Theme 2 / S-5 Project:

Evaluations of CMIP3 Model Performances for Various Phenomena in the Atmosphere and Oceans, in the Present-Day Climate and in Future Projections
(June 2007－March 2012)

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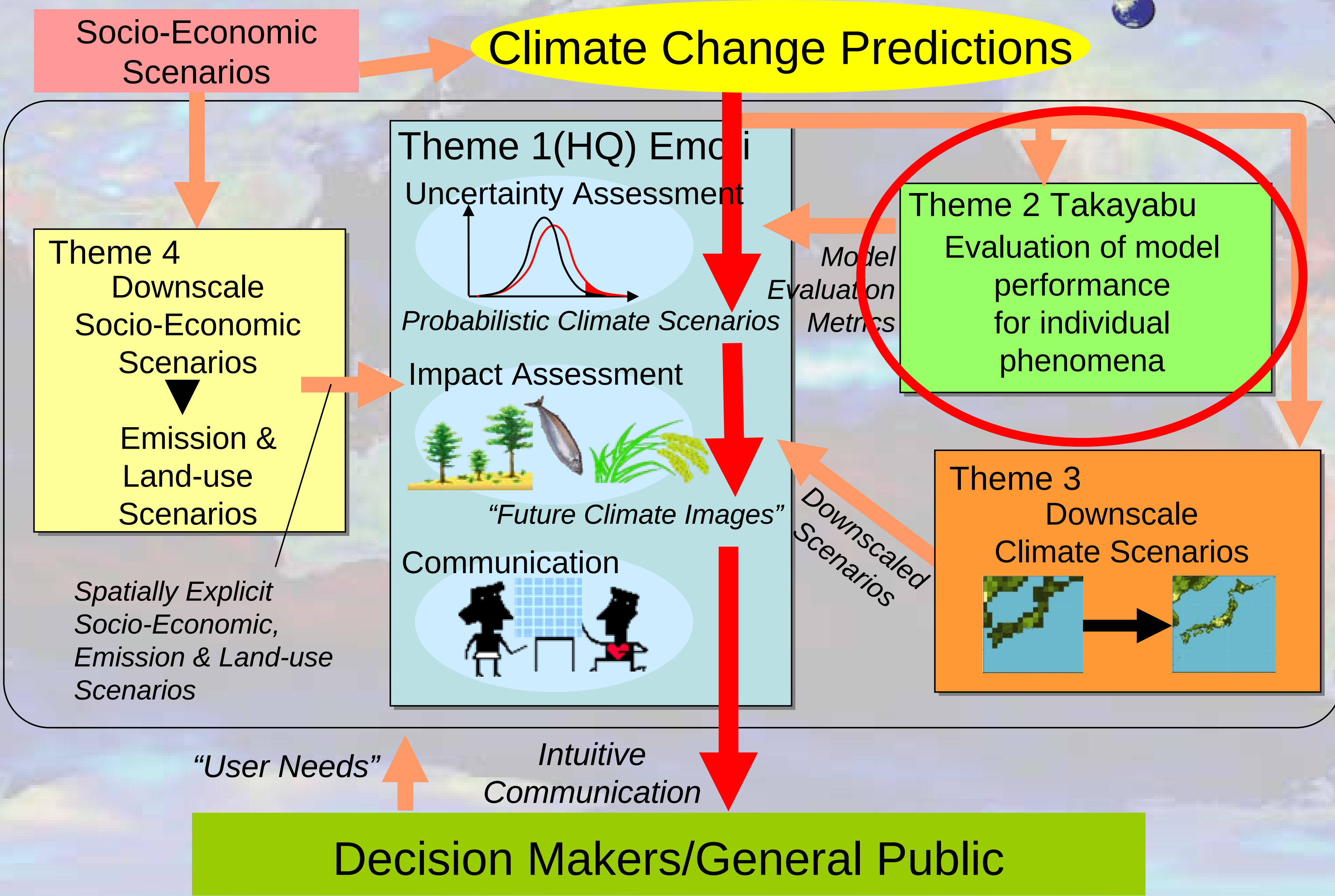
MoE GERF S-5: Integrated Research on Climate Change Scenarios to Increase Public Awareness and Contribute to the Policy Process

PL: Prof. Akimasa Sumi (IR3S, Univ. Tokyo)



Integrated Research on Climate Change Scenarios to Increase Public Awareness and Contribute to the Policy Process

(Period I : 2007-2009, II: 2010-2011)

Project Leader: Akimasa SUMI, The University of Tokyo

Objectives

- Convey detailed information about the impact of climate change on our society to policy makers and to the public. (Theme 1)
- Assign indices to quantify uncertainties embedded in future projections with domestic and international climate models. (Theme 2) <S-5-2>
- Generate spatially-specific projections for Japan and its environs, by utilizing regional climate models. (Theme 3)
- Downscaling socio-economic scenarios and the projection of land-use change. (Theme 4)

S-5 Theme2: We started with a question

How do we “notice” or how are we affected by the climate change?

