THE APPLICATIONS AND BENEFITS OF SYNTHETIC APERTURE RADAR

HARRIS® TECHNOLOGY TO CONNECT, INFORM AND PROTECT™

Today's Presenters

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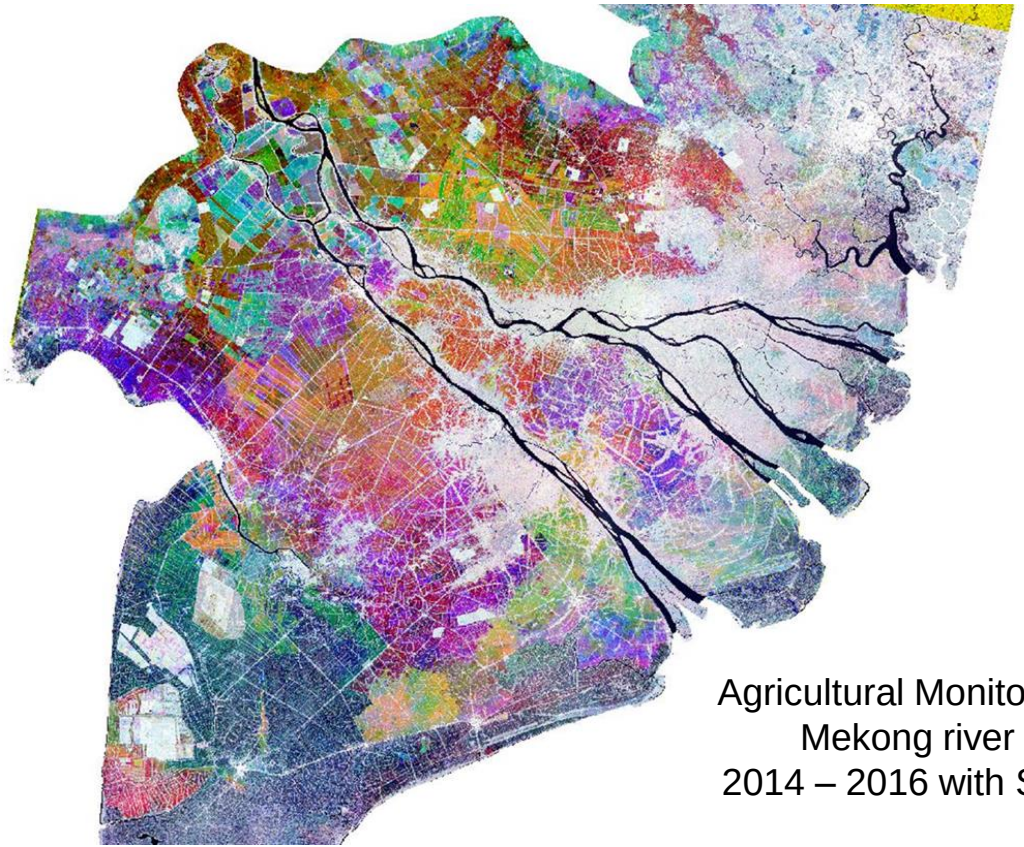
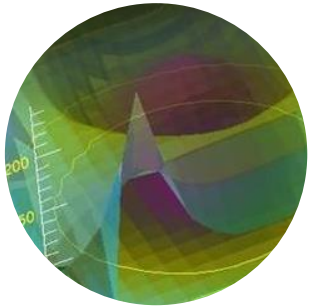
Overview

- **Introductions**
- **What is SAR?**
- **SAR benefits**
- **SAR in ENVI**
- **Applications**



Agricultural Monitoring in the Mekong river delta
2014 – 2016 with Sentinel-1

Harris Geospatial Solutions – SW Portfolio



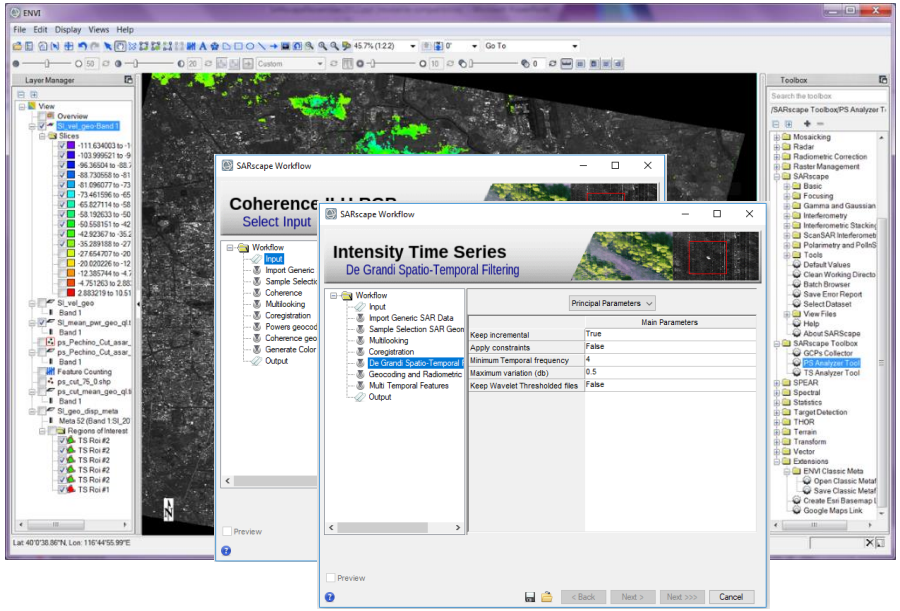
IDL

ENVI

SARscape

Geospatial Services Framework

An integrated software platform for operational processing of SAR data



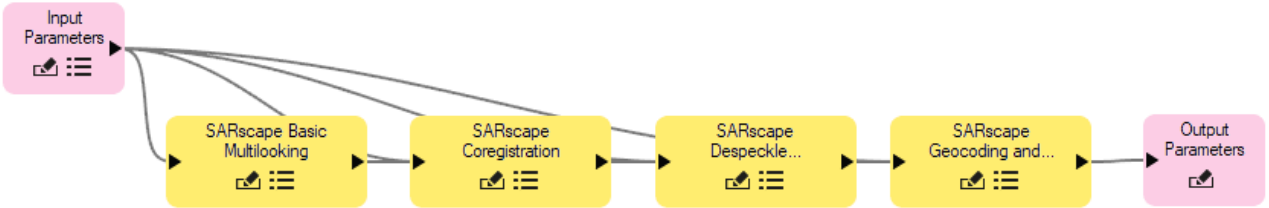
ENVI UI

ENVI Workflows

ENVI Modeler

ArcGIS Pro

Desktop-Enterprise-Cloud



Run SARscape where you are most comfortable.

ENVI UI

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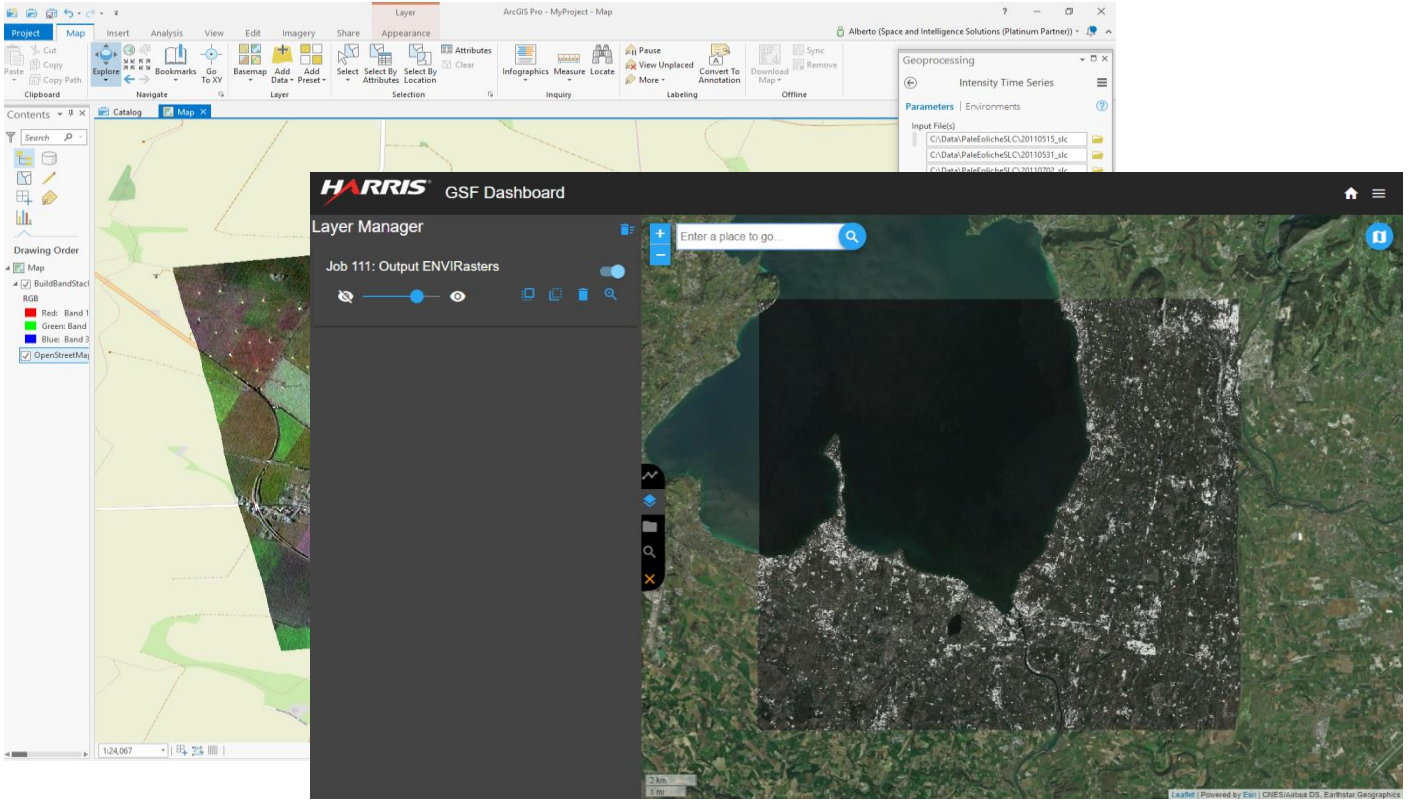
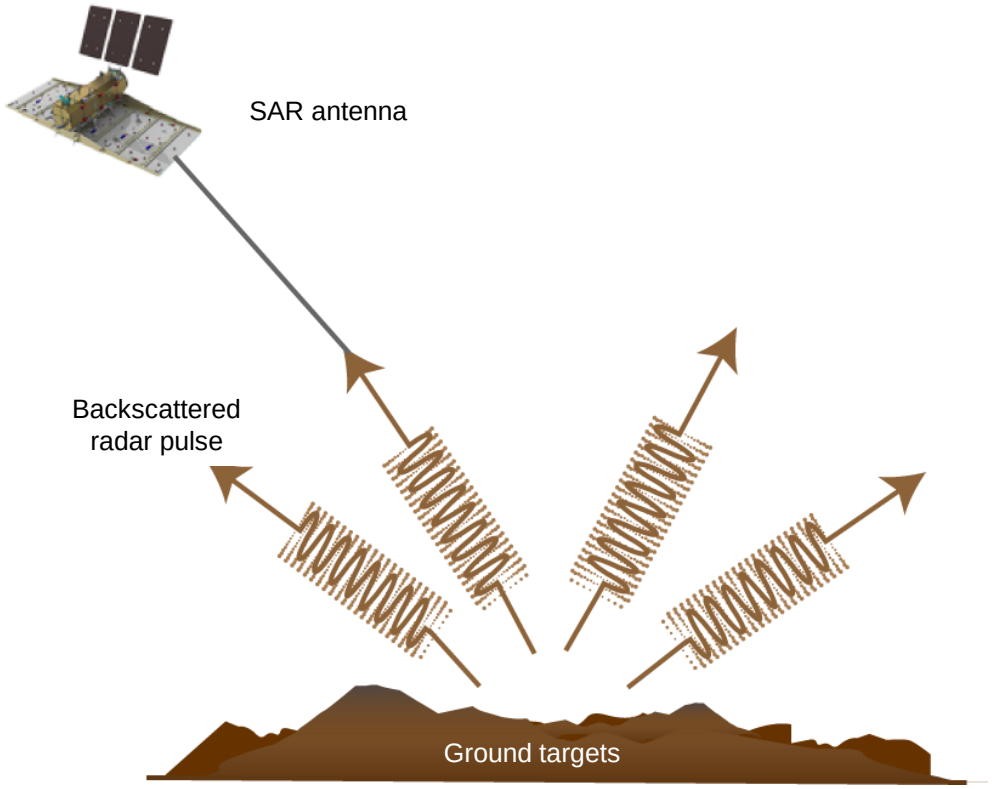


