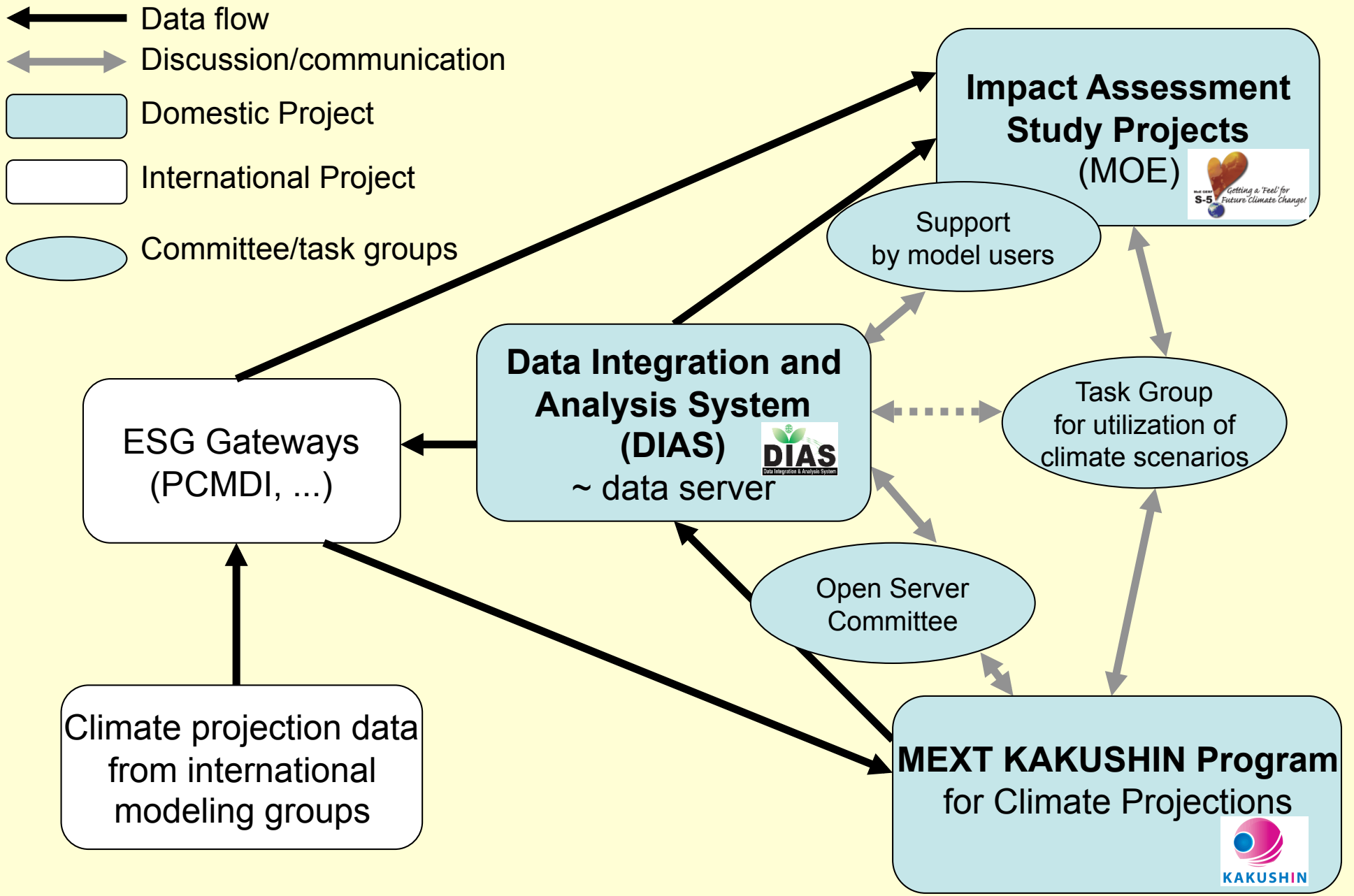
Climate Change Studies in Japan



after Kawamiya (2009)

The 2nd phase of Japanese global warming project on the Earth Simulator (Kakushin Program; 2007-2012)

- **Team 1: Long-term (JAMSTEC/NIES/AORI)** Tokioka
  - MIROC-ESM (T42L80+1.0x1.4L44+carbon cycle+aerosols+chemistry)
  - NICAM global CSRM, EMIC for uncertainty
  - physics ensemble
  - detailed dyn veg
  - crop yields, high tides
- **Team 2: Near-term (AORI/NIES/JAMSTEC)** Kimoto
  - MIROC AOGCMs (T213AGCM+1/4x1/6OGCM+aerosols; medres(T85) as well)
  - Initialization w/ obs. + 10-member ensemble
  - Flood/drought risk assessment
  - Regionally hi-res OGCM
- **Team 3: Hi-res time-slice (MRI/JMA)** Kitoh
  - 20km AGCM + 1km nested regional model near Japan
  - Impact on hydrology, flood risk assessment, Typhoons

Teams 1-3 all consist of Modelling/Uncertainty/Impact study components
ES was upgraded in March 2009 (2.x times faster)

Update on Japanese activity for CMIP5

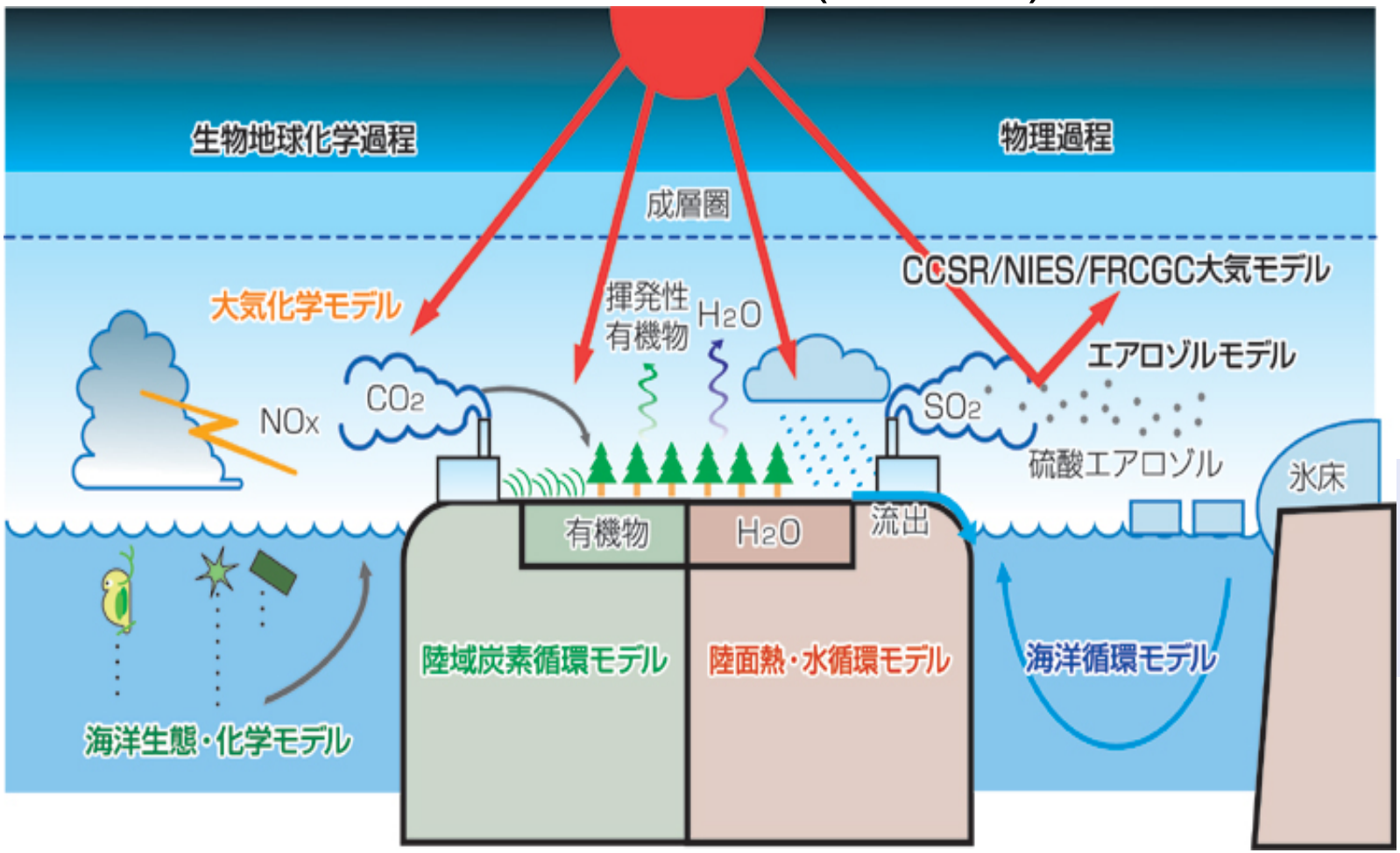
Masahide Kimoto
Atmosphere and Ocean Research Institute
The University of Tokyo

Japanese GCMs to enter CMIP5				
	Model name	Model category	Institute	Spec
Near-Term	**MIROC**4h	AOGCM	AORI/NIES/ JAMSTEC	T213L56+20km L48 AOGCM w/ aerosol
	MIROC5	AOGCM	AORI/NIES/ JAMSTEC	T85L40+1ºL50 **New Physics**
	MRI-CGCM3	AOGCM	MRI/JMA	TL159L48+1ºL51
Long-Term	**MIROC**-ESM	ESM	JAMSTEC/ AORI/NIES	T42L80+1ºL44 w/ carbon cycle
	MIROC-ESM-CHEM	ESM	JAMSTEC/ AORI/NIES	T42L80+1ºL44 w/ carbon cycle + chemistry
	MIROC5	AOGCM	AORI/NIES/ JAMSTEC	T85L40+1ºL50 New Physics
	MRI-ESM1	ESM	MRI/JMA	TL159L48+1ºL51
	MRI-CGCM3	AOGCM	MRI/JMA	TL159L48+1ºL51
Time Slice	**MRI**-AM20km **MRI**-AM60km	AGCM	MRI/JMA	TL959(20km)L64 TL319(60km)L64

Atmospheric Chemistry model: O_3、O、O1D、N、N、O、NO_2、NO_3、N_2O_5、HNO_3、HNO_4、H_2O_2、CO、C_2H_6、C_3H_8、 C_2H_4、C_3H_6、ONMV、C_5H_8、$C_{10}H_{16}$、CH_3COCH_3、CH_2O、
CH_3CHO、CH_3OH、NALD、MGLY、HACET、MACR、PAN、MPAN、ISON、CH_3OOH、C_2H_5OOH、C_3H_7OOH、ISOOH、HOROOH、CH_3COOOH、MACROOH、O_3S、O1DS、$SPRSO_2$、$SPRSO_4$、OCS、CH_4、N_2O、Cl、 ClO、OClO、ClOOCl、$ClONO_2$、HOCl、HCl、Cl_2、CH_3Cl、CCl_4、CH_3CCl_3、CFC11、CFC12、CFC113、HCFC22、Br、BrO、$BrONO_2$、HOBr、HBr、CH_3Br、Br_2、BrCl、H1211、H1301、$CHBr_3$、H、OH、HO_2、CH_3O_2、$C_2H_5O_2$、$C_3H_7O_2$、CH_3COO_2、$CH_3COCH_2O_2$、$HOC_2H_4O_2$、$HOC_3H_6O_2$、ISO_2、MACRO2 （84 speces）