Changes in Short Term Phenomena

e.g.

Typhoons

Heat waves

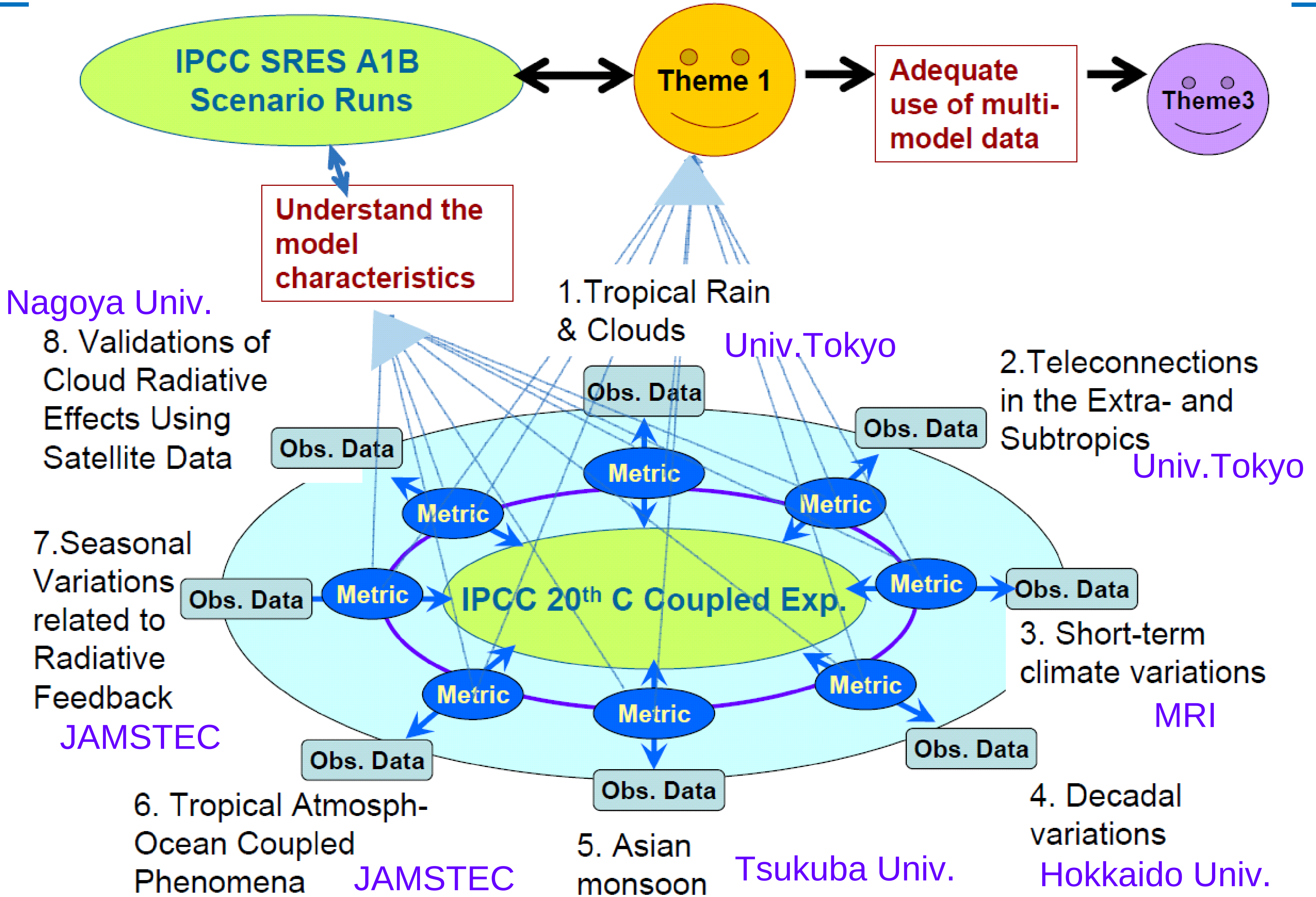
Extreme Precipitation

Draughts , etc.

