Japanese Status (ILS, MIROC)

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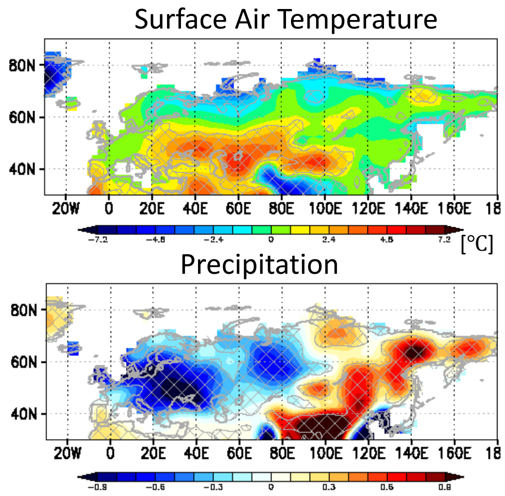
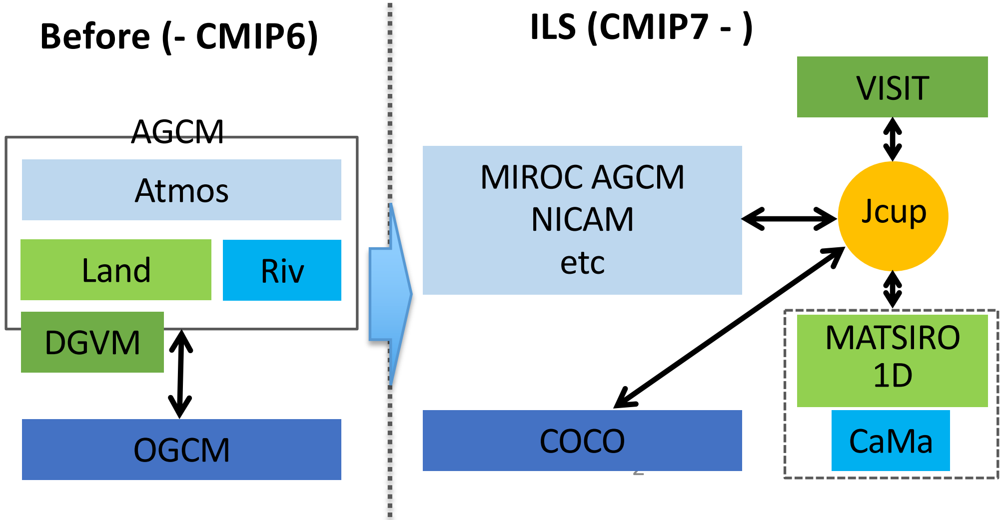
Background

- **Long standing biases of climate simulation**
  - Hot and dry summer
  - Too wet soil moisture in MATSIRO
  - Too little runoff in MATSIRO
  - Land model may be (partly) the cause.
- **History of land models**
  - Land models used to be developed as **a parameterization of AGCM** and coordinate for land and atmosphere are usually the same.
  - Not only coordinate issue, but **the development speed itself had been so slow**. (Newest studies could hardly be implemented in GCM.)



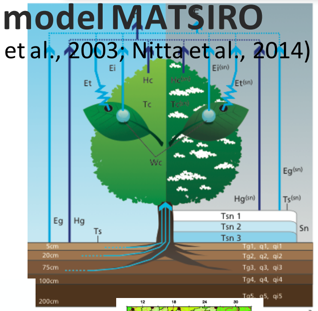
Hirota et al., 2014



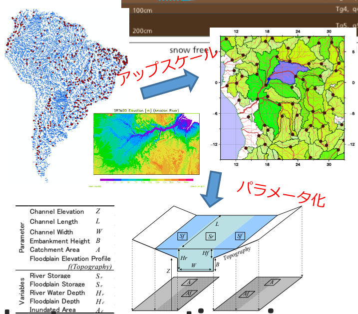
Integrated Land Simulator
(committed for MIROC7, etc.)

Development of Integrated Land Simulator (ILS)

Land model MATSIRO
(Takata et al., 2003; Nitta et al., 2014)

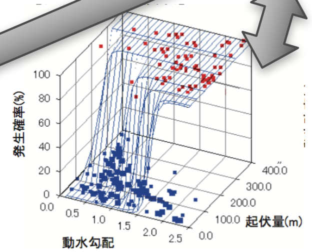


Implement new physical processes
- Snow aging by dust/BC
- Snow-fed wetlands
- River inundation and evaporation
- Sub-grid snow cover parameterization



Next-generation river model CaMa-Flood
(Yamazaki et al., 2011)

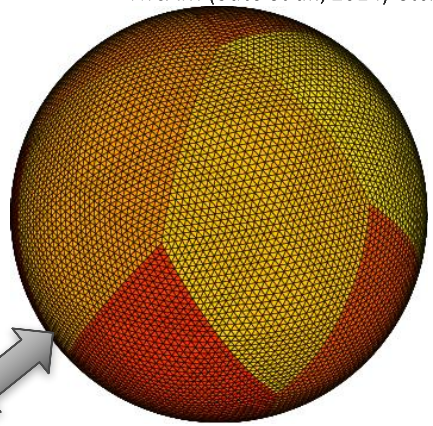
Global hydrology model with anthropogenic effects H08 (Hanasaki et al., 2008)

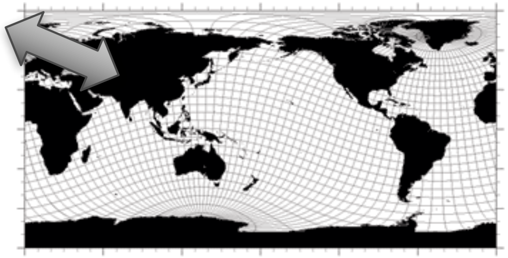


Models for water-related hazards

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

AGCMs
MIROC (Watanabe et al., 2010), NICAM (Sato et al., 2014) etc.



