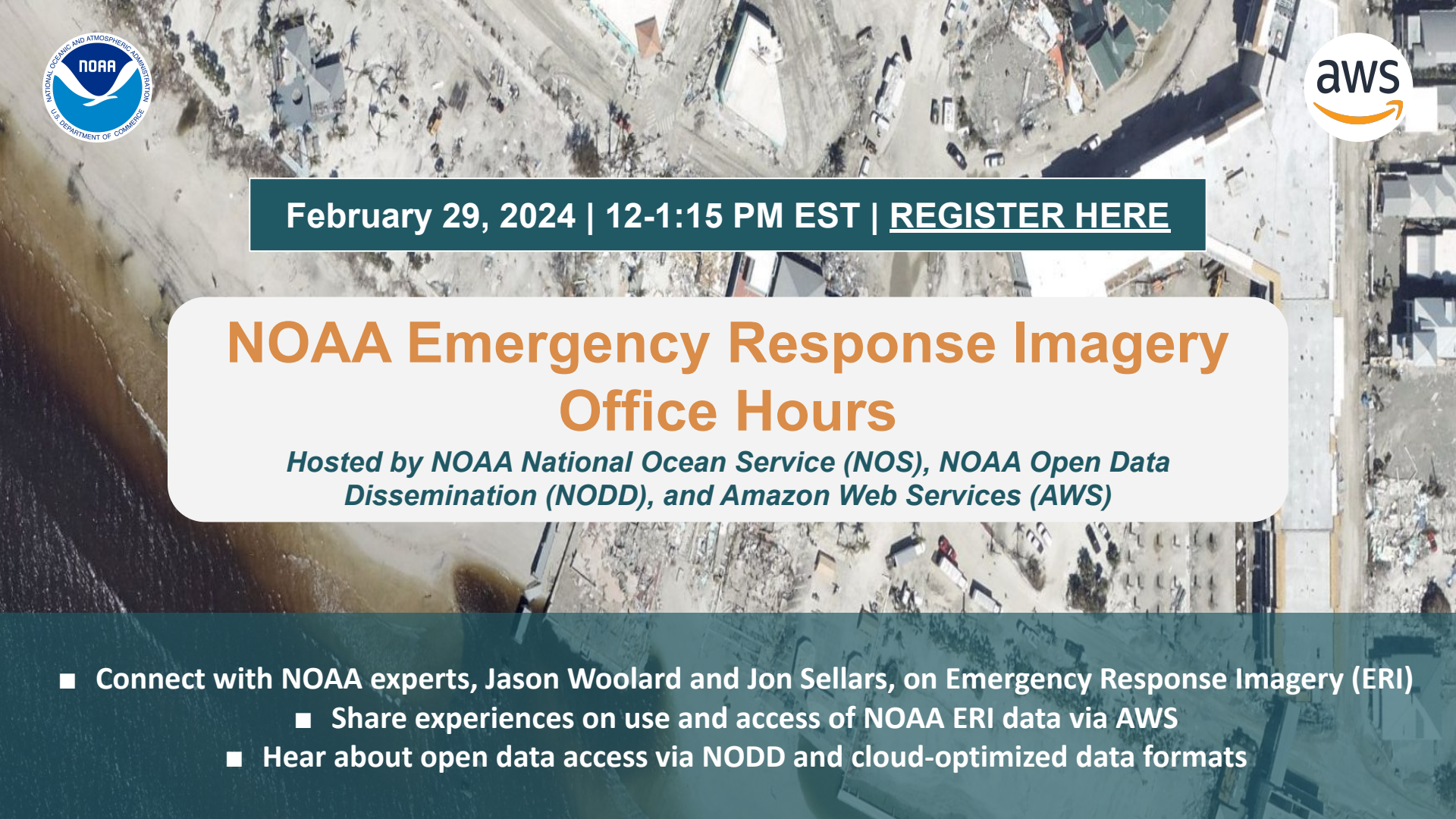

**February 29, 2024 | 12-1:15 PM EST | REGISTER HERE**

# NOAA Emergency Response Imagery Office Hours

***Hosted by NOAA National Ocean Service (NOS), NOAA Open Data Dissemination (NODD), and Amazon Web Services (AWS)***

- **Connect with NOAA experts, Jason Woolard and Jon Sellars, on Emergency Response Imagery (ERI)**
- **Share experiences on use and access of NOAA ERI data via AWS**
- **Hear about open data access via NODD and cloud-optimized data formats**

# GoogleMeet Webinar - Recorded

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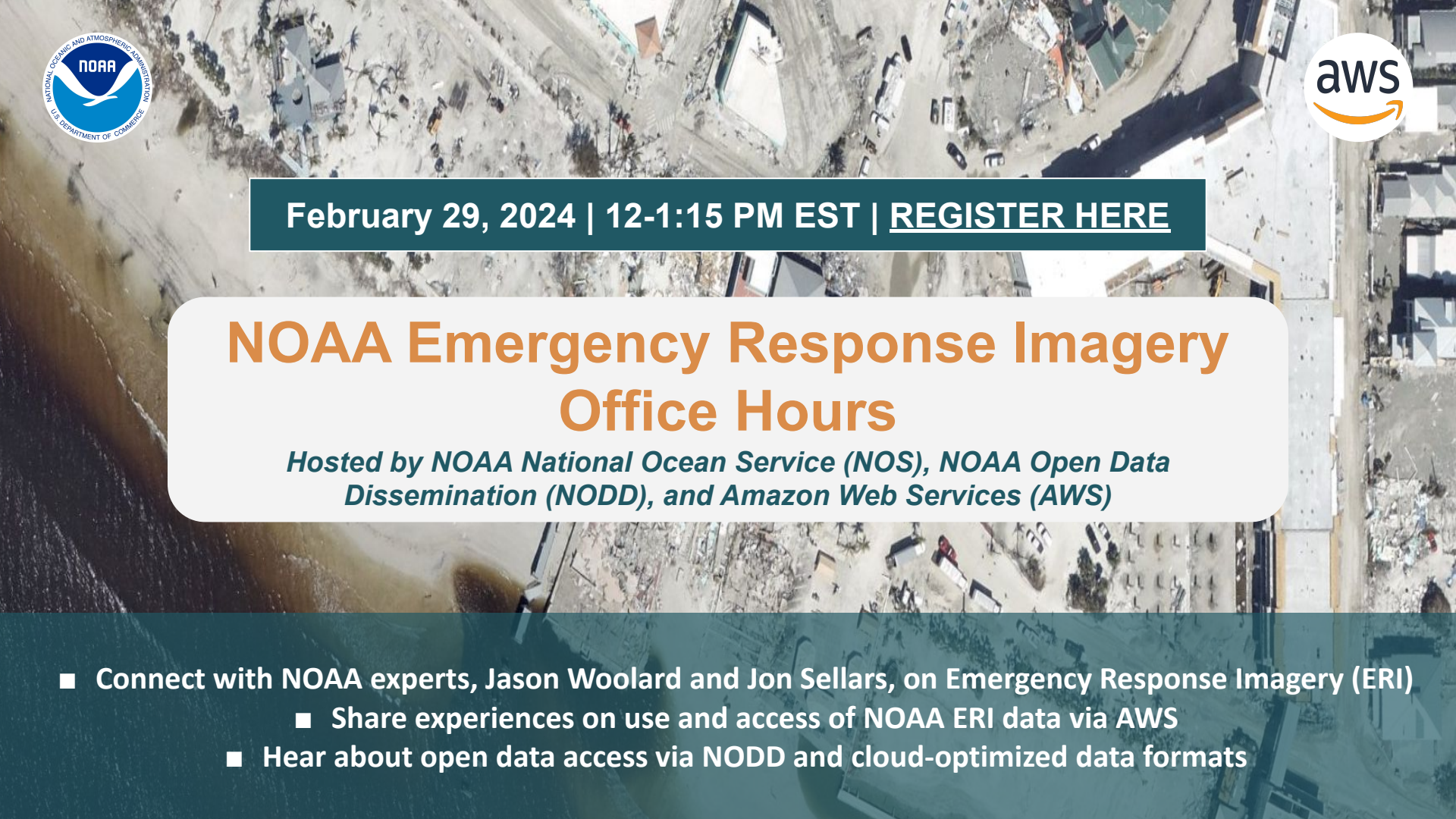
**Disclosure:** Voluntary; by joining and participating in the meeting consent is being given to the recording.

- Thank you for your registration and interest.
- Only hosts and presenters are asked to turn their video on.
- If do not wish to be part of the recording, please feel free to drop off.
- Meeting summary and presentation slides will be available on the NODD website
  - **NOAA.GOV/NODD**



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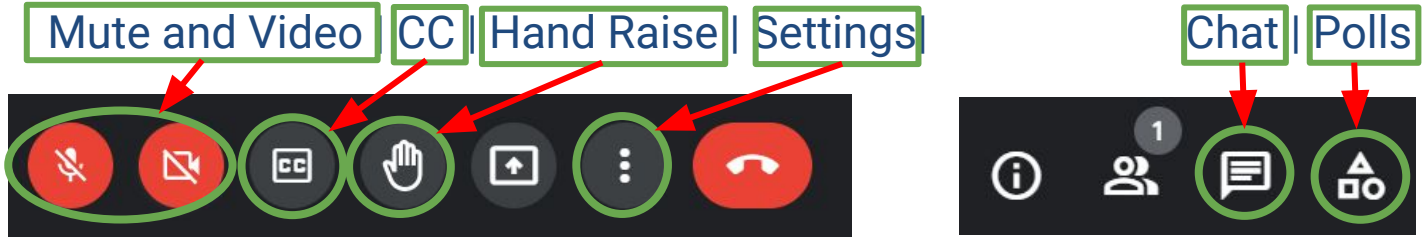
- **Hear about open data access via NODD and cloud-optimized data formats**

# GoogleMeet Webinar Logistics

## How to join the discussion!

- Keep yourself muted throughout (for call-in participants: to mute and unmute use *6) and videos off
- Raise your hand if you have a question and we'll respond in the order of the queue
- The following features of google meet:




- This webinar will be recorded.
- You can also join by phone line only if you are having connectivity issues.
- (US) +1 240-356-1205 PIN: 638 612 110#

# Guidelines for Discussion

- Keep it brief
- Keep it respectful
- Use the chat function for links, references and/or resources
- Submit questions through the chat function or raise your hand
- Identify who the question is directed to where possible

# Quick Google Poll

**POLL1**

- How do you access ERI data today?
  - On-prem via NOAA
  - Cloud
  - Both/Either
  - 3rd party/Web-based Viewer
  - None/Other

**POLL2**

- My primary goal for attending today is:
  - Technical use and access of ERI data
  - To learn about cloud access to data (e.g. NODD Program)
  - Meet and engage with NOAA staff scientists
  - Learn about AWS access and tools

# NODD Disseminates NOAA Line Office Data

**Open and Free, with Value to the Public:**

- From NOAA Line Offices via NODD to public cloud buckets of three CSPs =
  - ❏ An exponential number of users can access
- Harnesses the scalability of the cloud to improve data access
  - ❏ No egress costs for users or the agency
- No use restrictions or user registration
- Appropriate Metadata included

**NOAA Data is Growing Exponentially**


**TECHNOLOGY MODERNIZATION**

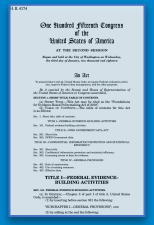
Reduces stress on NOAA's on-premise dissemination systems

Improves services for users

**FULL & OPEN PUBLIC ACCESS**

Supports Federal Data Strategy & Evidence Act Requirements

No egress costs

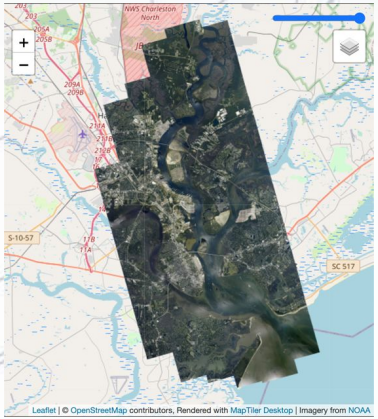


**ENABLES & ENGAGES USERS**

Catalyzes innovation in environmental services

Enables interoperability

# Using Emergency Response and Pre-Event Imagery from NOAA's Open Data Dissemination Program with Free and Open Source Software