Utilizing CMIP3 data provided by PCMDI :

simulation outputs from 25 models can be compared in terms of these influential phenomena, and other phenomena essential for climate projection

Strategy of Theme 2



S-5-2 Focused Phenomena

1. CCSR / Univ. of Tokyo
   Genesis of Tropical Cyclones, Tropical Convection
2. Dept. Earth Planetary Sci. / Univ. of Tokyo
   Climate modes related to summer/winter weather in Japan, Storm tracks
3. Meteorological Research Institute
   Daily and Monthly precipitation, temperature, ENSO, ..
4. Hokkaido University
   Pacific Decadal Oscillation
5. University of Tsukuba
   Winds and precipitation in Asian Monsoon regions
6. IORGC/ Japan Agency for Marine-Earth Science and Technology
   Madden-Julian Oscillation
7. FRCGC/ Japan Agency for Marine-Earth Science and Technology
   Baiu Front, Radiative Feedbacks of Clouds
8. Nagoya University
   Spread of clouds associated with atmospheric divergence

Scientific questions

What is the key mechanism for proper reproducibility of short-term atmospheric and oceanic phenomena, and which climate model is superior in that aspect?

How are the global/regional climate and the short-term phenomena related?

How can we /can’t we deduce the changes of short-term phenomena in a future climate utilizing the evaluations of the reproducibility of those in the present climate?

Strategy

① Focus on atmospheric or oceanic phenomena and study their key mechanisms.

② Propose “metrics” for individual phenomena by comparing performances of 20th C Coupled Experiments among CMIP3 multi-models and observations.

③ With the aid of these metrics,

1. Elucidate mechanisms of the reproducibility
2. Detect inter-relationships among different phenomena

④ Examine the validity of these “metrics” in future projections, by comparing them in A1B Scenario Runs and present-climate simulations.

We look for the relationships

Short Term Phenomena ⇔ Climate

Are these relationships robust?

→ Can we use metrics for present-day climate to evaluate the future projections?

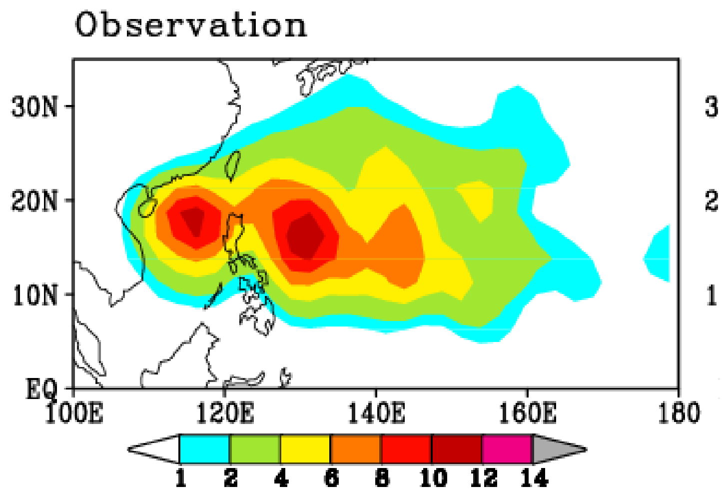
Example 1 (Typhoon Genesis)

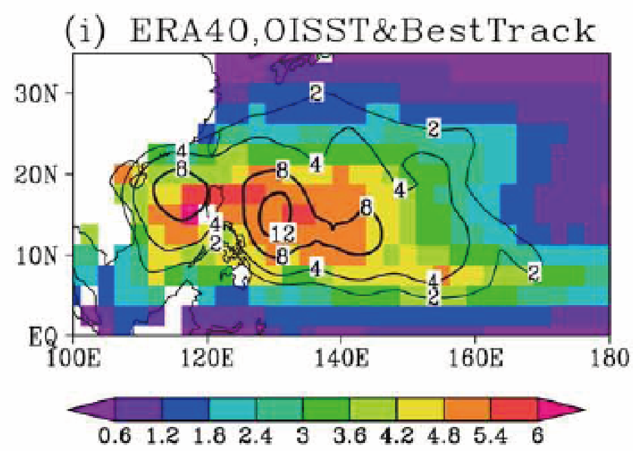
- How to evaluate
  - Count TC-like vortices
  - Evaluate environmental conditions: Genesis Potential

    (Gray 1975, Emanuel and Nolan 2004)

