SBSTA28 Side Event, Bonn, 5 June 2008

The use of the Earth Simulator in climate projections in Latin America

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**AESTO/MRI

The World Bank project on Climate Change in Latin America

The World Bank

Latin America and the Caribbean Region
Sustainable Development Department

Coordination and funding

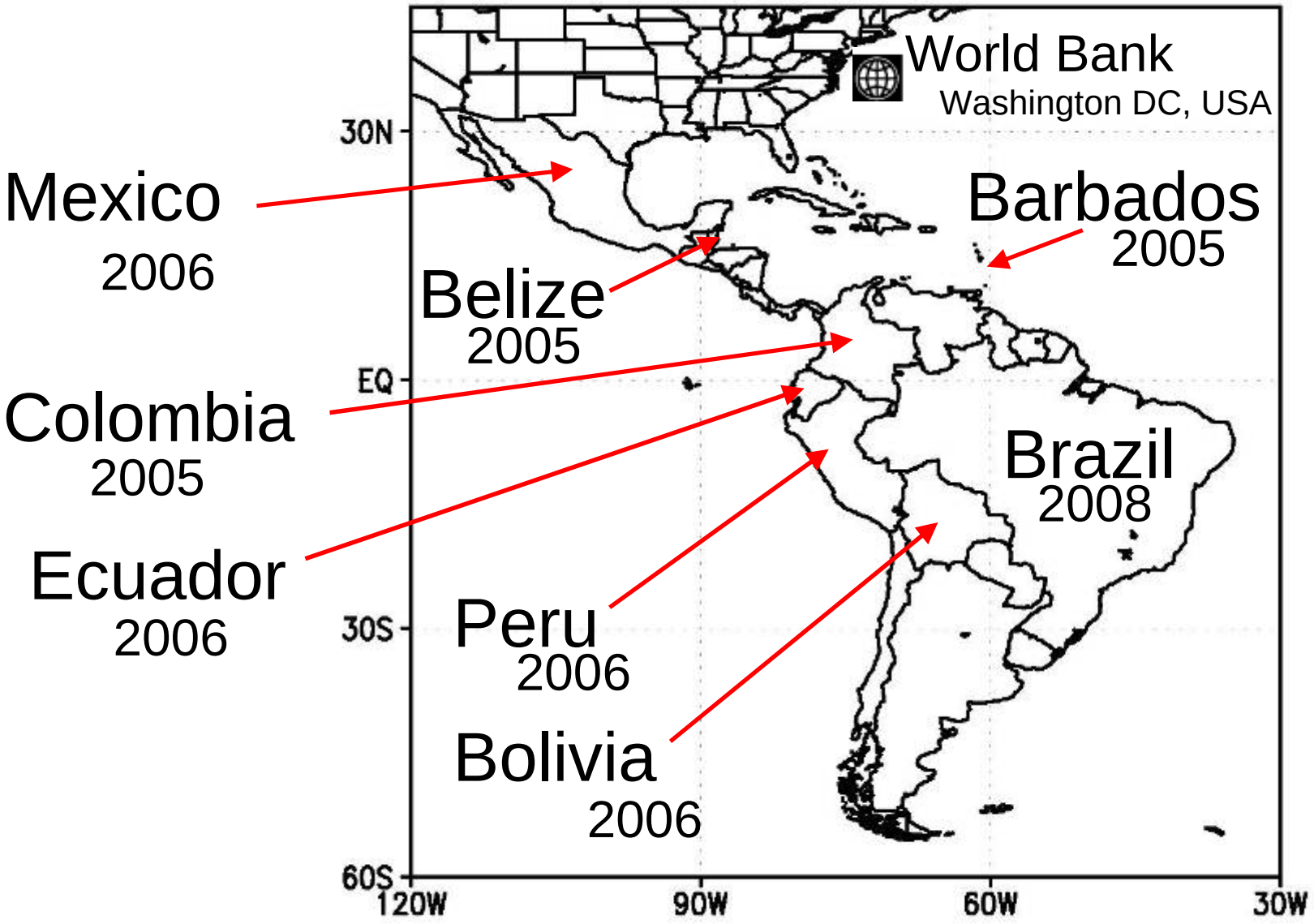
Meteorological Research Institute (MRI), JAPAN

Latin American Countries

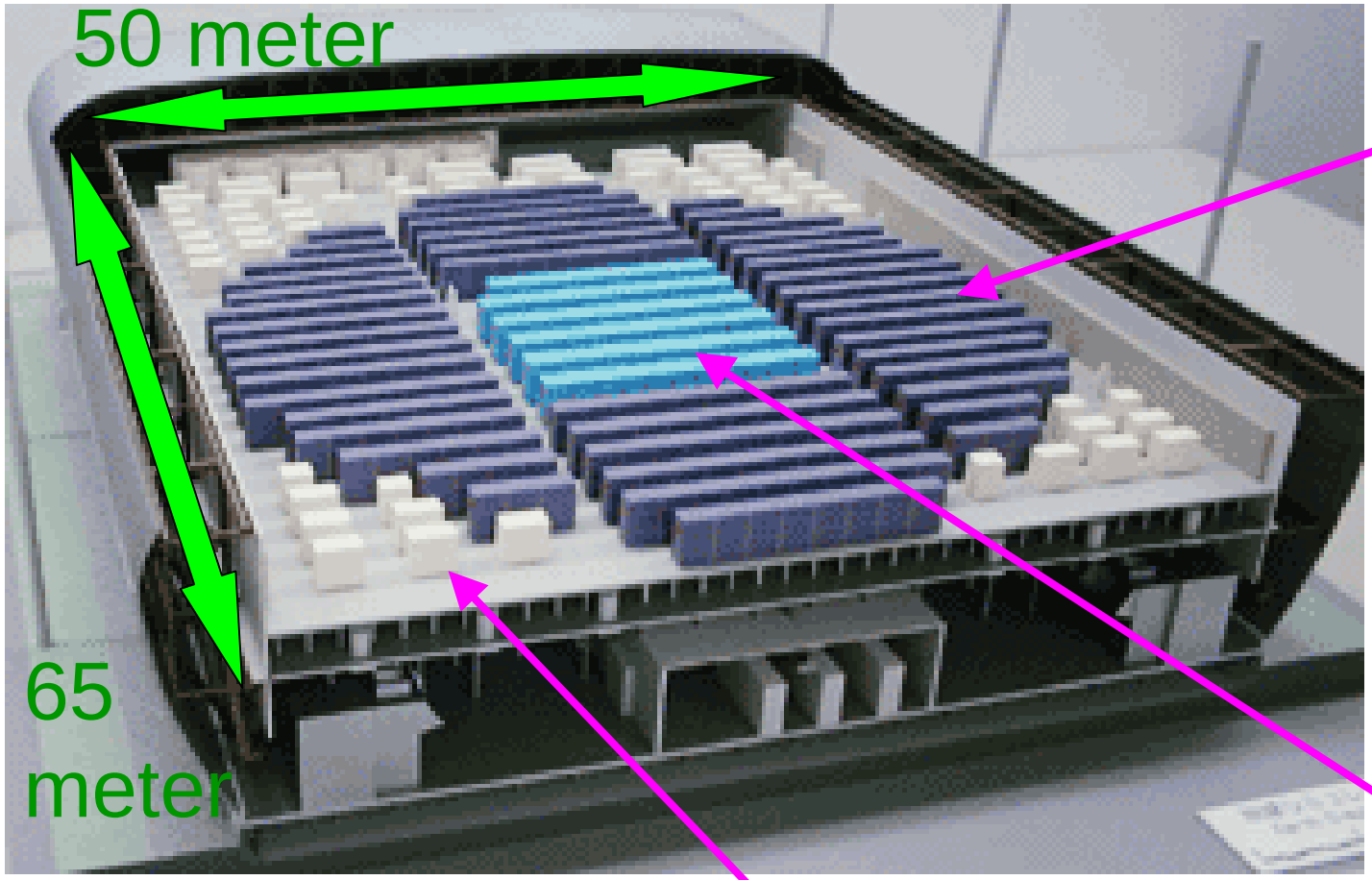
Cooperative research

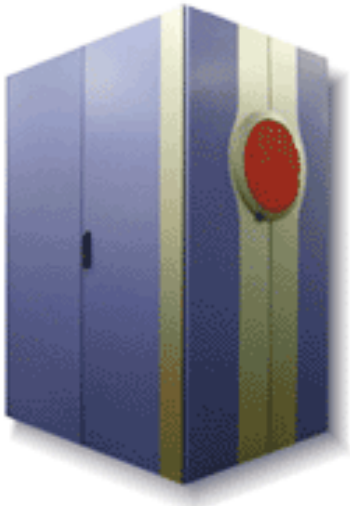
Latin American scientists stay at MRI about one month to evaluate climate changes in their countries with 20-km mesh AGCM simulations.

