database for Policy Decision making for Future Climate Change

Long-Term Impact Assessment of Storm Surge based on Mega-Ensemble Projection (d4PDF)

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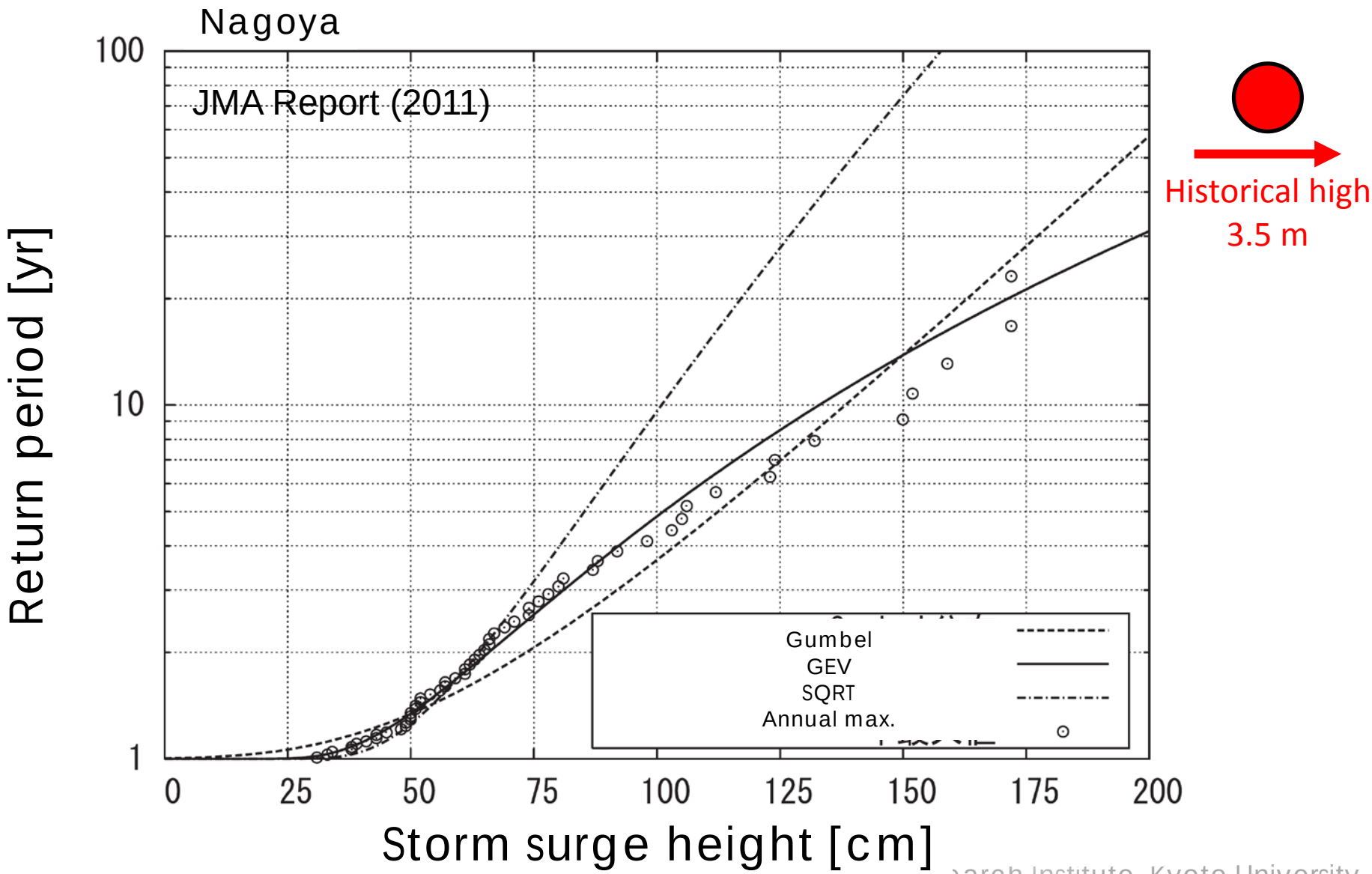
Difficulty of long-term extreme storm surge assessment



