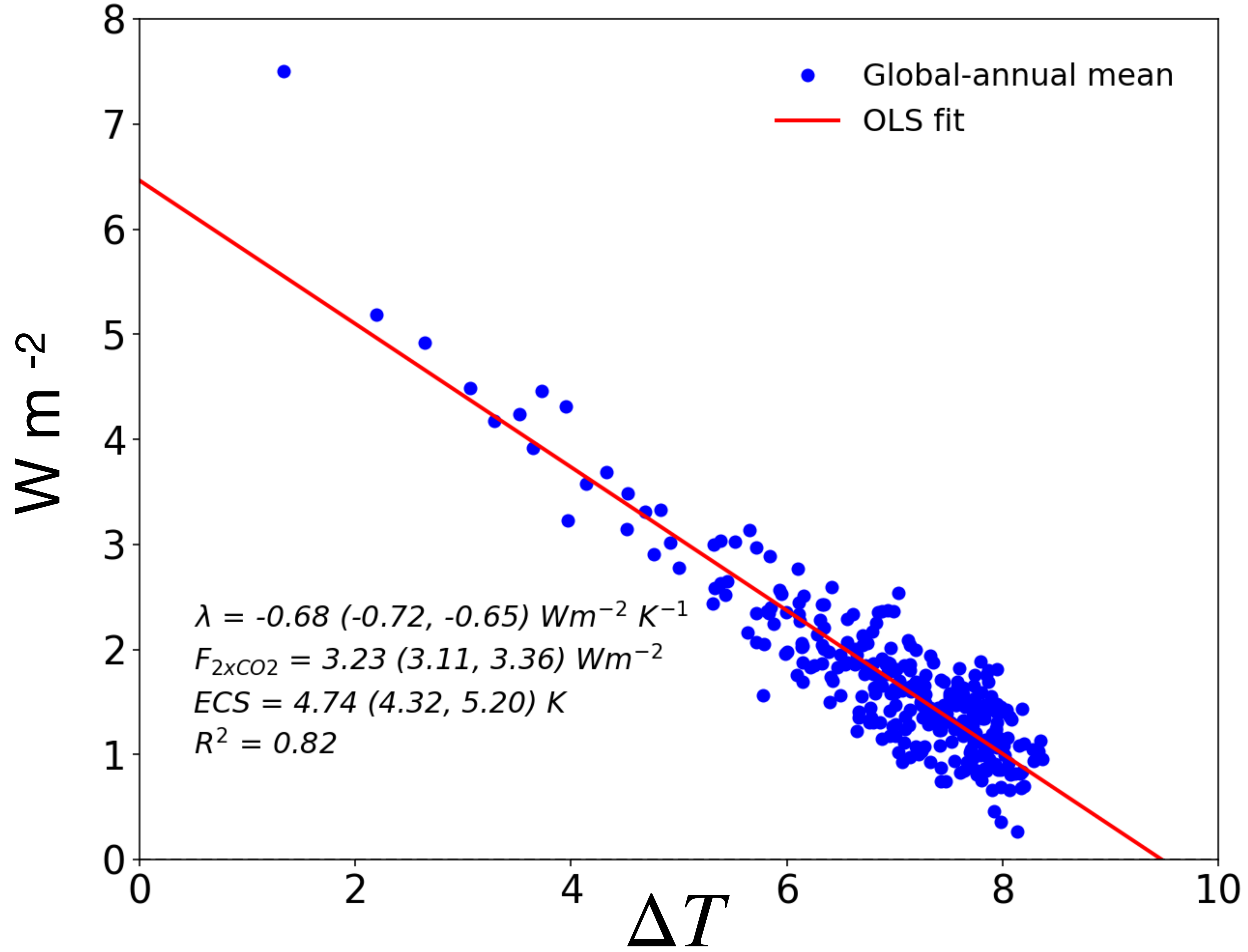
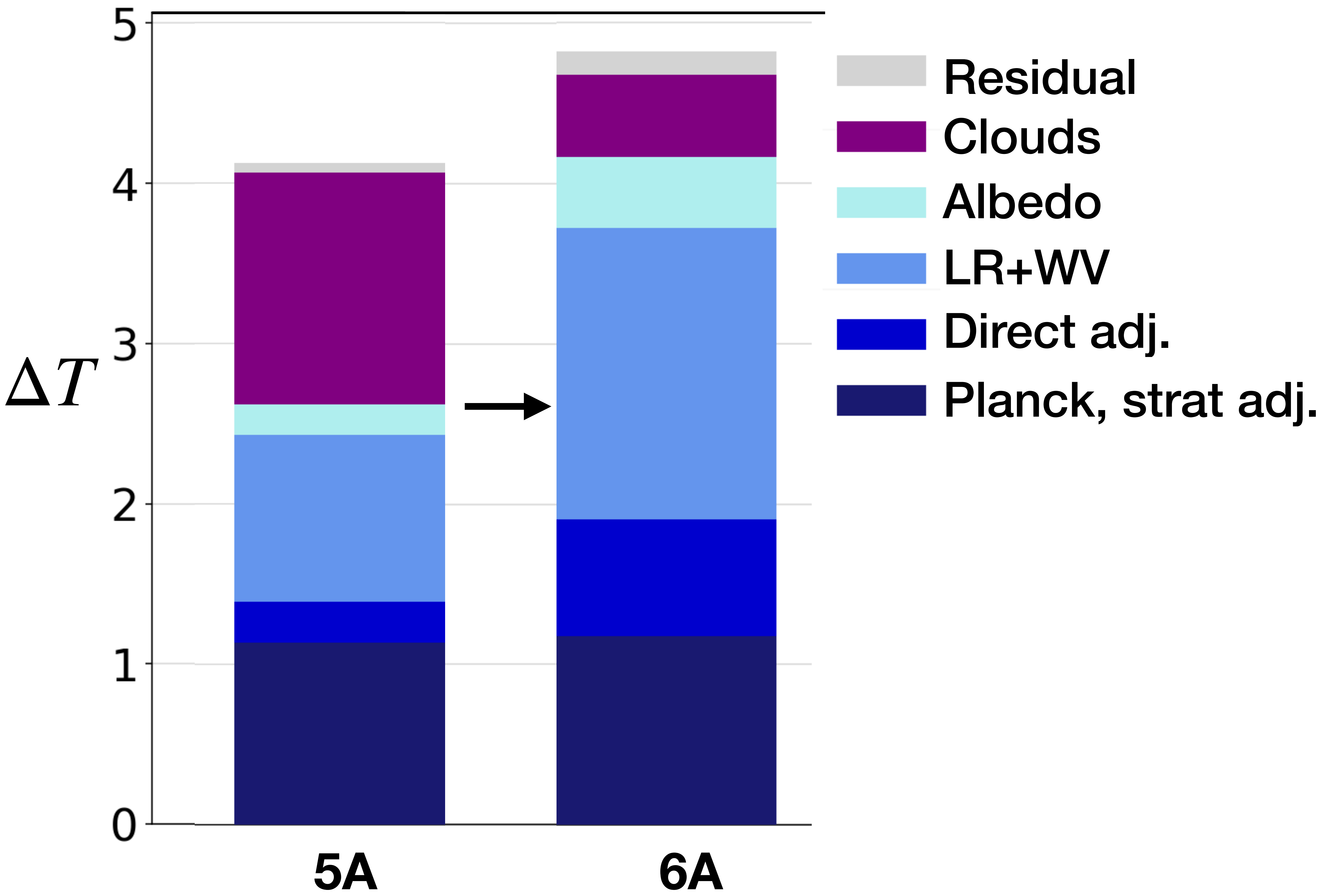
Climate sensitivity and feedbacks in the IPSL-CM6A-LR model

ECS = 4.7K vs. 4.1 in IPSL-CM5A



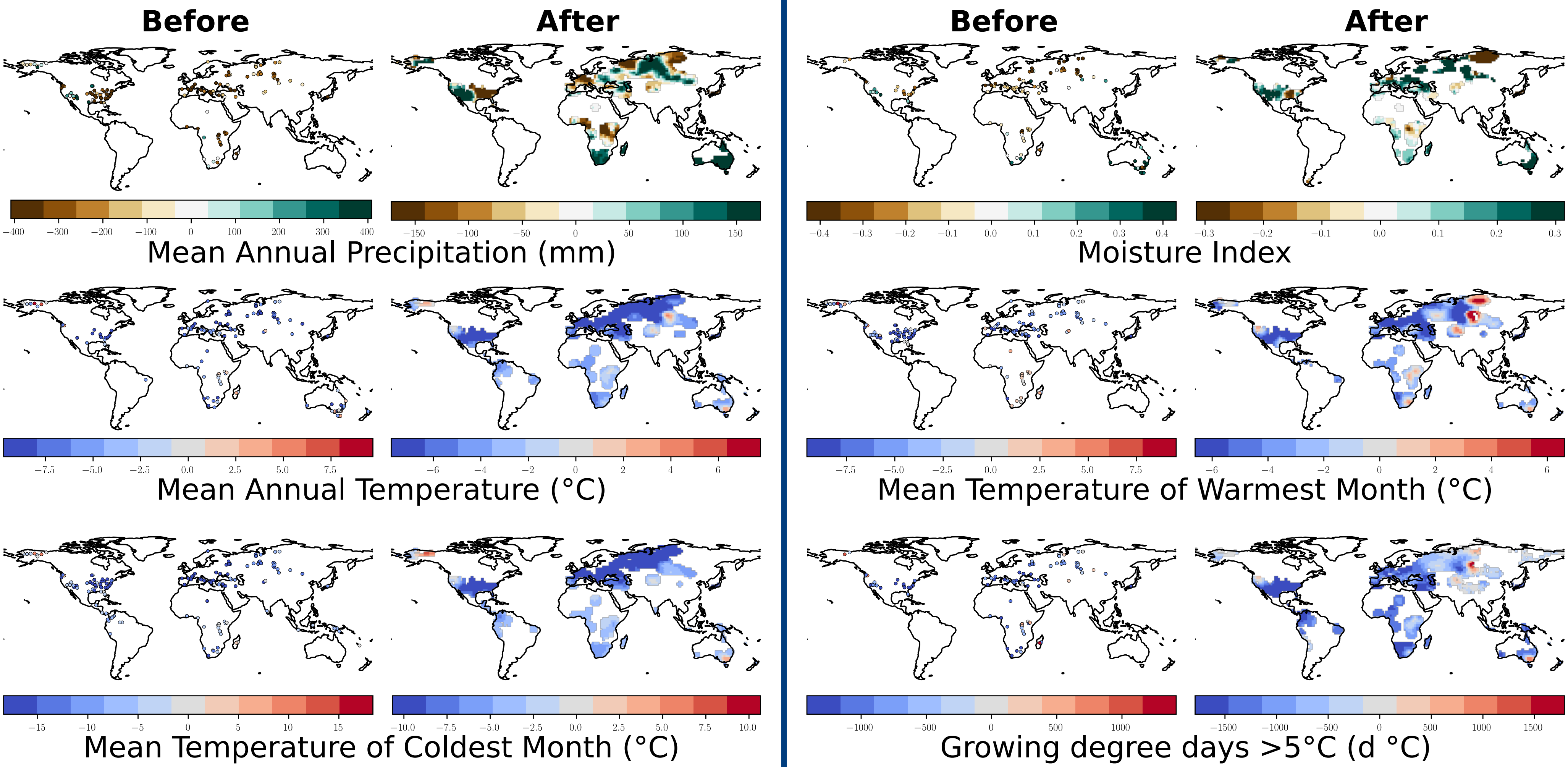
Contributions to ECS



Anna Lea Albright, Sandrine Bony, Jean-Louis Dufresne, Ionela Musat, Laurent Fairhead, Abderrahmane Idelkadi, Max Popp and Jessica Vial. Laboratoire de Météorologie Dynamique (LMD/IPSL), Sorbonne University, Paris France

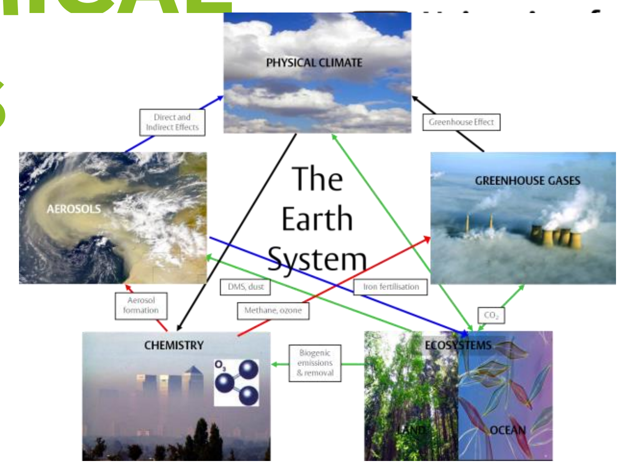
A new multi-variable benchmark for Last Glacial Maximum simulations

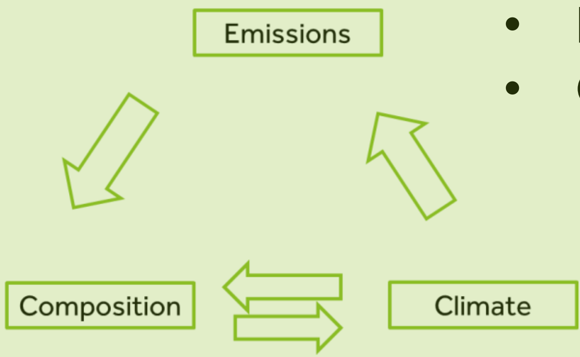
Session 2 - PO2



AerChemMIP: Biogeochemical Feedbacks in CMIP6 ESMs

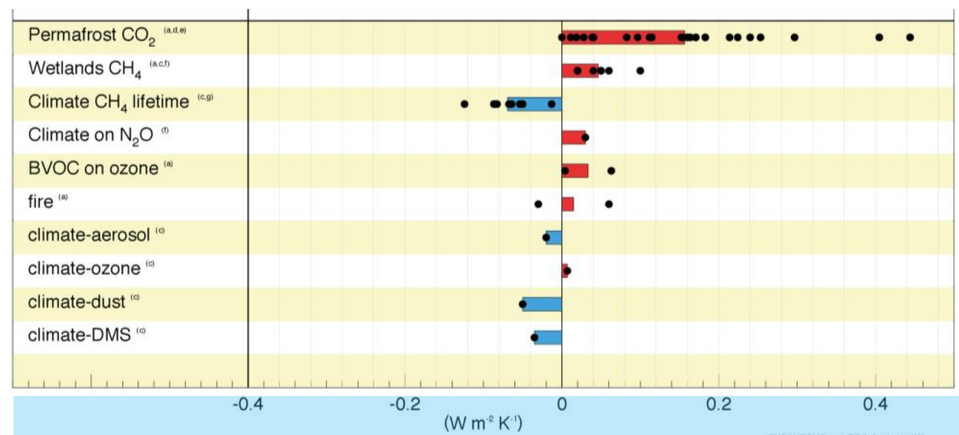
W. Collins, J.-F. Lamarque, M. Schulz

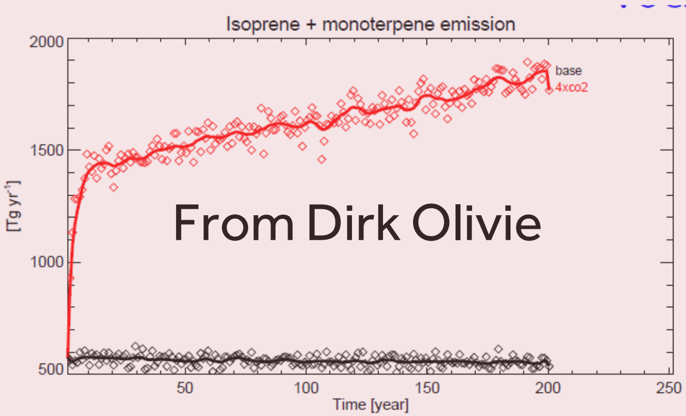




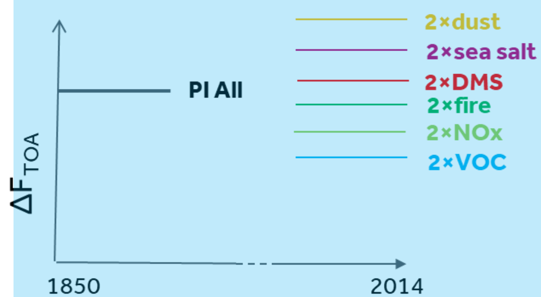
- Natural emissions
- Oxidation, removal

