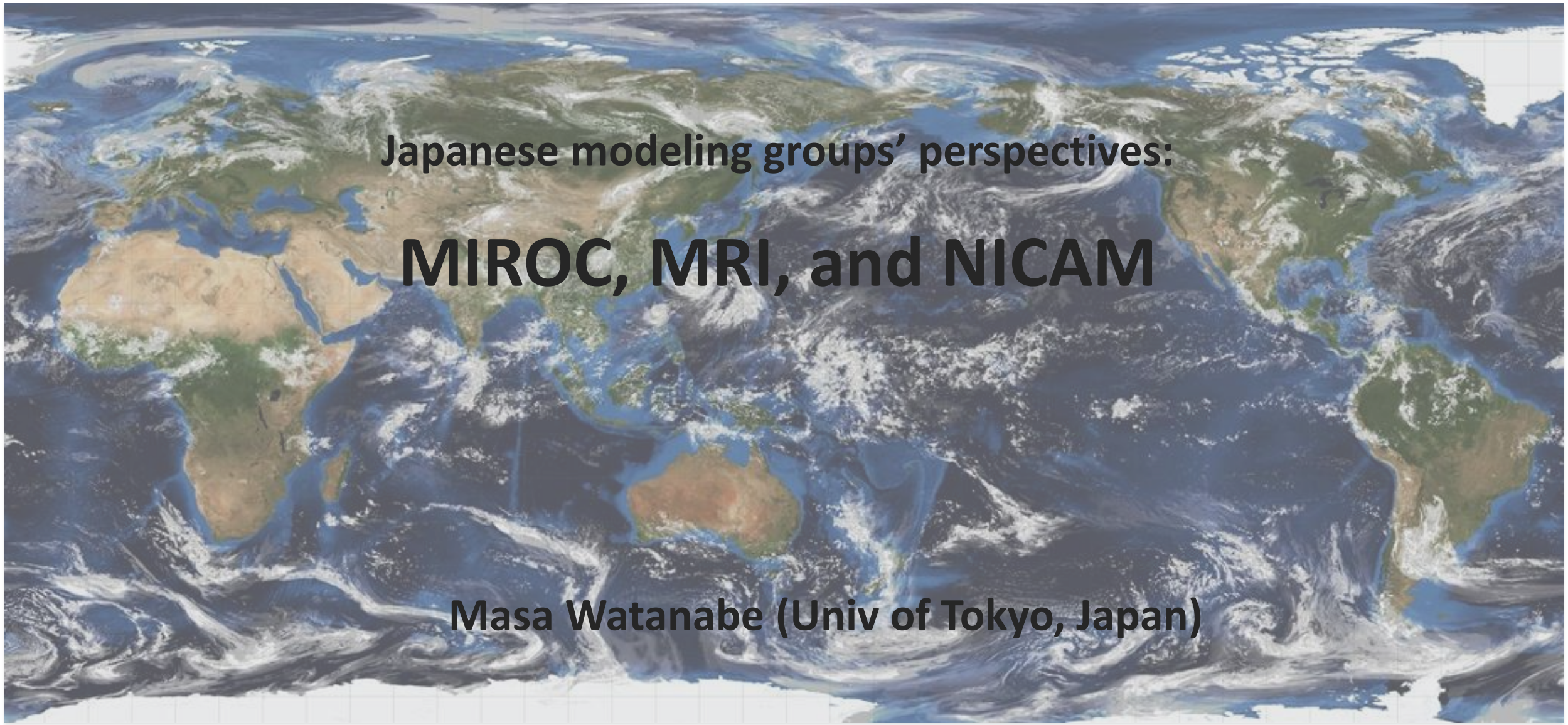
TOUGOU | Integrated Research Program for Advancing Climate Models



Japanese modeling groups' perspectives:

