Research Opportunities for ACAM: Opportunities and challenges within the global Climate-MIPs communities

CMIP: Coupled Model Intercomparison Project
Understanding past, present and future climate

CMIP is a project of the World Climate Research Programme (WCRP)'s Working Group of Coupled Modelling (WGCM).

Scientific Focus for CMIP is the **WCRP Grand Science Challenges**:

Clouds, Circulation and Climate Sensitivity
Changes in Cryosphere
Climate Extremes
Regional Sea-level Rise
Water Availability
Near-Term Climate Prediction
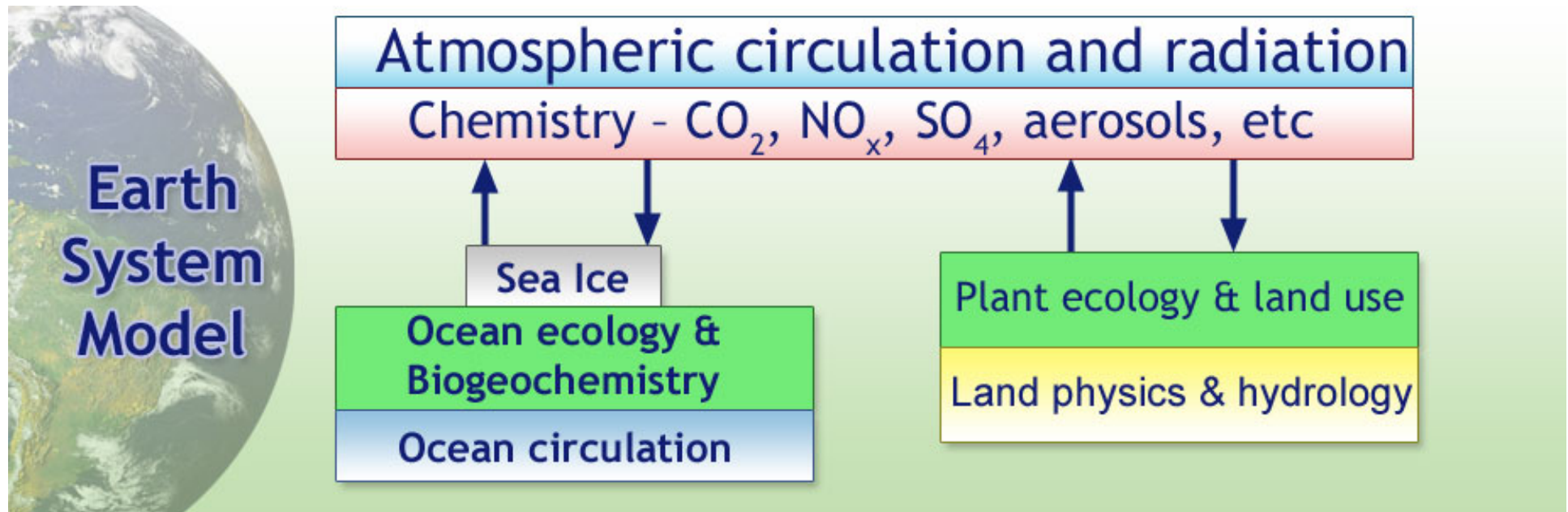Biogeochemical Cycles and Climate Change

What is CMIP ? Why CMIP ?

> Since 1995, **CMIP** has coordinated climate model experiments involving multiple international modeling teams worldwide.

> CMIP has led to a better understanding of past, present and future climate change and variability in a **multi-model framework.**

> CMIP defines **common experiment protocols, forcings and output.**

> CMIP has developed in phases, with the simulations of the fifth phase, CMIP5, now completed, and the planning of the sixth phase, i.e. CMIP6, well underway.

> CMIP's central goal is to advance scientific understanding of the Earth system.

> CMIP model simulations have also been regularly assessed as part of the IPCC Climate Assessments Reports and various national assessments.
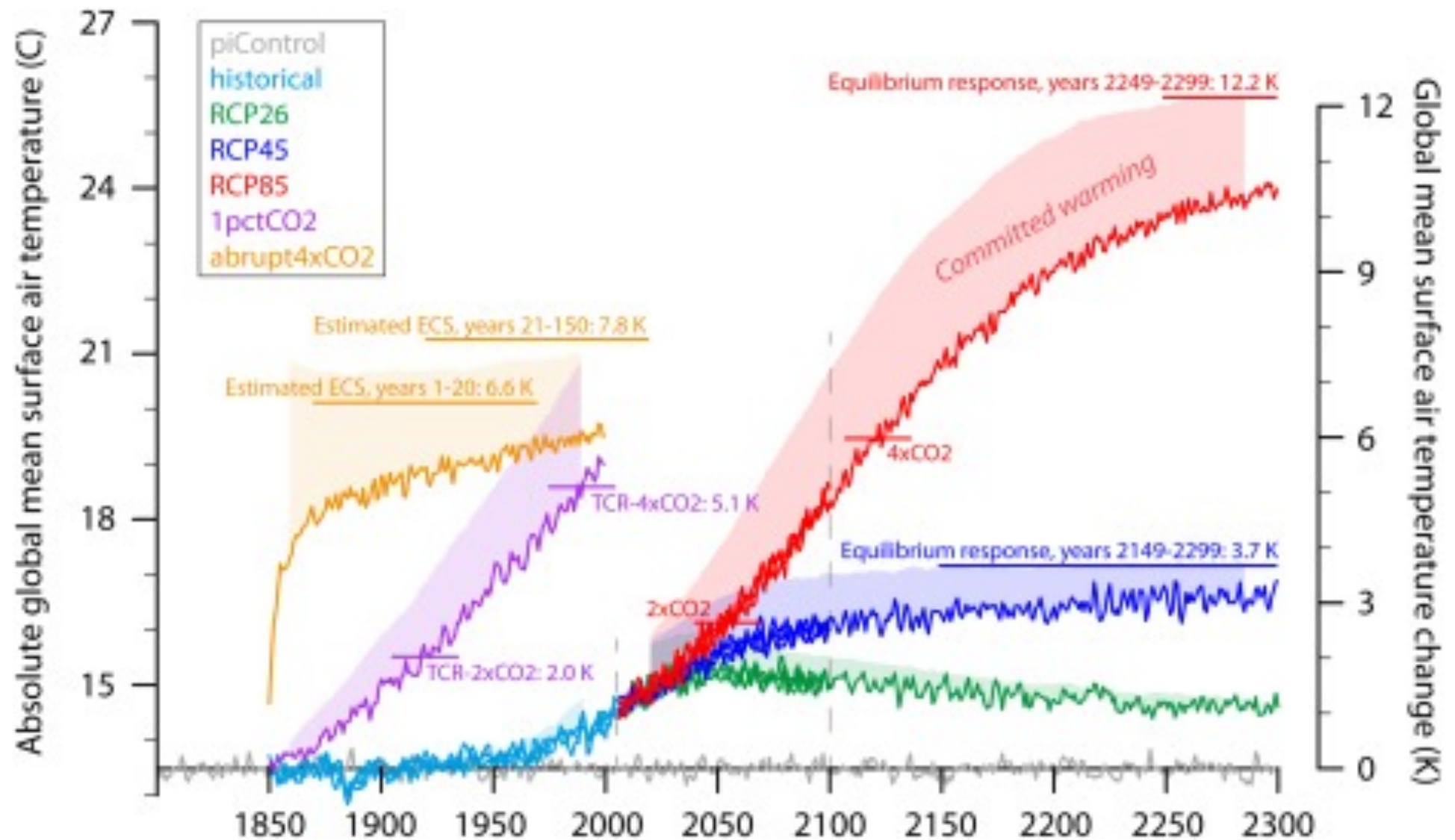
https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6 CMIP
The World Climate Research Programme's
Coupled Model Intercomparison Project