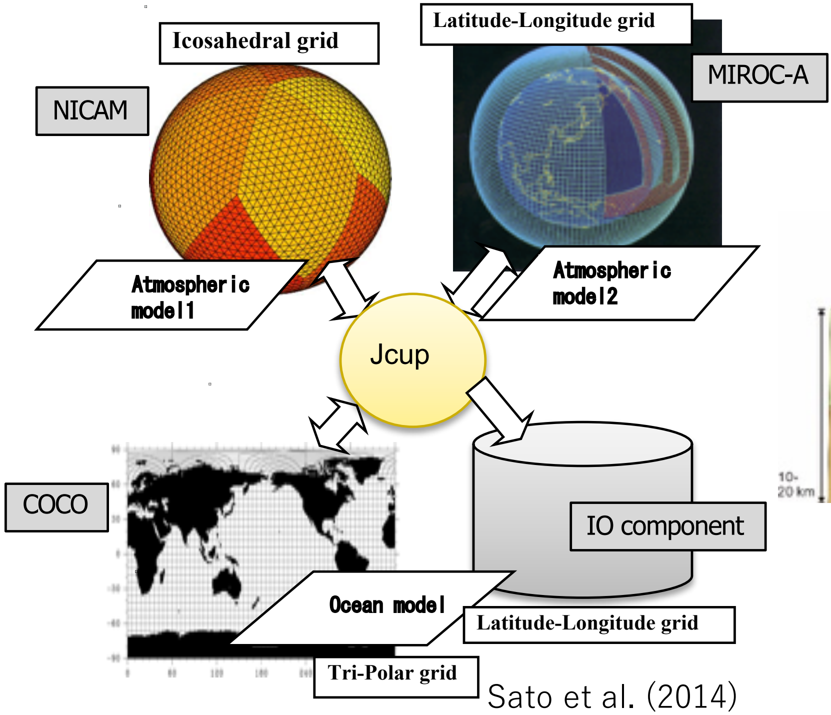


OGCMs COCO (Hasumi, 2006) etc.

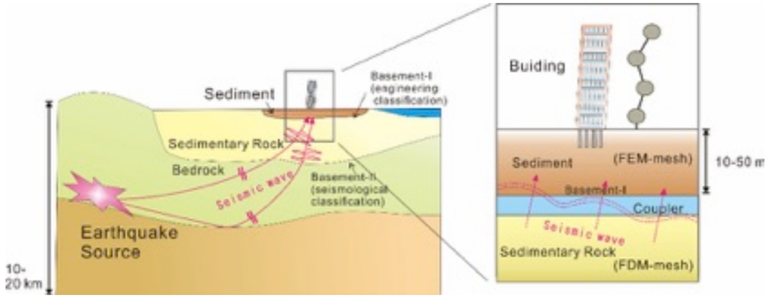
Contributing to improvement of climate models

Courtesy of
T. Arakawa

Jcup: General Purpose Coupler



Sato et al. (2014)



MATSUMOTO et al. (2014)

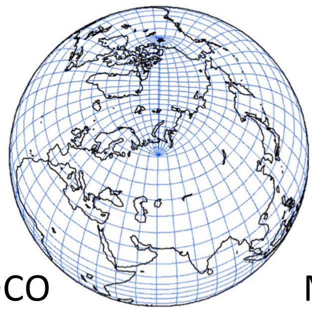
- Allows data exchange between >2 models with minimum modification of original models.
- Temporal integration, uneven time steps/exchange.
- Controlled by namelist.

Mapping Table Generator

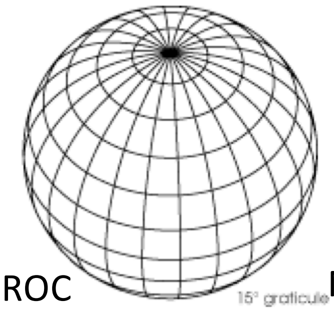
A. Takeshima

- Jcup reads Mapping Tables to re-grid quantities in multiple models without losing their mass and energy.

