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Assessing the effect of land cover on ISBA snow water equivalent and land surface temperature simulations over Europe

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Effect of using CCI land cover on ISBA Snow Water Equivalent (SWE) simulations over Europe

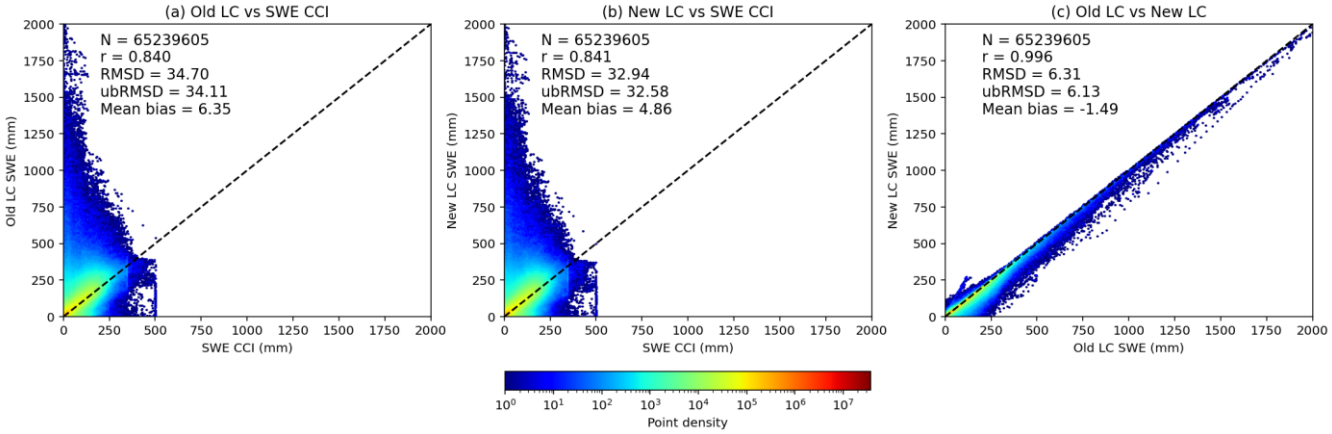

Figure S1 – SWE scatterplots: (a) Old LC vs. CCI SWE , (b) New LC vs. CCI SWE, (c) Old LC vs. New LC, for the period 2010–2022.

Assessment of ISBA LST simulations

Table S1: Same as Table 1 LST results, except for snow-free conditions only.

Model	vs. CCI variable	*R*	RMSD	ubRMSD	Mean bias	Number
ERA5	Daytime LST (K)	0.95	4.8	4.4	-1.9	13,763,309
ISBA Old LC		0.95	6.0	4.8	-3.7	16,180,931
ISBA New LC		0.95	6.2	4.8	-3.8	16,184,295
ERA5	Nighttime LST (K)	0.95	2.9	2.3	1.7	16,203,810
ISBA Old LC		0.93	2.9	2.8	0.9	19,100,617
ISBA New LC		0.93	2.9	2.8	0.9	19,114,811

Table S2: Same as Table 1 LST results, except for the DJF season only.

Model	vs. CCI variable	*R*	RMSD	ubRMSD	Mean bias	Number
ERA5	Daytime LST (K)	0.95	3.7	3.7	0.3	506,139
ISBA Old LC		0.93	5.0	4.5	-2.0	757,420
ISBA New LC		0.93	4.9	4.6	-1.9	757,420
ERA5	Nighttime LST (K)	0.93	3.2	3.0	1.3	2,429,343
ISBA Old LC		0.88	3.9	3.9	0.4	3,083,096
ISBA New LC		0.88	3.8	3.8	0.6	3,083,096

Note: DJF stands for December-January-February

Table S3: Same as Table 1 LST results, except for the DJF season and snow-free conditions only.

