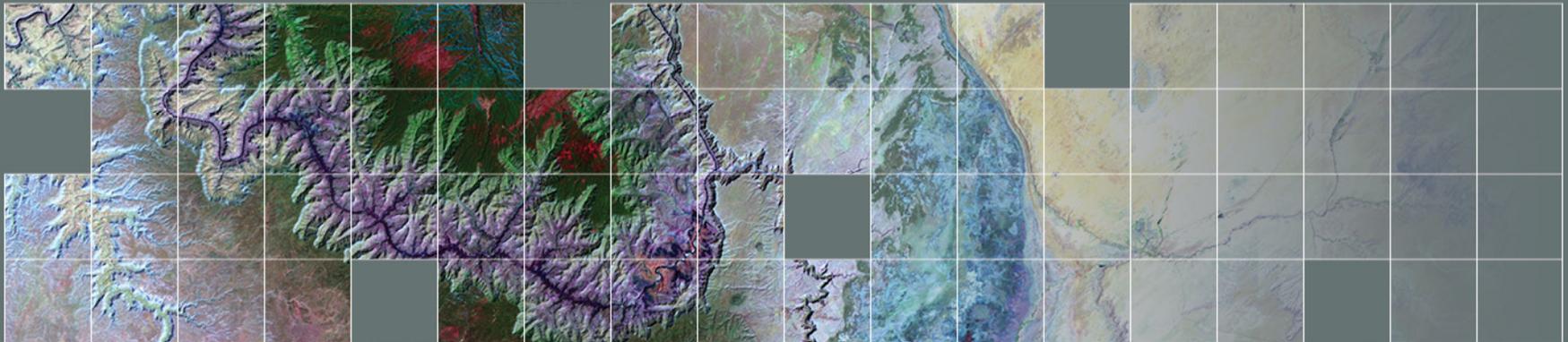




Climate and Land Use Change  
**Earth Resources Observation and Science (EROS) Center**

# USGS Sentinel-2 Status



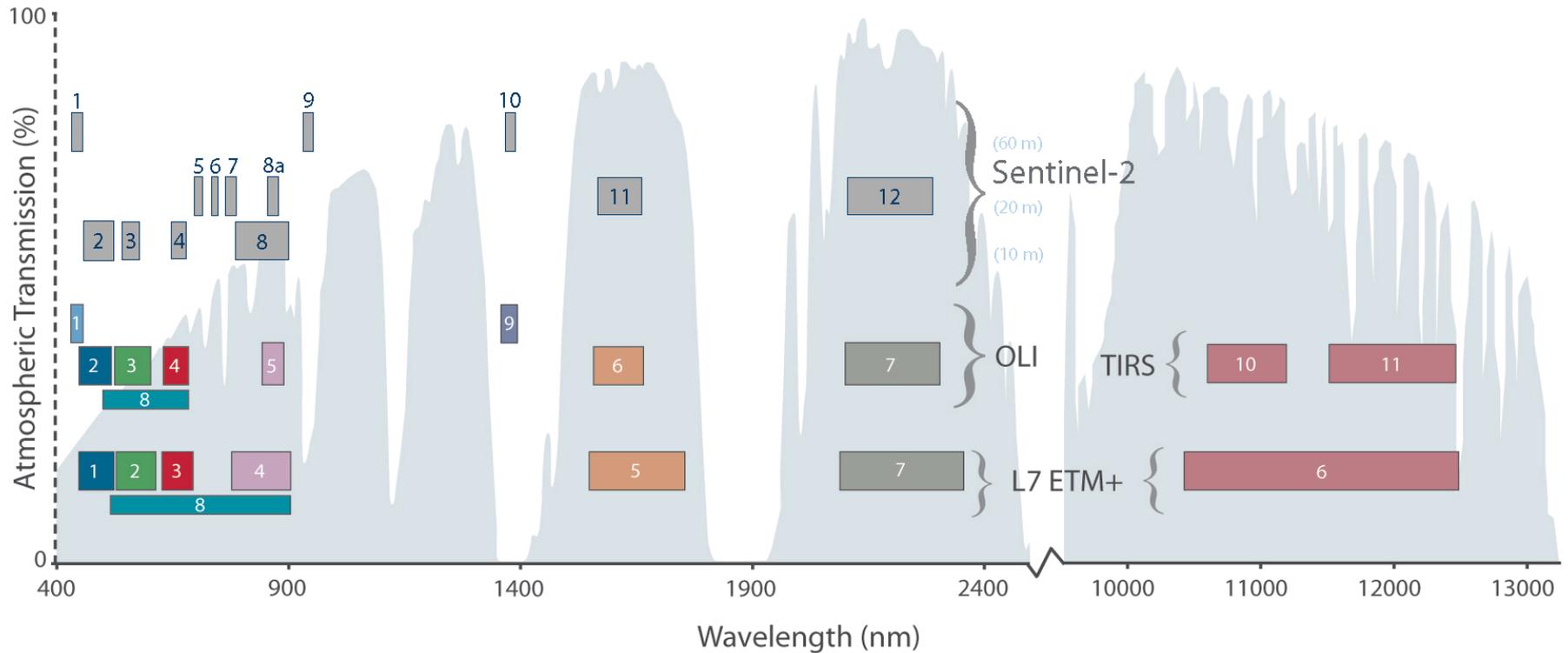
**John Dwyer**  
**March 2, 2016**  
**NASA ASP Wildfire Meeting**

