Future climate change projection: achievement and plan

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JAPAN

Figure SPM.5

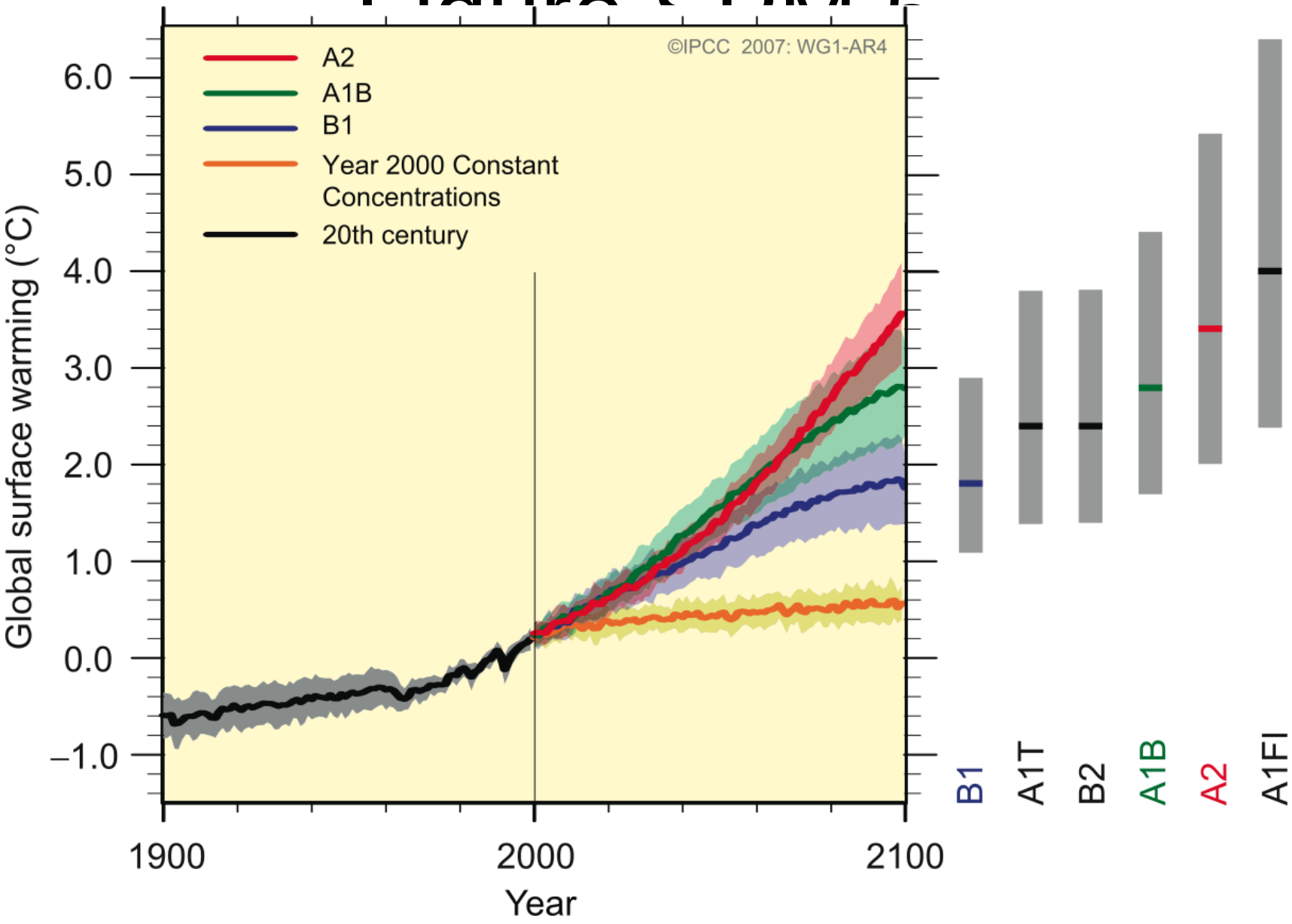
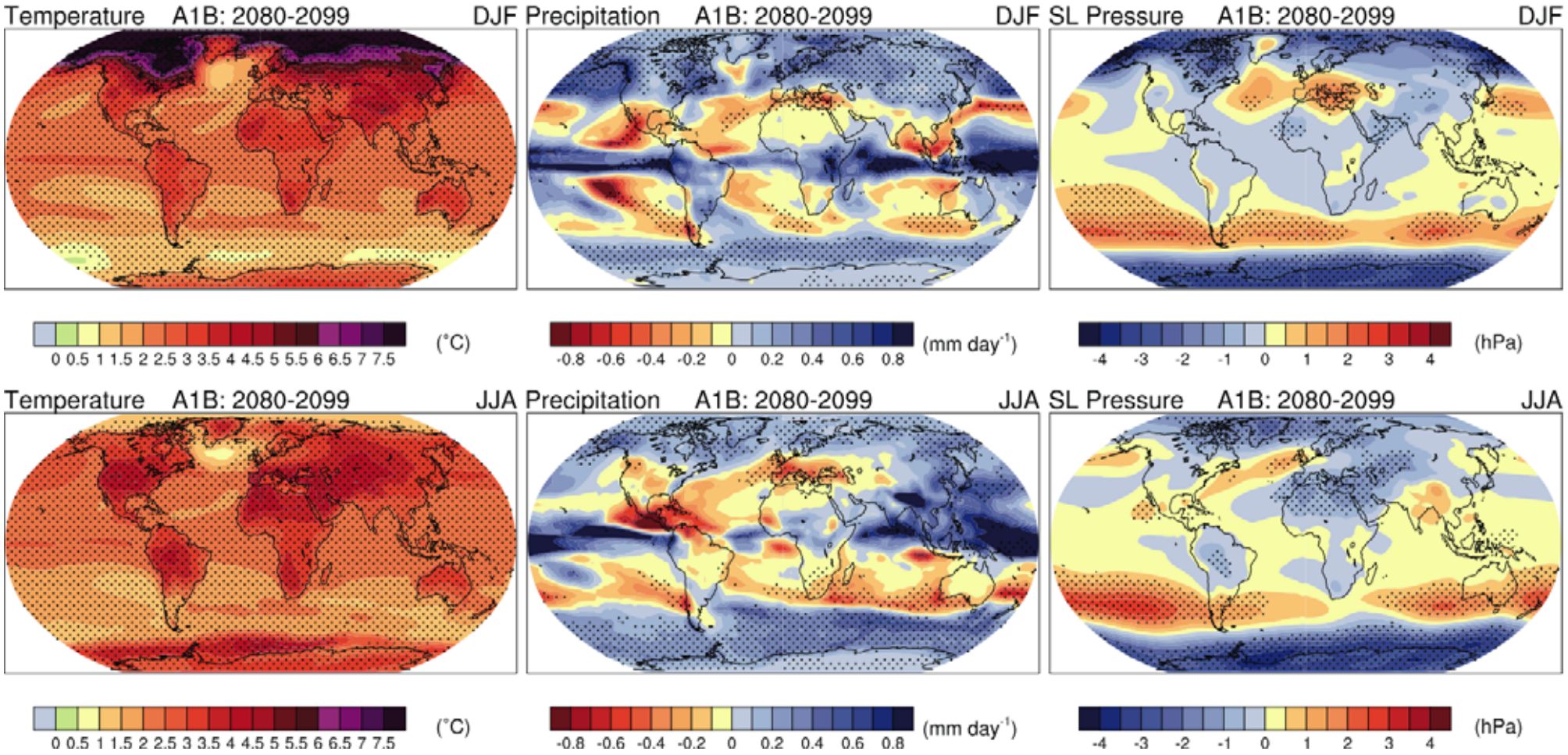
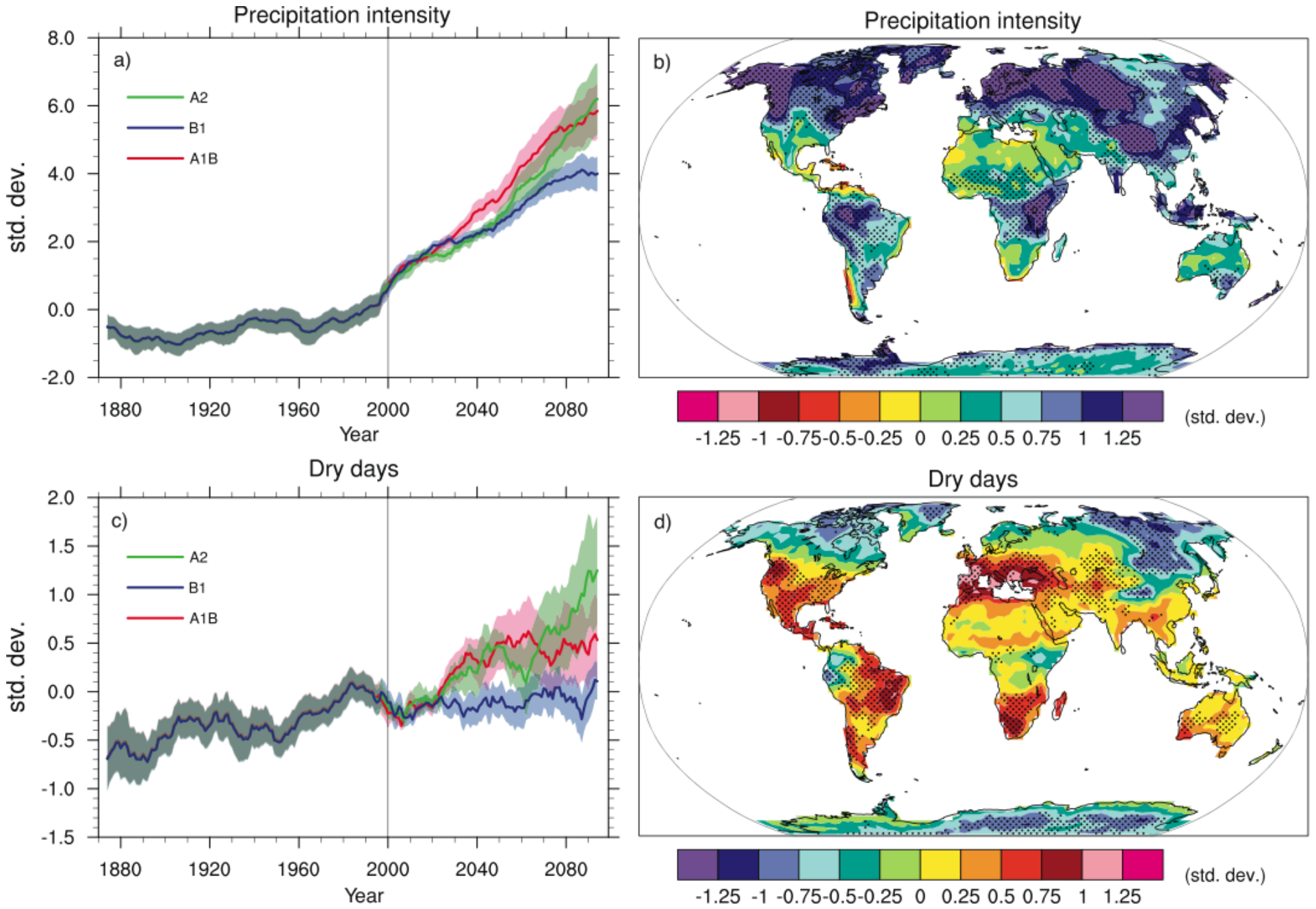

