

Earth Observation with Satellite Remote Sensing and ArcGIS Pro

A hands-on workshop sponsored by TexasView

Monday, October 21, 2019

Instructor: Teresa Howard

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TexasView, a member of AmericaView

AmericaView is a nationwide partnership of remote sensing scientists who support the use of Landsat and other public domain remotely sensed data through applied remote sensing research, K-12 and higher STEM education, workforce development, and technology transfer.

<https://americaview.org>

Agenda

- Where to find free Earth Observation data
- Lesson 1: Overview of satellite data used in this workshop
- Lesson 2: Introduction to ArcGIS Pro and raster basics
- Lesson 3: Mosaic datasets and time series
- Lesson 4: Working with vegetation indices, surface temperature, burn area, and dynamic surface water and

About me

- MAG from Texas State University
- More than 22 years involved in GIS and remote sensing
- At UT Center for Space Research since 2000
- TexasView/AmericaView collaboration also since 2000
- Taught ArcMap/ERDAS Imagine based workshop 6+ times
- First time teaching Forum workshop using ArcGIS Pro

About you

- Name and affiliation, if applicable
- Local or out-of-town?
- What piqued your interest in this workshop?
 - Earth observation satellites?
 - Image processing in ArcGIS Pro?
 - Something else?

Resources for Data Discovery & Collection

- [USGS Earth Explorer](https://earthexplorer.usgs.gov) (demoed): <https://earthexplorer.usgs.gov>*
- [USGS GloVis](#) (link to video courtesy of VermontView)*
- [Landsat Look](#) (how-to guide on workshop USB flash drive)
- NASA's [EarthData](#) (access to visualization and data products)^
- NASA's LP DAAC [AppEEARS](#) ^

* Create single account for USGS Earth Explorer & GloVis

^ Create NASA EarthData account for data download from this site and other NASA data sites, including LP DAAC downloads from Earth Explorer and AppEEARS

Earth Explorer Search Criteria

- Use Geocoder Address or GNIS search and click Show button OR upload simple shapefile or KML
- As an example, type in El Paso in Address/Place box then click Show button.
- For Date Range, use calendars or type: 09/01/2019 to current date
- Click Data Sets button to proceed

The screenshot shows the USGS Earth Explorer search interface. The USGS logo is at the top left. The page title is "EarthExplorer - Home". Below the title is a navigation bar with tabs: "Home", "Search Criteria", "Data Sets", "Additional Criteria", and "Results". The "Search Criteria" tab is selected. The main content area is titled "1. Enter Search Criteria". It contains a text box for "Address/Place" with the value "El Paso" and a "Show" button. Below this is a section for "Date Range" with a "Search from" date of "09/01/2019" and a "Search to" date of "current date". The "Search months" dropdown is set to "(all)". Red checkmarks are placed over the "Geocoder" tab, the "Address/Place" text box, the "Show" button, the "Date Range" section, and the "Search from" and "Search to" date fields.

USGS
science for a changing world

EarthExplorer - Home

Home

Search Criteria Data Sets Additional Criteria Results

1. Enter Search Criteria

To narrow your search area: type in an address or place name, enter coordinates or click the map to define your search area (for advanced map tools, view the [help documentation](#)), and/or choose a date range.

Geocoder KML/Shapefile Upload

Select a Geocoding Method

Address/Place

Address/Place

Show Clear

Polygon Circle Predefined Area

Degree/Minute/Second Decimal

No coordinates selected.

Use Map Add Coordinate Clear Coordinates

Date Range Result Options

Search from: mm/dd/yyyy to: mm/dd/yyyy

Search months: (all)

Data Sets » Additional Criteria » Results »


















USGS Earth Explorer Data Sets








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:

- ☒ **Landsat** 
 - ☒ **Landsat Collection 1 Level-3**
 - ☒   Dynamic Surface Water Extent
 - ☐   Fractional Snow Covered Area
 - ☒   Burned Area
 - ☒ **Landsat Analysis Ready Data (ARD)**
 - ☒   U.S. Landsat 4-8 ARD
 - ☒ **Landsat Collection 1 Level-2 (On-Demand)**
 - ☒ **Landsat Collection 1 Level-1**
 - ☒   Landsat 8 OLI/TIRS C1 Level-1
 - ☐   Landsat 7 ETM+ C1 Level-1
 - ☐   Landsat 4-5 TM C1 Level-1
 - ☐   Landsat 1-5 MSS C1 Level-1
 - ☒ **Landsat Legacy**

