# Element 2: Country-specific Space Data Services

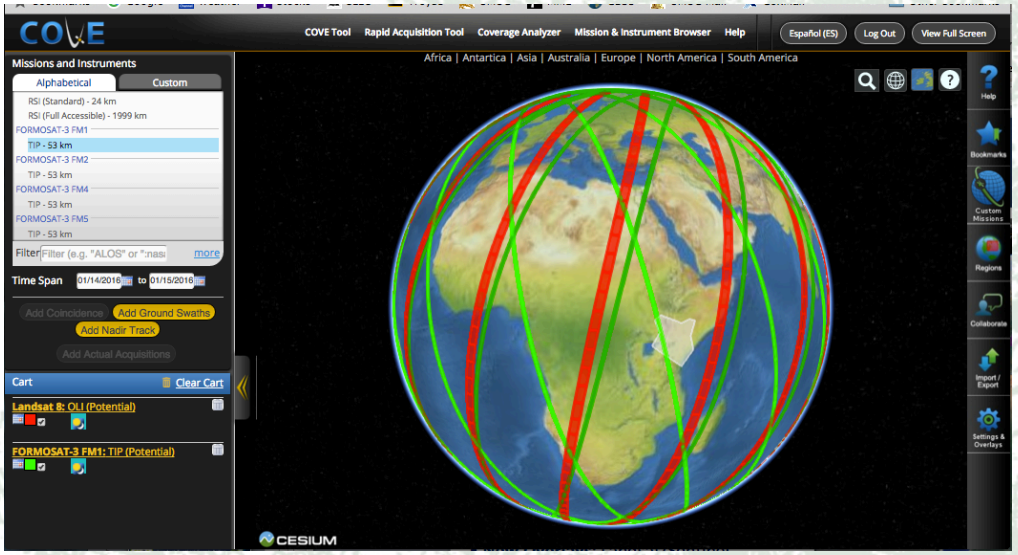
*Brian Killough / NASA, CEOS SEO*

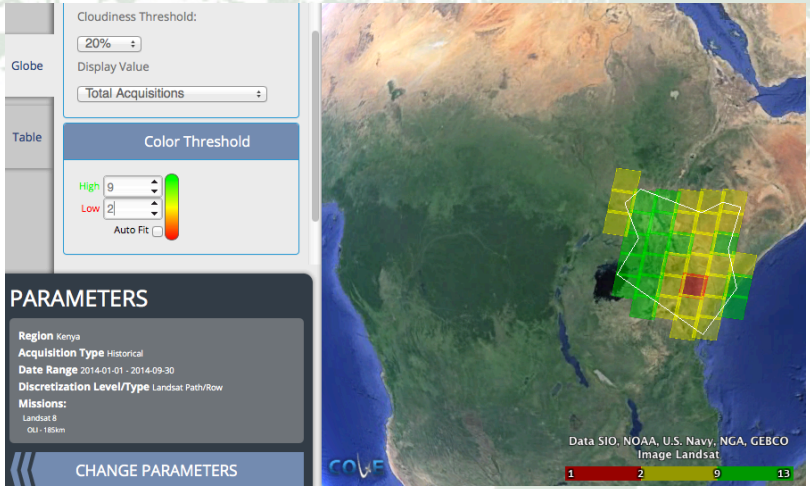
*SDCG-9 Session #XX, Agenda Item #XX*

# COVE Tool

www.ceos-cove.org

- 260 missions, 705 mission-instrument combinations. 5800+ unique users in 2015. The tool is FREE and Open!
- **January 2016**: Changed from Google Earth to Cesium for globe interface and added new Custom Mission Tool.
- **New Missions**: Sentinel-1A/2A, CBERS-4, RCM 1-3 (notional), FY-3C, PROBA-V, TET-1.
- **Current Archive Links**: Landsat, SPOT, Pleaides, Radarsat-2, ALOS-1, TerraSAR-X. Coming soon: Sentinel-1A and Sentinel-2A.
- **New Overlays**: Landsat/Sentinel constellation revisit performance, Global Phenology (2001/2014 monthly NDVI Min/Max)



