

# Future climate projections with high horizontal resolution model for impact assessments in water sectors in Southeast Asia

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## Introduction

### Backgrounds

- Atmospheric scientists want to know how climate extremes change under a global warming climate?
- Specific-sector scientists want to know to what degree the climate extremes devastate human activities and societies.

Typhoon Haiyanon  
November 3, 2013



Debris littering the streets of Tacloban City



### Objectives

We develop future climate projections to meet the two requirements from the both scientific communities.



Meteorological  
Research  
Institute

AOGS2018 at Hawaii, Jun



# Introduction

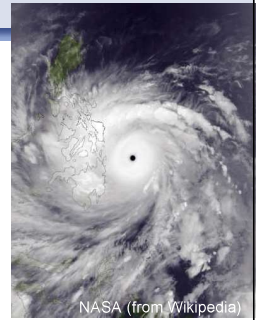
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# Integrated Climate Change Projection Integrated Research Program for Advancing Climate Models

## Strong Cooperation

Theme C Integrated Climate Change Prediction

Elucidating how and why regional warming occurs so that global warming information can be utilized by society.

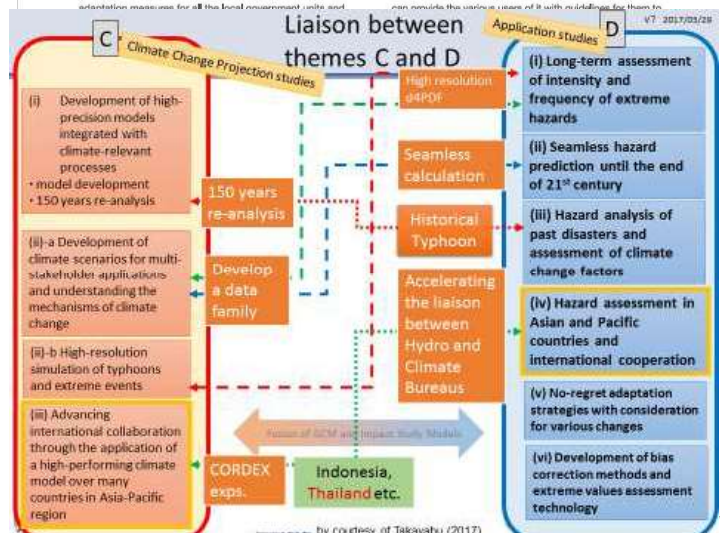


Area Representative : Izuru Takayabu  
(Japan Meteorological Business Support Center)

International society is seeking stronger cooperation with "the physical science basis" of Working Group I (WG1) and "Impacts, adaptation and vulnerability" of Working Group II (WGII) within the Intergovernmental Panel on Climate Change (IPCC). In Japan, the development of global warming adaptation measures for all the local government units and

types of demand for it therefore needs to be output. We intend to carry out future predictions and experiments for use in reproducing current climates in various scenarios and experiments that reproduce past climates through assimilating data. Then by assessing the adequacy of the resulting data we can provide the various users of it with a dialogue for them to

