New approaches in climate prediction for better adaptation: near-term prediction and high-resolution ensembles
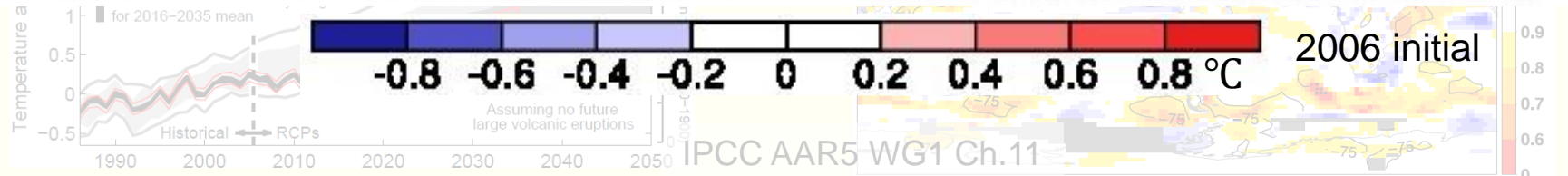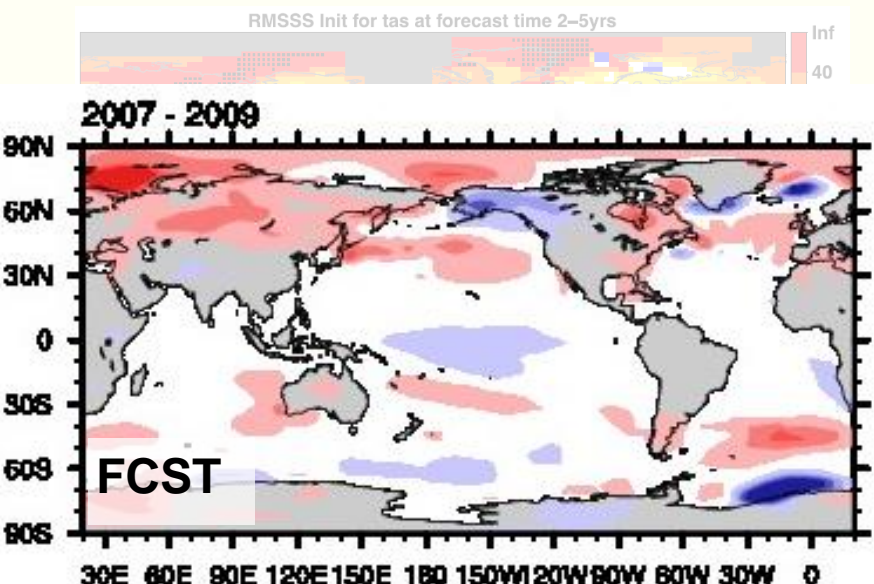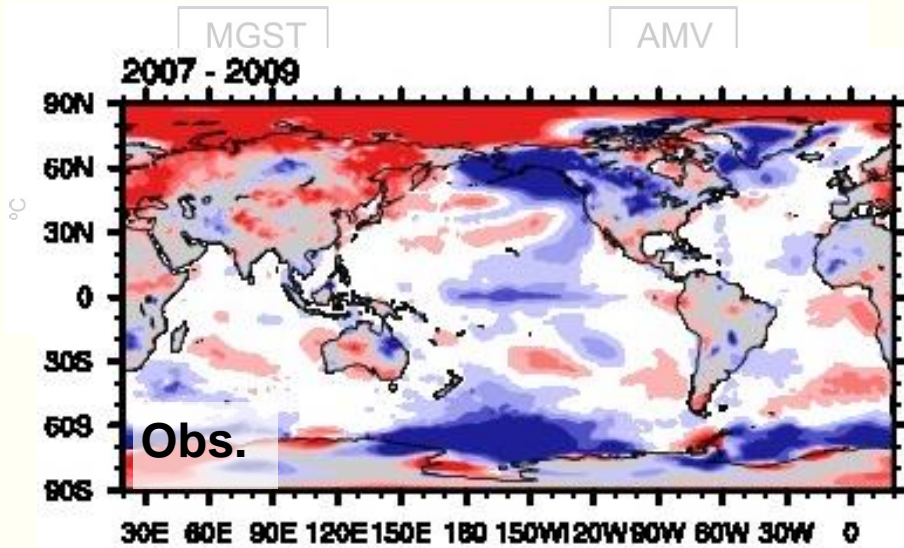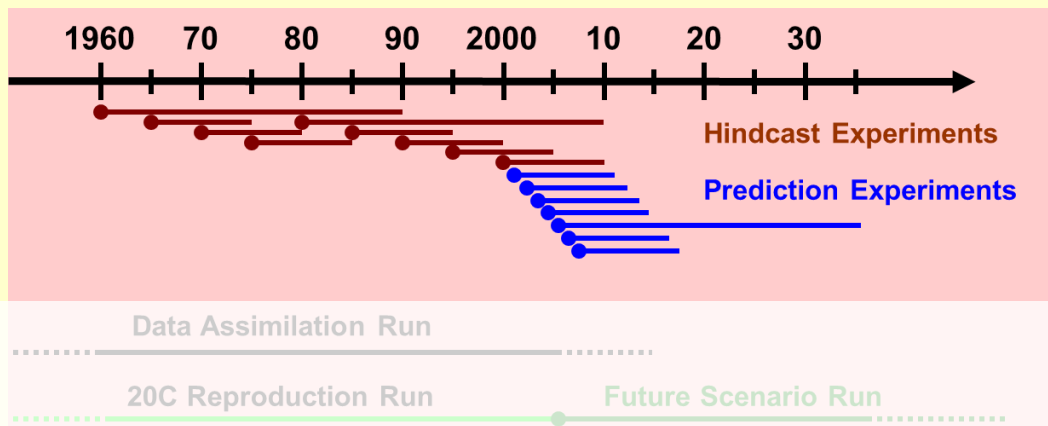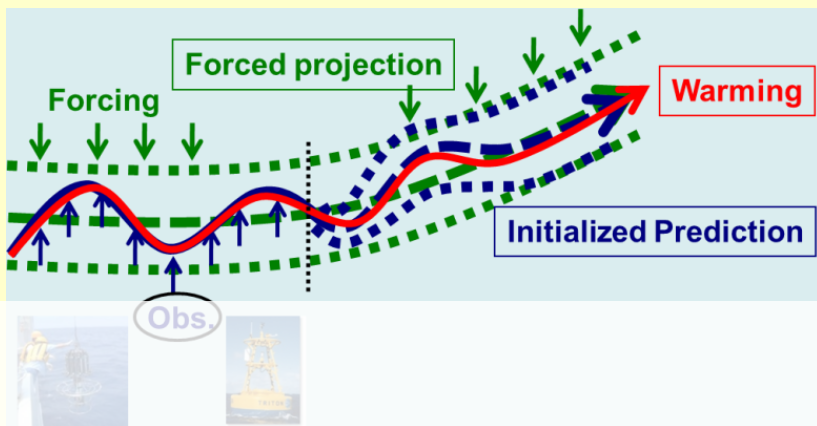
Masahide Kimoto 🇯🇵

