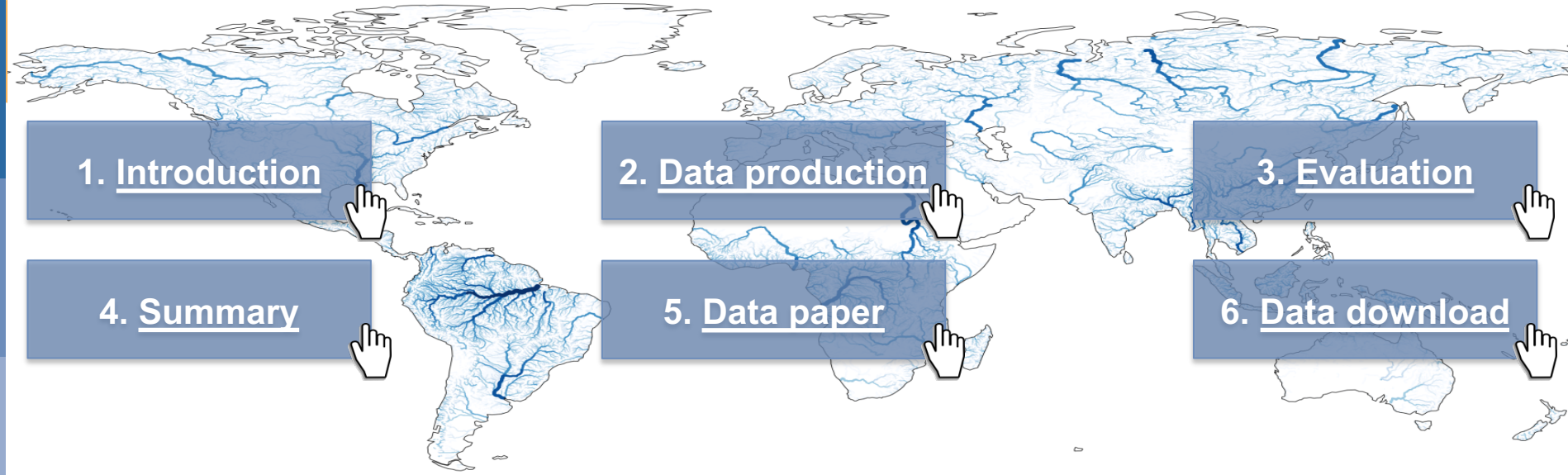

GloFAS-ERA5 operational global river discharge reanalysis 1979-present

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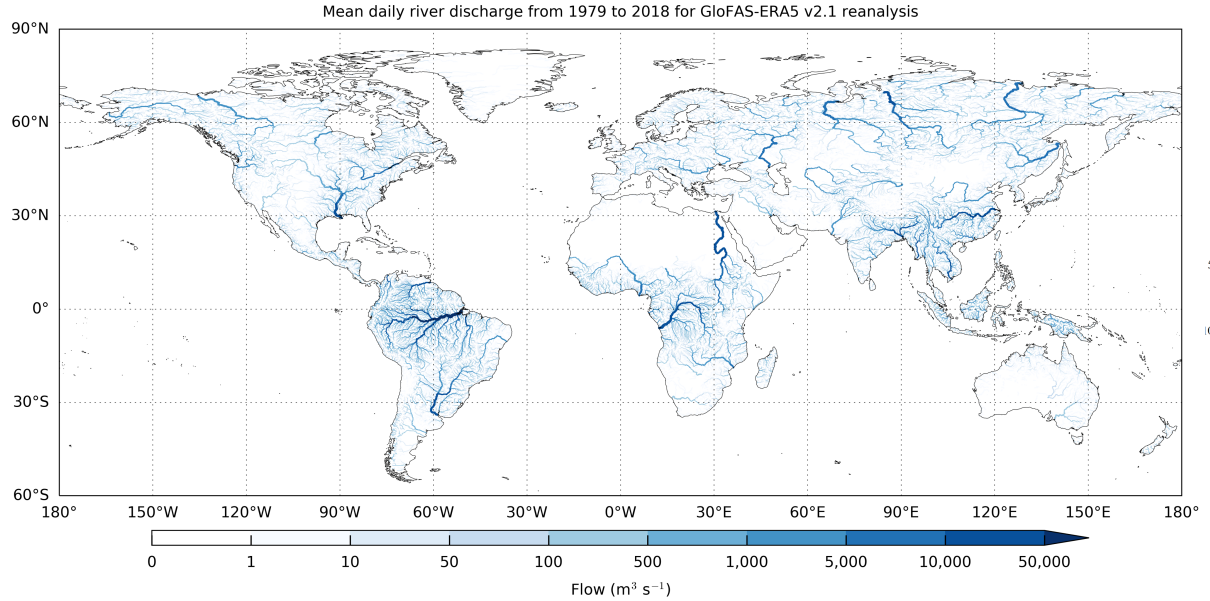
New dataset for large scale hydrology



