Regional and Spatial Analysis on 3E under a Constraint on Radiative Forcing:
Integrated Assessment Using Economic, Land-use, and Ecosystem Models

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and

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Summary of RCPs

- Representative Concentration Pathways

- Pre-scenarios to develop new scenarios for AR5

- Input for climate models and basis for development of socioeconomic scenarios

- The data are provided not only in the regional scale but also in the gridded scale (0.5 x 0.5 degrees) for gases emissions and land-use change.

- Four RCPs exist and each one scenario is analyzed by one modeling team.
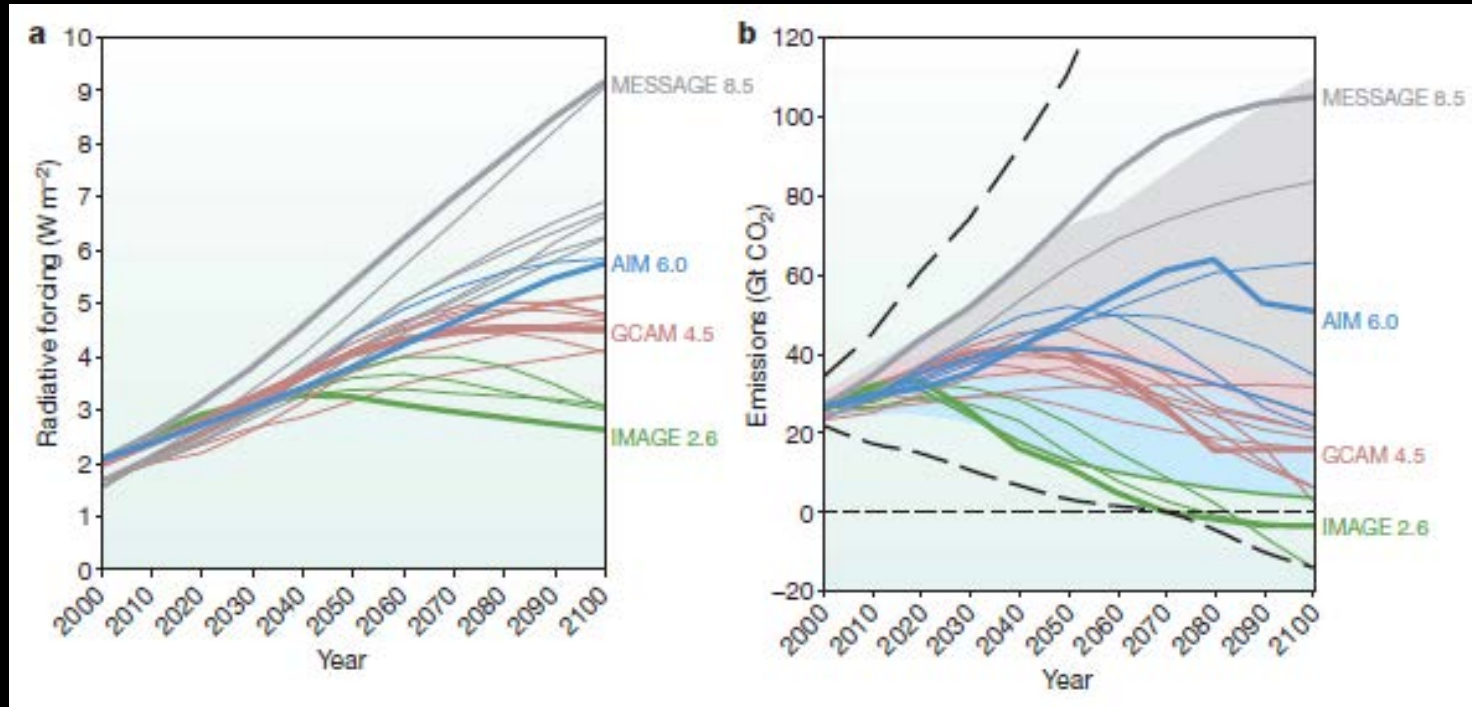
Approach toward AR5
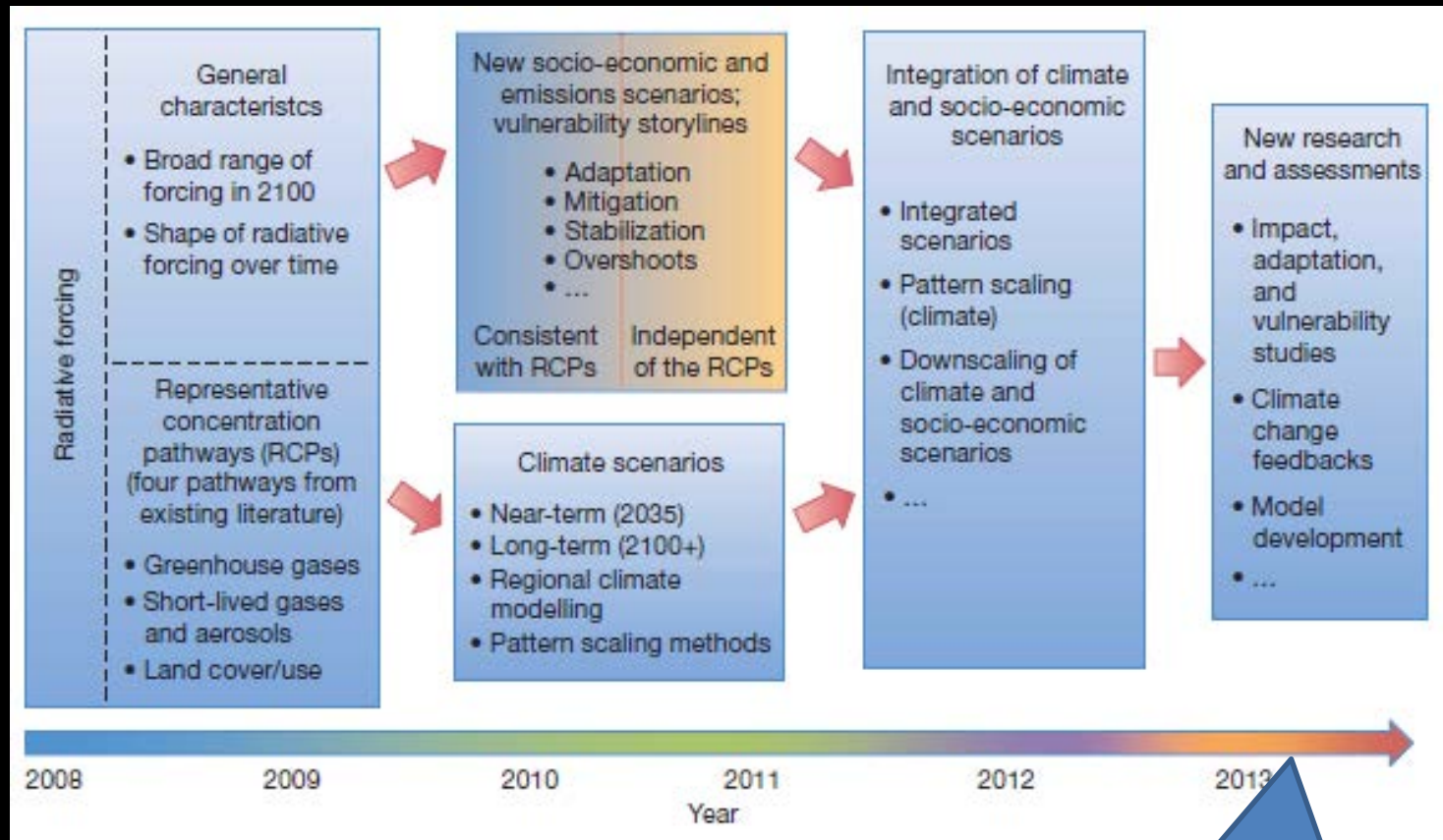
Source: Moss et al. (2010)

Publication Dates
-WGI Report: Sep., 2013
-WGII Report: Mar., 2014
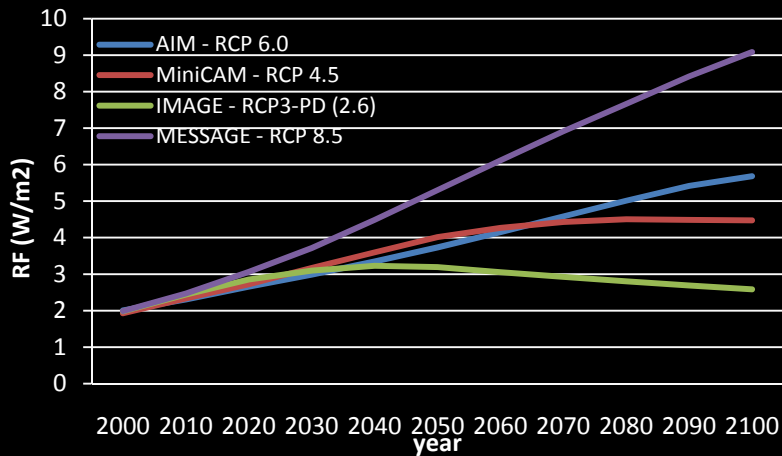-WGIII Report: Apr., 2014
-Synthesis Report: Sep., 2014

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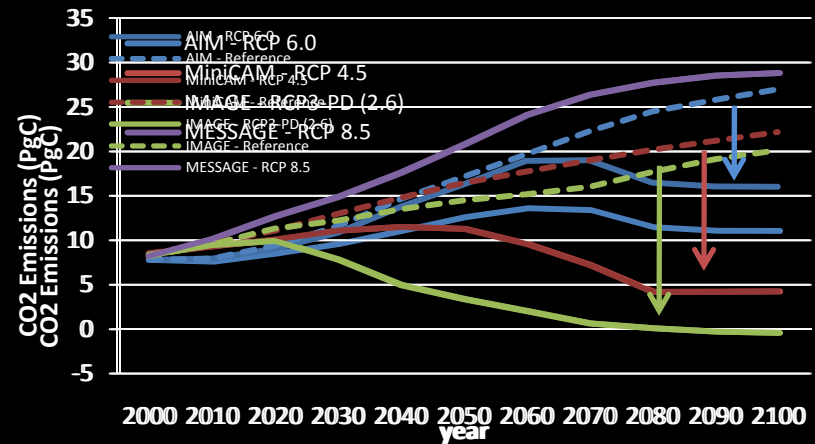# Selection of RCPs

Source: Moss et al. (2010)

Name	Radiative Forcing	Concentration	Pathways Shape
RCP8.5	8.5W/m^2 (in 2100)	<= ~1370ppm CO_2-eq	Rising
RCP6.0	~6.0W/m^2 (stabilization after 2100)	~850ppm CO_2-eq	Stabilization without overshoot
RCP4.5	~4.5W/m^2 (stabilization after 2100)	~650ppm CO_2-eq	Stabilization without overshoot
RCP3-PD	< 3W/m^2 (peak and decline) $\Rightarrow$ 2.6W/m^2	< ~490ppm CO_2-eq	Peak & decline

Four RCPs: RF and CO2 Emissions

Radiative Forcing 2000-2100

Legend (left chart):
- AIM - RCP 6.0
- MiniCAM - RCP 4.5
- IMAGE - RCP3-PD (2.6)
- MESSAGE - RCP 8.5

