



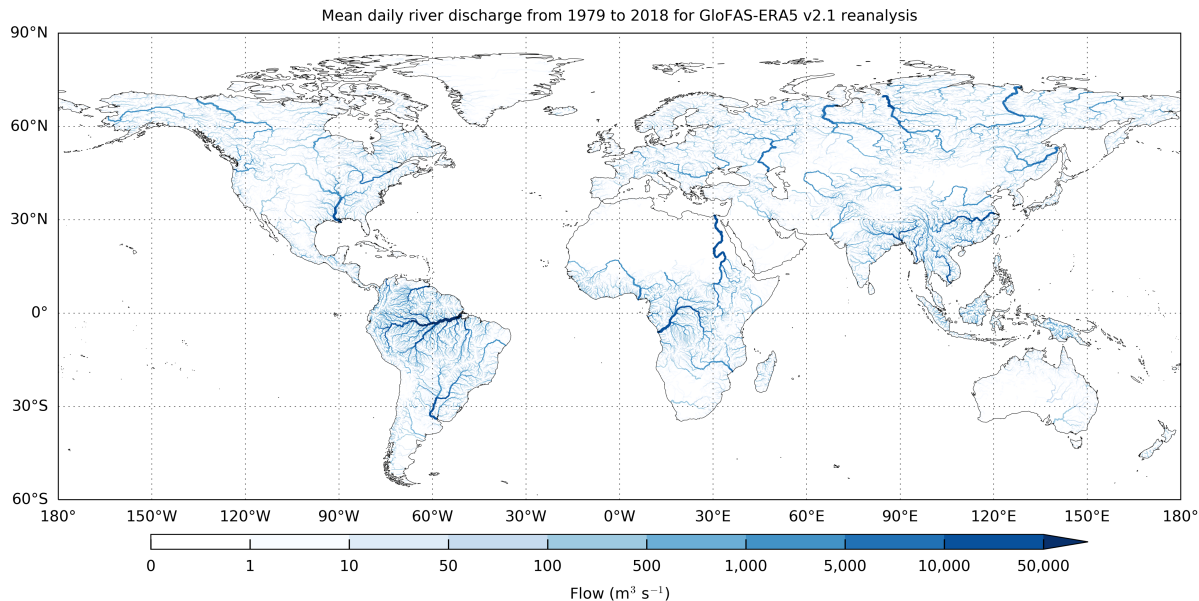
GloFAS-ERA5 operational global river discharge reanalysis 1979-present

Shaun Harrigan, Ervin Zsoter, Lorenzo Alfieri, Christel Prudhomme, Peter Salamon,
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New dataset for large scale hydrology



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GloFAS-ERA5 operational global river discharge reanalysis 1979-present

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Click [here](#) for full details,
evaluation and how to download
data in Harrigan et al. (2020)
data paper in ESSD



- Estimating river discharge for every river in the world in real time is a challenge due to lack of in situ observations
- Optimally combining Earth observations with Numerical Weather Prediction (NWP) modelling and hydrological modelling to provide a 'reanalysis' is a way forward
- GloFAS-ERA5 river discharge reanalysis dataset freely available from 1979 to near real time

