Energy and Development in Emerging Countries

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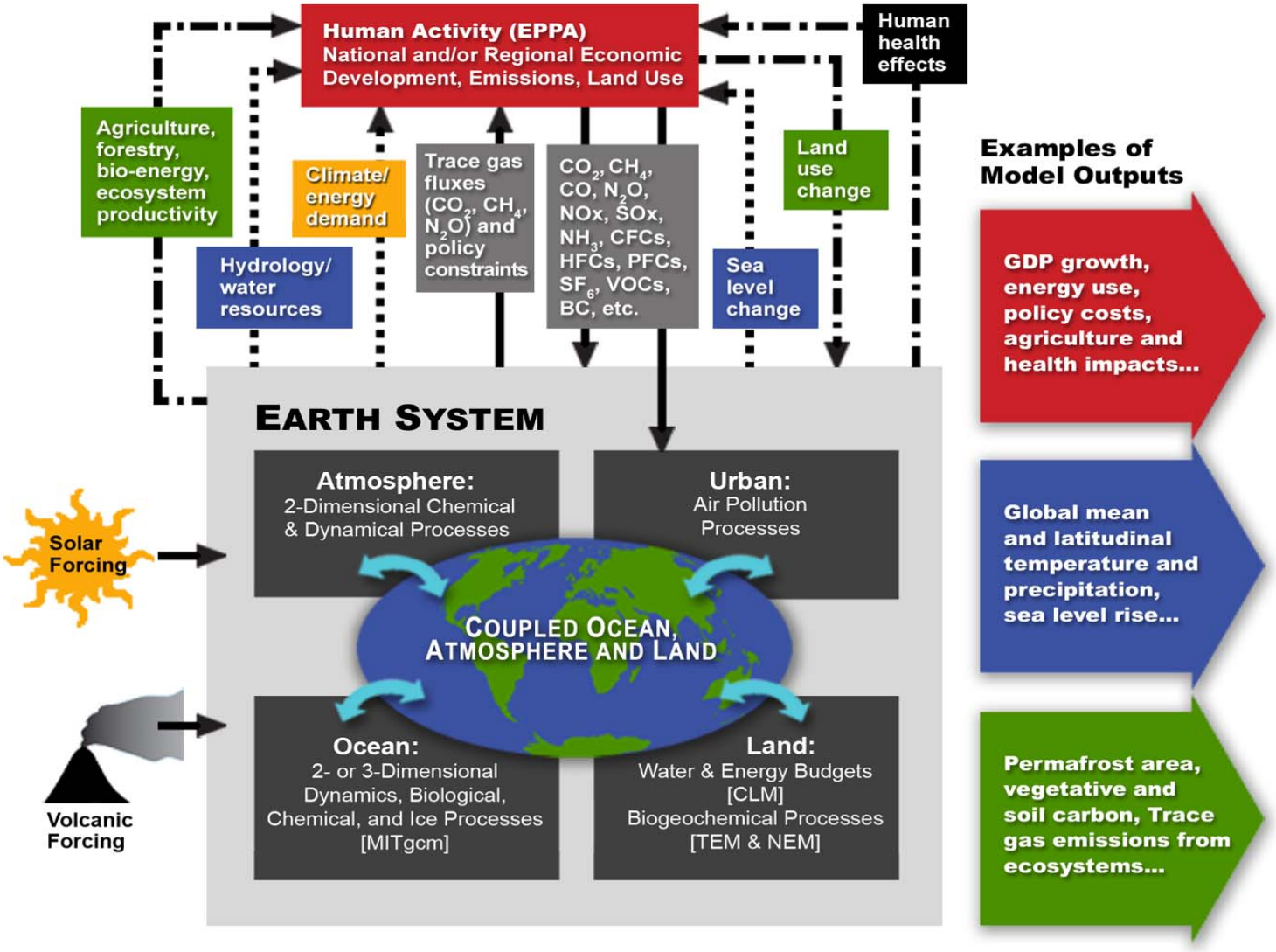
Motivation: A Few Observations

- Many emerging countries are advancing, some rapidly.
- With population and economic growth there will be further demands on natural resources and use of energy.
- If this happens, climate change will bring rising temperatures and changes in precipitation, river runoff and soil moisture.
- Still need to satisfy needs of current population
  - ✓ .8 b. lack clean water
  - ✓ 2.4 b. without sanitation
  - ✓ 1.3 b. with no electricity
- Food production may need to rise by 70% by 2050
  - ✓ Irrigation the biggest water
  - ✓ Irrigation the biggest water
  - ✓ 40% of cereal output is from irrigated land
- Energy is in general a small water consumer, examples of energy-water conflicts
  - ✓ Biofuels expansion, irrigation and food prices
  - ✓ Shale gas development
  - ✓ Power plant cooling and environmental flows

UN, 2013

We use the MIT Integrated Global System Model (IGSM) to study sustainable development of the planet.



