



NOAA

The Weather and Climate Toolkit

Steve Ansari
Physical Scientist
NOAA National Centers for Environmental Information





Overview:

- The Weather and Climate Toolkit (WCT) is free, public domain desktop software
- First released in 2008
- Windows, Mac and Linux
- User interface and command-line script support

- Why?

Easier access to weather and climate data in complex formats (including lots of NOAA data)

- A tool that complements other tools
- Works on cloud environments
- Works with local or remote data
- Can run offline

Supports 2 of 5 NESDIS Strategic Objectives



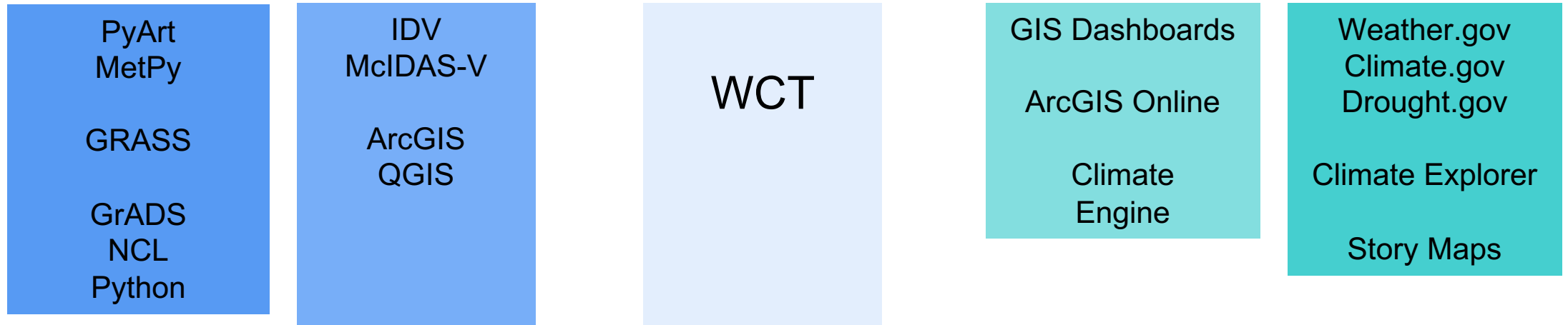
Provide consistent ongoing enterprise-wide user engagement to ensure timely response to user needs



Deliver integrated program development to provide a suite of products and services



Where does the WCT fit?



Complex
Technical
Flexible
Software

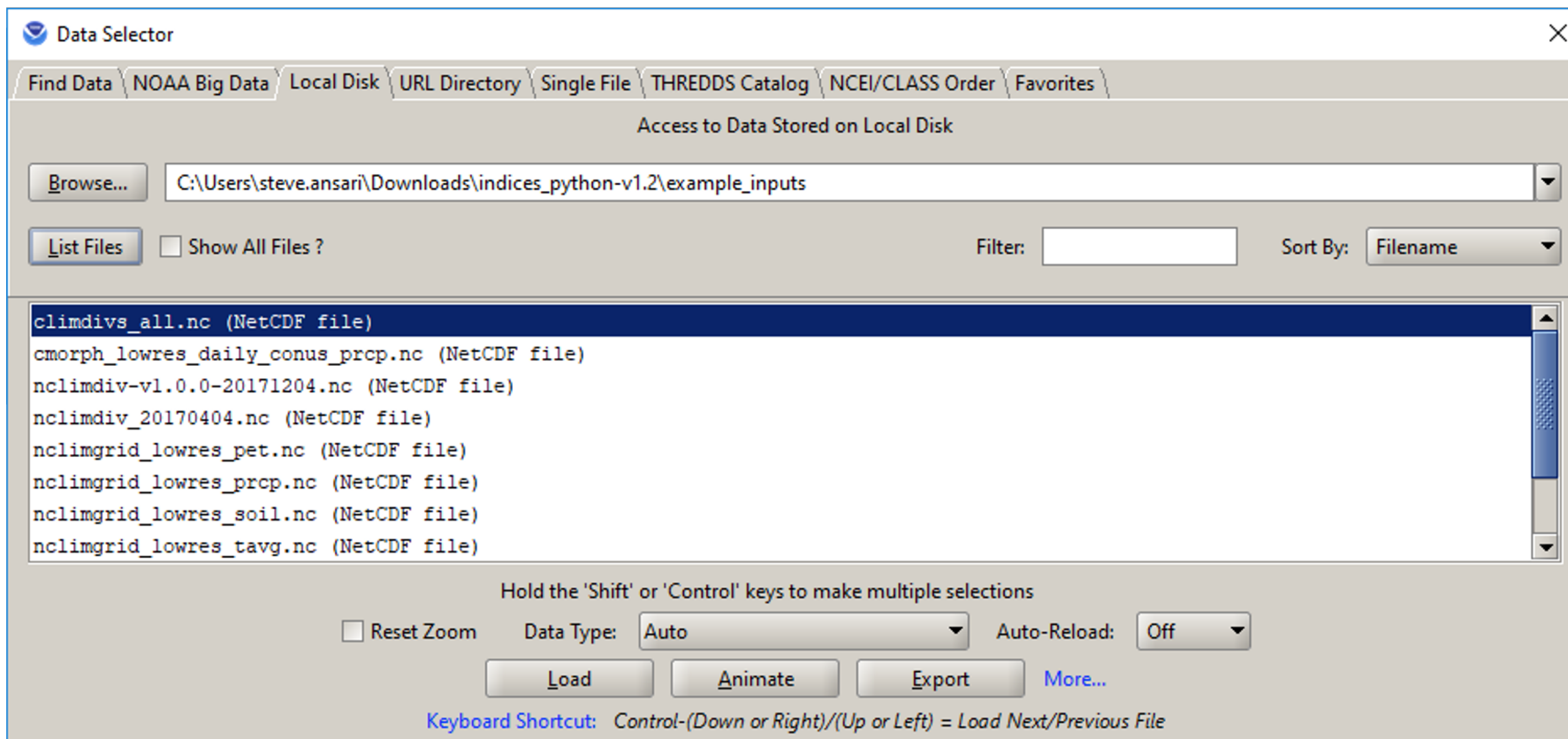
Simple
Public-focused
Specific
Web-based



Supported Data Sources:

Local computer / disk

Example: I made some NetCDF files





Supported Data Sources:

Remote files – HTTP(s), FTP

Example: MRMS data from NOAA NCEP, with auto-reload

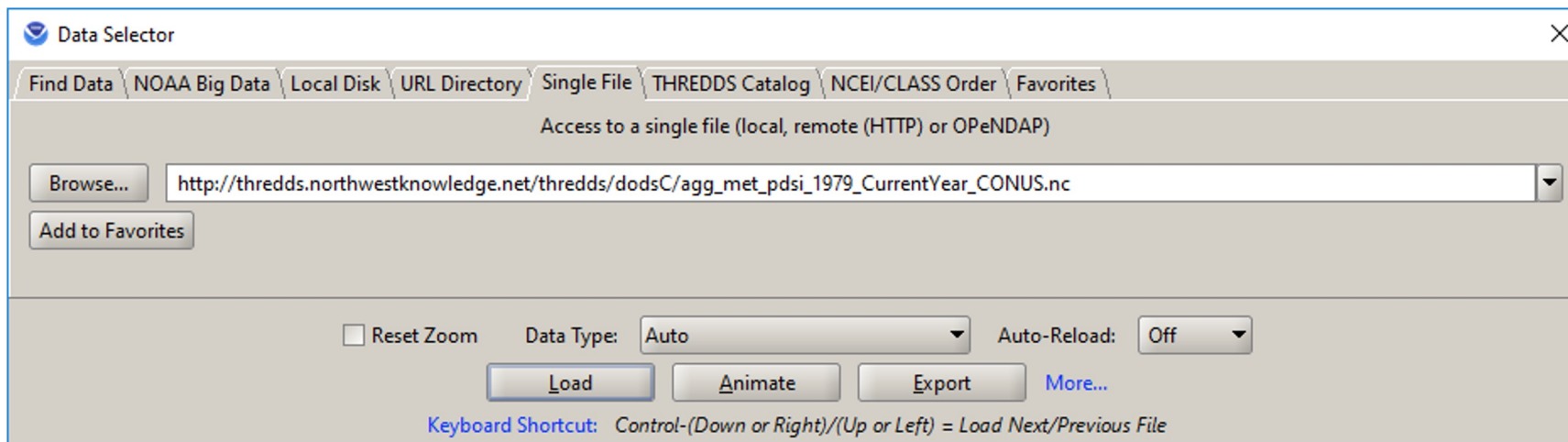
The screenshot shows the 'Data Selector' application window. The 'URL Directory' tab is selected, and the 'Enter Custom URL' field contains 'https://mrms.ncep.noaa.gov/data/2D/SeamlessHSR/'. Below the URL field, there are buttons for 'List Files' and 'Show All Files?', a 'Filter' input field, and a 'Sort By' dropdown menu set to 'Filename'. A list of files is displayed, with the first file selected: 'MRMS_SeamlessHSR_latest.grib2.gz (Multi-Radar Multi-Sensor (MRMS) - Hybrid Scan Reflectivity)'. Below the list, there are controls for 'Cache', 'Reset Zoom', 'Data Type' (set to 'Auto'), and 'Auto-Reload' (set to 'Off'). The 'Auto-Reload' dropdown is circled in red. At the bottom, there are buttons for 'Load', 'Animate', 'Export', and 'More...', along with a keyboard shortcut: 'Control-(Down or Right)/(Up or Left) = Load Next/Previous File'.



Supported Data Sources:

Remote endpoints – HTTP(s), FTP, OPeNDAP

Example: 40 year Palmer Drought Severity Index aggregation





Supported Data Sources:

Remote endpoints – THREDDS

Example: Satellite data at NCEI

The screenshot shows the 'Data Selector' application window. The title bar reads 'Data Selector'. The interface includes a tabbed menu with 'Find Data', 'NOAA Big Data', 'Local Disk', 'URL Directory', 'Single File', 'THREDDS Catalog', 'NCEI/CLASS Order', and 'Favorites'. The 'THREDDS Catalog' tab is active, displaying 'Access to Data Stored in a THREDDS Data Server'. A text field for 'Enter THREDDS Catalog URL' contains 'https://www.ncei.noaa.gov/thredds/catalog.xml'. Below this is a 'List Files' button. The main content area shows a breadcrumb path: 'Root / Satellite / NCEI THREDDS Server : Category Listing :: satellite / Climate Data Records Program / Climate Data Records (CDR)'. A list of data categories is displayed, including AVHRR Aerosol Optical Thickness, AVHRR Reflectance Cloud Properties PATMOS-X, AVHRR Polar Pathfinder, AVHRR Surface Reflectance, Daily Precipitation (PERSIANN), Geostationary IR Channel Brightness Temperature - GridSat B1, Global Precipitation Climatology Project, HIRS Ch12 Brightness Temperature, International Satellite Cloud Climatology Project (ISCCP) H Series, and Leaf Area Index & Fraction of Absorbed Photosynthetically Active Radiation (LAI FAPAR). An 'Icon Legend' on the right explains the icons: a blue folder for 'Directory', a green 'O' icon for 'OPeNDAP Access (subset)' (noting it is faster for multiple variables), and a white 'H' icon for 'HTTP Access (full download)' (noting it is faster for single variables). At the bottom, there are controls for 'Cache', 'Reset Zoom', 'Data Type' (set to 'Auto'), 'Auto-Reload' (set to 'Off'), and buttons for 'Load', 'Animate', 'Export', and 'More...'. A keyboard shortcut is noted: 'Control-(Down or Right)/(Up or Left) = Load Next/Previous File'.





Supported Data Sources:

Data in the NOAA Open Data Dissemination project: Ex) NEXRAD, GOES data from Amazon

The screenshot displays the NOAA Weather and Climate Toolkit interface. A 'Data Selector' dialog box is open, showing a list of data files. The selected file is 'G16 C13 20200112 23:51:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))'. The background shows a satellite radiance map of the Amazon region with a color scale from 9.47 to 109.02 mW m⁻² sr⁻¹ (cm⁻¹)-1.