Summary of GloFAS-ERA5 v2.1 attributes

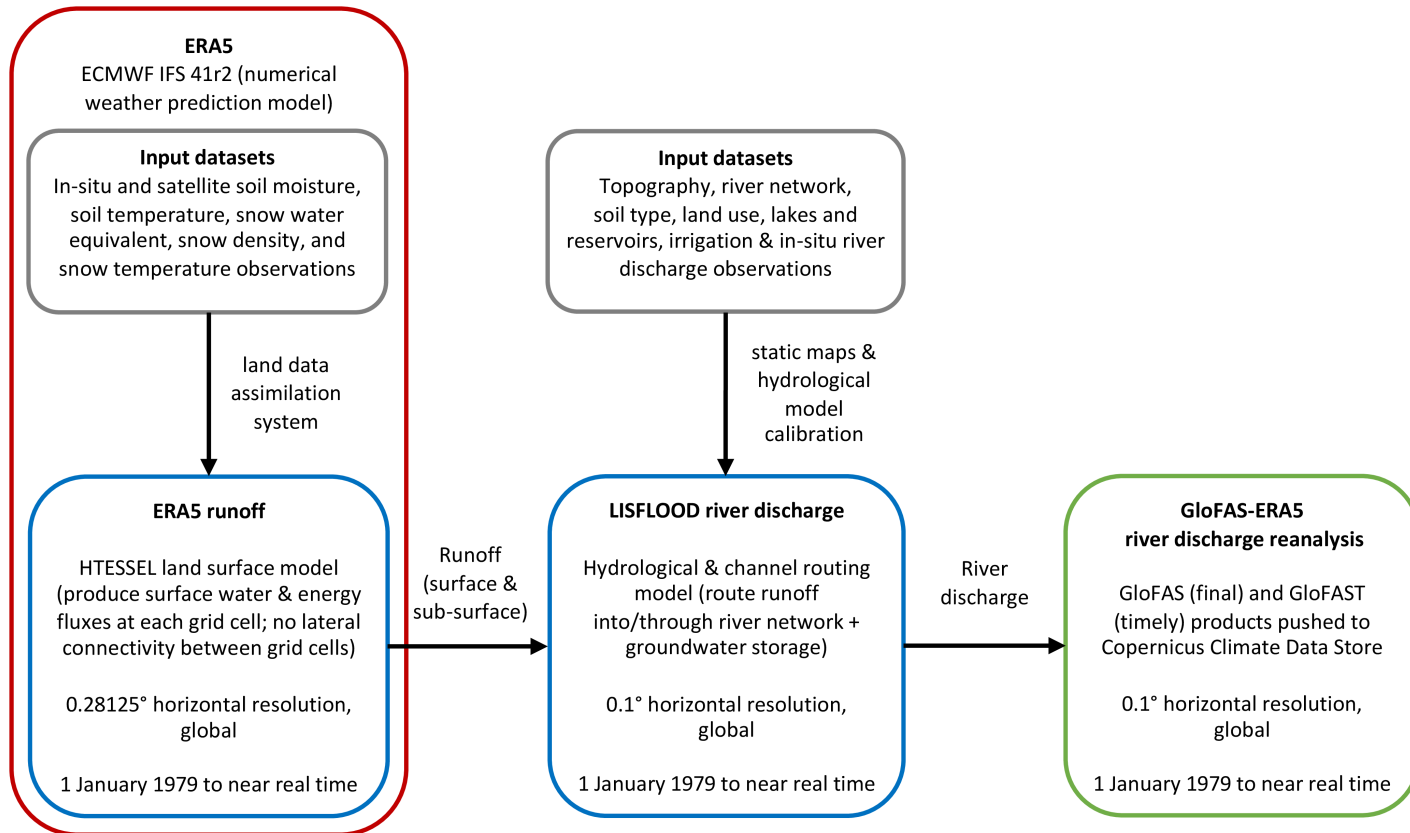


Data available on Copernicus Climate Data Store (CDS) [here](#) 

Dataset attributes	Details
Horizontal coverage	Global except for Antarctica (90° N-60° S, 180° W-180° E)
Horizontal resolution	0.1° x 0.1° gridded
Spatial reference system	Latitude/Longitude (WGS 84, EPSG:4326)
Vertical resolution	Surface level for river discharge
Temporal resolution	Daily data
Temporal coverage	1979-01-01 to near real time
Availability behind real time	i.) GloFAS (consolidated final product): 2 to 3 months, updated on CDS monthly ii.) GloFAST (intermediate timely product): 2 to 5 days, updated on CDS daily
File format	NetCDF
Data size on disk	Approximately 21.7 MB uncompressed per global NetCDF file for one day (full dataset currently ~320 GB uncompressed)



Dataset production





Evaluation against river discharge observations

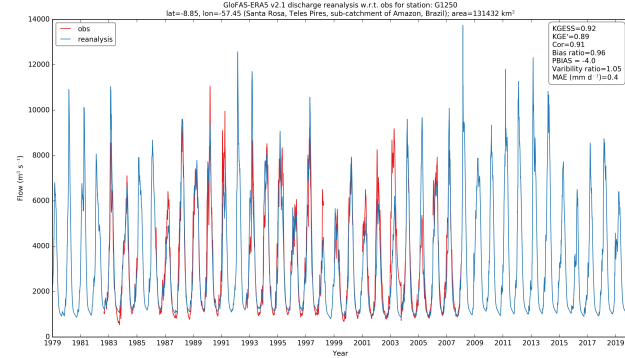


- **Global river discharge observations:**

- 1801 stations with at least 4 years of data over 1979-2018
- Catchment drainage area from 575 km² to 4,664,200 km²

