10.1071/WF23130
International Journal of Wildland Fire

Supplementary Material

Remote sensing applications for prescribed burn research

Anna LoPresti[A,*], *Meghan T. Hayden*[A], *Katherine Siegel*[A,B], *Benjamin Poulter*[C], *E. Natasha Stavros*[D] and *Laura E. Dee*[A]

[A]Department of Ecology and Evolutionary Biology, University of Colorado Boulder, Boulder, CO 80309, USA

[B]Cooperative Programs for the Advancement of Earth System Science, University Corporation for Atmospheric Research, Boulder, CO 80309, USA

[C]NASA Goddard Space Flight Center, Biospheric Sciences Laboratory, Greenbelt, MD 20771, USA

[D]WKID Solutions LLC, 4001 Discovery Drive, Boulder, CO 80303, USA

*Correspondence to: Email: Anna.Lopresti@colorado.edu

Table S1. Prescribed burn feature categories. Features are grouped based on the physical characteristic viewed by a remote sensor. For Active Fire and Burned Area categories, similar features maybe analyzed (e.g. fire counts), but are differentiated by whether the remote sensor is used during the burn (Active Fire) or post-burn (Burned Area) to capture the feature.

Prescribed burn feature category	Included features
Active fire (features analyzed during burn)	Fire behavior Fire progression Fire radiative power Fireline intensity Active fire perimeter Fire detection Active fire size Fire thermal energy Active fire counts Fire temperature Fire radiative energy/radiative energy density Fire fronts
Burned area (features analyzed post-burn)	Burned area/extent Burn severity Burn magnitude Burn timing/seasonality Burned area counts Time since last fire
Smoke	Smoke plume Smoke plume structure/convection Smoke plume turbulence Smoke plume area Smoke plume density Smoke vertical profiles Smoke boundaries Trace gases Smoke optical properties Smoke emissions/aerosols Pyroconvection Smoke temperature/humidity profiles Radial winds Smoky days
Soil	Soil microtopography Surface roughness Soil temperature
Vegetation	Land cover classification Land cover change vegetation spectral signatures Chlorophyll concentration Total canopy moisture Vegetation water status Vegetation structure Vegetation composition

	Vegetation height Biomass Vegetation greenness Vegetation wetness Burned vegetation Unburned vegetation Fuel loads Fuel fragmentation Vegetation dormancy Combustion completeness Leaf area index Evapotranspiration rates Canopy bulk density Rangeland components Forest stand density Fuel consumption Vertical vegetation profiles Vegetation recovery

Table S2. Codebook used for data extraction and classification. Text was lifted directly from the studies for each code. Then, the direct text was used to classify the data into limited sets of categories to facilitate comparison across the review. Columns with the direct text, and columns with the classified information, were both retained.

column name	description	classifications
paper ID	randomly assigned number for each paper	
full screener	initials of author assigned to full screening (AL or MH)	
full screen inclusion	whether the paper is included or excluded based on the full reading (y/n)	
country	country of study location (if multiple locations, separate with semicolon)	
geographic location	the most specific jurisdiction name of the study location	
spatial extent	the area of analysis (e.g., hectares, acres)	
sample size	the number of prescribed fires analyzed	
land use type	the land use type within which the study occurred.	biomes (REF), anthromes (REF)
RS data product	remote sensing data product used for the analysis (e.g. sentinel-2)	terrestrial, airborne, spaceborne
RS data type	the type of remote sensor used for the analysis (e.g. lidar)	

spatial resolution	spatial resolution of the RS method (e.g. 30m)	very high (<.5), high (.5-2m), medium (2-30m), low (30 m) (REF)
temporal resolution (study)	temporal resolution of the study (e.g., June 2013)	
temporal resolution (sensor)	temporal resolution of the RS sensor/platform (e.g., 6-day return time)	
spectral resolution	spectral resolution of the sensor (e.g., band 1, or 400 nm)	Visible, NIR, SWIR, MWIR, Thermal
index	name of any remote sensing indexes used for analysis (e.g. NDVI)	
Active or passive	whether the remote sensing method is active or passive	active, passive
Analysis timing	When the remote sensing method was employed relative to the burn	Pre-burn, during burn, post-burn
prescribed burn feature analyzed	the physical feature that the remote sensing instrument viewed (e.g., canopy structure, smoke plume)	Vegetation features; burned area features; active fire features; smoke features; soil features
research interest (prescribed burn)	the research aim(s) related to prescribed burning addressed with remote sensing	Determined through content analysis
research interest (remote sensing)	the research aim(s) related to remote sensing addressed by the paper	Determined through content analysis
conclusion (prescribed burn)	Finding(s) of the prescribed burn research aim(s)	Determined through content analysis
conclusion (remote sensing)	Finding(s) of the remote sensing research aim(s)	Determined through content analysis

Data Sources: 120 publications included in the literature review analysis

1. Allen KA, Denelle P, Ruiz FMS, Santana VM, Marrs RH (2016) Prescribed moorland burning meets good practice guidelines: A monitoring case study using aerial photography in the Peak District, UK *Ecological Indicators* **62**, 76–85.