58 chem. tracers；58 photo-dissociation reactions；184 chem. reactions

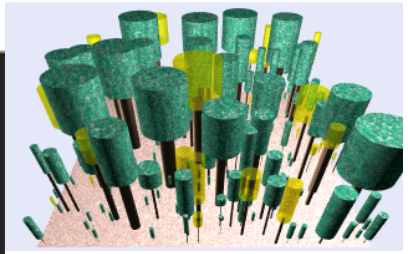
MIROC-ESM (T42L80)



Aerosol model (SPRINTARS)

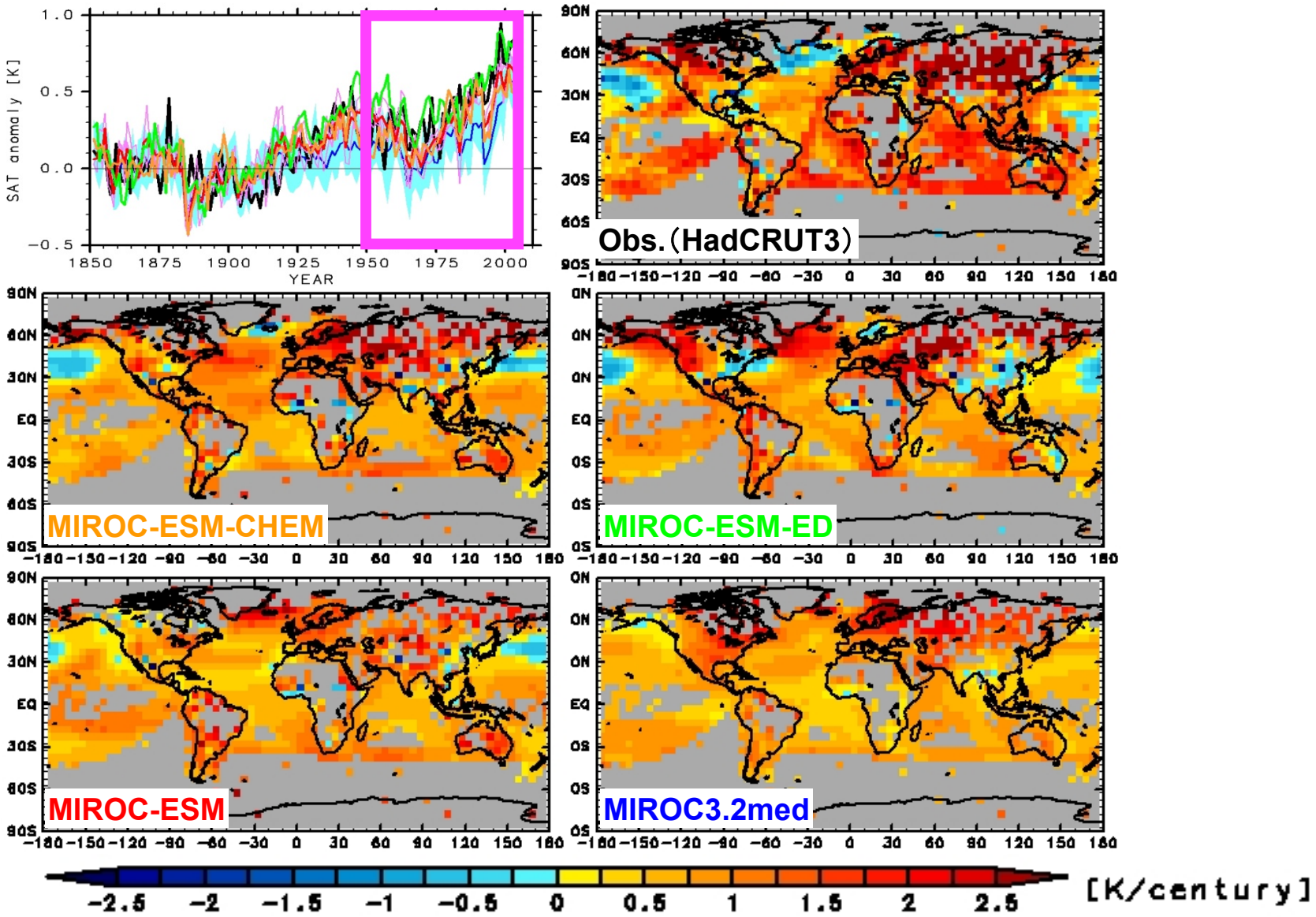
Carbon cycle model (Sim-cycle)

