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EXERCISE 1
Setting up the Cover Mapper

Introduction
In this exercise, you will learn how to set up the Cover Mapper tool within the Landscape Pattern Monitoring Portal to create Landsat composites, perform change detection, create land cover maps, and export the results.

Objectives
- Learn how to navigate the Cover Mapper
- Set up and understand the inputs to the application

Prerequisites
- **You have downloaded the sample CSV file from Collect Earth Online**
- **You are using the Google Chrome web browser (preferably wide-screen)**
- **You have a strong internet connection (preferably wired)**

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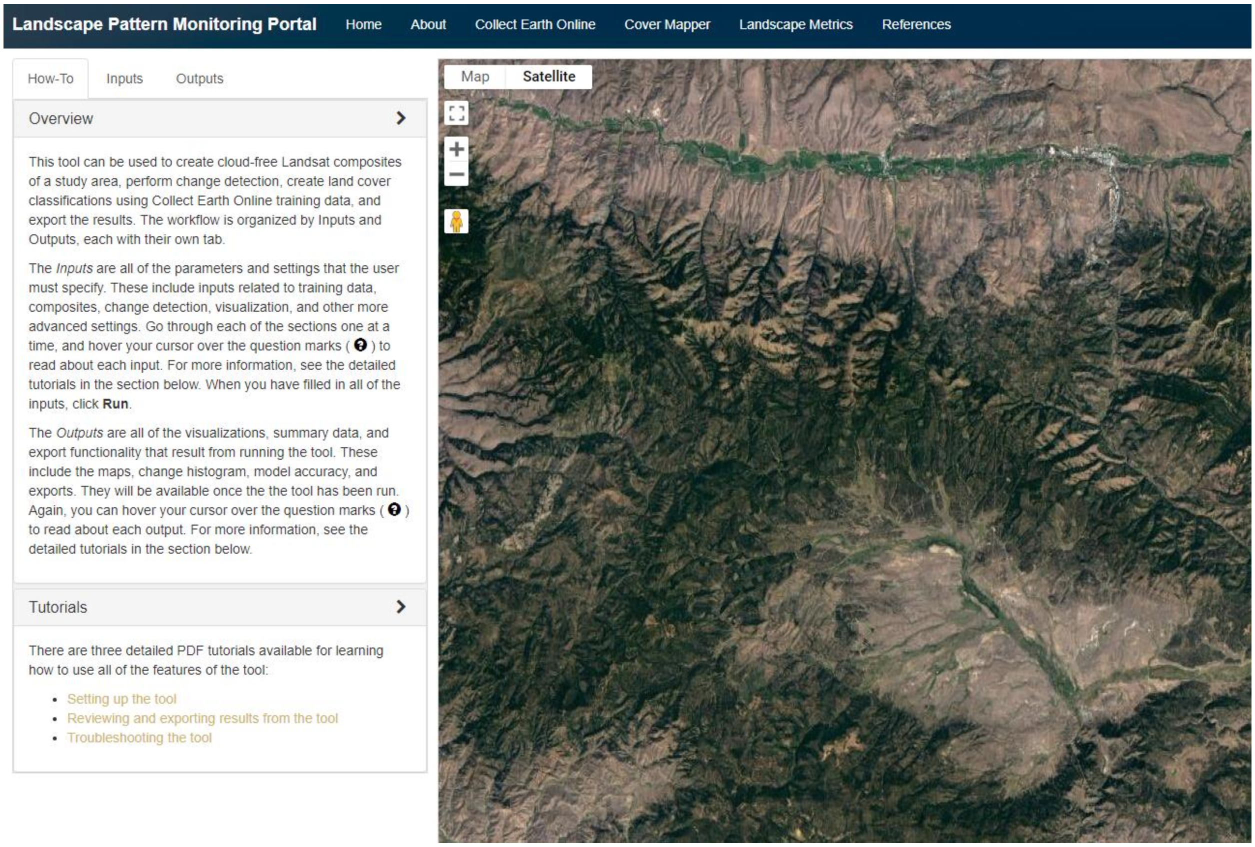
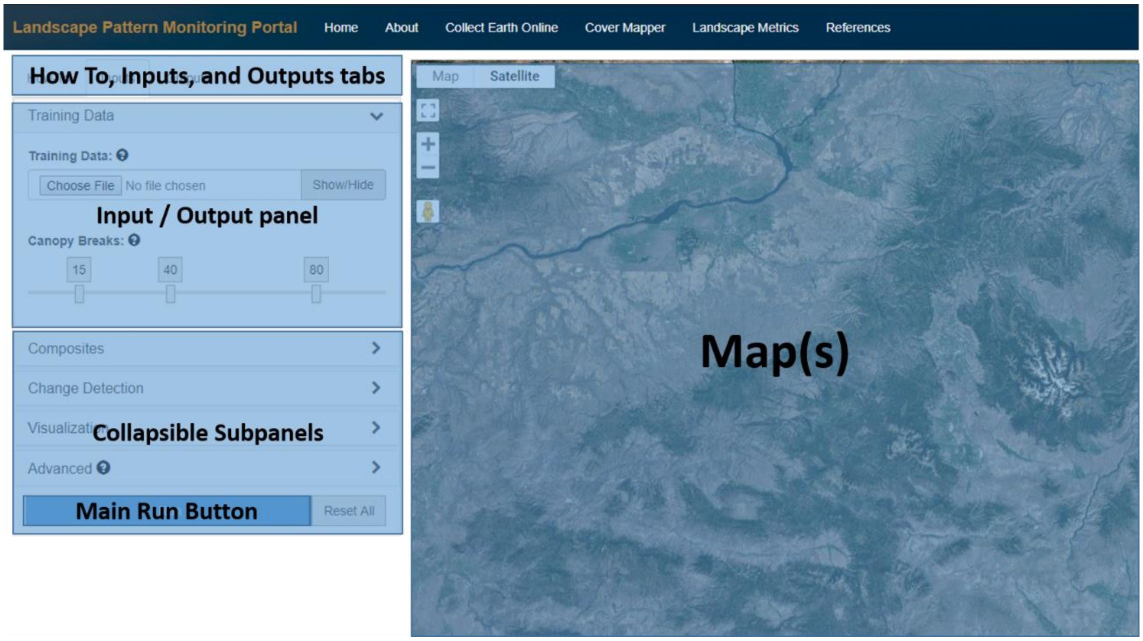
Part 1: Setting up application inputs

