



Committee on Earth Observation Satellites

CEOS Analysis Ready Data Strategy and Early Progress

Session introduction

Z. Szantoi/COM/LSI-VC Co-Lead and A.
Lewis/GA/SIT Co-Chair

CEOS SIT Technical Workshop 2020
Session and Agenda Item #5.2.1
16 September 2020



Objectives and expected outcomes



Plenary outcomes to support:

- Report on progress of the CEOS ARD Strategy
- Endorsement of the *CEOS Analysis Ready Data - Involving the Private Sector* paper
- Endorsement of CEOS Interoperability Terminology v1.0 (WGISS)
- Progress on current and possible future CEOS ARD pilots

Objectives for this session:

- Take stock of the CEOS ARD Strategy and progress, and identify any highlights or challenges to be taken to Plenary
- Review the CEOS Analysis Ready Data – Involving the Private Sector paper prior to submission for endorsement at Plenary
- Review WGISS work on CEOS Interoperability Terminology and discuss issues to be addressed to allow endorsement at Plenary
- Demonstrate results from CEOS ARD (Landsat Collection-2) (provisional) applied for Modified Normalised Difference Water Index (MNDWI)



- 1. Session introduction, context, welcome**
[10 minutes, Z. Szantoi and A. Lewis]
- 2. CEOS ARD Strategy Progress Update**
[30 minutes, A. Lewis]
- 3. CEOS ARD framework update (adding Advisory Notes)**
[10 minutes, A. Lewis]
- 4. Interoperability terminology report**
[15 minutes, R. Woodcock/WGISS Chair TBC]
- 5. Private sector paper engagement: lessons, feedback and next steps**
[15 minutes, A. Siqueira]
- 6. Pilot: DE Africa Trial of / plans for CEOS ARD**
[15 minutes, A. Lewis]
- 7. Wrap-up - Next steps including Plenary preparation**
[15 min]



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CEOS ARD Strategy Progress Update

A. Lewis/GA/SIT Co-Chair

CEOS SIT Technical Workshop 2020

Session and Agenda Item #5.2.2

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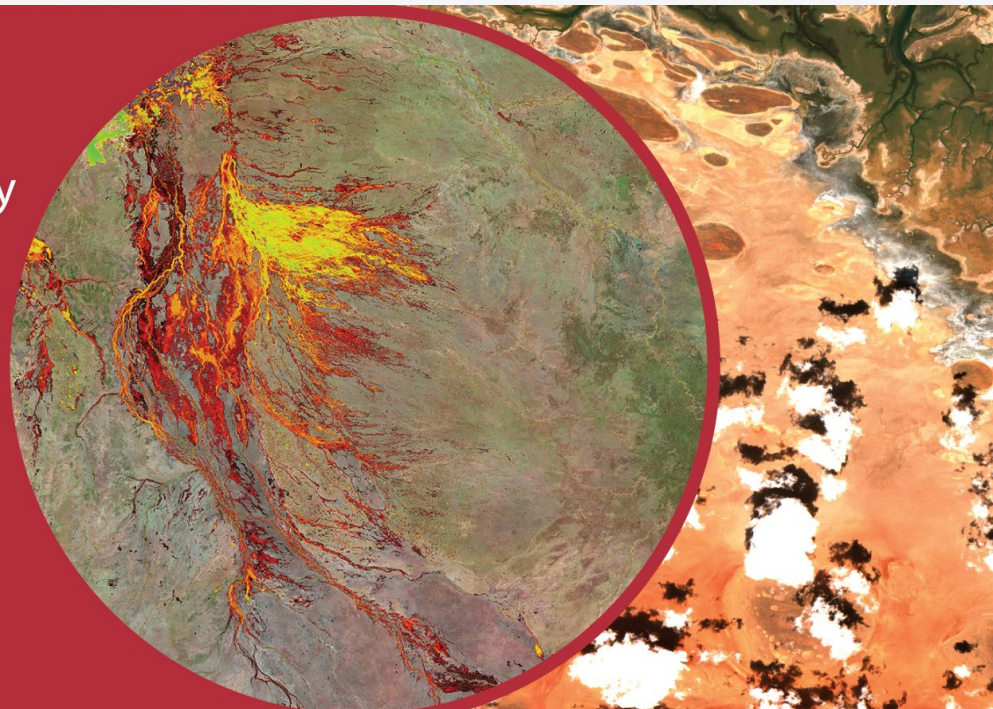
SIT Chair Priority: Analysis Ready Data



- **Early Progress on CEOS ARD Strategy (endorsed at Plenary 2019)**
 - **PFS (product family specifications) progress**
 - **ARD Private Sector Engagement Paper**
 - **Interoperability terminology report**
- **Pilots: DE-Africa**

Analysis Ready Data

Implementation of a comprehensive Analysis Ready Data strategy for CEOS covering all aspects from user needs and specifications through to production and access, pilot activities, and communication and promotion.



