

Systems Engineering Tools for International Satellite Data Discovery and Analysis

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JECAM Meeting
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- CEOS and SEO Background
- CEOS Mission Database
- CEOS Data Policies
- COVE Tool
- Future Tools
- Data Services Projects





The Committee on Earth Observation Satellites (CEOS) serves as a focal point for international coordination and data exchange to optimize societal benefit from space-based Earth observations. CEOS represents 22 countries through its 31 space agencies and 24 associate members.



CEOS agencies collaborate on a variety of international projects that address key global issues ...

Data Access (SDCG, Policies) ... Promoting space data use

Agriculture (GEOGLAM) ... Food Security

Deforestation (GFOI) ... Carbon and Deforestation

Climate Change (ECV Database) .. Global Climate Change

Disaster Management (WGDisasters)... Floods, Earthquakes

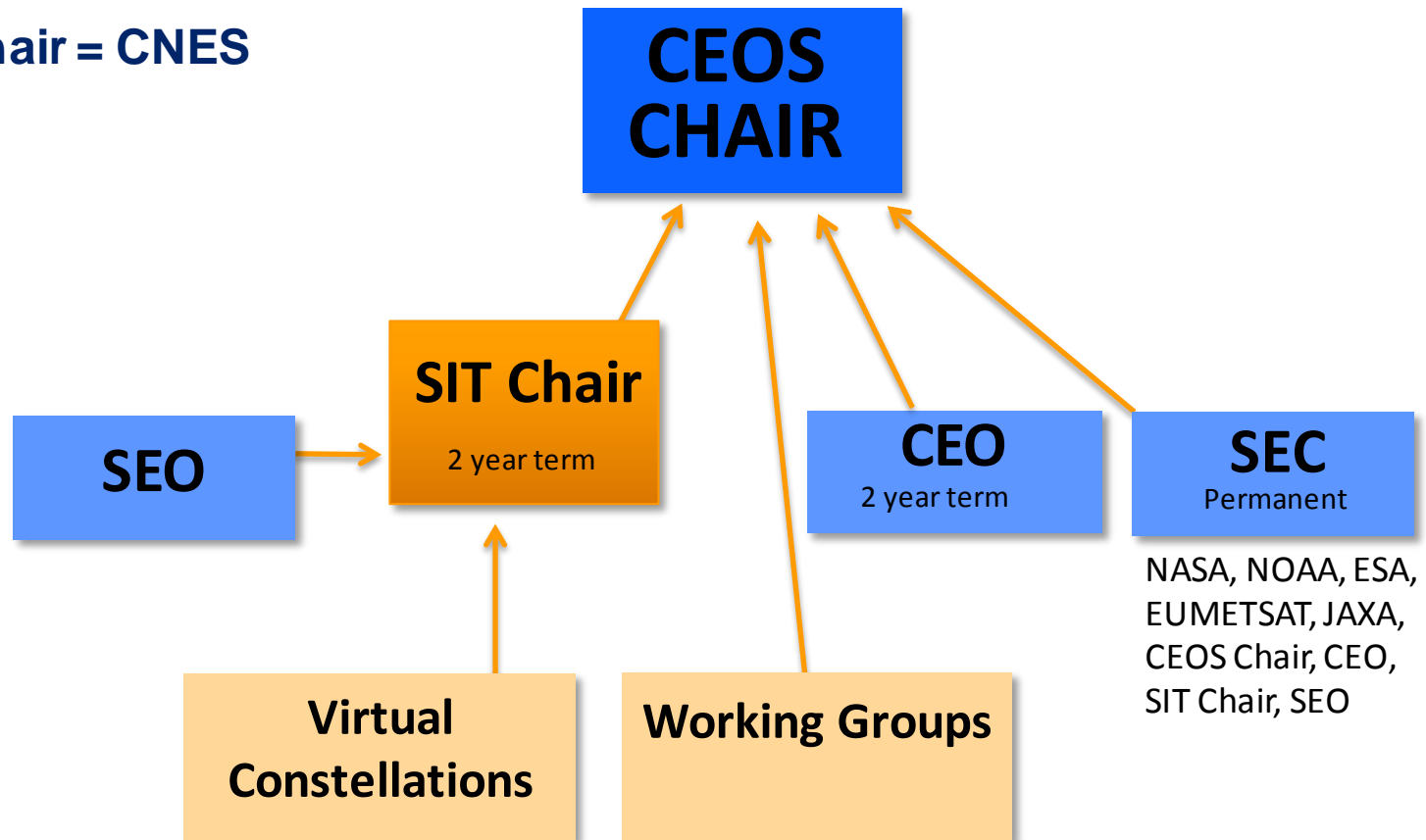




Current CEOS Chair = EUMETSAT (Germany)

