

Supplemental material for:

**Land-Atmosphere Interactions May Have Exacerbated the Drought and Heatwave over Northern Europe during Summer 2018**

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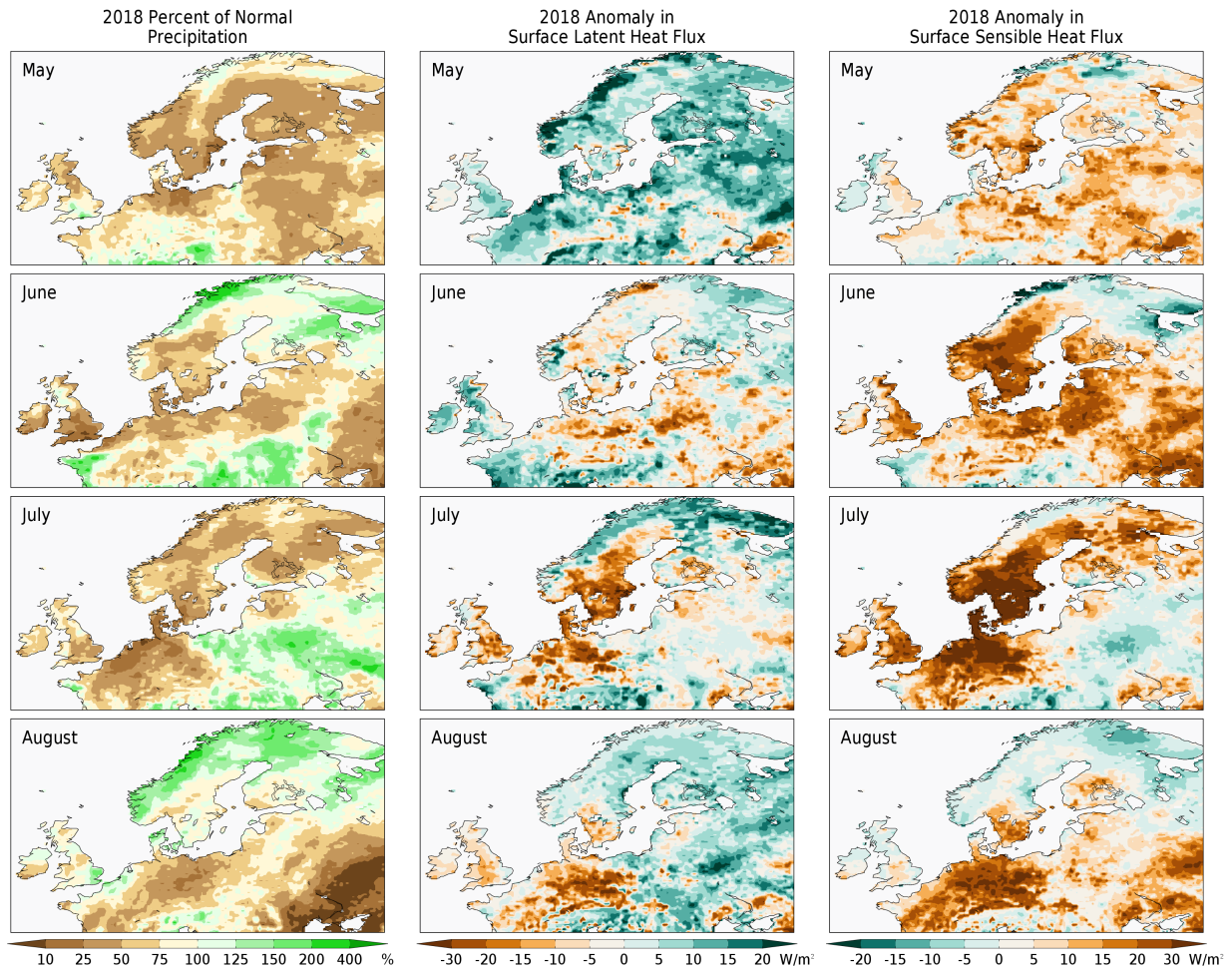
Figures S1-S8.

