Supplementary Material

Supplementary List 1. List of land cover classes and their description as in the land cover map GlobCover 2009.

1 irrigated croplands
2 rainfed croplands
3 mosaic cropland (50-70%) - vegetation (20-50%)
4 mosaic vegetation (50-70%) - cropland (20-50%)
5 closed broadleaved evergreen forest
6 closed broadleaved deciduous forest
7 open broadleaved deciduous forest
8 closed needleleaved evergreen forest
9 open needleleaved decid. or evergr. forest
10 mixed broadleaved and needleleaved forest
11 mosaic shrubland (50-70%) - grassland (20-50%)
12 mosaic grassland (50-70%) - shrubland (20-50%)
13 closed to open shrubland
14 closed to open herbaceous vegetation
15 sparse vegetation
16 closed to open forest regulary flooded
17 closed forest or shrubland permanently flooded
18 closed to open grassland regularly flooded
19 artificial surfaces
20 bare areas
21 water bodies
22 permanent snow and ice
23 undefined

Supplementary List 2. List of land cover classes and their description as in the land cover map GLC2000.

1 evergreen broadleaf tree
2 deciduous broadleaf tree closed
3 deciduous broadleaf tree open
4 evergreen needleleaf tree
5 deciduous needleleaf tree
6 mixed leaf tree
7 fresh water flooded tree
8 saline water flooded tree
9 mosaic tree / other nat.veg.
10 burnt tree cover

11 evergreen shrubs closed-open
12 deciduous shrubs closed-open
13 herbaceous cover closed-open
14 sparse herbaceous or grass
15 flooded shrub or herbaceous
16 cultivated & managed areas
17 mosaic crop/tree/natural veg.
18 mosaic crop/shrub or grass
19 bare areas
20 water bodies
21 snow & ice
22 artificial surfaces
23 undefined

Supplementary List 3. List of land cover classes and their description as in the land cover map CCI38.

1 No data
2 Cropland, rainfed
3 Herbaceous cover
4 Tree or shrub cover
5 Cropland, irrigated or post-flooding
6 Mosaic cropland (>50%) / natural vegetation (tree, shrub, herbaceous cover) (<50%)
7 Mosaic natural vegetation (tree, shrub, herbaceous cover) (>50%) / cropland (<50%)
8 Tree cover, broadleaved, evergreen, closed to open (>15%)
9 Tree cover, broadleaved, deciduous, closed to open (>15%)
10 Tree cover, broadleaved, deciduous, closed (>40%)
11 Tree cover, broadleaved, deciduous, open (15-40%)
12 Tree cover, needleleaved, evergreen, closed to open (>15%)
13 Tree cover, needleleaved, evergreen, closed (>40%)
14 Tree cover, needleleaved, evergreen, open (15-40%)
15 Tree cover, needleleaved, deciduous, closed to open (>15%)
16 Tree cover, needleleaved, deciduous, closed (>40%)
17 Tree cover, needleleaved, deciduous, open (15-40%)
18 Tree cover, mixed leaf type (broadleaved and needleleaved)
19 Mosaic tree and shrub (>50%) / herbaceous cover (<50%)
20 Mosaic herbaceous cover (>50%) / tree and shrub (<50%)
21 Shrubland
22 Shrubland evergreen
23 Shrubland deciduous
24 Grassland
25 Lichens and mosses
26 Sparse vegetation (tree, shrub, herbaceous cover) (<15%)
27 Sparse tree (<15%)
28 Sparse shrub (<15%)
29 Sparse herbaceous cover (<15%)

30 Tree cover, flooded, fresh or brakish water
31 Tree cover, flooded, saline water
32 Shrub or herbaceous cover, flooded, fresh/saline/brakish water
33 Urban areas
34 Bare areas
35 Consolidated bare areas
36 Unconsolidated bare areas
37 Water bodies
38 Permanent snow and ice

Supplementary List 4. List of land cover classes and their description as in the land cover map ECOCLIMAP.