Future CEOS Chair = JAXA (Japan)

Current SIT Chair = CNES



What is the SEO doing?



CEOS SEO Since 2007

Technical

- **COVE tool** - Data Acquisition Planning, Satellite Coverage Assessment
- **Space Data Coordination Group (SDCG)** - **GEOGLAM** (Agriculture and Food Security) and **GFOI** (Carbon/Deforestation)
- **Special Projects** – Data Services Prototypes, Data Policy Database
- **MIM** (Missions, Instruments, Measurements) Database ... with ESA
- Essential Climate Variable (**ECV**) Database ... with the Working Group on Climate

Management

- CEOS Website (under revision in 2014), Mailing Lists, Action Tracking
- Education Outreach (GEO, IGARSS)
- Training and Capacity Building (COVE training for SilvaCarbon, COVE conversion to Spanish)



- CEOS Mission, Instruments and Measurements (MIM) Database is the “official” database of agency missions (now and in the future).
- Developed by ESA, with support from NASA’s SEO.
- Details about agencies, launch dates, orbital parameters, instrument parameters (i.e., swath, bands, resolution, accuracy), and measurement applications.
- The community utilizes the MIM as the “best” site for Earth mission information.

CEOS MIM Database

Includes 259 CEOS missions



The screenshot shows the website header with the CEOS and ESA logos, the title 'THE CEOS DATABASE', and a navigation menu. The main content area is titled 'CEOS MISSION, INSTRUMENTS AND MEASUREMENTS DATABASE ONLINE' and contains a welcome message, a list of updates, and a table of contents for Agencies, Missions, Instruments, and Measurements.

CEOS MISSION, INSTRUMENTS AND MEASUREMENTS DATABASE ONLINE

Welcome to the CEOS Missions, Instruments and Measurements database online.

This database is updated annually based on a survey of CEOS member space agencies and has a number of applications:

- Information sharing in support of the coordination of future Earth observation mission, instrument and measurements plans.
- Earth observation measurement gap analysis - including that performed by the CEOS Systems Engineering Office (SEO).
- A connection between the Earth observation user community and satellite-operating agencies of CEOS.
- Generation of content for the print edition of *The Earth Observation Handbook*.

The most recent update of the database was completed in October 2013.

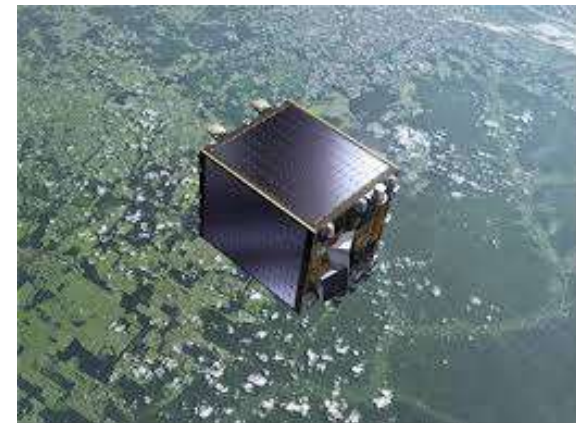
Agencies	Agency table with links to agency summary pages.
Missions	Table Searchable mission table with links to mission and instrument summary pages. Index An alphabetical list with links to mission summary pages.
Instruments	Table Searchable instrument table with links to instrument and mission summary pages. Index An alphabetical list with links to instrument summary pages.
Measurements	Overview An overview of the measurement categories and detailed measurements indexed in the database. Timelines Customizable measurement timelines with links to mission summary pages.

