

PlanetScope User Guide

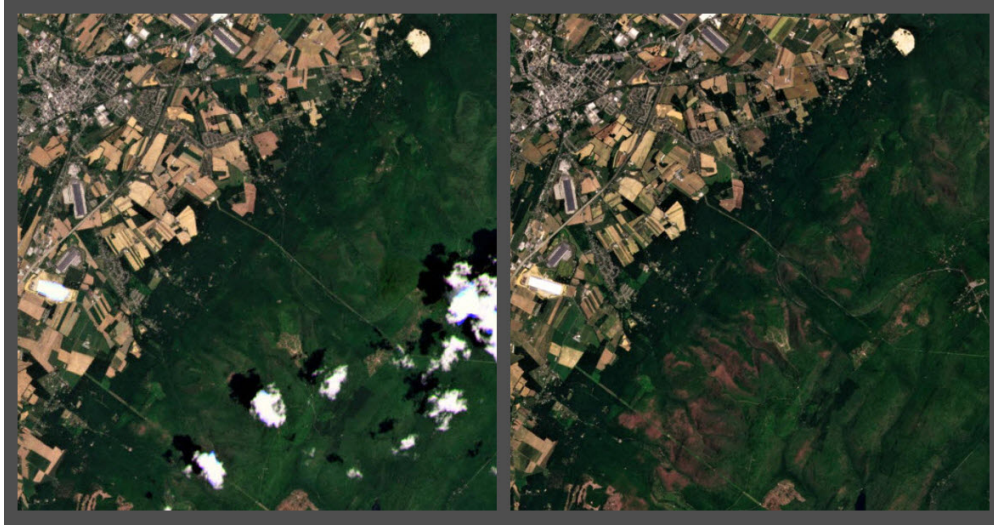


Figure 1. Planet imagery shows the progression of Lymantria dispar defoliation in Michaux State Park, Pennsylvania. The left image is from June 6, 2021 and the right image is from June 18, 2021.

Introduction

Planet offers two constellations of satellite platforms: PlanetScope (discussed in this document) and SkySat (covered in a companion document). From the Planet website, PlanetScope is described as “a constellation of approximately 130 satellites, able to image the entire land surface of the Earth every day (a daily collection capacity of 200 million km²/day).” PlanetScope products are offered as 3-5 meter, three- or four-band daily imagery across the globe, and biweekly composites of resampled 4.77 meter, four-band imagery, referred to as basemaps, that are compiled for 21 states for the 2021 growing season (April through December).

As a pilot program in 2021, the USDA entered a contract with Planet to make PlanetScope imagery available for use by all USDA employees and contractors. These new, small-satellite platforms have not been widely utilized due to their very recent commercial viability.

This guide provides step-by-step instructions for accessing and downloading PlanetScope daily imagery and basemaps using the ArcGIS Pro’s Planet Add-in. It is important to note that there are two ways to visualize and interact with the daily imagery and basemap datasets: as streaming imagery and as downloaded imagery (currently limited to basemap downloads only due to contract stipulations). Streaming views are manipulated for a pleasing visual appearance and are best suited for use as background imagery. The downloaded imagery has not been manipulated to improve appearance but has been resampled to standardize the pixel size. The resampling algorithms give the imagery a fuzzy appearance when viewed at native resolution and may limit the use of the imagery for analytical

purposes. In many cases, the daily imagery will likely need to be preprocessed to be suitable for change detection and other spatial and temporal analyses.

Objectives

- Introduce PlanetScope daily imagery and basemap data
- Request free Planet account
- Install ArcGIS Pro add-in
- Become familiar with querying and visualizing data in the ArcGIS Pro add-in
- Learn how to download biweekly basemaps

Prerequisites

- Installation of ArcGIS Pro and a basic understanding of how to use the software.



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Part 1: Overview of PlanetScope Imagery

The 2021 Planet imagery contract (effective April 2021 through April 2022) with the USDA provides access to two suites of PlanetScope image products: daily imagery and biweekly basemaps. Daily imagery is comprised of either 3-band ([PSScene3Band](#)) or 4-band ([PSScene4Band](#)) PlanetScope imagery, referred to collectively as [PlanetScope Scene Products](#). Derivative orthorectified products called [PlanetScope OrthoTile Products](#) are also available as part of the daily imagery suite. [Basemaps](#) are biweekly surface reflectance composites of the PlanetScope 4-band (RGBN) imagery. In this section, we introduce these different Planet datasets and detail important characteristics of each, including data extent and availability, spatial resolution, and data access.

More information about PlanetScope and the constellation of PlanetScope satellites are available on the [Planet website](#).

A. Daily Imagery

1. PlanetScope Scene Products
 - i. Individual scenes along a path
 - ii. Streaming spatial resolution varies from 3 to 5 meters
 - iii. Downloaded spatial resolution is a resampled 3 meters
 - iv. Covers from 280 to 630 square kilometers per scene depending on the instrument type
2. PlanetScope OrthoTile Products
 - i. Created from PlanetScope Scene Products
 - ii. Tiles are 25km x 25km (625 sq. km)
3. Data Availability
 - i. Available globally and for previous years
4. Data Access—using a GIS Planet add-in, users can:
 - i. View reduced resolution streaming images in your GIS project
 - ii. Delineate an area of interest (AOI) to query and download a resampled 3.0 meter TIFF
5. Viewing and Download Limits
 - i. There is no cap on streaming tile views per month USDA-wide;
 - ii. The daily imagery downloads are capped at 50,000 sq. km. USDA-wide. There is currently a hold on downloading daily imagery because the cap has been reached.

Note: Users are encouraged to limit downloads to an immediate AOI, though it is preferred that the download be a minimum of 100 sq. km per order.

B. Basemaps

1. Spatial resolution of downloaded imagery is 4.77 meters
2. Data Extent and Availability
 - i. Each downloaded quad (or tile) is 4,096 pixels by 4,096 pixels (382 km²)
 - ii. Data availability is limited to the 21 states shown in figure 2

iii. Basemap data is also limited to the USDA contract period (from mid-April to mid-December 2021). Basemaps will continue to be available for download and streaming through April 2022.

3. Data Access—using a GIS Planet add-in, users can:

- i. Review products available as reduced resolution streaming imagery that can be viewed in GIS software using Planet add-ins,
- ii. Delineate an AOI to clip and download as resampled 4.77 meter resolution TIFF.

