Imagery Sources and Usage in ArcGIS

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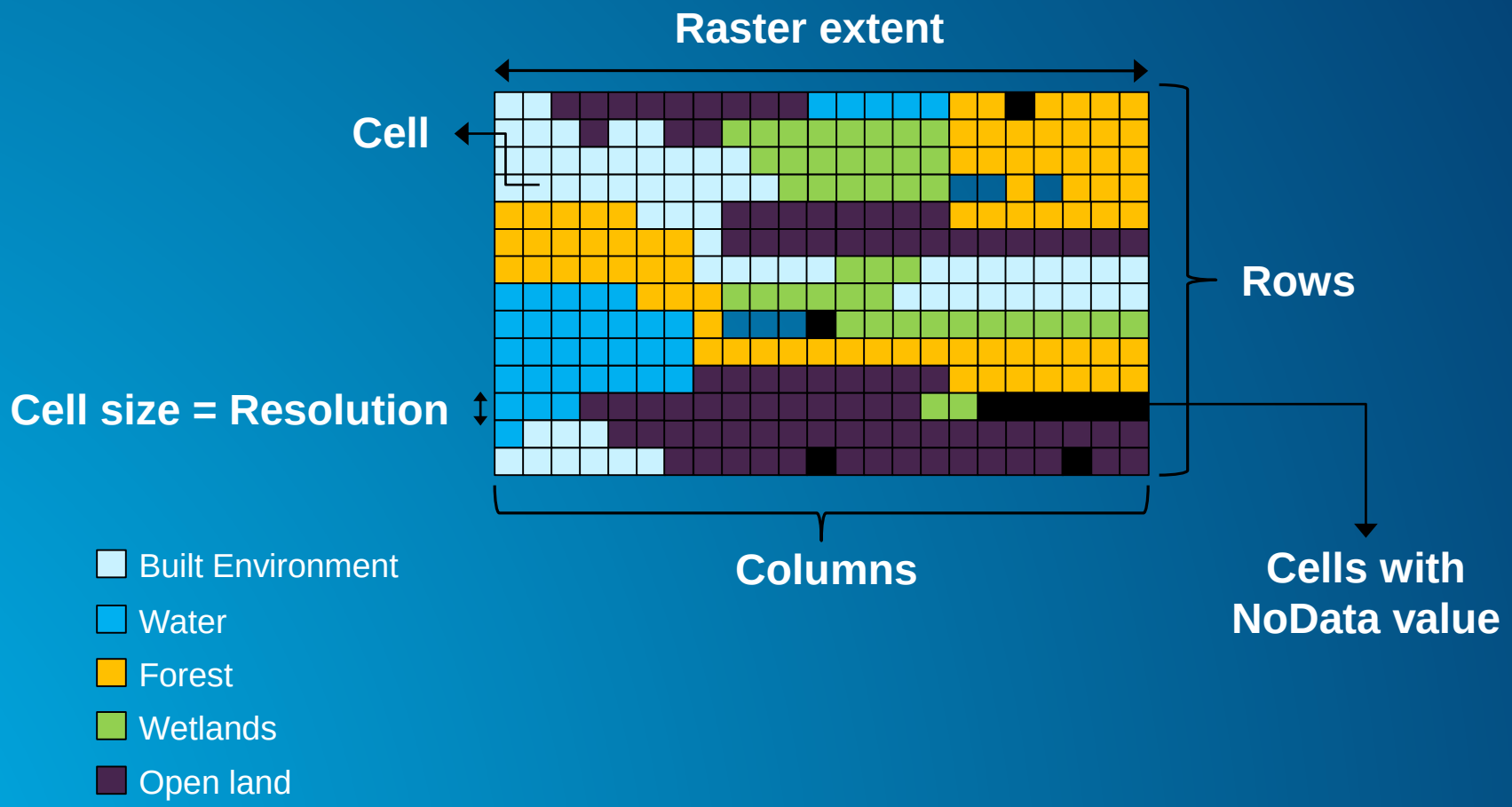
Imagery…

- … is visible intelligence

Agenda

- Imagery basics
- Sources of imagery
  - Platforms and sensors
  - Living Atlas
- Image usage
  - Image Storage
  - Image processing in ArcGIS Pro
  - Image Analysis techniques in ArcGIS Pro
- LAS Datasets
- Visualization

Image Anatomy



Spectral bands

- **We know:**
  - **Sunlight consist of more wavelengths of electromagnetic radiation than the human eye can see**
    - **e.g. sunburn**
- **Bands: A specific range of wavelengths of electromagnetic radiation**

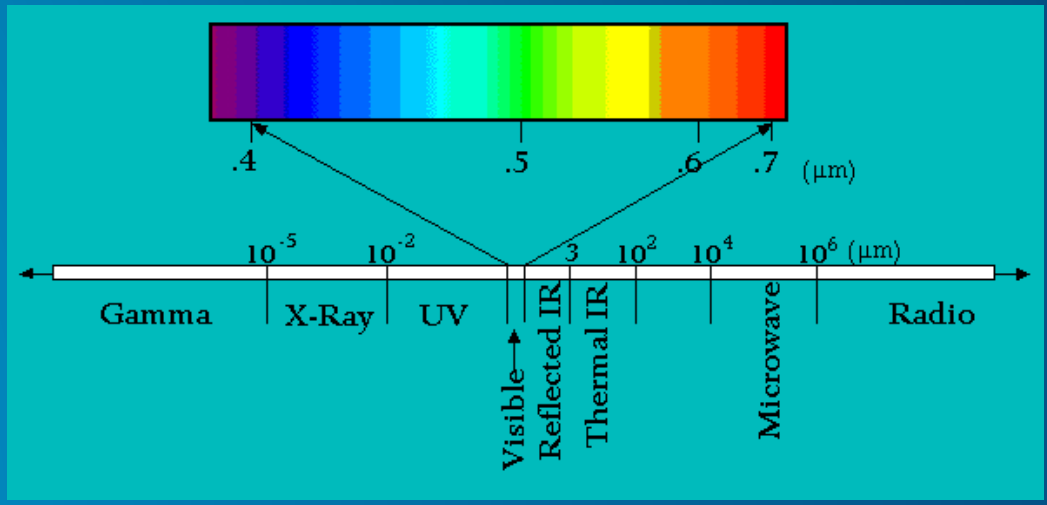
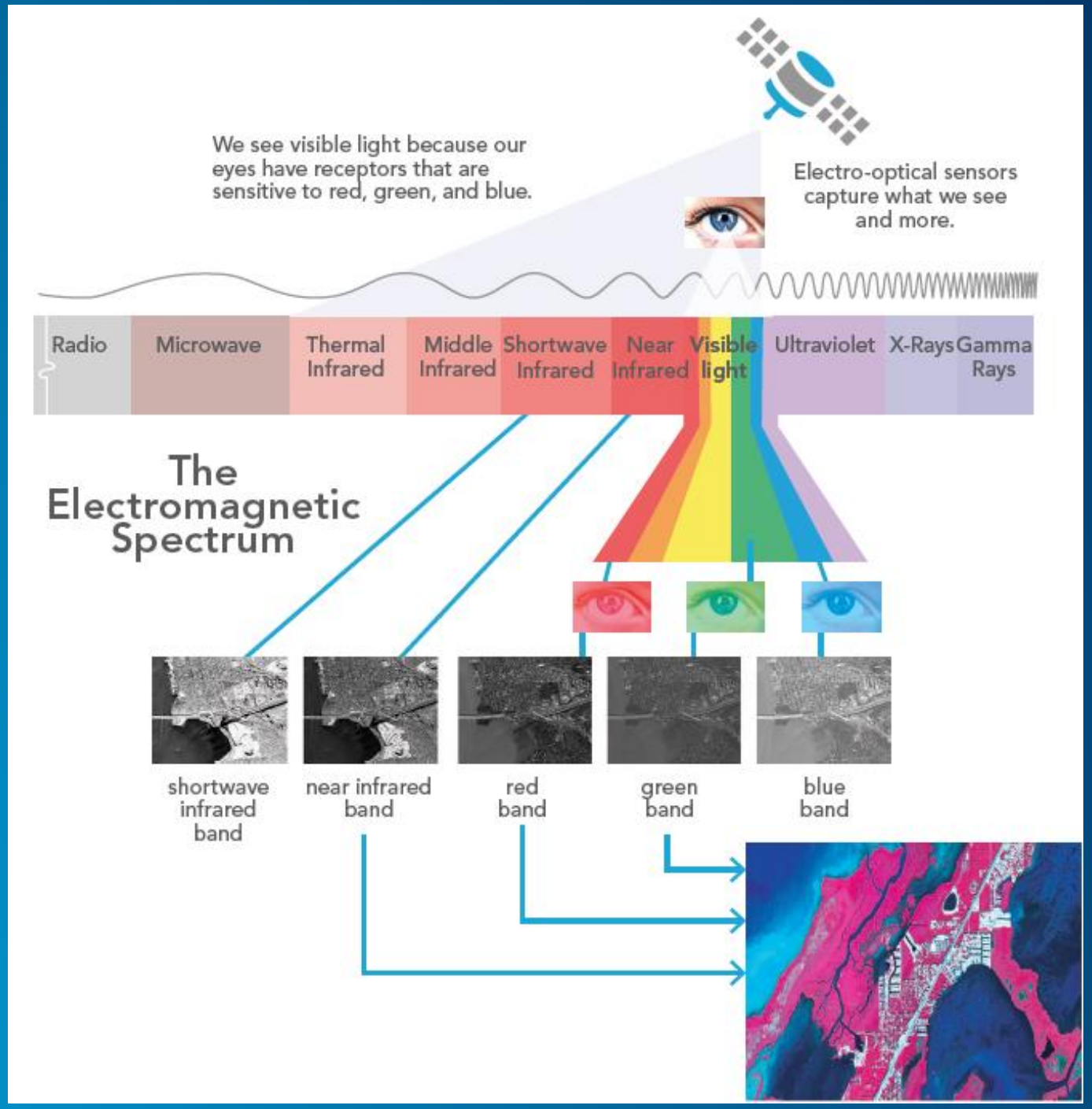


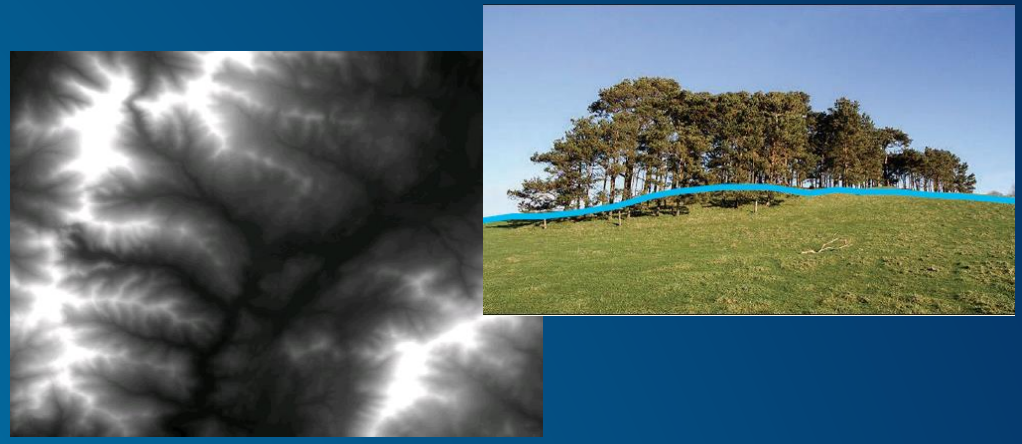
Image bands

- **Single Band**
- **Multispectral**



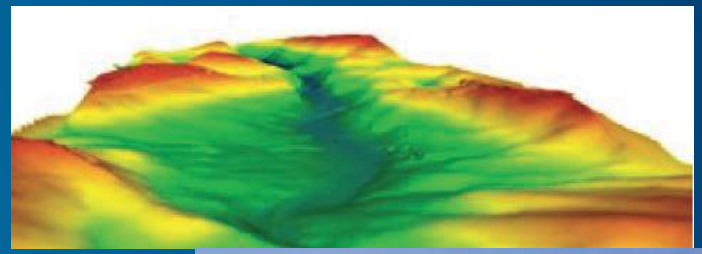
Types of Imagery: single band

- Grayscale imagery
- Digital Elevation Models (DEMs)