Participated countries :2005-2008



The Earth Simulator





Node (8 CPU)

Crossbar switch

Magnetic Disks

Nodes: 640

CPUs: 5120

Peak performance: 40 Tera flops

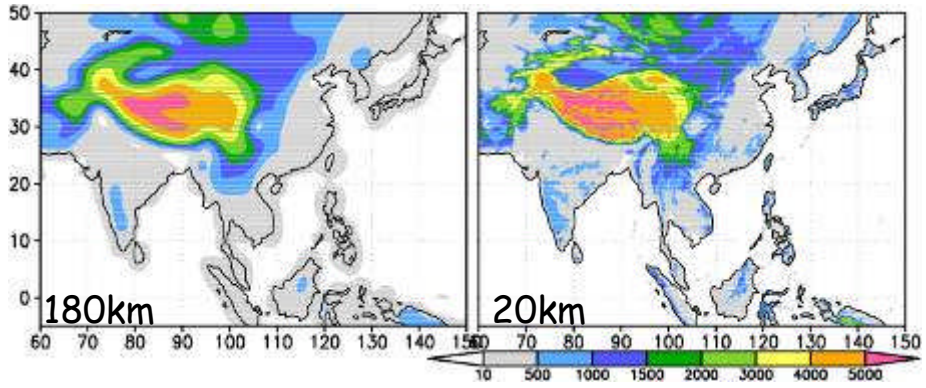
http://www.es.jamstec.go.jp/esc/jp/ES/index.html

Using the Earth Simulator

- Peak performance: 8 GFLOPS x 8 cpu x 640 nodes = 40 TFLOPS
- 4.3 %/year (~240,000 node hour) is allocated to the MRI group
- Costs: 380 Million Yen/year in my project
- MRI/JMA 20-km mesh AGCM
  - TL959(20km) with 60 layers
  - Uses 30 nodes of Earth Simulator
  - DT = 6 min
- Turnaround time integration:
  - 1 year integration needs between 2 days and 2 weeks
- Data transfer is a big issue

MRI/JMA Atmospheric GCM

- JMA : Operational global NWP model since Nov 2007
- MRI : Next generation climate model
- Resolution: TL959(20km) with 60 layers
- Time integration: Semi-Lagrangian Scheme (Yoshimura, 2004)
  2 days/1 year integration with DT=6 min and
  30 nodes of Earth Simulator (ES has total 640 nodes)
- Physics
  - SW radiation: Shibata & Uchiyama (1992)
  - LW radiation: Shibata & Aoki (1989)
  - Cumulus convection: Prognostic Arakawa-Schubert (Randall and Pan, 1993)
  - Land hydrology: MJ-SiB: SiB with 4 soil-layers and 3 snow-layers
  - Clouds: large-scale condensation, Cumulus, stratocumulus
  - PBL: Mellor & Yamada (1974,1982) level-2 closure model
  - Gravity wave drag: Iwasaki et al. (1989) + Rayleigh friction



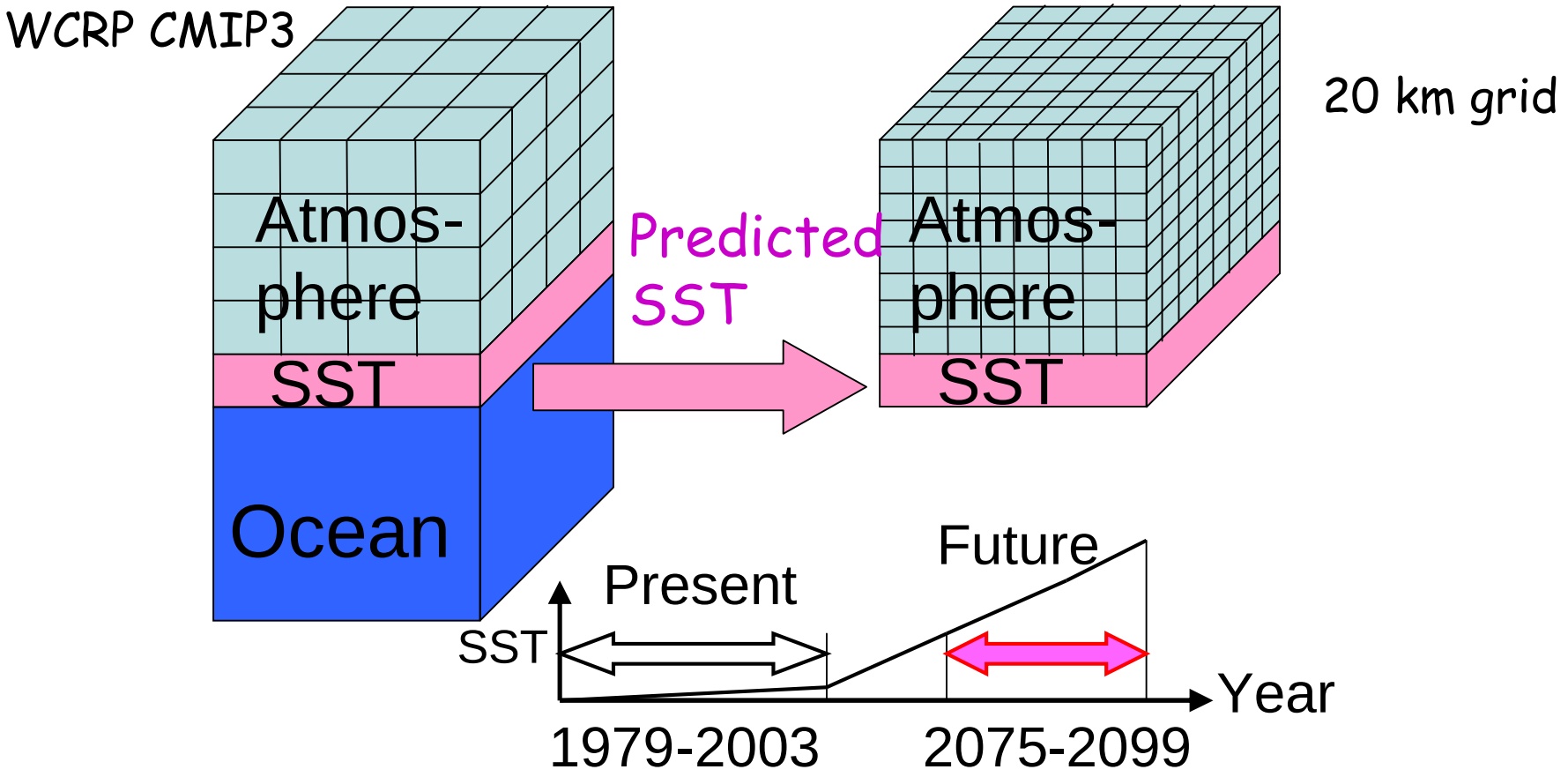
This model will be used in MRI-CGCM3 and MRI-ESM after introducing additional physics and tuning.

Time-slice experiments

Atmosphere-Ocean Couple Model, A1B Scenario

⇨

High resolution Atmosphere model experiment



Tropical Cyclones

Hurricane in a warmer future climate

QuickTimeý Ç²
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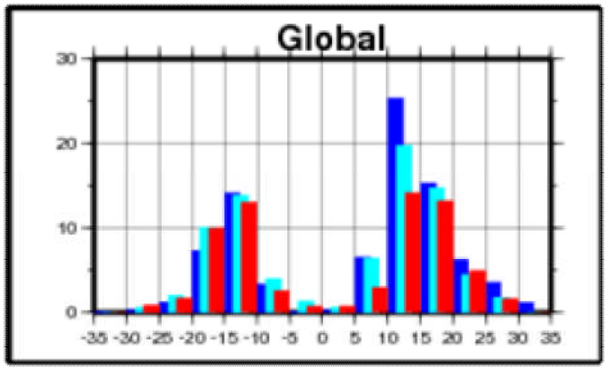
Annual number of TC genesis

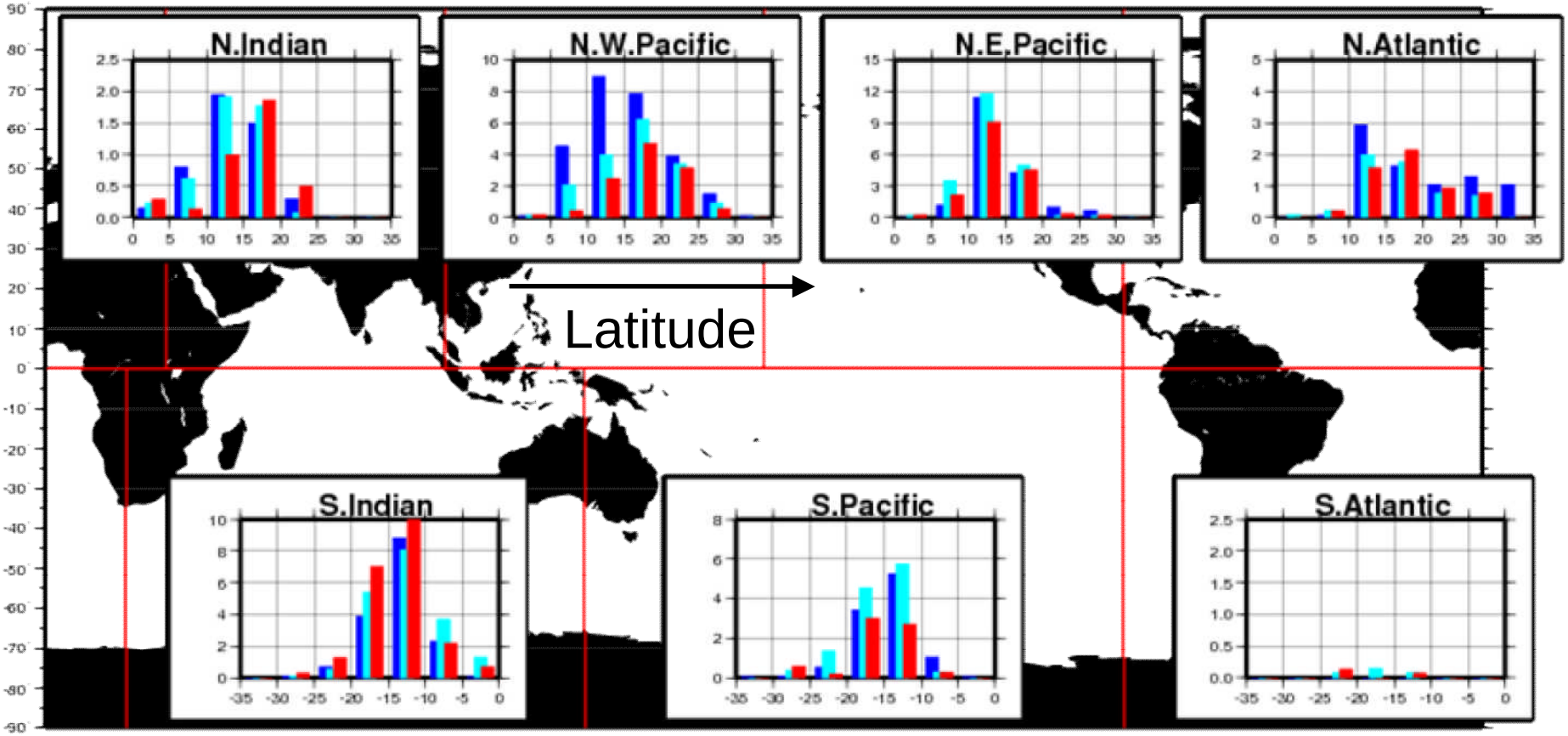
Annual Number of Tropical Storm Genesis for Each Latitude Belt

