ellie Johnston

• Jared Nease

• Andrew Jones

• Kenneth Rath

• Travis Franck



• Elizabeth Sawin

• Devan Hawkins



Overview

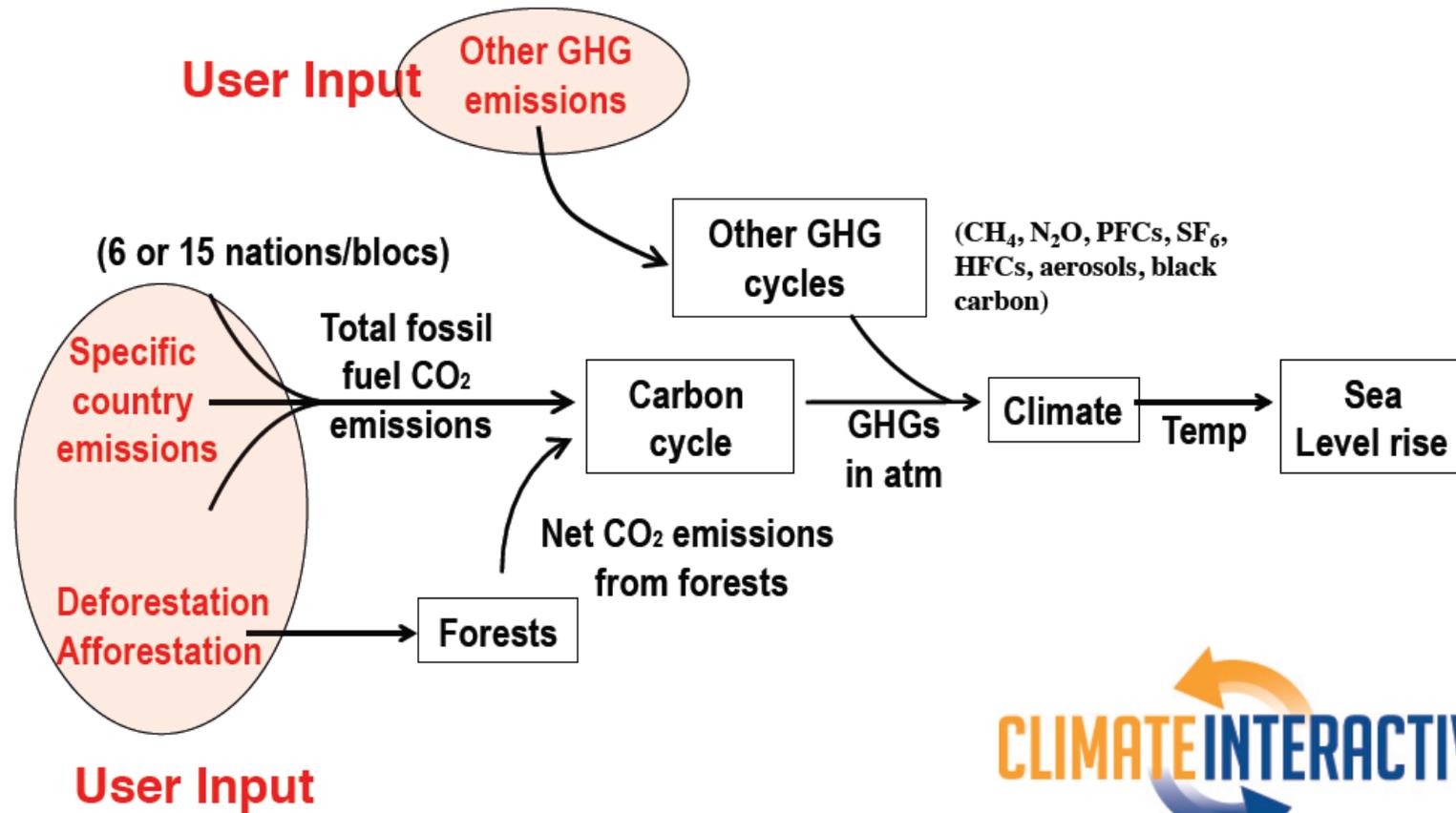
- Overview of C-ROADS
- Introduction to the *World Climate* exercise
- A short experiment: a mini-WCE
- Debrief
- How could you use this tool?

C-ROADS

(Climate Rapid Overview and Decision Support)

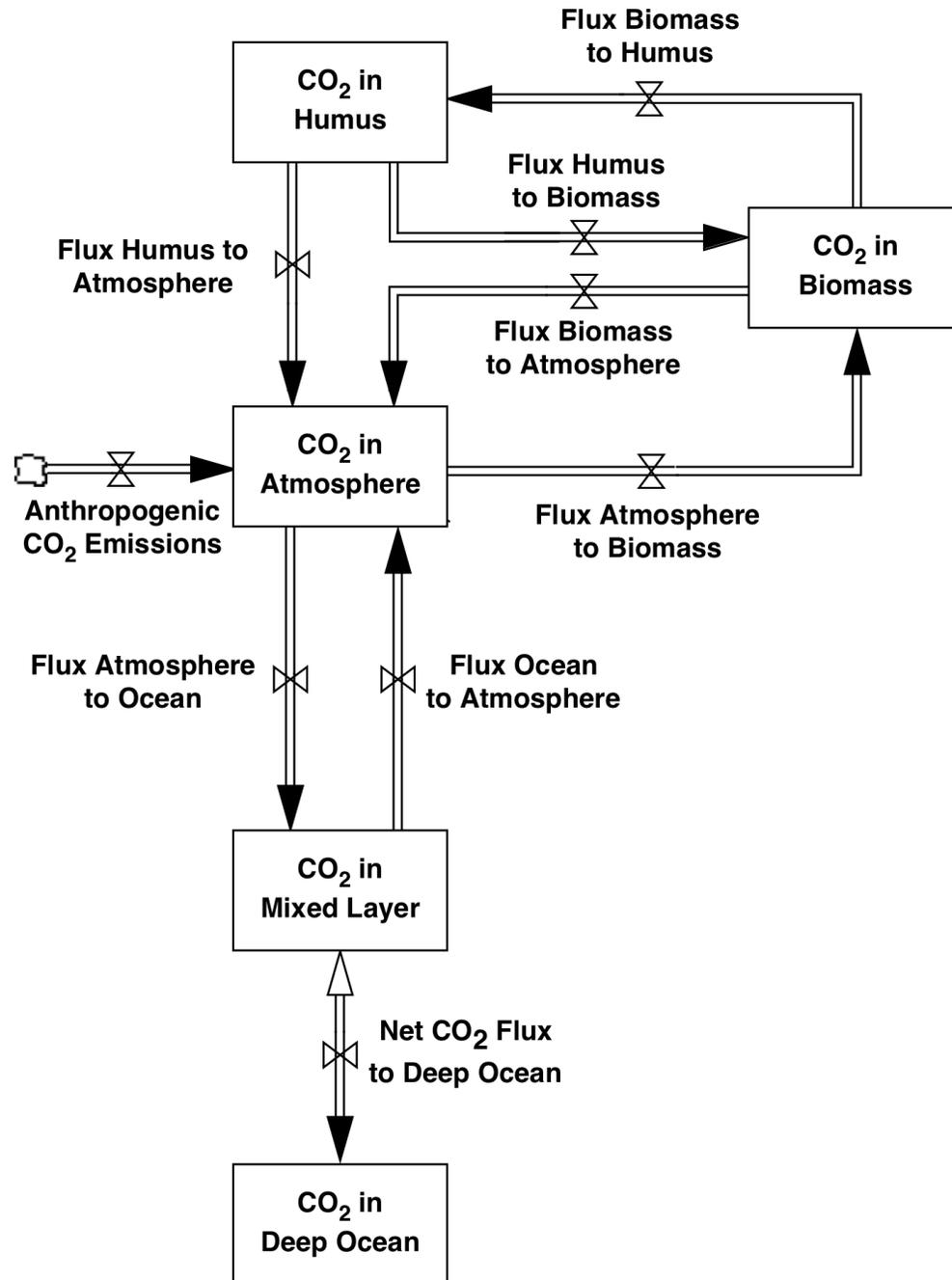
- Created in response to UN climate negotiations
- Apparent disconnect between delegates' pledges and scientific understanding of impact
- Intended to compliment, not replace, more complex climate models
- Make science accessible and interactive for decision-makers