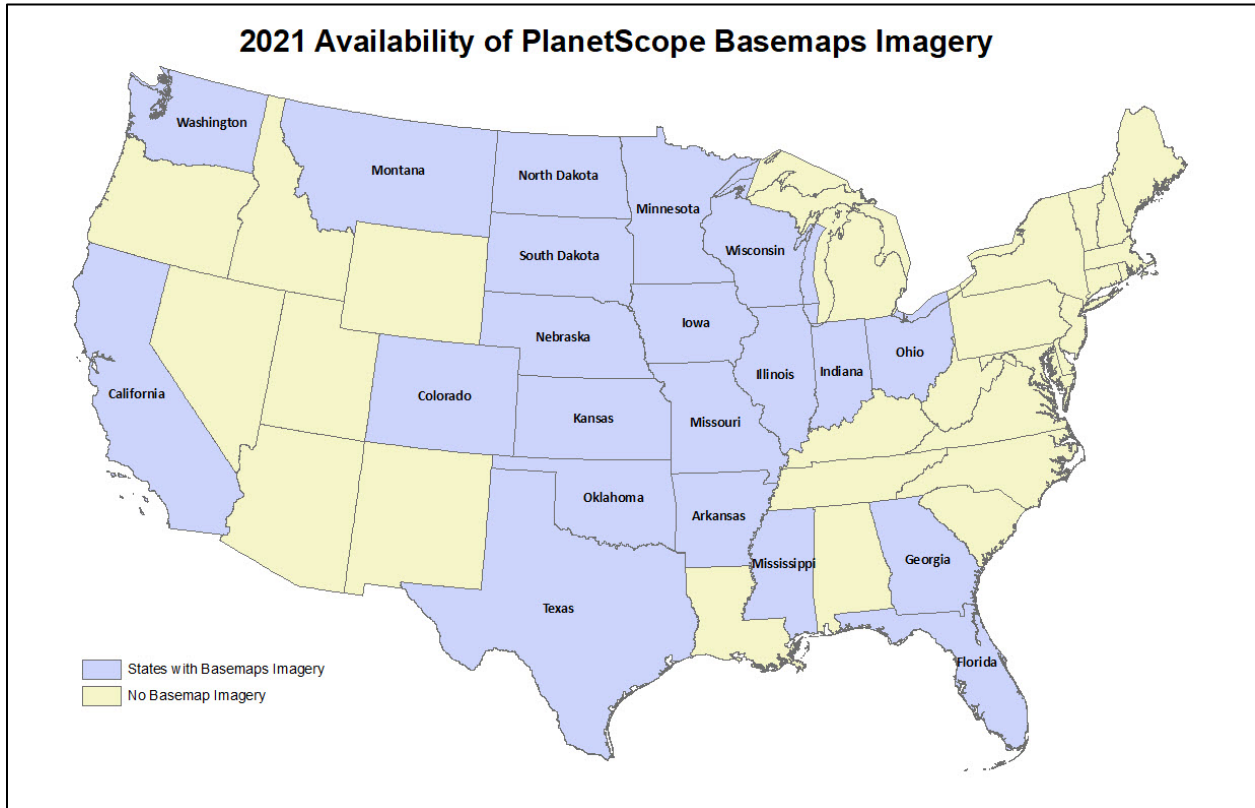


Figure 2. States where the Planet Basemap Biweekly composites are available to USDA users.

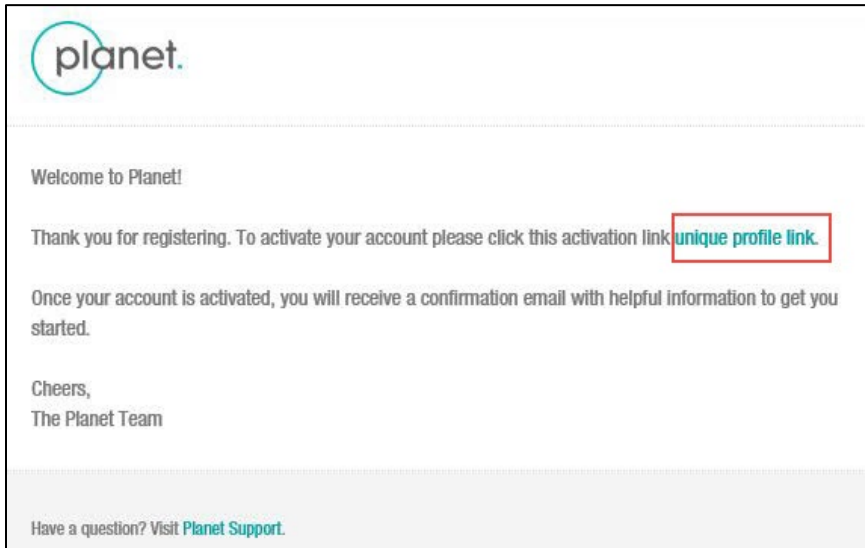
Part 2: Accessing the PlanetScope Products

There are multiple ways to access PlanetScope products. Both product suites can be viewed in streaming mode and downloaded through an ArcGIS Pro Add-in or directly through the [Planet Explorer webpage](#). This section walks through the steps for requesting a Planet account (required to access Planet data), installing the ArcGIS Pro Add-in, and connecting to the add-in in ArcGIS Pro.

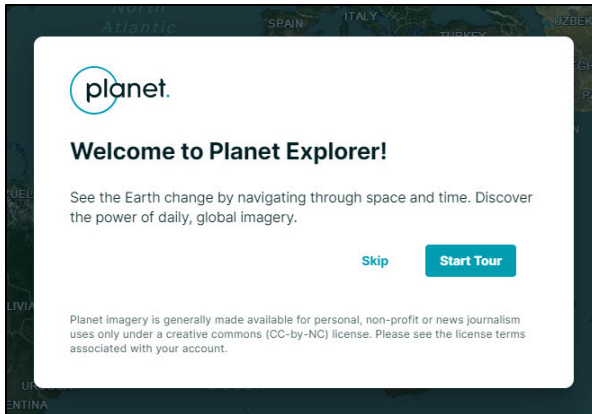
Note: There is also a [Planet plug-in available for QGIS](#) that has similar functionality to the ArcGIS Pro Add-in. Though QGIS is not the focus of this document, instructions are provided in Appendix A for installing the Planet QGIS plug-in.

A. Request Planet Account

1. To set up a Planet account linked to this USDA contract, contact Aaron Kamoske (aaron.kamoske@usda.gov) at GTAC. You will receive an email from Planet about a day later with log-in credentials embedded in a unique profile link. Clicking on the link launches the registration web page. We suggest that you click on the “permission to contact” box on the registration page, as this will enable you to receive notifications when software add-ins are updated.



2. Once the registration is completed and submitted, Planet launches a landing page offering a tour of the site.



B. Request the ArcGIS Pro 2.7 Planet 2.1 Add-in

Note: If you are new to ArcGIS Pro, there is [training available from GTAC](#). There is documentation about the [ArcGIS Pro Planet 2.1 Add-in](#) available as well.

1. The first step is to request the [Planet ArcGIS Pro 2.1 add-in](#). On the request form, be sure to check the box next to **Permission to Contact** to receive occasional communication from Planet.
2. Once you fill out and submit the form, a new web page will launch with a link to download the add-in from Planet.
3. Finally, check your email for a welcome message from Planet. There will be a link in the email to open/download [Planet’s ArcGIS Pro Add-in User Guide](#).
 - i. This User Guide is for Planet’s ArcGIS Pro Add-in 2.0, but the information is relevant to Add-in 2.1 as well.

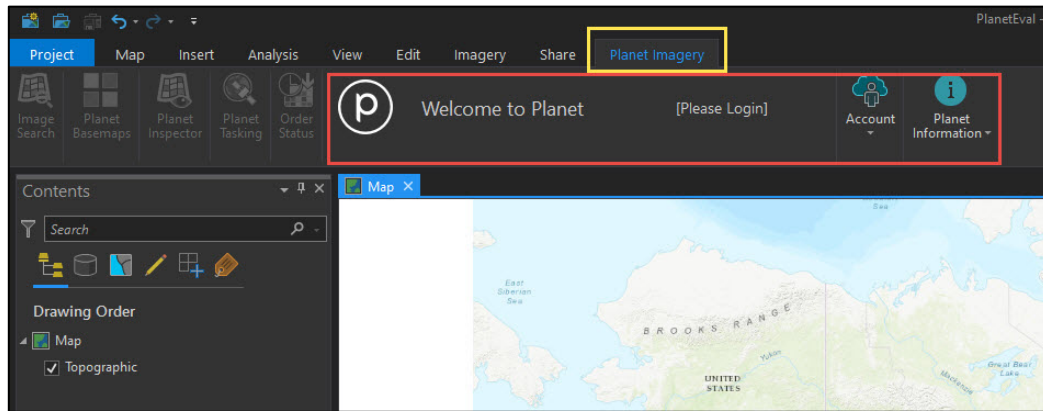
C. Install the ArcGIS Pro 2.7 Planet 2.1 Add-in

Note: Admin privileges are not needed to install the add-in.