Models

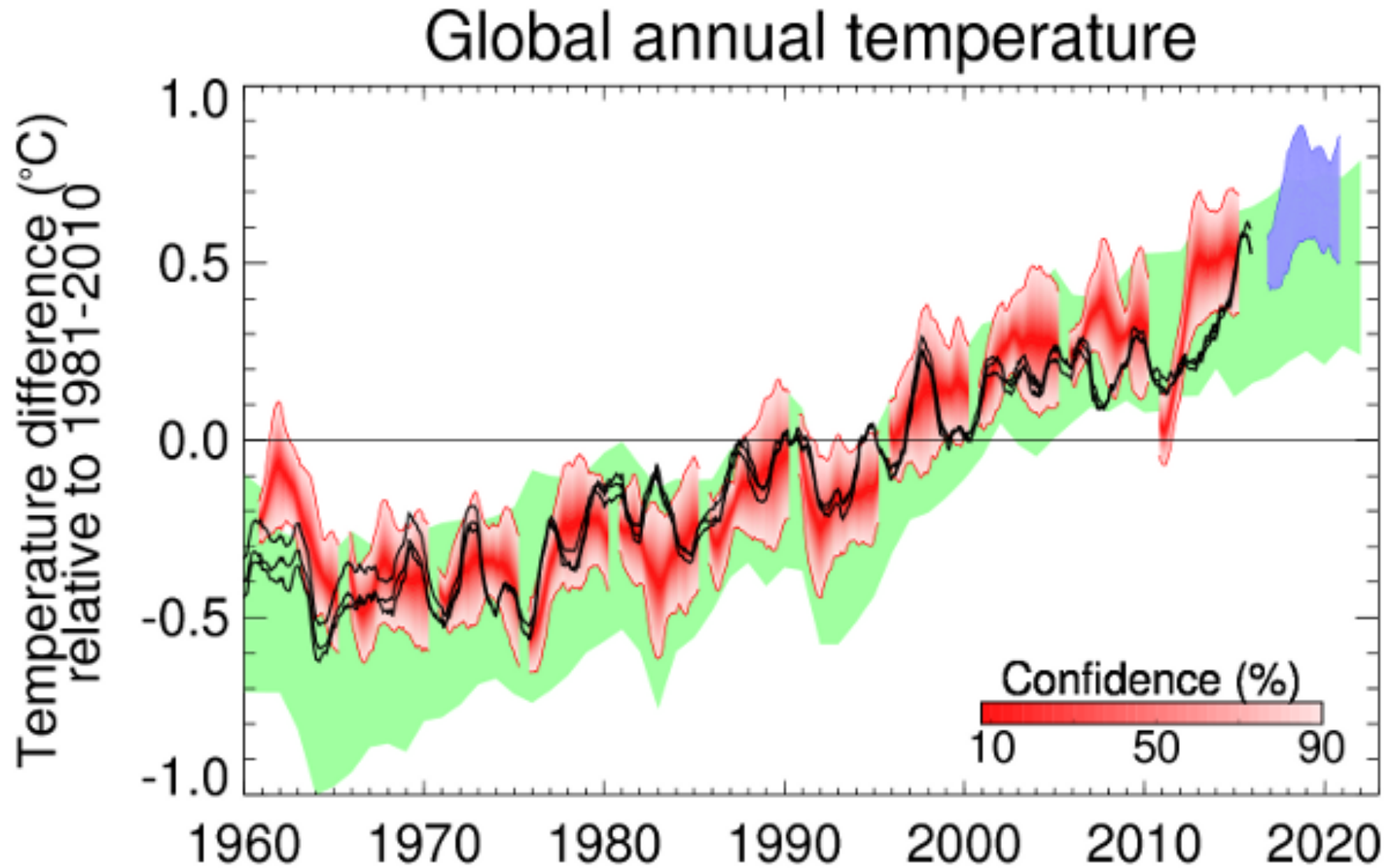
Example from GFDL

Which timescales ?
 Climate projections, decadal predictions

What we did for cmip5

Giorgetta et al., 2017

Decadal forecast simulations


Global annual temperature

Asian Summer Monsoon: Model performances and metrics

- Numerous efforts to quantify error and compare CMIP3/CMIP5
- CMIP models still have large dry biases for South Asia
– CMIP3/CMIP5 error pattern virtually identical, CMIP5 RMSE reduced compared to CMIP3
