



Emergency  
Management

# The Copernicus Global Flood Awareness System (GloFAS)

## Services and products

Christel Prudhomme, Ervin Zsoter, Calum Baugh and many others in ECMWF, JRC, the University of Reading and other partnerships





# What is GloFAS?

GloFAS is part of the Copernicus Emergency Mapping Service (CEMS) **Early Warning & Monitoring**

ECMWF as **CEMS Hydrological Computational Centre** run both EFAS & GloFAS operationally

- GloFAS couples NWP and Hydrological modelling to produce **global flood forecasts**
- **Complementary** information to National Hydrological and Meteorological Services (NHMS)
- **Freely available**, across the world
- **Riverine** flood forecasting only, mainly for **large catchments** (>2000km<sup>2</sup>)
- Collaborative effort

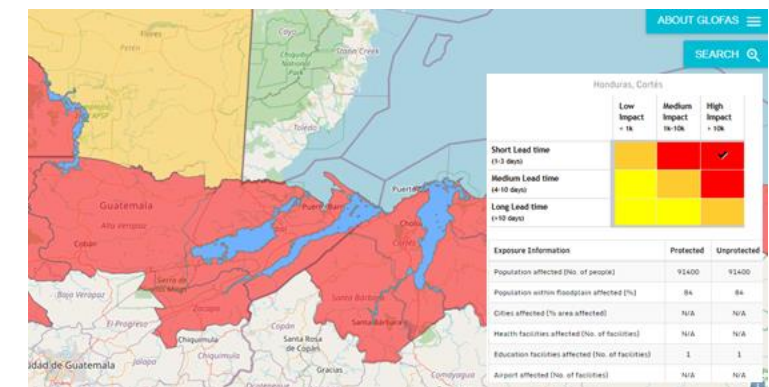
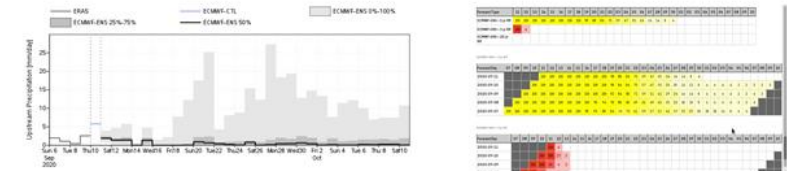
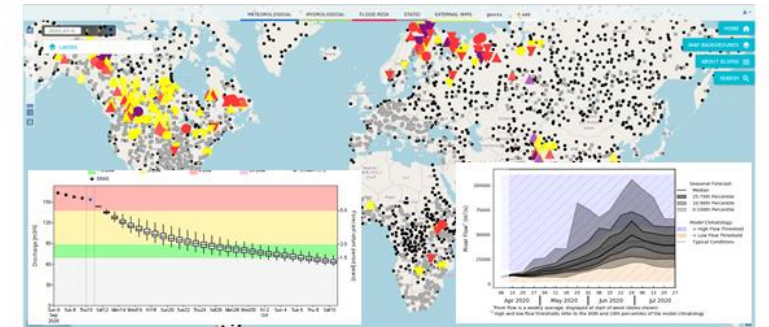




# What is GloFAS?

## What does GloFAS provide?

- Global **hydrological ensemble forecasts** updated daily
- **Map products and datasets** through dedicated web and data services
- **Highlights** of expected flooding and associated flood risk level over next 30 days
- **Seasonal hydrological outlook** showing wet/dry anomalies over next 16 weeks
- **Additional information** as hydrographs, initial condition maps, forecast consistency tables and performance layers to help interpret results

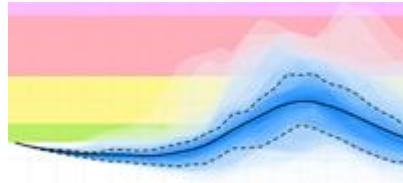




# GloFAS system timeline – a constant evolution



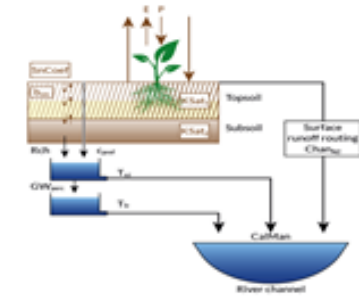
**2011**  
GloFAS adapted to run in ECMWF's pre-operational environment. Also first reforecasts produced



**GloFAS operational**  
Implemented with 24/7 support, included seamless 30-day predictions using the monthly forecasts



**GloFAS v2.1**  
GloFAS-ERA5 reanalysis in CDS  
New reforecasts  
Global flood risk assessment  
New web products



**GloFAS v3.1**  
New model (full Lisflood)  
Model recalibration  
New evaluation web layers  
Other web improvements

GloFAS experimental produced since July 2011, run at JRC

**2015**

**GloFAS Seasonal**  
Added in November 2017

**Apr 2018**

**GloFAS v2.0**  
Lisflood calibration  
ERA5(T) climatology and initialisation  
Reanalysis and 20-year reforecasts available  
Version numbering

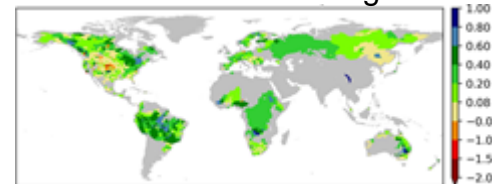
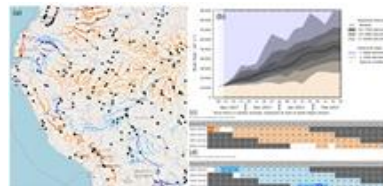
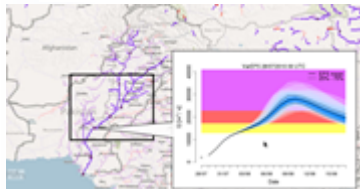
**Nov 2019**