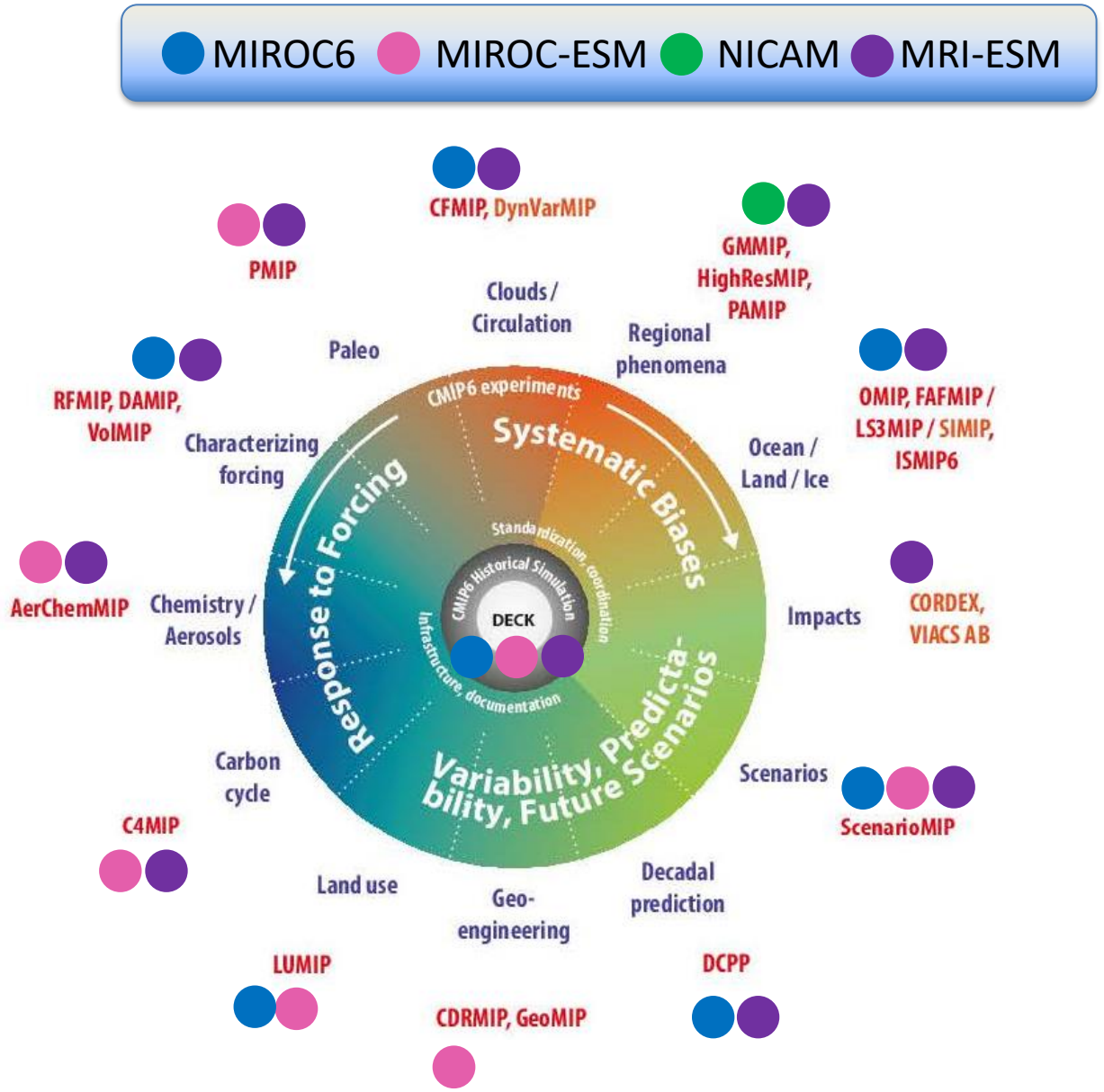
MIROC, MRI, and NICAM

Masa Watanabe (Univ of Tokyo, Japan)

Snapshot from 1 km NICAM prototype simulation

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 Tier1/2 experiments:
  (MIROC6) CFMIP, DCPP, RFMIP, DAMIP, LS3MIP
  (MIROC-ESM) C4MIP, AerChemMIP, PMIP, COVID-MIP
  (MRI-ESM) OMIP
- ✓ *NICAM* and *MRI-AGCM* contributed only to HiResMIP
- ✓ *MIROC6* produced a large ensemble (50 members) for historical and SSPs