A. Learn how to navigate the application

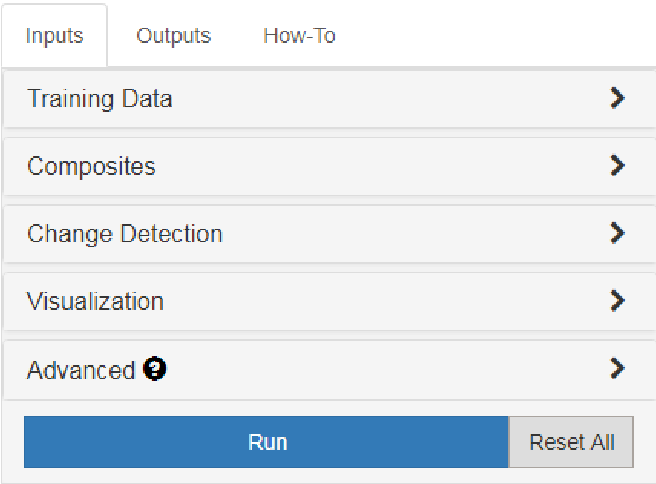
1. Upon first opening the **Cover Mapper** page, you should see a layout similar to this:



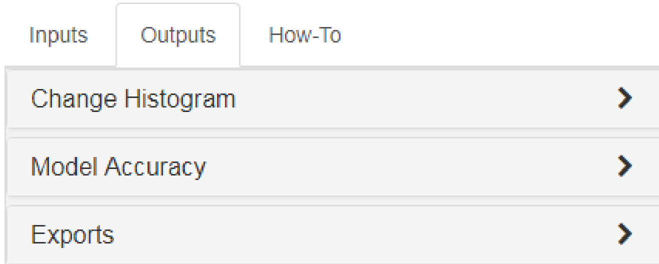
2. Click on the **Inputs** tab. The main sections of this layout are labeled in the image below:



3. To switch between the **Input** and **Output** panels, click the respective tabs. To expand or collapse the various subpanels, click the subpanel titles or the arrows next to them.
4. You can click and drag on the map to pan around. To zoom, you can double-click on a point, use your mouse scroll wheel, or click the **+** and **–** buttons on your keyboard or the icons in the lower right corner of the map. Finally, you can expand the map by clicking the icon in the upper left corner of the map. Press the ESC key on your keyboard to leave the full screen map.
5. The **Inputs** panel contains the following subpanels: Training Data, Composites, Change Detection, Visualization, and Advanced. In the remainder of this exercise we will go step-by-step through each of the subpanels before running the application.



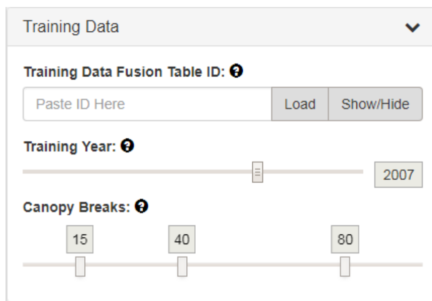
6. The **Outputs** panel contains the following subpanels: Change Histogram, Model Accuracy, and Exports. These subpanels are empty until after the application has been run. In Exercise 2 we will explore the content of these panels.



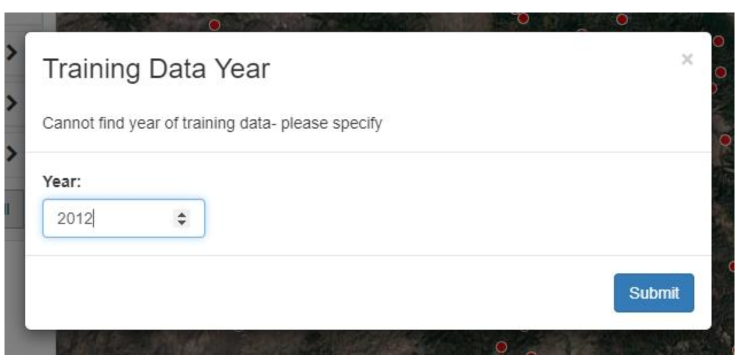
7. Lastly, if you wish to reset all of the inputs to their default values, you can click the Reset All button at the bottom right of the Inputs panel. This will clear your inputs, and refresh the web page.

