



Forest Carbon
Monitoring

Demonstration Products

User Workshop 1-2 March 2023

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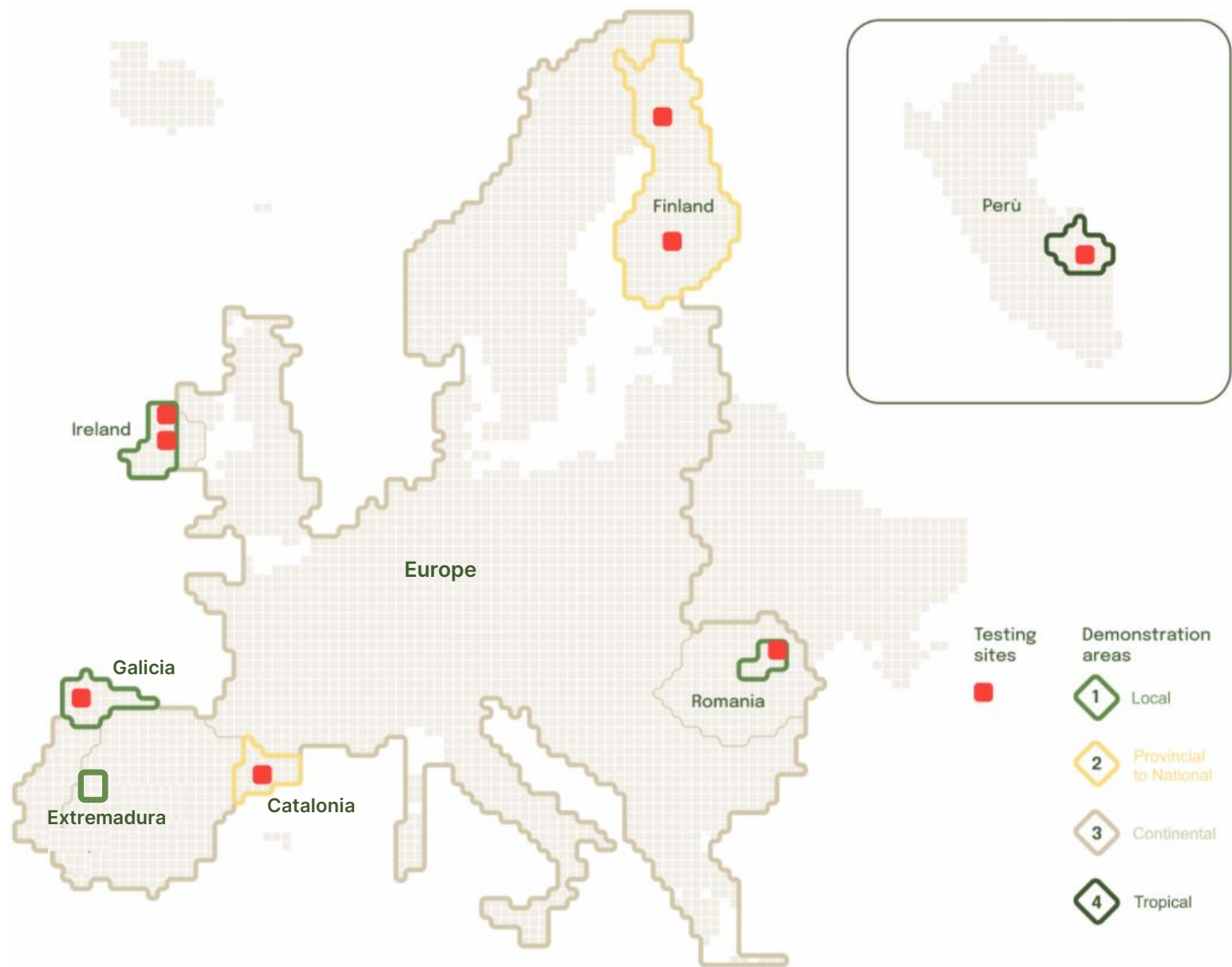


Demonstration sites

Demo area	Demo type	Method	Years
1. Finland	National	MS-NFI+ PREBAS	2017 + 2019
2. Ireland	Company 8 tiles	Probability+ PREBAS	2019 + 2020 +2021
3. Romania	Company 3 tiles	kNN + PREBAS	2019 + 2020 +2021
4. Catalonia	Regional 8 tiles	kNN + PREBAS	2019 + 2020
5. Galicia	Company 5 tiles	Probability+ PREBAS	2019 + 2020 +2021
6. Extremadura	Provincial 1 tile	Probability+ PREBAS	2017 + 2022
7. Peru	Provincial 16 tiles	Probability+ PREBAS	2020 + 2021
8. Europe	Continental 746 tiles	BIOMASAR	2020 + 2021

EO data:

- Peru Sentinel-2 + PALSAR-2 (mosaic)
- Europe Sentinel-1 + PALSAR2-2 (mosaic)
- All others Sentinel-2 + Sentinel-1



Demonstration products

Forest structure variable products (10 m spatial resolution)

Stem density

Height

Diameter

Basal area

Growing stock volume

Species proportions

Site type

Biomass and growth products (10-100 m spatial resolution)

Above ground biomass

Below ground biomass

Stem volume increment

Change products (10 m spatial resolution)