# Global Data Flow Scenarios

**Space Agencies**

**In-Country Users**



**BAU (Business as Usual)**

**Satellite**
**Top of Atmosphere (TOA)**
**Data Products**

**TOA** →

- Hard Drive delivery or internet download of TOA products
- Local storage and processing to ARD
- Local production of Forest Map products using scene-based tools

**TOA**

**Option 1**

***Space Agency Processing into Analysis-Ready Data (ARD)***

**ARD** →

- Hard drive delivery or internet download of ARD products
- Local storage
- Local production of Forest Map products using scene-based tools or Data Cubes



**Option 2**

**ARD**

**TOA**

***Computing Cloud or Data Hub***

- *Storage of TOA or ARD products*
- *Processing of TOA to ARD, if needed*
- *Scene-based or Data Cube formats*
- *Production of Forest Map Products*



**Forest Products** →

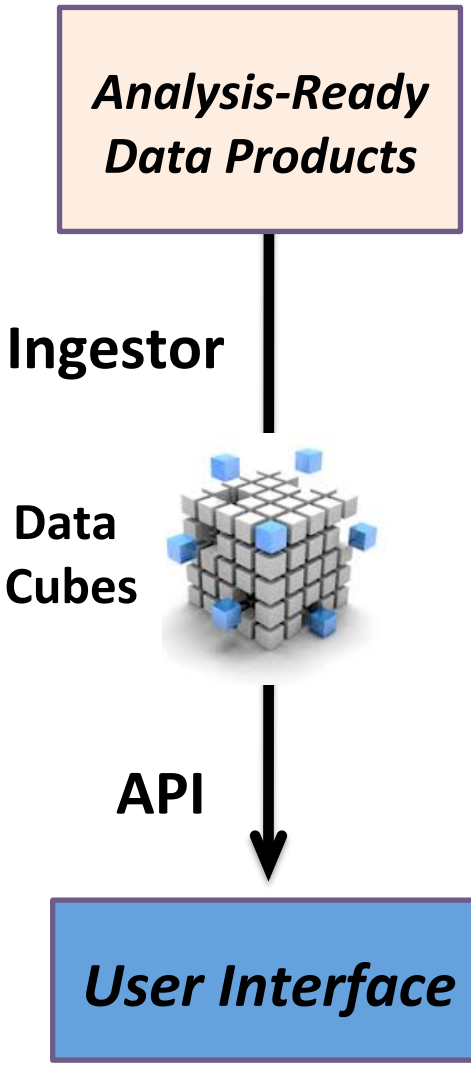
- Internet download of Forest Map products

# CEOS Data Cube Vision



- Free and open access to software
- Documented processes for data cube generation, new data ingestion, and user interfaces
- Cloud-based, regional data hub or local deployment
- Based on “Analysis Ready”, fully processed data products from satellite data providers
- Preservation of native data product grid formats
- Computational flexibility to create “nested grids” in common grid projections for multiple dataset interoperability and spatial consistency
- Provisions for a baseline user interface for data preparation (e.g. mosaics), statistics and common analysis products (e.g. change detection, water)
- Enable user development of applications through flexible APIs
- Architecture flexibility and standards to support Data Cubes for local, regional or country scales

# CEOS Data Cube




- Work with CEOS Space Agencies to develop plans for sustained provision of Analysis Ready Data (ARD)
- Sentinel-1/2 are highest priority.

- Develop prototype Data Cubes for **Kenya and Colombia** projects. Test local, hub and cloud-based deployment options.
- Expand datasets to include: SRTM, ALOS, MODIS, SPOT-5, Sentinel-1/2.
- Improve data cube ingestor software (creation) and data cube application software (analysis)

- Develop prototype reference user interfaces for the Kenya and Colombia projects.
- Consider features such as: mosaic creation, data cube analytics and visualization, land cover change detection, agriculture NDVI anomaly and water/non-water maps.
- Develop an API for users to create their own user interfaces