– Rainfall intensity skill correlated with skill in representing the rainfall climatology
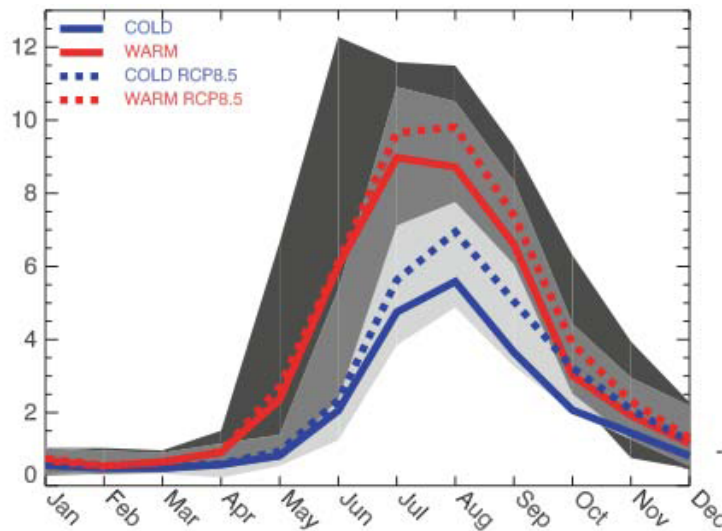- Marginal improvement across all metrics from CMIP3->CMIP5
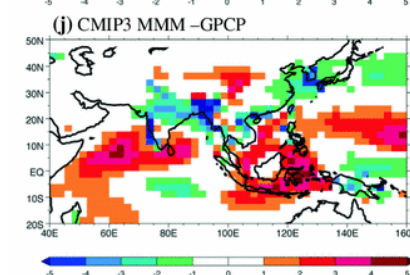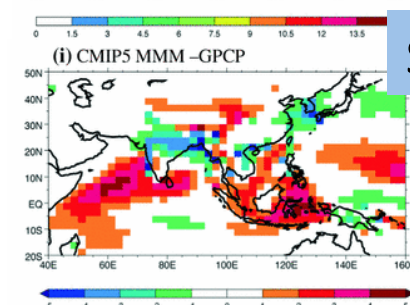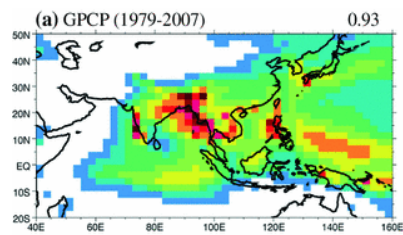
Sperber et al, 2013
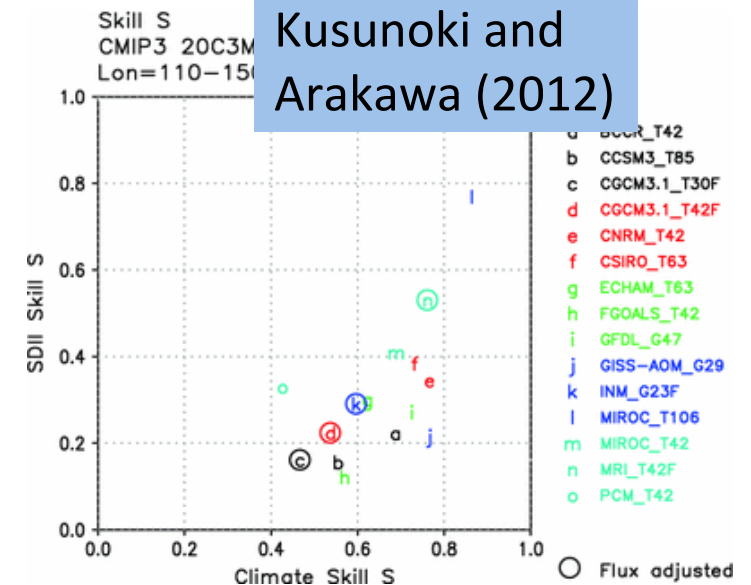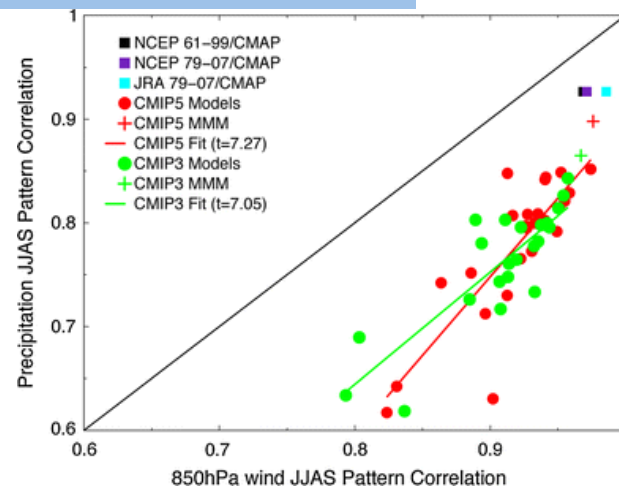
Kusunoki and Arakawa (2012)

Model SST biases and Interpretation of trends : e.g., Arabian Sea impact on monsoon annual cycle.