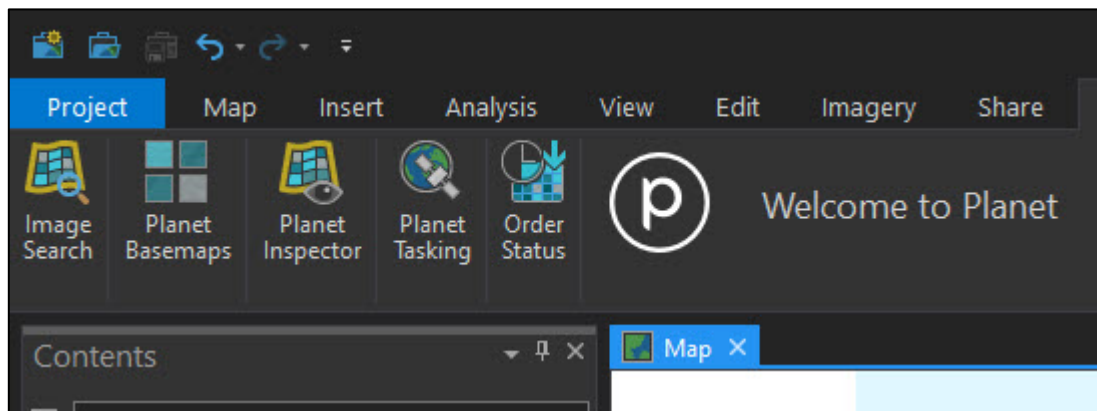
1. First, navigate to the location where you downloaded the Planet Add-in and double-click on the add-in to launch the installer.
2. Click on **Install Add-in**.
 - i. When complete, you’ll see an **Installation successful** pop-up message.
3. Click okay to dismiss message.

D. Launch ArcGIS Pro and Sign in

1. Open an existing ArcGIS Pro project or create a new project and select the **Map template**.

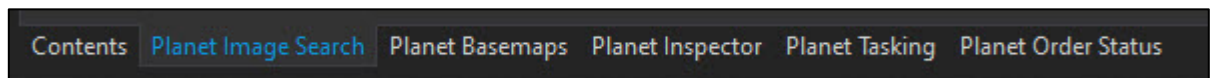


3. In the Planet login interface (red box above), click on Account to log into your account. Check the **Save credentials** box to stay logged into Planet between ArcGIS Pro sessions if desired.



E. Overview of the Planet Interface for ArcGIS Pro.

1. The ArcGIS Pro Planet add-in also creates a series of tabs at the bottom of the screen to allow users to quickly move between the ArcPro Contents interface and the five Planet add-in interfaces.



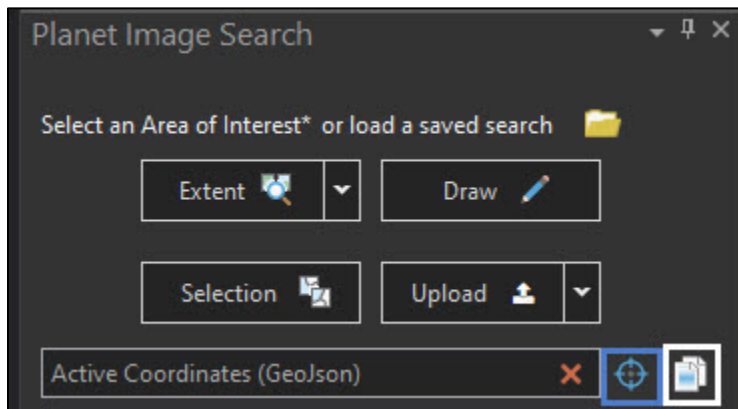
2. The **Planet Image Search** interface is used to interact with and order PlanetScope daily imagery. Part 3 explores this interface in more detail.
3. The **Planet Basemaps** interface is used to interact with and order biweekly basemap composites. Part 4 explores this interface in more detail.
4. The **Planet Inspector** interface is used to identify basemap source imagery. This interface is explored in more detail following the Planet Basemaps interface portion of Part 4.
5. The **Planet Tasking** feature is not available under this USDA contract with Planet. Other contract vehicles available for use by broader audiences, including the USDA, do include this feature. No further information on this interface will be provided in this document.
6. The **Planet Order Status** interface tracks the status of both daily and basemap orders. This interface is discussed in Part 3 under daily imagery but also applies to basemap imagery in Part 4.

Part 3: Exploring the Planet Daily Imagery

This section provides instructions for searching for, streaming, and downloading PlanetScope’s daily imagery using Planet’s ArcGIS Pro Add-In. Reduced resolution streaming views of the daily imagery are manipulated for a pleasing visual appearance and are best suited for use as background imagery. The streaming views of daily imagery are displayed as a natural color image. If you need to do quantitative analysis, we suggest you download the full resolution imagery. The downloaded imagery has not been manipulated to improve appearance and may look different from the corresponding streamed imagery.

A. Search for Daily Imagery Using the Image Search Interface

1. Make sure you **Planet Image Search** tab selected.
2. First, an AOI must be set using one of four methods described below. Once an AOI is defined by any of the methods listed below, the coordinates of the AOI will appear in the **Active Coordinate** box. Those coordinates can be cleared by clicking on the red ‘X’ on the right side of the Active Coordinate box.



Note: The AOI box Planet uses to search for imagery will always default to a simple rectangle covering the extent defined by any of the following input methods.

3. The **Extent** pulldown has three options.
 - i. The first option, **Current visible extent**, uses the current extent of the viewer as the AOI. Once clicked, a box will appear in the viewer showing the AOI.
 - ii. The second option, **Active map layer(s) extent**, uses one or more layers in the ArcGIS Pro Contents window to set the extent of the AOI. The name of the layer(s) highlighted in the Contents window is considered active. If more than one layer is selected, the AOI will be set to the broadest extent.
 - iii. The third option, **All map layers extent**, selects the maximum extent of all map layers in your current project.
4. The **Draw** option allows you to freestyle draw an AOI in your viewer.
 - i. Zoom into the approximate extent of interest.
 - ii. Click on the **Draw** button to start drawing and then double-click to complete the polygon.

Note: The Escape (ESC) key on your keyboard will deselect the Draw button if a sketch has not been started or clear a sketch in progress so it can be restarted.

5. The **Selection** option allows you to select a feature(s) in the viewer as the AOI.
6. The **Upload** option allows you to import an AOI extent from a GeoJSON file, feature class, or shapefile into the viewer without adding it to the Contents of your map project.
7. You also have the option to select a previously saved search by clicking folder icon above the Draw option.

Note: A search can be saved after results are returned by clicking on the Disc icon below the Search box.

8. The **Blue Target** icon (highlighted by the blue box above) zooms to the extent of the AOI.
9. The **White Paper** icon (highlighted in the white box above) copies the AOI extent to a GeoJSON file.

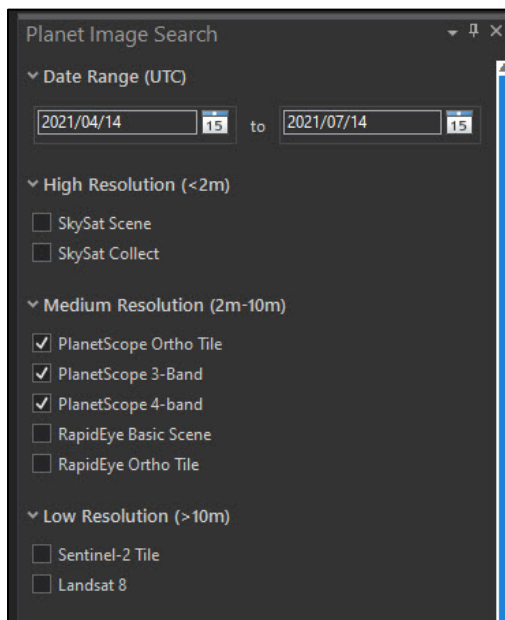
B. Filter Search Results

1. Once the AOI is set there are many **Filters** that can be applied to the search. At a minimum, the following filters must be set to refine the scope of your image search:
 - i. The **Date Range** filter defines the timeframe you're querying data for. Click on the left calendar to select a start date for your search. Click on the right calendar to select an end date for your search.

Reminder: The Tile View portion of the USDA contract does allow imagery from previous years to be streamed and downloaded.

- ii. Any combination of the Medium Resolution sensors (**PlanetScope Ortho Tile**, **PlanetScope 3-Band**, and/or **PlanetScope 4-Band**) can be selected.

Note: By default, the High Resolution SkySat Collect and Medium Resolution RapidEye Ortho Tile are selected, but they are not available under the current USDA contract.



