Scientific and Multidimensional Raster Support in ArcGIS

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Esri User Conference. July 12, 2017
What we will cover today

• Scientific Multidimensional Raster data

• Using Scientific Data in ArcGIS
  • Ingesting and managing
  • Visualizing and analyzing
  • Disseminating and consuming
  • Application(s) and use case
Scientific Multidimensional Data
Diverse Scientific Multidimensional Data

**Oceanographic**
- Salinity
- Sea Temperature
- Ocean current

**Meteorological**
- Temperature
- Water Vapor/Precipitation
- Wind speed/direction

**Terrestrial**
- Soil moisture
- NDVI
- Land cover
Challenges

Manage
- variety of formats
- volume & velocity
- redundancy

Analyze
- portability
- scalability
- reproducibility

Share
- integration
- standards
- accessibility
Multidimensional Rasters

- Gridded
- Multidimensional
- Multivariate

netCDF, Grib, HDF
Ingesting and Managing Data
Multidimensional Mosaic Dataset

Representing multivariate collection of multidimensional rasters in ArcGIS

- HDF
- GRIB
- netCDF
- d-aware rasters

spatially-indexed catalog
multi-resolution, multivariate, multidimensional
reduce storage redundancy & pixel resampling
defines information products
on-demand processing

mosaic dataset
mosaic
table
raster pixels
## Multidimensional Data Model

**Multidimensional Mosaic Dataset in Geodatabase**

- Ingest variables from netCDF, HDF & GRIB using raster types
  - Aggregate multiple variables, multiple files
- Support on-the-fly processing

<table>
<thead>
<tr>
<th>ID</th>
<th>RASTER</th>
<th>PRODUCT</th>
<th>VARIABLE</th>
<th>TIME</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;raster&gt;</td>
<td>netCDF</td>
<td>temperature</td>
<td>T1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>&lt;raster&gt;</td>
<td>netCDF</td>
<td>temperature</td>
<td>T2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>&lt;raster&gt;</td>
<td>netCDF</td>
<td>temperature</td>
<td>T3</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
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<td>netCDF</td>
<td>temperature</td>
<td>T1</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
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<td>netCDF</td>
<td>temperature</td>
<td>T2</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>&lt;raster&gt;</td>
<td>netCDF</td>
<td>temperature</td>
<td>T3</td>
<td>20</td>
</tr>
</tbody>
</table>

![Diagram showing multidimensional data model](image)
Raster Types for Multidimensional data

data on disk

netCDF
HDF
GRIB
d-aware rasters

raster type

crawls disk
identifies rasters
extracts metadata
attaches processing

mosaic dataset

stores no pixels
references rasters
stores processing & metadata

Format-agnostic direct ingestion of rasters into a mosaic dataset
Creating a Multidimensional Mosaic Dataset

Using Geoprocessing Tools

- Create a empty mosaic dataset
- Add select variables
Demo

Create multidimensional Mosaic Dataset using Raster types
Create Wind model using Vector Field Template
Visualizing and Analyzing
Slicing your data

• Slicing
  • By variable, using variable selector
  • By dimension using Select by Dimension Geoprocessing tool

• Visualizing
  • Time slider
  • Range slider
  • Vector field renderer
Demo

Visualize multidimensional data using time slider and range slider
Slicing your Mosaic dataset with Select by Dimension GP Tool
Visualize Wind data with vector field renderer
Raster Analysis

• **Geoprocessing Tools (GP)**
  • Tons of GP tools
  • GP tools, Python scripting and ModelBuilder → perfect automation of data management and analysis.

• **Dynamic On-the-Fly Processing using Raster Functions**
  • Manage and analyze large collection of rasters on the fly as the data is accessed and viewed
  • Quick and save time by not required to write the processed product to disk
  • Functions can be applied to various rasters (images) including:
    • Raster dataset layers
    • Mosaic datasets
    • Image service layers

Choose from dozens of built-in functions or implement your own algorithm using Python

Learn more at: github.com/Esri/raster-functions
Chaining Raster Functions

Elevation
- ElevR...
- Elev LT X

Slope
- SlopeR...
- Slope LT 30

Conservation area
- ConsR...
- Cons GT 1000

Soil Type
- SType...
- SType IN 1 2 3 5 6 7 8

Soil Acidity
- SAcidR...
- SAcid IN BET 1 7

... to compose a complex analytic model
Raster Function Templates

A portable & reusable chain of raster functions

Raster variables
MultiDim Mosaic Dataset comes with:

- Field stored with variable names (tag)
- Field defines groups(GroupName)

<table>
<thead>
<tr>
<th>Raster</th>
<th>Tag</th>
<th>StdTime</th>
<th>GroupName</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>Temperature</td>
<td>t1</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td>mean</td>
<td>t1</td>
<td>1</td>
</tr>
<tr>
<td>...</td>
<td>Temperature</td>
<td>t2</td>
<td>2</td>
</tr>
<tr>
<td>...</td>
<td>mean</td>
<td>t2</td>
<td>2</td>
</tr>
<tr>
<td>...</td>
<td>Temperature</td>
<td>t3</td>
<td>3</td>
</tr>
<tr>
<td>...</td>
<td>mean</td>
<td>t3</td>
<td>3</td>
</tr>
<tr>
<td>...</td>
<td>Temperature</td>
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<td>4</td>
</tr>
<tr>
<td>...</td>
<td>mean</td>
<td>t4</td>
<td>4</td>
</tr>
</tbody>
</table>
Raster Function/Model: Grouping

- **Windchill**
  - A raster function template that computes windchill on the Fahrenheit scale given rasters representing wind-speed and temperature.

- **Edit Properties**
  - Group Items By:
    - Group Field Name: Variable
    - Tag Field Name: StdTime
  - Definition Query
  - Thumbnail
Applying a Raster Function Template to Mosaic Dataset

Apply RFT to Mosaic Dataset:
Process each row
Process each group
Demo

Create Function Template and use it for dynamic processing and analysis for MultiDim Data
Disseminating

multivariate multidimensional mosaic dataset

professional geospatial analysts

Server

Online Content and Services

Desktop  Web  Device

Apps

Access / Identity

Services
Sharing Scientific Data

- Mosaic Dataset ➔ Share As Web Layer

Enable access to a dynamic representation of your information product as an image service
Consuming your services

- In any ArcGIS application or any WMS client

- In a web map
  - Identify web services driven by maps or datasets
  - Bring service layers into a web map

- In a map-based application
  - Configurable apps
  - Story Maps
  - Web AppBuilder
  - Custom web apps using ArcGIS API for JavaScript
Demo

Publish the scientific data (Image, WCS, WMS capability)

Dynamic Scientific Computing in Web

Using Image Service layer in ArcGIS Online Map Viewer
Few Take Away

1. Mosaic Dataset is a robust data model that allows you to manage your large collections of scientific multidimensional data
2. Raster function(s) can help with your efficient on the fly computing that saves Time and Resources
3. Mosaic Dataset is a quick way to build the live web service
4. Make your scientific data and research output usable with repeatable workflow to your larger community
Want to learn more....please join these sessions:

- Raster Analytics-Envision Center Presentation (SDCC: Envision Center 1)
  When: July 12, 2017 2-3.30 PM

- Image Management using Mosaic Datasets and Image Services (Room 3).
  When: July 13, 2017 8:30-9:45 AM

- Session 2084: Weather, Forecasting, and Radar Site-selection (Room 29 A/B)
  When: July 13, 2017 10-12PM.
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