DEM

- 3D Imagery
  - Digitial Terrain Models (DTM) – bare earth
  - Digital Surface Models (DSM) – height of surface features



DTM

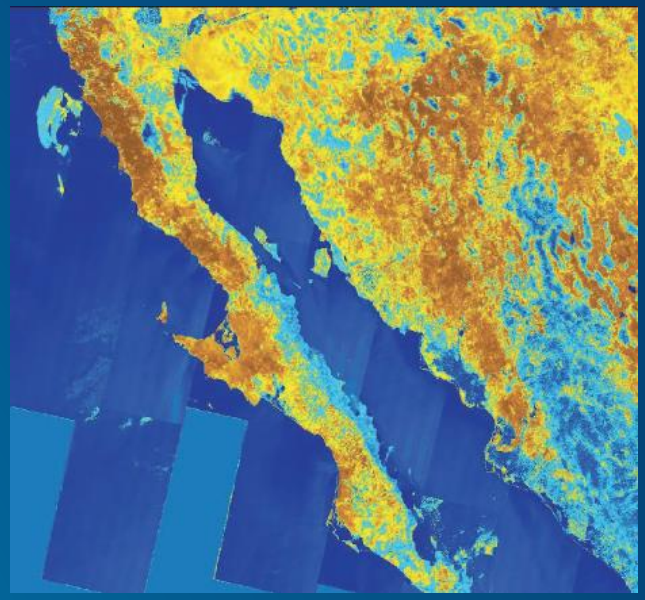
DSM

Multispectral Imagery

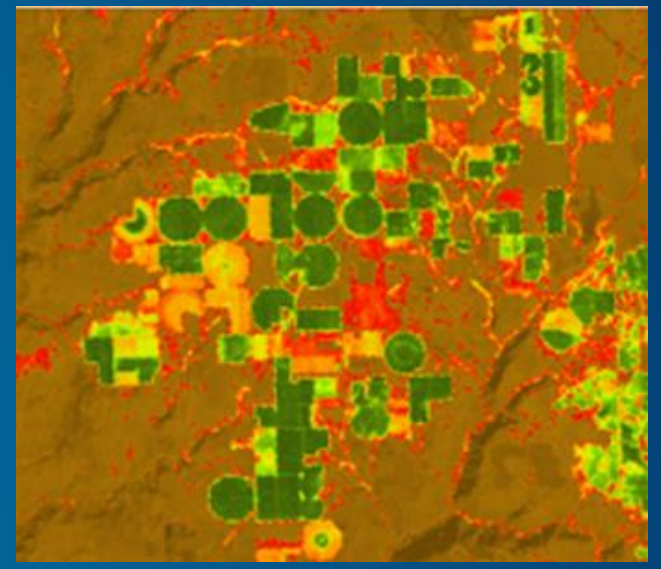
- **Multispectral**

NaturalColor

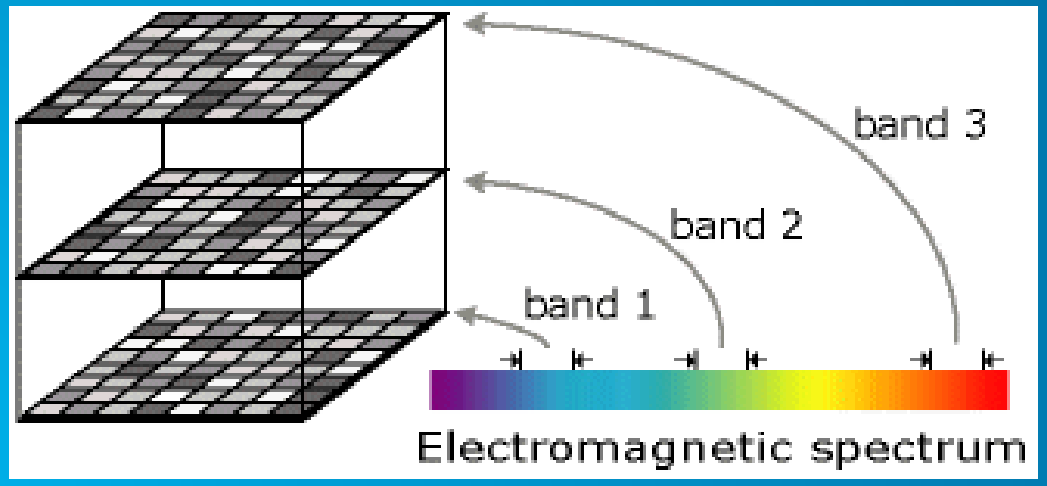
Color Infrared



NDMI

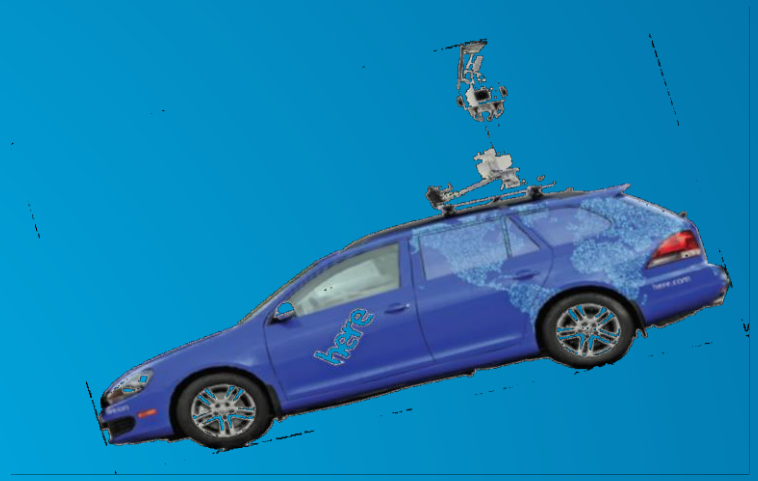


NDVI



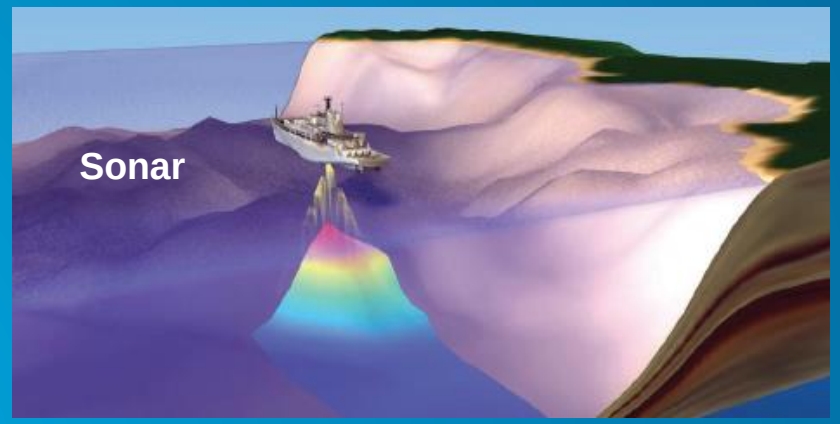
Sensor Platforms

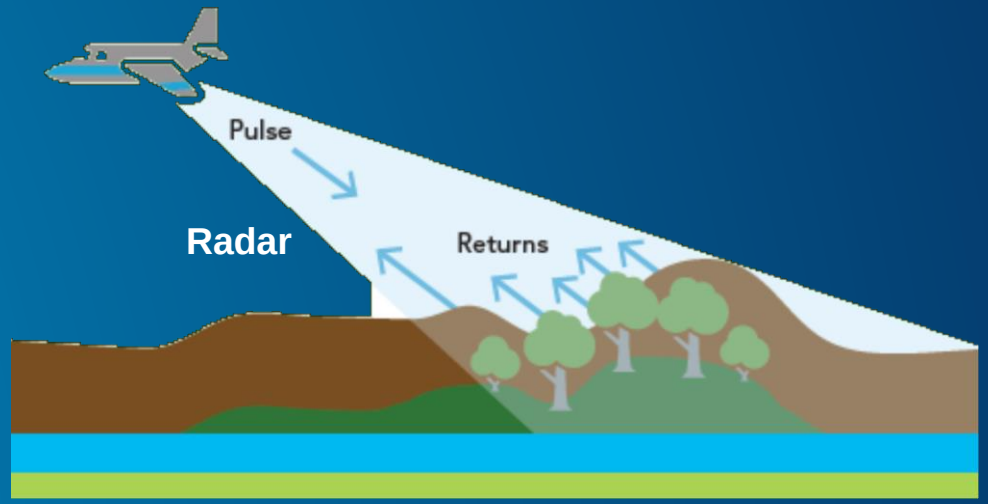
- **Platforms**
  - **Satellites**
  - **Aircrafts**
  - **Drones (UAVs)**
  - **Ground based / handheld**



Sensors

- **Sensors**
  - **Passive – record reflected sunlight**
    - **Cameras**
    - **Spectrometers**
  - **Active – emit energy and record reflected radiation**
    - **Lidar**
    - **Radar**
    - **Sonar**





