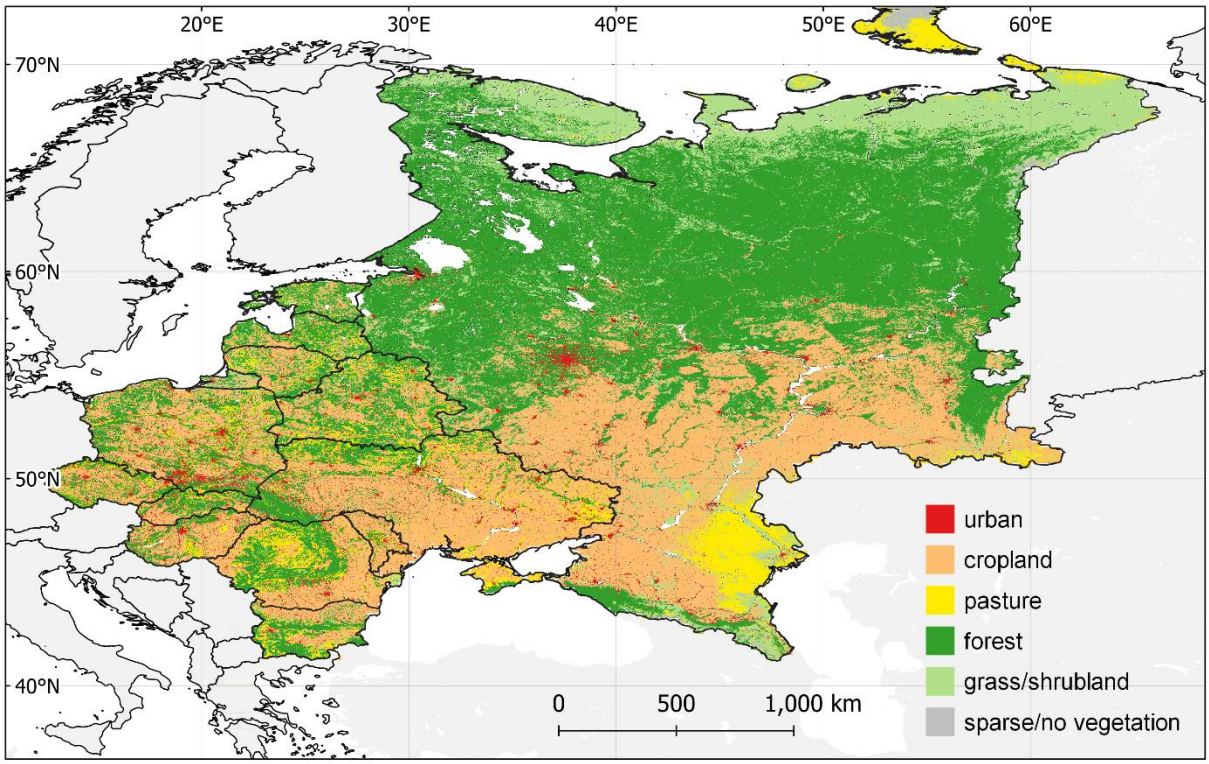
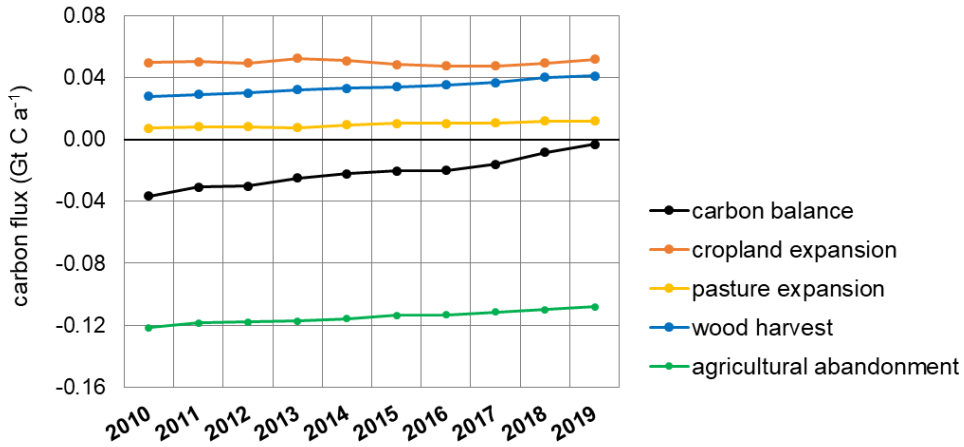
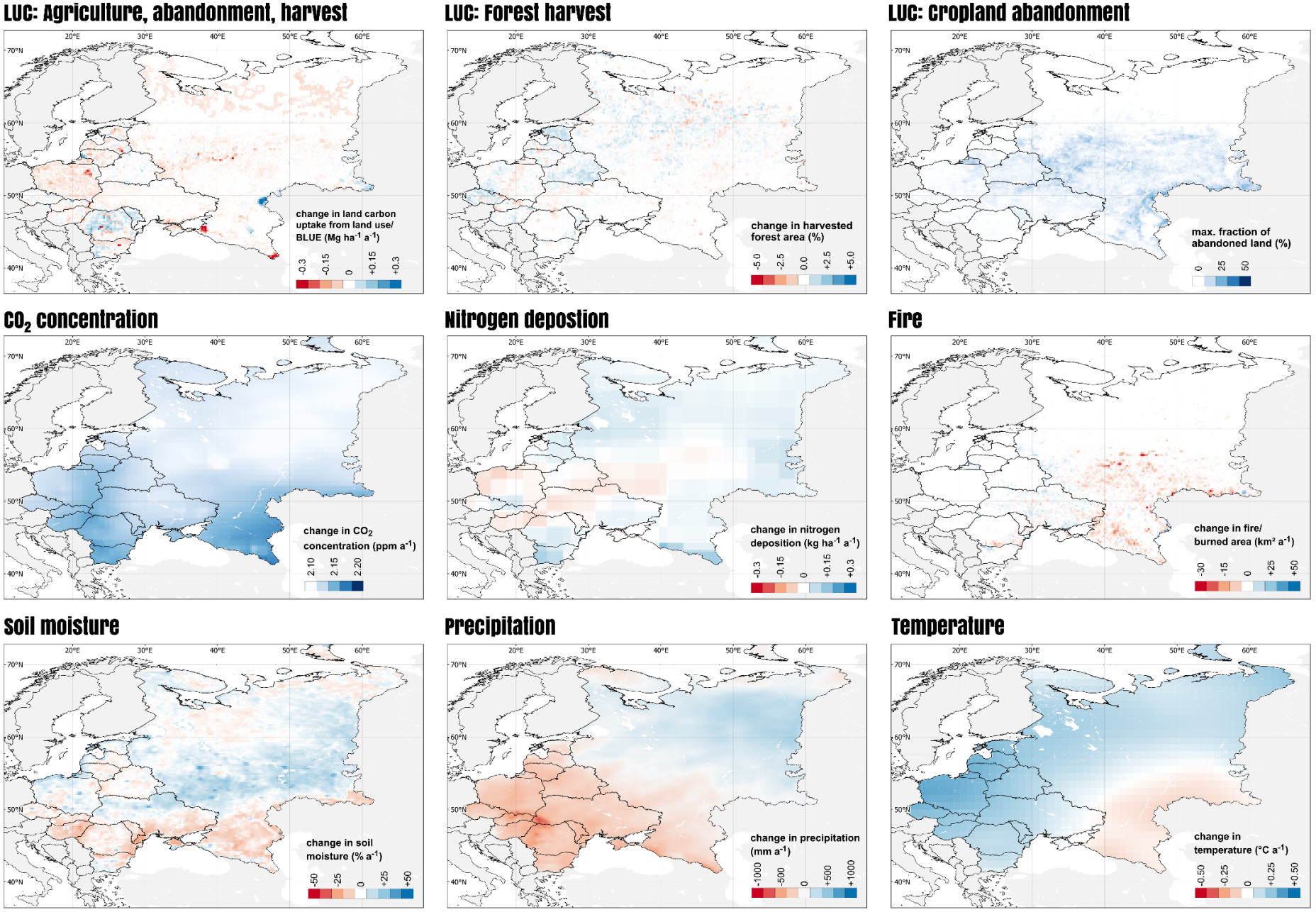
Supplementary Information