# Data Cube Datasets
## (priority order of addition)

- **Landsat-5/7/8** (Surface Reflectance) from USGS. Products available, by order.
- **SRTM** ... NASA Space Shuttle Digital Elevation dataset (Feb 2000) now available globally at 1-arcsec (30 meters) resolution.
- **ALOS** (PALSAR L-Band SAR). Free and open annual mosaics from 2007-2010 provided by JAXA. Working with Ake Rosenqvist (GFOI) to demo.
- **MODIS** (Terra, Surface Reflectance, 8-day Level-3 500-m Global, MOD09A1). Will work with GA/CSIRO to utilize their experience with this dataset.
- **SPOT-5** (10-meter multi-spectral). Plans to obtain SPOT-5 Take-5 data over Kenya sample site (processing complete in Sept 2015). Over time, CNES plans to process and release all of the past data.
- **Sentinel-1A:** C-band SAR data, plans to add sample images to prototype in early 2016
- **Sentinel-2A:** Plans to add sample images to prototype after investigating processing. Mid 2016.
- **RapidEye:** SDCG-8 action to obtain sample data for Data Cube ingestion testing.

# Kenya Project

- The **Kenya Data Cube Project** is led by NASA-SEO and the Australian Government. Supported by USGS and the Clinton Foundation (CCI and SLEEK).
- Two operating versions of the Kenya Data Cube ... One is deployed on the Amazon Cloud and one is deployed on a local computer. Considering options for a Regional Hub.
- 11.5 TB of uncompressed Landsat data (7500+ Landsat 7+8 scenes). Pixel information was extracted, reformatted into a UTM grid, and compressed into a 3.6 TB Data Cube. Application algorithms can be run directly on the compressed Data Cube.
- Kenya cube contains 42 path-row regions, repacked into 68 tiles (1-deg square). Total area = 840,072 $km^2$, 933 million pixels
- Demonstrated an operating sample user interface for mosaic creation at the recent SDCG meeting. Planning to add more data layers in the coming months ... SRTM, ALOS PALSAR Mosaics, MODIS.

