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APPLYING QC FLAGS

ECOSTRESS TUTORIALS

This tutorial will show you how to use a code to apply QC flags to ECOSTRESS data products. This code shows an example of applying QC flags to Land Surface Temperature (LST) products, but it can be modified for other ECOSTRESS products.

Table of Contents

What is a QC Flag?

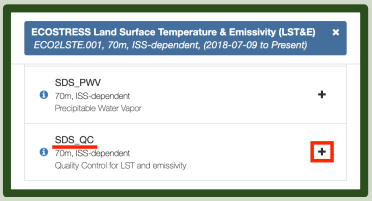
A QC flag is an image used to determine the quality of remotely sensed imagery. QC stands for quality control. In general, most people want to use only good pixels, or sometimes only the very best pixels in their research. ECOSTRESS QC masks have four options:

- 0 = Pixel is perfect
- 1 = Pixel is nominal quality
- 2 = Cloud detected
- 3 = Pixel was not produced

This code will help you remove pixels with 2 or 3 as their QC flags, or even 1, 2, and 3 if you want only the highest quality data. This will help improve the accuracy of your data. If you use this code to apply QC, you will not need to apply a cloud mask to your images because the cloud cover detection is accounted for in QC flag 2.

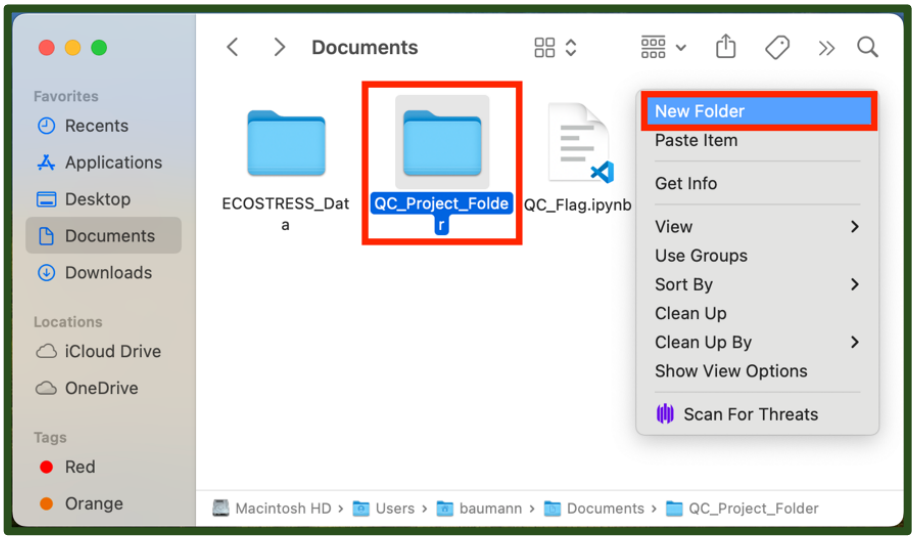
Tip: Make sure you have **QC** files downloaded in addition to your ECOSTRESS product files. If you do not know how to download these files, see the **Downloading from AppEEARS** tutorial. Oftentimes, QC files are **automatically** included in your requested files because they are important for good research.

However, to **ensure** they will be present in your requested files on AppEEARS, you can add them as a requested layer. Whatever product you are downloading, scroll through the options and look for **QC**, then press the **plus** to add it to your requested layers.

