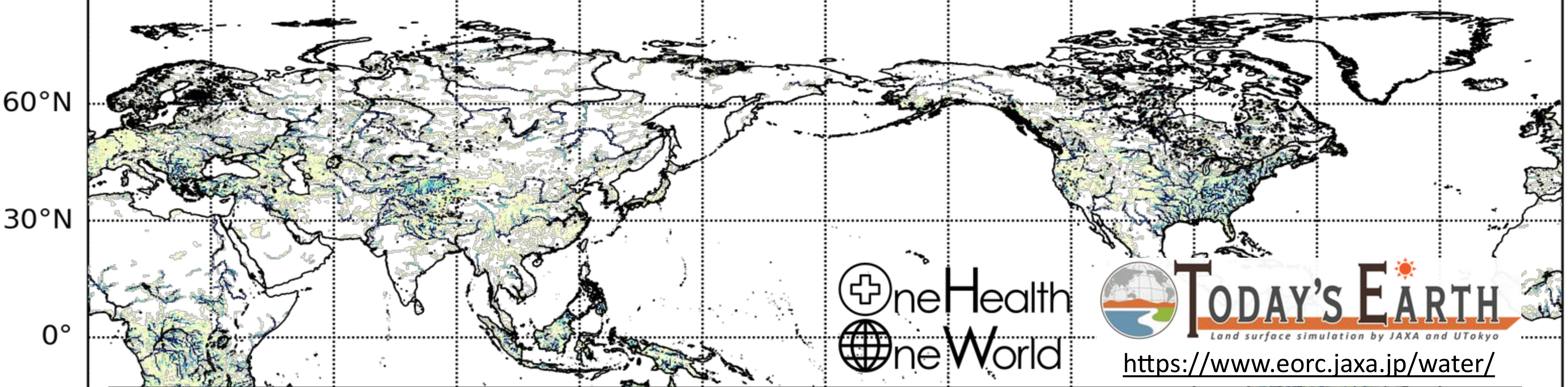


https://www.eorc.jaxa.jp/water/

Global km-scale Hackathon Tokyo Node

Global km-scale terrestrial hydrological modeling

Kei YOSHIMURA
Global Hydrological Prediction Center (GHPC),
Institute of Industrial Science, The University of Tokyo

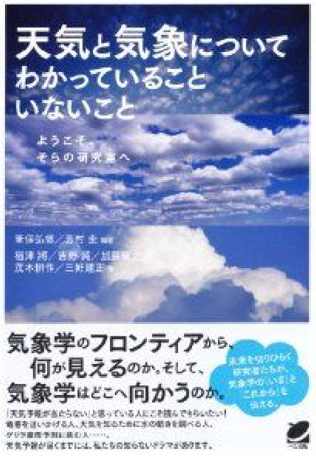
JAXA EORC 東京大学生産技術研究所 Institute of Industrial Science, The University of Tokyo

Kei Yoshimura

Professor, Institute of Industrial Science, U-Tokyo
Director, Global Hydrological Prediction Center
Deputy Director, UT Center for Climate Solutions
Also: JAXA/EORC, Civil Dept., Dept. of Nat. Environ., Atmos. Ocean Res. Inst., One-Health One-World, Data Commons

【Main Employment】

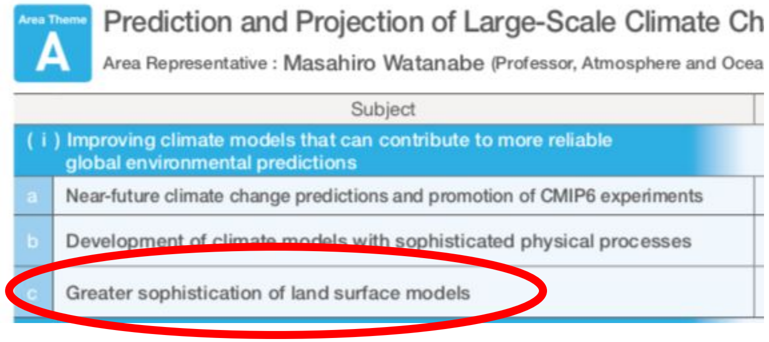
2000 B.Eng., 2002 M.Eng.
2001: Business School in Durham U.
2002~: Japan Sci. Tech.
2004~: Res. Assoc. in IIS.
2006：Thesis PhD.
2006~2010: SIO/UCSD
2010~2016: AORI (IIS)
2016~2017: IIS@Komaba
2017~: IIS@Kashiwa



【Main Research】

- Modeling and monitoring of water **isotopic** cycles
- Climate change mechanisms focusing on **land surface** processes
- Prediction of hydrological quantities and early and efficient information dissemination for disaster prevention and mitigation
- Relationship between historical events and climate change
- Estimation and prediction of extreme hydrological events using AI

History of Japanese projects on climate change and its prediction



Area Theme A Prediction and Projection of Large-Scale Climate Ch

Area Representative : Masahiro Watanabe (Professor, Atmosphere and Ocea

	Subject
(i)	Improving climate models that can contribute to more reliable global environmental predictions
a	Near-future climate change predictions and promotion of CMIP6 experiments
b	Development of climate models with sophisticated physical processes
c	Greater sophistication of land surface models

SENTAN
(FY2022~)

FY
2022

TOUGOU
(FY2017~)

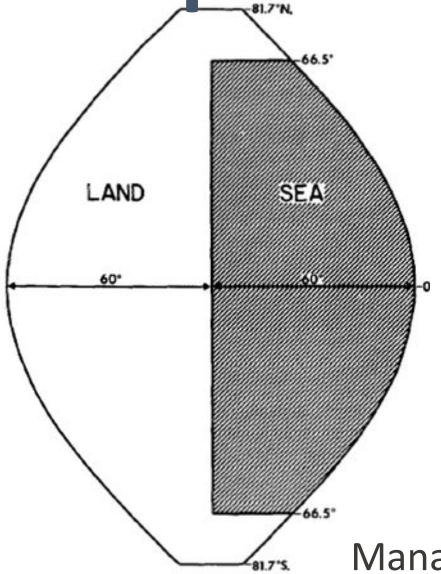
TOUGOU

2021-2022: AR6

Land-Specific Issues in the ESM: Development Regime

Background

- Since the days of Manabe's *bucket model*, it has been developed as one physical parameterization of the atmospheric model. (LSS: Land Surface parameterization Scheme)
  - Atmospheric resolution is not adequate for land and is overly simplified.
  - Land experts are often absent in the core GCM development group and the speed of development and improvement was slow.
- Improvements in land surface processes have not been able to resolve some of the apparent biases in climate models (e.g., Too hot and dry summer), even though they have been partially attributed to land.
  - Stand-alone models with more precise physics exist (e.g. MODFLOWS, HYDRUS, RRI, Alpine3D), but there has been no infrastructure to implement them.
  - Such land experts have not been involved in the development of land models for climate modeling.



Manabe, 1969

Tenki, 1987

Land-Specific Issues in ESM: Spatial Heterogeneity & Human Activity

Background (cont'd)

- Because the land area is spatially more complex/diverse than the atmosphere/ocean, a wide variety of processes must be considered at relatively high resolution relative to the atmosphere/ocean.
- Human activities have significantly modified the land area itself and cannot be represented by natural processes alone.

Objective

- To develop a framework that can be coupled with atmospheric/oceanic and other models while achieving high resolution and simple implementation of detailed elemental models on an appropriate grid system.
- To build a model that can withstand various applications (e.g., flood forecasting), not only as part of the lower boundary of the ESM.

1° X 1°（about 100km X 100km）

Integrated Land Simulator

Development of Integrated Land Simulator, ILS (Nitta et al., 2020)

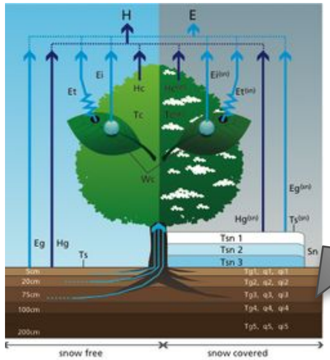
<u>will contribute MIROC7/CMIP7</u>

Basic concepts:

- Port the latest stand-alone models with smallest modification of the codes.
- Run the models with their preferred time steps and resolutions, and exchange necessary data with appropriate regridding by the coupler.

1-D Land Model MATSIRO

(Takata et al., 2003; Nitta et al., 2014; 2017)

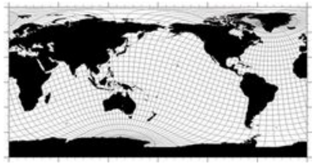


General purpose coupler Jcup (Arakawa et al., 2011)

AGCMs

MIROC (Tatebe et al., 2019)

NICAM (Sato et al., 2014) etc.

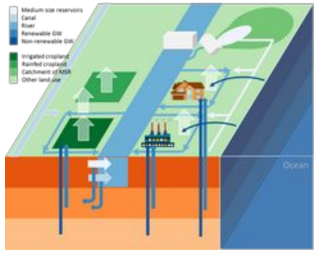


OGCMs

COCO (Hasumi, 2006) etc.

River Model CaMa-Flood

(Yamazaki et al., 2011;)



Human Impact Model H08

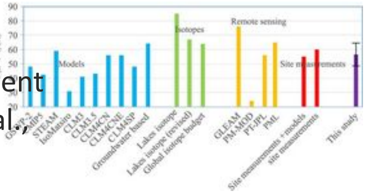
(Hanasaki et al., 2008)

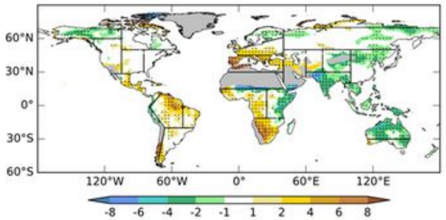
Following models are developed and will be coupled:

- Dynamic sediment transport model (Hatono and Yoshimura, 2020)
- 3D ground water model (Miura and Yoshimura, 2020)
- River water temp. and quality transport model (Tokuda et al., 2019)
- Dam operation model (Hanazaki et al., in prep.), Etc.

Key Achievements

- Global 90m DEM and hydrography data (Yamazaki et al., 2017; 2019)
- Global transpiration fraction on ET (Wei et al., 2017; 2016)
- Global aridity change by 1.5 degree agreement (Takeshima et al., 2020)





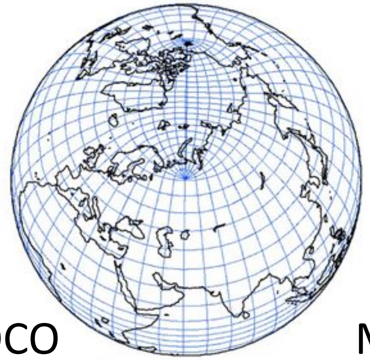
http://hydro.iis.u-tokyo.ac.jp/~akira/page/Works/contents/SPRING/

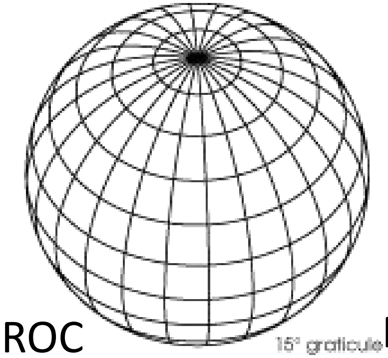
Courtesy of A. Takeshima

Development of a regridding tool SPRING

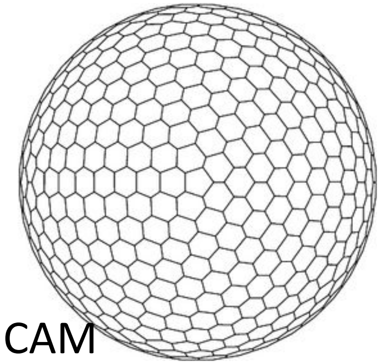
- Correspondence table of lattices used to exchange physical quantities between models of different lattice systems
- Distributes physical quantities according to the percentage of overlapped area between lattices
- Used not only for exchanging variables between models via JCup, but also for making boundary conditions, etc, by changing resolution (upscaling).

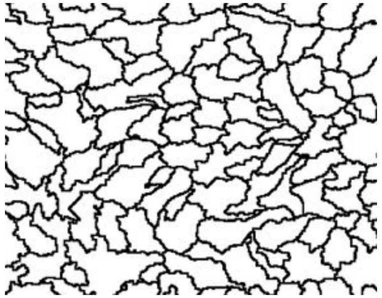
	Model	Coordinate	Grid # (lat*lon)
Ocn	COCO [Hasumi et al., 2000]	Tri-polar grid	256*360
Atm	MIROC [Watanabe et al., 2011] NICAM [Satoh et al., 2008]	T85 Pentagon/Hexagon	128*256 32*32*10
Lnd	MATSIRO [Takata et al., 2003]	0.5°*0.5° Rectangle	360*720
Riv	CaMa-Flood [Yamazaki et al., 2011]	Unique grid	360*720


COCO



MIROC


NICAM


CaMa-Flood

1-dimensionalization of MATSIRO

Takata et al., 2003
Nitta et al., 2014;2016;2020

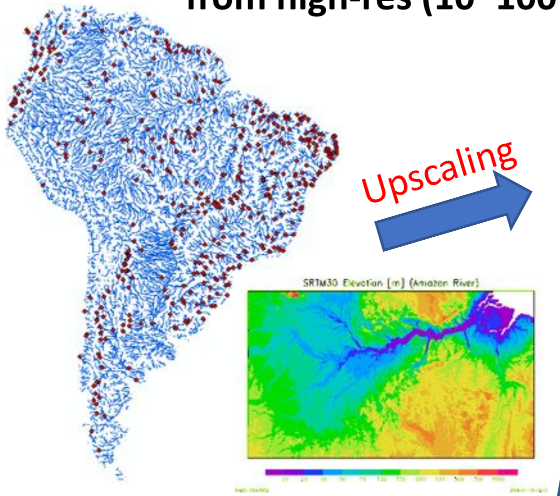
- MATSIRO is a land model of MIROC and NICAM models
- It has been also used for impact assessment studies
- It consists of 6 soil layers (14m in total), 3 snow layers, and a single canopy layer and includes various land physics (e.g. radiation transfer, bulk coefficient, snow, runoff, soil property…) and a tile scheme
- The performance has been evaluated through MIP studies.

Validation of Sensible Heat Flux (Nitta et al., 2020)

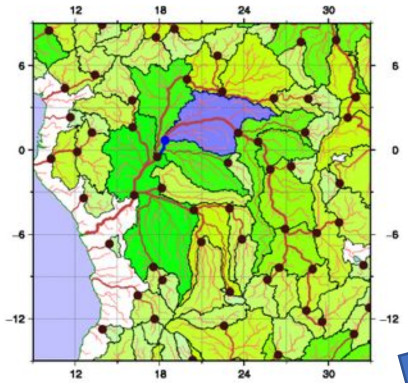
Yamazaki et al., 2013; 2014; etc.

River Inundation model CaMa-Flood

Abstract sub-grid topographic characteristic from high-res (10~100 m) DEM

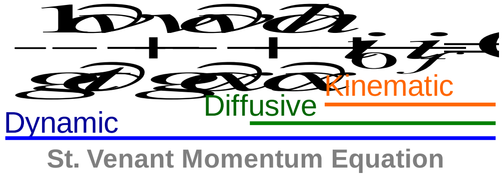


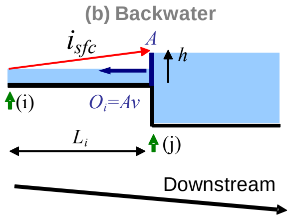
Upscaling



Parameterization

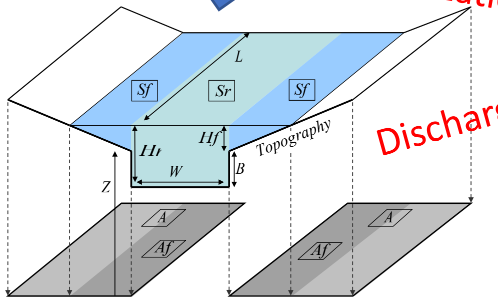
Diffusive Wave Equation
Depending on water level, “backwater” occurs.



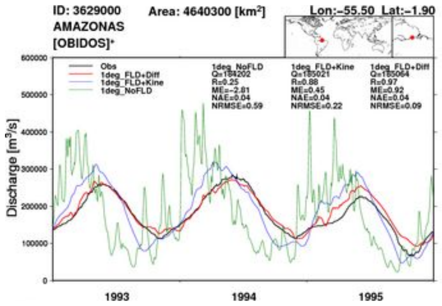


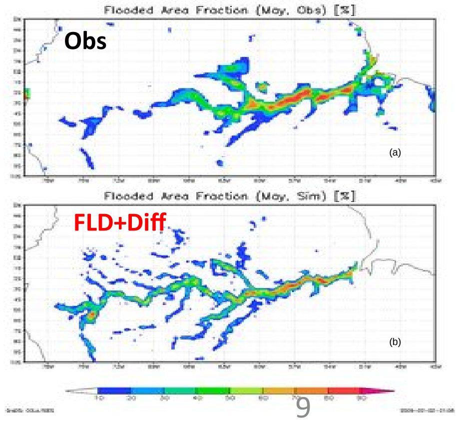
In addition to river discharge, water level altitude and inundation area is simulated.
→ comparable to satellite-based estimates.

Parameter	Channel Elevation	Z
	Channel Length	L
	Channel Width	W
	Embankment Height	B
	Catchment Area	A
	Floodplain Elevation Profile	*f(Topography)*
Variables	River Storage	S_r
	Floodplain Storage	S_f
	River Water Depth	H_r
	Floodplain Depth	H_f
	Inundated Area	A_f



Discharge, w-level, inundation are predicted.





Each grid represents basin shape with sub-grid topographic parameters. River water depth and inundation area is explicitly calculated.

Variably Saturated Groundwater Model

Miura and Yoshimura, 2020
Miura and Yoshimura, 2022

Governing equation

$$\frac{\partial\theta(\varphi)}{\partial t}+S_sS_w(\varphi)\frac{\partial\varphi}{\partial t}=\nabla\cdot[K(\varphi)\cdot\nabla(\varphi+Z)]+q$$

One dimensional
S_s ---> 0
q ---> exclude

θ ---> 0
$S_w(\varphi)$---> 1
$h=\varphi+Z$

Richards equation

$$\frac{\partial\theta}{\partial t}=\frac{\partial}{\partial z}\left[K(\theta)\left(\frac{\partial\varphi}{\partial z}+1\right)\right]$$

Groundwater equation

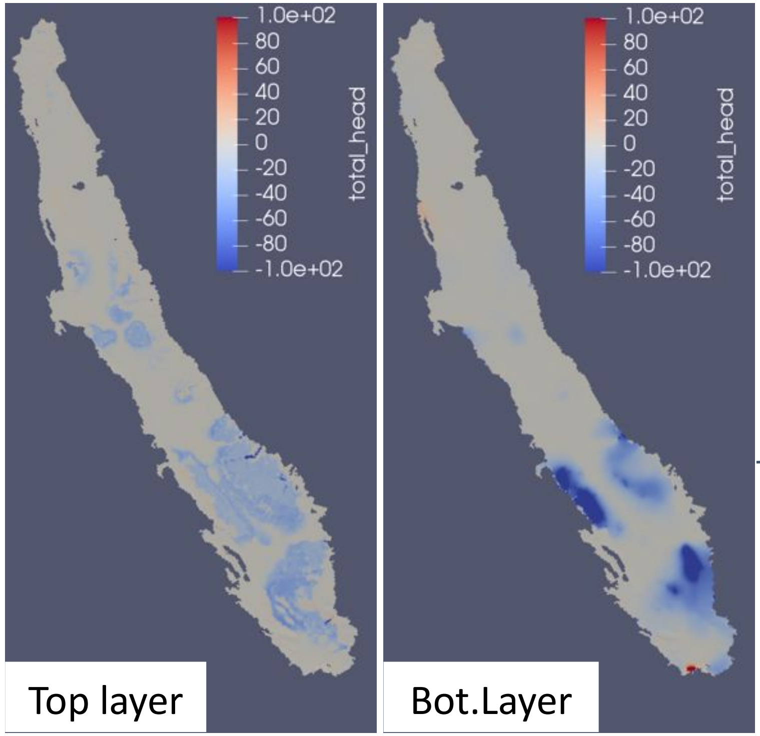
$$S_s\frac{\partial h}{\partial t}=\nabla\cdot[K\cdot\nabla(h)]+q$$

θ : water content
φ : pressure head
S_s: specific storage
S_w: saturation ratio
K : hydraulic conductivity
q : source/sink term

with GW pumping parameterization

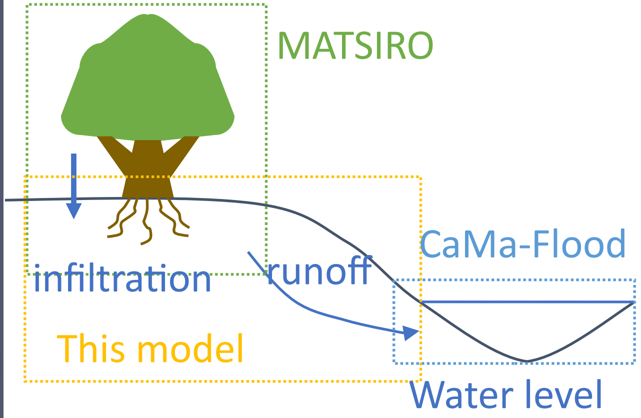
Unknown value	
Primary	Pressure head (φ)
Secondary	Water content (θ) Saturation ratio (S_w)
Primary to Secondary	Water retention (e.g. Van Genuchten model)

Model output
Groundwater level (Hydraulic head) Groundwater table
Flow velocity
Water balance



GW table drop after 100 years

Modulate this model in ILS and coupled with MATSIRO and CaMa-Flood.