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Researched and written by Synbios



- CEOS agencies currently operate 118 missions and 286 instruments.
- 2014 = 8 planned CEOS launches
 - ESA – **Sentinel-1A**
 - NASA – **GPM Core**, **OCO-2**, SMAP
 - JAXA – **ALOS-2**
 - INPE/China – CBERS-4
 - KARI – KOMPSAT-3A
 - CNES – VENUS
(microsat for vegetation)



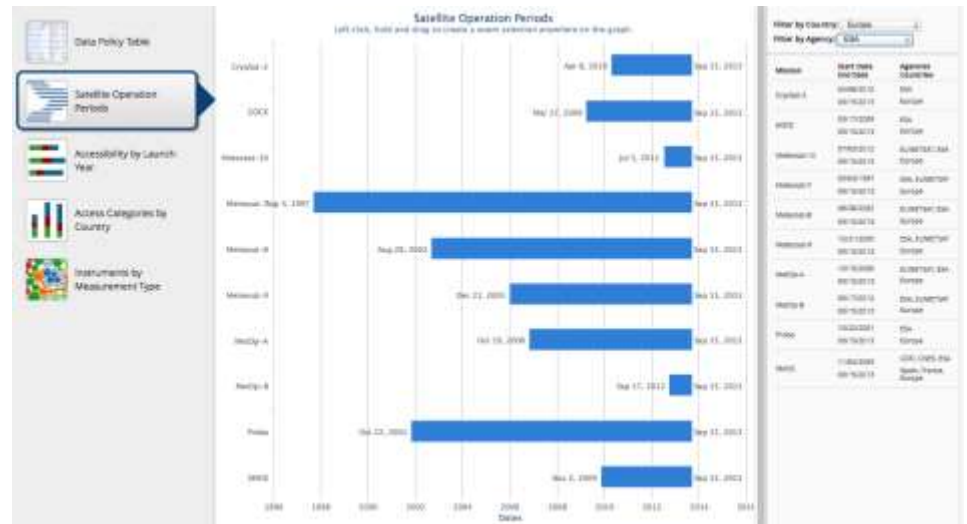


Access Summary

- ❑ Open (no registration) = 36%
- ❑ Open (simple registration) = 21%
- ❑ Open (advanced approval) = 5%
- ❑ Restricted = 33%
- ❑ Unknown = 5%

Comments

- ❑ This summary includes **205 missions** launched since 1990 and 615 mission-instrument combinations.
- ❑ **62%** of CEOS mission data is OPEN and accessible.





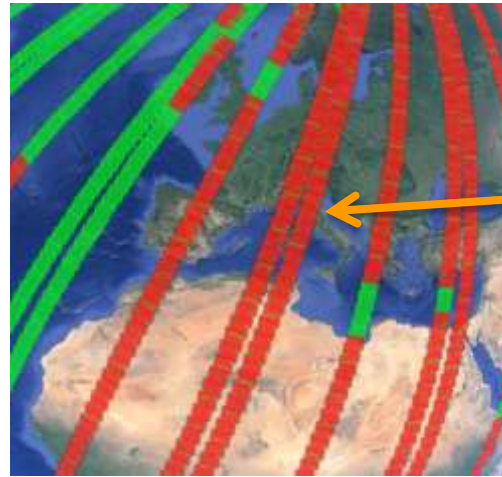
- Browser-based tool using **Google-Earth** to display satellite coverage swaths and calculate coincidence scene locations.
- Automated daily satellite position data from **CelesTrak**.
- Saved bookmarks and states, Google-Earth KML and Shapefile compatibility, collaborative sessions.
- **Output:** position, UTC time, viewing angles, solar angles, day/night, and EXCEL tables
- Large mission database: **237** missions, **644** Mission-Instrument combinations

Great tool to determine coincident satellite locations and conduct mission coverage assessments.

The screenshot shows the COVE web application interface. The main view is a globe with satellite coverage swaths overlaid. The left sidebar contains a 'Missions and Instruments' list with filters and a 'Cart' section. The top navigation bar includes 'Home', 'About', 'COVE Tool', 'Rapid Acquisition Tool', 'Mission & Instrument Browser', 'Forum', 'Help', 'Log In', and 'View Full Screen'. The bottom of the globe displays the text 'Data from: NOAA, U.S. Navy, WGA, JREBCO'.



