Federal GIS Conference

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Using netCDF and HDF in ArcGIS

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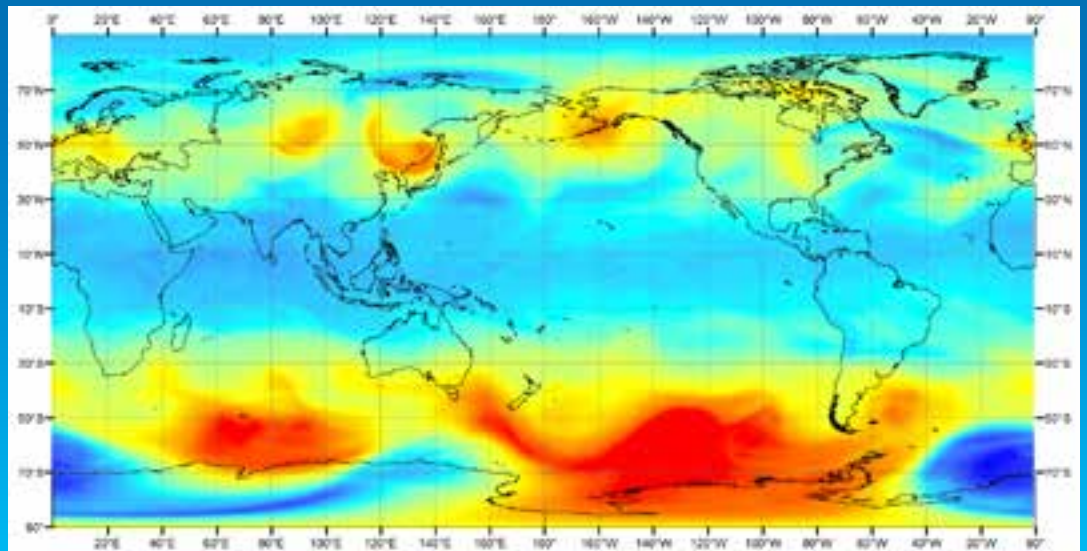
Outline

- NetCDF and HDF in ArcGIS
- Visualization and Analysis
- Sharing
- Customization using Python
- Demo
- Future Directions

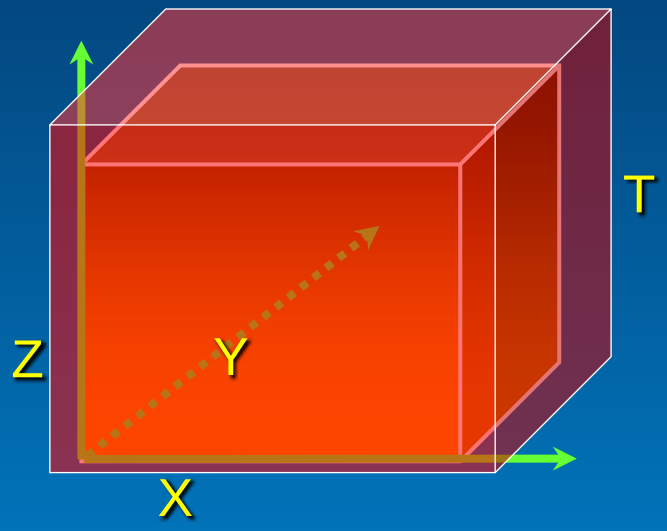
Scientific Data and Esri

- Direct support - NetCDF and HDF
- OPeNDAP/THREDDS – a framework for scientific data networking, integrated use by our customers
- Users of Esri technology
  - National Climate Data Center
  - National Weather Service
  - National Center for Atmospheric Research
  - U. S. Navy (NAVO)
  - Air Force Weather
  - USGS
  - Australian Navy
  - Australian Bur.of Met.
  - UK Met Office

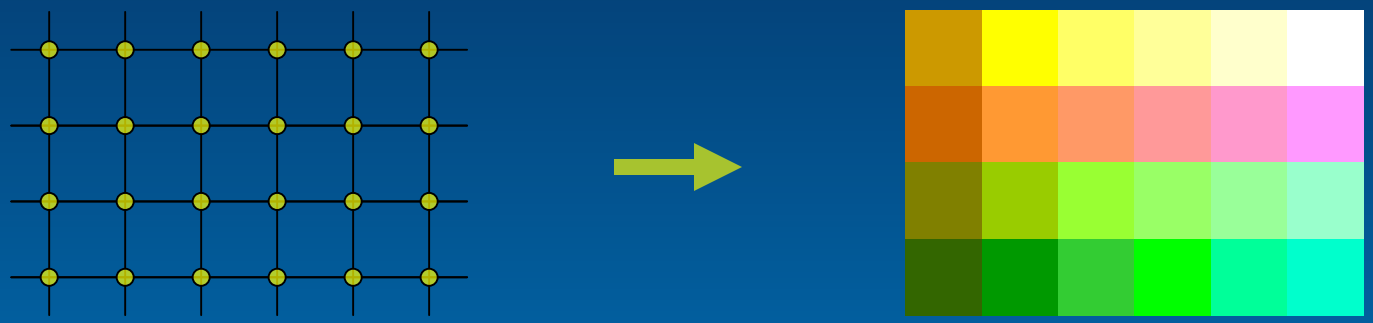


NetCDF Support in ArcGIS

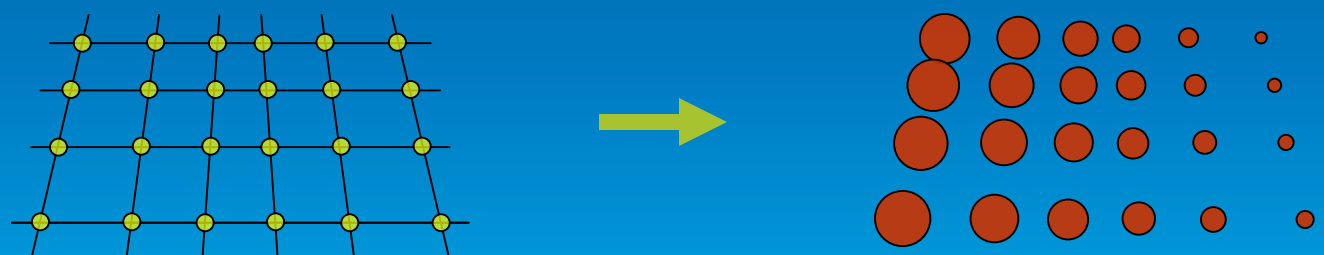
- ArcGIS reads/writes netCDF since version 9.2
- An array based data structure for storing multidimensional data.
- N-dimensional coordinates systems
- X, Y, Z, time, and other dimensions
- Variables – support for multiple variables
- Temperature, humidity, pressure, salinity, etc
- Geometry – implicit or explicit
- Regular grid (implicit)
- Irregular grid
- Points



