2011 MIT Joint Program Energy and Climate Change Outlook

John Reilly

The MIT Joint Program on the Science and Policy of Global Change
http://globalchange.mit.edu
November 10, 2011

The MIT Joint Program on the Science and Policy of Global Change

Questions or comments?
Contact: John Reilly
jreilly@mit.edu

Purpose of the Outlook

Projections of energy mix and impacts on the climate.

Regional tables with energy and emissions.

One emission scenario, three climate sensitivity scenarios.

Reflects Copenhagen Accord pledges for 2020.

Keeps 2020 goals afterwards with no additional policy.

Goal of the webinar: introduce the Outlook structure and major results, provide regional Excel files for feedback.

Hope: to make the MIT JP Outlook an annual publication.

Major Points

Temperature increases are substantial.

Most emissions growth is in developing regions.

Emissions in developed regions are flat, so a smaller lever to further impact global emissions.

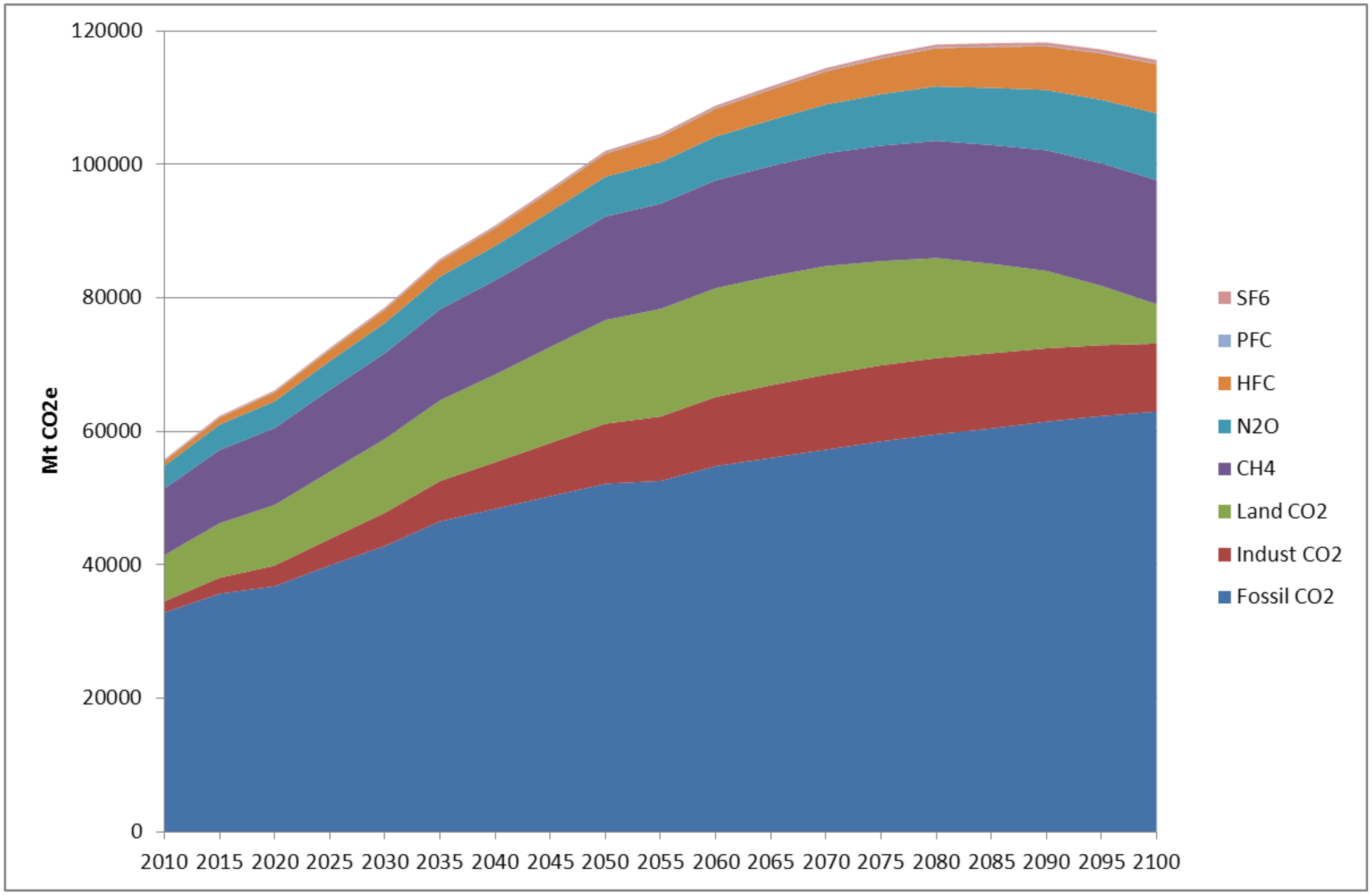
Transition to alternative energy is starting in developed countries and China, but the Copenhagen targets will not complete it.

Vehicle growth is substantial in developing regions.

Land emissions are important.

A lot more work is needed if the world wants to avoid substantial climate change.

Global Emissions



Fossil CO_2 is a major part

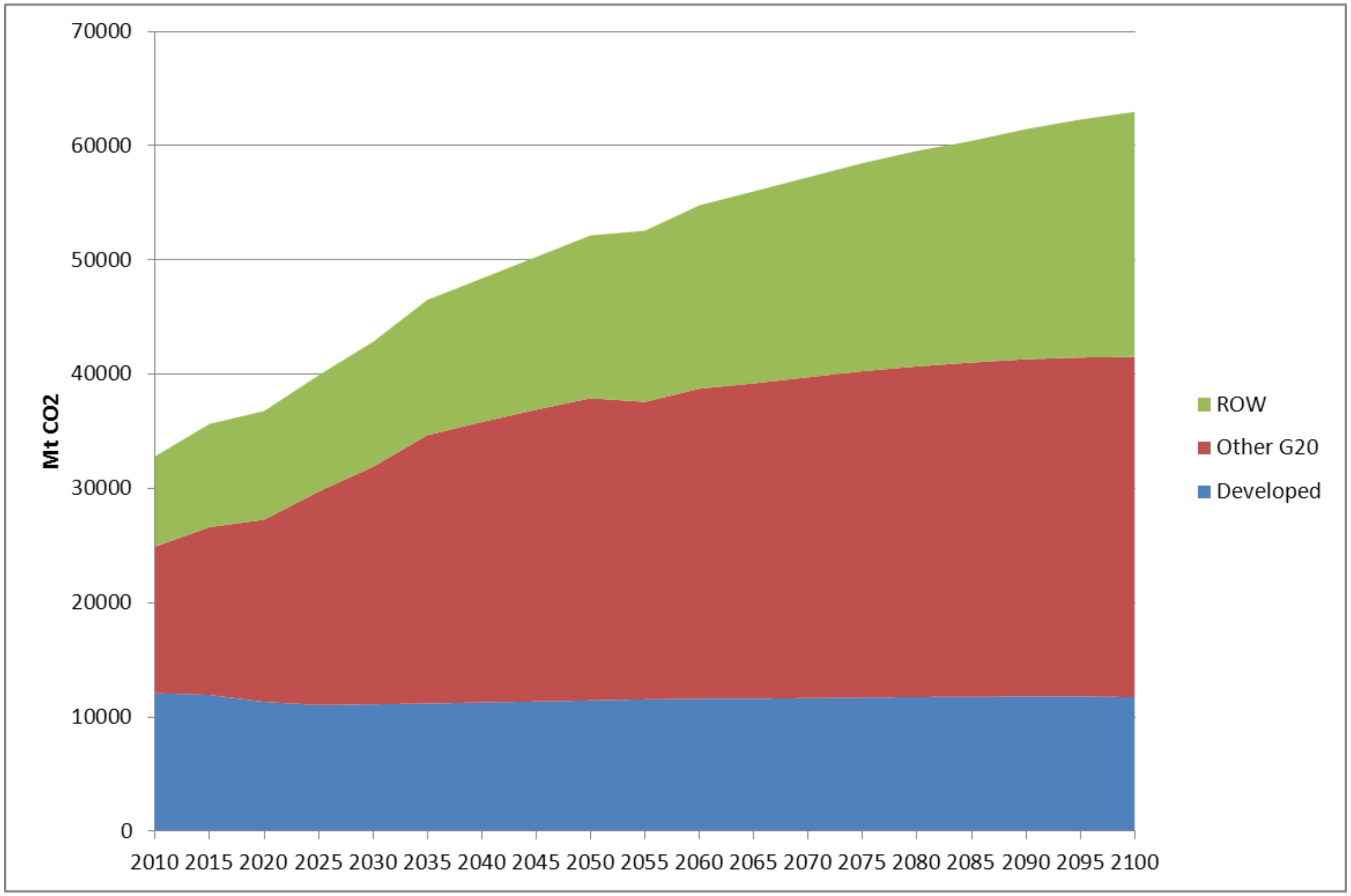
But other GHGs are important

Increased role of HFC (air conditioning)