U.S. Department of the Interior  
U.S. Geological Survey

# Science Drivers for Sentinel-2 Data

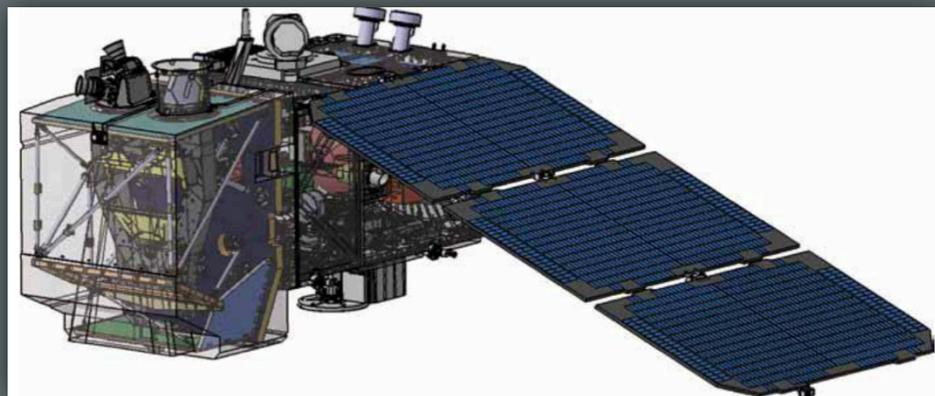
- Increase temporal coverage to improve probability of cloud-free acquisitions to enable the study of forest dynamics, vegetation phenology, agricultural monitoring and crop type mapping
- Augmentation of the Landsat data record
- Science assessment of new spectral bands and increased spatial resolution
  - 10 meter VNIR
  - 20 meter “red edge”
  - 60 atmospheric characterization