2. Ambrosia VG, Wegener SS, Sullivan DV, Buechel SW, Dunagan SE, Brass JA, Stoneburner, J, Schoenung, SM, (2003) Demonstrating UAV-Acquired Real-Time Thermal Data over Fires. *Photogrammetric Engineering & Remote Sensing* **69**, 391–402.

3. Angelo JJ, Duncan BW, Weishampel JF (2010) Using Lidar-Derived Vegetation Profiles to Predict Time since Fire in an Oak Scrub Landscape in East-Central Florida. *Remote Sensing* **2**, 514–525

4. Ansley RJ, Pinchak WE, Teague WR, Kramp BA, Jones DL, Barnett K (2010) Integrated Grazing and Prescribed Fire Restoration Strategies in a Mesquite Savanna: II Fire Behavior and Mesquite Landscape Cover Responses. *Rangeland Ecology and Management* **63(3),** 286–297.

5. Arkle RS, Pilliod DS, Welty JL (2012) Pattern and process of prescribed fires influence effectiveness at reducing wildfire severity in dry coniferous forests. *Forest Ecology and Management* **276**, 174–184.

6. Arnett JTTR, Coops NC, Daniels LD, Falls RW (2015) Detecting forest damage after a low-severity fire using remote sensing at multiple scales. *International Journal of Applied Earth Observation and Geoinformation* **35**, 239–246.

7. Arreola Amaya M, Clements CB (2020) Evolution of Plume Core Structures and Turbulence during a Wildland Fire. *Experiment Atmosphere* **11**, 842.

8. Aydell TB, Clements CB (2021) Mobile Ka-Band Polarimetric Doppler Radar Observations of Wildfire Smoke Plumes. *Monthly Weather Review* **149**, 1247–1264.

9. Bian Q, Ford B, Pierce JR, Kreidenweis SM (2020) A Decadal Climatology of Chemical, Physical, and Optical Properties of Ambient Smoke in the Western and Southeastern United States. *Journal of Geophysical Research: Atmospheres* **125**, e2019JD031372.

10. Bosch I, Gómez S, Vergara L (2011) A ground system for early forest fire detection based on infrared signal processing. *International Journal of Remote Sensing* **32**, 4857–4870.

11. Bowman DMJS, Walsh A, Prior LD (2004) Landscape analysis of Aboriginal fire management in Central Arnhem Land, north Australia. *Journal of Biogeography* **31**, 207–223.

12. Bucini G, Lambin EF (2002) Fire impacts on vegetation in Central Africa: a remote-sensing-based statistical analysis. *Applied Geography* **22**, 27–48

13. Butterfield HS, Malmstrom CM (2006) Experimental Use of Remote Sensing by Private Range Managers and Its Influence on Management Decisions. *Rangeland Ecology & Management* **59**, 541–548.

14. Cansler CA, Kane VR Hessburg PF, Kane JT, Jeronimo SMA, Lutz JA, Povak NA, Churchill DJ, Larson AJ (2022) Previous wildfires and management treatments moderate subsequent fire severity. *Forest Ecology and Management* **504,** 119764.

15. Chapman DS, Bonn A, Kunin WE, Cornell SJ (2010) Random Forest characterization of upland vegetation and management burning from aerial imagery. *Journal of Biogeography* **37,** 37–46.

16. Charland AM, Clements CB (2013) Kinematic structure of a wildland fire plume observed by Doppler lidar. *Journal of Geophysical Research: Atmospheres* **118**, 3200–3212.

17. Clark KL, Skowronski N, Hom J, Duveneck M, Pan Y, Tuyl SV, Cole J, Patterson M, Maurer S (2009) Decision support tools to improve the effectiveness of hazardous fuel reduction treatments in the New Jersey Pine Barrens. *International Journal of Wildland Fire* **18**, 268–277.

18. Clark TL, Reeder MJ, Griffiths M, Packham D, Krusel N (2005) Infrared observations and numerical modelling of grassland fires in the Northern Territory, Australia. *Meteorol Atmos Phys* **88**, 193–201.

