2018.01. 23@NIES-Forum

Present status of Research Program for Climate Change in Japan

Akimasa Sumi

IR3S

（Integrated Research System for Sustainability Science）

The University of Tokyo

Global Warming

- 2015.Nov. COP21 Paris Agreement
- We have entered a new stage.
- Every 5 years Global Stocktake

Role of climate models

- Future Issues
- Role of climate models has become more and more important!
- Validation of efforts every 5 years!

Model Development Program with Super-computer

High Preformance Computer Development

- Flagship Machine
  - Earth Simulator-Kei(京）Compuetr-Post Kei（京）Computer
  - Data Assimilation Research for localized severe rainfall(Dr.Miyoshi,AICS)
- HPC-Network
  - ES and Super computers in Universities
  - JAMSTEC and MRI Data Assimilation for meso-scale phenomena and atmospheric chemistry

Model Development Program with Super-computer

- The Earth Simulator
- “Kyousei（共生）”Project
  - 2002. 4－2007. 03
- “Kakusin(革新）”Project
  - 2007. 04－2012. 03
- “Sousei(創生）” Project
  - 2012.04-2017.03

Research Develoment Directions of Climate models

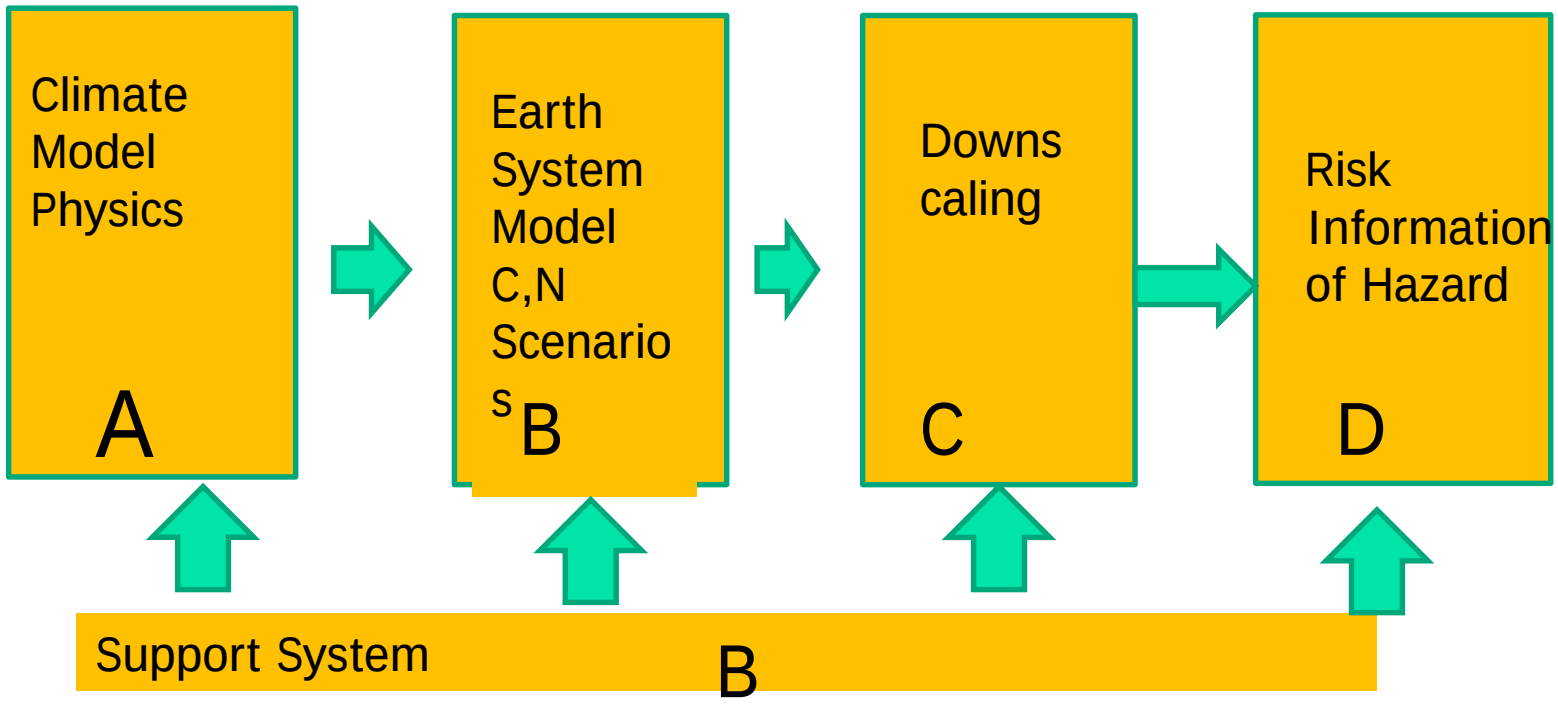
- High-resolution
  - Cloud permitting GCM (~870m)
  - Peta-machine is critical
- A large number of samples in Ensemble Methods
  - d4PDF

Integrated Research Program for Advancing Climate Models

- Region A:GlobalClimate Change Predictions and Development of Basic Model(Prof. Watanabe,AORI,UT)
- Region B:Sophiscated Earth System model for evaluating emission needed(Dr.Kawamiya,JAMSTEC)

Integrated Research Program for Advancing Climate Models

- Started at April,2017



Area Theme
A

Global Climate Change Predictions and Development of Basic Model

Atmosphere and Ocean Research Institute,
The University of Tokyo

▶Area Representative

Masahiro Watanabe
(Professor, Atmosphere and Ocean Research Institute,
The University of Tokyo)

Area subjects

Sophistication of climate models that can contribute to improving global environment change predictions

Reducing the uncertainty of climate change predictions and increasing the depth of scientific knowledge

▶Participating organizations

Japan Agency for Marine-Earth Science and Technology,
National Institute for Environmental Studies

Issues are

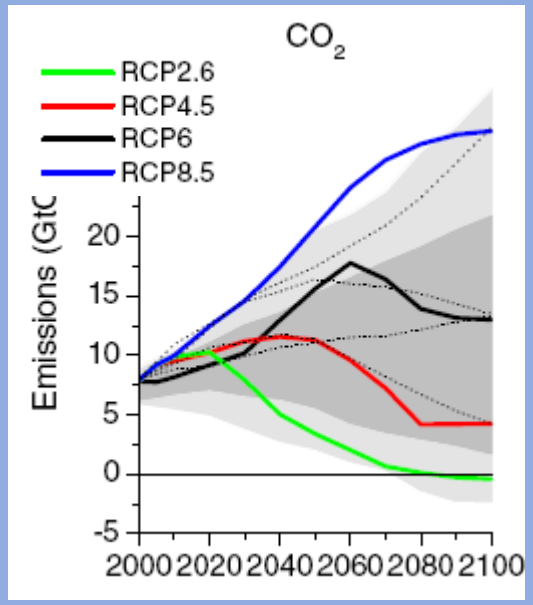
- More action-oriented research is requested!
- More detailed information is requested!
- Extreme event or adaptation
- Without scientific understanding, we cannot provide reliable information!