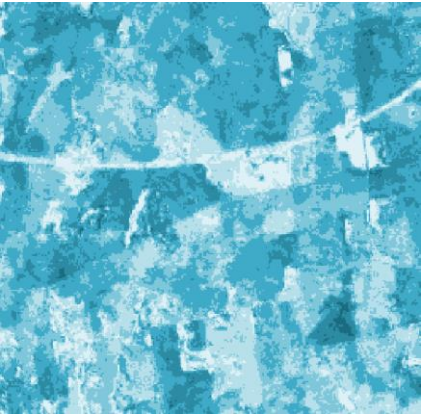
Change magnitude

Change type

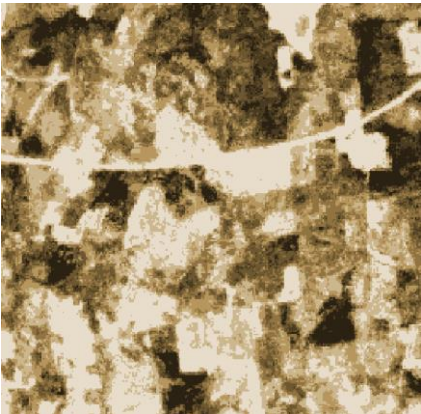
Biomass decrease mask



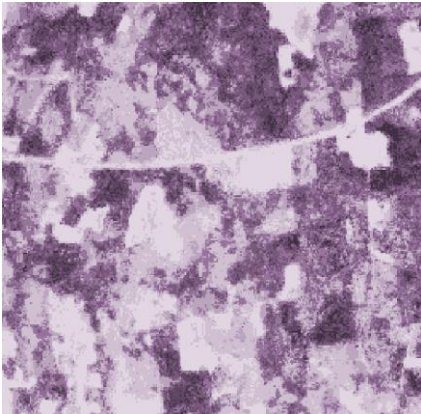
Sentinel-2



Height



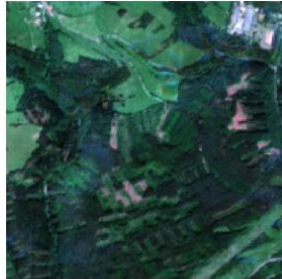
Growing Stock Volume



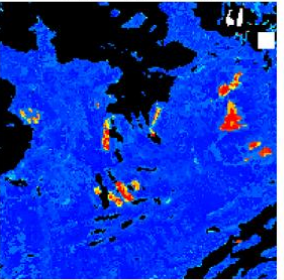
Below Ground Biomass



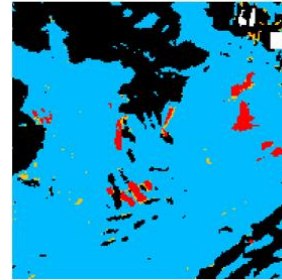
Sentinel-2 2020



Sentinel-2 2021



Change magnitude
0 300-



Biomass decrease mask
No data Non-forest Forest no change Partial clearance Total clearance

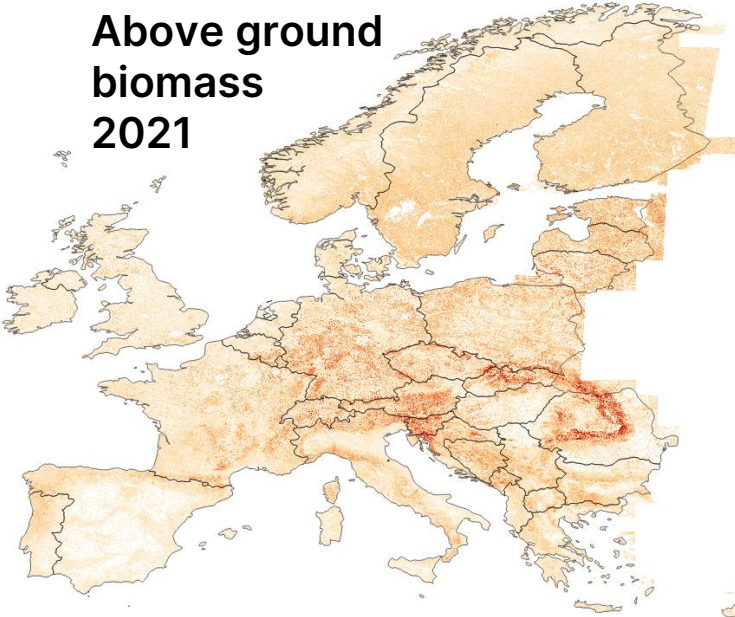
Demonstration products delivered

- Altogether 79 different demo products covering the users' interest areas were delivered