What is Synthetic Aperture Radar?



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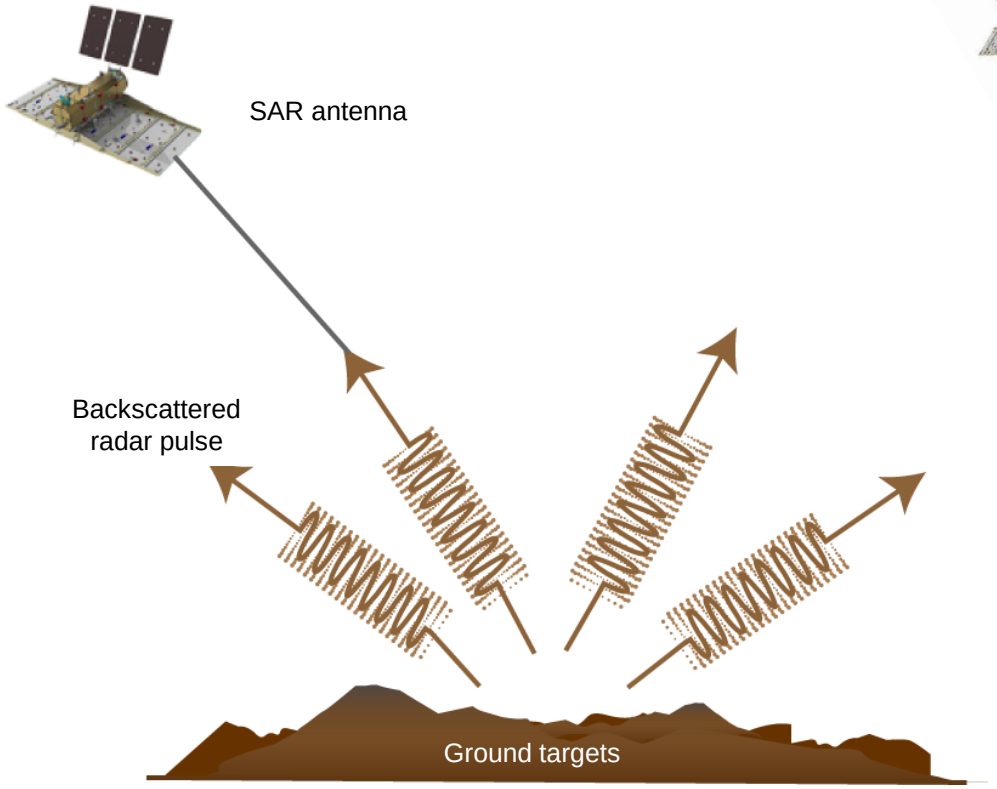
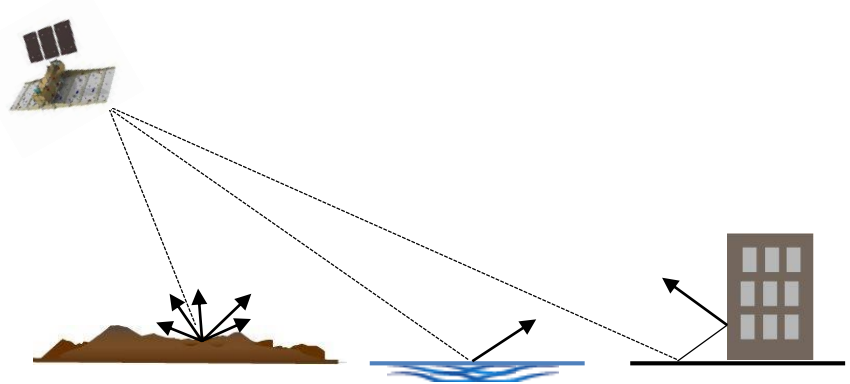
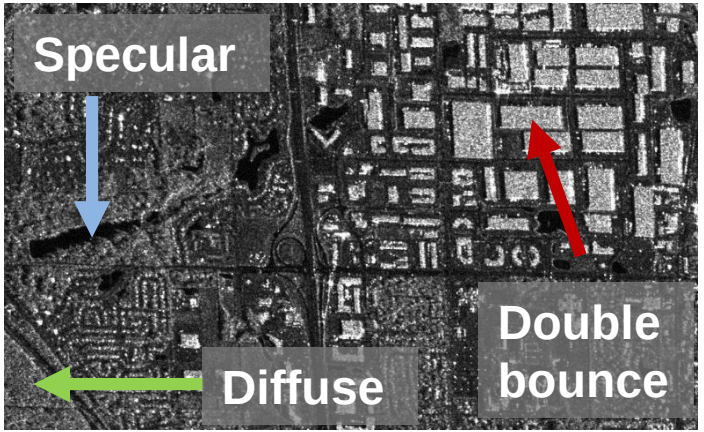
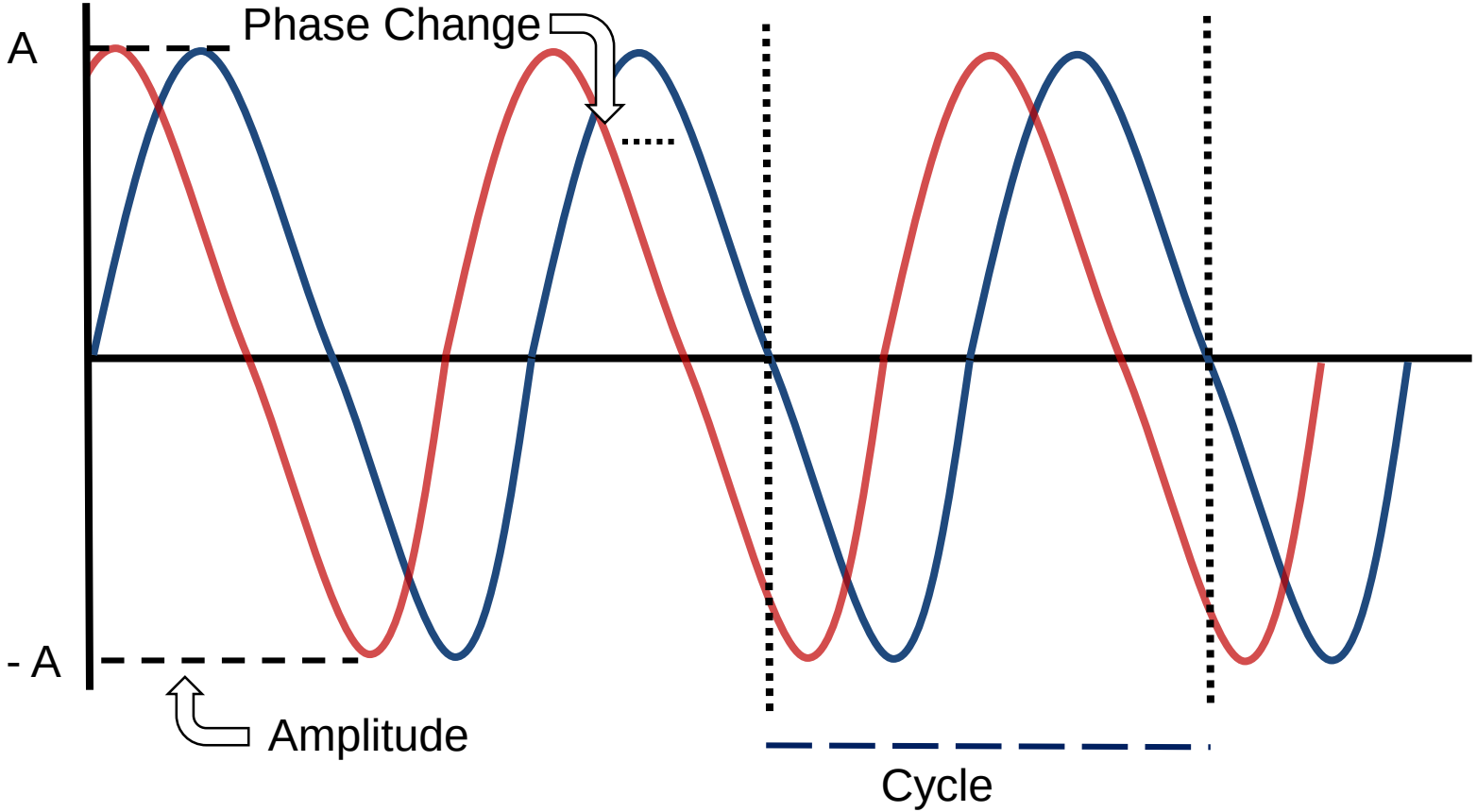




