MINUTES OF THE 1st CEOS LAND SURFACE IMAGING VIRTUAL CONSTELLATION MEETING (LSI-VC-1)

22nd – 24th February 2016
ESA ESRIN, Frascati, Italy

1 Introduction

Bianca Hoersch (ESA) welcomed everyone to the meeting, led a roundtable introduction, and reviewed some ESRIN facts and figures.

Tom Cecere (USGS) reviewed the background of the renewal of LSI-VC. He noted that it was felt that the SDCG for GFOI was performing many of the functions (in this case, specifically related to forest monitoring) that the LSI-VC ultimately aspires to, however the need for a more general LSI coordination body within CEOS remained. The role of the other Virtual Constellations is collecting, disseminating, and distributing domain specific products. The SDCG is a good example of what the LSI-VC should strive to achieve, however the scope of work is much broader; covering the numerous CEOS thematic observation strategies. LSI-VC should aim to define a framework that encourages CEOS member agencies with LSI assets to make data as free and open as possible.

Yves Crevier (CSA) is a strong believer in a structure like LSI-VC to coordinate all of the thematic groups within CEOS and harmonise imaging activities. He noted a paper published in the ISPRS Journal of Photogrammetry and Remote Sensing which presents a compendium of satellites under civilian and/or commercial control with the potential to gather global land-cover observations. A link to the paper was posted on the meeting website.

It was agreed that we must avoid duplicating the work of other existing CEOS groups. There are responsibilities that the LSI-VC would not expect to take on, such as interfacing with the user community and defining requirements – which would be the role of groups such as GEO.

David Jarrett (NASA) summarised what he sees as the role of LSI-VC for gap analyses: that is, to identify gaps, overlaps, and opportunities for optimization in order to improve interoperability and complementarity for current and future missions and to provide that information to CEOS and the respective individual space agencies for their consideration for future planning. The longer term goal is to harmonize acquisition plans across major international land surface imaging programs to support validated domain-specific requirements

Yves noted the multitude of bilateral discussions/arrangements taking place between CEOS agencies (e.g. RCM/Sentinel-1, Landsat/Sentinel-2, etc.) and LSI-VC could conceivably be a forum/mechanism for the types of discussions taking place bilaterally.

The other key role of LSI-VC is to investigate and make recommendations to CEOS on Analysis Ready Data (ARD) standards. Zoltan Szantoi (EC) reported that the European Commission would welcome input/recommendations on ARD standards/definitions.

2 Review of Agency Activities

LSI-VC members were invited to report on some related activities that are ongoing within their agencies.

Land Product Characterization System

Gene Fosnight (USGS) presented the Land Product Characterization System (LPCS) on behalf of Kevin Gallo (NOAA). The LPCS is a web-based system designed to facilitate the characterisation and validation of Analysis-ready Surface Reflectance data, including products from VIIRS, MODIS, Landsat, Sentinel-2/3 and GOES-R ABI. The tool compares SR values from different images/sensors for different surfaces for analysis and validation purposes. Outputs are in the form of summary tables and charts, and geographically registered and resampled image products (for additional analysis). LPCS is data agnostic and could conceivably be built on top of data archives to facilitate rapid and automated analyses.

LSI-VC-1-1	Gene and Kevin to investigate whether the Land Product Characterisation System (LPCS) could be presented at the upcoming WGCV-40 meeting in Canberra. Tom, Brian, Adam and Matt will be in attendance and could be called on to present on behalf of USGS.	**OPEN** *WGCV-40 has passed. LSI-VC to consider other opportunities to present the LPCS, such as WGCV-41.*

NASA Land Imaging Evolution

David Jarrett and Jeff Masek (NASA) presented NASA's Sustainable Land Imaging (SLI) strategy (which is carried out in collaboration with USGS). While recognising the scientific need for continuity with the 43-year Landsat record, NASA is seeing new trends and opportunities in land remote sensing. Trends and user needs include improved revisit, improved spectral characteristics, small satellites, increased synergy with international systems, and increased emphasis on information (rather than images).

NASA aims to expand their capabilities while maintaining continuity. The SLI strategy includes 3 parts: Landsat-9 (2020-2021 timeframe), Landsat-10, and Land Imaging Technology and Systems Innovation. Landsat-9 is driven by the need for mission continuity after the Landsat-7 mission ends, and Landsat-10 technical studies are underway. As part of the SLI, NASA has solicited, selected, and initiated science investigations focused on the construction of multi-system fusion datasets (Multi-Source Land Imaging Science, MuSLI), and Copernicus data access agreements are enabling this activity by providing access to all Sentinel-2 data. NASA is investing in the synergistic use of international data sources to improve land monitoring through the MuSLI initiative and a collaboration between NASA GSFC, ARC, and UMD to produce harmonized Landsat/Sentinel-2 (HLS) reflectance products.