Many CMIP3/5 models exhibit cold northern Arabian Sea during winter and spring, linking a series of coupled biases in the Indian Ocean.
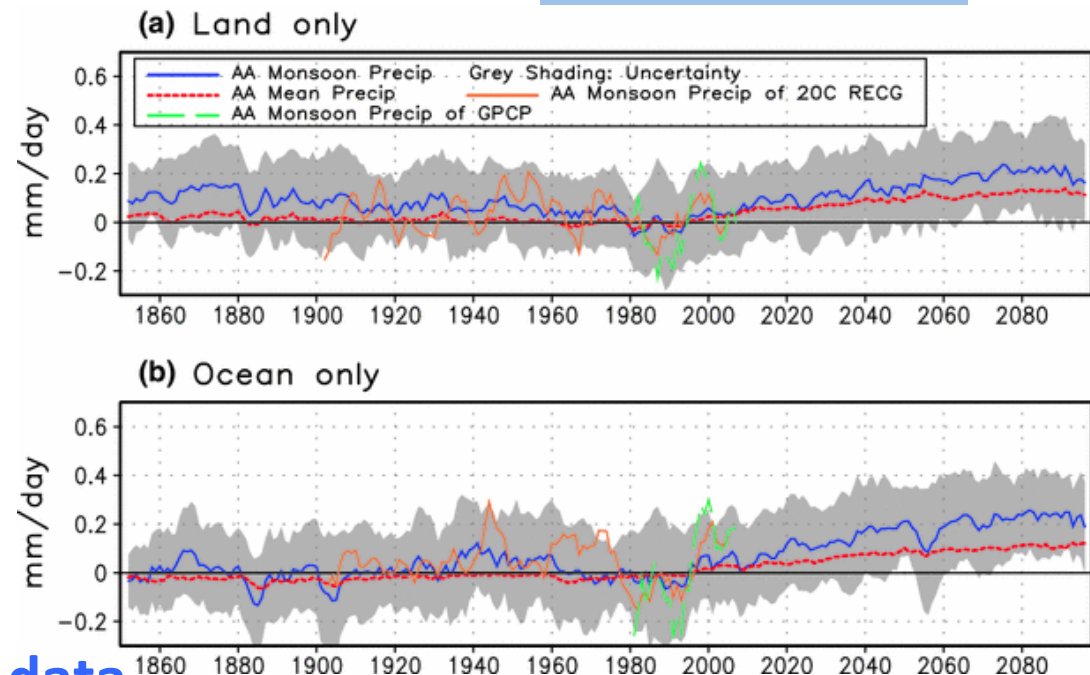

Levine et al, 2013

Wang et al (2011)

MANY STUDIES

Still a lot to do with CMIP5 data

Role of aerosols

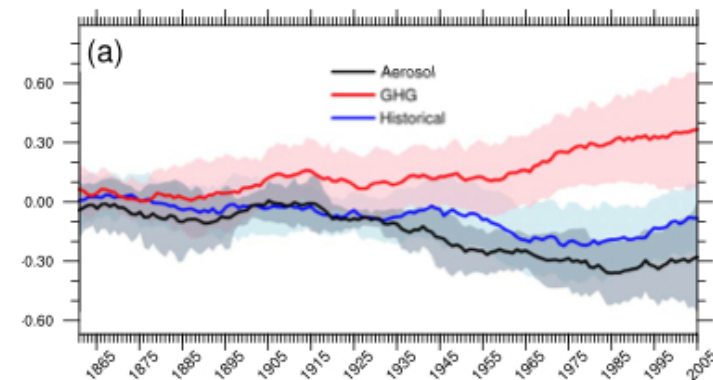|	
historicalAA	anthropogenic aerosols
historicalAnt	anthropogenic forcing
historicalBC	black carbon
historicalDs	Dust
historicalGHG	historical, well-mixed greenhouse gases only
historicalLU	land-use change
historicalMD	mineral dust
historicalNat	historical, natural forcing only
historicalOC	organic carbon
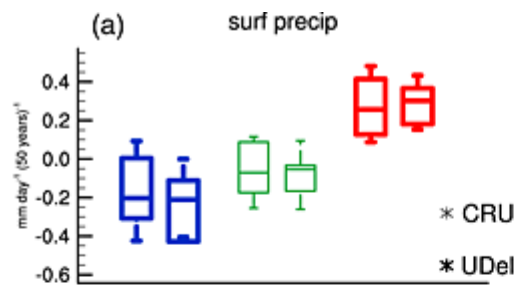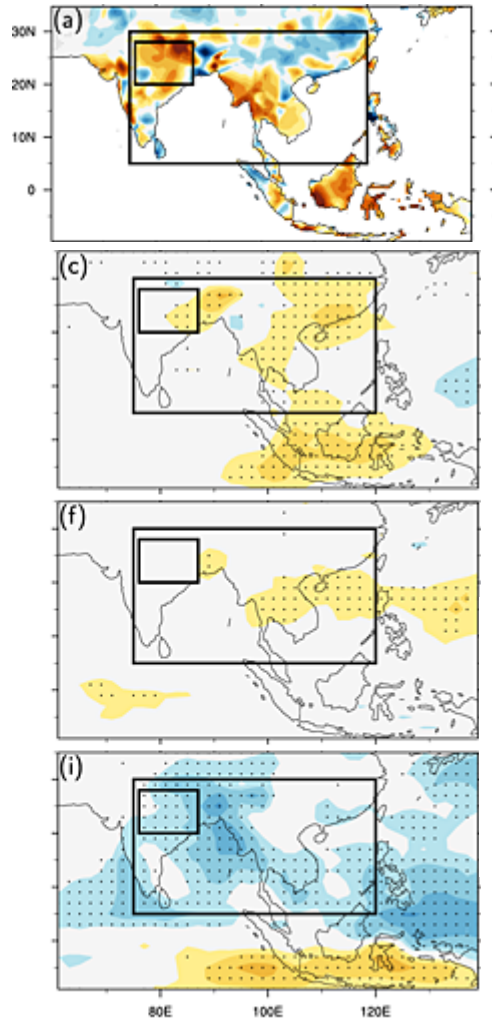
Saltzmann et al., 2014

Guo et al (2015)

Still a lot to do with CMIP5 data

CMIP6

to produce a consistent set of climate model simulations that can be scientifically exploited to address the three broad scientific questions :

(1)How does the Earth system respond to forcing?,

(2) What are the origins and consequences of systematic model biases?