Demo: Image Sources

Image Services

- **Provides imagery as a service**

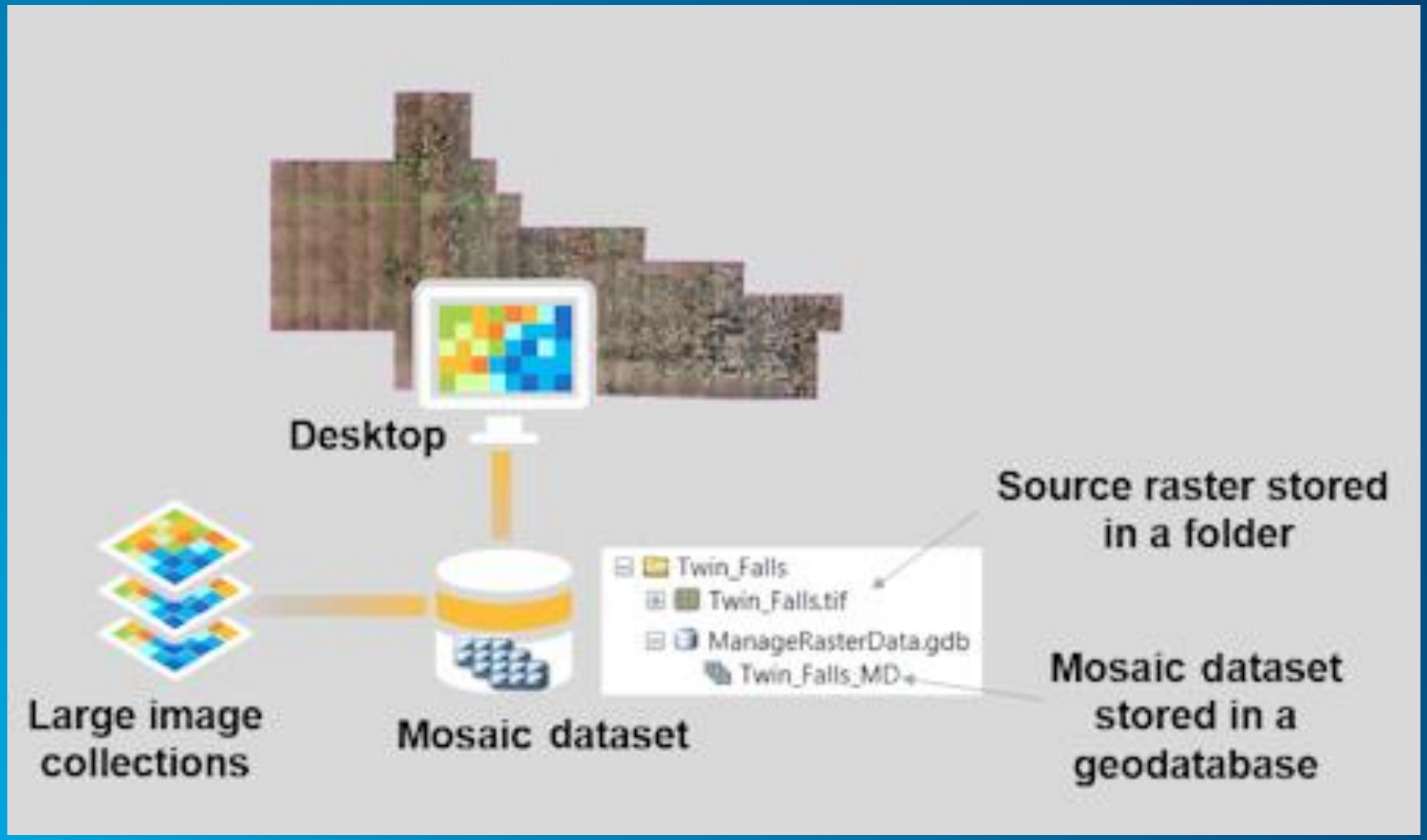
Pictures

Pixels

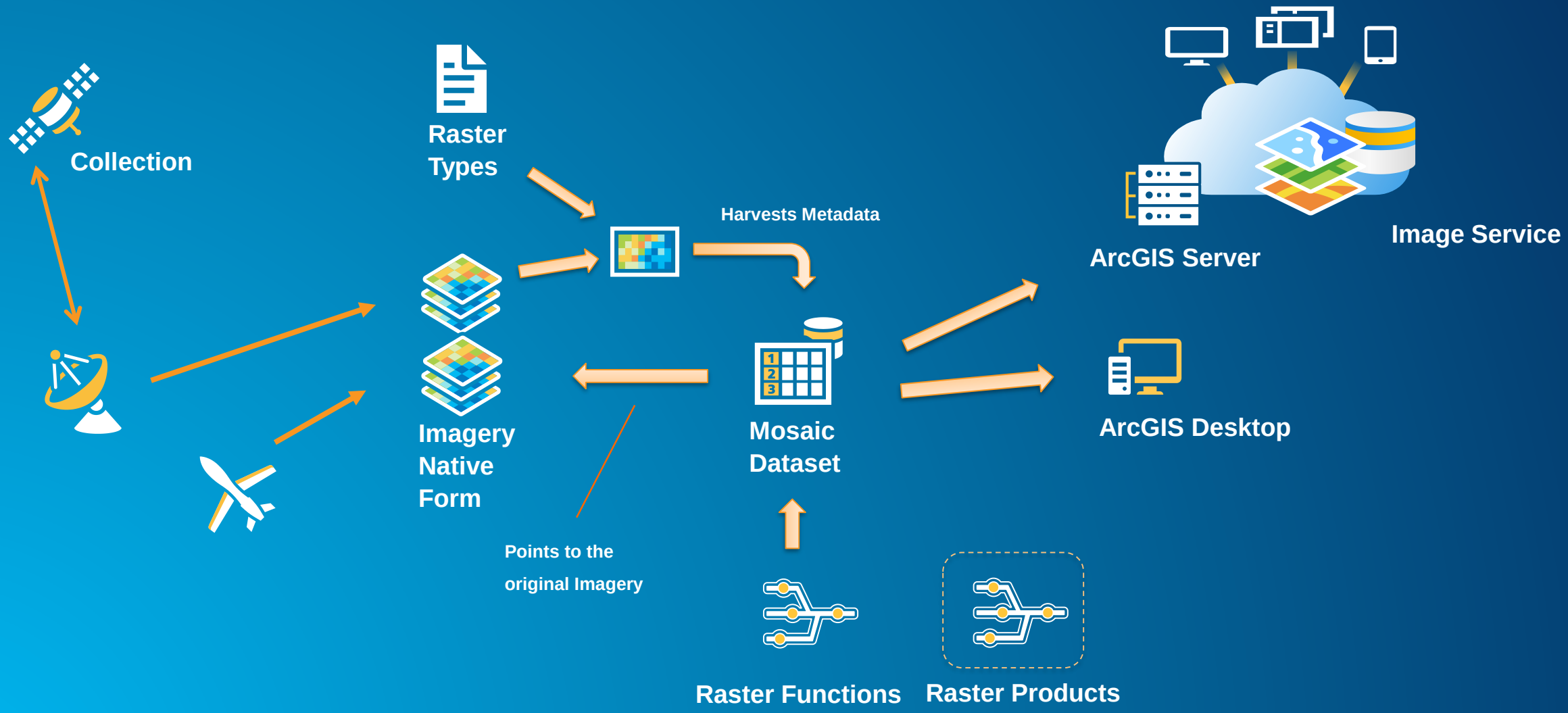
Metadata

Upload/Download

Image storage: Mosaic Dataset

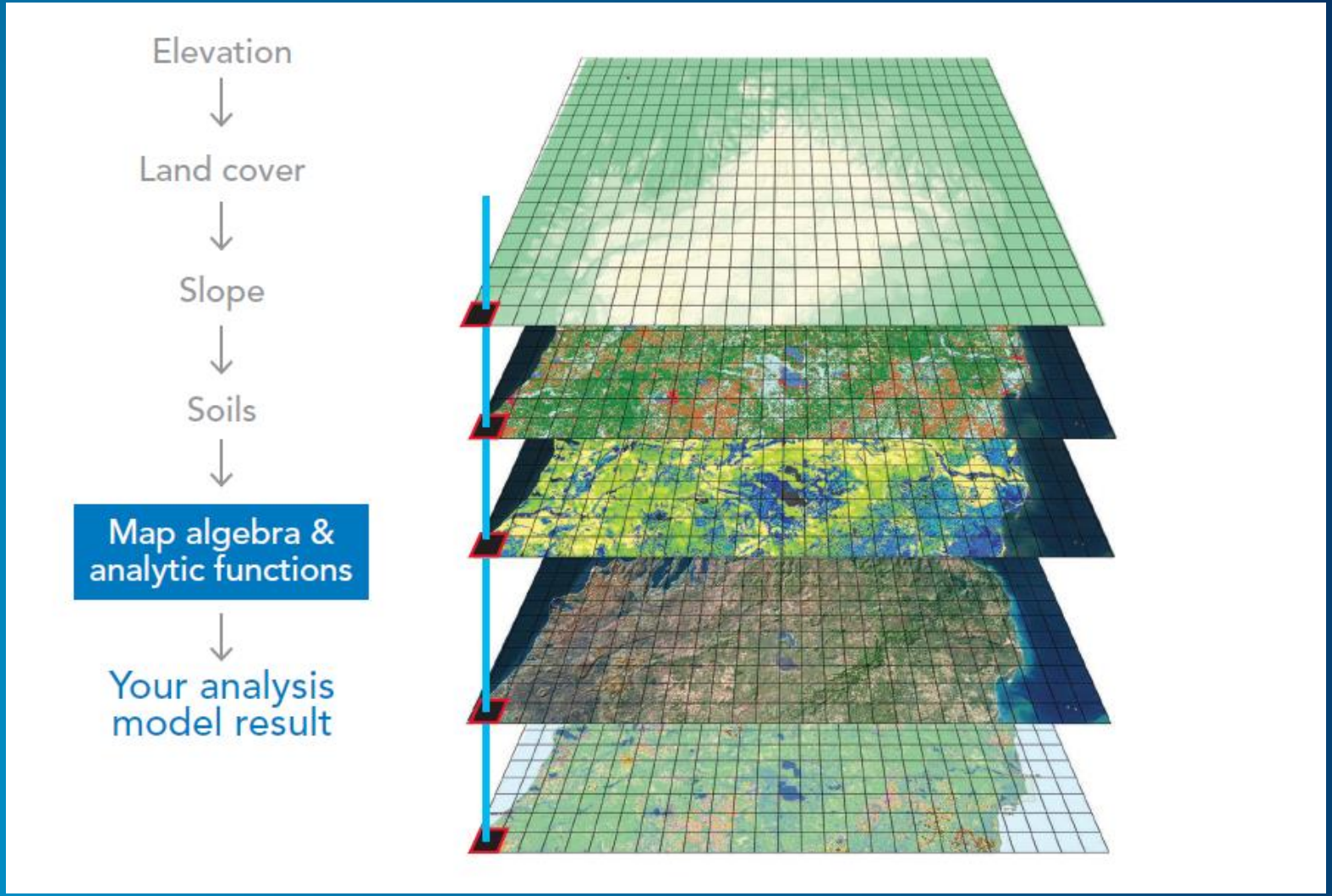


Imagery Workflow



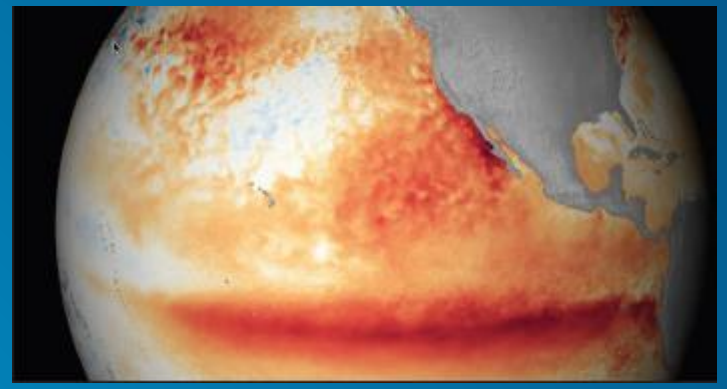
Usage: Image Analysis

- Landcover classification
- Change detection
- Suitability Analysis
- Crop Health
- Visibility Analysis
- Hydrological Analysis