Atmosphere and Ocean Research Institute
The University of Tokyo

Recent and near-future developments in climate projection

- Establishment of earth system models
  - w/ carbon and other bio-geochemical cycles
  - enables more realistic mitigation strategies
- Initialized climate prediction
  - Near-term (decadal) prediction (initiated in CMIP5/AR5)
  - Best use of earth system observations and state-of-the-art climate models
  - Seamless weather-climate prediction
  - Initializing earth system models
    - Monitoring and predicting air pollution, bio-geochemical processes, and emission
- High-resolution ensemble
  - Regional assessments
  - Event attribution for extreme events
  - Risk management / adaptation measures
- Breakthrough in model physics
  - Emergence of cloud-resolving climate models
    - reduces parameterization uncertainties
    - enables better assessments of extreme events and climate sensitivity
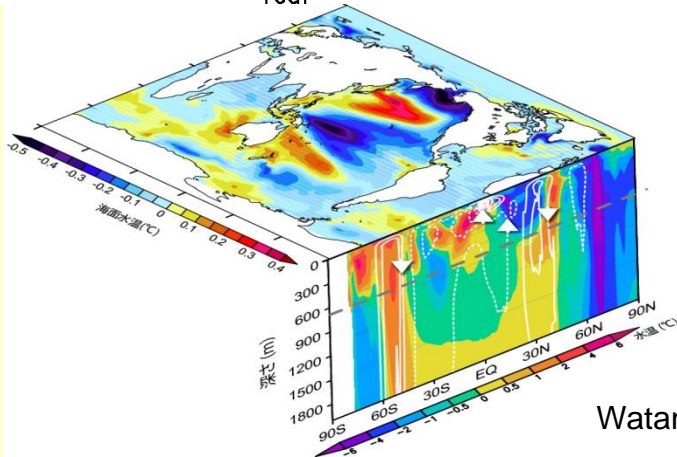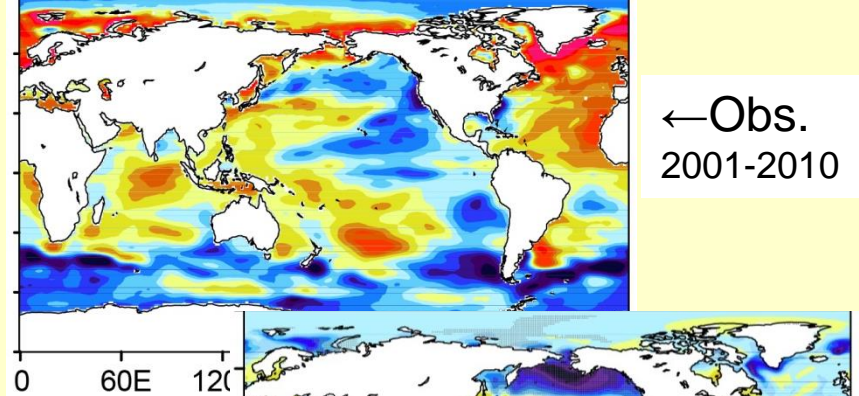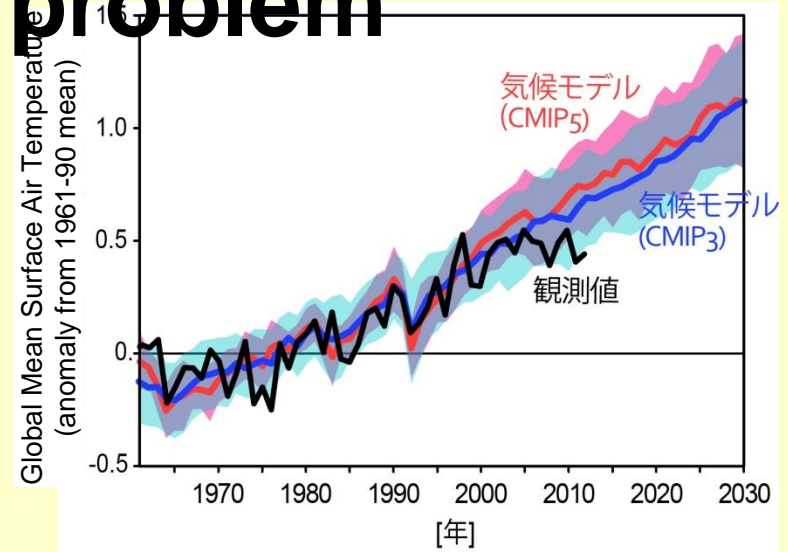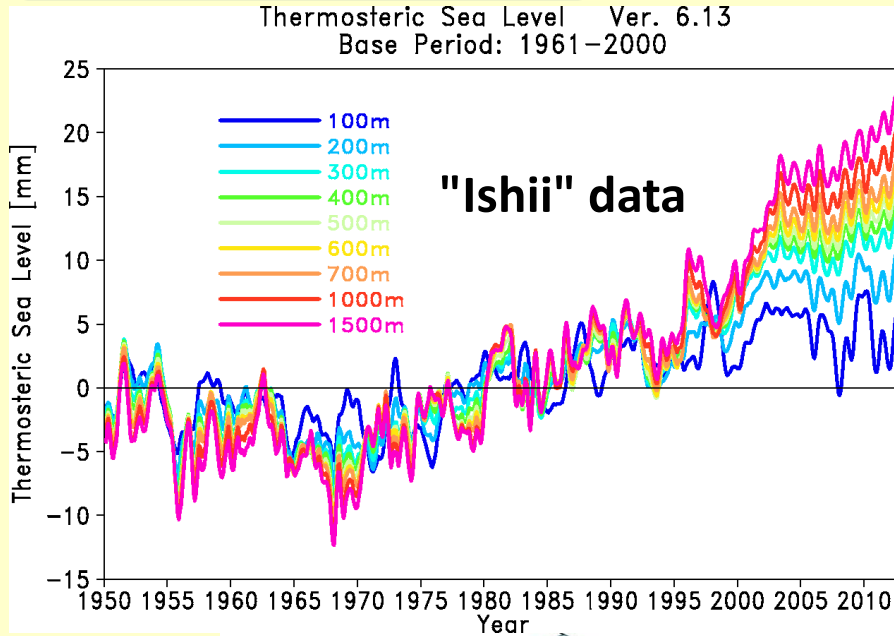
Near-term (decadal) prediction

CMIP Coupled Model Intercomparison Project
WCRP World Climate Research Programme

Forced projection

Forcing

Warming

Initialized Prediction

Obs.

1960 70 80 90 2000 10 20 30

Hindcast Experiments

Prediction Experiments

Data Assimilation Run

20C Reproduction Run   Future Scenario Run

MGST   AMV   RMSSS Init for tas at forecast time 2–5yrs

2007 - 2009

Obs.