C-ROADS

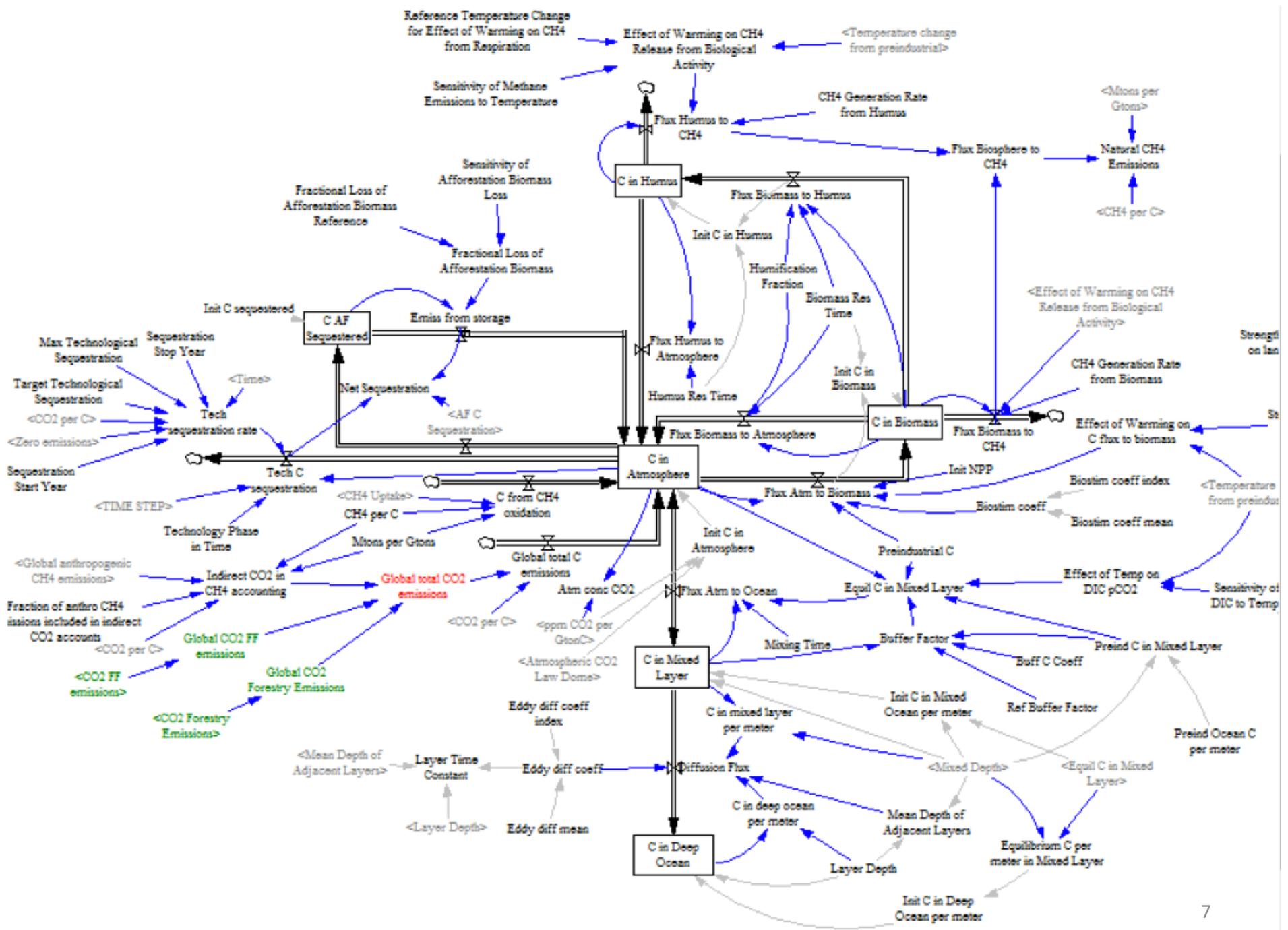


C-ROADS has been scientifically vetted and recommended as an official UN tool

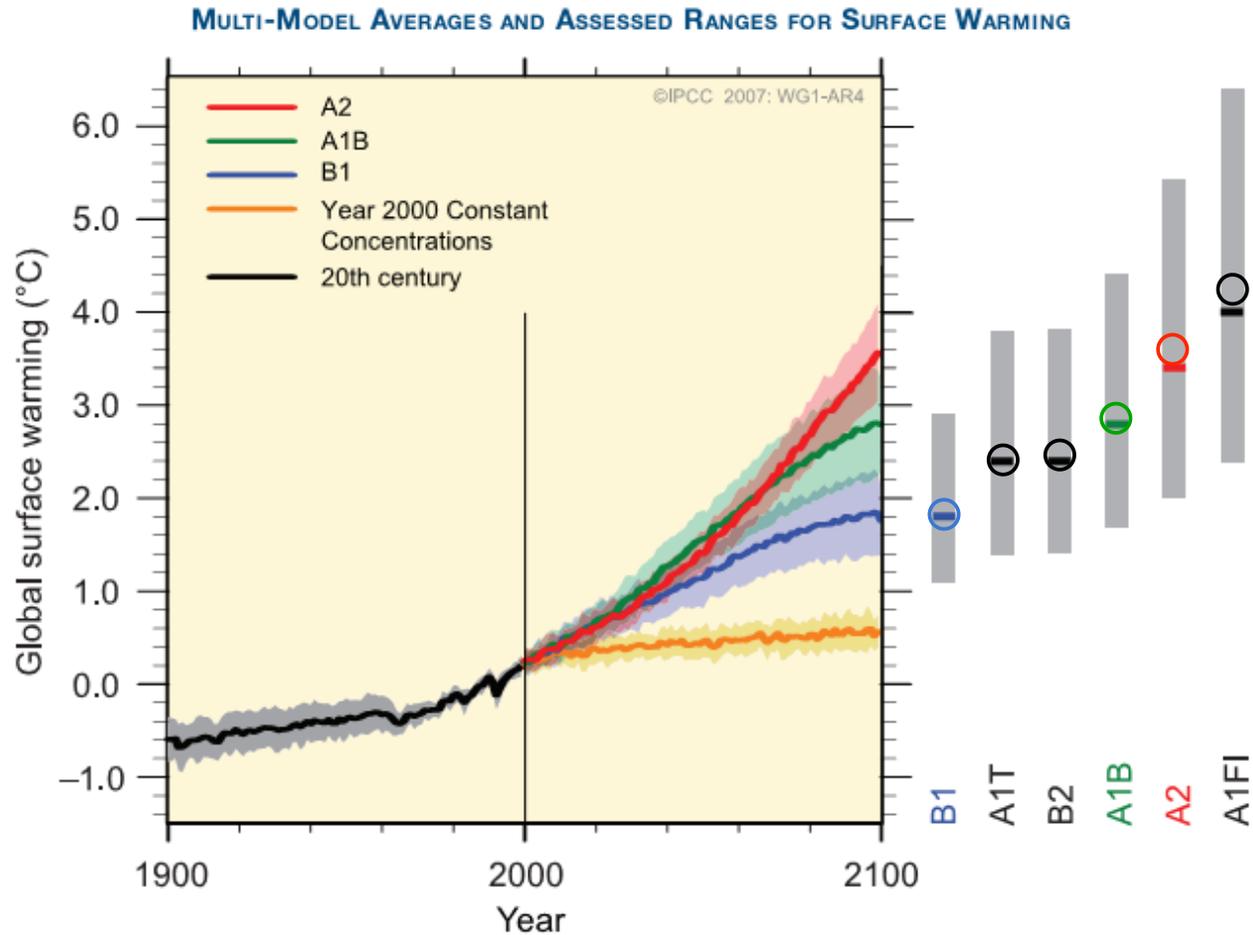
Carbon Cycle



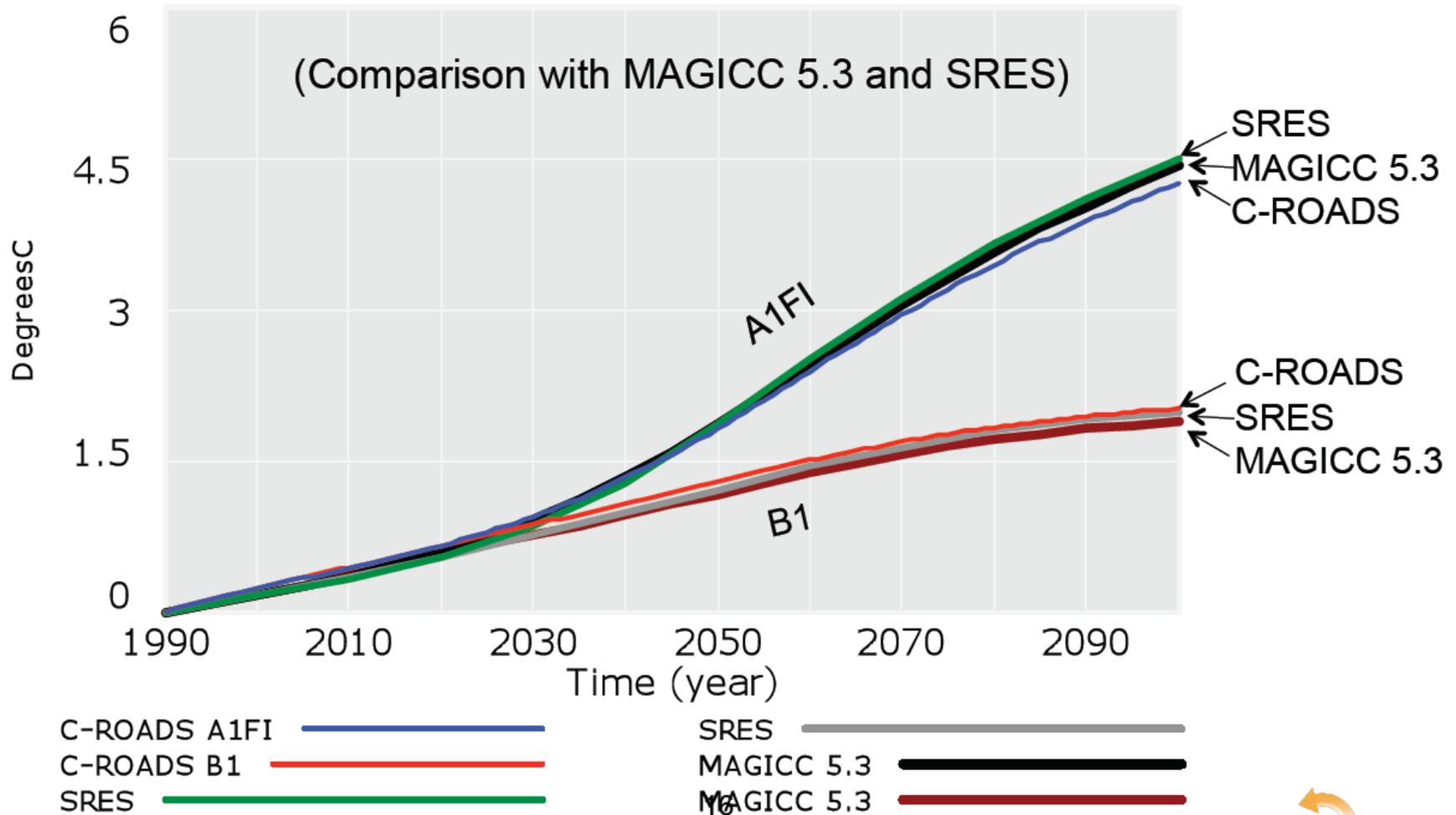
- Atmosphere
- Two biosphere compartments
- Ocean:
 - Mixed layer
 - 10 deep ocean layers
- Explicit stock/flow structure for other GHGs
 - CH₄
 - N₂O
 - HFCs, PFCs, SF₆, etc.
- Aerosols & Black Carbon