- ☒ **Commercial Satellites**
- ☒ **Declassified Data**
- ☒ **Digital Elevation**
- ☒ **Digital Line Graphs**
- ☒ **Digital Maps**
- ☒ **EO-1**
- ☒ **Global Fiducials**
- ☒ **HCMM**
- ☒ **ISERV**
- ☒ **Land Cover**
- ☒ **Landsat** 
- ☒ **NASA LPDAAC Collections**
- ☒ **Radar**
- ☒ **Sentinel**
 - ☒   Sentinel-2
- ☒ **UAS**
- ☒ **Vegetation Monitoring**
- ☒ **ISRO Resourcesat**
 - ☒   IRS AWiFS
 - ☒   IRS LISS-3

Clear All Selected

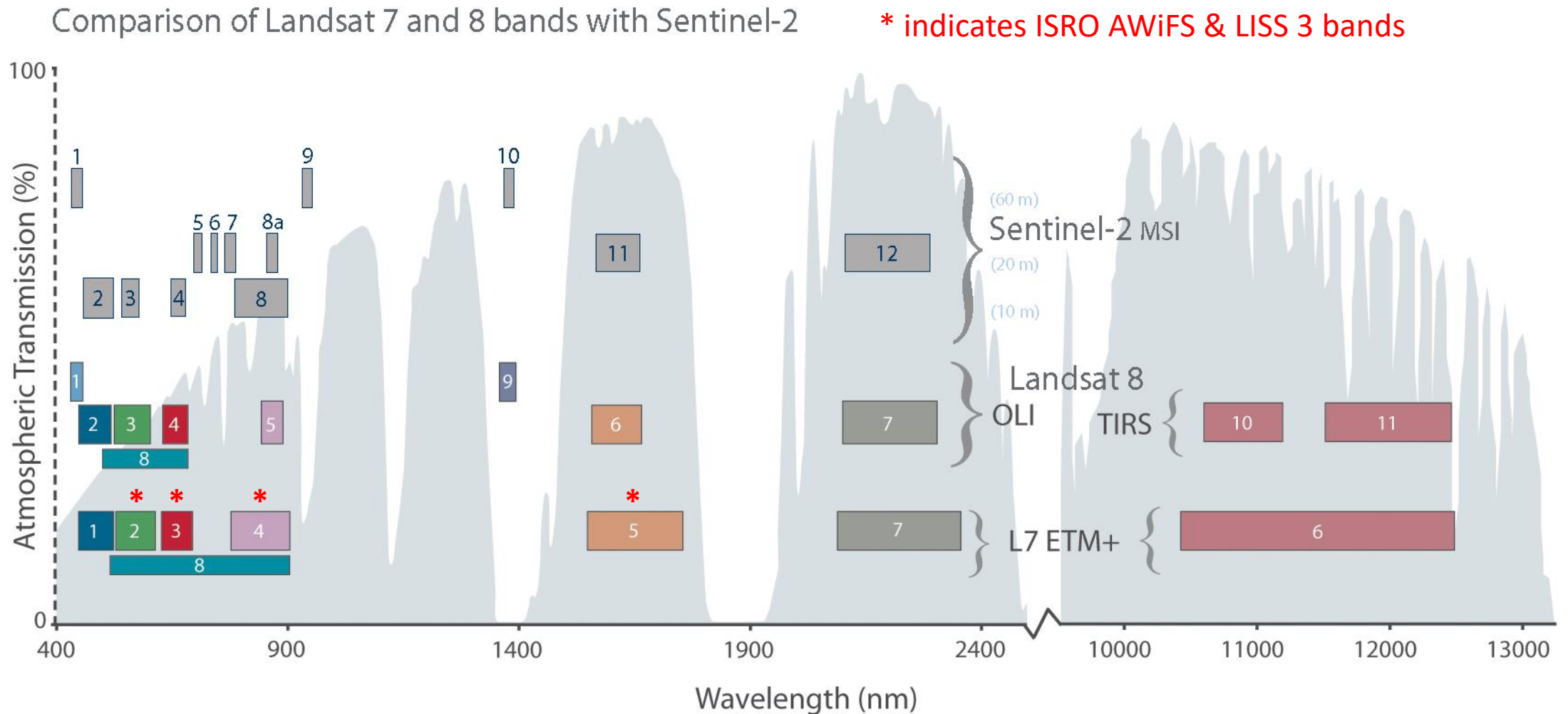
Additional Criteria »

Results »

Satellite Sensors & Products used in workshop

- [Landsat Analysis Ready Data \(ARD\)](#)
 - Surface Reflectance
 - Provisional Surface Temperature
- Landsat Collection 1 Level 3
 - [Dynamic Surface Water Extent](#)
 - [Burned Area](#)
- [Landsat 8 OLI/TIRS](#), [Landsat 7 ETM+](#), [Landsat 5 TM](#)
- European Space Agency (ESA) [Sentinel 2](#)
- Indian Space Research Organisation (ISRO) ResourceSat 1 & 2
 - [Advanced Wide Field Sensor \(AWiFS\)](#)
 - [Linear Imaging Self Scanning \(LISS-3\)](#)

