Extraction of reference perimeters from Sentinel-2 data for validation of Burned Area products over Africa

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Abstract. In this work, we present a procedure for building a dataset of fire reference perimeters from Sentinel-2 (S2) built on a sampling scheme designed on the characteristics of the S2 tiling system to identify validation units. The proposed sampling strategy and extraction of fire reference perimeters are applied to sub-Saharan Africa (latitude range 25°N- 35°S).

The workflow to generate the reference fire perimeters includes the following steps: 1) identification of validation units and stratified sampling, 2) definition of the long units and 3) generation of the reference perimeters. Validation units are defined from spatio-temporal partition of S2 2019 archive; each unit covers an area of about 100 km x 100 km that spatially overlaps the S2 tiles. The S2 archive for each suitable tile is inspected to identify S2 temporal series with maximum time step (t_{max}) of 16 days between pairs of consecutive clear-sky images; suitable temporal series are defined based on single scene cloud cover (< 10%) and maximum cumulated cloud cover over the time series (<30%). A minimum length of the validation unit is set to 100 days (L). S2 tiles where time series do not satisfy these requirements are discarded.

For each suitable S2 tile, total annual burned area (estimated from FireCCI51 BA product [1]) and major Olson biome [2] are computed. A total of 50 sampling units/tiles are sampled from the suitable population identified with a stratified random sampling approach with number of units allocated among strata based on the equation

$$n_h \propto N_h \sqrt{(\bar{}BA_h)}$$

where n_h is the number of S2 tiles to be sampled for stratum h, BA_h is the average total annual (2019) burned area for stratum h and N_h is the total amount of S2 tiles available for sampling for stratum h. For smaller strata, a minimum of n_h=2 is assigned.

Fire perimeters for sampled S2 validation units are extracted for pairs of consecutive S2 images to map areas burned between the two dates (t1, t2) (hereafter defined as "short units"); classification was implemented in Google Earth Engine (GEE) that applies a RF algorithm to identify burned polygons. All short units over the same area are combined to derive fire perimeters over the S2 "long unit".

Figure 1 shows example fire perimeters extracted from one S2 tile (35LMD) in tropical savanna. Panel 'a' represents the three classes output of RF and aggregated in the long-unit: in red the burned areas, green unburned and black cumulated cloud cover. S2 fire perimeters are stored with the date of detection within the time period covered by the

time series, that is the date t2 of the "short-unit" (panel 'b'). In panel 'c' FireCCI51 product is compared with fire perimeters extracted from S2 and spatial distribution of the agreement between classified and reference products is displayed (green=correct burned, red=omission and blue=commission).

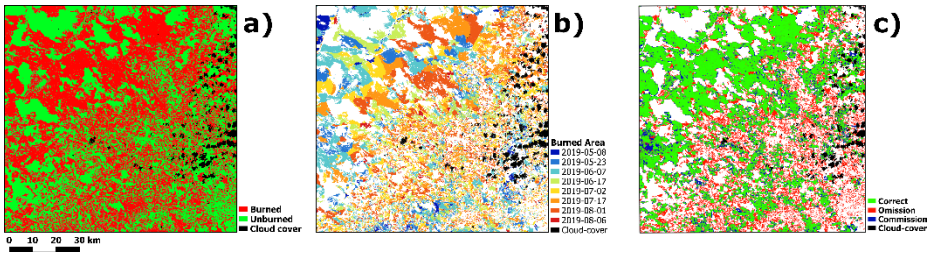

Fig. 1. For S2 tile 35 MLN (Tropical savanna, Africa): a) synthetic BA map over the "long-unit" showing areas burned over the period May 05 to August 06, 2019; b) BA polygons displayed with post-fire date attribute; c) spatial agreement between FireCCI51 product and S2 fire perimeters.

Fire reference perimeters extracted over the 50 S2 tiles for Africa, 2019, constitute a reference dataset for validation of large scale/continental BA products such as the FireCCI51 BA products. Preliminary comparison of S2 fire reference perimeters with perimeters derived from very high spatial resolution Planet images confirmed the high accuracy level with estimated commission error=20%, omission error=35% and dice coefficient=0.72.

Preliminary validation of the FireCCI51 Ba product over Africa, for the year 2019, was carried out by using S2 burned area perimeters as reference; out of the 50 S2 tiles, 21 were extracted and compared to FireCCI burned areas for the estimation of accuracy metrics. Results showed that over these tiles estimated accuracy metrics for the FireCCI BA products are commission error=28%, omission error=49% and dice coefficient=0.6, comparable with metrics found in Lizundia-Loiola et al. (2020) work validating the same product (commission=25.7%, omission=54.5%).

More in-depth analysis will be carried out by investigating the source of errors among those factors that can influence the detectability of burned surface, e.g. land cover characteristics, seasonality of fire, burn severity.

References

1. Lizundia-Loiola, J., Et al.: A spatio-temporal active-fire clustering approach for global burned area mapping at 250 m from MODIS data. Remote Sensing of Environment (236), pp. 111493 (2020).
2. Olson, D.M., Et al.: Terrestrial Ecoregions of the World: A New Map of Life on Earth. Bioscience (51), pp. 933-938 (2001).