Gridded Data



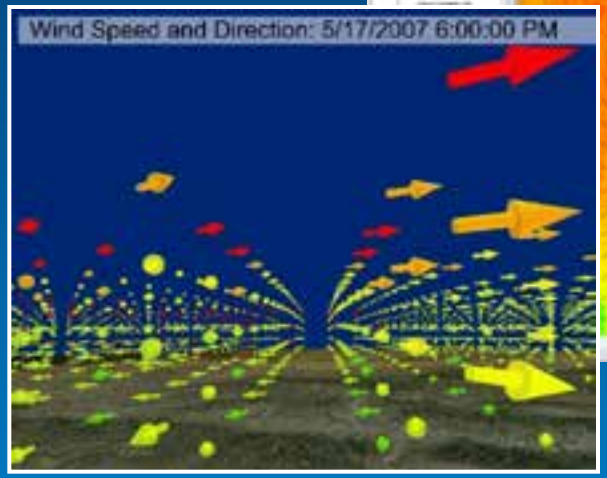
Regular Grid

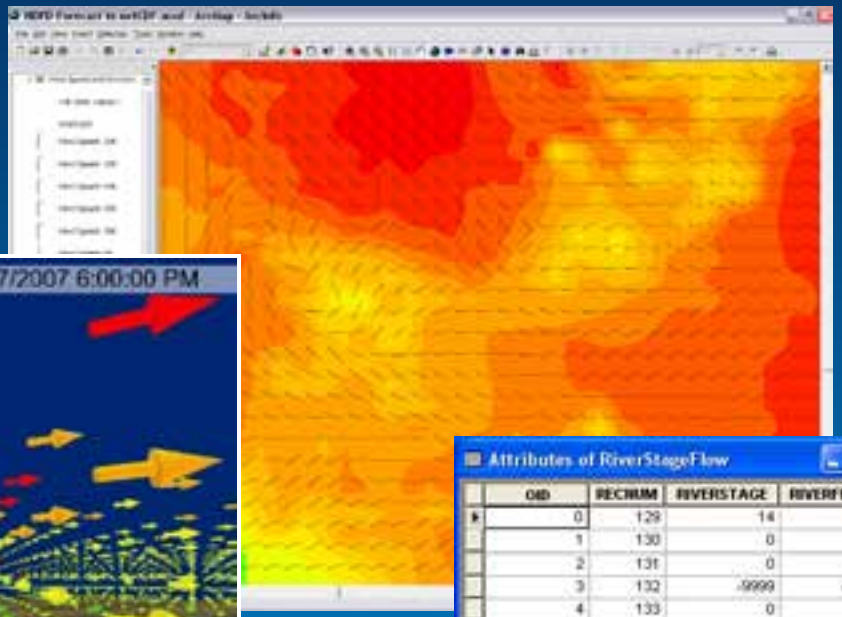


Irregular Grid

Reading netCDF data in ArcGIS

- NetCDF data is accessed as
  - Raster
  - Feature
  - Table





- Direct read
- Exports GIS data to netCDF

CF Convention

Climate and Forecast (CF) Convention
http://cf-pcmdi.llnl.gov/

Initially developed for
- Climate and forecast data
- Atmosphere, surface and ocean model-generated data
- Also for observational datasets

- The CF conventions generalize and extend the COARDS (Cooperative Ocean/Atmosphere Research Data Service) convention.

- CF is now the most widely used conventions for geospatial netCDF data. It has the best coordinate system handling.

NetCDF and Coordinate Systems

- Geographic Coordinate Systems (GCS)
  - X dimension units: degrees_east
  - Y dimension units: degrees_north
- Projected Coordinate Systems (PCS)
  - X dimension standard_name: projection_x_coordinate
  - Y dimension standard_name: projection_y_coordinate
  - Variable has a grid_mapping attribute.
  - CF 1.6 conventions currently supports thirteen predefined coordinate systems (Appendix F: Grid Mappings)
- Undefined
  - If not GCS or PCS
- ArcGIS writes (and recognizes) PE String as a variable attribute.

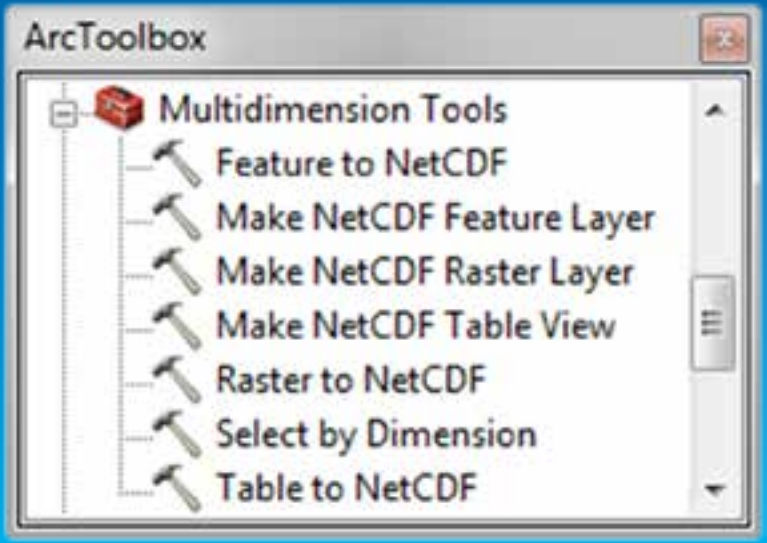
NetCDF Tools

Toolbox: Multidimension Tools

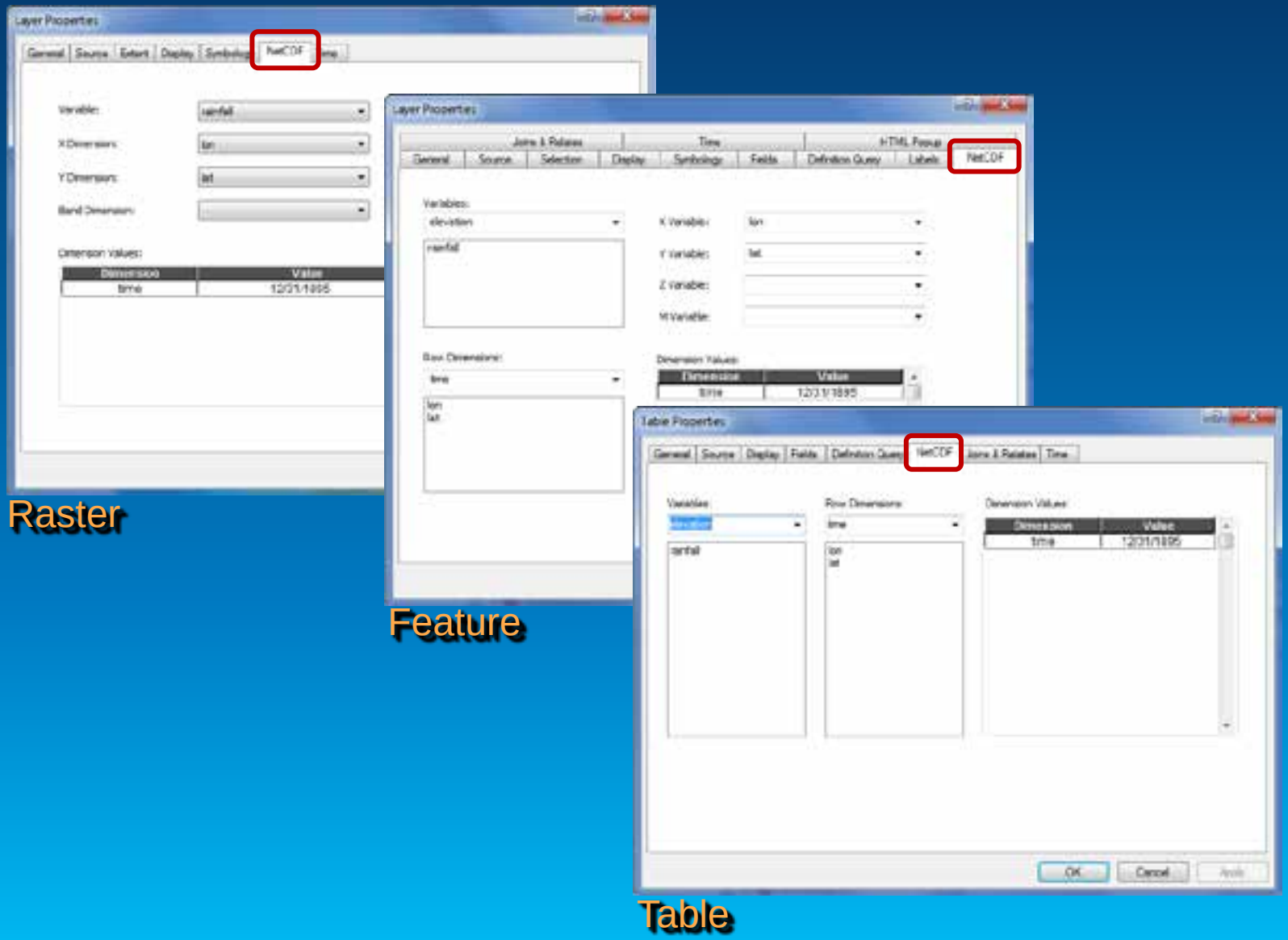
- Make NetCDF Raster Layer
- Make NetCDF Feature Layer
- Make NetCDF Table View

