

Synthetic Aperture Radar (SAR) in GIS

Products and Services from the Alaska Satellite Facility



ALASKA GEOSUMMIT 2023

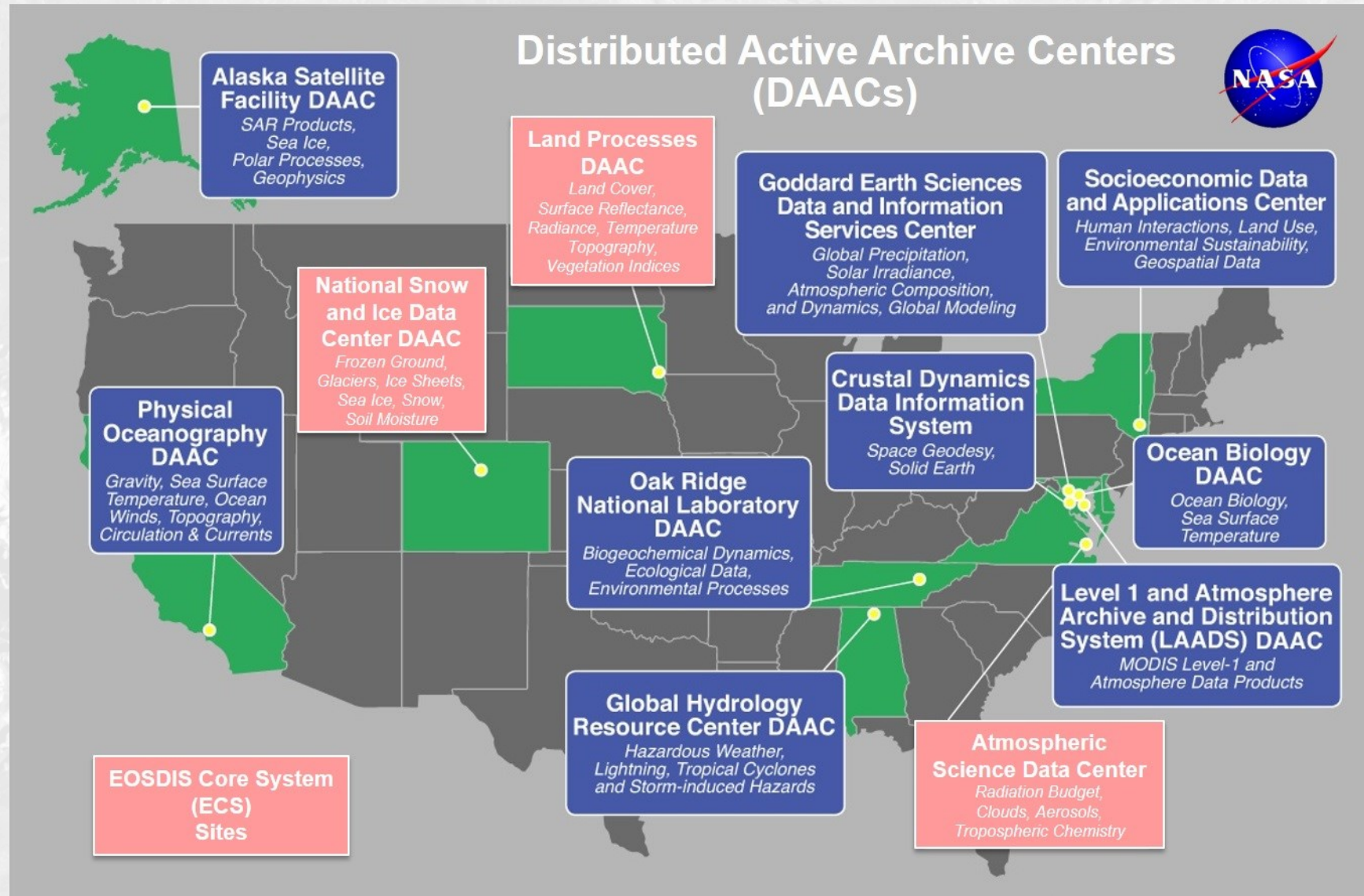
Heidi Kristenson, Senior GIS Specialist

Alaska Satellite Facility



About ASF DAAC

- 1 of 12 DAACs providing data and support services for EOSDIS (Earth Observing System Data and Information System)
- Maintains NASA archive of SAR data
 - Data from NASA, ESA, JAXA, CSA
- Our mission is to make SAR Remote Sensing Data more accessible





Sentinel-1



European Space Agency (ESA)
Copernicus Mission

- Global coverage with C-band SAR
- 2-satellite constellation
 - Sentinel-1A launched 2014, still active
 - Sentinel-1B launched 2016, [ended Dec 2021](#)
 - Each with 12-day return cycle, orbiting 180° apart (potential for 6-day repeat)
- Level 1 products (GRD & SLC)
 - Level 2 OCN products



NISAR



NASA & ISRO Collaboration
(Indian Space Research Organisation)

