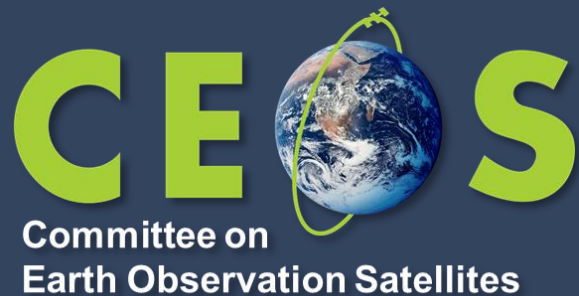


Update on NovaSAR-1 ARD Production and Application Demonstration



Zheng-Shu Zhou, CSIRO

Agenda Item 2.7

LSI-VC-14 2023, ESA/ESRIN

10th - 12th October 2023

Content

CEOS-ARD PFS Compliant NovaSAR-1 ARD Production

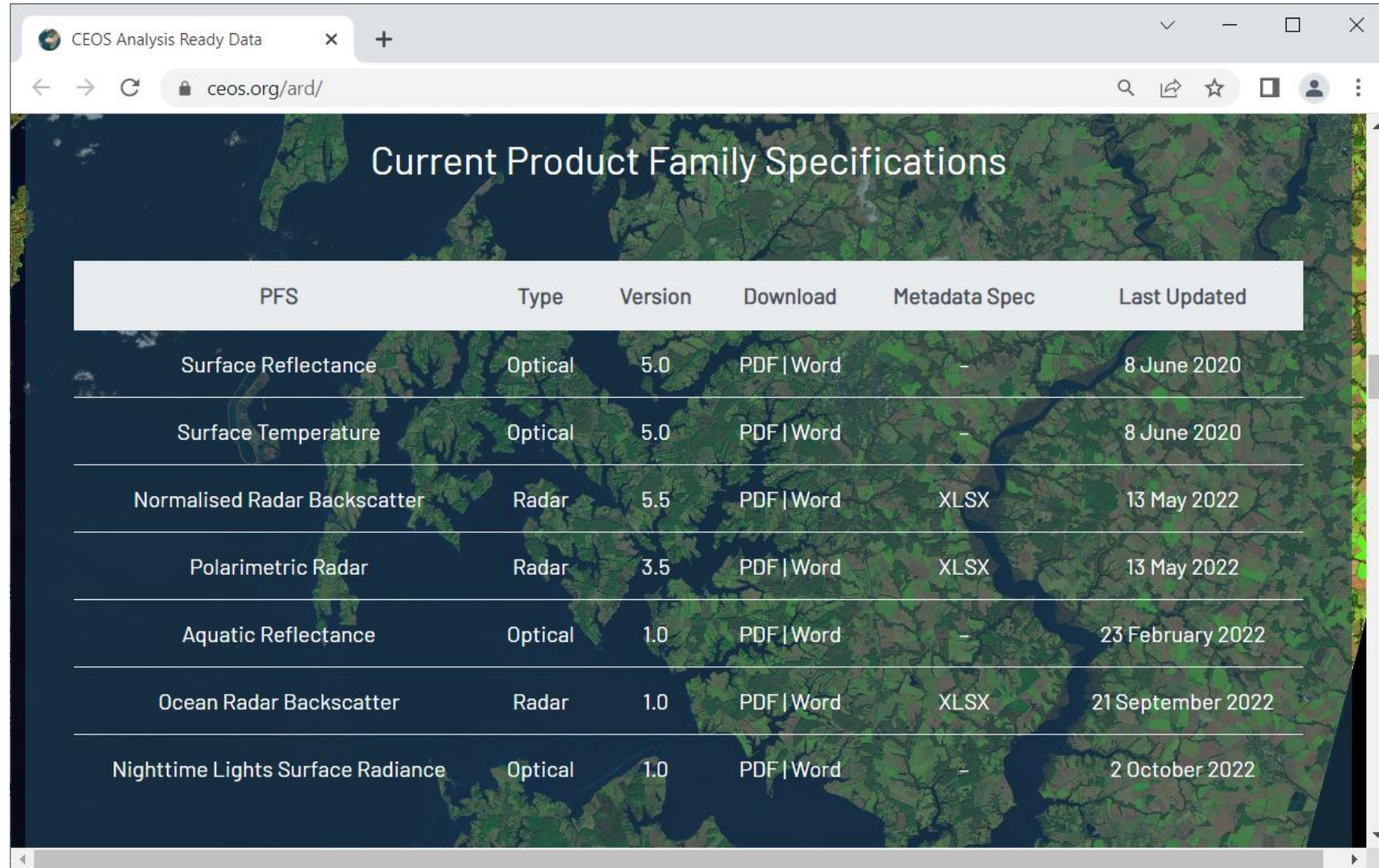
- CEOS-ARD NRB PFS
- Naming Conventions of NovaSAR-1 CEOS-ARD NRB Product
- NovaSAR-1 CEOS-ARD NRB Product File Structure and Data Format and Data Type
- Steps of CEOS-ARD NRB PFS v5.5 Compliant NovaSAR-1 ARD Production
- Samples of NovaSAR-1 CEOS-ARD NRB Product Including Per-pixel Metadata
- NovaSAR-1 ARD Product Conversions and Further Processing
- Outcome of Self-Assessment of CEOS-ARD NRB PFS v5.5 Compliant NovaSAR-1 ARDs
- NovaSAR-1 ARD Application Demonstration

Acknowledgements

This work has been doing with support of Eric Lehmann, Laura Brindle, Matt Nethery, Amy Parker of CSIRO. We would like to acknowledge Ake Rosenqvist of soloEO for his support to the NovaSAR-1 ARD work between 2019 and 2022.

CEOS-ARD NRB PFS 5.5

CSIRO aims to process NovaSAR-1 source images to ARD (analysis ready data) products under the requirements of CEOS-ARD NRB (Normalised Radar Backscatter) PFS (Product Family Specifications) version 5.5.



PFS	Type	Version	Download	Metadata Spec	Last Updated
Surface Reflectance	Optical	5.0	PDF Word	-	8 June 2020
Surface Temperature	Optical	5.0	PDF Word	-	8 June 2020
Normalised Radar Backscatter	Radar	5.5	PDF Word	XLSX	13 May 2022
Polarimetric Radar	Radar	3.5	PDF Word	XLSX	13 May 2022
Aquatic Reflectance	Optical	1.0	PDF Word	-	23 February 2022
Ocean Radar Backscatter	Radar	1.0	PDF Word	XLSX	21 September 2022
Nighttime Lights Surface Radiance	Optical	1.0	PDF Word	-	2 October 2022

Naming Conventions of NovaSAR-1 CEOS-ARD NRB Product

CEOS-ARD: CEOS Analysis Ready Data

NRB: Normalised Radar Backscatter

PFS: Product Family Specifications

v5.5: Version number of PFS

A: Ascending orbit

D: Descending orbit

L: Left pointing of antenna

R: Right pointing of antenna

QL: Quick Look

Sample of NovaSAR-1 CEOS-ARD NRB Product File Structure

CEOS-ARD_NRB_v5.5_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.zip:

Annotation

Measurement

Preview

CEOS-ARD_NRB_v5.5_N1_product_metadata.xml

CEOS-ARD_NRB_v5.5_N1_product_metadata.yaml

readme.txt

Sample of NovaSAR-1 CEOS-ARD NRB Product File Structure

- Subfolder of Annotation

CEOS-ARD_NRB_v5.5_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.zip

/Annotation:

CEOS-ARD_NRB_v5.5_GammaToSigmaRatio_N1_19589_scd_27_D_R_20210205T142144.tif

CEOS-ARD_NRB_v5.5_LocalIncidenceAngle_N1_19589_scd_27_D_R_20210205T142144.tif

CEOS-ARD_NRB_v5.5_Mask_N1_19589_scd_27_D_R_20210205T142144.tif

CEOS-ARD_NRB_v5.5_ScatteringArea_N1_19589_scd_27_D_R_20210205T142144.tif

Sample of NovaSAR-1 CEOS-ARD NRB Product File Structure

- Subfolder of Measurement

CEOS-ARD_NRB_v5.5_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.zip

/Measurement:

CEOS-ARD_NRB_v5.5_Gamma0_HH_N1_19589_scd_27_D_R_20210205T142144.tif

CEOS-ARD_NRB_v5.5_Gamma0_HV_N1_19589_scd_27_D_R_20210205T142144.tif

CEOS-ARD_NRB_v5.5_Gamma0_VV_N1_19589_scd_27_D_R_20210205T142144.tif

Sample of NovaSAR-1 CEOS-ARD NRB Product File Structure

- Subfolder of Preview

CEOS-ARD_NRB_v5.5_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.zip

/Preview:

Map_Overlay_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.bmp

Map_Overlay_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.kml

QL_image_HH.tif

QL_image_HV.tif

QL_image_VV.tif

Data Format and Data Type of NovaSAR-1 CEOS-ARD NRB Product

Data Format:

COG (Cloud Optimized GeoTif)

Data Types:

Float32 for per-pixel metadata except Mask with 8bits integer under Annotation

UINT16 for NRB under Measurement

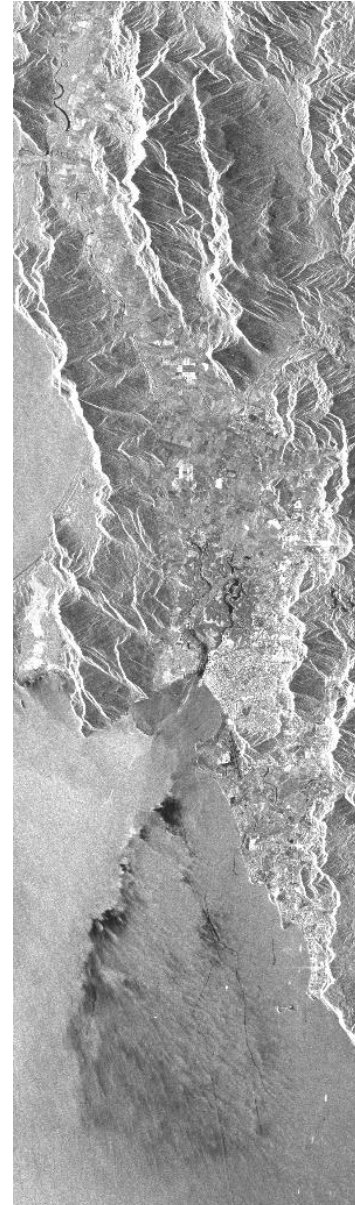
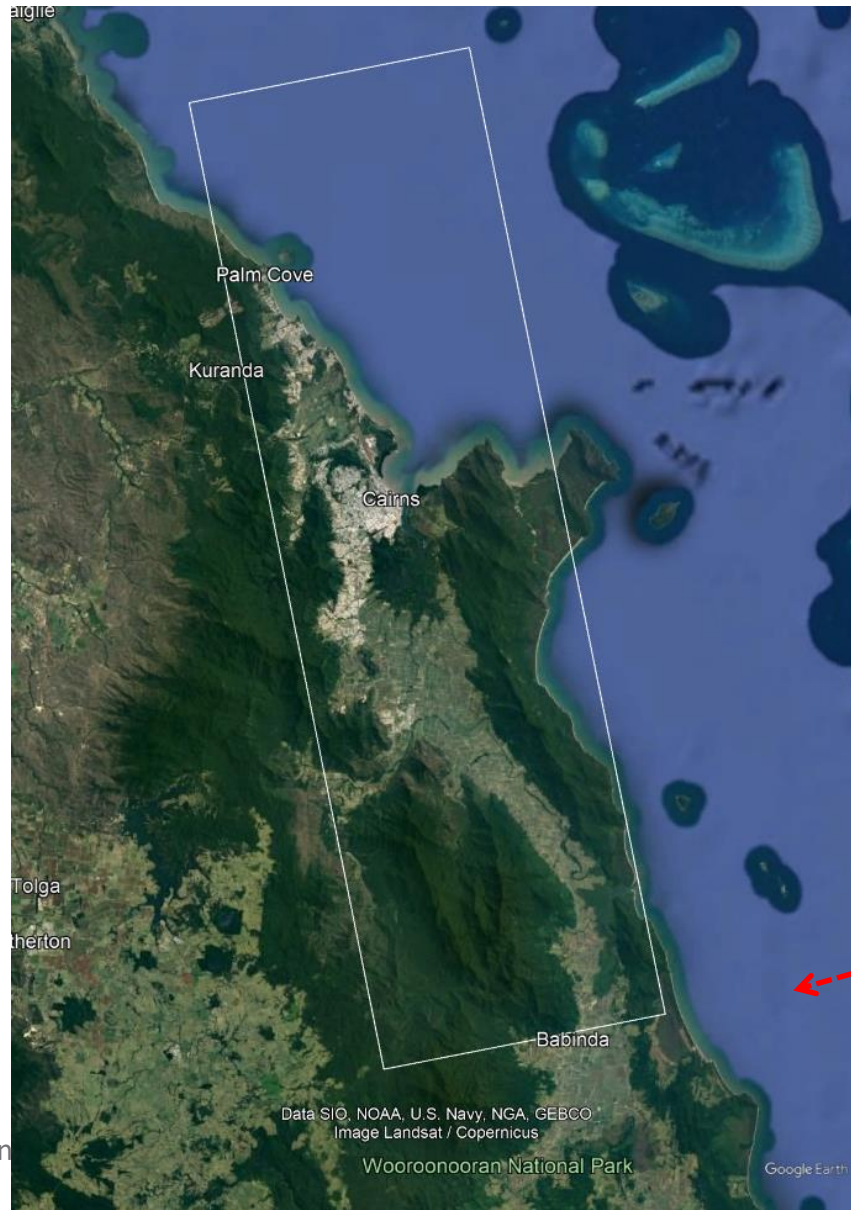
Steps of CEOS-ARD NRB PFS v5.5 Compliant NovaSAR-1 ARD Production