- Links to **mission archives** for: Landsat 7/8, SPOT 1-6, Pleiades-1A/1B, and Radarsat-2 (some modes).
- 2D global output in JPEG format and KML output for Google Earth.
- Overlays for MODIS Land Cover, Landsat and Sentinel-2 data grids, and ASTER DEM.
- **Conversion to Spanish.**



Landsat 8, Aug 1-3, over Europe
 Green (potential), Red (actual)
 Browse ... over northern Italy on Aug 3, 2013



2D global map of Radarsat-2 (W3 mode) coverage on Aug 1, 2013



January 1-8, 2014 over Africa

[COVE Tool](#)
[Rapid Acquisition Tool](#)
[Coverage Analyzer \(BETA\)](#)
[Mission & Instrument Browser](#)
[Help](#)

[Español \(ES\)](#)
[Log In](#)
[View Full](#)

[Africa](#) | [Antartica](#) | [Asia](#) | [Australia](#) | [Europe](#) | [North America](#) | [South America](#)

Missions and Instruments

Alphabetical

- ASTER (Full Accessible) - 711 km
- MISR - 360 km
- CERES - 2717 km
- MODIS - 2330 km
- MOPITT - 640 km
- TerraSAR-X
- TSX-SAR (Full Range) - 622 km
- TSX-SAR (StripMap-SM) - 287 km
- TSX-SAR (ScanSAR (Full Accessible 20-60 deg)) - 578 km

Filter [more](#)

Time Span to

[Add Coincidence](#) [Add Ground Swaths](#)

[Add Actual Acquisitions \(BETA\)](#)

[Add Planned Acquisitions \(BETA\)](#)

Cart [Clear Cart](#)

SPOT-6: NAOMI (Standard) (Actual)

PLEIADES-1A: HiRI (Standard) (Actual)

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Google earth



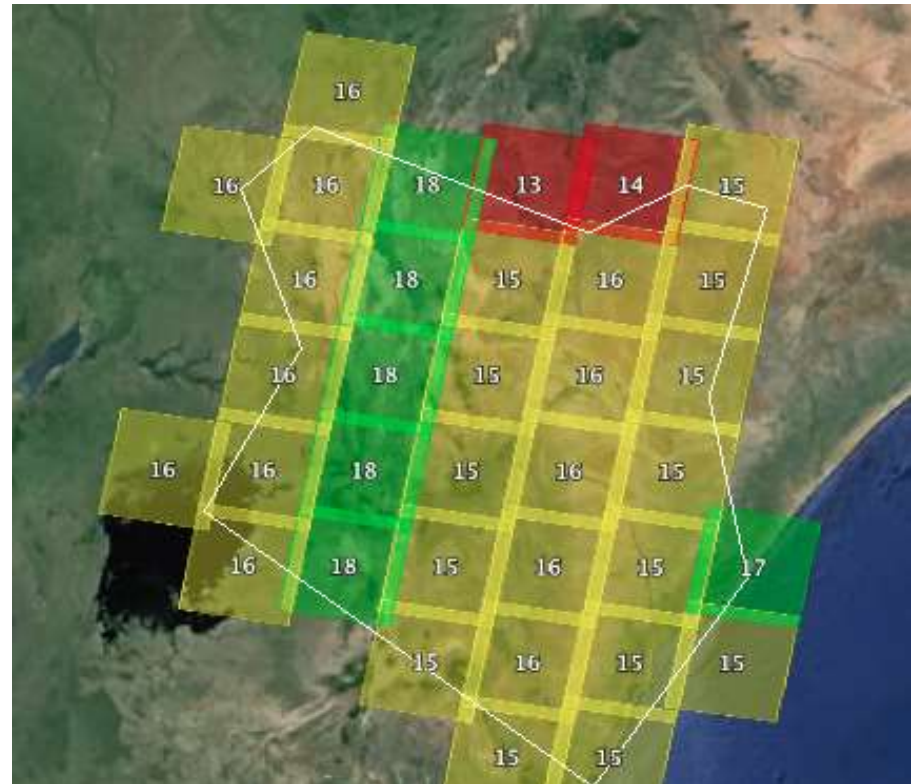
Coverage Analyzer (BETA)

New analysis tool for archive analyses. Users select the date range, region, grid size (or fixed Landsat WRS) and cloud cover threshold.