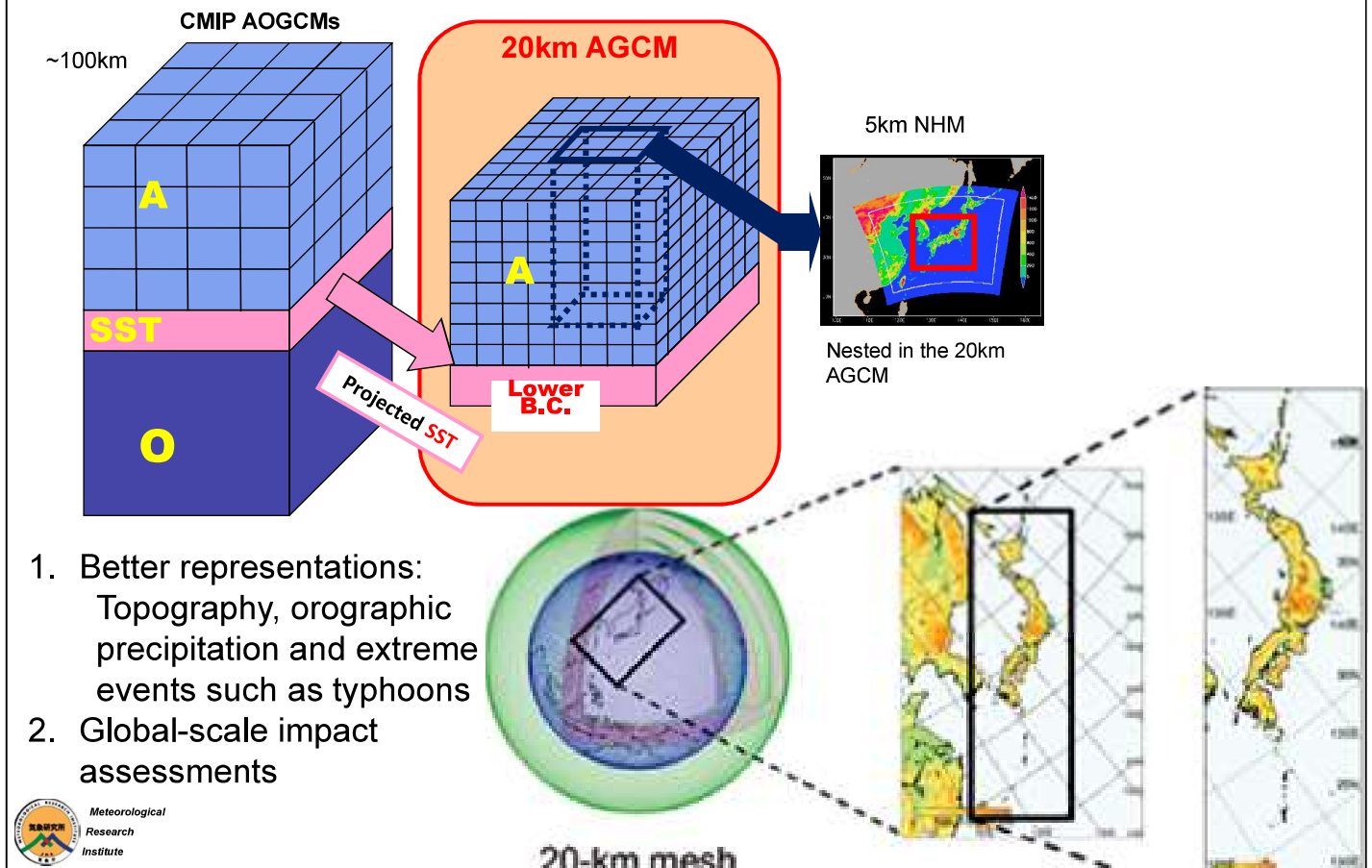
Liaison between themes C and D



February, 2018

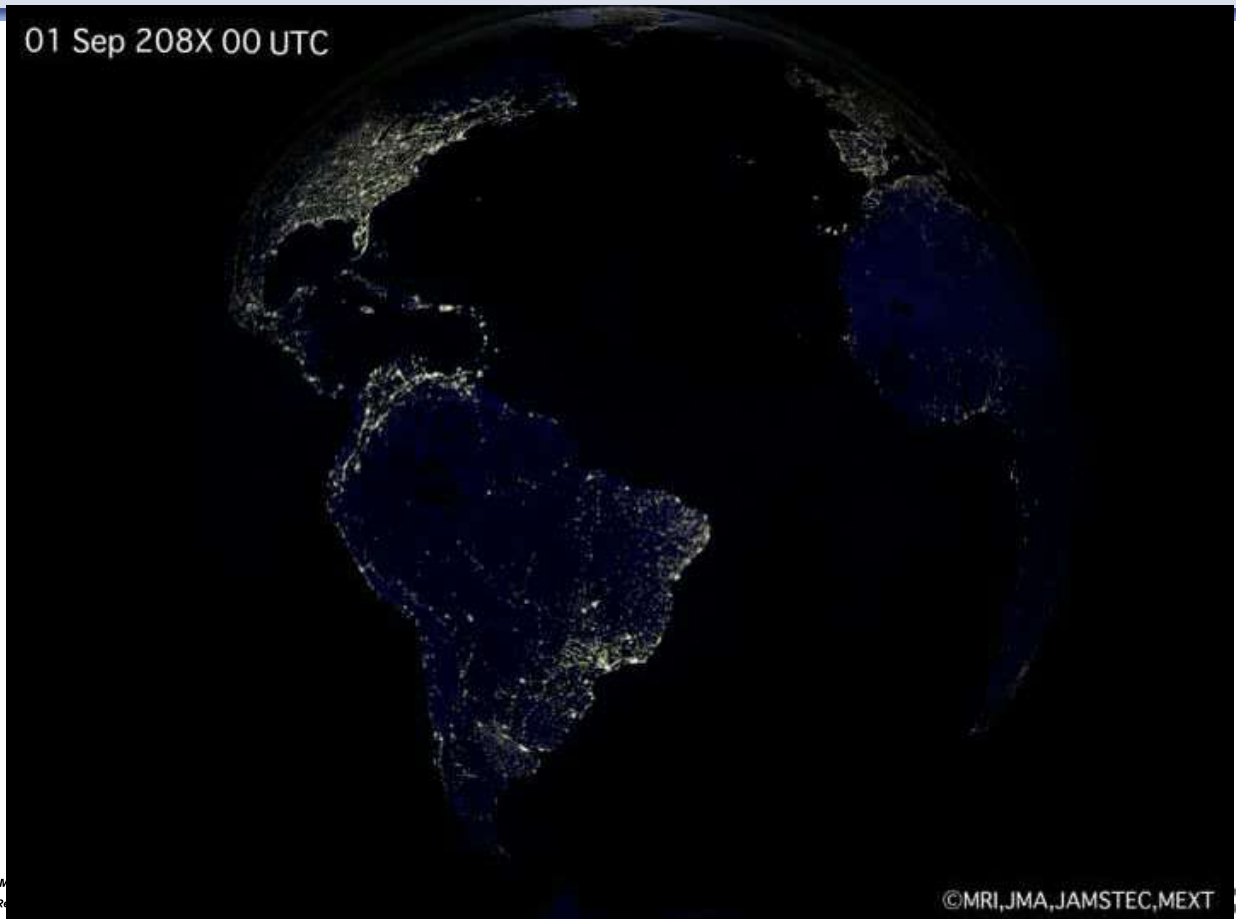
February 9, 2018 By courtesy of Takayabu (2017)

# Global Dynamical Downscaling



## Tropical cyclones in the 20-km AGCM

01 Sep 208X 00 UTC





# Uncertainty in climate projections

- Merit of our approach:
  - High horizontal resolution
  - High reproducibility of current climate and extremes
- Demerit:
  - Single model
  - Only two scenarios
- Countermeasure
  - Multi-physics of convections
  - Four scenarios but with low horizontal resolution (60 km) and 1950 to 2100.