An Economic Growth Scenario…

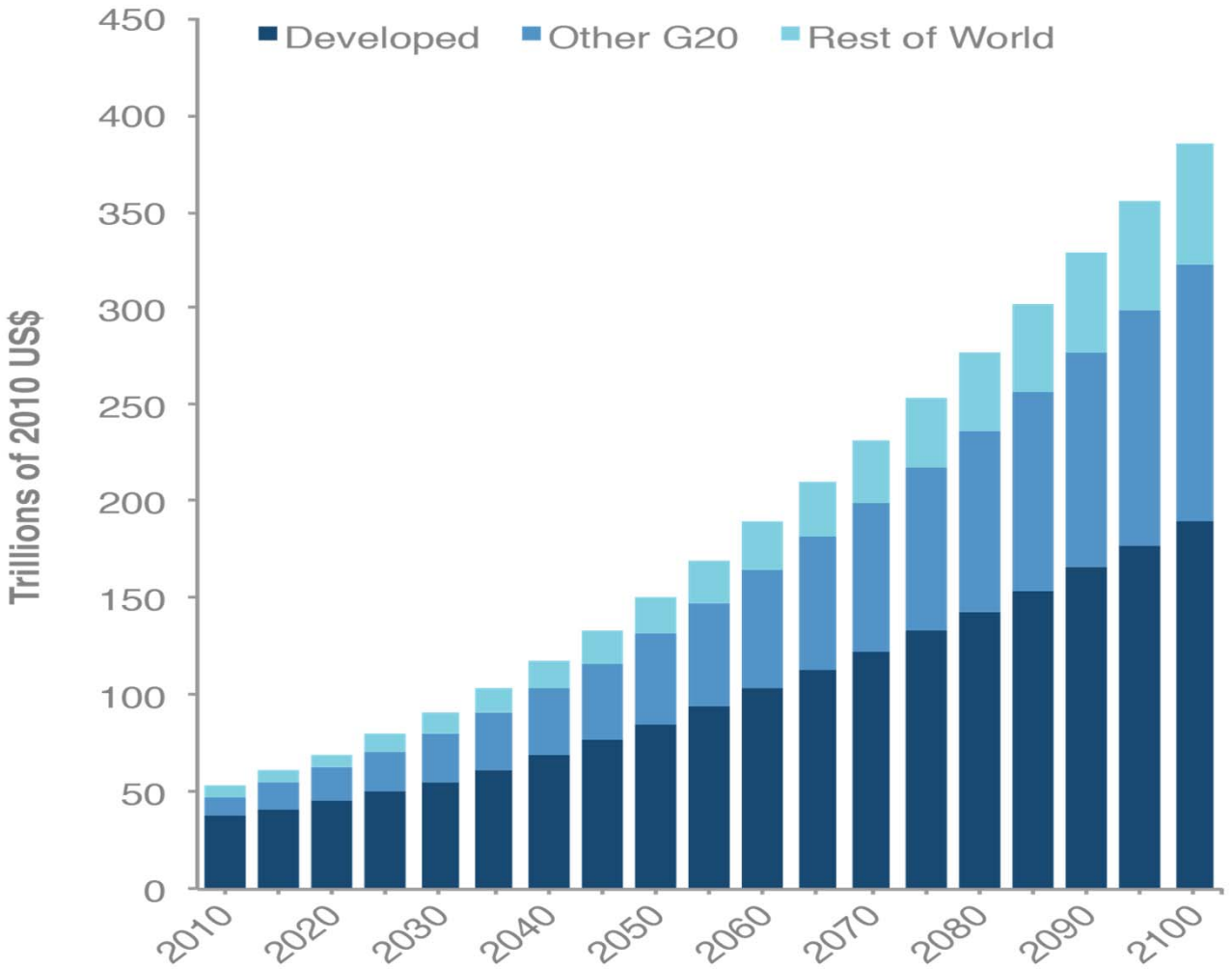


Figure 1: GDP, 2010-2100 for *Developed*, *Other G20*, and *Other Developing*, labeled Rest of the World.