B. Prepare training data inputs

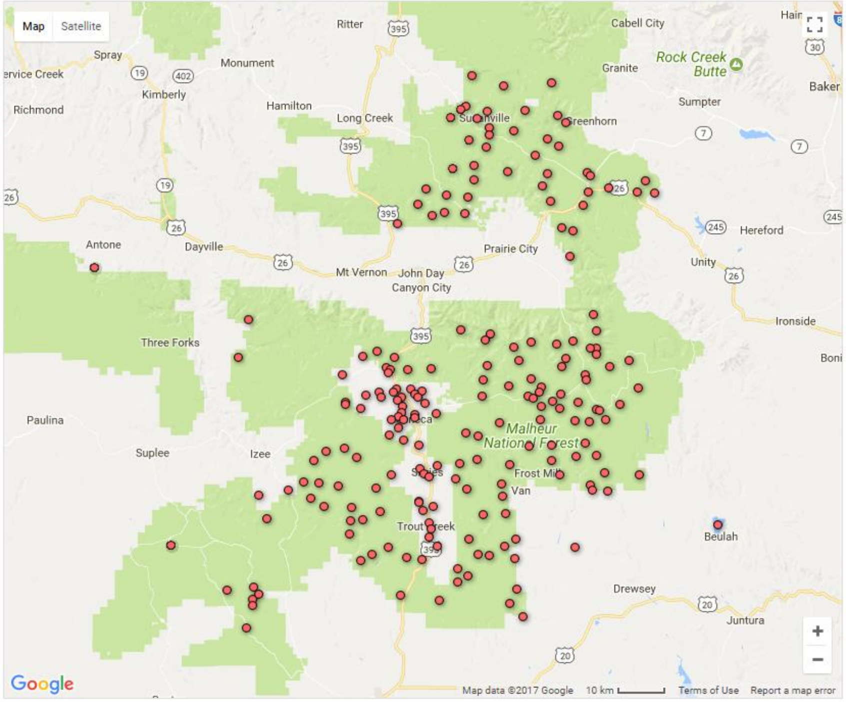
1. Return to the **Inputs** panel, and expand the **Training Data** subpanel. If this is your first time using the application, you should see the following:



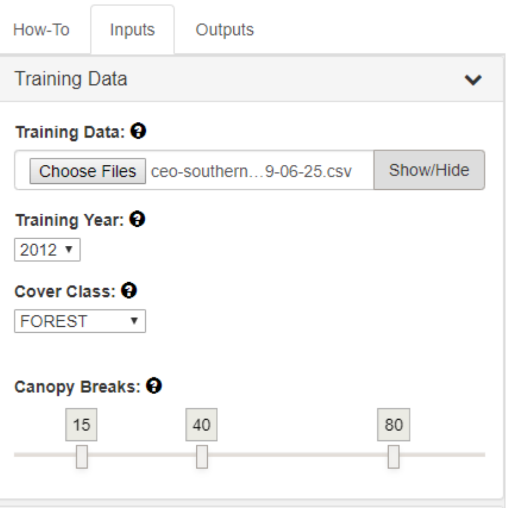
2. The first input requests **Training Data**. For this field, we will enter the Collect Earth Online plot data formatted as a CSV file. You can use Collect Earth Online data created using two image dates for interpretation or using one year of imagery for interpretation. If using a dataset created with only one year of imagery, a message will pop up asking you to specify the year of training data. The year of imagery that we used to create the training dataset in this example is **2012**. Click **Submit**.



3. Upon loading the training data, it should appear centered on the map as small red dots. You can show or hide these dots at any time by clicking the Show/Hide button. These dots, despite their apparent size on the map, represent 100 m radius plots (this was the plot size that was specified in Collect Earth Online).



4. At the same time, the Training Data subpanel will automatically update to include a new input field: **Cover Class**.

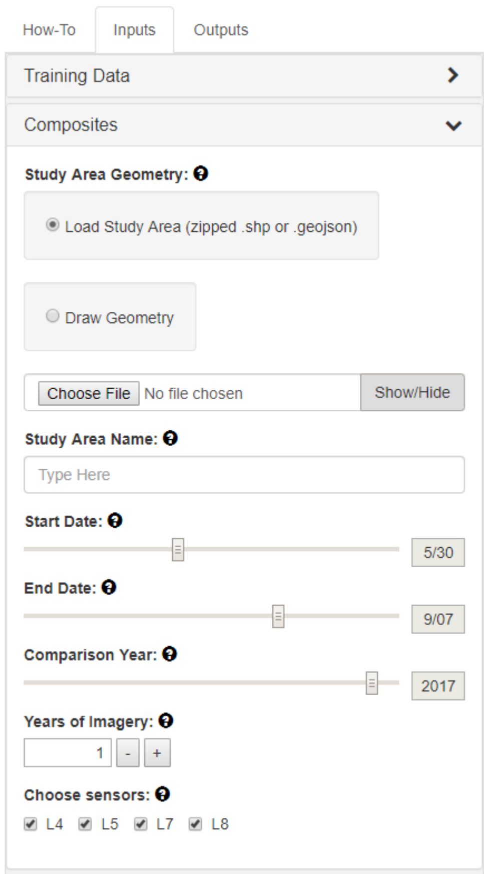


5. The **Cover Class** should be set to the cover type that contains percent canopy cover information. This column must only contain percentages between 0 and 100. For our example, set this to **FOREST**.
6. The last input for the Training Data subpanel is **Canopy Breaks**. These three breaks split the Cover Class into four different percent canopy cover classes or bins: 0% to the first break, the first break to the second break, the second break to the third break, and the third break to

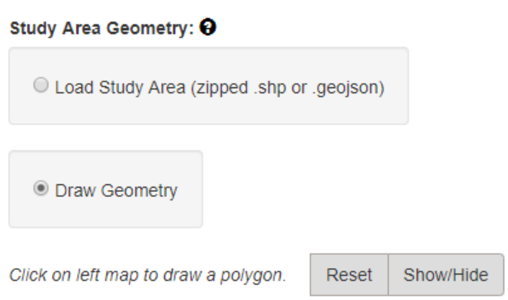
100%. Set these to **15**, **40**, and **80** by dragging the sliders. These breaks are primarily used for visualization and for the change/no-change mask. The actual modeling is based on the raw percent cover values.

