MINUTES OF THE SECOND CEOS LAND SURFACE IMAGING VIRTUAL CONSTELLATION MEETING (LSI-VC-2)

20th – 22nd July 2016
Los Angeles, California, USA

Wednesday – 20th July 2016

Session 1: Introduction

Welcome, Introduction, Objectives; Roundtable Introductions

Adam Lewis (GA), Bianca Hoersch (ESA) and Jenn Lacey (USGS) welcomed everyone to the meeting and gave some opening statements. At SIT-31 it was clear that the CEOS community has high expectations for the VC, however it was also noted that we should "walk before trying to run". We are doing this by taking the lead of the CEOS ARD definition, which will be central to many CEOS activities including the Data Cube and other future data distribution architectures. Priorities for LSI-VC-2 include discussing the need for subgroups to progress our main work threads, advancing the ARD definition, and to decide the VC's level of involvement in the Data Cube initiatives of the SEO. Bianca noted that the approach to Analysis Ready Data (ARD) appears to be going in a different direction in Europe, and LSI-VC-2 is a key opportunity to ensure that the CEOS and European approaches are consistent. Yves Crevier (CSA) added that CSA is participating to ensure that Synthetic Aperture Radar (SAR) is well represented in the definition document.

Jonathon Ross (GA, CEO) noted that we are entering a period where a lack of data is not the key challenge, it is how we are going to work together to put that data to work. One way forward is for each agency to take its own approach, but it is not clear that would be doing the right thing by users and, by implication, by agencies when they come back looking for investment in future missions.

Last year was a big year with three major global agendas endorsed: The Sendai Framework for Disaster Risk Reduction, the Paris Climate Agreement, and the Global Goals for Sustainable Development. Through the work of CEOS, each of these agendas recognises the potentially critical role that satellite Earth observations can play in achieving the objectives and monitoring progress.

A particular point to note is that in the Kyoto Statement, all CEOS Principals agreed that international space agency cooperation in support of these three key global agendas would be a priority focus, and that collaboration, rather than mere coordination will be critical if satellite Earth observations are to live up to this potential.

In this context, it is key to remember: this is not just about helping sophisticated scientists, this is critically about helping countries where the more technical barriers we put in place the more they will continue to question how useful satellite Earth observations really are in a practical sense. That was certainly what Principals had in mind when they agreed to 'reboot' the LSI-VC at the Kyoto Plenary.

Both the CEOS Chair, CSIRO, and the SIT Chair, ESA, are looking to this group to provide some guidance on how we can work together, in the land remote sensing domain, to do this. Both the CEOS Chair and SIT Chair are looking to this group to come up with solutions on how the two big, global, open land imaging systems – Landsat and Sentinel-2 – can work together and set an example.

The participants introduced themselves in a *tour de table*.

Review of LSI-VC-1 Actions and Subgroup Status

Matt Steventon (CEOS Chair Team) reviewed the status of the actions recorded at LSI-VC-1. He noted that there were 19 Actions – 13 of which have been completed, 2 are in progress, 2 are on hold, and 2 are to be progressed at LSI-VC-2.

Matt also reviewed the current status of the three subgroups – Requirements (including carbon), ARD/Data Cube, and Work Plan/Timeline – noting that the existing membership is suggested and based on indicated interests. The three subgroups have been proposed to distribute work load, engage VC members and increase participation in tasks, and to capitalise on members' unique experience and perspectives.

Session 2: CEOS LSI Analysis-Ready Data

Introduction, Review of ARD Definition Document

Adam Lewis (GA) recalled that the LSI-VC was tasked with progressing the CEOS definition of Analysis Ready Data (ARD) for land surface imaging at CEOS SIT-31. ARD are satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis without additional user effort.

The document was first initiated by the CEOS Systems Engineering Office (SEO) and since SIT-31 various inputs have been received from LSI-VC members. Now, at the occasion of LSI-VC-2, we have a near-final draft for discussion and confirmation. At the conclusion of this meeting we will have a final draft for discussion at CEOS SIT Technical Workshop in September, after which the document will be submitted to CEOS Plenary in November. This process was agreed, however Brian Killough (NASA, SEO) noted that endorsement at Plenary is a big agency commitment, implying that action will be taken, so we must be considerate of the position of other agencies.

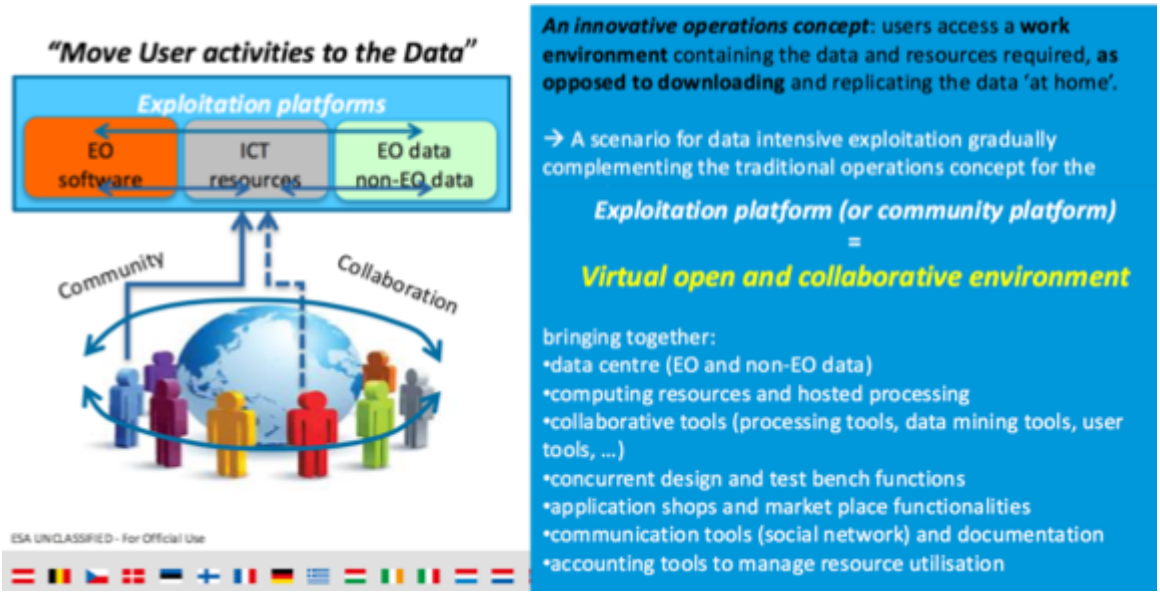
Adam noted that the ARD definition is supposed to be sufficiently high-level and non-specific to allow application to all sensors. The definition is a set of guidelines that sensor-specific specifications can be written to follow.

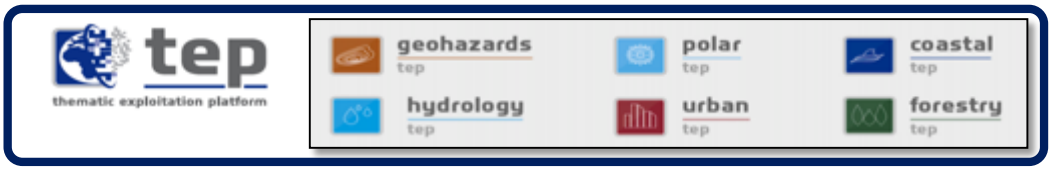
Yves Crevier (CSA) asked how the definition of ARD is different to the terminology used by the CEOS WGISS Data Stewardship Interest Group to define data processing levels. Brian noted that the terminology used to define data processing levels is relevant to the definition of ARD – according to the definitions it should meet the minimum requirements of Level-2 or higher.

European Perspective on ARD

Bianca Hoersch (ESA) noted that Europe is considering alternatives to the centralised 'process and push' method of data distribution. ESA's goal is to create an online working environment that allows users to work on data (including from other sources such as *in situ* measurements) without downloading it, avoiding large internet transfers.

ESA is pursuing the Thematic Exploitation Platform (TEP) approach – a distributed data processing solution that will be the backbone of Europe's EO strategy. There are currently six domain-specific TEPs, however there are plans for a general TEP as well as TEPs for R&D (e.g. Earth Explorers) and commercial data. For the Copernicus missions the approach is being agreed and prepared with the EC. For more information see the presentation file at http://ceos.org/meetings/lsi-vc-2/ and also https://tep.eo.esa.int





Bianca also shared ESA's perspective on the concept of 'Analysis Ready Data', noting that the core of the agency's concern revolves around the fact that different users/applications have different definitions of 'analysis-ready', and therefore it is not correct to say that data processed to any certain level will be 'analysis-ready' for all. ESA/EC are also wary of agreeing to host another dataset – citing the significant storage and processing resources that are required to do so. Yves Crevier (CSA) and Steve Covington (USGS) noted that the ARD definition document doesn't rule out the possibility of creating ARD on the fly using platforms such as the TEPs.

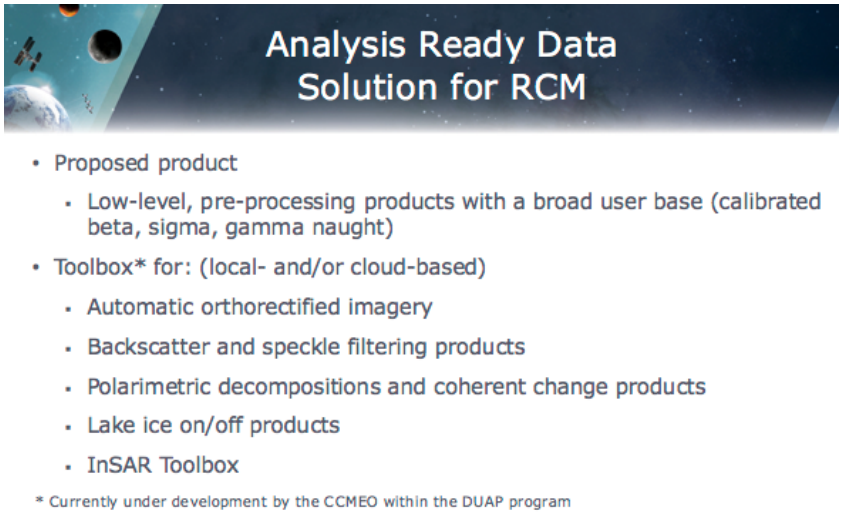
Jonathon Ross (GA, CEO) noted that the TEPs are completely dependent upon users having robust connections to the internet, which serves Europe and European scientists well, however this architecture does little to support developing countries with poor telecommunications infrastructure. Jonathon also noted that while TEPs could act as hosts for Data Cubes, there must be some way to integrate large amounts of data from other sources such as Landsat, otherwise the key interoperability benefits of the Data Cube infrastructure will not be realised. Data sovereignty is another big issue for countries, and their unwillingness to use foreign-owned TEPs is a likely hurdle.

Canadian Perspective on ARD

Yves Crevier (CSA) shared his perspective of how ARD applies in the Canadian context. Radarsat-2 offers a large variety of modes and products to support many advanced applications. The system is designed in an à la carte fashion to support the custom needs of users.

Yves noted that a coherent archive of data does not exist, due to the large offering of imaging modes. There is however a precedent created in support of marine security stakeholders (MSSR mode) which demonstrates the possibility of defining a terrestrial ARD product in the future – in particular for the Radarsat Constellation Mission (RCM).

The RCM acquisition strategy will follow a systematic standard coverage concept, allowing coherent thematic data collection (based on requirements from various user communities). This supports the concept of defining a SAR ARD product (perhaps a beta/gamma/sigma nought) that could be supplied alongside data processing toolboxes for the generation of higher level products.