With current energy policies…

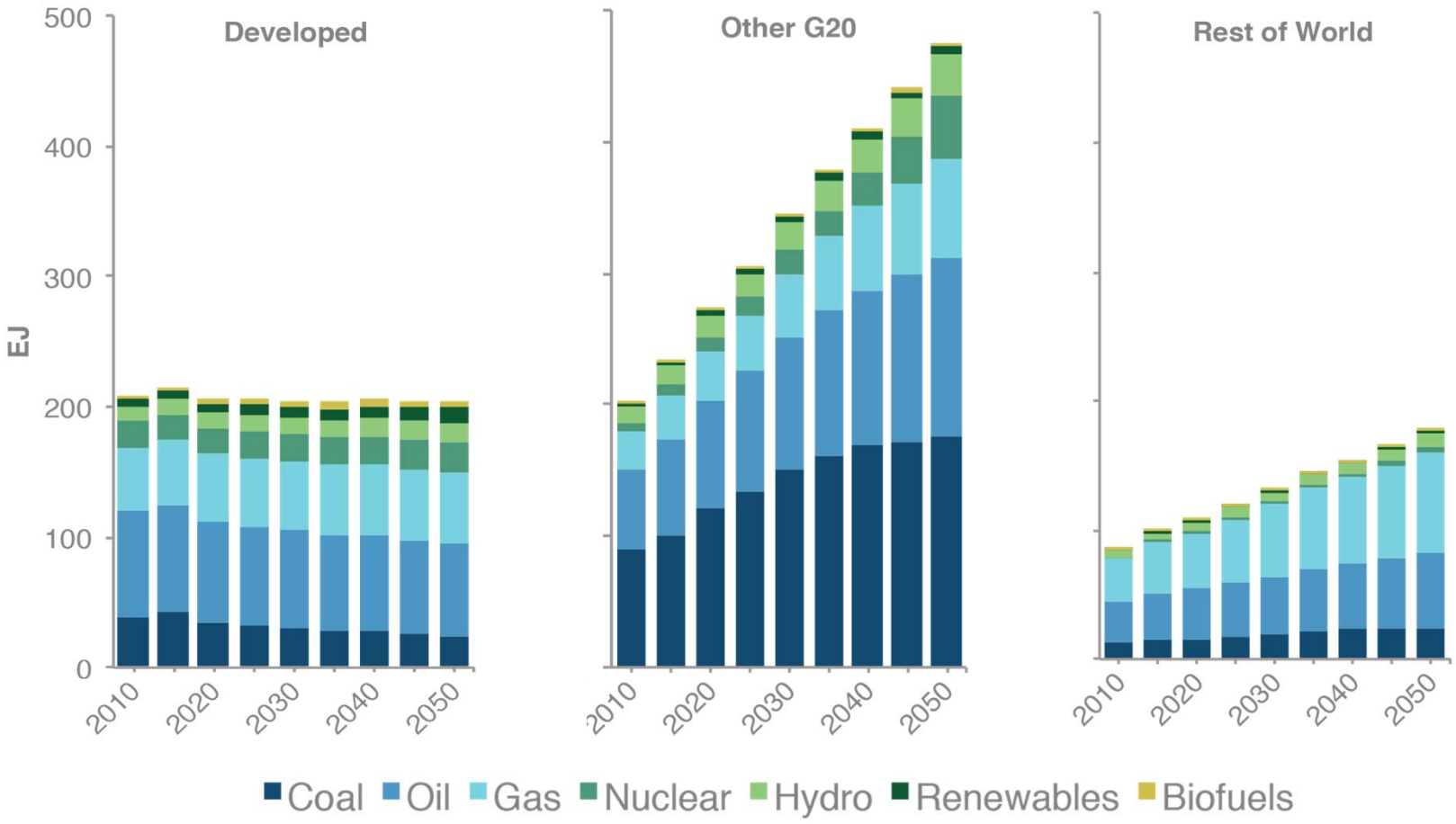


Figure 2: Energy use by fuel type: *Developed*, *Other G20*, *Other Developing*

Leads to significant environmental