2 track approach

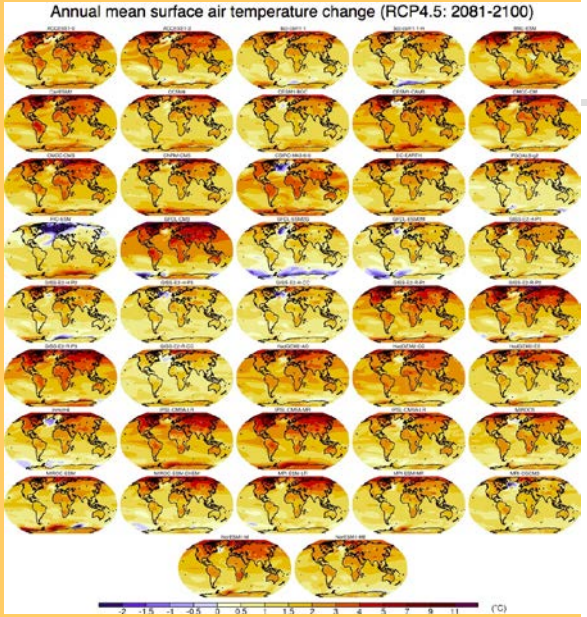
- Application and Basic science
- d4PDF many samples in Ensemble Method
- Climate Sensitivity
- Integration of Climate models with Scenario studies
- Integrated impact studies

D4PDF

Emission Scenario

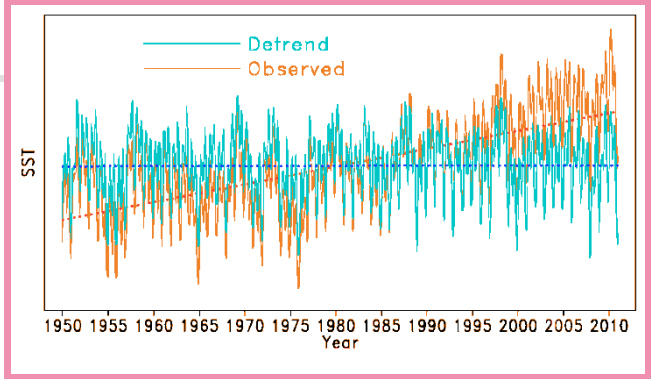


Climate Models



(IPCC AR5)

InternalVariabilty



発生頻度の低い異常天候や極端気象の変化の不確実性を十分に評価できていない。

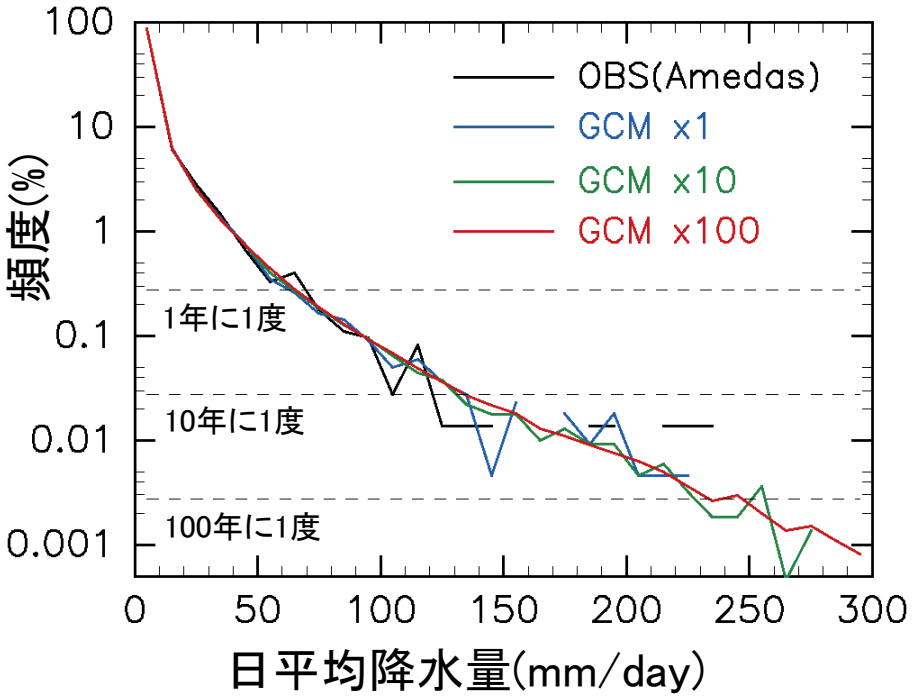
Global, Large-scale: CMIP5

Extremes, Regional-scale: 60km

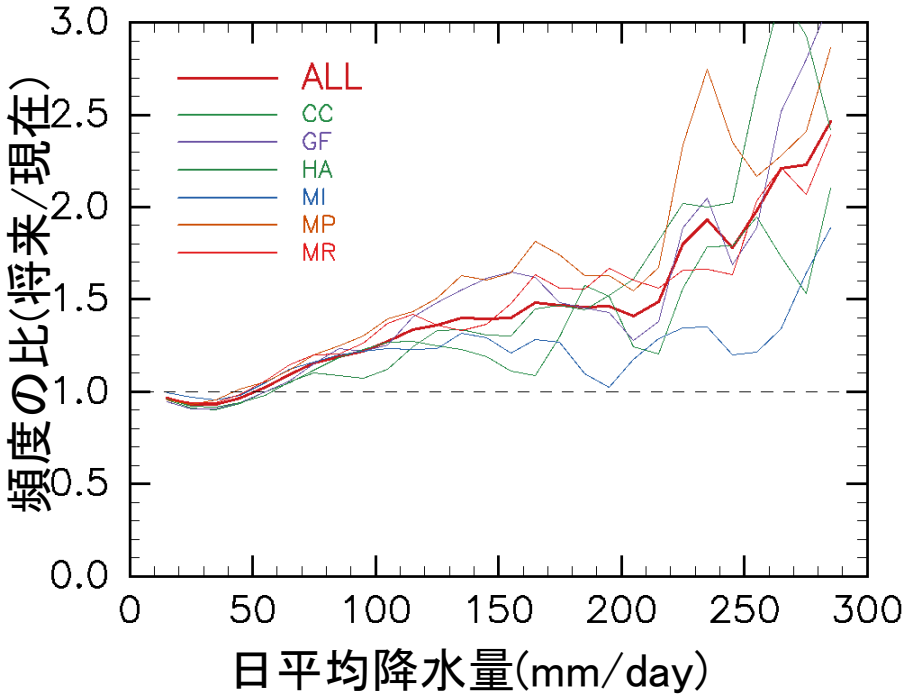
High Resolution・
Large Ensembles
Statistical Information

