Session-5: CORDEX-Asia ESD

- 16:00-16:20 5-1 Koji Dairaku
  "Hi-Resolution Multi-Ensemble Statistical Downscaling Regional Climate Scenarios"
- 16:20-16:40 5-2 Nuzba Shaheen
  Performance Evaluation and Statistical Downscaling of CORDEX RCMs for Impact Assessment Studies in South Asia and South East Asia
- 16:40-17:00 5-3 Shaukat Ali
  Future Projections of Climate Extremes over Pakistan using QM, DQM and QDM Statistical Downscaling/Bias-Correction
- 17:00-17:20 5-4 Ashwini Aniruddha Kulkarni
  Statistical Downscaling for South Asian Region
- 17:20-17:40 5-5 Seonae Kim
  Statistical Downscaling for Daily Precipitation in Korea using Combined PRISM RCM, and Quantile Mapping: Part 1. Methodology and Evaluation in Historical Simulation.

Follow-up discussions at Dinner Meeting on 3rd and Planning Meeting on 4th

NIED
National Research Institute for Earth Science and Disaster Prevention

Hi-resolution multi-ensemble statistical downscaling regional climate scenarios and CORDEX Asia ESD

Koji DAIRAKU

National Research Institute for Earth Science
and Disaster Resilience, Japan

2-4th Oct 2017, Tsukuba

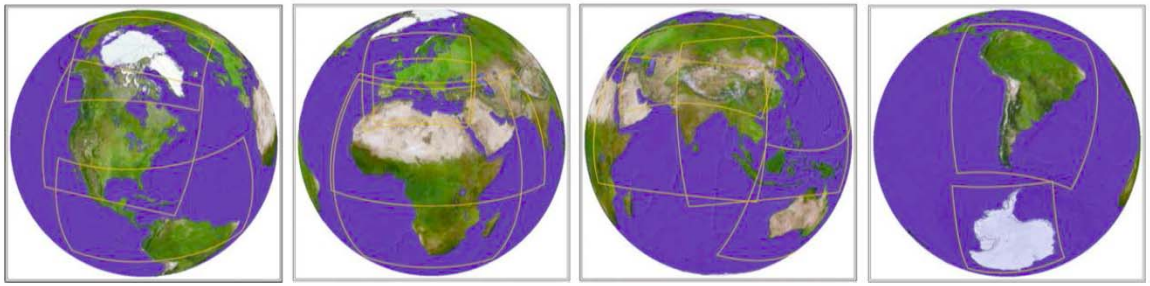
Backgrounds of developing regional climate scenarios

- ✓ The Asia-Pacific region are increasingly threatened by large scale natural disasters. Growing concerns that loss and damages of natural disasters are projected to further exacerbate by climate change and socio-economic change.
- ✓ The **Paris Agreement** dealing with greenhouse gas emissions mitigation and adaptation entered into force in 2016. **National Plan for Adaptation to the Impacts of Climate Change** was endorsed by the Japan Cabinet in 2015. **Sustainable Development Goals(SGDs)** set targets of 17 goals (include climate action) to be achieved over the next 15 years in 2015.
- ✓ **Fundamental regional climate information** is indispensable for understanding changing climate and making decisions on **when and how to act.**
- ✓ Spatio-temporal comprehensive and consistent information is necessary and useful for decision making.

CORDEX (Coordinated Regional Climate Downscaling Experiment)

Scientific Vision: To advance and coordinate the science and application of regional climate downscaling through global partnerships

- ✓ Scientific Challenges: **Added value, Human element, Coordination of regional coupled modelling, Precipitation, Local wind systems**
- ✓ Flagship Pilot Studies (FPS) 2016- (Selection: 3 times/year)
  - SAM: Extreme precipitation events
  - EUR+MED: Convective phenomena
  - EUR: Impact of Land use changes on climate
  - MED: Role of the natural and anthropogenic aerosols
  - MED: Role of air-sea coupling and small scale ocean processes on the regional climate



CORDEX (Coordinated Regional Climate Downscaling Experiment)

✓ Climate Service

- Partnership with World Meteorological Organization (WMO) - **Global Framework for Climate Services (GFCS)**
- **Climate Service Center Germany**
  - Site-characteristic Climate-Fact-Sheet
  - Climate Signal Maps
  - Web-based climate service product
    - **www.atlas.impact2c.eu**
- Earth System Grid Federation (**ESGF**) regional nodes: Japan, India（Under developing: Korea, Thai）

What is downscaling?

◆ A lot of regional downscaling research activities

CORDEX, PRUDENCE, ENSEMBLES, PIRCS, NARCCAP, MRED, RMIP, S5-3, SOUSEI, SI-CAT, CCSN, etc.

◆ **Dynamical downscaling**

+ Based on physics, Output variables are physically consistent, physical interpretation.

- relatively large bias (effects of systematic errors in the driving large scale fields), computationally expensive.