- using GAMMA processing sequences and Python codes

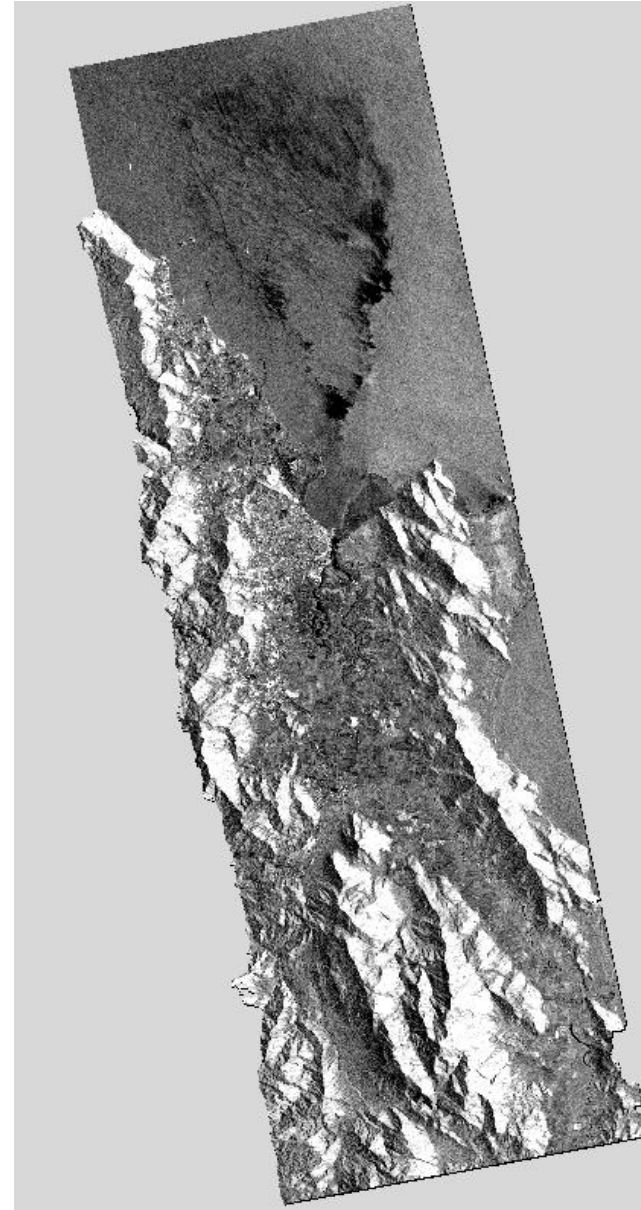
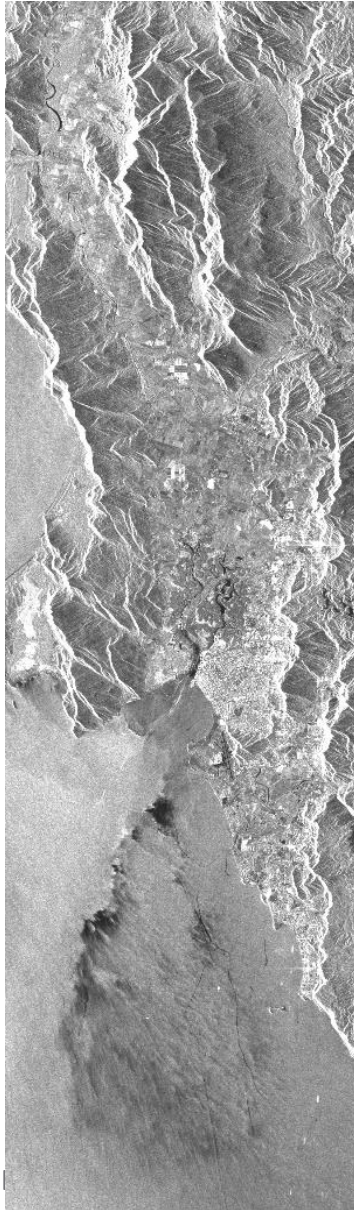
- 1). Source Data Import: File unzip, read-in with radiometric calibration
- 2). Multi-Look
- 3). DEM Preparation: COP-DSM crop, translation and resampling
- 4). Geocoding: Calculate lookup table and DEM related products, generate accurate layover and shadow map; Calculate terrain-based sigma/gamma nought normalization area; Geocoding lookup table refinement using offset polynomials;
- 5). Terrain Flattening with Gamma0 normalization area, then Geocoding of image data using a refined lookup table
- 6). Generation of Per-Pixel Metadata Images: Mask of layover and shadow; Local incidence angle; Gamma To Sigma Ratio; Local contributing area
- 7). Creation of KML footprint and Quick-look images
- 8). Scaling and GeoTiff Output
- 9). Generation of General Metadata File
- 10). Package of Product by zip compression

Samples of ARD Processing:

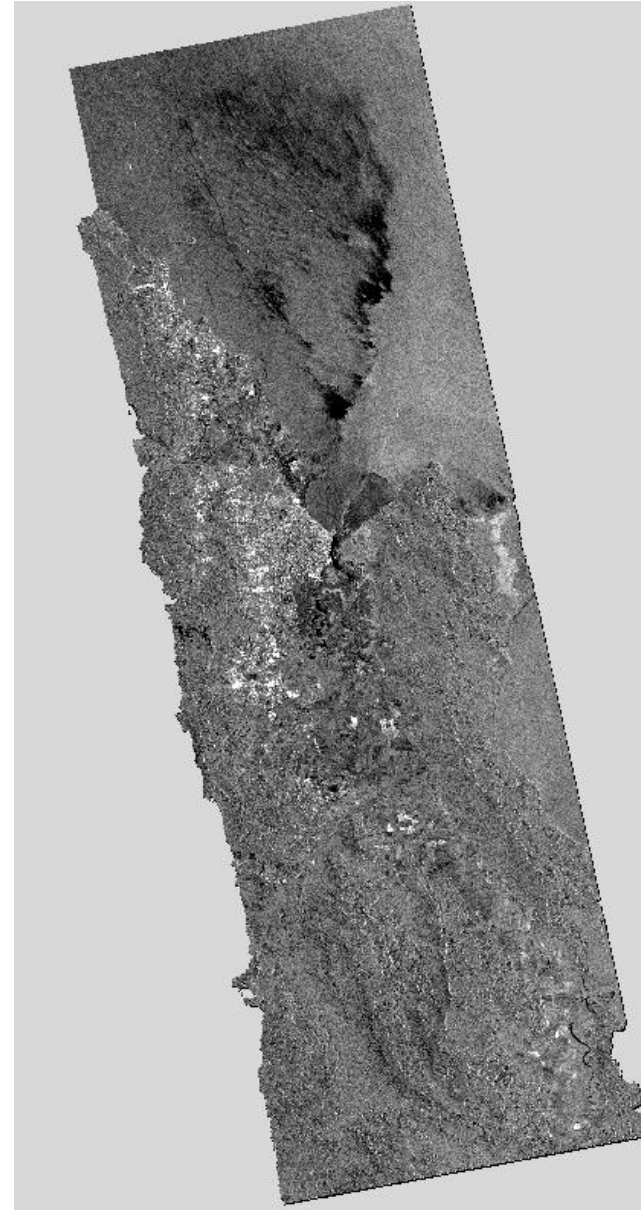
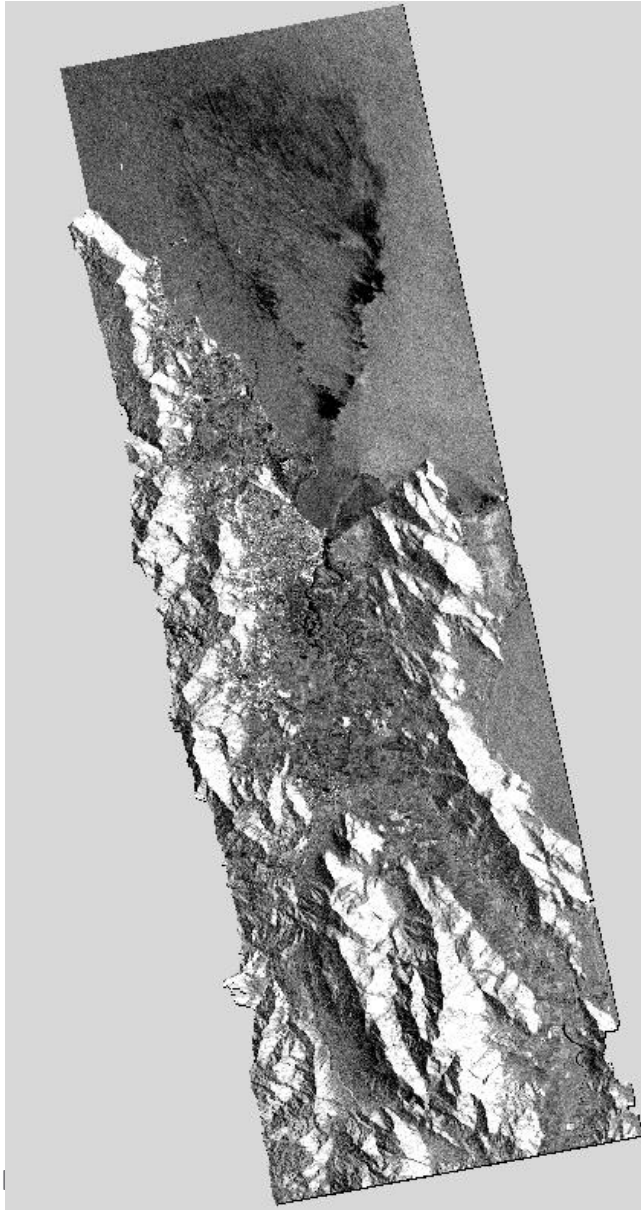
Footprint and Source Image of Acquisition 39919 in Ascending Left-look Configuration