Land use CO_2

Industrial and Cement CO_2

Fossil CO_2 Emissions by major group



Developed regions (USA, CAN, EUR, JPN, ANZ) have a smaller share over time

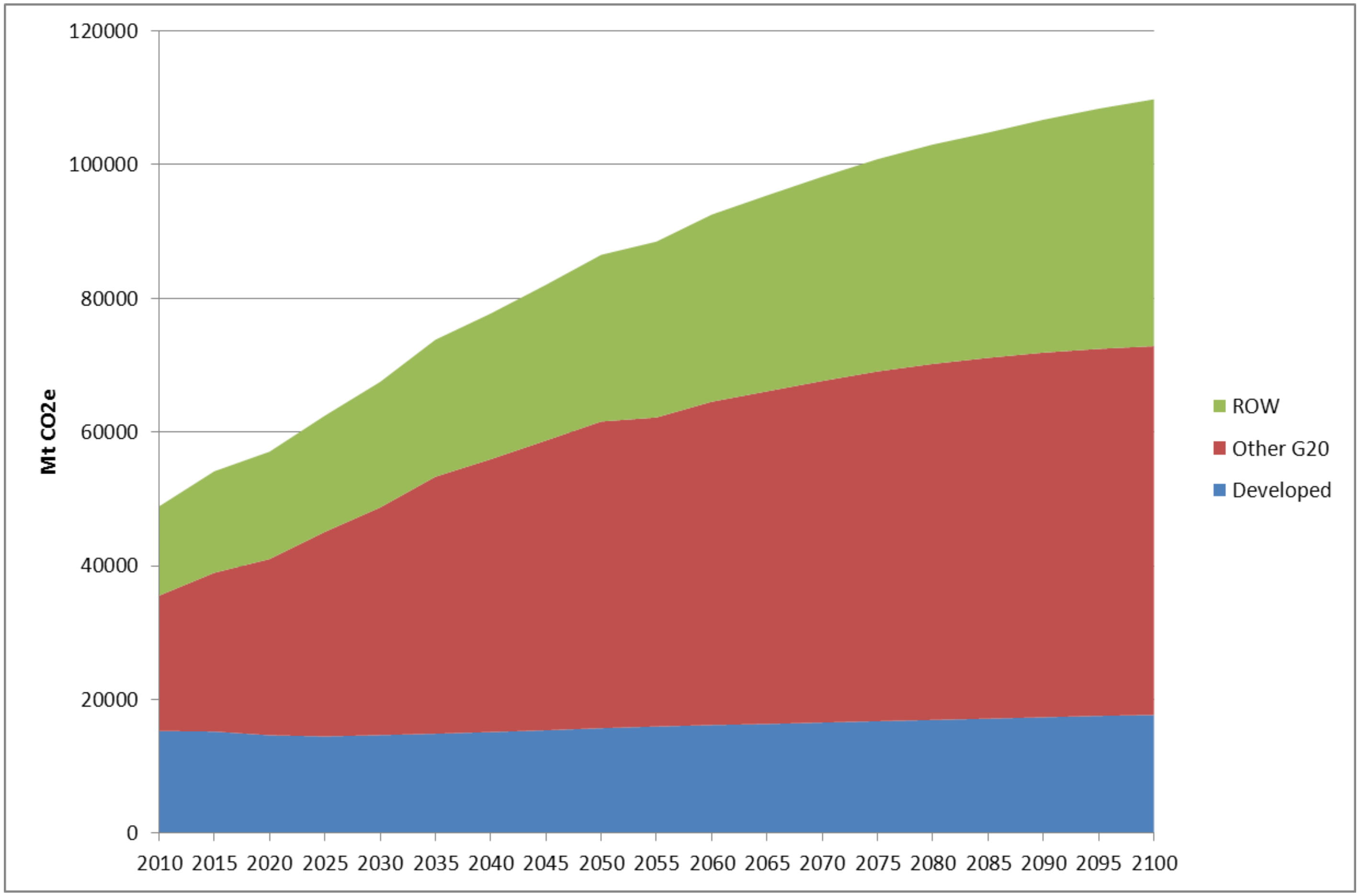
Even if they cut to zero – limited impact

Other G20 regions (CHN, IND, RUS, BRA, MEX) grow substantially even with intensity targets in China and India

Rest of the world regions grow substantially

Focusing on G20 only will miss a lot of opportunities

GHG Emissions by major group



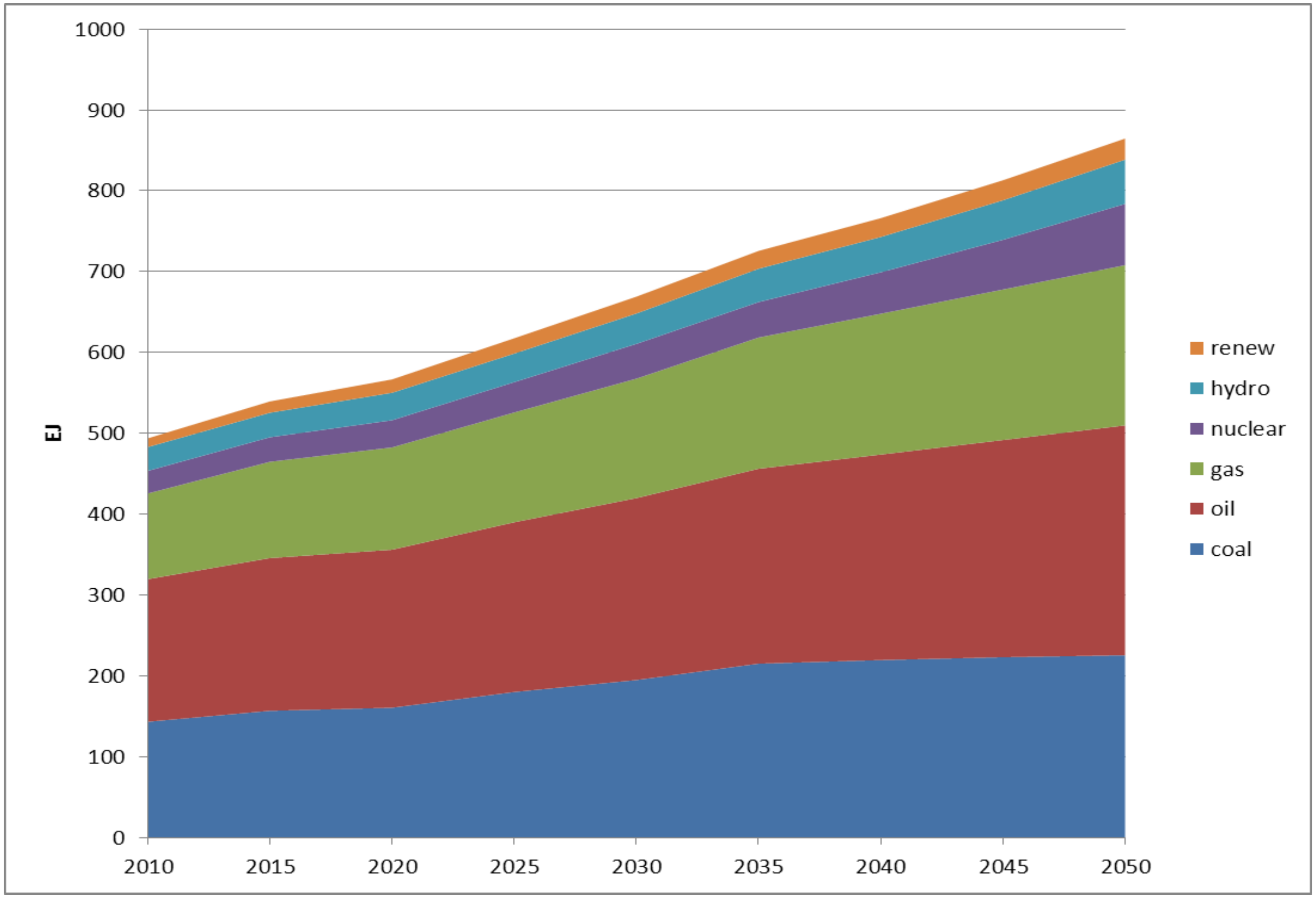
For GHGs the picture is similar

Developed regions have even smaller share for GHGs

Fossil CO2 share of developed regions:
2010 – 40%,
2100 – 20%

GHGs share of developed regions:
2010 – 30%,
2100 – 15%

Global Energy Use



Reliance of fossil fuels dominated by developing regions

Coal levels off

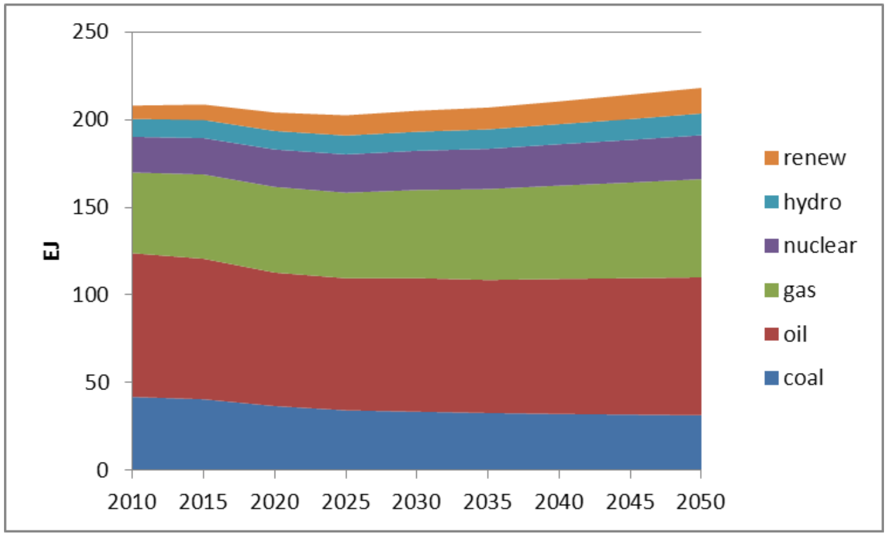
Larger role of natural gas and oil

Renewables increase 2.5 times by 2050

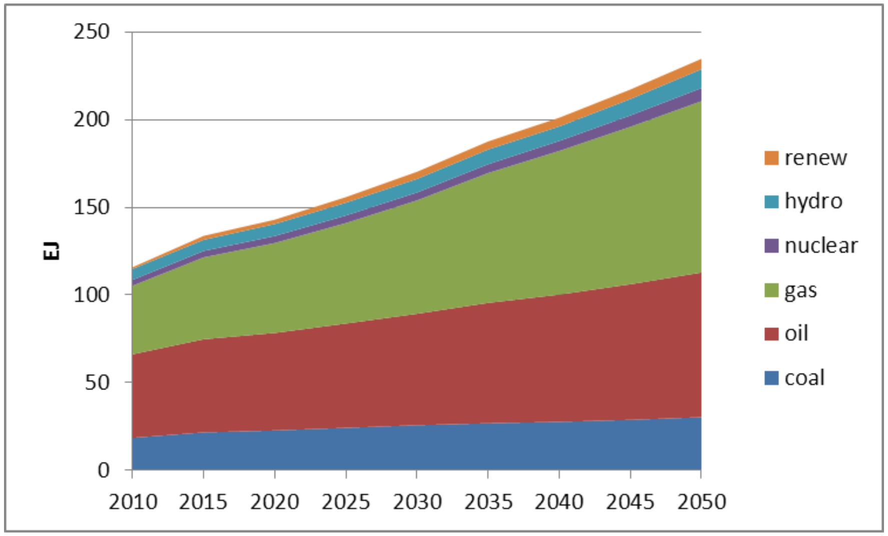
We have not forced renewables by RPS or other mandates

