

Supplementary Information

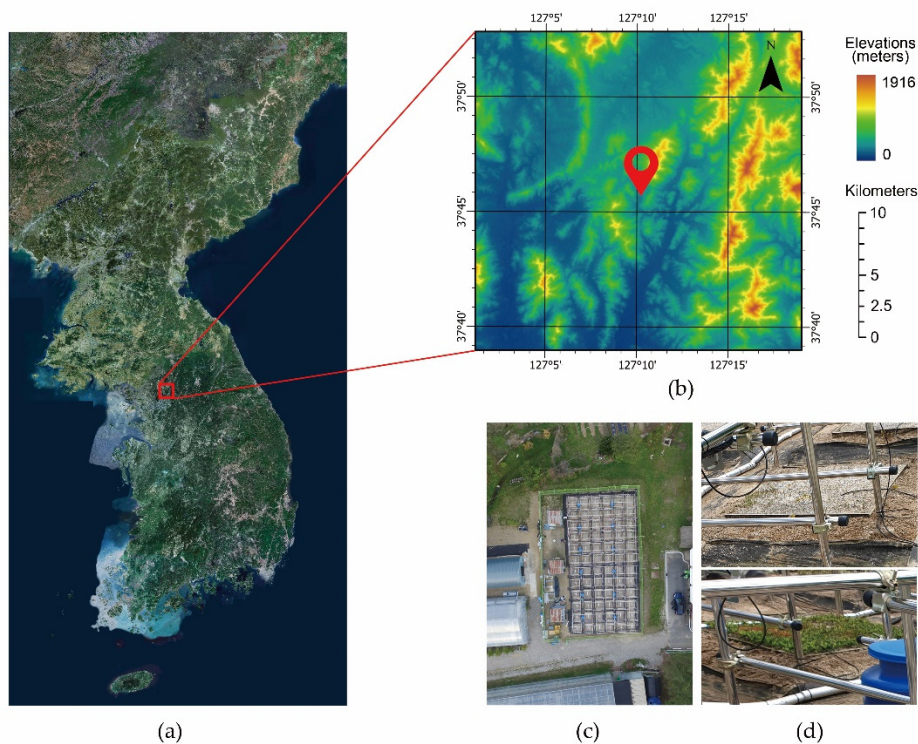
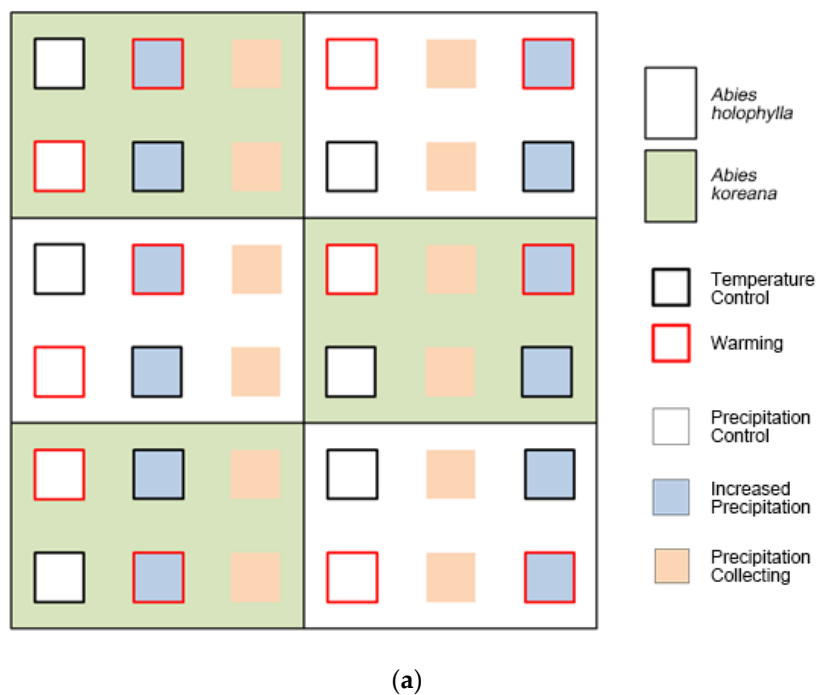
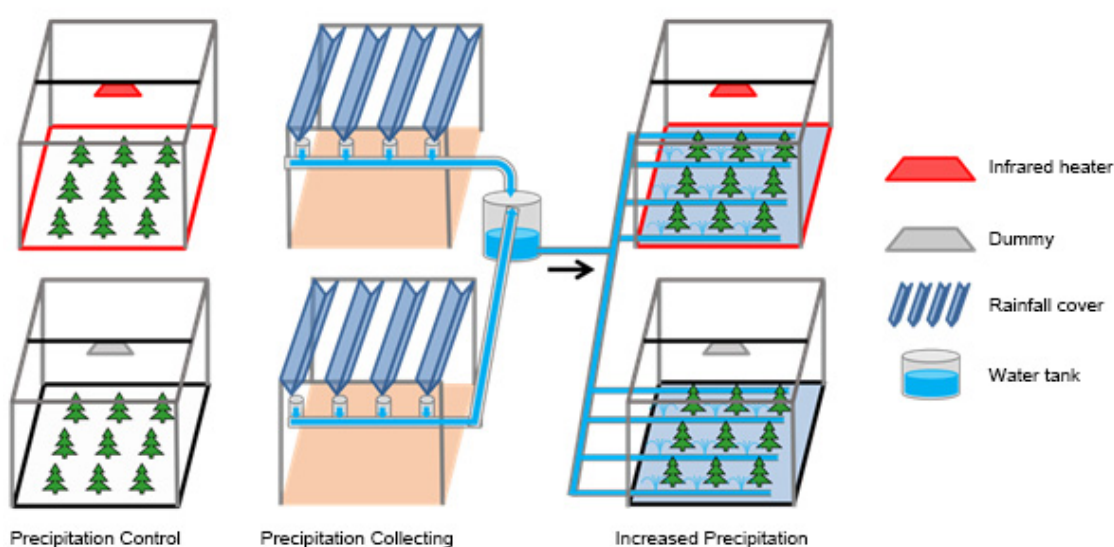