1 : Sea and ocean
2 : Inland waters
3 : Rivers
4 : Bare land
5 : Rocks
6 : Permanent snow and ice
7 : Urban and built-up

8 : Tropical undefined islands
9 : Subpolar undefined islands

ENF = Evergreen Needleleaf Forest
10 : S-America cool ENF
11 : Boreal ENF
12 : Asia subtropical ENF
13 : American Continental ENF
14 : American Subtropical ENF
15 : American Cool Marine ENF

EBF = Evergreen Broadleaf Forest
16 : Africa Equatorial EBF
17 : Africa Tr. wind EBF
18 : Oceanian Equatorial EBF
19 : Asia tropical EBF
20 : Oceania tropical EBF
21 : Amazonian EBF
22 : SH subtropical EBF
23 : Cent. America Tr. wind EBF

DNF = Deciduous Needleleaf Forest
24 : Asian boreal DNF

DBF = Deciduous Broadleaf Forest
25 : S-America tropical DBF

26 : N-America humid continental DBF
27 : Cent. America Tr. wind DBF
28 : S-America humid subtropical DBF

MF = Mixed Forest
29 : Africa dry tropical MF
30 : S-America cool MF
31 : NH Subpolar MF
32 : NH Humid subtropical MF
33 : NH Continental MF

WL = Wood Land
34 : NH Africa WL
35 : SH Africa WL
36 : Tr. wind humid and subtrop. WL
37 : Oceanian Equatorial WL
38 : Asia wet tropical WL
39 : S-America tropical WL
40 : S-America humid subtropical WL
41 : NH Subpolar WL
42 : NH Continental WL
43 : Asia humid subtropical WL
44 : N-America Semi arid WL
45 : N-America moderate polar WL
46 : S-America moderate polar WL
47 : N-America humid subtropical WL

WG = Wooded Grassland
48 : NH Africa semiarid WG
49 : NH Africa dry tropical WG
50 : Africa dry equatorial WG
51 : SH Africa dry tropical WG
52 : Oceania tropical WG
53 : Oceania semiarid WG
54 : Oceania subtrop. cool marine WG
55 : Asia humid and subtropical WG
56 : S-America trop. and subtrop. WG
57 : S-America Tr. wind WG
58 : S-America semiarid WG
59 : NH Subpolar WG
60 : NH Continental WG
61 : Asia wet and dry tropical WG
62 : N-America semi arid WG
63 : N-America humid subtropical WG
64 : S-America moderate polar WG
65 : Cent. Amer. Tr. wind & trop. WG
66 : NH Africa dry summer subtrop. WG

CS = Closed Shrubland
67 : NH Africa arid CS
68 : NH Africa semiarid CS
69 : SH Africa semiarid CS
70 : Oceania arid CS
71 : Oceania, S-America semiarid CS
72 : Oceania Tr. wind CS
73 : SH dry summer subtropical CS
74 : Asia polar CS
75 : Asia continental CS
76 : Asia tropical CS
77 : N-America polar CS
78 : N-America continental CS
79 : NH Africa dry summer subtrop. CS

OS = Open Shrubland
80 : NH arid OS
81 : NH semiarid tropical OS
82 : SH Africa and Oceania arid OS
83 : S-America semiarid tropical OS
84 : Asia dry tropical OS
85 : NH Polar OS
86 : N-America Subpolar OS
87 : N-America semiarid continental OS

G = Grassland
88 : Africa wet Tropical G
89 : NH Africa Semiarid G
90 : SH Africa Semiarid G
91 : S-America, Oceania equatorial G
92 : S-America, Oceania Semiarid G
93 : Oceania cool littoral G
94 : Asia wet and dry tropical G
95 : NH S-America wet tropical G
96 : SH S-America wet tropical G
97 : S-America semiarid G
98 : S-America moderate polar G
99 : NH semiarid Continental G
100 : Asia Subpolar G
101 : Asia humid Continental G
102 : Asia semiarid tropical G
103 : N-America continental G
104 : Asia humid subtropical G

