CBERS-4A, WPM Fused Imagery Dataset

Emiliano F. Castejon[1], Lubia Vinhas[2], Anderson R. Barbosa[2], Gilberto R. Queiroz[1], Diego S. Gomes[2], Raphael Costa[1], Jeferson S. Arcanjo[3], Wildson Queiroz [2], Ricardo C. M. Sousa[3], Julio C. L. D'Alge[3], José T. M. Bacellar[3]

[1]Divisão de Geoinformática e Observação da Terra – DIOTG

[2]Divisão de Projeto Estratégico 2 – BIG

[3]Laboratório de Geração de Imagens – LGI

Instituto Nacional de Pesquisas Espaciais – INPE – Avenida dos Astronautas, 1758, 12221-010 São José dos Campos - SP

{emiliano.castejon, lubia.vinhas, anderson.barbosa, gilberto.queiroz, diego.gomes, raphael.costa, jeferson.arcanjo, wildson.queiroz, ricardo.cartaxo, julio.dalge, jose.bacellar }@inpe.br

Abstract. *This work describes the dataset WPM Fusion, created and maintained by INPE. WPM is the Multispectral and Panchromatic Wide-Scan Camera, on board the CBERS-4A satellite. WPM images consist of five bands: blue, red, green, and NIR, with 8 meters of spatial resolution, and a panchromatic band with 2 meters of spatial resolution. The WPM Fusion is generated from the fusion of the 8-meter bands and the 2-meter band, resulting in a new 2-meter multispectral image.*

1. Introduction

The CBERS 04A is the fifth satellite of the China-Brazil Earth Resources Satellite (CBERS) program, a collaboration between Brazil and China, operated by the China Centre for Resources Satellite and Data Application (CRESDA) and the Instituto Nacional de Pesquisas Espacias (INPE) - Brazil's National Institute for Space Research. CBERS 04A sensors capture optical images of Earth's surface for various applications, including agriculture, forestry, environmental monitoring, and disaster management. It has three imaging instruments on board: a high-resolution optical imager - Wide Scan Multispectral and Panchromatic Camera (WPM); and two different multi-spectral radiometers, a Multispectral Camera (MUX) and a Wide Field Imager (WFI) (INPE, 2023).

In terms of data distribution, INPE was a pioneer in adopting an open data policy for Landsat class imagery back in 2004; anyone can download and use the image products from the CBERS missions without any access restrictions or fees. The images are selected in a catalog application available at the portal http://www.dgi.inpe.br/catalogo/explore (Figure 1). Users access the portal, select the satellites and sensors in which they are interested, and refine the search using spatial and temporal criteria or cloud cover percentage. After user authentication, the system presents a graphical interface for the user to download the data that was selected.

The data generated by CBERS sensors is transmitted to INPE's ground stations located in Cuiaba, State of Mato Grosso. Once received at the ground station, the raw data is processed to correct for various factors such as effects of the atmosphere on the

reflectance values, sensor noise, and orbit variations. This results in digital images or scenes, in raster raster representation. INPE's system generates images that are georeferenced automatically and most of the images are orthorectified. The images are available to download in GeoTiff format, with each band in a separate file, to be processed separately or in distinct color compositions. The images are generated in 16 bits per pixel, in analytical format.

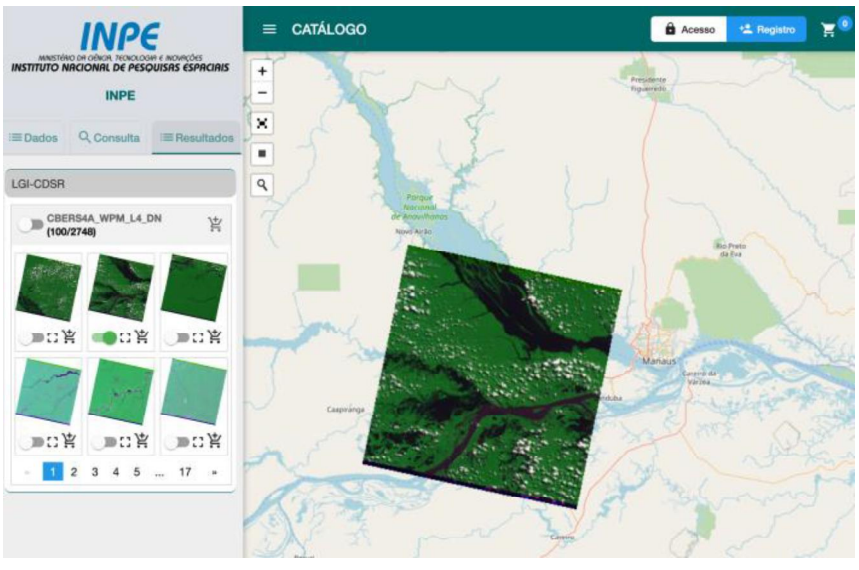


Figure 1. INPE's image catalog.

