applied sciences

MDPI

On the representativeness of UTOPIA land surface model for creating a database of surface layer, vegetation and soil variables in Piedmont vineyards, Italy

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S1. Supplementary material

The supplementary material is divided into four sections, each of them containing:

1. the statistics of the input data used for the UTOPIA simulations: observations carried out in vineyards are compared with GLDAS2.0 and GLDAS2.1;

2. all figures referred to each simulation listed in Table 3; figures represent statistics of the simulations and their data are expressed in form of violin plots evaluated with the software R;

3. the time series of simulated and observed variables for which observed data were sufficient to show the time trend of daily values during a vegetative season;

4. a table containing the correlation coefficients between observed and simulated data in experiments EXP1-3.

S1.1 Input data statistical analysis

In order to understand how differences in input data could influence output data, in the following tables the statistical analysis about some input data are reported. For each variable and site, a first table reports the typical statistical indices (mean value, standard deviation – indicated with σ - , median, minimum, and maximum values, and range), and a second table reports the correlation coefficients among all possible couples of variables. Here, observations indicate the measurements carried out in the vineyards.

Table S1. Statistics – mean daily global solar radiation (W m^{-2}) – CF site

	Mean	σ	Median	Min	Max	Range
Observations	240.1	86.4	257.7	9.1	364.3	355.2
GLDAS2.1	236.3	72.2	256.2	38.5	323.8	285.3
GLDAS2.0	199.8	47.5	208.5	76.8	277.9	201.1

Table S2. Correlation coefficient – mean daily global solar radiation (W m^{-2}) – CF site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	0.91	0.77
GLDAS2.1	0.91	1.00	0.83
GLDAS2.0	0.77	0.83	1.00

Table S3. Statistics – mean daily global solar radiation (W m^{-2}) – CO site

	Mean	σ	Median	Min	Max	Range
Observations	154.5	97.6	157.0	1.7	330.9	329.2
GLDAS2.1	170.9	97.6	164.5	11.7	333.2	321.5
GLDAS2.0	155.6	69.5	165.7	36.0	274.9	238.9

Table S4. Correlation coefficient – mean daily global solar radiation (W m^{-2}) – CO site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	0.94	0.85
GLDAS2.1	0.94	1.00	0.88
GLDAS2.0	0.85	0.88	1.00

Table S5. Statistics – mean daily global solar radiation (W m^{-2}) – FB site

	Mean	σ	Median	Min	Max	Range
Observations	172.0	111.1	162.5	1.0	382.9	381.9
GLDAS2.1	158.9	97.8	144.7	2.3	332.3	330.0
GLDAS2.0	150.5	71.5	154.2	36.5	280.4	243.9

Table S6. Correlation coefficient – mean daily global solar radiation (W m^{-2}) – FB site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	0.95	0.86
GLDAS2.1	0.95	1.00	0.89
GLDAS2.0	0.86	0.89	1.00

Table S7. Statistics – daily cumulated precipitation (mm) – CF site

	Mean	σ	Median	Min	Max	Range
Observations	2.6	0.4	2.4	2.2	3.1	0.9
GLDAS2.1	3.5	0.6	3.2	2.7	4.3	1.6
GLDAS2.0	3.2	0.5	2.9	2.6	4.0	1.4

Table S8. Correlation coefficient – daily cumulated precipitation (mm) – CF site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.0	1.0	1.0
GLDAS2.1	1.0	1.0	1.0
GLDAS2.0	1.0	1.0	1.0

Table S9. Statistics – daily cumulated precipitation (mm) – CO site

	Mean	σ	Median	Min	Max	Range
Observations	2.4	0.3	2.4	2.0	3.0	1.0
GLDAS2.1	3.0	0.4	2.9	2.3	3.7	1.4
GLDAS2.0	3.4	0.4	3.4	2.7	4.2	1.5

Table S10. Correlation coefficient – daily cumulated precipitation (mm) – CO site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	1.00	0.99
GLDAS2.1	1.00	1.00	1.00

GLDAS2.0	0.99	1.00	1.00

Table S11. Statistics – daily cumulated precipitation (mm) – FB site

	Mean	σ	Median	Min	Max	Range
Observations	2.0	0.7	2.1	0.7	3.3	2.6
GLDAS2.1	3.1	1.1	3.1	1.1	5.2	4.1
GLDAS2.0	2.7	1.1	2.7	0.7	4.7	4.0

Table S12. Correlation coefficient – daily cumulated precipitation (mm) – FB site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	1.00	1.00
GLDAS2.1	1.00	1.00	1.00
GLDAS2.0	1.00	1.00	1.00

Table S13. Statistics – mean daily air temperature (°C) – CF site

	Mean	σ	Median	Min	Max	Range
Observations	19.3	4.5	19.9	6.3	27.0	20.7
GLDAS2.1	18.8	4.5	19.1	6.1	27.0	20.9
GLDAS2.0	19.6	3.6	20.3	8.1	27.6	19.5

Table S14. Correlation coefficient – mean daily air temperature (°C) – CF site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	0.98	0.83
GLDAS2.1	0.98	1.00	0.83
GLDAS2.0	0.83	0.83	1.00

Table S15. Statistics – mean daily air temperature (°C) – CO site

	Mean	σ	Median	Min	Max	Range
Observations	12.9	8.4	12.6	-8.8	27.7	36.5
GLDAS2.1	10.4	8.4	10.0	-6.8	25.9	32.7
GLDAS2.0	14.1	7.1	13.7	-3.6	27.9	31.5

Table S16. Correlation coefficient – mean daily air temperature (°C) – CO site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	0.99	0.95
GLDAS2.1	0.99	1.00	0.95
GLDAS2.0	0.95	0.95	1.00