Best Track(over 34kt)
HP0A,HF0A(by Oouchi et.al(2007))

abscissa: latitude
ordinate: annual averaged number



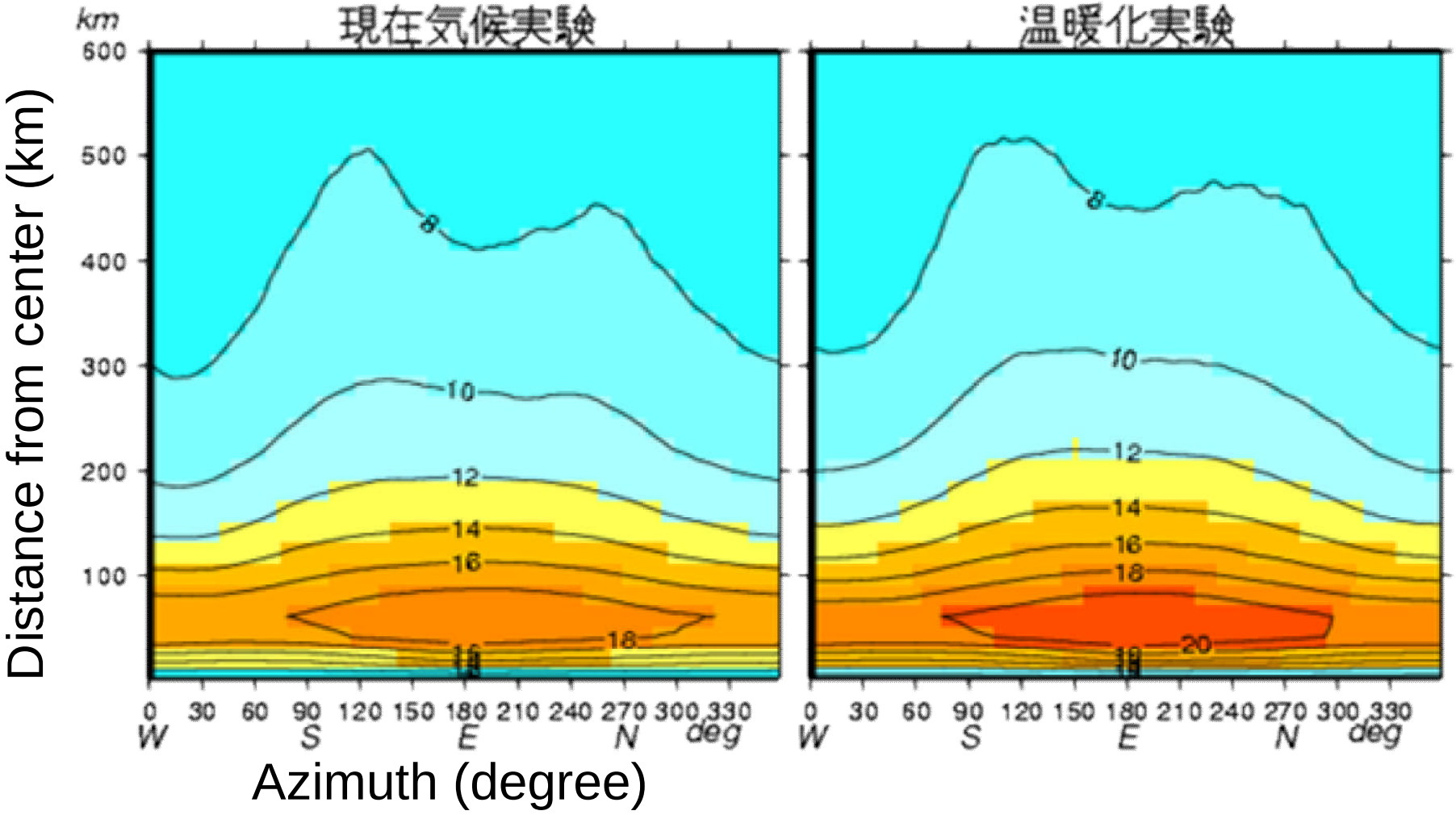
Best Track(1979-1998)
Observation
SP0A(1979-1991)
Present-day
SF0A(2074-2087)
Future