©IPCC 2007: WG1-AR4
A2
A1B
B1
Year 2000 Constant Concentrations
20th century
Global surface warming (°C)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
–1.0
1900
2000
2100
Year
B1
A1T
B2
A1B
A2
A1FI

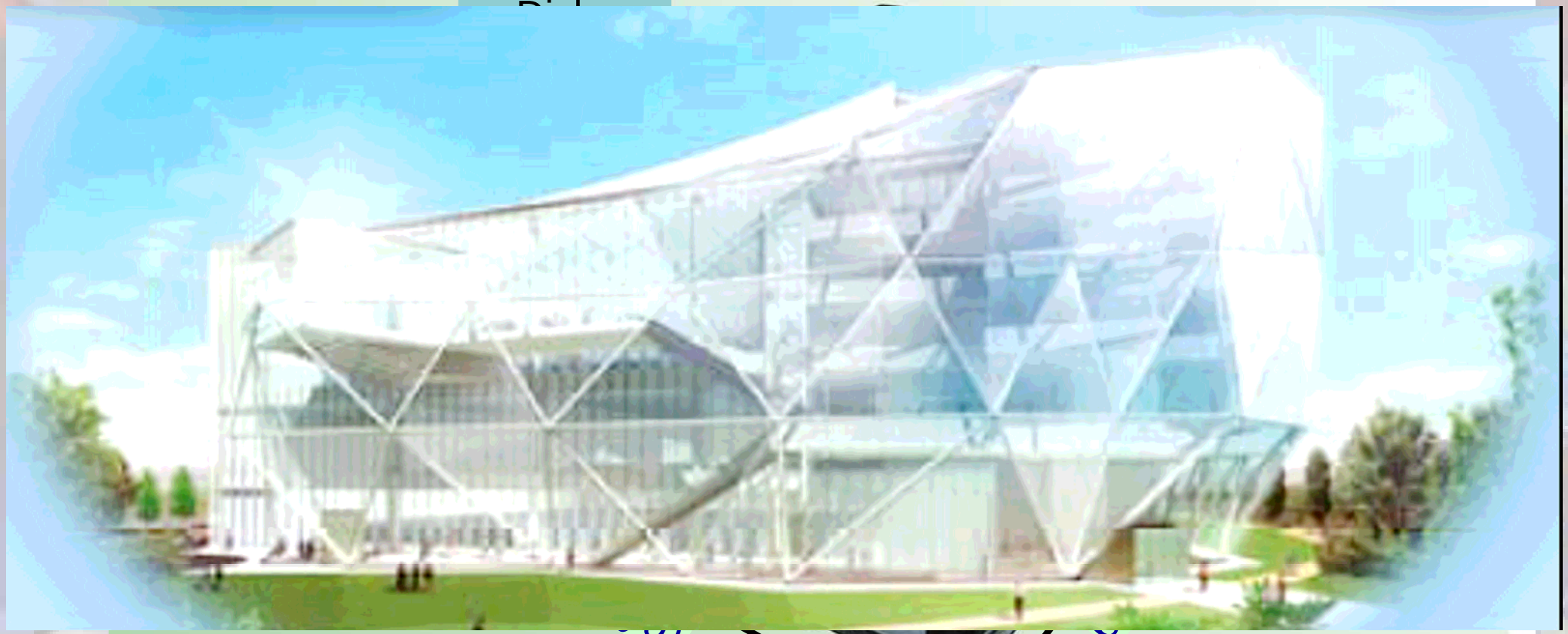
Figure 10.9


Temperature A1B: 2080-2099 DJF
Precipitation A1B: 2080-2099 DJF
SL Pressure A1B: 2080-2099 DJF
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5
(°C)
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
(mm day-1)
-4 -3 -2 -1 0 1 2 3 4
(hPa)
Temperature A1B: 2080-2099 JJA
Precipitation A1B: 2080-2099 JJA
SL Pressure A1B: 2080-2099 JJA
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5
(°C)
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8
(mm day-1)
-4 -3 -2 -1 0 1 2 3 4
(hPa)


Precipitation intensity
a)
A2
B1
A1B
std. dev.
8.0
6.0
4.0
2.0
0.0
-2.0
1880
1920
1960
2000
2040
2080
Year
Precipitation intensity
b)
-1.25 -1 -0.75 -0.5 -0.25 0 0.25 0.5 0.75 1 1.25
(std. dev.)
Dry days
c)
A2
B1
A1B
std. dev.
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1880
1920
1960
2000
2040
2080
Year
Dry days
d)
-1.25 -1 -0.75 -0.5 -0.25 0 0.25 0.5 0.75 1 1.25
(std. dev.)