Table S17. Statistics – mean daily air temperature (°C) – FB site

	Mean	σ	Median	Min	Max	Range
Observations	13.0	8.4	13.1	-8.9	28.1	37.0
GLDAS2.1	12.2	8.3	12.1	-8.6	27.5	36.1
GLDAS2.0	13.8	7.0	13.7	-3.3	27.7	31.0

Table S18. Correlation coefficient – mean daily air temperature (°C) – FB site

	Observations	GLDAS2.1	GLDAS2.0
Observations	1.00	0.99	0.95
GLDAS2.1	0.99	1.00	0.95
GLDAS2.0	0.95	0.95	1.00

S1.2 Intercomparisons of UTOPIA

Violin plots could be considered similar to box plots, except that they also show the kernel probability density of the data at different values. Typically, violin plots will include a marker for the median of the data and a box indicating the interquartile range, as in standard box plots. Thus, the sight of several violin plots listed one following the other allows to visually compare in a very easy way the distribution of the variable, the portion of the range containing most values, the mean and median values, etc. The Figures are here presented in the same sequence in which experiments have been commented in the text. Since comments are already present in the text, here only captions have been included.

S1.2.1 UTOPIA simulations compared with observations

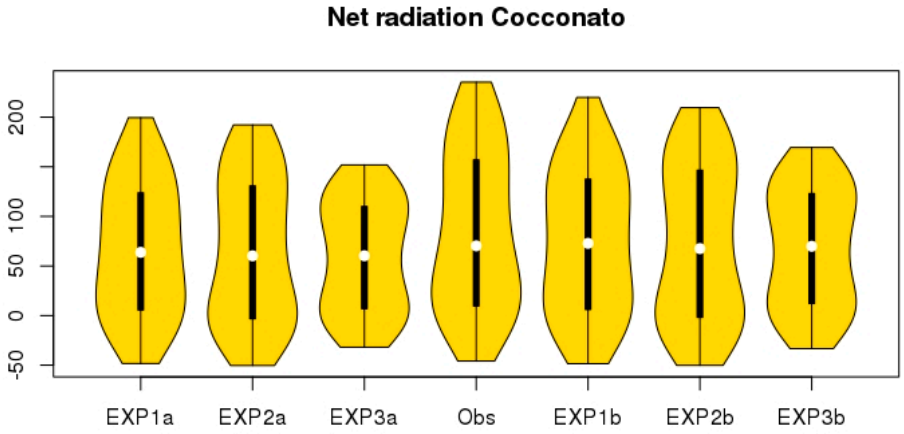

Figure S1. Violin plots of net radiation (W m^{-2}) in Cocconato site.

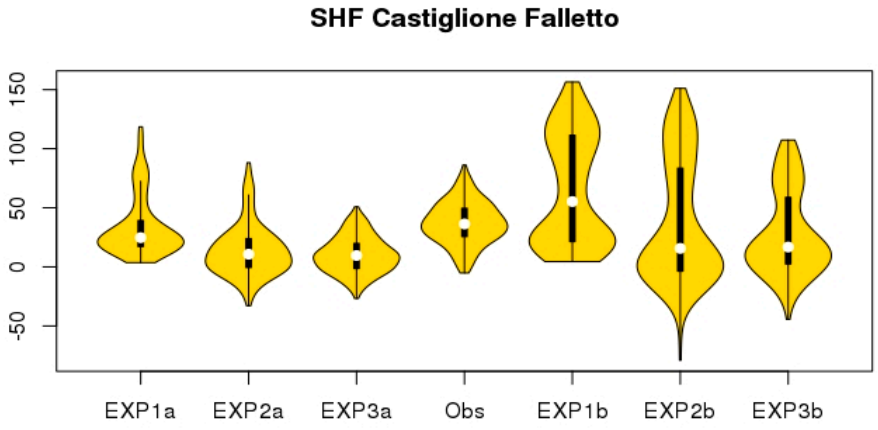

Figure S2. Violin plots of sensible heat fluxes (W m^{-2}) in Castiglione Falletto site.

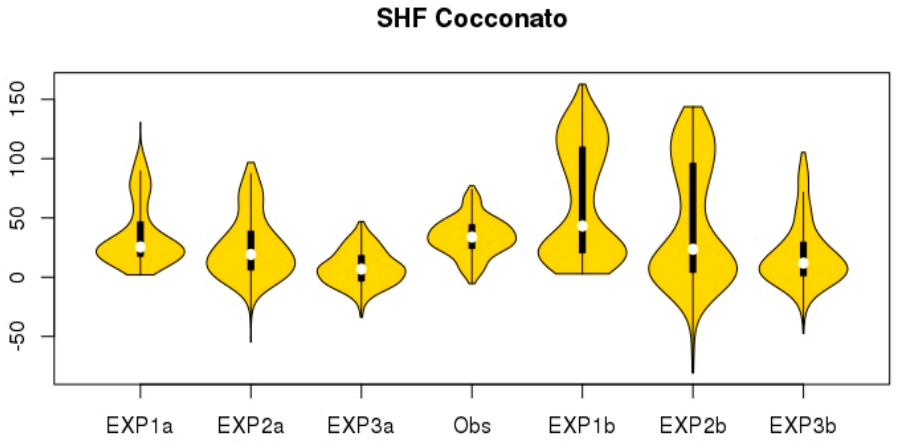

Figure S3. Violin plots of sensible heat fluxes (W m^{-2}) in Cocconato site.