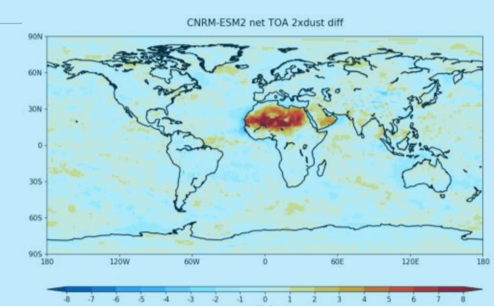
Very little information on biogeochemical feedbacks available for AR5





Use 4xCO2 to get emission per K





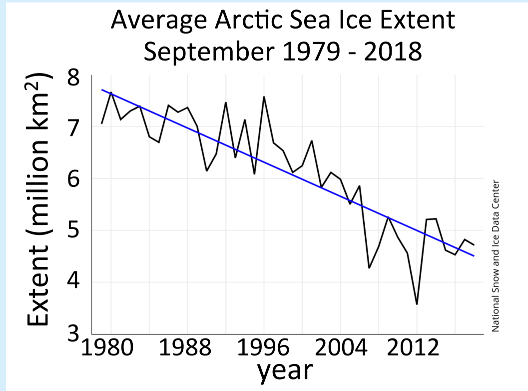
Use AerChemMIP to get ERF per emission

2-P04: Energy conserving and physically consistent method for isolating the impacts of sea-ice changes in a multi-model framework

Ivana Cvijanovic[1], Xavier Levine[1], Pablo Ortega[1] and Donald Lucas[2]

[1] Barcelona Supercomputing Center, Barcelona, Spain; [2] Lawrence Livermore National Laboratory, Livermore, California, USA

Question: Can we improve methods for isolating the impacts of sea-ice loss on the climate system?

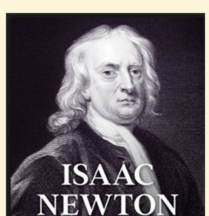


? ? ?

Problem: Most of the existing methods are either unphysical or non-energy conserving (or both):

1. paint the sea ice black

2. ignore fundamental physical laws



Possible solution: Perturbed sea-ice physics parameter simulations

isolate parameters that have the strongest impact

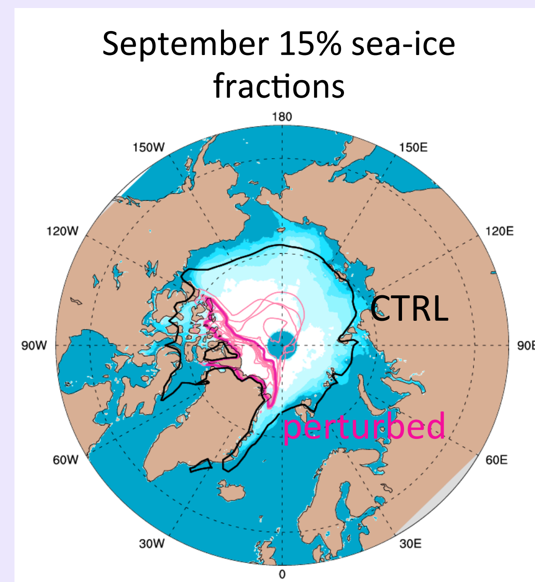
↓

perturb parameter values within the expert defined range

↓

run the model to achieve the new ice state

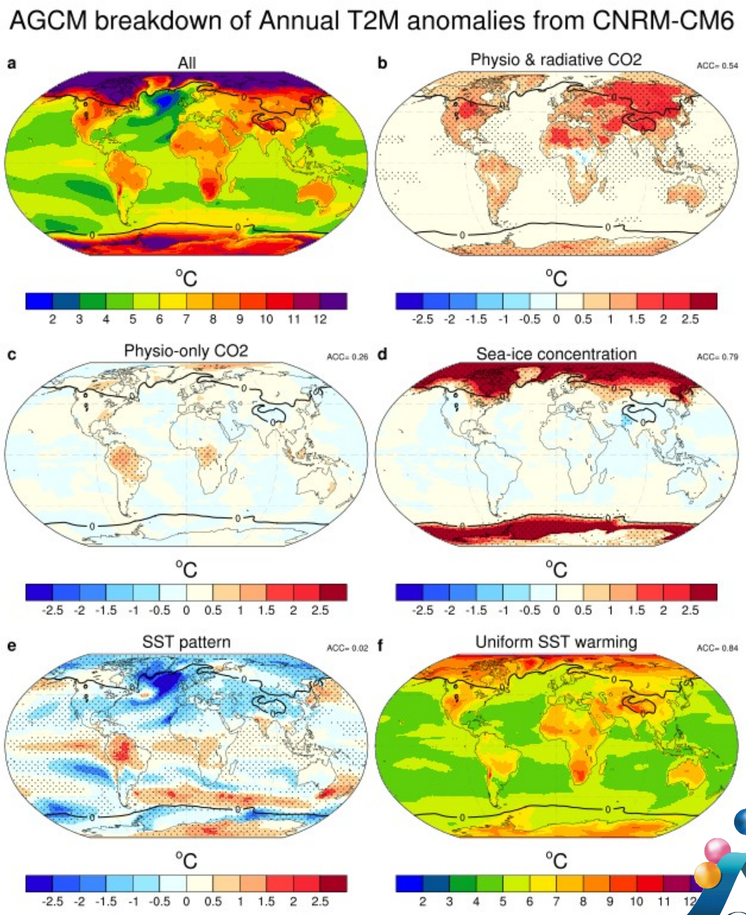
So far implemented in: CICE4 (CESM), NEMO/LIM (EC-Earth)



Assessing the linearity and additivity of water cycle changes simulated by CNRM-CM6-1 (Tuesday, P05, Hervé Douville)

The main objectives are :

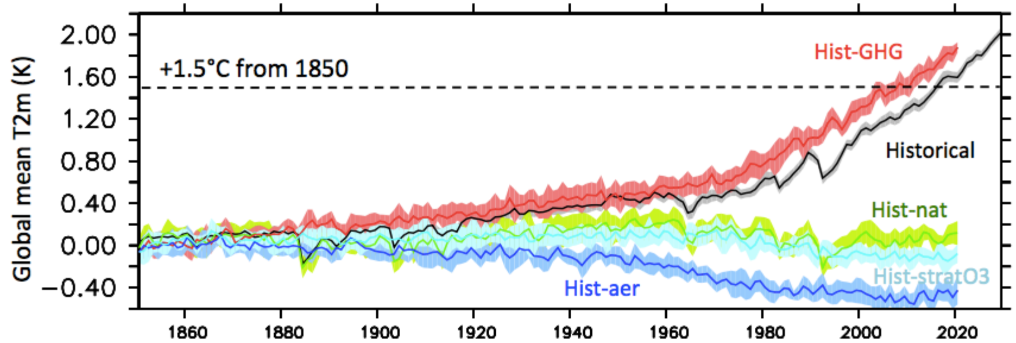
- To promote the use of CNRM-CM6-1/ESM2-1 in CMIP6 multi-model analyses ;
- To promote the realization and use of CFMIP Tier 2 AGCM experiments (cf. figure);
- To emphasize potential non-linearities in the water cycle response to increasing CO2 ;
- To emphasize the need for new (multi-variate) D&A studies related to the water cycle ;
- NB : AR6 WGI Chapter 8 looks for CMIP6 analyses (submission cut off : 31/12/2019)

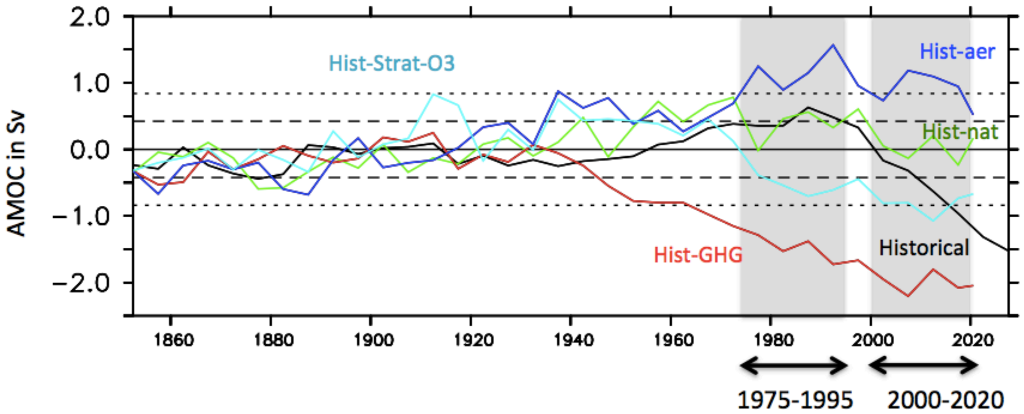


North Atlantic response to external forcing and role of the anthropogenic-aerosols

Guillaume Gastineau*, Menegoz Martin, Robson Jon, Bellucci Alessio and Cassou Christophe

*Sorbonne université, LOCEAN, UPMC/CNRS/IRD/MNHN, Paris, France

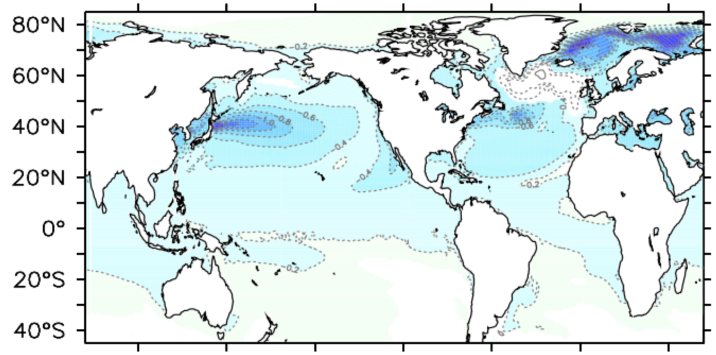




IPSL-CM6A-LR DAMIP simulations:

- AMOC/AMV increase due to aerosol in the 1980's
- AMOC decrease since the 1960 due to GHG.

SST (in K) hist-aer 1975-1995

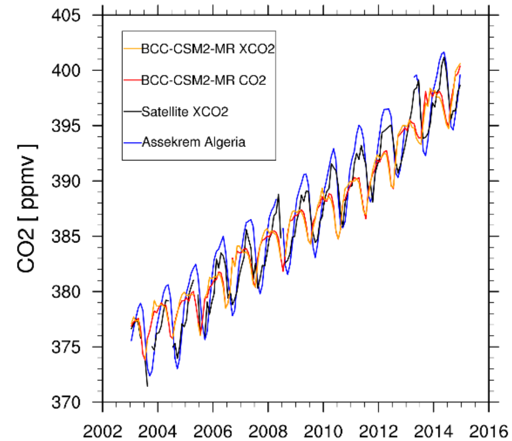


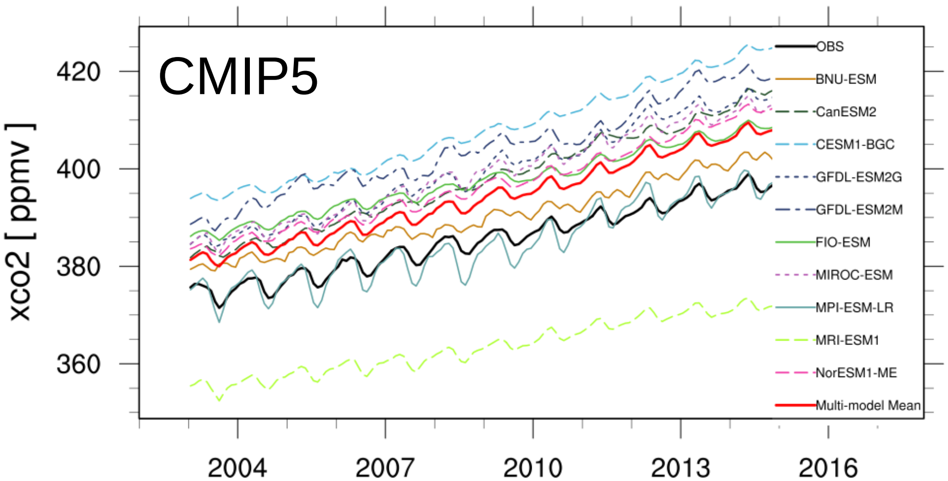
B.K. Gier, M. Buchwitz, V. Eyring, M. Reuter, P.M. Cox, P. Friedlingstein

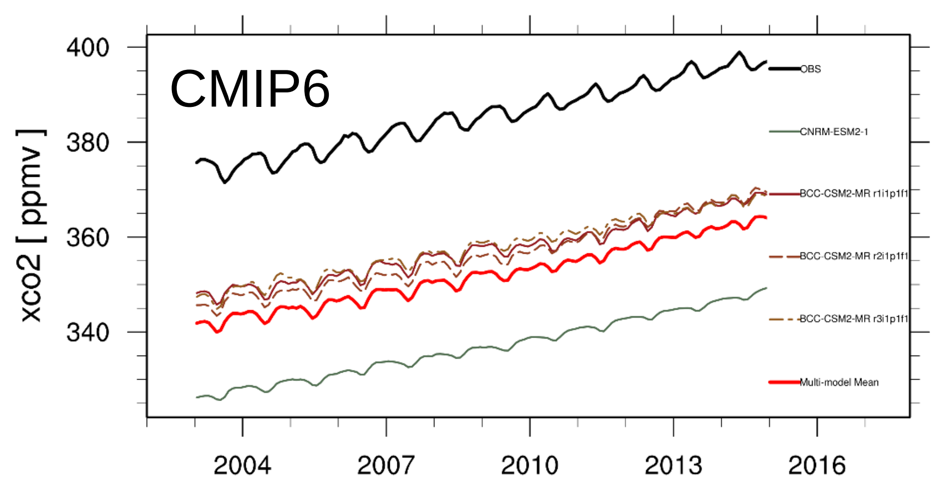
Changes of Growth Rate and Seasonal Cycle Amplitude of Column CO_2 in CMIP5&6 models and Satellite Data

- Are satellite observations and column CO_2 suitable to investigate the Carbon Cycle?
- Are emission driven CMIP6 Models able to reproduce the carbon cycle better than the CMIP5 ensemble?