- Raster to NetCDF
- Feature to NetCDF
- Table to NetCDF

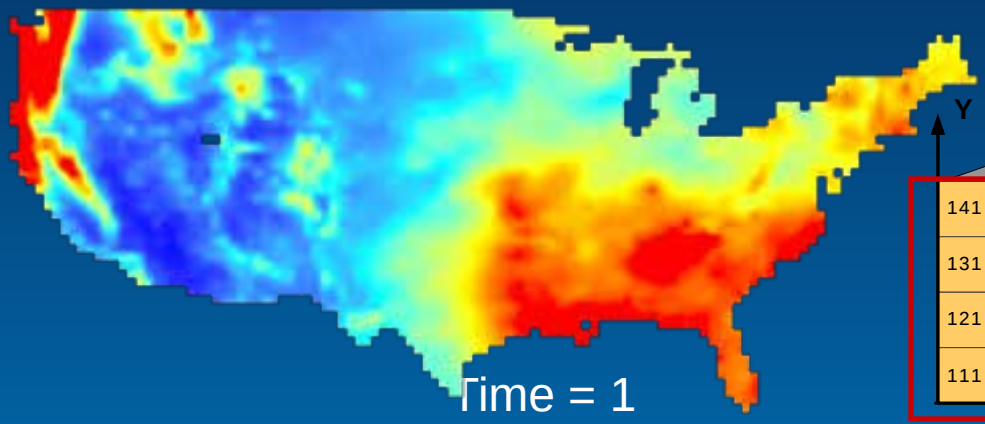
- Select by Dimension

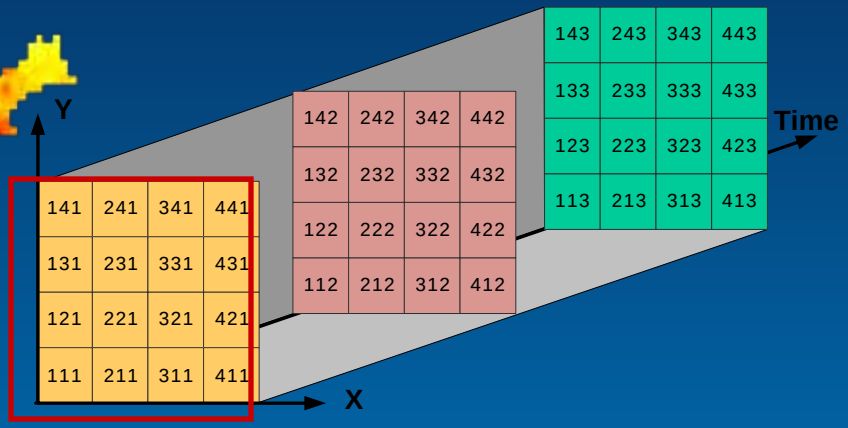


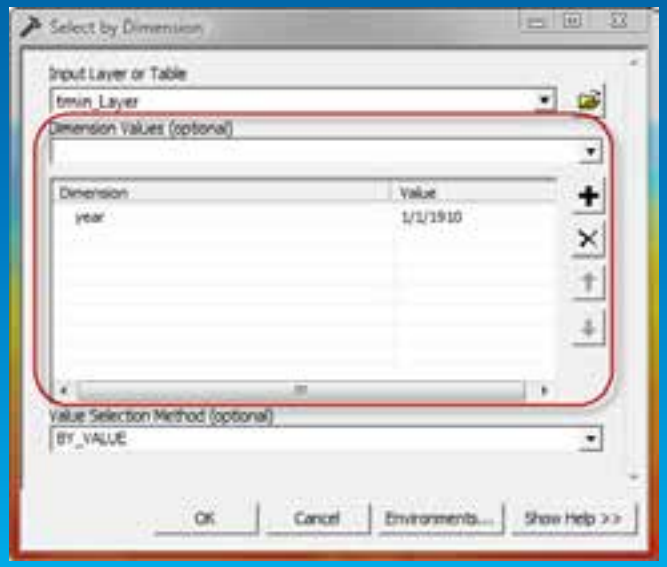
NetCDF Layer/Table Properties



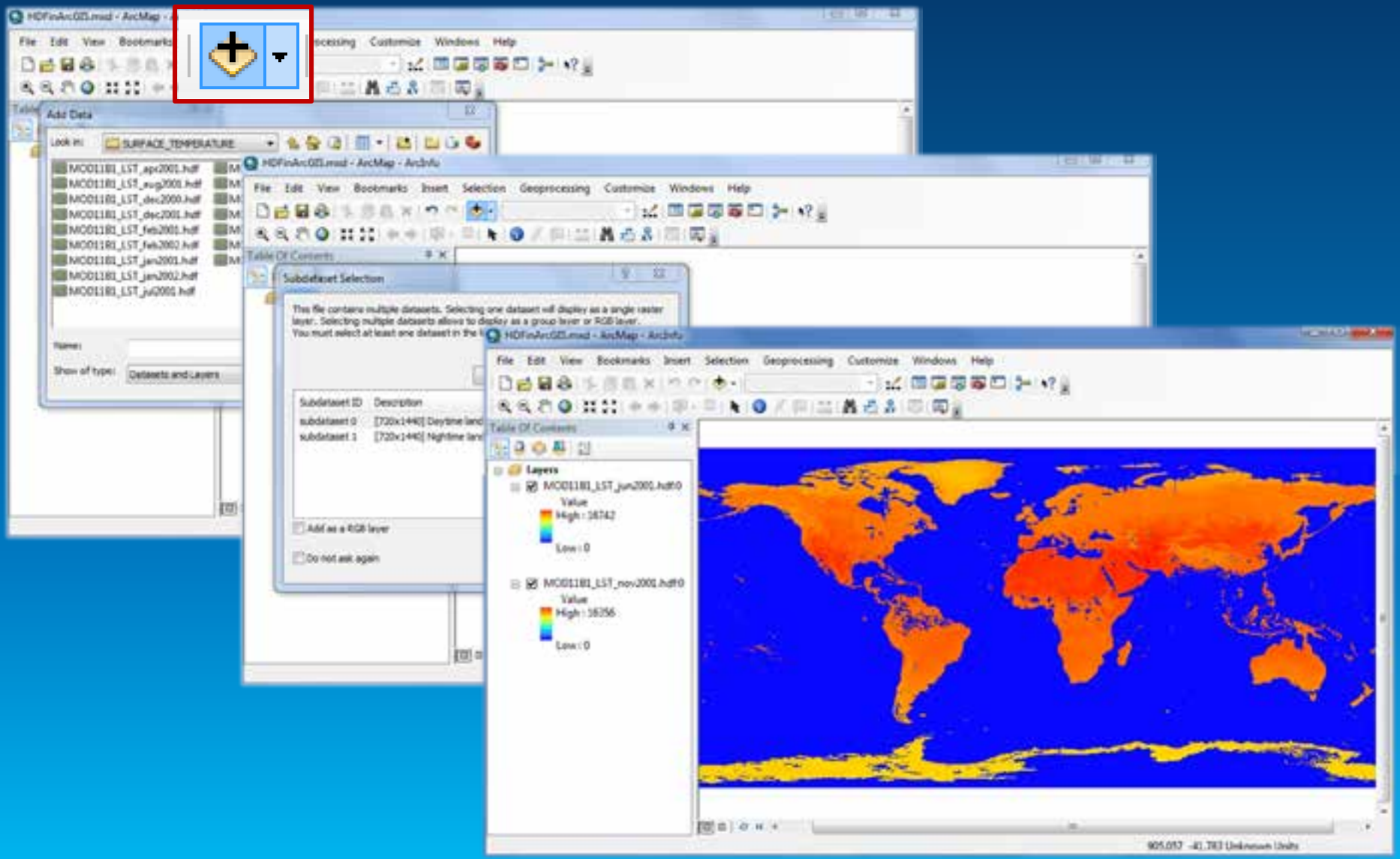
Changing Time Slice







Reading HDF in ArcGIS

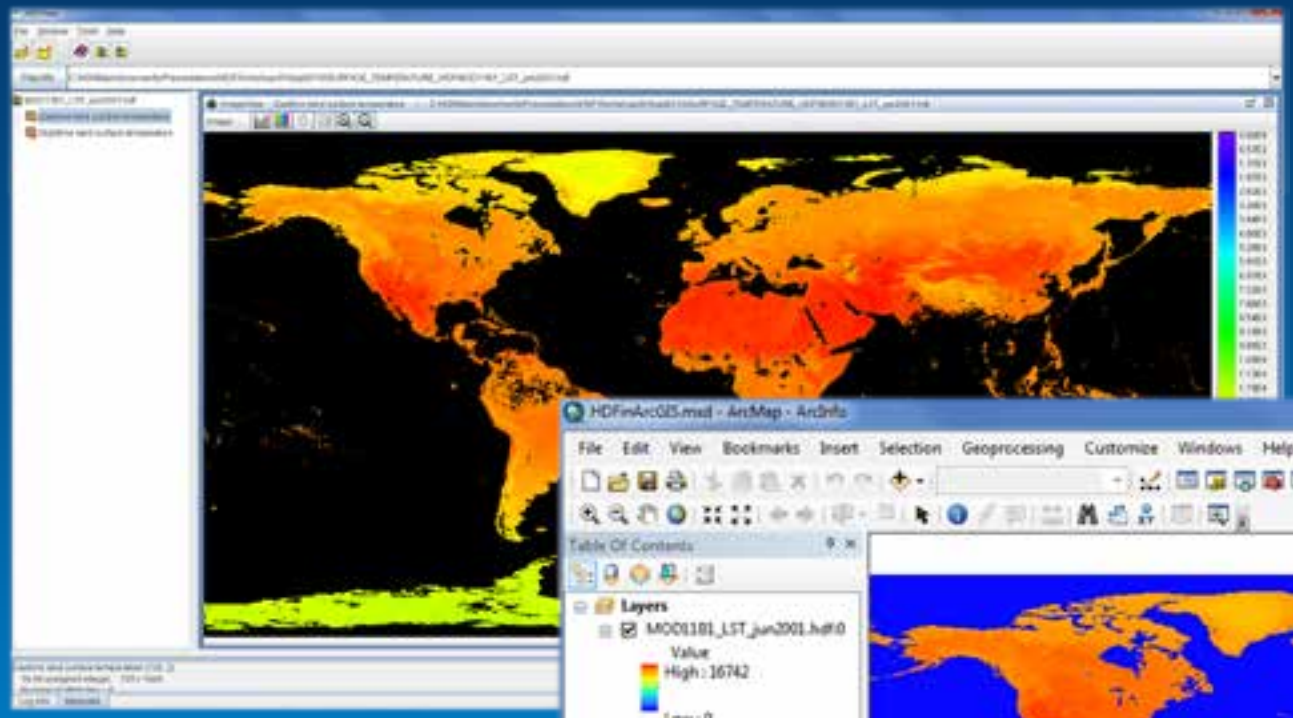


HDF Raster Support

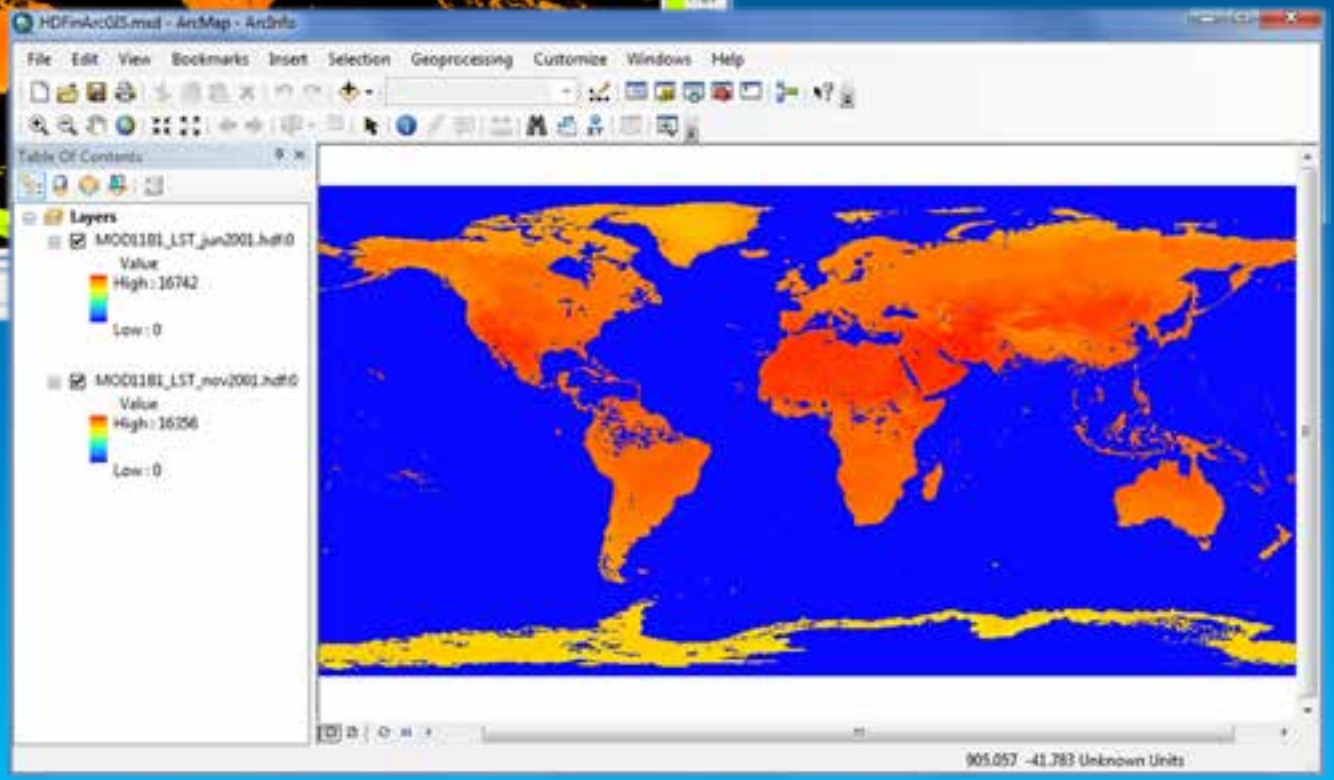
Raster Concept	ArcGIS 10.1 Support
Raster Format	ü HDF4 • read: open a HDF subdataset as a Raster Dataset • write: APIs available but not exposed in UI ü HDF5 • read: open a HDF subdataset as a Raster Dataset • write: not supported at this time
Raster Type	ü HDF4, HDF5 • direct ingest of one or many HDF subdatasets into a Mosaic Dataset using the Raster Dataset Raster Type or the Table Raster Type ** Esri interested in discussing other Raster Types*
Raster Product	** Esri interested in discussing other Raster Products*
Raster Product Definition	** Esri interested in discussing other Raster Product Definitions*

