Climate Modeling Activity in Japan

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with contributions from

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Major climate modeling groups in Japan

CCSR+NIES+FRCGC

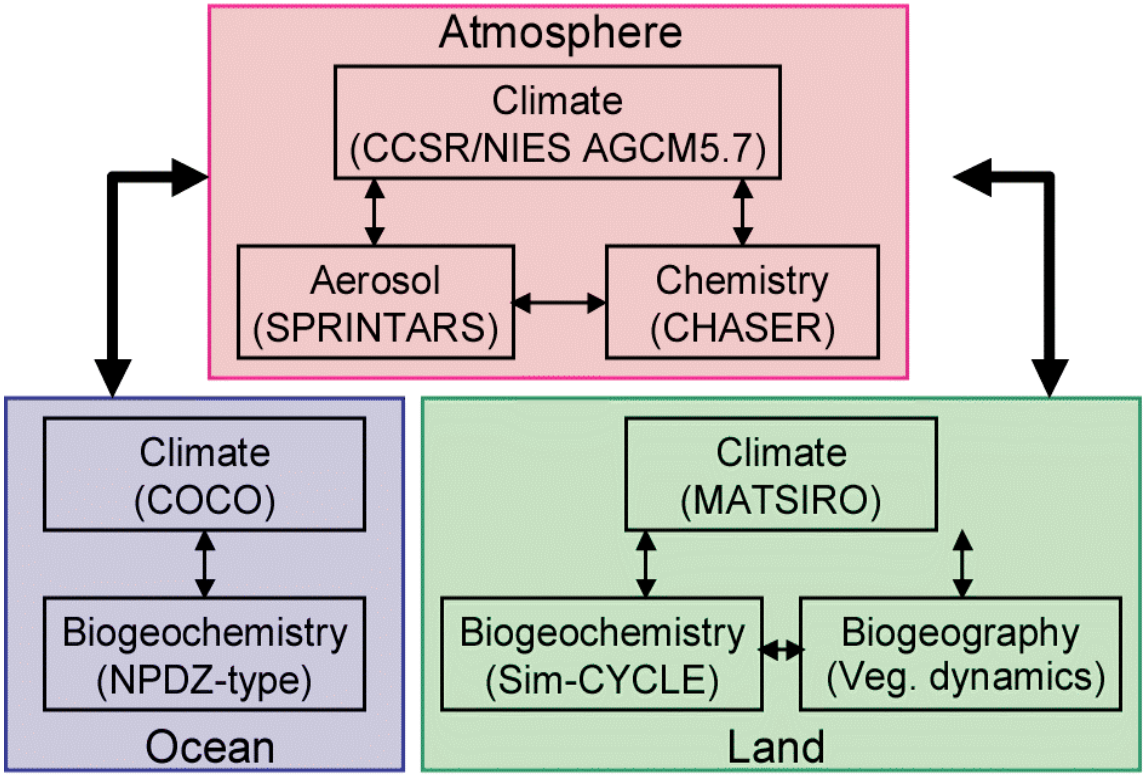
- earth system model for long-term global environmental projection
- high-resolution coupled ocean-atmosphere GCM for near-term climate prediction

MRI

- earth system model
- super-high-resolution atmospheric models for projection of changes in extremes in the future

FRCGC: Frontier Research Center for Global Change
CCSR: Center for Climate System Research of the University of Tokyo
NIES: National Institute for Environmental Studies
MRI: Meteorological Research Institute of Japan Meteorological Agency

CCSR/NIES/FRCGC Earth System Model (ESM)



AGCM

CCSR/NIES/FRCGC

T42(~2.8ºx2.8º)

L80 (TOA:80km)

OGCM

COCO (CCSR/FRCGC)

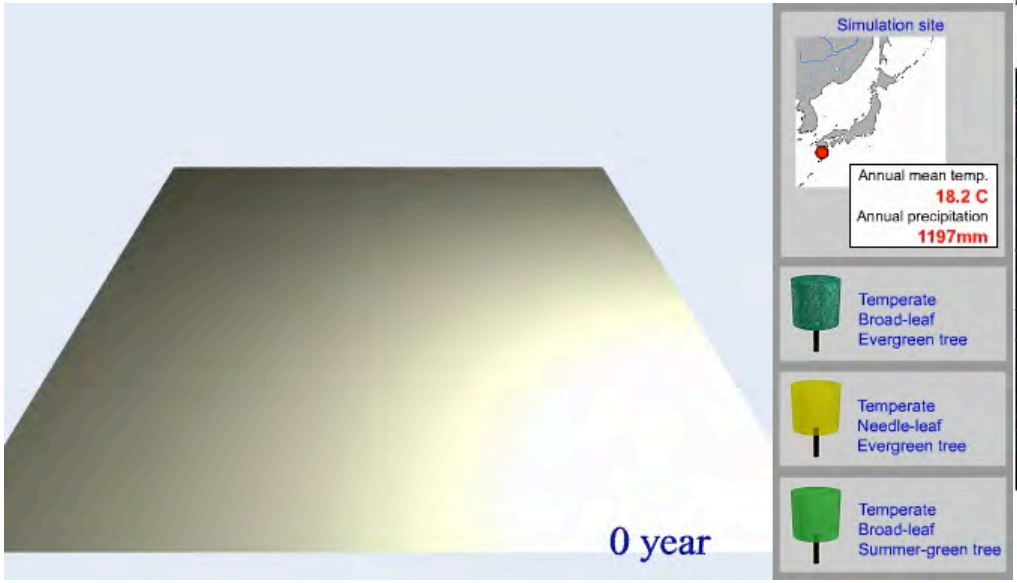
"Bended axis" grid system

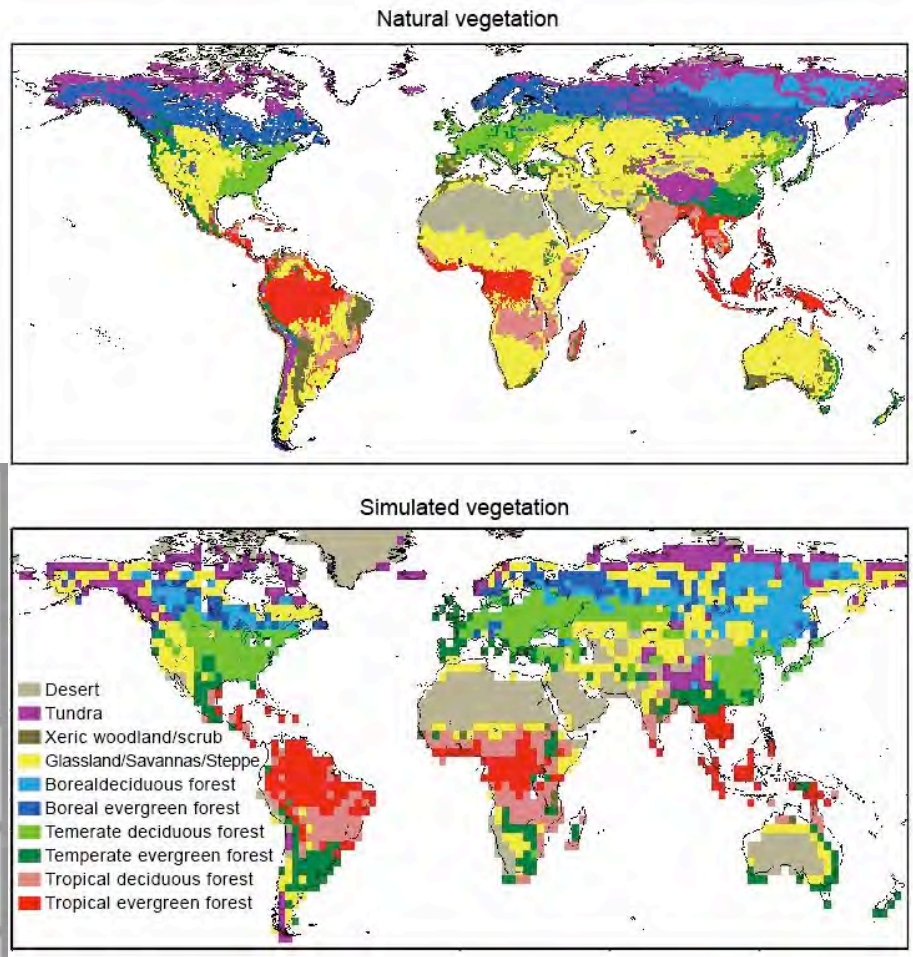
(0.5-1.0)º x 1.4º

Also T85 without chemistry?