Figure S1. (a) Satellite image of Korea, (b) Digital Elevation Model (DEM) of the study site, (c) aerial photo of the open-field experimental site, and (d) photos of the seedlings. Additional details on the experimental layout are provided in Figure S2.





(b)

Figure S2. (a) Layout of the experimental plots and (b) design of the experimental warming and increased precipitation system.**Table S1.** Results (p-values) of the initial ANOVA testing for the main and interaction effects of the experimental factors on the physiological (A, E, gs, Chl, Ci/Ca, and A/Ci) and growth (height and RCD) parameters of *Abies holophylla* and *Abies koreana* seedlings per month of assessment.

	Physiology											
	A				E				gs			
	Jul	Aug	Sep	Oct	Jul	Aug	Sep	Oct	Jul	Aug	Sep	Oct
	Sp	W	P	Sp*W	Sp*P	W*P	Sp*W*P					
Sp	0.320	<0.001	0.758	0.108	0.341	<0.001	0.101	0.048	0.090	<0.001	0.043	0.032
W	0.007	<0.001	<0.001	0.225	0.038	0.003	<0.001	0.011	0.059	0.010	<0.001	0.020
P	0.164	0.291	0.917	0.512	0.621	0.038	0.935	0.840	0.436	0.04	0.85	0.908
Sp*W	0.509	0.793	0.851	0.395	0.031	0.092	0.232	0.450	0.045	0.256	0.294	0.556
Sp*P	0.311	0.66	0.356	0.958	0.869	0.894	0.403	0.448	0.947	0.736	0.512	0.612
W*P	0.900	0.078	0.589	0.240	0.544	0.536	0.684	0.352	0.552	0.694	0.52	0.383
Sp*W*P	0.982	0.063	0.497	-	0.423	0.071	0.444	-	0.433	0.118	0.385	-