Wind velocity (m/s) at mature stage

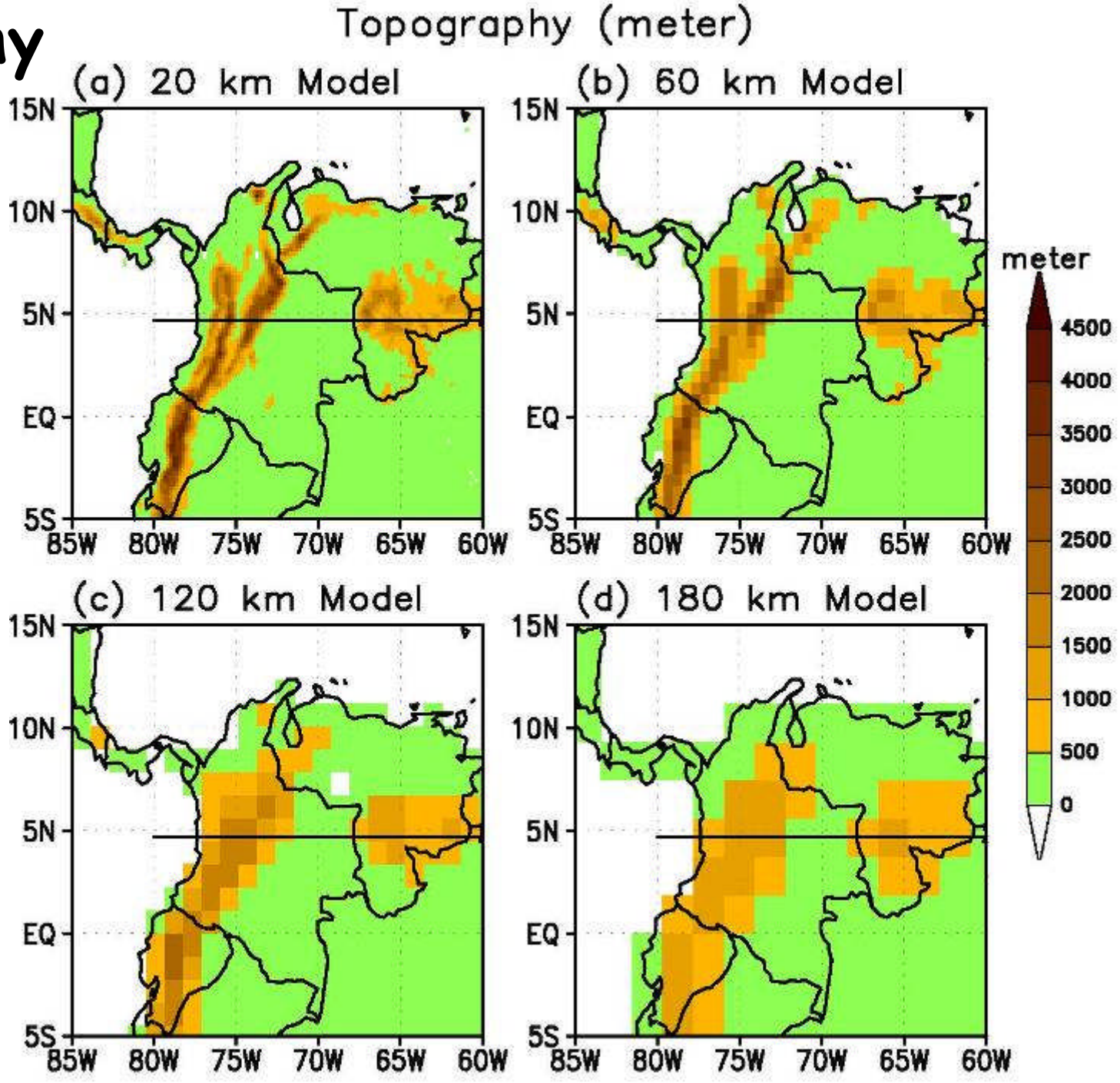
Present-day
1979-1991

Future
2074-2087

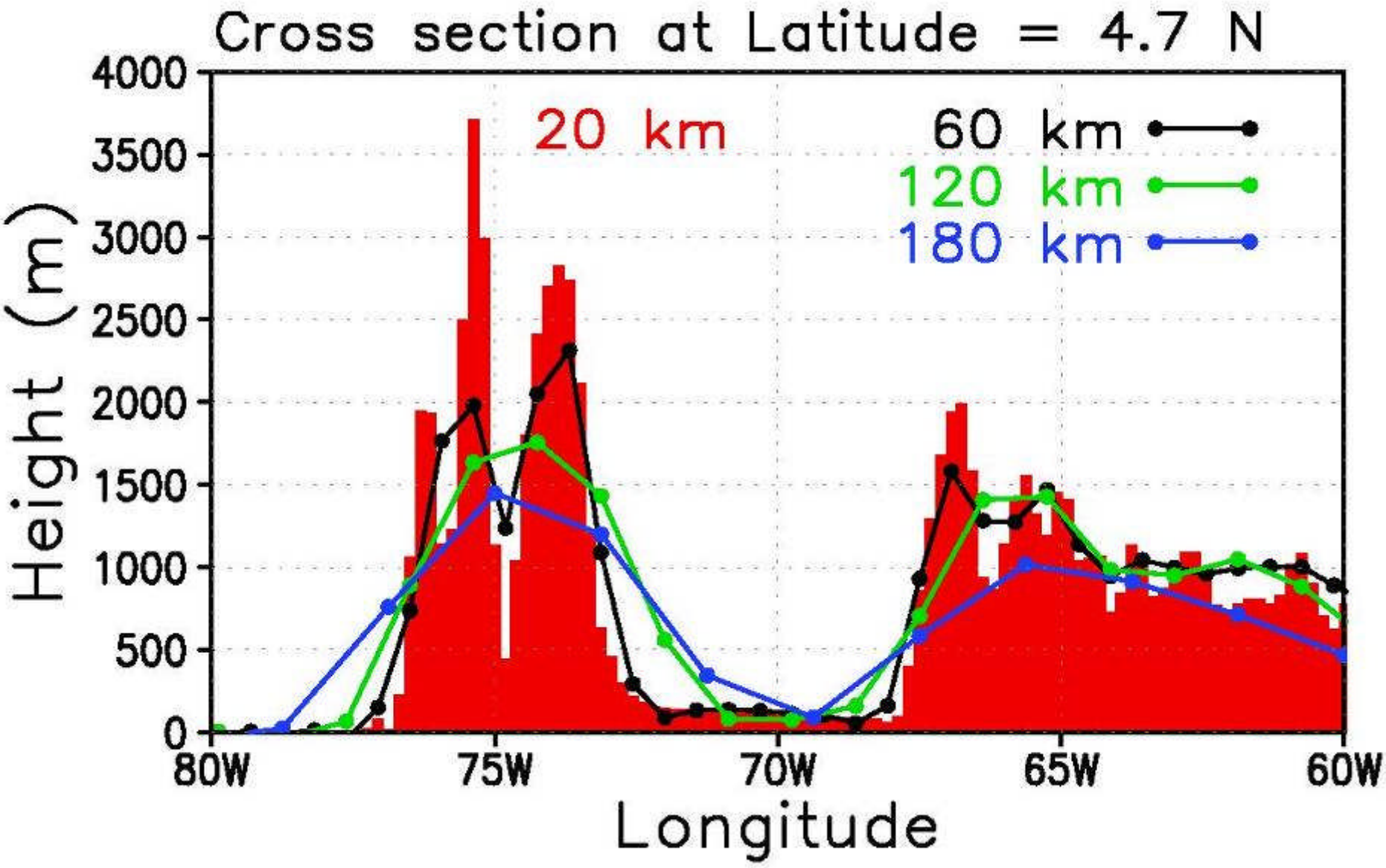


Climate Change in Latin America

Topography

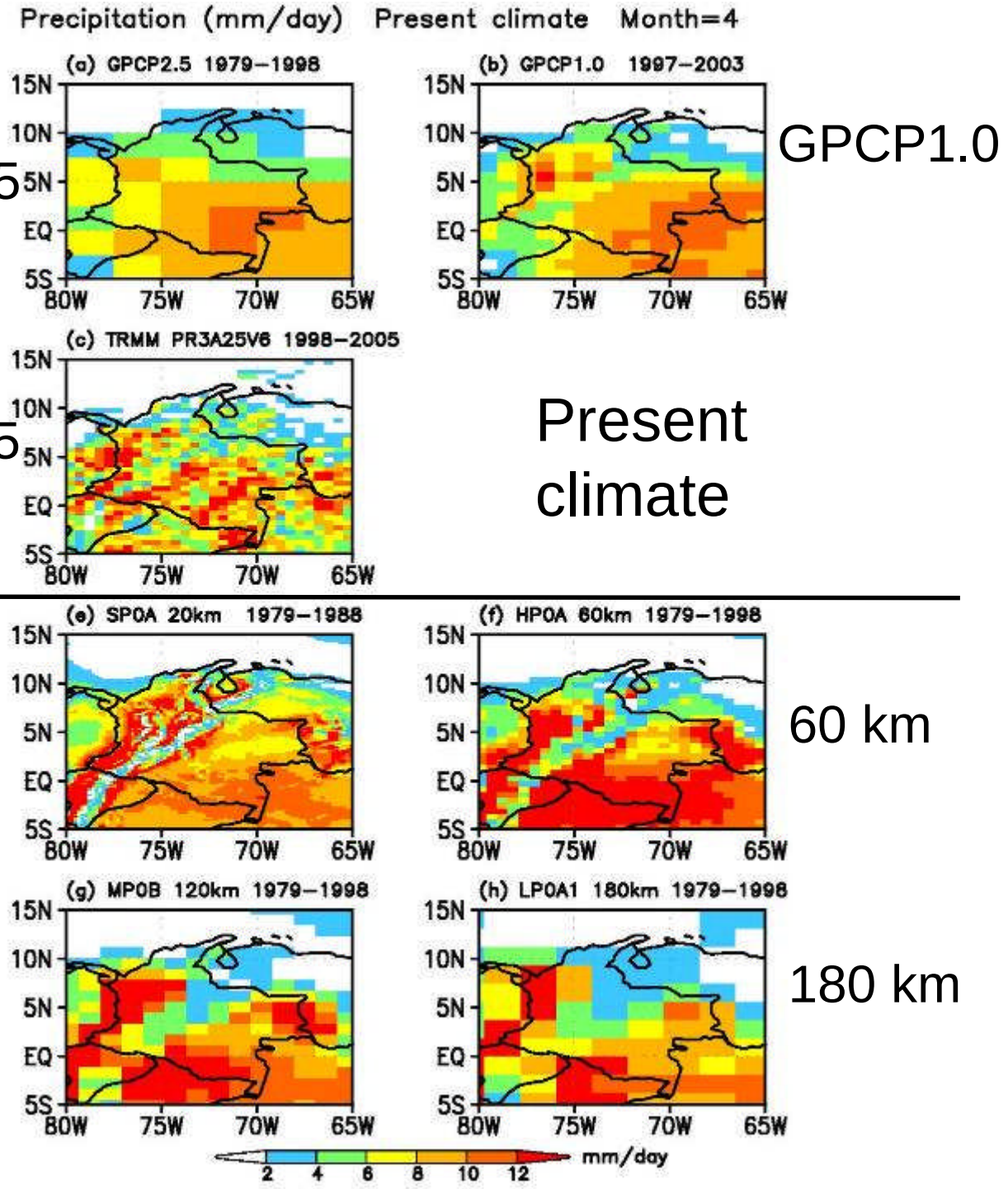

Topography (meter)
(a) 20 km Model
(b) 60 km Model
(c) 120 km Model
(d) 180 km Model
15N
10N
5N
EQ
5S
85W
80W
75W
70W
65W
60W
meter
4500
4000
3500
3000
2500
2000
1500
1000
500
0

