



**PRÉFET  
DE LA RÉGION  
OCCITANIE**

*Liberté  
Égalité  
Fraternité*

# FLOOD WARNING IN FRANCE AND FOR THE GARONNE RIVER ORGANIZATION AND TOOLS

# Summary

## 1. French Hydrographic Network

## 2. Historical Overview of flood forecasting

## 3. French Organization for flood forecasting

## 4. The flood warning service « Vigicrues »

## 5. Data and tools for hydrometeorological forecast

## 6. Other VIGICRUES services

# Rivers in France

- Five major rivers over France

⇒ Seine (Paris) 79 000 km<sup>2</sup> ;  
Q<sub>year</sub> = 560 m<sup>3</sup>/s

⇒ Loire (Orléans, Nantes) 117 500 km<sup>2</sup>  
Q<sub>year</sub> = 930 m<sup>3</sup>/s

⇒ Rhin (Strasbourg) 40 000 km<sup>2</sup>  
Q<sub>year</sub> = 1000 m<sup>3</sup>/s

⇒ Rhône (Lyon) 95 000 km<sup>2</sup>  
Q<sub>year</sub> = 1600 m<sup>3</sup>/s

⇒ Garonne (Toulouse) 55 000 km<sup>2</sup>  
Q<sub>year</sub> = 630 m<sup>3</sup>/s



# Flood forecast in France : historical overview

- ⇒ Flood forecast in France was historically organized in the middle of the XIX e century on the major rivers, after a succession of big floods ;
- ⇒ water level measurements sites were created from 1857 on the Garonne river

DEPARTEMENT  
de la Haute-Garonne

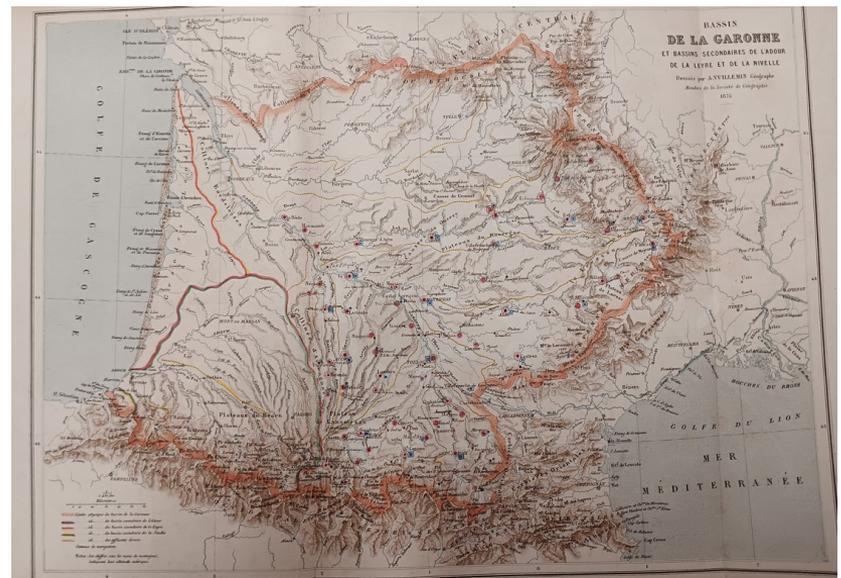
**OBSERVATIONS sur les hauteurs d'eau**  
à Trèbelle de Pont-Neuf en Garonne  
pendant le mois de Mars 1855.

**OBSERVATIONS.**  
La hauteur d'eau doit être observée aux six points ci-dessous pendant le cours de l'eau.  
Quand leur hauteur sera au-dessous de la hauteur d'eau ci-dessous, on observera les hauteurs d'eau ci-dessous.

