



TOUGOU

Integrated Research Program  
for Advancing Climate Models

# Introduction of TOUGOU theme C -Integrated Climate Projection-

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**Integrated Research Program for Advancing Climate Models**

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In Japan, not only the citizens, but also cats keep high interest on extreme weather's increase perhaps caused by the climate change...



# Background of the design of TOUGOU program

- **International**

- IPCC AR6 reports are scheduled to be published in 2021.
  - Shake hands among WGI. II. and III are strongly recommended in AR6 scoping meeting and also in IPCC 46<sup>th</sup> meeting.
    - WGI: The physical science basis
    - WGII: Impacts, adaptation and vulnerability
    - WGIII: Mitigation of climate change
- Paris agreement has been engaged in Dec. 2015.

# Background of the design of TOUGOU program

- **Domestic**

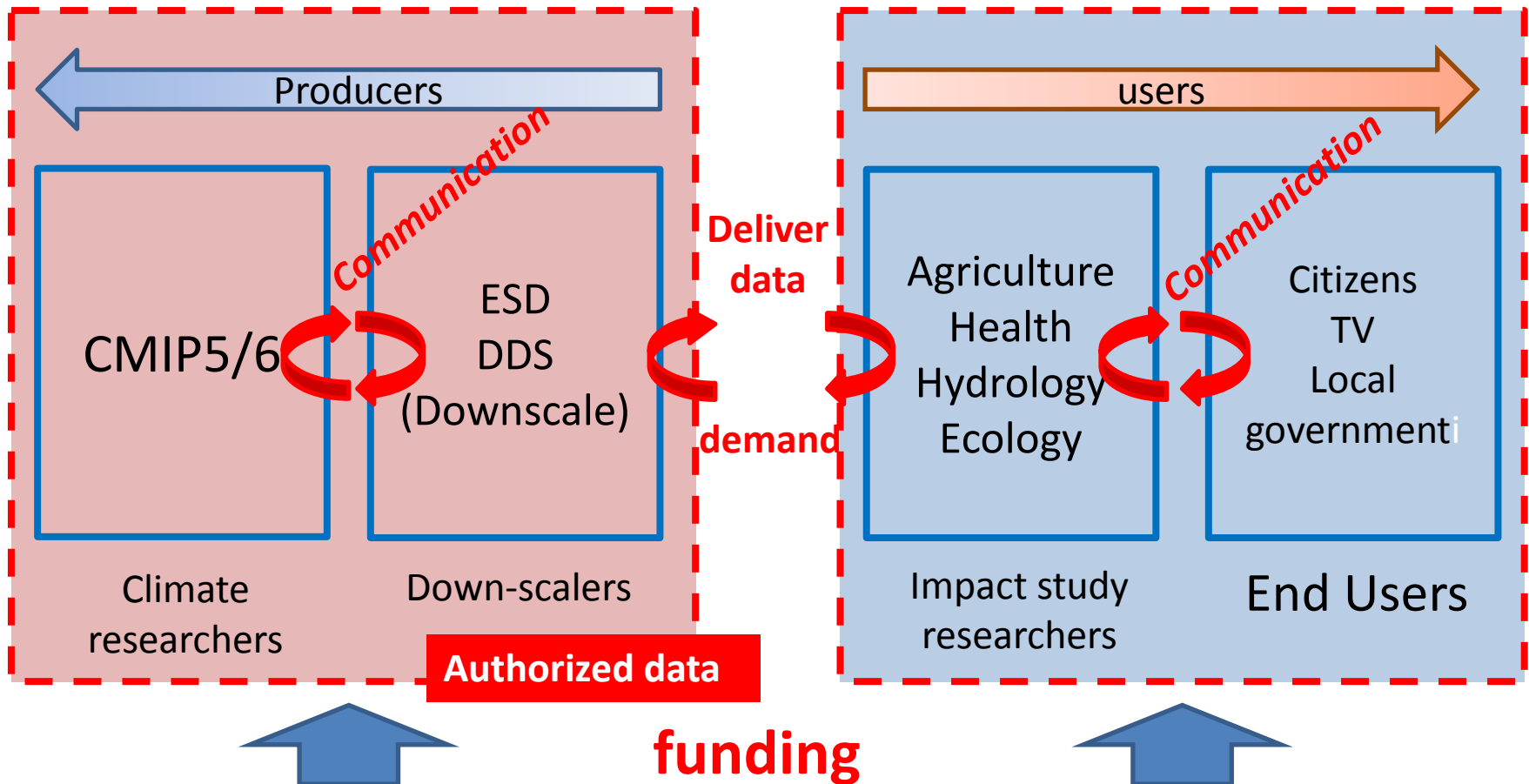
- Nov. 2015: “National Plan for Adaptation to the Impacts of Climate Change” has been decided by the Cabinet.
  - Vision of society: By promoting adaptation measures to climate change impacts, to build a secure, safe and sustainable society that is able to minimizing and avoiding damage for life of citizens, properties, economics, and natural environment due to its impacts, and to be resilient against damage.
    - ➔ A-PLAT (Climate change adaptation platform) has been prepared.
- May 2016: “Global Warming Adaptation Plan” has been decided by the Cabinet, following to Paris agreement.
  - ➔ APAN (the Asia Pacific Adaptation Network)



## The targets of TOUGOU theme C are

- To arrange the authorized climate change projection data around Japan Islands.
- To prepare a high accuracy, local scale climate change data, especially of extreme events.
  - Heavy precipitation events in summer monsoon season
  - Tropical cyclones

# Why we need the authorized data



MEXT, MAFF, MOE, JMA ...  
(Relevant government authorities)

# How to prepare the authorized data

We have to consider...

- How to handle the variety of the scenarios.
- Compare pros and cons of ESD and DDS.
- Clarify the position of MRI-AGCM/NHRCM DS system in CMIP5 model results.
- Crossing boundary between the ministries and produce a dataset family usable for the climate change impact study researchers

**➔ To respond to the various demand from users, we arrange the projection data by considering its temporal and space scale.**

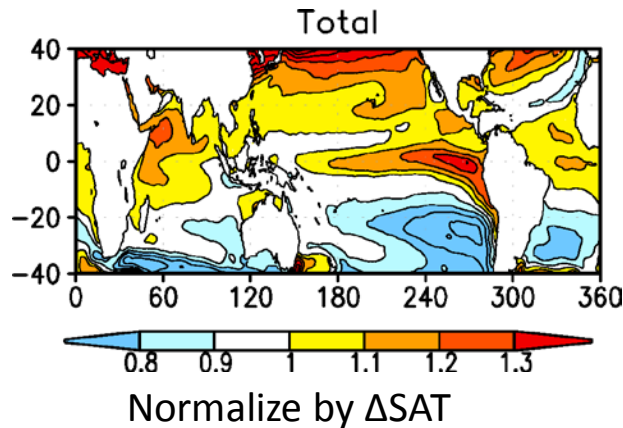


Next, on heavy precipitation ...