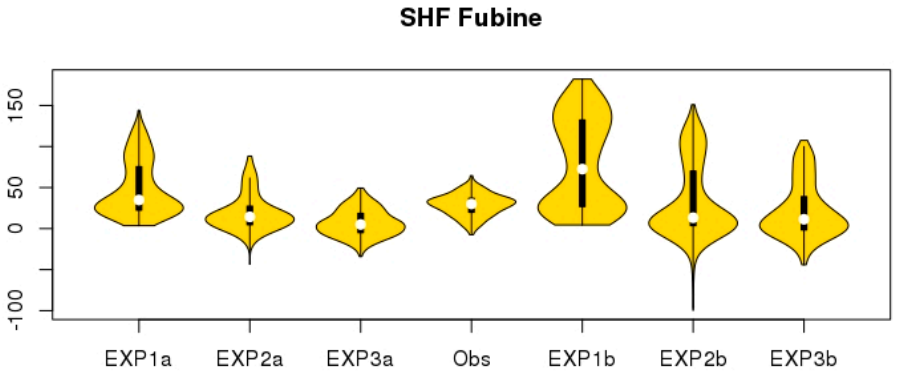

Figure S4. Violin plots of sensible heat fluxes (W m^{-2}) in Fubine site.

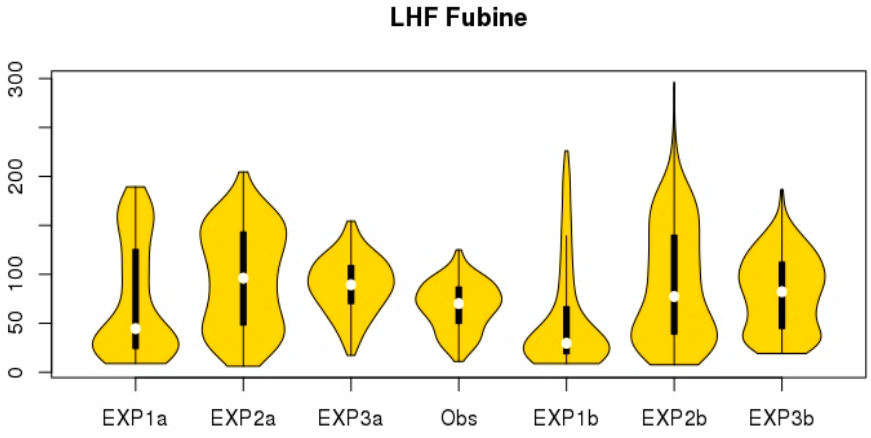

Figure S5. Violin plots of latent heat fluxes (W m^{-2}) in Fubine site.

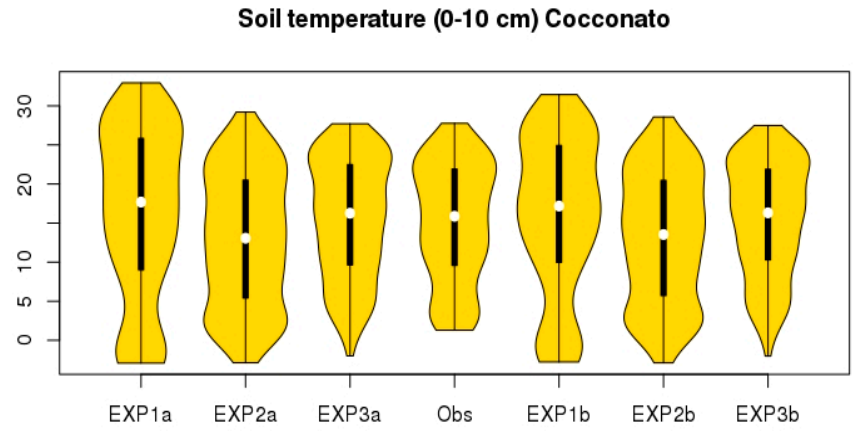

Figure S6. Violin plots of soil temperature (°C) in Cocconato site.

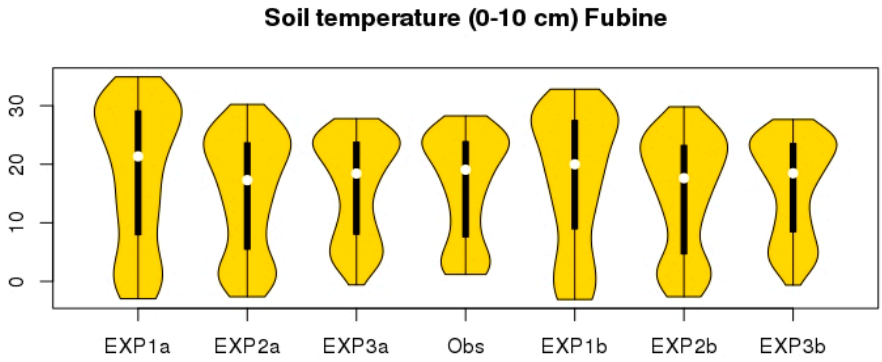

Figure S7. Violin plots of soil temperature (°C) in Fubine site.

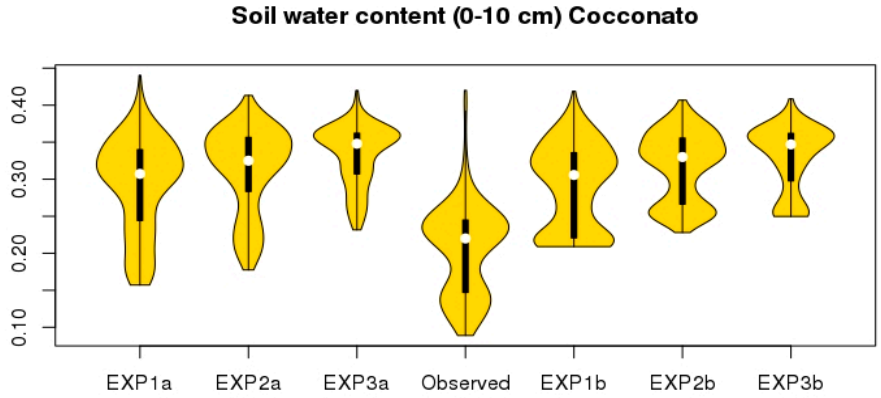

Figure S8. Violin plots of volumetric soil water content (m^3 m^{-3}) in Cocconato site.