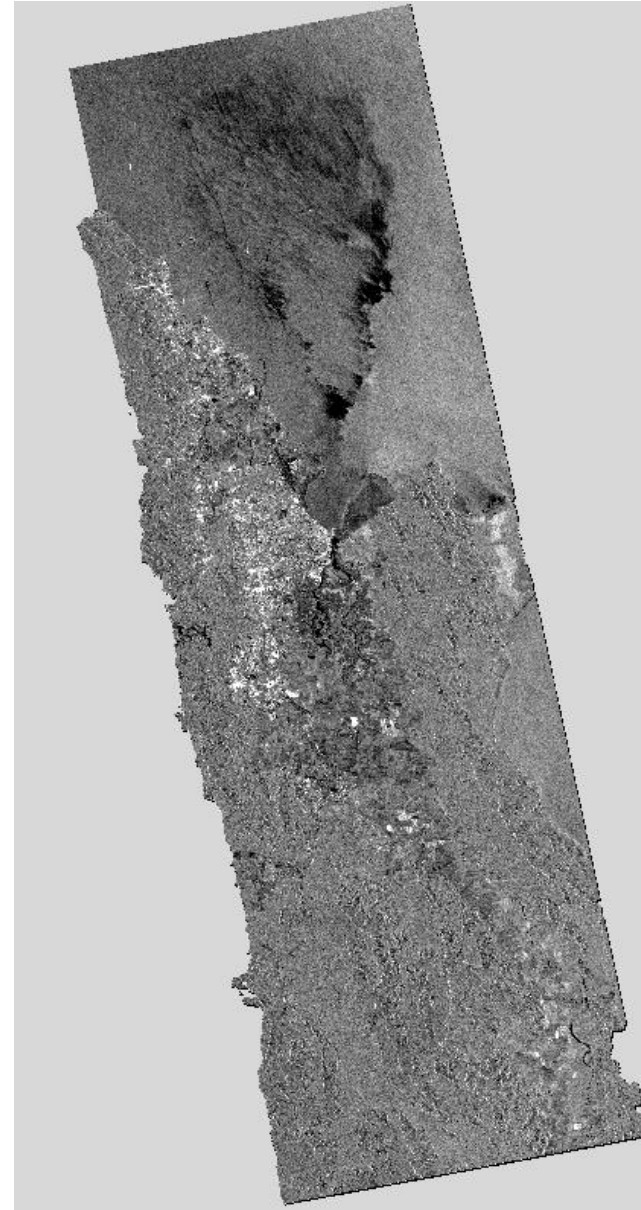
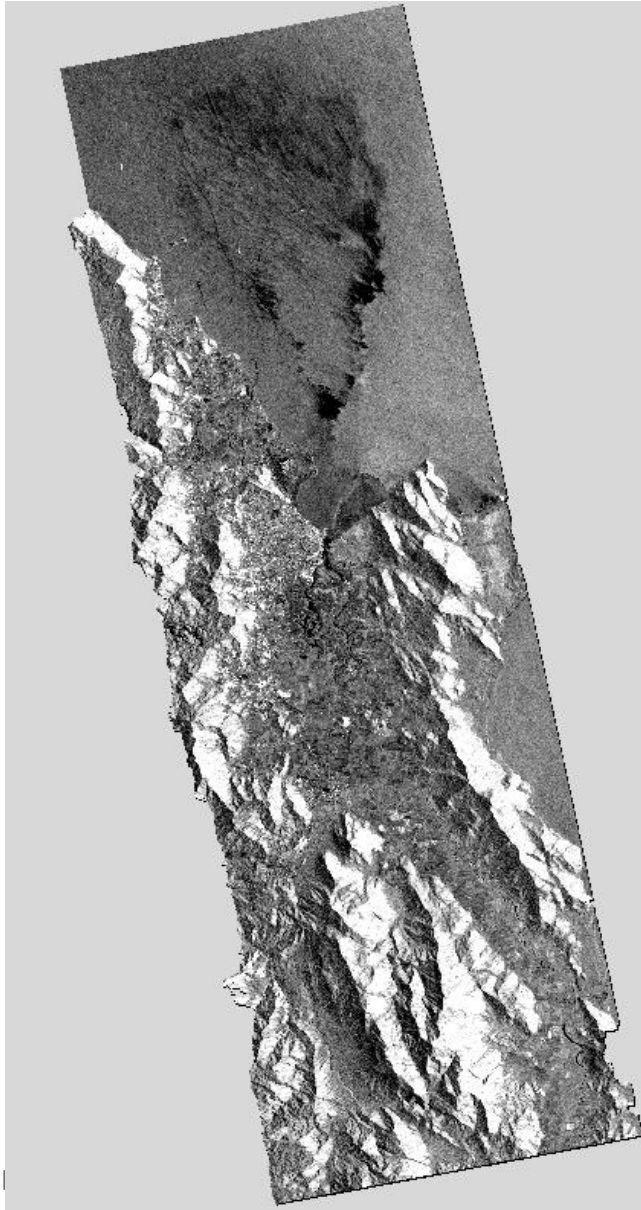
Geometric Terrain Correction of Acquisition 39919: HH Source (left) and Beta0 (right)



Radiometric Terrain Correction of 39919: HH Beta0 (left) and Sigma0-RTC (right)

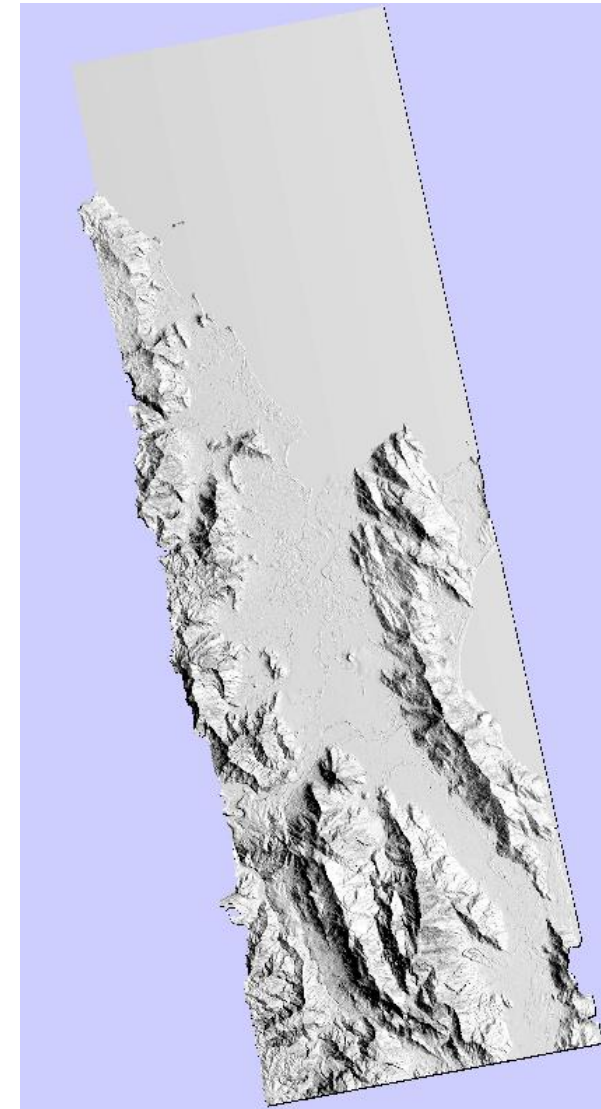
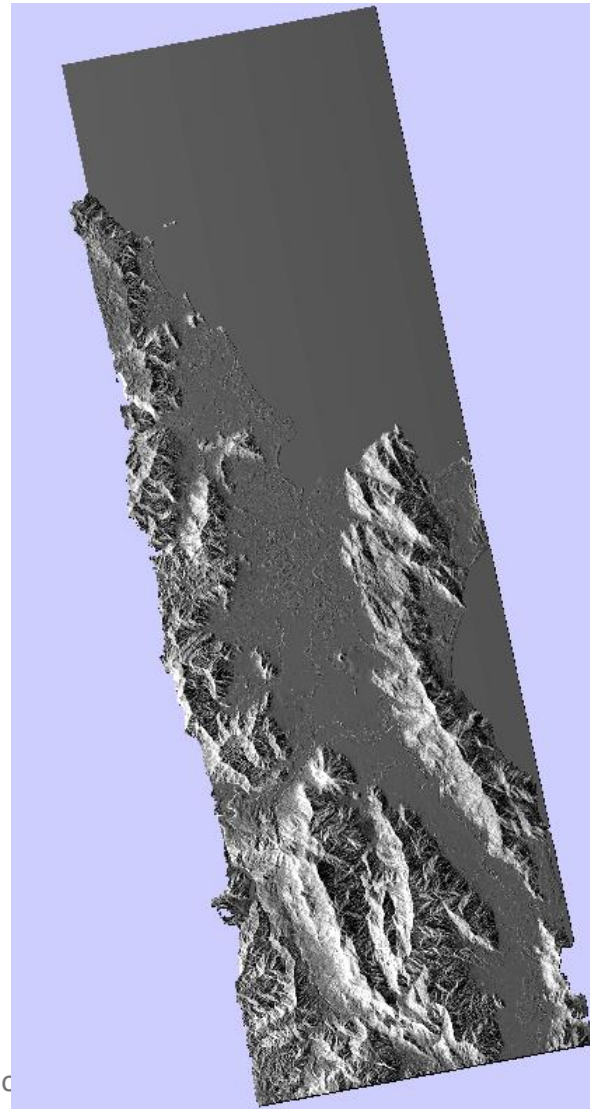
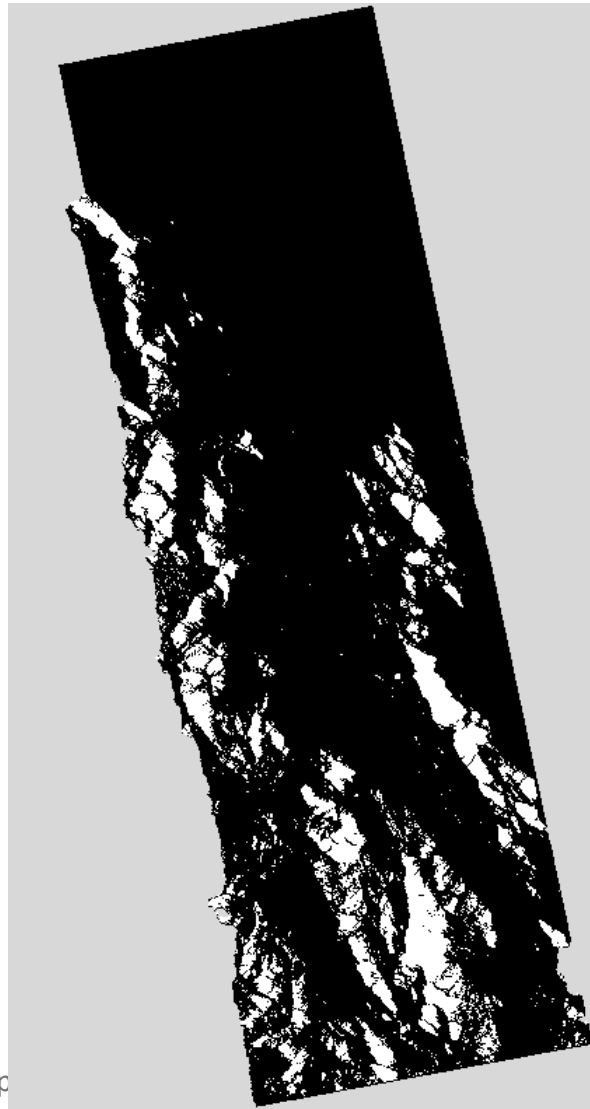


Radiometric Terrain Correction of 39919: HH Beta0 (left) and Gamma0-RTC (right)



