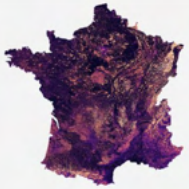
Présentation des données FORMS-T et FORMSpoT

Cartographie de la hauteur, du volume et de la biomasse des forêts françaises à haute résolution à l'aide de données satellites et d'algorithmes d'apprentissage profond

Martin Schwartz, Laboratoire des Sciences du Climat et de l'Environnement (LSCE)

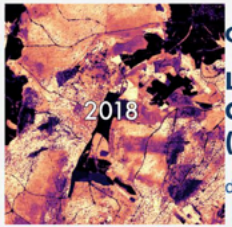


Comment nous citer :

LSCE. (2026): FORMS-T: Forest Multiple Source height, wood volume, and biomass time-series (2018-present) in France at 10 to 30 m resolution. Data Terra. (Collection)

doi:10.71961/0ts1-zz77

RIS Citation | BibTeX Citation | Copier



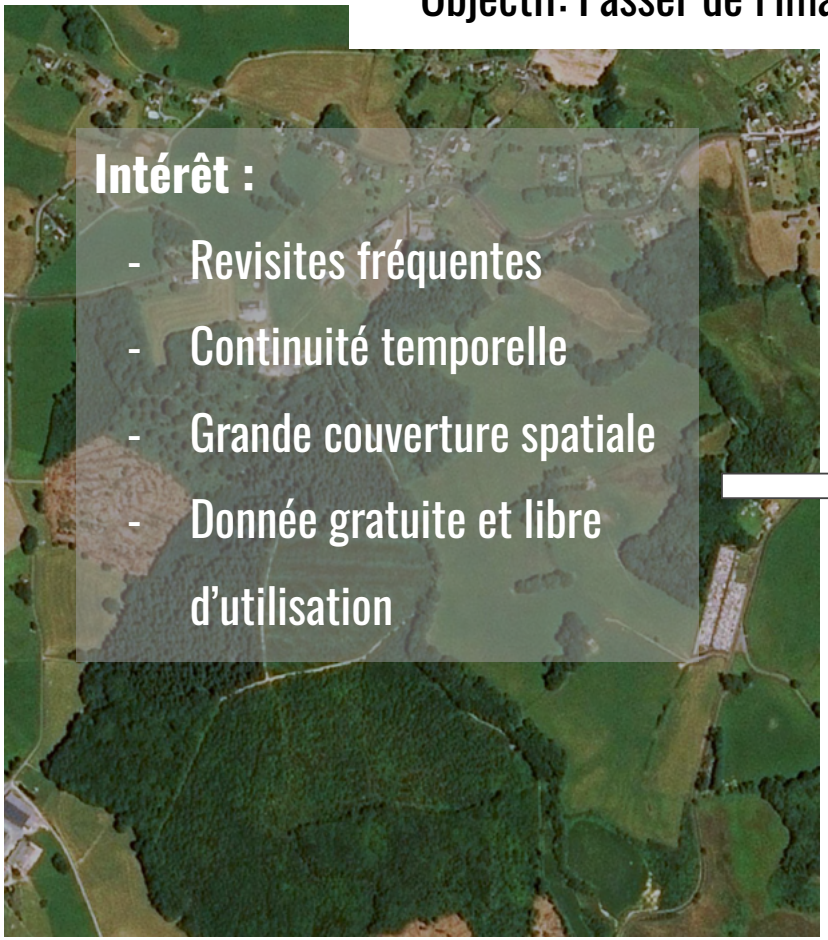
Comment nous citer :

LSCE. (2026): FORMSpoT : A Decade of Tree-Level, Country-Scale Forest Monitoring. Data Terra. (Collection)

doi:10.71961/F879-K244

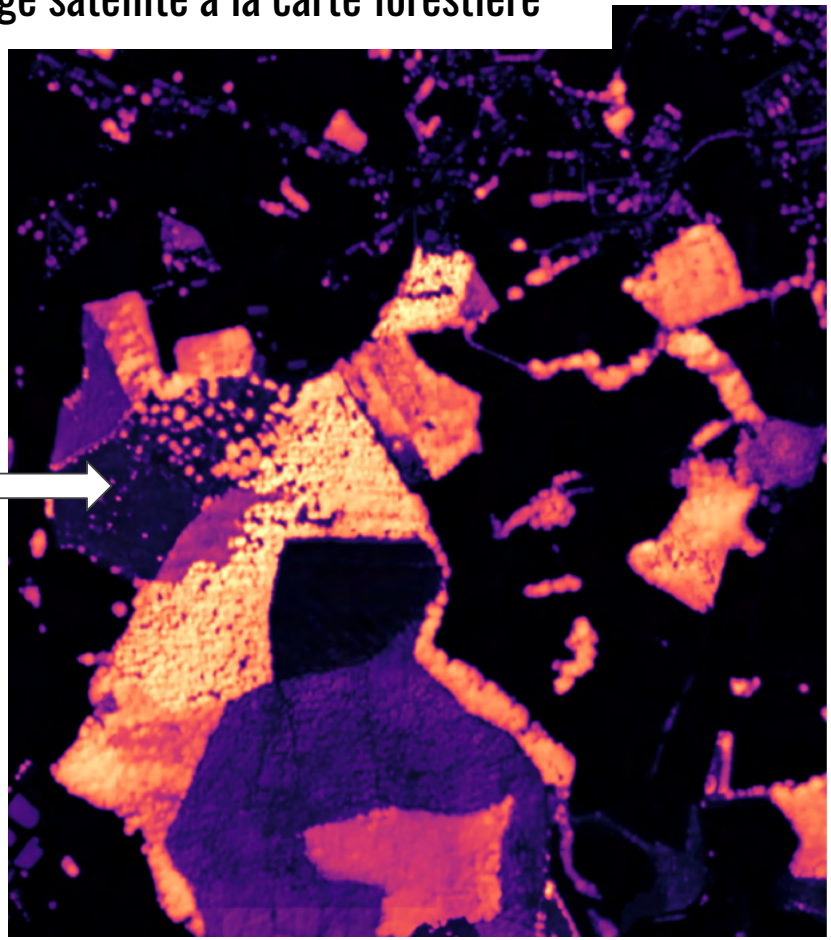
RIS Citation | BibTeX Citation | Copier

Objectif: Passer de l'image satellite à la carte forestière



Intérêt :

- Revisites fréquentes
- Continuité temporelle
- Grande couverture spatiale
- Donnée gratuite et libre d'utilisation



30 m

0 m

Données FORMS-T : FORest Multiple Source - Time series

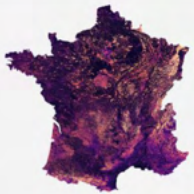
https://doi.theia.data-terra.org/FormsT/

DATA TERRA · LSCE · IGN · iSPA · ENS · Universität Münster · Theia Data Terra

Identifier DOI 10.71961/0ts1-zz77

DataCite Metadata HTML, XML

License



Enlarge

How to cite :

LSCE. (2026): FORMS-T: Forest Multiple Source height, wood volume, and biomass time-series (2018-present) in France at 10 to 30 m resolution. Data Terra. (Collection)

doi:10.71961/0ts1-zz77

RIS Citation | BibTeX Citation | Copy

Description

This collection contains France-wide forest attribute maps (2018 - present) derived from a deep learning framework that leverages data from Sentinel-1, Sentinel-2, and GEDI satellites.

The products are organized into 3 datasets:

- Forms-T Biomass: biomass map with a 30 m resolution. Units are expressed in megagrams per hectare ($Mg.ha^{-1}$)
- Forms-T Height: canopy height map with a 10 m resolution. Units are expressed in centimeters (10^{-2} m)
- Forms-T Volume: standing wood volume map with a 30 m resolution (WVD files). Units are expressed in cubic meters per hectare ($m^3.ha^{-1}$)

Recommended usage: products can also be visualized and accessed in Python without downloading, via the following STAC catalog: https://browser-theia.stac.teledetection.fr/. A Python code snippet for accessing and using the data via STAC is available here.

Products can also be visualized in QGIS by following the instructions provided in the CDS Theia Montpellier catalog or by directly adding XYZ tiles.
Products can also be downloaded as .tif files directly from this Zenodo repository.

Biomasse, Volume, hauteur des forêts Françaises à 10 m de résolution

Images satellites

?

Modèle de Deep Learning

?

Carte de hauteur

Equations Allométriques

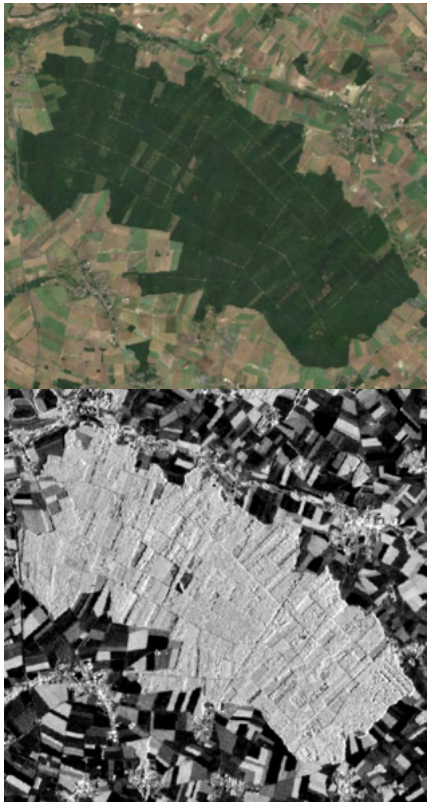
Cartes de Biomasse

Données de hauteur

?

Biomasse, Volume, hauteur des forêts Françaises à 10 m de résolution

Images satellites



Modèle de Deep Learning

?

Carte de hauteur

Equations Allométriques

Cartes de Biomasse

Données de hauteur

?