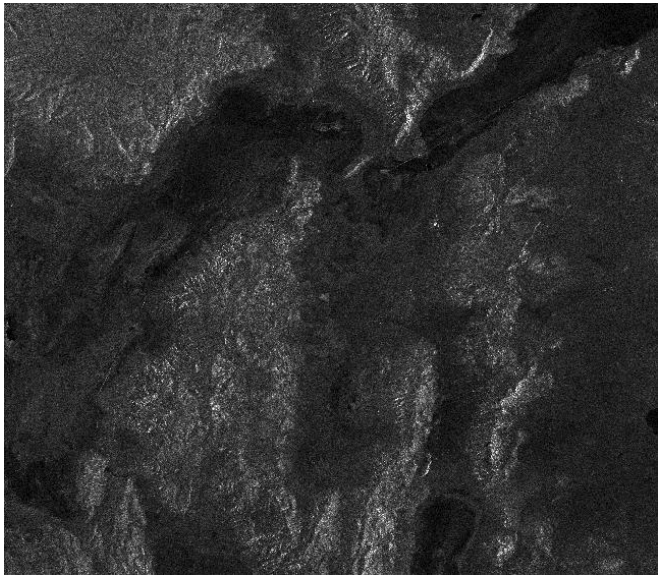


Backscatter Results: Amplitude and Phase



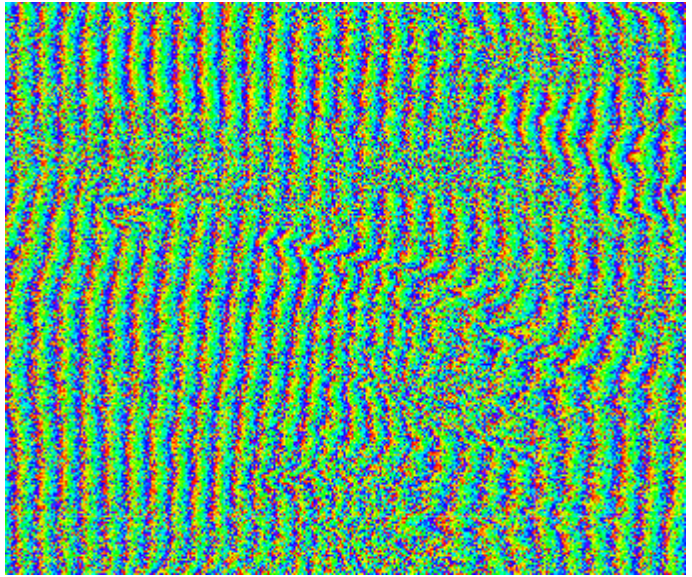
Amplitude and Phase

Amplitude/Intensity (A^2)



Amplitude shows visual characteristics based upon scattering returns, which can give us information on surface roughness and dielectric properties.

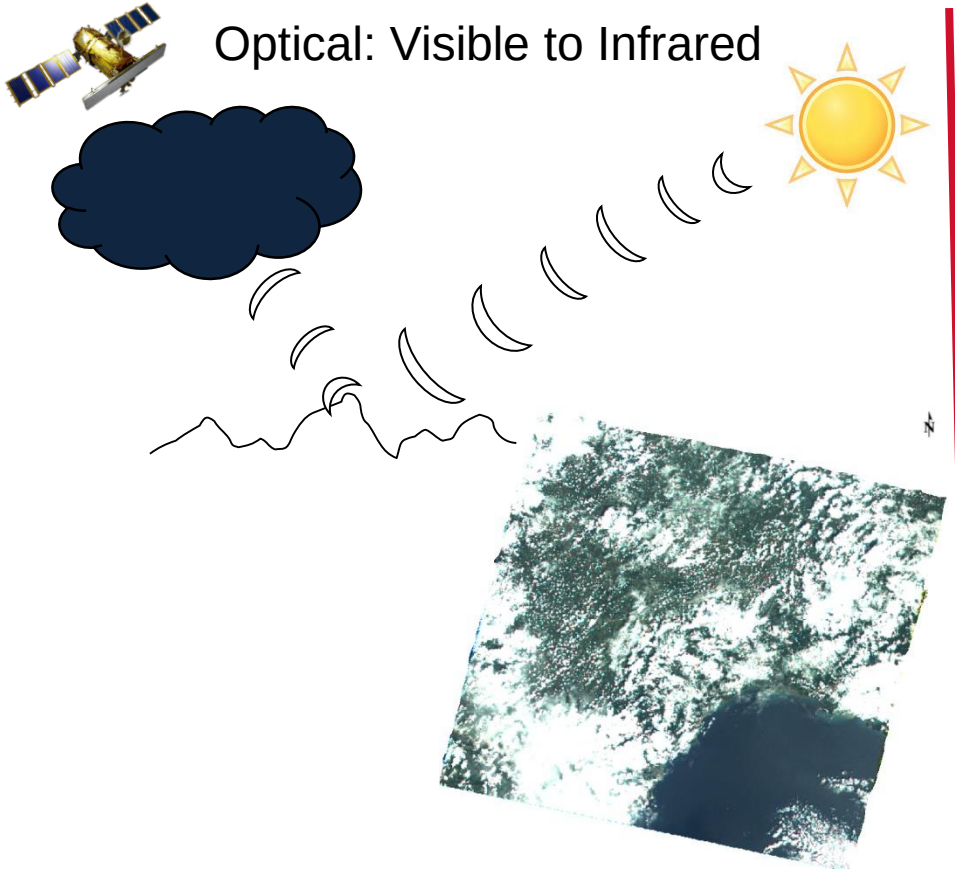
Phase



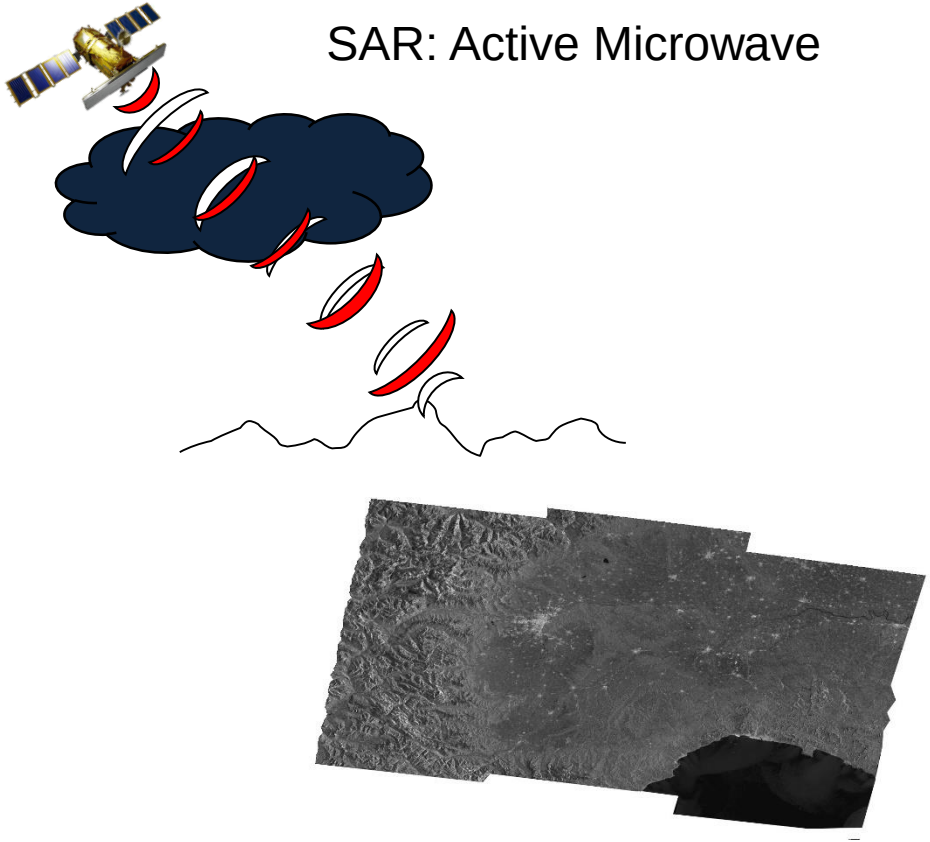
The phase of one scene may not be visually useful, but phase allows for powerful techniques such as polarimetry and interferometry over multiple scenes.

Why SAR?