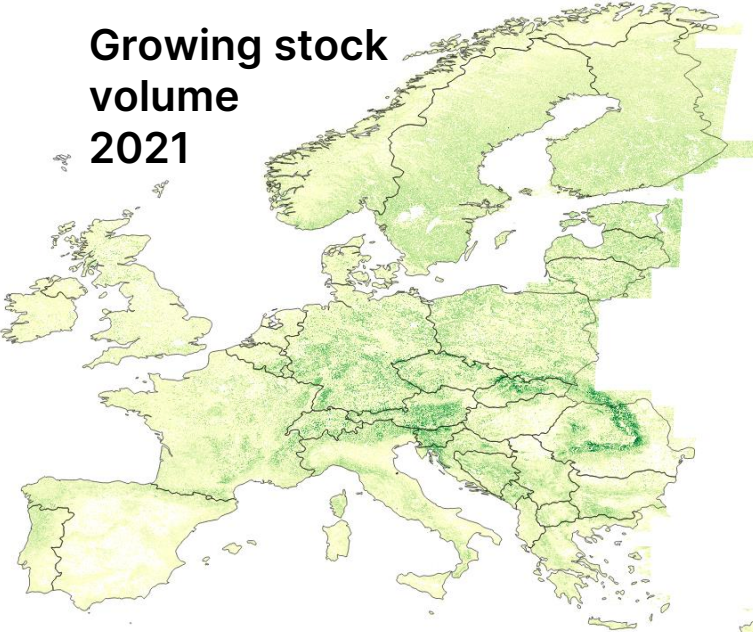
Demo area (N of products)	Forest structure									Biomass and growth			Change		
	Stem density	Basal area	Diameter	Height	Volume	Individual species %	Conifer %	Broad-leaf %	Site type	Above ground biomass	Below ground biomass	Stem volume incr.	Change magnitude	Change type	Biomass decrease mask
1. Finland (3)										X	X	X			
2. Ireland (15)	X	X	X	X	X	X		X		X	X	X	X	X	X
3. Romania (13)		X	X	X	X		X	X	X	X	X	X	X	X	X
4. Catalonia (12)		X	X	X	X		X	X		X	X	X	X	X	X
5. Galicia (10)		X	X	X	X					X	X	X	X	X	X
6. Extremadura (9)		X	X	X	X					X	X		X	X	X
7. Peru (8)		X	X	X	X					X			X	X	X
8. Europe (9)					X					X	X		X	X	X

Examples of products - European wide mapping (I)

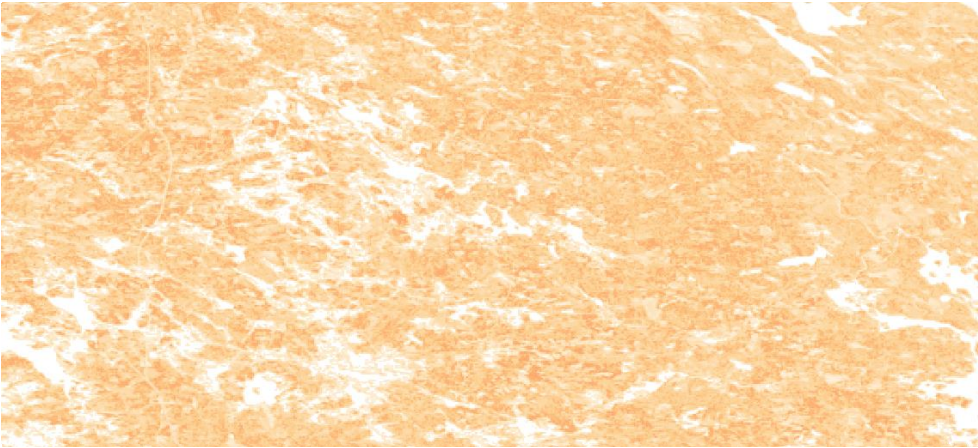
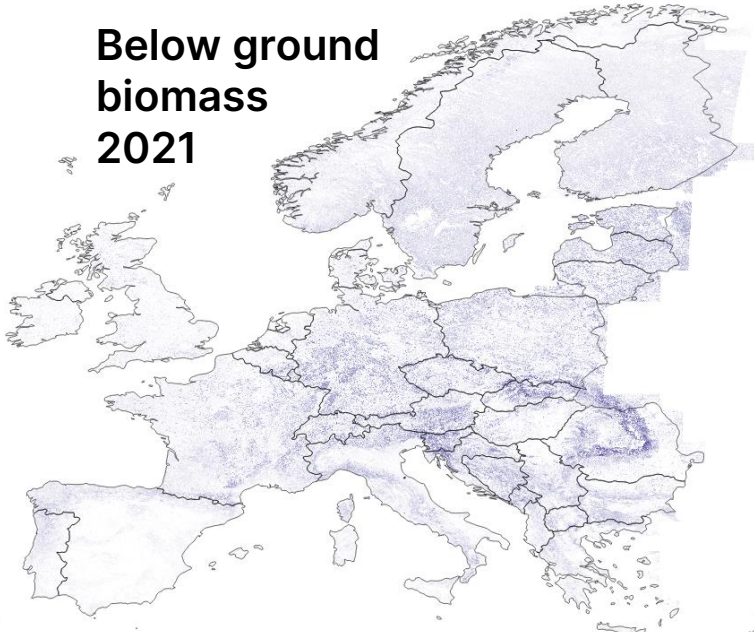
Above ground biomass
2021