C-ROADS Calibration to AR4 Scenarios



When Input with High and Low Emissions, C-ROADS Produces Temperature Output Consistent with the Models in IPCC's AR4



C-ROADS Scientific Review Panel

- Dr. Robert Watson, Former chair, IPCC
- Mr. Eric Beinhocker, McKinsey Global Institute
- Dr. Klaus Hasselmann, Max-Planck Institut für Meteorologie
- Dr. David Lane, London School of Economics
- Dr. Jørgen Randers, Norwegian School of Management (BI)
- Dr. Stephen Schneider, Stanford University
- Dr. Bert de Vries, Netherlands Environmental Assessment Agency, RIVM

Conclusions of the scientific review panel

- The C-ROADS model *“reproduces the response properties of state-of-the-art climate models very well.”*
- *“Given the model’s capabilities and its close alignment with a range of scenarios published in the Fourth Assessment Report of the IPCC, we support its widespread use among a broad range of users and recommend that it be considered as an official United Nations tool.”*

U.S. State Dept's Jonathan Pershing Presenting C-ROADS Results to the UN

  UNFCCC Webcast

Bonn Climate Change Talks – March 2009
Seventh session of the AWG-KP and fifth session of the AWG-LCA

OnDemand Webcast

Floor English

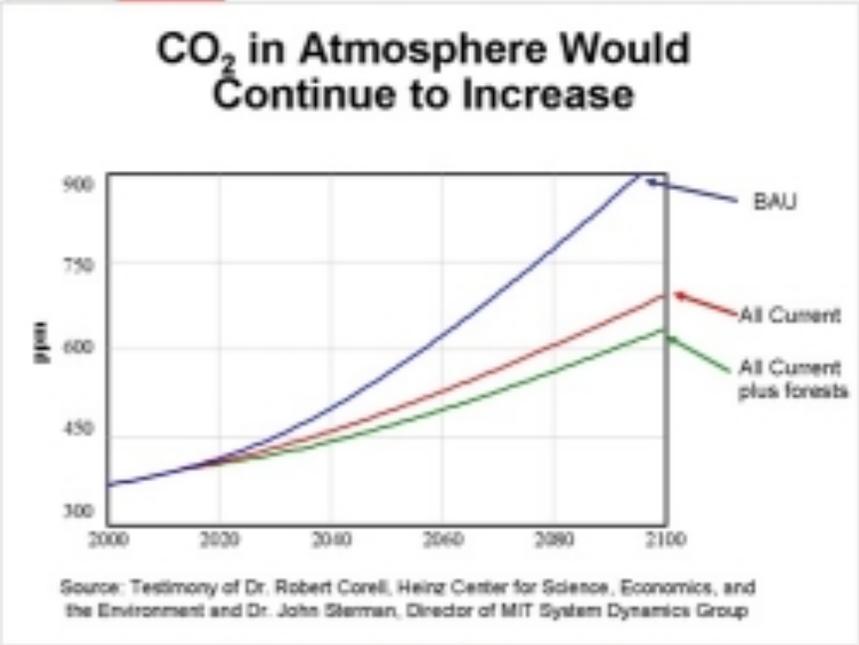


Mr. Jonathan Pershing
United States of America

Organizer: UNFCCC
Type: Plenary
Date: 01 April 2009
Time: 10:00 CEST
Location: Saal Maritim

Agenda Charts

CO₂ in Atmosphere Would Continue to Increase



Year	BAU (ppm)	All Current (ppm)	All Current plus forests (ppm)
2000	370	370	370
2020	420	410	400
2040	500	480	460
2060	620	560	520
2080	750	640	580
2100	900	700	620

Source: Testimony of Dr. Robert Corell, Heinz Center for Science, Economics, and the Environment and Dr. John Sterman, Director of MIT System Dynamics Group

Slide 6 of 7



“C-ROADS works, it is important, and it is already getting broad dissemination, ... I used it!”

Secretary of State John Kerry

President Obama Briefed with C-ROADS 48 Hours Before Copenhagen Summit

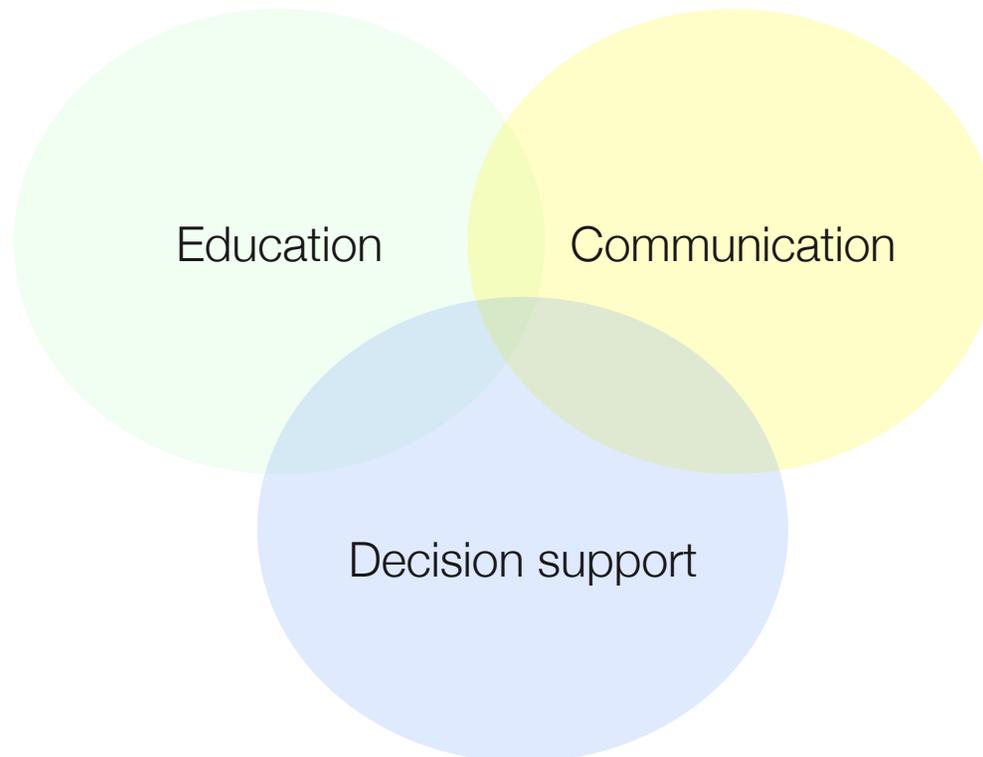


C-ROADS users around the world



World Climate

- Role-playing game framed by science through C-ROADS
- What is the global deal that YOU would negotiate?



