Jet Propulsion Laboratory
California Institute of Technology

ARIA: Delivering state-of-the-art InSAR products for end users

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AGU 2016

ARIA Project Team

JPL + Caltech

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Overview

- ARIA's SAR-related capabilities
- Example products
  - Nominal processing
  - Event response
- Access to ARIA's InSAR products
  - Facet search/ API
- How should end users prepare?
  - GIS tools
- Next steps

ARIA Overview

"We have high hopes for ARIA."

Keiko Saito
World Bank

Integrating
Space Geodesy
Seismology
Modeling

"This is exactly the kind of product we are looking for."

Anne Rosinski
Calif. Geol. Survey

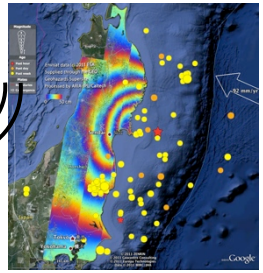
Radar Sensors

GPS Networks

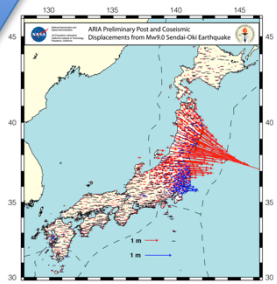
Seismic Networks

Optical Sensors

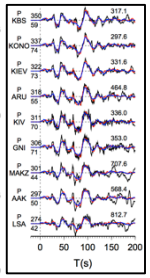