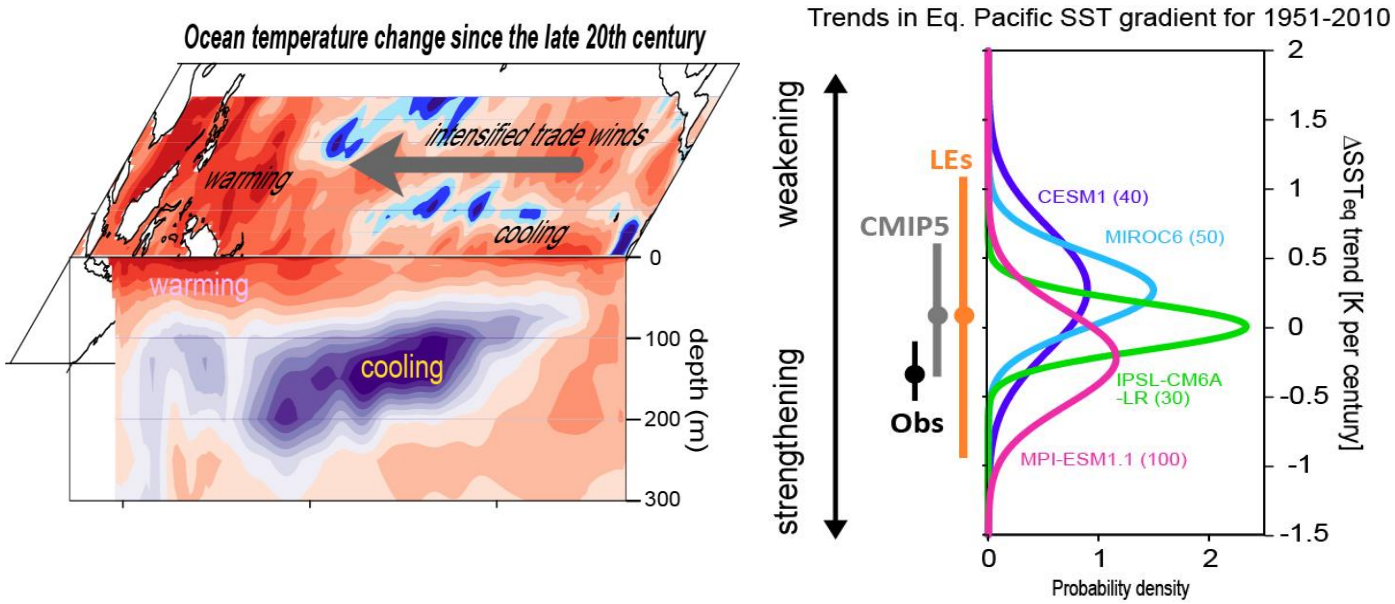


Recent highlights in MIROC/MRI/NICAM science activities

- ✓ Using large ensembles (*N*=50) for attributing past climate changes & projections
- ✓ Probabilistic event attribution
- ✓ Earth system assimilation and prediction
- ✓ Toward exa-scale high resolution simulations