660+ Instruments

180+ Active Missions and Growing Rapidly

60+ Member Agencies

34+ Countries

5 Working Groups

7 Virtual Constellations

CEOS Analysis Ready Data Strategy

1. CEOS ARD User Needs & Specifications
2. Assured Production & Access
3. Pilots & Feedback
4. Communication & Promotion

CEOS Analysis Ready Data Strategy

October 2019

Version 1.0 CEOS Plenary 2019

CEOS
Committee on
Earth Observation Satellites

CEOS 2
Global cooperation program
Established by



Pillars

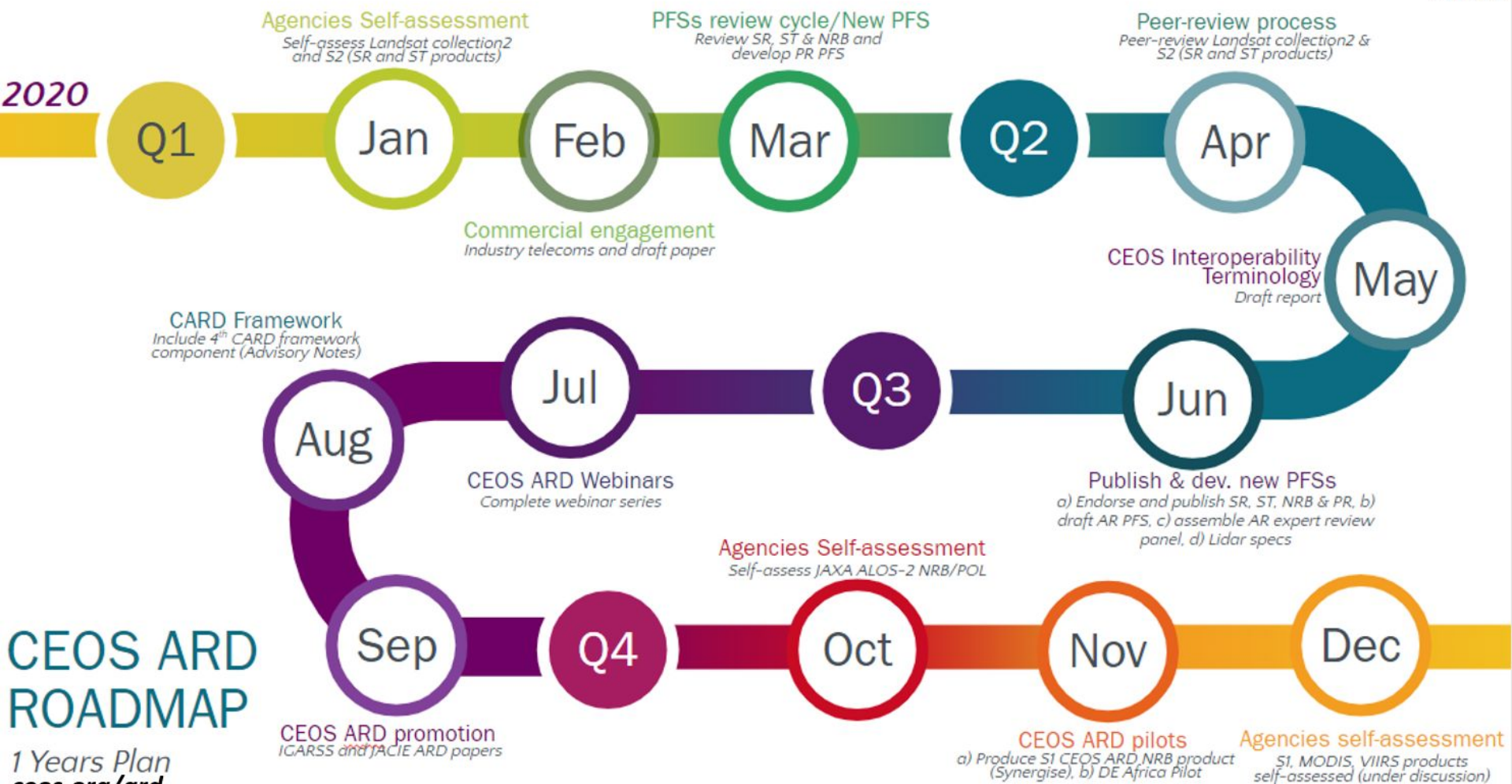
- 1. CEOS ARD User Needs & Specifications**
- 2. Assured Production and Access**
- 3. Pilots and Feedback**
- 4. Communication & Promotion**

Outcome

Ensure CEOS Agency missions increase the users and uses of data and continue to informing decision-making for a prosperous and sustainable future for humankind.

Approach

The Strategy is foreseen as an informal collection of ARD-related activities across the CEOS structure, with light oversight and coordinated reporting supported by SIT



CEOS ARD Strategy Activities Status

1: CEOS ARD User Needs & Specifications

- 1.1 Continue development of the CARD4L Product Family Specifications
- 1.2 Identify the need for and prioritise development of future target products as the basis for new CEOS ARD specifications
- 1.3 Develop further CEOS ARD technical specifications based on established need and prioritisation
- 1.4 CEOS Interoperability Terminology Report

2: Assured Production and Access

- 2.1 Engage Big Data hosts and aggregators and establish formal pipelines and procedures to promote CEOS ARD hosting and uptake on their platforms
- 2.2 Facilitate discovery of and access to CEOS Agency ARD
- 2.3 Survey users' needs with regard to ARD accessibility and provide feedback to all data providers
- 2.4 CEOS Paper on the Interplay of Industry and CEOS ARD

3: Pilots and Feedback

- 3.1 Production of CEOS ARD and supply to data aggregators and platforms
- 3.2 Digital Earth Africa (DE Africa)
- 3.3 GFOI Pilot
- 3.4 GEOGLAM Pilot
- 3.5 Mekong Data Cube Pilot
- 3.6 Other Pilots

4: Communication & Promotion

- 4.1 GEO Week Side Event: Analysis Ready Data
- 4.2 CEOS–Industry ARD Workshop
- 4.3 CEOS ARD stocktake and outlook
- 4.4 Engagement with standards organisations
- 4.5 Promotion of CEOS ARD to data providers
- 4.6 Communication with CEOS ARD users



PFS progress

- SR, ST, NRB, PR endorsed
- Interferometric and Geocoded SLC SAR in development
- Aquatic Reflectance PFS in development
- LIDAR terrain and canopy height PFS under discussion

First CARD4L complaint Datasets

- USGS Landsat Collection 2 SR & ST
- ESA Sentinel-2 SR currently being assessed

Cooperative processes to assess and peer-review

- WGCV have been pivotal
- Peer reviews have been completed or are in train



ARD beyond land

- CEOS-COAST uptake of ARD
- SIT WS Session 2.2 - “Beyond Land” - Actions to follow
- Draft PFS for Aquatic Reflectance
- Provisional Aquatic Reflectance Product from USGS
- “ARD no longer a desire of global users but becoming a requirement and expectation.”