- iii. Of the remaining filters (Area Cover, Cloud Cover, Ground Sample Distance, Off-nadir Angle, Sun Azimuth, Sun Elevation, Item IDs, Ground Control, Standard Image Quality, and Access Filter), it is suggested that you:
 - (a) Turn on the **Standard Image Quality**, which assures the imagery has passed all of Planet’s quality checks.
 - (b) Turn on the **Access Filter** so that only imagery you have access to will display.
 - (c) Set a maximum **Cloud Cover** filter to eliminate images highly impacted by clouds.

*Note: The **Instrument Filter** allows you to limit your search to specific [Planet Instruments](#) (PS2, PS2.SD, and PSB.SD). An example of where this would be desirable is when the Planet imagery needs to be interoperable with Sentinel-2 imagery in which case you would select the PS2.SD and PSB.SD instruments.*

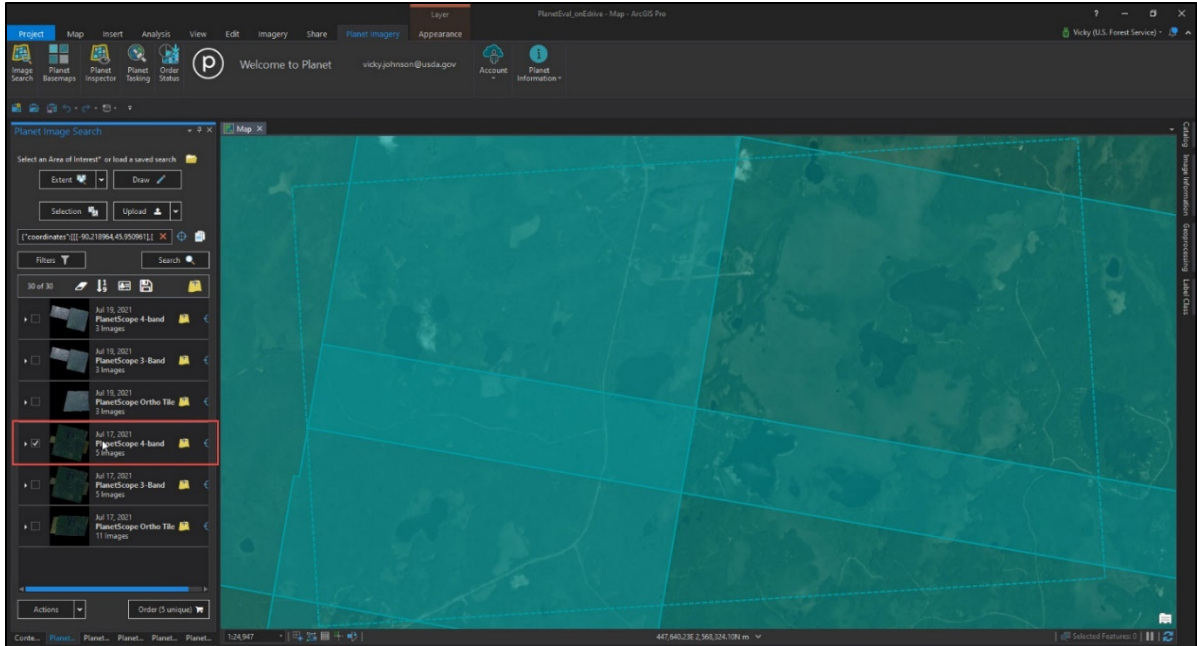
2. When the filters are all set, click on the **Back** button at the bottom of the filter screen and then click **Search**.

C. Review Daily Imagery Search Results

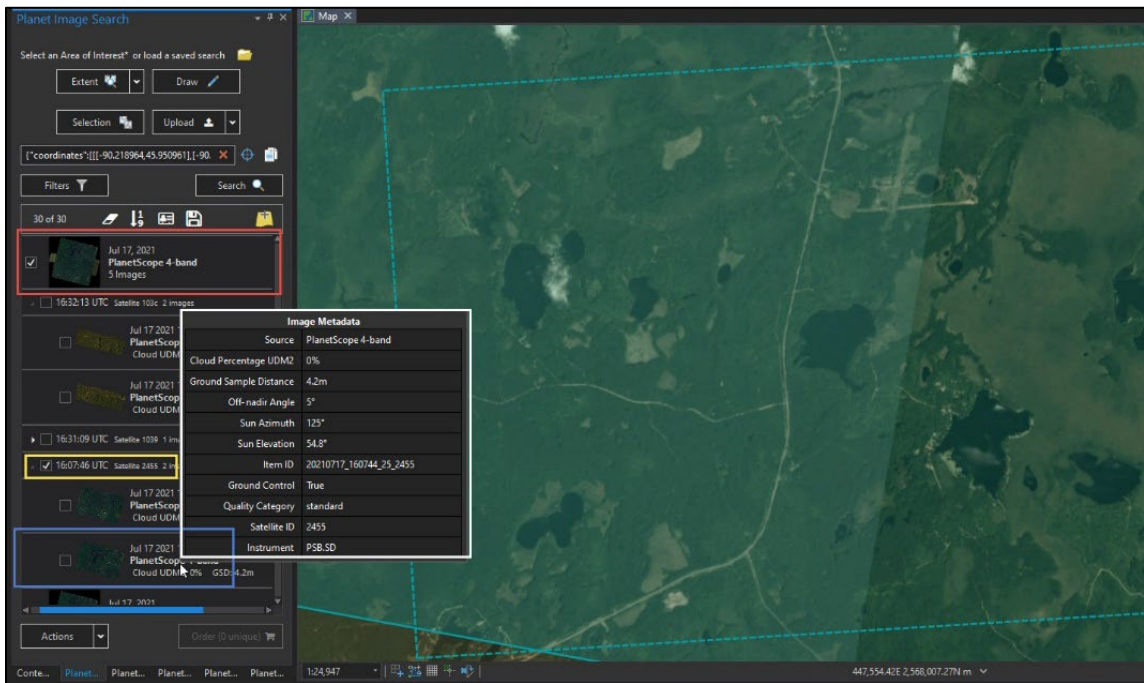
1. The search results (outlined by green box below) will display in the area below the Filter box.
 - i. Images returned will be grouped in nested sets based on the type of product (4-Band, 3-Band, and Ortho Tile if all three products are selected in Filters). The product sets are displayed by date, with the most recent first.



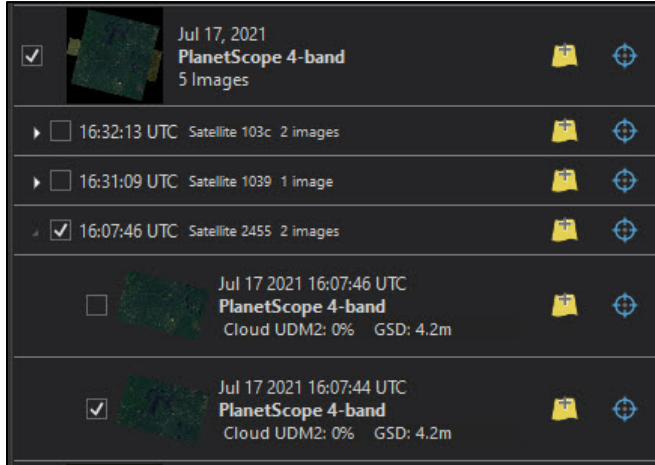
2. Using the cursor, hover over a product to see its footprints in the viewer in relation to the AOI. The red box below highlights the product set whose footprints are displayed in the viewer. This product set has five images.



3. When the product sets are expanded (red box below), images are nested by the satellite ID (yellow box). In the following example from the PlanetScope 4-Band product set dated July 17, 2021, two images were acquired with Satellite 103c on the PS2 platform. One image was acquired with Satellite 1039 on the PS2 platform, and two images were acquired with Satellite 2455 on the PSB.SD platform. Hovering with the cursor over one of the individual images (blue box below) will show the footprint of the image in the viewer and display a pop-up box (white box) with metadata for the image. The three images from the PS2 platform have a ground sampled distance (GSD) of 3.9 meters. The two images from the PSB.SD platform have a GSD of 4.2 meters.