Environmental Vorticity, Shear, Atmosph. Stability, Humidity

$$\mathrm{GP} = \left|10^5 \eta_{850}\right|^{1.5} \frac{1}{\left(1 + 0.1\left|\mathbf{u}_{850} - \mathbf{u}_{200}\right|\right)^2} \left(\frac{V_{\mathrm{pot}}}{70}\right)^3 \left(\frac{H_{700}}{50}\right)^3$$



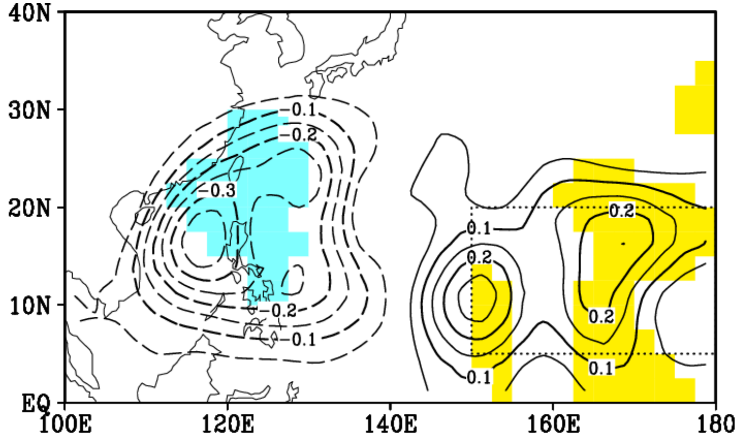


Needs to be examined if GP is applicable to warmer climate

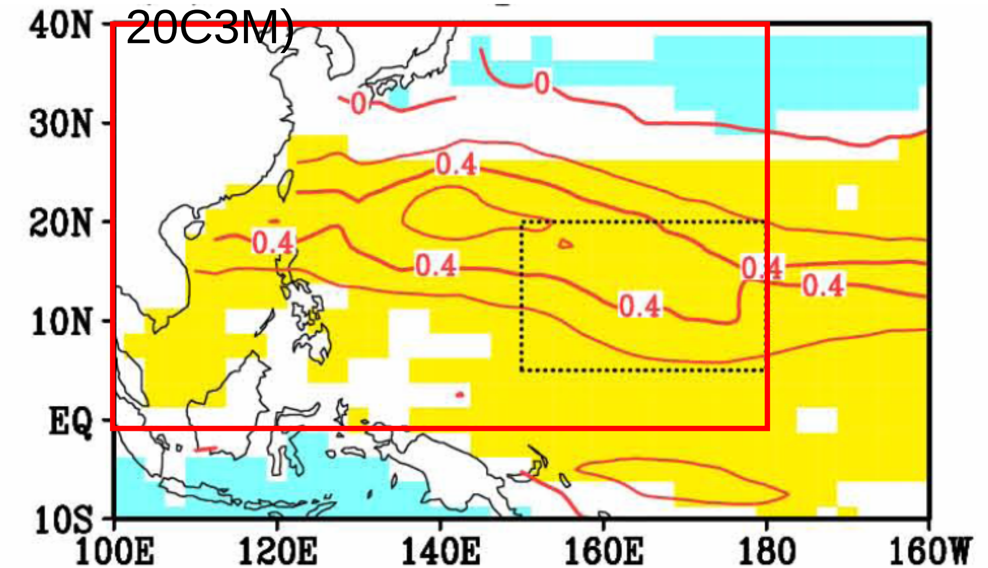
TCG numbers and GP :Change

Ensembles of 5 good-performing models

Diff Genesis Number（GW-20C3M)



Diff Genesis Potential （GW-20C3M)