King Air 350


DSSV6

https://www.noaa.gov/information-technology/open-data-dissemination

# ER Imagery Processing Workflow

jpeg aerial imagery
raw gps/imu


## AWS Virtual Machines

128 CPUs
1000 GB RAM
8 x 3750 NVMe SSD
Ubuntu Linux OS

image- orthorectification
mosaic processing
web map tiling

raw gps/imu

processed nav solution

**local PC/laptop for NavData / trajectory processing**

## AWS S3 Storage

html / javascript viewer
xyz map tiles
WMTS support
NODD

NODD

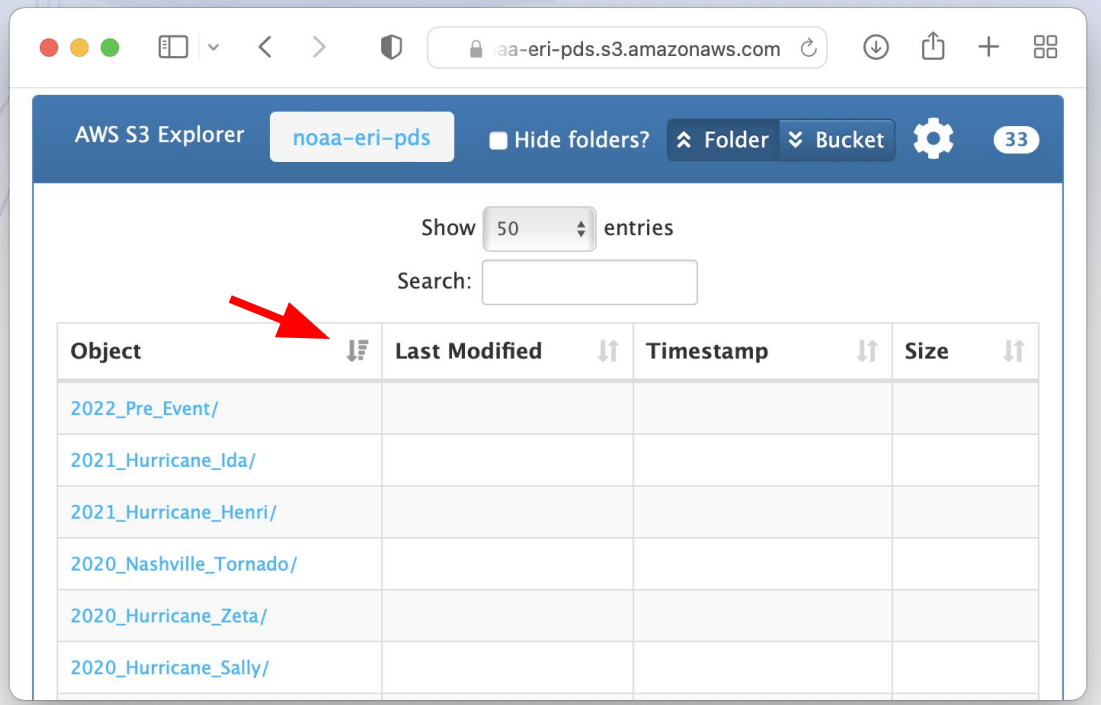
CDN

In Cloud analysis

Web browsers GIS clients

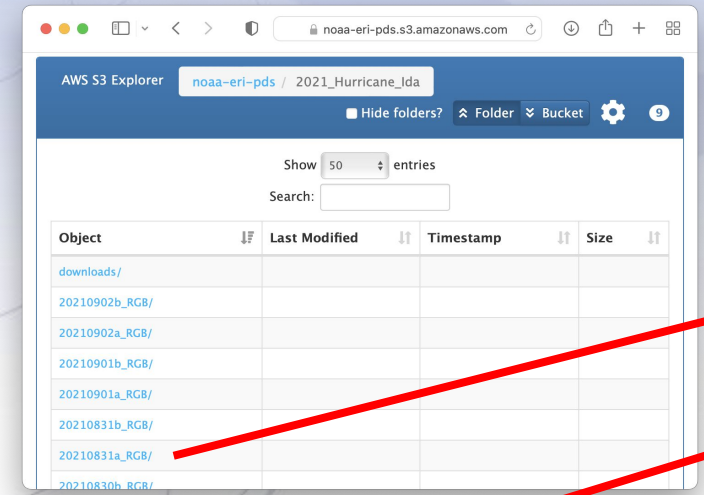
# Using the Bucket Browser

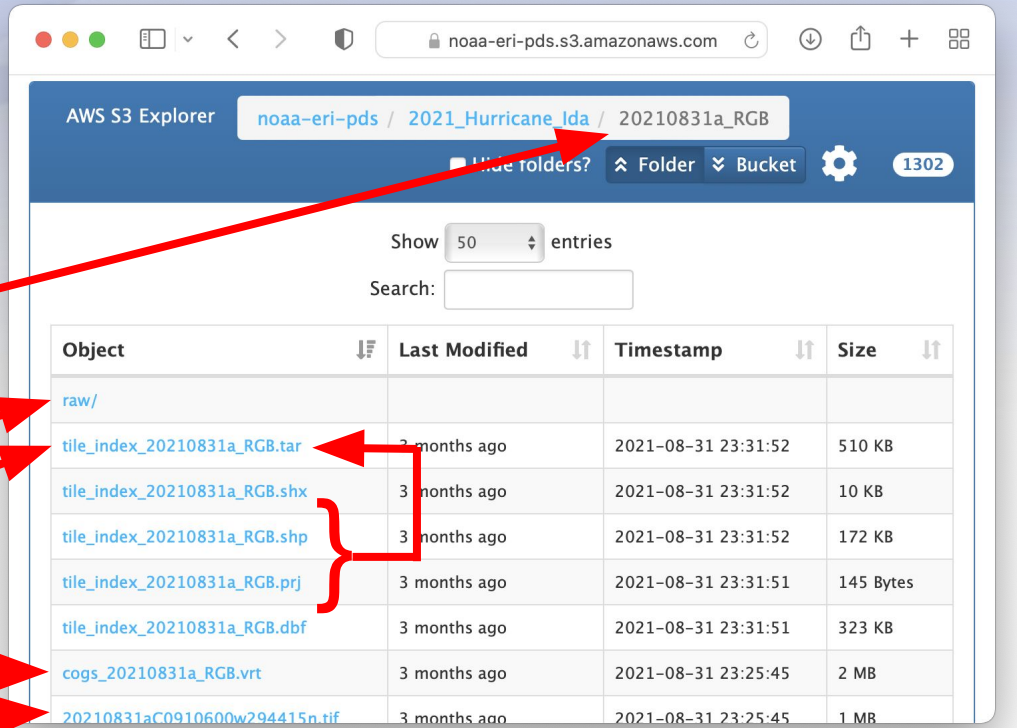
https://noaa-eri-pds.s3.amazonaws.com/index.html




Pro tip: If you just want to view the imagery visit https://storms.ngs.noaa.gov/ for storm viewers and links to Web Map Tile Services (WMTS)

# Directory Structure for Hurricane Laura 2020 to Present*




RAW data for this group

Tile index for this group

GDAL Virtual Format[1]

Cloud Optimized Geotiff (COG)[2]

[1] https://gdal.org/drivers/raster/vrt.html#vrt-gdal-virtual-format

[2] https://www.cogeo.org

*Prior to 2020 only the Cloud Optimized Geotiff data are available via this portal.

# RAW Data

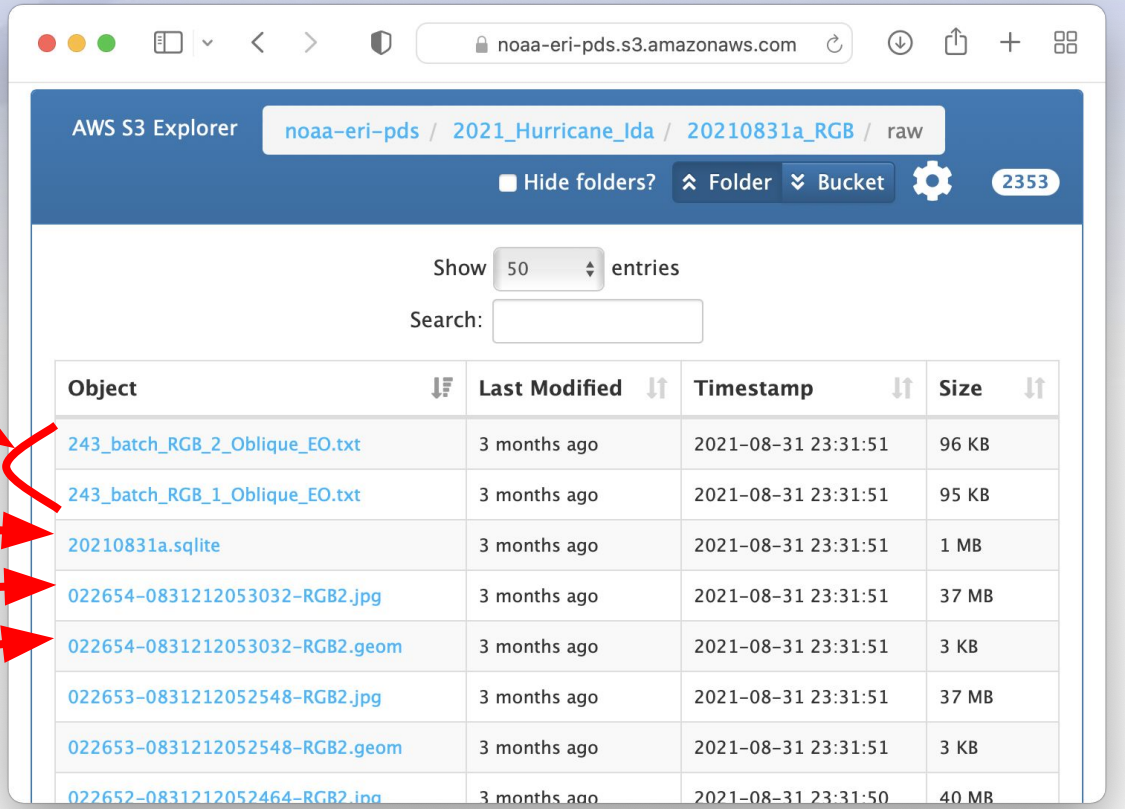
Exterior Orientation

- may not be available for all flights
- may contain references to data not in this group

Footprint index and tile schema

JPEG image

Geometry file (next slide)



# Geometry file

The OSSIM[3] geometry file (.geom) is used during orthorectification of the imagery. It contains all of the interior and exterior orientation parameters for the camera. Each directory may contain images from multiple cameras. Some parameters that may be useful to advanced users are shown.

```
...
distortion.center:  0 0
distortion.convergence_threshold:  1e-05
distortion.dxdy:  0.0052 0.0052
distortion.k0:  -2.88559891337079e-08
distortion.k1:  -1.39659435252217e-05
distortion.k2:  3.8231137376565e-09
distortion.k3:  -1.04476955995087e-13
distortion.max_iterations:  10
distortion.type:  ossimMeanRadialLensDistortion
ecef_platform_position:  -194257.970578342 -5511483.02673332 3194679.9333477
focal_length:  51.588
image_id:  C28570029
kappa:  101.45834
latlonh_platform_position:  30.250081405699 -92.0186139175529 651.074 WGE
ll_lat:  30.2479079361336
ll_lon:  -92.0152570619964
lr_lat:  30.2540936817812
lr_lon:  -92.0164591284596
meters_per_pixel_x:  0.0658892609459362
meters_per_pixel_y:  0.0658892609459362
number_lines:  7760
number_of_adjustments:  1
number_samples:  10328
omega:  3.48179
phi:  -0.69092
pixel_size:  0.0052 0.0052
principal_point:  -0.133 0.266
...
```

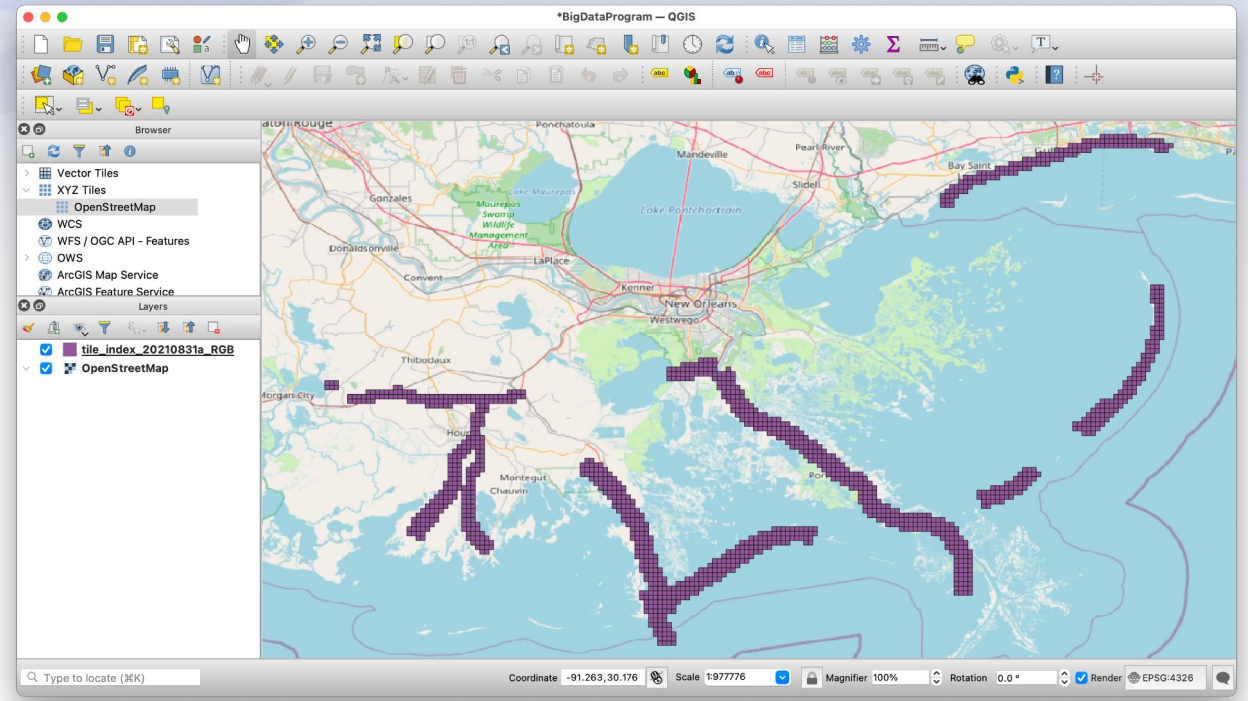
[3] https://github.com/ossimlabs/ossim

# Using the data in Quantum GIS[4]

Download the tile index tar file (mentioned previously)

Drag and drop into QGIS
- Or extract and load the SHP

Load the OpenStreetMap layer for reference (available by default) or other basemap data

