

# Challenges of Climate Modelling: AR6

June-Yi Lee, IBS Center for Climate Physics **Baylor Fox-Kemper, Brown University** 

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SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis



In AR6, important roles played by (especially in process/regional chps): CMIP6 Other Models

1) Deck--notable for ECS/TCR vs. CMIP5

2) Scenarios

3) HighResMIP

4) PMIP

5) other MIPs

1) Emulators

2) Reanalysis

3) CORDEX, RCMs

4) Other Regional/Process Models, e.g.,

**GlacierMIP** 

**ISMIP6** 

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Sea Surface Temperature (SST) and its changes with time.

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## Sea Surface Temperature (SST) Anomalies and Maps

Observation-based estimates and CMIP6 multi-model means, biases and projected changes

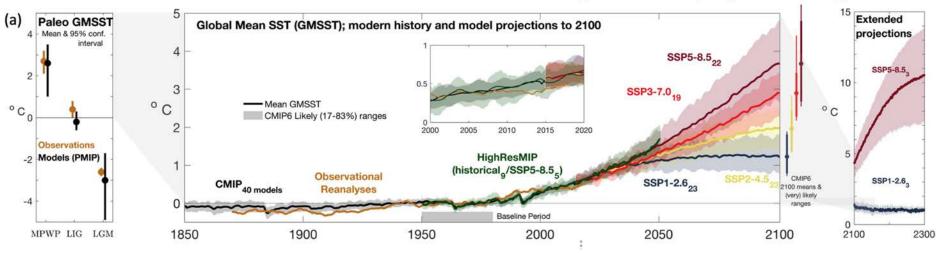


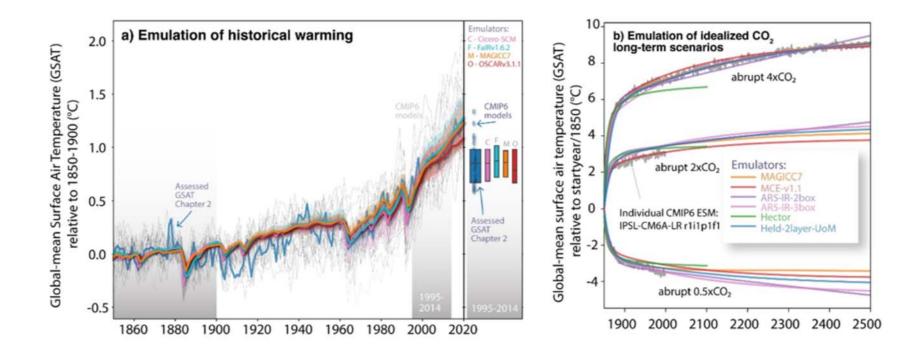
Fig 9.6: Reanalysis, CMIP6, HighResMIP, PMIP, Extended

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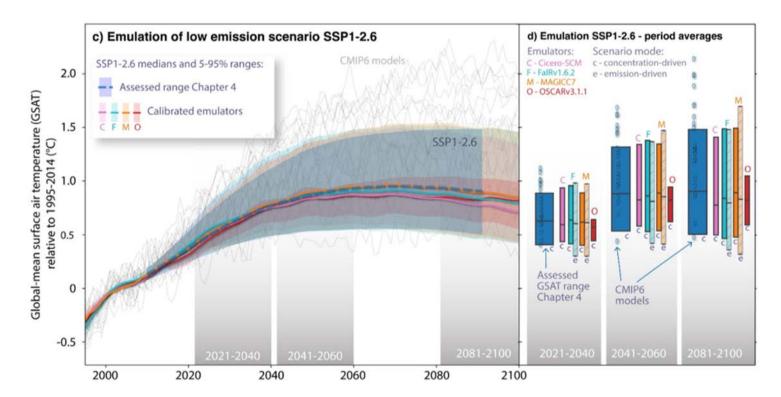
Cross-Chapter Box 7.1, Fig 1: CMIP6, Historical, Deck, Emulators

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**Cross-Chapter Box 7.1, Fig 1: CMIP6, Scenarios, Emulators** 

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#### Antarctic Ice Sheet Cumulative Mass Change & Equivalent Sea Level Contribution

