Using Satellite Data in GIS

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Versioning:
20210429,Soracco
20210401,Soracco
2020, Soracco
2019, Soracco

This Training

- Component of the *NOAA CoastWatch Satellite Training Course*
- Comprised of 3 modules: Data, Tools, Exercise(s)
- Uses ESRI ArcMap, but techniques work with QGIS and other GIS software
- Updated from CoastWatch Satellite GIS training originally given in 2000 for avenue-based ArcView 3.1

This slide has no audio

A few notes on ArcMap for NOAA Users

- The exercises and screenshots were created using ArcGIS 10.7
- The current version of ArcMap is 10.8.1
- The EDC has been updated and will install with any version of ArcMap 10.4+
- ArcMap 10.8.1 is the final release of ArcMap and all future development will go into ArcGIS Pro. ArcMap 10.8.1 will continue to be supported until 2026 via the normal Esri support cycle. If you are unsure of which product to choose, consider ArcGIS Pro.
- ESRI support for ArcMap 10.8.1

ESRI support for ArcMap 10.8.1

Product Life Cycle

Product Lifecycle Policy

Product: **ArcGIS Desktop 10.8.1**
Release Date: **July 28, 2020**
Support status: **General Availability**

		General Availability Jul 2020 - Feb 2022	Extended Support Mar 2022 - Feb 2024	Mature Support Mar 2024 - Feb 2026	Retired March 01, 2026
Technical Support	Request Case	✓	✓	✓	
	Phone and Chat	✓	✓	✓	
	Online support resources	✓	✓	✓	✓
Software Support	Software updates and patches	✓	✓		
	Software hotfixes	✓	✓		
	New environment certification	✓			

Note for Software Hotfixes: For details about hotfix policies, please refer to the Developer Technologies section in the Esri Product Lifecycle Support Policy document.

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Using Satellite Data in GIS: Tools

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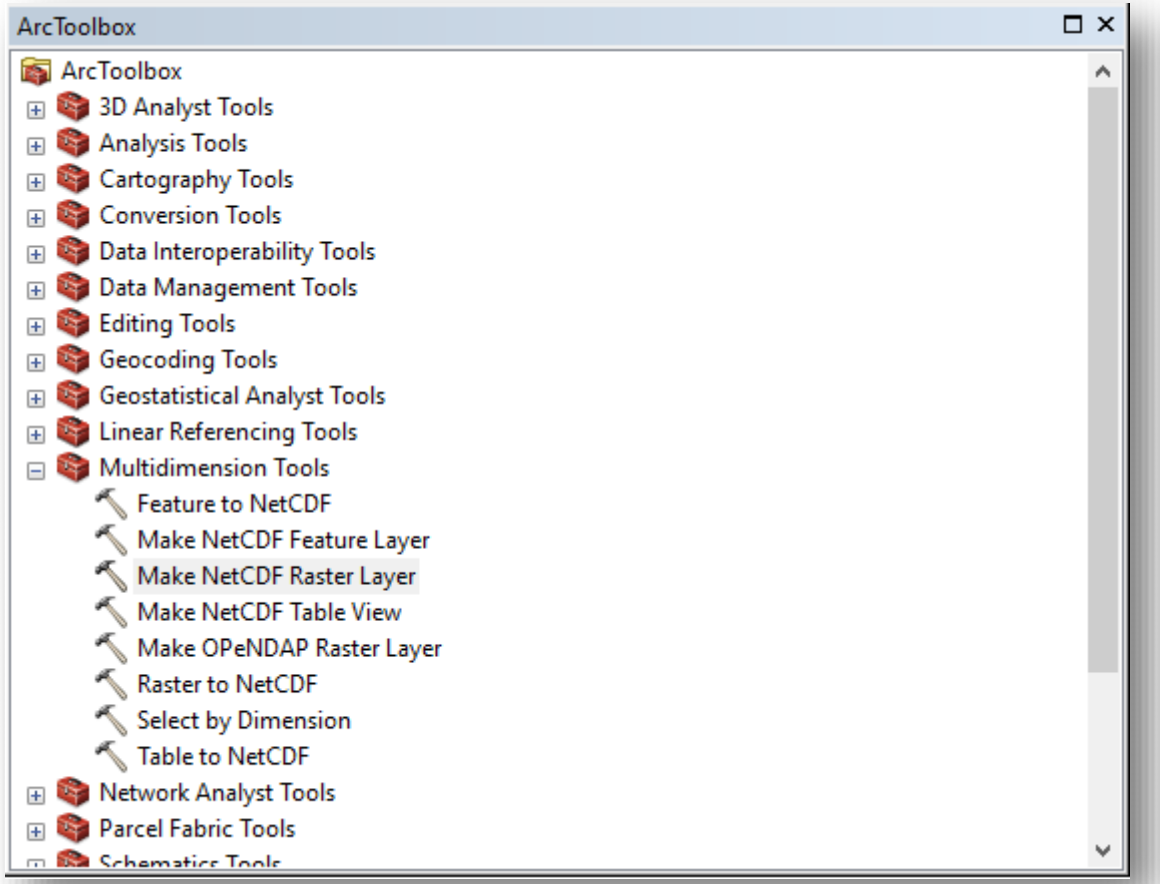
Overview: Tools/Methods

- ArcGIS built-ins
- ArcGIS add-ons
- External



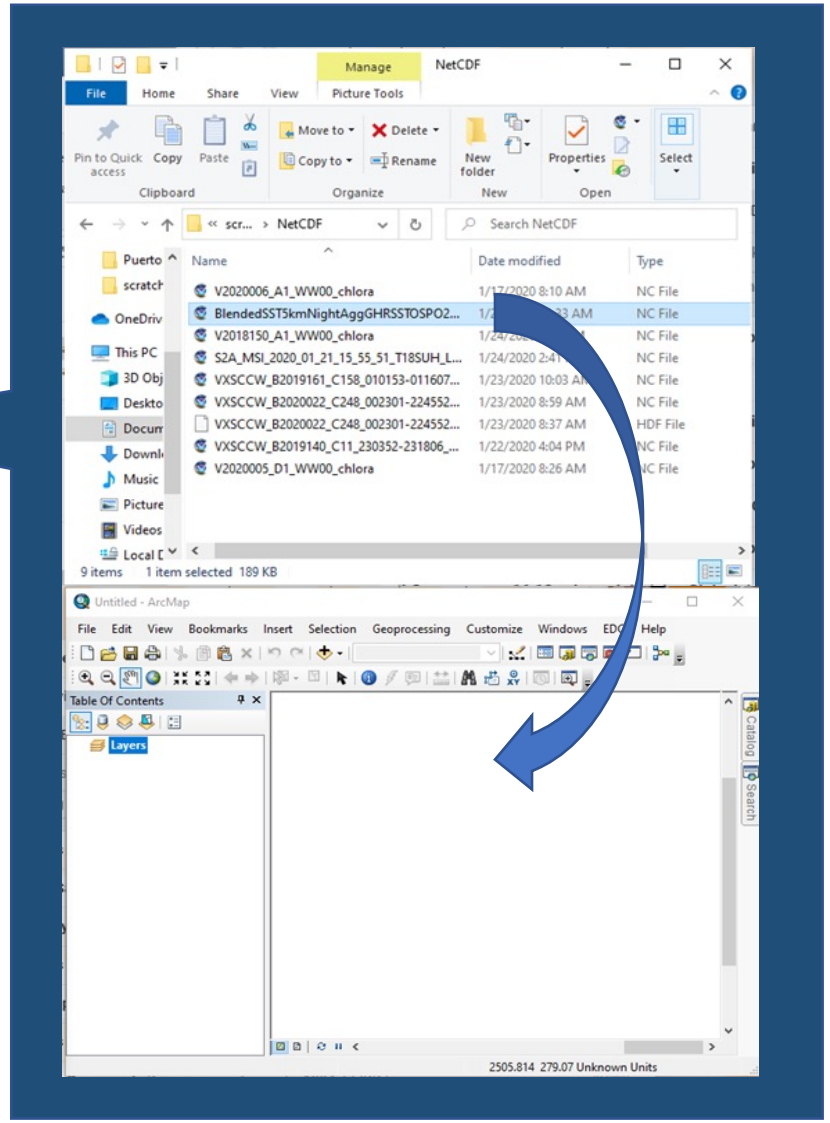
ArcMap's Toolbox

Useful Extensions / Add-ons

- ArcGIS Spatial Analyst (license) – ESRI
  - Raster tools
- Environmental Data Connector (EDC v1.3.7.1)
  - Helper tool to obtain multidimensional data (space-time-+)
  - Run from ArcMap or as standalone
  - Graphical-user-interface to ERDDAP / THREDDS services
  - https://www.pfeg.noaa.gov/products/EDC/EDCdownloads.html
- CoastWatch Utilities:
  - Command line tools: cwexport, cwsample, cwrender
  - https://coastwatch.noaa.gov/cw/user-resources/coastwatch-utilities.html

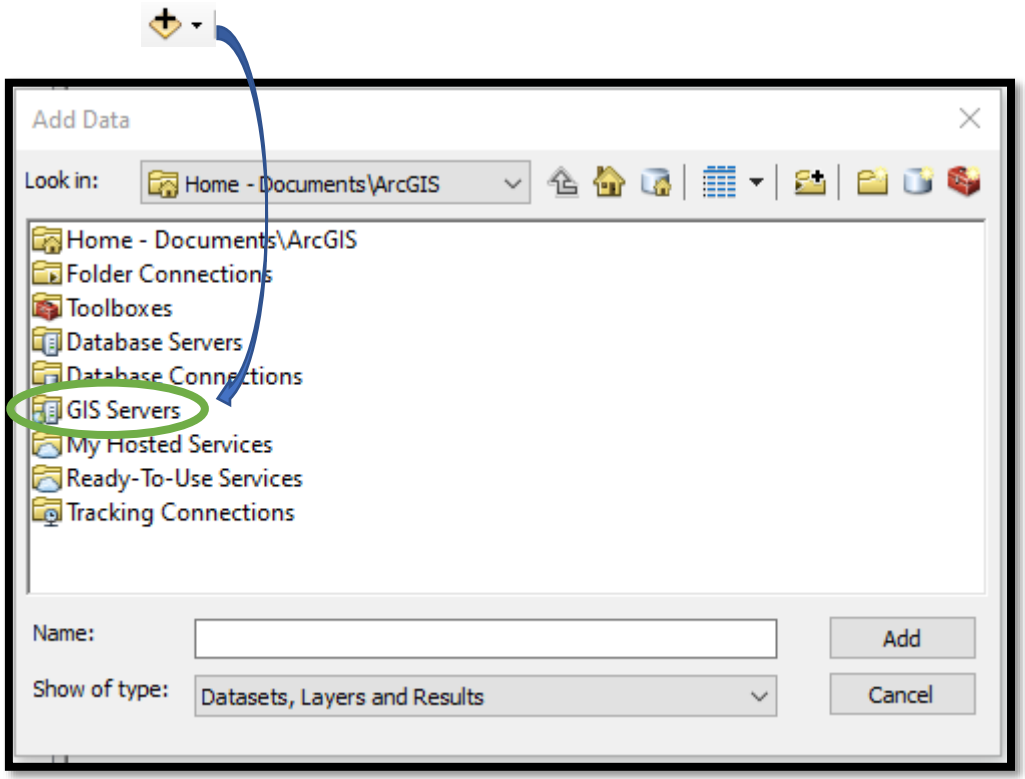
Methods to add Satellite Data

- WMS and WCS
- Drag-n-drop
  - GeoTIFF, HDF, NetCDF, JPEG2000
- Multidimension Toolbox
  - Make OpenDAP Raster Layer (ArcToolbox->Multidimensional Tools)
  - Make NetCDF Raster Layer (ArcToolbox->Multidimensional Tools)
- EDC (Environmental Data Connector) EDC
- Programmatically: Python, Jupyter Notebooks