**GloFAS v2.2**  
New GloFAS datasets in MARS/CDS  
New web and improved products  
Forecast skill layer

**May 2021**

**GloFAS v3.2**  
Global Flood Monitoring products added to GloFAS

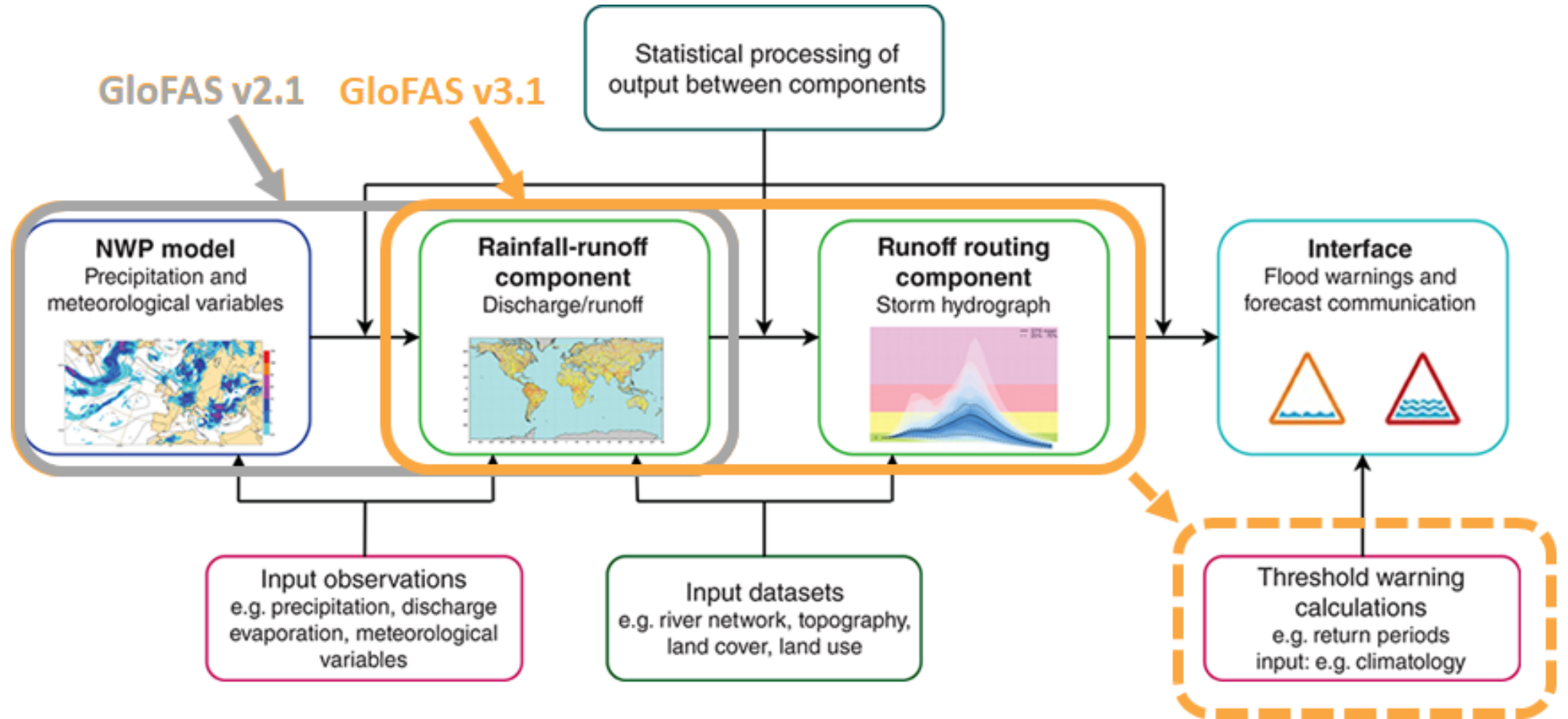
**Oct 2021**



**27 Oct 2021**



# GloFAS modelling chain – backbone of GloFAS

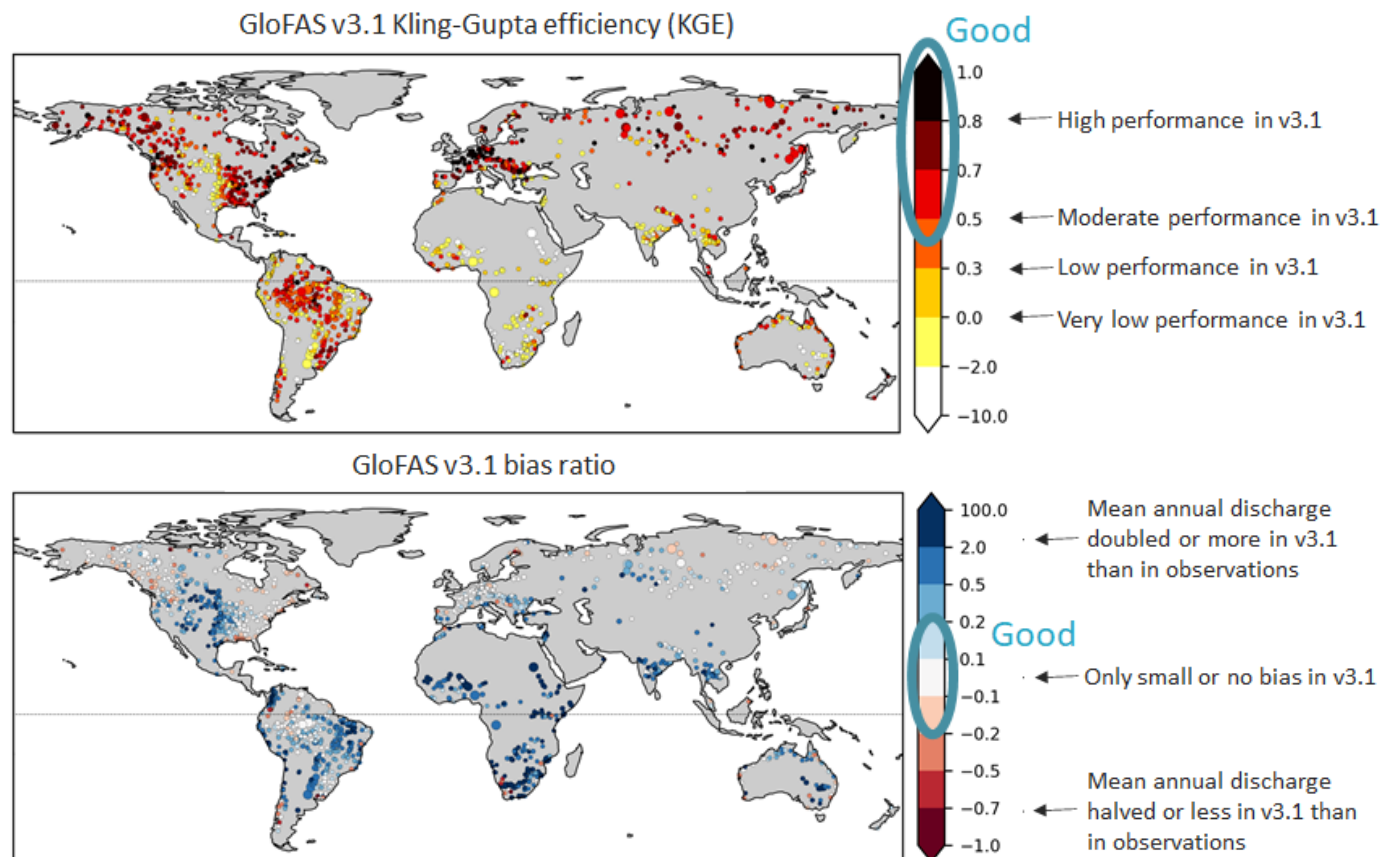
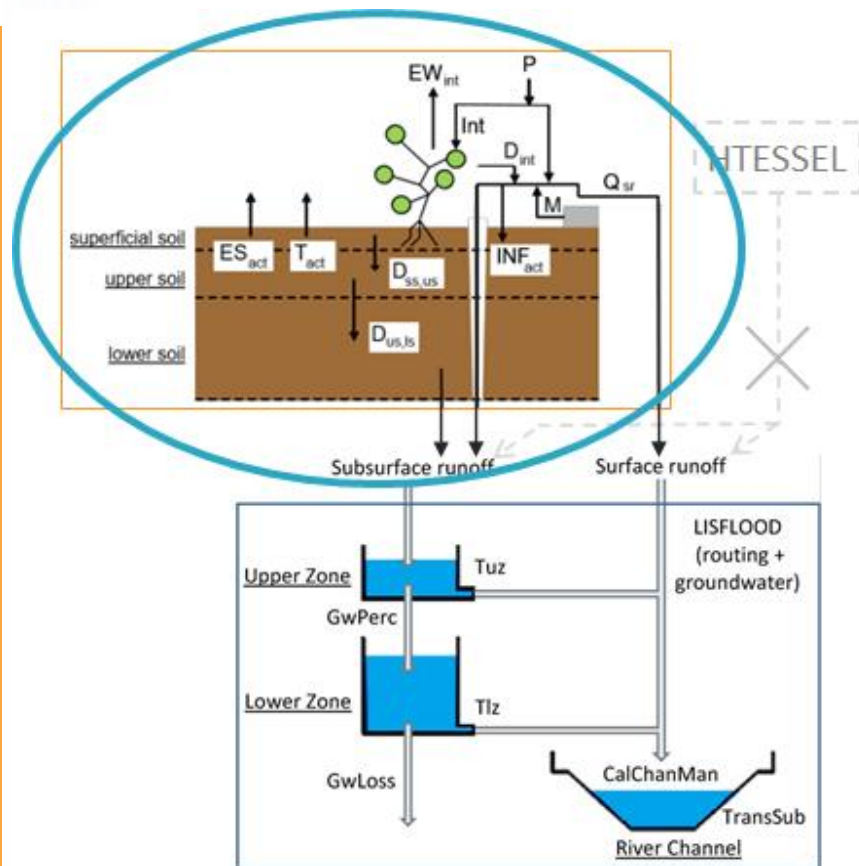


