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
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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](http://NOAA.GOV/NODD)
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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:
  - Mute and Video
  - CC
  - Hand Raise
  - Settings
  - Chat
  - Polls

- 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
NOAA Data is Growing Exponentially

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

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

NODD Disseminates NOAA Line Office Data
Using Emergency Response and Pre-Event Imagery from NOAA’s Open Data Dissemination Program with Free and Open Source Software

https://www.noaa.gov/information-technology/open-data-dissemination
ER Imagery Processing Workflow

AWS Virtual Machines
- 128 CPUs
- 1000 GB RAM
- 8 x 3750 NVMe SSD
- Ubuntu Linux OS
- Image orthorectification
- Mosaic processing
- Web map tiling

AWS S3 Storage
- HTML / JavaScript viewer
- XYZ map tiles
- WMTS support
- NODD

In Cloud analysis

Web browsers
- GIS clients

Local PC/laptop for NavData / trajectory processing

jpeg aerial imagery
- Raw GPS/IMU

CDN

© Mapbox © OpenStreetMap: Improve this map
Using the Bucket Browser


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.
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)
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.

---

https://github.com/ossimlabs/ossim
Using the data in Quantum GIS\textsuperscript{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

\textsuperscript{4}https://qgis.org/en/site/
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.
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

* 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*):

```bash
gdalinfo /vsicurl/https://noaa-eri-pds.s3.amazonaws.com/2021_Hurricane_Ida/20210831a_RGB/20210831aC0910045w294200n.tif
```

Driver: GTiff/GeoTIFF
Size is 9415, 9415
Coordinate System is:
GEOGCRS["WGS 84", DATUM["World Geodetic System 1984", ELLIPSOID["WGS 84",6378137.0,298.257223563, LENGTHUNIT["metre",1]], PRIMEM["Greenwich",0], ANGULARUNIT["degree",0.0174532925199433]], CS[ellipsoidal,2], AXIST["geodetic latitude (Lat)",north, ORDER[1], ANGULARUNIT["degree",0.0174532925199433]], AXIST["geodetic longitude (Lon)",east, ORDER[2], ANGULARUNIT["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, 90d1'14.64"N)
Center (-91.0062500, 29.6937500) (91d 0'22.50"W, 29d41'37.50"

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=Alpha, 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
Using the GDAL CLI

Get information about a particular COG VRT:

gdalinfo vsicurl://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 84,6378137.298257223563,
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 = (-91.1001000, 30.4126000)
Pixel Size = (0.000001348911312, -0.000001348911312)
Corner Coordinates:
Upper Left (-91.1001000, 30.4126000) (91d 6' 0.36"W, 30d 24' 45.36"N)
Lower Left (-91.1001000, 29.0124004) (91d 6' 0.36"W, 29d 04' 44.64"N)
Upper Right (-88.7749606, 30.4126000) (88d 46' 29.64"W, 30d 24' 45.36"N)
Lower Right (-88.7749606, 29.0124004) (88d 46' 29.64"W, 29d 04' 44.64"N)
Center (-89.9375003, 29.7125002) (89d 56' 15.00"W, 29d 42' 45.00"N)
Band 1 Block=128x128 Type=Byte, ColorInterp=Red
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

```
```

