

Correction

Correction: Parks et al. Mean Composite Fire Severity Metrics Computed with Google Earth Engine Offer Improved Accuracy and Expanded Mapping Potential. *Remote Sens.* 2018, 10, 879

Sean A. Parks ^{1,*} , Lisa M. Holsinger ¹, Morgan A. Voss ², Rachel A. Loehman ³  and Nathaniel P. Robinson ⁴ 

¹ Aldo Leopold Wilderness Research Institute, Rocky Mountain Research Station, US Forest Service, 790 E. Beckwith Ave., Missoula, MT 59801, USA; lisa.holsinger@usda.gov

² Department of Geography, University of Montana, Missoula, MT 59812, USA; morgan.voss@mt.gov

³ Alaska Science Center, US Geological Survey, 4210 University Drive, Anchorage, AK 99508, USA; rloehman@usgs.gov

⁴ W.A. Franke College of Forestry and Conservation & Numerical Terradynamic Simulation Group, University of Montana, Missoula, MT 59812, USA; n.robinson@tnc.org

* Correspondence: sean.parks@usda.gov; Tel.: +1-406-542-4182



Citation: Parks, S.A.; Holsinger, L.M.; Voss, M.A.; Loehman, R.A.; Robinson, N.P. Correction: Parks et al. Mean Composite Fire Severity Metrics Computed with Google Earth Engine Offer Improved Accuracy and Expanded Mapping Potential. *Remote Sens.* 2018, 10, 879. *Remote Sens.* 2021, 13, 4580. <https://doi.org/10.3390/rs13224580>

Received: 3 September 2021

Accepted: 13 September 2021

Published: 15 November 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

In our paper titled, ‘Mean Composite Fire Severity Metrics Computed with Google Earth Engine Offer Improved Accuracy and Expanded Mapping Potential’ (Parks et al., 2018, [1]), we incorrectly executed the relativized delta normalized burn ratio (RdNBR) equation in Google Earth Engine. This error affects the ‘mean compositing’ results pertaining to RdNBR, and perhaps more importantly, the equation was incorrect in the Earth Engine code we distributed with the paper. Results and code pertaining to the delta normalized burn ratio (dNBR) and the relativized burn ratio (RBR) are not affected.

Our goals for this correction are threefold: (1) to acknowledge that the originally published paper and accompanying Earth Engine code did not correctly implement the RdNBR equation, (2) to correct the Earth Engine code so that the RdNBR equation is correctly executed, and (3) to provide updated tables and figures pertaining to RdNBR (as correctly implemented in Earth Engine).

Although this error is most unfortunate, it does not change the overall message of the paper: that producing fire severity metrics using the mean compositing approach in Earth Engine usually provides a slight improvement over paired-scene assessments and that using Earth Engine makes the process relatively fast and easy.

The Earth Engine code has been updated and RdNBR is now correctly executed: <https://code.earthengine.google.com/c76157be827be2f24570df50cca427e9> (accessed on 12 September 2021)

We updated all tables and figures affected by this error (see below). We opted to use the same table and figure numbers as originally published in Parks et al. (2018) [1], thereby facilitating easier comparison between the originally published paper and this correction.

We are extremely sorry for this error. The original article has been updated.

1. Earth Engine Code

The Earth Engine code has been updated and RdNBR is now correctly executed: <https://code.earthengine.google.com/c76157be827be2f24570df50cca427e9> (accessed on 12 September 2021).

2. Error in Tables 2–7

The original and corrected Tables 2–7 appear below. The corrected tables are exactly as originally published in Parks et al. (2018) [1] except for those cells highlighted in gray.

Original Version

Table 2. Mean R^2 of the correspondence between CBI and each MTBS- and GEE-derived fire severity metric across the 18 fires. MTBS: Monitoring Trends in Burn Severity; GEE: Google Earth Engine. The correspondence between CBI and the severity metrics were computed for each of the 18 fires and the mean R^2 is reported here.