This work describes the dataset *WPM Fusion*, generated from the fusion of the 8-meter bands and the 2-meter band of WPM Images, resulting in a new 2-meter multispectral image. Figure 2 shows a panchromatic image (a) and a color composition (b) of a WPM image.

(a) Panchromatic band (2 m) (b) RGB Composition (8 m)

Figure 2. Clips of a CBERS 04A/WPM Image.

2. The Fusion process

Optical remotely sensed images, such as the CBERS 04A/WPM images, vary in spectral, spatial, and temporal resolution. Multispectral sensors with high spectral resolution and narrow spectral bandwidth have lower spatial resolution compared to panchromatic sensors, which have a wide spectral bandwidth and higher spatial resolution. With appropriate algorithms, it is possible to combine these data and produce imagery with the best characteristics of both, namely high spatial and high spectral resolution, a process known as multisensor data fusion. A fused image is a combination of two or more geometrically registered images of the same scene into a single image that can provide

more interpretation capabilities and reliable results. Ghassemian (2016) describes the process of data fusion and reviews different techniques to execute this process.

A typical CBERS 04A / WPM scene size, in GeoTIFF format, is around 2 GB for the pan band and 150 MB for the multispectral bands. The generation of a fused WPM image can be time- and computer-power-intensive and requires specific image processing software. Thus, INPE is systematically generating the fused image from the WPM dataset in its TI infrastructure and making it available for users according to its open data policy.

The image fusion algorithm to generate the WPM Fused images is based on the Principal Component Analysis (PCA) (Jolliffe; Cadima, 2016; Silva, 2009), implemented in the TerraLib library (Camara, et al., 2008). A Python script orchestrates the process to generate the fused images. It is parameterized to select specific areas of interest, acquisition time intervals, or cloud coverage below a given percentage.

Processing levels of CBERS 04A images are L2 (Level 2) which are system corrected images, which users can expect some translation error; and L4 (Level 4) orthorectified images with ground control points. In this version of the dataset only L4 images are processed to generate the fusion image. So, the fusion image has the same level of geometrical correction than the original image, they are orthorectified.

3. The dataset

At the time of this writing, the collection of WPM Fused contains around 1.900 images, acquired from March to November 2023. All the images intersect the extension of Brazil and have a maximum of 50% cloud cover. Figure 3 illustrates the spatial distribution of the collection of scenes. As can be seen, the collection almost completely covers the extent of Brazil.

The WPM Fused images are three band images (RGB), codified in 8 bits, in GeoTIFF format. Each WPM fused scene have the same swath of 92 km as the original WPM bands. Figure 4 shows some examples of WPM Fused images.