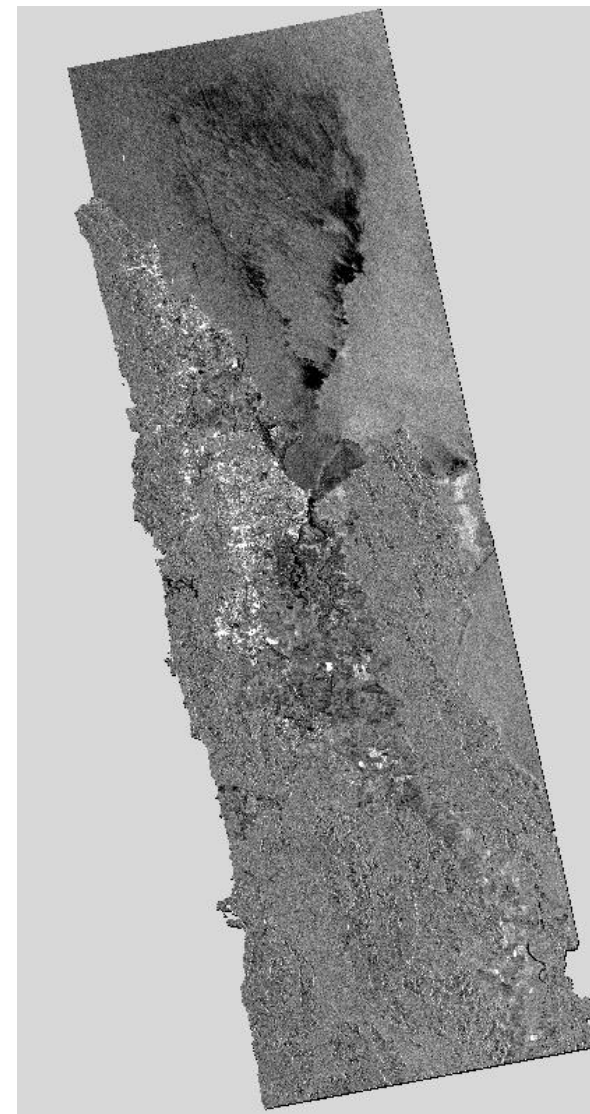
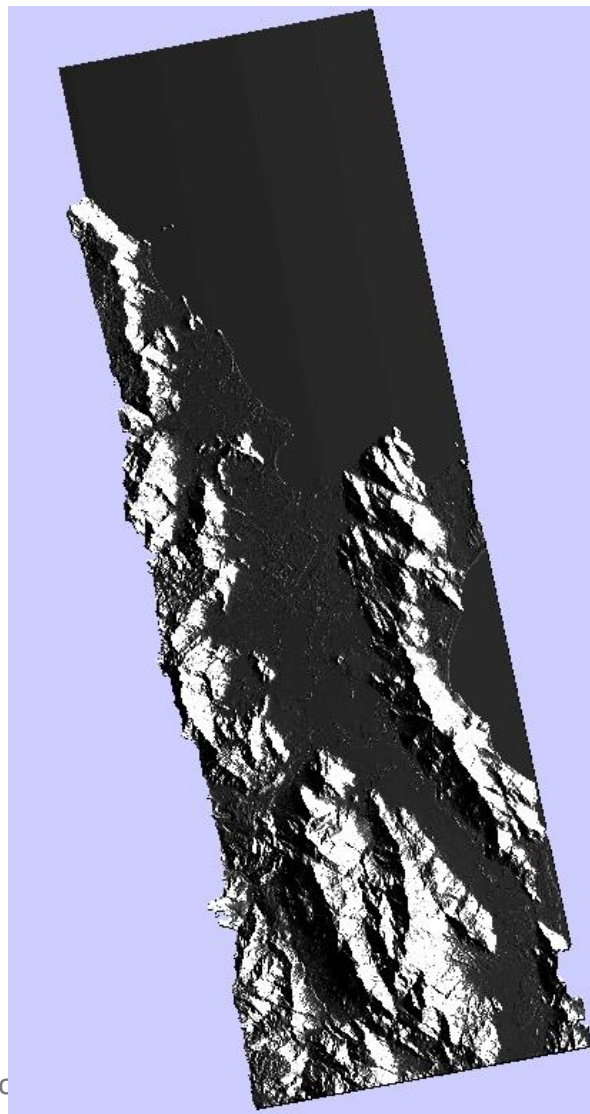
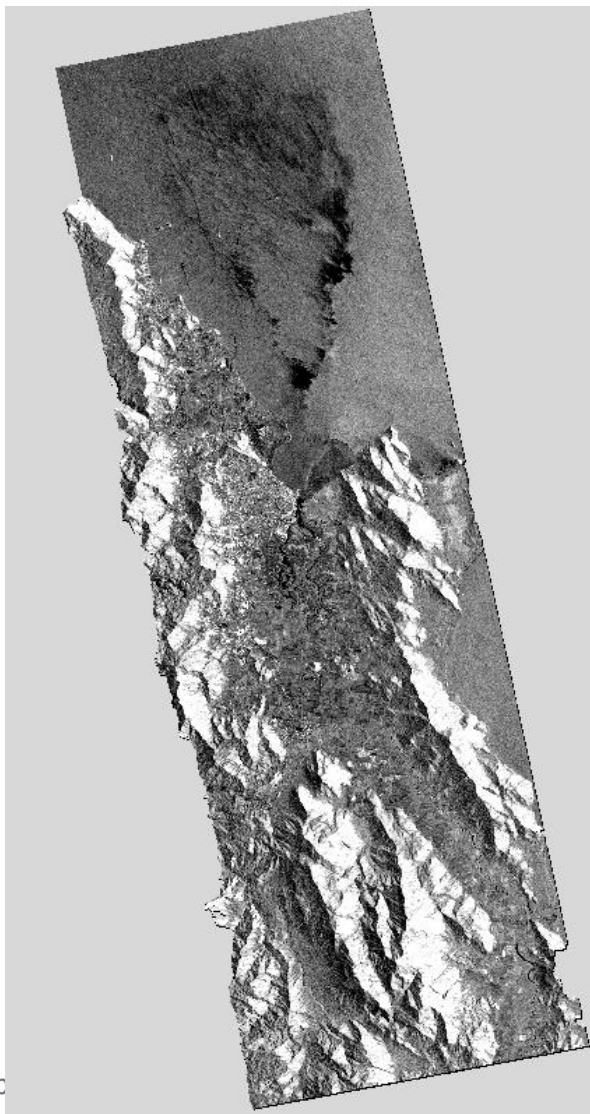
Per-pixel Metadata Images of NovaSAR-1 CEOS-ARD NRB Product

39919: Mask (left), LocalIncAngle (centre) and GammaToSigmaRatio (right)



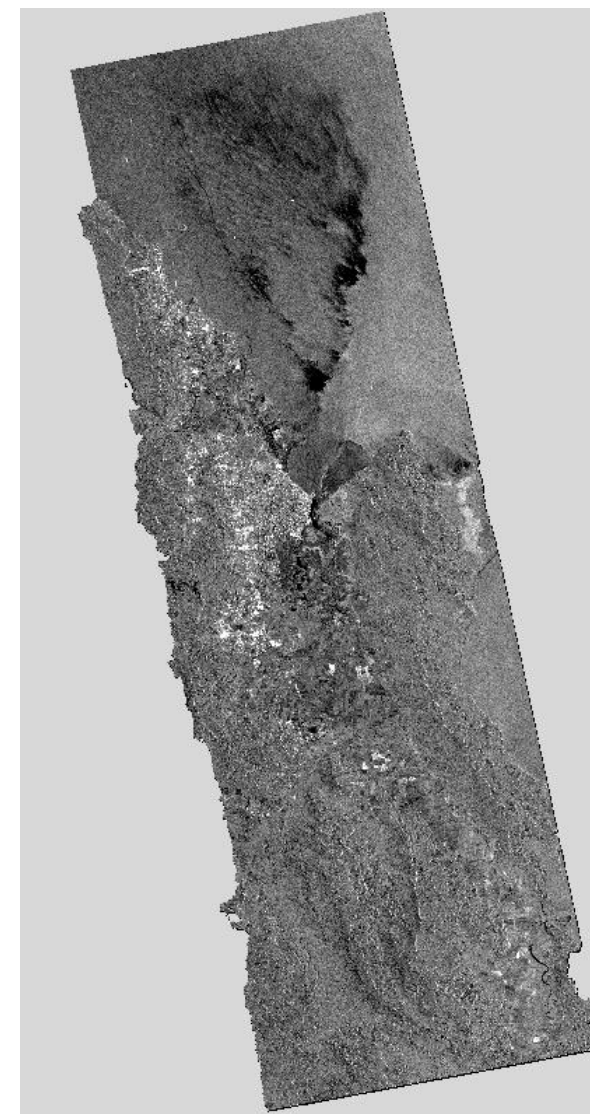
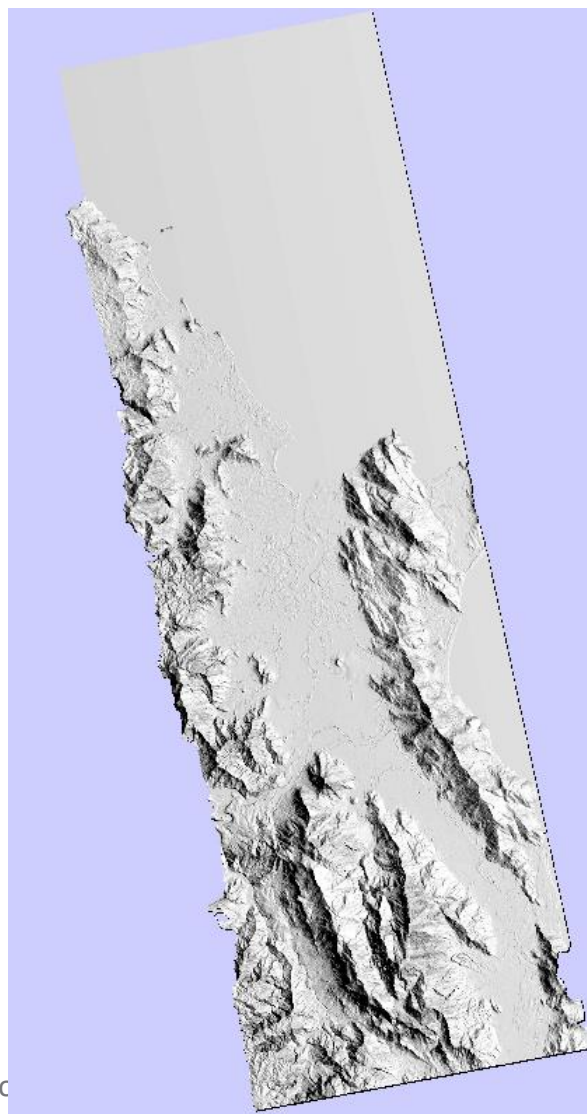
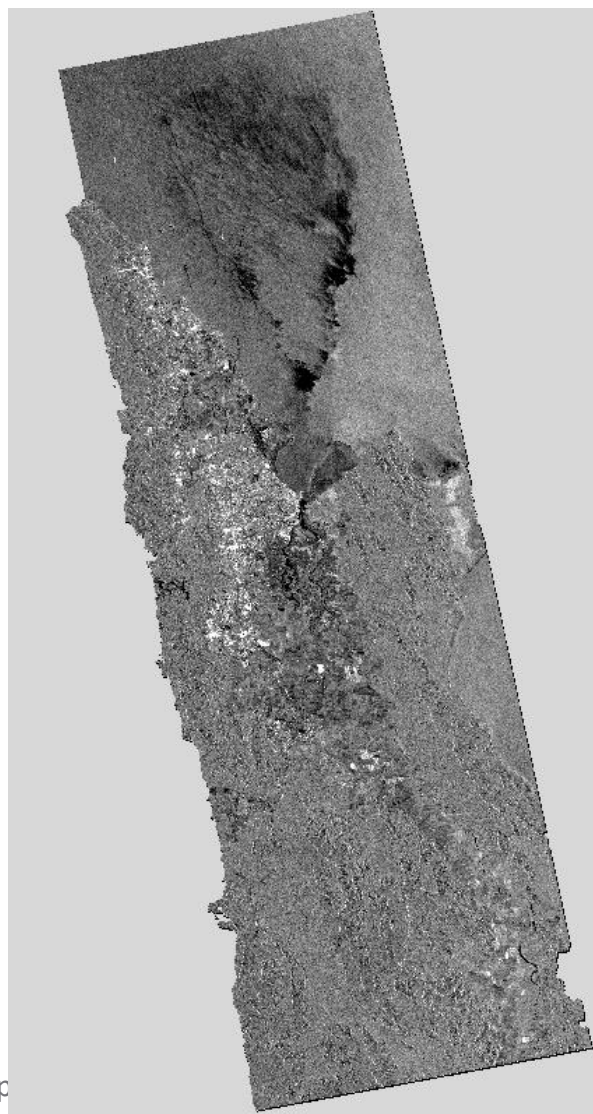
Backscatter Conversion of NovaSAR-1 CEOS-ARD NRB Product

39919: Beta0 (left) **divided** by ScatteringArea (centre) equals to Gamma0-RTC (right)

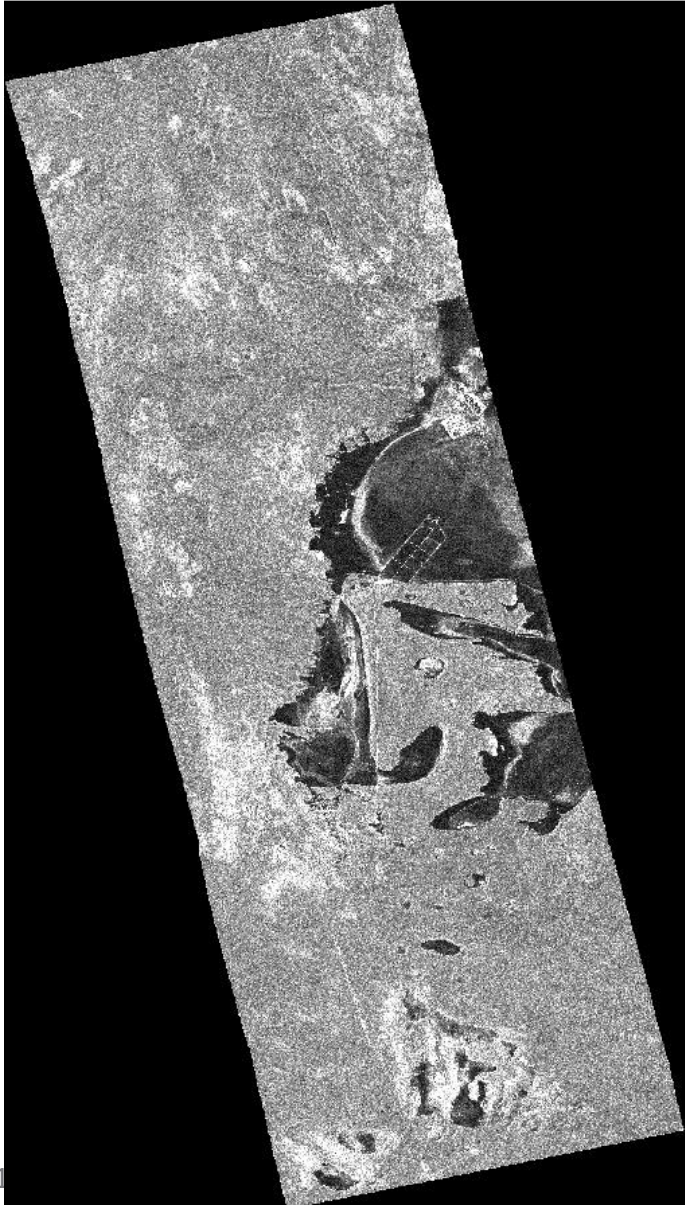


Backscatter Conversion of NovaSAR-1 CEOS-ARD NRB Product

39919: Gamma0-RTC (left) **multiplying** by GammaToSigmaRatio (centre) equals to Sigma0-RTC (right)



