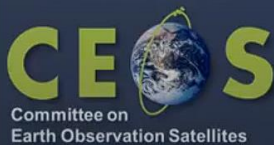


CEOS-ARD for Synthetic Aperture Radar

Ake Rosenqvist^{1,2}, Takeo Tadono², Francois Charbonneau³,
Clément Albinet⁴, Bruce Chapman⁵, Danilo Dadamia⁶,
Guillaume Hajdush⁷, Josef Kelldorfer⁸, Marco Lavallo⁵,
Tom Logan⁹, Franz Meyer⁹, Nuno Miranda³, Paolo Pasquali¹⁰,
Marko Repse¹¹, Hari Priya Sakethapuram¹², Andreia Siqueira¹³,
David Small¹⁴, Medhavy Thankappan¹³, John Truckenbrodt¹⁵,
Fang Yuan¹⁶, Howard Zebker¹⁷, Zheng-Shu Zhou¹⁸

1 – soloEO; 2 – JAXA; 3 – NRCan; 4 – ESA; 5 – NASA JPL;
6 – CONAE; 7 – CLS group; 8 – EBD; 9 – ASF; 10 – sarmap;
11 – Sinergise; 12 – ISRO; 13 – Geoscience Australia;
14 – Univ. Zürich; 15 – DLR; 16 – Digital Earth Africa;
17 – Stanford Univ; 18 – CSIRO



LSI-VC-15

Commercial Engagement
Session

Tokyo, Japan, April 5, 2024



CEOS ARD for SAR Current status



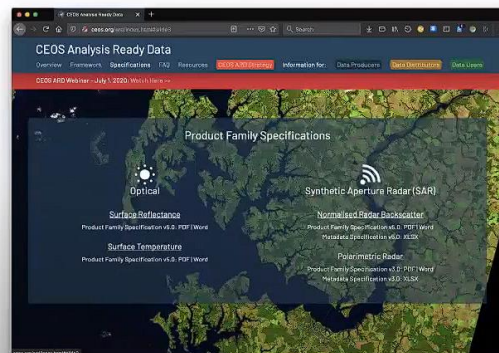
CEOS ARD specifications for Synthetic Aperture Radar (SAR) products:

Endorsed and available at <http://ceos.org/ard>

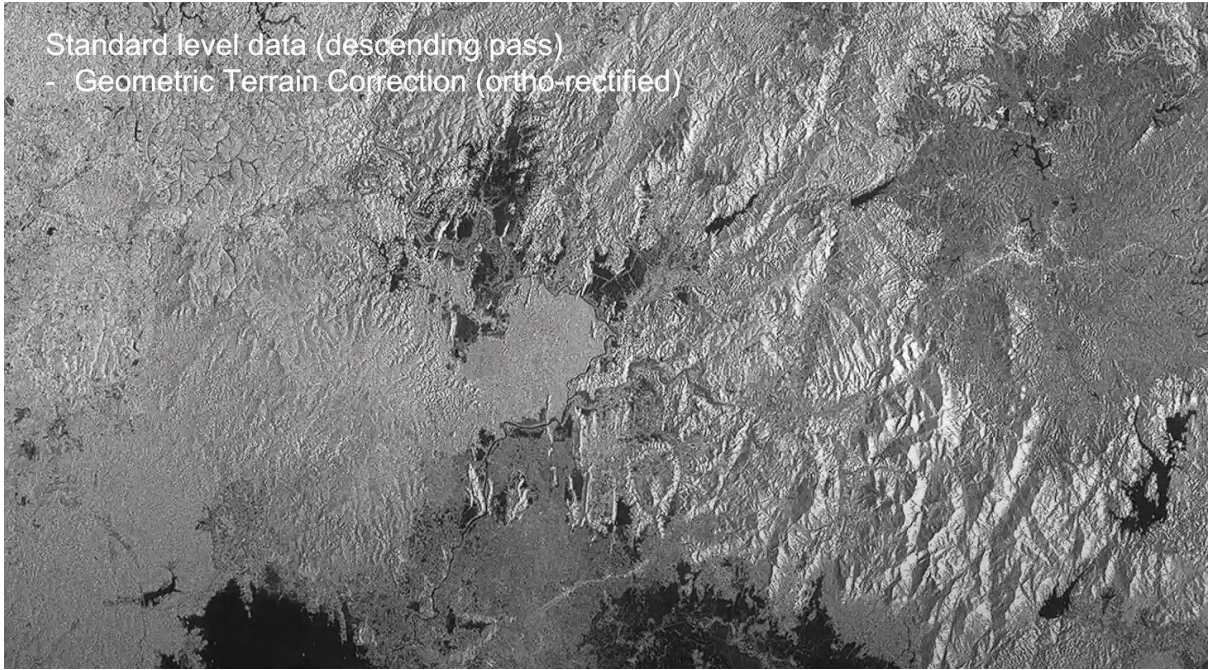
- CEOS-ARD for Synthetic Aperture Radar
 - Normalised Radar Backscatter (NRB)
 - Polarimetric Radar (POL)
 - Ocean Radar Backscatter (ORB)
 - Geocoded SLC (GSLC)
- Surface Reflectance (SR)
- Surface Temperature (ST)
- Nightlight Radiance (NLSR)
- Aquatic Reflectance (AR)