Model	vs. CCI variable	*R*	RMSD	ubRMSD	Mean bias	Number
ERA5	Daytime LST (K)	0.95	3.7	3.7	-0.1	365,268
ISBA Old LC		0.93	5.1	4.6	-2.3	575,952
ISBA New LC		0.93	5.1	4.6	-2.2	578,760
ERA5	Nighttime LST (K)	0.85	2.8	2.4	1.4	1,366,420
ISBA Old LC		0.71	3.0	3.0	0.6	1,812,468
ISBA New LC		0.72	3.0	2.9	0.7	1,822,756

Note: DJF stands for December-January-February

Table S4: Same as Table 1 LST results, except for the JJA season only.

Model	vs. CCI variable	*R*	RMSD	ubRMSD	Mean bias	Number
ERA5	Daytime LST (K)	0.94	5.2	4.6	-2.3	9,061,548
ISBA Old LC		0.94	6.3	4.8	-4.1	9,318,740
ISBA New LC		0.94	6.4	4.9	-4.3	9,318,740
ERA5	Nighttime LST (K)	0.92	2.9	2.3	1.8	8,410,374
ISBA Old LC		0.89	2.9	2.7	1.0	8,620,065
ISBA New LC		0.89	2.9	2.7	1.0	8,620,065

Note: JJA stands for June-July-August

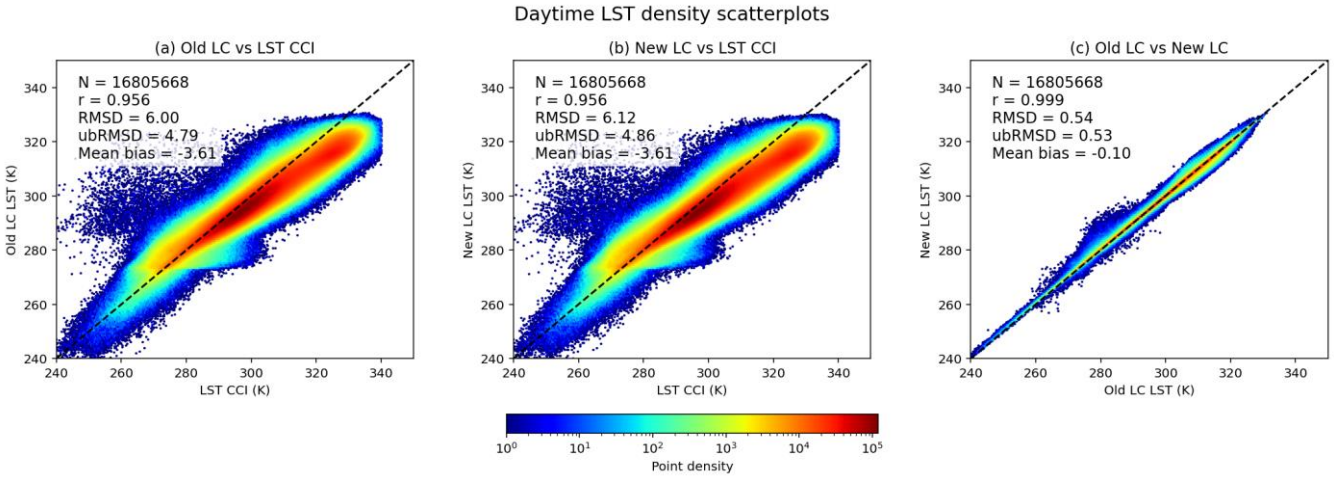

Figure S2 – Daytime LST scatterplots: (a) Old LC vs. CCI LST, (b) New LC vs. CCI LST, (c) Old LC vs. New LC, corresponding to Table 1.

