

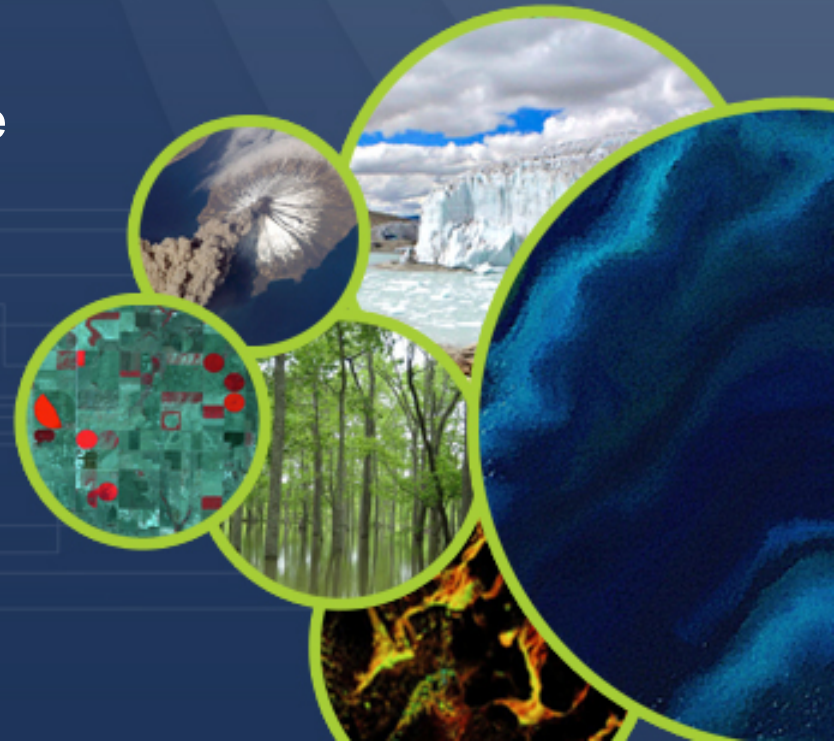


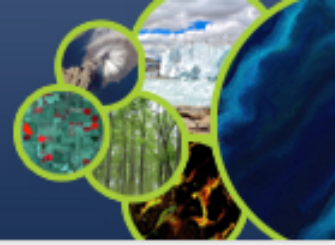
# CEOS Tools and Data Services for Enhanced Access, Analysis and Interoperability of Climate Datasets

Brian Killough  
Head, CEOS Systems Engineering Office  
NASA

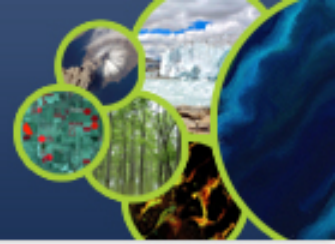
NOAA Climate Data Record Annual Meeting  
August 5, 2015

[www.ceos.org](http://www.ceos.org)





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** ... Promoting space data use

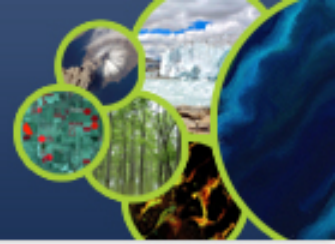
**Agriculture** ... Global Food Security (GEOGLAM, UN-FAO)

**Deforestation** ... Carbon and Deforestation (GFOI, UN-REDD)

**Climate Change** ... Global Climate Change (UNFCCC)

**Disaster Management** ... Floods, Earthquakes (UNISDR)





## Enhanced Access ...

- **CEOS Data Policy Portal** ([www.ceos-datapolicy.org](http://www.ceos-datapolicy.org))
- **CWIC Tool** ([ceos.org/ourwork/workinggroups/wgiss/projects/cwic/](http://ceos.org/ourwork/workinggroups/wgiss/projects/cwic/))  
Managed by the CEOS Working Group on Information Systems and Services (WGISS) ... common standards for searching satellite data collections

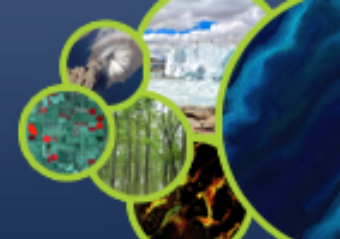
## Enhanced Analysis ...

- **COVE Tool** ([www.ceos-cove.org](http://www.ceos-cove.org))
- **MIM (Mission, Instrument and Measurement) Database** ([www.eohandbook.com](http://www.eohandbook.com)) ... Managed by ESA with support from CEOS-SEO. Represents all CEOS agency current missions and future mission plans.

