Developing Cloud-base ArcGIS Image Services on NASA Earthdata GIS (EGIS)

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Outline

- NASA Earthdata GIS (EGIS)
- ArcGIS Image Service: Bridging the Gap
- NASA TROPOMI Level2 (L2) Data
- Service Development Process
- Summary

NASA Earthdata GIS (EGIS)

- **A Gateway to NASA's Earth Science Data for GIS communities:** https://gis.earthdata.nasa.gov
- **GIS-Ready and Cloud-Native**: Formatted for easy integration into popular GIS software and cloud-based analysis platforms
- **More than Just Maps**: Providing capabilities for spatial and temporal analysis, allowing users to extract deeper insights from the data

Why Use EGIS

- **Free and Open Access:** Supporting research, education, and public engagement
- **Rich and Diverse Datasets**: Covering a wide range of Earth science disciplines
- **Interoperability and Accessibility**: Making it easy to integrate into diverse workflows and applications
- **Support for Open Science**: Provideing resources for collaborative workflows, enabling broader community involvement

ArcGIS Image Service: Bridging the Gap

- **Simplifying Data Access and Utilization**
- **Transforming Complex Data into User-Friendly Visualizations**
- **Seamless Integration with ArcGIS Platform and Existing Workflows**
- **Facilitating Various Scientific, Environmental, and Public Health Applications**

TROPOspheric Monitoring Instrument (TROPOMI)

- **A State-of-the-Art Satellite Instrument Onboard Sentinel-5 Precursor (Sentinel-5P or S5P)**
- **Spectral Range Spanning Ultraviolet, Visible, Near-Infrared, and Shortwave Infrared Wavelengths**
- **Exceptional Spatial and Temporal Resolutions**
- **Providing Essential Measurements of Atmospheric Components**

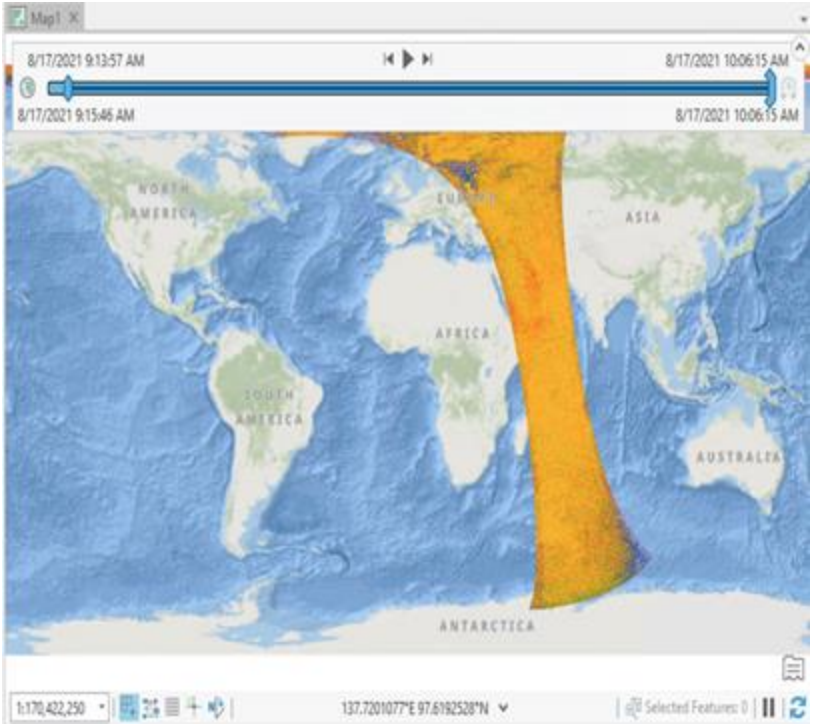
  Including O3, NO2, SO2, CH4, CO, and HCHO, as well as cloud and aerosol properties

  Air quality of measurements, well suited to monitor wildfires and quantify their effects

TROPOMI Level 2 (L2) Data

- Available at NASA GES DISC, provided by ESA on behalf of the European Commission
  https://disc.gsfc.nasa.gov/datasets?keywords=S5P