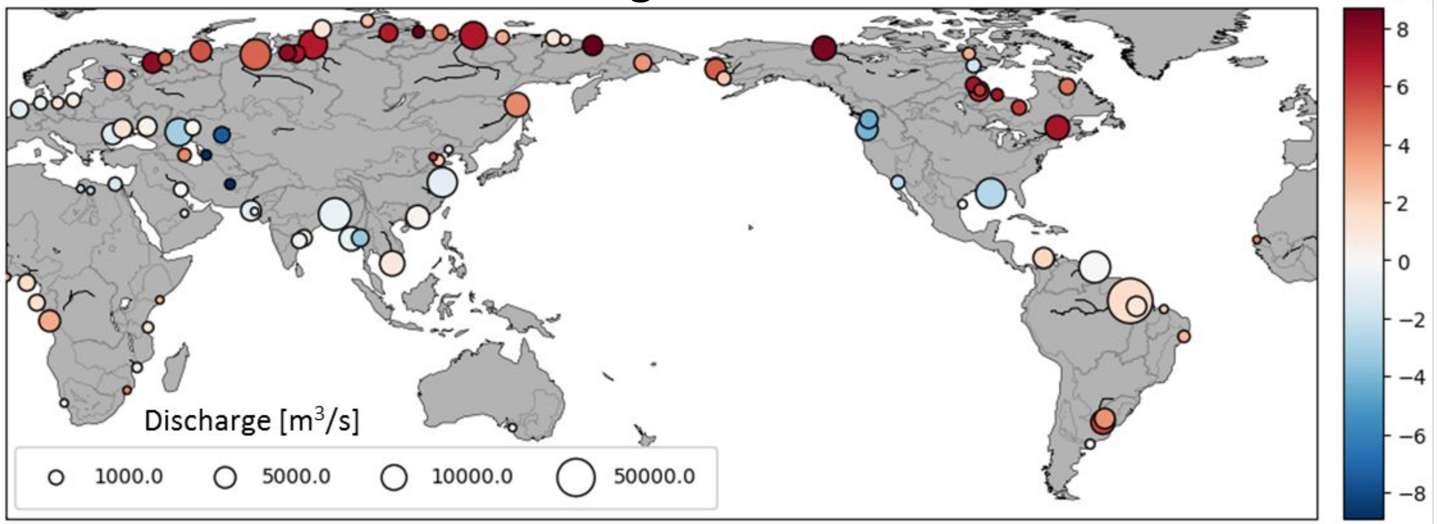


➔ Better reproducibility in low flow.

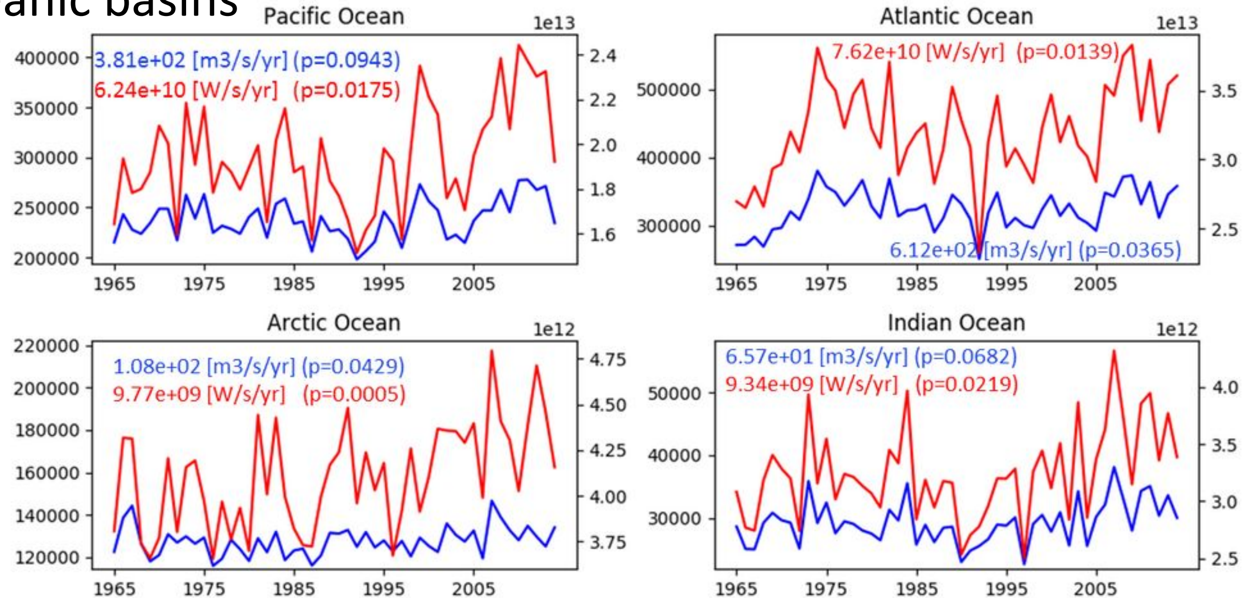
River water temperature & Surface Flux from Rivers/Lakes

Arctic rivers effectively transports energy from warmer South to colder North region

Temperature difference between river water at mouth & the nearest coastal ocean [°C]



Long-term trend of Freshwater[m³/s] (left) and thermal discharge[W] (right) into oceanic basins



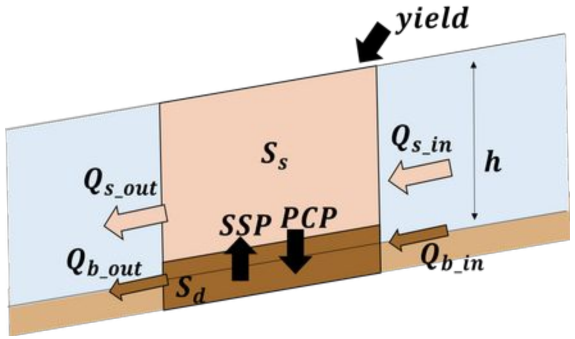
1965~2014 regression coefficient and p value

These estimation are conducted with global-scale river water temperature model [Tokuda et al., 2019]

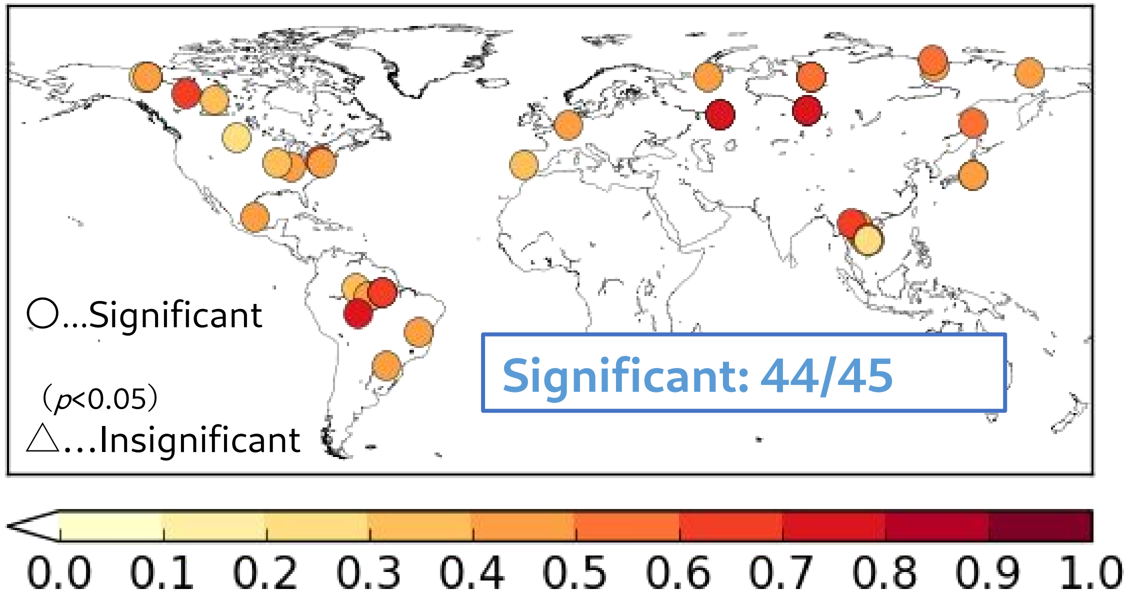
Misako Hatono@Tohoku U.

Sediment dynamics modeling

- Incorporated sediment dynamics into CaMa-Flood within the framework of ILS
  - ✓ Considers suspended sediment and bedload
  - ✓ Seasonal variation is well represented. Regional calibration improves accuracy in peak values

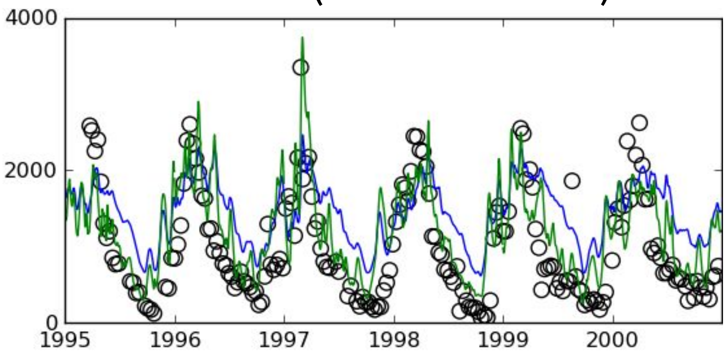


Schematic of sediment model



Correlation coefficient of suspended sediment

Amazon(Obidos station)



Suspended sediment[10^3ton/yr]

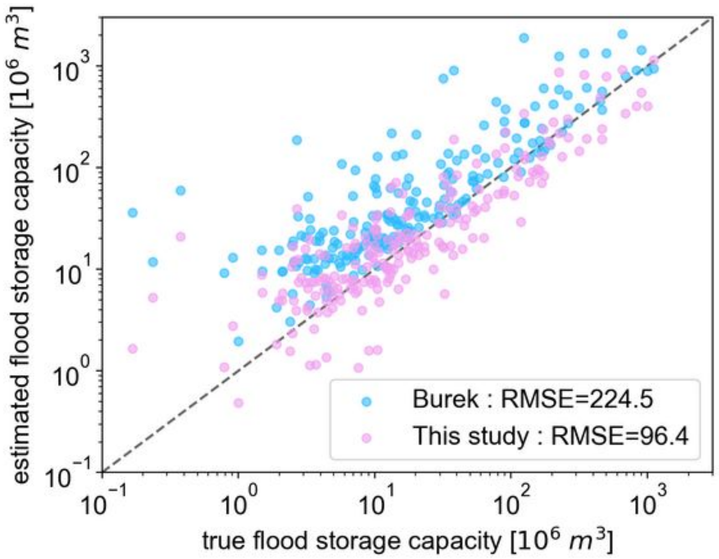
Obs. **CTL** **Calibrated**

Hatono and Yoshimura, 2020

General-purposed Dam Operation Scheme

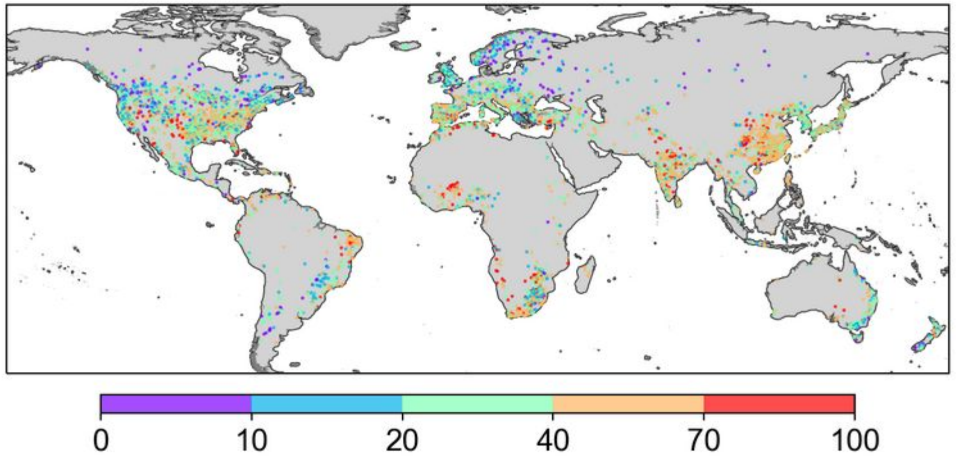
	Estimation of Flood Storage Capacity (FSC)	Global applicability	Characteristic of operation
Burek et al., 2013	70% of total storage (Vmax)	○	×
Yassin et al., 2019	45%-ile of observed volume	×	○
This Study	75%-ile of GRSAD* is converted to volume using ReGeom**	○	○

*Global Reservoir Surface Area Dataset: Zhao and Gao, 2018
**Global Reservoir Geometry Database: Yigzaw et al., 2018



Validation of FSC at 212 dam reservoirs

Hanazaki, Yamazaki, Yoshimura, 2022



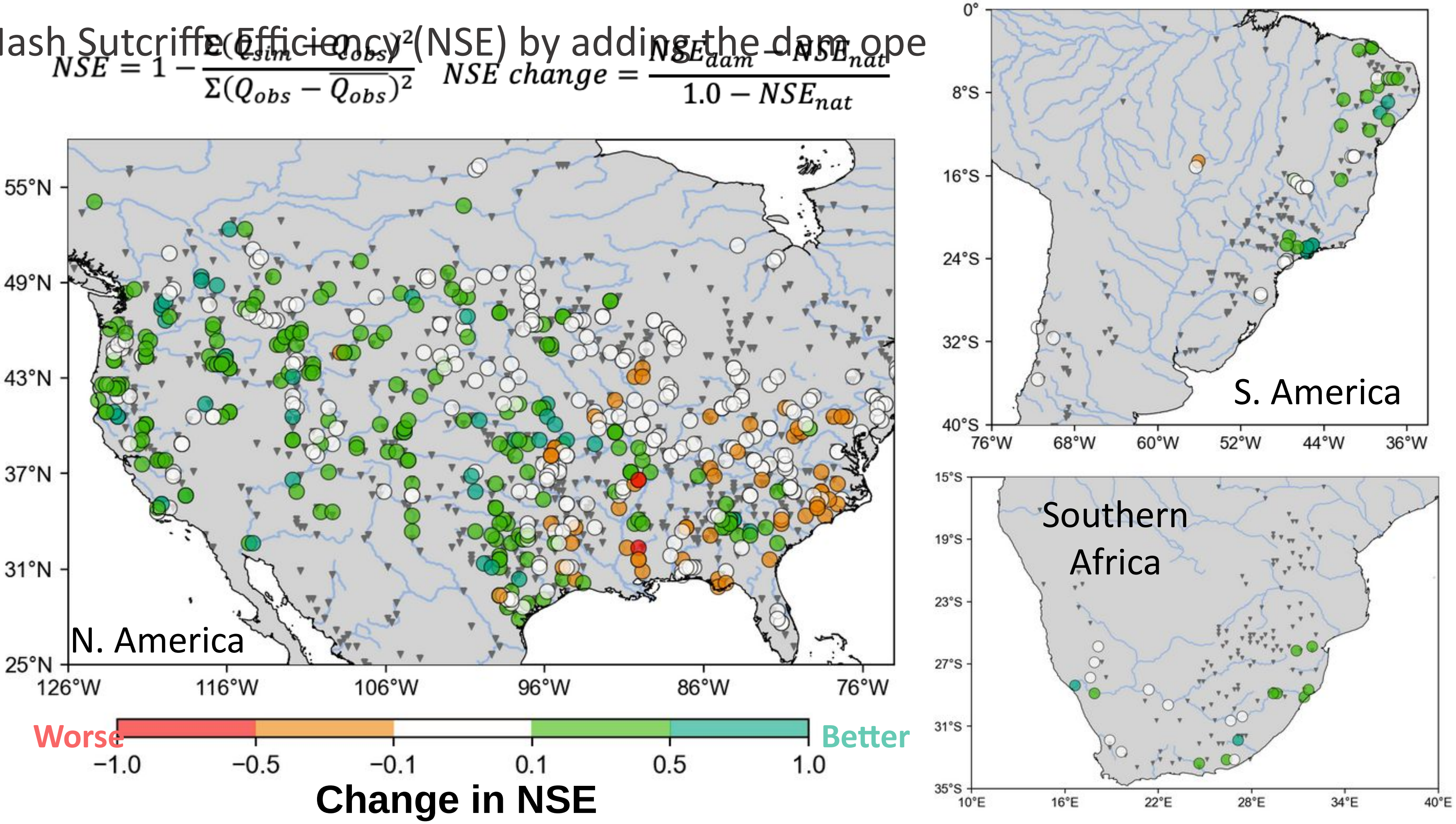
Distribution of FSC ratio at 6862 dams [%]

Improved accuracy of FSC estimation by utilizing time-series of observed reservoir surface area that reflects the impact of actual dam operations

Reproducibility of river discharge at downstream of dams

- Change of Nash Sutcriffe Efficiency (NSE) by adding the dam ope

$$NSE = 1 - \frac{\Sigma(Q_{sim} - Q_{obs})^2}{\Sigma(Q_{obs} - \overline{Q_{obs}})^2} \quad NSE\ change = \frac{NSE_{dam} - NSE_{nat}}{1.0 - NSE_{nat}}$$



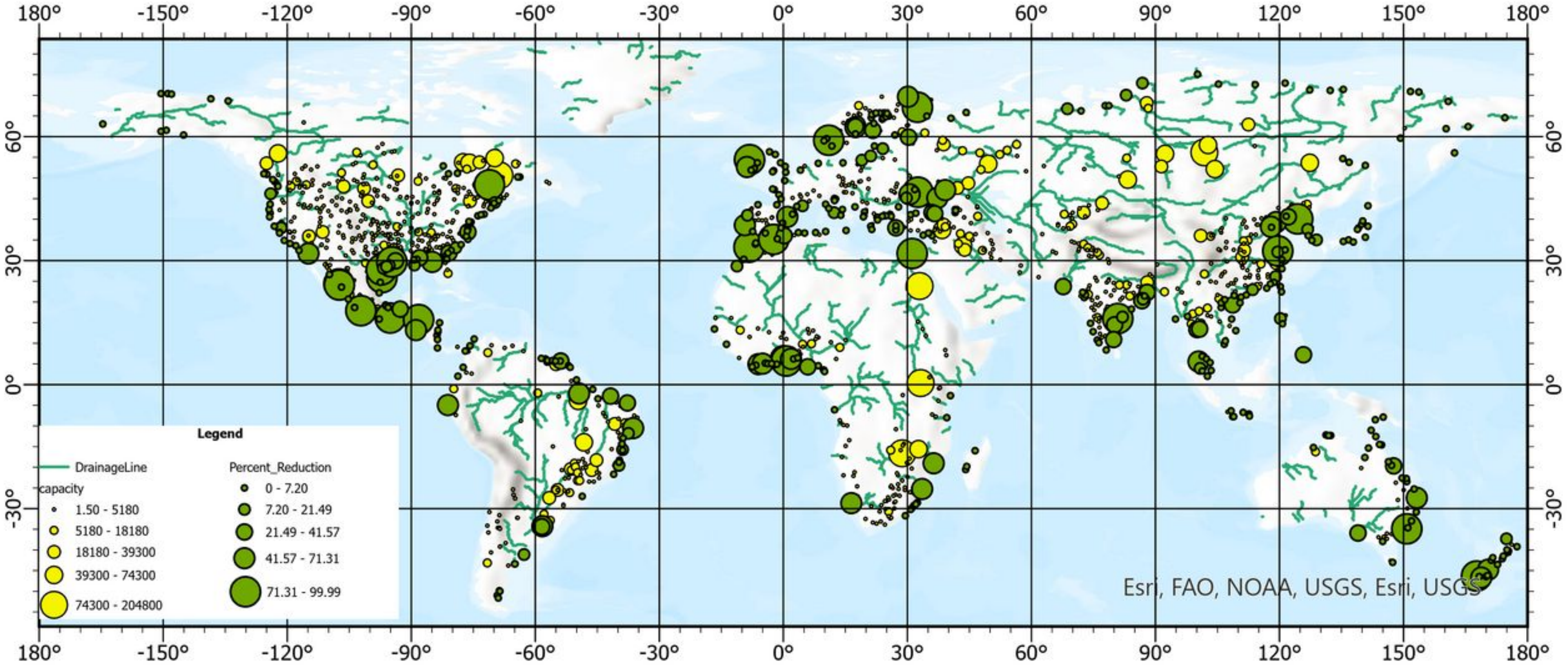
NSE significantly improved at 283 out of 687 discharge sites