## Enhanced Interoperability ...

- **Essential Climate Variable (ECV) Inventory** ([www.ecv-inventory.com](http://www.ecv-inventory.com))  
Managed by the CEOS-CGMS Joint Working Group on Climate
- **CEOS Data Cube** ([www.ceos-cube.org](http://www.ceos-cube.org)) ... **NEW in July 2015**





CEOS Data Policy [Home](#) [Data Explorer](#) [Labs](#) [Reference Library](#) [Contact](#)

## Data Explorer

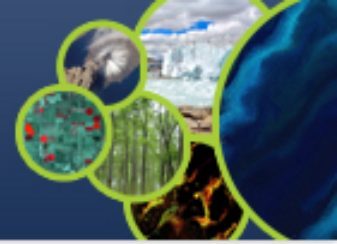
Data Policy Table

Show  entries
 Search: 
[Show / hide columns](#)
[CSV](#)
[PDF](#)
[Filter Results](#)

Mission	Mission Agency	Launch Date	Mission Status	Instrument	Instrument Agencies	Access	IDN	Client Portal	Access Comments
ALOS	JAXA	2006-01-24	DECOMMISSIONED	AVNIR-2	JAXA	Restricted	<a href="#">Link</a>	<a href="#">Cross-EX / Pegasus / ESA Earthnet</a>	Paid for service, requires.....MORE
ALOS	JAXA	2006-01-24	DECOMMISSIONED	PALSAR	JAXA,METI	Restricted	<a href="#">Link</a>	<a href="#">Cross-EX / Pegasus / ESA Earthnet</a>	Paid for service, requires.....MORE
ALOS	JAXA	2006-01-24	DECOMMISSIONED	PRISM	JAXA	Restricted	<a href="#">Link</a>	<a href="#">Cross-EX / Pegasus / ESA Earthnet</a>	Paid for service, requires.....MORE
BIRD	DLR	2001-10-22	DECOMMISSIONED	HSRS	DLR	Open-AP		<a href="#">DLR Catalog</a>	ESA Space Data Set.....MORE
BIRD	DLR	2001-10-22	DECOMMISSIONED	WAOSS-B	DLR	Open-AP		<a href="#">DLR Catalog</a>	ESA Space Data Set.....MORE
CryoSat-2	ESA	2010-04-08	IN ORBIT	SIRAL-2		Open-SR		<a href="#">EarthNet (CryoSat FTP)</a>	Requires registration and.....MORE
CryoSat-2	ESA	2010-04-08	IN ORBIT	DORIS-NG	CNES	Open		<a href="#">CDDIS (FTP)</a>	Anonymous FTP
Envisat	ESA	2002-03-01	DECOMMISSIONED	AATSR	UKSA	Open-SR	<a href="#">Link</a>	<a href="#">EOLI / MERCI</a>	Eoli-sa and MERCI require.....MORE
Envisat	ESA	2002-03-01	DECOMMISSIONED	AATSR	ESA	Open-SR	<a href="#">Link</a>	<a href="#">EOLI</a>	Eoli-sa and EFWS