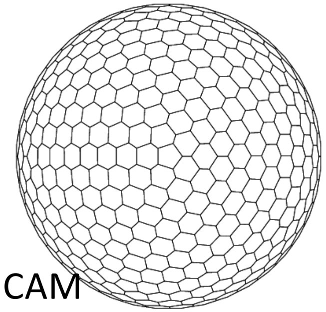
	Model	Coordinate	Grid # (lat*lon)
Ocn	COCO [Hasumi et al., 2000]	Tri-polar grid	256*360
Atm	MIROC [Watanabe et al., 2011] NICAM [Satoh et al., 2008]	T85 Pentagon/Hexagon	128*256 32*32*10
Lnd	MATSIRO [Takata et al., 2003]	0.5°*0.5° Rectangle	360*720
Riv	CaMa-Flood [Yamazaki et al., 2011]	Unique grid	360*720



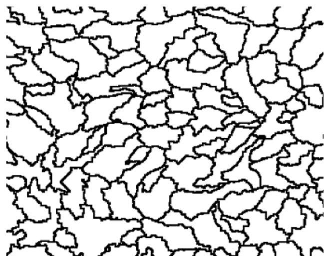
COCO



MIROC



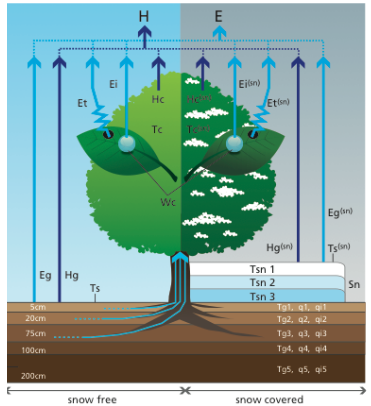
NICAM

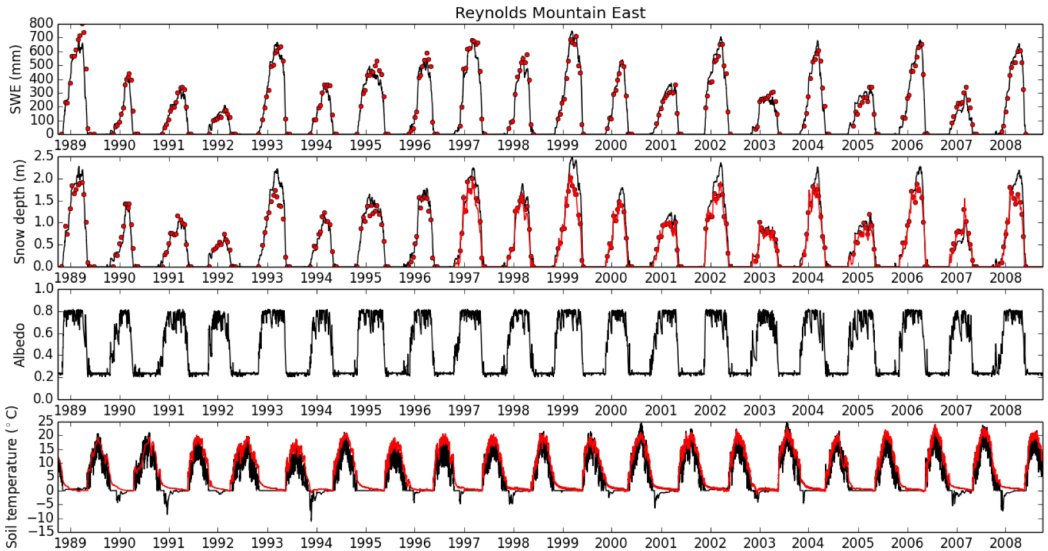


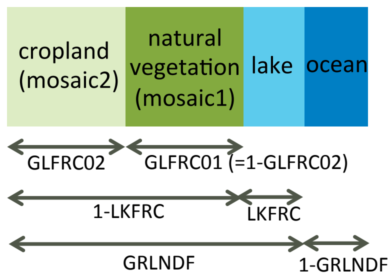
CaMa-Flood

MATSIRO

- MATSIRO is a land model of MIROC and NICAM models
- It has been also used for impact assessment studies
- It consists from 6 soil layers (14m in total), 3 snow layers, and a single