CO2 Emissions 2000-2100

Legend (right chart):
- AIM - RCP 6.0
- AIM - Reference
- MiniCAM - RCP 4.5
- IMAGE - RCP3-PD (2.6)
- IMAGE - RCP3-PD (2.6)
- MESSAGE - RCP 8.5
- IMAGE - Reference
- MESSAGE - RCP 8.5

Four RCPs: Population and GDP
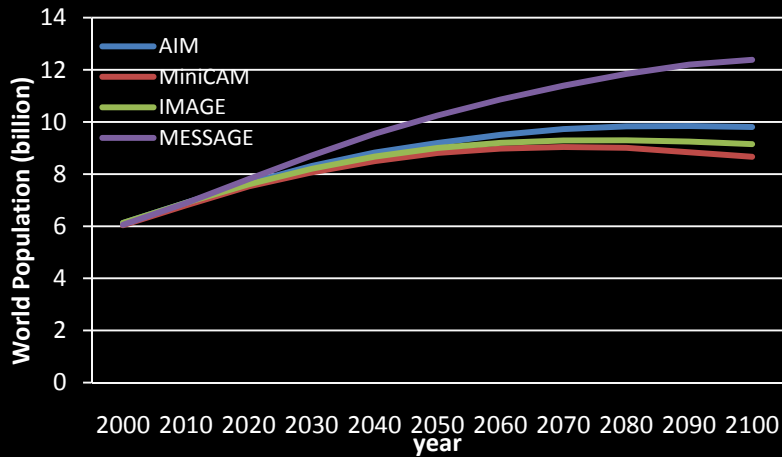
Population Scenarios 2000-2100
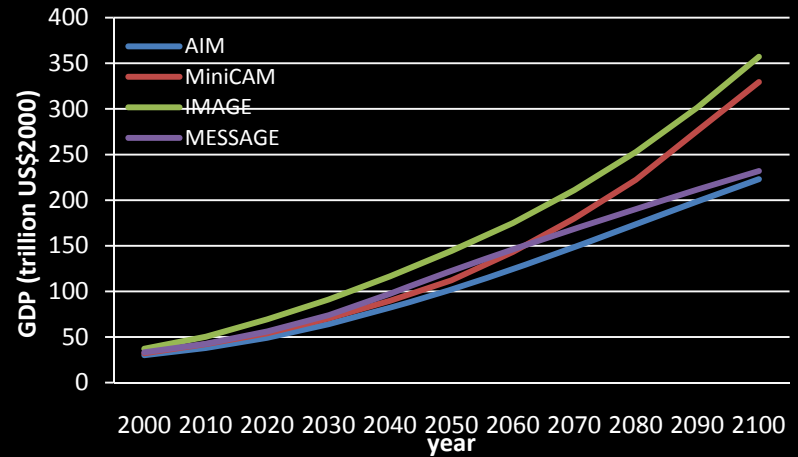
GDP Scenarios 2000-2100

Flow of RCP6.0 Analysis

RF

AIM/Impact [Policy]

Base year emissions

Pop & GDP scenario

GHG & aerosol emissions pathways

Pop & GDP Downscale

AIM/CGE [Global]

Pop & GDP gridded data

Regional & sectoral emissions & economic scenario

Land Use Downscale

Land-use change

Emissions Downscale

Land use

Emissions from land-use and burning

Ecosystem Model

Emissions from energy & industry

Global
Country
Region
Grid

RCP6.0 spatially-detailed scenario

AIM/Impact [Policy]

Integrated assessment
(Emission/Climate/Impacts)

GHG Emissions

Energy-economic model

Global GHG emission path

Simple climate model

GMTI
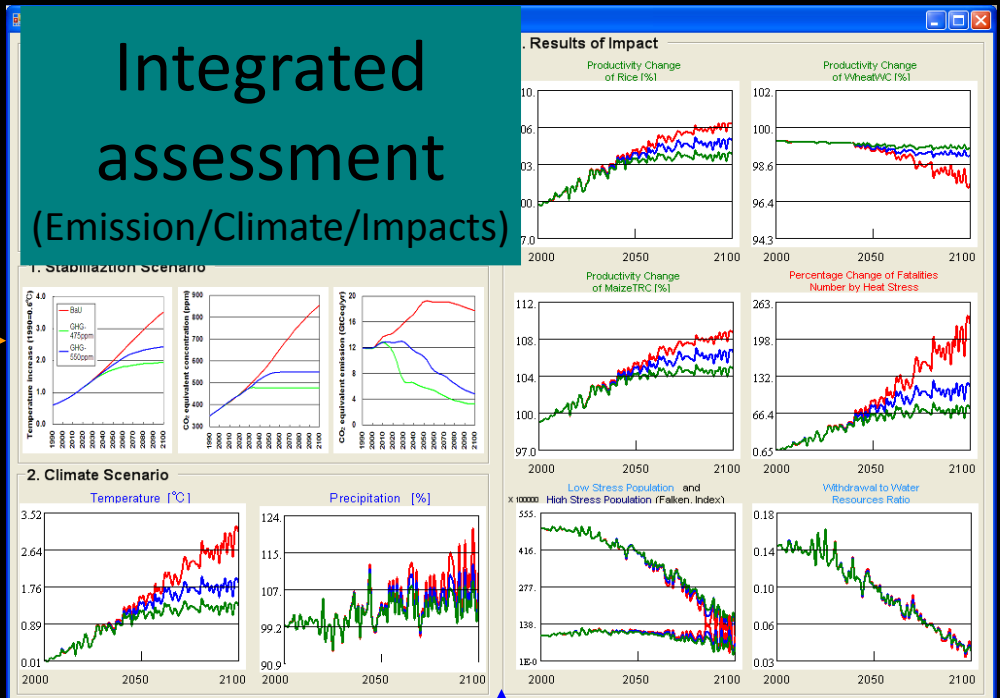
Impact/ Adaptation

National/ Sector-wise impacts

Pattern scaling module

Climate Scenario by country

Potential impact estimation module
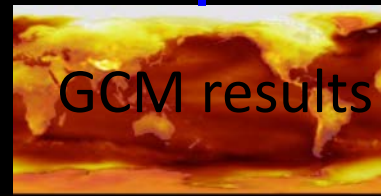
GCM results
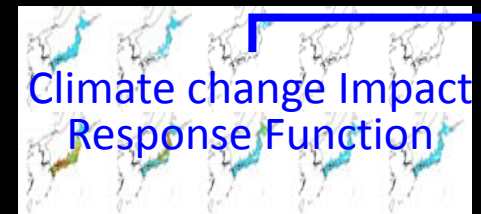
Climate change Impact Response Function

Adaptation

8
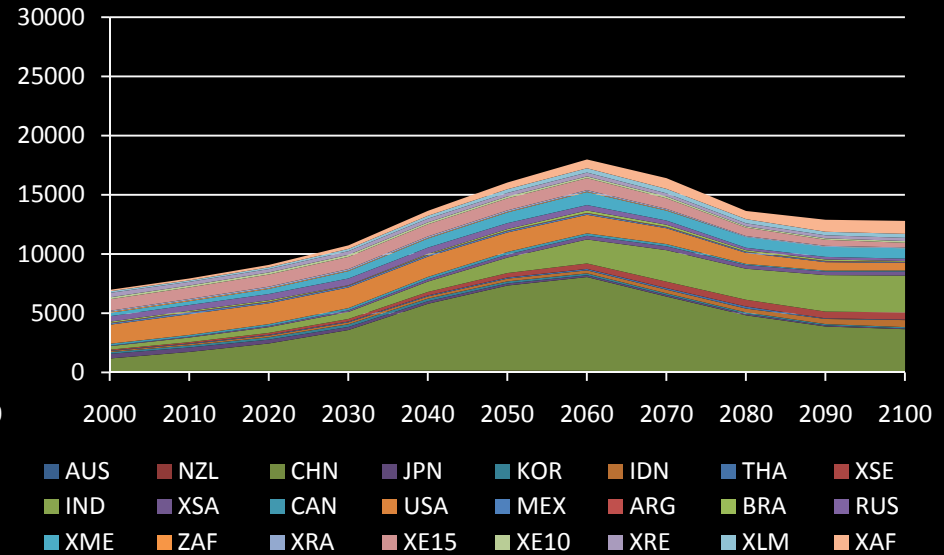
Global Emissions Pathways
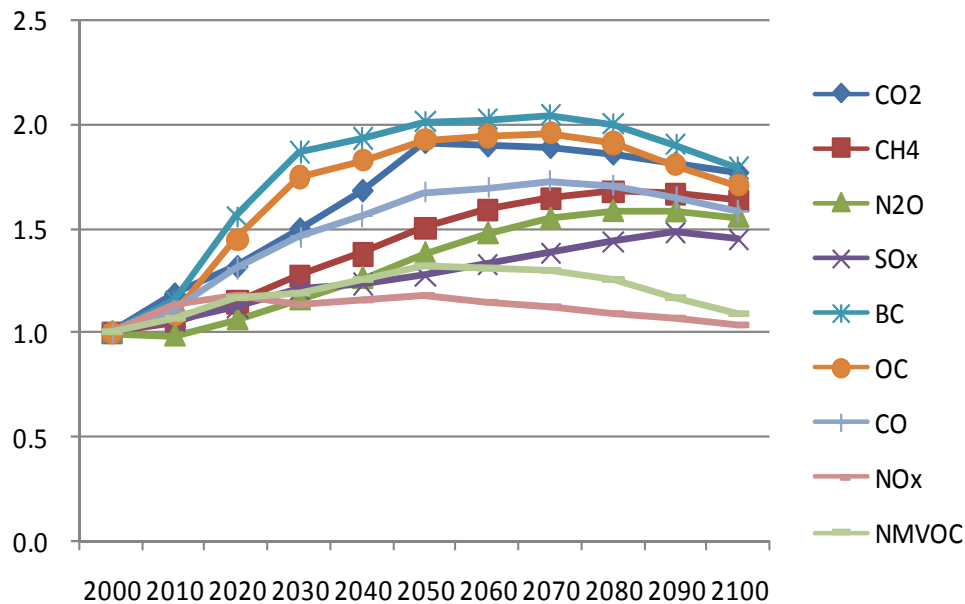
Reference
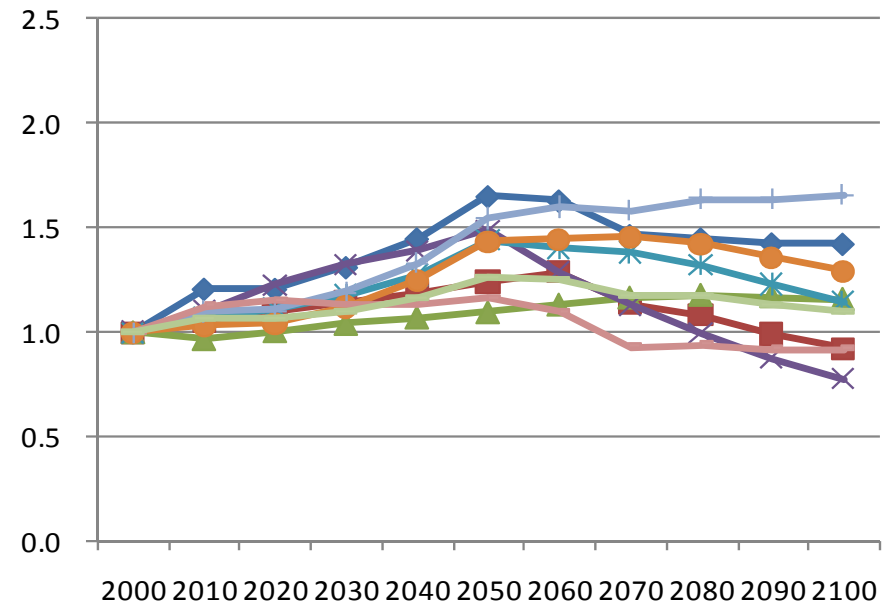
RCP6.0

unit: 2000=1.0

AIM/CGE [Global]

Gases emissions

Production sectors

Production factor market

- capital
- land
- labor
- resource

Commodity market

- food
- energy
- service
- ...

