Introduction of IPCC WG1 AR5 and S-12 project related to short-lived climate pollutants

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Contents

- General introduction of radiative forcing and future projection on short-lived climate pollutants (SLCPs) assessed in the IPCC WG1 AR5.
- General introduction of the Environment Research and Technology Development Fund S-12.
Global mean surface air temperature in IPCC AR5

(Top) Observed global annual mean combined land and ocean surface temperature anomalies, from 1850 to 2012 from three data sets. Anomalies are relative to the mean of 1961–1990.

(Bottom) CMIP5 multi-model simulated time series from 1950 to 2100 for a change in global annual mean surface temperature relative to 1986–2005. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). Black (grey shading) is the modelled historical evolution using historical reconstructed forcings. The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as colored vertical bars. The numbers of CMIP5 models used to calculate the multi-model mean is indicated.

(IPCC WG1 AR5, 2013).
Radiative forcing assessed in IPCC AR5

<table>
<thead>
<tr>
<th>Emitted compound</th>
<th>Resulting atmospheric drivers</th>
<th>Radiative forcing by emissions and drivers</th>
<th>Level of confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO₂</strong></td>
<td>CO₂</td>
<td>1.68 [1.33 to 2.03]</td>
<td>VH</td>
</tr>
<tr>
<td><strong>CH₄</strong></td>
<td>CO₂, H₂O, O₃, CH₄</td>
<td>0.97 [0.74 to 1.20]</td>
<td>H</td>
</tr>
<tr>
<td>Halo-carbons</td>
<td>O₃, CFCs, HCFCs</td>
<td>0.18 [0.01 to 0.35]</td>
<td>H</td>
</tr>
<tr>
<td><strong>N₂O</strong></td>
<td>N₂O</td>
<td>0.17 [0.13 to 0.21]</td>
<td>VH</td>
</tr>
<tr>
<td>Anthropogenic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CO</strong></td>
<td>CO₂, CH₄, O₃</td>
<td>0.23 [0.16 to 0.30]</td>
<td>M</td>
</tr>
<tr>
<td>NMVOC</td>
<td>CO₂, CH₄, O₃</td>
<td>0.10 [0.05 to 0.15]</td>
<td>M</td>
</tr>
<tr>
<td><strong>NOₓ</strong></td>
<td>Nitrate, CH₄, O₃</td>
<td>-0.15 [-0.34 to 0.03]</td>
<td>M</td>
</tr>
<tr>
<td>Short-lived gases and aerosols</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerosols and precursors</td>
<td>Mineral dust, Sulphate, Nitrate</td>
<td>-0.27 [-0.77 to 0.23]</td>
<td>H</td>
</tr>
<tr>
<td>(Mineral dust, SO₂, NH₃, Organic carbon and Black carbon)</td>
<td>Organic carbon, Black carbon</td>
<td>-0.55 [-1.33 to -0.06]</td>
<td>L</td>
</tr>
<tr>
<td><strong>Cloud adjustments due to aerosols</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Albedo change due to land use</strong></td>
<td></td>
<td>-0.15 [-0.25 to -0.05]</td>
<td>M</td>
</tr>
<tr>
<td>Natural</td>
<td>Changes in solar irradiance</td>
<td>0.05 [0.00 to 0.10]</td>
<td>M</td>
</tr>
<tr>
<td><strong>Total anthropogenic RF relative to 1750</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td>2.29 [1.13 to 3.33]</td>
<td>H</td>
</tr>
<tr>
<td>1980</td>
<td></td>
<td>1.25 [0.64 to 1.86]</td>
<td>H</td>
</tr>
<tr>
<td>1950</td>
<td></td>
<td>0.57 [0.29 to 0.85]</td>
<td>M</td>
</tr>
</tbody>
</table>

IPCC WG1 AR5 (2013)

Toward an Integrated Approach to Co-benefits in Asia (March 6, 2013; Yokohama, Japan)
Effective radiative forcing (ERF)