Output shows the number of acquisitions meeting the criteria within that region.

Tabular output is coming soon

...



Landsat-8 total acquisitions in 2013 over Kenya, <20% cloudy, Level-1T processed

NOTE: Colors ranges can be defined by the user.
Still in early BETA testing



- **Demo ...** Search for potential Landsat-7 images over El Zapotillo, Sinaloa, Mexico in late 2013 (Oct, Nov, Dec).
- Run COVE using the ...
Rapid Acquisition Tool
- Mission: Landsat 7 (ETM),
Dates: Sept 15-30, 2013,
Region: El Zapotillo, Sinaloa,
Mexico (custom),
Compute Acquisitions ...



Severe flooding in Zapotillo, Sinaloa, Mexico from Tropical Storms Ingrad and Manuel - **Sept 21, 2013**



- **Results:** 7 potential acquisitions found over El Zapotillo, Sinaloa, Mexico in late 2013. 2 are duplicates.
- Oct 6, Oct 22, Nov 7, Nov 23, Dec 9, and Dec 25

Landsat 7 ETM over
The Landsat World Reference System was used for this mission.

Mission	Time	Lat	Lon	Path	Row	Solar Zenith	Solar Azimuth	Daylight	Region Incidence Angle Range	Region Viewing Azimuth Angle Range	TLE Date
1 Landsat 7 - ETM (from TLE)	2013-OCT-06 17:25:30.0 (UTC)	23.0	-106.1	31	44	35.4	140.5	true	-0.3 to 3.9	121.8 to 218.2	2013-OCT-06 18:21:30 (UTC)
2 Landsat 7 - ETM (from TLE)	2013-OCT-22 17:25:30.0 (UTC)	23.0	-106.1	31	43	39.9	147.0	true	-0.4 to 3.8	120.1 to 208.0	2013-OCT-22 18:21:40 (UTC)
3 Landsat 7 - ETM (from TLE)	2013-NOV-07 17:25:30.0 (UTC)	23.0	-106.1	31	43	44.3	151.0	true	-0.3 to 3.9	118.8 to 197.8	2013-NOV-07 06:49:34 (UTC)
4 Landsat 7 - ETM (from TLE)	2013-NOV-23 17:25:30.0 (UTC)	23.0	-106.1	31	43	48.2	152.7	true	-0.1 to 3.9	117.8 to 181.4	2013-NOV-23 18:21:50 (UTC)
5 Landsat 7 - ETM (from TLE)	2013-NOV-23 17:26:30.0 (UTC)	22.9	-106.1	31	45	48.0	153.0	true	-0.3 to 3.5	119.2 to 188.9	2013-NOV-23 18:21:50 (UTC)
6 Landsat 7 - ETM (from TLE)	2013-DEC-09 17:26:30.0 (UTC)	23.0	-106.1	31	45	50.9	152.8	true	-0.4 to 3.8	117.0 to 181.1	2013-DEC-09 18:21:57 (UTC)
7 Landsat 7 - ETM (from TLE)	2013-DEC-25 17:26:30.0 (UTC)	23.0	-106.1	31	45	52.1	151.1	true	-0.3 to 3.8	116.4 to 175.2	2013-DEC-25 18:22:00 (UTC)



Landsat-7 image over El Zapotillo on Oct 6, 2013. Cloudiness = 17% (browse image on right)