SEIB-DGVM as terrestrial ecosystem model

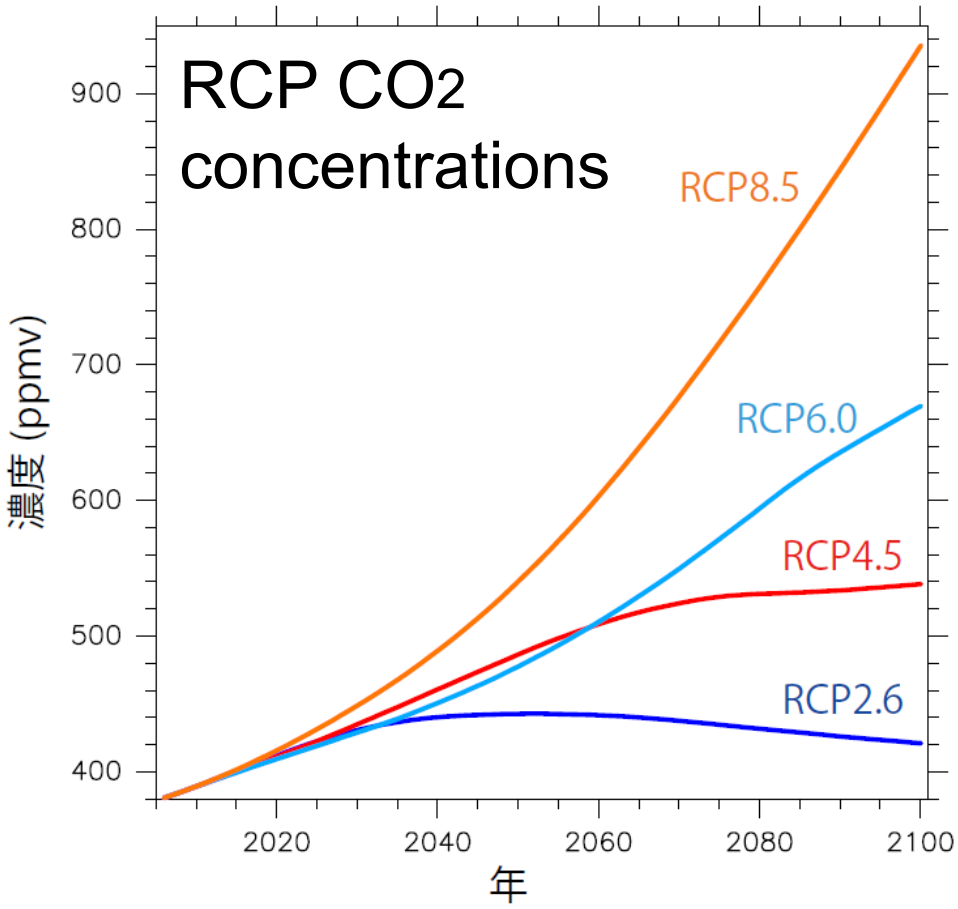


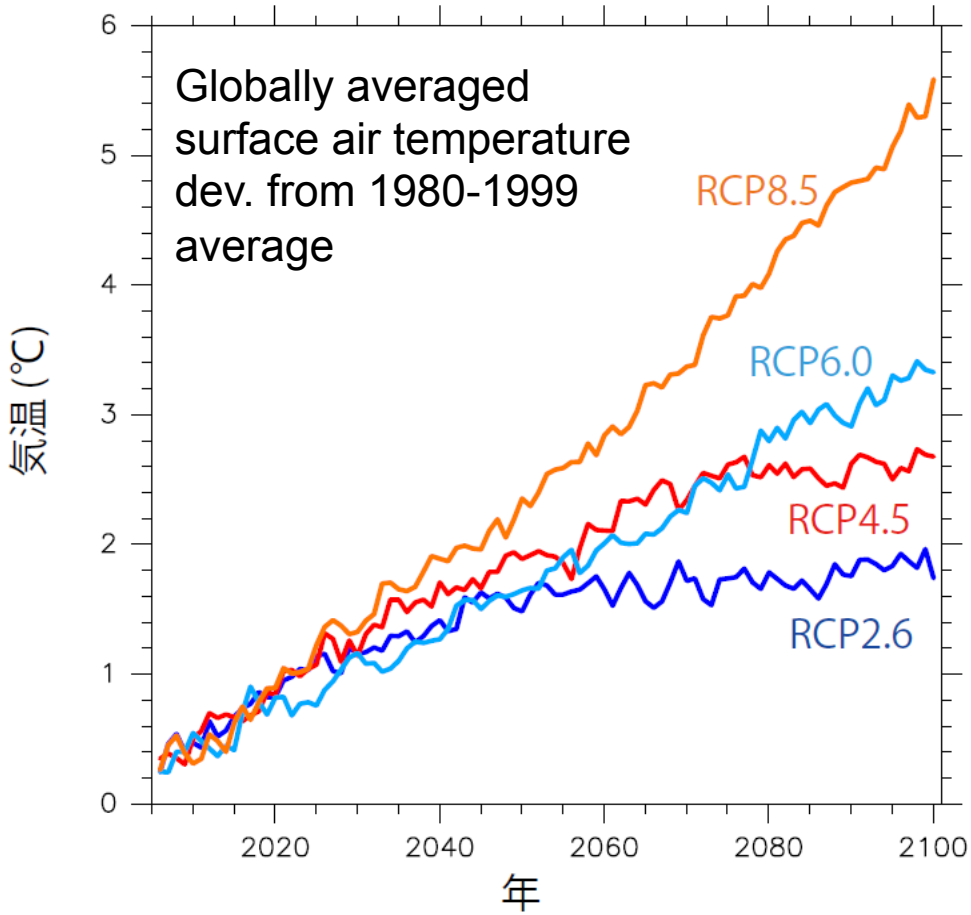
NPZD-type Marine eco-system model

Linear trend in annually averaged surface air temperature（1951－2005）

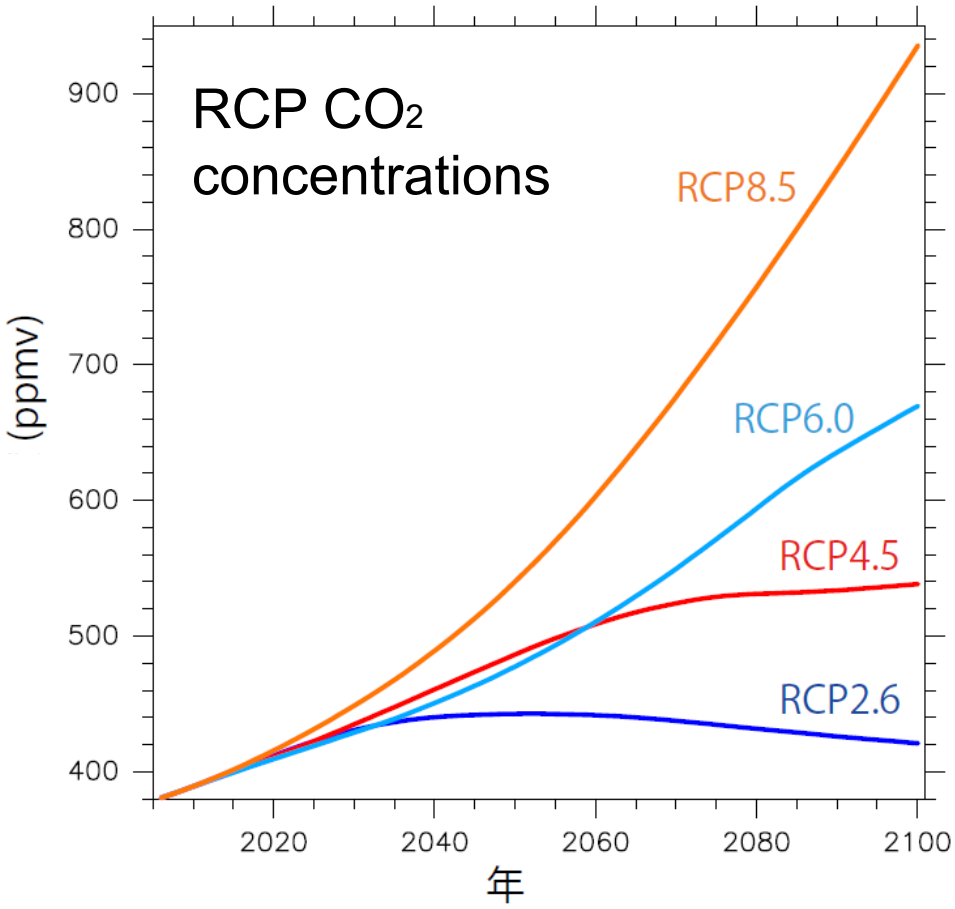


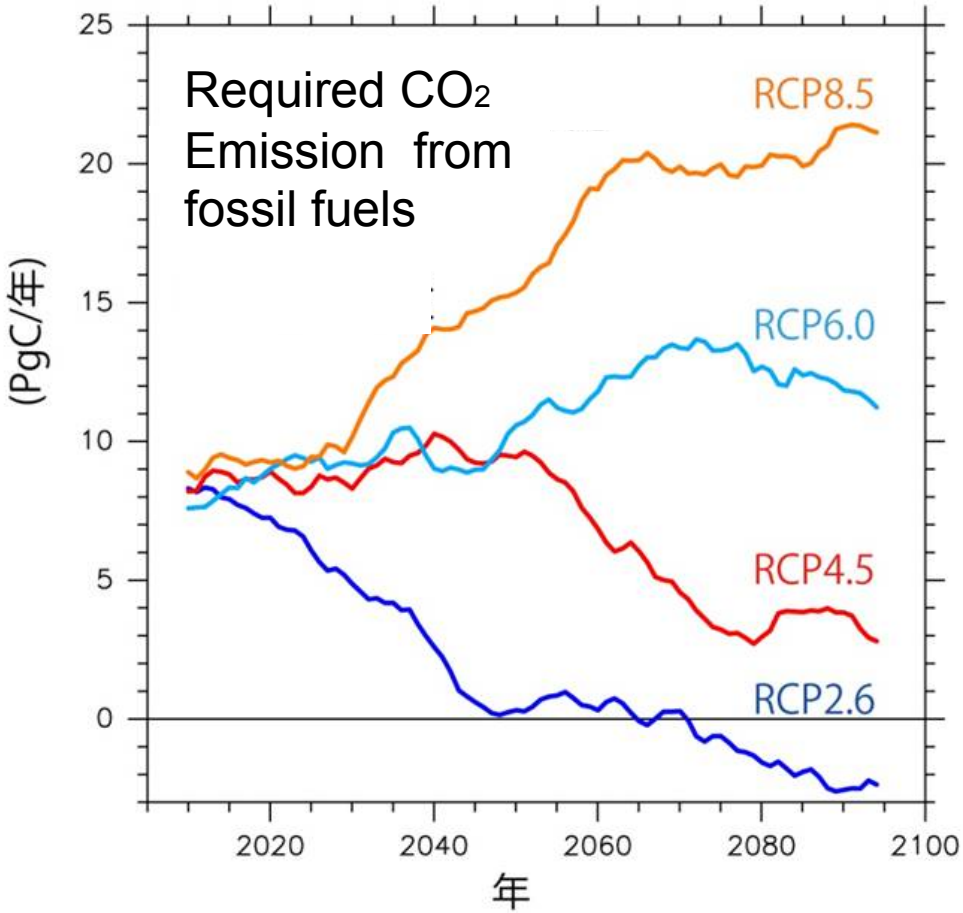
RCP CO_2 concentration scenarios and globally averaged surface air temperature



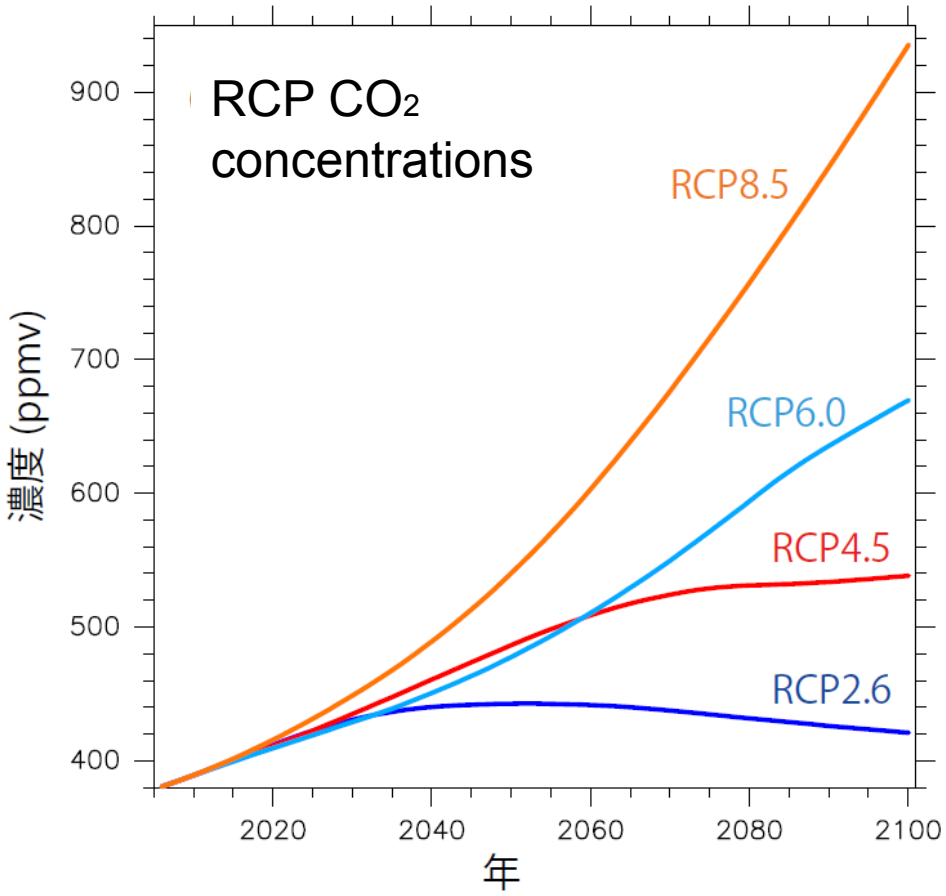


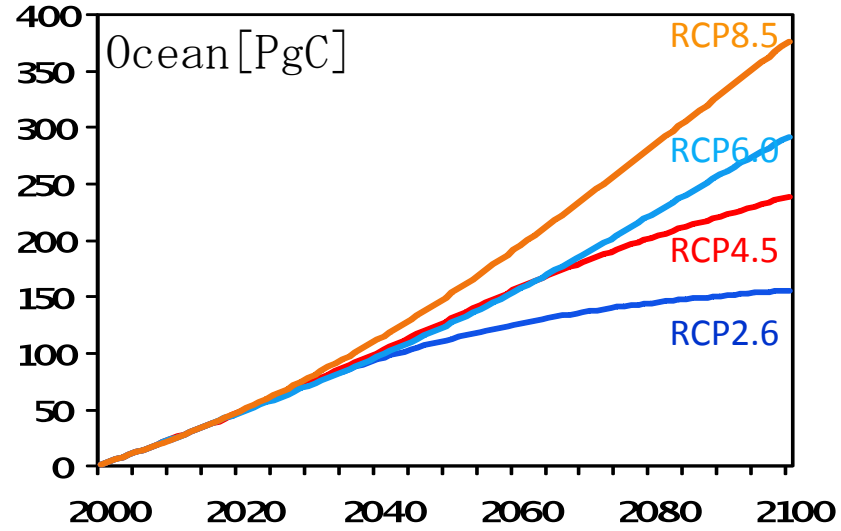
Required anthropogenic CO_2 emission from fossil fuels for RCP concentration scenarios