World Climate has been played by...

- Nobel-prize winning scientists
- European Union government policymakers
- CEOs from major corporations in China, EU, USA
- Oil executives
- University students on five continents
- High school students
- AND MORE...

Instructional settings?

- Formal (ninth grade to graduate students)
- Informal (civic organizations, decision-makers – including university presidents and high-level policymakers)
- ~9-60 participants (3-bloc or 6-bloc)
- Across disciplines: from STEM to arts and humanities
 - C-ROADS brings rigorous science into user-friendly, interactive format
 - Role-playing: engaging, visceral, social dynamics

Setting up *World Climate*

- Students get:
 - Briefing statement that summarizes their negotiating bloc's interests (based on actual negotiating positions)
 - Opportunity to research climate-related emissions, impacts, policy before exercise
 - Brief overview of UNFCCC, historical emissions, population and GDP for each negotiating bloc

And the instructor gets to be....





United Nations Framework Convention on Climate Change



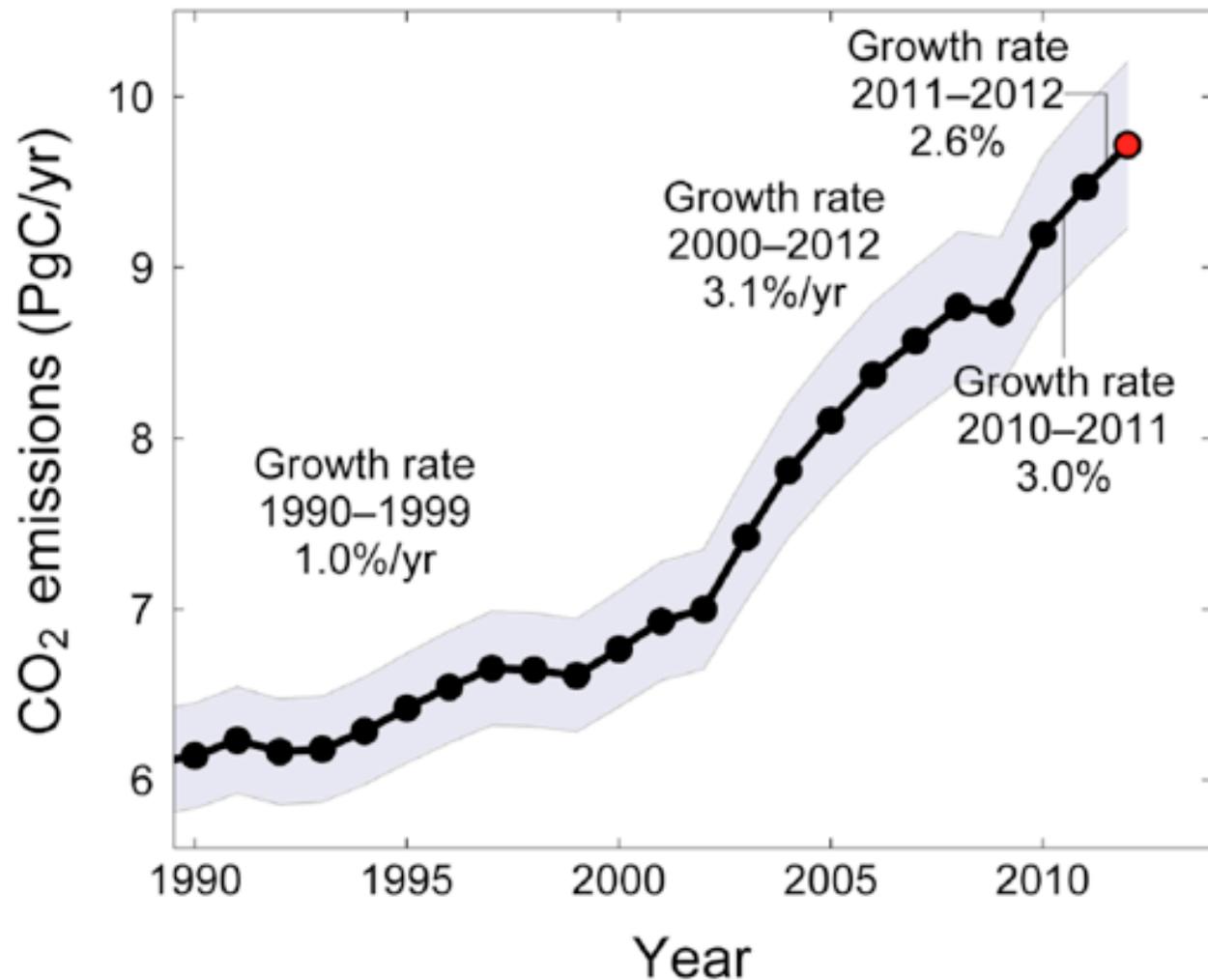
©EnchantedL.