19. Copeland SM, Munson SM, Bradford JB, Butterfield BJ (2019) Influence of climate, post-treatment weather extremes, and soil factors on vegetation recovery after restoration treatments in the southwestern US. *Applied Vegetation Science* **22,** 85–95.

20. Darques R (2016) Wildfires at a Pan-Mediterranean Scale: Human-Environment Dynamics Through MODIS Data. *Hum Ecol* **44,** 47–63.

21. Dickinson MB, Hudak AT, Zajkowski T, Loudermilk EL, Schroeder W, Ellison L, Kremens RL, Holley W, Martinez O, Paxton A, Bright BC, O'Brien JJ, Hornsby B, Ichoku C, Faulring J, Gerace A, Peterson D, Mauceri J (2015) Measuring radiant emissions from entire prescribed fires with ground, airborne and satellite sensors – RxCADRE 2012. *Int J Wildland Fire* **25,** 48–61.

22. El Houssami M, Mueller E, Filkov A, Thomas JC, Skowronski N, Gallagher MR, Clark K, Kremens R, Simeoni A (2016) Experimental Procedures Characterising Firebrand Generation in Wildland Fires. *Fire Technol* **52**, 731–751.

23. Fernandez-Carrillo A, McCaw L, Tanase MA (2019) Estimating prescribed fire impacts and post-fire tree survival in eucalyptus forests of Western Australia with L-band SAR data. *Remote Sensing of Environment* **224**, 133–144.

24. Ferrero E, Alessandrini S, Anderson B, Tomasi E, Jimenez P, Meech S (2019) Lagrangian simulation of smoke plume from fire and validation using ground-based lidar and aircraft measurements. *Atmospheric Environment* **213**, 659–674.

25. Finney MA, McHugh CW, Grenfell IC (2005) Stand- and landscape-level effects of prescribed burning on two Arizona wildfires. *Can J For Res* **35**, 1714–1722.

26. Fisher R, Bobanuba WE, Rawambaku A, Hill GJE, Russell-Smith J (2006) Remote sensing of fire regimes in semi-arid Nusa Tenggara Timur, eastern Indonesia: current patterns, future prospects. *Int J Wildland Fire* **15**, 307–317.

27. Franke J, Barradas ACS, Borges MA, Menezes Costa M, Dias PA, Hoffmann AA, Orozco Filho JC, Melchiori AE, Siegert F (2018) Fuel load mapping in the Brazilian Cerrado in support of integrated fire management. *Remote Sensing of Environment* **217**, 221–232.

28. Gallagher MR, Skowronski NS, Lathrop RG, McWilliams T, Green EJ (2020) An Improved Approach for Selecting and Validating Burn Severity Indices in Forested Landscapes. *Canadian Journal of Remote Sensing* **46**, 100–111.

29. Gharun M, Possell M, Jenkins ME, Poon LF, Bell TL, Adams MA (2017) Improving forest sampling strategies for assessment of fuel reduction burning. *Forest Ecology and Management* **392**, 78–89.

30. Giglio L, Csiszar I, Restás Á, Morisette JT, Schroeder W, Morton D, Justice CO (2008) Active fire detection and characterization with the advanced spaceborne thermal

emission and reflection radiometer (ASTER). *Remote Sensing of Environment* **112**, 3055–3063.

31. Goodrich DC, Wei H, Burns IS, Guertin DP, Spaeth K, Hernandez M, Holifield-Collins C, Kautz M, Heilman P, Levick LR, Ponce G, Carrillo E, Tiller R (2020) Evaluation of Conservation Effects Assessment Project Grazing Lands conservation practices on the Cienega Creek watershed in southeast Arizona with AGWA/RHEM modeling tools. *Journal of Soil and Water Conservation* **75**, 304–318.

32. Gupta V, Reinke K, Jones S (2013) Changes in the spectral features of fuel layers of an Australian dry sclerophyll forest in response to prescribed burning. *Int J Wildland Fire* **22**, 862–868.

33. Gupta V, Reinke KJ, Jones SD, Wallace L, Holden L (2015) Assessing Metrics for Estimating Fire Induced Change in the Forest Understorey Structure Using Terrestrial Laser Scanning. *Remote Sensing* **7**, 8180–8201.

34. Henry MC, Hope AS (1998) Monitoring post-burn recovery of chaparral vegetation in southern California using multi-temporal satellite data. *International Journal of Remote Sensing* **19**, 3097–3107.