Imagery applications

Engineering and Construction

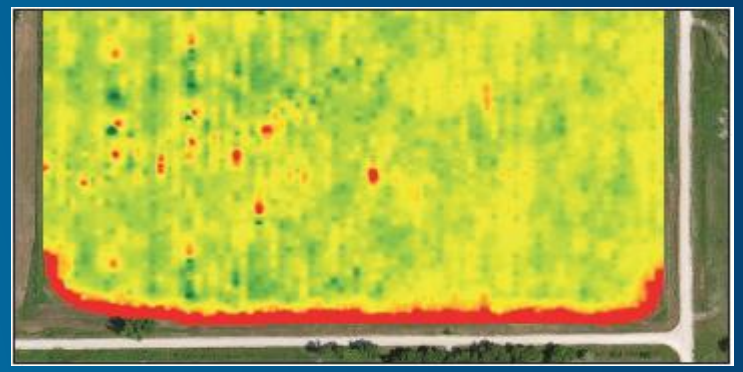


Climate and weather study

Humanitarian Aid

Forestry

Natural Disaster Management



Precision Agriculture

Raster Functions

- Apply an algorithm on-the-fly to an existing raster/image layer (raster dataset or mosaic dataset)
- Can be applied to a pixel or block of pixels (segment)
- Can be chained into Raster Function Chains

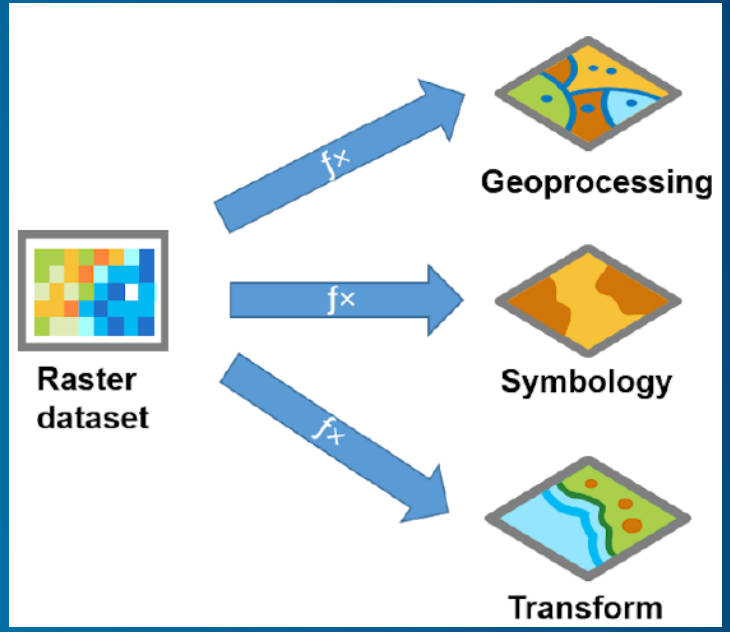
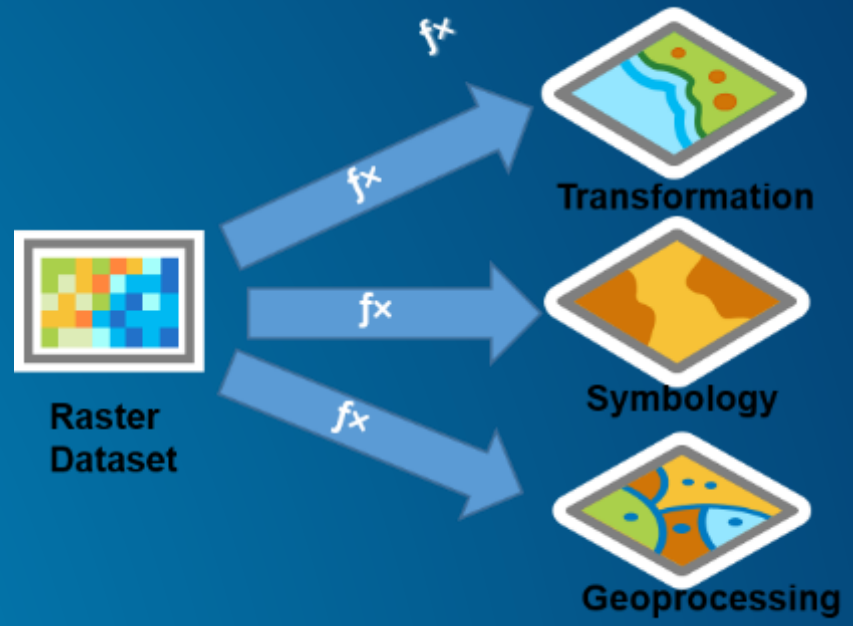


Image Processing: Raster functions

- **Raster functions can:**
  - **Transform the data**
  - **Alter symbology properties**
  - **Replicate geoprocessing tools**

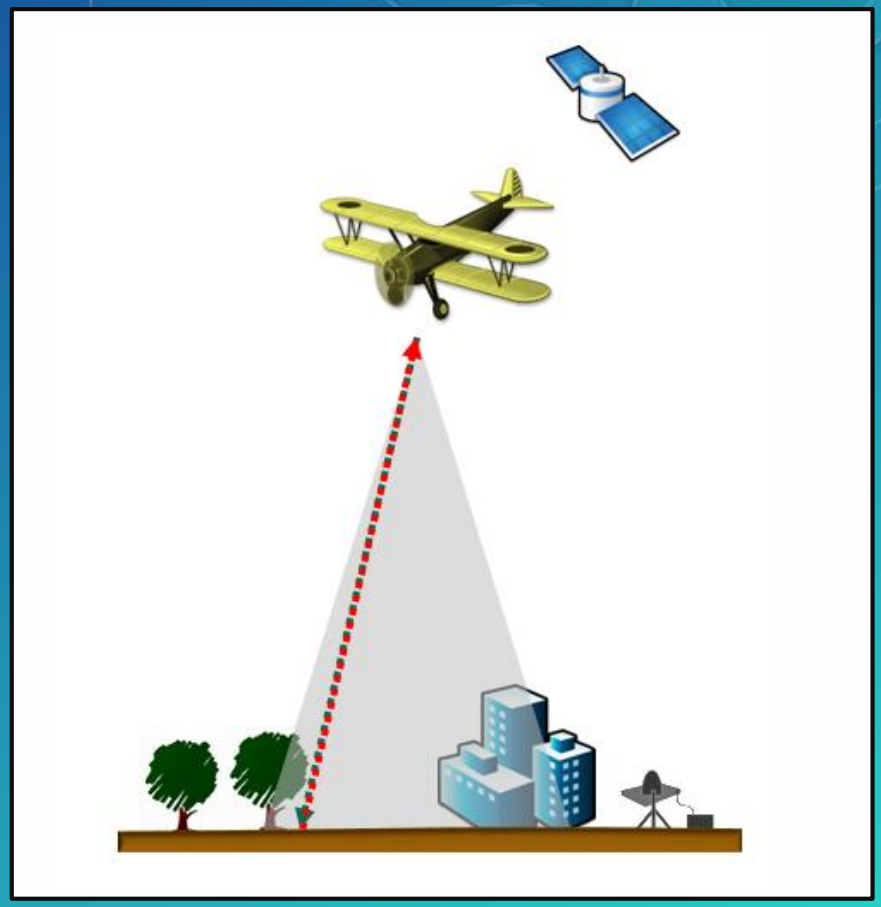
Quality	Geoprocessing tool	Raster function
Has quick processing speed		X
Does not modify input data		X
Adjusts input parameters after processing		X
Can be used in process chain	X	X



Demo: Image Analysis in ArcGIS Pro

LiDAR Background

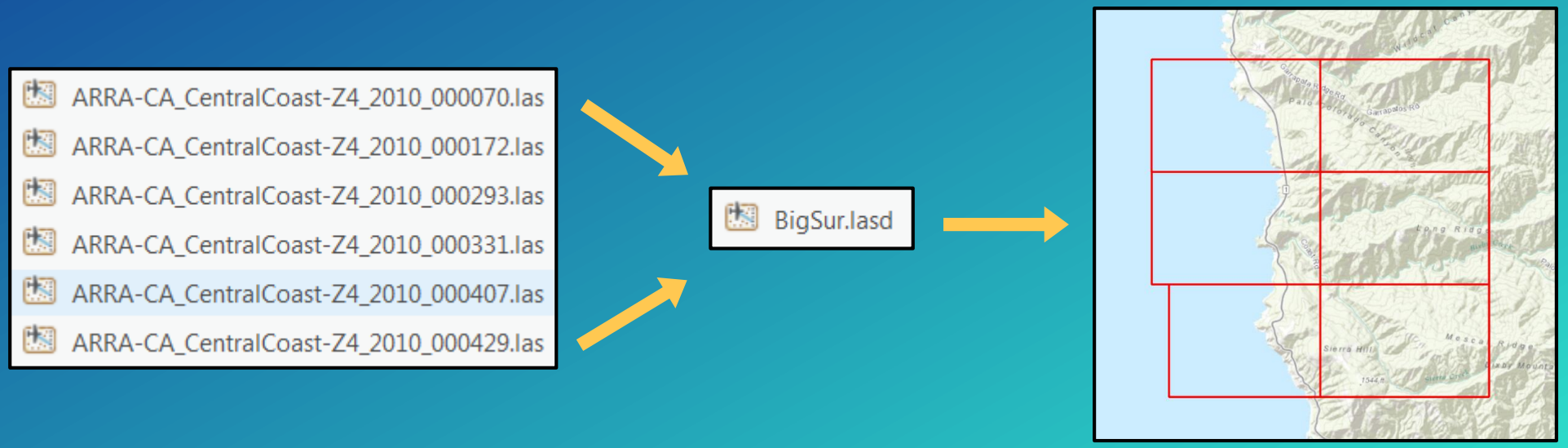
- LiDAR – Light Detection and Ranging
  - Optical remote sensing technique using laser light to densely sample the Earth's surface, producing a point cloud of highly accurate x,y,z measurements
  - Originated in the 1960s; Supported in ArcGIS since version 10.1
  - Types of Point Clouds
    - Airborne scanned-based LiDAR
    - Airborne Geiger mode LiDAR
    - Mobile / Tripod-based LiDAR
    - Photogrammetric point clouds
  - LiDAR point cloud attributes
    - x,y,z measurements
    - Intensity
    - Return number
    - Class code
    - RGB



- LAS is the default data structure for working with LiDAR point clouds
  - LAS is an industry-standard, binary file format developed by ASPRS
  - LAS/zLAS can be used individually now (~Pro 1.4)