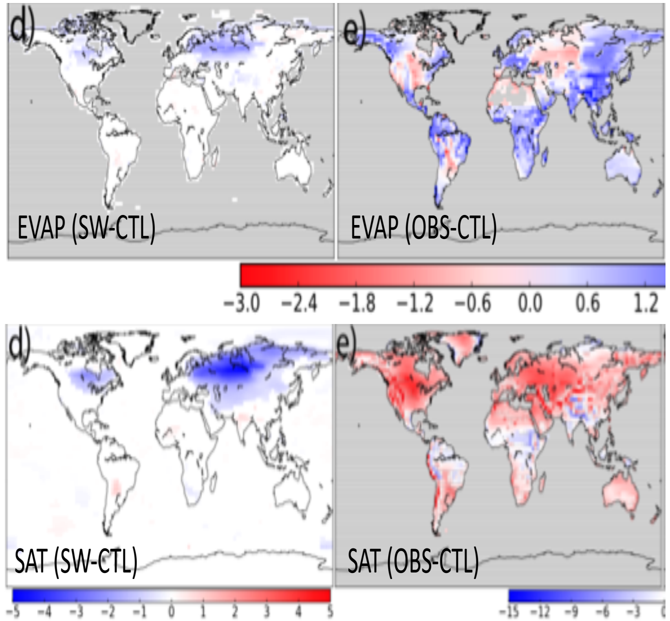


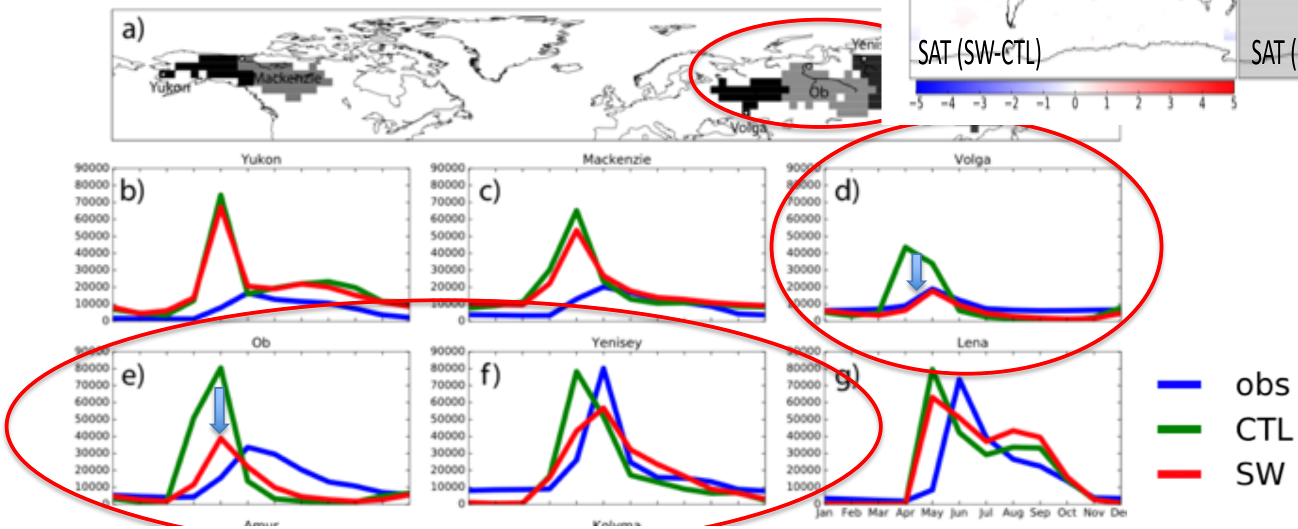




Red: observation Black: simulation Courtesy of Dr. Essery

Recent Implementation: Snow-derived Wetland

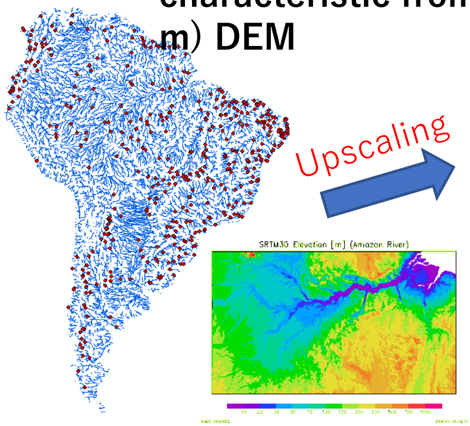




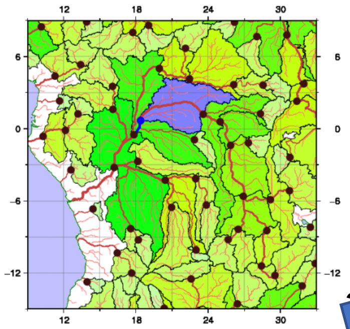
Nitta et al., 2017

CaMa-Flood (Yamazaki et al., 2011)

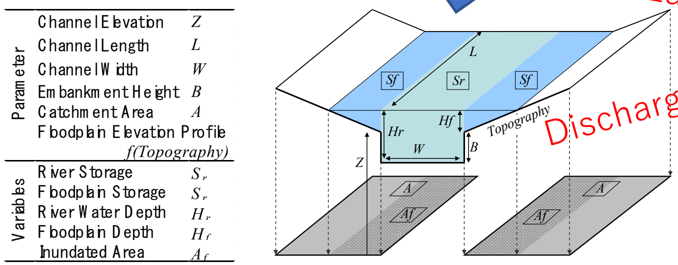
Abstract sub-grid topographic characteristic from high-res (10~100 m) DEM



Upscaling



Parameterization



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

Diffusive Wave Equation Depending on water level, "backwater" occurs.

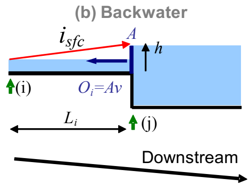
$$\frac{1}{g}\frac{\partial v}{\partial t}+\frac{v}{g}\frac{\partial v}{\partial x}+\frac{\partial h}{\partial x}+i_0-i_f=0$$

Kinematic

Diffusive

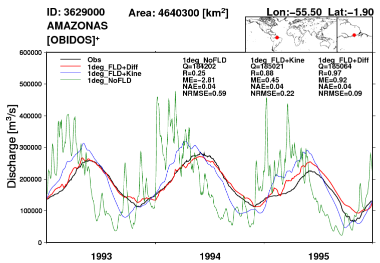
Dynamic

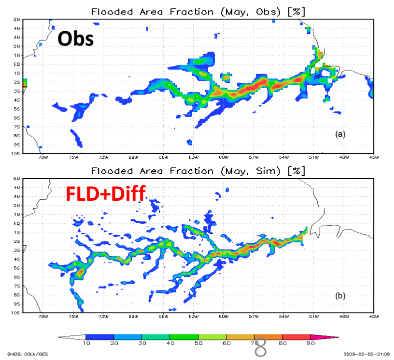
St. Venant Momentum Equation



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

Discharge, w-level, inundation are predicted.