Development of an dynamics global vegetation model (SEIB-DGVM)

Observed and simulated potential vegetation



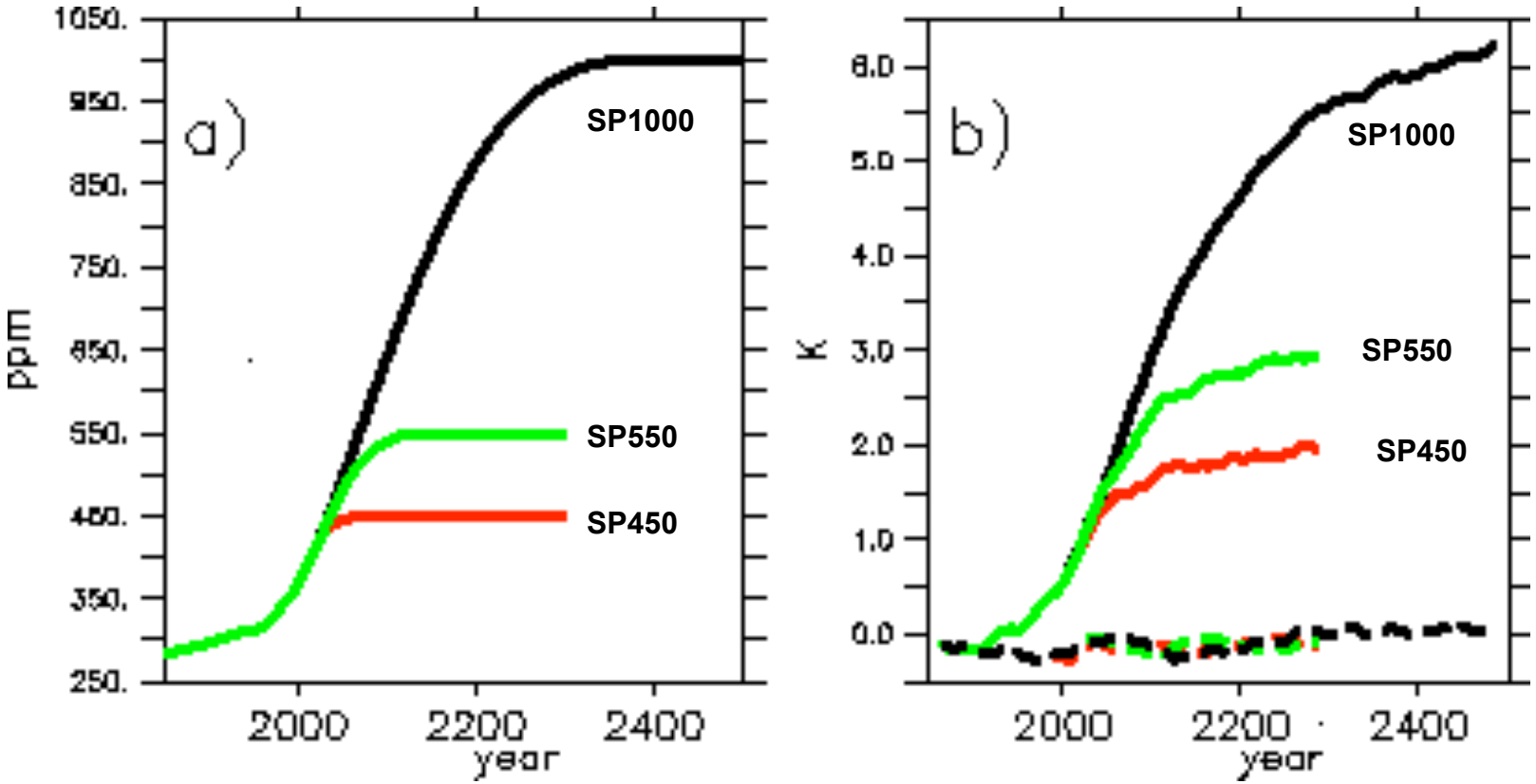


It's an individual-based model…

Computer simulation for CO_2 Stabilization（1）

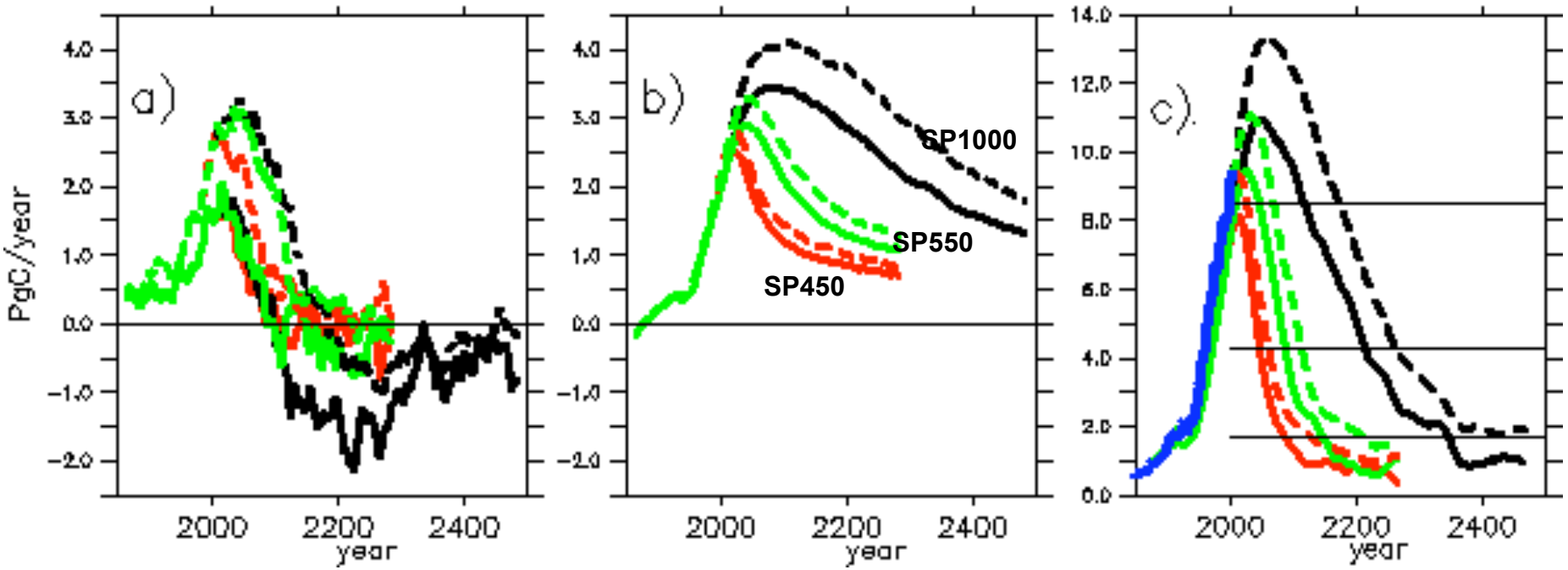
Projection of temperature change under stabilization scenarios using an earth system model

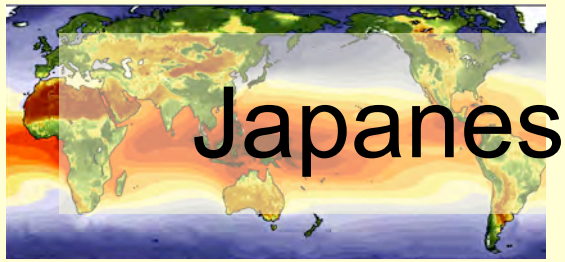
CO2 concentration scenarios → Temperature projection



Computer simulation for CO_2 Stabilization（2）

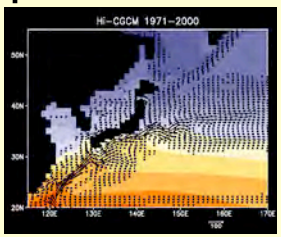
Carbon Sinks and anthropogenic emission pathways under stabilization scenario