Calculation Methodology
- Online or offline pair of radiative transfer calculations within one simulation

Traditional definition in past IPCC
- Difference between two offline radiative transfer calculations with prescribed surface and tropospheric conditions allowing stratospheric temperature to adjust

Effective radiative forcing
- Difference between two full coupled atmosphere-ocean model simulations

IPCC WG1 AR5 (2014)

Toward an Integrated Approach to Co-benefits in Asia (March 6, 2013; Yokohama, Japan)
Future projection of radiative forcing for SLCP

Multi-model mean radiative forcing (W m$^{-2}$) due to aerosol–radiation interaction of all anthropogenic aerosols (top left) and total ozone (bottom left) in 2030 (left each) and 2100 (right each) relative to 2000 for RCP2.6 (top each) and RCP8.5 (bottom each) based on the ACCMIP simulations. Top right shows multi-model mean effective radiative forcing (W m$^{-2}$) including both aerosol–radiation and aerosol–cloud interactions by all anthropogenic aerosols in 2030 (left) and 2100 (right) relative to 2000 for RCP8.5. Global area-weighted means are given in the upper right of each panel. (IPCC WG1 AR5, 2013)
Time series of simulated atmospheric aerosols

**BC column loading (RCP2.6)**

- Column loading (Tg)
- Time series from 1850 to 2100
- Regions: Asia, Europe, N America, S America, Oceania, Africa, Near/Middle East

**BC column loading (RCP6.0)**

- Column loading (Tg)
- Time series from 1850 to 2100

**Sulfate column loading (RCP2.6)**

- Column loading (Tg)
- Time series from 1850 to 2100

**Sulfate column loading (RCP6.0)**

- Column loading (Tg)
- Time series from 1850 to 2100

Time series of regional total mass column loadings of BC (top) and sulphate (bottom) from 1850 to 2100 for RCP2.6 (left) and 6.0 (right) simulated by SPRINTARS (Takemura, ACP, 2012).
GWP and GTP for WMGHG and SLCP

Temperature response by component for total anthropogenic emissions for a 1-year pulse (IPCC WG1 AR5, 2014).

<table>
<thead>
<tr>
<th>Species</th>
<th>GWP</th>
<th>GWP</th>
<th>GWP</th>
<th>GWP</th>
<th>GTP</th>
<th>GTP</th>
<th>GTP</th>
<th>GTP</th>
<th>GTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CH</td>
<td>104.2</td>
<td>83.9</td>
<td>48.4</td>
<td>28.5</td>
<td>99.9</td>
<td>67.5</td>
<td>14.1</td>
<td>4.3</td>
<td></td>
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<tr>
<td>N</td>
<td>246.6</td>
<td>263.7</td>
<td>275.6</td>
<td>264.8</td>
<td>253.5</td>
<td>276.9</td>
<td>281.8</td>
<td>234.2</td>
<td></td>
</tr>
<tr>
<td>BC</td>
<td>4349.2</td>
<td>2421.1</td>
<td>1139.3</td>
<td>658.6</td>
<td>2398.2</td>
<td>702.8</td>
<td>110.0</td>
<td>90.7</td>
<td></td>
</tr>
<tr>
<td>OC</td>
<td>–438.5</td>
<td>–244.1</td>
<td>–114.9</td>
<td>–66.4</td>
<td>–241.8</td>
<td>–70.9</td>
<td>–11.1</td>
<td>–9.1</td>
<td></td>
</tr>
<tr>
<td>SO</td>
<td>–253.5</td>
<td>–141.1</td>
<td>–66.4</td>
<td>–38.4</td>
<td>–139.6</td>
<td>–40.9</td>
<td>–6.4</td>
<td>–5.3</td>
<td></td>
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<tr>
<td>NOx</td>
<td>134.2</td>
<td>16.7</td>
<td>–15.6</td>
<td>–10.8</td>
<td>2.8</td>
<td>–86.3</td>
<td>–27.8</td>
<td>–2.8</td>
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</tr>
<tr>
<td>CO</td>
<td>8.6</td>
<td>5.9</td>
<td>3.2</td>
<td>1.9</td>
<td>6.8</td>
<td>3.7</td>
<td>0.7</td>
<td>0.3</td>
<td></td>
</tr>
</tbody>
</table>

