#### Climate and Earth System Change at Different Levels of Global Mean Warming

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UKESM

#### **CMIP6** ScenarioMIP: Shared Socio-economic Pathways (SSPs) Α of range

- CMIP6 : Sixth Coupled Model **Intercomparison Project**
- 23 MIPS, 33 modeling groups and 16 countries.
- Evaluate how well models simulate recent past
- Provide projections for future climate change
- One of society's most robust and reliable source of climate information.

socio-economic, technological and geopolitical futures that are each associated with a future emission and land use scenario.

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Socio-economic challenges for adaptation





## The UKESM1 CMIP6 ScenarioMIP ensemble

Scenario	Socio-economic future	TOA radiative forcing at 2100	UKESM members	Simulation length
piControl	pre-industrial	0.0Wm-2	1	1400 years
Historical	Observed	N/A	19	1850-2014
ssp1-19	Sustainability	1.9 Wm <sup>-2</sup>	5	2015-2100
ssp2-16	Middle of the road	2.6 Wm <sup>-2</sup>	12	2015-2100
ssp2-45	Middle of the road	4.5 Wm <sup>-2</sup>	5	2015-2100
ssp3-70	Regional rivalry	7.0 Wm <sup>-2</sup>	12	2015-2100
ssp5-85	Fossil fuel Dev.	8.5 Wm <sup>-2</sup>	5	2015-2100
ssp4-34	Inequality	3.4 Wm <sup>-2</sup>	5	2015-2100
ssp5-34-OS	Fossil Fuel + overshoot mitigation	3.4 Wm <sup>-2</sup> follows ssp5-85 to 2040	5	2015-2100



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## **Global Warming Thresholds**

In addition to analysing the temporal evolution of climate change, we can also ask:

- How will the climate & Earth system look at different levels of global mean warming ?
- ❑ What regional changes (and associated impacts) might be avoided if global warming is limited to X°C instead of Y°C?
- Analyse changes in the coupled Earth system at different levels of global warming; using the UKESM1 and the scenarioMIP multi-model ensemble

We identify the year a UKESM1 simulation exceeds a global warming threshold (GWT) relative to it's own 1850-1900 climate and using 21 year centred mean climate states.





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## Year of Threshold Exceedance









#### Zonal Analysis : Land vs Ocean Warming



Annual Surface Temperature Zonal Anomalies for ssp3-7.0 at different thresholds.

#### Significant Arctic Amplification.

Ratio of Land vs Ocean Warming

Land warms ~50% more.

Maximinum difference in the subtropics.





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#### Spatial seasonal patterns of surface warming at $GWT = 2^{\circ}C$ and $GWT = 4^{\circ}C$







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# Spatial Patterns of Precipitation



#### Summary and Next Steps

- Establish the significance of changes compared to internal (natural) variability
- Sensitivity of changes per GWT to different SSP pathways.
- Extend to other variables; e.g. precipitation minus evaporation, soil moisture
- Extend to higher time frequencies; *e.g. heatwaves, droughts, extreme rainfall, wind storms etc*
- Extend to impacts-relevant metrics; *e.g. drought duration, water availability, warm/humid nights etc*
- Focus on sensitive regions; *e.g. Mediterranean, Amazon, Northern latitudes, monsoon systems*.
- Consider co-variability of changes/impacts across the coupled Earth system; e.g. heatwaves/droughts & changes in vegetation, carbon uptake, air quality (all interactive in UKESM1)
- Expand to marine changes and associated impacts
- Expand to use the CMIP6 multi-model ensemble