Automated Data Collection & Processing



Radar



GPS

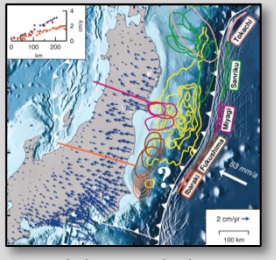


Seismology

Monitoring & Near Real-Time Assessment

Building Damage & Inundation

Permanent Ground Deformation

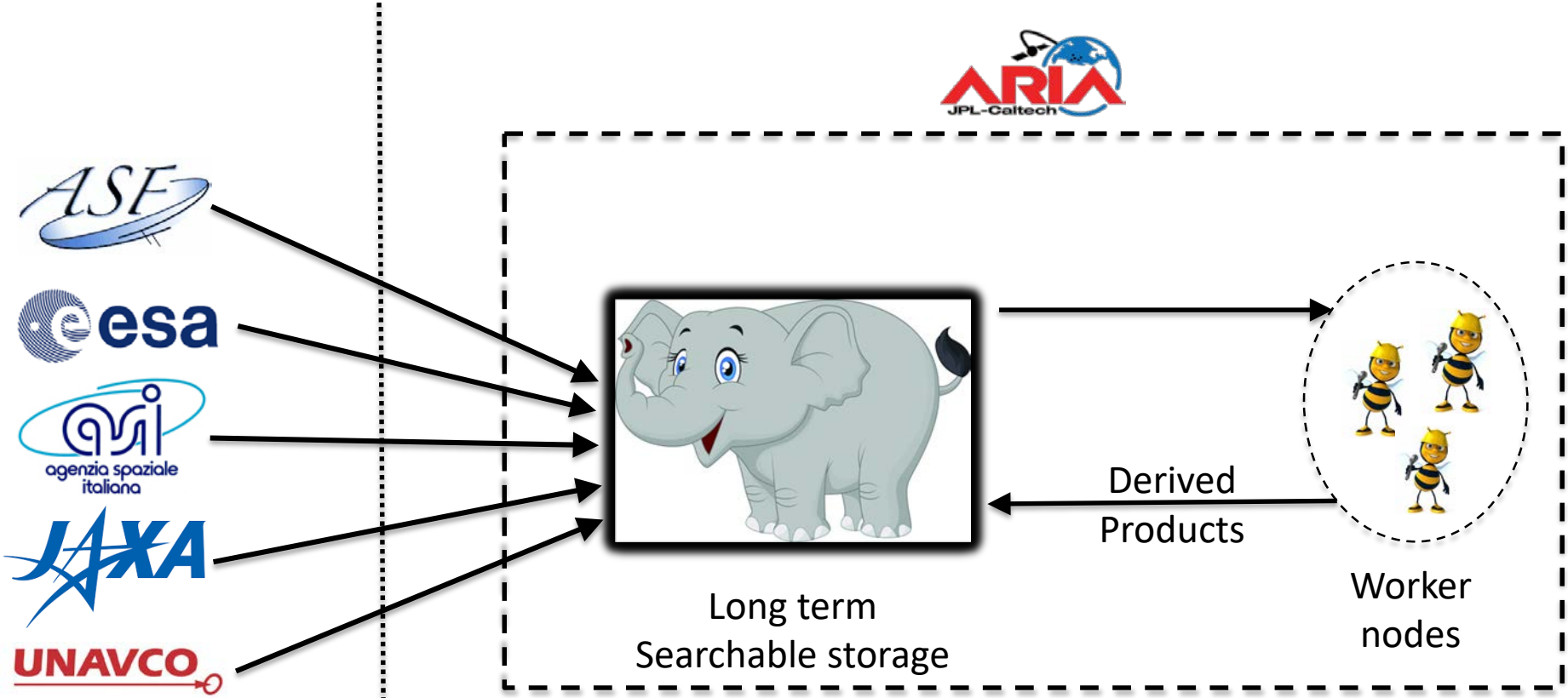


High-Resolution Hazard Assessment from Fault Models

Examples from the 2011 M9.0 Tohoku-Oki (Japan) earthquake

Potential Partners

AOI-driven data archive

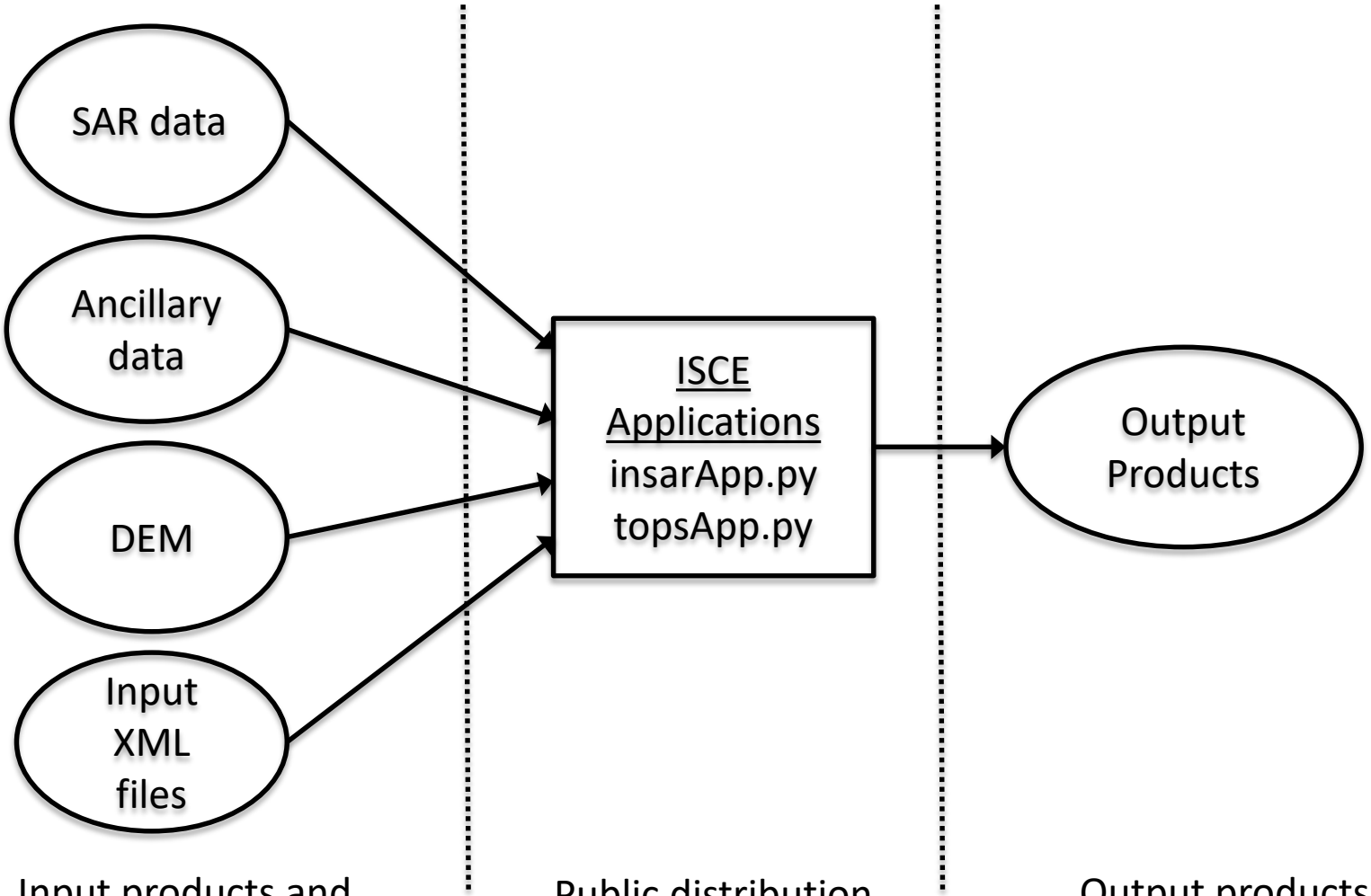


External SAR
Level-0 and Level-1
Data sources

Easy to add

- New data feeds / sources
- New AOIs
- New types of products

ISCE-driven workflows



Input products and configuration files are staged on a worker node

Public distribution of ISCE is used in production

Output products are tagged with appropriate metadata and archived

Stripmap interferograms

- ARIA processing system was initially set up to process ALOS and COSMO-SkyMed stripmap datasets