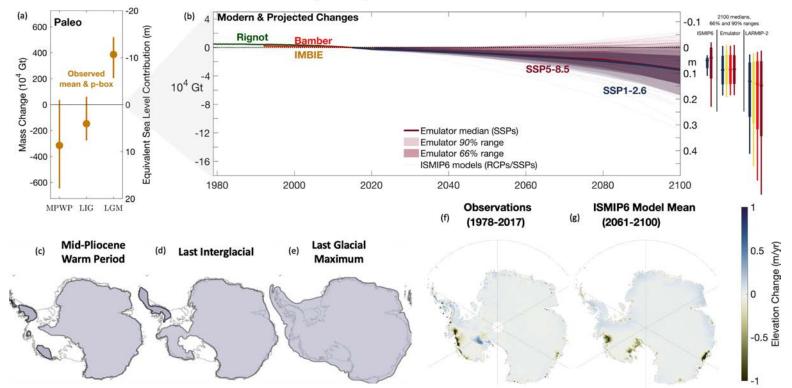


Fig 9.19: CMIP6, ISMIP6, Scenarios, Emulators, PMIP

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centuries  $O\Delta$ ABL: Atmospheric boundary layer **Hi-res GCMs** PDV, AMV GCMs AMV: Atlantic Multidecadal Variability CAT: Clear air turbulence decades CRMs: Convection resolving models **RCMs** QBO ENSO: El Niño-Southern Oscillation LES: Large Eddy Simulation ENSO MCS: Mesoscale convective system years Monsoon MJO: Madden-Julian oscillation **Planetary** PDV: Pacific Decadal Variability waves QBO: Quasi-biennial Oscillation OLM Blockings Tropical Baroclinic waves months TC: Tropical cyclone TC UC: Urban canopy OA Fronts waves weeks ∧ CH1−CH9 Polar CRMs O CH10-CH12, Atlas Squall Lows Land-Sea MCs O □ Not covered in AR6 WGI report davs lines breeze 0 Urban OA Föhn **UC-Models** effect Thermals Thunder Storms hours Tornadoes Cumulus convection Whirlwind **Down Bursts** CAT minutes Plumes Circumference of the Earth ABL turbulence seconds 10 m 100 m 1000 km 10000 km 1 km 10 km 100 km Reference region Continental region Typological region

Fig 10.3: CMIP, RCMs, CORDEX, etc.





## Challenges of Climate Modeling: The IPCC Assessment Perspective

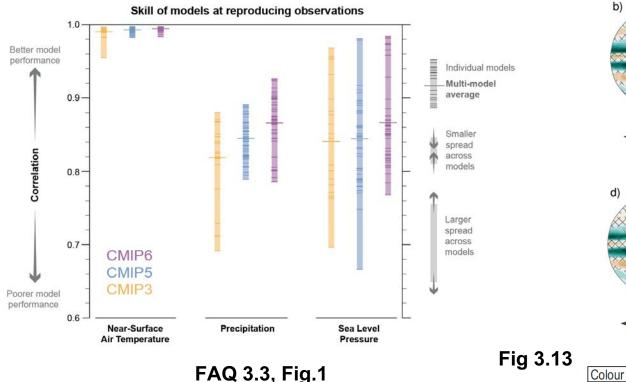
- Improving the "fitness-for-purpose" of climate models
- Better quantifying various sources of uncertainty
- Improving near-term climate information for risk assessment and adaptation
- Better constraining future changes beyond GSAT, OHC, and GMSL
- Improving regional climate information
- Issues on scenario selection and scenario feasibility

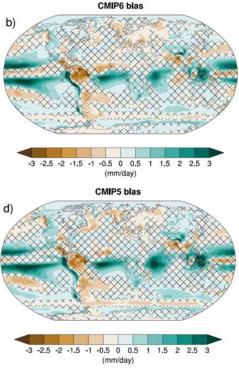
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## Improving the "fitness-for-purpose" of the climate models





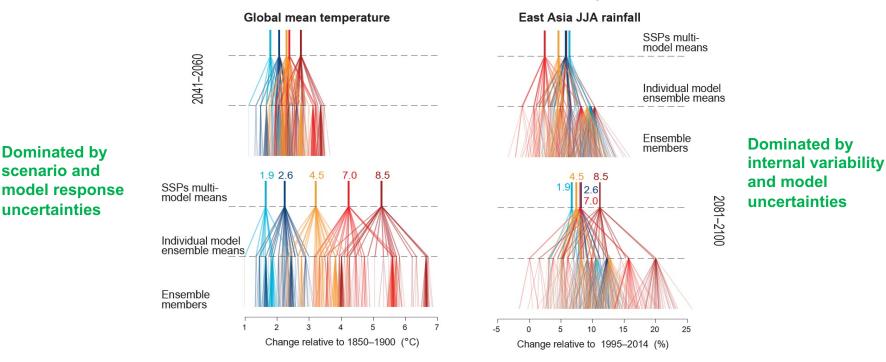
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scenario and

uncertainties

## Better quantifying various sources of uncertainty



#### Cascade of uncertainties in climate projections

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**Fig 1.15** 

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# Improving near-term information for risk management and adaptation