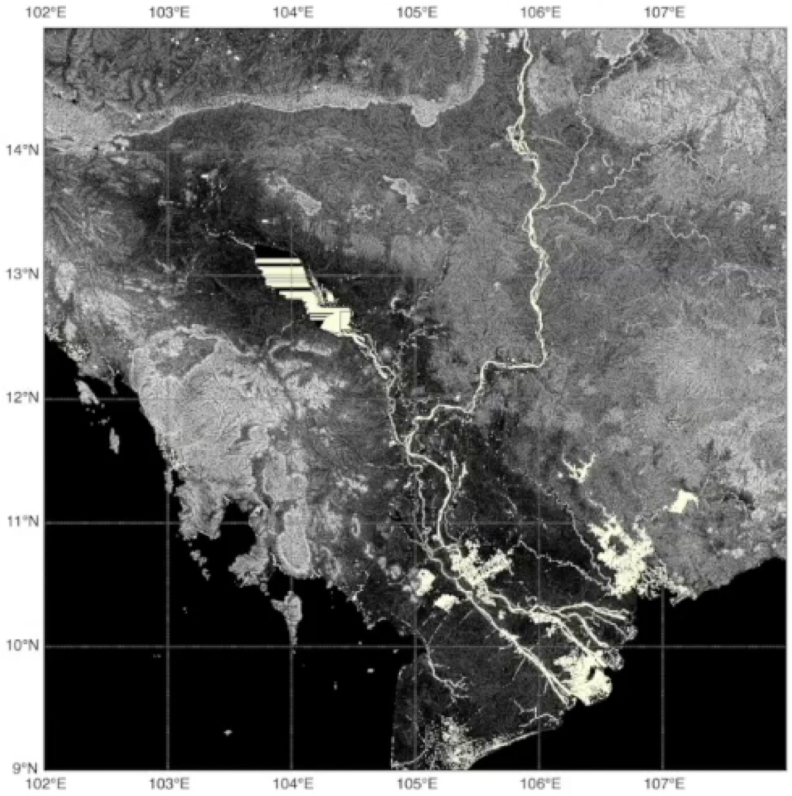


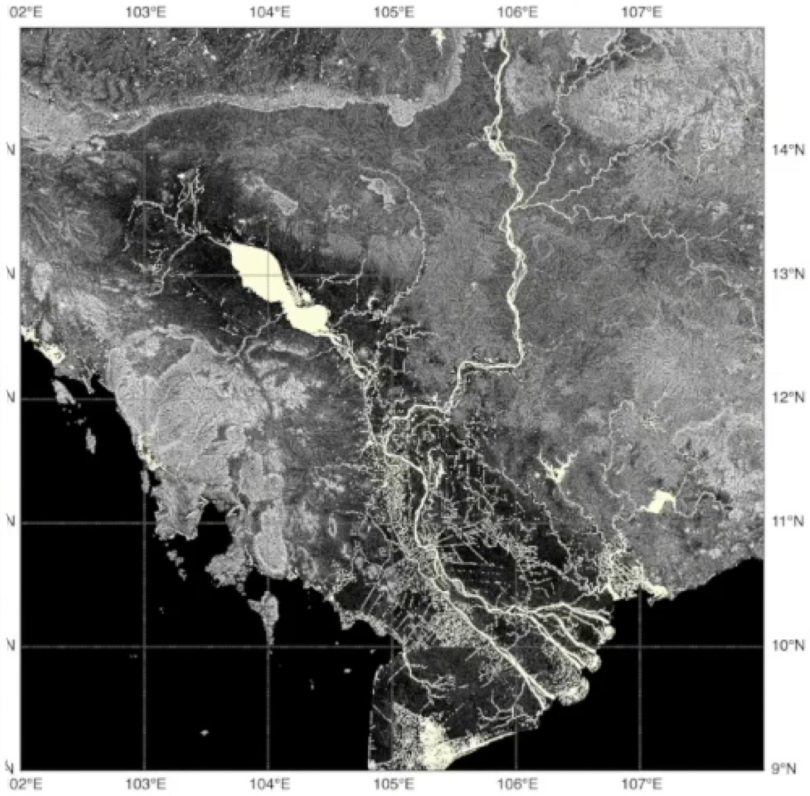


Importance of accurate hydrography data

[Old] SRTM + HydroSHEDS

[New] MERIT Hydro

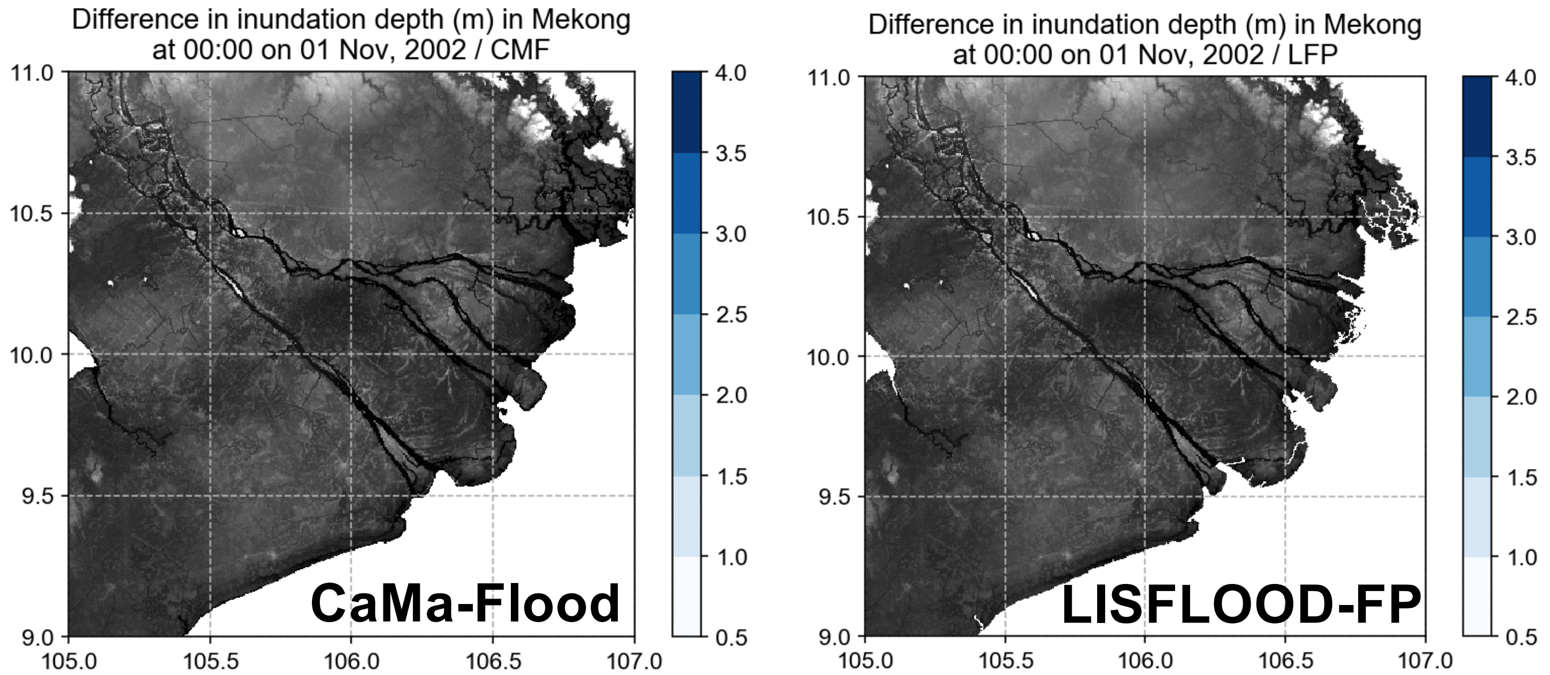




CaMa-Flood simulation at 0.1deg resolution + Diagnostic downscaling to 3sec

Courtesy of D. Yamazaki

(underway) Coupling to 2D inundation model

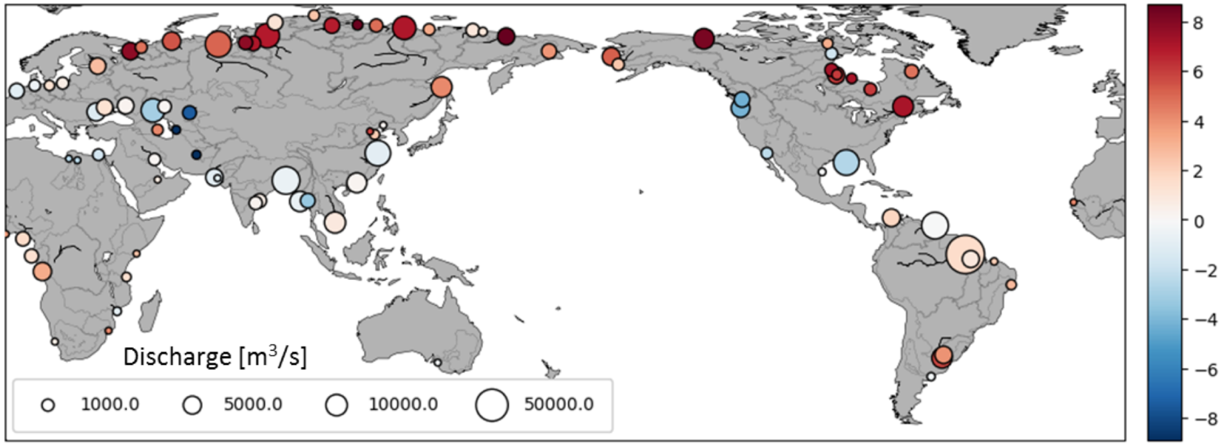