	Mean R^2 without $dNBR_{offset}$		Mean R^2 with $dNBR_{offset}$	
	MTBS-Derived	GEE-Derived	MTBS-Derived	GEE-Derived
dNBR	0.761	0.768	0.761	0.768
RdNBR	0.736	0.782	0.751	0.782
RBR	0.784	0.791	0.784	0.790

Table 3. R^2 of the five-fold cross-validation of the correspondence between CBI and each MTBS- and GEE-derived fire severity metric for 1681 plots across 18 fires; standard error shown in parentheses. The values characterize the average of five folds and represent the severity metrics excluding and including the $dNBR_{offset}$.

	R^2 without $dNBR_{offset}$ (Standard Error)		R^2 with $dNBR_{offset}$ (Standard Error)	
	MTBS-Derived	GEE-Derived	MTBS-Derived	GEE-Derived
dNBR	0.630 (0.026)	0.660 (0.025)	0.655 (0.026)	0.682 (0.025)
RdNBR	0.616 (0.026)	0.723 (0.024)	0.661 (0.027)	0.732 (0.024)
RBR	0.683 (0.025)	0.722 (0.024)	0.714 (0.025)	0.739 (0.024)

Table 4. Classification accuracy (percent correctly classified) and 95% confidence intervals (CI) for the three fire severity metrics (with and without the $dNBR_{offset}$). Each fire severity metric is classified into categories representing low, moderate, and high severity based on index-specific thresholds (see Table 7) and compared to the same classes based on composite burn index thresholds.

		Without $dNBR_{offset}$		With $dNBR_{offset}$	
		Accuracy (%)	95% CI	Accuracy (%)	95% CI
dNBR	MTBS-derived	69.6	67.3–71.8	70.2	68.0–72.4
	GEE-derived	71.3	69.0–73.4	71.7	69.5–73.9
RdNBR	MTBS-derived	71.4	69.2–73.5	73.6	71.4–75.6
	GEE-derived	73.9	71.8–76.0	73.9	71.8–76.0
RBR	MTBS-derived	72.4	71.1–74.5	73.5	71.4–75.6
	GEE-derived	73.5	71.4–75.6	74.1	72.0–76.2

Table 5. Confusion matrices for classifying as low, moderate, and high severity using the severity metrics computed without the $dNBR_{offset}$. Confusion matrices for MTBS-derived metrics are on the left and confusion matrices for GEE-derived metrics are on the right. UA: user’s accuracy; PA: producer’s accuracy.

Reference CBI Class						Reference CBI Class					
Classified using MTBS-derived dNBR		Low	Mod.	High	UA	Classified using GEE-derived dNBR		Low	Mod.	High	UA
	Low	401	159	18	69.4		Low	407	139	13	72.8
	Mod.	91	412	114	66.8		Mod.	87	438	123	67.6
	High	5	124	357	73.5		High	3	118	353	74.5
	PA	80.7	59.3	73.0			PA	81.9	63.0	72.2	
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RdNBR		Low	Mod.	High	UA	Classified using GEE-derived RdNBR		Low	Mod.	High	UA
	Low	366	142	7	71.1		Low	396	130	7	74.3
	Mod.	119	451	99	67.4		Mod.	97	470	105	69.9
	High	12	102	383	77.1		High	4	95	377	79.2
	PA	73.6	64.9	78.3			PA	79.7	67.6	77.1	
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RBR		Low	Mod.	High	UA	Classified using GEE-derived RBR		Low	Mod.	High	UA
	Low	380	127	12	73.2		Low	403	130	9	74.4
	Mod.	113	462	102	68.2		Mod.	90	464	111	69.8
	High	4	106	375	77.3		High	4	101	369	77.8
	PA	76.5	66.5	76.7			PA	81.1	66.8	75.5	

Table 6. Confusion matrices for classifying as low, moderate, and high severity using the severity metrics computed with the $dNBR_{offset}$. Confusion matrices for MTBS-derived metrics are on the left and confusion matrices for GEE-derived metrics are on the right. UA: user’s accuracy; PA: producer’s accuracy.

