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Improvement of river water storage in JUELS using high resolution river-routing scheme

Hee-sook Ji*, Ui-yong Byun**, Eun-chul Chang**,
Yoon-jin Lim*, Yoon-jae Kim*

*National Institute of Meteorological Sciences, Korea Meteorological Administration
** Kongju National University, Korea

sookkool@korea.kr

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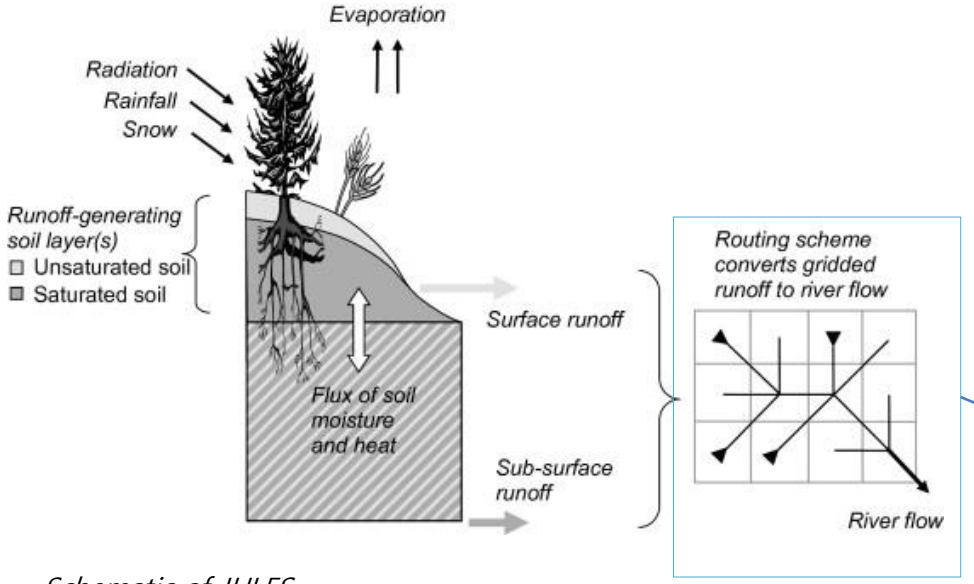
River Routing in Land Surface Model

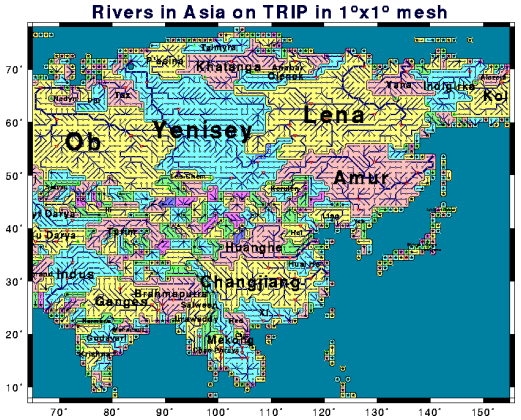


Schematic of JULES soil-column highlighting stores and fluxes of water (Dadson et al., 2011)

River Routing

- Requirements
  - NWP forecasting: River flow for flooding risk and infrastructure flooding (established flooding model an EA requirement)
  - CAMMs: Trafficability
  - Regional climate model: Freshwater for shelf-sea ocean models and peak flow as a proxy for flooding risk
  - Global climate model: Freshwater fluxes to ocean, feedback on soil moisture and inundation, link to water resources model
  - NCOF: 5 day forecasts of freshwater fluxes in European domain, to better accuracy than climatology.
- Available Tools
  - River Flow Model (RFM): Routes surface and sub-surface runoff through a river network
  - Grid-2-gird (G2G): Uses RFM, but own runoff generation and horizontal water transfer
  - Total Runoff Integrated Pathways (TRIP): River routing model at coarse resolution

- River discharge is one of the important components in the hydrological cycle, which transports precipitation to river basin outlets throughout river-routing processes.
- JULES has TRIP and RFM as river routing schemes that are used to route surface and sub-surface runoff from inland grid cells across the river network to river basin outlets.

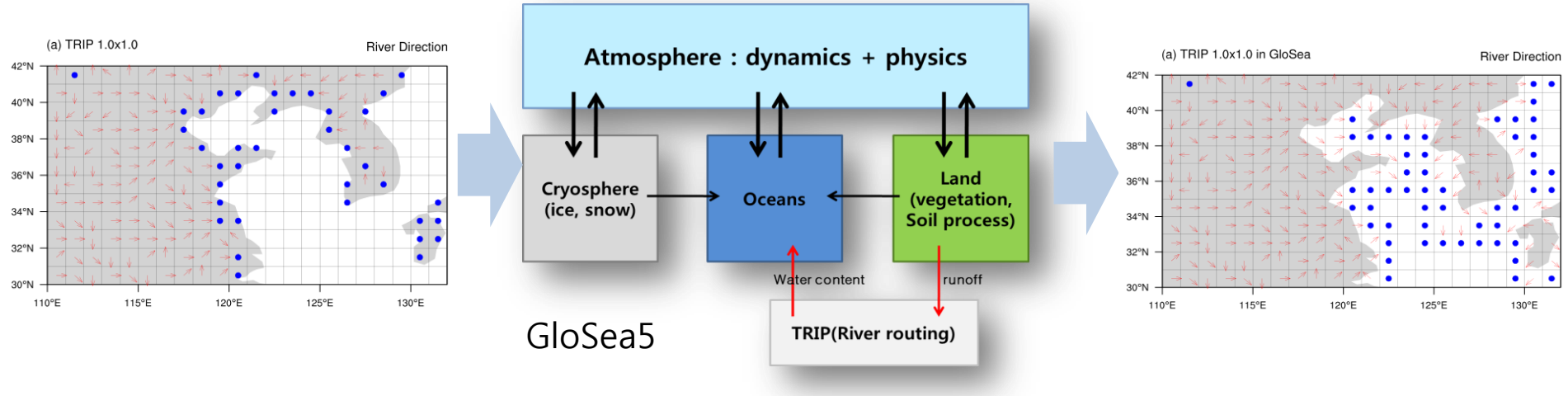


TRIP river network map [Oki et al., 1998]

