



Jet Propulsion Laboratory
California Institute of Technology

InSAR Scientific Computing Environment Enhanced Edition (ISCE3)

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Acknowledgement

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With contributions from ISCE3 team:

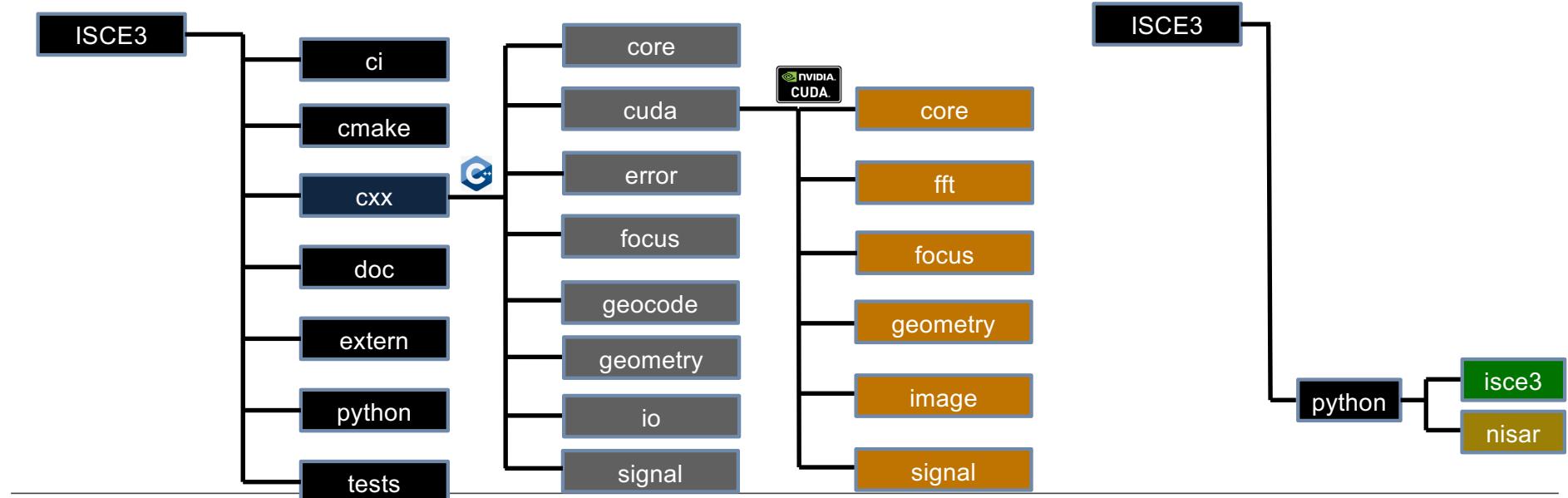
Geoffrey Gunter, Brian Hawkins, Ryan Burns, Virginia Brancato, Gustavo Shiroma, Hirad Ghaemi, Liang Yu, Bo Huang, Jungkyo Jung, Xiaodong Huang, Scott Staniewicz, Seongsu Jeong, Michael Avazis, Marco Lavalle, and Paul Rosen

ISCE3 general overview

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- ISCE3 is an open-source library for processing Synthetic Aperture Radar (SAR) data
- A successor to the ISCE2
- It is a ground-up redesign focusing on improved modularity, documentation, and test-driven development (funded originally by AIST and matured by NISAR)
- The development is driven by NISAR needs. Core developers are NISAR ADT team
- The processor for NISAR.
- The workflows to produce Sentinel-1 products (e.g., RTC and CSLC) are built on ISCE3 modules



