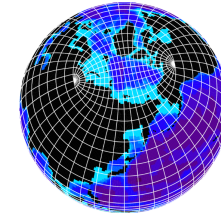


Japanese modeling groups' perspectives:

MIROC, MRI, and NICAM

Masa Watanabe (Univ of Tokyo, Japan)

From CMIP5 to CMIP6



Model lineup

- ✓ MIROC6 CGCM (T85L81+1deg)
- ✓ MIROC-ES2L (T42L40+1deg)
- ✓ MIROC-ES2M (T85L81+1deg)
- ✓ MRI-ESM2 (TL159L80+1deg)
- ✓ MRI-AGCM3.2H (TL319L64)
- ✓ NICAM AGCM (28km)

Major changes

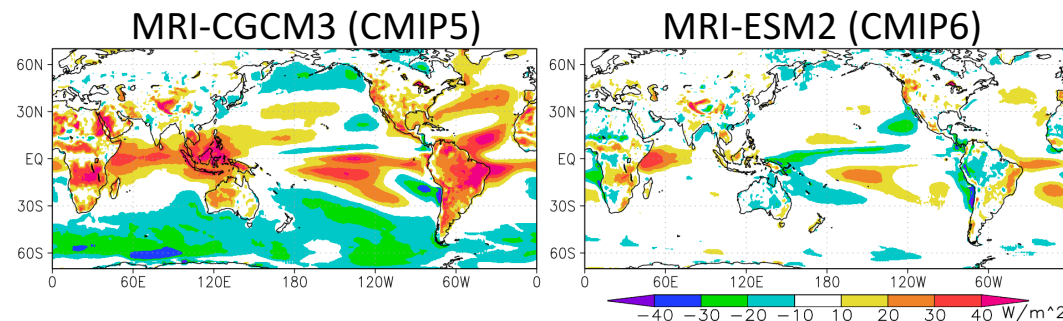
- High-top + Updated shallow clouds
- Offline chemistry
- High-top + Online chemistry + Nitrogen cycle
- High-top + Updated physics
- High resolution version of MRI-ESM AGCM
- Storm resolving model (low res version)

Example of model bias reduction

Annual-mean TOA SW radiation (against CERES)

Improved

- Too bright tropical clouds
- Too few liquid clouds

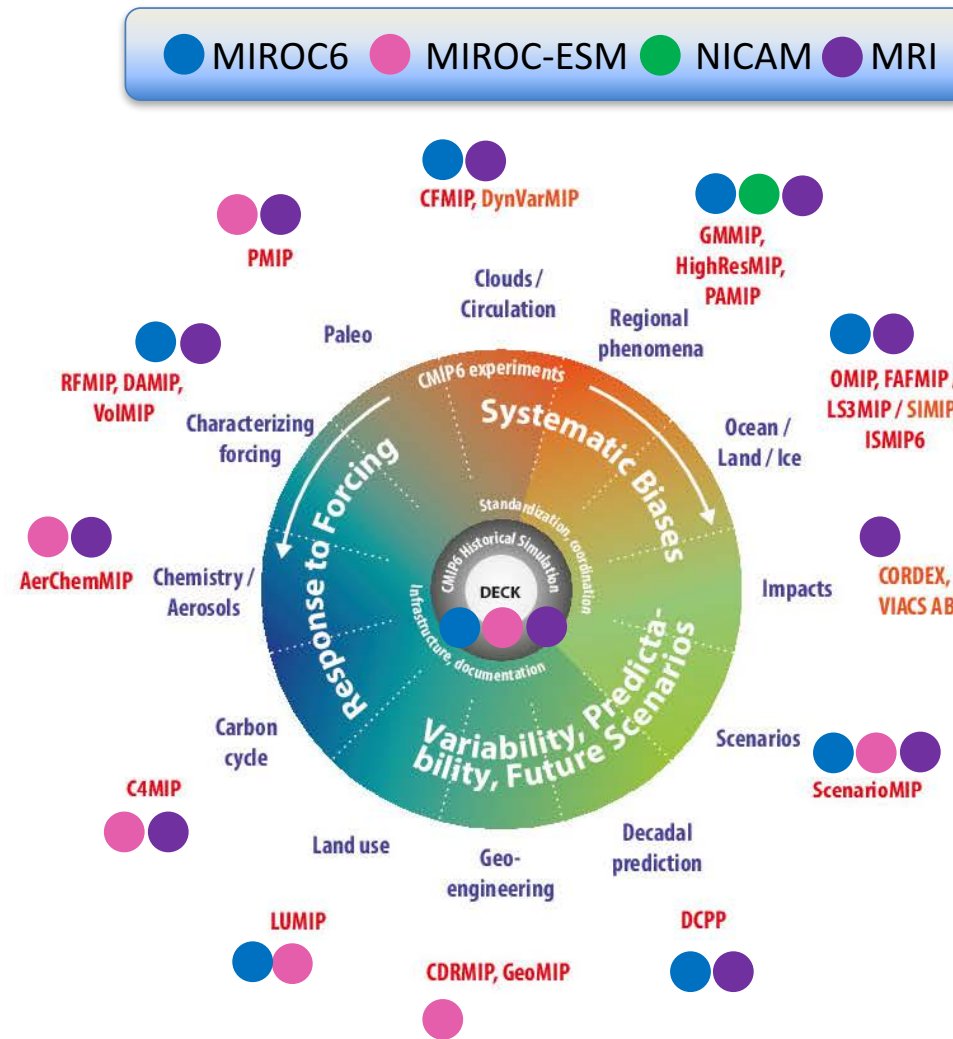


*** Yet, none of these GCMs/ESMs shows ECS > 4K**

Kawai et al. (2019 GMD)