◆ **Statistical downscaling**

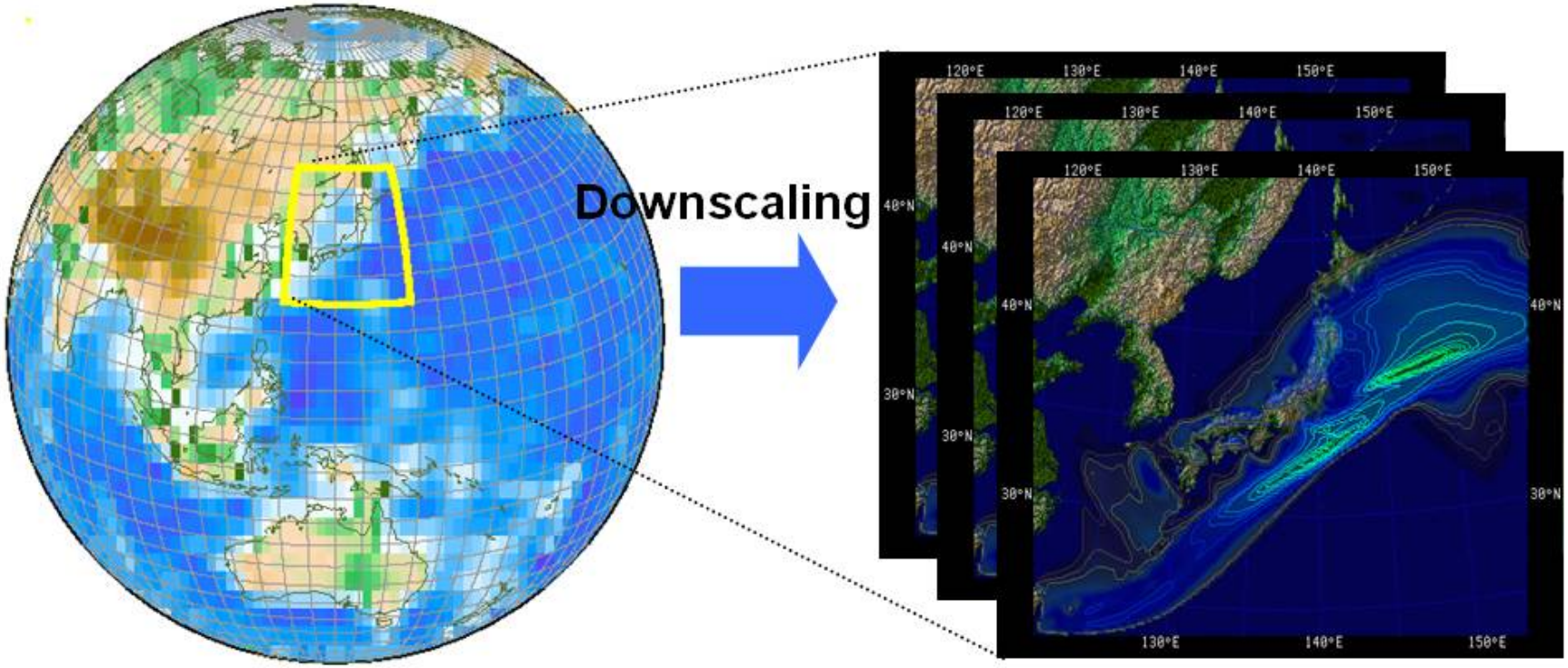
+ relatively accurate, simple, computationally economical, provide specific local information by tailored model (e.g., points, catchments).

- Not based on physics, assumption of stable climate (cannot account for possible systematic changes or feedback processes), less consistency between different variables.

Dynamical and statistical downscaling methods are complementary.

Multi-model ensemble experiment

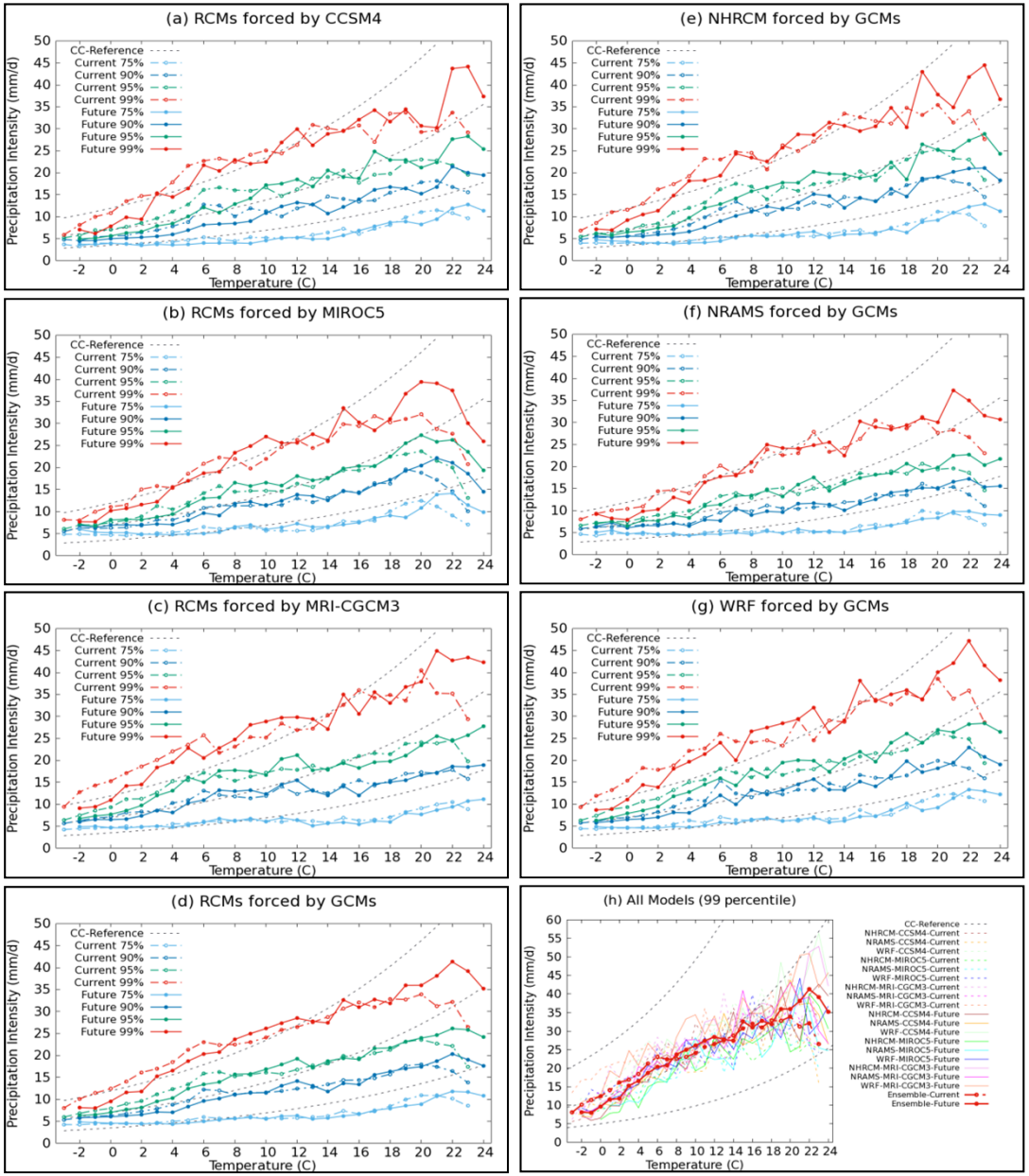
- Ensemble downscaling experiment by multi-regional climate models to investigate the range of structural uncertainty