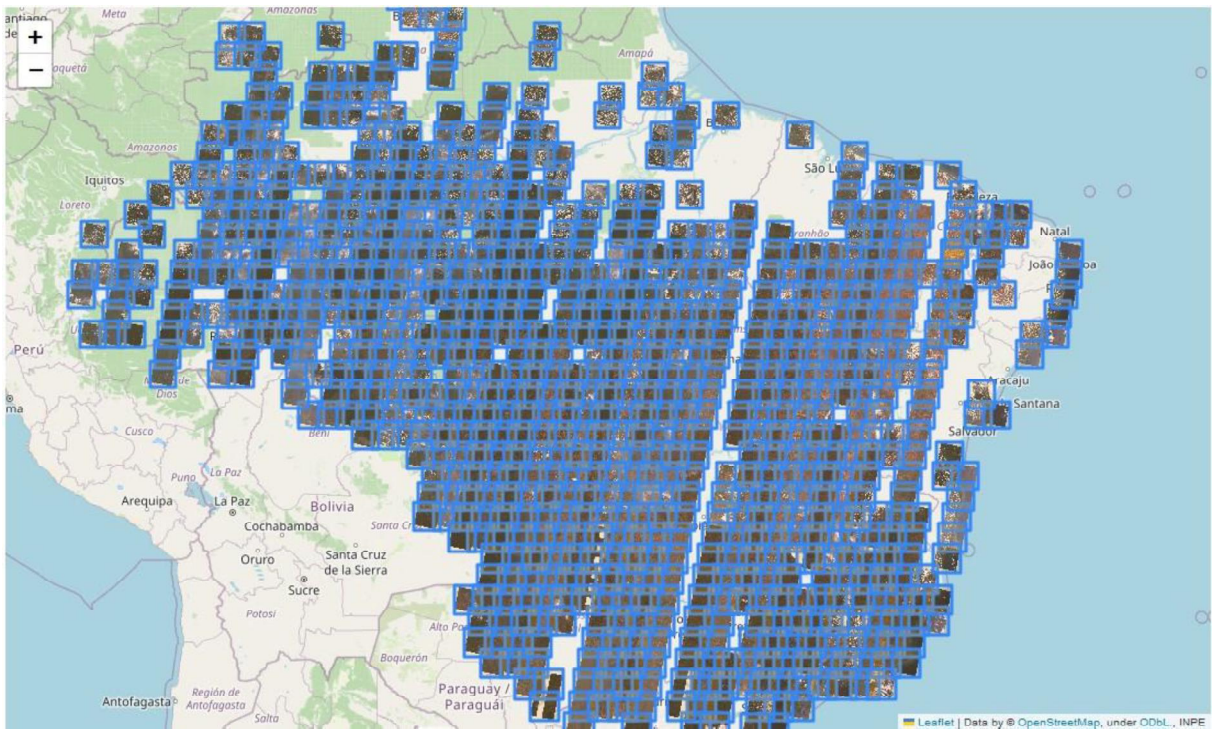
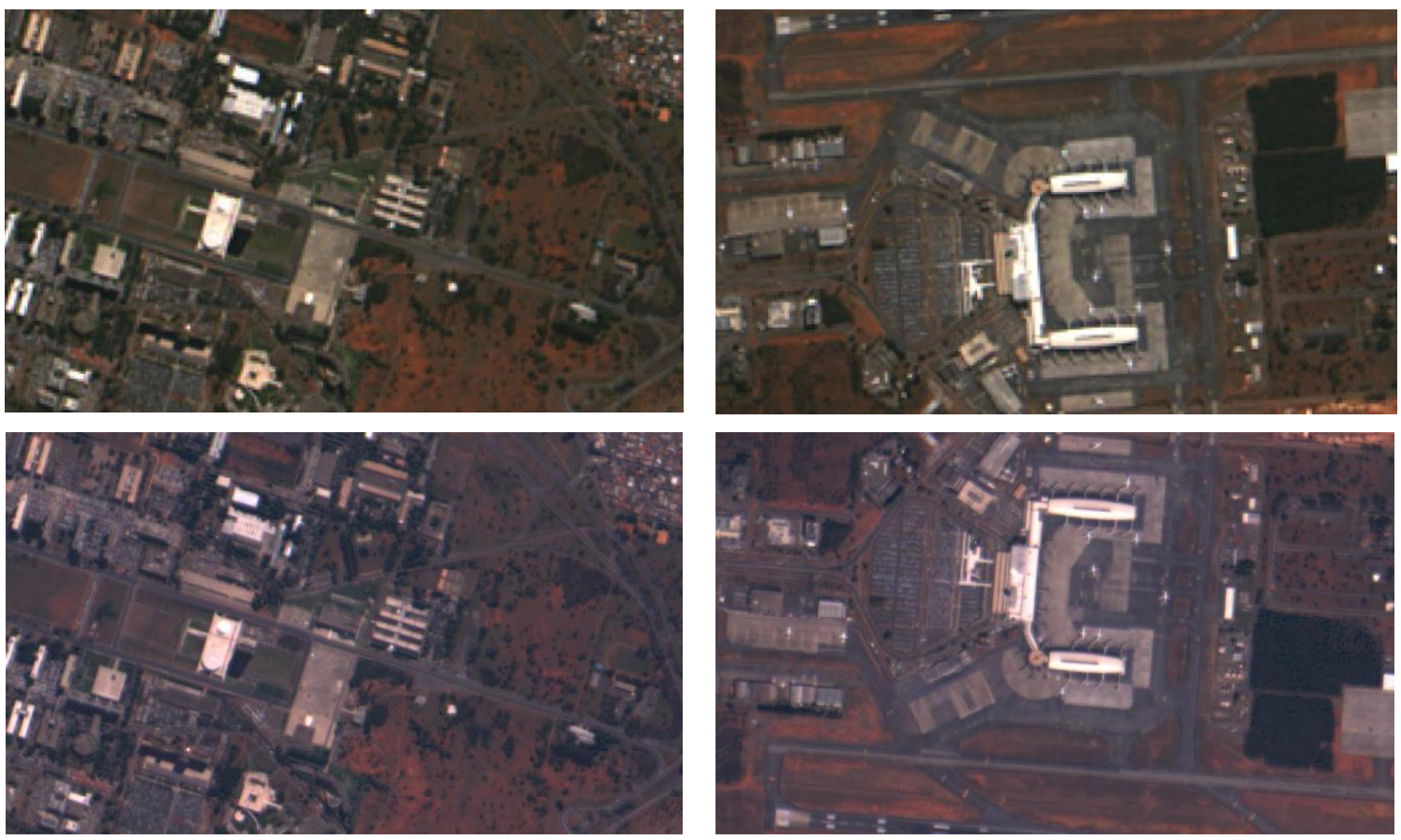