Source : https://gedi.umd.edu/

Global Ecosystem Dynamics Investigation

Infrared light from GEDI

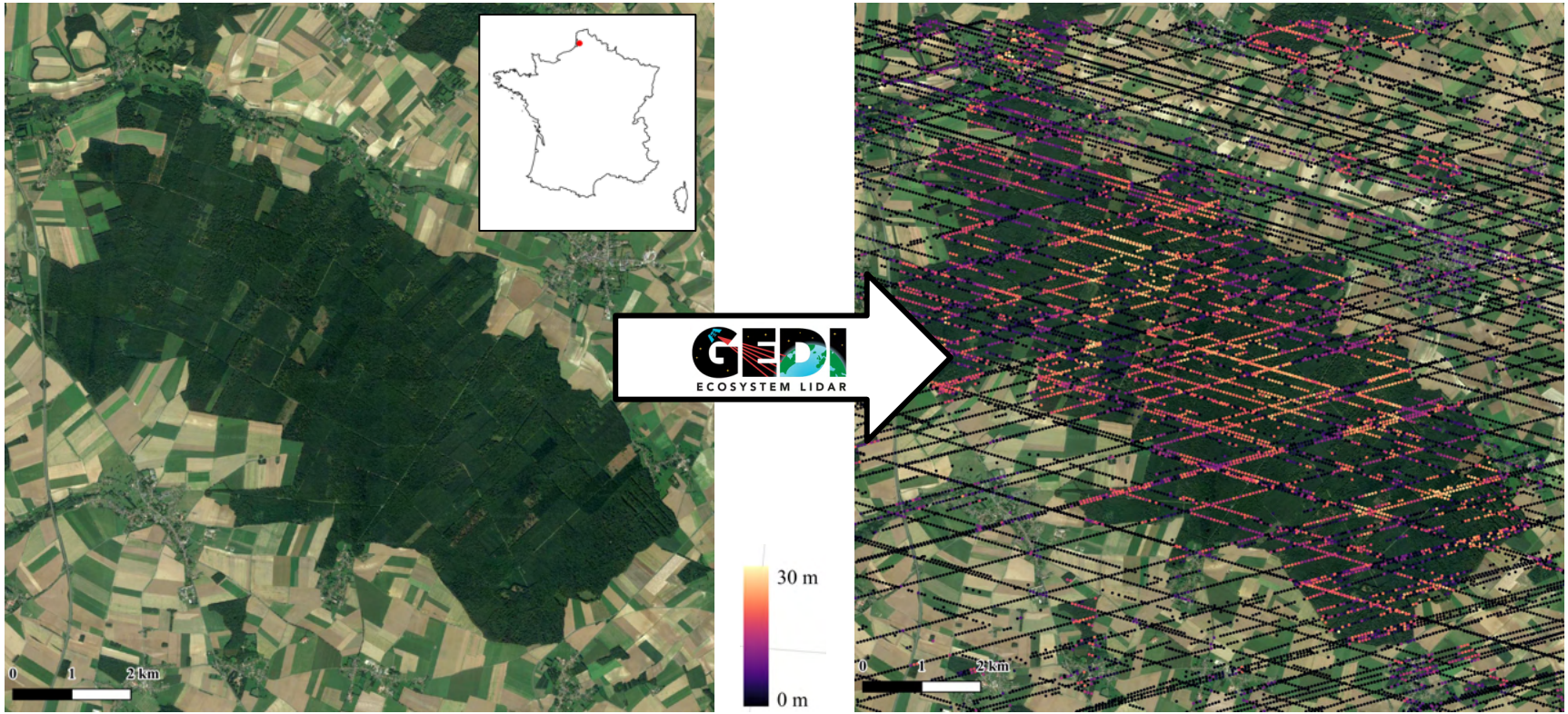
Waveform that gives information on forest vertical structure

Forest Height

Global Ecosystem Dynamics Investigation

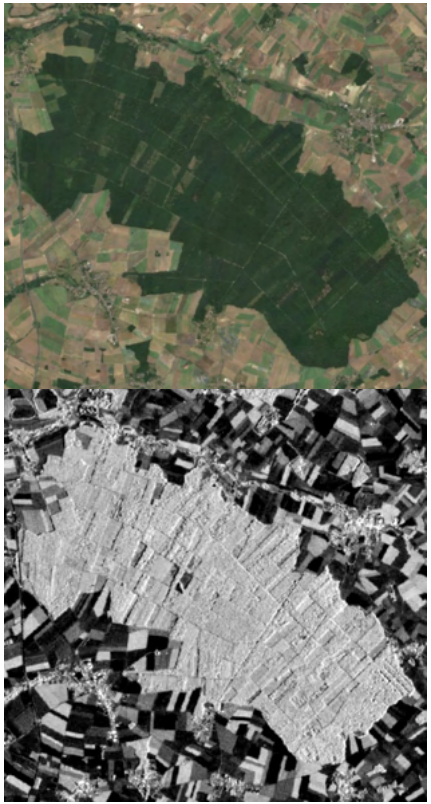
Crecy Forest, Somme, © Google Maps

GEDI height measurements



Biomasse, Volume, hauteur des forêts Françaises à 10 m de résolution

Images satellites



Modèle de Deep Learning

?