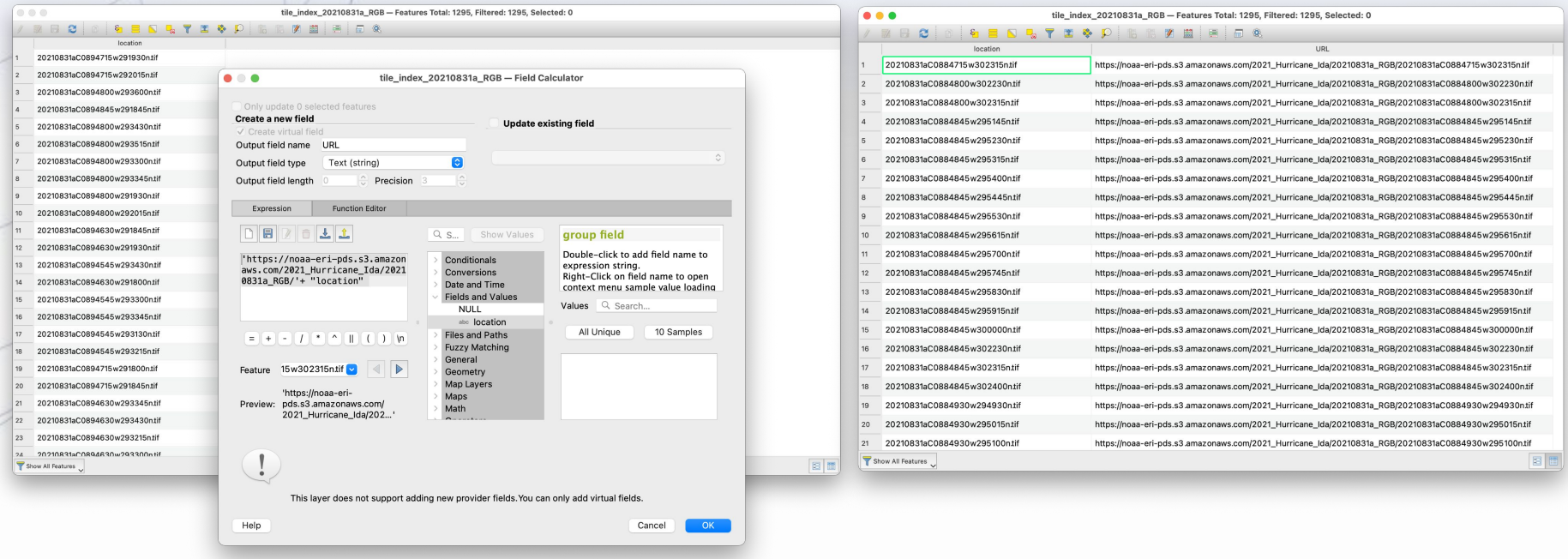



[4] https://qgis.org/en/site/

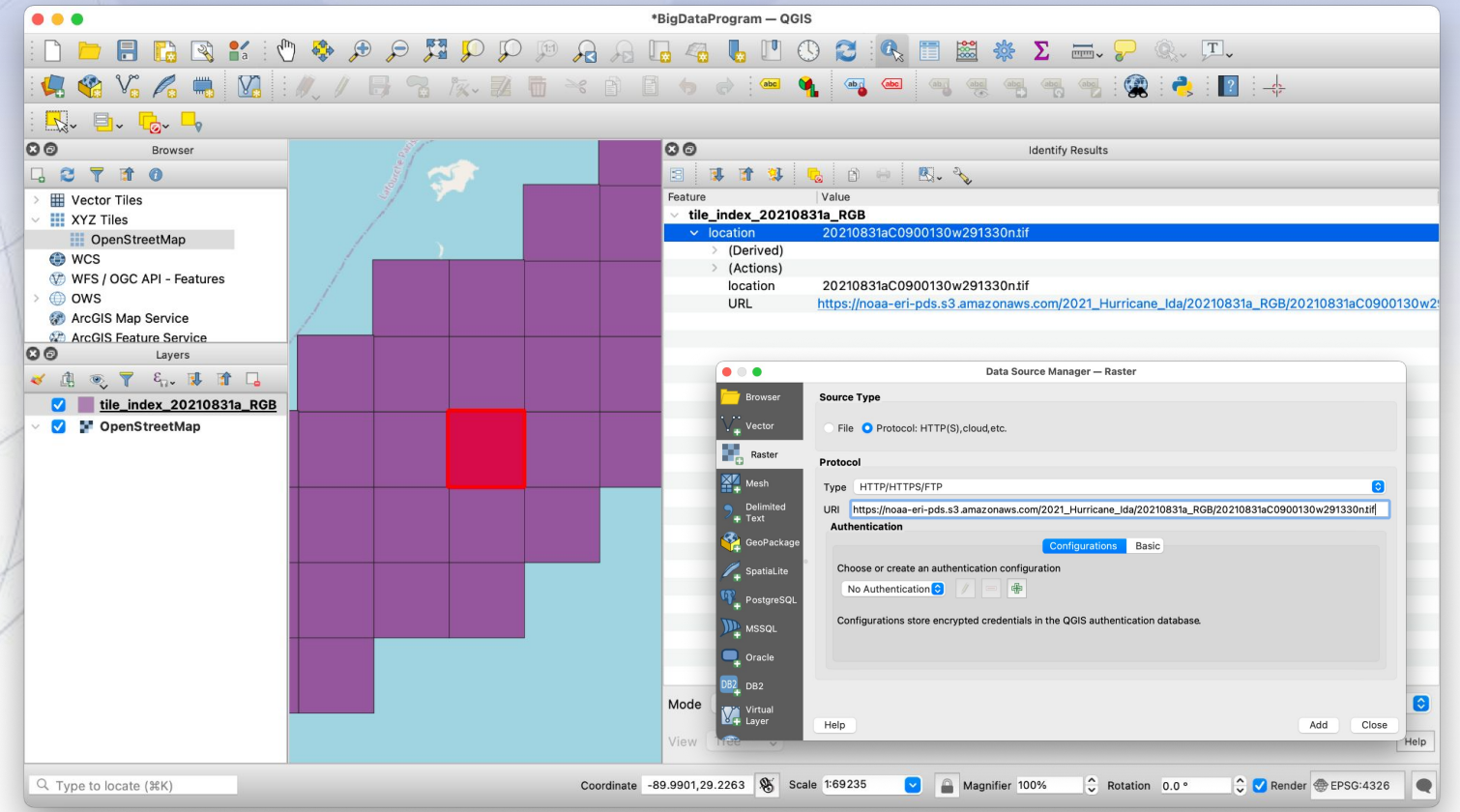
# Edit the attributes to create download URLs

Use the “Field Calculator” to create a virtual field containing download links.
Be sure to use the correct path (unique for each group) and note the single quotes vs double quotes.

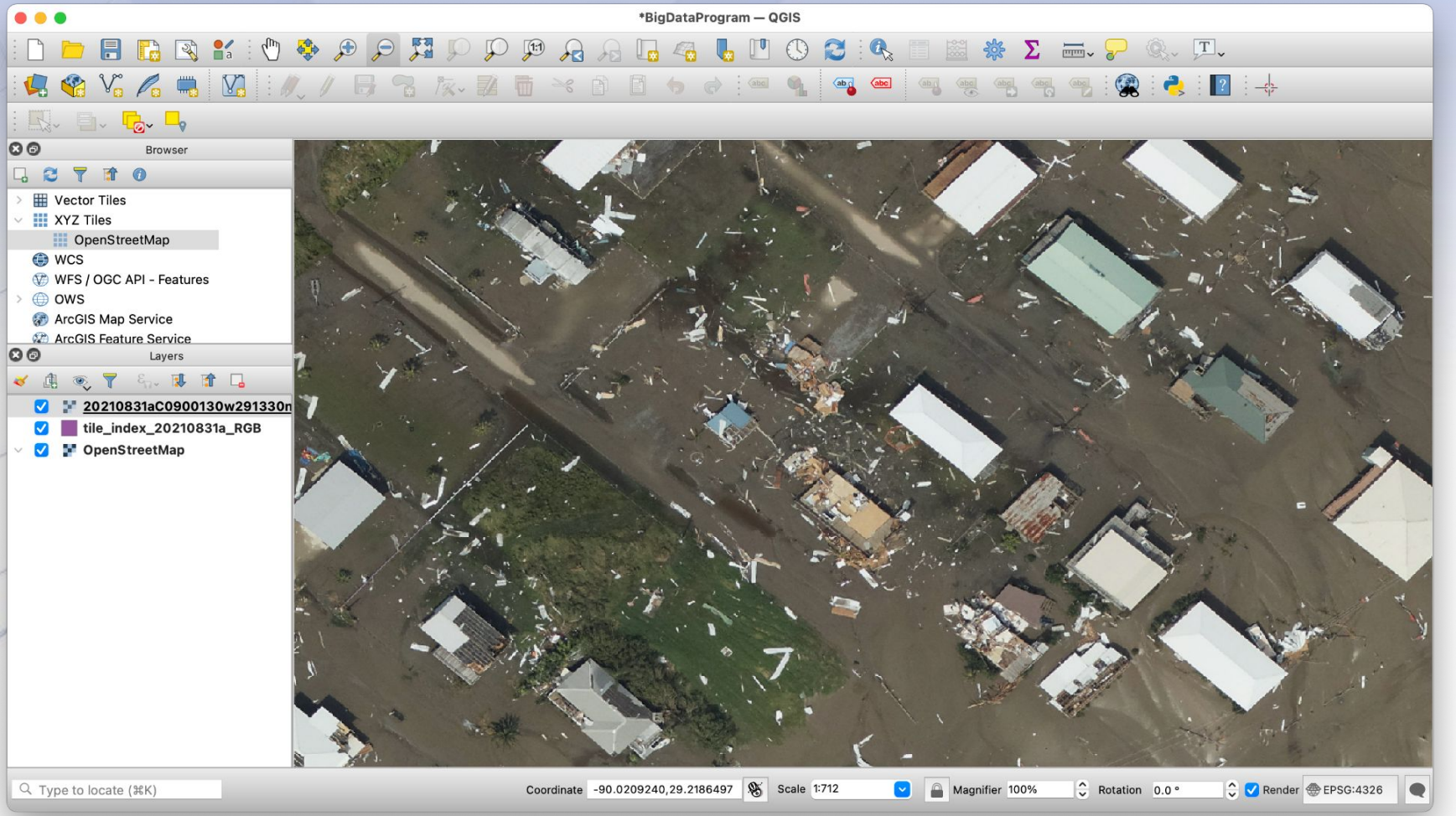
'https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/'+ "location"



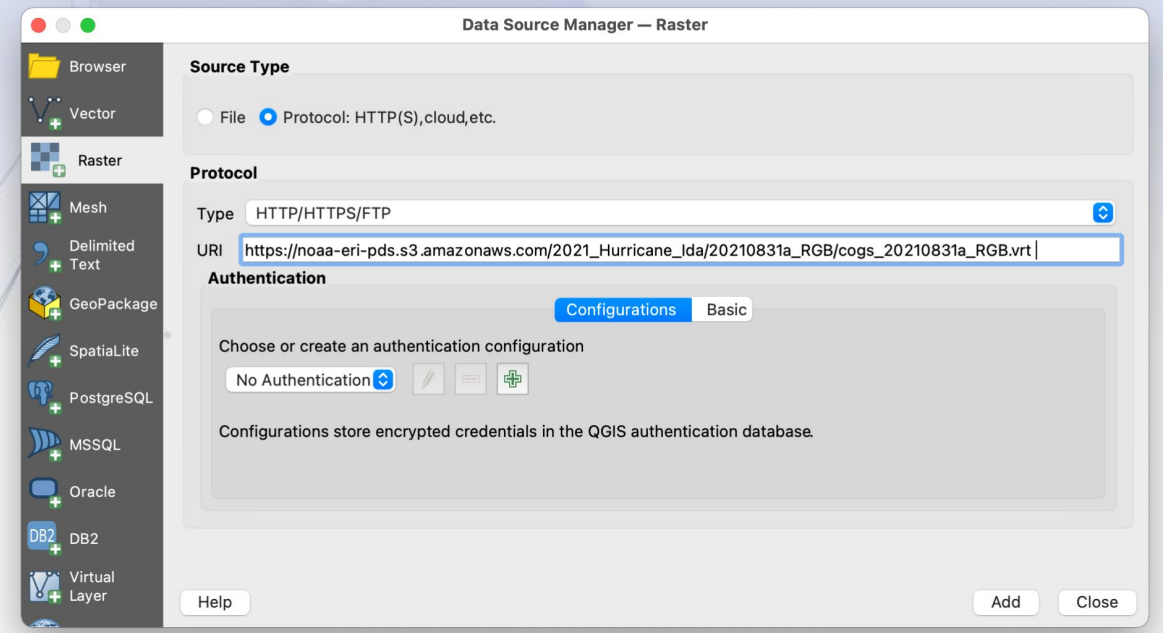
# Using the COGs in Quantum GIS




Pro tip: The WMTS will load faster and provide full coverage. The individual COGs are better for users that want to analyze or save the image.
Ida WMTS: https://storms.ngs.noaa.gov/storms/ida/services/WMTSCapabilities.xml See: https://storms.ngs.noaa.gov for a list of all storms.


