WGCM 18th session, 10 October 2014

MRI participation in CMIP6

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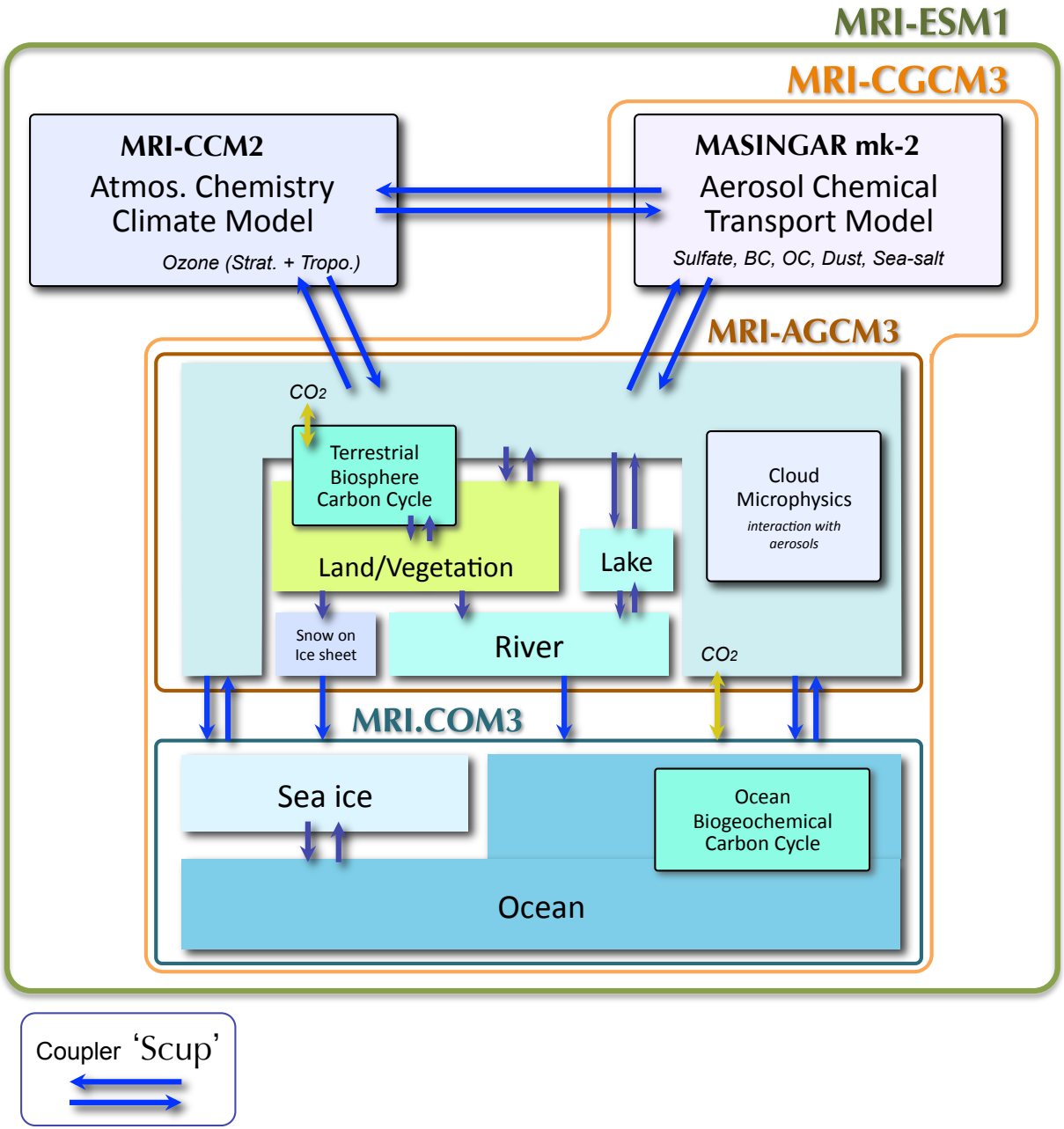
Meteorological Research Institute Earth System Model ver. 1



MRI-CGCM3
= AGCM + OGCM
+ Aerosol

MRI-ESM1
= AGCM+OGCM
+ Aerosol
+ Ozone
+ Carbon cycle

CMIP5 version

AGCM: T_L159 L48
(H.~120km, Top:0.01hPa)
OGCM: 1°×0.5° L51
Aerosol: T_L95 L48
(H.~180km, Top:0.01hPa)
Ozone: T42 L48
(H.~280km, Top:0.01hPa)

MRI-ESM1.x for CMIP6

	CMIP5	CMIP6
Model Name	MRI-CGCM3 MRI-ESM1	MRI-ESM1.x
Atmos. Horiz. res.	T_L159 (≈120 km)	←
Atmos. Vert. res.	L48, Top=0.01hPa	L80, 41 (>100hPa), 39 (<100hPa) Top=0.01hPa
Ocean Horiz. res.	1° × 0.5° (Tripolar grid)	←
Ocean Vert. res.	L51	←
Atmos. chem.	Aerosols (MRI-CGCM3) All (MRI-ESM1)	All (tropo. & storato., incl. volc. aer.)
Biogeochem.	Yes (MRI-ESM1)	Yes (depends on the experiment)