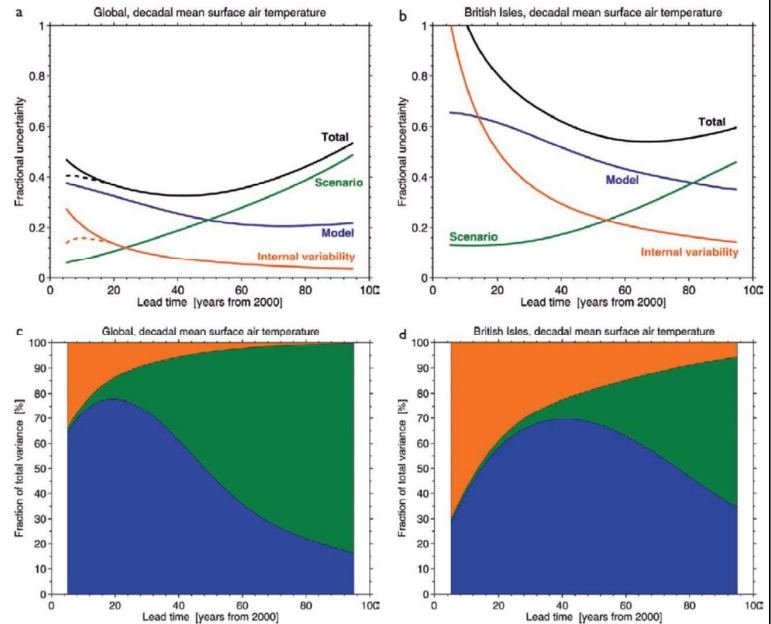


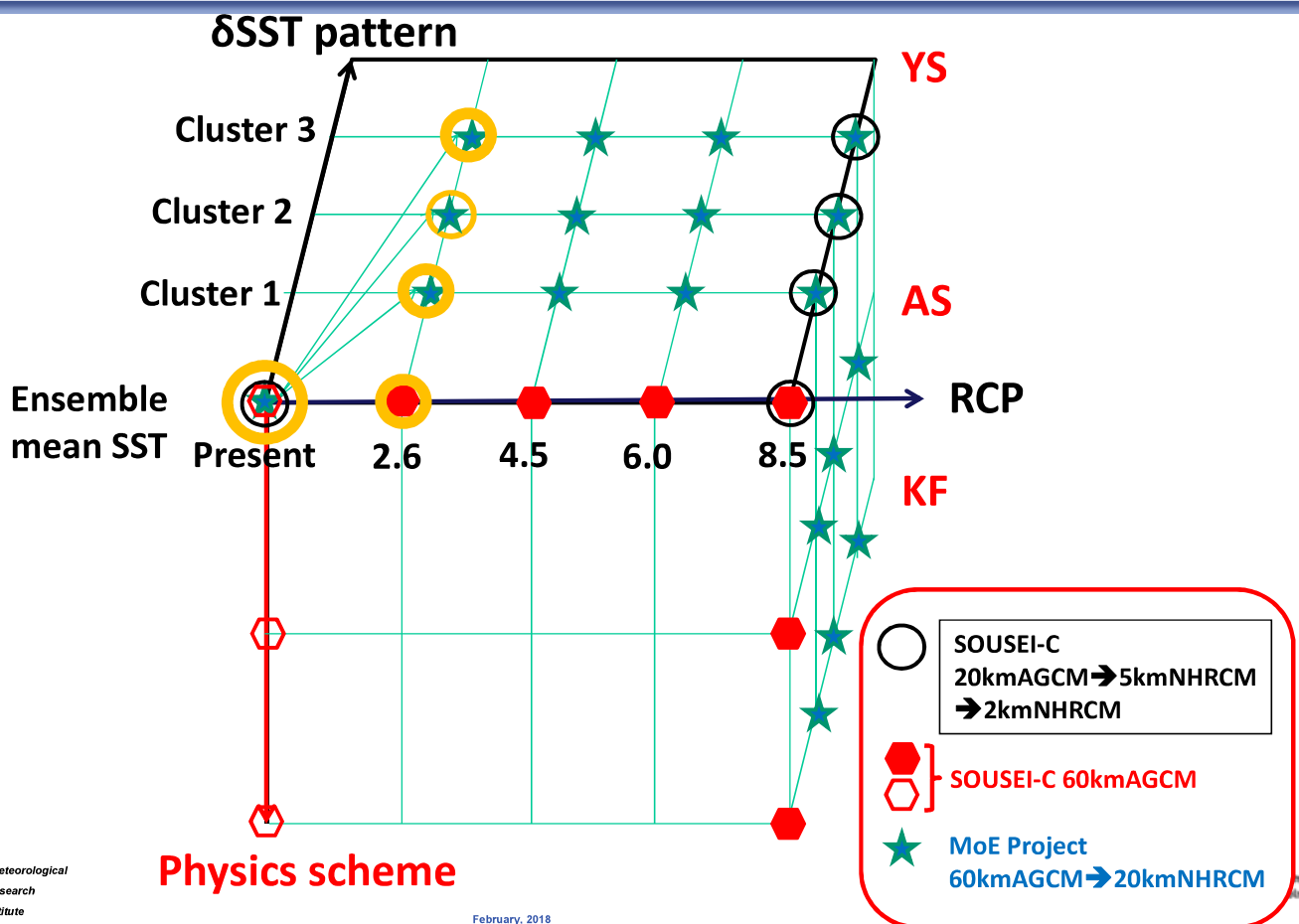
FIG. 4. The relative importance of each source of uncertainty in decadal mean surface temperature projections is shown by the fractional uncertainty (the 90% confidence level divided by the mean prediction) for (a)