Nuclear power growth in developing regions

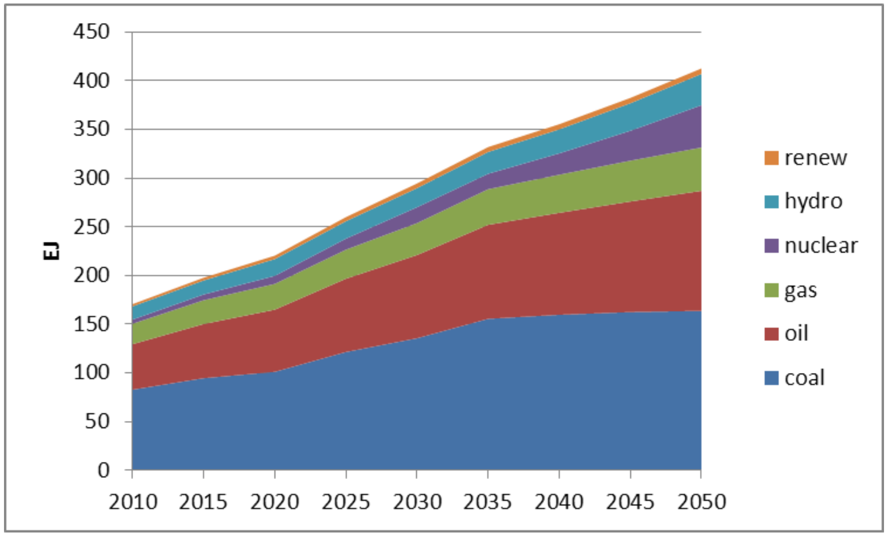
Energy Use by major group



Developed



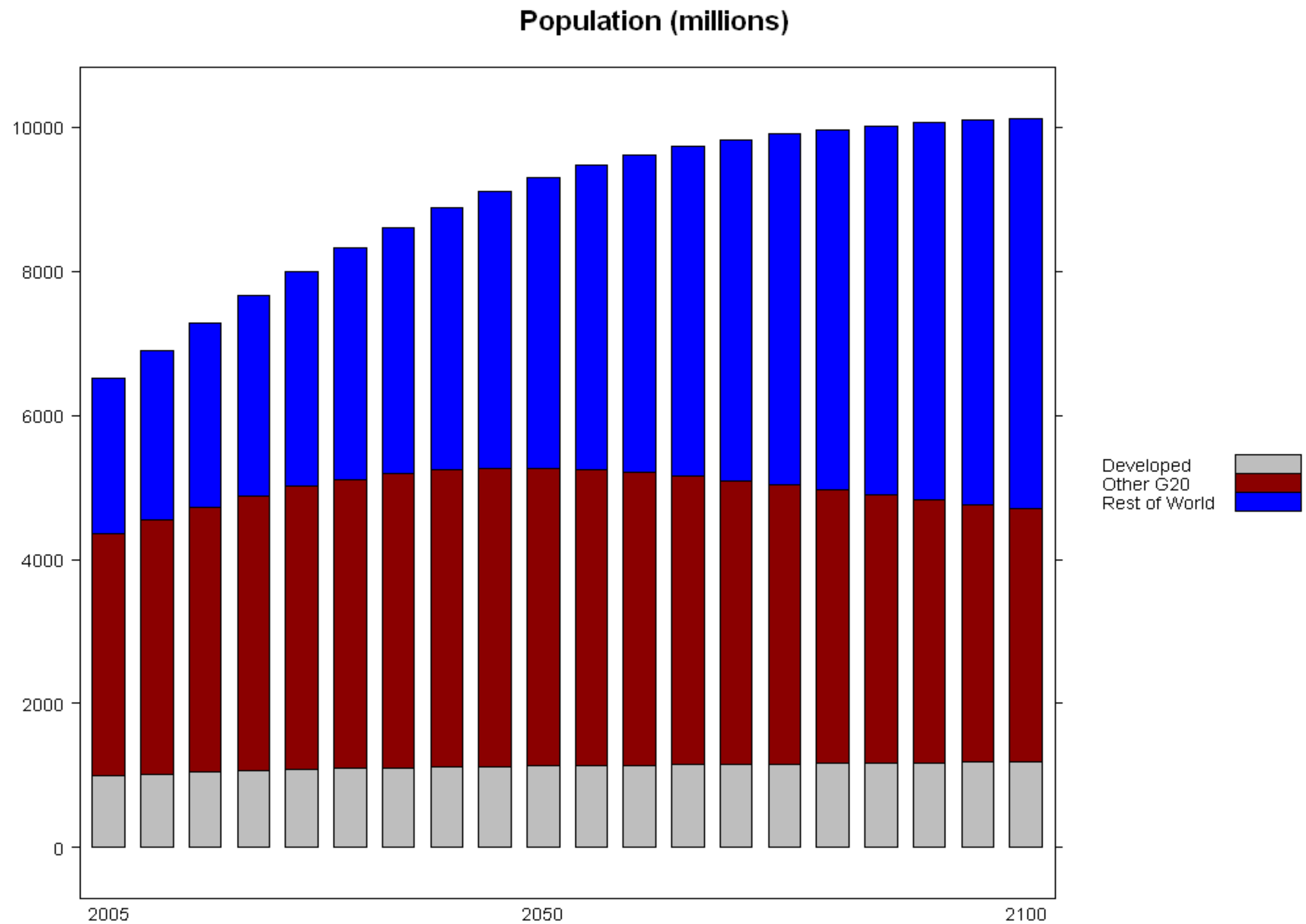
ROW



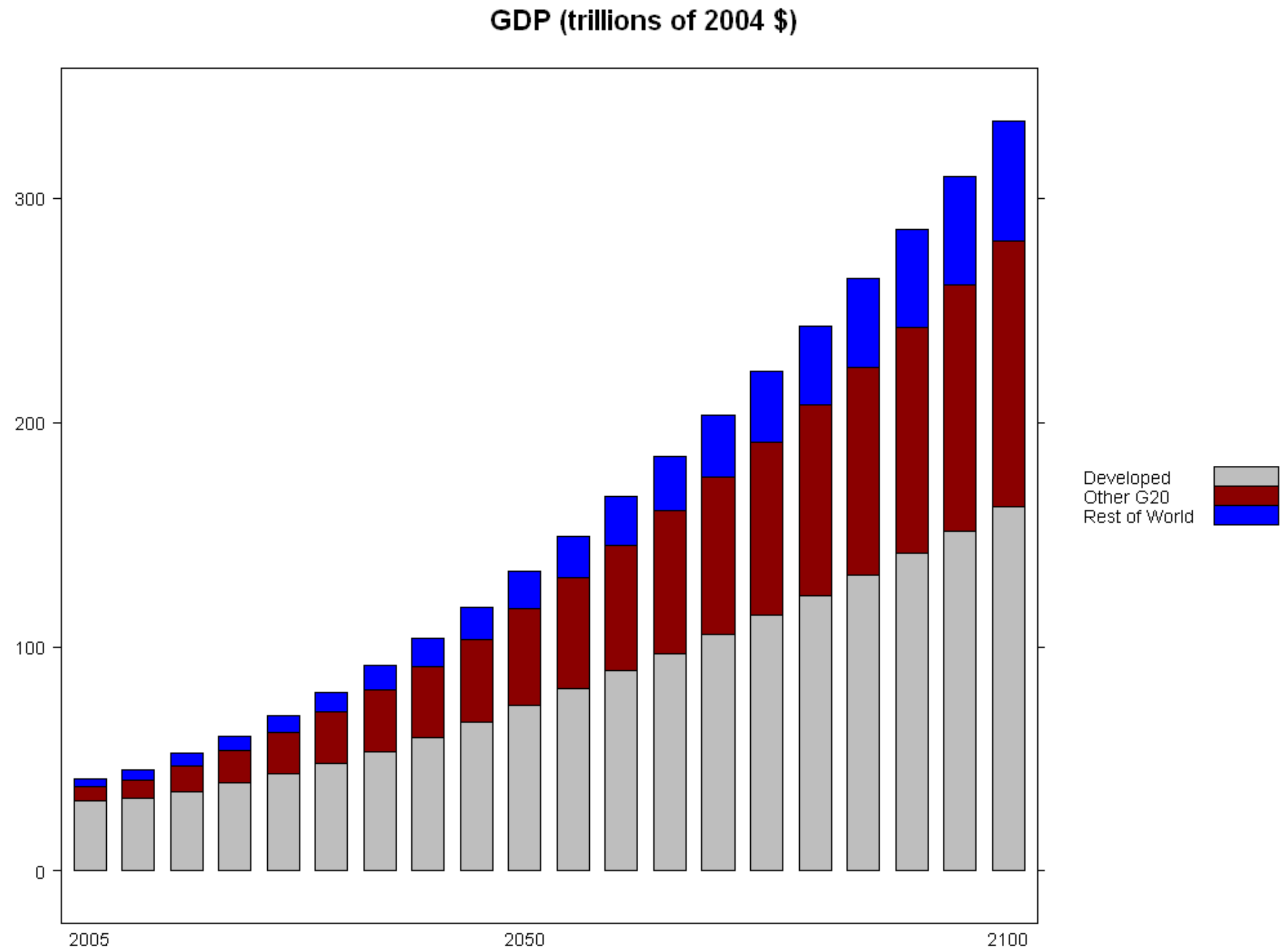
Other G20

The MIT Joint Program on the Science and Policy of Global Change

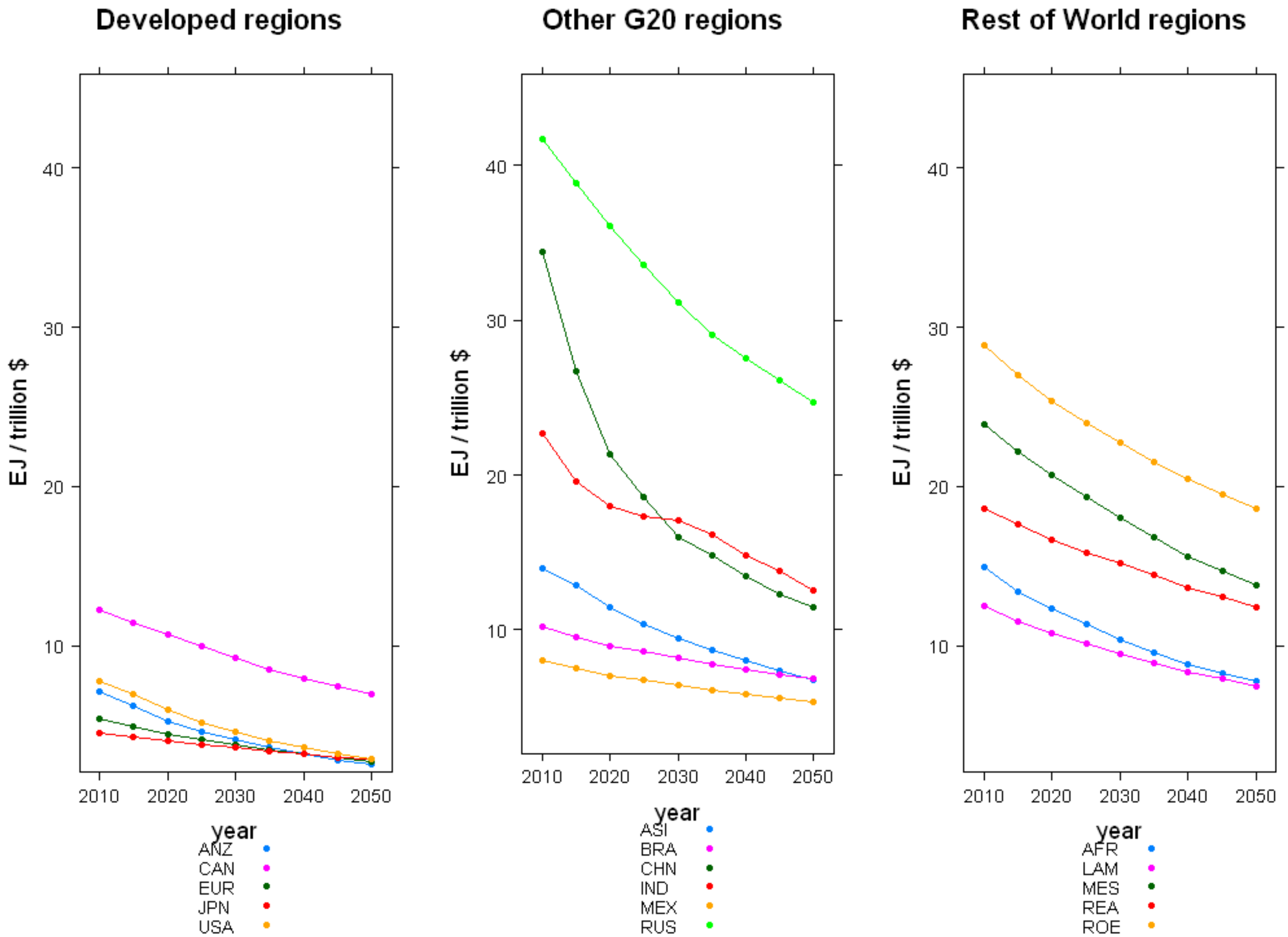
Global Population



Global GDP

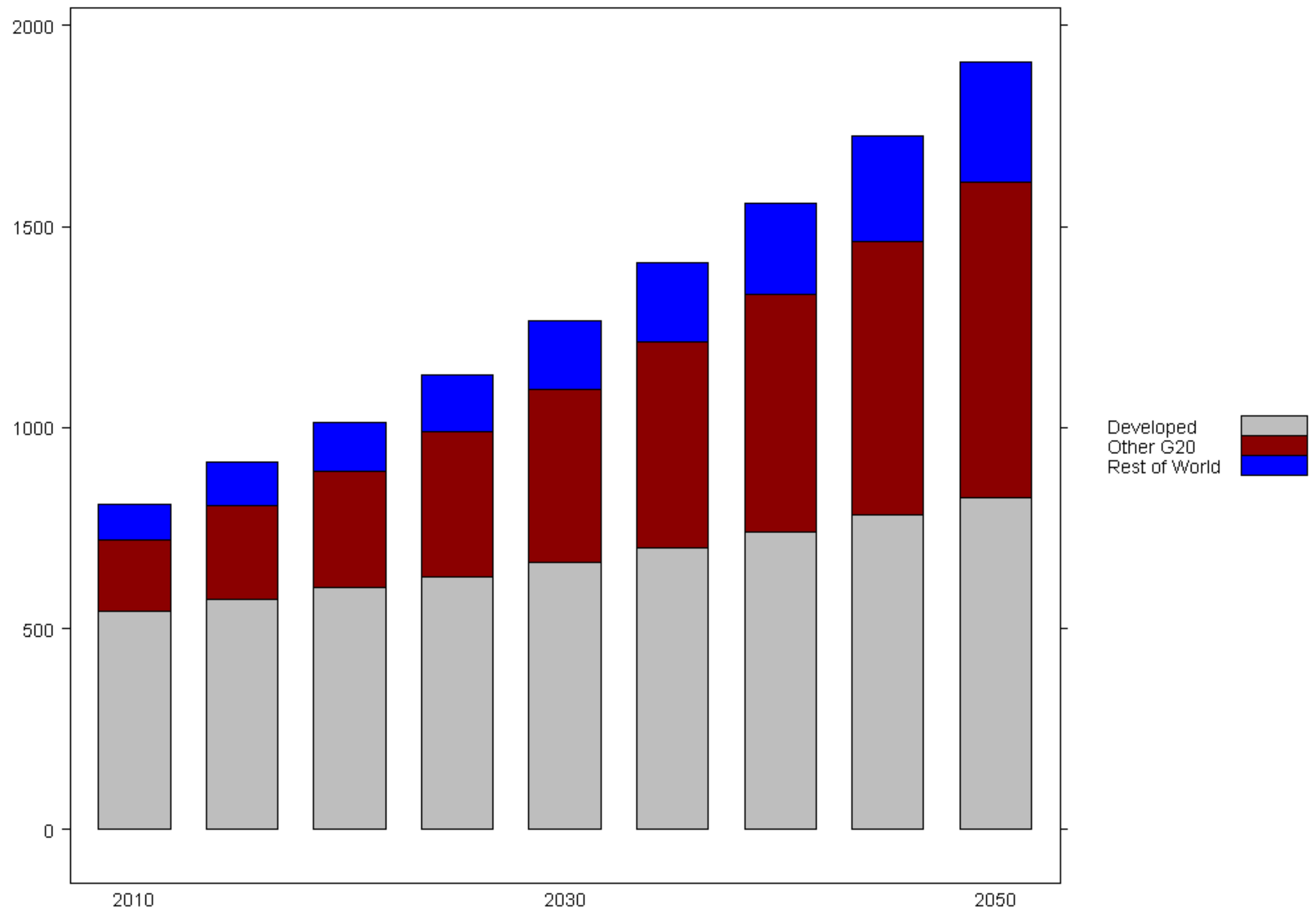

GDP (trillions of 2004 $)
300
200
100
0
2005
2050
2100
Developed
Other G20
Rest of World