2007 - 2009

FCST

-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 ℃

2006 initial

IPCC AAR5 WG1 Ch.11

Recent pause in global warming: the "Hiatus" problem

hiatus【haɪéɪţəs】
隙間, 裂け目, 間隙, 活動休止
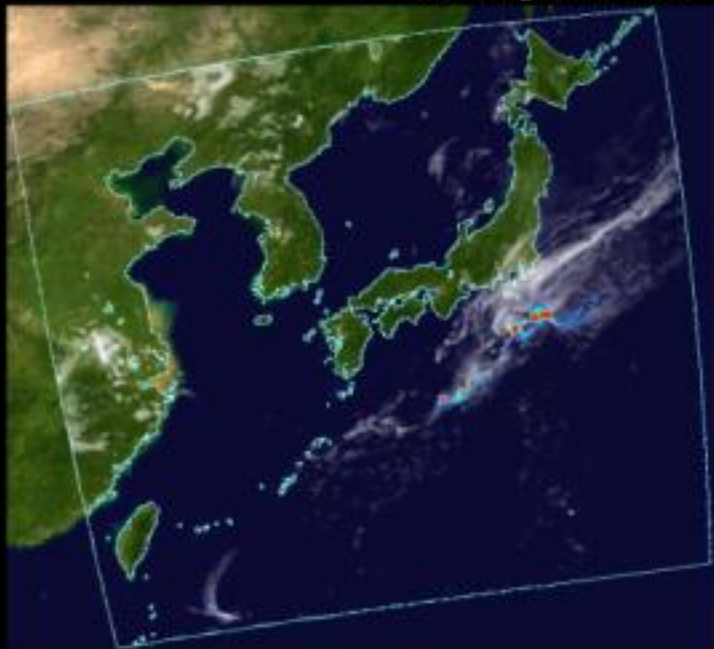(類) an interruption in the intensity
or amount of something

Thermosteric Sea Level   Ver. 6.13
Base Period: 1961-2000

"Ishii" data

- 100m
- 200m
- 300m
- 400m
- 500m
- 600m
- 700m
- 1000m
- 1500m

Global Mean Surface Air Temperature (anomaly from 1961-90 mean)

気候モデル (CMIP5)
気候モデル (CMIP3)
観測値
[年]

←Obs.
2001-2010

Hiatus
pattern
in GCM→
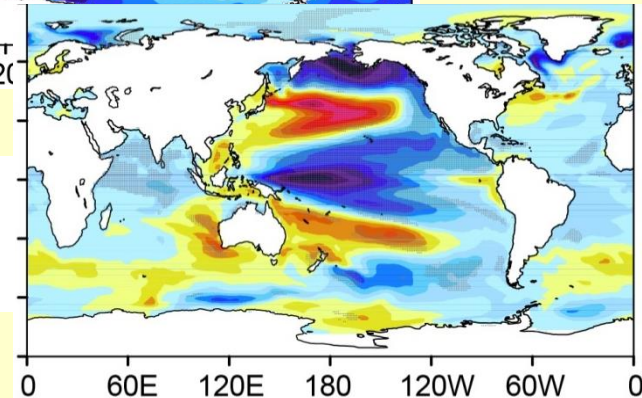
Watanabe et al. (2013)
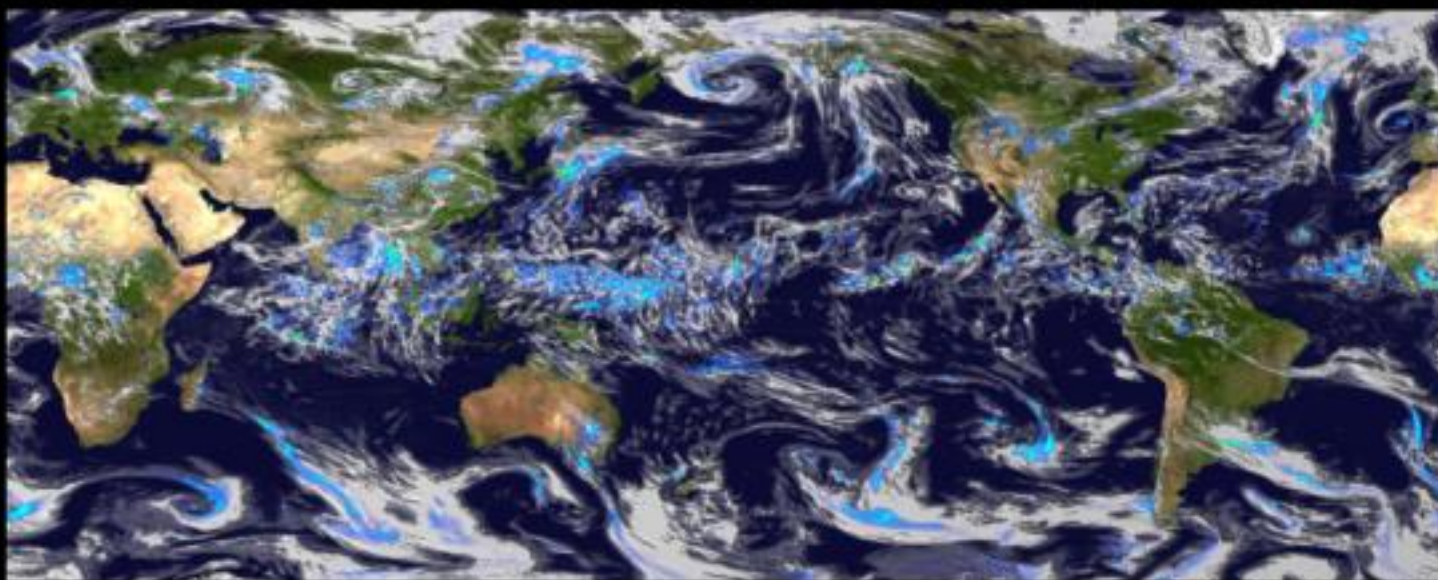
5km Regional Model

