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Forest impacts on snow accumulation and ablation across an elevation gradient in a temperate montane environment

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10 Supplemental Materials

Table S1. Sensors on the Oregon ForEST Micro-Meteorological stations

Climate Variable	Sensor Brand	Model Number
Air Temp/RH	Climatronics	102798-G0-H1
Solar Radiation	Li-Cor, Inc	Li-200SL
Wind Speed/Dir	Met-One	034B
Snow Depth	Campbell Scientific	SR-50A
Soil Temp/Moisture	Decagon Devices	5TM
Datalogger	Campbell Scientific	CR1000x

Table S2. Algorithms for Estimating Clear Sky and Cloud Corrected Emissivity

Source	Algorithm
	Clear sky emissivity
Prata (1996)	$\varepsilon_{\text{clear}} = 1 - (1 + w) exp^{-(1.2+3w)^{0.5}}$
	$w = 465 \frac{e_o}{T_o}$
Dilley and O'Brien (1998)	$\varepsilon_{\text{clear}} = (5.31 * 10^{-13} \frac{T_{\text{air}}^2}{\sigma})$
	Cloud cover correction
Unsworth and Montieth (1975)	$\varepsilon_{\text{adj}} = (1 - 0.84 * c)$
Kimball et al. (1982)	$L_{\downarrow} = L_{\text{clear}} + \tau_8 * c * f_8 * \sigma * T_c^4$
	$\tau_8 = 1 - \varepsilon_{z_8}(1.4 - 0.4 * \varepsilon_{z_8})$
	$\varepsilon_{z_8} = 0.24 + 2.98 * 10^{-6} * \varepsilon_o^2 * exp^{\frac{3000}{T_o}}$
	$f_8 = -0.6732 + 0.624 * 10^{-2}\, T_c - 0.914 * 10^{-5}\, T_c^2$
Crawford and Duchon (1999)	$\varepsilon_{adj} = (1 - S) + S\, \varepsilon_{clear}$

Table S3. Estimated RMSE from six longwave algorithms at two sites

Site	Method	RMSE (W m^{-2})
Forest	Kimball-Dilley	26.8
	Kimball-Prata	50.1
	Unsworth-Dilley	15.8
	Unsworth-Prata	9.1
	Crawford-Dilley	9.3
	Crawford-Prata	8.5
Open	Kimball-Dilley	31.7
	Kimball-Prata	77.6
	Unsworth-Dilley	31.1
	Unsworth-Prata	24.5
	Crawford-Dilley	22.6
	Crawford-Prata	26.1

Table S4: List of abbreviations

BRT	Binary regression tree
CC	Canopy closure (%)
C_e	Bulk transfer coefficient for vapor exchange
C_{en}	Bulk transfer coefficient for vapor exchange under neutral stability
C_h	Bulk transfer coefficient for sensible heat
C_{IE}	Canopy Interception Efficiency (%)
C_p	specific heat of dry air (J kg^{-1} K^{-1})
DBH	Diameter at breast height (m)
e_a	Atmospheric vapor pressure at height *Z* above snow surface (Pa)
ε_{adj}	Adjusted atmospheric emissivity
ε_{clear}	Atmospheric emissivity
e_0	Vapor pressure at the snow surface (Pa)
ε_{snow}	Snow surface emissivity
$ForEST\ Network$	Forest Elevation Snow Transect Network
F_S	Forest site
g	Acceleration due to gravity (m s^{-2})
k	von Karman's constant
$L\uparrow$	Longwave radiation emitted by the snowpack (W m^{-2})
$L\downarrow$	Longwave radiation received by the snowpack (W m^{-2})
LAI	Leaf area index
L_{clear}	Incoming longwave radiation under clear skies (W m^{-2})
L_v	Latent heat of vaporization or sublimation (J kg^{-1})
MRB	McKenzie River Basin
$NRCS$	Natural Resources Conservation Service
O_S	Open site
Pa	Total atmospheric pressure (Pa)
PNW	Pacific Northwest
ΔQ	Change in total energy at the snow surface (W m^{-2})
Q_C	Conductive energy (W m^{-2})
Q_E	Latent heat (W m^{-2})
Q_H	Sensible heat (W m^{-2})
Q_L	Total longwave radiation (W m^{-2})
Q_S	Total solar radiation (W m^{-2})
r	Solar ratio (%)
r_s	Spearman's rank correlation coefficient