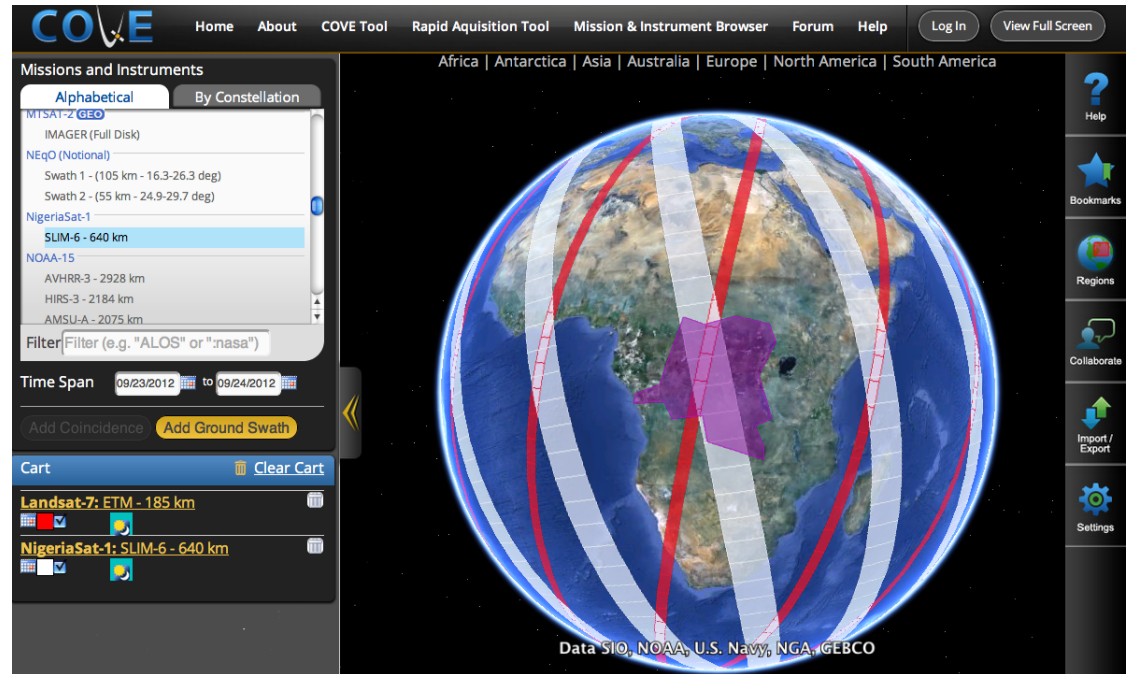
## Data Summary

- Open Access = 62% , Restricted or Unknown = 38%
- CEOS Agencies are currently operating **134 missions**
- Database includes **352 missions** launched since 1990 and 650 mission-instrument combinations.
- Tool includes direct links to primary data portals.

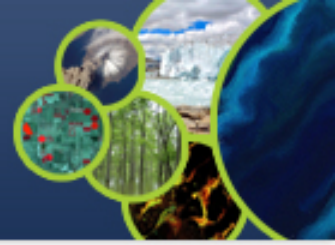


- **Free and Open** browser-based tool using **Google-Earth** to display satellite coverage swaths and calculate coincidence scene locations.
- Automated daily satellite position data from **CelesTrak**.
- Saved bookmarks and states, Google-Earth KML and Shapefile compatibility, collaborative sessions.
- Output: position, UTC time, viewing angles, solar angles, day/night, and EXCEL tables
- Large mission database: **254 missions, 692 Mission-Instrument** combinations

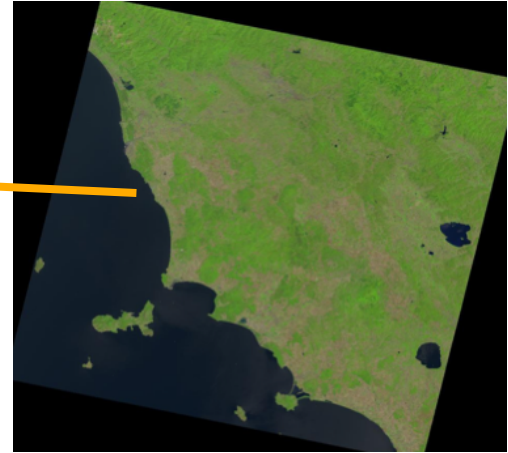
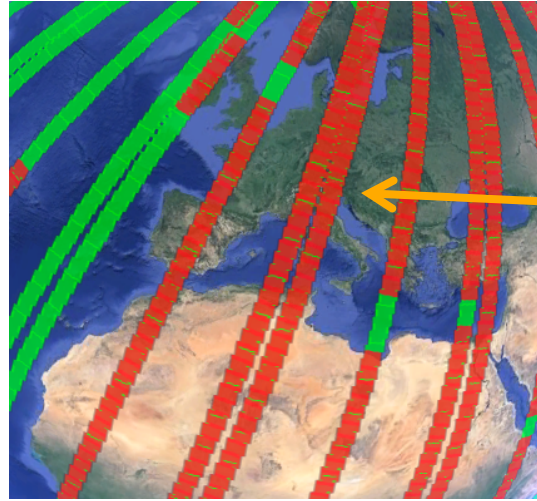
Calculate coincident satellite locations and past and future mission coverage.



>20,000 unique users in 2014.

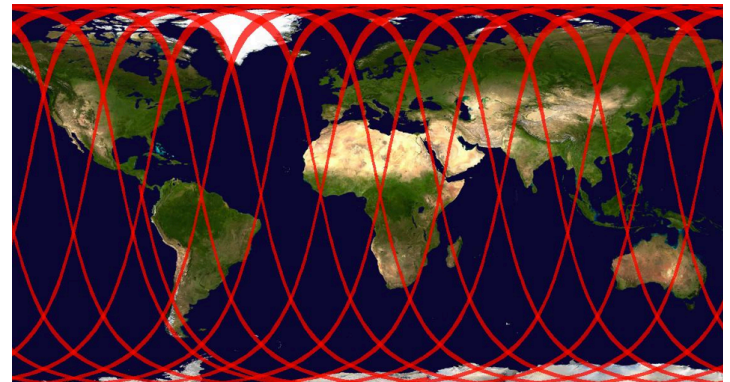


- **Data Overlays:** Landsat tiles, Sentinel-2 tiles, ASTER DEM, GlobCover, MODIS LCC.
- **Future Overlays:** Vegetation Phenology
- **Data Archive Links:** Landsat 7/8, SPOT 1-6, Pleiades-1A/1B, Radarsat-2, ALOS-1
- **Future Data Archive Links:** Envisat, ERS-1/2, Sentinel-1A/2A.
- 2D global output in JPEG format and KML output for Google Earth
- Spanish version available.