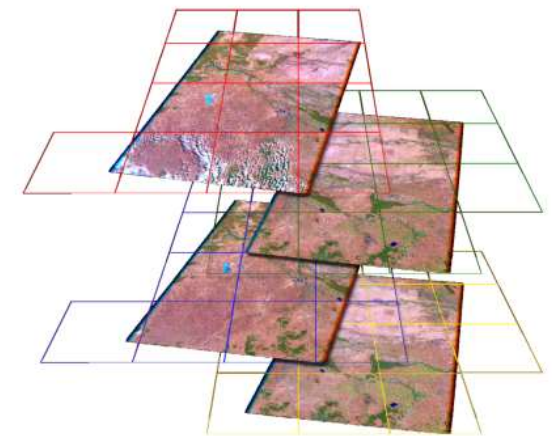
Google Earth Engine

- The SEO is developing an interface for Google Earth Engine using an API. This tool will allow users to analyze Landsat 7 and Landsat 8 images in detail. The system will allow processing of images to surface reflectance (LEDAPS), cloud masking, and the creation of cloud-free mosaics.



“Data Cubes”

- The SEO is working with Geosciences Australia on a “data cube” concept for enhanced use of Landsat data in Tanzania. “Data Cubes” will allow users to query data (via an API) in time and space without the need to download individual scenes. Band-level data and cloud information is stored in “stacks” to allow easy analysis.





GFOI	GEOGLAM	Pilot Project Name	Key Participants	Countries	Datasets
X		FAO Pilot for UN-REDD	SEO, FAO, KSAT, Norway	Ecuador, Tanzania, Uganda	Landsat-7 2013 Only (16TB)
X		Kenya Pilot	SEO, CSIRO, Clinton Foundation	Kenya	Landsat-7/8 66 Scenes (128GB)
X		Colombia DEM Pilot	SEO, SilvaCarbon, DLR	Colombia	TanDEM-X 24 Tiles (31GB)
	X	Asia-RICE Pilot	SEO, AXA	Indonesia	Radarsat-2 35 Scenes (210GB)
X	X	Data Cube Pilot	SEO, Geoscience Australia	Tanzania	Landsat-7/8 and MODIS (all history)
	X	JECAM Pilot	SEO, JECAM	TBD	TBD



- The SEO is working directly with UN-FAO and KSAT (funded by Norway) to develop a pilot **Space Data Management System (SDMS)** for **Ecuador, Uganda and Tanzania** to support UN-REDD.
- The planned features of this prototype are ...
 - Password protected (secure) access for each country with separated country data
 - Ability for countries to download and upload datasets
 - Dedicated storage for Landsat datasets. Initially populated with only 2013 **Landsat-7** data over each country for testing and evaluation.
 - Web-based image visualization
 - Cloud computing processing with OpenForis toolset and additional FAO analysis tools.
 - Data archive search and discovery of Landsat using the COVE tool. Also provide a link to the USGS data ordering tool for data access.
- Follow-on 3-year proposal under evaluation at FAO to expand the SDMS to 13 more REDD+ countries.



- The SEO is working directly with Stephen Ward (contracted to CSIRO) and Mwangi Kinyanjui (Kenya) to develop a data services prototype for **Kenya**. This project is also supported by the Clinton Foundation. The features of this prototype will include ...
 - Password protected (secure) access for Kenya users.
 - Space-based datasets
 - Initially upload Landsat 7 and Landsat 8 scenes from 2013/2014*
 - Consider adding more Landsat datasets for <2013 annual mapping*
 - Investigate SPOT datasets (over 5 years old) to fill gaps in Landsat*
 - Investigate options for cloud masking and the production of cloud-free mosaic scenes. - **FUTURE**



The SEO is working directly with Sylvia Wilson (USGS, SilvaCarbon), Edersson Cabrera Montenegro (Colombia) and Gustavo Galindo Garcia (Colombia) to develop a data services prototype for **Colombia**. The features of this prototype will include ...

- Password protected (secure) access for Colombia users.
- Download and upload capability of datasets.
- Dedicated storage for TanDEM-X DEM datasets acquired through the Intermediate DEM (IDEM) Announcement of Opportunity (closed March 18). The SEO submitted a proposal to TanDEM-X, but a decision is pending.
- IDEM datasets will cover 8 tiles over Colombia (see figure). Each tile location will provide 3 DEM resolutions ... 12-meter, 30-meter, and 90-meter.
- Total data storage ... 24 tiles, 1.3 GB each = 31 GB
- Cloud computing processing capability to allow local users to test SAR data processing tools (e.g., Gamma Modular SAR Processor) on locally stored datasets.