- **Evaluation of hydrological skill:**

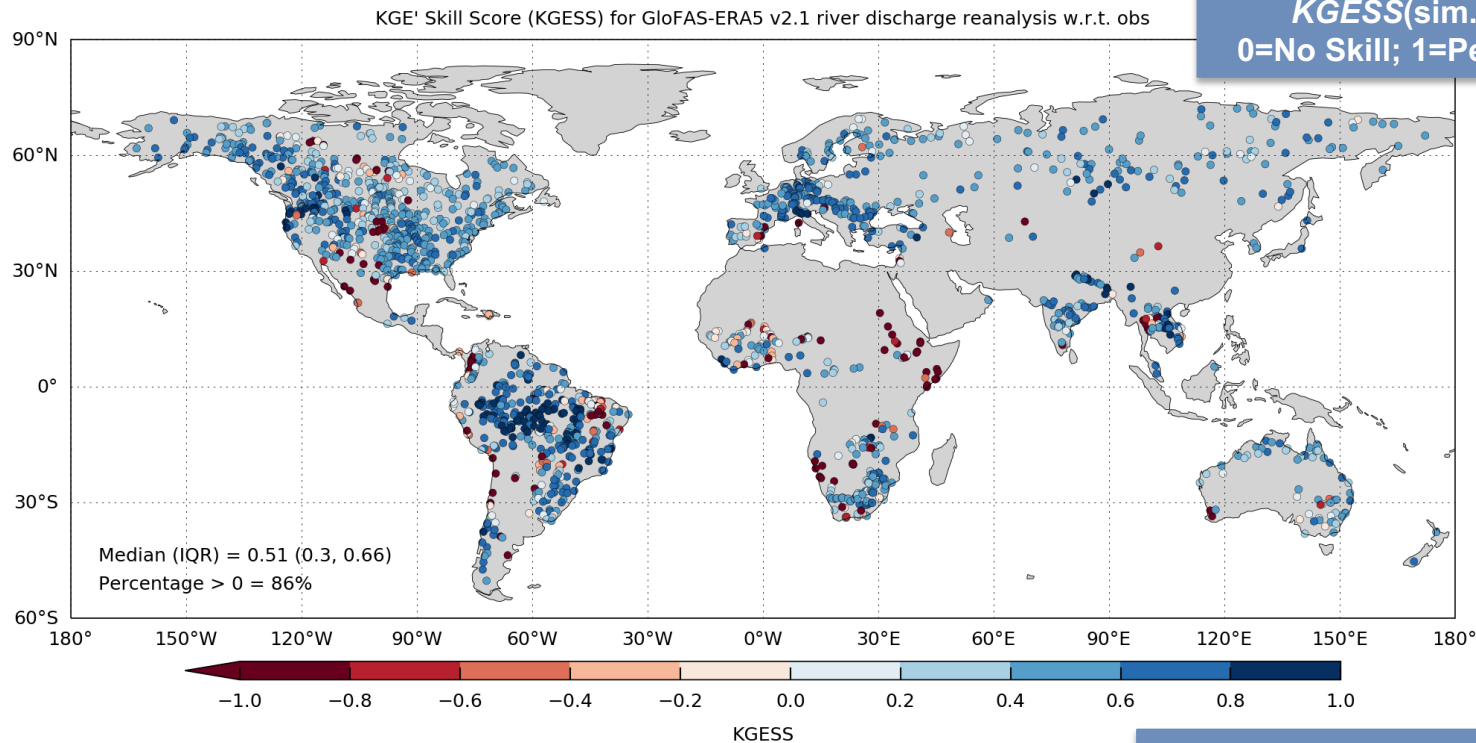
- Modified Kling-Gupta Efficiency (KGE'; Gupta et al., 2009; Kling et al., 2012)
 - Decomposed into Pearson correlation (r), bias ratio (β) and variability ratio (γ)
- We expressed as KGE' Skill Score (**KGESS**) to calculate hydrological **skill** against a benchmark:
 - $KGE'_{reanalysis}$: KGE' for reanalysis v observations
 - KGE'_{bench} : KGE' for mean flow benchmark v observations (proposed by Knoben et al., 2019)
 - KGE'_{perf} : Perfect value of the KGE', which is 1