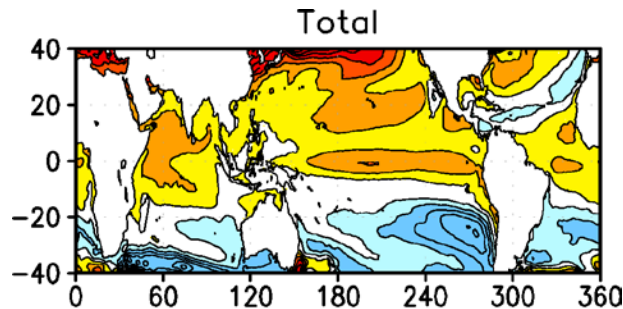
Change of Baiu precipitation behavior

$\Delta SST$

HFA\_rcp85  
CMIP5 mean  
 $\Delta SST$  pattern

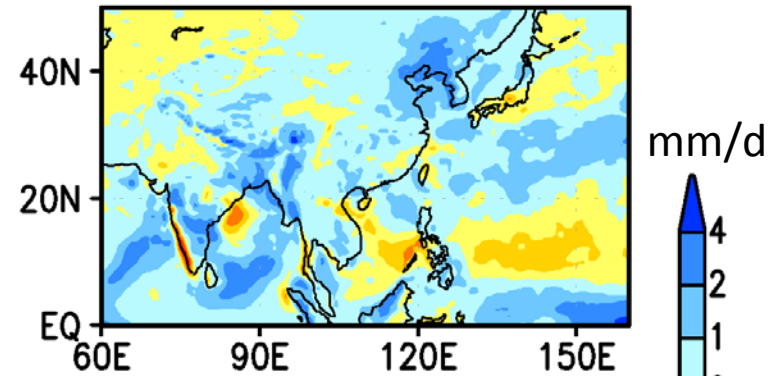


Change to  
CMIP3 mean  
 $\Delta SST$  pattern  
and calc.

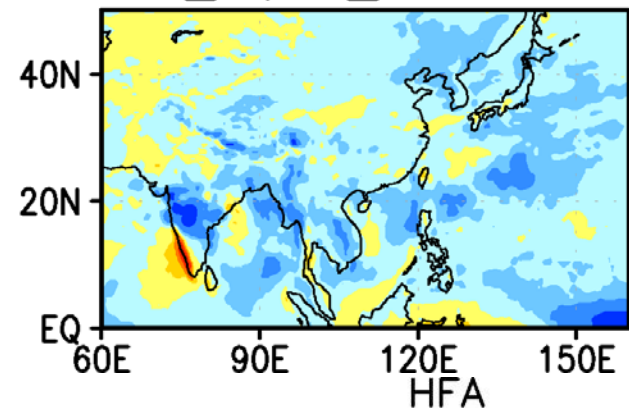


AGCM3.2H(YS) precip jja

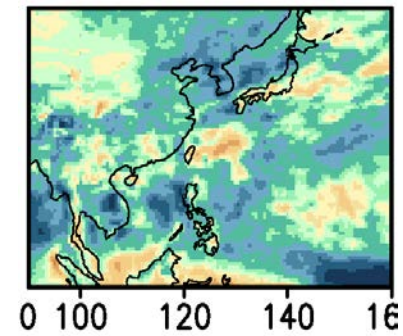
HFA\_rcp85



HFA\_rcp85\_a1bSST



Calc.  
done by  
CMIP3  
condition



When we change SST pattern from CMIP5 to CMIP3, precipitation around Japan Isls., and tropical NW Pacific increase

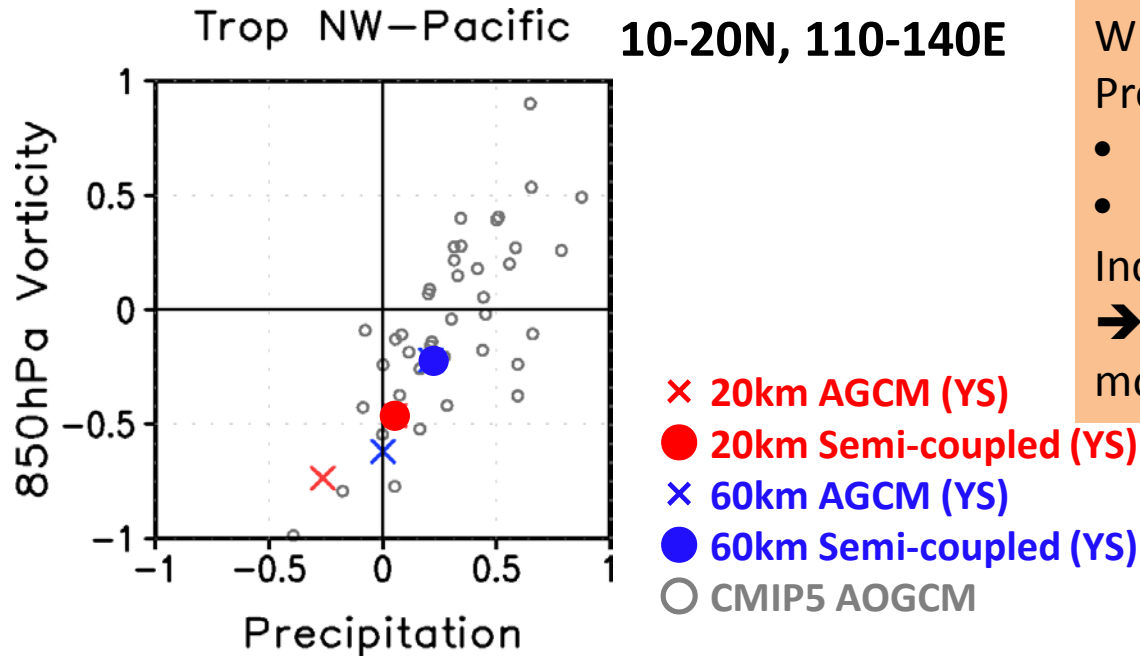
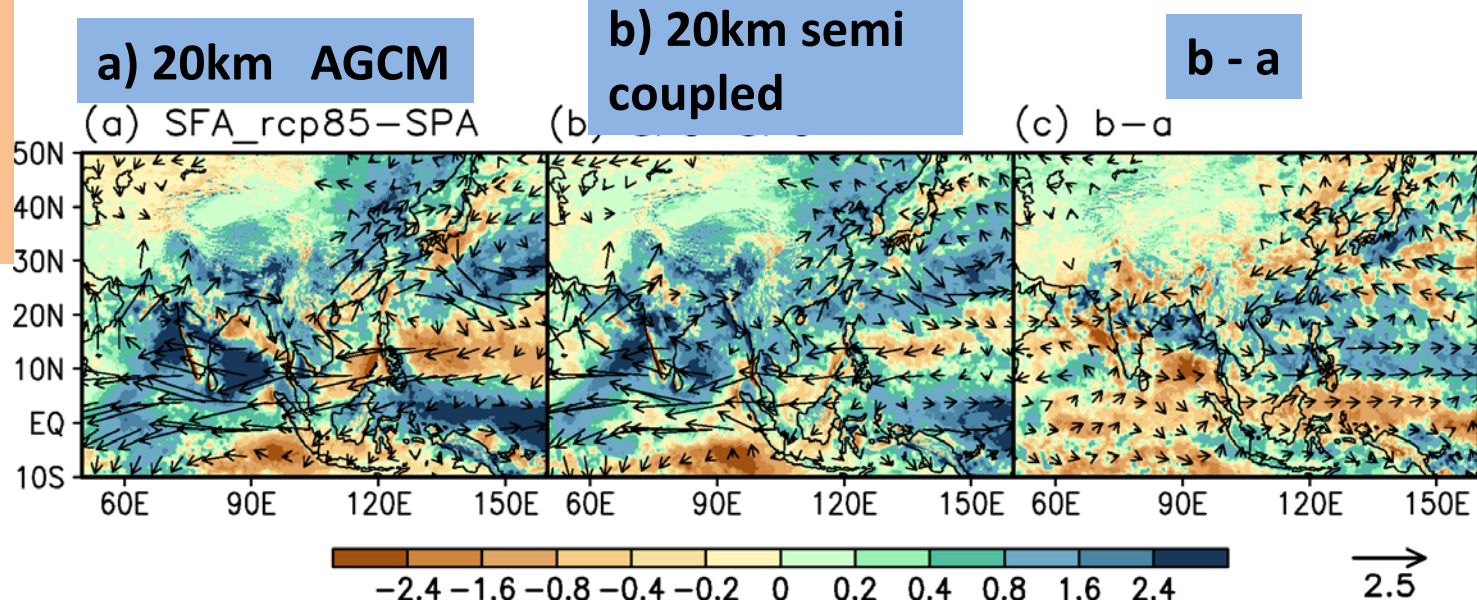
→ Which explain the difference in the precipitation pattern between CMIP3 and 5