HAUTEUR D'EAU	ÉTAT DE L'EAU		OBSERVATIONS											
	Hauteur	Direction	Observations											
1	1.00													
2	1.00													
3	1.00													
4	1.00													
5	1.00													
6	1.00													
7	1.00													
8	1.00													
9	1.00													
10	1.00													
11	1.00													
12	1.00													
13	1.00													
14	1.00													
15	1.00													
16	1.00													
17	1.00													
18	1.00													
19	1.00													
20	1.00													
21	1.00													
22	1.00													
23	1.00													
24	1.00													
25	1.00													
26	1.00													
27	1.00													
28	1.00													
29	1.00													
30	1.00													
31	1.00													
32	1.00													
33	1.00													
34	1.00													
35	1.00													
36	1.00													
37	1.00													
38	1.00													
39	1.00													
40	1.00													
41	1.00													
42	1.00													
43	1.00													
44	1.00													
45	1.00													
46	1.00													
47	1.00													
48	1.00													
49	1.00													
50	1.00													
51	1.00													
52	1.00													
53	1.00													
54	1.00													
55	1.00													
56	1.00													
57	1.00													
58	1.00													
59	1.00													
60	1.00													
61	1.00													
62	1.00													
63	1.00													
64	1.00													
65	1.00													
66	1.00													
67	1.00													
68	1.00													
69	1.00													
70	1.00													
71	1.00													
72	1.00													
73	1.00													
74	1.00													
75	1.00													
76	1.00													
77	1.00													
78	1.00													
79	1.00													
80	1.00													
81	1.00													
82	1.00													
83	1.00													
84	1.00													
85	1.00													
86	1.00													
87	1.00													
88	1.00													
89	1.00													
90	1.00													
91	1.00													
92	1.00													
93	1.00													
94	1.00													
95	1.00													
96	1.00													
97	1.00													
98	1.00													
99	1.00													
100	1.00													

Observé par le *[Signature]* ingénieur.

⇒ Flood forecast was permitted by the development of the telegraph transmission (transmission of the water level upstream to downstream the river)



Map of the Garonne hydrographic network and hydrometric sites in 1875

Water level statement for the Garonne in Toulouse (Pont-Neuf) in 05/1857

# Flood Forecast in France in 2025

Organisation des Services de Prévision des Crues (SPC)

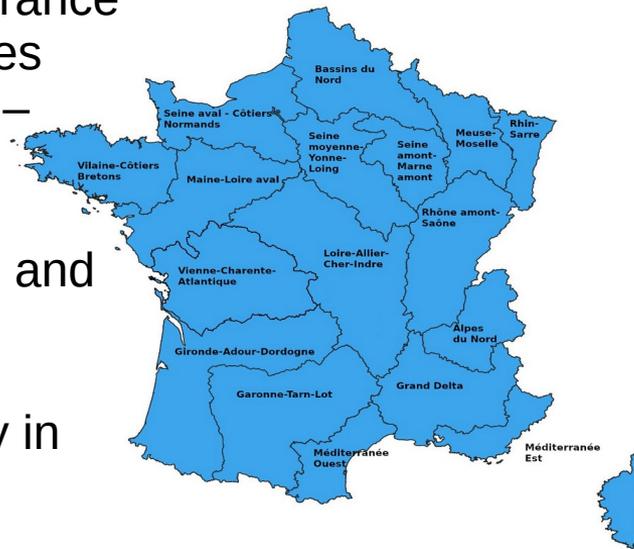
⇒ 17 Flood forecasting services in metropolitan France (550 000 km<sup>2</sup>) + 2 services in the French territories Overseas (French Guyana and La réunion island – located in Indian Ocean )...

⇒ 450 engineers or technicians (flood forecasters and hydrometric technicians)

⇒ hosted by the regional direction of the Ministry in charge of Environment

⇒ 1 central service, located in Toulouse, in charge of technical and strategical animation (30 agents)

⇒ Garonne river flood forecasting service ~ 35 agents



# The french flood warning service VIGICRUES

Publication du 03/02/2021  
à 15h55

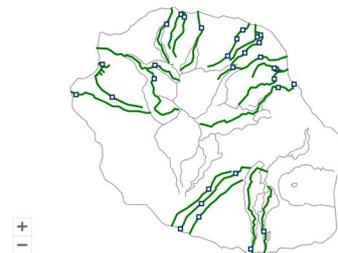
- main watercourses
- displays the flood risk...
- according to a four colors scale...
- ...24 hours of anticipation
- scale = piece of river
- Since 2006
- 23 000 km of watercourses
- 75 % of population covered
- target : Security services and every citizen (Website)



[www.vigicrues.gouv.fr](http://www.vigicrues.gouv.fr)

Carte de La Réunion

L'état maximum de la vigilance crues à La Réunion est ■  
**▲ Pas de risque de crue génératrice de débordements, mais restez ATTENTIF aux évolutions météorologiques**



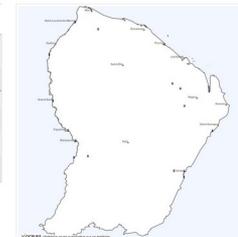
<https://www.vigicrues-reunion.re/>

Territoire Guyane

La vigilance est suspendue sur le territoire jusqu'au 15.02.2021 à 10h00.