Optical: Visible to Infrared



SAR: Active Microwave



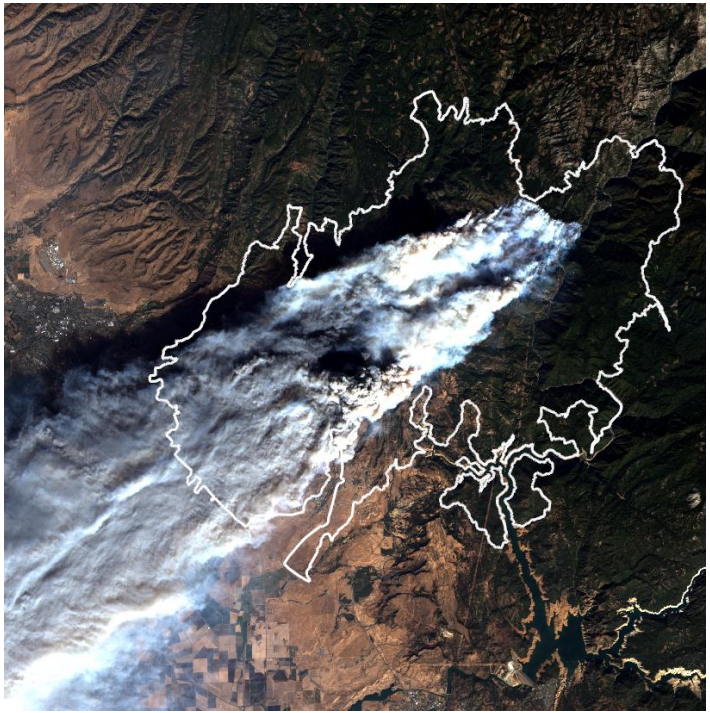
Optical vs. SAR

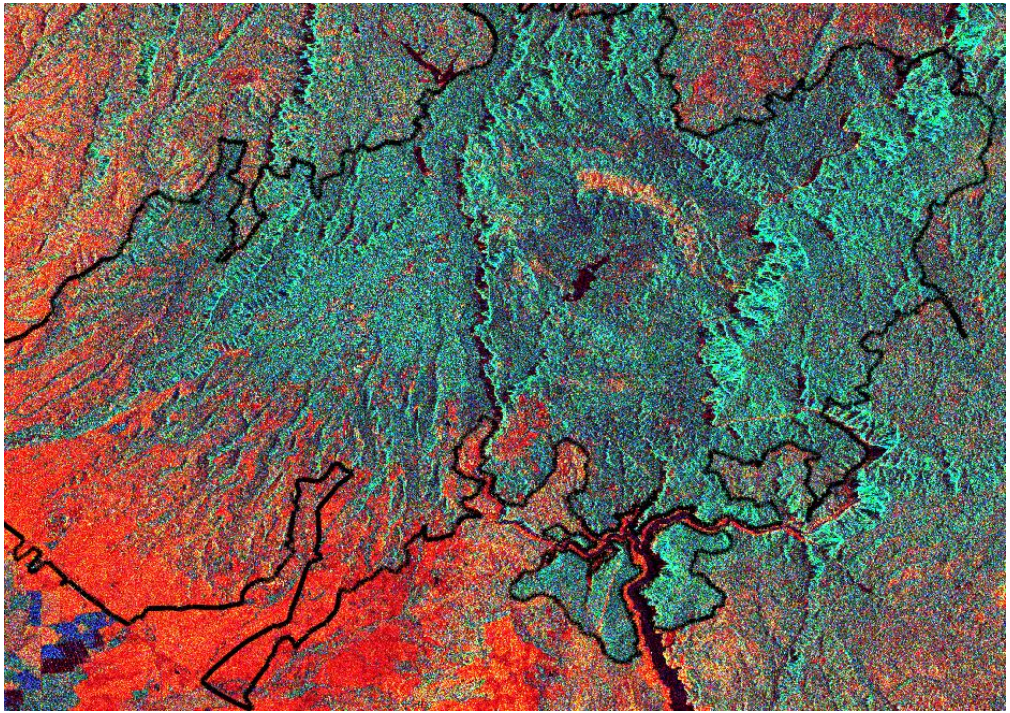
TerraSAR-X -Indianapolis
07/01/ 2007

QuickBird - Indianapolis
07/01/ 2007

Camp Fire, California, USA

Optical imagery during Camp Fire vs SAR imagery of extent during the fire

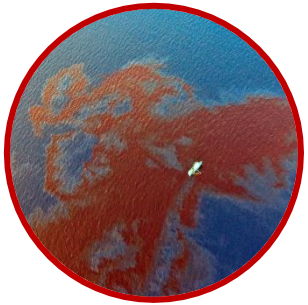




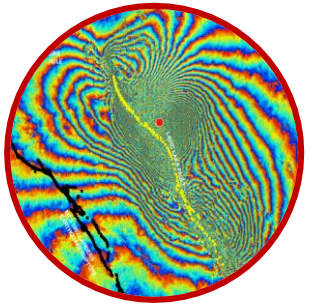
Synthetic Aperture Radar Applications

Landslides

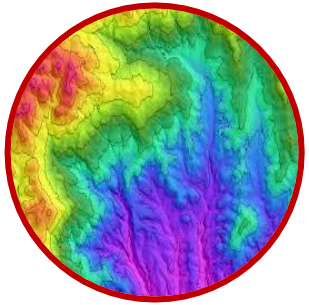
Glaciers and permafrost


Oil spills

Subsidence


Earthquakes

Shipping


DEM generation

Biomass

Deforestation

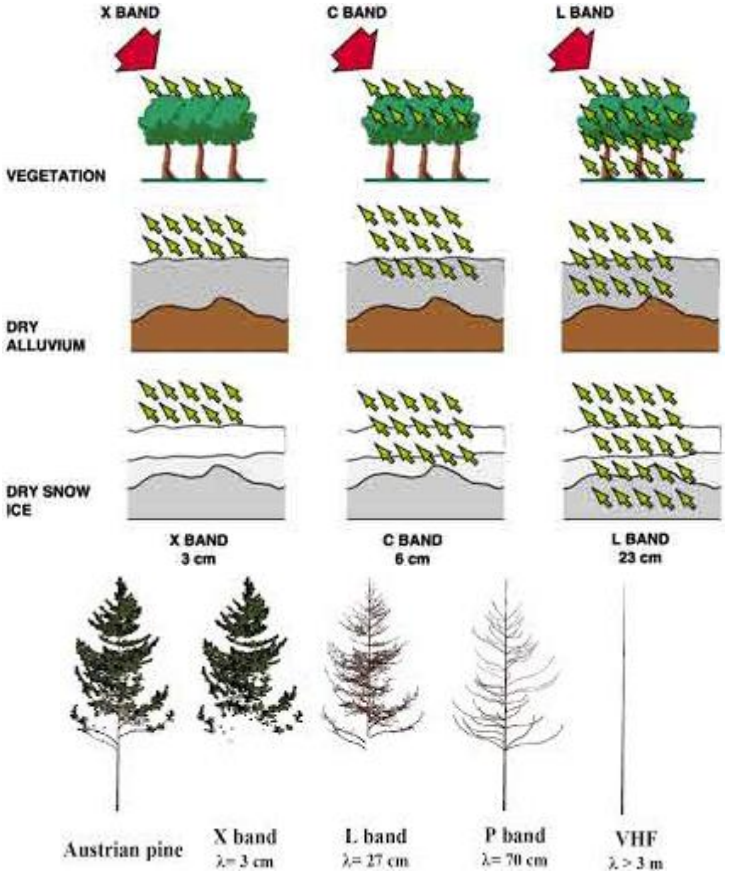
Flooding

Volcano monitoring

Activity monitoring

Radar frequency and applications

Band	Frequency	Applications
VHF	300 kHz - 300 MHz	Foliage/ground penetration, biomass
P	300 MHz - 1 GHz	Biomass, soil moisture, ground penetration
L	1 - 2 GHz	Agriculture/forestry, soil moisture, ground penetration
S	3-4 GHZ	Agriculture, biomass, ocean
C	4 - 8 GHz	Ocean, agriculture, general surface investigation
X	8 - 12 GHz	Ocean, agriculture, general surface investigation (high resolution)
Ku	14 - 18 GHz	Glacial/ice, snow cover
Ka	27 - 47 GHz	Glacial/ice, very high resolution imagery



Synthetic Aperture Radar satellite missions

HARRIS

JERS
1992 - 1998

ALOS
2006 - 2011

ALOS-2
2014

SAOCOM
2018

NISAR
2021

L-Band

ERS-1
1991 - 2000

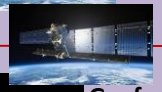
EnviSat-1
2002 - 2012

RISAT-1
2012

ERS-2
1995 - 2011

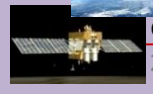
Sentinel-1A
2014

RADARSAT-2
2007



Sentinel-1B
2015

RADARSAT-1
1995 - 2013



Gaofen-1
2013

C-Band

COSMO-SkyMed
2007

COSMO-SkyMed 2nd generation

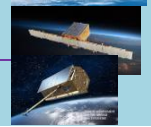
TerraSAR-X
2007

CAPELLA SPACE constellation

TanDEM-X
2010

XpressSAR constellation

KOMPSAT-5
2013



ICEYE constellation

PAZ

UMBRA LAB

X-Band

1991 | 2000 | 2005 | 2010 | 2015 | 2018 | 2020

SARscape data processing in ENVI

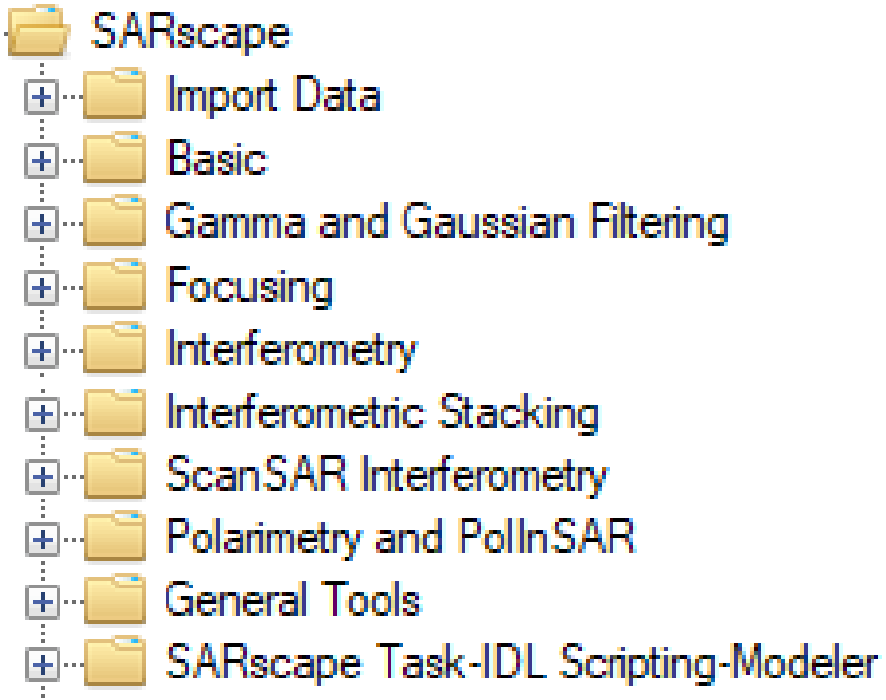
Import

Multilooking

Coregistration

Filtering

Geocoding & Radiometric calibration



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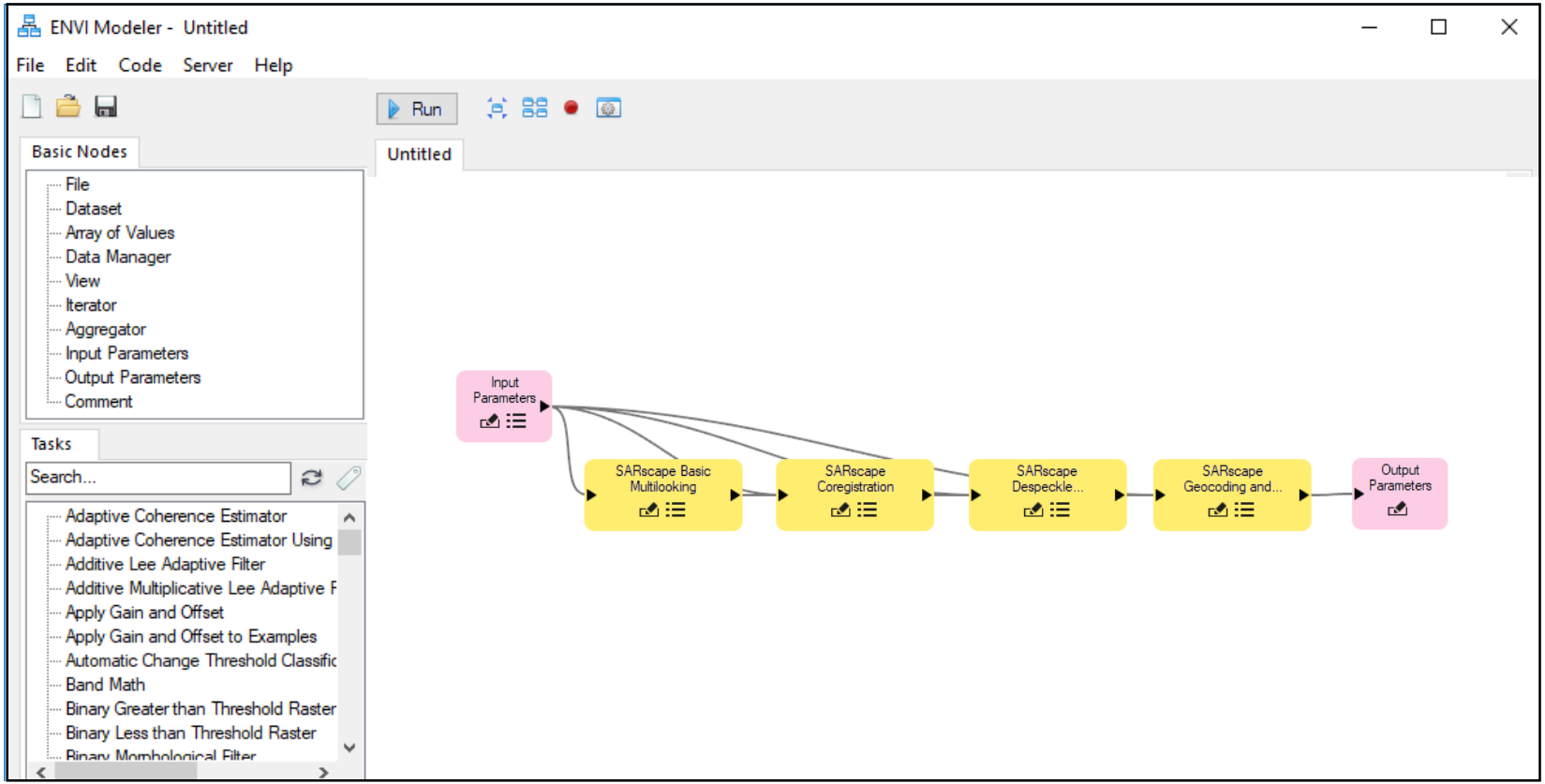