## Change of Baiu precipitation behavior

## The effect of Air Sea coupling

JJA mean  
precip.  
UV850hP  
(Chenge)



When we use the air-sea interaction,  
Precipitation in

- Tropical NW Pacific
- Around Japan Isls.

Increase

➔ Difference between CMIP models decrease

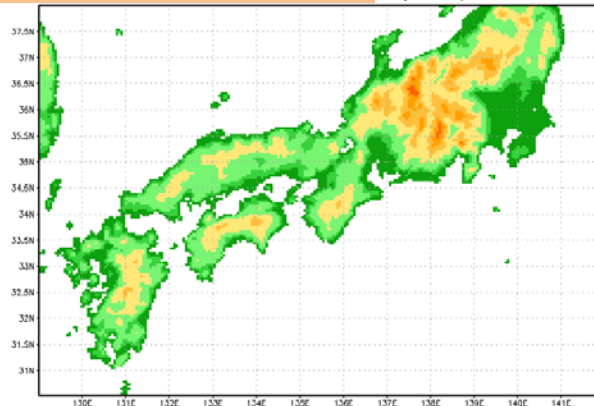
# Rainfall distribution of NHRCM05/02

- Wide area -

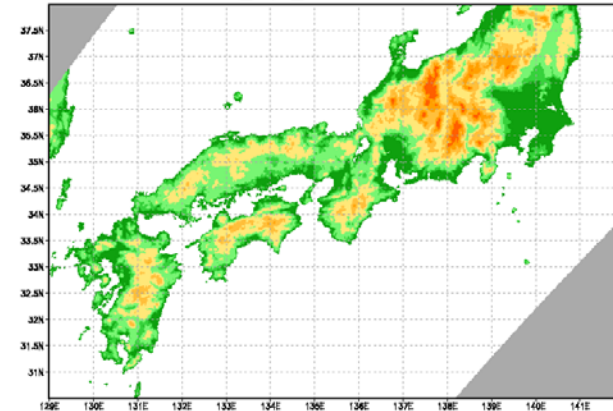
(Courtesy of Morimoto and Nakakita 2017) (DPRI)

Potential of high resolution model. Here 5km and 2km grid model results are compared

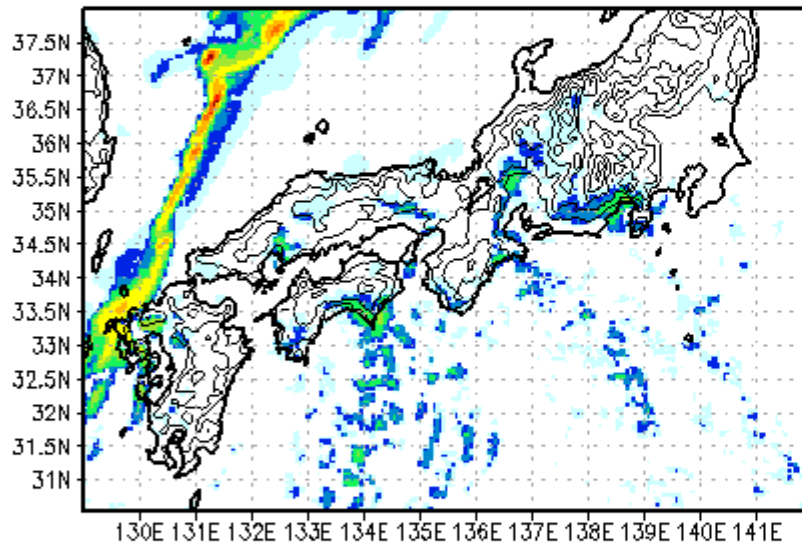
M (IDW05)