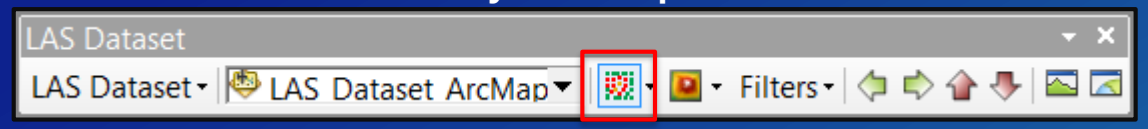
The LAS Dataset

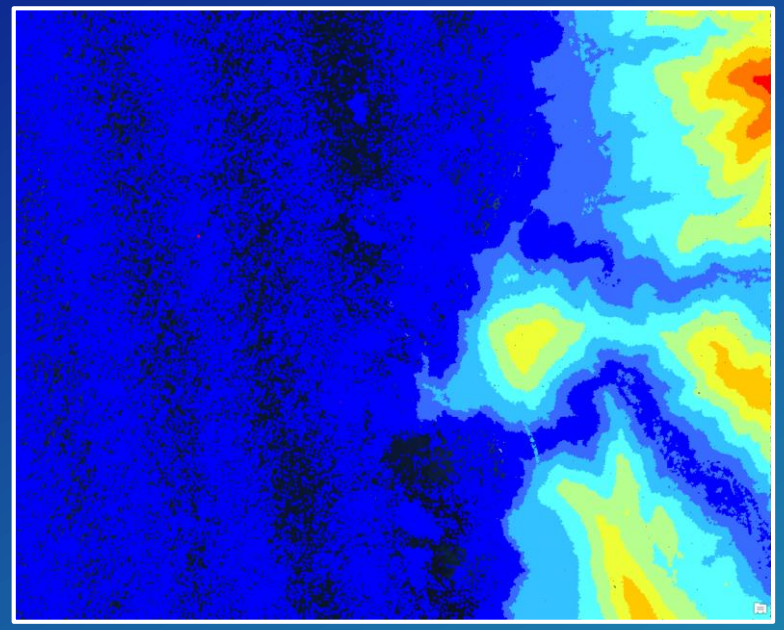
- **LAS Dataset**
  - **“Container” for storing reference to many LAS/zLAS files on disk**
    - **Pointer to the original LAS/zLAS files**
    - **Quick to create, small in file size, easy to update with additional LAS/zLAS files**
  - **Quick display of LAS/zLAS data as point clouds or a dynamic TIN in 2D or 3D**
  - **Excellent for QA/QC of LiDAR coverage (point density/spatial extent)**
  - **Basis for generated products such as DEMs and DSMs or TINs**
  - **Recommend Tiled LAS tool for large LAS files**