Australian Government

NASA

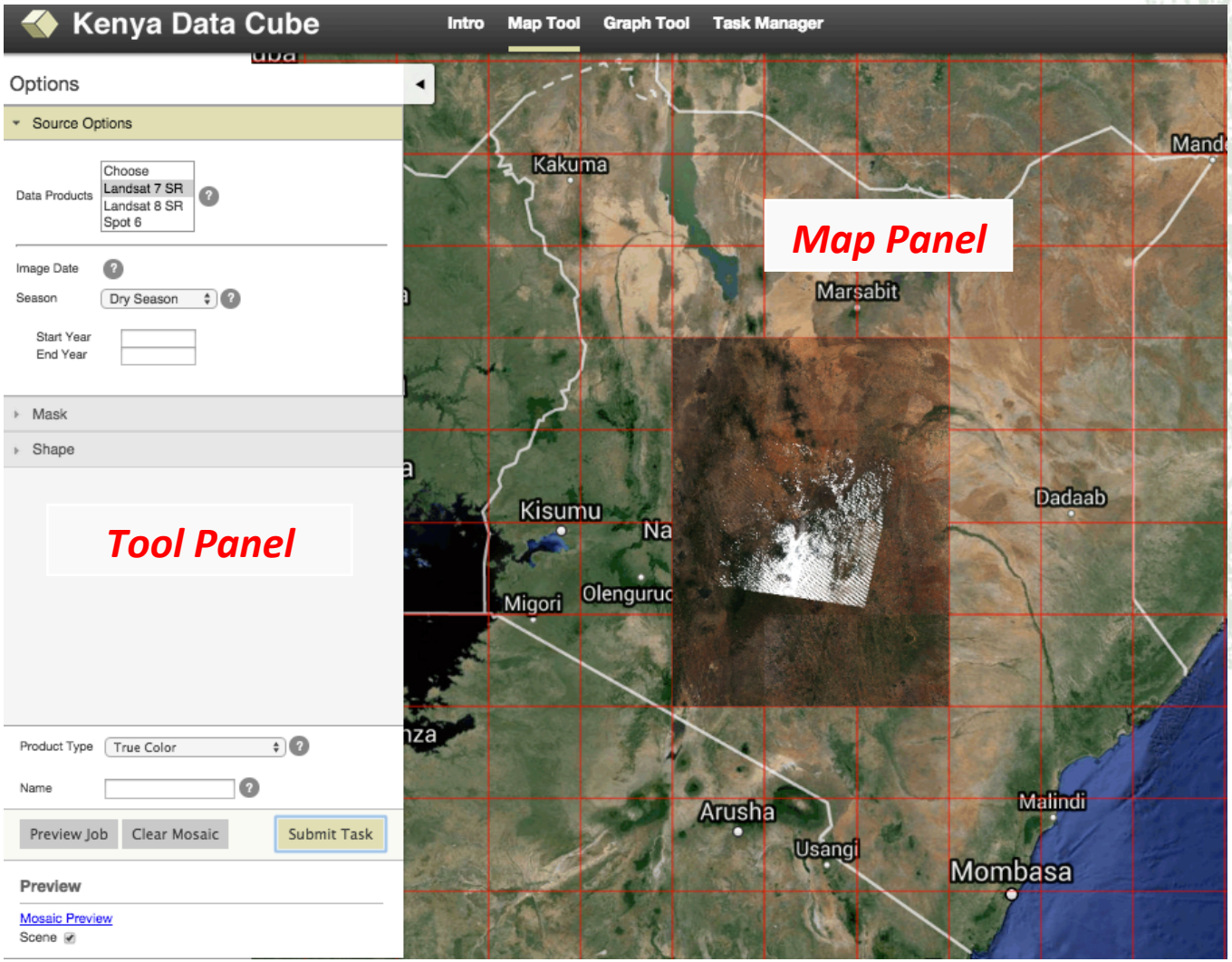
USGS science for a changing world

SLEEK
SYSTEM FOR LAND-BASED EMISSIONS ESTIMATION IN KENYA

# Colombia Project

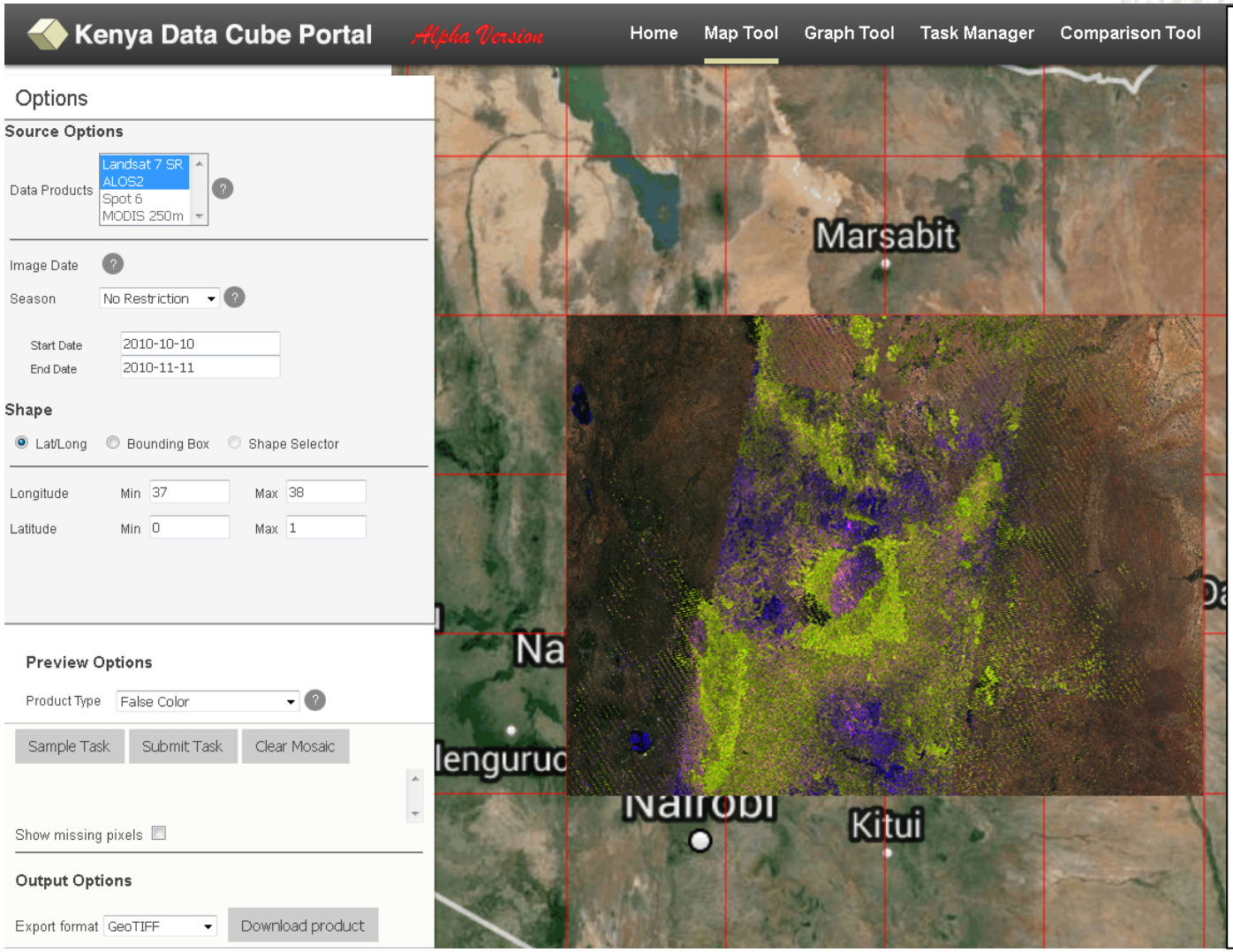
- The **Colombia Data Cube Project** is led by NASA-SEO and the Colombian Government. Supported by CSIRO (Australia, CEOS Chair Team) and IDEAM (Institute of Hydrology, Meteorology and Environmental Studies).
- A mini-cube (4 Landsat path-row regions) was delivered on October 14-15. Includes all historic Landsat data back to 2000. This meeting defined the objectives and detailed project development plan through 2016.
- Colombia cube contains 4 path-row regions, repacked into 20 tiles (1-deg square). Total area = 246,020 $km^2$, 273 million pixels.
- Colombian researchers are eager to expand the Data Cube to the full country and to develop enhanced user interfaces to support forest and agriculture applications. Additional datasets will also be added.