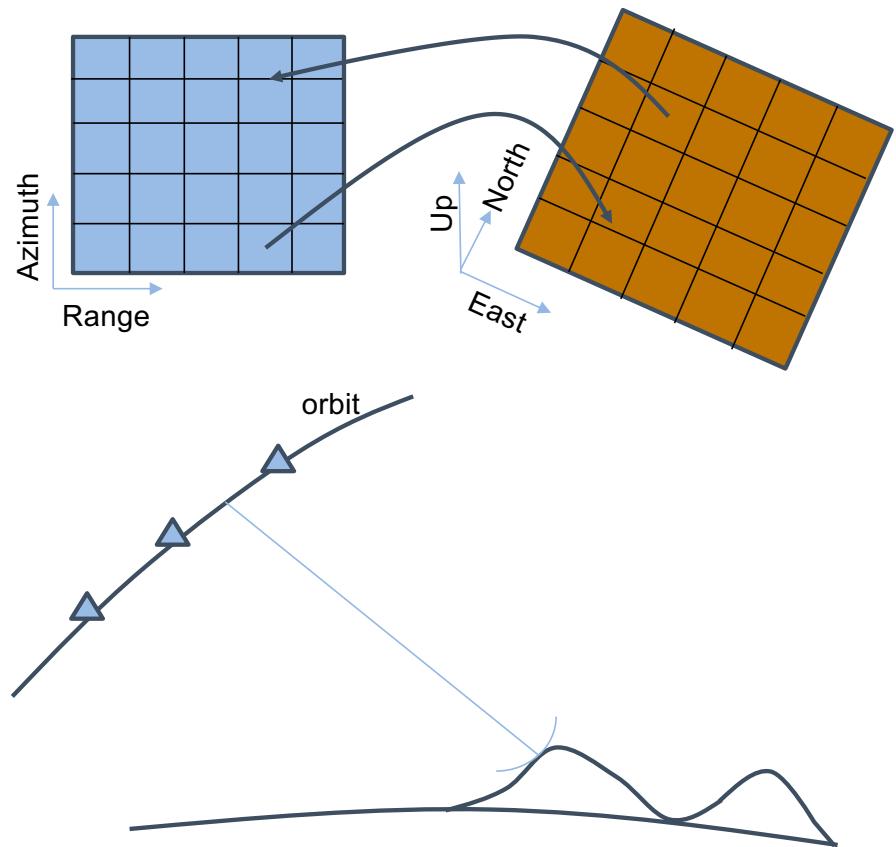
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ISCE3 low level functionalities

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- **Geometrical computations**
 - Forward mapping from radar coordinates to geo-coordinates
 - Inverse mapping from geocoded coordinates to radar coordinates
- **Geodetic transformations**
 - Lat/lon to XYZ
 - Reprojection
- **Interpolation**
 - Nearest, bilinear, biquintic, Sinc, etc
- **Convolution**
- **FFT computations**
- **DateTime**
- **Orbit**
- **Look Up Tables**
-



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ISCE3 modular design and functionalities

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The modular design of ISCE3 allows for convenient downstream workflow development

Core/basic functionalities

- **Geometrical computations**
 - Forward mapping from radar coordinates to geo-coordinates
 - Inverse mapping from geocoded coordinates to radar coordinates
- **Geodetic transformations**
 - Lat/lon to XYZ
 - Reprojection
- **Interpolation**
 - Nearest, bilinear, biquintic, Sinc, etc
- **Convolution**
- **FFT computations**
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Core modules

- **Image formation**
- **Geometrical offsets computation**
- **Image matching (cross correlation)**
- **Geocoding**
- **Radiometric Terrain Correction**
- **Interferogram formation**
- **Phase unwrapping**

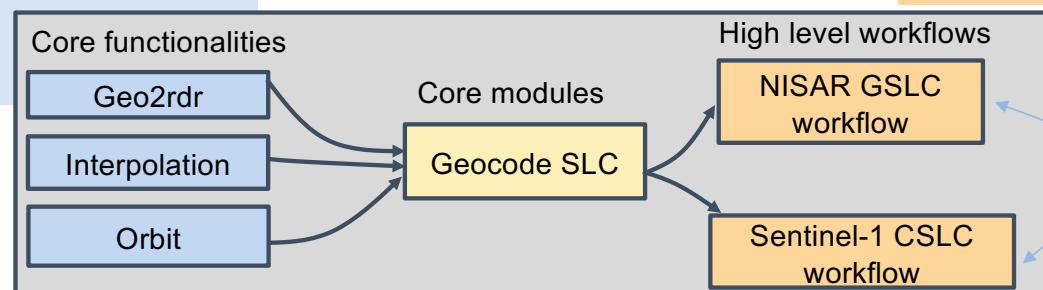
Workflows

NISAR (a package inside ISCE3 repository):

- RSLC focusing
- GSLC workflow
- GCOV workflow
- InSAR workflow
- Offsets workflow

Sentinel-1 (outside ISCE3):