Working with LiDAR in ArcMap

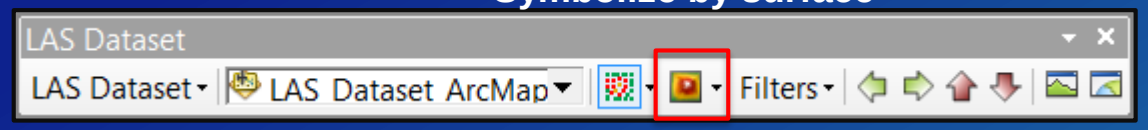
Symbolize points

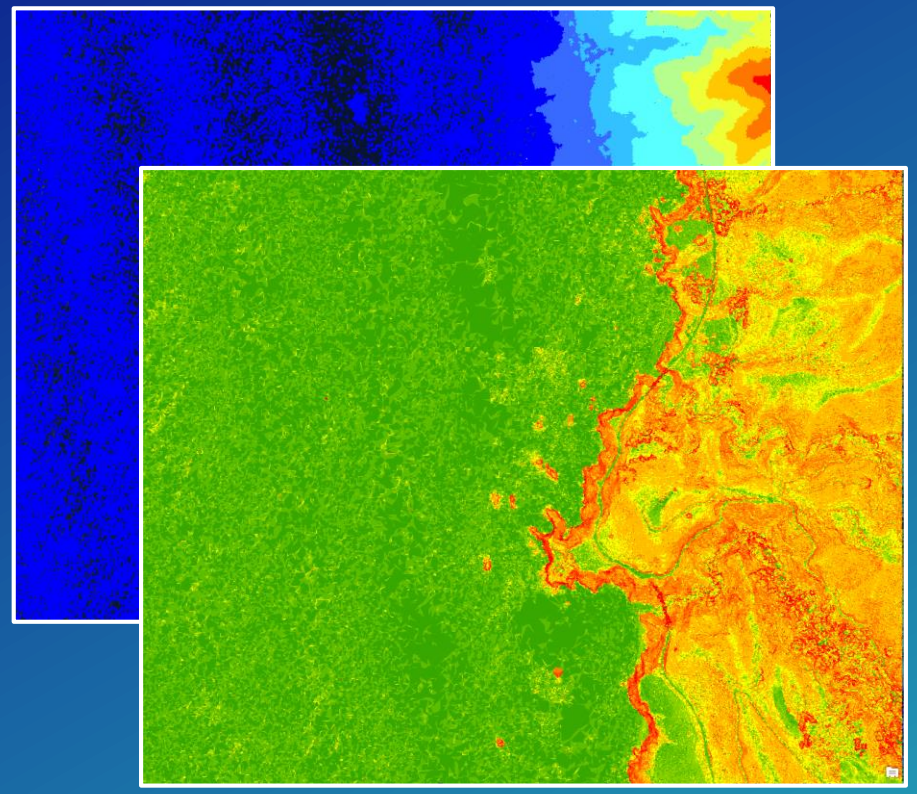




Working with LiDAR in ArcMap

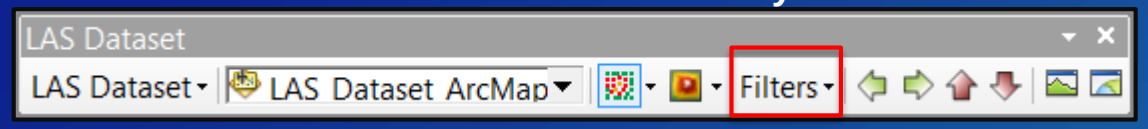
Symbolize by surface

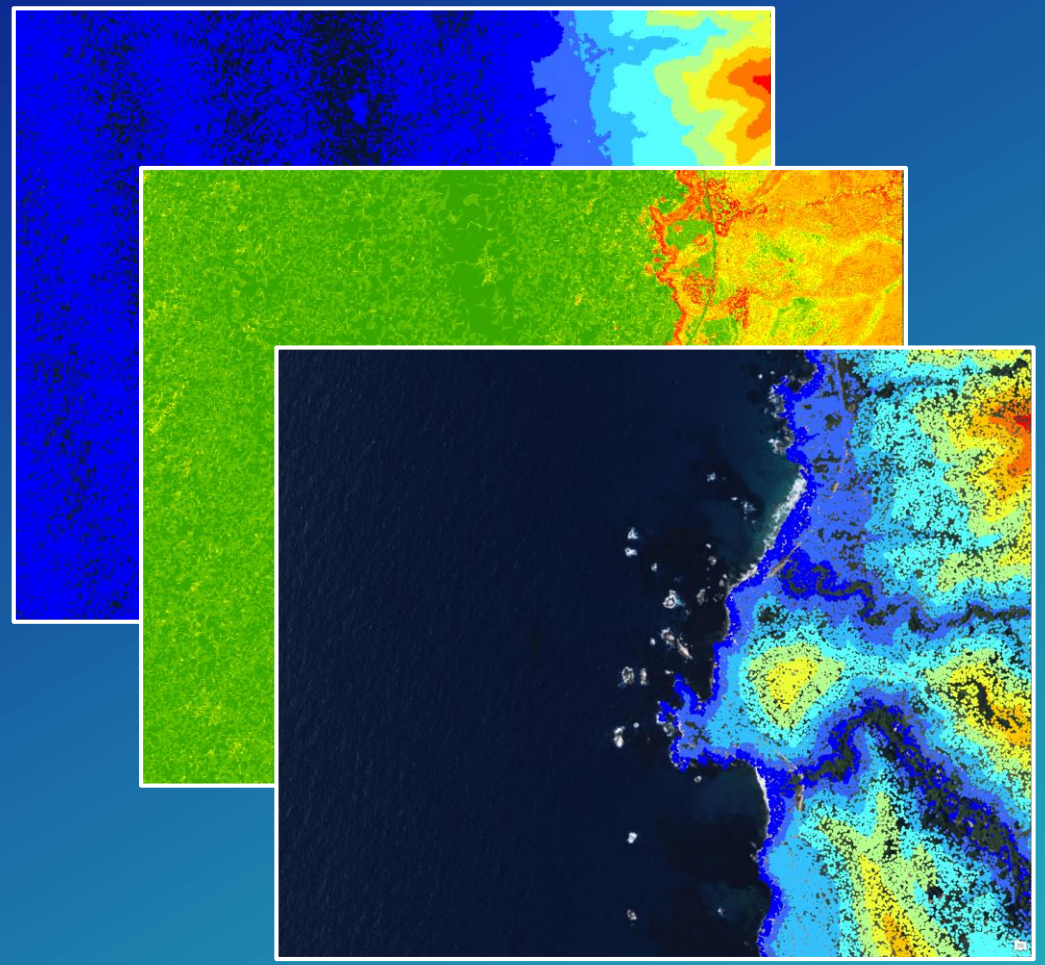




Working with LiDAR in ArcMap

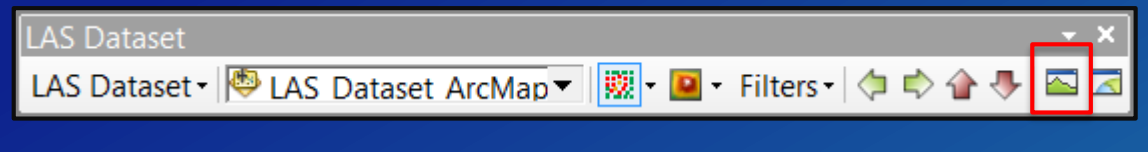
Filter by return

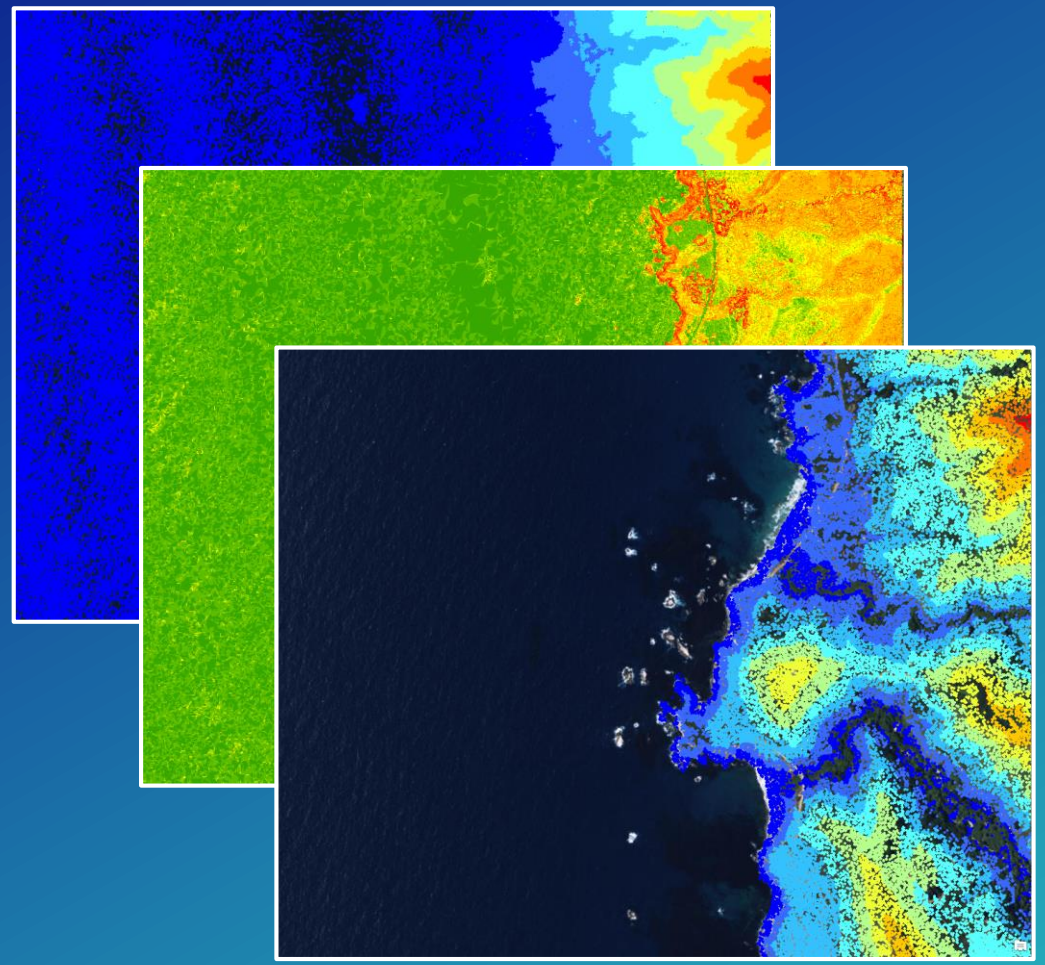


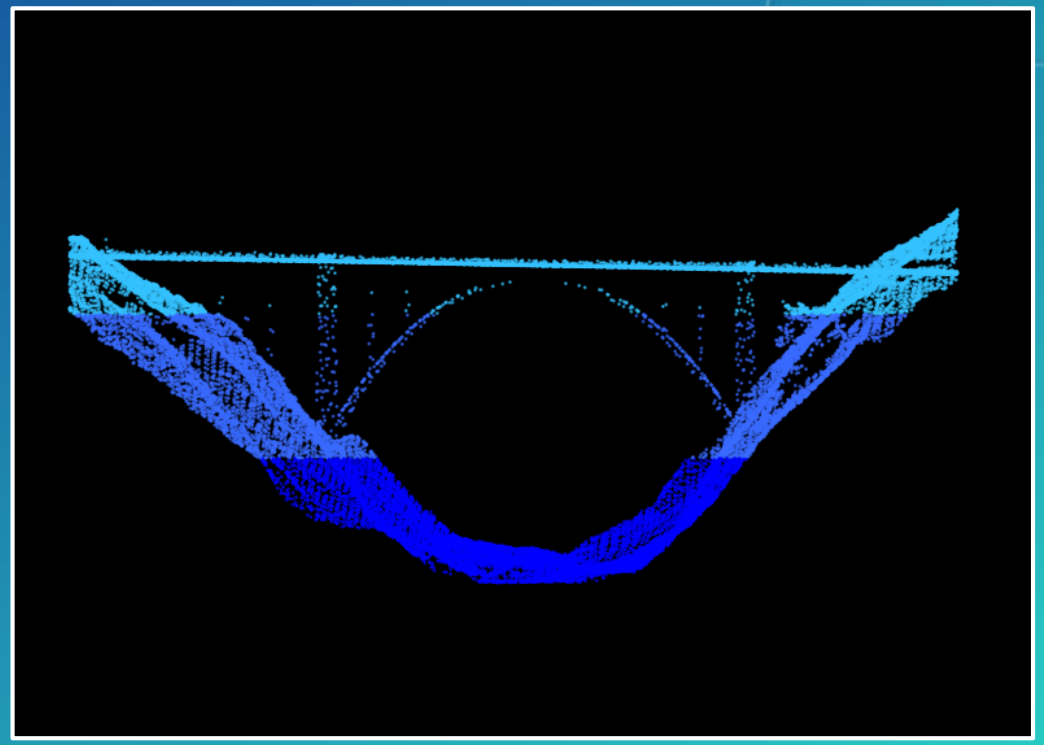


