

M.O.S.A.I.C.S. Tutorials - Lab 3:

Mapping Burn Scars using EMIT L2A data

Background



[The Eaton Fire: How the System Failed Altadena](#)

In January of 2025, drought conditions and Santa Ana winds contributed to the devastating spread of wildfires in Los Angeles County, California. The Eaton fire burned through the San Gabriel Mountains, destroying habitat, and spread to the surrounding Altadena communities. Wildfire, a natural ecological phenomenon, can be exacerbated by climate change, leading to extreme events like the LA fires. It is critical to evaluate the extent and effects of wildfires, as such events will continue to occur with increasing frequency and severity. Wildfires can affect the ecological health and safety of burned areas for years after the fires cease. Remotely-sensed hyperspectral imagery from Jet Propulsion Laboratory's EMIT mission allows researchers to map the extent of burned areas (burn scars) and assess the effects that fires have on vegetation and soil.

In this lab, we will use EMIT hyperspectral data to map the Normalized Burn Ratio (NBR) index to identify the Eaton Fire burn scar. We will compare the spectral signatures of the burn scar before and after the Eaton Fire.

Sections and Requirements

Sections:

1. Generating the Normalized Burn Ratio Index
2. Define our Region of interest
3. Generating our Mean Spectrum Plot
4. Exporting the Spectrum Plot
5. Assignment

Requirements:

- WISER installed on MacOS or Windows
- [Pre-Fire and Post-Fire EMIT scenes downloaded](#)

Note: The EMIT L2A reflectance data used in this lab have been orthorectified and clipped to the San Gabriel Mountains, north of Altadena in Southern California, using AppEEARS.

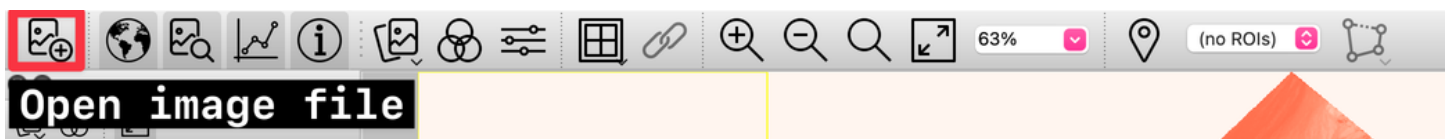
1. Generating the Normalized Burn Ratio Index

Burn scars that may not be visible to the naked eye can be mapped using **burn-related indices** generated from **hyperspectral imagery**. The **Normalized Burn Ratio (NBR) Index** allows us to visualize changes in surface reflectance caused by fire and identify burned areas.

1. Select the icons for the **Context Pane**, **Zoom Pane**, **Spectrum Plot**, and **Dataset Information** windows. Expand the **Spectrum Plot** window so that you are able to view the spectrum that will be generated in **Section 3**.

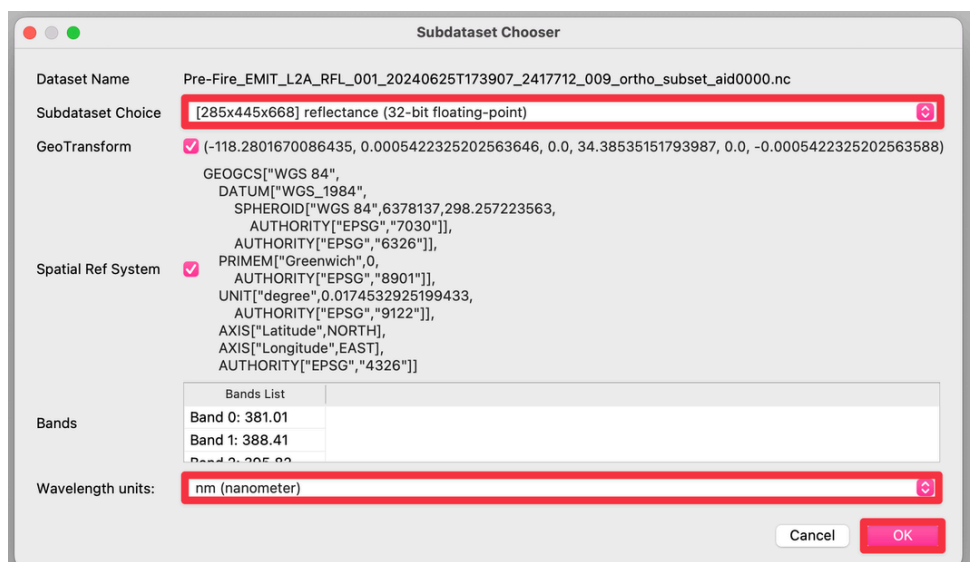


2. In the Main Toolbar, click the **Open Image File** icon.



3. Navigate through your file directory to find the **Pre-Fire** and **Post-Fire** EMIT scenes. You may use the **Command** key (MacOS) or the **Control** key (Windows) to select both the **Pre-Fire** and **Post-Fire** EMIT NetCDF-4 (.nc) files. Click **Open**.