$$KGESS = \frac{KGE'_{reanalysis} - KGE'_{bench}}{KGE'_{perf} - KGE'_{bench}}$$



Overall performance

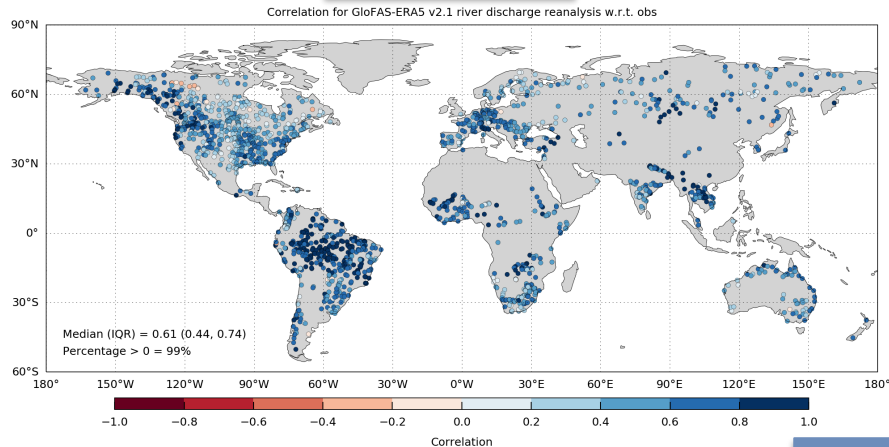




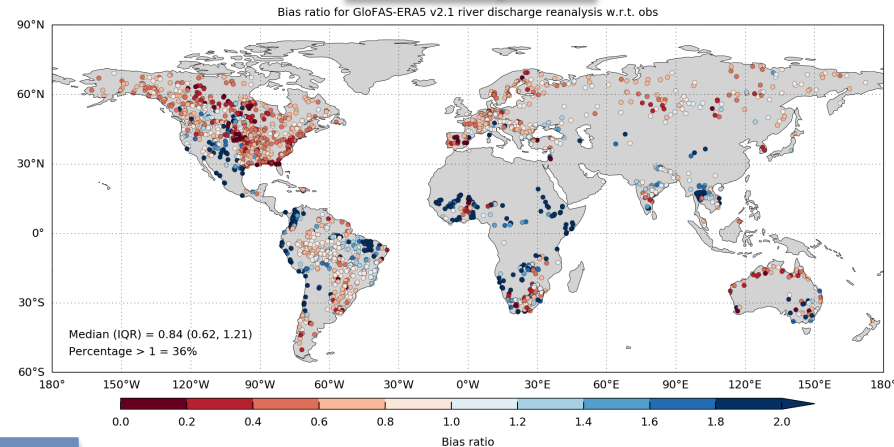
KGE' Decomposition



Correlation r



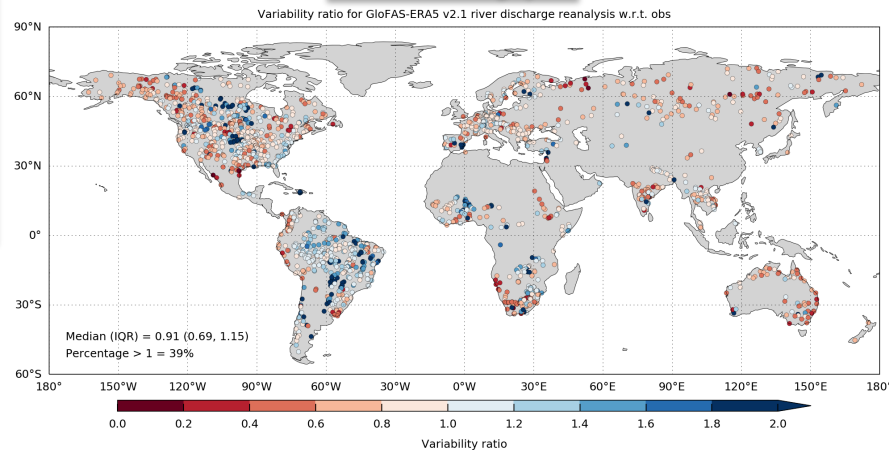
Bias β



Almost all (99%)
catchments show positive
correlation

Global median Pearson
correlation coefficient of
0.61 (IQR = 0.44, 0.74)