“The Earth Simulator”

- 2002 Jun – 2004 Jun: The fastest in the world
- 2007 Nov: The 30th fastest
- 2009: will be upgraded (double)
- 2011: 10Peta FLOPS computer (not mainly for Earth)



Courtesy of the Earth Simulator Center

What has been done on ES?

	Conventional	On ES
Coupled Atmosphere-Ocean Model (100s-year)	Atm. ~300 km Ocn. ~100 km	**Atm. ~100 km** **Ocn. ~20 km**
Time-slice Global Atmospheric Model (10s-year)	~100 km	**~20 km**

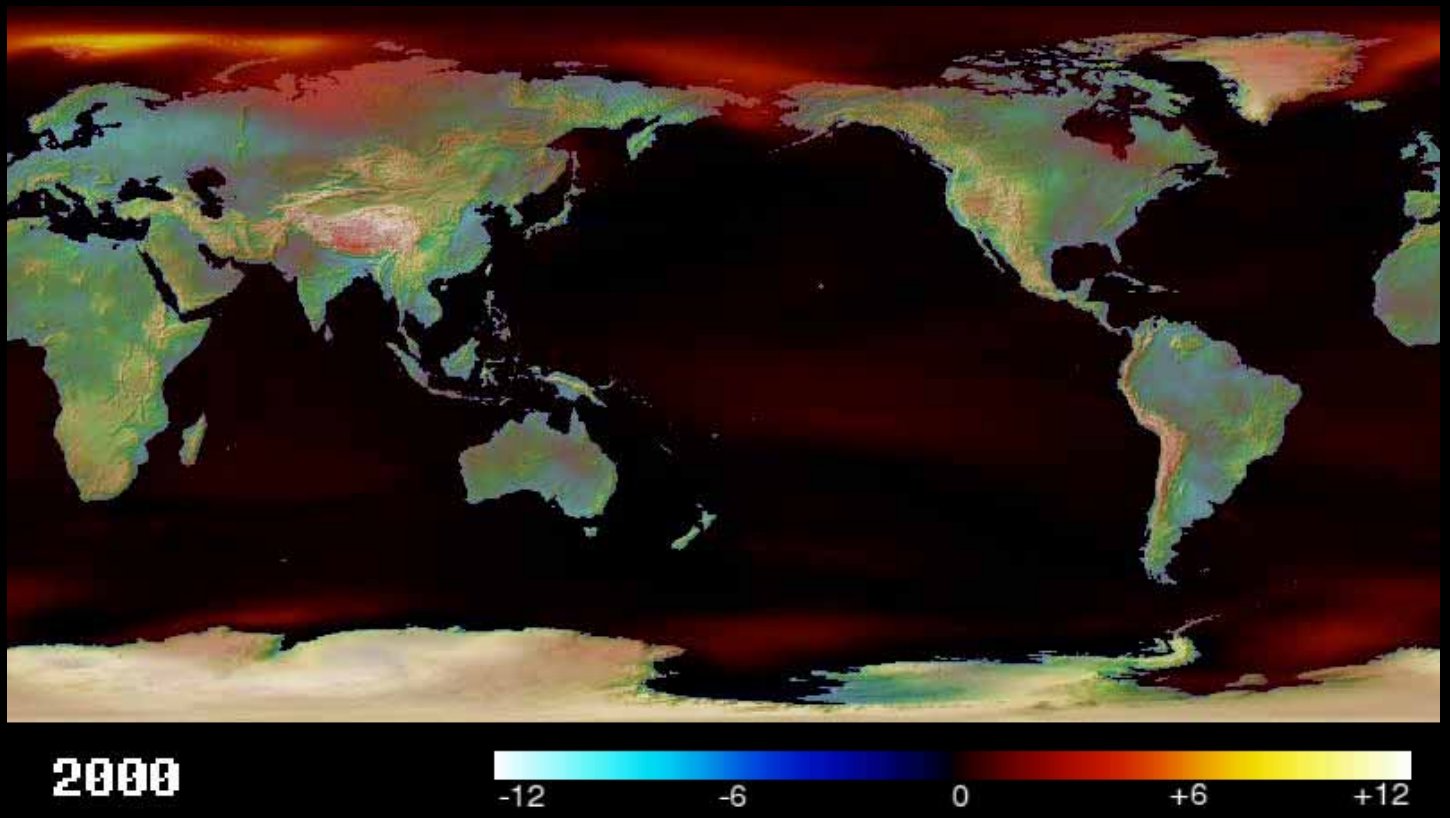
Earth System Model at conventional resolution

Global Cloud Resolving Model (10s-days, ~3.5km)

CCSR/NIES/FRCGC AOGCM: MIROC-hi

Atm. ~100 km, 56 levels
Ocn. ~20 km, 48 levels

+ Land, Sea ice, River,
Interactive Aerosols



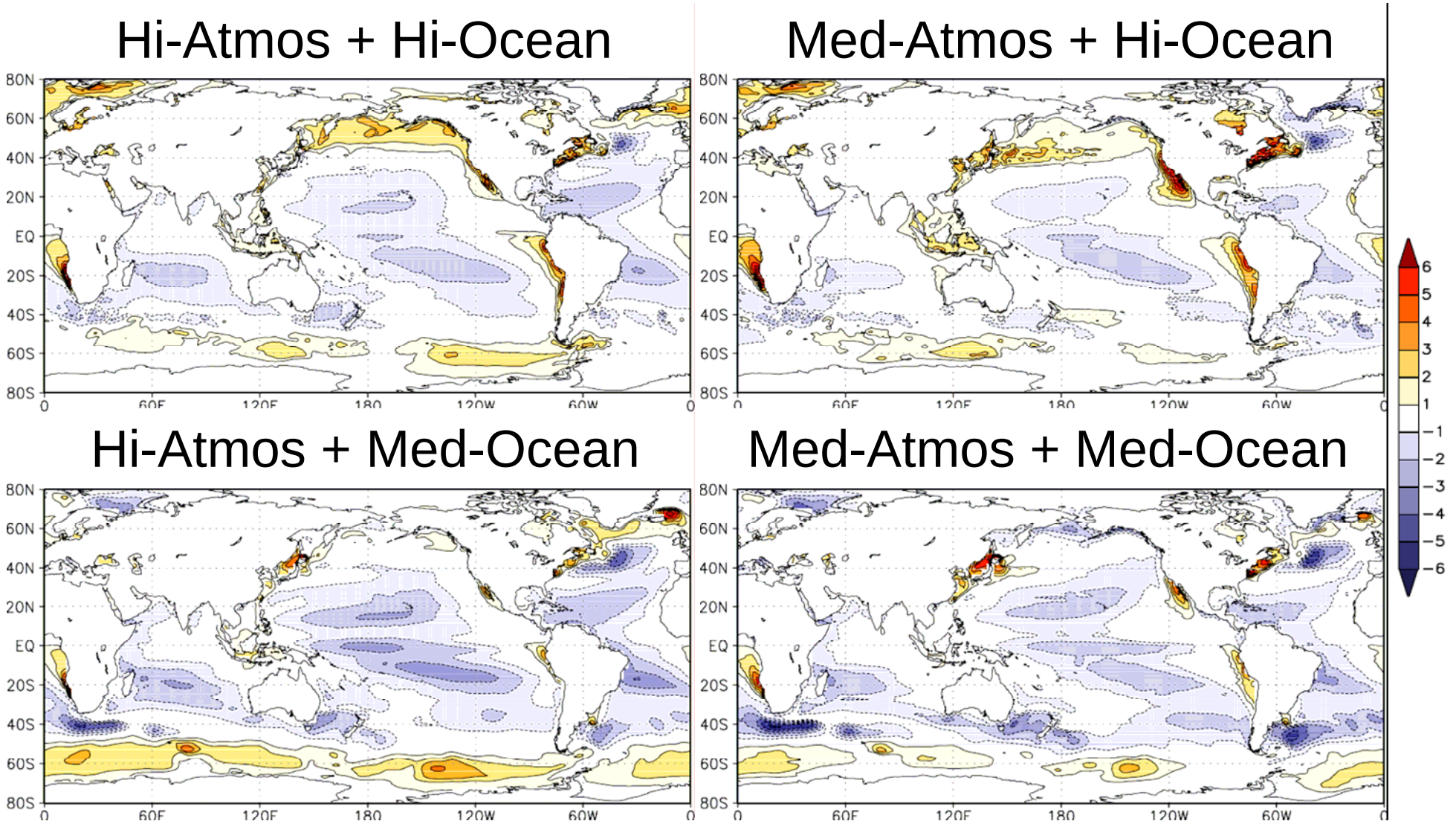
100-year integration
in 30 elapsed days
on 86 ES nodes