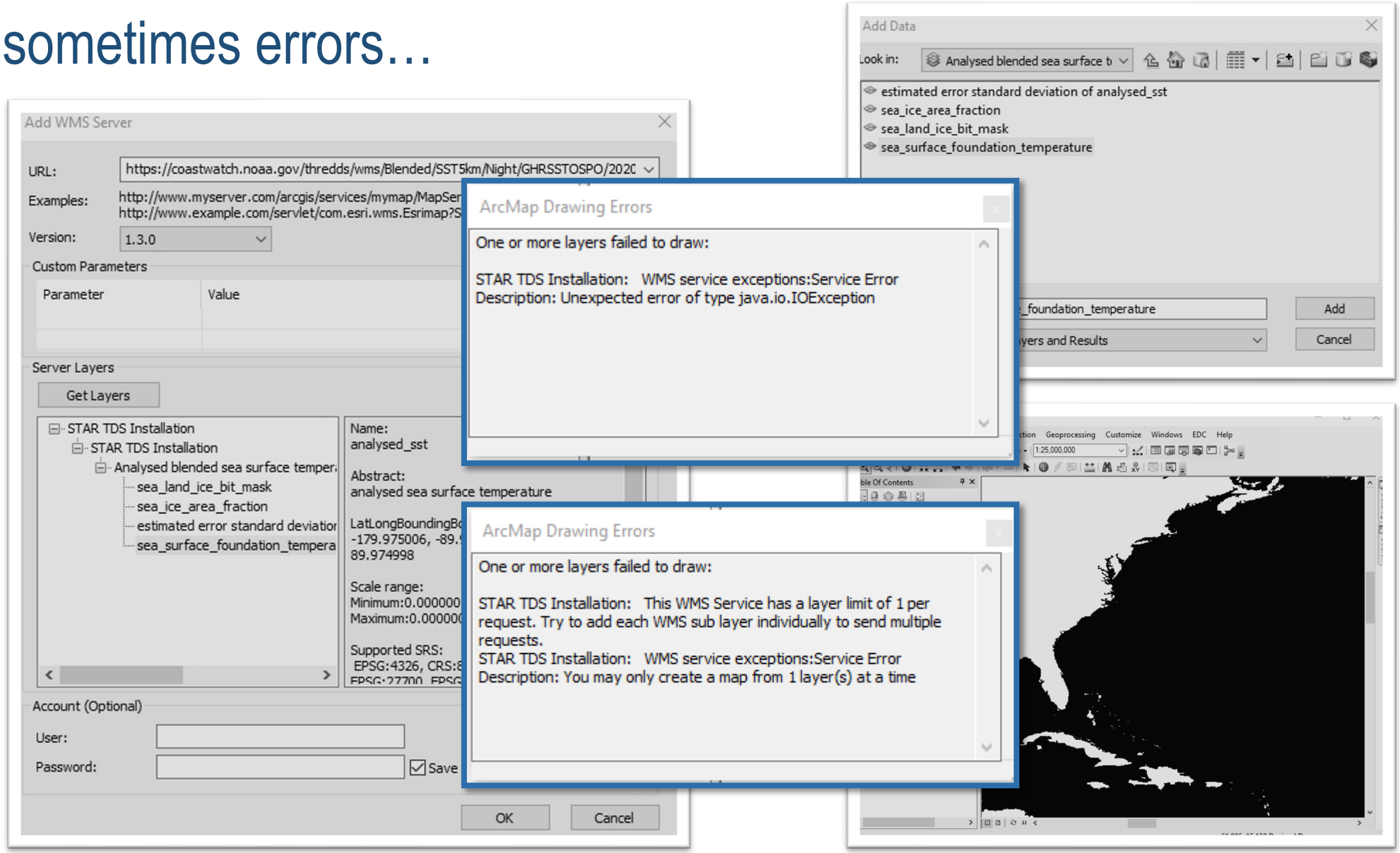


Web Mapping and Coverage Services (WMS and WCS)

- Add Data 
- WMS: image
- WCS: data values
- Comments:
  - Ok for single time/place
  - Can be frustrating on finding the correct URL
  - Each change in PZI results in refresh call…and sometimes errors