- Uses “insarApp.py” workflow to generate stripmap interferogams
    - Can support all sensors that ”insarApp.py” can handle.
    - Processing parameter configuration same as “insarApp.py”
    - Frame stitching possible starting at RAW level

- ARIA also uses the ISCE readers to catalog and archive incoming Level-0 RAW and Level-1 SLC data.

TOPS interferograms

- Uses “topsApp.py” workflow to generate Sentinel-1 TOPS mode interferogams from Level-1 SLCs
    - Processing parameter configuration same as “topsApp.py”
    - Can handle multiple slice stitching

- Currently, single swath processing implemented
    - 80 Km swath is sufficient for most applications
    - Phase unwrapping problem tractable

- Fine coregistration in azimuth using Enhanced Spectral Diversity (ESD)

Nominal Processing

Parameter	insarApp	topsApp
Pair selection	F(Bperp,Δt,sensor)	Δt < 72 days
Number of looks	~ 30m	~ 30m
Phase unwrapping	Snaphu + MCF	Snaphu + MCF
Coregistration	Amplitude correlation	Geometric
Geocoded output	SRTM 30m grid	SRTM 30m grid
DEM	SRTM + GDEM2	SRTM + GDEM2
Adaptive filter strength	0.5	0.5

- Frame-by-frame processing – 70% overlap
- Latitude band based processing
  - Allows for multi-frame stitching
  - Once latitude band is filled, processing jobs are launched

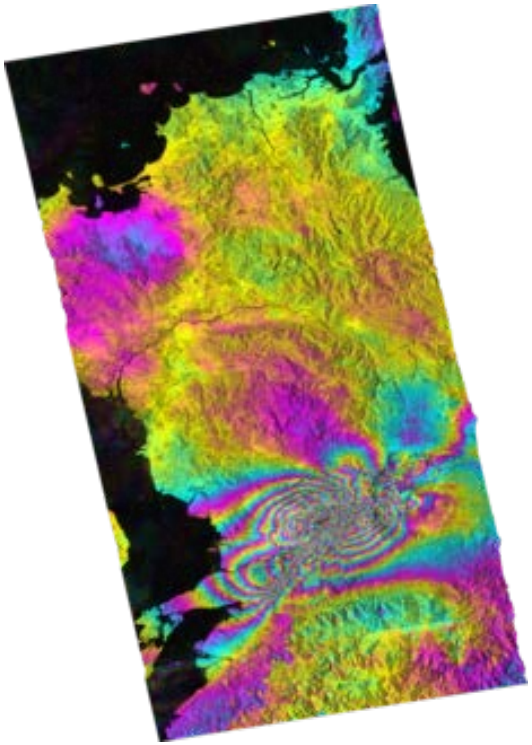
Event response

- To respond to an event, a new “Area of Interest” (AOI) needs to be added to the system
  - Can be triggered automatically if needed
  - Data search / ingest from external sources immediately kicks off

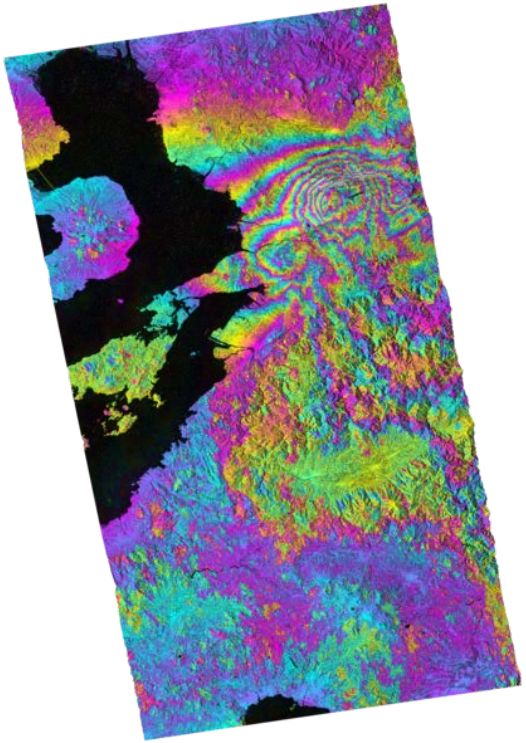
- Some processing parameter setup takes place depending on the size of the event
  - Single/ multi frame interferograms

- Email notifications can be set up to notify users when SAR data / derived products become available in the ARIA system

