

Feasibility of Burned Area Mapping based on ICESAT-2 Photon Counting Data

a) Forest cover mapping

Table S1. Confusion matrix of forest map classification based on Sentinel-2 data and Landsat 8 data in two study areas, where R_sum means row sum, C_sum is column sum, U_Acc is user's accuracy and P_Acc is producer's accuracy.

Northern California forest										
Sentinel-2 map	Reference				Landsat 8 map	Reference				
	Forest	Non-forest	R_sum	U_Acc		Forest	Non-forest	R_sum	U_Acc	
	Forest	92	8	100		Forest	103	23	126	
	Non-forest	16	84	100		Non-Forest	5	69	74	
	C_sum	108	92	200		C_sum	108	92	200	
P_ACC	85.19%	91.30%			P_Acc	95.37%	75%			
Western New Mexico forest										
Sentinel-2 map	Reference				Landsat 8 map	Reference				
	Forest	Non-forest	R_sum	U_Acc		Forest	Non-forest	R_sum	U_Acc	
	Forest	80	20	100		Forest	83	26	109	
	Non-forest	7	93	100		Non-Forest	4	87	91	
	C_sum	87	113	200		C_sum	87	113	200	
P_ACC	91.95%	82.30%			P_Acc	95.40%	76.99%			

Table S2. Confusion matrix of burn maps based on Sentinel-2 data and Landsat 8 data in two study areas.

Northern California forest										
Sentinel-2 map	Reference				Landsat 8 map	Reference				
	Unburn	Burned	R_sum	U_Acc		Unburn	Burned	R_sum	U_Acc	
	Unburn	98	2	100		Forest	103	1	104	
	Burned	27	73	100		Non-Forest	22	74	96	
	C_sum	125	75	200		C_sum	125	75	200	
P_ACC	78.4%	97.33%			P_Acc	82.4%	98.66%			
Western New Mexico forest										
Sentinel-2 map	Reference				Landsat 8 map	Reference				
	Unburn	Burned	R_sum	U_Acc		Unburn	Burned	R_sum	U_Acc	
	Unburn	99	1	100		Unburn	102	4	109	
	Burned	24	76	100		Burned	21	73	91	
	C_sum	123	77	200		C_sum	123	77	200	
P_ACC	80.48%	98.70%			P_Acc	82.92%	94.80%			

b) Logistics regression

Based on the stepwise procedure and removal of those insignificant metrics using training samples, four metrics, namely, RH95, mean canopy height, the number of canopy photons and apparent surface reflectance, were selected in logistic regression with Sentinel-2 derived data. Table S3 shows the coefficients and 95% confidence intervals. Variance inflation factors (VIF) are lower than 10, indicating that there may be multicollinearity among the five metrics, but not enough to cause concern. Coefficients of mean (mean canopy height), n_ca_photons (the number of canopy photons) and asr (apparent surface reflectance) are negative, which means they are negatively correlated with burn probability. When n_ca_photons increases, the probability that the current segment was burned decreases.

Based on the Landsat 8 forest cover map and burn map, the fitted logistic model selected four metrics, namely, RH50, n_ca_photons, asr and n_te_photons (the number of terrain photons). Variances of inflation factors (VIFs) show that there was no multicollinearity. Moreover, all coefficients are negative, which means that the increase of these three metrics will cause the decrease of burn probability.

Table S3. Coefficients and 95% confidence intervals of logistic regression based on Sentinel-2 based samples and Landsat 8 based samples. VIF means variance of inflation factors.

Sentinel-2	Coefficient	Standard error	VIF	Lower bound	Upper bound
Intercept	5.9403	0.7424	-	4.4851	7.3955
RH95	0.0787	0.0390	7.8605	0.0021	0.1553
mean	-0.2095	0.0624	7.6397	-0.3318	-0.0872
n_ca_photons	-0.0203	0.0040	1.3118	-0.0281	-0.0123
asr	-58.3731	7.1268	1.2859	-72.3413	-44.4048
Landsat 8	Coefficient	Standard error	VIF	Lower bound	Upper bound
Intercept	6.4587	0.6239	-	5.2358	7.6815
RH50	-0.1066	0.0210	1.4777	-0.1478	-0.0654
n_ca_photons	-0.0215	0.0034	1.3068	-0.0283	-0.0146
asr	-43.6604	6.5347	1.4487	-56.4682	-30.8525
n_te_photons	-0.0144	0.0041	2.0388	-0.0225	-0.0063

Figure S1 shows the probability of each testing sample derived from corresponding logistic regression model. For those burned segments, values of asr (apparent surface reflectance) tend to be small and burned probabilities are high. Moreover, unburned points and burned points are mixed when probabilities range in 0.25 and 0.75. Therefore, both Sentinel-2 derived samples and Landsat 8 derived samples have large uncertainties when probability locates between 0.25 and 0.75.

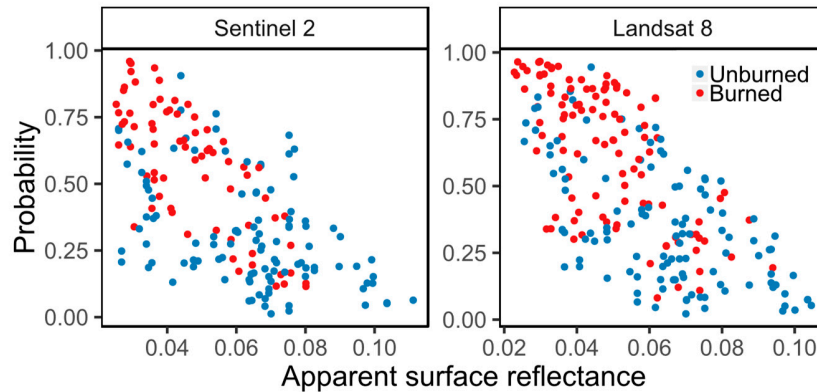


Figure S1. Scatterplot of asr (apparent surface reflectance) to probabilities calculated by logistic regression models using testing samples from Sentinel-2 derived samples and Landsat 8 derived samples, respectively.