Hawkins and Sutton (2009, BAMS)

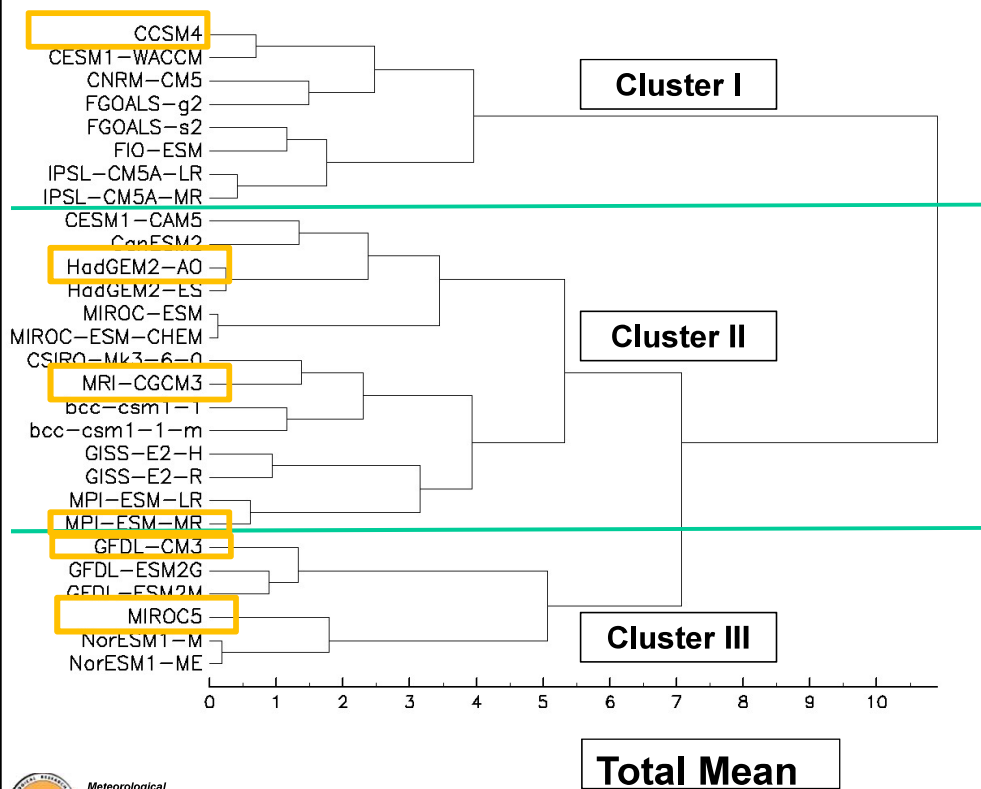


University

## Matrix of ensemble experiments under RCPs



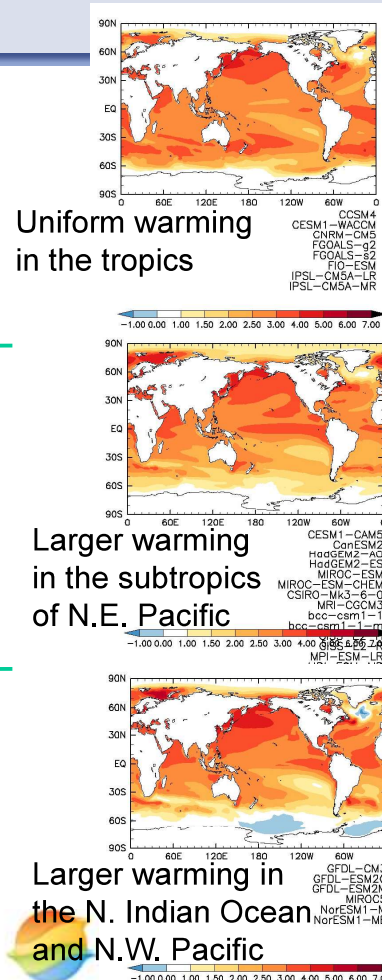
# Cluster analysis results



Meteorological Research Institute

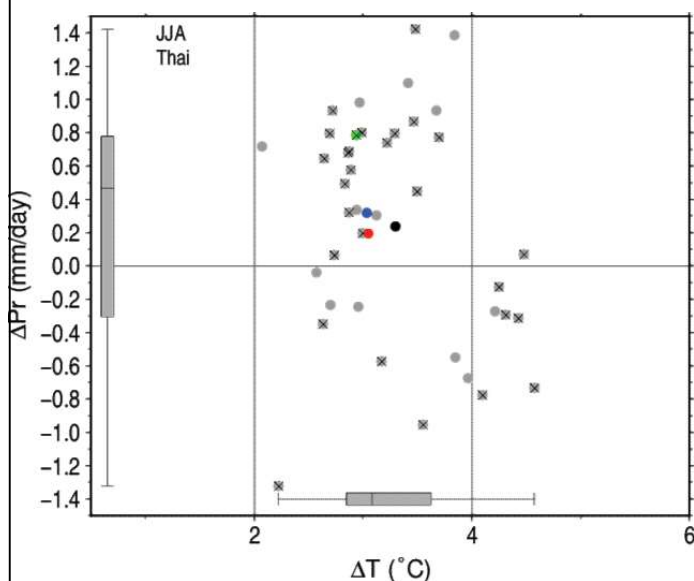
by courtesy of Mizuta (2014, JpGU)

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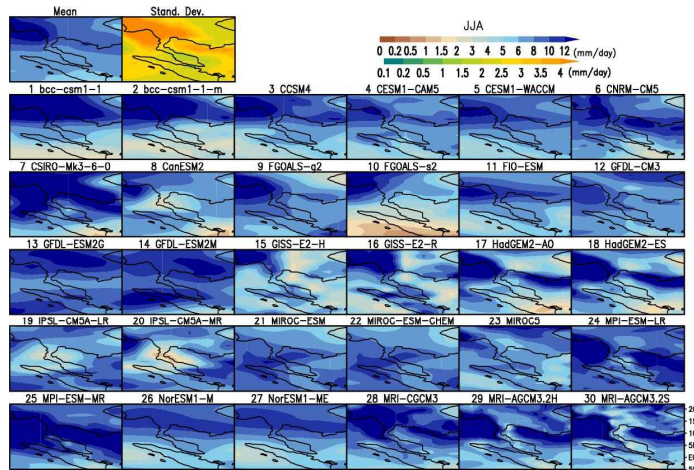


## Future projection uncertainties in JJA precipitation in CMIP5 MME

### Future Changes



### JJA precipitation among the CMIP5 MME under RCP8.5



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February, 2018 by courtesy of Ito (2018)