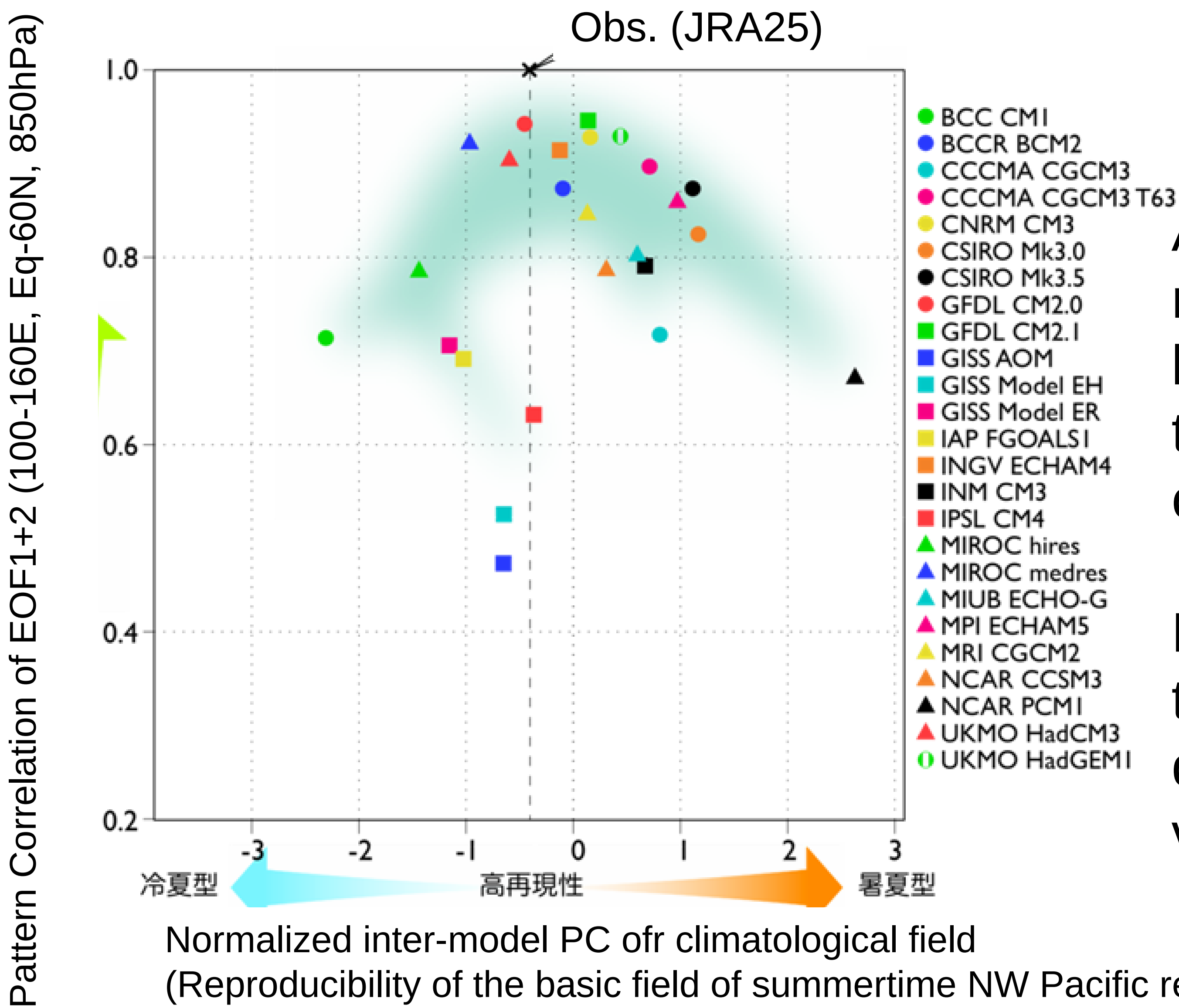


ontours : 21CsenarioRuns– 20C3M

Color : Yellow 5 good models agree to increase, Blue to decrease

Change in GP do not necessarily represent the change in TC numbers

Example 2（PJ pattern）



Normalized inter-model PC ofr climatological field
(Reproducibility of the basic field of summertime NW Pacific region)