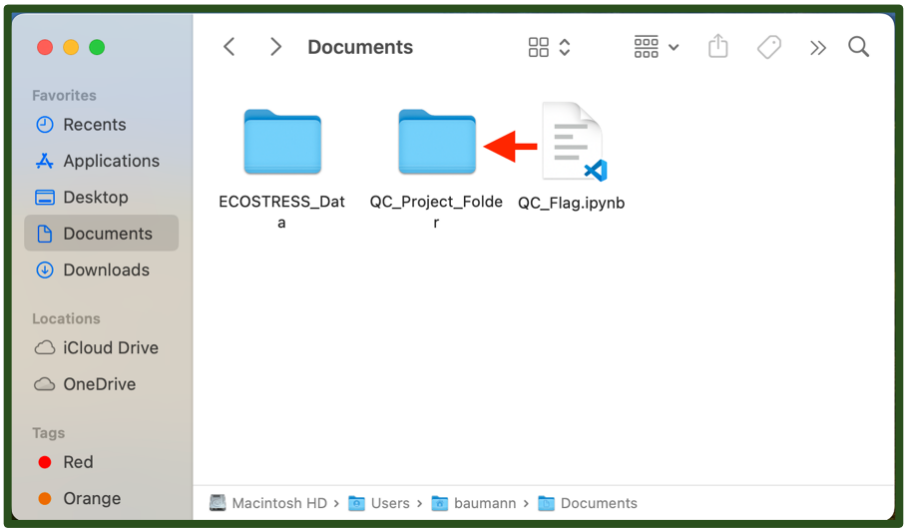


APPLYING QC FLAGS TO IMAGES

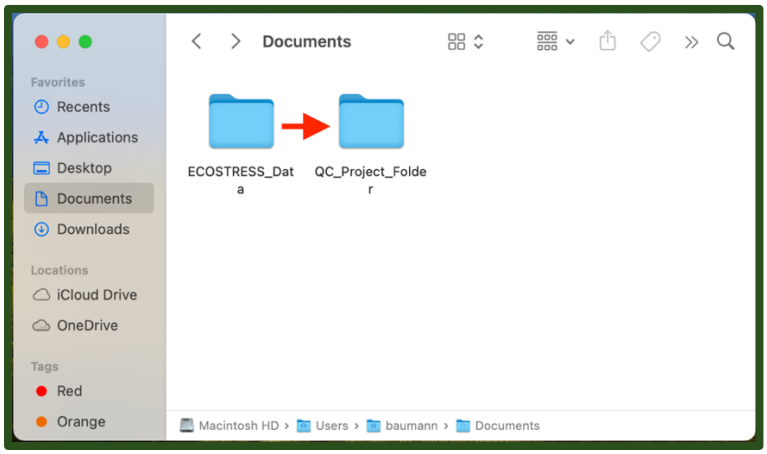
1. Download the **QC_Flag** code from https://github.com/ECOSTRESS-Tutorials/ECOSTRESS-QC-Flag.
2. Open your **finder**. Create a **project folder** to store all the files for this project by **right clicking** and selecting **New Folder**. Name your new folder so that you know it is the main project folder.



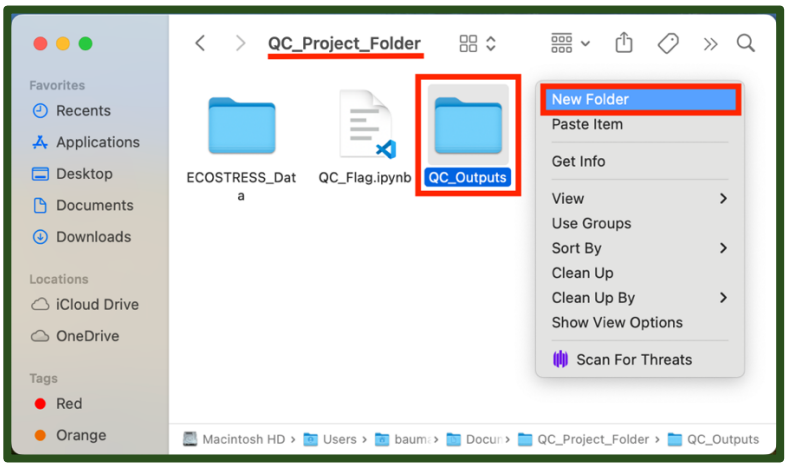
3. **Move** the **downloaded code** file into the project folder.



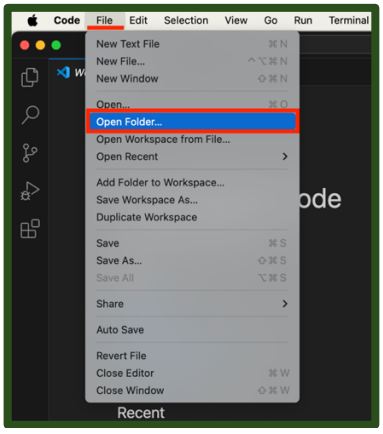
4. **Move** the folder with your **downloaded ECOSTRESS data** into the project folder.