# Comparison of Landsat & Sentinel-2



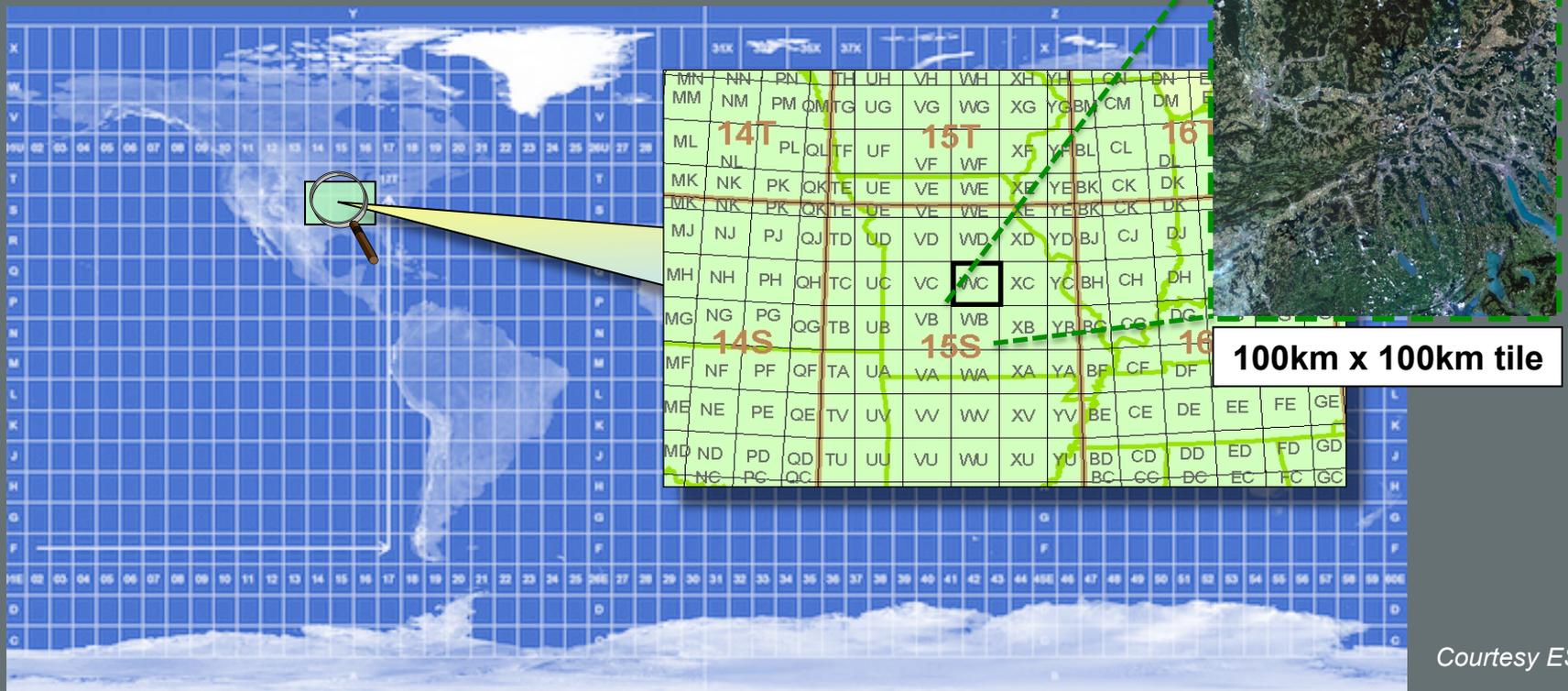
# Background of USGS & NASA Collaboration

- Multiple products will be made available including L1C that is analogous to Landsat L1T. It is anticipated that 900GB of downlinked data per day per satellite will be processed to L1C by ESA.
- L1C product is ortho-rectified Top of Atmosphere (TOA) reflectance provided as 100x100km<sup>2</sup> tiles with data size of 500MB. L1C product is 12-bit, and includes coefficients to convert to radiance, a QA band, and systematic processing for data between +84 degrees north and -54 degrees south.
- 1.6TB/day/satellite
- NASA and European collaboration to generate surface reflectance and biophysical parameters available for distribution.



# L1C Granularity - Tiling approach

- Global Reference System in UTM space (6°x8° grid zones)
- Each grid zone is split into 100x100km (TBC) UTM “tiles”
- An average orbit covers ~200 tiles, i.e. 10<sup>6</sup> /year/satellite.
- One tile weights ~ 500MB with all bands



Courtesy ESA

# USGS Plans for Sentinel-2 Data

- **Presented Investigation Summary “Sentinel-2 Augmentation to Landsat Data Record” to Land Remote Sensing Program October, 2014**
  - Scope and Ops Con assumptions used for analysis
  - Investigation Analysis & Findings
  - Architecture Recommendation & Implementation Summary
  - Risks & Considerations
  - Work packages and associated cost estimates
- **Collaborating with NASA on pre-flight calibration and data characterization to define Science data processing to enable Landsat and Sentinel-2 data synergy**