Background: Climate study on storm surge

Maximum storm surge

- Direct forcing by GCM
  - Pros: physically correct, Cons: number of sample
  - Emanuel (2006), Yasuda et al. (2011)
- Pseudo global warming experiments (SGWE)
  - Pros: accuracy, Cons: limited parameter space
  - **Ninomiya (2017)**
- Climatological approach
  - Pros:, consistent to climatology, Cons: accuracy
  - Emanuel (2012,2013)

Long-term: probabilistic assessment

- Joint Probability Method
  - Pros: number of sample, Cons: accuracy
  - Irish et al. (2017)
- Stochastic tropical cyclone model
  - Pros: number of sample, Cons: accuracy
  - Kumagai (2016), Nakajo et al. (2014)
- Direct forcing by GCM
  - Pros: physically correct, Cons: number of sample

Outline and Summary

Methodology

- Ensemble run of GCM for historical and +4K climate conditions
- Statistical storm surge model is applied to estimate 100 year or longer return value

Conclusion

- Mega ensemble experiments enable to apply for extreme natural disasters
- Application to TC and storm surge
  - Future change of TC
    - cyclogenesis↓, central pressure ↓, track shift→
  - Storm surge height
    - Short-term ↓ by decreasing cyclogenesis
    - Mid to long-term ↑ by stronger TC and track shift

d4PDF

Outline of d4PDF
Mega ensemble experiments

- d4PDF: database for (4) Policy Decision making for Future climate change
  - www.miroc-gcm.jp/~pub/d4PDF/
  - Mizuta et al. (2017) BAMS
- Frame work
  - Experimental design and run
    - AORI, MRI, DPRI (SOUSEI Program)
  - Computation
    - JAMSTEC Earth Simulator 3 (ES3) NEC SX-ACE
      - 1.31 PFLOPS (peak) 5120 nodes
  - Data archive
    - DIAS system (approx. 1.5PB)
    - www.diasjp.net