**Table S1:** Correlations between COSMOS stations and their encompassing ERA5 grid cells for daily time series of volumetric soil water content (VWC) and daily maximum temperature ( $T_{Max}$ ). For each year, the period 15 May through 15 October is included in the calculation; days with missing data are excluded (of 154 days, the largest number missing is 10 for VWC, 7 for  $T_{Max}$ ).

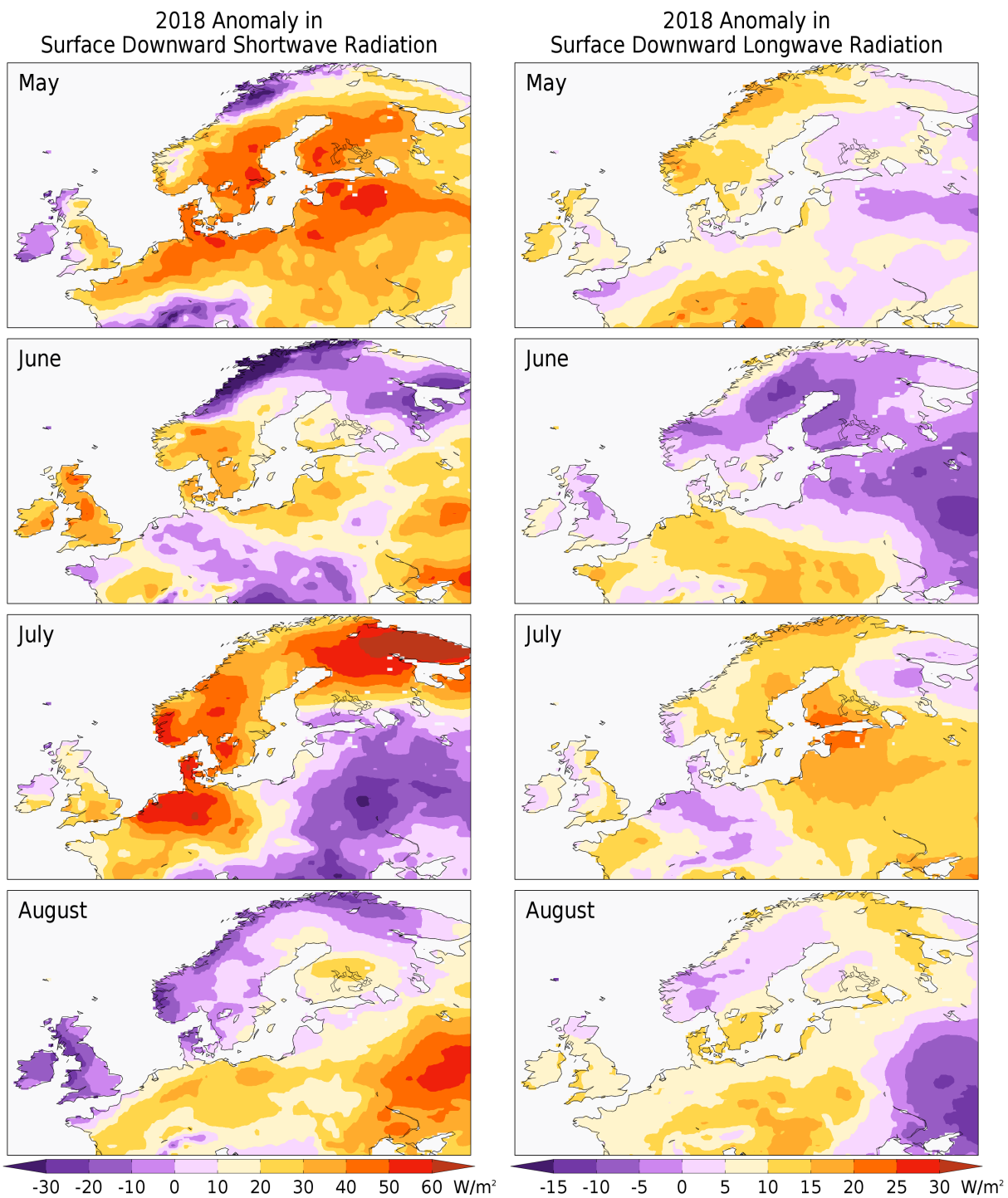
COSMOS Station	VWC 2017	VWC 2018	$T_{Max}$ 2017	$T_{Max}$ 2018
Bickley Hall	0.76	0.91	0.94	0.97
Cardington	0.83	0.66	0.94	0.97
Euston	0.73	0.86	0.95	0.97
Hadlow	0.78	0.68	0.96	0.97
Hartwood Home	0.69	0.85	0.93	0.95
Lullington Heath	0.78	0.89	0.93	0.93
Porton Down	0.81	0.89	0.95	0.96
Redhill	0.72	0.91	0.95	0.96
Riseholme	0.84	0.56	0.95	0.97
Sheepdrove	0.76	0.87	0.96	0.96