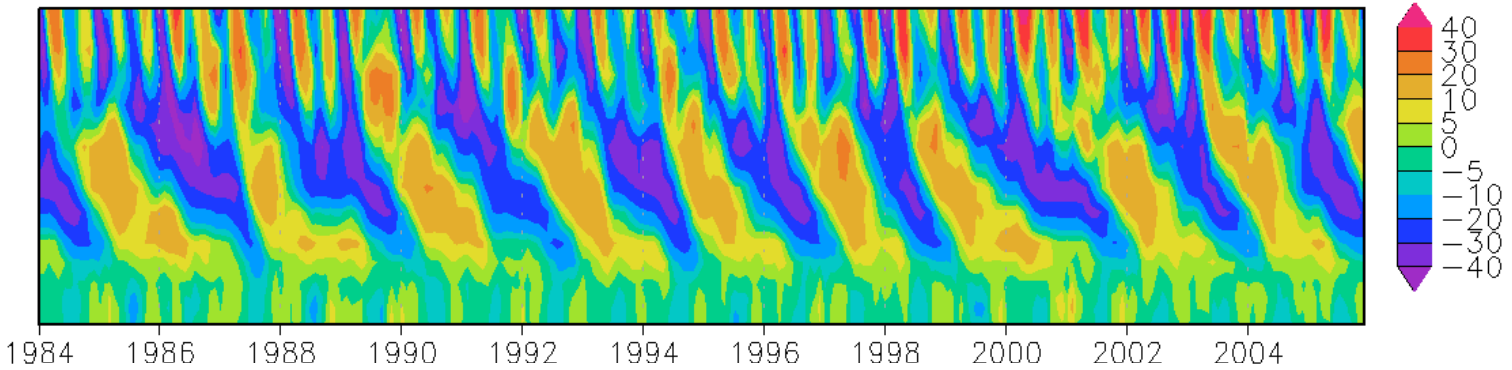
Many improvements

- Stratospheric QBO
  Increased vertical layers and introduction of non-orographic GWD (Hines-scheme)
- Low clouds
  CTE-EIS stratocumulus parameterization, vertical layers, cloud physics, etc.
- Asian summer monsoon
- Sea ice distribution in the winter North Atlantic

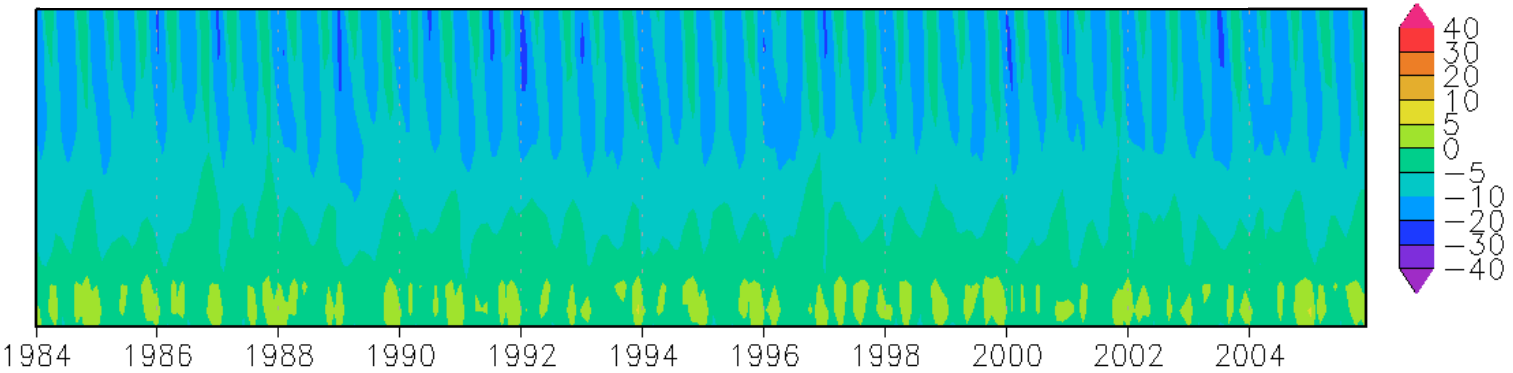
Stratospheric QBO in MRI-ESM1.x

Zonal Wind at the Eq.