$\boldsymbol{Ri_B}$	Bulk Richardson number
$\boldsymbol{RMSE}$	Root mean squared error
$\boldsymbol{ROS}$	Rain on snow
$\boldsymbol{SDD}$	Snow disappearance date
$\boldsymbol{S_{in}}$	Incoming solar radiation (W m^{-2})
$\boldsymbol{S_{out}}$	Reflected solar radiation (W m^{-2})
S_{VF}	Sky view fraction (%)
$\boldsymbol{SWE}$	Snow Water Equivalent
$\boldsymbol{T_{air}}$	Air Temperature (K)
$\boldsymbol{T_c}$	Forest canopy temperature (K)
$\boldsymbol{T_{dew}}$	Dewpoint temperature (K)
$\boldsymbol{T_{snow}}$	Snow surface temperature (K)
$\boldsymbol{U(z)}$	Wind speed (m s^{-1}) at height *Z* (m) above the snow surface
$\boldsymbol{\omega}$	Precipitable water (cm)
$\boldsymbol{WY}$	Water year
$\boldsymbol{Z_0}$	Surface roughness length (m)
$\boldsymbol{\alpha}$	Albedo
$\boldsymbol{\rho_a}$	Density of air (kg m^{-3})
$\boldsymbol{\sigma}$	Stefan-Boltzman constant