Kumamoto, Japan



20160408-20160420
Track 156, IW1
(3 more)

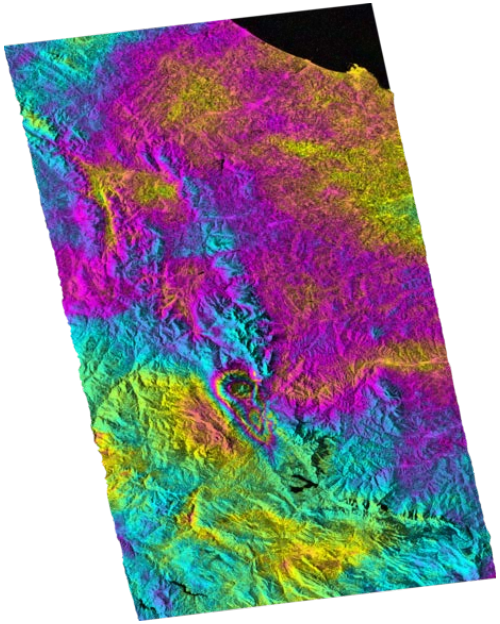


20160401-20160425
Track 54, IW3
(4 more)

- Numerous interferograms from various imaging geometries were automatically processed by the ARIA system
- The interferogram processing jobs were triggered as the data was ingested by the system.

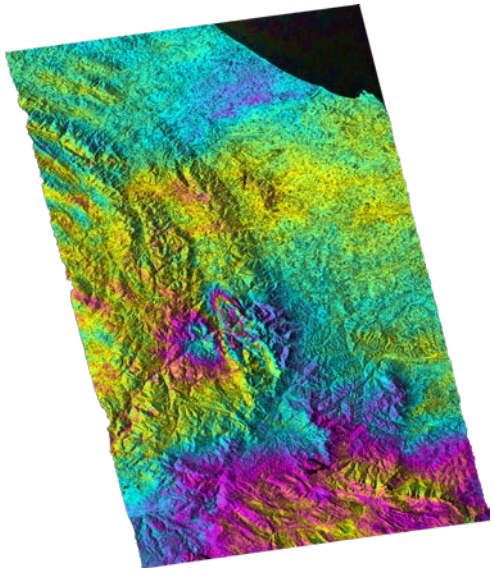
3 more interferograms for ascending Track 163 were also generated

Italy



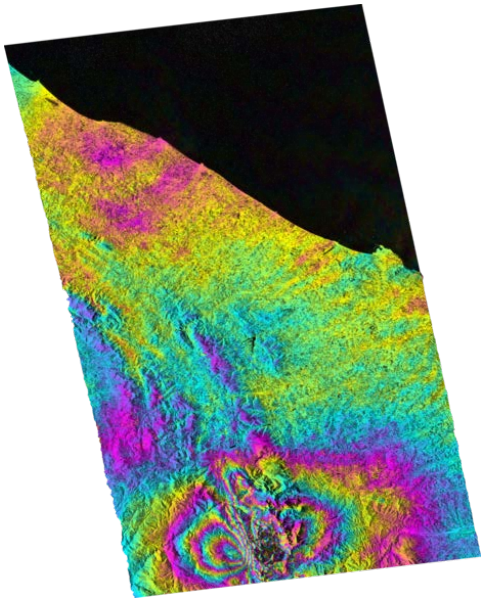
20160815-20160827
Track 117, IW3
Amatrice EQ

Time tag in the ARIA system:
2016-08-29 04:11:44



20161021-20161027
Track 44, IW1
Visso EQ

S1A/S1B interferogram time tag:
2016-10-31 20:16:13



20161019-20161031
Track 95, IW1
Visso + Norcia EQ

S1A/S1B interferogram time tag:
2016-11-01 22:03:15

- Automatic processing kicks off as soon as the AOI is included in the system.