Variability γ



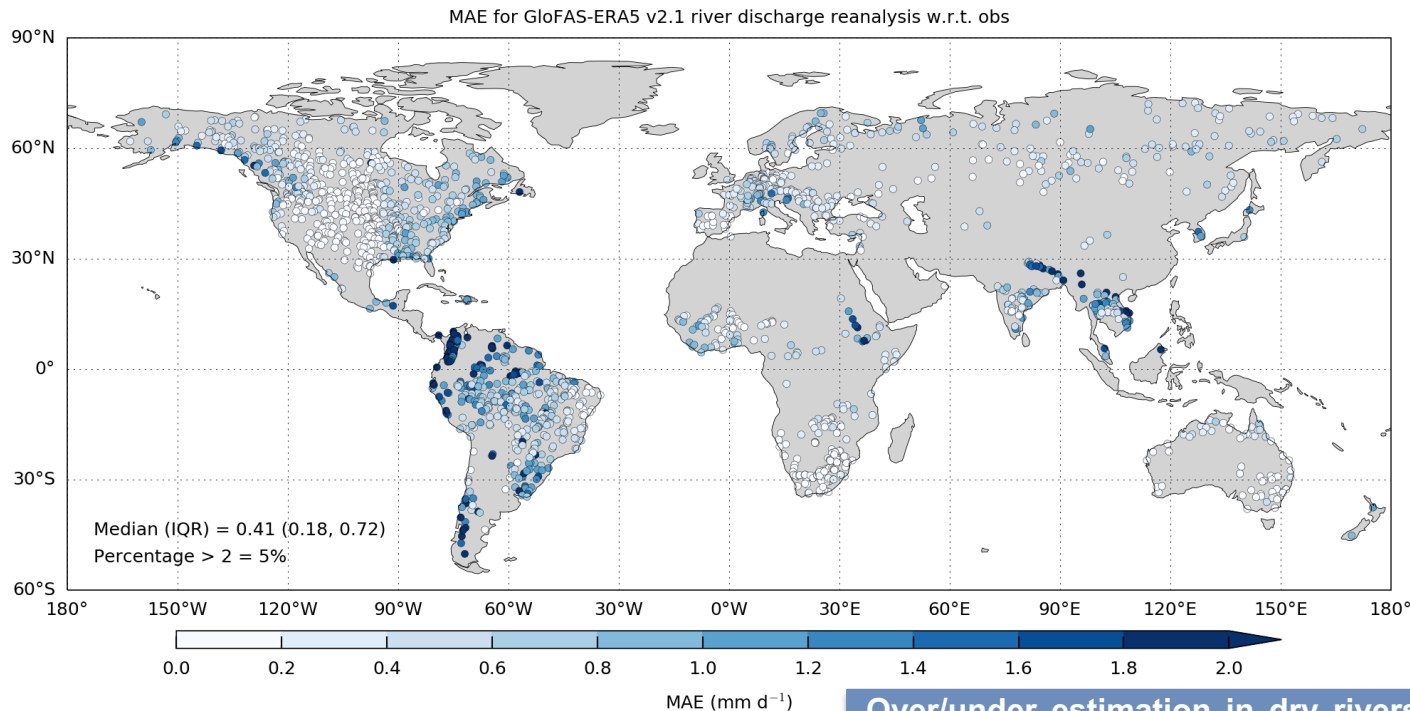
Global median bias
(expressed as PBIAS) of
-16 % (IQR = -38 %, 21 %)

12 % of catchments have
positive PBIAS > 100 % (i.e.
bias ratio > 2)

Variability errors less
severe than bias with
median -9 % (IQR = -31 %, 15 %)