USGS Definition of Analysis Ready Data and LC MAP

Tom Cecere spoke briefly on behalf of Jennifer Lacey (USGS), noting work done within USGS to define Landsat-specific ARD, as well as the USGS Land Change Monitoring, Assessment and Projection project.

LSI-VC-1-2	Tom to share the USGS Landsat ARD definition once it has been approved for release.	**CLOSED** *Sent with 7th April teleconference agenda*

Surface Reflectance (SR) products are central to the ARD definition and are the common baseline for the harmonization of multiple optical sensor data for time series analysis. Variation in aerosol optical thickness is a key factor. The initial public release of the USGS Sentinel-2 mirror archive has been announced. The population of the archive continues.

3 Terms of Reference Review

Adam Lewis (GA) reviewed the Terms of Reference of the LSI-VC, which were endorsed at the 29th CEOS Plenary in November 2015. A discussion on the role of the LSI-VC followed:

- Identification of the authoritative sources of observation requirements is a key task for the LSI-VC. We have numerous CEOS endorsed strategies/requirements, however we should be aware of other outside sources.
- The ToR refer to LSI-VC 'engaging' with the CEOS Data Cube pilot activities being undertaken by the SEO. The meaning of 'engaging' will be discussed and confirmed over the next few days, when defining the LSI-VC Work Plan Tasks.
- The CEOS Work Plan Tasks were reviewed. During LSI-VC-1, these tasks will be broken down into smaller sub-tasks that are achievable on shorter time scales.
- The CEOS Work Plan calls on LSI-VC to define intercomparable ARD products within the context of land surface imaging. This would ideally cover standard inputs/outputs (TOA or SR), and key characteristics (stackability, geometric accuracy, data provenance, etc.)
- Yves Crevier (CSA) asked whether the CEOS WP Task on increasing the visibility of land surface imaging data holdings is intended to benefit CEOS agencies or the user community. This CEOS Work Plan objective is explicitly linked to CEOS WP objective VC-1, which aims to: *"ensure search and accessibility (when possible) of these datasets…so as to ensure coverage of all datasets required by VCs."*
- The mangrove related objective/deliverable in the CEOS WP appears to be at a bit of a different level to the others, and it was suggested that it might be folded into the main carbon objective/deliverable.
- LSI-VC should restrict itself to the requirements already outlined in the various CEOS strategies (starting with Carbon) before making a call for further inputs.

4 LSI-VC/SDCG Joint Session Objectives

A quick discussion was held to confirm the objectives for the joint session with SDCG. The LSI-VC would like to confirm SDCG's validated requirements and how these are set, get an overview of the coordination work of the SDCG, and to solicit feedback on the role of LSI-VC.

5 LSI-VC/SDCG Joint Session

Adam Lewis (GA) opened the meeting by stating the objectives and intended role of the LSI-VC. He noted that the ultimate expectation of the LSI-VC appears to be that CEOS is able to maintain the theme-specific functions being performed by SDCG for GFOI for forests, and is able to generalise these functions to apply to other land surface domains (including surface water). LSI-VC is seeking guidance from SDCG at this early stage to help guide initial work. Adam briefly reviewed the main tasks laid out in the ToR and Implementation Plan of the LSI-VC.

Ivan Petiteville (ESA) suggested that the LSI-VC Co-Chairs prepare a profile of roles, resources, and assignments for the group. Gene Fosnight (USGS) added that the membership of the team is critical – a sufficient level of engagement with agencies is required to ensure that priorities make their way into agency activities.

SDCG/GFOI Overview

Frank Martin Seifert (ESA) presented an overview of GFOI and the SDCG, including membership and the CEOS Space Data Strategy for GFOI. The LSI-VC will seek to learn from, but not replace SCCG. The LSI-VC is also limited in capacity and capability, and Adam Lewis (GA) suggested that, due to its scope and limited resources, the LSI-VC would expect to contribute more usefully at a strategic level rather than in technical specifics, especially in comparison to the SDCG. However LSI-VC needs to ensure that it has sufficient linkages to groups that are defining requirements as well as the user community.

CEOS SEO Overview of GFOI Support

Brian Killough (NASA/CEOS SEO) presented an overview of the support provided to GFOI by the CEOS Systems Engineering Office (SEO).

The CEOS Visualization Environment (COVE, http://www.ceos-cove.org/) is a suite of tools for analyzing satellite sensor coverage for more than 100 Earth-observing satellites. It is able to display past/future orbital tracks, and for missions where a direct link to a metadata archive is available, is also able to show where scenes were captured by the satellite. There are a multitude of tools allowing users to produce tabular reports and historical coverage analyses. Archive links currently exist for Landsat, Sentinel-1 and

Sentinel-2, which are all sourced from USGS infrastructure due to the common format. An ESA/EC Sentinel-2 archive connection is expected to be added within the next month.