Yves noted that CSA considers orthorectification part of the higher-level products. Brian Killough (NASA, SEO) and Steve Covington (USGS) suggested that orthorectification is a necessary component of a SAR ARD product in order to promote the production of satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis without additional user effort.

ARD Requirements and Benefits

Adam Lewis (GA) presented some context and background information to aid the discussion around the need for ARD. He presented an example based on temperature measurements, noting that while thermometers (sensors) will always vary, the measurements should be consistent and comparable. In order to do this for remotely sensed measurements, we need to know: location (for stackability), general metadata (where did the measurement come from, i.e. what instrument/mission), and quality metadata (i.e. cloud impact, land type, missing data, accuracy). The concept of ARD aims to capture all of these requirements and remove barriers to use.

Adam noted that ARD need not exclude commercial data, as it is just a definition that providers can choose to follow. Data policy is a different potential barrier to data use that is not within the scope of the ARD definition document.

Brian Killough (NASA, SEO) noted that surface reflectance is the optimum target for ARD. The algorithm used to reach this point is not important, as long as it is well documented. He added that the majority of users he has interacted with want the ability to easily perform cloud masking. This is a computationally difficult process, so doing the calculations once and storing the results (as metadata flags) is favourable. For this reason, cloud metadata is included in the ARD definition (in the quality metadata section).

It was agreed that radar data is a crucial element of land surface imaging and must be included in the CEOS ARD definition. The document currently includes two radar-specific requirements: radiometric correction for topography (using a DEM) and incidence angle. Adam noted the progress that GA and UKSA have recently made on implementing a SAR Data Cube using orthorectified gamma-nought from ALOS-1/2 and Sentinel-1 via a UK Catapult project.

Action 01	*Adam Lewis to share the Catapult report: 'Collaborative Synthetic Aperture Radar Solutions for Australia', along with any other supporting materials.*	**October 2016**

It was agreed that the ARD definition document should be open for future revisions.

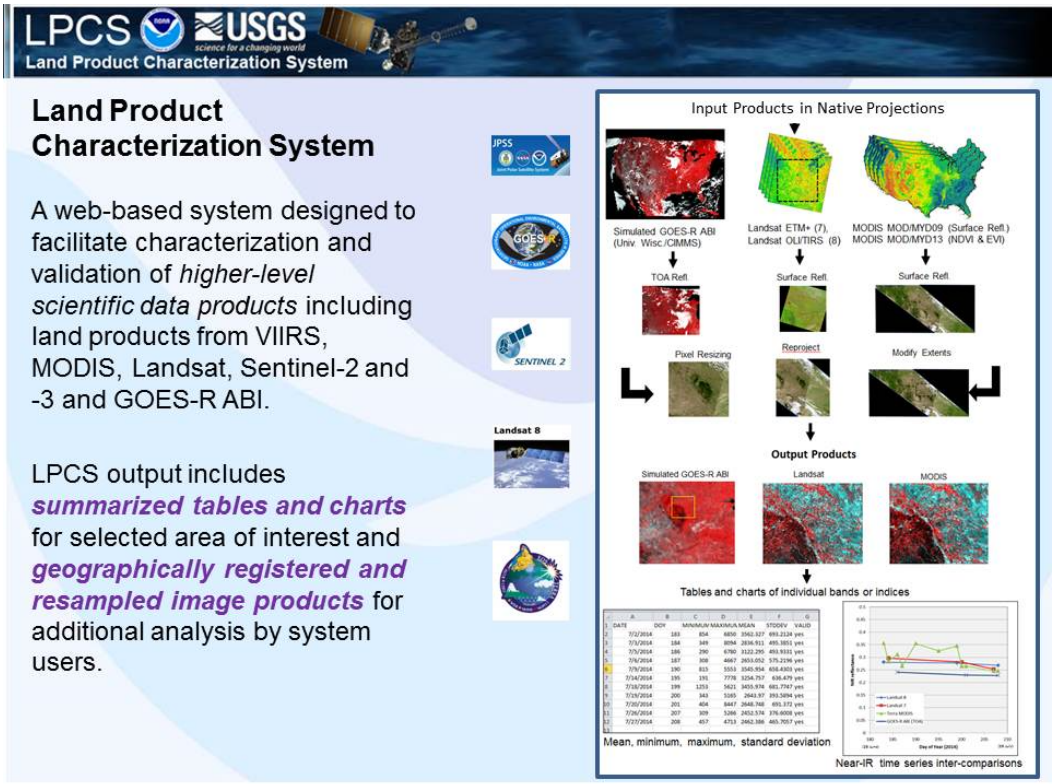
Bianca Hoersch (ESA) noted ESA's issues with the name 'Analysis Ready Data' – data processed to the level specified will not be 'analysis-ready' for all users and applications. Jenn Lacey (USGS) suggested revising the name if it is causing issues. Bianca supported this idea and she noted that ESA agrees with the utility of a dataset that is pre-processed to a level such as that specified in the document. Bianca noted that the ESA TEPs will facilitate the generation of many different products, and 'CEOS ARD' could certainly be among them.

Adam reviewed the next steps for the ARD definition document. Over the course of this meeting we will revise the definition and produce a final draft for review by all LSI-VC members. The definition will be presented for information and review at SIT Technical Workshop, after which it will be presented to CEOS Plenary. At CEOS Plenary LSI-VC will ask CEOS to accept the high-level definition of ARD and to initiate a broader CEOS strategy for ARD.

Steve Labahn (USGS) noted that USGS will be CEOS Chair in 2017, and one of their goals will be to encourage and track agency adoption of ARD. Brian supported this, noting that the production of ARD will not only aid users but also help agencies promote the use of their data.

Land Product Characterization System (LPCS)

Kevin Gallo (NOAA) presented the Land Product Characterization System (LPCS) – a web-based system for comparative analysis of satellite data and the generation of higher level products. The LPCS allows users to identify areas and dates of interest and will return available images from a variety of datasets. The LPCS will display all relevant browse images based on the user input and will then give users the opportunity to define output products, such as sensor comparison analyses (figures, tables, statistics) as well as higher level products such as surface reflectance. The LPCS performs auto-registration of data to common map projections and offers several resampling options. LPCS also outputs the georegistered images that have been selected for analysis.



USGS is producing ECVs using Landsat and NOAA will also produce ECVs using ABI/GOES-R and VIIRS. There are several mutual products of interest and the LPCS will be a critical tool for comparing the products from these distinct sources.

The LPCS is currently operating across two different systems – one for ordering and download and a second for data processing. These systems will be integrated in the near future. New datasets (VIIRS, ABI/GOES-R, Sentinel-2/3) will also be added (currently only MODIS and Landsat-8 are supported) along with new analysis tools, as resources allow.

Kevin closed his presentation by noting that LPCS has been accepted as the CEOS LPV tool by WGCV. The LPV team requested the addition of MODIS albedo products and some new analysis tools, and the integration has been initiated.

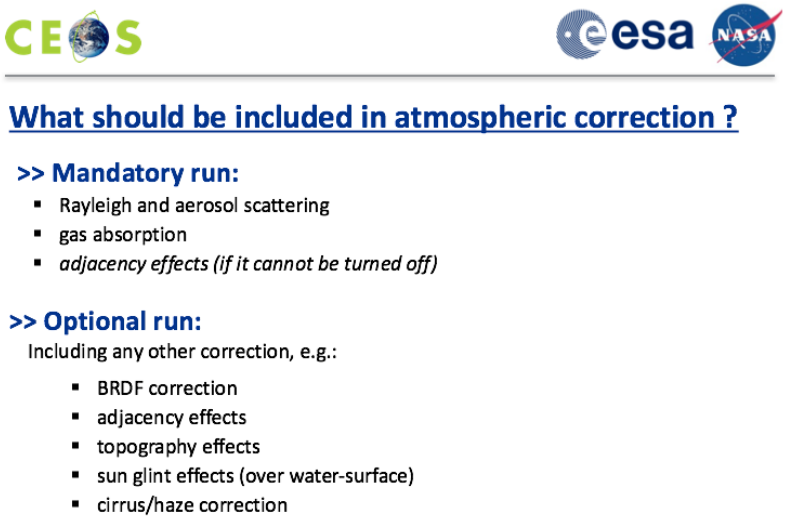
John Dwyer (USGS) noted that USGS will likely use LPCS for long-term quality assurance of the Landsat surface reflectance and surface temperature products. Greg Stensaas (USGS) reported that USGS will assess the user base and load once the system becomes operational and will hold further discussions around how the system is utilised.

Kevin noted that the LPCS will be publicised once the migration to a single integrated system is complete.

John asked whether the LPCS codebase might be shared via GitHub to stimulate collaborative development. Greg supported the idea, noting however that this would only be a consideration in the future.

Atmospheric Correction Inter-comparison eXercise

Jeff Masek (NASA) introduced the Atmospheric Correction Inter-comparison eXercise (ACIX) – an International collaborative initiative to inter-compare a set of atmospheric correction (AC) processors for high spatial resolution optical sensors (focusing on Landsat-8 and Sentinel-2). There are a number of methods for the AC of optical data, and ACIX aims to take stock of the strengths, weaknesses, commonalities and differences of 14 AC processors, utilising a common intercomparison procedure and collection of test sites.



The 1st ACIX workshop was held in late June, during which the intercomparison protocol and procedures were defined, along with the definition of test regions and time periods for quality assessment. Results are expected by October, with a final analysis report targeted for mid-December. A final workshop will be held at ESA ESRIN in Q1 2017.

A number of test sites have been selected across a variety of biomes. Jonathon Ross (GA) asked whether there are any gaps in the selected test sites. Leo Lymburner (GA) noted that a salt lake site was proposed due to the concern that highly reflective sites were under represented, however it was not included in the final list.

Jeff also gave a brief status update on the Multi-Source Land Imaging (MuSLI) initiative – a collaboration between NASA GSFC, ARC, and UMD to produce harmonized Landsat/Sentinel-2 (HLS) reflectance products. Jeff noted that sample products are expected in the next few weeks. These products will have the Landsat-8 AC applied as well as a BRDF correction. Composite images are yet to be produced. Brian Killough (NASA, SEO) noted that the MuSLI products have great potential for application in a Data Cube.

Action 02	*Jeff Masek to share the EARSeL presentation on the harmonized Landsat/Sentinel-2 (HLS) processing system.*	**COMPLETE**

Future Data Access and Analysis Architectures Ad Hoc Team Report

Tom Cecere (USGS) reported the latest on the CEOS Future Data Access and Analysis Architectures Ad Hoc Team (FDA-AHT) and the report being prepared for presentation at CEOS Plenary. The FDA-AHT is preparing a report to assess the potential of new technologies and approaches to the distribution of satellite data – identifying key issues and opportunities and proposing a plan of action for consideration by CEOS.

Tom noted that this activity is separate to the ARD definition being prepared by LSI-VC and will not propagate the definition. The FDA report will focus on data distribution architectures, and these may or may not utilise such a definition.

The FDA-AHT structure has recently changed, and the team is currently working to devise recommendations for presentation at CEOS Plenary. The team includes representatives from many CEOS agencies, as well as the SEO and WGISS, however Tom noted that Chinese representation is unfortunately missing.

A final draft of the report will be ready by the end of August, allowing a 2-week review period ahead of SIT Technical Workshop, during which a pre-Plenary discussion of the recommendations is planned.

Jonathon Ross (GA) noted that the FDA report is the interface between data (in particular ARD) and the technical solutions for its distribution to users.

