

Observation de la Terre et Hydrologie :

cartographie d'urgence des inondations en Allemagne
de décembre 2023 et janvier 2024 par le service Copernicus

et

étude topographique des eaux de surface, du Rhin et des lacs environnants,
avec la mission SWOT

Nadine THOLEY & Hervé YESOU

ICube - SERTIT

SERTIT : SErvice Régional de Traitement d'Image et de Télédétection

Plateforme technologique et de services
du laboratoire ICube au sein de l'Université de Strasbourg



➤ Plus de 30 ans d'expérience dans la valorisation
et le transfert technologique dans le domaine de
l'Observation de la Terre

➤ Production d'information géographique à partir
d'imagerie spatiale pour :



Aménagement du
territoire



Suivi des ressources
naturelles



Gestion des risques
et des crises



ISO 9001



- Opérateur du dispositif européen
Copernicus Emergency
Management Service



- Opérateur national pour le CNES et
la Charte Internationale Espace et
Catastrophes Majeures



- Opérateur pour des acteurs privés
et publics de la gestion des risques
et des crises

<https://sertit.unistra.fr/>

Copernicus Emergency Management Service

- **Dispositif européen** créé en 2012 (CE)
- Un 'core' service de Copernicus
(Programme Européen d'observation et de surveillance de la Terre)

- En support à la **gestion des risques et des crises** lors de **catastrophes naturelles ou anthropiques**
 - 🏠 **Rapid Mapping (RM)**
24/7, besoins urgents (gestion de crise)
 - 🏠 **Risk & Recovery Mapping (RRM)**
8/7, analyse des risques, suivi de la reconstruction
 - 🏠 **Early Warning** (alertes : EFAS / GloFAS, EFFIS)

- Couverture mondiale
- Fourniture gratuite et à la demande d'information géospatiale

- Activation par des **utilisateurs autorisés (AU)**
Rapid Mapping (06/03/2024): 716 activations en Europe et dans le monde depuis 2012



<https://emergency.copernicus.eu/>

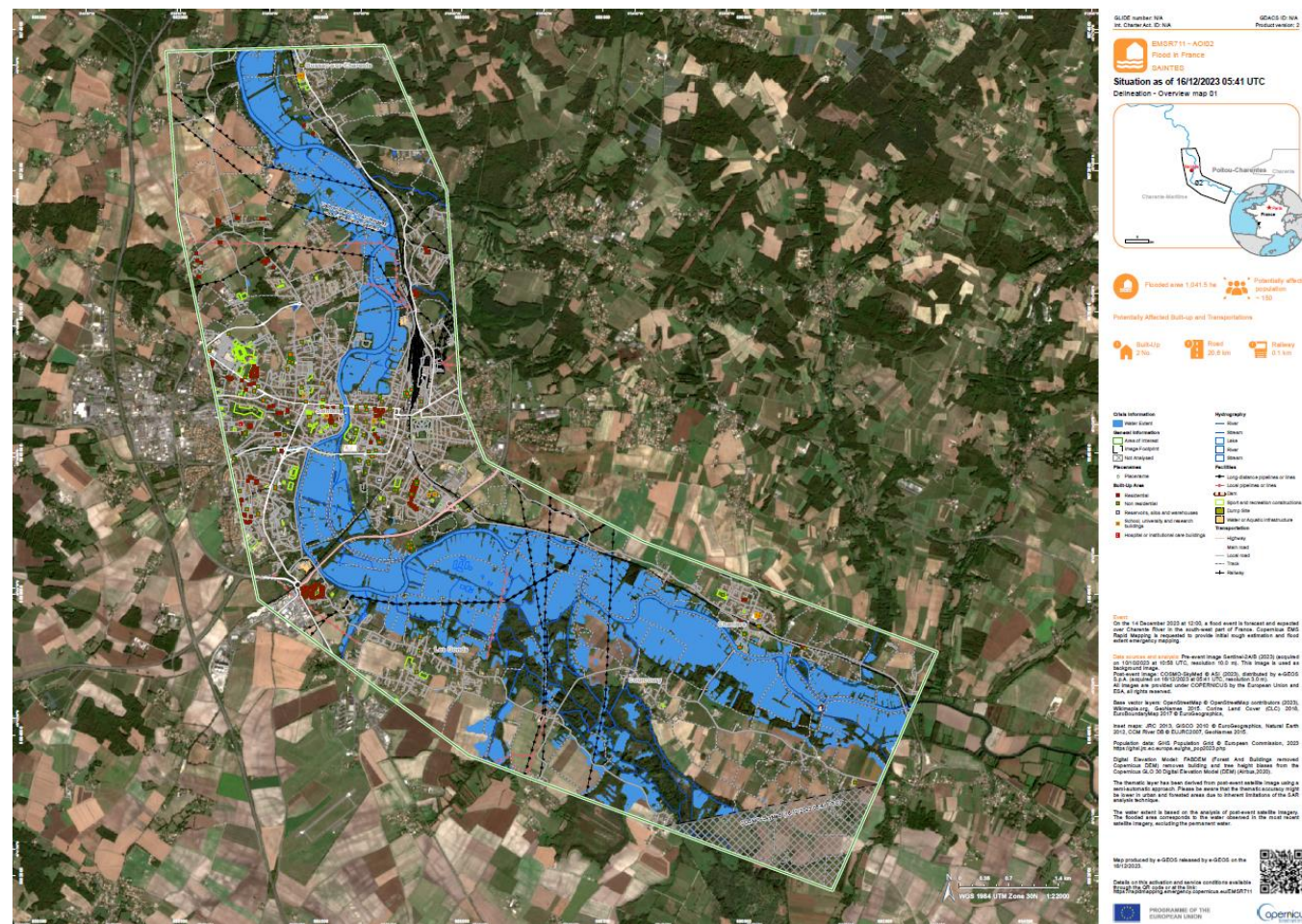
CEMSR: dernières activations



COPERNICUS
Emergency Management Service

<https://emergency.copernicus.eu/mapping/list-of-activations-rapid>

Code	Name	Activating Entity	Event Type	Activation Time	Country
EMSR716	Cargo Ship Oil Spill in Aruba	EC Services DG ECHO	Other	2024-03-02	Trinidad and Tobago , Aruba
EMSR715	Wildfire in Valparaiso region, Chile	EC Services DG ECHO	Wildfire	2024-02-04	Chile
EMSR714	Tropical Cyclone BELAL-24 in Réunion Island	France Centre Operationnel de Gestion Interministeriel de Crises (C.O.G.I.C)	Storm	2024-01-15	France
EMSR713	Flood in Saarland region, Germany	Germany Gemeinsames Melde- und Lagezentrum von Bund und Landern (GMLZ)	Flood	2024-01-03	Germany
EMSR712	Flood in Lower Saxony region, Germany	Germany Gemeinsames Melde- und Lagezentrum von Bund und Landern (GMLZ)	Flood	2023-12-22	Germany
EMSR711	Flood in southwestern France	France Centre Operationnel de Gestion Interministeriel de Crises (C.O.G.I.C)	Flood	2023-12-14	France
EMSR710	Flood in Romania	Romania National Operations Centre - General Inspectorate for Emergency Situations	Flood	2023-11-30	Romania
EMSR709	Wildfires in Bolivia	EC Services DG ECHO	Wildfire	2023-11-21	Bolivia
EMSR708	Flood in Belgium	Belgium Centre Gouvernemental de Coordination et de Crise	Flood	2023-11-10	Belgium
EMSR707	Cologne Festival, Germany	Germany Gemeinsames Melde- und Lagezentrum von Bund und Landern (GMLZ)	Other	2023-11-09	Germany
EMSR706	Flood in northern France	France Centre Operationnel de Gestion Interministeriel de Crises (C.O.G.I.C)	Flood	2023-11-07	France



Les inondations du Sud Ouest de la France : Situation le 16/12/2023 (acq. et production 16/12/2023)