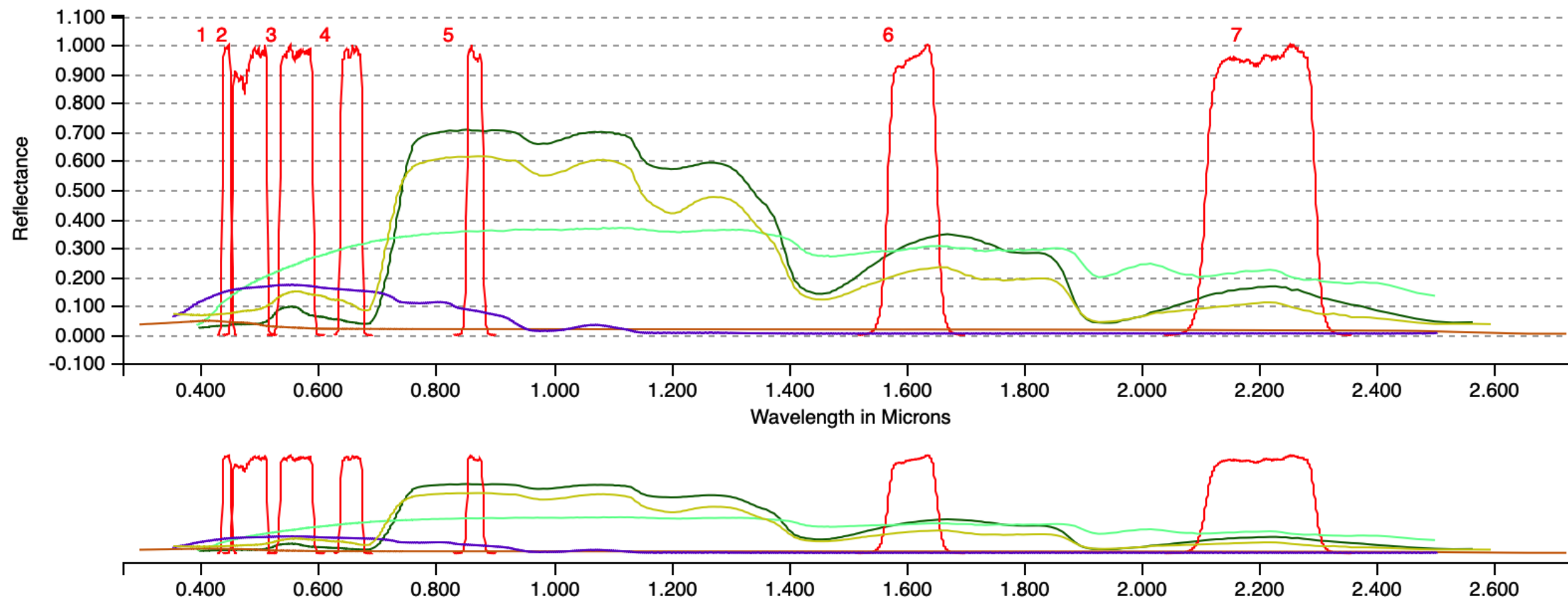
Electromagnetic spectrum for remote sensing



Bands/Spectra/Convolve

Reset

USGS Spectral Characteristics Viewer



Bands

■ Landsat 8 OLI

Spectra

■ Lawn Grass ■ Dry Grass ■ Clear Water ■ Turbid Water ■ Juniper Bush

NASA Resources






















Landsat 8 OLI Spectral Bands by Charlie Loyd of MapBox

- <https://landsat.gsfc.nasa.gov/landsat-8/landsat-8-bands/>

Images of Change

- [Mendecino Fire](#) **OLI July 26, 2018 - Aug. 11, 2018**
- [Mississippi Flooding](#) **OLI Feb. 27, 2014 - Feb. 25, 2019**

Landsat 8 OLI ARD Surface Reflectance Files

7z \\Mac\Home\Documents\TV\Workshop 2019\ARD\DFW\LC08_CU_016014_20190731_20190822_C01_V01_SR.tar\			
File Edit View Favorites Tools Help			
       			