Draft Terminology report

- LSI-VC and WGIS collaboration
- For endorsement at CEOS Plenary

Draft CEOS Paper on the Interplay of Industry and CEOS ARD

- Lead by LSI-VC
- For endorsement at CEOS Plenary



ARD Website updates

- First ARD Webinar materials (e.g. recording)
- ARD Frequently Asked Questions (following from the Webinar)
- Samples of CARD4L complaint datasets (coming soon)
- Table of dataset compliance (work in progress)

Communication & Promotion

- 2nd ARD webinar (Nov 2020)
- Paper and ARD session - virtual IGARSS 2020
- Engagement with Standards - Participation in OGC's TESTBED16 ARD activity

DE Africa data flows (Sentinel-2, Landsat, Sentinel-1)

- DE Africa is establishing continental coverage of CEOS ARD (CARD4L compliant where possible)
- Industry is playing key roles in production (Sinergise, Element-84)
- Covered in following segment

CEOS ARD Framework: Advisory Notes



CEOS Analysis Ready Data: Processed and Organized for Immediate Analysis

CEOS ARD Framework

1. Definition
2. Product Family Specification
3. Product Alignment Assessment

4. Advisory Notes

CEOS Analysis Ready Data are satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis, with a minimum of additional user effort, and interoperability both through time and with other datasets.

CEOS Analysis Ready Data Product Family Specifications detail specific 'Threshold' and 'Target' requirements for:

- General Metadata
- Per-pixel Metadata
- Radiometric and Atmospheric Corrections
- Geometric Corrections

Initial Product Family Specifications included Surface Reflectance, Surface Temperature, and Radar Backscatter. Further Specifications are in active development.

Systematic and regular provision of CEOS Analysis Ready Data will greatly reduce the data processing burden on global satellite data users.



LSI-VC-9-19

LSI-VC Leads to work with WGISS and the SIT Chair Team to consider how to tie the work of WGISS (and WGCV) on guidance materials related to data policy, data formats, interoperability, etc. to CEOS ARD under the CEOS ARD Strategy and CARD4L Framework.




Examples:

- STAC
- COG

to support interoperability

the community is saying that specifications are fine, but there are other considerations too, like file formats and discoverability. We don't want to specify file formats (but we may want to offer some guidance on certain options. e.g. where there is convergence on some key approaches like COG and STAC.





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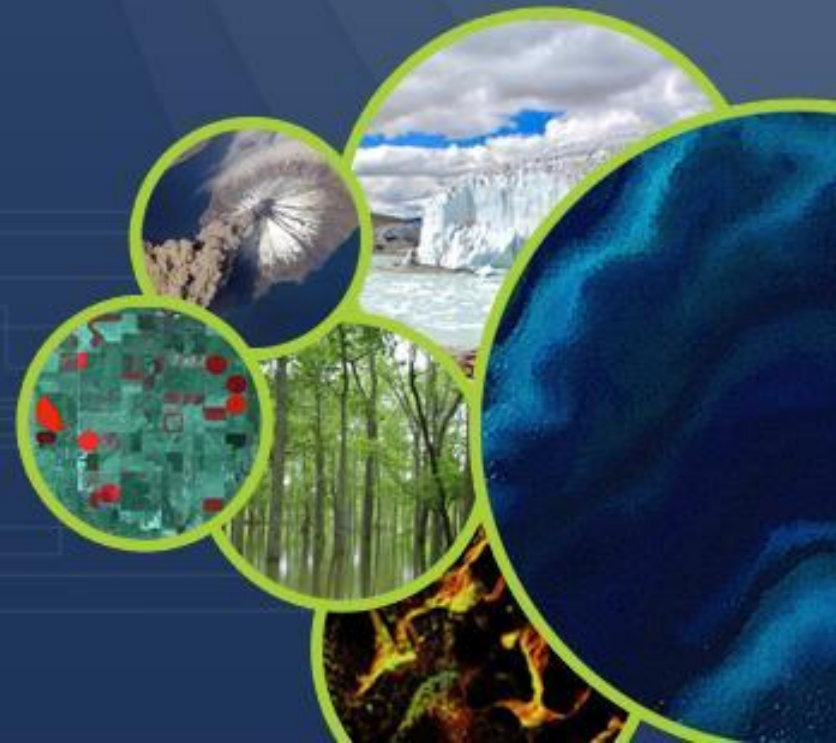
Interoperability terminology report overview

Rob Woodcock, WGISS Chair

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Presentation:

- <https://drive.google.com/file/d/1qyCu8A5riy6mctZ7Q8WP49tgi7zST1UW/view?usp=sharing>

Document:

- <https://drive.google.com/file/d/1W52fXz08a2YoKymd5DS2g19A4B-lpfBn/view>



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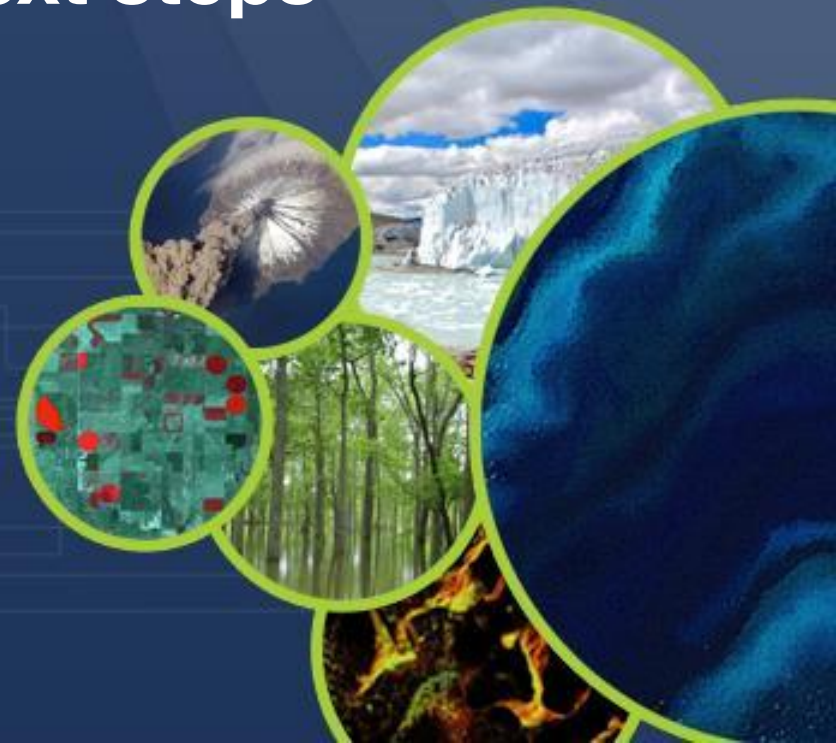
Private sector paper engagement: feedback, recommendations and next steps