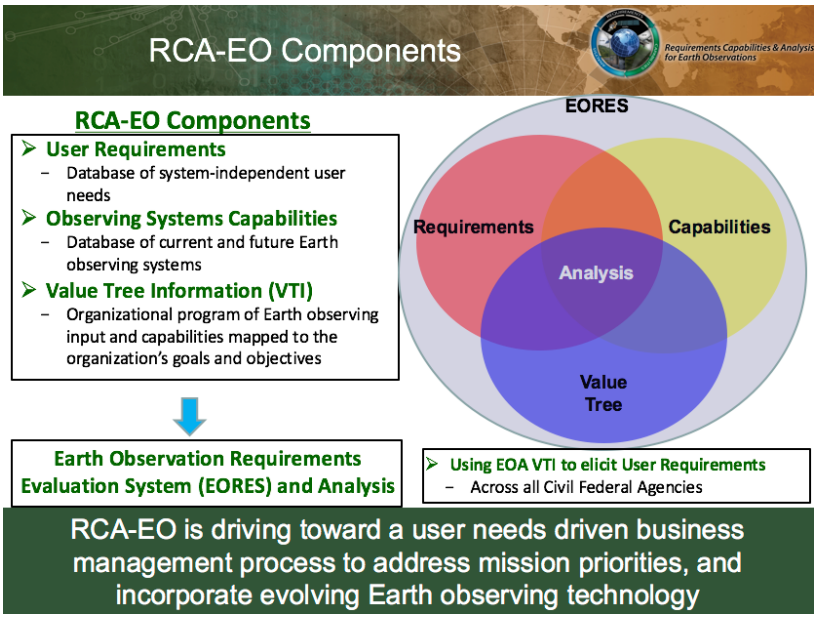
Session 3: Gap Analyses and Increasing the Visibility of Land Surface Imaging Data Holdings

USGS Gap Analysis Tools and Processes / Requirements Capabilities & Analysis for Earth Observations (RCA-EO)

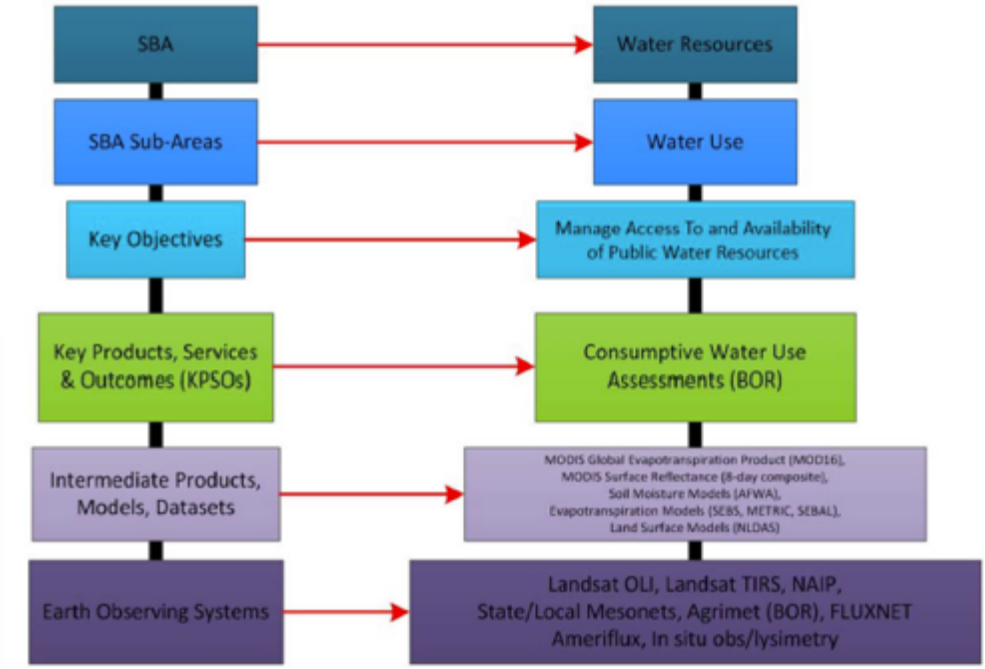
Greg Stensaas (USGS) introduced the USGS Land Remote Sensing (LRS) Programme's RCA-EO initiative. USGS is partnering with U.S. Federal agencies to document user requirements for Earth observation data and the benefits that these data provide to Federal programmes. RCA-EO was established to help USGS and other agencies take better advantage of U.S. and international Earth observation capabilities, and to develop requirements-driven, prioritized investment decisions for new EO systems, products, and services. RCA-EO has been developed in partnership with NOAA, leveraging their legacy efforts from the past 12 years.

RCA-EO is built upon the Earth Observation Requirements Evaluation System (EORES) – a relational database system architecture that stores EO requirements and capabilities, and

provides a web-based user interface allowing users to display, edit and browse information; compare requirements to capabilities; assess the ability of observing systems to meet Federal objectives; and inform the development of new EO systems.



Greg noted that USGS uses RCA-EO to input to the U.S Decadal Survey and National Earth Observation Assessment (which informs the National Strategy for Civil Earth Observations). EO requirements are deduced by looking at high-level SBAs and applications and then assessing technical requirements using a sensor/satellite agnostic approach:



For more information see the presentation and the RCA-EO website:
http://remotesensing.usgs.gov/rca-eo/

Jenn Lacey (USGS) noted that RCA-EO has been extremely successful in allowing USGS HQ to prove the utilisation of Landsat across U.S. Federal agencies.

Greg noted that the emergence of commercial start-ups such as Planet Labs has presented new challenges around capturing the capabilities of EO systems.

Greg reported that an analysis of global requirements has also been undertaken through a survey of the Landsat user base and analyses of user registrations. He noted that more research is required to discern the balance between research and application use.

Steve Covington (USGS) noted that RCA-EO is focused on medium resolution satellite data (driven in particular by the need to define requirements for Landsat 10), however the goal is to serve as a more general source to inform U.S. decision making processes and justify budgets.

Jenn reminded everyone that the purpose of this session is to consider how RCA-EO might be applied to CEOS gap analysis efforts around the various CEOS thematic strategies.

Greg noted that the RCA-EO team is working with ESA and GA to ensure consistency with their user requirement/usage tracking efforts.

RCA-EO is not yet open to the public, and USGS is still considering what functions could be made available for public use. Adam Lewis (GA) asked whether a decoupled external interface could be set up to facilitate the collection of user requirements. Greg noted that it is a possibility.

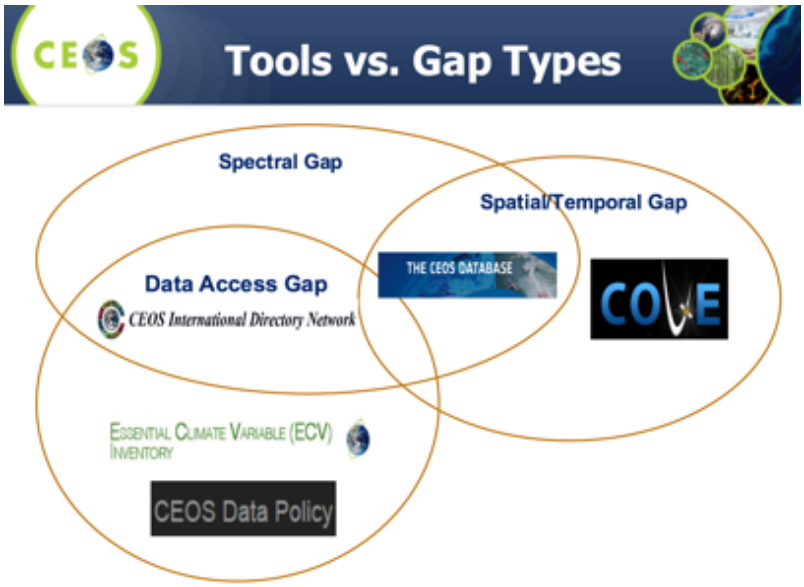
Greg reported that EORES has the potential to include geographic requirements, but this is an aspect of the database that is yet to be explored.

Matt Steventon (CEOS Chair Team) asked whether the EOA SBAs are ranked in terms of 'importance'. Greg reported that the individual SBA teams apply weightings to the sub-items within the SBA, which are then ranked only within their specific SBA.

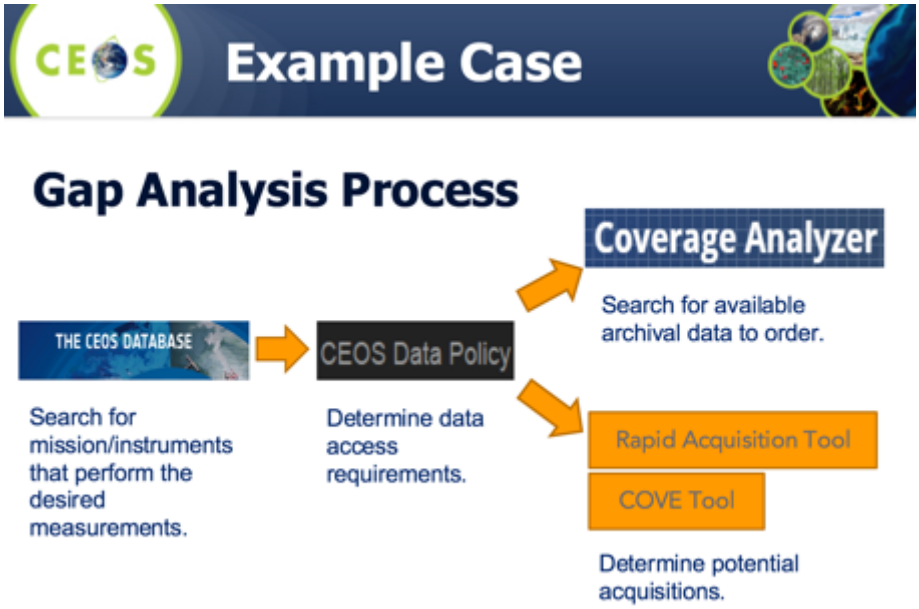
CEOS Information Systems and Gap Analyses

Brian Killough (NASA, SEO) reviewed 7 CEOS information systems/tools and presented a summary of their applicability to certain aspects of gap analyses:

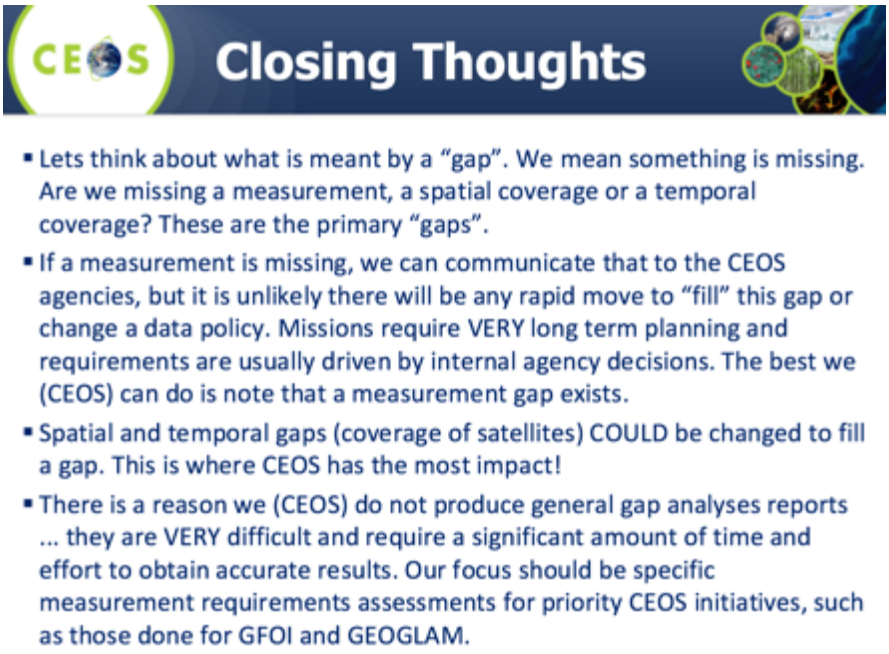
Gap	CEOS MIM Database	COVE Tool	Rapid Acquisition Tool	Coverage Analyzer	Data Policy Portal	IDN	ECV
Spatial Coverage		Groundtrack Pattern	Potential Acquisition Visualization	Archival Data Coverage Assessment			
Instrument Resolution	Existing and Planned Missions						
Revisit Performance		Coincidence Observation Prediction	Overpass Prediction	Archival Revisit Analysis			
Mission Continuity	Shows Status of Missions and Gaps				Displays Current/ Future missions		
Spectral	Bands shown for each instrument					Search by instrument and/or science objective	
Data Access/ Availability					Data policy by instrument	Data products shown	Essential Climate Variables and the capturing satellites



The SEO has taken stock of the gap analysis process and looked at how these systems would be leveraged. Brian presented an example for a single requirement (see below). He noted that performing this process on a large scale would require a lot of resources, likely making it unfeasible.



