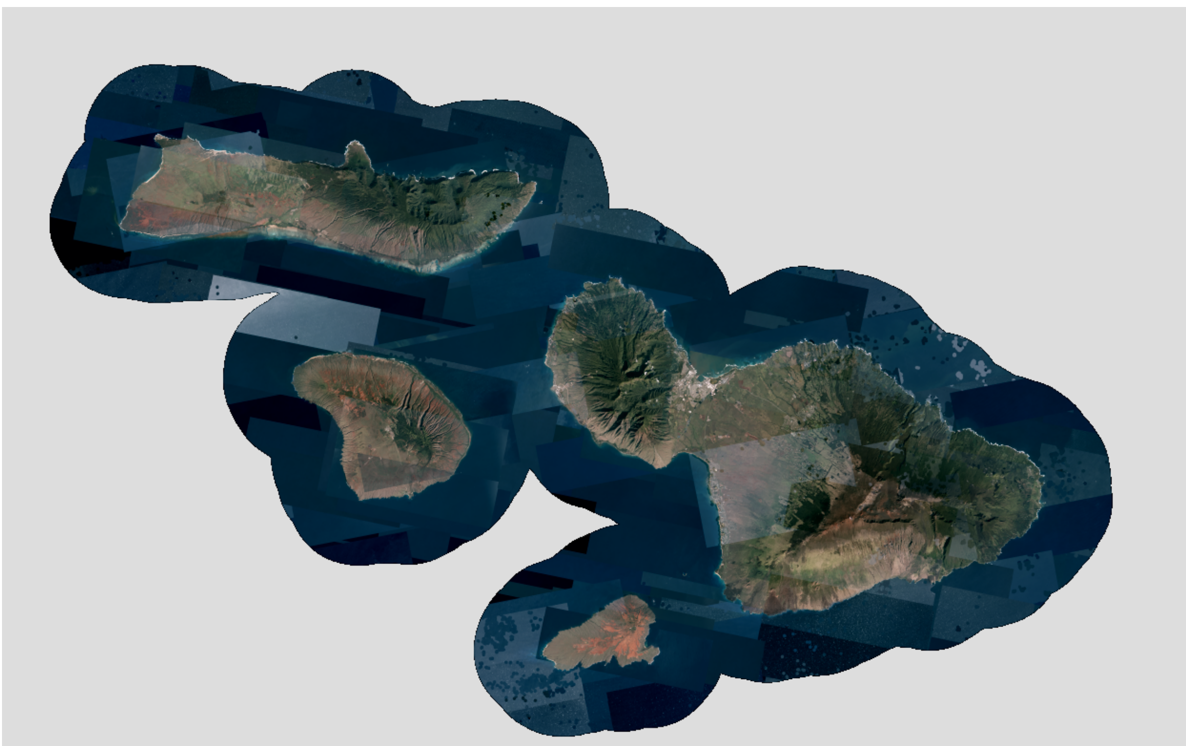
# SURFACE REFLECTANCE BASEMAPS
## Technical Datasheet

Planet's Surface Reflectance Basemaps are recent, complete, and analysis-ready mosaics that empower you to do quantitative analysis over broad areas. To address a variety of use cases, we offer an Analytic Surface Reflectance Basemap as well as what we call Normalized Surface Reflectance Basemaps. This document provides information on the advantages and trade-offs of each, and ultimately helps your organization select the one most suited to your application.

## OFFERINGS

**Surface Reflectance Basemaps** use PlanetScope Surface Reflectance data as the input. In order to preserve calculated pixel values, no color balancing or color adjustments are applied. As a result, these basemaps will contain visible seam lines, and, if they are built with imagery from a narrow timeframe, are more likely to contain clouds.



An example of an Analytic Surface Reflectance Basemap over Hawaii.

**Normalized Surface Reflectance Basemaps** use PlanetScope Surface Reflectance data as the input as well. However, additional processing is applied to enhance spatial and temporal consistency. As a result, these basemaps are less likely to contain seam lines. However, calculated pixel values and spectral responses will be less accurate and may not be suited for your application.

An example of a Normalized Surface Reflectance Basemap over Hawaii.