東京での日降水量 (60km model)

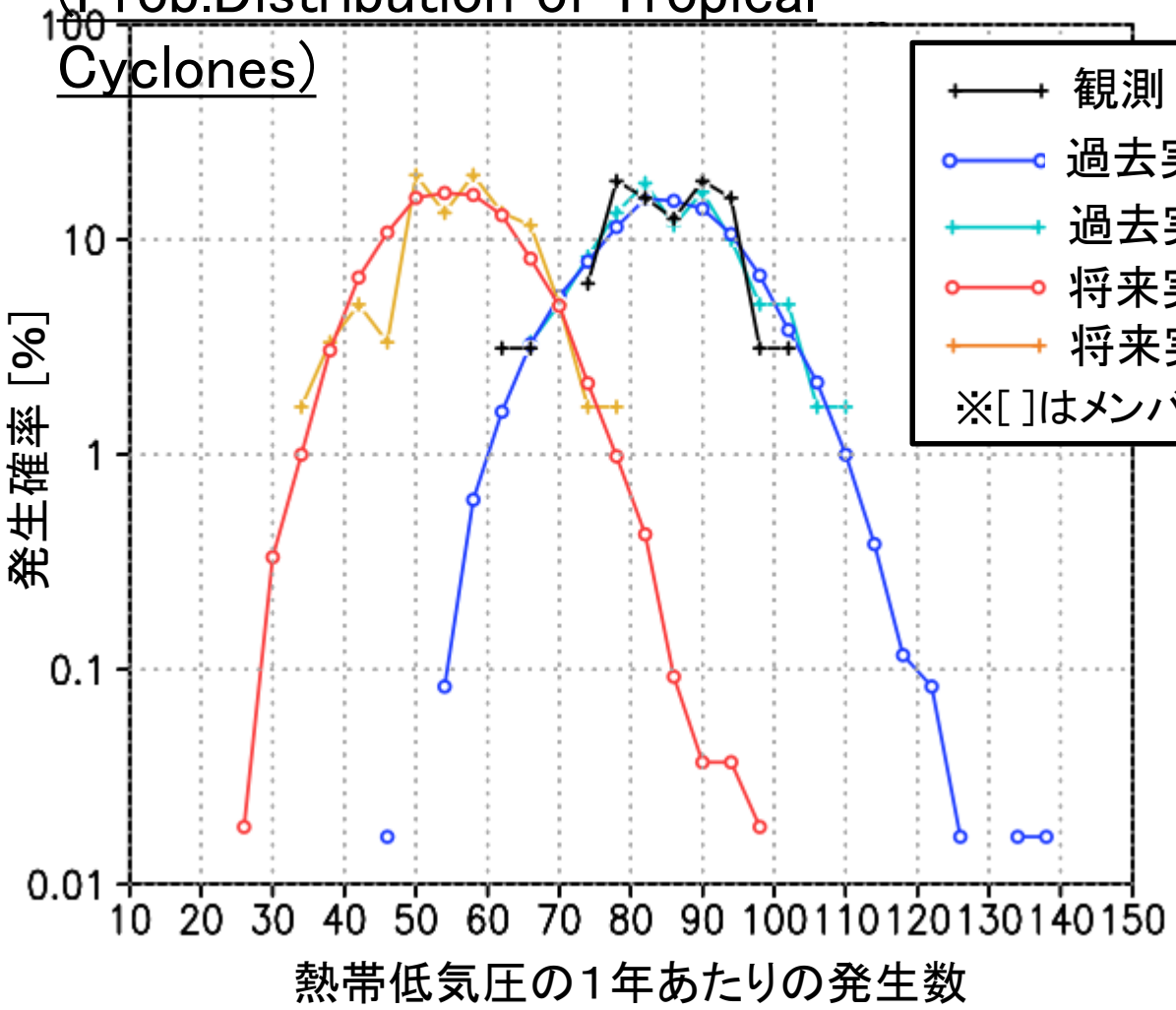
(a) 現在の東京の日降水量頻度分布



(b) +4℃で頻度が何倍になるか



熱帯低気圧全球年発生数の確率分布 (Prob.Distribution of Tropical Cyclones)



観測 [1]	N=84.3 (32年)
過去実験 [100]	N=84.6 (60年)
過去実験 [1]	N=84.9 (60年)
将来実験 [90]	N=54.7 (60年)
将来実験 [1]	N=55.7 (60年)

※[ ]はメンバー数

年々変動の標準偏差

HPB(1951-2010): 10.35 (±0.90)

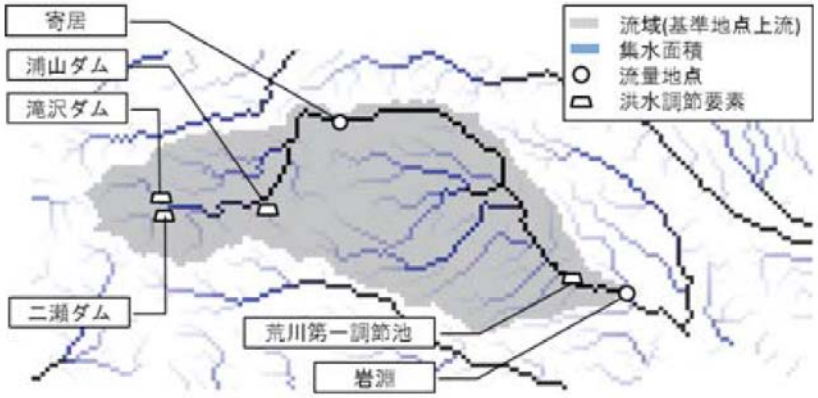
HPB(1979-2010): 9.74 (±1.24)

観測(1979-2010): 8.91

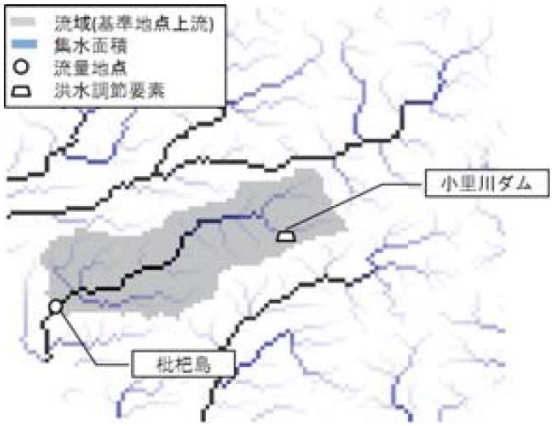
HFB(2051-2110): 8.76 (±0.88)

(by K. Yoshida)