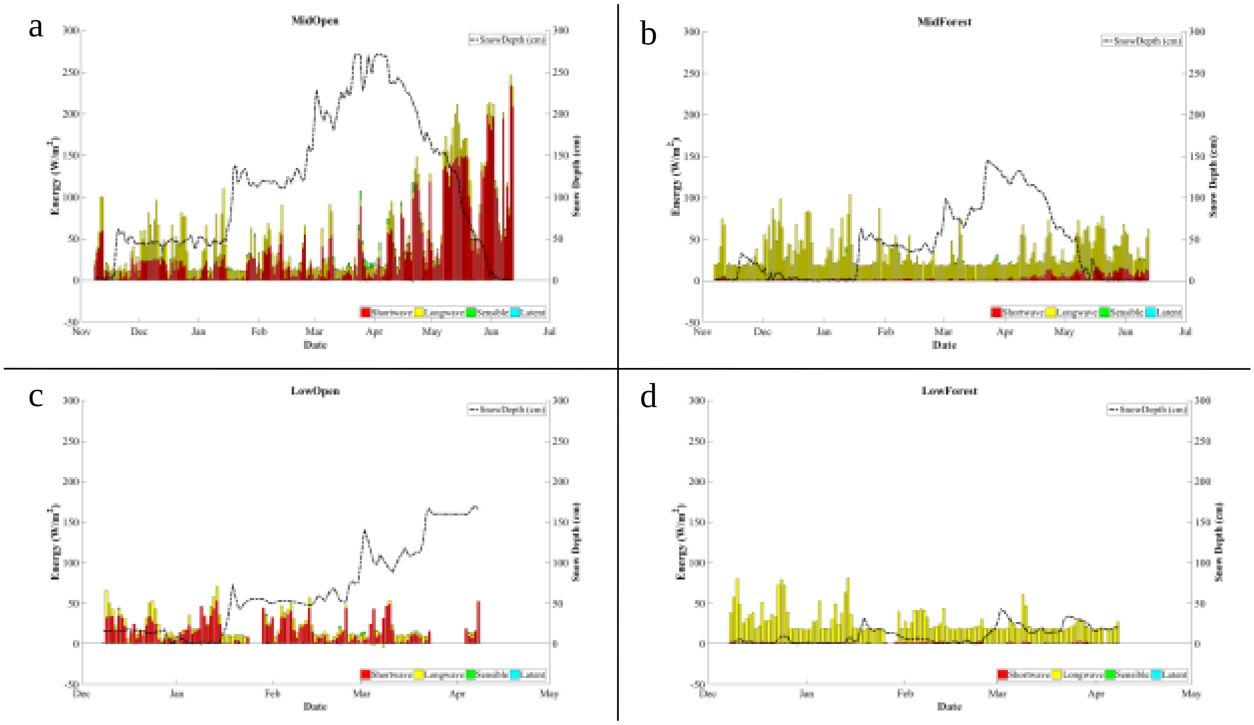

Figure S1: WY 2012 calculated daily mean energy balance component magnitudes (bars) and the daily measured snow depth (dashed line) for Mid-Open (a); Mid-Forest (b); Low-Open (c); and Low-Forest (d).

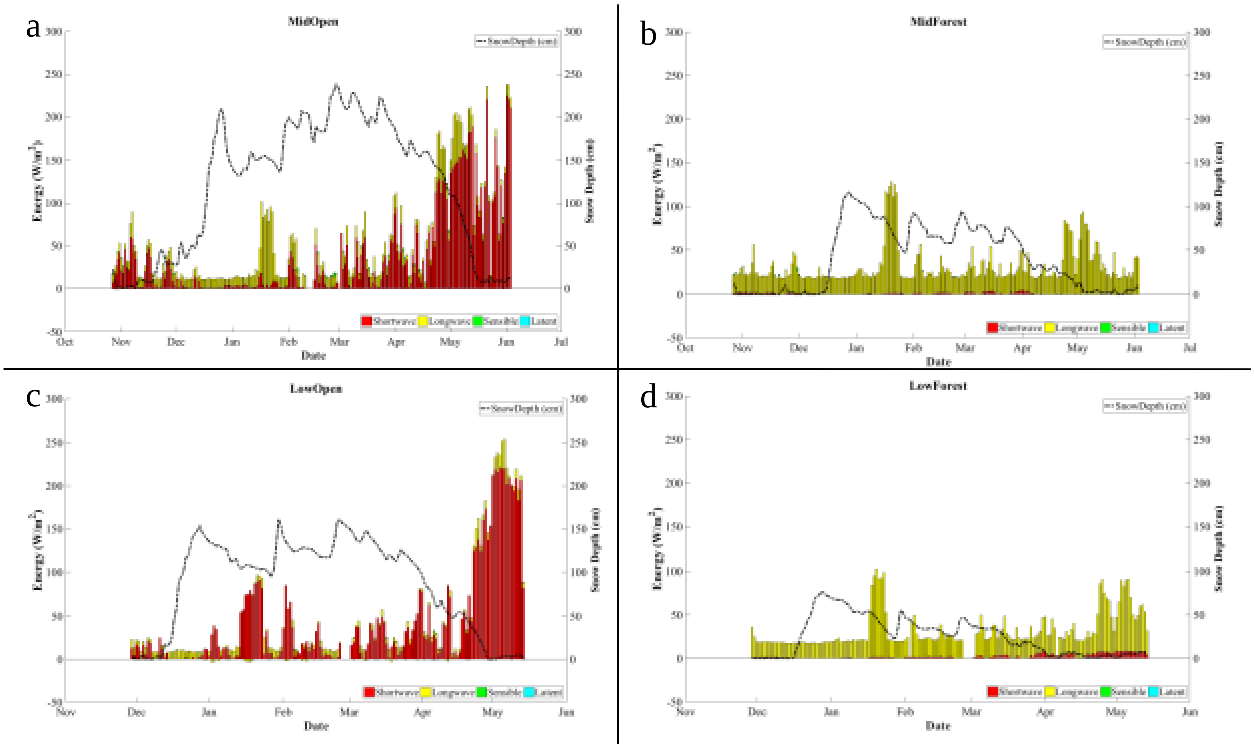

Figure S2: WY 2013 calculated daily mean energy balance component magnitudes (bars) and the daily measured snow depth (dashed line) for Mid-Open (a); Mid-Forest (b); Low-Open (c); and Low-Forest (d).