Reference CBI Class						Reference CBI Class					
Classified using MTBS-derived dNBR		Low	Mod.	High	UA	Classified using GEE-derived dNBR		Low	Mod.	High	UA
	Low	397	156	13	70.1		Low	402	141	10	72.7
	Mod.	98	425	118	66.3		Mod.	92	451	126	67.4
	High	2	114	358	75.5		High	3	103	353	76.9
	PA	79.9	61.2	73.2			PA	80.9	64.9	72.2	
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RdNBR		Low	Mod.	High	UA	Classified using GEE-derived RdNBR		Low	Mod.	High	UA
	Low	378	133	5	73.3		Low	386	122	7	75.0
	Mod.	112	467	92	69.6		Mod.	108	478	103	69.4
	High	7	95	392	79.4		High	3	95	379	79.5
	PA	76.1	67.2	80.2			PA	77.7	68.8	77.5	
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RBR		Low	Mod.	High	UA	Classified using GEE-derived RBR		Low	Mod.	High	UA
	Low	390	135	6	73.4		Low	386	123	7	74.8
	Mod.	105	460	97	69.5		Mod.	107	481	103	69.6
	High	2	100	386	79.1		High	4	91	379	80.0
	PA	78.5	66.2	78.9			PA	77.7	69.2	77.5	

Table 7. Threshold values for each fire severity metric corresponding to low (CBI = 0–1.24), moderate (CBI = 1.25–2.25), and high severity (CBI = 2.25–3).

		MTBS-Derived			GEE-Derived		
		Low	Moderate	High	Low	Moderate	High
Excludes dNBR_{offset}	dNBR	≤186	187–429	≥430	≤185	186–417	≥418
	RdNBR	≤337	338–721	≥722	≤248	249–544	≥545
	RBR	≤134	135–303	≥304	≤135	136–300	≥301
Includes dNBR_{offset}	dNBR	≤165	166–440	≥411	≤159	160–392	≥393
	RdNBR	≤294	295–690	≥691	≤212	213–511	≥512
	RBR	≤118	119–289	≥289	≤115	116–282	≥283

Corrected Version

Table 2. Mean R^2 of the correspondence between CBI and each MTBS- and GEE-derived fire severity metric across the 18 fires. The correspondence between CBI and the severity metrics were computed for each of the 18 fires and the mean R^2 is reported here.

	Mean R^2 without dNBR _{offset}		Mean R^2 with dNBR _{offset}	
	MTBS-Derived	GEE-Derived	MTBS-Derived	GEE-Derived
dNBR	0.761	0.768	0.761	0.768
RdNBR	0.736	0.764	0.751	0.759
RBR	0.784	0.791	0.784	0.790

Table 3. R^2 of the five-fold cross-validation of the correspondence between CBI and each MTBS- and GEE-derived fire severity metric for 1681 plots across 18 fires; standard error shown in parentheses. The values characterize the average of five folds and represent the severity metrics excluding and including the dNBR_{offset}.

	R^2 without dNBR _{offset} (Standard Error)		R^2 with dNBR _{offset} (Standard Error)	
	MTBS-Derived	GEE-Derived	MTBS-Derived	GEE-Derived
dNBR	0.630 (0.026)	0.660 (0.025)	0.655 (0.026)	0.682 (0.025)
RdNBR	0.616 (0.026)	0.692 (0.025)	0.661 (0.026)	0.669 (0.026)
RBR	0.683 (0.025)	0.722 (0.024)	0.714 (0.025)	0.739 (0.024)

Table 4. Classification accuracy (percent correctly classified) and 95% confidence intervals (CI) for the three fire severity metrics (with and without the dNBR_{offset}). Each fire severity metric is classified into categories representing low, moderate, and high severity based on index-specific thresholds (see Table 7) and compared to the same classes based on composite burn index thresholds.