Brian presented some closing thoughts for consideration by the LSI-VC:



Adam Lewis (GA) suggested that LSI-VC shouldn't avoid including measurement gaps in its scope of work, however we should be aware that the CEOS response will be long-term, if any. Due to the long lead-times associated with mission development, Adam supported the idea of ongoing measurement assessments so that potential gaps can be identified before they become a problem.

Brian supports the GFOI/GEOGLAM model for LSI-VC, i.e. specific measurement requirement assessments for priority CEOS initiatives.

Yves Crevier (CSA) noted that it would be very advantageous to be able to integrate and harmonise the requirements coming from various communities of practice, such that CEOS could identify acquisition overlaps and gaps, and effectively determine associated impacts.

CEOS MIM Database

Tom Cecere (USGS) presented some potential improvements to the CEOS MIM Database that could increase its utility for gap analyses. He noted in particular that the database only has very coarse summaries of the spectral properties of instruments. Tom suggested that making the spectral band information more accurate and machine-readable would be a very worthwhile enhancement.

Tom also noted that the instrument measurement parameters (selectable from a pre-defined menu) are added manually at the discretion of the MIM survey respondent. He added that accuracy information is lacking for many of the measurements. He suggested that this is perhaps because higher-level product accuracy is not being assessed on the agency side. He asked whether there might be a way to objectively assign measurement parameters (and their accuracies) to instruments if more detailed spectral information was available.

Brian Killough (NASA, SEO) noted that the MIM database is built around the idea that all information is supplied by the agencies alone – there is no scope for the ESA MIM Database team to present information that is different to that supplied by an agency.

Greg Stensaas (USGS) suggested that a user-driven determination of the measurement parameters might be a possible approach. He added that this could draw on some of the RCA-EO work.

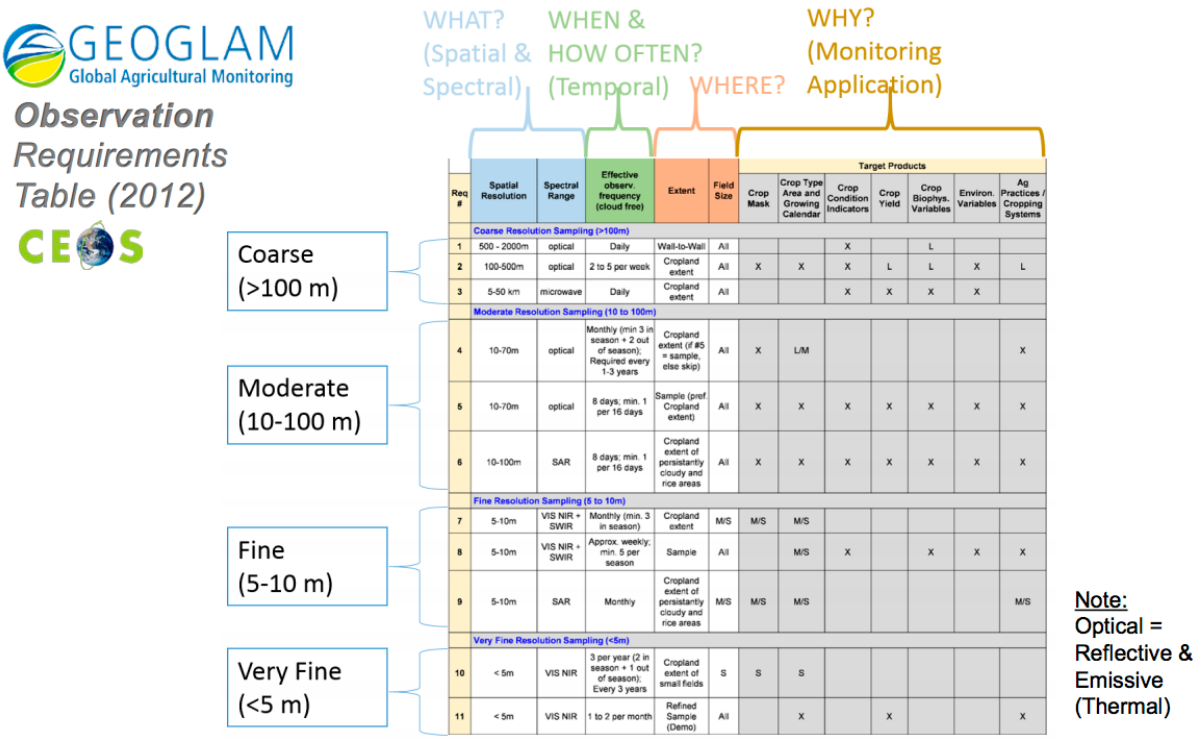
Yves Crevier (CSA) suggested that LSI-VC compile a list of enhancements for consideration by the ESA MIM Database team. Adam Lewis (GA) supported the suggestion and added that we should restrict the initial scope to key LSI missions/instruments.

Action 03	*Adam Lewis to communicate to the ESA MIM Database team (perhaps via the expected CEOS information systems survey): LSI-VC's understanding of the limitations of the CEOS MIM Database, and to share suggested technical improvements for consideration.*	**October 2016**

GEOGLAM Requirements Process

Alyssa Whitcraft (GEOGLAM Secretariat) presented some background on the GEOGLAM initiative, noting the objective of GEOGLAM is to strengthen global agricultural monitoring by improving access to and utilization of Earth observations (space-based land observations, agro-meteorology, and *in situ* measurements). By providing coordinated Earth observations from satellites and integrating them with ground-based and other *in situ* measurements, the initiative will contribute to generating reliable, accurate, timely and sustained crop monitoring information and production outlooks. The unique characteristics of crop monitoring (e.g., high observation frequency requirements, dynamic and diverse crop systems, etc.) mean that no single mission is capable of providing all of the required measurements – a coordinated strategy is necessary. It is for this reason that the CEOS ad

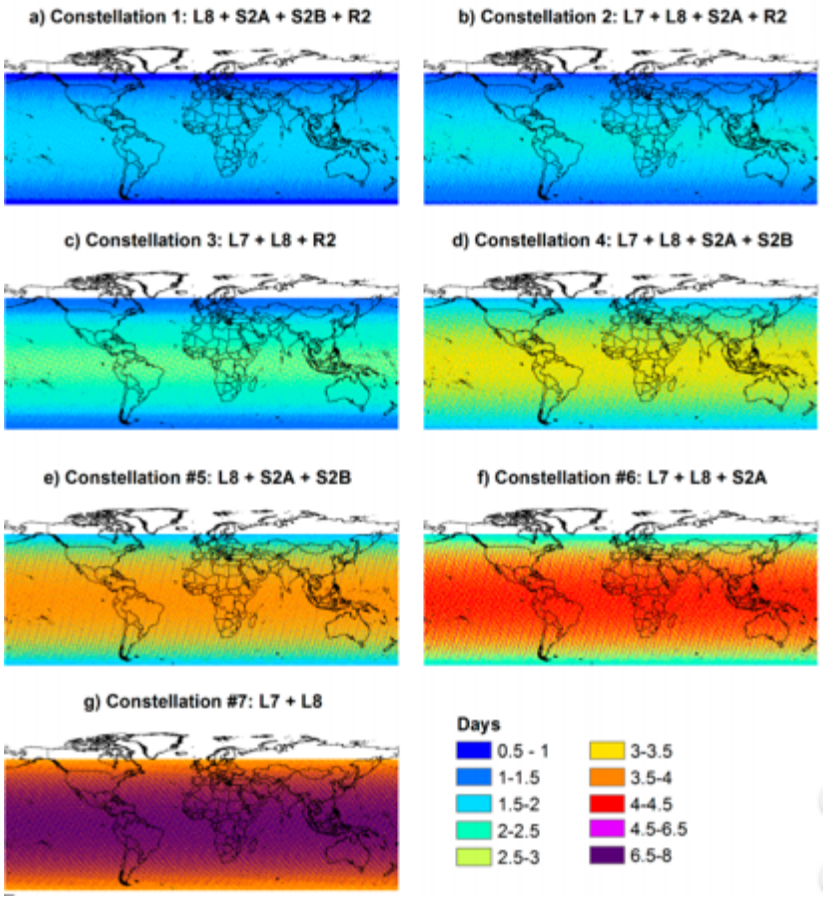
hoc Working Group on GEOGLAM was established, and in 2012 published a comprehensive table of requirements (shown below).



Req #	Spatial Resolution	Spectral Range	Effective observ. frequency (cloud free)	Extent	Field Size	Target Products: Crop Mask	Crop Type Area and Growing Calendar	Crop Condition Indicators	Crop Yield	Crop Biophys. Variables	Environ. Variables	Ag Practices / Cropping Systems
Coarse Resolution Sampling (>100m)												
1	500 - 2000m	optical	Daily	Wall-to-Wall	All			X		L		
2	100-500m	optical	2 to 5 per week	Cropland extent	All	X	X	X	L	L	X	L
3	5-50 km	microwave	Daily	Cropland extent	All			X	X	X	X	
Moderate Resolution Sampling (10 to 100m)												
4	10-70m	optical	Monthly (min 3 in season + 2 out of season); Required every 1-3 years	Cropland extent (if #5 = sample, else skip)	All	X	L/M					X
5	10-70m	optical	8 days; min. 1 per 16 days	Sample (pref Cropland extent)	All	X	X	X	X	X	X	X
6	10-100m	SAR	8 days; min. 1 per 16 days	Cropland extent of persistantly cloudy and rice areas	All	X	X	X	X	X	X	X
Fine Resolution Sampling (5 to 10m)												
7	5-10m	VIS NIR + SWIR	Monthly (min. 3 in season)	Cropland extent	M/S	M/S	M/S					
8	5-10m	VIS NIR + SWIR	Approx. weekly; min. 5 per season	Sample	All		M/S	X		X	X	X
9	5-10m	SAR	Monthly	Cropland extent of persistantly cloudy and rice areas	M/S	M/S	M/S					M/S
Very Fine Resolution Sampling (<5m)												
10	< 5m	VIS NIR	3 per year (2 in season + 1 out of season); Every 3 years	Cropland extent of small fields	S	S	S					
11	< 5m	VIS NIR	1 to 2 per month	Refined Sample (Demo)	All		X		X			X

Alyssa clarified that GEOGLAM does not aim to perform precision agricultural management, but rather to monitor and report on production/food supply. She noted that the requirements table includes TIR under *optical*. Steve Covington (USGS) suggested that TIR be included explicitly in future revisions. Steve noted that observation frequency is key, rather than satellite revisit, and he suggested that LSI-VC keep this in mind (Alyssa noted that in the table, this is described as "Effective observation frequency (cloud-free)").