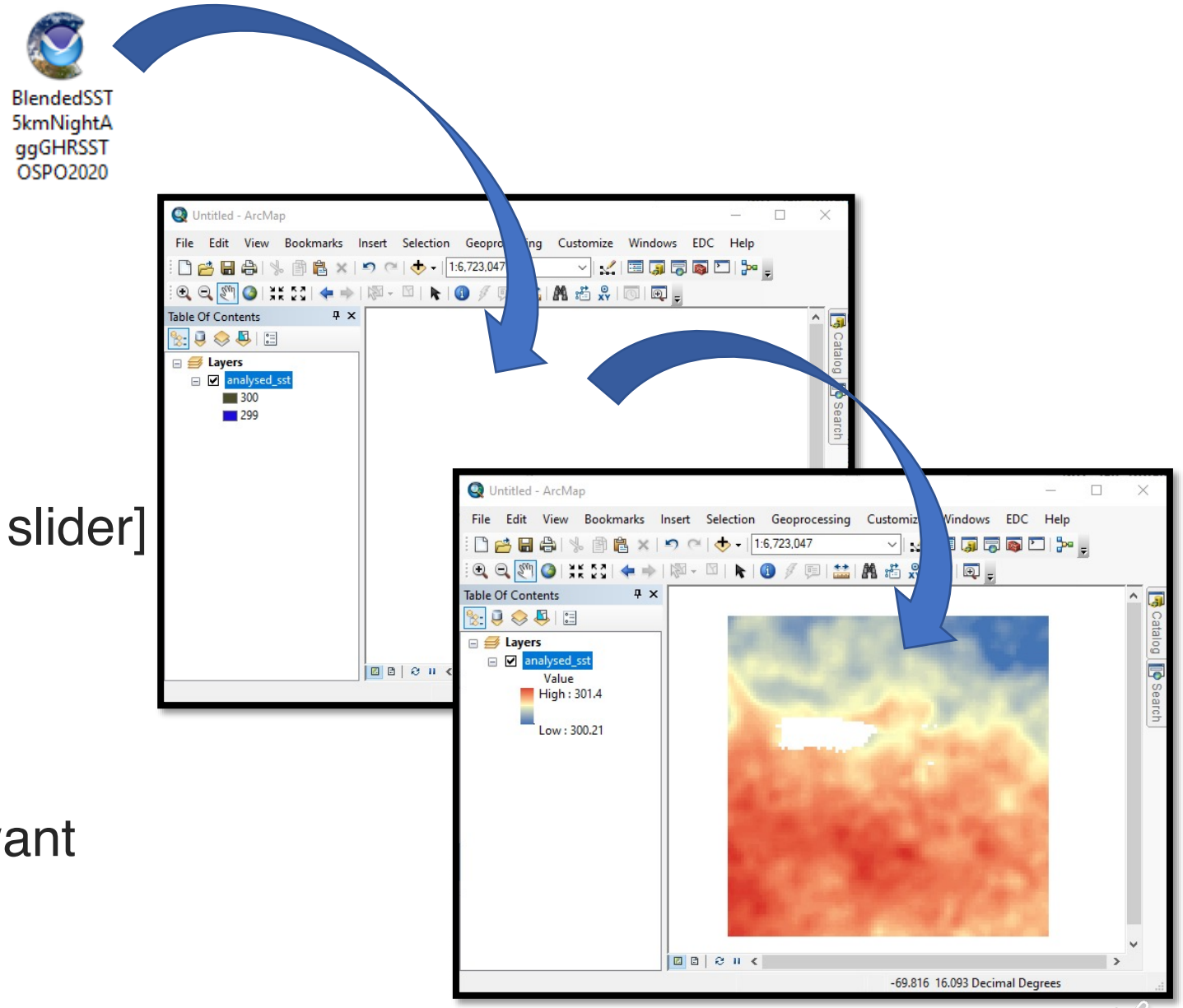


And sometimes errors…



Drag -n- Drop

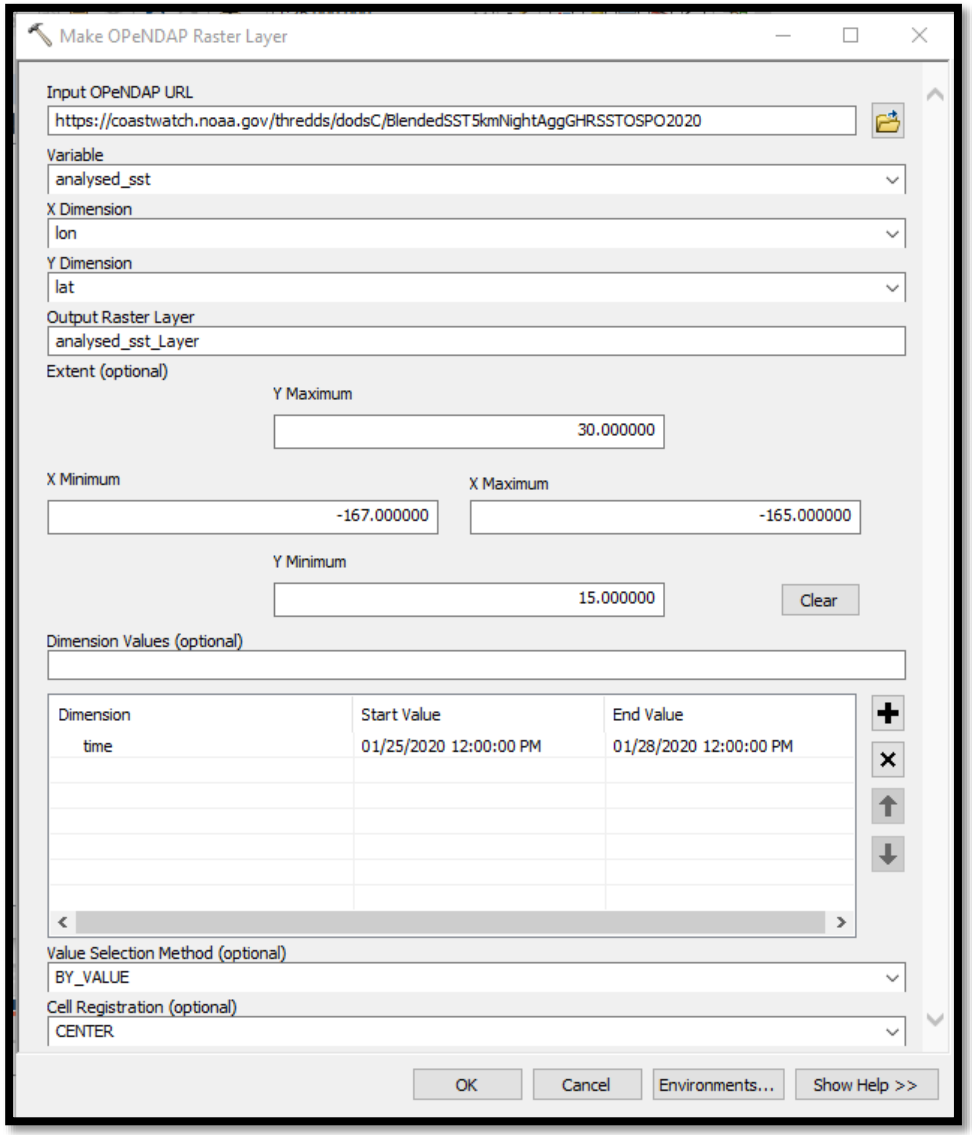
- Quick and easy
- Requires configuration
  [symbology, NetCDF, time, time slider]
- Comments:
  - Defaults to first variable
  - Don't always get what you want



Make OpenDAP Raster Layer

ArcToolbox->Multidimension Tools->Make OpenDAP Raster Layer

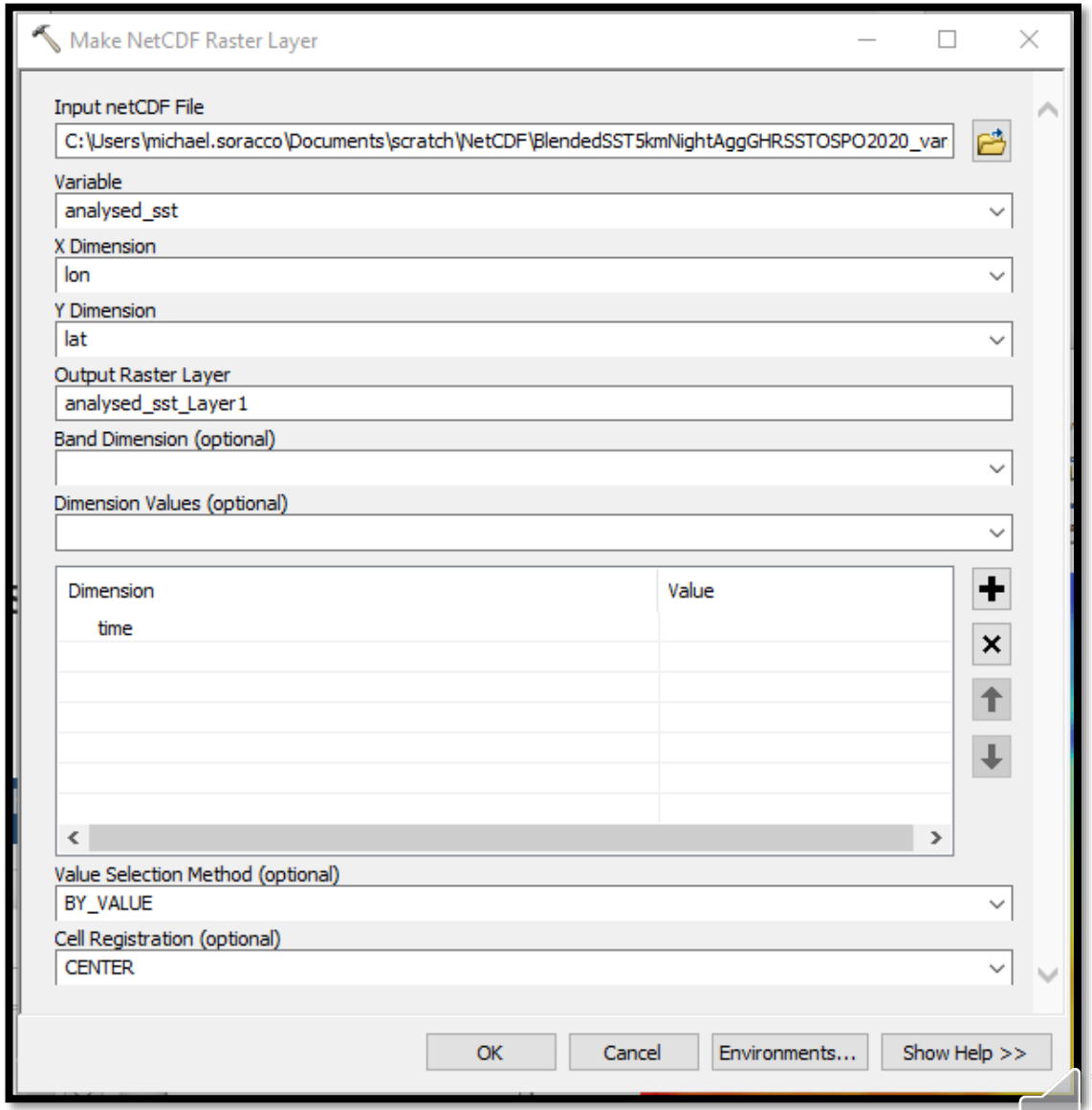
- A few clicks 
- Menu-driven configuration to maximize usefulness
- Handles file or aggregates. Enter URL without extension
- Requires additional configuration [time, time slider] to maximize usefulness
- Comments:
  - Unexpected Errors
  - Results may vary



Make NetCDF Raster Layer

- A few clicks 
- Menu-driven configuration to maximize usefulness
- Requires configuration [time, time slider]

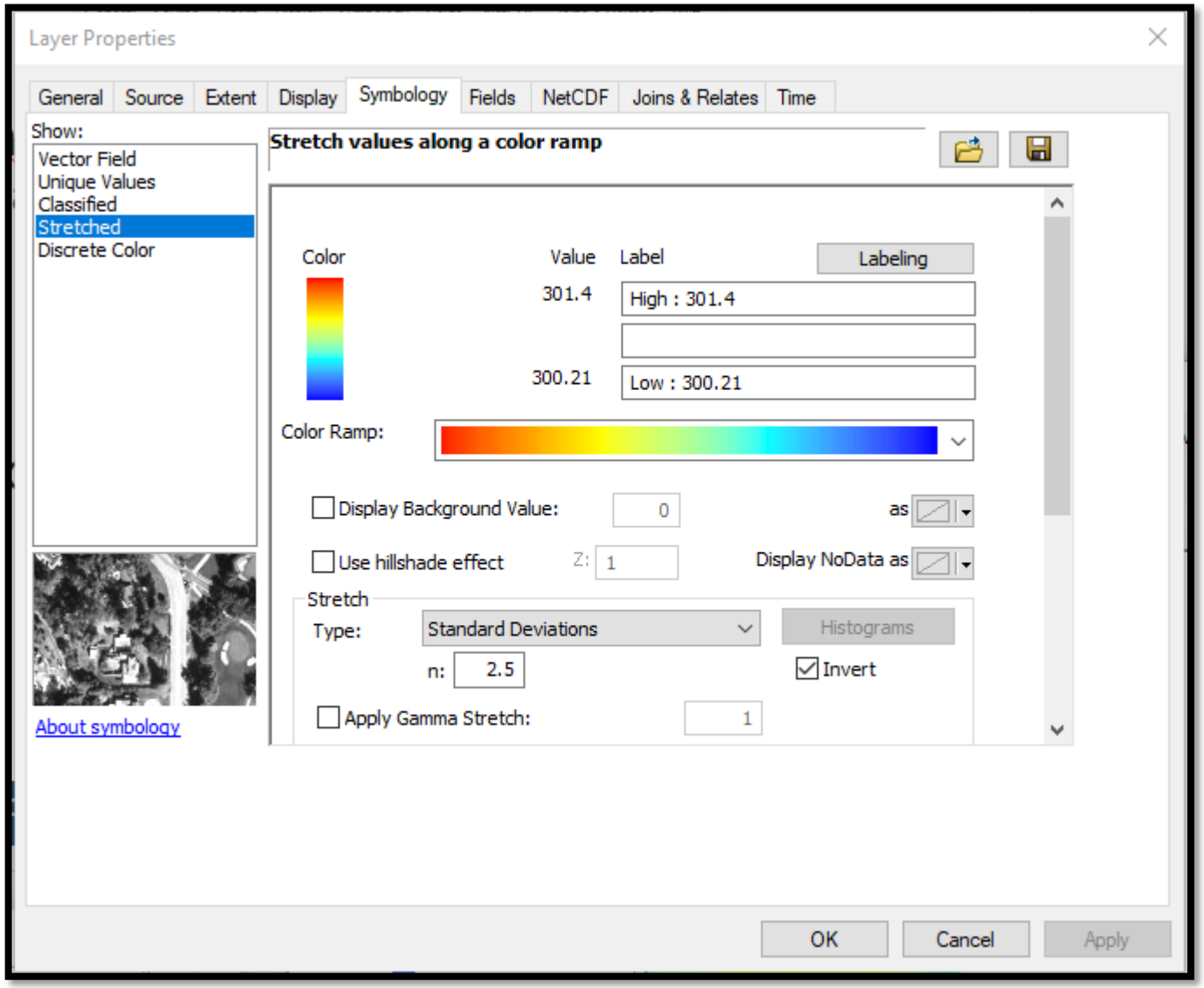
ArcToolbox->Multidimension Tools->Make NetCDF Raster Layer