- Control
- 1%/yr CO2
- 20C
- SRES A1B
- SRES B2

submitted to AR4

CCSR/NIES/FRCGC/MEXT RR2002

Sea Surface Temperature bias



2090

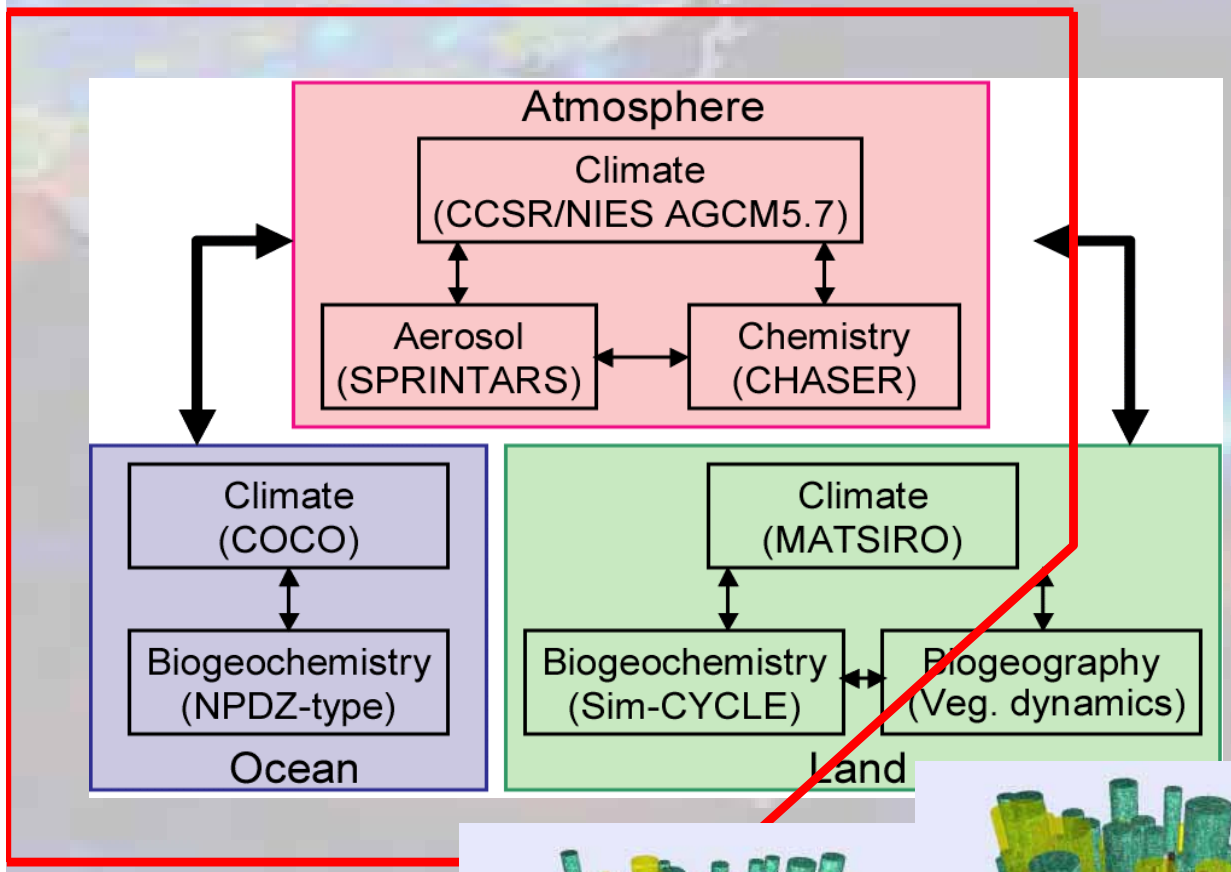
-12 -6 0 +6 +12

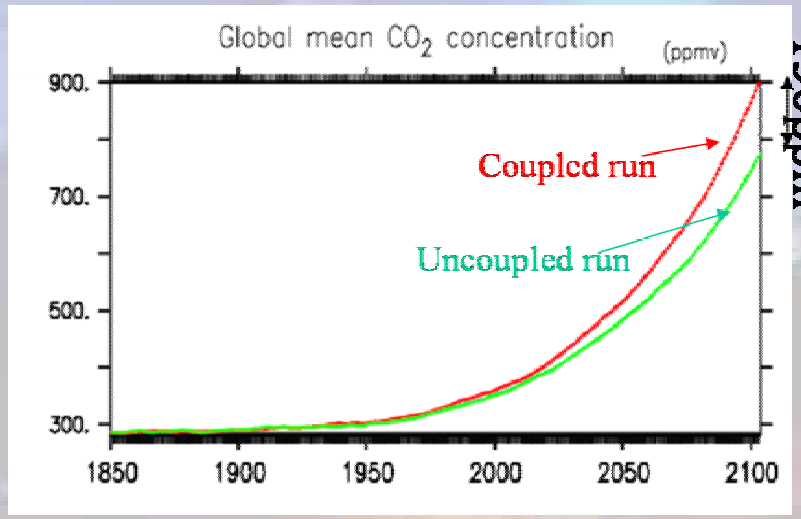
submitted to AR4

CCSR/NIES/FRCGC/MEXT RR2002

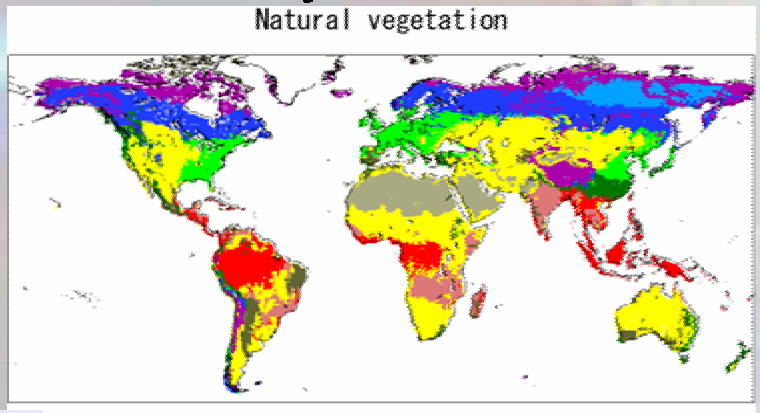
Kyousei Integrated Synergetic System Model of the Earth (KISSME)