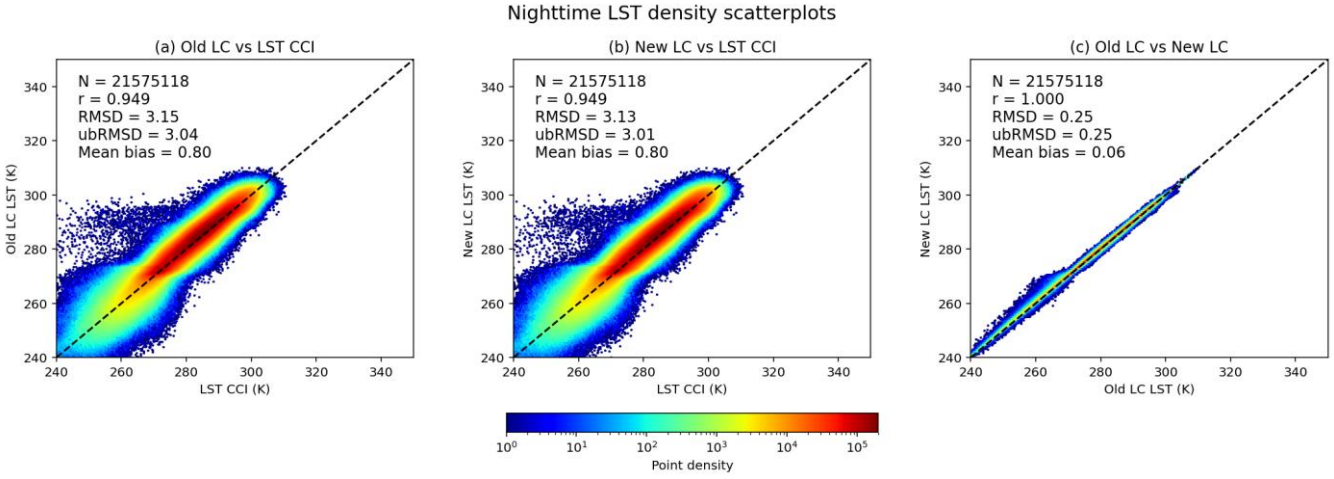

Figure S3 – Nighttime LST scatterplots: (a) Old LC vs. CCI LST, (b) New LC vs. CCI LST, (c) Old LC vs. New LC, corresponding to Table 1.

How do LC changes affect ISBA SWE simulations?