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Open Access Earth System Science Data Discussions

GloFAS-ERA5 operational global river discharge reanalysis 1979-present

Shaun Harrigan[1], Ervin Zsoter[1], Lorenzo Alfieri[2], Christel Prudhomme[1,3,4] Peter Salamon[2], Fredrik Wetterhall[1], Christopher Barnard[1], Hannah Cloke[5,6,7,8], and Florian Pappenberger[1]

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[8]Centre of Natural Hazards and Disaster Science, CNDS, Uppsala, Sweden

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

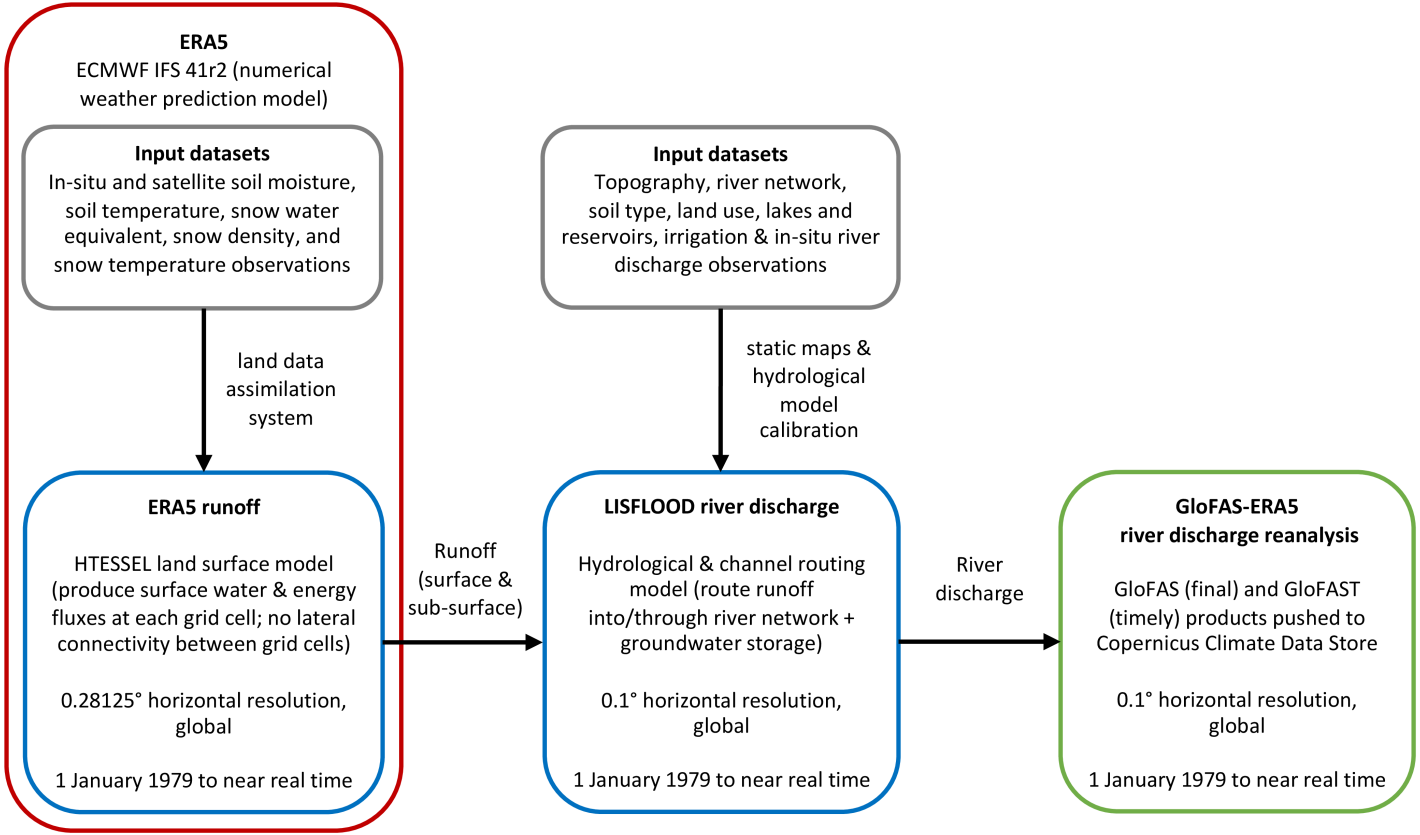
- Estimating river discharge for every river in the world in real time is a challenge due to lack of in situ observations
- Optimally combining Earth observations with Numerical Weather Prediction (NWP) modelling and hydrological modelling to provide a ‘reanalysis’ is a way forward
- GloFAS-ERA5 river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