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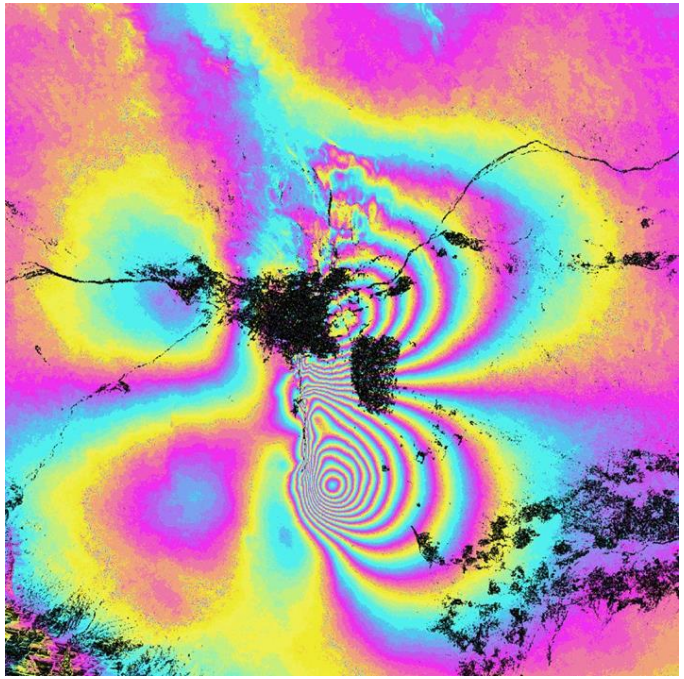
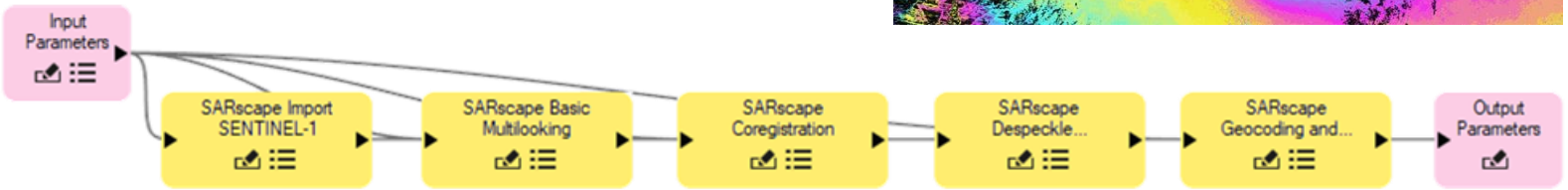


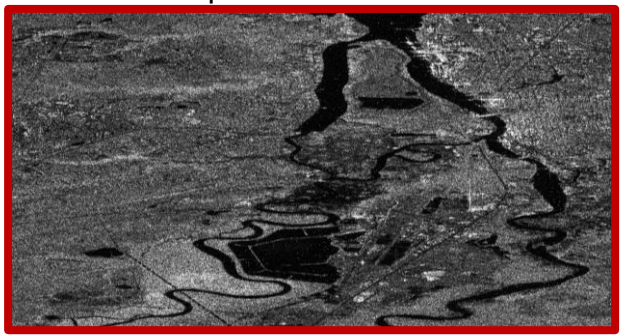


Data Import

Import

- Subset by ROI
- Choose polarization
- Mosaic same track

Imported Sentinel-1



Multilooking

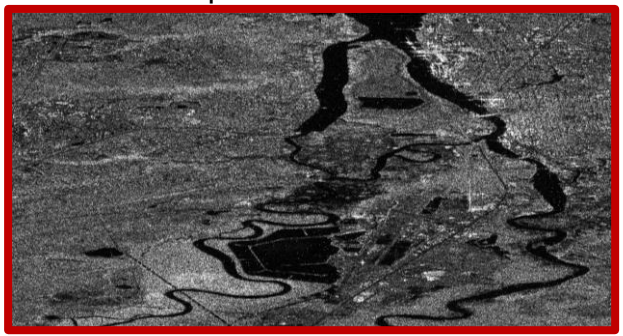
Import

- Subset by ROI
- Choose polarization
- Mosaic same track

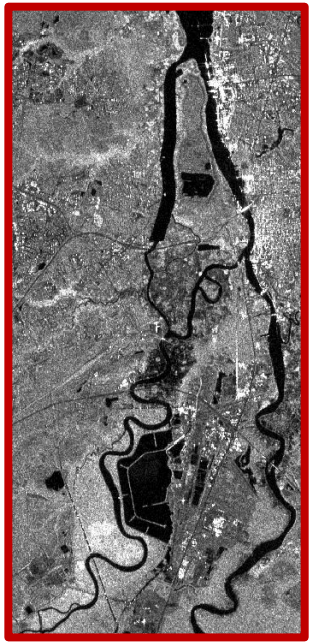
Multilooking

- Choose grid size
- Removes speckle
- Convert to ground range

Imported Sentinel-1



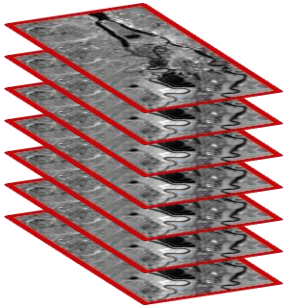
Multilooked



Coregistration

Coregistration

- Aligns pixel footprints when working with overlapping images
- Critical step for multitemporal analyses



Despeckling

Coregistration

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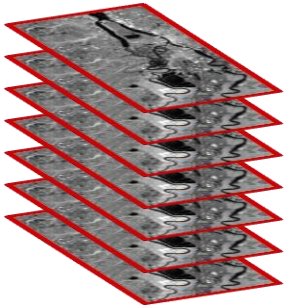
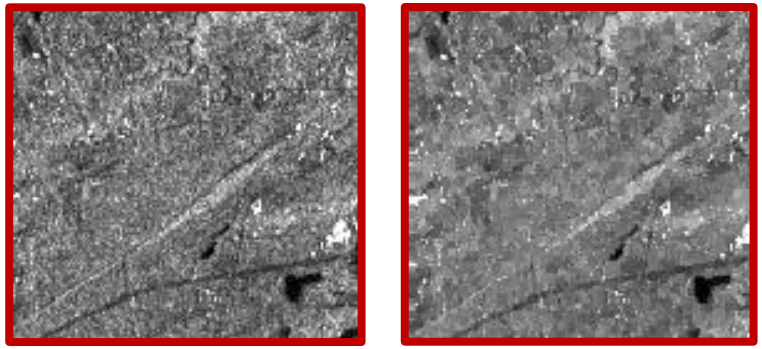
- Critical step for multitemporal analyses



Filtering



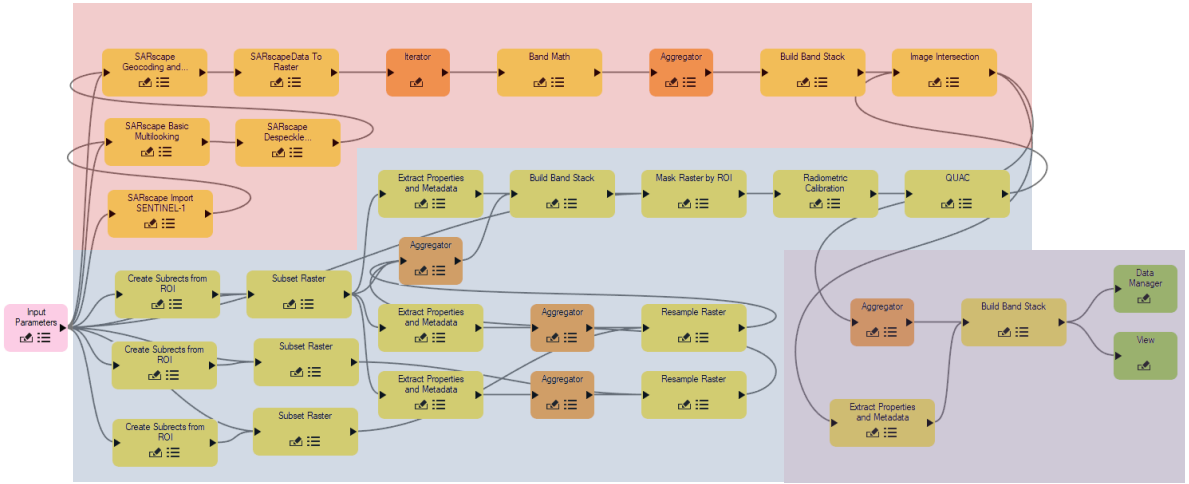
Geocoding and Radiometric Calibration

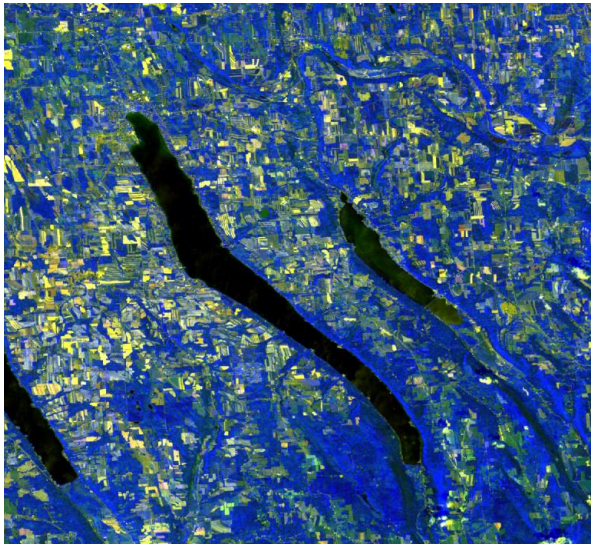
Geocoding & Radiometric Calibration

- Apply projection
- Calibrate backscatter intensity to allow for direct comparison to other scenes

SARscape and the ENVI modeler

Automate and batch process your data in the ENVI modeler with SARscape tasks





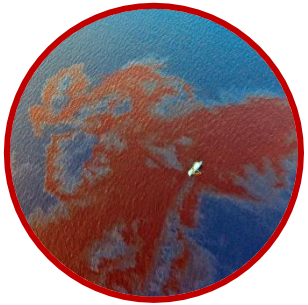
Full preprocessing and fusion of Sentinel-1 (all bands) and Sentinel-2

<u>Skaneateles Lake, NY</u>
Red- Red (Sentinel-2)
Green- Green (Sentinel-2)
Blue- VV (Sentinel-1)