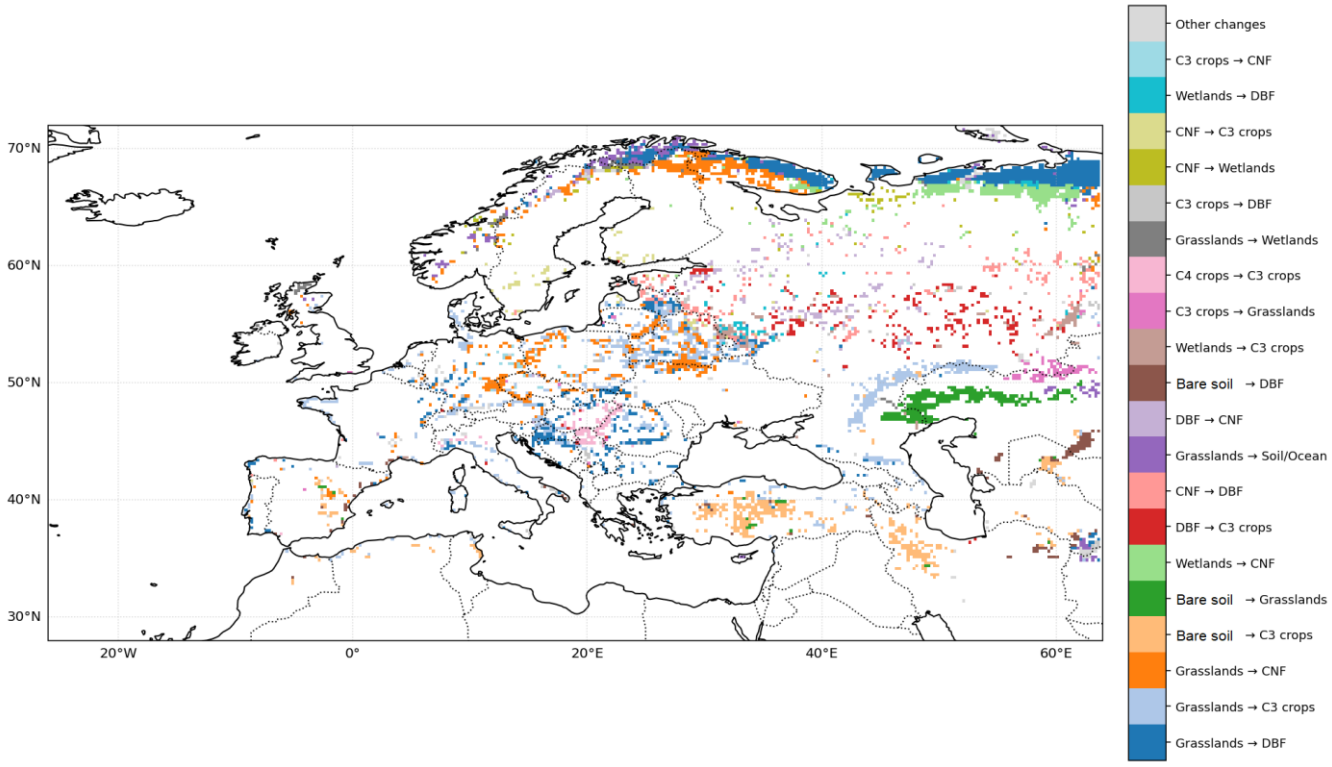

Figure S4 – Spatial distribution of the top 20 most frequent dominant land cover transitions from Old LC to New LC over snow relevant grid cells where valid ESA CCI SWE data are available. All remaining transitions are grouped as "Other changes" Only transitions involving a change in dominant plant functional type (PFT) are shown.