**Table S2:** Correlations between UKCEH flux towers and their encompassing ERA5 grid cells for daily time series of volumetric soil water content (VWC), latent heat flux (LHF), sensible heat flux (SHF), evaporative fraction (EF; values excluded if not in range  $-0.1 \leq EF \leq 1.25$ ), net radiation ( $R_{Net}$ ), 2m air temperature ( $T_{2m}$ ), and precipitation (Prec). For each year, the period 15 May through 15 October is included in the calculation; days with missing data are excluded (7-18% missing for EF, otherwise 0-2% missing except 11% for 2018 VWC at Great Fen).

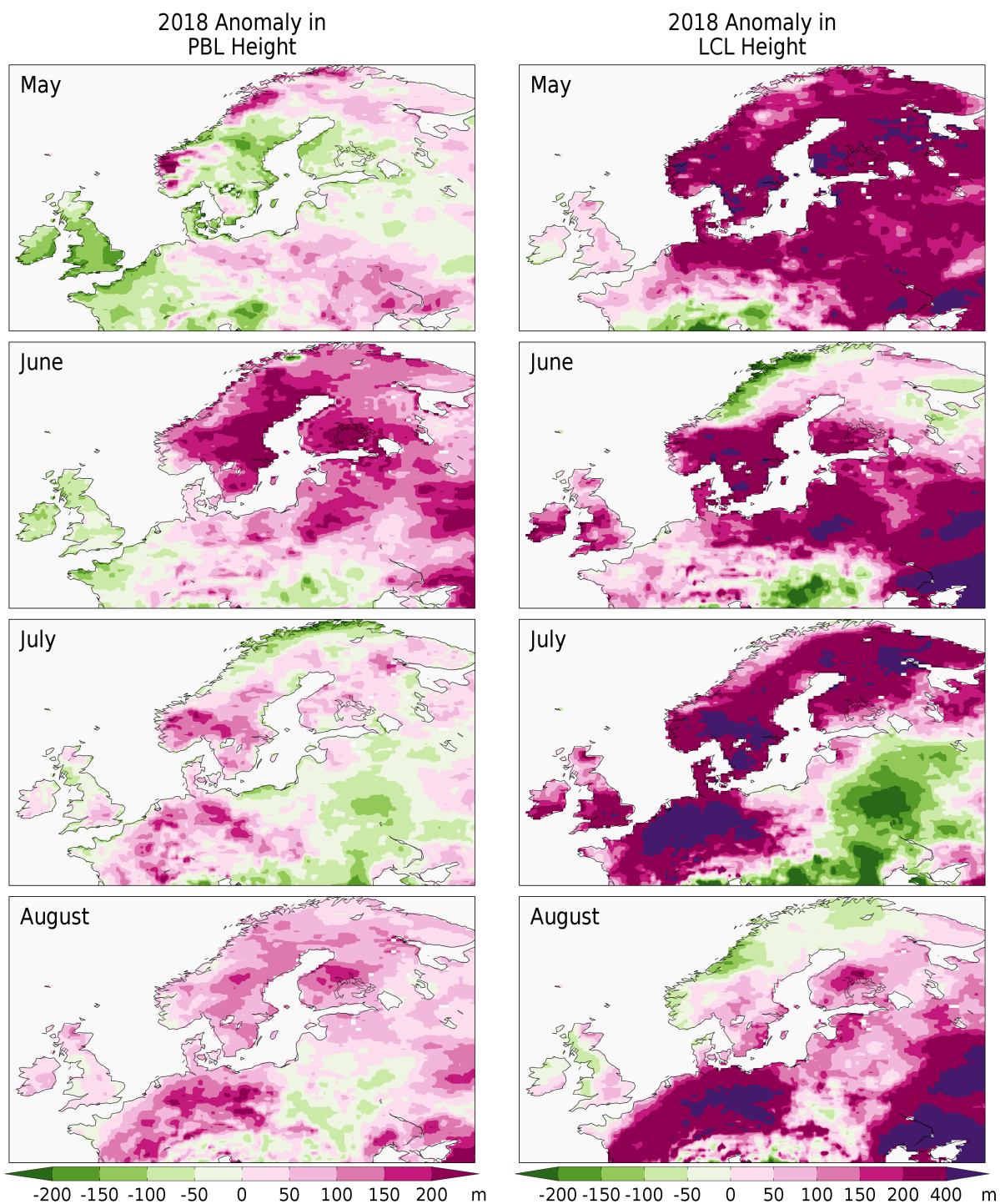
Flux Tower	Year	VWC	LHF	SHF	EF	$R_{Net}$	$T_{2m}$	Prec.
Sheepdrove	2017	0.78	0.84	0.77	0.69	0.88	0.99	0.89
	2018	0.70	0.68	0.86	0.68	0.90	0.99	0.78
Great Fen	2017	0.52	0.80	0.73	0.54	0.87	0.98	0.67
	2018	0.65	0.78	0.84	0.74	0.93	0.98	0.77