LSI-VC-1-3	Brian (SEO team) to confirm whether ALOS-1 metadata is retrieved from the ASF and to investigate with ESA the possibility of including European ALOS-1 holdings.	*The SEO metadata for ALOS-1 was pulled from the Japanese G-Portal holdings. Since this mission is complete, we do not have any update mechanisms in place. If ESA desires that we add their ALOS-1 holdings, we will need to obtain that metadata.*

Brian also presented the SEO's work on Data Cubes, including the pilot projects for Kenya and Colombia. He noted that Colombia has been proactive; adding and analysing data using the tools and user interface provided by the SEO. The Colombian team is using their own local IT infrastructure, but are also investigating an expansion to cloud-based commercial servers such as Amazon AWS.

Brian added that while some countries do wish to do all of their own data processing, he has increasingly found that many countries are happy to receive pre-processed SR products.

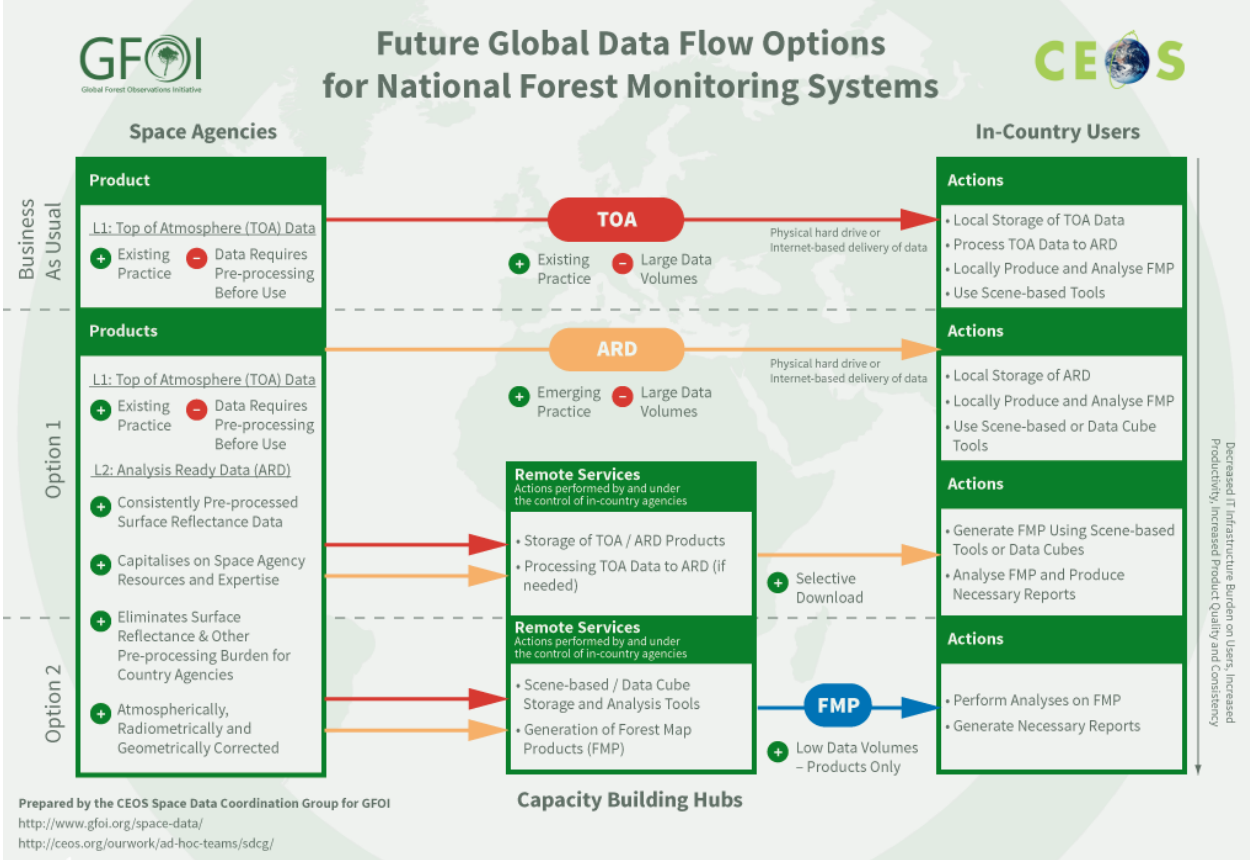
A custom mosaic tool has been built on top of the Data Cube, and is able to quickly produce cloud-free mosaics by combining a number of scenes. The SEO is also considering a land change detection tool for the FAO (BFAST – Breaks For Additive Season and Trend).