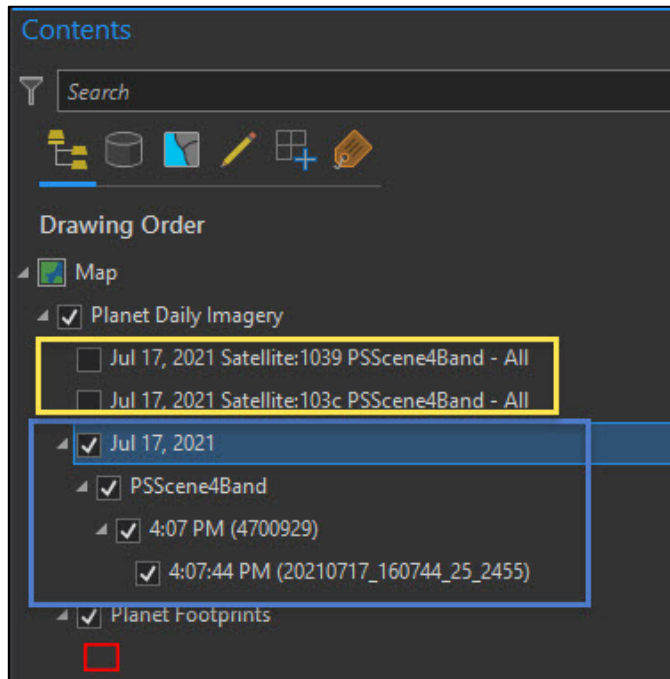


4. To the right of all levels of the nested images there are two icons.
 - i. The **Blue Target** icon zooms the viewer to the extent of image to the left of it.
 - ii. The **Yellow Folder** icon adds the reduced resolution streaming image (and any images nested below that level) to the ArcGIS Pro Contents table.



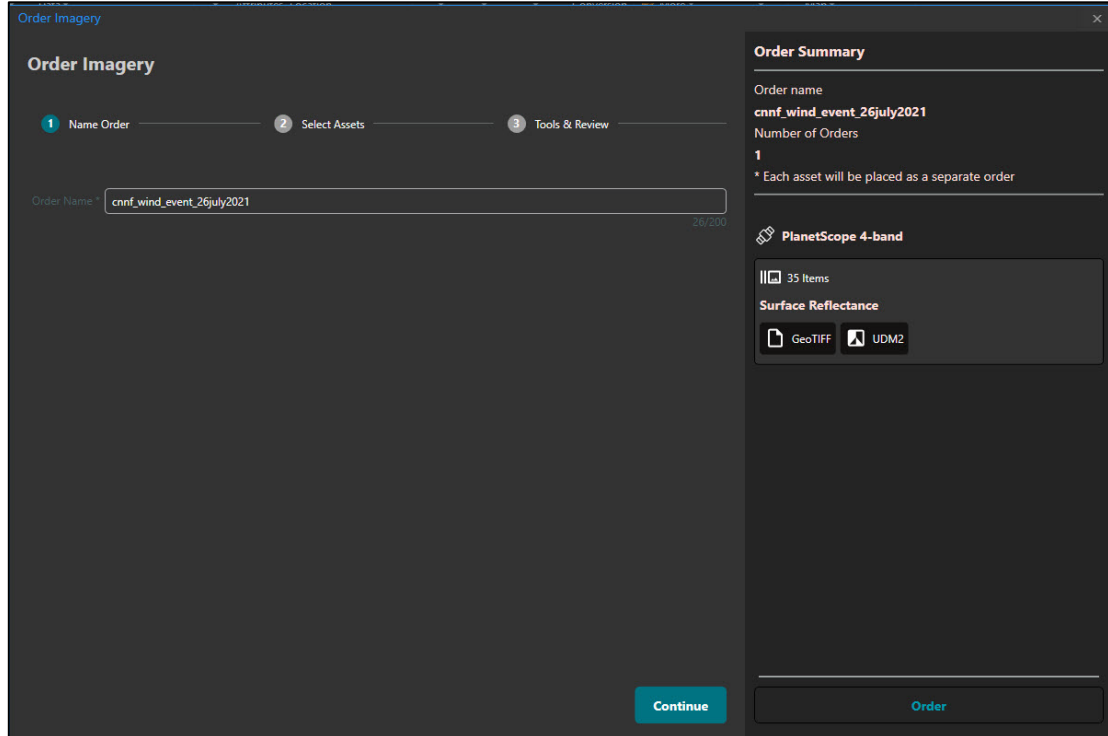
D. Stream Daily Imagery

1. The yellow box below highlights how the nested satellite (1039 and 103c) images appear in the **Contents** table. The yellow box shows images added as a nested group. Images added in this fashion to the Contents table display only the date of acquisition, the satellite number, and the product type. They do not expand to show any additional information.
2. The blue box depicts how a single image displays when added to the **Contents** table. When images are added individually, they can be expanded to display additional information about the time of acquisition.

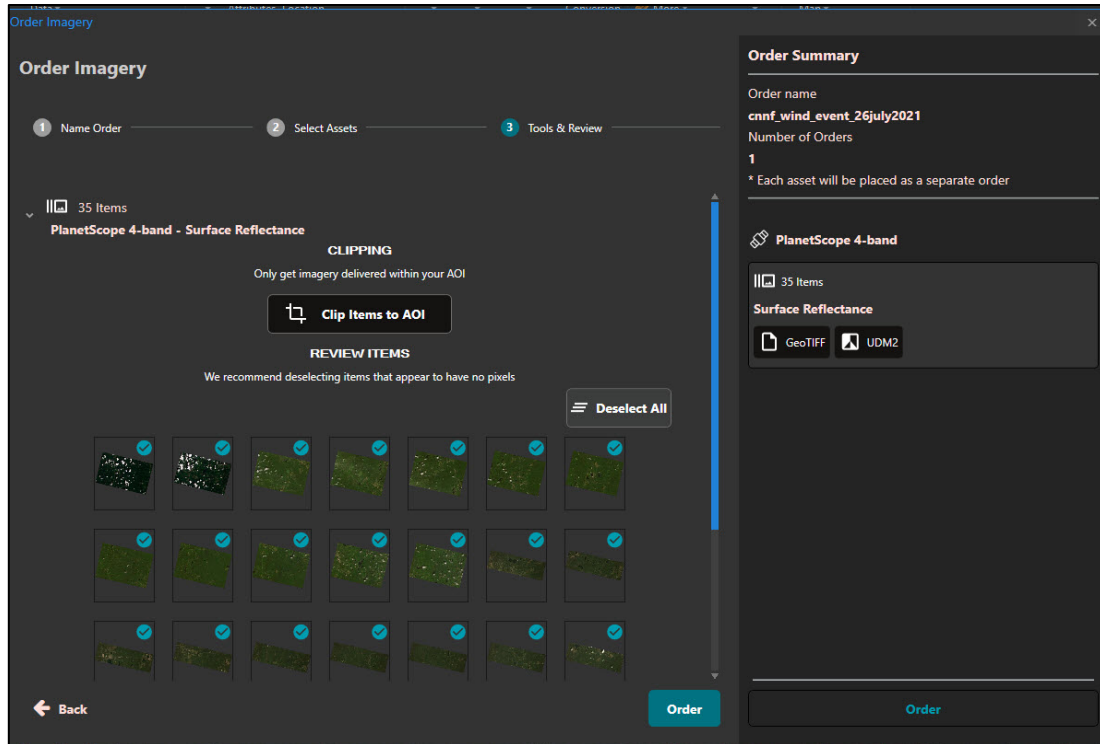


E. Download Daily Imagery

1. On the **Image Search** interface, select imagery to download by checking the box beside the desired images and clicking on the **Order** button.
2. The **Order Imagery** interface will appear prompting you to provide a 'Name' for the order. Once entered, the name will appear in the **Order Summary** on the right. The example below shows a single order comprised of only one product type (PlanetScope 4-band). If multiple product types (or assets) are included in the order, each product type will be submitted as a separate order.
3. Click **Continue**.



4. On the second Order Imagery screen we suggest you accept the default **Surface Reflectance** rectified asset and click **Continue**.
5. The third Order Imagery screen allows you to review your order.