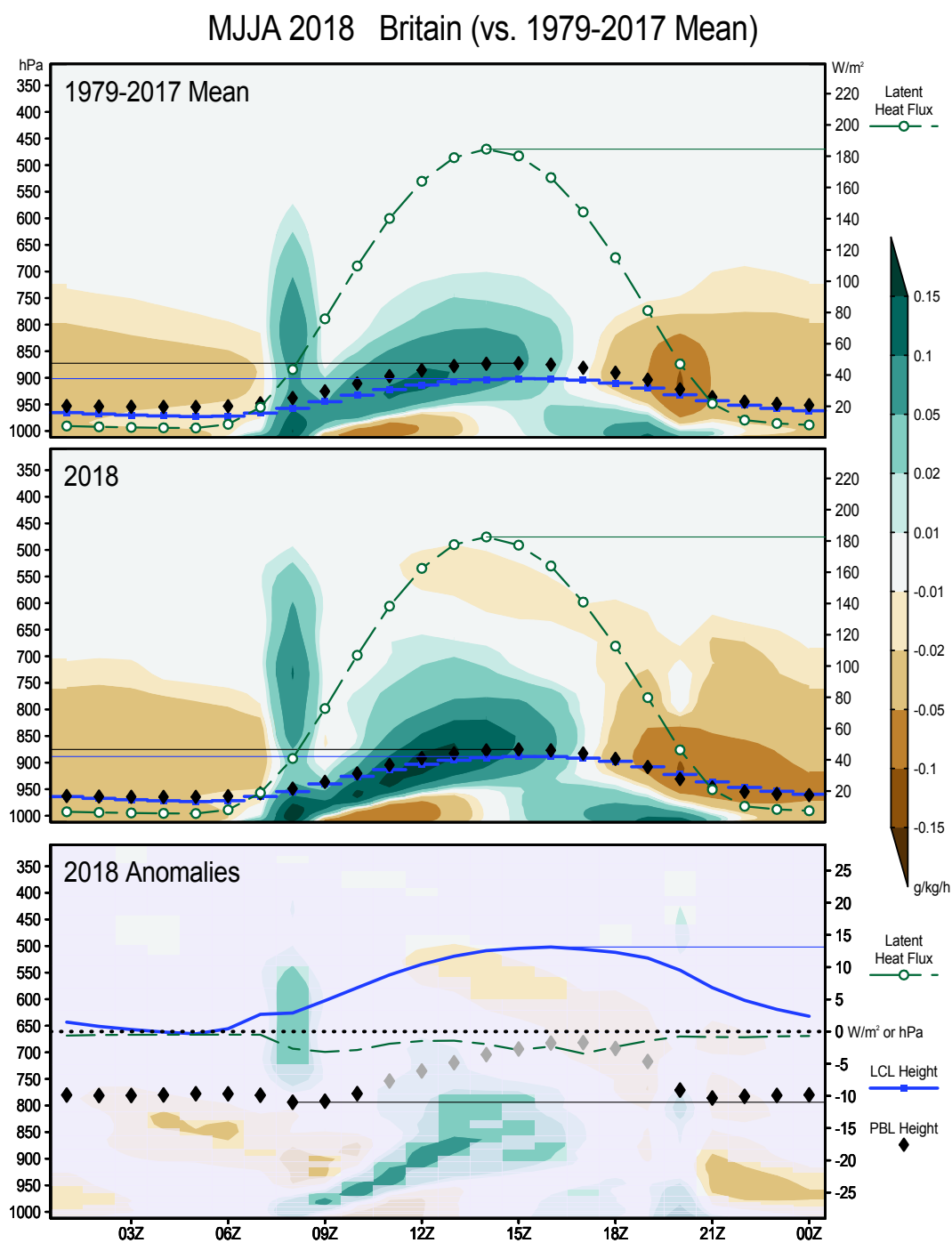
**Figure S1:** As in Figure 4, for monthly anomalies in precipitation (left column, as a percentage of normal for each month); surface latent heat flux (middle column) and surface sensible heat flux (right column).