LSI-VC-1-4	Zoltan to share with Brian Killough and Adam Lewis: details of the JRC tool under development which calculates a prediction of seasonality based on phenology, and could be connected to the Data Cube via an API.	**May 2016**

Global Data Flows Study Overview

Gene Fosnight (USGS) introduced the SDCG's Global Data Flows Study. The Study aims to identify alternative solutions for reducing barriers to effective use of satellite data in implementing measurement, reporting and verification (MRV) methodologies within national forest monitoring systems (NFMS) in support of REDD+. A key goal is to shift the burden of creating ARD products from the user community to space agencies in order to reduce user costs and ensure quality control.

LSI-VC-1-5	Matt to circulate the current draft of the SDCG Global Data Flows Study.	**COMPLETE**



Gene noted that ARD applies to both optical and radar, as well as tiled and Data Cube formats. Ake Rosenqvist (JAXA) noted that there are many unique factors that need to be considered when defining ARD for radar data.

A discussion was held around the definition of ARD specifications. Some questions were raised:

- Where does the responsibility for defining domain-specific ARD lie – is it with the thematic groups or LSI-VC?
- Who interfaces with users and collects their ARD requirements/feedback?
- When LSI-VC is fully operational would SDCG/GFOI maintain a relationship with users to ensure that the ARD is still acceptable or would LSI-VC take on the role?

In response to the third question, Brian Killough (NASA/CEOS SEO) suggested that an expert representative from each thematic area could sit on the LSI-VC and provide a link to users and requirements.

It was agreed that the way forward is to:

- encourage CEOS space agencies to coordinate the production of, and access to, consistent ARD; and,
- invite users and capacity building partners to provide feedback on how space agency products and access might be improved.

6 LSI-SDCG Discussion Session

Stephen Ward (SDCG Sec) noted that the LSI-VC has been tasked by the CEOS SIT Chair to undertake a survey and produce a short report on the tools or processes used by larger space agencies to manage multiple different requirements and stakeholders in the operation of their space infrastructure (or indeed any complex, high in demand systems). The SIT Chair would like to understand how CEOS might be able to assess whether it can accommodate all of the requests being taken on. The LSI-VC will add this task to their initial Work Plan, which is being defined over the next few days.

This task will be applicable to LSI-VC's broader task of distilling and compiling all of the existing CEOS thematic strategy requirements, facilitating assessment of CEOS capacity and gap analyses.

If CEOS had a way to streamline acquisition requests, including an automated way to assess coverage gaps and overlaps, it would eliminate a lot of the need to establish new ad hoc Working Groups.

LSI-VC-1-6	Brian Killough (with George Dyke) to summarise (for SIT-31) the current suite of CEOS commitments based on the various acquisition strategies that have been agreed and/or endorsed by CEOS.	**SIT-31**

It was agreed that defining ARD from a multi-thematic perspective should be achievable by the end of 2016. SDCG has provided a definition of ARD from the forestry perspective (formalised in the SDCG Global Data Flows Study), however LSI needs to do the same for many different domains. It was noted that the CEOS Future Data Architectures ad-hoc team should provide good input.

Tom Cecere (USGS) suggested that an LSI-VC equivalent of the GFOI Space Data Portal might be one way to achieve the CEOS Work Plan action on increasing the visibility of land surface imaging data holdings.

Yves Crevier (CSA) noted the requirement submission page implemented by the NASA Arctic-Boreal Vulnerability Experiment (ABoVE, http://above.nasa.gov/about.html?#about) and suggested that CEOS/LSI-VC might consider such an approach for requirement collection.

LSI-VC-1-7	Zoltan to share information on EC's work on biodiversity, which was undertaken in collaboration with GEO BON Working Group 3 (terrestrial ecosystem change).	**COMPLETE** *Nothing to report except that EC participated in workshops to define the Essential Biodiversity Variables and how to measure (some of) them with satellite data.*

Ake Rosenqvist (JAXA) noted JAXA's legacy with wetlands/RAMSAR, and expressed willingness to provide advice on the LSI-VC CEOS Work Plan objective/deliverable on establishing enhanced collaboration on wetlands and inland waterway monitoring.

In addition to working on the objectives/deliverables identified in the current CEOS Work Plan, it was agreed that LSI-VC needs to consider the longer-term future of the group. LSI-VC will discuss this further when defining their Work Plan and will add a separate Work Plan task area on long-term LSI-VC strategy.

7 SIT-31 Discussion

A discussion was held on the task assigned to LSI-VC by the SIT Chair. By SIT-31 (April 19th – 20th) LSI-VC will prepare a short report, presenting the results of a survey on tools or processes used by larger space agencies to manage multiple different requirements and stakeholders in the operation of their space infrastructure (or any other complex, in demand systems).