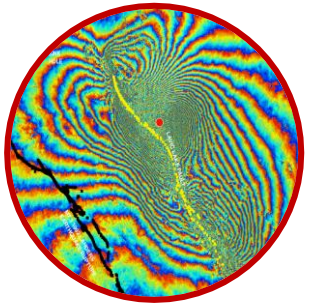
Synthetic Aperture Radar Applications

Landslides

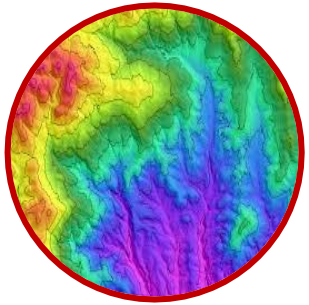
Glaciers and permafrost


Oil spills

Subsidence


Earthquakes

Shipping


DEM generation

Biomass

Deforestation

Flooding

Volcano monitoring

Activity monitoring

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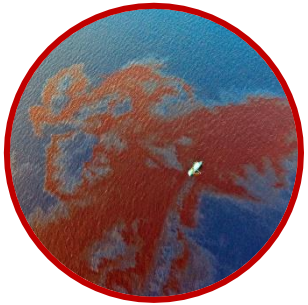
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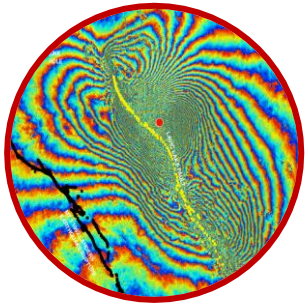
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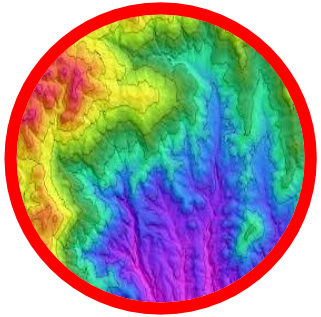
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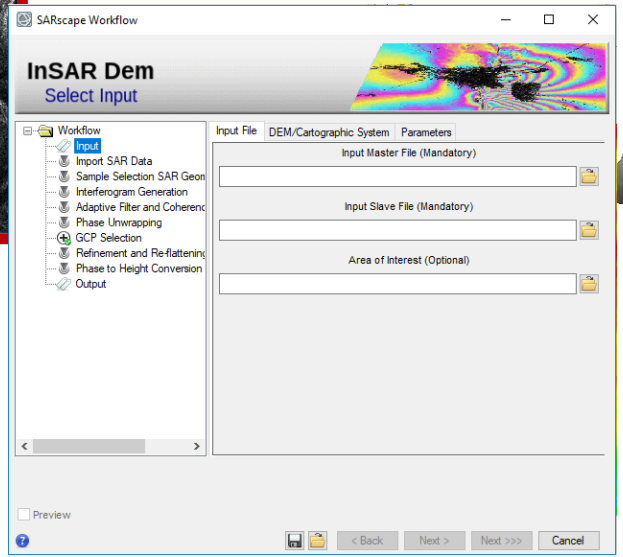
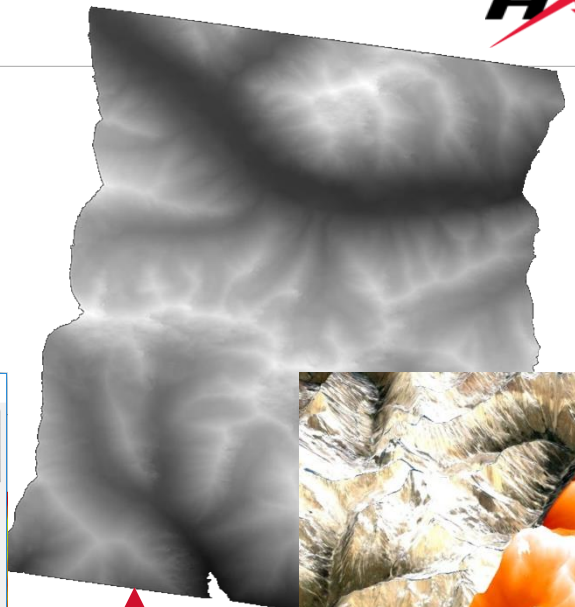
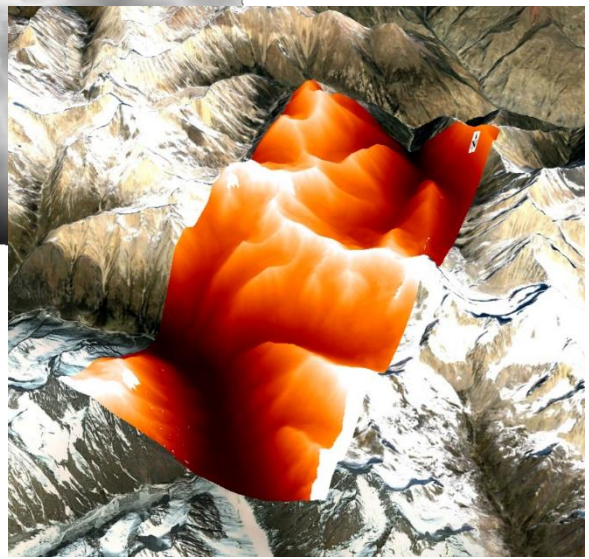
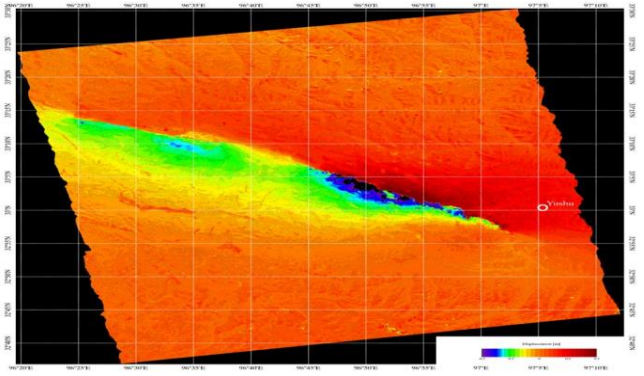


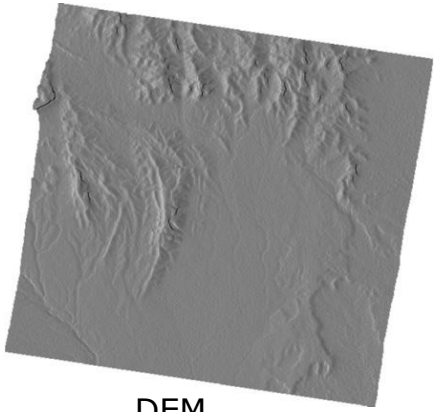




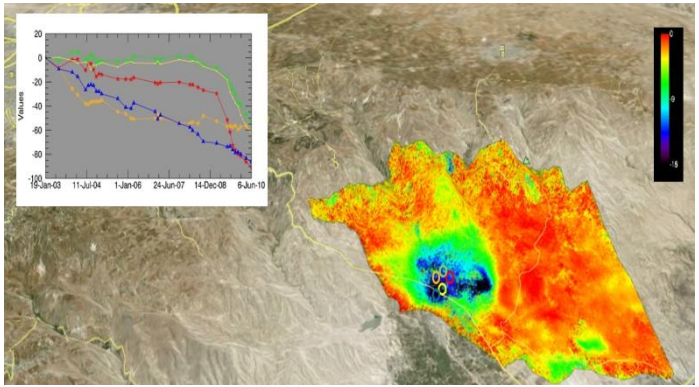
Terrain and Infrastructure Monitoring



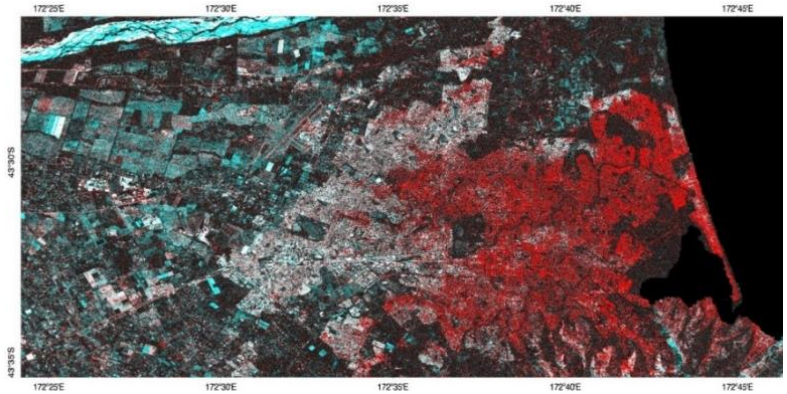
Displacement



DEM



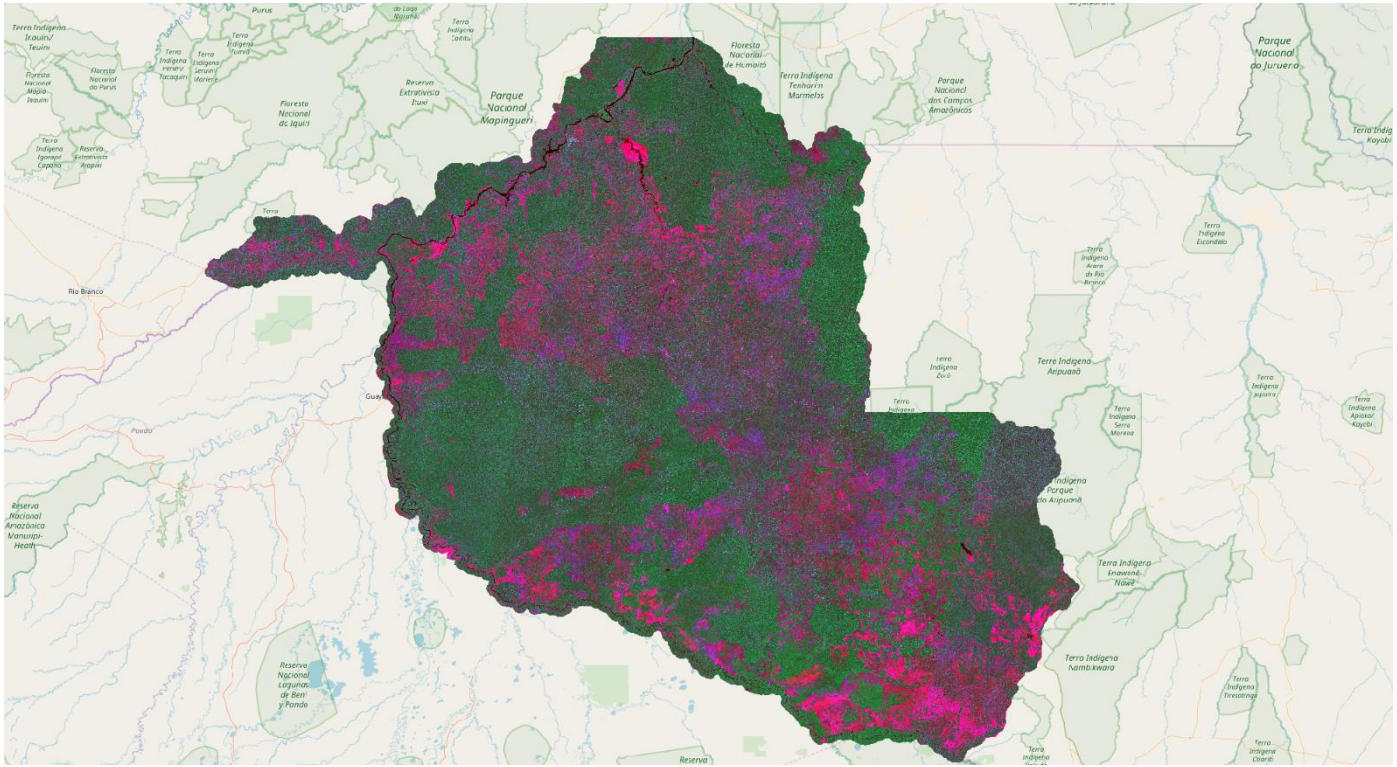
Multi-Temporal Analyses of the Displacement