Energy Intensity by EPPA Region



Energy use per unit of GDP

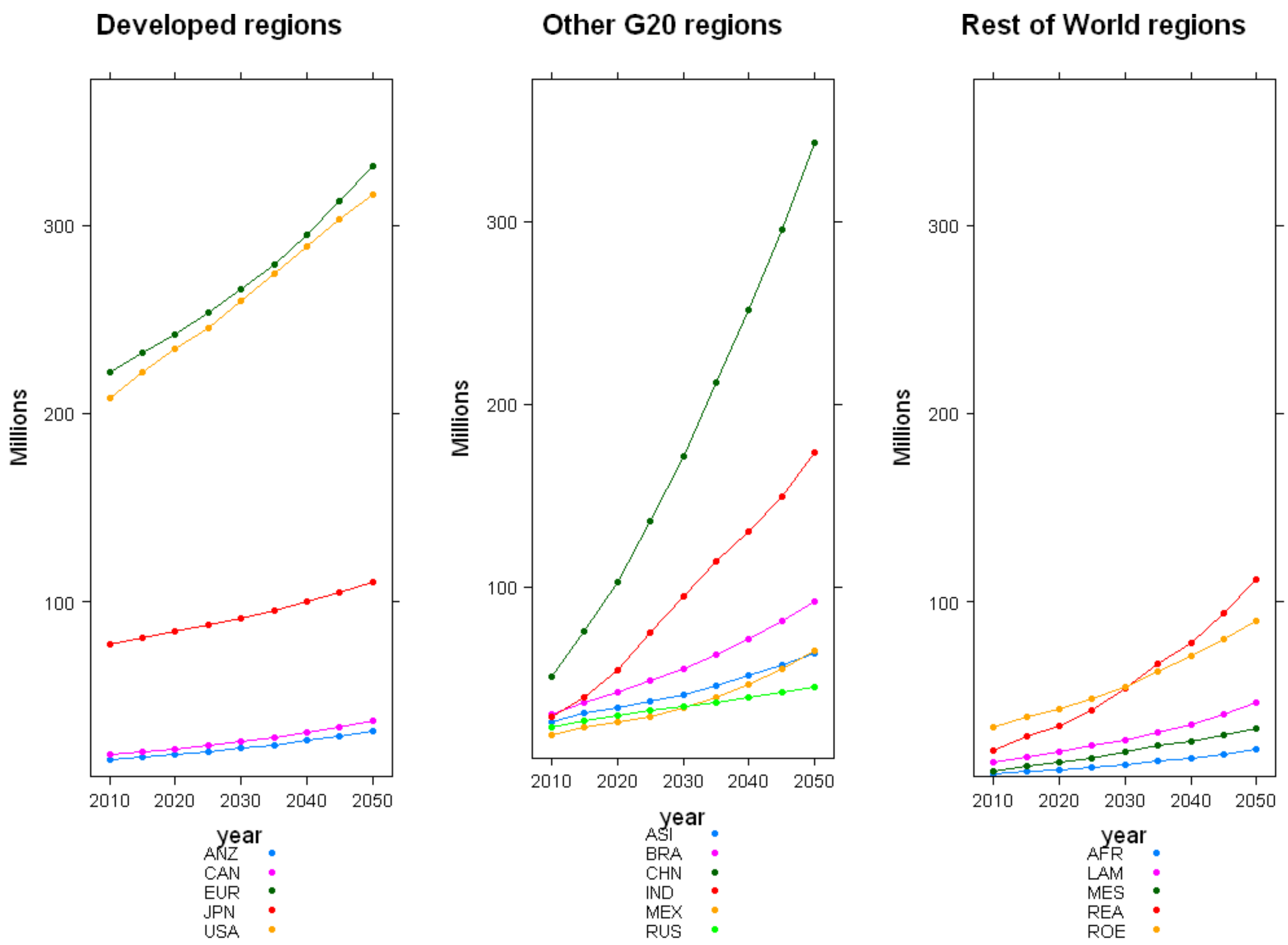
Vehicle Stock



Private Vehicles: cars and light trucks

millions

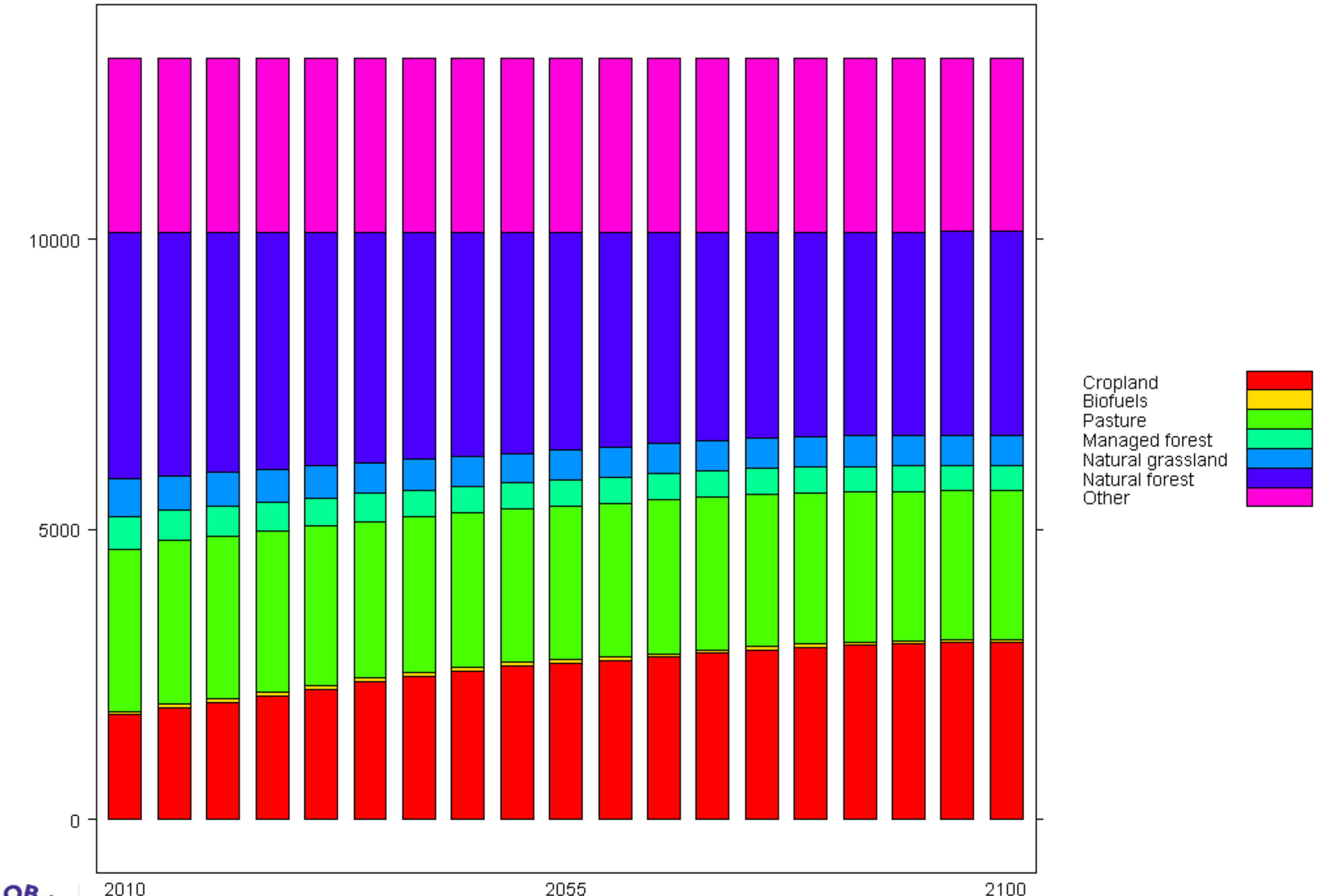
Vehicle Stock by EPPA Region



Private Vehicles: cars and light trucks

millions

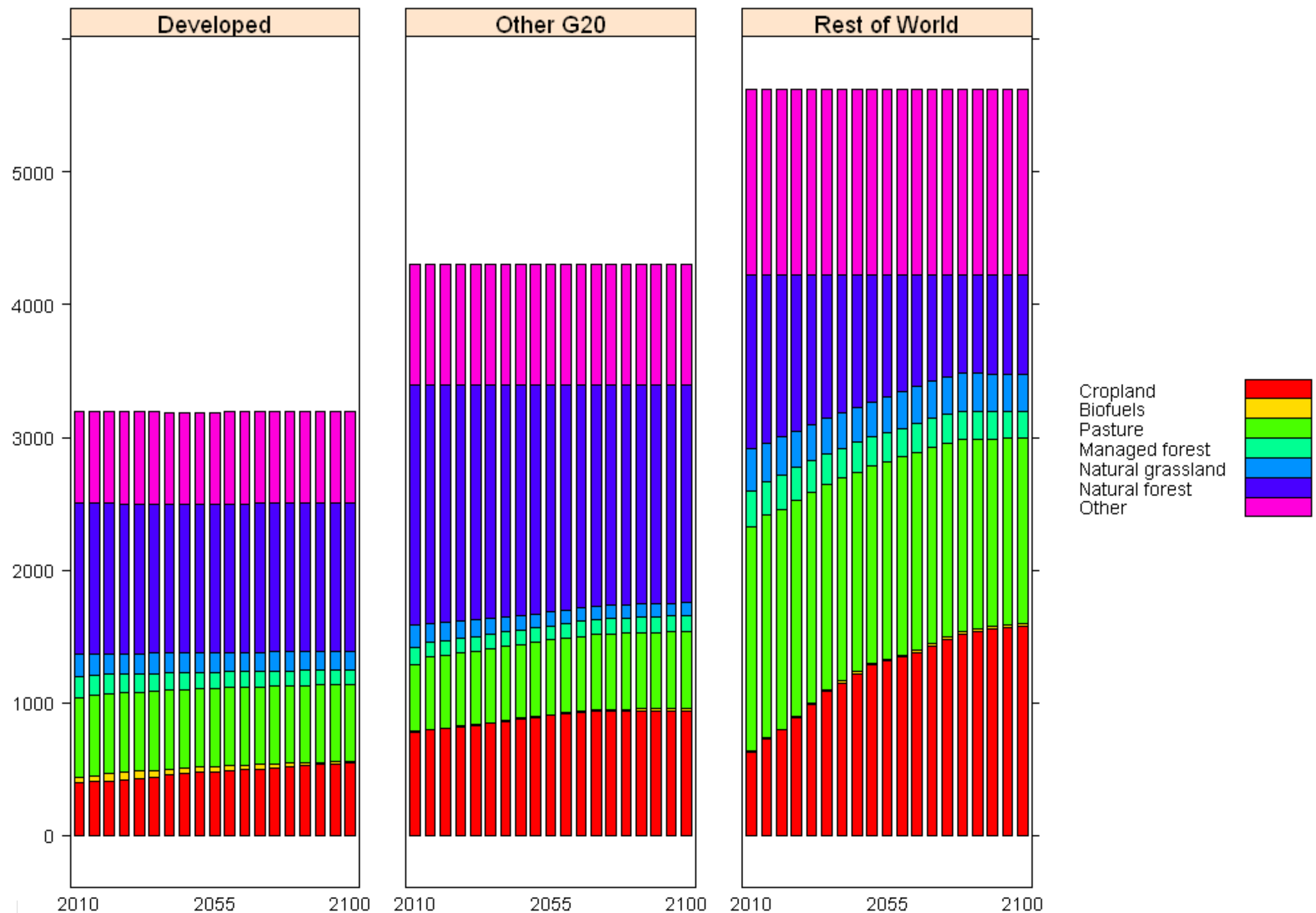
Land Use



Global Land Use

Megahectares (Mha)

Land Use by major group

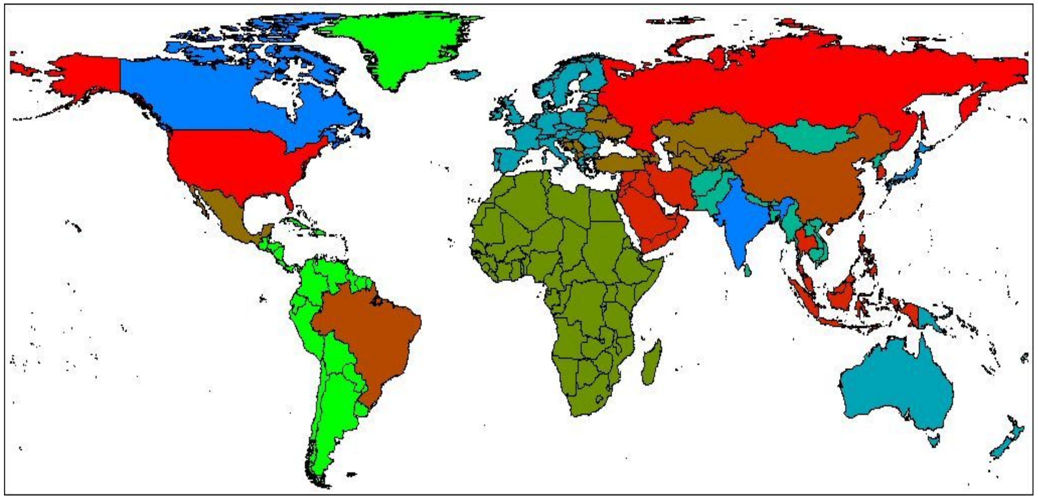


Megahectares (Mha)

The MIT Joint Program on the Science and Policy of Global Change

Example of a regional Excel file

<u>16 regions</u>



- USA
- EU
- Rest of Eurasia
- Canada
- Japan
- Aus. & N.Z.
- Russia
- China
- India
- Mexico
- Brazil
- Middle East
- Africa
- Rest of Latin America
- Dynamic Asia
- Rest of Asia