2km Regional Model
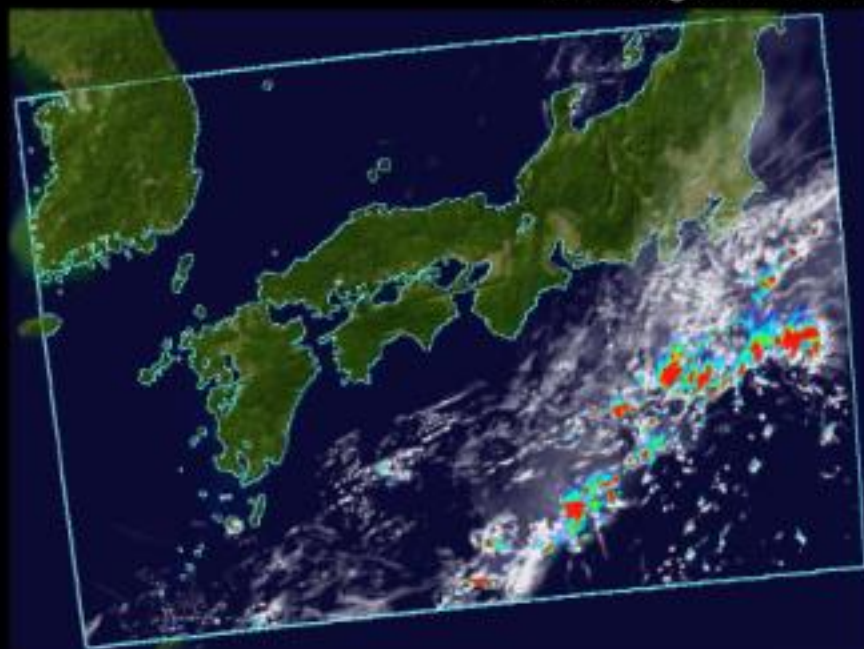
20 km Global Model

05 Sep
208X
00 UTC

mm/hour

© MRI, JMA, JAMSTEC, MEXT

Changes in extremes

Future change of TC days

Green circles indicate >90% significance