A. Siqueira/GA/SIT Chair Team & A.
Lewis/GA/SIT Co-Chair

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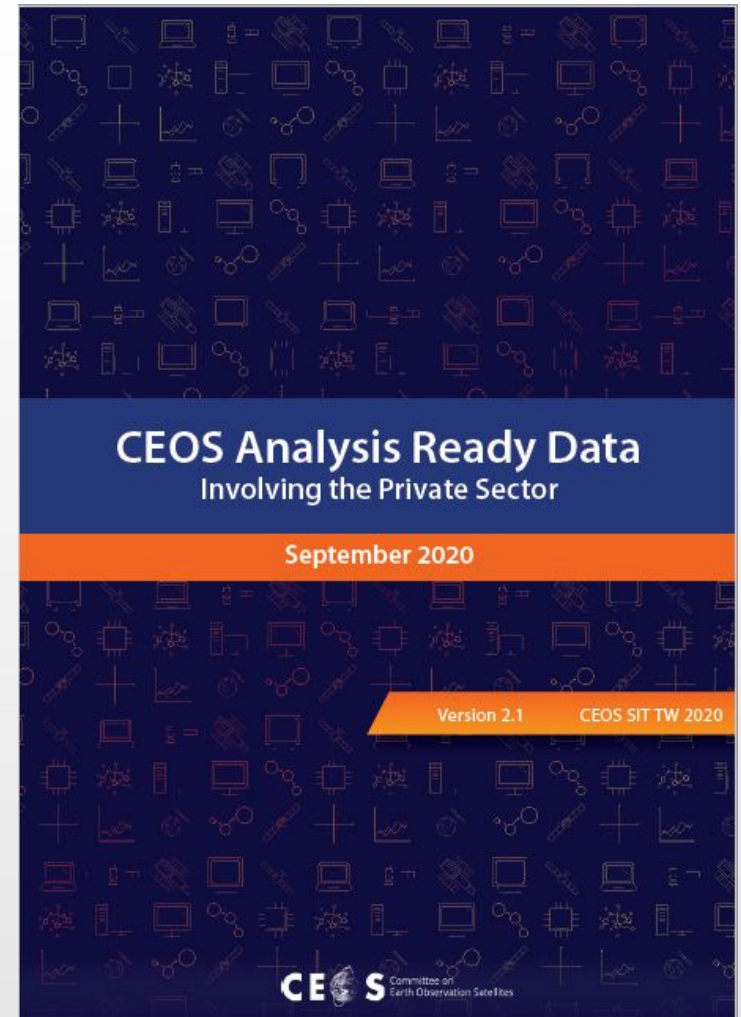
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1. The paper was circulated in March 2020 for comments and presented at SIT35.
2. The paper addresses the Task 2.4 of the CEOS Analysis Ready Data Strategy.
3. The paper presents an initial evaluation of the views from the private sector on how the CEOS community needs to engage to take CARD to the next level.
4. The paper provides an overarching rationale and possible next steps to engage with data providers, data hosts and data users in the private sector.

Objective: Review the draft paper prior to submission for endorsement at CEOS Plenary.



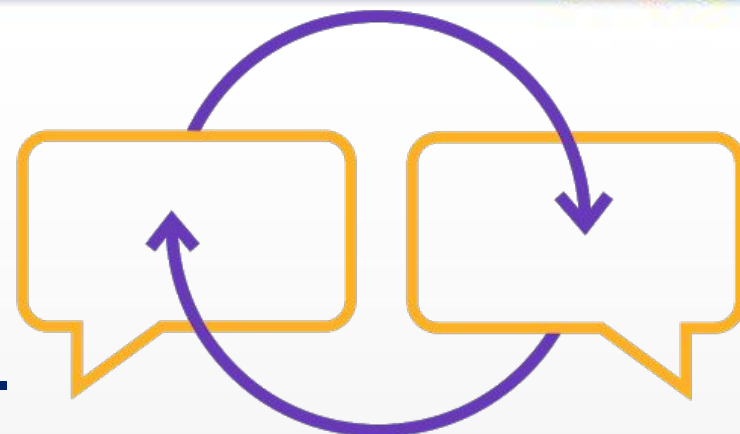


1. Executive Summary
2. Remit and Purpose
3. Background
4. Private Sector Interest, Activities, and Roles
5. The Importance of CEOS ARD as Industry Involvement Grows
6. **Engagement with Industry on CARD4L**
7. **Recommended Approach and Principles**
8. **Next Steps and Conclusions**
9. Appendix 1: De-identified comments from discussions with industry





- **ESA emphasised the importance of engaging with the private sector.**
- **Catapult suggested to include the value-add sector in the list of type of organisations CEOS wish to engage with.**
- **NOAA provided some important feedback on CEOS-ARD as a whole, i.e., that it is important to also address data policy, data formats, interoperability & etc.**
- **GEO SEC provided positive feedback and stated that the engagement with the private sector is an important and welcome action from CEOS.**
- **Inputs from the LSI-VC-9 meeting including Industry educational outreach.**



Target Outcomes from Engagement

- Industry and CEOS efforts on Analysis Ready Data are coordinated.
- Private sector companies produce products according to CEOS Analysis Ready Data Specifications.
- Specifications are improved through the involvement of industry expertise and viewpoints.
- Industry involvement increases the evidence base for the value of CEOS Analysis Ready Data.