Welcome Delegates



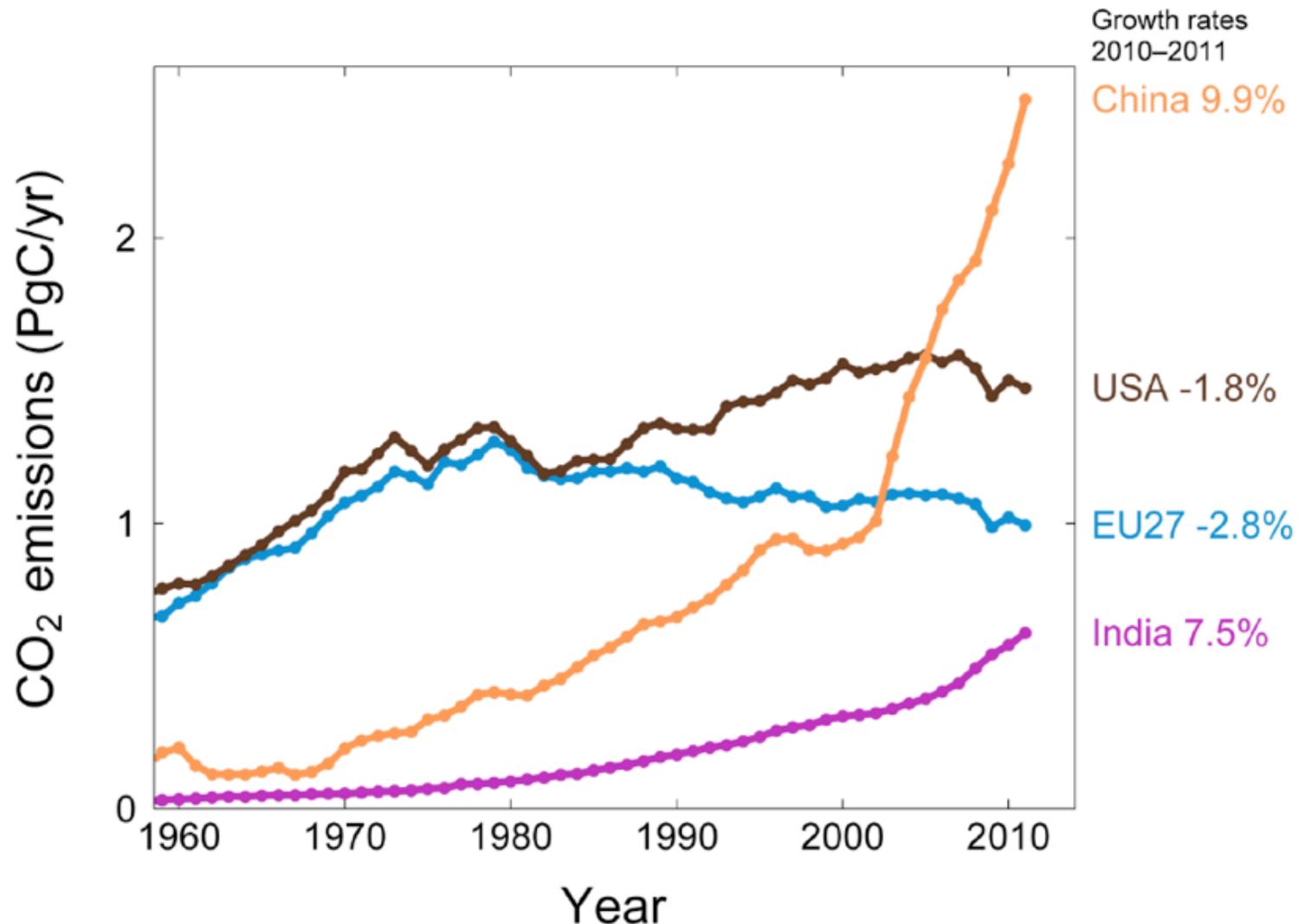
Global fossil and cement emissions: $9.5 \pm 0.5 \text{PgC}$ in 2011, 54% over 1990
Projection for 2012: $9.7 \pm 0.5 \text{PgC}$, 58% over 1990



Uncertainty is $\pm 5\%$ for one standard deviation (IPCC “likely” range)

Source: [Peters et al. 2012a](#); [Le Quéré et al. 2012](#); [CDIAC Data](#); [Global Carbon Project 2012](#)

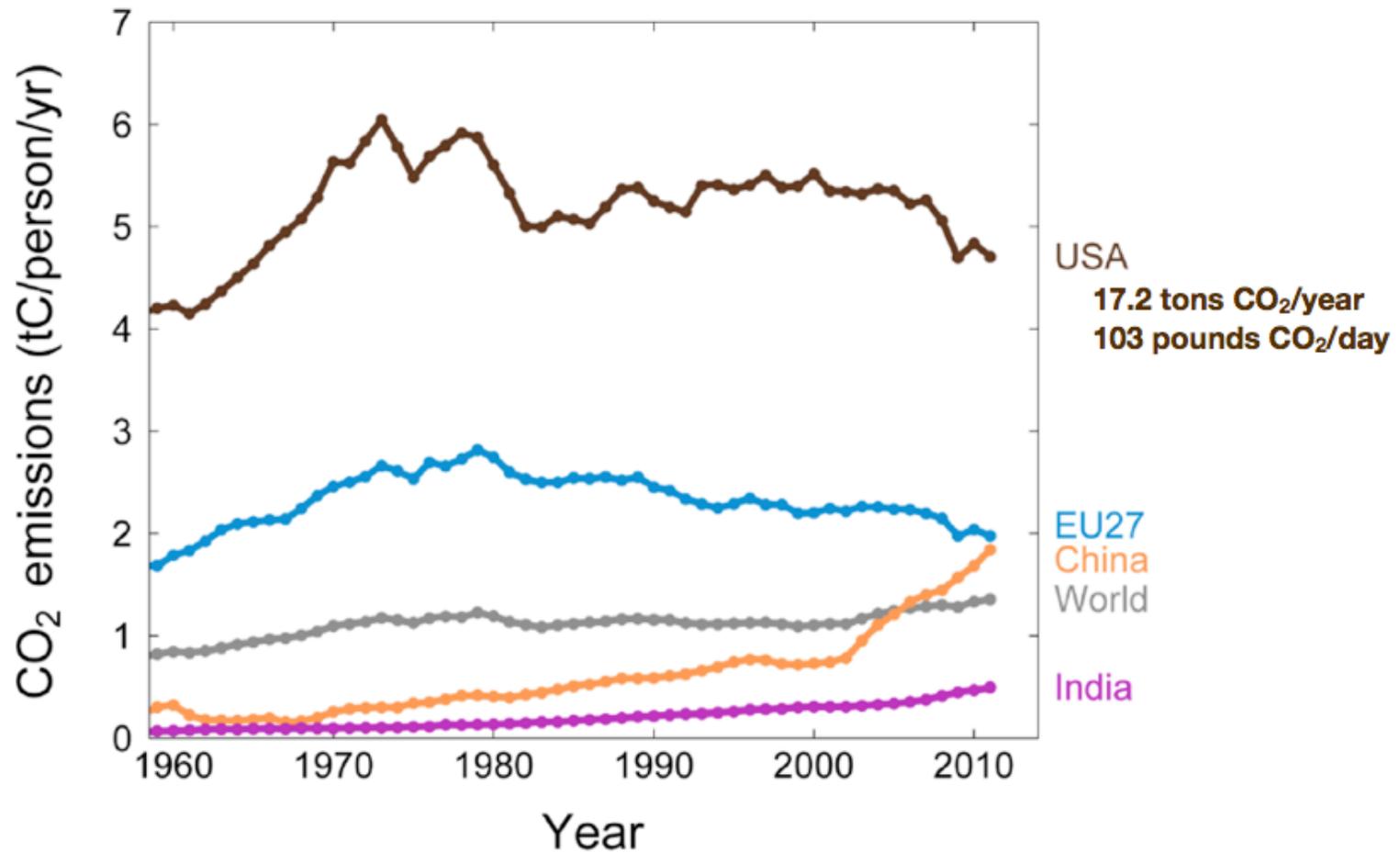
Top four emitters in 2011 covered 62% of global emissions
China (28%), United States (16%), EU27 (11%), India (7%)



The growing gap between EU27 and USA is due to emission decreases in Germany (45% of the 1990-2011 cumulative difference), UK (19%), Romania (13%), Czech Republic (8%), and Poland (5%)

Source: [CDIAC Data](#); [Le Quéré et al. 2012](#); [Global Carbon Project 2012](#)