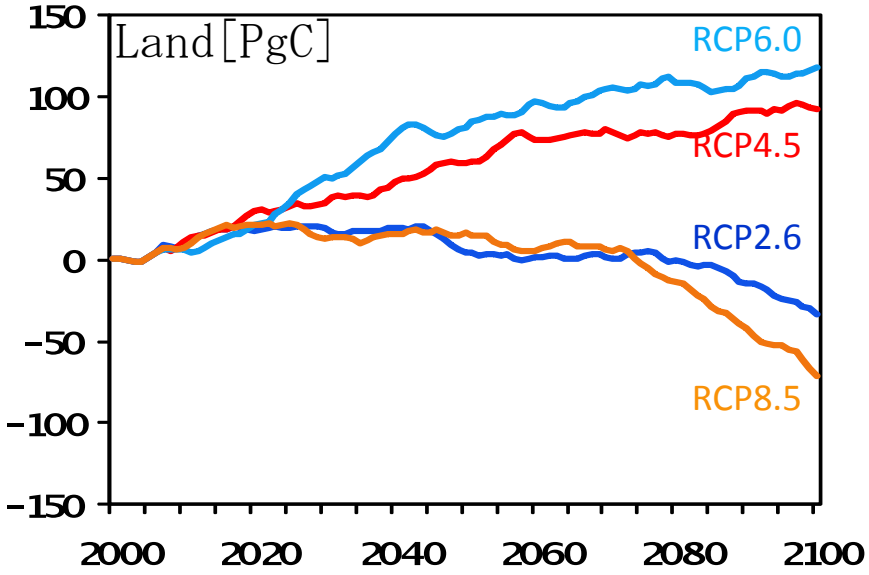




carbon storage changes in ocean and land





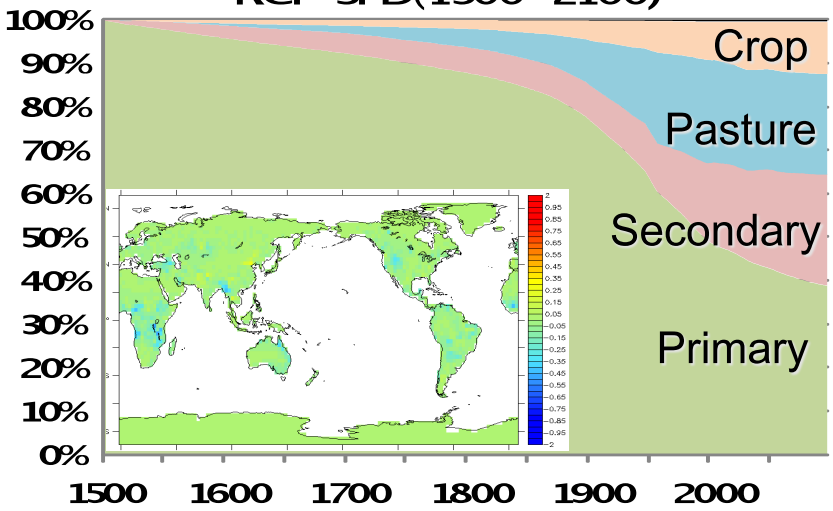


Land use change scenarios in RCP

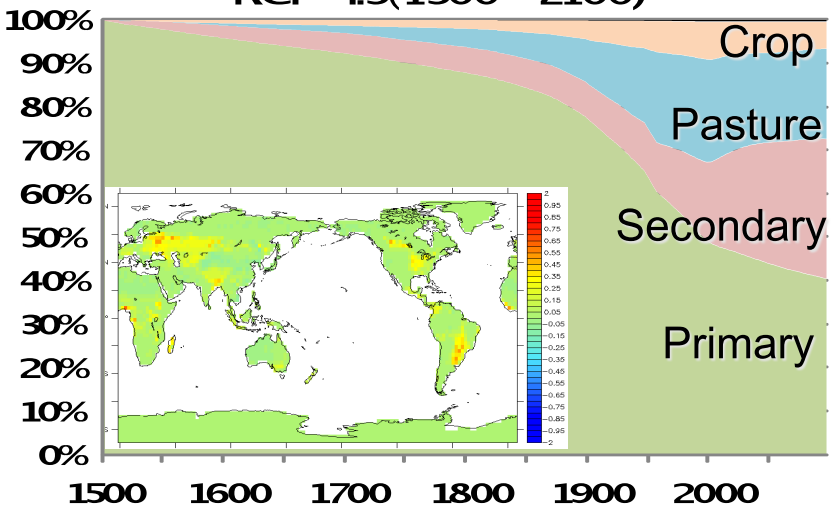
時系列グラフは1500年からの各土地利用が占める割合の変化

空間分布図は、非農業用地(=1次植生＋2次植生)の2000年からの変化量(赤：増加、青：減少)

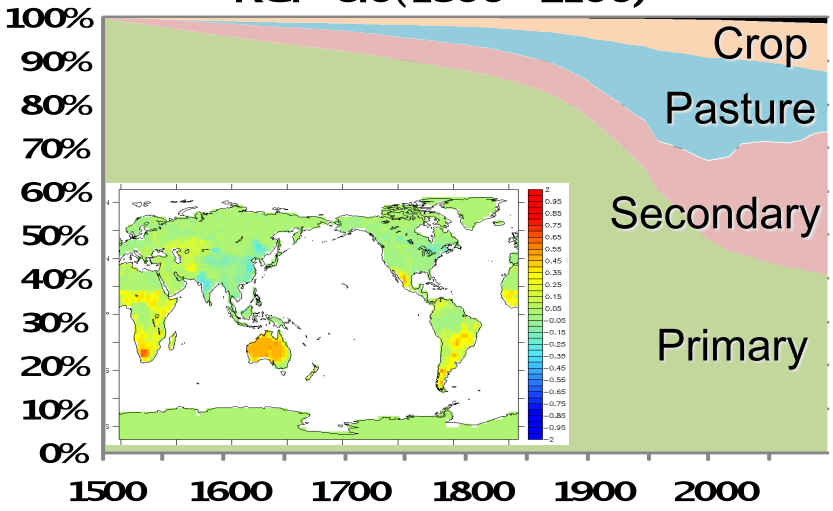
RCP-3PD(1500～2100)



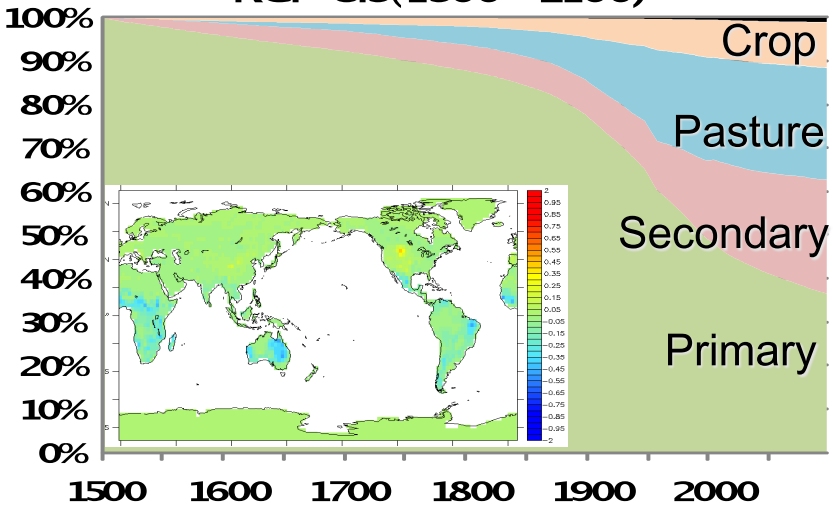
RCP-4.5(1500～2100)



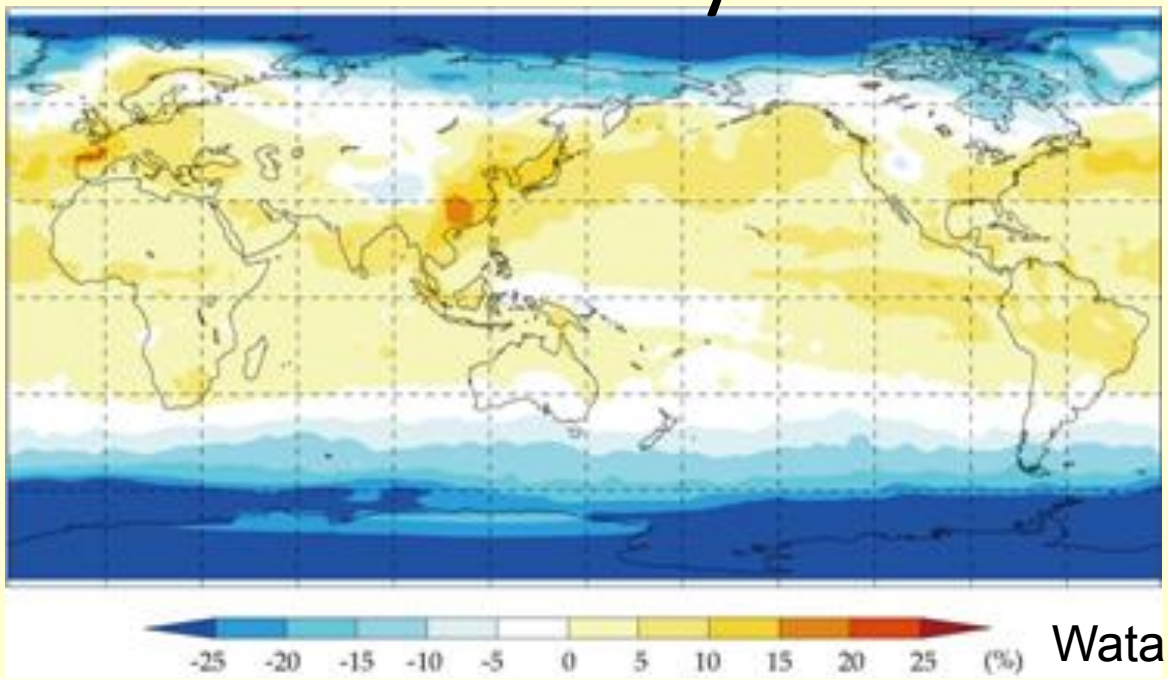
RCP-6.0(1500～2100)



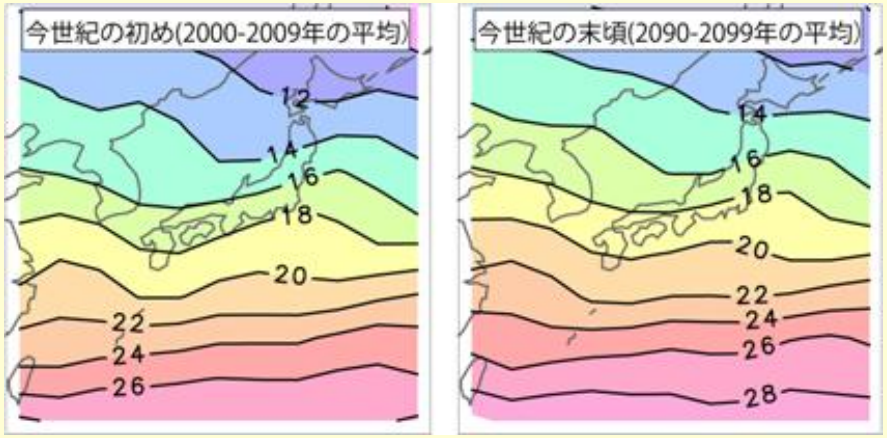
RCP-8.5(1500～2100)

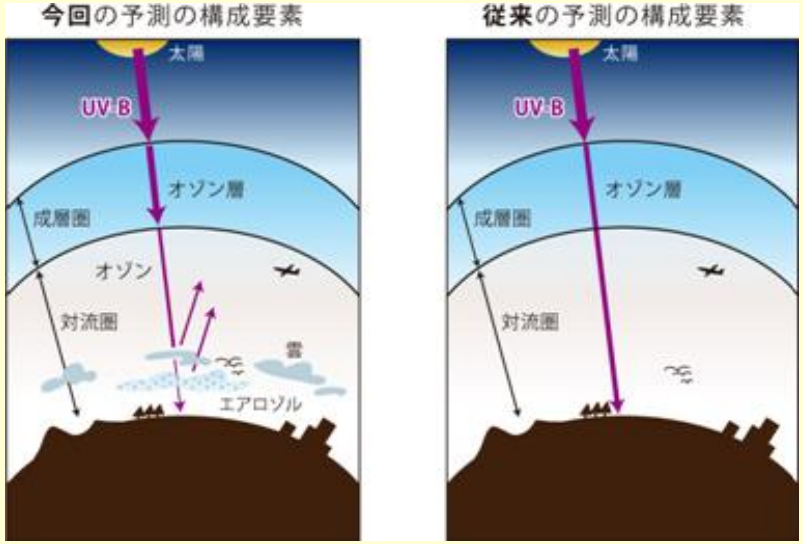


Projected UV-B increase by MIROC-ESM-CHEM



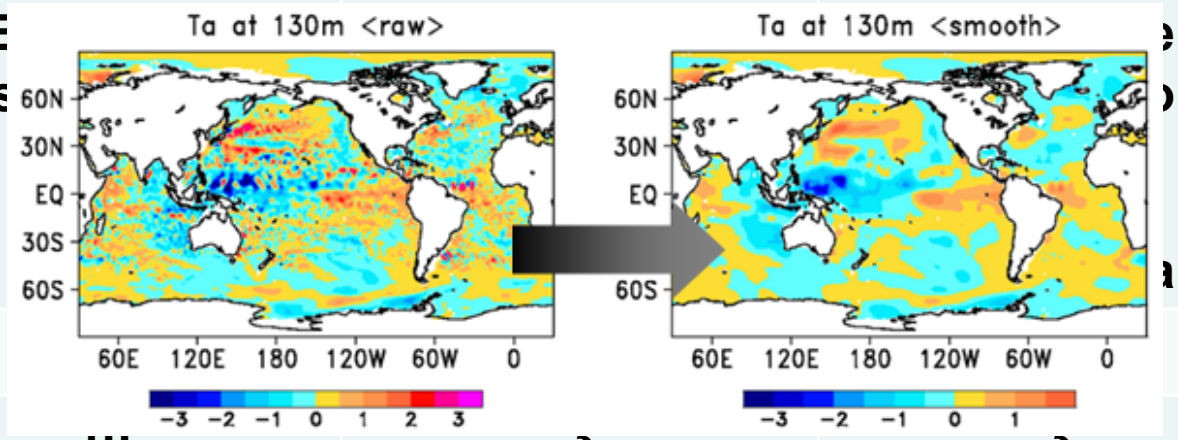
Watanabe et al. (2011)