- OPERA RTC workflow for Sentinel-1
- OPERA CSLC workflow for Sentinel-1



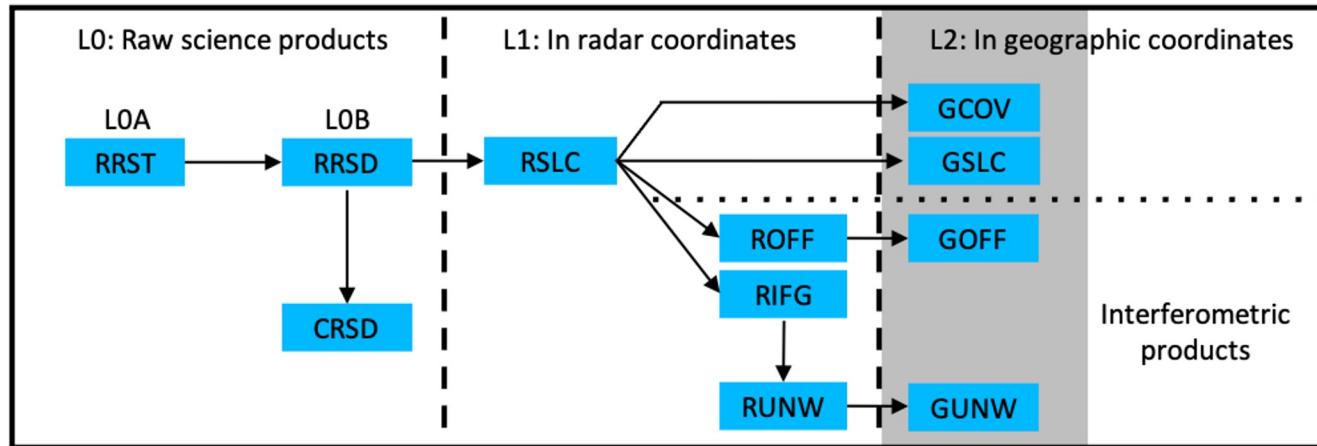
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ISCE3 supports NISAR mission

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ISCE3 will be used to process NISAR raw data (L0B) to Level-1 and Level-2 products