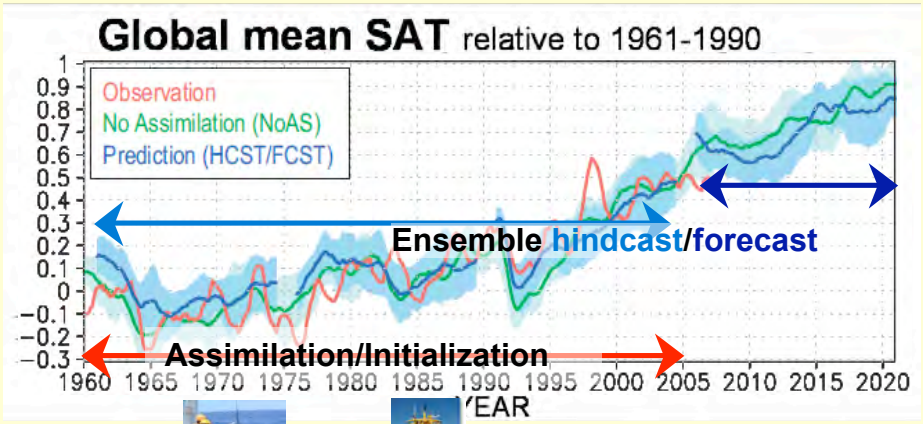


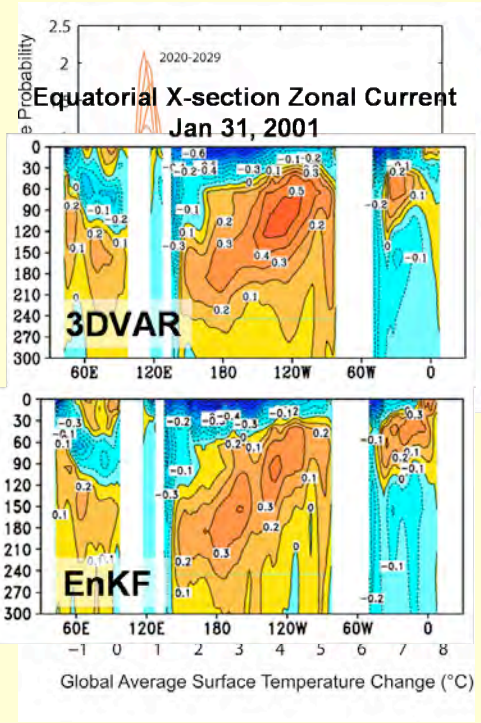


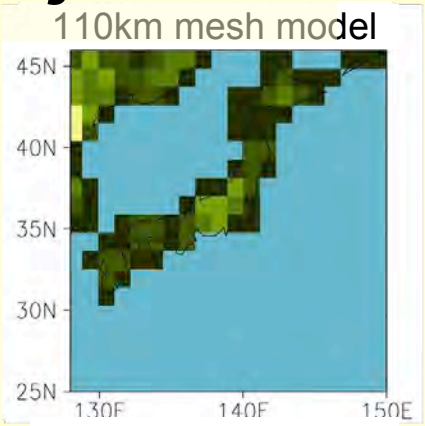
Japanese CLIMATE 2030 Project

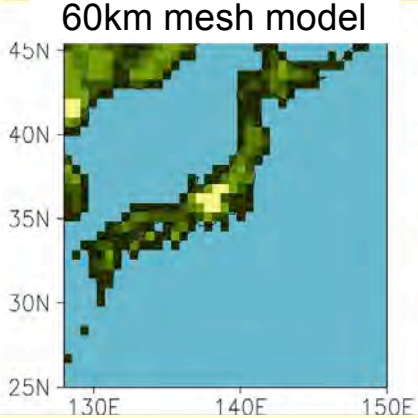
- A near-term prediction up to 2030 with a high-resolution coupled AOGCM
  - 60km Atmos + 20x30km Ocean
  - w/ updated cloud PDF scheme, PBL, etc
  - advanced aerosol/chemistry
- Estimate of uncertainty due to initial conditions
  - 10(?)-member ensemble
  - For impact applications
    - water risk assessment system
    - impacts on marine ecosystems
    - etc.
- Test run w/ 20km AOGCM (in 2011)