Decadal Prediction Experiments by MIROC

	MIROC3m	MIROC4h	MIROC5
Atmosphere	300km L20	60km L56 NEW	155 km L44 NEW
Ocean	1.4° x 0.5-1.4° L44	0.28° x 0.19° L48	1.4° x 0.5-1.4° L50
Forcing	CMIP3/SRESA1B	CMIP5/RCP4.5	CMIP5/RCP4.5
Initialization	Ocean T&S IAU (0 ～700m)	Ocean T&S IAU (0～3000m) Eddy Conserving	Ocean T&S IAU (0～3000m)
Ensemble generation	E… As…		…on …an)
Ensemble Size			
Historical	10	3	3
Assimilation	10	1	3
Hindcasts	10	3	6
Document	K-1 model	Sakamoto et al.	Watanabe et al.



http://amaterasu.ees.hokudai.ac.jp/~fswiki/pub/wiki.cgi?page=CMIP5

System for Prediction and Assimilation by MIROC

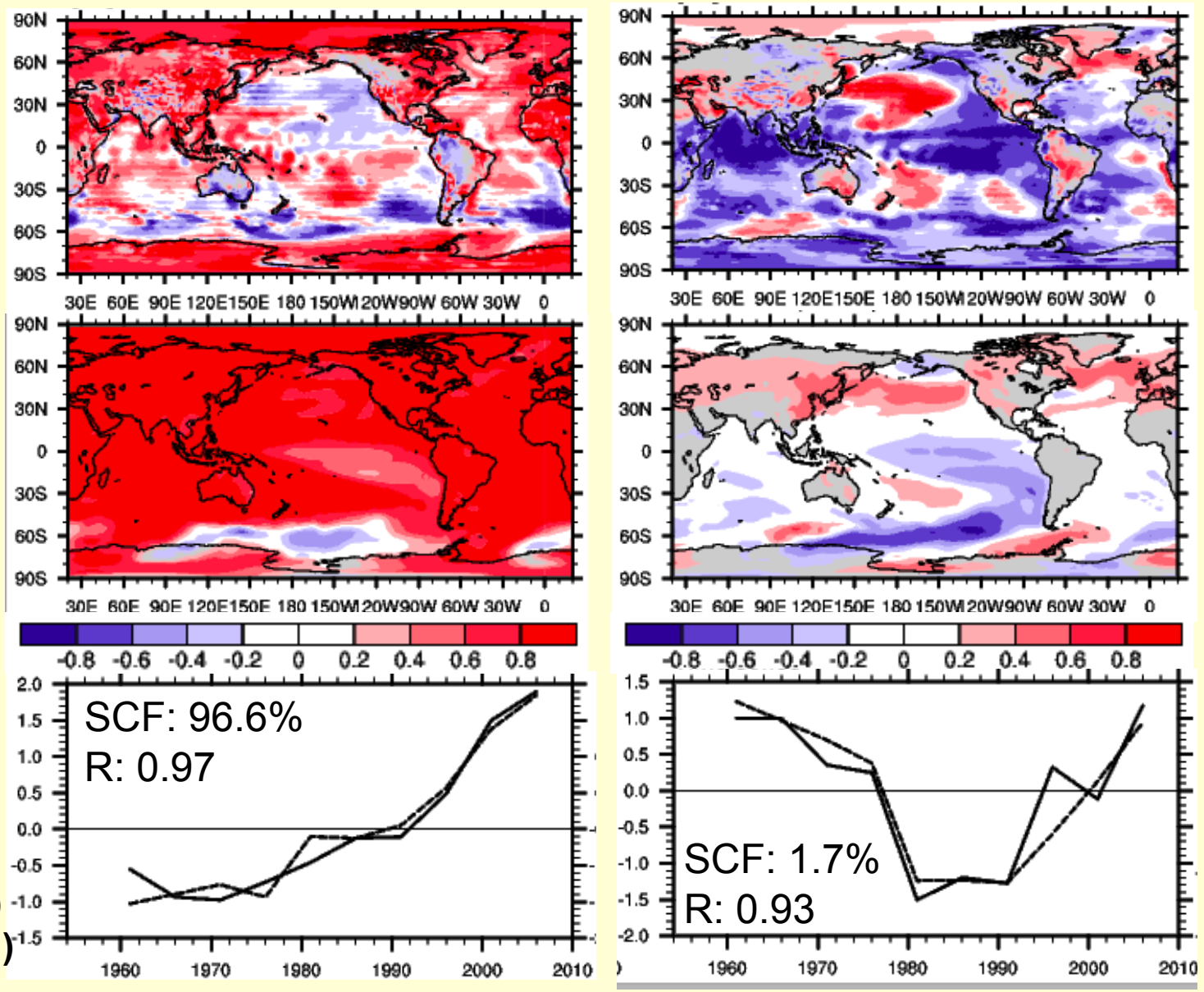
Predictable Component

SVD between OBS SAT and 1-3yr HCST

Obs

MIROC

SVD1 **SVD2**



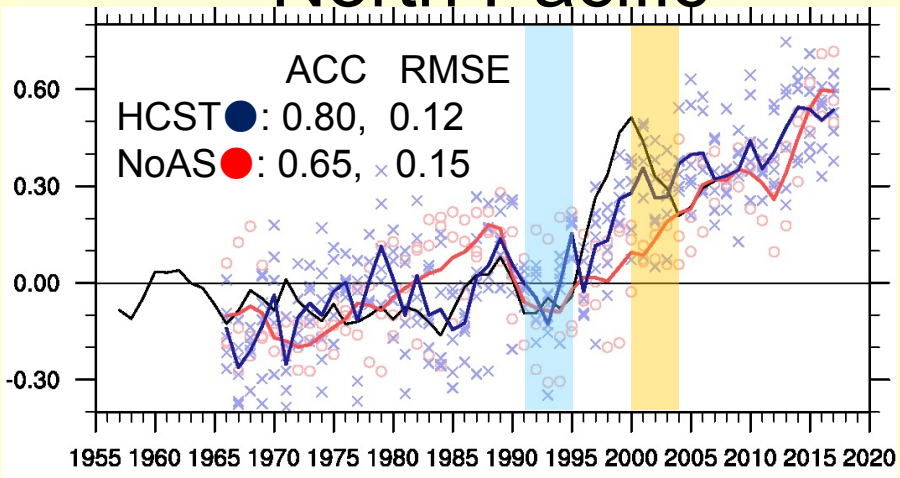
Mochizuki et al. (2011)
Chikamoto et al. (2011)

Based on a 3-model ensemble (MIROC3m, MIROC4h, MIROC5)

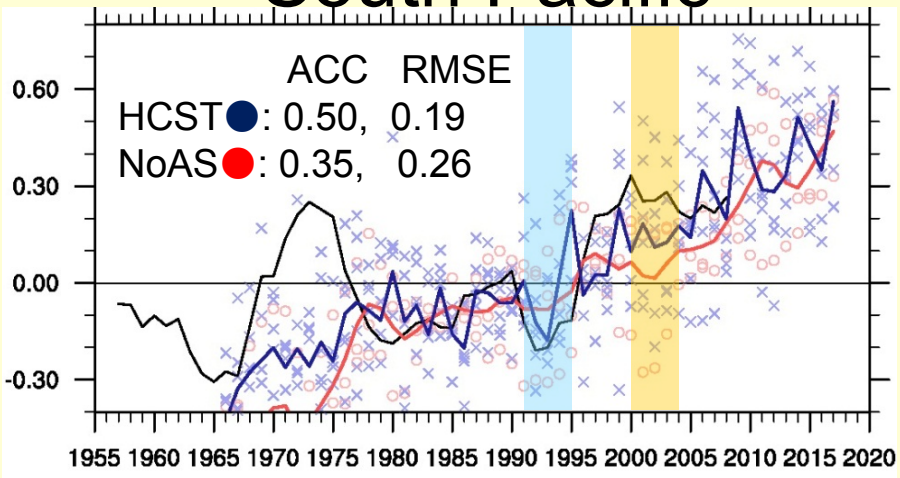
System for Prediction and Assimilation by MIROC