C. Prepare composites inputs

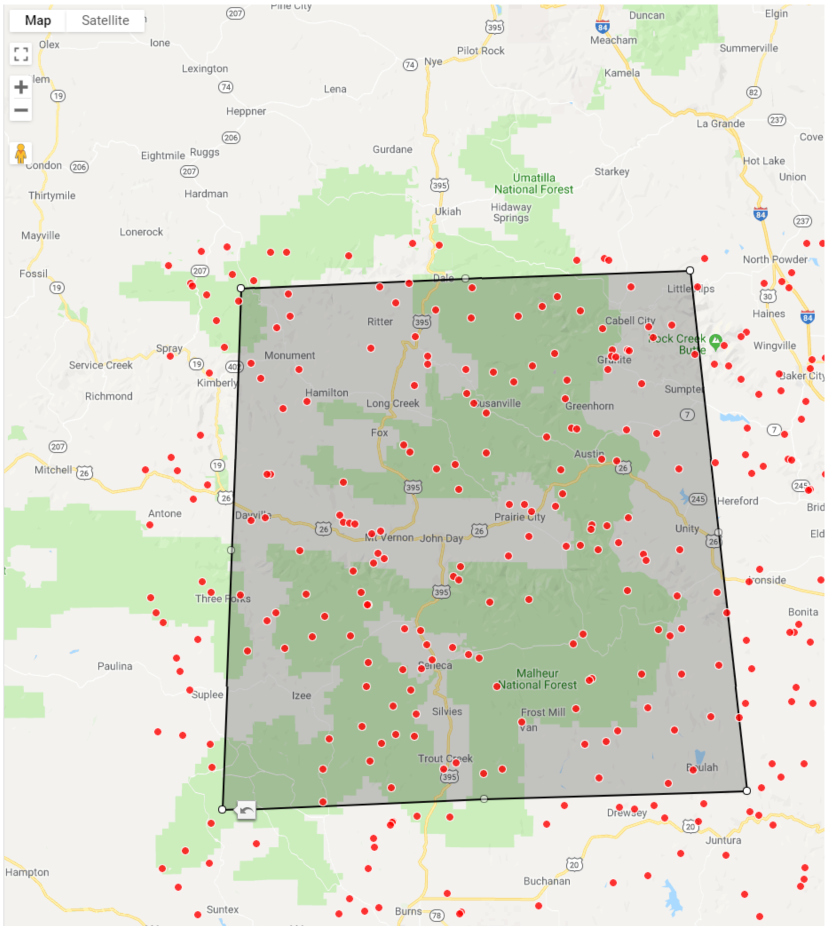
1. Remain on the Inputs panel, and expand the **Composites** subpanel. If this is your first time using the application, you should see the following:



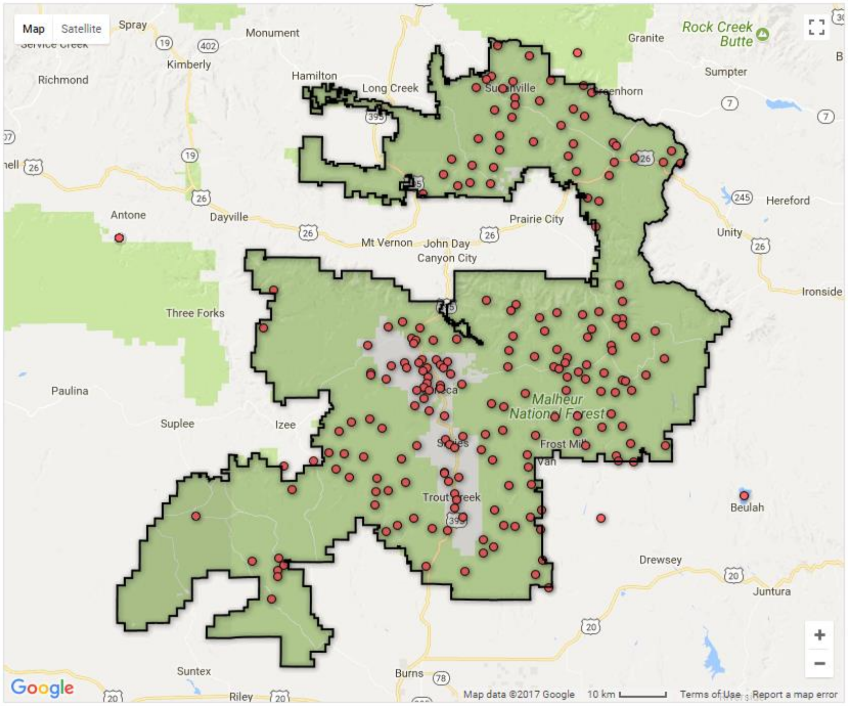
2. There are two different ways to set a **Study Area Geometry**: (1) Load Study Area (zipped .shp or .geojson), or (2) Draw Geometry. Let's first try drawing a polygon. Click the **Draw Geometry** radio button. You should see a slightly different subpanel:



3. Click on the map to add vertices of a polygon. You can click and drag the geometry to move it. You can also click and drag on the vertices or the midpoints of line segments to add additional points. If you want to start over, click the Reset button. You can show or hide this polygon at any time by clicking the Show/Hide button. Note that the study area need not include all of the training data points.



