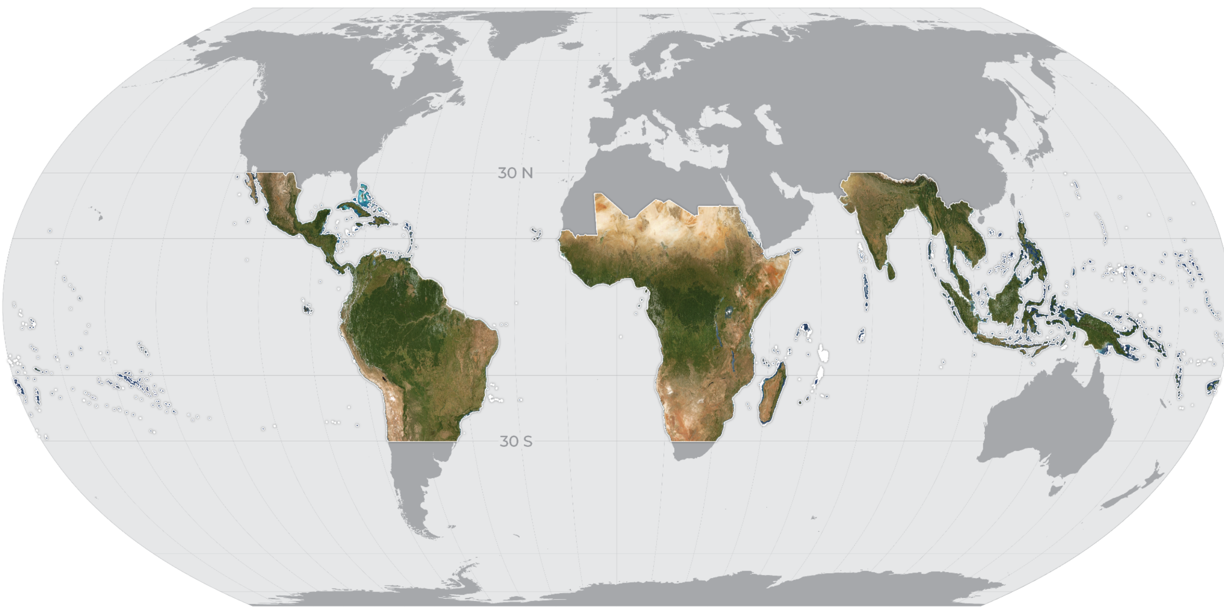
Norwegian Ministry of Climate and Environment NICFI Norway's International Climate and Forest Initiative KSAT KONGSBERG SATELLITE SERVICES planet. AIRBUS

PLANET BASEMAPS FOR NICFI DATA PROGRAM

ADDENDUM TO BASEMAPS PRODUCT SPECIFICATION



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1. Overview of NICFI Basemaps

Planet has entered a comprehensive partnership with KSAT and Airbus to provide users all over the world access to mosaics produced using Planet imagery to combat deforestation and forest degradation. The basemaps cover the area between 30N & 30S comprising the countries highlighted in the graphic above. During the contract, users can expect to see bi-annual mosaics between the period of December 2015 to August 2020, followed by monthly mosaics from September 2020 onwards for the next couple of years.

2. Basemap Production Algorithm

Up until May 2017, we have incorporated Rapideye data into the mosaics to make sure coverage is optimum. Superdove data is included in mosaics from 2020 onwards, due to the amalgamation of sensors into the mosaic, additional normalization and harmonization are required to correct for the differences between each of these sensors.

More details are available in Planet's Imagery Product Specifications:
https://assets.planet.com/docs/Planet_Combined_Imagery_Product_Specs_letter_screen.pdf
and Basemap Product Specifications:
https://assets.planet.com/products/basemap/planet-basemaps-product-specifications.pdf

The biannual and monthly mosaics delivered as part of this contract are optimized for the time intervals and area of interest for the project. While they are broadly similar to Planet's standard normalized analytic product, they differ in a few key ways. NICFI data has been optimized specifically for deforestation detection in the tropics, and may not be suitable for other use cases. Our standard surface reflectance basemaps are targeted for general scientific applications, and are more appropriate for land cover classification algorithms and other time-based research applications.