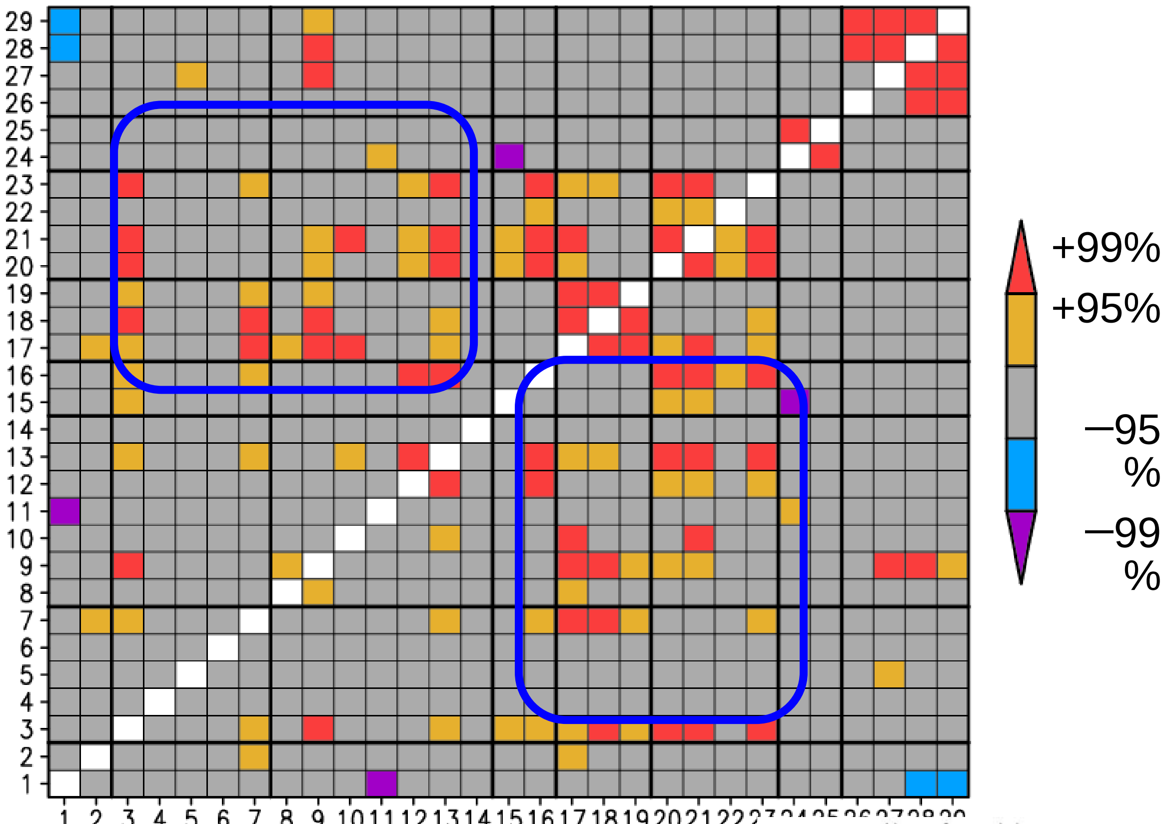
Asian region mode which has a large impact on the summer-time climate of Japan

Reproducibility of the basic field determines that of variations.

Performance metrics

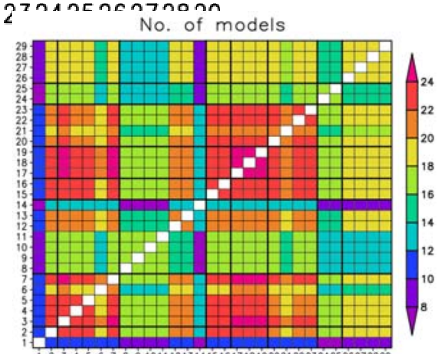
Intercomparison of Performance Metricws

Significances of correlation



1	TC gen. freq. RMSE (1)
2	TC GP RMSE (1)
3	PJ pattern S (2)
4	Silk road pat. July S (2)
5	Silk road pat. Aug. S (2)
6	Storm Track RMSE (2)
7	Center of PH S (2)
8	ENSO vs Asia DJF (3)
9	ENSO vs Asia MAM (3)
10	ENSO vs Asia JJA (3)
11	ENSO vs Asia JJA2 (3)
12	ENSO SST S (3)
13	ENSO OHC S (3)
14	Daily V of Tsfc (3)
15	PDO S (4)
16	Decadal ENSO S (4)
17	Monsoon Prec. S (5)
18	Monsoon Low Wind S (5)
19	Monsoon Upper Wind S (5)
20	MJO spectrum norm. (6)
21	MJO spectrum prec. norm. (6)
22	MJO spectrum BG norm. (6)
23	MJO distribution S (6)
24	Cloud gain factor (7)
25	Cloud gain factor net (7)
26	ITCZ prec. (8)
27	ITCZ upper cloud (8)
28	ITCZ OLR (8)
29	ITCZ upper div. (8)