Shortname:	S5P_L2__SO2____HiR
Longname:	Sentinel-5P TROPOMI Sulphur Dioxide SO2 1-Orbit L2 5.5km x 3.5km
DOI	10.5270/S5P-74eidii
Version	2
Format:	netCDF
Spatial Coverage:	-180.0,-90.0,180.0,90.0
Temporal Coverage:	2018-05-07 to current
File Size:	936 MB per file
Spatial Resolution:	5.5 km x 3.5 km
Temporal Resolution:	1 Day (101.5 minutes / orbit)



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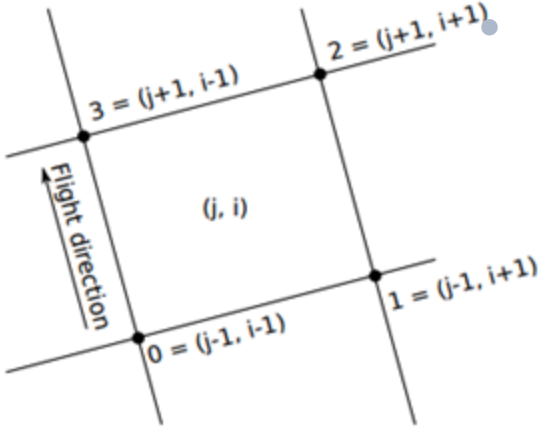
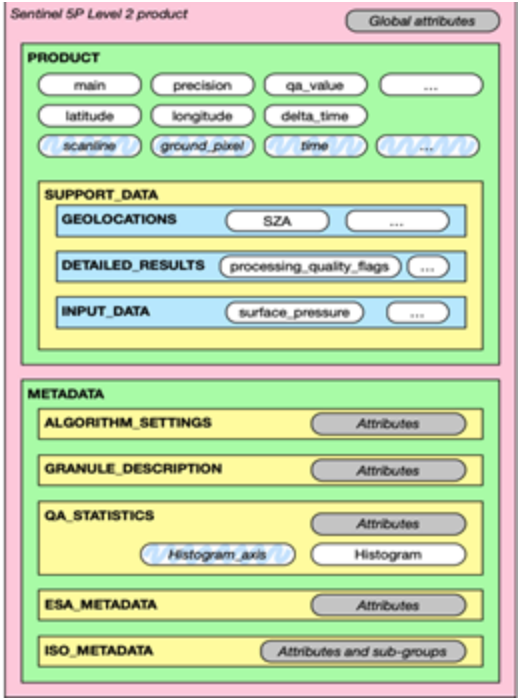
Challenges of TROPOMI L2 Data

- **None-gridded Data Format: A barrier to accessibility.**



Geolocation
Latitude: pixel center latitude
Longitude: pixel center longitude
Pixel Corners: pixel boundary



Complexity for users unfamiliar with earth science data formats
Traditional GIS software may struggle with processing the data complexity

https://sentinel.esa.int/documents/247904/2474726/Sentinel-5P-Level-2-Product-User-Manual-Sulphur-Dioxide