- Global coverage with L-band SAR
 - Limited coverage with S-band SAR
- 1 satellite
 - Due to launch in 2024
 - 12-day repeat cycle
- Level 1 and 2 products
 - Pre-processed analysis-ready products
 - Algorithms for Level 3 products

Vertex Data Search



EARTHDATA Other DAACs Feedback

ASF Data Search Vertex

Search Type: Geographic Search Dataset: Sentinel-1 Area of Interest: POLYGON((-86.988 41.73) Filters: 1,000 of 54 Files

Start: May 14 2020 End: May 29 2020 File Types: GRD_HD,SLC

Map View Zoom Layers Area of Interest Opacity 100%

lat 40.2195° lon -86.9466°

27 Scenes (54 of 54 Files) Queue On Demand Scene Detail 2 Files

- S1B_IW_GRDH_1SDV_20200527T233217_20200527T233242_021774_02953A_2D69 Sentinel-1 • C-Band
- S1B_IW_GRDH_1SDV_2020... A965 May 27 2020 23:33:07Z
- S1B_IW_GRDH_1SDV_2020... D8BA May 27 2020 23:32:42Z
- S1B_IW_GRDH_1SDV_2020... 2D69 May 27 2020 23:32:17Z
- S1B_IW_GRDH_1SDV_2020... B5A3 May 27 2020 23:31:48Z
- S1A_IW_GRDH_1SDV_2020... A55F May 26 2020 23:41:48Z

S1B_IW_GRDH_1SDV_20200527T233217_20200527T233242_021774_02953A_2D69

Start Time: 05/27/20, 23:32:17Z Stop Time: 05/27/20, 23:32:42Z Beam Mode: IW Path: 48 Frame: 138 Flight Direction: ASCENDING Polarization: VV+VH Absolute Orbit: 21774 Data courtesy of ESA Citation

L1 Single Look Complex (SLC) 4.58 GB

L1 Detected High-Res Dual-Pol (GRD-HD) 977.83 MB

SEARCH: Baseline SBAS More Like This

© 2023 ASF | Contact | Non-Discrimination

Explore and access/download all of ASF's data holdings

Programmatic Access

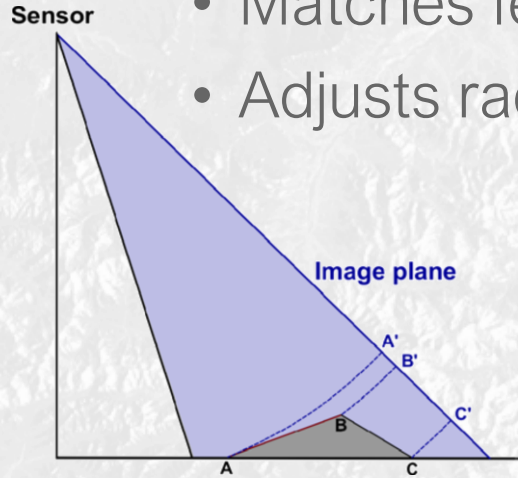
- asf_search Python module
- Search API

Radiometric Terrain Correction (RTC)