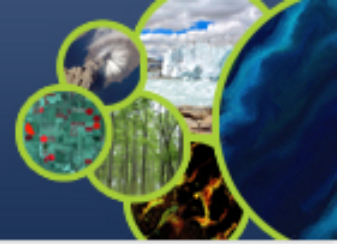


Landsat 8, Aug 1-3, 2013 over Europe  
Green (potential), Red (actual)  
Browse ... Northern Italy

2D global map  
of Radarsat-2  
on Aug 1, 2013







## January 1-8, 2014 over Africa ... Data Acquisitions

COVE

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

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

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

terr

more

Time Span

1/1/2014

to

1/8/2014

Add Coincidence

Add Ground Swaths

Add Actual Acquisitions (BETA)

Add Planned Acquisitions (BETA)

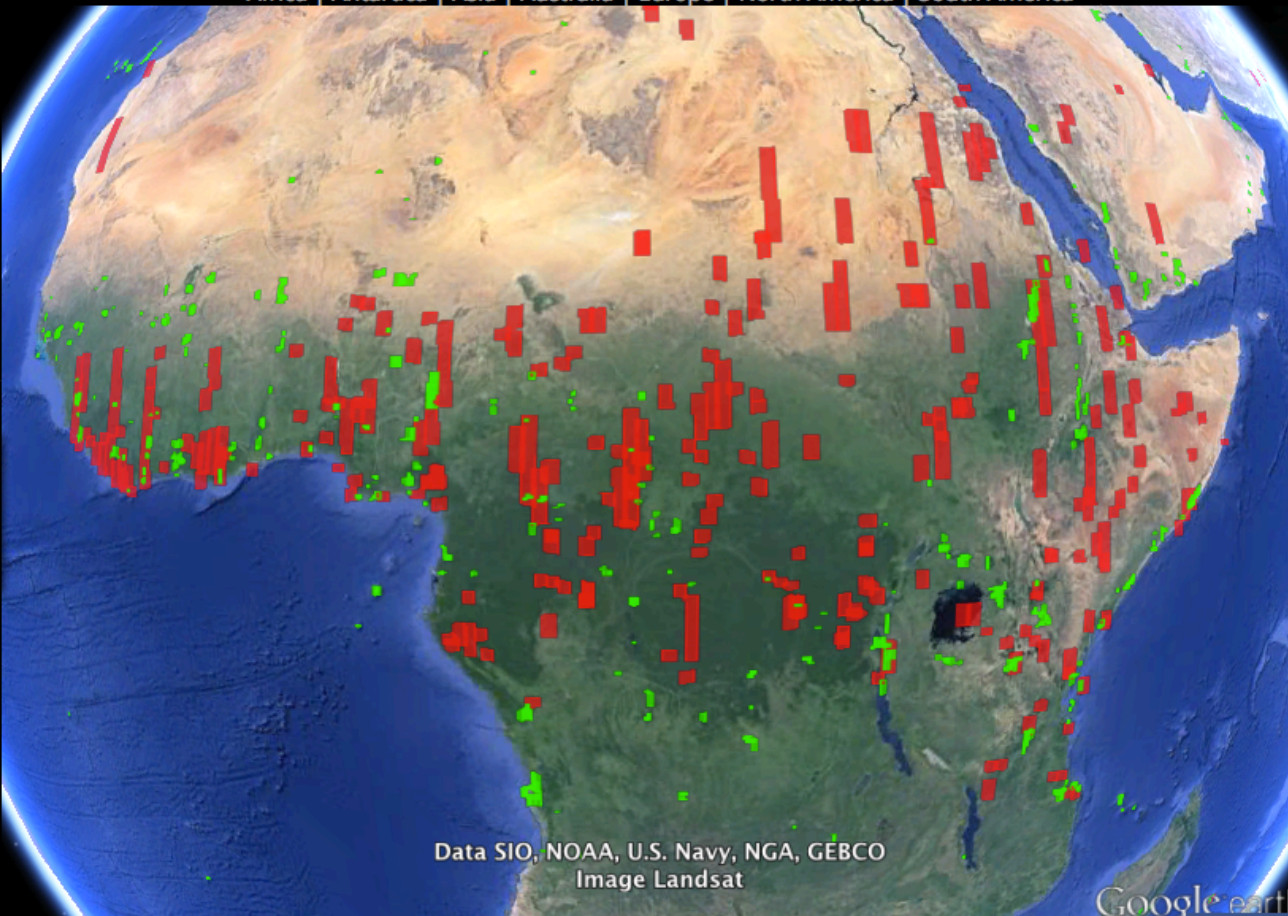
Cart

Clear Cart

SPOT-6: NAOMI (Standard) (Actual)