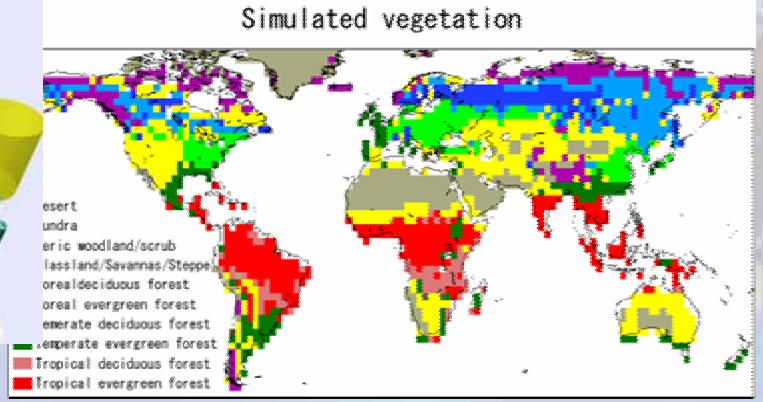
Extension to the Stratosphere

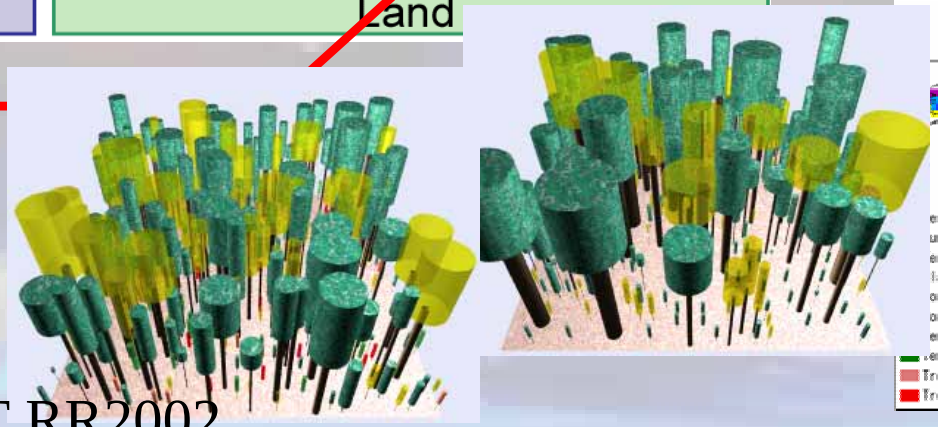




Carbon Cycle Feedback



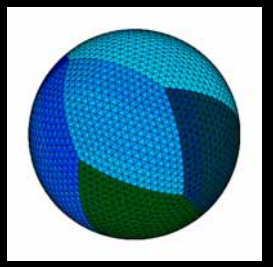


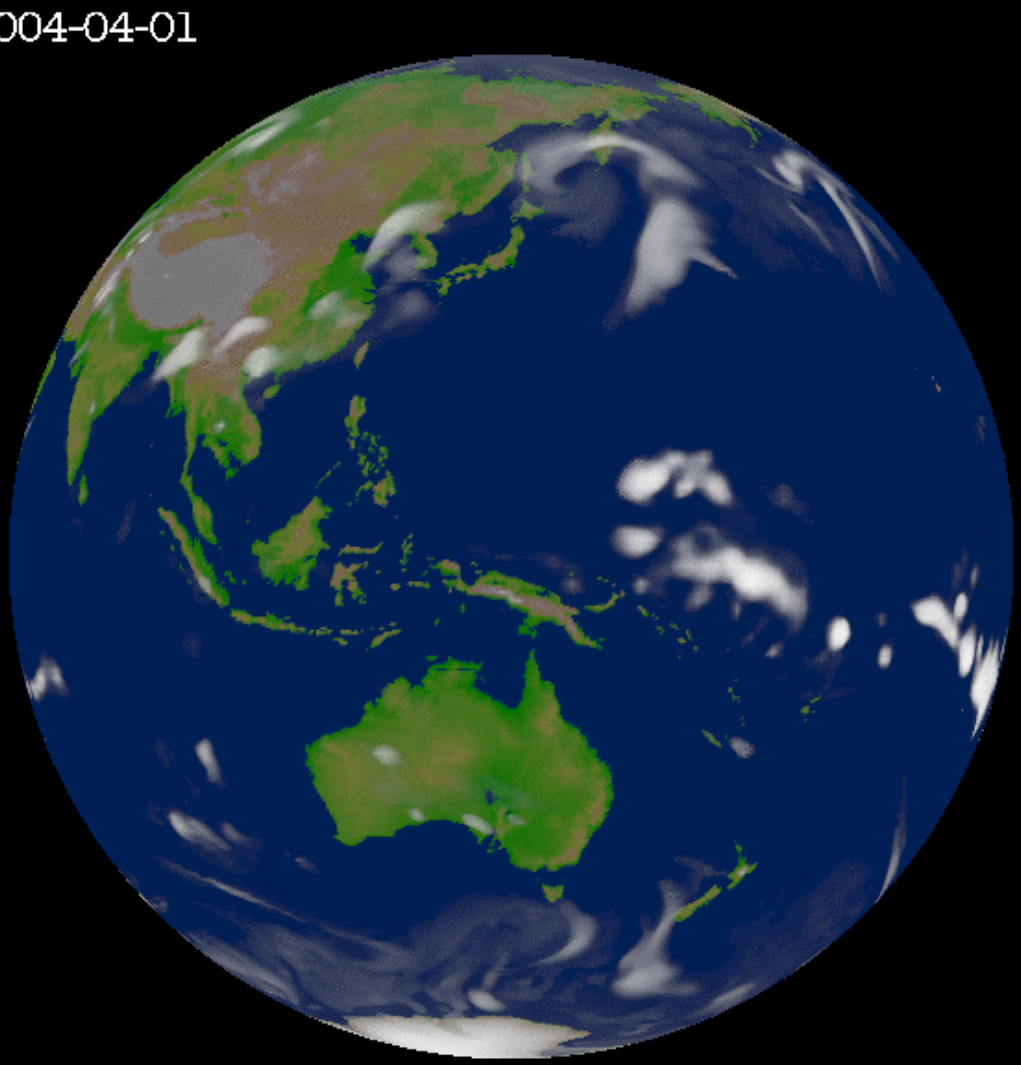


Individual-based Dynamic Vegetation

FRCGC/MEXT RR2002

A global cloud-resolving AGCM : NICAM





- Nonhydrostatic
- Icosahedral grid

3.5 km-grid model

10-day integration
in ~2 elapsed days
on 320 ES nodes
Δ t = 15 sec

Vertically 54 levels

Courtesy of M. Satoh et al. (CCSR/FRCGC/JST CREST)

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

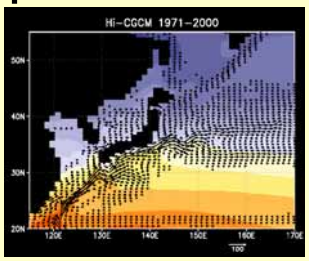
- Team 1: Carbon cycle w/ ESM (FRCGC/NIES/CCSR)
- Team 2: Near-term prediction w/ hi-res AOGCM (CCSR/NIES/FRCGC)
- Team 3: Time-slice exp w/ 20km AGCM (MRI/JMA)