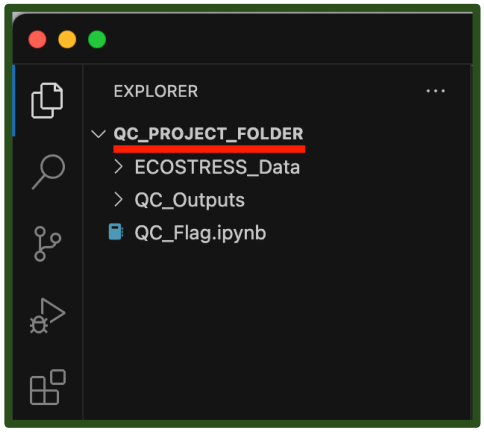


5. **Open the project folder** and create a new **sub folder** to store the completed QCed files. To do this, go inside the project folder, **right click**, and select **New Folder**. Then name the folder so that you know it is for the **outputs**.

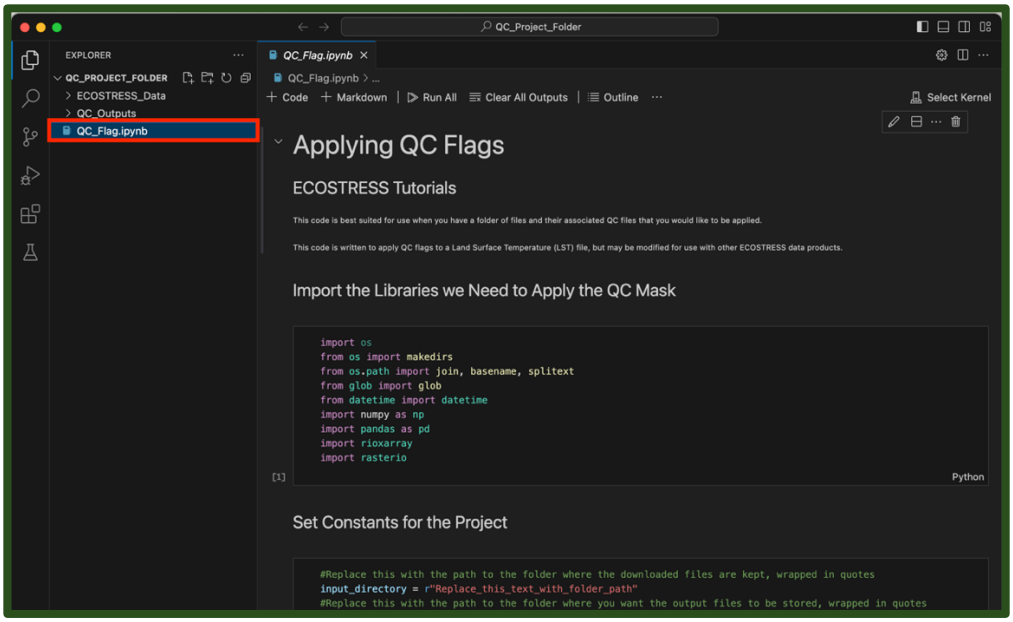


6. Open **Visual Studio Code** and use **File > Open Folder…** to get connected to the main project folder that contains the downloaded ECOSTRESS files, the QC_Flags code, and the output subfolder.