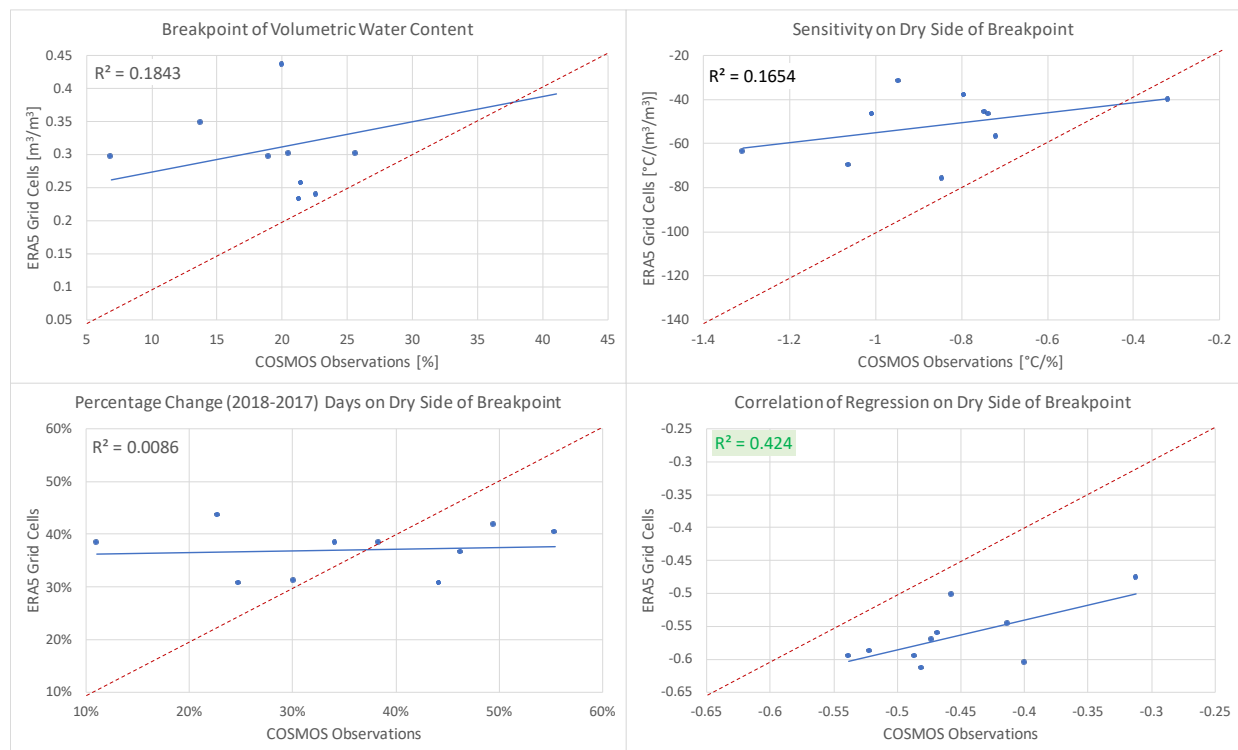
**Figure S2:** As in Figure 4, for monthly anomalies in surface downward shortwave radiation (left column) and surface downward longwave radiation (right column).