- **Establishing mechanisms for constructive and appropriate engagement with the private sector.**
- **Avoid unnecessary barriers to participation (from industry) in the CARD discussion and processes.**
- **Provide appropriate documentation on the various aspects of the CARD initiative.**
- **Identify a CEOS ARD framework process for assessing private data products for compliance with Specifications.**
- **Move CEOS concepts into the broader standards discussion to be more inclusive of the private sector.**





- **Continue to share Information on CEOS Analysis Ready Data to build support**
 - Ensure that CEOS ARD Specifications and concepts continue to be publicly available
 - Add supplementary materials to the CEOS ARD website
- **Understand the Industry Perspective**
 - Continue 'light touch' teleconferences and emails
 - Reach out to industry leaders for tactical advice and ideas including on how to run workshops for industry
 - Convene workshops with industry
 - Leverage existing opportunities
- **Engage Industry in Specifications**
 - Engage industry specialists in specifications working groups
 - Move CEOS specifications into the broader community





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Pilot: DE Africa Trial of CEOS ARD

A. Lewis/GA/SIT Co-Chair & Ee-Faye
Chong/GA

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Digital Earth Africa is entirely dependent on CEOS Analysis Ready Data. We are establishing continental data pipelines for S2, Landsat, S1. Expect about 2 PB of data.

The MNDWI is one specific example of the power of CEOS ARD (CARD). It can be directly produced from Landsat Collection-2 data, but results from Level-1 data are often poor. MNDWI is the basis for sub-pixel waterline extraction that has been proven to allow continental-scale monitoring of coastline change - erosion and deposition.

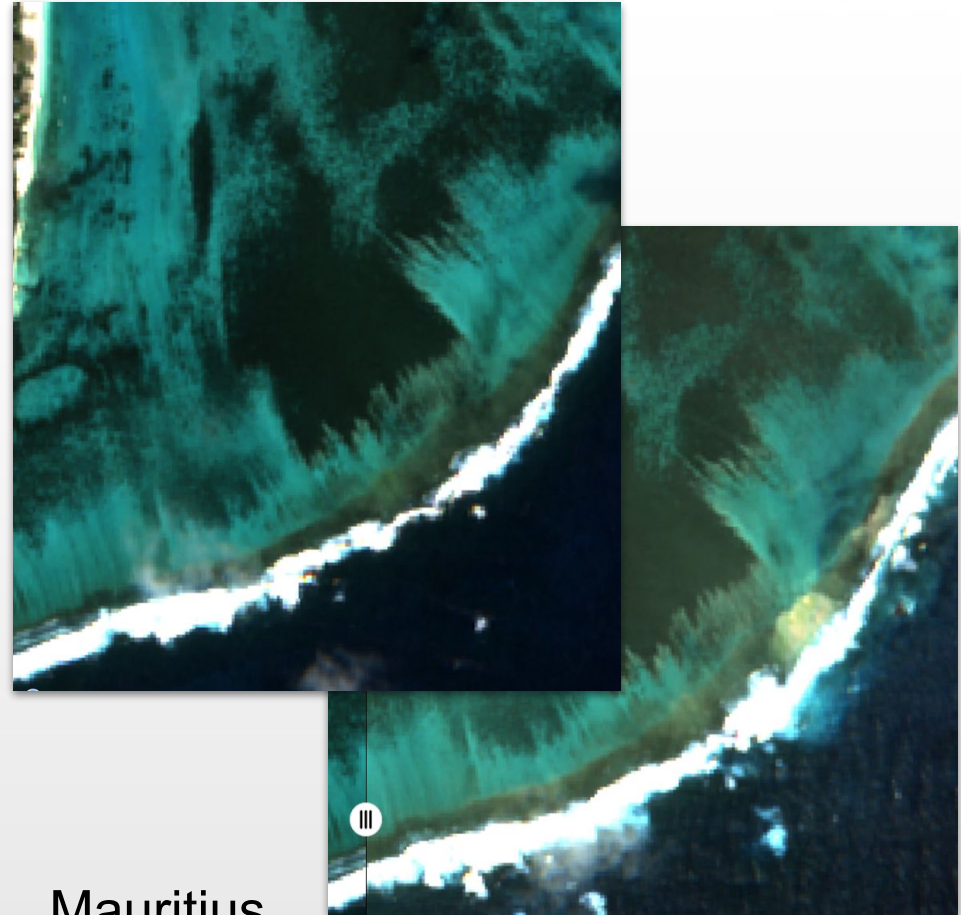
Ideally, the pipelines of ARD would be direct from the space agencies. Programs like DE Africa still have to “wrangle data”.

- **Landsat Collection-II : direct from USGS (anticipated)**
- **Sentinel-2 surface reflectance : Sen2cor, BRDF correction is needed**
- **Sentinel-1 NRB : We are developing a pipeline with Synergise, & SEO**

DE Africa is full continent, full detail



Africa, 2013-2019
(Geomedian, Landsat)



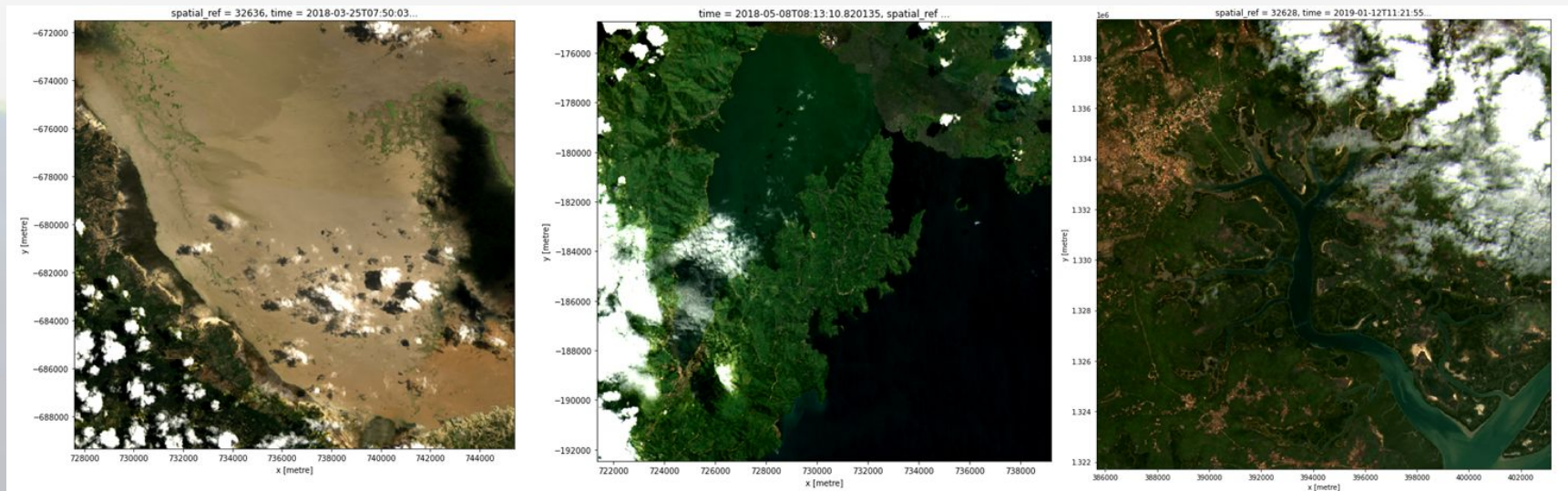
Mauritius,
July 17 2020 v. Sept 10 2020
(Surface reflectance, Sentinel-2)