CEMSR : Cartographie des Inondations en Basse-Saxe (Allemagne) de Décembre 2023

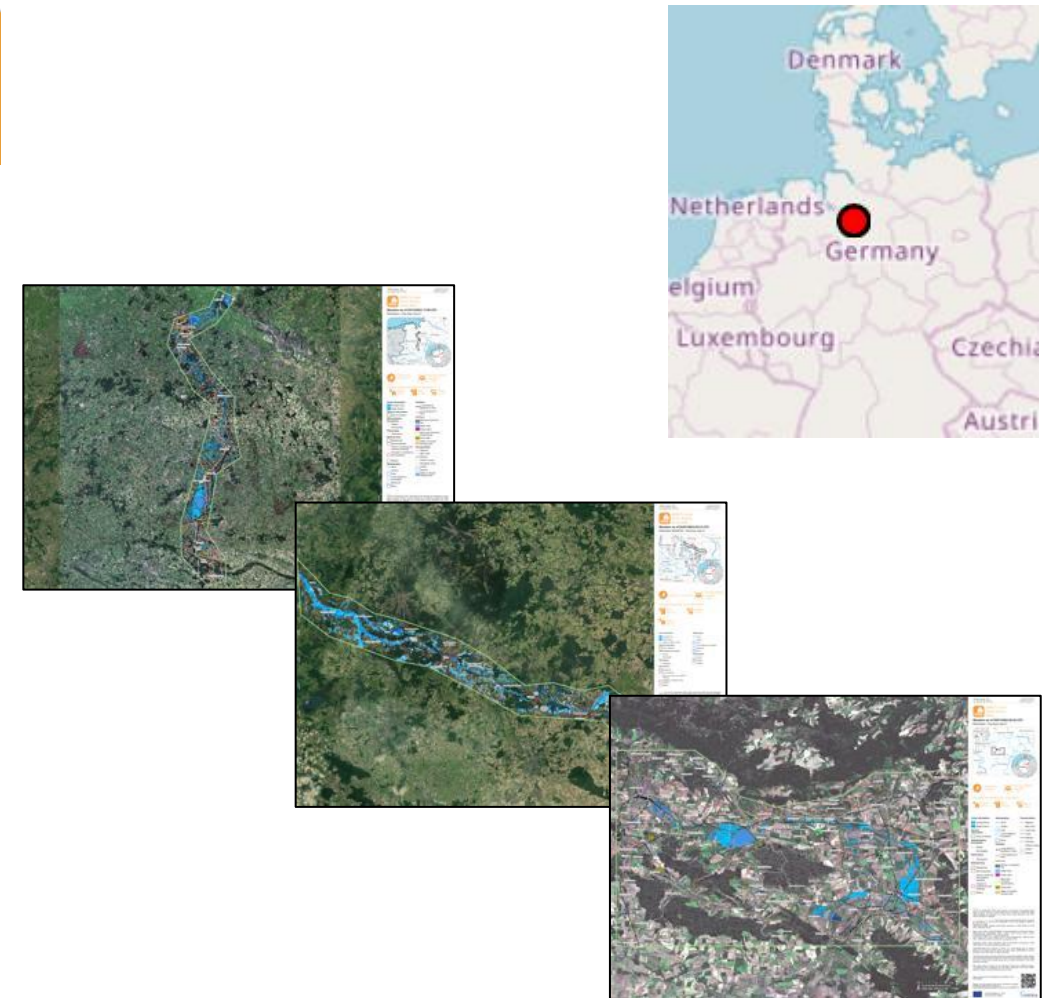
EMSR712 - Flood in Lower Saxony region, Germany

Activation time (UTC): 22/12/2023, 17:45

Event time (UTC): 24/12/2023 morning

Authorised User: Germany | Gemeinsames Melde- und Lagezentrum von Bund und Landern (GMLZ)

Activation reason: On the 24 December 2023, flood events are forecast and expected over state of Lower Saxony in North West part of Germany. Copernicus EMS Rapid Mapping is requested to provide initial rough estimation and flood extent emergency mapping.



<https://rapidmapping.emergency.copernicus.eu/EMSR712/>



EMSR712 : Zones observées entre le 24/12/2023 et le 07/01/2024

10 AOIs

- 01 Hase River
- 02 Hunte River
- 03 Weser River North
- 04 Weser River South
- 05 Aller River
- 06 Leine-Rhume Rivers
- 07 Innerste River
- 08 Fuhse River
- 09 Oker-Schunter Rivers
- 10 Berga

Products: 71 out of 71 (DEL, DEL Monit)

N° Maps: 99



Weser River North

9 observations
du 25/12/2023
au 07/01/2024

- S1 25/12/2023
- S1 27/12/2023
- S1 30/12/2023
- CSK 01/01/2024
- S1 03/01/2024
- PAZ 04/01/2024
- PAZ 05/01/2024
- S1 06/01/2024
- CSK 07/01/2024

9 produits
(DEL, DEL Monitx)



GLIDE Number: N/A
Int. Charter Act. ID: N/A
Product version: 1

EMSR712 - A0103
Flood in Germany
WESER RIVER NORTH

Situation as of 06/01/2024 17:09 UTC
Delineation MONIT07 - Overview map 01

Flooded area: 8,288.9 ha
Potentially affected population: ~14,900

Potentially Affected Built-up and Transportations

Built-up: 74.7 ha
Road: 121.8 km
Railway: 4.8 km

Oris Information	Hydrography
Flooded Area	River
Maximum Water Extent	Stream
Water Extent	Lake
General Information	Land Subject to Inundation
Area of Interest	Reservoir
Administrative boundaries	River
Region	Facilities
Municipality	Long-distance pipeline or line
Place names	Local pipeline or line
Place name	Water or Aquatic Infrastructure
Built-up Area	Dam
Residential	Mining or extraction site
Non residential	Water Well
School, university and research buildings	Power plant
Hospital or institutional care buildings	Sport and recreation constructions
Military	Dump Site
	Water or Aquatic Infrastructure
	Transportation
	Alfield
	Helipad
	Harbour

Full transportation network available in the SUP.

Notes: On the 24 December 2023, flood events are forecast and expected over state of Lower Saxony in North West part of Germany. Copernicus EMS Rapid Mapping is requested to provide initial rough estimation and flood extent emergency mapping.

Metadata: The event image Sentinel-2A/B (2023) acquired on 06/01/2024 at 10:35 UTC, resolution 10 m. The image is used as background image. Pre-event image Sentinel-1A/B (2024) acquired on 06/01/2024 at 17:09 UTC, resolution 20 m. All images are provided under Copernicus by the European Union and ESA, all rights reserved.

Data sources: Base vector layers: OpenStreetMap © OpenStreetMap contributors (2023), Wikimapia.org, GeoNames 2018, Corine Land Cover (CLC) 2018, EuroGeoInformation 2017 © EuroGeoInformation, Natural Earth Inset maps: JRC 2015, OSGEO 2010 © EuroGeoInformation, Natural Earth 2012, OCHA River DB © EUR/OC2007, GeoNames 2015. Population data: OIG Population Grid © European Commission, 2023. https://ghsl.jrc.ec.europa.eu/ghsl_pos2023.zip

Processing: Digital Elevation Model: FABDEM (PolarGrid Building removed CopernicusDEM) remove building and tree height biases from the Copernicus GLO 30 Digital Elevation Model (DEM) (Arius 2020).

The thematic layer has been derived from post-event satellite image using an automatic approach. Please be aware that the thematic accuracy might be lower in urban and forested areas due to inherent limitations of the SAC analysis technique.

The water extent is based on the analysis of post-event satellite imagery. The maximum water extent corresponds to the water observed in all.

Map produced by GAFAG released by e-GEOS on the 07/01/2024.

Details on this activation and service conditions available through the QR code or at the link: <https://rapidmapping.emergency.copernicus.eu/EMSR712>

PROGRAMME OF THE EUROPEAN UNION

opernicus



CEMSR : Cartographie des Inondations en Sarre (Allemagne) de Janvier 2024

EMSR713 - Flood in Saarland region, Germany

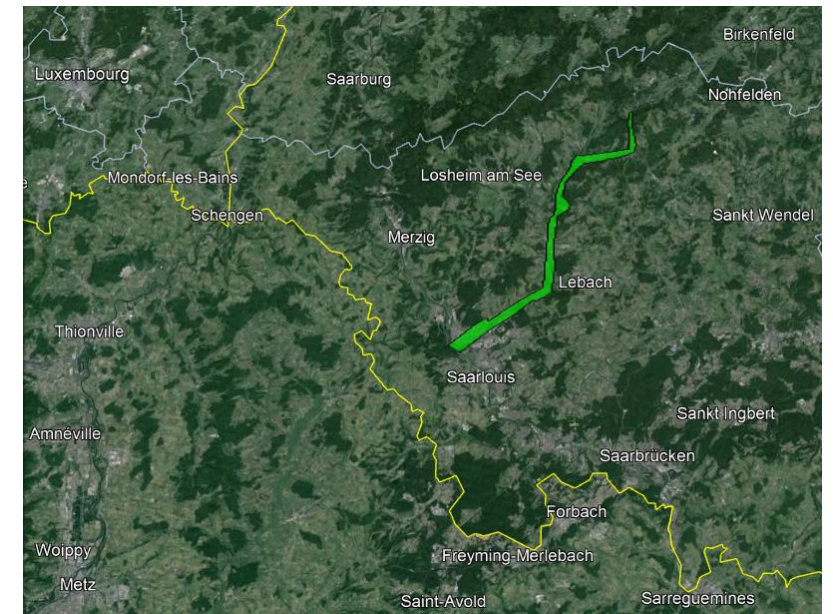


Activation time (UTC): 03/01/2024, 16:10

Event time (UTC): 02/01/2024 evening

Authorised User: Germany | Gemeinsames Melde- und Lagezentrum von Bund und Landern (GMLZ)

Activation reason: Due to the currently prevailing flood situation in Germany, a 20 to 50-year flood is expected for the federal state of Saarland. The 1st wave will peak between 02.01.2024 around 18:00 and 03.01.2024 06:00, the 2nd wave is expected to peak in the night from 03.01.2024 to 04.01.2024. Specifically, this concerns the area of the river "Prims". Copernicus EMS Rapid Mapping is requested to provide initial roughestimation, flood extent and damage assessment of the flood event for the emergency mapping