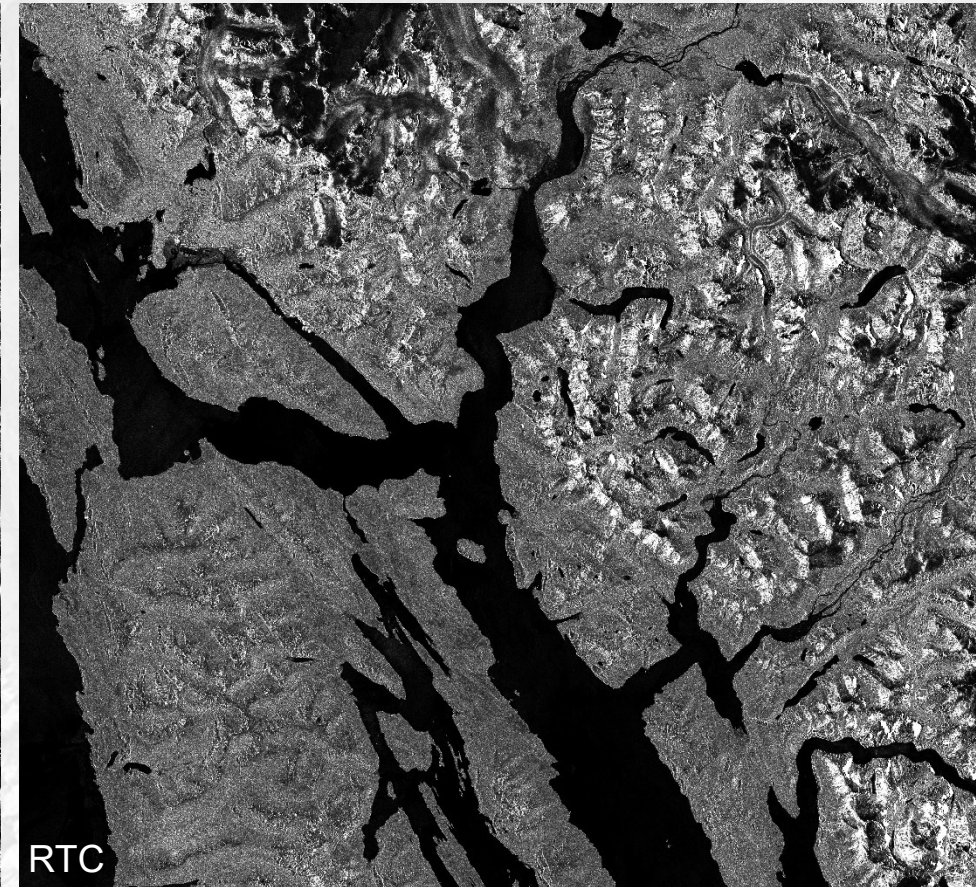
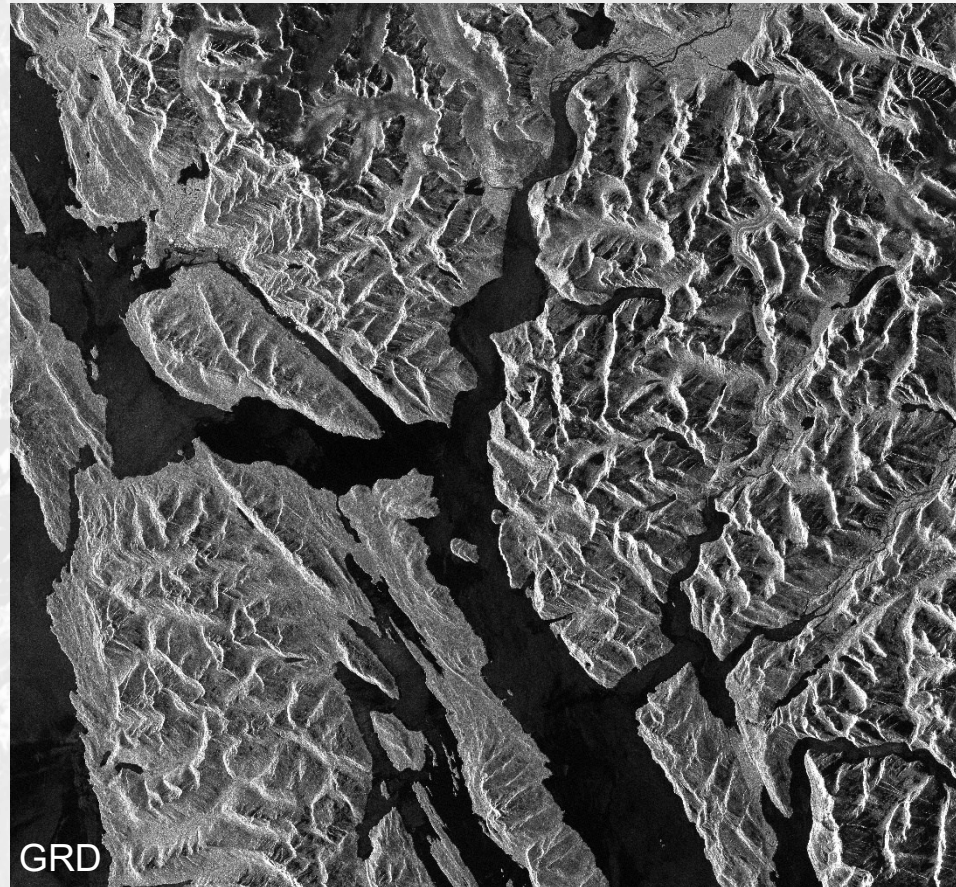


ASF

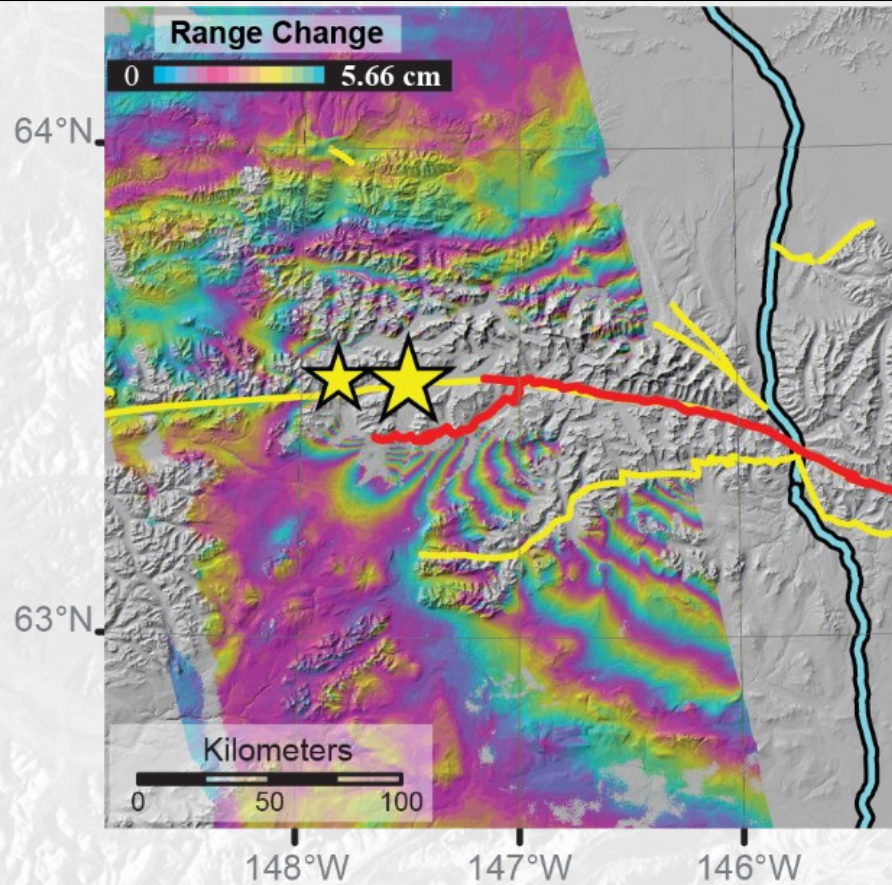
- Matches features in SAR image to actual landscape features
- Adjusts radiometric returns to represent the appropriate surface area