Working with LiDAR in ArcMap

LiDAR point profile

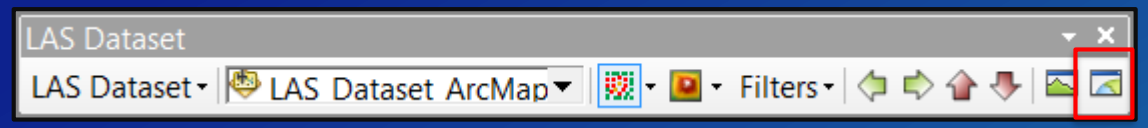


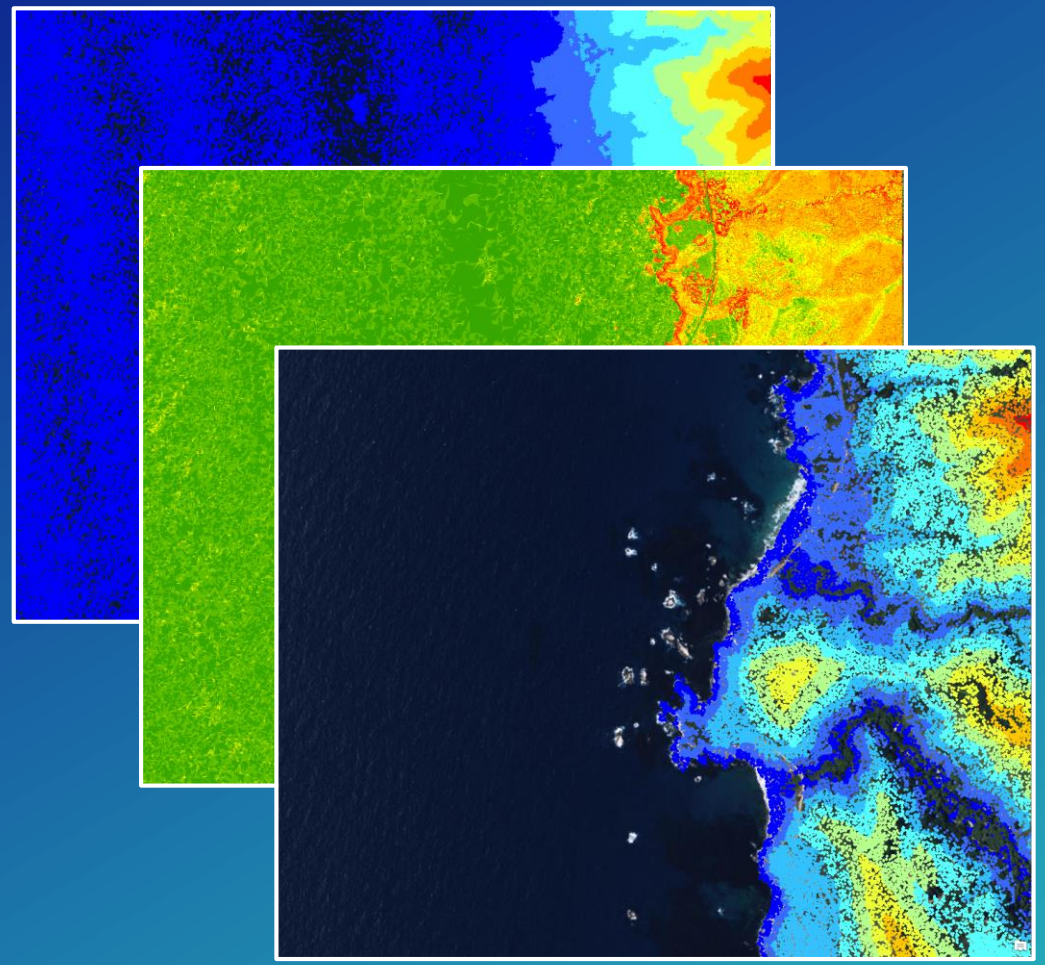


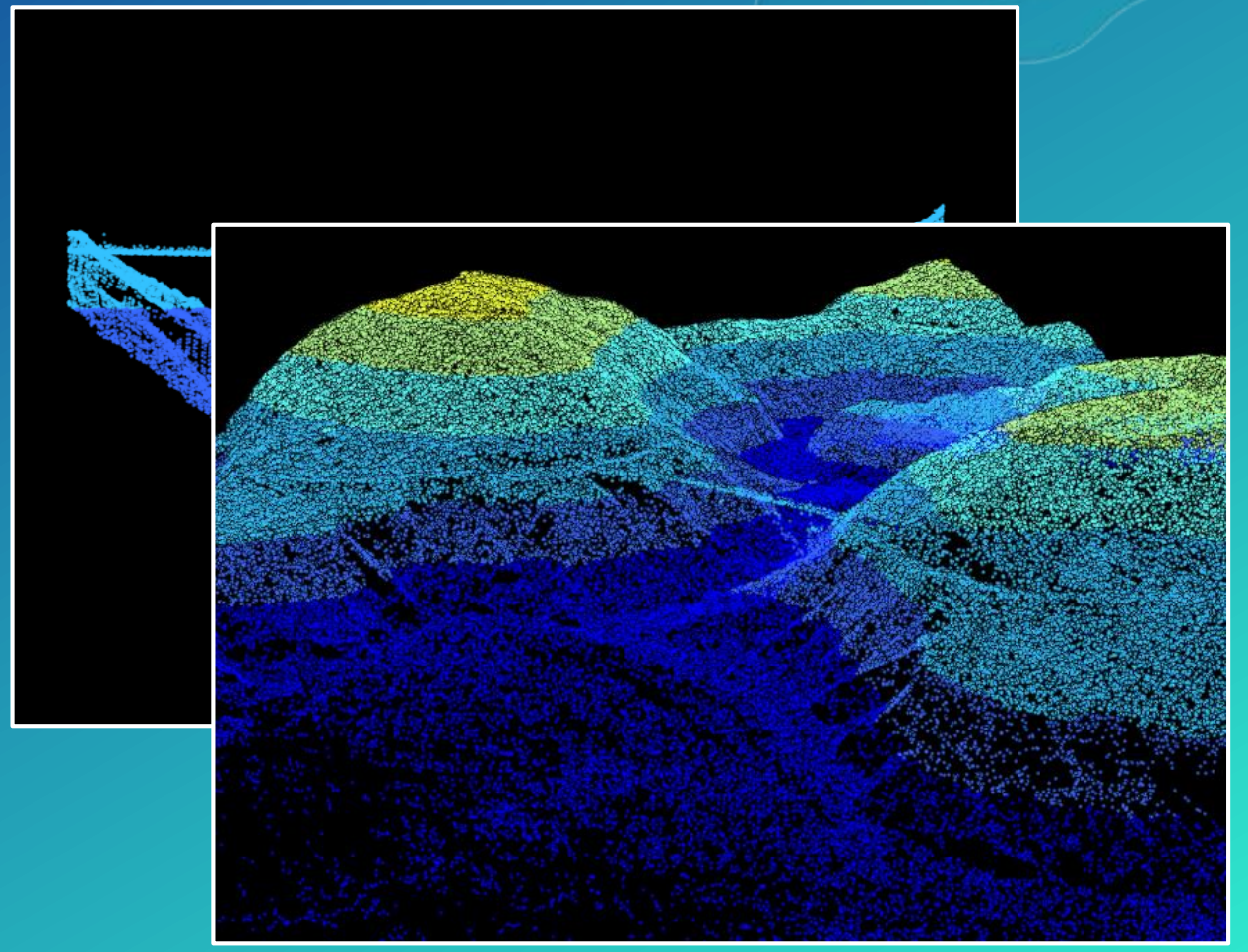


Working with LiDAR in ArcMap

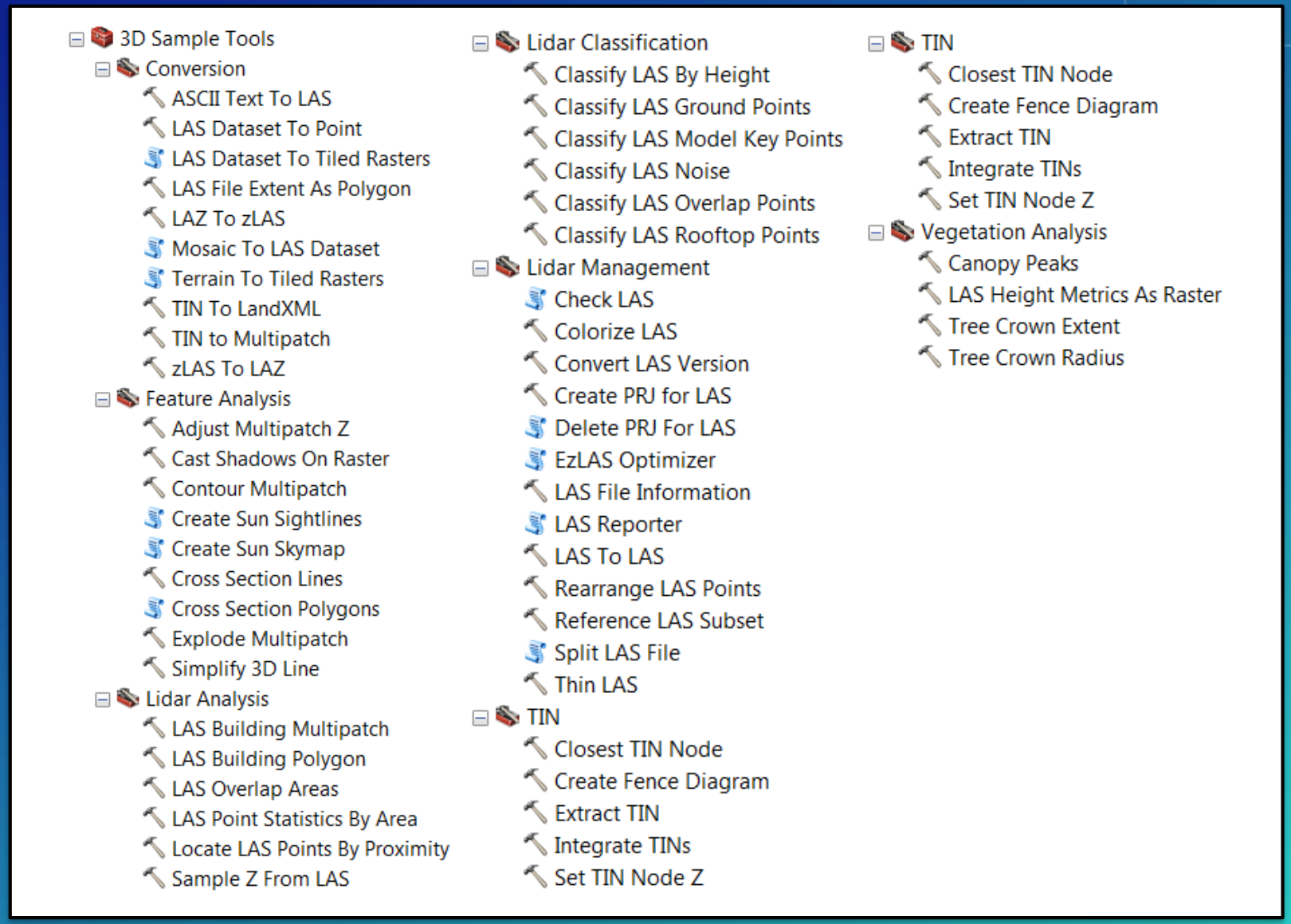
3D view







Working with LiDAR in ArcMap

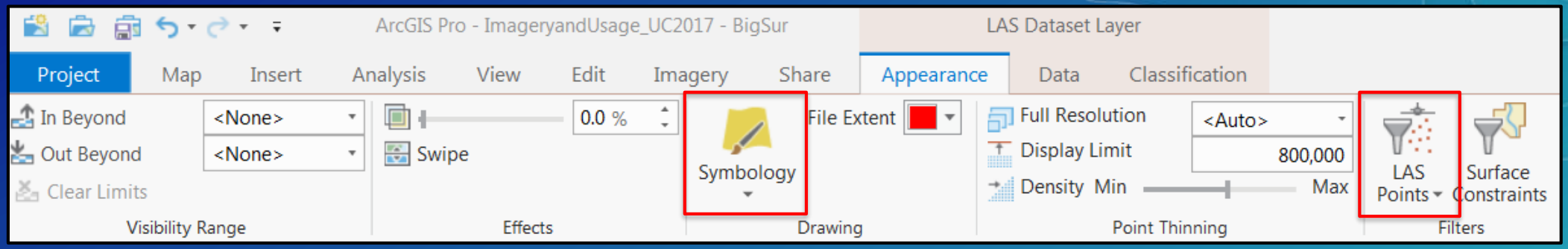


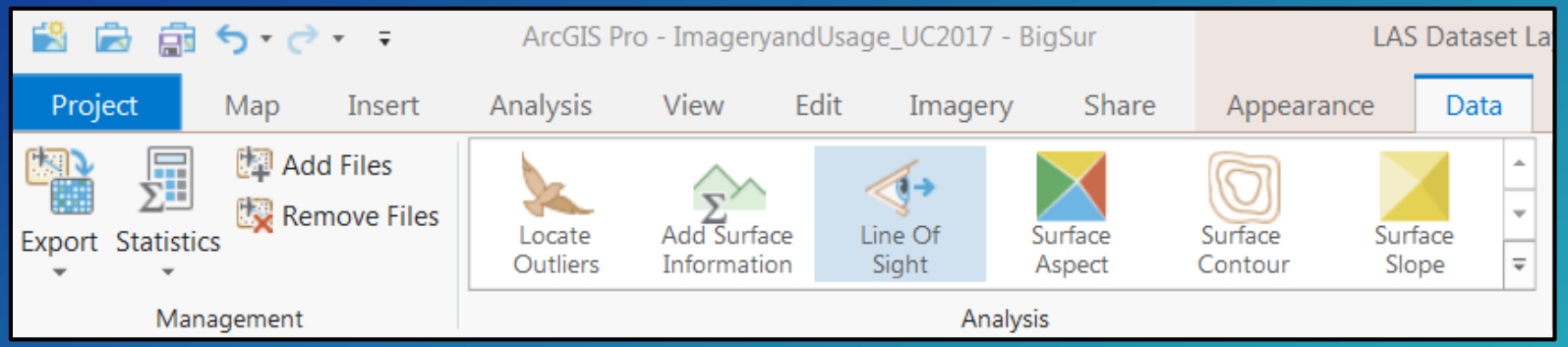
https://www.arcgis.com/home/item.html?id=fe221371b77940749ff96e90f2de3d10