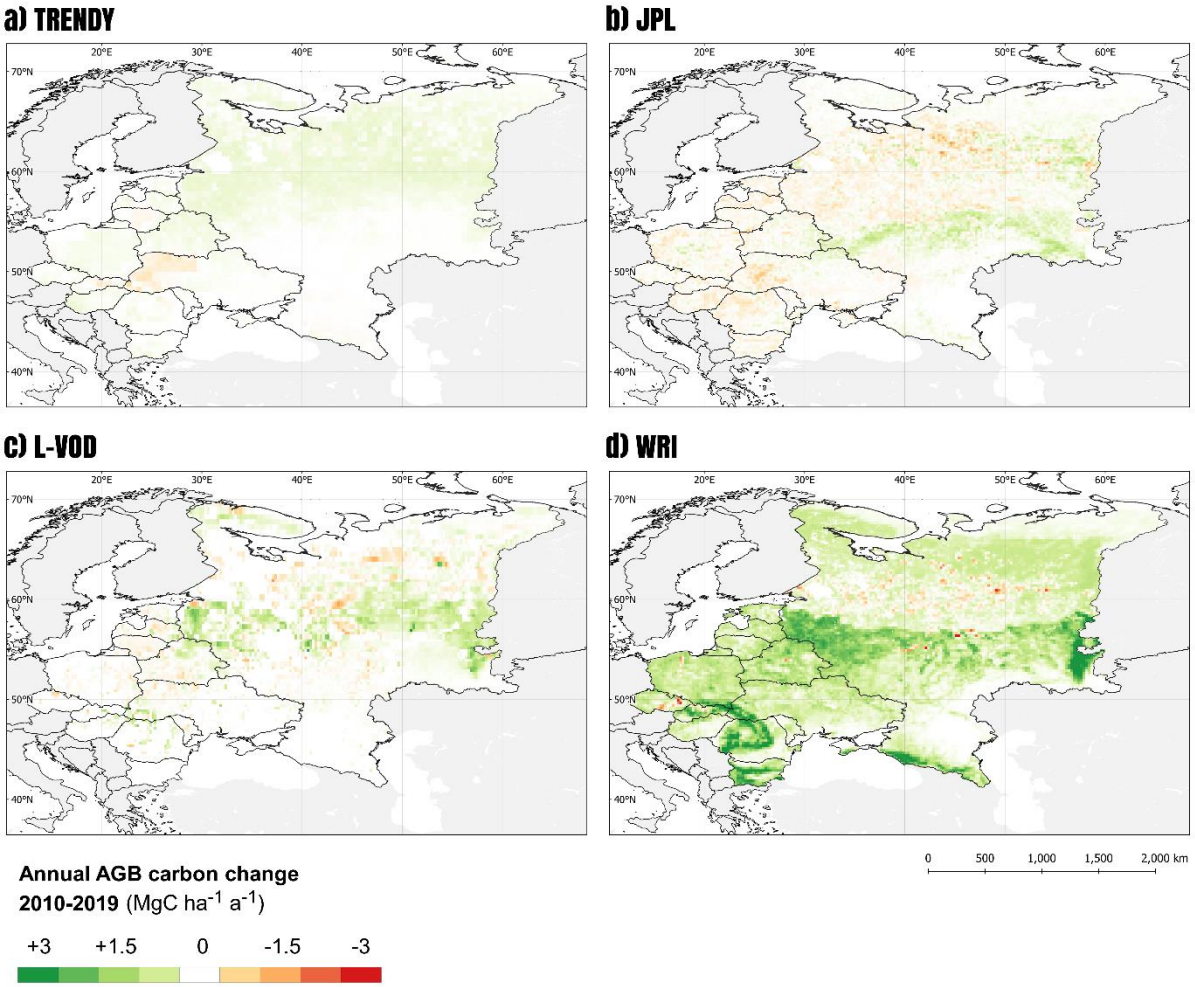
Supplementary Figure 1: Land use/cover map of Eastern Europe in 2019 based on the HILDA+ dataset [2].