Gases emissions

Final demand sector

Japan

China

...

Trade

Climate change

Annual parameter change

Energy technology model: energy efficiency
Agriculture model: land productivity

...

Scenarios: population, GDP, ...

Feedback
e.g. Land productivity change due to climate change

CO2 Emissions from FF and Industry (TgC)
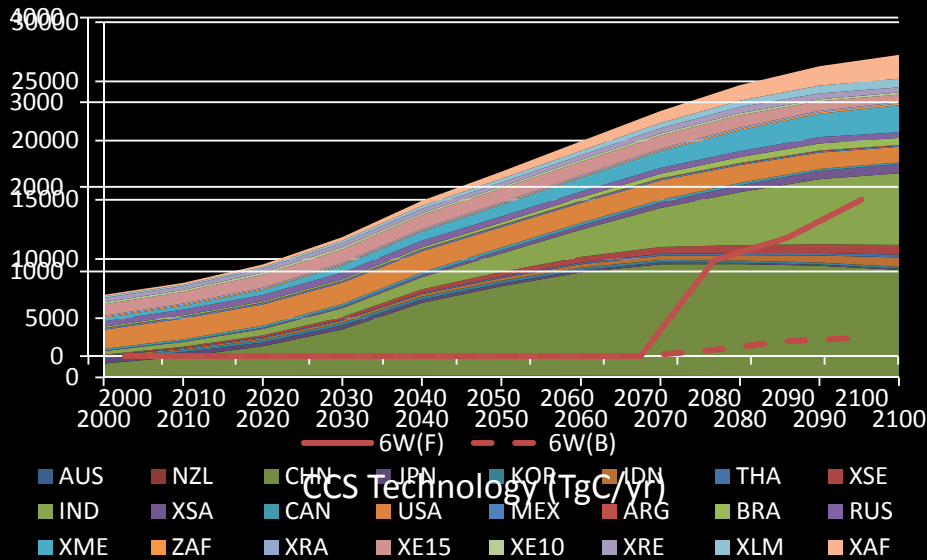
Reference

RCP6.0

- CO2 emissions from fossil fuels and industry will be abated about 40% in 2100.

Energy (EJ)

Primary (Reference)

Coal ■ Oil ■ Gas ■ Nuclear ■ Biomass ■ Hydro ■ Renewables

Primary (RCP6.0)

Coal ■ Oil ■ Gas ■ Nuclear ■ Biomass ■ Hydro ■ Renewables

Final (Reference)

Solids ■ Liquids ■ Gas ■ Electricity

Final (RCP6.0)

Solids ■ Liquids ■ Gas ■ Electricity

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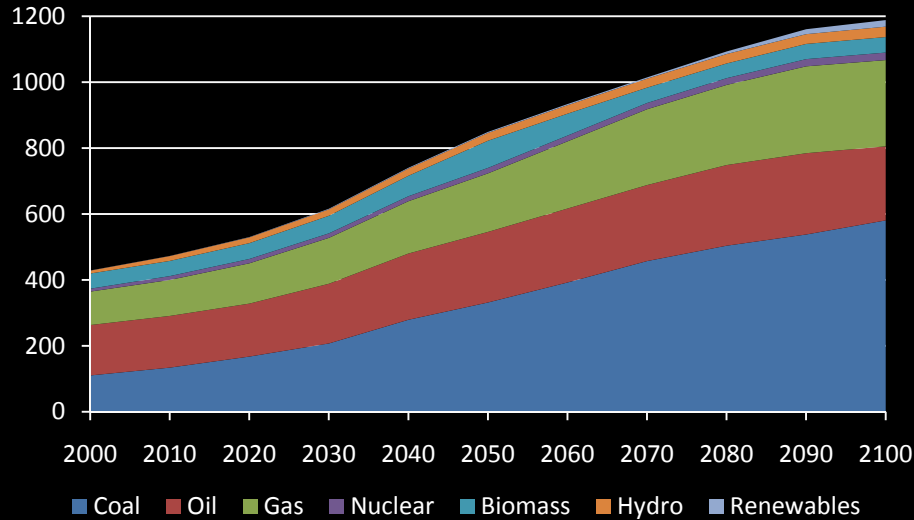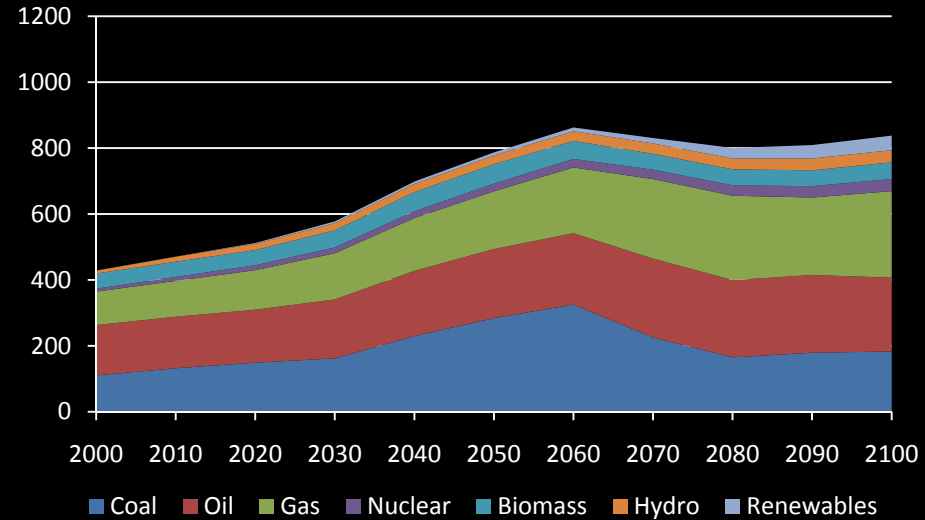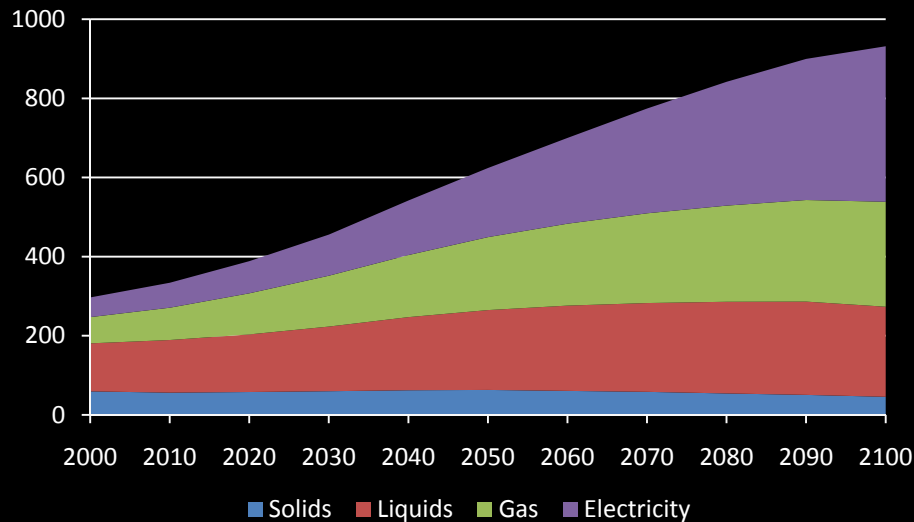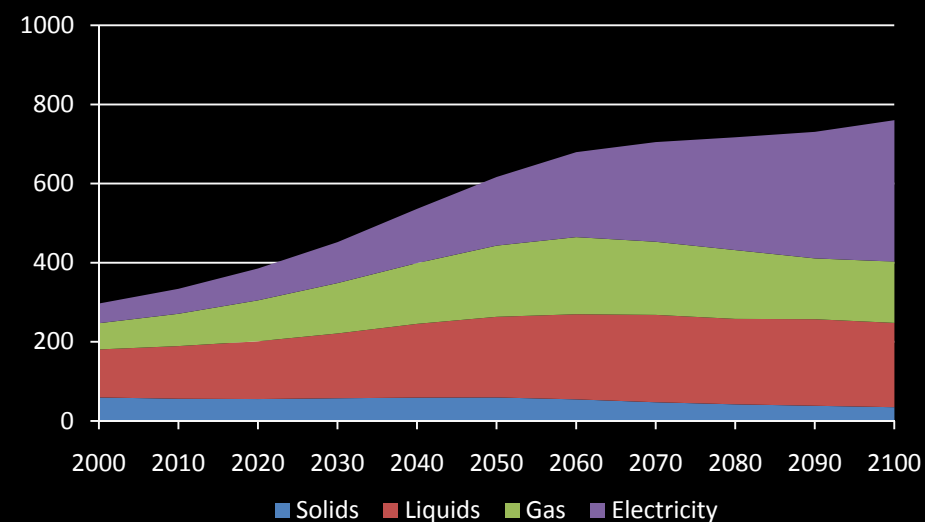
GDP (tri. US$2000)
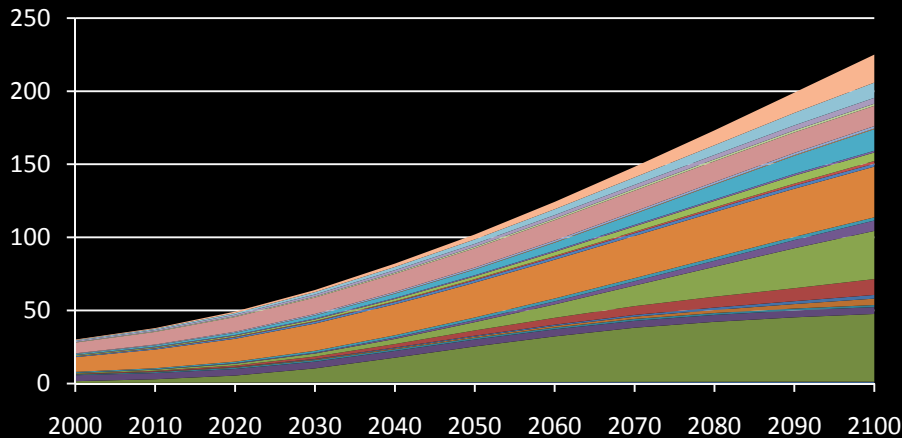
Reference
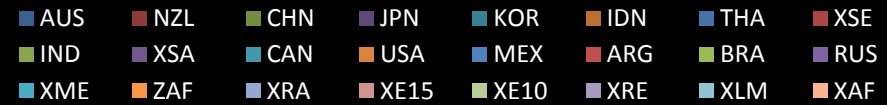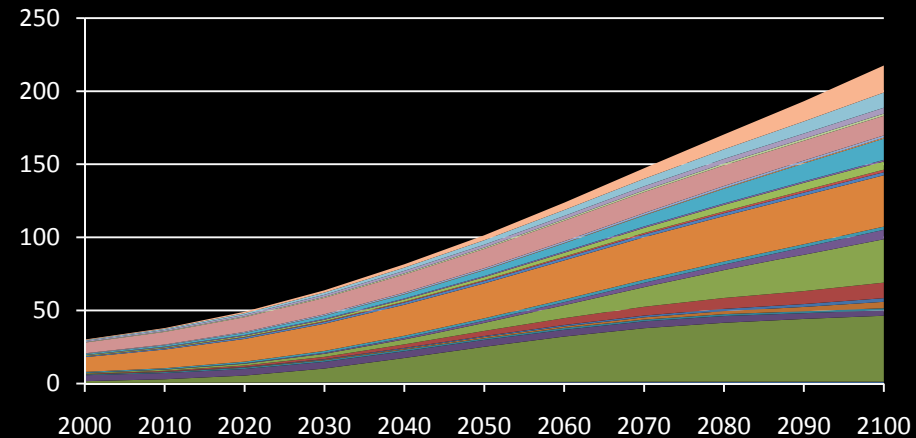
RCP6.0

- Although GDP will increase more in the reference case than in the RCP6.0, the difference is not so large.