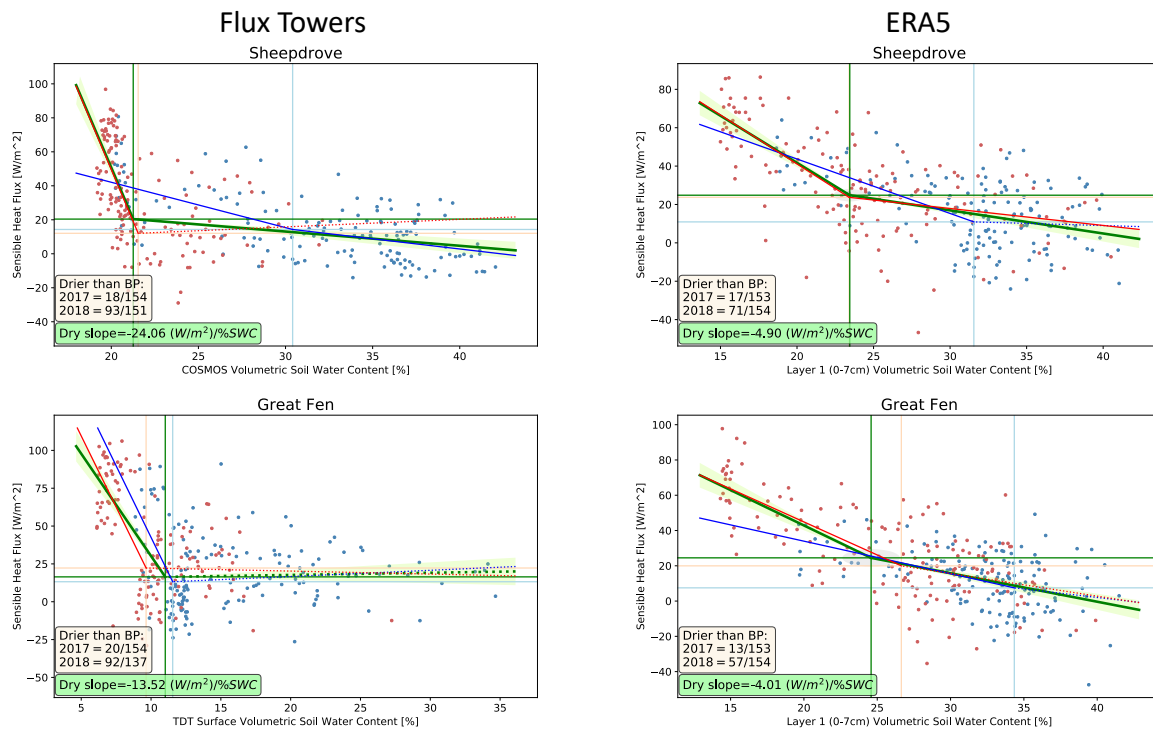
**Figure S3:** As in Figure 4, for monthly anomalies in daily mean ERA5 diagnostic planetary boundary layer height (left column) and daily mean lifted condensation level (right column).