Situation par tronçon de vigilance crues :

Voir sur la carte	Nom	État	Alt. MSL
<input type="radio"/>	L'eau amont	▲	2h
<input type="radio"/>	L'eau aval	▲	2h
<input type="radio"/>	Moyenne vallée de Maroua	▲	2h
<input type="radio"/>	Basse vallée de Maroua	▲	2h



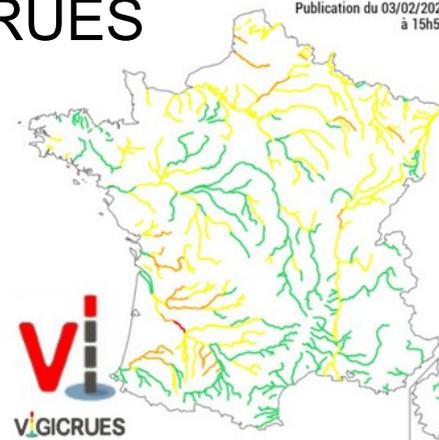
Cliquer sur un symbole (▲) de la carte pour afficher les données de la station.

<https://www.vigicrues.gouv.fr/territoire/973>

# The French flood warning service VIGICRUES

Publication du 03/02/2021  
à 15h55

- produced twice a day (10h00 a.m and 04h00 p.m)
- produced 4 times a day during major floods (06h00 a.m, 10h00 am .m, 04h00 p.m, 10h00 p.m.)
- water level are displayed on the VIGICRUES website as soon as the flood begins



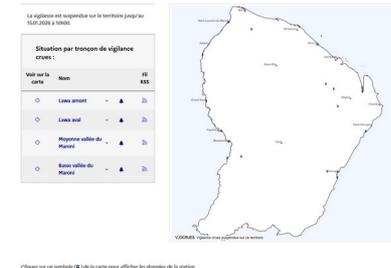
[www.vigicrues.gouv.fr](http://www.vigicrues.gouv.fr)



Carte de La Réunion



Territoire Guyane

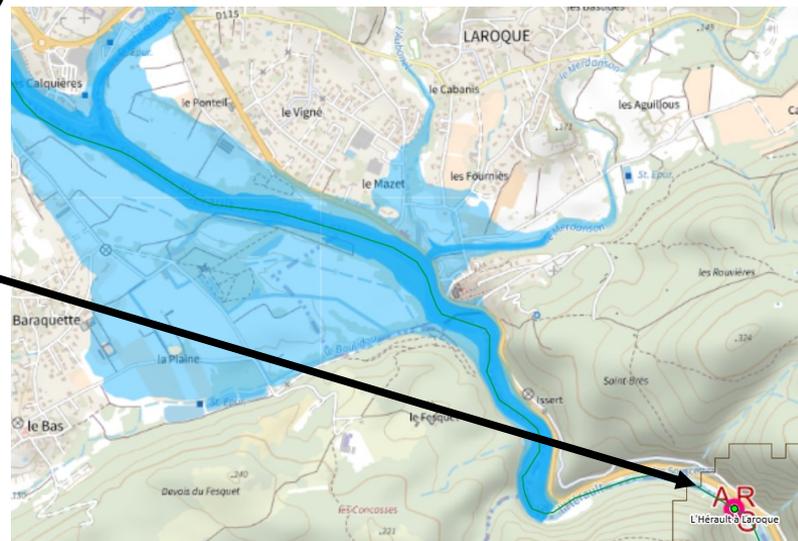
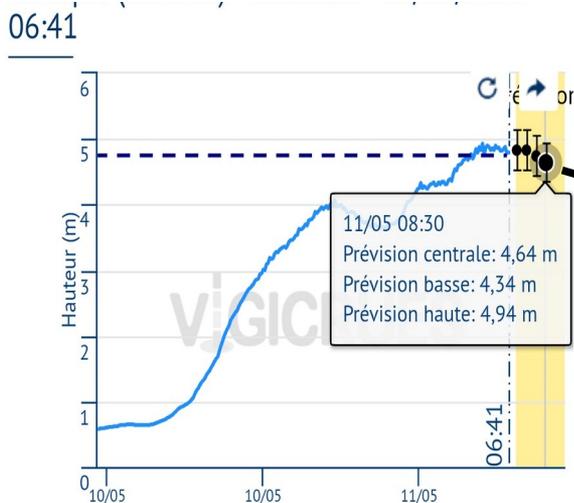