Outline of d4PDF

Mizuta et al. (2017) BAMS

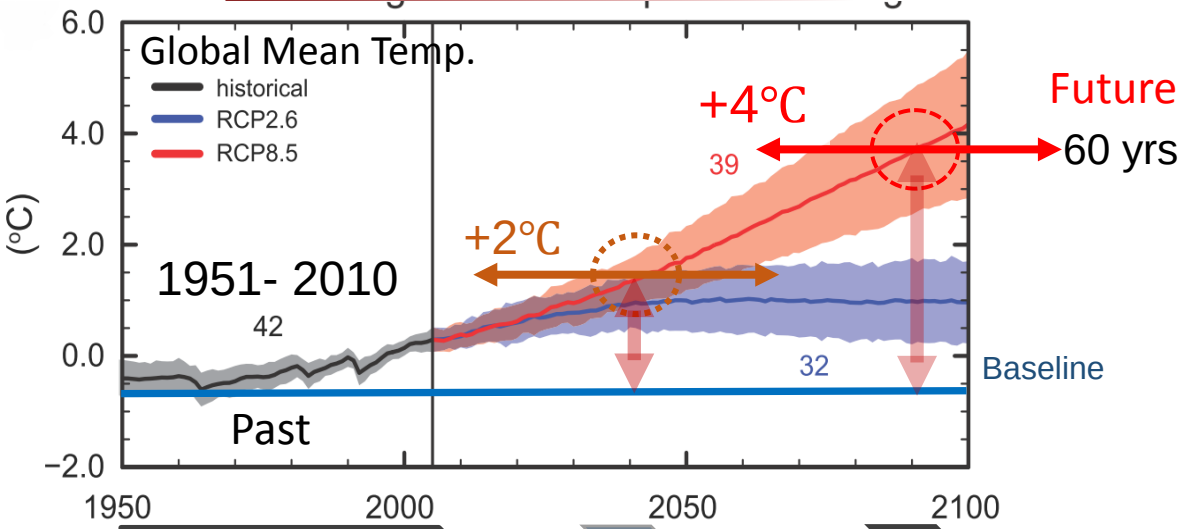
BC: SST

Past : 6000 yrs

Historical 60 yrs SST variation

✕

100 Perturbation due to observation (δT)



Global: MRI 60km AGCM — 100 member → 90 member

East Asia: MRI 20km RCM — 50 member → 90 member

Past (100δT)

Future (6ΔT × 15δT)