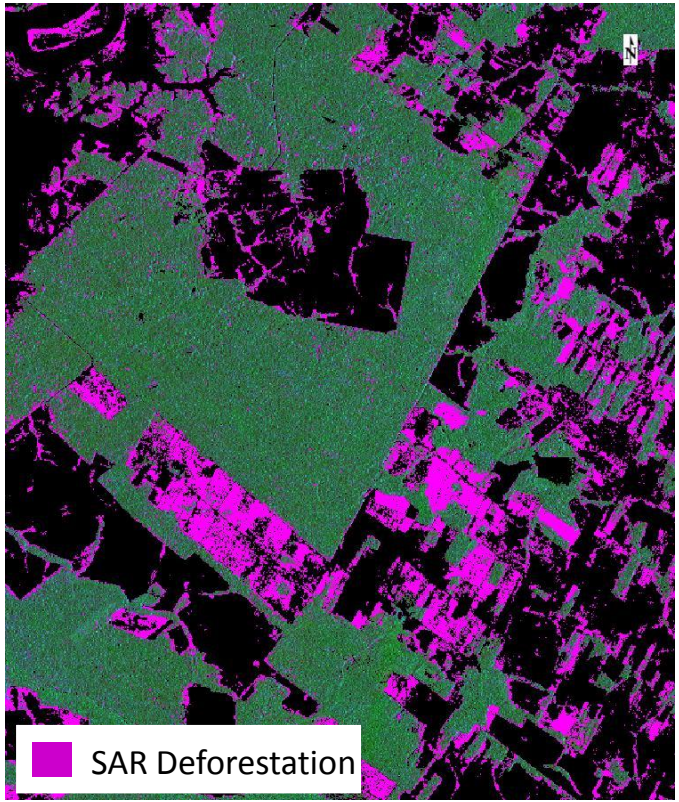
Identification of areas affected by catastrophic events