* TRIP : Total Runoff Integrating Pathways scheme [Oki et al., 1998]
* RFM : River Flow Model [Dadson et al., 2011]

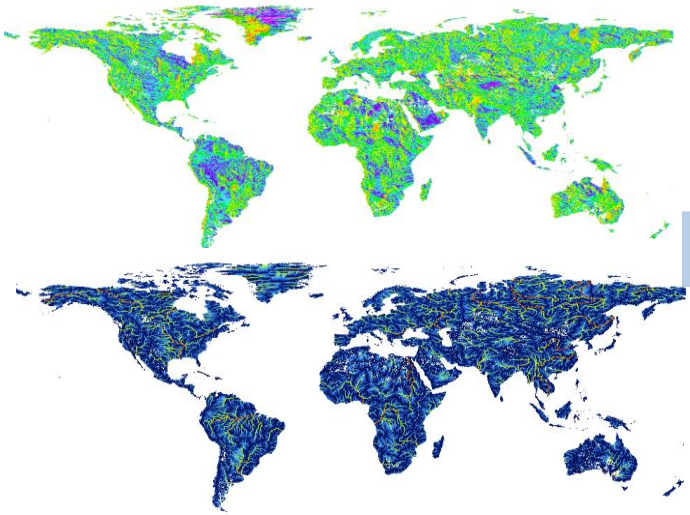
River Routing in Land Surface Model

- The aim of TRIP is to provide a method for routing runoff from land surface to river basin outlets to enable the validation of the runoff part of land-surface parameterizations in global climate models (GCMs).
- To run TRIP module, several ancillaries are required, such as river direction and river sequence, but there are only 1 and 0.5 degree horizontal resolution data (http://hydro.iis.u-tokyo.ac.jp/~taikan/TRIPDATA)
- In addition, for a long term simulation and a coupled with climate model (for example, (KMA seasonal forecast model; Glosea5), river storage and river mouth data are also needed.



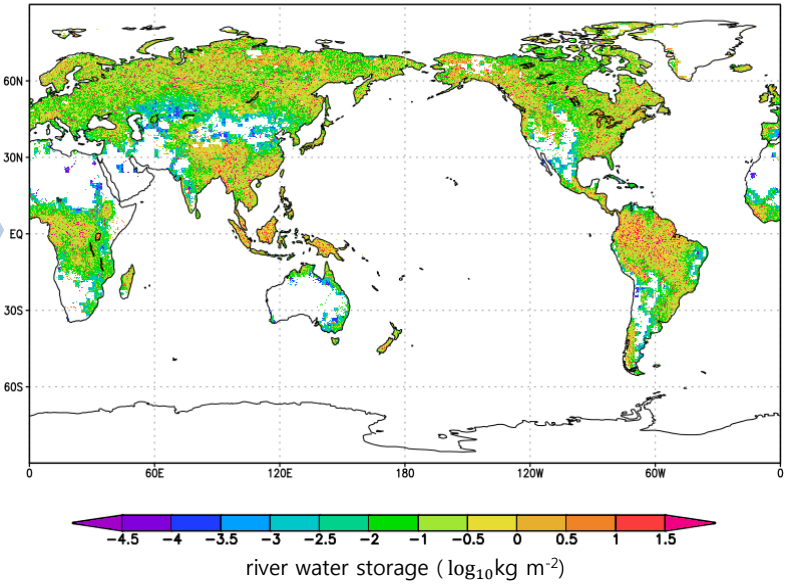
Objectives

- **To implement a high resolution TRIP module to JULES modeling framework**
  - Generation of the 0.125 degree resolution ancillaries (river direction, river sequence)
  - Construction of JULES-high resolution TRIP
- **To product climatological river water storage data for simulating long term period**