RSLC: Range-Doppler Single Look Complex

RIFG: Range-Doppler Interferogram

RUNW: Range-Doppler Unwrapped Interferogram

ROFF: Range-Doppler Offsets

GUNW: Geocoded Unwrapped Interferogram

GSLC: Geocoded SLC

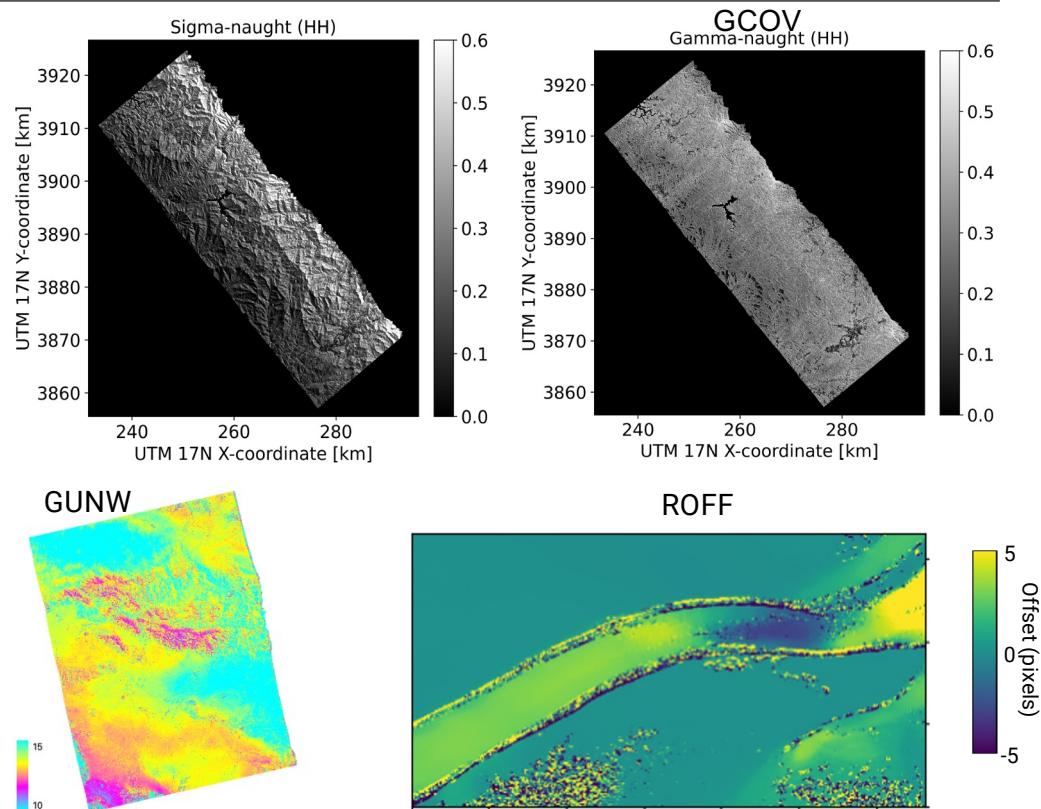
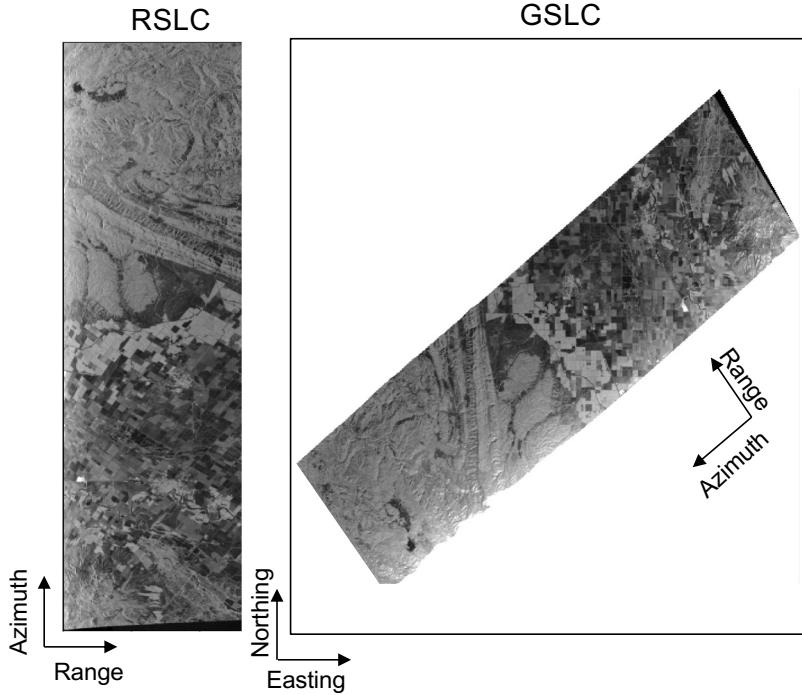
GOFF: Geocoded Offsets