*BigDataProgram — QGIS
Browser
Vector Tiles
XYZ Tiles
OpenStreetMap
WCS
WFS / OGC API - Features
OWS
ArcGIS Map Service
ArcGIS Feature Service
Layers
20210831aC0900130w291330n
tile_index_20210831a_RGB
OpenStreetMap
Type to locate (⌘K)
Coordinate
-90.0209240,29.2186497
Scale
1:712
Magnifier
100%
Rotation
0.0 °
Render
EPSG:4326

# Using the COG VRTs* in Quantum GIS




* Zoom into scales of 1:10,000 or larger prior to loading for optimal performance

# Using the COG VRTs* in Quantum GIS

* Zoom into scales of 1:10,000 or larger prior to loading for optimal performance

# Using the COG VRTs* in Quantum GIS

COG

1:250
~400% zoom

WMTS

* Zoom into scales of 1:10,000 or larger prior to loading for optimal performance

# Using the GDAL Command Line Interface (CLI)[5]

Get information about a particular COG (note the /vsicurl/ prefix*):

```
gdalinfo /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/20210831aC0910045w294200n.tif
Driver: GTiff/GeoTIFF
Files: /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/20210831aC0910045w294200n.tif
Size is 9415, 9415
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (-91.012600000000006,29.700099999999999)
Pixel Size = (0.000001348911312,-0.000001348911312)
Metadata:
  AREA_OR_POINT=Point
  TIFFTAG_DATETIME=2021:08:31 23:59:59
  TIFFTAG_MAXSAMPLEVALUE=0
  TIFFTAG_MINSAMPLEVALUE=1
Image Structure Metadata:
  COMPRESSION=LZW
  INTERLEAVE=PIXEL
```

```
Corner Coordinates:
Upper Left  ( -91.0126000,  29.7001000) ( 91d 0'45.36"W, 29d42' 0.36"N)
Lower Left  ( -91.0126000,  29.6874000) ( 91d 0'45.36"W, 29d41'14.64"N)
Upper Right ( -90.9999000,  29.7001000) ( 90d59'59.64"W, 29d42' 0.36"N)
Lower Right ( -90.9999000,  29.6874000) ( 90d59'59.64"W, 29d41'14.64"N)
Center      ( -91.0062500,  29.6937500) ( 91d 0'22.50"W, 29d41'37.50"N)
Band 1 Block=512x512 Type=Byte, ColorInterp=Red
  Overviews: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
  Mask Flags: PER_DATASET ALPHA
  Overviews of mask band: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
Band 2 Block=512x512 Type=Byte, ColorInterp=Green
  Overviews: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
  Mask Flags: PER_DATASET ALPHA
  Overviews of mask band: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
Band 3 Block=512x512 Type=Byte, ColorInterp=Blue
  Overviews: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
  Mask Flags: PER_DATASET ALPHA
  Overviews of mask band: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
Band 4 Block=512x512 Type=Byte, ColorInterp=Alpha
  Overviews: 4707x4707, 2353x2353, 1176x1176, 588x588, 294x294
```

[5] https://gdal.org/programs/index.html#raster-programs

GDAL is available for Linux, Mac and Windows. Ubuntu Linux 20.04 was used for this demo.

*The /vsicurl/ prefix tells GDAL to use its built in Virtual File System driver

*This driver may also allow you to access the data using programs with GDAL raster support such as ESRI https://doc.arcgis.com/en/imagery/workflows/best-practices/storing-imagery-in-the-cloud.htm

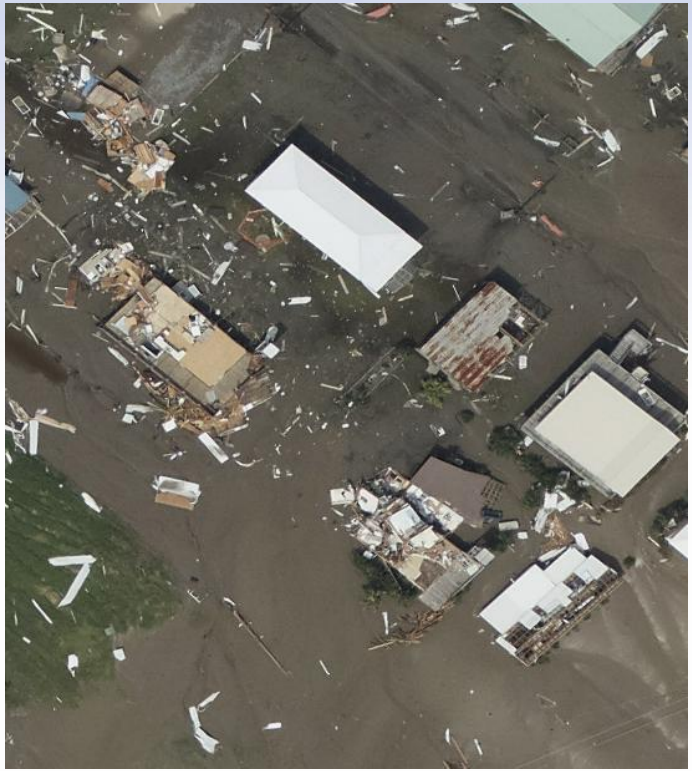
# Using the GDAL CLI

## Get information about a particular COG VRT:

```
gdalinfo /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/cogs_20210831a_RGB.vrt
Driver: VRT/Virtual Raster
Files: /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/cogs_20210831a_RGB.vrt
       /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/20210831aC0884715w302315n.tif
       …
       <1293 tif files>
       …
       /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/20210831aC0910600w294415n.tif
Size is 1723760, 1038022
Coordinate System is:
GEOGCRS["WGS 84",
    DATUM["World Geodetic System 1984",
        ELLIPSOID["WGS 84",6378137,298.257223563,
            LENGTHUNIT["metre",1]]],
    PRIMEM["Greenwich",0,
        ANGLEUNIT["degree",0.0174532925199433]],
    CS[ellipsoidal,2],
        AXIS["geodetic latitude (Lat)",north,
            ORDER[1],
            ANGLEUNIT["degree",0.0174532925199433]],
        AXIS["geodetic longitude (Lon)",east,
            ORDER[2],
            ANGLEUNIT["degree",0.0174532925199433]],
    ID["EPSG",4326]]
Data axis to CRS axis mapping: 2,1
Origin = (-91.100099999999998,30.412600000000001)
Pixel Size = (0.000001348911312,-0.000001348911312)
Corner Coordinates:
Upper Left  ( -91.1001000,  30.4126000) ( 91d 6' 0.36"W, 30d24'45.36"N)
Lower Left  ( -91.1001000,  29.0124004) ( 91d 6' 0.36"W, 29d 0'44.64"N)
Upper Right ( -88.7749006,  30.4126000) ( 88d46'29.64"W, 30d24'45.36"N)
Lower Right ( -88.7749006,  29.0124004) ( 88d46'29.64"W, 29d 0'44.64"N)
Center      ( -89.9375003,  29.7125002) ( 89d56'15.00"W, 29d42'45.00"N)
Band 1 Block=128x128 Type=Byte, ColorInterp=Red
  Mask Flags: PER_DATASET
Band 2 Block=128x128 Type=Byte, ColorInterp=Green
  Mask Flags: PER_DATASET
Band 3 Block=128x128 Type=Byte, ColorInterp=Blue
  Mask Flags: PER_DATASET
```

# Using the GDAL CLI

The VRT file allows you to to treat the 1295 mosaic COGs (~210 GB of data!) in this group as a single file without having to download the entire dataset. This facilitates some interesting possibilities. For example, the following command will subset a section of Grand Isle, LA in a couple of seconds



```
gdal_translate -projwin -90.02114 29.21892 -90.02040 29.21809
"/vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/cogs_20210831a_RGB.vrt" 20210831a_subset.jpg
Input file size is 1723760, 1038022
0...10...20...30...40...50...60...70...80...90...100 - done.
```

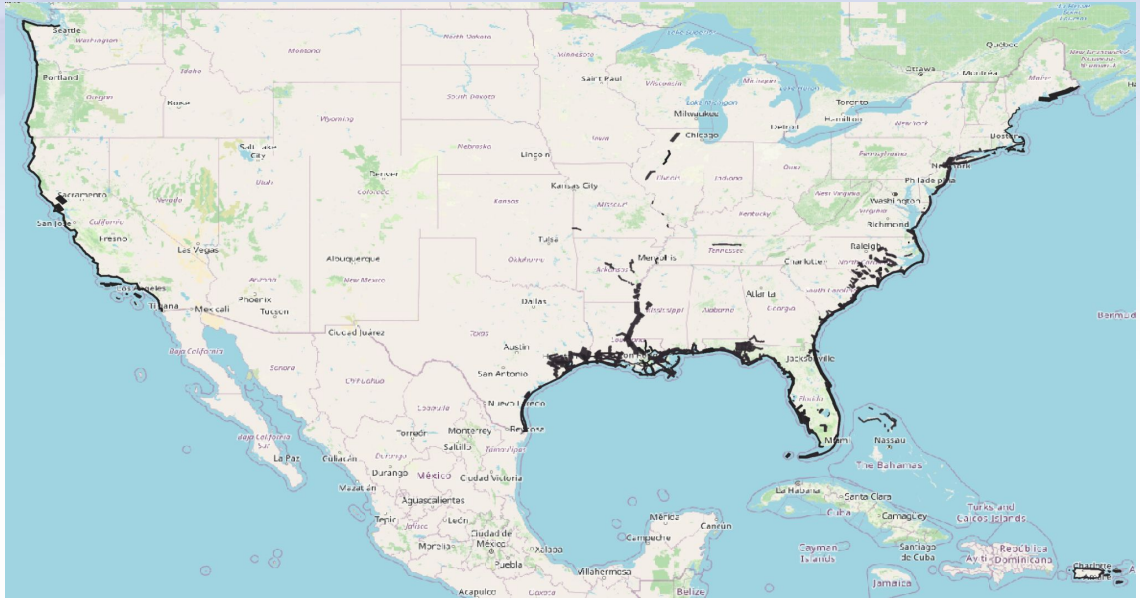
The output image can be any supported GDAL format. JPG was selected as an example.

# Using the GDAL CLI

In 2024, we created a GeoParquet* index for the ERI data holdings. The GeoParquet 1.0.0 format is supported at GDAL 3.8.0. Newer versions of QGIS can load the index directly from the Cloud as can the GDAL CLI tools.

Note that the ‘datetime’ field has 12:00:00+00 as the time. The majority of the available data are mosaics of multiple images and 12:00 UTC is a reasonable estimate of the earliest time data would have been collected.

Pre-Event ‘datetime’ has be set to the beginning of the year in which it was collected.




This index is available at:
https://noaa-eri-pds.s3.amazonaws.com/noaa_eri_pds.parquet

* https://gdal.org/drivers/vector/parquet.html#vector-parquet

# Using the GDAL CLI*

Query the index for available collections:

```
ogrinfo -ro -dialect SQLITE -sql "SELECT DISTINCT collection from noaa_eri_pds ORDER BY collection"
/vsicurl/https://noaa-eri-pds.s3.amazonaws.com/noaa_eri_pds.parquet | grep -e "(S" | awk '{print $4}'
```

2005_Hurricane_Katrina
2006_Tropical_Storm_Ernesto
2007_Hurricane_Humberto
2008_Hurricane_Gustav
2008_Hurricane_Ike
2009_NorEaster
2011_Hurricane_Irene
2011_Joplin_Tornado
2012_Hurricane_Isaac
2012_Hurricane_Sandy
2014_Hurricane_Arthur
2015_Illinois_Tornadoes
2015_Midwest_Flood
2016_Hurricane_Matthew
2016_Louisiana_Flooding
2017_Hurricane_Harvey
2017_Hurricane_Irma
2017_Hurricane_Maria
2017_Hurricane_Nate
2018_Hurricane_Florence
2018_Hurricane_Michael
2018_Tropical_Storm_Gordon
2019_Hurricane_Barry
2019_Hurricane_Dorian
2020_Hurricane_Delta
2020_Hurricane_Laura
2020_Hurricane_Sally
2020_Hurricane_Zeta
2020_Nashville_Tornado
2021_Hurricane_Henri
2021_Hurricane_Ida
2022_Hurricane_Ian
2022_Hurricane_Nicole
2022_Pre_Event
2023_California
2023_Hurricane_Idalia
2023_Hurricane_Lee
2023_Pre_Event

* and Linux bash

# Using the GDAL CLI*

Query the index for available data in an area:

```
ogrinfo -ro -spat -90.02114 29.21892 -90.02040 29.21809 -dialect SQLITE -sql "SELECT * from noaa_eri_pds ORDER BY datetime"
/vsicurl/https://noaa-eri-pds.s3.amazonaws.com/noaa_eri_pds.parquet | grep -e "location (St" | awk '{print $4}'
```

```
https://noaa-eri-pds.s3.amazonaws.com/2005_Hurricane_Katrina/aug31JpegTiles_GCS_NAD83/aug31C0900130w291330n.tif
https://noaa-eri-pds.s3.amazonaws.com/2008_Hurricane_Gustav/GUSTAVC24974234_3_1/geo-C24974351.tif
https://noaa-eri-pds.s3.amazonaws.com/2008_Hurricane_Gustav/GUSTAVC24974234_3_1/geo-C24982257.tif
https://noaa-eri-pds.s3.amazonaws.com/2008_Hurricane_Gustav/GUSTAVC24974234_3_1/geo-C24982269.tif
https://noaa-eri-pds.s3.amazonaws.com/2008_Hurricane_Gustav/GUSTAVC24974234_3_1/geo-C24982280.tif
https://noaa-eri-pds.s3.amazonaws.com/2012_Hurricane_Isaac/sep02aJpegTiles_GCS_NAD83/sep02aC0900130w291330n.tif
https://noaa-eri-pds.s3.amazonaws.com/2019_Hurricane_Barry/20190719a_RGB/20190719aC0900130w291330n.tif
https://noaa-eri-pds.s3.amazonaws.com/2020_Hurricane_Zeta/20201029a_RGB/20201029aC0900130w291330n.tif
https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/20210831aC0900130w291330n.tif
https://noaa-eri-pds.s3.amazonaws.com/2022_Pre_Event/GC2201b_OB_N_RGB/GC2201b_OB_N_C0900130w291330n.tif
https://noaa-eri-pds.s3.amazonaws.com/2023_Pre_Event/GC2301a_OB_N_RGB/GC2301a_OB_N_C0900130w291330n.tif
```