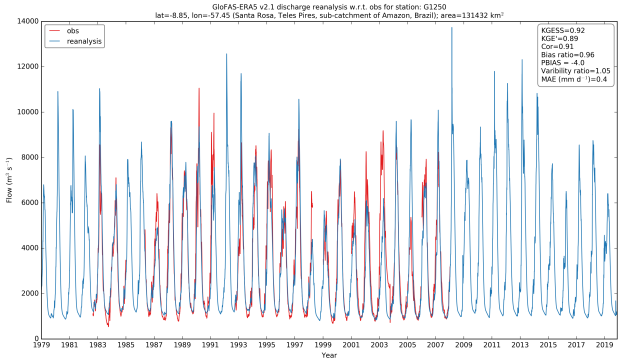
Dataset attributes	Details
Horizontal coverage	Global except for Antarctica (90° N-60° S, 180° W-180° E)
Horizontal resolution	0.1° x 0.1° gridded
Spatial reference system	Latitude/Longitude (WGS 84, EPSG:4326)
Vertical resolution	Surface level for river discharge
Temporal resolution	Daily data
Temporal 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

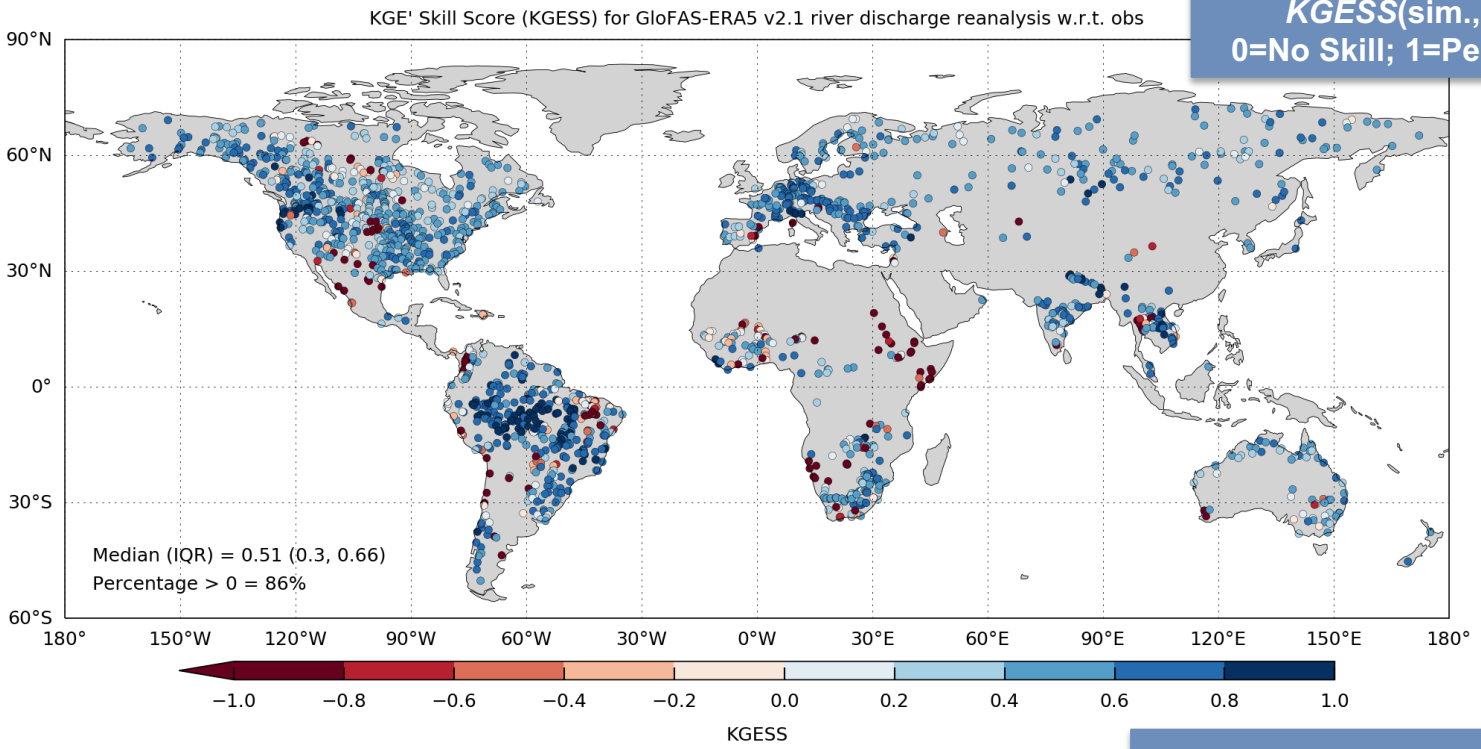