35. Huang R, Zhang X, Chan D, Kondragunta S, Russell AG, Odman MT (2018) Burned Area Comparisons Between Prescribed Burning Permits in Southeastern United States and Two Satellite-Derived Products. *Journal of Geophysical Research: Atmospheres* **123**, 4746–4757.

36. Hudak AT, Dickinson MB, Bright BC, Kremens RL, Loudermilk EL, O'Brien JJ, Hornsby BS, Ottmar, RD (2015) Measurements relating fire radiative energy density and surface fuel consumption – RxCADRE 2011 and 2012. *Int J Wildland Fire* **25,** 25–37.

37. Hudak AT, Kato A, Bright BC, Loudermilk EL, Hawley C, Restaino JC, Ottmar RD, Prata GA, Cabo C, Prichard SJ, Rowell EM, Weise DR (2020) Towards Spatially Explicit Quantification of Pre- and Postfire Fuels and Fuel Consumption from Traditional and Point Cloud Measurements. *Forest Science* **66**, 428–442.

38. Hulet A, Roundy BA, Petersen SL, Jensen RR, Bunting SC (2014) An Object-Based Image Analysis of Pinyon and Juniper Woodlands Treated to Reduce Fuels. *Environmental Management* **53**, 660–671.

39. Jain TB, Graham RT, Byrne JC, Bright BC (2020) Canopy Opening and Site Preparation Effects on Conifer and Understory Establishment and Growth after an Uneven-Aged Free Selection Regeneration Harvest in the Northern Rocky Mountains, USA. *Forests* **11**, 622.

40. Junpen A, Garivait S, Bonnet S (2013) Estimating emissions from forest fires in Thailand using MODIS active fire product and country specific data. *Asia-Pacific J Atmos Sci* **49**, 389–400.

41. Kato S, Kouyama T, Nakamura R, Matsunaga T, Fukuhara T (2018) Simultaneous retrieval of temperature and area according to sub-pixel hotspots from nighttime Landsat 8 OLI data. *Remote Sensing of Environment* **204,** 276–286.

42. Kaufman YJ, Justice CO, Flynn LP, Kendall JD, Prins EM, Giglio L, Ward DE, Menzel WP Setzer AW (1998) Potential global fire monitoring from EOS-MODIS. *Journal of Geophysical Research: Atmospheres* **103**, 32215–32238.

43. Kiefer MT, Heilman WE, Zhong S, Charney JJ, Bian X, Skowronski NS, Hom JL, Clark KL, Patterson M, Gallagher MR (2014) Multiscale Simulation of a Prescribed

Fire Event in the New Jersey Pine Barrens Using ARPS-CANOPY. *Journal of Applied Meteorology and Climatology* **53**, 793–812.

44. Klauberg C, Hudak AT, Bright BC, Boschetti L, Dickinson MB, Kremens RL, Silva CA (2018) Use of ordinary kriging and Gaussian conditional simulation to interpolate airborne fire radiative energy density estimates. *Int J Wildland Fire* **27**, 228–240.

45. Knight CA, Tompkins RE, Wang JA, York R, Goulden ML, Battles JJ (2022) Accurate tracking of forest activity key to multi-jurisdictional management goals: A case study in California. *Journal of Environmental Management* **302**, 114083.

46. Kovalev VA, Newton J, Wold C, Hao WM (2005) Simple algorithm to determine the near-edge smoke boundaries with scanning lidar. *Appl Opt, AO* **44**, 1761–1768.

47. Lacki MJ, Dodd LE, Skowronski NS, Dickinson MB, Rieske LK (2017) Relationships among burn severity, forest canopy structure and bat activity from spring burns in oak–hickory forests. *Int J Wildland Fire* **26**, 963–972.

48. Lacouture DL, Broadbent EN, Crandall RM (2020) Detecting Vegetation Recovery after Fire in A Fire-Frequented Habitat Using Normalized Difference Vegetation Index (NDVI). *Forests* **11**, 749.

49. Li F, Zhang X, Kondragunta S, Schmidt CC, Holmes CD (2020) A preliminary evaluation of GOES-16 active fire product using Landsat-8 and VIIRS active fire data, and ground-based prescribed fire records. *Remote Sensing of Environment* **237**, 111600.

50. Lin H-W, McCarty JL, Wang D, Rogers BM, Morton DC, Collatz GJ, Jin Y, Randerson JT (2014)Management and climate contributions to satellite-derived active

fire trends in the contiguous United States. *Journal of Geophysical Research: Biogeosciences* **119**, 645–660.

51. Liu T, Mickley LJ, McCarty JL (2021) Global search for temporal shifts in fire activity: potential human influence on southwest Russia and north Australia fire seasons. *Environ Res Lett* **16**, 044023.

