The ScenarioMIP Process: Deliveries to CMIP6

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Scenarios of key importance as connection between research communities

Facilitates large research community by:
- Providing input to scientific papers (comparability)
- Enabling synthesis → assessment report

WG2 Community:
*Scenarios provide insight into... socio-economic development (vulnerability) and climate change (impacts)*

WG3 Community:
*Scenarios provide insight into... socio-economic development, emissions, climate targets in order to determine mitigation effort*

Updates needed:
- new insights into historic/near term forcers.
- new requirements models
- new questions

WG1 community –
*Scenario provide insight into... plausible development of forcers and plausible climate futures*
Set-up of CMIP6 (scenario work WG1 models)
From IAM to ESM

IAM

Historical Land-use
- Gridded
- UML database

Future land-use

Historical Emissions
- Gridded
- CEDS database

Future Emissions

Emission Harmonisation & downscaling

Historical conc.
- Gridded/global

Future conc.

MAGICC

O3

O3 forcing

BC/OC tool

Aerosol forcing

Energy system
Agriculture
Land use
Emissions
Climate
Gridded/regional
IAMC database

Started 2012
Finished 2017

Started 2017
Finished 2018

Started 2019
Finished 202x
Translating land use

Gridded land use, land cover, land management

Harmonisation Anomaly method Attribute changes in IAM data to LUH2 grid finding nearest available cell

Gridded land use, land cover, land management

IAM

LUH2

ESM
So what could possibly go wrong?

Unfortunately...

Lost in translation (IAM $\rightarrow$ LUH2)
Lost in translation (LUH2 $\rightarrow$ ESM)
Not translated
Other possible mismatch
The ScenarioMIP Process: Deliveries to CMIP6

Matthew Gidden, Maarten van den Berg, Keywan Riahi, Detlef van Vuuren, Michaela Hegglin, Malte Meinshausen, Till Kuhlbrodt, Ralf Doscher, and many others

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The CMI P6 Context

CMIP6 MIPs
- C4MIP
- GeoMIP
- ISIMIP6
- RFRMIP
- AerChemMIP
  - Low NTCF Ensemble
- LUMIP
- ViACS AB
- CORDEX
- GeoMIP
- DAMIP
- DCPP

CMIIP6 Matrix

Shared Socioeconomic Pathways
(Rich et al., 2017)

Climate Scenarios

Radiative Forcing in 2018

O’Neill et al., 2016
Hodges et al., 2018

Gridded Scenarios of Land Use and Land Use Change
Hart et al., 2016

Harmonization with ameis (Gidden et al., 2018)

Before
After

Radiative Forcing Calculated with MAGICC

History
Harmonization Year
Future

Downscaling to Countries

Gridding (Feng et al., 2018)

Additional Data,
- E.g.,
- VIC Simulation
- Some Calculations
- Etc.

CEDS Historical Data
Anthropogenic
Hosely et al., 2017
Land Use
Van Marie et al., 2017
Harmonization of Scenarios

A methodology and implementation of automated emissions harmonization for use in Integrated Assessment Models

Matthew J. Gidden a, R. Fujimori b, A. Maarten van den Berg c, D. Klein d, S. J. Smith d, D. P. van Vuuren e, K. Riahi b

Global CH4 emissions

Tetrafluoromethane (CF₄) a
Methane (CH₄)
Carbon Dioxide (CO₂) e
Carbon Monoxide (CO)
Hydrofluorocarbons (HFCs) a
Nitrous Oxide (N₂O) a
Ammonia (NH₃)
Nitrogen Oxides (NOₓ)
Organic Carbon (OC)
Sulfur Hexafluoride (SF₆) a
Sulfur Oxides (SOₓ)
Volatile Organic Compounds (VOCs)

Aircraft a
Energy Sector
Forest Burning
Grassland Burning
Industrial Sector
International Shipping a
Residential Commercial
Solvents Production and Transportation Sector
Waste

a Global total trajectories are harmonized due to lack of detailed historical data.

b Global sectoral trajectories are harmonized due to lack of detailed historical data.

c A global trajectory for land-use CO₂ is used; non-land-use sectors are region-specific.
Downscaling Results for ESMs

Downscaling

- IAM emissions (native IAM regions)
- Historical emissions (base year)
- AFOLU emissions
- Energy-related emissions
- GDP
- Population

Gridding

- Linear downscaling
- Downscaled emissions (by country)
- IPAT downscaling*

Reformatting, separation

Gridded anthropogenic emissions
Gridded open burning emissions
Gridded aircraft emissions

0.5°, CF-compliant NetCDF files


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Concentrations and Extensions

- Concentration fields provided by M. Meinshausen & Z. Nicholls
- Includes seasonality and extensions to 2500
- Publication expected early next year

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Ozone & Nitrogen Deposition Fields

Main characteristics

Based on two fully interactive chemistry-climate models
Futures scenarios used: SSP1-26, SSP2-45, SSP3-70, SSP5-85

Notes / Issues

• (+) CMIP6 ozone in the past and future are deemed more realistic than in CMIP5 (ACCMIP/SPARC)
• (-) Present day too little ozone depletion in the NH

Figure: Seasonal evolution of total column ozone in the 2000s from the new CMIP6 database.

Main characteristics

Based on NCAR CAM-Chem, a fully interactive CCM

Notes / Issues

• Historical database was based on CMIP5 emissions
• Merging with CMIP6-based future emissions (SSPs) needs scaling of variability and mean

Figure: Timeseries of global mean NHx dry deposition for database based on CMIP5 (black/red, official CMIP6 database!) and CMIP6 (yellow/grey, offset by 1E-12).
### Summary of Deliverables

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Tier 1</th>
<th>Tier 2 – 1.9/OS</th>
<th>Tier 2 - Others</th>
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<tbody>
<tr>
<td>Harmonized Emissions</td>
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<td>Gridded Emissions</td>
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<tr>
<td>Gridded Landuse</td>
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<td>![In Process]</td>
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<td>Concentrations &amp; Extensions</td>
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<tr>
<td>Ozone &amp; Nitrogen</td>
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</table>

- **Available**
- **In Process**
- **Not Planned**
Thank you!

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