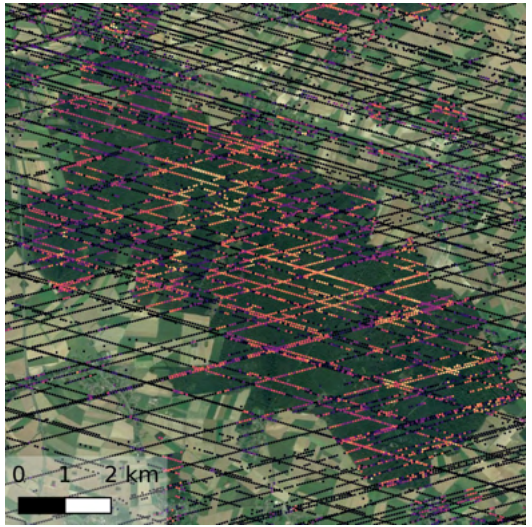
Carte de hauteur

Equations Allométriques

Cartes de Biomasse

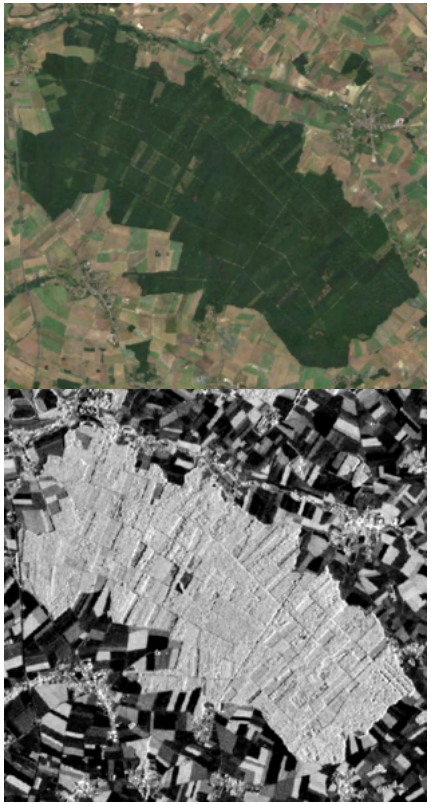
Données de hauteur

Hauteurs GEDI



Biomasse, Volume, hauteur des forêts Françaises à 10 m de résolution

Images satellites



Modèle de Deep Learning

U-Net

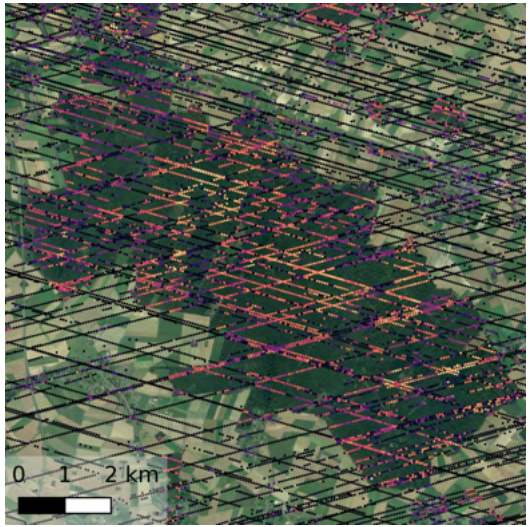
Carte de hauteur

Equations Allométriques

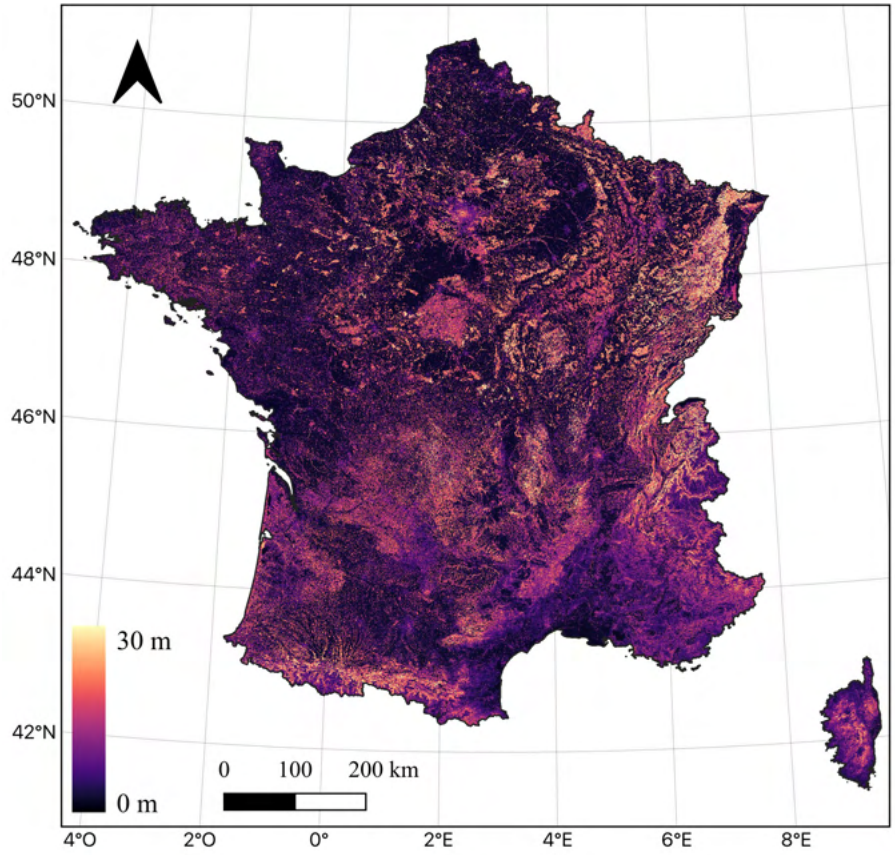
Cartes de Biomasse

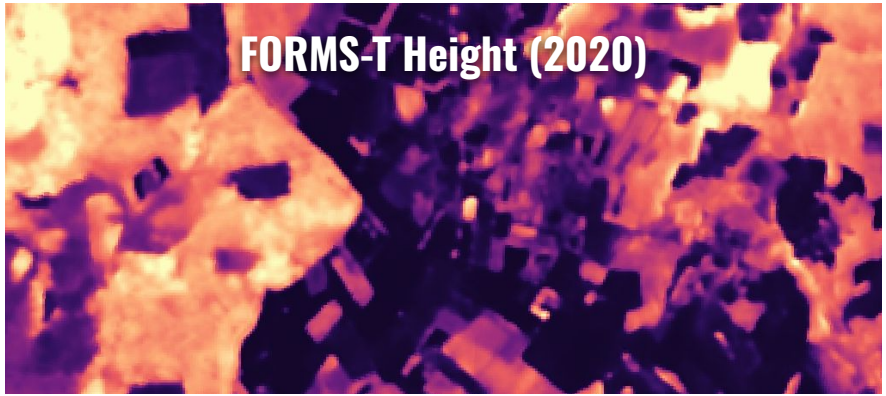
Données de hauteur

Hauteurs GEDI



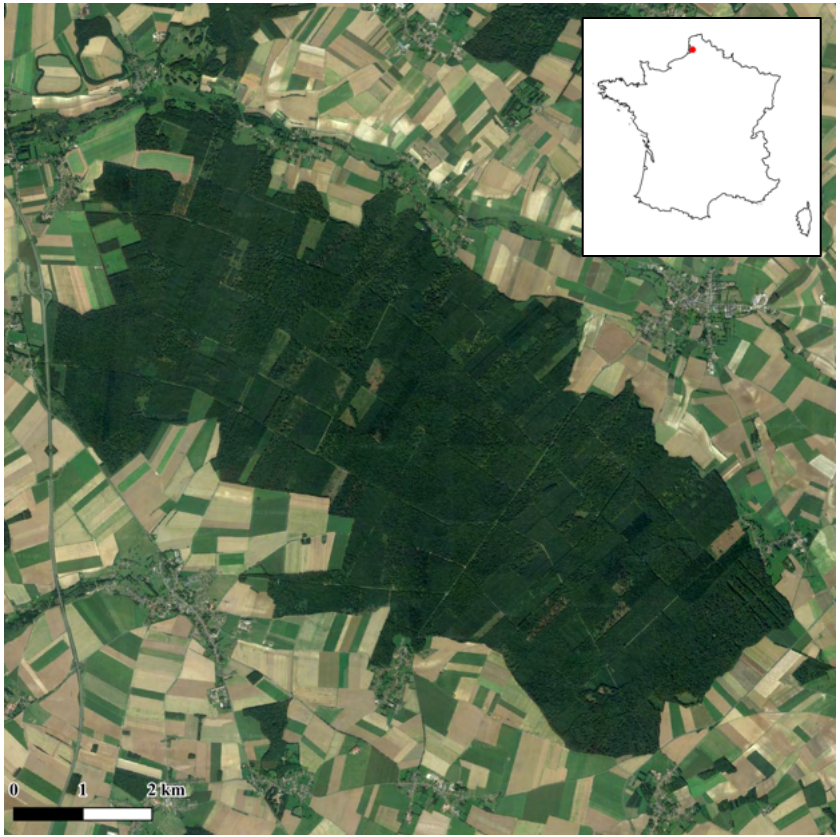
Cartes de hauteur

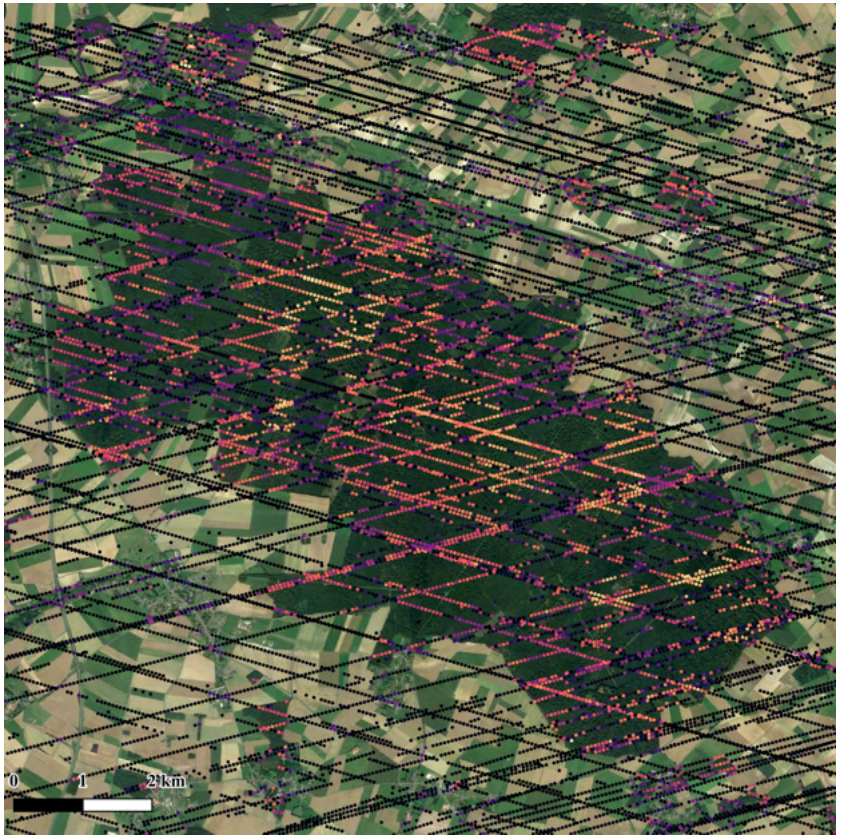




FORMS-T Carte de hauteur

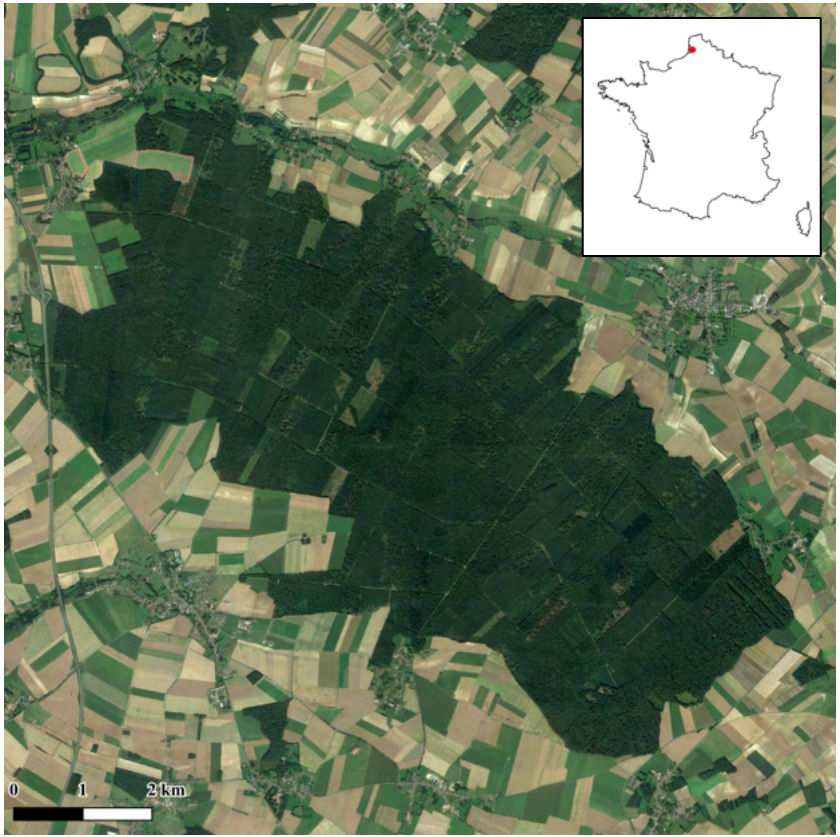
Google Maps, Forêt de Crécy (France)



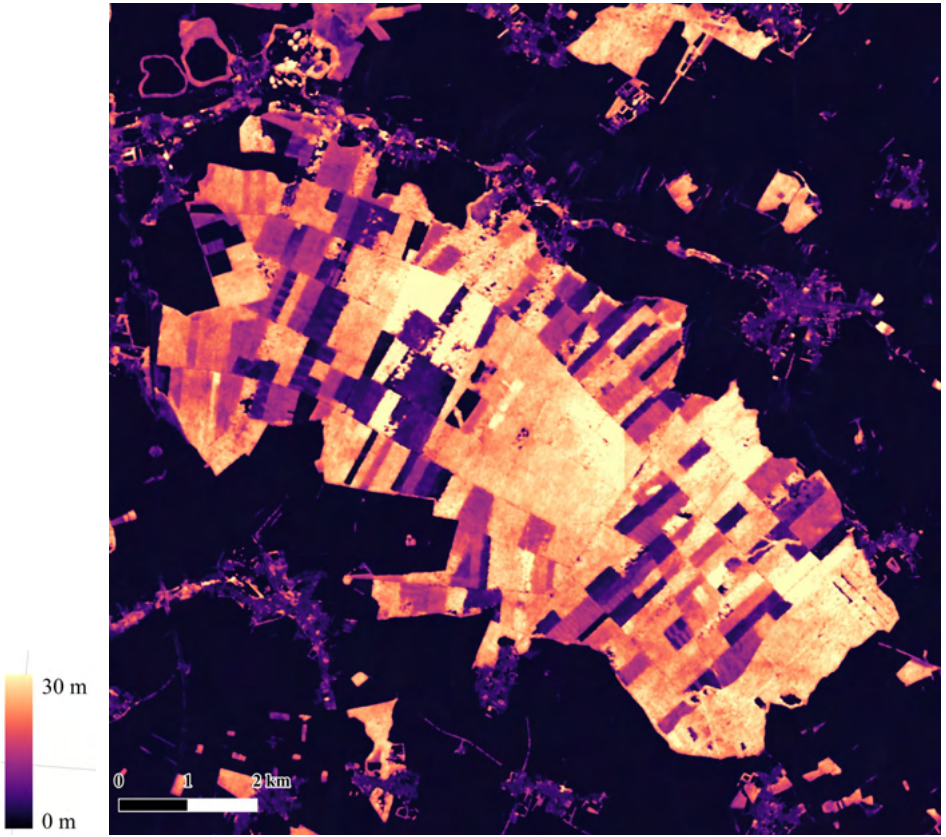


FORMS-T Carte de hauteur

Google Maps, Forêt de Crécy (France)

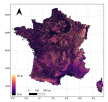


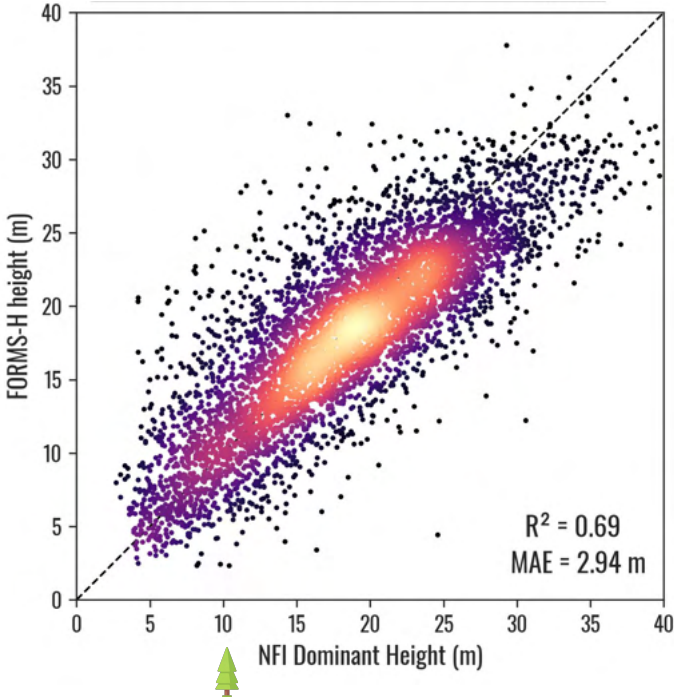
FORMS-T



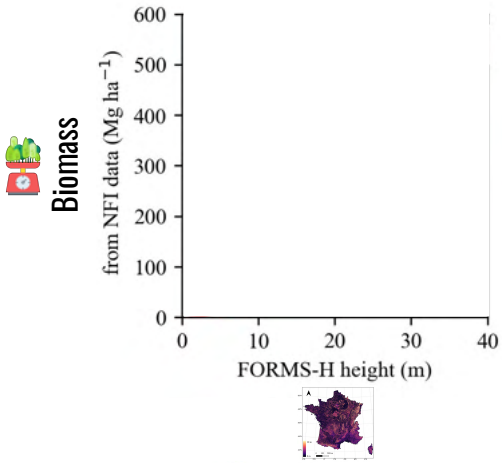
Validation avec un jeu de données indépendant

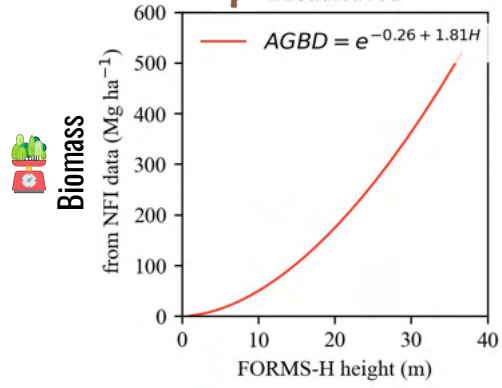
Comparaison avec des mesures de terrain (5 475 plots)
Inventaire forestier national 2020, IGN