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NISAR Sample products

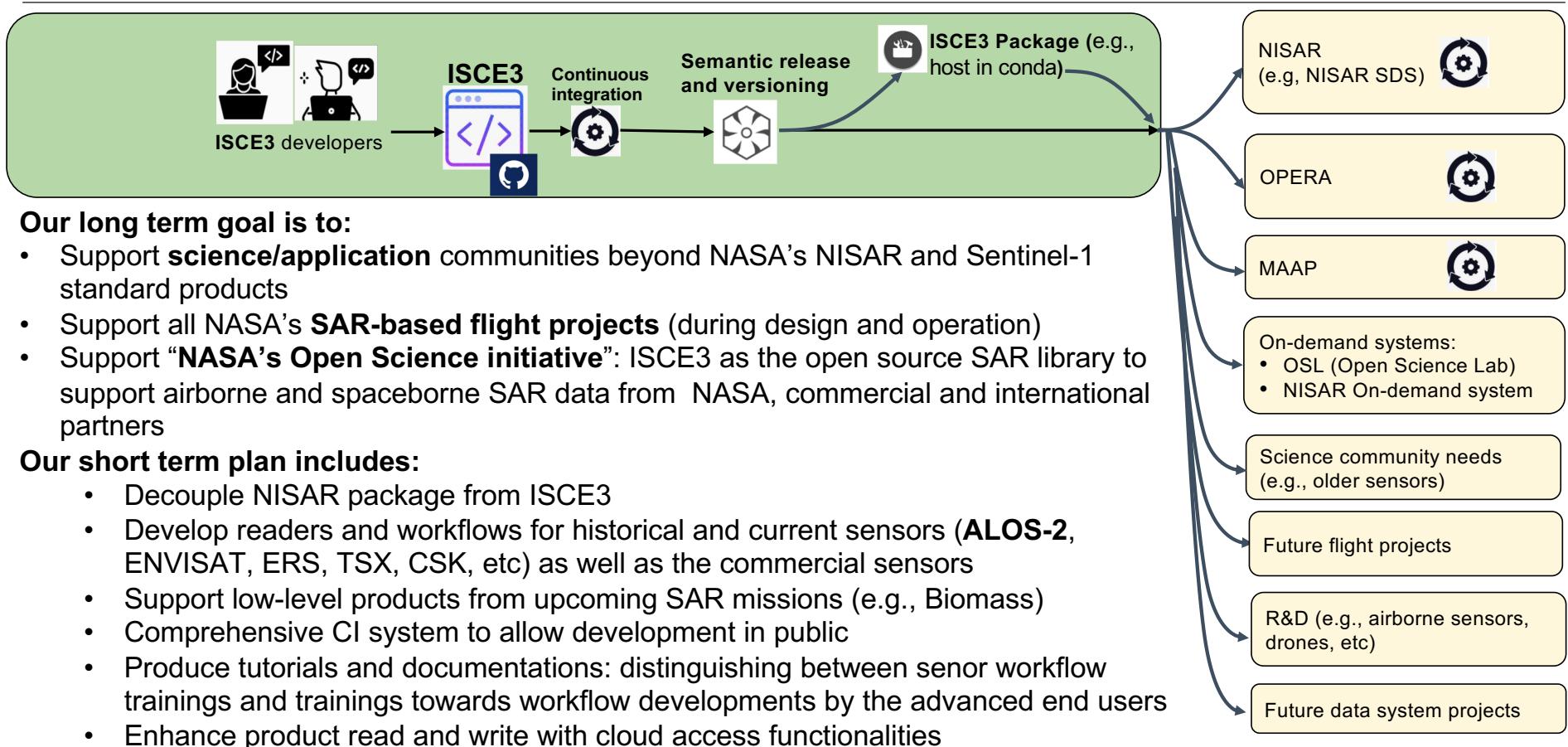


Visit NISAR website for the latest NISAR sample products: <https://nisar.jpl.nasa.gov/data/sample-data/>

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ISCE3, current status and future plans

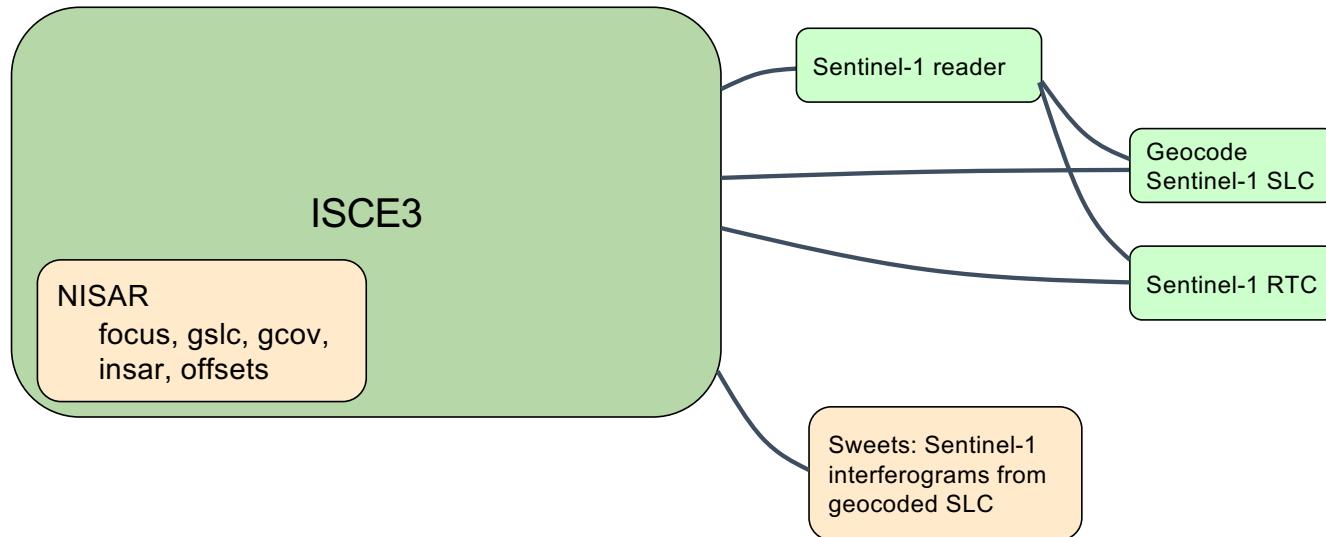
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ISCE3 based tools for processing Sentinel-1 data

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ISCE3 based tools for Sentinel-1 :

Matured tools

- Sentinel-1 reader
- Radiometric Terrain Corrected backscatter from Sentinel-1
- Geocoded SLC from Sentinel-1

Under development tools:

- *sweets*: workflow for creating unwrapped interferograms from Sentinel-1 geocoded SLCs