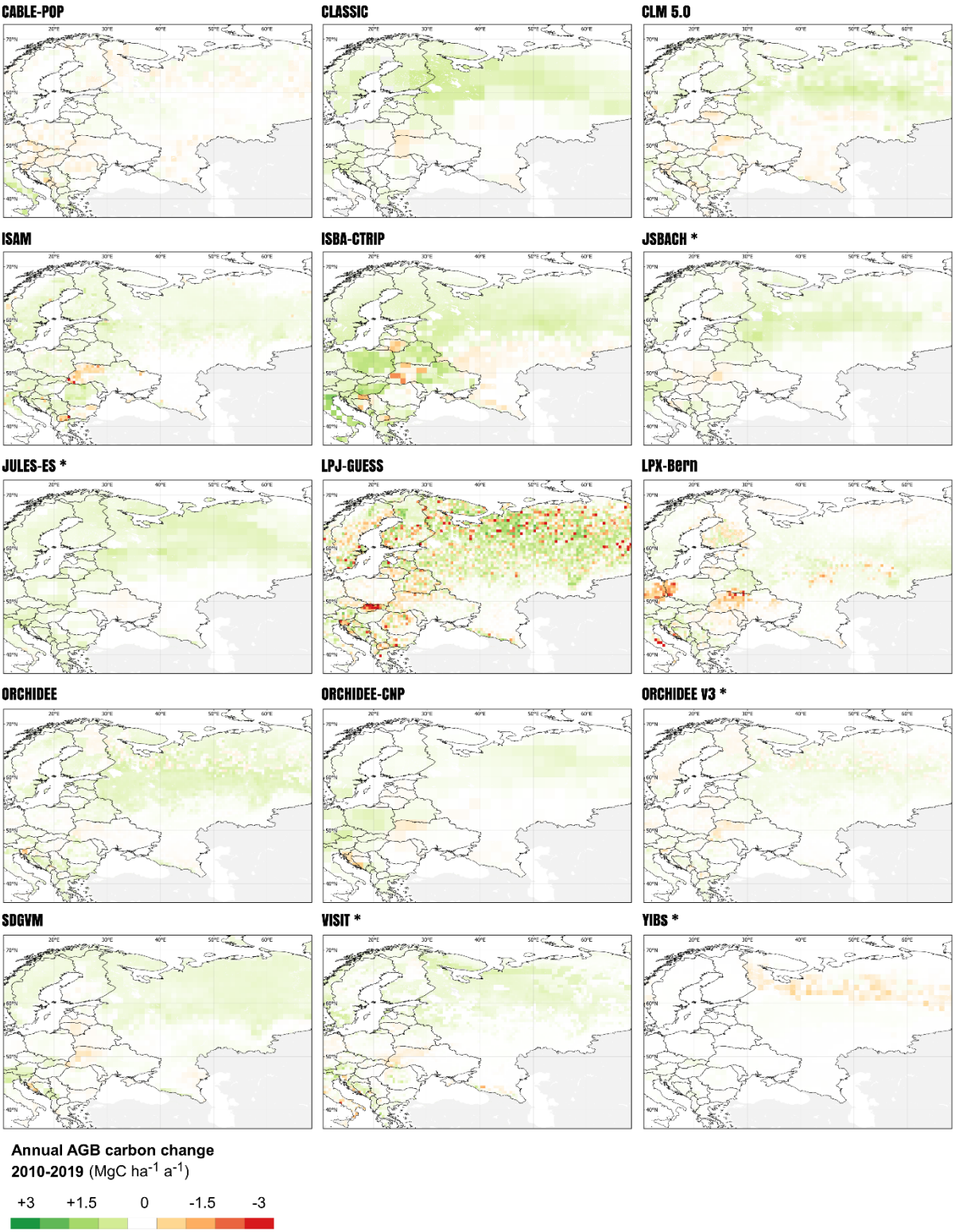
Supplementary Figure 2: Annual net carbon flux from land use change (carbon balance), derived from the BLUE model using the HILDA+ land use forcing[1], and its component fluxes from cropland and pasture change, wood harvest (net flux of release from product and slash decay and uptake by regrowth), and agricultural abandonment in Eastern Europe in 2010-2019. Negative values represent a carbon sink.