Displaying MODIS LST Data

HDFView



ArcGIS



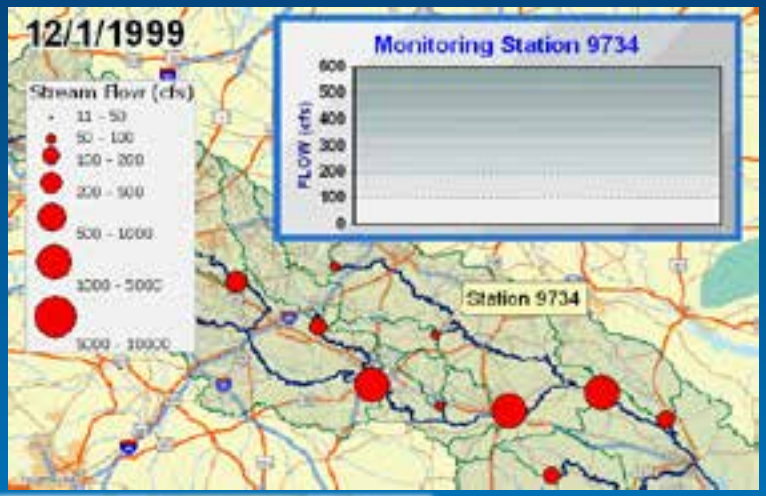
Using netCDF Data in ArcGIS

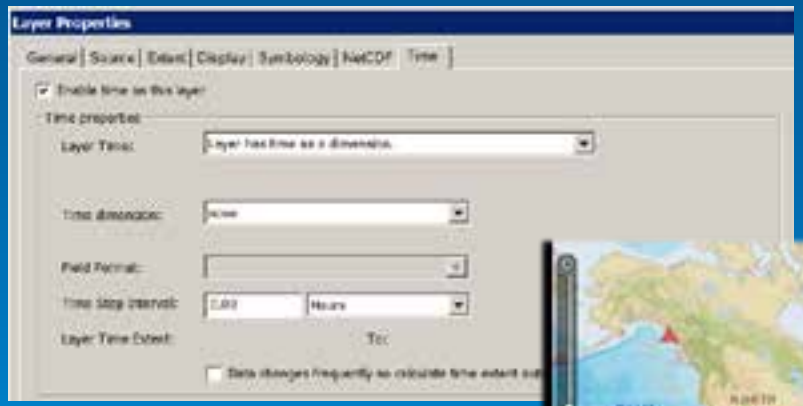
Behaves the same as any layer or table

- Display
  - Same display tools for raster and feature layers will work on netCDF raster and netCDF feature layers.
  - Mosaic dataset and function
- Graphing
  - Driven by the table just like any other chart.
- Animation
  - Multidimensional data can be animated through a dimension (e.g. time, pressure, elevation)
- Analysis Tools
  - A netCDF layer or table will work just like any other raster layer, feature layer, or table. (e.g. create buffers around netCDF points, reproject rasters, query tables, etc.)