Population/GDP Downscaling Model

Population Scenario

2000

2050

2100

2010/2/21
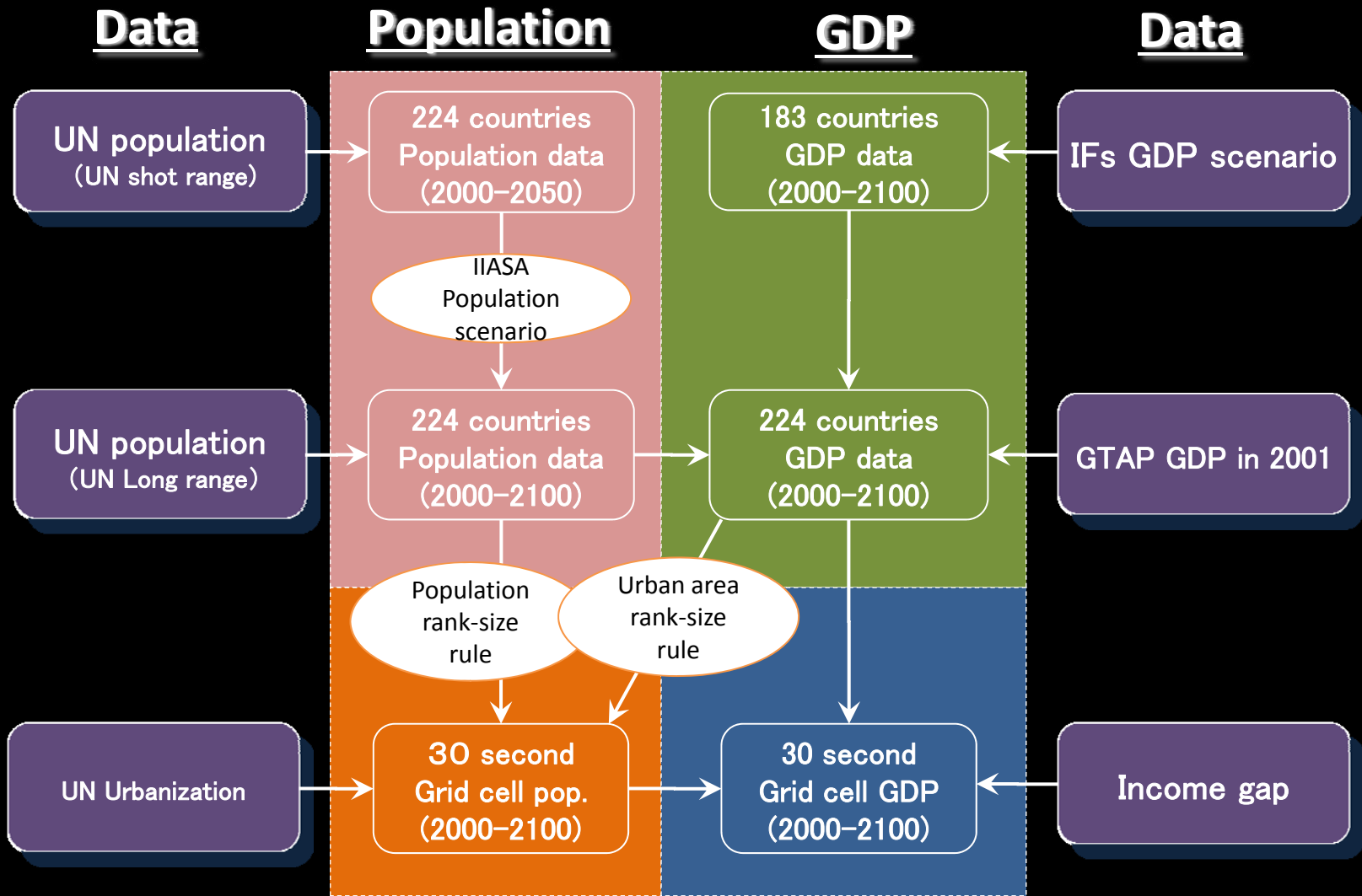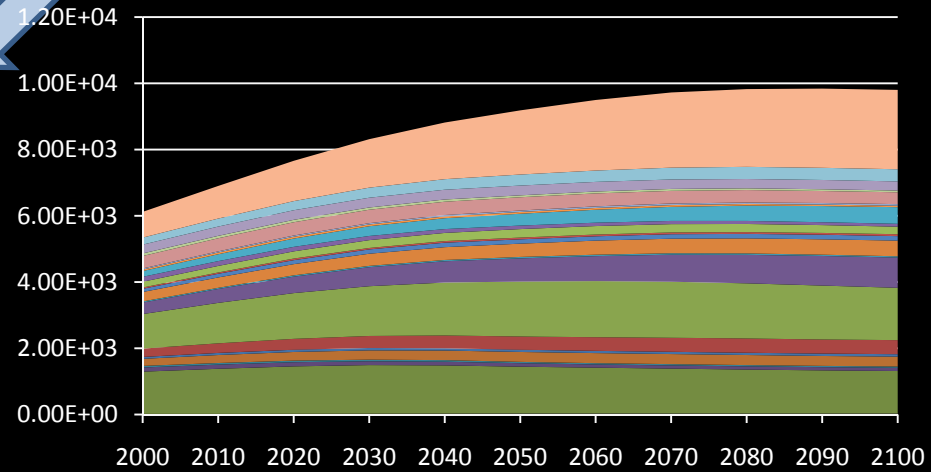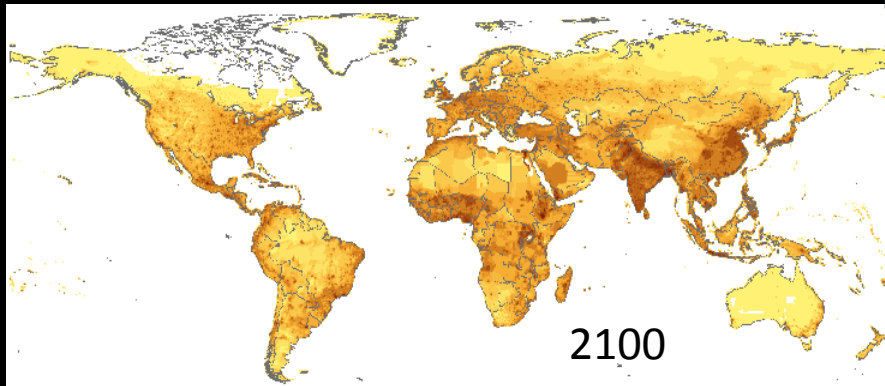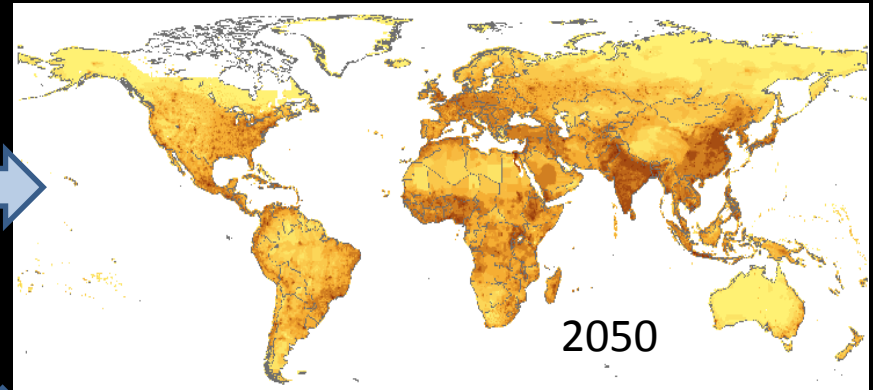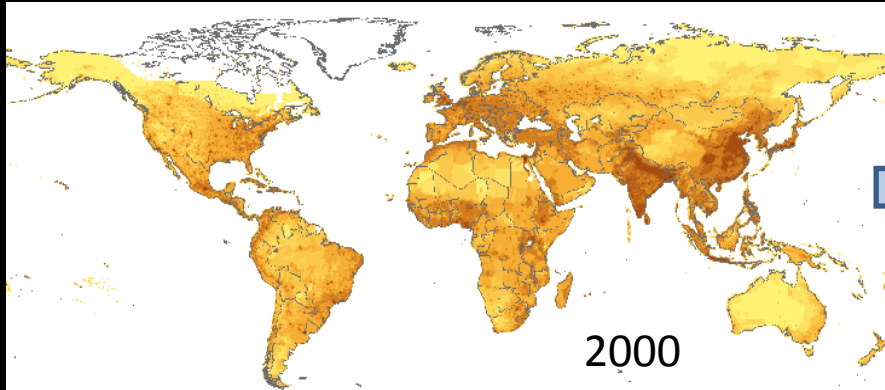
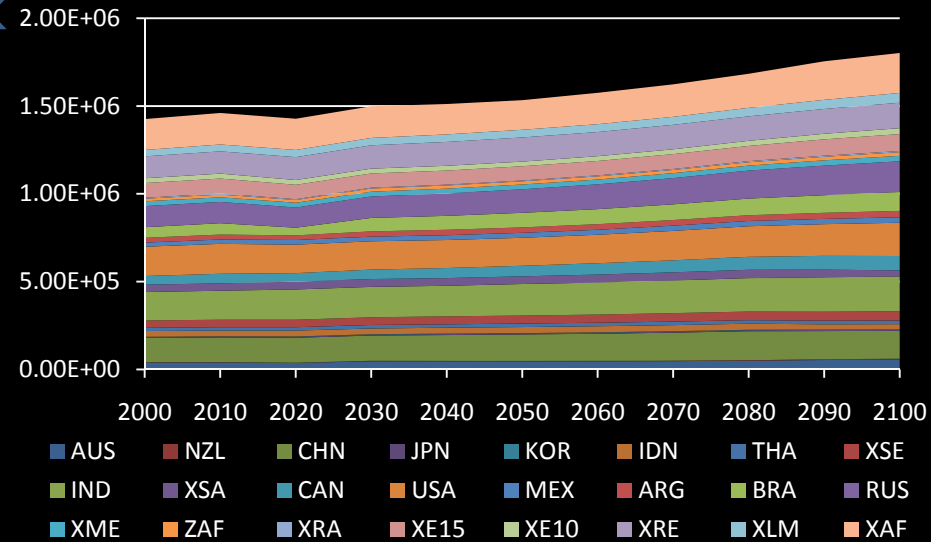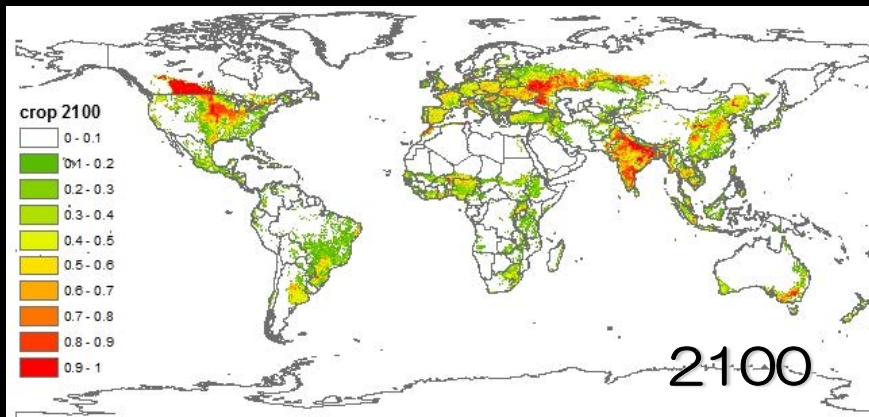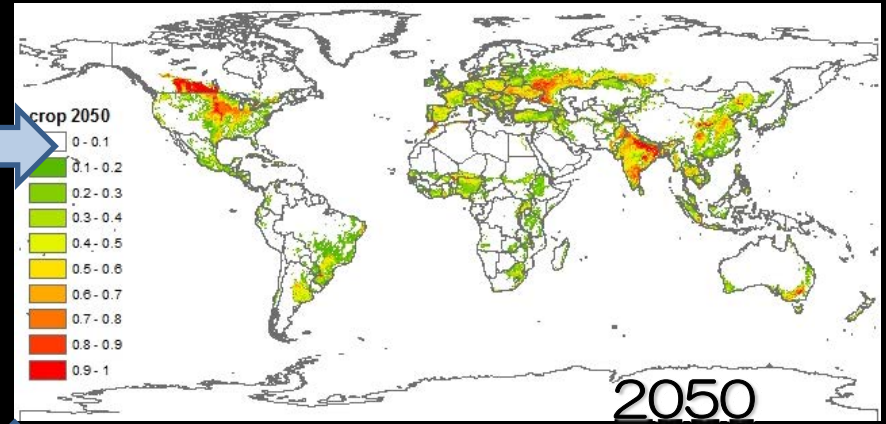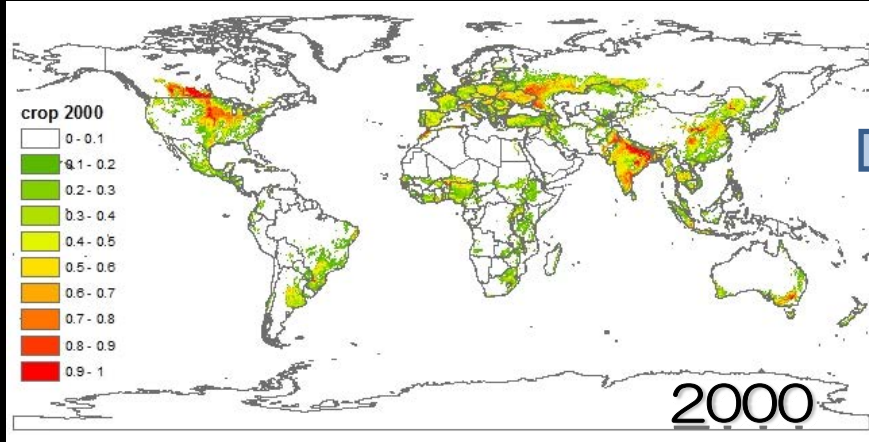|						
AUS	NZL	CHN	JPN	KOR	IDN	THA	XSE
IND	XSA	CAN	USA	MEX	ARG	BRA	RUS
XME	ZAF	XRA	XE15	XE10	XRE	XLM	XAF