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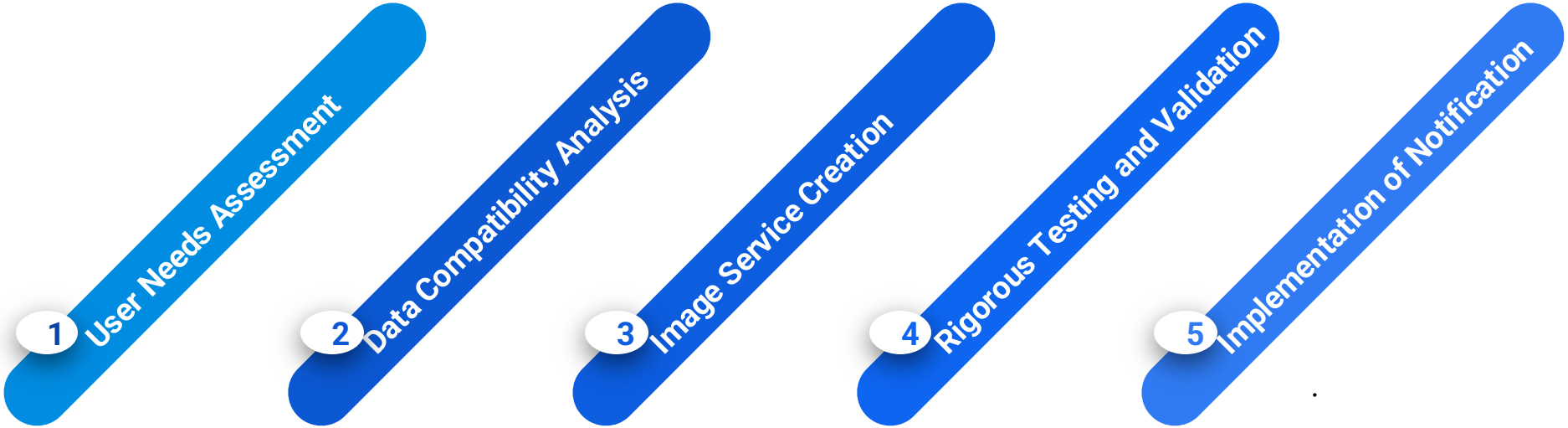
Service Development Process



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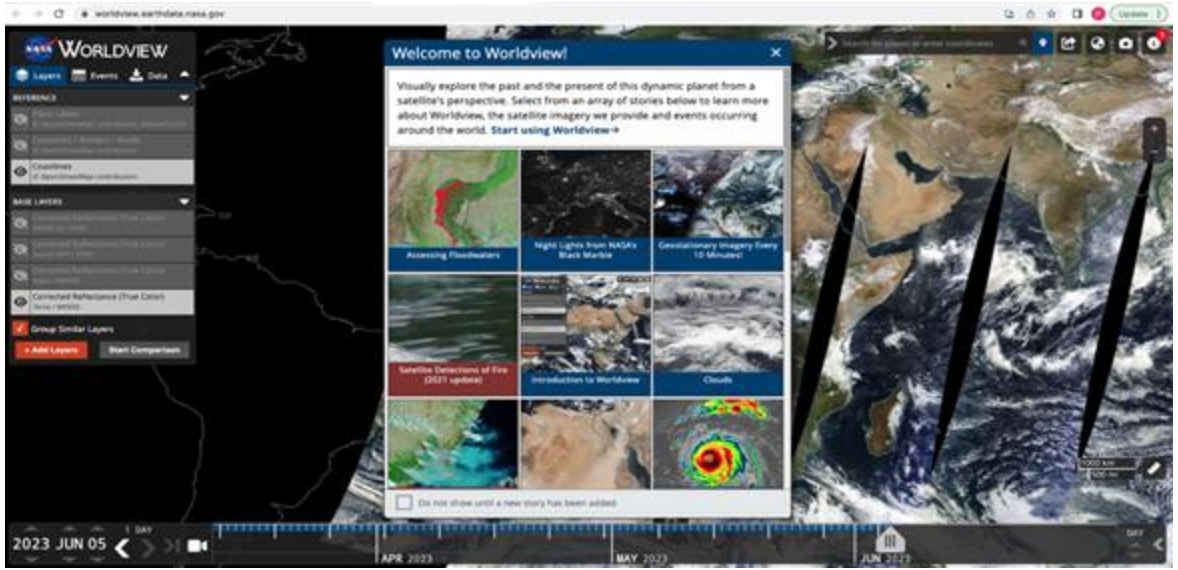
User Needs Assessment

- **NASA Global Imagery Browse Services (GIBS)**
  - Global, Full Resolution Imagery
  - Flexible Data Ingestion Mechanism
  - Consolidated Colormap Consistent with Other GIBS Products
  - Cloud-Native Notification