Example of a regional Excel file

Economic Indicators		2010	2015	2020	2025	2030	2035	2040	2045	2050
GDP	(bil 2005 $)	12,230	13,928	15,663	17,544	19,935	22,667	25,643	28,976	32,759
Consumption	(bil 2005 $)	8,397	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19,329	21,848
GDP growth	(% / yr)	1.0	[illegible]	2.4	2.3	2.6	[illegible]	[illegible]	2.5	2.5
Population	(millions)	310.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	393.5	403.1
GDP per capita	(2005 $)	39,400	43,000	46,464	50,154	55,115	60,787	66,865	73,638	81,268
GHG Emissions										
CO2 -- total	(Mt CO2)									
fossil		5,549	5,534	5,205	4,870	4,871	4,871	4,871	4,871	4,872
industrial		52	57	61	65	70	75	80	86	91
CH4	(Mt)	31.8	[illegible]	[illegible]	[illegible]	[illegible]	31.8	32.3	32.9	33.6
N2O	(Mt)	1.00	[illegible]	[illegible]	[illegible]	[illegible]	1.16	1.23	1.31	1.40
PFCs	(kt CF4)	1.16	1.03	0.93	0.86	0.81	0.75	0.72	0.69	0.68
SF6	(kt)	1.68	1.80	1.85	1.93	2.09	2.32	2.55	2.82	3.12
HFCs	(kt HFC-134a)	157	194	226	271	312	348	389	434	484
Total GHG emissions	(Mt CO2eq)	6,829	6,879	6,586	6,308	6,394	6,486	6,583	6,689	6,811
Primary Energy Use	(EJ)									
Coal		20.2	19.7	17.6	15.2	14.2	13.4	12.7	12.2	11.8
Oil		27.1	26.4	24.4	23.3	23.5	22.9	23.2	23.4	23.6
Gas		22.5	[illegible]	23.3	[illegible]	23.6	24.4	25.1	25.6	26.0
Nuclear		8.0	[illegible]	[illegible]	[illegible]	9.2	9.5	9.7	10.0	10.3
Hydro		2.7	2.8	2.9	3.1	3.2	3.2	3.4	3.5	3.7
Renewables (solar and wind)		3.0	3.4	3.8	4.2	4.5	4.9	5.2	5.6	6.1
Biofuels		1.1	1.6	2.2	2.5	2.5	2.6	2.6	2.7	2.7
Total primary energy use		84.6	85.5	82.8	79.9	80.8	80.9	81.9	83.0	84.2
Electricity Production	(TWh)									
Coal		1,965	1,988	1,861	1,678	1,648	1,620	1,591	1,565	1,546
Oil		173	177	172	161	164	168	171	171	172
Gas		577	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,086
Nuclear		815	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	993	[illegible]	1,053
Hydro		280	[illegible]	300	318	322	[illegible]	[illegible]	[illegible]	378
Renewables (solar and wind)		307	346	388	434	462	497	534	576	623
Total electricity		4,116	4,264	4,271	4,201	4,324	4,461	4,595	4,726	4,857
Transportation										
Number of vehicles	(millions)	208	222	233	244	258	272	287	300	313
Vehicle miles traveled	(trillions)	2.49	2.65	2.79	2.92	3.09	3.26	3.43	3.59	3.75
Miles per gallon, realized on-road average	(mpg)	20.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25.5
Oil consumption for transport	(bil gallons)	120.2	125.5	128.1	129.0	132.4	136.1	139.9	143.5	146.7
Land Use	(billion Ha)									
Cropland		181.9	184.0	186.5	188.2	190.9	198.4	202.5	206.2	209.5
Biofuels		17.3	21.7	25.2	25.3	24.3	16.9	15.9	14.8	13.7
Pasture		116.5	116.2	114.5	114.5	115.1	116.8	115.9	115.0	114.2
Managed forest		54.8	[illegible]	[illegible]	39.9	37.4	35.1	32.7	30.7	29.0
Natural grassland		85.6	[illegible]	[illegible]	85.6	85.6	85.6	85.6	85.6	85.6
Natural forest		323.6	324.0	324.4	324.7	324.9	325.1	325.2	325.3	325.4
Other		119.6	119.6	119.6	119.6	119.6	119.6	119.6	119.6	119.6
Air Pollutant Emissions	(Tg)									
SO2		7.78	6.80	5.66	4.72	4.22	3.81	3.44	3.12	2.84
NOx		11.22	10.96	10.37	9.76	9.75	9.85	9.95	10.06	10.22
Ammonia		3.23	3.34	3.44	3.51	3.64	3.87	4.08	4.32	4.59
Volatile organic compounds		9.46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.52
Black carbon		0.23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.14
Organic particulates		0.95	0.88	0.82	0.76	0.72	0.70	0.67	0.65	0.63
Carbon monoxide		45.39	45.00	43.77	42.11	42.67	43.60	44.52	45.49	46.59