Growing stock volume
2021



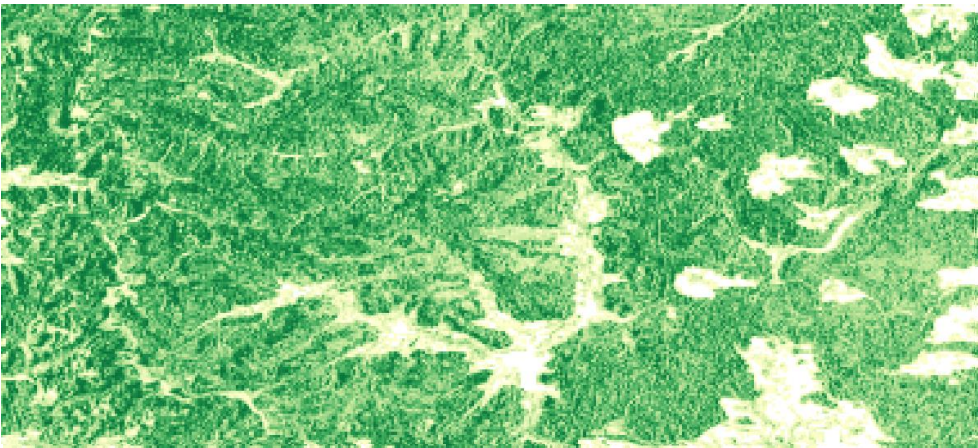
Below ground biomass
2021



20 X 30 km
subset in
Finland

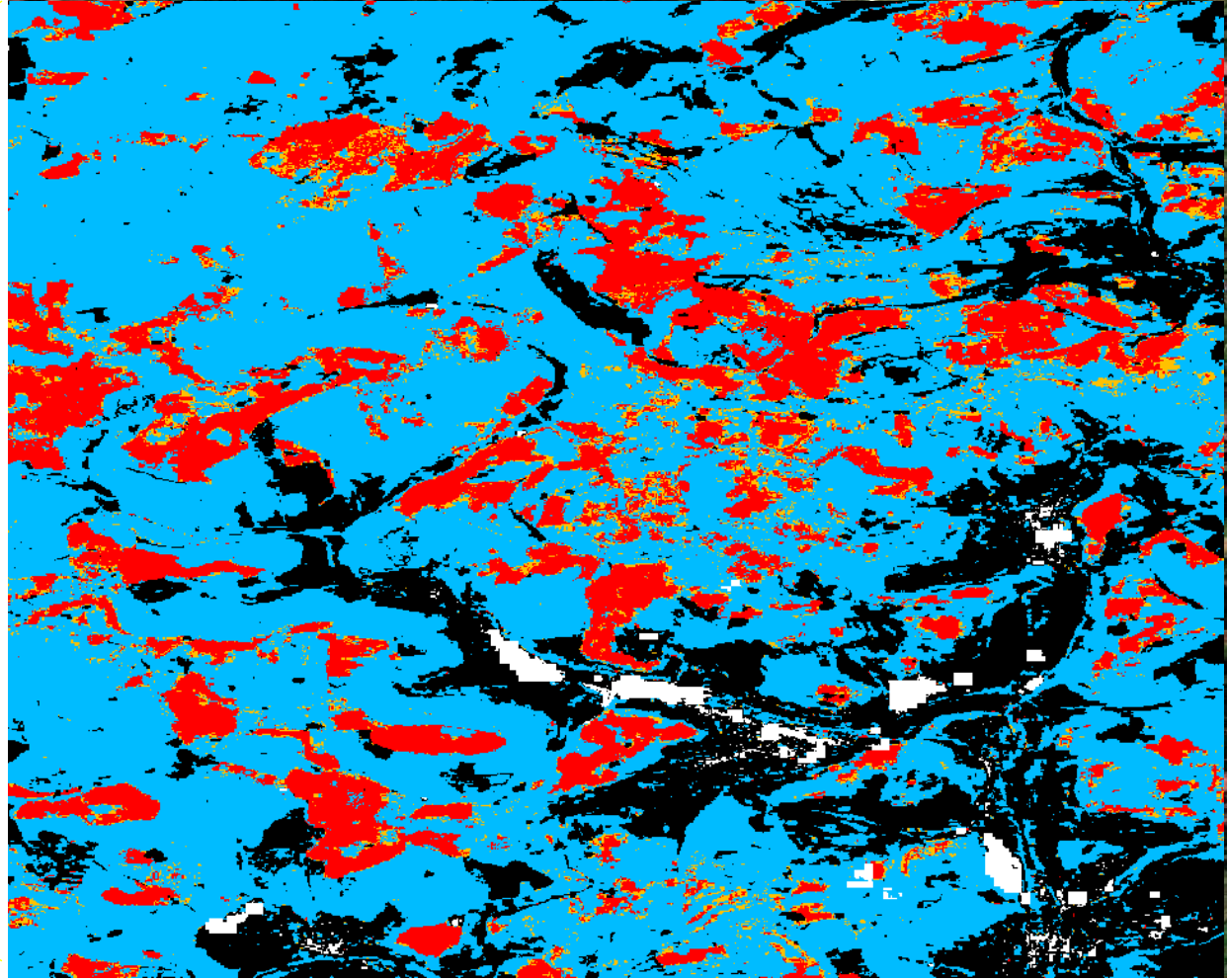
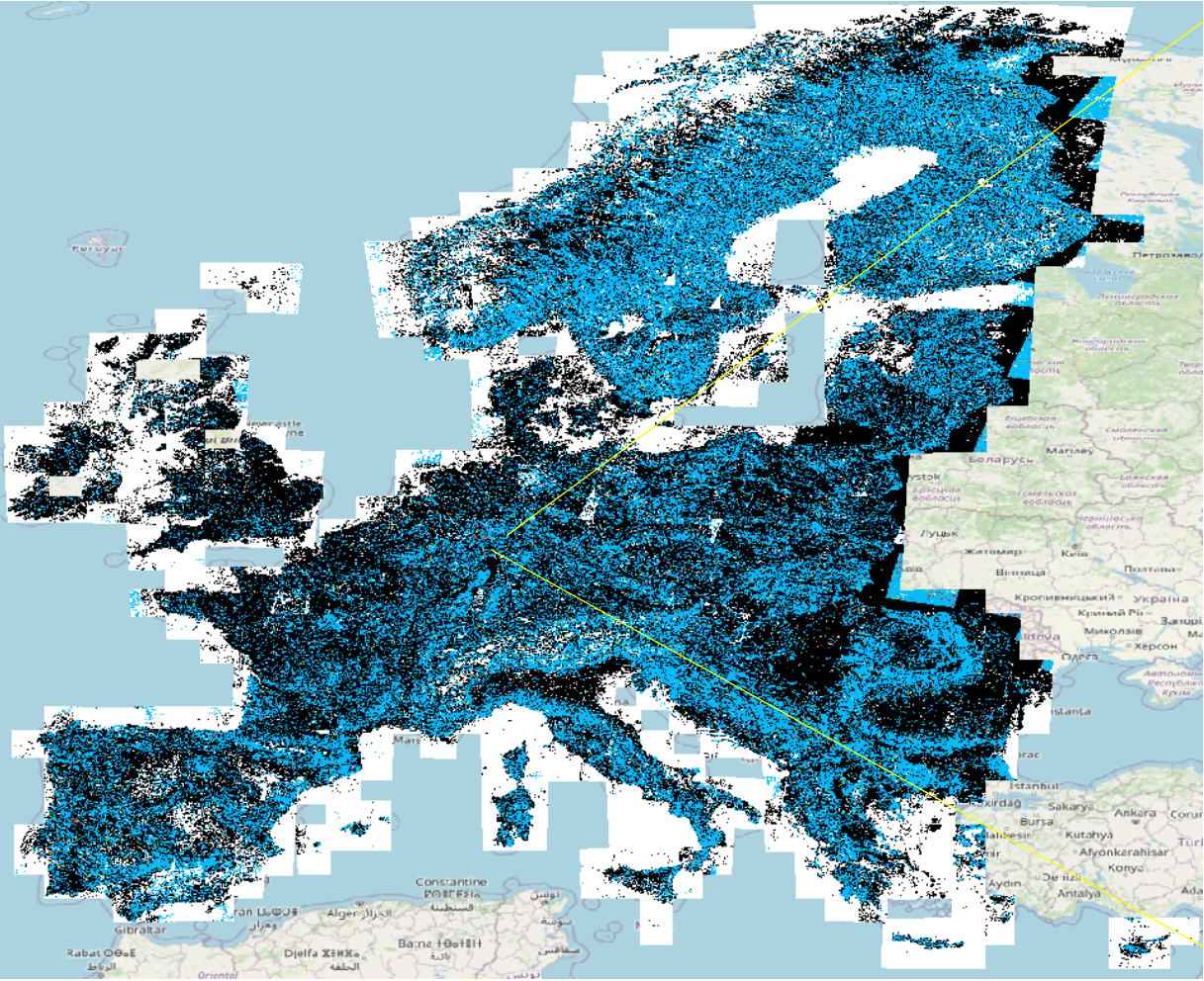
20 X 30 km
subset in
Germany