<https://www.vigicrues-reunion.re/>

<https://www.vigicrues.gouv.fr/territoire/973>

# The French flood warning service VIGICRUES : flood mapping

- for a given water level at a hydrometric station, everyone (public and security forces) can visualize the extend of the flooding area (available on the VIGICRUES website)
- static maps built by the flood forecasting service (hydraulic modelling or spatial interpolation of flooding marks on past events )



# VIGICRUES : SMARTPHONE APP

**Bulletin d'information national de vigilance crues**

Producteur de l'information : SCHAPI

**L'état maximum de la vigilance crues métropolitaine est vert**

Date de publication de l'information: 10/10/2022 à 15:55

Date de prochaine actualisation au plus tard : 11/10/2022 à 10:00

Toutes les heures mentionnées sont des heures légales.

Commentaire général sur la situation

Pas de vigilance particulière requise.

Conseils de comportement

Tenez-vous informé des évolutions de la situation.

Carte des cours d'eau et des stations

TOULOUSE

les Chalets, les Amidonniers, Bourrassol, Saint-Cyprien, la Croix de Pierre, la Pointe, Empalot, les Recollets, Saint-Roch, le Busca, Saint-Michel, les Carmes, Saint-Etienne, les Augustins, Saint-Georges, Arnaud Bernard, Matabiau, Jumeaux, Compans, les Chalets.

Risques de crue :

- Risque de crue majeure
- Risque de crue génératrice de débordements importants
- Risque de crue génératrice de débordements
- Pas de vigilance particulière requise

Station de Toulouse [Pont-Neuf] (Garonne)

Commentaires à la station

Prévision : Pas de valeurs de prévision de hauteurs sur la station pour cette période.

Graphique

Toulouse [Pont-Neuf] (Garonne) - Hauteurs - 10/10/2022 19:51

Hauteur (m)

0.75, 0.5

04/10 00:00, 06/10 00:00, 08/10 00:00, 10/10 00:00

Accueil, Mes favoris, Recherche, Mon compte

Mes avertissements

Station Toulouse [Pont-Neuf]

Hauteur

Supérieur à 1,4

Mail inactif

Notification téléphone active



Allows to be notified on one's smartphone when :

- a given water level is reached at a given gauge ;
- a warning is issued on a given river ;

# Interaction with the meteorological warning service

The French meteorological agency, METEO FRANCE, produces :

- twice a day ...
- a meteorological warning map ...
- concerning 8 hazards : heavy rainfalls, thundersortms, waves / coastal tides strong winds, snow and ice, cold weather, heatwaves and floods ...
- at departmental scale

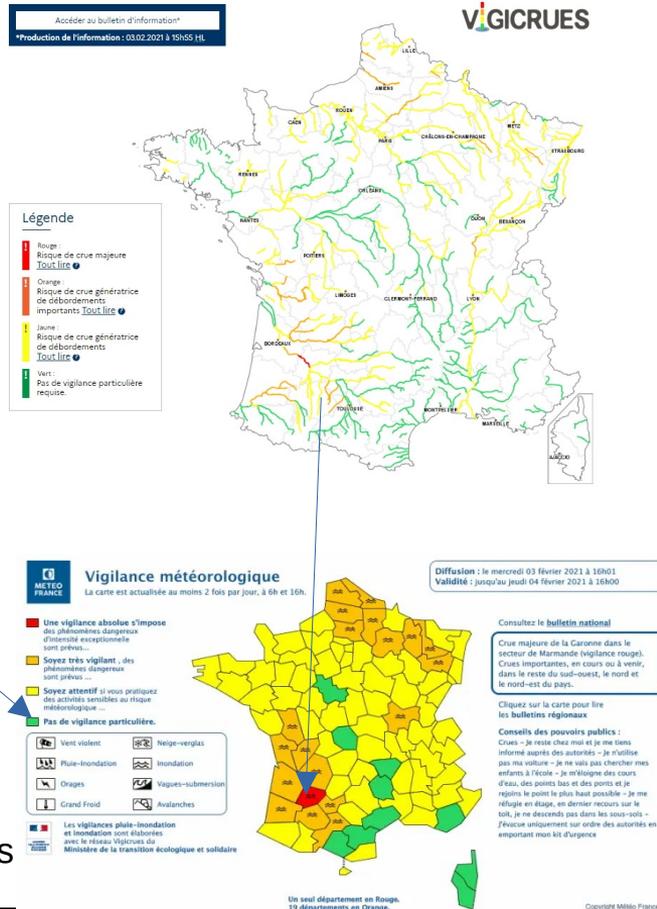
The flood warning is also displayed on the meteorological warning map with this pictogram :



The department is in France the administrative level at which the civil defence services are coordinated.