4. In the **Subdataset Chooser** window that pops up, ensure that for **Subdataset Choice**, the **reflectance** subdataset is selected, and that the **Wavelength Units** are in **nanometers**. Click **OK**.



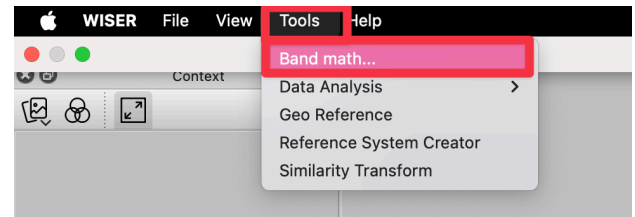
5. The **Subdataset Chooser** window will pop up again for the second EMIT image we selected. Ensure again that **Subdataset Choice** and **Wavelength Units** are set as **Reflectance** and **Nanometers**, respectively.

6. The EMIT images will load into the Main Window as a true-color composite. Click **Zoom to fit** from the Main Toolbar to resize the image to the extent of the Main Window.



M.O.S.A.I.C.S. Tutorials - Lab 3: Mapping Burn Scars with EMIT L2A data

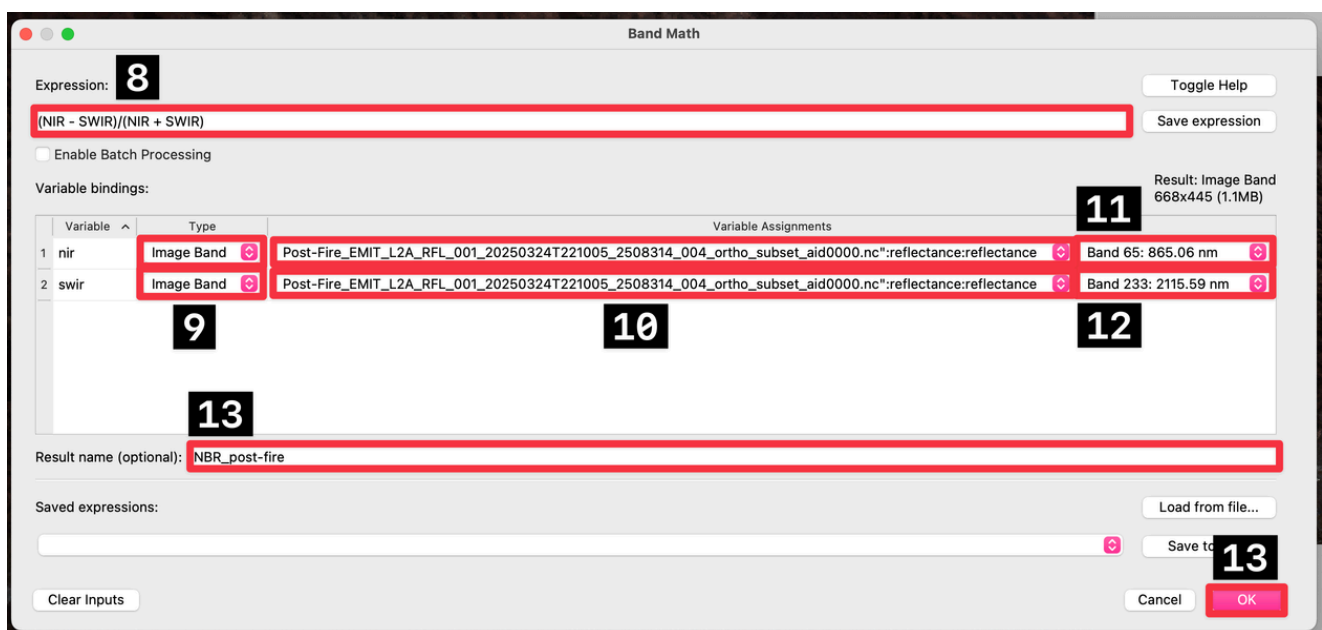
- To calculate the NBR index, select **Band math...** from the Menu bar above the application window. The **Band Math** window will pop up.



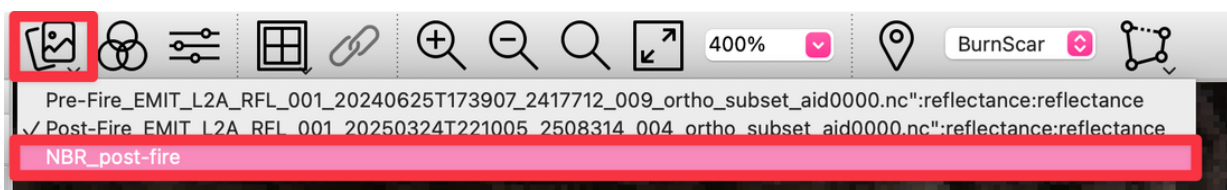
- Type: **(NIR - SWIR)/(NIR + SWIR)** in the **Expression** field. You may have to scroll within the **Variable bindings** window to adjust the settings for each variable for **step 8**, or you may drag the edge of the **Band Math** window to expand it. You may click **Toggle Help** on the upper right portion of the **Band Math** window to toggle off the information on the **Band-Math Operators** to allow more room for the **Variable bindings** window.