4. Next, let’s try adding shapefile. Click the **Load Study Area (zipped .shp or .geojson)** radio button to revert to the original Composites subpanel. For this example, you can use **Malheur.zip**, which is a small zip file containing a shapefile representing the boundary of the Malheur National Forest. Click **Choose File**, navigate to the zip, and open it.
5. Upon loading, the study area should appear centered on the map as a lightly shaded polygon with a black border. You can show or hide this boundary at any time by clicking the **Show/Hide** button.



> ***Note:*** *If you have both drawn a study area polygon AND loaded a study area Fusion Table, the application will use the loaded geometry for the study area. In other words, the drawn polygon is only used if a geometry has not been loaded from file.*

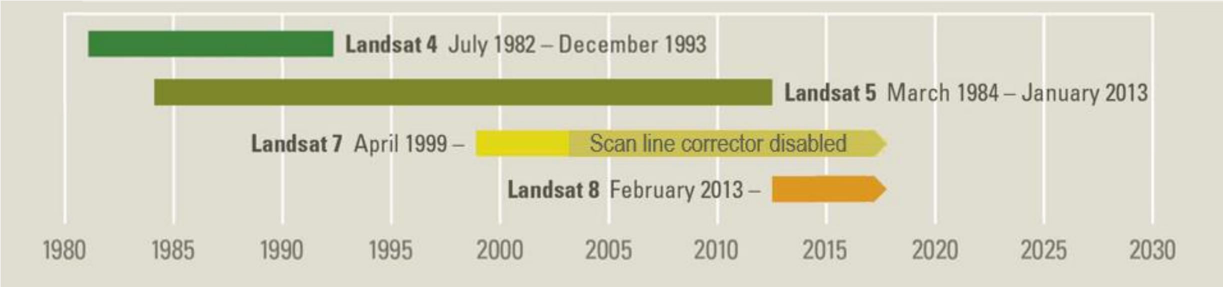
6. *[Optional]* You may add a **Study Area Name**. If you load a geometry, the name of the zip file will be used by default, though you can always edit it. This is only used as a prefix for exported raster filenames. Try to keep the name short, i.e., under 10 characters. Leave the name set as **Malheur**.
7. Cloud-free composites take ideal pixels from multiple images and mosaic them together into a single cloud-free scene. Therefore, the date range of images to include in composites depends on the project needs and characteristics of the study area. For example, if we only want to pull pixels from around the time the area experiences peak greenness, we might want to limit the date range to a smaller temporal window. If the area experiences a high percentage of cloud cover, we may have to include 2 years of imagery to ensure that there is a clear view of each pixel found within the entire extent. For this exercise, set the **Start Date** to **5/30** and the **End Date** to **9/07**, either by dragging the sliders or by clicking the slider handles and using the arrow keys on your keyboard. This date range will capture the peak of greenness for this region of Oregon, as well as the senescence of grasses, which will make them easier to differentiate from other vegetation.
8. The next input is **Comparison Year**. This is the year that will be compared to the training year and can be any year before or after the training year (but not the same as the training year). This year will determine the year for one of the Landsat composites and one of the land cover maps. Set this input to **2016** either by dragging the slider or by clicking the slider handle and using the arrow keys on your keyboard. We're using 2016, because there was a very large fire

in the area during the summer of 2015, and we want to ensure that it is captured in the imagery.

9. The **Years** of **Imagery** input defines the number of years of imagery to include for each composite. For example, a 5/30 to 9/07 composite for 2016 with 2 years of imagery will actually include imagery in the date range of 5/30 to 9/07 for both 2016 and 2017. A composite with 3 years of imagery will include the years before and after the desired year (e.g., 2014 – 2016). To strictly restrict the imagery from just the given year, set the years of imagery to 1. For this example, though, **set the years of imagery to 2** to gather more imagery.

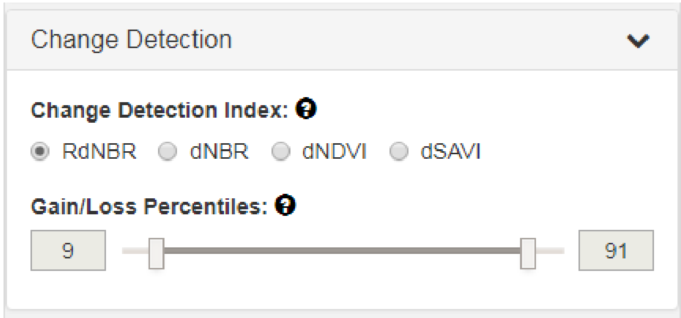
Note: *While you can set* ***Years of Imagery*** *to 1 (i.e., only pull imagery from the year specified by the training year or comparison year), these are not the only parameters to be set for an image composite. While the area might not experience much noise or cloud-cover, parameterizing the other variables may restrict the availability of images used in the generation of the composite and cause data gaps (e.g., holes) in your imagery. Feel free to set this variable to 1, but if after running the script you notice holes across your composite, you are missing pixels – you will need to adjust your parameters to include more image options, either by extending the date range or by fiddling with other variables.*

10. The last input for the Composites subpanel is to **Choose sensors**. These are the four available Landsat sensor image collections from which the composites will be made. The options are any combination of Landsat 4 TM (**L4**), Landsat 5 TM (**L5**), Landsat 7 ETM+ (**L7**), and Landsat 8 OLI (**L8**). Unless you have a particular reason for excluding a sensor, we recommend that you keep all four sensors checked. Another reason to not exclude sensors, is that you may run into issues if your training and/or comparison years do not have any imagery available for your chosen sensor(s). See the graphic below for a timeline of Landsat 4, 5, 7, and 8 missions. As a final detail, recall that from May 2003 onward, the scan line corrector on Landsat 7 was disabled, leading to images with striping gaps. Consequently, we recommend not solely relying on Landsat 7 for imagery after 2003.