# Implementation Tiers and Options

## ■ **Implementation Tiers:**

- ✓ **Tier 1:** EROS will pull a copy of all L1C data from ESA, create single tile based products from ESA multi-tile based products, host a copy at EROS, generate a Full Resolution Browse (FRB) and enable basic data discover capabilities (no other processing included)
- **Tier 2:** In addition to Tier 1, add a minimal amount of processing necessary to increase usability of the data, including reformatting data to be more consistent with Landsat Level 1 and resampling the Level 1C data to a 30m common grid and tiling scheme (Landsat-like) for distribution as an on-demand Landsat-like product
- **Tier 3:** This is a separate and parallel scenario to Tier 2 to render the MSI data interoperable with Landsat and significantly increase the usability/utility of the data for research/applications and makes the data as seamlessly similar as possible to Landsat data for the user (feasibility pending and therefore, not yet estimated)

## ■ **Additional defined options:**

- ✓ **Option 1:** Increased disk cache for S2 to 360 days and added 10% each year to improve user experience
- **Option 2:** Generate surface reflectance products from S2 data and archive and distribute to the public (currently assuming use of NASA Ames Research Center (ARC) for processing SR data)
- **Option 3:** Provide coincident search and discovery of both inventories (Landsat & S2) simultaneously in EarthExplorer and provide aggregated results (feasibility pending and therefore, not yet estimated)

## ■ **Scope and Schedule remain contingent upon available funding**

# Current Data Availability from ESA

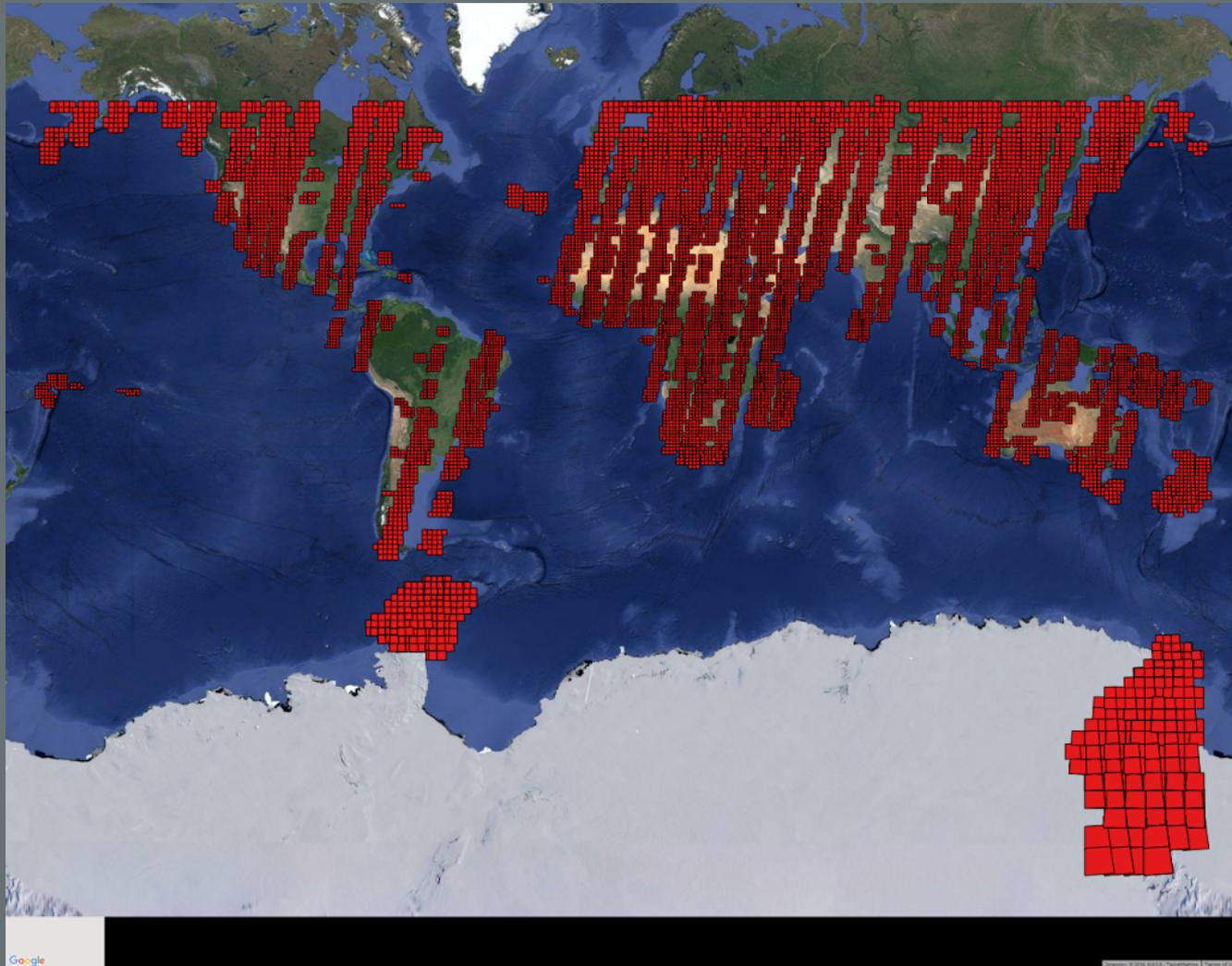
- **Current “operational” version of Copernicus ground data processing system is 2.01**
  - This became effective for acquisitions starting ~December 12, 2015 and implemented December 17
  - Data acquired during commissioning and up through November to be reprocessed by the end of 2<sup>nd</sup> quarter of 2016
  - ESA currently “bundles” data for 300Km by 300Km geographic blocks
    - USGS “unbundles” the SAFE files to build a tile-based inventory
- **ESA collecting ~2000 tiles/day**