Topography at 4.7N



Precip

April



GPCP2.5

GPCP1.0

TRMM 0.5

Present climate

Observation

Model

20 km

60 km

120 km

180 km

Precip

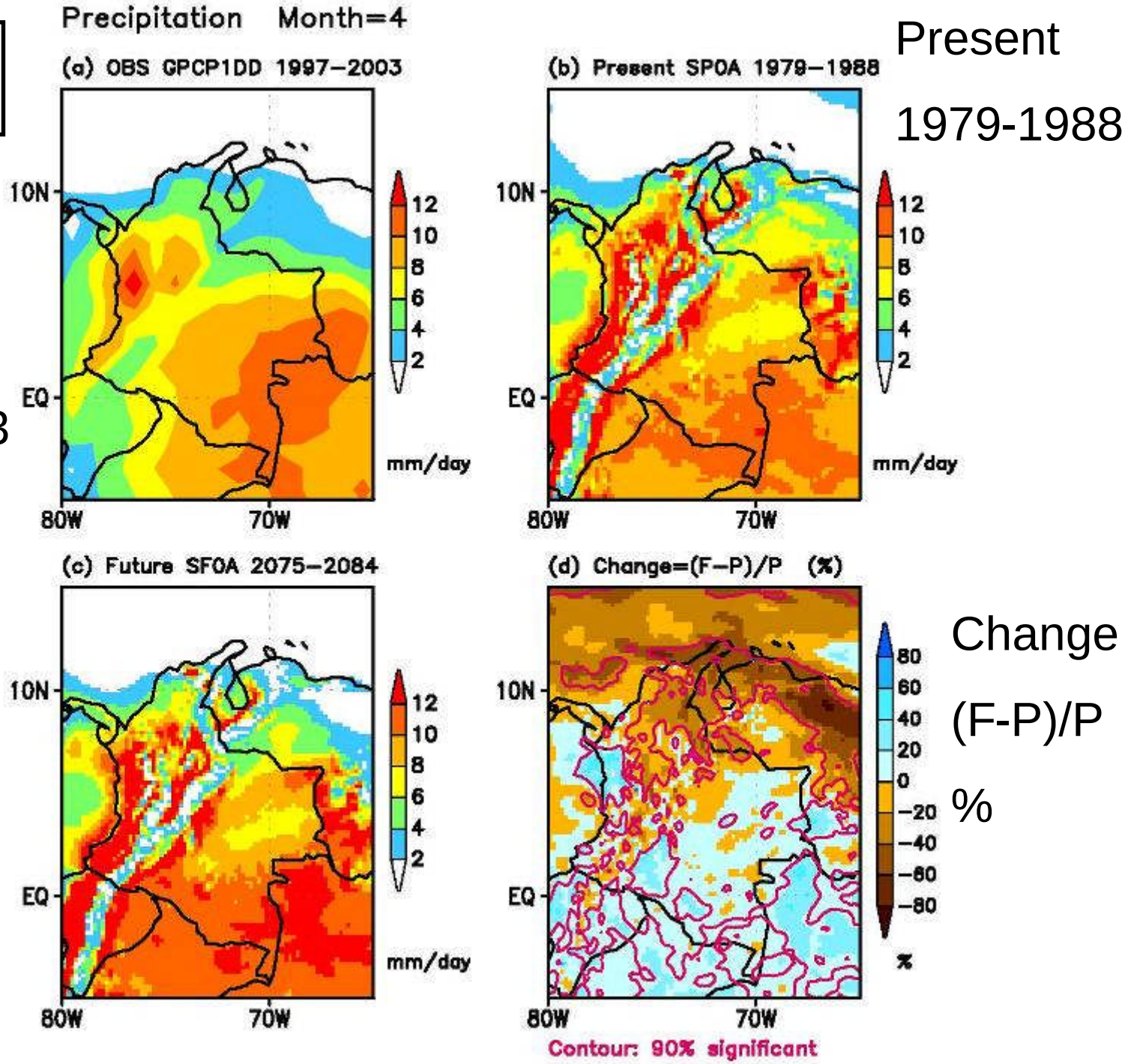
April

GPCP1.0

1997-2003

Future

2075-2084



Present

1979-1988

Change

(F-P)/P

%

Simple daily precipitation intensity index (SDII)

$$\text{SDII} = \frac{\text{Annual total precipitation}}{\text{Number of rain day}}$$

where "rain day": day of precipitation $\geqq$ 1 mm/day

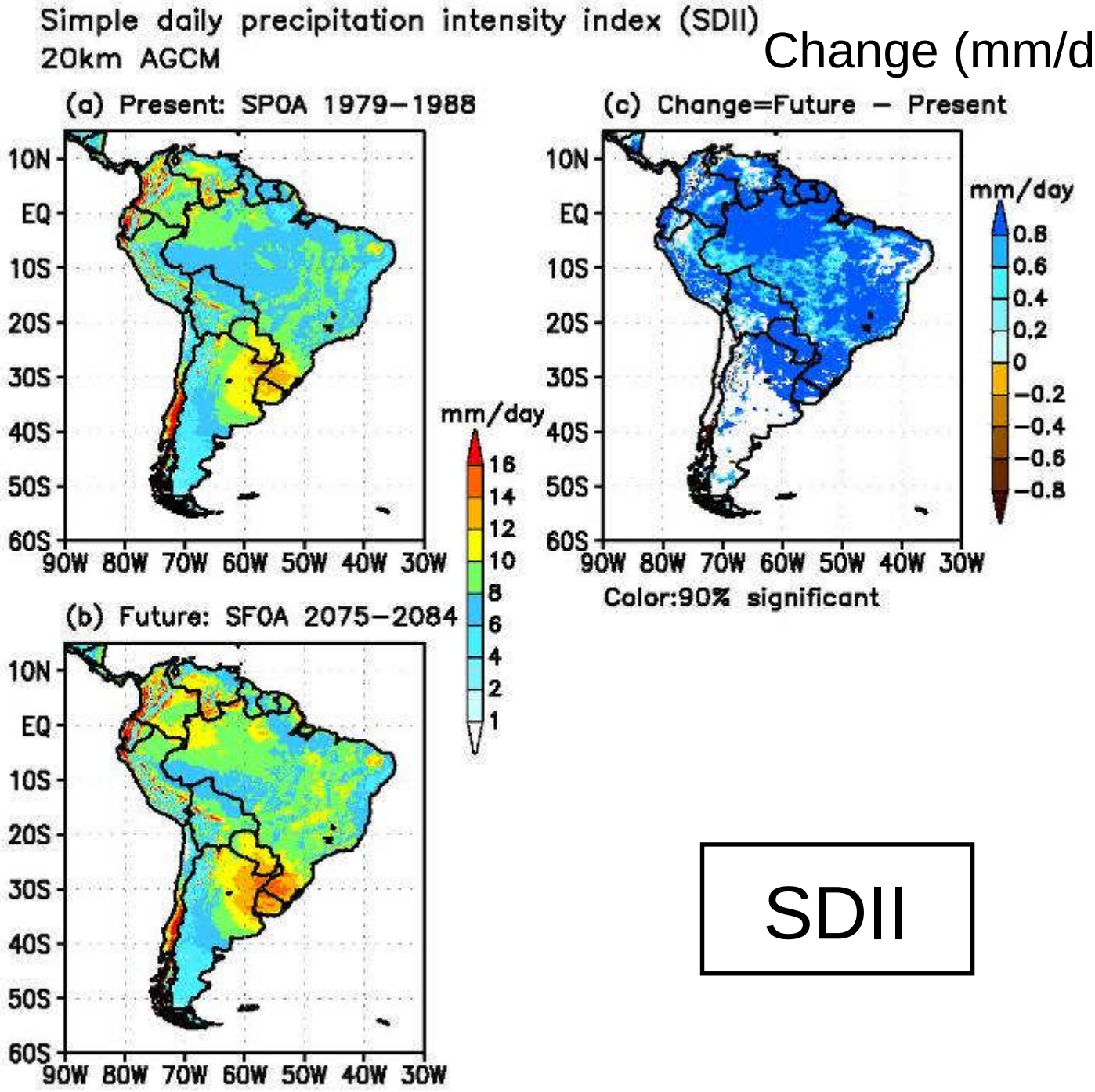
Present

1979-1988

Future

2075-2084

Change (mm/day)

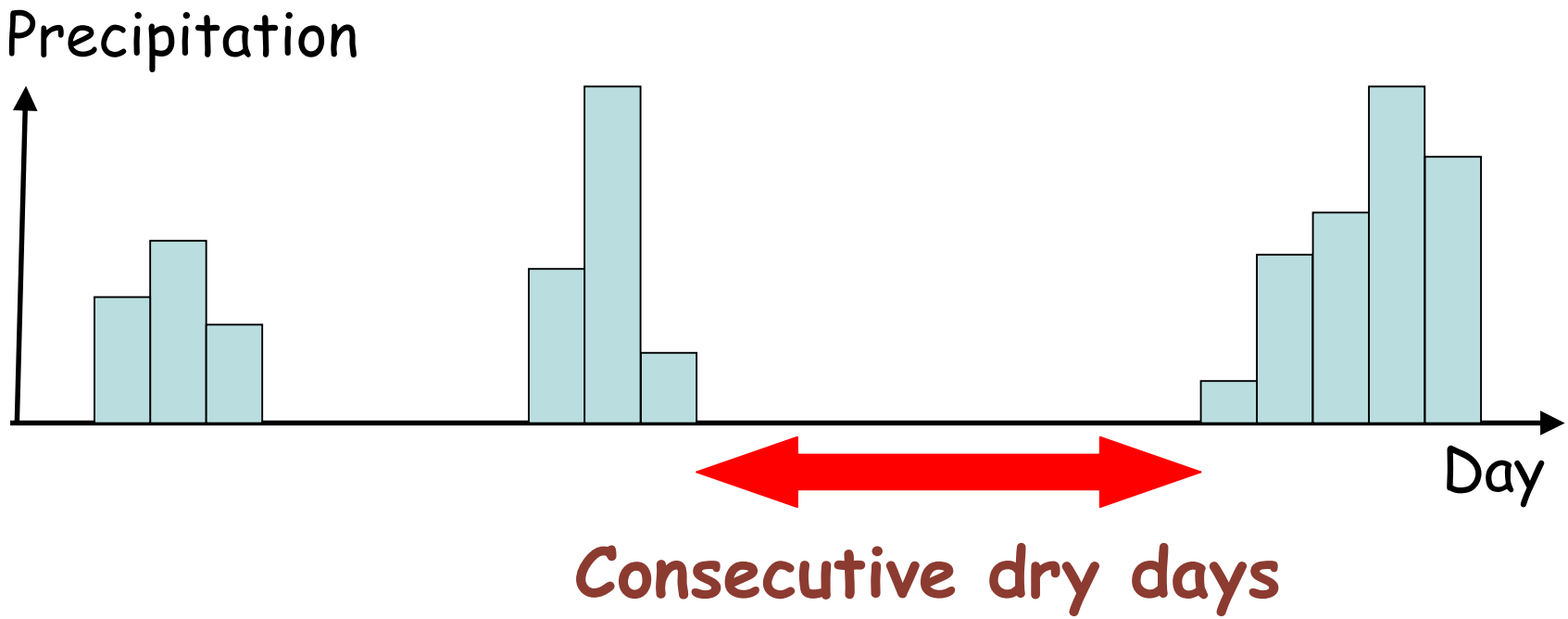


SDII

Drought index

Maximum number of consecutive dry days (CDD)