# Reference User Interface




- Selectable data products
- Selectable time periods
- Selectable region
- Selectable product (mosaic or latest scene)
- Selectable output image (true color, false color)

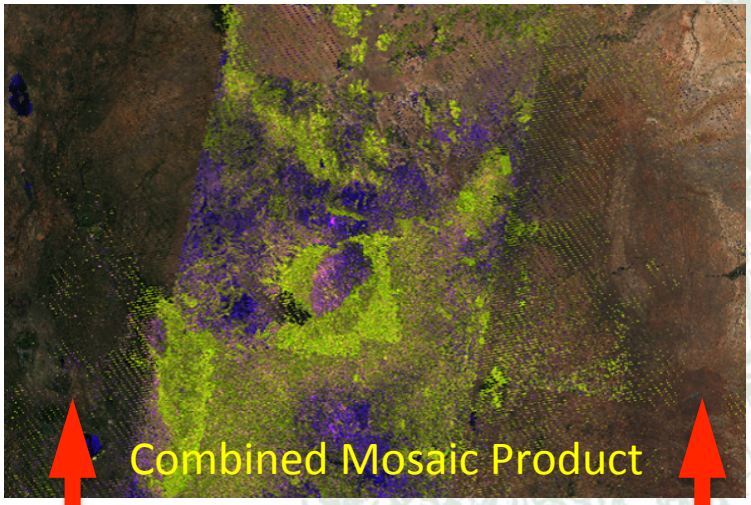
# Interoperable Optical and Radar Data in the CEOS Data Cube



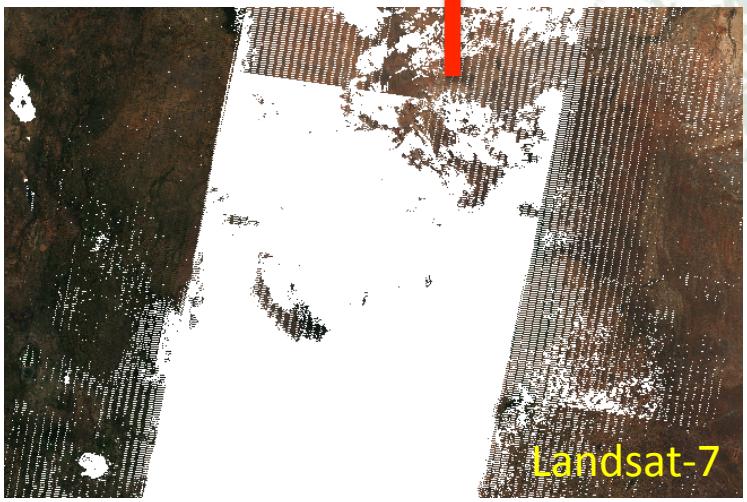

- Kenya **Data Cube** project plans to integrate optical and radar data within the same user interface.
- **Landsat-7** mosaics and **ALOS PALSAR** mosaics (example on the left) can be utilized together for improved forest classifications in persistant cloudy regions.
- **ALOS** data provides unique information about vegetation structure and biomass especially in low density and regrowing forest regions.