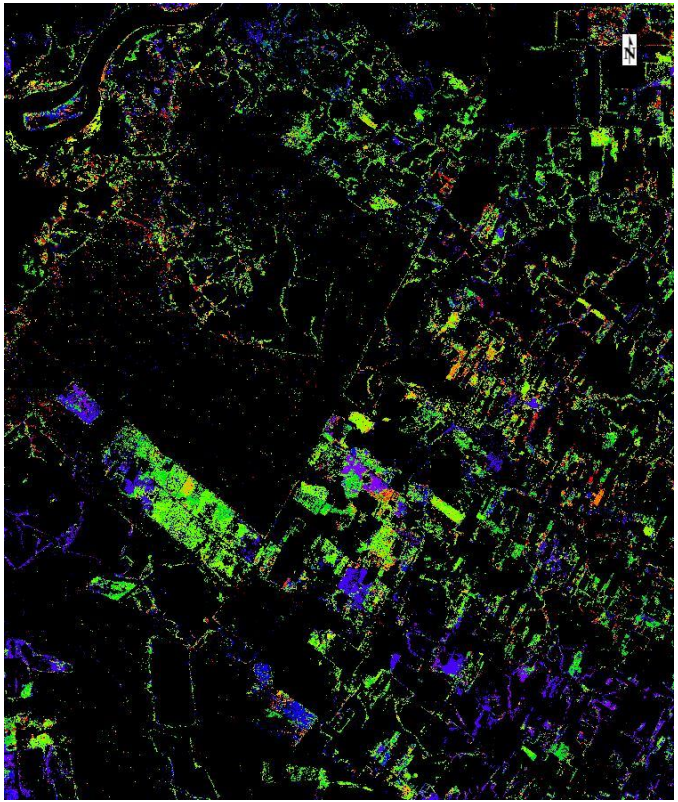
Deforestation

- **Coefficient of variation**
- **Mean**
- **Gradient**



Tracking Deforestation



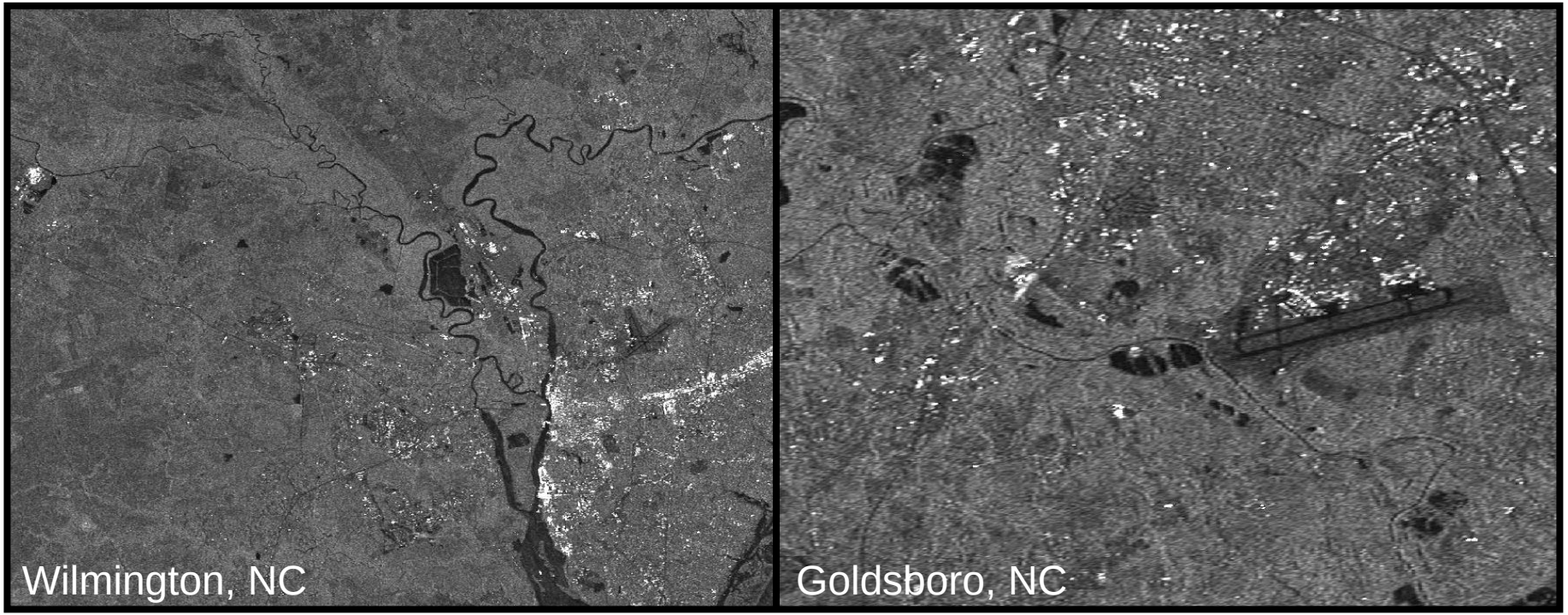


Disaster Management: Flood Mapping

Hurricane Florence, September 2018

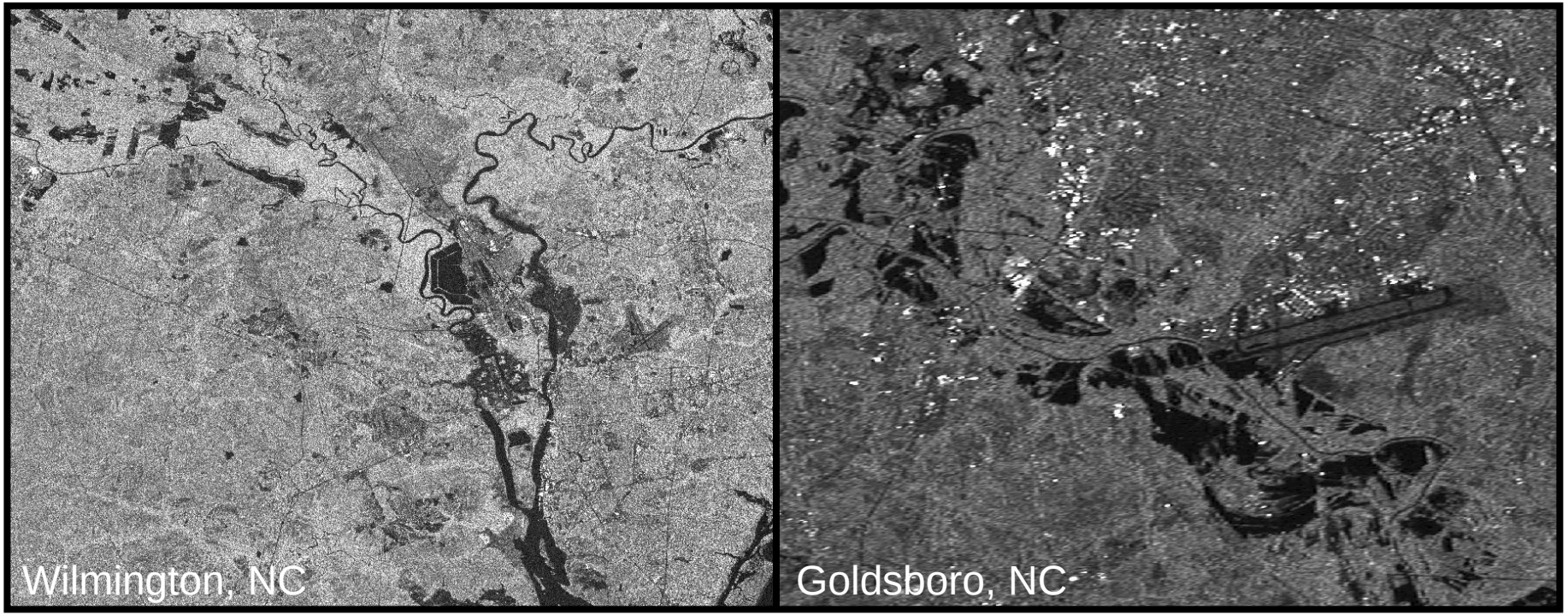
Disaster Management: Flood Mapping

Pre-storm SAR



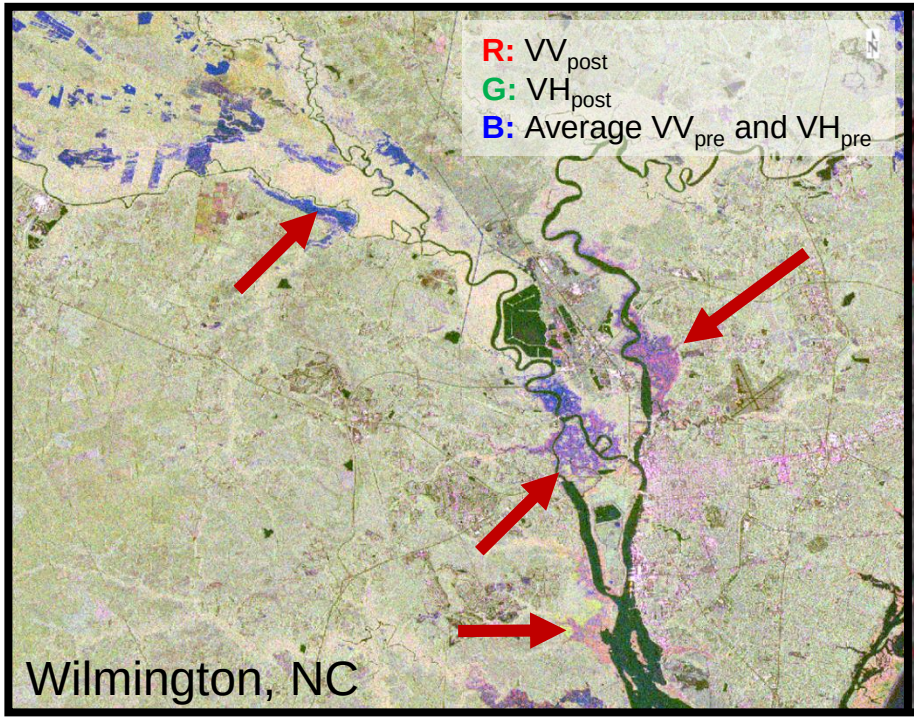
Disaster Management: Flood Mapping

Post-storm SAR

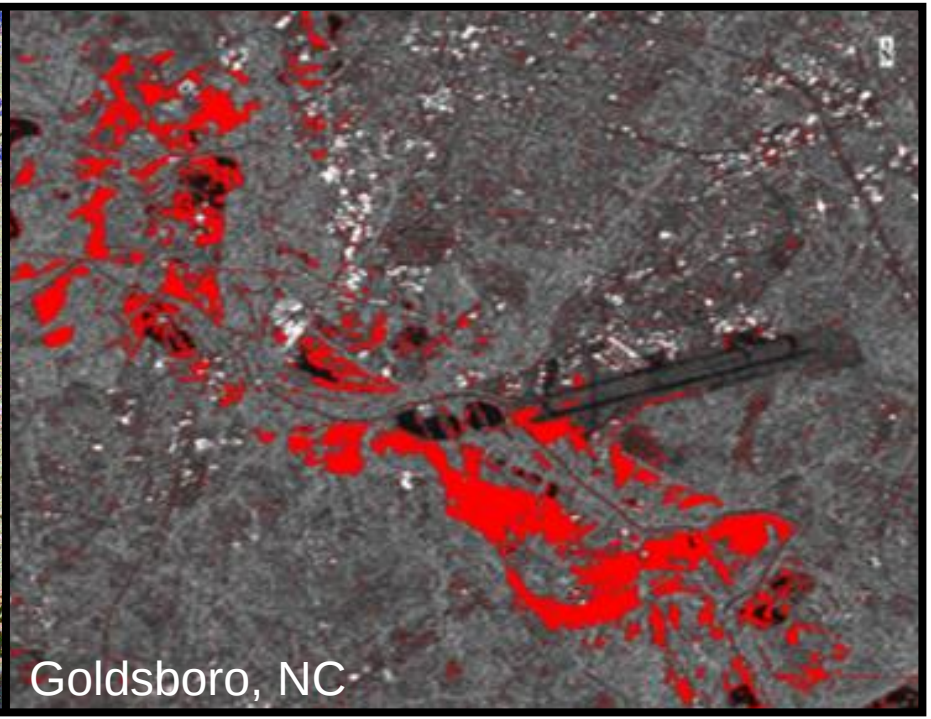


Disaster Management: Flood Mapping

Flood map products



Dual-polarimetric RGB



Threshold and ratio calculation

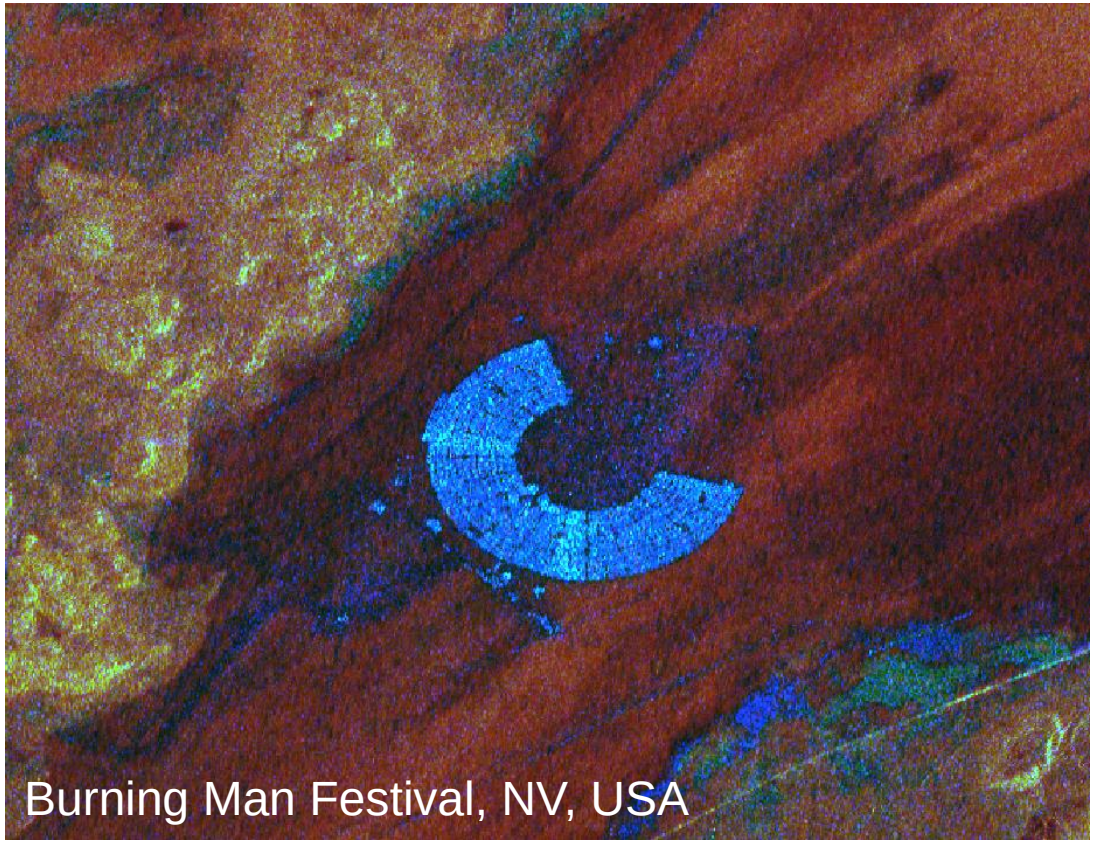
Activity Monitoring: Change Detection

Coherent change detection over
Burning Man Festival
Black Rock Desert, NV, USA

R: Coherence

G: Average backscatter

B: Difference in backscatter between pre (2018-06-08) and during (2018-08-31)



Questions?

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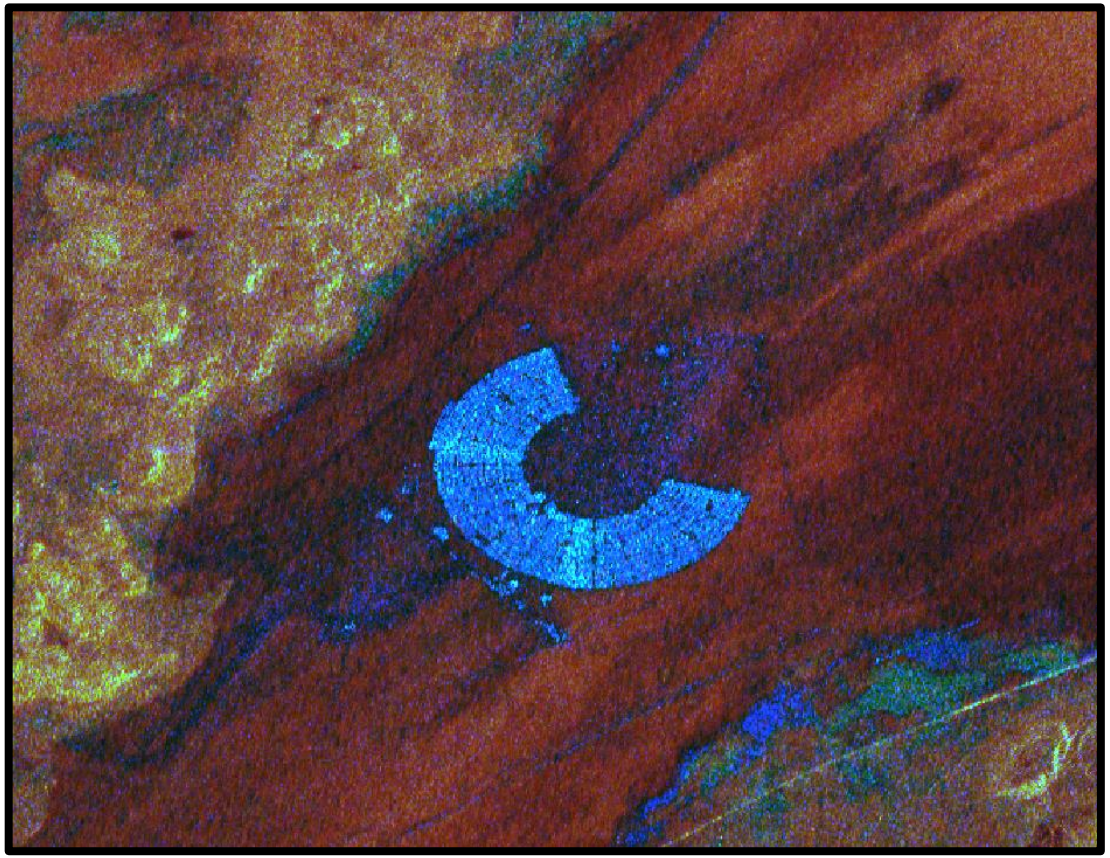
Upcoming events

December 10 – 14, 2018:

See ENVI and SARscape at the AGU fall meeting! (booth # 1359)

Washington DC

January 17, 2019

Webinar

Land & Sea Applications using SAR