Climate shift in mid-1990s

North Pacific



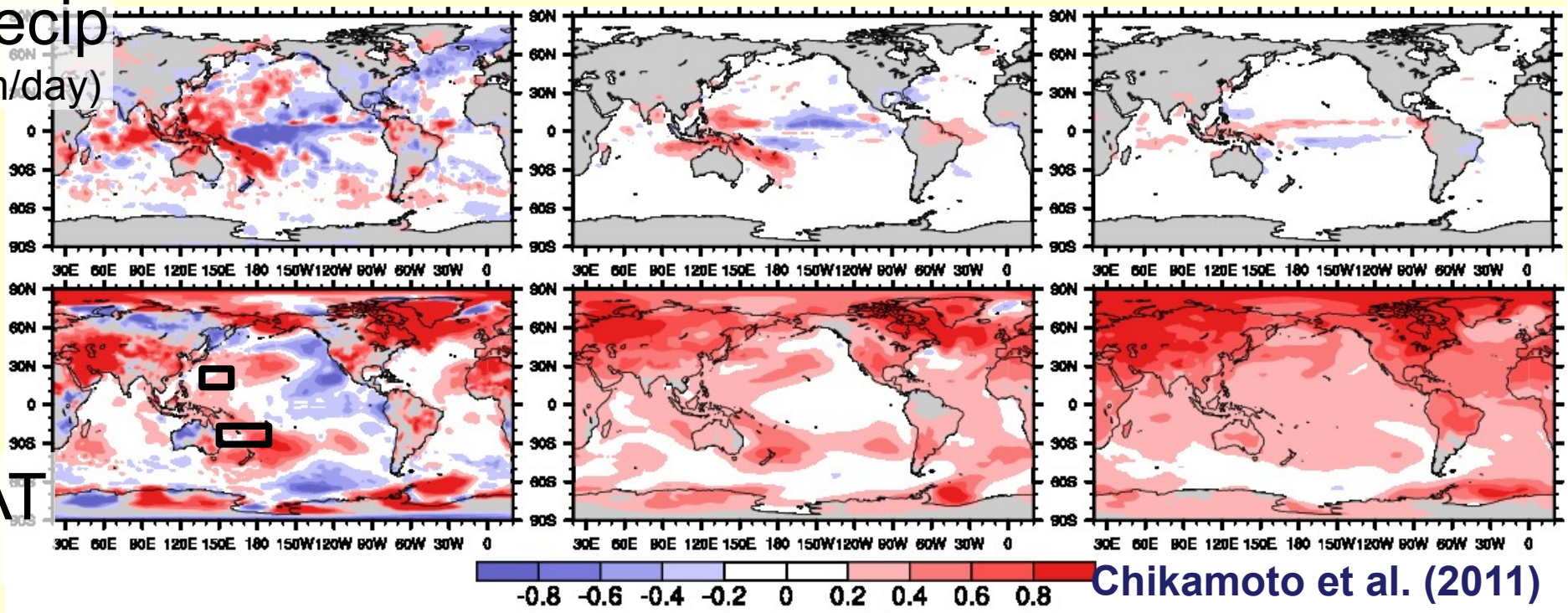
South Pacific



Obs HCST NoAS

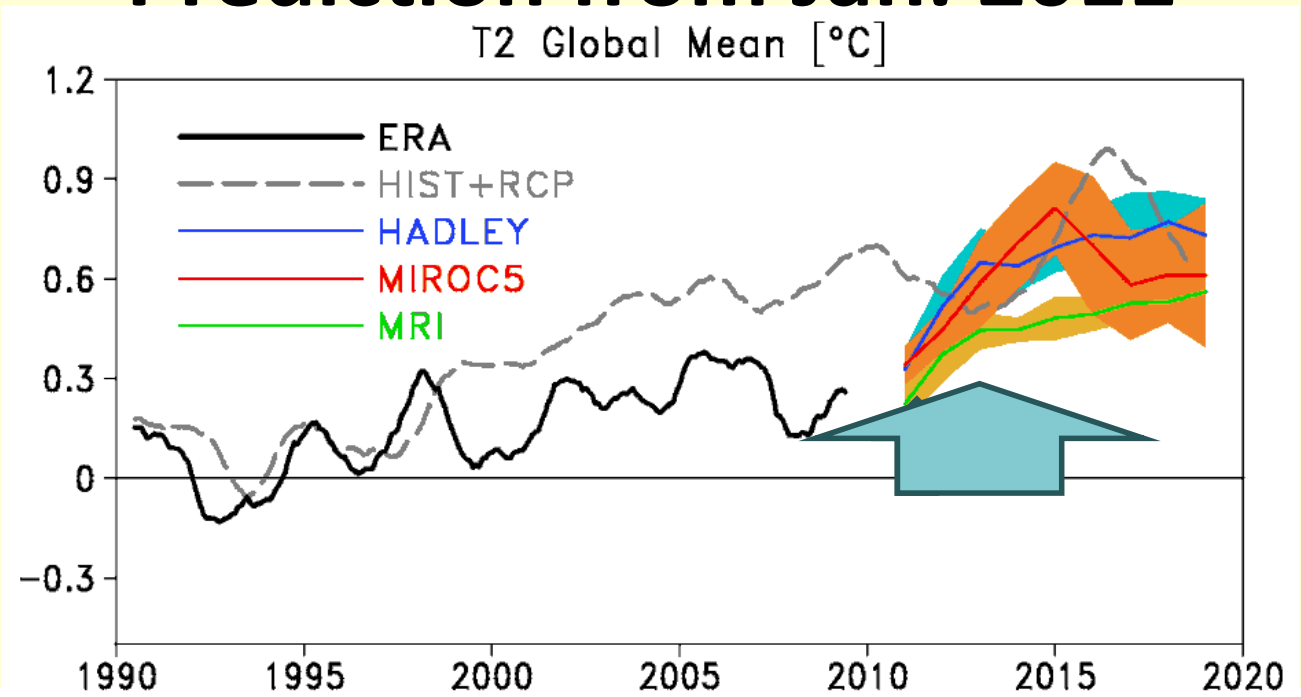
Precip (mm/day)

SAT (℃)



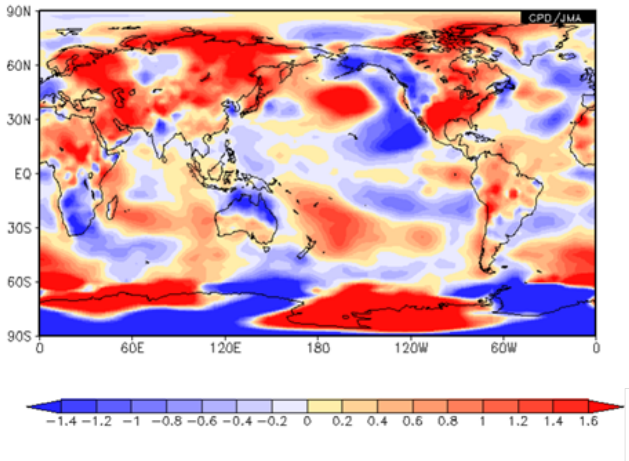
Chikamoto et al. (2011)

