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Can we go beyond burned area assessment with fire patch metrics from global remote rensing?

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Fire is a major event influencing global biogeochemical cycles and contribute to the emissions of CO_2 and other greenhouse gases to the atmosphere. Global burned area (BA) datasets from remote sensing have provided the fruitful information for quantifying carbon emissions in global biogeochemical models, and for DGVM's benchmarking. Patch level analysis from pixel level information recently emerged as an informative additional feature of the regime as fire size distribution. The aim of this study is to evaluate the ability of global BA products to accurately represent characteristics of fire patches (size, complexity shape and spatial orientation). We selected a site in the Brazilian savannas (Cerrado), one of the most fire prone biome and one of the validation test site for the ESA fire-Cci project. We used the pixel-level burned area detected by Landsat, MCD45A1 and the newly delivered MERIS ESA fire-Cci for the period 2002-2009. A flood-fill algorithm adapted from Archibald and Roy (2009) was used to identify the individual fire patches (patch ID) according to the burned date (BD). For each patch ID, we calculated a panel of patch metrics as area, perimeter and core area, shape complexity (shape index and fractal dimension) and the feature of the ellipse fitted over the spatial distribution of pixels composing the patch (eccentricity and direction of the main axis). Paired fire patches overlapping between each BA products were compared. The correlation between patch metrics were evaluated by linear regression models for each inter-product comparison according to fire size classes. Our results showed significant patch overlaps (>30%) between products for patches with areas larger than 270ha, with more than 90% of patches overlapping between MERIS and MCD45A1. Fire Patch metrics correlations showed R2>0.6 for all comparisons of patch Area and Core Area, with a slope of 0.99 between MERIS and MCD45A1 illustrating the agreement between the two global products. The slope varied between 0.6 and 0.8 when compared to the landsat data, illustrating the underestimation of fire patch size in this region from global products. Indices of shape complexity were less correlated with R2 around 0.5 between global products, and around 0.2 between global products and the landsat data, illustrating the loss of complexity at coarse resolution. The correlations for the features of the fitted ellipse (eccentricity and directional angle) both increased with fire size classes from 0.2 for fire size 90-270ha to 0.6 for fire size >900ha for eccentricity and from 0.4 to 0.8 for the directional angle. Slopes of the regressions were around 0.6 for eccentricity and between 0.6 and 1 for directional angle for fire size classes >450ha. We conclude that global BA products acknowledged to underestimate BA due to missing small fires, also underestimate large patch areas. Patch complexity are the less correlated features. The features of the fitted ellipse, used in DGVM fire modules, appear to be a reliable information in both global remote sensing products for patches larger than 400ha and could be further used for global pyrogeography or DGVM benchmarking.