Time series Assekrem Algeria (23.2625, 5.6322) Mod Offset: 28







Universität Bremen

Session 2, Poster 07

DLR

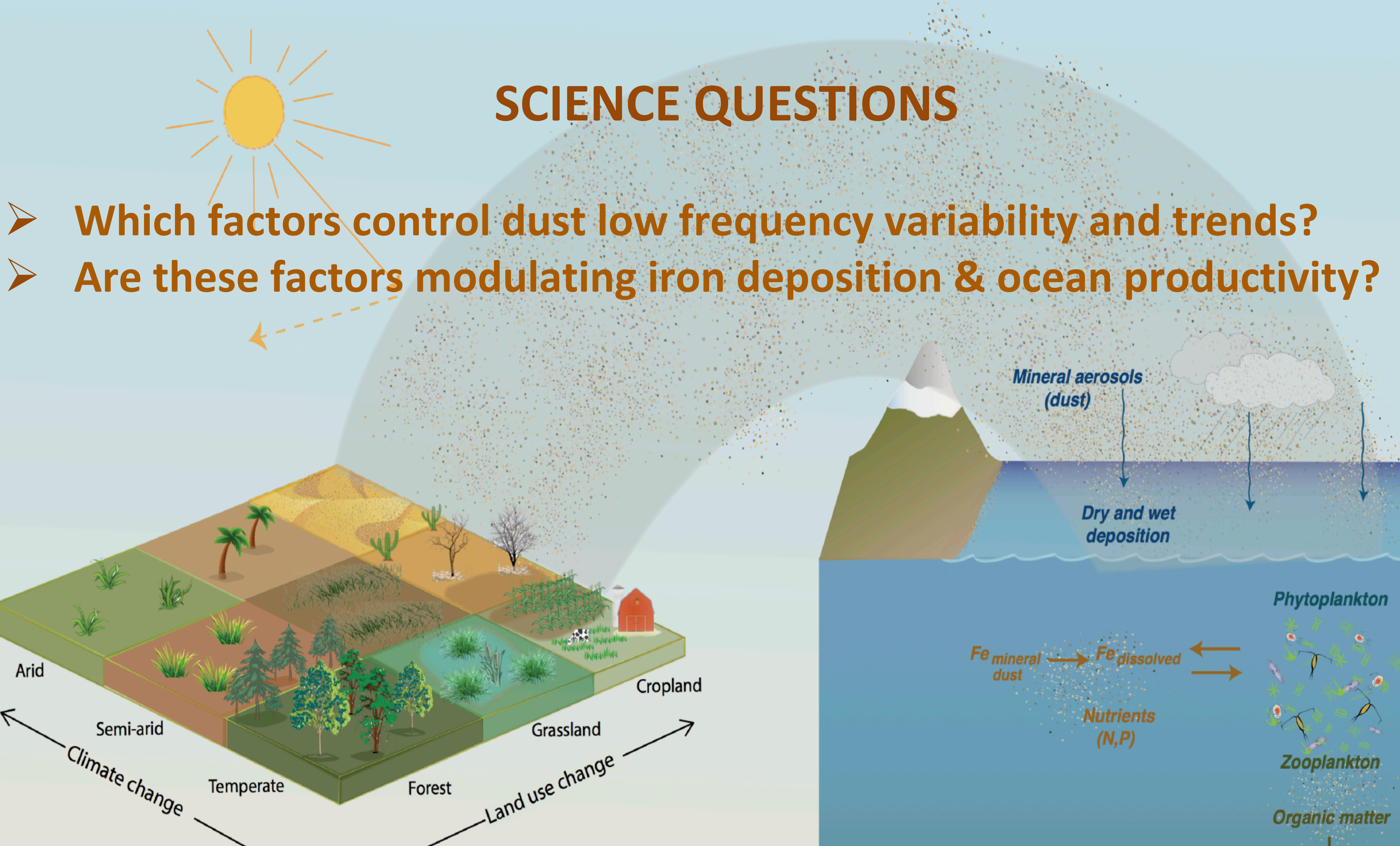
gier@uni-bremen.de

Improving aerosol forcing with a fully consistent modeling of dust lifecycle in GFDL ESM4

Paul Ginoux et al. , Tuesday Morning POSTER P08

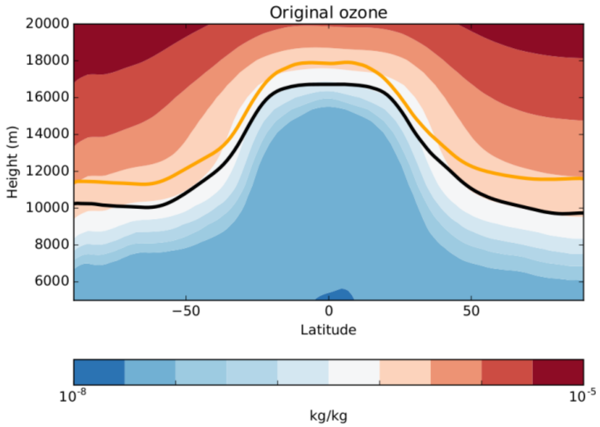
SCIENCE QUESTIONS

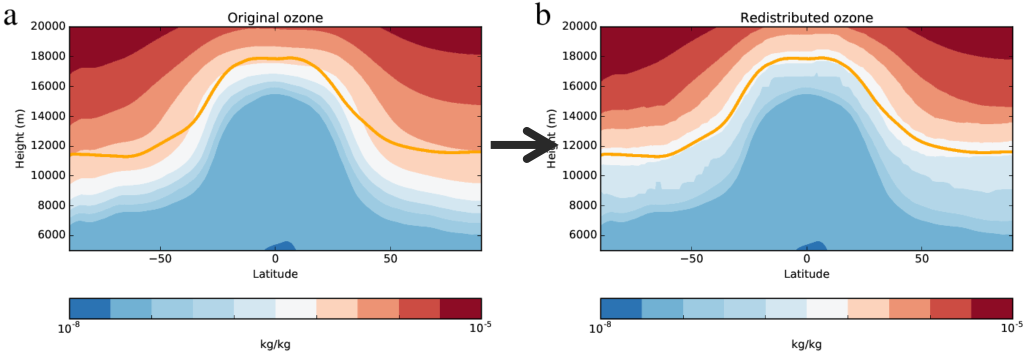
- **Which factors control dust low frequency variability and trends?**
- **Are these factors modulating iron deposition & ocean productivity?**



Met Office Hadley Centre

The impact of fixed ozone in 4xCO2 simulations (2_P09)





- Prescribed pre-industrial ozone in 4xCO2 simulations leads to a dynamical/ozone tropopause mismatch and high ozone concs in the tropical upper troposphere
- This impacts cold point T, stratospheric water vapour, downwelling LW radiation, and surface climate sensitivity
- Describe a scheme to redistribute ozone, removing this mismatch but retaining ozone distribution as closely as possible
- Describe implementation of this in Met Office GC3.1 CMIP6 simulations
- Demonstrate impacts of scheme in abrupt-4xCO2 and piControl simulations

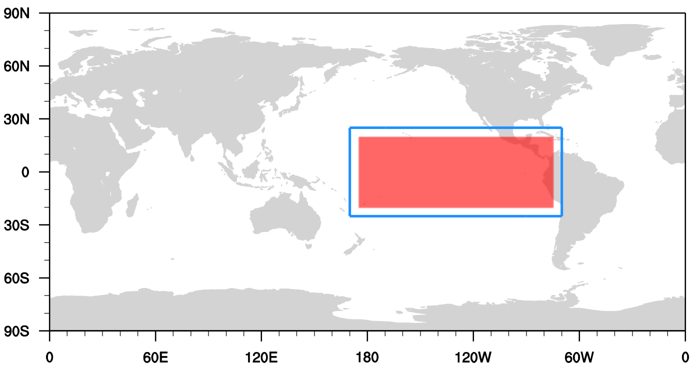
Interannual variability of northern hemisphere land monsoon rainfall in CMIP6 GMMIP pacemaker experiments

Xin HUANG (*E-mail: huangxin@lasg.iap.ac.cn*) Tianjun ZHOU

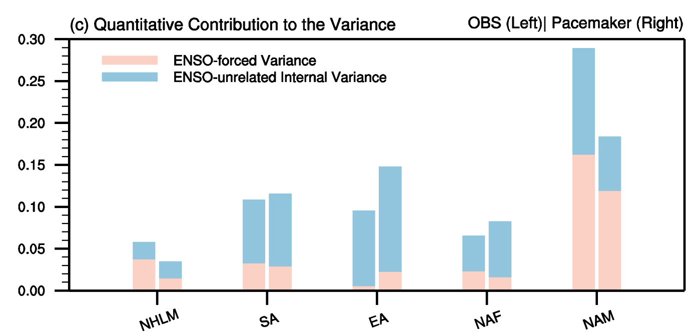
Session 2- P10

CMIP6 Model Analysis Workshop, 25-28 March 2019, Barcelona (Spain)

- **Data:** Using a 8-member ensemble of the Pacific Ocean-Global Atmosphere (POGA) experiment based on CESM1.2
- **Objective:** Investigate the ENSO-forced and ENSO-unrelated interannual variability of monsoon rainfall
- **Advantage:** Realistic evolution of ENSO as in observation & air-sea interaction over the rest of the globe



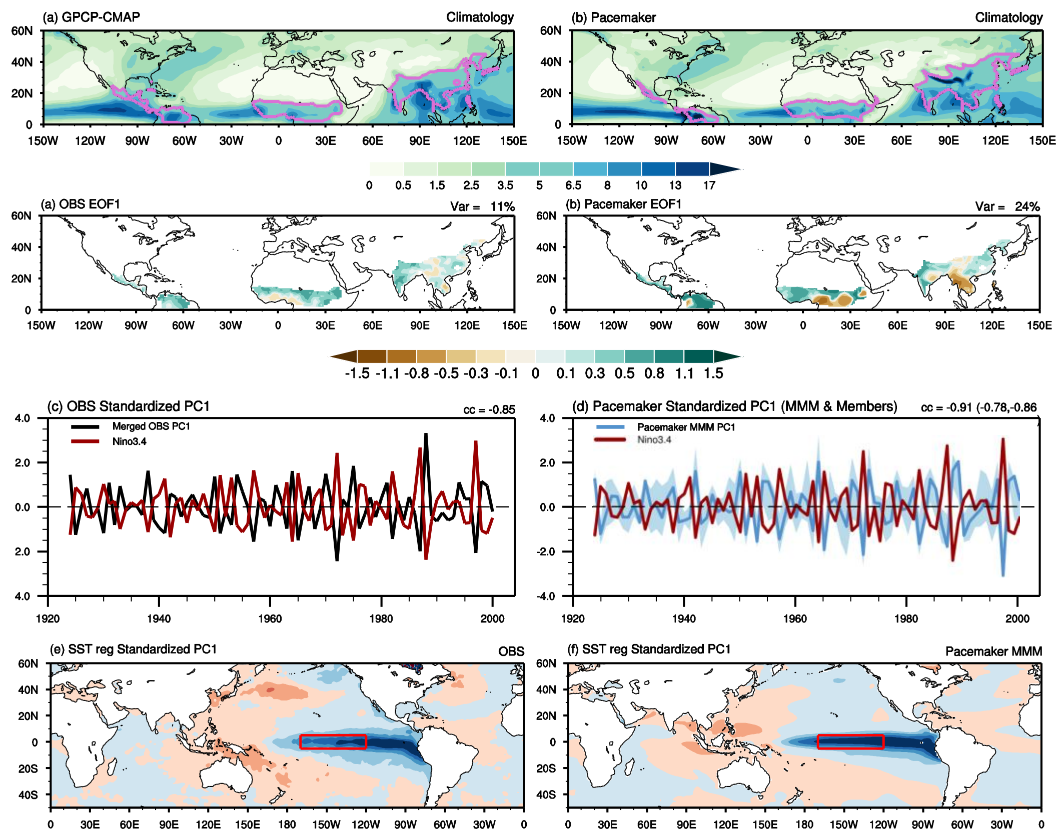
SST restored in POGA pacemaker experiment



Separate the rainfall into ENSO-forced and ENSO-unrelated variability to calculate their contribution to the total variance as

Observation: $P = r \times Nino3.4 + P'$

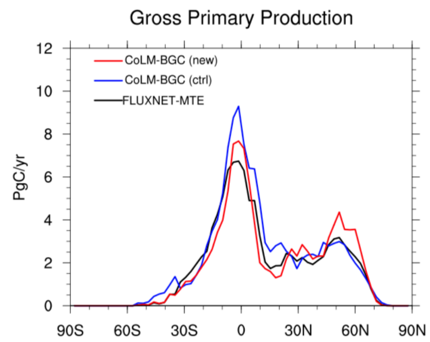
Pacemaker: $P(i) = P_{MMM} + P'(i)$



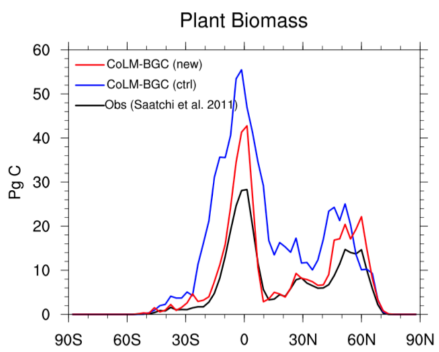
8-member ensemble mean of POGA captures ENSO-forced interannual variability of northern hemisphere land monsoon rainfall

Reducing terrestrial carbon cycle biases in BNU-ESM and CAS-ESM

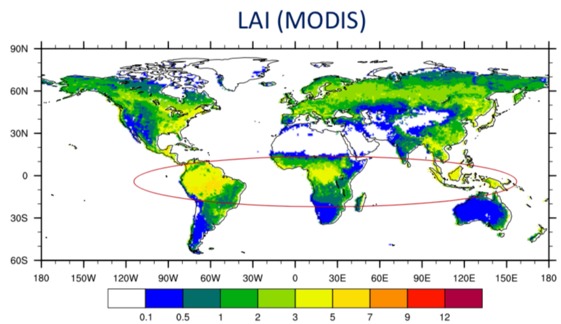
Duoying Ji, Beijing Normal University

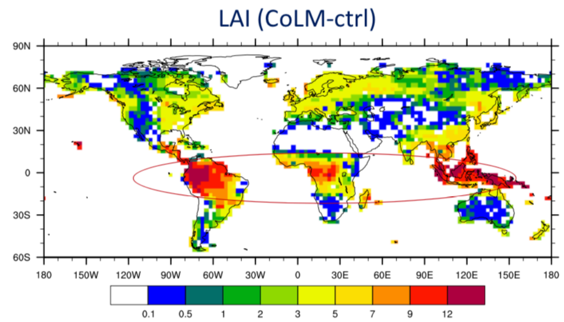


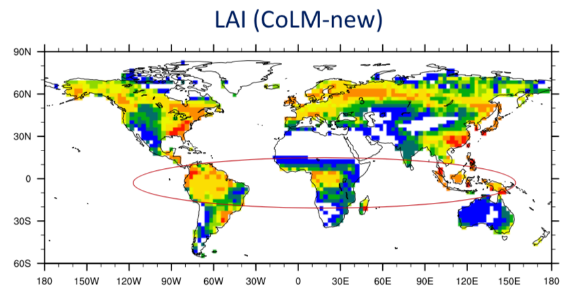
FLUXNET-MTE	110
CoLM (Ctrl)	127
CoLM (New)	112