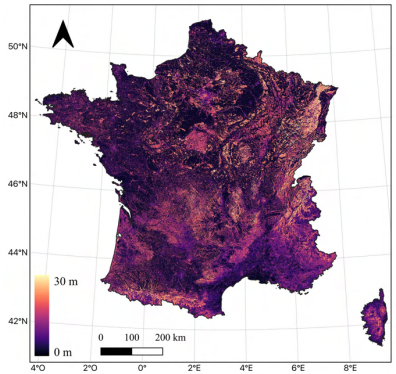


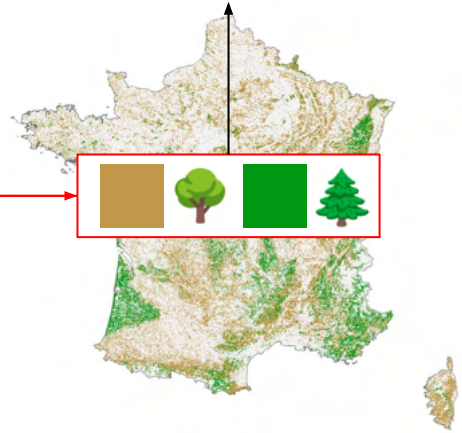
Passage à la biomasse





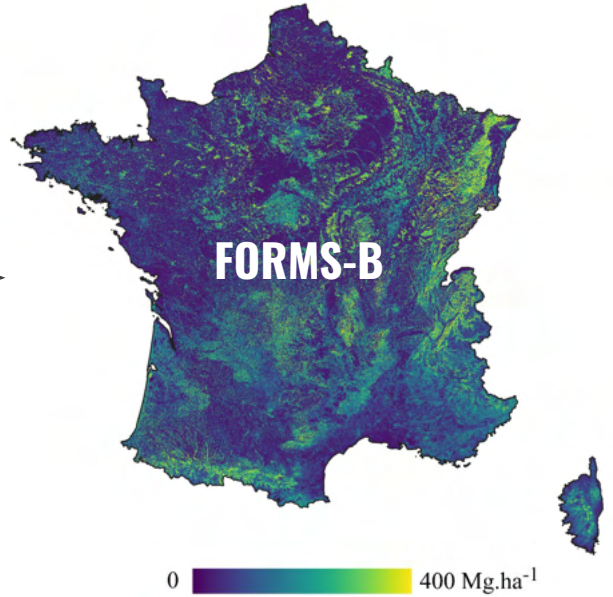
FORMS-H





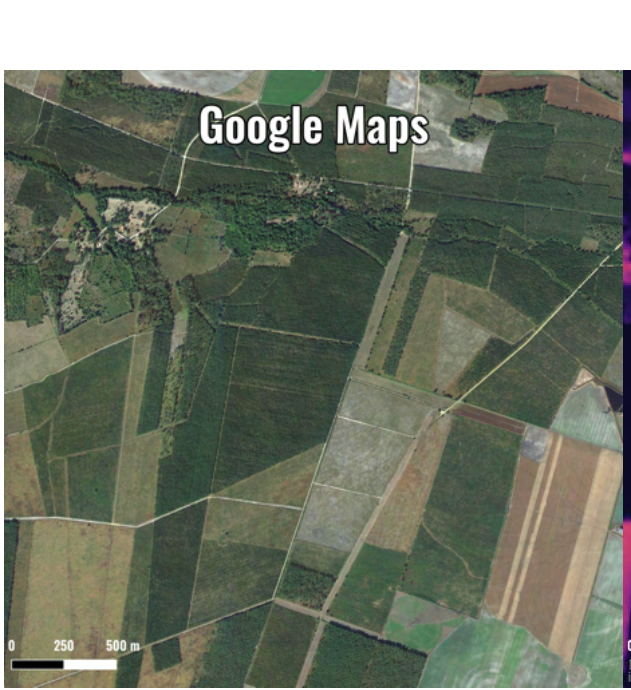
Copernicus Dominant Leaf Type Map

Biomass à 30 m de resolution



Schwartz et al. (2023, 2025)

Evolution temporelle

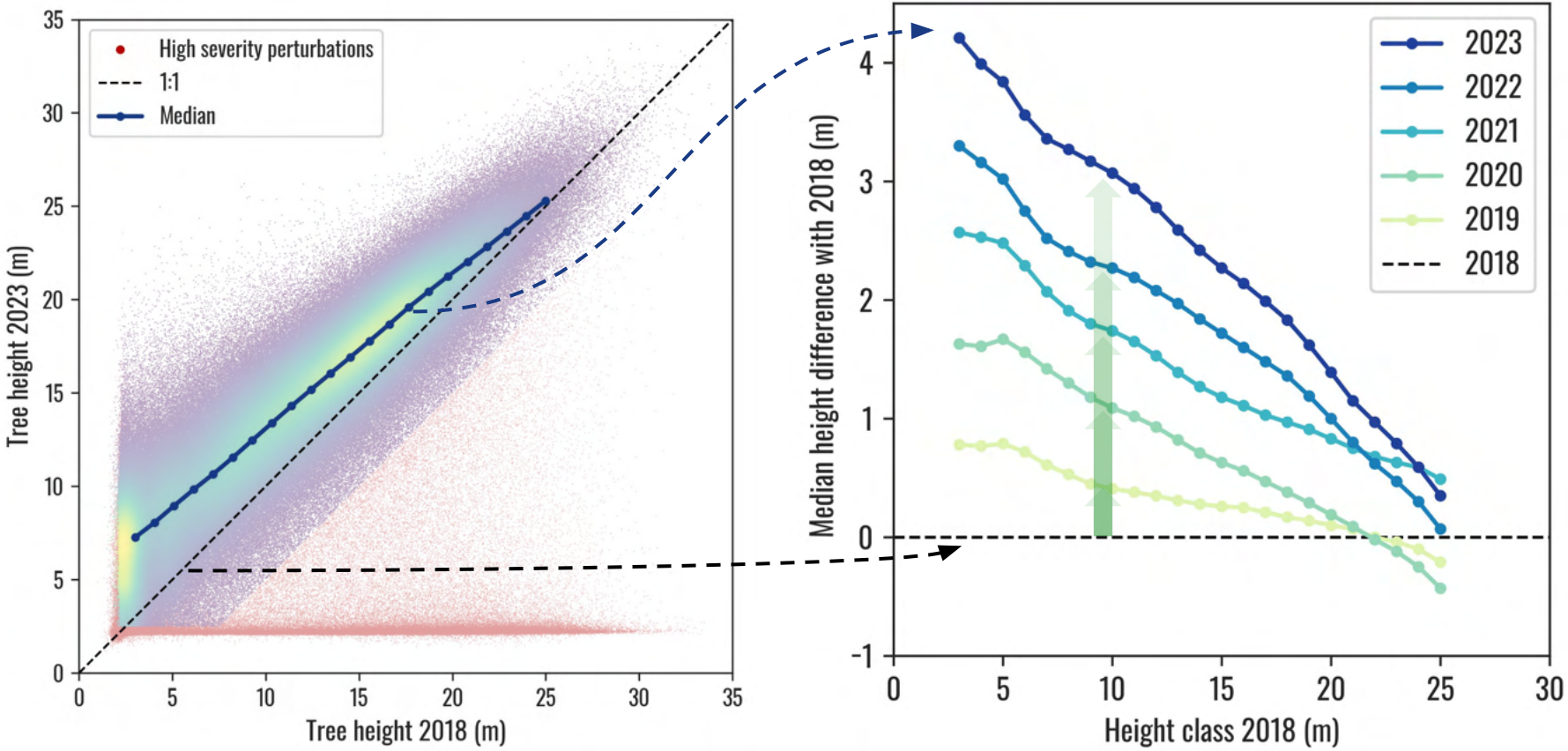


Plantations de pins maritimes (Landes)