TOUGOU Integrated Research Program for Advancing Climate Models

# Change in annual precipitation

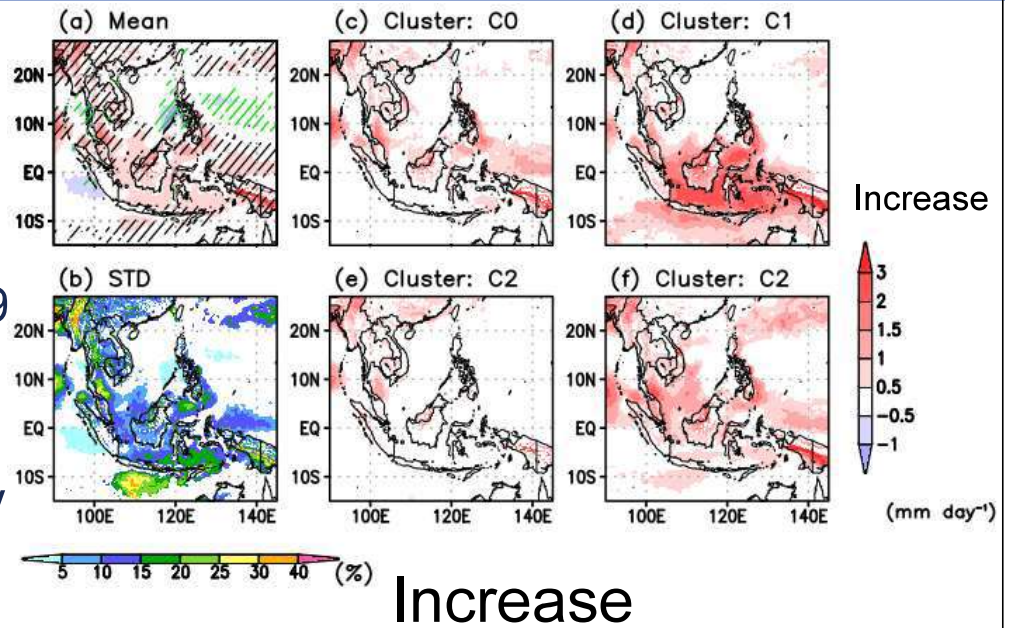
MRI-AGCM3.2S

20-km grid spacing

Period: 2075-2099

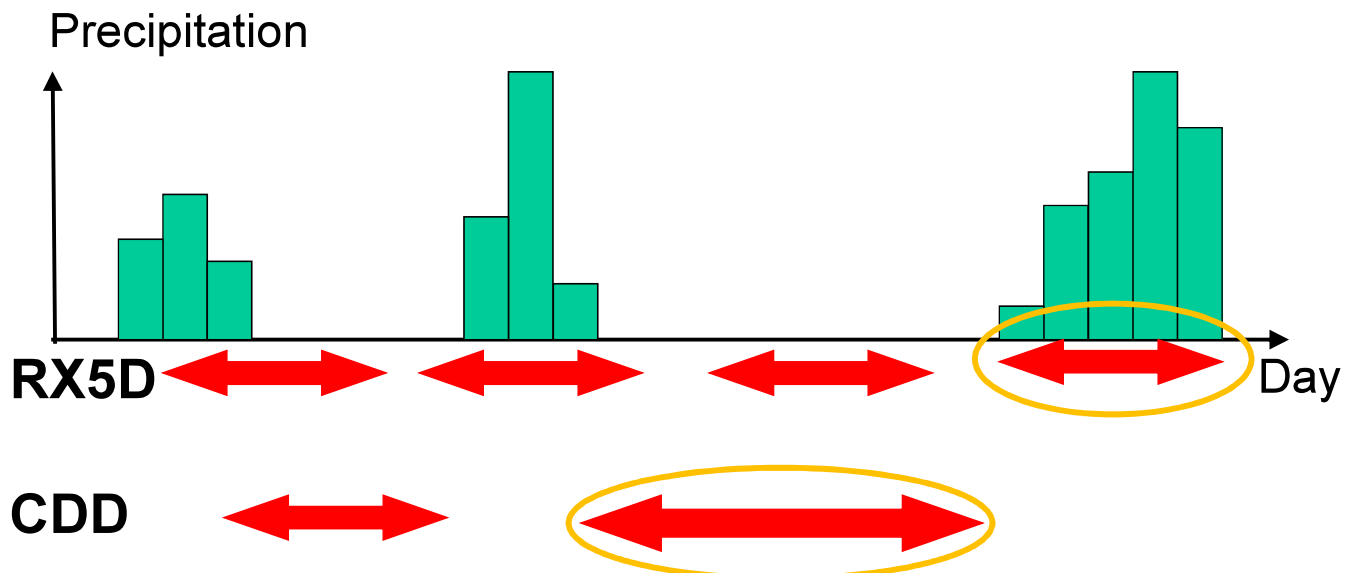
Scenario: RCP8.5

SST: 4 different SSTs projected by CMIP5 models



## Rainfall and Drought indices

- Maximum of 5-day rainfall total (**RX5D**) for a year
- Maximum number of consecutive **dry days** (**CDD**)  
where "dry day": day of precipitation < 1 mm/day





# Change in 5-day rainfall total

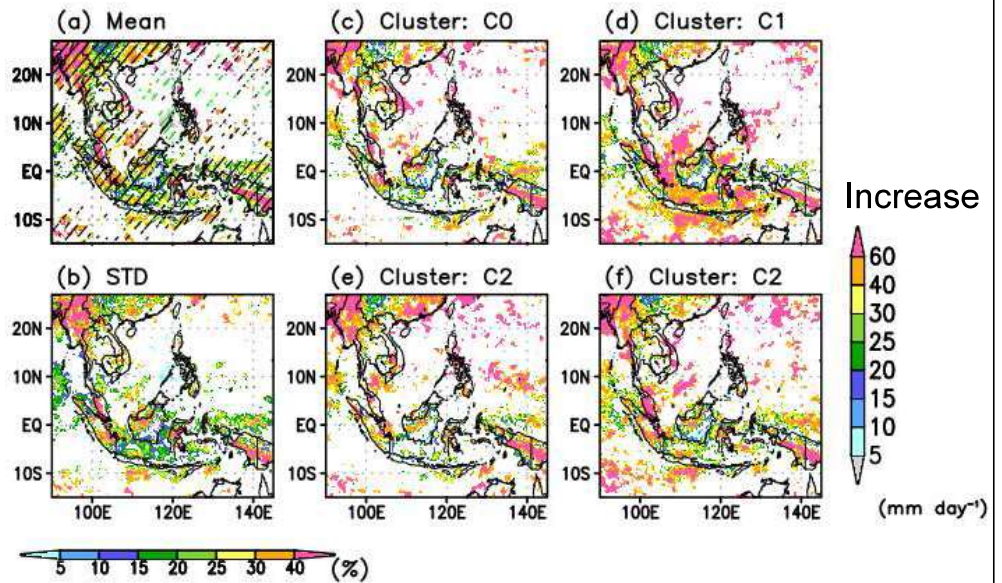
MRI-AGCM3.2S

20-km grid  
spacing

Period: 2075-2099

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# Change in 5-day rainfall total