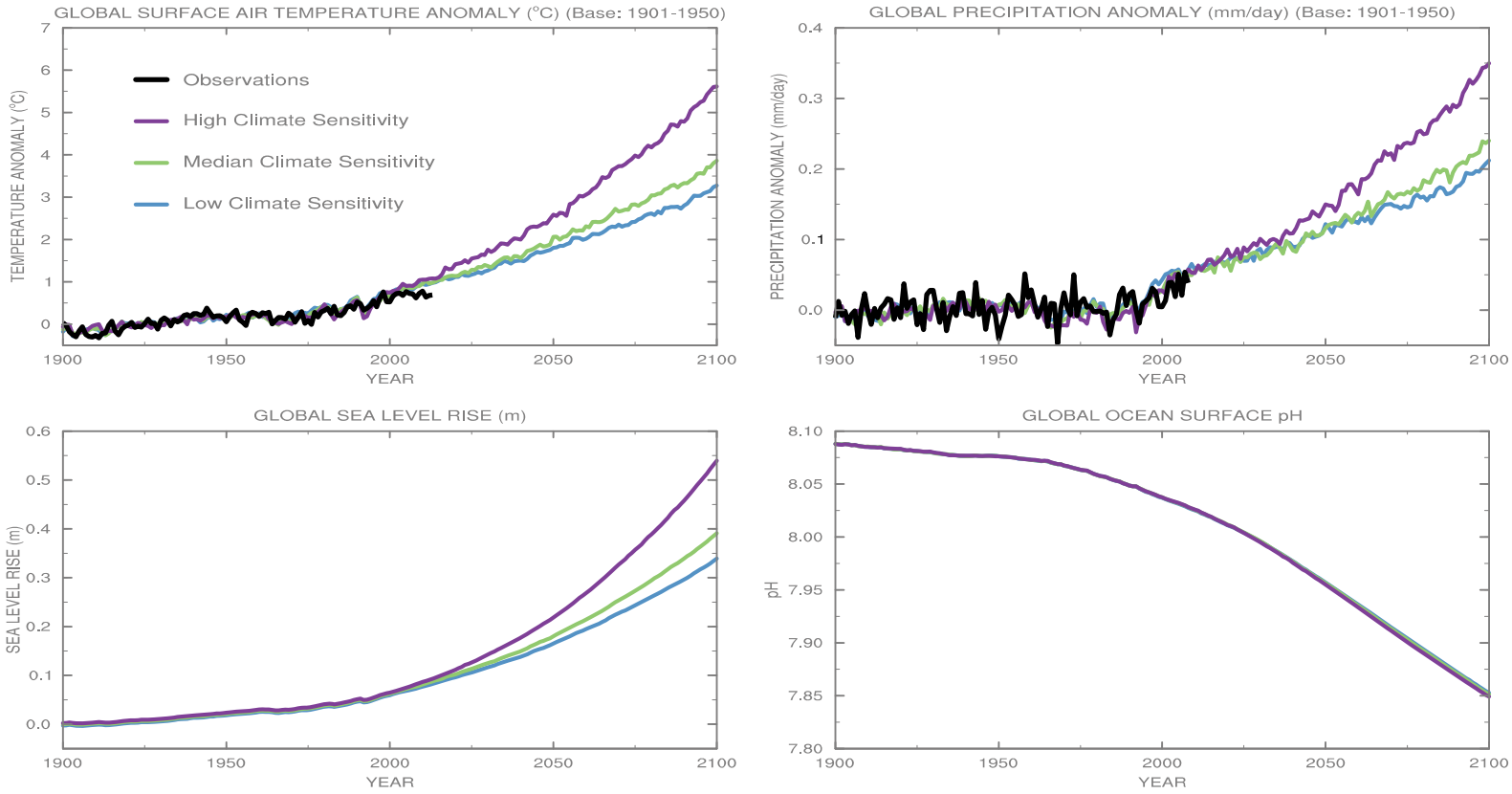
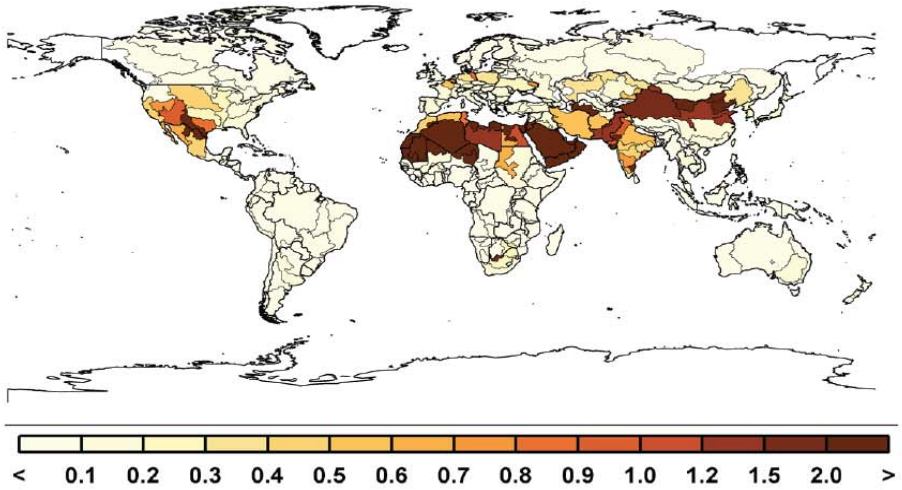
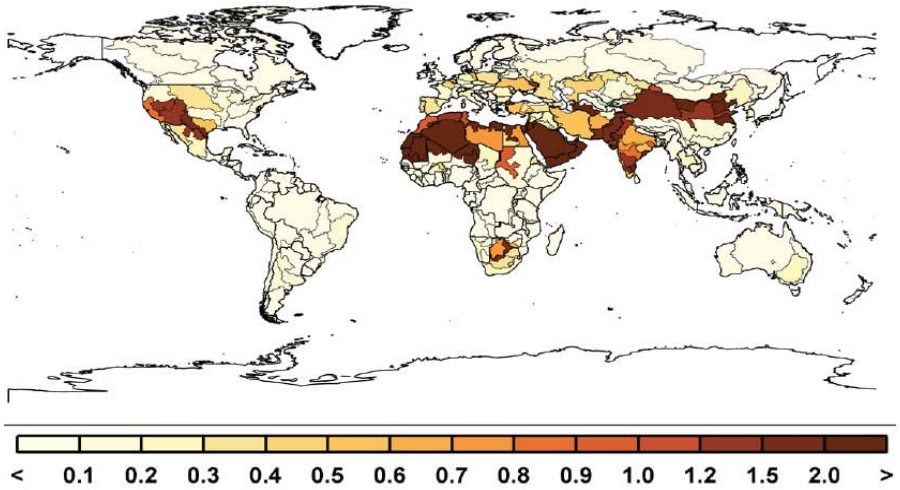
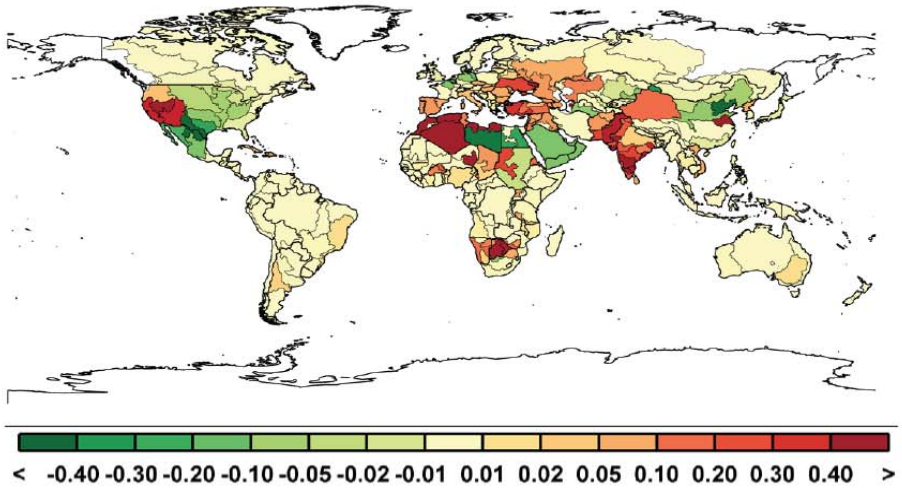


