# Recent advances in topography data & hydrodynamic model for precise global flood simulation

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# Flood models are powerful tool to understand flood risk & reduce damage but they still contain large uncertainties...



### Recent advance in "Data" for better flood simulation



### We released MERIT DEM in 2017 [Yamazaki et al. 2017, GRL]

Global 3" DEM by multi-error removal:
Speckle Noise
Stripe Noise
Absolute Bias
Tree height bias

Highest-ever vertical accuracy as a freely-available global DEM

Data available online: http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT\_DEM/

(a) Pearl River Basin



Global 3-sec river dataset (similar to HydroSHEDS)

### Water Resources Research



Accepted Articles Accepted, unedited articles published online and citable. The final edited and typeset version of record will appear in the future.

MERIT Hydro: A high-resolution global hydrography map based on latest topography datasets

Dai Yamazaki 🕿, Daiki Ikeshima, Jeison Sosa, Paul D. Bates, George Allen, Tamlin Pavelsky

First published: 28 May 2019 | https://doi.org/10.1029/2019WR024873

Research Article 🖻 Open Access 💿 🗿 🗐 😒

#### Abstract

High-resolution raster hydrography maps are a fundamental data source for many geoscience applications. Here we introduce MERIT Hydro, a new global flow direction map at 3 arc-second resolution (~90 m at the equator) derived from the latest elevation data (MERIT DEM) and water body datasets (G1WBM, GSWO, and OpenStreetMap). We developed a new algorithm to extract river networks near-automatically by separating actual inland basins from dummy depressions caused by the errors in input elevation data. After a minimum amount of hand-editing, the constructed hydrography map shows good agreement with existing quality-controlled river network datasets in terms of flow accumulation area and river basin shape. The location of river streamlines was realistically aligned with existing satellite-based global river channel data. Relative error in the drainage area was <0.05 for 90% of GRDC gauges, confirming the accuracy of the delineated global river networks.

Just published on WRR on 28May (Open Access) http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT\_Hydro/

### E & & O

Figures References Related Information

Metrics

#### Details

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Check for updates



Schematic Procedure: (actually 30,000 line Fortran90 code)

Tone, Kinu, Kokai-gawa river in Japan





Spatial coverage extended to N90-S60



You can navigate MERIT Hydro data on Google Earth (KML downloadable)



Supplement data layer are prepared in consistently. Ready to be integrated with flood models. (flow accumulation, river width, adjusted elevation)



Supplement data layer are prepared in consistently. Ready to be integrated with flood models. (flow accumulation, river width, adjusted elevation)

### http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT\_Hydro/

#### MERIT Hydro: global hydrography datasets

Last Update: 17 May, 2019

Front Page **General Information Data Description Known Problems Quick Look Figures** Use of Data Registration

**Developper Webpage** 

**Global River Width** 

G3WBM/G1WBM Global Water Map

**OSM Water Layer** 

**Global River Data** 

Japan Flow Direction

MERIT DEM

Accurate DEM

**MERIT Hydro** 

J-FlwDir

**OpenStreetMap Water** 

Download

Dai Yamazaki

CaMa-Flood **Global Hydrodynamic** 

Model

**GWD-LR** 

Links

#### FrontPage

#### General Information

#### **Product Info**

MERIT Hydro is a global hydrography datasets, developed based on the MERIT DEM and multiple inland water maps. It contains flow direction, flow accumulation, hydrologically adjusted elevations, and river channel width.