In the **Variable bindings** window:

- For the **Type**: select **Image Band** from the dropdown list for both **NIR** and **SWIR** variables.
- For the **Variable Assignments**: select the **Post-Fire** layer from the dropdown list for both **NIR** and **SWIR** variables.
- For the **NIR** variable, select **Band 64: 857.59 nm** from the dropdown list.
- For the **SWIR** variable, select **Band 233: 2115.59 nm** from the dropdown list.
- Type "**NBR_post-fire**" in the **Result name** field. Click **OK**.



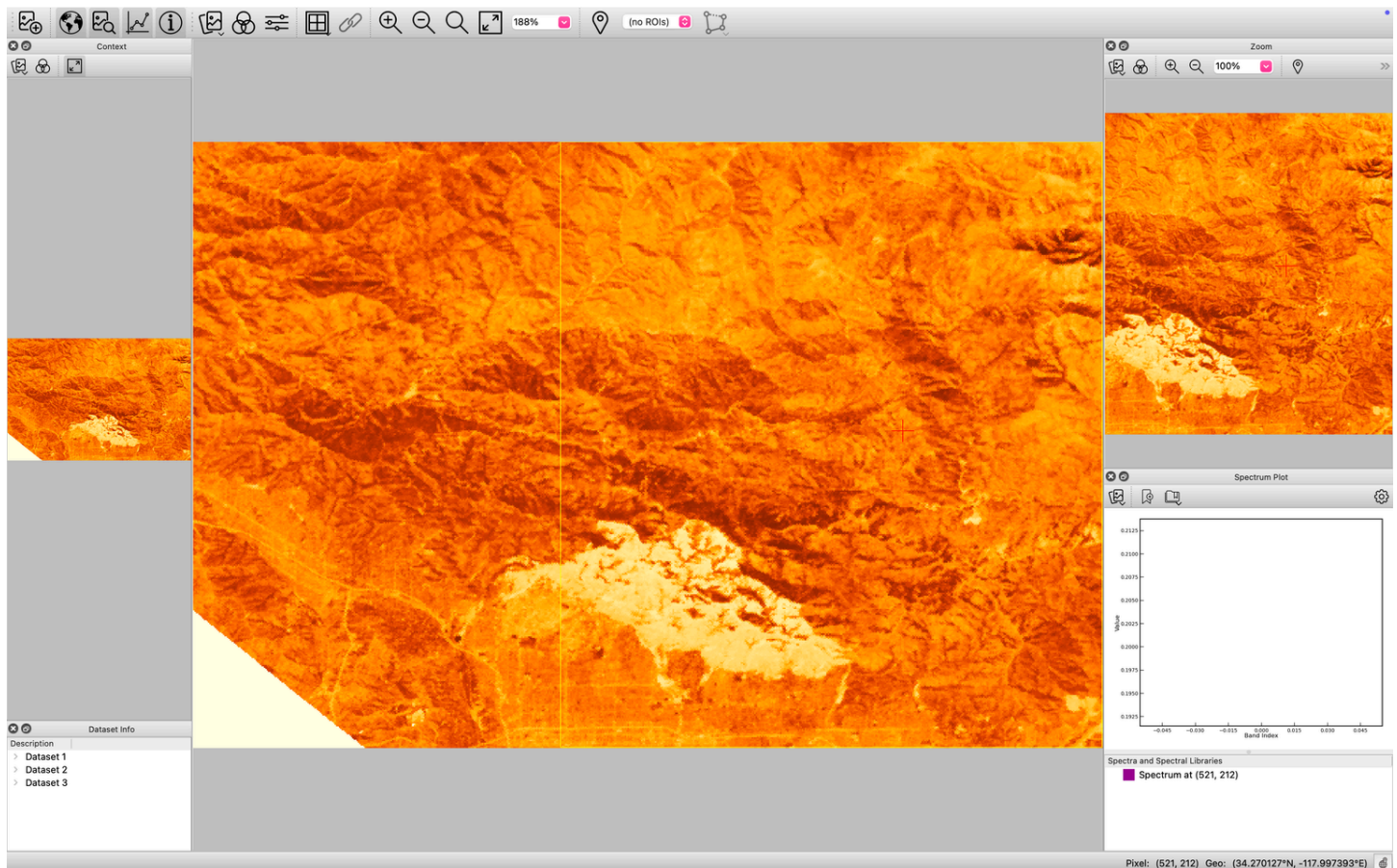
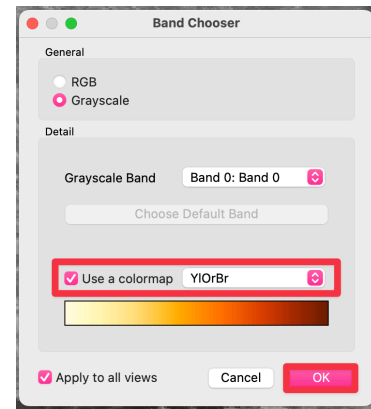
- After about 20 seconds, click the **Select Dataset to View** icon in the Main Toolbar, and select **NBR_post-fire** layer from the dropdown list. The computed layer should load in grayscale.
- Note: WISER will take longer to complete a band math calculation on an EMIT granule or a larger dataset.*



- Click the **Band Chooser** icon from the Main Toolbar to select a color map.