Add Extract Test Copy Move Delete Info			
 \\Mac\Home\Documents\TV\Workshop 2019\ARD\DFW\LC08_CU_016014_20190731_20190822_C01_V01_SR.tar\			
Name	Size	Packed Size	Modified
 LC08_CU_016014_20190731_20190822_C01_V01.xml	87 525	87 552	2019-08-22 08:06
 LC08_CU_016014_20190731_20190822_C01_V01_LINEAGEQA.tif	155 709	156 160	2019-08-22 07:50
 LC08_CU_016014_20190731_20190822_C01_V01_PIXELQA.tif	601 079	601 088	2019-08-22 07:50
 LC08_CU_016014_20190731_20190822_C01_V01_RADSATQA.tif	172 731	173 056	2019-08-22 07:47
 LC08_CU_016014_20190731_20190822_C01_V01_SRAEROSOLQA.tif	3 290 931	3 291 136	2019-08-22 08:03
 LC08_CU_016014_20190731_20190822_C01_V01_SRB1.tif	40 801 758	40 801 792	2019-08-22 08:02
 LC08_CU_016014_20190731_20190822_C01_V01_SRB2.tif	40 796 074	40 796 160	2019-08-22 08:02
 LC08_CU_016014_20190731_20190822_C01_V01_SRB3.tif	41 512 454	41 512 960	2019-08-22 08:02
 LC08_CU_016014_20190731_20190822_C01_V01_SRB4.tif	43 397 146	43 397 632	2019-08-22 08:02
 LC08_CU_016014_20190731_20190822_C01_V01_SRB5.tif	44 255 852	44 256 256	2019-08-22 08:02
 LC08_CU_016014_20190731_20190822_C01_V01_SRB6.tif	44 926 728	44 926 976	2019-08-22 08:03
 LC08_CU_016014_20190731_20190822_C01_V01_SRB7.tif	42 498 452	42 498 560	2019-08-22 08:02

```

<?xml version="1.0" encoding="utf-8" ?>
- <ard_metadata version="1.1" xmlns="https://landsat.usgs.gov/ard/v1"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="https://landsat.usgs.gov/ard/v1
  https://landsat.usgs.gov/ard/ard_metadata_v1_1.xsd">
- <tile_metadata>
- <global_metadata>
  <data_provider>USGS/EROS</data_provider>
  <satellite>LANDSAT_8</satellite>
  <instrument>OLI/TIRS_Combined</instrument>
  <level1_collection>01</level1_collection>
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  <south>32.6411660566</south>
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- <projection_information datum="WGS84" projection="AEA" units="meters">
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  <corner_point location="LR" x="-15585.000000" y="1064805.000000" />
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  <>false_northing>0.000000</false_northing>
</albers_proj_params>
</projection_information>

```

Landsat 8 OLI XML Metadata

An Introduction to working with multispectral satellite data in ArcGIS Pro

Lesson 1

Lesson 1 – in which you learn...

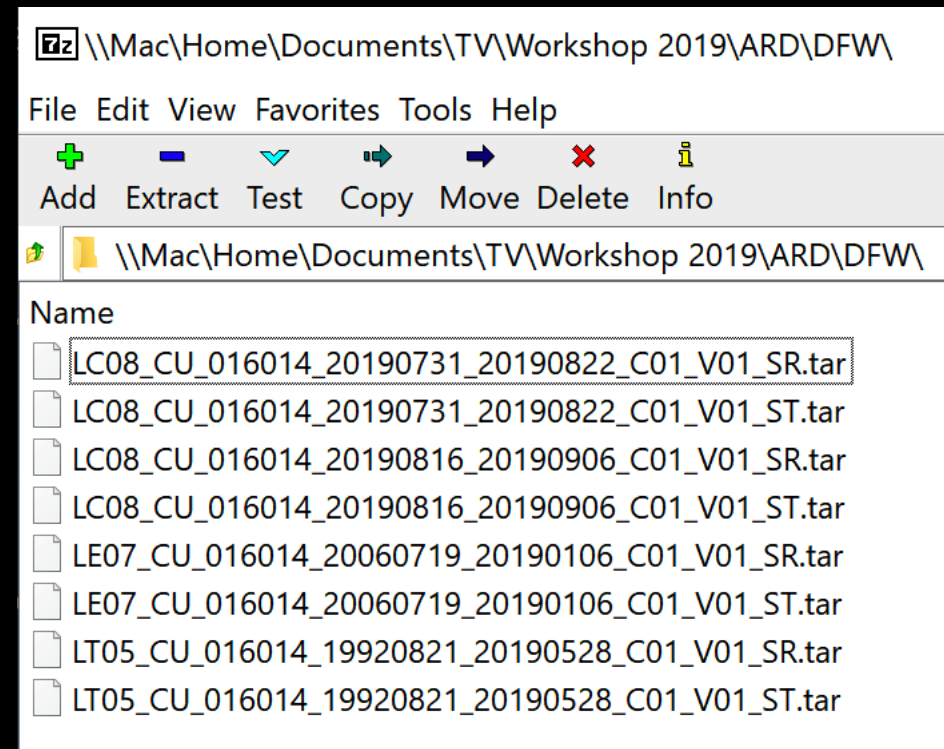
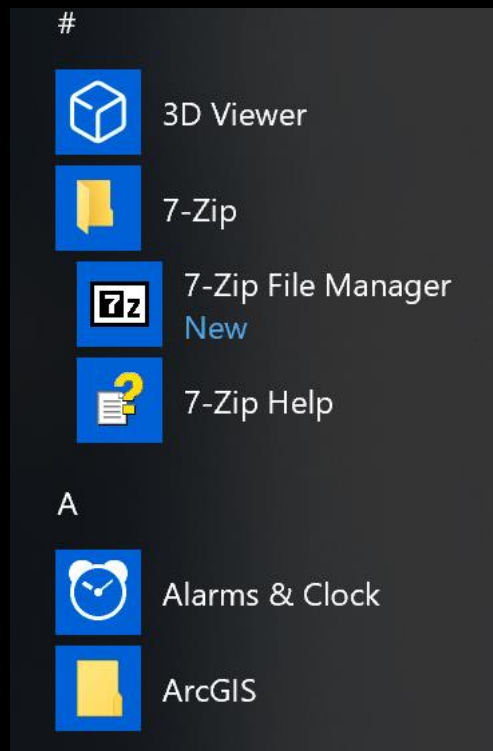
- How to unpack tar and gz files from USGS EROS
- The basic map interface in ArcGIS
- How to add image files
- What each individual band of Landsat spectral data looks like
- The difference between:
 - Analysis-ready data: surface reflectance and surface temperature
 - Landsat Collection 1 Level 3 data: burned area and dynamic surface water
 - Sentinel 2 data
 - ISRO AWiFS and LISS-3 data