Toward an Integrated Approach to Co-benefits in Asia  (March 6, 2013; Yokohama, Japan)
Confidence level of the forcing mechanisms in the 4 last IPCC assessments. In the previous IPCC assessments the level of scientific understanding (LOSU) has been adopted instead of confidence level, but for comparison with previous IPCC assessments the LOSU is converted approximately to confidence level. The thickness of the bars represents the relative magnitude of the current forcing (with a minimum value for clarity of presentation) (IPCC WG1 AR5, 2014).

Toward an Integrated Approach to Co-benefits in Asia (March 6, 2013; Yokohama, Japan)
Promotion of measures on climate change by assessing environmental impact and searching reduction path of SLCPs

**Theme 1**
Construction of structural analysis and evaluation system for cases of air quality change

**Theme 2**
Improvements of integrated assessment models and quantification of future scenarios

**Theme 3**
Assessment of climate-environment and impacts by numerical models

**Theme 4**: Integrated operational system (toolkits & data archive)

policymakers, stakeholders, science communities, general communities

Toward an Integrated Approach to Co-benefits in Asia (March 6, 2013; Yokohama, Japan)
Members and expected outcome

**Theme 1**: Construction of structural analysis and evaluation system for cases of air quality change
1) National Institute for Environmental Studies
2) Asia Center for Air Pollution Research
3) Meteorological Research Institute

**Theme 2**: Improvements of integrated assessment models and quantification of future scenarios
1) National Institute for Environmental Studies
2) Mizuho Information & Research Institute
3) Kyoto University

**Theme 3**: Assessment of climate-environment and impacts by numerical models
1) Kyushu University
2) Nagoya University
3) Kyoto University
4) Ibaraki University
5) JAMSTEC
6) Kinki University

- Needs for government
  - Elucidating effects on SLCP measures
  - Promotion of measures on climate change considering co-benefit
  - Contributions to the IPCC Assessment Reports and Climate and Clean Air Coalition (CCAC)

- Proposal on reduction path of SLCPs in Asia from science

- Suggestion to revise existing policies on climate change and SLCPs from science
  - Targets of reducing WMGHG emissions
  - Regulations of WMGHG/SLCP emissions, etc.

- Development of integrated assessment system for reducing WMGHGs/SLCPs
  - e.g., US-EPA toolkit for governmental administrators

- Other contributions
  - UNEP/ABC, UNFCCC, EANET, etc.
  - Information toward meetings of Ministers for Environment and working groups for PM2.5 and photochemical oxidants
Key messages

• Assessment on short-lived climate pollutants (SLCPs) in the IPCC WG1 AR5.
  ‣ Confidence level of assessment of radiative forcing is high for tropospheric ozone and the aerosol-radiation interaction, while it is still low for the aerosol-cloud interaction.
  ‣ Radiative forcing of black carbon should continue to be assessed with changes in other aerosol species.
  ‣ Future regional atmospheric loading and radiative forcing of aerosols and ozone much depend on scenarios.
  ‣ New definition of “effective radiative forcing” has been adopted.

• Environment Research and Technology Development Fund S-12 will quantitatively assesses climate change and environmental impacts by SLCPs and develops integrated system for searching suitable paths toward reducing WMGHGs/SLCPs basically from scientific approaches.

Acknowledgements

• MIROC (AORI/NIES/JAMSTEC GCM) developing group
• NIES supercomputer system (NEC SX-8R/9A)
• Funding Program for Next Generation World-Leading Researchers in Japan (GR079)