Global River Direction & Sequence map

JULES -TRIP



High Resolution TRIP ancillaries

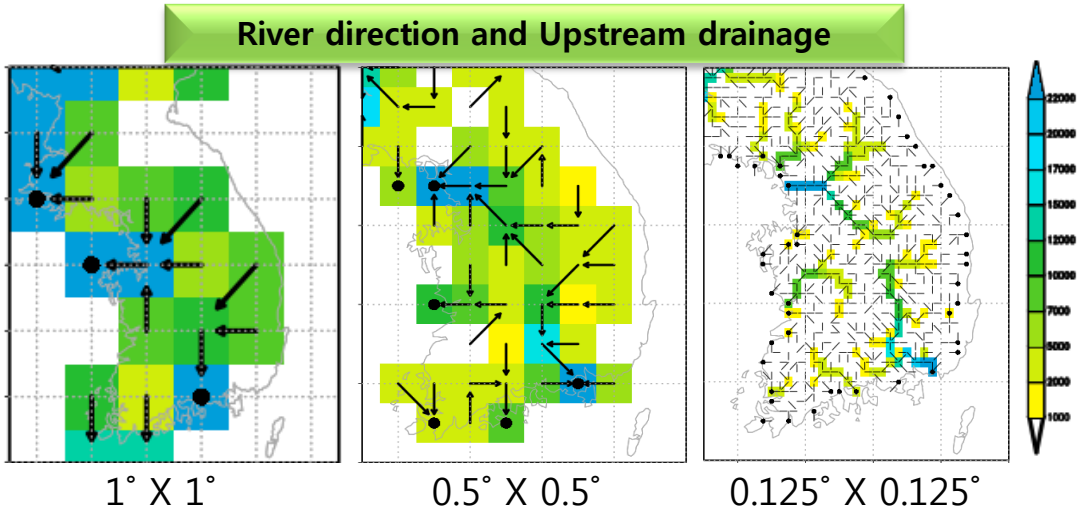
River Direction

- DRT(Global Dominant River Tracing , [Wu et al., 2012]) data set is used for generating 0.125 degree resolution river directions.
- The DRT data set provides the river direction to the neighboring grids with resolutions from 1/16 to 2 degree, which is the most appropriate for the simple advection approach of TRIP.
- From the original DRT data set, which includes only river direction, we have added further information concerning grid points for the coastal river mouth and assigned individual identification numbers.

DRT		
32	64	128
16		1
8	4	2

TRIP		
8	1	2
7	9	3
6	5	4

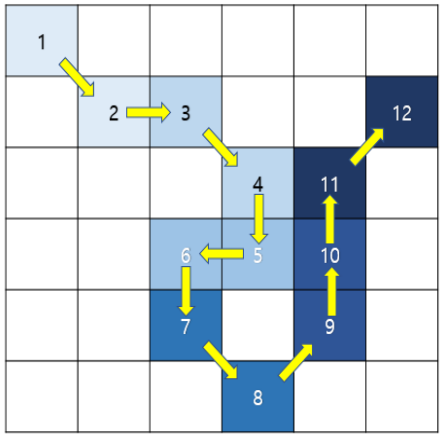
* 9 means river mouth



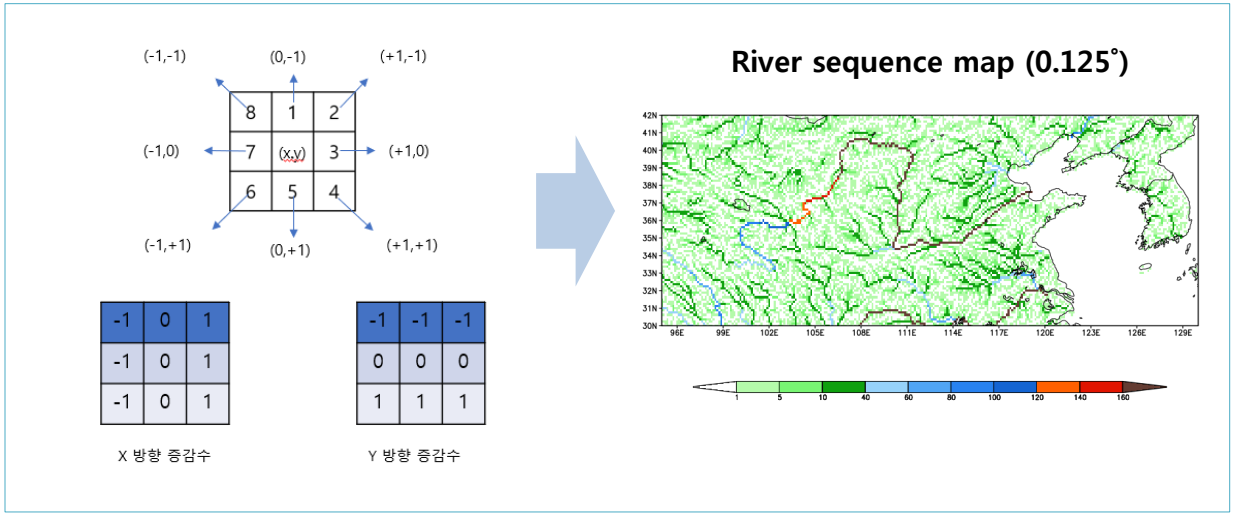
High Resolution TRIP ancillaries

River Sequence

- River sequence is the same concept as the river pathway number, and values of grids is increasing towards river mouths based on passing the number of grids.