S1.2.2 Intercomparison between UTOPIA and NOAH simulations initialized with GLDAS2.0/2.1

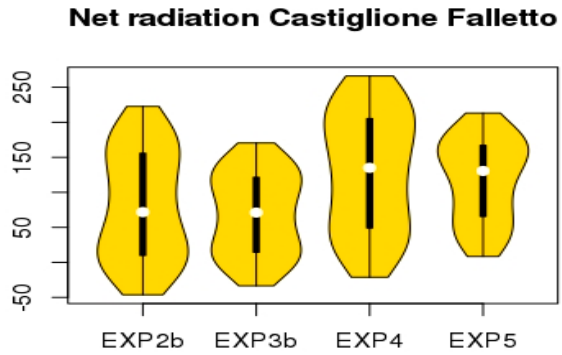

Figure S9. Violin plots of net radiation (W m^{-2}) in Castiglione Falletto site.

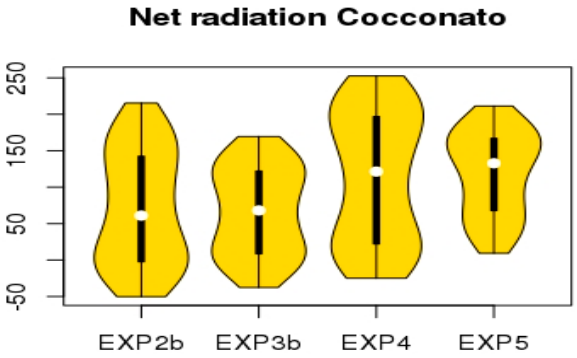

Figure S10. Violin plots of net radiation (W m^{-2}) in Cocconato site.

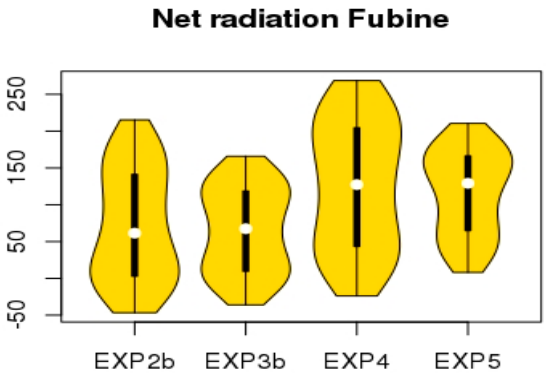

Figure S11. Violin plots of net radiations (W m^{-2}) in Fubine site.

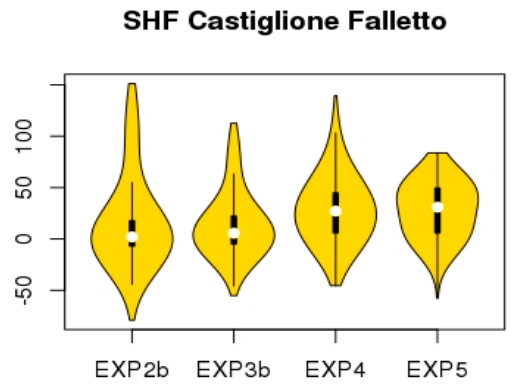

Figure S12. Violin plots of sensible heat fluxes (W m^{-2}) in Castiglione Falletto site.

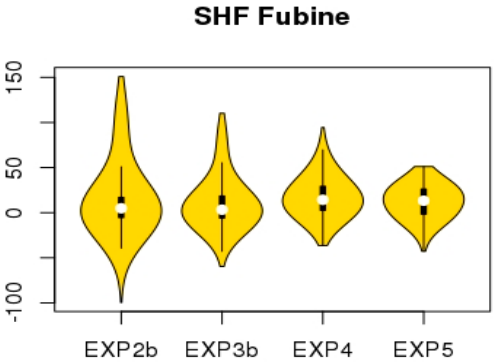

Figure S13. Violin plots of sensible heat fluxes (W m^{-2}) in Cocconato site.

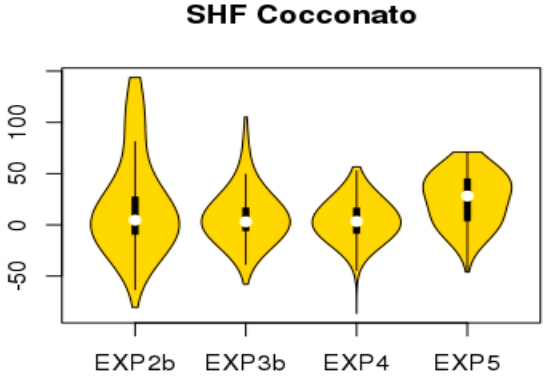

Figure S14. Violin plots of sensible heat fluxes (W m^{-2}) in Fubine site.