Average magnitude of errors in mm d⁻¹



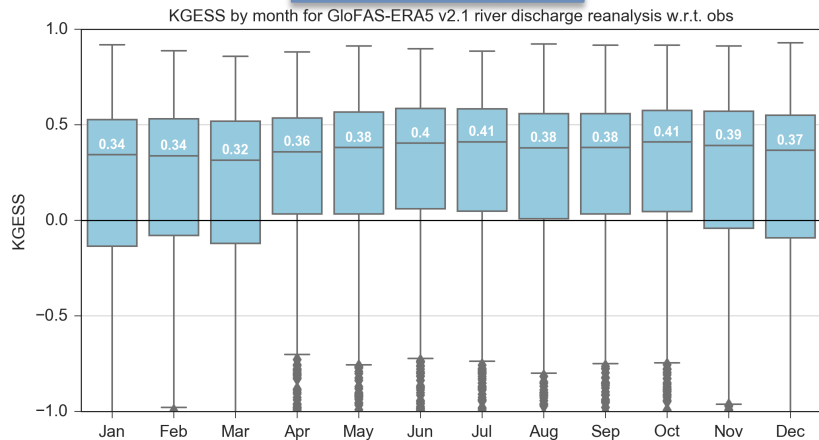
Over/under estimation in dry rivers can produce large percentage biases (e.g. Africa, central US, eastern Brazil and Australia), so it is important to also look at average magnitude of errors, here using Mean Absolute Error (MAE) of flows standardised by upstream area into mm d⁻¹