Layer Properties: Symbology

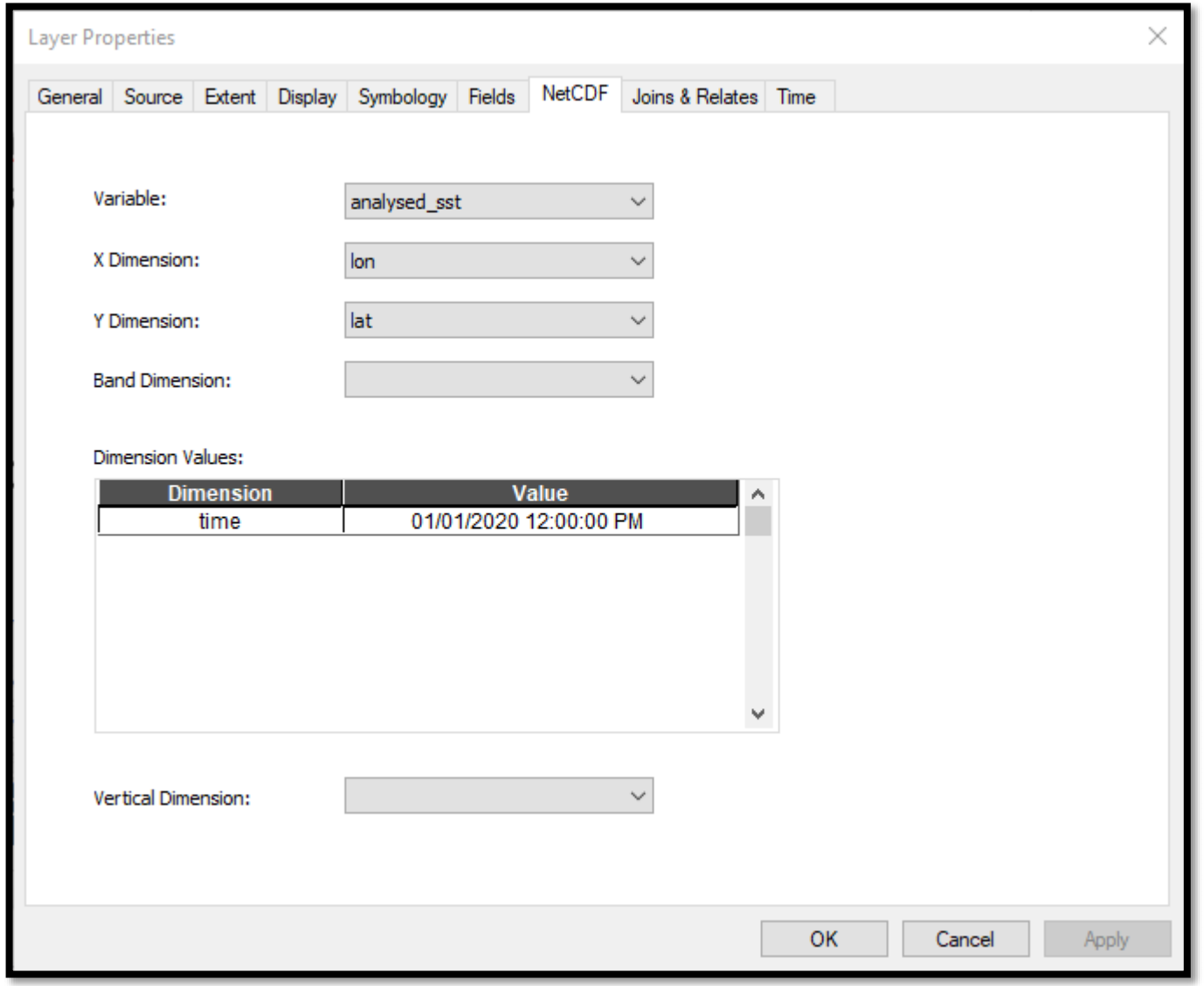
- ArcToolbox-> Multidimension Tools-> Make NetCDF Raster Layer

- Menu-driven configuration to maximize usefulness



Layer Properties: NetCDF

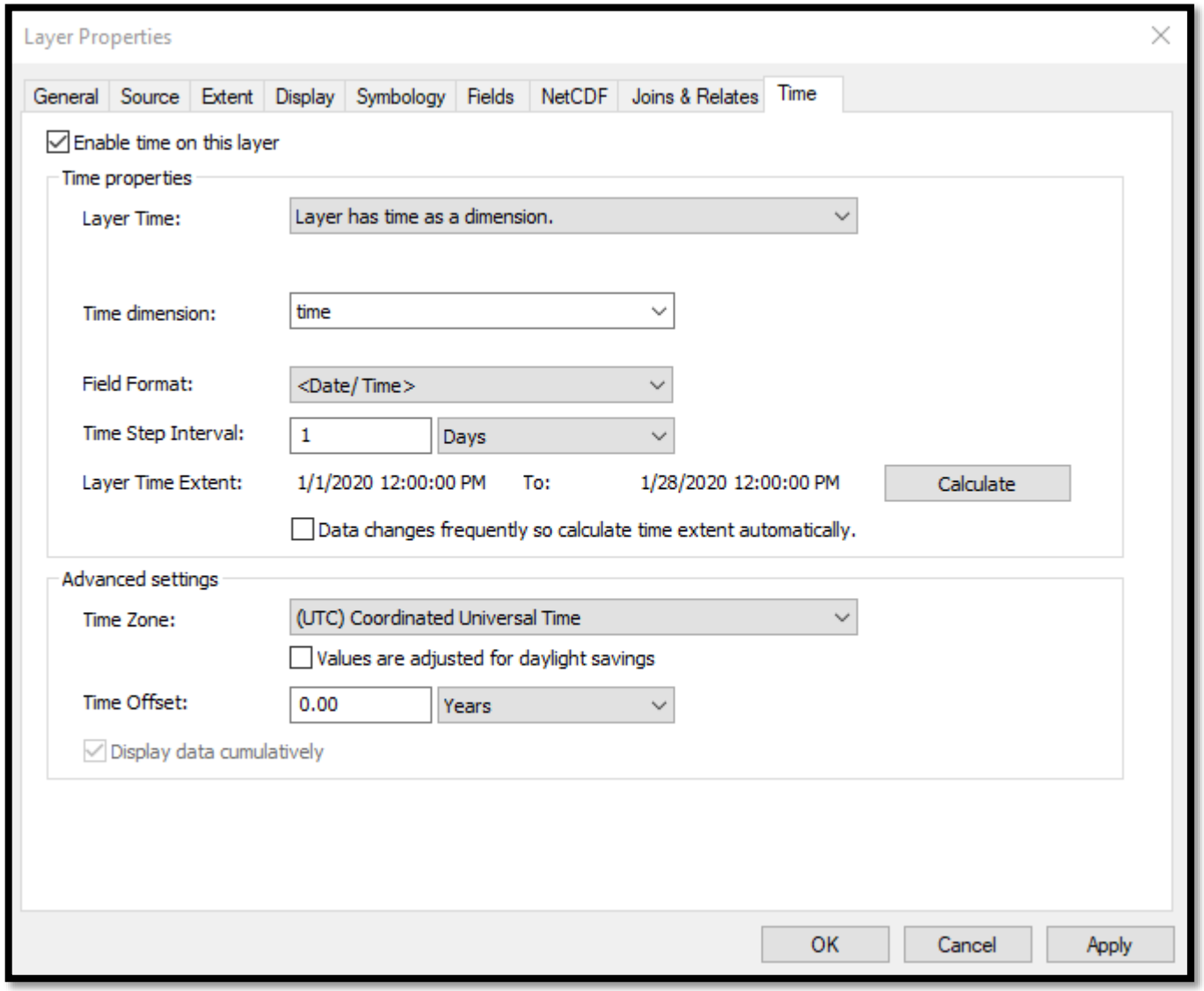
- ArcToolbox-> Multidimension Tools-> Make NetCDF Raster Layer
- Menu-driven configuration to maximize usefulness



Layer Properties: Time

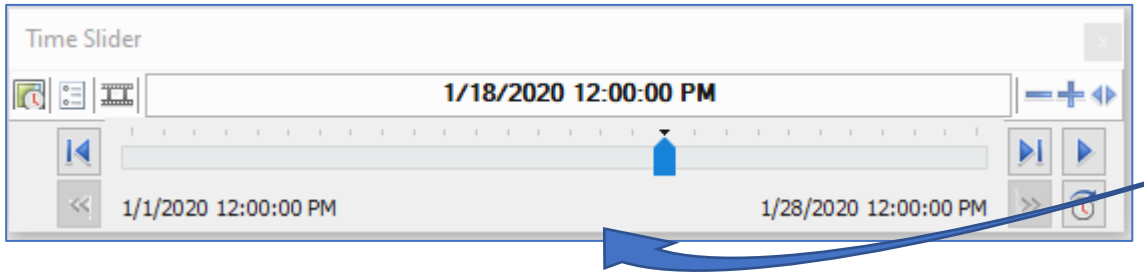
- ArcToolbox->Multidimension Tools->Make NetCDF Raster Layer