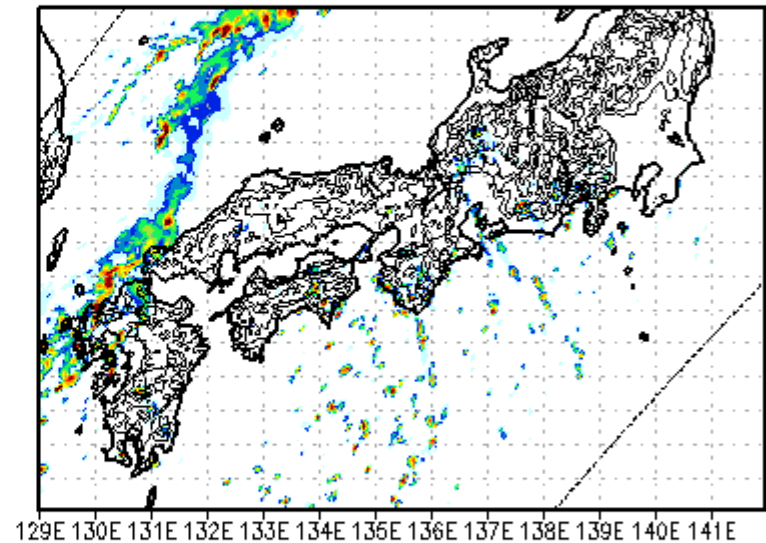
model\_topo\_2kmNHRCM (IDW02)



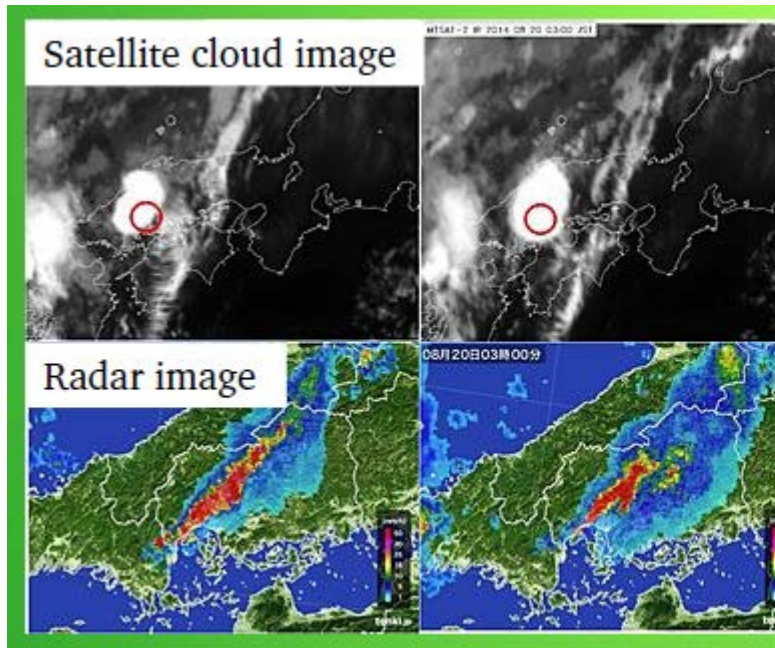
rr 5km 19810823 0930JST



rr 2km 19810823 0910JST



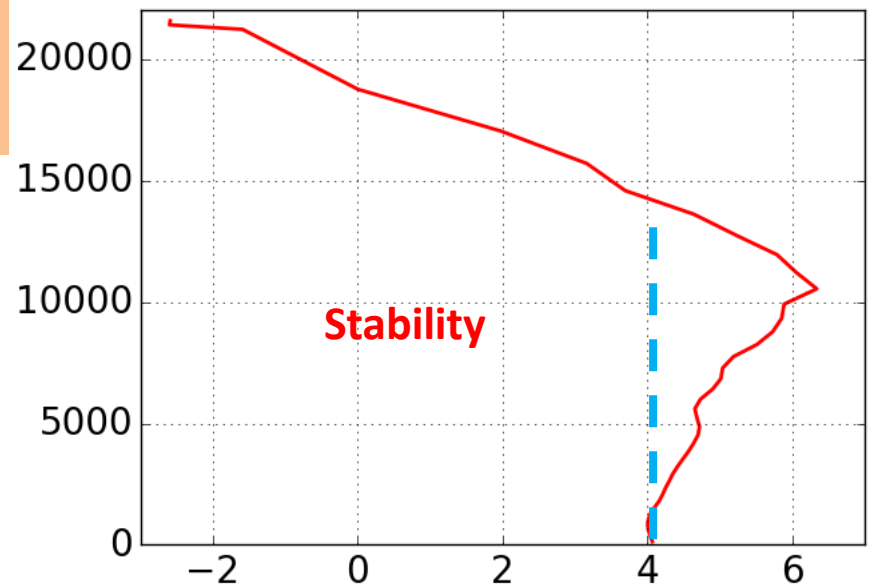
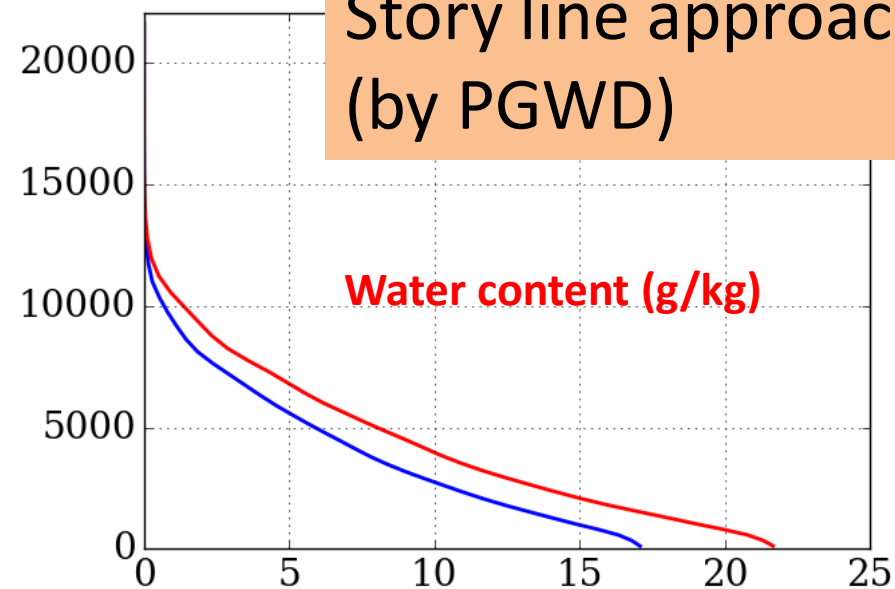
# HIROSHIMA flood (Aug. 2014)



Picture of the disaster



Story line approach  
(by PGWD)