C = Crops
105 : NH Africa arid C
106 : NH Africa, Asia wet and dry trop. C

107 : SH Africa wet and dry tropical C
108 : SH Afr. Tr. wind & semiarid trop. C
109 : Oceania dry summer subtropical C
110 : Cent. & S-Amer., Oceania Tr. wind C
111 : S-America humid subtropical C
112 : SH S-America tropical C
113 : N-Amer., Asia semiarid continental C
114 : Asia humid continental C
115 : Asia humid subtropical C
116 : Asia subpolar C
117 : Asia semiarid tropical C
118 : N-America humid continental C
119 : N-America humid subtropical C
120 : NH dry summer subtropical C
121 : NH Africa dry summer subtropical C
122 : SH Africa dry summer subtropical C
123 : Bare soil with sparse polar vegetation

124 : Warm subtropical wetlands
125 : Subpolar wetlands

151 : Dense urban
152 : Mediterranean sub-urban
153 : Temperate sub-urban
154 : Cold sub-urban
155 : Industries and commercial areas
156 : Road and rail networks
157 : Port facilities
158 : Airport
159 : Mineral extraction, construction sites
160 : Urban parks
161 : Sport facilities

162 : Spanish crops
163 : Estremadura crops
164 : Mediterranean crops
165 : Atlantic coast crops
166 : Temperate crops
167 : Po plain crops
168 : Warm temperate crops
169 : Ukrainian crops
170 : Subpolar crops
171 : Mountain crops
172 : Central Europe crops
173 : Turkish crops

174 : Mediterranean irrigated crops

175 : Irrigated crops
176 : Rice fields

177 : Mediterranean vineyards
178 : Temperate vineyards
179 : Mediterranean fruit trees
180 : Temperate fruit trees
181 : Olive groves

182 : Temperate pastures
183 : Atlantic border pastures
184 : Central and Eastern Europe pastures
185 : Ukrainian pastures
186 : Subpolar pastures

187 : Spanish complex cultivation pattern
188 : Mediter. complex cultivation pat.
189 : Temperate complex cultivation pat.
190 : French complex cultivation pat.
191 : Balkanish complex cultivation pat.

192 : Mediterranean crops and woodland
193 : Crops and woodland
194 : French crops and woodland
195 : Balkanish crops and woodland
196 : Spanish crops and woodland
197 : Baltic states crops and woodland

198 : Agro-forestry areas

199 : Spanish broad-leaved forest
200 : Estremadura broad-leaved forest
201 : Mediterranean broad-leaved forest
202 : Atlantic coast broad-leaved forest
203 : Temperate broad-leaved forest
204 : Moutain broad-leaved forest
205 : Balkanish broad-leaved forest
206 : Subpolar broad-leaved forest
207 : Black Sea broad-leaved forest

208 : Mediterranean pines
209 : Landes forest
210 : Moutain coniferous forest
211 : Temperate coniferous forest
212 : Subpolar Taiga
213 : Russian Taiga
214 : Turkish coniferous forest

215 : Mediterranean mixed forest
216 : Atlantic coast & french mixed forest
217 : Subpolar mixed forest
218 : Mountain mixed forest
219 : Eastern Europe mixed forest

220 : Mediterranean GR
221 : Atlantic coast GR
222 : Balkanish GR
223 : Estremadura GR
224 : Subpolar GR
225 : Tundra

226 : Turkish moors
227 : Mediter. moors & heath lands
228 : Moutain moors & heath lands
229 : Atlantic coast moors & heath lands