Evolution de la hauteur 2018-2023

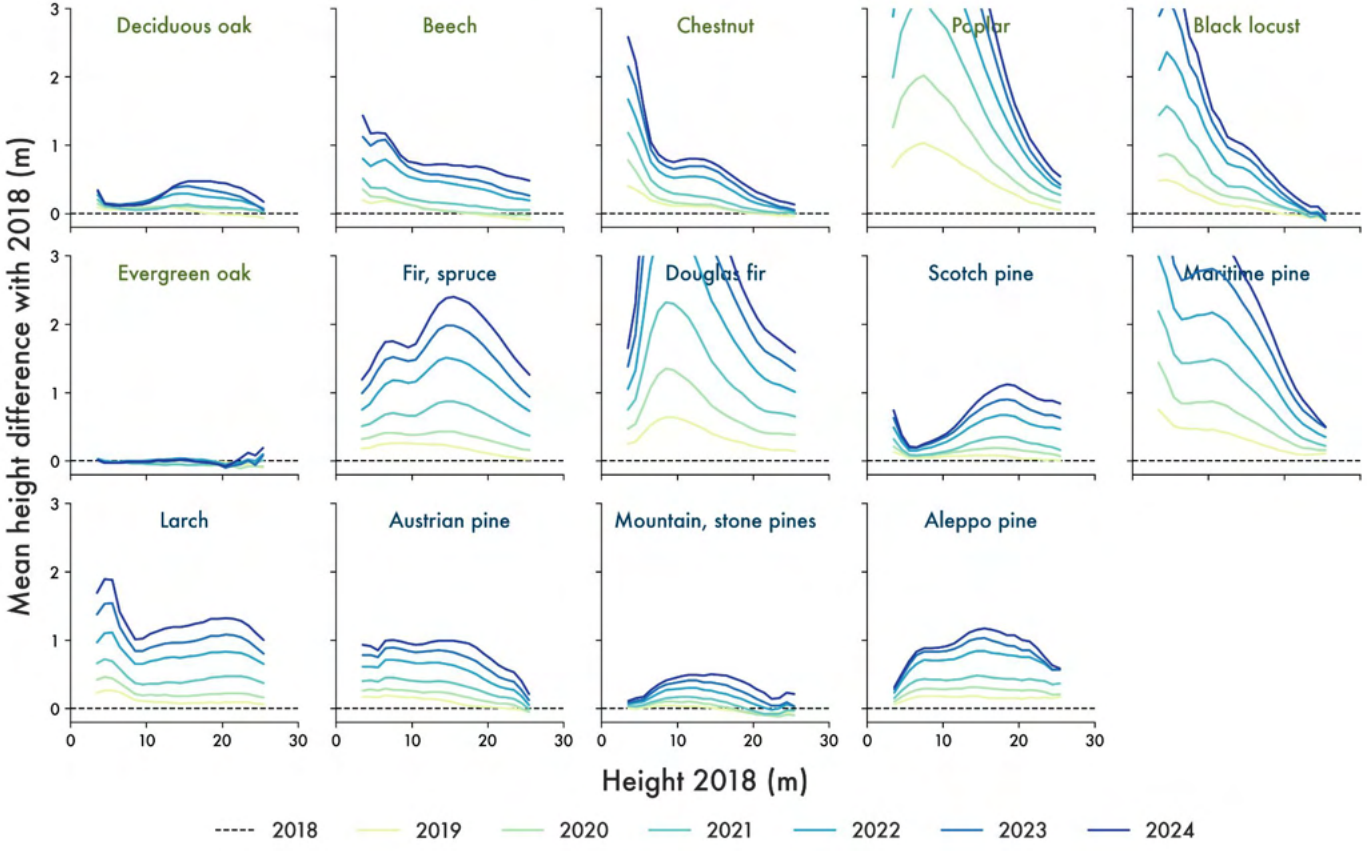
Difference 2018 - 2023

FORMS-T: Observer la croissance

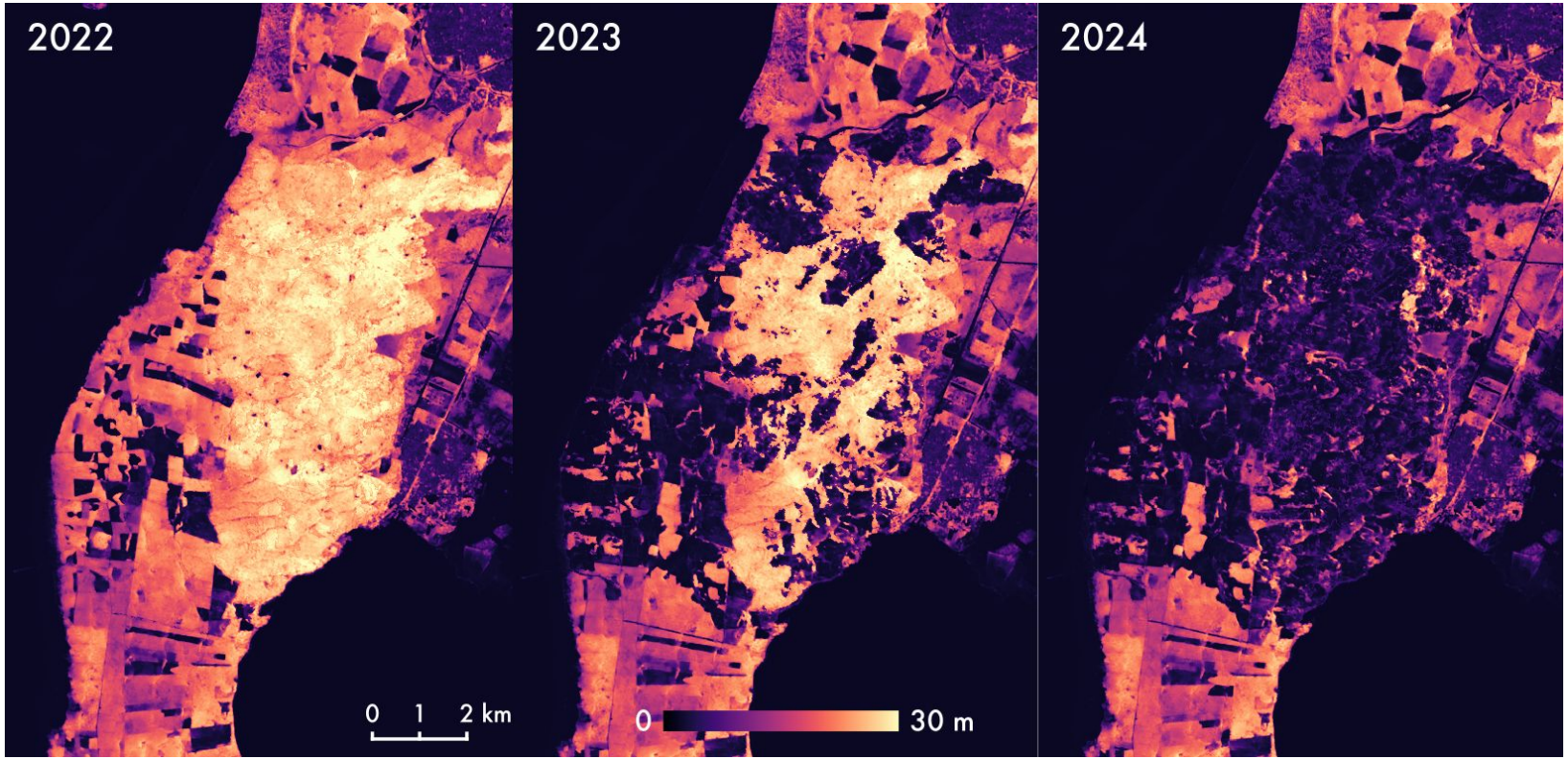


FORMS-T: Observer la croissance

Des dynamiques de croissance très différentes d'une espèce à l'autre, illustrant la **grande variabilité des stratégies de croissance et des pratiques de gestion**



Exemple: Après les incendies de 2022 dans les Landes



Forêt de la teste de Buch, Landes, France

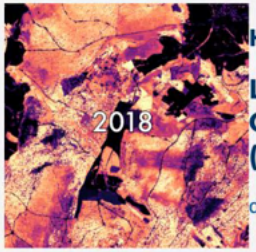
Données FORMSpoT: FORest Mapping with Spot Time-Series

https://doi.theia.data-terra.org/FORMSpoT/

Identifier DOI 10.71961/F879-K244

DataCite Metadata HTML, XML

License



How to cite :

LSCE. (2026): FORMSpoT : A Decade of Tree-Level, Country-Scale Forest Monitoring. Data Terra. (Collection)

doi:10.71961/F879-K244

RIS Citation | BibTeX Citation | Copy

Description

FORMSpoT provides annual forest canopy height maps at 1.5 m spatial resolution over metropolitan France for the period 2014–2024, derived from SPOT-6/7 satellite imagery.

FORMSpoT-Δ complements these maps with annual forest disturbance polygons, enabling tree-level monitoring of forest dynamics across the country.

The canopy height maps were generated using a hierarchical vision transformer model (PVTv2) trained on co-registered SPOT-6/7 imagery and Airborne Laser Scanning (ALS) reference data from the French LiDAR HD program. The resulting annual height time series was further processed to ensure temporal consistency before deriving disturbance polygons based on year-to-year height losses.

Input Data

Comment suivre les perturbations de forêts en Europe ?

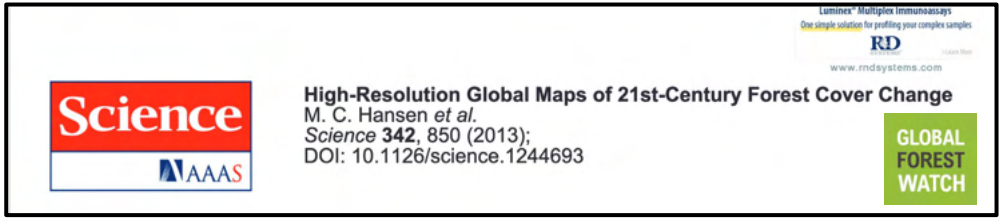
Avec Landsat 30 m. Perturbations >0.1 ha


Earth Syst. Sci. Data, 17, 2373–2404, 2025
https://doi.org/10.5194/essd-17-2373-2025

Earth System Science Data

The European Forest Disturbance Atlas: a forest disturbance monitoring system using the Landsat archive

Alba Viana-Soto and Cornelius Senf



Science
AAAS

High-Resolution Global Maps of 21st-Century Forest Cover Change
M. C. Hansen *et al.*
Science **342**, 850 (2013);
DOI: 10.1126/science.1244693

GLOBAL FOREST WATCH


nature sustainability

ANALYSIS

https://doi.org/10.1038/s41893-020-00609-y

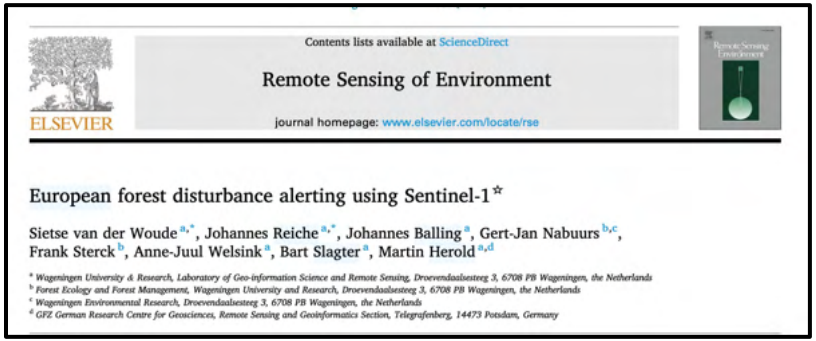
Check for updates

Mapping the forest disturbance regimes of Europe

Cornelius Senf [1,2] ✉ and Rupert Seidl [1,2,3]

Avec Sentinel-1, 10 m, Perturbations > 100m2 (en théorie)

→ **Beaucoup de petites perturbations manquantes**


Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

ELSEVIER

European forest disturbance alerting using Sentinel-1 ☆

Sietse van der Woude [a,*], Johannes Reiche [a,*], Johannes Balling [a], Gert-Jan Nabuurs [b,c], Frank Sterck [b], Anne-Juul Welsink [a], Bart Slagter [a], Martin Herold [a,d]

[a] Wageningen University & Research, Laboratory of Geo-information Science and Remote Sensing, Droevendaalsesteeg 3, 6708 PB Wageningen, the Netherlands
[b] Forest Ecology and Forest Management, Wageningen University and Research, Droevendaalsesteeg 3, 6708 PB Wageningen, the Netherlands
[c] Wageningen Environmental Research, Droevendaalsesteeg 3, 6708 PB Wageningen, the Netherlands
[d] GFZ German Research Centre for Geosciences, Remote Sensing and Geoinformatics Section, Telegrafenberg, 14473 Potsdam, Germany

France: Opportunité d'aller au dela de cette limite

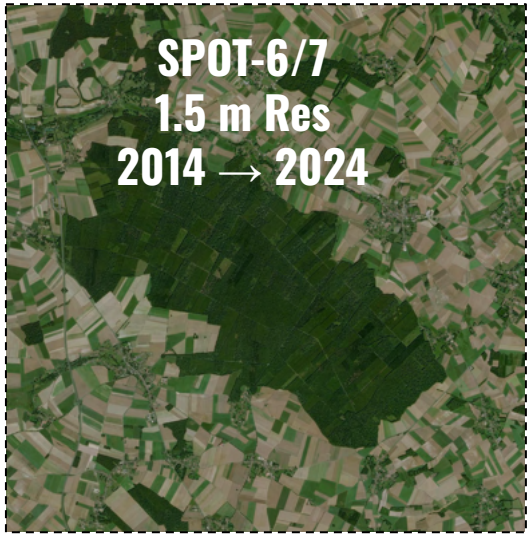
- Mosaiques SPOT-6/7 annuelles 2014 → 2025 à 1.5 m resolution

- LiDAR HD sur tout le territoire

→ Creer des cartes de hauteur annuelles
→ En déduire des polygones de perturbations
→ Observer les petites perturbations manquées à plus basse résolution

FORMSpoT

Image satellites



Modèle de deep learning

PVTv2 (hierarchical vision transformer)