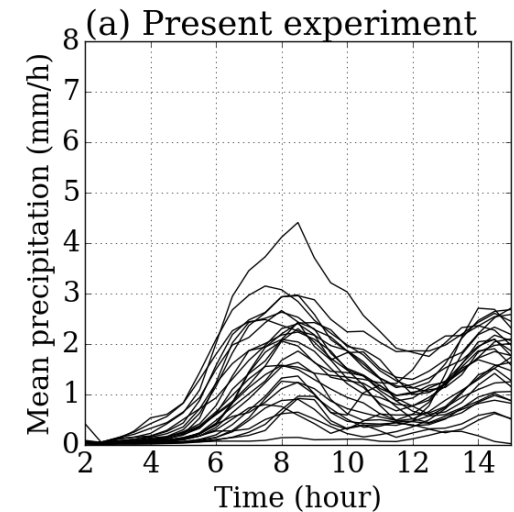
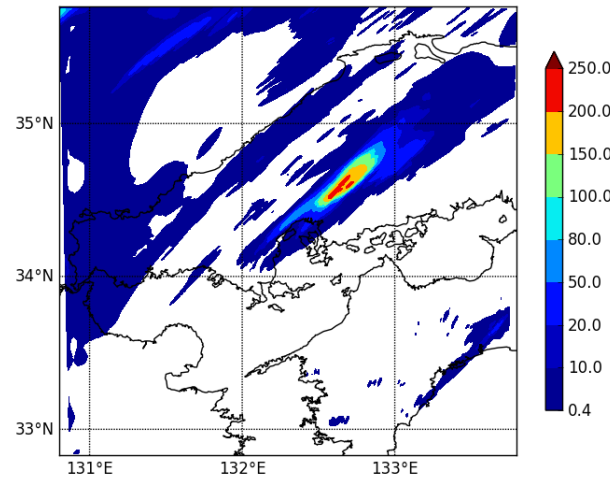




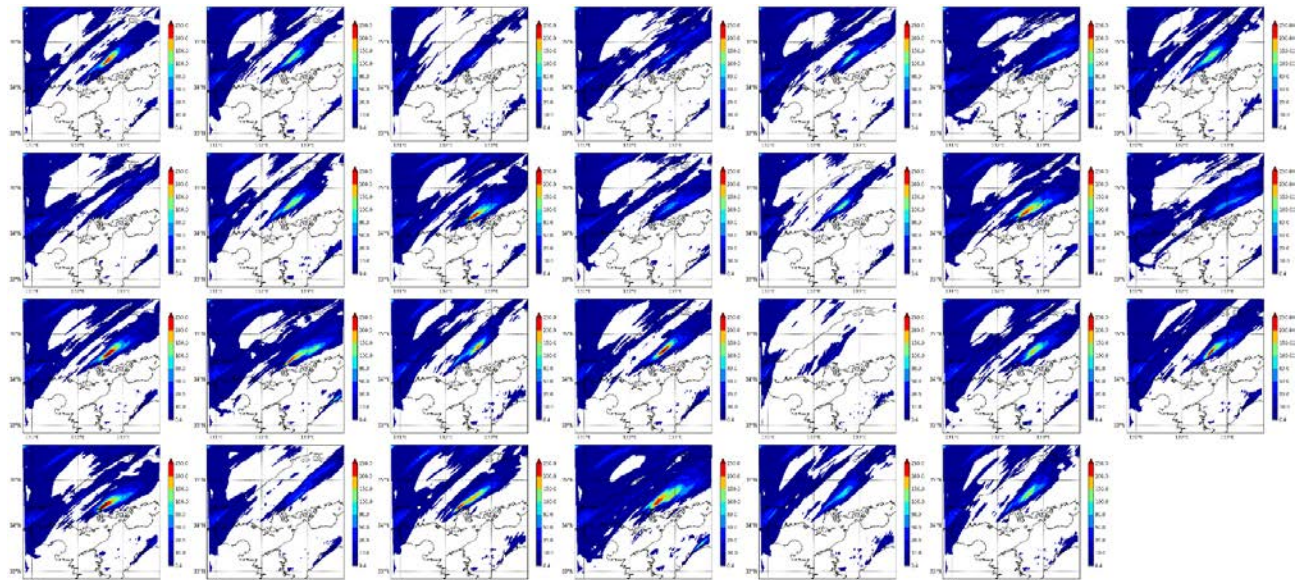
# Here we use $\delta x=500\text{m}$ model and catch the heavy precipitation event

6hourly  
precipitation  
patterns of  
HIROSHIMA flood  
case.

➔ Control experiment.

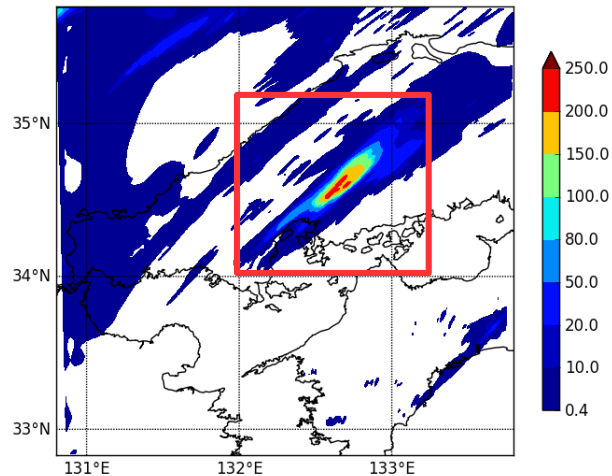


All ensemble cases  
➔ We adopt all these  
calculations to build an  
ensemble

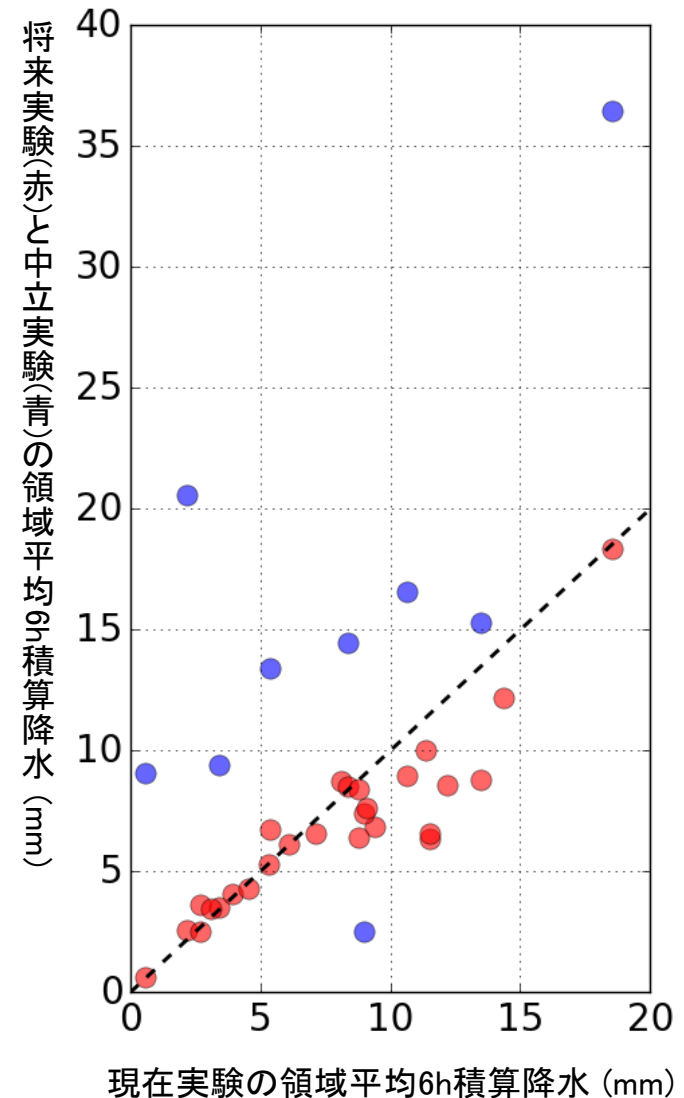


# Precipitation amounts change

Area mean precipitation (6 hour)