Measurement to Linear Intensity



Band Maths@mylophote-fl

Target product:
[1] CARD4L_NRB_v5.5_Gamma0_VV_N1_40075_grd_13_A_R_20221210T024557

Name: Intensity

Description:

Unit:

Spectral wavelength: 0.0

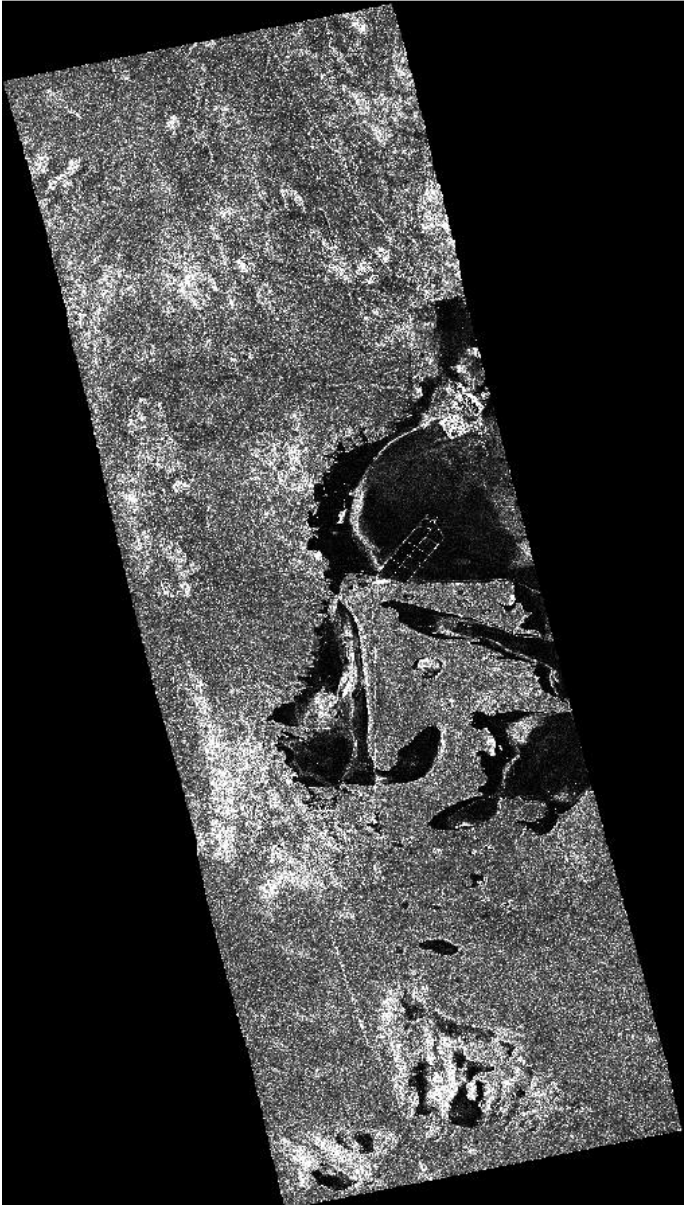
Virtual (save expression only, don't store data)

Replace NaN and infinity results by NaN

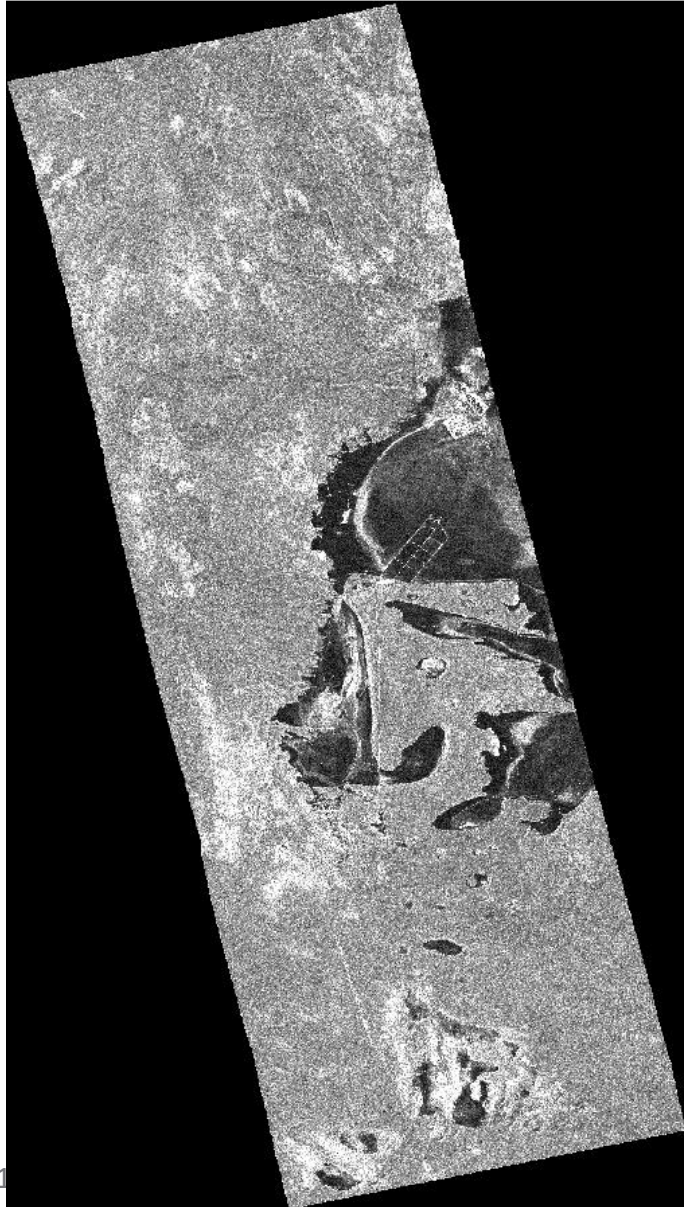
Generate associated uncertainty band

Band maths expression:
(band_1 / 14125.3754) * (band_1 / 14125.3754)

Buttons: Load... Save... Edit Expression... OK Cancel Help



Measurement to Intensity in dB



Band Maths@mylophote-fl

Target product:
[1] CARD4L_NRB_v5.5_Gamma0_VV_N1_40075_grd_13_A_R_20221210T024557

Name: Intensity_dB

Description:

Unit:

Spectral wavelength: 0.0

Virtual (save expression only, don't store data)

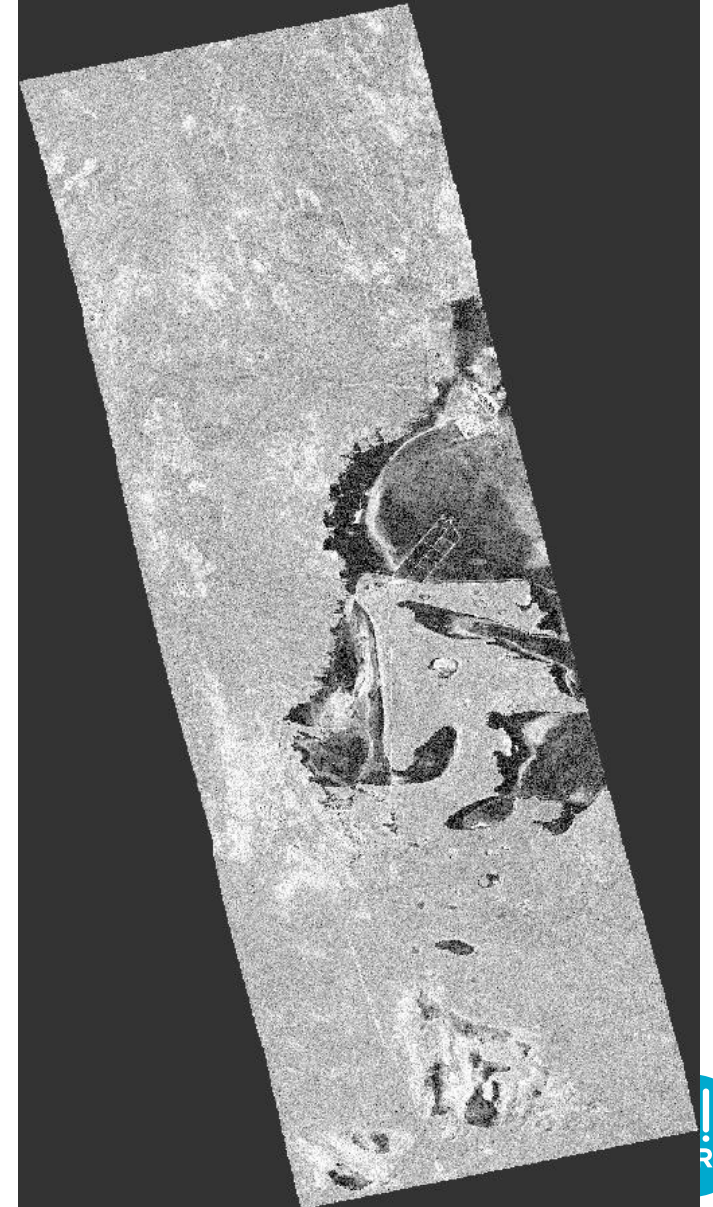
Replace NaN and infinity results by NaN

Generate associated uncertainty band

Band maths expression:
20 * log10(band_1) - 83

Load... Save... Edit Expression...