Stephen Ward (SIT Chair team) explained the background of the request, noting that CEOS lacks any management framework to understand its commitments and whether these can be met. CEOS is facing increasing demands, and is unable to respond to those demands in an informed manner due to a lack of information, and needs a way to assess the capacity and ability of agencies to meet the numerous requirements. The SIT Chair would like to understand what capabilities exist for thematic acquisition planning, visibility of multiple requirements and multi-mission capacity, and whether the challenges faced by CEOS are similar to those faced by individual agencies and countries.

The goal is to help CEOS understand the scale of requests; and assessing gaps, overlaps and optimisation of missions are key steps in doing so. Stephen clarified that the scope is existing requirements; that is, optimising existing mission acquisitions in support of existing CEOS strategies.

George Dyke (SIT Chair team) and the CEOS SEO are undertaking an assessment of the current suite of CEOS commitments based on the various acquisition strategies that have been agreed and/or endorsed by CEOS, and this input will be key to making these assessments (potentially using tools/processes identified by LSI-VC, if possible).

It was clarified that it is not LSI-VC's goal to raise new requirements, but rather to assess and assist with optimisation of CEOS assets that address existing validated land surface imaging requirements. It is possible to imagine a future in which new validated requirements could be submitted by thematic experts, and automatically assessed and optimised without having to establish new CEOS ad-hoc teams. Existing CEOS tools such as COVE and the MIM database could be leveraged for gap analyses and acquisition optimisation if the required archive metadata was consistently available from agencies.

LSI-VC-1-8	CEOS SEO to provide a plan covering their future development activities for CEOS web tools and services.	**COMPLETE** *The SEO is planning to add the Sentinel-2A acquisition archive to COVE. No other updates are planned for COVE in 2016. Data Services will continue for Asia-Rice through the end of 2016. The SEO will explore data services options with the JECAM group.*

8 Review of Agency Activities (continued)

Geoscience Australia

Adam Lewis (GA) reviewed some of the development work being done around the Data Cube at Geoscience Australia, including the Water Observations from Space (WOfS), water colour analyses, sea tide level time series analyses, and evolution of the gridding system. He also noted work done to support the Victorian Government, in which average median surface reflectance coverage of Australia was used to construct a mosaic to facilitate rapid land use classifications. He added that some teams within GA are exploring application of ALOS PALSAR data in the Data Cube infrastructure.

Canadian Space Agency

Yves Crevier (CSA) reported on a number of a relevant activities ongoing within CSA/Canada, noting that CSA's priority is SAR and arctic monitoring. He spoke about the planned national terrestrial monitoring framework for Canada, which aims to establish a long-term, coherent archive/monitoring strategy of Radarsat-2 and RCM datasets to support a broad spectrum of terrestrial monitoring activities, including geology, agriculture, forestry, and arctic monitoring, among many others. Stakeholders are currently being consulted on their desired approach to terrestrial monitoring, and the Australian TERN and AusCover model is being investigated.

Users strongly desire an ARD product (calibrated, orthorectified) for radar datasets, and the definition of a suitable 'common denominator' product is a priority to facilitate new application development. If a suitably high-level ARD product can be defined, it is possible that many of the commercial restrictions of the datasets might be avoided. Natural Resources Canada (NRCAN) is also developing a Data Cube platform.

9 Work Plan Discussion Sessions

A series of LSI-VC Work Plan discussion sessions followed. Some key discussion points are noted below, and the main output of the discussion is reflected in the draft Work Plan tasks attached in Appendix A. Some short-term actions not suitable for inclusion in the Work Plan tasks are also noted below.

Bianca Hoersch (ESA) reviewed the CEOS Carbon Strategy to provide some context for the LSI-VC's CEOS Work Plan task on identifying gaps in/opportunities for acquisition-planning in support of the CEOS Carbon Strategy. The Strategy identifies a collection of carbon related parameters (biomass, land cover, vegetation type, etc.) and identifies the types of mission data required for each.

It was noted that CEOS possesses many of the tools required for gap analyses (e.g. the MIM database, COVE, Data Policy Portal), though further development and work to tie them together would be required. It was agreed that a high-level system diagram would be produced to summarise this information. Using input from the CEOS SEO, Bianca and Jeff Masek (NASA) will make a start on defining the satellites/sensors applicable to each of the land surface parameters set out in the CEOS Carbon Strategy.

LSI-VC-1-9	CEOS SEO to develop a list of medium (10-100m) and moderate (250-1000m) resolution satellite data records measuring land properties relevant to carbon science and describe their data policies, measurement type, domain, time of record, resolution and other relevant product details. These initial results will be given to LSI-VC (Bianca Hoersch and Jeff Masek) as a basis for further linkage to the parameters set out in the CEOS Carbon Strategy.	**COMPLETE** There are two CEOS actions (CARB-08-03 and CARB-08-04) that address public availability of historical moderate resolution and medium resolution satellite data records. The SEO has developed a spreadsheet that summarizes the mission/instrument combinations and data policies of missions relevant to carbon. There are many missions with restricted or fee-based access.