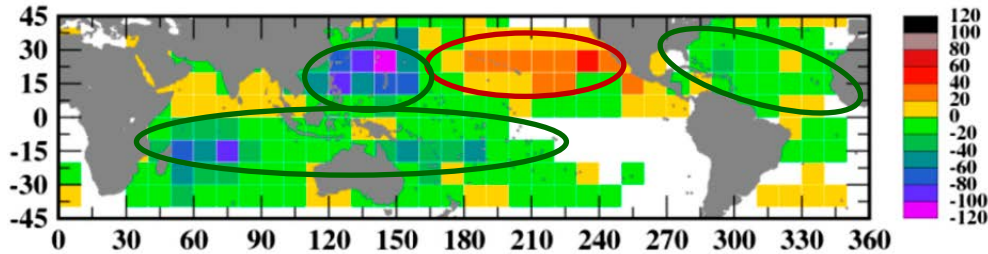
- Area averaged precipitation amount change are shown in the figure.
- Horizontal axis : precipitation of present condition
- Vertical axis: Precipitation of the future condition.
- Blue dots: Stability not changed.
- Red dots: Stability and WV has changed to the future condition



# Change of all TC occurrence frequency

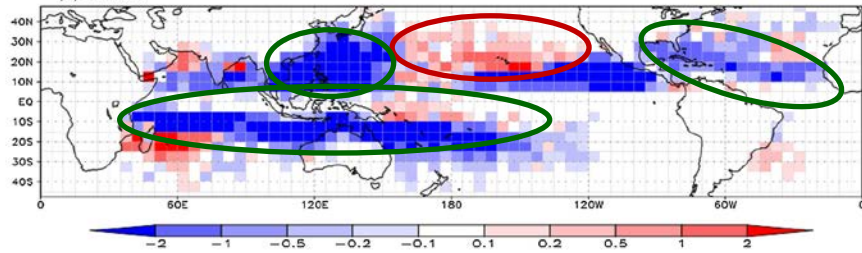
Knutson et al. (2015) [HiRAM+ hurricane model]

c) Late 21<sup>st</sup> century minus present-day



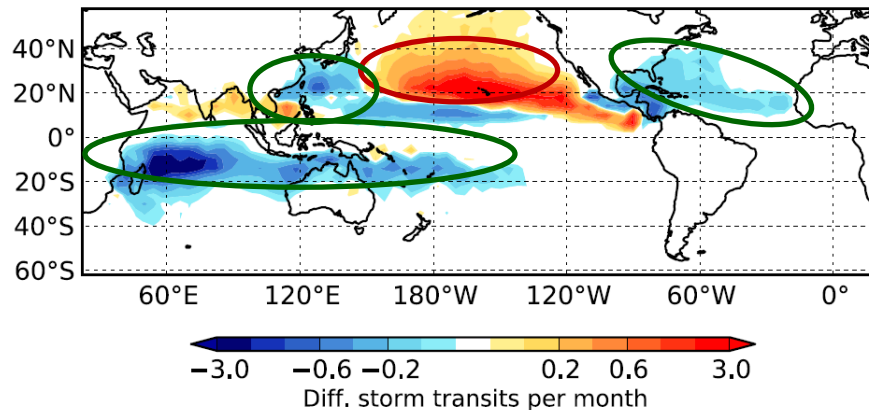
Sugi et al. (2016) [多種MRI-AGCM3.2]

(d) Cat 0-5

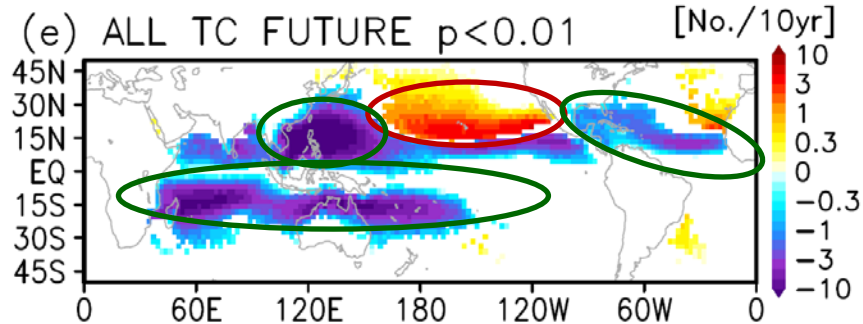


Roberts et al. (2015) [MetOffice GA3.0]

N512



## d4PDFの4°C上昇実験



The common results are,

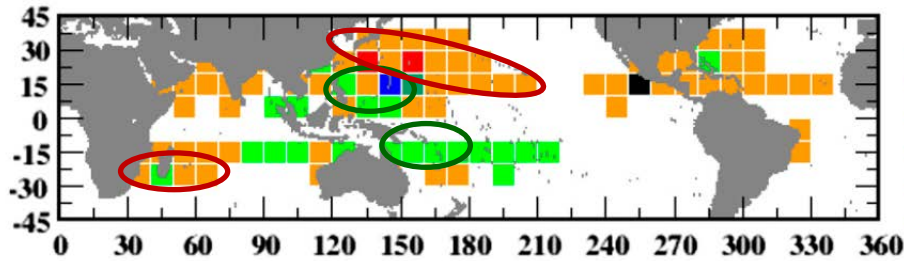
- Decrease → WNP, SIO, SPA
- Increase → Around Hawaii



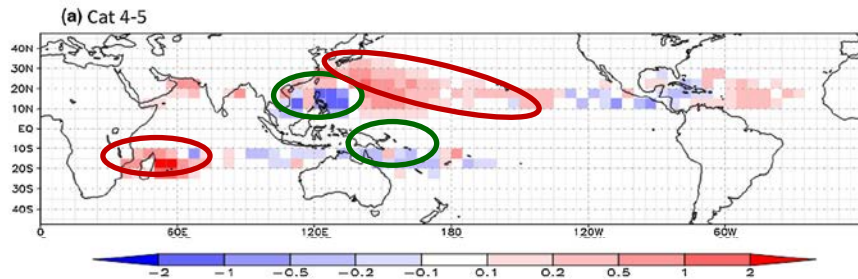
# Occurrence frequency change of Cat-4/5 TC