- New modelling chain introduced with GloFAS v3.1
- Same hydrological component for GloFAS and GloFAS Seasonal
- Parallel modelling chains operated for major cycle changes as pre-operational/ legacy systems (from v3.1), with forecasts available on [stage.globalfoods.eu](https://stage.globalfoods.eu)



# GloFAS hydrological modelling chain and performance

- 0.1 degree grids (excluding Antarctica)
- ERA5(-T) as initial condition, calibration and reference simulation
- Calibration over 1226 catchments globally
- Overall good hydrological representation, some systematic bias





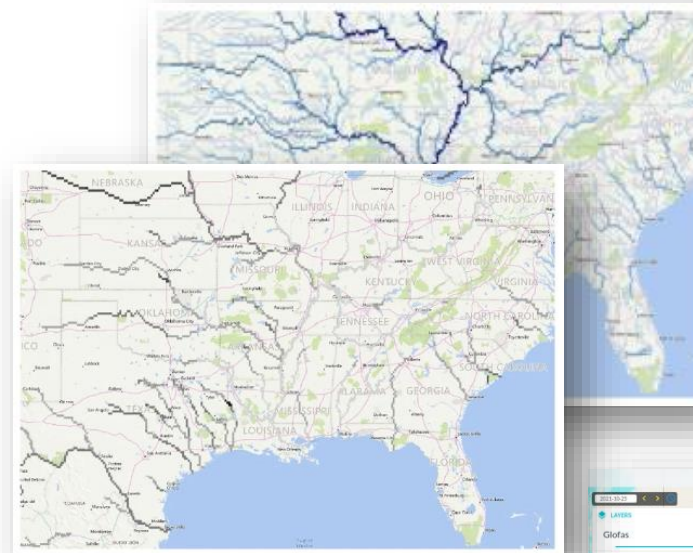
# GloFAS products – helping forecast interpretation

## Initial and antecedent condition maps (from v2.2)

- Precipitation, snowmelt of 3 days preceding the forecast and initial snow cover, soil moisture and 2m temperature
- Absolute values and anomaly maps

## Static maps

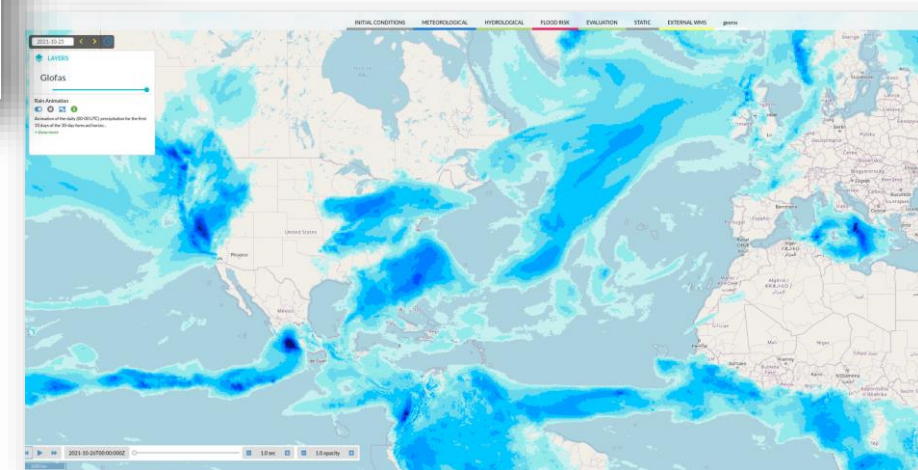
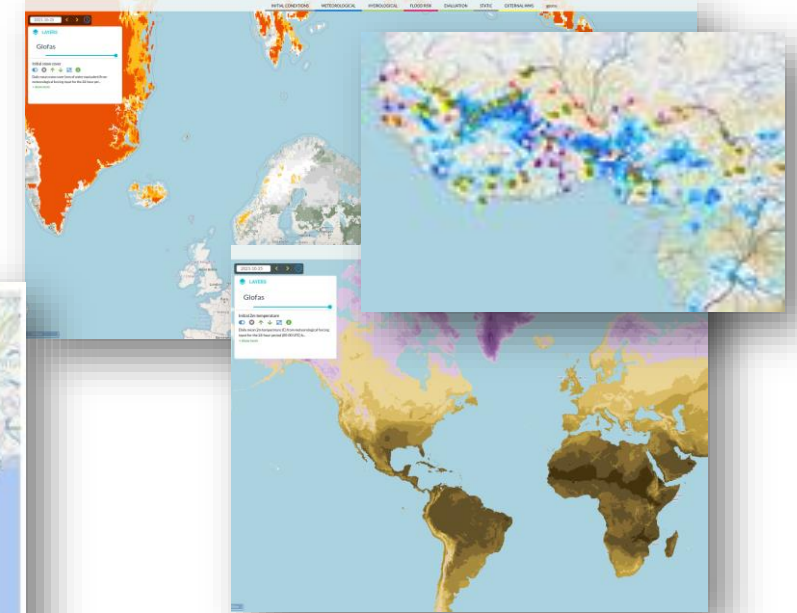
- Hydrological model network (reservoir influence, upstream area, ...)
- Geographical features (major rivers, administrative regions)