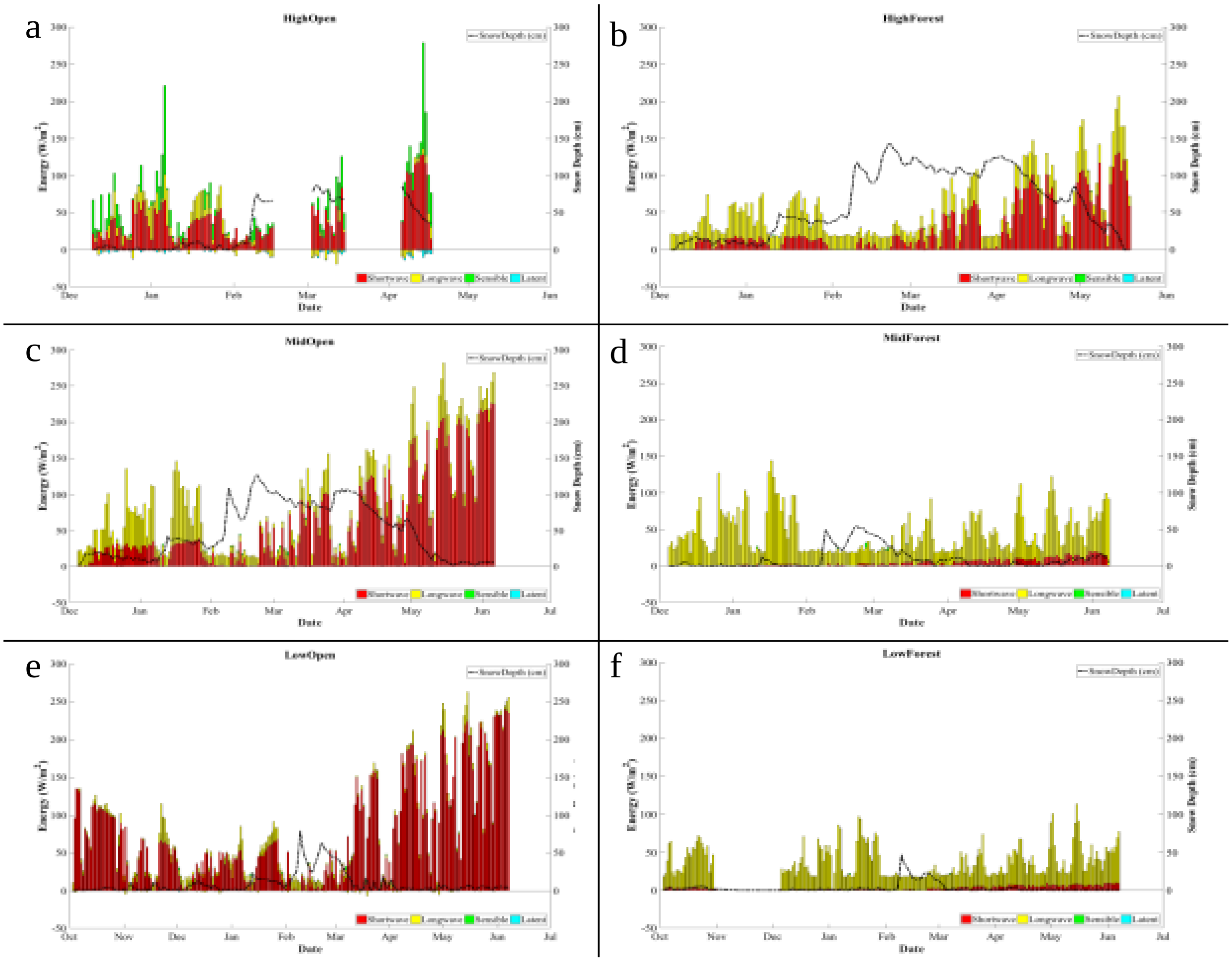

Figure S3: WY 2014 calculated daily mean energy balance component magnitudes (bars) and the daily measured snow depth (dashed line) for High-Open (a); High-Forest (b); Mid-Open (c); Mid-Forest (d); Low-Open (e); and Low-Forest (f).