Amberley, New Zealand

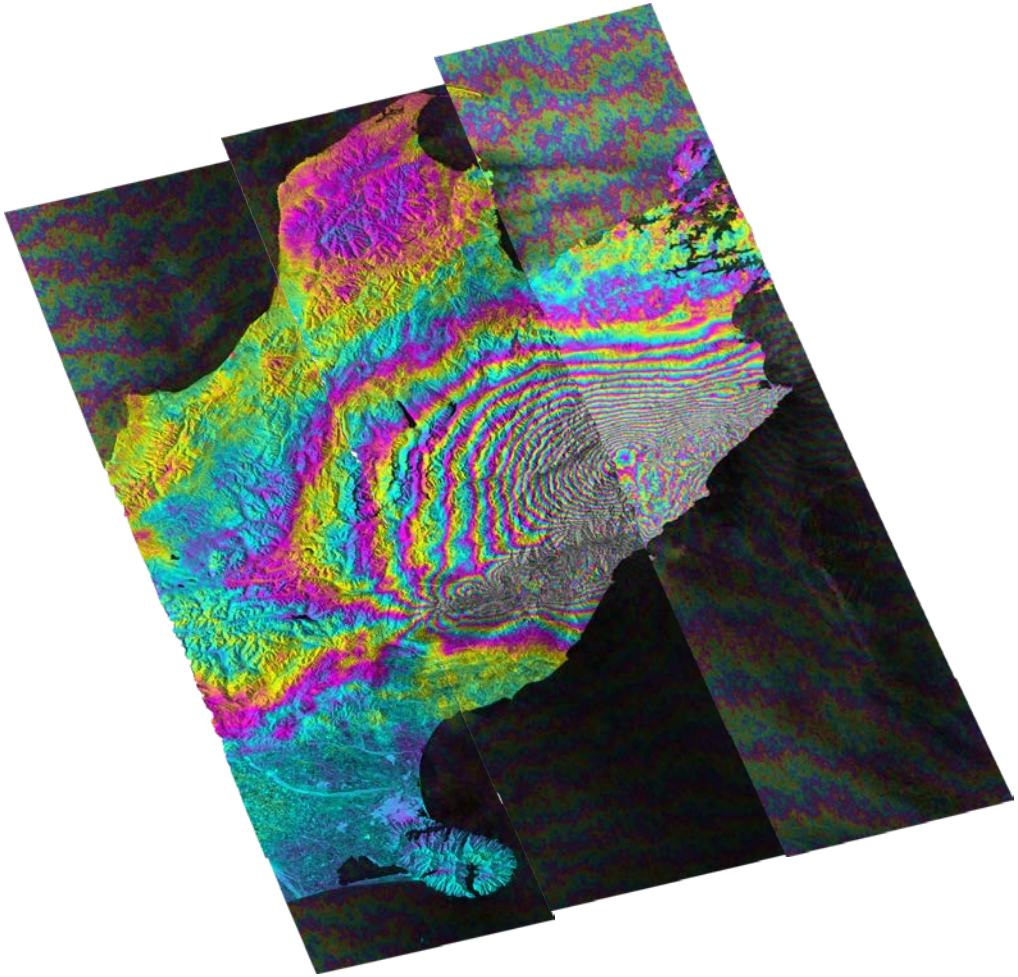
20161103-20161115
Track 52, IW1-3

ARIA time tag:
2016-11-16 21:25:20

- Master date: 2 S1A SAFE products
- Slave date: 3 S1A SAFE products

- Processed consistently. Mosaicking in geocoded space shows no discontinuities.