Knutson et al. (2015) [HiRAM+ hurricane model]

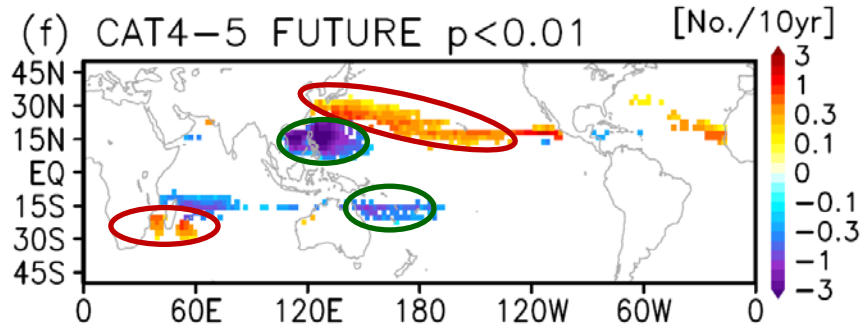
c) Late 21<sup>st</sup> century minus present-day



Sugi et al. (2016) [多種MRI-AGCM3.2]



Present study



Common results here are,

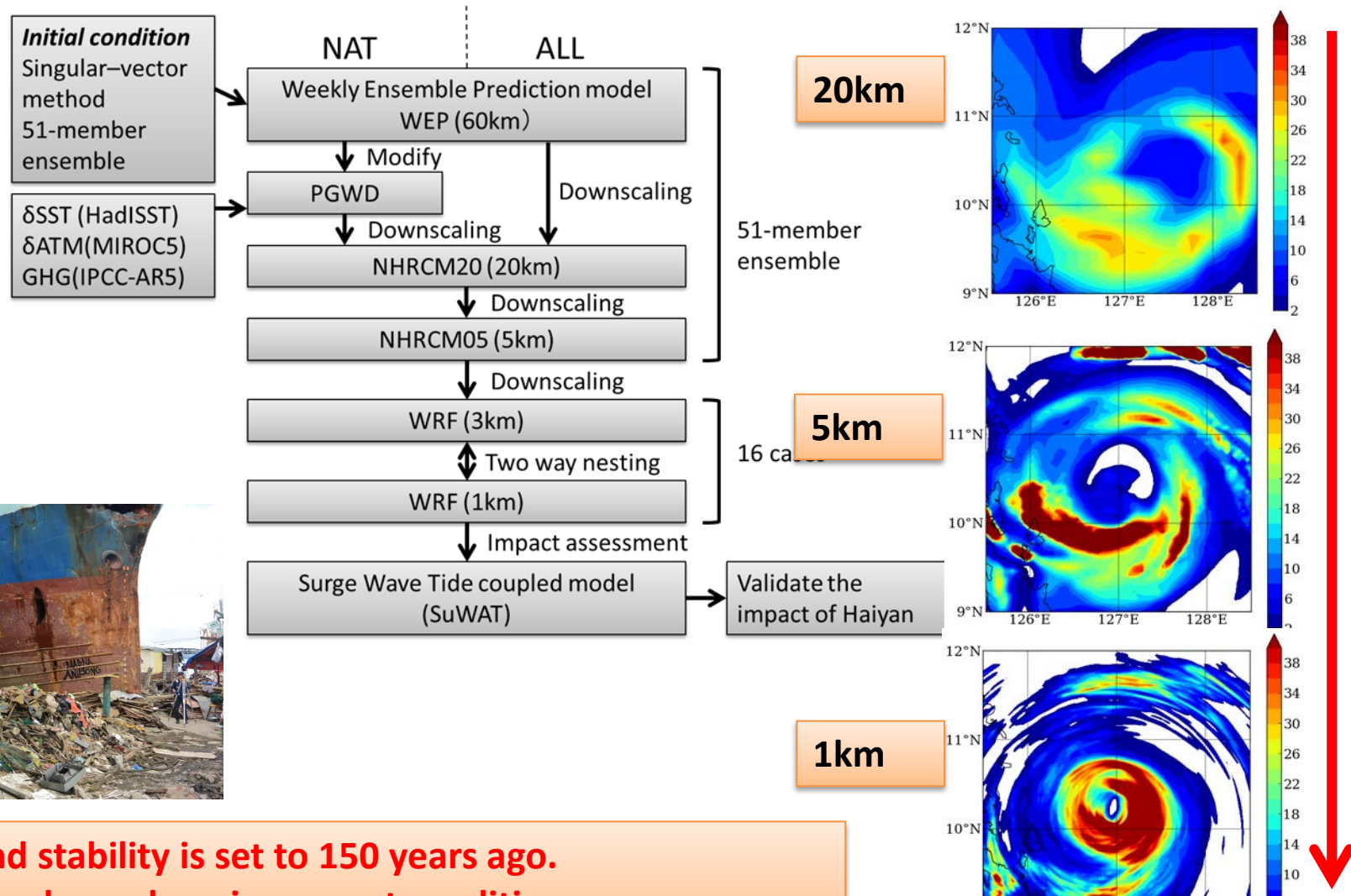
\* Decrease → NWP, SPA

\* Increase → From south of Japan  
Islands to Hawaii Islands.