There was a general feeling that the CEOS MIM Database could be updated to better facilitate gap analyses. There was some criticism of the measurement classes applied to instruments and their accuracy, due to their dependence on input from survey respondents. It was suggested that the database could be improved by, instead of asking respondents to specify measurements, the various CEOS thematic observation strategies be used in combination with more detailed sensor characteristics (band information, etc.) to auto-define the applicable measurements.

LSI-VC-1-10	Matt Steventon (with George Dyke) to follow up Tom Cecere and Brian Killough (potentially in Canberra during March) on the issues identified with the MIM database (around the incompleteness of instrument measurement assignments) and to consider how the MIM might be adapted in the future to better support the functionality required for gap analyses.	**April/May 2016**
LSI-VC-1-11	All to review the Land section of the CEOS Carbon Strategy.	**April/May 2016**

It was agreed that stackability and pixel provenance are the defining features of ARD. A minimum geometric accuracy is required to enable stacking of temporal data.

10 Long-term Strategic Outlook for LSI-VC

Adam Lewis (GA) suggested that the long-term strategic outlook for LSI-VC should be considered further. A fifth LSI-VC Work Plan task area was added in response.

11 Wrap Up and Adjourn

Adam and Bianca closed the meeting and thanked everyone for their attendance. The Co-Chair's will confirm the draft Work Plan tasks and identify key milestones and a calendar. Some further actions were raised during the closing sessions.

LSI-VC-1-12	Co-Chair's to confirm the draft Work Plan tasks, add some context/background, and circulate for edits/feedback from the team.	**May 2016**
LSI-VC-1-13	Co-Chairs to identify key milestones and produce a calendar/timeline.	**April 2016**
LSI-VC-1-14	Matt to set up an LSI-VC Google Drive and invite LSI-VC members to join.	**April 2016**

LSI-VC-1-15	Co-Chairs to investigate the options for an LSI-VC-2 meeting some time in the September timeframe – preferably around a meeting that will have some representation from WGClimate.	**COMPLETE** *LSI-VC-2 will be held during the week of July 18th at NASA Ames or in San Diego (dates and venue TBC)*
LSI-VC-1-16	Co-Chairs to organise a teleconference with WGClimate and solicit their feedback on our initial approach to addressing gaps and opportunities for acquisition planning in support of the CEOS Carbon strategy.	**May 2016**
LSI-VC-1-17	Co-Chairs to assess the potential implications of the CEOS Water Strategy.	**July 2016/LSI-VC-2**
LSI-VC-1-18	Adam to discuss future support from Symbios with Stephen Ward.	**COMPLETE**
LSI-VC-1-19	Members to bring the Copernicus next generation user requirements process to the awareness of their agencies: https://spacetec.typeform.com/to/jGtmco	**CLOSED**

APPENDIX A
DRAFT Work Plan Tasks

1: Increase the visibility of land surface imaging data holdings. The LSI-VC will work with WGISS to list relevant datasets to ensure visibility through CWIC etc.

1-1: Establish a meeting with WGISS to discuss the information required from the LSI-VC to increase the visibility of data holdings. **Responsibility: Brian/Adam**

1-2: Develop a strategy/solution for communicating access updates for existing missions (i.e. when access conditions change, new availability etc.). Updates could be collected via the MIM database survey/CEOS Plenary. Also consider how foreign language data portals might be better advertised.

1-3: Explore the utility of an LSI-VC equivalent of the GFOI Space Data Portal. The plan should articulate the benefits for CEOS/LSI-VC.

2: Identify gaps in/opportunities for acquisition planning in support of the CEOS Carbon Strategy

2-1: Lead a survey on tools or processes used by space agencies to manage multiple different requirements and stakeholders, and present the results at SIT-31 in the form of a short report and presentation. This is currently limited to the identification of tools. The context is that CEOS lacks any management framework to understand its commitments and whether these can be met. CEOS is facing increasing demands, and is unable to respond to those demands in an informed manner due to a lack of information, and needs a way to assess the capacity and ability of agencies to meet the numerous thematic strategy requirements. **Due: SIT-31, Responsibility: Coordinated by ESA, all members of the LSI-VC to contribute. Bianca will initiate this Work Plan task by sending an email with example input from the ESA perspective.**

2-2: Define what constitutes a 'validated requirement' and ensure that there is enough specificity in the requirements being put forward in the various CEOS thematic strategies – starting with Carbon.

