Some observations on Simple Climate Models

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Sevilla
1.5 Special Report with MAGICC and FAIR

The summary assessment is that both models exhibit plausible temperature responses to emissions. It is too premature to say that either model may be biased. As MAGICC is more established in the literature than FAIR, the veracity of these reduced complexity climate models is a substantial knowledge gap in the overall assessment of pathways and their temperature thresholds.

The differences between FAIR and MAGICC have a substantial effect on their remaining carbon budgets (see IPCC SR1.5 2.SM Mitigation pathways compatible with 1.5°C in the context of sustainable development – Supplementary Material).
What is the easiest way below 1.5°C? Update your climate model...

The IPCC Special Report on 1.5°C #SR15 uses MAGICC & FAIR to estimate temperatures, but scenarios are grouped with MAGICC.

Regroup with FAIR & temperatures are about 0.25°C lower, & 1.5°C much easier...
MAGICC6

- Core model in IPCC reports, default climate model in IAM scenario databases, many publications and projects using it
- Developed at Uni Melbourne (M. Meinshausen, Z. Nicholls, external contributors)
- Proprietary license and contributor agreement
- CC-BY-NC-SA MAGICC6 Windows binary available
- Written in Fortran, ~15,000 lines
- Runtime: 0.3 – 1.0s
- Tests and Continuous Integration with Python
MAGICC6

- Very long development history:
- MAGICC4 (IPCC TAR and AR4)
- MAGICC7 planned to be released in 2019
Hector

- Developed at Pacific Northwest National Laboratory (PNNL)
- Open Source on GitHub, GPL license
- Written in C++, ~10,000 lines of code
- Runtime: < 0.1 s
- Hartin et al. (2015) A simple object-oriented and open-source model for scientific and policy analyses of the global climate system – Hector v1.0
Active development on GitHub:

9 contributors

10 releases since 2014
FAIR

- Finite Amplitude Impulse-Response simple climate-carbon-cycle model
- Pure Python implementation
- ~1.800 lines of code
- Run time: < 0.1s
- Under active development (13 releases since 2017)
- Open Source on Github, Apache License
AR5 CMIP5 Ensemble – Reference period 1986 - 2005

Scenario: RCP26
CMIP5 Ensemble
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1986 - 2005

Temperature (°C)

0.0
0.5
1.0
1.5
2.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0

1900 1950 2000 2050 2100

CMIP5 median
Scenario: RCP26
CMIP5 Ensemble and MAGICC6 (Default config)
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1861 - 1890
FAIR and CMIP5 Ensemble

Scenario: RCP26
CMIP5 Ensemble and FAIR (Default config)
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1861 - 1890

Temperature change from 1861-1890 to 2100.
Scenario: RCP26
CMIP5 Ensemble and Hector 2.0 (Default config)
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1861 - 1890
SCMs (in default config) and CMIP5 Ensemble – Ref. Period 1861 - 1890

Scenario: RCP26
CMIP5 Ensemble and SCMs (Default config)
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1861 - 1890
SCMs (in default config) and CMIP5 Ensemble – Ref. Period 1986 - 2005

Scenario: RCP26
CMIP5 Ensemble and SCMs (Default config)
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1986 - 2005

Hawkins & Sutton (2016), American Meteorological Society
FAIR’s default gets warmer with new releases
FAIR 1.3.4 with different ECS and TCR values from AR5 CMIP5 ensemble

Scenario: RCP26
FAIR Default Config, ECS/TCR varied
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1861 - 1890

Temperature change over time with different ECS and TCR values for FAIR 1.3.4 simulations.
Probabilistic MAGICC 600 run: RCP26

MAGICC6 600-run (live.magicc.org)
Scenario: RCP26
AR5 WG1 CMIP5 Ensemble (32 models)
Reference period: 1986 - 2005
Probabilistic MAGICC 600 run: RCP85

MAGICC6 600-run (live.magicc.org)
Scenario: RCP85
AR5 WG1 CMIP5 Ensemble (39 models)
Reference period: 1986 - 2005
Probabilistic tuning availability

- MAGICC6: widely used, but not publicly available
- MAGICC7: work has started
- FAIR: ensemble used in SR15
- Hector: probabilistic setup on GitHub
Reproducibility & Comparability

- Full scenario input
- Full parameter sets
- Testing of influence of reference periods
- Calibration sources (e.g. temperature observations)
- Version used
  - Open Source Code or
  - Archived and versioned binary
OpenSCM
https://github.com/openclimatedata/openscm/

Unified interface to Simple Climate Models
- command line interface
- direct coupling to IAMs

Under development …
If there is some functionality you want, please make an issue on GitHub
Questions or comments ...

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