MIROC6 CGCM

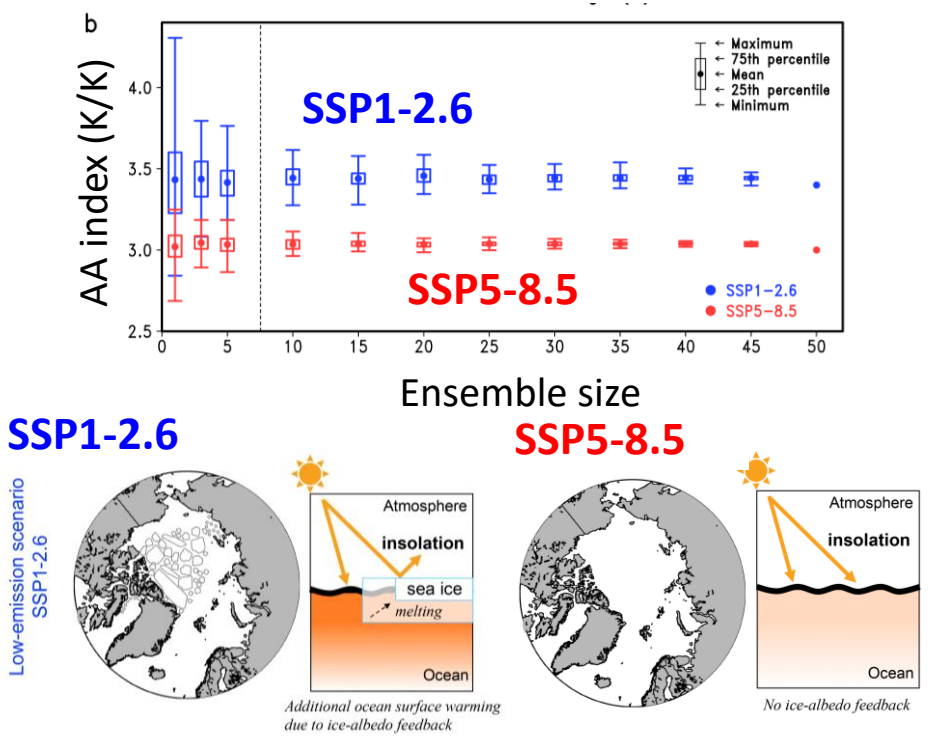
1951-2010 trends in the zonal SST gradient



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

Watanabe, Dufresne, Kosaka, Mauritsen & Tatebe (2020 Nature CC)

Scenario dependence of the Arctic amplification



Ono et al. (2021 Comm Earth & Env, in rev)

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- ✓ Using large ensembles (*N*=50) for attributing past climate changes & projections
- ✓ Probabilistic event attribution (EA)
  - ☐ Yukiko Imada (MRI) has started serving as a member of LHA EPESC WG3
- ✓ Earth system assimilation and prediction
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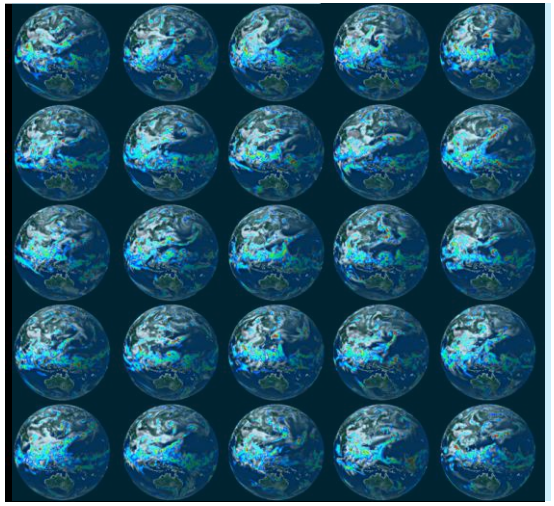
MRI-AGCM

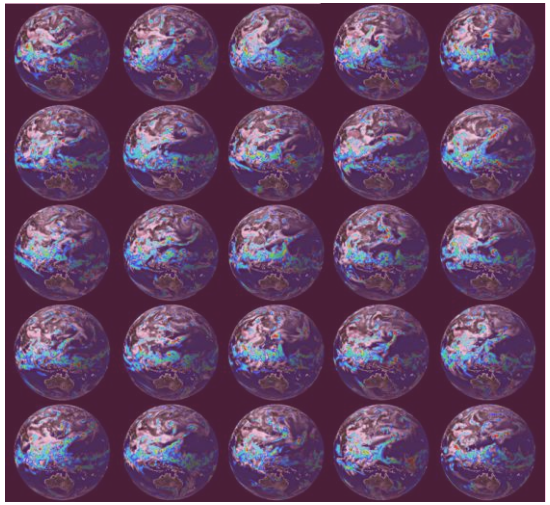
d4PDF database for Policy Decision making for Future climate change

100-member ensembles with 60km AGCM + 20km RCM for EA, downscaling, and any other applications