Land-use Model
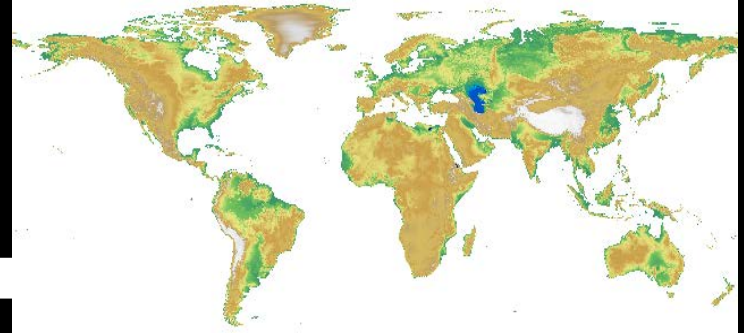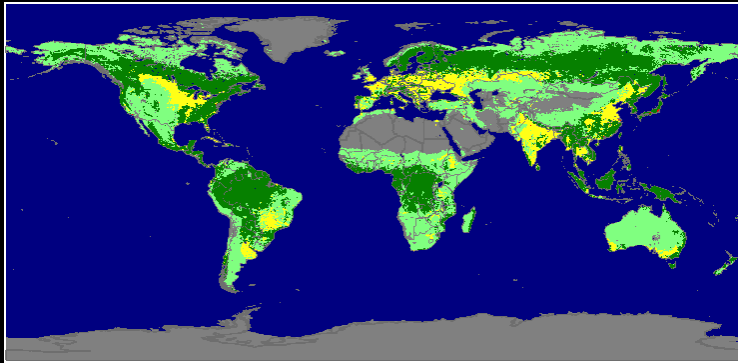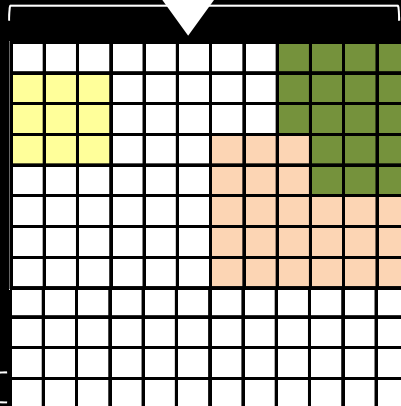
Geophysical constraint
・Built-up area < 5 degree
・Forest < 20 degree
  etc.

0.5 degree

1. Urban (GDP, crop price…)
2. Cropland (yield, slope angle…)
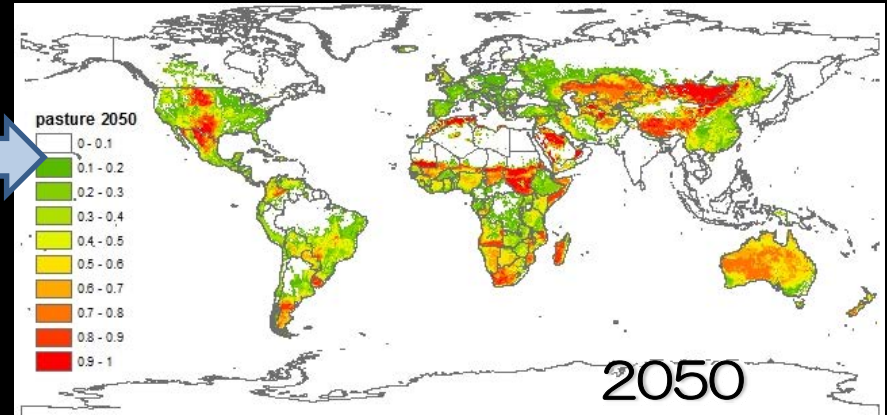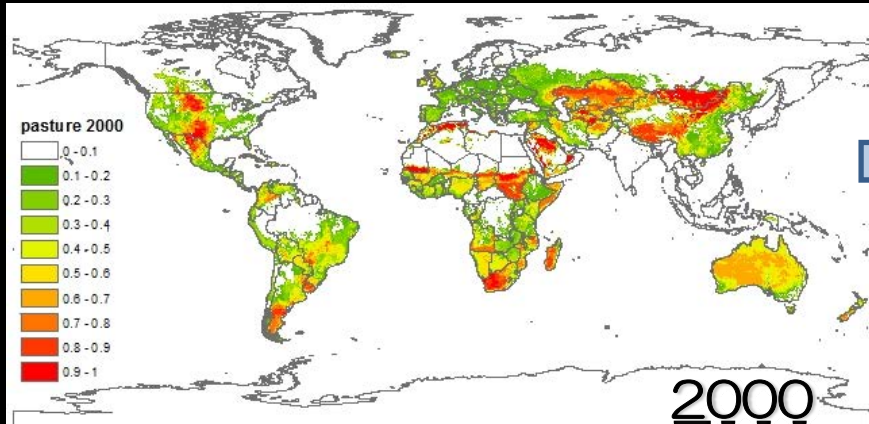3. Pasture (NPP, slope angle…)
4. Harvest forest (population density..)

1km

Land-use Scenario (Cropland)

2000

2050

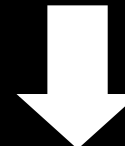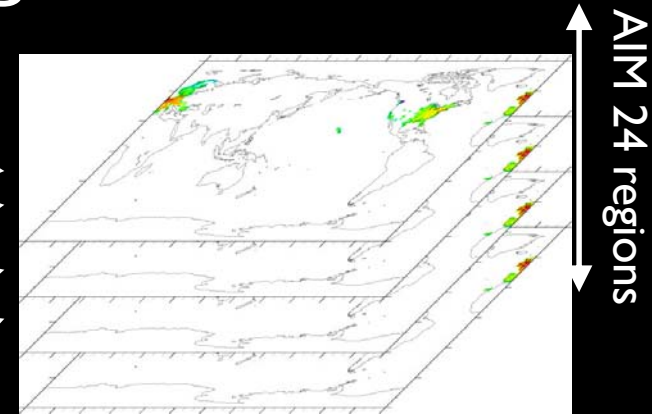2100

Land-use Scenario (Pasture)