#### Data Summary

High-resolution raster hydrography maps are a fundamental data source for many geoscience applications. Here we introduce MERIT Hydro, a new global flow direction map at 3 arc-second resolution (~90 m at the equator) derived from the latest elevation data (MERIT DEM) and water body datasets (G1WBM, GSWO, and OpenStreetMap). We developed a new algorithm to extract river networks near-automatically by separating actual inland basins from dummy depressions caused by the errors in input elevation data. After a minimum amount of hand-editing, the constructed hydrography map shows good agreement with existing guality-controlled river network datasets in terms of flow accumulation area and river basin shape. The location of river streamlines was realistically aligned with existing guality-controlled river network datasets in terms of flow accumulation area and river basin shape. error in the drainage area was smaller than 0.05 for 90% of GRDC gauges, confirming the accuracy of the delineated global river networks. Discrepancies in flow accumulation area were found mostly in arid river basins containing depressions that are occasionally connected at high water levels and thus resulting in uncertain watershed boundaries. MERIT Hydro improves on existing global hydrography datasets in terms of spatial coverage (between N90 and S60) and representation of small streams, mainly due to increased availability of high-guality baseline geospatial datasets. The new flow direction and flow accumulation maps, along with accompanying supplementary layers on hydrologically adjusted elevation and channel width, will advance geoscience studies related to river hydrology at both global and local scales.

#### Data Sources

MERIT Hydro was developed by processing the following products as baseline data (all are freely available from their web page).

#### **Digital Elevation Model**

- U-Tokyo MERIT DEM: link to MERIT DEM webpage

#### Water Body Data

- U-Tokyo G1WBM water body data: link to G1WBM webpage - OpenStreetMap water body layer: link to the OSM Water Layer webpage - EC-JRC Global Surface Water Occurence: link to the GSWO

#### Other Input Data

- U-Maryland Landsat forest cover data: link to the Global Forest Change webpage

#### Tigris-Euphrates River



#### Registration for Download

Please fill the Google Form to get an access to MERIT Hydro

or please contact to the developer (yamadai [at] iis.u-tokyo.ac.jp) to get an access.

#### Download

Current version is v1.0 [17 May, 2019].

#### UPDATE NOTE:

[v1.0] (17 May, 2019)Official Release MERIT Hydro. River width around coastal area was modified, due to uncertainty in water masks in coastal zone. [v0.7] (25 Jan, 2019)Pre-release version.

#### Flow Direction Map (password required)

	N60-N90					
	dir_n60w180.tar	dir_n60w150.tar	dir_n60w120.tar	dir_n60w090.tar	dir_n60w060.tar	dir_n60w030.tar
	dir_n60e000.tar	dir_n60e030.tar	dir_n60e060.tar	dir_n60e090.tar	dir_n60e120.tar	dir_n60e150.tar
	N30-N60					
	dir_n30w180.tar	dir_n30w150.tar	dir_n30w120.tar	dir_n30w090.tar	dir_n30w060.tar	dir_n30w030.tar
	dir_n30e000.tar	dir_n30e030.tar	dir_n30e060.tar	dir_n30e090.tar	dir_n30e120.tar	dir_n30e150.tar
	N00-N30					
	dir_n00w180.tar	n00w150 no data	dir_n00w120.tar	dir_n00w090.tar	dir_n00w060.tar	dir_n00w030.tar
	dir_n00e000.tar	dir_n00e030.tar	dir_n00e060.tar	dir_n00e090.tar	dir_n00e120.tar	dir_n00e150.tar
	S30-N00					
	dir_s30w180.tar	dir_s30w150.tar	dir_s30w120.tar	dir_s30w090.tar	dir_s30w060.tar	dir_s30w030.tar
	dir_s30e000.tar	dir_s30e030.tar	dir_s30e060.tar	dir_s30e090.tar	dir_s30e120.tar	dir_s30e150.tar
	S60-S30					
	dir_s60w180.tar	s60w150 no data	s60w120 no data	dir_s60w090.tar	dir_s60w060.tar	dir_s60w030.tar
	dir_s60e000.tar	dir_s60e030.tar	dir_s60e060.tar	dir_s60e090.tar	dir_s60e120.tar	dir_s60e150.tar
Adjusted Elevation (password required)						
	N60-N90					
	elv_n60w180.tar	elv_n60w150.tar	elv_n60w120.tar	elv_n60w090.tar	elv_n60w060.tar	elv_n60w030.tar
	elv_n60e000.tar	elv_n60e030.tar	elv_n60e060.tar	elv_n60e090.tar	elv_n60e120.tar	elv_n60e150.tar
	N30-N60					
	elv_n30w180.tar	elv_n30w150.tar	elv_n30w120.tar	elv_n30w090.tar	elv_n30w060.tar	elv_n30w030.tar
	elv_n30e000.tar	elv_n30e030.tar	elv_n30e060.tar	elv_n30e090.tar	elv_n30e120.tar	elv_n30e150.tar
	N00-N30					
	elv_n00w180.tar	n00w150 no data	elv_n00w120.tar	elv_n00w090.tar	elv_n00w060.tar	elv_n00w030.tar
	elv_n00e000.tar	elv_n00e030.tar	elv_n00e060.tar	elv_n00e090.tar	elv_n00e120.tar	elv_n00e150.tar
	S30-N00					
	elv_s30w180.tar	elv_s30w150.tar	elv_s30w120.tar	elv_s30w090.tar	elv_s30w060.tar	elv_s30w030.tar
	elv_s30e000.tar	elv_s30e030.tar	elv_s30e060.tar	elv_s30e090.tar	elv_s30e120.tar	elv_s30e150.tar
	S60-S30					
	elv_s60w180.tar	s60w150 no data	s60w120 no data	elv_s60w090.tar	elv_s60w060.tar	elv_s60w030.tar
	elv_s60e000.tar	elv_s60e030.tar	elv_s60e060.tar	elv_s60e090.tar	elv_s60e120.tar	elv_s60e150.tar