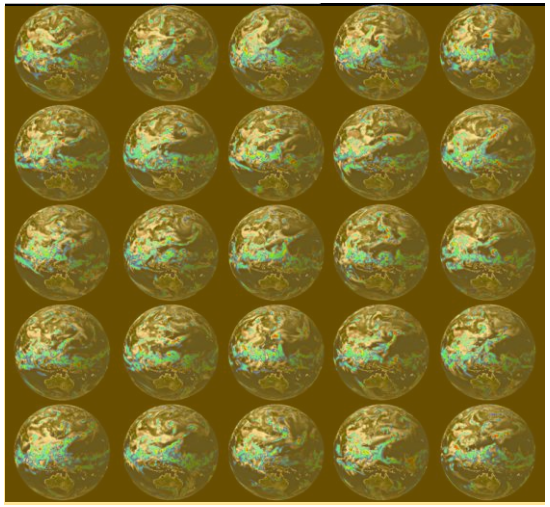
without global warming



present day (AMIP)



future climate (+1.5, +2, +4K)



Mizuta et al. (2017 BAMS)

Courtesy of Y Imada

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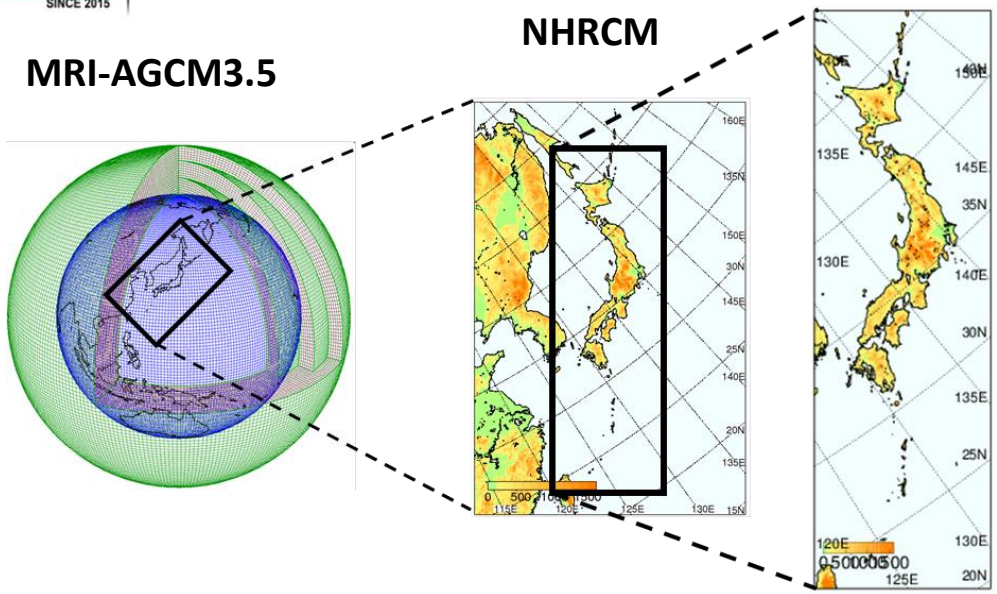
MRI-AGCM

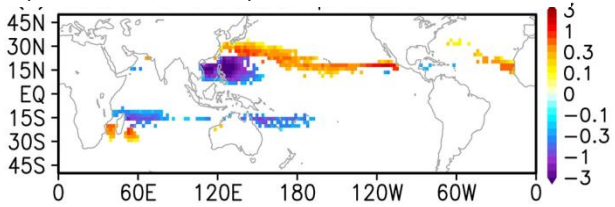
d4PDF database for Policy Decision making for Future climate change

MRI-AGCM3.5

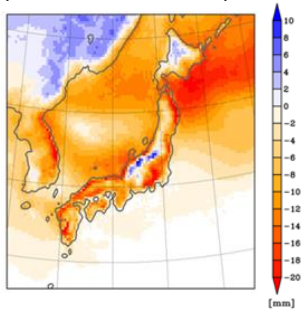
NHRCM



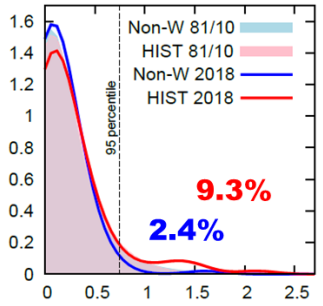
future changes of severe tropical storms (Yoshida et al. 2017)



future changes of severe snowfall events (Kawase et al. 2016)



E/A: severe precip. in July 2018, Japan (Imada et al. 2020)



Regional attribution of
- Heatwaves
- Heavy rain
- Tropical cyclones
- Severe snowfall
- etc.