# USGS Sentinel-2 Inventory Status

- **MSI Level-1C products**
  - Product bundles downloaded: 1485
  - Tiles generated: 18,331
  - Product bundles yet to be downloaded: 9718
- **Science Data Hub contains 13,698 bundles generated by old version of software and 11,491 generated by version 2.01**

# Coverage Map of Tiles USGS Tiles



# Known Issues

- **Current Sentinel-2 Level-1C product generation was suspended February 21 due to radiometric anomalies that are currently being characterized**
- **Internet-2 connectivity to the International Data Hub (IntHub) via Geant expected by the end of March**
  - To date there has been no Internet-2 connectivity to any of the Sentinel data hubs, resulting in poor network performance
- **Cloud cover scores did not account for zero-fill**
- **Long file names cause problems for Windows OS, but should be usable in Windows 10**

# USGS suggestions for ESA consideration

- **Provide automated access to L1C products for the International Data Hub**
  - Similar to API that is available on the Science Data Hub
  - Increase number of concurrent connections allowed per user id
- **Provide Database reconciliation tools for the International Data Hub**
- **Provide tile based rather than bundled tile L1C products**
- **Shorten file naming convention for L1C products**
- **Change cloud cover scores to pertain only to valid image data (not to zero-fill)**
  - Implemented late February

# EarthExplorer – earthexplorer.usgs.gov

USGS Home  
Contact USGS  
Search USGS

**EarthExplorer** Page Expires In 1:58:27

[Home](#) [1 New System Message](#) [Save Criteria](#) [Load Favorite](#) [Manage Criteria](#) Item Basket (0) cgacke RSS Feedback Help

**Search Criteria** [Data Sets](#) [Additional Criteria](#) [Results](#)

## 2. Select Your Data Set(s)

Check the boxes for the data set(s) you want to search. When done selecting data set(s), click the *Additional Criteria* or *Results* buttons below. Click the plus sign next to the category name to show a list of data sets.

Use Data Set Prefilter [\(What's This?\)](#)