D. Prepare change detection inputs

1. Remain on the Inputs panel, and expand the **Change Detection** subpanel. If this is your first time using the application, you should see the following:

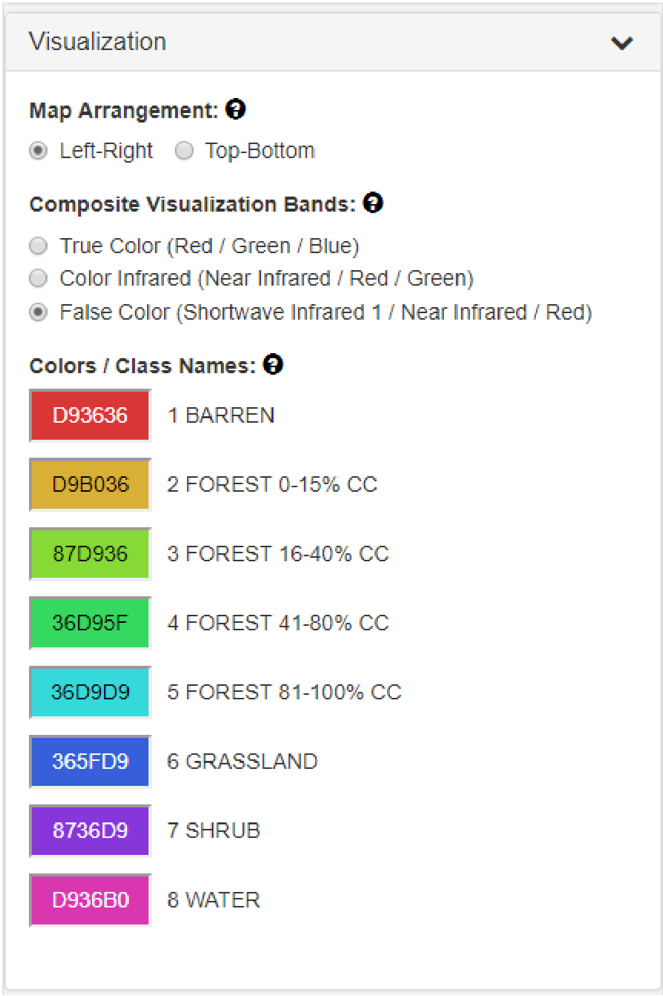


2. Select a **Change Detection Index**. Depending on the characteristics of your study area, one index may yield improved results over the others. The available options include:
   i. **RdNBR** (relative differenced Normalized Burn Ratio)
   ii. **dNBR** (differenced Normalized Burn Ratio)
   iii. **dNDVI** (differenced Normalized Difference Vegetation Index)
   iv. **dSAVI** (differenced Soil-Adjusted Vegetation Index; L = 0.5).

   For this example, leave **RdNBR** selected.
3. The **Gain/Loss Percentiles** define the thresholds for considering a change detection index value to be an outlier, and therefore a way to separate change from no-change. For example, if the thresholds are set to **10** and **90** (default) and you have selected **RdNBR** as your change detection index, then any pixel with an RdNBR value below the 10^{th} percentile of landscape-wide RdNBR will be considered change (gain), and any pixel with an RdNBR value above the 90^{th} percentile will be considered change (loss). All other pixels will be classified as no-change. To include more pixels as change, bring the sliders closer together. To classify fewer pixels as change, bring the sliders farther apart.

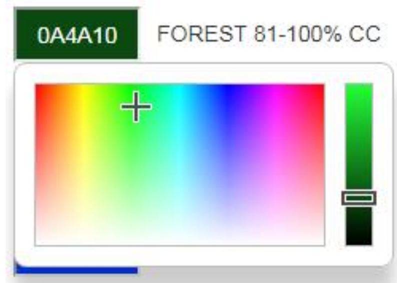
E. Prepare visualization inputs

1. Remain on the inputs panel, and expand the **Visualization** subpanel. If this is your first time using the application and you've successfully loaded the training data, you should see the following:



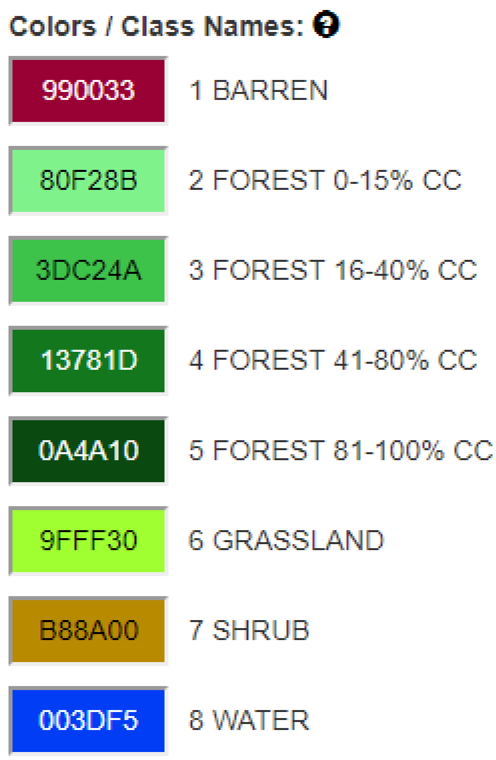
2. All of these visualization inputs can be modified again after running the application. That said, it's best to prepare them beforehand to reduce confusion later.
3. The **Map Arrangement** describes whether the two output maps will be arranged left-right (i.e., side-by-side) or top-bottom. If you have a smaller screen, we recommend using top-bottom, otherwise stay with left-right. You can easily change your choice at any time after running the application.
4. The **Composite Visualization Bands** describes which Landsat bands will be used to display the composites after running the script. We recommend **False Color** for the greatest contrast between vegetation/non-vegetation and among different kinds of vegetation. You can change your choice after running the application by using the Update Layers button (visible after running), but it takes some time to update the layers. The options include:
   i. **True Color** (Red / Green / Blue)
   ii. **Color Infrared** (Near Infrared / Red / Green)
   iii. **False Color** (Shortwave Infrared 1 / Near Infrared / Red)
5. Set the **Colors / Class Names** to define the colors for each class in the land cover maps. The labels here are generated automatically from the Training Data inputs (Classification Field,