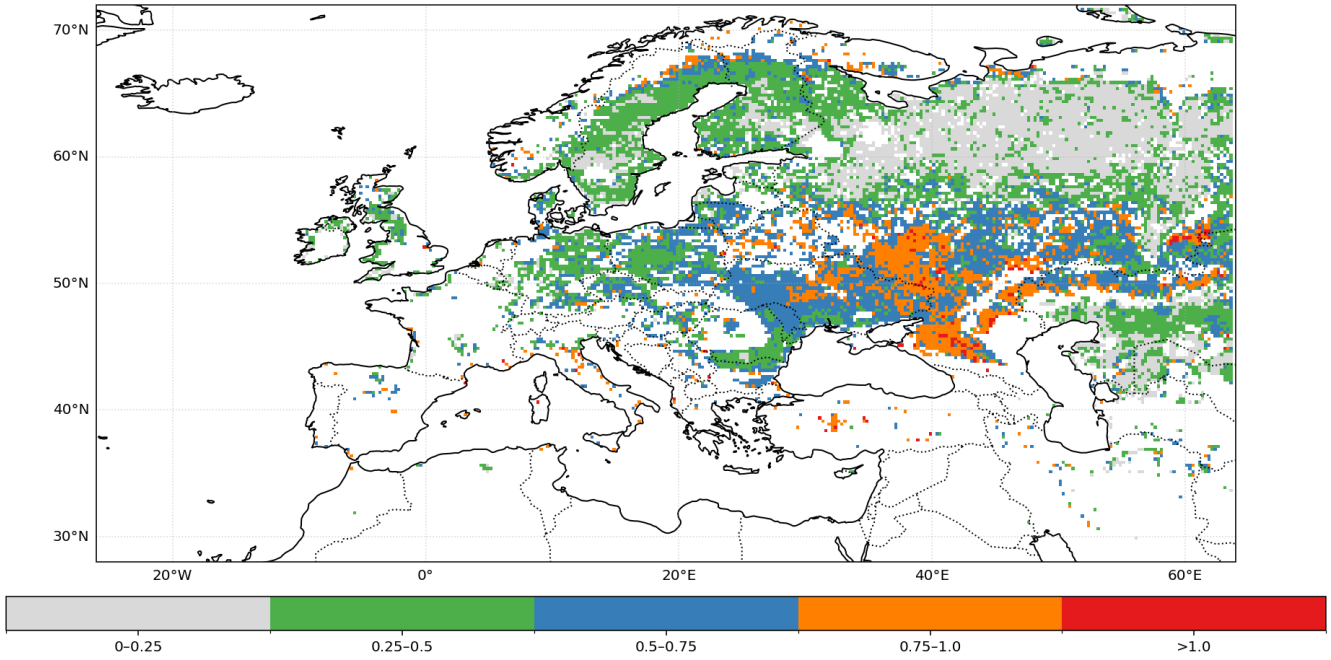

Figure S5 – Spatial distribution of grid cells with unchanged dominant PFT but modified sub-grid non-dominant vegetation fractions. The colour classes represent intervals of the sum of absolute changes in PFT fractions. Values may exceed 1 due to the use of absolute differences across multiple PFT fractions.

Effect of using CCI land cover on ISBA Leaf Area index (LAI) simulations over Europe

In order to better understand the downstream impacts of changes in land cover, we analysed the differences in leaf area index (LAI) climatology between the new land cover derived from the Climate Change Initiative (CCI) and the old land cover (ECOCLIMAP-SG and ECOCLIMAP-II, respectively). As shown in Figure S1, significant LAI variations, frequently surpassing 1 m^2 m^{-2} and occasionally exceeding 2 m^2 m^{-2} in certain regions of Spain and France, demonstrate the substantial sensitivity of the modelled vegetation state to land cover inputs. These LAI differences are consistent with transitions in land cover classes. For instance, a transition from bare soil or rocks in ECOCLIMAP-II to crops or deciduous forests in ECOCLIMAP-SG results in a larger simulated LAI. Decreases in LAI are also observed in urban areas, as larger cities are better represented in ECOCLIMAP-SG.

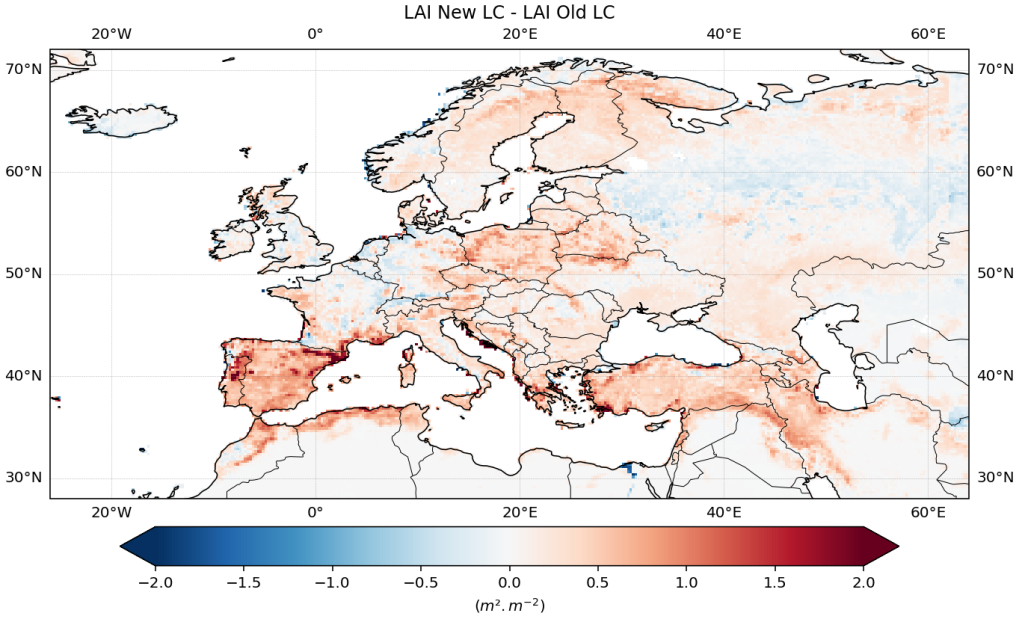

Figure S6 – Mean LAI differences between ISBA simulations using CCI land cover vs. pre-existing LC ("New LC" and "Old LC",respectively), from 2019 to 2022.