## Meteorological forecast maps

- 10-day probability precipitation forecast
- Animated daily precipitation maps of next 10 days ensemble mean forecast to follow meteorological system evolution (from v2.2)

<https://confluence.ecmwf.int/display/COPSRV/GloFAS+products>



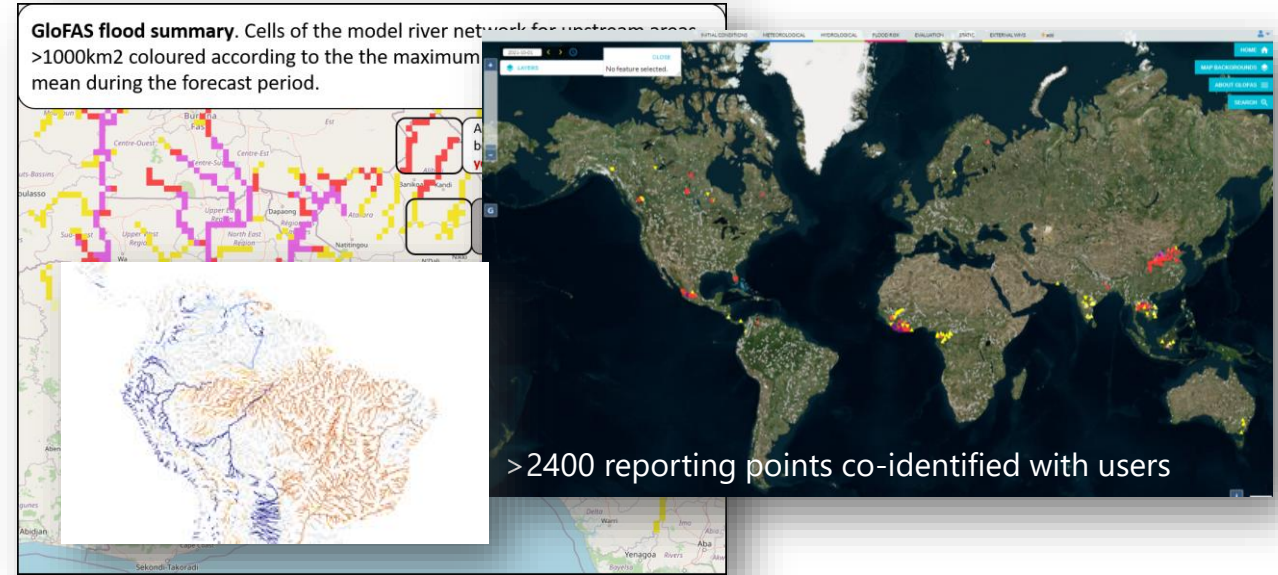


# GloFAS products – summary maps and reporting points

## Forecast layers

- Range of products with different emphasis (e.g. forecast range, highlights, etc...)
- Additional detail on forecast timeline for some layers

## Maps of flood signal highlights/ seasonal outlooks



## Reporting point metadata table

Station ID	Country	Basin	River	Station Name	Point ID	Drainage Area [km <sup>2</sup> ]	Longitude [Deg]	Latitude [Deg]	LISFLOOD Drainage Area [km <sup>2</sup> ]	LISFLOOD X [Deg]	LISFLOOD Y [Deg]
NA	NA	NA	NA	Not a station	DE001244	NA	78.25	24.95	19,282	78.25	24.95

Point Forecast

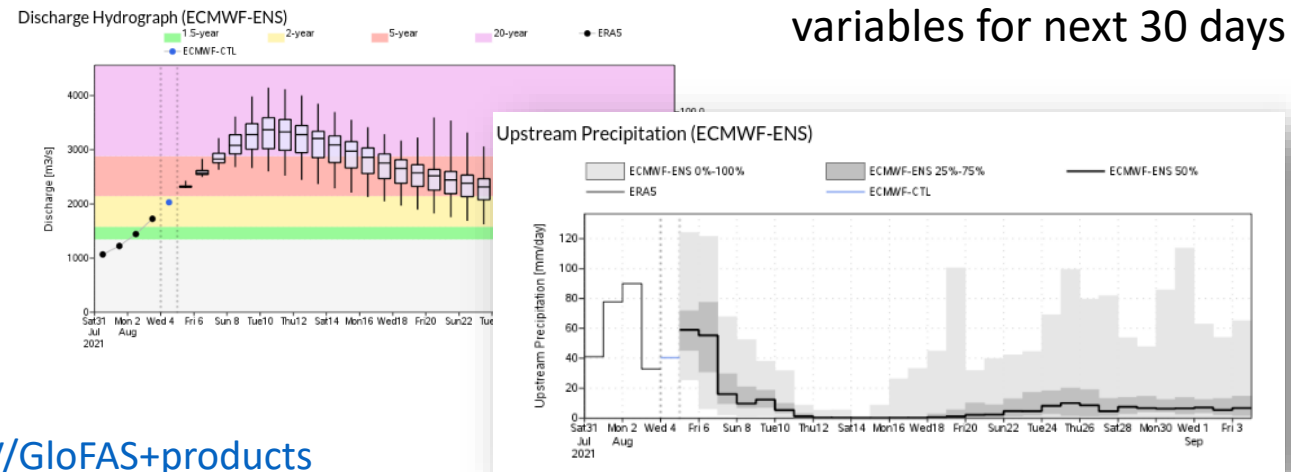
Forecast Date	Maximum probability (2 yr / 5 yr / 20 yr)	Discharge tendency	Alert level	Peak forecasted
2021-08-05 00:00	100 / 100 / 88		3	in 5 days (on 2021-08-10)

## Forecast consistency tables

ECMWF-ENS > 20 yr RP

Forecast Day	30	31	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
2021-08-05									31	86	88	88	86	78	75	67	59	47	29	18	14	6	2	2	2					
2021-08-04									18	45	51	49	47	47	37	35	25	18	10	6	4	2	2	2						
2021-08-03								2	18	27	29	35	33	31	29	27	25	20	16	12	12	8	6	6	4	2	2	2		
2021-08-02							6	24	33	41	45	47	49	47	43	33	31	24	18	16	14	14	10	10	8	6	2	4		
2021-08-01							6	35	53	55	55	53	51	49	49	49	39	37	33	27	22	20	20	18	16	18	18	18		
2021-07-31							4	25	41	45	47	53	53	51	49	45	43	43	41	39	33	33	31	29	25	25	25	18	20	
2021-07-30							2	6	16	18	22	25	25	29	27	29	22	16	14	14	14	12	10	10	10	4	4	6	6	6