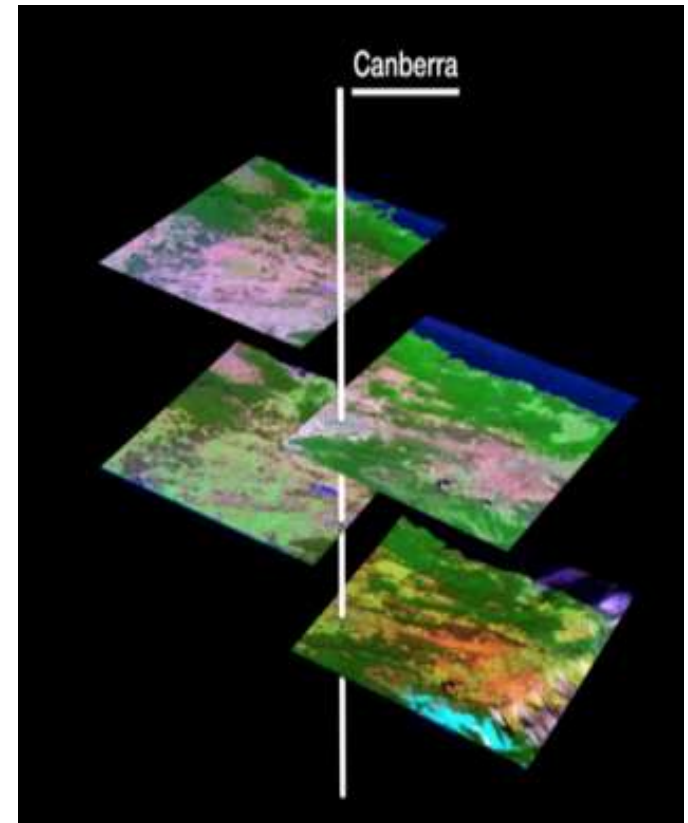




- The SEO is working directly with the **Asia-RiCE** team (Shin-ichi Sobue) and Yves Crevier (CSA) to develop a data services prototype for **Indonesia**. The features of this prototype will include ...
 - Password protected (secure) access for Indonesia Asia-RiCE science users.
 - Download and upload capability for datasets and analysis products.
 - Dedicated storage for up to **35 Radarsat-2 images**, provided by CSA.
Estimated storage space is ~6GB per scene, for Wide-Fine (FOW2) dual-pol images. Total storage space is ~210GB.
 - Cloud computing processing capability to allow JAXA to run SAR processing tools on remote servers for enhanced performance.



- The SEO is working directly with Geoscience Australia (Jonathon Ross) to develop a data services prototype for **Tanzania** that uses the “Data Cube” concept. The features of this pilot study will include ...
 - Ability to support both GFOI (forest cover) and GEOGLAM (agriculture).
 - Supercomputer will develop a data cube for all historical Landsat (5,7,8) and MODIS over Tanzania, stacked in space and time and band, similar to the approach used in Australia.
 - An Advanced Programming Interface (API) will be developed to allow users to conduct queries on the data cube and generate products, such as forest cover report (change detection), crop maps, etc.





- The SEO would like to conduct a pilot study with the JECAM team (Ian Jarvis and Pierre Defourny) to develop a data services prototype for a few **JECAM test sites**. The features of this prototype will include ...
 - Password protected (secure) access for each JECAM science user with the ability to share data and tools across test sites. Data for each test site will be separated in site-based folders.
 - Dedicated storage for currently utilized datasets, including those purchased commercially (if license agreements allow).
 - Cloud computing processing capability to allow users to run analysis tools on local datasets.

JECAM needs to define the test sites, datasets and processing tools. We will also need to discuss data access and user license agreements. **Coming on Wednesday ... Open Data Sharing Solutions**



- CEOS Website: <http://www.ceos.org>
- MIM Database: <http://database.eohandbook.com>
- COVE Tool: <http://www.ceos-cove.org>
- Data Policy Portal: <http://www.ceos-datapolicy.org>



The End