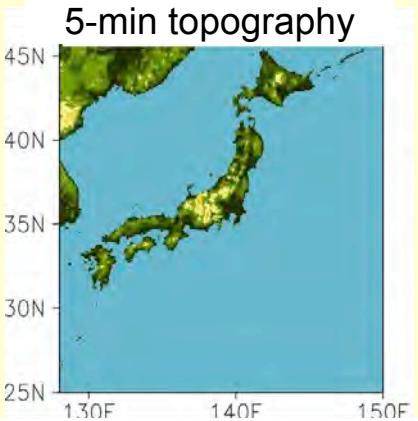






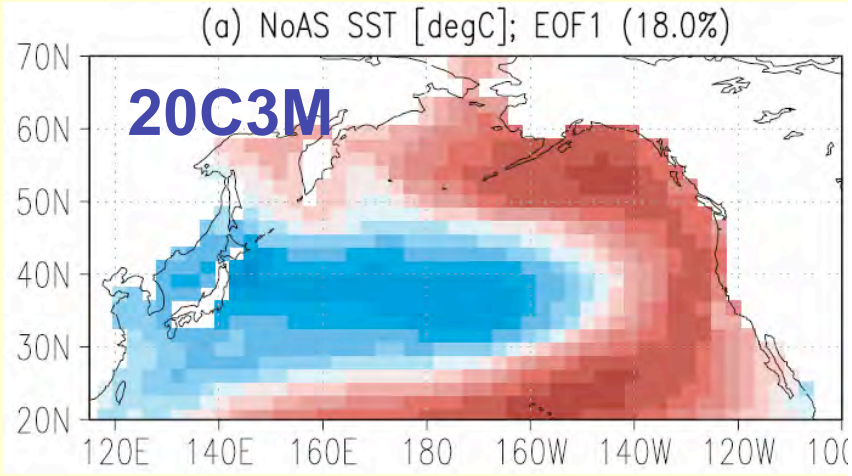


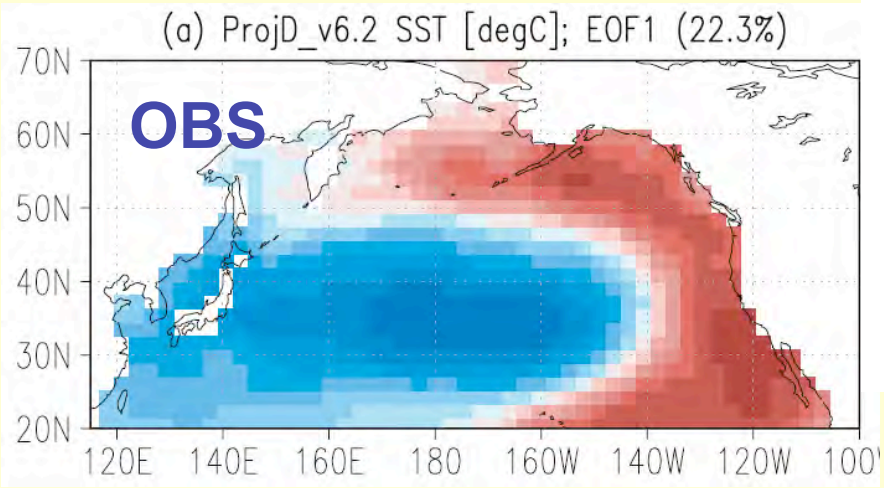




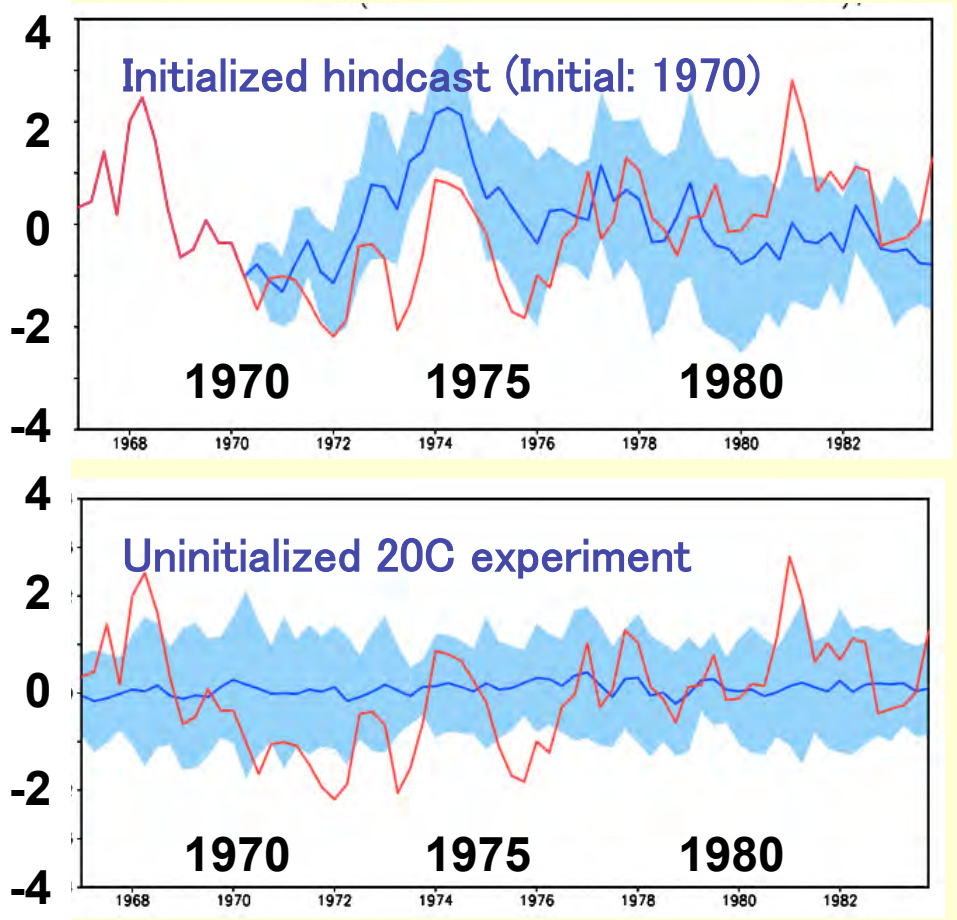
Predictability of PDO: Impact of initialization

SST EOF1





Time series projected on to simulated PDO

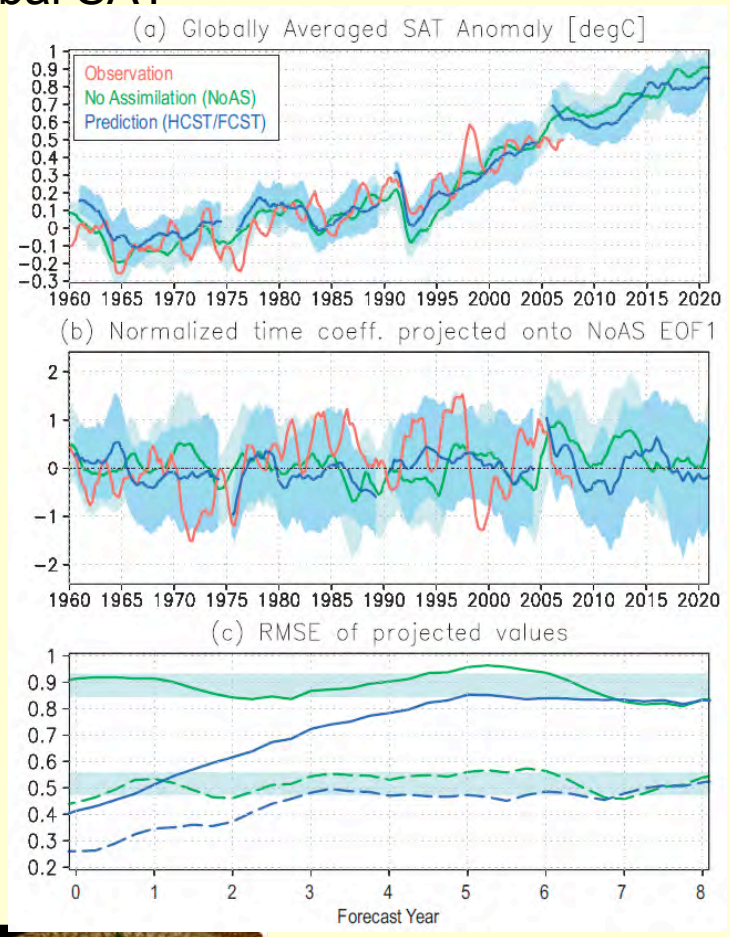


Mochizuki et al. (2009, submitted)

Decadal Predictability?

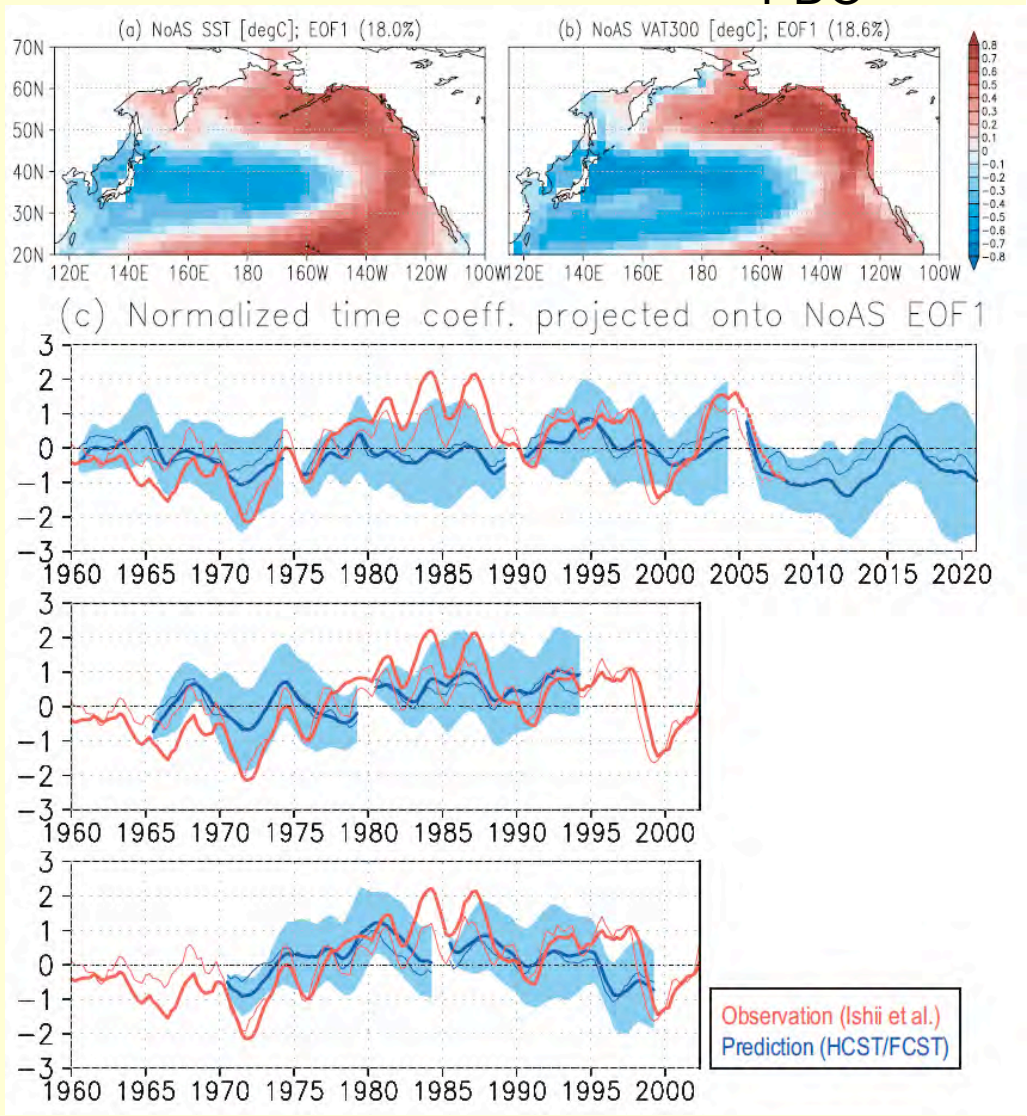
Assimilation vs. Hindcasts w/ & w/o initialization

Global SAT



SPAM:
System for
Prediction and
Assimilation by
MIROC

PDO



Mochizuki et al. (2009)