Data Selector Dialog:

- Find Data: NOAA Big Data | Local Disk | URL Directory | Single File | THREDDS Catalog | NCEI/CLASS Order | Favorites
- Access to data available from cloud collaborators in the NOAA Big Data Project [?]
- GOES-16 | Amazon | Amazon Documentation / NCEI News Article
- List Files | ABI-L1b-RadC | (C13) "Clean" Longwave Window Band (IR) | Sun 01/12/2020 | (GMT/UTC)
- File list:
 - G16 C13 20200112 23:21:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
 - G16 C13 20200112 23:26:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
 - G16 C13 20200112 23:31:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
 - G16 C13 20200112 23:36:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
 - G16 C13 20200112 23:41:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
 - G16 C13 20200112 23:46:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
 - G16 C13 20200112 23:51:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))**
 - G16 C13 20200112 23:56:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
- Cache: . / .
- Hold the 'Shift' or 'Control' keys to make multiple selections
- Reset Zoom | Data Type: Auto | Auto-Reload: Off
- Buttons: Load, Animate, Export, More...
- Keyboard Shortcut: Control-(Down or Right)/(Up or Left) = Load Next/Previous File

Map Legend:

G16 C13 20200112 23:51:16 (GOES-16/17 Radiance Data "Clean" Longwave Window Band (IR))
Rad (mW m⁻² sr⁻¹ (cm⁻¹)-1)

9.47	29.38	49.29	69.20	89.11	109.02
------	-------	-------	-------	-------	--------



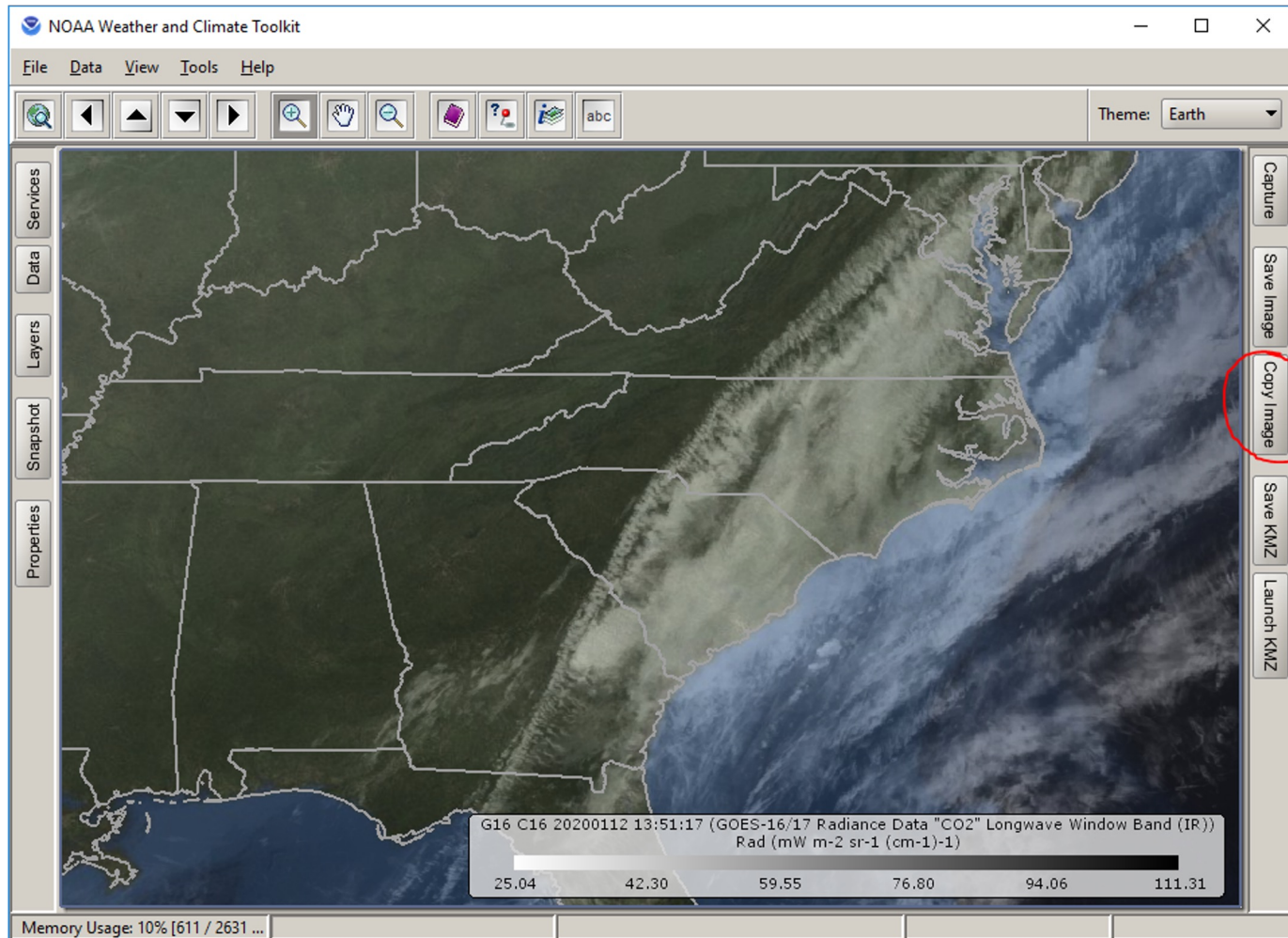
Simple Time Saving Features:

1. Copy/paste map into PowerPoint or Email
1. Map Themes
1. A series of map 'screen captures'



Simple Time Saving Features:

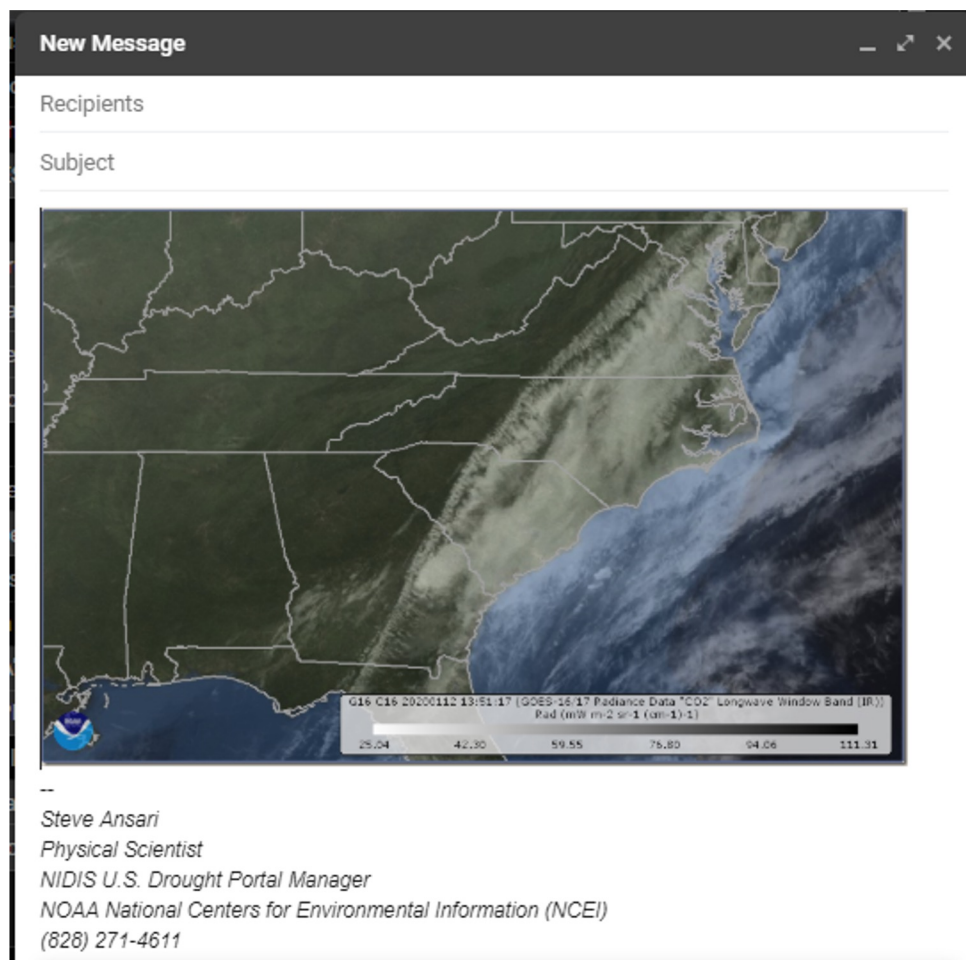
1. Copy/paste map into PowerPoint or Email





Simple Time Saving Features:

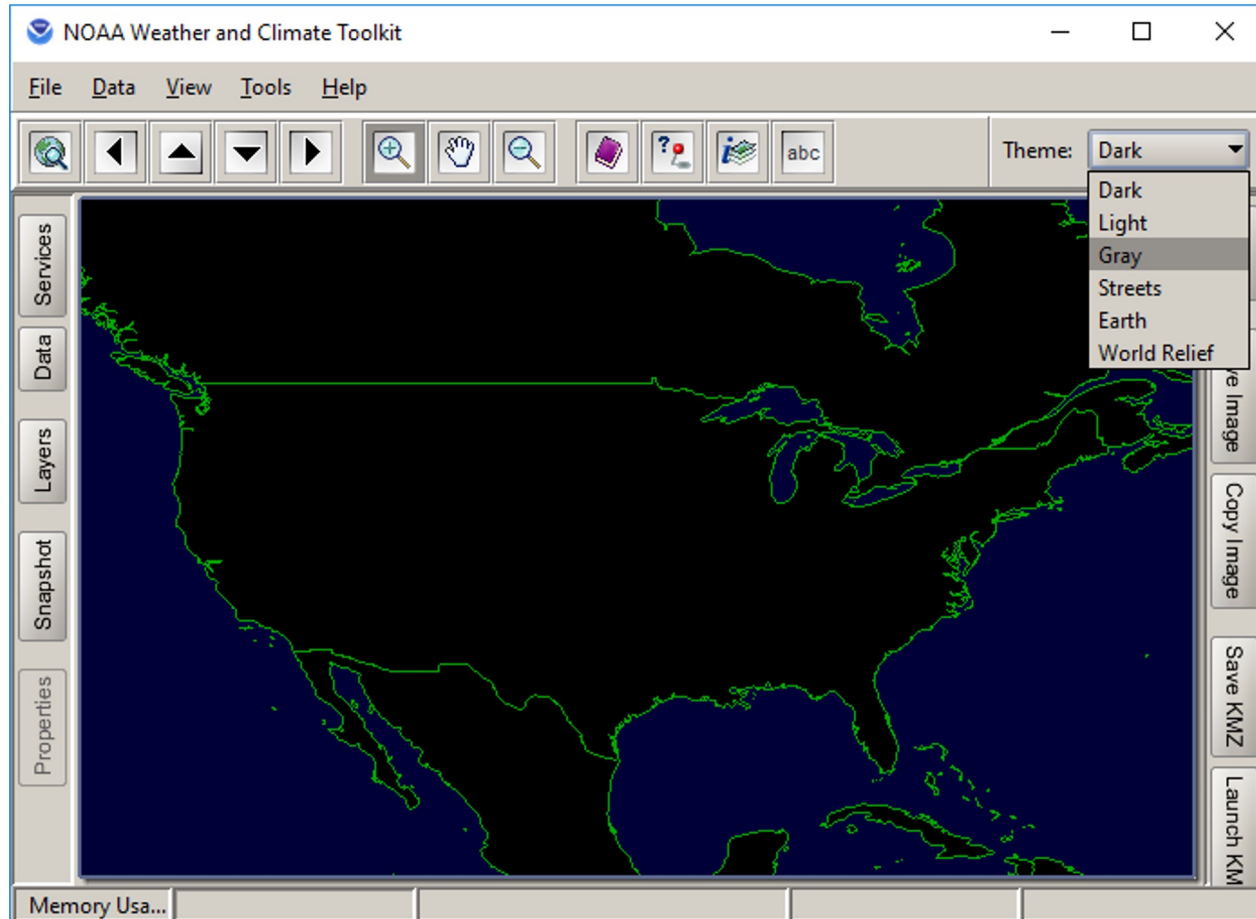
1. Copy/paste map into PowerPoint or Email





Simple Time Saving Features:

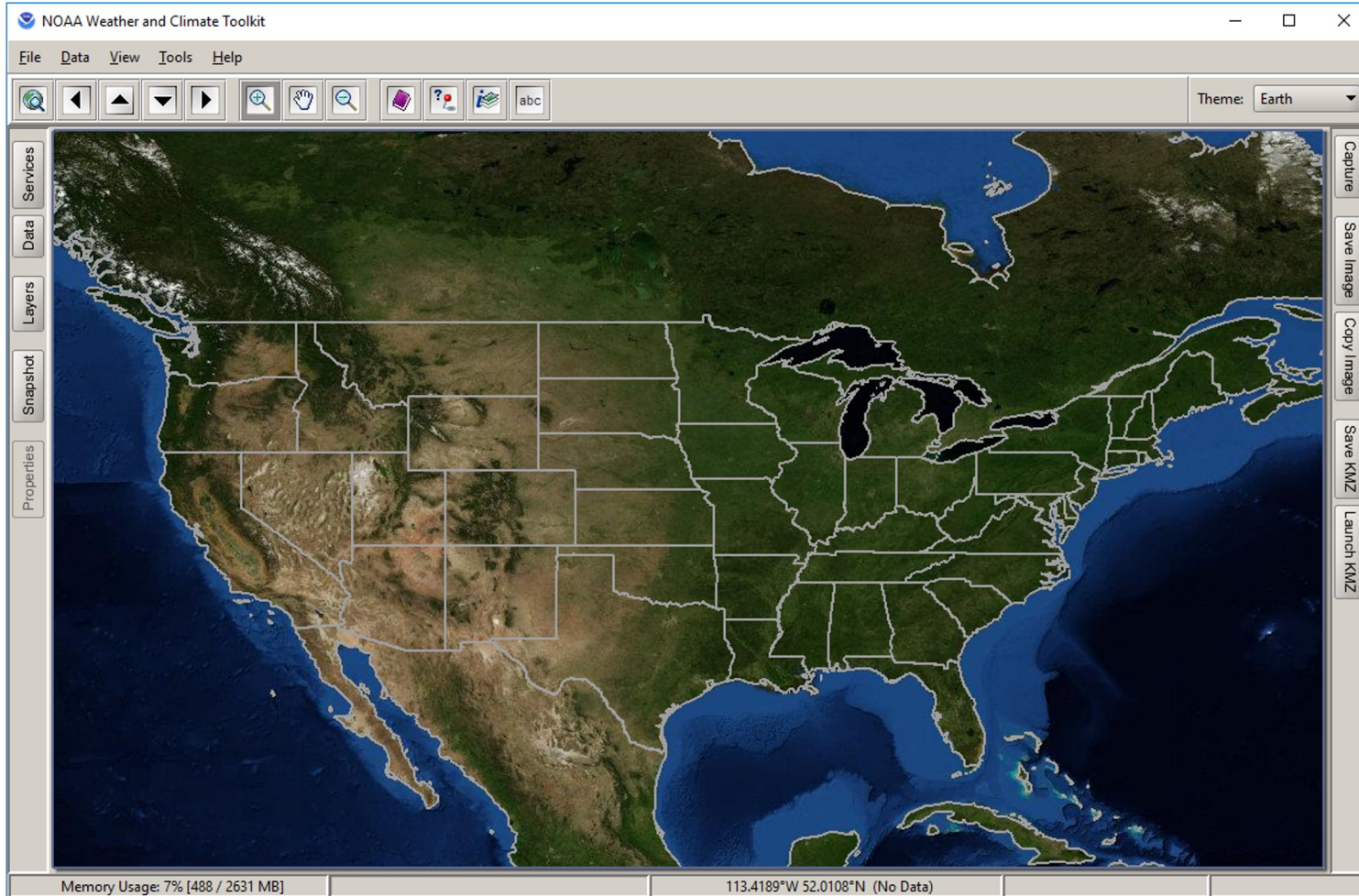
2. Map Themes





Simple Time Saving Features:

2. Map Themes





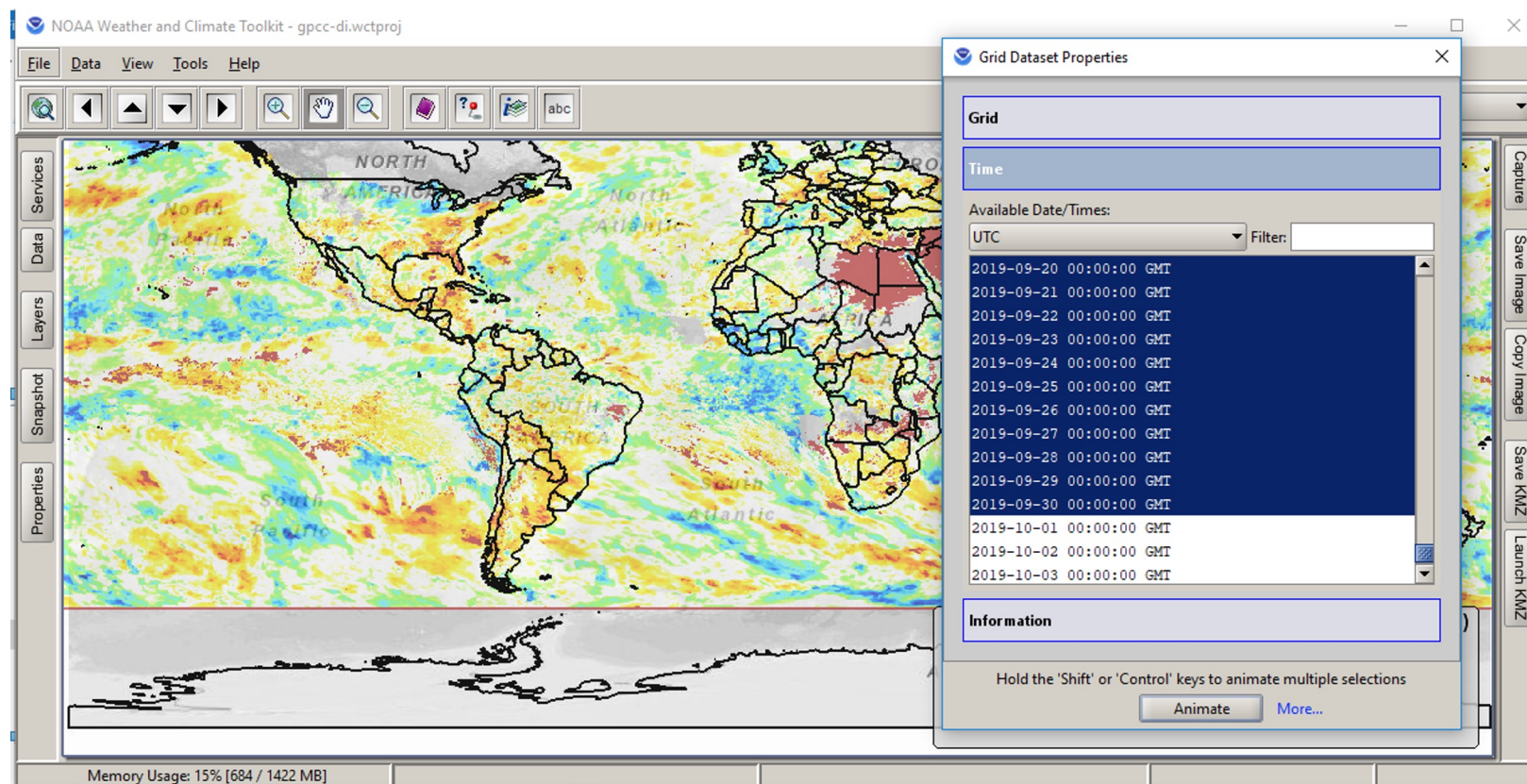
Animations:

1. A NetCDF file with a time dimension
2. A series of GRIB files
 1. A series of map 'screen captures'
 2. NEXRAD files from Hurricane Ian
3. Comparing Hurricane Ian and Charley



Animations:

1. A NetCDF file with a time dimension





File Data View Tools Help

Services Data Layers Snapshot Properties

Grid Dataset Properties

Grid

Time

Available Date/Times:

UTC Filter:

2019-09-20 00:00:00 GMT
2019-09-21 00:00:00 GMT
2019-09-22 00:00:00 GMT
2019-09-23 00:00:00 GMT
2019-09-24 00:00:00 GMT
2019-09-25 00:00:00 GMT
2019-09-26 00:00:00 GMT
2019-09-27 00:00:00 GMT
2019-09-28 00:00:00 GMT
2019-09-29 00:00:00 GMT
2019-09-30 00:00:00 GMT
2019-10-01 00:00:00 GMT
2019-10-02 00:00:00 GMT
2019-10-03 00:00:00 GMT

Information

Hold the 'Shift' or 'Control' keys to animate multiple selections

Animate More...

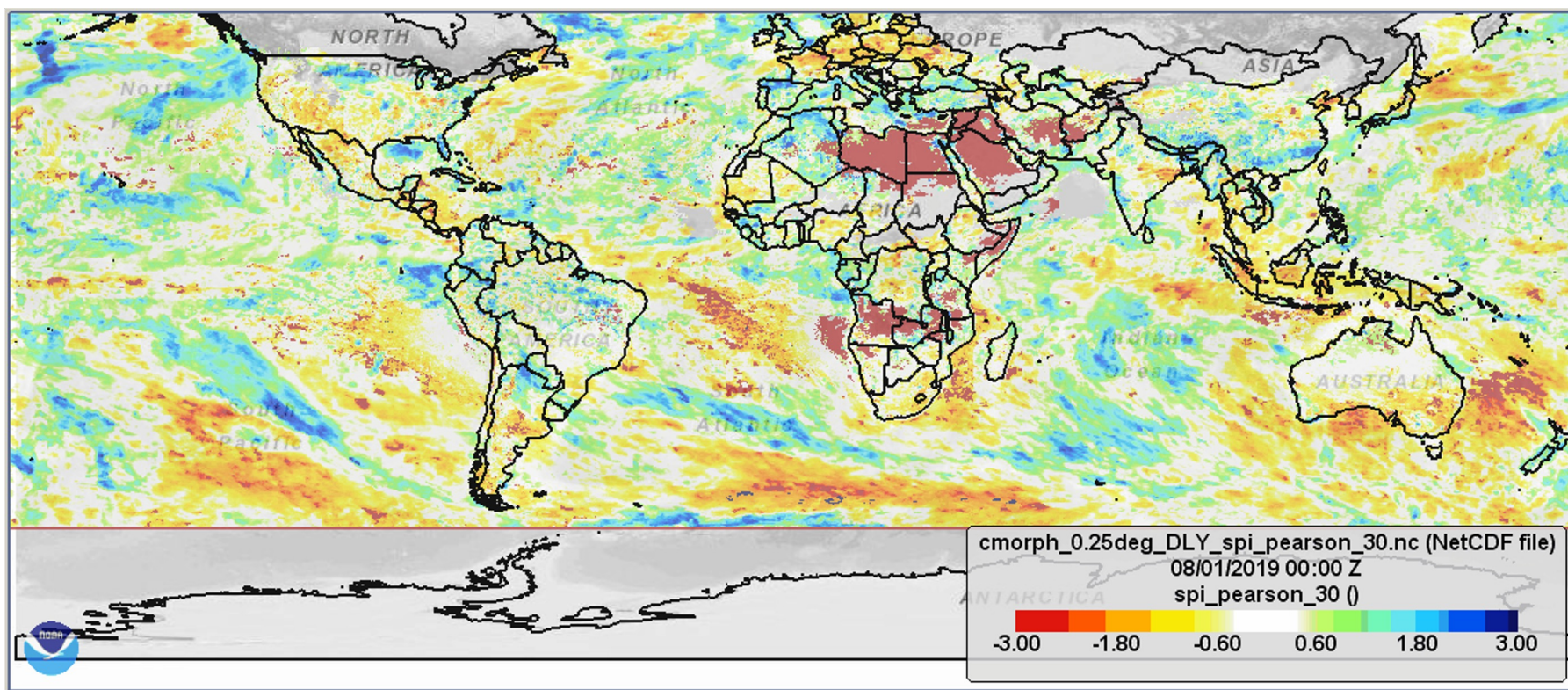
Capture Save Image Copy Image Save KMZ Launch KMZ

Memory Usage: 32% [624 / 14...]



Animations:

1. A NetCDF file with a time dimension





Animations:

2. A series of GRIB files

The screenshot displays the NOAA Weather and Climate Toolkit interface. The main window shows a map of Southeast Asia and Australia with a color-coded drought index. The 'Theme' is set to 'Gray'. A 'Grid Dataset Properties' window is open, showing a list of gridded variables, with 'di_06' selected. A 'Data Selector' window is also open, showing a list of GPCC_DI files from 201905 to 201912, with 'di_06' selected. The 'Animate' button is circled in red.