12. In the **Band Chooser** window, toggle on the **Use a colormap** option, and select **YlOrBr** from the dropdown list. Select **OK**. The computed **NBR_post-fire** layer will now regenerate in psuedo-color.



Interpretation

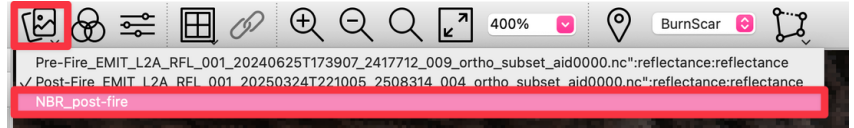
The NBR index is a common burn severity index used to visualize burn scars. The color ramp we selected is a standard, color-blind friendly way to visualize NBR in pseudo-color. Unburned vegetation will appear brown or orange (positive, near-one index values), while burn scars will show up as light yellow (negative, or near-zero index values). Shaded regions or bare soil may also appear light yellow.

The NBR uses the difference between the Short-wave Infrared (SWIR) portion of the EMS and the Near Infrared portion of the EMS, normalized by the sum. The SWIR is absorbed by water/moisture and reflected by ash/charcoal, while the NIR is reflected by structured, healthy vegetation. Researchers can exploit this relationship to derive the NBR index using hyperspectral data and mapped burned areas, which are limited in moisture and vegetation presence, and are likely to include ash and charcoal. In the southern portion of the Post-Fire EMIT granule, captured two months after the Eaton Fire, the burn scar is apparent in light yellow, contrasting with the orange and brown in the surrounding areas.

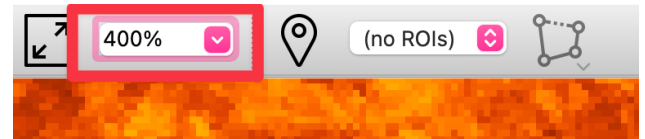
2. Defining our Region of Interest

Now that we have mapped the **NBR index**, we can define our **Region of Interest (ROI)** around the burn scar to compare the **spectral signature** of the burned area before and after the Eaton Fire.

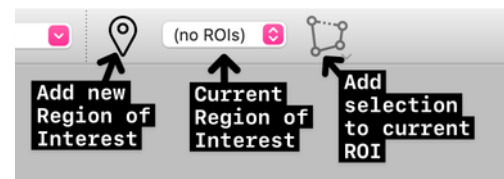
1. Ensure that the **NBR_post-fire** layer is selected using the **Select Dataset to View** icon in the Main Toolbar.



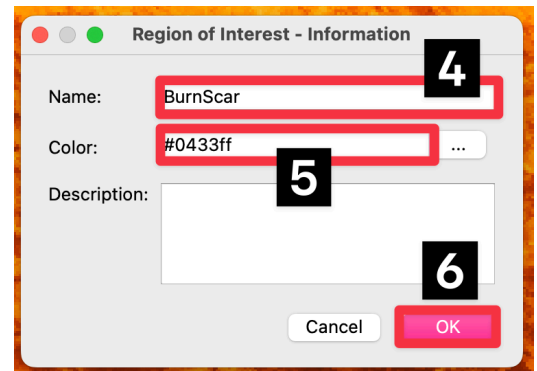
2. Adjust the zoom level to **400%** using the dropdown list to the right of the **Zoom to fit** icon. Pan to the southern portion of the image, where there is a cluster of yellow pixels.



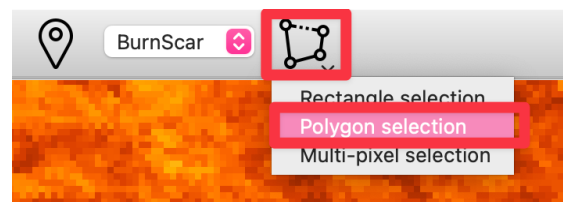
3. Click the **Create region of interest** icon in the Main Toolbar to bring up the **Region of Interest - Information** window.