**Figure S4:** As in Figure 8 for moisture budget terms. Shading is for changes in water vapor content (specific humidity), and the lines and/or symbols are as indicated. Peculiar vertical features around 08 and 20UTC are artifacts of the 12-hour data assimilation cycle.

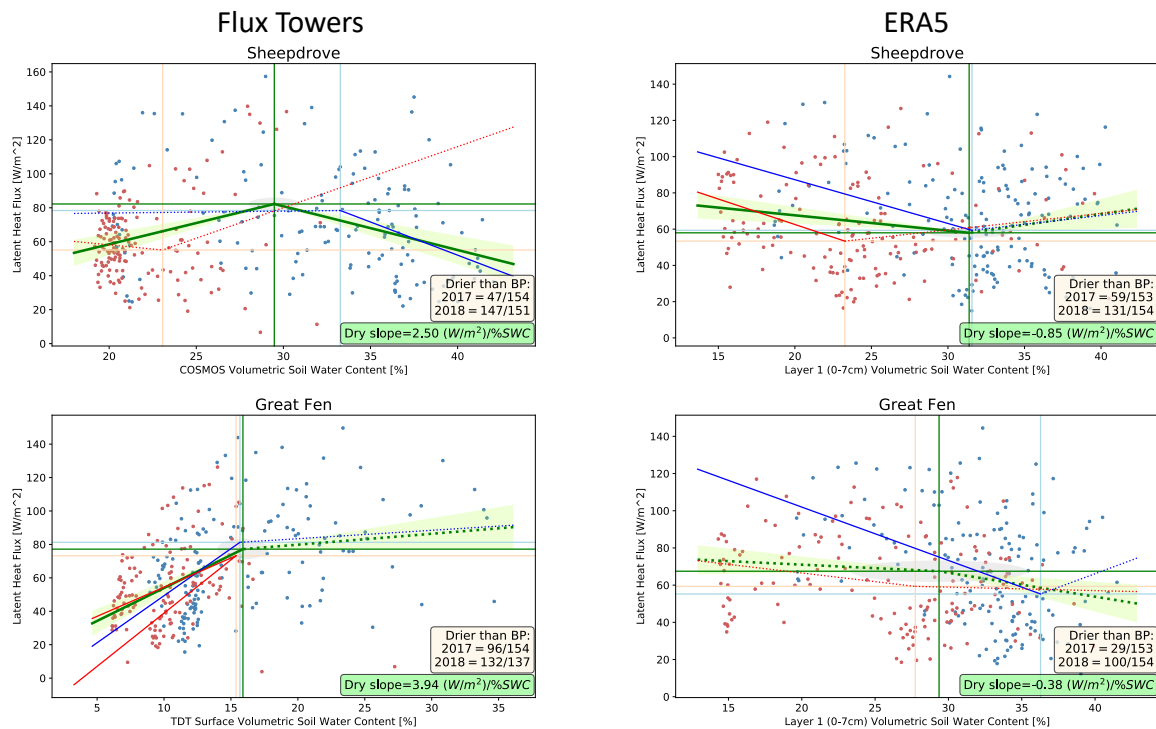


**Figure S5:** Comparison of selected breakpoint statistics between COSMOS stations and ERA5 grid cells containing each station; The estimated value of near-surface volumetric soil water content at the breakpoint (upper left); the increase in the number of dry days in 2018 compared to 2017 (lower left), the slope of the regression of daily maximum temperature on volumetric soil water content on the dry side of the breakpoint (upper right); and the correlation of that regression (lower right). In each panel, the dotted red line represents  $X=Y$ , perfect agreement between COSMOS and ERA5 data. The  $R^2$  value shows the goodness of fit of the blue line to the points.