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

Africa | Antartica | Asia | Australia | Europe | North America | South America



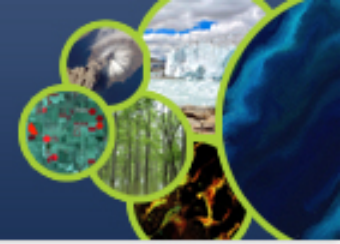
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image Landsat

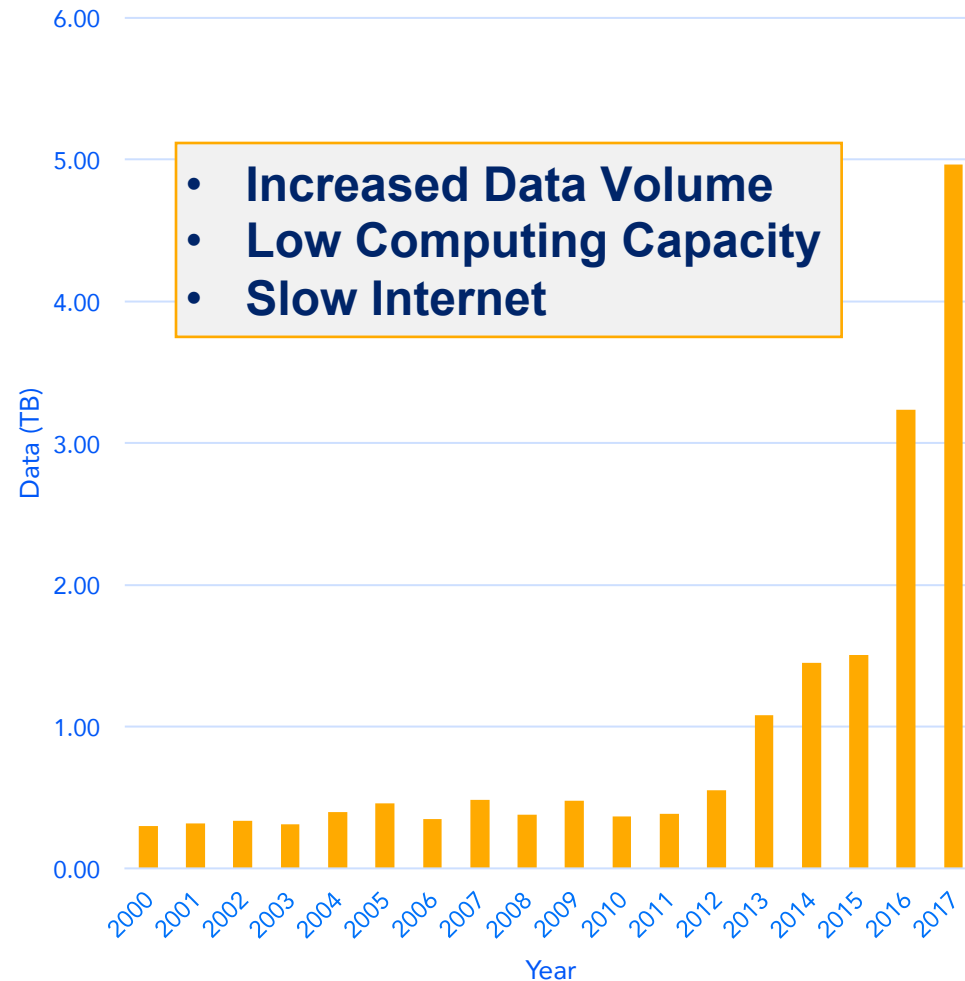
Google earth



# We have a growing space data problem ...

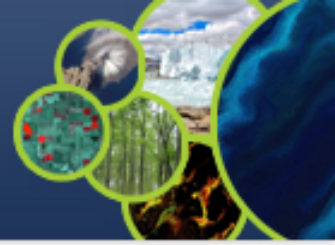


## Land Imaging Data Growth over Kenya



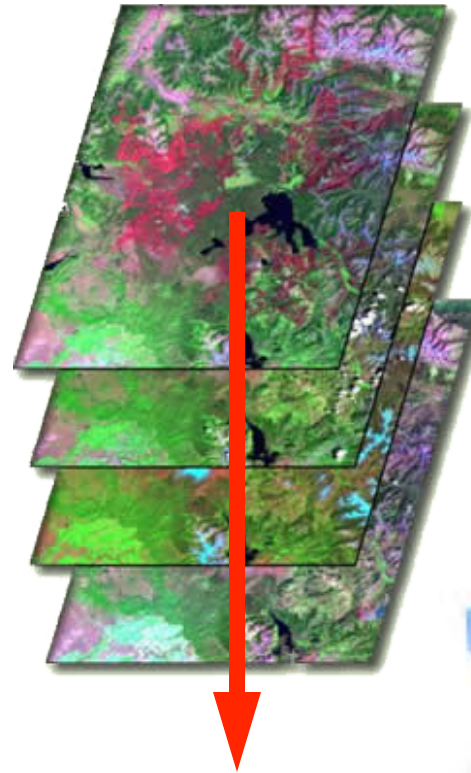
- A significant growth in land imagery data (optical and radar) from Landsat (NASA/USGS) and Sentinel (EC/ESA) will increase data volumes by >10 times in the next few years.
- Kenya could have 5TB of annual Landsat and Sentinel-2 data by 2017.
- **Recent testing** ... Processing a scene takes ~1 minute in U.S. and ~1 hour in Kenya. Downloading a scene takes ~6 seconds in U.S. and ~30 minutes in Kenya.
- Kenya says it spends 90% of its time getting the data and processing it.