7. In the **EXPLORER** tab, find the **QC_Flags** code and **click** on it to open it.

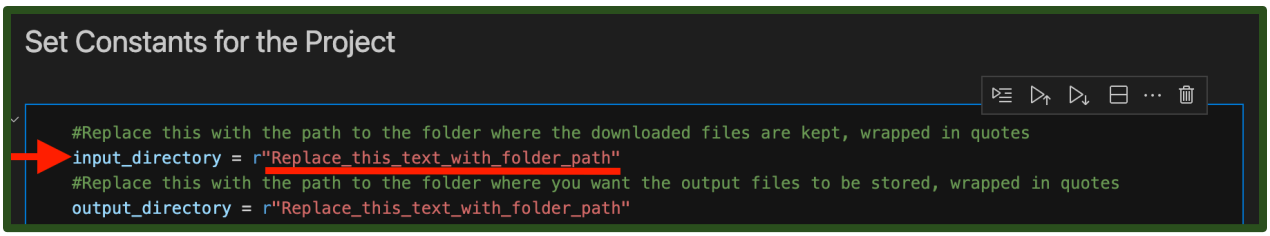


Tip: If you want to know more about what each line of the code does, read the **comments** in the code. Comments in the code are identified by **#**. These comments do not actually change how the code runs, but they can be helpful to put notes on how the code works for yourself or other users. This can also be helpful if you want to customize the code because it will guide you to which parts you may want to change!

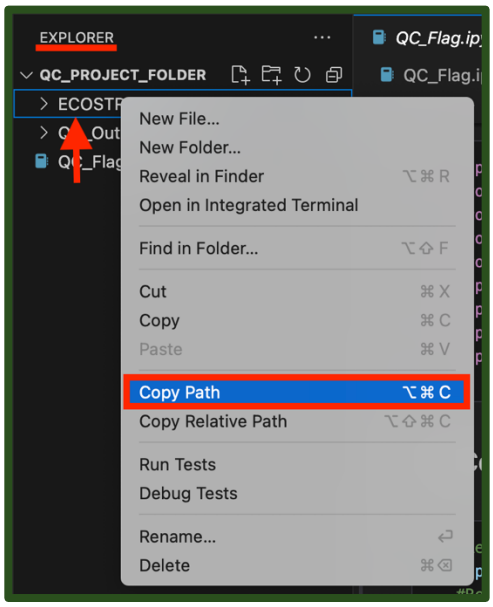
Examples of comments (**green text following the #**):

```
#Establish aesthetics
pd.set_option("display.max_colwidth", None) #Shows the entire table when it prints
alpha = 0.7 #Sets the transparency of the image to 70%
fig_width_px = 1080 #Defines the size of the figure
fig_height_px = 720
ET_cmap = [ #Lists the colors we want to use in our displays
```

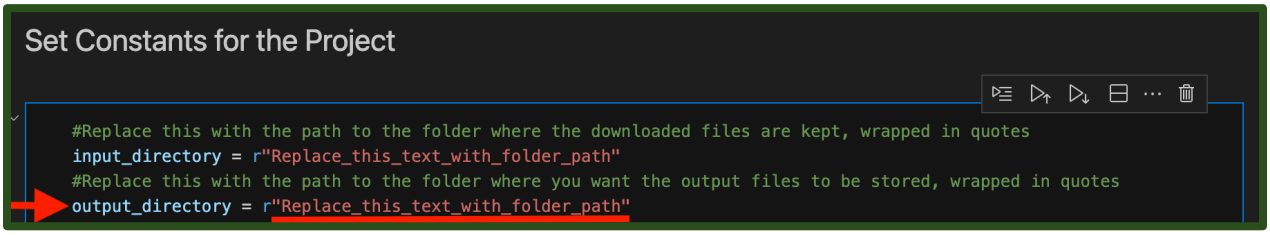
8. Then, find the section of the code titled **Set Constants for the Project**. Find the variable called **input_directory**. Change the text that says **"Replace_this_text_with_folder_path"** to the path of the main folder where your ECOSTRESS files are stored.



a. To **copy the folder path**, use the **EXPLORER** panel on the left side of Visual Studio Code to find the folder you are interested in. Once you have found it, **right click** on it and select **Copy Path**. Now you can paste the path into your code. Make sure it is still **wrapped in quotes** and has **r** outside the first quote.



9. Then, find the variable called **output directory**. Change the text that says **"Replace_this_text_with_folder_path"** to the path of the folder where you want the output files to be stored. Make sure it is still **wrapped in quotes** and has **r** outside the first quote.