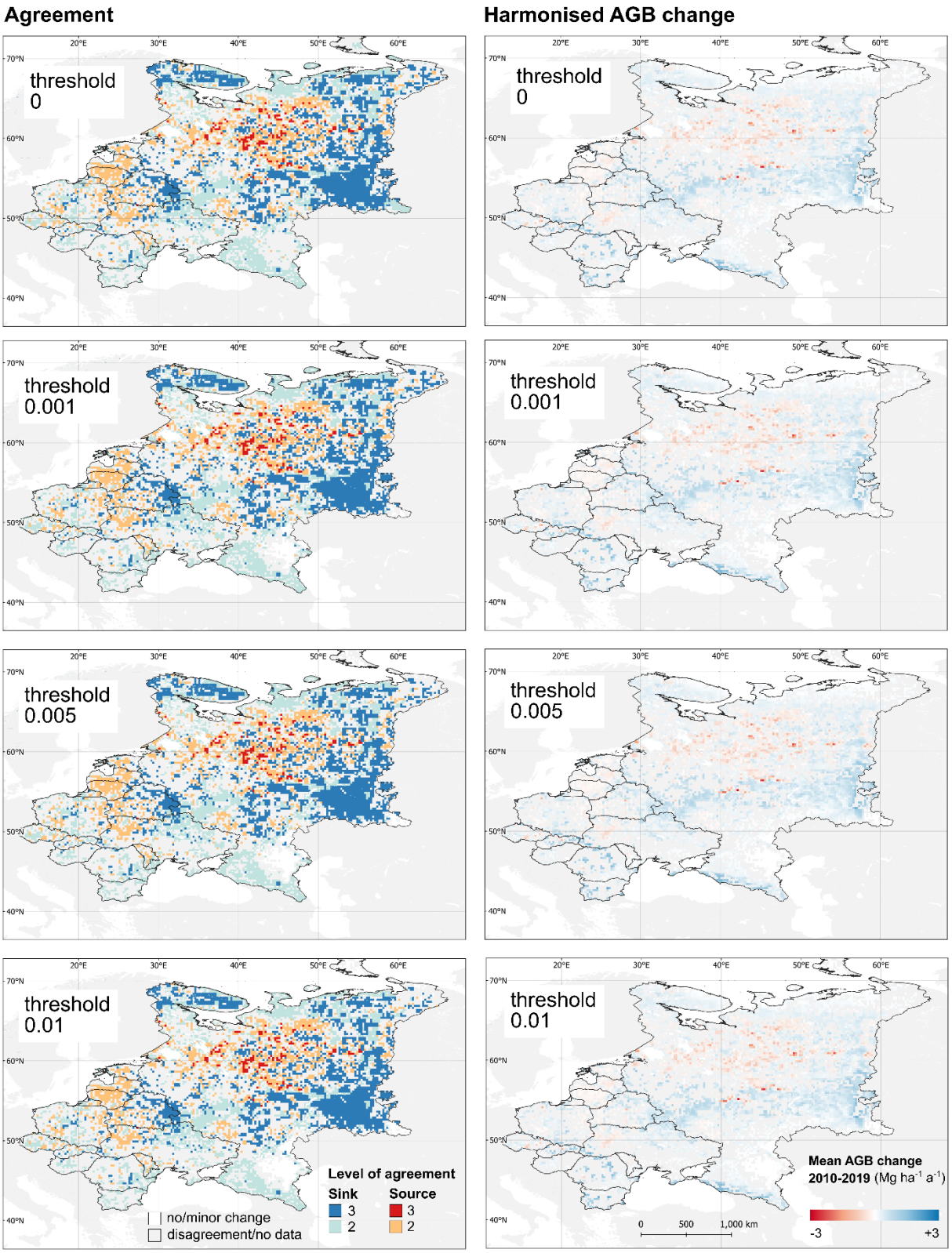
Supplementary Figure 3: Spatial trends of possible underlying drivers and influencing factors of AGB carbon change in Eastern Europe during 2010-2019. Values are normalised to a mean value of 0 (except from cropland abandonment, which does not show change but the fraction of abandonment).