These differences have been expanded upon below:

a. Scene Selection

Apart from the standard scene selection algorithm, for these mosaics we have included a metric that looks specifically into the number of ground control points (GCPs) used by our rectification process when taking scenes into consideration. The metric is useful in making a relative ranking of rectification confidence for scenes at a particular location. Based on this, we are able to select scenes that have a higher location confidence which would minimize any issues seen with band misalignment in dove-classic data and maximize positional accuracy for all data types. However, the positional accuracy specification for Planetscope scenes is based on the 90th percentile of overall geolocation error. That means that up to 10% of the basemap data will be significantly misaligned and shifts of hundreds of meters to kilometers may be observed in some cases.

In order to increase coverage in particularly cloudy areas, these mosaics also utilize scenes that have been marked as “test” quality. Every scene in Planet’s catalog can be classified as “Test” or “Standard” quality. The main difference between these two states is the amount of GCPs that can be applied to a scene in order to ground-lock it, a “test” quality scene contains usable data and it is preferable to include “test” quality scenes in cloudy areas as they will have passed the base level of rectification before proceeding to be published onto our platform. In areas where unrectified data is published (e.g. Gabon), these mosaics will contain data that has not gone through the full orthorectification process and in rare cases may have kilometer scale location inaccuracies. However, including only fully-rectified data would significantly decrease coverage and increase cloud cover.

b. Atmospheric Correction

In our standard basemap, the atmospheric correction algorithm applied tends to over-correct scenes, especially in the tropics. This happens when the MODIS based atmospheric optical thickness estimates are incorrect or unavailable. These overcorrections lead to invalid values in the scenes, which then affect the mosaic. Hence, for this mosaic, we have based the corrections on seasonal models of Landsat data by applying normalization and harmonization of TOAR scene data to SR corrected Landsat data. This process has minimal impact on the end values of the mosaic, but it’s important to understand that NICFI basemap “surface reflectance” data is not the result of a radiative transfer model, while the scene SR data is.

More information can be found in our surface reflectance white paper: https://support.planet.com/hc/en-us/articles/360012629573-Planet-Surface-Reflectance-Product

c. Cloud Masking

NICFI basemaps apply a similar cloud masking strategy as standard SR basemaps. Therefore, pixels marked as cloud, heavy haze, or cloud shadow based on UDM2 have been excluded. However, to meet coverage requirements, in locations where all observed scenes have cloudy or otherwise unusable pixels at that spot, the best-ranked cloudy/etc pixels will be used instead of marking the pixel as nodata. In standard basemaps, nodata would be shown in these cases instead of cloudy pixel values. The UDM2 asset for each quad can be used to identify locations where pixels flagged as invalid have been included in the basemap data.

UDM2: https://developers.planet.com/docs/data/udm-2/

Prior to late 2018, UDM2 is not available. For these timeframes, the UDM cloud classification is used instead.

UDM: More information on our UDM can be found on page 91 of our product specifications:
https://assets.planet.com/docs/Planet_Combined_Imagery_Product_Specs_letter_screen.pdf

d. Normalization

Planet designed NICFI basemaps to be compatible with the historical record of Landsat data, and optimized for deforestation detection via short-term differences in Normalized Difference Vegetation Index (NDVI), qualities prioritized by the NICFI technical advisors. Unfortunately, these features impact other potential applications of the NICFI dataset.

In order to prioritize compatibility between biannual and monthly mosaics as well as detectability of abrupt month-to-month changes, some seasonal variations in vegetation greenness are smoothed out over a 6-month period. This technique works well for monitoring NDVI thresholds in tropical rainforest, but it can reduce evidence of phenology in other ecosystems.