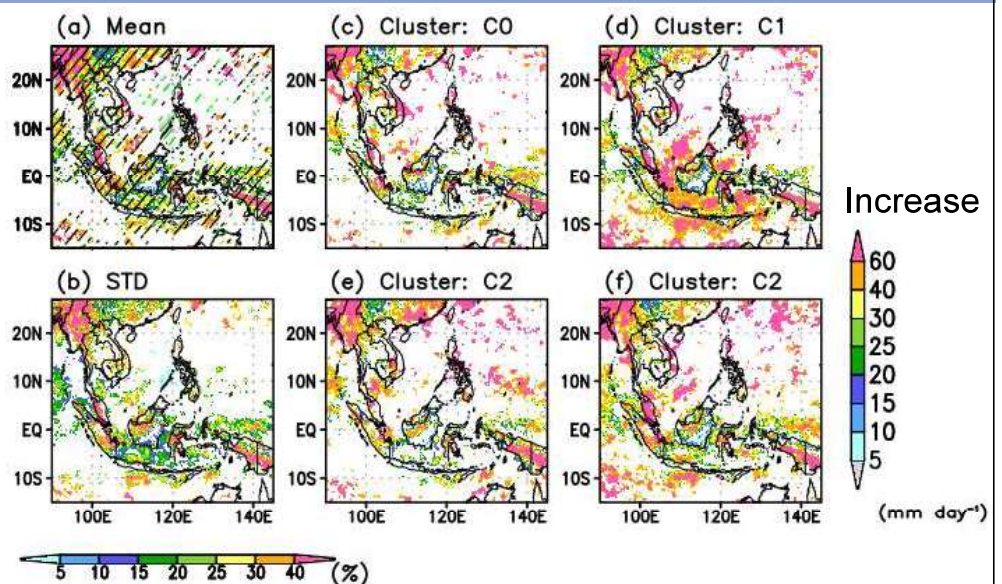
MRI-AGCM3.2S

20-km grid  
spacing

Period: 2075-2099

Scenario: RCP8.5

SST: 4 different  
SSTs projected by  
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"It rains less frequently, but when it does rain,  
there is more precipitation for a given event."  
(Tebaldi et al. 2006)

# Change in consecutive dry days

MRI-AGCM3.2S

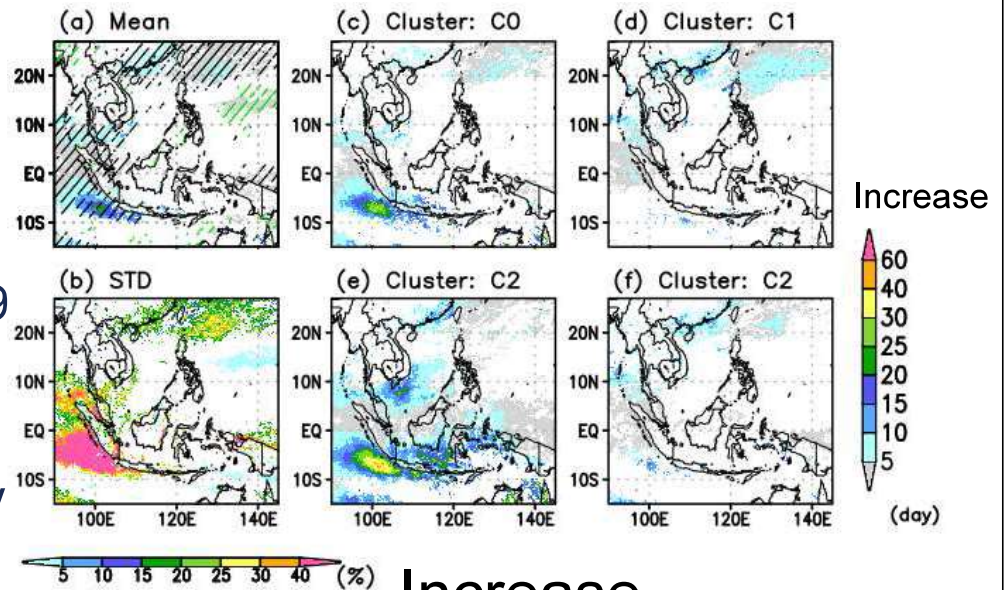
20-km grid  
spacing

Period: 2075-2099

Scenario: RCP8.5

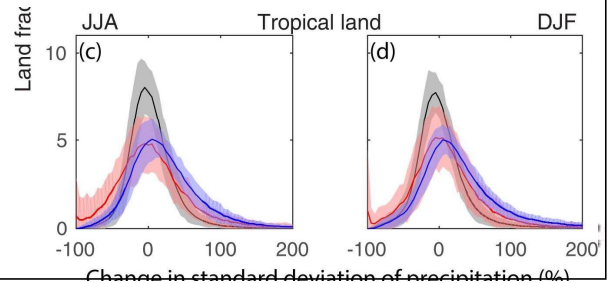
SST: 4 different

SSTs projected by  
CMIP5 models



Increase

precipitation variability in most climate models increases over a majority of global land area in response to warming (66% of land has a robust increase in variability of seasonal-mean precipitation (Pendergrass et al. 2017 Nature))