Unpacking ARD & Landsat Level 3 tar files

On Windows use freeware 7-Zip

Find latest version at <https://www.7-zip.org/download.html>

Executable file available in Software folder on USB flash drive



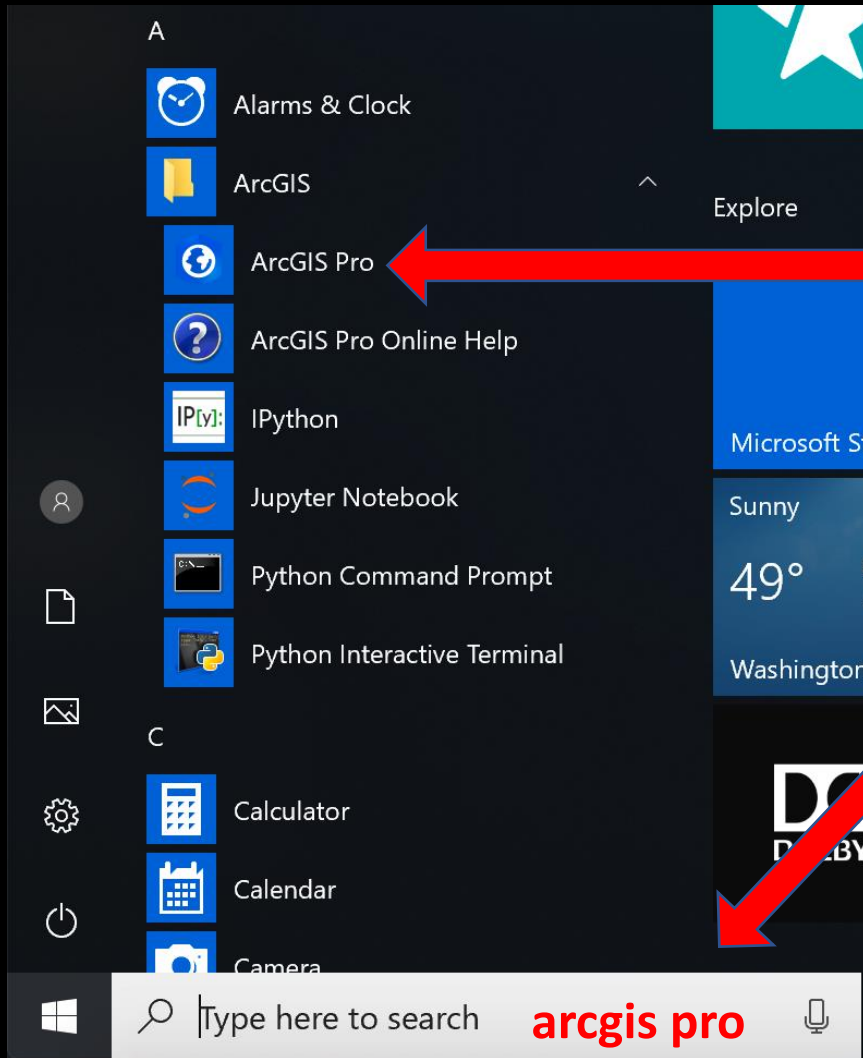
Understanding ARD file naming conventions