ECONOMIC INDICATORS

GHG EMISSIONS

ENERGY USE

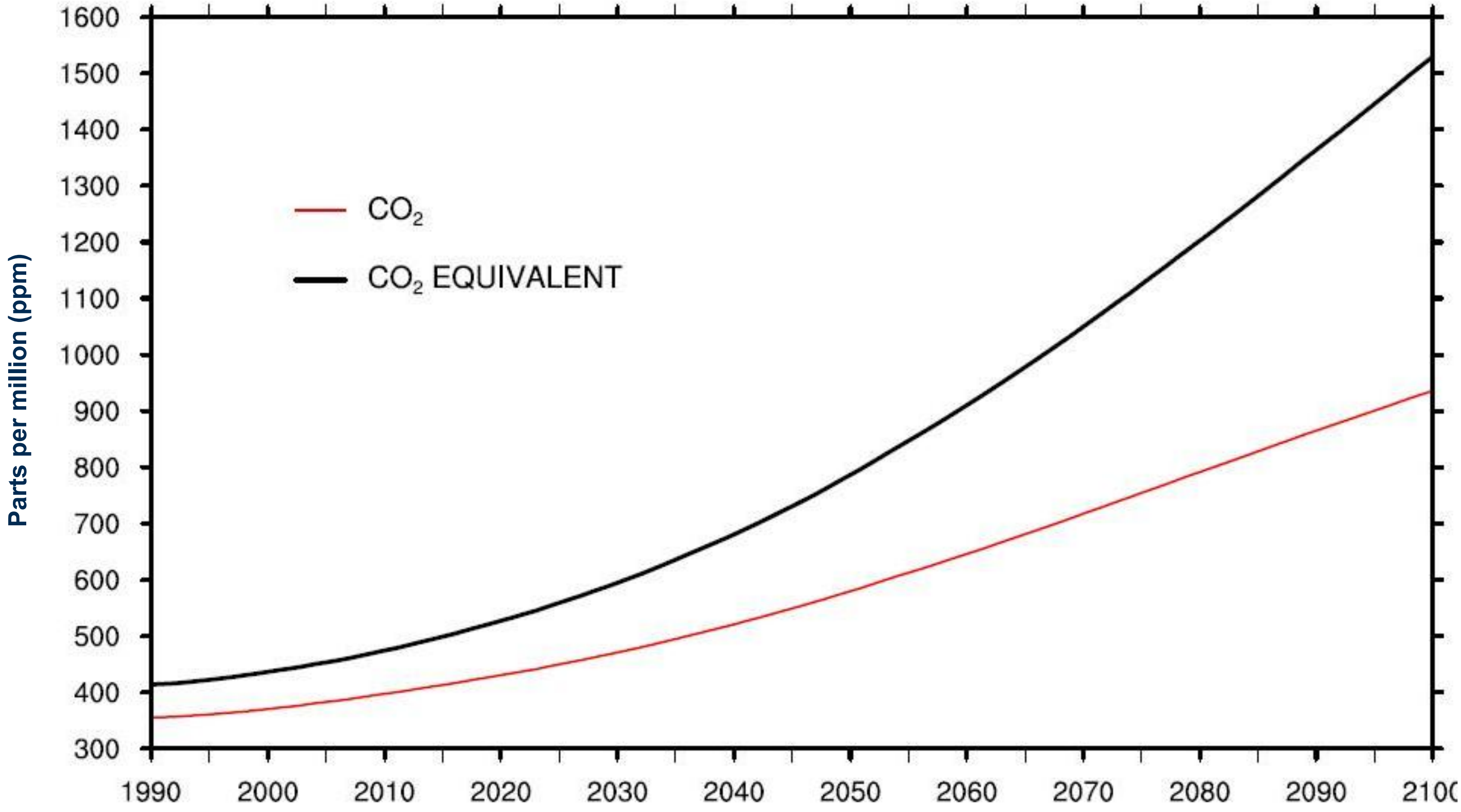
ELECTRICITY PRODUCTION

PRIVATE TRANSPORTATION

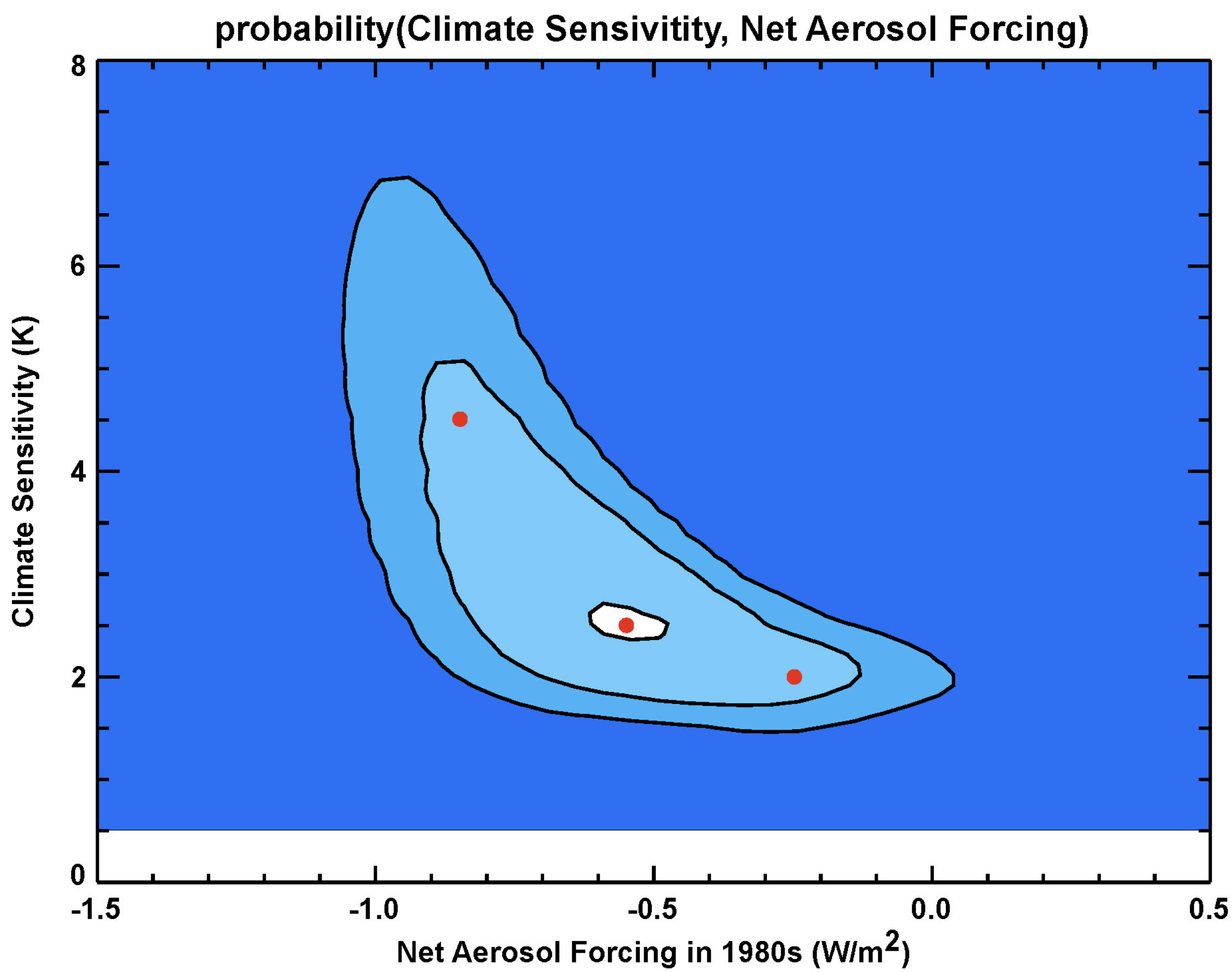
LAND USE

AIR POLLUTANT EMISSIONS

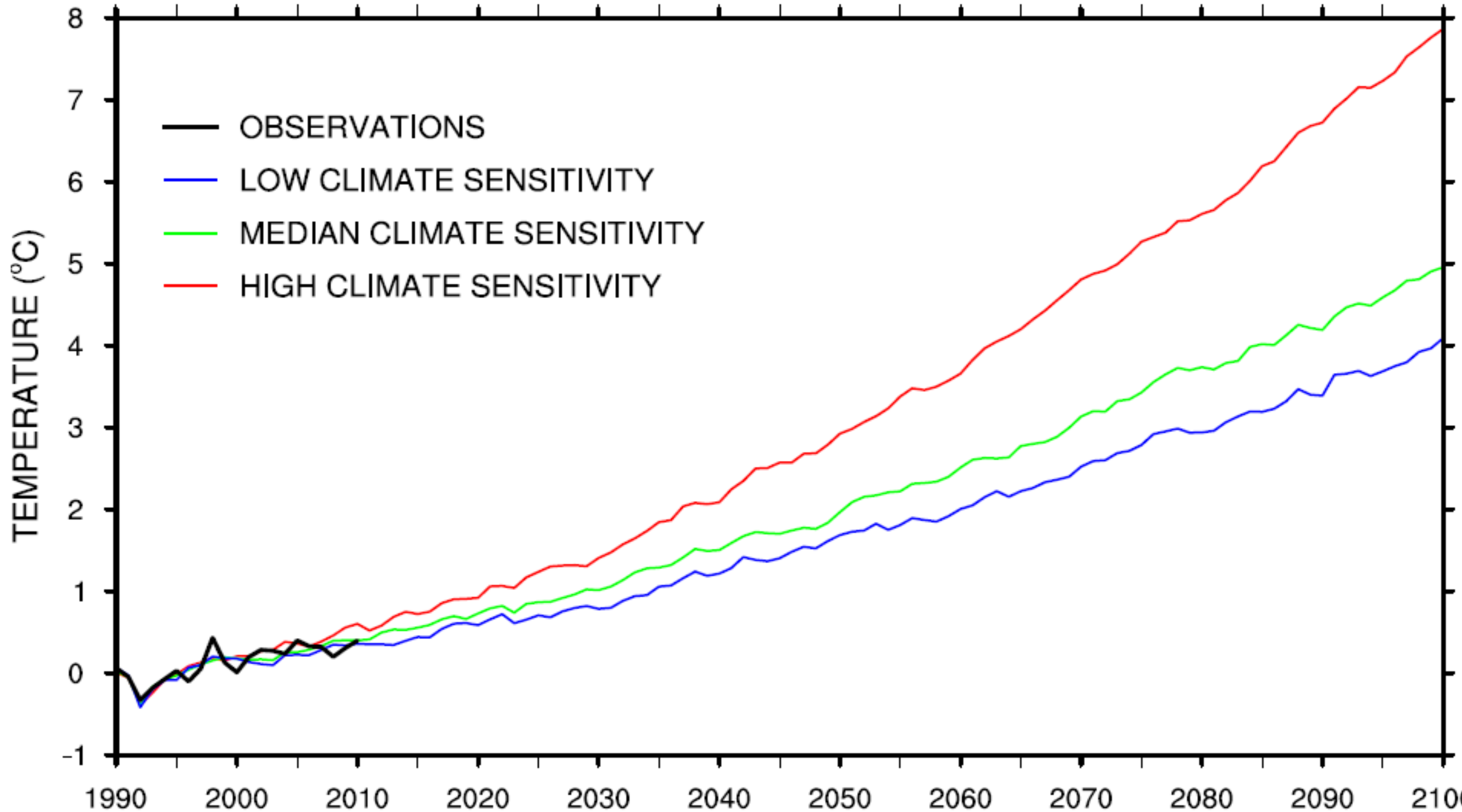