- In the future, multi-swath processing will be employed for such scenarios

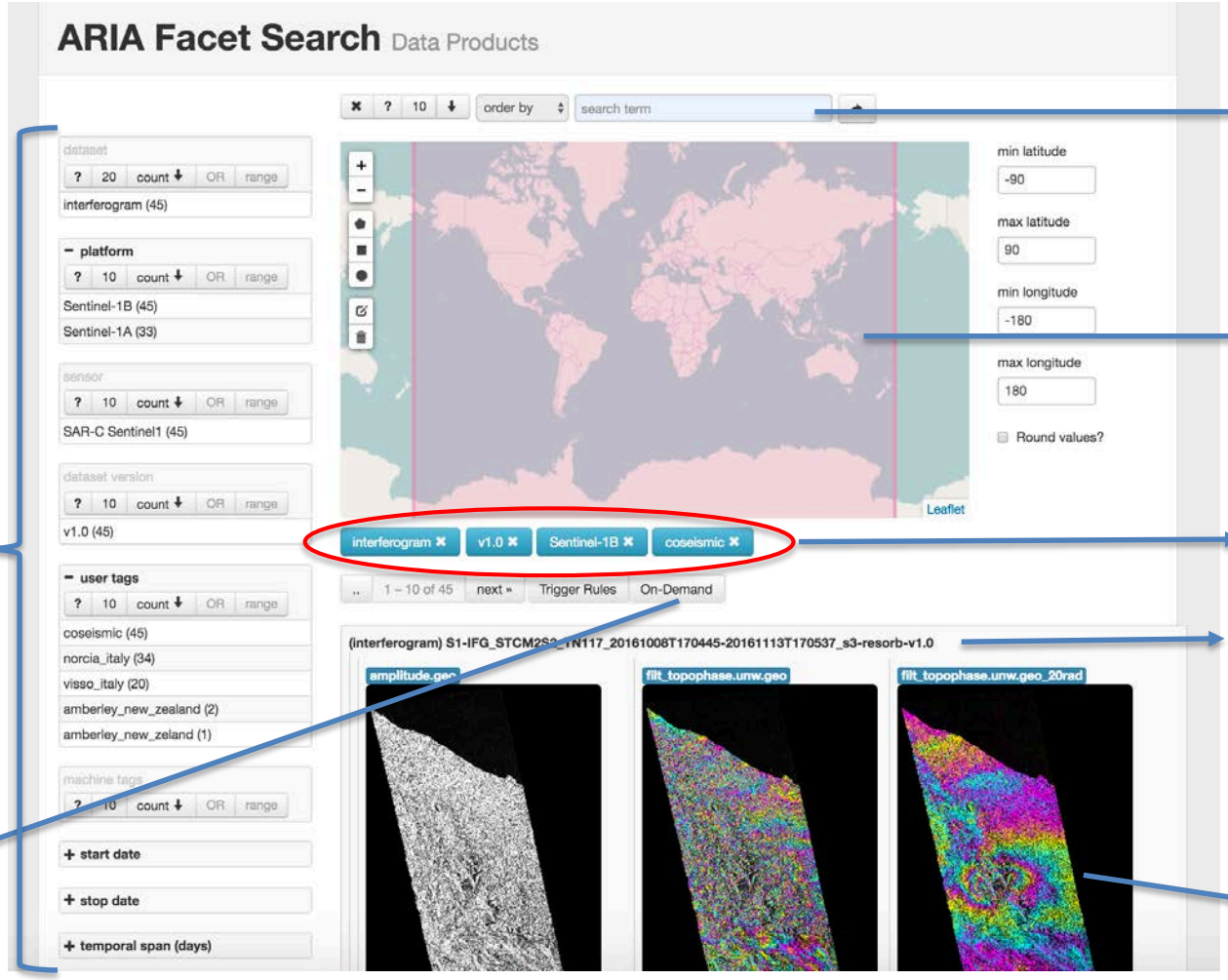


Overlay of geocoded products rewrapped at 20 radians.

User interaction with ARIA

- SAR data + Derived product search
  - Unified interface for all sensors + derived products
  - Geo-queries supported
  - Can search by product version number
- Custom processing
  - Can launch processing jobs with custom parameters
- Tagging data
  - Users can tag data products with specific names for easy discovery / exchanging information
- Notifications
  - When new data is available / processing is completed

Searching for Data – Facet Search



Text search box

Interactive map for filtering results

Active filters

Product name

Quicklook

Filtering criterion

On-demand processing options

Searching for Data - API

```python
from ariaES import ARIA


if __name__ == '__main__':
    '''
    Demo of ARIA ES query library
    '''

    prms = {'dataset': 'interferogram',
            'system_version':'v0.9',
            'metadata.trackNumber': 137,
            }


    bbox = [35.35, -119.15]

    aa = ARIA()
    rr = aa.query(params=prms, bbox=bbox)

    results = [val for val in rr]
    print('Number of results returned: ', len(results))
```

- ElasticSearch-based queries
- Can analyze search results metadata to download only the subset needed for analysis in an automated manner.

How can users prepare?

- Shift focus from handling Level-0 and Level-1 data to using higher level products
  - Majority of users just use SAR processing software packages as a black box

- Start using APIs
  - GUIs not feasible for large data volumes
  - SSARA and Sentinel-1 APIs are a good start
  - Use APIs to search and filter data before downloading

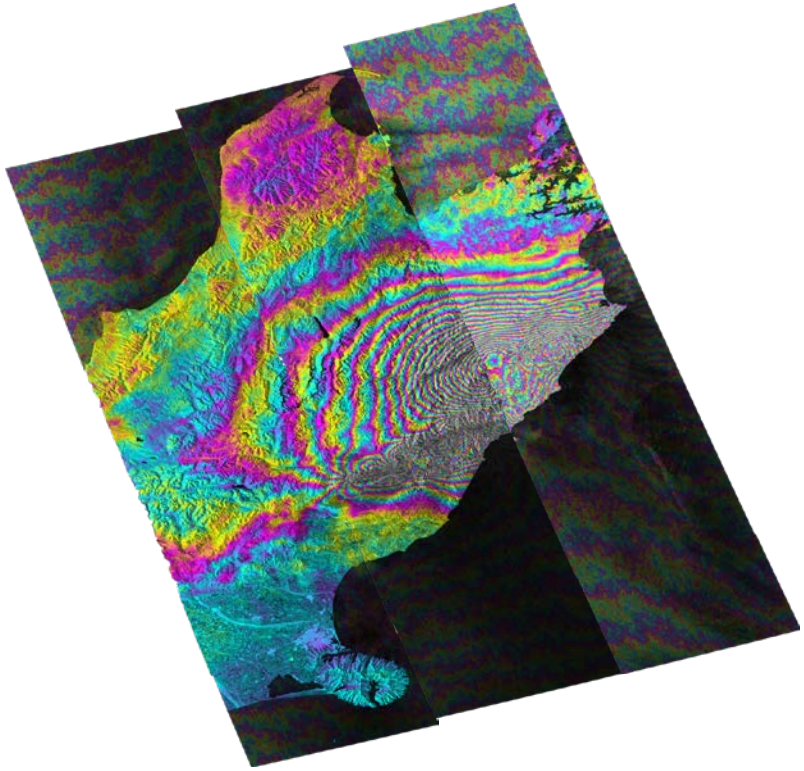
- Automate downloads
  - Manual click-and-download not a scalable option
  - Fault-tolerant downloading
  - Programmatically download data using APIs