* and Linux bash

# Using the GDAL CLI*

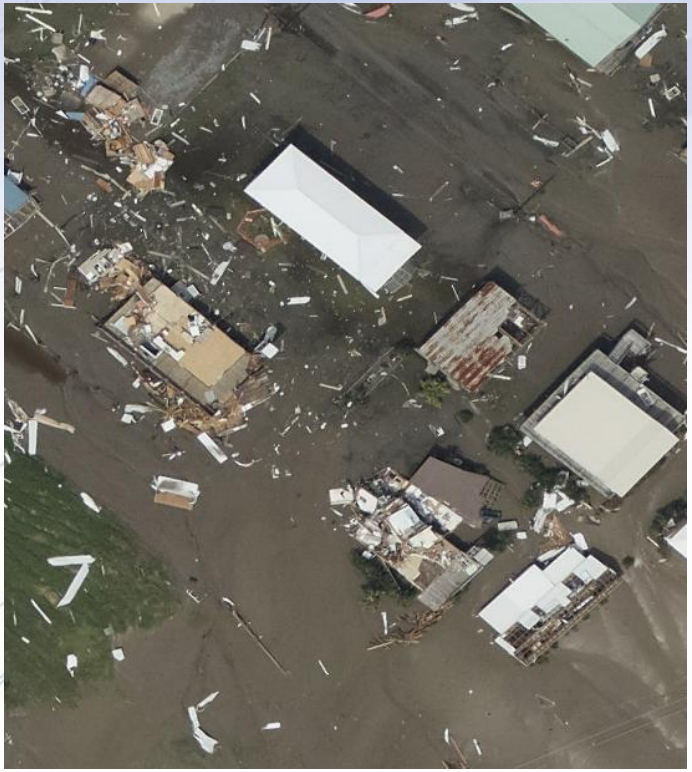
Save most recent data for a location to a file:

```
ogrinfo -ro -spat -90.02114 29.21892 -90.02040 29.21809
-dialect SQLITE -sql "SELECT * from noaa_eri_pds ORDER BY
datetime DESC LIMIT 1"
/vsicurl/https://noaa-eri-pds.s3.amazonaws.com/noaa_eri_pds.p
arquet | grep -e "location (St" | awk '{print "/vsicurl/"$4}' |
gdal_translate -b 1 -b 2 -b 3 -of JPEG -projwin -90.02114
29.21892 -90.02040 29.21809 --optfile /vsistdin/ most_recent.jpg
```

Note this is the same area from an earlier example.