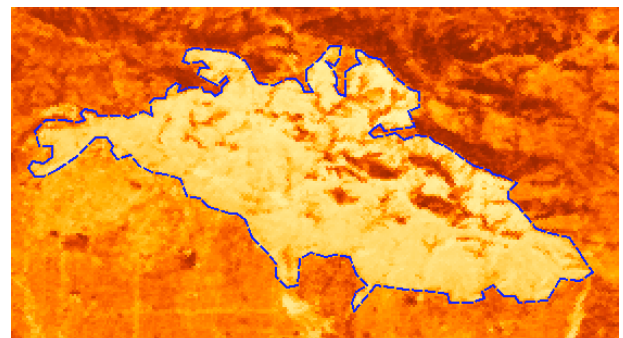
4. In the **Region of Interest - Information** window, type "**BurnScar**" in the **Name** field. The preselected color for the polygon is yellow.
5. To select a contrasting color for the polygon outline, paste "**#0433ff**" in the **Color** field; alternatively, click the ellipses to the right of the **Color** field and select **Blue** from the pop-up window, and click **OK**.
6. In the **Region of Interest - Information** window, click **OK**.



7. To delineate the polygon, click the **Add selection to Current ROI** icon in the Main Toolbar and select **Polygon Selection** from the dropdown menu.



8. Delineate a polygon around the light yellow region of the image by clicking around the perimeter of the lightest pixels in the San Gabriel Mountains. To undo a misplaced point, use the **Esc** key on your keyboard. To close the polygon boundary around the ROI, click the first point you placed along the perimeter. The polygon should look like this:

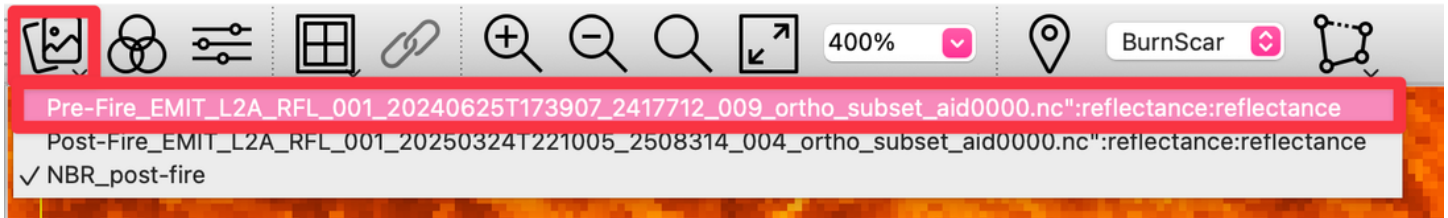


Tip: Focus on the lightest yellow pixels when delineating the ROI polygon; try to avoid orange and brown pixels. The Eaton fire burned urban areas and vegetation, but for this example, we want to focus on changes in vegetation in the San Gabriel Mountains. To save time, you may also outline a smaller polygon within the burned region.

3. Generating our Mean Spectrum Plot

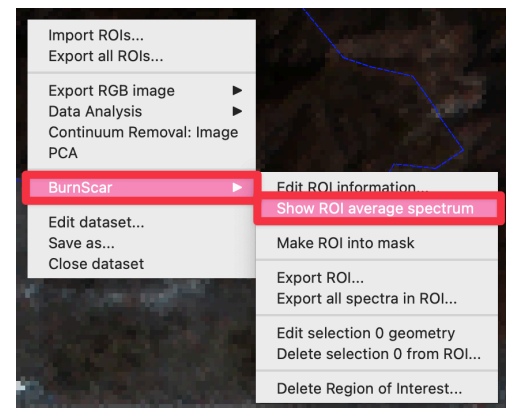
Now that we have defined our **ROI**, we can assess reflectance differences before and after the Eaton Fire by generating the mean spectral signature of our ROI from of our the **Pre-Fire** and **Post-Fire** EMIT images.

1. Use the **Select Dataset to View** icon in the Main Toolbar and select the **Pre-Fire** layer from the dropdown list.

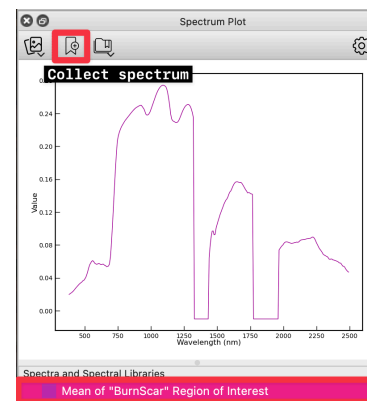


2. Hover your mouse over the BurnScar ROI polygon and right-click within the delineated polygon to bring up the context menu. Select the name of the ROI, **BurnScar**, from the context menu. Select **Show Average ROI spectrum** from the extended menu.

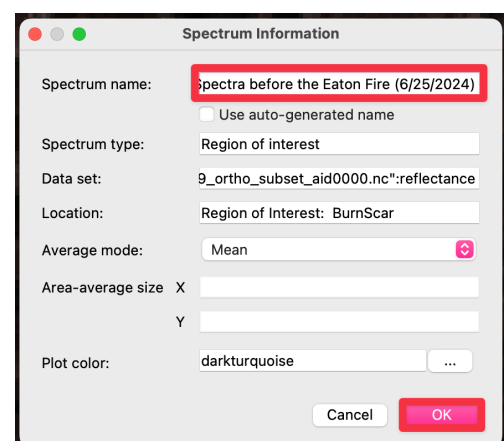
After about 30 seconds, the mean spectrum of the ROI will appear in the spectrum plot window. Do not click anywhere else on the image in the Main Window; you may need to regenerate the mean spectrum plot.