e.g., Iizumi et al., JGR 2011, Ishizaki et al., JMSJ, 2012, 2012b, Iizuka, Dairaku et al., JMSJ, 2012, Iizumi et al., JGR, 2012, Sasaki et al., JMSJ, 2012, Tsunematsu et al., JGR, 2013; Nayak, Dairaku, HRL, 2017; Nayak, Dairaku et al., Clim. Dyn. in print.

CORDEX-EA(RMIP): Tang et al., Int. J. Clim., 2016; Li et al., Int. J. Clim., 2016, Niu et al., Int. J. Clim., accepted.

Future scenario of extreme precip.



- ✓ Future projected changes of the Clausius-Clapeyron (CC) relationship over Japan by using multi-model ensemble downscaling experiments (3RCMsx3GCMs, RCP4.5)
- ✓ Peaks pf extreme precipitation linked to temperatures(19-22℃).
- ✓ The peak of extreme precipitation intensities with temperatures is projected to shift about 2℃ (20℃→22℃).
- ✓ Insufficient water vapor supply for saturation at higher temperatures can cause less formation of clouds and extreme precipitation.

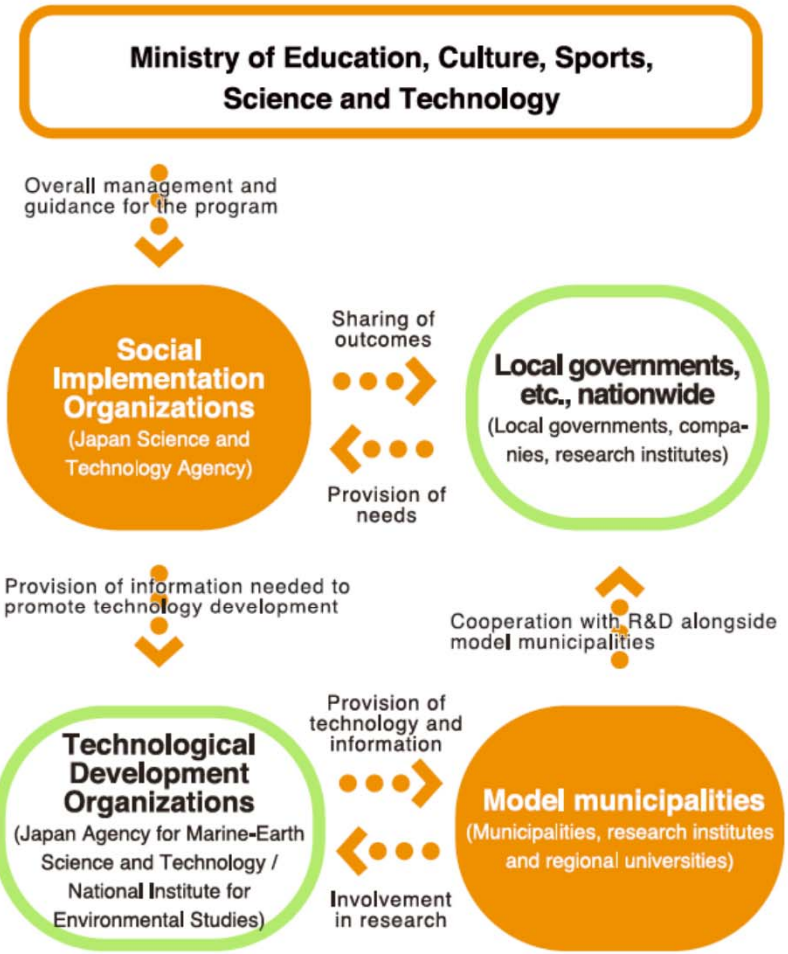
Nayak, Dairaku et al., Clim. Dyn. in print.