* and Linux bash

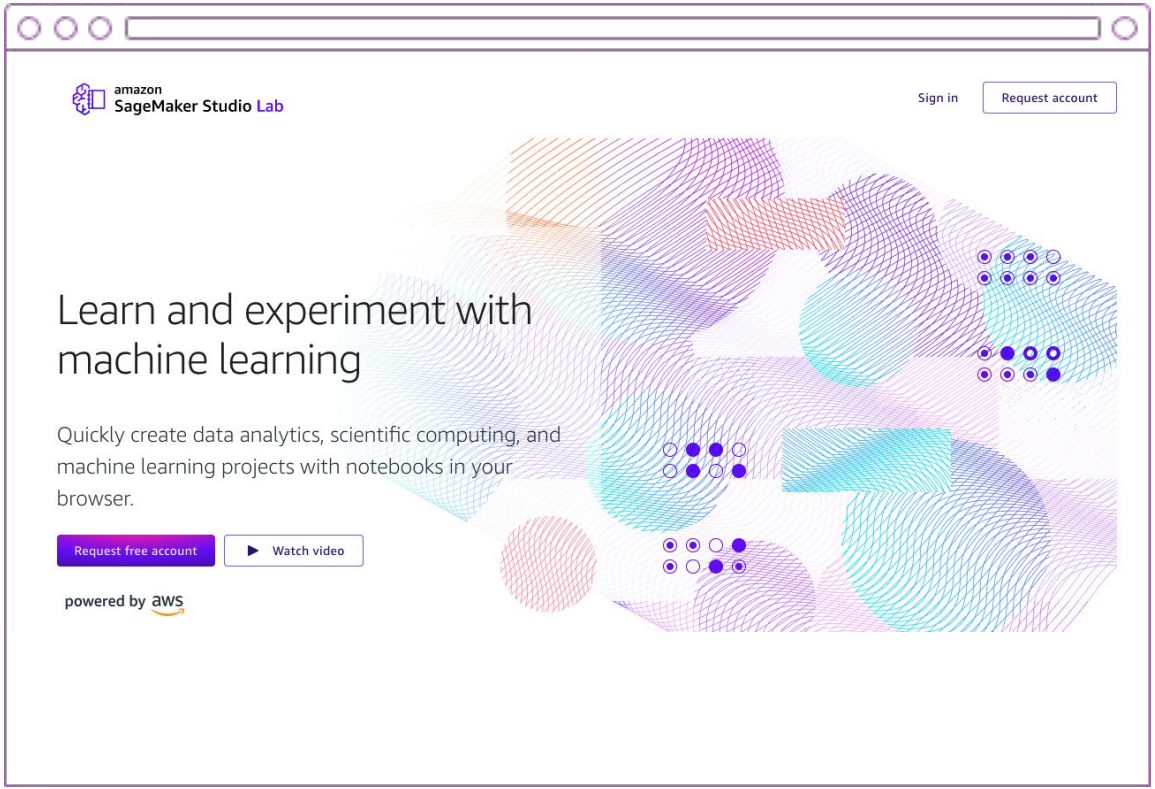
# Compare to example from earlier



Post Hurricane Ida 2021

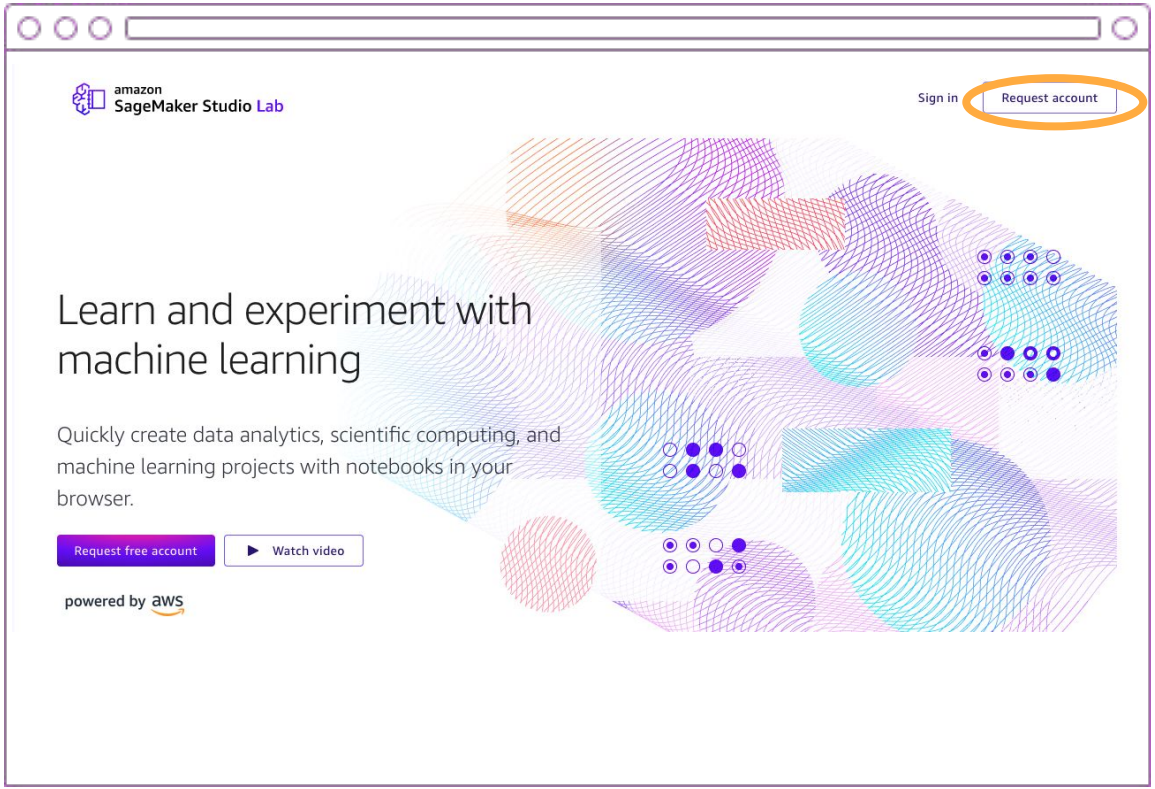
Pre-Event 2023

# Step 1: Create a SageMaker StudioLab account



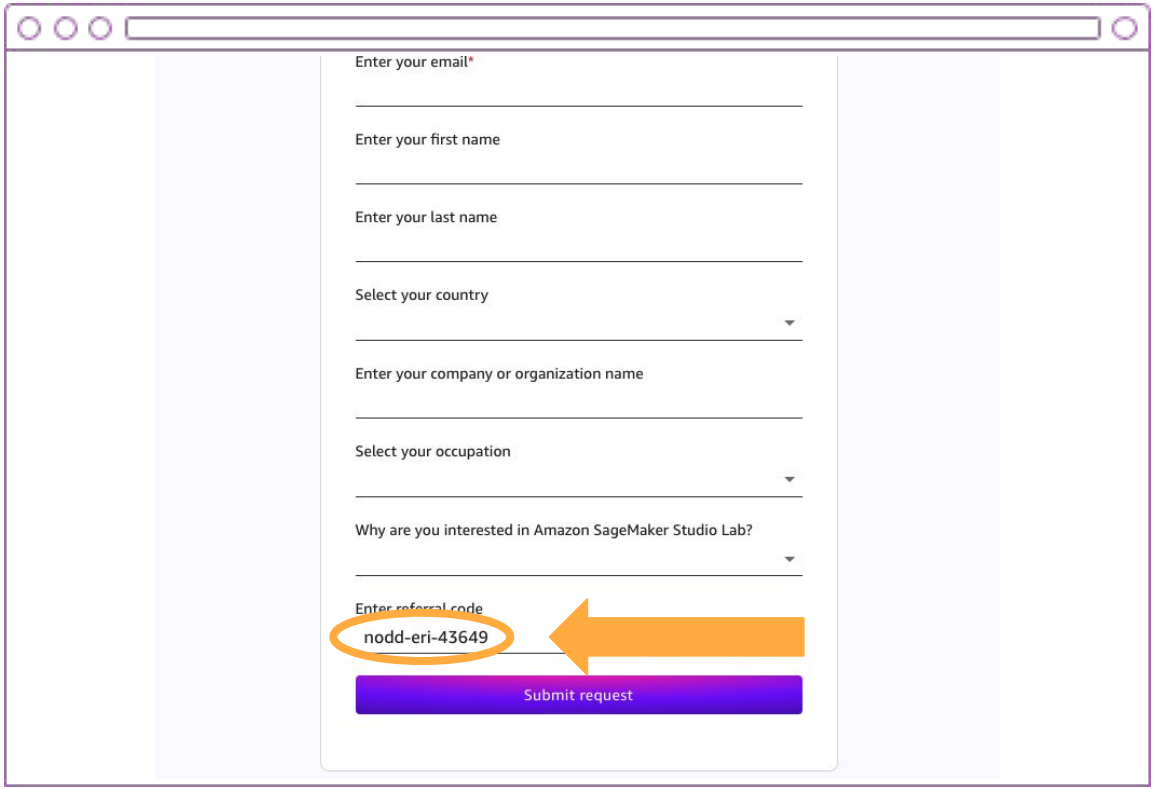

**https://studiolab.sagemaker.aws**

# Step 1a: Request account




**https://studiolab.sagemaker.aws**

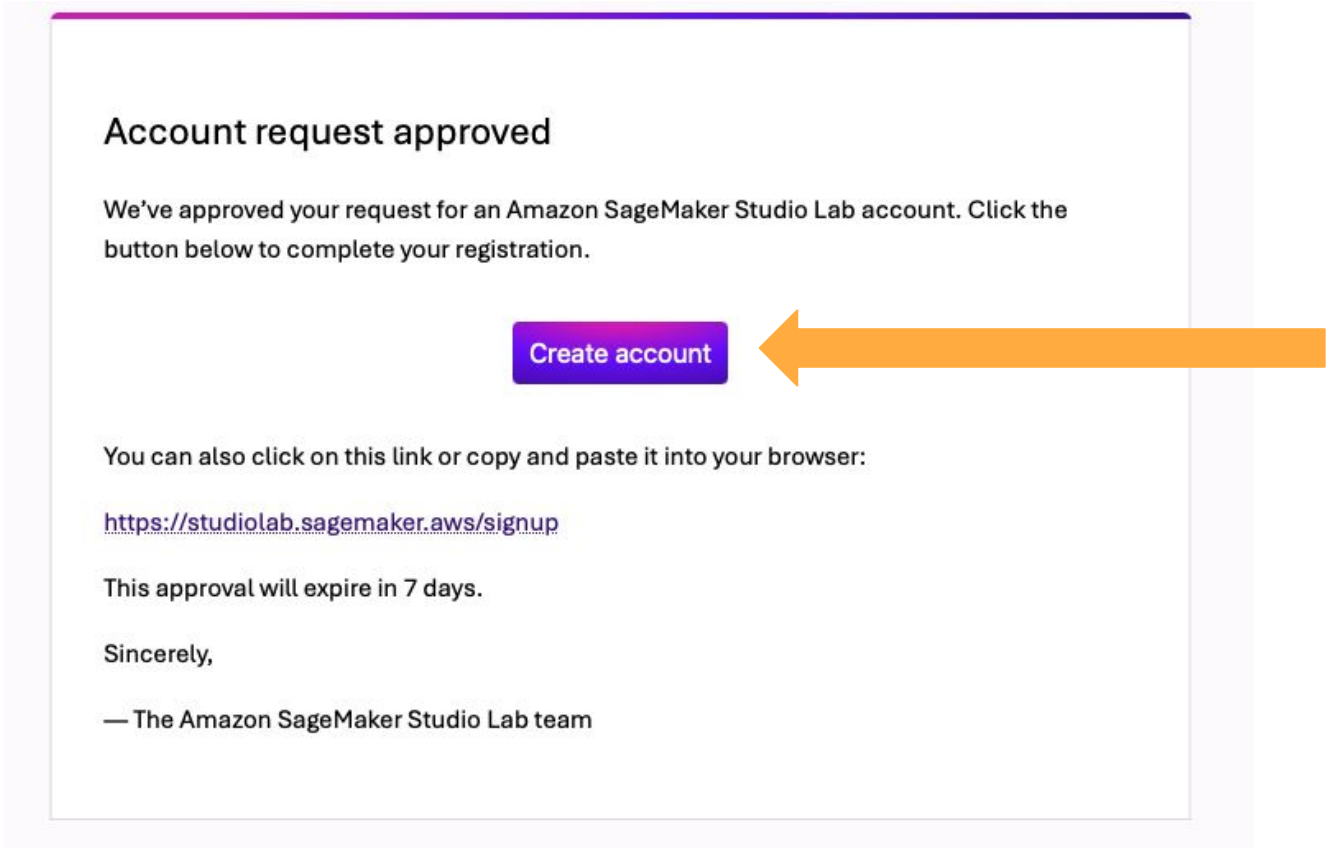
# Step 1b: Use Referral Code



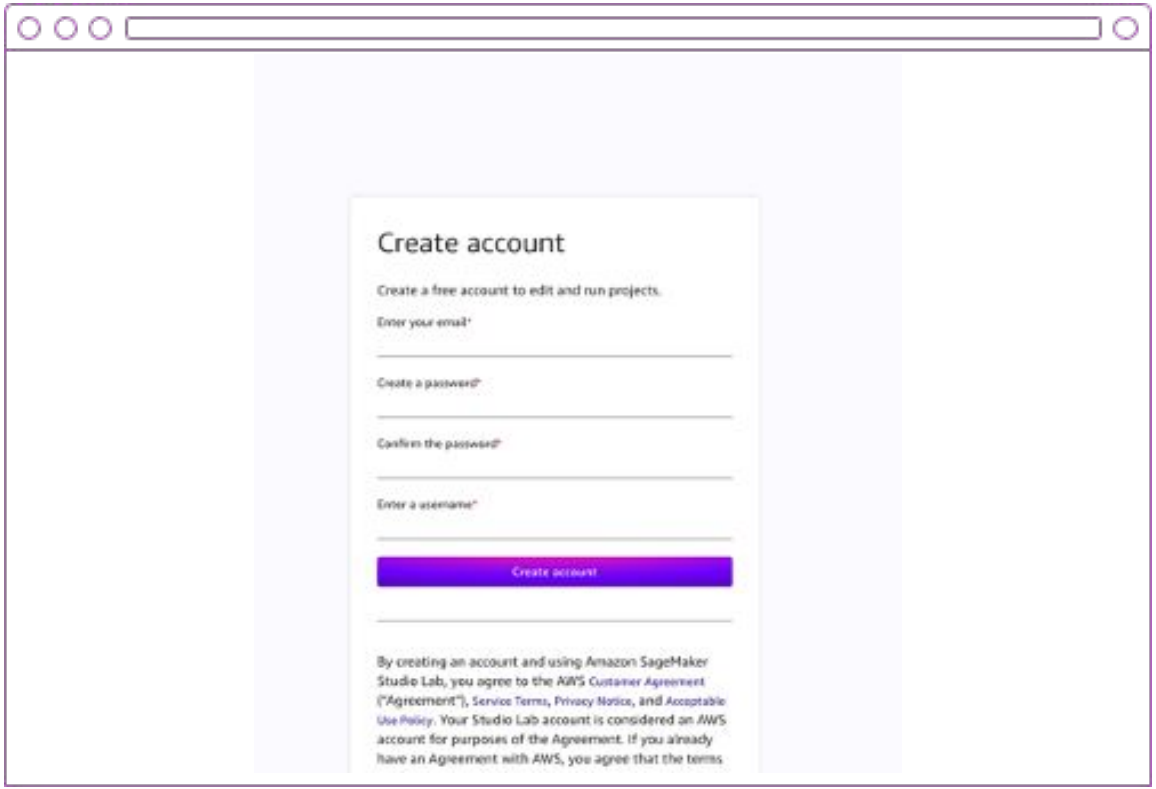

NOTE: If you are watching the recording, do **not** use the Referral Code as it will have expired. But you can still create an account without it.

**nodd-eri-43649**

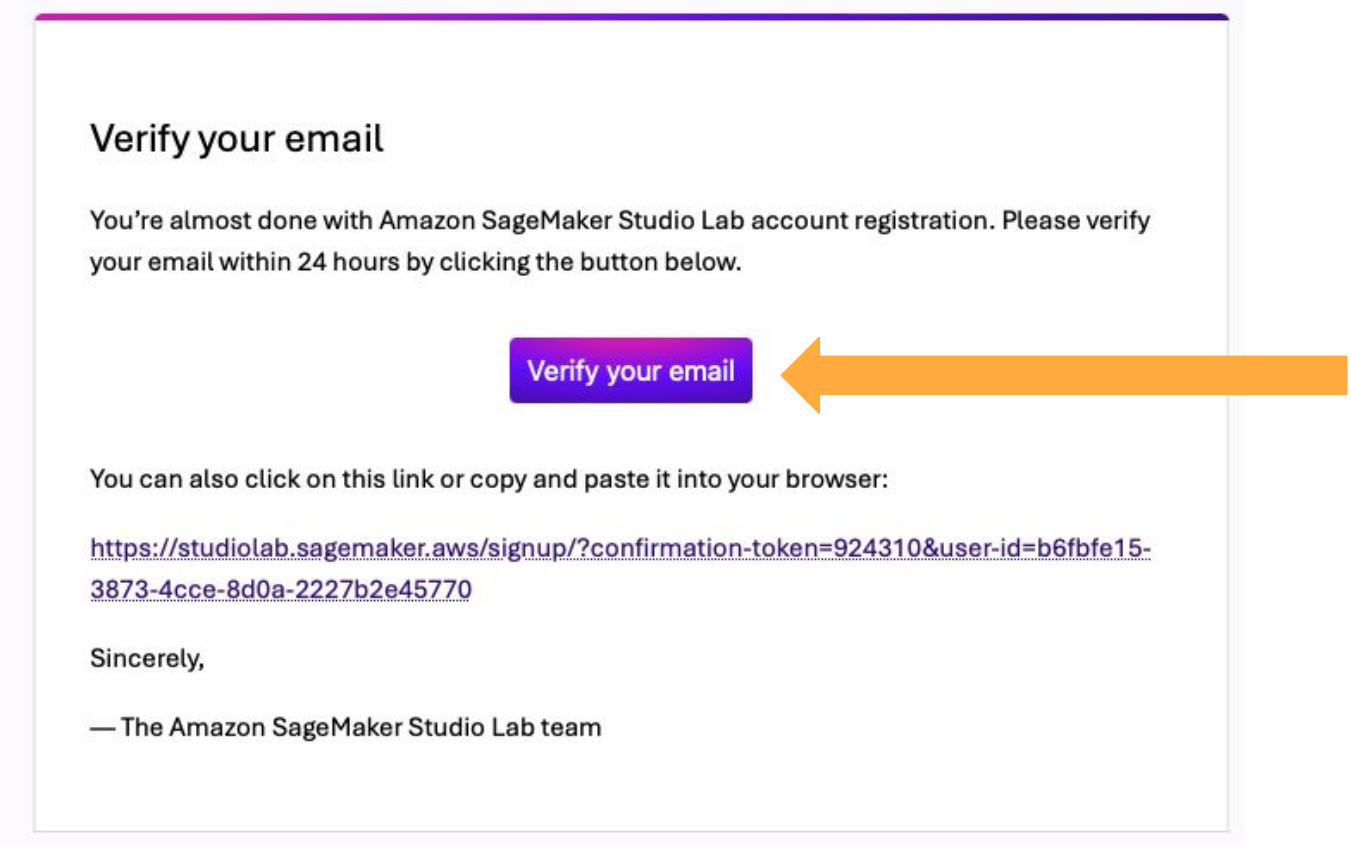
# Step 2: “Account request Approved” email