Courtesy of H. Ikeuchi

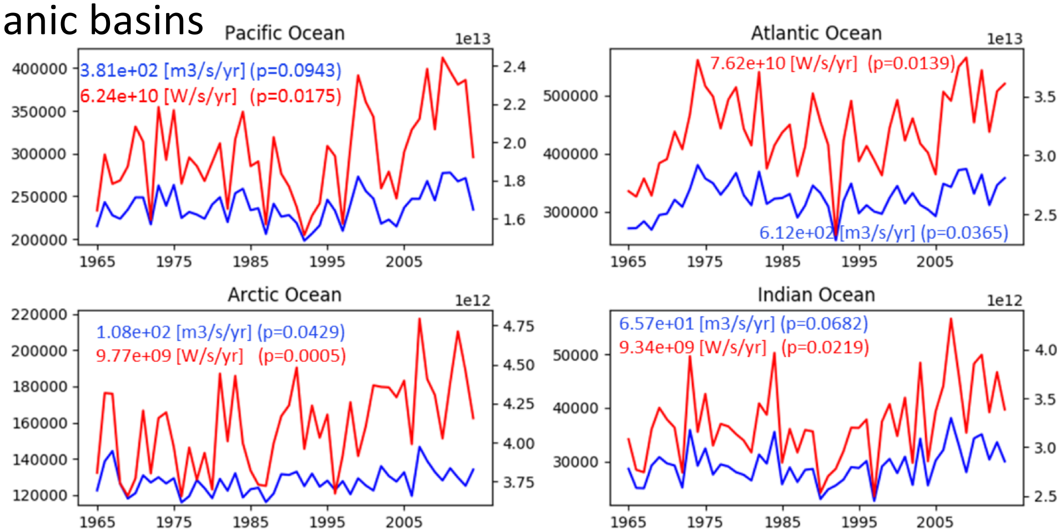
Energy transportation driven by river water （Daisuke TOKUDA）

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



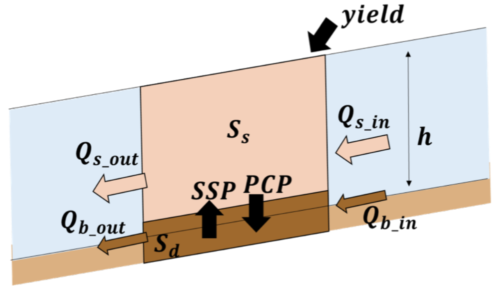
1965~2014 regression coefficient and p value

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

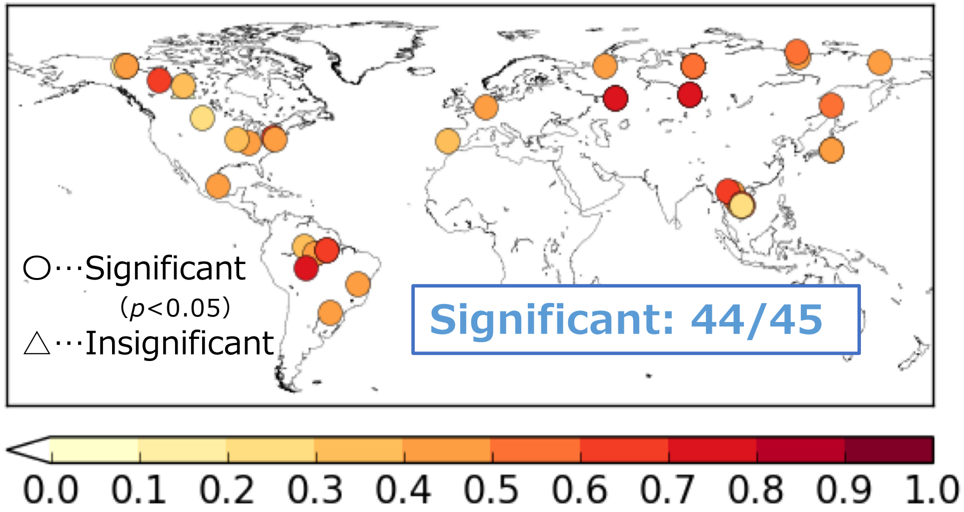
Misako Hatono@Tohoku U.

Sediment dynamics modeling

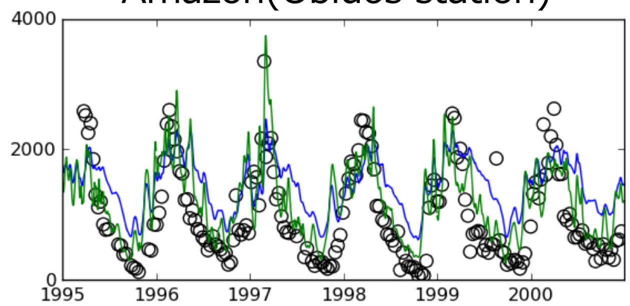
- Incorporated sediment dynamics into CaMa-Flood within the framework of ILS
  - ✓ Considers suspended sediment and bedload
  - ✓ Seasonal variation is well represented. Regional calibration improves accuracy in peak values



Schematic of sediment model



Correlation coefficient of suspended sediment



Suspended sediment[10^3ton/yr]