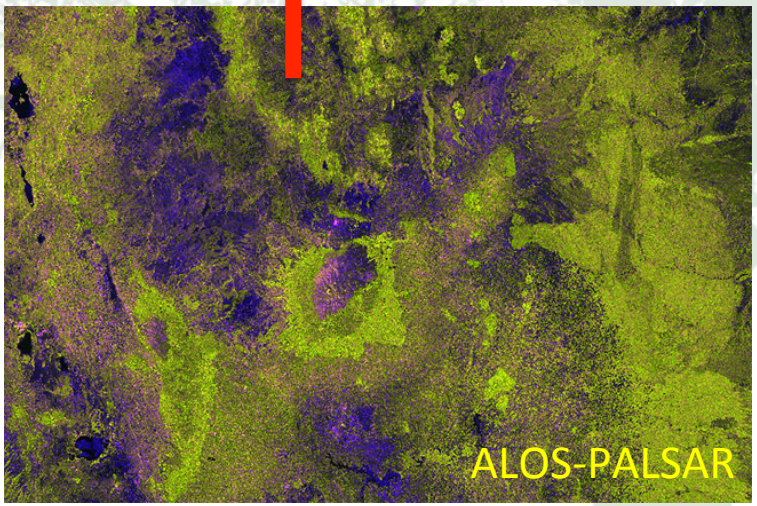
# Landsat-ALOS Mosaic Example

An integrated mosaic was created with the Data Cube over central Kenya for Oct-Nov 2010 using Landsat-7 and the 2010 ALOS-PALSAR 25m mosaic.




ALOS-PALSAR data can be used to fill areas of cloud cover and scan line “banding” within the Landsat-7 imagery for improved forest classification and biomass information.



# Reference UI Options

- **(1) Mosaics**: Custom cloud-free mosaics using Landsat. User defined regions and times (annual or months). Output in JPG or GEOTIFF formats or reingestion into Data Cube as a product layer. Ouput support for False Color combinations, Tasseled-Cap, NDVI, other indices or custom. Also allow this tool to connect to tools below for additional analyses.
- **(2) Statistics**: Link to mosaic tool (#1) to include: no-data%, cloud%, total pixels, total area. Also be able to plot (per pixel or region) band or index values, metadata (provenance).
- **(3) Change Detection**: LandTrendr, CCDC, others? Pixel based or defined regions. Cloud-filtering is part of the process.
- **(4) Agriculture**: NDVI Anomaly (similar to Crop Monitor). MODIS or Landsat based. Support from UMD.
- **(5) Land Classification**: Link to mosaic tool #1. Landsat: basic clustering algorithm for n-types and land class types (e.g. FAO Open Foris). Use JAXA SAR classes for ALOS. Do we need to add supervised field data in each region?

# Commercial Data Examples

Here are 4 examples of CEOS data services projects where we are hosting commercial and/or restricted data ...

- **Colombia:** TanDEM-X digital elevation data from DLR. 16 scenes over 8 sites. Delivered in Dec 2014 via an Amazon Cloud data system. (top right image)
- **Kenya**: SPOT-5 Take-5 data (one location over central Kenya, 31 Images, April to Sept 2015) will be used for the Data Cube project. (bottom right image)
- **Asia-RiCE** project uses Radarsat-2 (CSA/MDA), RISAT-1 (ISRO) and ALOS-2 (JAXA) restricted data on a scene-based SDMS system provided by the CEOS-SEO via an Amazon Cloud.
- **JECAM** project (GEOGLAM R&D for agriculture) is planning to host restricted Radarsat-2 data on a scene-based SDMS. Working with Agri-Food Canada on Amazon cloud-hosting plans.