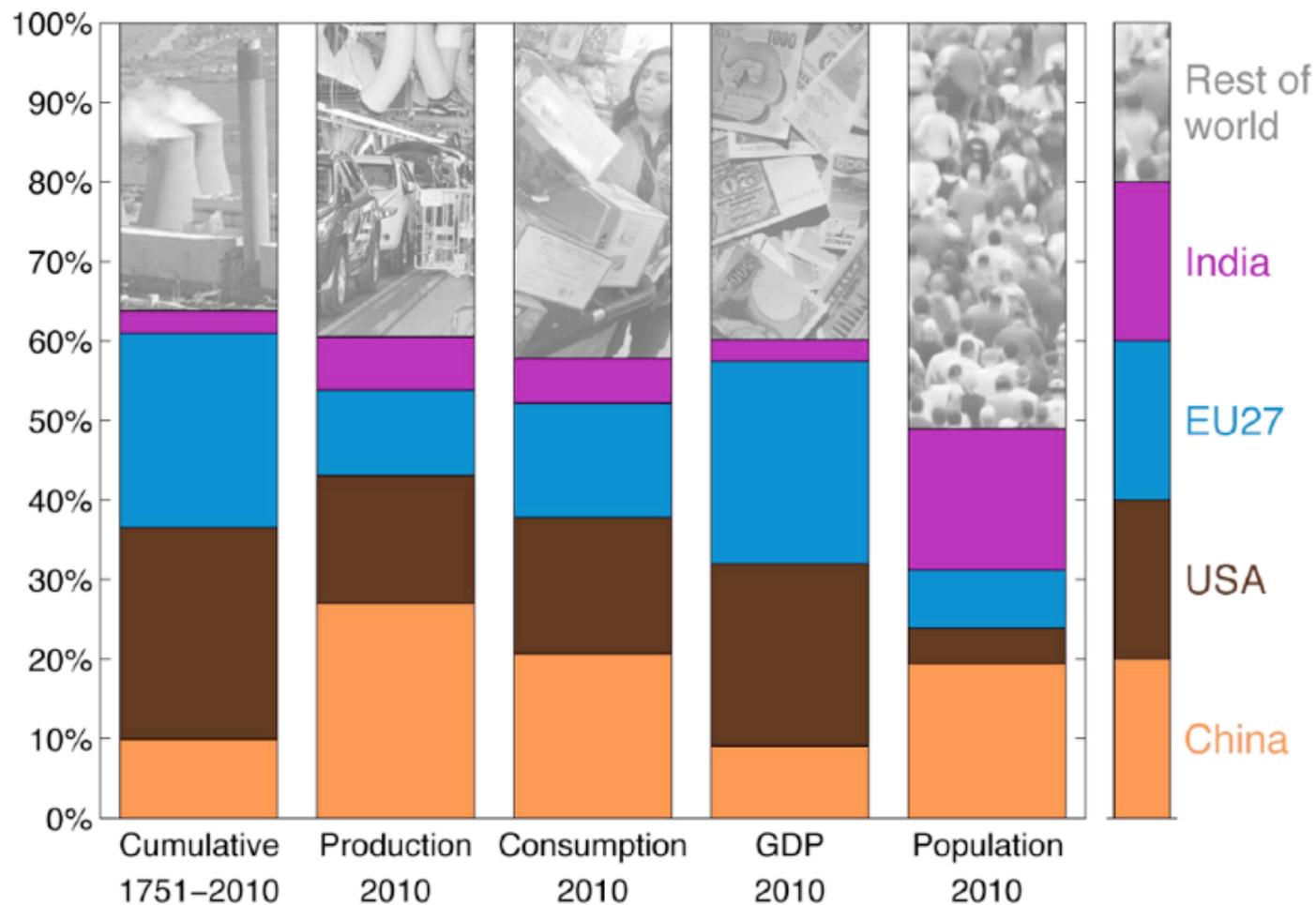
World average per capita emissions in 2011 were 1.4tC/p
China (1.8tC/p), United States (4.7tC/p), EU27 (2.0tC/p), India (0.5tC/p)



Chinese per capita emissions are almost equal to the EU27, and 36% higher than the global average

Source: [CDIAC Data](#); [Le Quéré et al. 2012](#); [Global Carbon Project 2012](#)

Depending on perspective, the importance of individual countries changes



Cumulative emissions from 1751; Production is also called Territorial; GDP: Gross Domestic Product

Source: [CDIAC Data](#); [Unstats](#); [Le Quéré et al. 2012](#); [Global Carbon Project 2012](#)

Your Goals

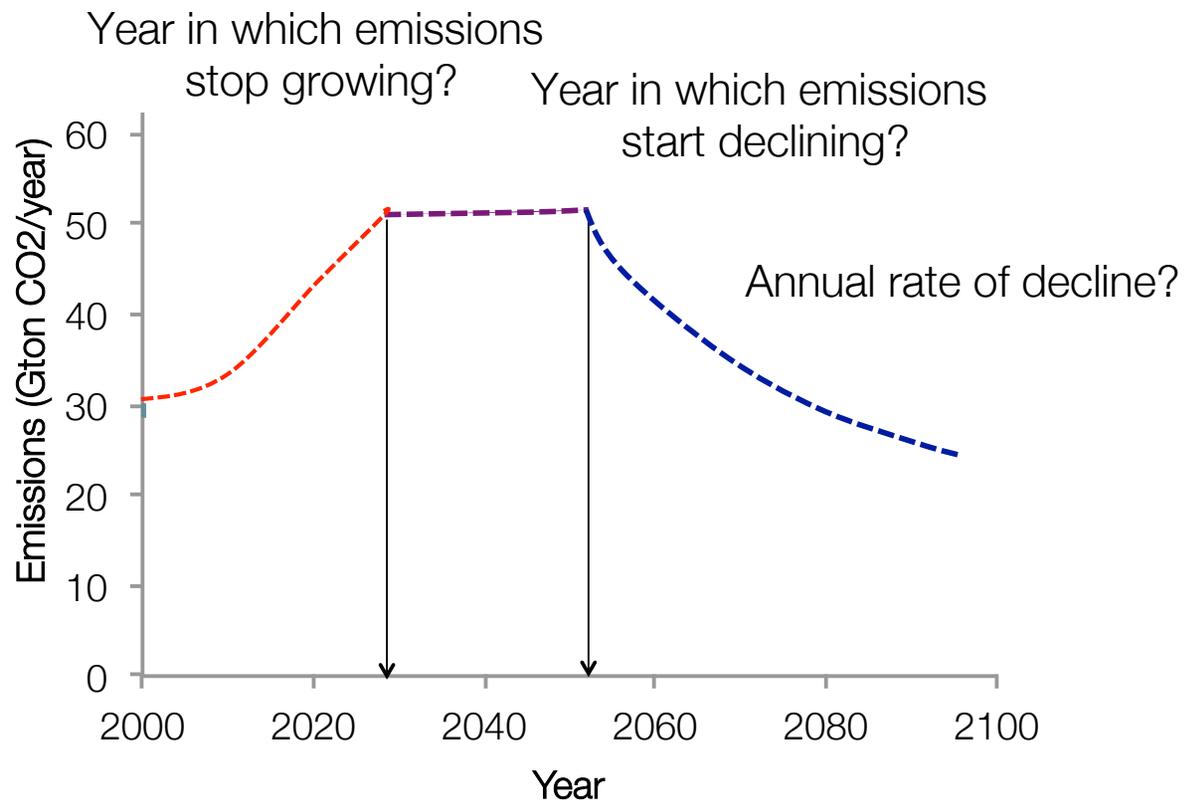
- Achieve emissions reduction commitments to stabilize GHG levels by 2100 at a level that limits global warming to no more than 2 °C above preindustrial levels (450 ppm CO₂)
- Agree on a deal to share costs of mitigation and adaptation fund to aid less developed nations.