The mayor of every city is responsible for security

If the mayor can not face the crisis, the departmental prefect authority replaces the mayor for crisis management

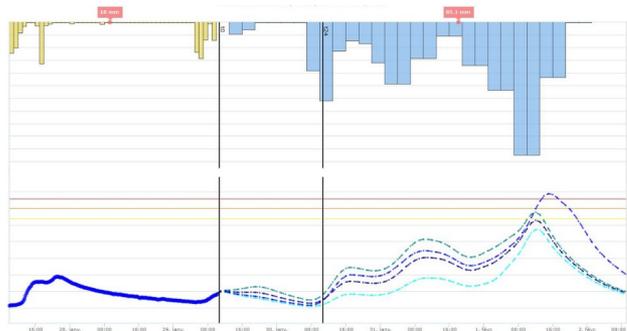


# Flood Warning Vigicrues



Meteorological Data  
(rainfall observations and forecasts)

Hydrological data  
(Water level, soil humidity, snow high, ...)



Flood forecasting service analysis

**Level of Warning**

At every warning level rise, the Flood forecasting Service warns the department Prefect authorities (by phone)

Hydrometeorological model forecast

Dissemination to Public and **civil security services** coordinated with **meteorological warnings**

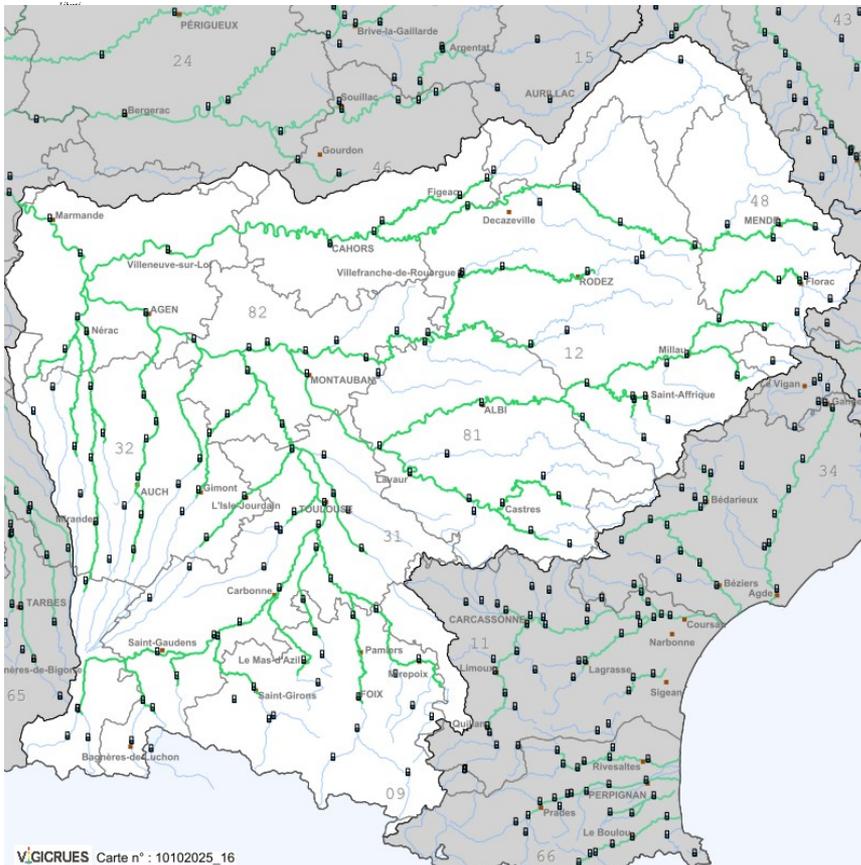


**Prefect warns the Mayor**



# Data and tools for hydrometeorological anticipation

⇒ Water level measurements : 140 gauges



Garonne watershed (50 000 km²)