AOI 01 : Prims River

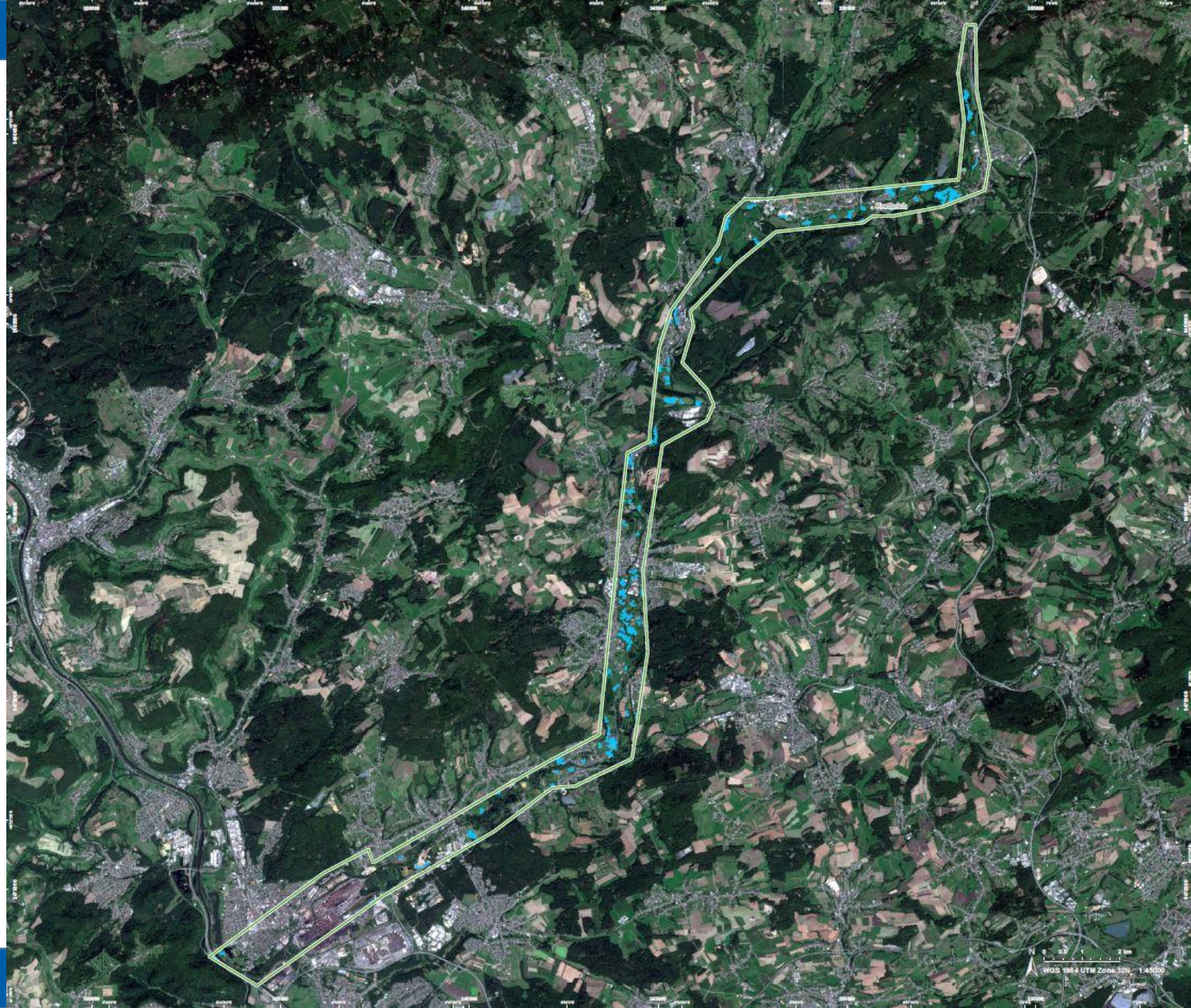
<https://rapidmapping.emergency.copernicus.eu/EMSR713/>

Prims River

3 observations
du 04/01/2024
au 06/01/2024

- S1 04/01/2024
- CSK 05/01/2024
- CSK 06/01/2024

1 produit
(DEL)



EMSR713 - AO101
Flood in Germany
PRIMS RIVER

Situation as of 04/01/2023 17:24 UTC
Delineation - Overview map 01

Flooded area: 131.3 ha
Potentially affected population: ~150

Potentially Affected Sub-up and Transportations

- Build-Up: 28 No.
- Road: 5.6 km
- Railway: 0.1 km

Crisis Information	Hydrography
Flooded Area	River
Area of Interest	Stream
Administrative boundaries	Lake
Province	River
Municipality	Mining or extraction site
Place names	Power plant
Build-Up Area	Sport and recreation constructions
Non residential	Dump Site
School, university and research buildings	Water or Aquatic infrastructure
Hospital or institutional care buildings	Transportation
	Highway
	Main road
	Local road
	Track
	Railway
	Harbour

Rivers: Due to the currently prevailing flood situation in Germany, a 20 to 50-year flood is expected for the federal state of Saarland. The 1st wave will peak between 03.01.2024 around 15:00 and 03.01.2024 09:00, the 2nd wave is expected to peak in the night from 03.01.2024 to 04.01.2024. Specifically, this concerns the area of the river "Prims". Copernicus EMS Rapid Mapping is requested to provide initial rough estimation, flood extent and damage assessment of the flood event for the emergency mapping.

Data sources and attributions: Pre-event image: Sentinel2A/R (2023) (acquired on 10/08/2023 at 10:36 UTC, resolution 10.0 m). This image is used as background image.
Post-event image: Sentinel-1A/S (2024) (acquired on 04/01/2024 at 17:24 UTC, resolution 30.0 m).
All images are provided under Copernicus by the European Union and ESA, all rights reserved.

Base vector layers: OpenStreetMap © OpenStreetMap contributors (current year), Wikimedia.org, Geonames 2015, Corine Land Cover (CLC) 2018, EuroBoundaryMap 2017 © EuroGeographics, road map: JRC 2013, OSM 2013 © EuroGeographics, Natural Earth 2012, OSM River DB © EURC2007, Geonames 2015.

Population data: DHS Population Grid © European Commission, 2023
https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&code=sdg11.6.2
Digital Elevation Model: FAO/UNEP
Topographic Elevation Model: Copernicus DEM (removes building and tree height biases from the Copernicus GLO 30 Digital Elevation Model (DEM) (ARbus,2020)).

The thematic layer has been derived from post-event satellite image using a semi-automatic approach. Please be aware that the thematic accuracy might be lower in urban and forested areas due to inherent limitations of the SAR analysis technique.

The water extent is based on the analysis of post-event satellite imagery. The flooded area corresponds to the water observed in the most recent satellite imagery, excluding the permanent water.

Map produced by ThalesAir France released by e-GEOSS on 04/01/2024

Details on this activation and service conditions available through the QR code or at the link: <https://rapidmapping.emergency.copernicus.eu/EMSR713>

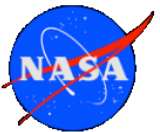
PROGRAMME OF THE EUROPEAN UNION
Copernicus

Etude topographique des eaux de surface, du Rhin et des lacs environnants, avec la mission SWOT

SWOT

- Nouvelle mission altimétrique Franco-Américaine SWOT (2023-2026).

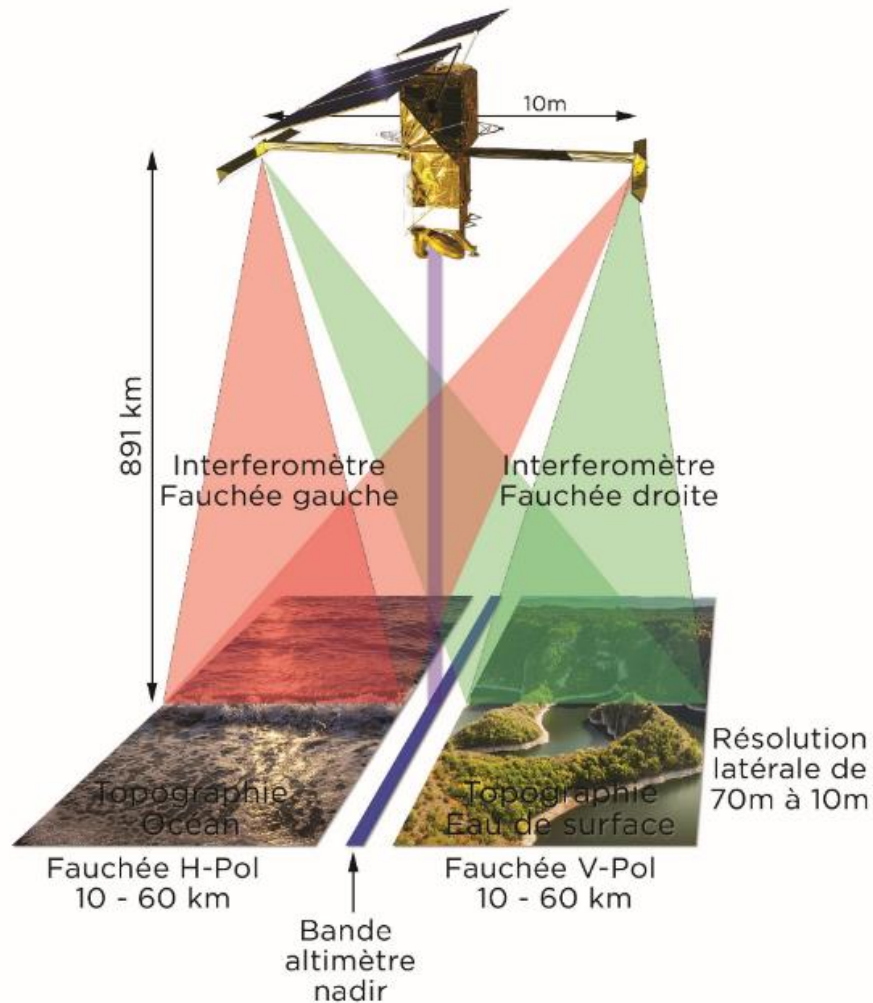
SWOT
SURFACE WATER & OCEAN TOPOGRAPHY



- Capacités des satellites imageurs et altimétriques pour le suivi des surfaces en eau, hauteurs et variations de volume des réservoirs.
- Lancement 16 décembre 2022
- Données depuis fin mars 2023