3. Once the mean spectrum has been generated, select the **“Mean of BurnScar Region of Interest”** in the **Spectrum and Spectral Libraries** section of the **Spectrum Plot** window and click the **Collect Spectra** icon to save the mean spectrum to the plot. The **“Mean of BurnScar Region of Interest”** spectra will now be moved to the **Collected Spectra** section in the **Spectra and Spectral Libraries** section of the **Spectrum Plot** window.

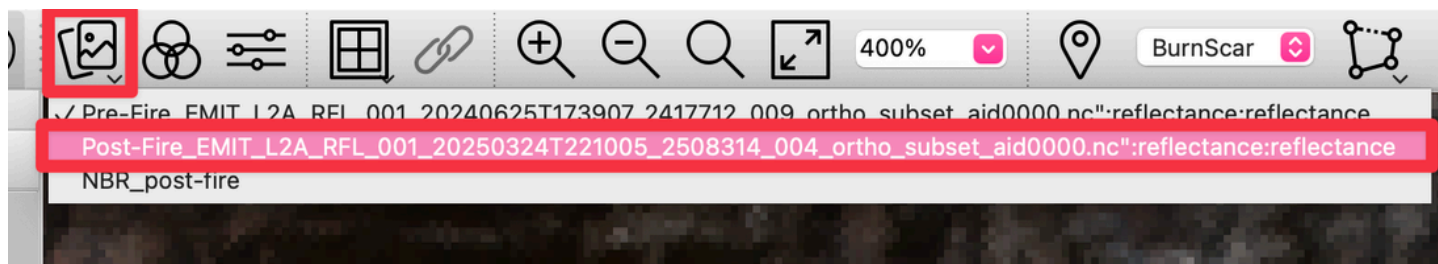


4. Select the **“Mean of BurnScar Region of Interest”** row from the **Collected Spectra** section of the **Spectra and Spectral Libraries** in the **Spectrum Plot** window and right-click to bring up the context menu.
5. From the context menu, select **Edit...** and in the **Spectrum Name** field, type **“Mean Spectra before the Eaton Fire (6/25/2024)”**. You may also use the ellipses to the right of the **Color** field to adjust the color of the spectra to increase contrast if necessary. Click **OK**.

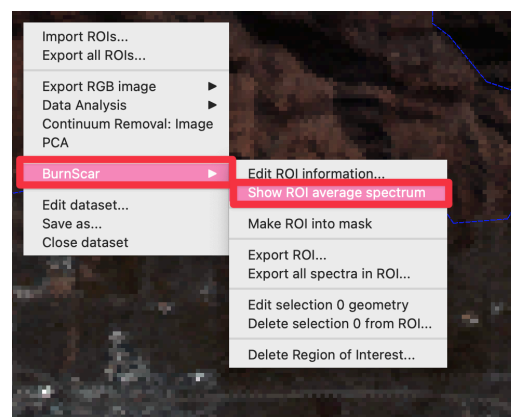


M.O.S.A.I.C.S. Tutorials - Lab 3: Mapping Burn Scars with EMIT L2A data

5. To now generate and collect the mean spectra of the Post-Fire layer on the same plot, click the **Select Dataset to View** icon to select the **Post-Fire** layer.



6. Hover your mouse over the ROI and right-click to bring up the context menu. Select the name of the ROI, **BurnScar**, from the context menu. Select **Show Average ROI spectrum** from the extended menu.



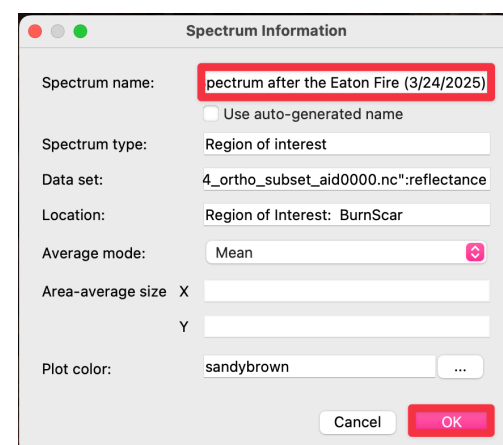
After about 30 seconds, the mean spectrum of the ROI will appear in the **Spectrum Plot window**. Larger areas will take more time to generate the mean spectrum.