- **Global river discharge observations:**
  - 1801 stations with at least 4 years of data over 1979-2018
  - Catchment drainage area from 575 km^2 to 4,664,200 km^2



- **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

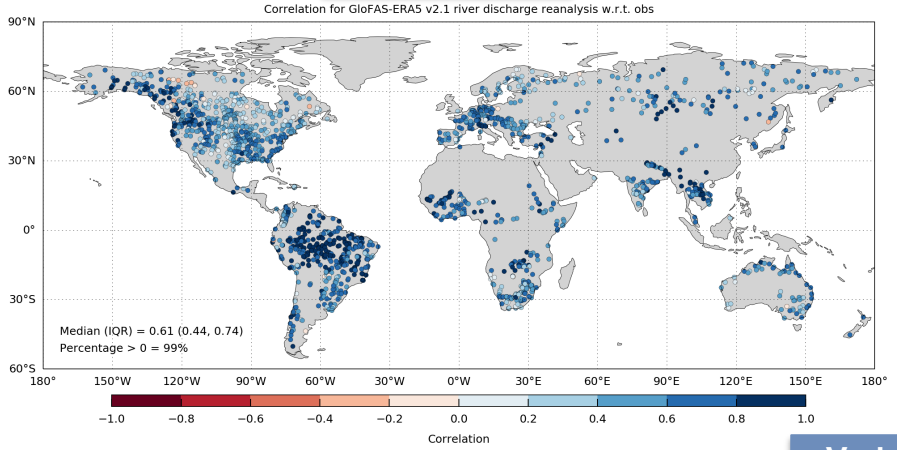


***KGESS*(sim., obs.)**
0=No Skill; 1=Perfect skill

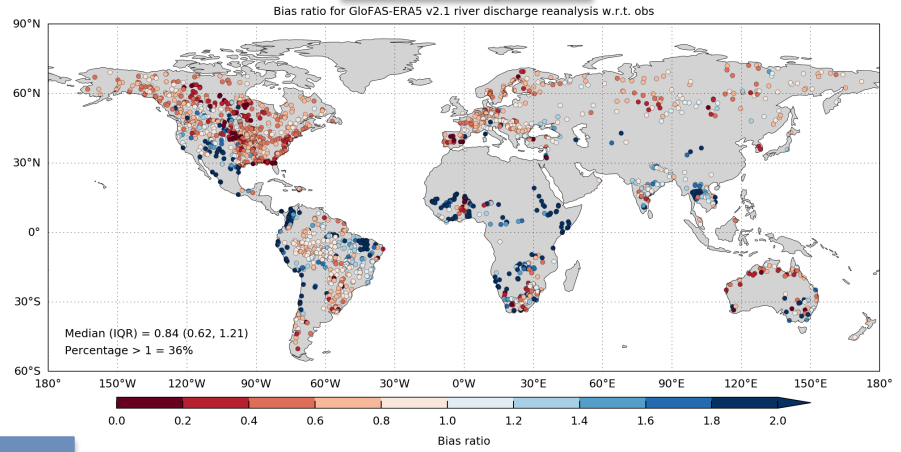
GloFAS-ERA5 river discharge reanalysis shows hydrological skill in 86 % of catchments