The signal backscattered from the mountaintop (B) is received shortly after the signal from the bottom, even though the bottom (A) is much closer to the sensor on the ground, making the mountains look like they're leaning left, with bright tops.



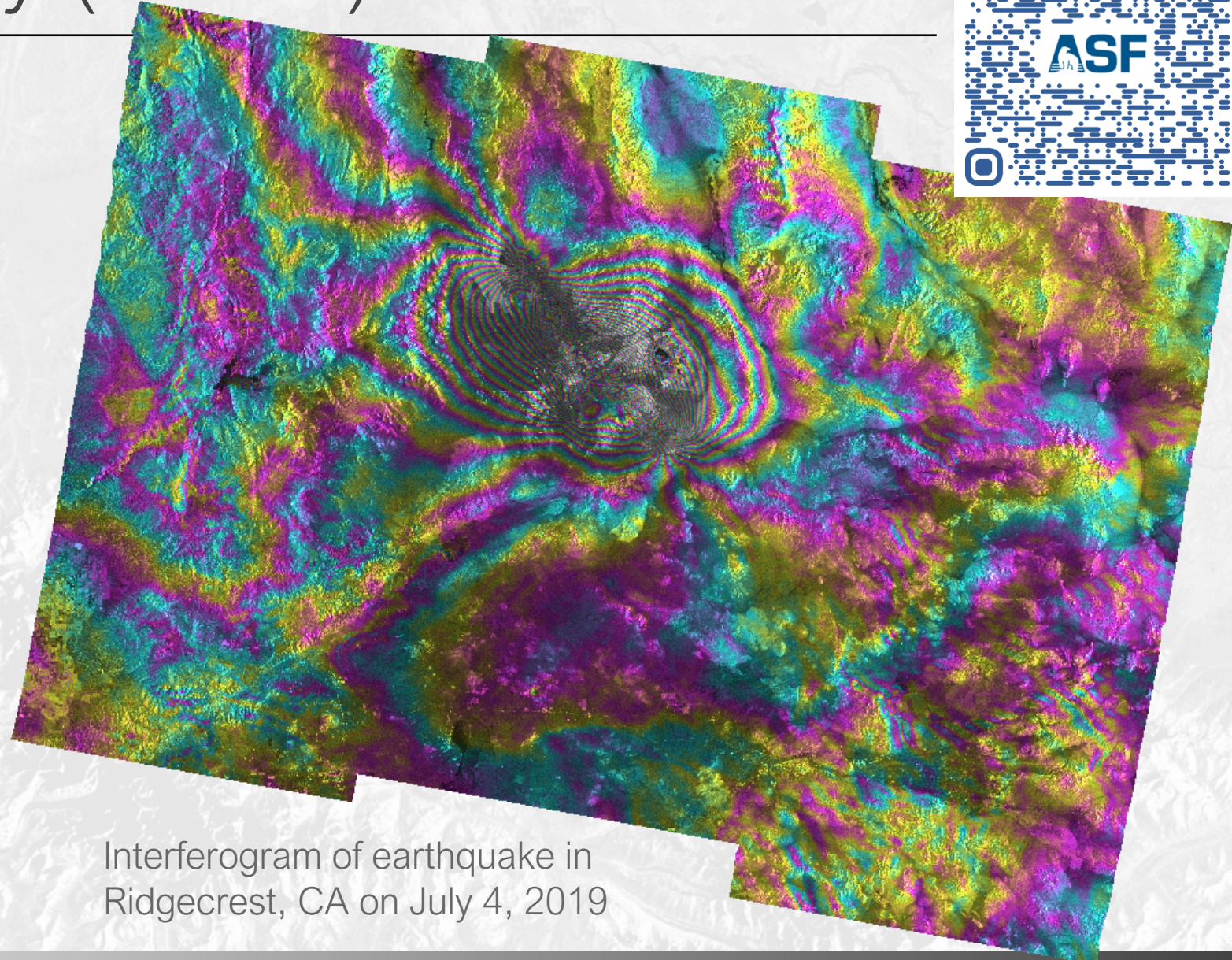
SAR Interferometry (InSAR)