Prediction from Jan. 2011

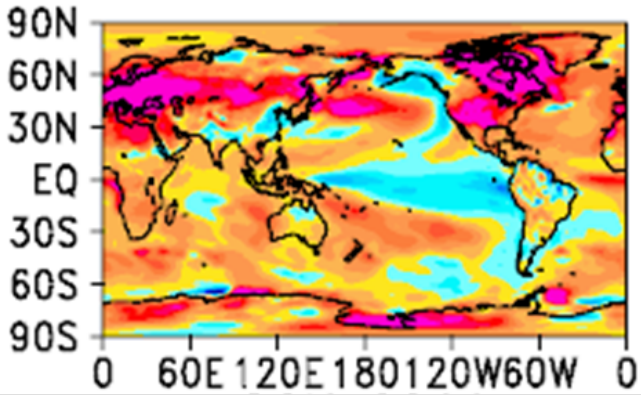


JJA 2011

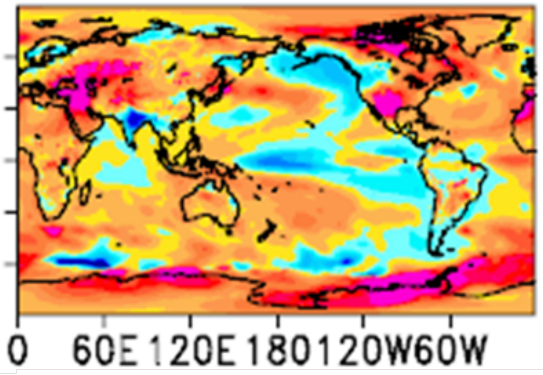
Obs

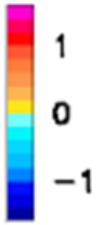


MIROC5



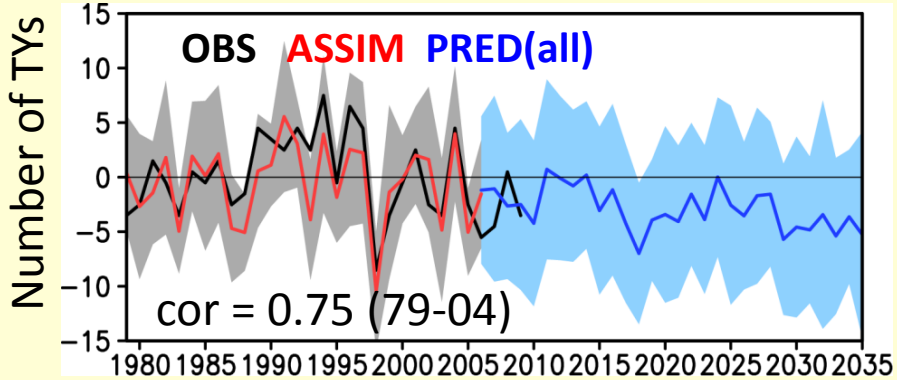
MRI



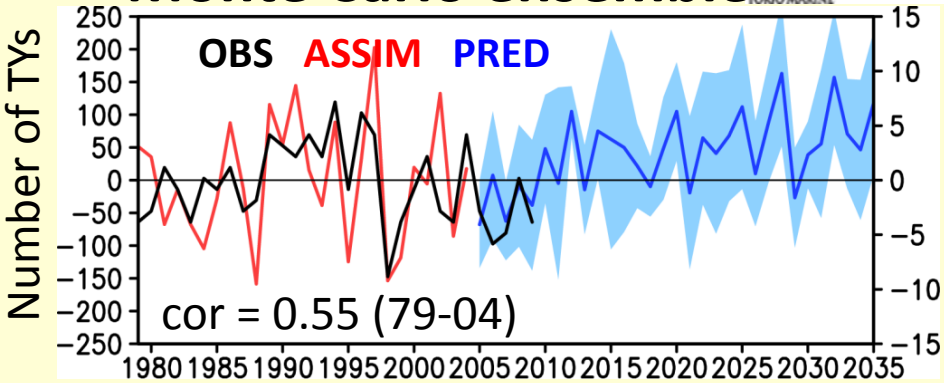


Predicted near-term changes in Typhoons

MIROC ensemble

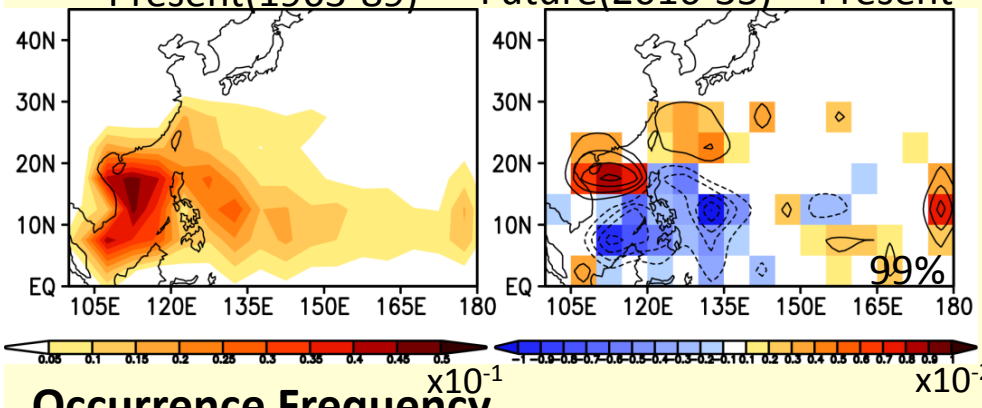


Monte Carlo ensemble



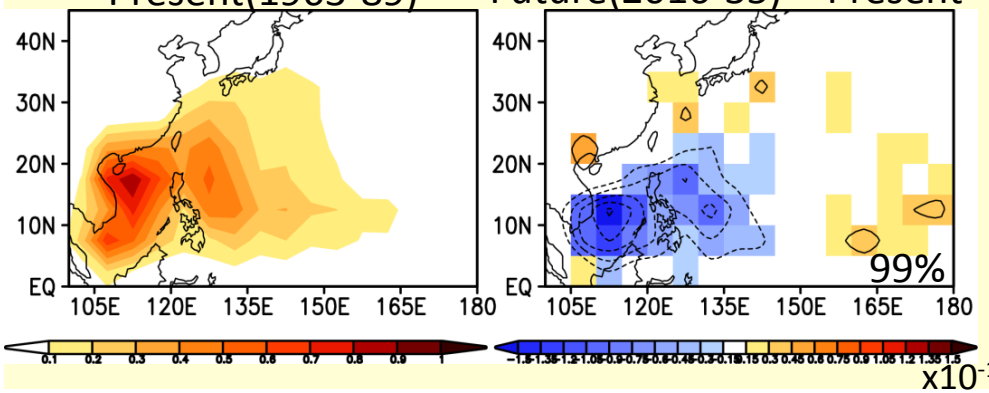
Genesis Frequency

Present(1963-89) Future(2016-35) — Present



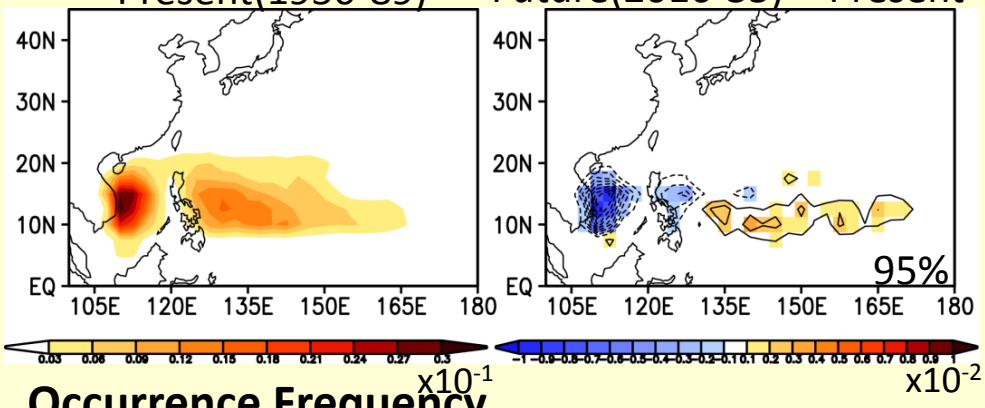
Occurrence Frequency

Present(1963-89) Future(2016-35) — Present



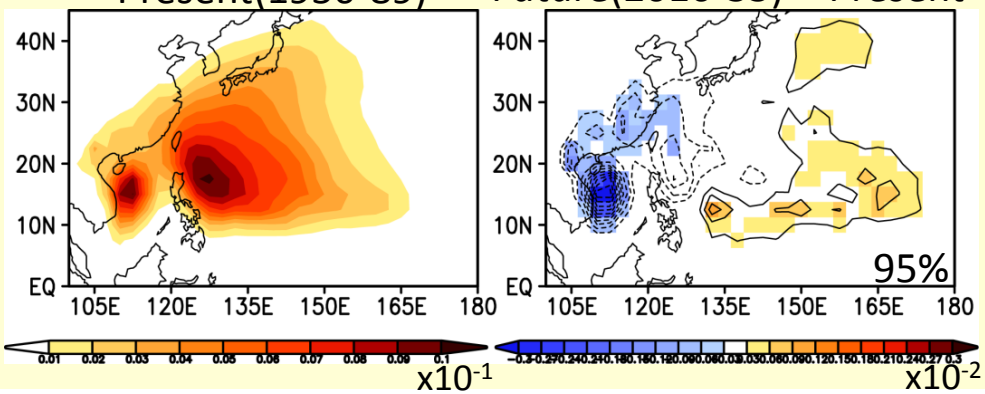
Genesis Frequency

Present(1950-89) Future(2016-35) — Present



Occurrence Frequency

Present(1950-89) Future(2016-35) — Present



KAKUSHIN Team for Extremes Projetion

PI: Akio Kitoh
(MRI/JMA)

Projection by AOGCMs

Time-slice exp by a high-resolution AGCM

Nested time-slice experiments

280-120km
AGCMs

CMIP3 models

Atmos

SST

Ocean

200-50km
OGCMs

Projected SST

20km mesh
AGCM

Atmos

SST

Boundary condition

5km/2km/1km mesh
Cloud-resolving model

5km domain

1km domain

2km domain

Boundary condition

SST

Present

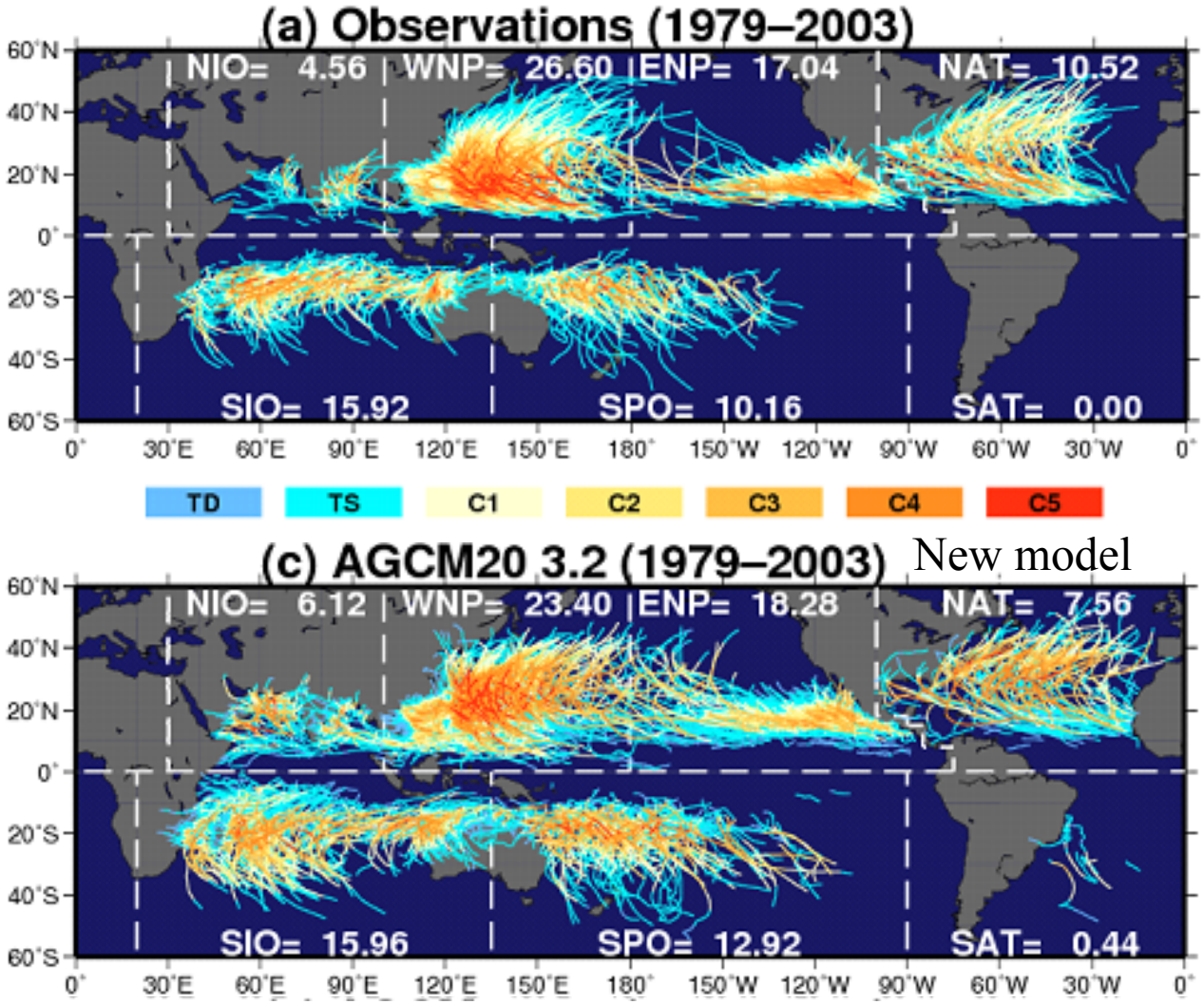
Near Future

Future

year

1979−2003 2015−2039 2075−2099

Problems with the previous 20-km mesh MRI-AGCM



Number for each basin denotes the annual mean number of TCs.

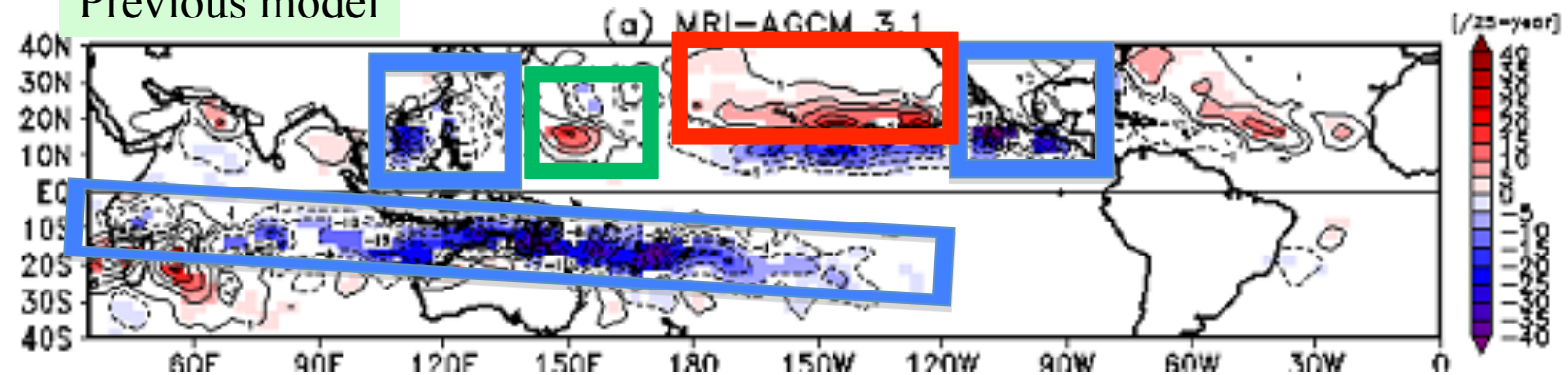
Predicted TC number in the WNP is underestimated — Improved

TC intensity is weak compared with observations — Improved

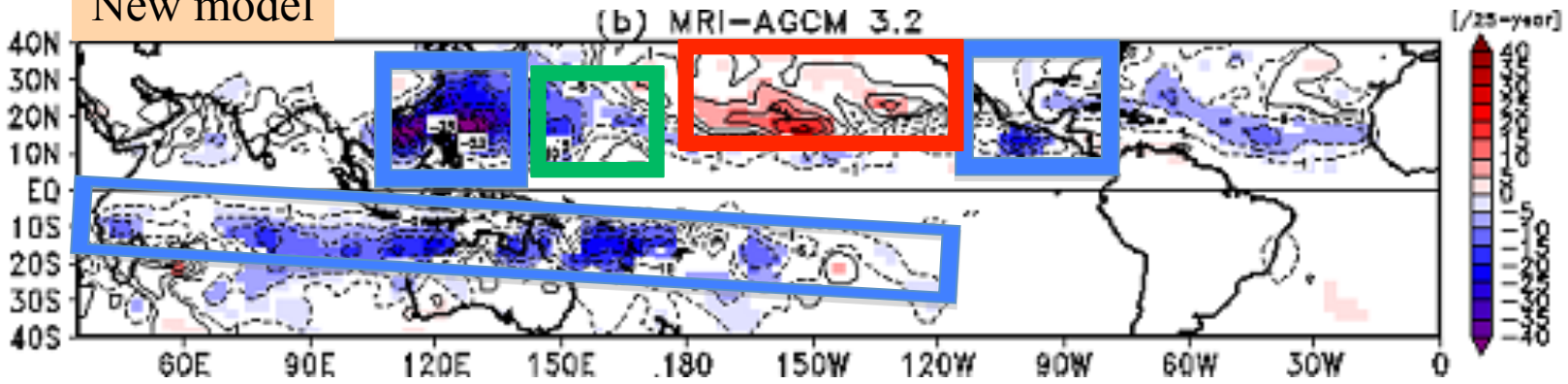
Murakami et al. (2011, submitted)

Comparison of projected future changes between models
- Frequency of TC occurrence -