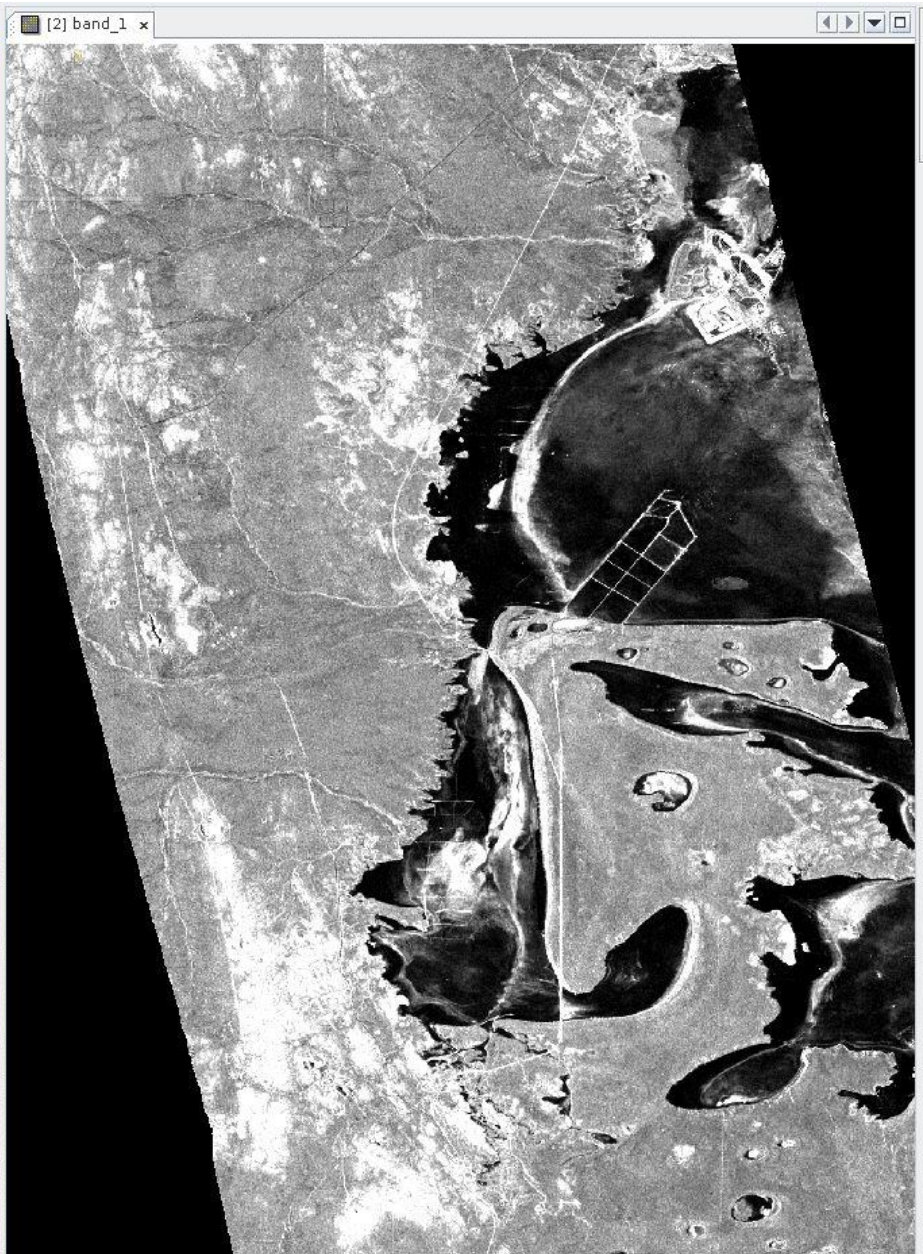
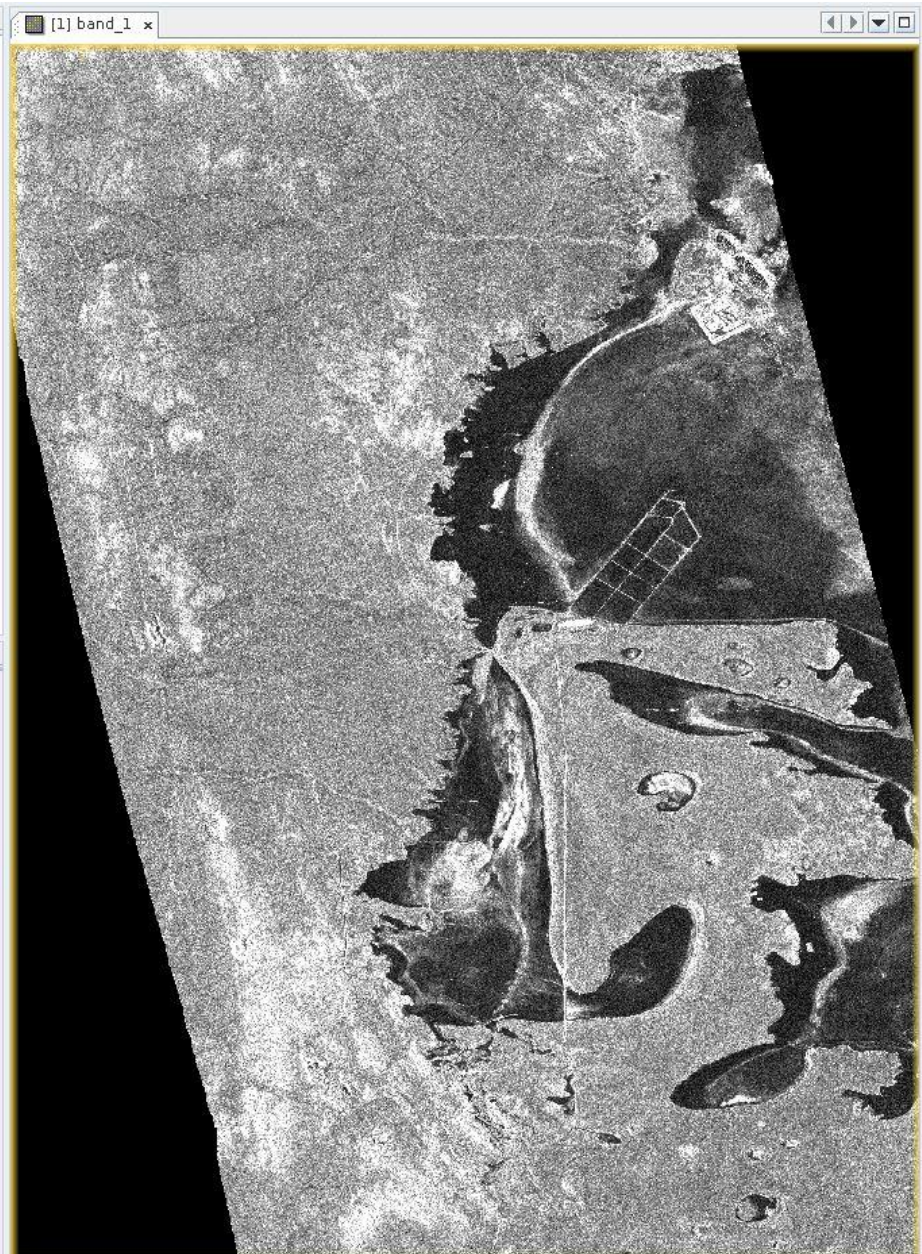
OK Cancel Help



Speckle Filtering of Measurement

Product Explorer x Pixel Info

- [1] CARD4L_NRB_v5.5_Gamma0_VV_N1_40075_grd_13_A_R_20221210T024557
 - Metadata
 - Vector Data
 - Bands
 - band_1
- [2] CARD4L_NRB_v5.5_Gamma0_VV_N1_40075_grd_13_A_R_20221210T024557_Spk
 - Metadata
 - Vector Data
 - Bands
 - band_1



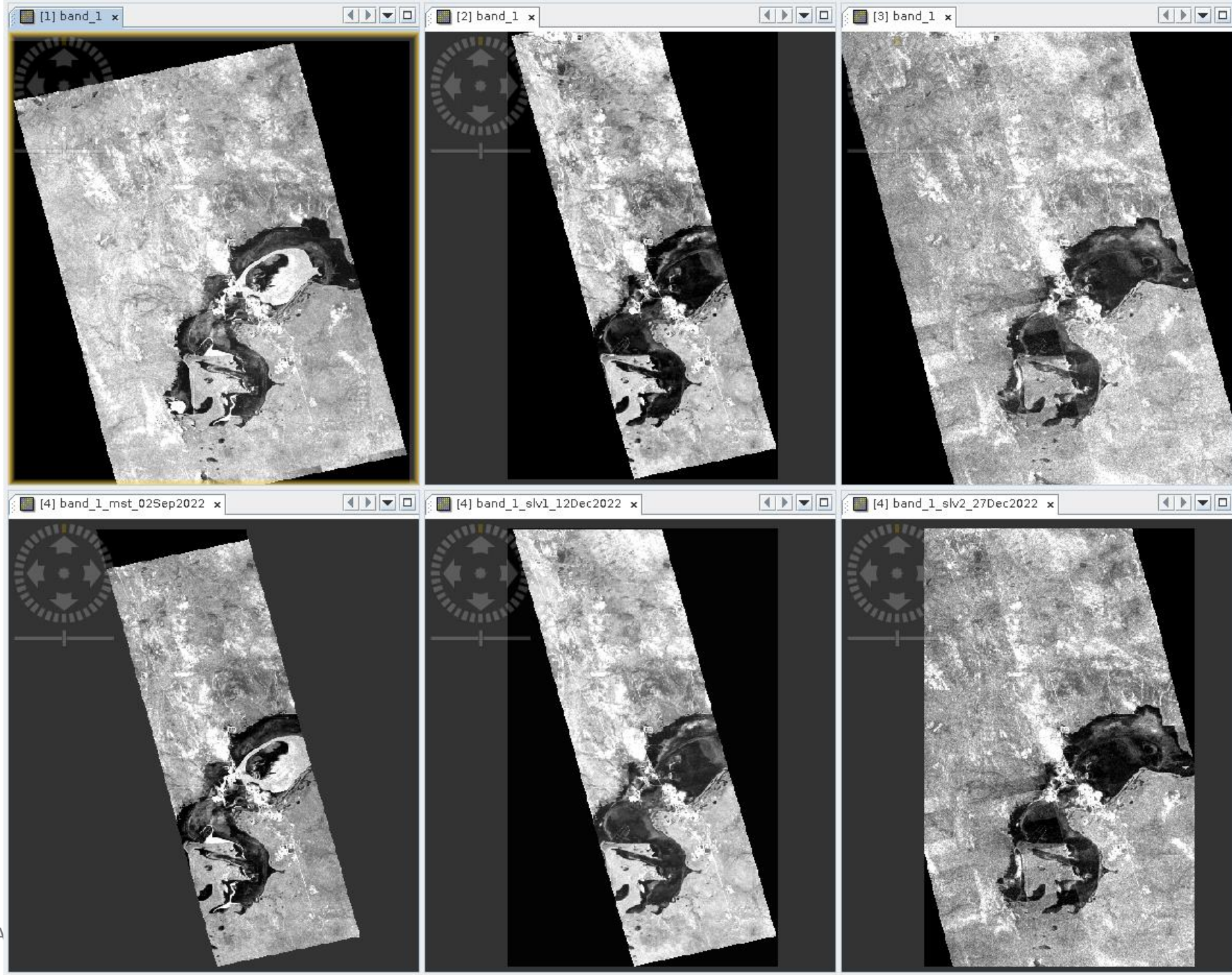
Navigation - [1] b... Colour Manipulati... Uncertainty Visual... World View x

Off Globe

20 Km

This panel displays a world view map of the Moon's surface. A red rectangular box indicates the geographic location of the radar data shown in the adjacent panels. The map includes a scale bar labeled '20 Km' and the text 'Off Globe' at the bottom.

Co-registration of Measurements



Perth, 8 August 2023

CSIRO Self-assessment for CEOS-ARD PFS NRB v5.5 compliance.

Valid for the following sample NovaSAR-1 ARD products:

- ScanSAR, Tri-Pol, NovaSAR_01_19589_scd_210205_142144_VV_HH_HV:
ftp://ftp.csiro.au/zsz/N1_ARD/samples_20230808/CEOS-ARD_NRB_v5.5_NovaSAR_01_19589_scd_27_210205_142144_VV_HH_HV_D_R.zip
- ScanSAR, HH+HV, NovaSAR_01_39919_scd_221205_004444_HH_HV:
ftp://ftp.csiro.au/zsz/N1_ARD/samples_20230808/CEOS-ARD_NRB_v5.5_NovaSAR_01_39919_scd_32_221205_004444_HH_HV_A_L.zip
- ScanSAR, VV+HH, NovaSAR_01_35668_scd_220714_011528_VV_HH:
ftp://ftp.csiro.au/zsz/N1_ARD/samples_20230808/CEOS-ARD_NRB_v5.5_NovaSAR_01_35668_scd_23_220714_011528_VV_HH_A_L.zip
- ScanSAR, HH, NovaSAR_01_17461_scd_201201_002656_HH:
ftp://ftp.csiro.au/zsz/N1_ARD/samples_20230808/CEOS-ARD_NRB_v5.5_NovaSAR_01_17461_scd_21_201201_002656_HH_A_R.zip
- ScanSAR, HV, NovaSAR_01_11419_scd_200504_131618_HV:
ftp://ftp.csiro.au/zsz/N1_ARD/samples_20230808/CEOS-ARD_NRB_v5.5_NovaSAR_01_11419_scd_31_200504_131618_HV_D_L.zip

Summary Self-Assessment Table – CSIRO NovaSAR-1

		Threshold	Target
1	General Metadata		
1.1	Traceability	Not required	
1.2	Metadata Machine Readability	Yes	
1.3	Product type	Yes	
1.4	Document Identifier	Yes	
1.5	Data Collection Time	Yes	
1.6	Source Data Attributes		
1.6.1	Source Data Access	Yes	
1.6.2	Instrument	Yes	
1.6.3	Source Data Acquisition Time	Yes	
1.6.4	Source Data Acquisition Parameters	Yes	
1.6.5	Source Data Orbit Information	Yes	Partial
1.6.6	Source Data Processing Information	Yes	Partial
1.6.7	Source Data Image Attributes	Yes	
1.6.8	Sensor Calibration	Not required	
1.6.9	Performance Indicators	Yes	
1.6.10	Source Data Polarimetric Calibration Matrices	Not required	
1.6.11	Mean Faraday Rotation Angle	Not required	
1.6.12	Ionosphere Indicator	Not required	
1.7	CARD4L Product Attributes		
1.7.1	Product Data Access	Yes	
1.7.2	Ancillary Data	Not required	
1.7.3	Product Sample Spacing	Yes	
1.7.4	Product Filtering	Yes	
1.7.5	Product Bounding Box	Yes	
1.7.6	Product Image Extent	Yes	
1.7.7	Product Image Size	Yes	
1.7.8	Product Pixel Coordinate Convention	Yes	
1.7.9	Product Coordinate Reference System	Yes	

Outcome of CSIRO submission for CEOS-ARD evaluation of NovaSAR NRB products [SEC=OFFICIAL]



Medhavy Thankappan <Medhavy.Thankappan@ga.gov.au>

To Labahn, Steven T; Peter.STROBL@ec.europa.eu; Siqueira Andreia; Matthew Steventon; libby
 Cc Zhou, Zheng-Shu (Data61, Kensington WA); Held, Alex (S&A, Black Mountain);
 Garthwaite, Matt (S&A, Black Mountain); Ake Rosenqvist (soloEO); Philippe Goryl; **+4 others**

Thu 5/10/2023 8:41 AM

This sender Medhavy.Thankappan@ga.gov.au is from outside your organization.