NOAA Weather and Climate Toolkit - gpcc-di.wctproj

File Data View Tools Help

ab Theme: Gray

Grid Dataset Properties

Grid

Gridded Variables: Filter:

di_01 Global Precipitation Climatology Centre Drought Index

di_03 Global Precipitation Climatology Centre Drought Index

di_06 Global Precipitation Climatology Centre Drought Index

di_09 Global Precipitation Climatology Centre Drought Index

di_12 Global Precipitation Climatology Centre Drought Index

Data Selector

Find Data NOAA Big Data Local Disk URL Directory Single File THREDDS Catalog

Access to Data Stored in a Remote

Enter Custom URL https://opendata.dwd.de/climate_environment/GPCC/GPCC_DI/2019

List Files Show All Files?

- GPCC_DI_201905.nc.gz (NetCDF file)
- GPCC_DI_201906.nc.gz (NetCDF file)
- GPCC_DI_201907.nc.gz (NetCDF file)
- GPCC_DI_201908.nc.gz (NetCDF file)
- GPCC_DI_201909.nc.gz (NetCDF file)
- GPCC_DI_201910.nc.gz (NetCDF file)
- GPCC_DI_201911.nc.gz (NetCDF file)
- GPCC_DI_201912.nc.gz (NetCDF file)

Cache /

Hold the 'Shift' or 'Control' key

Reset Zoom Data Type: Auto

Load

Keyboard Shortcut: Control-(Down or Right)

GPCC_DI_201912.nc (NetCDF file)
12/01/2019 00:00 Z
di_06 ()

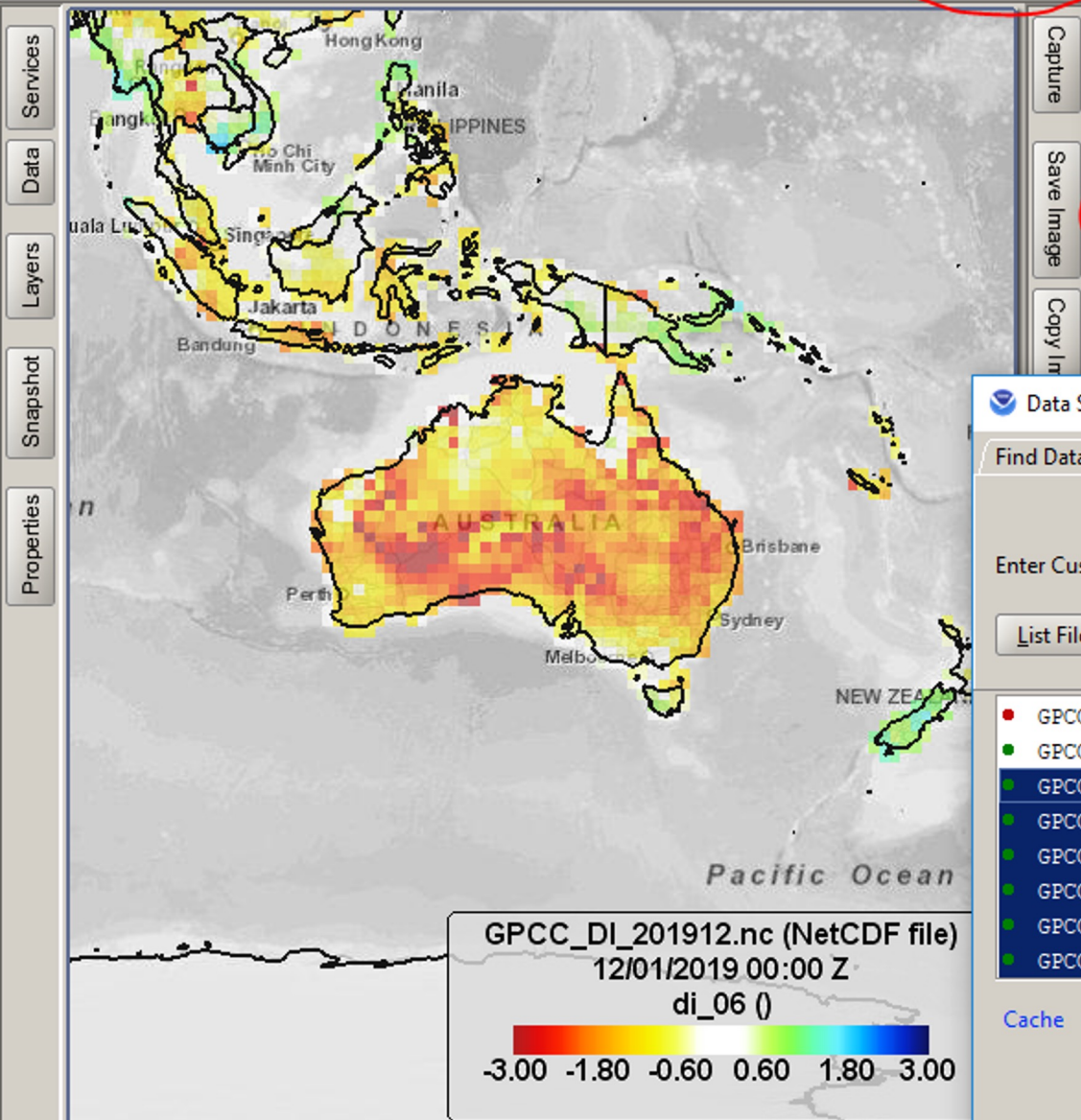
-3.00 -1.80 -0.60 0.60 1.80 3.00

Memory Usage: 17% [519 / 1422 MB]



File Data View Tools Help

Navigation toolbar with icons for zoom, pan, and other map functions. A dropdown menu shows 'Theme: Gray' with a red circle around it.



Grid Dataset Properties

Grid

Gridded Variables: Filter:

- di_01 Global Precipitation Climatology Centre Drought Index
- di_03 Global Precipitation Climatology Centre Drought Index
- di_06 Global Precipitation Climatology Centre Drought Index**
- di_09 Global Precipitation Climatology Centre Drought Index
- di_12 Global Precipitation Climatology Centre Drought Index

Data Selector

Find Data NOAA Big Data Local Disk URL Directory Single File THREDDS Catalog

Access to Data Stored in a Remote Data Store

Enter Custom URL

List Files Show All Files?

- GPCC_DI_201905.nc.gz (NetCDF file)
- GPCC_DI_201906.nc.gz (NetCDF file)
- GPCC_DI_201907.nc.gz (NetCDF file)**
- GPCC_DI_201908.nc.gz (NetCDF file)**
- GPCC_DI_201909.nc.gz (NetCDF file)**
- GPCC_DI_201910.nc.gz (NetCDF file)**
- GPCC_DI_201911.nc.gz (NetCDF file)**
- GPCC_DI_201912.nc.gz (NetCDF file)**

Cache /

Hold the 'Shift' or 'Control' key

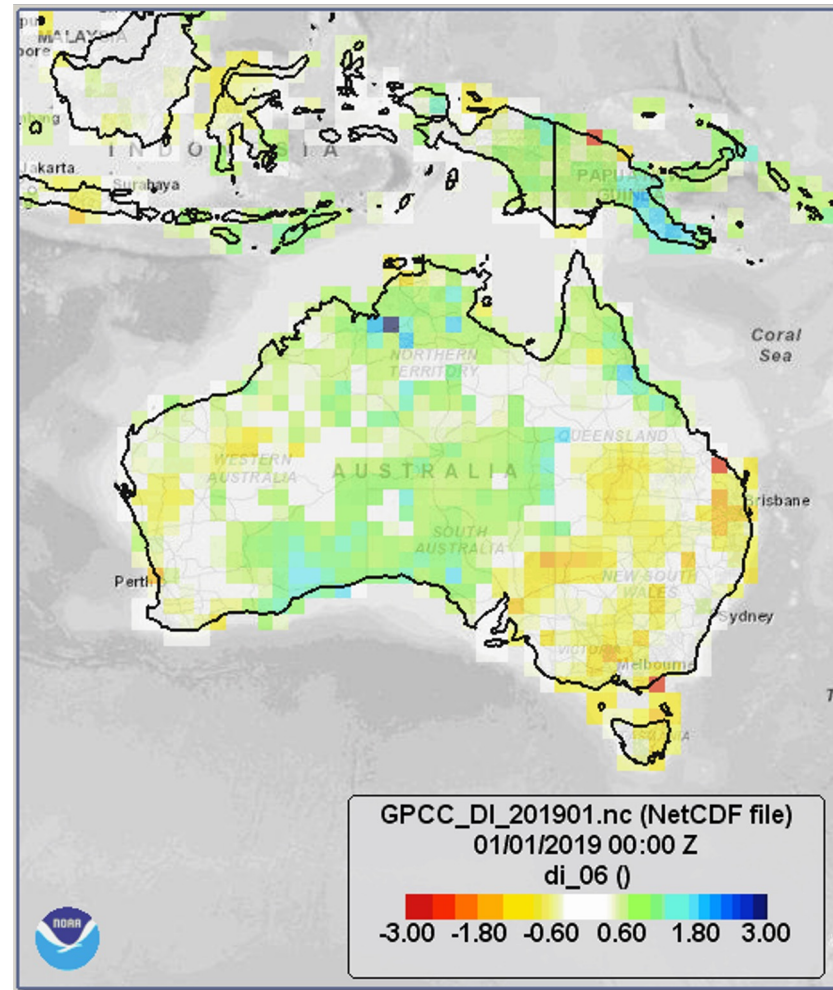
Reset Zoom Data Type: Auto

Keyboard Shortcut: Control-(Down or Right)



Animations:

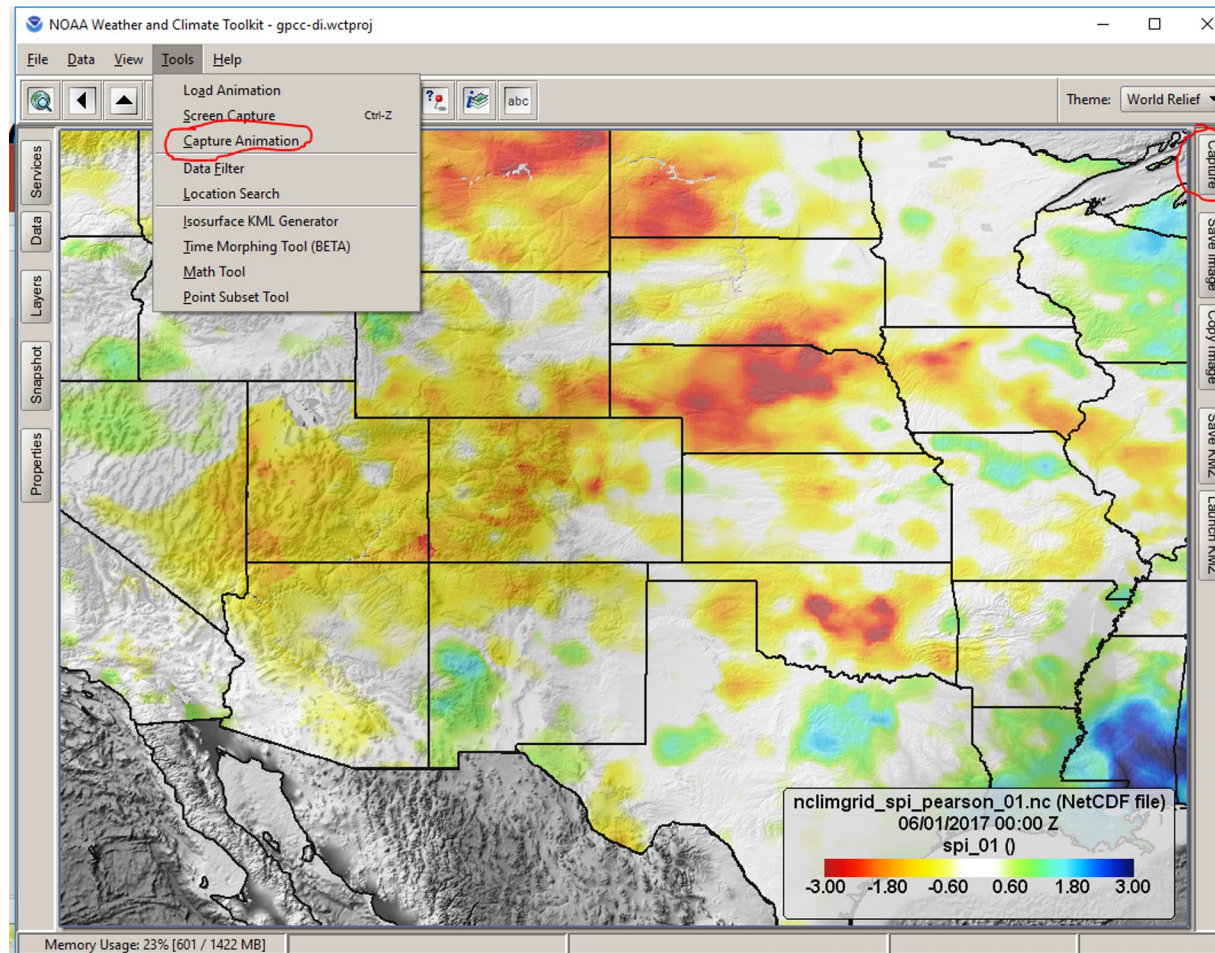
2. A series of GRIB files

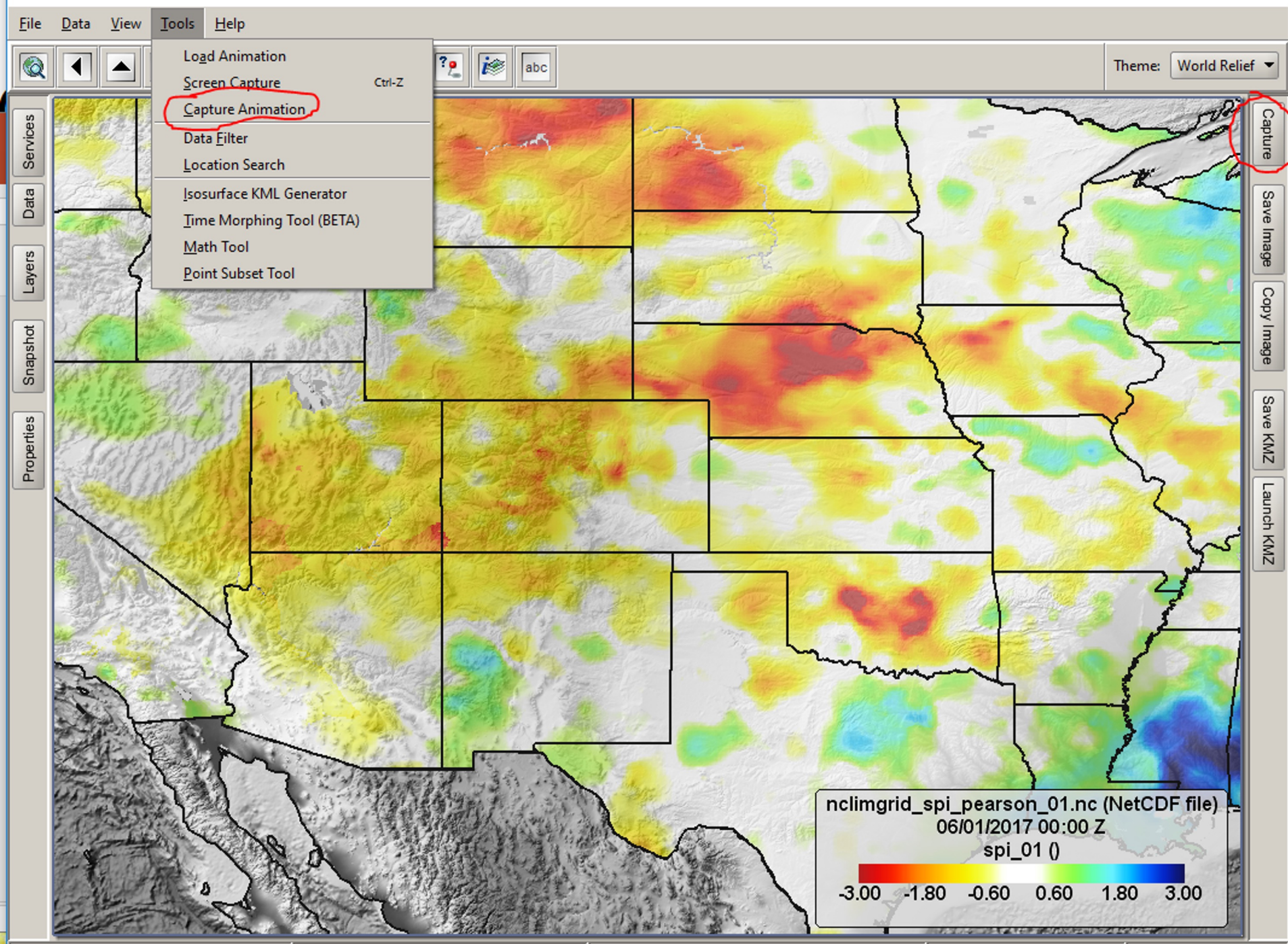




Animations:

3. A series of map 'screen captures'

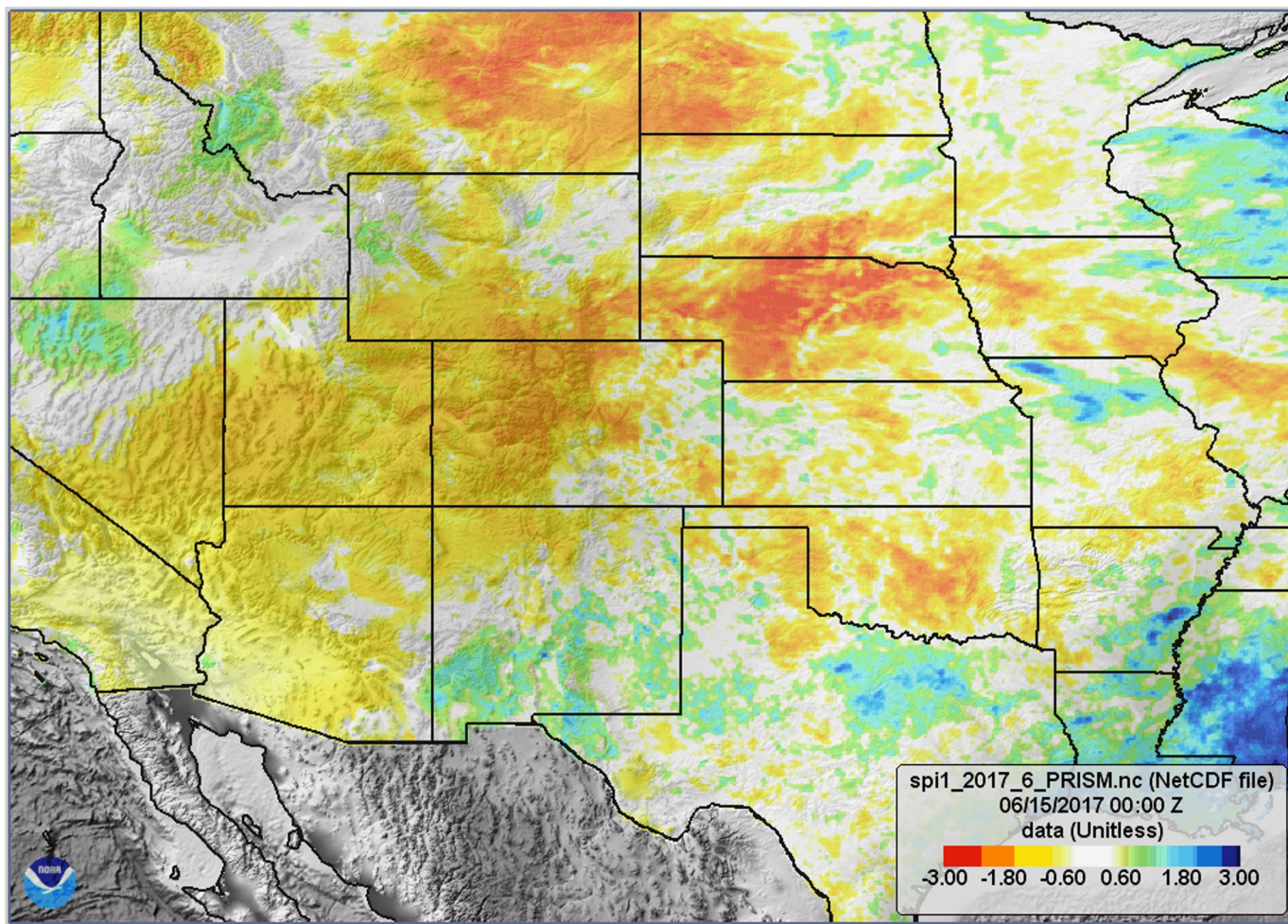






Animations:

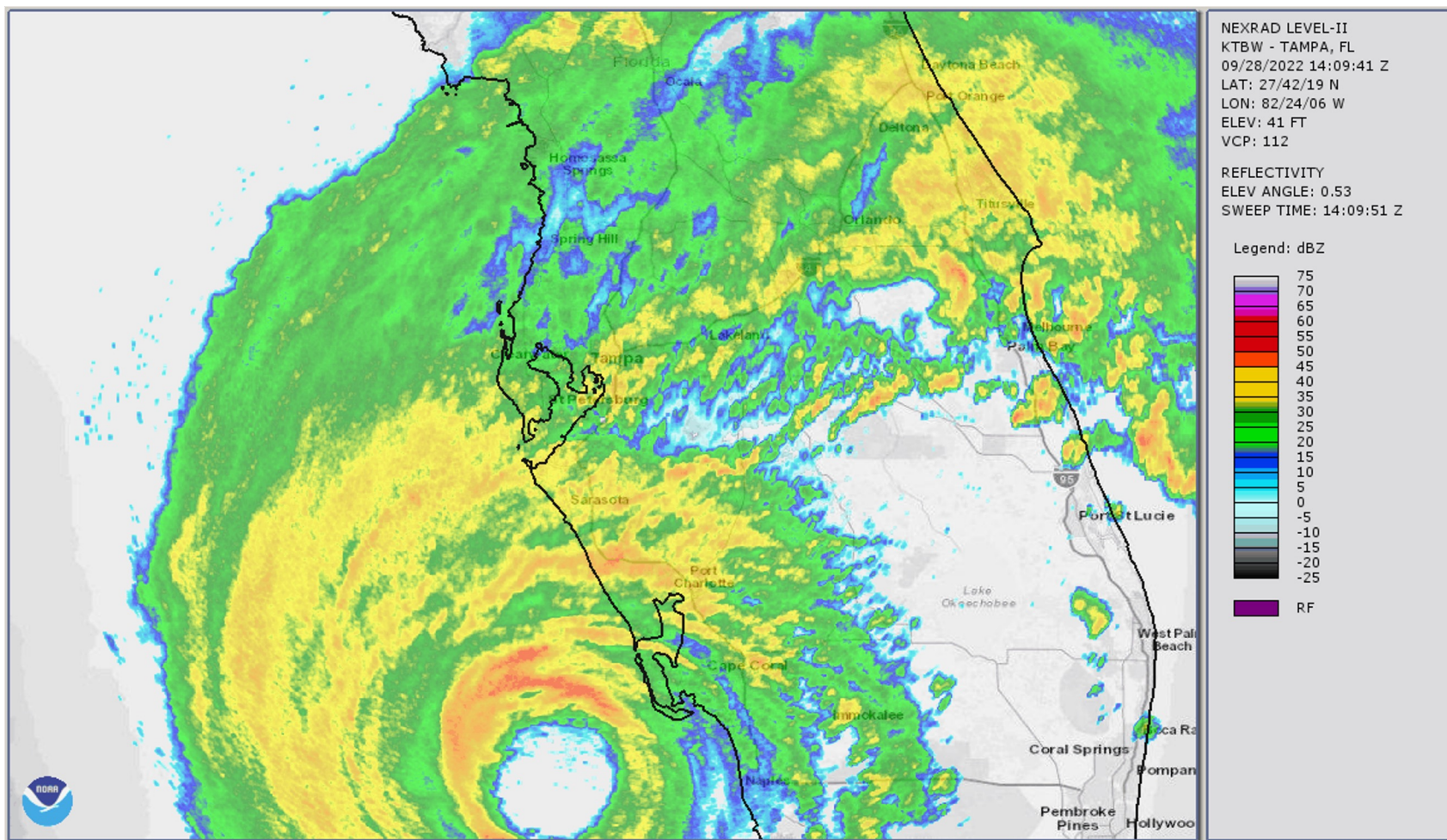
3. A series of map 'screen captures'





Animations:

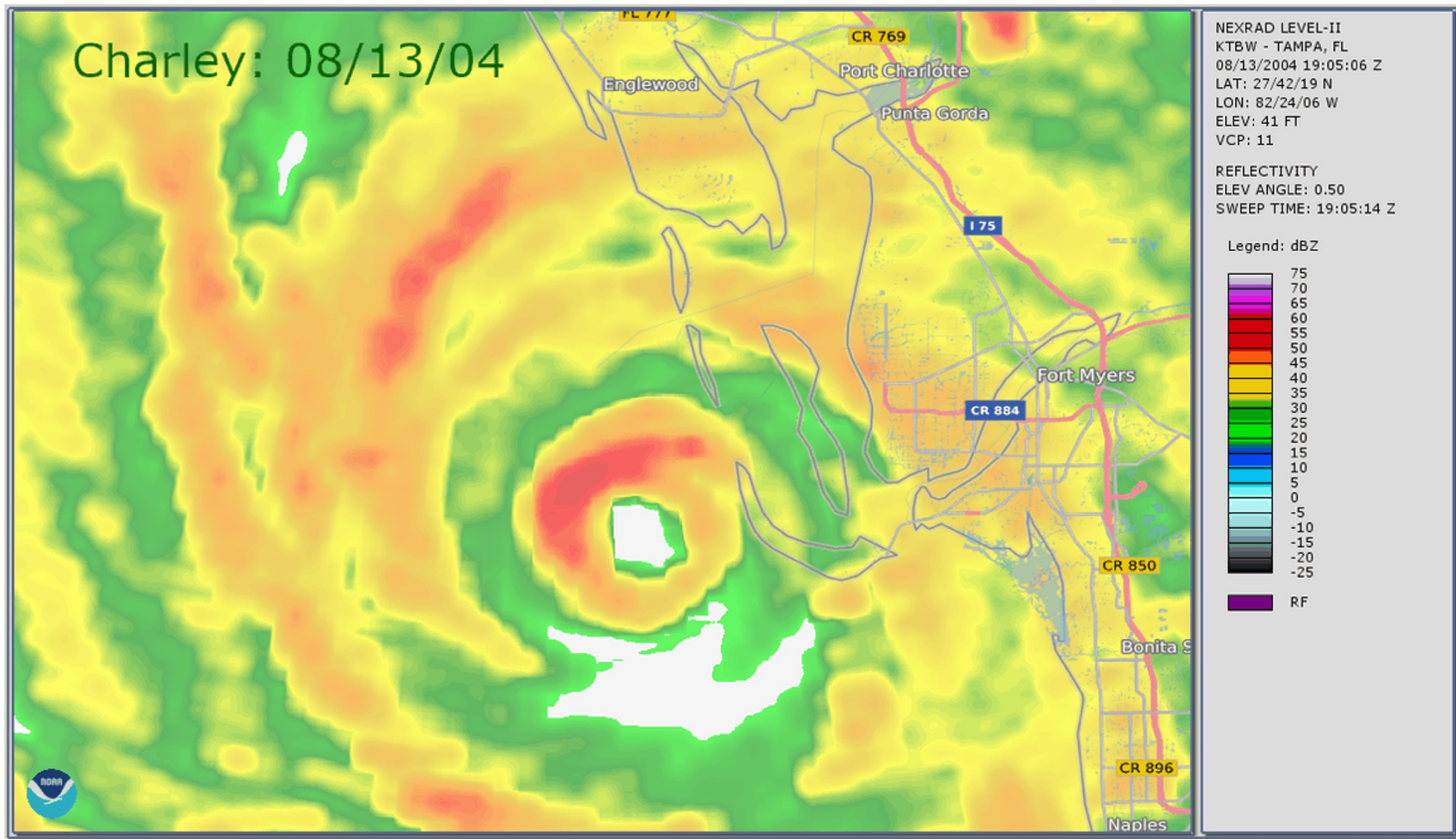
4. NEXRAD Radar from Hurricane Ian





Animations:

5. Comparing Hurricane Ian and Charley





Interoperability with GIS tools:

The WCT converts NOAA data into common formats, such as Shapefile, JSON, CSV, NetCDF, GeoTIFF and more.

Use Cases:

1. Compare with census data in GIS tools
2. Upload data into ArcGIS Online for use in StoryMaps or online map viewers
3. Create map tiles for high-performance visualizations
4. Use the command-line WCT version to convert data to web-ready GeoJSON in an automated script running on the cloud.



Data Export: User Interface Workflow

The screenshot displays the NOAA Weather and Climate Toolkit interface. A 'Data Selector' dialog box is open, showing a URL: `https://tgftp.nws.noaa.gov/S/SL.us008001/DF.of/DC.radar/DS.32dhr/SL.kgsp/sn.last`. The dialog includes options for 'Reset Zoom', 'Data Type' (set to 'Auto'), and 'Auto-Reload' (set to 'Off'). Below these are buttons for 'Load', 'Animate', 'Export', and 'More...'. The 'Export' button is circled in red. A keyboard shortcut is noted: `Control-(Down or Right)/(Up or Left) = Load Next/Previous File`. The background shows a radar map of the Southeastern United States, with a legend for dBZ ranging from -25 to 75. The map includes labels for cities like Atlanta, Charlotte, and Greenville, and states like Georgia and South Carolina. The status bar at the bottom indicates 'Memory Usage: 31% [1330 / 1422 MB]'.



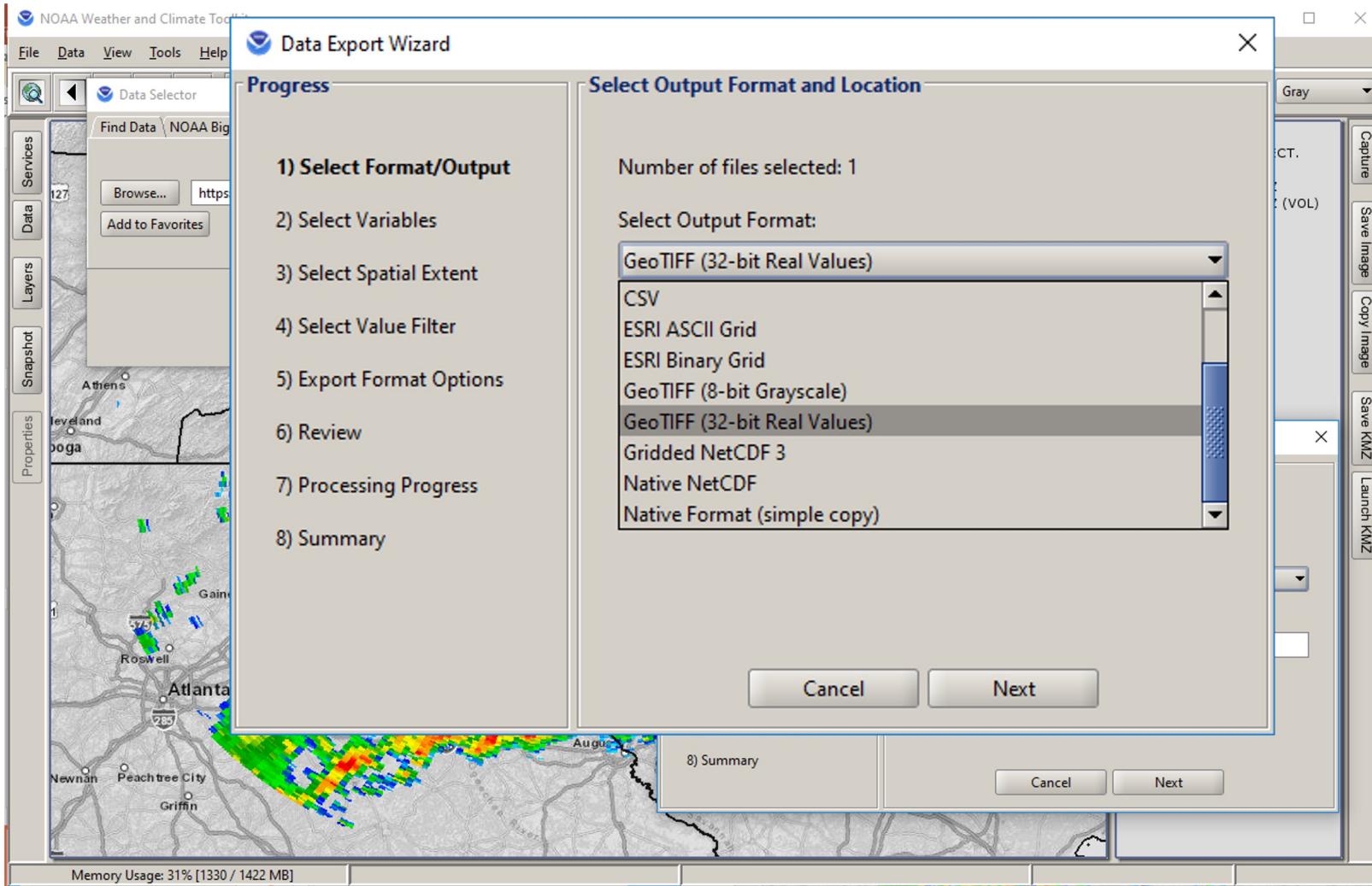
Data Export: User Interface Workflow

The screenshot displays the NOAA Weather and Climate Toolkit interface. A radar map of the Atlanta region is visible in the background. Two dialog boxes are overlaid on the map:

- Data Selector:** This dialog is open to the 'Single File' tab. The 'Find Data' section includes tabs for 'NOAA Big Data', 'Local Disk', 'URL Directory', 'Single File', 'THREDDS Catalog', 'NCEI/CLASS Order', and 'Favorites'. The 'Access to a single file (local, remote (HTTP) or OPeNDAP)' section contains a 'Browse...' button and a text field with the URL: `https://tgftp.nws.noaa.gov/SL.us008001/DF.of/DC.radar/DS.32dhr/SL.kgsp/sn.last`. Below this are 'Add to Favorites', 'Reset Zoom', 'Data Type: Auto', and 'Auto-Reload: Off' options. The 'Export' button is circled in red. A keyboard shortcut is noted: `Control-(Down or Right)/(Up or Left) = Load Next/Previous File`.
- Data Export Wizard:** This wizard is currently at the 'Select Output Format and Location' step. The progress list on the left includes: 1) Select Format/Output, 2) Select Variables, 3) Select Spatial Extent, 4) Select Value Filter, 5) Export Format Options, 6) Review, 7) Processing Progress, and 8) Summary. The 'Select Output Format and Location' section shows 'Number of files selected: 1', 'Select Output Format: GeoTIFF (32-bit Real Values)', and 'Select Output Directory: C:\work\wct-tests\l2-export'.



Data Export: User Interface Workflow





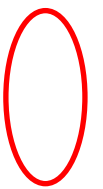
Data Visualization

Severe Weather in Google Earth

The screenshot displays the NOAA Weather and Climate Toolkit interface. The main map shows a radar overlay with color-coded intensity levels (green, yellow, orange, red). Several storm reports are visible on the map, including one near Millport, MS, and another near Carrollton, MS. A 'Data Services' menu is open on the left, highlighting 'SPC Storm Reports'. A 'U.S. Preliminary Storm Reports Browser' window is open in the foreground, showing a table of reports for January 11, 2020. The 'Load Radar Data (Level-II)' button in the browser window is circled in red.

