INVESTIGATING SPACEBORNE L-BAND POLARIMETRIC SAR FOR OPERATIONAL WILDFIRE MAPPING IN BC

Ashlin Richardson[1], Lucio Mascolo[2], Subhadip Dey[3], Armando Marino[4], Hao Chen[5], Sasha Nasonova[1], Andre Beaudoin[5]

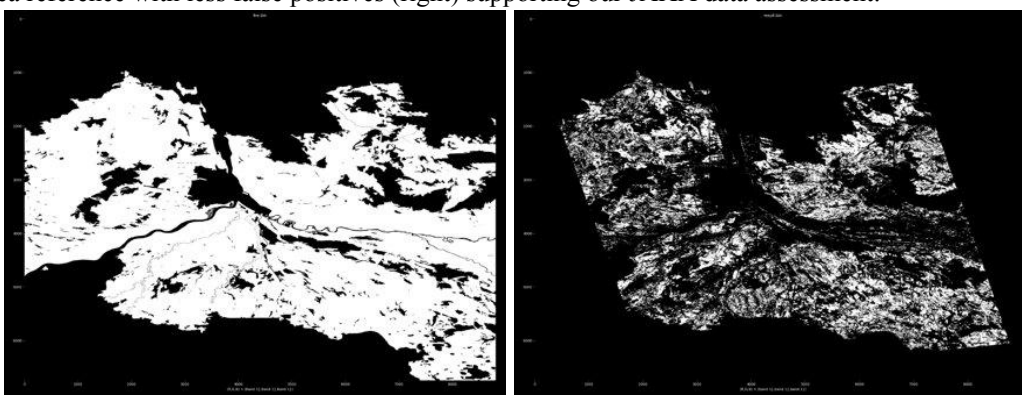
[1]BC Ministry of Forests, PO Box 9502, Stn Prov Govt, Victoria BC V8W9C1 Ashlin.Richardson@gov.bc.ca
[2]Global Change Unit, Imaging Processing Laboratory, University of Valencia, PO Box 22085 E-46071 Valencia, Spain lucio.mascolo@ua.es
[3]Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur, Kharagpur 721302, India sdey2307@gmail.com
[4]Department of Biological and Environmental Sciences, University of Stirling, Stirling FK9 4LA, UK armando.marino@stir.ac.uk
[5]Canadian Forest Service, 506 Burnside Rd W, Victoria, BC V8Z 1M5 hchen@canada.ca

ABSTRACT

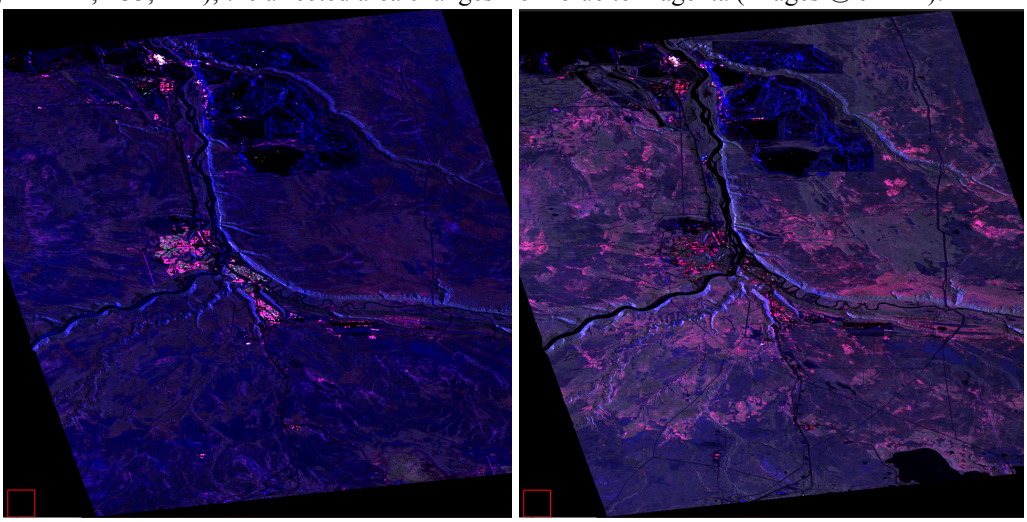
This paper investigates L-band Polarimetric Synthetic Aperture Radar (PolSAR) data to support optical fire and burn severity mapping (Tanase et al, 2015) under cloud cover (Goodenough et al, 2011) for the reason that L-band data are more sensitive to tree branches, stems and biomass when compared with C-band systems like Radarsat-2/RCM and Sentinel-1. Moreover Quad-Pol (QP) data are higher dimensional and improve the potential to discern between different types of materials, including but not limited to the ability to correct ionospheric distortion affecting L-band. Due to scarcity of ALOS-2/PALSAR-2 data over British Columbia in the QP mode, we chose the 2016 Horse River fire affecting Fort McMurray, Alberta Canada to study operational potential of L-band QP SAR using several methods, as we expect wider QP data availability in future.