The Modified Normalised Difference Water Index is ...

$$\text{MNDWI} = \frac{\text{Green} - \text{SWIR}}{\text{Green} + \text{SWIR}}$$

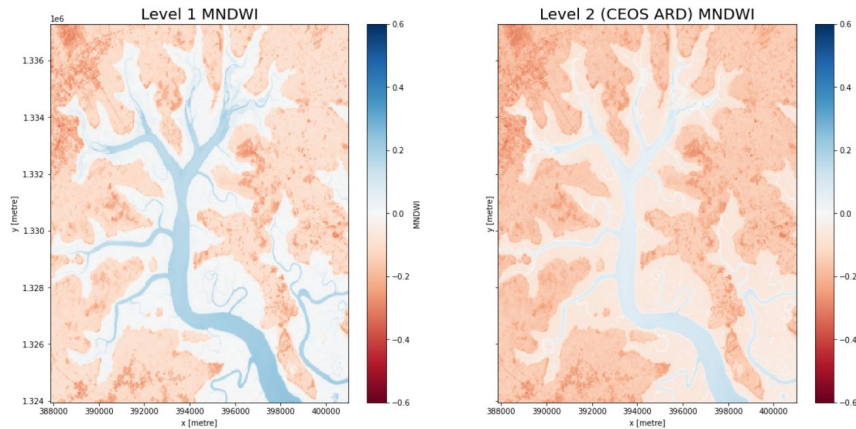
We looked at how MNDWI performs for three areas in Africa