Visualizing with animation

- Use animation to visualize temporal changes in a dataset

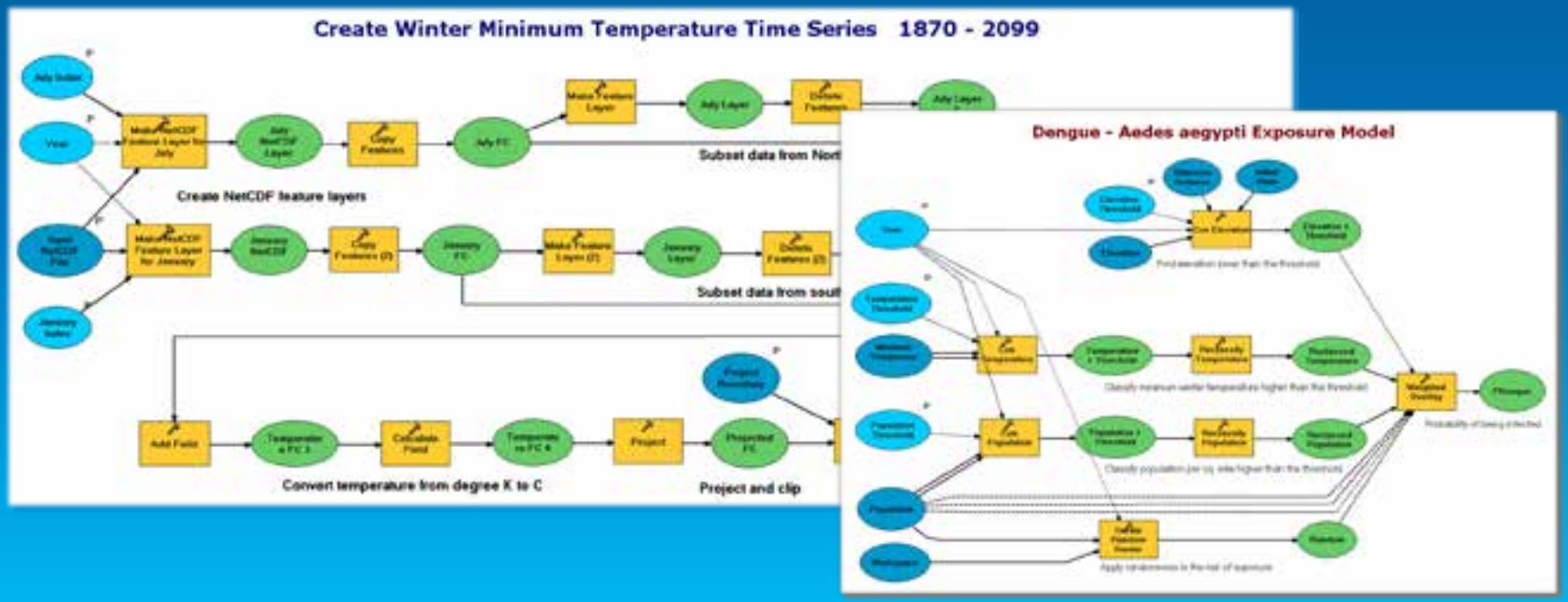




Spatial and Temporal Analysis

- Several hundreds analytical tools available for raster, features, and table

- Temporal Modeling
  - Looping and iteration in ModelBuilder and Python



Sources of Scientific Data

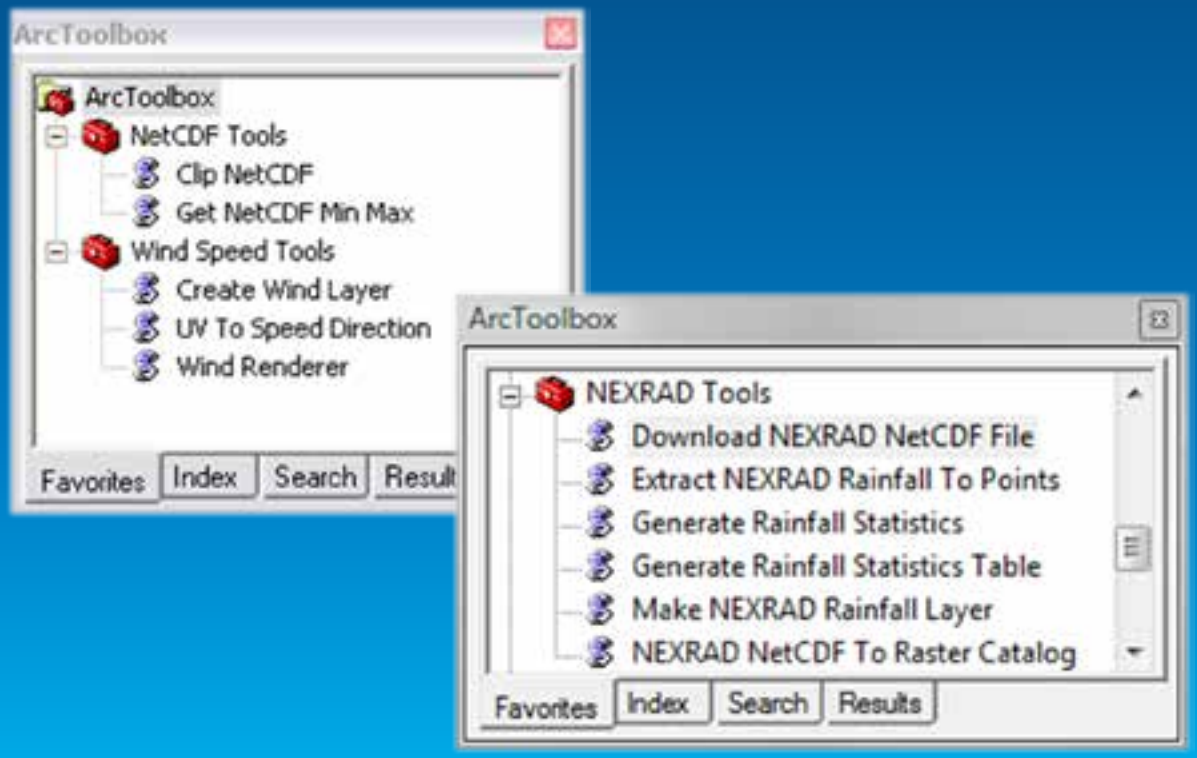
- NOAA
  - National Climatic Data Center (NCDC)
  - National Oceanographic Data Center (NODC)
  - Earth System Research Laboratory, Physical Science Division
- NASA
  - Global Change Master Directory (GCMD)
  - EOSDIS Data Center
- USGS
  - Earth Resources Observation and Science (EROS) Center
- Unidata's Motherload THREDDS Data Server (TDS)
- …. and many more

Sharing

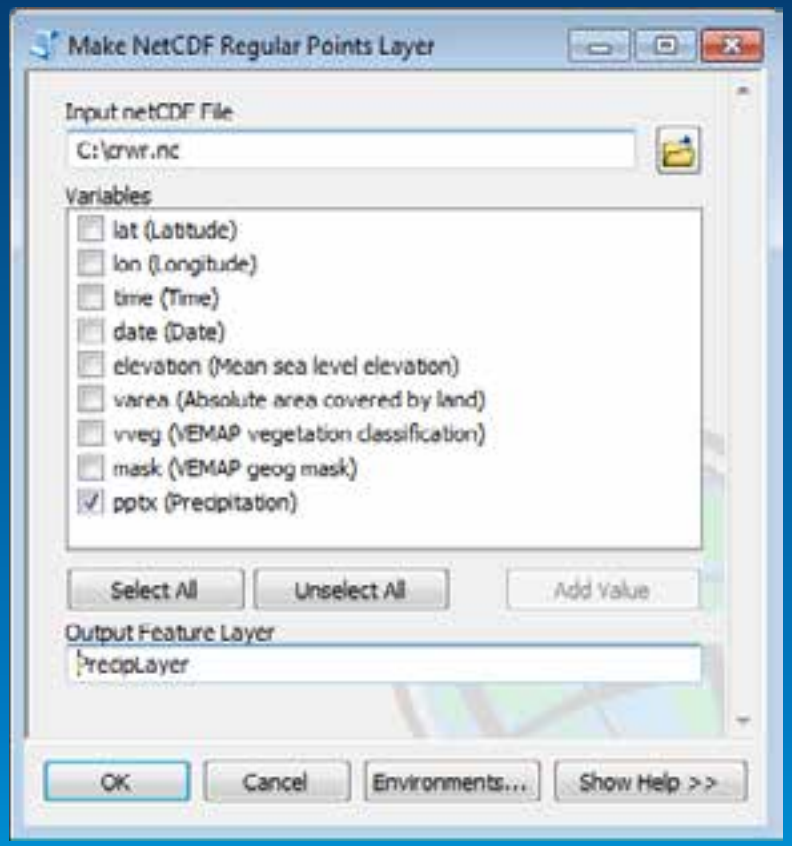
- Map Service
  - Makes maps available to the web.
- Image Service
  - Provides access to raster data through a web service.
- Geoprocessing Service
  - Exposes the analytic capability of ArcGIS to the web.
- Map Package
  - To share complete map documents and the data referenced by the layer it contains.
- Geoprocessing Package
  - To share your geoprocessing workflow.