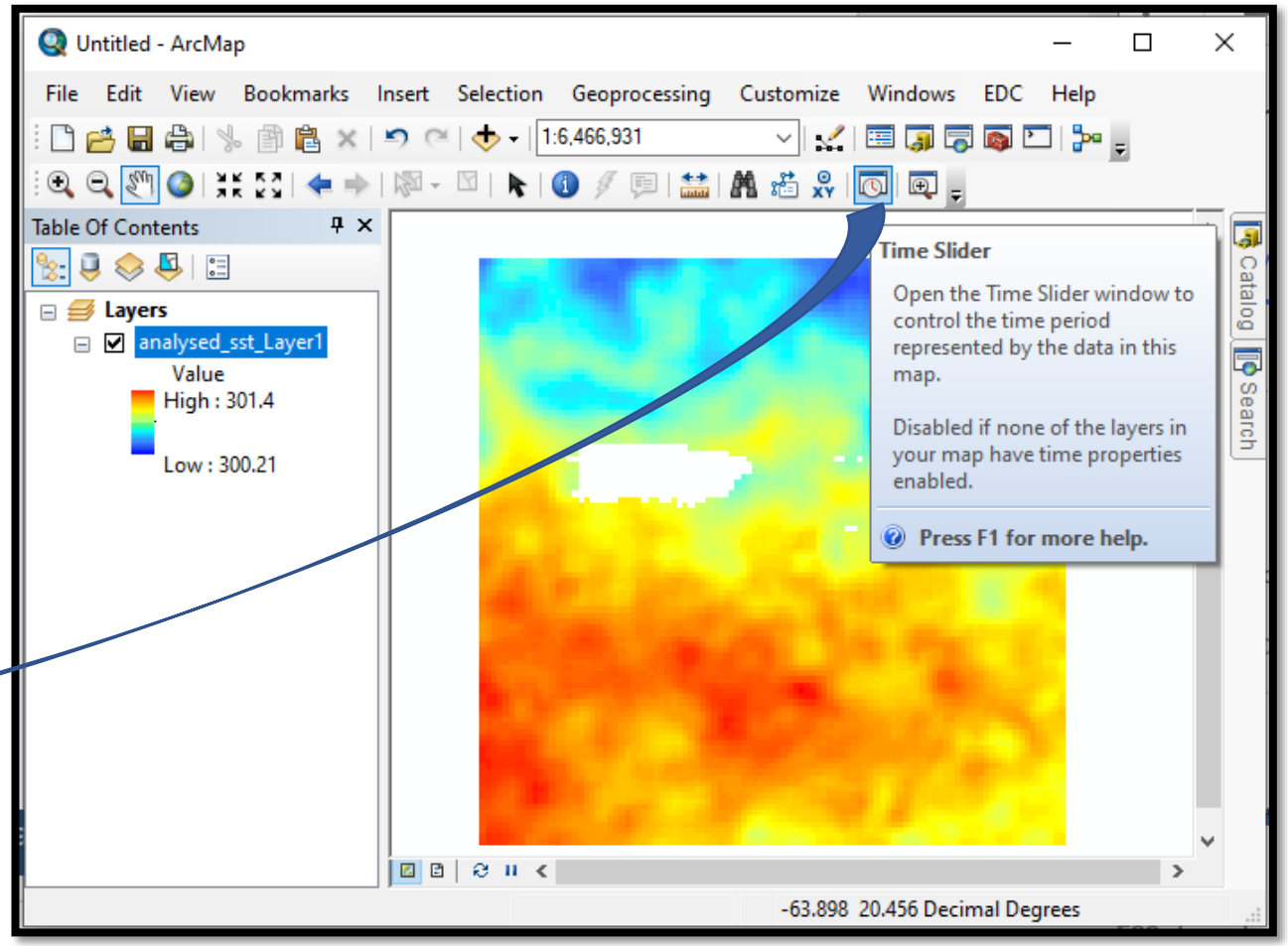
- Menu-driven configuration to maximize usefulness



Enable Time Slider for the Map

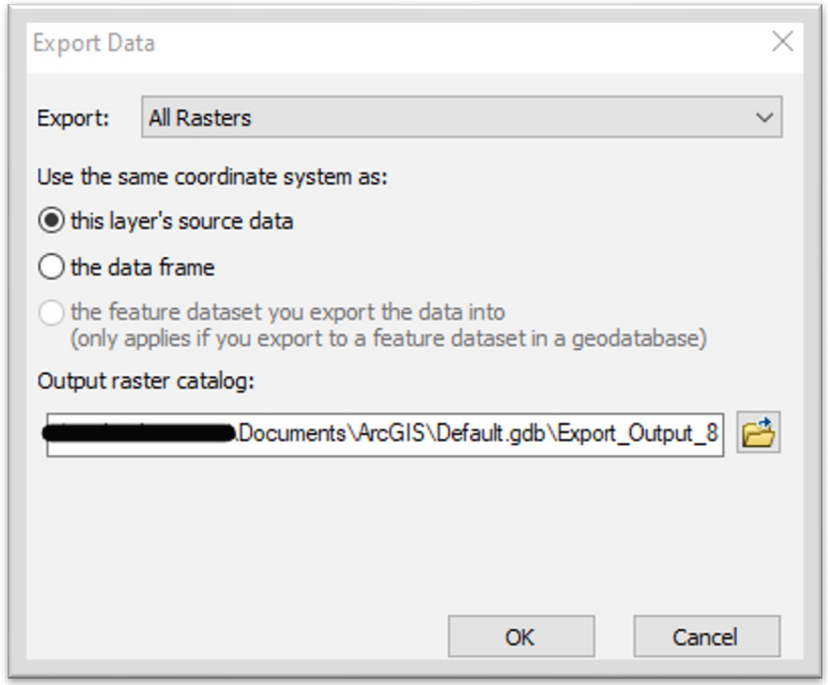
- Select the ‘Time Slider’ icon to activate the slider control





Export Data to Geospatial Database

- Right-mouse-click on layer -> Click Data -> Export Data
- Set the desired GeoDatabase location
- Select Export

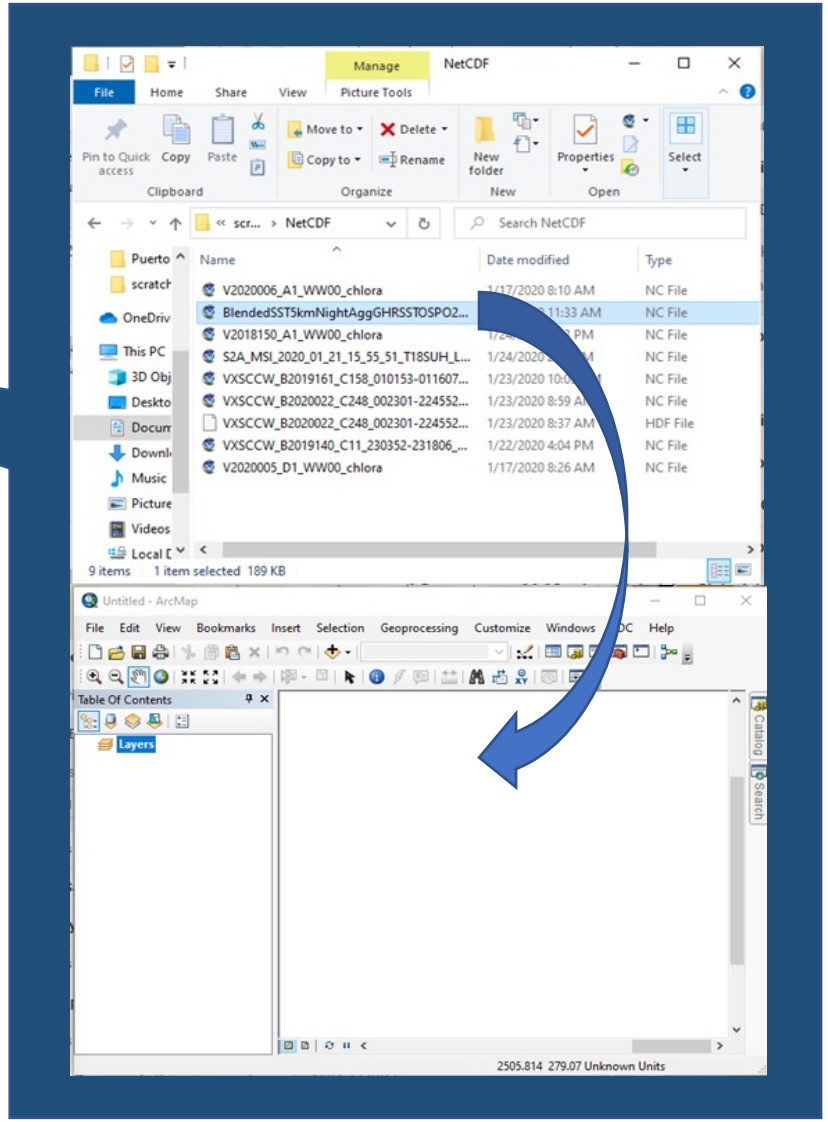


Recap Methods to add Satellite Data

- **Drag-n-drop**
  - GeoTIFF, HDF, NetCDF, JPEG2000
- **Multidimension Toolbox**
  - Make NetCDF Raster Layer (ArcToolbox->Multidimensional Tools)