(>70 papers)

Courtesy of M Ishii

Recent highlights in MIROC/MRI/NICAM science activities

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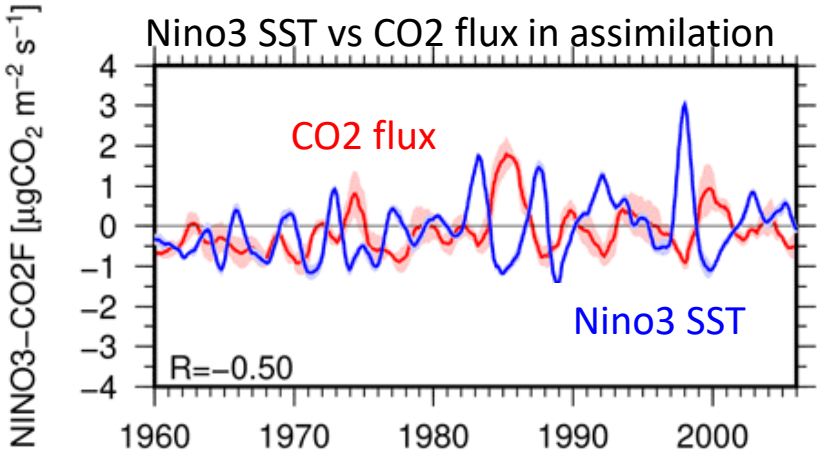
MIROC-ESM

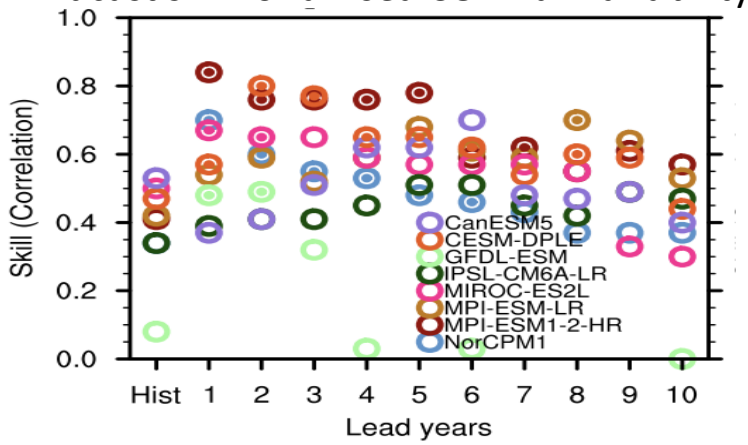
First version Earth system prediction system using MIROC-ES2L

Nino3 SST vs CO2 flux in assimilation



Watanabe et al. (2020 OS)

Hindcast skill for air-sea CO2 flux variability



Illyina et al. (2021 GRL)

- Anti-correlation between CO2 flux & Nino3.4 SST well reproduced
- 2yr prediction skill for the CO2 flux improved in some ocean regions
- Need to assimilate Earth system variables

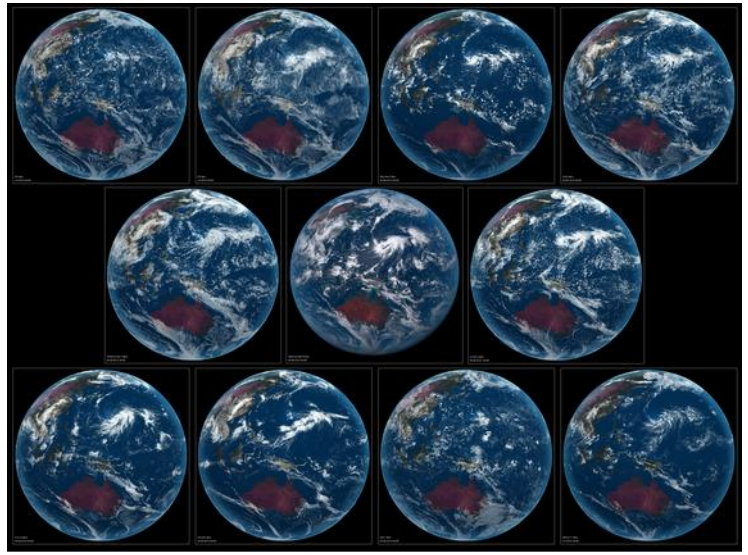
Recent highlights in MIROC/MRI/NICAM science activities