2021



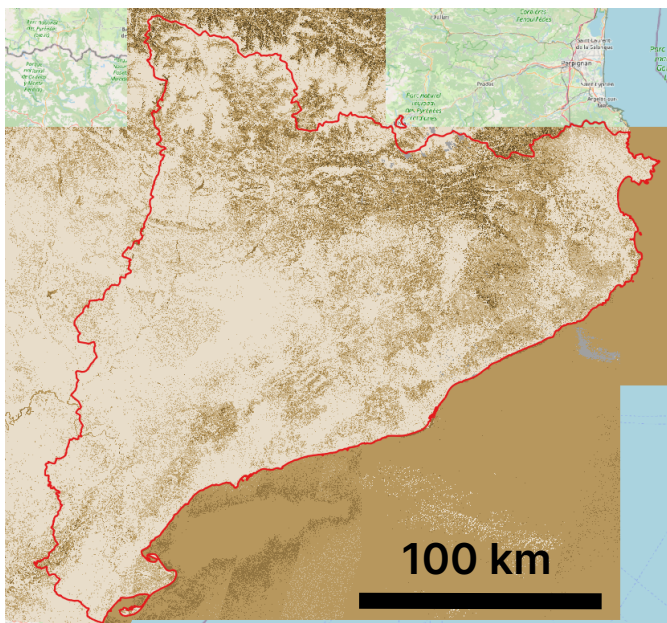
Examples of products - European wide mapping (II)

