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Toward structural assessment of semi-arid African savannahs and woodlands: The potential of multitemporal polarimetric RADARSAT-2 fine beam images

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Abstract

Woody vegetation structure affects wildlife habitat selection and species diversity for a wide range of taxa, and at a variety of scales. Indicators of woody structure can indicate the spatio-temporal variability of biodiversity, species occurrence and assemblages. Woody cover is the simplest and most widely used structural metric. Combined with the vegetation height, it provides a volumetric indicator, which is more informative, and is simple to calculate. We therefore assessed the utility of multi temporal polarimetric RADARSAT-2 C-band imagery to map measures of woody volumetric indices in Low veld savannahs, in the vicinity of the Kruger National Park, South Africa. RADARSAT-2 Quad-Pol fine beam images were acquired at three key phenological stages of the seasonal savannah cycle: i) wet (summer), ii) dry (winter), and iii) end of wet (autumn). Multi-polarized band intensities (C-HH, C-HV, and C-VV, with V = vertical and H = horizontal) and polarimetric decomposition variables (Freeman–Durden, Cloude–Pottier, and Van Zyl) were derived from the SAR images and used to predict structural metrics (woody canopy cover, cylindrical woody volume, and woody canopy volume, see definition in Section 3.3) derived from1.1 m LiDAR strips acquired across the study area, and coinciding with 12% of the SAR dataset. The best single relationship (R2 = 0.66) was obtained between the cross-polarized HV intensity band and the total canopy volume (TCV). In terms of the seasonality, the best results were obtained using the SAR imagery from the dry season when most woody plants have lost their leaves and the grass-soil layer was dry. Validation outputs of best predictive models for TCV, at the individual season level, yielded an R2 of 0.67, a Standard Error of Prediction (SEP) of 39%,

and consisted of the SAR parameters: C-HH, C-HV, C-VV, and Freeman–Durden decomposition parameters. At the multi-seasonal level, the best predictive models for TCV yielded an R2 of 0.75, a SEP of 35%, and comprised of the same variables but for all three seasons. The C-band SAR data thus provided encouraging results in open, semi-arid savannahs and hint at larger area structural assessments than is possiblewith LiDAR sensors alone. The combined use of C-band and L-band (ALOS-Palsar 2) should also be investigated.