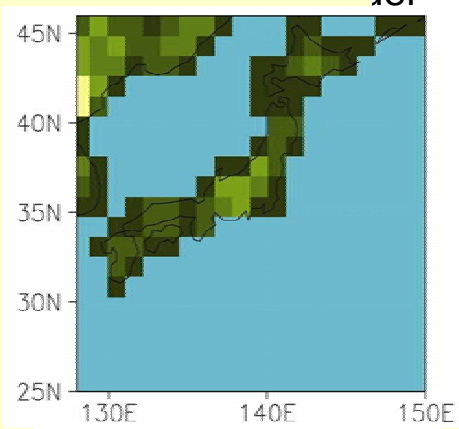
Teams 1-3 all consist of Modelling / Uncertainty / Impact sub-teams

- Others
  - CSRM, global as well as regional
  - Hi-res OGCM

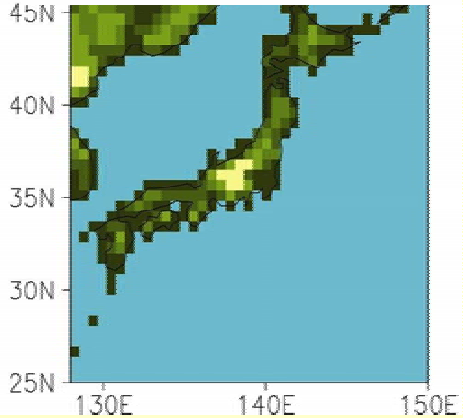
Japanese CLIMATE 2030 Project

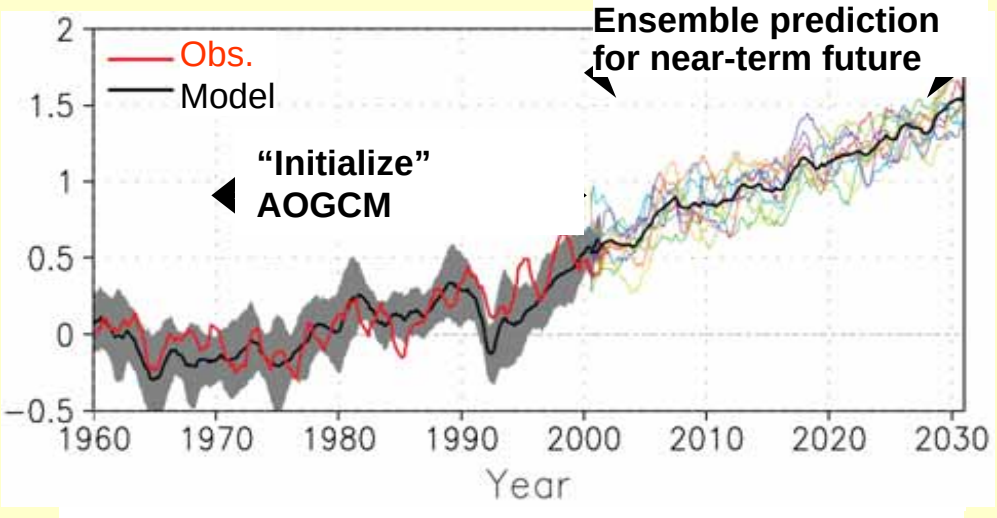
- A near-term prediction up to 2030 with a high-resolution coupled AOGCM
  - 60km Atmos + 20x30km Ocean
  - w/ updated cloud PDF scheme, PBL, etc
  - advanced aerosol/chemistry
- Estimate of uncertainty due to initial conditions
  - 10(?)-member ensemble
  - For impact applications
    - water risk assessment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