How can users prepare?

- Geospatial data manipulation
  - Cropping, mosaicking, regridding, reprojection etc
  - Can learn a lot from optical remote sensing community
  - Don't reinvent the wheel

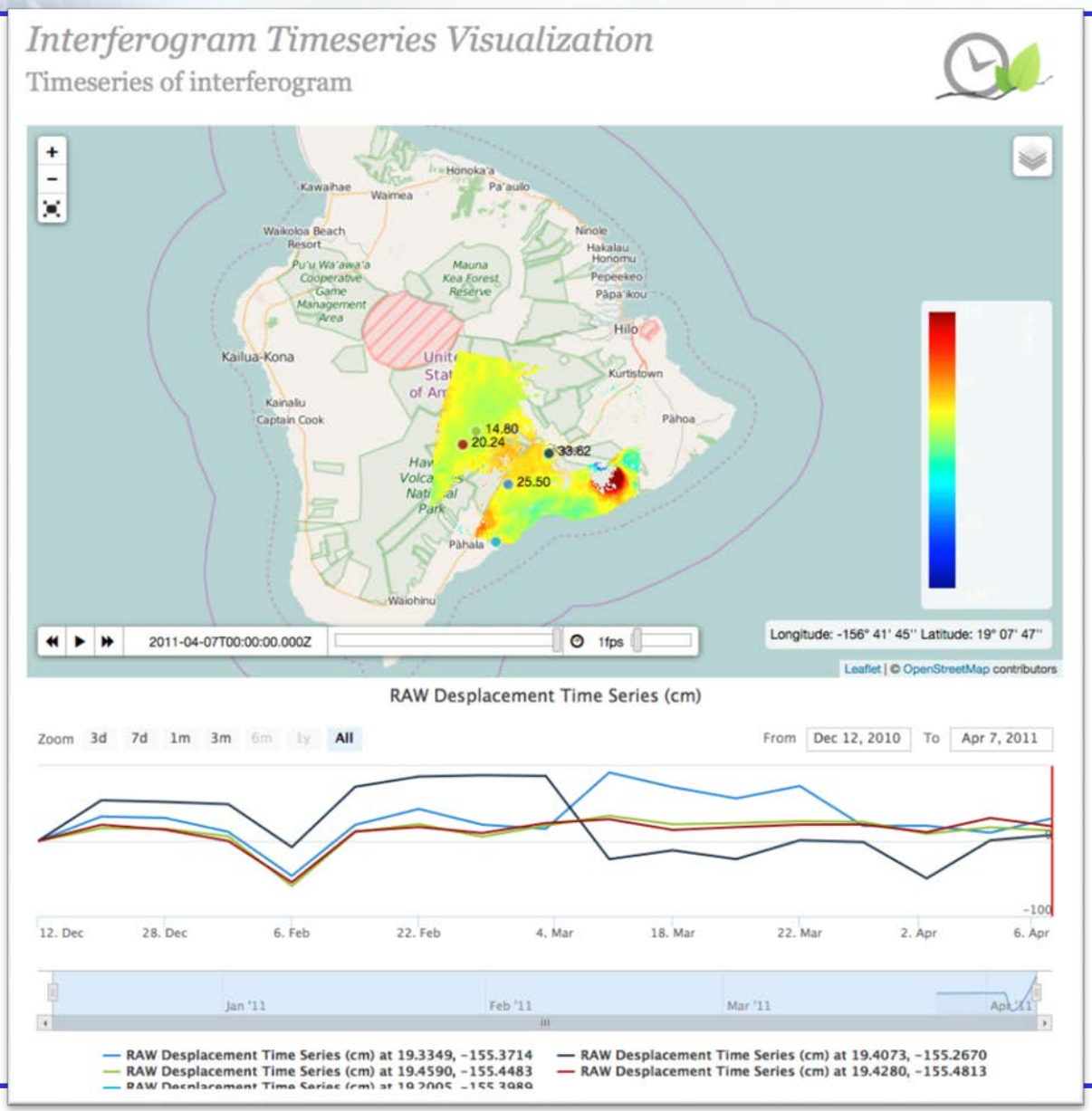
- Large scale merge tools will always be needed with any automated system
  - Wide-area analysis
  - Edge cases
  - Application dependent