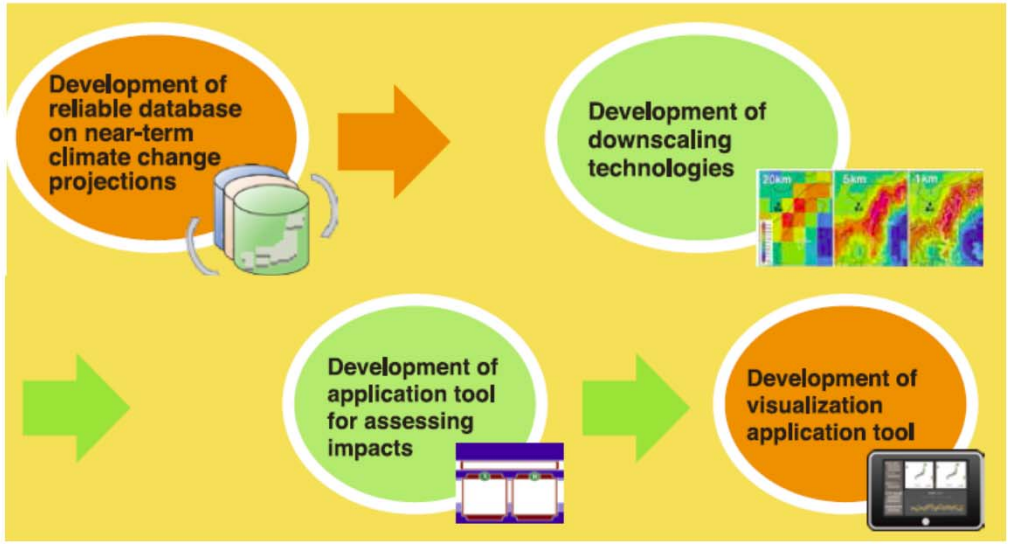
SI-CAT The Social Implementation Program on Climate Change Adaptation Technology

SI-CAT develops reliable technologies for near-term climate change projections that apply to reviewing and formulating climate change countermeasures by local governments and assessing the effectiveness of the countermeasures against climate change impacts in Japan. It conducts the project to realize reliable social implementation through development, which unites seeds of technologies with the needs of local governments. It also supports to adopt municipal adaptation measures appropriate for regional characteristics, which are taken against extreme weather phenomena (extreme heat or torrential rains) that are on the increase due to climate change.

FRAMEWORK

(Dec2015-Mar2020)



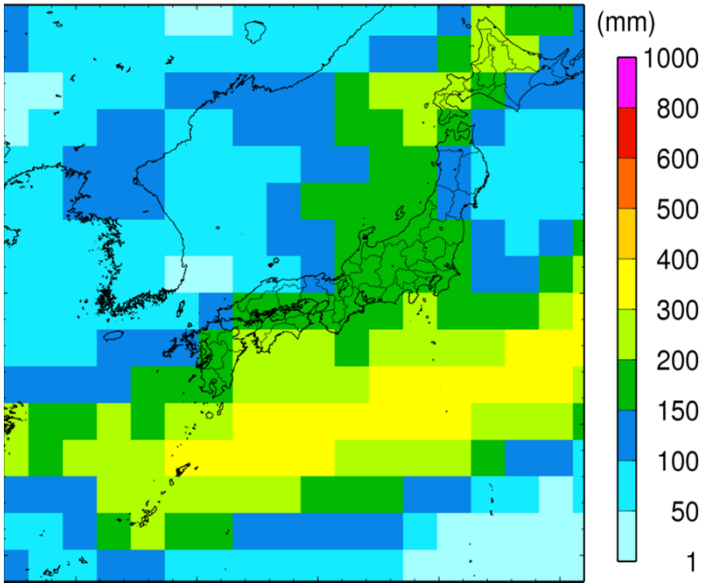


Develop multi-model ensemble near-term regional climate scenarios with 1km horizontal grid-spacing over Japan by **dynamical and statistical downscaling methods** to support various regional adaptation measures

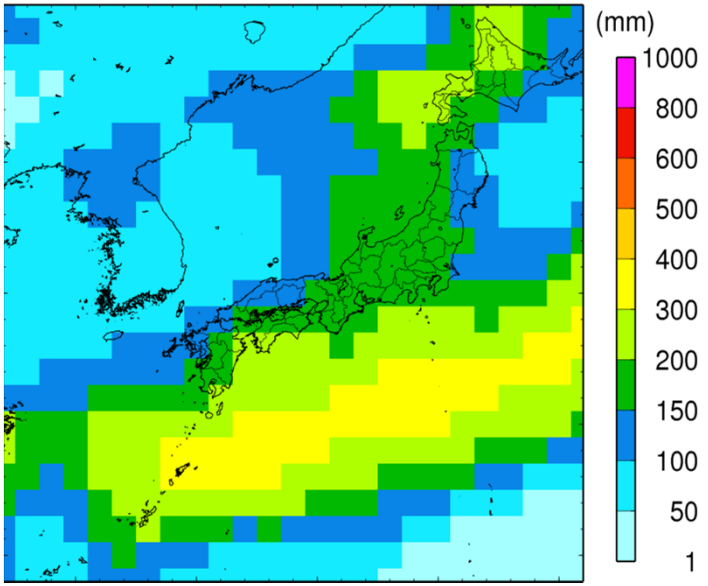
ESD Output Sample

(BCSD, Wood et al. 2002, Wood et al. 2004, Maurer et al. 2008)