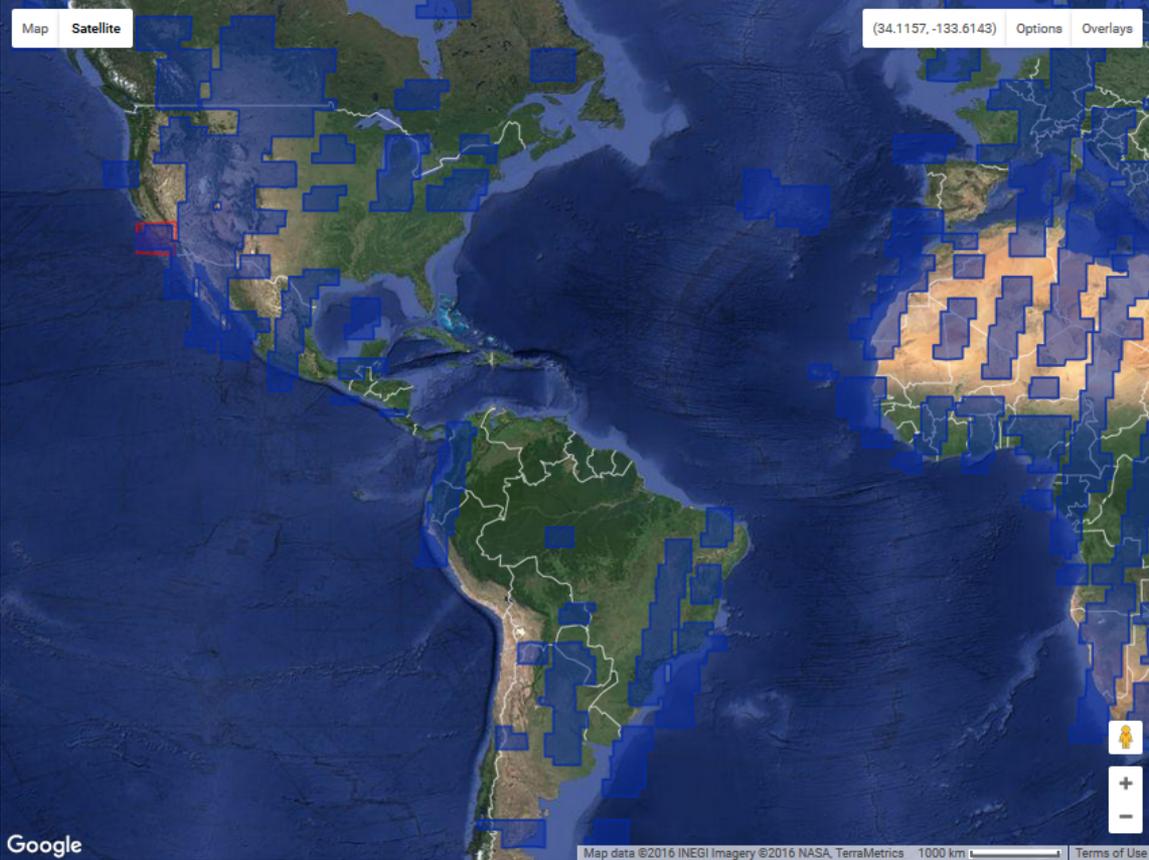
Data Set Search:

- Aerial Imagery
- AVHRR
- CEOS Legacy
- CIDR Requirements
- Commercial Satellites
- Declassified Data
- Digital Elevation
- Digital Line Graphs
- Digital Maps
- EO-1
- Global Fiducials
- Global Land Survey
- HCMM
- ISERV
- Land Cover
- Landsat Archive
- Landsat Legacy
- Landsat MRLC
- NASA LPDAAC Collections
- Radar
- Sentinel-2

[Clear All Selected](#) [Additional Criteria »](#) [Results »](#)

### Search Criteria Summary (Show)

[Clear Criteria](#)



Map **Satellite** (34.1157, -133.6143) Options Overlays

Google Map data ©2016 INEGI Imagery ©2016 NASA, TerraMetrics 1000 km Terms of Use

The up-to-date Google map is not for purchase or for download; it is to be used as a guide for reference and search purposes only.

# EarthExplorer – Results / Overlay / Order

The screenshot displays the USGS EarthExplorer interface. At the top left is the USGS logo with the tagline "science for a changing world". The main header includes "EarthExplorer" and a page expiration timer "Page Expires In 1:50:17". Navigation links include "Home", "1 New System Message", "Save Criteria", "Load Favorite", "Manage Criteria", "Item Basket (14)", "cgacke", "RSS", "Feedback", and "Help".

The "Search Results" section (4. Search Results) provides instructions on how to use multiple data sets. Below this, the "Hide Result Controls" section contains several checkboxes, all of which are checked: "Show All Footprints From Current Page", "Show All Browse From Current Page", "Add All Results From Current Page to Bulk Download", and "Add All Results From Current Page to Order". There are also dropdown menus for "Compare Browse" (set to "Map Overlay") and "All Scenes", along with a "Compare" button and a "Browse Opacity" slider set to 100%.