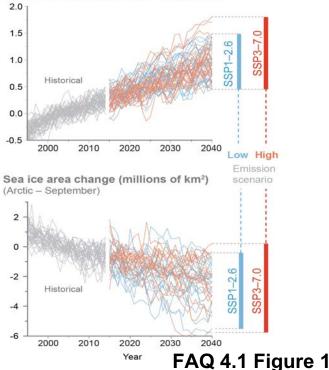
### Large uncertainties in near-term information due to

- Internal variability (single-model initial-condition large ensembles and storylines approach providing a more comprehensive spectrum of possible changes associated with internal variability)
- Model uncertainty
- Uncertainties in forcings from natural and anthropogenic aerosols

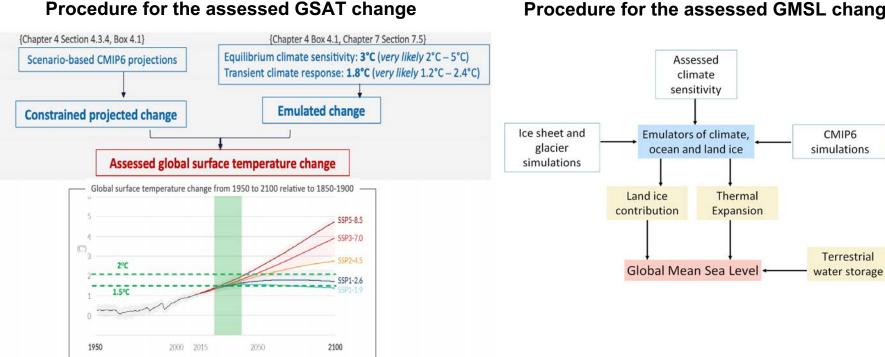
## FAQ 4.1: How will climate change over the next 20 years?

Current climatic trends will continue in the next 2 decades but their exact magnitude cannot be predicted, because of natural variability.





Better constraining future changes beyond GSAT, OHC, and GMSL



Procedure for the assessed GMSL change

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Fig SPM.8, Figure 4.11

Schematic based on 9.6.3.2; Table 9.7; 9.SM.4

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## Improving regional climate information

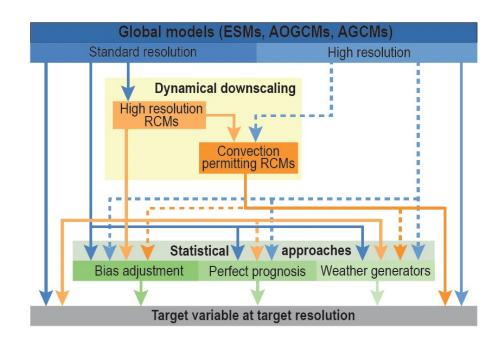
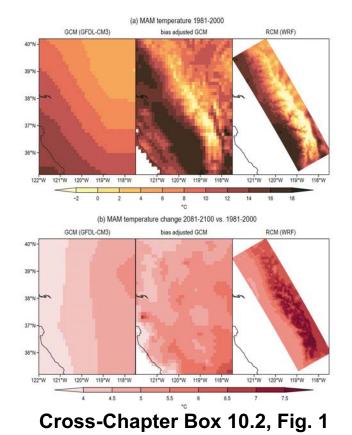


Figure 10.5



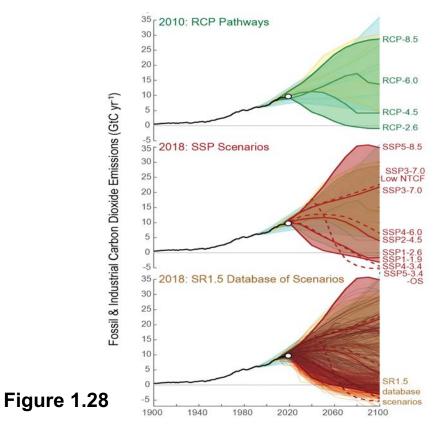
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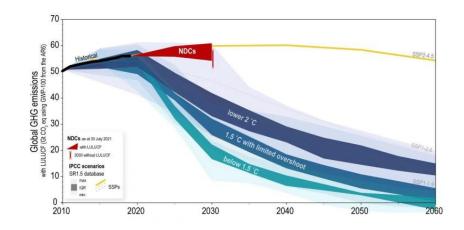
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## Issues on scenario selection and scenario feasibility





Source: UN Climate Change Full DNC Synthesis Report (2021)



## **Summary and Discussion**

- A wide range of numerical models from physical emulators to Earth System models of varying resolution are used to investigate climate futures under a range of scenarios in AR6
- Challenges still remain on adequacy and causation of recent climate change and future climate in some metrics (fitness-forpurpose)
- Deeper analysis of these multiple lines of modeling evidence benefits from better temporal alignment of the CMIP cycle with the IPCC assessment process (e.g., SROCC=deeper analysis, AR6=newer models)