CO_2 and GHG Concentrations



Climate Sensitivity

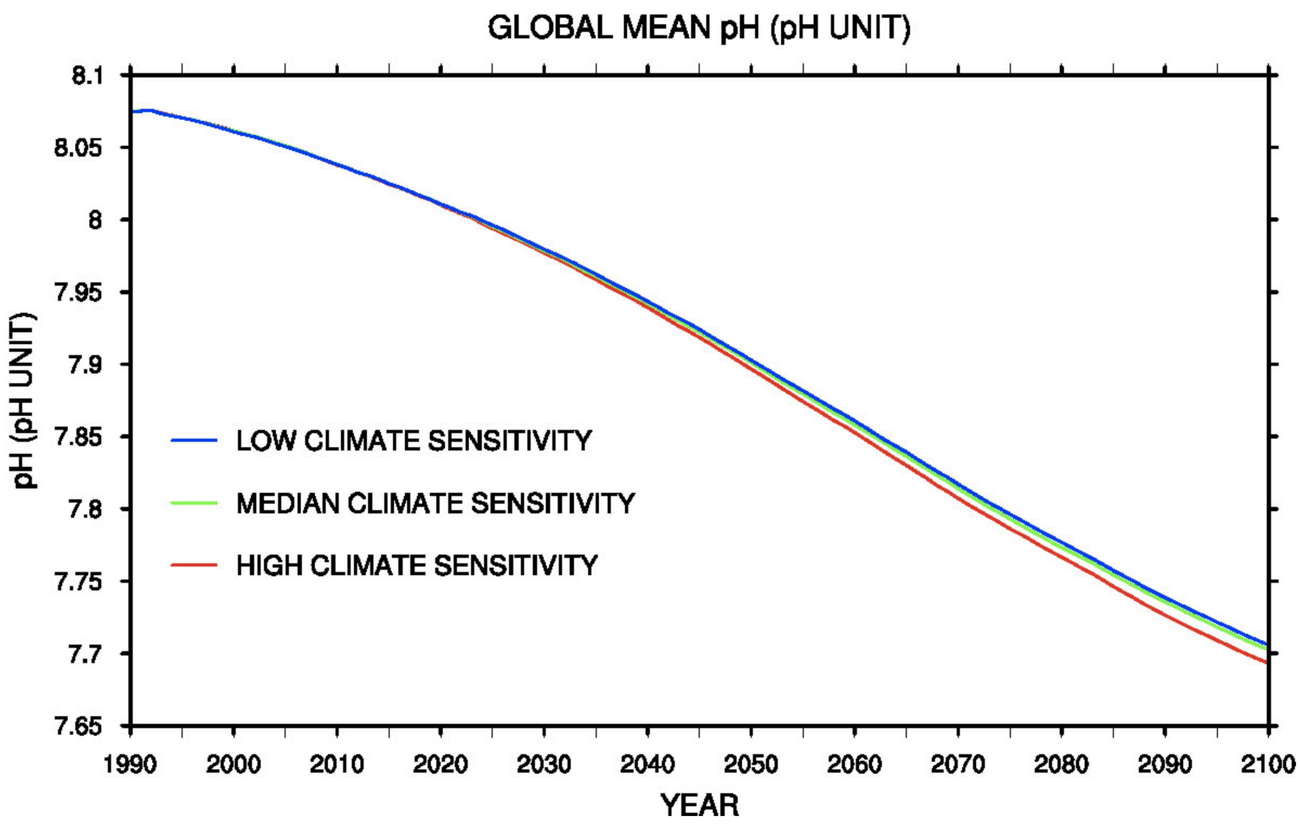


Temperature Increase



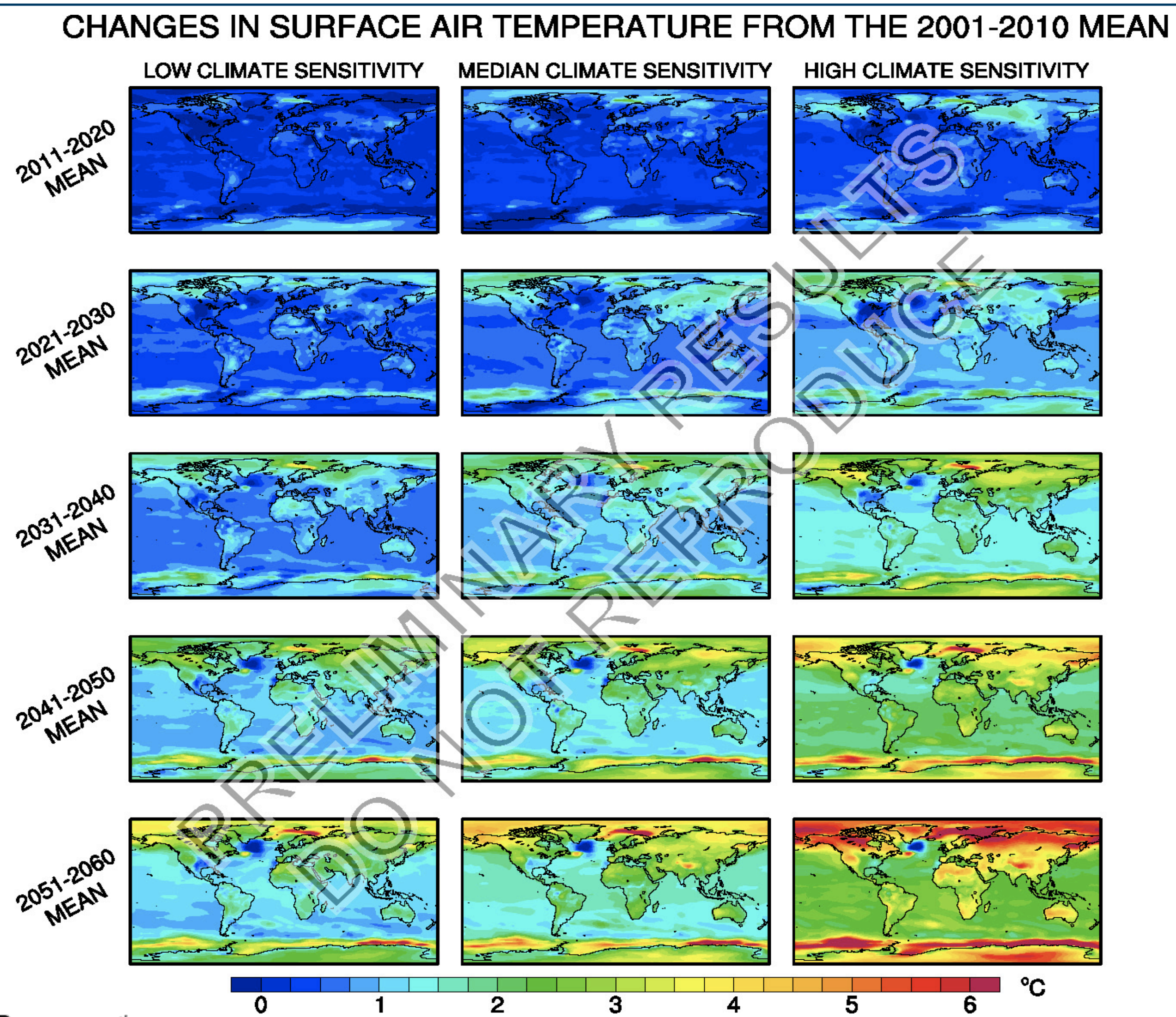
- Global average surface temperature change relative to 2000
- Black line - observations