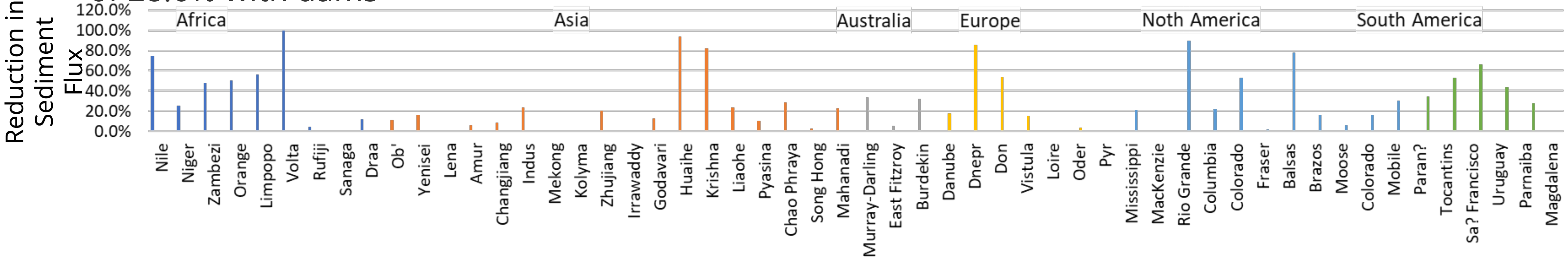
Hanazaki, Yamazaki, Yoshimura, 2022

Reduction in Sediment Flux (%) at river mouths

Rivers which are impacted by dams (168 in number) show 30.1 percent reduction in Suspended Sediment Flux

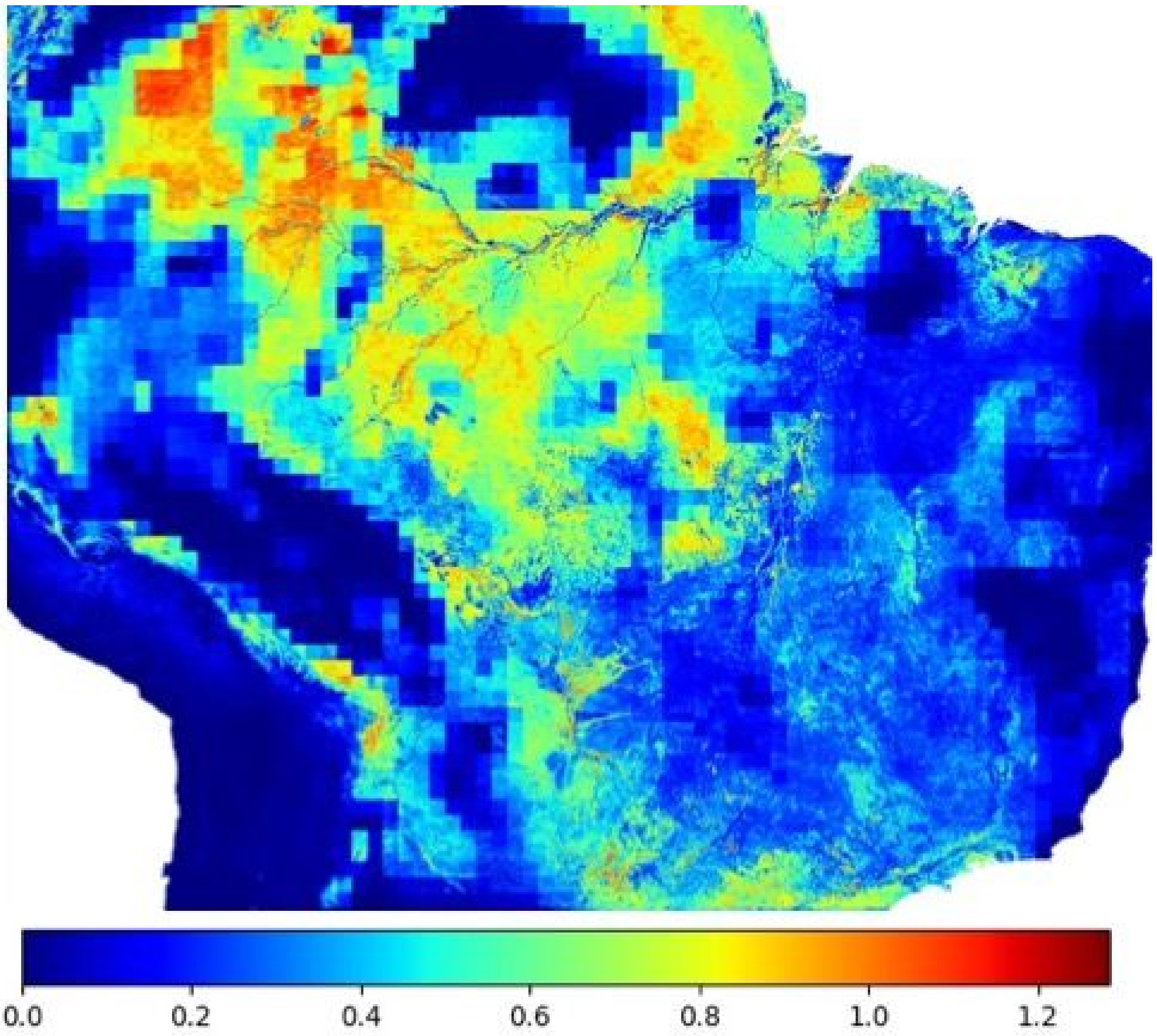
Large Rivers with drainage area > 100k km^2 Show a reduction of 28.6% with dams





Aslam et al., in prep.

Preliminary result of globally 1km resolution experiment using *Fugaku*



Courtesy of T. Nitta

🡐Canopy intercepted water amount (kg/m2)
Areas that appear angular represent areas where the atmospheric conditions given by the low resolution are more influential than the land surface conditions given by the high resolution (land use type, leaf area, soil classification, etc.).

Variables sensitive to high-resolution boundary condition data

Improvement of subgrid parameterization

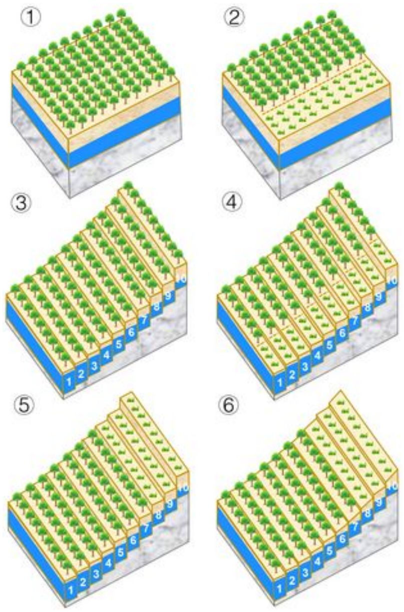
Improvement of subgrid parameterization

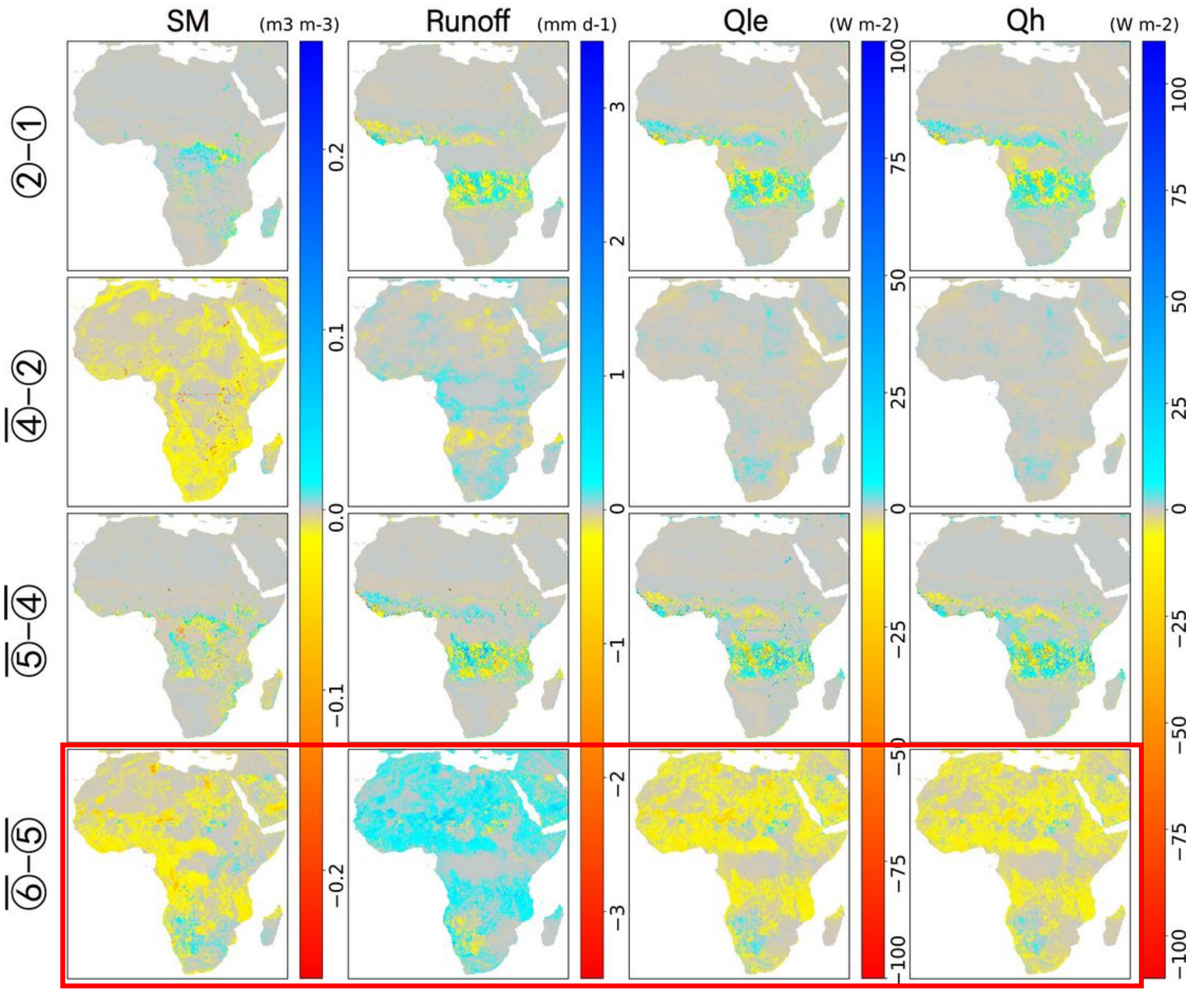
Improvement of subgrid parameterization

Shuping Li, PhD Thesis

- **Water and energy variation at continental level**

- When additionally resolve **topographic heterogeneity,** increasing Runoff and decreasing SM, Qle and Qh occur in much wider area (Sahara), respectively.

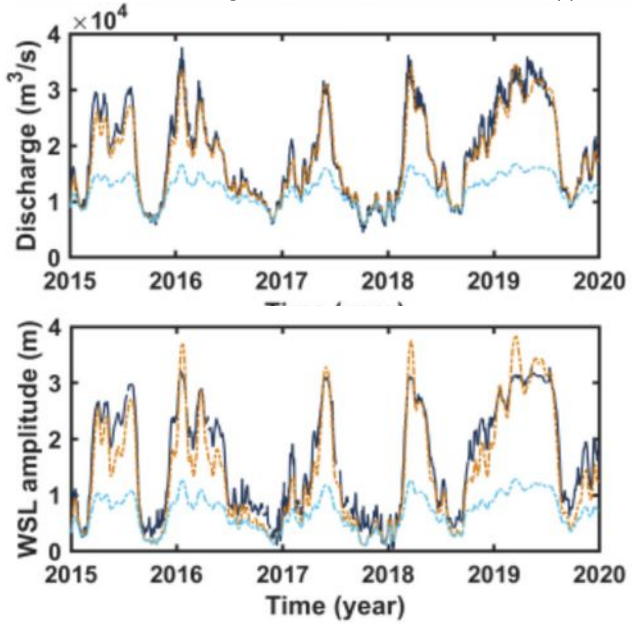




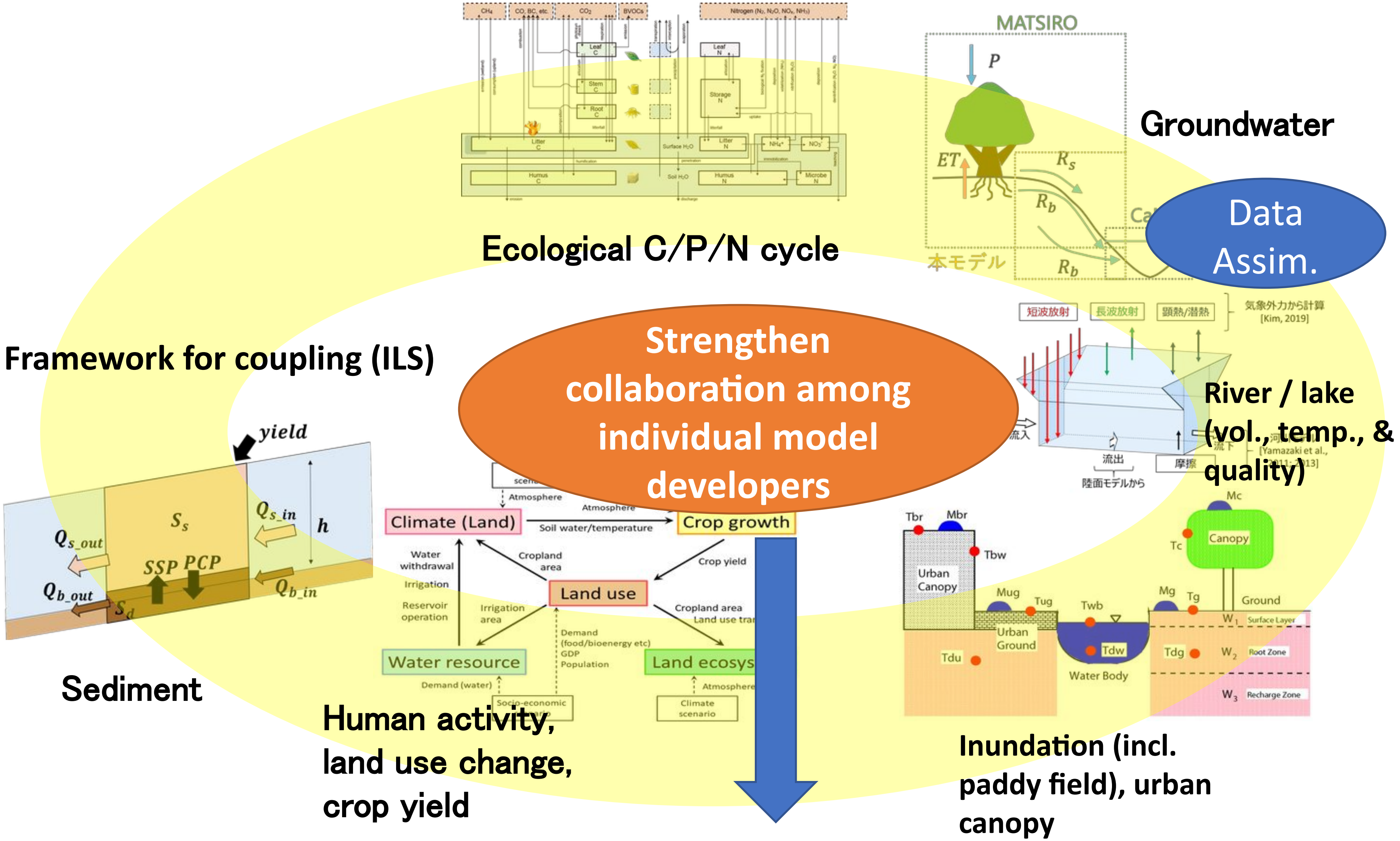
Modeling Levees

Courtesy of Gang Zhao

Validation of Discharge and Water Level at the Mississippi River



Community Effort of Land Model Development



Construction of a platform model consisting of a group of stand-alone models and maintenance of various peripheral softwares incl. regridding and coupling.

Coupling to Weather, Climate, and Earth System Models

Terrestrial Hydro-Simulation System: Today's Earth (TE)

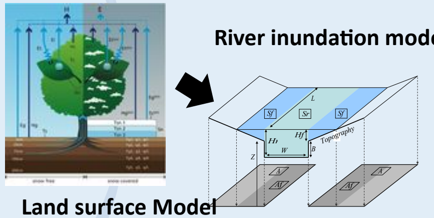
- Realtime estimates of water cycle on the planet is now available using the framework of global hydrology with various earth observation data and meteorological predictions.

TE–Global (Global System) Ma et al., 2024
Data is available on a 0.5-degree grid for the entire globe.
Development of global 0.1-degree grid is underway.
TE–Global NEXRA (Ensemble System) Yamamoto et al., in press.
128 ensemble 0.5-degree grid for the entire globe.
TE–Japan (Regional System) Ma et al., 2021
Currently operating on a grid of approximately 1 km.
39-hours prediction was started from March 2020.

Input Data Generator:
Fusion of satellite observation data and JMA reanalysis/forecast data to create an integrated atmospheric data set for model input.

Validation

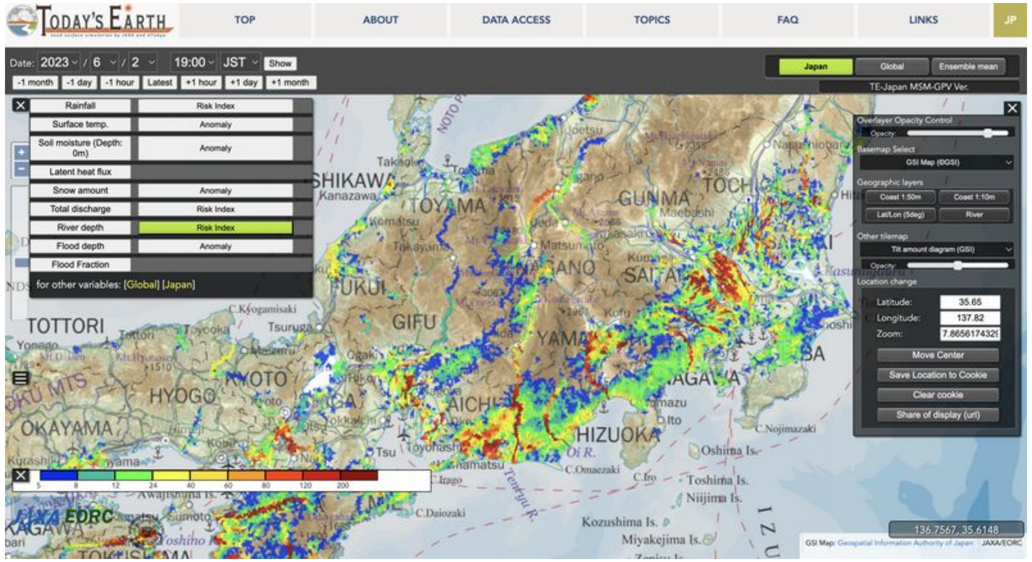
Integrated Land Simulator:
Advanced simulations using a combination of a land surface process model and a river inundation model



Improvement

Data Provider：
In addition to various hydrological quantities, hazard information is estimated, and made them available to the public.

3-yr (until 2024 Jan) daily snow / streamflow variations from TE-Global



Snapshot of flood risk on 2023/6/2 19JST from TE-Japan

- TE supports sustainable water management by monitoring floods, droughts, available water resources, etc.