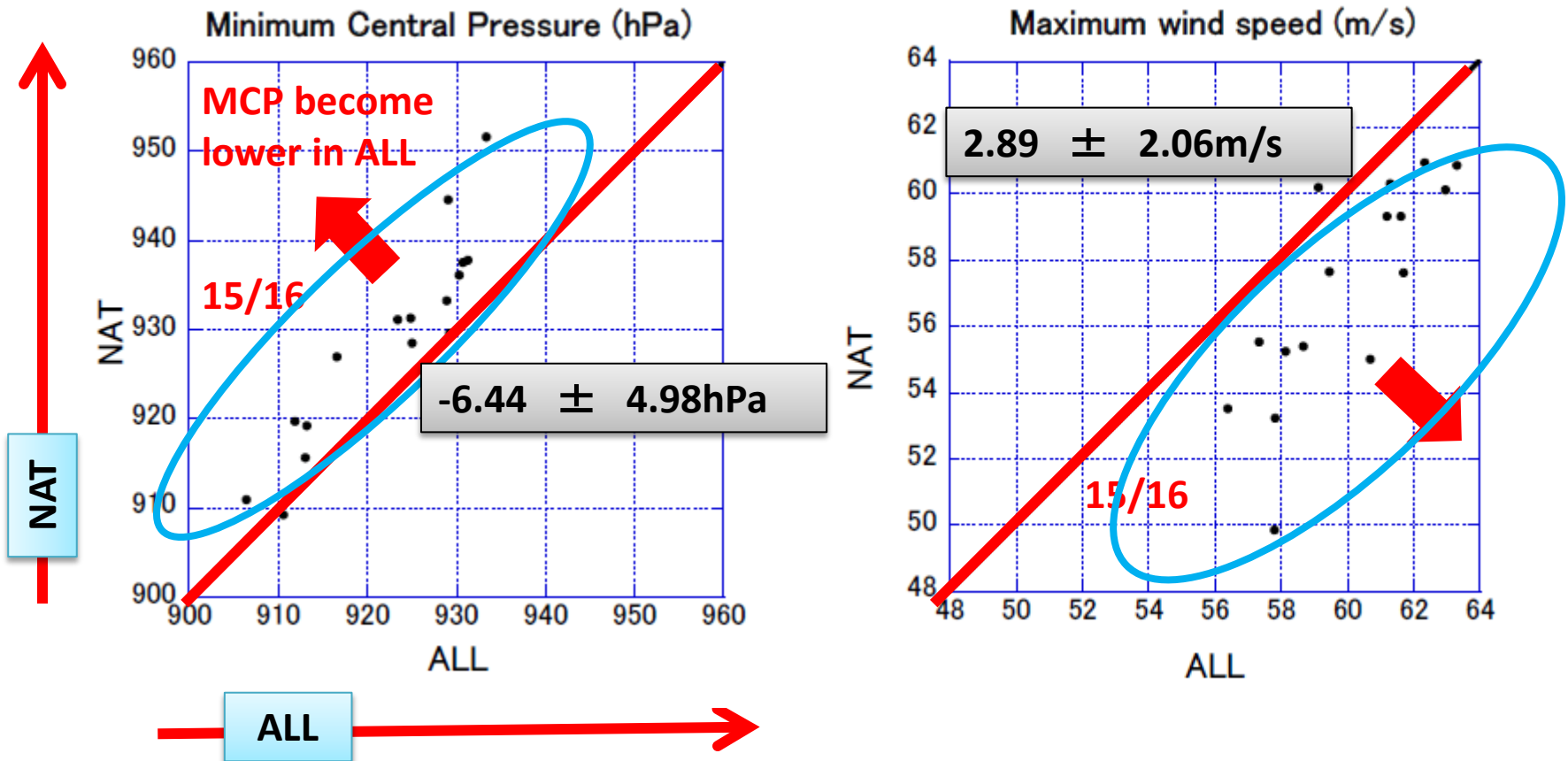


We cannot discuss on the details  
of TC by using only GCM. Thus, we  
use high resolution regional model.

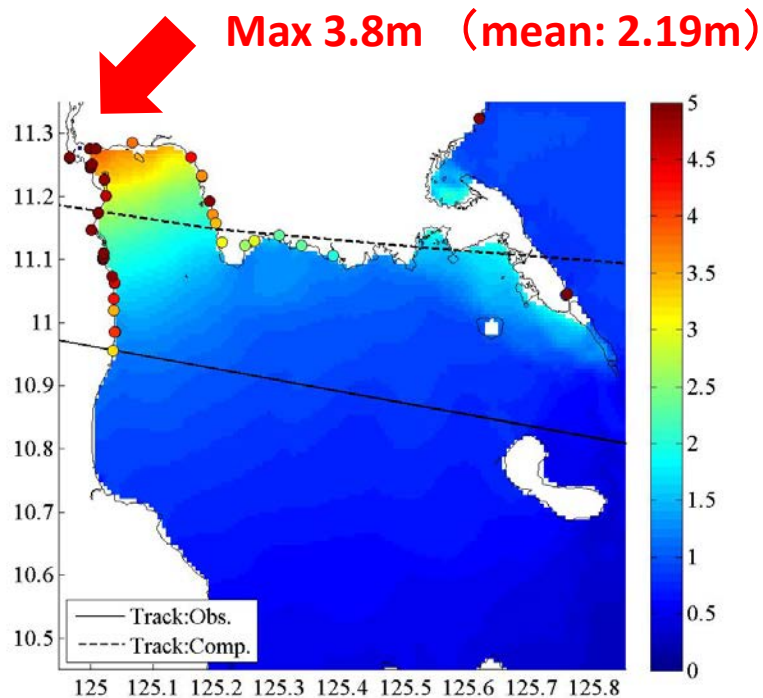
# ALL and NAT exps. of Haiyan



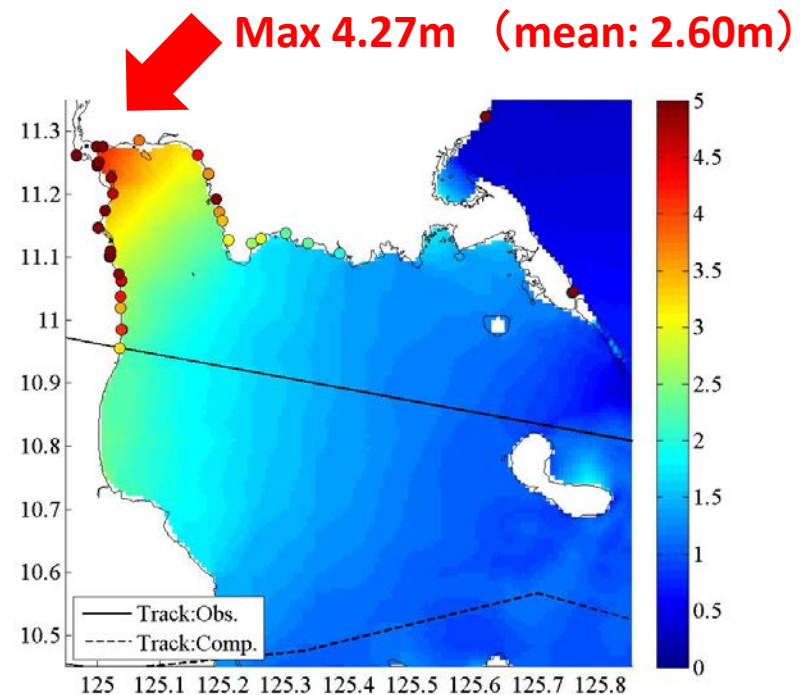
# Difference of strength of typhoon Haiyan between ALL and NAT exps.



# Difference of storm surge among ALL and NAT exps.



**NAT**



**ALL**

**Storm surge height around Tacloban increase about 20% in ALL cases, compared to NAT cases.**

(Takayabu et al., 2015 ERL)



## The targets of TOUGOU theme C are

- To arrange the authorized climate change projection data around Japan Islands.
- To prepare a high accuracy, local scale climate change pattern data.
  - Especially extreme events such as heavy precipitation and tropical cyclones.
- We also aim at co-working with foreign countries.