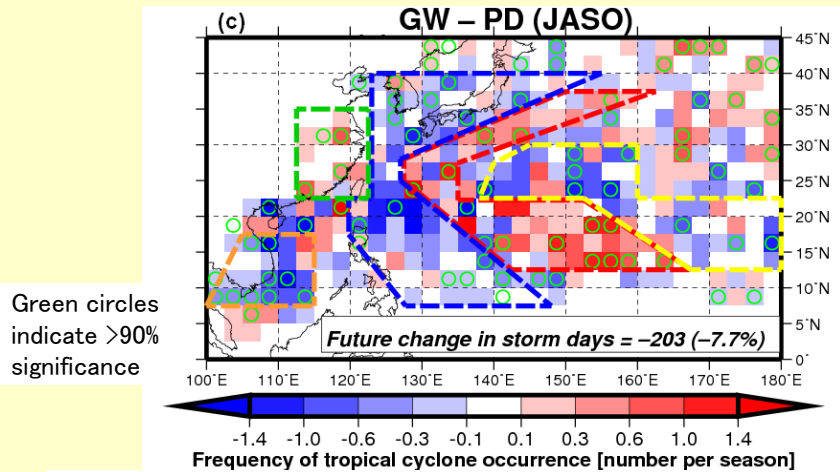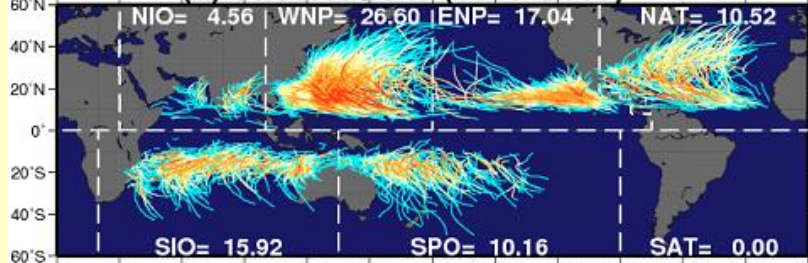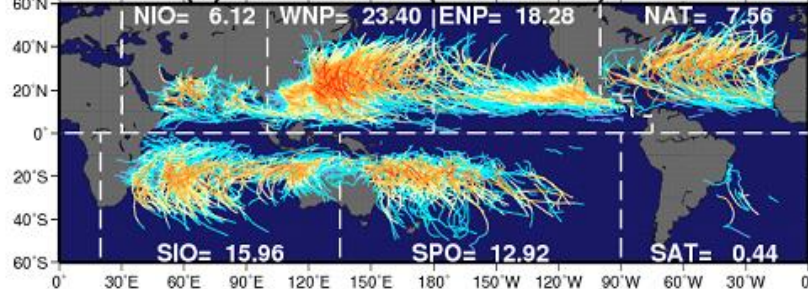
MRI/JMA (2012)
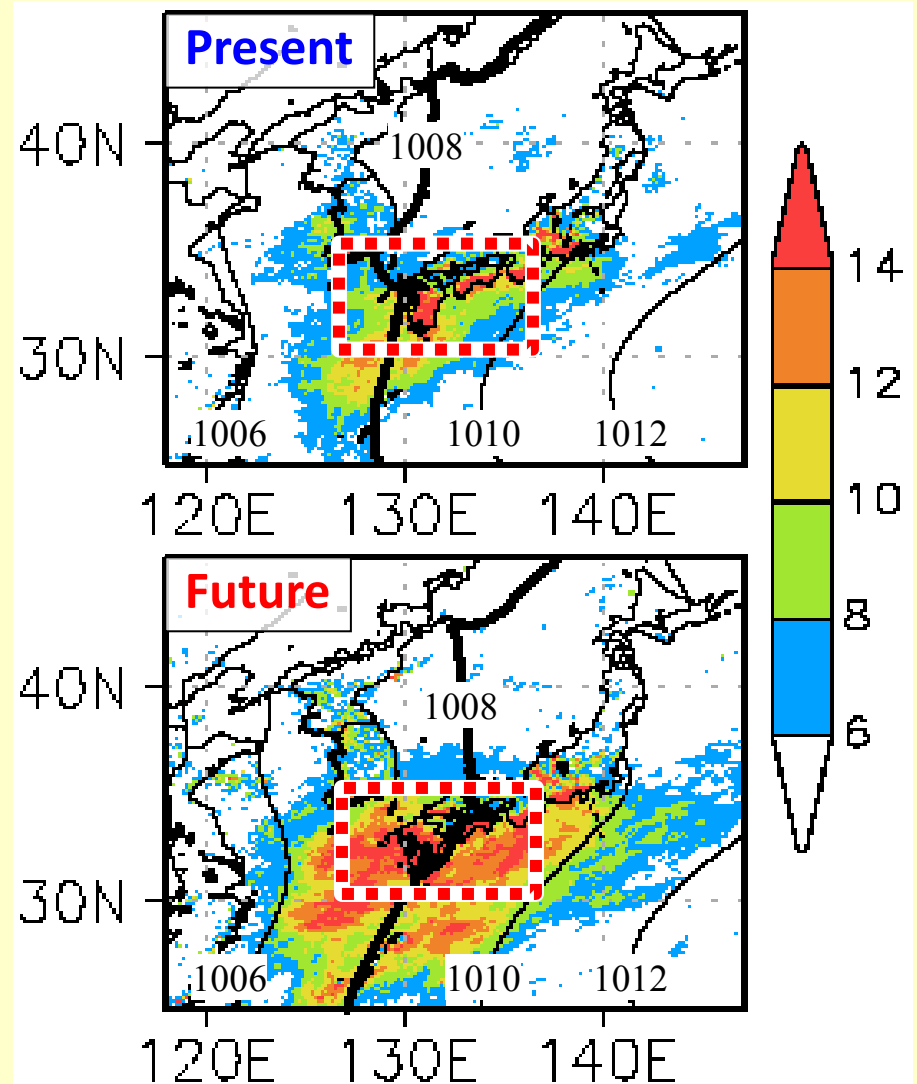
Daily precipitation (mm) during July 1-10
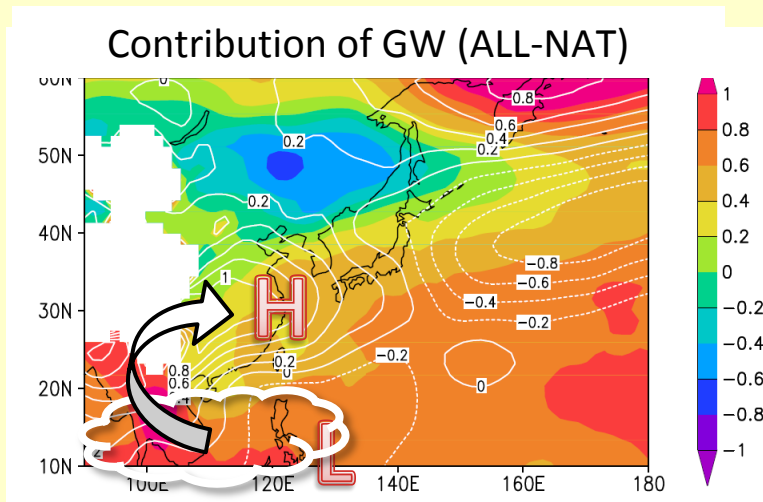(Top: 1979-2003; Bottom: 2075-2099)