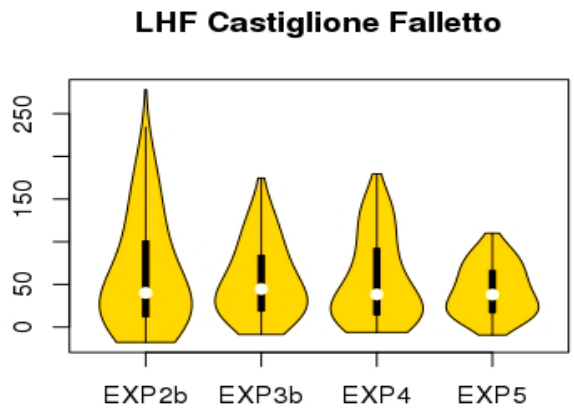

Figure S15. Violin plots of latent heat fluxes (W m^{-2}) in Castiglione Falletto site.

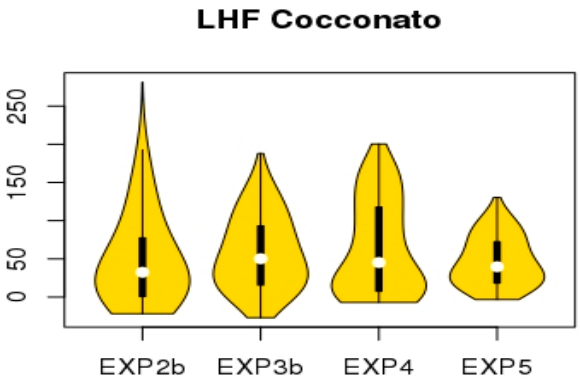

Figure S16. Violin plots of latent heat fluxes (W m^{-2}) in Cocconato site.

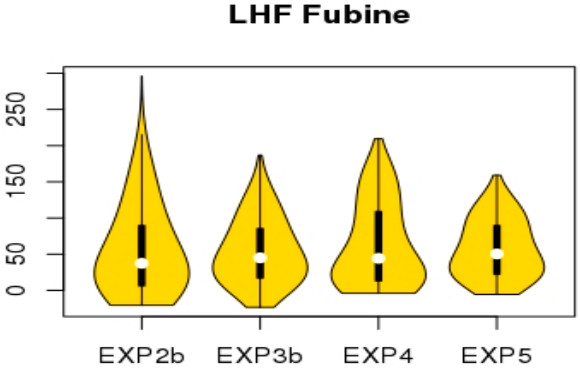

Figure S17 Violin plots of latent heat fluxes (W m^{-2}) in Fubine site.

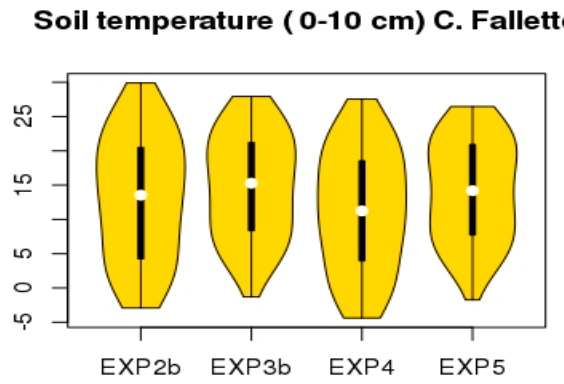

Figure S18. Violin plots of soil temperatures (°C) in Castiglione Falletto site.

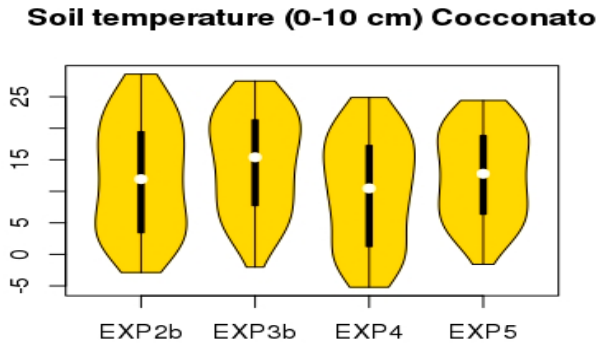

Figure S19. Violin plots of soil temperatures (°C) in Cocconato site.

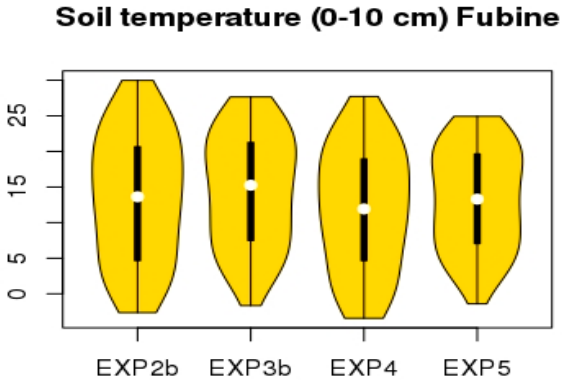

Figure S20. Violin plots of soil temperatures (°C) in Fubine site.

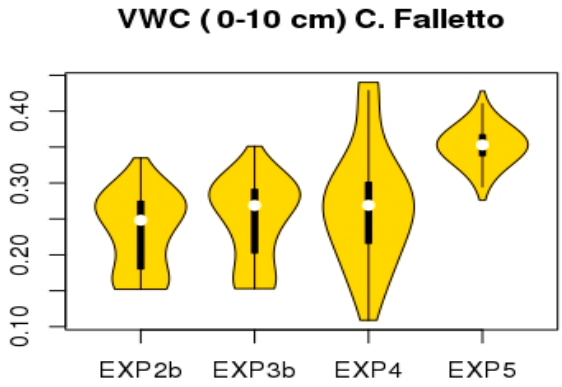

Figure S21. Violin plots of volumetric soil water content (m^3 m^{-3}) in Castiglione Falletto site.