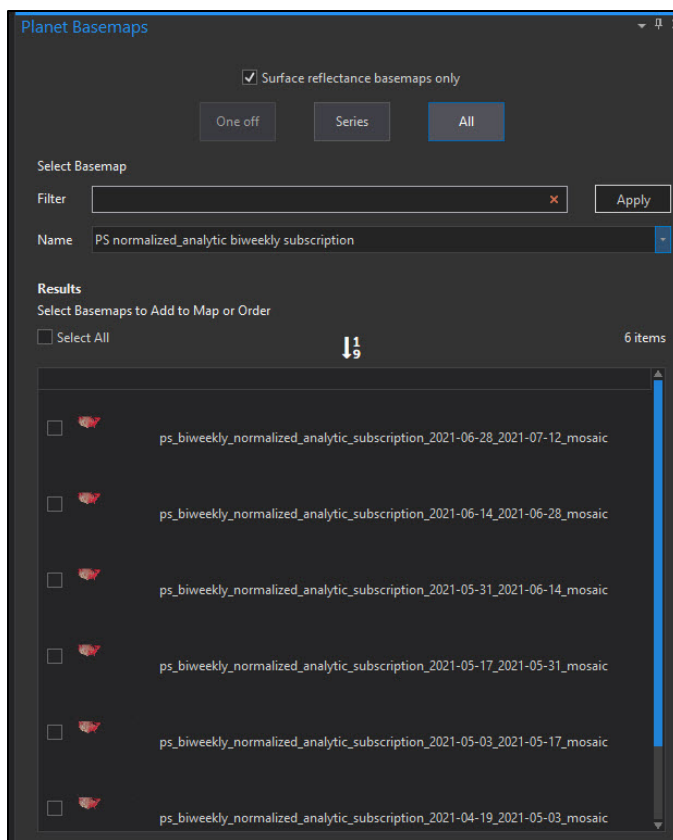
- i. Each image in the order appears as a thumbnail with a check box in its upper right corner. If an image does not meet your needs, uncheck the box to remove it from the order.
 - ii. You can also clip the imagery to an AOI by clicking on the **Clip Items to AOI** button.
6. When finished with the review, click the **Order** button.
 7. When the Order button is clicked, the **Planet Order Status** interface opens. This interface allows you to monitor the progress of new orders and download completed orders. All orders you have placed remain in this window allowing older orders to be re-downloaded if needed.

Part 4: Exploring the Planet Basemaps Imagery

This section provides instructions for searching for, streaming, and downloading PlanetScope’s basemaps using Planet’s ArcGIS Pro Add-In. Reduced resolution streaming views of the basemaps are manipulated for a pleasing visual appearance and are best suited for use as background imagery. The streaming views of basemap can be displayed as a color infrared image or as a limited selection of preset indices. If you need to perform quantitative analysis, you must download the full resolution imagery. The downloaded imagery has not been manipulated to improve appearance and may look different from the corresponding streamed imagery.

A. Open Planet Basemaps Interface and Load Imagery

1. Select the **Planet Basemaps** tab at the bottom of your ArcGIS Pro window.
2. On the interface, check the box next to **Surface reflectance basemaps only**. These are the only images included in the USDA subscription.
3. Since there is only one basemap dataset available under the USDA contract, leave the default **All** button selected.



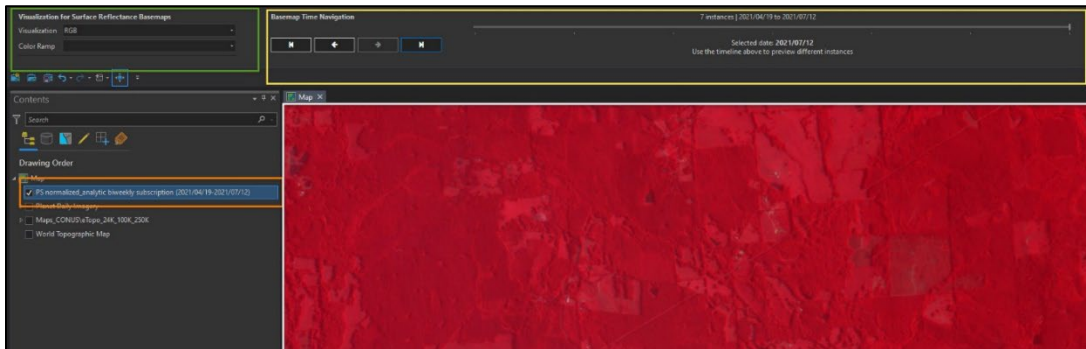
Note: When the 'All' button is selected, the 'Filter' option is not active.

4. Click on the small arrow on the right side of the box labeled **Name** and select **PS normalized_analytic biweekly subscription** from the dropdown menu. The **Results** window will populate with all basemaps available for streaming ordered, with the most recent

composite at the top. Each basemap name ends with the date range of images contained in the composite. Check the boxes beside each of the basemaps you wish to examine or check the Select All box at the top of the Results window.

B. Stream Selected Basemaps in ArcGIS Pro Contents Window

1. Click on the **Explore Selected** at the bottom of the Results window. Three things will happen:
 - i. The focus will move to the **Contents** interface where the selected images are loaded as a single layer (orange box below);
 - ii. The “layer” will appear in the viewer as a false color infrared image (white box below), and;
 - iii. A new ribbon will appear above the viewer. There are two components to the ribbon. The **Visualization for Surface Reflectance Basemaps** (VSRB) (green box below) and the **Basemap Time Navigation** (BTN) (yellow box below). The VSRB has a **Visualization** pull-down with seven preset image index options (see Appendix B) that can be applied on-the-fly to the composite in the viewer, and a **Color Ramp** pull-down that contains an assortment of color ramps that can be applied to the indices. The BTN consists of navigation controls (beginning, back, next, end) and the timeline. The number of instances and the date range of biweekly composites appear above the timeline. The date of the biweekly composite seen in the viewer appears below the timeline.

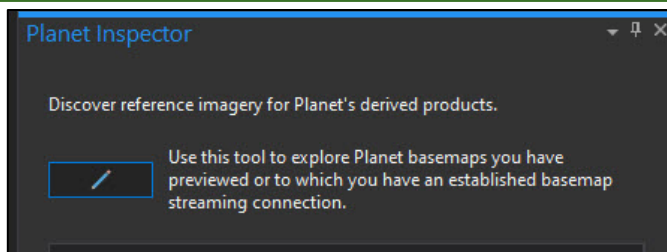


Note: This ribbon will persist in the Content interface and Planet Add-in interfaces, but it disappears when a regular ArcGIS Pro tab is selected.

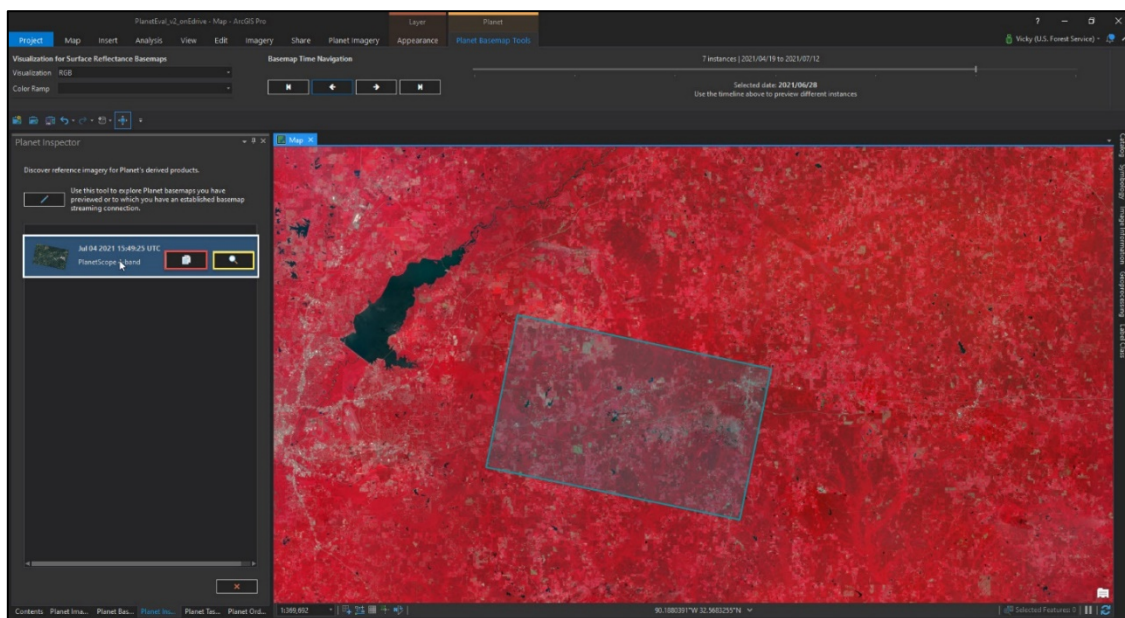
2. Zoom to an AOI, select a visualization index if something other than false color infrared is desired, and then click through the BTN to select a basemap to examine. Make sure the Planet basemap layer is selected (appears with a blue box around it as seen in the graphic above) in the ArcGIS Pro Contents tab.