Our Global Task

Manage the Unavoidable
and
Avoid the
Unmanageable

Task 1: Emissions

- *Each delegation will set its own fossil fuel emissions targets. You will set:*
 - In what year will GHG emissions in your bloc stop growing (if any)?
 - In what year (if desired), will your GHG emissions begin to fall?
 - If emissions will fall, what is your annual rate of decline
 - Long-term, average sustained rate
 - 3.5% is considered a maximum rate that can be sustained without economic damage (Emissions Gap Report 2010)
- *REDD policies:*
 - *Deforestation:* 0 – 1 scale. 1 continues BAU deforestation path, 0 gradually eliminates deforestation over coming decades.
 - *Afforestation:* 0 – 1 scale. 0 = no new area set aside for afforestation; 1 = maximum feasible afforestation area.



Start year		2015	Percent change by that year achieved through annual reduction rate of:						
Starting year emissions in Gton CO2-eq		54.7							
Target year	Number of years		-0.5%	-1.0%	-1.5%	-2.0%	-2.5%	-3.0%	-3.5%
2020	5	2%	5%	7%	10%	12%	14%	16%	
2030	15	7%	14%	20%	26%	31%	36%	41%	
2040	25	12%	22%	31%	39%	46%	53%	58%	
2050	35	16%	30%	41%	50%	58%	65%	71%	
2060	45	20%	36%	49%	59%	68%	74%	79%	
2070	55	24%	42%	56%	67%	75%	81%	85%	
2080	65	28%	48%	62%	73%	80%	86%	90%	
2090	75	31%	53%	68%	78%	85%	89%	93%	
2100	85	35%	57%	72%	82%	88%	92%	95%	

Task 2: Burden Sharing

- We are creating the “UN Green Climate Fund” for
 - Disaster relief
 - Food and water
 - Immigration and refugees
 - Mitigation — Investing in any necessary non-cost-saving mitigation to achieve Task 1 goals
- Total cost is \$100 Billion per year (ramping up to that level by 2020)
- How much will you contribute or draw?
- How much should others contribute?
- Terms?

We will

- Confirm submitted new emissions commitment or confirm “Business As Usual”
- Allow for a 2 minute presentation by each group about their emissions reduction commitment and why
- Simulate climate results and learn if we are on track to meet our collective goal
- If necessary, prepare for the next round

C-Learn:

<http://forio.com/simulate/simulation/climateinteractive/c-learn/>

(or navigate to sim from ClimateInteractive.org)

Teachable moments between rounds

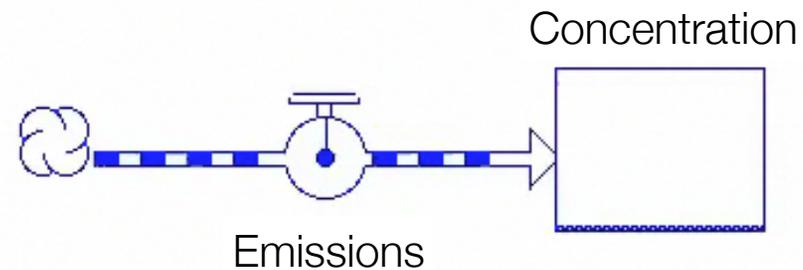
- Expected impacts
- Reinforcing and balancing feedbacks
- Time delays



- A moment for affective processing

Debrief: key insights

- Stock-flow failure and **scale** of action



- Impact of time delays and **urgency**
- Meeting goal is **possible**, but not easy
- Climate change education is important...

An opportunity: building robust mental models through simulations and games

- Compress time and reality
- Create experiences without requiring the ‘real thing’
- *“When ... the consequences of our decisions unfold over decades and centuries... simulation becomes, perhaps, the only way we can discover for ourselves how complex systems work.” Stermann 2011*
- Learning through the same iterative process as the scientific method:
 - Form hypothesis, test through interaction with simulation, form new hypothesis, re-test, etc.

Why simulation games...

- Analytic and affective processing engaged through
 - computer simulations that represent best available science
 - learning through experience (learning by doing)
 - social interactions and visceral response to outcomes
- Learn from/teach other participants

Evaluator's comments:

“World Climate was cited as among the course activities ‘promoting the most learning.’”

“The World Climate experience seems to have been very powerful at shaping the students’ understanding of what it will truly take to enact climate change policy on a global scale.”

“They particularly appreciated the experience of approaching the issue from a point of view other than their own.”

Example of student comments:

“Let me stress, I love this exercise.”

An invitation to join a growing community

- > 40 *WCE* facilitators from fourteen countries and five continents, 1000's of students
- Early high school to executive MBAs
- Ongoing effort to
 - Improve accessibility
 - Develop new exercises
 - Research learning

World Energy

- Participants take on roles of key economic and energy sector leaders
- Game challenges them to create a global transition to a low-carbon economy
- Framed by rigorous analysis through EnROADS simulation

- *“There are many conflicting interests in the real world and I felt like the simulation game and the people playing their roles represented those interests very well... We actually arrived at a solution... even with all the various stakeholders represented... And we potentially saved humanity!*
- *“To know that this isn’t a mock-up, but this is a real tool – the White House, the UN, climate scientists are using it – this is the best information that we have... was very exciting.”*

-- World Energy participant at MIT

Thank you

- Questions?

- *World Climate* tools:
 - <http://www.climateinteractive.org/tools/world-climate/>

- Videos of *World Climate* and *World Energy*:
 - <http://www.climateinteractive.org/project-news/seeing-the-global-energy-and-climate-transition-simulations-in-action/>