**We need a better solution ...**



- Proven concept in Australia by Geoscience Australia and the Australian Space Agency (CSIRO).
- A multi-dimensional (space, time, data layers) **Data Cube** is an efficient and effective solution!
- **Shift in Paradigm** ... Pixels vs Scenes (no pixels lost)
- **Analysis Ready” Data** Products vs. Unprocessed Data (leave processing to the Space Agencies).
- **Data Cube** approach supports an infinite number of applications, makes it easier for users to access and use space-based data, and allows efficient time series analyses and data assimilation.

## Data Cubes!



**TIME**

**Data Layer #1**

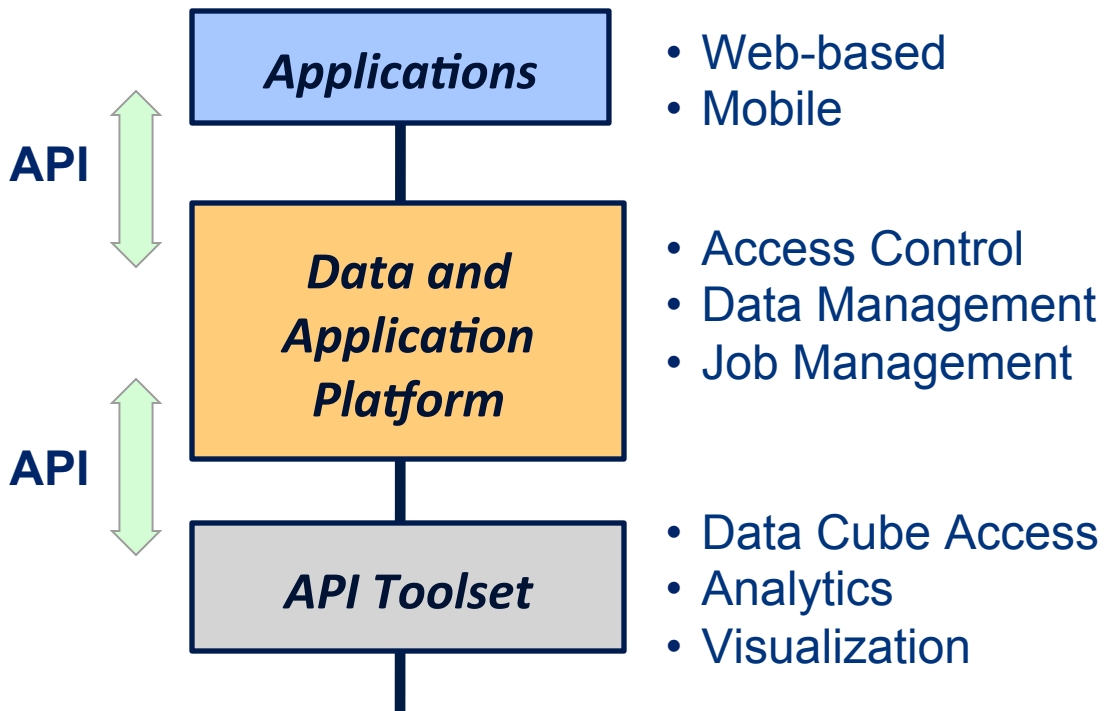
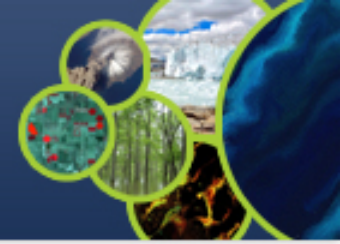
**Data Layer #2**

**Data Layer #3**

**Data Layer #4**



# General CEOS Data Cube Architecture



## CEOS is developing ...

A flexible Data Cube architecture that supports infinite user applications, increasing and diverse datasets (**space and in-situ**), local or cloud-based deployment, and automated ingestion of new datasets.