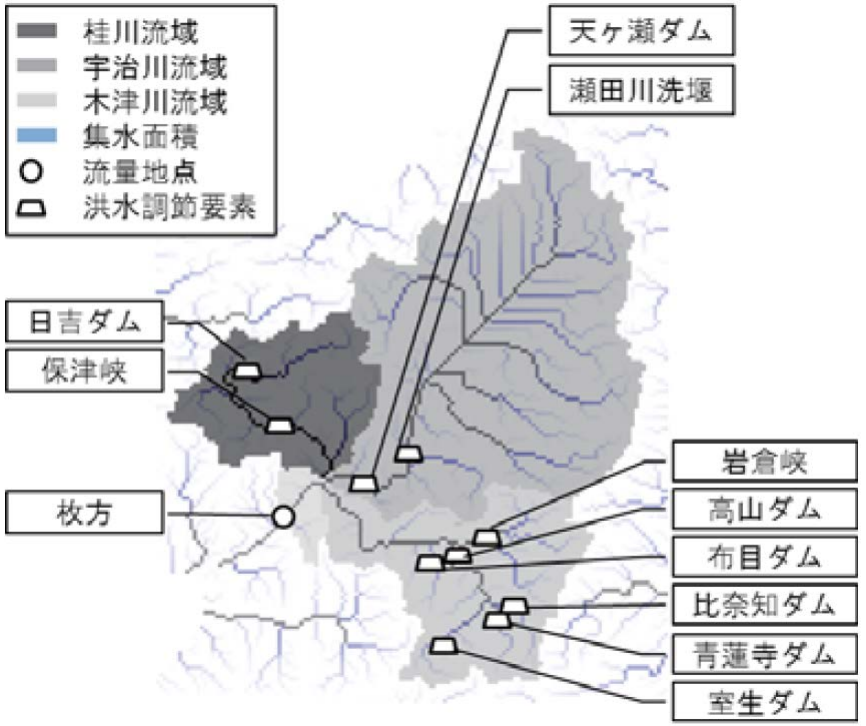
d4PDFを用いた三大都市圏の河川流量極値の変化（立川、宮脇、田中（智）、萬）



(a)荒川流域(2940km^2)



(b)庄内川流域(1010km^2)

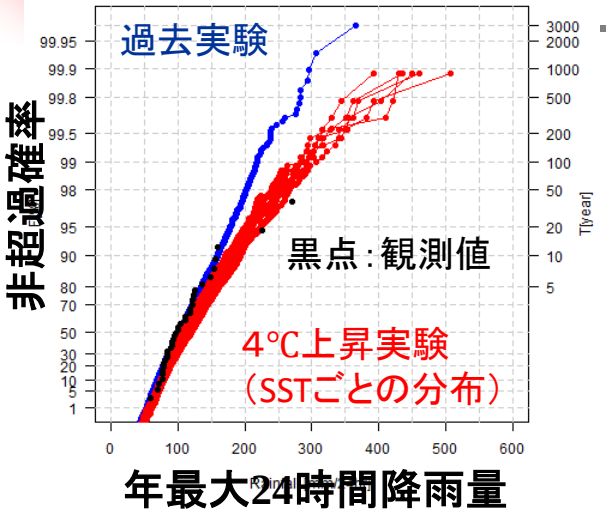


(c)淀川流域(8240km^2)

図中のダムおよび調整地の流水制御を降雨流出モデルに導入した

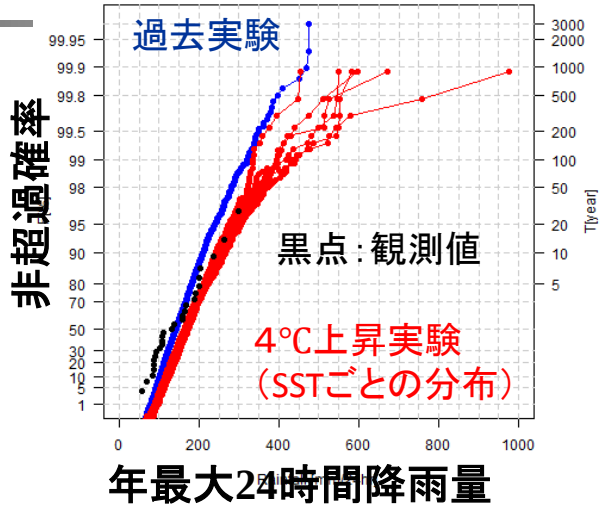
d4PDFを用いた淀川、庄内川および荒川の流域平均雨量の年最大24時間雨量の確率分布

淀川流域（枚方上流域）



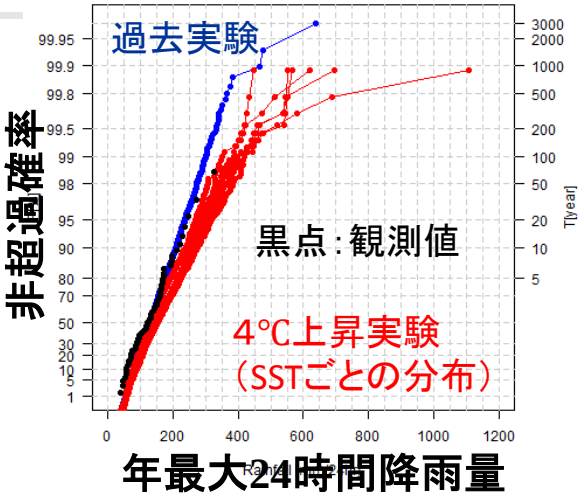
■計画降雨(1/200 24時間雨量)
261mm / 24hrs
■過去実験(1/200超過確率)
239mm / 24hrs
■将来実験(SSTごとの1/200超過確率の年最大24時間雨量の平均値)
329mm / 24hrs

庄内川流域（枇杷島上流域）



■計画降雨(1/200 24時間雨量)
376mm / 24hrs
■過去実験(1/200超過確率)
350mm / 24hrs
■将来実験(SSTごとの1/200超過確率の年最大24時間雨量の平均値)
474 / 24hrs

荒川流域（岩淵上流域）



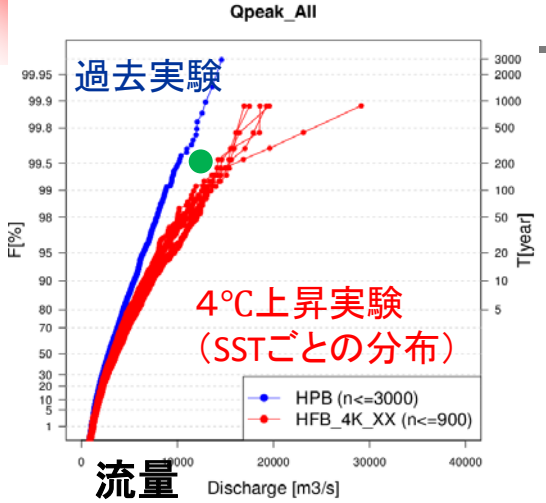
■計画降雨(1/200 3日雨量)
548mm / 3 days
■過去実験(1/200超過確率)
480 mm / 72hrs
■将来実験(SSTごとの1/200超過確率の年最大72時間雨量の平均値)
610 / 72 hrs