The "Data Set" section shows "Sentinel-2" data. It displays a list of results, with the first three items visible. Each item includes an "Entity ID", "Coordinates", and "Acquisition Date". A red arrow points from the "Download" icon of the second result to a "Download Options" dialog box. This dialog box offers two download options: "L1C Tile in JPEG2000 format (403.0 MB)" and "Full Resolution Browse in GeoTIFF format (6.3 MB)".

The main map area shows a satellite view of California with several colored overlays (red, purple, green, blue) representing different data sets. The "Search Criteria Summary" section at the top of the map area includes a "Map" button, a "Satellite" button, a coordinate box showing "(37.7853, -125.6299)", and "Options" and "Overlays" buttons. The map is credited to Google and includes a scale bar and "Terms of Use" link.

# EarthExplorer – Bulk Download Application

EarthExplorer

Home 1 New System Message Item Basket (14) cgacke ▾

Please Note: This page will expire at 3:59:15 PM CST. Once expired, you will be logged out and your order may be lost.

## Bulk Download

Note: Data sets may contain items with multiple product options. Expand a data set to view your list of ordered scenes including metadata and product options.

▼ Sentinel-2 (14)

Save Changes **Proceed To Checkout »**

EarthExplorer

Home 1 New System Message Item Basket (14) cgacke ▾  [RSS](#) [Fee](#)

Please Note: This page will expire at 4:00:32 PM CST. Once expired, you will be logged out and your order may be lost.

## Bulk Download

Note: File sizes are approximate. Final file size may vary slightly.

Data Set	Qty.	Products
Sentinel-2	14	14
		<b>Total Size:</b>

Return To Item Basket **Submit Order**

EarthExplorer

Home 1 New System Message Item Basket (0) cgacke ▾  [Feedback](#) [Help](#)

## Bulk Download

Your Bulk Download order number 620521 has been received. A notification has also been sent to the email provided in your USGS Registration profile. **To begin the download process, the [Bulk Download Application \(BDA\)](#) is required.** First time users: please download, install and open the BDA. Returning users: please open the BDA installed on your system. You will be required to login using the EarthExplorer username and password used to complete your download request. Information and installation links can also be found at <http://earthexplorer.usgs.gov/bulk>

If your order is Available, highlight the order number and click Select Order. On the next page, navigate to the download destination, make changes as you see fit for your system, highlight the first item in the list, and click Begin Download. When all items are downloaded you can select another order or close the window. The system will also keep track of failed downloads and retry them.

Bulk download orders are available for two weeks, after which they are removed. You will need to place a new order to obtain data products if you do not download them from original order.

Data Set	Scenes	File Size
Sentinel-2	14	4.3 GB
		<b>Total:</b>
		14
		4.3 GB

Return To EarthExplorer

Install BDA on Desktop



# EarthExplorer – BDA on Desktop

**Bulk Download Application**

File Settings View Help

Destination: D:\CommVault\Software\bda\  
Free Space: 822,322,500.0 KB (784.2 GB)

Downloads: --

Entity ID

Status

Remaining: 0 Errors: 0

Progress: 0%

Begin Download Clear Completed Downloads

**Orders**

Select an order

Order ID	Date Ordered	Status
615471	02/16/2016 11:18:18 AM	Available
619442	02/24/2016 1:07:32 PM	Available
619526	02/24/2016 3:50:18 PM	Available
620165	02/25/2016 7:50:12 PM	Available
620314	02/26/2016 4:45:14 AM	Available
620514	02/26/2016 1:50:49 PM	Available
620521	02/26/2016 2:01:27 PM	Available

Select Order Cancel

# EarthExplorer – BDA download

**Bulk Download Application**

File Settings View Help

Destination  
D:\CommVault\Software\bda  
Free Space: 818,030,364.0 KB (780.1 GB)

Downloads  
Order 620514

Entity ID	Product	Data Set	File Size	Status
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	403.0 MB	Pending
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	456.7 MB	Pending
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	486.4 MB	Pending
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	16.9 MB	Pending
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	374.9 MB	Pending
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S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	150.4 MB	Pending
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	238.4 MB	Pending
S2A_OPER_MSI_L1C_TL_MTI_201512...	L1C Tile in JPEG2000 format	Sentinel-2	604.3 MB	Pending

Remaining: 14 scenes (4.3 GB) Errors: 0

Progress  
0%

**Begin Download** Clear Completed Downloads