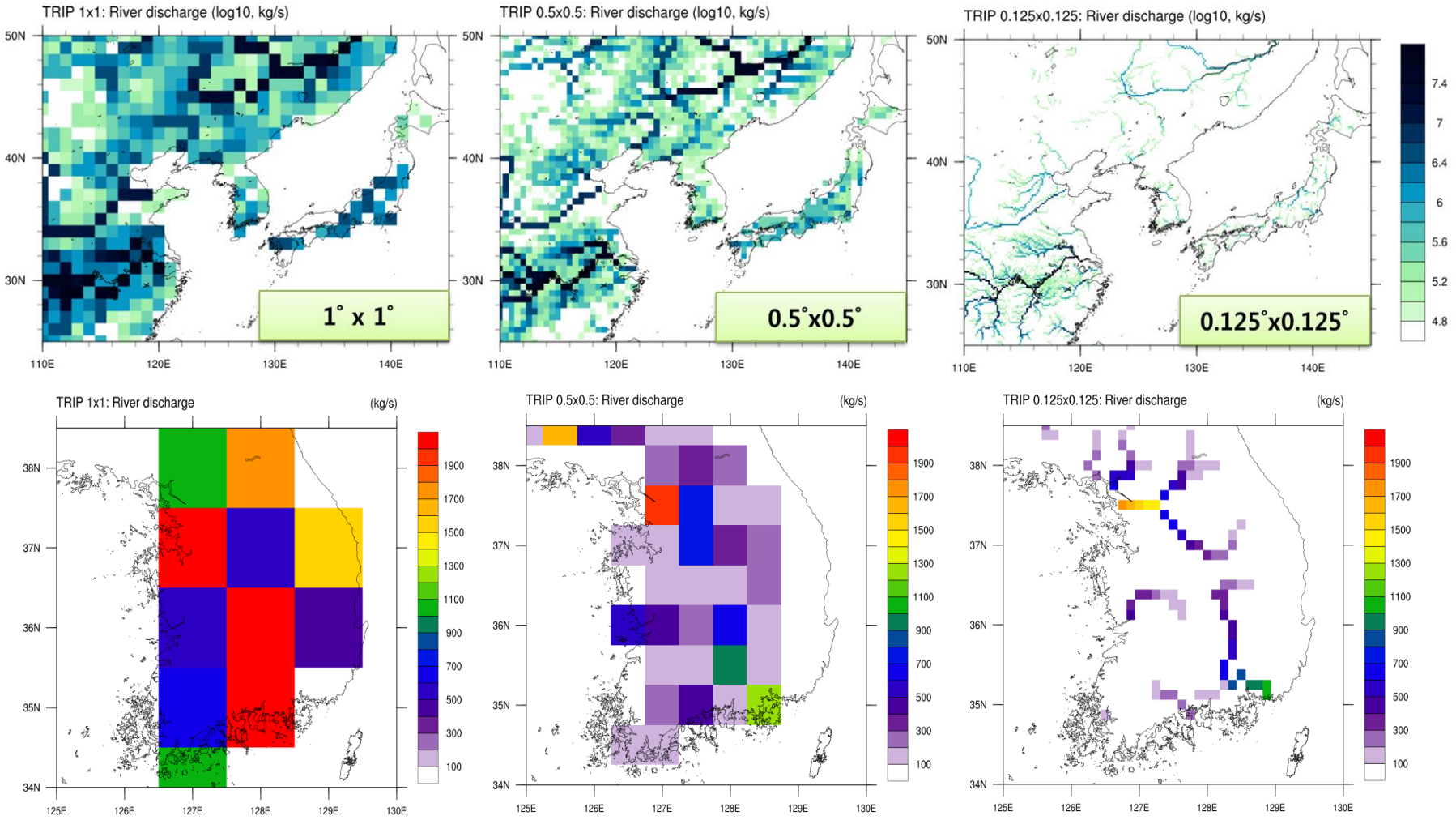


Concept of river sequence



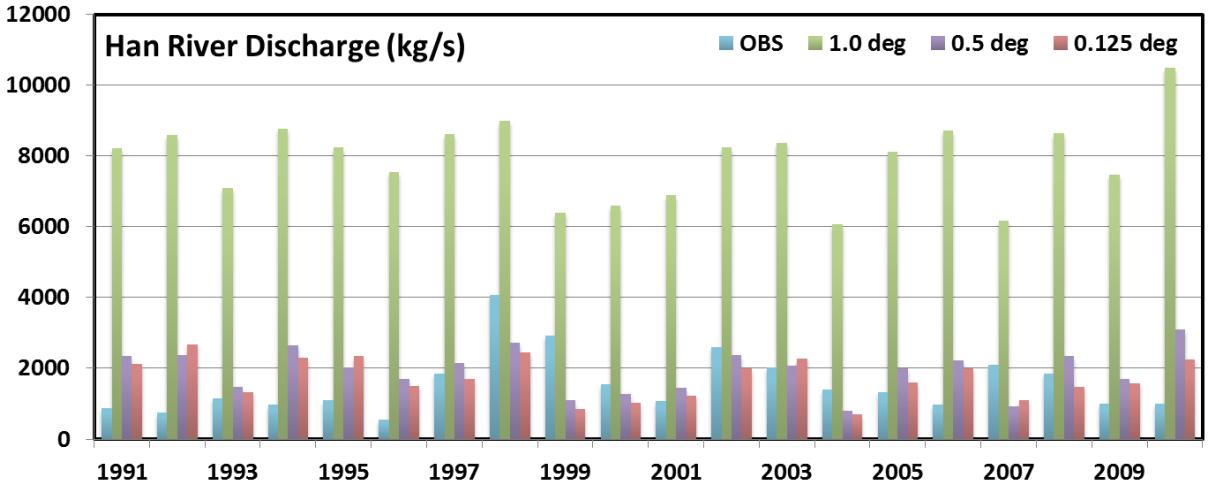
Results

- **Comparison of the different spatial resolution ancillaries**

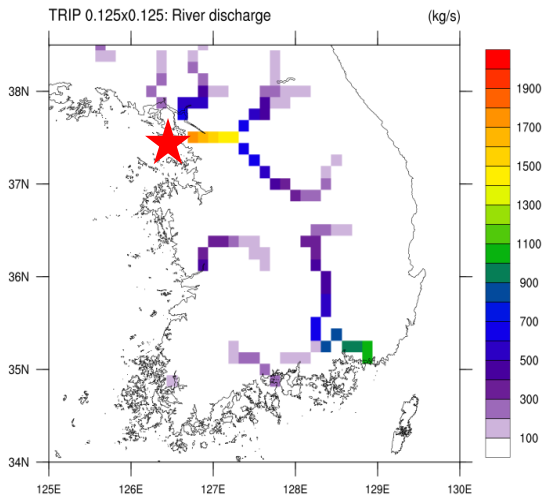


Evaluation

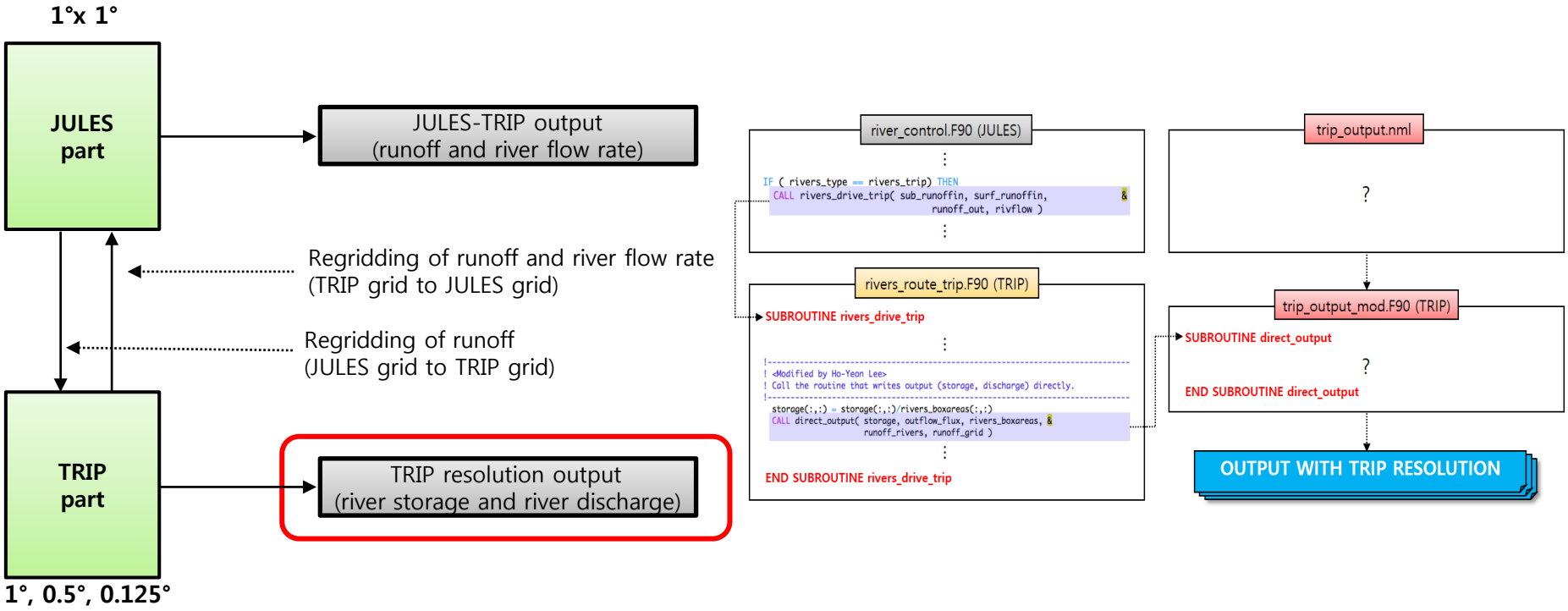
- **The observed and simulated river discharge**



Han river basin	OBS	1.0° × 1.0°	0.5° × 0.5°	0.125° × 0.125°