LC08_CU_012017_20190125_20190613_C01_V01_SRB1.tif

LXSS_US_HHHVVV_YYYYMMDD_yyyymmdd_CCC_vvv_product_band

- L = Landsat
- X = Sensor (C, O, E, T)
- SS = Satellite (08, 07, 05, 04)
- US = grid region ("CU" = CONUS)
- HHH = horizontal tile number, VVV = vertical tile number
- YYYYMMDD = collection date
- Yyyymmdd = processing date
- CCC = ARD collection number
- Vvv = ARD version number
- Product = 2 character product reference
- Band is only in surface reflectance products

Let's crank up ArcGIS Pro



- Click on Windows Start menu
- Option 1 – Open ArcGIS folder in A section and choose ArcGIS Pro
- Type *ArcGIS Pro* in the Search box

We will
open an
existing
project
(aprx)

ArcGIS® Pro

Open

Recent Projects

Your recent projects will appear here.

New

Blank Templates



Map



Catalog



Global Scene



Local Scene

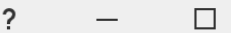


Start without a template
(you can save it later)

Recent Templates

Your recent templates will appear here.

ArcGIS Pro



Teresa



Teresa Howard

<https://www.arcgis.com>

[Sign out](#)

C:\Student\EO_SRS_ArcGISPro\ArcPro_RS_2019\ ArcPro_RS_2019.aprx



Open another project

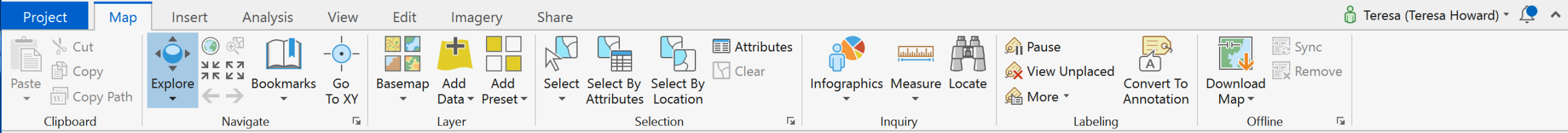


Settings



Select another project template

[Learn about creating project templates](#)