Future: 5400 yrs

Detrened historical 60 yrs SST variation

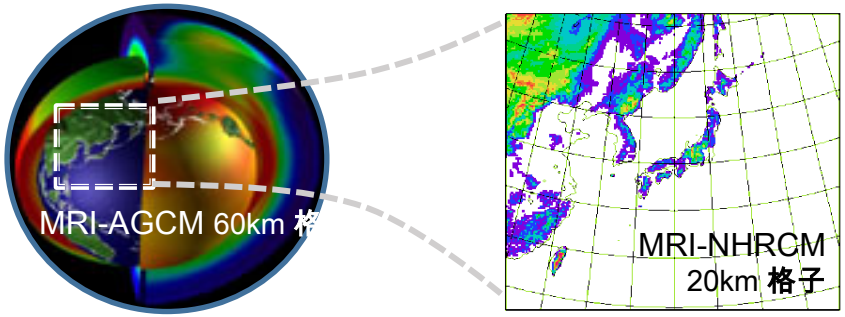
✕

15 Perturbation due to observation (δT)

✕

6 SST global warming patterns (CMIP5) (ΔT)

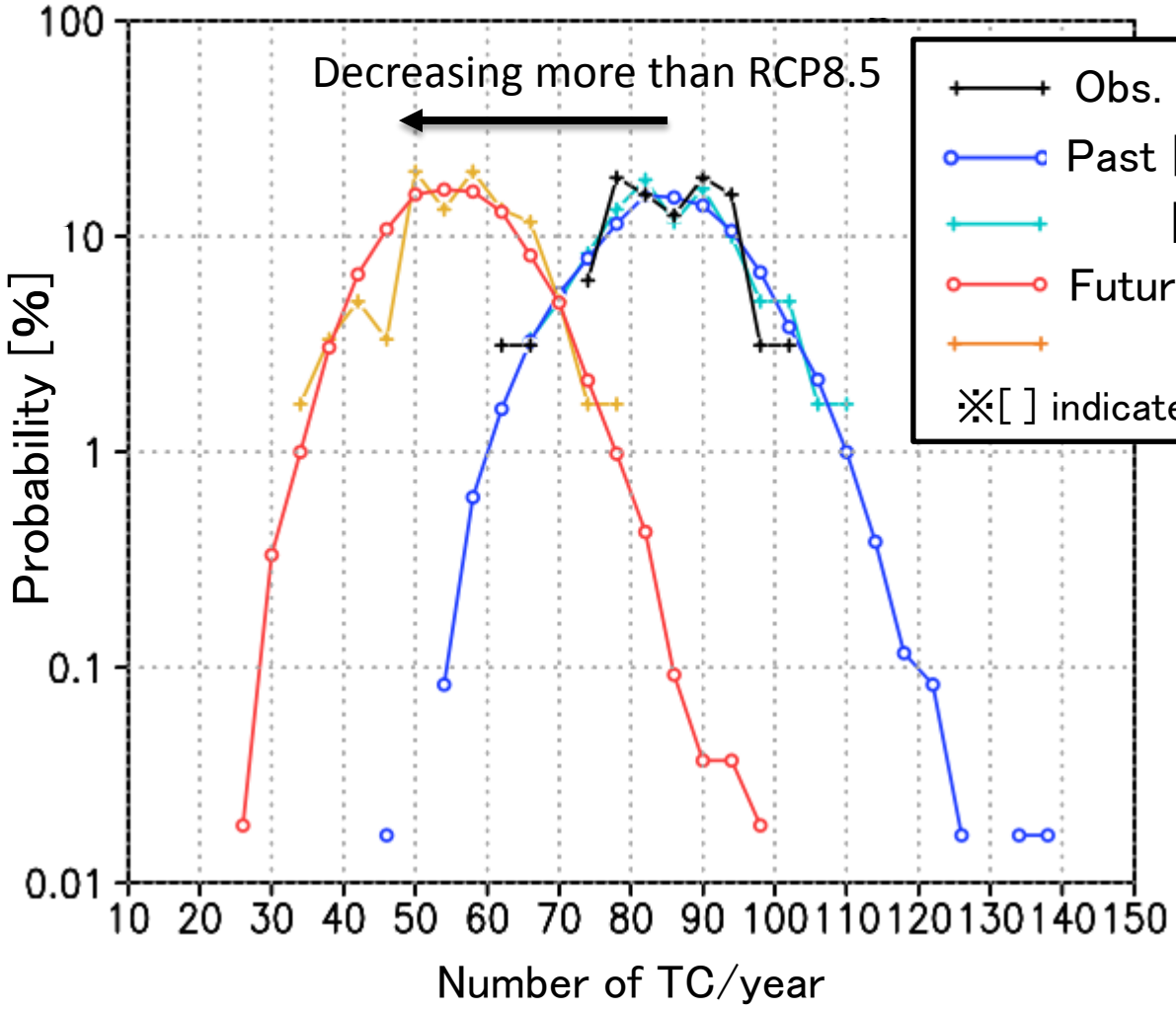
SST



AGCM+Wave coupling → Shimura tomorrow

FUTURE CHANGE OF TROPICAL CYCLONE

Cyclogenesis



Obs. [1] N=84.3 (32 yrs)
Past [100] N=84.6 (60 yrs)
[1] N=84.9 (60 yrs)
Future [90] N=54.7 (60yrs)
[1] N=55.7 (60 yrs)
※[ ] indicates number of member

Annual variation

HPB(1951-2010): 10.35 (±0.90)

HPB(1979-2010): 9.74 (±1.24)