**Open Source** software to allow free and open access, Advanced Programming Interface (API) access, future data and capability growth, and commercial opportunities.



**Data Cube**

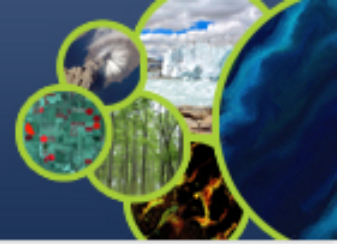
**Analysis-Ready Data Products**

**Space Agency**



**Satellite**

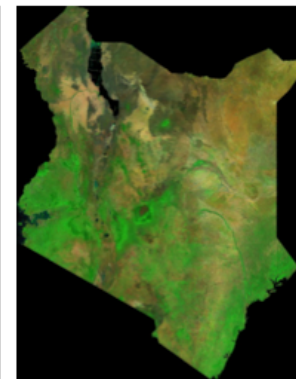




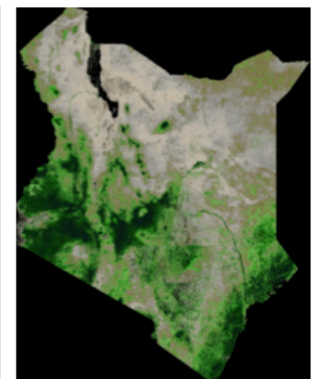
- We have created **two operating versions of the Kenya Data Cube**. One is deployed on the Amazon Cloud and one is deployed on a local computer.
- Historic Landsat-7/8 data (**7500+ scenes**) from 2000 to 2014 was obtained from USGS (11.5TB uncompressed, SR products). Pixel information was extracted and compressed into a 3.6TB Data Cube. The Data Cube **uses 1/3 less storage** to gain access to the same pixel information. Application algorithms can be run directly on the compressed Data Cube.
- We have demonstrated a reference a user interface that can generate a cloud-free mosaic and run simple algorithms (e.g., Tasseled Cap Index, NDVI)
- The team continues to improve the data ingestor software, the data analysis software and user interface. Following NASA internal approval of Open Source release, the tools will be available to anyone (for free) to develop their own data cube and user interface.



Natural Color

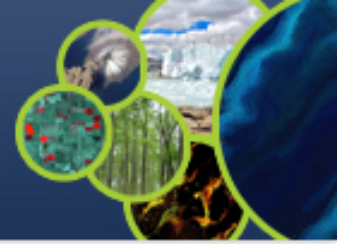
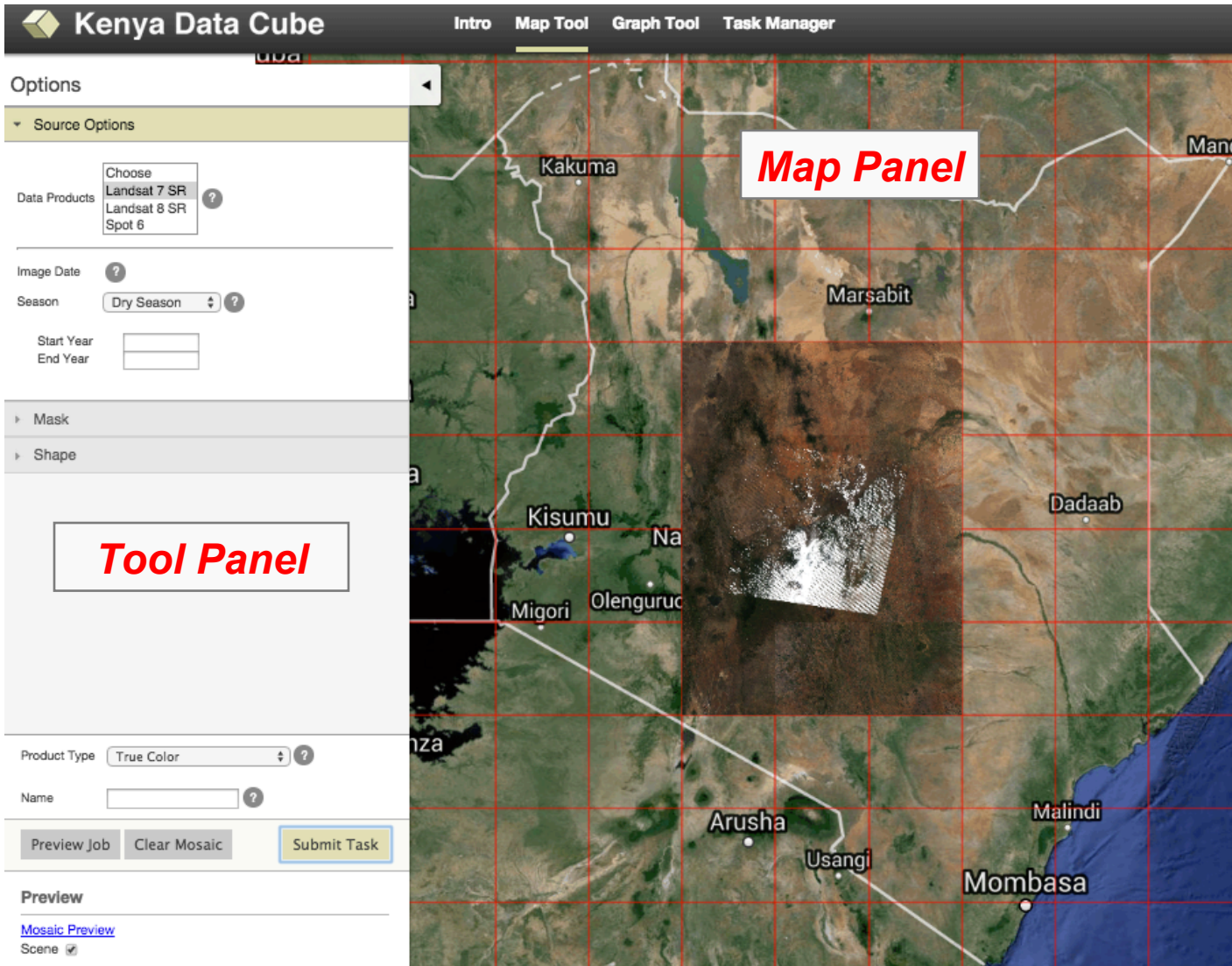