Changes

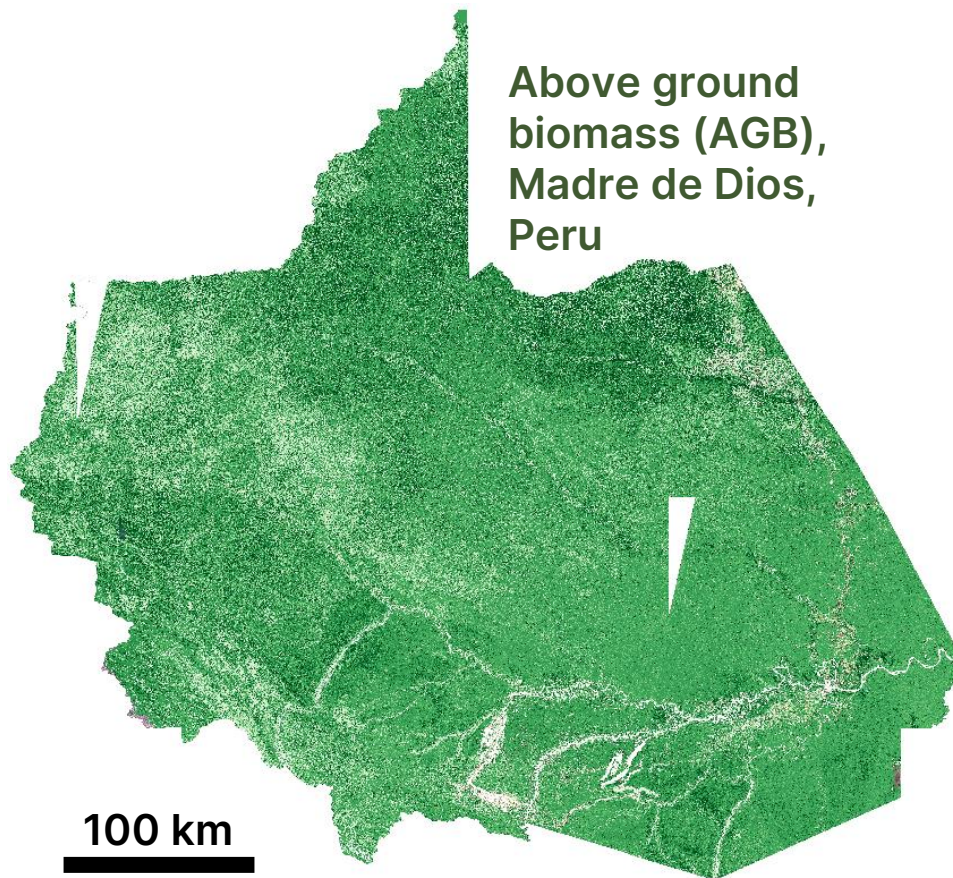


Examples of provincial/national products

Growing stock volume (GSV), Catalonia, Spain

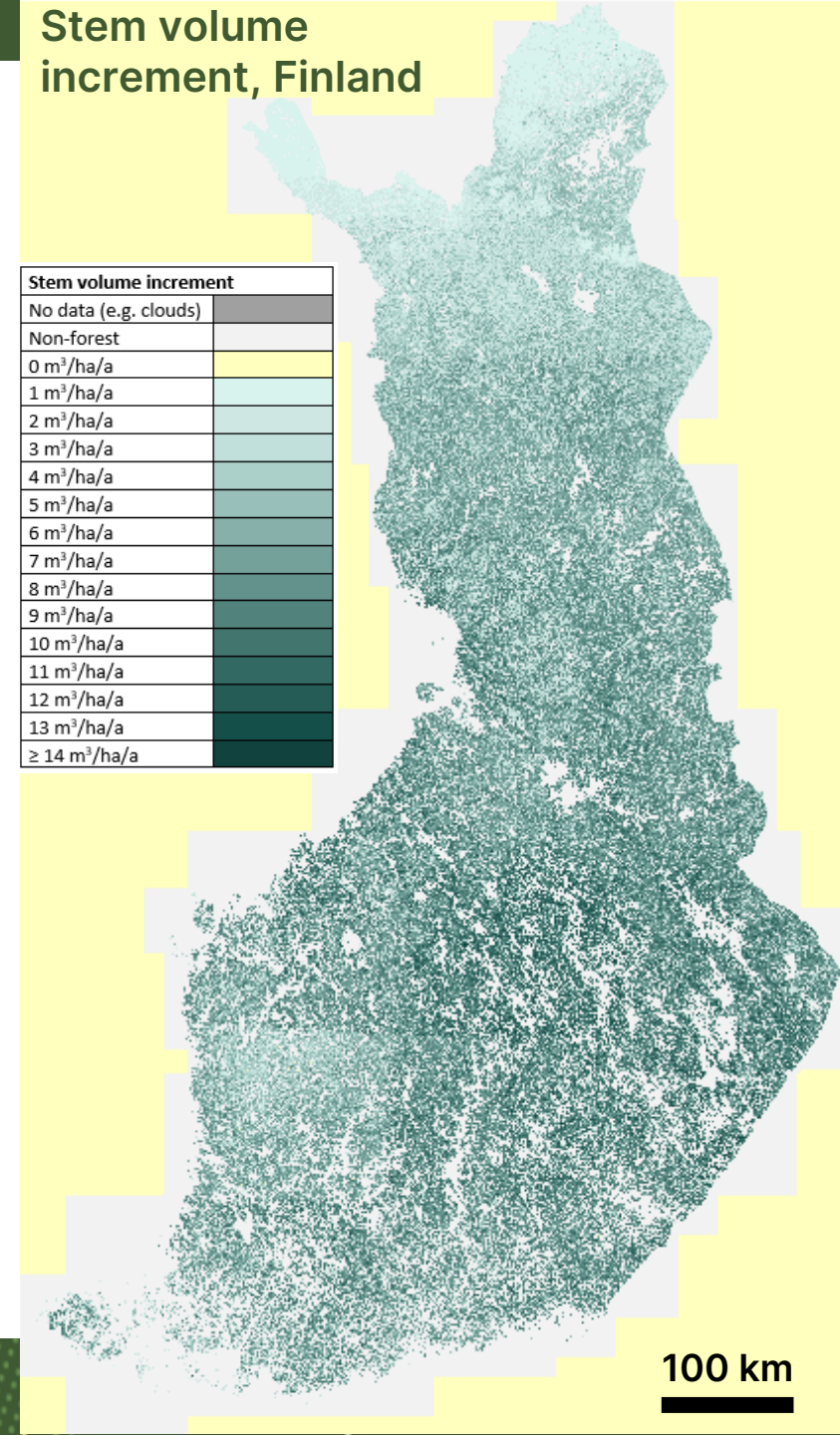


Above ground biomass (AGB), Madre de Dios, Peru

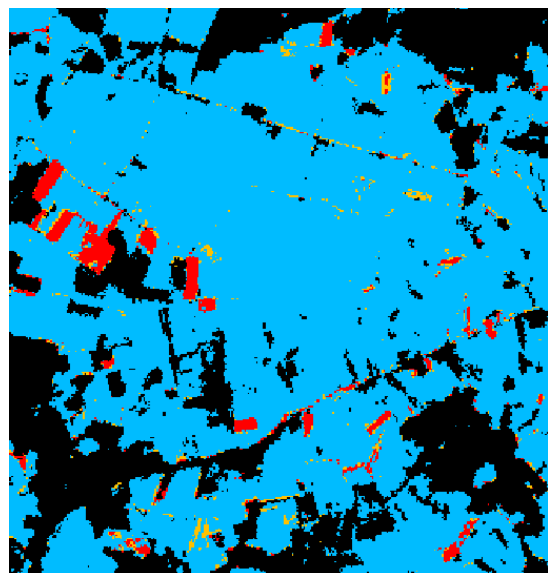
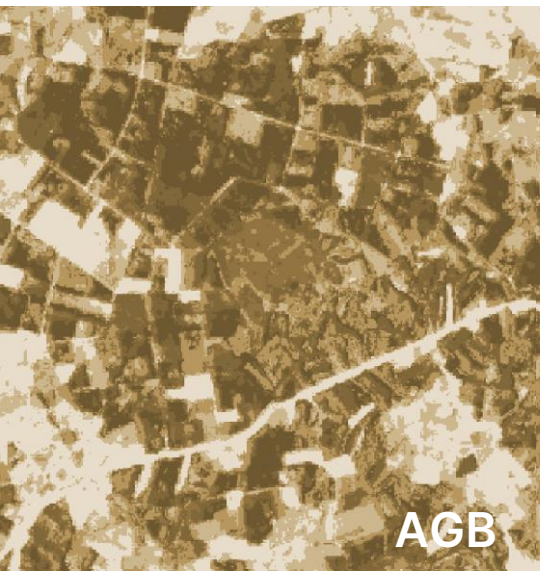
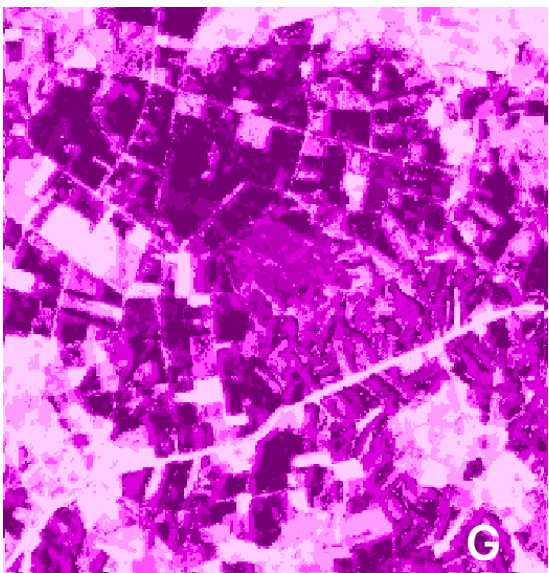