52. Loschiavo J, Cirulis B, Zuo Y, Hradsky BA, Stefano JD, Loschiavo J, Cirulis B, Zuo Y, Hradsky BA, Stefano JD (2017) Mapping prescribed fire severity in south-east Australian eucalypt forests using modelling and satellite imagery: a case study. *Int J Wildland Fire* **26**, 491–497.

53. Loudermilk EL, Achtemeier GL, O'Brien JJ, Hiers JK, Hornsby BS (2014) High-resolution observations of combustion in heterogeneous surface fuels. *Int J Wildland Fire* **23**, 1016–1026.

54. Malmstrom CM, Butterfield HS, Barber C, Dieter B, Harrison R, Qi J, Riaño D, Schrotenboer A, Stone S, Stoner CJ, Wirka J (2009) Using Remote Sensing to Evaluate the Influence of Grassland Restoration Activities on Ecosystem Forage Provisioning Services. *Restoration Ecology* **17**, 526–538.

55. Malone SL, Kobziar LN, Staudhammer CL, Abd-Elrahman A (2011) Modeling Relationships among 217 Fires Using Remote Sensing of Burn Severity in Southern Pine Forests. *Remote Sensing* **3**, 2005–2028.

56. Marion R, Michel R, Faye C (2004) Measuring trace gases in plumes from hyperspectral remotely sensed data. *IEEE Transactions on Geoscience and Remote Sensing* **42**, 854–864.

57. McCarthy G, Moon K, Smith L (2017) Mapping fire severity and fire extent in forest in Victoria for ecological and fuel outcomes. *Ecological Management & Restoration* **18**, 54–65.

58. McCarthy N, McGowan H, Guyot A, Dowdy A (2018) Mobile X-Pol Radar: A New Tool for Investigating Pyroconvection and Associated Wildfire Meteorology. *Bulletin of the American Meteorological Society* **99**, 1177–1195.

59. Miao Z, Lathrop RG, Xu M, La Puma IP, Clark KL, Hom J, Skowronski N, Van Tuyl S (2011) Simulation and sensitivity analysis of carbon storage and fluxes in the New Jersey Pinelands. *Environmental Modelling & Software* **26**, 1112–1122.

60. Miller JED, Damschen EI, Ratajczak Z, Özdoğan M (2017) Holding the line: three decades of prescribed fires halt but do not reverse woody encroachment in grasslands. *Landscape Ecol* **32**, 2297–2310.

61. Mohler RL, Goodin DG (2012) Identifying a suitable combination of classification technique and bandwidth(s) for burned area mapping in tallgrass prairie with MODIS imagery. *International Journal of Applied Earth Observation and Geoinformation* **14**, 103–111.

62. Mohler RL, Goodin DG (2010) A comparison of red, NIR, and NDVI for monitoring temporal burn signature change in tallgrass prairie. *Remote Sensing Letters* **1**, 3–9.

63. Nguyen TH, Jones SD, Soto-Berelov M, Haywood A, Hislop S (2018) A spatial and temporal analysis of forest dynamics using Landsat time-series. *Remote Sensing of Environment* **217**, 461–475.

64. Norton J, Glenn N, Germino M, Weber K, Seefeldt S (2009) Relative suitability of indices derived from Landsat ETM+ and SPOT 5 for detecting fire severity in sagebrush steppe. *International Journal of Applied Earth Observation and Geoinformation* **11**, 360–367.

65. Noson AC, Schmitz RA, Miller RF (2006) INFLUENCE OF FIRE AND JUNIPER ENCROACHMENT ON BIRDS IN HIGH-ELEVATION SAGEBRUSH STEPPE. *Western North American Naturalist* **66**, 343–353.

66. Nowell HK, Holmes CD, Robertson K, Teske C, Hiers JK (2018) A New Picture of Fire Extent, Variability, and Drought Interaction in Prescribed Fire Landscapes: Insights From Florida Government Records. *Geophysical Research Letters* **45**, 7874–7884.

67. O'Brien JJ, Loudermilk EL, Hornsby B, Hudak AT, Bright BC, Dickinson MB, Hiers JK, Teske C, Ottmar RD (2015) High-resolution infrared thermography for capturing wildland fire behaviour: RxCADRE 2012. *Int J Wildland Fire* **25**, 62–75.

68. O'Neill AL, Head LM, Marthick JK (1993) Integrating remote sensing and spatial analysis techniques to compare aboriginal and pastoral fire patterns in the East Kimberley, Australia. *Applied Geography, Special Issue Geographical Information Systems and Remote Sensing in Land Use Planning* **13**, 67–85.