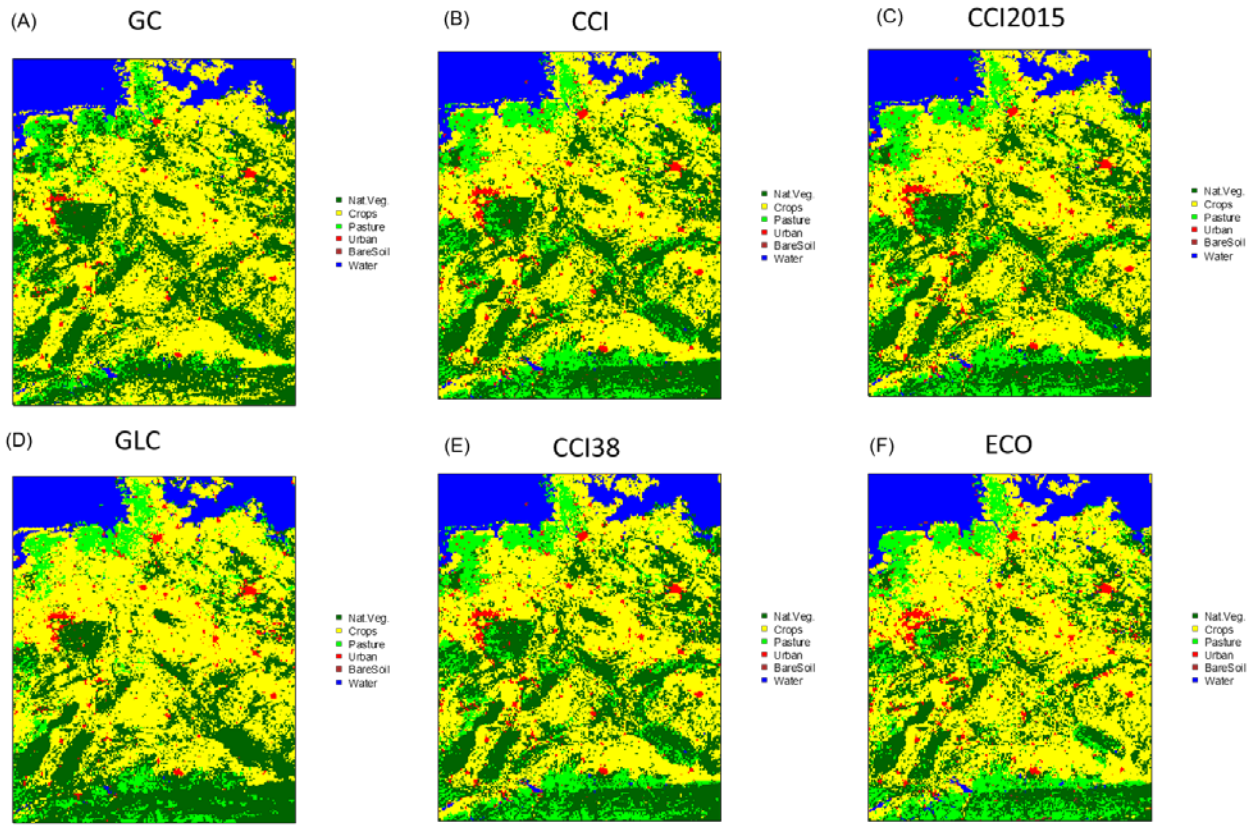
230 : Turkish shrubland
231 : Mediterranean maquis
232 : Moutain maquis

233 : Spanish woodland
234 : Mediterranean woodland
235 : Temperate woodland

236 : Sparsely vegetated areas
237 : Burnt areas
238 : Temperate wetlands
239 : Subpolar wetlands
240 : Peat bogs
241 : Salines and salt marshes

242 : Intertidal flats
243 : Coastal lagoons

Supplementary Figure 1: Land cover maps showing six dominant land cover types for the simulations GC (A), CCI (B), CCI2015 (C), GLC (D), CCI38 (E) and ECO (F).



Supplementary Table 1:

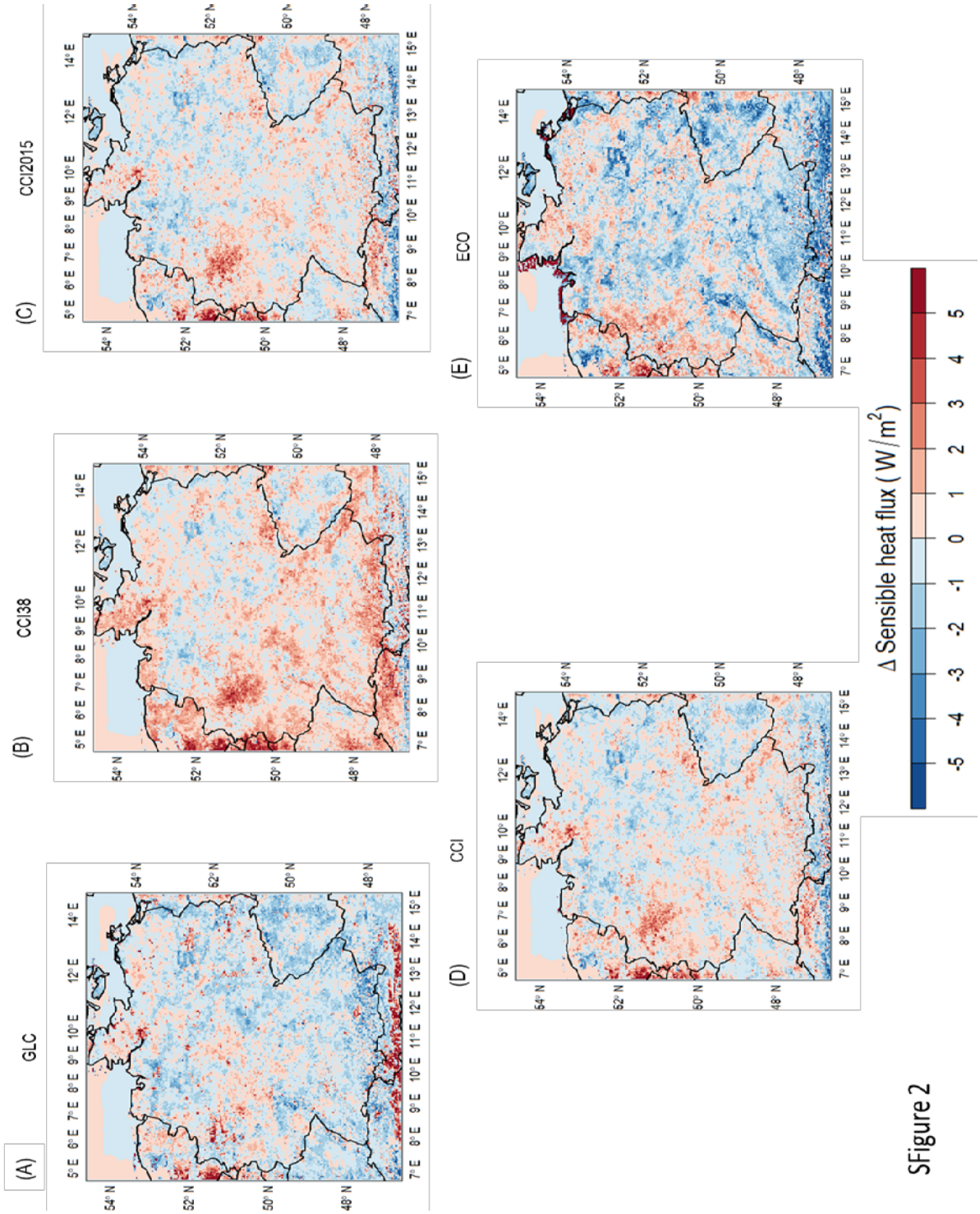
Performance statistics between the daily 2-m temperature, its maximum and minimum values, of the simulation experiments (see Table 1 for abbreviation explanations) and temperature observations based on HYRAS for the Kling-Gupta-Efficiency (KGE) index, root mean squared deviation, Pearson correlation in time and distribution added value (DAV) index. The parameters are first calculated for each grid point and then averaged over all grid points.