Surface reflectance (Landsat C2) v. L1 data

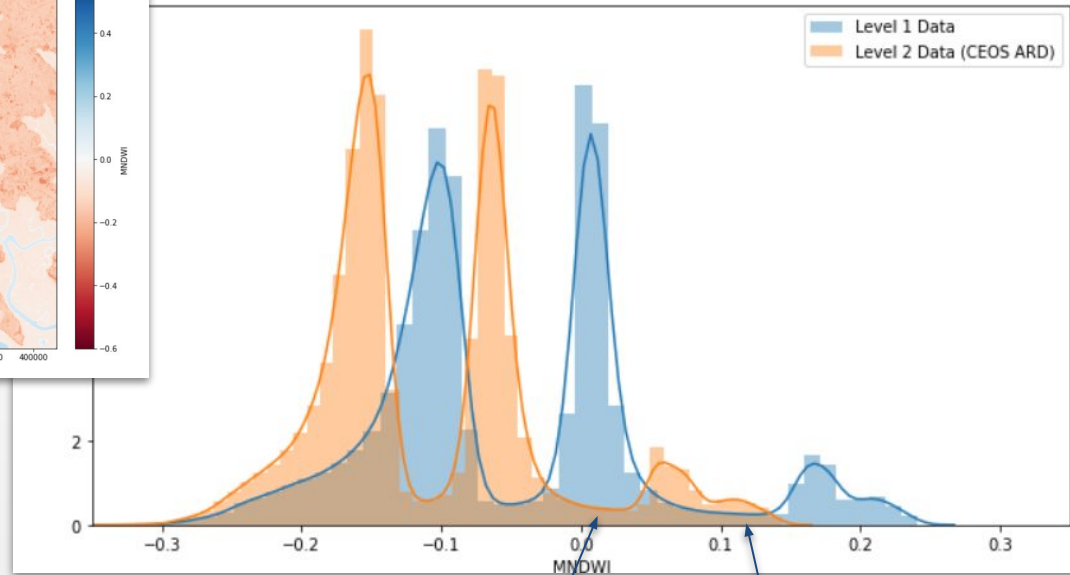


MNDWI: Level 1 vs Level 2 Data



1. Index

Rio Baboque - MNDWI Frequency Histogram

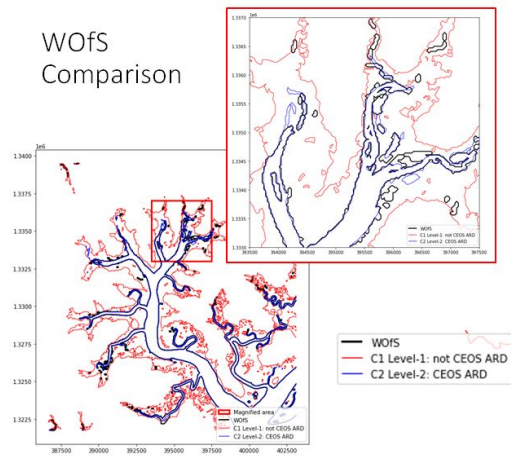


2. Histograms

C2 data:
MNDWI
mimima
stable on
zero

L1 data:
MNDWI
mimima
un-stable and
non-zero

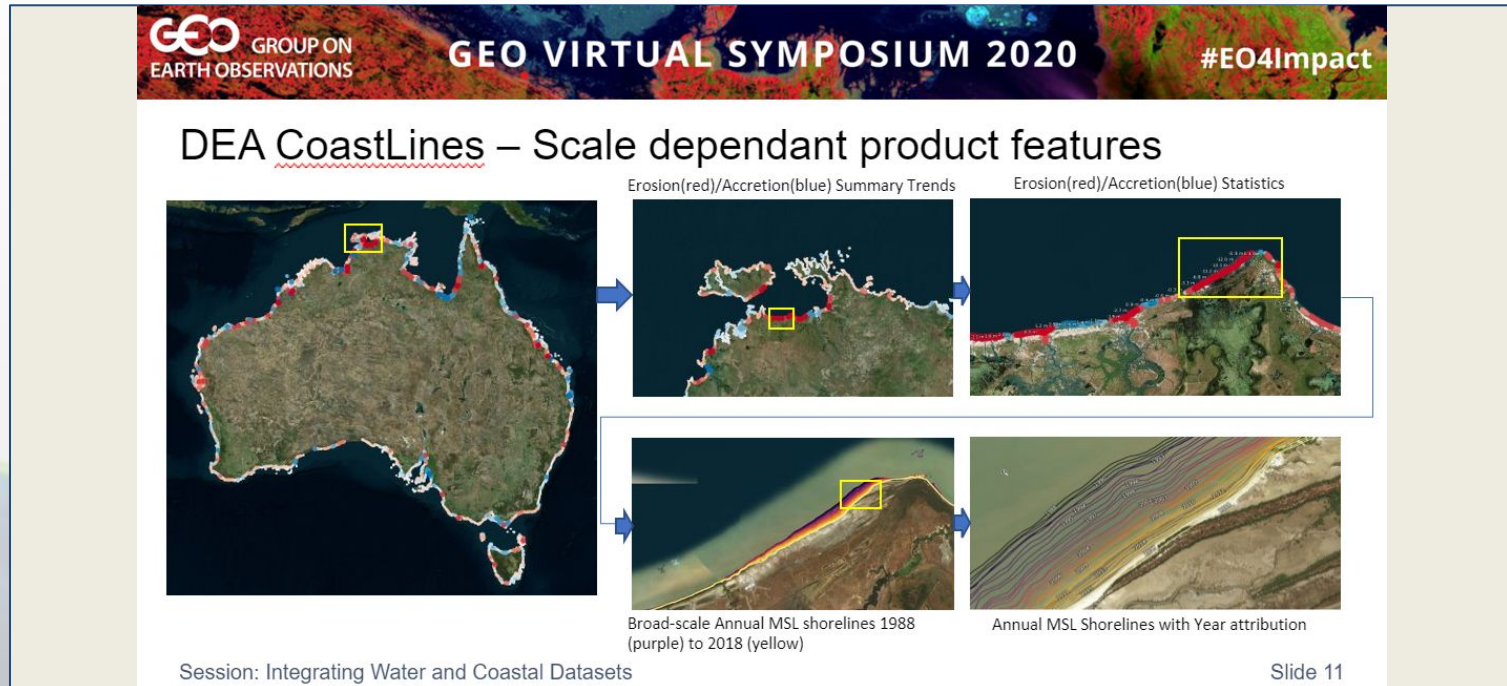
WOfS
Comparison



3. Waterline extraction



For one example, MNDWI is the basis for sub-pixel waterline extraction that can be used to monitor coastal changes at continental scales.

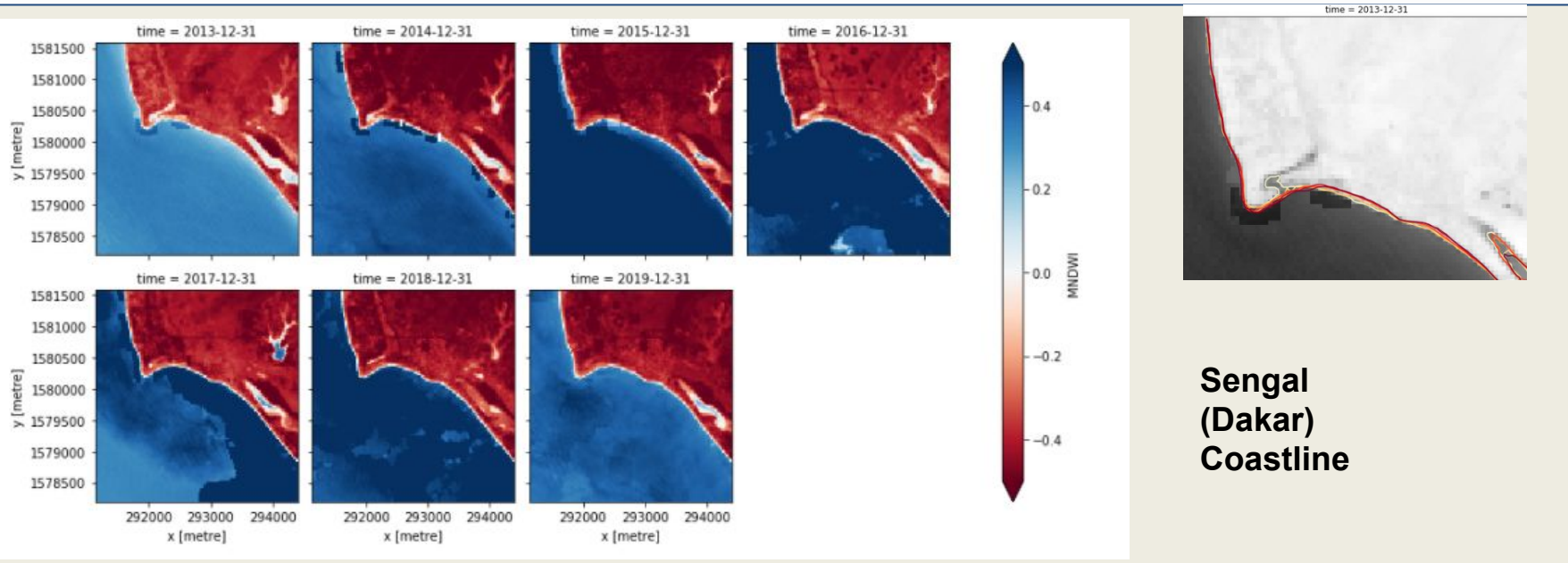


These methods are published* and proven, but rely on a stable MNDWI. Analysis ready data (e.g., Landsat Collection-2) provides the necessary quality.