KGE' Decomposition

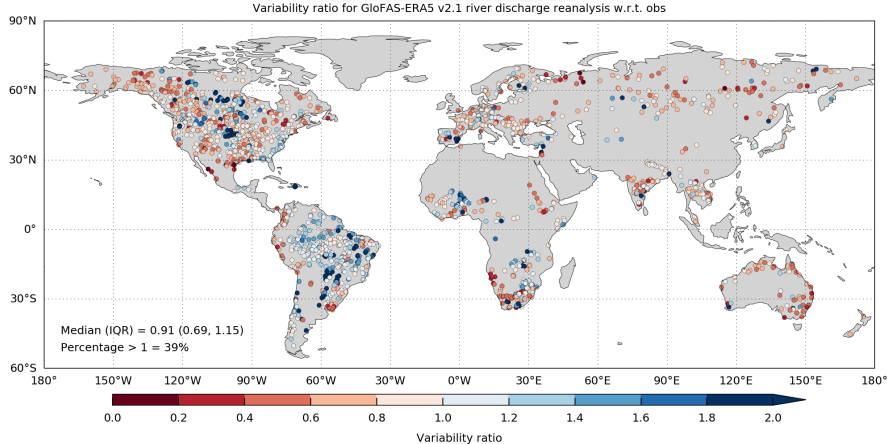
Correlation r



Bias β



Variability γ



Almost all (99%) catchments show positive correlation

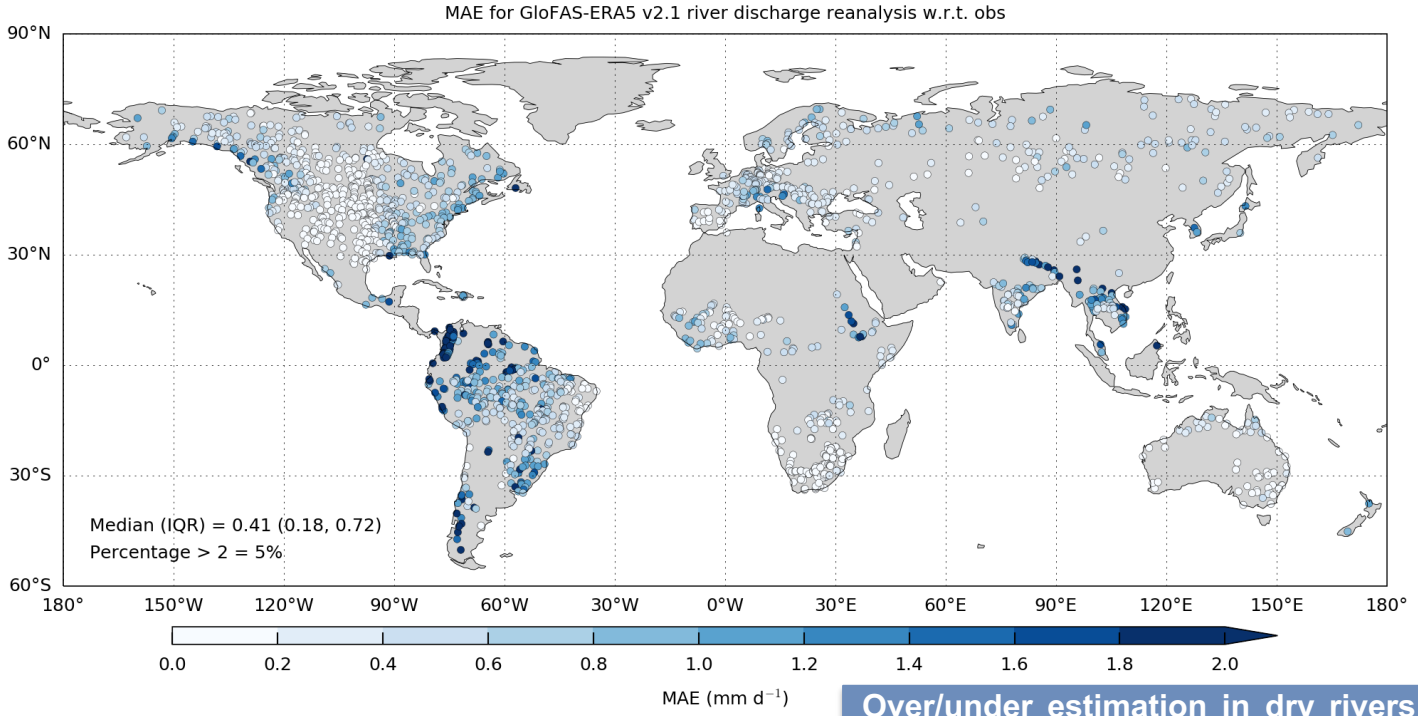
Global median Pearson correlation coefficient of 0.61 (IQR = 0.44, 0.74)