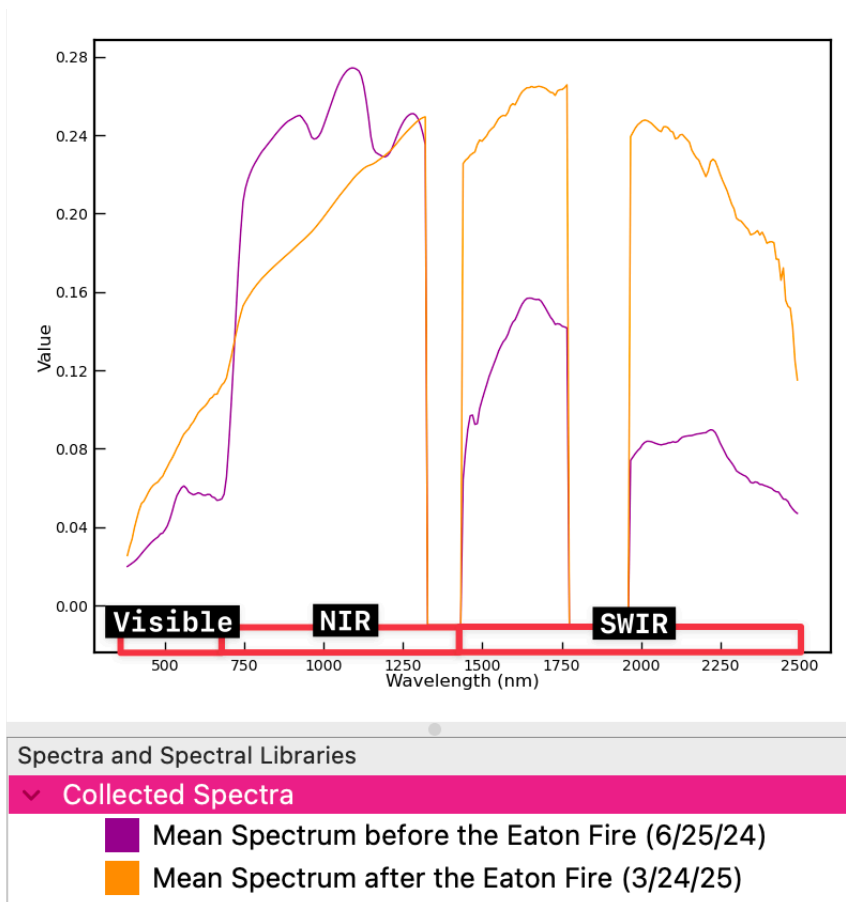
7. Once the spectrum has been generated, select the '**Mean of BurnScar Region of Interest**' in the **Spectra and Spectral Libraries** section of the **Spectrum Plot window** and click the **Collect Spectra** icon to save the mean spectrum to the plot.



The '**Mean of BurnScar Region of Interest**' spectra will now be moved to a section, **Collected Spectra**, in the **Spectra and Spectral Libraries** section of the **Spectrum Plot window**.

8. Select the '**Mean of Burn_scar Region of Interest**' row from the **Collected Spectra** section of the **Spectra and Spectral Libraries** in the **Spectrum Plot window** and right click to bring up the context menu, from the context menu, select **Edit...** and in the **Spectrum Name** field, type "**Mean Spectrum after the Eaton Fire (3/24/2025)**". Click **OK**.





Interpretation

In this figure, the y-axis represents the value, or intensity of the spectral reflectance, and the x-axis represents the wavelength reflected in nanometers (nm). In the visible light portion of the EMS (x-axis, 400nm to 700nm), you may observe that the mean spectrum before the fire is lower in value than after the fire. Healthy vegetation absorbs red and blue light in the visible light portion of the EMS, resulting in lower reflectance values. After the fire, the reflectance in the visible light portion of the EMS is higher, indicating less vegetation.

In the NIR portion of the EMS (750nm to 1300nm), the pre-fire spectrum is higher than the post-fire spectrum. Healthy vegetation reflects NIR light, and structured vegetation scatters it, increasing NIR reflectance. After the Eaton Fire, the reflectance intensity is lower, indicating less healthy vegetation and less vegetation cover.

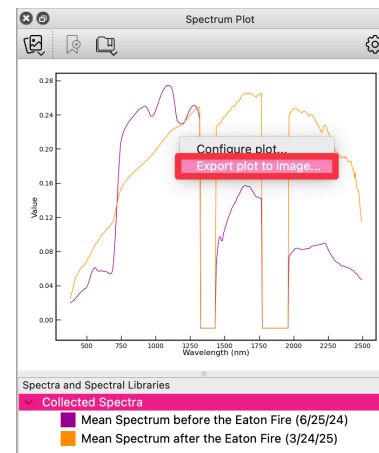
In the SWIR portion of the EMS (1300nm to 2500nm), post-fire reflectance is higher. Because water absorbs light in the SWIR, the lower reflectance values before the fire indicate higher moisture content. After the fire, the higher reflectance in the SWIR indicates less moisture, likely due to hydrophobic soil and reduced vegetation cover. Charcoal and ash also reflect light in the SWIR.

You may also observe gaps in the spectrum plot at 1300nm to 1400nm and 1800nm to 1900nm; these are atmospheric water absorption bands and are not related to surface features.

