Model emulation/simple models/reduced complexity model

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Outline

1. Applications of emulators

2. Where to next?

Applications of emulators

- Attribution of present-day warming by emissions (e.g. IPCC AR6 WG1 Fig SPM.2)
- Attribution of future warming (e.g. IPCC AR6 WG1 Fig SPM.4)
- Projections of sea level rise to 2300 (e.g. IPCC AR6 WG1 Fig SPM.8)
- Projections of future warming, especially post-2100 (e.g. IPCC AR6 WG1 Ch. 4)
- Integrators of knowledge (IPCC AR6 cross working group effort)
- and others…

COP26 session: https://www.youtube.com/watch?v=0LE0CqnaEcE

Applications of emulators - integrators of knowledge

- IPCC WG1 assesses multiple aspects of the climate system

Emulator		Assessed ranges		
Assessed range		Lower	Central	Upper
Key metrics				
ECS (°C)		2.00	3.00	
TCRE (°C per 1000 GtC)**		1.00	1.65	2.30
TCR (°C)		1.20	1.80	2.40
Historical warming and Effective Radiative Forcing				
GSAT warming (°C)	1995-2014 relative to 1850-1900	0.67	0.85	0.98
Ocean heat content change (ZJ)*	1971-2018	329	396	463

IPCC AR6 WG1 Table 7.SM.4

Applications of emulators - integrators of knowledge

- IPCC WG1 assesses multiple aspects of the climate system
- Emulators can capture all of these well simultaneously and make projections for arbitrary emissions scenarios

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Applications of emulators - integrators of knowledge

"MAGICC7 and FaIRv1.6.2 emission based emulators are able to represent the WGI assessment to within small differences (defined here as within typical rounding precisions of ±5% for central estimates and ±10% for ranges) across more than 80% of metric ranges"

Emulator		Assessed ranges			CICERO-SCM			FaIRv1.6.2			MAGICC7			OSCARv3.1.1		
Assessed range		Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
Key metrics																
ECS (°C)		2.00	3.00			3.05	4.09	2.05	2.95	5.07	1.93	2.97	4.83	1.84	2.54	3.90
TCRE (°C per 1000 GtC)**		1.00	1.65	2.30				1.29	1.53	1.82	1.37	1.73	2.19	1.50	1.52	1.83
TCR (°C)		1.20	1.80	2.40	1.38	1.71	2.32	1.36	1.81	2.46	1.27	1.88	2.61	1.51	1.82	2.05
Historical warming and Effective Radiative Forcing																
GSAT warming (°C)	1995-2014 relative to 1850-1900	0.67	0.85	0.98	0.68	0.85	0.98	0.72	0.87	1.02	0.72	0.86	0.97	0.67	0.78	0.98
Ocean heat content change (ZJ)*	1971-2018	329	396	463	250	288	329	346	381	423	325	382	436	174	243	508

IPCC AR6 WG1 Table 7.SM.4

Applications of emulators - integrators of knowledge

Probabilistic calibrations then allow assessment of global-mean warming of arbitrary emissions scenarios in line with WG1 science