Monsoon/MJO vs.
summer monsoon /ENSO
correlates very well



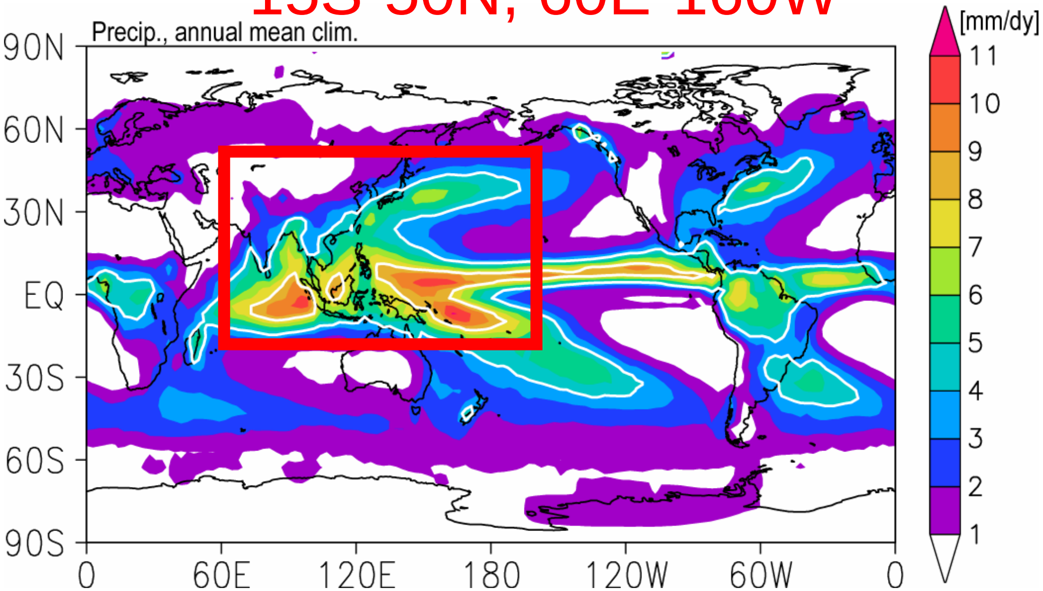
Users want a simple conclusion.

Is there a good metric for “Asian Climate” ?

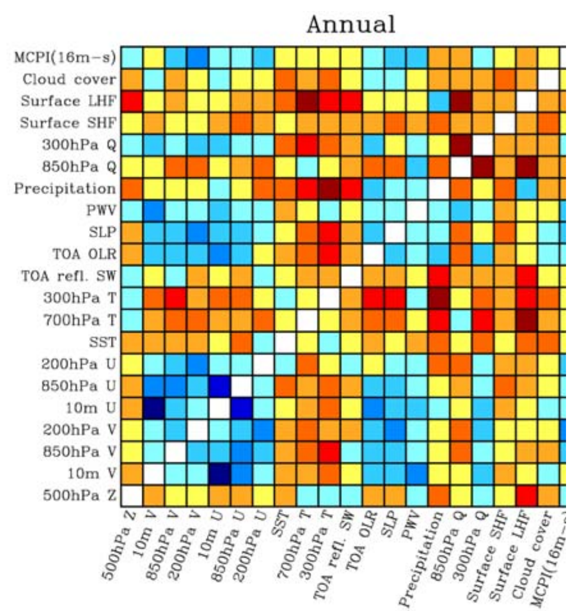
A metric or some reduced numbers of metrics to represent certain groups of phenomena ?

Asian Metrics (experimentarily..)

15S-50N, 60E-160W



Ref. Global Metrics
Gleckler et al. (2008)



MCPI(16m−s)
Cloud cover
Surface LHF
Surface SHF
300hPa Q
850hPa Q
Precipitation
PWV
SLP
TOA OLR
TOA refl. SW
300hPa T
700hPa T
SST
200hPa U
850hPa U
10m U
200hPa V
850hPa V
10m V
500hPa Z