Mean (kgs^{-1})	1552.2	7904.8	1934.4	1720.8



Construction of JULES-TRIP System

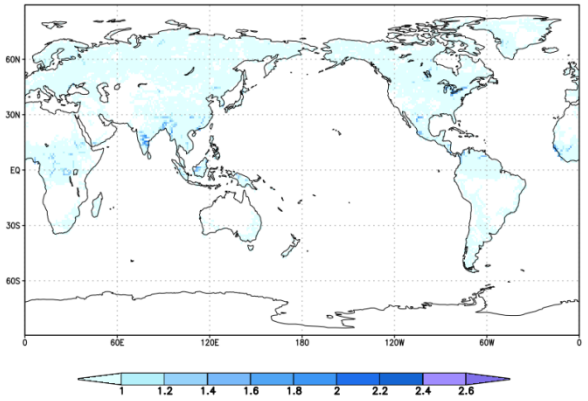


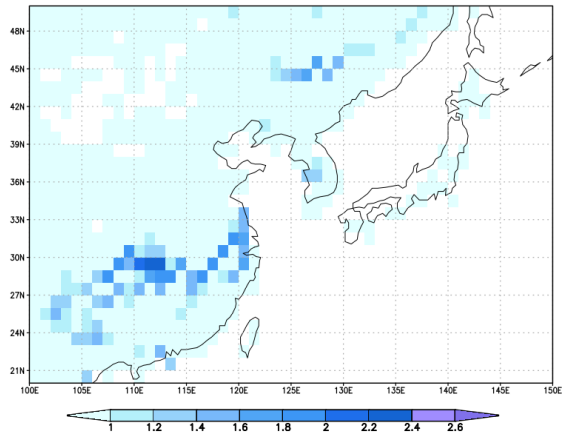
- In JULES-TRIP system, The river storage and discharge are calculated in TRIP using simulated runoff from JULES. After then runoff and river flow rate is re-simulated in JULES using calculated river storage and discharge.