69. Palaiologou P, Essen M, Hogland J, Kalabokidis K (2020) Locating Forest Management Units Using Remote Sensing and Geostatistical Tools in North-Central Washington, USA. *Sensors* **20**, 2454.

70. Petrakis RE, Villarreal ML, Wu Z, Hetzler R, Middleton BR, Norman LM (2018) Evaluating and monitoring forest fuel treatments using remote sensing applications in Arizona, USA. *Forest Ecology and Management* **413**, 48–61.

71. Picotte JJ, Robertson K (2011) Timing Constraints on Remote Sensing of Wildland Fire Burned Area in the Southeastern US. *Remote Sensing* **3,** 1680–1690.

72. Pouliot GA, Pace TG, Biswadev R, Pierce T, Mobley D (2008) Development of a biomass burning emissions inventory by combining satellite and ground-based information. *JARS* **2**, 021501.

73. Prasad VK, Kant Y, Gupta PK, Elvidge C, Badarinath KVS (2002) Biomass burning and related trace gas emissions from tropical dry deciduous forests of India: A study using DMSP-OLS data and ground-based measurements. *International Journal of Remote Sensing* **23**, 2837–2851.

74. Price OF, Bradstock RA (2012) The efficacy of fuel treatment in mitigating property loss during wildfires: Insights from analysis of the severity of the catastrophic fires in 2009 in Victoria, Australia. *Journal of Environmental Management* **113**, 146–157.

75. Price OF, Russell-Smith J, Watt F (2012) The influence of prescribed fire on the extent of wildfire in savanna landscapes of western Arnhem Land, Australia. *Int J Wildland Fire* **21**, 297–305.

76. Prins EM, Feltz JM, Menzel WP, Ward DE (1998) An overview of GOES-8 diurnal fire and smoke results for SCAR-B and 1995 fire season in South America. *Journal of Geophysical Research: Atmospheres* **103**, 31821–31835.

77. Radford IJ, Gibson LA, Corey B, Carnes K, Fairman R (2015) Influence of Fire Mosaics, Habitat Characteristics and Cattle Disturbance on Mammals in Fire-Prone Savanna Landscapes of the Northern Kimberley. *PLOS ONE* **10**, e0130721.

78. Radford IJ, Woolley L-A, Corey B, Vigilante T, Hatherley E, Fairman R, Carnes K, Start AN, Wunambal Gaambera Aboriginal Corporation (2020) Prescribed burning benefits threatened mammals in northern Australia. *Biodivers Conserv* **29**, 2985–3007.

79. Ratajczak Z, Briggs JM, Goodin DG, Luo L, Mohler RL, Nippert JB, Obermeyer B (2016) Assessing the Potential for Transitions from Tallgrass Prairie to Woodlands: Are We Operating Beyond Critical Fire Thresholds?. *Rangeland Ecology & Management* **69**, 280–287.

80. Rauste Y, Herland E, Frelander H, Soini K, Kuoremaki T, Ruokari A (1997) Satellite-based forest fire detection for fire control in boreal forests. *International Journal of Remote Sensing* **18**, 2641–2656.

81. Rigge M, Homer C, Shi H, Meyer D, Bunde B, Granneman B, Postma K, Danielson P, Case A, Xian G (2021) Rangeland Fractional Components Across the Western United States from 1985 to 2018. *Remote Sensing* **13**, 813.

82. Rowell EM, Seielstad CA, Ottmar RD, Rowell EM, Seielstad CA, Ottmar RD (2015) Development and validation of fuel height models for terrestrial lidar – RxCADRE 2012. *Int J Wildland Fire* **25**, 38–47.

83. Roy DP, Landmann T (2005) Characterizing the surface heterogeneity of fire effects using multi-temporal reflective wavelength data. *International Journal of Remote Sensing* **26**, 4197–4218.

84. Sá ACL, Pereira JMC, Silva JMN (2005) Estimation of combustion completeness based on fire-induced spectral reflectance changes in a dambo grassland (Western Province, Zambia). *International Journal of Remote Sensing* **26**, 4185–4195.

85. Sankey JB, Ravi S, Wallace CSA, Webb RH, Huxman TE (2012) Quantifying soil surface change in degraded drylands: Shrub encroachment and effects of fire and vegetation removal in a desert grassland. *Journal of Geophysical Research: Biogeosciences* **117**.