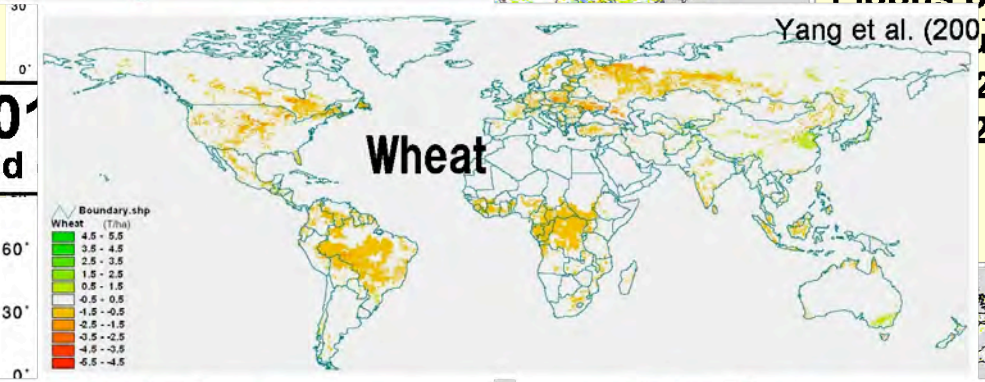
Impact assessment

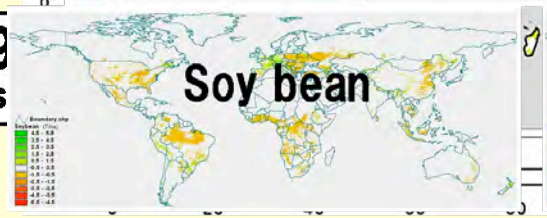
Changes in crop yields for a centennial in 2070-2100 from 1975-2005

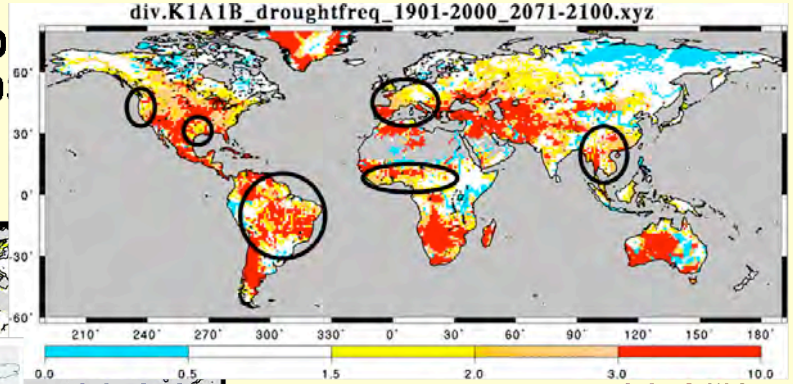
Oki et al. (2007)

Floods of a centennial

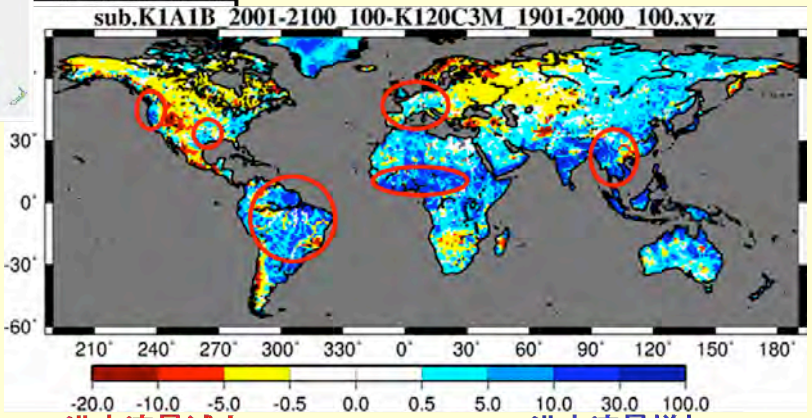
Yang et al. (2007)





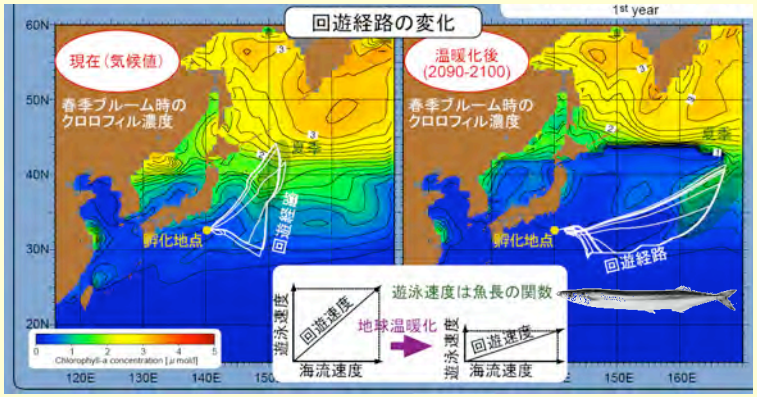


渇水頻度減少　　渇水頻度増加



洪水流量減少　　洪水流量増加

Hirabayashi et al. (2006)



