WEATHER RADAR DATA SERVICES AT NOAA'S NATIONAL CLIMATIC DATA CENTER

26th IEEE (MSST 2010) Symposium on Massive Storage Systems and Technologies, May 3-5 2010

Stephen Del Greco
NOAA's National Climatic Data Center
Remote Sensing and Applications Division

NOAA's Mission

To understand and predict changes in Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs

NOAA Goals:

Climate Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Weather & Water Serve Society's Needs for Weather and Water Information

Commerce & Transportation Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation

Ecosystems Protect, Restore, and Manage the Use of Coastal and Ocean Resources through an Ecosystem Approach to Management

Mission Support Provide Critical Support for NOAA's Mission

Data Management Services

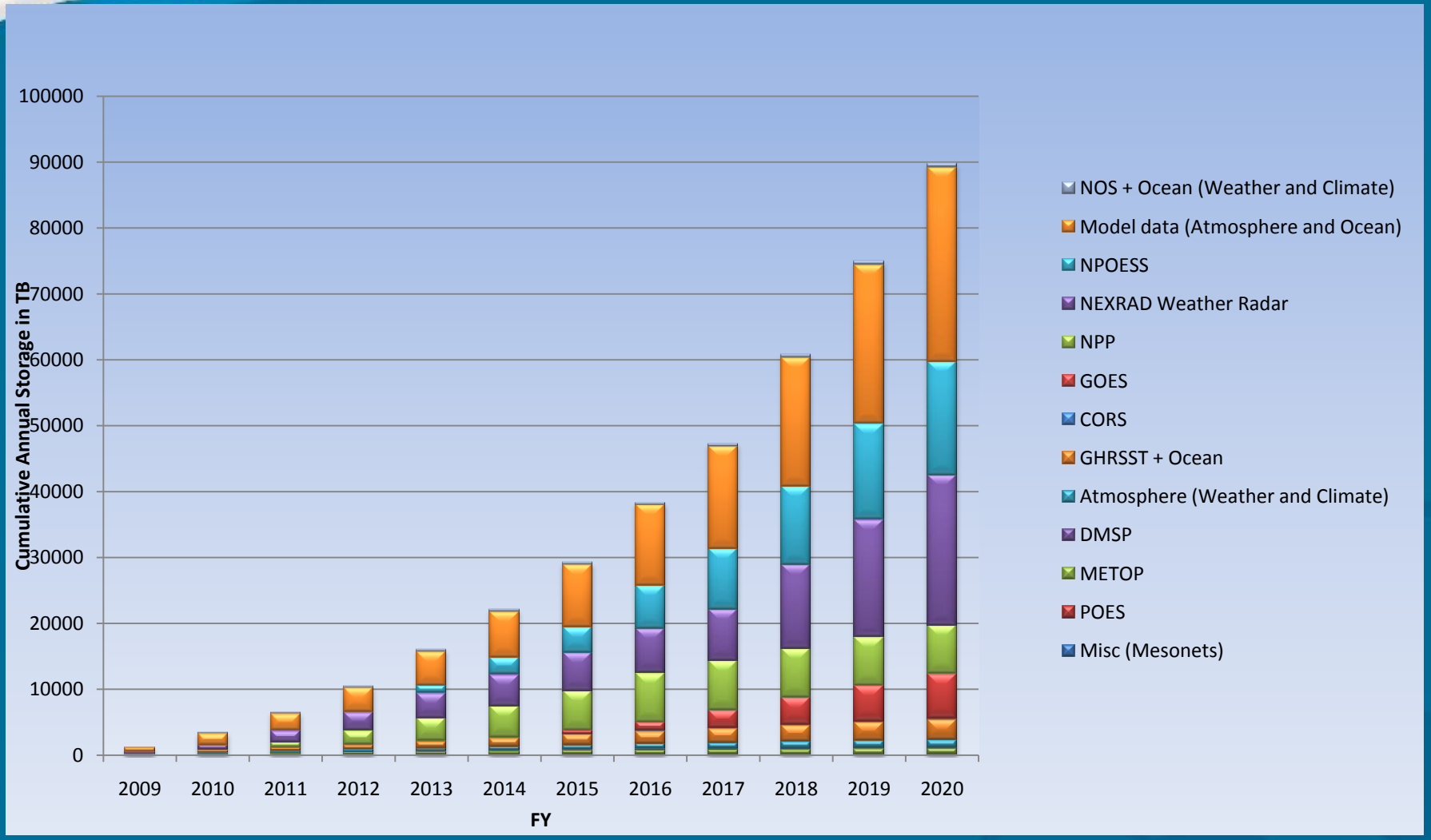
- NOAA anticipates extremely large data growth over the next several years from both Space and Earth based platforms