Type	Date/Time	Size	Location
Wind	2020-01-11 12:00 Z	UNK	2 NW LAFAYETTE
Wind	2020-01-11 12:00 Z	UNK	1 WSW WATERPR...
Wind	2020-01-11 12:00 Z	UNK	MYRTLE
Wind	2020-01-11 12:00 Z	UNK	1 NNW BRADEN
Wind	2020-01-11 12:03 Z	UNK	VALLEY PARK
Wind	2020-01-11 12:05 Z	UNK	GLEASON
Wind	2020-01-11 12:09 Z	UNK	2 N CALHOUN CITY
Tornado	2020-01-11 12:10 Z	UNK	CADIZ
Wind	2020-01-11 12:10 Z	UNK	3 NNW LAFAYETTE

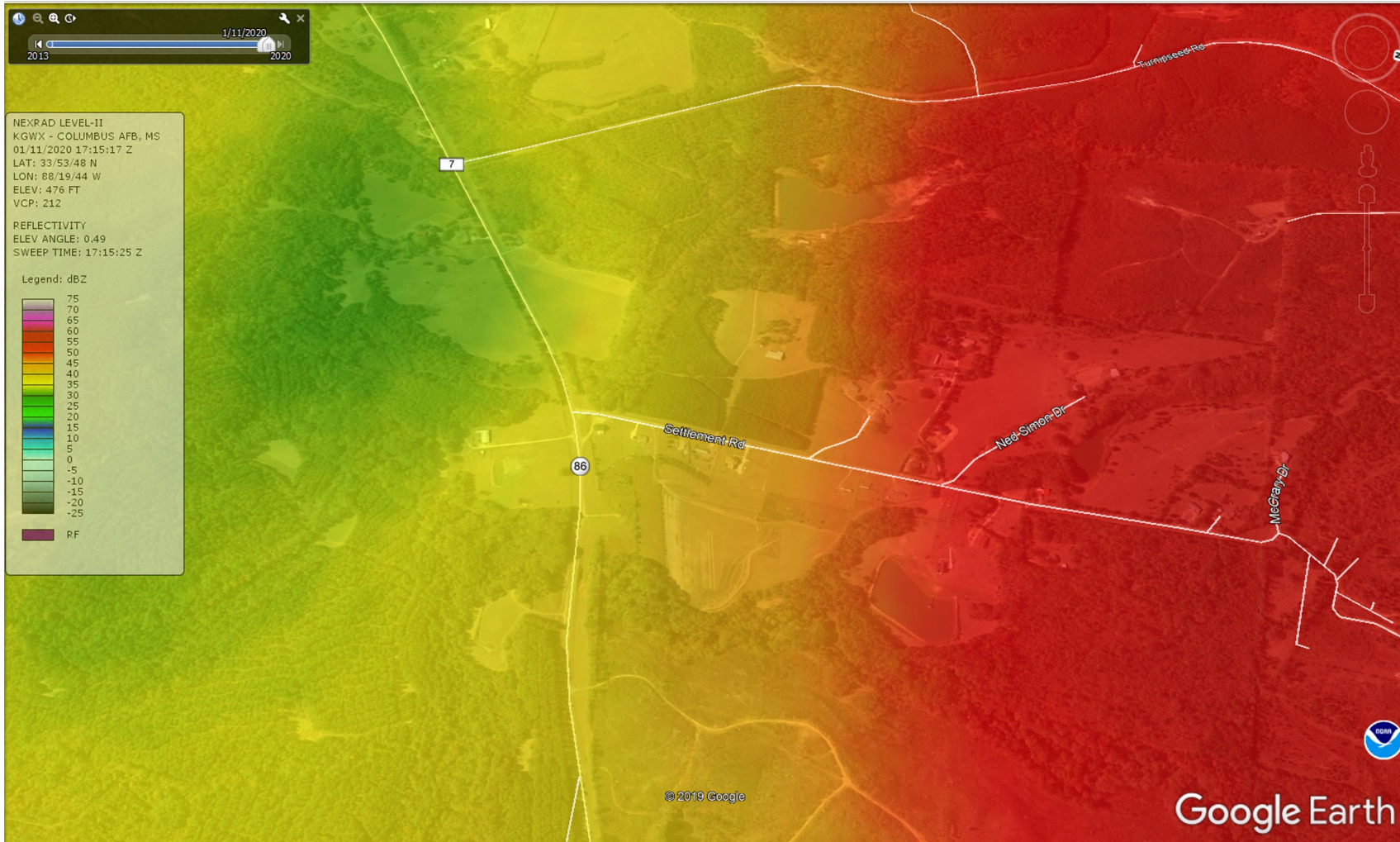
*** 3 FATAL... 7 INJ *** 22 HOMES SUFFERED VARYING DEGREES OF DAMAGE NEAR SETTLEMENT RD. MANY TREES WERE DOWNED. 3 PEOPLE LOST THEIR LIVES IN AT LEAST 2 DIFFERENT HOMES (BMX)





Data Visualization

Severe Weather in Google Earth





Data Visualization

Severe Weather in Google Earth





Data Visualization

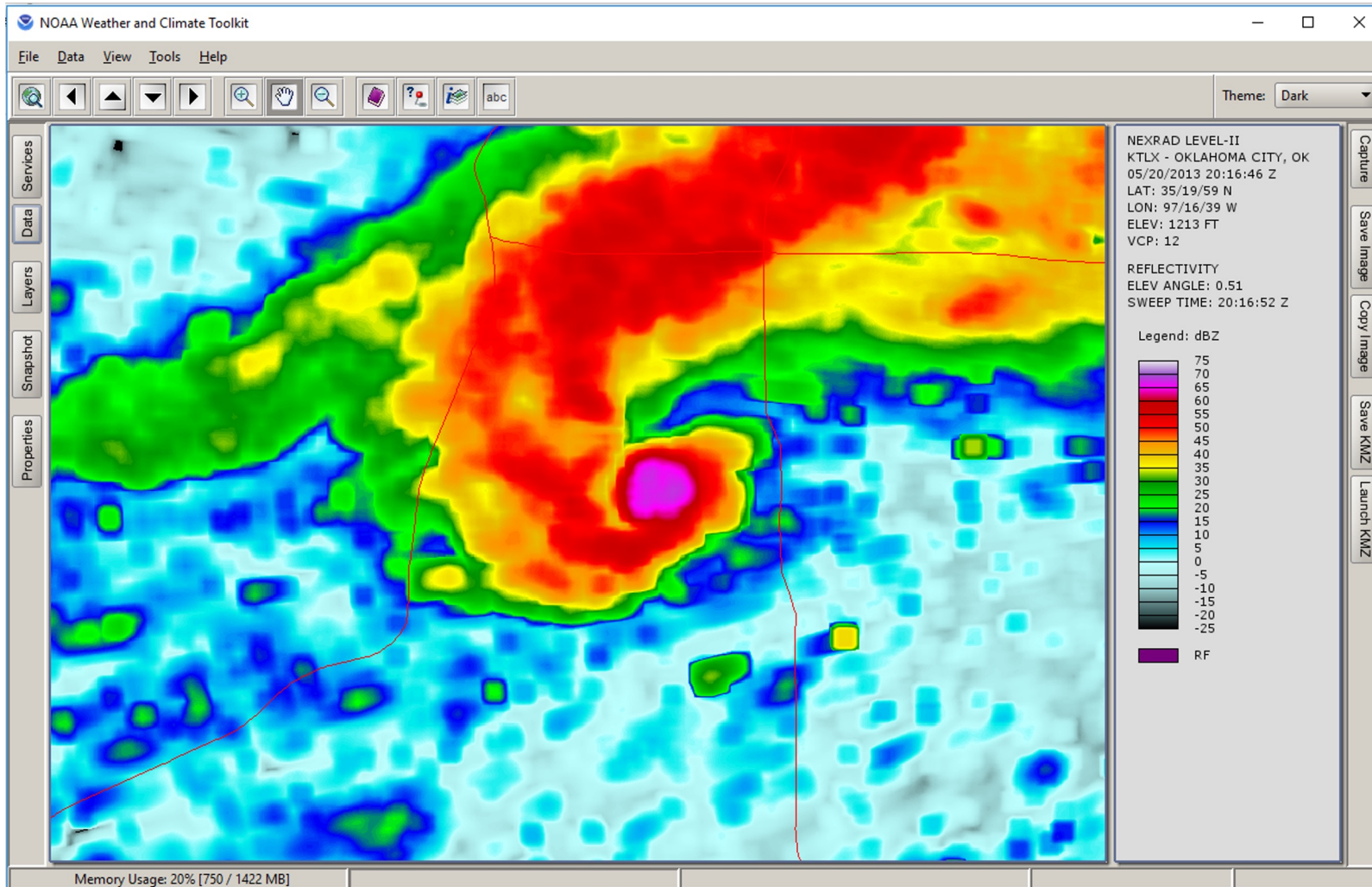
Severe Weather in Google Earth





Data Visualization

Severe Weather in Google Earth





Data Visualization

Severe Weather in Google Earth

The screenshot displays the NOAA Weather and Climate Toolkit interface. A 'Data Selector' window is open, showing a list of data files for 'KTLX V06' on '20130520'. The 'Amazon' dropdown menu is highlighted with a red circle. Below the list, there are controls for 'Reset Zoom', 'Data Type' (set to 'Auto'), and 'Auto-Reload' (set to 'Off'). The main window shows a radar plot with a color scale legend for dBZ, ranging from -25 to 75. The plot shows a large area of high reflectivity (red and yellow) over Oklahoma City, OK, on May 20, 2013. The legend indicates that values above 40 dBZ are associated with severe weather. The interface also includes a 'Properties' panel on the right with metadata for the selected data, such as 'NEXRAD LEVEL-II', 'KTLX - OKLAHOMA CITY, OK', and 'REFLECTIVITY'. The status bar at the bottom shows 'Memory Usage: 20% [750 / 1422 MB]'.





Data Visualization

Severe Weather in Google Earth

The screenshot displays the NOAA Weather and Climate Toolkit interface. A 'Map Layer Selector' dialog box is open, showing settings for three active layers: Radar, Grid/Satellite, and Location/Station. The 'Radar (Active)' layer has 'Visible' checked, 'Transparency' at 0%, 'Smoothing' set to 3 (circled in red), and 'Legend' set to Large (circled in red). The 'Grid/Satellite (Active)' layer has 'Visible' unchecked, 'Transparency' at Default, and 'Legend' at Medium. The 'Location/Station (Active)' layer has 'Visible' unchecked, 'Transparency' at Default, and 'Legend' at Medium. The main map area shows a radar reflectivity map of Oklahoma City, OK, with a color scale legend on the right ranging from -25 dBZ (dark blue) to 75 dBZ (red). The legend also includes 'RF' (Rainfall) in purple. The map shows a large area of high reflectivity (red and yellow) in the north and west, with a smaller area of high reflectivity (red and yellow) in the south and east. The map is overlaid on a satellite image of the region.





Data Visualization

Severe Weather in Google Earth

The screenshot displays the NOAA Weather and Climate Toolkit interface. A 'KMZ Export' dialog box is open, showing options for altitude, elevation exaggeration, shadow creation, and sweep inclusion. The main window shows a radar reflectivity map with a color scale legend ranging from -25 dBZ to 75 dBZ. A blue arrow points from the 'Launch KMZ' button in the right-hand toolbar to the 'Launch KMZ' button in the dialog box. The 'Launch KMZ' button in the toolbar is circled in red.

KMZ Export Options

- Altitude (m): (Actual height of radar beam center)
- Elevation Exaggeration:
- Create Shadow?:
- Sweeps to Include:

Custom Display Settings

- Engage Settings Override:
- Smoothing Factor:
- Min Value Filter:
- Transparency (%):