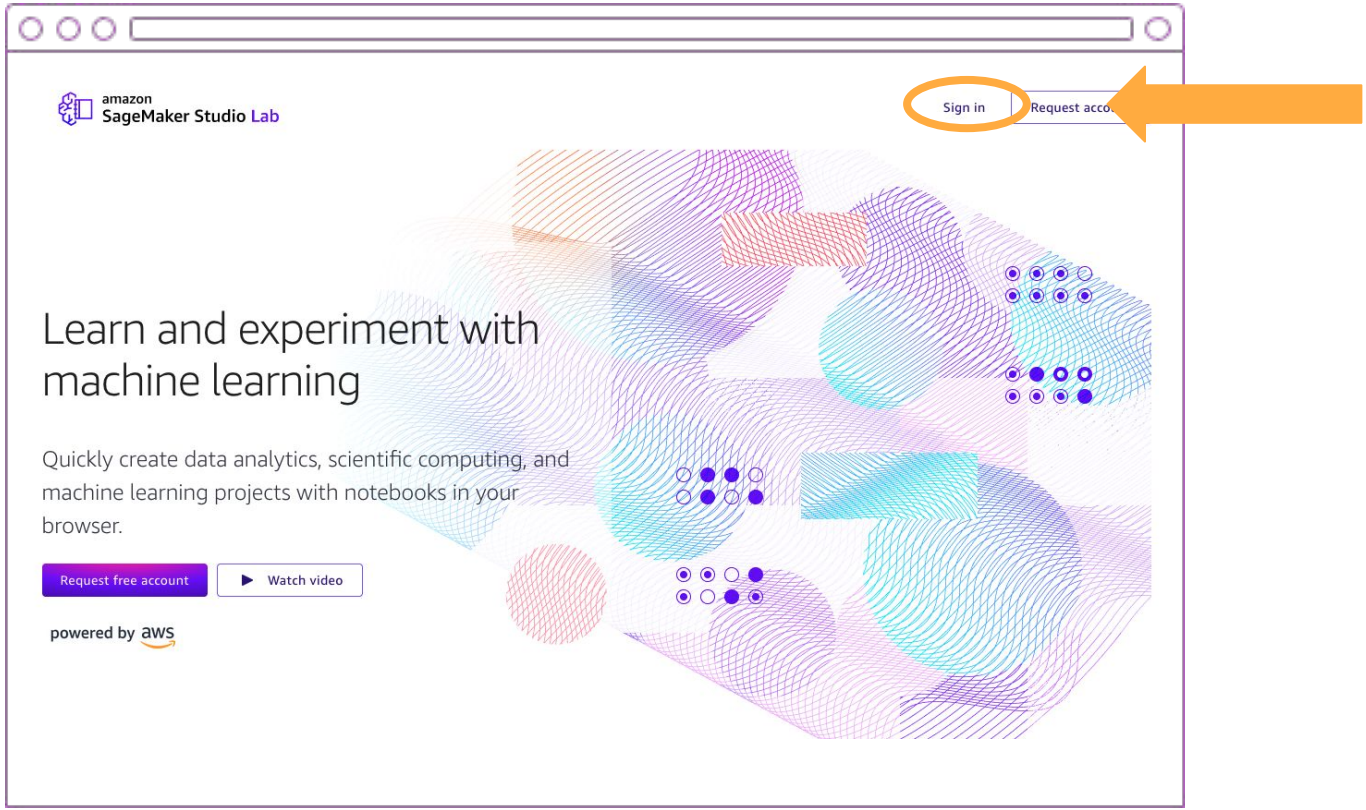
# Step 3: Create Account



# Step 4: Verify email

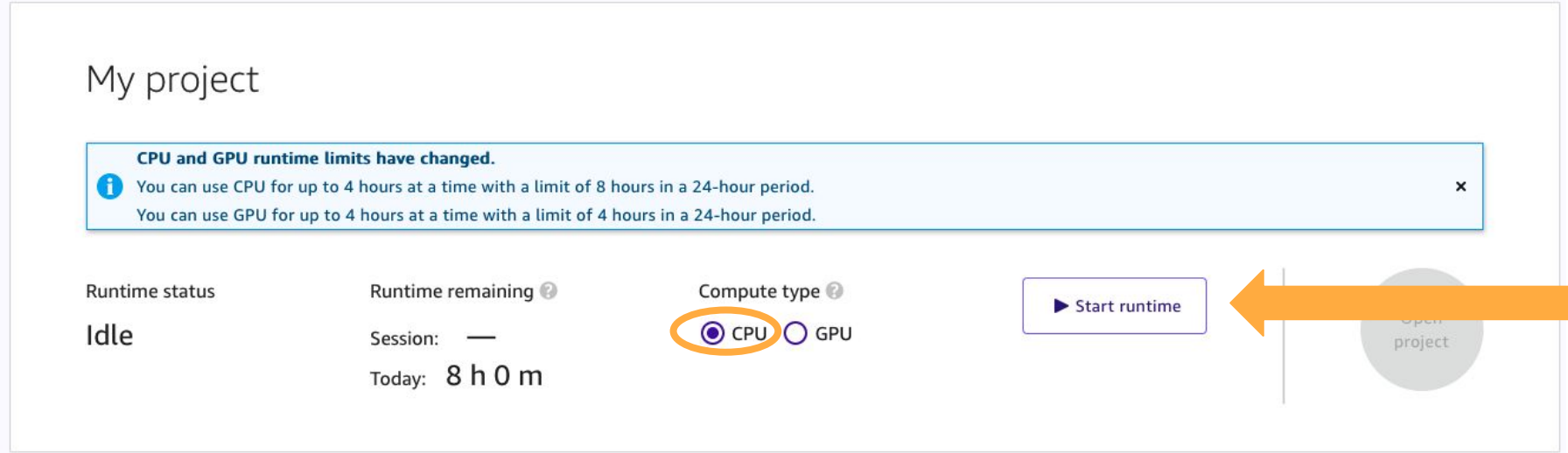


# Step 5: Sign In

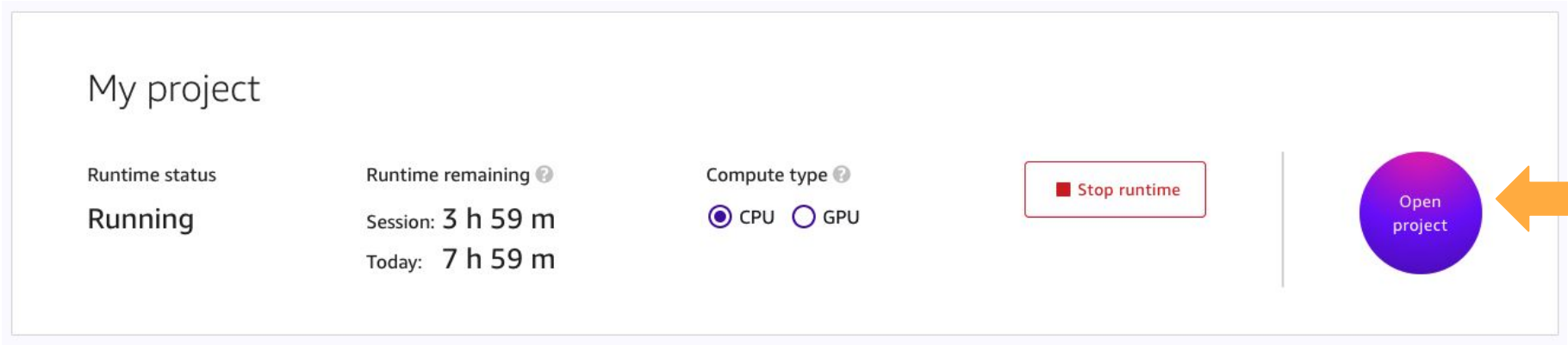



**https://studiolab.sagemaker.aws**

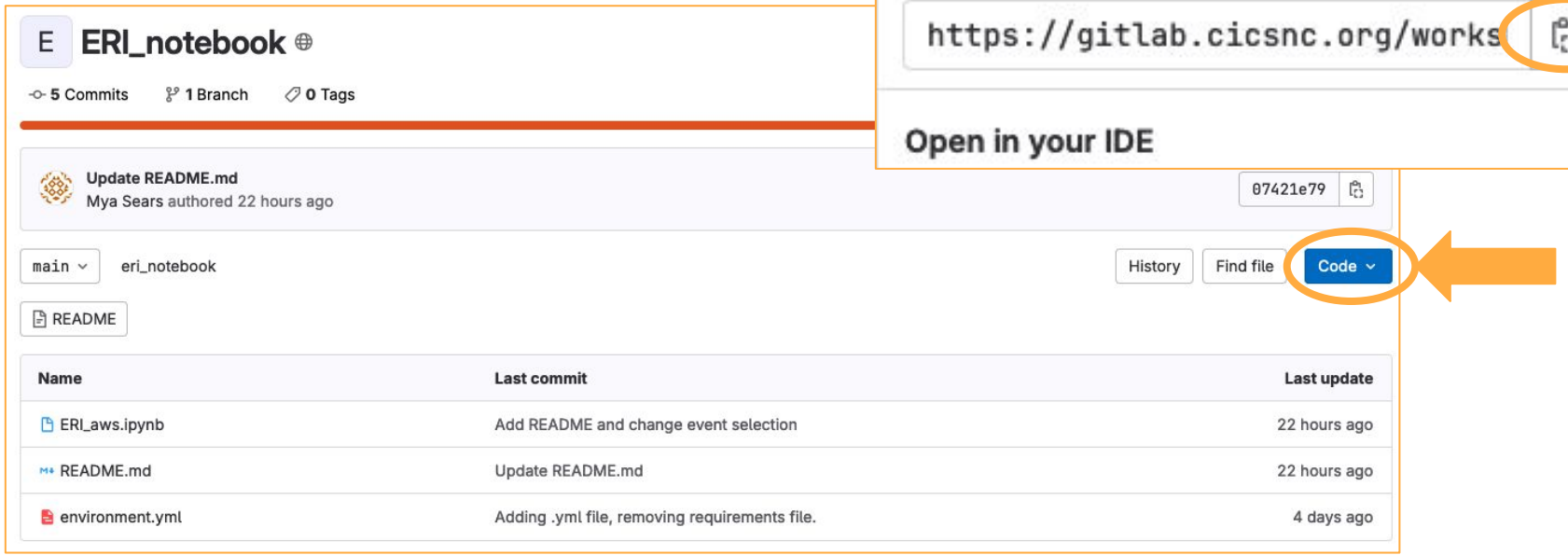
# Step 6: Start CPU runtime



# Step 7: Open Project

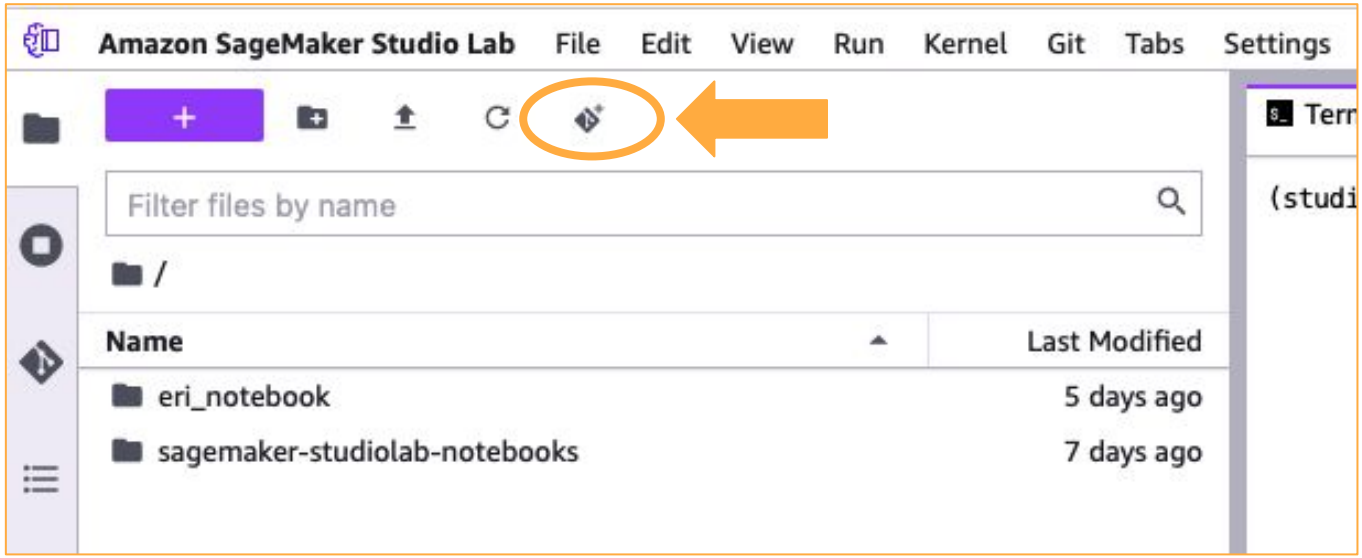


# Step 8a: Github Repo

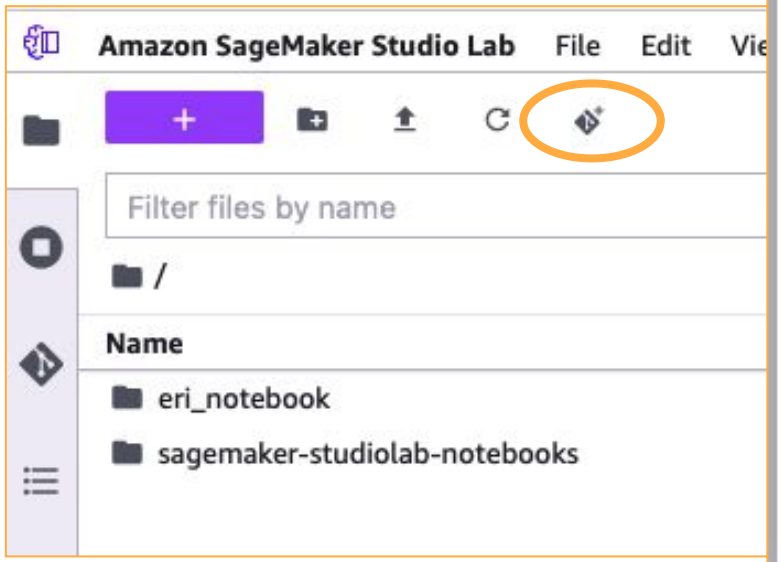

**https://gitlab.cicsnc.org/workshop-development/eri_notebook**

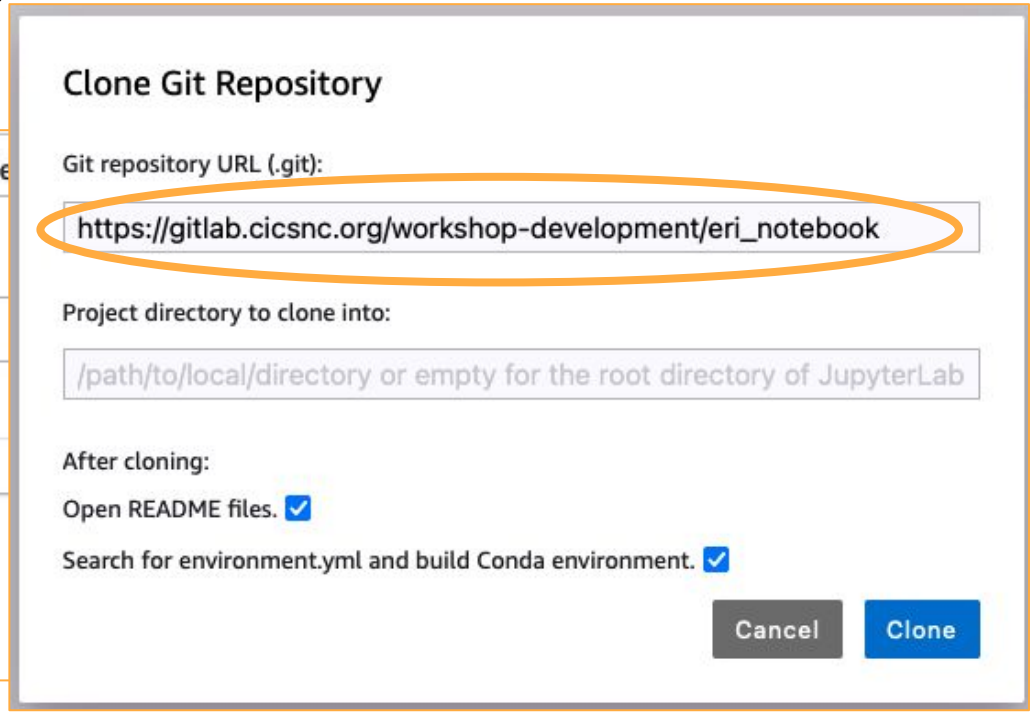
# Step 8b: Clone Repo




**https://gitlab.cicsnc.org/workshop-development/eri_notebook**

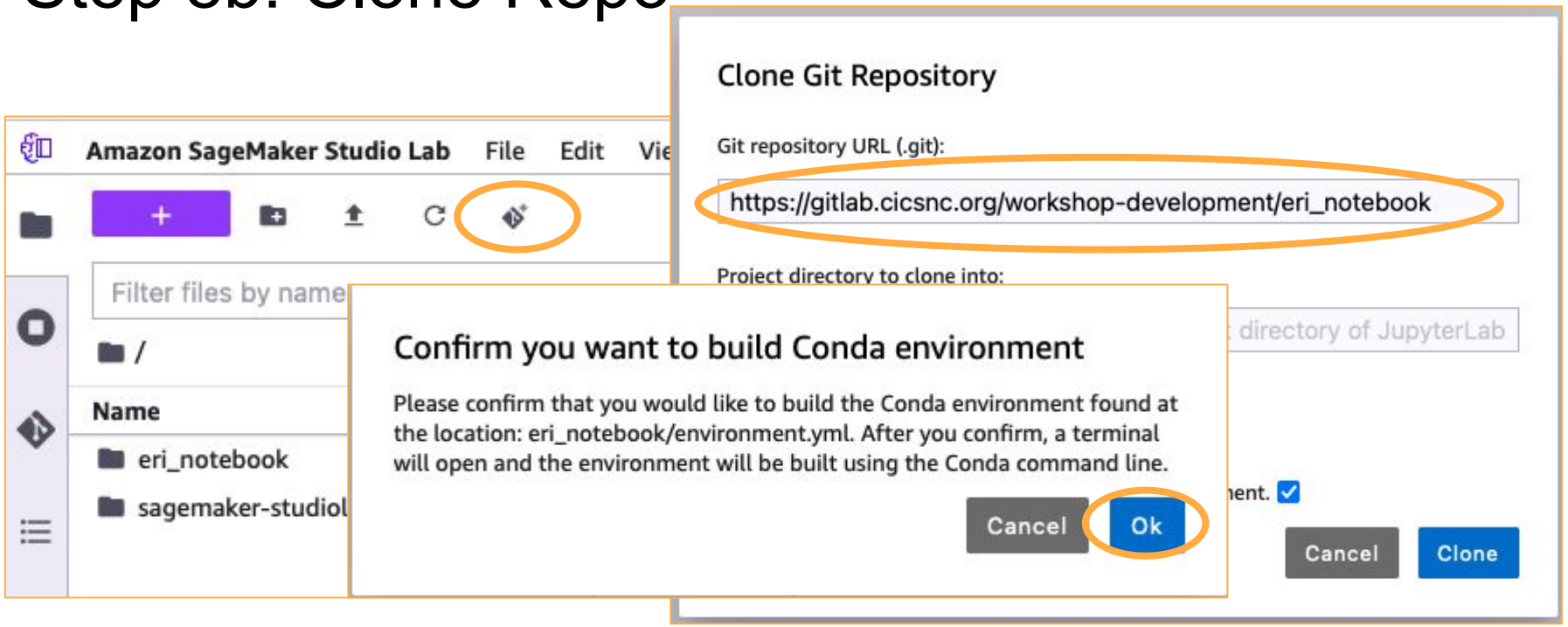
# Step 8b: Clone Repo



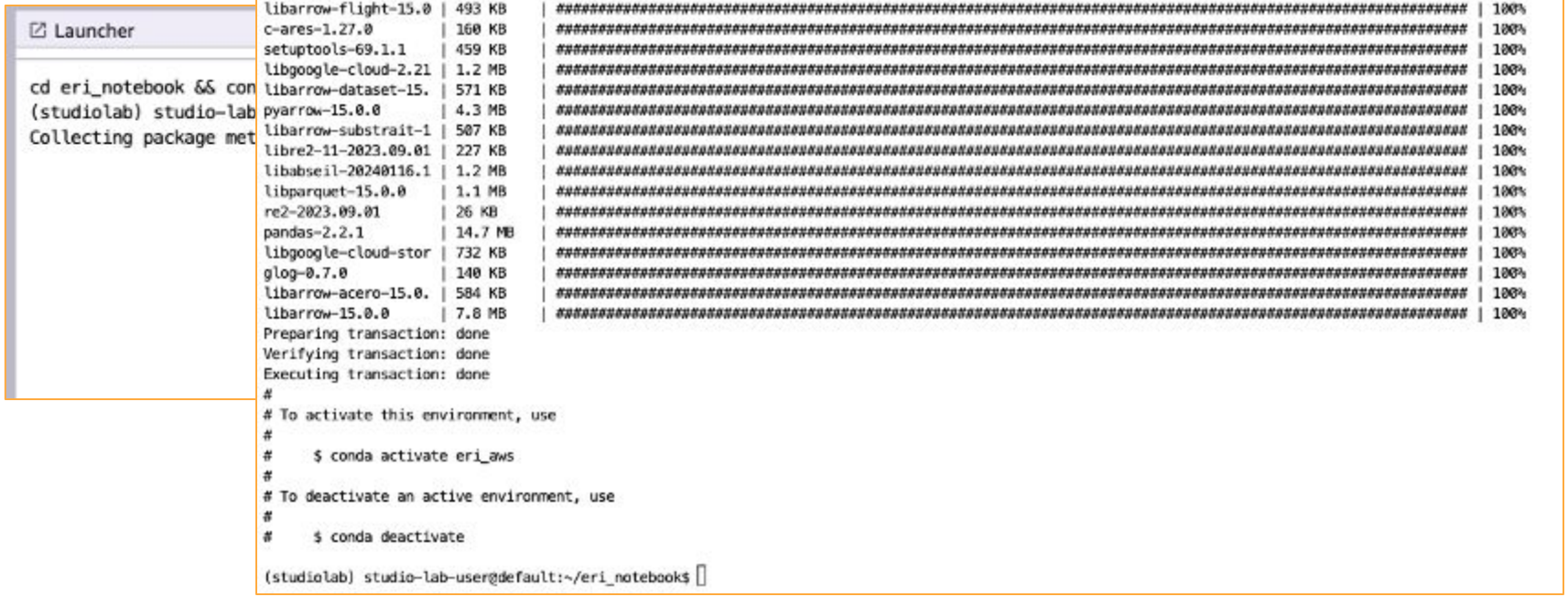

**https://gitlab.cicsnc.org/workshop-development/eri_notebook**

# Step 8b: Clone Repo

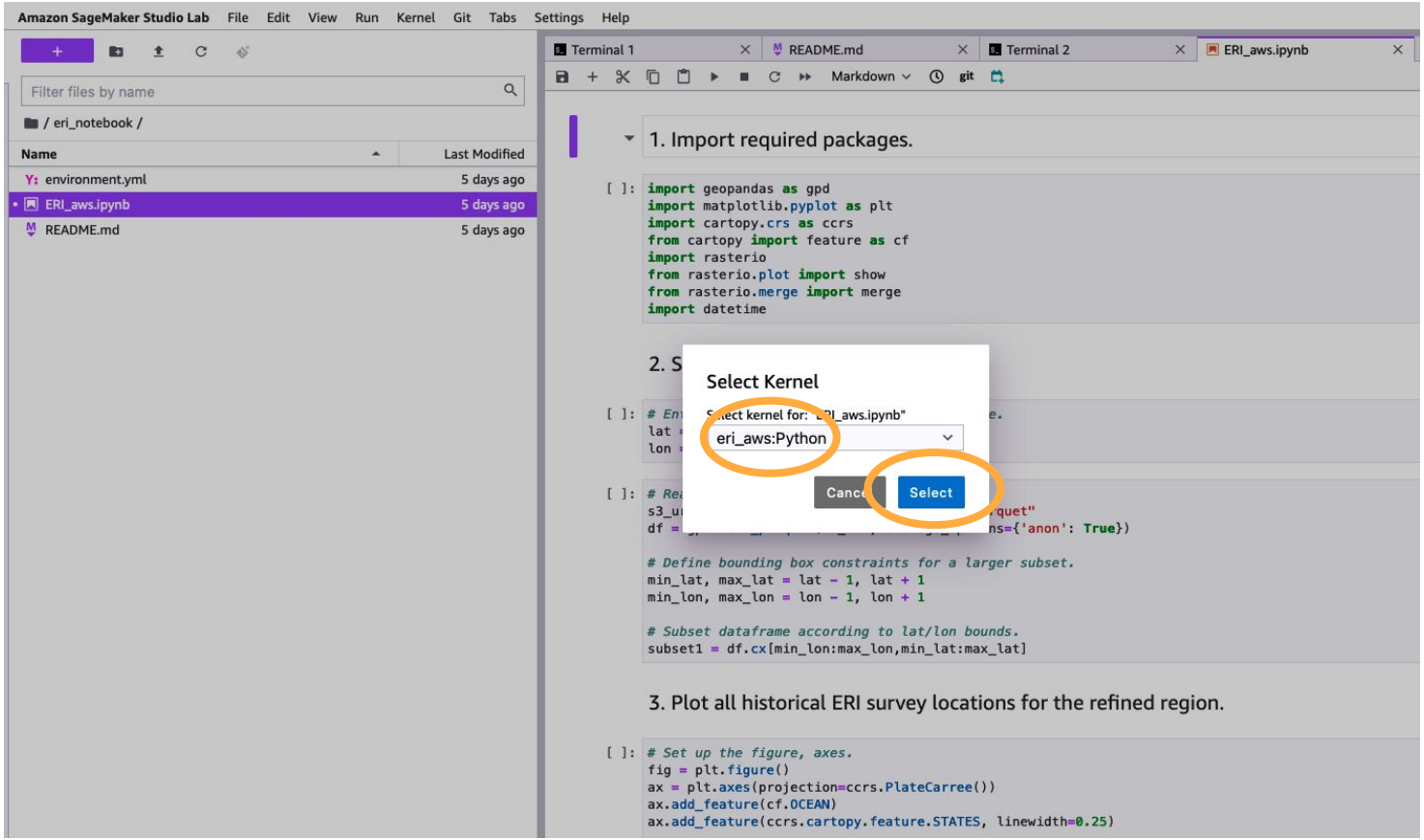



**https://gitlab.cicsnc.org/workshop-development/eri_notebook**

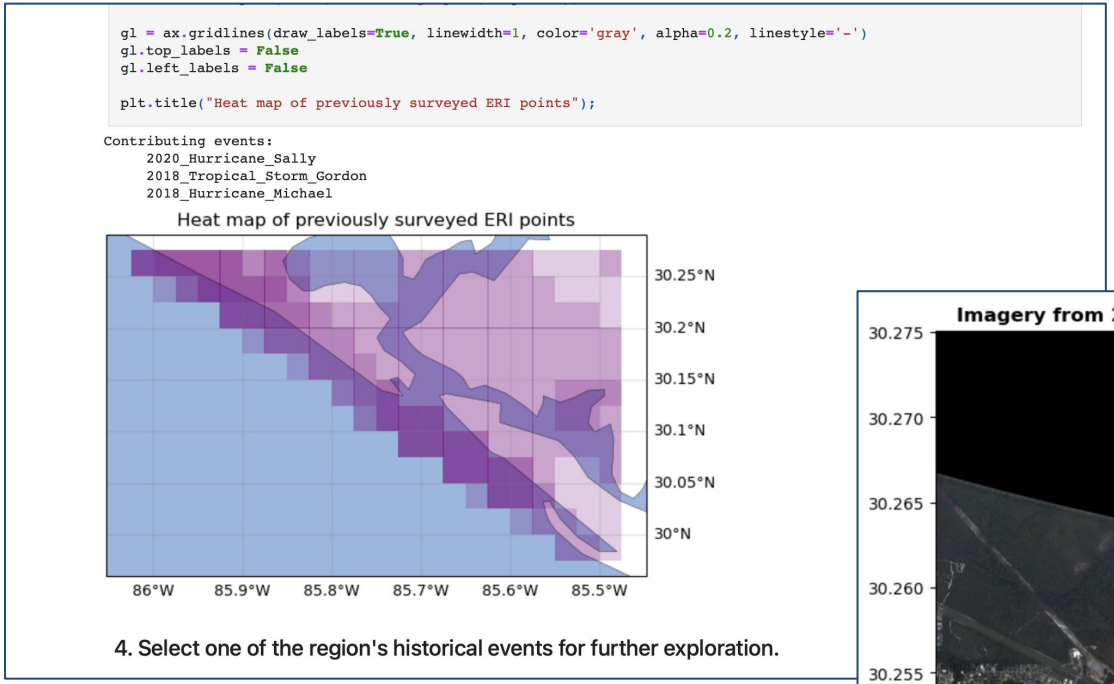
# Step 9: Wait

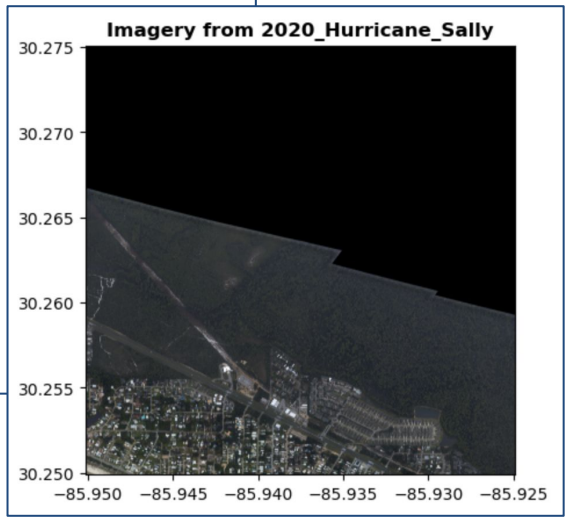

Launcher
cd eri_notebook && con
(studiolab) studio-lab
Collecting package met
Downloading and Extracting Packages
orc-1.9.2 | 995 KB | ########## | 100%
libprotobuf-4.25.2 | 2.7 MB | ########## | 100%
libgpg-error-1.48 | 260 KB | ########## | 100%
ipython-8.22.1 | 579 KB | ########## | 100%
libarrow-flight-sql- | 190 KB | ########## | 100%
libarrow-gandiva-15. | 875 KB | ########## | 100%
libgrpc-1.61.1 | 7.3 MB | ########## | 100%
libarrow-flight-15.0 | 493 KB | ########## | 100%
c-ares-1.27.0 | 160 KB | ########## | 100%
setuptools-69.1.1 | 459 KB | ########## | 100%
libgoogle-cloud-2.21 | 1.2 MB | ########## | 100%