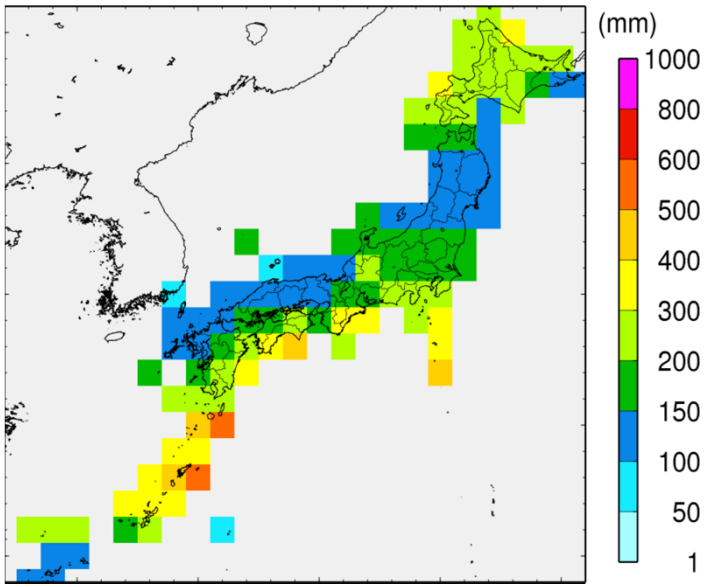
MIROC5 Original



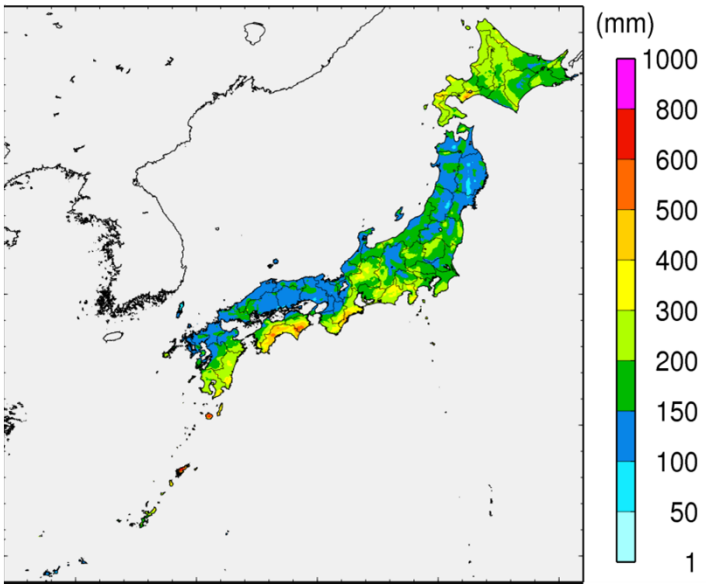
1degree Regridded



Bias corrected



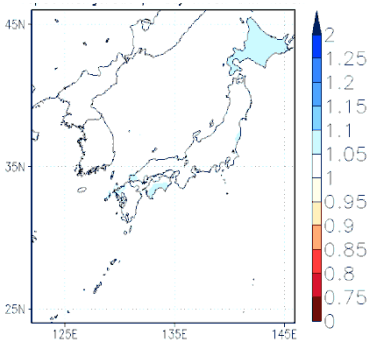
Downscaled



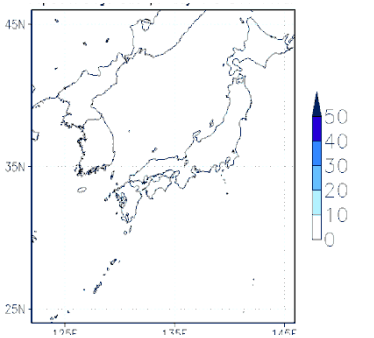
Projected future change of annual precipitation （pr, Daily）

37 models (CMIP5, RCP8.5, 2026-2050)