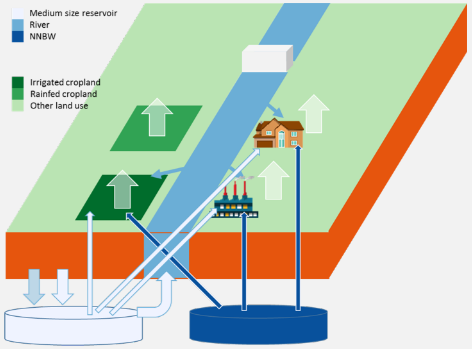
Obs. **CTL** **Calibrated**

New Water Management

will be coupled with ILS

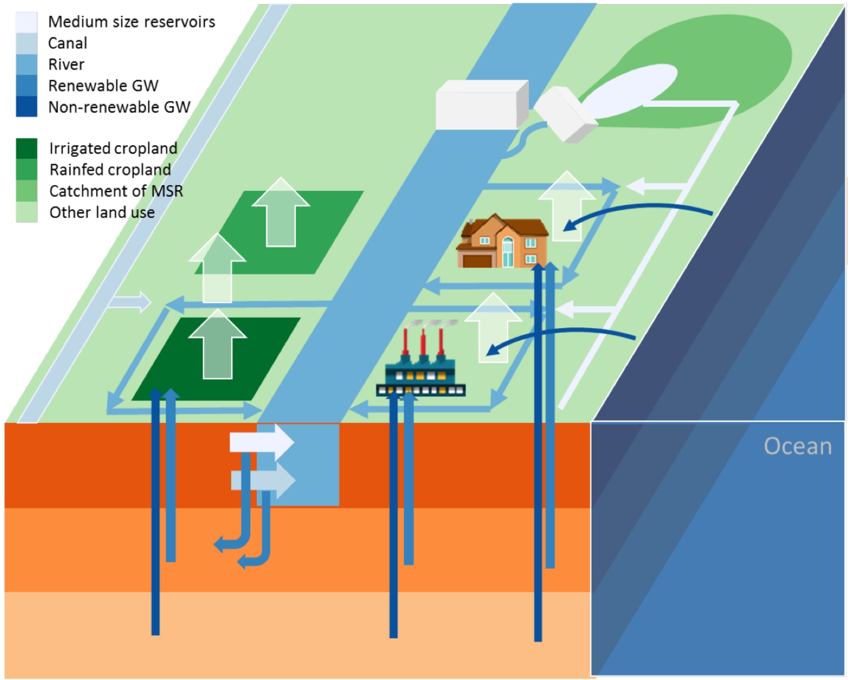
Target: Can be used by long-term national/state water management plan. 10km-resolution

Global Water Resource model H08 (Hanasaki et al., 2008)



No separated consideration of ground water (unconf'd/conf'd) & surface soil moisture.

- Pumping from GW
- Navigation channel, glacier, lakes
- Withdraw, Return, Loss
- Small dams <1km^3



Courtesy of N Hanasaki

Next Generation Water Management model

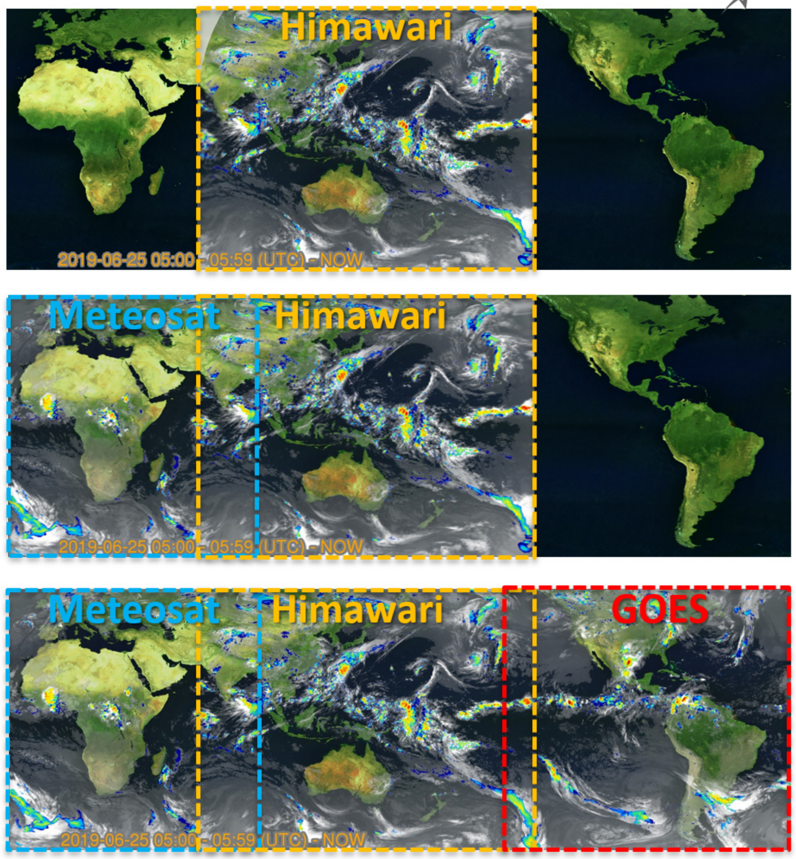
Realtime ver. of GSMaP is now available

- JAXA has operated the "JAXA Realtime Rainfall Watch (GSMaP_NOW)" website from November 2015, which provides "realtime" rainfall information within GEO-satellite Himawari domain. The domain of the JAXA Realtime Rainfall Watch had been extended to GEO-satellite Meteosat region since November 2018.
- From Jul 1, 2019, the domain of JAXA Realtime Rainfall Watch (GSMaP_NOW) has been extended to the whole globe by utilizing GEO-satellite GOES, which means that we can use global rainfall data in realtime.

Nov.2015
Open to the public

Nov.2018
Extended to
Meteosat region

Jun.2019
Extended to
GOES region
=Whole globe!



Realtime Global Rainfall is now available!

Visit GSMaP_NOW !! → https://sharaku.eorc.jaxa.jp/GSMaP_NOW/index.htm