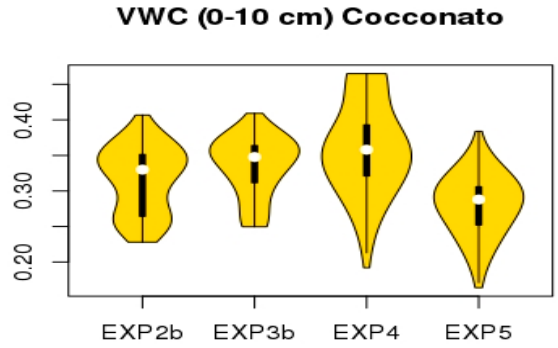

Figure S22. Violin plots of soil volumetric water content (m^3 m^{-3}) in Cocconato site.

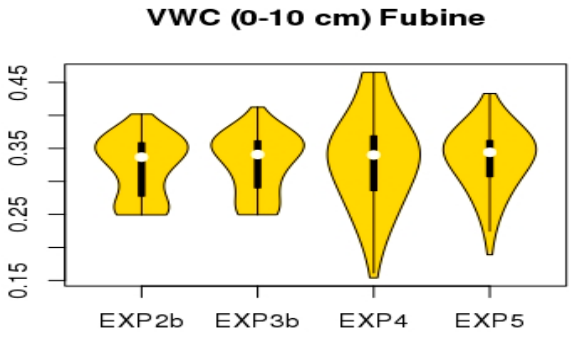

Figure S23. Violin plots of soil volumetric water content (m^3 m^{-3}) in Fubine site.

S1.3 Time trend of a term of simulated and observed variables

In this section, we display a few examples of time trend of some variables for which experimental data are sufficient to reconstruct a seasonal trend of daily values during vegetative seasons. Variables selected are: net radiation, sensible and latent heat flux, and soil temperature.

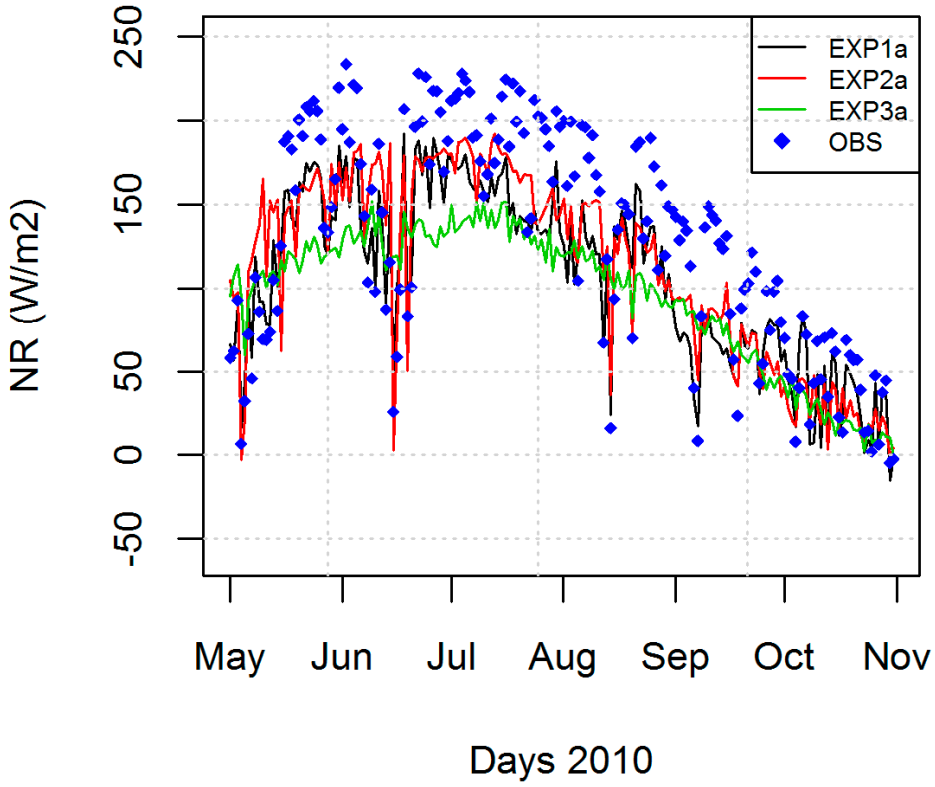

Figure S24. Time series of simulated and observed net radiation (W m^{-2}) at Cocconato site.