Extreme event projection with super-high-resolution atmospheric models

MRI / JMA / AESTO

Atmosphere-Ocean model

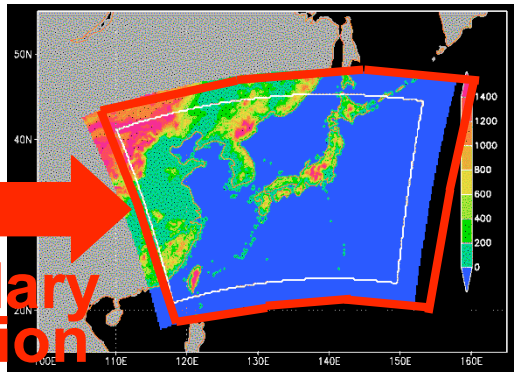
180km mesh

High-resolution global atmospheric model

20km mesh

Regional cloud resolving model by nesting

5km & 1km mesh



Atmos phere

SST

Ocean

100−50km mesh

Predicted SST

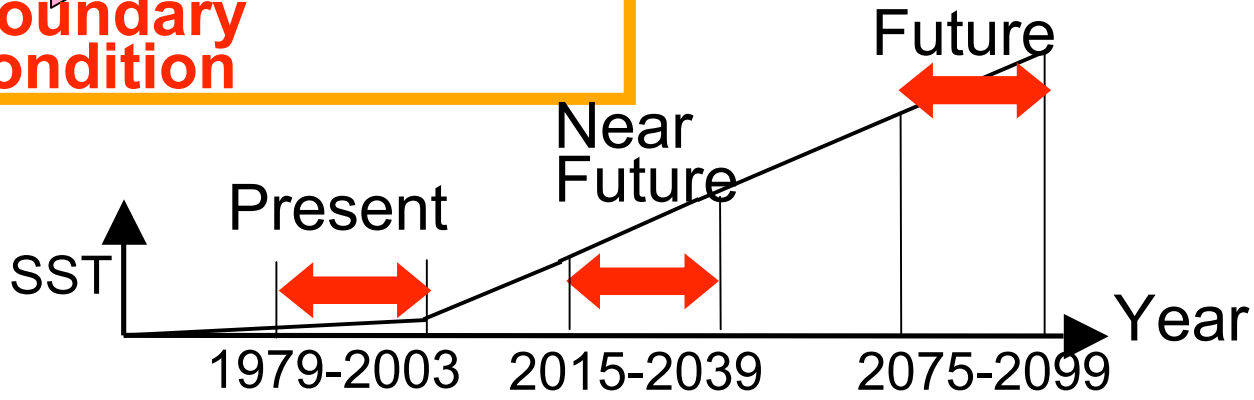
Atmos phere

SST

Boundary condition

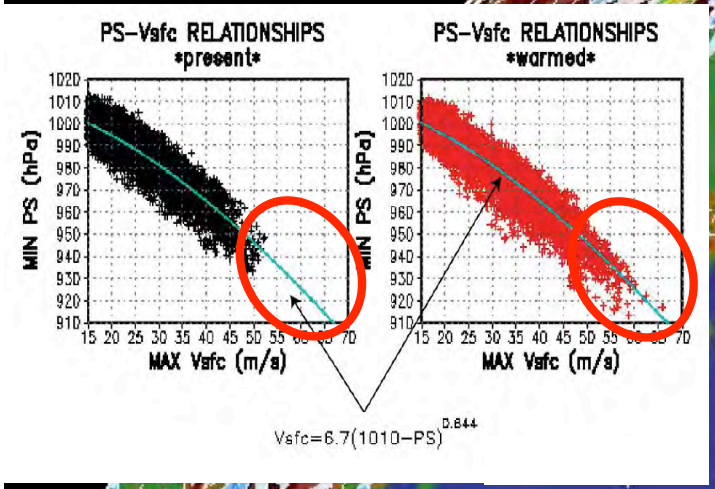
Boundary condition

SST=Sea Surface Temperature



Tropical cyclones

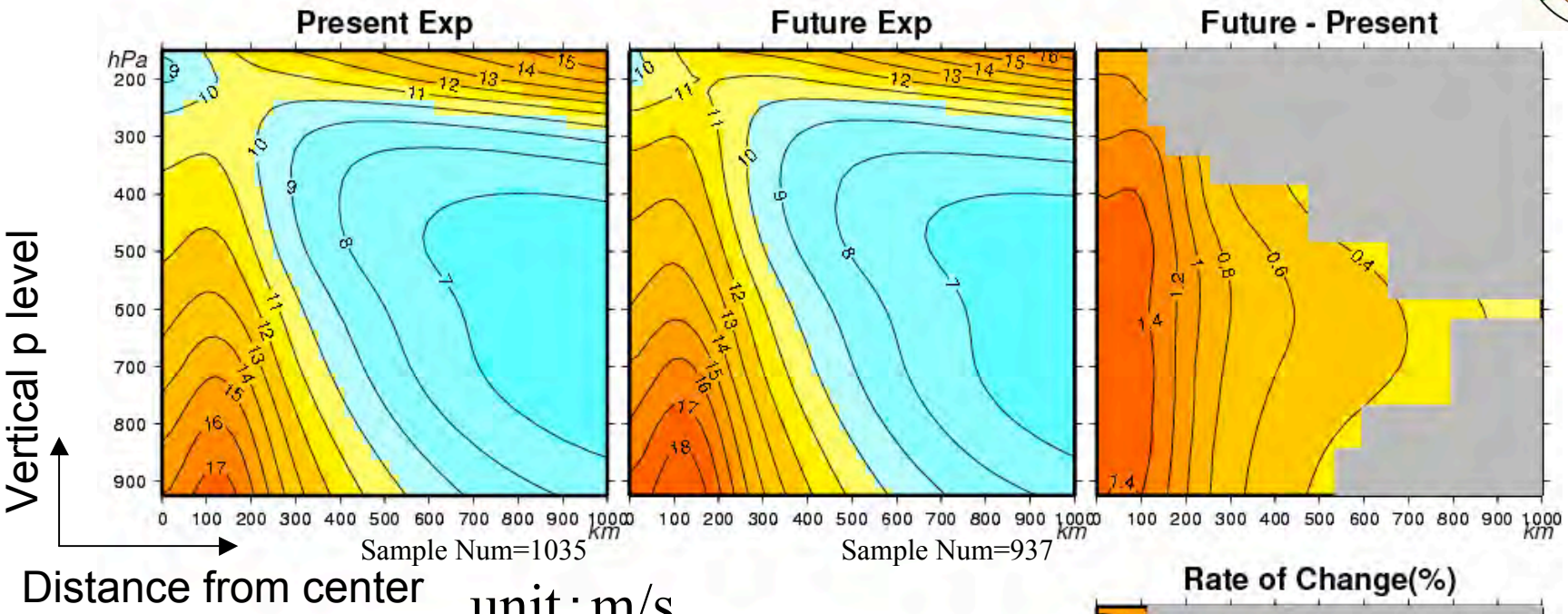
MEXT Kyo-sei Project (FY2002-2006)
and KAKUSHIN Program (FY2007-2011)
using the Earth Simulator by MRI/JMA/AESTO

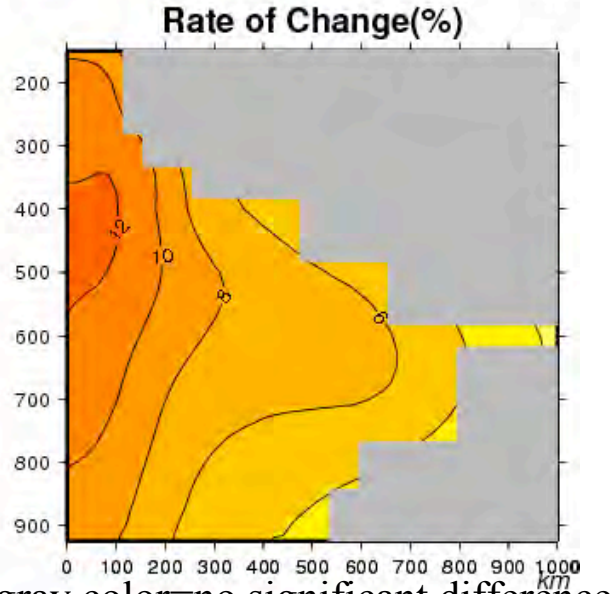


It is *likely* that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation associated with ongoing increases of tropical sea surface temperatures.

There is *less confidence* in projections of a global decrease in numbers of tropical cyclones. [IPCC AR4]

Wind Profile Change(at max wind speed)





#gray color=no significant difference

- Large increase in strong wind radius at mid level of troposphere
- Large change of inner-core wind velocity