86. Sankey JB, Sankey TT, Li J, Ravi S, Wang G, Caster J, Kasprak A (2021). Quantifying plant-soil-nutrient dynamics in rangelands: Fusion of UAV hyperspectral-LiDAR, UAV multispectral-photogrammetry, and ground-based LiDAR-digital photography in a shrub-encroached desert grassland. *Remote Sensing of Environment* **253**, 112223.

87. Santos FLM, Nogueira J, Souza RAF de, Falleiro RM, Schmidt IB, Libonati R (2021) Prescribed Burning Reduces Large, High-Intensity Wildfires and Emissions in the Brazilian Savanna. *Fire* **4,** 56.

88. Schroeder W, Ellicott E, Ichoku C, Ellison L, Dickinson MB, Ottmar RD, Clements C, Hall D, Ambrosia V, Kremens R (2014) Integrated active fire retrievals and biomass burning emissions using complementary near-coincident ground, airborne and spaceborne sensor data. *Remote Sensing of Environment* **140**, 719–730.

89. Schweizer D, Preisler HK, Cisneros R (2019) Assessing relative differences in smoke exposure from prescribed, managed, and full suppression wildland fire. *Air Qual Atmos Health* **12**, 87–95.

90. Shrestha M, Broadbent EN, Vogel JG (2021) Using GatorEye UAV-Borne LiDAR to Quantify the Spatial and Temporal Effects of a Prescribed Fire on Understory Height and Biomass in a Pine Savanna. *Forests* **12**, 38.

91. Silberstein RP, Dawes WR, Bastow TP, Byrne J, Smart NF (2013) Evaluation of changes in post-fire recharge under native woodland using hydrological measurements, modelling and remote sensing. *Journal of Hydrology* **489**, 1–15.

92. Skowronski N, Clark K, Nelson R, Hom J, Patterson M (2007) Remotely sensed measurements of forest structure and fuel loads in the Pinelands of New Jersey. *Remote Sensing of Environment, The Application of Remote Sensing to Fire Research in the Eastern United States* **108**, 123–129.

93. Skowronski NS, Gallagher MR, Warner TA (2020) Decomposing the Interactions between Fire Severity and Canopy Fuel Structure Using Multi-Temporal, Active, and Passive Remote Sensing Approaches. *Fire* **3(1)**, 7.

94. Skroblin A, Legge S, Webb T, Hunt LP (2014) EcoFire: regional-scale prescribed burning increases the annual carrying capacity of livestock on pastoral properties by reducing pasture loss from wildfire. *The Rangeland Journal* **36**, 133–142.

95. Soja AJ, Al-Saadi JA, Giglio L, Randall D, Kittaka C, Pouliot GA, Kordzi JJ, Raffuse SM, Pace TG, Pierce T, Moore T, Roy B, Pierce B, Szykman JJ (2009) Assessing satellite-based fire data for use in the National Emissions Inventory. *JARS* **3**, 031504.

96. Soverel NO, Coops NC, Perrakis DDB, Daniels LD, Gergel SE (2011) The transferability of a dNBR-derived model to predict burn severity across 10 wildland fires in western Canada. *Int J Wildland Fire* **20**, 518–531.

97. Sowden M, Blake D (2021) Using infrared geostationary remote sensing to determine particulate matter ground-level composition and concentration. *Air Qual Atmos Health*

98. Srivastava SK, Lewis T, Behrendorff L, Phinn S (2020) Spatial databases and techniques to assist with prescribed fire management in the south-east Queensland bioregion. *Int J Wildland Fire* **30**, 90–111.

99. Sühs RB, Giehl ELH, Peroni N (2020) Preventing traditional management can cause grassland loss within 30 years in southern Brazil. *Sci Rep* **10**, 783.

100. Tariq A, Shu H, Gagnon AS, Li Q, Mumtaz F, Hysa A, Siddique MA, Munir I, (2021a) Assessing Burned Areas in Wildfires and Prescribed Fires with Spectral Indices and SAR Images in the Margalla Hills of Pakistan. *Forests* **12**, 1371.

101. Tariq A, Shu H, Li Q, Altan O, Khan MR, Baqa MF, Lu L (2021b) Quantitative Analysis of Forest Fires in Southeastern Australia Using SAR Data. *Remote Sensing* **13**, 2386 .

102. Temudo MP, Oom D, Pereira JM (2020) Bio-cultural fire regions of Guinea-Bissau: Analysis combining social research and satellite remote sensing. *Applied Geography* **118**, 102203.

103. Tian X, Zhao F, Shu L, Wang M (2013) Distribution characteristics and the influence factors of forest fires in China. *Forest Ecology and Management* **310**, 460–467.