River storage data

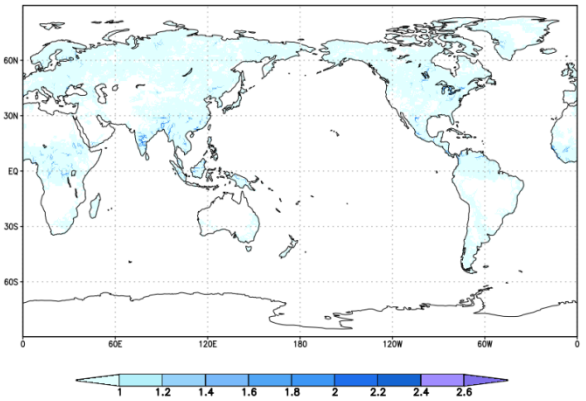
- **Comparison of the different spatial resolution**

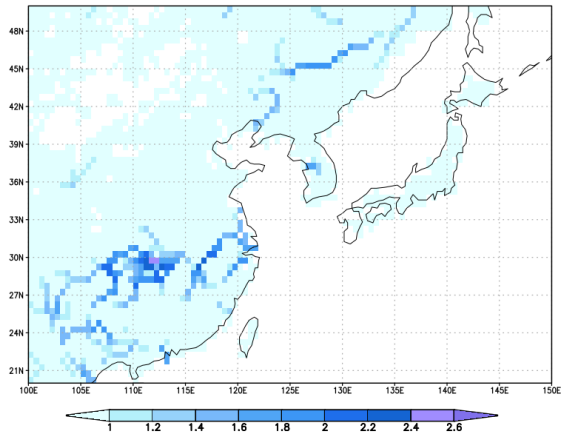
1°x 1°



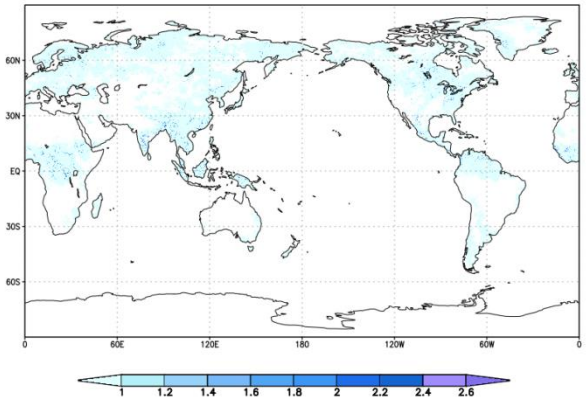


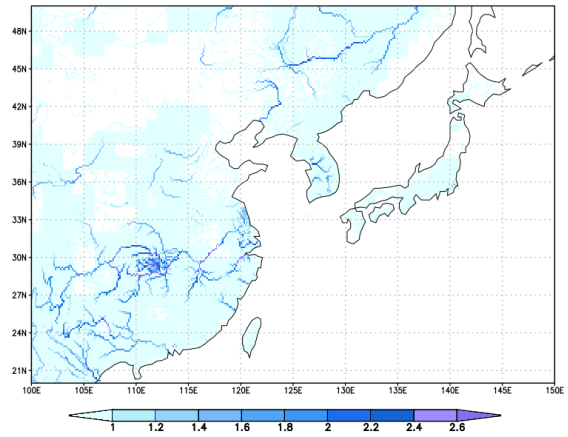
0.5°x 0.5°





0.125°x 0.125°





* 2014.08.27 00UTC, river water storage ($\log_{10}$ kg m^{-2})

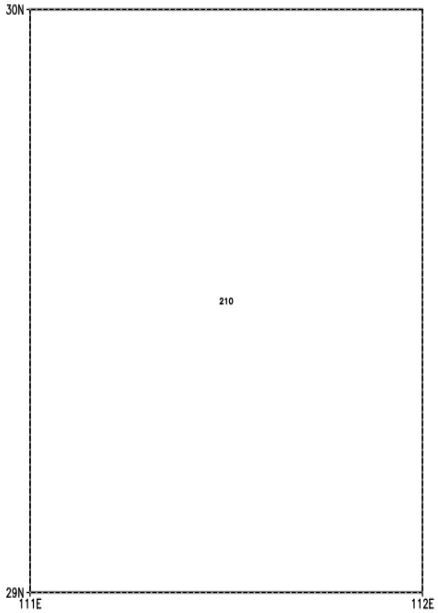
River storage data

- **Storage conservation**

2014. 8. 27 00UTC [29°N - 30°N, 111°E - 112°E]

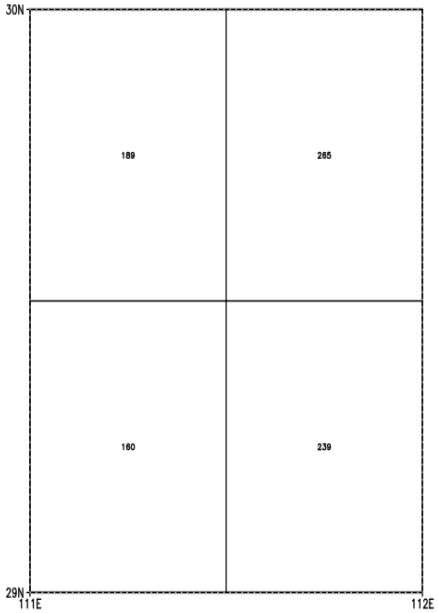
River storage
[kg m^{-2}]