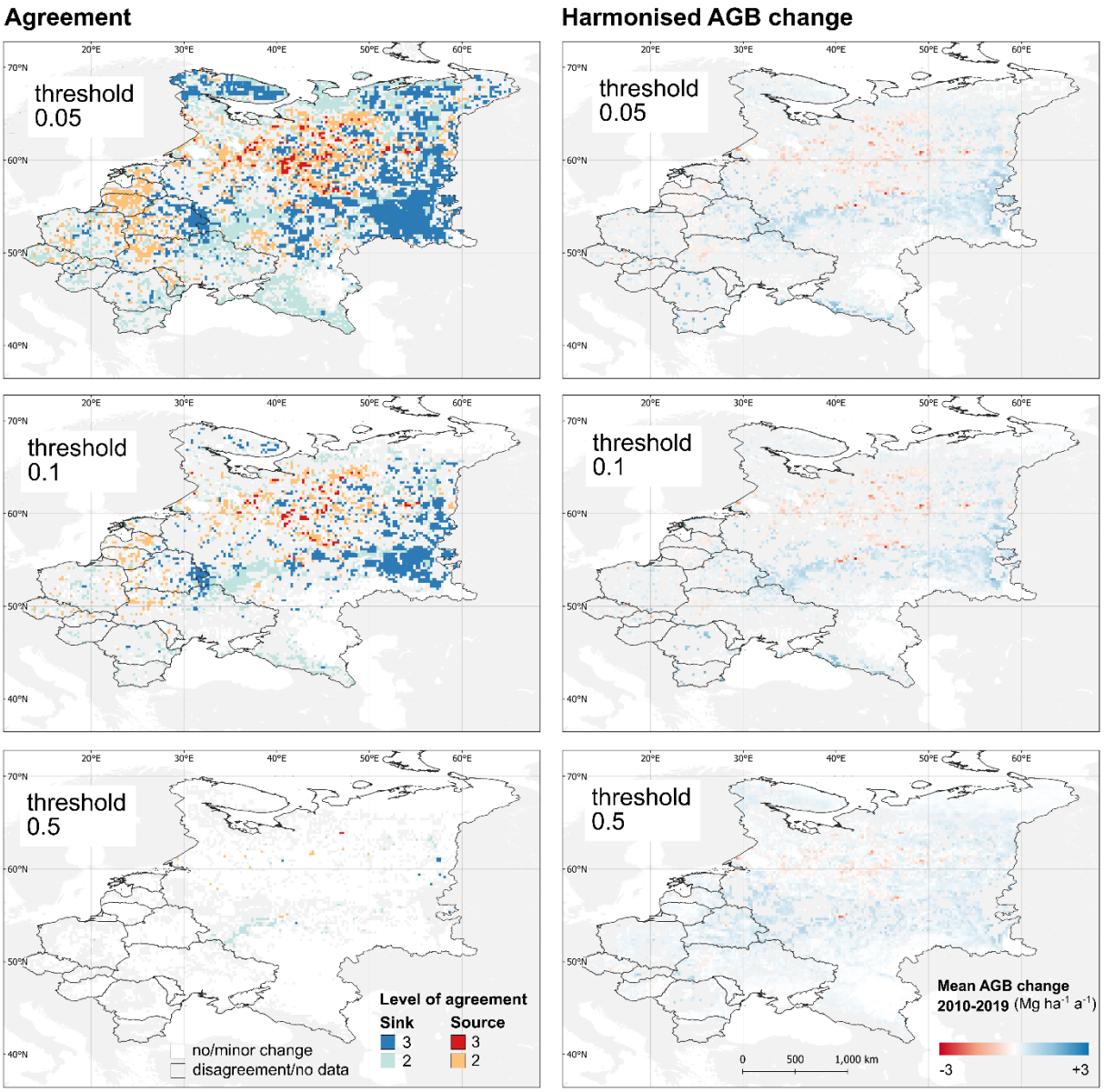
Supplementary Figure 4: Spatial patterns of carbon gains and losses in AGB (in Mg C ha^{-1} a^{-1}) from a) TRENDY (mean of 15 models), b) JPL[3], c) L-VOD[4] and d) WRI[5] in Eastern Europe during 2010-2019.



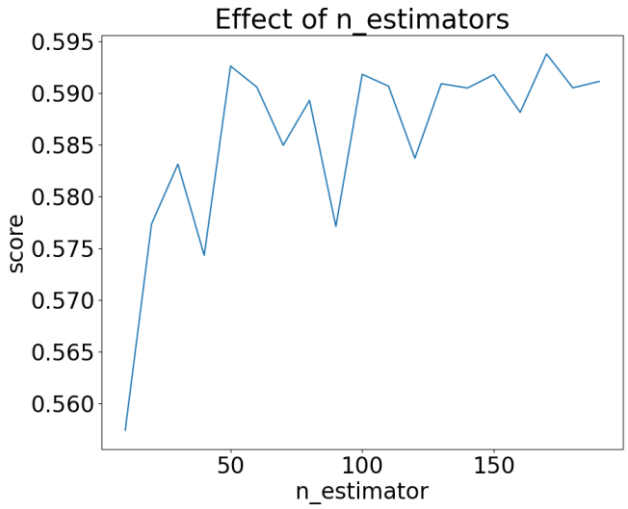
Supplementary Figure 5: Spatial patterns of AGB carbon change (in Mg C ha^{-1} a^{-1}) in Eastern Europe during 2010-2019 from 15 TRENDY models. These models account for both land-use and environmental changes as drivers of carbon fluxes. *****) Carbon in roots (cRoot) was not available for calculating the AGB carbon change, but computed from above-/below-ground biomass ratio [6].