CMIP6 experiments with MIROC/MRI/NICAM

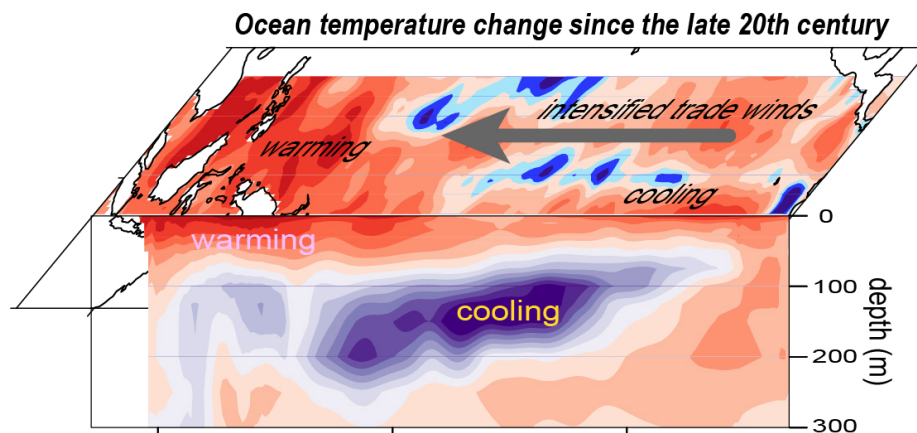
- ✓ **MIROC6, MIROC-ESM & MRI-ESM** participated in DECK
- ✓ SSC members in 9 MIPs, in which we contributed to coordinate Tier I/2 experiments:
 - (**MIROC6**) CFMIP, DCP, RFMIP, DAMIP, LS3MIP
 - (**MIROC-ESM**) C4MIP, AerChemMIP, PMIP
 - (**MRI-ESM**) OMIP
- ✓ **NICAM** and **MRI-AGCM** contributed only to HiResMIP
- ✓ **MIROC6** produced a large ensemble (50 members) for historical and SSPs



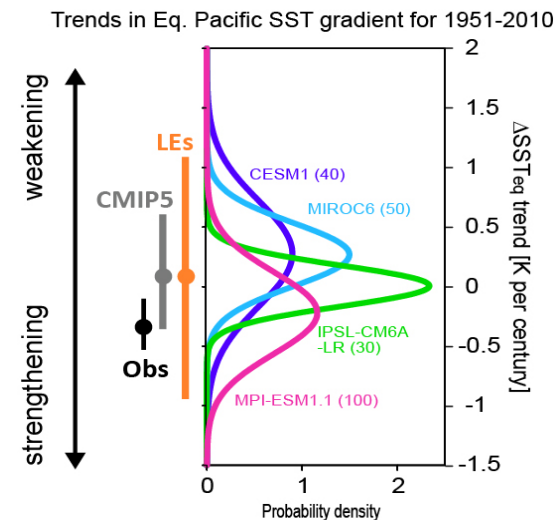
Science issues in MIPs

- ✓ Using large ensembles (LEs) for attributing past SST pattern change relevant to ECS (*CFMIP*, *DAMIP*)
- ✓ Probabilistic event attribution
- ✓ Earth system prediction (*DCPP*)
- ✓ AGCM-based high resolution simulations (*HighResMIP*)

1951-2010 trends in the zonal SST gradient



Combined four LEs suggest the observed strengthening of the SST gradient can arise from internal variability

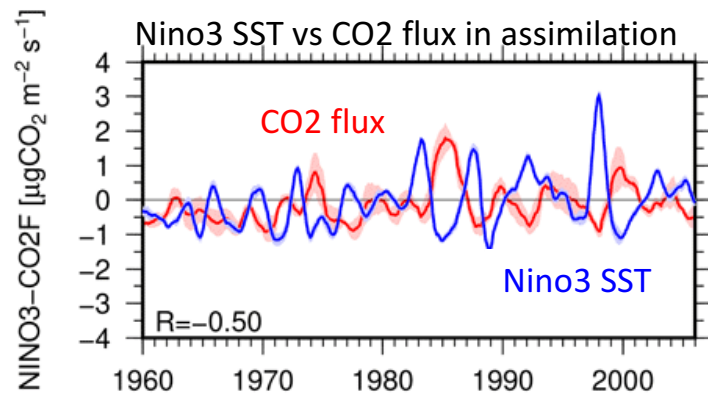


Watanabe et al. (2020 Nature CC)