1° x 1°



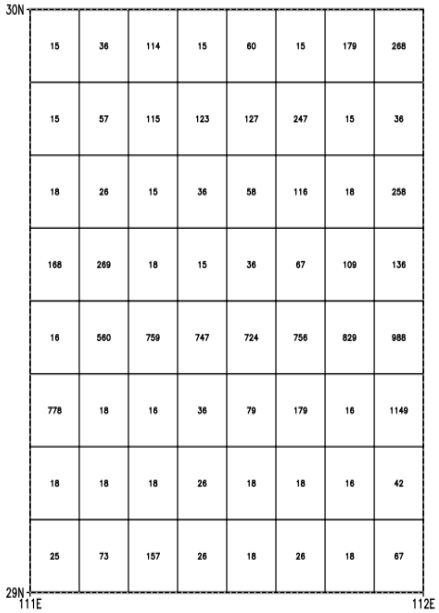
average	210.0
range	210

0.5° x 0.5°



average	212.91
range	160~265

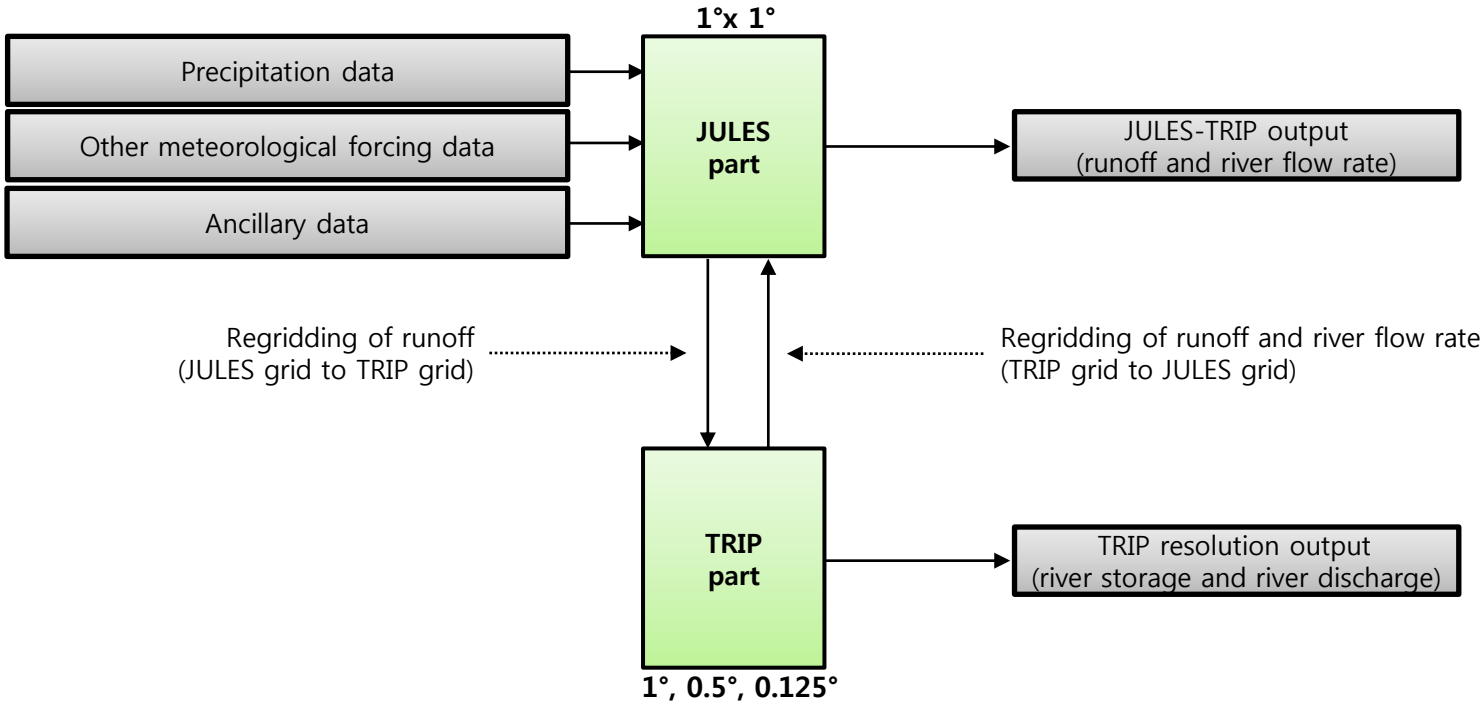
0.125° x 0.125°



average	172.6
range	15~1149

Generation of climatological river water storage

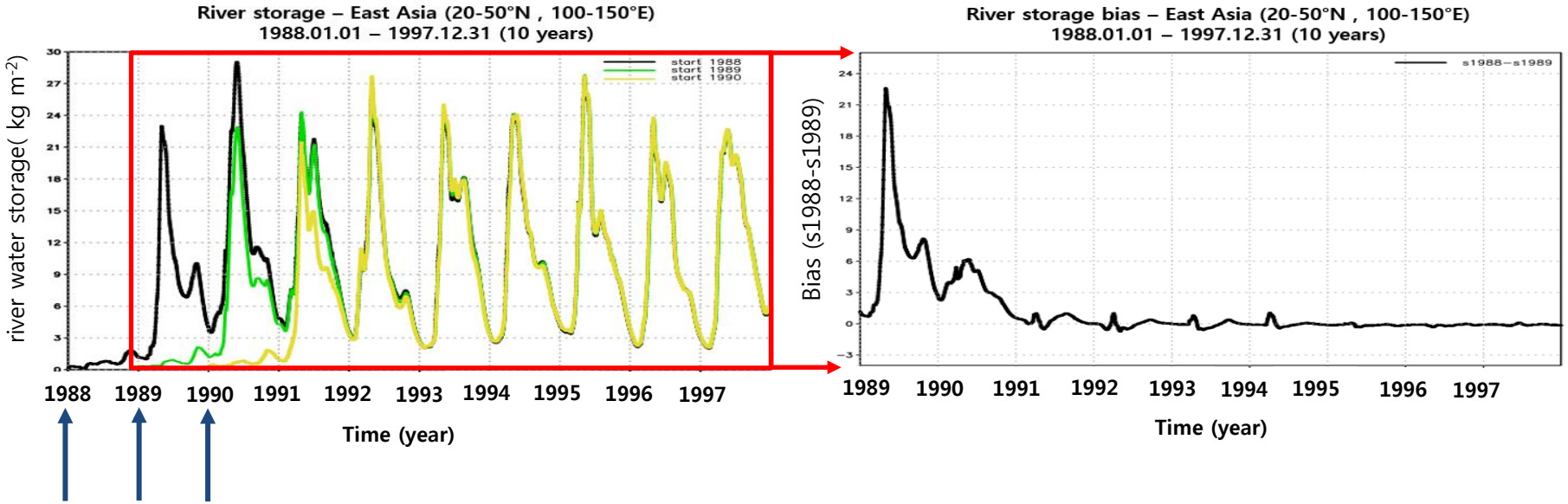
Processes



- Climatological river water storage has been simulated using reanalysis data during 1988-1997 in modified JULES. The reanalysis data are precipitation from CPC and meteorological forcing from DA126.