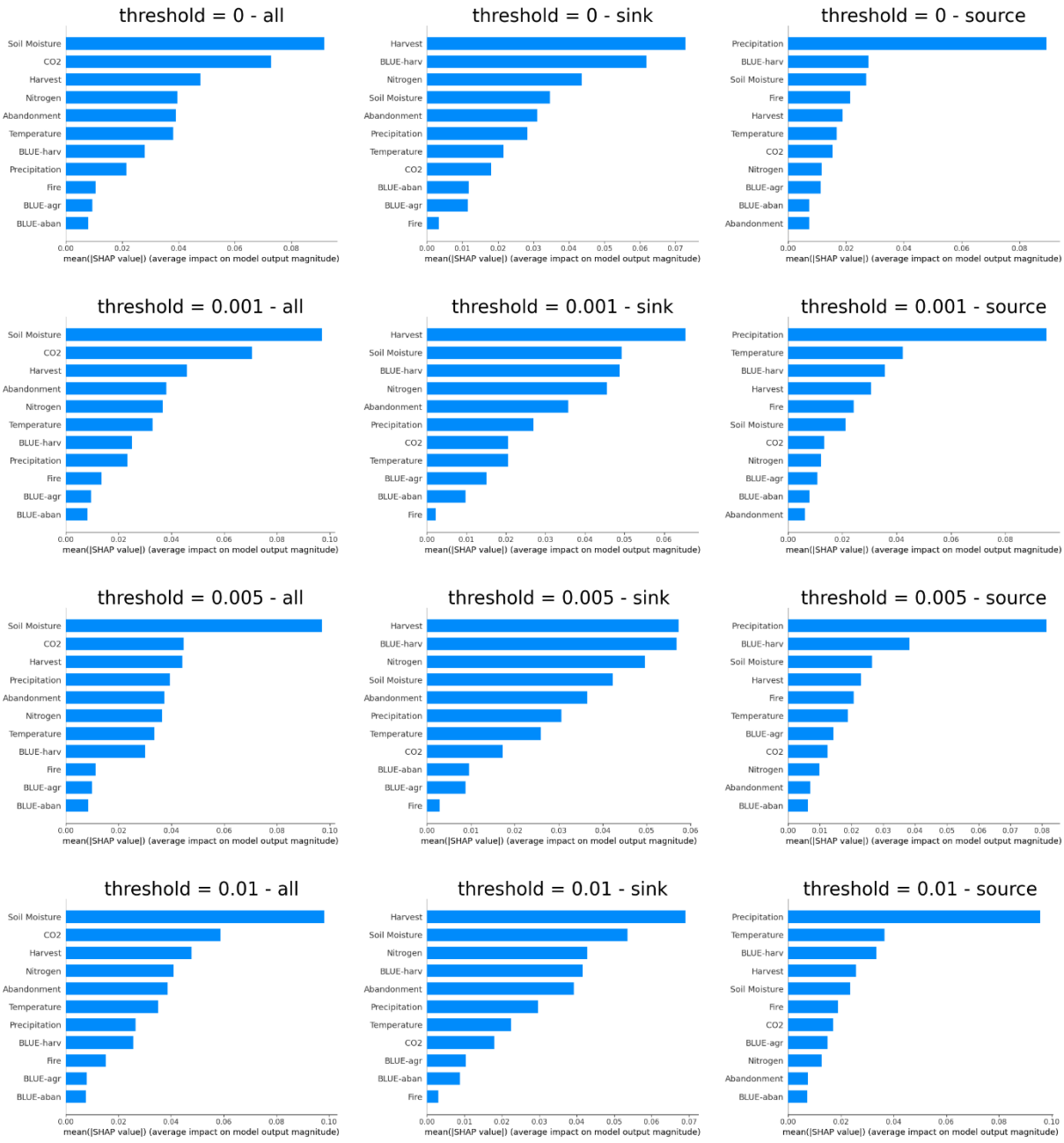
Supplementary Figure 6: Sensitivity of agreement (left column) on carbon gains (source) and losses (sink) as well as harmonised mean AGB change (right column) in Eastern Europe during 2010-2019 from three datasets (L-VOD, JPL, and WRI) to different thresholds. Sources are defined by ΔAGB < *threshold*, sinks by ΔAGB > *threshold* in Mg C ha^{-1} a^{-1}. Levels of agreement represent the number of agreeing datasets. The harmonised mean AGB change was derived for all datasets that agree on either a carbon source or sink or no/minor change in areas with an agreement level of at least 2. Areas of disagreement are displayed in grey.