		Without dNBR _{offset}		With dNBR _{offset}	
		Accuracy (%)	95% CI	Accuracy (%)	95% CI
dNBR	MTBS-derived	69.6	67.3–71.8	70.2	68.0–72.4
	GEE-derived	71.3	69.0–73.4	71.7	69.5–73.9
RdNBR	MTBS-derived	71.4	69.2–73.5	73.6	71.4–75.6
	GEE-derived	73.4	71.2–75.5	73.1	71.0–75.3
RBR	MTBS-derived	72.4	71.1–74.5	73.5	71.4–75.6
	GEE-derived	73.5	71.4–75.6	74.1	72.0–76.2

Table 5. Confusion matrices for classifying as low, moderate, and high severity using the severity metrics computed without the $dNBR_{offset}$. Confusion matrices for MTBS-derived metrics are on the left and confusion matrices for GEE-derived metrics are on the right. UA: user's accuracy; PA: producer's accuracy.

Reference CBI Class						Reference CBI Class					
Classified using MTBS-derived dNBR		Low	Mod.	High	UA	Classified using GEE-derived dNBR		Low	Mod.	High	UA
	Low	401	159	18	69.4		Low	407	139	13	72.8
	Mod.	91	412	114	66.8		Mod.	87	438	123	67.6
	High	5	124	357	73.5		High	3	118	353	74.5
	PA	80.7	59.3	73.0	PA		81.9	63.0	72.2		
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RdNBR		Low	Mod.	High	UA	Classified using GEE-derived RdNBR		Low	Mod.	High	UA
	Low	366	142	7	71.1		Low	385	136	5	73.2
	Mod.	119	451	99	67.4		Mod.	105	465	100	69.4
	High	12	102	383	77.1		High	7	94	384	79.2
	PA	73.6	64.9	78.3	PA		77.5	66.9	78.5		
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RBR		Low	Mod.	High	UA	Classified using GEE-derived RBR		Low	Mod.	High	UA
	Low	380	127	12	73.2		Low	403	130	9	74.4
	Mod.	113	462	102	68.2		Mod.	90	464	111	69.8
	High	4	106	375	77.3		High	4	101	369	77.8
	PA	76.5	66.5	76.7	PA		81.1	66.8	75.5		

Table 6. Confusion matrices for classifying as low, moderate, and high severity using the severity metrics computed with the $dNBR_{offset}$. Confusion matrices for MTBS-derived metrics are on the left and confusion matrices for GEE-derived metrics are on the right. UA: user's accuracy; PA: producer's accuracy.

Reference CBI Class						Reference CBI Class					
Classified using MTBS-derived dNBR		Low	Mod.	High	UA	Classified using GEE-derived dNBR		Low	Mod.	High	UA
	Low	397	156	13	70.1		Low	402	141	10	72.7
	Mod.	98	425	118	66.3		Mod.	92	451	126	67.4
	High	2	114	358	75.5		High	3	103	353	76.9
	PA	79.9	61.2	73.2	PA		80.9	64.9	72.2		
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RdNBR		Low	Mod.	High	UA	Classified using GEE-derived RdNBR		Low	Mod.	High	UA
	Low	378	133	5	73.3		Low	390	137	5	73.3
	Mod.	112	467	92	69.6		Mod.	101	460	104	69.2
	High	7	95	392	79.4		High	6	98	380	78.5
	PA	76.1	67.2	80.2	PA		78.5	66.2	77.7		
Reference CBI class						Reference CBI class					
Classified using MTBS-derived RBR		Low	Mod.	High	UA	Classified using GEE-derived RBR		Low	Mod.	High	UA
	Low	390	135	6	73.4		Low	386	123	7	74.8
	Mod.	105	460	97	69.5		Mod.	107	481	103	69.6
	High	2	100	386	79.1		High	4	91	379	80.0
	PA	78.5	66.2	78.9	PA		77.7	69.2	77.5		

Table 7. Threshold values for each fire severity metric corresponding to low (CBI = 0–1.24), moderate (CBI = 1.25–2.25), and high severity (CBI = 2.25–3).