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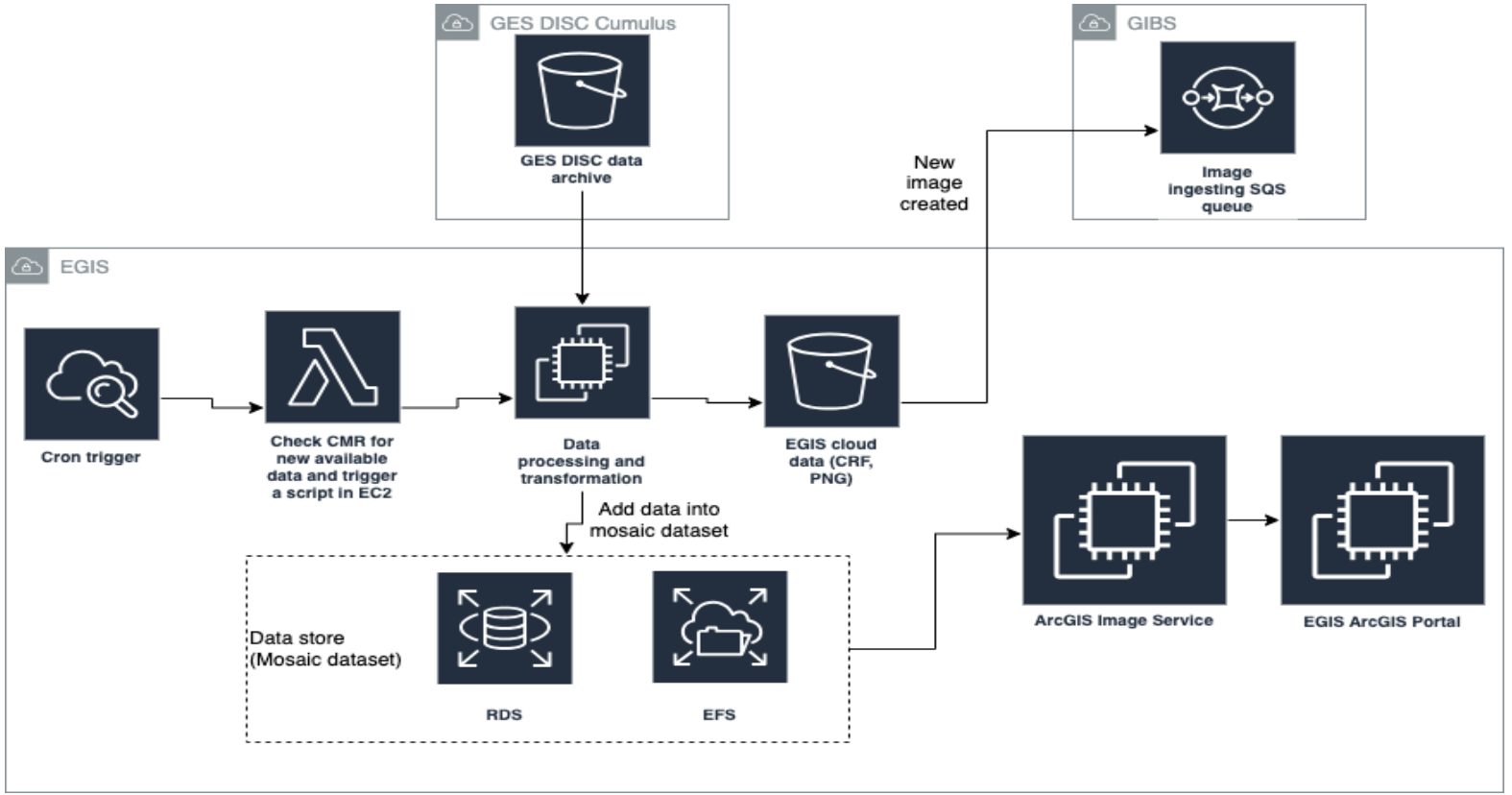
Service Workflow