	Physiology								Growth			
	Chl				Ci/Ca				Height		RCD	
	Jul	Aug	Sep	Oct	Jul	Aug	Sep	Oct	Aug	Dec	Aug	Dec
	Sp	W	P	Sp*W	Sp*P	W*P	Sp*W*P					
Sp	0.277	<0.001	0.001	0.035	0.281	0.025	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
W	0.199	0.002	0.003	0.919	0.685	<0.001	0.252	0.038	0.217	0.954	0.724	0.325
P	0.677	0.650	0.881	0.004	0.645	0.178	0.284	0.969	0.086	0.976	0.512	0.782
Sp*W	0.548	0.831	0.468	0.896	0.116	0.660	0.012	0.010	0.042	0.174	0.368	0.104
Sp*P	0.986	0.886	0.270	0.210	0.480	0.217	0.216	0.555	0.019	0.433	0.722	0.583
W*P	0.853	0.039	0.165	0.087	0.486	0.613	0.34	0.955	0.884	0.452	0.344	0.684
Sp*W*P	0.674	0.23	0.966	-	0.599	0.577	0.088	-	0.256	0.830	0.688	0.421

Sp: species; W: warming; P: increased precipitation; A: net photosynthetic rate; E: transpiration rate; gs: stomatal conductance; Chl: total chlorophyll content; Ci: intercellular CO₂ concentration; Ca: ambient CO₂ concentration; RCD: root collar diameter. For each

attribute and month of assessment, the means with the same superscript within the same column are not significantly different at $p < 0.05$ between the species, warming, and increased precipitation treatments. Significant p -values are highlighted in bold.

Table S2. Effects of treatments on environmental factors.

Variables	Species	Warming (W)	Increased Precipitation (P)	Warming and Increased Precipitation (W*P)
Air temperature (°C)	Ah	+3.3 (+3.0, +3.6)	−0.2 (−0.6, +0.2)	+3.3 (+2.2, +6.3)
	Ak	+3.0 (+2.0, +3.3)	−0.2 (−0.5, +0.1)	+2.8 (+2.2, +3.1)
Soil temperature (°C)	Ah	+2.7 (+1.3, +3.8)	−0.5 (−1.2, +0.1)	+2.4 (+0.9, +5.0)
	Ak	+4.2 (+2.6, +6.0)	−0.5 (−0.9, −0.0)	+3.7 (+1.9, +5.8)
Soil volumetric water content (SWC) (%)	Ah	−1.1 (−16.2, 8.5)	+25.8 (−1.2, +45.8)	+2.5 (−17.1, +17.0)
	Ak	−27.0 (−36.1, −9.7)	+9.0 (−6.3, +24.5)	+4.3 (−15.1, +7.1)

The differences between the treatments and control groups are presented. The values in the brackets represent the minimum and maximum difference values. Absolute differences are shown for air and soil temperatures, while relative differences are shown for soil volumetric water content (SWC). Ah: *Abies holophylla*; Ak: *Abies koreana*.