- NOAA's Data Centers will need to provide access to petabytes of data that are distributed across multiple NOAA facilities

- Will need to integrate these data with data from other disciplines (environmental, biological, social, etc..) that are distributed on other databases both in the public and private sector domain

- Export data to common data formats - Shapefile, Well-Known Text, Arc/Info ASCII GRID, Gridded and Raw NetCDF, GeoTIFF and KMZ (Google Earth)

NCDC Projected Archive Growth



NCDC Data Management

To meet NOAA's mission NCDC will need to function in a wider information landscape

- Support distributed data management and services

Adopt technologies and standards to be interoperable with DataNet, Earth System Grid, GEO-IDE, EOSDIS, etc.

- NetCDF, LDM, CF conventions, ISO 19115-2

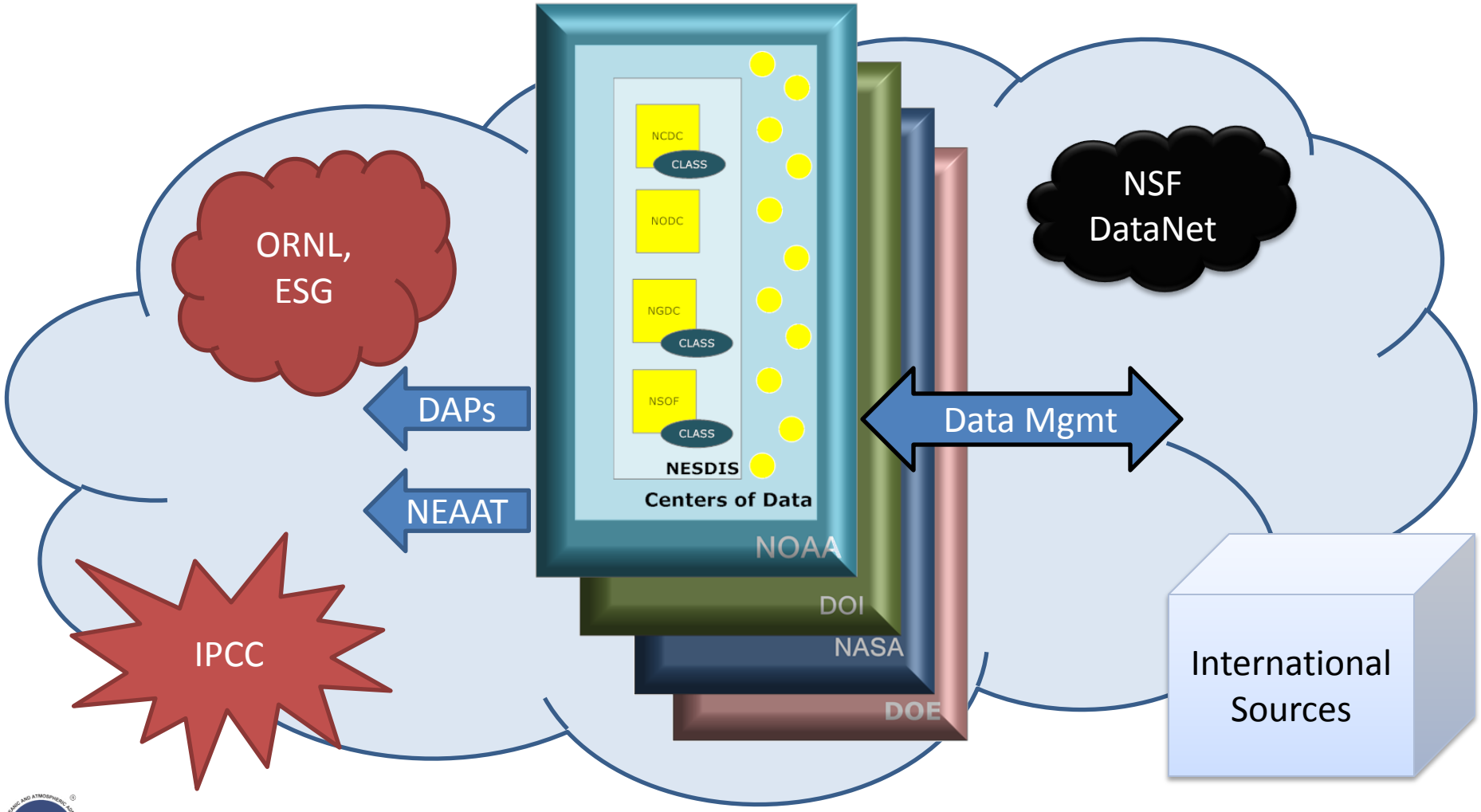
Move out of the Box and into the Cloud

- Utilize highly distributed storage and computing (RENCI, Oak Ridge National Lab)

Implement supporting technologies to enable interoperability with Designated Communities (OGC, WMS/WFS)

Institute rules-based data management to enable true federation of NOAA Centers of Data (iRODS)