2000

2050

2100
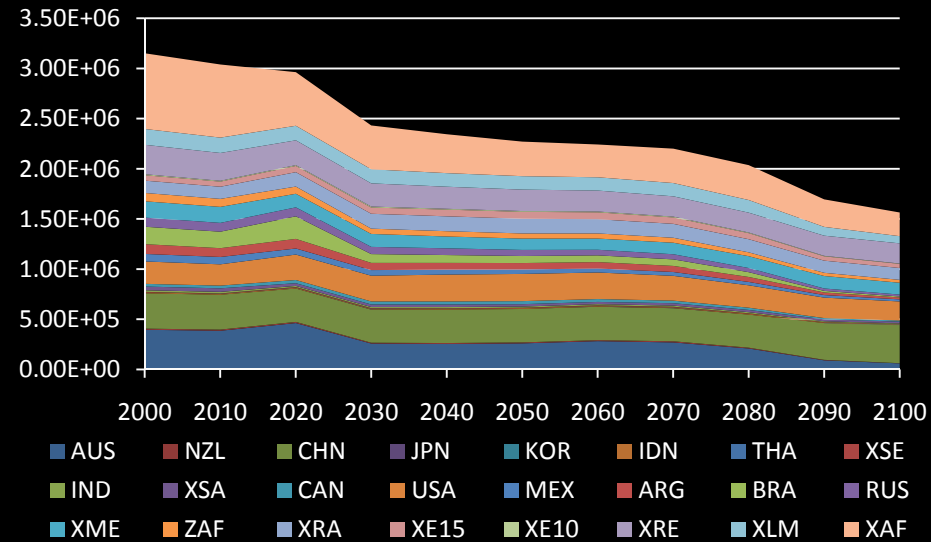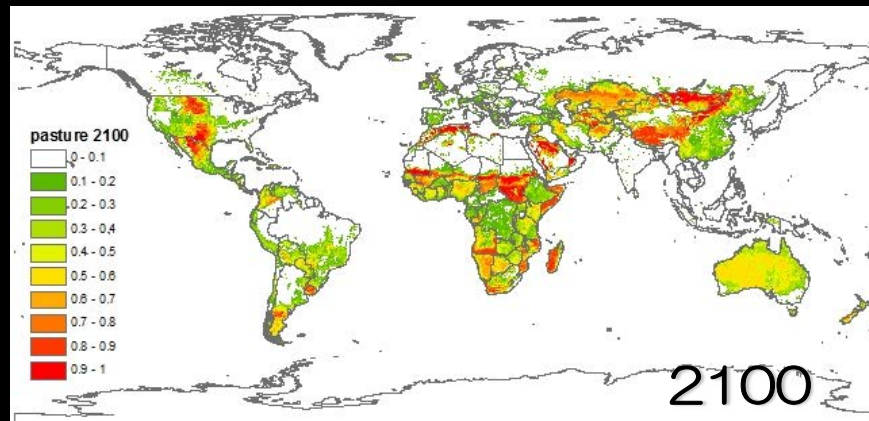
2010/2/21

Flow of RCP6.0 Analysis

2010/2/21

22
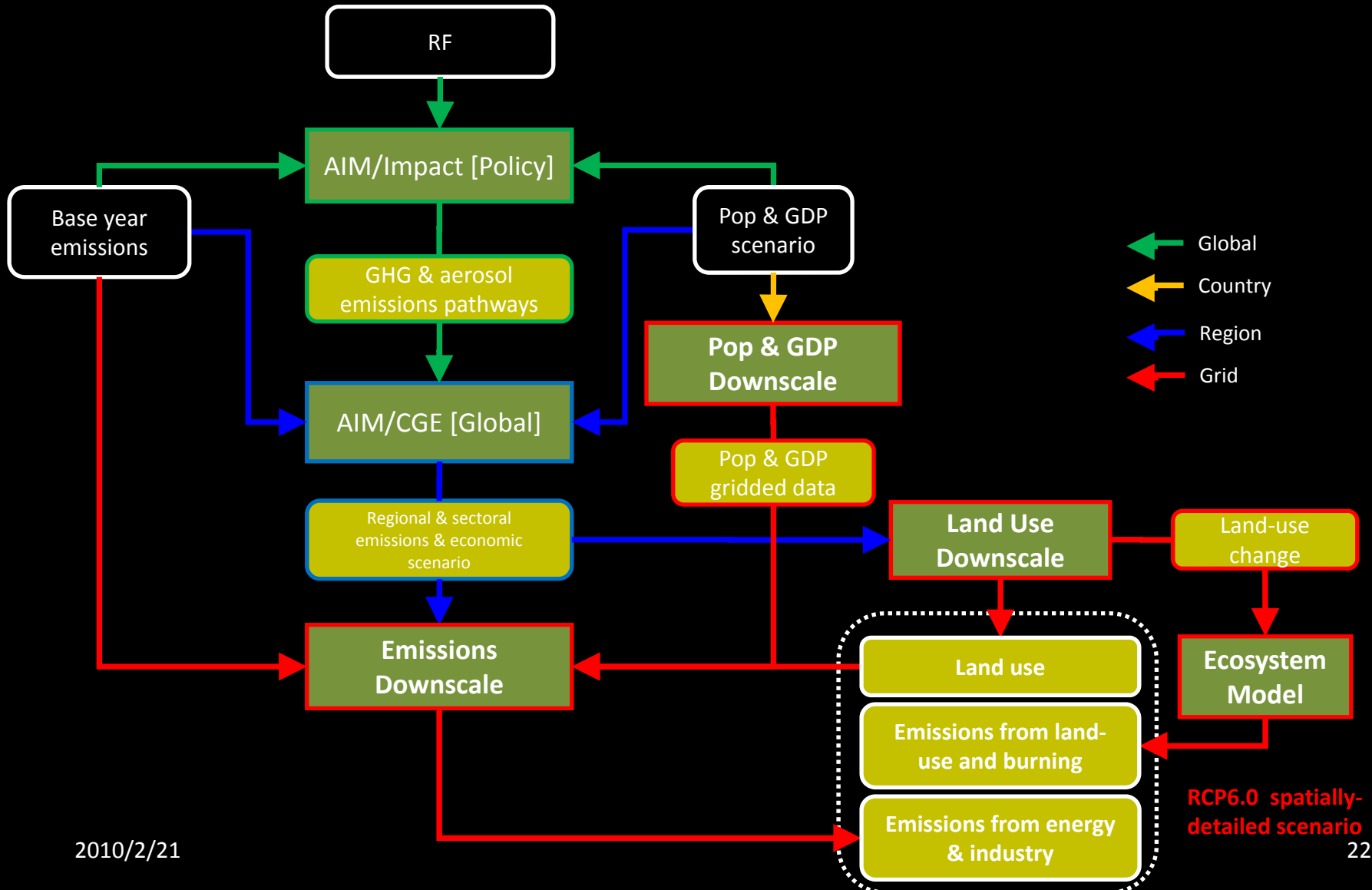
Emissions Downscaling Model

Sector	Region	Indicators
Electricity	XE15	Population
Electricity	USA	Population
…	…	…
Agriculture	XE15	Cropland
From AIM/CGE [Global]		…

AIM 24 regions

Summed up
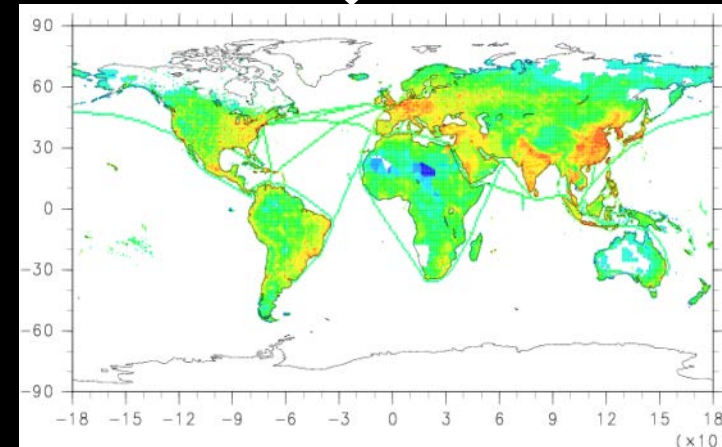
Downscaling by Indicator
- Power plant & energy conv. (POP)
- Industry: process & combustion (GDP)
- Solvent use (GDP)
- Residential & commercial (Rural POP)
- Waste (POP)
- Agriculture: waste (Cropland)

Global Distribution
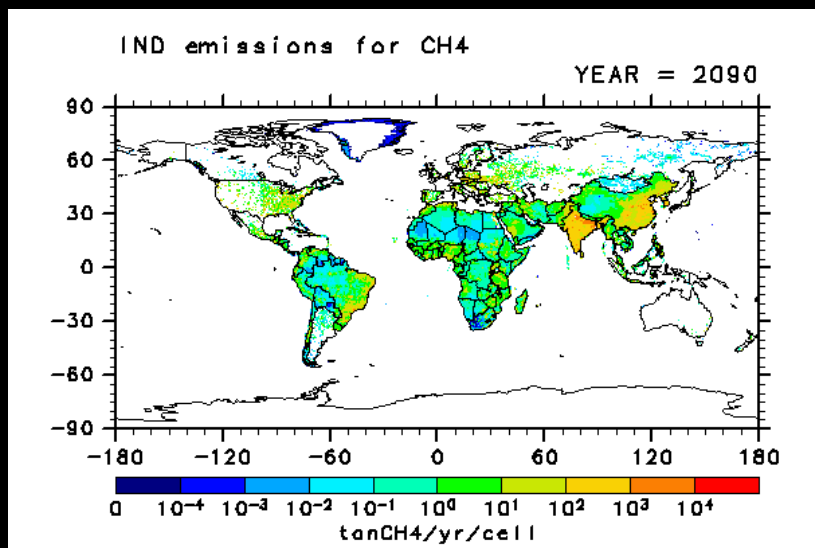- International shipping
- Aviation

Regional Distribution
- Transportation (road & railroad)
- Agriculture : Animal & Soil

Emissions Downscaling Methods

|	Method	Sector and indicator
Case 1	Changes in regional emissions are downscaled according to spatially explicit indicators for each sector and each region.	・ENE (total population) ・IND (GDP) ・SLV (GDP) ・DOM (rural population) ・WST (total population) ・AWB (cropland area)
Case 2	Global distribution at year 2000 is scaled by world total emissions.	・SHP ・AIR
Case 3	Regional distribution at year 2000 is scaled by regional total emissions for each region.	・TRA ・AGR
Case 4	Estimate with terrestrial carbon cycle model (VISIT).	・SAV ・LCF

Case 1 (CH4 from Industry)