Alyssa presented some results from an analysis carried out in collaboration with CEOS SEO of the revisit capabilities of different mission constellations as compared against the spatially explicit GEOGLAM requirements, which account for usual cloud cover. The results show that while not all of the moderate-resolution (10-100m) optical requirements are being met due to persistent and pervasive cloud cover, it is possible to get close with sufficient mission coordination. The results also demonstrate a level of diminishing returns with the addition of further optical missions, and that coordination of cloud-penetrating SAR over agricultural areas could, in particular, make a large difference for GEOGLAM.



Adam Lewis (GA) suggested that LSI-VC could learn from the experience of the CEOS ad hoc Working Group on GEOGLAM and apply the same requirements process to other thematic areas. He added that LSI-VC should consider both space and time requirements/capabilities.

Steve Labahn (USGS) noted that on the 9th of July USGS and USDA entered an agreement with ISRO to obtain AWiFS coverage for the U.S.

LSI-VC Requirements Approach

Adam Lewis (GA) opened the discussion session by asking what role LSI-VC should play in CEOS requirements analysis.

Jeff Masek (NASA) noted that medium resolution land surface imaging is saturated with the availability of Landsat 7, Landsat 8 and Sentinel-2A; however, significant potential remains around the coordination of SAR acquisitions, given the variety of imaging modes and unique user requirements.

Yves Crevier (CSA) noted that the CEOS ad hoc teams play a crucial role in eliciting requirements from the communities of practice.

Steve Covington (USGS) noted that both the observational requirements and the downstream product/service requirements should be considered. It is important to have an end-to-end perspective.

Adam suggested that LSI-VC could play a role in bringing together the requirements (using a common framework) and the necessary observing capabilities – such as is done by the CEOS

ad hoc Working Group on GEOGLAM. It was agreed that LSI-VC should explore the adoption of the approach used by the CEOS ad hoc Working Group on GEOGLAM.

Thursday – 21st July 2016

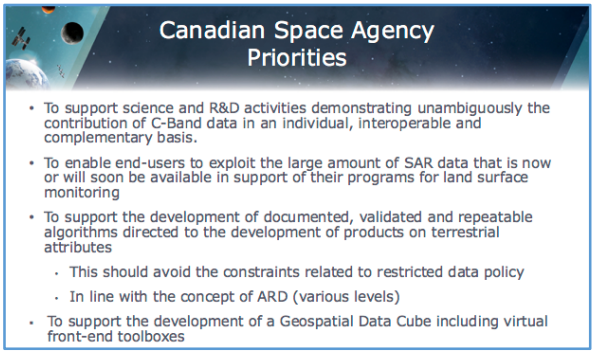
Session 4: Agency Activity Reports

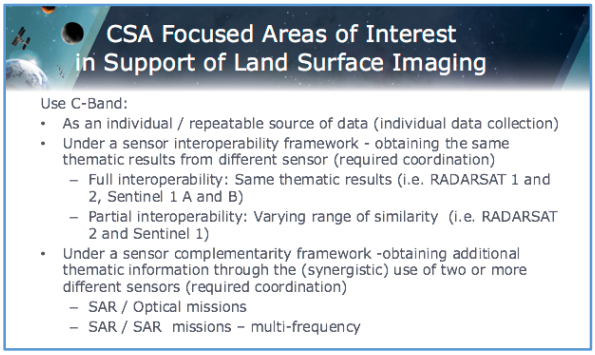
Canadian Space Agency

Yves Crevier (CSA) reviewed the activities of the Canadian Space Agency. He noted that while a systematic and coherent observation plan was not established for Radarsat-1 and Radarsat-2, the agency hopes to achieve this with the Radarsat Constellation Mission (RCM). He added that the challenge faced by CSA is that there are a large number of users and stakeholders, each with their own imaging requirements. There is however an opportunity to establish national-scale, long-term, and standardized information for effective monitoring and management across a number of Federal agencies.

Yves suggested that in general, the EO community needs to give more consideration to the potential of SAR for terrestrial monitoring, noting in particular that it will alleviate many of the issues that users have with optical data (e.g. cloud cover). In order to make the most of SAR, interoperability and complementarity with optical data must be ensured, and the data needs to be easily accessible. Yves noted that 'interoperability' and 'complementarity' are often misused in the SAR-optical context, and he referred everyone to Wulder et al. (2015) for further information.

The Radarsat programme was developed to empower Canadian industry, however this also resulted in a very stringent space policy act that complicates the availability and accessibility of data. In addition to supporting scientific activities and upstream R&D, CSA is aiming to demonstrate the value of building an information industry to provide pull for future missions. Yves closed by presenting some other CSA priorities, including focus areas related to land surface imaging:





Adam Lewis (GA) noted that Geoscience Australia and CSIRO established a SAR-based Data Cube using ALOS, ALOS-2, and Sentinel-1. Unfortunately, Radarsat-2 was excluded due to complications with the data policy. Yves noted that one way around the restrictions of the data policy is to distribute higher level information products. Yves and Adam acknowledged that the biggest hurdle to the full exploitation of Radarsat is the data policy. The data policy for RCM is unknown at this stage.

Brian Killough (NASA, SEO) has been working with Ian Jarvis (Agriculture and Agri-Food Canada, AAFC) to set up a Radarsat-based Data Cube for JECAM, however they are having trouble finding a server. NASA is unable to host foreign restricted datasets and AAFC are not able to purchase cloud hosting directly.

European Space Agency/Europe

Bianca Hoersch (ESA) reviewed the major EO activities of ESA, including their contributions to Copernicus as well as the Earth Explorer missions. Biomass (a P-band radar mission) and FLEX (vegetation fluorescence mission) have been selected as the next two Earth Explorers.

Bianca noted that Sentiel-1A is performing nominal routine operations and Sentinel-2A has just passed its first annual operations review. It is operating an average of 14.2 minutes per orbit (83% capacity) and acquiring over Europe, Africa and Greenland systematically. Sentinel-2B is scheduled for an early March 2017 launch (launcher and location TBC). The Sentinel-3A commissioning phase concluded successfully last week.

Bianca reported that once Sentinel-1B is fully operational, daily production is expected to increase three-fold to 10 TB by 2017. Pass-through operations (real-time transmission) will be ramped up over Europe, which should improve product timeliness (currently 4-5 hours after acquisition).

It was noted that Sentinel-1 acquisition segments are available online at: https://sentinel.esa.int/web/sentinel/missions/sentinel-1/observation-scenario/acquisition-segments

Jonathon Ross (GA) asked whether there is any indication that partners outside of Europe might be able to undertake direct pass-through operations via European Data Relay Satellite (EDRS). There was no conclusive answer, however it is unlikely at this stage.

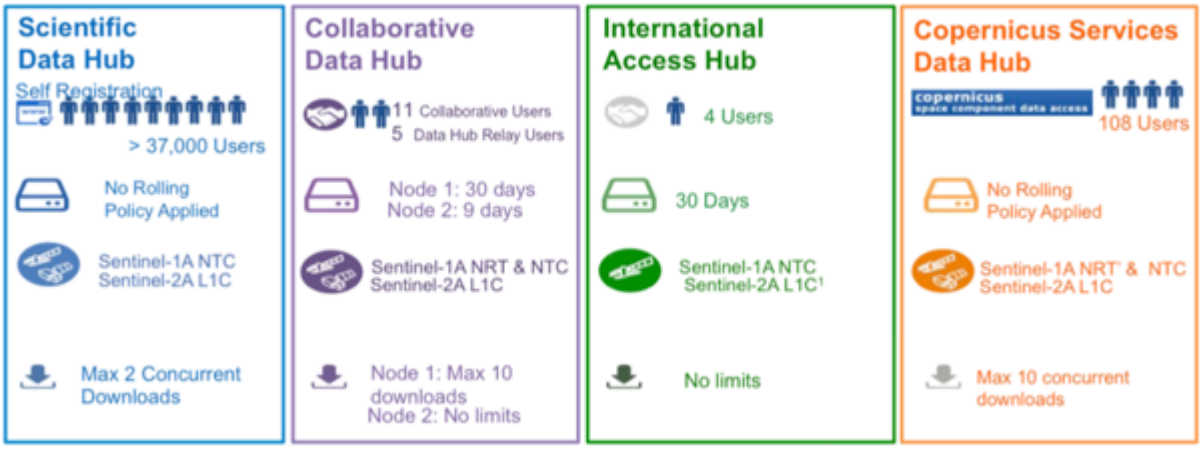
Bianca reported the following Sentinel-2 mission outlook:

Bianca confirmed that Sentinel-2 Level-2A (surface reflectance) products will be generated systematically following a summer 2016 pilot project and atmospheric correction algorithm study (separate to ACIX). The Sentinel Toolbox will remain available for users that wish to perform their own processing.

Action 04	*Bianca Hoersch to inform the LSI-VC about the schedule for:* *a) the migration to Sentinel-2 tiles; and,* *b) the reprocessing of the existing archive.*	**COMPLETE** *Tiles will be available in September and the first Commissioning Phase reprocessing will be done by the end of the year.*

Bianca noted that a Sentinel-2 Validation Team (S2VT) meeting is planned for November. She added that it is an open meeting.

Bianca closed by noting some data distribution statistics and she presented the following access options for Copernicus data:

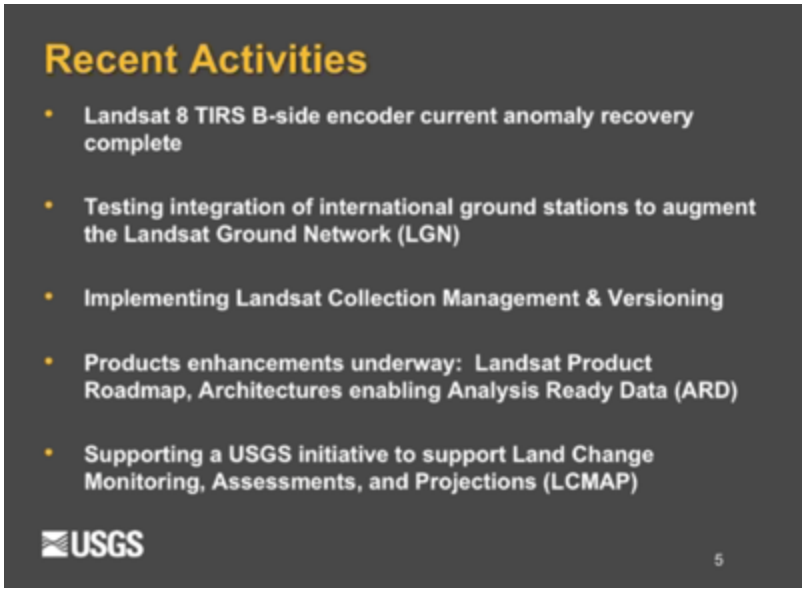


Kristi Kline (USGS) noted that USGS has identified high latency on the encryption layer of the Copernicus data hubs, and this might be causing the download issues they are experiencing. She suggested that ESA consider encrypting only the headers (the practice at USGS). Bianca acknowledged the issue and noted that ESA hopes the switch to tiles will also help reduce latency.

United States Geological Survey

Jenn Lacey (USGS) presented an overview of the current status of Landsat operations and USGS activities. She reported that Landsat 7 end-of-mission planning is underway, and its orbital altitude will be lowered 8 km to maximise its potential for overlap with Landsat 9, resulting in a new mean local time of 09:15. Landsat 7 has also been selected as the prime candidate for NASA's on-orbit servicing and refueling trial, however any extended operations are reliant upon the identification of funding.