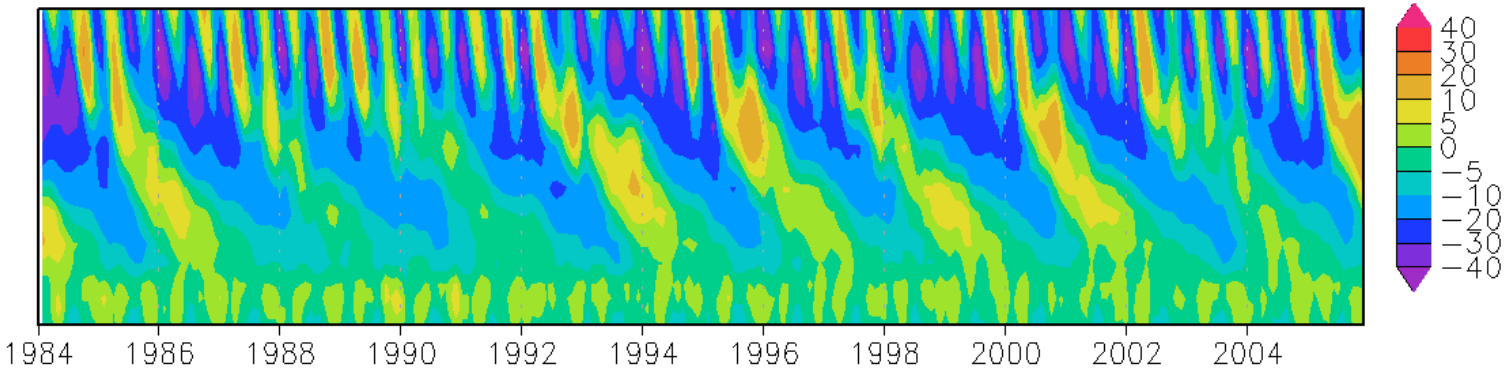
ERA-Interim



MRI-ESM1 CMIP5 esmHistorical

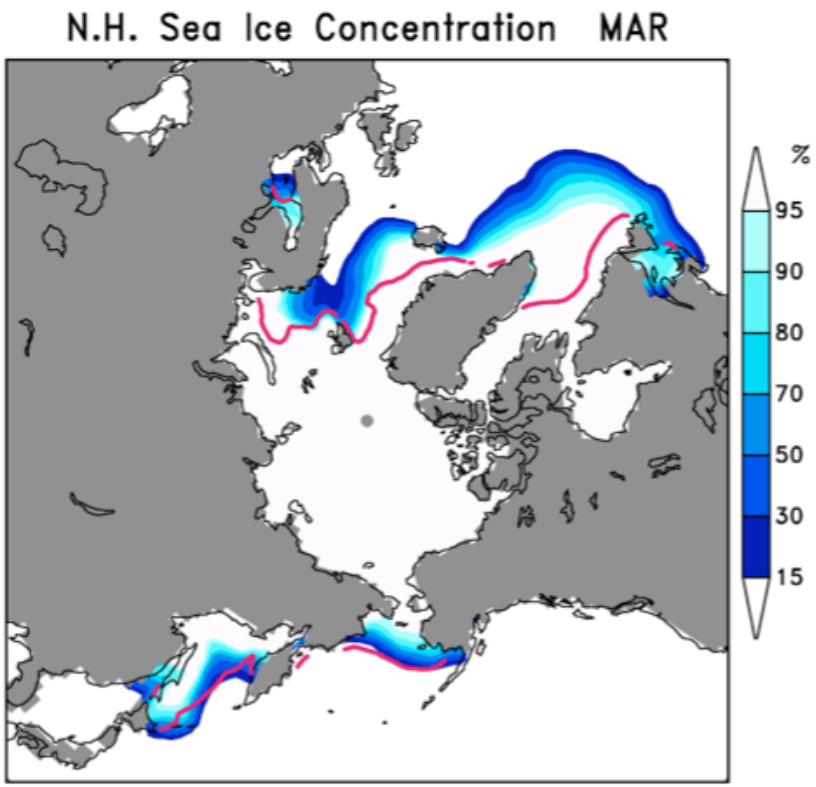


MRI-ESM1.x Test

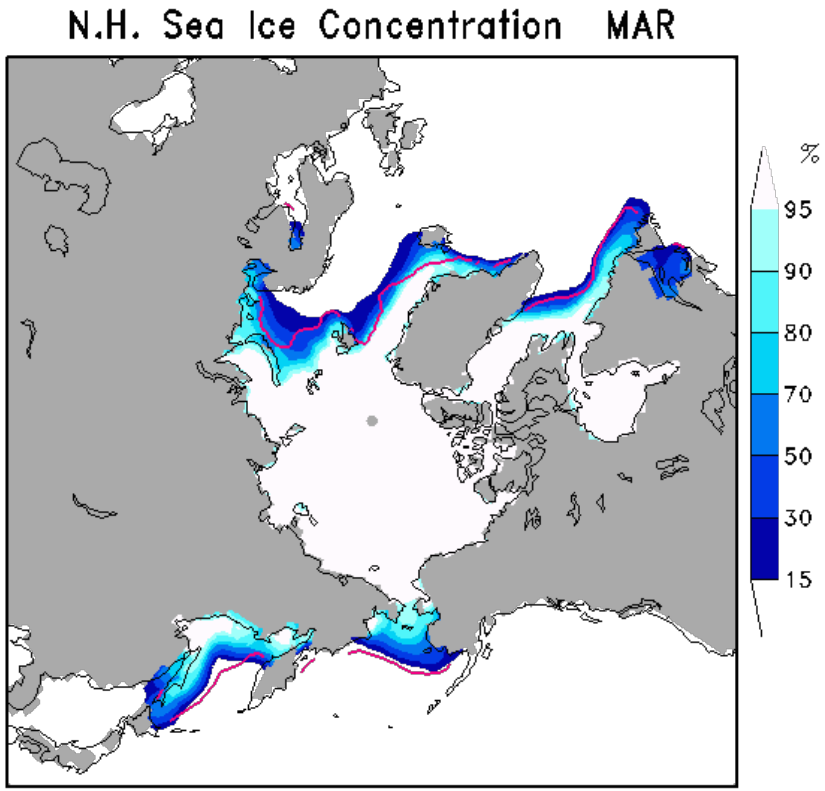


N.H. Sea Ice Distribution

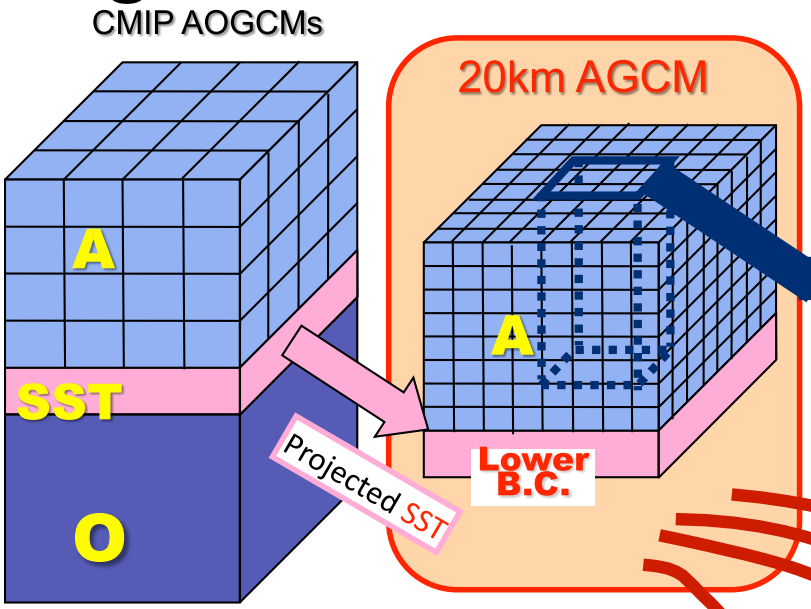
CMIP5 historical (1979-2005)



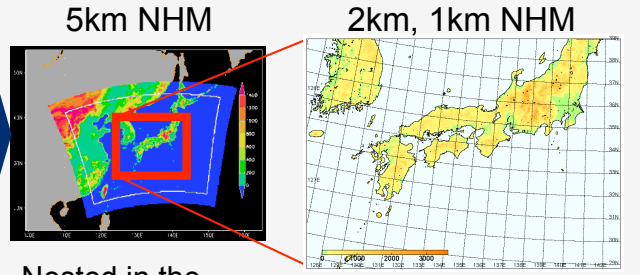
MRI-ESM1.x Test (1987-1996)



High-resolution time-slice experiments by MRI-AGCM



Dynamical Downscaling by Regional Climate Model