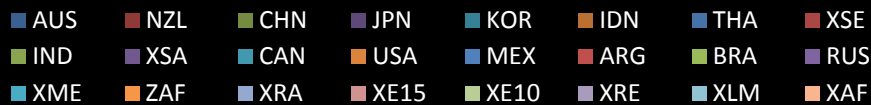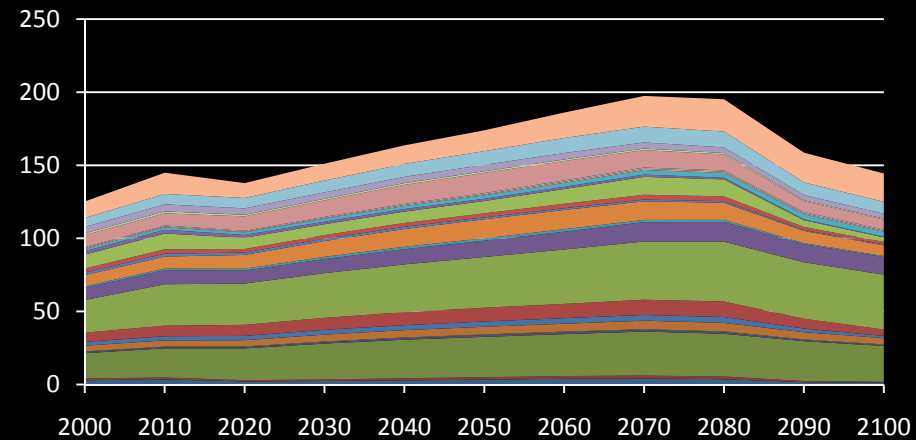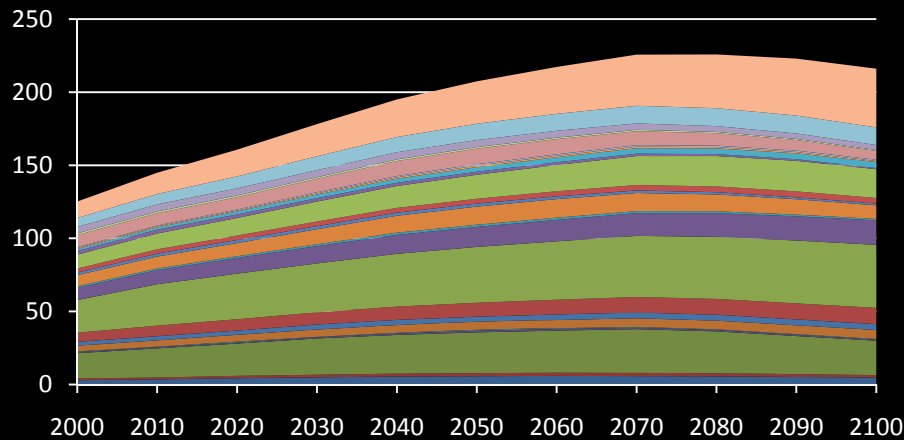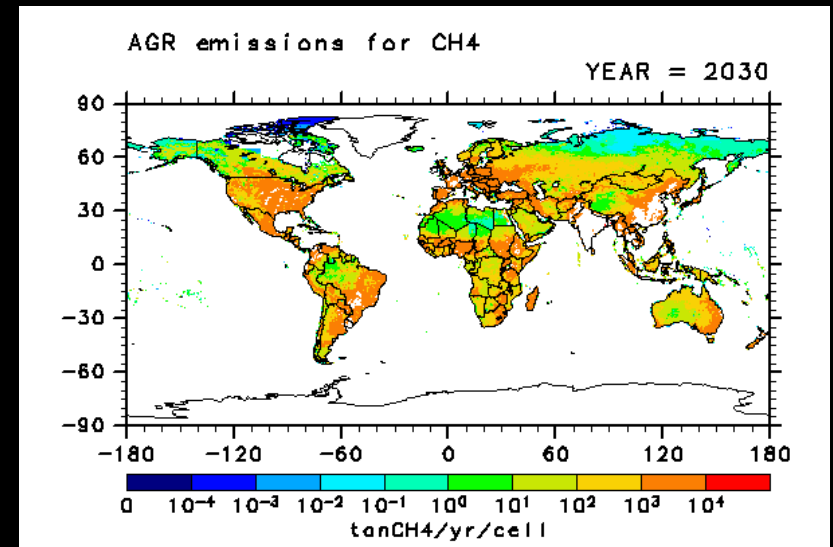Reference
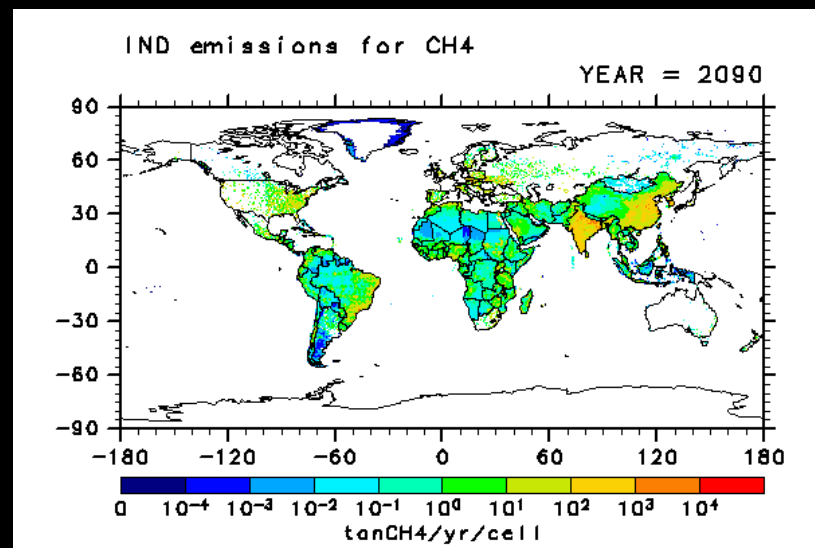
RCP6.0
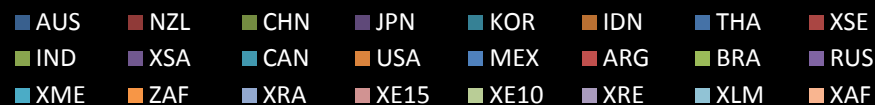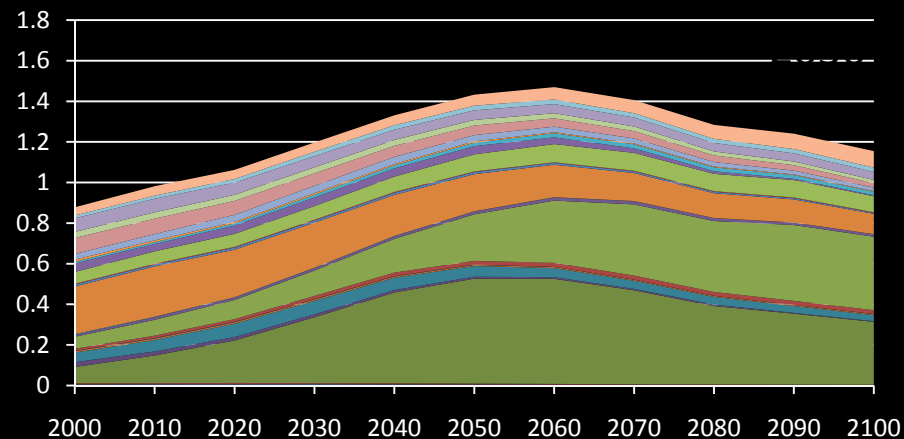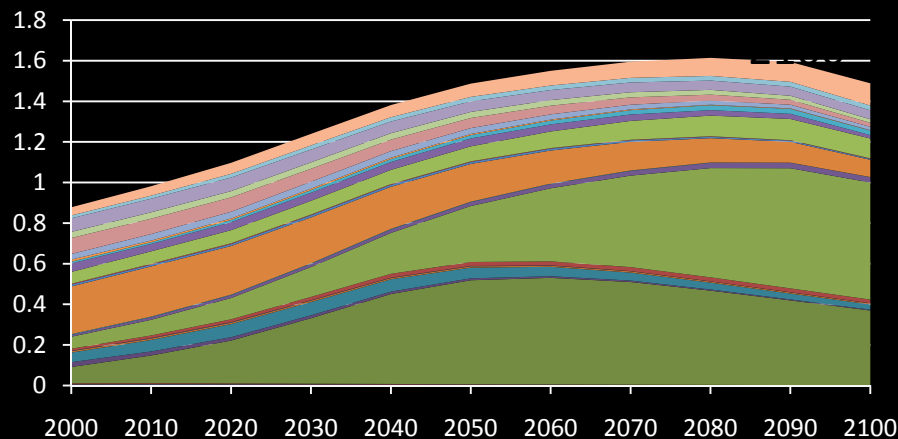
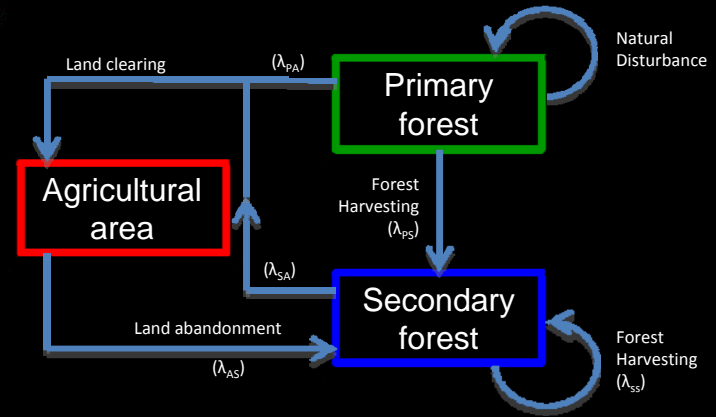# Case 2 (CH4 from International Shipping)
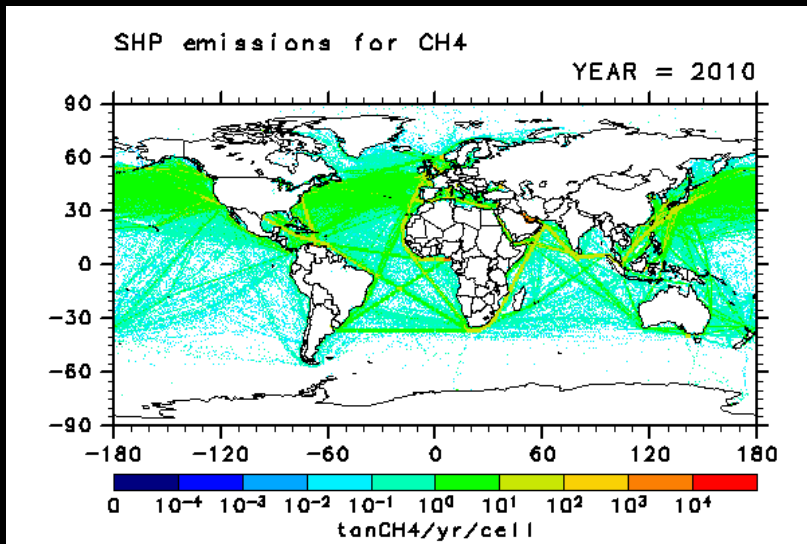
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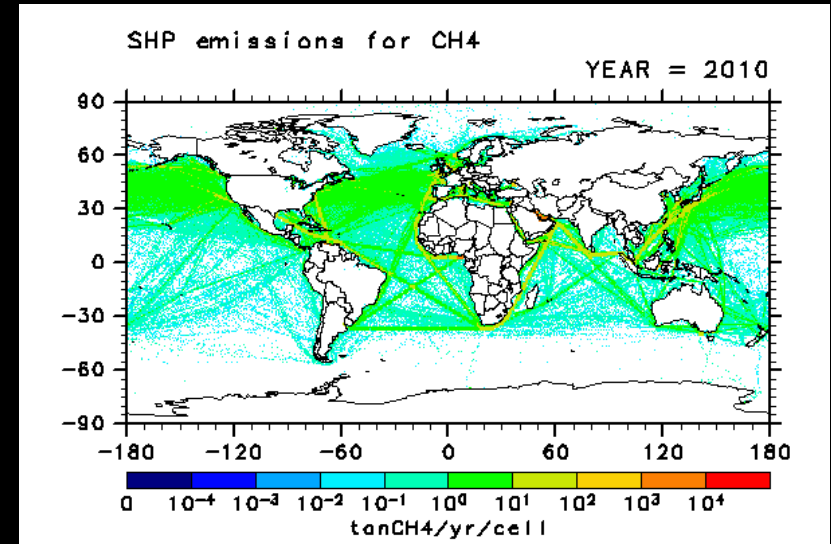
RCP6.0