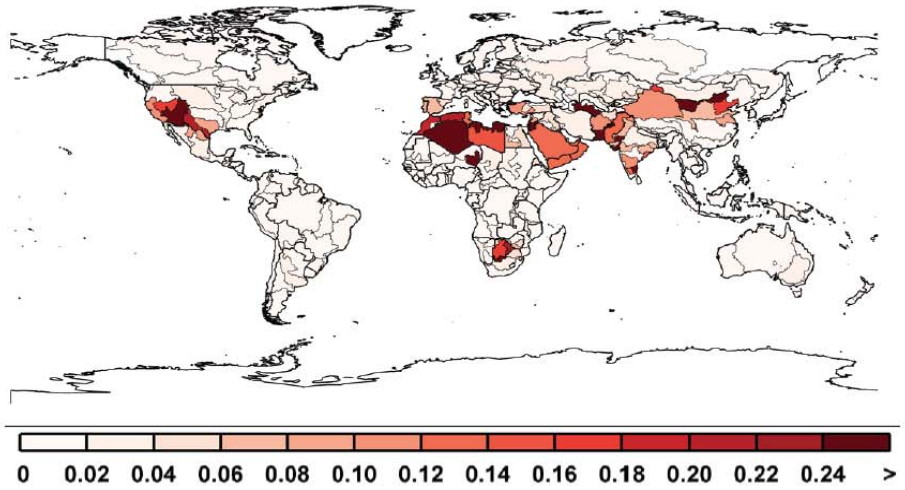
Figure 3. Indicators of global climate change: mean surface temperature, precipitation, and sea level anomalies (compared with the 1901-1950 mean) for high, median, and low earth system response to radiative forcing and ocean pH. (Note: Sea level rise includes only that due to thermal expansion, and the full effects of warming on sea level would only be observed over 100's to 1000's of years and so the committed sea level rise is 10's of meters unless warming is reversed.