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.
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/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/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:

```bash
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.parquet | 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

Learn and experiment with machine learning

Quickly create data analytics, scientific computing, and machine learning projects with notebooks in your browser.

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.
Account request approved

We’ve approved your request for an Amazon SageMaker Studio Lab account. Click the button below to complete your registration.

Create account

You can also click on this link or copy and paste it into your browser:

https://studiolab.sagemaker.aws/signup

This approval will expire in 7 days.

Sincerely,

— The Amazon SageMaker Studio Lab team
Step 3: Create Account

Create account

Create a free account to edit and run projects.
Enter your email*

Create a password*

Confirm the password*

Enter a username*

Create account

By creating an account and using Amazon SageMaker Studio Lab, you agree to the AWS Customer Agreement ("Agreement"), Service Terms, Privacy Notice, and Acceptable Use Policy. Your Studio Lab account is considered an AWS account for purposes of the Agreement. If you already have an Agreement with AWS, you agree that the terms
Step 4: Verify email

Verify your email

You’re almost done with Amazon SageMaker Studio Lab account registration. Please verify your email within 24 hours by clicking the button below.

Verify your email

You can also click on this link or copy and paste it into your browser:

https://studiolab.sagemaker.aws/signup/?confirmation-token=924310&user-id=b8f6fe15-3873-4c3e-8d0a-2227b2e45770

Sincerely,

— The Amazon SageMaker Studio Lab team
Step 5: Sign In

https://studiolab.sagemaker.aws
Step 6: Start CPU runtime
Step 7: Open Project

My project

Runtime status: Running
Runtime remaining: 3 h 59 m
Today: 7 h 59 m
Compute type: CPU

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

```
Download and Extracting Packages

<table>
<thead>
<tr>
<th>Name</th>
<th>Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>orc-1.9.2</td>
<td>995 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libprotobuf-4.25.2</td>
<td>2.7 MB</td>
<td>100%</td>
</tr>
<tr>
<td>libgpg-error-1.48</td>
<td>260 KB</td>
<td>100%</td>
</tr>
<tr>
<td>ipython-8.22.1</td>
<td>579 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libarrow-flight-sql</td>
<td>190 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libarrow-gandiva-15.0</td>
<td>875 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libarrow-1.6.1</td>
<td>7.3 MB</td>
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<td>libarrow-flight-15.0</td>
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<td>c-ares-1.27.0</td>
<td>160 KB</td>
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</tr>
<tr>
<td>setuptools-69.1.1</td>
<td>459 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libgoogle-cloud-2.21</td>
<td>1.2 MB</td>
<td>100%</td>
</tr>
<tr>
<td>libarrow-dataset-15.0</td>
<td>571 KB</td>
<td>100%</td>
</tr>
<tr>
<td>pyarrow-15.0.0</td>
<td>4.3 MB</td>
<td>100%</td>
</tr>
<tr>
<td>libarrow-subset-1</td>
<td>587 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libre2-2023.09.01</td>
<td>227 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libsbseil-2024016.1</td>
<td>1.2 MB</td>
<td>100%</td>
</tr>
<tr>
<td>libparquet-15.0.0</td>
<td>1.1 MB</td>
<td>100%</td>
</tr>
<tr>
<td>re2-2023.09.01</td>
<td>26 KB</td>
<td>100%</td>
</tr>
<tr>
<td>pandas-2.2.1</td>
<td>14.7 MB</td>
<td>100%</td>
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<tr>
<td>libgoogle-cloud-stor</td>
<td>732 KB</td>
<td>100%</td>
</tr>
<tr>
<td>glog-0.7.0</td>
<td>140 KB</td>
<td>100%</td>
</tr>
<tr>
<td>libarrow-acero-15.0</td>
<td>584 KB</td>
<td>100%</td>
</tr>
<tr>
<td>Libarrow-15.0.0</td>
<td>7.8 MB</td>
<td>100%</td>
</tr>
</tbody>
</table>

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_notebooks]
```
Step 10: Launch Notebook
Jupyter Notebook Demo

```
g1 = ax.gridlines(draw_labels=True, linewidth=1, color='gray', alpha=0.2, linestyle='--')
g1.top_labels = False
plt.title('Heat map of previously surveyed ERI points');
```

Contributing events:
2020_Hurricane_Sally
2018_Tropical_Storm_Gordon
2018_Hurricane_Michael

Heat map of previously surveyed ERI points

4. Select one of the region's historical events for further exploration.
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/](https://storms.ngs.noaa.gov/)

● **NOAA Open Data Dissemination:**
  ○ [noaa.gov/nodd](http://noaa.gov/nodd)
  ○ Email: NODD@noaa.gov

● **AWS Emergency Response Imagery:**
  ○ [https://registry.opendata.aws/noaa-eri/](https://registry.opendata.aws/noaa-eri/)