(3) How can we assess future climate changes given climate variability, predictability and uncertainties in scenarios?

As in CMIP5, the model output will be freely accessible through data portals after registration. ESGF centres (see details on the CMIP Panel website at http://www.wcrp-climate.org/index.php/wgcm-cmip/about-cmip)

Which experiments and which data available ? CMIP6

A handful of common experiments
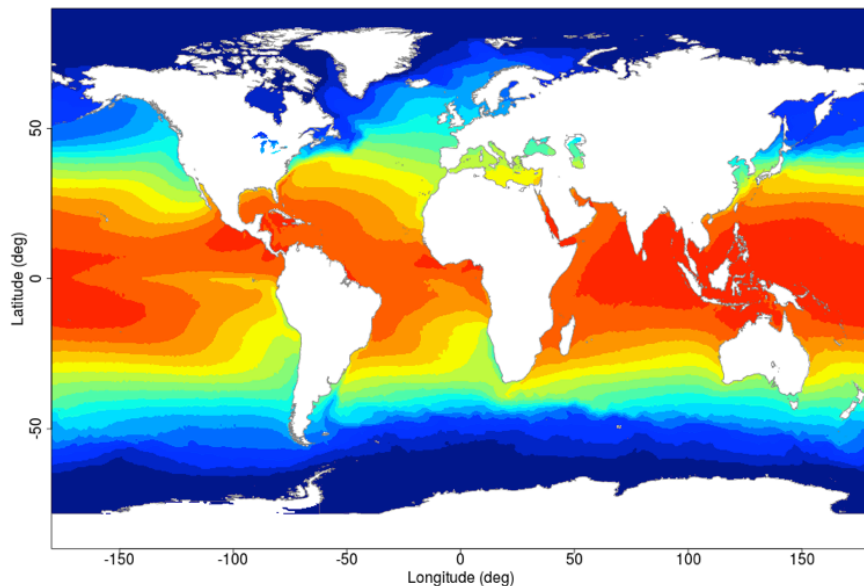
DECK (entry card for CMIP)
i.   AMIP simulation (~1979-2014)
ii.   Pre-industrial control simulation
iii. 1%/yr CO_2 increase
iv.   Abrupt 4xCO_2 run
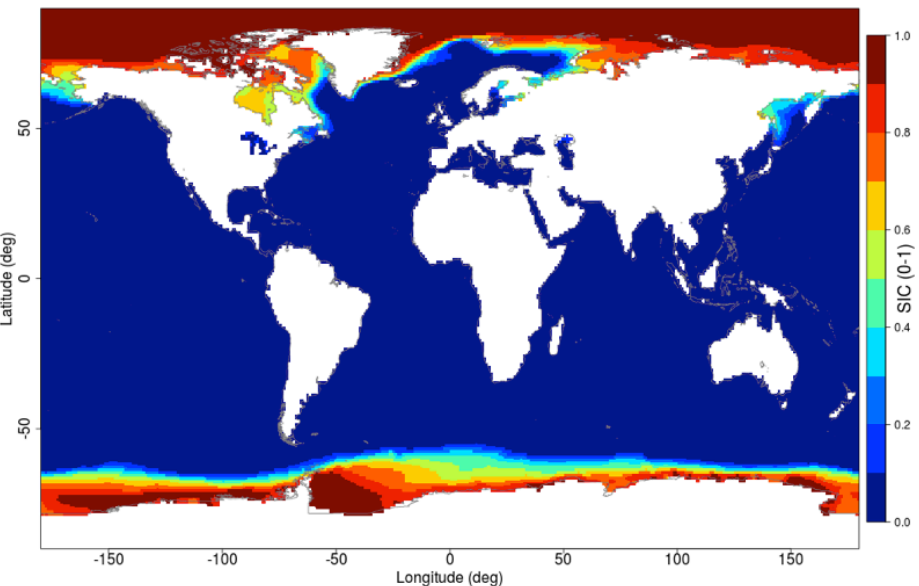
CMIP6 Historical Simulation (entry card for CMIP6)
v.   Historical simulation using CMIP6 forcings (1850-2014)
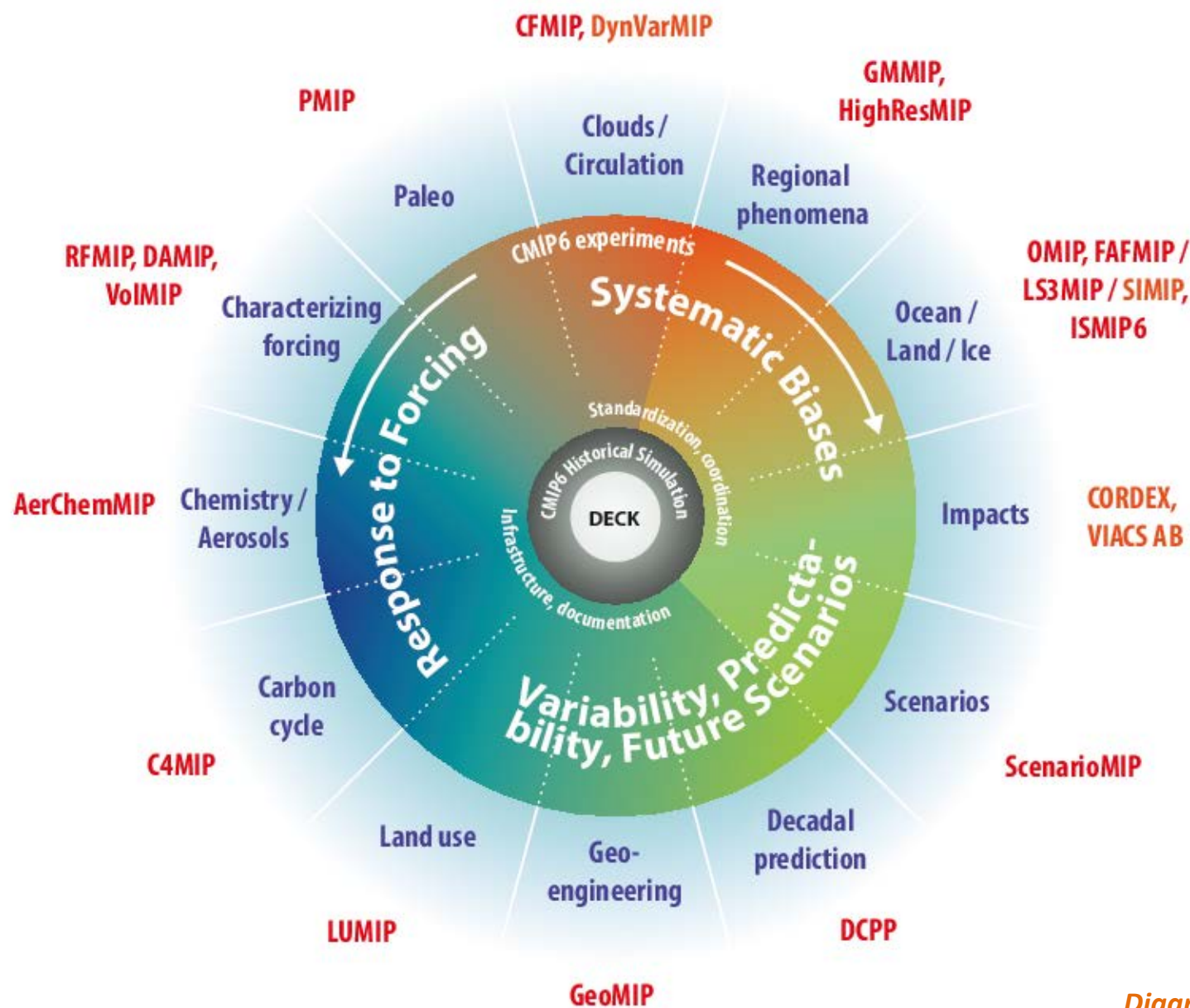
+ Different MIPs