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 %)

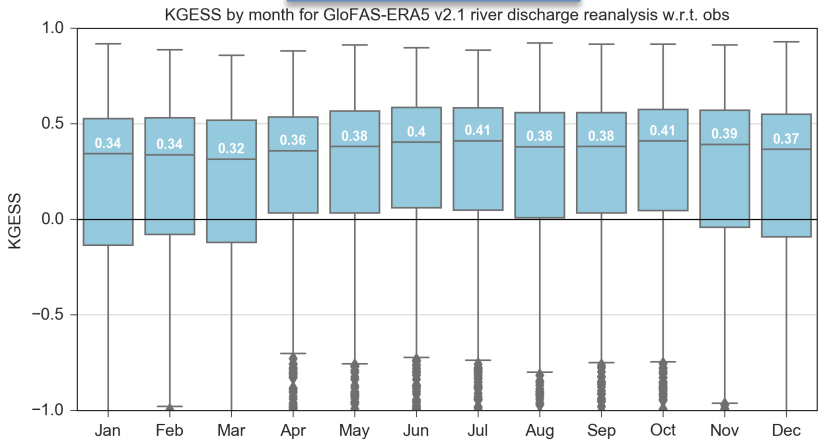
Average magnitude of errors in mm d^{-1}



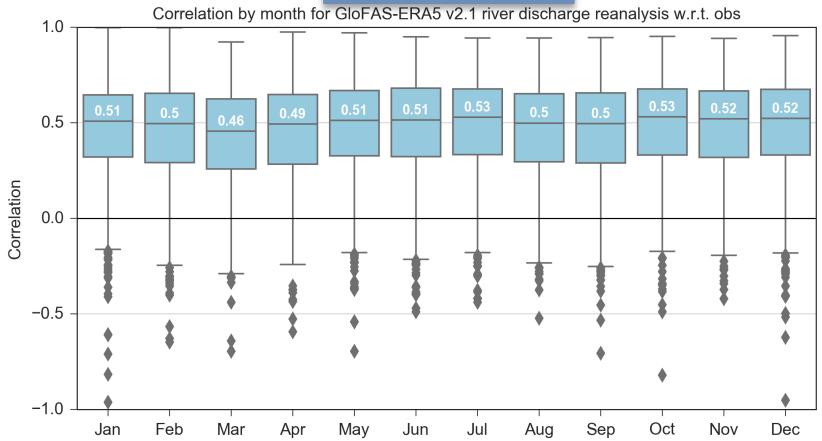
Over/under estimation in dry rivers can produce large percentage biases (e.g. Africa, central US, eastern Brazil and Australia), so it is important to also look at average magnitude of errors, here using Mean Absolute Error (MAE) of flows standardised by upstream area into mm d^{-1}