In the pipeline:

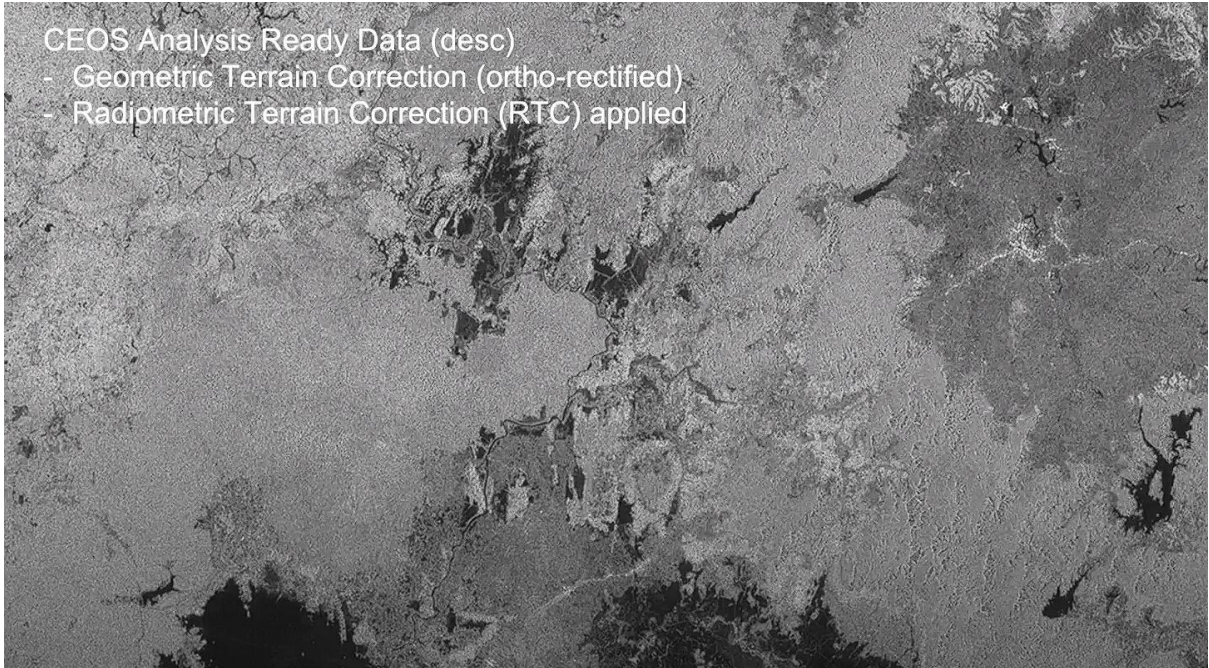
- Interferometric Radar (INSAR)
- Lidar Terrain & Canopy Height



Standard level data (descending pass)
- Geometric Terrain Correction (ortho-rectified)



CEOS Analysis Ready Data (desc)
- Geometric Terrain Correction (ortho-rectified)
- Radiometric Terrain Correction (RTC) applied



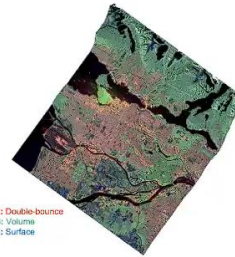


CEOS-ARD for SAR Polarimetric Radar (POL)