Stem volume increment, Finland

Stem volume increment	
No data (e.g. clouds)	
Non-forest	
0 m ³ /ha/a	
1 m ³ /ha/a	
2 m ³ /ha/a	
3 m ³ /ha/a	
4 m ³ /ha/a	
5 m ³ /ha/a	
6 m ³ /ha/a	
7 m ³ /ha/a	
8 m ³ /ha/a	
9 m ³ /ha/a	
10 m ³ /ha/a	
11 m ³ /ha/a	
12 m ³ /ha/a	
13 m ³ /ha/a	
≥ 14 m ³ /ha/a	

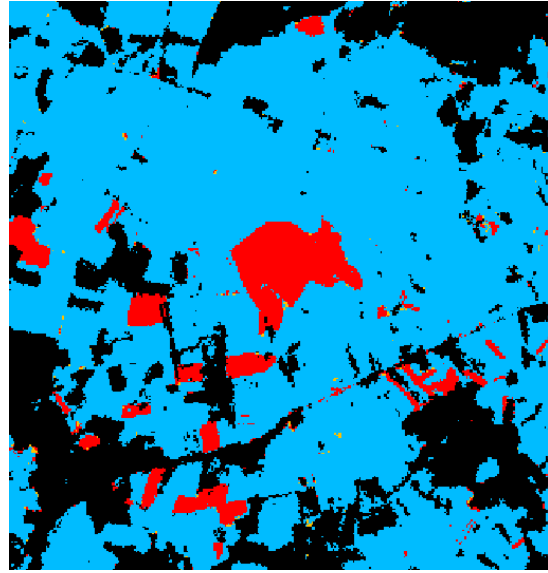
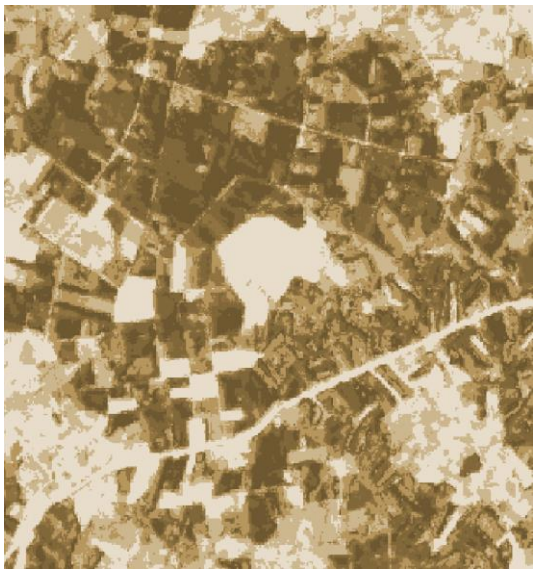