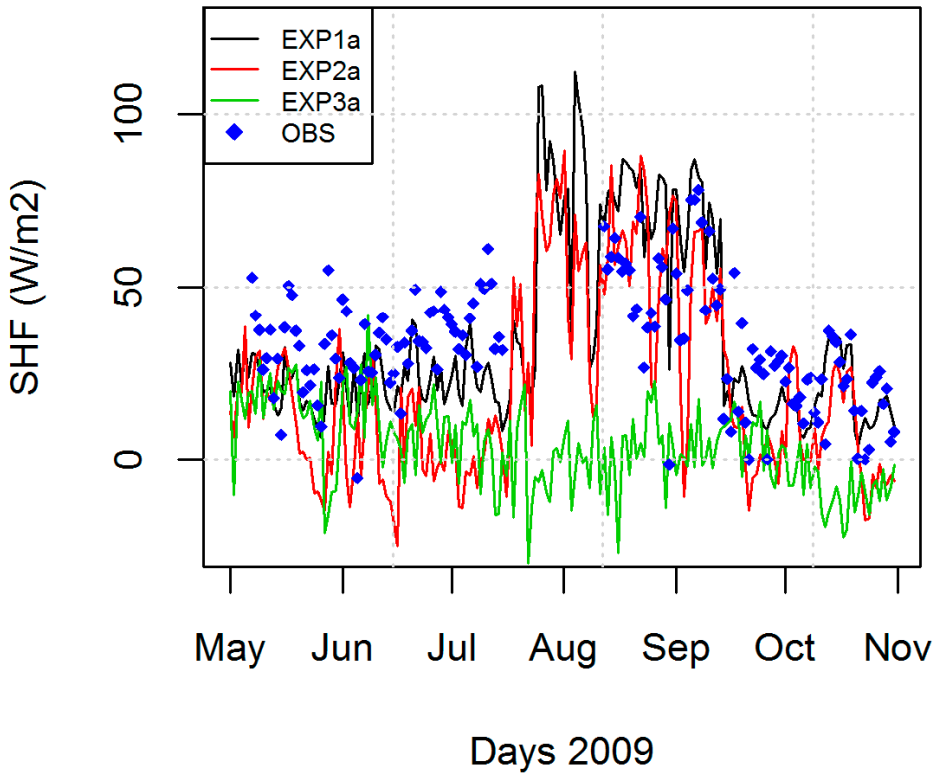

Figure S25. Time series of simulated and observed sensible heat flux (W m^{-2}) at Castiglione Falletto site.

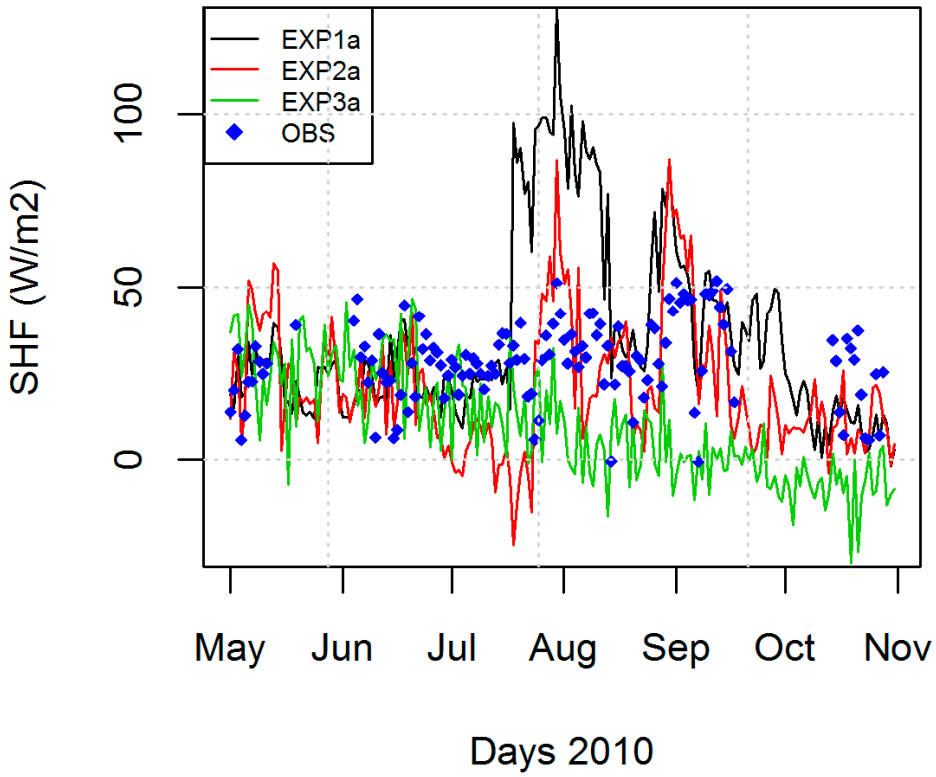

Figure S26. Time series of simulated and observed sensible heat flux (W m^{-2}) at Cocconato site.

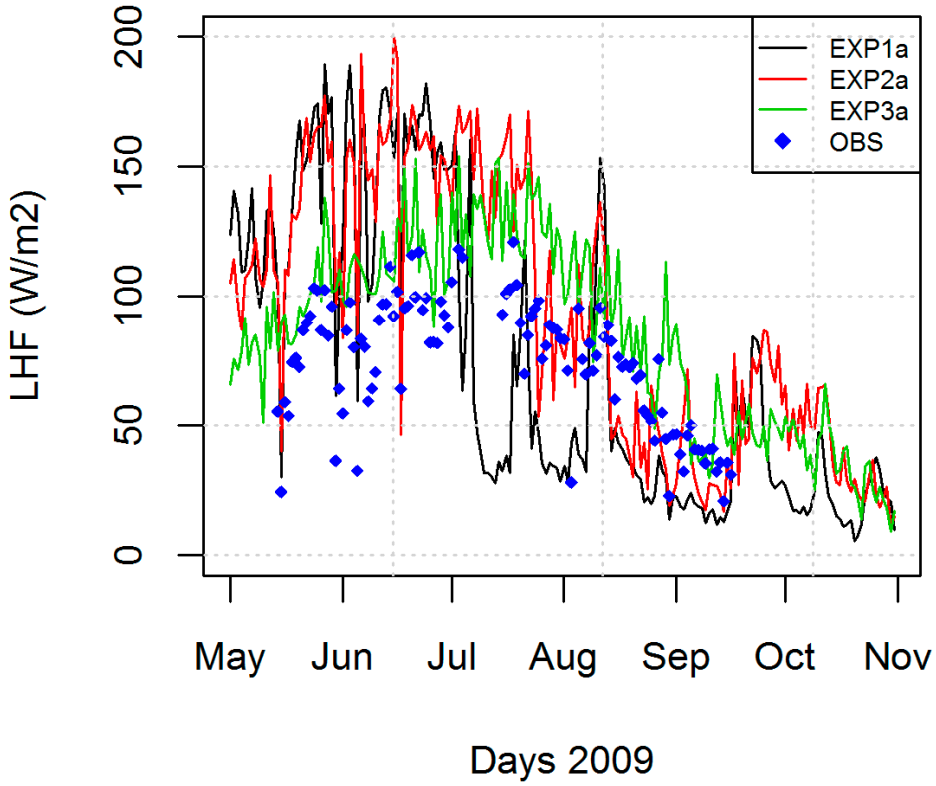

Figure S27. Time series of simulated and observed latent heat flux (W m^{-2}) at Fubine site.