False Color (7,4,2)



NDVI

# Kenya Data Cube User Interface Demo

The screenshot displays the Kenya Data Cube User Interface. The top navigation bar includes links for Intro, Map Tool, Graph Tool, and Task Manager. The interface is divided into two main sections: the Map Panel and the Tool Panel.

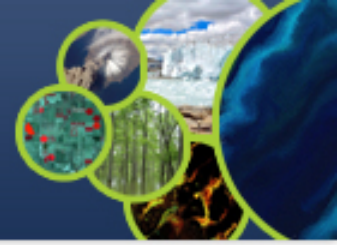
**Map Panel:** This panel shows a satellite map of Kenya with a red grid overlay. A white box labeled "Map Panel" is placed over the map. The map includes labels for various locations: Kakuma, Marsabit, Dadaab, Kisumu, Na, Migori, Olenguruc, Arusha, Usangi, Malindi, and Mombasa.

**Tool Panel:** This panel contains several options for data selection and processing. It includes a "Source Options" dropdown menu with a "Choose" button and a list of data products: Landsat 7 SR, Landsat 8 SR, and Spot 6. There are also fields for "Image Date", "Season" (set to "Dry Season"), "Start Year", and "End Year". Below these are sections for "Mask" and "Shape". At the bottom, there are buttons for "Preview Job", "Clear Mosaic", and "Submit Task". A "Preview" section at the very bottom includes a "Mosaic Preview" link and a "Scene" checkbox.

- Selectable data products could include **BOTH space and in-situ data layers**
- Interface will create cloud-filtered mosaics and create custom analysis products
- Output will be JPEG or GEOTIFF files for input into the user workflow
- Data Cube content and User Interface is customizable using Open Source Software

# GEO Plenary 2015

## “In Situ” Side Meeting



- A “Non Space-based Observations Coordination Side Meeting” is planned for November 10, 2015 (TBD) at the GEO Plenary meeting in Mexico City, Mexico.  
**YOU ARE INVITED ... Open Meeting**
- There is no global group responsible for non space-based coordination, such as CEOS for space. The European community (mostly EEA and Copernicus) have been the leaders.
- A new GEO Foundational task (GD5) is proposed for “Non Space-based Observation Resources” Previously, this task was included in the GEO Infrastructure (IN-01) task, “Earth Observations”, led by Brian Killough (NASA, CEOS). It is now proposed to separate space and non-space coordination in the new GEO Foundational Task plan to allow the community to become more organized, focused and achieve greater success.
- **Meeting Objectives:** CEOS has agreed to work with GEO to develop a detailed task plan for the new non space-based foundational task (GD5, GEOSS non Space-based Earth Observation Resources) and complete a report to define the state of global coordination and recommendations for the future.