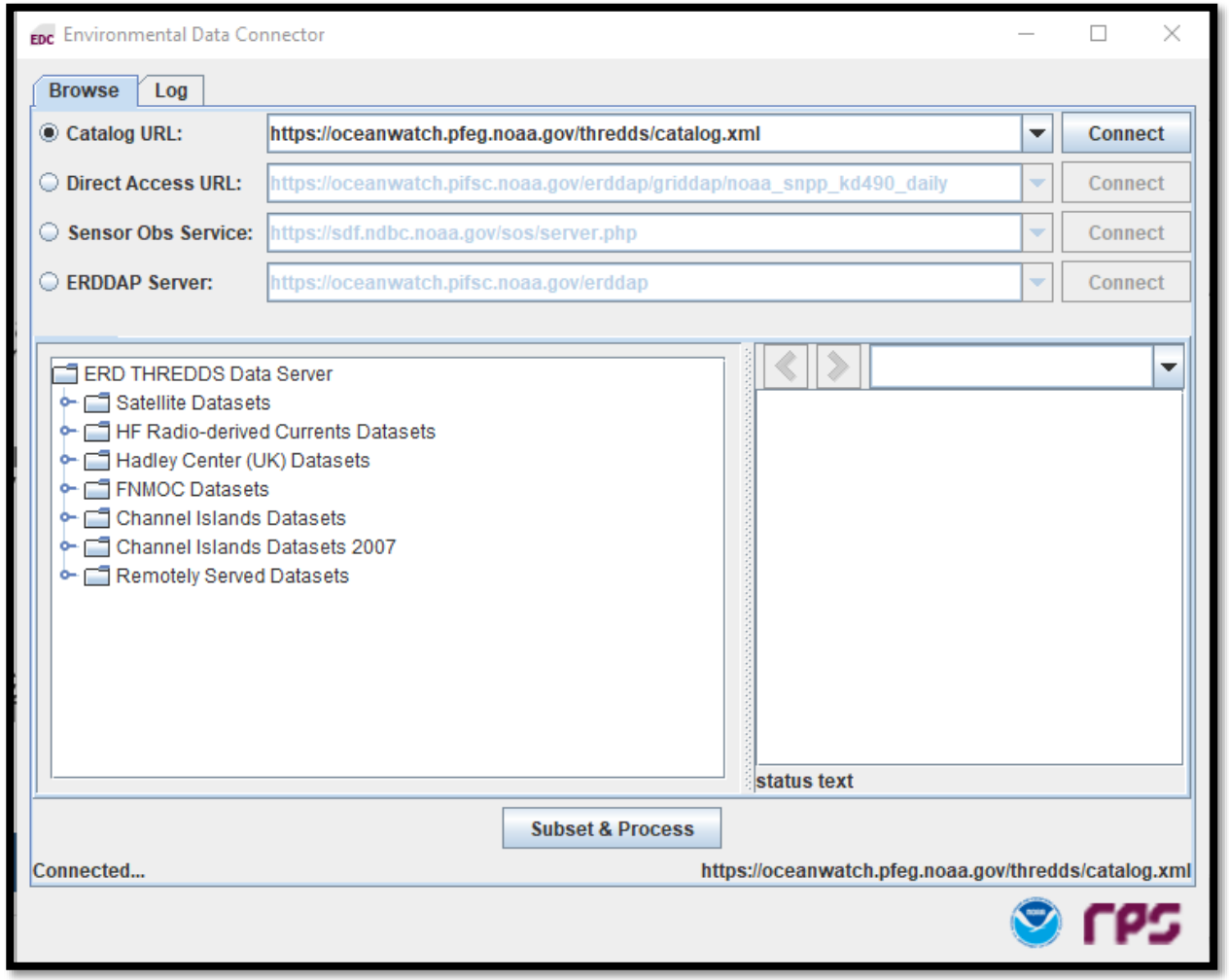
- **EDC** (Environmental Data Connector) EDC
- Programmatically: Python, Jupyter Notebooks

- Multidimension Toolbox
  - Make OpenDAP Raster Layer (ArcToolbox->Multidimensional Tools)
- WMS and WCS



Environmental Data Connector

- Updated for ArcMap 10.8
- Connects to a variety of services
- Provides data listings
- Subsets by space and time to only retrieve data that is needed
- Simplifies import by automating the ‘layer properties’ steps

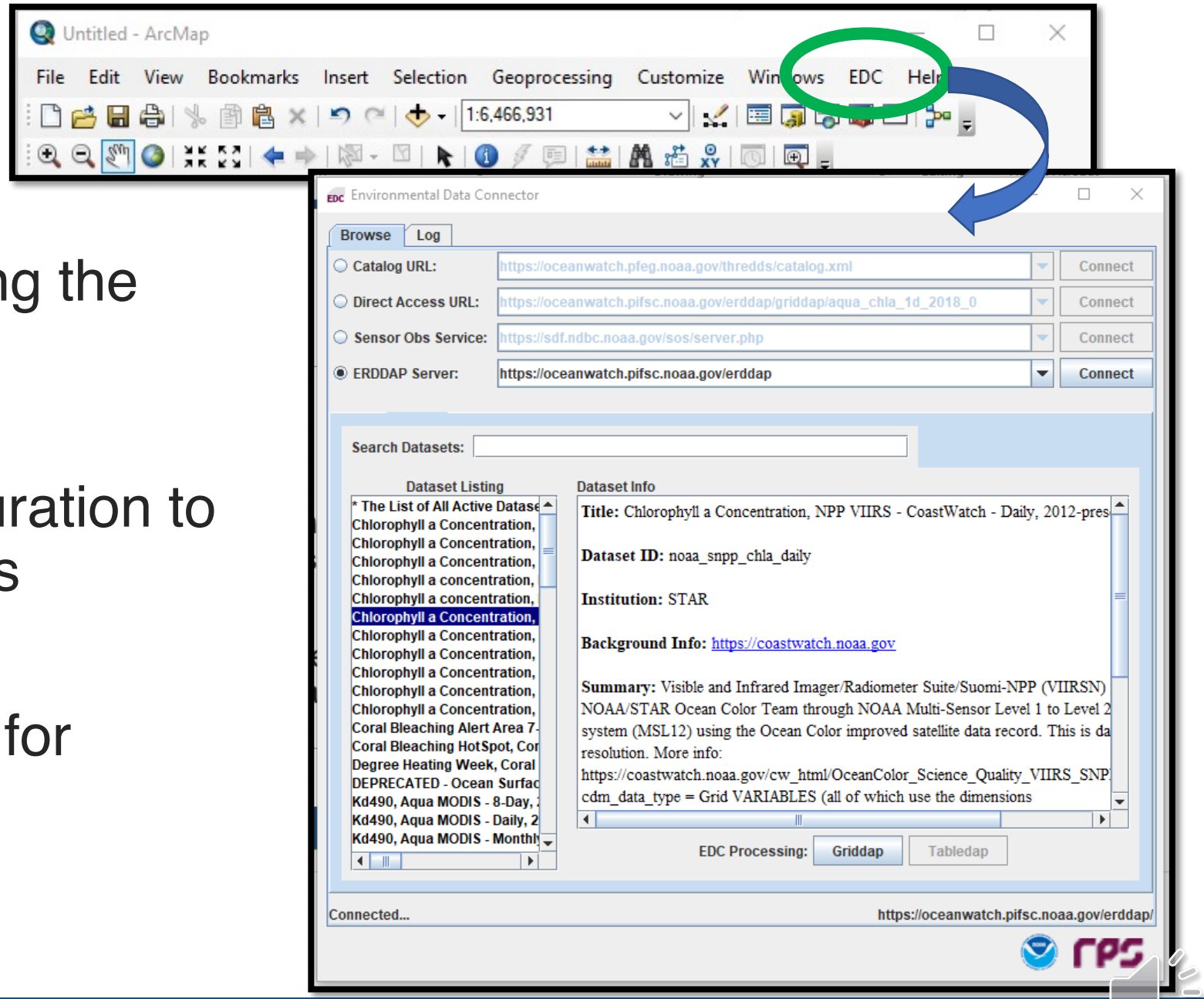


Installing EDC

- Use Java to run the ‘setup.jar’ file
  - Java –jar <path>\setup.jar
  - Upon execution, it will re-launch under wscript with command-line options
- Installation:
  - Creates directory for EDC standalone programs
  - Integrates with ArcMap
  - Requires advance installation of Java (OpenJDK)
  - Extra steps/permissions if installed within Program Files.

Activating EDC

- Activated by selecting the EDC menu
- Menu-driven configuration to maximize usefulness
- Custom Time Slider for syncing data