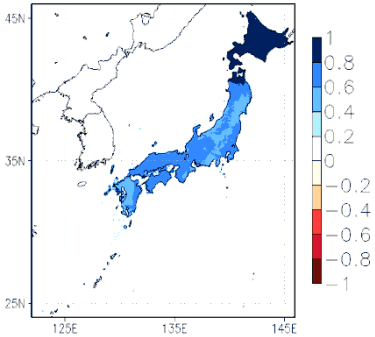
Ensemble average

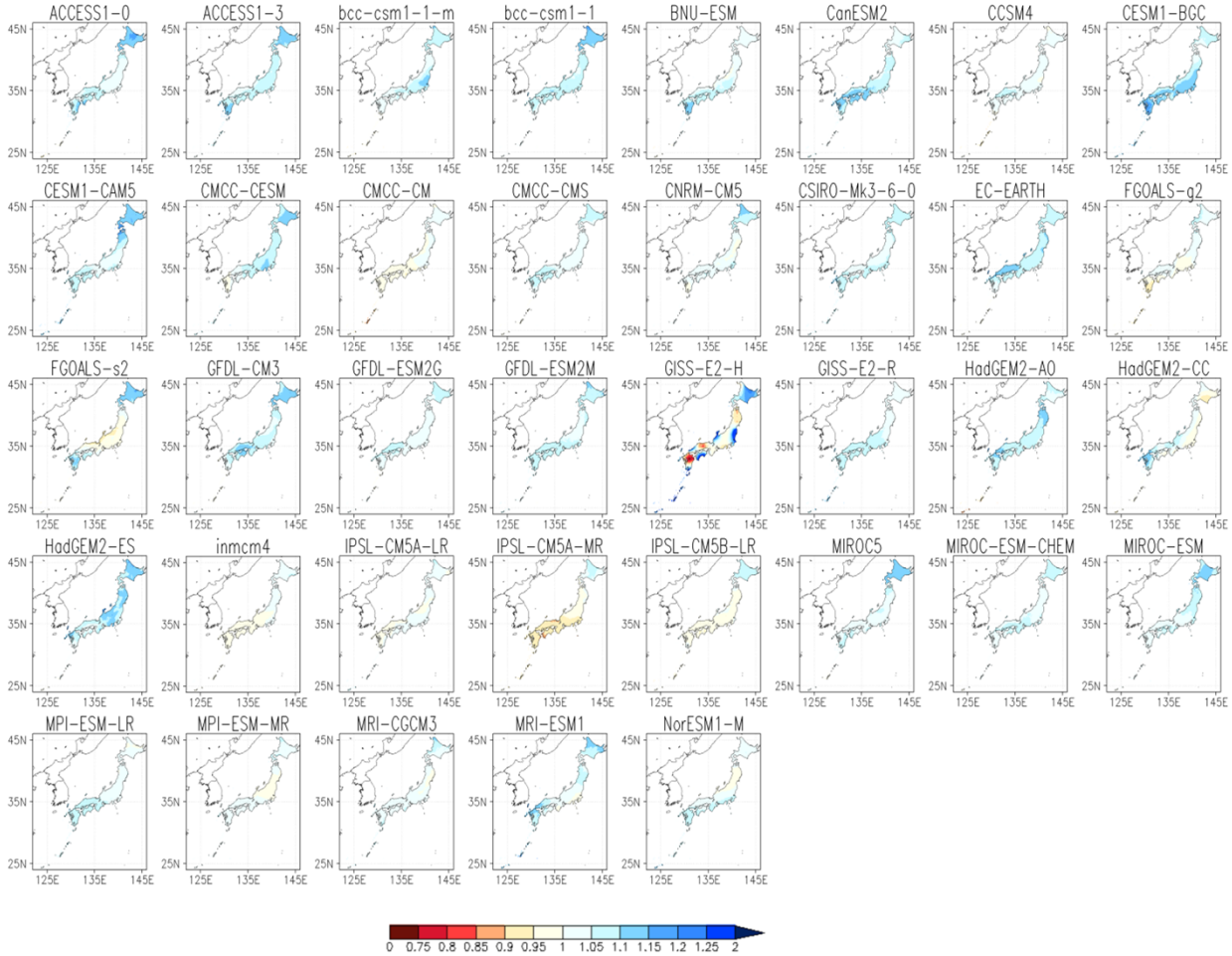


Standard Deviation



Ratio of models of increase/decrease change



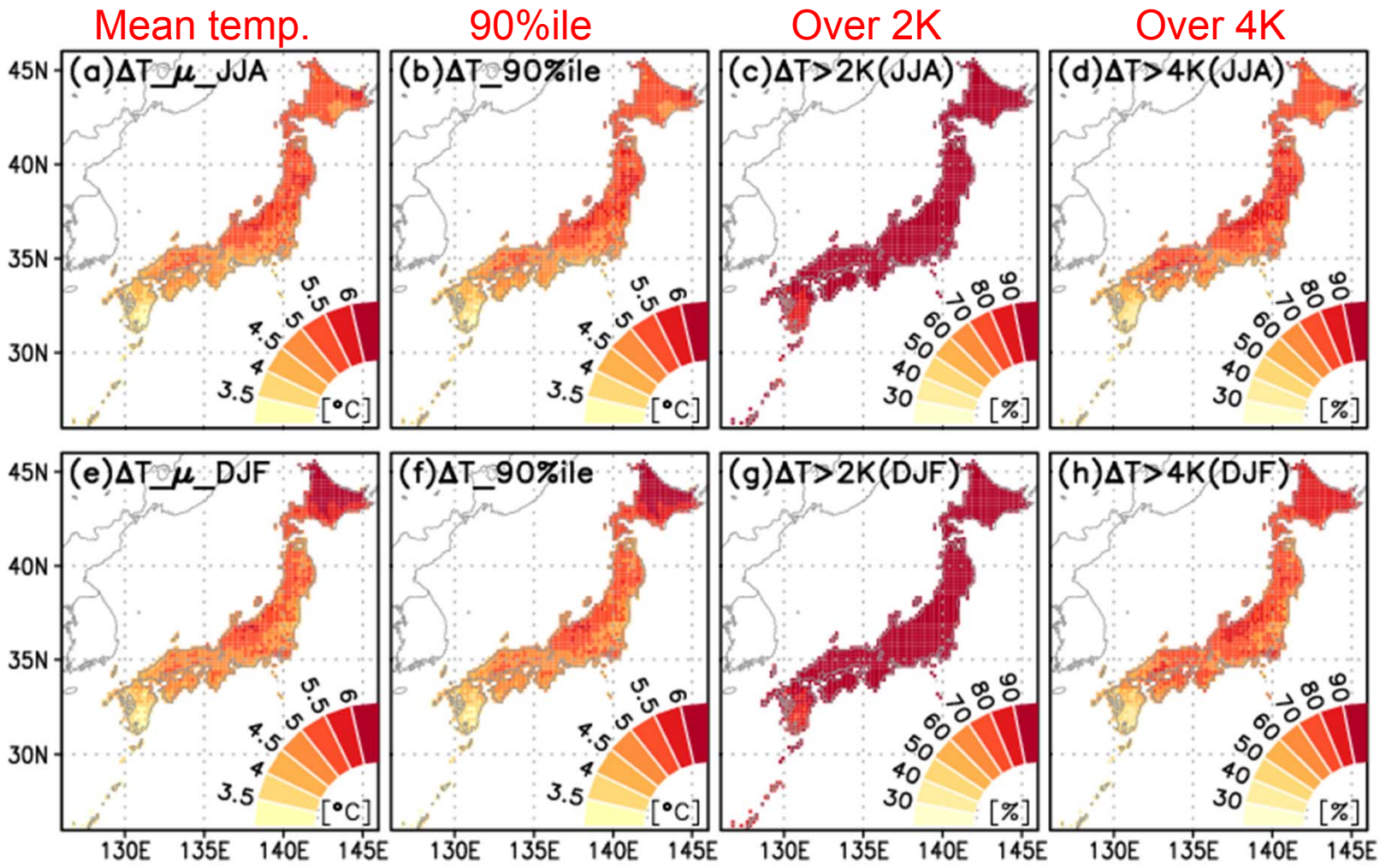


- ✓ Each model projected different responses because of structural differences.
- ✓ The most models show increase of precipitation (qualitative consistentency) .
- ✓ Working on multi-methods ensemble

Dairaku, in prep.