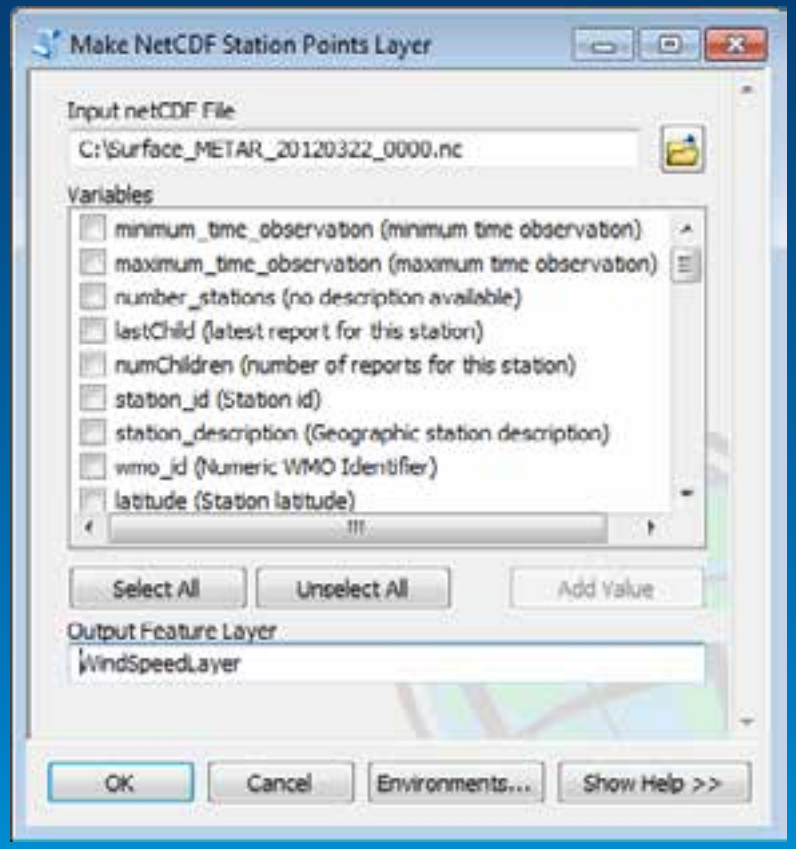
Script Tools

- Python is used to build custom tools for specific tasks or datasets



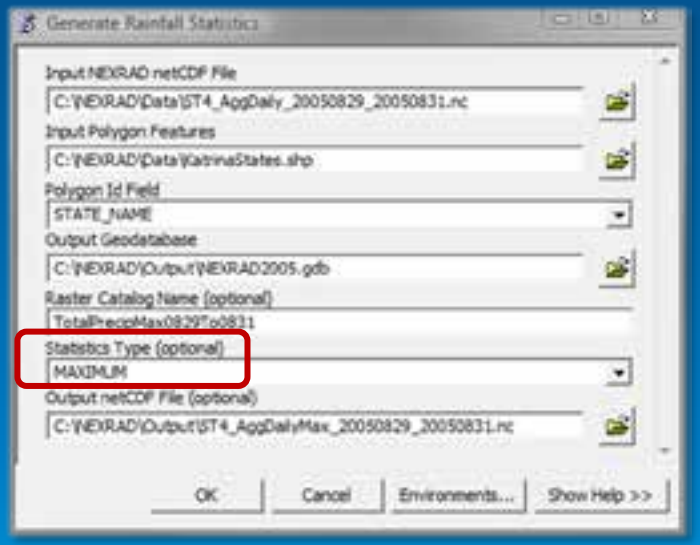
Reading Features from a netCDF File

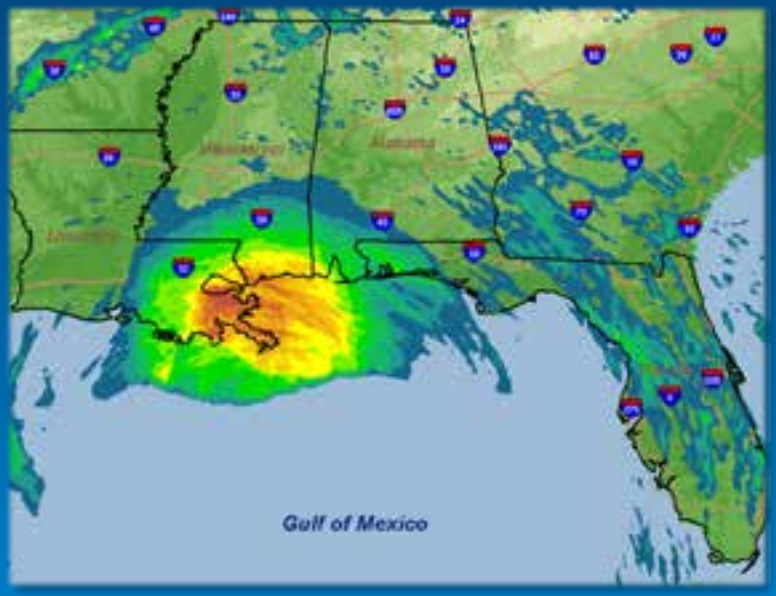


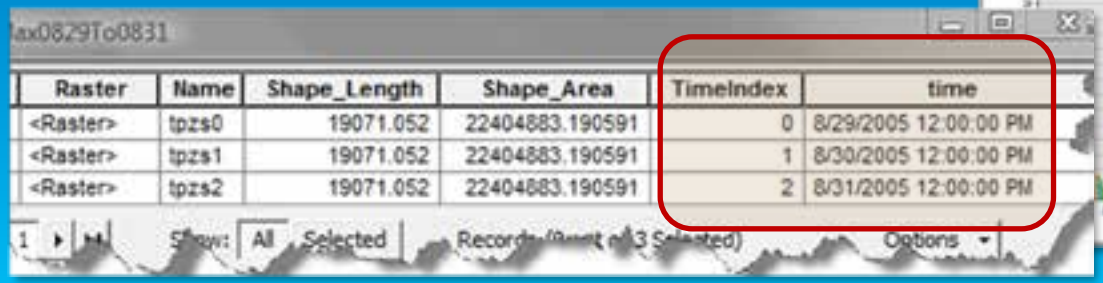


Generate Rainfall Statistics

- Calculates specified statistics for all time steps
- Outputs a raster catalog
- Optionally outputs a netCDF file







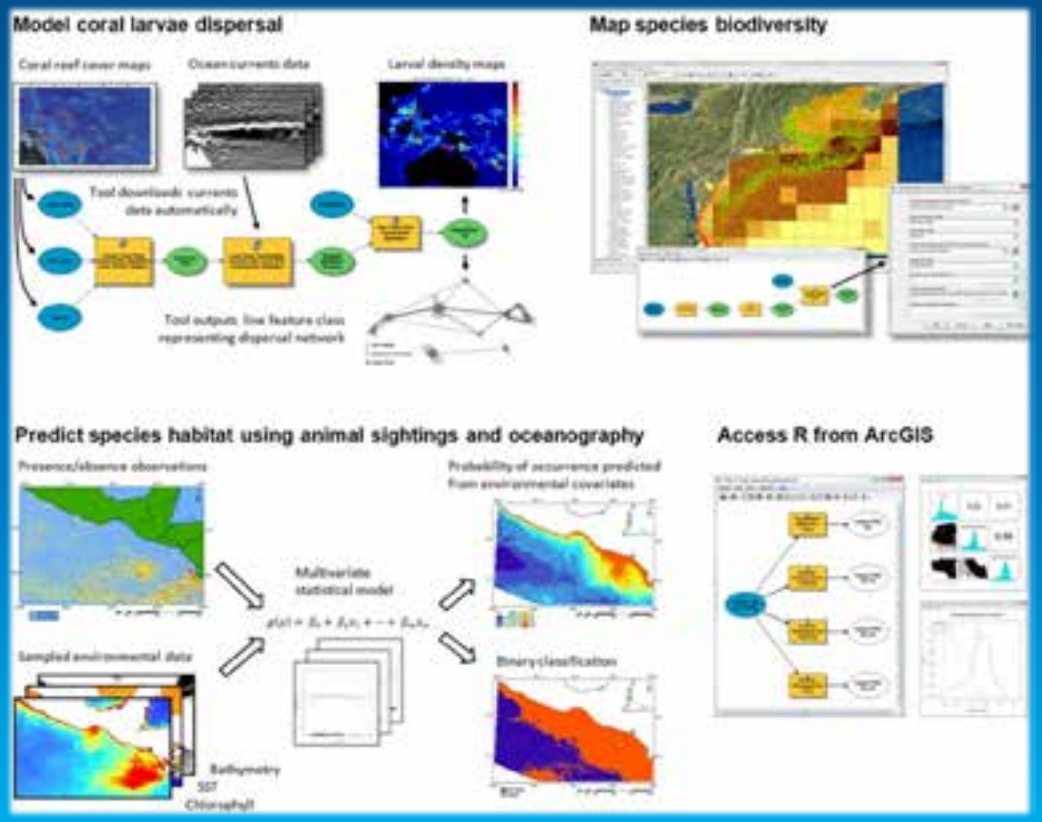
Raster	Name	Shape_Length	Shape_Area	TimeIndex	time
<Raster>	tpzs0	19071.052	22404883.190591	0	8/29/2005 12:00:00 PM
<Raster>	tpzs1	19071.052	22404883.190591	1	8/30/2005 12:00:00 PM
<Raster>	tpzs2	19071.052	22404883.190591	2	8/31/2005 12:00:00 PM