## Future evolution of river discharge and associated water balance variables for next 30 days

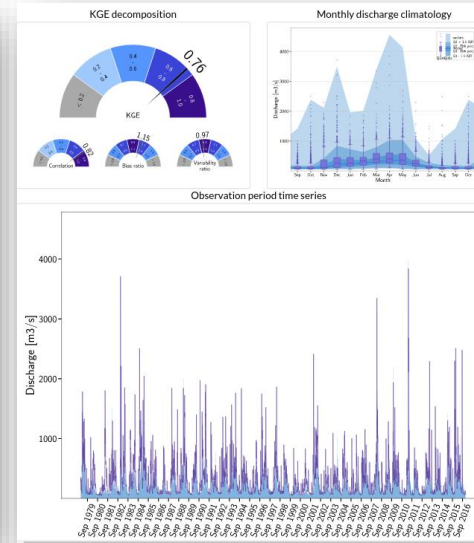
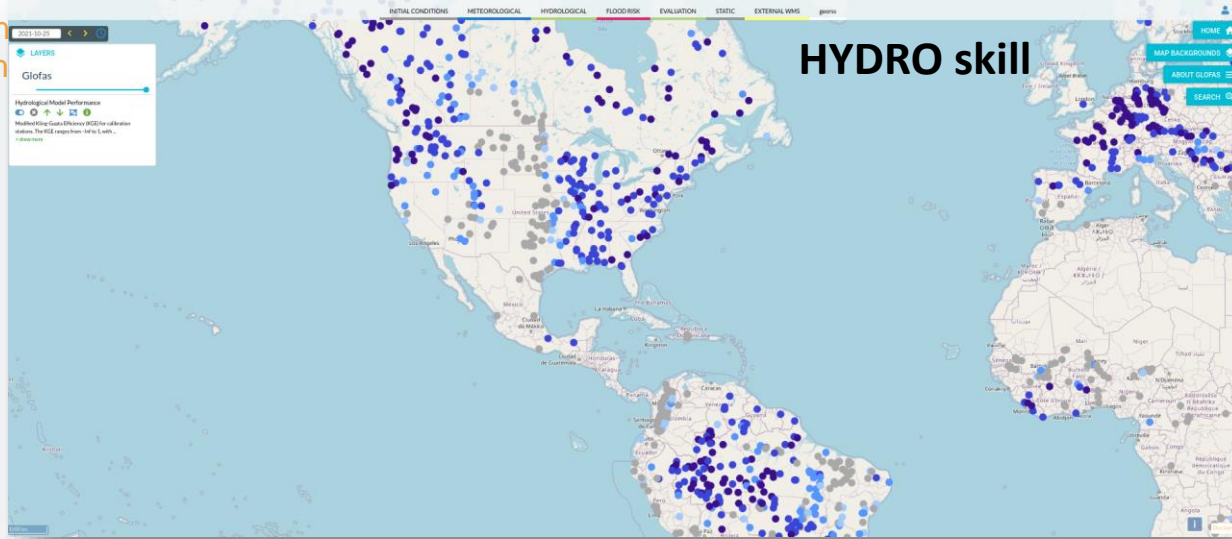






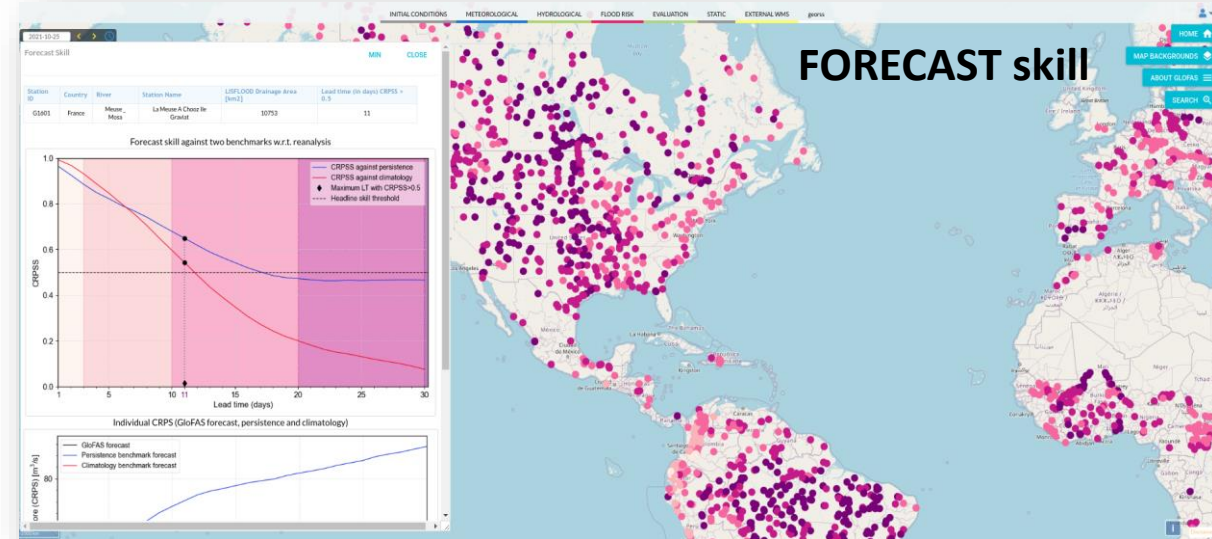
# GloFAS products – evaluation layers

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## Evaluation layers

- Forecast skill layers with all reporting points
- Hydrological skill layer with points that have sufficient river discharge observations
- Updated at each new modelling cycle (major upgrade)
- Updated when reporting point layer upgrades
- Provide background information to help interpret results