■青色の折線：d4PDF（過去実験）を用いた流域平均24時間年最大雨量の頻度分布。3000個のデータ（60年×50アンサンブル）を用いて非超過確率（ワイブル公式）と年最大24時間雨量を表示した。
■赤色の折線：d4PDF（4℃上昇実験）を用いた流域平均24時間年最大雨量の頻度分布。SSTごとに900個のデータ（60年×15アンサンブル）を用いて非超過確率（ワイブル公式）と年最大24時間雨量を表示した。
■黒点：観測値

京大(工、立川ら)

d4PDFを用いた淀川、庄内川および荒川の年最大時間流量の確率分布

淀川流域（枚方）

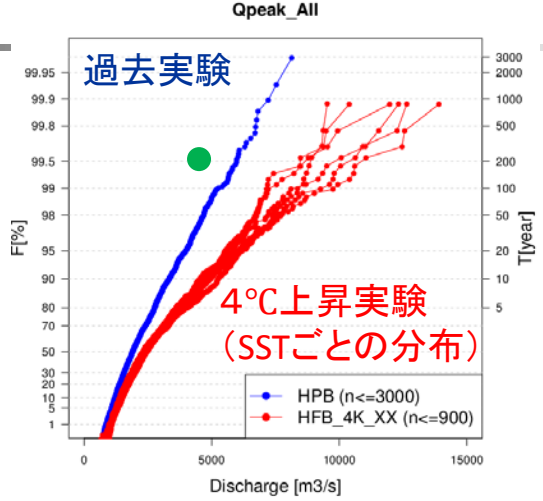


超過確率

流量

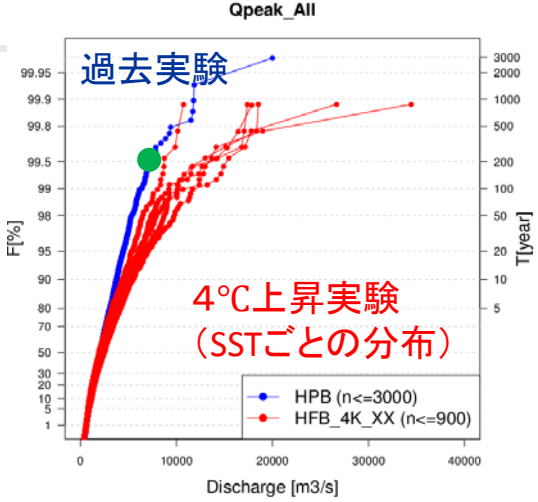
■基本高水(1/200確率)
17,500 m^3 /sec
■計画高水流量(1/200確率)
12,000m^3 /sec
■過去実験(1/200超過確率)
10,100m^3/sec
■将来実験(1/200超過確率)
15,200m^3/sec

庄内川流域（枇杷島）



■基本高水(1/200確率)
4,700 m^3 /sec
■計画高水流量(1/200確率)
4,400m^3 /sec
■過去実験(1/200超過確率)
6,000m^3/sec
■将来実験(1/200超過確率)
9,500m^3/sec

荒川流域（岩淵）



■基本高水(1/200確率)
14,800 m^3 /sec
■計画高水流量(1/200確率)
7,000m^3 /sec
■過去実験(1/200超過確率)
7,600m^3/sec
■将来実験(1/200超過確率)
12,800m^3/sec

■青色の折れ線：d4PDF（過去実験）を用いた流量計算による年最大時間流量の頻度分布。3000個のデータ（60年×50アンサンブル）を用いて非超過確率（ワイブル公式）と年最大時間時間流量を表示した。
■赤色の折れ線：d4PDF（4℃上昇実験）を用いた流量計算による年最大時間流量の頻度分布。SSTごとに900個のデータ（60年×15アンサンブル）を用いて非超過確率（ワイブル公式）と年最大時間流量を表示した。
■緑点：計画高水流量

京大(工、立川ら)

Area Theme **B**

Sophisticated Earth system model for evaluating emission reductions needed

Japan Agency for
Marine-Earth Science and Technology

▶Area Representative

Michio Kawamiya
(Director, Project Team for Advanced Climate Modeling,
Japan Agency for Marine-Earth Science and Technology)

Area subjects

Development of ESM and analysis of the Earth system

Earth-human system interaction

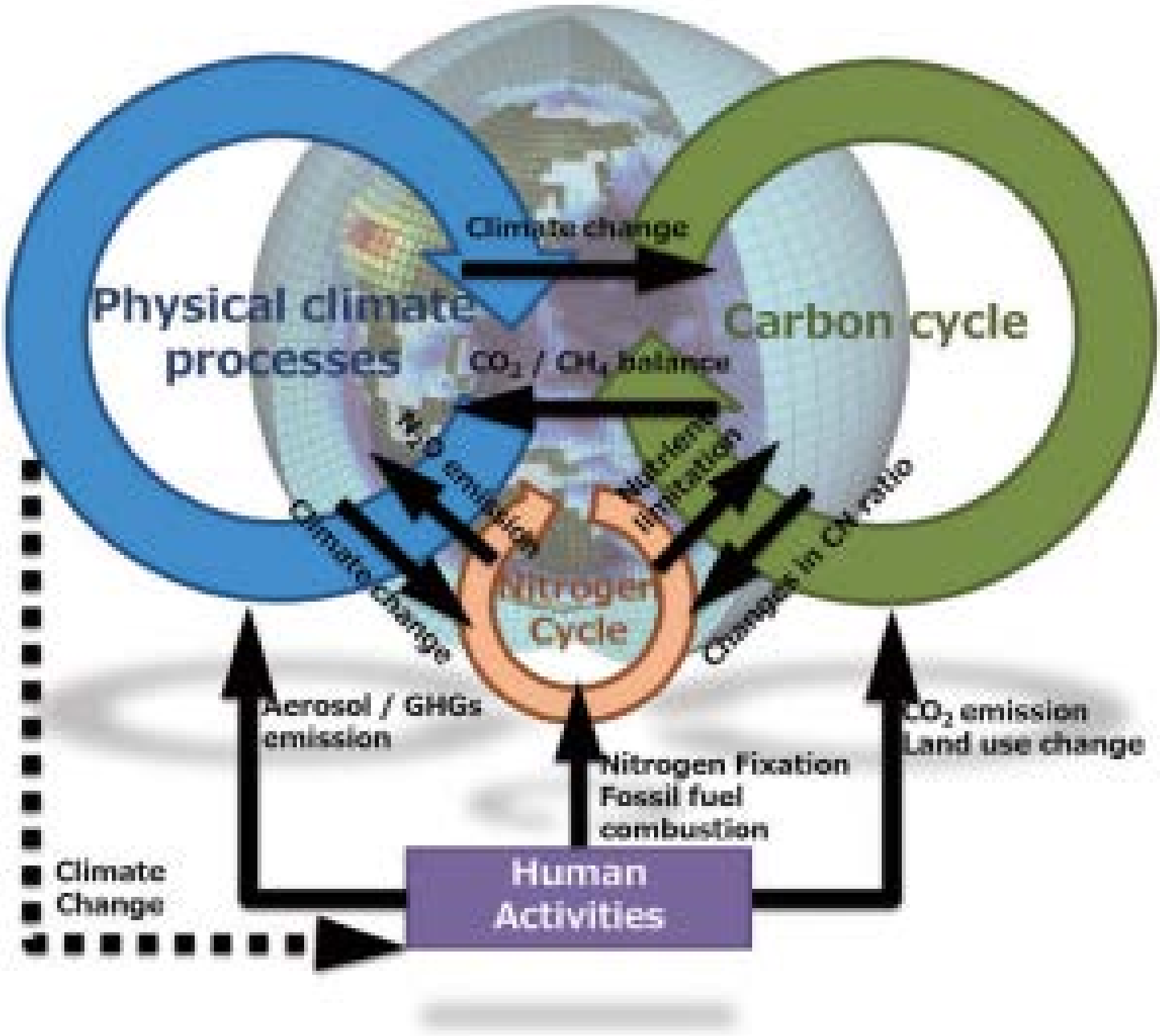
Technical and clerical support for inter-theme cooperation