Cover Class, and Canopy Breaks). So, if they look strange, double-check that you've chosen the correct Training Data inputs. This color selection input also serves as the legend for the land cover maps. The default color pattern is a rainbow, but you can easily change individual class colors to any 8-bit RGB color. If you have a six-digit hex-color code you would like to use, simply type that into a color picker text field (e.g., **0A4A10** for a dark green). Otherwise, click on a color picker and choose a color visually. The main selection area has hue along the horizontal direction, and saturation along the vertical direction. Value (i.e., lightness) is specified by the small vertical slider on the right side.



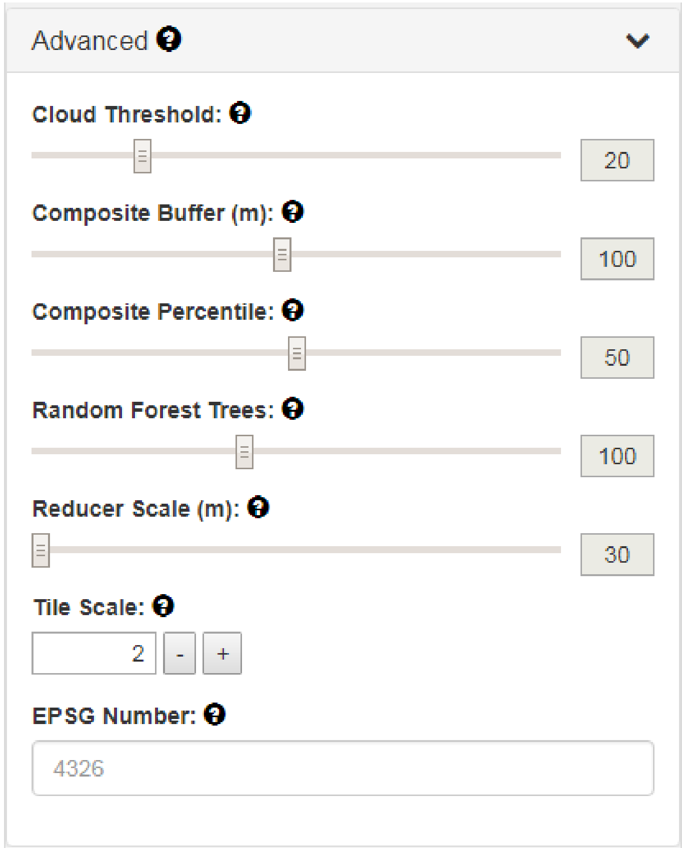
Again, it is possible to change colors after running the application, by clicking the Update Layers button (visible after running), but it may take a minute or more to update the layers.

6. Here is an example of some suggested color choices, but feel free to explore others:



F. *[Optional]* Prepare advanced inputs

1. Remain on the **Inputs** panel, and expand the **Advanced** subpanel. These advanced settings are set properly by default and do not need to be modified. The main reasons to change any of these settings are to: (1) fine-tune composite settings, (2) change the classification settings, or (3) handle memory-related errors (see Exercise 3 on troubleshooting for more information). If this is your first time using the application, you should see the following:



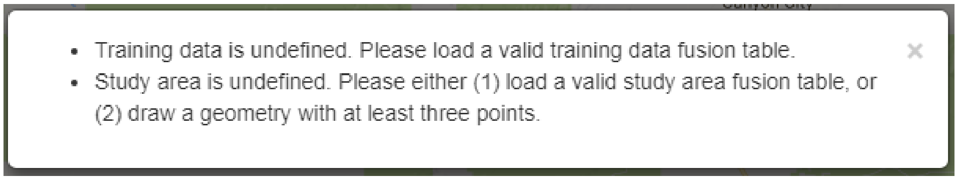
2. The **Cloud Threshold** determines how much the application will attempt to remove clouds. If you are familiar with the cloud percentage threshold used when acquiring imagery using the Earth Explorer or Global Visualization Viewer interfaces, you will be familiar with this parameter. The lower you set the threshold, the more it will exclude pixels from cloudy images. A default value of **20** is recommended.
3. The **Composite Buffer** is used to buffer the composite area by a given distance in meters. We suggest a default distance of **100**.
4. The **Composite Percentile** is used to reduce the stack of images available for any given pixel to form the actual composite pixel value. The default value of **50** is equivalent to using the **median**. That means that if there are an odd number of images, the program will order the available pixel values and use the middle image pixel value. If there are an even number of images, the program will order the available pixel values and take the average of the two center-most pixel values.
5. For land cover classification, the application uses a Random Forest model. These are models that combine the predictions from many decision trees to return a prediction with lower

variance. The details of Random Forest modeling are beyond the scope of this exercise, but if you are interested, here is a presentation on their application in remote sensing: http://whrc.org/wp-content/uploads/2016/02/DecisionTrees_RandomForest_v2.pdf. The number of **Random Forest Trees** can be set by the user, with a recommended default value of **100**.