Impact Assessments

- Disasters
- Agriculture
- Water Resources

Study of Future Change in Extreme Events

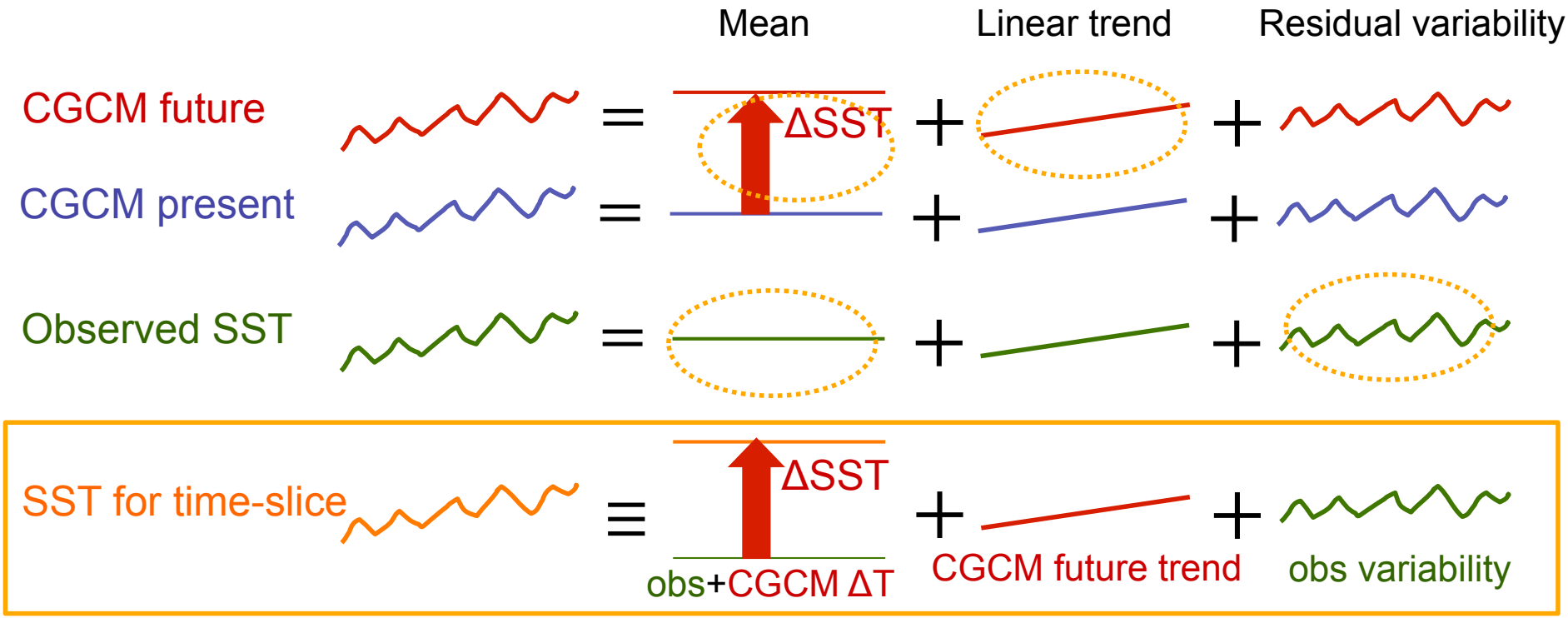
- Tropical Cyclones (e.g. Murakami et al. 2012)
  →less number, more intense
- East Asia Monsoon (e.g. Kusunoki et al.2006)
  →seasonal migration delayed
- Extreme Rainfall (e.g. Kamiguchi et al. 2006)
  →more frequent
- Blockings (e.g. Matsueda et al. 2009)
  →less frequent
- Extratropical Cyclones(e.g. Mizuta et al.2011)