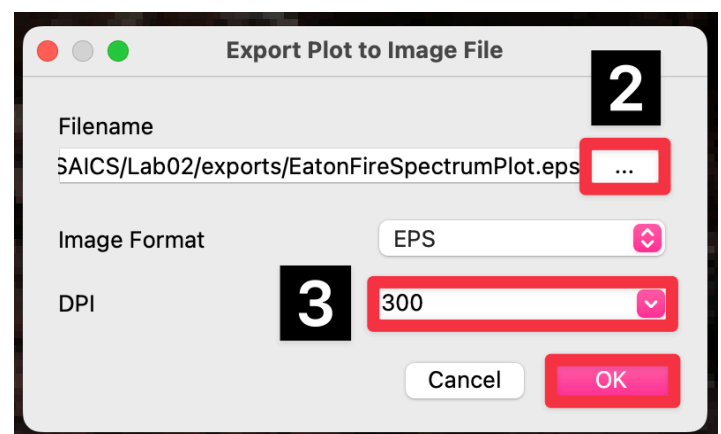
Overall, the pre-fire spectrum is dominated by indicators of healthy vegetation. After the Eaton fire, the spectrum shows that the burned areas are experiencing loss of vegetation cover, structure, and moisture.

4. Exporting the Spectrum Plot

1. To export your spectrum plot as an image, right-click the plot in the **Spectrum Plot window** and select **Export plot to image...** from the context menu.



2. Select the ellipses (...) in the Filename field and navigate through your file directory to select a folder you want to save the plot to. Type a descriptive filename in the **Filename** field. For this example, we used **"EatonFireSpectrumPlot"**.
3. In the **Export Plot to Image File** window, for the **DPI**, select **300** from the dropdown list and click **OK**. The plot will save as an EPS, a high-resolution vector image file format. Alternatively, you may select **PNG** from the Image Format dropdown list.

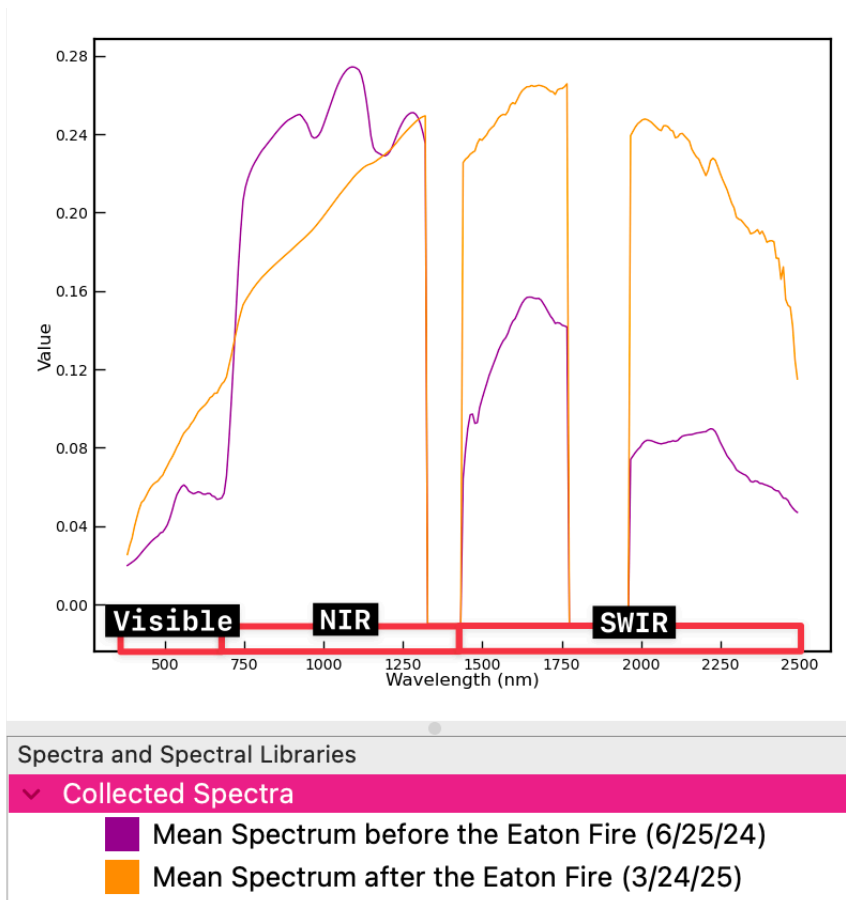


Note: The spectrum plot you exported will not include the information in the Spectra and Spectral Libraries section of the Spectrum Plot window. Take a screenshot of the plot with the Spectra and Spectral Libraries section of the Spectrum Plot window so that you can construct a legend for your plot.

TIP: If you get an error **Errno30** when saving your spectrum plot as an image, click the ellipses to the right of the filename field and navigate to the folder you want to save the file in, and type the file name in the filename field of your file explorer. This issue is more common for MacOS users.

5. Assignment

Refer back to the spectrum plot generated in **Section 3**:



Please Submit:

- A **screenshot of your spectrum plot**,
- A **screenshot of your NBR index map**,
- A **paragraph** where, in your own words, you **describe the differences in reflectance between the pre-fire and post-fire spectra**.