Action 05	*Jenn Lacey to share Brian Sauer's Landsat Science Team meeting presentation related to data collection management.*	**COMPLETE**



Gene Fosnight (USGS) reported that Landsat 8 is performing an average of 684.8 acquisitions per day, including around 12 highly off-nadir Antarctic and Arctic acquisitions to support special requests. He added that night coverages of Landsat 8 are focused on calibration sites and volcanoes.

NASA

Jeff Masek (NASA) presented an overview of NASA's Earth science mission portfolio, noting that the NASA-ISRO SAR Mission (NISAR, dual L+S band) in particular is a potentially important mission from the LSI-VC perspective. The objective of NISAR is to understand: the response of ice sheets to climate change and the interaction of sea ice and climate; the dynamics of carbon storage and uptake in wooded, agricultural, wetland, and permafrost systems; and, the likelihood of earthquakes, volcanic eruptions, and landslides. Jeff noted that all data will be made available freely and openly, consistent with the long-standing NASA Earth Science open data policy. NISAR is the SAR component of the cancelled DESDynI mission, with the GEDI laser altimeter (on the ISS) being the other half. For technical details see the presentation on the LSI-VC-2 meeting page: http://ceos.org/meetings/lsi-vc-2/

GEDI will be used to measure forest structure and biomass in the tropics with up to 80% accuracy in 500 m^2 cells. Jeff noted that the mission is planned to be operating at the same time as NISAR and BIOMASS, and this presents a good opportunity for coordination in the GFOI context. He added that GEDI is now a 2-year mission in order to produce a global biomass assessment.

Jeff noted that the ECOSTRESS mission (also on the ISS) aims to collect 1-years' worth of data – not necessarily over 1 calendar year.

Jeff reported that Landsat 9 is a rebuild of Landsat 8 with a number of enhancements. OLI-2 is essentially unchanged, however TIRS will be substantially rebuilt to make it a Class B instrument (5-year design life). The rebuild will include other technical upgrades to address the stray light issue in band 11 and to fix the scene select mirror encoder electronics. The target for launch is currently the 15th of December 2020.

Geoscience Australia

Adam Lewis (GA) presented an update on GA's activities. He noted that GA is increasing its cooperation with USGS and Europe (in particular around the Copernicus data hub). Development of the Australian Geoscience Data Cube (AGDC) continues, with version 2 now released as open source on GitHub. Chris Holden (Boston University) and Brian Killough (NASA, SEO) are using AGDCv2 and Brian has implemented GA's Water Observations from Space (WOfS) algorithm.

Action 06	*Jonathon Ross to investigate whether the SAR WOfS algorithm developed through the Australia-UK Catapult project can be shared.*	**COMPLETE** *Cannot be shared*

GA is currently reprocessing their entire Landsat archive to meet the needs of AGDCv2 and they are also adding the ability to ingest Sentinel-2 data. GA is developing a new collection management system with smart versioning to avoid unnecessary reprocessing in the future.

Adam closed his presentation with a number of Data Cube demonstrations, including an Australia-wide tidal level variation product. For more details see the presentation on the LSI-VC-2 meeting page: http://ceos.org/meetings/lsi-vc-2/

Brian noted his recent visit to the World Bank and their interest in applying the Data Cube – in particular for Africa and the Pacific Islands. The tidal level variation algorithm would likely be very useful for the Pacific Islands.

Action 07	*Brian Killough to send Bianca Hoersch and Jonathon Ross the list of Pacific Islands of interest to the World Bank regarding Data Cube development. Bianca Hoersch to check acquisition possibilities with Sentinel-2.*	**COMPLETE** *All priorities added within S2 plan*

Session 5: LSI-VC Activities in Support of the CEOS Strategy for Carbon Observations from Space

Review of CEOS Carbon Commitments (CARB-08)

Matt Steventon (CEOS Chair Team) reviewed the history of the *CEOS Strategy for Carbon Observations from Space*:

Jonathon Ross (GA) noted that the carbon action assignments (to specific CEOS groups) were endorsed at the 28th CEOS Plenary and that Mark Dowell (EC) has been assigned to oversee implementation of the CEOS Carbon Strategy.

A discussion was held around the 4 actions specifically assigned to LSI-VC:

- **CARB-08-02:** The relevant CEOS VCs and CEOS WG Climate will act to include IGCO priorities for continuity carbon-related observations of the land surface from space in their respective activities to coordinate the VCs and climate-related measurements. *2017-Q4*
- **CARB-08-03:** CEOS Agencies with historical moderate-resolution (~250 m - 1 km) satellite data records will strive to ensure these data are publicly available and used to create the moderate-resolution (~250 m - 1 km) records of land properties over the historical satellite record that are useful for carbon science. They will coordinate their efforts with relevant CEOS WGs and VCs. *2017-Q4*
- **CARB-08-04:** CEOS Agencies with historical medium-resolution (~30 m -100 m) satellite data records will strive to ensure these data are publicly available and used to create the medium-resolution records of land properties over the historical satellite record that are useful for carbon science. They will coordinate their efforts with relevant CEOS WGs and VCs. *2017-Q4*
- **CARB-08-06:** Individual CEOS Agencies with interests in and/or mandates for developing 1) satellites to observe wetlands and inland waters and 2) wetland and inland water data products will coordinate their efforts in consultation with relevant CEOS WGs and VCs. *2016-Q2*

For CARB-08-02 it was agreed that LSI-VC should review the document: *Integrated Global Carbon Observation Theme: A Strategy to Realize a Coordinated System of Integrated Global Carbon Cycle Observations,* to determine whether it is the appropriate resource. The end product might be a table of IGCO priorities with a mapping to the capabilities – similar to the GEOGLAM example. The LSI-VC will also consider a response to Mark Dowell with further questions on the intent of this action.

Action 08	*Adam Lewis to coordinate LSI-VC action on 'CARB-08-02: Inclusion of IGCO continuity priorities in VC and WGClimate activities'. Brian to send Adam the IGCO document.*	**October 2016**

Brian Killough (NASA, SEO) presented the outputs that the SEO generated in response to CARB-08-03 and CARB-08-04. The SEO has developed a list of moderate and medium resolution satellite data records measuring land properties relevant to carbon science and described their data policies, measurement type, domain, time of record, resolution and other relevant product details.

Mission	Instrument	Agency	Launch	Policy	Repeat or Revisit	Swath	Resolution
Optical - Moderate Resolution (250 to 1000m)							
Terra	MODIS	NASA	Dec 1999	Open	1 day	2330 km	250, 500, 1000m
Aqua	MODIS	NASA	May 2002	Open	1 day	2330 km	250, 500, 1000m
SPOT-5	VGT-2	CNES	May 2002	Open	1 day	2276 km	1150 m
Suomi-NPP	VIIRS	NASA	Oct 2011	Open	1 day	3000 km	375, 750m
MTSAT-2	Imager	JMA	Feb 2006	Open	<1 day	Full Earth Disk	1, 4km
MTSAT-1R	JAMI	JMA	Feb 2005	Open	<1 day	Full Earth Disk	1, 4km
COMS	MI	KARI/KMA/ITT	Jun 2010	Open	<1 day	Full Earth Disk	1, 4km
Meteosat-10	SEVIRI	EUMETSAT/ESA	Jul 2012	Open	<1 day	Full Earth Disk	1, 3km
HJ-1B	IR	CAST	Sep 2008	TBD		720 km	150, 300m
Terra	MISR	NASA	Dec 1999	Open		380 km	275m, 550m, 1.1km
COMS	GOCI	Korea	Jun 2010	Open		1440 km	236 x 500m
BJ-2	CCD camera	ISRO	Jul 2015	Open	<1 day	Full Earth Disk	1km
Elektro-L N1	MSU-GS	Russia	Jan 2011	Open		Full Earth disk	1000, 4000 m
Proba-V	VGT-P	ESA/BELSPO	May 2013	Fee *	1 day	2285 km	100, 300, 1000m
Sentinel-3A	OLCI	ESA	Feb 2016	Open	4 days	1270 km	300, 500, 1000m

Mission	Instrument	Agency	Launch	Policy	Repeat or Revisit	Swath	Resolution
Optical - Medium Resolution (10 to 250m)							
Landsat-7	ETM+	NASA/USGS	Apr 1999	Open	16 days	183 km	15, 30, 60m
NMP-EO-1	ALI	NASA	Nov 2000	Open	16 days	185 km	10, 30m
HJ-1A	HSI	CRESDA/CAST	Sep 2008	Open	31 days	50 km	100m
HJ-1A	CCD	CAST	Sep 2008	Open	31 days	360 km (per set)	30m
UK-DMC2	SLIM-6-22	UKSA	Jul 2009	Fee	7 days	640 km	22 m
Deimos-1	SLIM-6-22	Commercial	Jul 2009	Fee	7 days	640 km	22 m
Meteor-M N1	KMSS	ROSKOSMOS	Sep 2009	Open	~ 4 days *	900 km	60 m, 120 m
ResourceSat-2	AWiFS	ISRO	Apr 2011	Fee	5 days	740 km	56 m
ResourceSat-2	LISS-3	ISRO	Apr 2011	Fee	24 days	141 km	23.5 m
Landsat-8	OLI + TIRS	NASA/USGS	Feb 2013	Open	16 days	183 km	15, 30, 100m
CBERS-4	WFI-2	INPE/CAST	Dec 2014	TBD	5 days	866 km	73 m
CBERS-4	MUXCam	INPE/CAST	Dec 2014	TBD	26 days	120 km	20 m
CBERS-4	IRS (China)	INPE/CAST	Dec 2014	TBD	26 days	120 km	40, 80m
Proba	CHRIS	ESA/UKSA	Oct 2001	Open	7 days	14 km	18, 36m
NMP-EO-1	Hyperion	NASA	Nov 2000	Open	16 days	185 km	30m
SJ-9A	MUX	CRESDA	Oct 2012	Open	69 days	30 km	10m
Sentinel-2A	MSI	ESA	Jun 2015	Open	10 days	290 km	10, 20m
Sentinel-2B	MSI	ESA	2016	Open	10 days	290 km	10, 20m

The LSI-VC Leads thanked Brian and the SEO for their effort. It was agreed that once Brian makes a few final updates, the tables should be circulated for LSI-VC review and feedback, before transmission to Mark Dowell. LSI-VC might have a role to play in prompting action from CEOS agencies in response to CARB-08-03 and CARB-08-04, however these tables are considered to be the extent of LSI-VC's action for now.

Action 09	*Brian Killough to make some final adjustments to the SEO's CARB-08-03 and CARB-08-04 responses and to circulate the spreadsheets to LSI-VC members for review and submission to Mark Dowell.*	**October 2016**

It was noted that CARB-08-06 is currently due in Q2 2016, and it was agreed that this date must be changed. It is also necessary to assess the potential overlap with the CEOS Water Strategy.

Action 10	*LSI-VC Leads to ensure that the due date for CARB-08-06 is changed and to assess the potential overlap with the CEOS Water Strategy.*	**SIT TW**

It was noted that we are expected to report our carbon action status before the 2016 SIT Technical Workshop. The indication to date has been that we will just report back showing good progress and that we have an idea of the next steps – it is not expected that all of the carbon actions will be complete by this time.