Projection of climate change around Japan

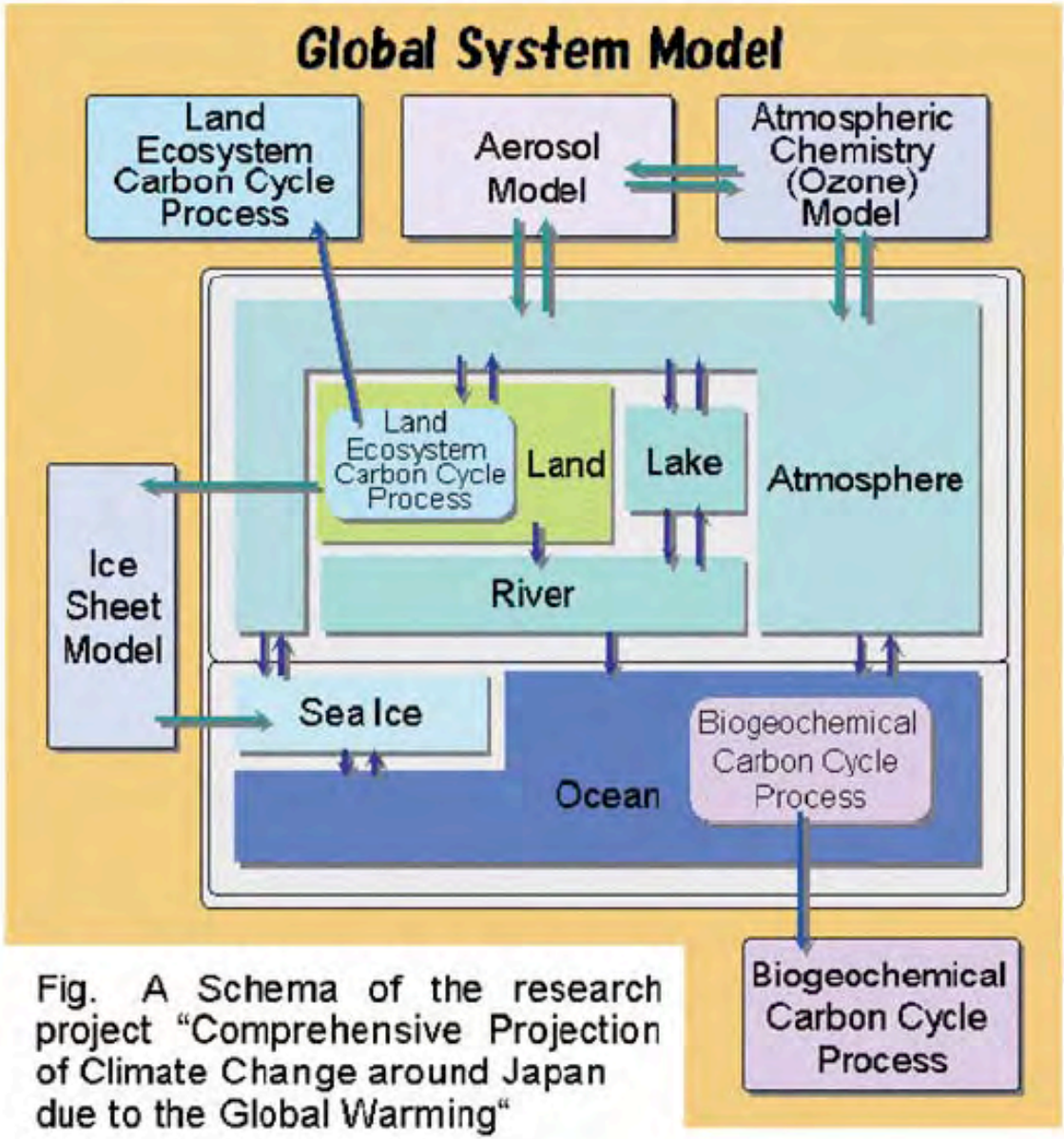
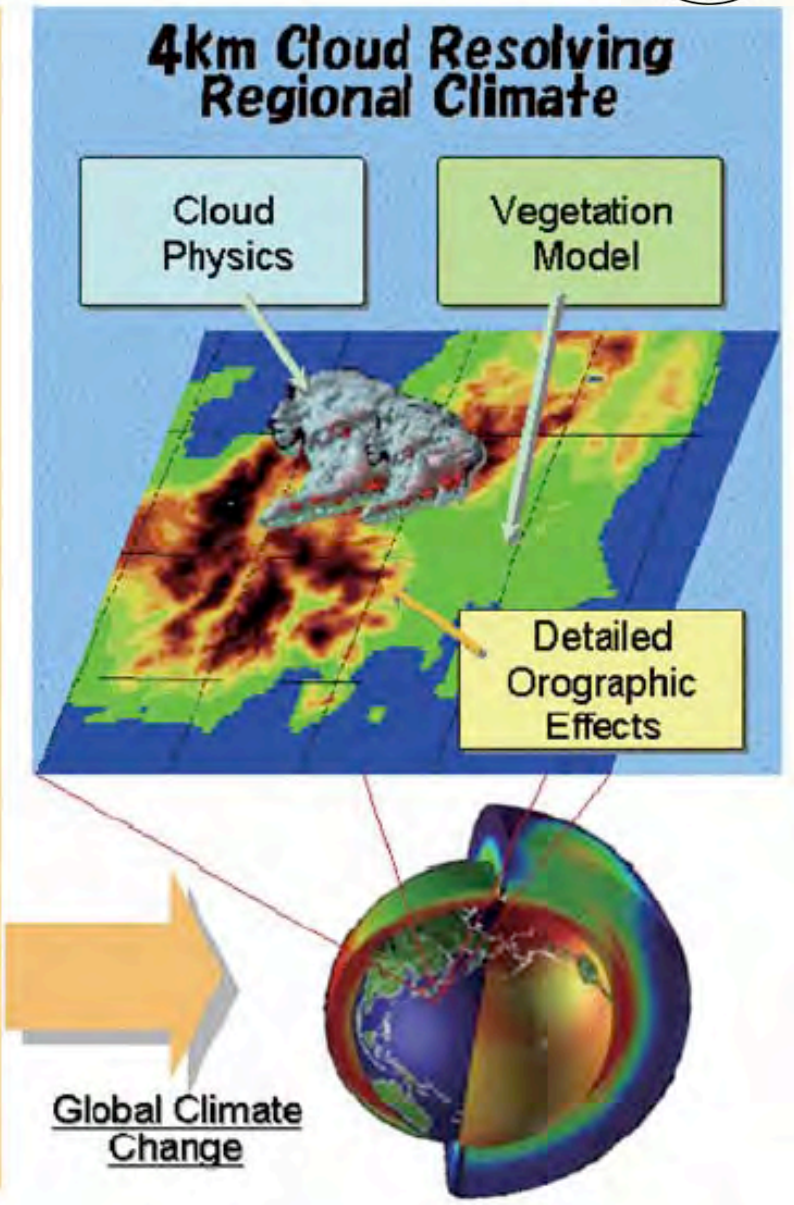
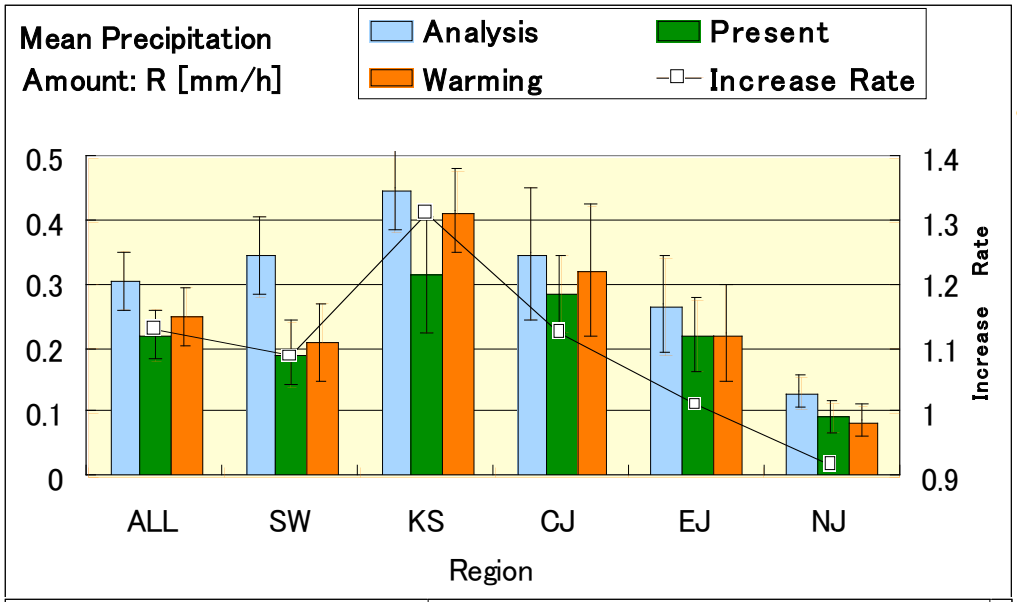
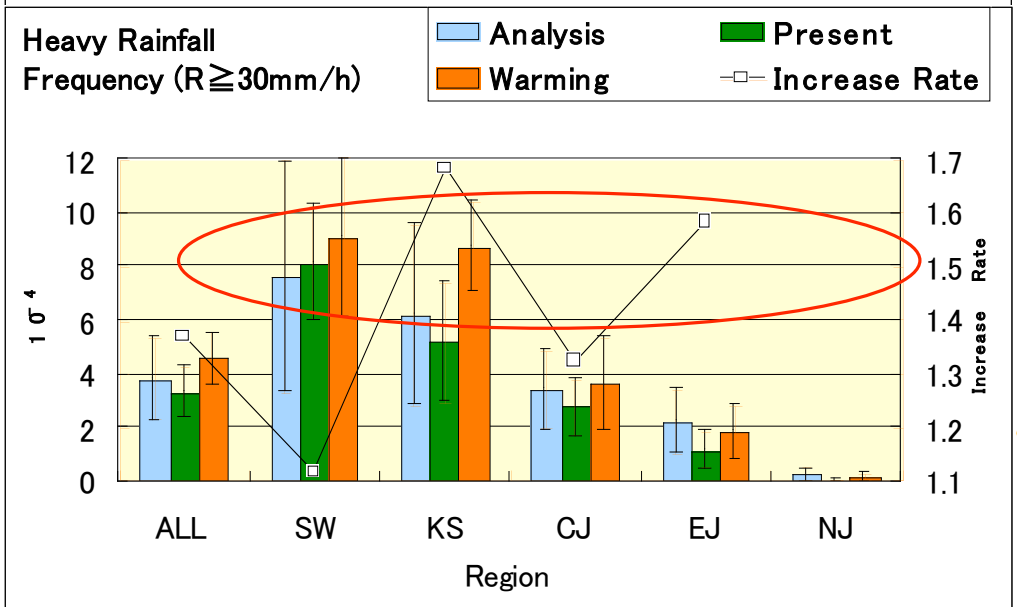


Fig. A Schema of the research project "Comprehensive Projection of Climate Change around Japan due to the Global Warming"



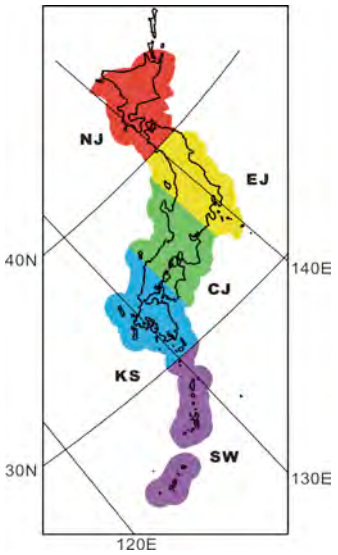
Baiu precipitation around Japan





June-July mean precipitation decreases in North Japan, increases in other areas.