▶Participating organizations

Central Research Institute of Electric Power Industry, Research Organization for Information Science and Technology, National Institute for Environmental Studies

Earth System Model

- Physical Process + Bio-Geochemical Cycle
- Carbon Cycle
- Nitrogen Cycle
- Interaction with scenario studies


Climate change
Physical climate processes
Carbon cycle
CO_2 / CH_4 balance
N_2O emission
Nutrient limitation
Climate change
Changes in C/N ratio
Nitrogen Cycle
Aerosol / GHGs emission
Nitrogen Fixation
Fossil fuel combustion
CO_2 emission
Land use change
Climate Change
Human Activities

Interaction to Scenario Studies

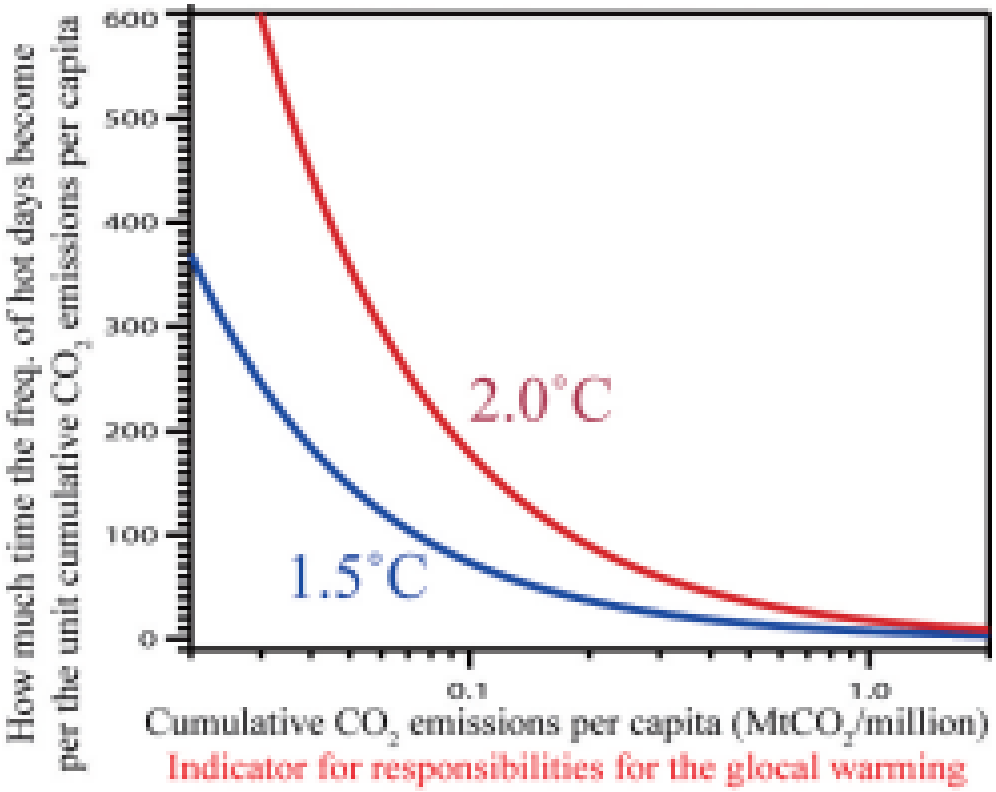


Fig. 1: Inequalities with increasing extreme hot events per unit responsibility and capability of mitigation

Relationships between "the cumulative CO_2 emissions per capita" and "how long the freque of extreme hot days (1 day per 100 years with th present climate) become per the unit cumulative CO_2 emissions per capita" with respect to 1.5°C and 2.0°C runs. There is a significant inequality the 2.0°C runs ons with lower responsibilitie have larger in s in hot days per unit responsibility. Additional mitigation efforts from 2.0°C to 1.5°C will reduce this inequality. The analysis is based on the HAPPI project.

Area Theme C

Integrated Climate Change Prediction

Japan Meteorological Business Support Center

▶Area Representative

Izuru Takayabu

(Japan Meteorological Business Support Center)

Area subjects

Development of high-precision models integrated with climate-relevant processes

Development of climate scenarios for multi-stakeholder applications and understanding the mechanisms of climate change

Advancing international collaboration through the application of a high-performing climate model over many countries in the Asia-Pacific region

▶Participating organizations

Nagoya University

Downscaling

- Statistical Downscaling and Dynamical Downscaling
- Bias Correction
- Estimate of Probability of Extreme Events
- Application to Adaptation Action