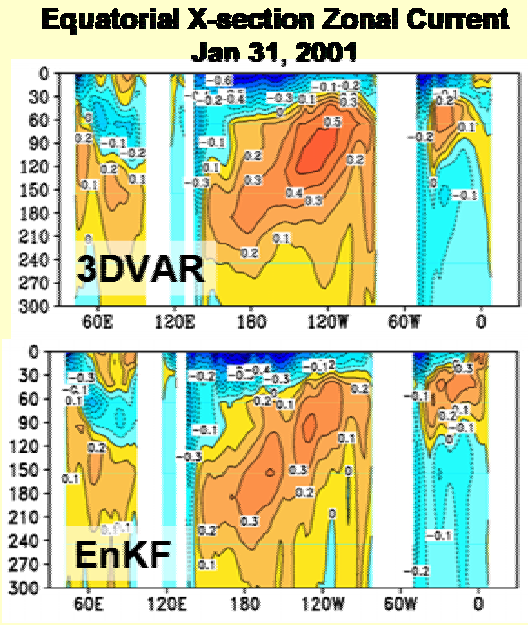




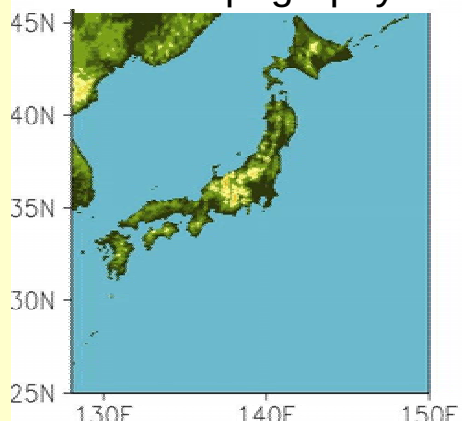
60km mesh model





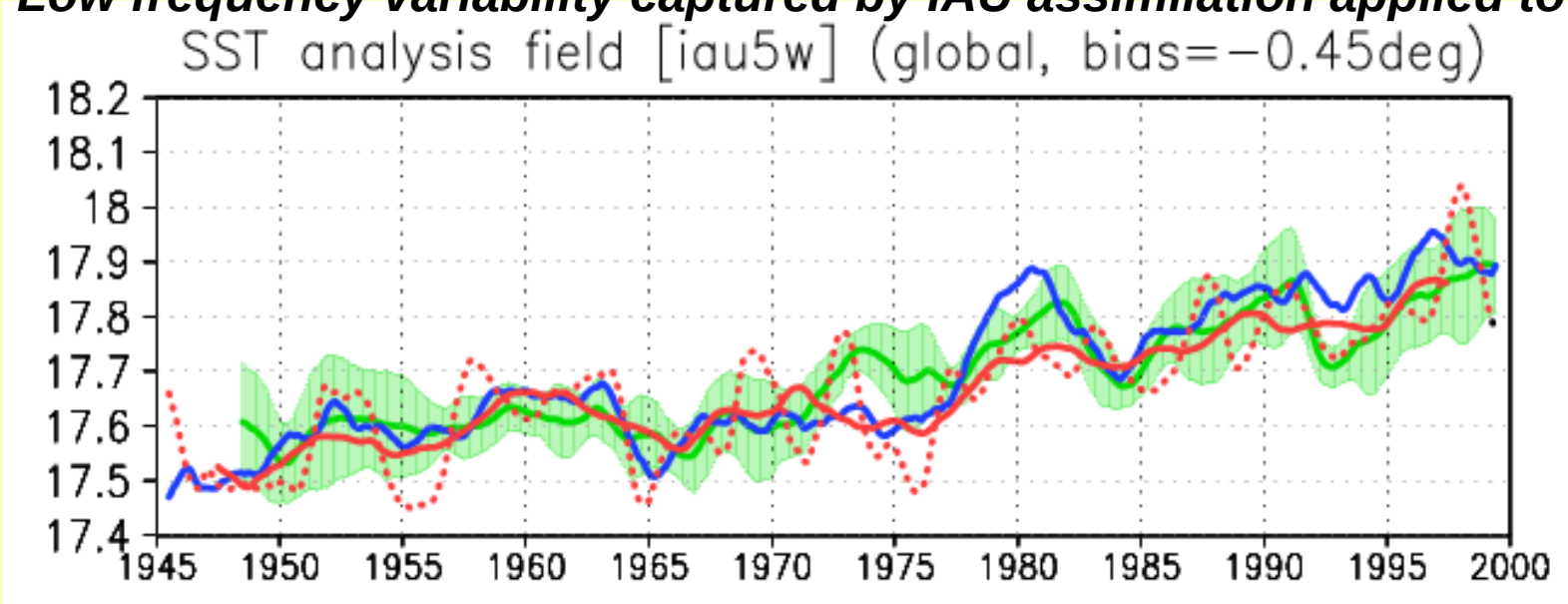


5-min topography



LF Assimilation: Global mean SST

Low frequency variability captured by IAU assimilation applied to MIROC



Global-average SST

red: observation-0.45

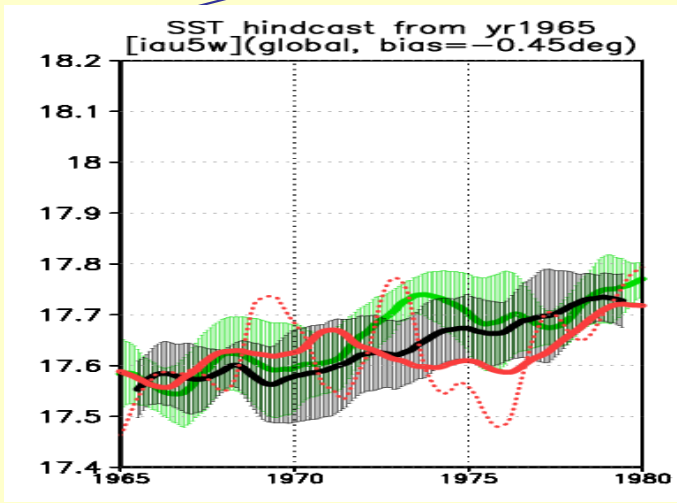
blue: assimilation

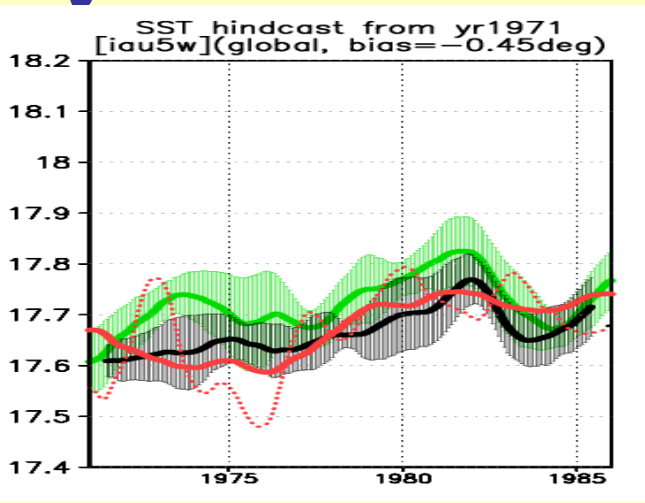
black: prediction

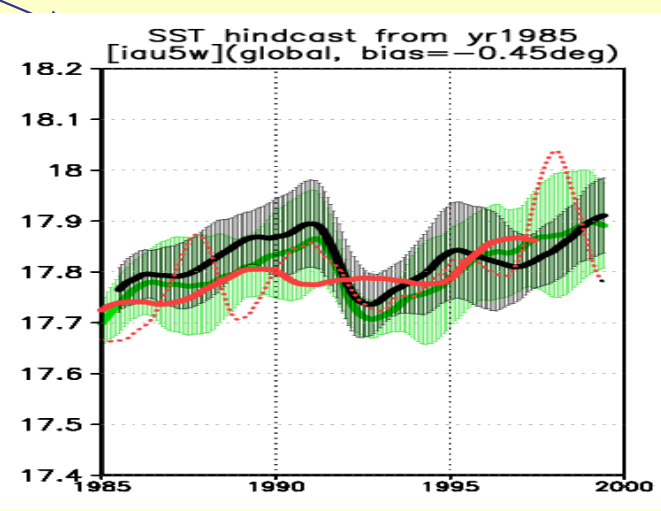
green: reference

(1-yr moving average)

15yr ensemble predictions based on the initialization of low frequency variability