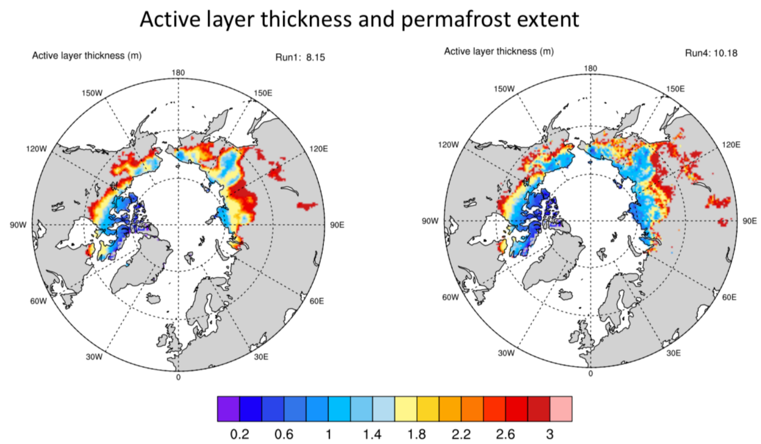


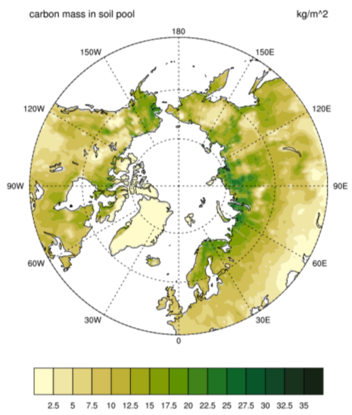
IPCC (2013)	450 – 650
CoLM (Ctrl)	798
CoLM (New)	542

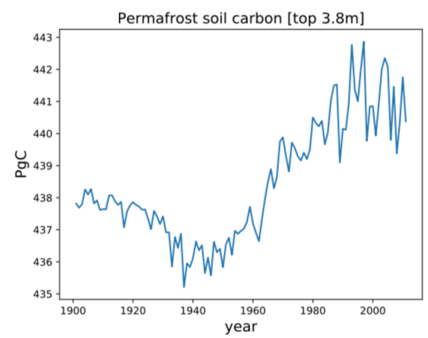








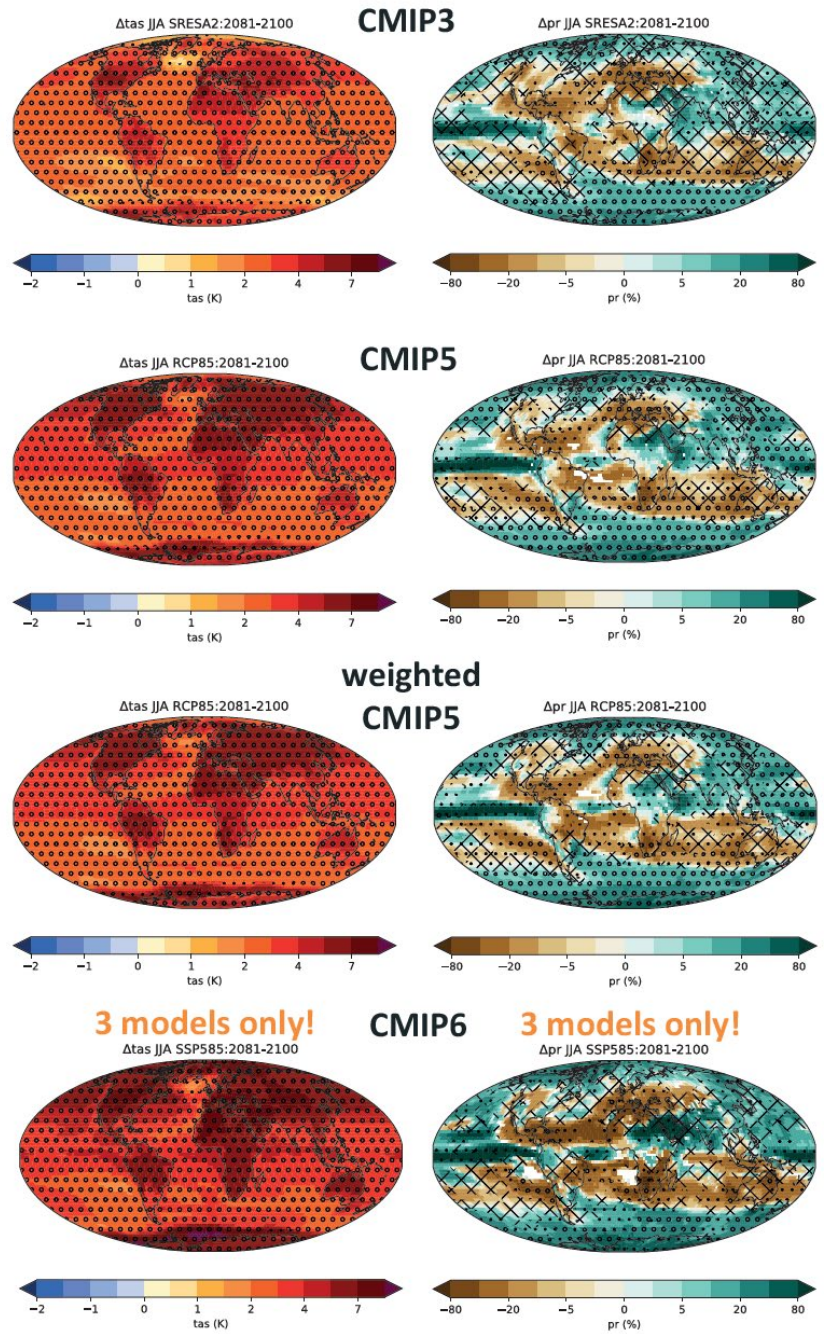




Projection uncertainties in the next generation of climate models and ensembles

Reto Knutti, Ruth Lorenz, Lukas Brunner
ETH Zurich

- Why are projection uncertainties not reduced even though models are getting "better"?
- Can model weighting improve reliability?
- Would projections as a purpose point to other developments than curiosity?
- Which metrics should we use to measure quality?
- How many models and ensemble members do we need?



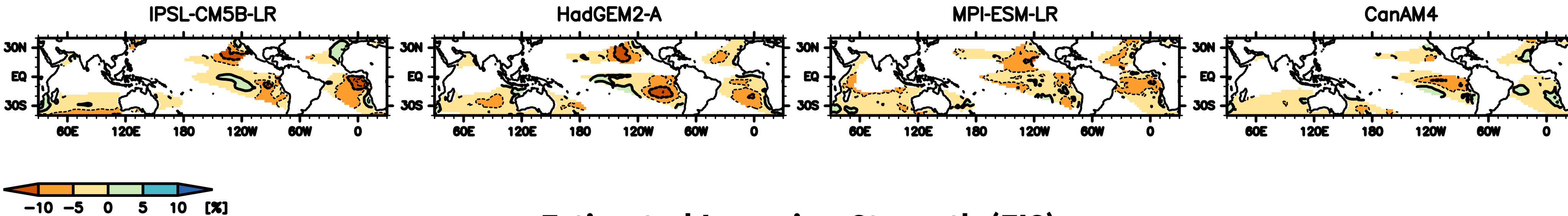
2-P13

CMIP5 subtropical marine low cloud feedback interpreted through a unified predictive index

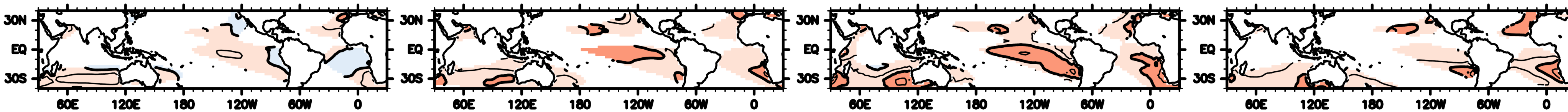
*Tsuyoshi Koshiro, Hideaki Kawai, and Seiji Yukimoto
(Meteorological Research Institute, Tsukuba, Japan)

[amip4K − amip]

Low stratiform cloud amount ***decrease***

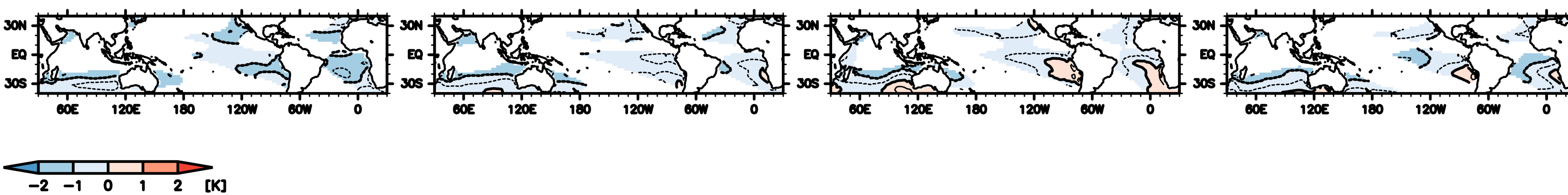


Estimated Inversion Strength (EIS) ***increase***



Our new index
Kawai et al. (2017, JCLI)

Estimated Cloud-Top Entrainment Index (ECTEI) ***decrease***

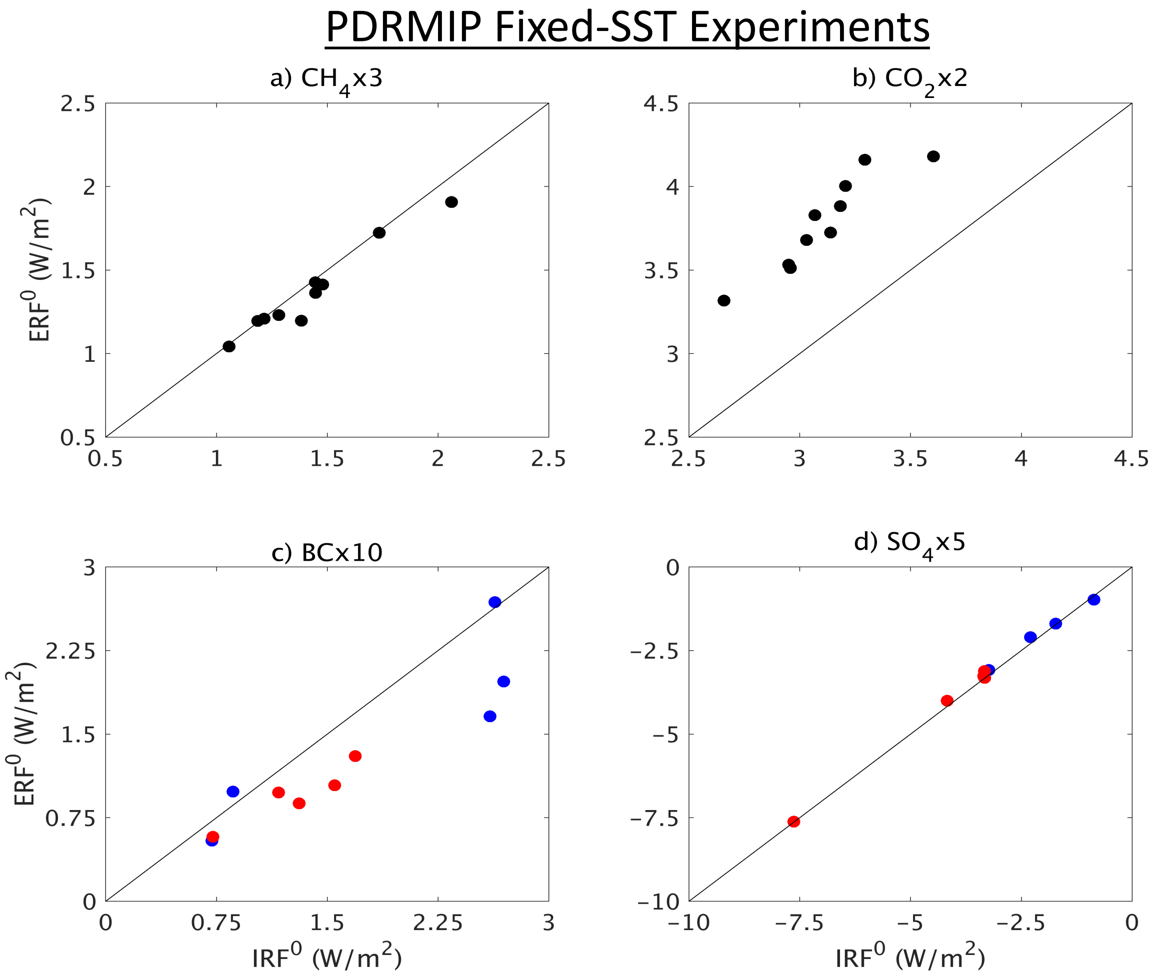


EIS: a predictive index based on the difference in potential temperatures between the 700-hPa level and the surface
ECTEI: a refinement of EIS taking into account a specific humidity gap between the 700-hPa level and the surface

Low cloud feedback can be explained by ECTEI, instead of EIS.