Statistic parameter	Simulation	Meteorological parameter		
		T2m	Tmax	Tmin
KGE	GC	0.931	0.903	0.718
	GLC	0.930	0.903	0.715
	CCI38	0.929	0.903	0.715
	CCI2015	0.928	0.903	0.713
	CCI	0.928	0.903	0.714
	ECO	0.926	0.901	0.712
RMSD	GC	1.045	3.127	2.489
	GLC	1.047	3.121	2.489
	CCI38	1.050	3.129	2.490
	CCI2015	1.052	3.127	2.490
	CCI	1.051	3.126	2.490
	ECO	1.061	3.138	2.488
CORR	GC	0.991	0.937	0.931
	GLC	0.991	0.937	0.931
	CCI38	0.991	0.937	0.931
	CCI2015	0.991	0.937	0.931
	CCI	0.991	0.937	0.931
	ECO	0.990	0.937	0.931
DAV	GC	0.0	0.0	0.0
	GLC	-0.001	0.0	-0.001
	CCI38	-0.001	0.002	-0.002
	CCI2015	-0.001	0.001	-0.002
	CCI	-0.001	0.001	-0.002
	ECO	-0.001	0.0	-0.001

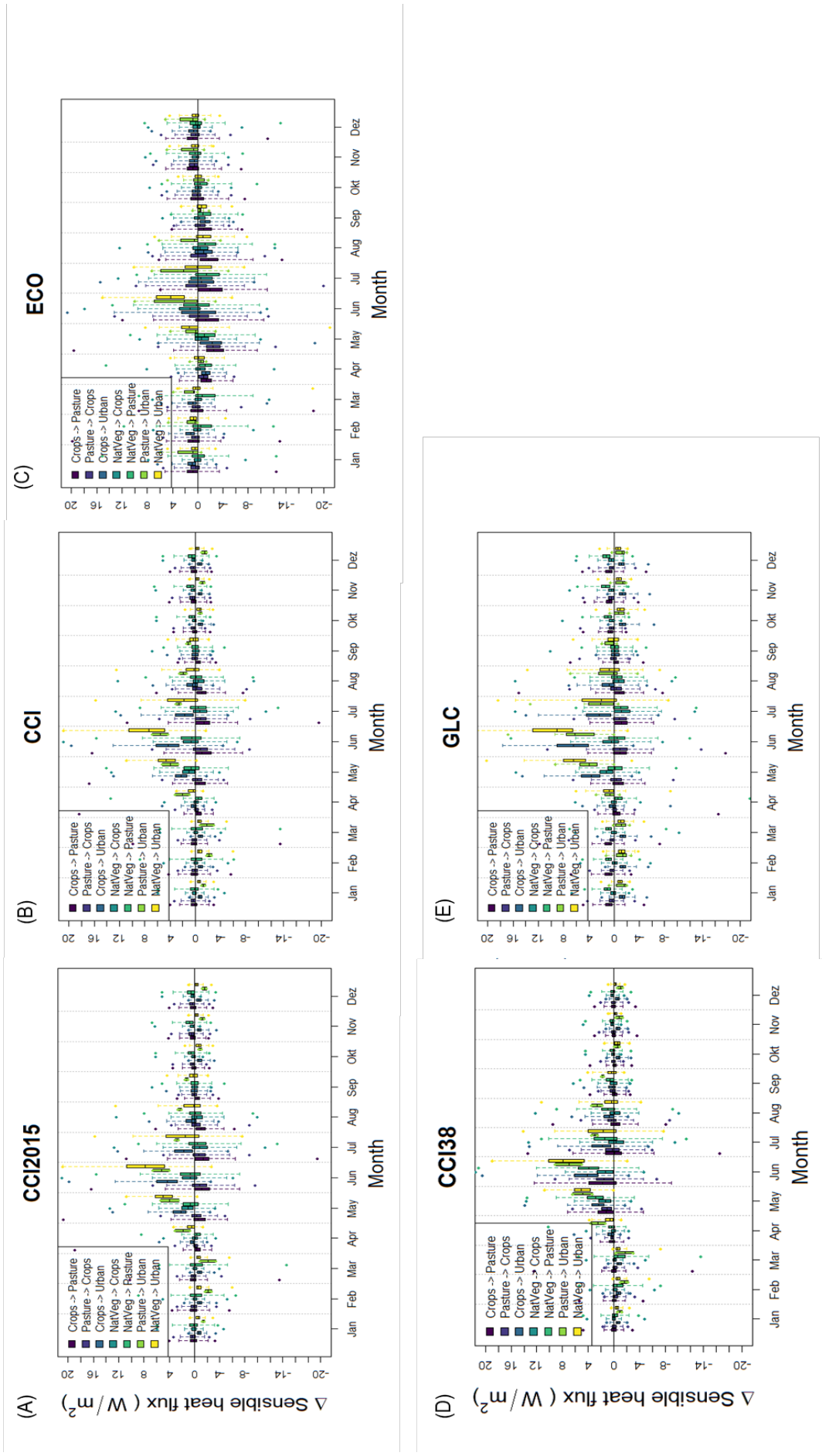
A statistical analysis of the climatic data demonstrates that the differences between simulations are small, (see STable 1). However, consistent performance discrepancies can be extracted. The performance values based on KGE for T2m are higher than 0.9 for all simulations meaning a good performance compared with observations. The highest performance value is 0.931, which is obtained with the simulation based on the GC dataset. The simulations based on GLC obtains the second highest performance value of 0.93 followed by CCI with 38 land cover classes at 0.929. The KGE of the simulation based on the CCI of 2000 and of 2015 shows a value of 0.928 and ECO is the lowest, with a value of 0.926. The RMSE for T2m is lowest at 1.045 for the simulations based on GC, followed by GLC at 1.047 and then CCI at 1.05. The spatial correlation coefficients of the six simulations with the HYRAS observational dataset are very similar at approximately 99%. The GC simulation outperforms the over simulation experiments based on DAV. The other experiments show a loss of performance as indicated by the negative DAV values.