Kanada et al. (2012)

Event Attribution

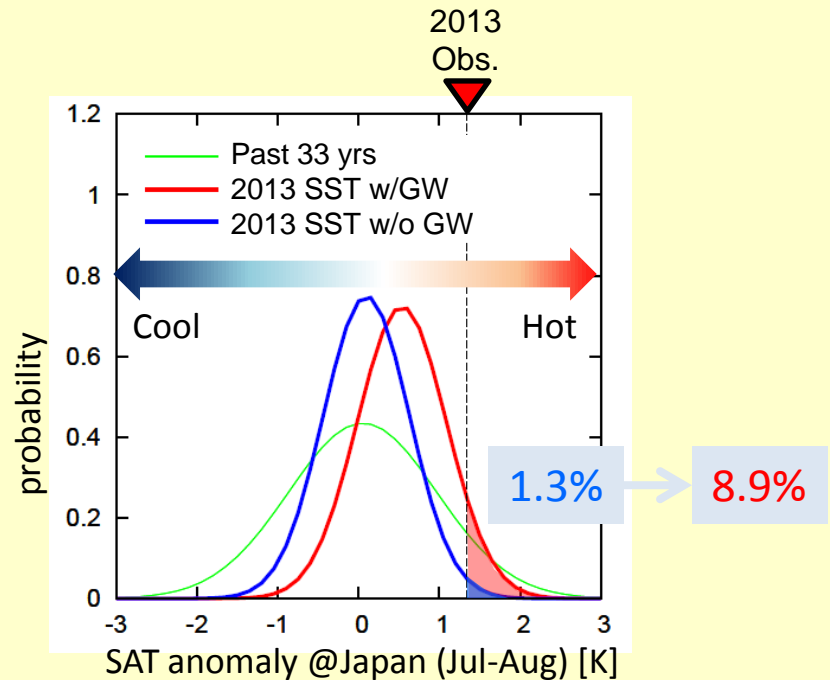2013 heat wave in Japan …

 caused by global warming?

No, but …

 it may have contributed,

and …

the risk of having similar or severer events has increased by XX %.
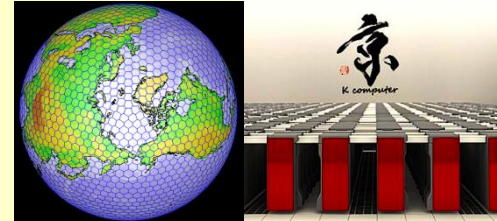

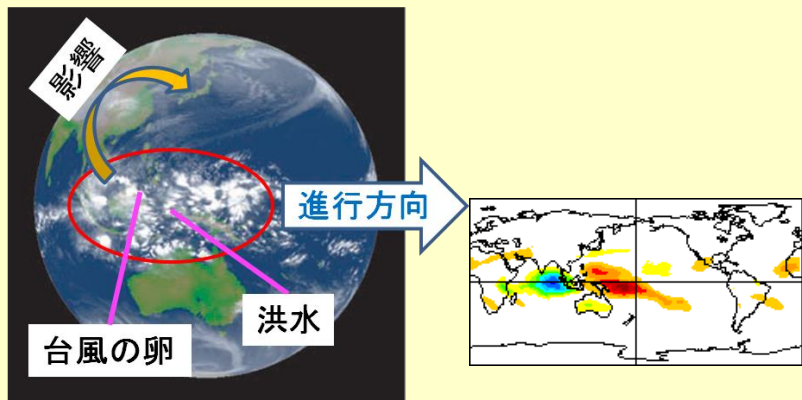Contribution of GW (ALL-NAT)