Water stress—↑ in many tropical regions





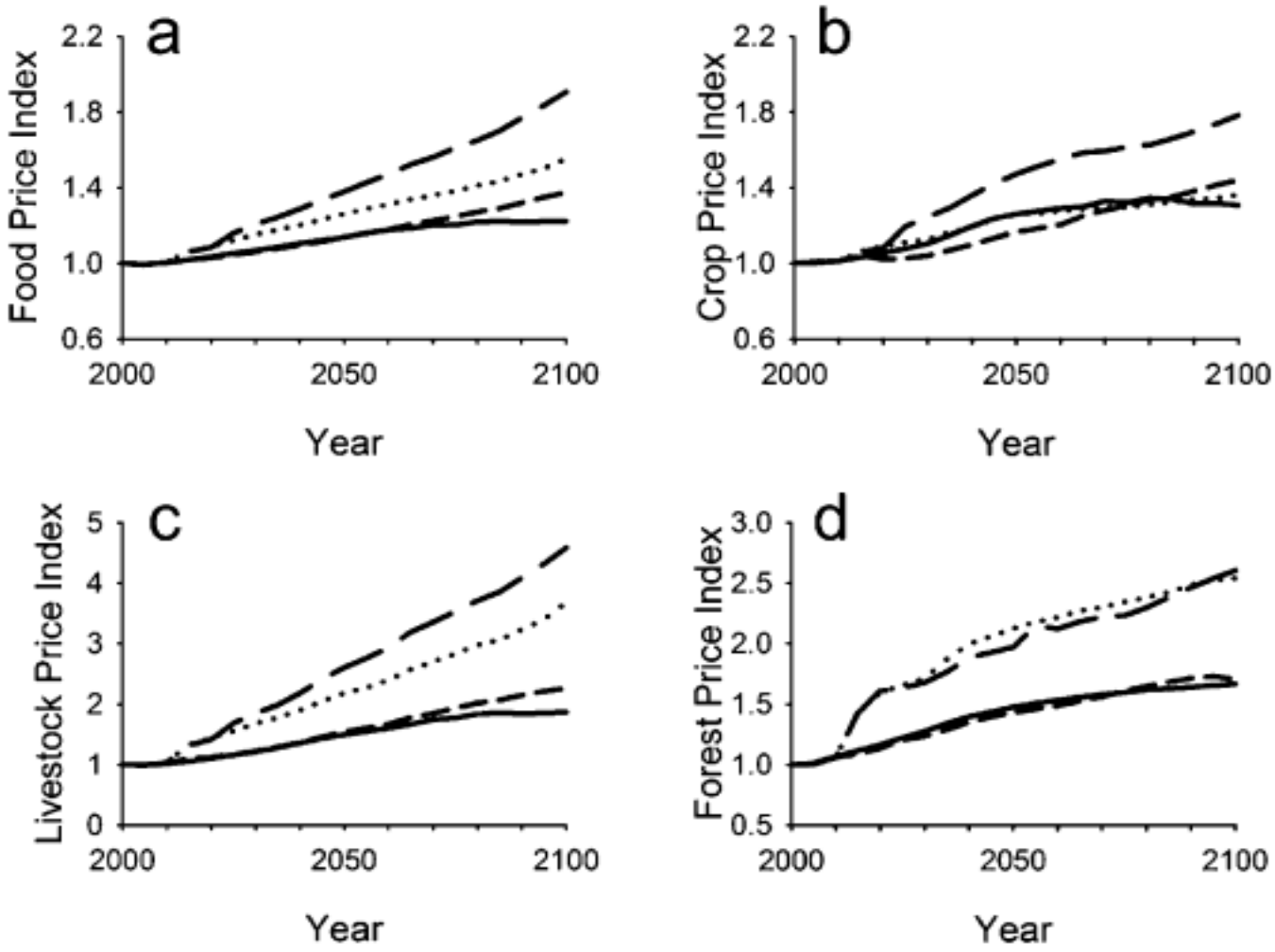




MIT JOINT PROGRAM SCIENCE POLICY GLOBAL CHANGE

MIT Joint Program 2014 Climate and Energy Outlook
See Details:http://globalchange.mit.edu/research/publications/other/special/2014Outlook

Food, Energy, and Carbon Tradeoffs



Surprising result: No-policy and energy only about the same.

Less environmental damage w/ energy policy, but higher energy and GHG control costs offset benefit to crops.

Energy+Land has big price impacts. w/o biofuels some pressure off.

Solid: no-policy
Dots: No biofuels
Short Dash: Energy-Only (~550ppm)
Long Dash:Energy+ Land (~500ppm)

Challenge: Achieve "Green Growth"

- Is there any other option?
- Options are really (1) no or little real growth or (2) green growth.
- Supposed tradeoff between economic development and environment is mostly a false one if environment is evaluated properly.
- Environmental damage to crops, human health, water resources, land, oceans/fisheries is a drag on economic growth.
- False idea that environment is a "luxury" good.

- Why has this changed? Scale of human activity at a size that earth systems can no longer absorb or quickly recover from damage we inflict.

Green Growth Challenge: Coordinated Policies

- Internalize externalities into regular economic decisions—classic economic prescription.
- Better data on “non-market” linkages.
- Valuation of existing links(Expanded accounting).
- Formal modeling of policy impacts (costs of abating, benefits of abatement linked to economic growth)
- Coordination among countries as many environmental effects are transboundary if not global.
  - ✓ Conventional air pollution.
  - ✓ Greenhouse gases
  - ✓ Water resources, water supplies
  - ✓ More strongly connected through global markets for agriculture, other goods.

General Equilibrium, Energy, and "Non-Market" Impacts

		INTERMEDIATE USE						*HOUSEHOLD SERVICES*		FINAL USE				OUTPUT
		1	2	...	*j*	...	*n*	*Mitigation of Pollution Health Effects*	*Labor-Leisure Choice*	Consumption	Investment	Government Purchase	Net-export	
DOMESTIC PRODUCTION	1													
	2													
	:													
	i													
	:													
	Medical Services for Health Pollution							*Medical Services*		*Health Services*				
	n													
IMPORTS	1													
	2													
	:													
	i													
	:													
	n													
LEISURE									*Leisure*	*Leisure*				
VALUE-ADDED	Labor							*Labor*	*Labor*					
	Capital													
	Indirect Taxes													
	Resources													
INPUT														

Figure 1. Social Accounting Matrix for EPPA-HE. Source: Nam *et al*. (2010), p. 5016.