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Data Compatibility Analysis

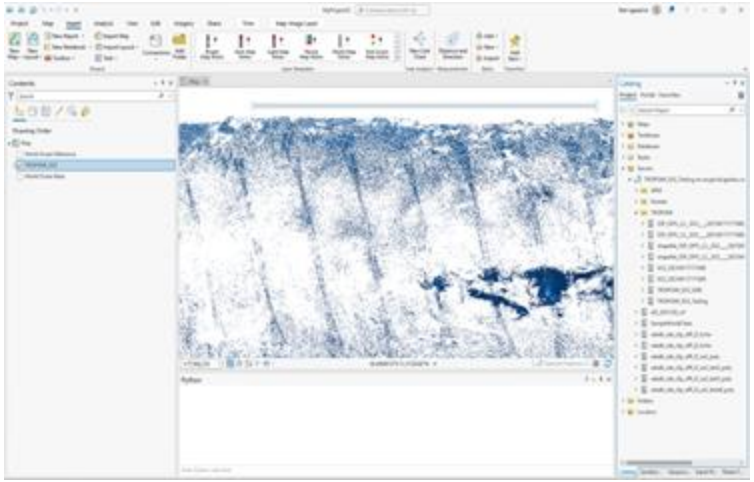
- **Evaluating TROPOMI L2 Data Structure**: Pixel boundary marked by four coordinates in longitude and latitude
- **Determining Necessary Data Transformation**
  - Generating Polygon Feature Layers from NetCDF
  - Converting Polygon Features to A Raster Dataset
  - Merging Multiple Datasets into A New Global Raster Dataset
    - Cloud Raster Format (CRF)
  - Creating a Symbology

Image Service Creation

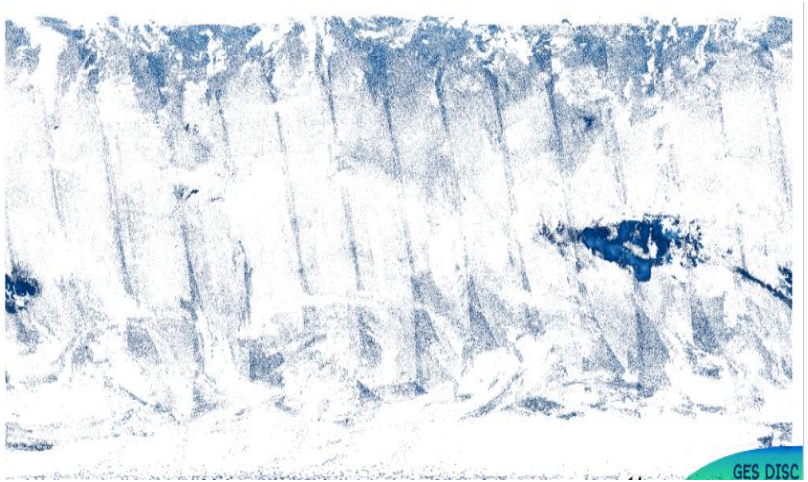
- **Creating A Multi-Temporal Mosaic of CRF Files**
- **Publishing An Image Service**
  - Using ArcGIS pro to publish an image service
  - Using ArcPy to publish an image service
  - Using REST API to publish an image service with a JSON file
- **Loading a Raster Function Template for Default Symbology**

Rigorous Testing and Validation

- **Conducting Extensive Testing to Ensure Accuracy and Performance**
- **Validating Data Integrity and Visualization Quality with Our Science Team**
- **Collecting Feedback from Users to Refine Services**



Using TROPOMI SO2 in ArcGIS Pro



Loading Daily Global Imagery of TROPOMI SO2 via OGC WMS

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Implementation of Notification

- **Developing a cloud-Native System to Ensure Users Stay Informed and Engaged with the Latest Updates, New Data Availability, and Service Changes**
  - Amazon Simple Notification Services (SNS): A fully managed messaging service
    - Facilitating communication between distributed systems, microservices, and serverless applications

Conclusion

- The image service will significantly enhance the usability and impact of TROPOMI data.
- The comprehensive development process ensures a reliable, user-centric service that meets diverse needs.
- Challenges
  - Handling non-gridded data
  - Ensuring data integrity and accuracy
  - Scalability and performance optimization