Dear LSI-VC Co-chairs and Secretariat (cc CSIRO Reps, WGCV Chair, Co-chair),

On behalf of WGCV, I am pleased to share the outcome of the CEOS-ARD self-assessment submitted by CSIRO for 14 NovaSAR Normalised Radar Backscatter (NRB) products (on NRB PFS v5.5), as listed below.

	Mode Type	Mode Name	CEOS-ARD Assessment
●	Maritime	Maritime	No
●	ScanSAR	20m_ScanSAR_HHHV	Yes
		20m_ScanSAR_HHVV	Yes
		30m_ScanSAR_VVHHHV	Yes
		35m_ScanSAR_100km_VVHHHV	Yes
●	ScanSAR Wide	33m_ScanSAR_195km_HH	Yes
		50m_ScanSAR_195km_HHHV	Yes
●	StripMap	6m_StripMap_HH	Yes
		6m_StripMap_VV	Yes
●	ScanSAR	20m_ScanSAR_HH	Yes
		20m_ScanSAR_VV	Yes
		30m_ScanSAR_HH	Yes
		30m_ScanSAR_VV	Yes
●	ScanSAR Wide	40m_ScanSAR_195km_HV	Yes
		40m_CoCross_ScanSAR_Mid_HHHV	Yes
		45m_ScanSAR_195km_HHHV	No
		50m_Co6+Cross1_ScanSAR_195km_HHHV	No



Outcome of CSIRO submission for CEOS-ARD evaluation of NovaSAR NRB products [SEC=OFFICIAL]



Medhavy Thankappan <Medhavy.Thankappan@ga.gov.au>

To ; ; ; ; ;
Cc ; ;
; ; ; **+4 others**

This sender Medhavy.Thankappan@ga.gov.au is from outside your organization.



Thu 5/10/2023 8:41 AM

The documents containing the outcome of the evaluation and the original self-assessment submission with comments and feedback are attached for reference (attached zip files).

All 14 CSIRO NovaSAR NRB products identified above have been evaluated as CEOS-ARD compliant at the Threshold level.

Congratulations CSIRO!

Please note that the assessment did not require a full WGCV Review Panel evaluation as the submission was complete only for Threshold level items.

For any additional feedback about the assessment, please contact Peter.Harrison@ga.gov.au with copy to me.

Please note that the term 'CARD4L' has now been replaced by 'CEOS-ARD', to reflect use in other domains including land.

Kind regards
Medhavy and Peter

Medhavy Thankappan

Director, Science and Data Quality Assurance
Satellite Land Imaging Collection Branch
Space Division | **GEOSCIENCE AUSTRALIA**

Phone: +61 2 6249 9310 Mob: +61 448055627
Email: Medhavy.Thankappan@ga.gov.au Web: www.ga.gov.au

Cnr Jerrabomberra Avenue and Hindmarsh Drive Symonston ACT 2609
GPO Box 378 Canberra ACT 2601 Australia



Summary Self-Assessment Table – CSIRO NovaSAR-1

Re: Outcome of CSIRO submission for CEOS-ARD evaluation of NovaSAR NRB products [SEC=OFFICIAL]



Matthew Steventon <matthew@symbioscomms.com>

To Medhavy Thankappan; CEOS LSI-VC; ard-oversight-group@lists.ceos.org;
 Zhou, Zheng-Shu (Data61, Kensington WA)

Cc Labahn, Steven T; Peter.STROBL@ec.europa.eu; Siqueira Andreia; libby;
 Held, Alex (S&A, Black Mountain); Garthwaite, Matt (S&A, Black Mountain); **+ 6 others**

This sender matthew@symbioscomms.com is from outside your organization.

You forwarded this message on 11/10/2023 9:49 AM.



Thu 5/10/2023 7:00 PM

Congratulations to Zheng-Shu and the CSIRO team!

LSI-VC and CEOS-ARD colleagues – please see the message below regarding the NovaSAR NRB products being evaluated as CEOS-ARD compliant at the Threshold level.

ceos.org/ard has been updated to reflect the achievement.

CSIRO team, we welcome your use of the CEOS-ARD branding on your sites/data portal as you see fit. The package of branding is [here](#).

Libby will make a post on the CEOS-ARD social media shortly.

And thanks of course to Medhavy and Peter for working through the numerous products!

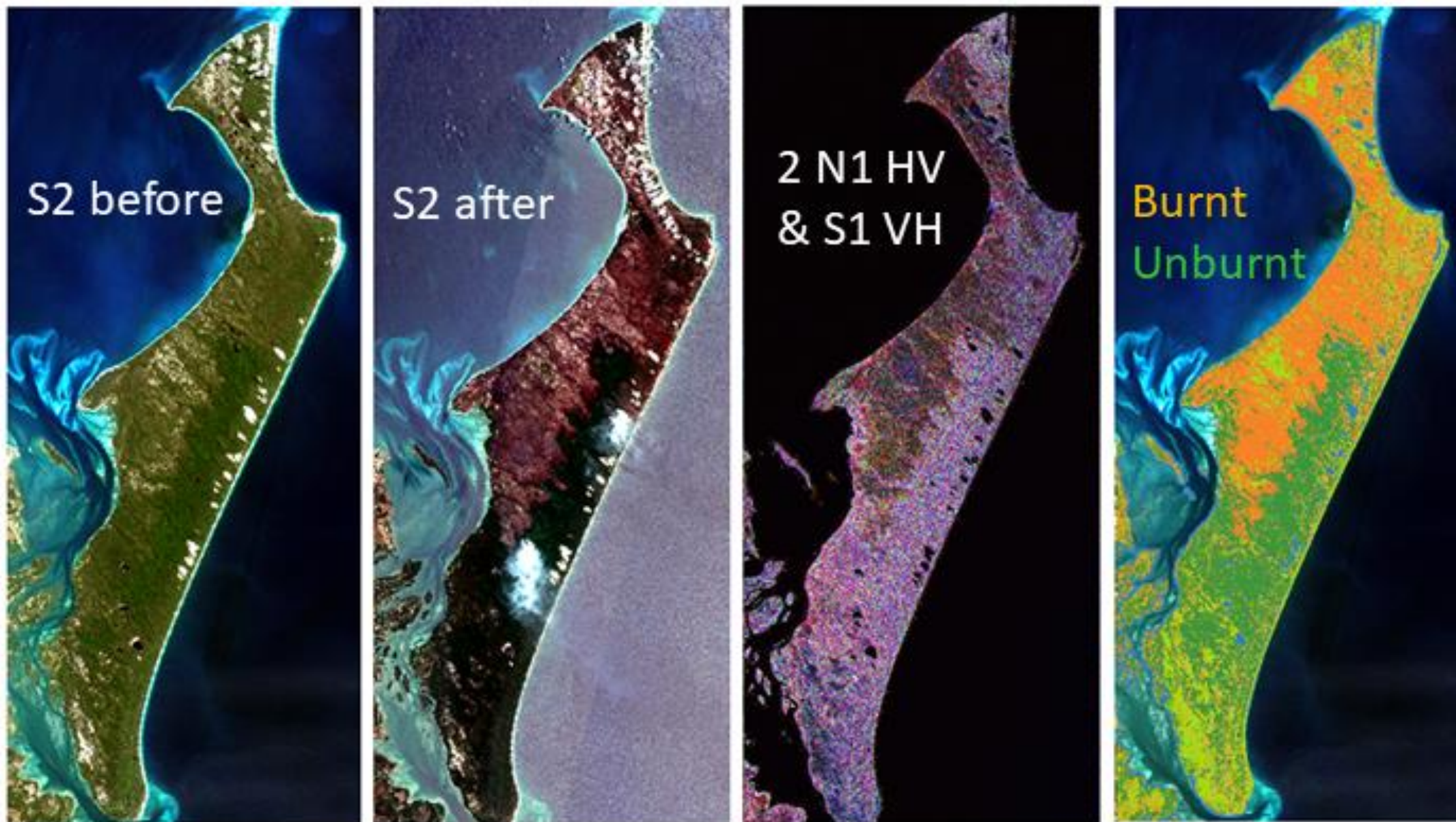
Best regards,
Matt



NovaSAR-1 ARD Application Demonstrations

- Burn Area Mapping in Fraser Island, QLD in Oct-Dec 2020

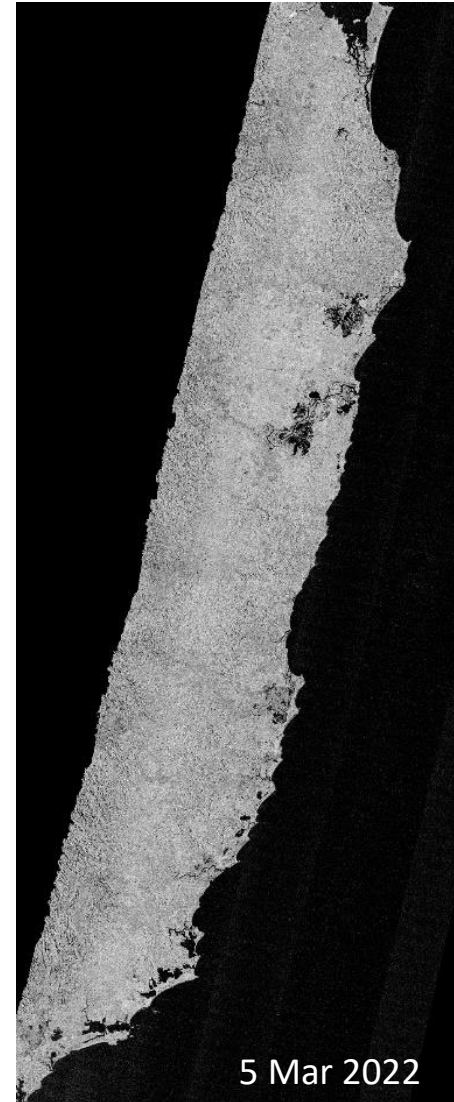
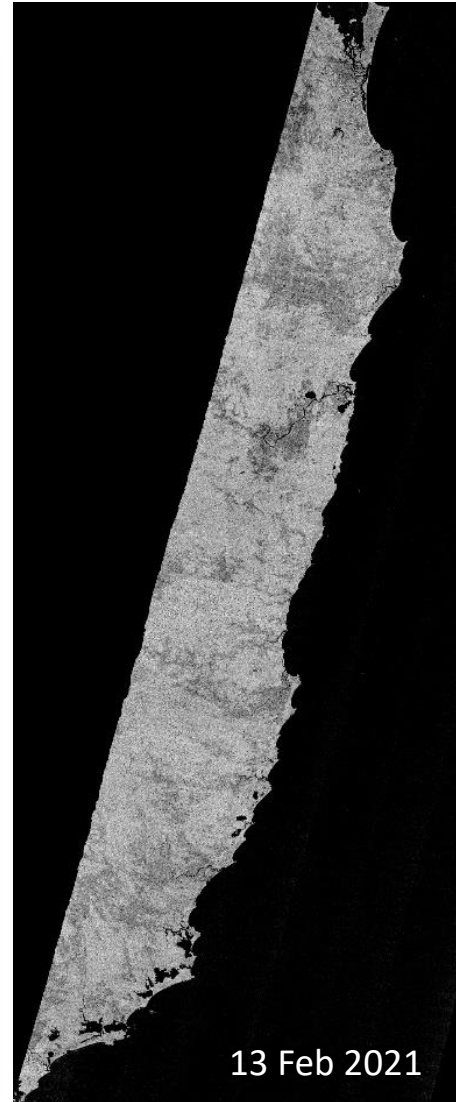
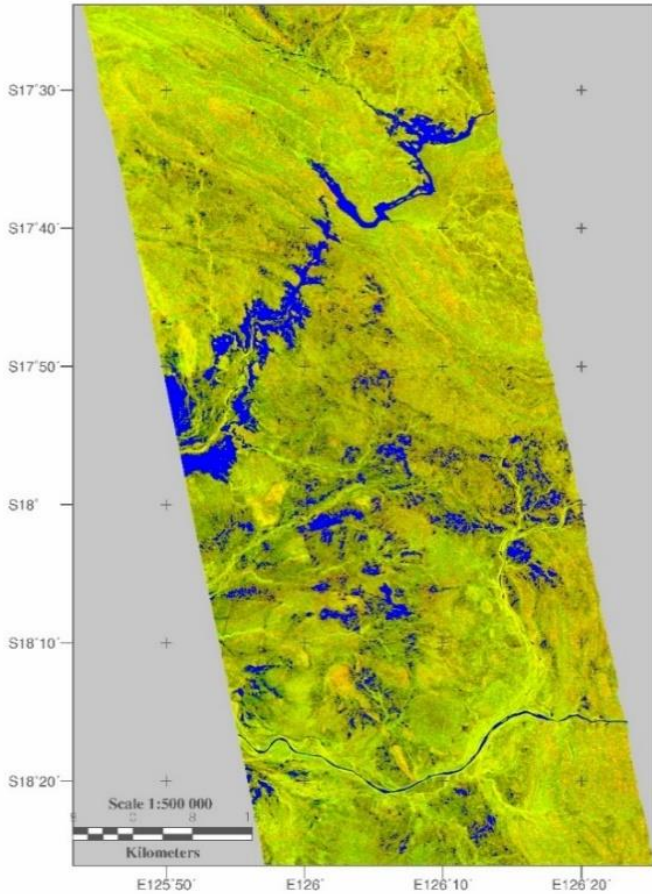
(Ticehurst et al, 2021)