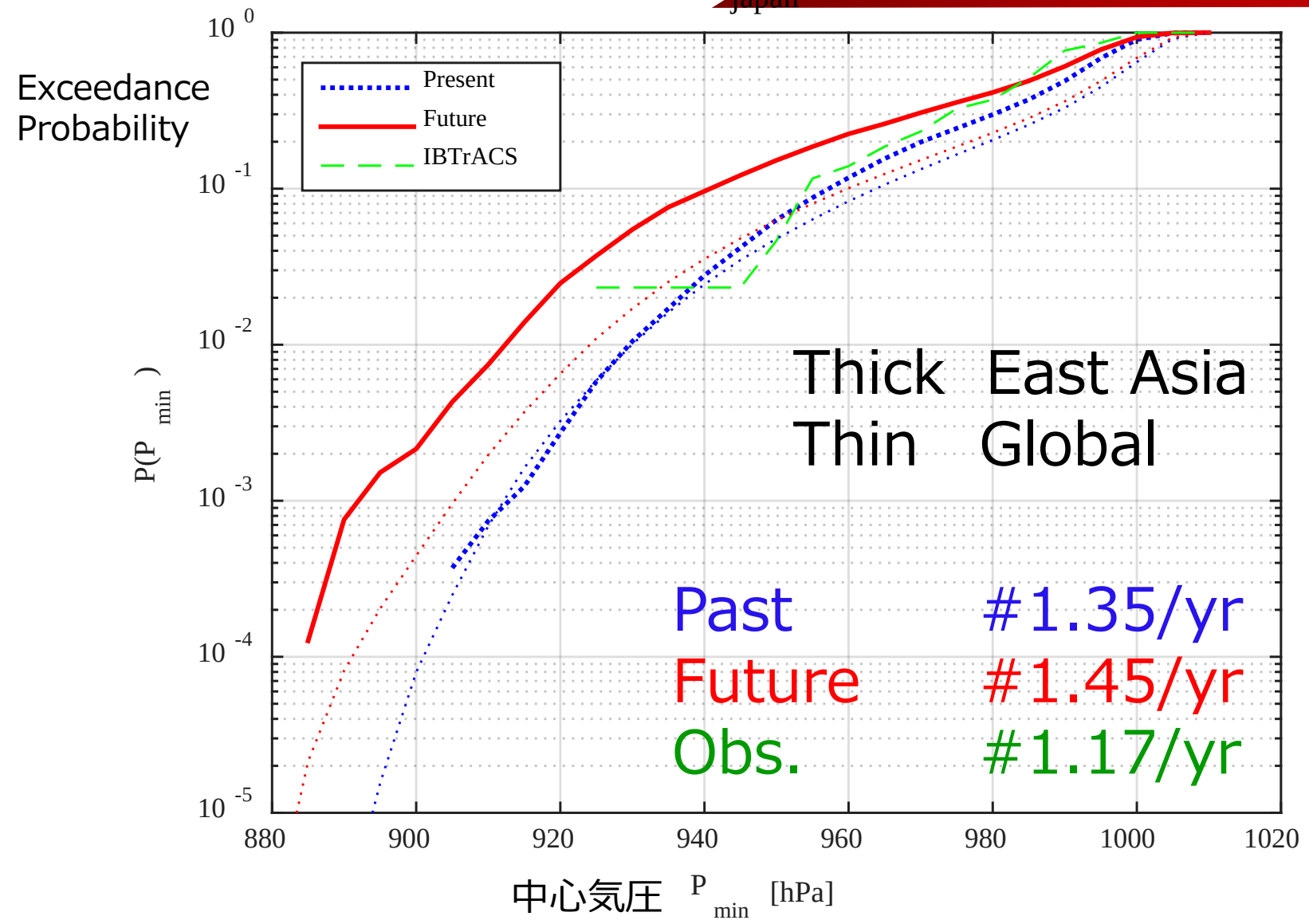
Obs. (1979-2010): 8.91

HFB(2051-2110): 8.76 (±0.88)

作成:吉田

Future change of min central pressure

japan



FUTURE CHANGE OF STORM SURGE

Storm surge height estimation

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Wind speed/SLP

Target locations

Calibrated statistical model

- Storm surge simulation is performed (100 events)