21 CMIP6-Endorsed MIPs
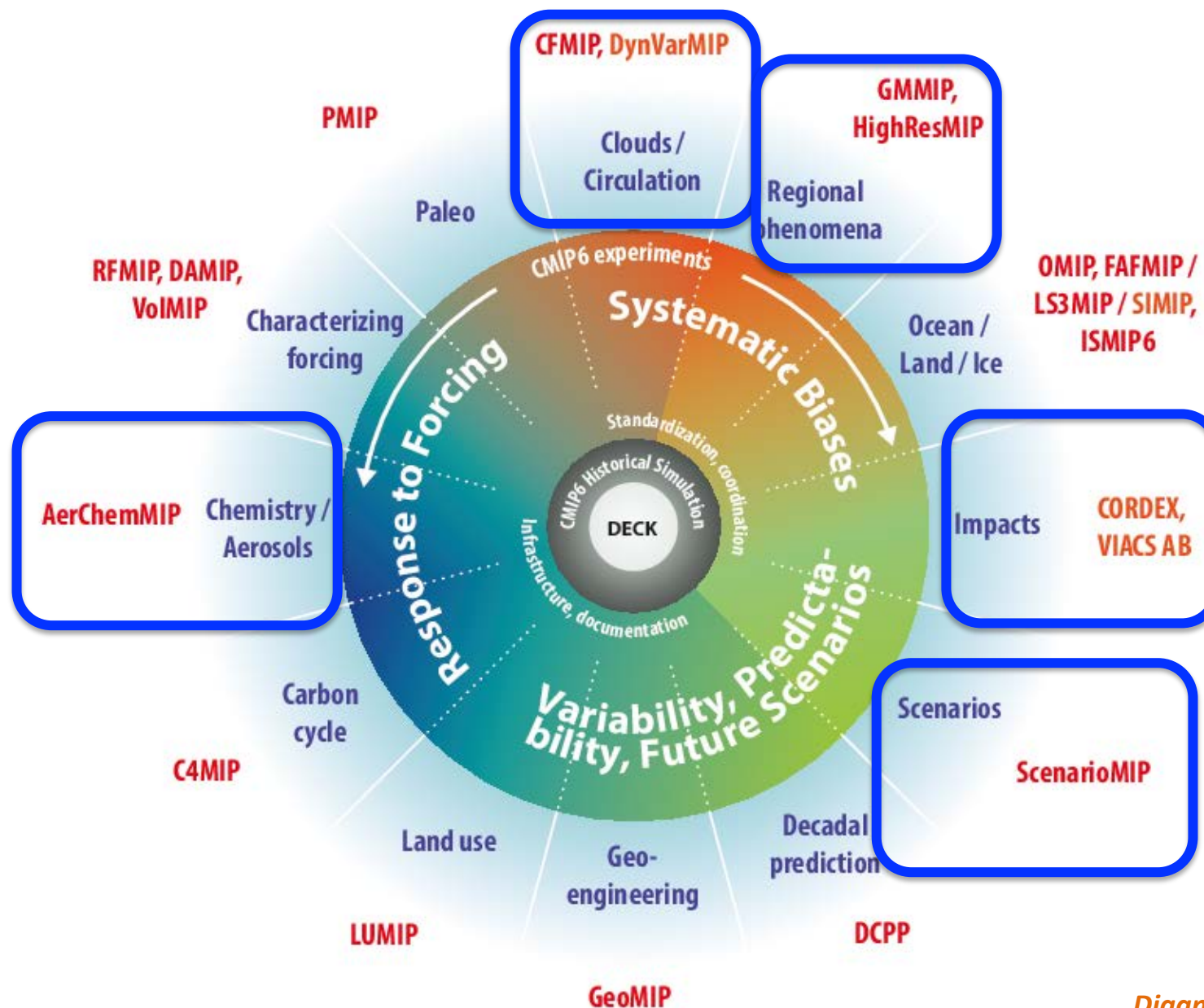

Eyring et al., GMD, 2016

Diagnostic MIPs

21 CMIP6-Endorsed MIPs

Eyring et al., GMD, 2016

Diagnostic MIPs

Short name of MIP	Long name of MIP	Primary goal(s) in CMIP6	Main CMIP6 science theme
AerChemMIP	Aerosols and Chemistry Model Intercomparison Project	(a) Diagnosing forcings and feedback of tropospheric aerosols, tropospheric ozone precursors and the chemically reactive WMGHGs; (b) documenting and understanding past and future changes in the chemical composition of the atmosphere; (c) estimating the global-to-regional climate response from these changes.	Chemistry/ Aerosols
ScenarioMIP	Scenario Model Intercomparison Project	(a) Facilitating integrated research on the impact of plausible future scenarios over physical and human systems, and on mitigation and adaptation options; (b) addressing targeted studies on the effects of particular forcings in collaboration with other MIPs; (c) help quantifying projection uncertainties based on multi-model ensembles and emergent constraints.	Scenarios
GMMIP	Global Monsoons Model Intercomparison Project	(a) Improving understanding of physical processes in global monsoons system; (b) better simulating the mean state, interannual variability, and long-term changes of global monsoons.	Regional phenomena
HighResMIP	High-Resolution Model Intercomparison Project	Assessing the robustness of improvements in the representation of important climate processes with weather-resolving global model resolutions (~ 25 km or finer), within a simplified framework using the physical climate system only with constrained aerosol forcing.	Regional phenomena
CORDEX*	Coordinated Regional Climate Downscaling Experiment	Advancing and coordinating the science and application of regional climate downscaling (RCD) through statistical and dynamical downscaling of CMIP DECK, CMIP6 *historical*, and ScenarioMIP output.	Impacts
DynVarMIP*	Dynamics and Variability Model Intercomparison Project	Defining and analysing diagnostics that enable a mechanistic approach to confront model biases and understand the underlying causes behind circulation changes with a particular emphasis on the two-way coupling between the troposphere and the stratosphere.	Clouds/ Circulation