Similar statistical results are extracted for the Tmax and Tmin climatic variables. The KGE values are higher than 0.9 for Tmax and 0.7 for Tmin for all simulations. The highest performance values are obtained with the simulation based on the GC dataset, where Tmax and Tmin equal 0.903 and 0.718, respectively. The KGE values of the simulations based on GLC and the CCI of 2000 and of 2015 are similar and equal 0.903 and 0.71, respectively. The RMSE for Tmax is lowest at 3.121 for the simulations based on GLC, followed by GC and CCI2015 at 3.127, and then CCI at 3.129. The RMSE for Tmin is lowest at 2.489 for the simulations based on GLC and GC, followed by CCI at 2.490 and then CCI2015 at 2.491. The spatial correlation coefficients of the six simulations with the HYRAS observational dataset for Tmax and Tmax are very similar approximately 94% and 93%, respectively. The simulations with GC outperforms the over simulation experiments based on DAV. The other experiments have a loss of performance indicated by the negative DAV values.

Supplementary Figure 2: Distribution of sensible heat flux (A) to (E), LAI (E) to (H), and plant cover (I) to (L) differences between the experimental simulation based on the GLC land cover map (first column), the CCI38 land cover map (second column), the CCI2015 land cover map (third column), the CCI land cover map (fourth column) and the control simulation based on the GC land cover map over the vegetation period (May to September) from 2002 to 2011. Please see Table 1 for abbreviations.



SFigure 3. Monthly differences in daily sensible heat flux due to dominant land cover changes (more than 40%) between CCI2015 and GC (A), CCI and GC (B), ECO and GC (C), CCI38 and GC (D), and GLC and GC (E) for the time period from 2002 to 2011. Cropland grid cells change into pasture type (purple), pasture grid cells change into crops (dark blue), crop grid cells change into urban type (blue), natural vegetation grid cells change into crop type (dark green), natural vegetation grid cells change into pasture type (green), pasture grid cells change into urban type (light green), and natural vegetation grid cells change into urban type (yellow). Differences are calculated for grid cells, where the listed land cover type change occurs. Please see Table 1 for abbreviations of simulation experiments.


(A)
CCI2015
(B)
CCI
(C)
ECO
(D)
CCI38
(E)
GLC
Δ Sensible heat flux (W / m²)
Month
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Okt
Nov
Dez
Crops -> Pasture
Pasture -> Crops
Crops -> Urban
NatVeg -> Crops
NatVeg -> Rasture
Pasture -> Urban
NatVeg -> Urban