where "dry day": day of precipitation < 1 mm/day



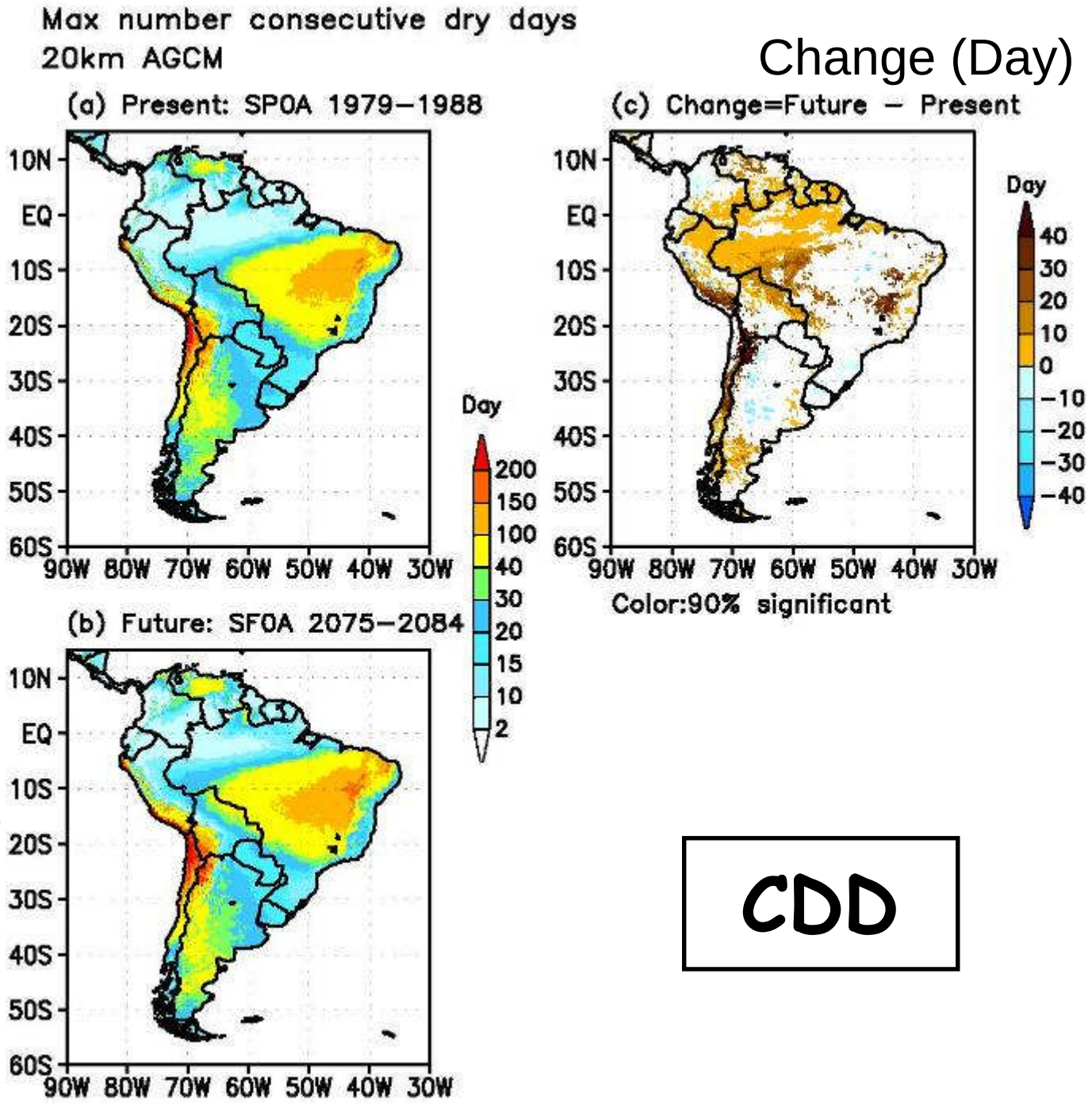
Present

1979-1988

Future

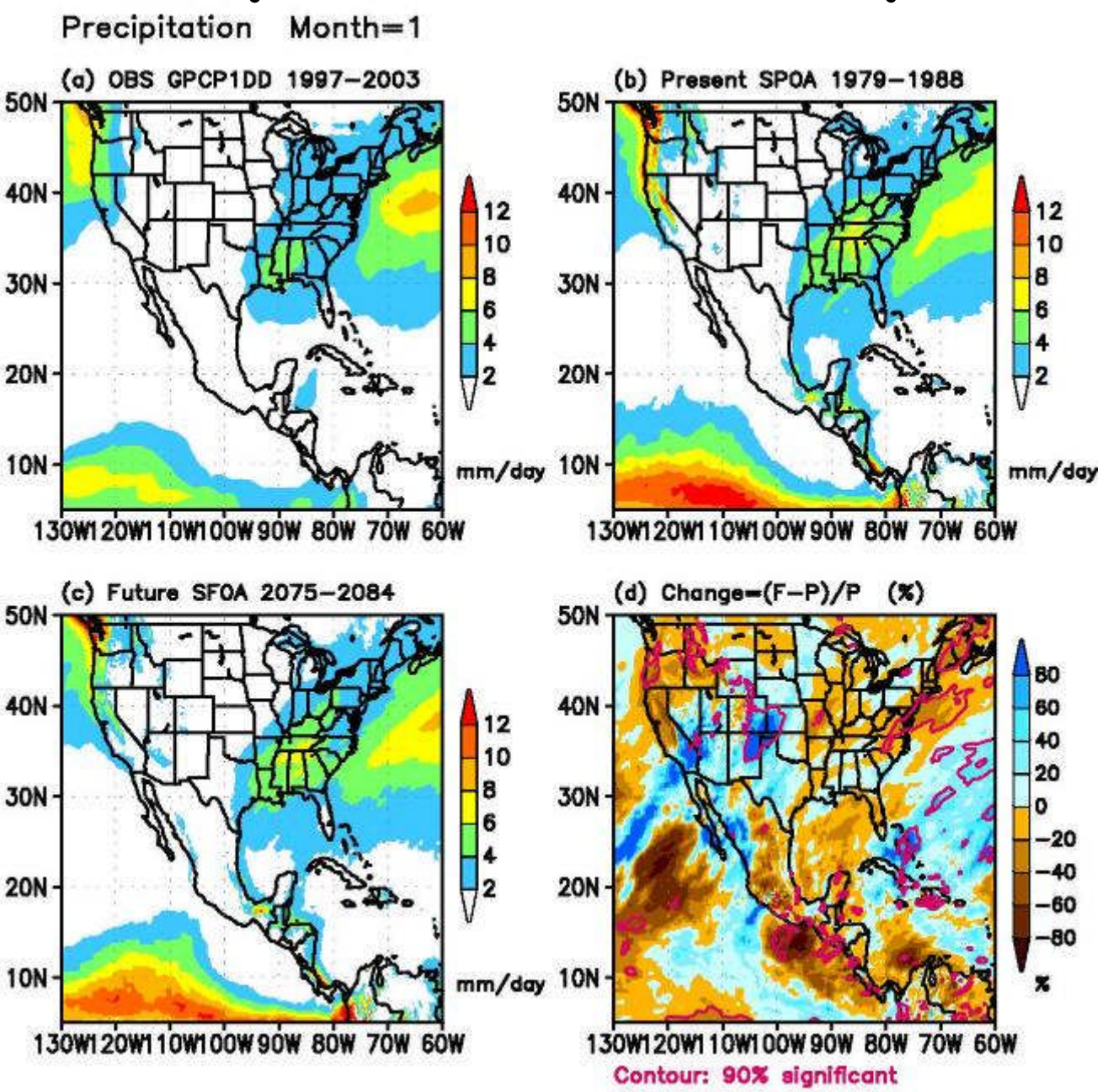
2075-2084

Change (Day)