Interferogram for the analysis of effects of earthquakes along the Denali fault

Large star: 7.9 main shock epicenter, November 2002

Small star: 6.7 foreshock epicenter, October 2002



Interferogram of earthquake in Ridgecrest, CA on July 4, 2019

Analysis-Ready Products from ASF

search.asf.alaska.edu/#/?maxResults=1000

EARTHDATA Other DAACS Feedback

ASF Data Search Vertex

Search Type: Geographic Search Dataset: Sentinel-1 Area of Interest: WKT Filters: 1,000 of 17,757,011 Files

On Demand Downloads Help English hjkristenson

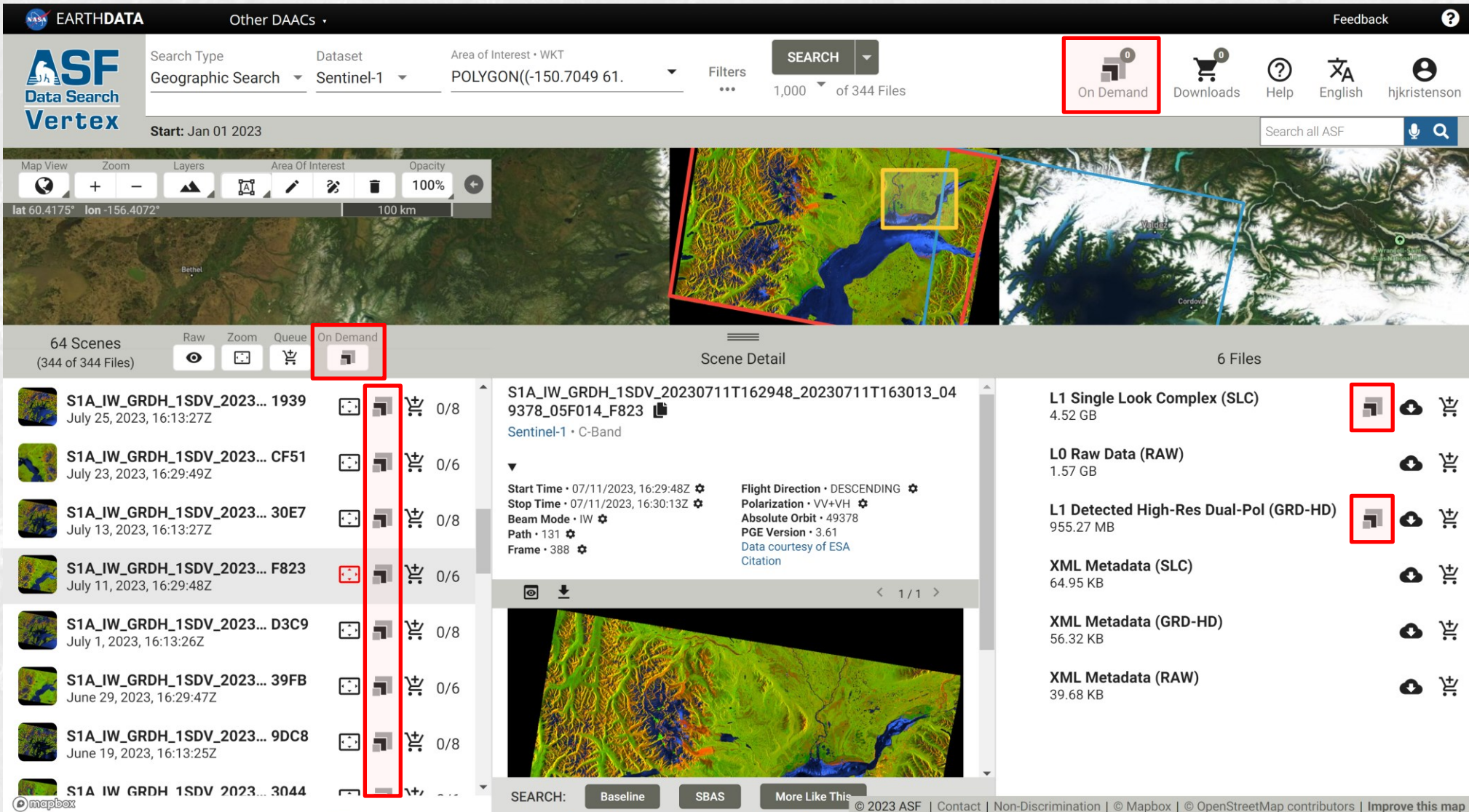
Product Name	Description	Period	Source
Sentinel-1	Sentinel-1 includes twin satellites that each carry C-band synthetic aperture radar (SAR), together providing all-weather, day-and-night imagery of Earth's surface.	2014 to Present	ESA
S1 Bursts (beta)	Sentinel-1 BURST products are the individual radar pulse responses that make up the 3 sub-swaths of every Sentinel-1 SLC product.	2014 to Present	ESA
OPERA-S1 (beta)	Sentinel-1 RTC backscatter products providing near-global coverage, as well as Sentinel-1 CSLC products covering North America.	2014 to Present	OPERA-JPL
ALOS PALSAR	PALSAR was developed to contribute to the fields of mapping, precise regional land-coverage observation, disaster monitoring, and resource surveying.	2006 to 2011	JAXA/METI
ARIA S1 GUNW	NISAR-format Level 2 standardized Sentinel-1 Interferogram products generated by JPL's Advanced Rapid Imaging and Analysis (ARIA) project.	2014 to Present	ARIA-JPL
UAVSAR	Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) is specifically designed to acquire airborne repeat-track SAR data for differential interferometric measurements.	2008 to Present	NASA