C. Identify Basemap Source Imagery Using the Planet Inspector Interface.

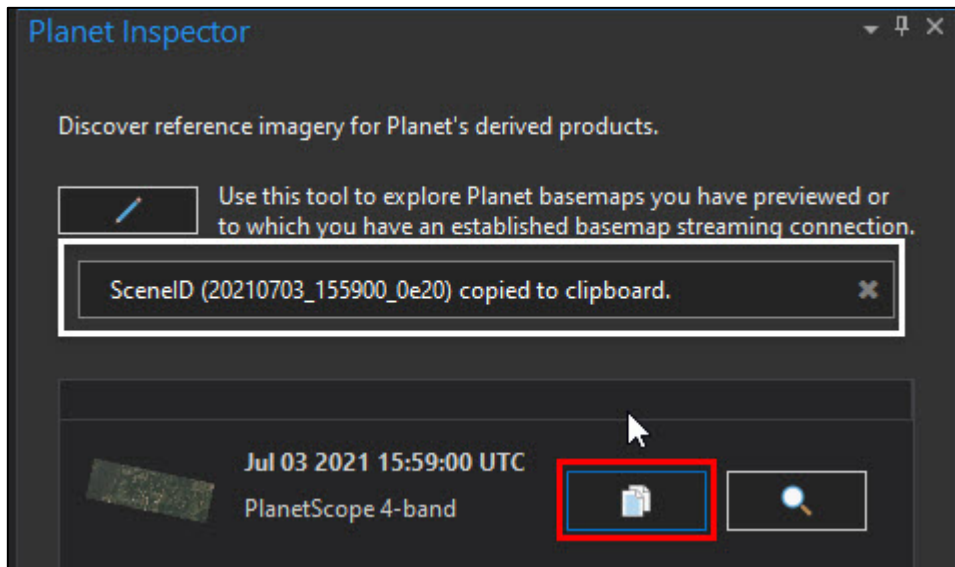
1. Click on the **Planet Inspector** tab at the bottom of ArcGIS Pro.
2. The cursor over the basemap in the viewer has three behaviors: the pointing finger is the default; the hand that pans the image in the viewer appears when the left mouse button is held down and dragged; the crosshair that selects a point to explore is active only after the pencil icon has been clicked.
3. Click on the **Pencil** icon.



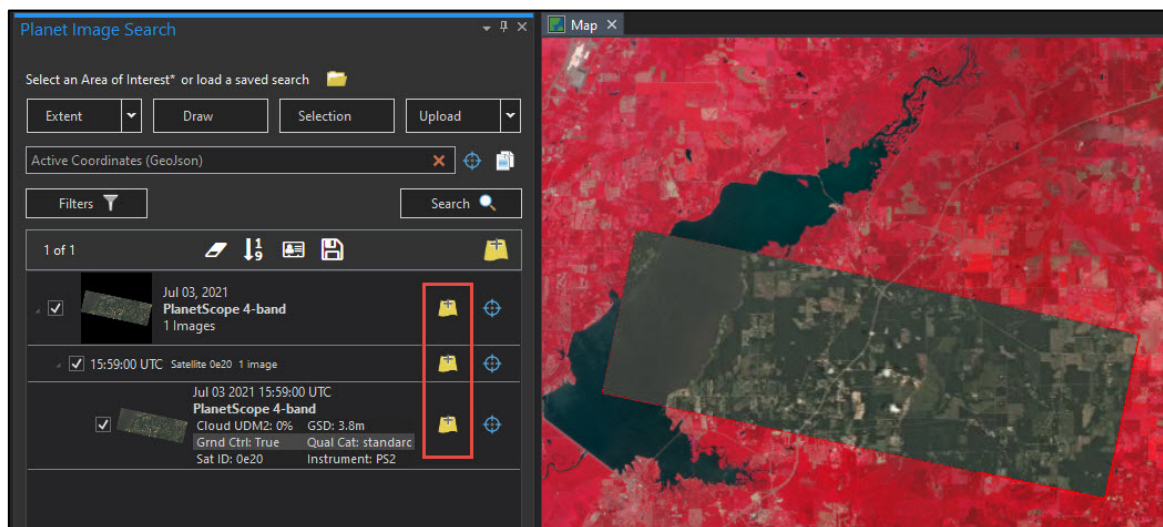
4. Click on a location in the view extent to find out more about the image source for the basemap at that location.
5. Product set information appears in the window below the pencil icon. Hover over the product set box (highlighted in white) to see the footprint of the 4-band image contained in the product set.



6. When the **Paper** icon is selected, the **SceneID** displays below the pencil icon.



- When the **Magnifying Glass** is selected, three things happen: the product set is added to the Planet Image Search tab, the focus moves to that tab, and the image is displayed as an RGB in the viewer. As before, click on the folder icon to add the streamed image to your ArcGIS Pro Contents viewer.

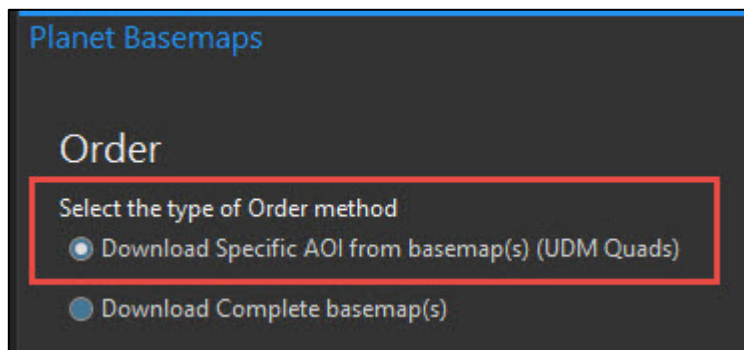


- At this point, all **Planet Image Search** interactions are available with the individual image.

*Note: The **Image Inspector** allows only one image to be explored at a time. If you click on another location using the Inspector's pencil icon, the previous image will be removed from the Image Search box as well as the Inspector box. If important, be sure to save the **SceneID** of an image before selecting another area to explore.*

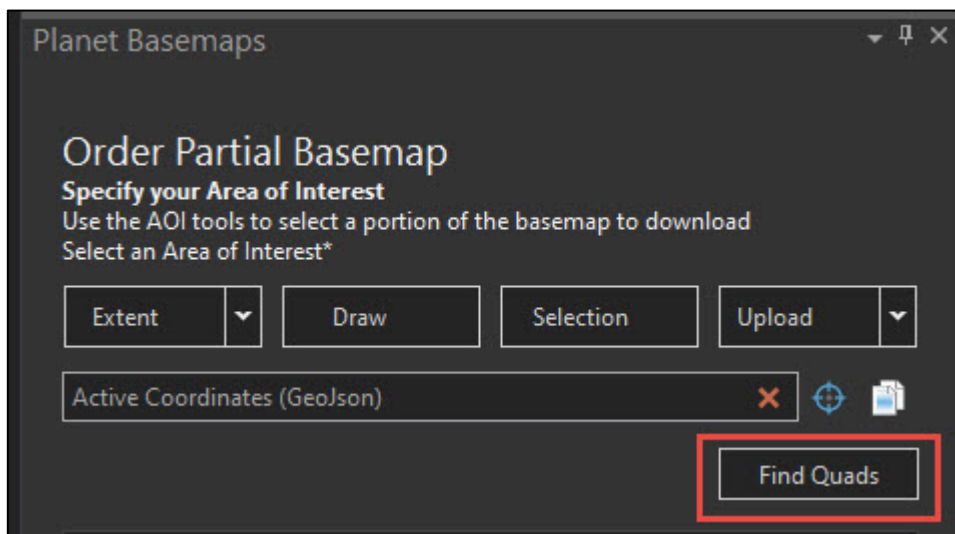
D. Download Basemap Quads

- On the **Basemaps** interface, select biweekly composite basemaps to download by checking the box beside the desired images or check the '**Select All**' box (see graphic Part 4: A.2). Then click on the **Order** button at the bottom of the interface.
- The Planet Basemaps interface will change to show two **Order** methods. The default '**Download Specific AOI from basemap(s) (UDM Quads)**' (red box) is the only method that works in the ArcGIS Pro Add-In. Click **Next** at the bottom of the interface.