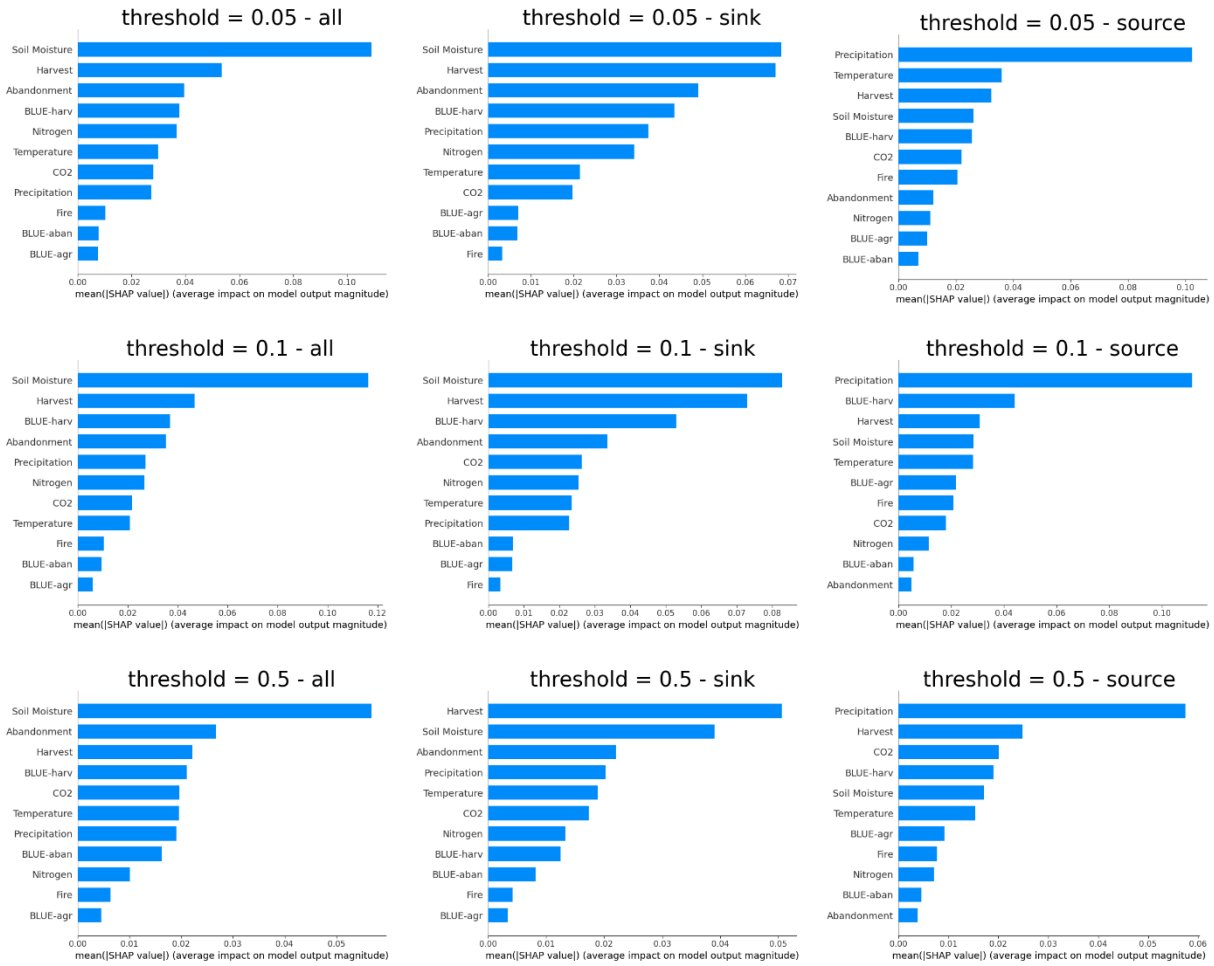
Supplementary Figure 6 (continued): Sensitivity of agreement (left column) on carbon gains (source) and losses (sink) as well as harmonised mean AGB change (right column) in Eastern Europe during 2010-2019 from three datasets (L-VOD, JPL, and WRI) to different thresholds. Sources are defined by ΔAGB < *threshold*, sinks by ΔAGB > *threshold* in Mg C ha^{-1} a^{-1}. Levels of agreement represent the number of agreeing datasets. The harmonised mean AGB change was derived for all datasets that agree on either a carbon source or sink or no/minor change in areas with an agreement level of at least 2. Areas of disagreement are displayed in grey.



Supplementary Figure 7: Exemplary performance analysis of a random forest regression model: the random forest model with 170 decision trees resulted in the highest score (R^2 value of around 0.592 for the test set). Here, all grid cells of AGB carbon change were taken into account (subset 3).



Supplementary Figure 8: Sensitivity of driver analysis in form of feature importance based on average Shapley values from random forest regression to different thresholds of AGB carbon change. Thresholds were applied to derive the harmonised mean AGB change from three datasets (L-VOD, JPL, and WRI), which was used as a response variable for random forest regression. Random forest regression was applied to three different subsets: all (overall AGB carbon change), sink (AGB carbon sink areas only), source (AGB carbon source areas only), see Table S5 for model performance and sample sizes.



Supplementary Figure 8 (continued): Sensitivity of driver analysis in form of feature importance based on average Shapley values from random forest regression to different thresholds of AGB carbon change. Thresholds were applied to derive the harmonised mean AGB change from three datasets (L-VOD, JPL, and WRI), which was used as a response variable for random forest regression.

Supplementary Table 1: List of European subregions (in bold) and included countries.

Region	**North**	**West**	**South**	**East**
Countries included	Denmark	Austria	Albania	Belarus
	Finland	Belgium	Bosnia and Herzegovina	Bulgaria
	Sweden	France	Croatia	Czechia
	Norway	Ireland	Greece	Hungary
		Germany	Kosovo	Estonia
		Liechtenstein	Macedonia	Latvia
		Luxembourg	Montenegro	Moldova
		Netherlands	Italy	Lithuania
		Switzerland	Portugal	Poland
		United Kingdom	Serbia	Romania
			Slovenia	Slovakia
			Spain	Ukraine
				European **Russia** (Eastern border: Ural Mountains)
				EE: East + Russia

Supplementary Table 2: Standard deviations (as variability across time) of average land above-ground biomass (AGB) carbon flux (in Gt C a^{-1}) from different datasets (see Table 1, Table 2 and Figure 2 in the main paper) for European regions.