Annotations on the screenshot:

- Coming Soon...** (Yellow box around S1 Bursts)
- New!** (Red box around OPERA-S1)
- Available Only On Demand** (Blue box around Sentinel-1)
- Pre-Processed** (Yellow box around ALOS PALSAR)
- RTC** (Label at the bottom right of the map area)

- Sentinel-1
 - On Demand RTC
 - On Demand InSAR
- Sentinel-1 Bursts
 - InSAR in development
- OPERA S1
 - Since mid-October
 - Near-global
 - Forward processing
- ALOS PALSAR
 - 2006-2011
 - Subset have pre-processed RTC
- ARIA S1 GUNW
 - InSAR products
 - Limited locations
- UAVSAR
 - Airborne sensor
 - Limited space/time

On-Demand Processing with HyP3



ASF Data Search Vertex

Search Type: Geographic Search | Dataset: Sentinel-1 | Area of Interest: POLYGON((-150.7049 61. ...)

Start: Jan 01 2023 | 1,000 of 344 Files

Map View | Zoom | Layers | Area Of Interest | Opacity | 100%

64 Scenes (344 of 344 Files) | Raw | Zoom | Queue | **On Demand**

Scene ID	Date	Thumbnail	On Demand	Download	Share	Progress
S1A_IW_GRDH_1SDV_2023... 1939	July 25, 2023, 16:13:27Z		<input checked="" type="checkbox"/>			0/8
S1A_IW_GRDH_1SDV_2023... CF51	July 23, 2023, 16:29:49Z		<input checked="" type="checkbox"/>			0/6
S1A_IW_GRDH_1SDV_2023... 30E7	July 13, 2023, 16:13:27Z		<input checked="" type="checkbox"/>			0/8
S1A_IW_GRDH_1SDV_2023... F823	July 11, 2023, 16:29:48Z		<input checked="" type="checkbox"/>			0/6
S1A_IW_GRDH_1SDV_2023... D3C9	July 1, 2023, 16:13:26Z		<input checked="" type="checkbox"/>			0/8
S1A_IW_GRDH_1SDV_2023... 39FB	June 29, 2023, 16:29:47Z		<input checked="" type="checkbox"/>			0/6
S1A_IW_GRDH_1SDV_2023... 9DC8	June 19, 2023, 16:13:25Z		<input checked="" type="checkbox"/>			0/8
S1A IW GRDH 1SDV 2023... 3044			<input checked="" type="checkbox"/>			...

Scene Detail | 6 Files

S1A_IW_GRDH_1SDV_20230711T162948_20230711T163013_04 9378_05F014_F823
Sentinel-1 • C-Band

Start Time • 07/11/2023, 16:29:48Z | Stop Time • 07/11/2023, 16:30:13Z | Beam Mode • IW | Path • 131 | Frame • 388

Flight Direction • DESCENDING | Polarization • VV+VH | Absolute Orbit • 49378 | PGE Version • 3.61 | Data courtesy of ESA Citation