Downscaling MRI/JMA

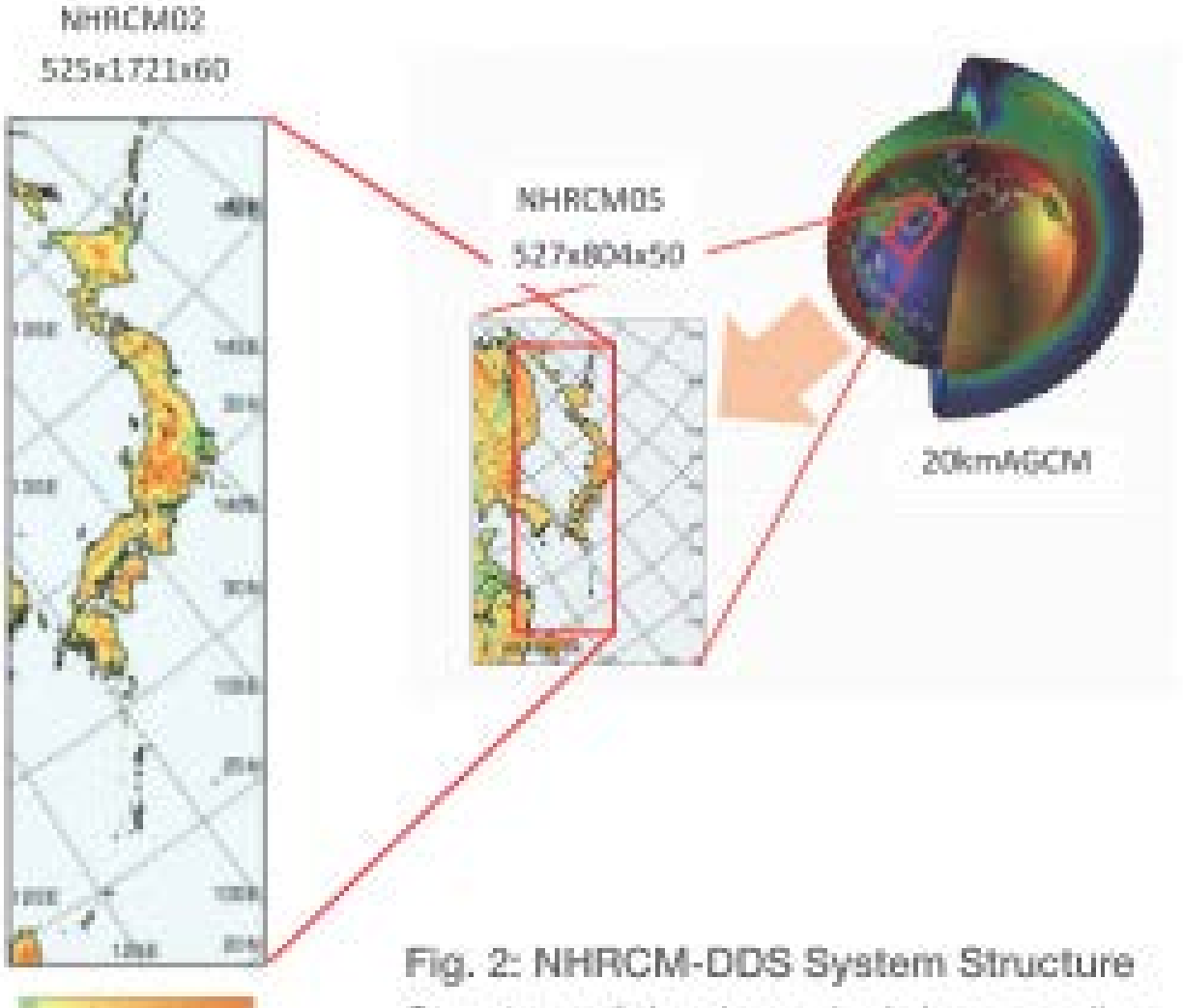


Fig. 2: NHRCM-DDS System Structure

Area Theme
D

Integrated Hazard Prediction

Disaster Prevention Research Institute,
Kyoto University

▶Area Representative

Eiichi Nakakita
(Professor, Disaster Prevention Research Institute,
Kyoto University)

Area subjects

- Long-term assessment of intensity and frequency of extreme hazards
- Seamless hazard prediction until the end of the 21st century
- Hazard analysis of past disasters and assessment of climate change factors
- Hazard assessment in Asian and Pacific countries and international cooperation
- No-regret adaptation strategies with consideration for various changes
- Development of bias correction methods and extreme values assessment technology

▶Participating organizations

Nagoya Institute of Technology, Hokkaido University,
National Agriculture and Food Research Organization,
Public Works Research Institute

Coordination with Hydrology-people

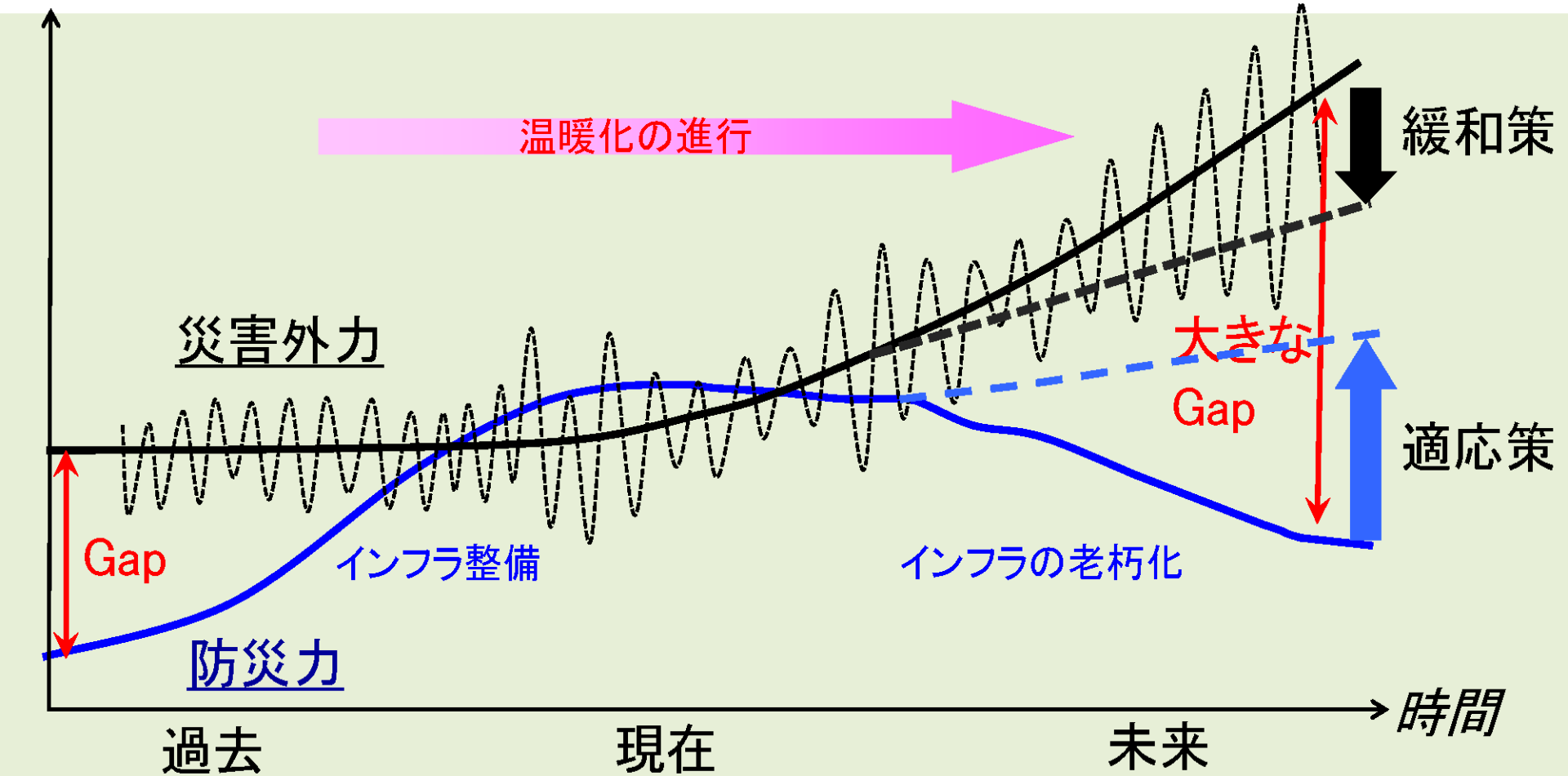
- Implementation of our knowledge in an actual operation
- Dam operation
- Flood control