Case 3 (CH4 from Agriculture)
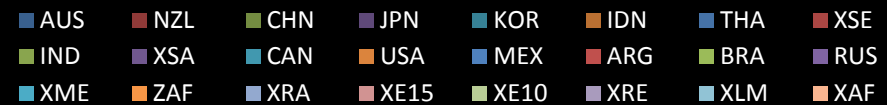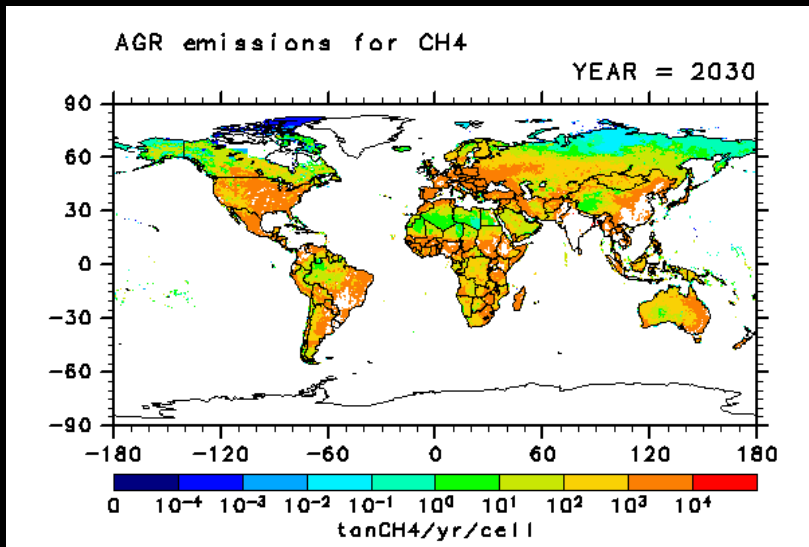
Reference

RCP6.0

Terrestrial Carbon Cycle Model (VISIT)

Land-use change

2000
- ☐ 0 - 0.1
- 🟩 0.1 - 0.2
- 🟩 0.2 - 0.3
- 🟩 0.3 - 0.4
- 🟨 0.4 - 0.5
- 🟨 0.5 - 0.6
- 🟧 0.6 - 0.7
- 🟧 0.7 - 0.8
- 🟥 0.8 - 0.9
- 🟥 0.9 - 1
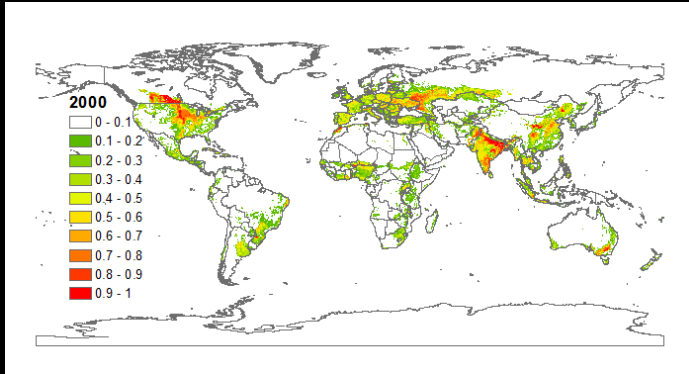
Transition matrix of Land-use change by grid (λ)

Land clearing (λ_{PA})   Primary forest   Natural Disturbance

Agricultural area

Forest Harvesting (λ_{PS})

(λ_{SA})   Secondary forest

Land abandonment (λ_{AS})   Forest Harvesting (λ_{SS})

CO2 Emissions from LUC (TgC)
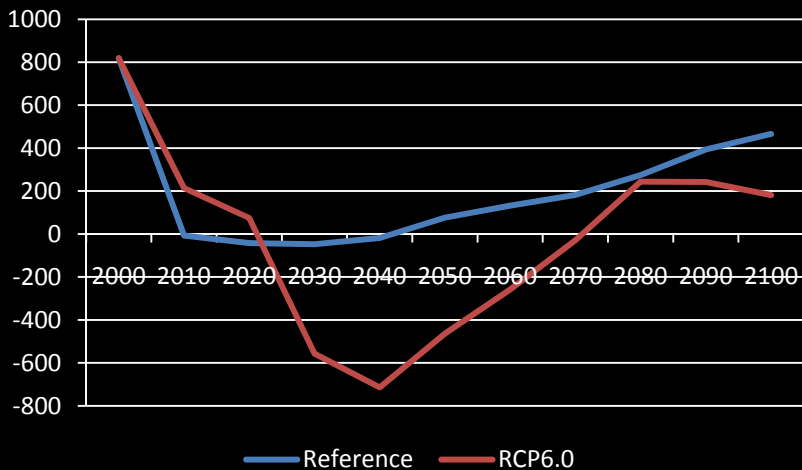
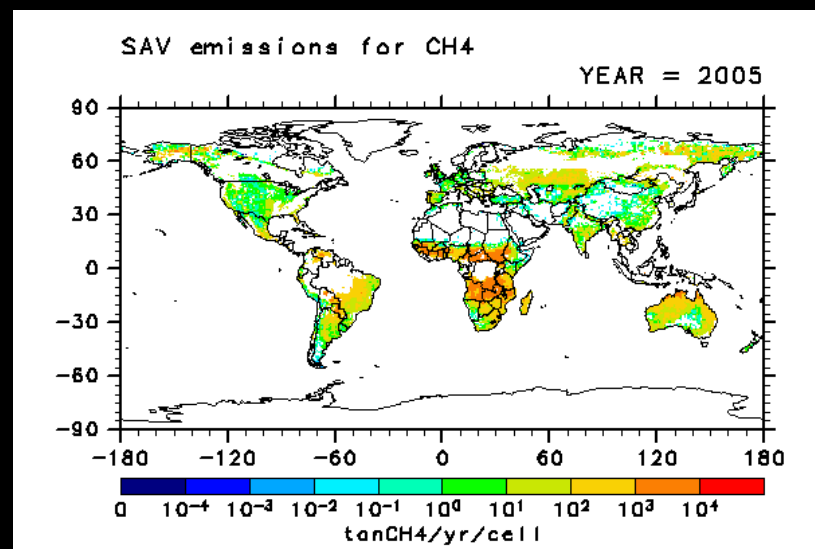Reference ——— RCP6.0

Assessing carbon cycle by TCC model using the matrix
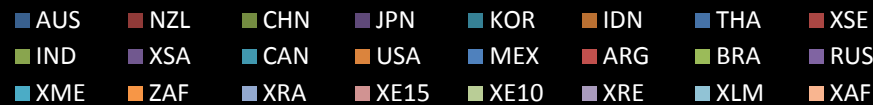
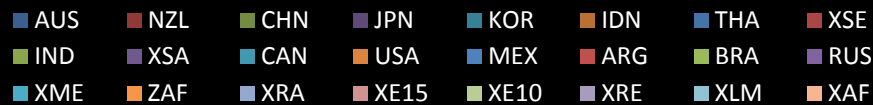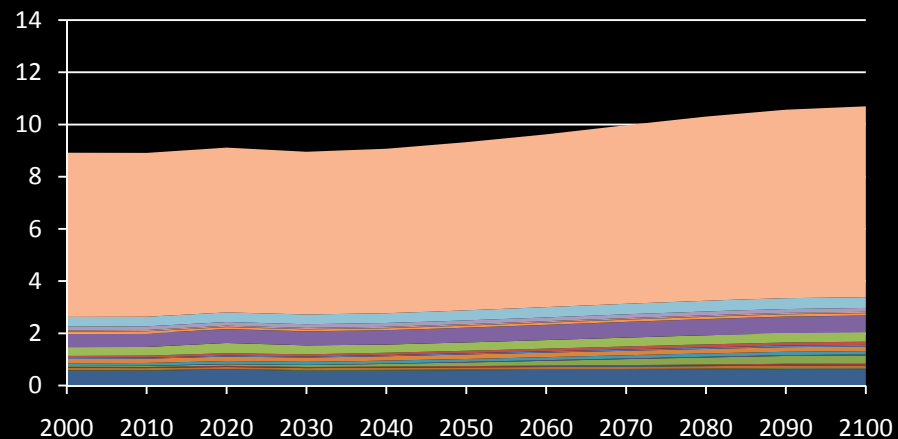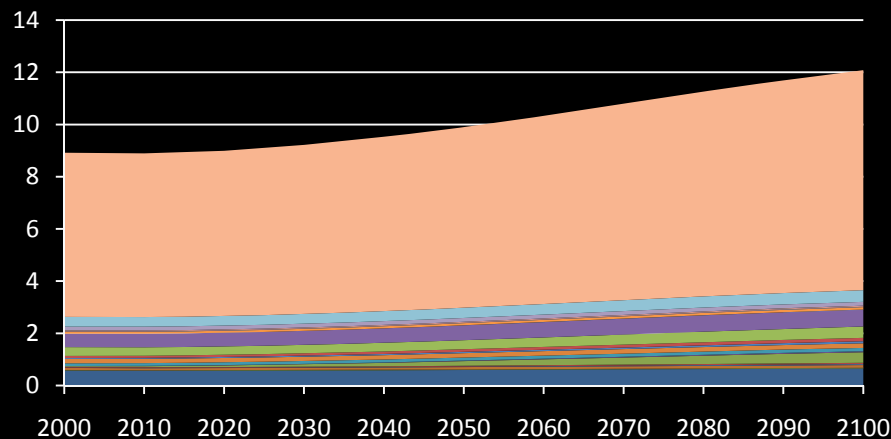2010/2/21   AIM Intl. WS@NIES   29

Case 4 (CH4 from Savanna Burning)
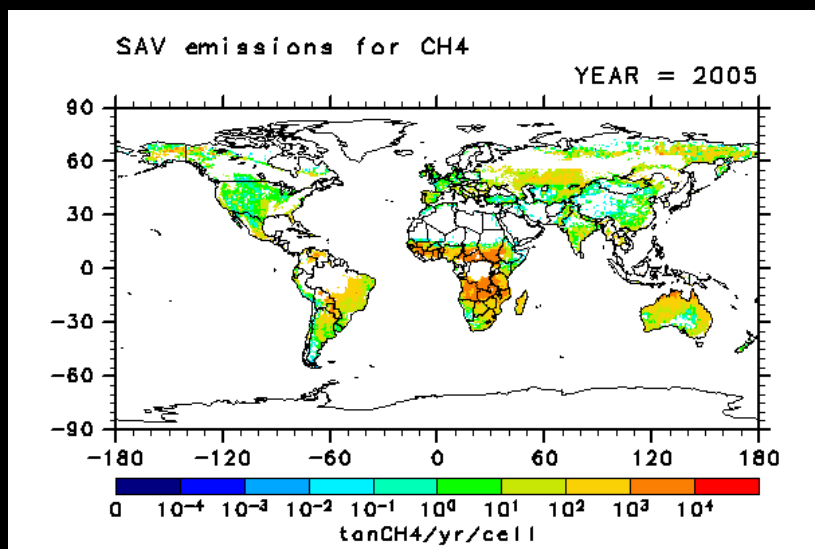
Reference

RCP6.0

Next Step

- Extension after 2100
- Development of new IAM scenarios and storylines
- Sensitivity analysis
- Coordination with IAV and CM
- Downscaling methods

etc...