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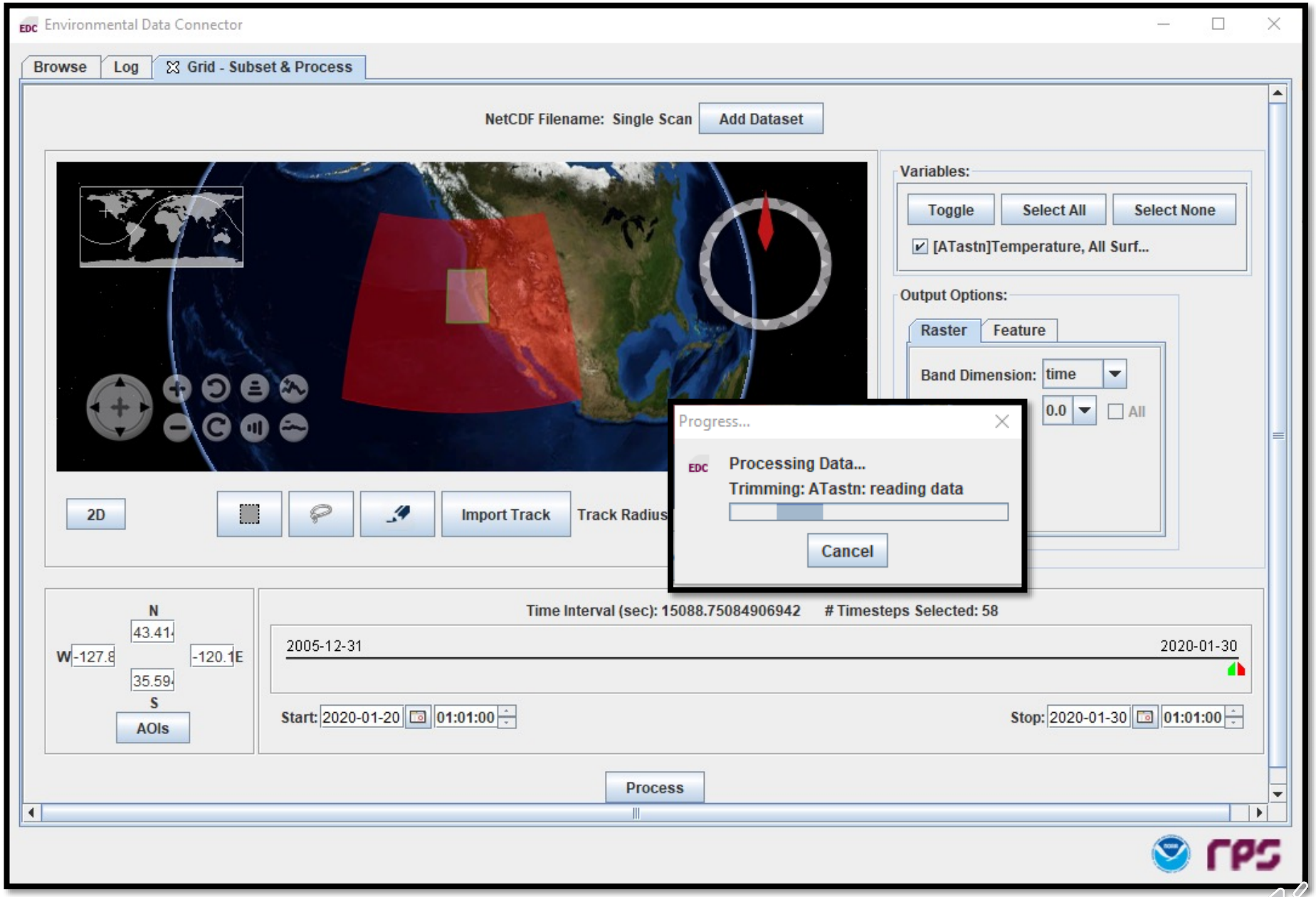
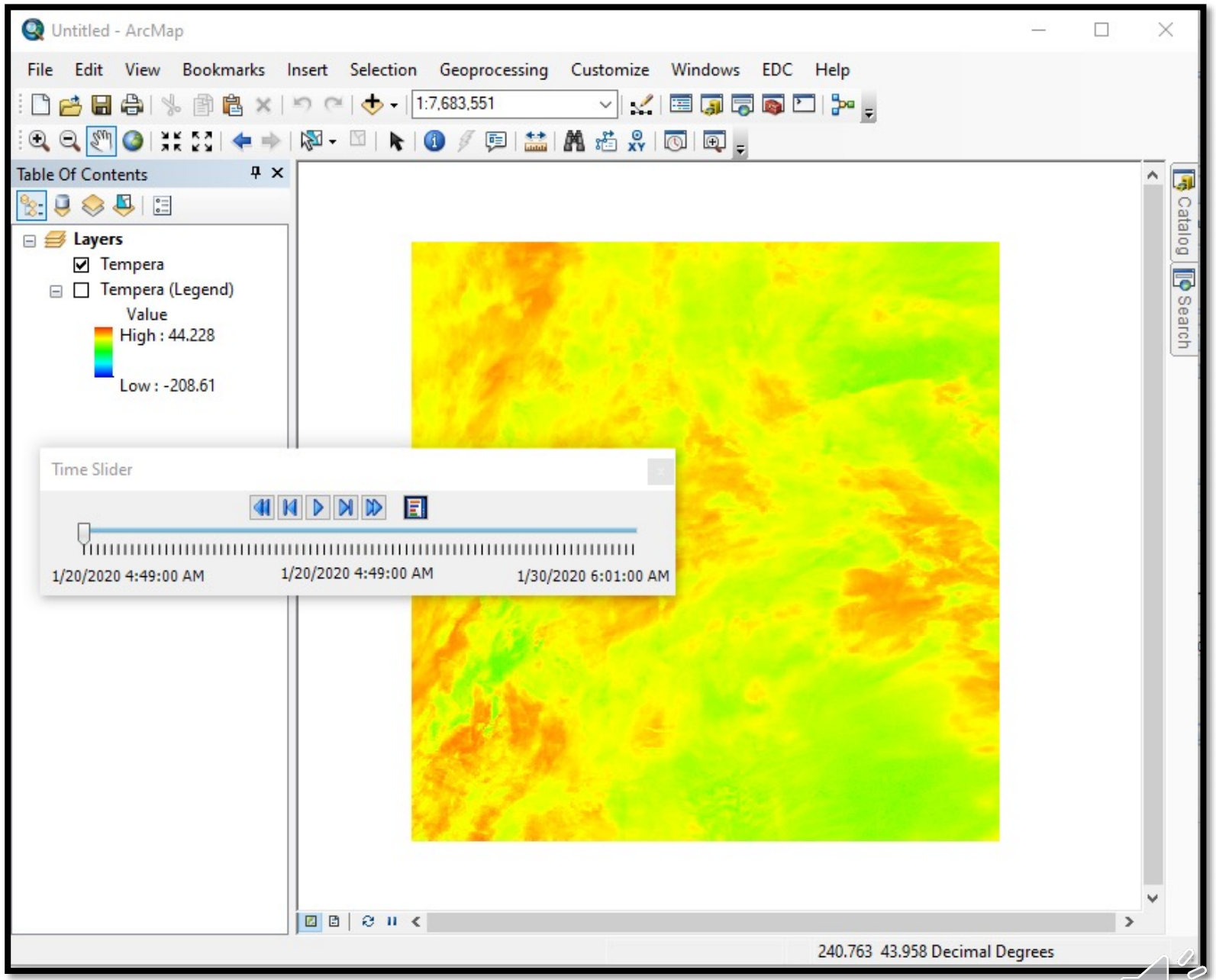
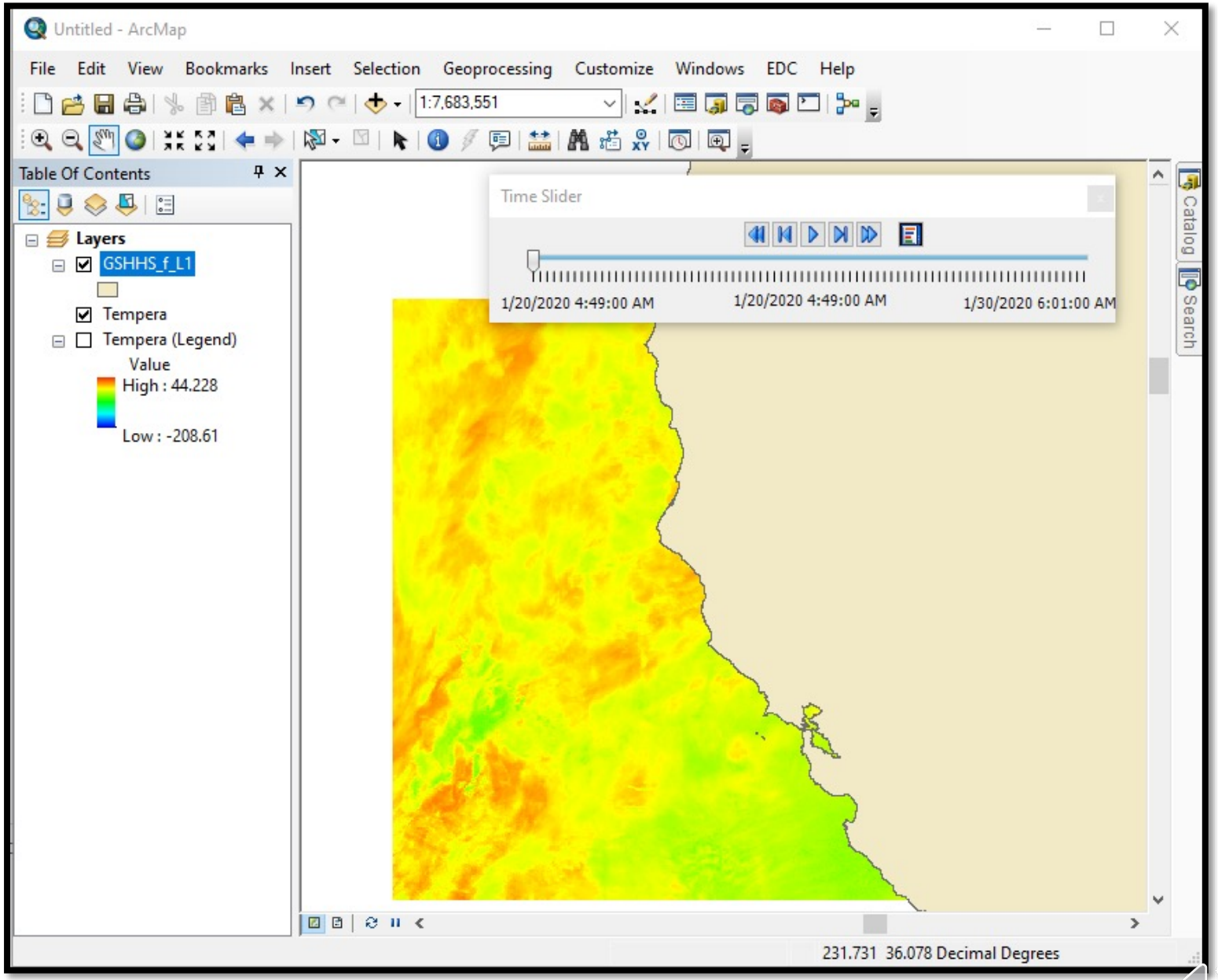


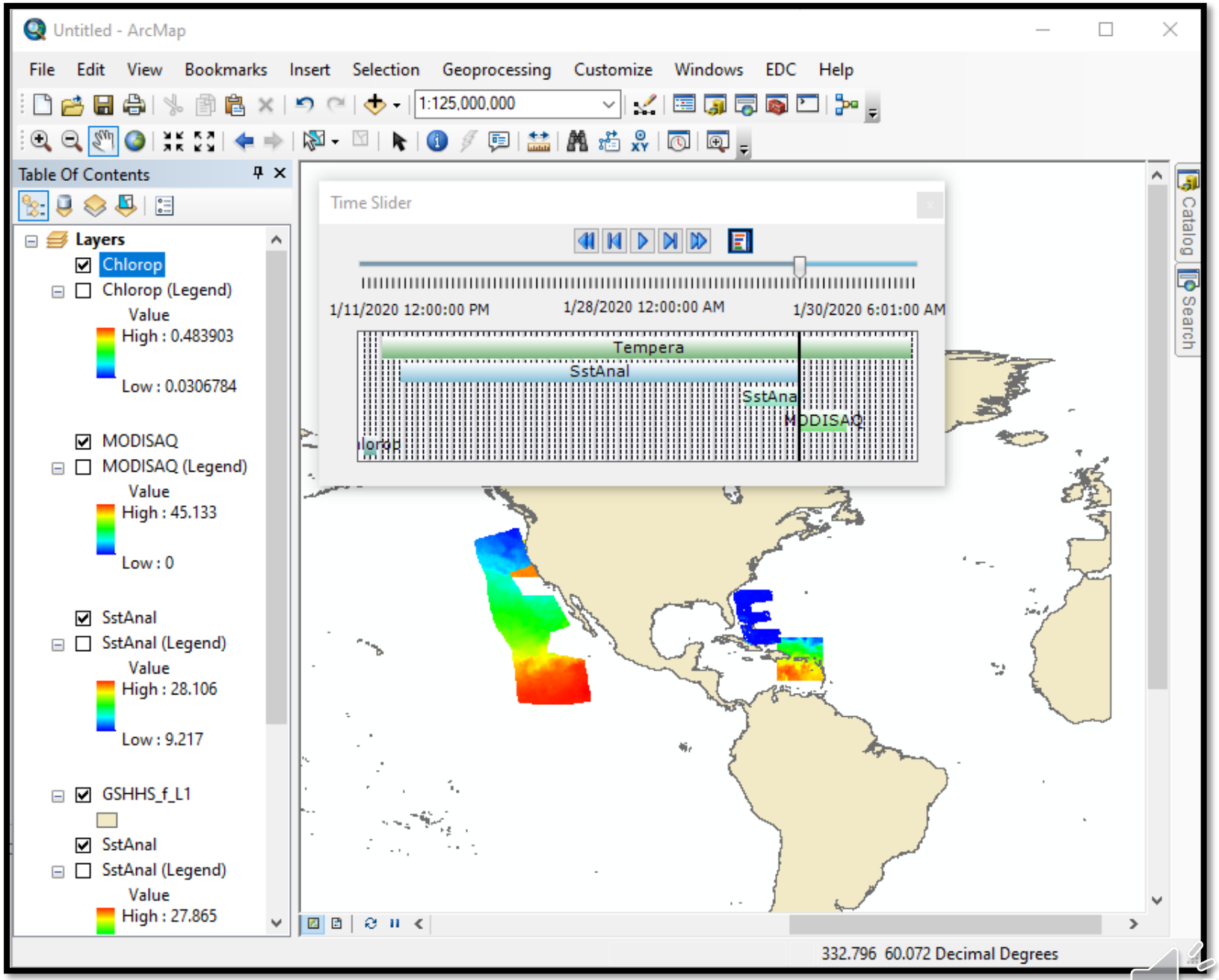
- Layer and Layer's Legend are loaded time-enabled with default scaling and color bar applied.