Regional Climate Change

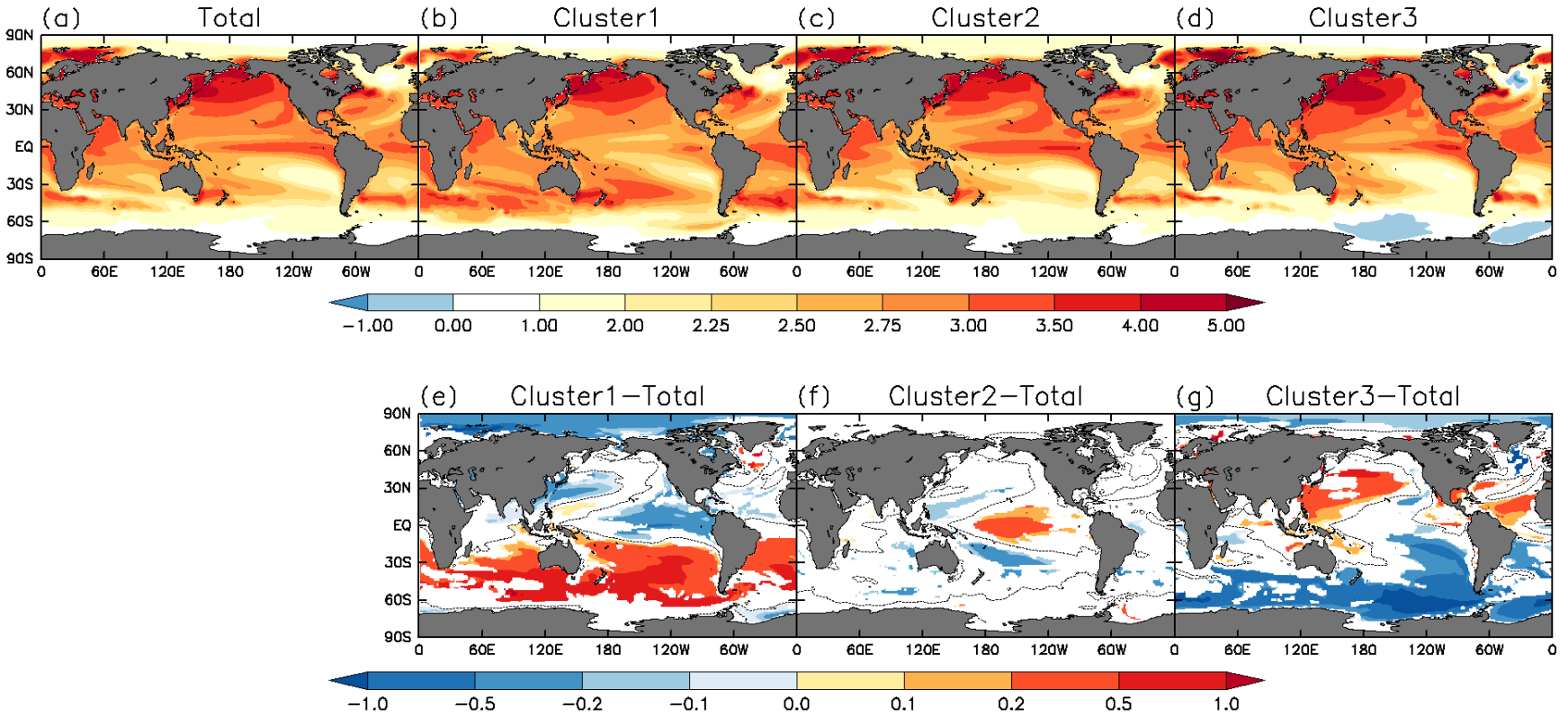
- Outputs provided to researchers of each region
  (Korea, China, Taiwan, Philippines, Thailand, Indonesia, Viet Nam, Bangladesh, India, Israel, Saudi Arabia, Senegal, Spain, Netherland, UK, Ireland, Denmark, Switzerland, Germany, USA, Mexico, Columbia, Barbados, Belize, Bolivia, Peru, Ecuador, Brazil, Argentina, Australia, Papua New Guinea)