Imada et al. (2014)

Warming increases the risk of heat wave

cf. BAMS reports for 2011-13 events

Global Cloud System Resolving Model
NICAM

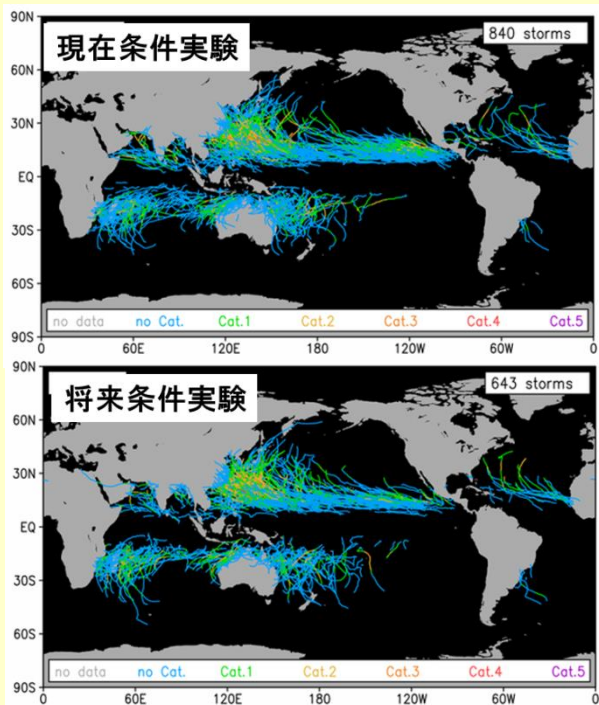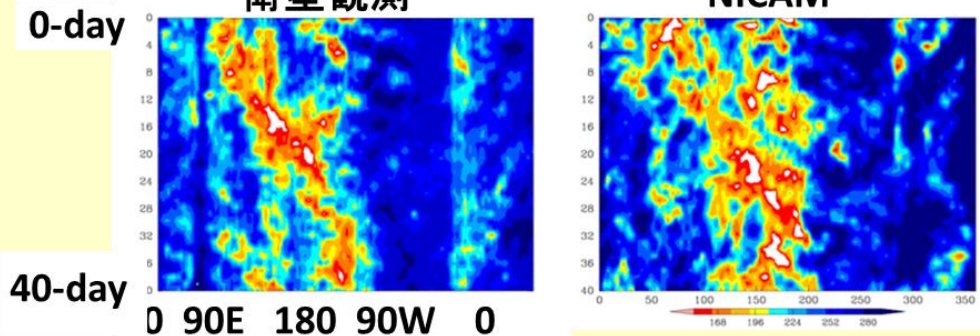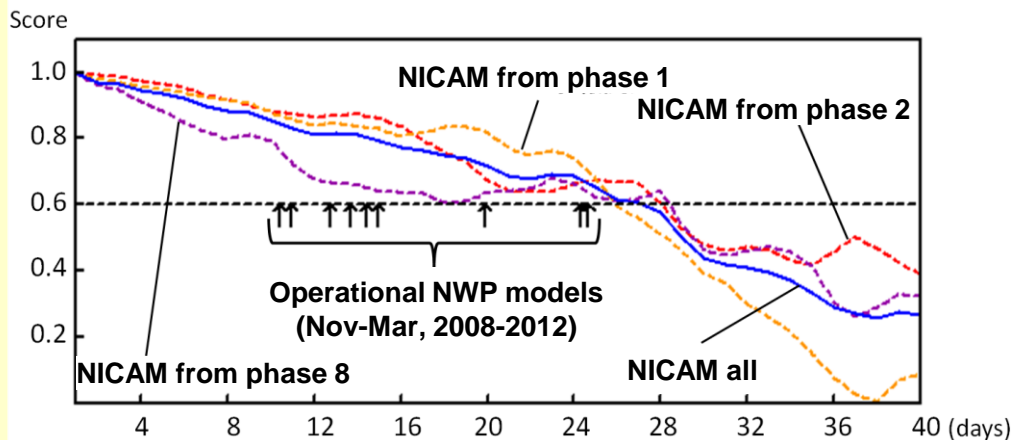マデン＝ジュリアン振動 （MJO）

Miura et al. 2007 *Science* に加筆

赤外放射（雲）の時間－経度断面

衛星観測　　　　　　NICAM

0-day

40-day

0　90E　180　90W　0

現在条件実験　　840 storms

将来条件実験　　643 storms

Prediction skill : NICAM vs. Operational NWP

Score

NICAM from phase 1

NICAM from phase 2

Operational NWP models
(Nov-Mar, 2008-2012)

NICAM from phase 8

NICAM all

Miyakawa et al. (2014) Nature Communications