ML Postprocessing of NWP precipitation (implemented in Today's Earth – Japan)

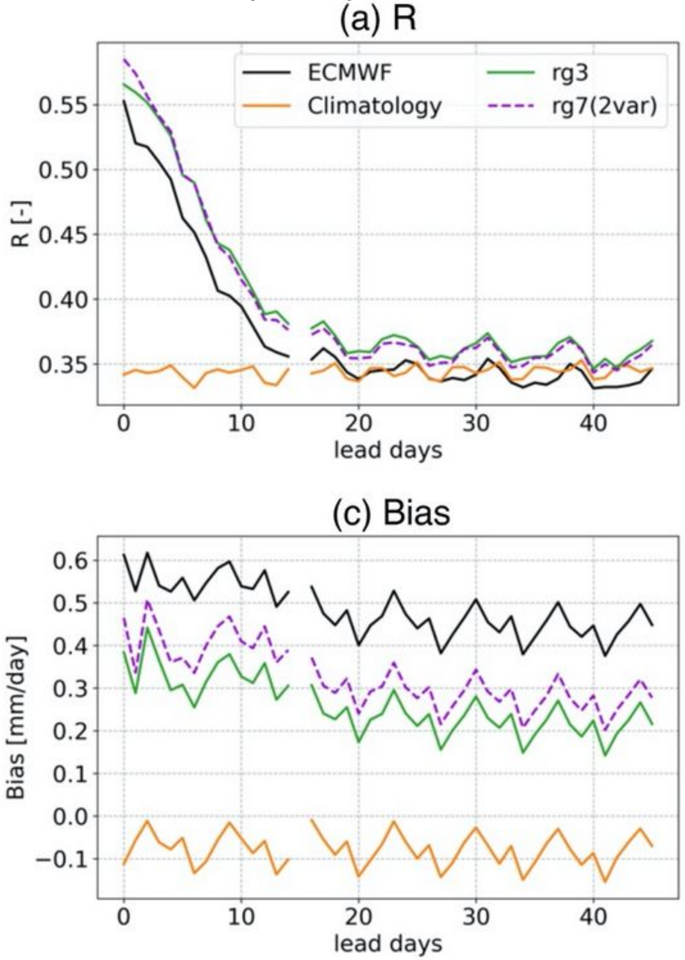
Yoshikane, T. and K. Yoshimura, A bias correction method for precipitation through recognizing mesoscale precipitation systems corresponding to weather conditions, PLOS water, 2022. https://doi.org/10.1371/journal.pwat.0000016

Yin, G., T. Yoshikane, K. Yoshimura, K. Yamamoto, T. Kubota, A support vector machine-based method for improving real-time hourly precipitation forecast in Japan, J. Hydrol., 2022. https://doi.org/10.1016/j.jhydrol.2022.128125

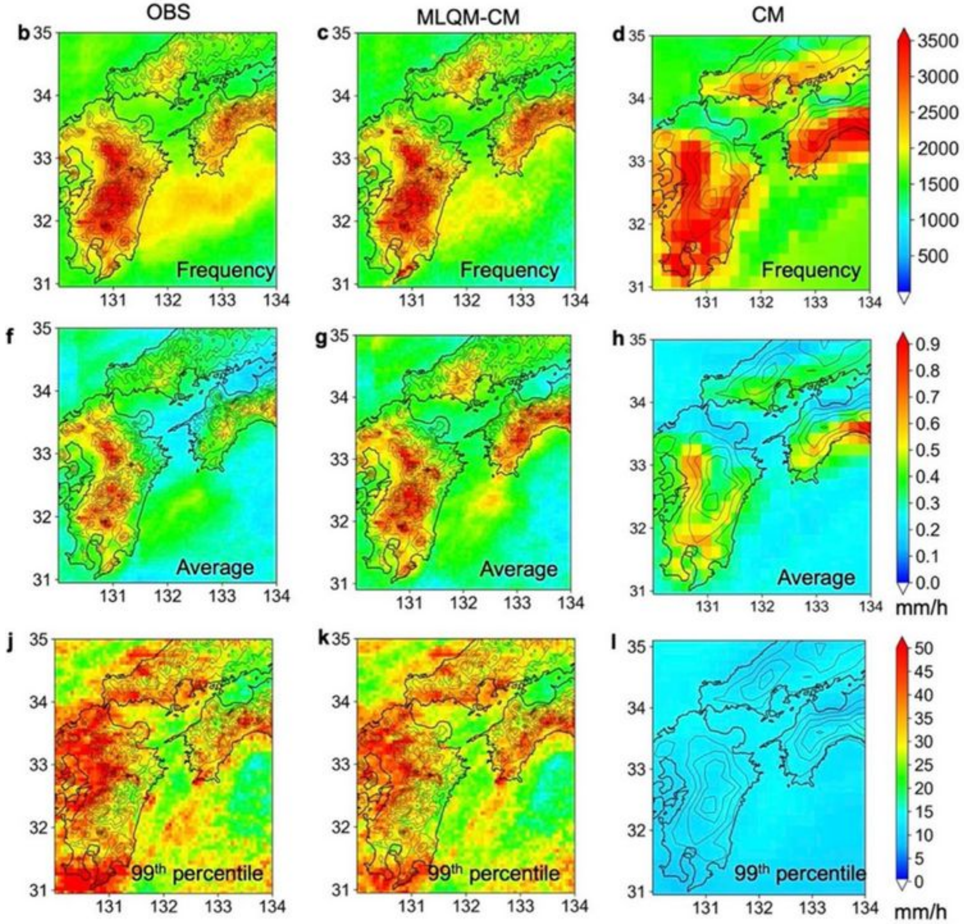
ML Postprocessing of Seasonal/Climate prediction

Global

S2S precipitation skill



Bias correction of climate projection



Regional

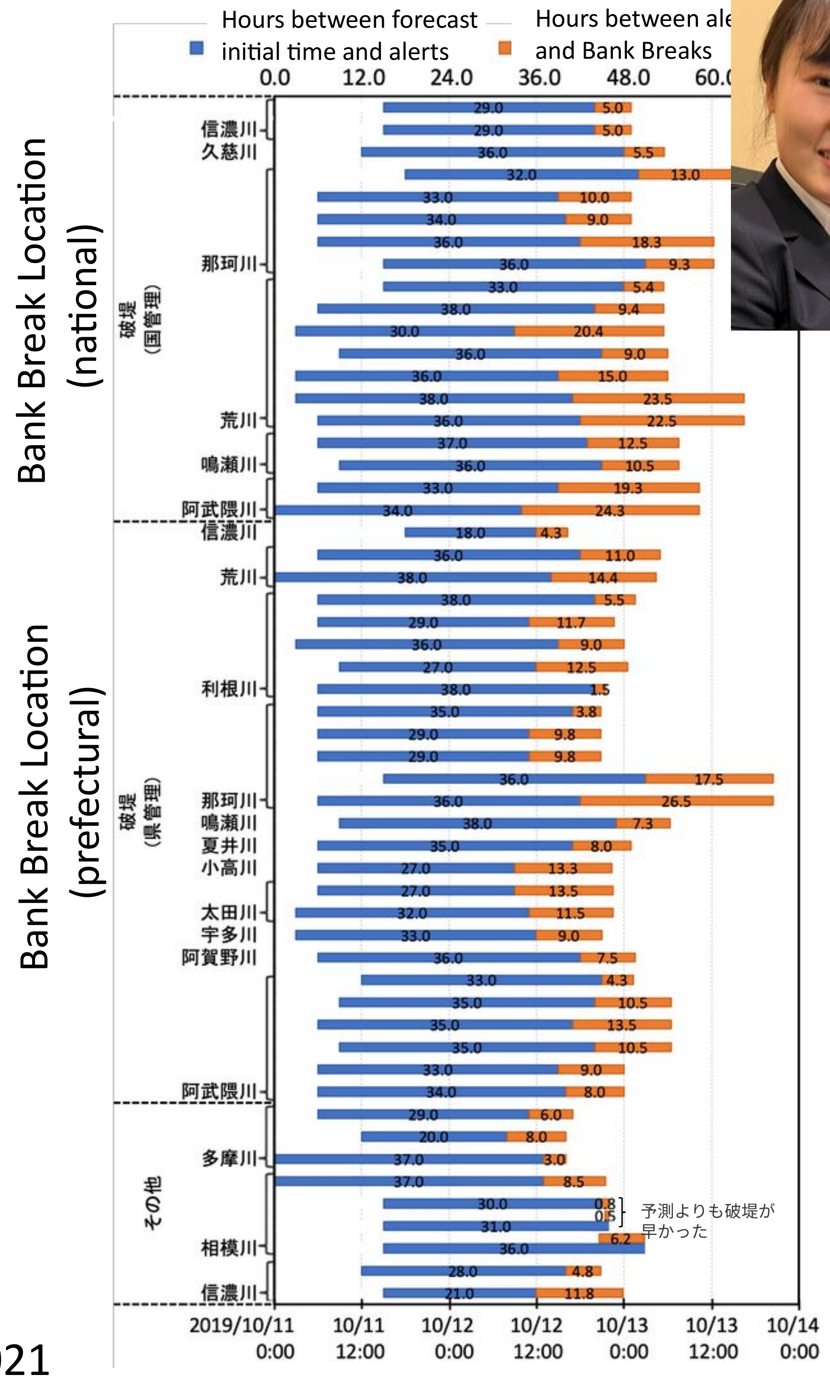
Yin, G., T. Yoshikane, R. Kaneko, K. Yoshimura, Improving global subseasonal to seasonal precipitation forecasts using a support vector machine-based method, JGR-Atmos, 2023. https://doi.org/10.1029/2023JD038929

Yoshikane, T. and K. Yoshimura, A downscaling and bias correction method for climate model ensemble simulations of local-scale hourly precipitation, Sci. Rep. 13, 9412, 2023. https://doi.org/10.1038/s41598-023-36489-3

Predictability for Floods by Hagibis 2019

©NHK

- According to authority, there were **142 levee-broken sites**. TE-Japan **successfully gave “alerts” at 129 sites** (i.e., 1/200yr water level) with sufficient lead time (in average 32.3 hours). Levees were destroyed 8.5 hours later than the “alerts”.
- False alarm rate is about **90% at 3am Oct 11**, but decreased to **70% since 9am Oct 11**, and reached 60% at 9pm Oct 12, when actual flooding started to occur.

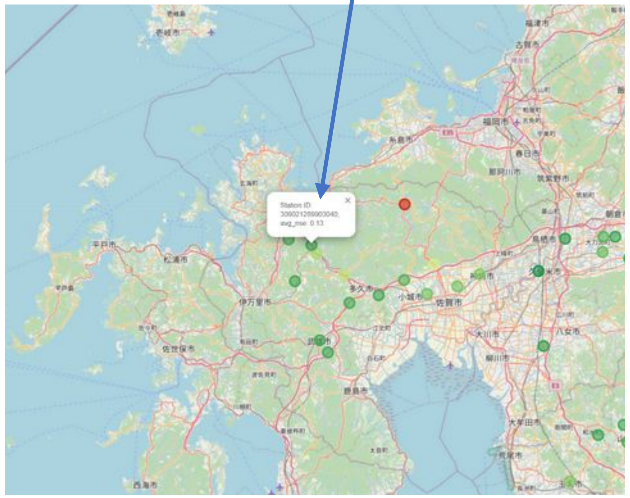


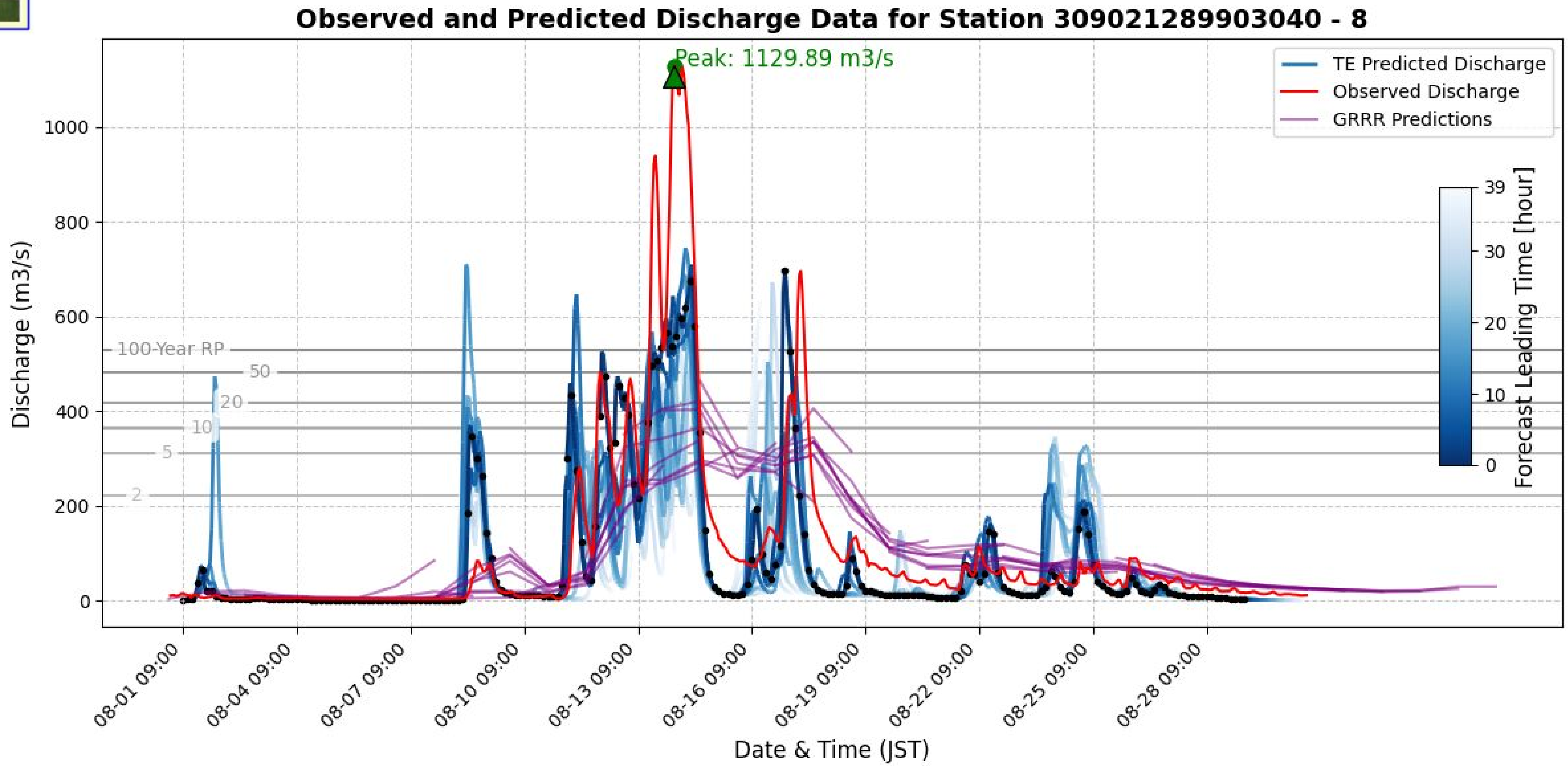
Ma et al., 2021

Comparing flood magnitude and timing predictions

- Comparing prediction of Today's Earth (CaMa flood) and Google's Runoff Reanalysis & Reforecast (GRRR) with the observation data (Q)
  - https://colab.research.google.com/drive/1FnXXSEQqU1TJhMPiNeWUTr9LnbJwZzMm

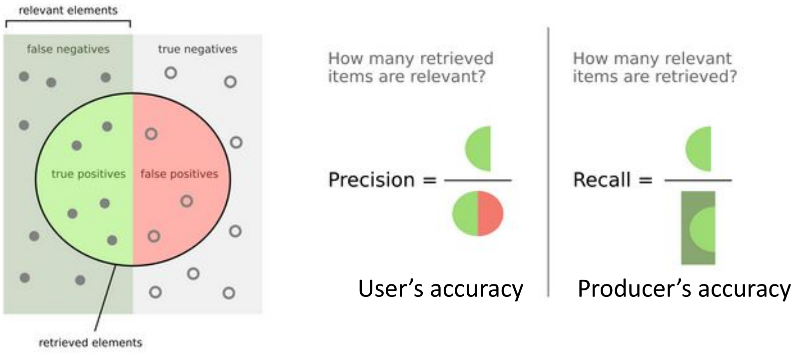
- Example for one station location (underestimation of TE)
- 2021-08, Heavy rain Kyushu
- Matsuura river, Saga



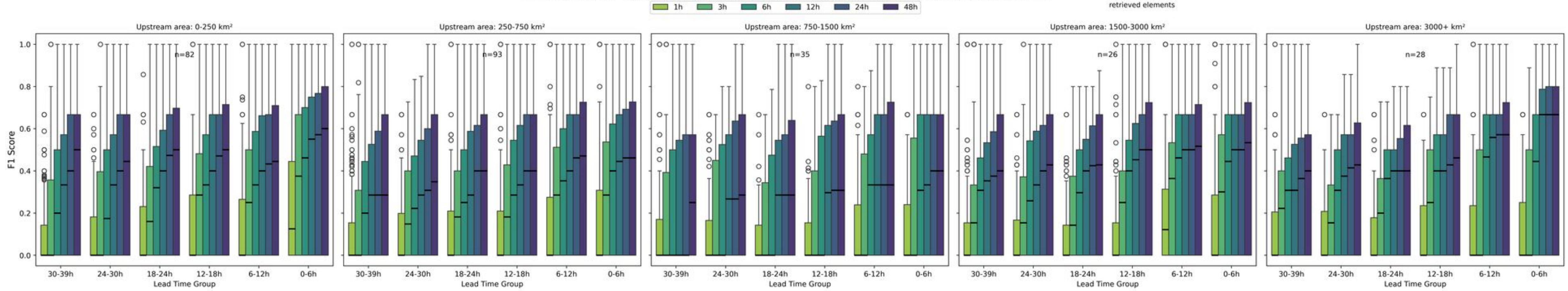


F1 Score and dependency on different time windows

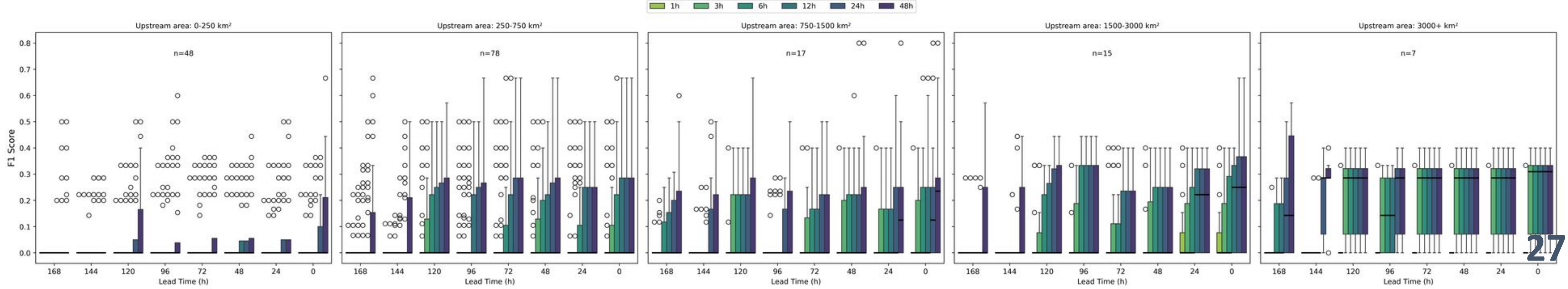
$$F_1 = \frac{2}{\mathrm{recall}^{-1} + \mathrm{precision}^{-1}} = 2\frac{\mathrm{precision} \cdot \mathrm{recall}}{\mathrm{precision} + \mathrm{recall}} = \frac{2\mathrm{TP}}{2\mathrm{TP} + \mathrm{FP} + \mathrm{FN}}$$



F1 Score Sensitivity to Time Windows per Upstream Area (TE Model), standby Q threshold



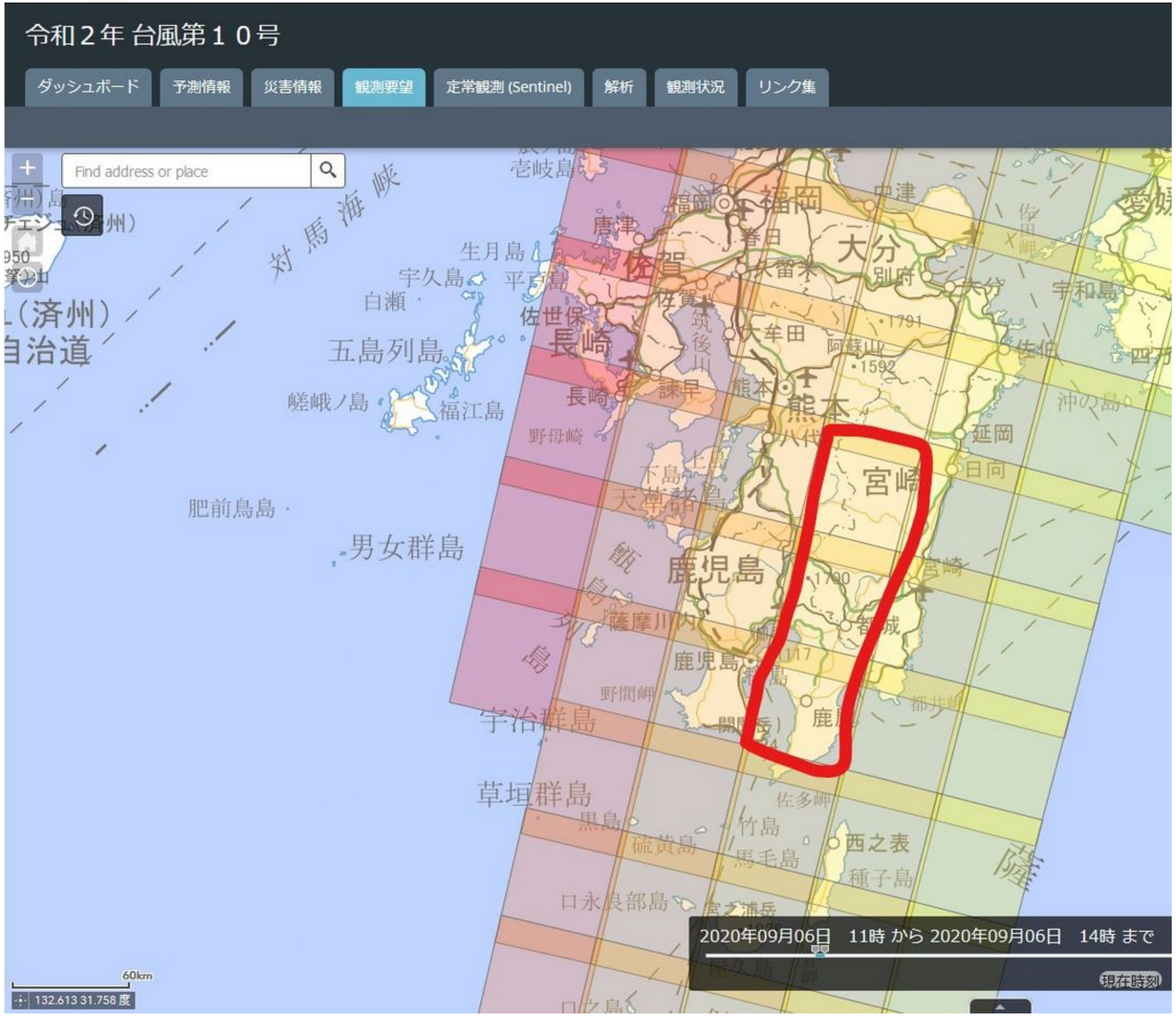
F1 Score Sensitivity to Time Windows per Upstream Area (GRRR Model), standby Q threshold



Using TE-J for "One-Stop System" by NIED/SIP

- TE-Japan assists the responsible river-management bureau of MLIT to make decision where to shoot by Palsar-2 on ALOS-2, and to request International Charter. It has been used for July heavy rain event and Typhoon 10 in September (and in present).