- Spatial alignment

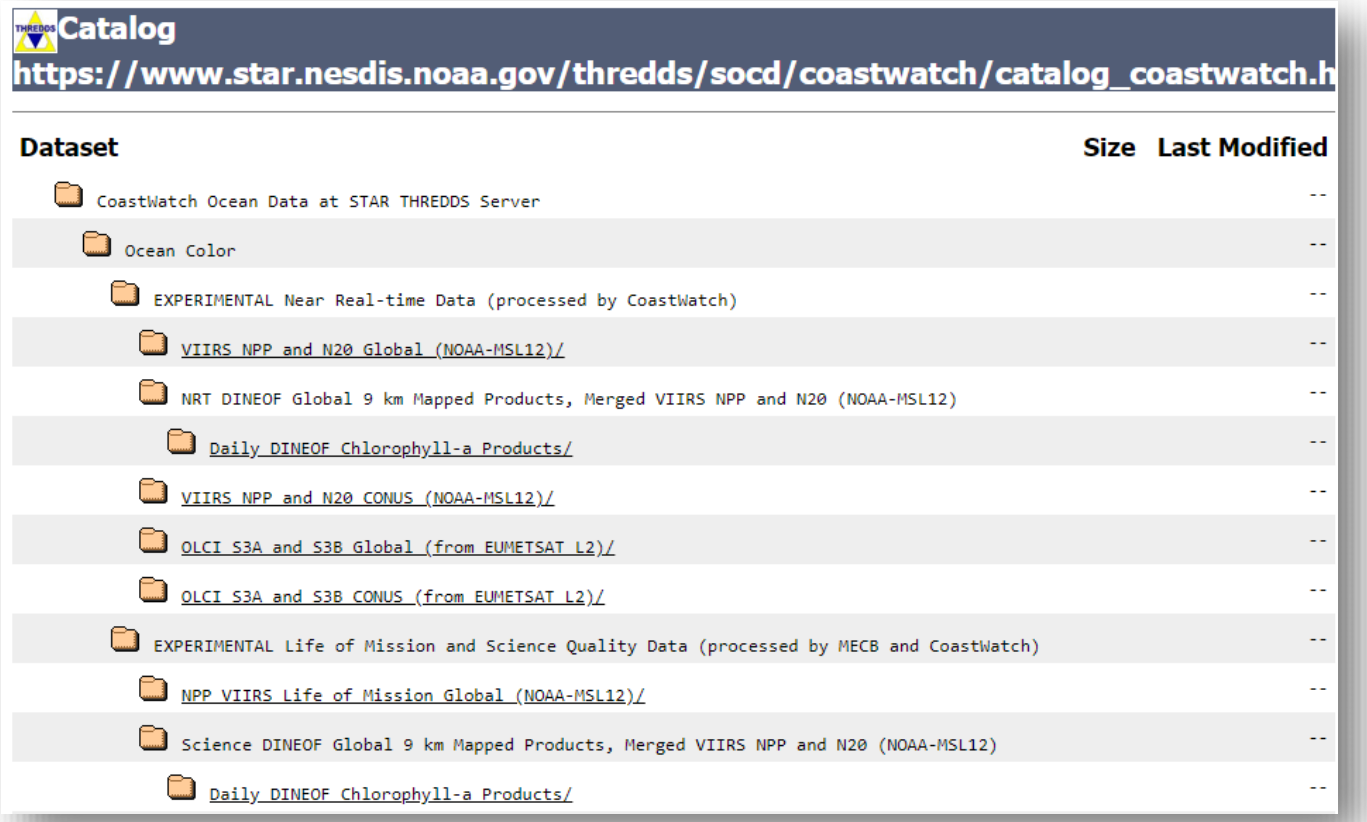


- Time Slider shows alignment/range of temporal data



Additional Services to Obtain Data

- OpenDAP
- THREDDS
- ERDDAP



Example of THREDDS Catalog

OpenDAP (Open Data Access Protocol)

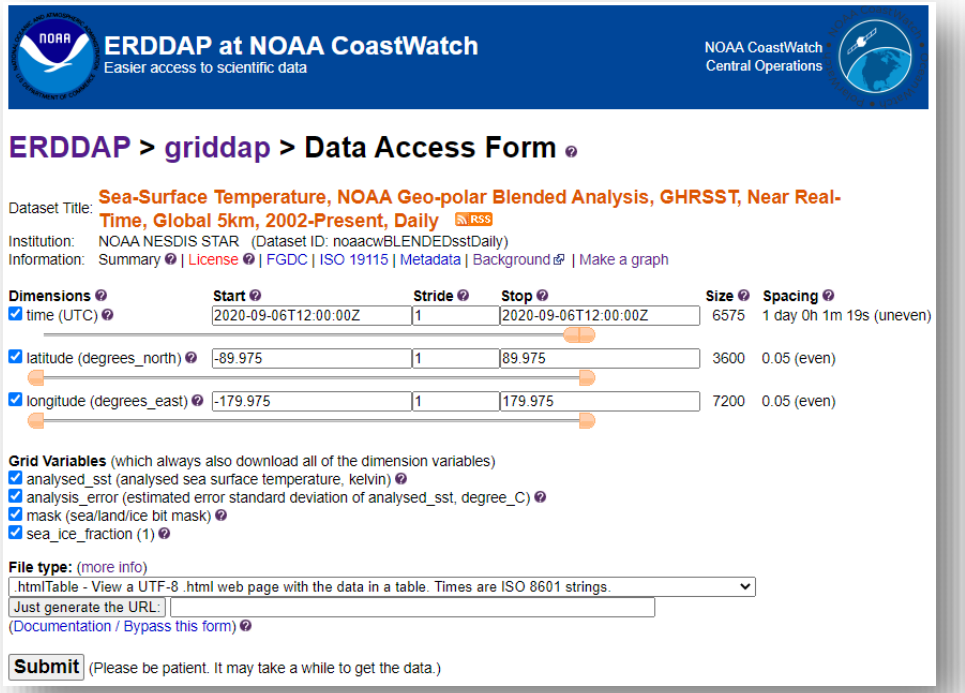
- Data model
- Application Program Interface (API)
- Dataset Descriptor Structure (DDS)
  - https://coastwatch.noaa.gov/erddap/griddap/noaacwBLENDEDsstDaily.dds
- Dataset Attribute Structure (DAS)
  - https://coastwatch.noaa.gov/erddap/griddap/noaacwBLENDEDsstDaily.das
- Used within THREDDS / ERDDAP

```
Dataset {
  Float64 time[time = 6575];
  Float32 latitude[latitude = 3600];
  Float32 longitude[longitude = 7200];
  GRID {
    ARRAY:
      Float32 analysed_sst[time = 6575][latitude = 3600][longitude = 7200];
    MAPS:
      Float64 time[time = 6575];
      Float32 latitude[latitude = 3600];
      Float32 longitude[longitude = 7200];
  } analysed_sst;
  GRID {
    ARRAY:
      Float32 analysis_error[time = 6575][latitude = 3600][longitude = 7200];
    MAPS:
      Float64 time[time = 6575];
      Float32 latitude[latitude = 3600];
      Float32 longitude[longitude = 7200];
  } analysis_error;
  GRID {
    ARRAY:
      Byte mask[time = 6575][latitude = 3600][longitude = 7200];
    MAPS:
      Float64 time[time = 6575];
      Float32 latitude[latitude = 3600];
      Float32 longitude[longitude = 7200];
  } mask;
  GRID {
    ARRAY:
      Float32 sea_ice_fraction[time = 6575][latitude = 3600][longitude = 7200];
    MAPS:
      Float64 time[time = 6575];
      Float32 latitude[latitude = 3600];
      Float32 longitude[longitude = 7200];
  } sea_ice_fraction;
} noaacwBLENDEDsstDaily;
```

Example of Dataset Descriptor Structure

THREDDS and ERDDAP

- Provide additional means to obtain data
- Temporal and Spatial Subsetting
- Useful services:
  - OpenDAP (THREDDS)
  - NetCDF Subset Service (THREDDS)
  - GRIDDAP (ERDDAP)
  - TableDAP (ERDDAP)



ERDDAP GRIDDAP Data Access Form

Things to keep track of

- Data Units:
  - SST may come in Kelvin or degrees Celsius (rarely Farenheit)
  - Chl comes in several units that do not necessarily change the values

- Time: Check the time zones for data – likely UTC

- Dateline: Most satellite data on services are composited daily products and may span 180W-180E
  - May introduce a mismatch in actual data collection time across the dateline

- Projection / Map Units:
  - Note units within ArcMap – usually the first data loaded sets projection and units
  - Ellipsoids/Datum – satellite data is most likely WGS84, land/coastal data may be NAD83

Additional Resources

- Environmental Data Connector
  - Download: https://www.pfeg.noaa.gov/products/EDC/EDCdownloads.html
  - User Guide: https://www.pfeg.noaa.gov/products/PFELData/EDC/EDC-1.3.7-ReleaseNotes_UserGuide.pdf
- ArcGIS [w/EDC] Satellite Data Tutorials/Examples
  - Tutorial for EDC and Make NetCDF Raster
    - ArcGIS_EDC_Training_PFEG.pdf
    - https://coastwatch.pfeg.noaa.gov/projects/arcgis/

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