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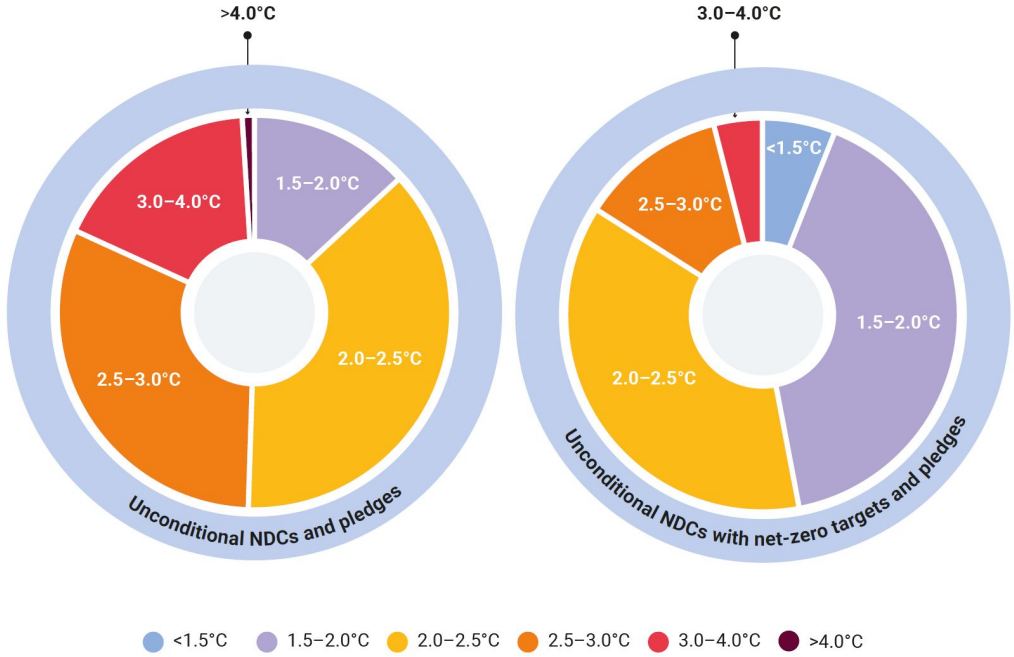
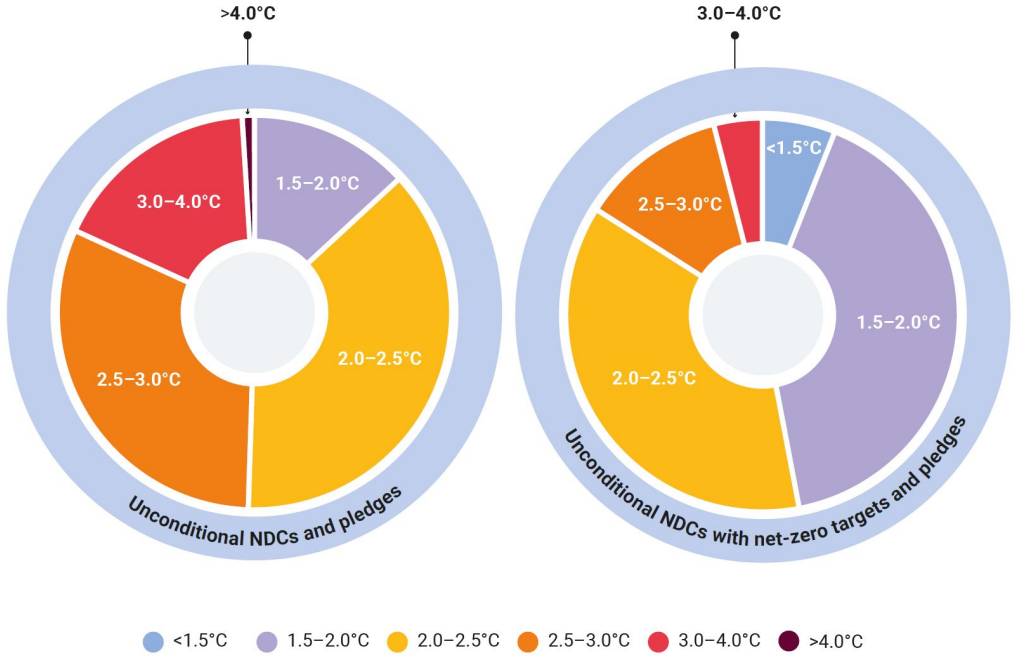


Source: UNEP Emissions Gap Report 2021

Applications of emulators - integrators of knowledge

Probabilistic calibrations then allow assessment of global-mean warming of arbitrary emissions scenarios in line with WG1 science (try it out at live.magicc.org)



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Emulation that starts with emissions but goes beyond global-mean temperature, e.g. to global- or regional-mean precipitation, ice sheets or regional extreme temperatures.

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- SCENGEN (https://www.cgd.ucar.edu/cas/wigley/magicc/)
- Rasmussen et al. 2016 (https://doi.org/10.1175/JAMC-D-15-0302.1)
- MESMER-MAGICC (Beusch et al., GMD 2022, https://doi.org/10.5194/gmd-15-2085-2022)

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Key considerations:

a) Validation
b) How do these downstream interactions link (or not) with other constraining/calibration
c) How many models/teams?