Performance by month

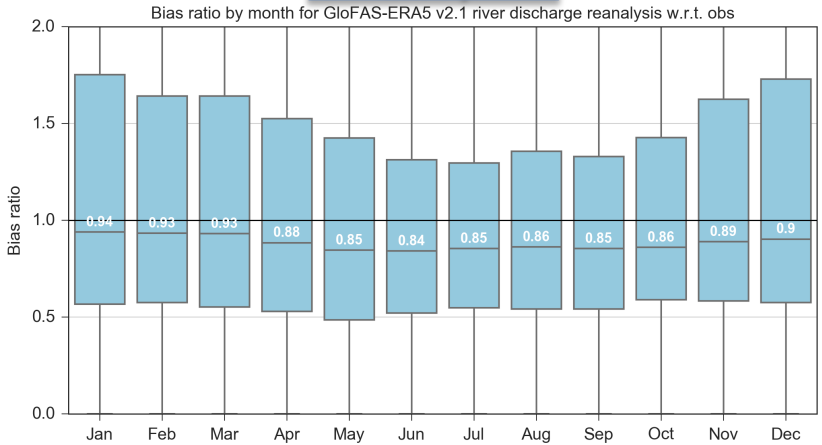
KGE Skill Score



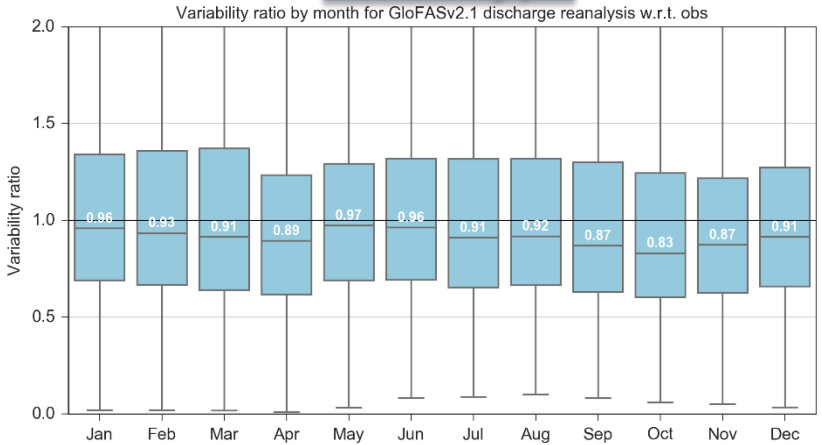
Correlation r



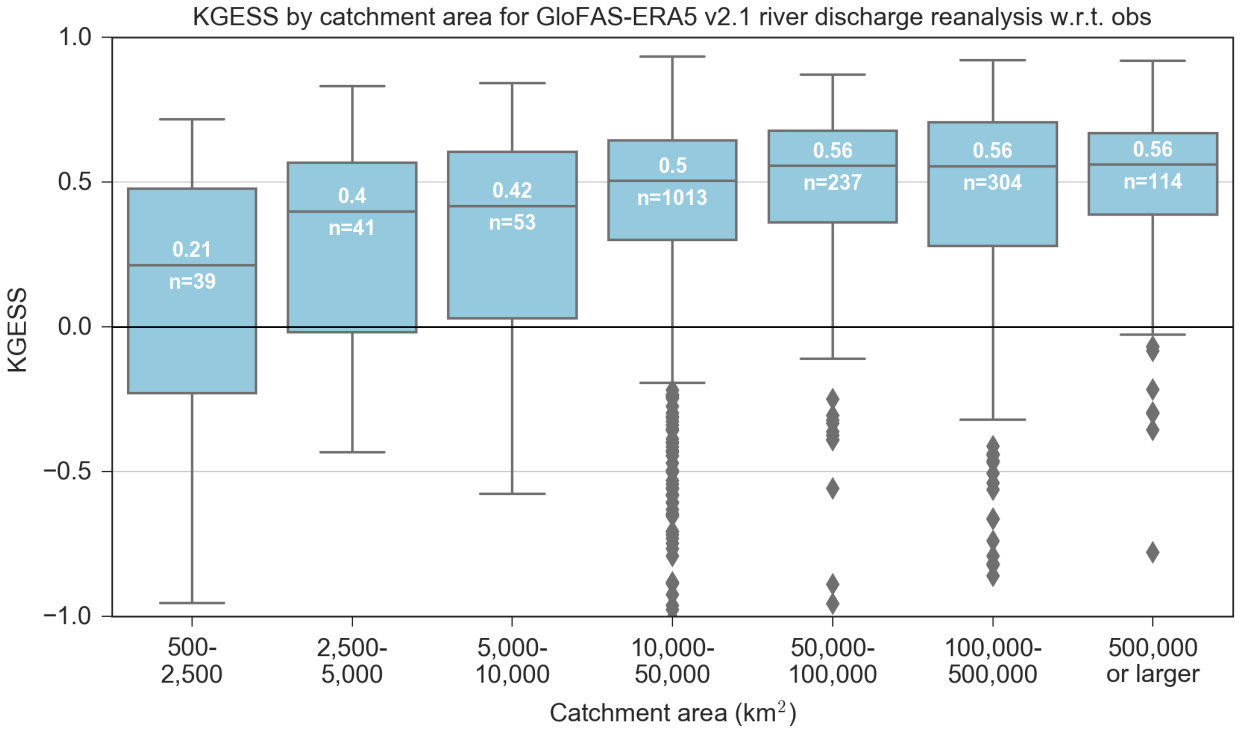
Bias β



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

Summary

- 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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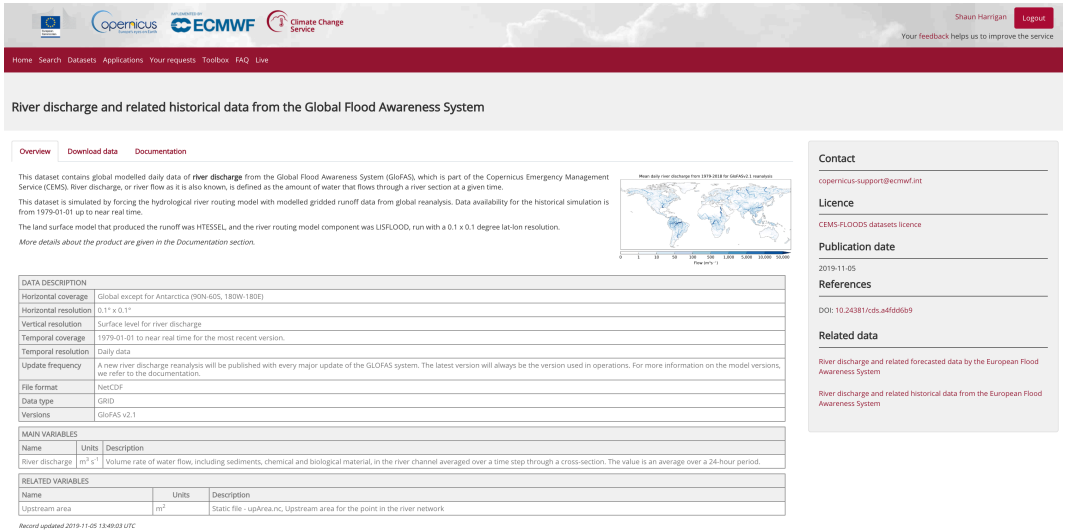
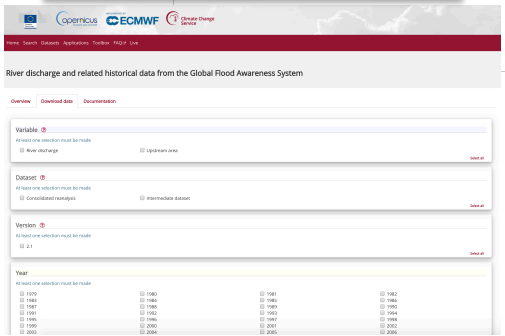
Download: Copernicus Climate Data Store (CDS)



CDS website form



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':'2019',
        'month':'01',
        'day':'01',
        'format':'tgz'
    },
    'download.tar.gz')

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

c.retrieve(
    'cems-glofas-historical',
    {
        'variable':'River discharge',
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        'year':'2019',
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        'day':'13',
        'format':'tgz'
    },
    'download.tar.gz')
```

- Download direct from CDS website form
- Programmatic access via CDS Python API

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