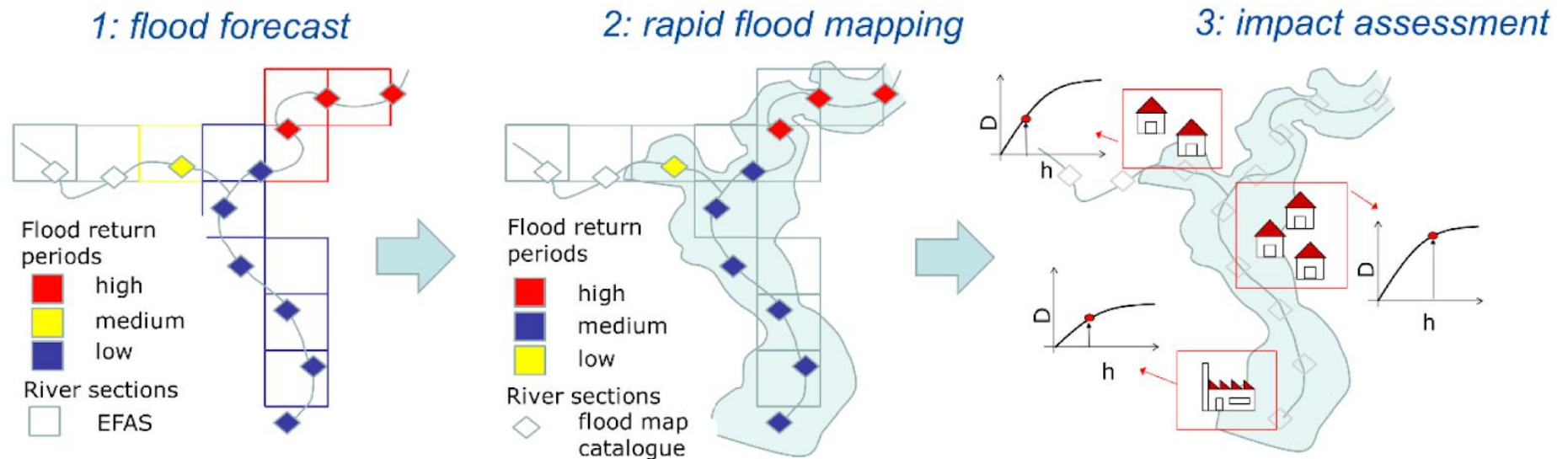
<https://confluence.ecmwf.int/display/COPSRV/GloFAS+products>



## GloFAS products - flood risk assessment layers

**Rapid Impact Assessment** procedure links streamflow forecasts to inundation estimates – calculate exposure

- At each location where ensemble mean streamflow forecast >10 yr return period
- Extract flood inundation footprint from a library of maps
- Calculate the population, land surface types and critical infrastructure exposed within the flood footprint
- Summarise results to administration regions





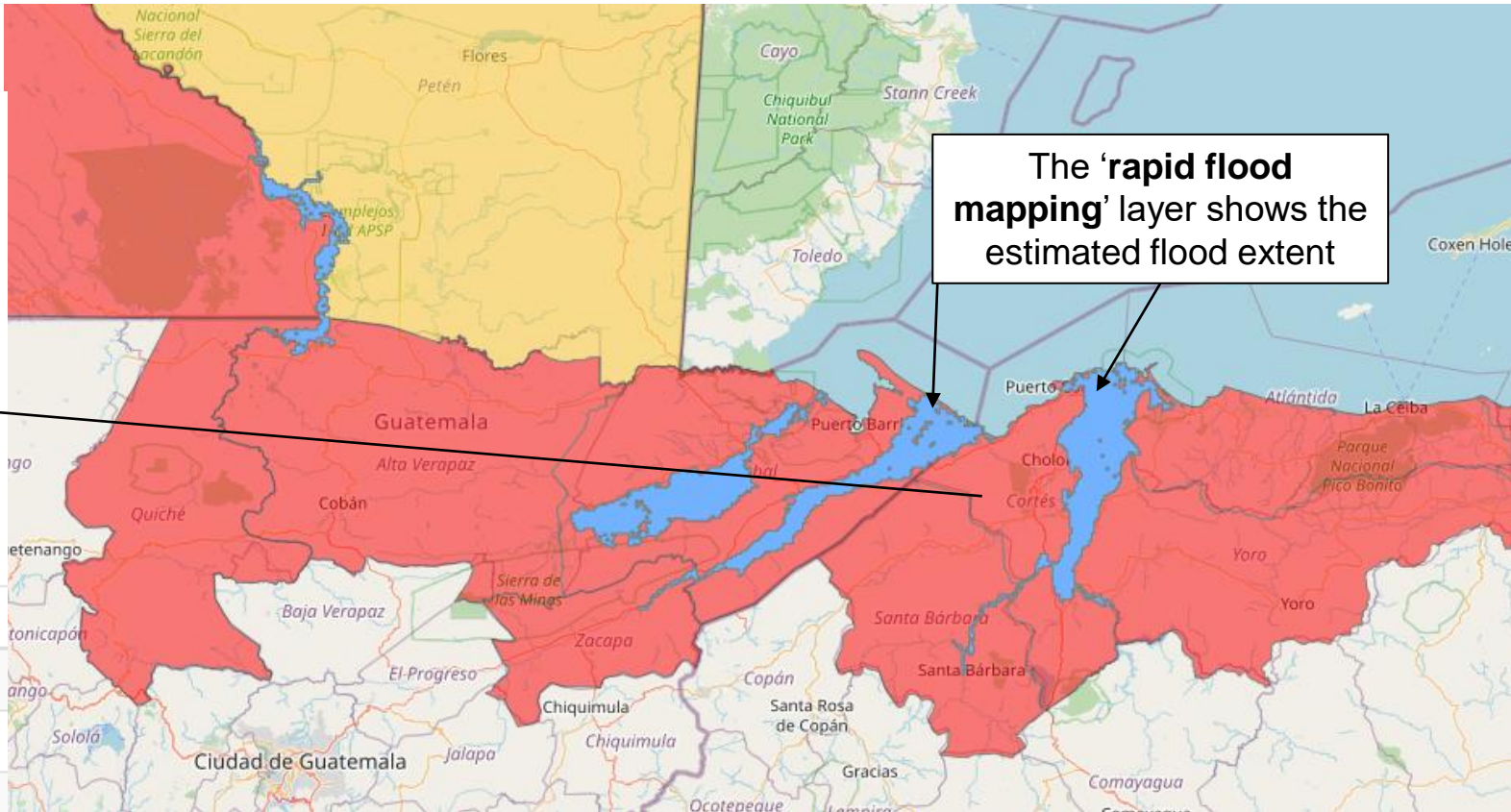
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# GloFAS products - flood risk assessment layers

The 'rapid impact assessment' summarises the exposure and flood event information over the next 30 days per administration region

Honduras, Cortés

	Low Impact < 1k	Medium Impact 1k-10k	High Impact > 10k
Short Lead time (1-3 days)	Yellow	Red	Red with checkmark
Medium Lead time (4-10 days)	Yellow	Yellow	Red
Long Lead time (>10 days)	Yellow	Yellow	Yellow



Exposure Information	Protected	Unprotected
Population affected [No. of people]	91400	91400
Population within floodplain affected [%]	84	84
Cities affected [% area affected]	N/A	N/A
Health facilities affected (No. of facilities)	N/A	N/A
Education facilities affected (No. of facilities)	1	1
Airport affected (No. of facilities)	N/A	N/A

From GloFAS v2.2 (Nov 2019) the exposure to airports, health, powerplants and education facilities and impact of flood defences (FLOPROS) are included



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# GloFAS data services – Product viewer and WMS-T

## Web map viewer

<https://www.globalfloods.eu/>

Implemented by the European Commission as part of the Copernicus Programme

Log in

Home About Products Access Resources GloFAS Wiki

### GloFAS system upgrade to 3.1

The preliminary date for operational release of GloFAS v3.1 is 26 May 2021. This includes the following features and new products:

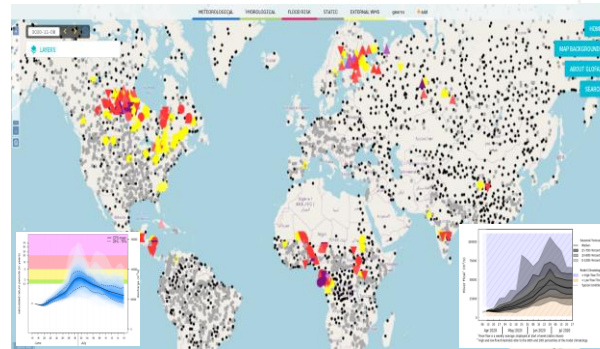
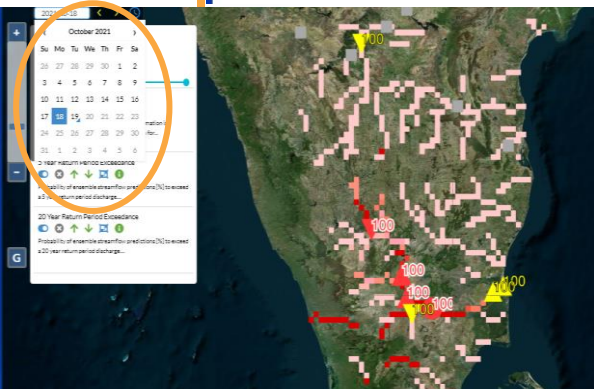
- ✓ New system based on the open-source LISFLOOD model
- ✓ Updates of the reporting points & rapid risk assessment layers
- ✓ New hydrological skill layer
- ✓ GloFAS v3.1 datasets are available at the Copernicus Climate Data Store

Find out more

GloFAS v3.1

GloFAS is composed of an integrated hydro-meteorological forecasting chain and of a monitoring system that analyses results daily for GloFAS forecasts and monthly for GloFAS Seasonal.

[Read more...](#)



## Web Mapping Service WMS-T

- From any GIS environment or web browser <http://globalfloods-ows.ecmwf.int/glofas-ows/ows.py?SERVICE=WMS&REQUEST=GetCapabilities>
- Example of layer that can be accessed: [https://ows.globalfloods.eu/glofas-ows/ows.py?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetMap&BBOX=23.07970000000000255,-44.29690000000000083,73.775800000000000382,76.9921999999999999686&CRS=EPSG:4326&WIDTH=1439&HEIGHT=602&LAYERS=AccRainEGE&STYLES=&FORMAT=image/png&DPI=96&MAP\\_RESOLUTION=96&FORMAT\\_OPTIONS=dpi:96&TRANSPARENT=TRUE](https://ows.globalfloods.eu/glofas-ows/ows.py?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetMap&BBOX=23.07970000000000255,-44.29690000000000083,73.775800000000000382,76.9921999999999999686&CRS=EPSG:4326&WIDTH=1439&HEIGHT=602&LAYERS=AccRainEGE&STYLES=&FORMAT=image/png&DPI=96&MAP_RESOLUTION=96&FORMAT_OPTIONS=dpi:96&TRANSPARENT=TRUE)

Created by Christe Pruthi on 11 Nov 2020, last modified by Karen Okagan on Nov 23, 2020

**CEMS-Floods**

CEMS-Floods include two operational services, both operated by ECMWF who has the responsibility for running the forecasts, post-processing, and hosting their information system platforms.

EFAS is the European Flood Awareness System. It is operational since 2012 in collaboration with several European organisations responsible for producing and providing the flood information. It provides pan-European overview maps of flood probabilities up to 15 days in advance, seasonal streamflow outlooks up to 3 months ahead, and flash-flood risk.

GloFAS is the Global Flood Awareness System. It is operational since 2018 and provides global overview maps of flood probabilities up to 30 days in advance and seasonal streamflow outlooks up to 4 months ahead.

These wiki pages describe some of the main CEMS-Floods products and services, including product versioning and data access.

Common tools: Browse by content	EFAS: Browse by content	GloFAS: Browse by content
<ul style="list-style-type: none"> <li>CEMS-Floods Services</li> <li>CEMS-Flood data access</li> <li>CEMS-Flood data descriptions</li> <li>CEMS-Flood web services</li> <li>How to</li> <li>How to read EFAS data files</li> <li>Interpreting the EFAS Grid File</li> <li>GRIB to NetCDF4 Conversion Tool</li> <li>GloFAS mapping locations onto the river network</li> <li>Terminology</li> <li>EFAS data terminology</li> <li>CEMS-Floods Publications</li> <li>CEMS-Floods feasibility and development studies</li> </ul>	<ul style="list-style-type: none"> <li>EFAS models and procedures</li> <li>EFAS meteorological forcing and land surface data</li> <li>EFAS hydrological forecasting chain</li> <li>EFAS hydrological model</li> <li>EFAS Flash Flood indicators</li> <li>EFAS medium-range forecasting</li> <li>EFAS sub-seasonal and seasonal forecasting</li> <li>EFAS evaluation</li> <li>EFAS operational system</li> <li>EFAS contributors</li> <li>EFAS input data</li> <li>EFAS operational system</li> <li>Latest operational release: EFAS v4.2</li> <li>EFAS products</li> </ul>	<ul style="list-style-type: none"> <li>GloFAS models and procedures</li> <li>GloFAS meteorological forcings</li> <li>GloFAS hydrological models</li> <li>GloFAS medium-range forecasting</li> <li>GloFAS sub-seasonal and seasonal forecasting</li> <li>GloFAS evaluation</li> <li>GloFAS diagnostic and web reporting points</li> <li>GloFAS operational system</li> <li>Next operational release: GloFAS v3.1</li> <li>GloFAS products</li> <li>Overall GloFAS products summary</li> </ul>

Training, tutorial, wiki documentation



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# GloFAS data services – Data access

## CDS catalogue and access

<https://cds.climate.copernicus.eu/cdsapp#!/dataset/cems-glofas-historical?tab=overview>

## Tailored ftp service

- For information not available through the CDS and time critical access
- Set-up up to 15 working days

**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

**Download data**

```

import cdsutils as ct
ct.application(title='Download data')
ct.output.download()
ct.output.liveimg()
del ct.application()
data = ct.catalogue.retrieve('cems-glofas-historical')
{
  'system_version': 'version 3.1',
  'hydrological_model': '15dFlood',
  'product_type': 'consolidated',
  'variable': 'river_discharge_in_the_last_24_hours',
  'year': '1999',
  'month': 'january',
  'today': '01',
}
# update attribute to 'discharge-global' to set the GloFAS palette
data.ct.cds.update_attributes(data.attrs['cds_magic.style_name'] = 'discharge-global')
# call live plot
fig = ct.liveimg.plot(data)
  