L1 Single Look Complex (SLC) 4.52 GB

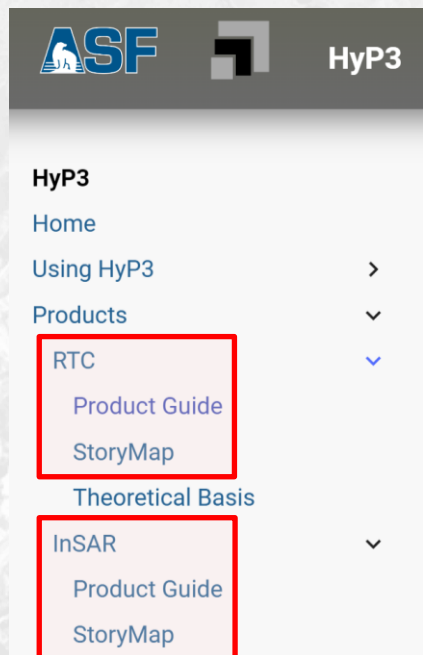
L0 Raw Data (RAW) 1.57 GB

L1 Detected High-Res Dual-Pol (GRD-HD) 955.27 MB

XML Metadata (SLC) 64.95 KB

XML Metadata (GRD-HD) 56.32 KB

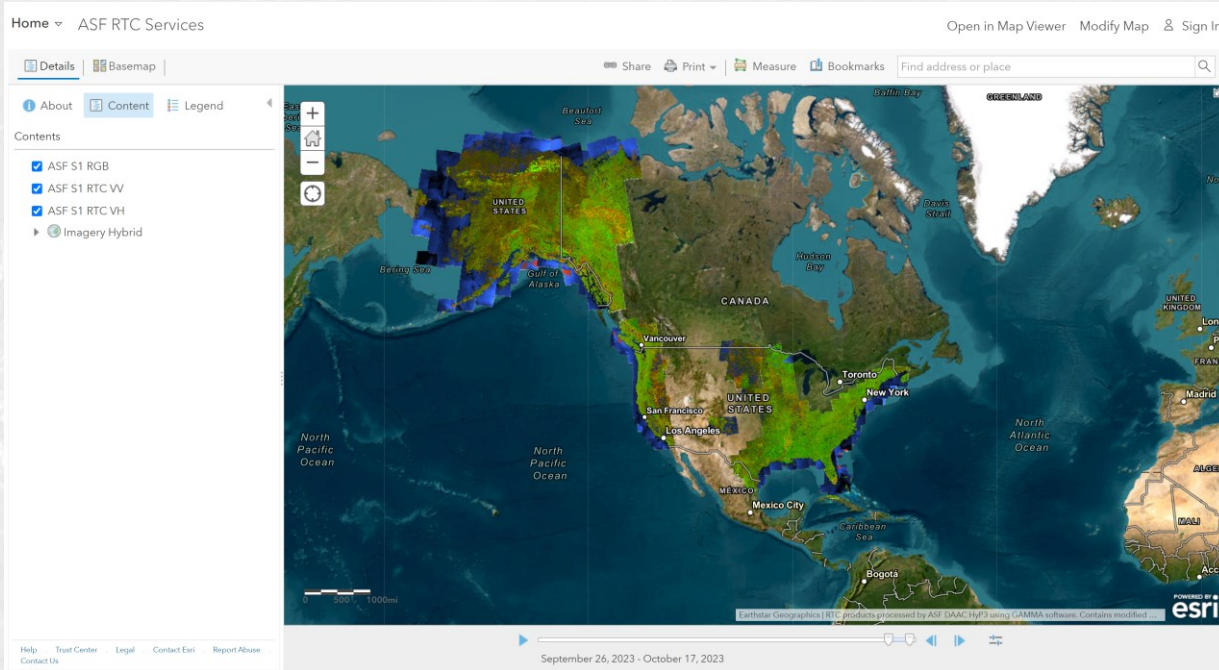
XML Metadata (RAW) 39.68 KB



ASF HyP3

- Home
- Using HyP3 >
- Products >
 - RTC
 - Product Guide
 - StoryMap
 - Theoretical Basis
- InSAR >
 - Product Guide
 - StoryMap

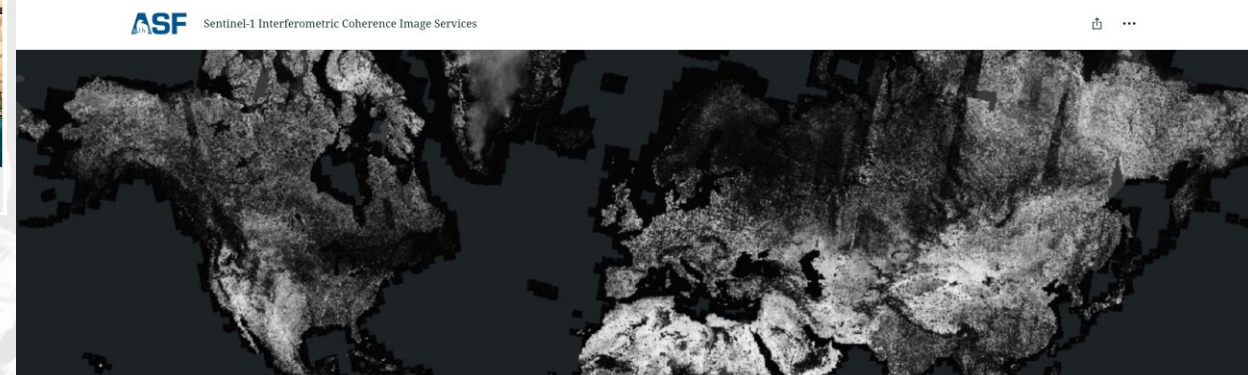
Image Services – Keeping it in the Cloud



- Global Seasonal Sentinel-1 Interferometric Coherence and Backscatter Data Set
- Image Services are hosted on NASA's Earthdata GIS Image Server



- Developed in support of the NASA Applied Sciences Disasters Program
- On-Demand RTC products and RGB Decomposition over requested AOIs



Sentinel-1 Interferometric Coherence Image Services

Enhancing access to the Global Seasonal Sentinel-1 Interferometric Coherence and Backscatter Dataset with Image Services