Scale



Sensor



Both GSM modem and Radio modem



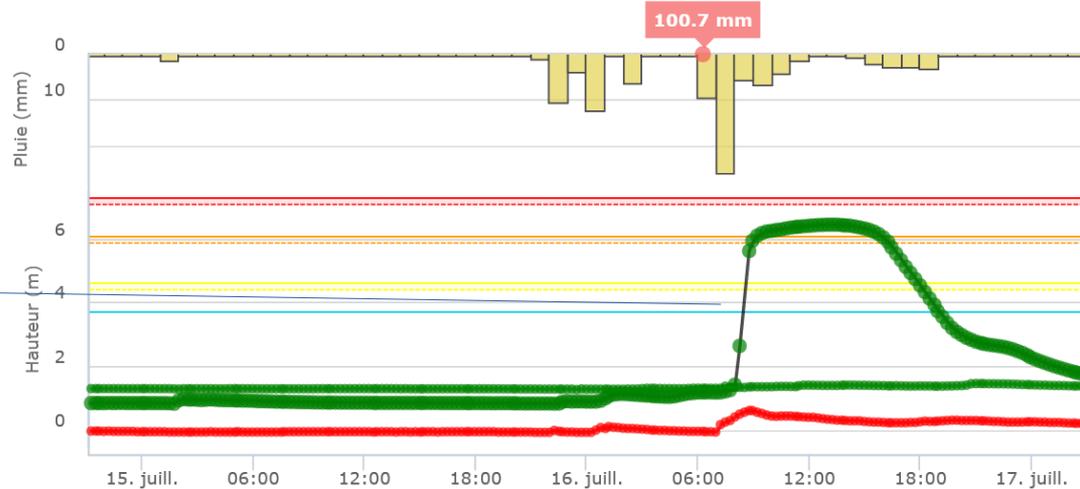
# Water level monitoring

⇒ Forecasters are called by the station if water rises above a pre-defined threshold