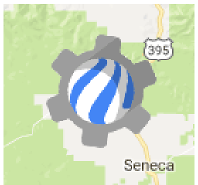
6. The **Reducer Scale** is the scale at which the composites are sampled at the training data locations to produce the classification and regression training data. It can be thought of as the radius of the training plots in meters. **30** m is the smallest reducer scale, and is the value we recommend, unless you have persistent memory errors (see Exercise 3 on troubleshooting).
7. **Tile Scale** is a scaling factor used to reduce aggregation tile size. Using a larger tile scale may enable computations that run out of memory with the default value of **2**. For more information, see Exercise 3 on troubleshooting.
8. The last input for the **Advanced** subpanel is the **EPSG Number**. This is a code used to specify the exported raster's coordinate reference system. The default value is **4326** which corresponds to a Web Mercator projection. For a complete list of available EPSG numbers, go to: http://spatialreference.org/ref/epsg/.

G. Run the application

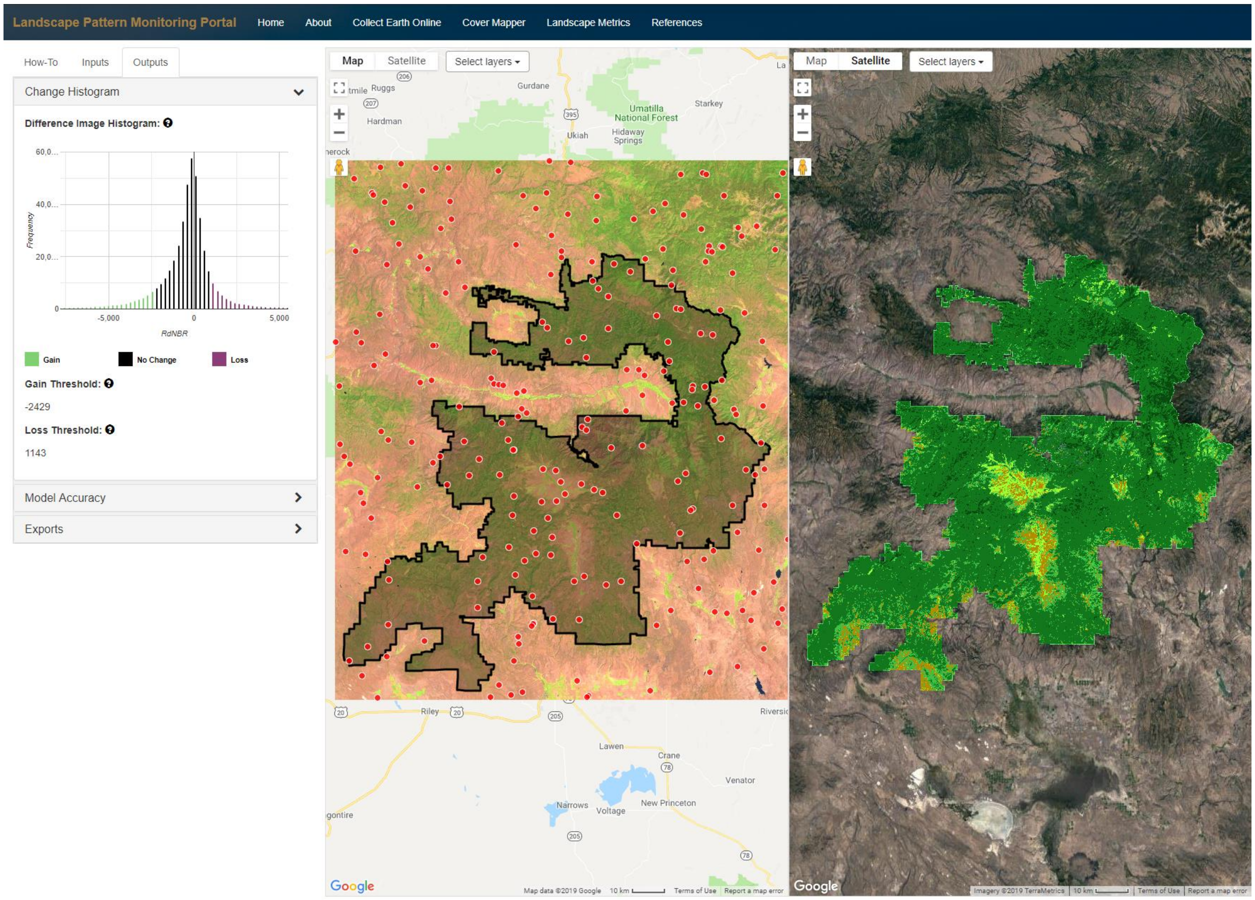
1. Quickly double-check that you've specified all of the required inputs correctly. Then click the main **Run** button at the bottom of the inputs panel.
2. If you've made an invalid selection, in most cases a helpful error message will display on clicking the Run button. Follow the directions to fix your inputs.



3. If there are no invalid input selections, Google Earth Engine will begin running the application with your inputs. You can tell that the application is running, because spinning gears will display on the screen in multiple places. The application may take between 1-7 minutes to run, so please be patient. How long the application takes depends on several factors, including: the size of the study area, the amount of training data, the number of days between the start and end dates for your composites, and most of the advanced inputs.



4. If portions of the application have not finished running after approximately 6-7 minutes, those portions of the page will display an error message. If this is the case for you, go to Exercise 3 to explore various troubleshooting options.
5. If the spinning gears all disappear and you see a page similar to the one below, then the application has successfully run! We will explore the map layers in the next exercise.



Congratulations! You've completed this exercise on setting up the Southern Blues map viewer application. You now have all the information you need to set up and run your own application. In the next exercise you will learn how to review the results and create exports.