Legend: dBZ

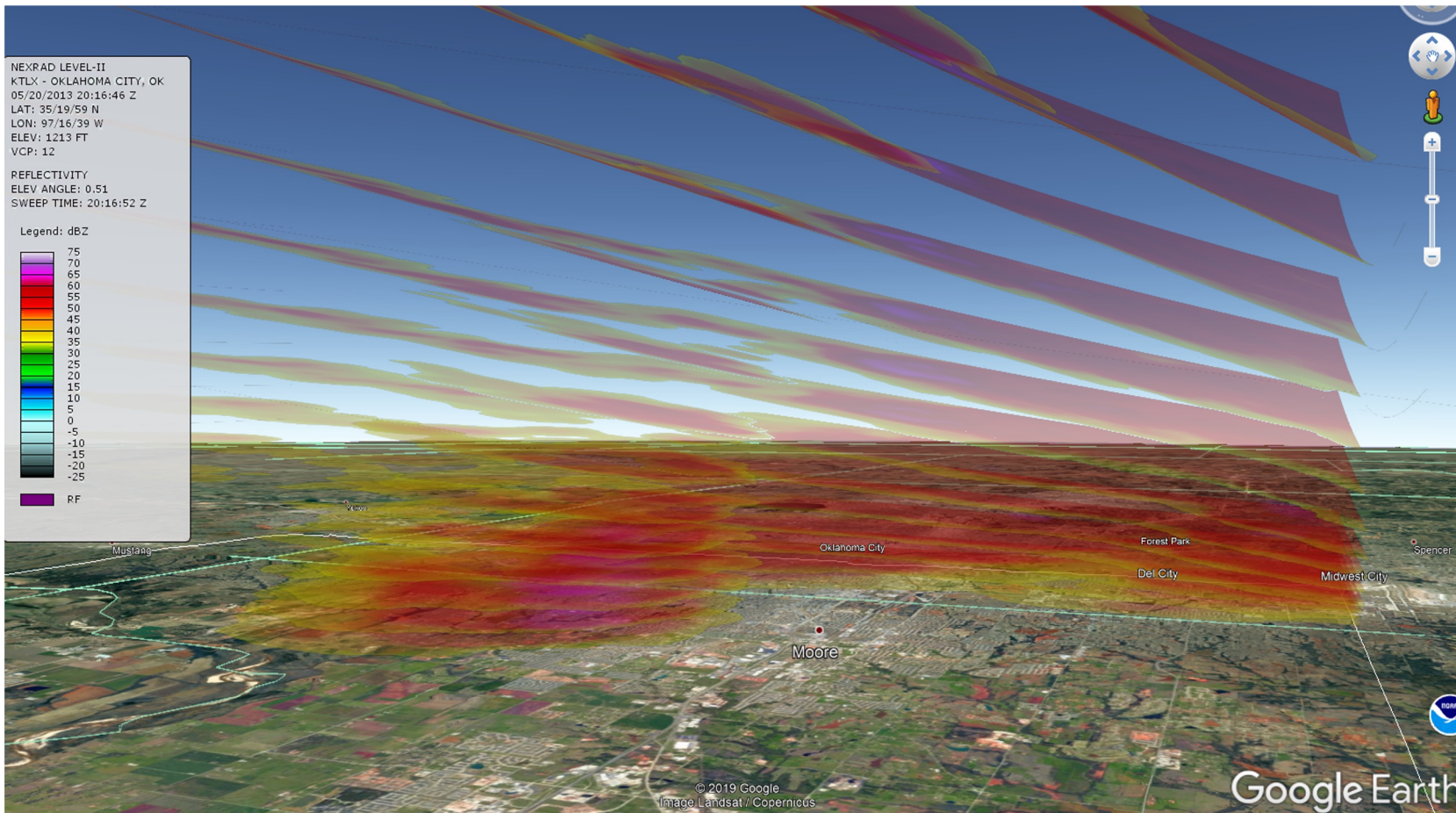
75
65
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
RF





Data Visualization

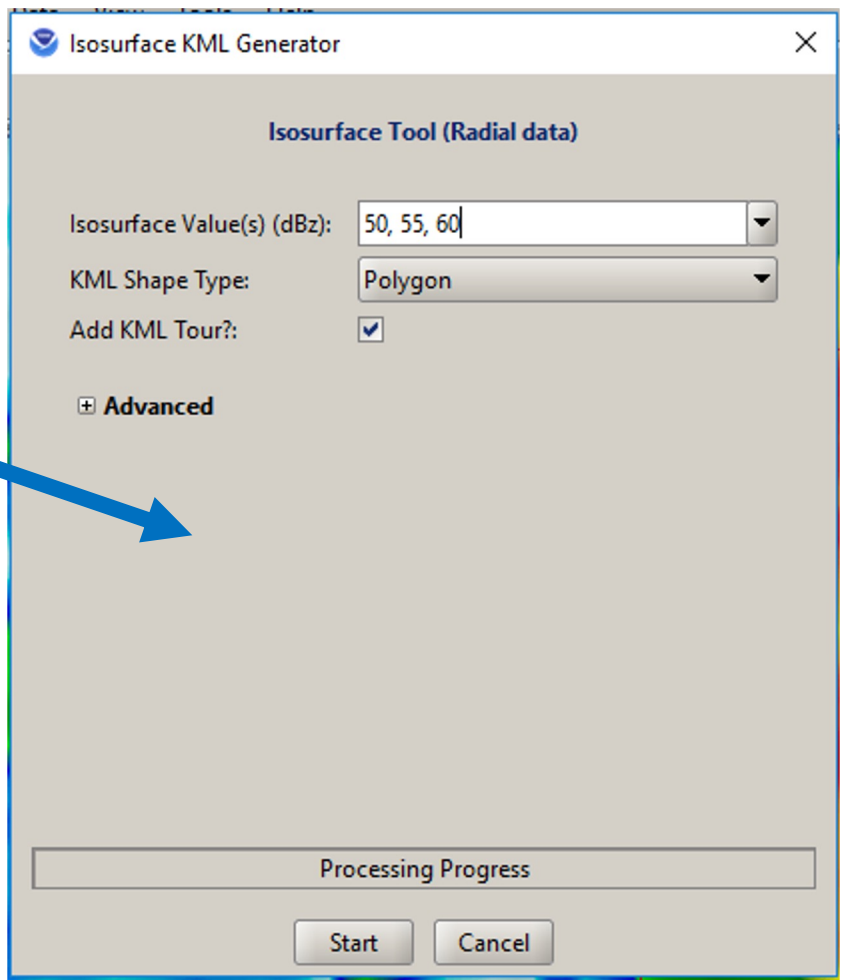
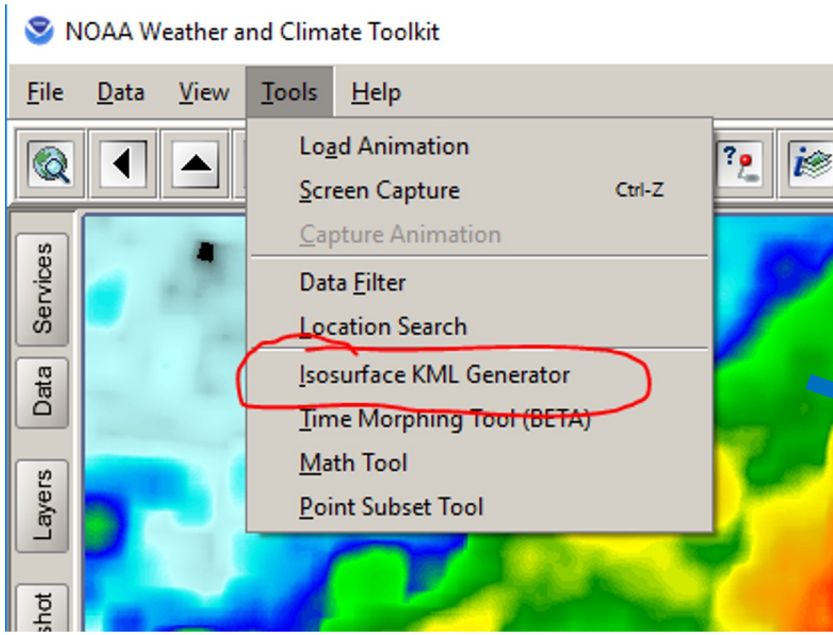
Severe Weather in Google Earth





Data Visualization

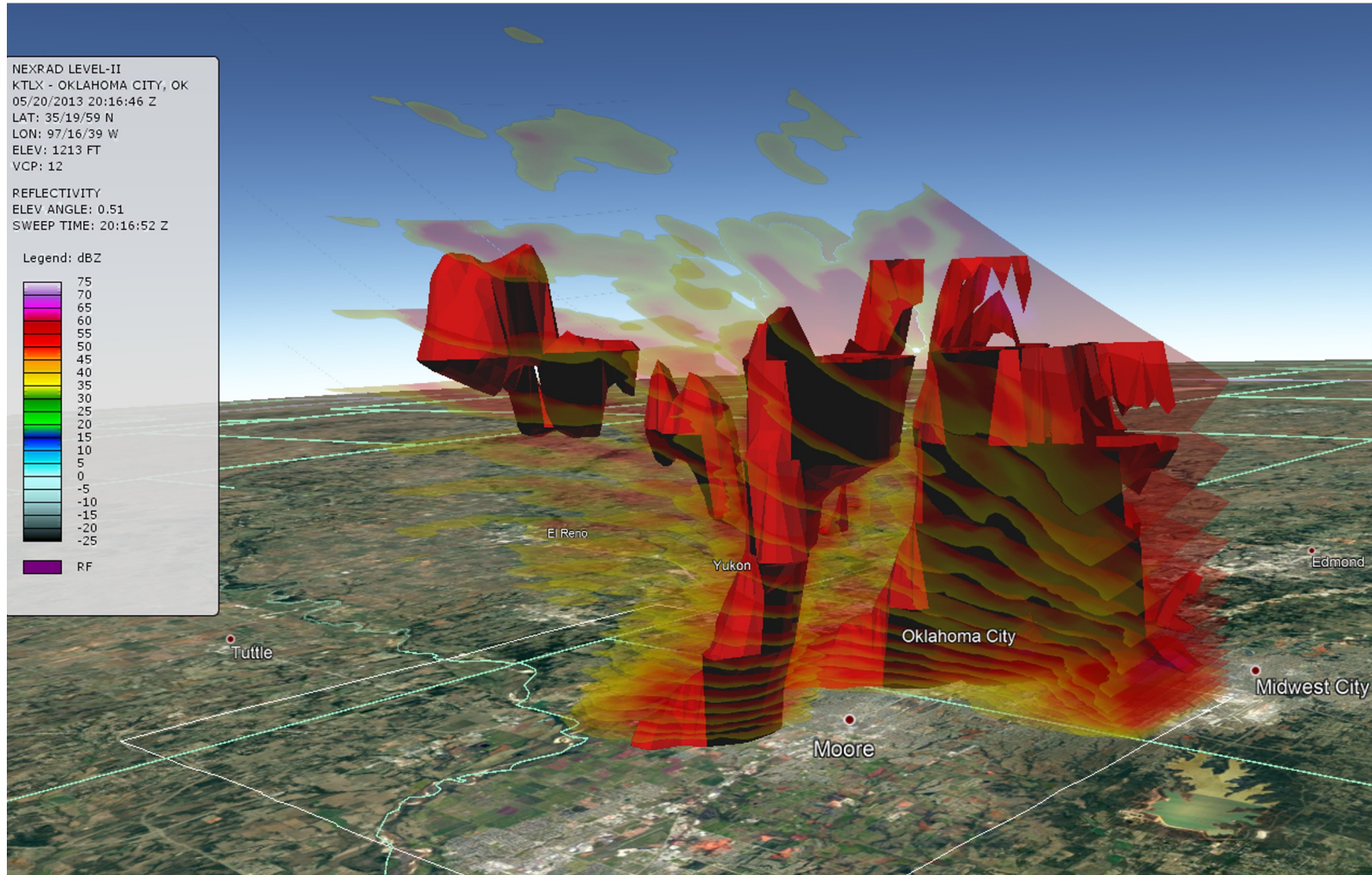
Severe Weather in Google Earth





Data Visualization

Severe Weather in Google Earth





Data Visualization

Severe Weather in Google Earth

The screenshot displays the Google Earth Pro interface with a 3D visualization of severe weather data. The data is represented as a 3D surface plot showing isobars (lines of equal atmospheric pressure) over a geographic area. The surface is color-coded, with red and orange indicating higher values and blue and green indicating lower values. The plot is centered over a region that includes Oklahoma City and Moore. The 'Movie Maker' dialog box is open, showing options for recording a tour. The 'Record from' section has 'A saved tour: Start tour here (My Places / Sightseeing Tour)' selected. The 'Save to' field is set to 'C:/Users/steve.ansari/Documents/movie.m4v'. The 'Video parameters' section shows 'HD 720p (1280x720 pixels, 60 frames/sec)' and 'Picture size (pixels): 1280 x 720'. The 'Output configuration' section shows 'File type: H.264 (.m4v)' and 'Picture quality: High'. The 'Layers' panel on the left shows the 'Isosurface: 50.00 dBz' layer selected. The 'Movie Maker' dialog box has several elements circled in red: the 'Tools' menu in the top menu bar, the 'Record from' section, the 'Save to' field, the 'Double-click to tour' checkbox in the 'Layers' panel, and the 'Create Movie' button.



Summary:

- The Weather and Climate Toolkit (WCT) is free, public domain desktop software.
- Windows, Mac and Linux
- User interface and command-line script support

- Why?

Easier access to weather and climate data in complex formats (including lots of NOAA data)

- A tool that complements other tools (GDAL, NCO, ArcGIS/QGIS, various Python packages)
- Works on cloud environments
- Works with local or remote data
- Can run offline

Supports 2 of 5 NESDIS Strategic Objectives



Provide consistent ongoing enterprise-wide user engagement to ensure timely response to user needs



Deliver integrated program development to provide a suite of products and services



Do you use the WCT? Please let me know how!

Thank you!

Steve.Ansari@noaa.gov

<https://www.ncdc.noaa.gov/wct/>

- Tutorials:
<https://www.ncdc.noaa.gov/wct/tutorials>