Co-registration débruitage temporel

Serie temporelle de hauteurs

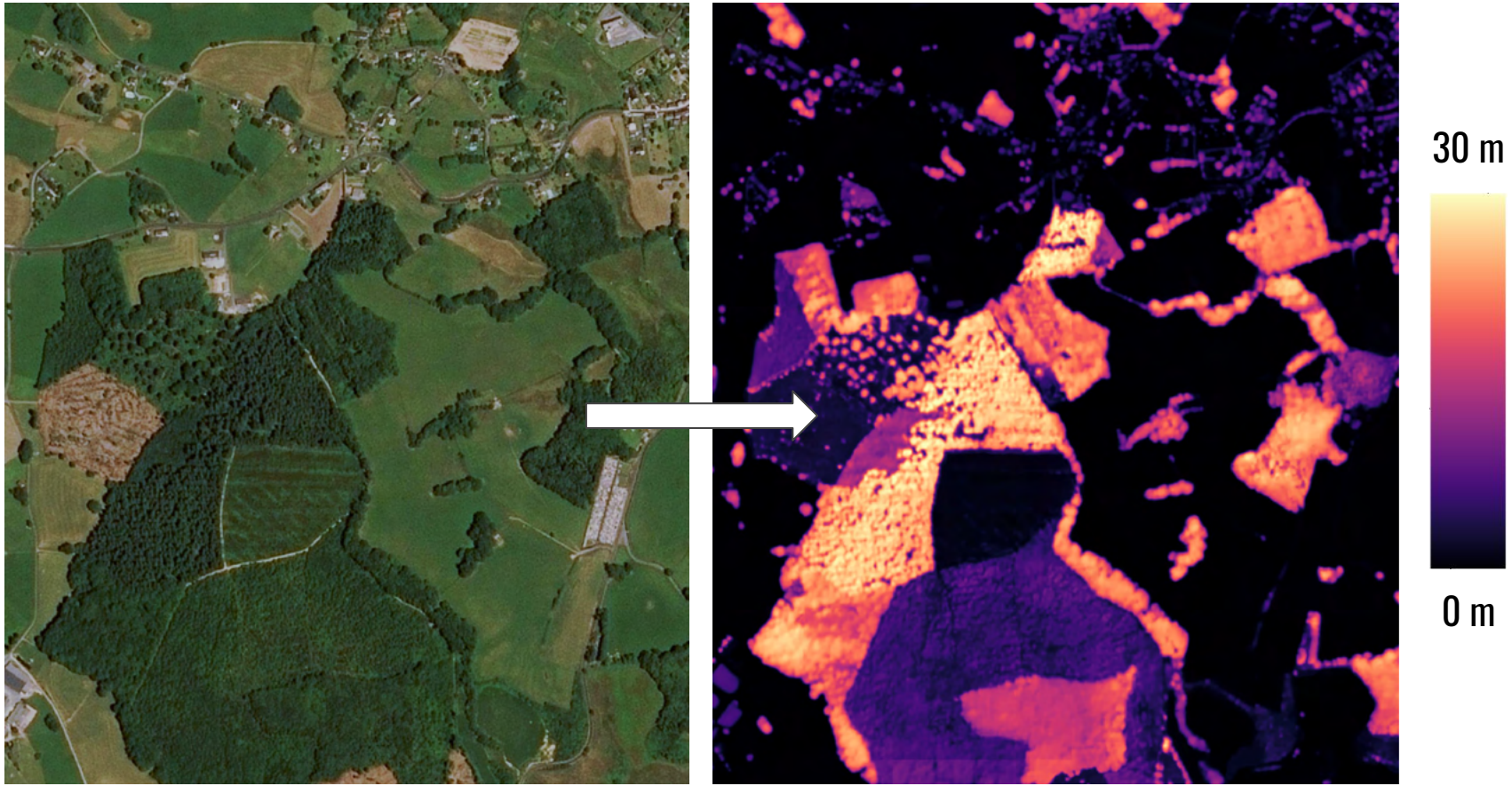
Perturbations forestières

Données de hauteur

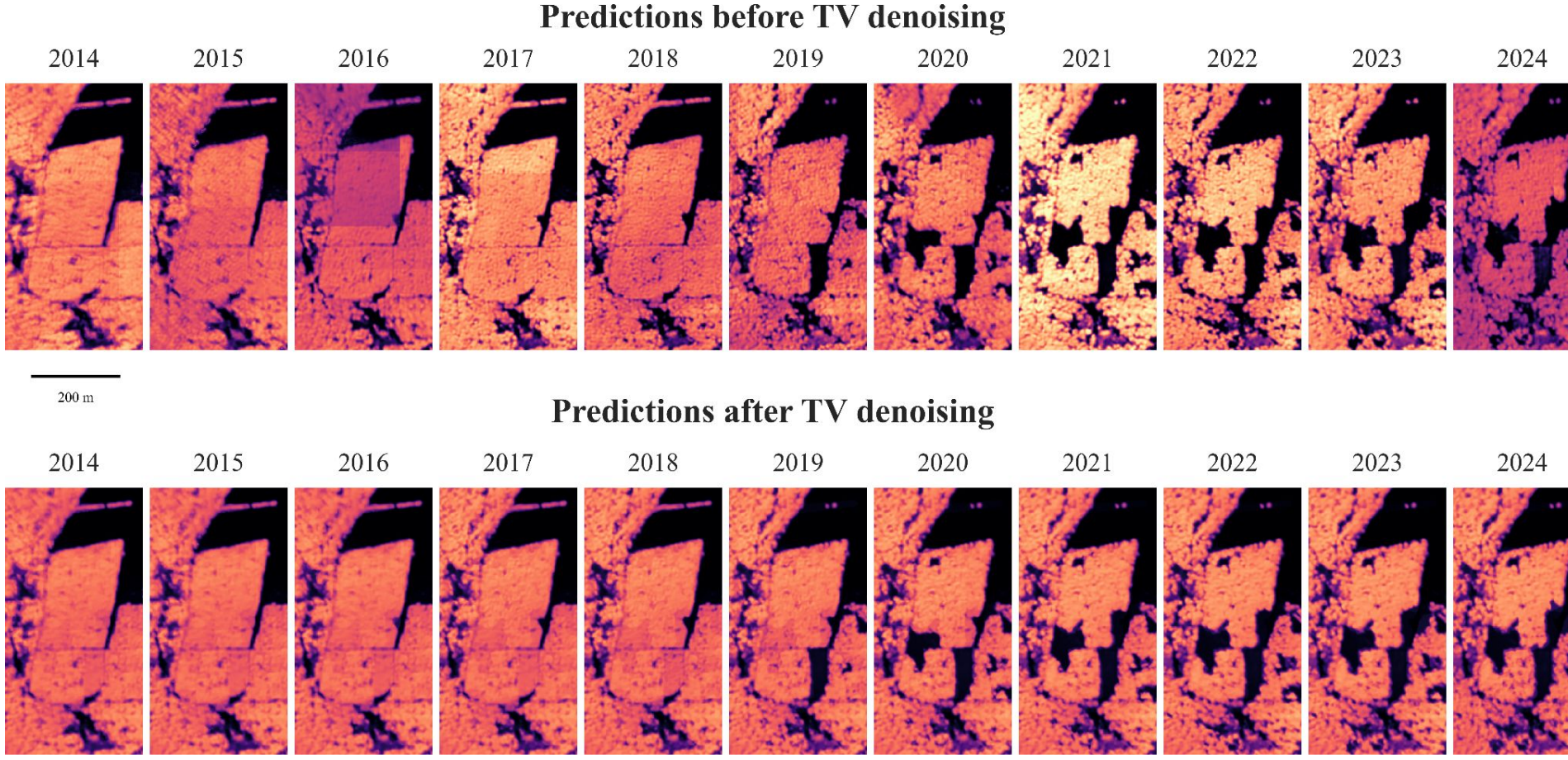
Lidar HD

Hauteur à très haute résolution venant d'acquisition LIDAR aériennes ✈️

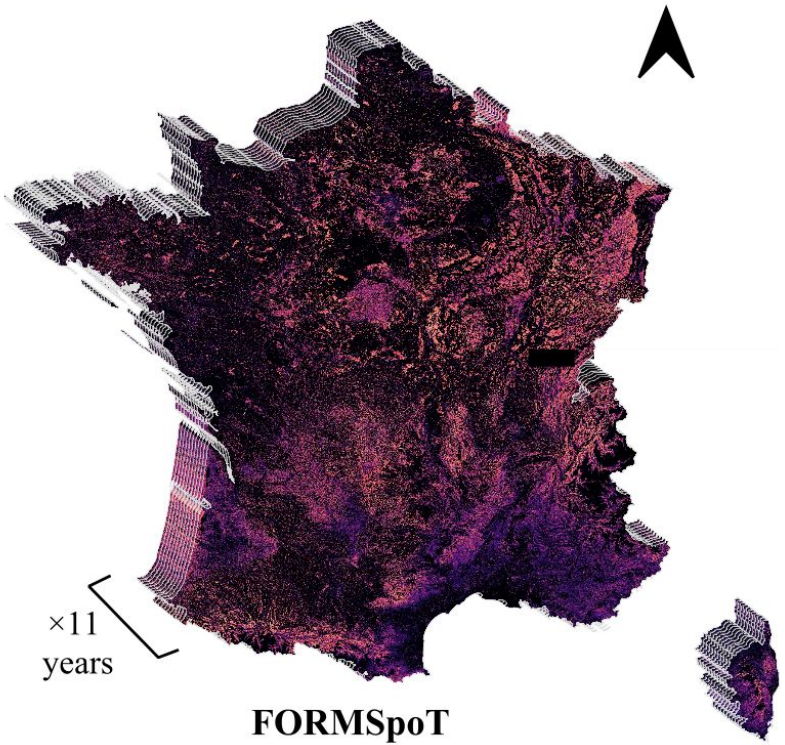
FORMSpoT

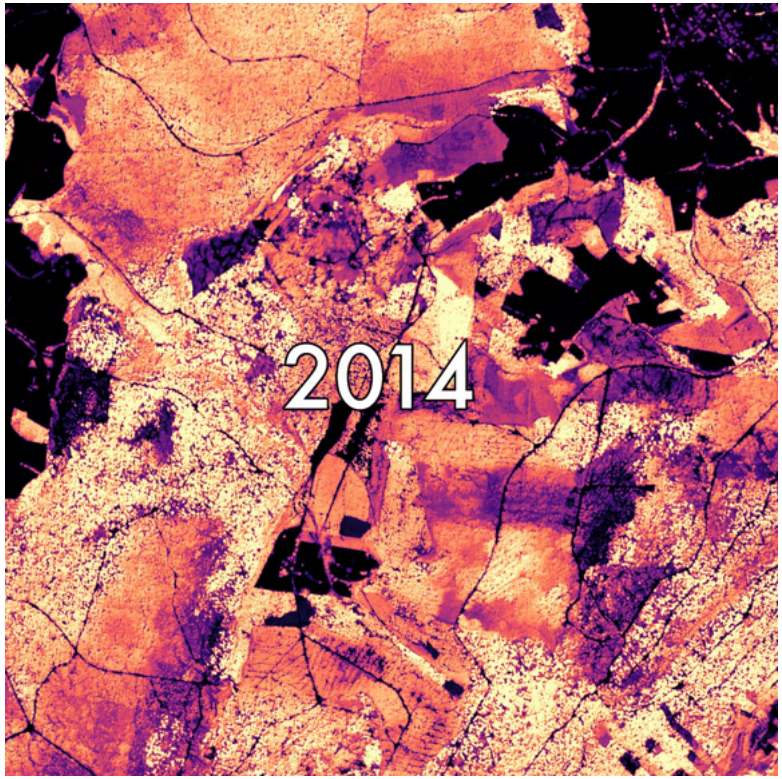


Débruitage temporel



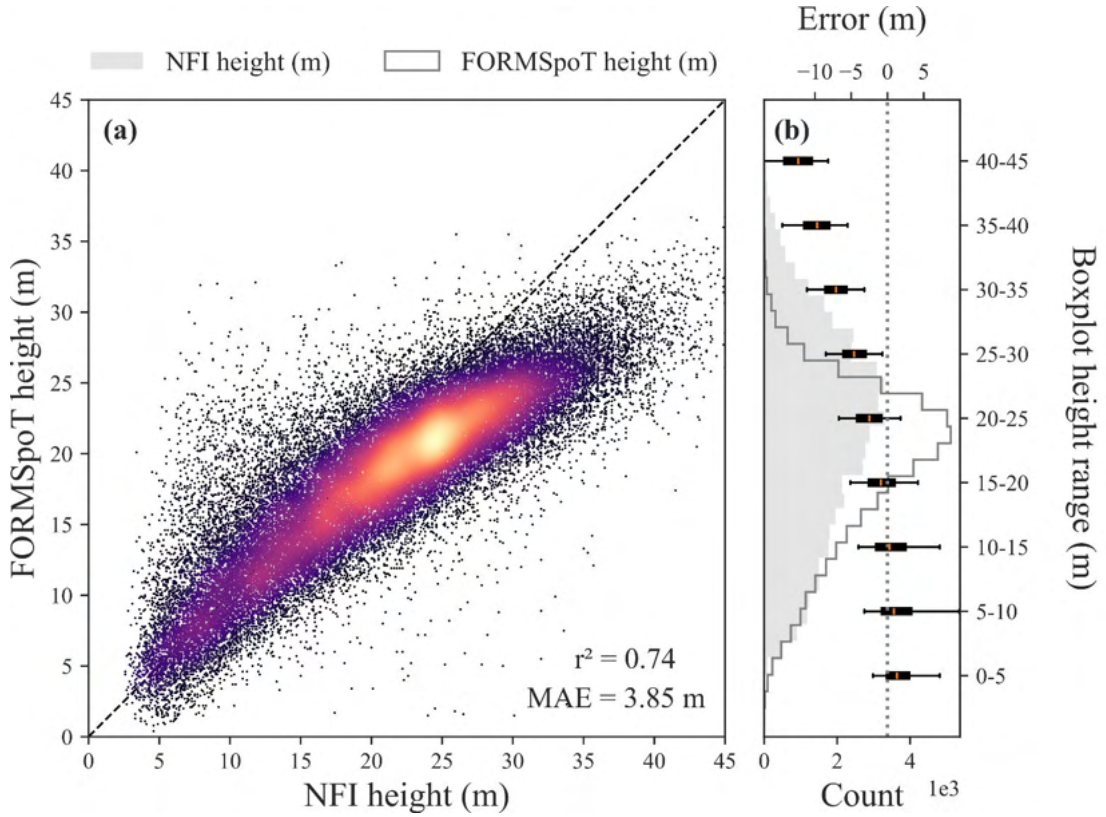
FORMSpoT Serie temporelle de hauteur 2014-2024 à 1.5 m de resolution