Inter-model spread in instantaneous radiative forcing across multiple climate drivers

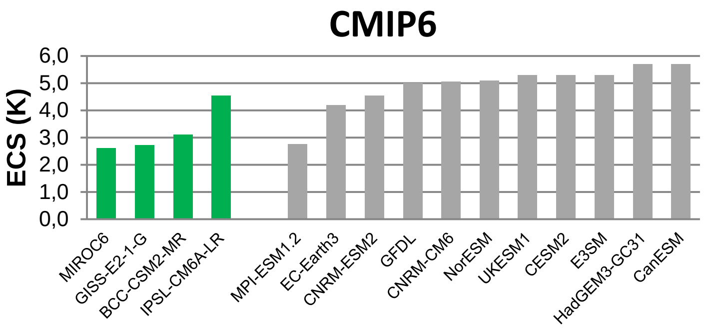
Ryan Kramer et al., Poster: 2-P14

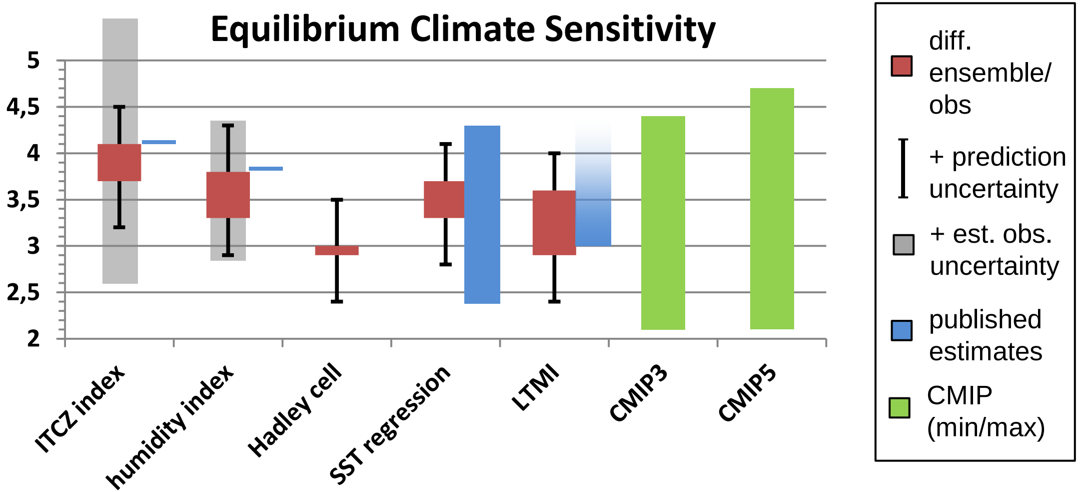


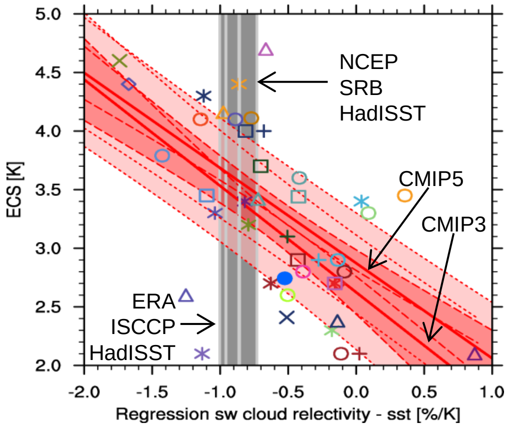
Inter-model spread in instantaneous radiative forcing accounts for most of the spread in effective radiative forcing.

Axel Lauer, Veronika Eyring, Manuel Schlund

P15: Consistency and robustness of emergent constraints for equilibrium climate sensitivity







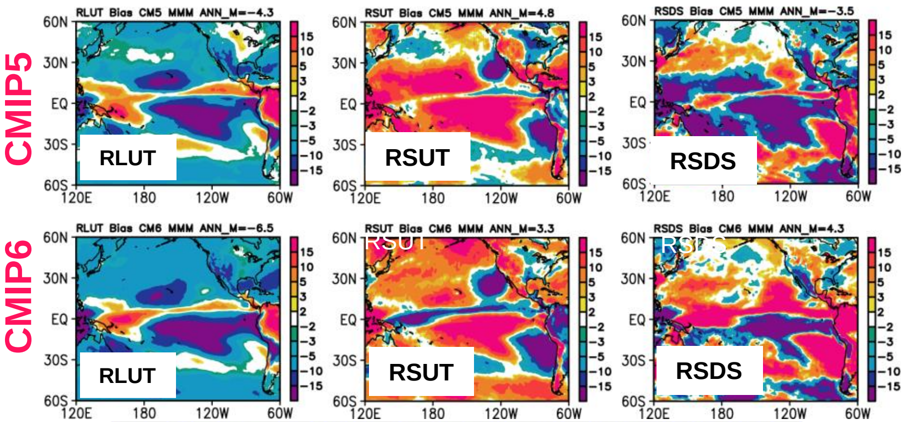
- Focus emergent constraints: precipitation, humidity, mixing, clouds, dynamics
- All tested emergent constraints are sensitive to the model ensemble and/or the observational datasets used
- **For details see poster P15 (session 2)**

DLR

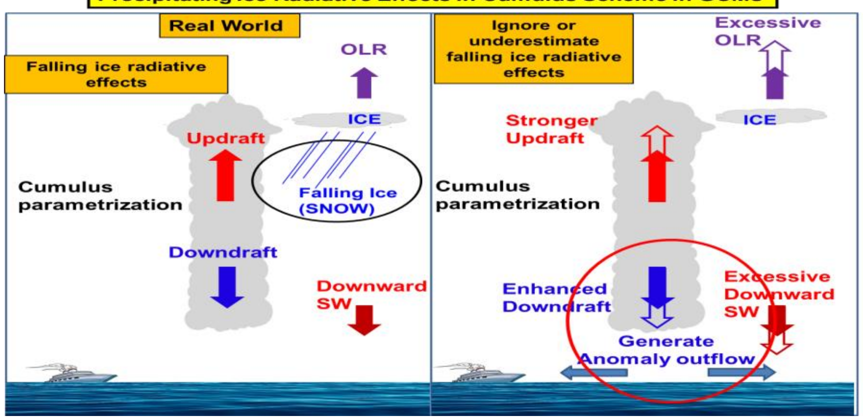
Comparisons of Simulated Cloud-Radiation-Circulation-Precipitation Coupling over Tropical Pacific Oceans in CMIP3, CMIP5 and CMIP6: Preliminary Results

Jui-Lin (Frank) Li, *J. H. Jiang, W.-L. Lee, M. Richardson, Yi-Hui Wang, Jia-Yuh Yu, E. Fetzer, G. Stephens*

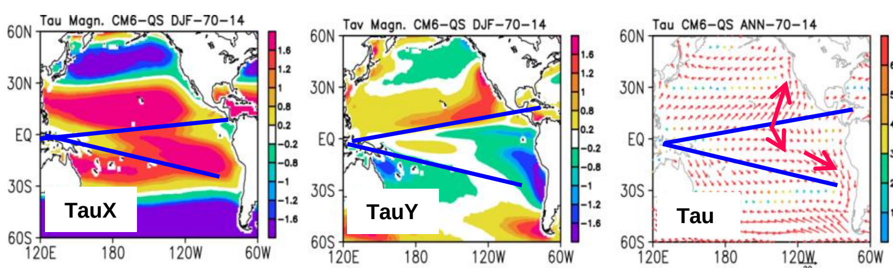
Bias of CMIP5 & CMIP6 Ensemble Mean Radiation



Precipitating Ice Radiative Effects in Cumulus Scheme in GCMs



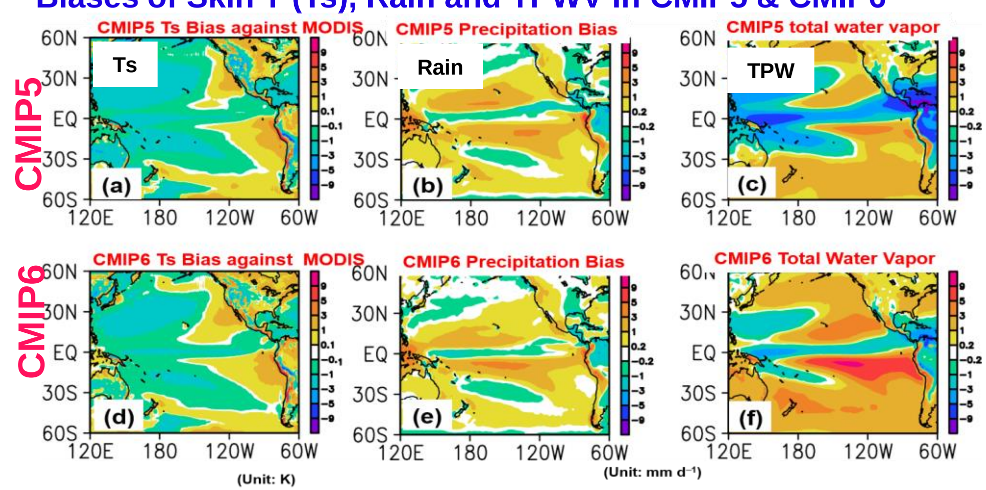
Bias of CMIP6 Ensemble Mean Surface Wind Stress



Science Question: The missing Falling Ice Radiative Effects (FIRE) in GCMs often disjoints nature between model representations and the observations in most GCMs (e.g., CMIP3, CMIP5). Previous studies (Li et al., 2012,2013,2014,2015) have shown missing FIRE plays a partial role in biasing radiation, surface wind stress, precipitation, SSTs, and other related fields over Pacific in many CMIP3 and CMIP5 models.

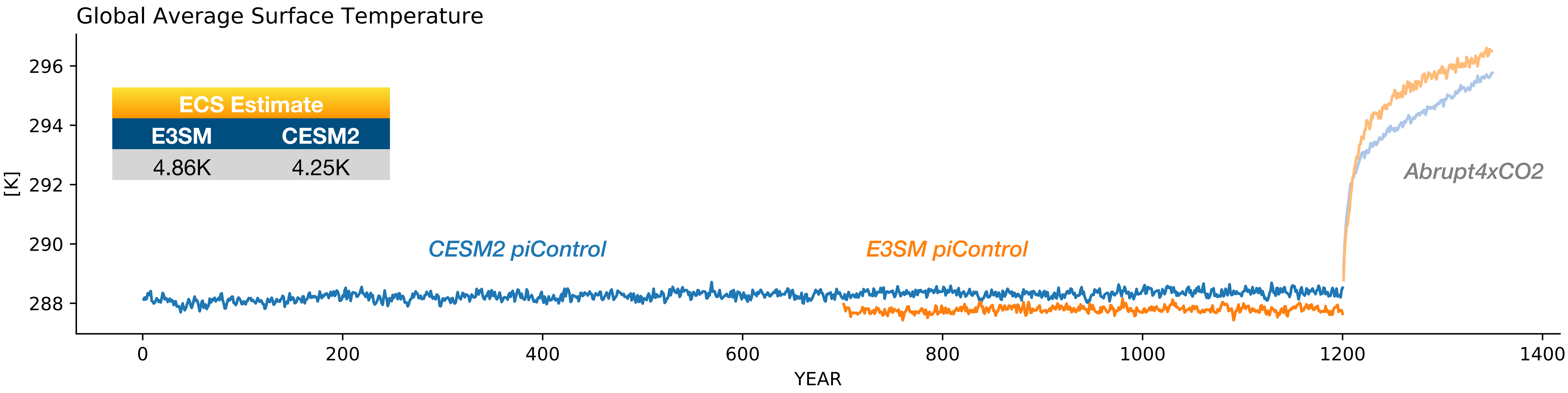
Method & Results: The abovementioned biases, commonly seen in CMIP3 & CMIP5, are found in CMIP6. Without FIRE, the CMIP models produce weaker surface wind stress, warmer ocean surface temperature, increased precipitation, and column total water vapor in the sub-tropical Pacific Ocean.

Biases of Skin T (Ts), Rain and TPWV in CMIP5 & CMIP6

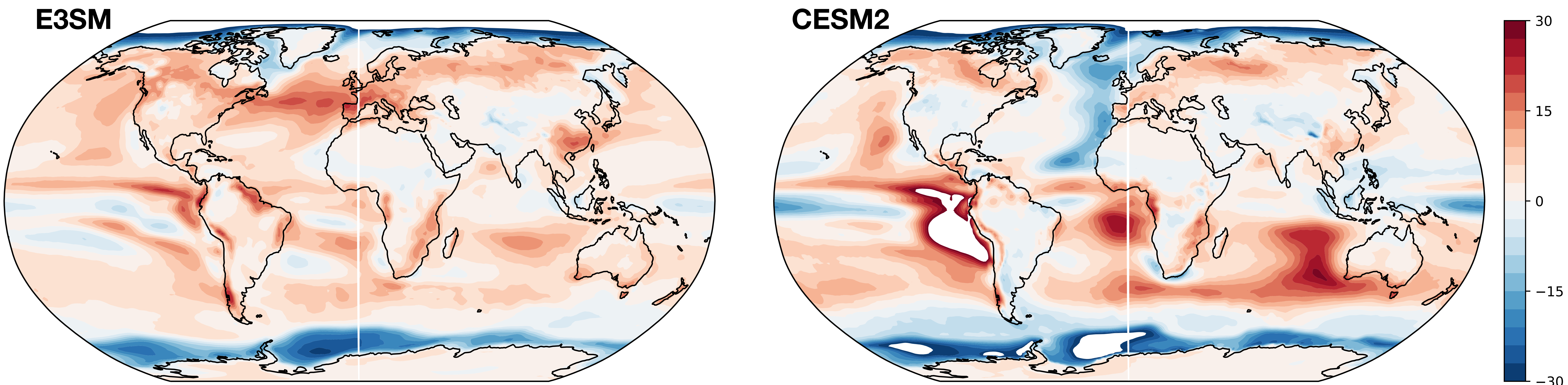


Climate sensitivity and cloud feedbacks in CESM2 and E3SM

Brian Medeiros, Julio Bacmeister, Cecile Hannay, Stephen Klein, Mark Zelinka

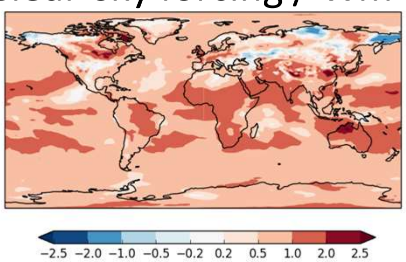


Change in Cloud Radiative Effect (last 50y of abrupt4xCO2)

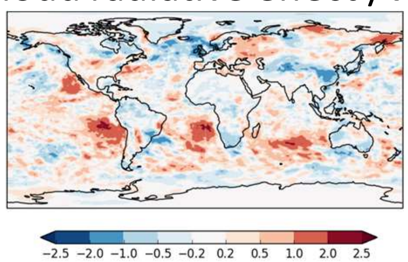


UKESM1: An assessment of the pre-industrial to present-day anthropogenic forcing by methane

Clear-sky forcing / Wm^{-2}

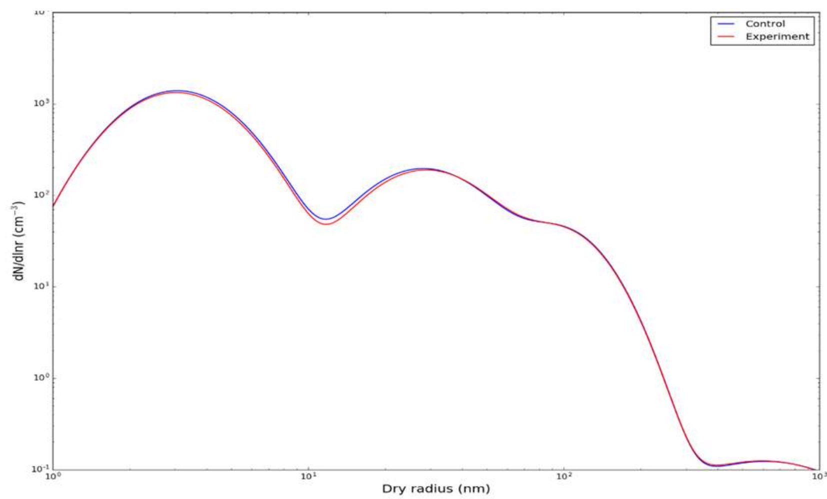


Cloud radiative effect /Wm^{-2}



NET	LW_{CS}	SW_{CS}	LW_{CRE}	SW_{CRE}	NET_{CS}	NET_{CRE}
+0.93 ±0.04	+0.72 ±0.02	+0.14 ±0.02	-0.39 ±0.02	+0.46 ±0.03	+0.86 ±0.03	+0.07 ±0.03