It increases 30% in Kyushu.



5-km mesh Regional Climate Model results

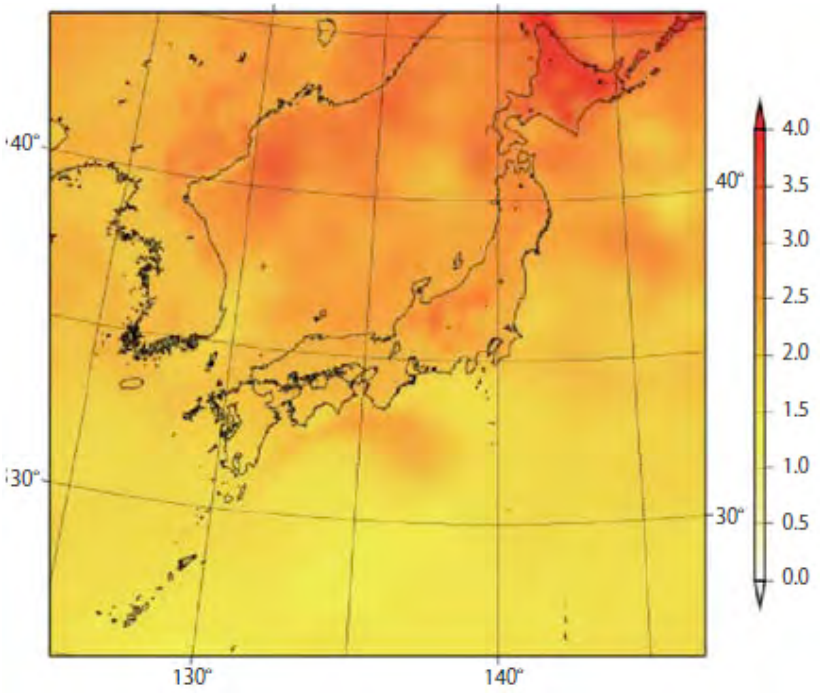
Caution: uncertainty not tested yet

Heavy rainfall frequency increases in all areas (30-40%).

It increases 70% in Kyushu.

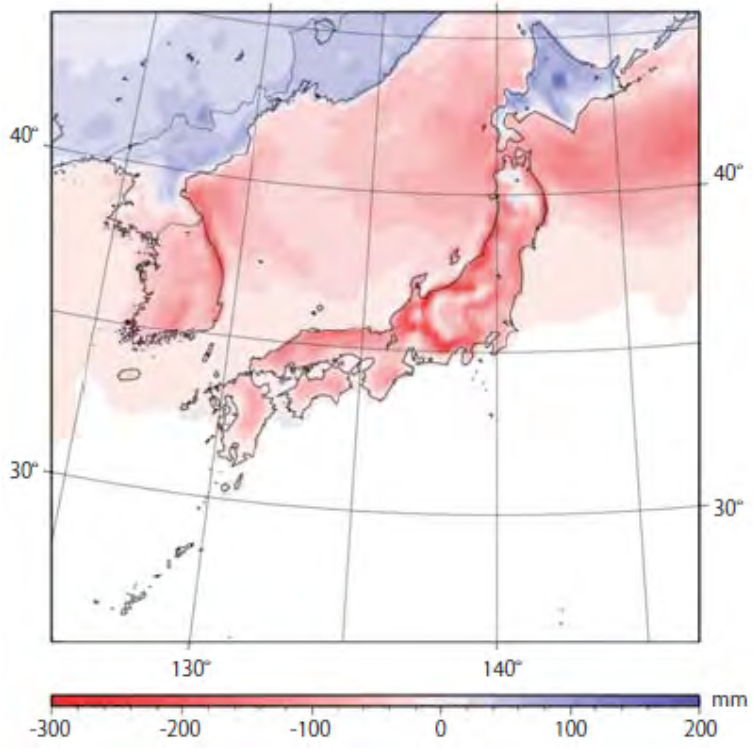
Projection around Japan

Projected surface temperature changes in winter



Temperatures are projected to increase by 1.5 to 3°C for the A1B scenario (1 to 2°C for the B1 scenario)

Projected snowfall changes in winter

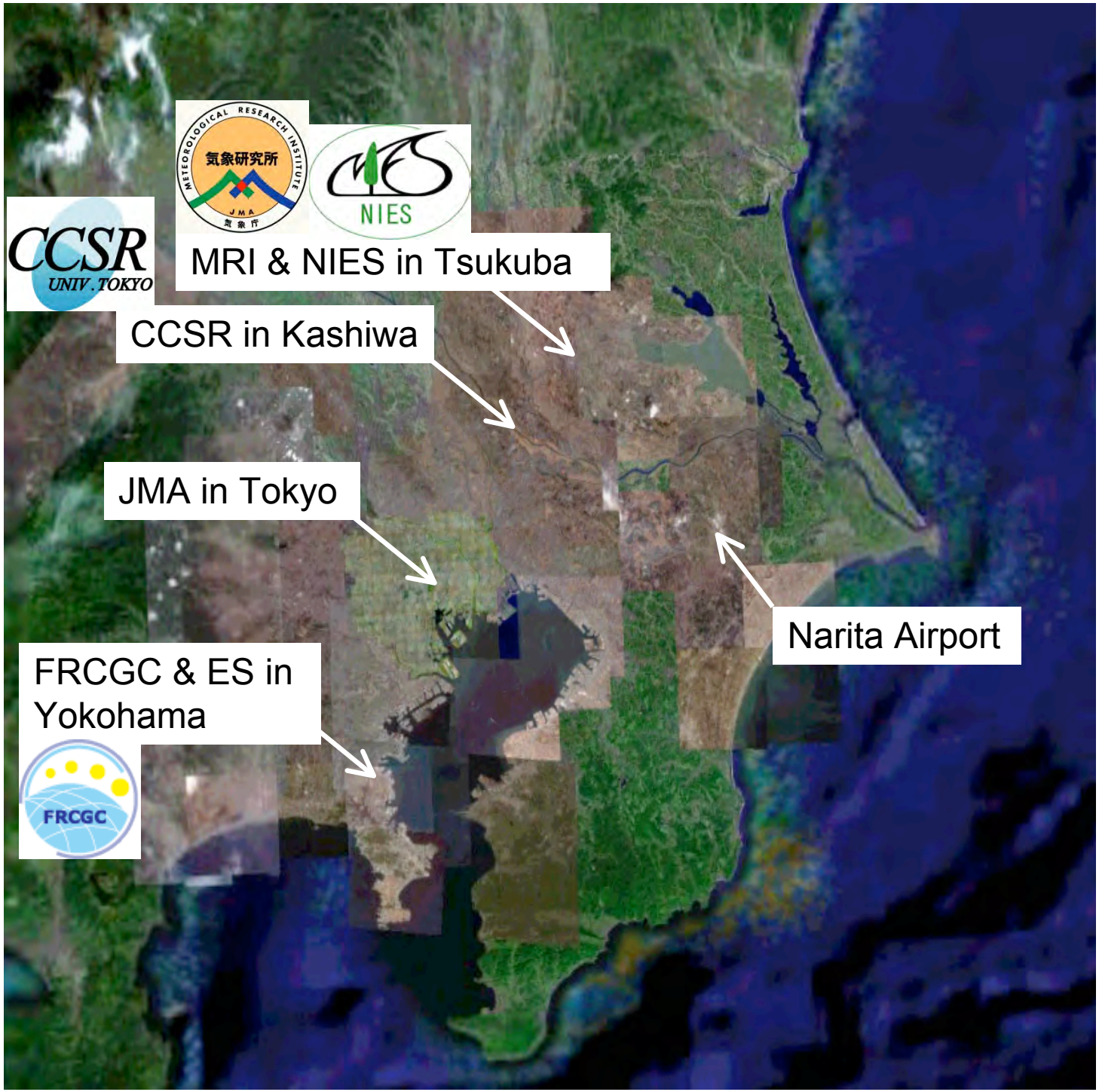


Snowfall in the Tohoku district is projected to decrease, while snowfall in Hokkaido is projected to increase

MRI Coupled Atmosphere-Ocean Regional Climate Model (CRCM) results

2081-2100 relative to 1981-2000 for the SRES A1B scenario

JMA (2008)


MRI & NIES in Tsukuba
CCSR in Kashiwa
JMA in Tokyo
Narita Airport
FRCGC & ES in Yokohama