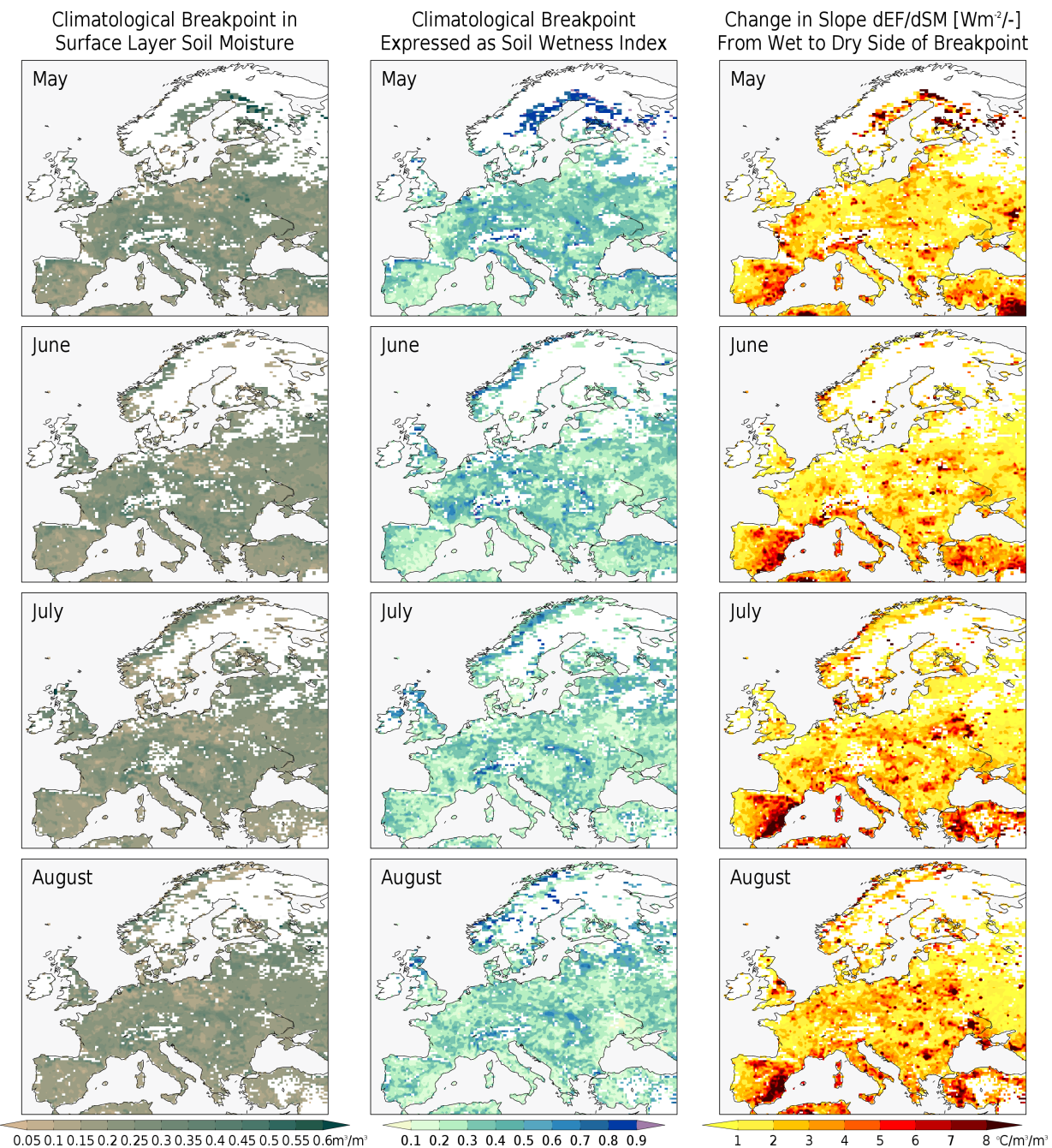


**Figure S6:** As in Figure 11 for sensible heat flux as the dependent variable.





**Fig S7:** As in Figure 11 for latent heat flux as the dependent variable.



**Fig S8:** As in Figure 6 for breakpoint of evaporative fraction (EF) versus volumetric soil moisture.