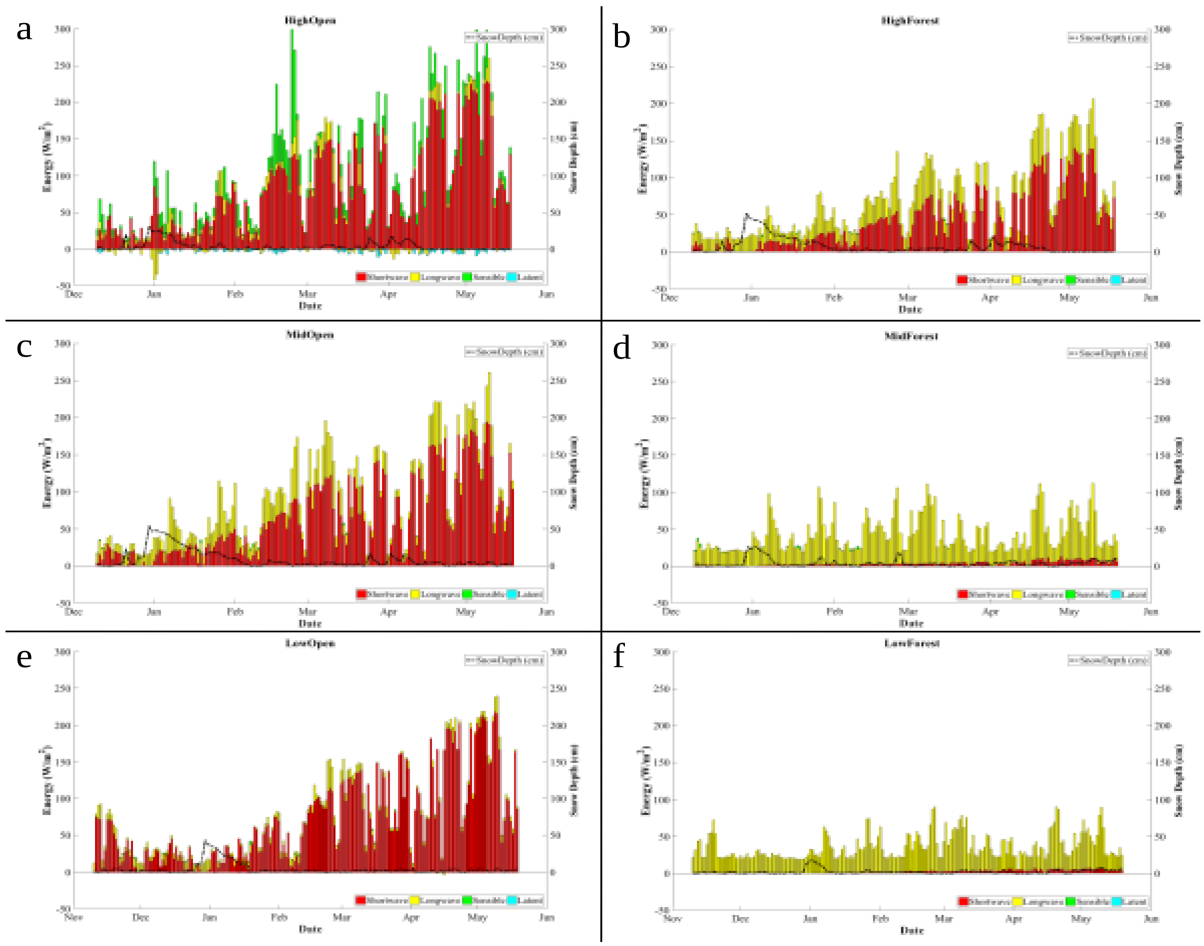

Figure S1: WY 2015 calculated daily mean energy balance component magnitudes (bars) and the daily measured snow depth (dashed line) for High-Open (a); High-Forest (b); Mid-Open (c); Mid-Forest (d); Low-Open (e); and Low-Forest (f).