SWE model performance: ubRMSD

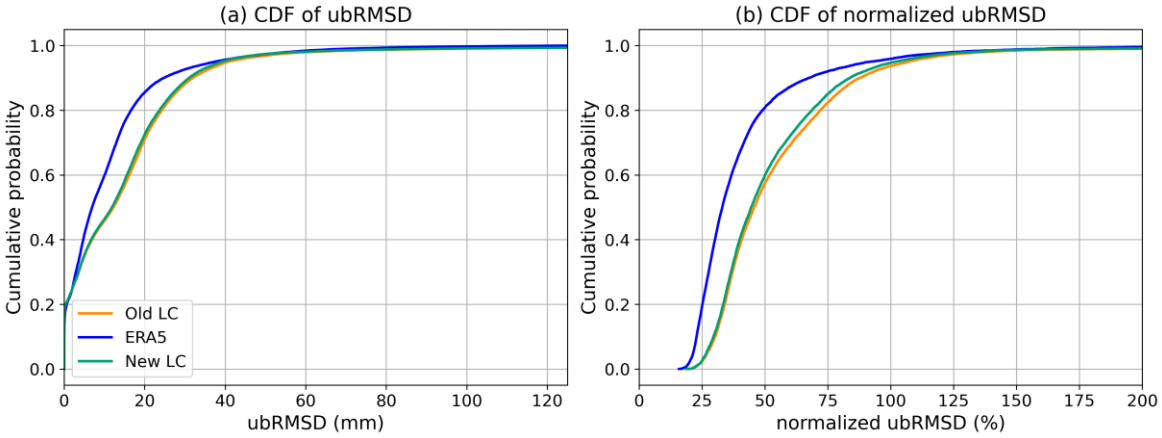

Figure S7 – Cumulative distribution functions (CDFs) of ubRMSD for SWE simulations from Old LC, New LC, and ERA5 (red, green, and blue, respectively), benchmarked against CCI SWE over the whole European domain for the period 2010–2022.

Possible CCI SWE saturation

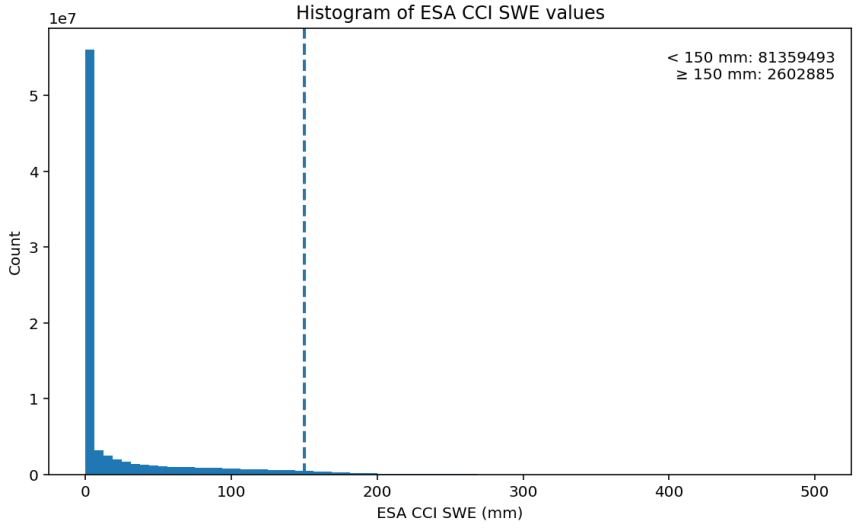

Figure S8 – Statistical distribution of SWE values in the ESA CCI dataset over the evaluation domain, from 2010 to 2022.