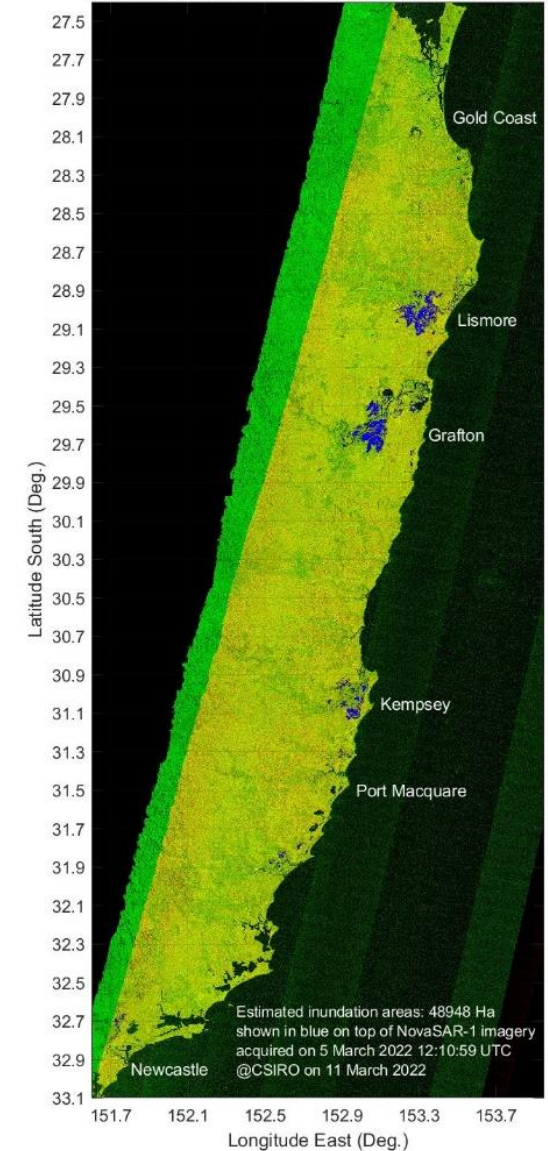
NovaSAR-1 ARD Application Demonstrations

- Flood maps in Kimberley WA on 4 Jan 2023 (left) and in East Coast on 5 Mar 2022 (right)

Flooding Map in Kimberley WA Captured by NovaSAR-1 on 4 Jan 2023 10:00:44 AWST

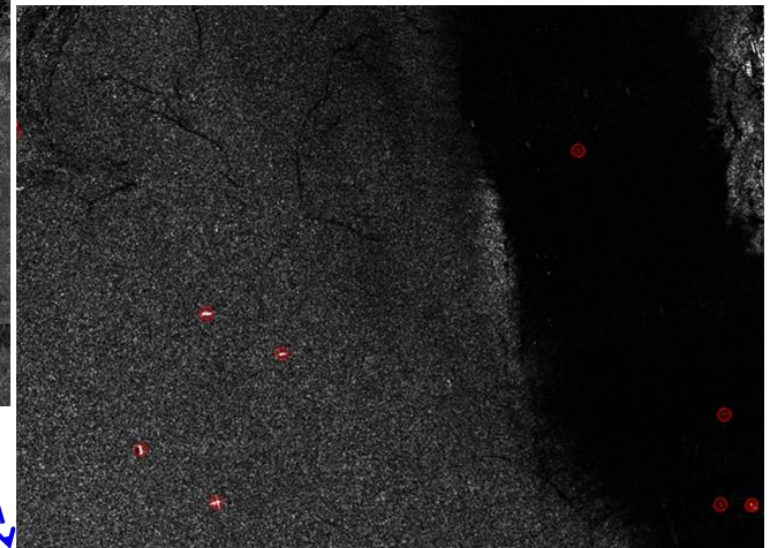
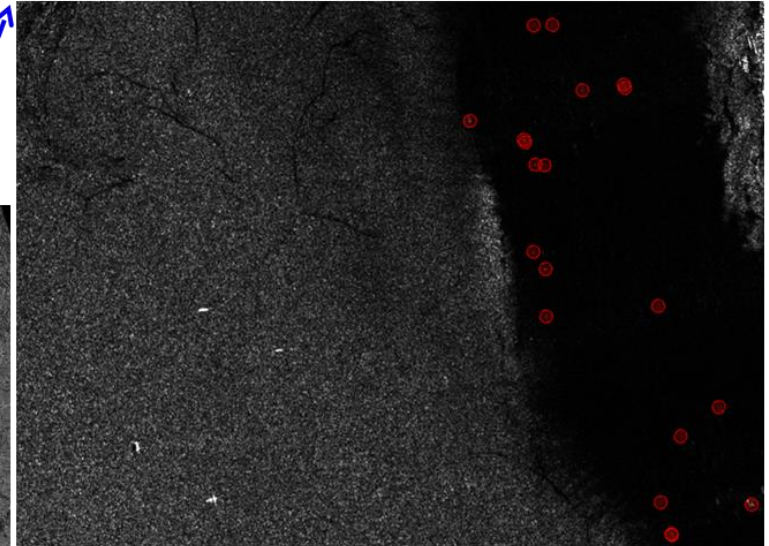
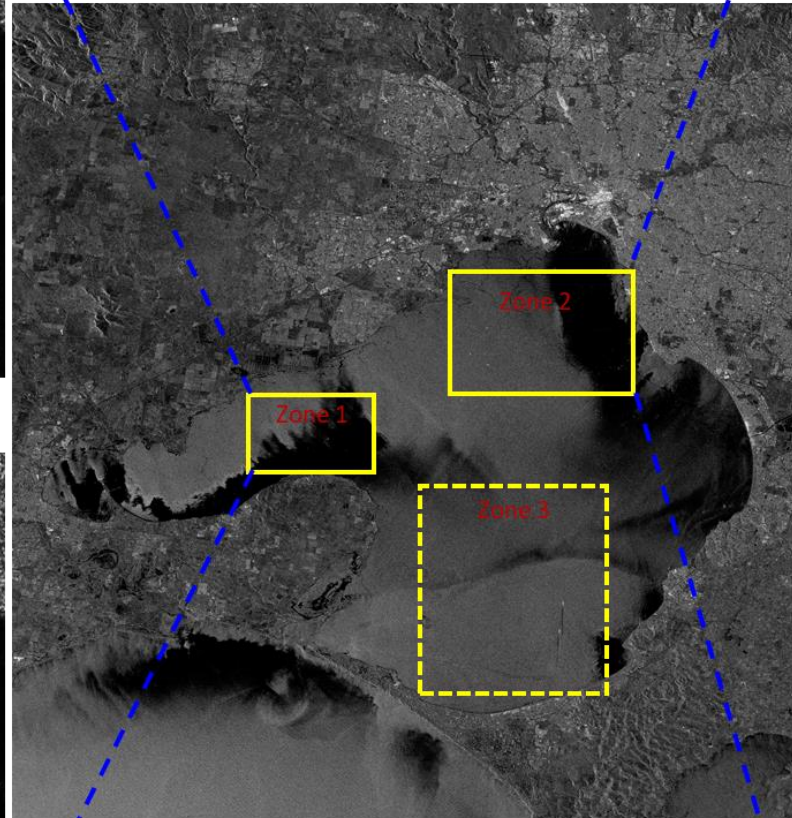
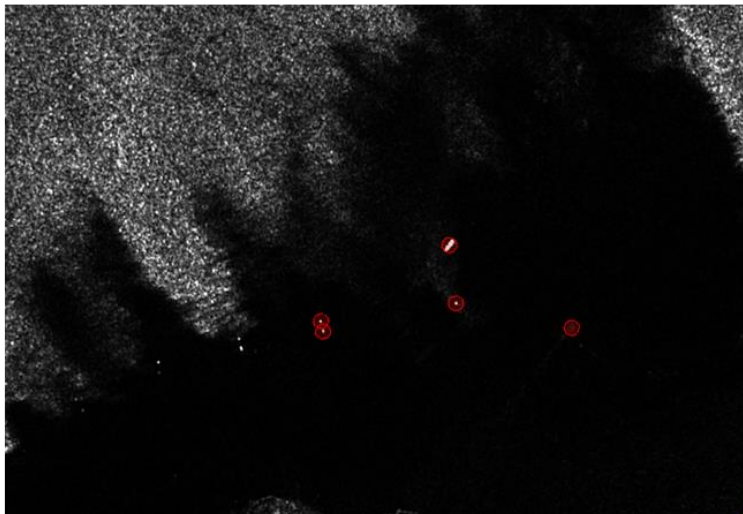
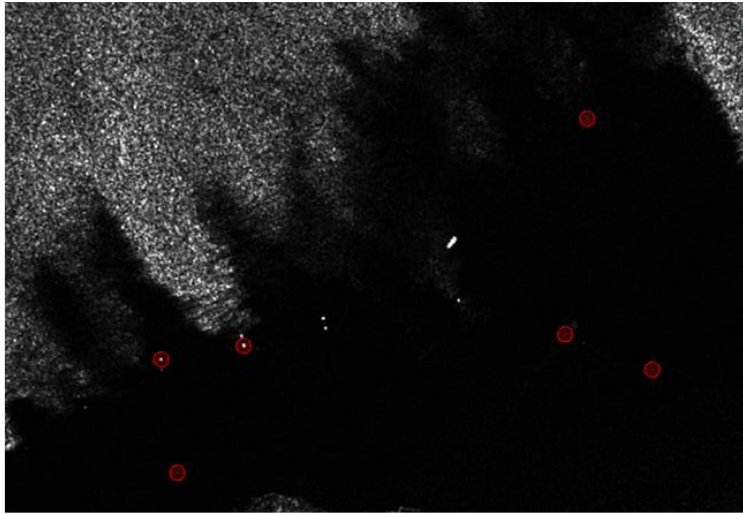


NovaSAR-1 Flood Map at 12:10:59 UTC of 5 Mar 2022



NovaSAR-1 ARD Application Demonstrations

Ship Detection in Port Phillip Bay by NovaSAR-1: Detected ship (size <100m) candidates in red circles for Zone 1 (top left), Ship ($\geq 100\text{m}$) candidates in red circles for Zone 1 (low left), VV image around Port Phillip Bay in VIC (centre), Ship (<100m) candidates in red circles for Zone 2 (top right), Ship ($\geq 100\text{m}$) candidates in red circles for Zone 2 (low right)



Thank you

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