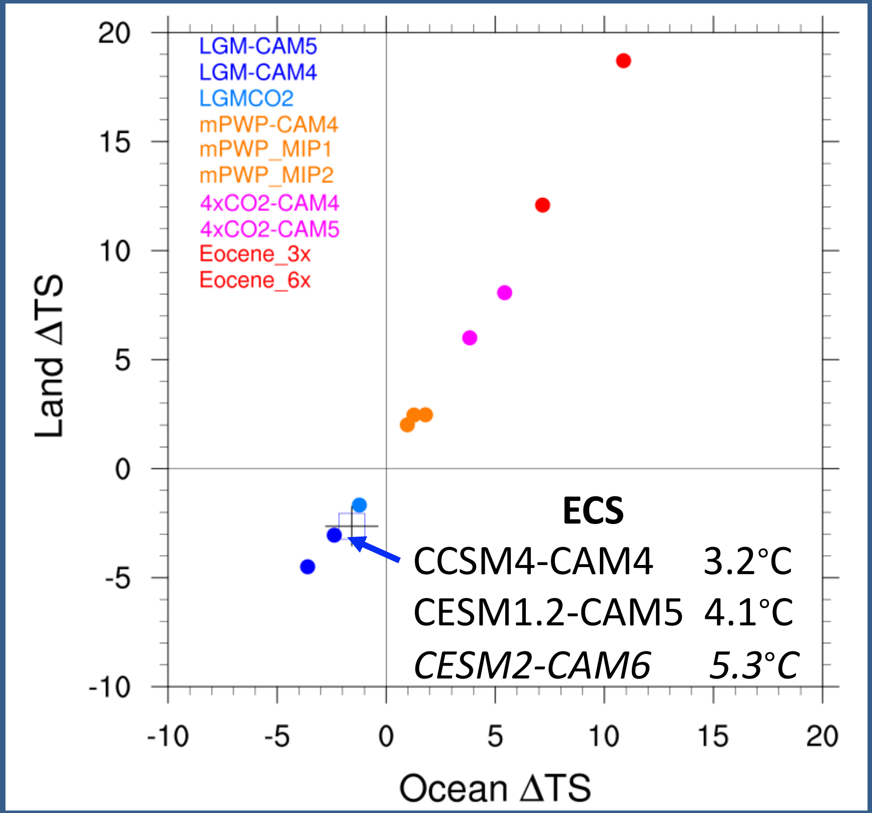
Agent	This work / Wm^{-2}
Aerosols	+0.13
O_3	+0.21
Stratospheric H_2O	+0.03 (Not completed)
CH_4	+0.56 (Not completed)



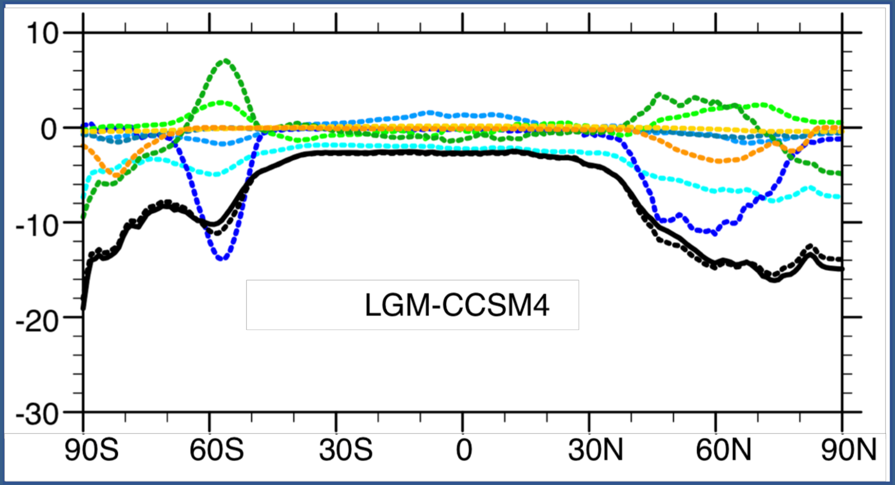
- ES Interactions increase CH4 ERF by more than 50%
- CH4 gives rise to an aerosol forcing of 0.13 Wm^{-2}
- This is driven by oxidant changes leading to a change in the aerosol size distribution, giving rise to less reflective clouds

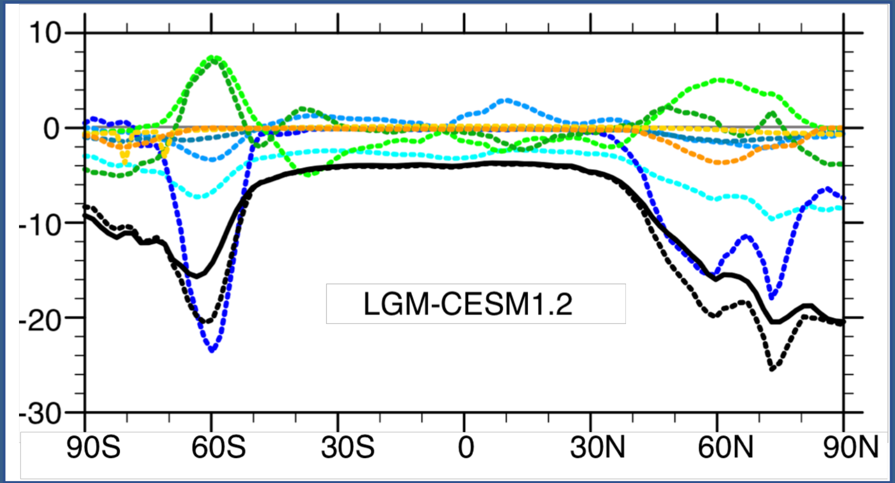
Using simple indices of global climate change: PMIP and CMIP simulations and paleoclimate data to evaluate how the Earth system responds to strong forcings

Bette Otto-Bliesner, Esther Brady, Ran Feng, Jiang Zhu, & Bob Tomas



CMIP6-PMIP4 simulations provide an 'out-of-sample' testbed for evaluating CMIP6 simulations under future projections





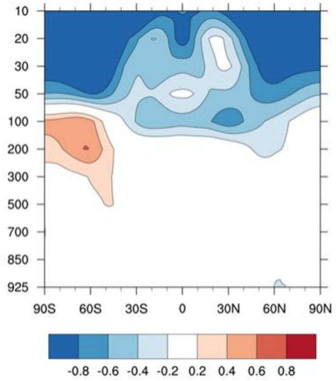
NCAR is sponsored by National Science Foundation

Influence of CMIP6 Forcing on Historical and Decadal Hindcast Simulations with MPI-ESM

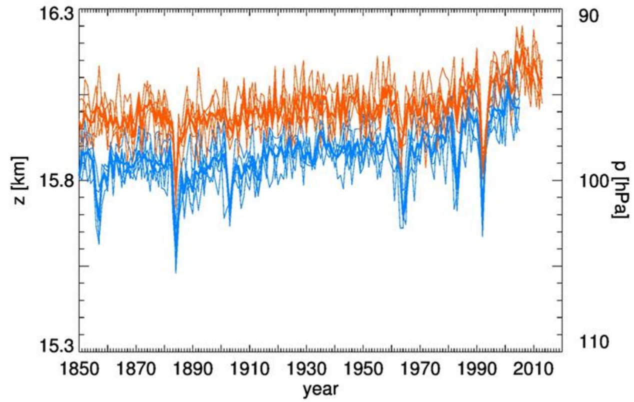
H. Pohlmann et al.

Differences between **Historical simulations** with CMIP5 and CMIP6 forcing:

- Temperature:

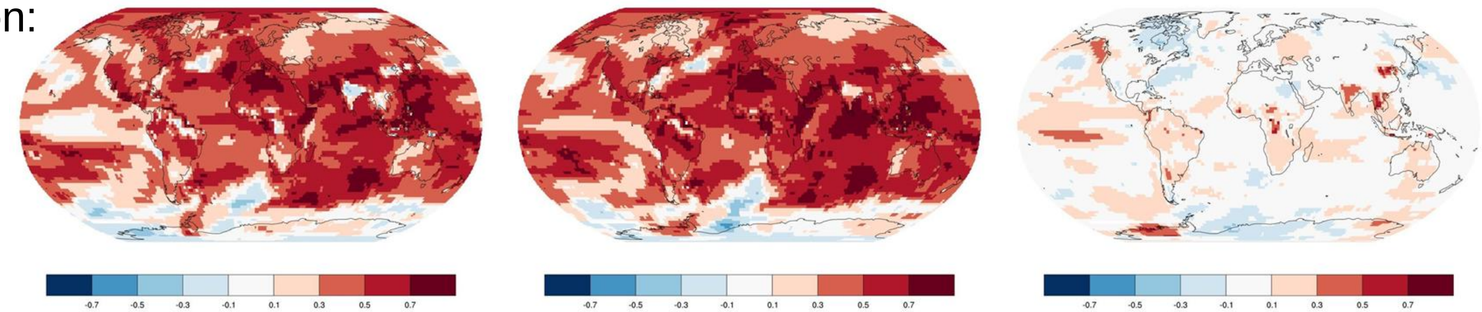


- Tropopause height:



Differences between **Decadal hindcast simulations** with CMIP5 and CMIP6 forcing:

- SAT correlation:



CMIP5 CMIP6 diff

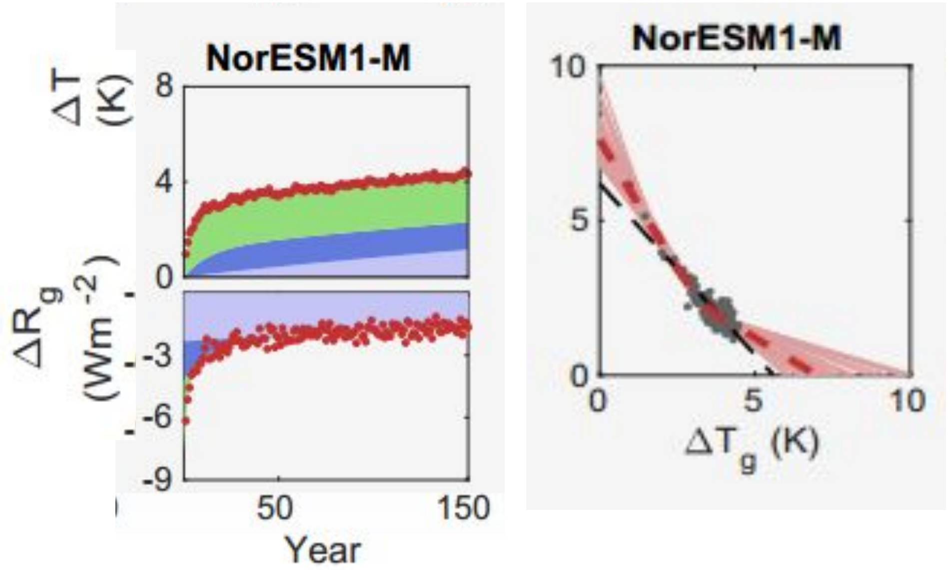
Uncertainties in Earth System Response on multiple timescales and implications for climate policy

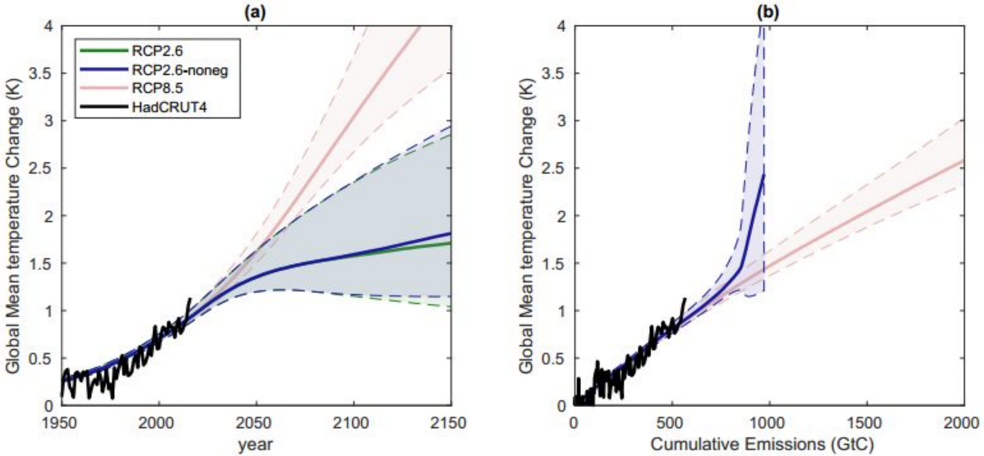
3 statements:

1 - ECS is likely <4.5K

2 - the longer we observe the climate system, the more accurately we know ECS

2 - Climate response is more usefully described for policy in terms of TCRE than ECS





Historical aerosol forcing diagnosis in CMIP6, AerChemMIP and AeroCom models

poster 2-P22

Michael Schulz[1], Gunnar Myhre[2], Bill Collins[3], Jean-Francois Lamarque[4]

1 - Norwegian Meteorological Institute (Norway)
2 - Center for International Climate and Environmental Research [Oslo] (Norway)
3 - University of Reading (United Kingdom)
4 - National Center for Atmospheric Research [Boulder] (United States)

Climate crisis => worried scientists => perfectionating ESMs => model bugs => delayed AerChemMIP simulations

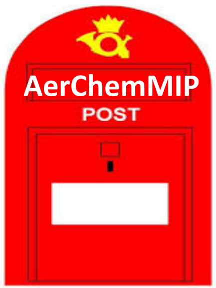
Three diagnostic strategies provide consistent, sufficiently detailed CMIP6 aerosol forcing history

- Difference of historic emission perturbation simulations
- Output of aerosol free SW TOA radiation diagnostics
- PD+PI ERF calculations, with AOD, CCN and load evolution