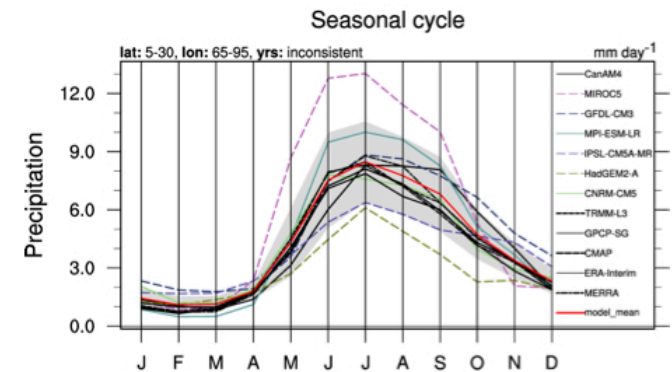# Resolution, why is it important / new ?
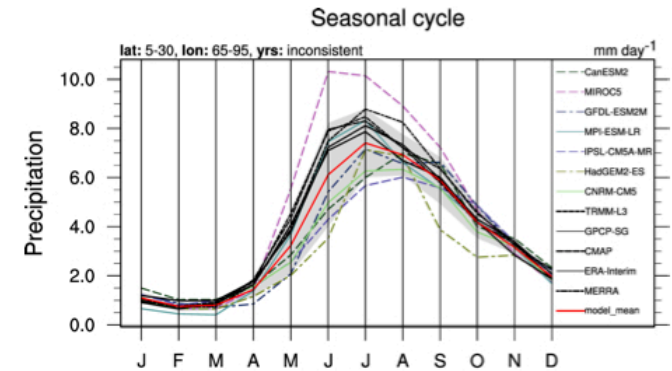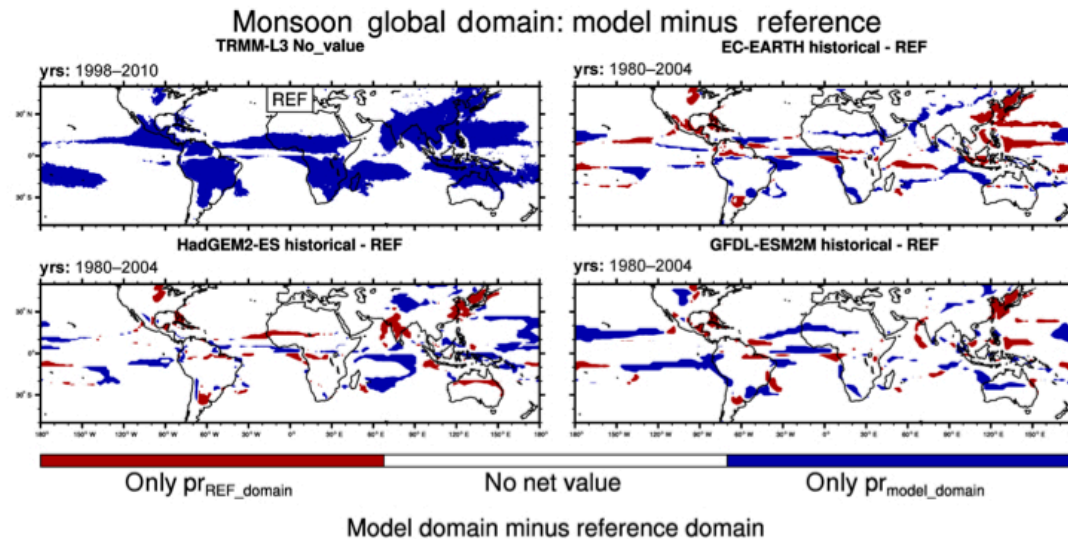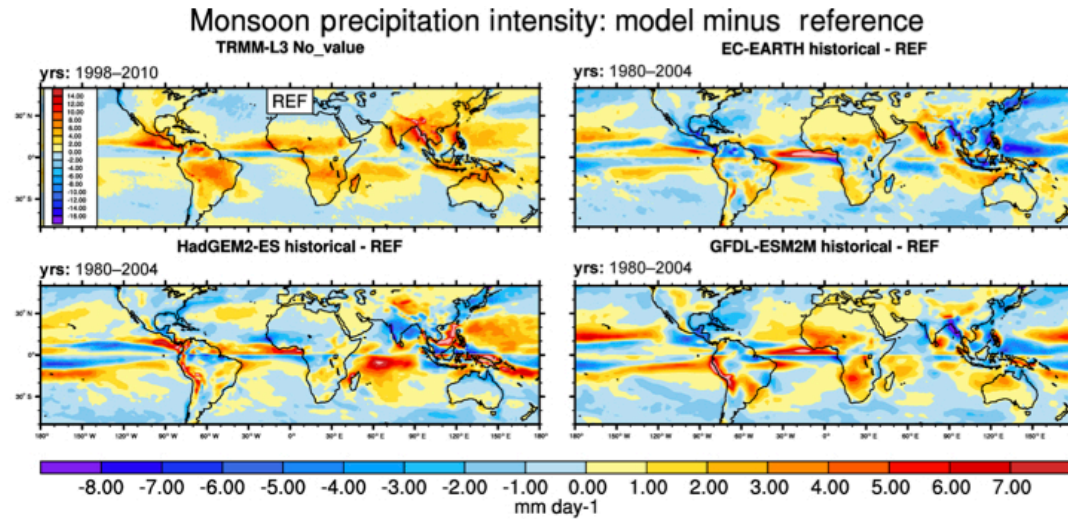
T159
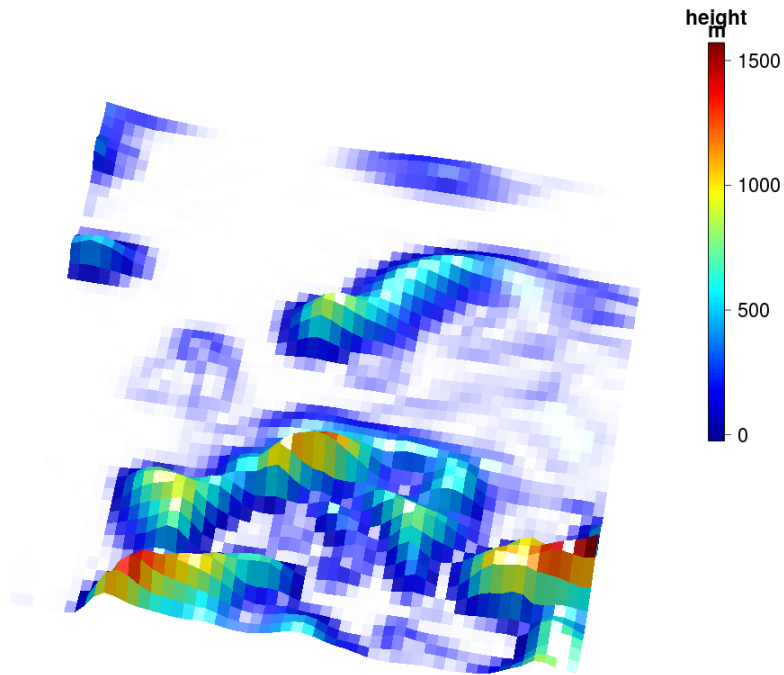
T1279
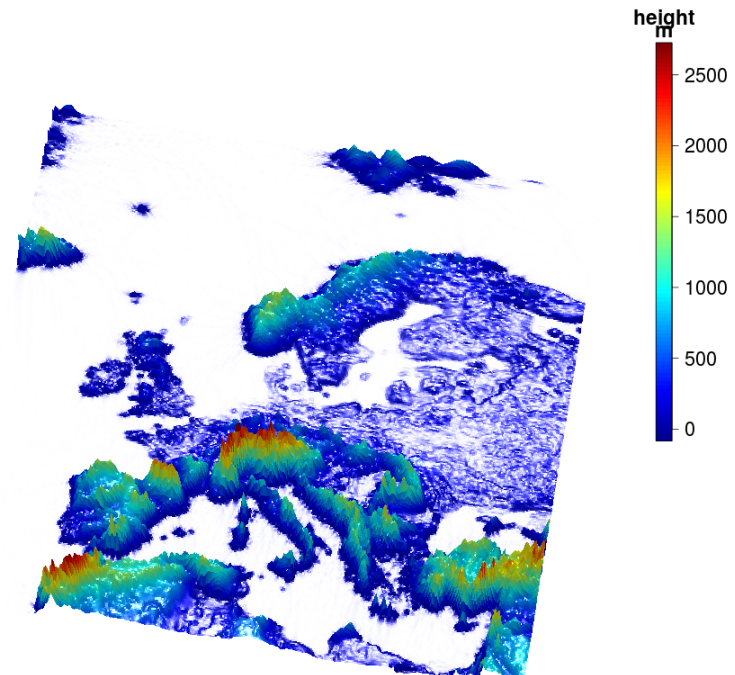
T159L91 (125km):

T255L91 (80km):

T511L91 (40km):

T799L91 (25km):

T1279L91 (16km):

MODEL EVALUATION
Metrics and Diagnostics from our community filled within ESMValTool?

Eyring et al., 2016

Linked EU projects / initiatives:

PRIMAVERA (H2020) : https://www.primavera-h2020.eu/
(PRocess-based climate sIMulation: AdVances in high-resolution modelling and European climate Risk Assessment)
Copernicus C3s : http://www.copernicus.eu/main/climate-change
(Service to give access to information for monitoring and predicting climate, providing access to several climate indicators / indices for both the identified climate drivers and the expected climate impacts.)

Take home message:
A lot to do with existing / future simulations
Strenght: MultiModel Approach

What can we do as a community
Common Analysis
Defining acam Diagnostics / Metrics
Proposing acamMIPs
Link to wg2 Discussion