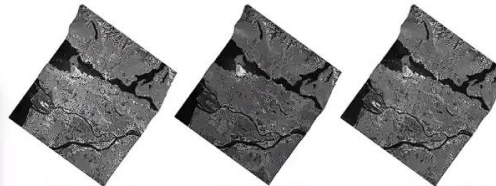


- **CEOS-ARD Polarimetric Radar [POL]**
 - General Metadata, Per-pixel Metadata, Geometric & Radiometric corrections near-identical to NRB
- POL Measurement Data covers two product types:
 - Polarimetric Decomposition
 - Data Providers to decide what decompositions to offer to users (e.g. Eigen value; Pauli, Freeman-D; Yamaguchi, etc.)
 - Polarimetric Covariance Matrix
 - Polarimetric phase and amplitude preserved
 - For polarimetric time-series and Pol-InSAR applications

RADARSAT-2 (MDA)
Processing
F. Charbonneau (NRCan)



R: Double-bounce
G: Volume
B: Surface



Matrix element (1,1)
REAL
HH Intensity

Matrix element (2,2)
REAL
HV Intensity

Matrix element (3,3)
REAL
VV Intensity

Matrix elements (1,2) (1,3) & (2,3)
COMPLEX (Re + Im): Polarimetric phase

```

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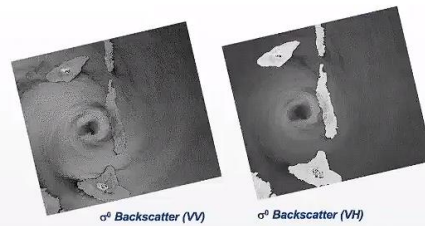


CEOS-ARD for SAR Ocean Radar Backscatter (ORB)



CEOS-ARD ORB – Simplified version of the NRB product for ocean applications

- Radar Measurement data:
 - Geoid-corrected backscatter
 - Expressed as σ^0
- Per-pixel metadata:
 - Threshold (required):
 - Geoid Incidence Angle image
 - Mask image (including land mask)
 - Acquisition ID image (for composite products)
 - Target (desired):
 - Noise power image (if applied)
 - Per-pixel Geoid
 - Look Direction image



```

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Sentinel-1 IWS
CEOS-ARD ORB (mock-up)
(Processing: soloEO)



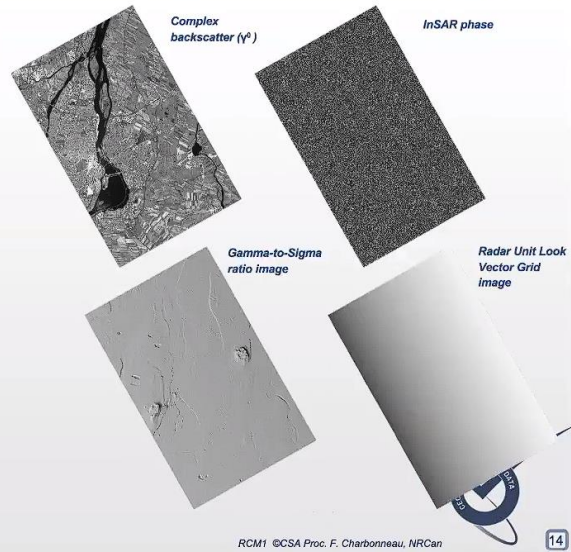


CEOS-ARD for SAR Geocoded SLC (GSLC)



CEOS-ARD Geocoded Single-Look Complex [GSLC]

- Radar Measurement data:
 - Backscatter in complex format (I+Q) from which both **amplitude** and **phase** can be derived
 - Radiometry: Radiometric slope correction, expressed as γ^D
 - Geometry:
 - Ground-based map projection (i.e. not slant range)
 - Corrected relative to a common reference orbit → Co-registered GSLC images in a stack have same geometry → interferometric applications feasible by simple image math
- Per-pixel metadata (Threshold):
 - Local Incidence Angle image
 - Mask image
 - Acquisition ID image (for composite products)



```

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```



CEOS-ARD for SAR One PFS to Rule Them All



CEOS ARD for Synthetic Aperture Radar (CARD4SAR) PFS

Single specification document for all CEOS-ARD SAR products:

- NRB, POL, ORB, GLSC

- Goals:
 - Ensuring consistent parameter names and specifications across all SAR PFSs
 - Simplifying revisions and change tracking
 - Maintains PFS clarity and readability while describing multiple products
 - No changes to (Threshold) specifications for endorsed PFSs

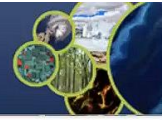


- The CEOS-ARD for SAR product specification was endorsed and released in October 2023





CEOS ARD Synthetic Aperture Radar



More information at <http://ceos.org/ard>

CEOS-ARD sample products: <https://gofile.me/6A5cs/t8W6ExxRA>