100 year seamless prediction

- Interaction with social scenario
- Evaluation of our action such as Adaptation and/or regulation

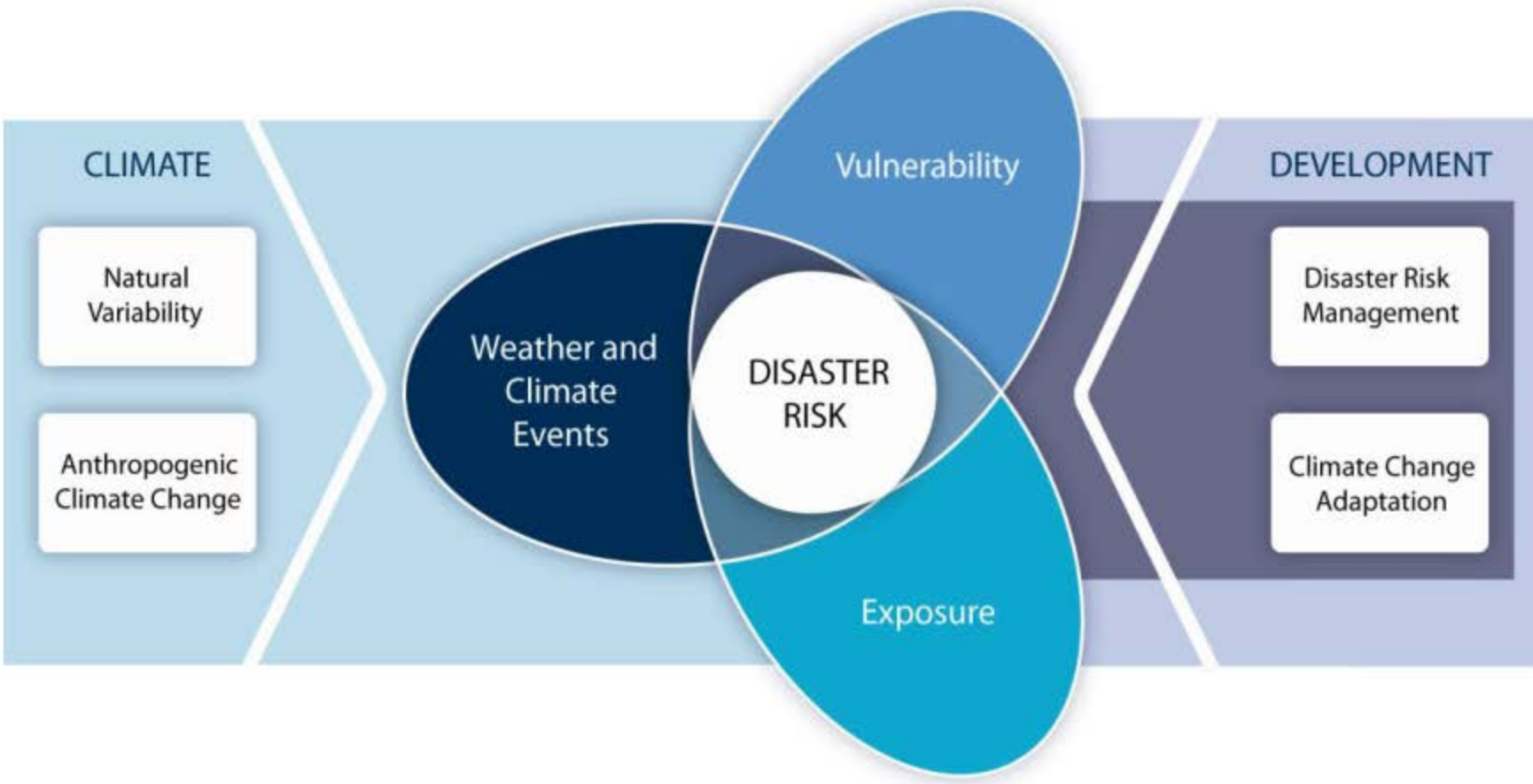
Relationship between adaptation and Mitigation

- Integration of mitigation options and adaptation options



出典：環境省環境研究総合推進費S8資料

Increasing vulnerability, exposure, or severity and frequency of climate events increases disaster risk



Strategy for Adaptation for Climate Change

- （1）Mainstreaming in governmental policy
- （2）Increase of Scientific Knowledge
- (3) Provide risk information shared with people
- (4) Promotion of adaptation in local/regional scale
- (5) International Collaboration

Areas for Adaptation

- (1) Agriculture, forestry and fishery
- (2) Water resources and environments
- (3) Eco-system
- (4) Natural Disaster and Coastal Zone
- (5) Health
- (6) Daily Life

Action in Japan

- (1) Adaptation Act
- (2) Regional Adaptation Consortium
- (3) Increase of NIES capability

A-PLAT

気候変動適応情報プラットフォーム
Adaptation for the future.

CLIMATE CHANGE
ADAPTATION
PLATFORM, JAPAN

環境省 Ministry of the Environment

National Institute for Environmental Studies, Japan

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Climate Change Adaptation | National Adaptation Plan of Japan | Impact & Adaptation | Let's Adapt! | International Action

LET'S ADA
Tips for
Communit
and Society

IMPACT &
ADAPTATI
IN JAPAN

Summary

- Basic science associated with model development and global warming
- Application of our knowledge to actual issues
- Integration of mitigation and adaptation
- Evaluation of our action