		MTBS-Derived			GEE-Derived		
		Low	Moderate	High	Low	Moderate	High
Excludes dNBR_{offset}	dNBR	≤186	187–429	≥430	≤185	186–417	≥418
	RdNBR	≤337	338–721	≥722	≤338	339–726	≥727
	RBR	≤134	135–303	≥304	≤135	136–300	≥301
Includes dNBR_{offset}	dNBR	≤165	166–440	≥411	≤159	160–392	≥393
	RdNBR	≤294	295–690	≥691	≤312	313–706	≥707
	RBR	≤118	119–289	≥289	≤115	116–282	≥283

3. Error in Figure 2

The original and corrected Figure 2 appears below. This corrected figure is exactly as originally published in Parks et al. (2018) [1] except for the panel indicated by the red outline.

Original Version

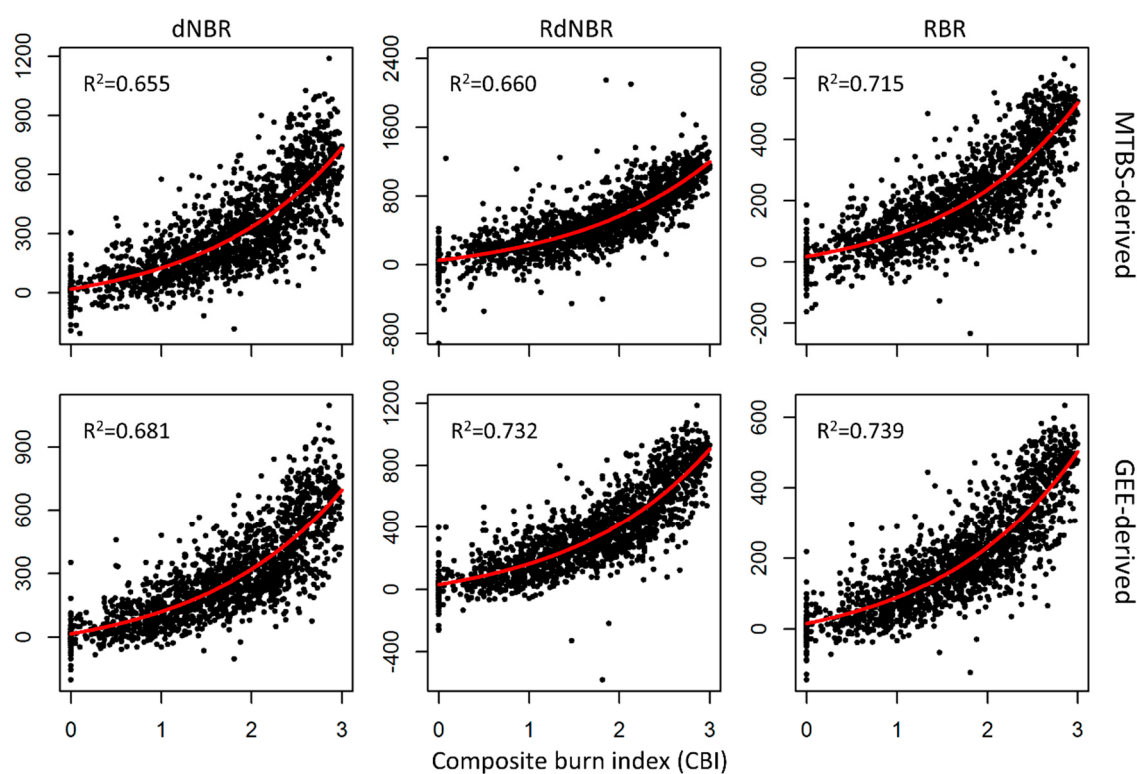


Figure 2. Plots show each MTBS- (top row) and GEE-derived (bottom row) severity metric and the corresponding field-based CBI. All severity metrics include the dNBR_{offset}. Red lines show the modeled fit of the nonlinear regressions for all 1681 plots. The model fits and the resulting R² shown here were not produced using cross-validation and therefore may differ slightly from the results shown in Table 3.