Setup of time-slice experiments

- Present-day climate experiment (1979-2003): AMIP-type
  - observed SST and sea–ice concentration
  - observed global–mean concentrations of CO2 and other GHGs
- Future climate experiment (2075-2099)
  - SST warming in the CMIP coupled models is added to the obs. SST
  - changing concentrations of GHGs following the emission scenario



Cluster analysis of ΔSST pattern of



(Mizuta et al. 2014)

- Cluster analysis applied to normalized ΔSST of CMIP5 models
- The clustered ΔSST patterns can be used as the lower boundary change for AGCMs to study on what part of the climate change could depend solely on the pattern of the SST change.

MRI's CMIP6 Plan

Models: MRI-ESM1.x, MRI-AGCM3.xS, (NHRCM)
Infrastructure:
Fujitsu 1.2 Pflops at MRI (Mar. 2015~) approx. 25% for CMIP6
# of years of experiments:
20,000 years (MRI-ESM1.x)
200 years (MRI-AGCM3.xS)
MIPs to contribute to:

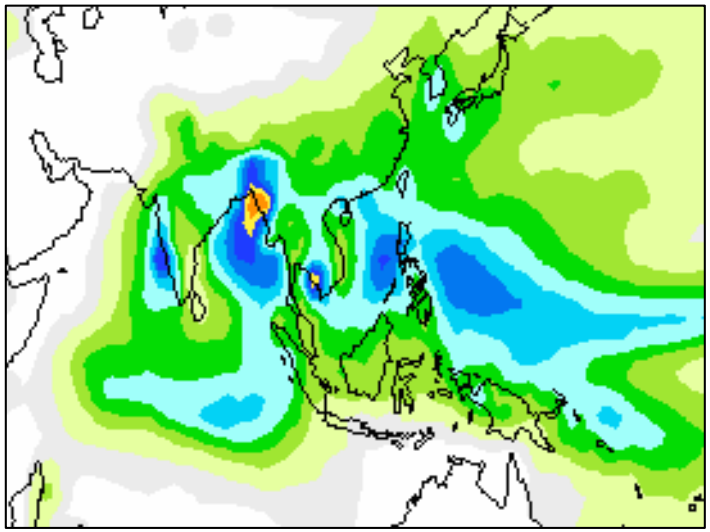
- *Planning*:
  AeroChemMIP, C4MIP, CFMIP, DAMIP, DCPP
  HighResMIP, OCMIP6, PMIP, VolMIP, (CORDEX)
- *Under consideration*:
  GeoMIP, (GDDEX), GMMIP, LS3MIP
  ScenarioMIP

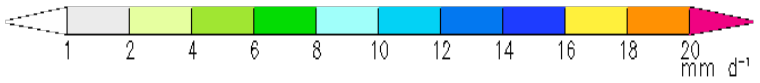
Backup Slides

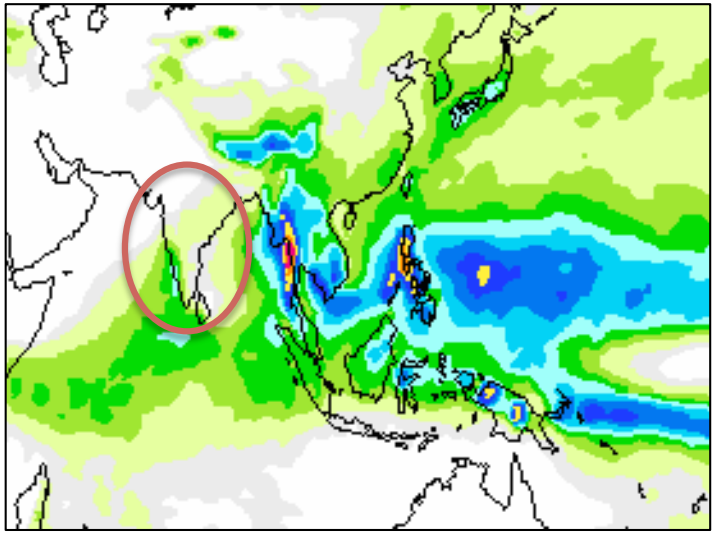
Asian Summer Monsoon Precipitation

Precipitation
JJA mean

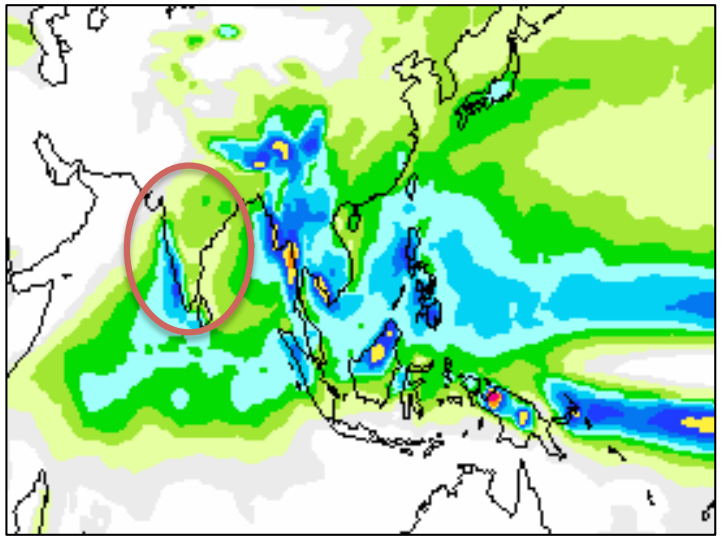
CMAP (1987-1996)