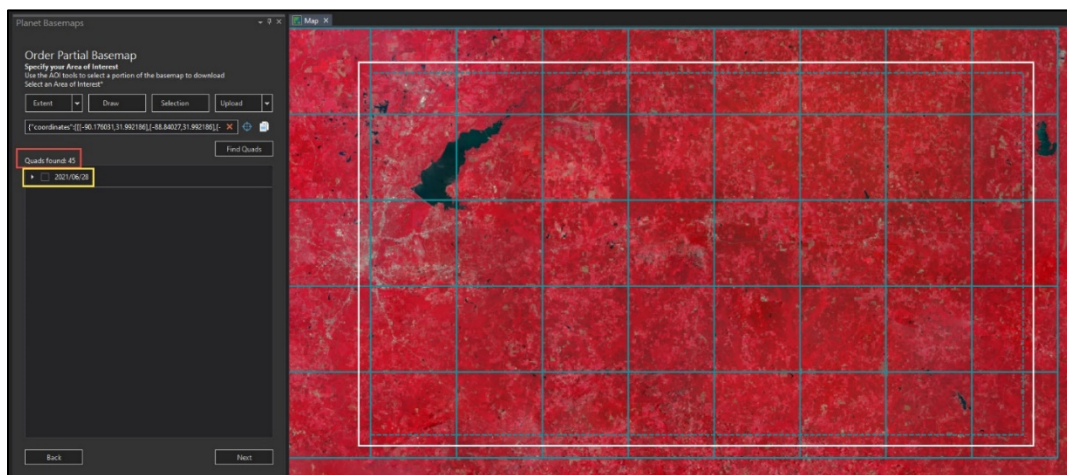


Note: If you try to select the 'Download Complete basemap(s)' method, a message pops up stating that 'The area is too large to download from the ArcGIS Add-In'.

3. The Planet Basemaps interface will change again to **'Order Partial Basemaps'** where you are asked to specify an AOI. The AOI tools shown below function the same as the Image Search interface. See Part 3A for a description of each AOI tool.
4. Once you have your AOI set, click on **'Find Quads'** (red box).



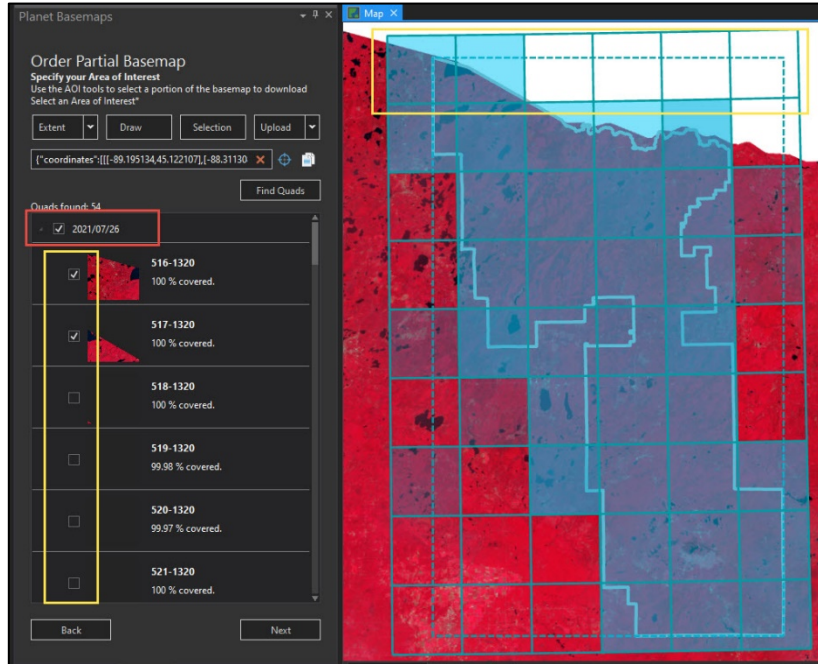
- i. When the search for quads is complete, the panel on the left shows the number of quads that overlap the AOI (red box) and a collapsed list of the quads returned labeled with the start date of the basemap biweekly composite (yellow box). If multiple basemaps were part of the order, a series of dates (most recent first) representing the start date of each biweekly composite will be listed. In the viewer, a grid of blue boxes representing the quads is overlain on the AOI (white box).



Note: In the graphic above all basemaps quads returned in the query are needed to completely cover the AOI. A different graphic with an irregularly shaped AOI is used below to better show how to remove unneeded quads from a basemap order.

5. Expand the list of quads by clicking on the small arrow to the left of the basemap start date and check the box between the small arrow and the start date to display all the quads. There are several quads that are outside of the AOI that can be removed from the order. The two quads in the first row, shaded in blue in the viewer, are the same images with checks next to

the quads in the panel. These are two of the images that will be ordered. The remaining four images (clear in the viewer/unchecked in the panel) in the first row will be removed from the order. This query started with 54 quads in the order. Once unneeded quads were removed, the order contains only 32 quads. Click **Next**.



6. On the final screen enter an **Order Name** and click **Submit Order**. An Order Confirmation message should now display on the left panel showing your order was successful. To monitor the status of the order, click on the **Order Status** panel.

Appendix A: QGIS Planet Plug-in Installation

A. Installing the QGIS Planet Plugin V2

1. Download [QGIS plugin](#) to your local machine. Downloads as a zip file. Do not unzip the file.
2. Launch QGIS
3. From the ribbon, click on 'Plugins' and the select 'Manage and Install Plugins'.
4. Click on the box with three dots to the right of the Zip file box and navigate to the zip file on your local machine.
5. Click 'Install Plugin' button. A security warning appears. Click 'Yes'.
6. Once the installation finishes a brief message in blue appears at the top of the Plugin interface window stating that the installation was successful. The message disappears quickly so you may miss it if you look away. Close the Plugin interface.
7. There is now a 'Welcome to Planet' login button the QGIS ribbon. Click on the 'Log In' button to sign into your Planet account.

Note: It is suggested that you do not check the 'Save credentials' box. When this box is checked, QGIS launches its 'Authentication Manager' application where you are required to set a master password.

8. For additional information about this plugin please see the [Planet QGIS Plugin V2 Documentation](#).

Appendix B: Planet Basemaps Visualization Indices

The ArcGIS Pro Planet Add-in provides six on-the-fly remote sensing indices that can be applied to streaming basemaps. [Planet Remote Sensing Indices](#) shows the abbreviations and formulae of the indices. The indices and a link to a description of each index from the [L3Harris™ Geospatial Alphabetical List of Spectral Indices](#) are provided below.

Note: Though it is shown in the pulldown list, 'RGB' is not one of the visualization options available for Surface Reflectance basemaps.

1. [Modified Soil-adjusted Vegetation Index \(MSAVI2\)](#)
2. [Modified Triangular Vegetation Index \(MTVI2\)](#)
3. [Normalized Difference Vegetation Index \(NDVI\)](#)
4. [Normalized Difference Water Index \(NDWI\)](#)
5. [Triangular Greenness Index \(TGI\)](#)
6. [Visual Atmospheric Resistance Index \(VARI\)](#)