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## Integrating GEDI and Landsat for the analysis of forest disturbances and biomass changes in Italy

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Provide answers to how deforestation has contributed to atmospheric CO2 concentrations





#### Climate change and forest disturbance



#### **Remote Sensing**

Global **Ecosystem Dynamics** Investigation

AboveGround Biomass Density - Level 4 18 April 2019 to 02 September 2020

# Aim of the work

To assess GEDI AGBD data across Italy and its use to study the rate of biomass increase following forest disturbances

## Workflow

Comparison of about four million AGBD data from GEDI pulses with ALS data available across Italy Mapping forest disturbances in Italy between 1985 and 2019 using Landsat imagery and 3I3D Analysis of about one million AGBD GEDI pulses for all years following predicted disturbances



A focus on coppice forest clearcuts was performed using a reference dataset of 10K ha forest harvestings created in Tuscany between 1999 and 2016

## Matherials



Use:

following harvesting

#### 1) ALS data

harmonizing data from **29 flight campaigns** carried out in the period 2004–2017, mainly between the years 2008 and 2011

#### → **Google Earth Engine**

#### Cloud-free composites 1985-2019

35 forest disturbance maps with a spatial resolution of 30 m

• study the rate of biomass increase

• estimate 3I3D performance in predicting forest harvesting

#### 4) GEDI Level 4A data



ECOSYSTEM LIDAR Predicts -in tons per ha- the AGBD for each sampled geolocated laser pulse

## Methods

## **Aboveground Biomass Density & Canopy Height** Analysis

The correlation between AGBD and CHM was assessed using all GEDI pulses acquired in IT where ALS were available (over 3mln pulses)

#### Data aggregation was needed:



CHM and AGBD ordered by CHM value and aggregated by averaging into groups of 25 Coefficient of determination (r2) between aggregated AGBD and CHM Analysis at National and Regional levels (NUTS 1 & 2)

### **Aboveground Biomass Density to Year Since Last** Disturbance

Comparison between AGBD and YSLD using: • 3I3D predicted disturbances (1985-2019)

#### YSLD = 0

if GEDI pulse 2019 & forest disturbance 2019 YSLD = 35

if GEDI pulse 2020 & forest disturbance 1985

• reference dataset of **clearcuts** in Tuscany (1999-2016)

YSLD = 3

if GEDI pulse 2019 & forest disturbance 2016 YSLD = 21

if GEDI pulse 2020 & forest disturbance 1999

## Results



AGBD of GEDI pulses acquired over Italian forests.

- Over 6mln GEDI pulses over IT (2019-20); over 5mln on forest.
- 48% of GEDI pulses over forest areas also covered by ALS data

Left—scatter plot of aggregated AGBD and CHM with the blue line showing the linear correlation. Right—a map indicating the different correlations for each Italian region



48% of GEDI pulses on forests covered by ALS data

Consistent relationship between AGBD and the CHM (r2 0.75)

3mln ha of forest disturbance in IT during 1985-2019 1,080,483 GEDI pulses acquired over mapped forest disturbances

AGBD in the reference forest harvestings increase more rapidly than in predicted forest disturbance

**Omission errors: 29% (2012) - 65% (2001);** Commission errors: 18% (2014) - 88% (2003)



## Results

Median of AGBD values per YSLD in the reference dataset of forest harvestings (A) and all forest disturbances predicted across Italy (B). The black points show average values calculated using a moving window of 5 YSLD

# **Take-home** messages



GEDI provides data that may complement incomplete ALS datasets



Relevant data source for forest disturbance characterization



Forest monitoring programs must consider a more in-depth characterization of forest disturbance in terms of biomass

#### **GEDI AGBD advances the understanding** of forest biomass changes

#### AGBD product correctly captured the expected biomass increment due to post-disturbance forest recovery

#### Future research on using GEDI to **Statistically rigorously compare** biomass changes caused by different drivers of forest disturbance



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#### Integrating GEDI and Landsat: Spaceborne Lidar and Four Decades of Optical Imagery for the Analysis of Forest Disturbances and Biomass Changes in Italy

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