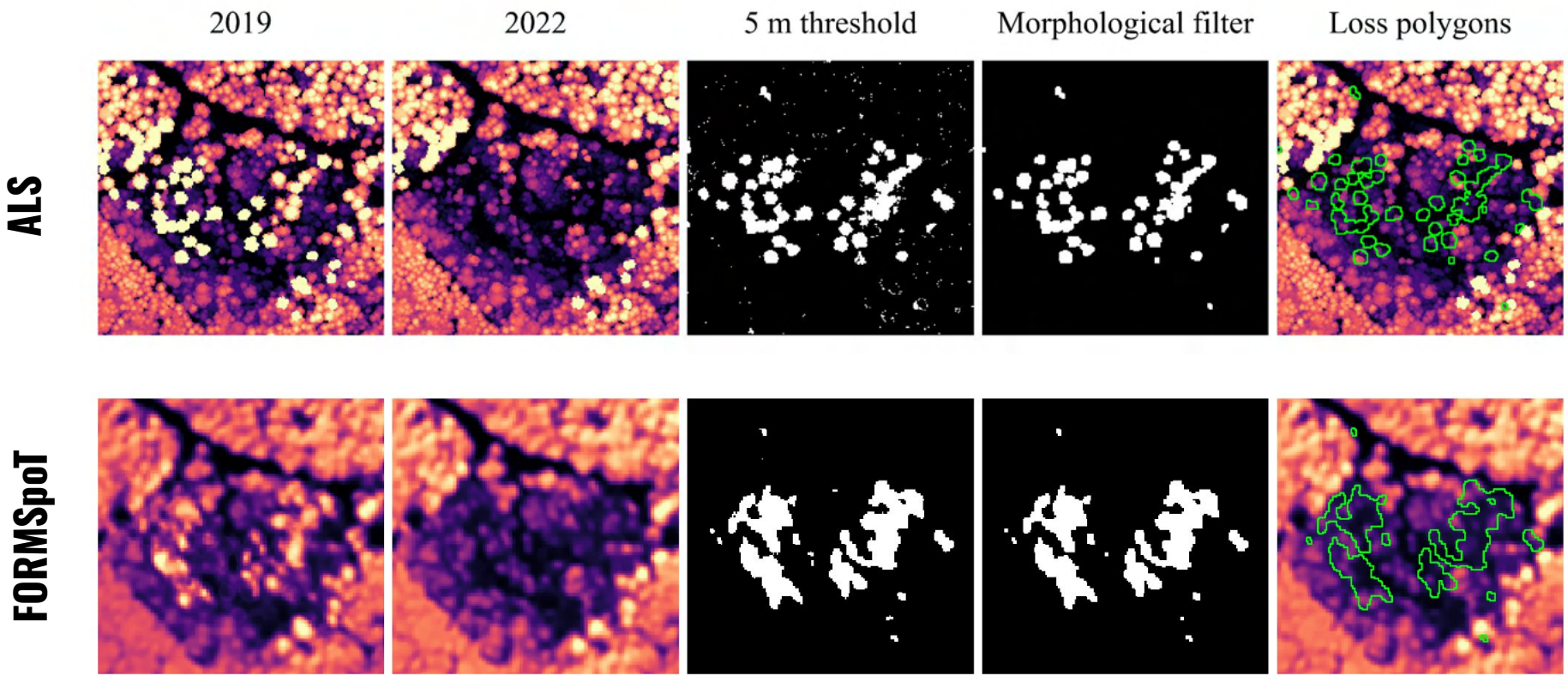
Forest height

FORMSpoT: Validation avec l'inventaire forestier

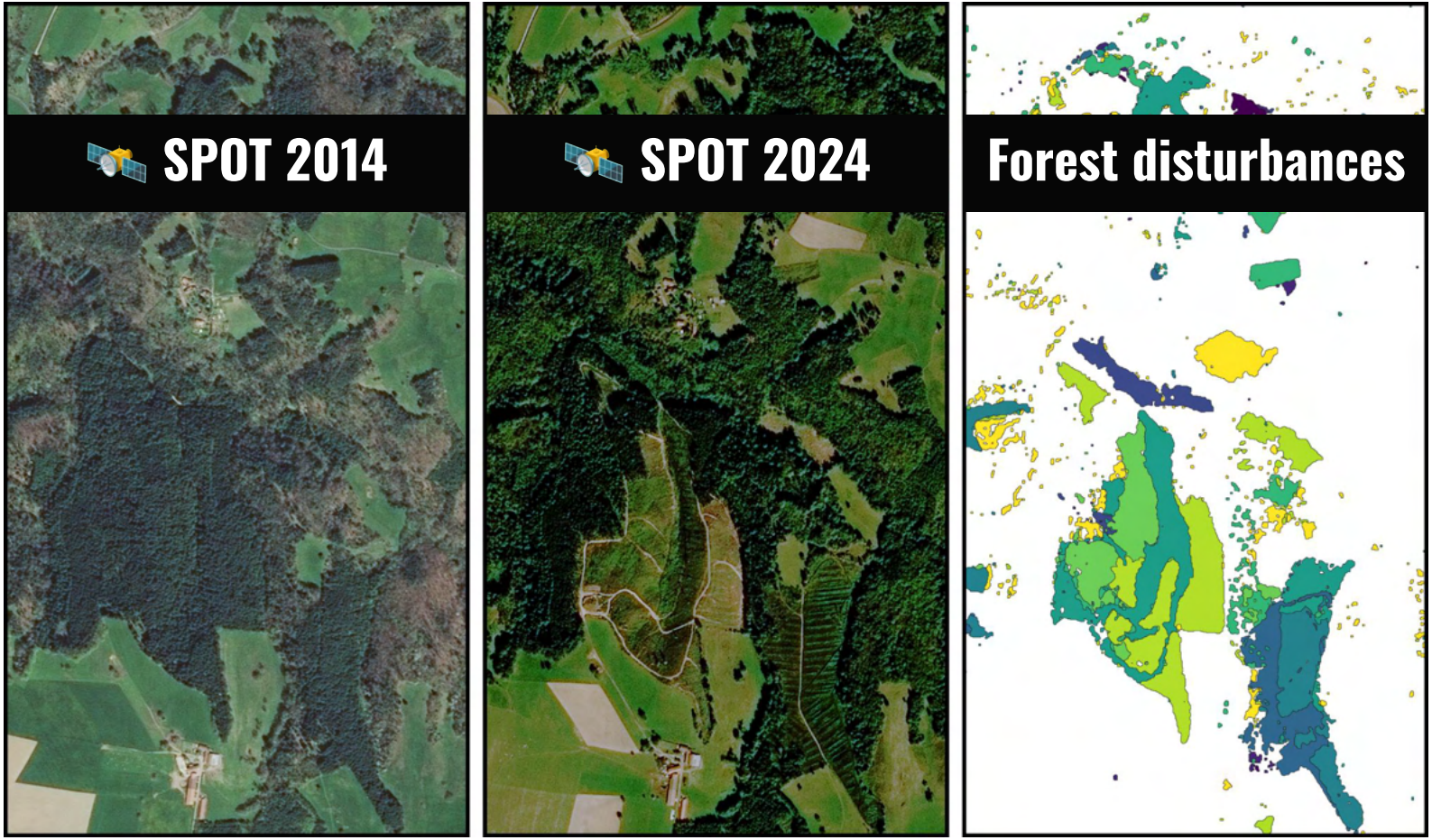


(c)	MAE (m)	r²
2014	3.71	0.7
2015	3.77	0.73
2016	3.84	0.73
2017	3.89	0.75
2018	3.88	0.75
2019	3.81	0.75
2020	3.8	0.76
2021	3.83	0.74
2022	3.87	0.76
2023	3.99	0.74
2024	3.98	0.73
SD	0.08	0.02

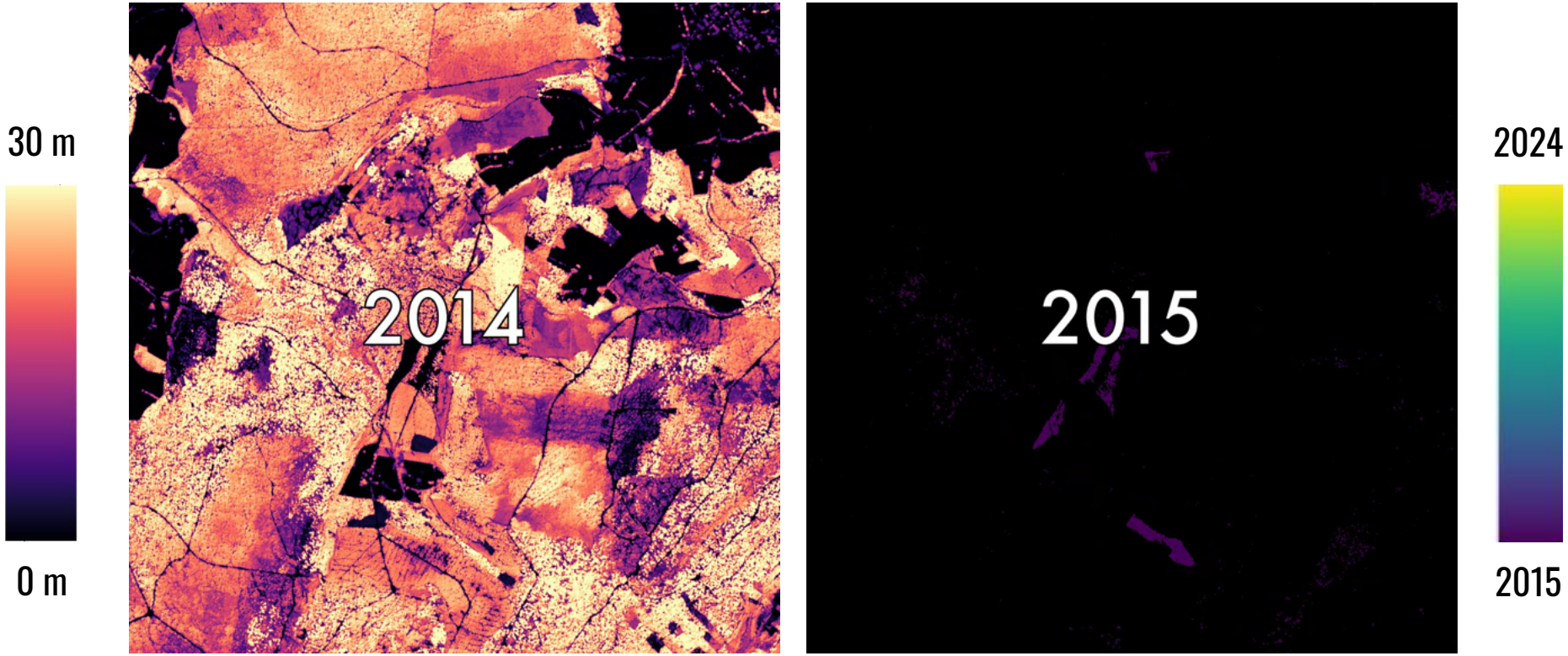
FORMSpoT : Calcul des perturbations forestières pour obtenir FORMSpoT-Δ