Figure 3. CBERS 04A/WPM Fused image collection.



(a) National Congress building, Brasília. Top: original RGB 8m composition; bottom: fused RGB 2m composition.

(b) Brasília airport. Top: original RGB 8m composition; bottom: fused RGB 2m composition.

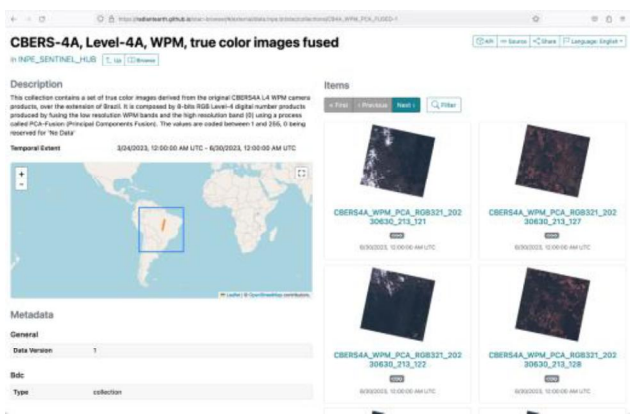
Figure 4. Examples of WPM Fused images.

The collection of fused images is exposed following the Spatio Temporal Asset Catalog (STAC) specification, which provides a common structure for describing and cataloging spatiotemporal assets. STAC aims to standardize the way geospatial asset metadata is structured and queried. It is well suited to data with structured time and location

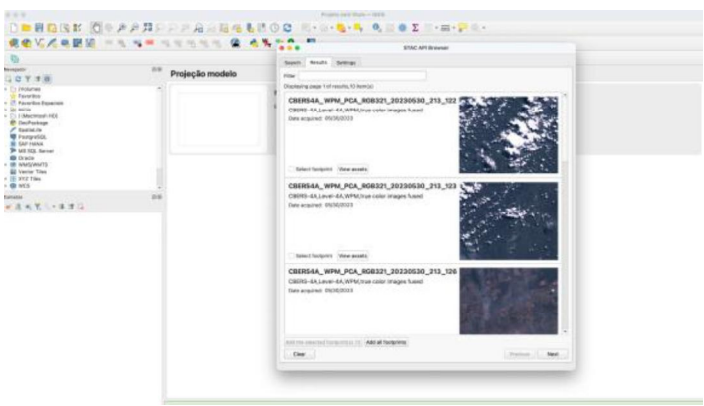
collection, such as satellite imagery. The STAC specifications define related JSON object types connected by link relations to support a traversable interface and a RESTful API providing additional browse and search interfaces (Radiant Earth Foundation, 2023). The STAC server endpoint to access INPE's WPM Fused collection is https://data.inpe.br/stac/collections/CB4A_WPM_PCA_FUSED-1. Figure 5 shows some examples of clients using the STAC API to browse the dataset.

3. Final Remarks

The CBER-4A WPM Fusion data is being maintained and updated continuously by along with the processing of CBERS data. This new product has been used by INPE's application, for example to validate deforestation and degradation alerts mapping from lower resolution imagery. As the fusion images are in COG Geotiff format they can easily be served by geographical Web Visualization Services such as Tile Mapping Service (TMS) or Web Map Services (WMS). These services are being deployed at INPE who intends to make them freely available for the community. INPE also intends to develop examples of use in interactive environments such as Jupyter notebooks for Python.



(a) https://radiantearth.github.io/stac-browser.



(b) QGis STAC plugin client

Figure 5. Clients accessing the CBERS 04A/WPM Fused collection via STAC.

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