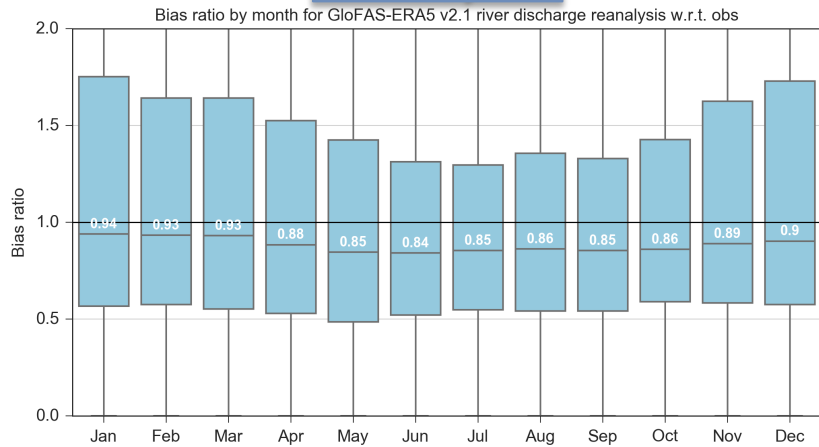
Performance by month



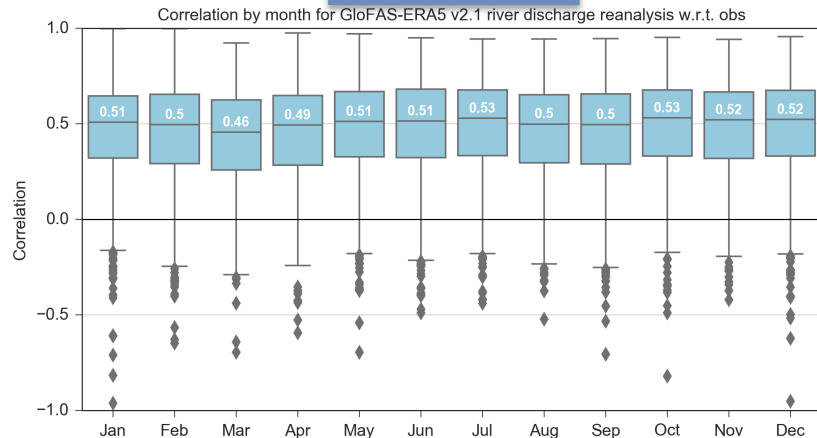
KGE Skill Score



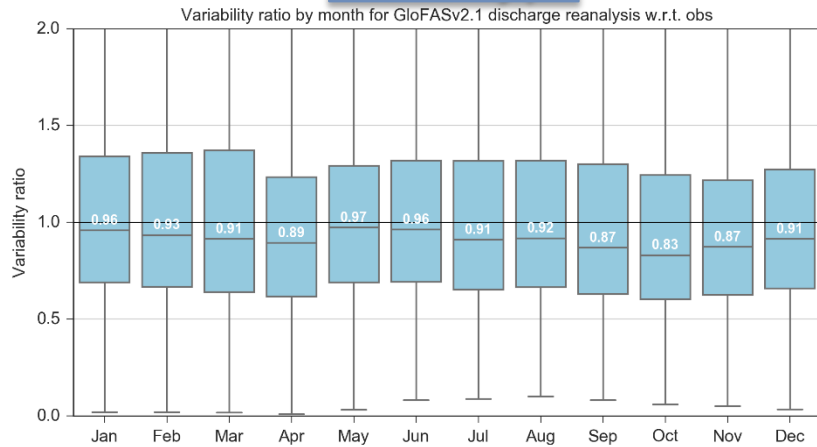
Bias β



Correlation r

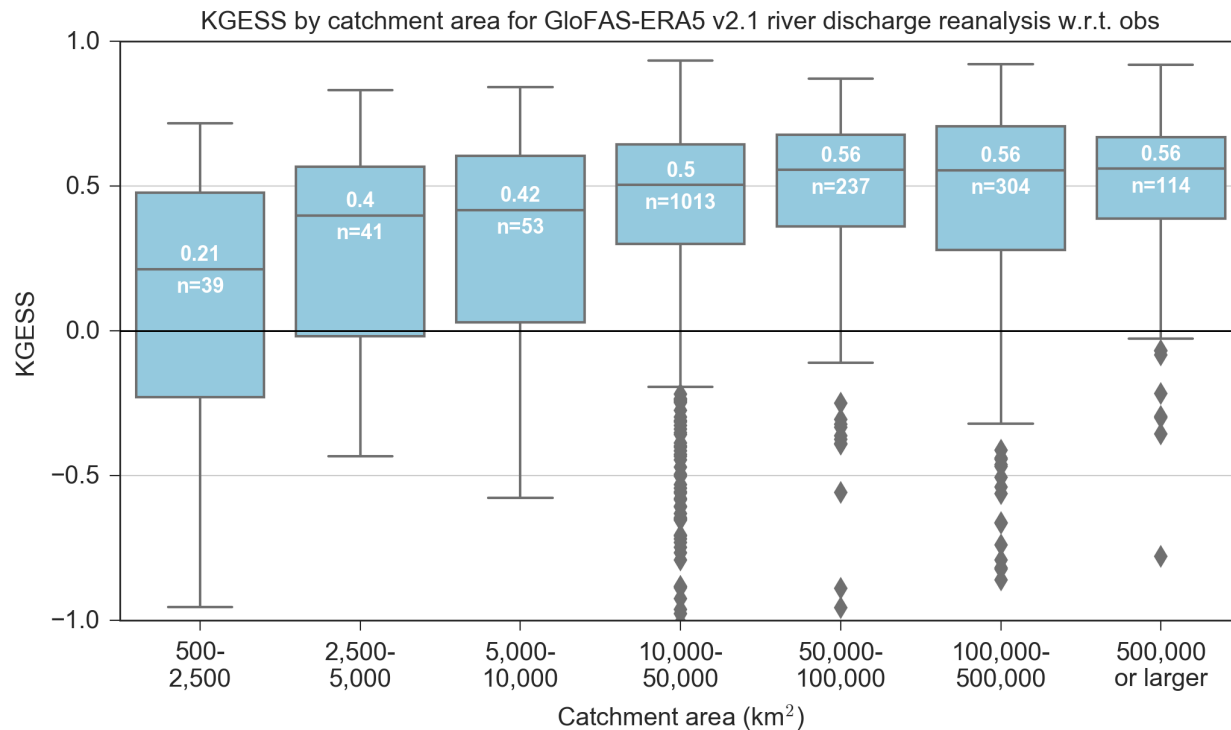


Variability γ





Performance by catchment size



Skill lowest for catchments in the three categories < 10,000 km² with median KGESS = 0.21 (n=39), 0.4 (n=41), and 0.42 (n=53)

Performance improves as catchment size increases, with median KGESS = 0.56 for catchments > 50,000 km²

- New operational global river discharge reanalysis freely available from 1979 to near real time
- GloFAS-ERA5 shows hydrological skill in 86 % of catchments:
 - Although, water balance errors have been identified in the reanalysis, e.g. western coast of S. America, Sudan and Ethiopia and tributaries of the Ganges - Future versions will aim to improve on these issues. Users are advised to undertake more in-depth evaluation for their region of interest
- Long-term and operational nature of GloFAS-ERA5 provides a valuable dataset to the community for large scale hydrology applications, e.g.:
 - Monitoring global flood and drought conditions
 - Understanding hydroclimatic variability and change
 - Initialising hydrological forecasts & forecast evaluation
 - As raw input to post-processing and machine learning methods

Full details and evaluation [here](#)
in data paper (Harrigan et al.,
2020) submitted to ESSDD

Download dataset [here](#) from
Copernicus Climate Data Store
(CDS)
DOI: 10.24381/cds.a4fdd6b9

Questions?