Norwegian Meteorological Institute

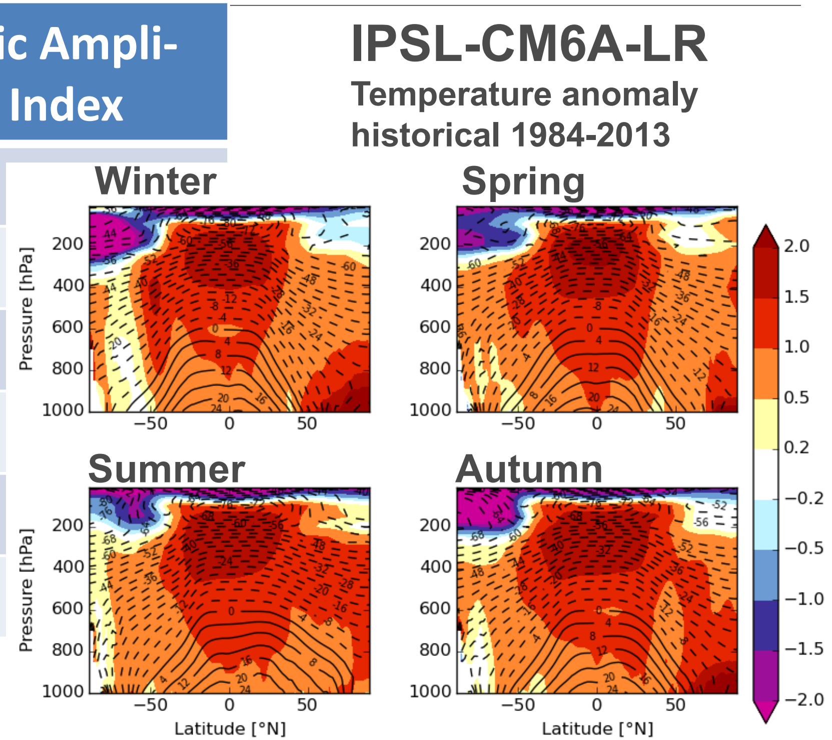
New interactive AeroCom evaluation interface *courtesy J.Gliss / A.Mortier*

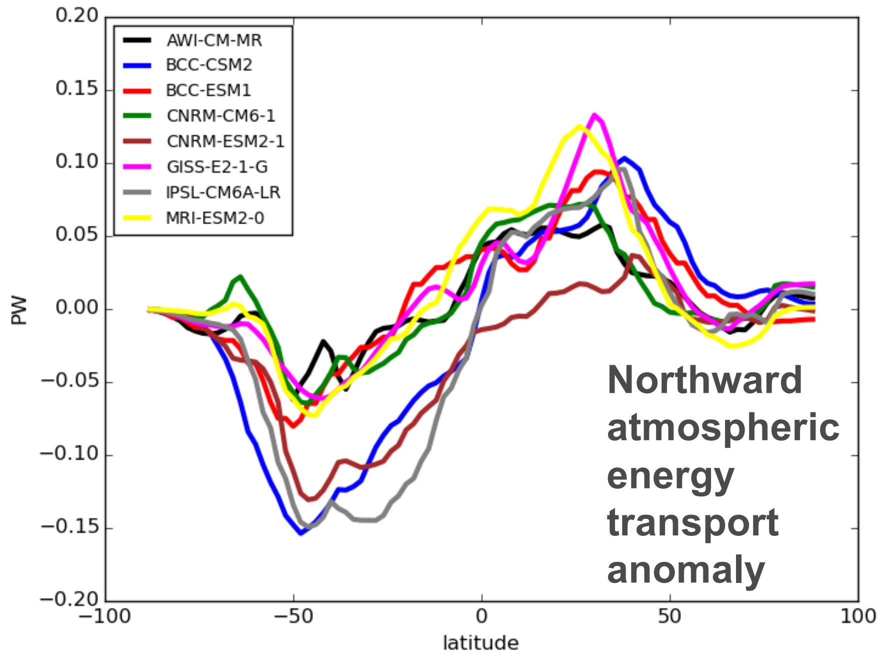
Complaints about AerChemMIP diagnostics can be posted at the poster



Polar Amplification and atmospheric meridional energy transport – Tido Semmler

historical 1984-2013	Arctic Amplification Index	Antarctic Amplification Index
AWI-CM-MR	2.0	1.7
BCC-CSM2-MR	2.2	0.6
BCC-ESM1	-0.5	3.7
CNRM-ESM2-1	2.8	0.3
GISS-E2-1-G	1.8	2.1
IPSL-CM6A-LR	2.5	0.6



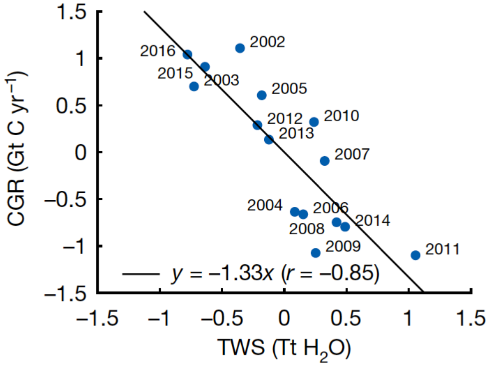


AWI-CM-MR	AAI	AAAI
abrupt-4xCO2 1st 30 years	2.1	1.1
abrupt-4xCO2 2nd 30 years	2.0	1.2
1pctCO2 1st 30 years	2.6	1.5
1pctCO2 2nd 30 years	2.1	1.5
historical 1984-2013	2.0	1.7

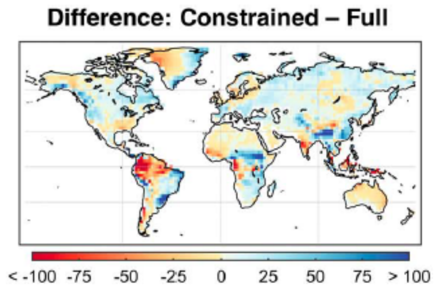
Global soil moisture-carbon feedbacks: Planned joint analyses from LS3MIP and C4MIP

Sonia I. Seneviratne(1), V. Brovkin (2), P. Friedlingstein (3), C. Jones (4), V. Arora (5), H. Kim (6), and G. Krinner (7)

1) ETH Zurich, Zurich, Switzerland; 2) MPI-Meteorology, Germany; 3) U. Exeter, Exeter, UK; 4) Met Office, Exeter, UK; 5) CCCMA, Victoria, Canada; 6) U. Tokyo, Tokyo, Japan; 7) CNRS-IGE, Grenoble, France

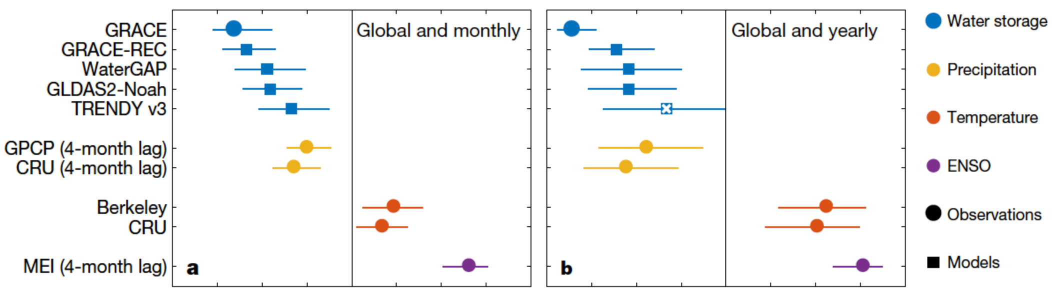


Evidence of strong **global-scale** Land-water – CO_2 feedbacks from observations, which are **underestimated in CMIP5 ESMs land modules**



Observational constraints on CMIP5 water-cycle projections: More drying in Amazon, less in Mediterranean

(Padron et al. 2019, Nature)



(Humphrey et al. 2018, Nature)

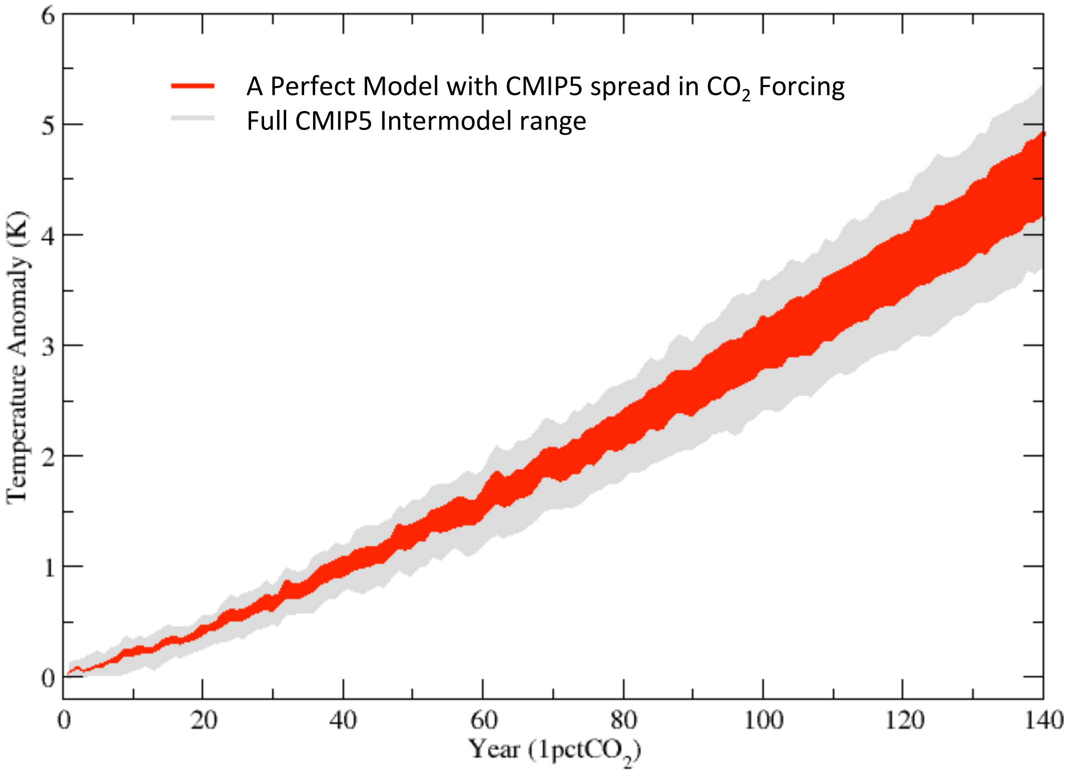
Assess soil moisture-CO_2-climate feedbacks in **CMIP6**:

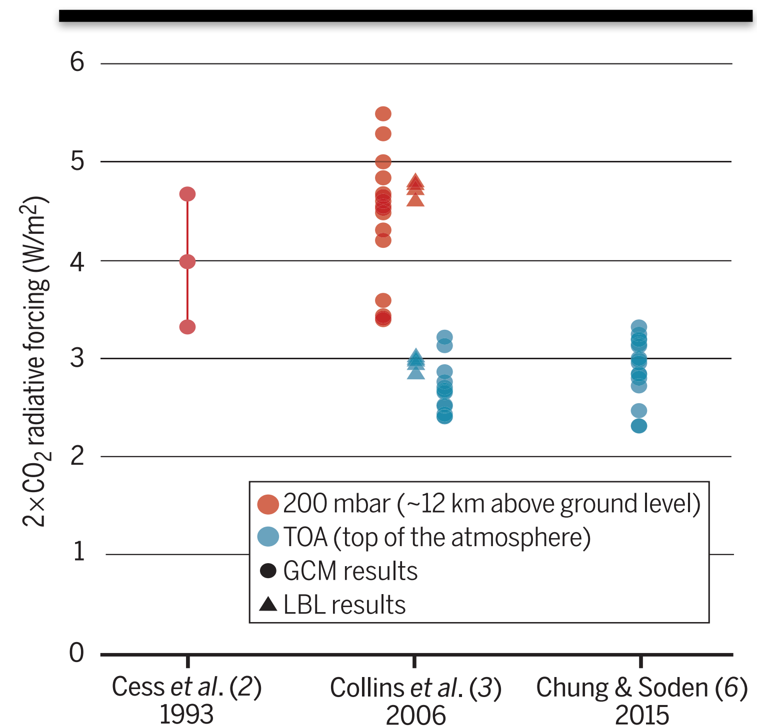
- Similar biases?
- Impacts on climate sensitivity?
- Joint LS3MIP-C4MIP analyses

Also general discussions on LS3MIP!

Tools for Computing Radiative Forcing in CMIP6 Models

- *Models do use consistent radiative forcing (even for identical emission scenarios)*





- **Forcing uncertainty is a significant contributor to intermodel spread.**

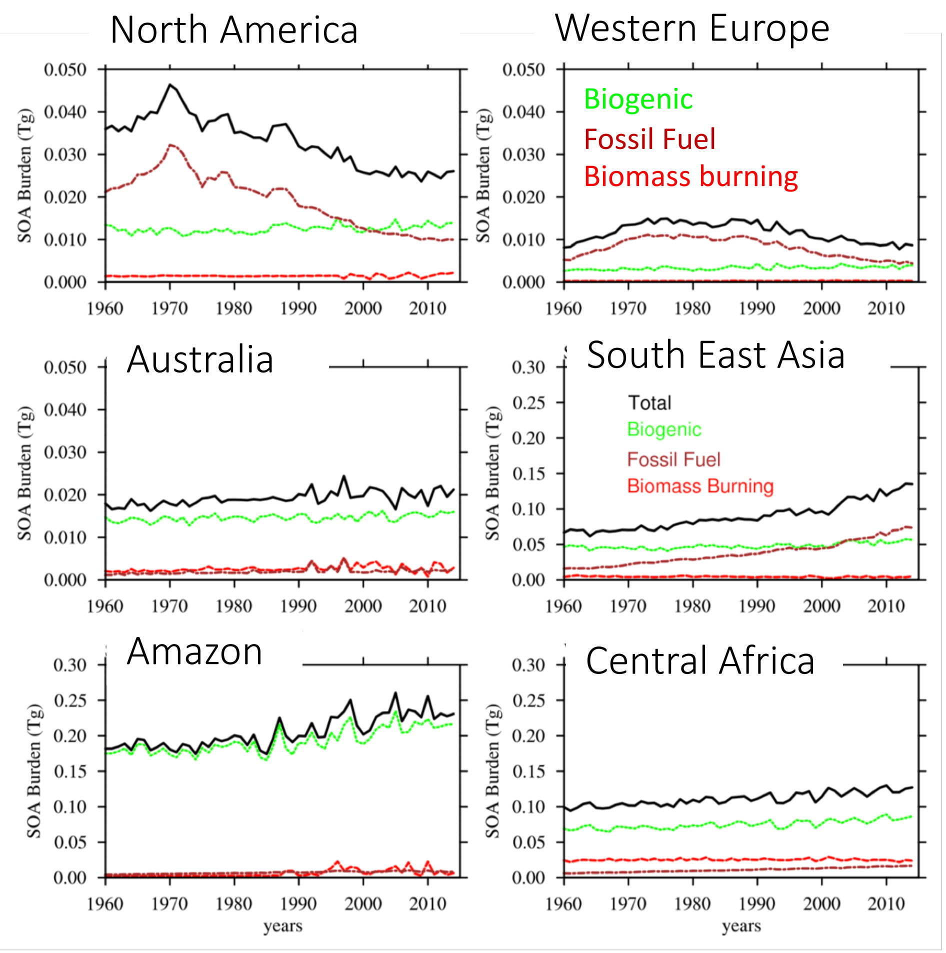
- **Forcing uncertainty remains a problem for over 25 years.**