Previous model



New model

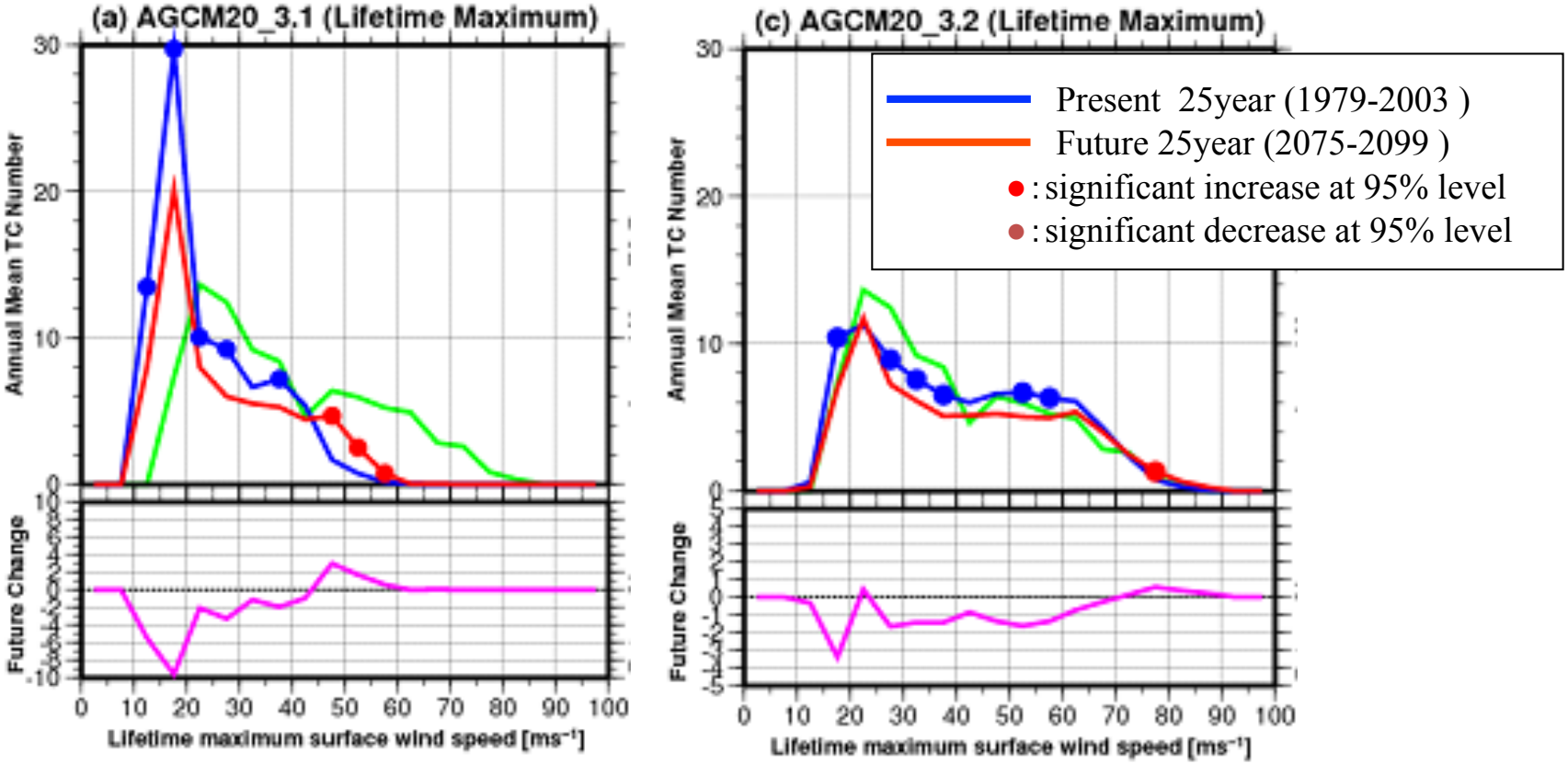


- Both models show significant decrease in TC frequency over the South Pacific and western portion of WNP
- Both models show significant increase in TC frequency over the central Pacific
- Inconsistent in the eastern quadrant of WNP

Comparison of projected future changes between models - TC intensity -

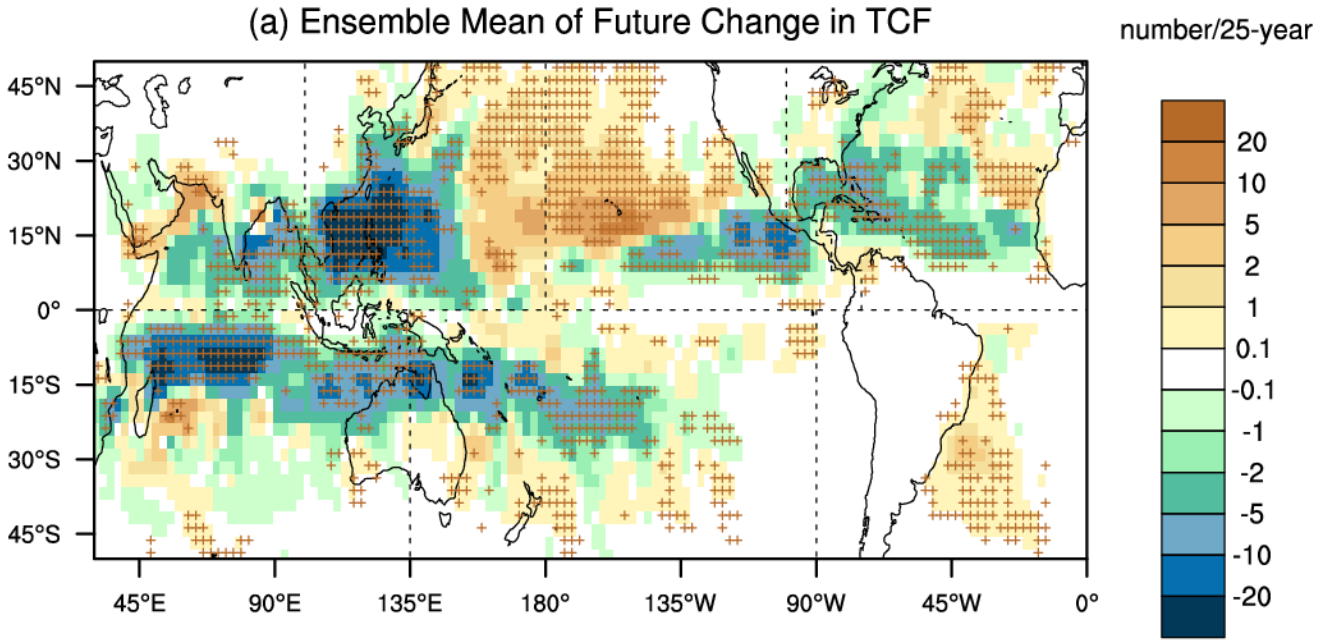
Previous model

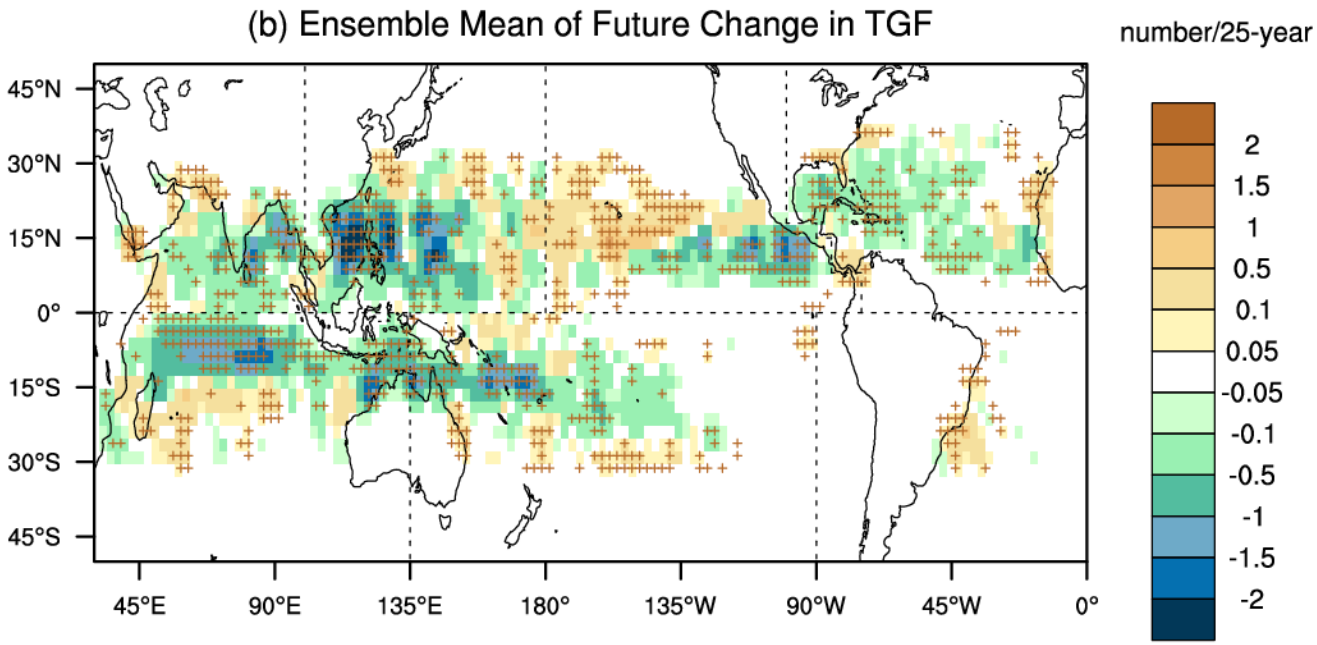
New model



- Both models show significant decrease in the frequency of weak TCs
- New model projects a more subtle increase in the frequency of intense TCs

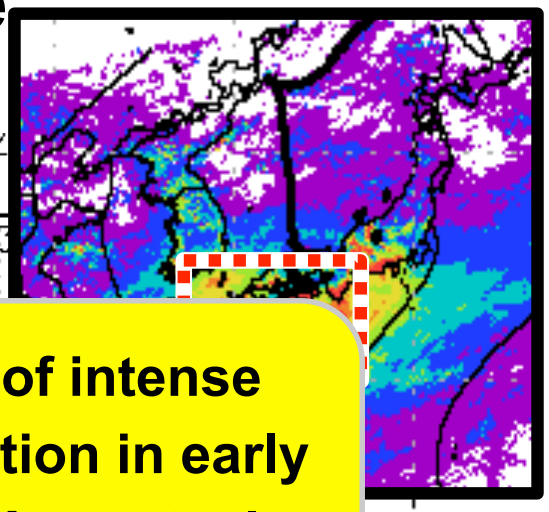
Future changes in TC frequency and genesis frequency





Cross mark indicates that the difference is statistically significant at the 90 % confidence level or above and more than 10 experiments show the same sign of the mean change.

Seasonal variations of domain-average rainfall amount around west Japan



25yr-mean precipitation (MA=5day): Averaged in 12
Present(blue:1979-2003),Future(red:2075-2099),RA(black:1
Mean value: Present=7.33, Future=7.93

Obs.

Present

Future

Ratios of intense precipitation in early July and August also increase

The Baiu

TC+front

Obs

Pres

Future(25yrs)

Mean precipitation amounts in early July and August increase

With high confidence above the 90%

0 2 4 6 8 10 12 14

1JUN 16JUN 1JUL 16JUL 1AUG 16AUG 1SEP 16SEP 1OCT 16OCT