NOAA's Data Centers Will Function in a Wider Information Landscape

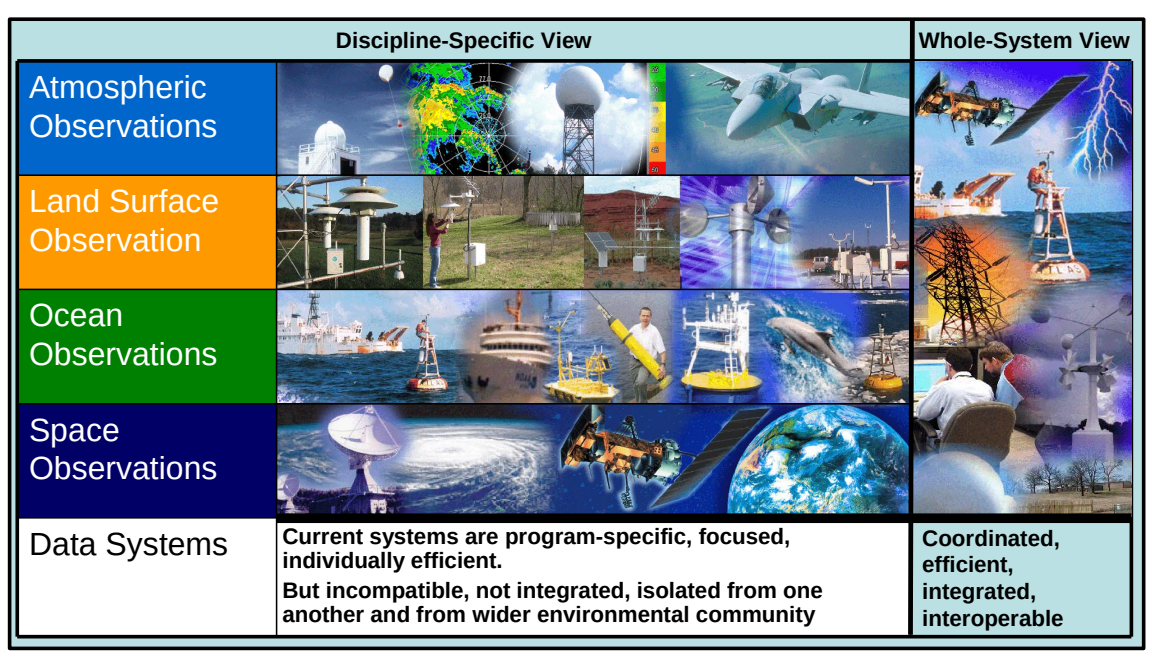


National Climatic Data Center

Societal Benefit Areas

Support :

- Disaster reduction
- Human Health
- Climate
- Water Resources
- Weather
- Ocean Resources
- Agriculture & Land-Use
- Ecosystems



Managing NCDC's Weather Radar Data

Radar Networks Supported

Primary radar network data and products archived at NCDC:

- Weather Surveillance Radar 1988 Doppler (WSR-88D)
  - * Common Name: Next Generation Radar (NEXRAD) (S-Band)
  - * 159 NEXRAD Sites (ConUS, Alaska, Hawaii, Puerto Rico, Guam, Korea)
- Depart of Transportation - Terminal Doppler Weather Radars (TDWR)
  - * 45 Sites (ConUS) Level III products, (C-band)

Other Radar Network data and products available:

- NOAA Regional & ConUS Radar-based Precipitation Mosaic (Multi-sensor product)
- RIDGE Mosaics (Radar Integrated Display with Geospatial Elements)

Radar Networks Supported

- Environment Canada Radar Network 41 Sites (C-band)
- NOAA 3-D Reflectivity and QPE mosaic (1km resolution)

Potential future Radar networks data and products available:

- Collaborative Adaptive Sensing of the Atmosphere (CASA) Radar network (X-band)
- Phase Array Radar Networks (~2020)

Potential support for other global radar networks or programs

- GEWEX – Global Energy and Water Cycle Experiment
- OPERA - Operational Programme for the Exchange of weather Radar information, www.knmi.nl/opera

NCDC Radar Archives

- Entire NEXRAD Period of Record: 1991 – Present
- Archives hold over 1.5 petabyte

Ingest

- Increases at over 672 gigabytes/day (245.3tb per year)
- Projected increase to ~ 2.2 terabyte/day in ~ 2012 (Dual Pol)
- Potential increase ~ 10.9 terabyte/day ~ 2020 (Phase Array)