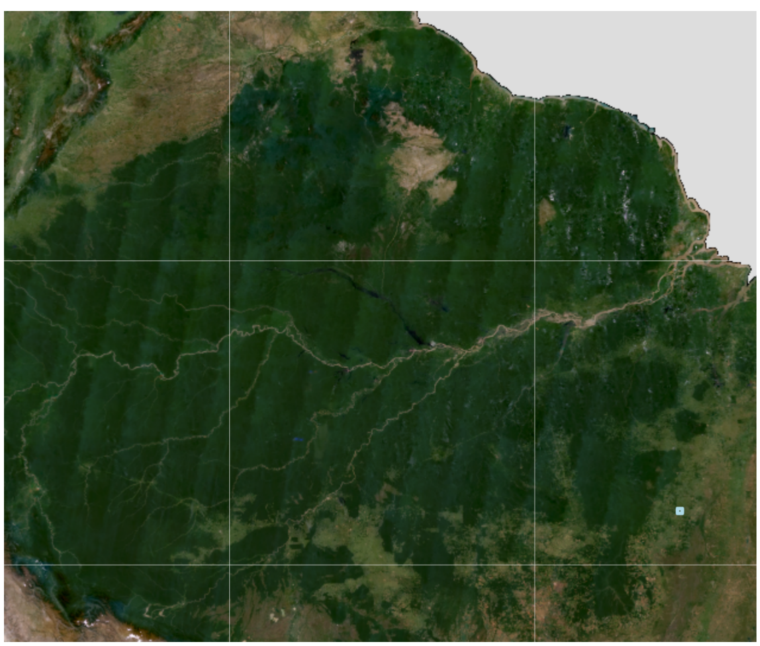
Standard Planet SR basemaps are normalized to BRDF-corrected Sentinel2 data and are designed to apply less smoothing of seasonal variations. As a result, standard basemaps are less suited for tropical rainforest deforestation monitoring, but may be a better fit than NICFI for other ecosystems.

e. Visual Processing Differences

Unlike standard visual basemaps, NICFI visual basemaps apply the cloud masking strategy mentioned above. Standard visual basemaps do not apply cloud masks at all, which avoids artifacts, but increases cloud cover. Beginning in April 2022, standard visual basemaps apply a visual sharpening filter in post-processing to match the processing applied to the visual scene product. To maintain consistency throughout the series, NICFI visual basemaps do not apply this filter. As a result, NICFI visual basemaps will appear less sharp than standard visual basemaps or the visual scene products. They will match the visual sharpness of SR scene data or the SR basemap product. Note that like standard visual basemaps, NICFI visual basemaps are normalized to BRDF-corrected MODIS data. As a result, NICFI visual basemaps do not display the BRDF effects that are apparent in the Landsat-normalized NICFI SR basemaps.

3. BRDF Effects

Over large, dark areas, such as the Amazonian rainforest shown below, an alternating pattern of light and dark diagonal stripes are visible in Planet's normalized surface reflectance mosaics. Example below:



This artifact occurs due to the viewing geometry of Landsat satellites used as our normalization target basemap and it is known as BRDF (Bidirectional Reflectance Distribution Function). BRDF is a mathematical description of how light reflects off a surface, given a ray of light hitting a surface and how an observer (or camera, satellite) perceives it from their viewpoint. The BRDF effect arises because Landsat satellites capture images at a small 7.5° angle from "straight down"/nadir.

This results in a slight effect in the measured surface reflectance values. On the captured image, the area slightly closer to the satellite records a slightly different amount of light than the area on the far side. While this difference is fairly small, a striping pattern becomes noticeable when scenes from neighboring satellite paths are viewed side by side over a dark area such as the forest above. While Landsat's surface reflectance algorithm, LaSRC, does not remove this effect, the huge advantage to Landsat is that it provides one of the longest time series of surface reflectance data of the Earth.

Using seasonal data (eg, fall, summer) over many years, Planet is able to create nearly complete, cloud free global Landsat mosaics for a normalization target. Basing normalization on LaSRC-processed Landsat data also allows direct interoperability with standard Landsat products. While removal may seem desirable, it can be time consuming, introduce its own biases in scientific analyses and leads to less compatibility with standard Landsat data.

If these artifacts are a concern, standard basemaps are normalized to BRDF corrected Sentinel2 data and do not contain this issue. They may be a better fit for your use case if compatibility with LaSRC processed Landsat data is not needed. However, if you're comparing basemaps to historical Landsat data, NICFI basemaps are a much better fit, as they'll match the data closely.

4. Basemap product naming convention

Bi-Annual: planet_medres_normalized_analytic_YYYY-MM_YYYY_MM_mosaic

Monthly: planet_medres_normalized_analytic_YYYY-MM_mosaic

5. Additional Support

Please contact our 24/7 support service by sending your request to nicfi-servicedesk@ksat.no.