# Recent advance in Hydrodynamic Modelling @U-Tokyo

Now MERIT Hydro is integrated to Global river model. CaMa-Flood "v4" is under development. Improved topography leads to accurate flood simulation!

### [Old] SRTM + HydroSHEDS



What is the major advantage of the new CaMa-Flood?

### Integration of satellite observation with flood simulation



Absolute water surface elev. (measurable by satellite) we can compare against satellite, but cannot attribute the source of errors. (flood extent & water elevation might be largely affected by topo errors)

(except for channel bathymetry).

Directly comparison with satellite! (flood extent & water elevation)

### Integration of satellite observation with flood simulation

Precise topography data

→ More & more observations for validation & calibration of global flood models



Visit poster by Megumi Watanabe (U-Tokyo)

### **Integration of satellite observation** with flood simulation

Precise topography data

 $\rightarrow$  More & more observations for validation & calibration of global flood models

### $\rightarrow$ Can we improve flood simulation by integrating satellite observations??



Visit poster by Megumi Watanabe (U-Tokyo)

# **Flood models are** powerful tool to understand flood risk & reduce damage but they **still contain large uncertainties...**



Implementing reservoir operation in flood forecast system

Visit poster by Risa Hanazaki (U-Tokyo)

Constructing continental-scale flood protection database

Visit poster/talk by Yoshiaki Tanaka (U-Tokyo)

### Real-time hydrology/flood monitoring @ U-Tokyo/JAXA



### Summary to today's talk:

We just published the accurate hydrography data: MERIT Hydro http://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT\_Hydro/

- It is "update of HydroSHEDS", based on latest topography inputs (MERIT DEM, Landsat water maps, OpenStreetMap)
- Flow Dir, Flow Acc, Adjusted DEM, river width, etc
   3-arcsec with GLOBAL coverage.

### Improved global flood model by integrating MERIT Hydro

Realistic topography → Direct comparison with satellites Global-scale validation/calibration is ongoing. (water surface elevation by altimetry, flood extent with Landsat, SAR, microwaves)

"CaMa-Flood ver.4" (with latest topography) will be available soon. + we are working for CaMa-Flood ver.5 (global calibrated flood model)