$$a\Delta P + b\frac{U^2}{h}$$

Storm surge

- Annual maximum storm surge
- EVA

Simple model

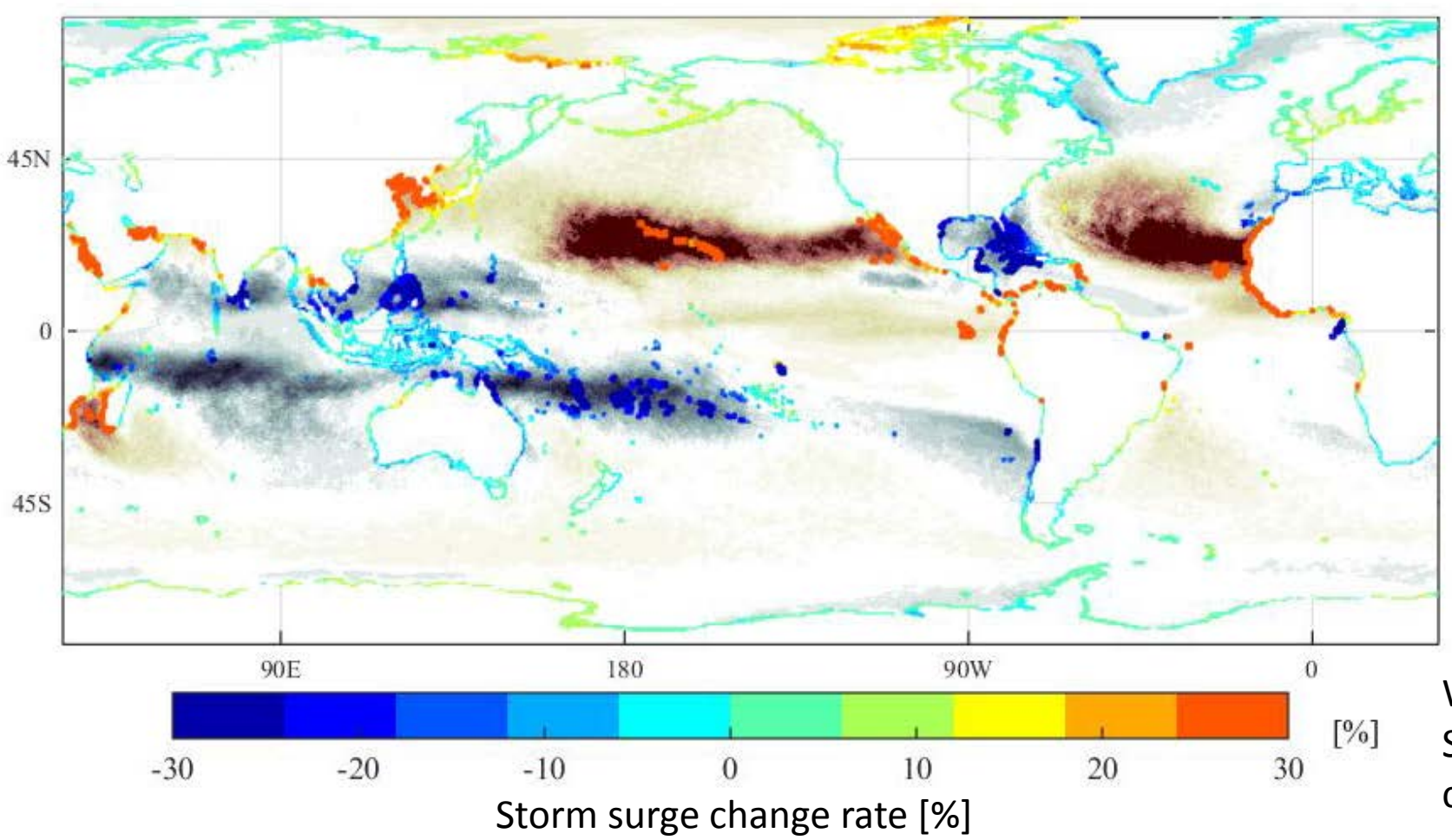
- Constant wind induced surge coefficient
- Water depth is considered (GEBCO)