Example of local level products - Galicia



2020

Basal area	
No data (e.g. clouds)	
Non-forest	
Open forest	
≤ 5 m ² /ha	
6-10 m ² /ha	
11-15 m ² /ha	
16-20 m ² /ha	
21-25 m ² /ha	
25-30 m ² /ha	
> 30 m ² /ha	



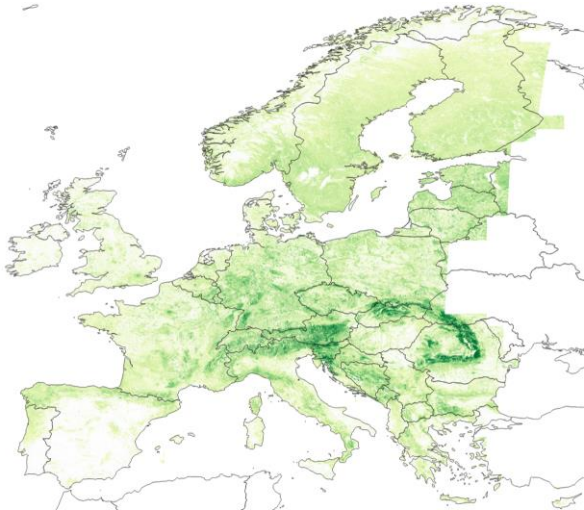
2021

Above Ground Biomass	
No data	
Non-forest	
0-25 t/ha	
26-50 t/ha	
51-75 t/ha	
76-100 t/ha	
101-125 t/ha	
126-150 t/ha	
151-175 t/ha	
> 175 t/ha	

Conclusions - Different purpose, different approach

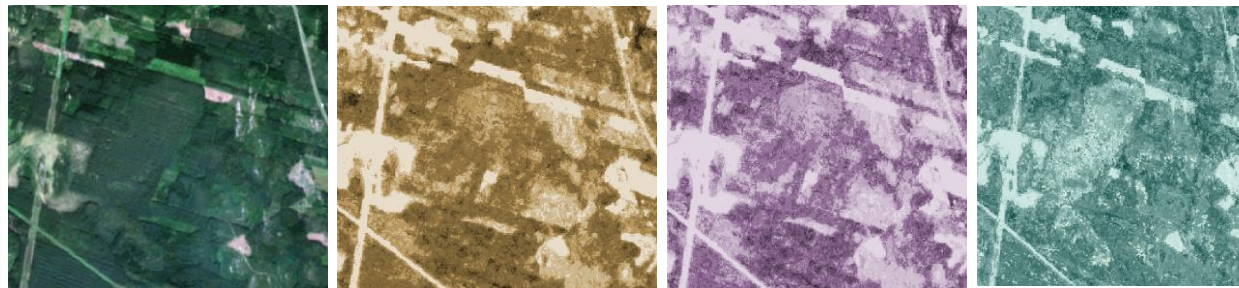
BIOMASAR

- Physical method, no need for field data in implementation
- Continental-wide consistency
- Volume and biomass in 20-100 m resolution

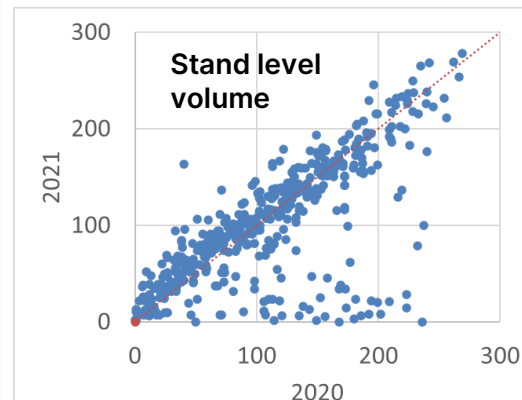


Probability + PREBAS

- Feasible with very limited numbers of field plots
- Maximizes synergy between field and EO data
- Multi-variable approach, ecologically feasible sets of estimates



Sentinel-2 Above ground biomass Below ground biomass Volume increment



Forest estate level statistics (Avg of holdings)

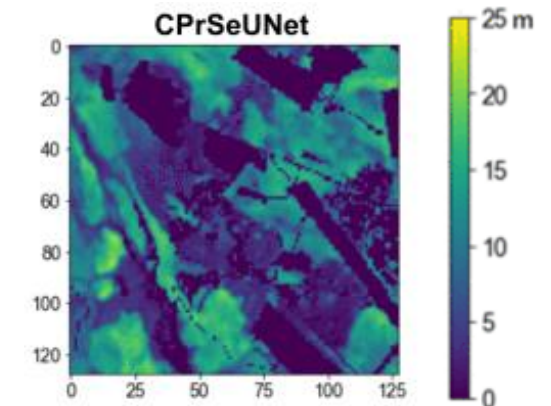
	D (cm)	G (m ² /ha)	H (m)	V (m ³ /ha)
2019	10,2	13,0	12,8	72,6
	1,1	1,9	1,6	16,1
2020	11,3	14,9	14,3	88,7
	0,9	1,6	1,1	13,8
2021	12,1	16,5	15,5	102,4

k-NN + PREBAS

- Powerful when ample amount of field plots available

Future: Deep learning

- Under rapid development
- Caution is required:
 - transparency of model
 - transferability to areas with no reference
 - sufficient amount of reference data in general
- Performance to be compared with operational systems and physics-based image analysis approaches





Forest Carbon
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Thank you!

More information at:

<https://www.forestcarbonplatform.org>