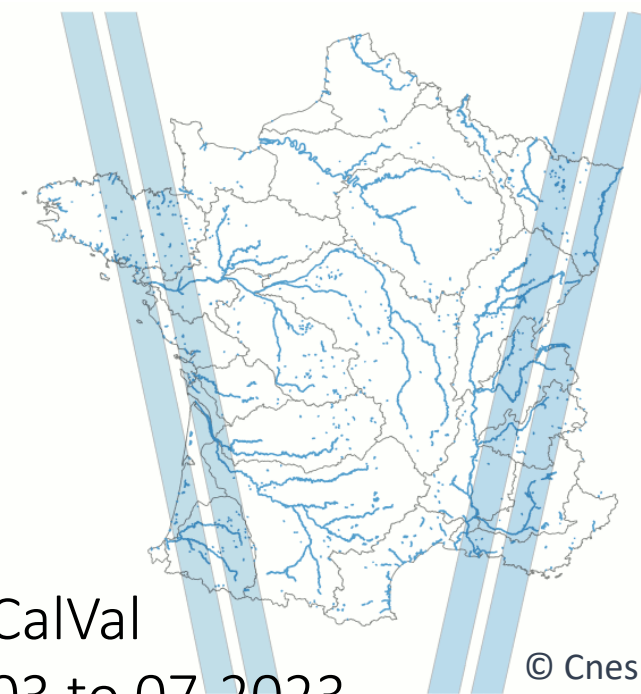
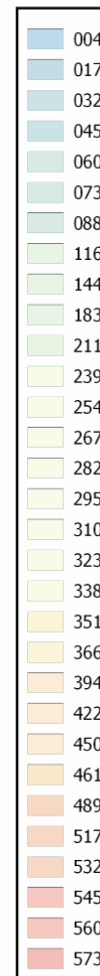
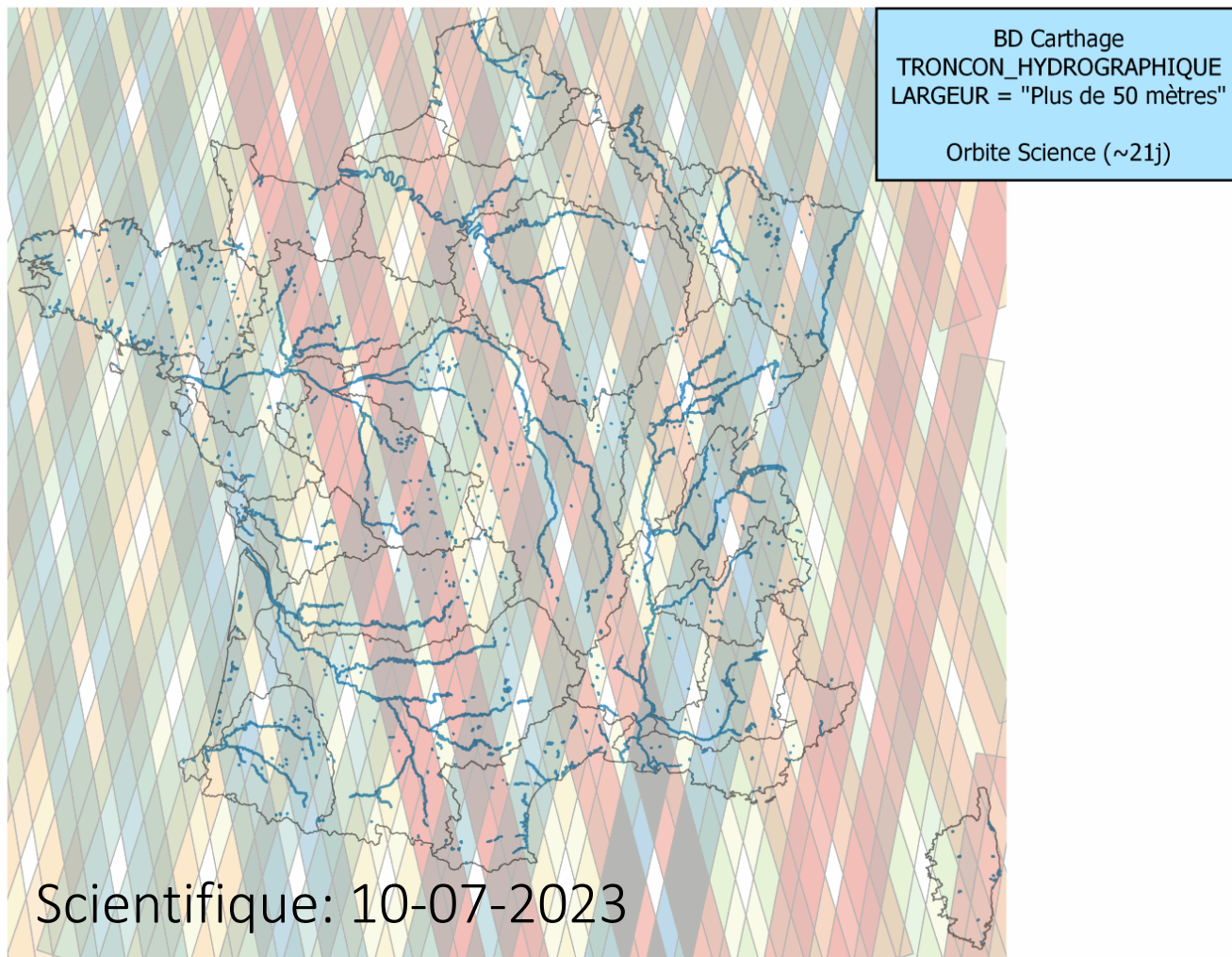
La mission SWOT



© Cnes/Mira Production

- Une coopération Nasa (USA) / Cnes (France) / CSA (Canada) / UKSA (UK)
- Un nouveau concept technique, l'altimétrie interférométrique à large fauchée (KaRIn)
 - une image bidimensionnelle
 - Fauchée 2 x 50 km
 - Mesure radar (tous temps + jour/nuit)
- Données
 - Mesures « directes » : Hauteur d'eau, Pente, Largeur
 - *Mesures indirectes : Débit, Vitesse et amplitude des marées, Amplitude des vagues, Vitesse des courants...*