What is already available to the community

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ISCE3 repository on public github
<https://github.com/isce-framework/isce3>

conda install -c conda-forge isce3

ISCE3 with Cuda:
conda install conda-forge::isce3-cuda

Sentinel-1 reader
<https://github.com/isce-framework/s1-reader>

conda install -c conda-forge s1reader

COMPASS (geocode Sentinel-1 SLC)
<https://github.com/opera-adt/COMPASS>

conda install -c conda-forge compass

Sentinel-1 RTC
<https://github.com/opera-adt/RTC>

Sweets
<https://github.com/isce-framework/sweets>

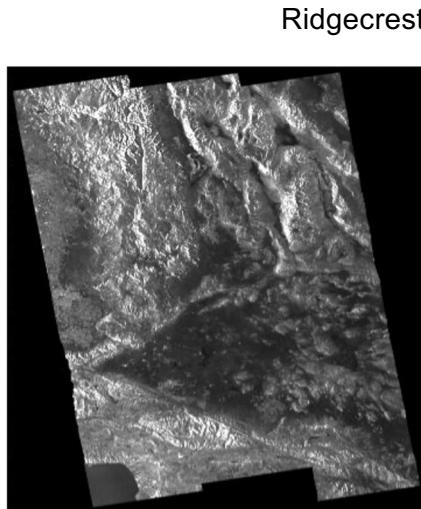
conda install -c conda-forge sweets

Geocoded Single Look Complex from NISAR and Sentinel-1

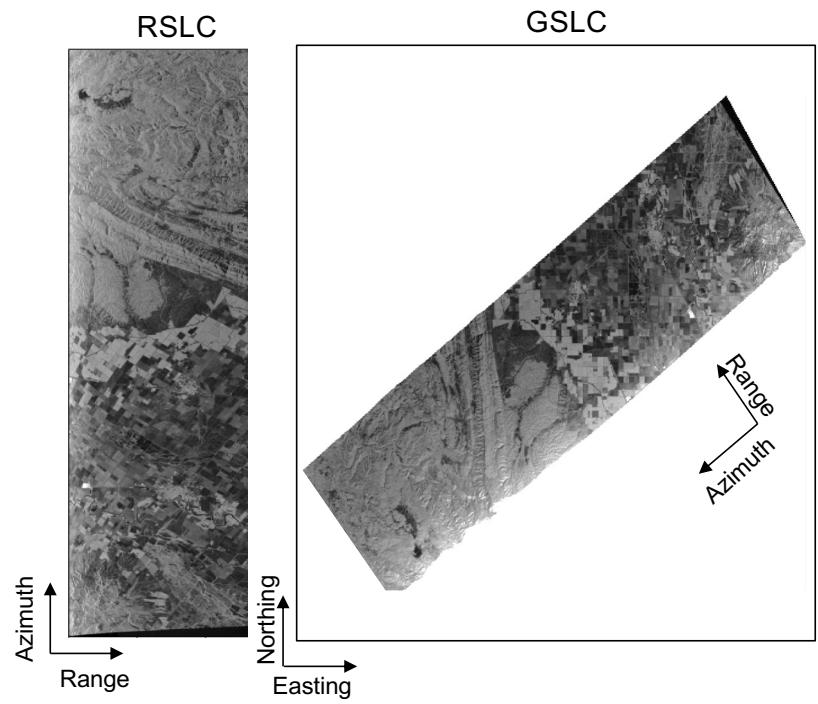
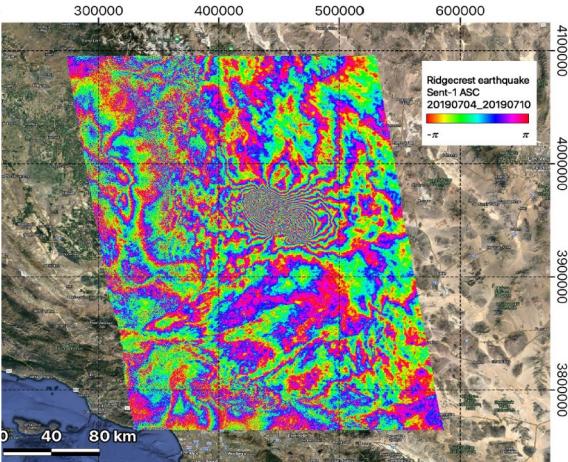
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ISCE3 can produce geocoded SLCs from NISAR and
Sentinel-1 SLCs



Ridgecrest earthquake, July 2019



- RSLC represents simulated NISAR product from UAVSAR
- GSLC is derived by geocoding the RSLC

<https://github.com/opera-adt/COMPASS>
<https://github.com/isce-framework/sweets>

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Radiometric Terrain Corrected from Sentinel-1