China Example: Air pollution health effects

Table 2. Estimated benefits of air quality control in China: WHO standards (1) and background levels (2)

Year	Policy 1 compared to historical				Policy 2 compared to historical			
	Δ Consumption		Δ Welfare		Δ Consumption		Δ Welfare	
	bn US$[a]	%[b]	bn US$[a]	%[b]	bn US$[a]	%[b]	bn US$[a]	%[b]
1975	11.5	17.1	16.2	10.5	12.5	18.5	17.5	11.3
1980	12.9	14.3	17.2	8.4	13.9	15.5	18.6	9.0
1985	16.4	10.9	22.1	6.5	18.0	12.0	24.2	7.1
1990	14.5	6.7	19.0	4.0	16.6	7.7	21.8	4.6
1995	22.5	5.8	32.9	3.7	26.1	6.7	37.9	4.2
2000	27.0	4.6	41.4	3.1	32.3	5.5	48.9	3.6
2005	38.0	4.1	66.4	3.0	46.6	5.0	78.6	3.6

[a] Billions of 1997 US$.

[b] % to historical consumption (or welfare) level for each year.

China Example: Trade and CO2 emissions

Table 1. CO_2 embodied in China's net exports and by region (mmt).

	Reference	Rebalance	Demand	Exp-Tax
China's net exports of emissions				
Agriculture	−2	0	−3	−2
Energy-intensive industry	312	214	158	226
Other industry	827	588	472	867
Services	40	325	290	42
Total	1177	1127	917	1133
Emissions by region				
China	5268	4986	5011	5239
U.S.	5583	5585	5582	5584
Europe	4150	4157	4155	4152
Japan	1067	1073	1072	1068
Korea	424	430	429	425
Taiwan	258	262	261	259
Rest of East Asia	474	482	482	475
Rest of world	9299	9327	9304	9306
Global	26,523	26,302	26,296	26,508