*Bishop-Taylor, R., Sagar, S., Lymburner, L., Alam, I., & Sixsmith, J. (2019). Sub-Pixel Waterline Extraction: Characterising Accuracy and Sensitivity to Indices and Spectra. *Remote Sensing*, 11(24)



For one example, MNDWI is the basis for sub-pixel waterline extraction that can be used to monitor coastal changes at continental scales.



DE Africa will work with CEOS-COASTS to test the appetite for these products in Africa* and to support a trial on the West Coast.

***working with CSE and WACOM**

Are the corrections sufficient?

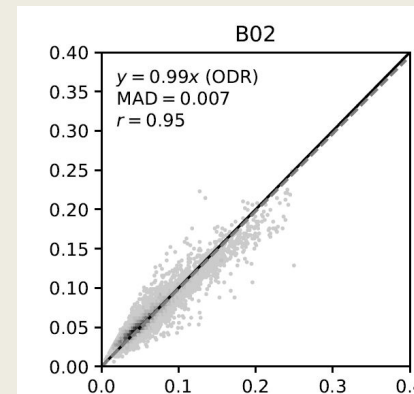


A recent report (paper in prep) shows that variations are present in Sentinel-2 data (ESA surface reflectance products) due to BRDF effects, i.e. 7-14% difference in values at swath edges.



The Joint Remote Sensing Research Program
Publication Series

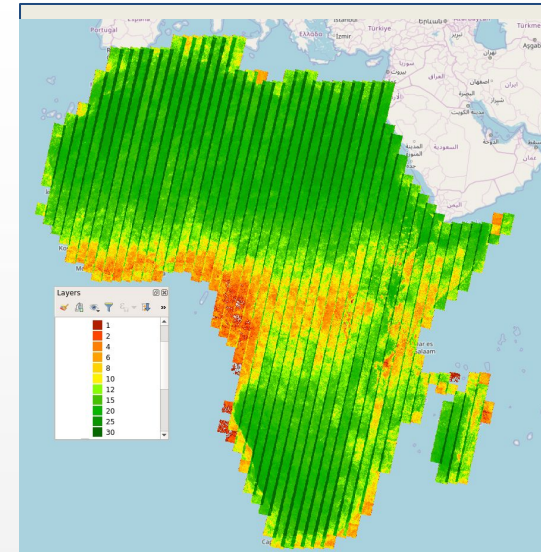
Assessing BRDF effects in the Sentinel-2
Level 2A product in the Australian landscape



A simple **BRDF** correction can reduce these variations to 1-2%



- **DE Africa is establishing a pipeline of Sentinel-1 data for all of Africa**
 - Data from 2017 onward will be processed, and the supply chain will be funded for one year
- **Sinergise will process the data to meet CARD4L Normalised Radar Backscatter (NRB) specification**
 - After a self-assessment DE Africa will ask Geoscience Australia to sponsor peer-review under the WGCV processes
- **We will use this case to approach the EC and ESA asking that they consider producing a NRB product (following CEOS ARD specifications)**



Africa, cloud-free pixels,
Landsat-8
2013-2019



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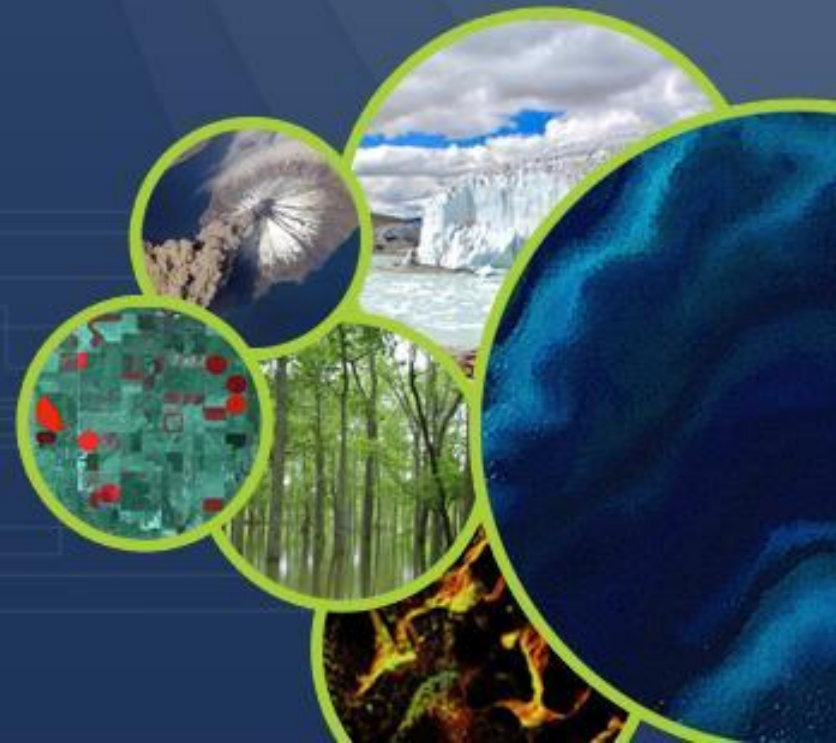
Wrap-up

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Wrap-up

- Preparing for Plenary



- **ARD and Interoperability**
 - Interoperability terminology for endorsement
- **Engaging with the Private Sector**
 - Private sector paper to Plenary for endorsement
- **Interest beyond land ARD framework (extension)**
 - AC-VC SST-VC next steps -> re-working the framework
 - Expressions of interest to be included in the work?
- **Progress - Growing number of Specifications (PFS)**
 - Aquatic Reflectance
 - Space Lidar
 - Radar
- **Use cases and ARD pipelines**