- ✓ Using large ensembles (*N*=50) for attributing past climate changes & projections
- ✓ Probabilistic event attribution
- ✓ Earth system assimilation and prediction
- ✓ Toward exa-scale high resolution simulations
  - ☐ Chihiro Kodama (JAMSTEC) is serving as a member of LHA Digital Earths

NICAM

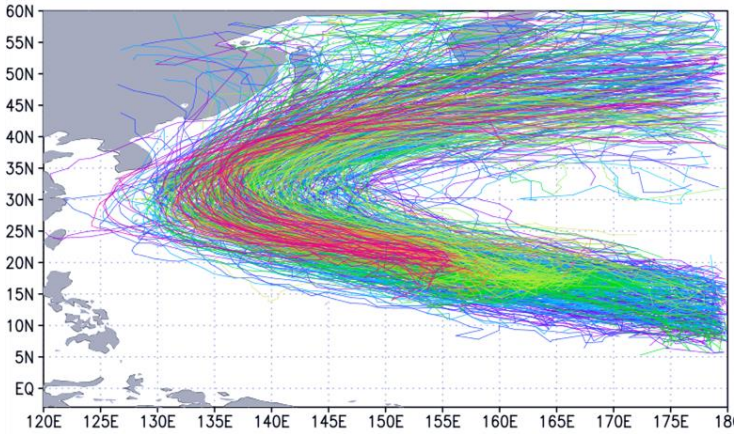
High-res modeling toward digital twin

Snapshots from 10 global storm resolving models



Ongoing activity outside of CMIP6
(RCEMIP, DYAMOND etc)

1000-mem super ensemble using
NICAM for Typhoon predictability



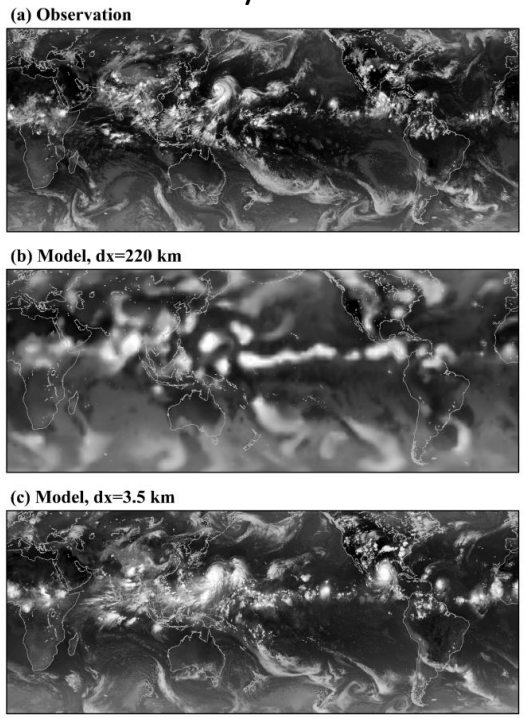
Shibuya et al. (2021, PEPS)

MJO/BSISO

Satellite Obs.