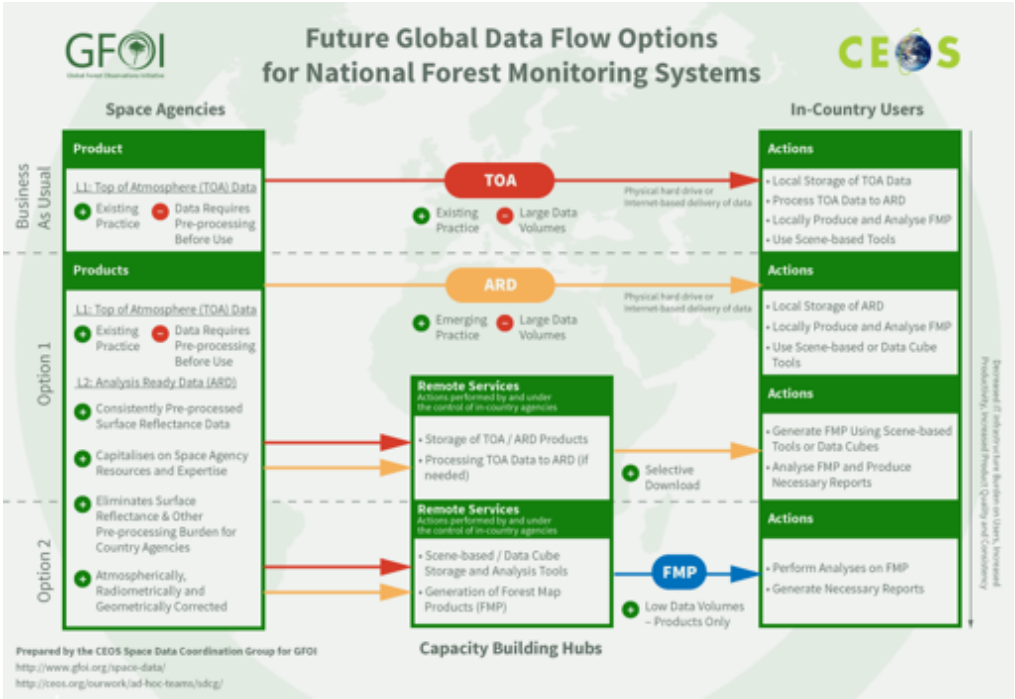
Action 11	*Leads to ensure that all four of the LSI-VC CARB-08 actions are updated/deferred to by the end of August in preparation for SIT Technical Workshop.*	**SIT TW**
Action 12	*Jonathon Ross/Matt Steventon to share the full CARB-08 action spreadsheet, which includes details of the supporting CEOS entities for each action.*	**SIT TW**

SDCG for GFOI and the Linkages to the CEOS Carbon Strategy and LSI-VC

Gene Fosnight (USGS) reviewed the aim of the Global Forest Observations Initiative (GFOI) and the role of the CEOS Space Data Coordination Component. GFOI seeks to foster forest monitoring and assessment that is robust, reliable, and achievable at reasonable cost, and supports planning for national development priorities including climate change mitigation and adaptation. Facilitation of forest observations in support of national forest monitoring systems is a fundamental objective for GFOI. CEOS has taken on the leadership of the space data component to support supply of data to participating countries.

With the launch of Landsat 8 and Sentinel-1 and -2, the SDCG's baseline, coordinated global data acquisition strategy is well covered. Focus has now shifted to Element 2 (a coordinated strategy for national data acquisitions) as well as Element 3 (data supply in support of GFOI R&D activities).

A current focus for the SDCG is the *Global Data Flows Study*. This document considers the barriers to effective use of satellite data in implementing measurement, reporting and verification within national forest monitoring systems in support of REDD+, and evaluates different solutions for reducing or removing these barriers and ensuring efficient global flows of the data.



Gene noted that many countries are using the University of Maryland/Matt Hansen global forest products as their 'Analysis Ready Data', however this dataset is not suited for country-level reporting.

It was noted that GFOI and GEOGLAM are evolving in parallel. They are facing the same challenges and issues related to data distribution and the collaboration we have seen is very positive.

Discussion: LSI-VC Strategy for Requirements (including carbon)

Adam Lewis (GA) asked whether there is an opportunity for LSI-VC to apply the lessons learned and approaches developed through GFOI and GEOGLAM to new thematic areas such as water. Brian Killough (NASA, SEO), Alyssa Whitcraft (GEOGLAM Secretariat) and Gene Fosnight (USGS) supported this, noting that the GEOGLAM approach to mapping requirements and capabilities is exemplary. It was agreed that there would be great utility in a standard 'CEOS approach' to requirements and capabilities analysis, which uses the GEOGLAM requirements matrix as a basis.

Tom Cecere (USGS) suggested that the more LSI-VC can do to formalise an approach to requirement-capability analysis, the better we can guide the necessary input from thematic communities of practice.

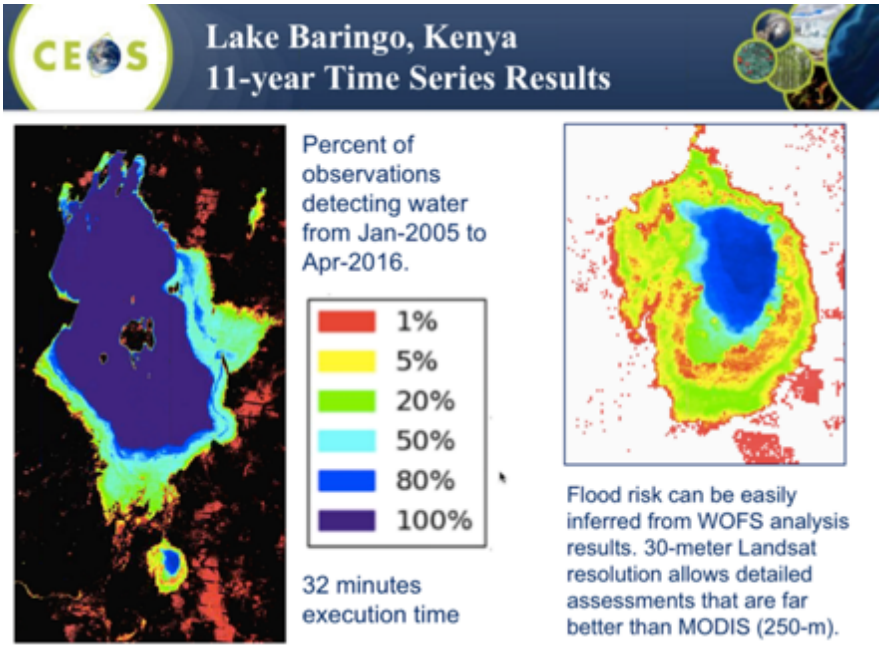
Action 13	*Brian Killough, Jenn Lacey and Bianca Hoersch to initiate a plan for LSI-VC to establish the 'CEOS approach' to requirements/capability analysis – applying the procedures that have been developed in GEOGLAM and SDCG, in particular the 'requirements matrix'.*	**LSI-VC-3**

Session 6: Data Cube Activities

SEO FDA Activities – CEOS Data Cube & 3-Year Work Plan

Brian Killough (NASA, SEO) presented some of the CEOS SEO's recent activities related to the Data Cube. In particular, he noted the custom mosaic tool as well as the SEO's implementation of GA's Water Observations from Space (WOfS) algorithm (in Python) and the recent demonstration to The World Bank, which was received very positively.

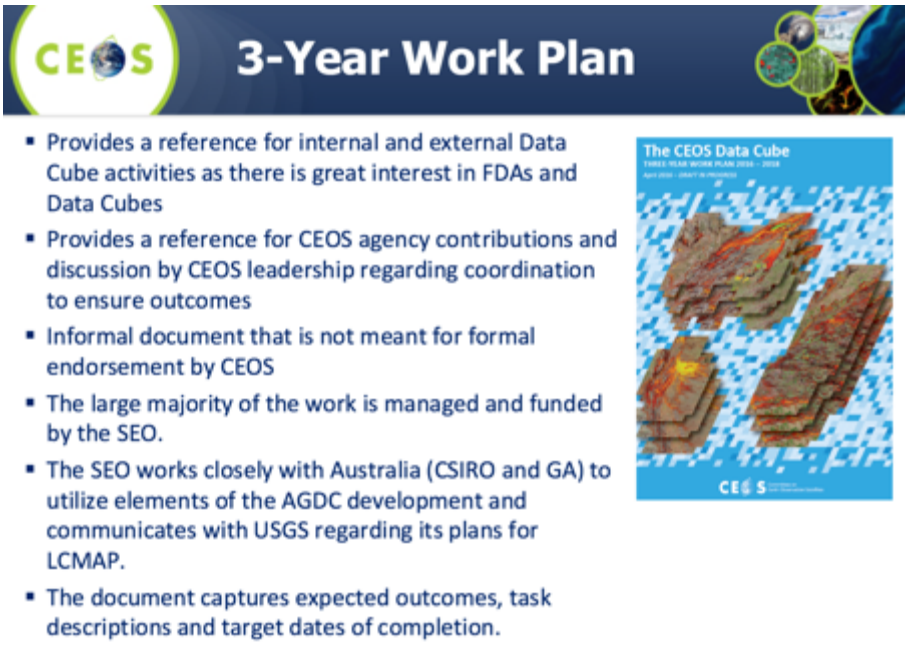
Action 14	*Adam Lewis and Brian Killough to explore the possibility of setting up a small Data Cube over Australia for validation of the SEO's implementation of the WOfS algorithm by comparing the results to GA's.*	**Q3 2017**



Brian noted that WOfS has great potential to inform sustainable building decisions based on historical flood extents, and The World Bank is very interested in applying the Data Cube and WOfS to the area surrounding Lake Chad in Africa.

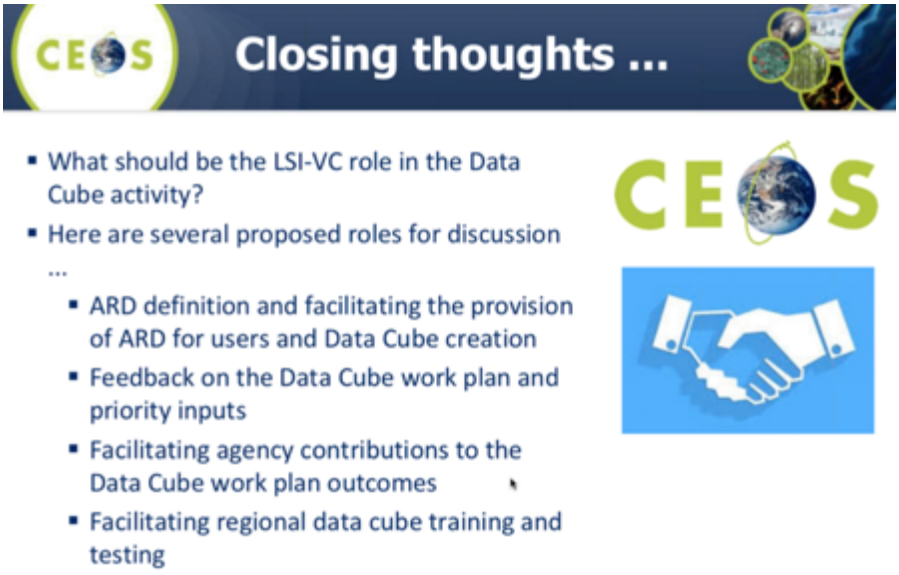
The SEO is involved in two in-country implementations of the Data Cube – with Colombia and Kenya. The Colombian team wish to apply the Data Cube for water management and forestry applications, and they are showing great progress. Kenya are investigating the application of the Data Cube for forestry purposes, and while their progress is a bit slower, Brian hopes that they will accelerate in 2017.