Science issues in MIPs

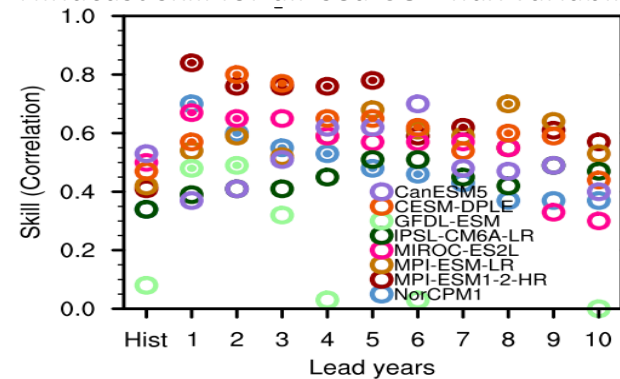
- ✓ Using large ensembles (LEs) for attributing past SST pattern change relevant to ECS (*CFMIP*, *DAMIP*)
- ✓ Probabilistic event attribution
- ✓ **Earth system prediction (*DCPP*)**
- ✓ AGCM-based high resolution simulations (*HighResMIP*)

Prototype Earth system prediction system using MIROC-ES2L



Watanabe et al. (2020 OS)

Hindcast skill for air-sea CO2 flux variability



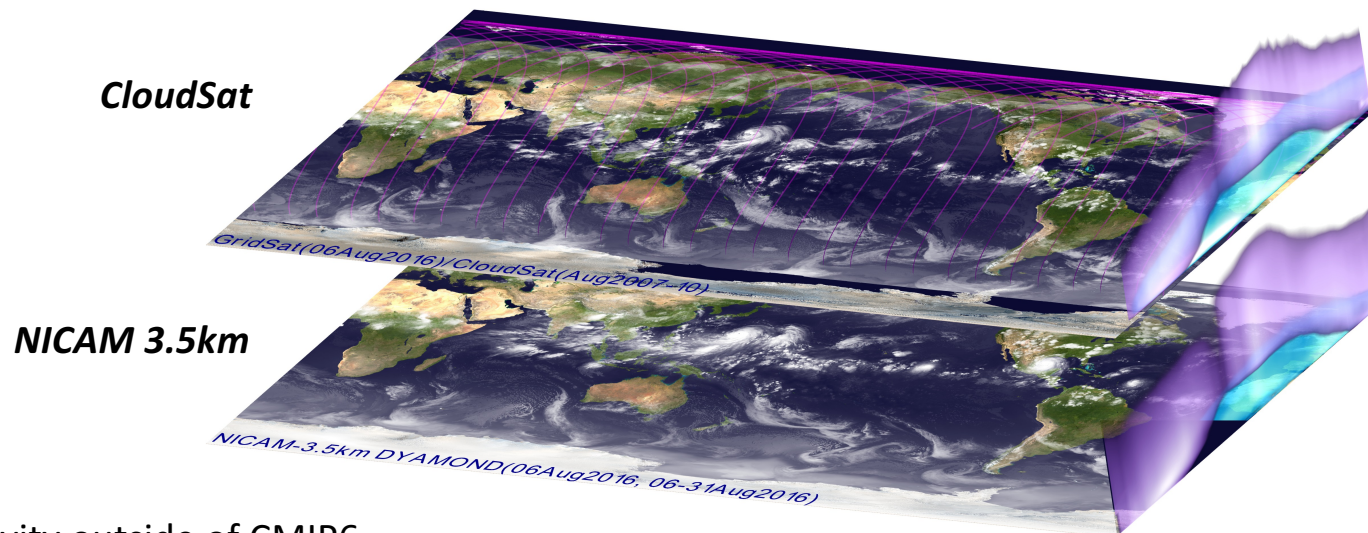
Illyina et al. (2020 in rev)

- Anti-correlation between CO2 flux & Nino3.4 SST well reproduced
- 2yr prediction skill for the CO2 flux improved in some ocean regions
- Participating in a model intercomparison

Science issues in MIPs

- ✓ Using large ensembles (LEs) for attributing past SST pattern change relevant to ECS (*CFMIP*, *DAMIP*)
- ✓ Probabilistic event attribution
- ✓ Earth system prediction (*DCPP*)
- ✓ AGCM-based high resolution simulations (*HighResMIP*)

High-res modeling for cloud studies



Ongoing activity outside of CMIP6
(RCEMIP, DYAMOND etc)

Kodama et al. (2020 GMD)

Beyond CMIP6

Ongoing efforts

- ✓ Model updates and integration
- ✓ No unified model, but separation between high-res models and ESMs
- ✓ Ensemble simulations for national adaptation purposes (e.g., d4PDF, Mizuta et al. 2017 BAMS), their fitness to CMIP unclear though

Remarks

- ✓ CMIP6 could maintain a momentum for new research & model development, but we need a break for refreshment toward CMIP7
- ✓ A dilemma emerging from maturing the CMIP cycle applies (as in other modeling centers): research vs 'service'-like computation
- ✓ There may be an option to pass the climate service part of CMIP7 to operational centers (with WGNE?), but our funding does not fit (budgets for CMIP calculations have been for research purpose)
- ✓ Problematic AMIP SST data?