Thanks!

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Download: Copernicus Climate Data Store (CDS)



River discharge and related historical data from the Global Flood Awareness System

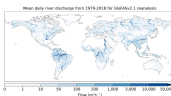
Overview Download data Documentation

This dataset contains global modelled daily data of river discharge from the Global Flood Awareness System (GloFAS), which is part of the Copernicus Emergency Management Service (CEMS). River discharge, or river flow as it is also known, is defined as the amount of water that flows through a river section at a given time.

This dataset is simulated by forcing the hydrological river routing model with modelled gridded runoff data from global reanalysis. Data availability for the historical simulation is from 1979-01-01 up to near real time.

The land surface model that produced the runoff was HTESSEL, and the river routing model component was LISFLOOD, run with a 0.1 x 0.1 degree lat-long resolution.

More details about the product are given in the Documentation section.



DATA DESCRIPTION

Horizontal coverage	Global except for Antarctica (RON 60S, 180W-180E)
Horizontal resolution	0.1° x 0.1°
Vertical resolution	Surface level for river discharge
Temporal coverage	1979-01-01 to near real time for the most recent version.
Temporal resolution	Daily data
Update frequency	A new river discharge reanalysis will be published with every major update of the GloFAS system. The latest version will always be the version used in operations. For more information on the model versions, we refer to the documentation.
File format	NetCDF
Data type	GRID
Version	GloFAS v2.1

MAIN VARIABLES

Name	Units	Description
River discharge	m ³ s ⁻¹	Volume rate of water flow, including sediments, chemical and biological material, in the river channel averaged over a time step through a cross-section. The value is an average over a 24-hour period.

RELATED VARIABLES

Name	Units	Description
Upstream area	m ²	Static file - upArea.nc, Upstream area for the point in the river network.

Record updated 2019-11-05 13:40:03 UTC

Contact

copernicus-support@ecmwf.int

Licence

CEMS-FLOODS datasets licence

Publication date

2019-11-05

References

DOI: 10.24381/cds.a4fdd6d9

Related data

River discharge and related forecasted data by the European Flood Awareness System

River discharge and related historical data from the European Flood Awareness System

CDS website form



River discharge and related historical data from the Global Flood Awareness System

Overview Download data Documentation

Variable:

Dataset:

Version:

Year:

CDS Python API request

```
# Example CDS Python API request script

# Code snippets can be found by clicking 'Show API request' at
# bottom of GloFAS-ERA5 reanalysis download form:
# https://cds.climate.copernicus.eu/cdsapp#!/dataset/cems-glofas-historical?tab=form

# Instructions on how to download CDS API can be found here:
# https://cds.climate.copernicus.eu/api-how-to

import cdsapi

c = cdsapi.Client()

# Example download consolidated data (GloFAS) for 31 December 2018 (note: date stamp
# represents end of 24 h averaging period)

c.retrieve(
    'cems-glofas-historical',
    {
        'variable': 'River discharge',
        'dataset': 'Consolidated reanalysis',
        'version': '2.1',
        'year': '2018',
        'month': '12',
        'day': '31',
        'format': 'tgs'
    },
    'download.tar.gz'
)

# Example download near real time intermediate data (GloFAS) for 12 November 2019 (note:
# date stamp represent end of 24 h averaging period)

c.retrieve(
    'cems-glofas-historical',
    {
        'variable': 'River discharge',
        'dataset': 'Intermediate dataset',
        'version': '2.1',
        'year': '2019',
        'month': '11',
        'day': '12',
        'format': 'tgs'
    },
    'download.tar.gz'
)
```

- Download direct from [CDS website form](#)
- Programmatic access via [CDS Python API](#)



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