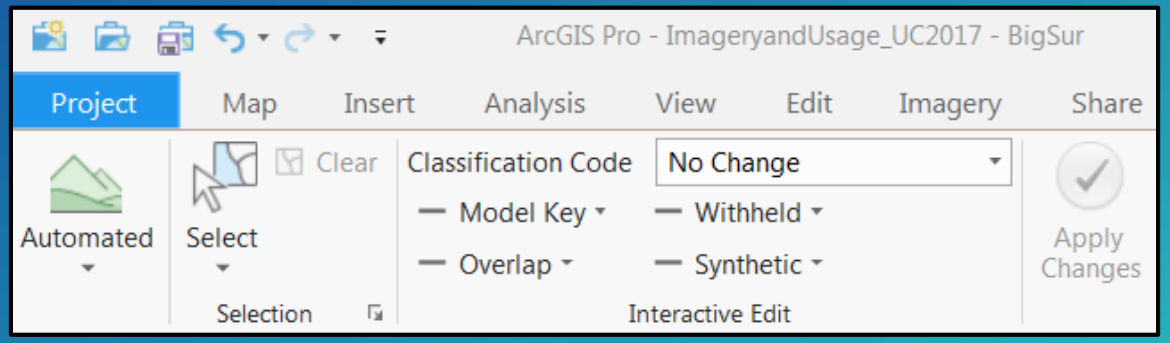
Working with LiDAR in ArcGIS Pro

LAS dataset point symbology

LAS dataset filter

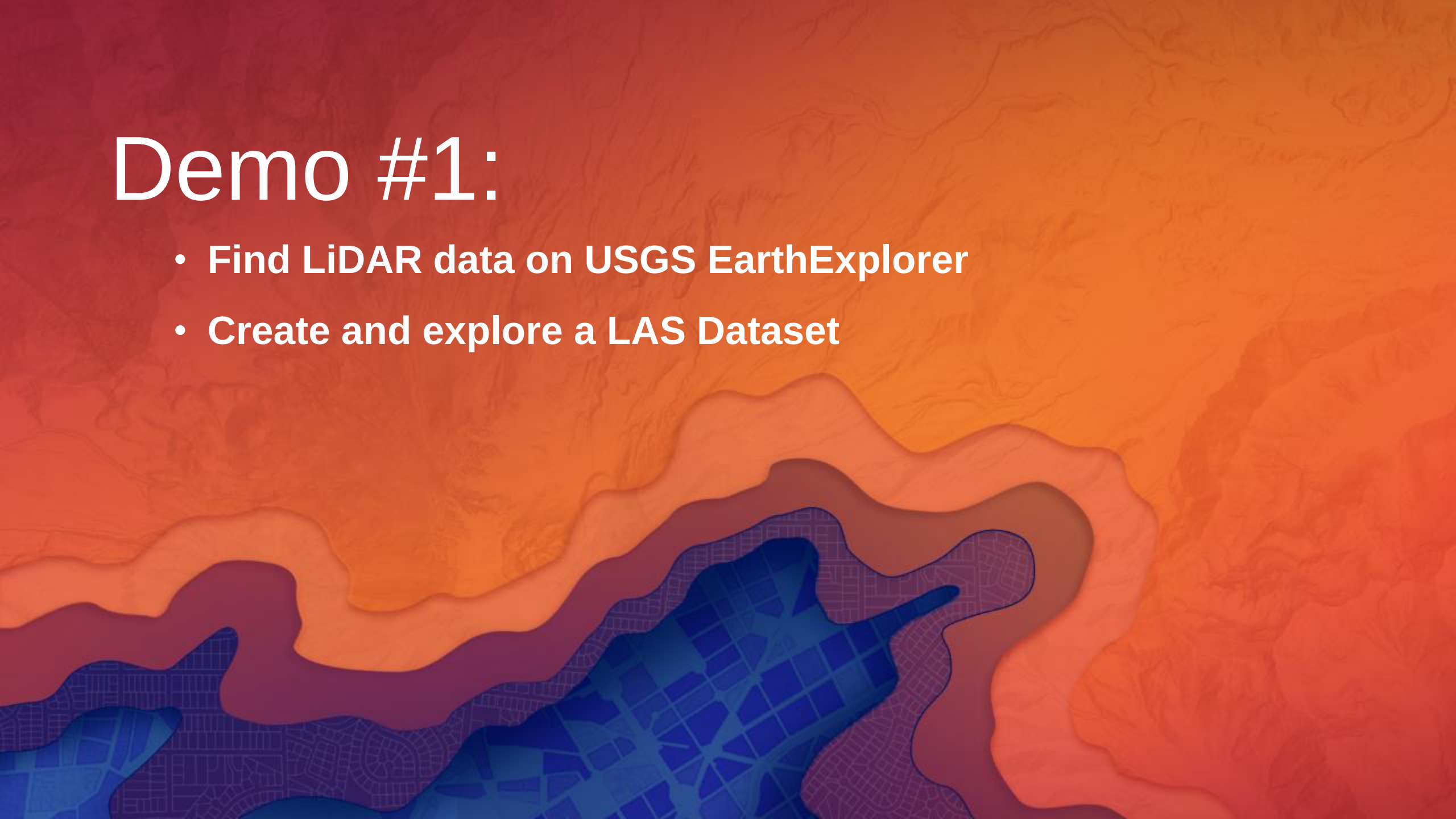






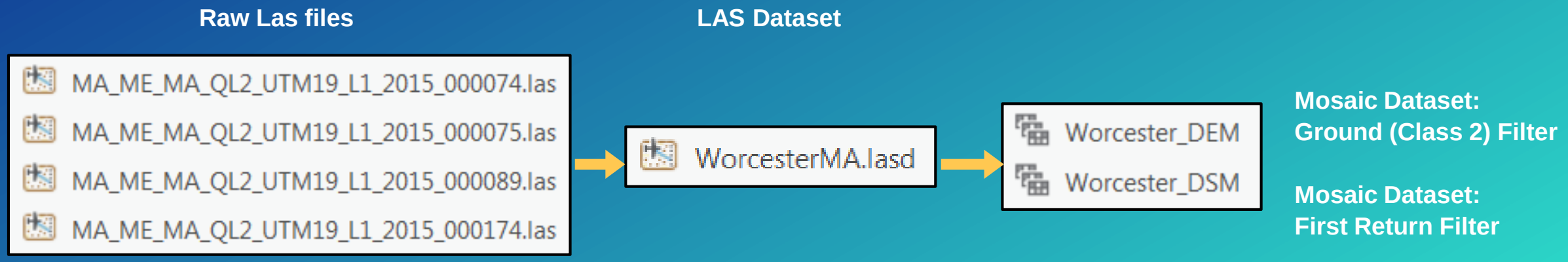
Demo #1:

- **Find LiDAR data on USGS EarthExplorer**
- **Create and explore a LAS Dataset**



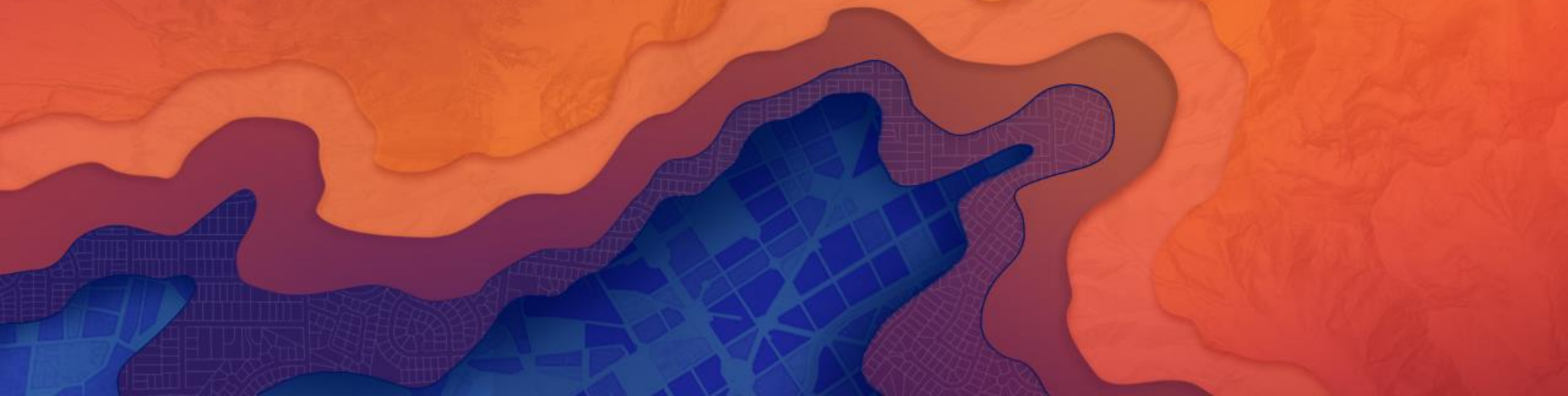
Working with LiDAR in a Mosaic Dataset

- LAS datasets can be directly read into the Mosaic Dataset
  - Use Raster functions or other tools (i.e. Viewshed, Contour, Profile)
  - Used as a DEM
  - Used to orthorectify imagery
  - Used in applications that support rasters but not LAS files or LAS datasets



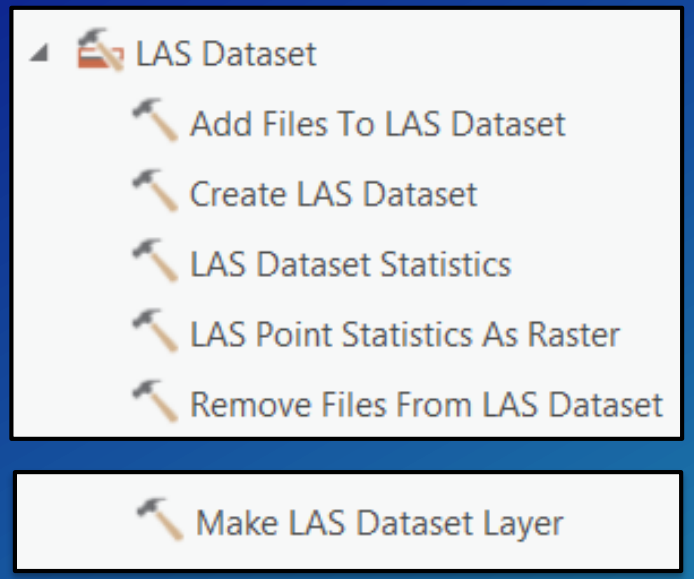
Demo #2:

- **Add LiDAR data to a Mosaic Dataset**
- **Use Raster functions on a Mosaic Dataset to create a Normalized Difference Surface Model (nDSM)**

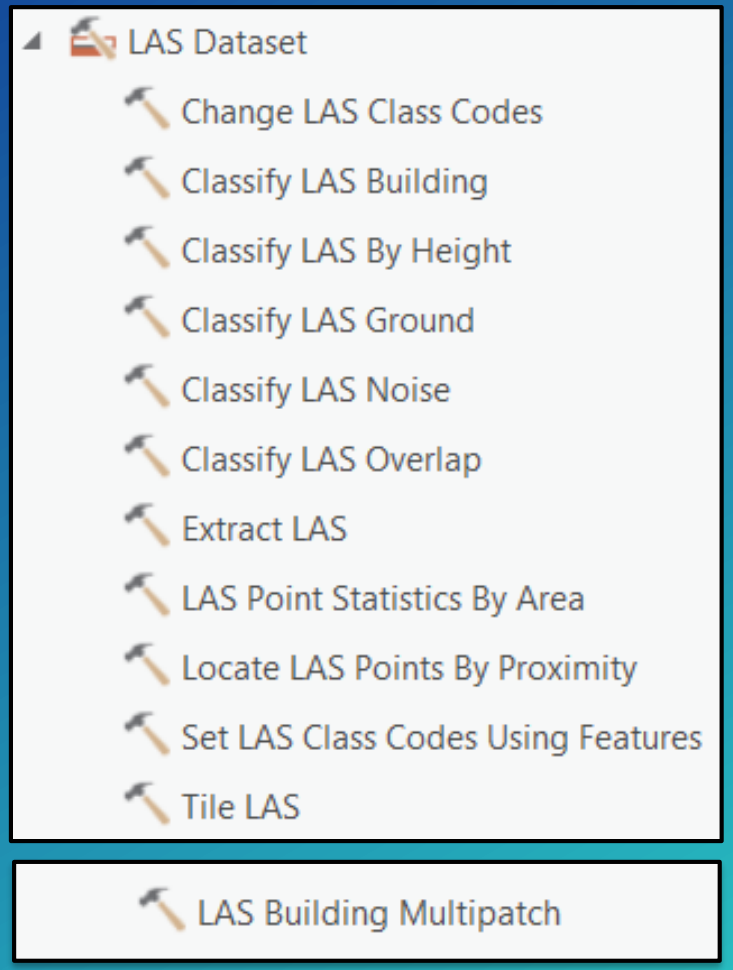


LiDAR and Geoprocessing in ArcGIS Pro

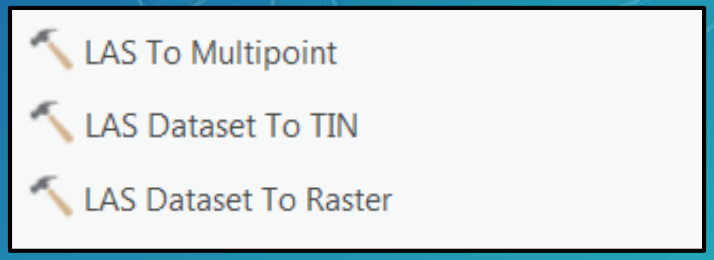
Data Management Tools



3D Analyst Tools



Conversion Tools



Demo #3:

- **Extract height values to building footprints from LiDAR**
- **Apply a Rule Package to create textured, realistic 3D buildings**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Appendix

Considerations for working with a LAS dataset

This table summarizes several factors that you should consider before building a LAS dataset.

Consideration	Recommendation
Coordinate system	• Data recommended to be delivered and consumed in a projected coordinate system. • If no spatial reference is present or if the LAS file has an incorrect spatial reference, add an accompanying projection file (.prj) file with a LAS file referenced by the LAS dataset.
Height measurements	• Use orthometric heights.
Lidar data types supported	• Use classified lidar data. • Surface constraint data can be photogrammetrically derived breaklines or GPS points.
Data storage	• Store the data locally. • Limit 1 to 2 million data points per every LAS file. • Limit file size to 25 to 50 MB, and no larger than 100 MB.
Version	• Tiled LAS with version 1.1 or later to access predefined classification codes. ArcGIS supports LAS versions 1.0, 1.1, 1.2, 1.3, and 1.4 (point record formats 0-5).

Appendix

Advantage	Description
Dynamic mosaicking	Stores multiple collections and projects: • Projections • Formats • Resolution
Elevation data storage	• Topographic data • Bathymetric data • Raster data • Point data
On-the-fly processing	Processes image as accessed: • Stretch, extract bands • Clip, mask • Reproject, orthorectify, pan-sharpen • Shaded relief, slope, aspect
Data access	• As raster • As source data • As data shared internally and online