Contents

Search

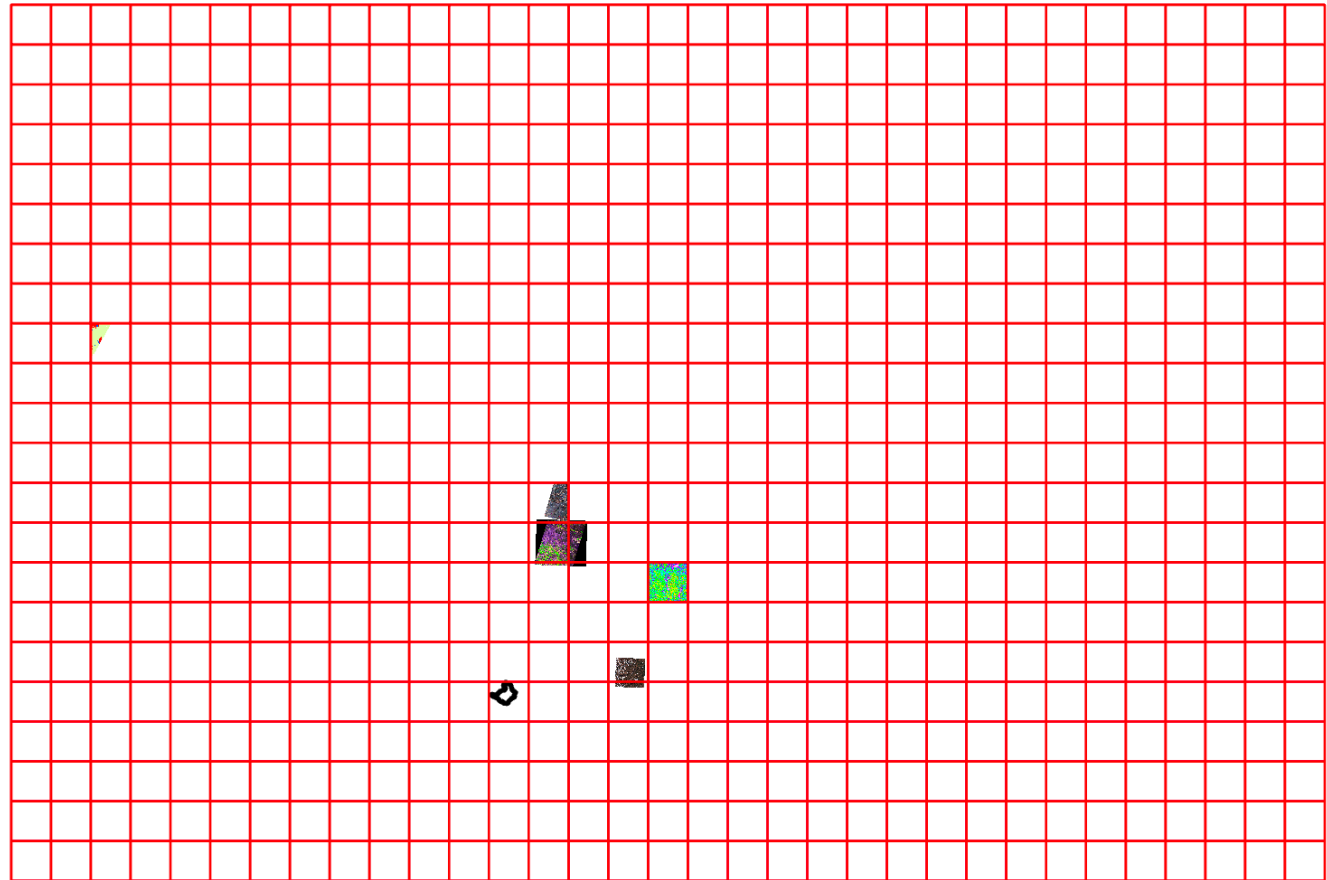


Drawing Order

 Lesson 0 Data Intro

- ▷ ☒ Satellite data collection grids
- ▷ ☒ Landsat examples
- ▷ ☒ ISRO ResourceSat
- ▷ ☒ ESA Sentinel 2 example
- ☐ World Topographic Map
- ☐ World Hillshade