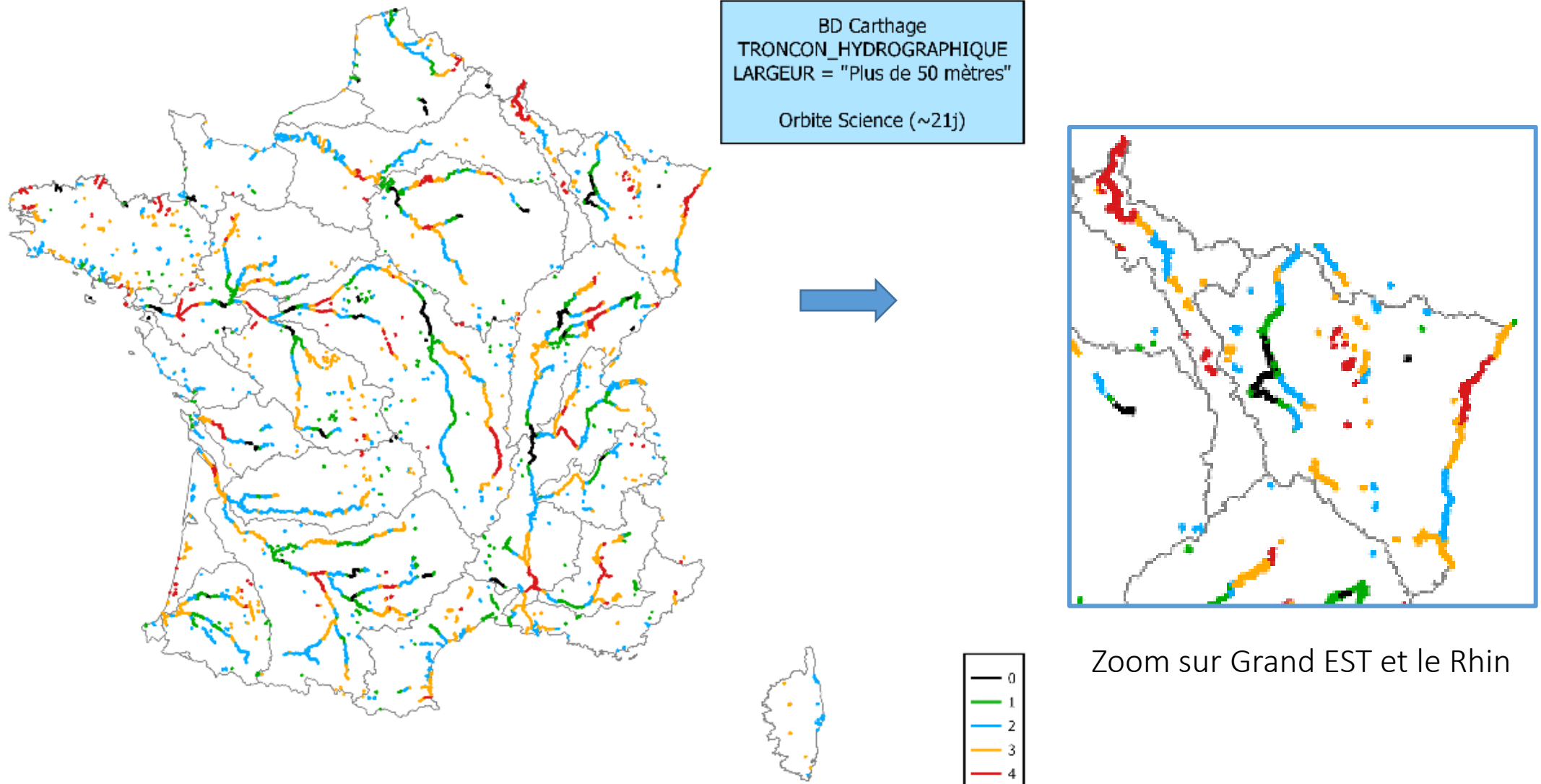
Orbite Scientifique – couverture de la France



Couverture selon les traces
(numérotées) à gauche, et jour par jour

Orbite Scientifique

Nombre d'observations par cycle (21 jours) sur les rivières et lacs français



CalVal SWOT Rhin

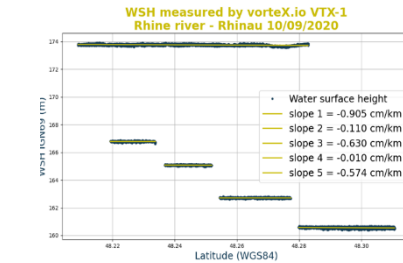
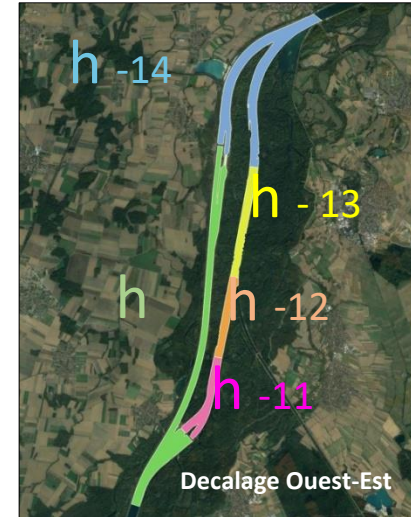
Validation des hauteurs, surfaces, volumes

Reconnaissance

- des éléments hydrauliques:
 - détection de saut liés aux barrages (12-15m) à des seuils (1,5m)
 - Digues,
- Des plans d'eau déconnectés et connectés (gravières)

1 - Rhin : des caractéristiques « uniques »

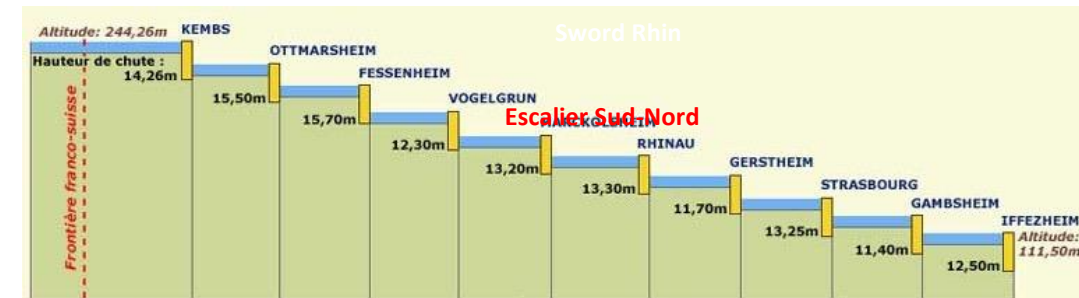
- Partie libre avec différentes orientations par rapport à la trace
- Partie canalisée avec des altitudes tranchées
 - En escalier du Sud vers le Nord par tranche de 13-10m
 - Décalage latéral Ouest-Est entre canal et le vieux Rhin



2- Lacs/réservoirs de montagne, en plaine et sur plateau (Vosges, Alsace, Lorraine)

3- Inondations de plaine

- Collecte des hauteurs d'eau**
 - in situ : casse tête, multi agences et transfrontaliers
 - Drone (Sept 2020) et réseau science citoyenne Collecte des surfaces (Sentinel2)
- Mise en place d'un Sword dédié

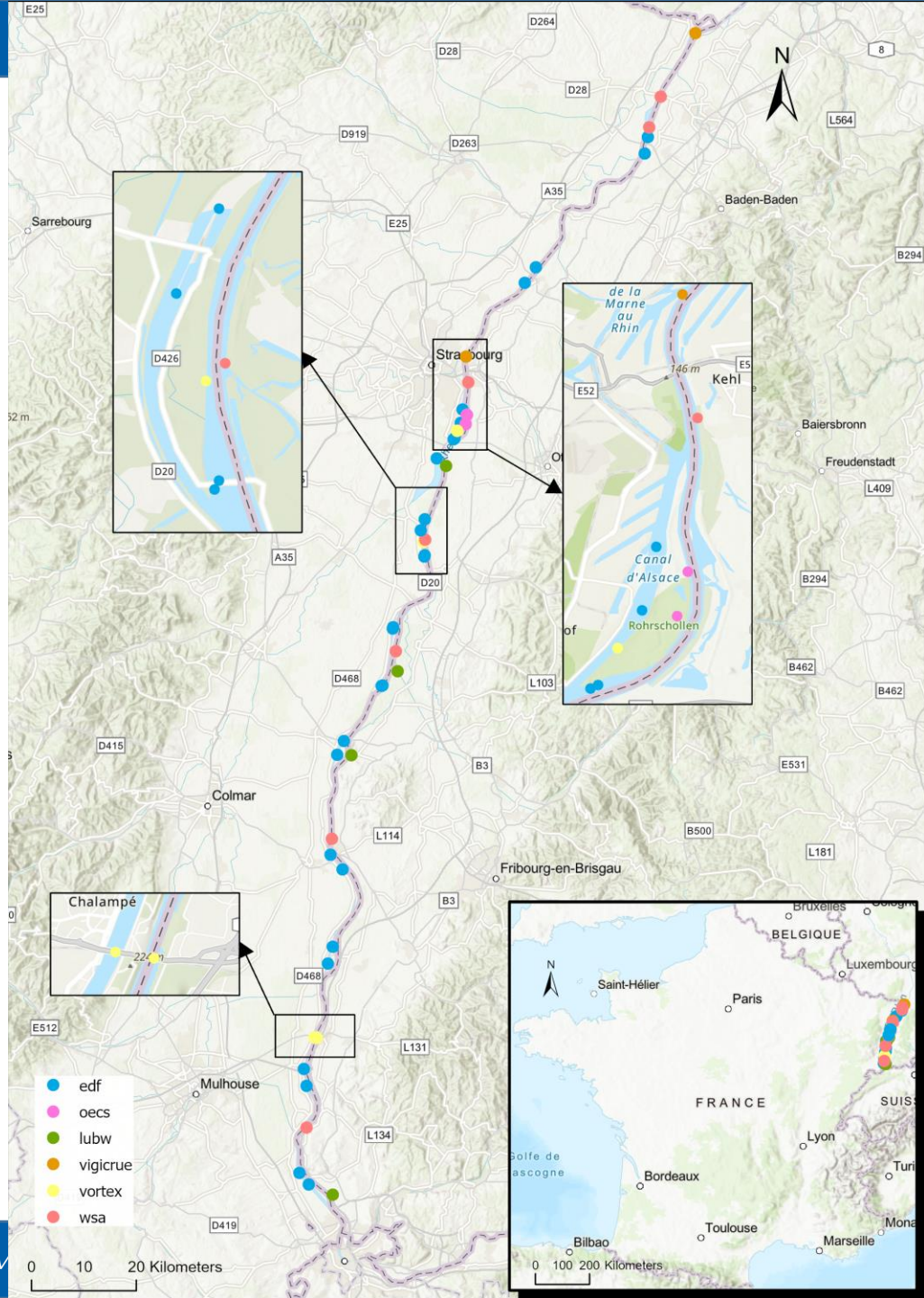
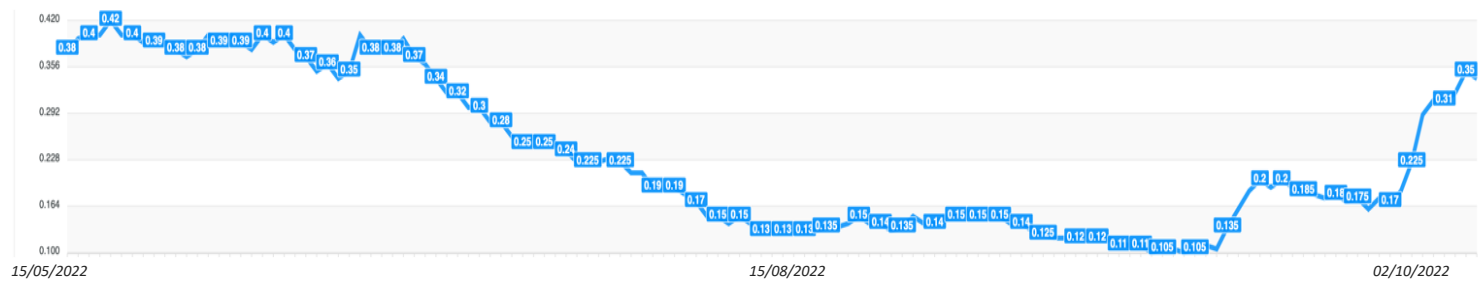