China Example: Pollution and CO_2 Synergies

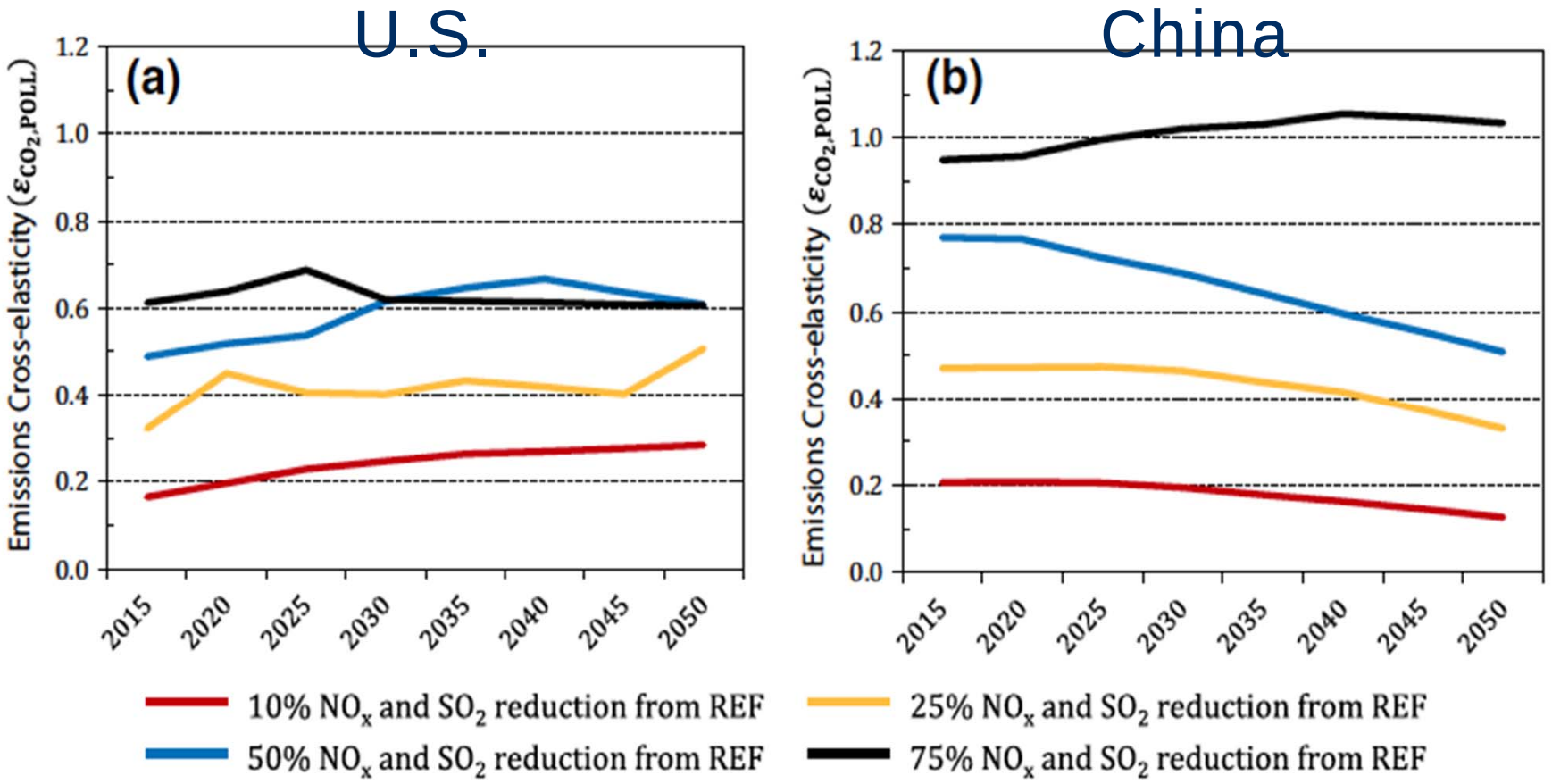
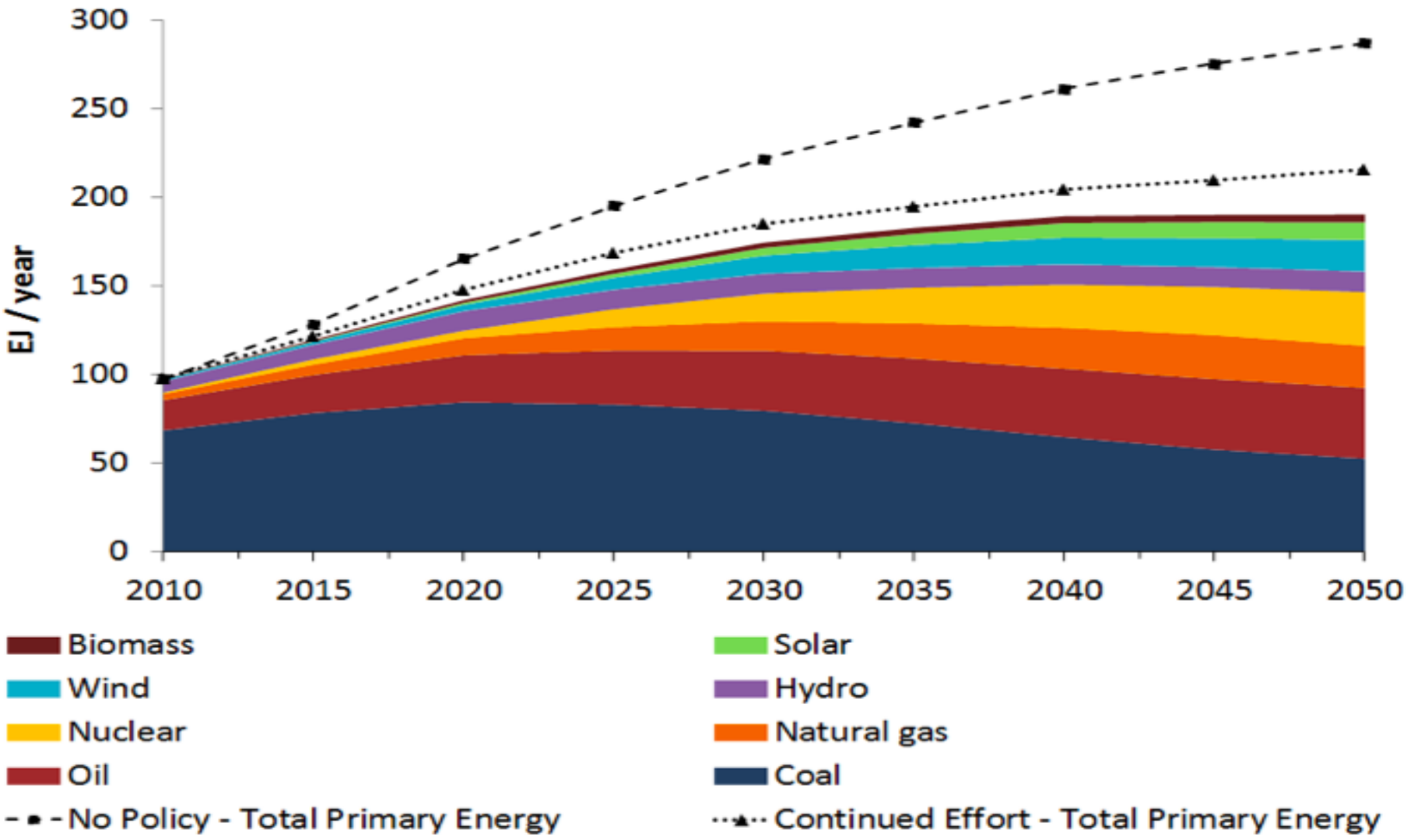


Figure 8. Cross emissions elasticity by scenario: (a) U.S., (b) China.

China Example: Pollution and CO_2 Synergies



Energy demand: *No Policy*, *Continued Effort*, and *Accelerated Effort* scenarios, with the primary energy mix shown for the *Accelerated Effort* scenario.

Thank You