Lesson 0 Data Intro X Lesson 1 Basics

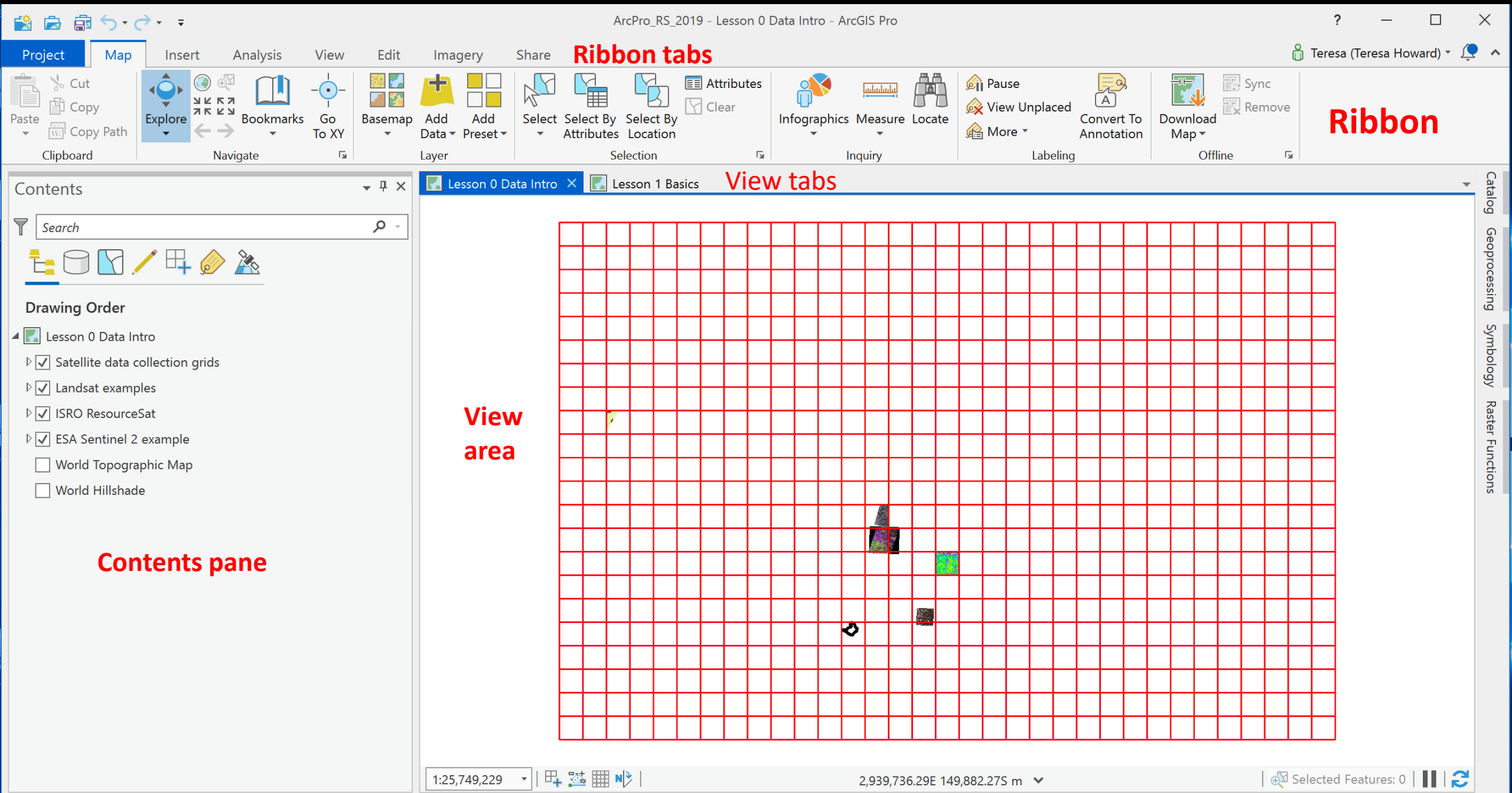


1:25,749,229

2,939,736.29E 149,882.27S m ▼

Selected Features: 0





For our tour, we will zoom to each layer group from top to bottom.

We will turn layers off and on.

We will investigate spatial resolution, coordinate systems, and data product characteristics.

The screenshot shows the 'Drawing Order' panel in QGIS. The 'Lesson 1 Data Intro' group is expanded, showing several layers. The 'Clipped Big Bend NP' layer is selected and highlighted in blue. A context menu is open over this layer, listing various actions. The 'Zoom To Layer' option is highlighted in blue. A tooltip for 'Zoom To Layer' is also visible, stating 'Zoom to the extent of the selected layers.' The background shows a map with a red grid overlay.

Drawing Order

- Lesson 1 Data Intro
 - ☒ Satellite data collection grids
 - ☒ Landsat examples
 - ☒ Clipped Big Bend NP
 - ☒ Landsat ARD Lake
 - ☒ Landsat ARD DFW
 - ☒ Mendocino Burn s
 - ☒ Landsat ARD Missi
 - ☒ ESA Sentinel 2 exam
 - ☒ ISRO ResourceSat
 - ☐ World Topographic M
 - ☐ World Hillshade

Context Menu for 'Clipped Big Bend NP':

- + Add Data
- ☀ New Group Layer
- 📄 Copy
- 📄 Paste
- 🗑 Remove
- 📁 Group
- 📁 Ungroup
- 🔍 Zoom To Layer**
- 🔍 Zoom To Make Vi
- 🖌 Symbology
- Sharing ▶
- 📄 View Metadata
- ✎ Edit Metadata
- 🗉 Properties

Zoom To Layer tooltip: Zoom to the extent of the selected layers.

Scale: 1:25,750,674

Basic image preprocessing

Lesson 2

Lesson 2 – in which you learn...

- How to composite using the composite band tool
- How to represent composite images
- All about band combinations
- How to composite using raster functions
- How to subset data into a rectangle
- How to clip to a polygon

Working with mosaic datasets

Lesson 3

Lesson 3 – in which you learn...

- How to prepare an empty mosaic dataset
- How to add images to a mosaic dataset
- How to change symbology in a mosaic dataset
- How to add a time attribute
- How to add a time dimension to the mosaic dataset
- How to view time series data in a mosaic dataset

Working with and creating derived datasets

Lesson 4

Lesson 4 – in which you learn...

- How to visualize Landsat ARD surface temperature
- How to calculate F° from K° using ARD surface temperature
- How to generate and apply .lyrx files
- How to calculate an NDVI raster using ISRO LISS-3 data
- How to visualize burned areas using Landsat Level 3 data
- How to visualize dynamic surface water extent using Landsat Level 3 data

Closing thoughts

We didn't cover raster reprojection and coordinate systems in this workshop, but fortunately...

Jarlath O'Neil-Dunne of the University of Vermont and VermontView/AmericaView has created an excellent Penn State University video series related to [Projecting Raster Data](#) using ArcGIS Pro.

<https://www.e-education.psu.edu/geog883/node/582>

Questions? Comments?

Reach me at teresahoward@utexas.edu

Thank you for you interest!