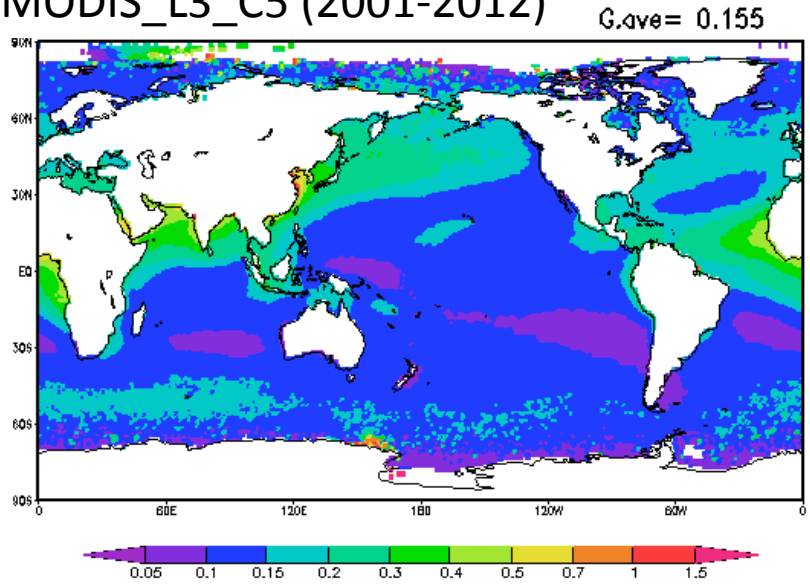
CMIP5
esmHistorical
(1987-1996)



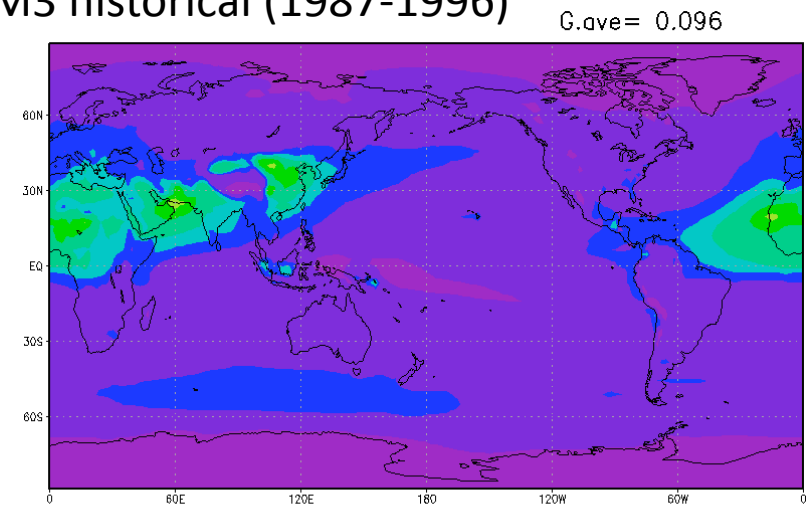
MRI-ESM1.x
Test
(1987-1996)

Aerosol Optical Thickness (550 nm)

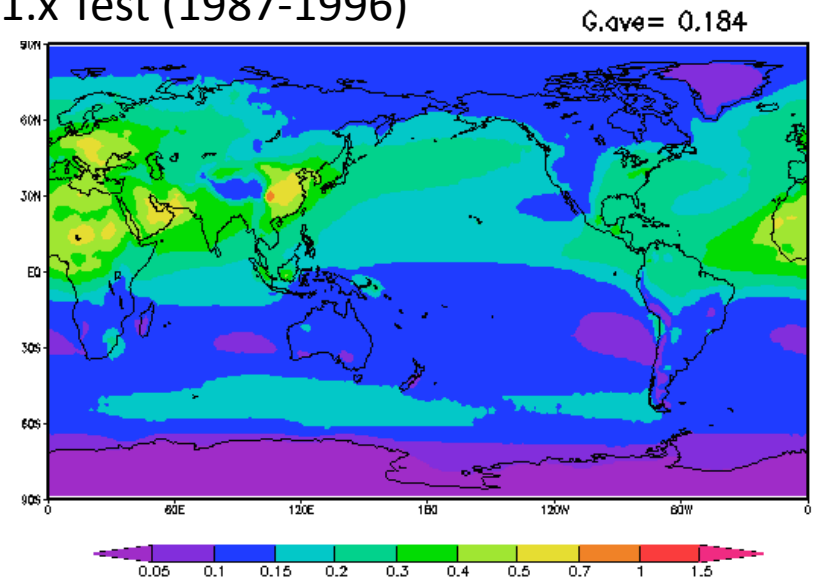
MODIS_L3_C5 (2001-2012)