Example Directory Set-up:

```
#Replace this with the path to the folder where the downloaded files are kept, wrapped in quotes
input_directory = r"/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data"
#Replace this with the path to the folder where you want the output files to be stored, wrapped in quotes
output_directory = r"/Users/baumann/Documents/QC_Project_Folder/QC_Outputs"
#This line makes sure that the output directory exists
```

10. The last thing you need to set up is how **strict** of a QC you would like. Under the section of code titled **Apply the QC Mask to the LST** Image, find the part of the code starting with the green comment **# Preprocess the QC File**. By **default**, the code will keep values **0 (pixel is perfect)** and **1 (pixel is nominal quality)**. However, if you would like to filter for **just 0** (perfect pixel values) you can do that by **commenting out** the current line of code, and **un-commenting** the QC flag for just 0 line of the code. To comment or uncomment a line of code, highlight the line and press **Command+/**. You will know the line is commented when it has a **#** in front of it and the text turns green.

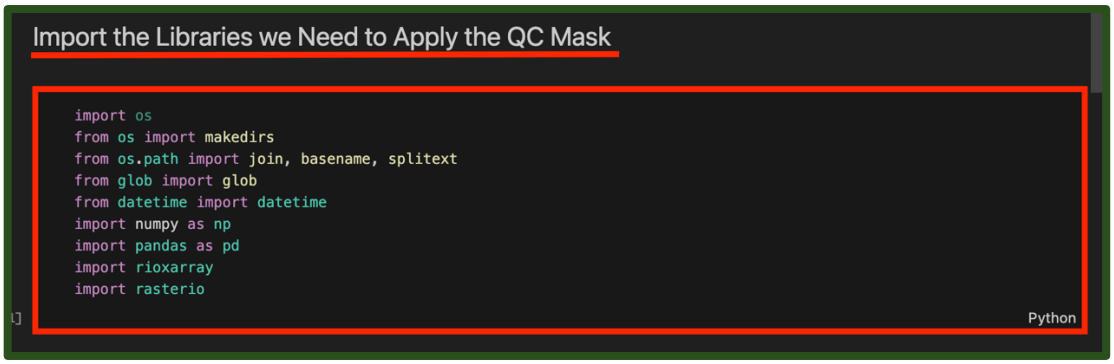
How your code should look if you want 0 (perfect) and 1 (nominal) pixels:

```
# Preprocess the QC file
QC_img_2 = preprocess_QC_file(QC_filename)
# Apply the QC flag to the LST layer
    #0 = pixel is perfect, 1 = pixel is nominal quality, 2 = cloud dete
    #If the QC flag is not 0, set the pixel to NaN
#ST.data = np.where(QC_img_2 != 0, np.nan, ST.data)
    #If the QC flag is not 0 or 1, set the pixel to NaN
ST.data = np.where((QC_img_2 != 0) & (QC_img_2 != 1), np.nan, ST.data)
```

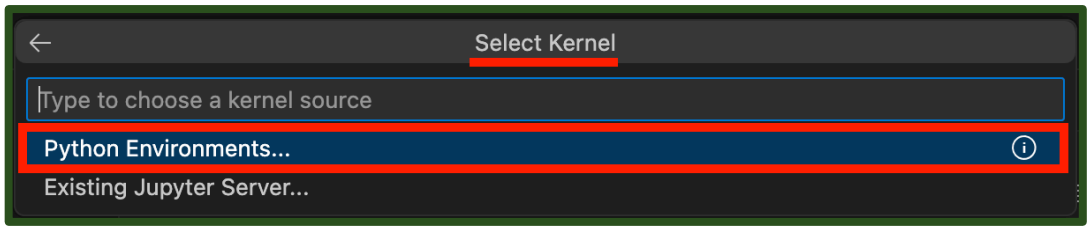
How your code should look if you want just 0 (perfect) pixels:

```
# Preprocess the QC file
QC_img_2 = preprocess_QC_file(QC_filename)
# Apply the QC flag to the LST layer
    #0 = pixel is perfect, 1 = pixel is nominal quality, 2 = cloud detec
    #If the QC flag is not 0, set the pixel to NaN
ST.data = np.where(QC_img_2 != 0, np.nan, ST.data)
    #If the QC flag is not 0 or 1, set the pixel to NaN
#ST.data = np.where((QC_img_2 != 0) & (QC_img_2 != 1), np.nan, ST.data)
```