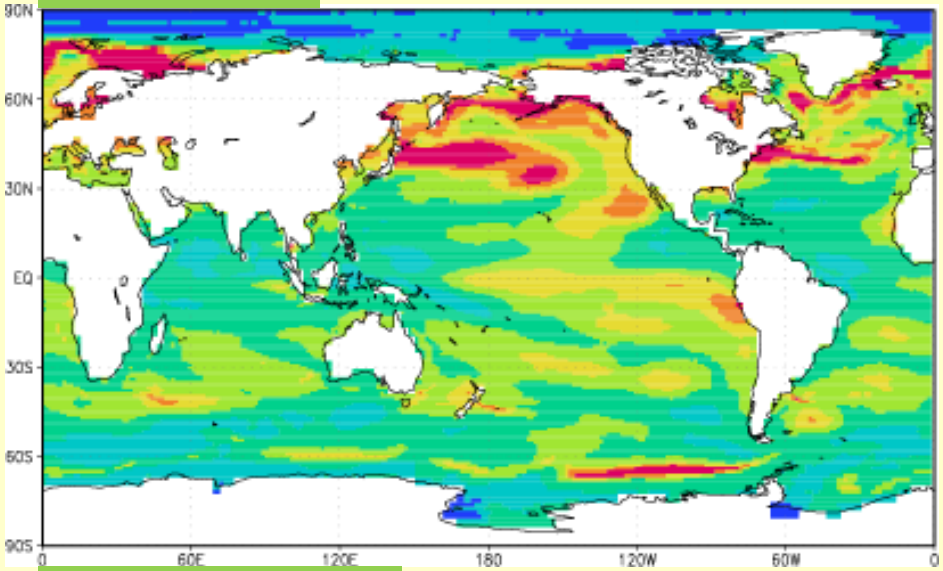




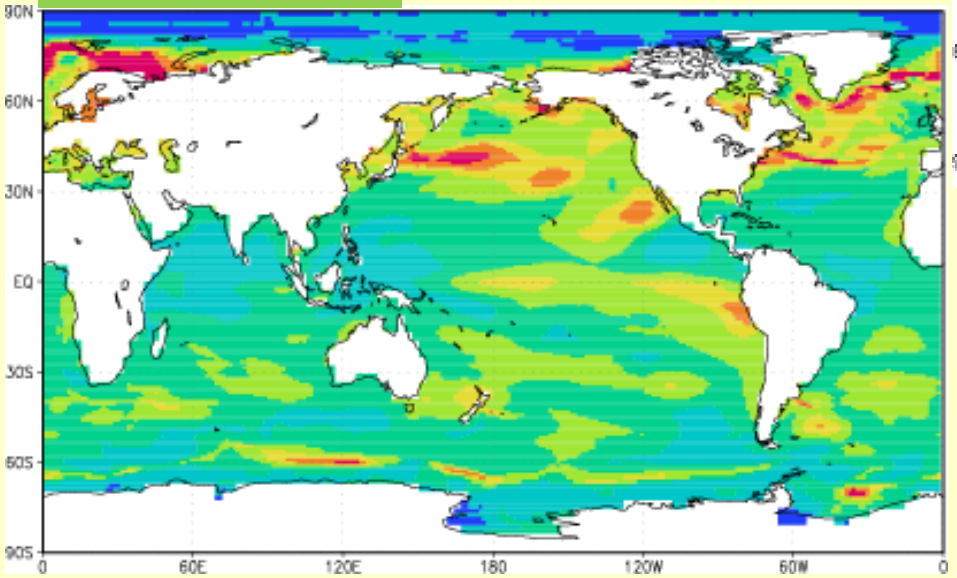


SSTA RMSE averaged over 3rd-15th year

FREE run

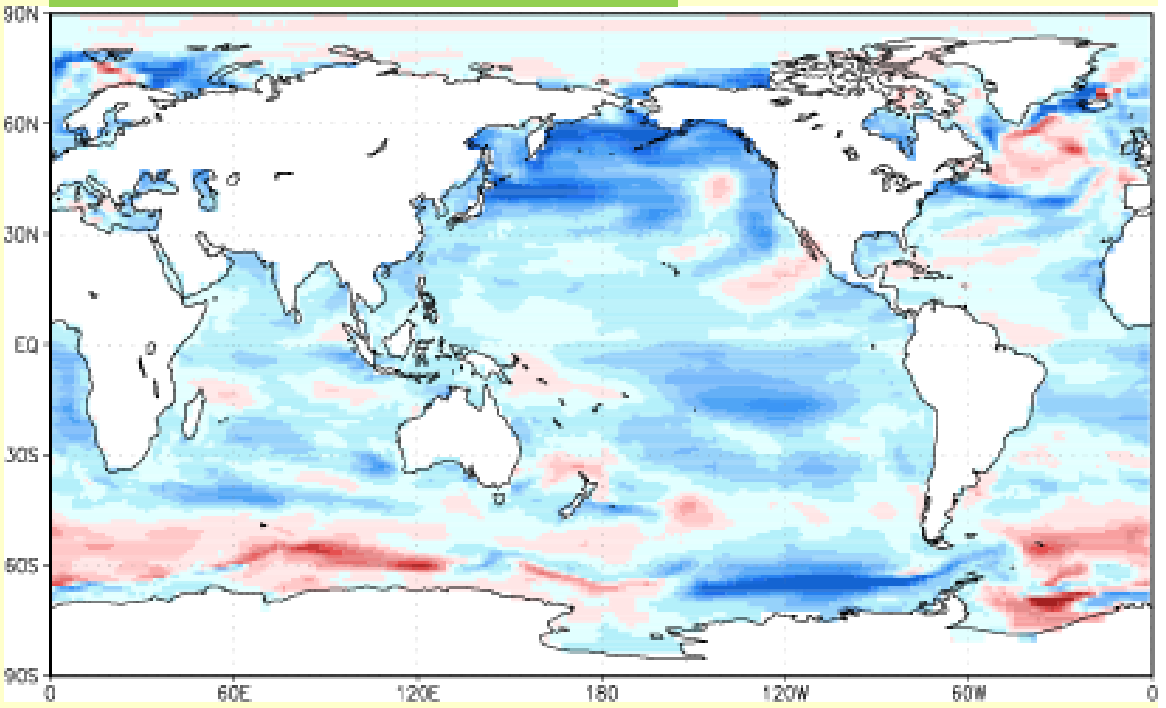


Initialized run



0℃ 0.6℃

Initialized run – Free run



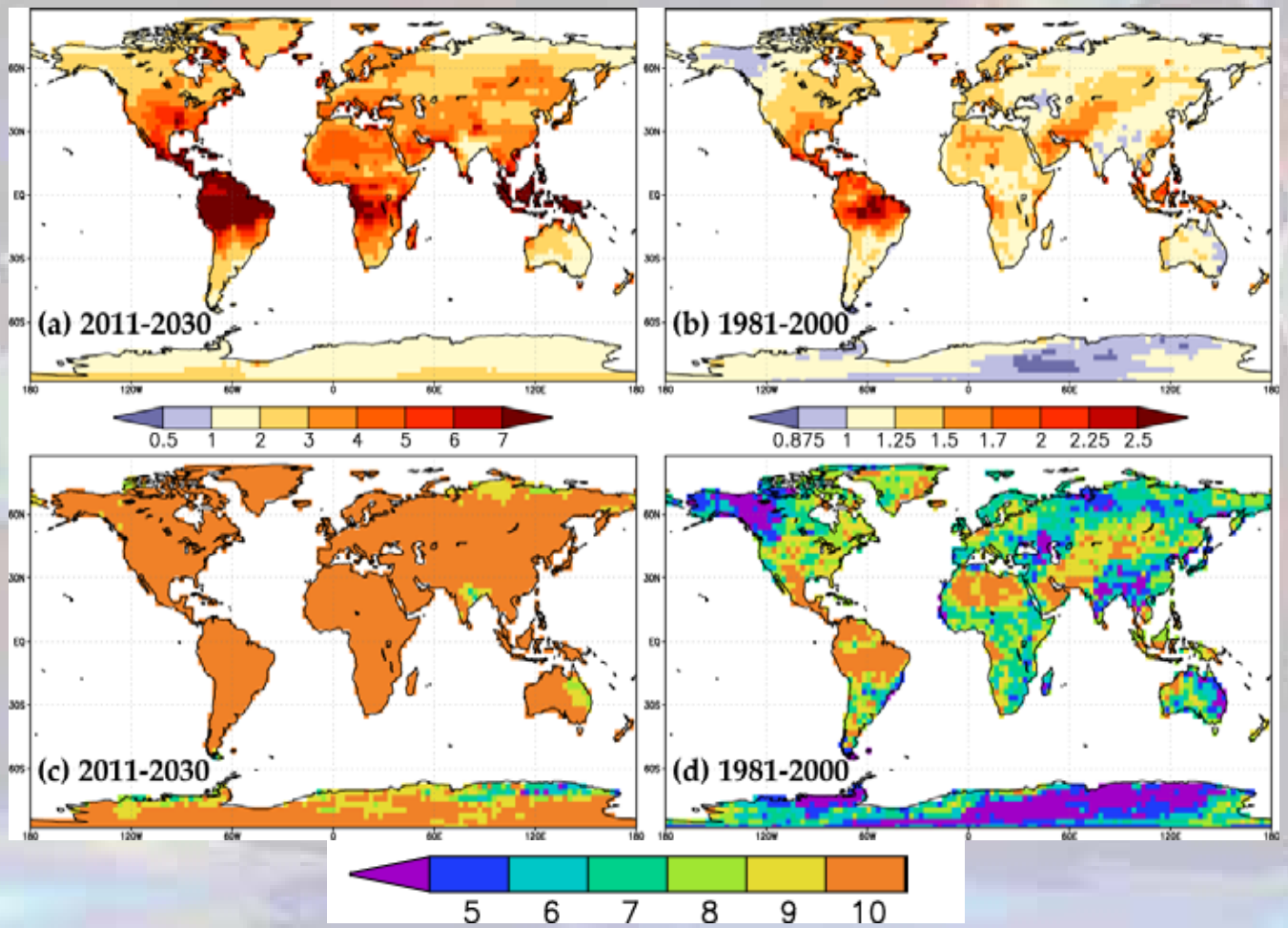
-0.2℃ 0℃ 0.2℃

Change in frequency of extreme warm night
Will it be robustly detected in ~2030 prediction?

10 member ensemble of MIROC-med (w/o realistic initialization)

Change in Frequency of warm night (ratio to the base period:1951-1970)

Number of runs that show increase



(Shiogama et al., 2007)