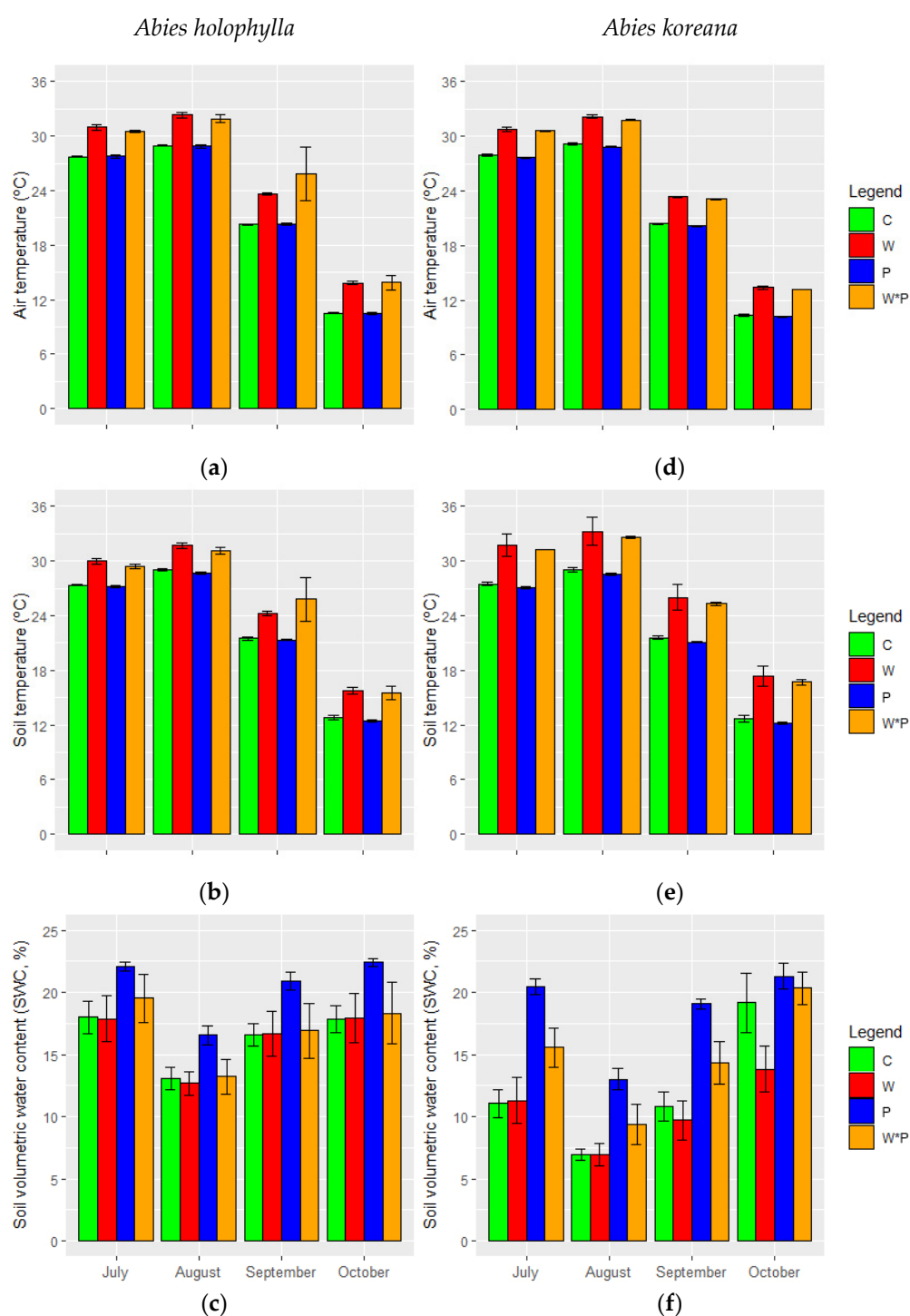


Figure S3. Monthly averaged (a, d) air temperature, (b, e) soil temperature, and (c, f) soil volumetric water content for *Abies holophylla* and *Abies koreana* seedlings under the four treatments from July to October 2018. Error bars represent standard error of the mean. The treatments included control (C), warming (W), increased precipitation (P), and both warming and increased precipitation (W*P). The trends in the variation of the daily environmental data over the entire experimental period are presented in Figure 1.