Community Developed Tools

- Geoprocessing Resource Center
  http://resources.arcgis.com/geoprocessing/

- Marine Geospatial Ecology Tools (MGET)
  - Developed at Duke Univ.
  - Over 180 tools for import management, and analysis of marine data

- Australian Navy tools
  (not publicly available)

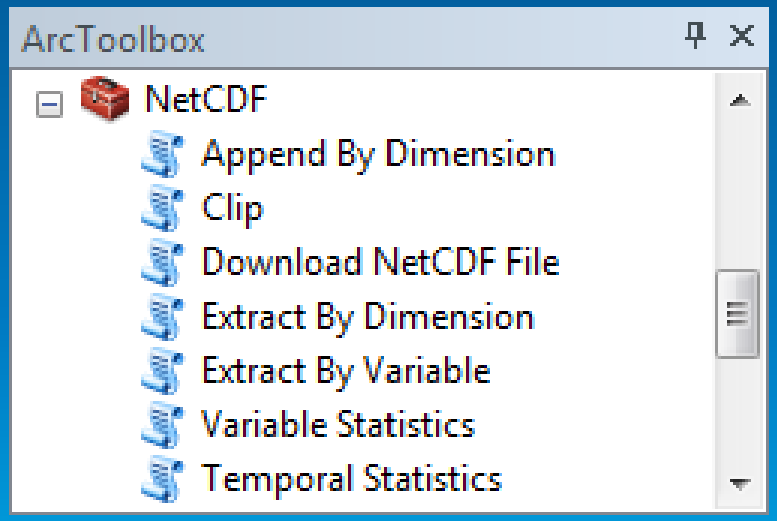


New NetCDF Tools (under development)

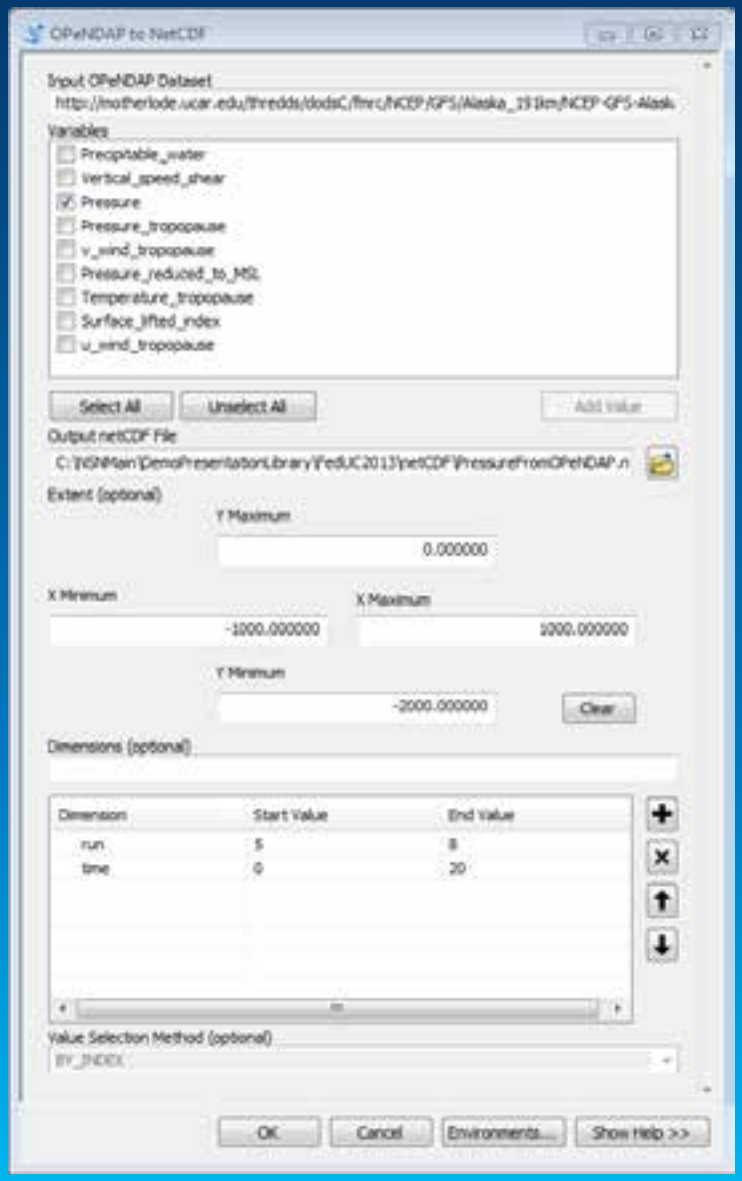
- OPeNDAP to NetCDF
- Clip

- Extract By Variable
- Extract By Dimension
- Append By Dimension

- Variable Statistics
- Temporal Statistics



OPeNDAP to NetCDF (OPeNDAP)



Demo

Demo

Demo

Demo

Demo

Scientific Data Workshop, Ocean Summit and Future Initiatives

- Esri recently hosted Ocean Summit in November 2012
- And Scientific Data Workshops in February 2012
- To understand the future need for scientific data support in ArcGIS
- Ongoing efforts - require close collaboration with all of you

- Some of the future initiatives are:
  - Support netCDF in mosaic dataset
  - Continue to support netCDF classic and netCDF4
  - Provide better support for HDF5
  - Provide tool to consume data served using THREDDS/OPeNDAP
  - Continue to support the evolving CF convention
  - Support a strong developer experience for netCDF and HDF using Python

  - What else?

Things to Consider…

- Embrace the Common Data Model (netCDF, HDF etc.)
- Use Data and metadata standards (OGC, CF etc)

- Provide “mechanism” so that we can access scientific data using a single set of APIs….
- and can expect data to be CF complainant

- Make your data “spatial” (by specifying geographic or a projected coordinate system)
- Clearly define workflow and requirements
- Create sample tools where possible

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Thank You

Please complete a session evaluation form.

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esri

Understanding our world.