There are two time series of ALOS-2 QP data available over Fort McMurray, with distinct but overlapping footprints. Whereas (JAXA, 2016) and (Plank et al 2019) analyse the series in which Fort McMurray appears slightly East of the footprint centre, we analyse the other series where Fort McMurray appears closer to the footprint centre, by classifying the burned area to help prepare for using L-band ALOS-4/PALSAR3, ROSE-L or NISAR missions in operational fire mapping scenarios in BC. Finally, as L-band SAR missions may not provide large coverage in QP mode yet, we hedge our bets and apply Dual-Pol (DP) methods of (Mascolo et al, 2021) providing physical polarimetric interpretation accessible from both DP and QP acquisition modes.

Due to the challenge posed by fire perimeter data's operational orientation, October 3, 2016 Landsat data classification was used along with existing CNFDB fire perimeter data (left), to create a burned area reference with less false positives (right) supporting our JAXA data assessment:


.

The 20150404 (pre) and 20160528 (post) images were initially classified using PolSAR parameters e.g. Coherency (T) elements (Goodenough et al, 2011) using only *k*NN with *k*=1 and very few positive and negative samples (N=20 training pixels for a raster of millions of pixels). E.g. using T22 only as in (JAXA, 2016) accuracy was 77% overall. For T11, T22, and T33 channels 80% accuracy was obtained. Moreover, there was 75% accuracy using T22 of post image only. Finally, 75% accuracy was found by classifying DP parameters (Mascolo et al, 2021) for post image only. So we expect to report much higher classification accuracy in the full paper by using Machine Learning (ML) algorithms, plus substantially more training samples. Finally, additional info gained from five other images available on the same footprint, such as with coherent change detection as in (Lehrbass et al, 2018) will be reported. Below the April 4th, 2015 (left) and May 28th, 2016 (right) images are visualized with Coherency matrix (T) parameters (encoded as R,G,B = T22, T33, T11); the affected area changes from blue to magenta (images © JAXA):



In conclusion, preliminary results showed operationally interesting information retrieval to be expanded and interpreted with detailed physical modelling in the full paper. Thanks to JAXA for ALOS-2/PALSAR-2 data provided under EORA3 for our project "BC Wildfire Service – Predictive Services Unit – Fuel Type Layer Project".

***Keywords*—** Radar, Polarimetric SAR, Fire mapping, ALOS-2, Wildfire, Fort McMurray

REFERENCES

Tanase, M.A., Kennedy, R., and Aponte, C. 2015. "Radar Burn Ratio for fire severity estimation at canopy level: An example for temperate forests." *Remote Sensing of Environment,* Vol. 170: pp: 14-31. doi: http://dx.doi.org/10.1016/j.rse.2015.08.025.

Goodenough, D. G., Chen, H., Richardson, A., Cloude, S., Hong, W., and Yang., L. 2011. "Mapping fire scars using Radarsat-2 Polarimetric SAR Data." *Canadian Journal of Remote Sensing,* Vol. 37 (No. 5): pp. 500-509. doi: https://doi.org/10.5589/m11-060.

JAXA EORC, 2016. "ALOS-2/PALSAR-2 Observation Results on Wildfire in Canada", JAXA Website, last modified January 21, 2016, https://www.eorc.jaxa.jp/ALOS-2/en/img_up/dis_pal2_can-forest_fire_20160509.htm.

Plank, S., Karg., S. and Matinis, S. 2019. "Full-polarimetric burn scar mapping - the differences of active fire and post-fire situations." *International Journal of Remote Sensing,* Vol 40 (No. 1): pp 253-268. doi: https://doi.org/10.1080/01431161.2018.1512768.

Mascolo, L., Cloude, S.R., Lopez-Sanchez, J.M. 2021. "Model-based decomposition of dual-pol SAR data: application to Sentinel-1." *IEEE Transactions on Geoscience and Remote Sensing,* Vol 60. doi: https://doi.org/10.1109/TGRS.2021.3137588**.**

Lehrbass, B., and Decker, V. 2017. "Natural Resources Canada's Response to the Fort McMurray Wildfire." Paper presented at EO Summit 2017, Montréal, Québec, June 2017.