ALOS-2 intensive observation was finally reserved by a meeting at 10:30pm on Sep 5 for 1pm shots on Sep 6., 2020. ➔



Ohki et al. 2020

Fusion with Satellite Observation (SAR)

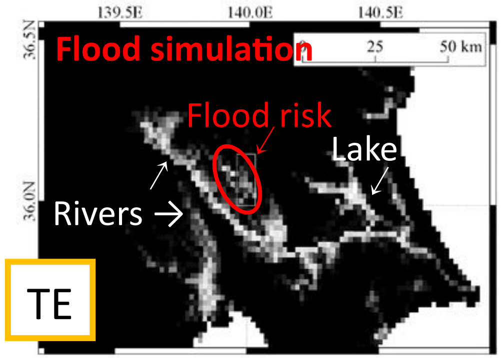
Probability of class i $P(F_i|\boldsymbol{x}) = \frac{P(F_i)P(\boldsymbol{x}|F_i)}{\sum_{j=0}^{3} P(F_j)P(\boldsymbol{x}|F_j)}$

PDF of Prior

PDF of SAR data for each class

SAR data $\boldsymbol{x} = \begin{pmatrix} \text{Co-event amplitude} \\ \text{Pre-event amplitude} \\ \text{Coherence difference}* \end{pmatrix}$

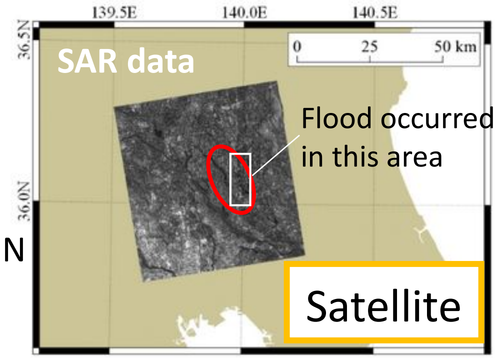
*co-event coherence − pre-event coherence



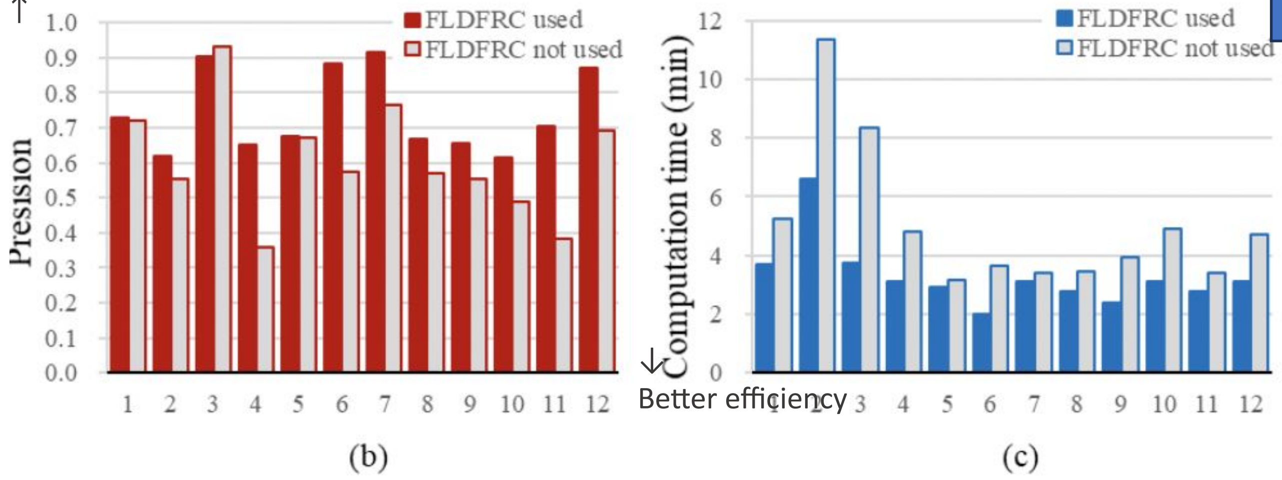
$P(\boldsymbol{x}|F_i) = \mathrm{N}(\boldsymbol{\mu}_i, \boldsymbol{\Sigma}_i)$

N : Gaussian Dist.

$\boldsymbol{\mu}, \Sigma$: Parameters of N (should be set along the incidence angle)

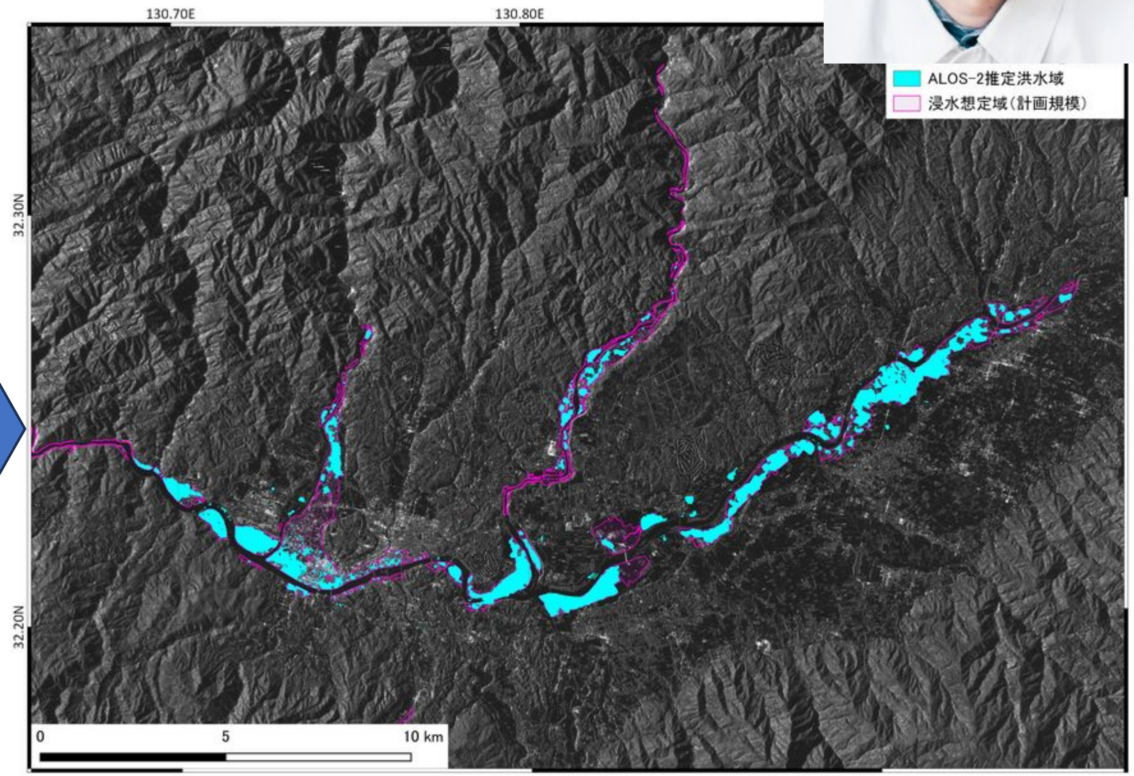


Better accuracy ↑



↓ Better efficiency

Though TE-J's low resolution (1.6 km), using predicted flood fraction as prior improves the SAR-based (3m) inundation estimates.



In July flood 2020, JAXA estimated the inundation promptly and announced it to the government.

https://www.eorc.jaxa.jp/ALOS-2/img_up/jdis_pal2_heavyrain_kyushu_20200706.htm

New! Impact-Based Alert (case of June 2-3, 2023)

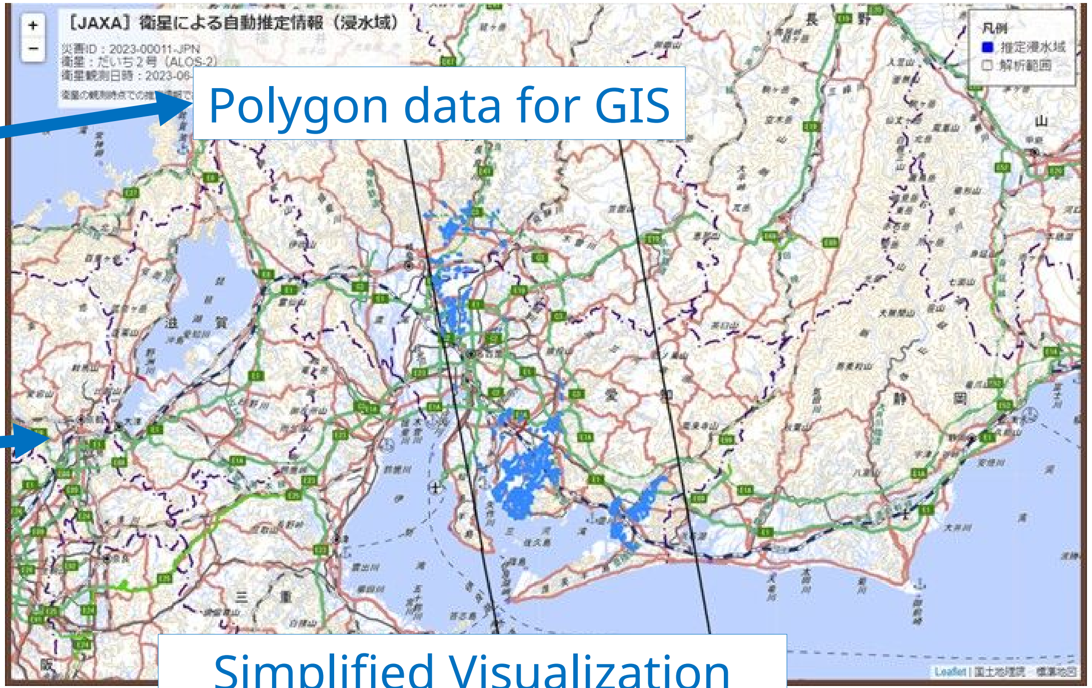
- June 2 23:44 ALOS-2 observation in the Chubu region (request from the River Planning Division, MLIT; use of the SIP system)
- June 3 02:43 Automatic email distribution of results to users (Cabinet Office, MILT, etc.).

Number of inundated houses

県	市区町村	行政区域	推定浸水	推定浸水
愛知県	西尾市	23213	3562.89	10097
愛知県	岡崎市	23202	1396.74	8984
愛知県	豊川市	23207	1252.02	3700
愛知県	豊橋市	23201	1334.66	3673
愛知県	安城市	23212	1489.44	3325
愛知県	一宮市	23203	459.03	1697
岐阜県	関市	21205	514	1527
愛知県	碧南市	23209	465.76	903
岐阜県	岐阜市	21201	339.9	874
愛知県	豊田市	23211	535.8	768

Alert email is sent from JAXA

Polygon data for GIS



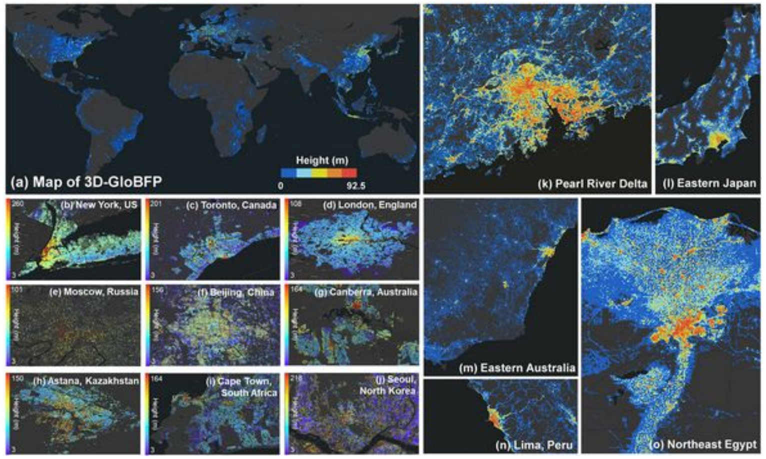
Simplified Visualization

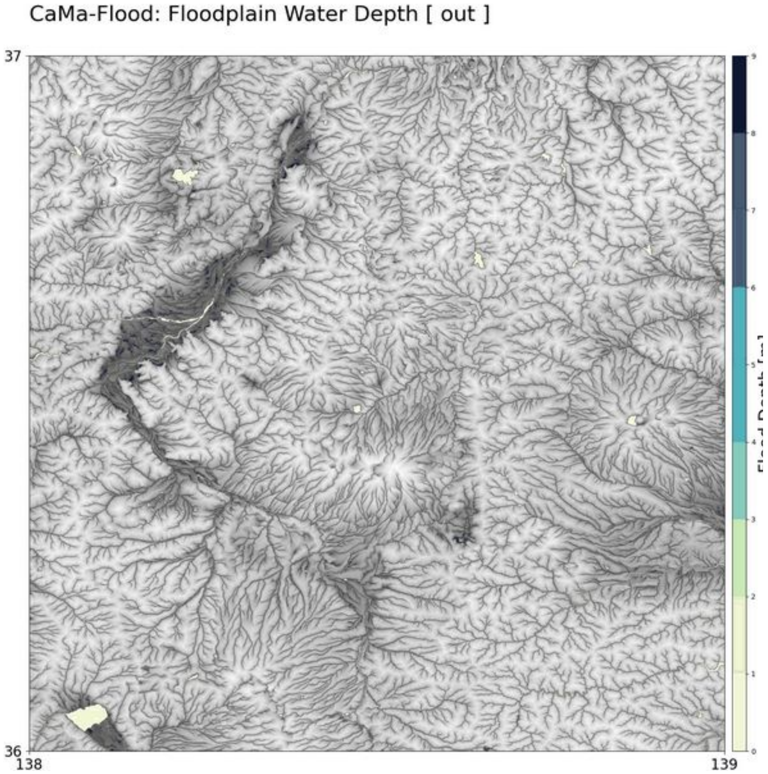
Courtesy of Dr. Masato Ohki @JAXA/EORC

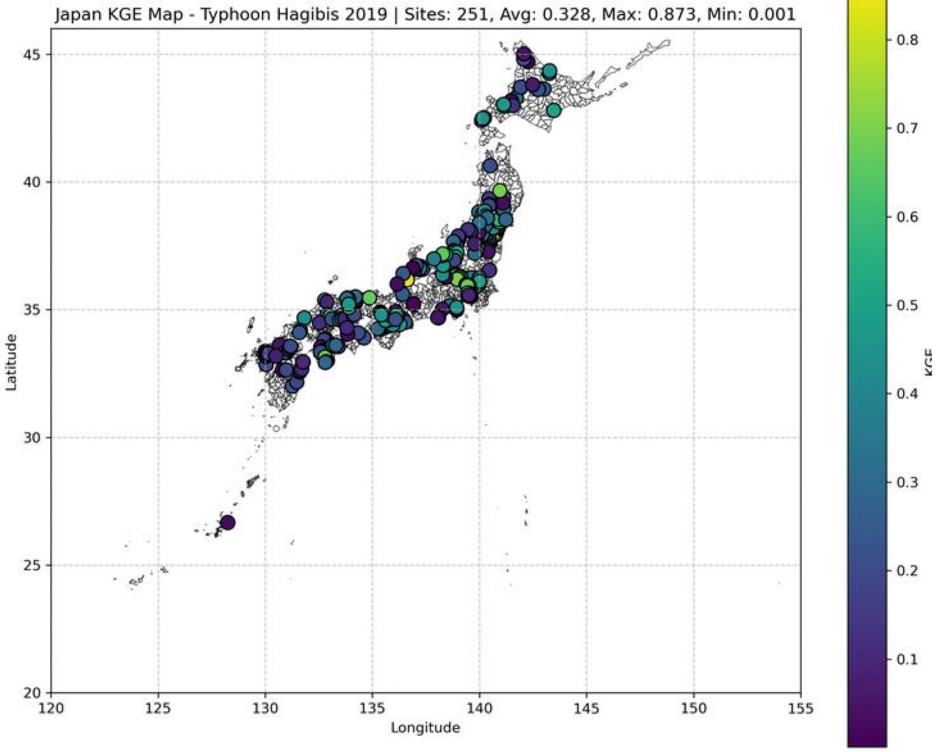
Courtesy of Isatama Winderto

Global Microsoft Building Footprints dataset

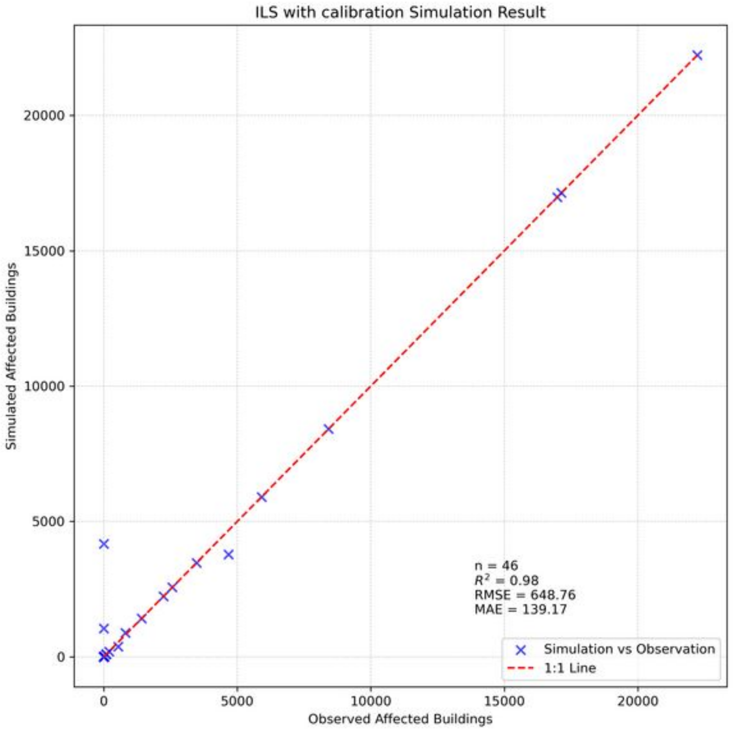
ESSD 3D-GloBFP Building Footprints with height dataset







ILS with levee+DAM parameter
(CaMa-Flood 4.20 ver.)