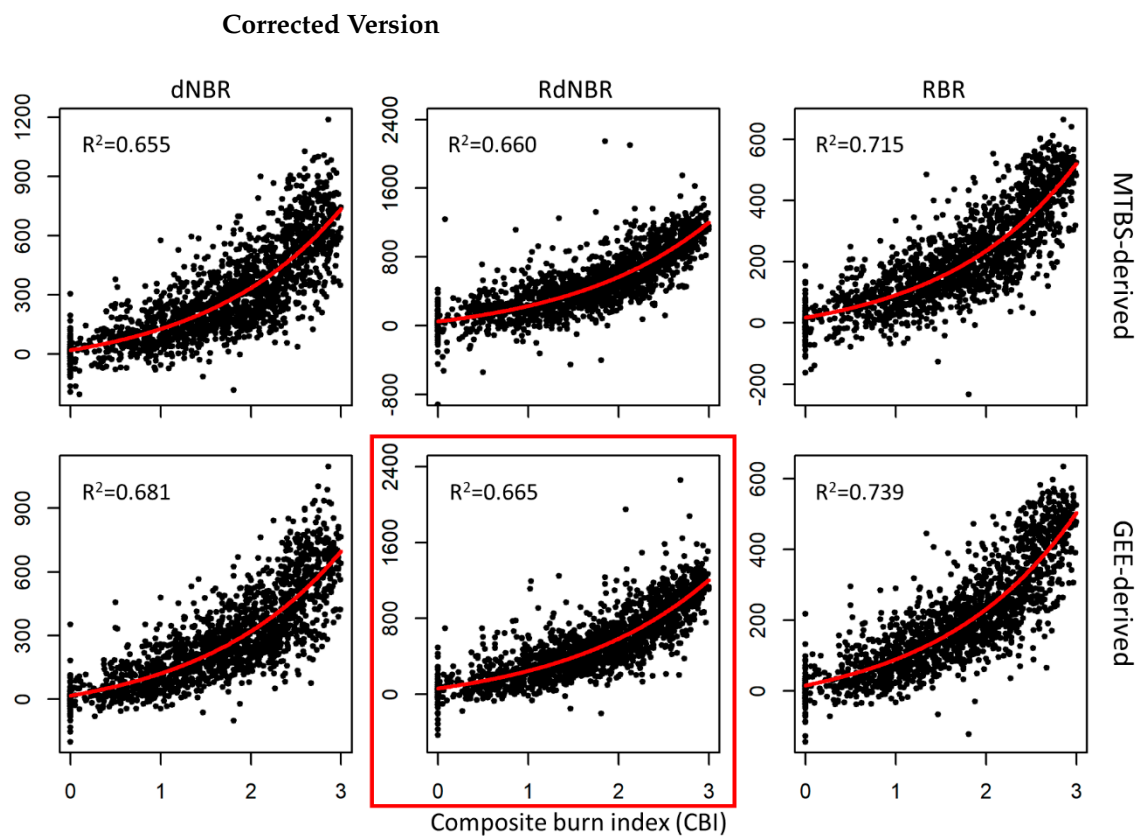


Figure 2. Plots show each MTBS- (top row) and GEE-derived (bottom row) severity metric and the corresponding field-based CBI. All severity metrics include the $dNBR_{offset}$. Red lines show the modeled fit of the nonlinear regressions for all 1681 plots. The model fits and the resulting R^2 shown here were not produced using cross-validation and therefore may differ slightly from the results shown in Table 3. Extreme RdNBR values are not shown to improve visual appearance of the RdNBR panels.

Reference

1. Parks, S.A.; Holsinger, L.M.; Voss, M.A.; Loehman, R.A.; Robinson, N.P. Mean Composite Fire Severity Metrics Computed with Google Earth Engine Offer Improved Accuracy and Expanded Mapping Potential. *Remote Sens.* **2018**, *10*, 879. [[CrossRef](#)]