ASF ArcGIS Toolbox



Custom ArcGIS Python Toolbox designed for use with ASF's On Demand RTC Products



- Download, unzip, use
- Series of tutorials that make use of the ASF ArcGIS Toolbox are listed in the [RTC On Demand tutorial StoryMap](#)
- Recording of a webinar demonstrating the use of these tools is available on the Earthdata YouTube channel: [NASA Data Made Easy: Part 6- Flood Mapping in a Geographic Information System](#)

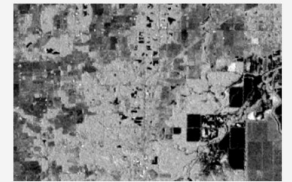
Tutorials

To learn how to use the tools included in the [ASF_Tools ArcGIS Toolbox](#) to work with the data from this case study, select from the following tutorials:

Scale Conversion Tool

Convert among common SAR scales (Power, Amplitude, dB)

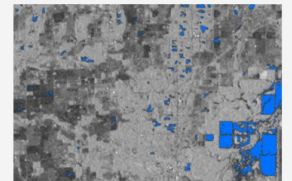
<https://www.arcgis.com>



Reclassify RTC Tool

Generate a water mask using a dB threshold approach

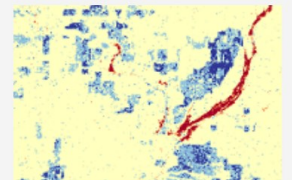
<https://storymaps.arcgis.com>



Log Difference Tool

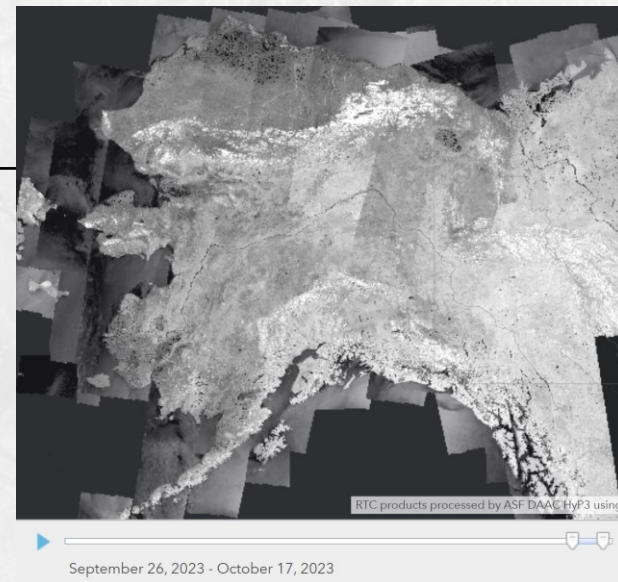
Identify change using the log difference between two images

<https://storymaps.arcgis.com>



Conference Themes

- How can your work be applied at the local level?
 - Check out our products and services and get in touch!
 - Sentinel-1 provides excellent coverage over most of Alaska
- How has coordination improved your work in Alaska?
 - Collaboration with end users, such as the Alaska Volcano Observatory, has led to product enhancements based on their feedback
- What about this work could bring innovation to Alaska?
 - Accelerate science by moving the SAR analysis start line closer to the finish
- How is your work accessed by the public or leveraged by others?
 - We have a global community of users – we'd like it to include you!



Contacts and Resources



ASF Data Search – Vertex:
<https://search.asf.alaska.edu/>

HyP3 Product Documentation:
<https://hyp3-docs.asf.alaska.edu/products/>

Vertex Documentation:
<https://docs.asf.alaska.edu/vertex/manual/>

ASF Website:
<https://asf.alaska.edu/>

Contact ASF:
<https://asf.alaska.edu/asf/contact-us/>

Heidi Kristenson
hjkristenson@alaska.edu



ASF AGOL

On-Demand RTC Story Map Tutorial
<https://storymaps.arcgis.com/stories/2ead3222d2294d1fae1d11d3f98d7c35>

On-Demand InSAR Story Map Tutorial
<https://storymaps.arcgis.com/stories/68a8a3253900411185ae9eb6bb5283d3>

NASA EOSDIS Webinar: Introduction to SAR
https://youtu.be/R_-T0BddWQY

NASA EOSDIS Webinar: SAR Applications in GIS
<https://youtu.be/uNslcJ8wCWA>

NASA EOSDIS Webinar: On-Demand Sentinel-1 RTC
<https://youtu.be/t41JX2qnHJA>

NASA EOSDIS Webinar: On-Demand Sentinel-1 InSAR
<https://youtu.be/R-t2utzo7mg>

SAR Handbook
<https://servirglobal.net/resources/sar-handbook>

EdX Alaska SAR MOOC Courses
<https://www.edx.org/certificates/professional-certificate/alaskax-synthetic-aperture-radar-sar-applications>

Earthdata Login
<https://urs.earthdata.nasa.gov/users/new>

On-Demand Video Tutorial
<https://search.asf.alaska.edu/#/?topic=onDemand>

ArcGIS Toolbox
<https://asf.alaska.edu/how-to/data-tools/gis-tools/>

Sentinel-1 Mission
<https://sentinel.esa.int/web/sentinel/missions/sentinel-1>



Earthdata GIS