NOAA Model Diagnostics Task Force

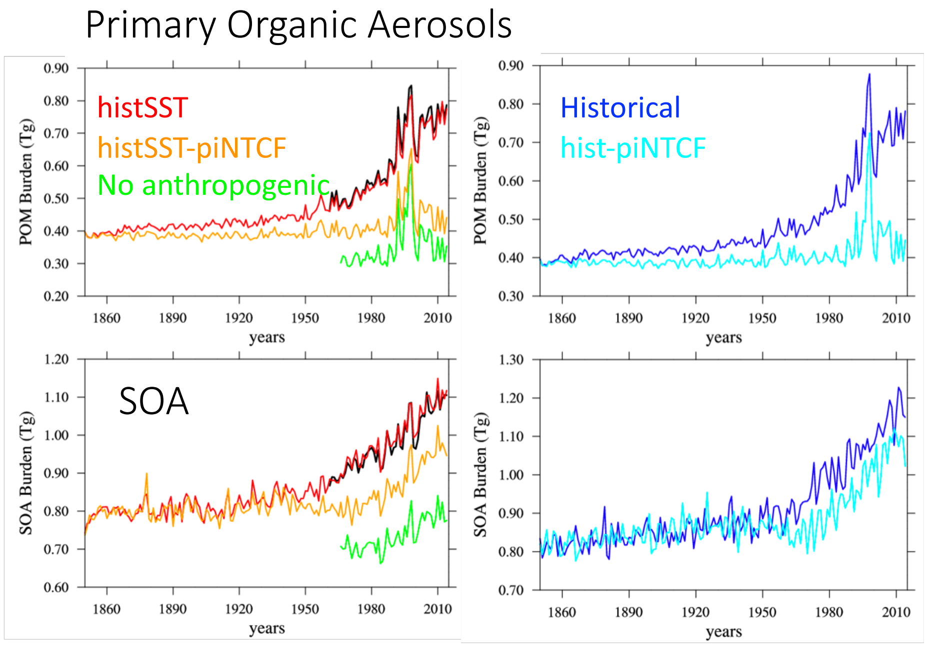
Representation and Trends of Organic Aerosols in CMIP6 AerChemMIP Simulations using the Whole Atmosphere Community Climate Model (WACCM6)

Simone Tilmes, Jean-Francois Lamarque, Louisa Emmons, Andrew Gettelman, Alma Roux, Mike Mills, Doug Kinnison, Pedro Campuzano Jost, Jose Jimenez, CESM2 team

Source contributions of secondary organic aerosols over different regions in WACCM6



Evolution of Organic Aerosols in WACCM6 AerChemMIP Simulations

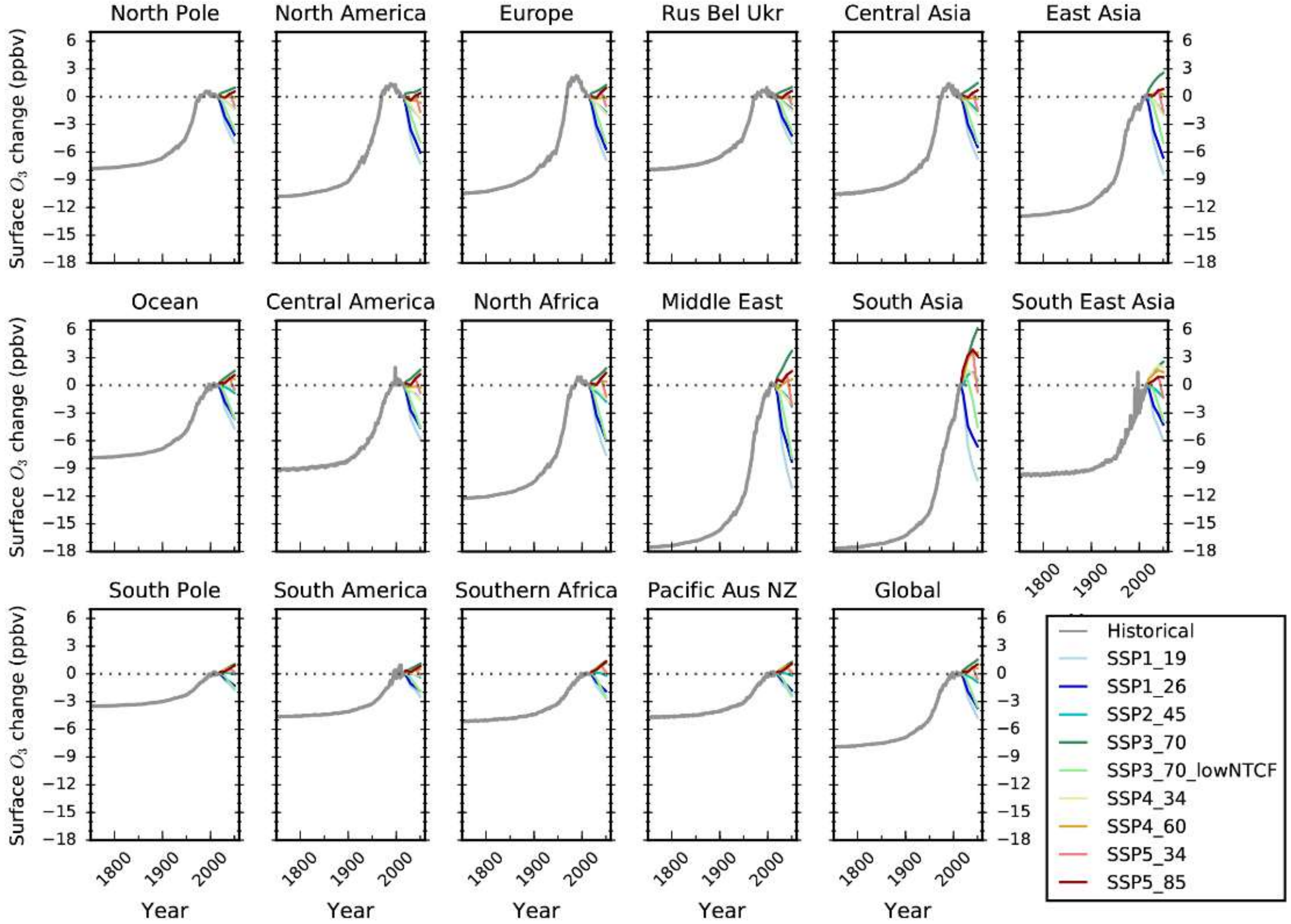


- Pre-industrial near-term climate forcer (piNTCF) experiments don't produce any increase in primary organic aerosols
- Simulations with piNTCF still show about half the increase in SOA burden compared historical simulations
- SOA precursors from biogenic emissions significantly contribute to the increase in SOA burden after 1960

Historical and Future Changes in Tropospheric Ozone using a Parameterised Approach with the CMIP6 emissions dataset

Session 2, Poster P27

- Parameterisation is able to quickly assess source-receptor responses in O_3 to emission perturbations across 16 regions
- Produces a 300 year change in surface O_3, O_3 column burden and O_3 radiative forcing
- Predictions compared to CMIP6 model, UKESM1



- Large range in future surface O_3 response across regions depending on SSP

Analysis of CMIP6 atmospheric moisture fluxes and the implications for projections of future change in regional rainfall

Ian G. Watterson (CSIRO), Harun Rashid (CSIRO), Richard Keane (UK Met Office)

The CMIP6 data tables now include the vertically integrated moisture transport or flux, in addition to precipitation and water vapour path, so multi-model analysis of atmospheric moisture will be feasible.

Currently, intuaw and intvaw are available only from 1pctCO2 simulations by three models. Trial simulations by three UM-based models have been added, to form a prototype CMIP6 ensemble. Convergence of flux relates to pr!

Figure 2: Six-model average of pr and conv (mm d⁻¹), and flux vectors in two seasons, period 1

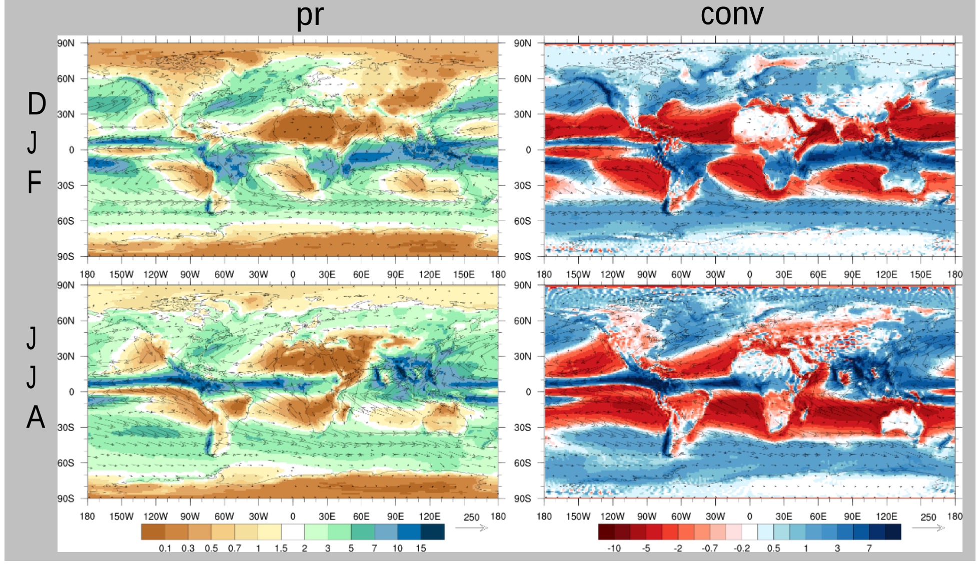
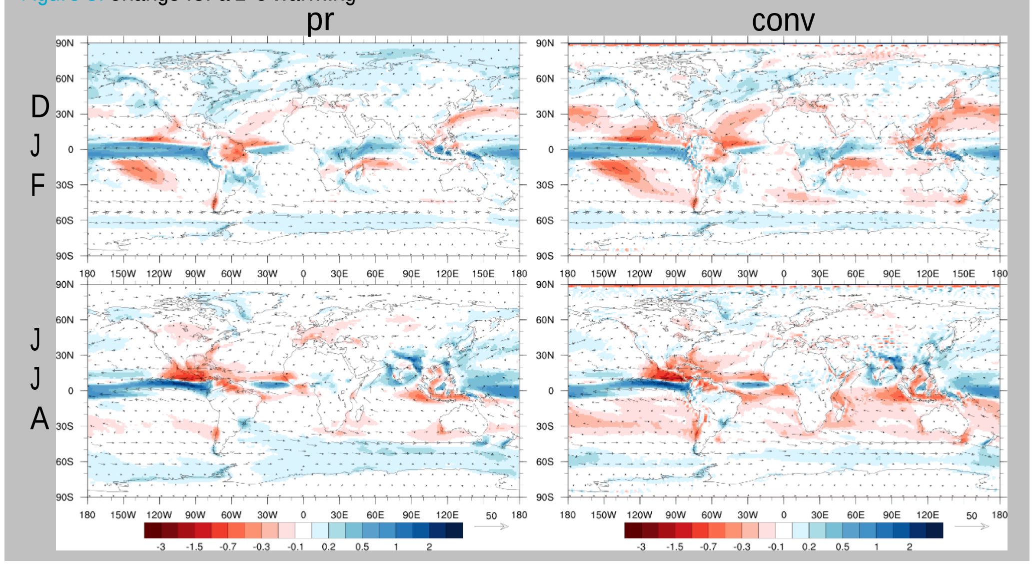


Figure 3: Change for a 1°C warming

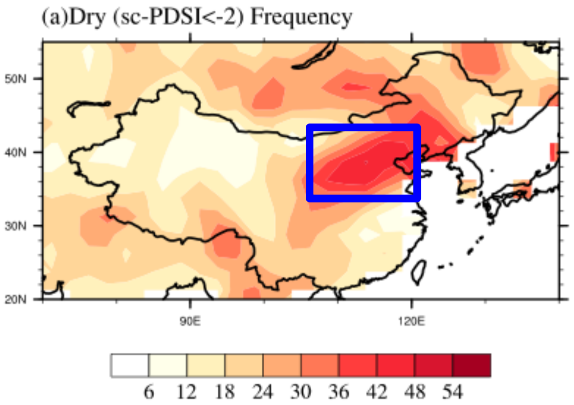


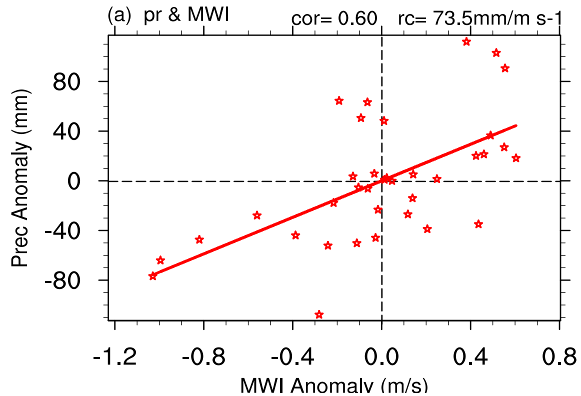
Aerosol forcing of extreme summer drought over North China

Lixia Zhang (lixiazhang@mail.iap.ac.cn), Peili Wu and Tianjun Zhou

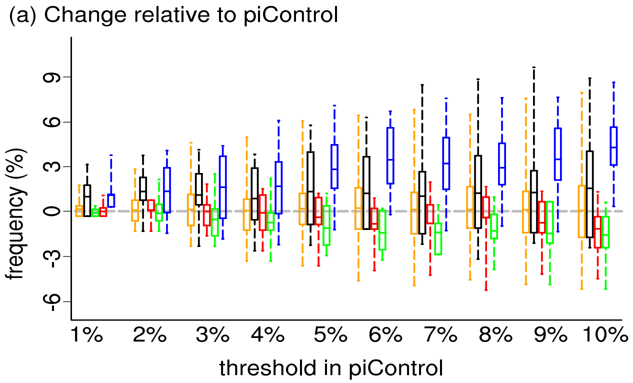
Motivation:

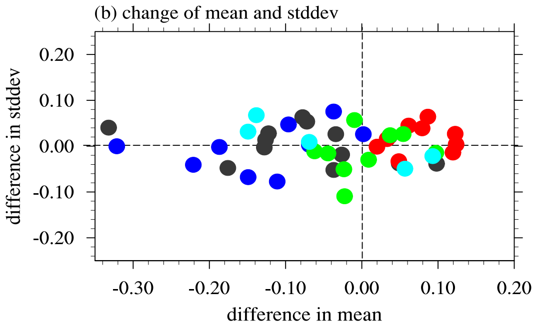
find a large-scale proxy for North China extreme summer droughts for attribution





- ✓ **Large-scale Proxy (MWI): V850 averaged over (20-45N,110-125E)**
- ✓ **Weakest MWI -> extreme North China summer drought**





orange: piControl Black: historical red: GHG forcing green: Nat forcing blue: Aerosol forcing

- ✓ **The probability of the extreme summer droughts under anthropogenic forcing has increased,**
- ✓ **Weakened East Asian summer monsoon circulation cause by the direct cooling effect from increased aerosol.**