Probability map of 2m air temperature

RCP8.5
40GCMs



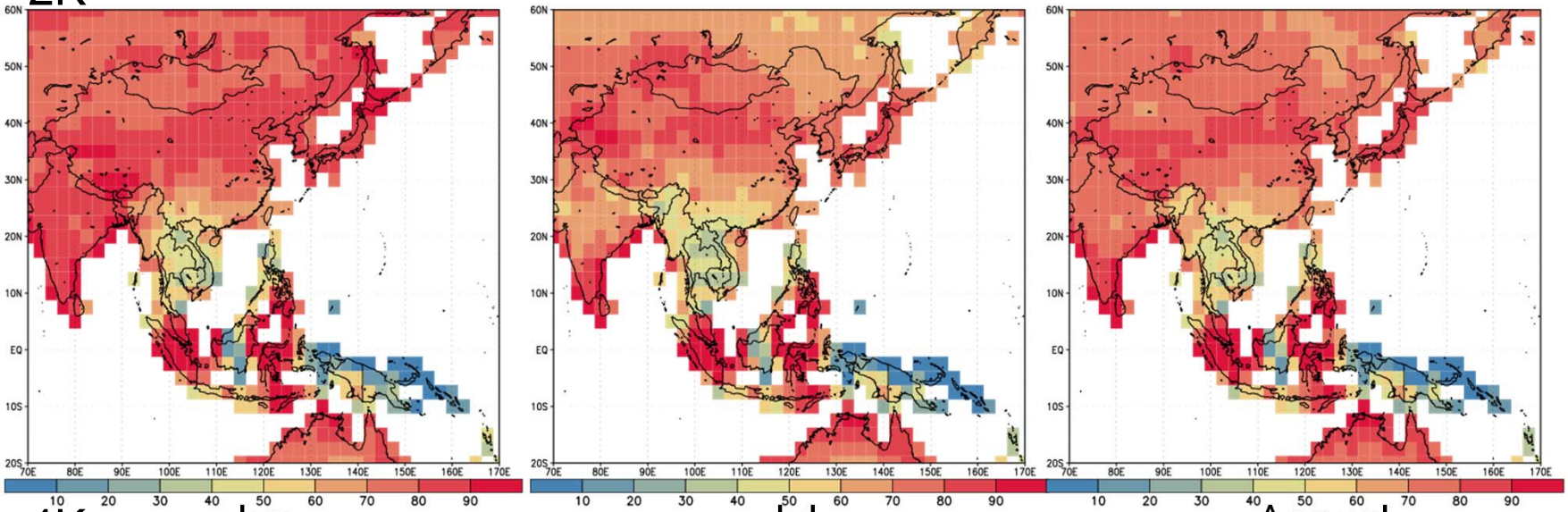
Very high probability of a temperature increase in excess of 2K (Over 90%)
High probability (50-80%) of 4K excess in most areas by the end of the 21st century (using Regression Method：Elastic Net)

(Ishizaki, Dairaku, Ueno, HRL, 2017)