libarrow-dataset-15. | 571 KB | ########## | 100%
pyarrow-15.0.0 | 4.3 MB | ########## | 100%
libarrow-substrait-1 | 507 KB | ########## | 100%
libre2-11-2023.09.01 | 227 KB | ########## | 100%
libabseil-20240116.1 | 1.2 MB | ########## | 100%
libparquet-15.0.0 | 1.1 MB | ########## | 100%
re2-2023.09.01 | 26 KB | ########## | 100%
pandas-2.2.1 | 14.7 MB | ########## | 100%
libgoogle-cloud-stor | 732 KB | ########## | 100%
glog-0.7.0 | 140 KB | ########## | 100%
libarrow-acero-15.0. | 584 KB | ########## | 100%
libarrow-15.0.0 | 7.8 MB | ########## | 100%
Preparing transaction: done
Verifying transaction: done
Executing transaction: done
#
# To activate this environment, use
#
#     $ conda activate eri_aws
#
# To deactivate an active environment, use
#
#     $ conda deactivate
(studiolab) studio-lab-user@default:~/eri_notebook$

# Step 10: Launch Notebook



# Jupyter Notebook Demo



# Questions and Discussion

- Please be brief in your questions / comments
- Use the chat or raise your hand for questions
- Identify who the question is directed to where possible
    - As questions are answered, we will go to the next in the chat queue and call on you to unmute yourself and ask your question.
    - We appreciate there may be questions that cannot be answered immediately and even those that we won't have an opportunity to get to: please be patient as we build our understanding and summary responses.

# Resources

We invite you to stay engaged with NOAA!

- **NOAA Emergency Response Imagery:**
  - https://storms.ngs.noaa.gov/
- **NOAA Open Data Dissemination:**
  - noaa.gov/nodd
  - Email: NODD@noaa.gov
- **AWS Emergency Response Imagery:**
  - https://registry.opendata.aws/noaa-eri/