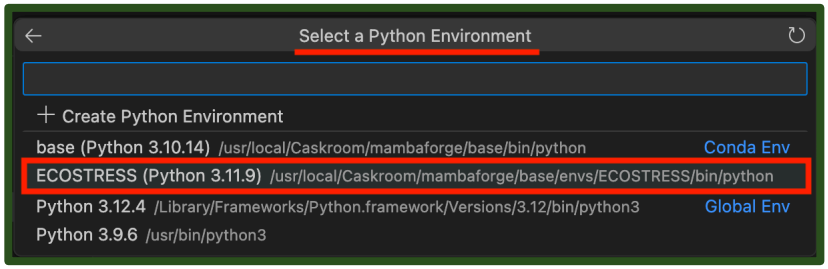
11. Now the code should be set up to be run with your images. Scroll back to the top to the section titled **Import the Libraries we Need to Apply the QC Mask**. This is the first block of code we want to run. Click into the box with the library importing code and press **Shift+Return** to run it.



12. At the top of the window, a pop up will appear prompting you to **select a kernel** to run your code with. Click on **Python Environments ...**

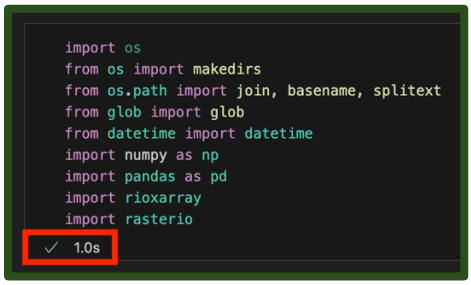


13. Select the **ECOSTRESS** environment that you created, or another one if you have a different one you want to use.



Tip: If you do not have an ECOSTRESS environment set up, follow the **Creating an Environment** tutorial to make one.

14. Let the code run for a few seconds. You will see the **seconds counting up** in the bottom left of the cell. You will know it is done when a **green check mark** appears.



15. Continue this process of running each block of code, in order from top to bottom, by clicking into the module with the code and pressing **Shift+Return**.
    a. The **Collect File Names** section of the code will return a table with the date and time of the image, LST image file path, the associated QC file path, and the output file path that the QCed image will be saved to.

Example:

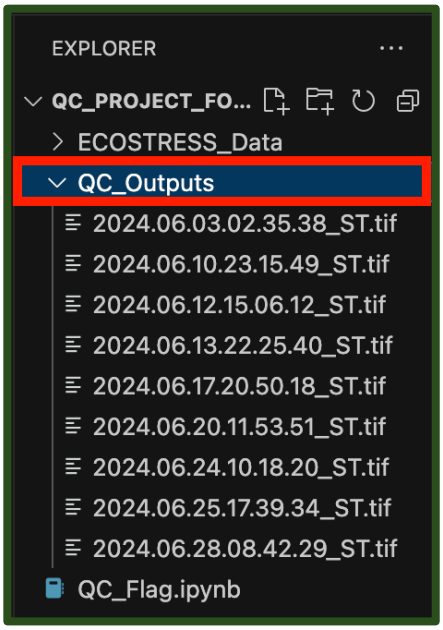
	datetime_UTC	ST_raw_filename
0	2024-06-03 02:35:38	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024155023538_aid0001.tif
1	2024-06-10 23:15:49	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024162231549_aid0001.tif
2	2024-06-12 15:06:12	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024164150612_aid0001.tif
3	2024-06-13 22:25:40	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024165222540_aid0001.tif
4	2024-06-17 12:41:16	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024169124116_aid0001.tif
5	2024-06-17 20:49:26	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024169204926_aid0001.tif
6	2024-06-17 20:50:18	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024169205018_aid0001.tif
7	2024-06-18 20:01:43	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024170200143_aid0001.tif
8	2024-06-18 20:02:35	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024170200235_aid0001.tif
9	2024-06-20 11:53:51	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024172115351_aid0001.tif
10	2024-06-24 10:18:20	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024176101820_aid0001.tif
11	2024-06-25 17:39:34	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024177173934_aid0001.tif
12	2024-06-28 08:42:29	/Users/baumann/Documents/QC_Project_Folder/ECOSTRESS_Data/ECO2LSTE.001_SDS_LST_doy2024180084229_aid0001.tif