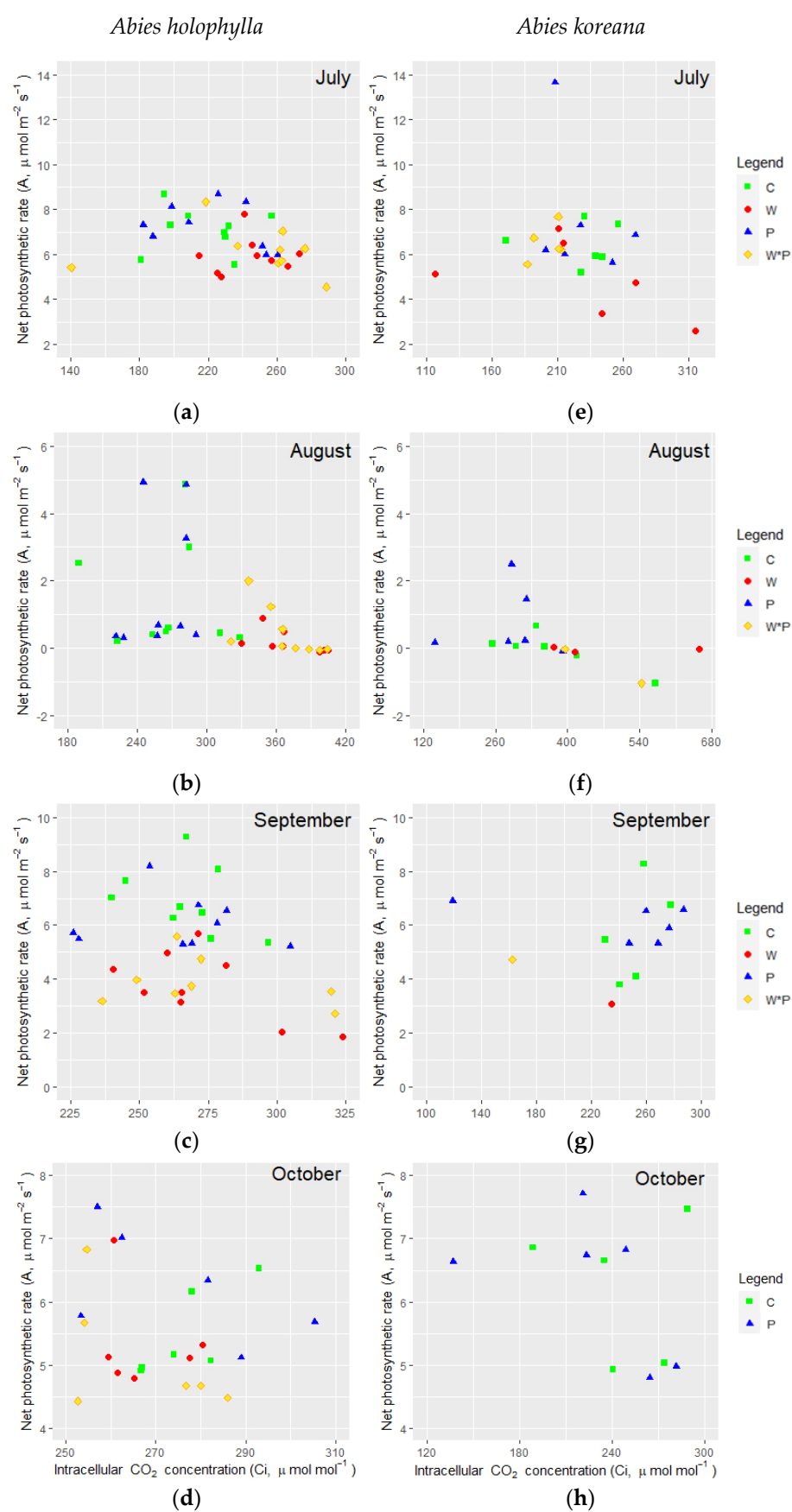


Figure S4. Effects of treatments on the relationships between net photosynthetic rate (A , $\mu\text{mol m}^{-2} \text{s}^{-1}$) and intracellular CO_2 concentration (C_i , $\mu\text{mol mol}^{-1}$) for (a–d) *Abies holophylla* and (e–h) *Abies koreana* from July to October. The treatments included control (C), warming (W), increased precipitation (P), and both warming and increased precipitation (W*P).