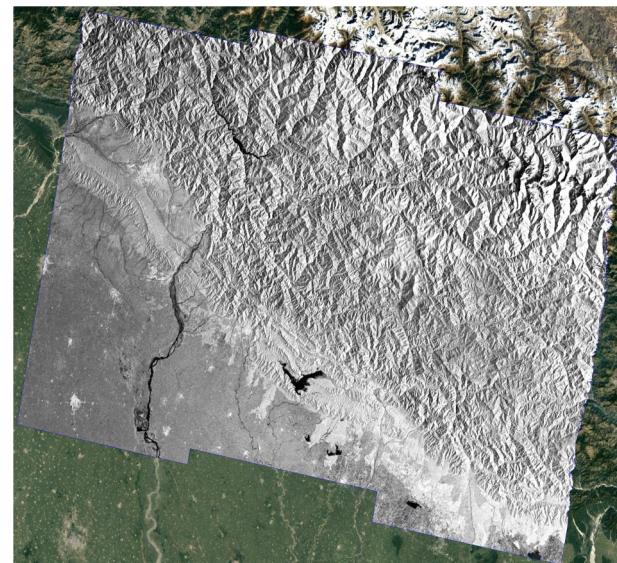
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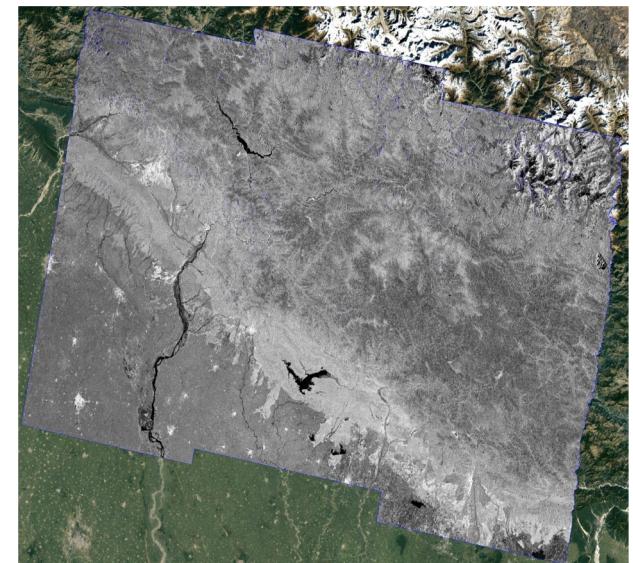
ISCE3 based tools are available to compute Radiometric Terrain Corrected SAR backscatter from Sentinel-1 imagery

The contribution of topography to the backscatter is estimated and removed using an area projection algorithm

Mosaic of Uncorrected SAR image - beta-naught



Mosaic of RTC burst products - gamma-naught



<https://github.com/opera-adt/RTC>

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Radiometric Terrain Corrected from Sentinel-1

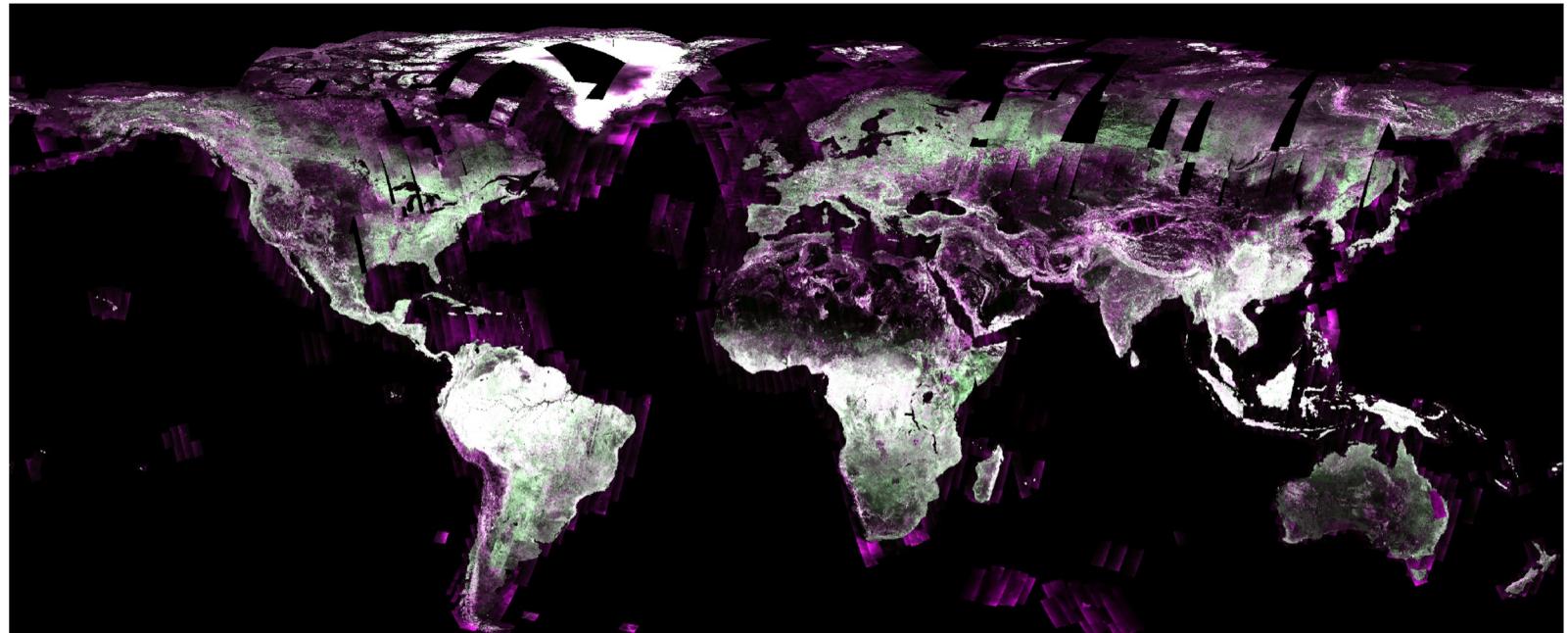
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ISCE3 based RTC products from Sentinel-1 scaled to globe by the OPERA data system