## Future changes in river discharges

Annual river discharges



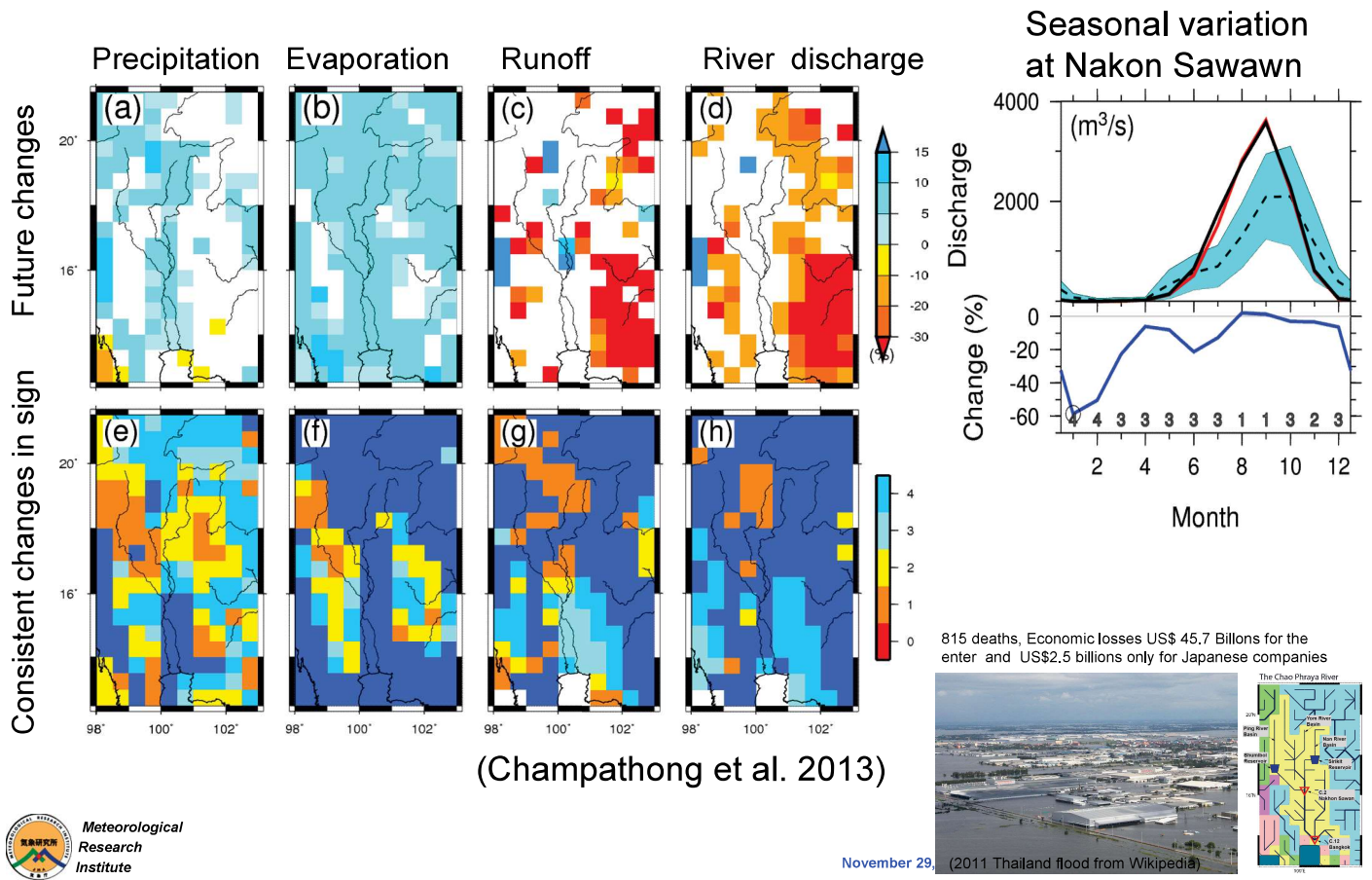
Consistent sign changes



Large features of the changes are presented and good for raising awareness.



# Chao Phraya River Basin in a future

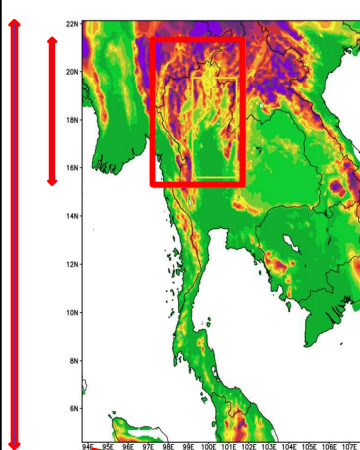


## Dr. Sasaki's Poster

## Strategies on Future Climate Projections for Asian Countries and Understanding of Mechanisms of Changes in Climate Extremes

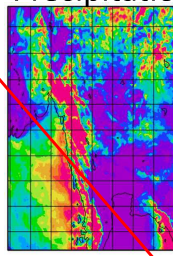
Domain for Thailand

5km 2km

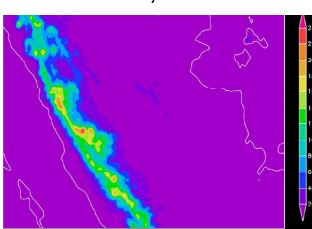


Thailand 5km

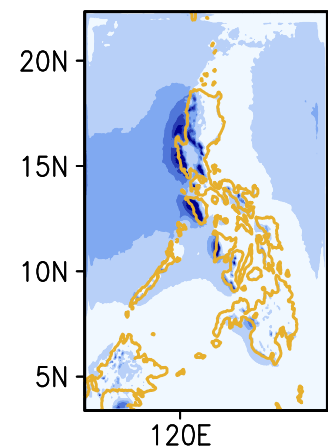
Precipitation



Precipitation for Batang Hari River, Indonesia



JJA Precipitation for Philippine with 5-km



- Cooperative Dynamical downscaling by invited Asian researchers
- Data provision for impact assessment and adaptation studies

# Summary

- We revealed that future changes in extreme precipitation such as annual maximum daily precipitation and 5-day precipitation total at the late 21st century are projected to increase in most Southeast Asian countries with robustness information not only in a statistical viewpoint but also an atmospheric mechanism viewpoint. The latter viewpoint is in progress.
- We have started research collaborations under a dynamical downscaling program, CORDEX-EA and SEA based on the same approach.

This work was conducted under the TOUGOU Program of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan.



February, 2018

Research Program  
Using Climate Models