Données de référence: hauteur d'eau

- Réseau unique: 40 stations
- Différents propriétaires de données
- Différents référentiels



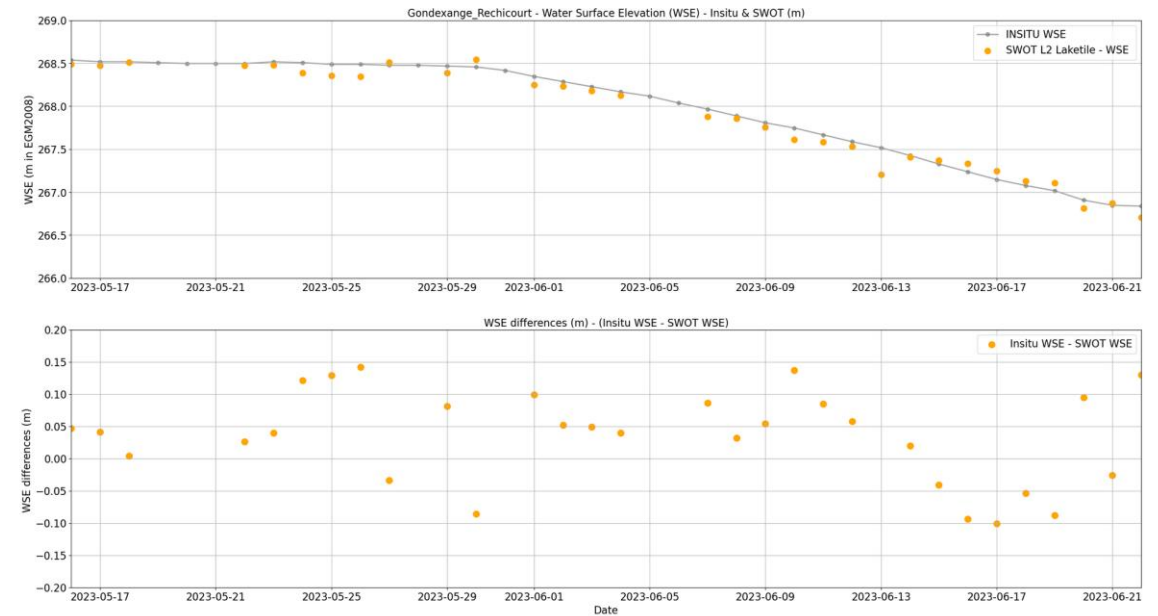
Réseau de science citoyenne
13 opérationnelles / 11 en attente d'installation



SWOT - lacs lorrains - vosgiens

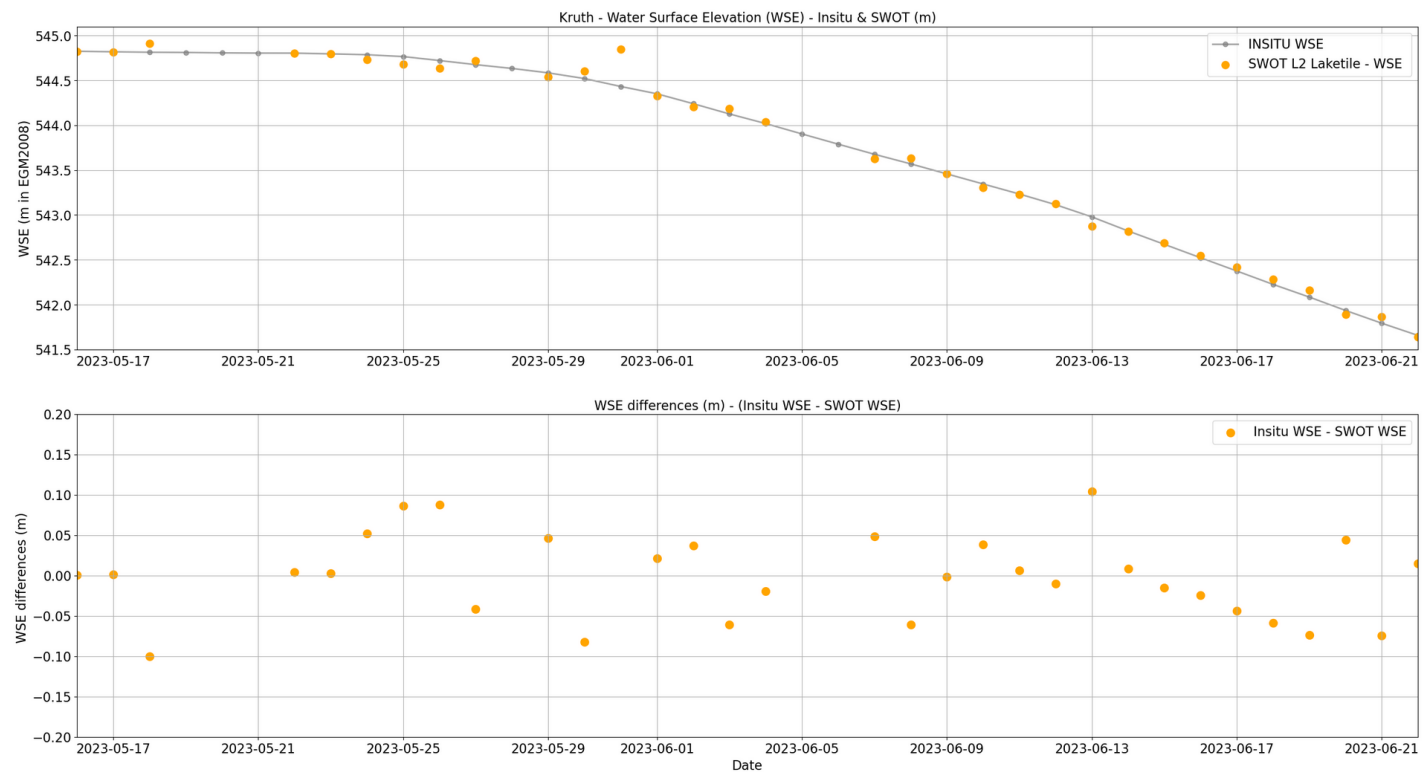
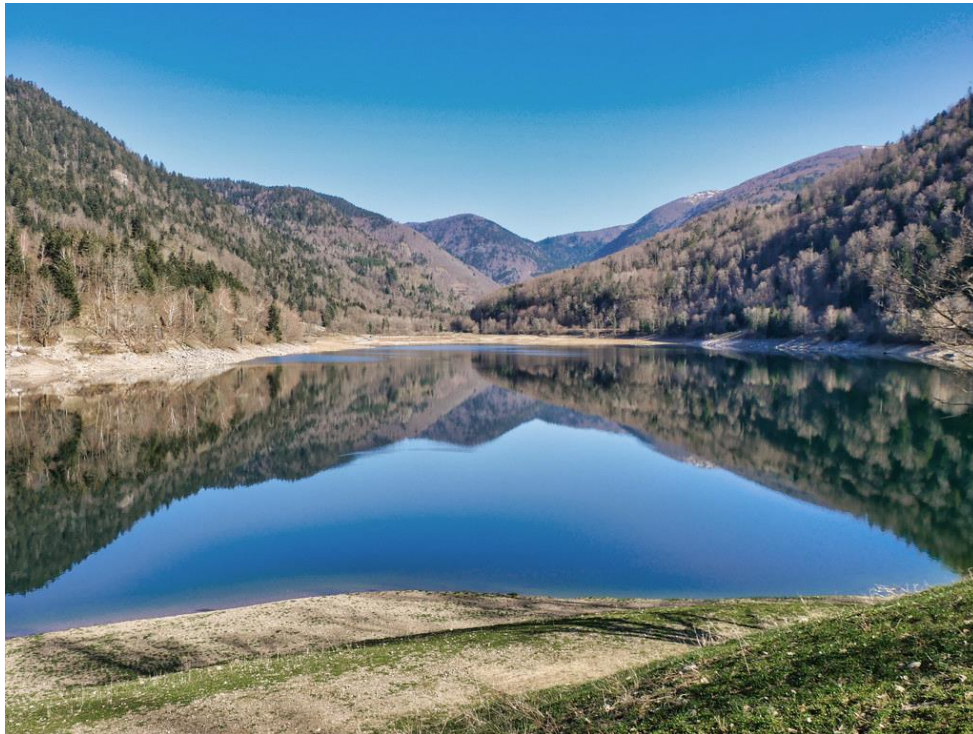
Gondrexange - Rechicourt basin