Data	**SURF**	**GOSAT**	**OCO2**	**L-VOD**	**JPL ****	**WRI ****	**UNFCCC**	**BLUE° ****
Period	2010-18	2010-15	2015-18	2010-19	2010-2019	2010-19	2010-19	2010-19
North	0.031	0.022	0.013	-0.003	0.042	0.022	0.009	0.001
West	0.059	0.115	0.033	0.018	0.014	0.032	0.005	0.007
South	0.033	0.050	0.024	0.007	0.035	0.030	0.012	0.010
East	0.111	0.097	0.063	0.016	0.085	0.039	0.005	0.008
Russia	0.218	0.127	0.053	0.083	0.065	0.065	0.003	0.005
EE	**0.105**	**0.088**	**0.036**	**0.099**	**0.079**	**0.103**	**0.127**	**0.013**
Europe	**0.081**	**0.088**	**0.042**	**0.127**	**0.170**	**0.187**	**0.064**	**0.028**

° includes AGB, below-ground biomass (BGB) and soil organic carbon (SOC)
** refers to gross carbon sink estimates.

Supplementary Table 3: Average net land above-ground biomass (AGB) carbon flux (in Gt C a^{-1}) from different datasets (see Table 1 and Figure 2 in the main paper) for European regions.

Data	**SURF**	**GOSAT**	**OCO2**	**L-VOD**	**JPL**	**WRI**	**UNFCCC**	**BLUE°**
Period	2010-18	2010-15	2015-18	2010-19	2010-19	2010-19	2010-19	2010-19
North	-0.08	-0.07	0.02	0.02	-0.01	-0.07	-0.07	0.01
West	-0.20	-0.17	0.04	-0.08	0.00	-0.13	-0.06	-0.01
South	-0.09	0.01	0.04	-0.07	0.01	-0.11	-0.10	-0.02
East	-0.09	-0.17	-0.09	-0.04	0.01	-0.15	-0.16	-0.03
Russia	-0.44	-0.33	-0.22	-0.41	-0.02	-0.21	-0.04	0.01
EE	**-0.53**	**-0.50**	**-0.32**	**-0.45**	**-0.01**	**-0.36**	**-0.20**	**-0.02**
EE share	59%	68%	143%	77%	140%	54%	47%	53%
Europe	**-0.89**	**-0.73**	**-0.22**	**-0.59**	**-0.01**	**-0.66**	**-0.44**	**-0.04**

° includes AGB, below-ground biomass (BGB) and soil organic carbon (SOC)

Supplementary Table 4: Hypothesised relationship between change of driver indicators and AGB carbon change, either sink (positive AGB change) or source (negative AGB change). Negative relations are displayed as -, positive relations are displayed as +, unclear relations are displayed as +/-.

Driver indicator	**Relation to AGB carbon sink**	**Relation to AGB carbon source**	**Description and reference**
BLUE-agr	-	+	Agricultural expansion leads to enhanced carbon emissions (carbon source)[7,8].
BLUE-aban	+	-	Agricultural land abandonment leads to enhanced woody biomass (carbon sink)[7,9,10].
BLUE-harv	-	+	Wood harvest removes biomass (carbon source)[8].
Harvest	-	+	*see BLUE-harv*
Abandonment $_{fraction}$	+	-	*see BLUE-aban*
Fire	-	+	Fires lead to biomass removal and enhanced carbon emissions (carbon source)[11].
Soil moisture	+/-	+/-	Unclear relation[12]
Precipitation	+/-	+/-	Unclear relation[12]
Temperature	+/-	+/-	Unclear relation[12]
CO_2	+	-	CO_2 fertilization effect enhances biomass production (carbon sink)[13,14].
Nitrogen	+	-	Nitrogen deposition enhances biomass production (carbon sink)[14].

Supplementary Table 5: Sensitivity of random forest regression to different thresholds of AGB carbon change for different subsets. Thresholds were applied to derive the harmonised mean AGB change from three datasets (L-VOD, JPL, and WRI), which was used as a response variable for random forest regression. N: number of pixels used (training plus test data), R^2: R-Squared/model performance, RMSE: root-mean-square error.

Subset: Overall AGB carbon change (both carbon sinks and sources)

Threshold	0	0.001	0.005	0.01	0.05	0.1	0.5
N	7086	7097	6965	6786	5689	5309	9373
R^2	0.56	0.56	0.59	0.6	0.59	0.55	0.52
RMSE	27%	26%	26%	27%	27%	25%	14%

Subset: AGB carbon sink (harmonised AGB carbon change > 0)

Threshold	0	0.001	0.005	0.01	0.05	0.1	0.5
N	5279	5224	5130	4983	4274	4182	8147
R^2	0.75	0.75	0.77	0.75	0.78	0.76	0.62
RMSE	15%	15%	14%	15%	14%	15%	11%

Subset: AGB carbon source (harmonised AGB carbon change > 0)

Threshold	0	0.001	0.005	0.01	0.05	0.1	0.5
N	1807	1811	1773	1742	1353	1065	1164
R^2	0.44	0.32	0.36	0.48	0.44	0.45	0.39
RMSE	20%	24%	19%	21%	24%	24%	14%

Supplementary references

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