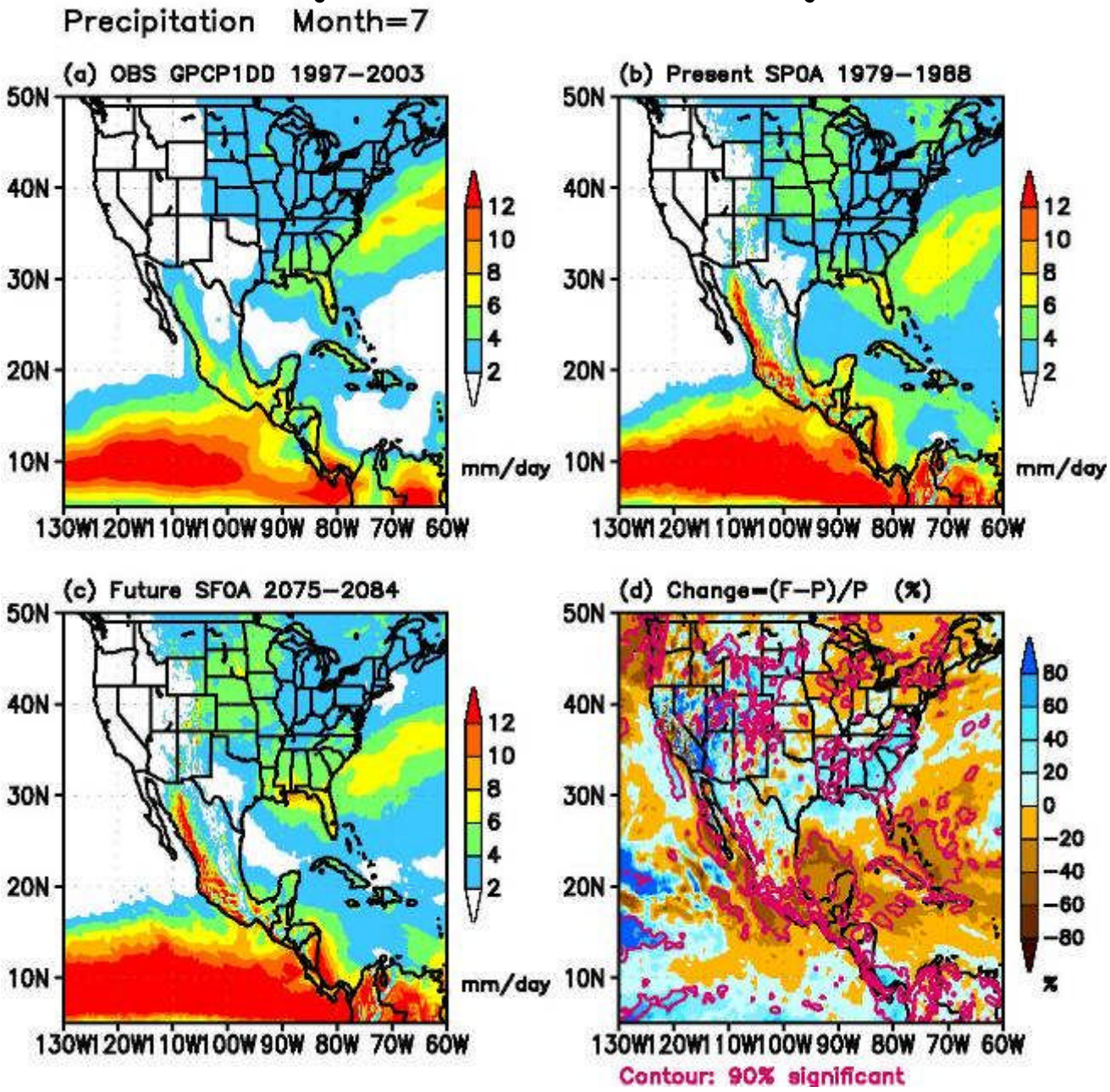


CDD

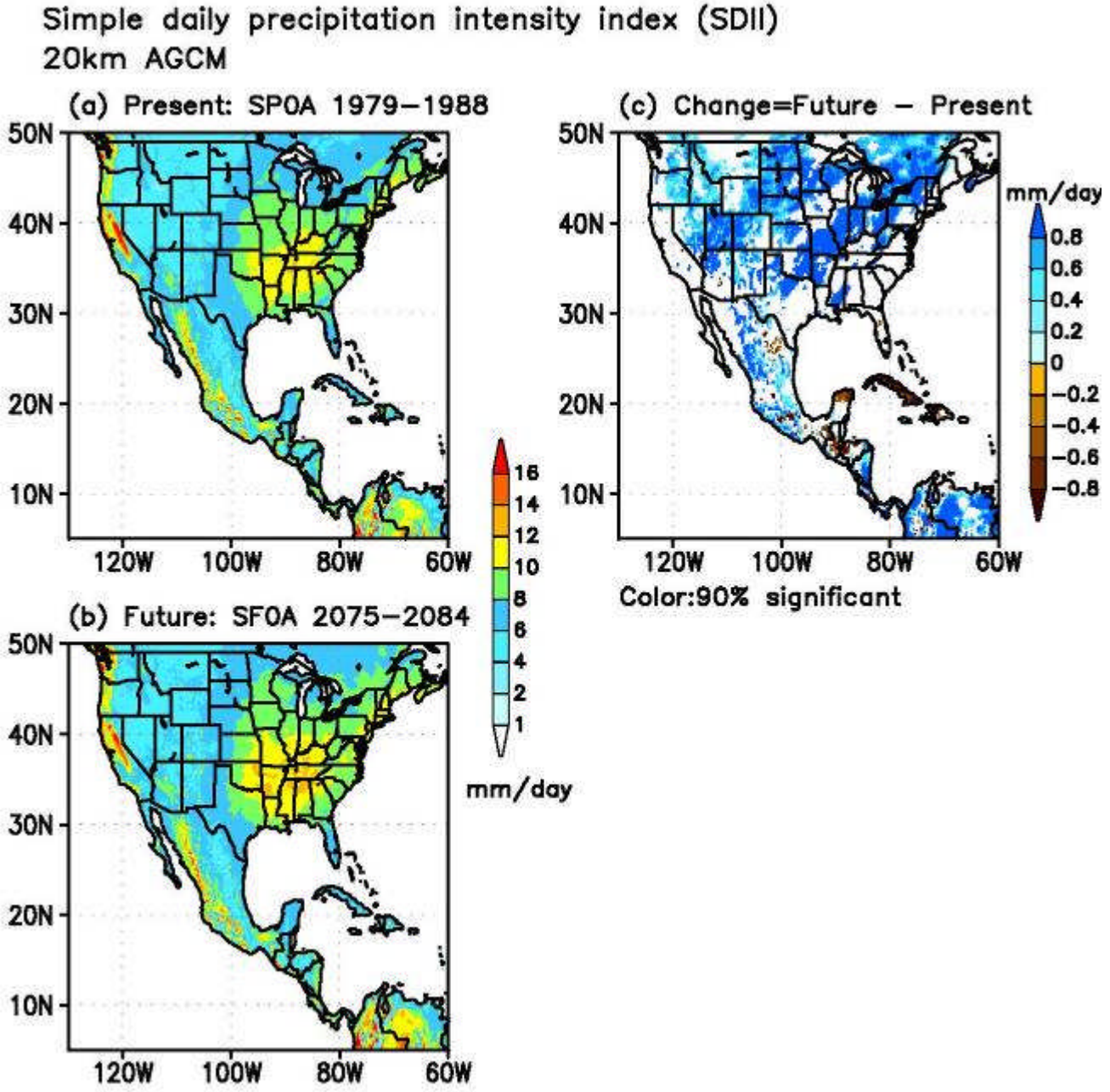
Precipitation: January



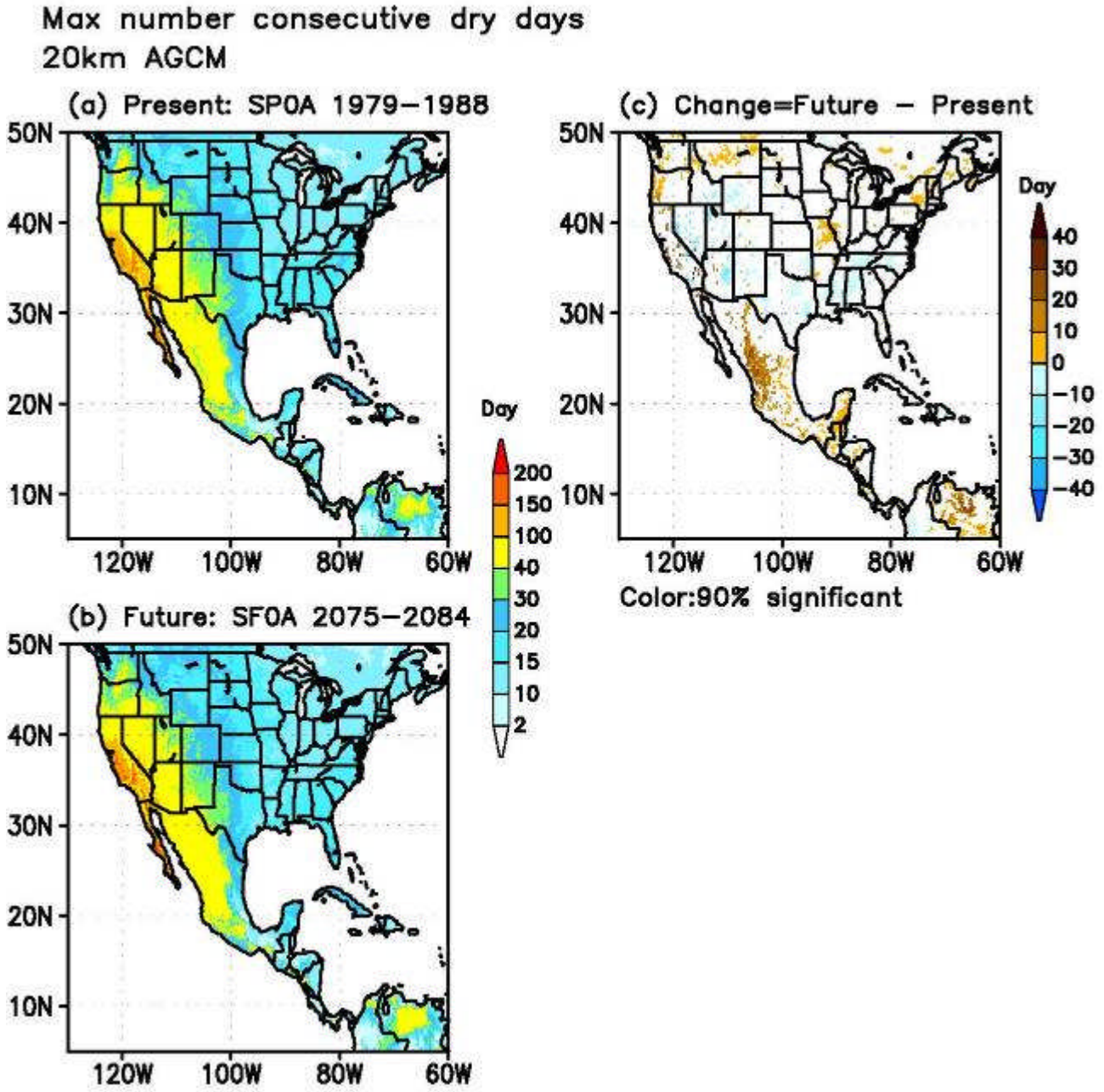
Precipitation: July



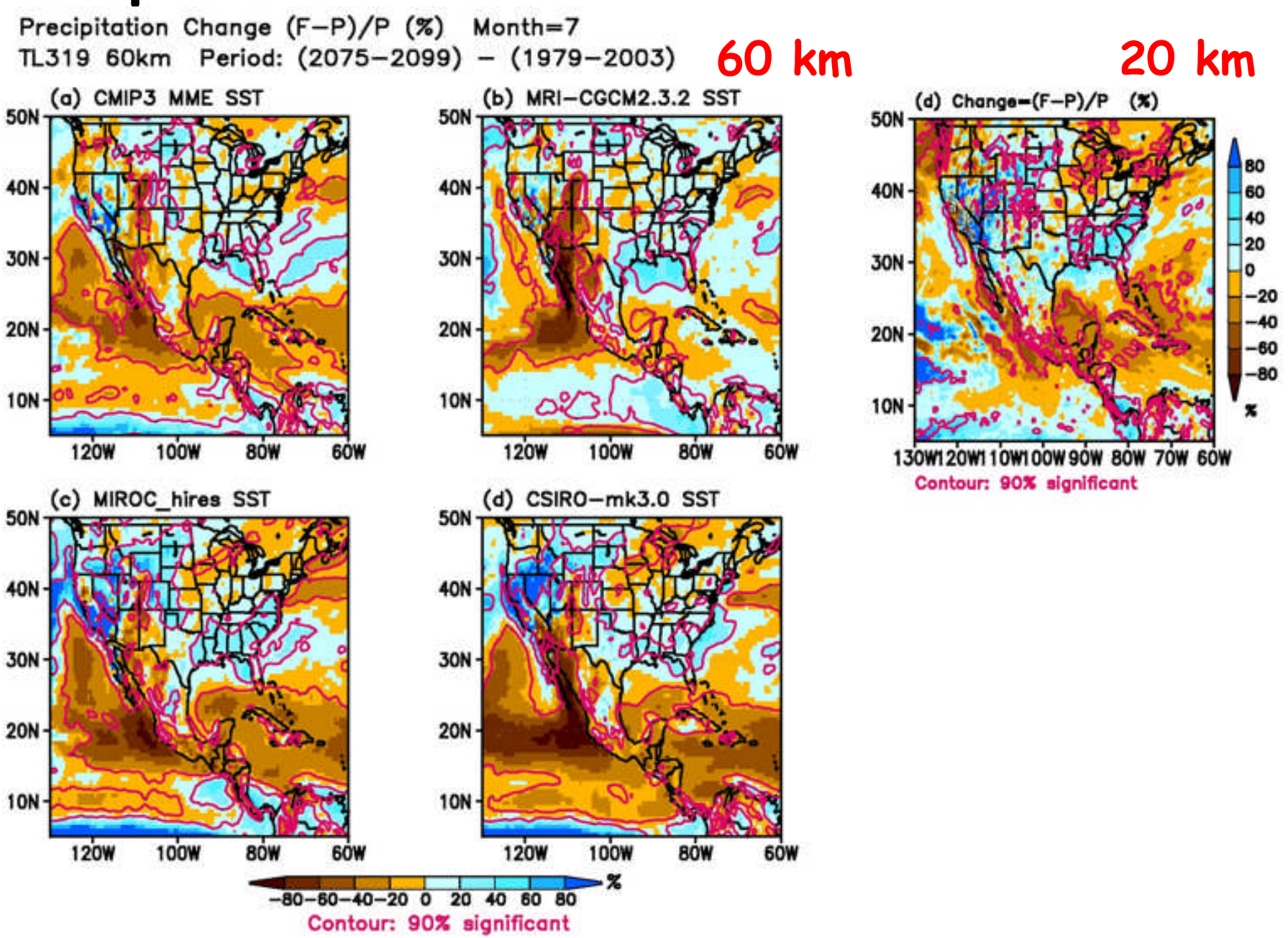
Simple Daily precipitation Intensity Index (SDII)



Maximum number of Consecutive Dry Days (CDD)



Comparison with 60-km mesh model results



Acknowledgements

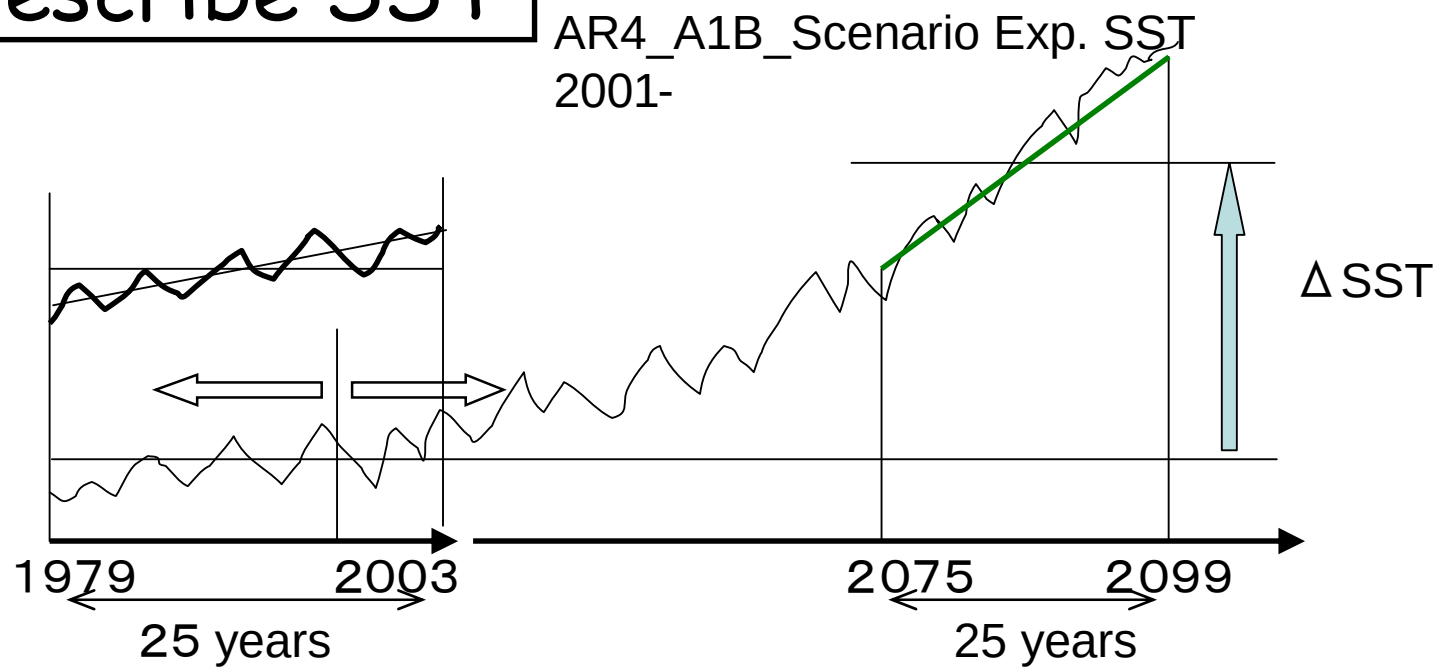
This study was conducted as a part of research theme "Projection of the change in the future weather extremes using super-high-resolution atmospheric