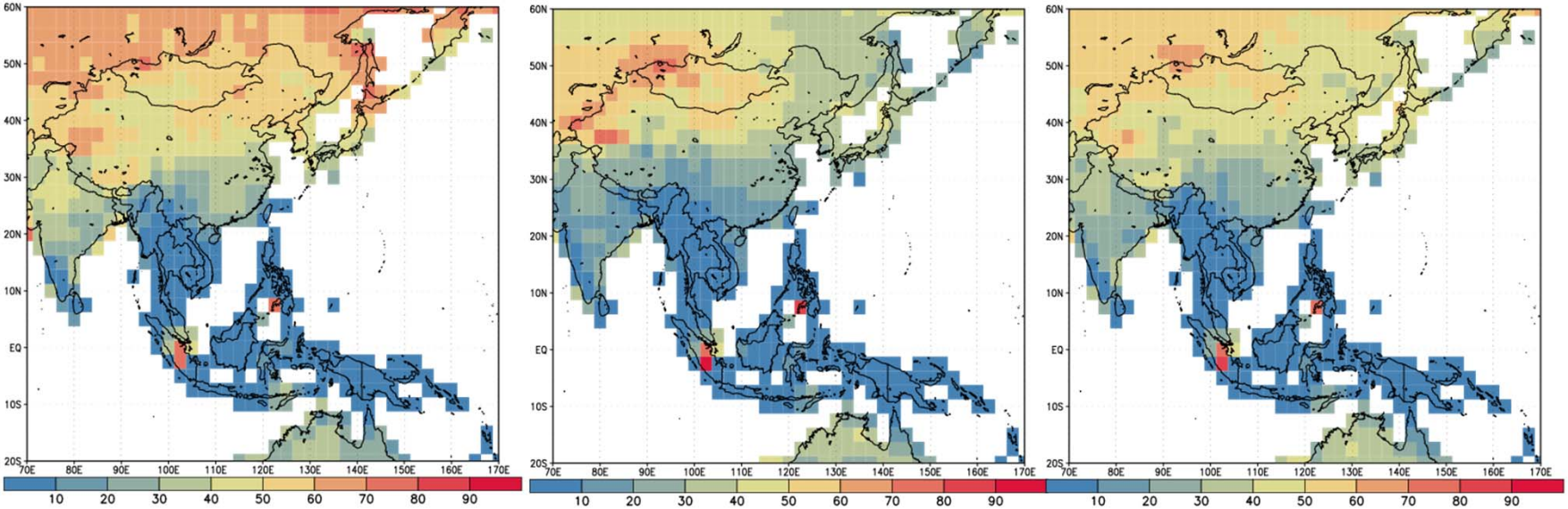
Future(A1b)-Present

Probability map of 2m Temperature (2069-2098)-(1969-1998)

ΔT>2K



ΔT>4K



Contributed to the report by the Ministry of Foreign Affairs in Japan for G7 Working Group on Climate Change and Fragility (Sep 6th 2017 press release)

Establish CORDEX Asia Empirical-Statistical downscaling (ESD) group

◆Background & Motivation

- Regional climate information and service is required for risk assessment on sub-national scale for climate change adaptation and IPCC AR6.
- Dynamical downscaling and Empirical-Statistical downscaling (ESD) can complement each other.
- Establish ESD group for well coordinated downscaling activities in Asia to find additional strength to support for what we are doing in isolation.
- What are the key needs? What is driving our science at current.

CORDEX Asia Empirical-Statistical downscaling (ESD) group

Current Members of CORDEX Asia-ESD group

Group Leader: **Koji Dairaku** (NIED, JAPAN)
China: Ailikun (Co-chair: ITP/CAS), Lianhua Zhu (NUIST), Lijun Fan (IAP/CAS)
India: Ashwini Kulkarni (IITM)
Indonesia: Ardhasena Sopaheluwakan (BMKG), Muhammad Ridho Syahputra (ITB)
Japan: M. Nishimori (NIAES), N. Endo (NIAES), A. Yatagai (**APHRODITE-2**, Hirosaki Univ.)
Korea: Hyunhan Kwon (Chonbuk Nati. Univ.)
Malaysia: Liew Juneng (Malaysia National Univ.), Ester Salimun (Univ. of Malaysia)
Pakistan: Nuzba Shaheen, Shaukat Ali (GCISC)
Philippines: Francia B. Avila (Ateneo de Davao Univ.)
Singapore: Bertrand Timbal (CCRS)
Sweden: Iréne Lake (SMHI)
Taiwan: Cheng-Ta Chen (NTNU), Chao-Tzuen Cheng, (NCDR)
Thailand: Jerasorn Santisirisomboon (Ramkhamhaeng Univ.), Chakrit Chotamonsak (Chiang Mai Univ.)
Vietnam: Quang Dinh (VNCWE)

- Integrating the science and application of downscaling activities in Asia (EA,SEA,SA etc.) to provide regional climate information and service for risk assessment and IPCC AR6.
- **A common benchmark** for investigating uncertainty of regional climate scenarios and risk analyses.

Main possible activities and goals of the CORDEX Asia ESD group

◆Produce regional climate statistical downscaling information based on **common protocols for a common benchmark** for investigating uncertainty of regional climate scenarios.

◆**Case studies in small domain** for developing and improving the methods where sufficient observation is available (e.g., city, coastal areas, agricultural lands, etc.) and for obtaining best/good practices of co-production /coordination with IAV community.

◆**Improve reference data** for improving ESD and DDS skills by collecting better observational data and its update.

◆**Training workshops** to share and exchange knowledge and techniques.

Enhance well-coordinated downscaling activities in Asia to provide regional climate information and service which is required for risk assessment on sub-national scale for climate change adaptation and IPCC AR6.

Discussions

How can we move forward from "Garbage in – garbage out" to "Garbage in or Excellence in - excellence out"?

- ✓ **Added Value:**
  ESD from the parent global model should be used as the **benchmark** (control) with which dynamic downscaling would have to improve on. (e.g., Iizumi et al., JGR, 2011)
- ✓ **Scale dependence of downscaling**
  Downscaling over complex terrain/coastal areas/land cover where dynamics and physics interact.
- ✓ **Implications of future scenario**

  Is the current assumption: "invariance of model bias under climate change" valid? Model bias is larger in higher temperature.
  What are deterministic and statistical metrics? Should we conserve "trend"?
- ✓ **Convection permitting (cloud resolving model)**
  be panacea for regional climate downscaling, in particular on sub-daily time-scale? ESDs can add values?

Summary and Issues

◆**Multi-model ensemble downscaling experiments** in Japan and CORDEX-EA.

Added values, Extreme events, Future projection, Uncertainty, etc.

◆Develop Hi-resolution **large ensemble** statistical downscaling and **probabilistic regional climate information**

Uncertainty in climate scenario ensemble experiments.

◆**Bottom-up process and risk-based approach(SI-CAT)**

Include more regional stakeholders to develop regional climate scenarios for policy-relevance.

◆Establish **CORDEX Asia ESD group**.

・**A common benchmark and stocktake** for a rich diversity of multi-model/method ensembles and for investigating uncertainty of climate scenarios and climate risks.

・Reduce a timeline gap from CMIP6 to regional risk analyses for possible interlink of IPCC with national/regional climate adaptation.