2-3: Review the parameters set out in the CEOS Carbon Strategy, and compile a statement of the satellites applicable to each (based on the guidance in the report). **Due: April 2016, Responsibility: Bianca to lead the initial assessment**

2-4: Initiate a meeting/teleconference with WGClimate. Ask them to comment on the requirements set out in the CEOS Carbon Strategy and their thoughts on the way forward for LSI-VC. Also ask them to

advance the general table initiated by Bianca for 2-3 by getting into more specific data requirements. LSI-VC Co-Chairs to contact WGClimate prior to their forthcoming meeting flagging overlapping interest and the need for a telecon to discuss this matter **Due: May (first contact), Q2 2016 (teleconference), Responsibility: LSI-VC Co-Chairs**

2-5: Compile a system-level summary of the workflow required for gap analyses of the CEOS thematic strategies (starting with Carbon). This initial system would consist of various CEOS tools (MIM database, COVE, etc.) and will assess the work required to link all of their inputs and outputs. This will define what needs to be done by each entity in order to make these systems work together to achieve the end goal. **Due: Q3 2016 (SIT Technical Workshop), Responsibility: CEOS SEO**

2-6: In coordination with WGISS, SEO to define a list of missing mission metadata and develop a strategy for how it might be acquired from CEOS agencies (perhaps using a metadata format recommendation which could be shared with CEOS agencies/commercial providers). This will require a specification of minimum metadata requirements as well as an assessment of CWIC metadata availability. **Due: Q2 2016, Responsibility: CEOS SEO**

3: Define intercomparable Analysis-Ready Data (ARD) products within the context of land surface imaging

3-1: Summarise current activities from CEOS agencies that relate to ARD – drawing on the work done on the SDCG Global Data Flows Study. The scope is surface reflectance, land surface temperature and an equivalent for radar. **Responsibility: LSI-VC members to contribute, Adam/Matt to initiate a Google Doc**

3-2: Working closely with other CEOS groups, review the current definitions of ARD and agree on key principles that define both optical and radar ARD (e.g. stackability, minimum requirements for geometric accuracy, provenance). **Due: May 2016 (initial version), July 2016 (reviewed by CEOS WG's), August 2016 (final version), Responsibility: LSI-VC members to contribute, Co-Chairs to assign sections to the appropriate experts within LSI-VC.**

3-3: Provide CEOS Plenary a summary report on the concepts and benefits of ARD, progress on/status of ARD production within CEOS agencies, challenges, and recommendations for 'CEOS Standard' ARD products.

4: Engage in the implementation of trial data cubes (from the perspective of the objectives of LSI-VC)

4-1: Compile a short report to CEOS Plenary on CEOS Data Cube activities and their relevance to the objectives of the LSI-VC. This could include a look back at what data sets are available via Data Cube

platforms, and how they apply to the objectives of LSI-VC and the CEOS thematic observation areas. This activity should be from the LSI-VC perspective (keeping in mind that a VC must integrate data from multiple sources) and draw upon and complement the work done in the Future Data Architectures (FDA) ad-hoc team – covering lessons learned from SEO pilot activities (costs, release procedures, shortcomings, etc.). **Due: SIT Technical Workshop (September 2016), Responsibility: Co-Chairs to choose a lead and call for a writing team, LSI-VC members to provide material.**

5: Long-term LSI-VC strategy and vision.

5-1: Develop a discussion paper on the strategy and vision for LSI-VC. This might, for example, consider how LSI-VC would integrate new activities (such as water), and cover topics such as the division of roles and responsibilities between stakeholders (GEO, requirement providers, CEOS AHT's and WG's, scientific community, commercial providers, etc.); the interface to the user community; and the representation of key stakeholders in LSI-VC. The paper should also consider the value proposition of LSI-VC, its aspirations, and available resources. **Due: Q2 2016 (first draft), Responsibility: Co-Chairs and other volunteers from LSI-VC.**

APPENDIX B

LSI-VC-1 Attendees

Organisation	Name
CSA	Paul Briand
CSA	Yves Crevier
EC/JRC	Zoltan Szantoi
ESA	Bianca Hoersch
GA	Adam Lewis
NASA	David Jarrett
NASA	Jeffrey Masek
NASA / CEOS SEO	Brian Killough
NASA / CEOS SEO	Kayla Fox
NASA / CEOS SEO	Paul Kessler
NASA / CEOS SEO	Sanjay Gowda
NASA / CEOS SEO	Shaun Deacon
NOAA	Kevin Gallo (remote)
SDCG/CEOS Chair Team	Matthew Steventon
USGS	Gene Fosnight
USGS	Thomas Cecere