River storage spin-up

Time series of the simulated river storage



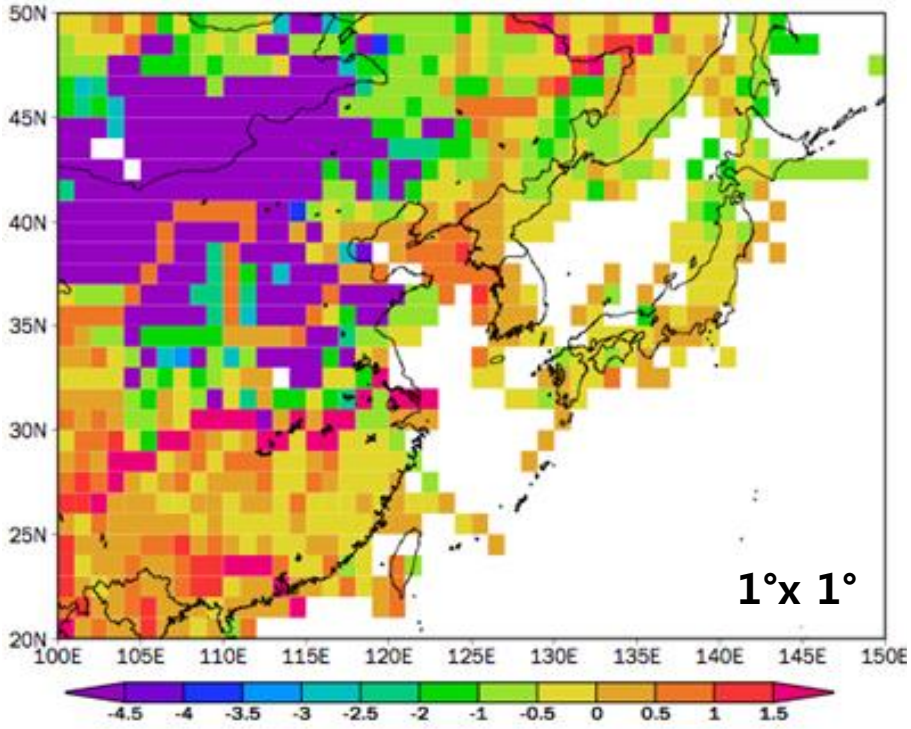
case1 case2 case3

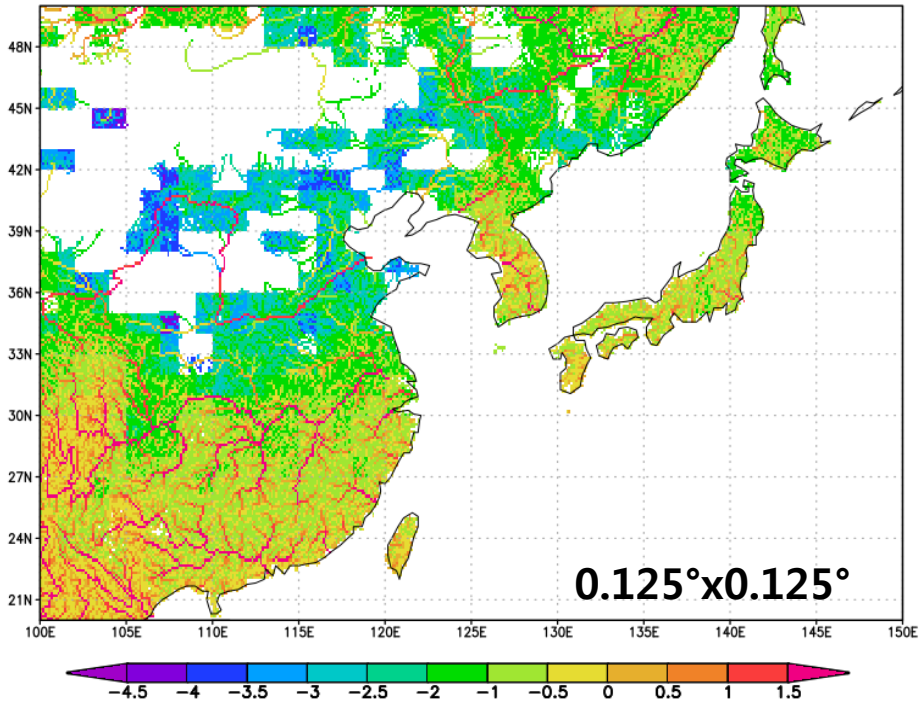
Initial value "0"

- About 2-year is suitable for spin-up period for generating climatological river storage

Results

The simulated river storage during the period of 1990-1997





Climatological river water storage on August (log_{10} kg m^{-2})

Summary and Future Plans

- JULES-high resolution TRIP(0.125 degree) has been developed. As a result, it is possible to get a high resolution river discharge data.

- The different source based climatological river water storage will be generated for a long term simulation and application studies.

- In addition, we will implement the 0.125 TRIP to GloSea5 system ((now) 1 -> (new) 0.125),
  and understand the interaction between atmosphere and ocean.

Thank You !