- $\sim 0.93 \text{ km}^2$ -
- Water surface elevation
- Error 1 sigma = 0.094 m



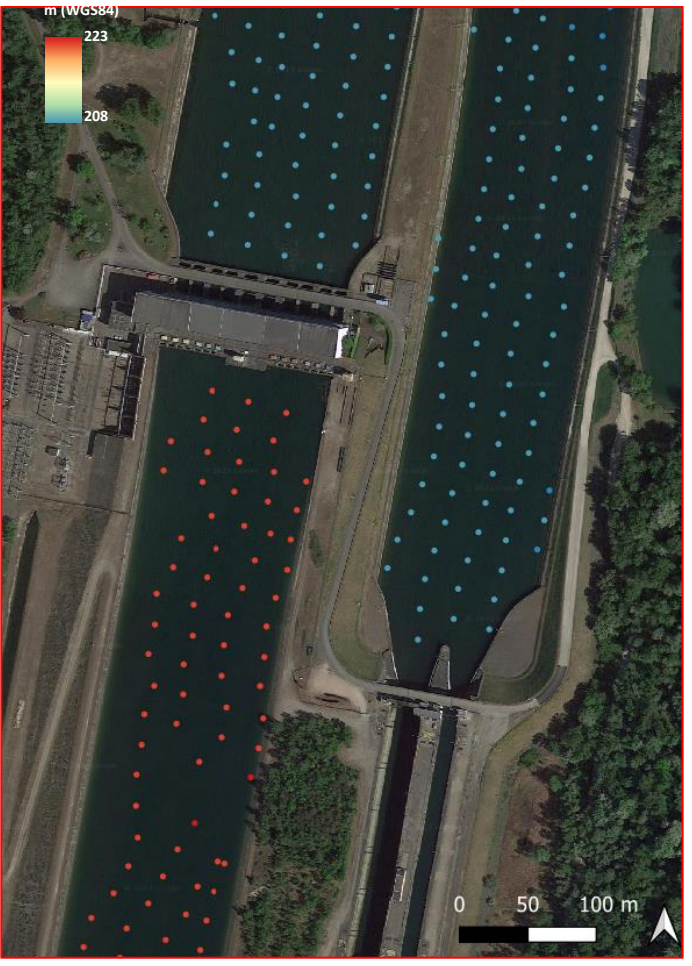
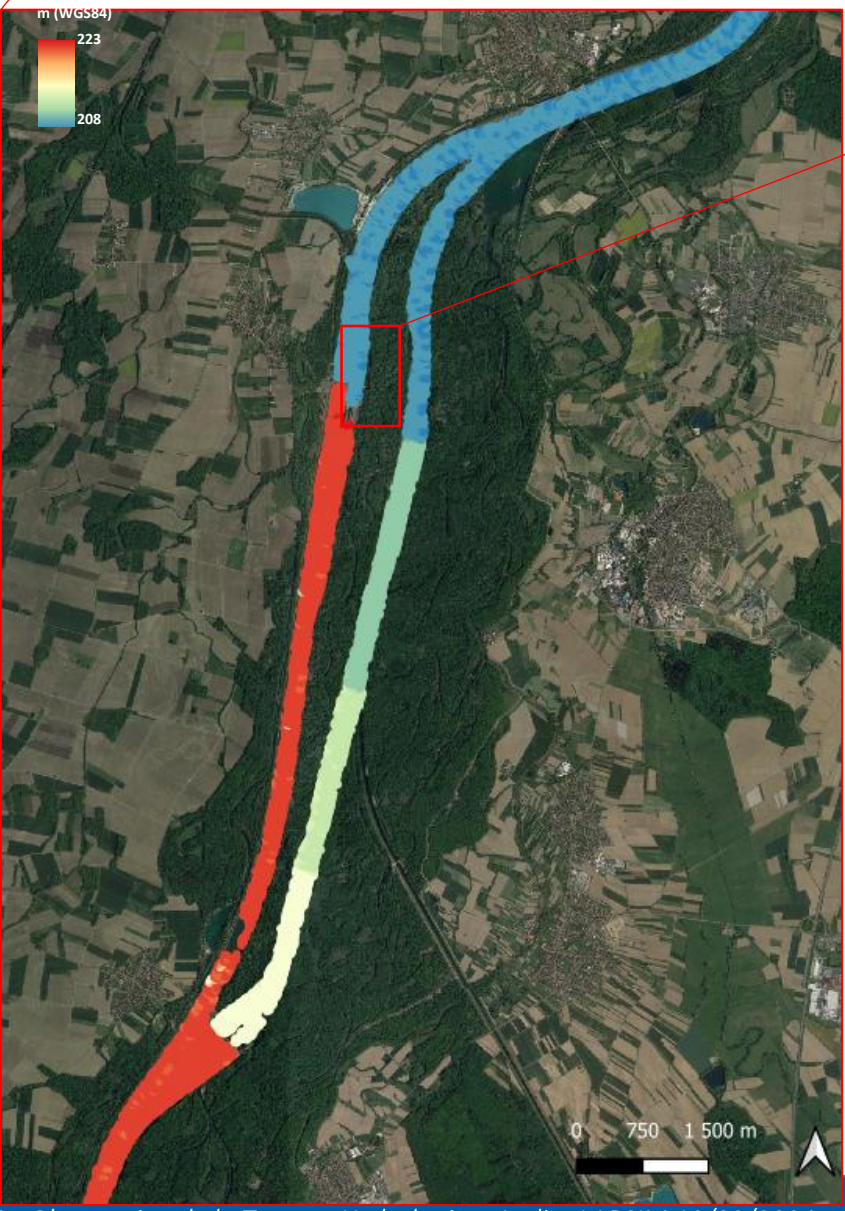
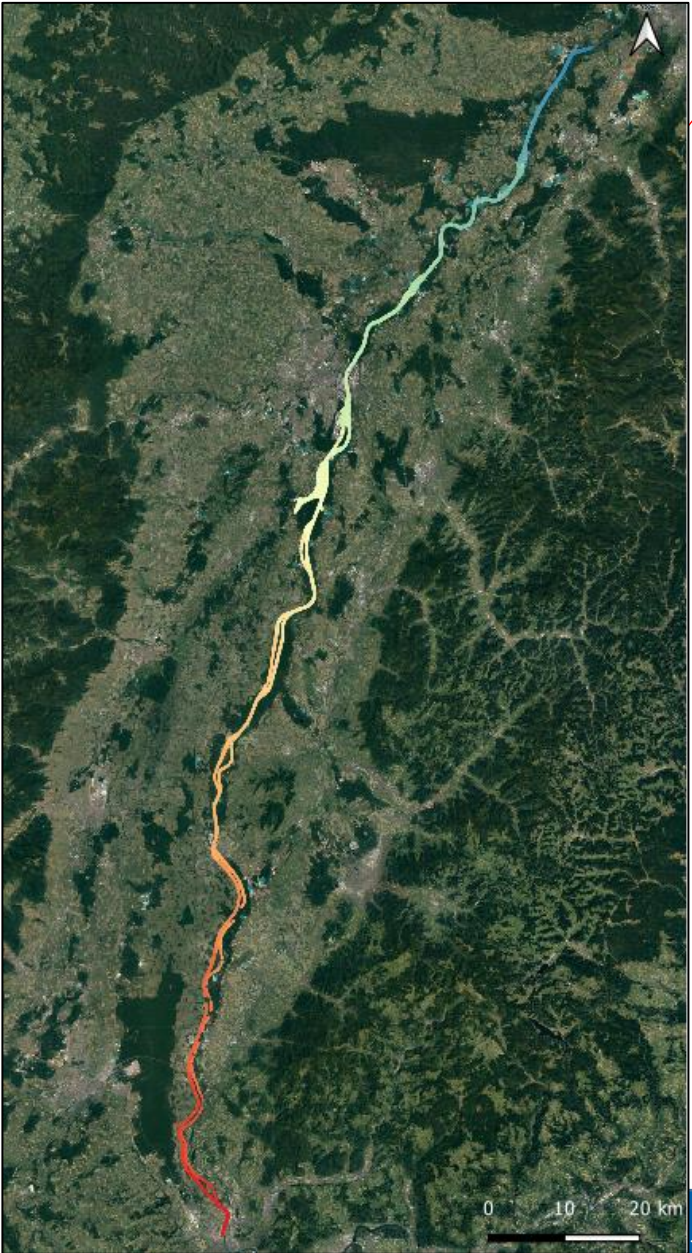
Kruth