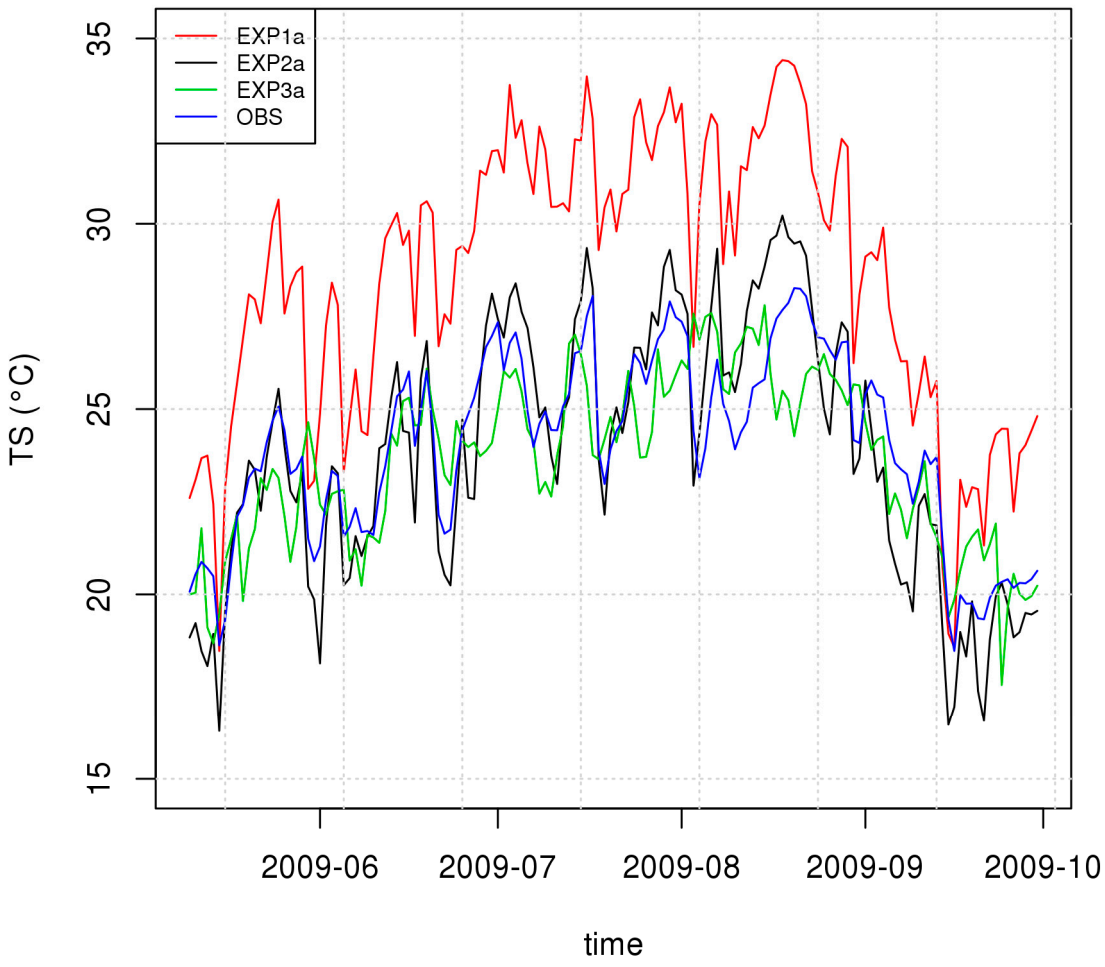

Figure S28. Time series of simulated and observed soil temperatures (°C) at Fubine site.

S1.4 Correlation coefficients

The following Table S1 reports the correlation coefficients between experimental data and UTOPIA model simulations in experiments EXP1-3, both for vineyards (a) and irrigated crops (b). The correlation has been evaluated on daily basis (e.g. using daily averages). The number of points is changing for each variable and depends on available observations: net radiation, soil temperature and moisture are those with more data, while turbulent heat fluxes are less frequent.

Table S19. Correlation coefficient between observed and simulated data in experiments EXP1-3.

	Station	Data number	EXP1a	EXP2a	EXP3a	EXP1b	EXP2b	EXP3b
RNET (W m^{-2})	CO	515	0.96	0.92	0.89	0.96	0.92	0.89
SHF (W m^{-2})	CF	271	0.60	0.32	0.10	0.49	0.23	0.21
SHF (W m^{-2})	CO	354	0.51	0.56	-0.25	0.38	0.31	0.07
SHF (W m^{-2})	FB	323	0.34	0.37	0.16	0.35	0.19	0.18
LHF (W m^{-2})	FB	268	0.48	0.72	0.70	0.16	0.32	0.14
TS (°C)	CO	494	0.99	0.98	0.98	0.99	0.98	0.98
TS (°C)	FB	400	0.99	0.99	0.98	0.99	0.99	0.98
VWC (m^3 m^{-3})	CO	427	0.81	0.69	0.66	0.74	0.65	0.58