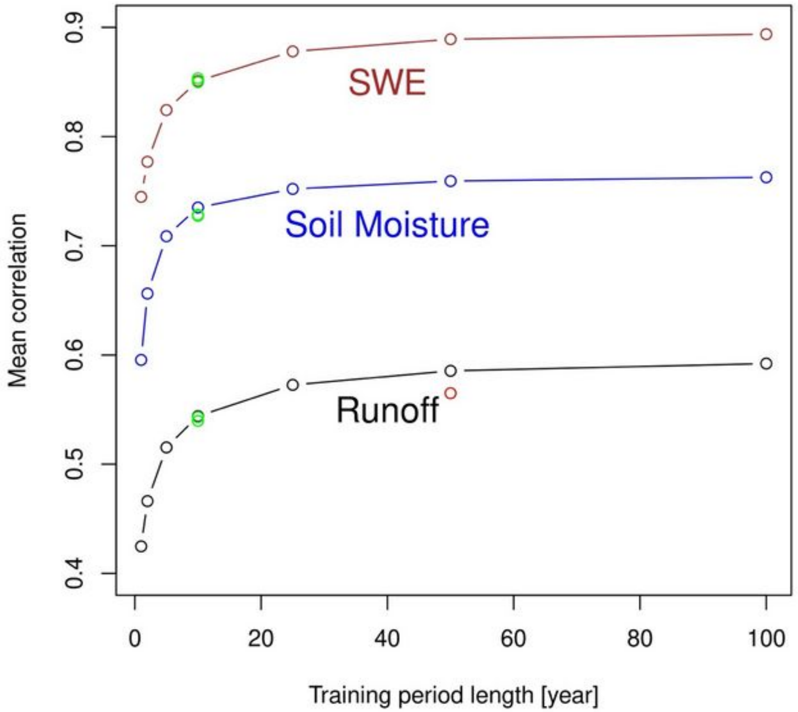
Development of MATSIRO Emulator

- Training: 1911-2010
- Cross-validation: 1901-1910
- Single starting parameter value for optimization

Model	Time requirement per model year
MATSIRO	1448.19 s
Emulator	**0.29 s**

NOTE: I/O and parameter optimization are computationally expensive for the emulator.

(right) 20 years daily data is enough to train the model.



Olson et al., 2024

April 10, 1910

Implement Emulator to Integrated Land Simulator (ILS)

May 2009

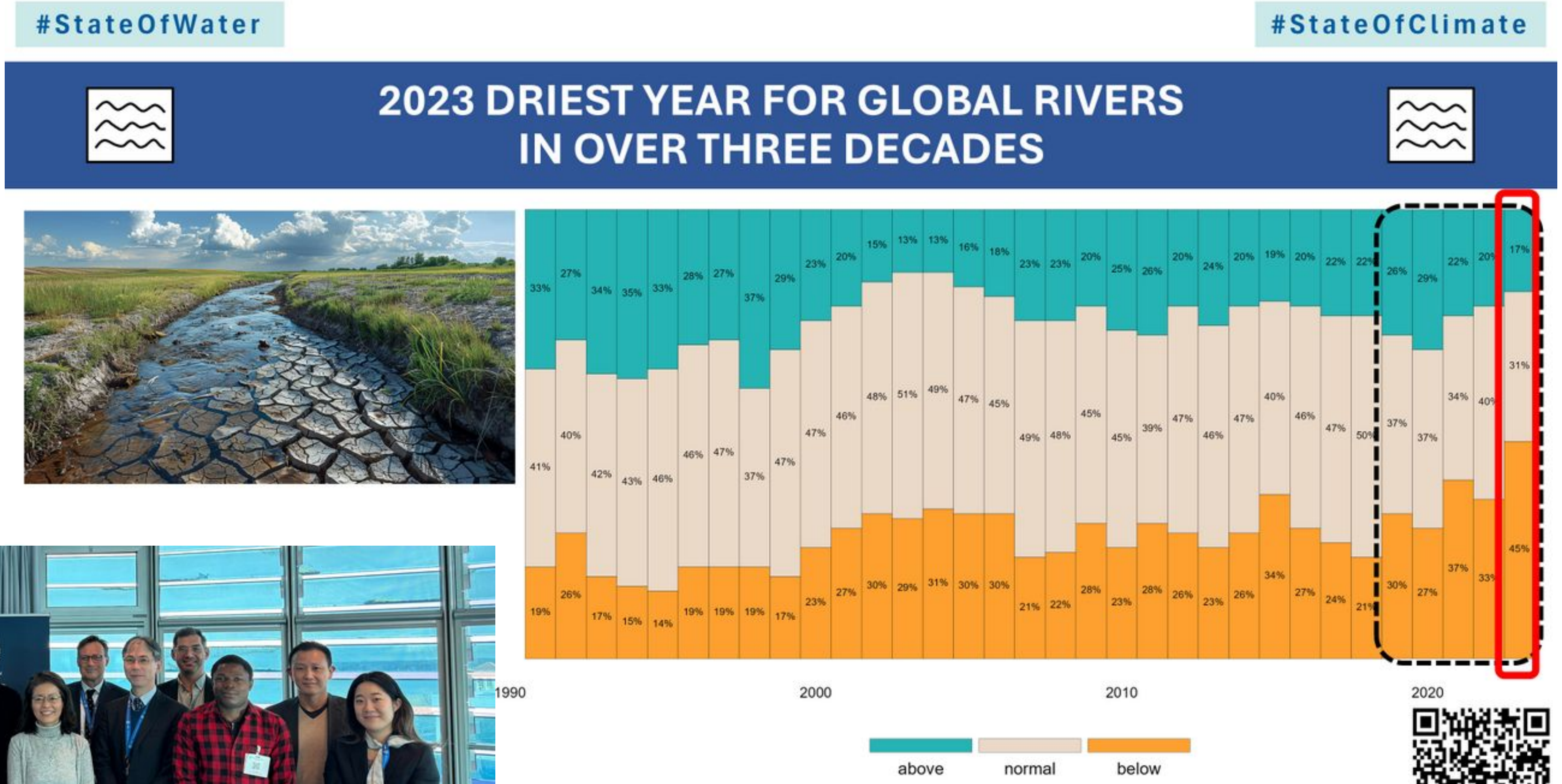
Discharge for major world rivers

emulator

ILS

Contribution to EW4All by UN/WMO
State of Global Water Resources 2021, 2022, 2023

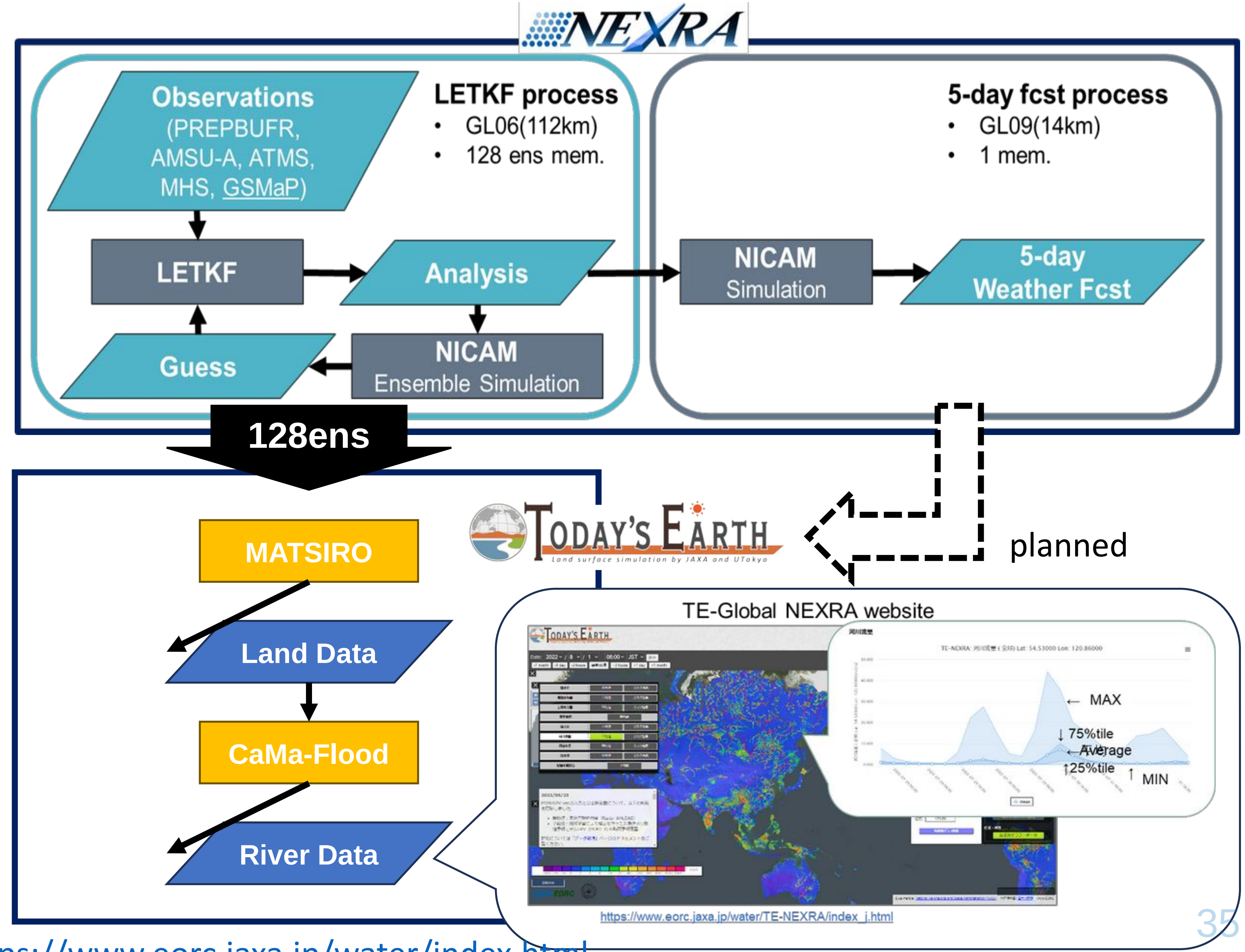
https://wmo.int/publication-series/state-of-global-water-resources-2023



Join the WMO's ET-OHPS activity (2023~)

Release of TE-Global NEXRA

- We aim to construct a novel global ensemble hydrological simulation system by utilizing NEXRA.
- Specifically, we input 128 ensemble members of analysis values (GL06/112km grid) to the global terrestrial hydrological simulation system Today's Earth (TE), which is developed and operated by JAXA and the University of Tokyo [Yoshimura et al., 2008, Ma et al., 2021].
- We have launched the operational system since August 2, 2023.



Yamamoto et al., in press

https://www.eorc.jaxa.jp/water/index.html

TODAY'S EARTH
Land surface simulation by JAXA and UTokyo

Website
https://www.eorc.jaxa.jp/water/

How to use
https://youtu.be/FaVpeZTq870?si=EjmWydqU0IsBaoVs

*Please turn on the automatic translation on YouTube

Thank you for your attention!

Take Home Summaries

	TE-Global (Global System)	TE-Global NEXRA (Global Ensemble System)	TE-Japan (Regional System)
Horizontal resol. (lat/lon)	Land：0.5 deg		1/60 deg.
Temporal resol.	Every 3 hour		Every hour
Latency	About 3 days~ (Depends on experiment)	About 1~5 days (Depends on operation status of JAXA super computing system (JSS))	**Real-time** *forecast data distribution is limited within research purpose due to the Japanese law
Satellite data used in the System	GSMaP, Terra/Aqua MODIS, NOAA AVHRR (AW3D, GCOM-C in prep.)	NEXRA (assimilate GSMaP, ATMS, AMSU-A, MHS) with 128 ensemble members	Himawari-8, NOAA AVHRR (GSMaP, ALOS HRLULC in prep.)
Product	River discharge/depth, Flooded area, Soil moisture, Snow amount, Evapotranspiration, etc.		

Will be updated within JFY2024!

Just released in last year!

TODAY'S EARTH
Land surface simulation by JAXA and UTokyo

https://www.eorc.jaxa.jp/water/

Summary

- We developed *Today's Earth*, or *TE*, a simulation system that provides integrated estimates of physical quantities related to the water cycle on land (e.g., soil moisture content, river flows, evapotranspiration, and many others).
- In the Japanese region in particular, we have established a system to distribute real-time prediction with a resolution of 1/60° grid (about 1 km grid) to the public. It is called *TE-Japan*. Global version (*TE-Global*) has 1/4° grid (about 25km grid; currently under upgrading to 1/10° grid).
- We tested the performance of *TE-Japan* for some extreme events. In the case of Typhoon Hagibis in 2019, at 129 of the 142 sites where breaches were reported, the system predicted a once-in-200 years flood level (defined as an alert) for an average of 32.3 hours prior to the event.
- A couple of satellite-and-simulation fusion methods are in operation. One is tasking of satellite operation before the flood, and the other is Bayesian inundation estimates right after the flood.
- The alert and monitoring of inundation are reported to the Japanese government.
- Efforts for making an emulator of LSM, multiple satellites (SAR) inundation detection, data assimilation, and deep-learning parameter calibration are on-going.

Probabilistic Fusion of SAR and Hydrological Simulation

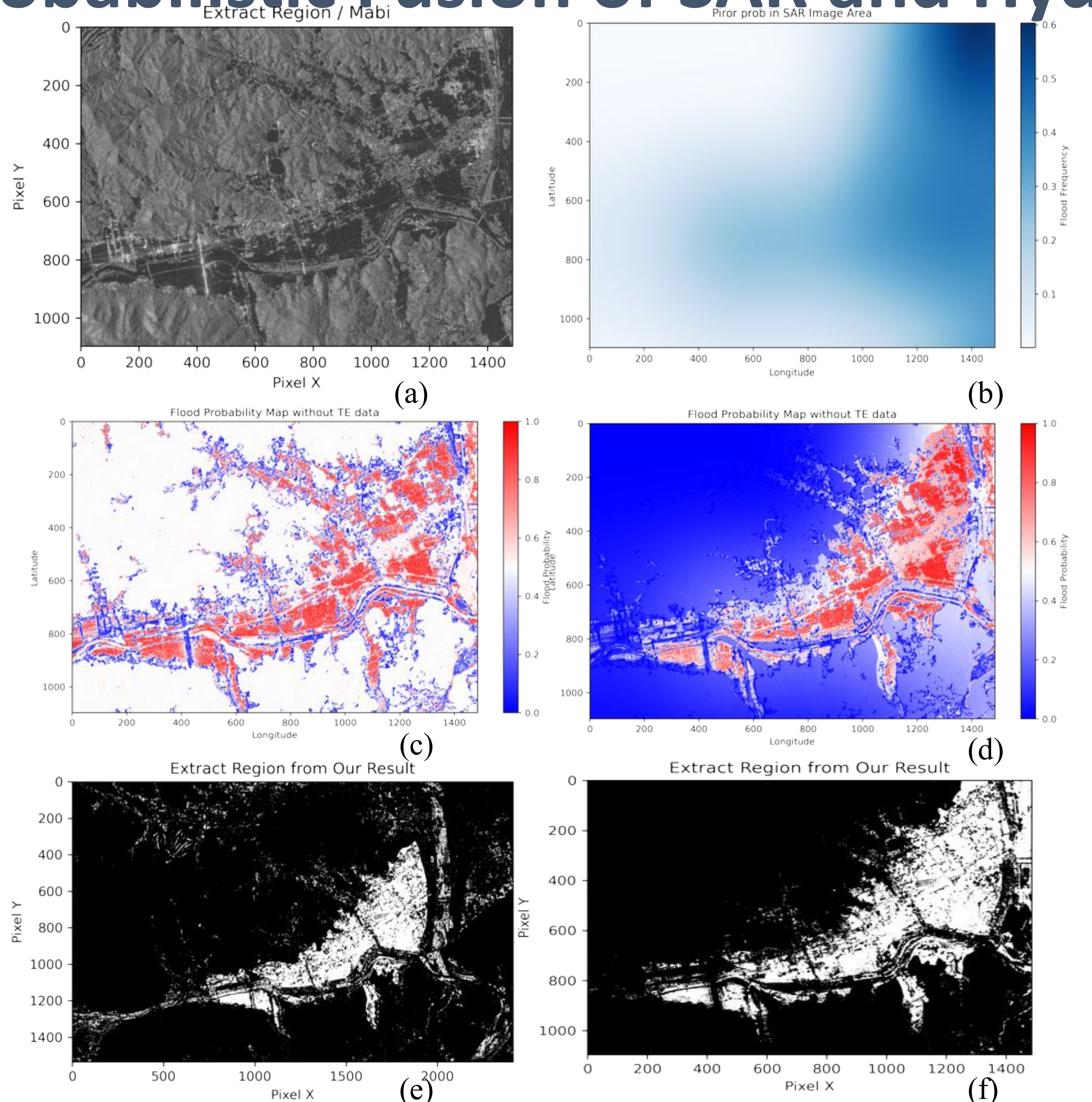


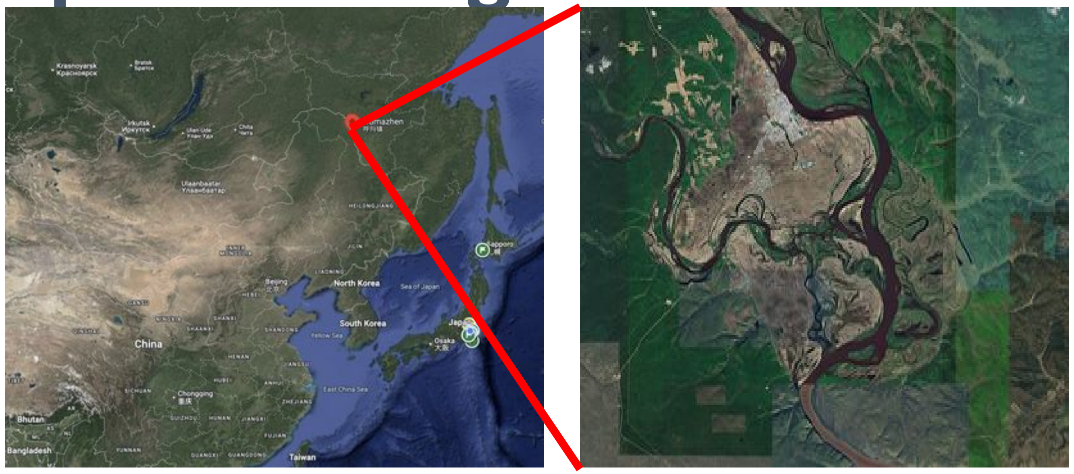
Fig 3. Comparison of Flood Detection Methods for Mabi Area Using ALOS SAR and Hydrological Data

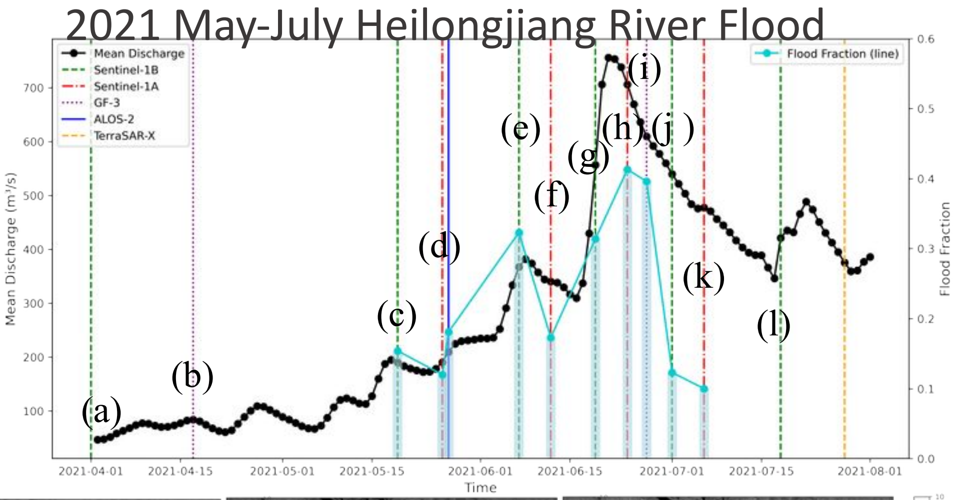
(a) ALOS SAR image of the Mabi area.
(b) Corresponding TE-Japan data for the same period.
(c) Predicted flood probability map using Bayesian method without hydrological data.
(d) Predicted flood probability map using Bayesian method with hydrological data.
(e) Binary flood inundation map without hydrological data.
(f) Binary flood inundation map with hydrological data.