- $\sim 0.81 \text{ km}^2$
- Water level, error 1 sigma = 0.060 m

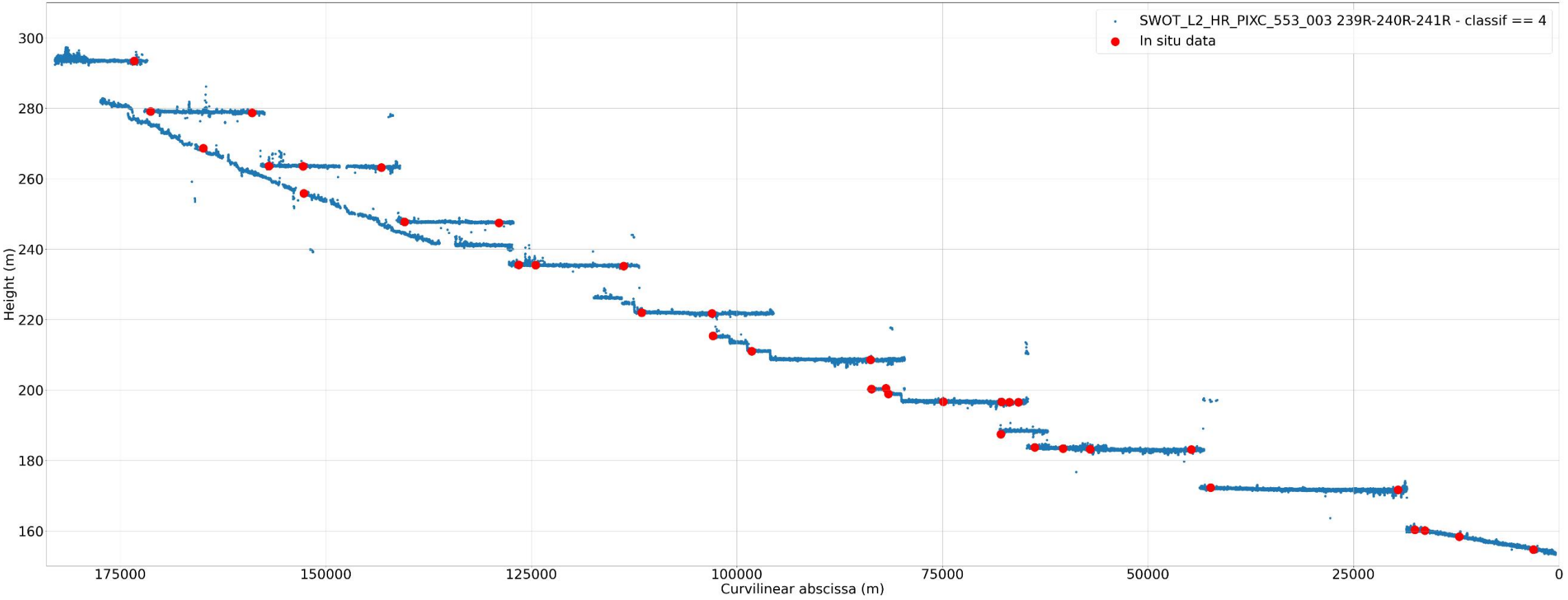


SWOT - Rhin

SWOT PIXC Height : nuage de points , classés eau et autres, altitude associée



Profil Rhin - SWOT PIXC & In situ data



Tile 003 239R

Tile 003 240R

Tile 003 241R

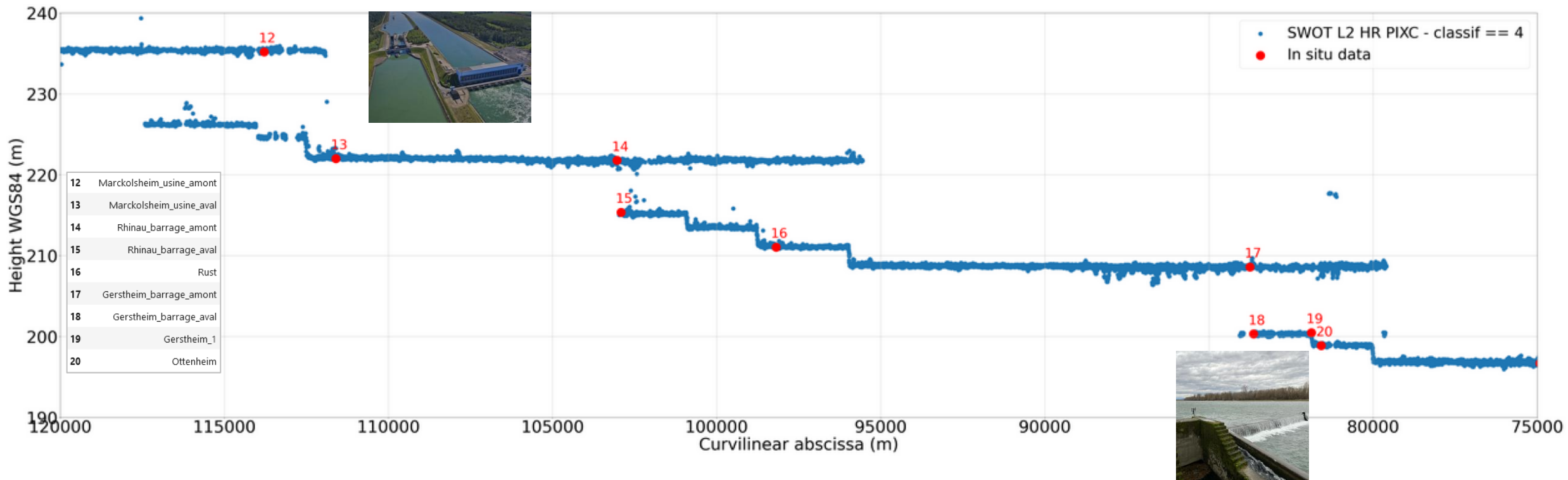


Profil Rhin - SWOT PIXC & In situ data

Marckolsheim

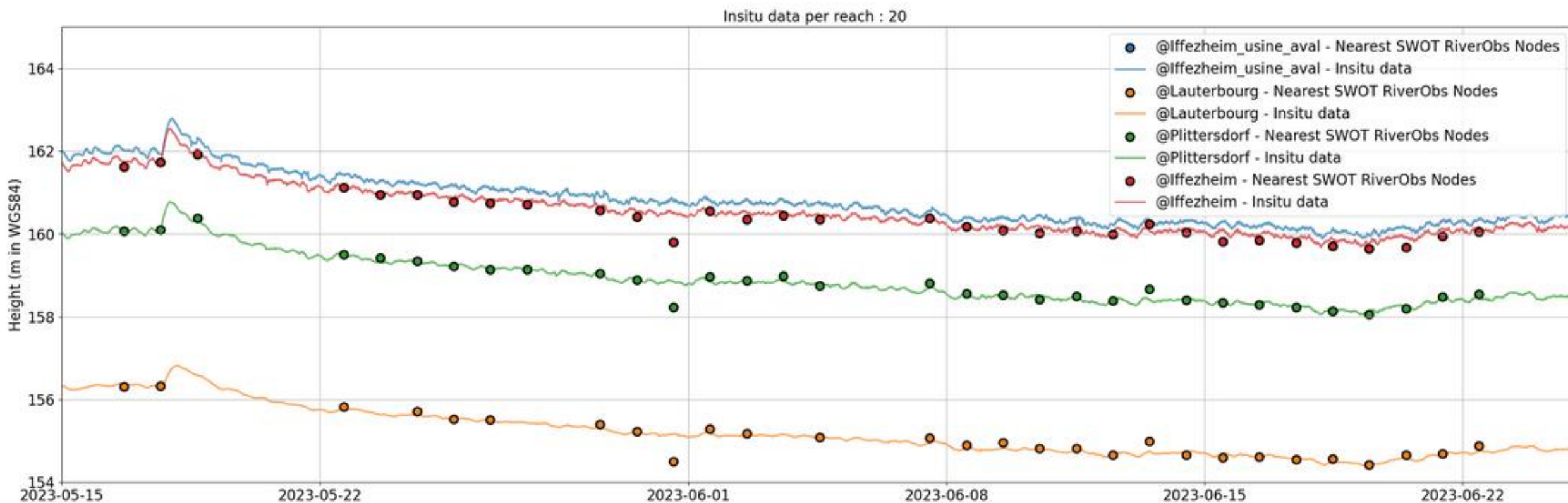
Rhinau

Gertsheim



Comparison insitu data vs nearest node

Station	Ecart médian (m)
Iffezheim	0.10
Plittersdorf	0.04
Lauterbourg	0.06





SERTIT

Parc d'innovation

300 Boulevard Sébastien Brant, CS 10413

F-67412 Illkirch Graffenstaden

Email :

n.tholeystampf1@unistra.fr

herve.yesou@unistra.fr

<https://sertit.unistra.fr/>