104. Valero MM, Verstockt S, Butler B, Jimenez D, Rios O, Mata C, Queen Ll, Pastor E, Planas E (2021) Thermal Infrared Video Stabilization for Aerial Monitoring of Active Wildfires. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing* **14**, 2817–2832.

105. Villarreal ML, Norman LM, Buckley S, Wallace CSA, Coe MA (2016) Multi-index time series monitoring of drought and fire effects on desert grasslands. *Remote Sensing of Environment* **183**, 186–197.

106. Walker RB, Coop JD, Parks SA, Trader L (2018) Fire regimes approaching historic norms reduce wildfire-facilitated conversion from forest to non-forest. *Ecosphere* **9**, e02182.

107. Wall WA, Hohmann MG, Just MG, Hoffmann WA (2021) Characterizing past fire occurrence in longleaf pine ecosystems with the Mid-Infrared Burn Index and a Random Forest classifier. *Forest Ecology and Management* **500**, 119635.

108. Wallace L, Gupta V, Reinke K, Jones S (2016) An Assessment of Pre- and Post Fire Near Surface Fuel Hazard in an Australian Dry Sclerophyll Forest Using Point Cloud Data Captured Using a Terrestrial Laser Scanner. *Remote Sensing* **8**, 679.

109. Walz Y, Maier SW, Dech SW, Conrad C, Colditz RR (2007) Classification of burn severity using Moderate Resolution Imaging Spectroradiometer (MODIS): A case study in the jarrah-marri forest of southwest Western Australia. *Journal of Geophysical Research: Biogeosciences* **112**.

110. Warner TA, Skowronski NS, Puma IL (2020) The influence of prescribed burning and wildfire on lidar-estimated forest structure of the New Jersey Pinelands National Reserve. *Int J Wildland Fire* **29**, 1100–1108.

111. Wells AG, Munson SM, Sesnie SE, Villarreal ML (2021) Remotely Sensed Fine-Fuel Changes from Wildfire and Prescribed Fire in a Semi-Arid Grassland. *Fire* **4**, 84.

112. Whitehead SC, Baines D, Whitehead SC, Baines D (2018) Moorland vegetation responses following prescribed burning on blanket peat. *Int J Wildland Fire* **27**, 658–664.

113. Wiens J, Sutter R, Anderson M, Blanchard J, Barnett A, Aguilar-Amuchastegui N, Avery C, Laine S (2009) Selecting and conserving lands for biodiversity: The role of remote sensing. *Remote Sensing of Environment, Monitoring Protected Areas* **113**, 1370–1381.

114. Wilkins JL, Pouliot G, Pierce T, Soja A, Choi H, Gargulinski E, Gilliam R, Vukovich J, Landis MS (2022) An evaluation of empirical and statistically based smoke plume injection height parametrisations used within air quality models. *Int J Wildland Fire* **31**, 193–211.

115. Williamson GJ, Price OF, Henderson SB, Bowman DMJS (2012) Satellite-based comparison of fire intensity and smoke plumes from prescribed fires and wildfires in south-eastern Australia. *Int J Wildland Fire* **22**, 121–129.

116. Wysong M, Legge S, Clark A, Maier S, Cowell S, Mackay G (2021) The sum of small parts: changing landscape fire regimes across multiple small landholdings in north-western Australia with collaborative fire management. *Int J Wildland Fire* **31**, 97–111.

117. Zajkowski TJ, Dickinson MB, Hiers JK, Holley W, Williams BW, Paxton A, Martinez O, Walker GW (2015) Evaluation and use of remotely piloted aircraft systems for operations and research – RxCADRE 2012. *Int J Wildland Fire* **25**, 114–128.

118. Zeng T, Liu Z, Wang Y (2016) Large fire emissions in summer over the southeastern US: Satellite measurements and modeling analysis. *Atmospheric Environment* **127**, 213–220.

119. Zeng T, Wang Y, Yoshida Y, Tian D, Russell AG, Barnard WR (2008) Impacts of Prescribed Fires on Air Quality over the Southeastern United States in Spring Based on Modeling and Ground/Satellite Measurements. *Environ Sci Technol* **42**, 8401–8406.

120. Zhan X, Sohlberg RA, Townshend JRG, DiMiceli C, Carroll ML, Eastman JC, Hansen MC, DeFries RS (2002) Detection of land cover changes using MODIS 250 m data. *Remote Sensing of Environment, The Moderate Resolution Imaging Spectroradiometer (MODIS): a new generation of Land Surface Monitoring* **83**, 336–350.