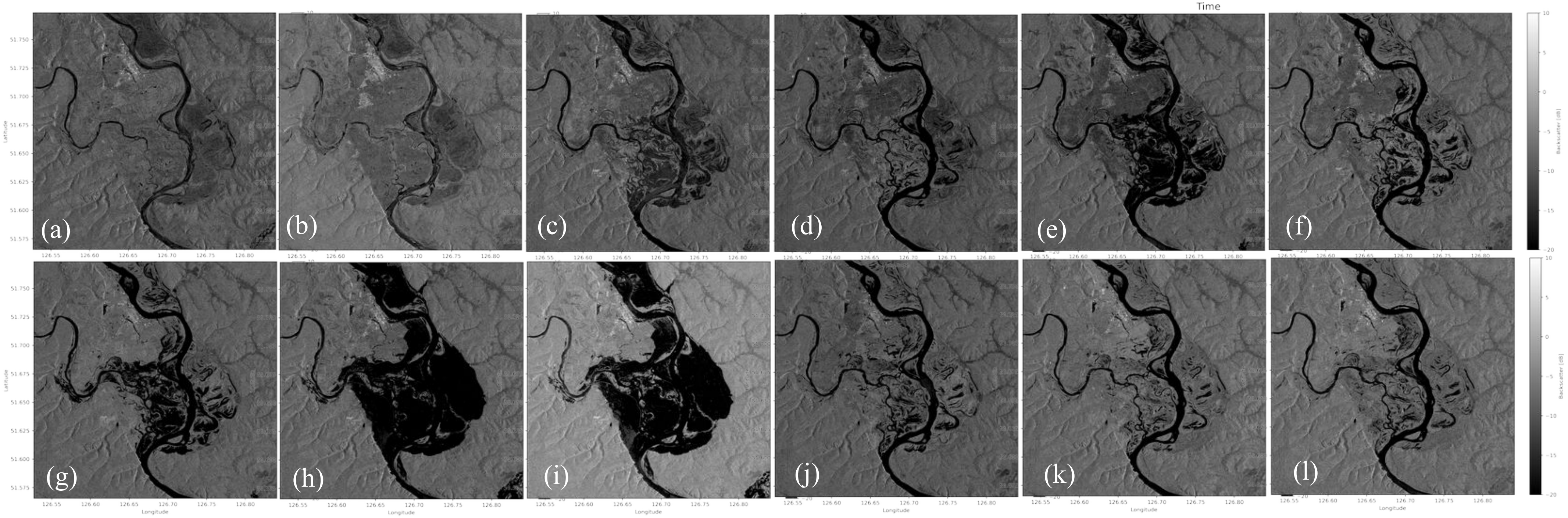
Without Today-Earth data (Comparison with results provided by GSI.)
F1-score: 0.6916
Precision: 0.6132

With Today-Earth data
(Comparison with results provided by GSI.)
F1-score: 0.8362
Precision: 0.7618

Temporal changes in inundation by multiple SAR satellites







Zhu et al., in prep.

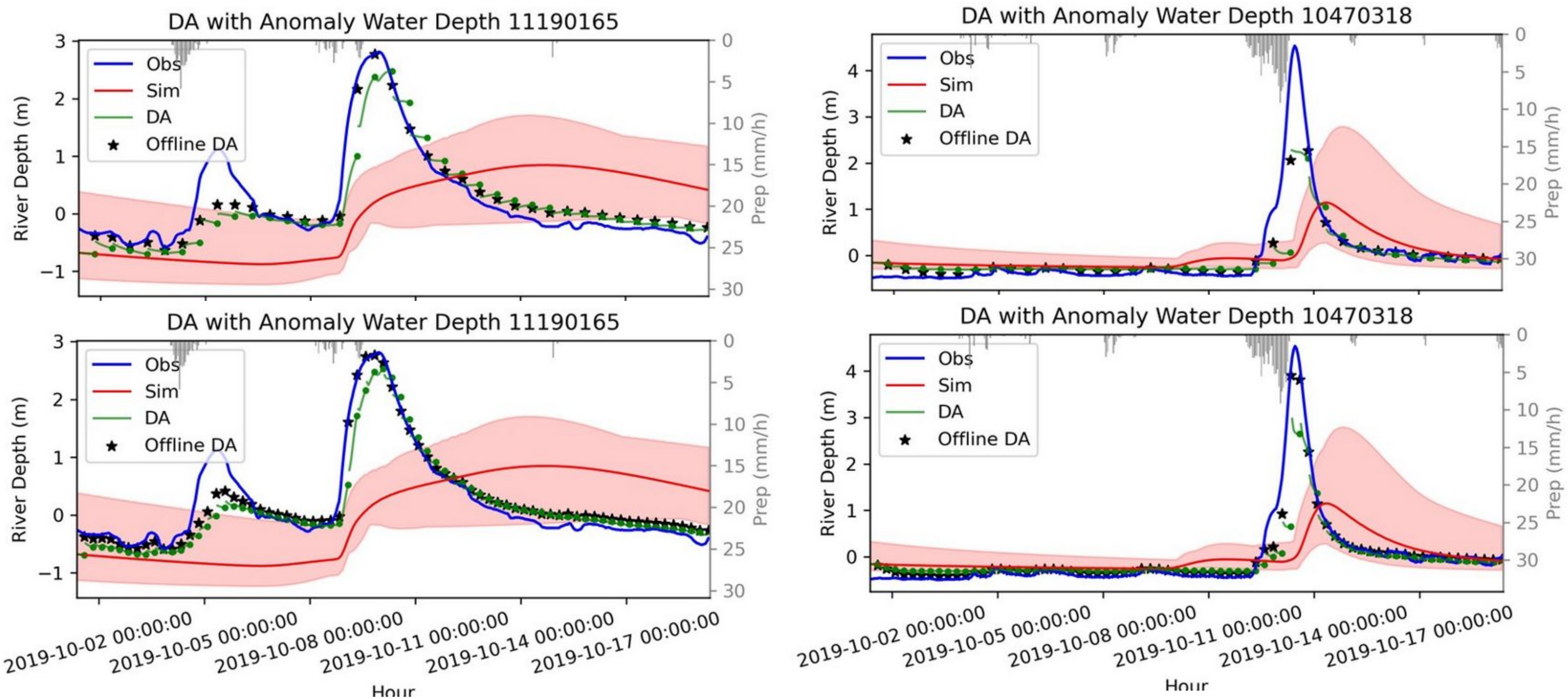
Data Assimilation with in-situ water level obs.

Anomaly Water Depth

Anomaly Water Depth

12h DA

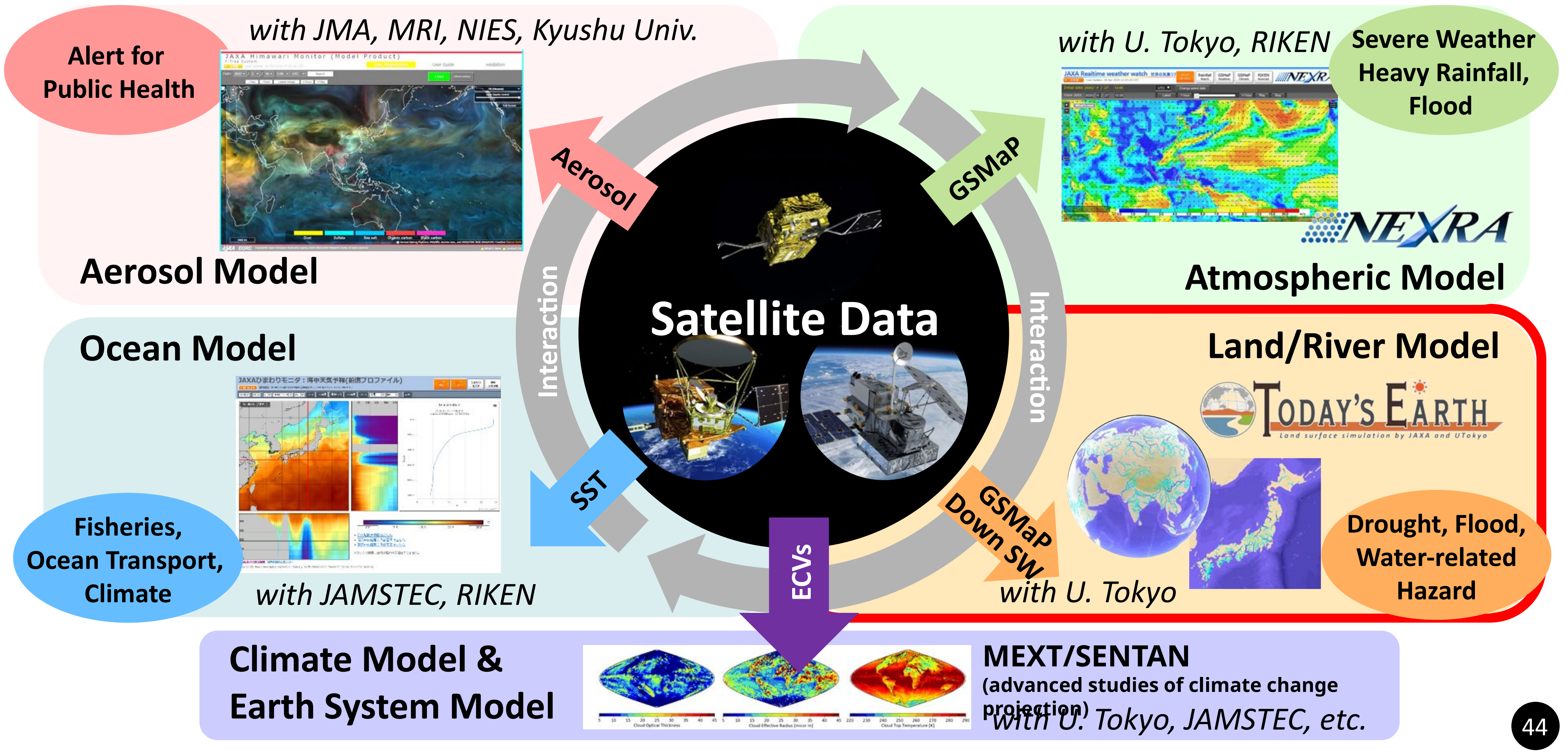
6h DA



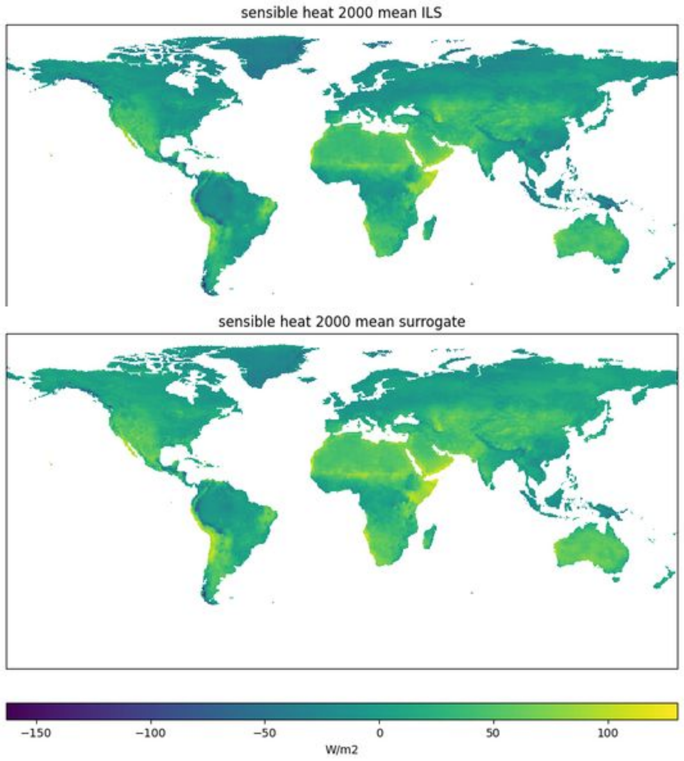
Should enhance localization parameter for DA.

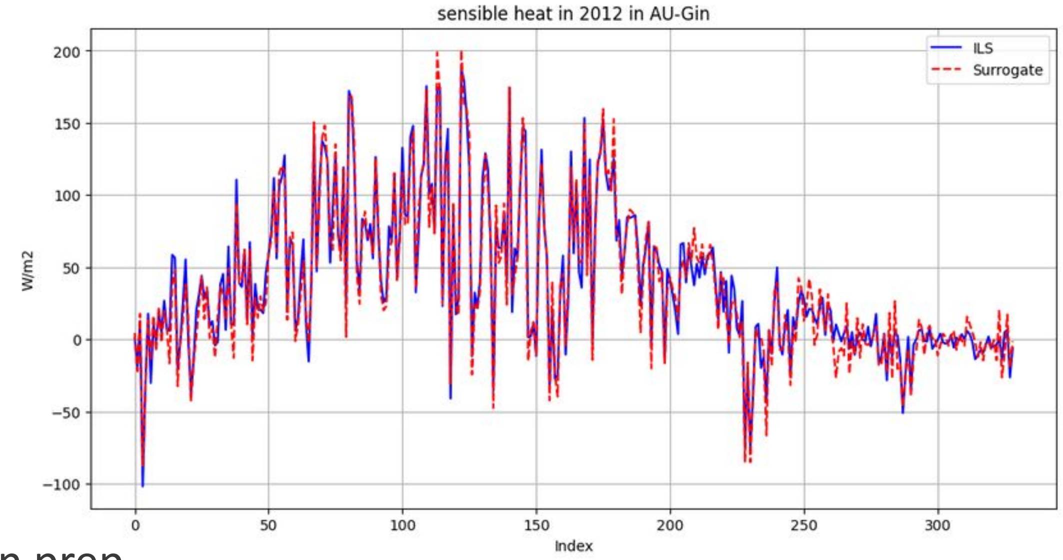
Liu et al., in prep. (H13F-1075 in AGU2024)

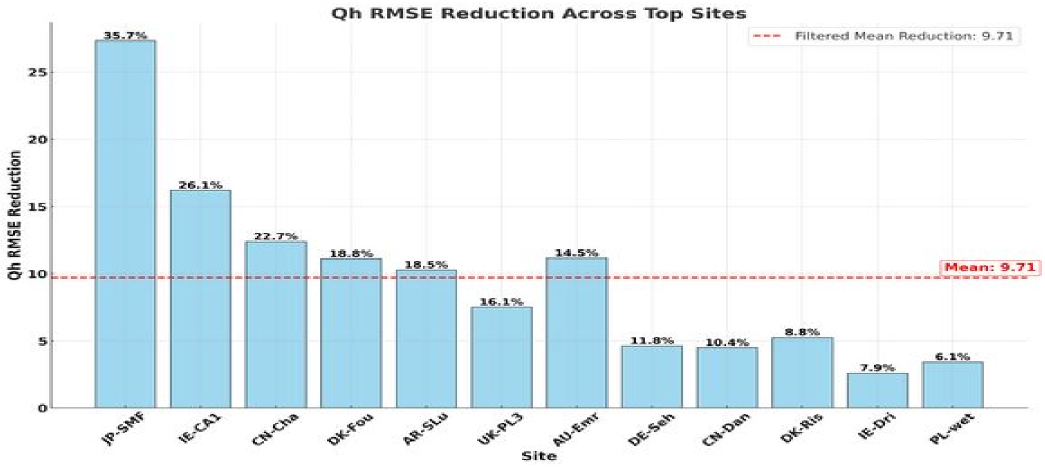
Satellite and Model Collaborations toward Earth Environment Predictions



Calibration of Model Parameters: Deep Learning Approach

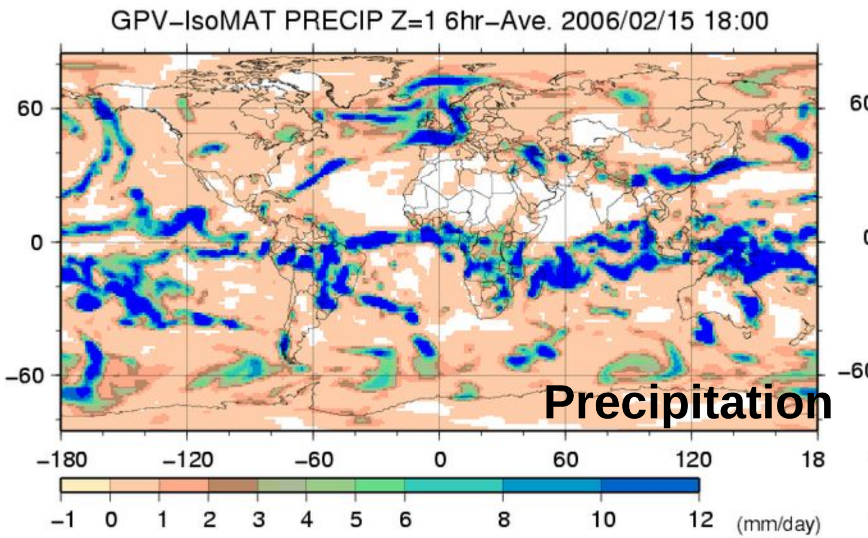


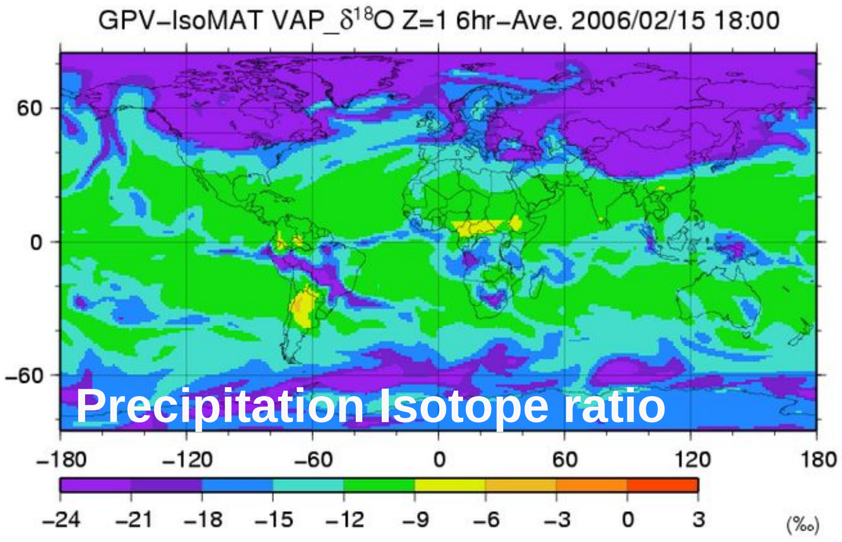


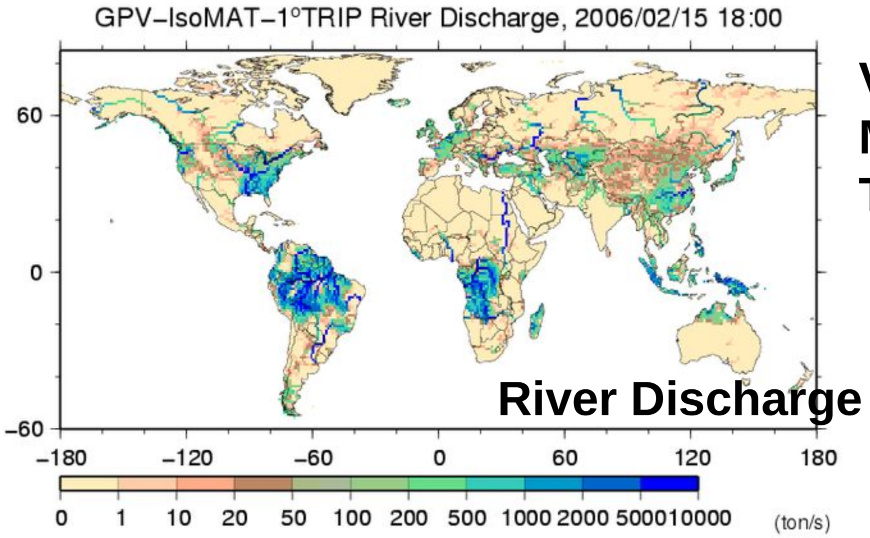


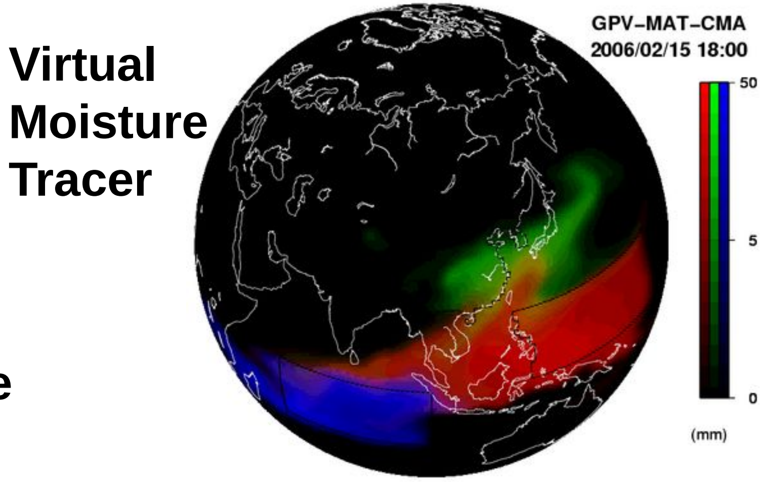
Xie et al., in prep.