LEZAT

La Lèze à Lézat-sur-Lèze (237 km<sup>2</sup>) BNBV : GC784, 239 km<sup>2</sup>

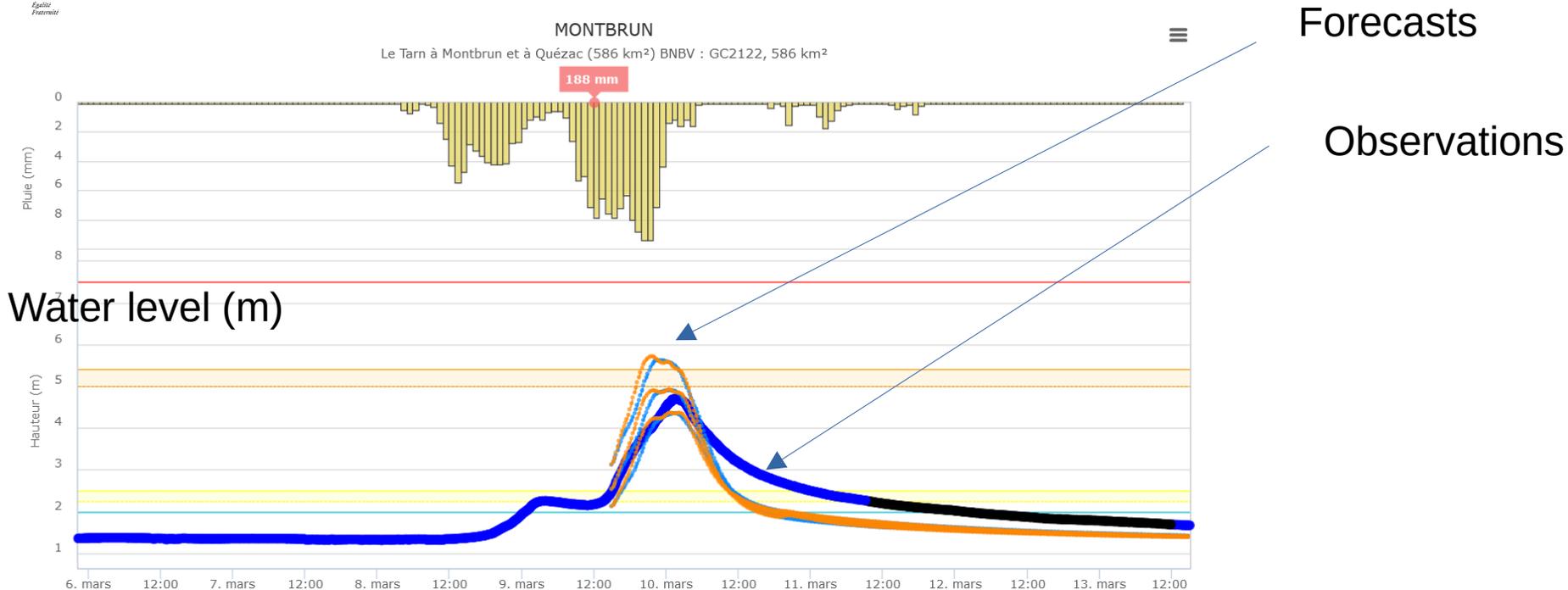




# The hydrological modelling tools

- more than 150 models run every day in the flood forecast service
  - all the models run in a automatic way 4 times a day and are hosted in 3 interconnected server rooms (electricity supply guaranteed by a power generator)
  - ⇒ forecasts on upstream gauges : Rainfall/runoff modelling
  - Global : Use of GR models <https://webgr.inrae.fr/outils/modeles-hydrologiques>
  - Distributed : models of the PLATHYNES platform  
<https://www.tandfonline.com/doi/full/10.1080/27678490.2024.2349548#abstract>
  - ⇒ forecasts on upstream gauges : hydraulic modelling
  - MASCARET and TELEAMC 2D : <https://www.opentelemac.org/>
  - the uncertainty is taken into account by using several meteorological rainfall forecast inputs and the parametric uncertainty of the hydrological model
-

# Role of flood forecaster



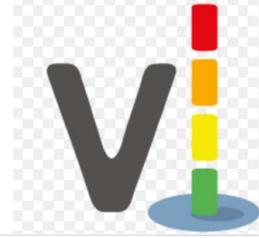
Analyse the different outputs, reduce if possible the uncertainty

# Organization

- 20 forecasters (on-call duty) :
  - on-call duty : 4 forecasters every week, 365 days/year,
  - shift work : When a major flood event occurs, crises room is used, with a 3\* 8 hours organization (between 2 and 5 forecasters)
- 8 hydrometric technicians (on-call duty) :
  - gauging site maintenance, flow measurements
- organization for flood mark survey :
  - service delivery of 5 private companies



# OTHER VIGICRUES PRODUCTS



## Capitalization of flood marks

<https://www.repèresdecrues.developpement-durable.gouv.fr/>

## Capitalization of water level measurements and discharges

<https://www.hydro.eaufrance.fr/>

# OTHER VIGICRUES PRODUCTS

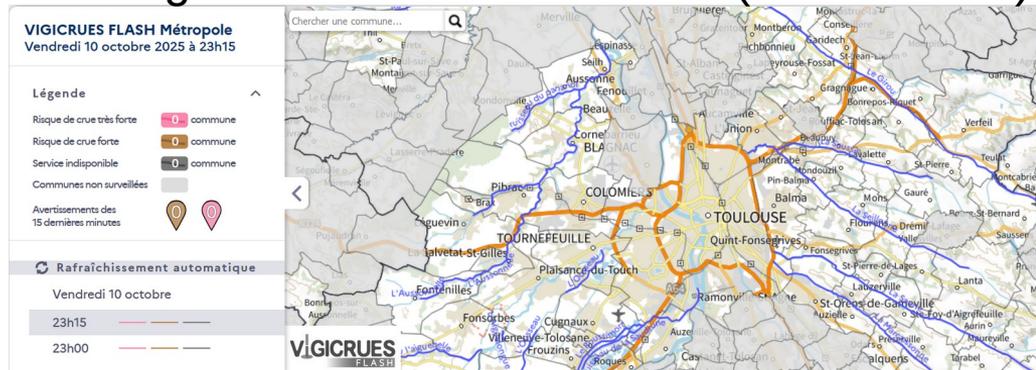


## Warnings on heavy rainfall at city scale (nowcasting)



<https://apic-vigicruesflash.fr/?mode=apic>

## Warnings on floods on little rivers (Tc < 6 hours)



<https://apic-vigicruesflash.fr/?mode=wf>

Automatic warnings  
Hazard of 5 and 15 years return period