APPENDIX C

LSI-VC-1 Actions Record – Updated 15th April 2016

No.	Action	Related CEOS Work Plan Items	Due Date/Status
LSI-VC-1-1	Gene and Kevin to investigate whether the Land Product Characterisation System (LPCS) could be presented at the upcoming WGCV-40 meeting in Canberra. Tom, Brian, Adam and Matt will be in attendance and could be called on to present on behalf of USGS.	VC-24	**OPEN** *WGCV-40 has passed. LSI-VC to consider other opportunities to present the LPCS, such as WGCV-41.*
LSI-VC-1-2	Tom to share the USGS Landsat ARD definition once it has been approved for release.	VC-24	**CLOSED** *Sent with 7th April teleconference agenda*
LSI-VC-1-3	Brian (SEO team) to confirm whether ALOS-1 metadata is retrieved from the ASF and to investigate with ESA the possibility of including European ALOS-1 holdings.	VC-25	*The SEO metadata for ALOS-1 was pulled from the Japanese G-Portal holdings. Since this mission is complete, we do not have any update mechanisms in place. If ESA desires that we add their ALOS-1 holdings, we will need to obtain that metadata.*
LSI-VC-1-4	Zoltan to share with Brian Killough and Adam Lewis: details of the JRC tool under development which calculates a prediction of seasonality based on phenology, and could be connected to the Data Cube via an API.	VC-24	**May 2016**
LSI-VC-1-5	Matt to circulate the current draft of the SDCG Global Data Flows Study.	VC-27	**COMPLETE**
LSI-VC-1-6	Brian Killough (with George Dyke) to summarise (for SIT-31) the current suite of CEOS commitments based on the various acquisition strategies that have been agreed and/or endorsed by CEOS.	VC-26	**SIT-31**

LSI-VC-1-7	Zoltan to share information on EC's work on biodiversity, which was undertaken in collaboration with GEO BON Working Group 3 (terrestrial ecosystem change).	–	**COMPLETE** *Nothing to report except that EC participated in workshops to define the Essential Biodiversity Variables and how to measure (some of) them with satellite data.*
LSI-VC-1-8	CEOS SEO to provide a plan covering their future development activities for CEOS web tools and services.	**VC-23**	**COMPLETE** *The SEO is planning to add the Sentinel-2A acquisition archive to COVE. No other updates are planned for COVE in 2016. Data Services will continue for Asia-Rice through the end of 2016. The SEO will explore data services options with the JECAM group.*
LSI-VC-1-9	CEOS SEO to develop a list of medium (10-100m) and moderate (250-1000m) resolution satellite data records measuring land properties relevant to carbon science and describe their data policies, measurement type, domain, time of record, resolution and other relevant product details. These initial results will be given to LSI-VC (Bianca Hoersch and Jeff Masek) as a basis for further linkage to the parameters set out in the CEOS Carbon Strategy.	**VC-23**	**COMPLETE** There are two CEOS actions (CARB-08-03 and CARB-08-04) that address public availability of historical moderate resolution and medium resolution satellite data records. The SEO has developed a spreadsheet that summarizes the mission/instrument combinations and data policies of missions relevant to carbon. There are many missions with restricted or fee-based access.
LSI-VC-1-10	Matt Steventon (with George Dyke) to follow up Tom Cecere and Brian Killough (potentially in Canberra during March) on the issues identified with the MIM database (around the incompleteness of instrument measurement assignments) and to consider how the MIM might be adapted in the future to better support the functionality required for gap analyses. A report should be provided back to LSI-VC.	**VC-23**	**April/May 2016**
LSI-VC-1-11	All to review the Land section of the CEOS Carbon Strategy.	**VC-23**	**April/May 2016**
LSI-VC-1-12	Co-Chair's to confirm the draft LSI-VC Work Plan tasks, add some context/background, and circulate for edits/feedback from the team.	–	**May 2016**

LSI-VC-1-13	Co-Chairs to identify key milestones and produce a calendar/timeline.	**–**	**April 2016**
LSI-VC-1-14	Matt to set up an LSI-VC Google Drive and invite LSI-VC members to join.	**–**	**April 2016**
LSI-VC-1-15	Co-Chairs to investigate the options for an LSI-VC-2 meeting some time in the September timeframe – preferably around a meeting that will have some representation from WGClimate.	**VC-23**	**COMPLETE** *LSI-VC-2 will be held during the week of July 18th at NASA Ames or in San Diego (dates and venue TBC)*
LSI-VC-1-16	Co-Chairs to organise a teleconference with WGClimate and solicit their feedback on our initial approach to addressing gaps and opportunities for acquisition planning in support of the CEOS Carbon strategy.	**VC-23**	**May 2016**
LSI-VC-1-17	Co-Chairs to assess the potential implications of the CEOS Water Strategy.	**VC-26**	**July 2016/LSI-VC-2**
LSI-VC-1-18	Adam to discuss future support from Symbios with Stephen Ward.	**–**	**COMPLETE**
LSI-VC-1-19	Members to bring the Copernicus next generation user requirements process to the awareness of their agencies: https://spacetec.typeform.com/to/jGtmco		**CLOSED**