FORMSpoT Exemple visuel



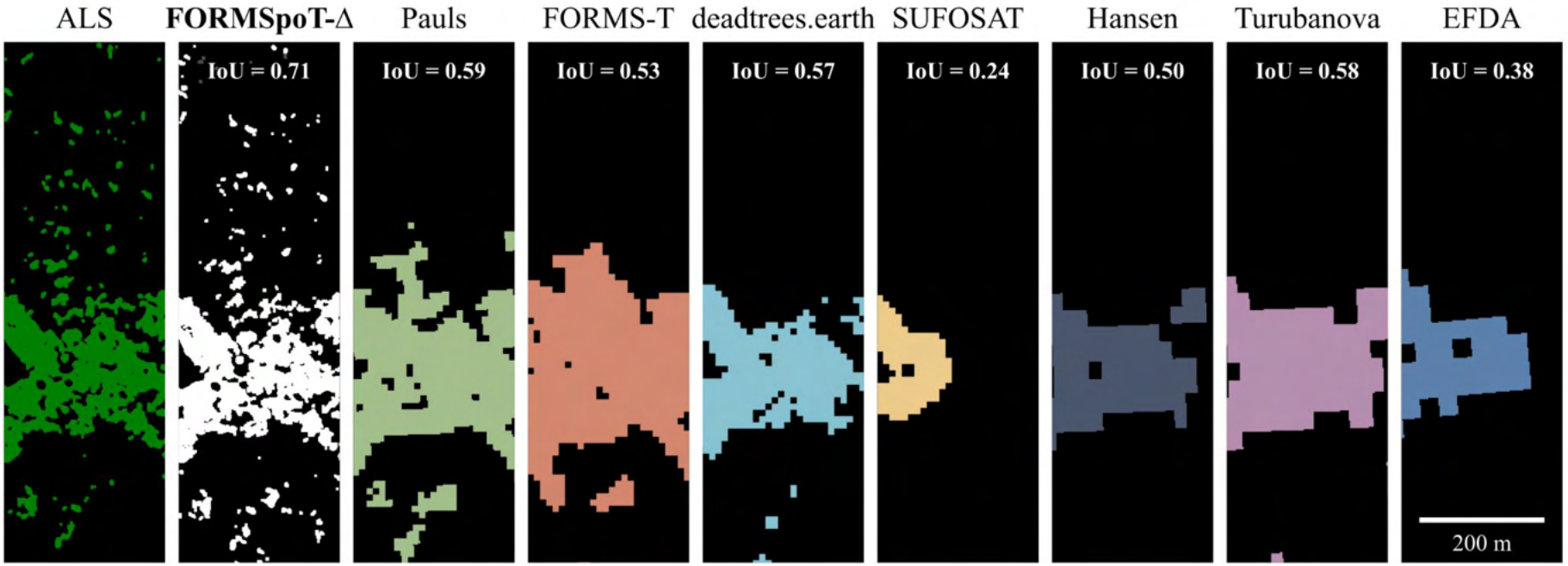
FORMSpoT et FORMSpoT-Δ



Hauteur **Perturbations**

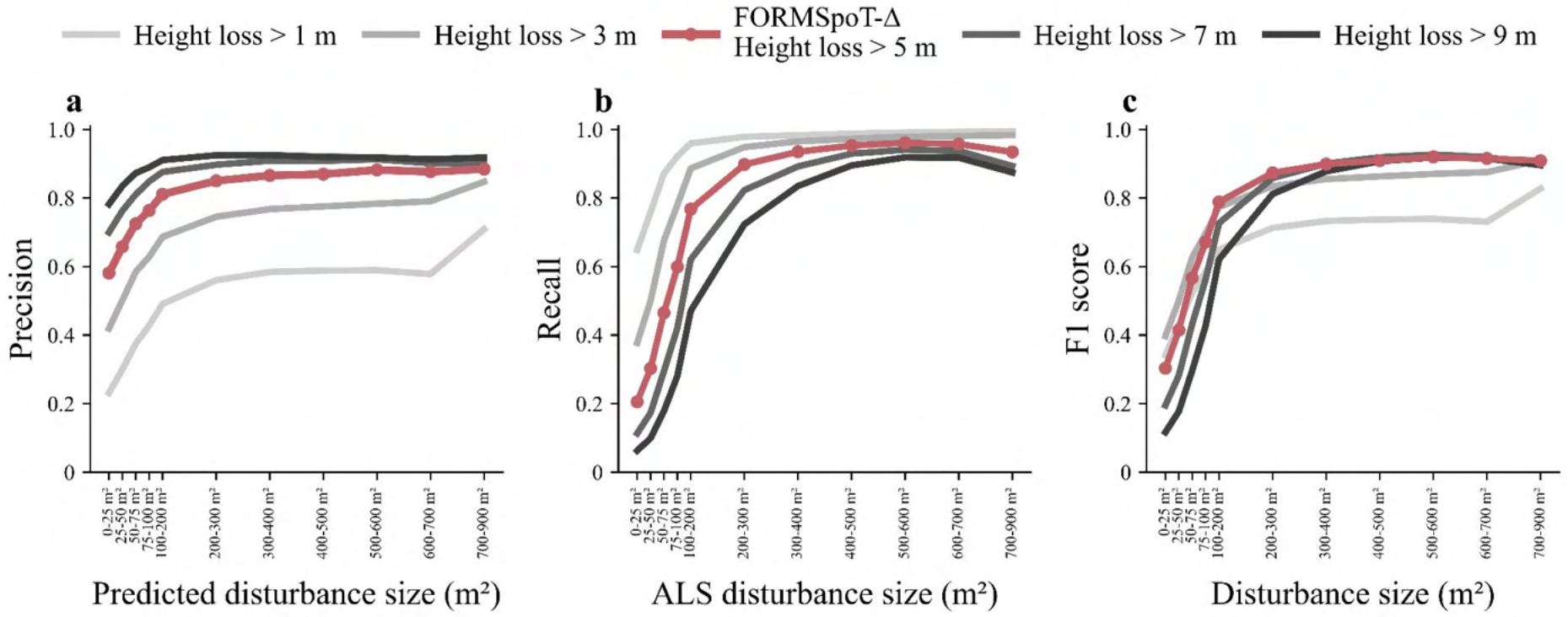
Schwartz et al. (2026)

FORMSpoT-Δ : Comparaison avec d'autres produits

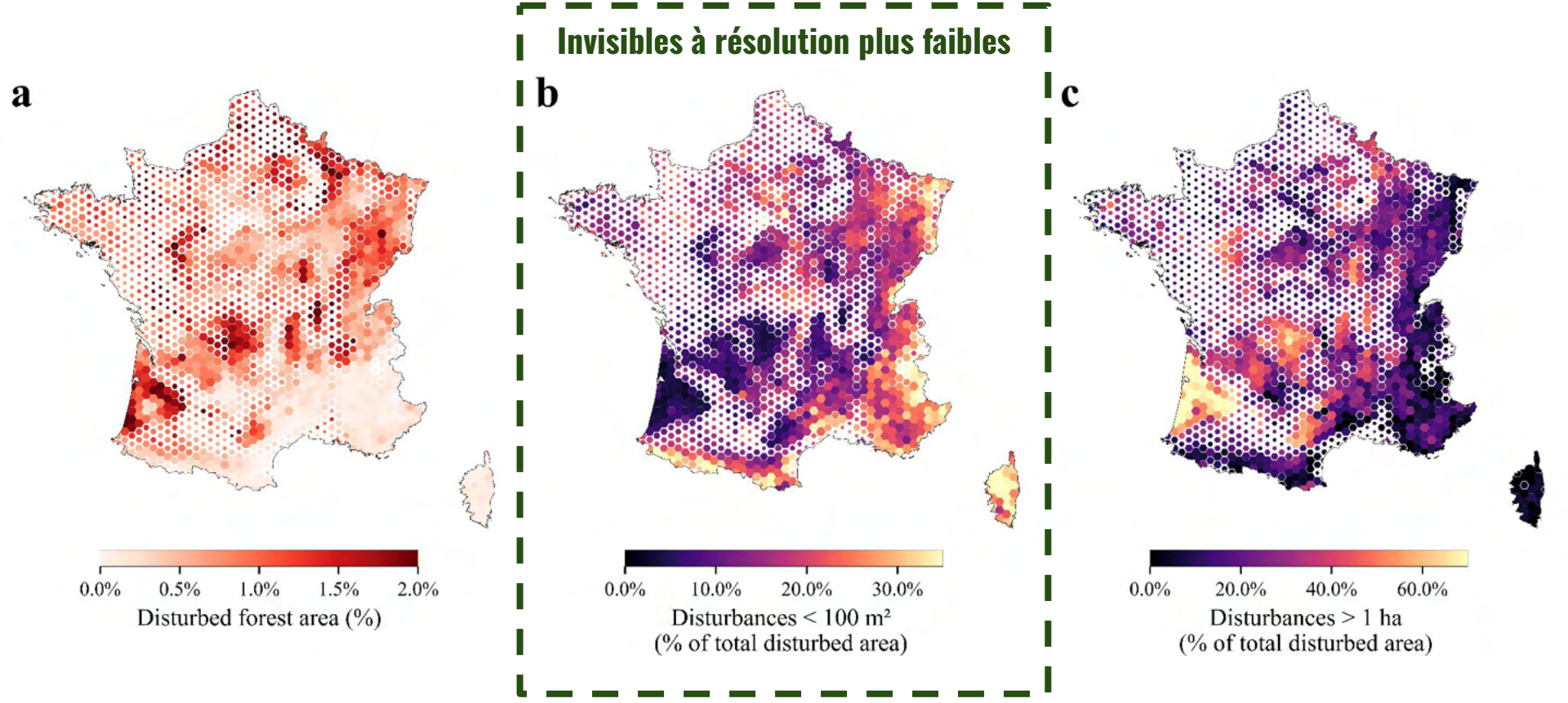


La joux, La Fresse (Jura, France)

FORMSpoT-Δ : Validation de la détection de perturbations



Régimes des perturbations en France



Merci pour votre attention

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