One cycle of
Sentinel-1 SLC
imagery was
processed to
burst RTC
products by the
OPERA data
system

A total ~270K
products were
generated



[Gustavo H. X. Shiroma, Heresh Fattahi, Franz Meyer, Seongsu Jeong, Luca Cinquini, Scott Collins, Bruce Chapman, Steven K. Chan, Alexander L. Handwerger, David Bekaert, The OPERA Radiometric Terrain Corrected SAR Backscatter From Sentinel-1 (RTC-S1) Product, IGARSS 2023]

The Sentinel-1 RTC product produced by OPERA project, is equivalent to NISAR GCOV product

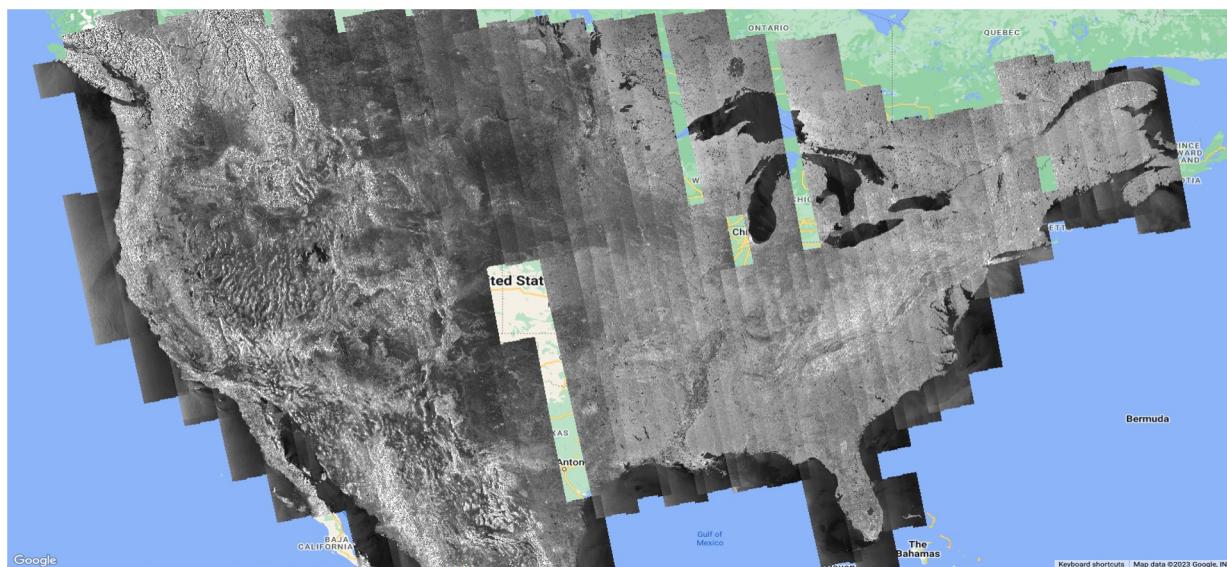
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Geocoded SLC from Sentinel-1

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Mosaic of ISCE3-based geocoded SLC from Sentinel-1 (CSLC-S1) backscatter amplitude for one cycle of Sentinel-1 data scaled over US by the OPERA data system



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Thank you!