Working Group

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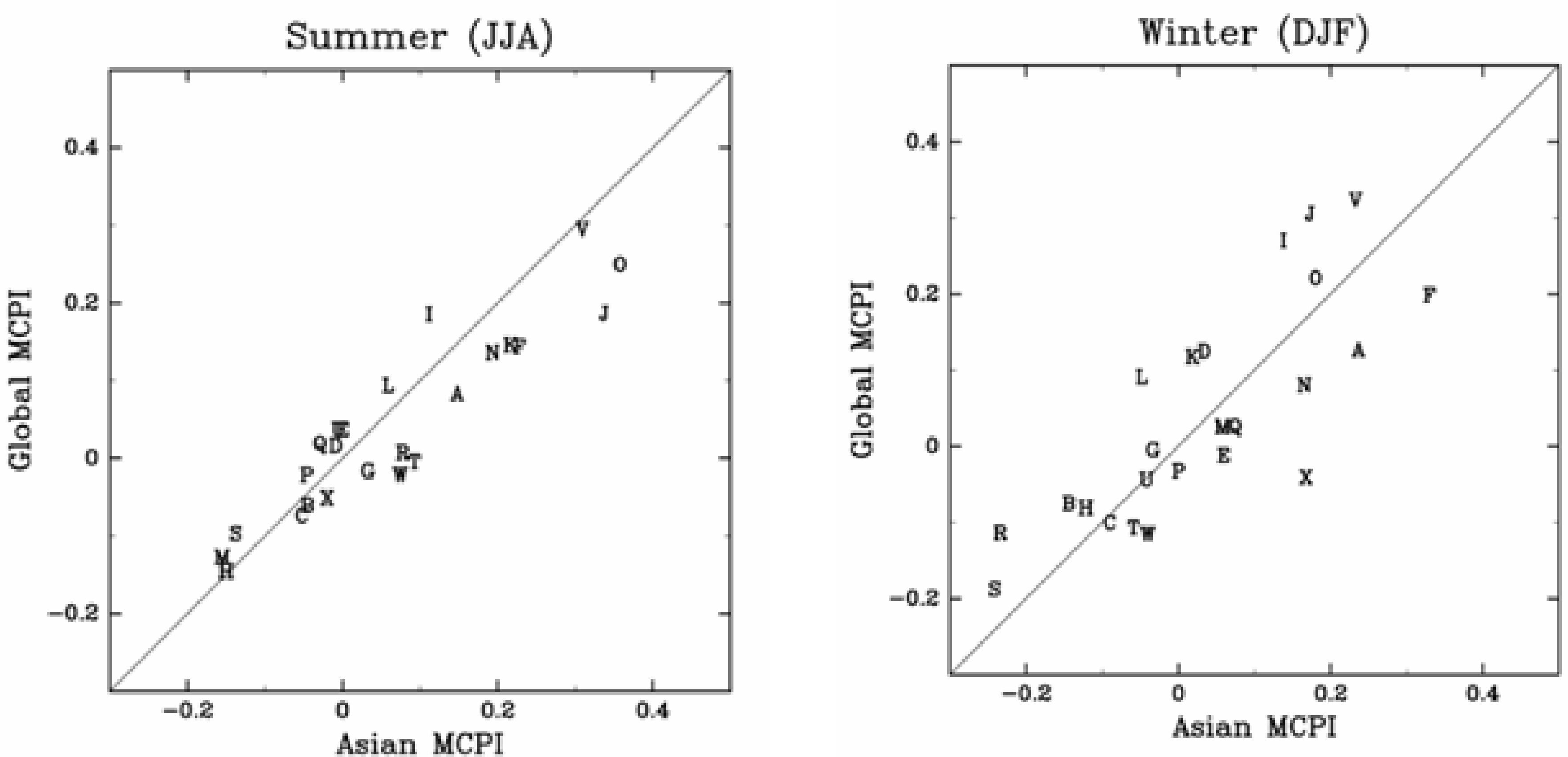
Asian vs Global MCPI



A : BCCR−BCM2.0
B : CGCM3.1(T47)
C : CGCM3.1(T63)
D : CNRM−CM3
E : CSIRO−Mk3.0
F : CSIRO−Mk3.5
G : GFDL−CM2.0
H : GFDL−CM2.1
I : GISS−AOM
J : GISS−EH
K : GISS−ER
L : FGOALS−g1.0
M : INGV−SXG
N : INM−CM3
O : IPSL−CM4
P : MIROC3.2(hires)
Q : MIROC3.2(medres)
R : ECHO−G
S : ECHAM5/MPI−OM
T : MRI−CGCM2.3.2
U : CCSM3
V : PCM
W : UKMO−HadCM3
X : UKMO−HadGEM1

Model Climate Performance Incex
Asian and Global MCPI correlates tighter in JJA. Errors are generally larger for Asian metric. Probably, global MCPI is largely affected by Asian summer monsoon.

Next Step

Short Term Phenomena ⇔ Climate

Performance Metrics Global Metrics / Asian Metrics

→ Understanding what controls the appearances of atmospheric and oceanic phenomena

Today

Dr. Peter Gleckler (PCMDI)

Performance metrics for climate models in AR5

Prof. Chidong Zhang (Univ. of Miami)

MJO Simulations by Global Climate Models

Satoru Yokoi Typhoon Genesis

Yu Kosaka   Summertime NW Pacific circulation

Tomoshige Inoue Evolution of Summer Monsoon

Kazuhiro Oshima   Pacific Decadal Oscillation

Masakazu Sueyoshi First baroclinic Rossby radius

Hiroki Ichikawa Precipitation/Cloud Areas vs large-scale circulation

Thank you