MRI-CGCM3 historical (1987-1996)



MRI-ESM1.x Test (1987-1996)



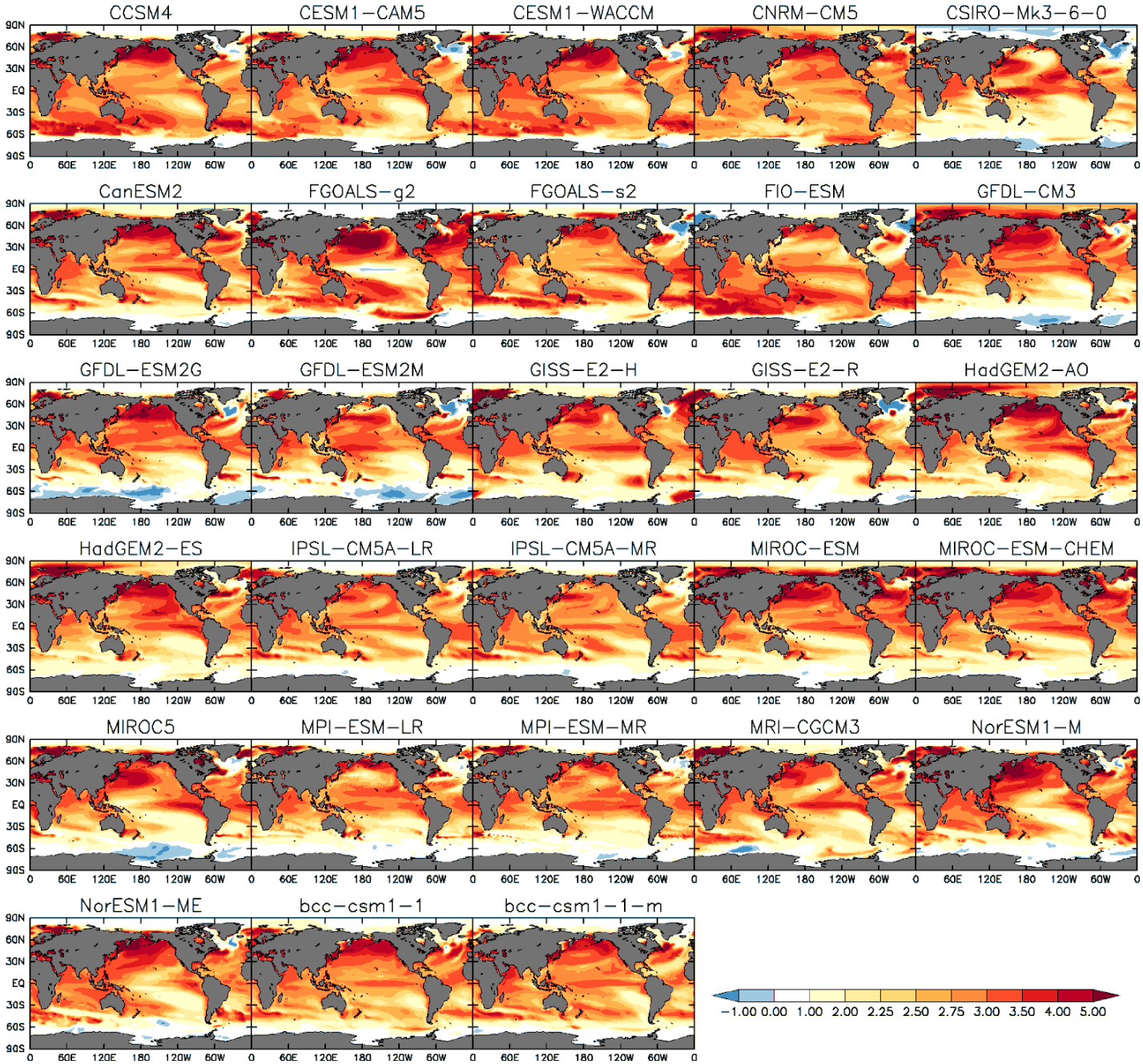
Cluster analysis of ΔSST pattern of CMIP5 models

- 28 CMIP5 models, of which historical +RCP2.6/4.5/8.5 results are available, are used.
- In addition to the average of all models, SST ensemble experiments uses the average of 3 groups of the models.
- Cluster analysis is applied to the warming pattern of the models:

(Endo et al., 2013, JGR; Murakami et al., 2012, Clim. Dyn.)

1. For each model, a mean SST change from the 1979-2003 mean to the 2075-2099 mean (RCP8.5) is computed.
2. The computed mean SST change is normalized by the tropical mean (30°S−30°N) SST change.
3. Multi-model ensemble mean of the normalized value is subtracted from that for each model.
4. Norms (or distances) between the models are defined as $2 \times (1 - r)$, using inter-model pattern correlation r .
5. The cluster analysis is applied using these norms.
6. When the final three groups are bounded, the clustering procedure is terminated.

CMIP5 normalized SST change (RCP8.5 - historical)



Cluster analysis results