Emission Pathway for 6W/m2

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Flowchart of RCP6.0

- **Radiative forcing**
- **AIM/Impact [Policy]**
- **GHG/Aerosol emission path**
- **AIM/CGE [Global]**
- **Population/GDP scenario**
- **Population/GDP Downscaling model**
- **Emission scenario [region]**
- **Emission downscaling model**
- **Landuse downscaling model**
- **Land-use change**
- **Land-cover/land-use**
- **Emission [fire, land-use change]**
- **Emission [others]**

**Base year data**

**Global**

**National**

**Region**

**Grid cell**
Results of AIM/CGE (Reference)
Results of AIM/CGE (6W/m²)

- **GDP**
  - X-axis: year (2000 to 2100)

- **Population**
  - Y-axis: million
  - X-axis: year (2000 to 2100)

- **CO2**
  - Y-axis: TgC
  - X-axis: year (2000 to 2100)
Results of AIM/CGE (Reference)

- **Primary energy**
  - Wind, Solar, Geoth., other
  - nuclear
  - coal
  - biomass
  - gas
  - oil

- **Final energy**
  - Electricity
  - Liquids
  - Solids
  - other
  - gas

The graphs show the projection of primary and final energy consumption for various energy sources and regions over the years 2000 to 2100.
Results of AIM/CGE (6W/m²)
Results of AIM/CGE (Reference)
Spatial explicit population/GDP scenario

**Data**
- UN population (UN Long range)
- UN population (UN shot range)
- UN Urbanization

**Population**
- 224 countries Population data (2000–2050)
- IIASA Population scenario
- Population rank-size rule

**GDP**
- 183 countries GDP data (2000–2100)
- 224 countries GDP data (2000–2100)
- Urban area rank-size rule
- 30 second Grid cell GDP (2000–2100)

**Data**
- IFs GDP scenario
- GTAP GDP in 2001
- Income gap
Population scenario

2000

2050

2100
Landuse downscaling model

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

Geophysical constraint
- Built-up area < 5 degree
- Forest < 20 degree etc.
Results (Land-use scenario)

Cropland
Results (Land-use scenario)

Pasture
Emission downscaling model

<table>
<thead>
<tr>
<th>Sector</th>
<th>region</th>
<th>indicator for downscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>electricity</td>
<td>Japan</td>
<td>population</td>
</tr>
<tr>
<td>electricity</td>
<td>China</td>
<td>population</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>agriculture</td>
<td>USA</td>
<td>agricultural area</td>
</tr>
</tbody>
</table>

From IAM

Downscale by indicator

Global distribution

Regional distribution

- Power plant & energy conv. (by population)
- Industry: process & combustion (by GDP)
- Solvent use (by GDP)
- Residential & commercial (by rural pop)
- Waste (by population)
- Agriculture: waste (by agriculture)

- International shipping
- Aviation
- Transportation (road & railroad)
- Agriculture: Animal & Soil
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)

$$E_s(x,y,t) = E_s(x,y,t-\Delta t) + \sum_r \left\{ e_{r,s}(t) - e_{r,s}(t-\Delta t) \right\} \times \frac{w_{r,s}(x,y,t)}{\iint w_{r,s}(x,y,t)dxdy}$$

$x$ : longitude  $y$ : latitude  $t$ : year  $r$ : region  $s$ : sector

$E_s(x,y,t)$ : gridded emissions from a sector $s$

$e_{r,s}(t)$ : regional emissions for region $r$ and for sector $s$ estimated by IAM

$w_{r,s}(x,y,t)$ : spatially explicit indicator for region $r$ and for sector $s$
Spatial explicit emission scenarios

Case 1 (Industry, NO2)

2000

2050

2100
Case 2

Global distribution at year 2000 is scaled by world total emissions. SHP & AIR

\[ E_s(x, y, t) = E_s(x, y, t_0) \times \frac{e_s(t)}{e_s(t_0)} \]

\( x \) : longitude  \( y \) : latitude  \( t \) : year  \( s \) : sector

\( E_s(x, y, t) \) : gridded emissions from a sector \( s \)

\( e_s(t) \) : global emissions for sector \( s \) estimated by IAM
Spatial explicit emission scenarios

Case 2 (International shipping, SO2)
Case 3

Regional distribution at year 2000 is scaled by regional total emissions for each region.

TRA & AGR

\[ E_s(x, y, t) = \sum_r E_{r,s}(x, y, t_0) \times \frac{e_{r,s}(t)}{e_{r,s}(t_0)} \]

\[ x : \text{longitude} \quad y : \text{latitude} \quad t : \text{year} \quad r : \text{region} \quad s : \text{sector} \]

\[ E_s(x, y, t) : \text{gridded emissions from a sector } s \]

\[ E_{r,s}(x, y, t) : \text{gridded emissions region } r \text{ and for sector } s \]

\[ e_{r,s}(t) : \text{regional emissions for region } r \text{ and for sector } s \text{ estimated by IAM} \]

\[ w_{r,s}(x, y, t) : \text{spatially explicit indicator for region } r \text{ and for sector } s \]
Spatial explicit emission scenarios

Case 3 (Agriculture, NH3)
Ecosystem model

CO2 emission by land use change

Assessing carbon cycle
Spatial explicit emission scenarios

Case 4 (savanna burning, BC)

RCP 6.0 BCe - Savanna burning (2000)

RCP 6.0 BCe - Savanna burning (2050)

RCP 6.0 BCe - Savanna burning (2100)
• Emissions from landuse change are diverse among models.

• Extension to 2300.