Brian also presented the CEOS Data Cube 3-Year Work Plan:



The Work Plan outcomes cover 5 key areas (refer to the presentation for full details): core technology, data preparation and formatting, user requirements and engagement, prototypes, and capacity building.

Brian presented the following closing thoughts for consideration by LSI-VC:



Action 15	*LSI-VC members to provide feedback on the CEOS Data Cube 3-Year Work Plan.*	**October 2016**

Brian noted that the SEO is wholly-responsible for the CEOS Data Cube. Only LSI-VC is actively engaged – mostly through the ARD definition – and Brian would like to see further pull and input from other CEOS groups. He added that it would be ideal to have input from other countries (e.g. China).

Tom Cecere (USGS) suggested that LSI-VC is not the forum for Data Cube development, however LSI-VC has a key role to play in defining ARD and therefore must remain aware of the latest developments. Brian noted that there might be room for an appropriately scoped CEOS Data Cube ad hoc team to serve as the forum for development (involving WGISS, LSI-VC, etc.), though this remains just an idea for now.

Action 16	*Brian Killough to investigate the CNES SPOT-5 Data Cube with Steven Hosford.*	**October 2016**

Bianca Hoersch (ESA) noted that the PROBA-V /Sentinel teams are investigating methodologies for combining Sentinel-2 and Sentinel-3 data to mitigate the loss of the PROBA-V/Vegetation dataset (expected to reach EOL in May 2018 at the latest). Brian suggested that the Data Cube could be a good platform for combining the datasets.

Session 7: Long-term LSI-VC Strategy and Vision

Discussion: LSI-VC — Is There a Big Objective?

Adam Lewis (GA) opened the discussion session by asking how we get out of a 'reactive' mode, and recalled the key elements of the LSI-VC mission:

- To maximise the value derived from CEOS agency land surface imaging assets and activities by providing an overarching coordination role; and,
- To facilitate coordinated and optimised land surface imaging contributions from CEOS agencies to enable access to fundamental measurement products in support of requirements linked to CEOS priorities. These priorities are typically derived from key stakeholders, such as UN programs and GEO.

Adam noted that activities to achieve this mission are expected in: synthesis of requirements, coordination of missions, consistency of products, and promotion of use. Adam also noted that while special working groups (e.g. SDCG/GFOI, GEOGLAM) have expertise, there is no recognised common CEOS approach and no mechanism to summarise the consolidated requirements and capabilities. The work of SDCG/GFOI and GEOGLAM provides key concepts such as the observation requirements matrix, and the various CEOS information systems are key tools that will facilitate this work. Adam asked whether there are other common concepts that LSI-VC could apply to other thematic areas such as water.

Brian Killough (NASA, SEO) supported the idea, noting that he has been involved in the process a number of times and it would be ideal to formalise the requirements matrix process to help new initiatives communicate their needs.

Action 17	*Brian Killough and Alyssa Whitcraft to add the specification table to the CARD4L specification document.*	**COMPLETE**

Matt Steventon (CEOS Chair Team) suggested that LSI-VC could act as the interface between the communities of practice (providing the requirements) and CEOS agencies (those with the capabilities). LSI-VC has a role to play as the central 'voice', preventing agencies being overwhelmed by numerous and perhaps conflicting requests. He asked how LSI-VC might communicate the requirements – in an *ad hoc* manner or perhaps via periodic reporting?

Jeff Masek (NASA) and Alyssa Whitcraft (GEOGLAM Secretariat) sought clarification on the scope of LSI-VC's work. It was agreed that LSI-VC should not stray into implementation or requirements gathering, rather just provide a uniform process for collecting requirements from thematic communities of practice and matching the requirements to CEOS capabilities.

Alyssa asked about the potential future disbanding the CEOS ad hoc Working Group for GEOGLAM. Jonathon Ross (GA, CEO) suggested that the CEOS ad hoc Working Group for GEOGLAM would exist alongside LSI-VC (as the experts that maintain the requirements) until such a time that the requirements reach a semi steady state, after which the ad hoc WG could be represented by a few representatives on the LSI-VC.

Tom Cecere (USGS) asked how LSI-VC might encourage more agencies to make their datasets open and free. He supported the idea of engaging more agencies in LSI-VC –

particularly those without free and open data policies. Jenn Lacey (USGS) supported this idea as well, however the LSI-VC was unsure that this would be a productive course of action.

Yves Crevier (CSA) suggested that LSI-VC should aim to understand the state of interoperability and complementarity between datasets and promote further action around this. He also suggested that LSI-VC could initiate interoperability/complementarity pilots.

Jenn suggested that the LSI-VC refer back to the Implementation Plan endorsed at the 2015 CEOS Plenary to help guide its work.

It was agreed that the final session of LSI-VC-2 would be used to step through the LSI-VC Implementation Plan, assess our progress, and detail the specific tasks for each activity area. It was also agreed that we would review the latest draft of the ARD definition document as a group.

LSI-VC-3

Hosting options for LSI-VC-3 were discussed briefly. It was noted that ESA ESRIN will host the WorldCover 2017 conference (http://worldcover2017.esa.int/) from the 14th to the 16th of March 2017, and Bianca suggested that LSI-VC-3 could be held the week after, on March 20th and 21st. If this is possible, Alyssa will attempt to schedule a GEOGLAM meeting for the following two days – March 22nd and 23rd.

Action 18	*Bianca Hoersch to explore the possibility of ESA ESRIN hosting LSI-VC-3 from March 20th – 21st .*	**COMPLETE** *Confirmed (rooms D and E)*

Friday – 22nd July 2016

Session 8: Wrap-up and Close

Review of the ARD Definition Document

The LSI-VC reviewed and edited the latest version of the ARD definition document. A number of changes and clarifications were made (see the change tracked version for details). In particular, the LSI-VC added clarification around the term 'analysis-ready', changed 'ARD' to 'CARD4L' (CEOS Analysis Ready Data for Land), and split the document into two parts (the high-level definition and the example specifications).

Action 19	*Brian Killough to circulate both of the CARD4L documents (high-level definition and example specifications) for review.*	**COMPLETE**

Action 20	*Adam Lewis to draft the task and potential membership of a radar team to progress the example specifications of SAR CARD4L. Membership should include JAXA, ESA (Bianca is POC), CSA (Paul Briand has confirmed), NASA, and UKSA. The team should start with the gamma-nought specification, and it was noted that the high-level definition is outside of scope.*	**October 2016**

LSI-VC Implementation Plan Review

Jenn Lacey (USGS) asked whether we require a Work Plan. Brian Killough (NASA, SEO) and Jonathon Ross (GA, CEO) suggested that we have a short, informal statement of work (preferably dot points) to help guide our efforts.

Following this suggestion, the LSI-VC reviewed the Implementation Plan objectives/deliverables and assigned tasks for each. The following is a summary of the decided tasks.

Phase 1 Activities (2015-2016)

Objective/Deliverable	Tasks
Identify gaps in/opportunities for acquisition-planning in support of the CEOS Carbon Strategy.	1. LSI-VC will create a general template and framework for requirement and capability assessment, based on the GEOGLAM requirements 'matrix' example. 2. This approach to requirement and capability assessment will be tested by applying it to the CEOS Carbon Strategy (in consultation with WGClimate/Mark Dowell, where necessary), using CEOS information systems and RCA-EO to aid the process wherever possible. 3. The framework will be tweaked based on the experience and shared with the CEOS community for feedback and revisions. 4. LSI-VC will adopt the framework for the assessment of all future requirements that are presented to CEOS. The framework/template will be shared with all communities of practice that approach CEOS to ensure that their submissions align with the requirements of LSI-VC.
Define intercomparable Analysis-Ready Data (ARD) products within the context of land surface imaging.	1. Brian will circulate the latest version of the CARD4L definition (updated during LSI-VC-2) to the LSI-VC Leads for review and distribution to LSI-VC members. 2. The definition will be shared with CEOS at the 2016 SIT Technical Workshop. 3. At the 2016 Plenary, CEOS will be asked to endorse the CARD4L definition, along with a decision to develop a strategy for implementing CARD4L within CEOS. The specification document will not be submitted for endorsement, but perhaps shared in the form of a

	presentation.
Increase the visibility of land surface imaging data holdings.	1. No specific action required. 2. The requirement/capability analysis process will be shared with WGISS.
Engage in the implementation of trial Data Cubes.	1. LSI-VC will provide feedback on the CEOS Data Cube 3-Year Work Plan. 2. Facilitate the engagement of CEOS agencies in the Data Cube effort and track the status of agency contributions.
Perform a scoping study for global data flows for long time series of land surface imaging data.	1. LSI-VC will review the Global Data Flows Study being prepared by the SDCG for GFOI.

Phase 2 Activities (2016-2017)

Objective/Deliverable	**Tasks**
Pilot approaches to conducting integrated assessments of gaps/opportunities in asset usage.	1. No specific action required – covered under Phase 1 task description.
Develop a roadmap for the routine production of intercomparable ARD.	1. LSI-VC will work with USGS as 2017 CEOS Chair to implement a strategy for the adoption of CARD4L within CEOS.
Assess lessons learned from Data Cube implementations (including Australian Geoscience Data Cube, etc.) and global data flows studies.	1. No specific action required at present.
Pilot large data set distribution covering three regions.	1. No specific action required at present.
Establishing enhanced collaboration on wetlands and inland waterway monitoring.	1. LSI-VC Leads will update the due date of CARB-08-06 with Mark Dowell (EC).

Phase 3 Activities (2017-2018)

Objective/Deliverable	Tasks
Continue to develop approaches for integrated assessments of gaps/opportunities in asset usage.	1. No specific action required – covered under Phase 1 task description.
Begin implementing steps toward the routine production of intercomparable ARD.	1. No specific action required at present.
Establishing enhanced collaboration on wetlands and inland waterway monitoring.	1. No specific action required at present.

It was agreed that the LSI-VC Implementation Plan should be revised ahead of CEOS Plenary. Jenn Lacey (USGS) offered to lead the effort.

Action 21	*Jenn Lacey to coordinate an update of the LSI-VC Implementation Plan ahead of CEOS Plenary.*	**LSI-VC-3**

Finally, it was decided that the subgroups are not necessary and the composition of LSI-VC membership is acceptable.

Action Review and Closing Remarks

Matt Steventon (CEOS Chair Team) reviewed the actions noted during LSI-VC-2, and some collaborative edits were made to the record. Some further actions were noted during the closing session.

Action 22	*Matt Steventon to speak with the ESA SIT Chair team to try and have the GEOGLAM SIT TW side meeting moved to Tuesday, in parallel with the VC/WG Day.*	**CLOSED** *Not necessary as there is no overlap on Monday*
Action 23	*Matt Steventon to ensure that all shareable presentations are on the LSI-VC-2 website.*	**COMPLETE**

The LSI-VC Co-Leads thanked everyone for attending and closed the meeting.

APPENDIX A

LSI-VC-2 Attendees

Organisation	Name
CEOS Chair Team	Matt Steventon
CSA	Yves Crevier
ESA	Bianca Hoersch
GA	Adam Lewis
GA	Jonathon Ross
GA	Leo Lymburner
GEOGLAM Secretariat	Alyssa Whitcraft
NASA	David Jarrett*
NASA	Jeff Masek
NASA, SEO	Brian Killough
NOAA	Kevin Gallo*
USGS	Brian Sauer
USGS EROS	David Hair
USGS EROS	Gene Fosnight
USGS EROS	Greg Stensaas
USGS EROS	Jenn Lacey
USGS EROS	John Dwyer
USGS EROS	Kristi Kline
USGS HQ, Aerospace	Steve Covington
USGS EROS	Steve Labahn
USGS HQ	Tom Cecere

* Remote participant