NICAM Δx=220km

NICAM Δx=3.5km



Courtesy of M Satoh & C Kodama

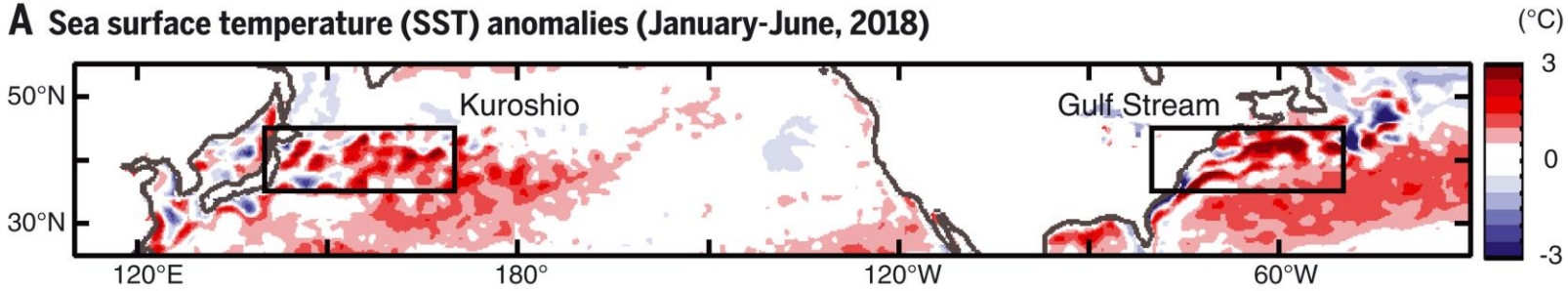
Shibuya et al. (2021, JMSJ)

Recent highlights in MIROC/MRI/NICAM science activities

The Gulf stream and Kuroshio current are synchronized

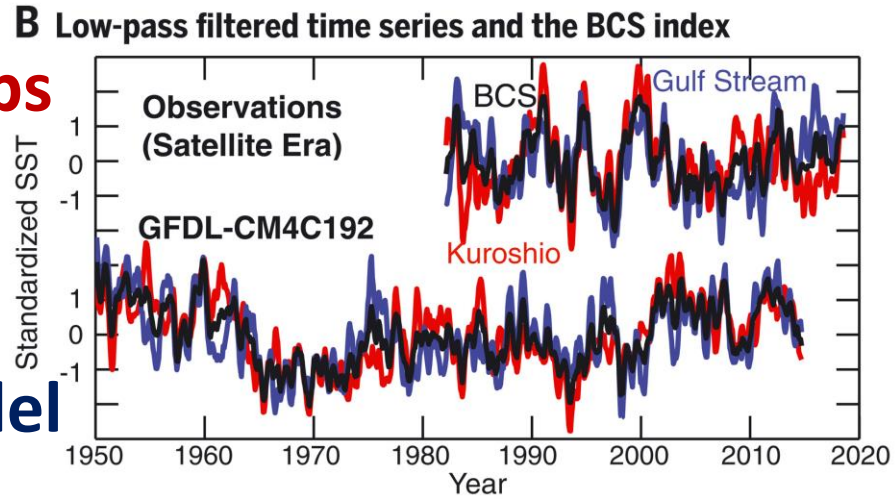
The Kuroshio/Gulf Stream synchronization was simulated only in high-res CGCMs (GFDL and MIROC) but not in conventional CMIP6 models!

Obs

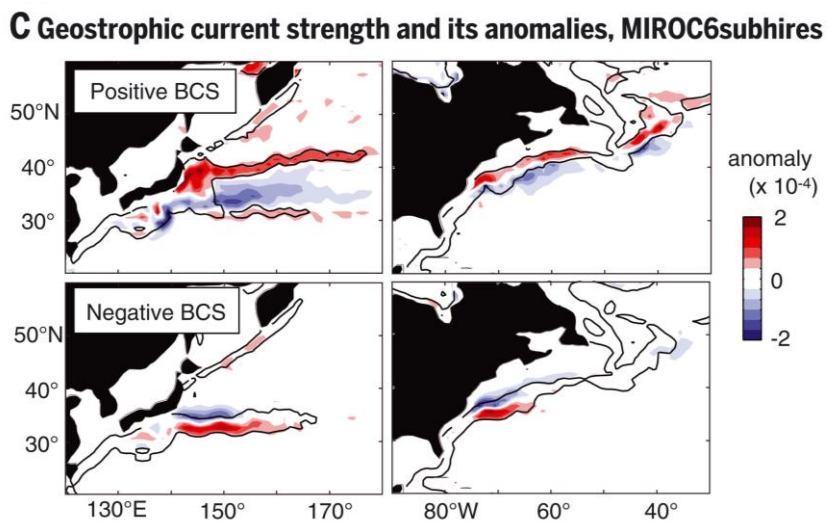


Obs

Model



Model



Kohyama, Yamagami, Miura, Kido, Tatebe & Watanabe (2021 Science)