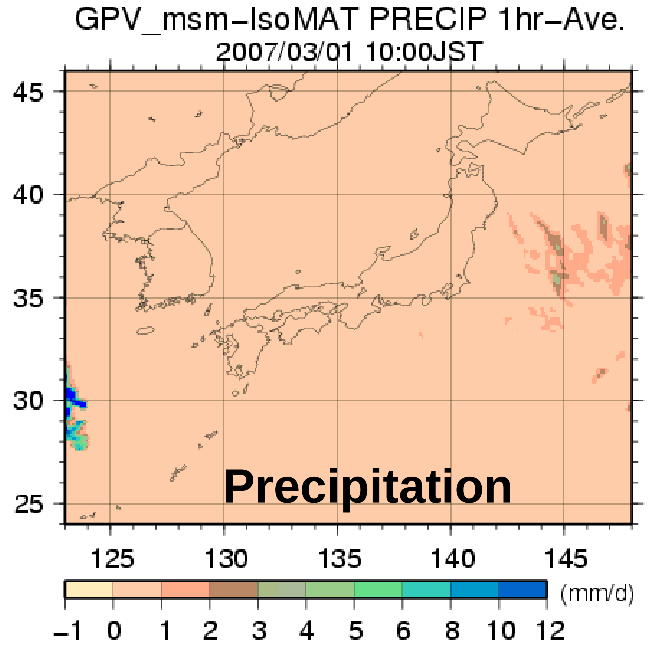
Old version of Today's Earth/Japan

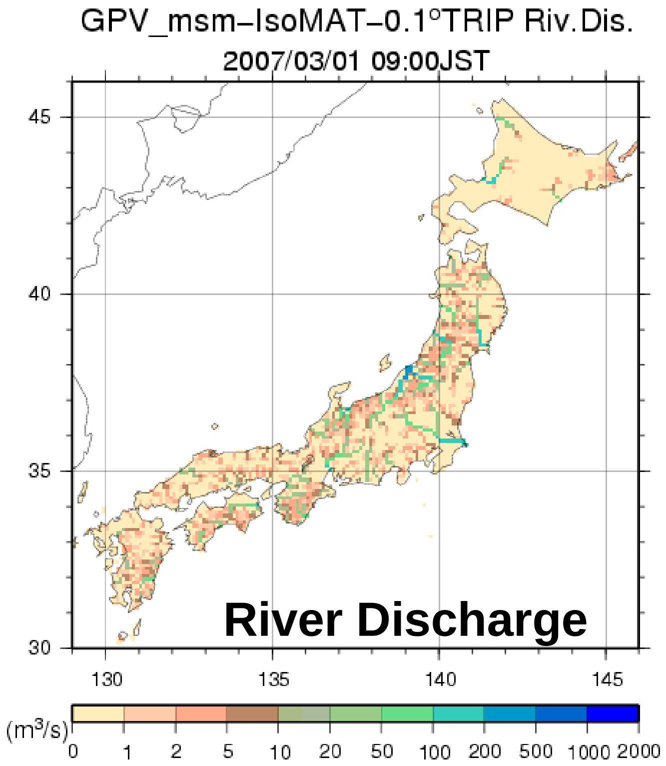










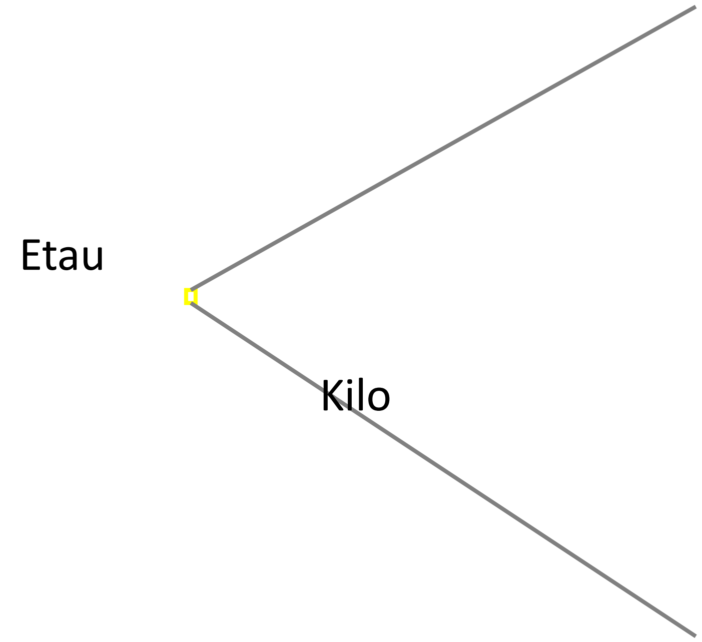


Yoshimura et al., 2007；Yoshimura et al., 2008

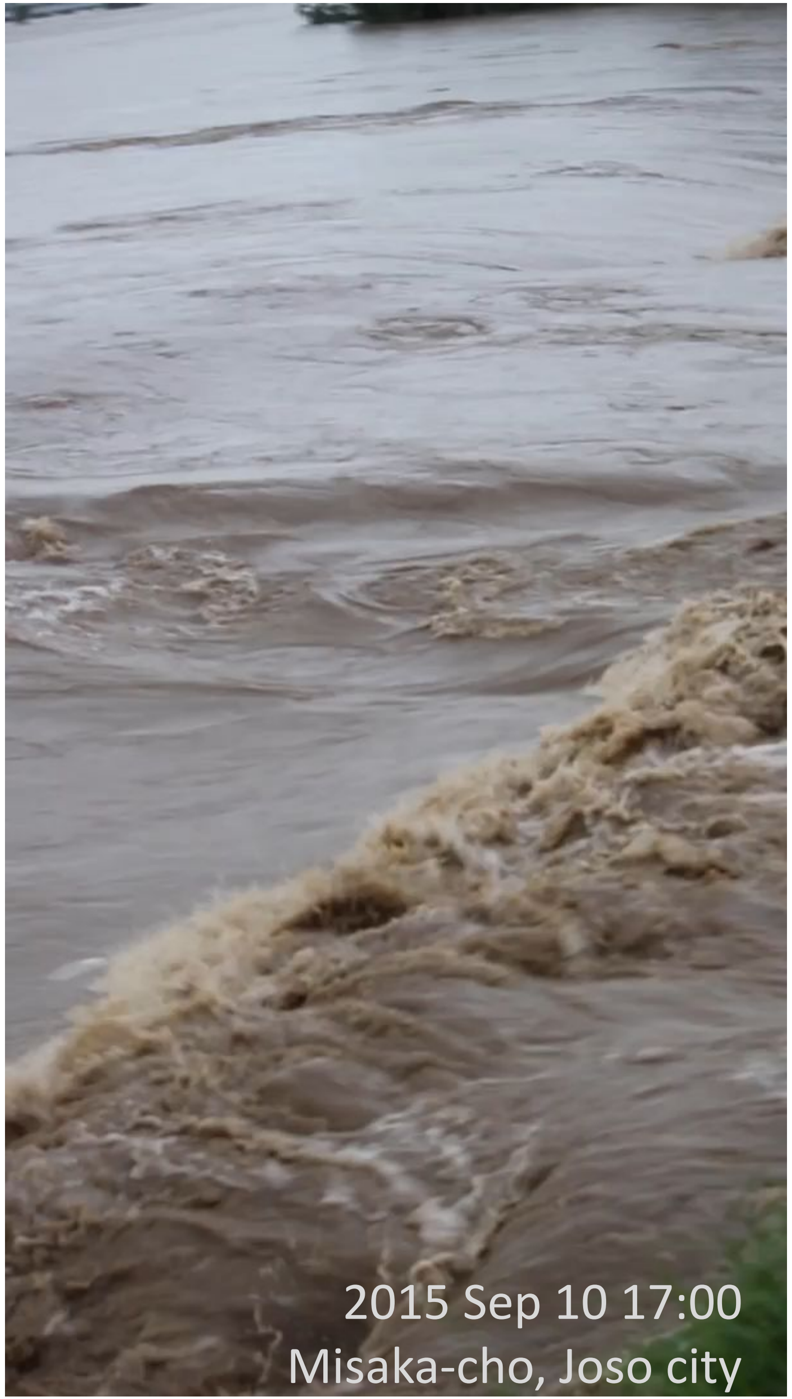
Source: Presentations in 2006-2007.

Kanto/Tohoku Heavy Rain (Sep 2015)

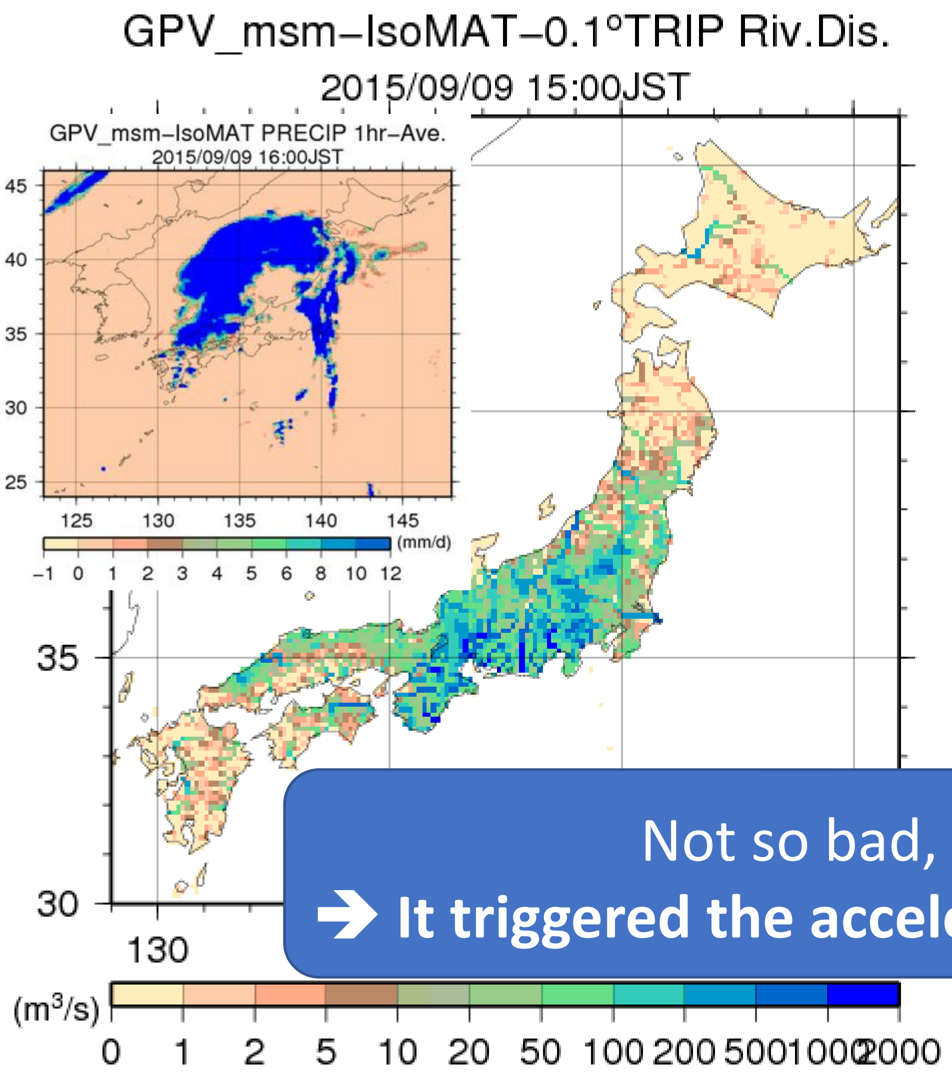
- Heavy precipitation for 8 to 10 September 2015 over Tochigi and Ibaraki prefectures was caused by clustered linear rain bands influenced by Typhoon Etau (No 18) and Kilo (No 17).
- Over 40 km^2 in Joso-city including **11,000 houses were inundated**, evacuation orders were issued for more than 10,000 citizens, and over 2,000 people were rescued by helicopters and boats.

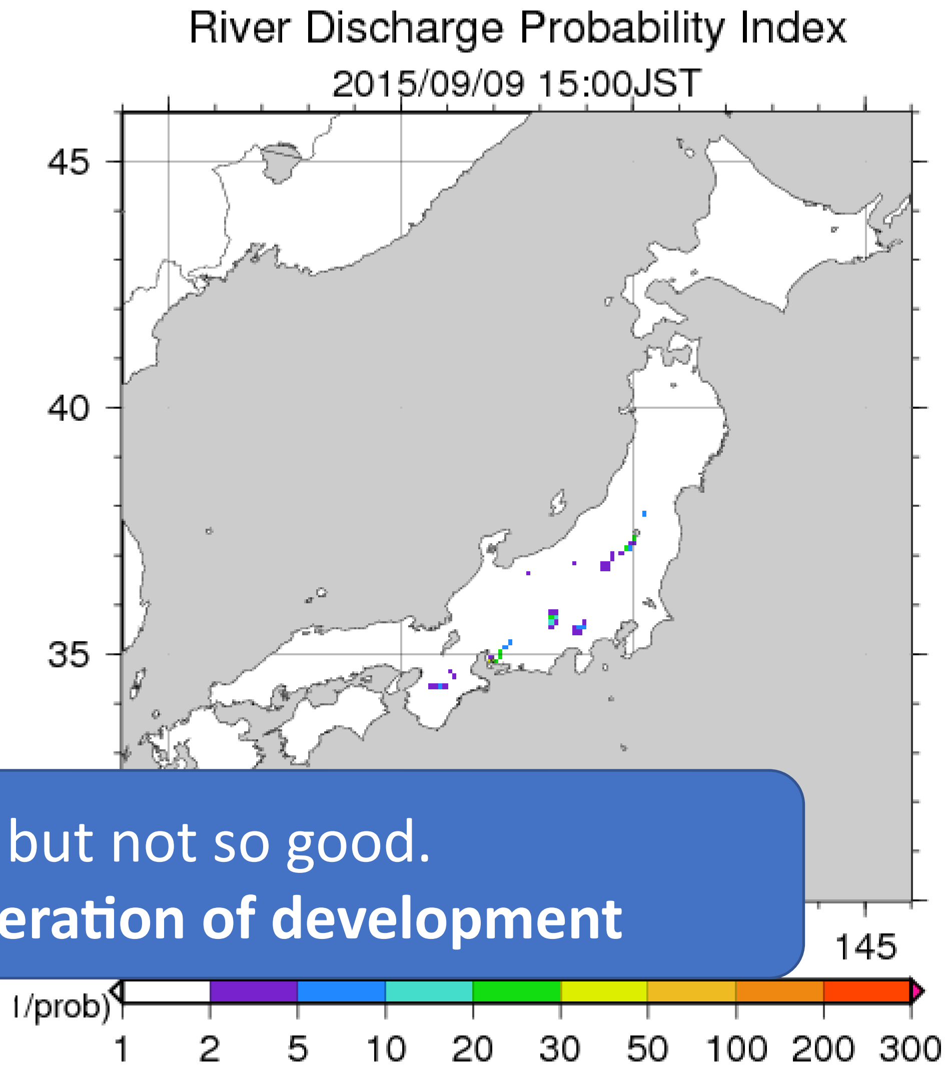


Yoshimura et al., 2016



Was Today's Earth able to predict the 2015 Kinu-River floods Earlier?





Not so bad, but not so good.

➔ **It triggered the acceleration of development**

Yoshimura et al., 2016

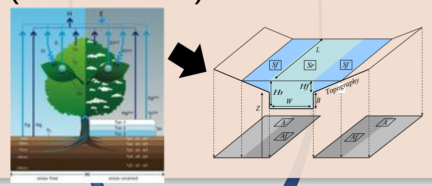
Implementation of fundamental improvements of TE

Today's Earth
Land surface simulation by JAXA and UTokyo

Forcing Data Preparation:
Satellite obs. and JMA reanalysis/forecast data

Validation

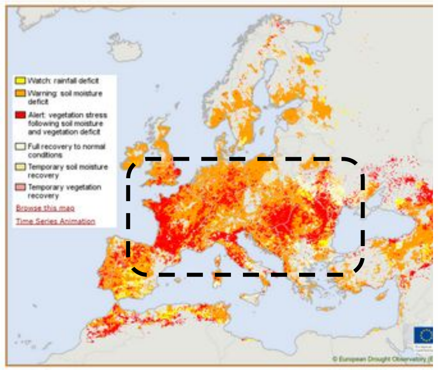
Model Simulation:
LSM(MATSIRO) + River Routing Model(CaMa-Flood)



Improvement

Data Provision:
Various hydrological parameters with risk indices

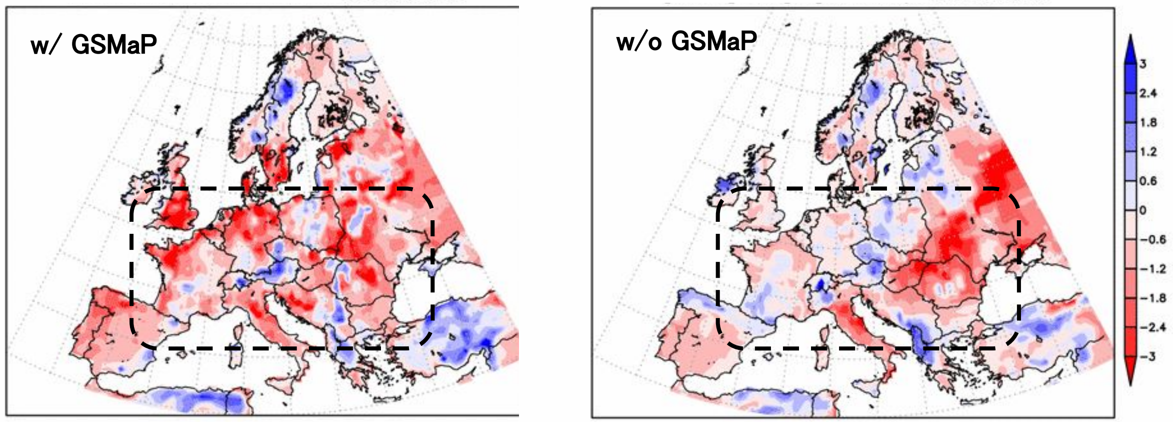
Drought Indicator by EC EDU



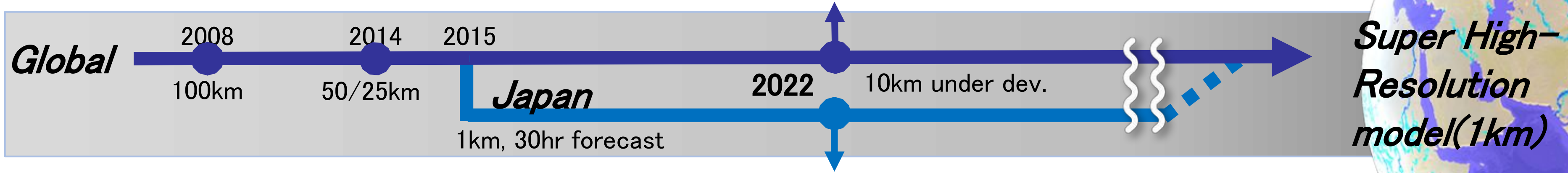
https://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000

Est. Soil Moisture Anomaly 2022.07.01Z

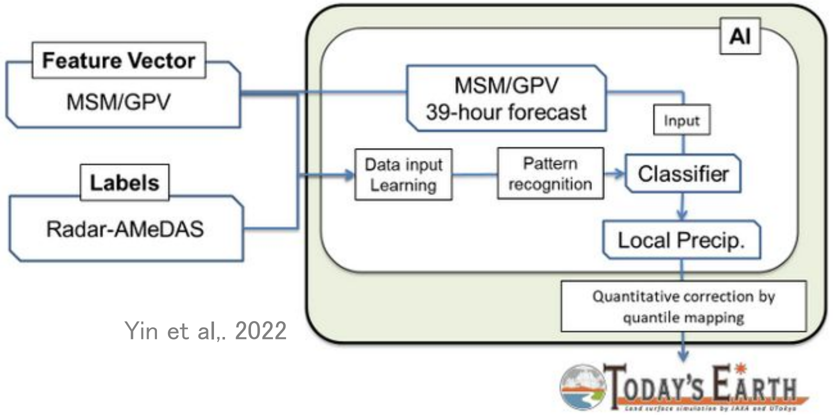
Est. Soil Moisture Anomaly 2022.07.01Z



Reproduction of the European Drought



Machine-Learning for Bias Correction of Forecasted Precipitation



Yin et al,. 2022