Ocean Acidity

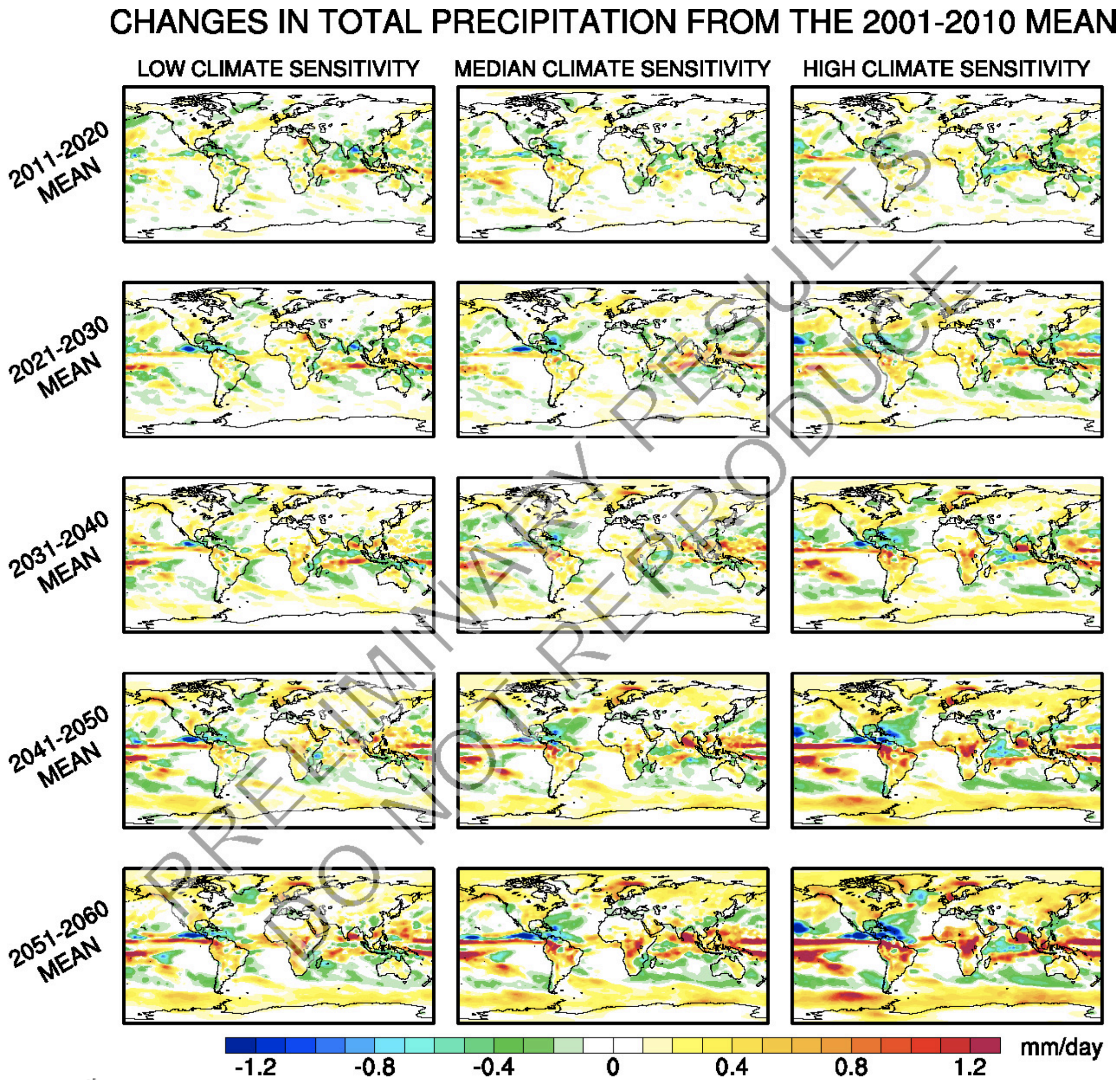


- **A decrease of 1 in pH scale corresponds to a factor of 10 increase in acidity.**

Regional Temperature Change

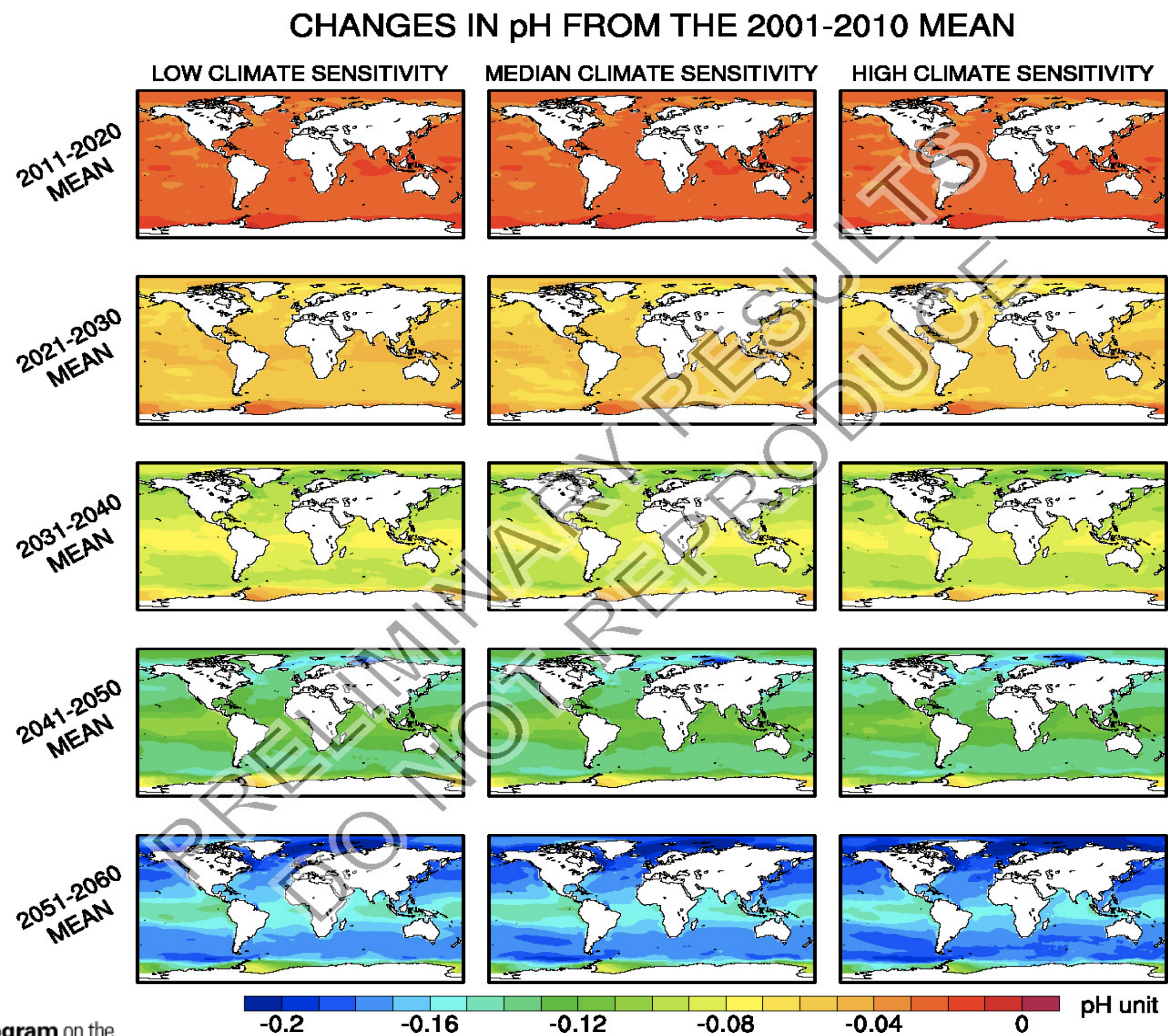


Regional Precipitation Change



Currently the average global precipitation is about 3 mm/day

Regional Ocean Acidity



Major Points

Temperature increases are substantial.

Most emissions growth is in developing regions.

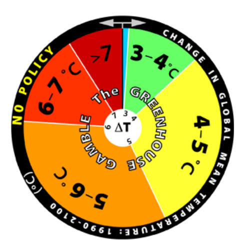
Emissions in developed regions are flat, so a smaller lever to further impact global emissions.

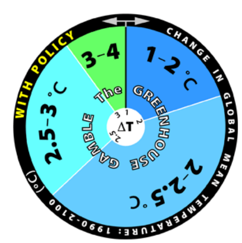
Transition to alternative energy is starting in developed countries and China, but the Copenhagen targets will not complete it.

Vehicle growth is substantial in developing regions.

Land emissions are important.

A lot more work is needed if the world wants to avoid substantial climate change.





Thanks are due:

Henry Jacoby

Sergey Paltsev

Valerie Karplus

Erwan Monier

Andrei Sokolov

Tony Smith-Grieco

Ioanna Karkatsouli

Adam Schlosser

Angelo Gurgel

Yongxia Cai

Jeff Scott

Stephanie Dutkiewicz

Frances Goldstein

Joint Program Sponsors Webinar Series
November . 10 . 2011 10:30 am - 12:00 pm EST

1. Thank you for joining us today at the second in the MIT Joint Program Sponsors Webinar series.

2. At the conclusion of the Webinar, online attendees will be presented with a brief survey. We hope that you will take a few minutes to provide feedback on today's session and make suggestions for future webinar topics. For those participating by telephone only, we welcome your comments at any time to Frances Goldstein by phone (+1.617.253.2682) or email (fkg@mit.edu).

3. Today's webinar has been recorded, and will be available in our webinar archive in the 'Sponsors Only" section of the Joint Program website, at:

   http://globalchange.mit.edu/sponsors/sponsorsonly/webinars.html

   (Click on the "Archived webinars" tab)

4. The next webinar in the series will be:

   Date: **January (date TBD), 2012**
   Time: **10:30 a.m. - 12:00 p.m. EST**
   Title: **TBD**
   Presenter: **TBD**

   We do hope you hold this date on your calendar and plan to attend.
   Details will be sent as we move closer to the event.

Thank you for participating in the MIT Joint Program Sponsors Webinar series.