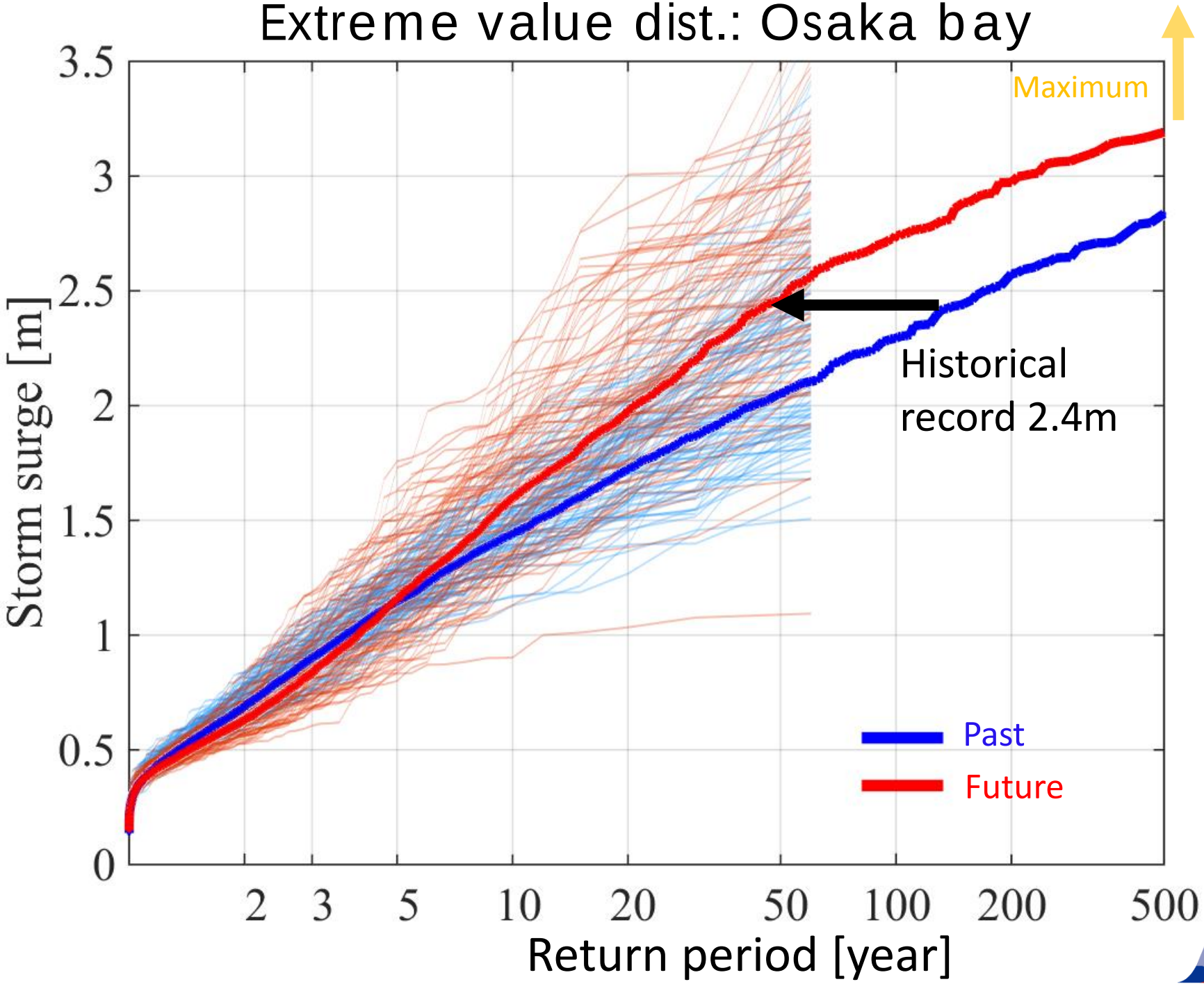
Storm surge

- Annual maximum storm surge
- EVA

Global

Future change: 100yrs storm surge




Extreme value dist.: Osaka bay
Maximum
Historical
record 2.4m
Past
Future
Storm surge [m]
Return period [year]
0
0.5
1
1.5
2
2.5
3
3.5
2
3
5
10
20
50
100
200
500
d4PDF

Conclusion

- Mega ensemble experiments enable to apply for extreme natural disasters
- Application to TC and storm surge
  - Future change of TC
    - cyclogenesis↓, central pressure ↓, track shift
  - Storm surge height
    - Short-term ↓ by decreasing cyclogenesis
    - Mid to long-term ↑ by stronger TC and track shift
- Future study
  - Dynamic storm surge simulation
  - Wave climate and other natural disasters

The End

https://www.miroc-gcm.jp/~pub/d4PDF/

See detail of d4PDF in

Mizuta, R. et al. (2017) Over 5000 years of ensemble future climate simulations by 60 km global and 20 km regional atmospheric models, The Bulletin of the American Meteorological Society (BAMS)