models" under the framework of the Innovative Program of Climate Change Projection for the 21st Century (KAKUSHIN), funded by the Ministry of Education, Culture , Sports, Science and Technology (MEXT). The KAKUSHIN program is a 5-year research program started in April 2007.

How to prescribe SST

Present SST

Observed SST
1979～2003

AR4_20thCentury
Exp. SST -2001



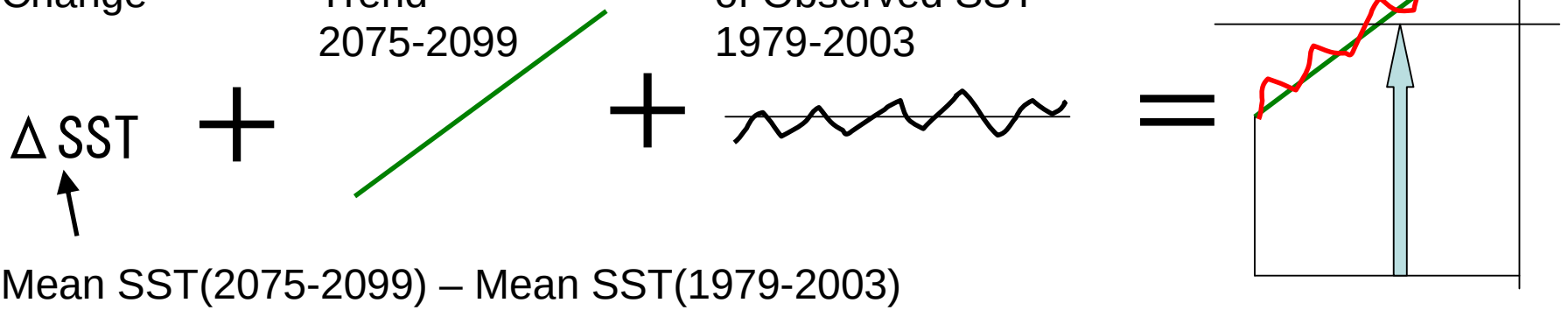
Future SSTA

also applies for 2015-2039

AR4_SST
Change

AR4 SST
Trend
2075-2099

Inter-annual variability
of Observed SST
1979-2003



Mean SST(2075-2099) – Mean SST(1979-2003)