## COMPARISON

| Surface Reflectance Basemap Type | Description | Data | Pixel Values | Normalization |
|---|---|---|---|---|
| Normalized (normalized_sr) | Spatial & temporal consistency; training data | 4-band, 16-bit | Modified Surface Reflectance | Landsat-8 Sentinel-2 |
| 8-Band Normalized SR (8b_normalized_sr) | Spatial & temporal consistency; training data | 8-band, 16-bit | Modified Surface Reflectance | Sentinel-2 |
| Analytic (analytic_sr)* | Spatial accuracy; precise spectral responses | 4-band, 16-bit | Surface Reflectance | None |

| | | | | |
|---|---|---|---|---|
| 8-Band Analytic SR (8b_analytic_sr) | Spatial accuracy; precise spectral responses | 8-band, 16-bit | Surface Reflectance | None |

**4-Band Analytic SR basemaps are only available for dates prior to August 2020.*

# USE CASES

**Analytic Surface Reflectance Basemaps** work particularly well for use cases where absolute radiometric accuracy is prioritized over consistency. They are also better suited for shorter time intervals (ie, biweekly or weekly), where the application requires recent imagery or is used for change detection.

- Crop health monitoring
- Flood impact analysis
- Wildfire burn assessment

**Normalized Surface Reflectance Basemaps** work well for use cases where spatial consistency is prioritized and/or training data for machine learning algorithms is being generated. They are also better suited for longer time periods where many scenes are being mosaicked together, and additional image processing is beneficial.

- Land cover classification
- Forest disease monitoring
- Flood risk analysis

# DEEP DIVE: NORMALIZED SURFACE REFLECTANCE BASEMAPS

Planet uses two independent methods: 1) normalization to reduce scene-to-scene variability and 2) seamline removal to minimize scene boundaries to create Normalized Surface Reflectance Basemaps.

The combination of normalization and seamline removal produces a nearly seamless mosaic that approximately honors the reflectance coefficients of the input data. However, because normalization and seamline removal are empirical techniques, we cannot guarantee the absolute radiometric accuracy of the results.

**Normalization Approach**

Normalization minimizes scene-to-scene variability by matching each scene to a Landsat or Sentinel-2 reference dataset. To do so, we fit a linear model for each scene based co-located, non-cloudy PlanetScope and Landsat or Sentinel-2 reference pixels. The linear model is constrained to always have a positive slope and produce values between 0 and 1. During fitting this model, we attempt to minimize two competing metrics:

1. The relative misfit between the scene and the normalization target reference (i.e. (a - b) / (a + b), to avoid overweighting bright values). This metric has a high weight during minimization.

2. Changes in ratios between bands (i.e. in visual terms, we try to preserve the whitebalance of the input). This metric has a lower weight during minimization.

The final model is unique to each scene and transforms the PlanetScope reflectance coefficients to match approximately the Landsat or Sentinel-2 reference values for each band. The same transformation is applied uniformly across the entire scene. As a result, we preserve small and medium scale changes, such as a stand of trees dying or a field being harvested.

However, we reduce changes that affect the entire scene uniformly. Most of these are artifacts, but we can reduce or remove real change that affects the entire scene such as a consistent greening of all vegetation. We also shift the spectral response of the scenes to be closer to the Landsat-based reference dataset. This means that objects may appear to have slightly different colors between normalized and un-normalized basemaps. As a result, if you are using PlanetScope's spectral response curves as input or constraints in your processing chain, normalized basemaps may be a poor choice.

The normalization results are dependent on our reference dataset. We use quarterly Landsat or monthly Sentinel-2 reference datasets that are composed of multiple scenes from the same season spanning several previous years. The Landsat and Sentinel-2 scenes are processed to surface reflectance using the USGS LaSRC pipeline and are mosaicked together using a percentile-based best-pixel approach to produce the reference dataset we use for normalization. These datasets are updated yearly with new data. More information about our normalization approach to Sentinel-2 can be found here.

**Seamline Removal Approach**

Seamline removal minimizes the visual appearance of scene edges, which is particularly useful for visual interpretation and use cases similar to supervised classification, where scene boundaries often introduce unwanted spatial artifacts in the final result.

During seamline removal we "flex" each scene to match its neighbor. Values near a scene boundary will change more than values away from a scene boundary; but we never blur, feather, or average values during this step. More precisely, we apply the following steps to each band independently after scenes have been composited into a mosaic quad:

1. Calculate the gradient of the image across the mosaic quad
2. Set the gradient values within 1 pixel of a scene boundary to 0
   Fix the original values along the edge of the mosaic quad
3. Solve for values in between that honor the modified gradients and the pixel values at the edge of the quad

Because seamline removal is applied independently for each band, it may alter band ratios near scene edges. This is most apparent when scenes do not match locally due to unmasked clouds, surf, fields being harvested, etc. If the differences are too large, the method will leave the original gradient values at the scene edge, resulting in a "hard" seamline, but avoiding artifacts that would occur otherwise.

Note that seamline removal may introduce artifacts at quad boundaries in some cases. This is most frequent over water, where normalization cannot fully correct for differences between scenes due to waves, sunglint, etc.