b. The **Apply the QC Mask to the LST Image** section of the code will return the name of the QCed file and its missing proportion. If the missing proportion is too high, it will give you a message saying **"Low quality scene. Skipping this file."** and that file will not be saved to the output folder.

Example:

```
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.03.02.35.38_QC.tif
missing proportion: 39.69248143161187%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.10.23.15.49_QC.tif
missing proportion: 0.0%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.12.15.06.12_QC.tif
missing proportion: 36.836898395721924%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.13.22.25.40_QC.tif
missing proportion: 35.10272878447606%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.17.12.41.16_QC.tif
missing proportion: 94.63392%
Low quality scene. Skipping this file.
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.17.20.49.26_QC.tif
missing proportion: 99.9507321206866%
Low quality scene. Skipping this file.
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.17.20.50.18_QC.tif
missing proportion: 1.278409090909091%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.18.20.01.43_QC.tif
missing proportion: 62.71757953273851%
Low quality scene. Skipping this file.
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.18.20.02.35_QC.tif
missing proportion: 99.98667998667999%
Low quality scene. Skipping this file.
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.20.11.53.51_QC.tif
missing proportion: 0.7322223231314141%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.24.10.18.20_QC.tif
...
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.25.17.39.34_QC.tif
missing proportion: 3.8867549562736725%
ST QCed file: /Users/baumann/Documents/QC_Project_Folder/QC_Outputs/2024.06.28.08.42.29_QC.tif
missing proportion: 0.0%
Output is truncated. View as a scrollable element or open in a text editor. Adjust cell output settings...
```

16. Once your code has run, check your **outputs** folder to make sure the files have been saved there correctly.



Tip: *Read if you do not want to skip files OR you used a polygon shapefile*

If you used a **non-rectangular** polygon shapefile instead of a rectangle selection or shapefile to download ECOSTRESS data, you will need to **adjust your code** so that it does not skip all of your images. Part of the code filters for **high quality** images by skipping files that have more than **50%** of the pixels missing. However, when your image is clipped to the shapefile you uploaded, it treats the surrounding area as **missing pixels**. This will cause your code to flag all of your images as having a high proportion of missing pixels, and thus they will **not** be saved. Alternatively, you may want to **keep all your images**, regardless of their missing proportions. To fix this, look in the **Apply the QC Mask to the LST Image** section, and find this part of the code:

```
##Make sure we are only using high quality scenes
#Quantify how many pixels are missing (NaN)
missing_proportion = np.count_nonzero(np.isnan(ST.data)) / ST.data.size
#Print the number of pixels that are missing
print(f"missing proportion: {missing_proportion * 100}%")

#if more than 50% of pixels are missing, we will skip the image
if missing_proportion > 0.5:
    print("Low quality scene. Skipping this file.")
    continue
```

Highlight that section of the code and press **Command+/** to comment it out. This means it will be ignored when the rest of the code runs. You will know you have commented it out when it looks like this:

```
# ##Make sure we are only using high quality scenes
# #Quantify how many pixels are missing (NaN)
# missing_proportion = np.count_nonzero(np.isnan(ST.data)) / ST.data.size
# #Print the number of pixels that are missing
# print(f"missing proportion: {missing_proportion * 100}%")

# #if more than 50% of pixels are missing, we will skip the image
# if missing_proportion > 0.5:
#     print("Low quality scene. Skipping this file.")
#     continue
```

Then you can proceed with the code as normal!

You have now QCed a batch of ECOSTRESS images!