- Possibly redo phase unwrapping after merge

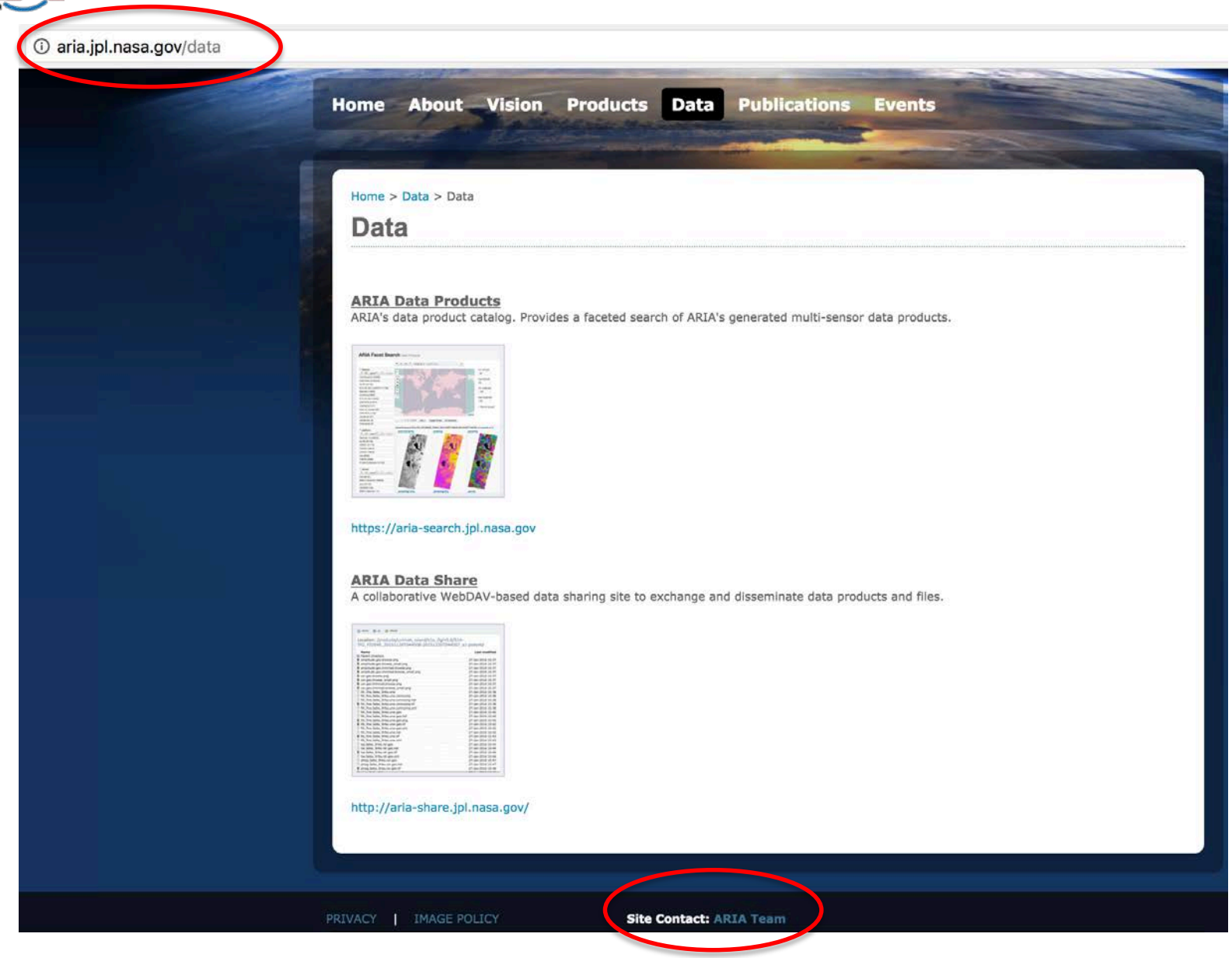


On-Demand Time Series Analysis

- On-demand processing of GIAnT-based time series
- Prototype time series discovery
- Cloud-based time series processing – data movement and cost issues



Current and future work

- Multi-swath stitching for Sentinel-1 TOPS interferograms
  - ISCE prototypes completed
- Continued time-series product development
- Simplification of search API
- On-boarding of other SAR sensors, as needed
- Development of products for Ecosystems and Cryosphere communities
- GRFN (Getting Ready for NISAR) project
  - Sentinel-1 data processing to simulate NISAR products
  - Joint effort with ASF-ESDIS to understand cloud environments and suitability for NISAR

How can users access data?