```

**Contact**

copernicus-support@ecmwf.int

**Licence**

CEMS-FLOODS datasets licence

**Publication date**

2019-11-05

**References**

DOI: 10.24381/cds.a4fd6b9e

**Related data**

Reforecasts of river discharge and related data by the European Flood Awareness System

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

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

River discharge and related historical data from the European Flood



**Common tools: Browse by content**

- Expand all Collapse all
- CEMS-Floods Services
  - CEMS-Flood data access
  - CEMS-Flood data descriptions
  - CEMS-Flood web services
- How to
  - How to read EFAS data files
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  - GRIB to NetCDF Conversion Tool
  - GloFAS mapping of the river network
- Terminology
  - EFAS data terminology
  - CEMS-Floods Publications
  - CEMS-Floods feasibility and development studies

**EFAS: Browse by content**

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  - EFAS hydrological forecasting chain
  - EFAS hydrological model
  - EFAS Flash Flood indicators
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  - EFAS sub-seasonal and seasonal forecasting
- EFAS operational system
  - EFAS contributers
  - GloFAS versioning system
  - EFAS input data
  - EFAS versioning system
  - Latest operational release: EFAS v4.2
  - EFAS products

**GloFAS: Browse by content**

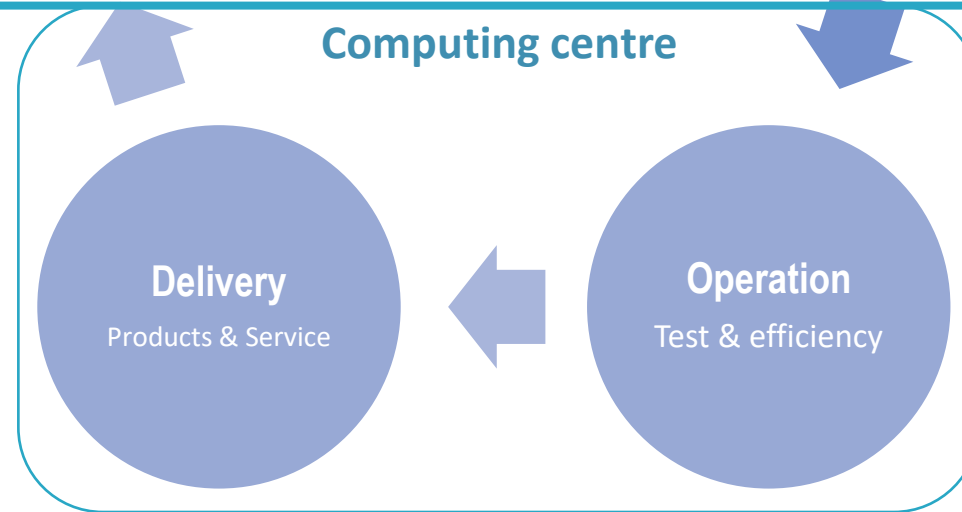
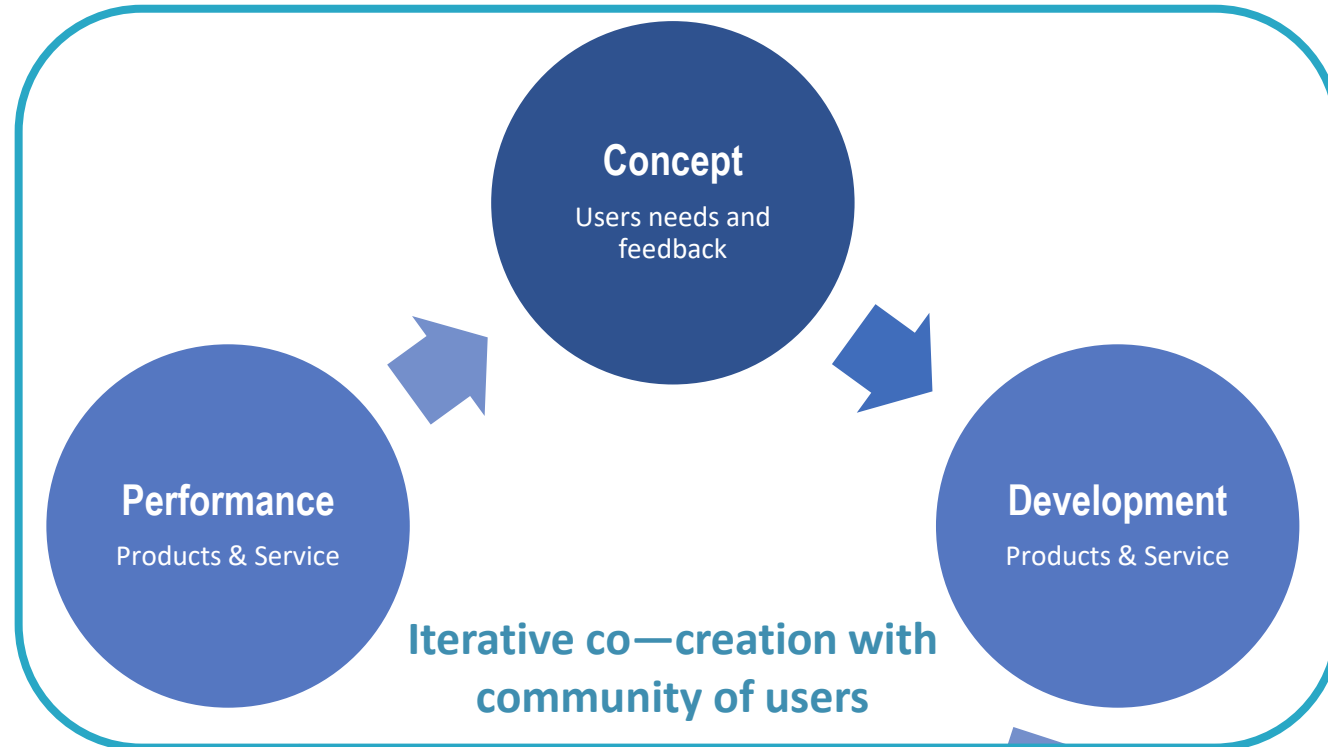
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  - Overall GloFAS products summary

GloFAS datasets in CDS	Main features
Historical reanalysis	Driven by ERA5 and ERA5T (in near real time)
Forecasts	Daily, 51 ensemble member forecasts out to 30 days
Reforecasts	Unique forecast set covering 20 years, produced with the same model as in real time
Seasonal forecasts	Forecasts with 51 ensemble members issued monthly out to 4 months
Seasonal reforecasts	Unique forecast set covering ~40 years, produced with the same model as in real time

<https://confluence.ecmwf.int/display/COPSRV/Data+services>



# Development and implementation cycle



## Outreach

- News item and email to close collaborators
- Update of wiki documentation
- Webinars and tutorials

## Computing centre

## Forecast system

- Pre-operational release at least 1 month ahead of launch
- Legacy suite continued for several months
- Products and services both available in the CDS and on the stage web interface



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# Thank you!

Questions and answers