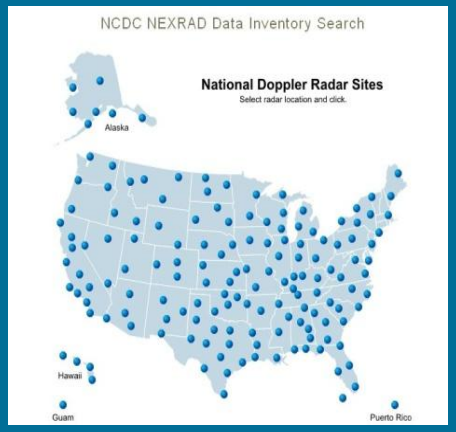
Dissemination statistics

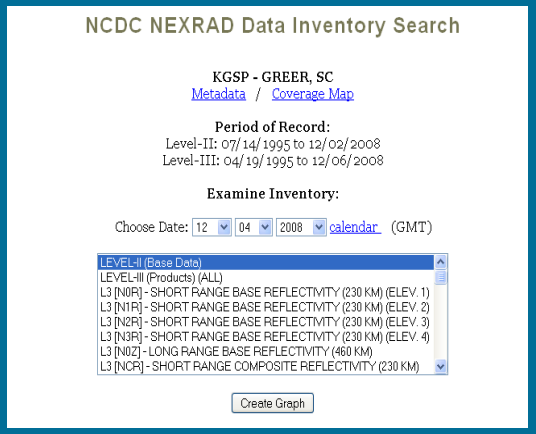
On-Line Access

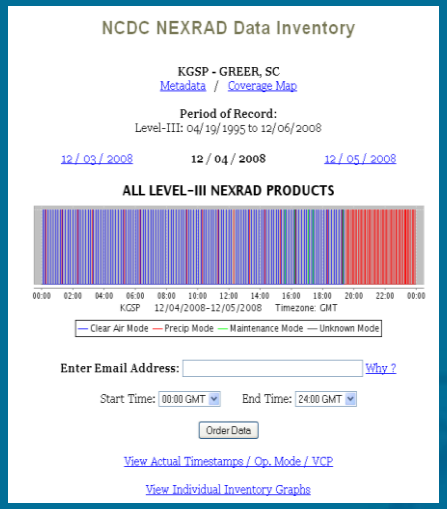
- **~ 250 Gigabyte radar data accessed on average per day (6tb accessed in 5 days last week in April 2010)**
- **File count over 200 million tar files retrieved per year (8hr or 1hr increment)**
- **Over 60 terabytes accessed last year**
- **21 minute average retrieval latency (Last 6 months 18.7tb with 7.4 minute average access)**

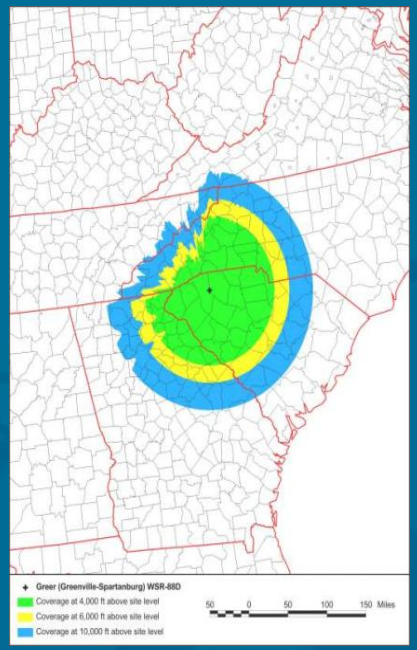
Direct Web Access

Direct digital access to radar inventories, data, and visualization software are available at no cost via the NCDC radar resources web page http://www.ncdc.noaa.gov/oa/radar/radarresources









NEXRAD Inventory: Select Site and Product
http://www.ncdc.noaa.gov/nexradinv/

Data Access and Support Tools

- Data inventory online search tool

- Data visualization – Desktop application Weather and Climate Toolkit (http://www.ncdc.noaa.gov/oa/wct)
  - * Standards based using Unidata Common Data Model
  - * Batch Processing
  - * Tutorials
  - * API/Source code release

- Data mining

Weather & Climate Toolkit Overview

- Free, public domain source code
- Desktop and command-line application
- Simple visualization and data export
- Platform independent (Java-based)
- Leverages community tools and standards (NetCDF for Java, Common Data Model, etc…)
- Successor to Java NEXRAD Tools

Toolkit Access

Data:

- **Raw data files on disk or remote location (URL, THREDDS, OPeNDAP, etc…)**

Services:

- **Easy to use dialogs for remote services distributed over web services (REST, WMS, WFS, OPeNDAP, NetCDF Subset Service, etc…)**

*** Some of these services are under development**

Data

Currently:

- **NEXRAD (Level-II and Level-III), TDWR, Canadian Sigmet Radar GOES Satellite, Gridded NetCDF**

Coming soon:

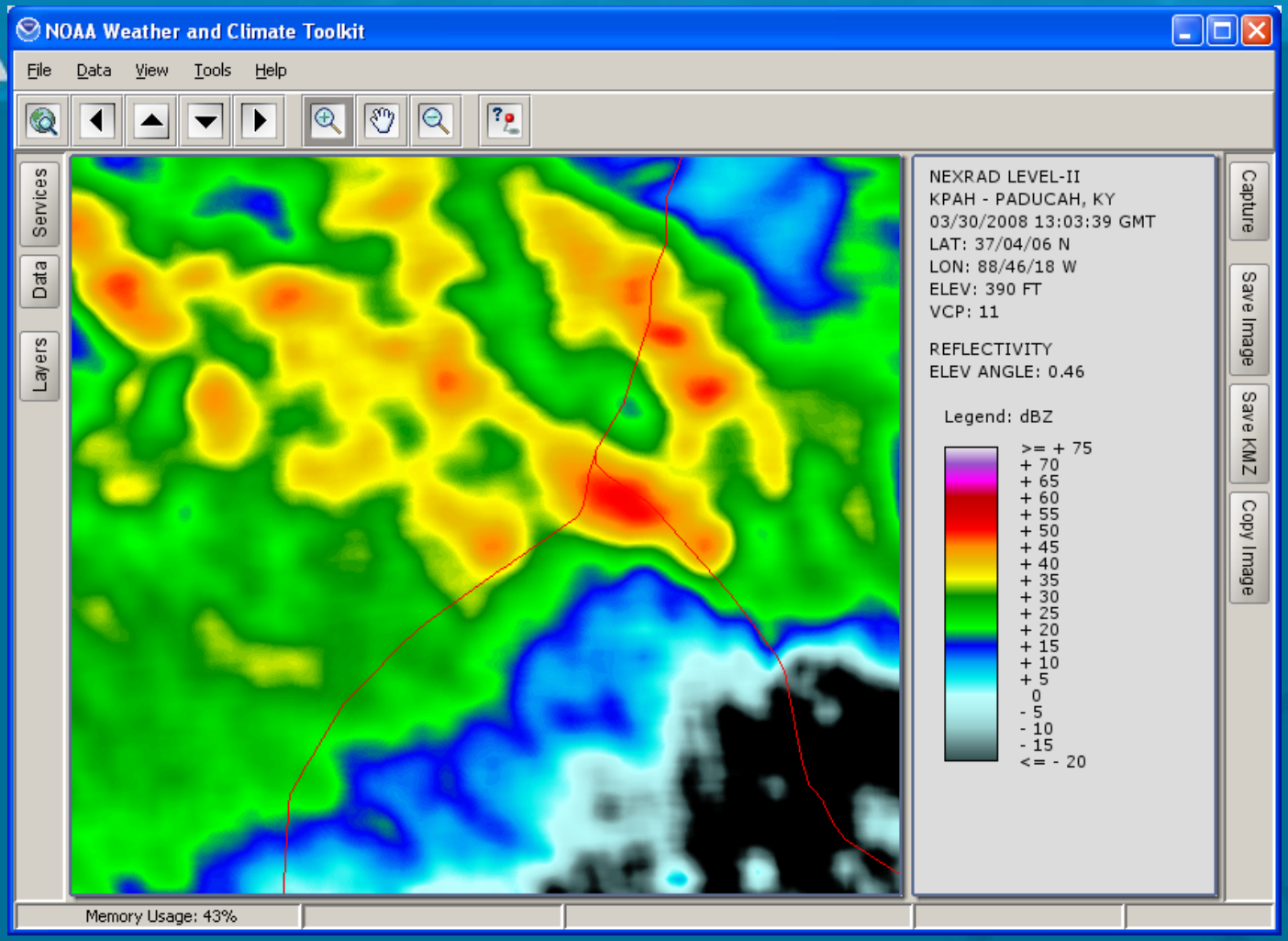
- **GINI, Generic NetCDF:**
  - **Feature types of Swath, Radial, Time Series, Point, etc…**

Visualization

Simple 2-D maps

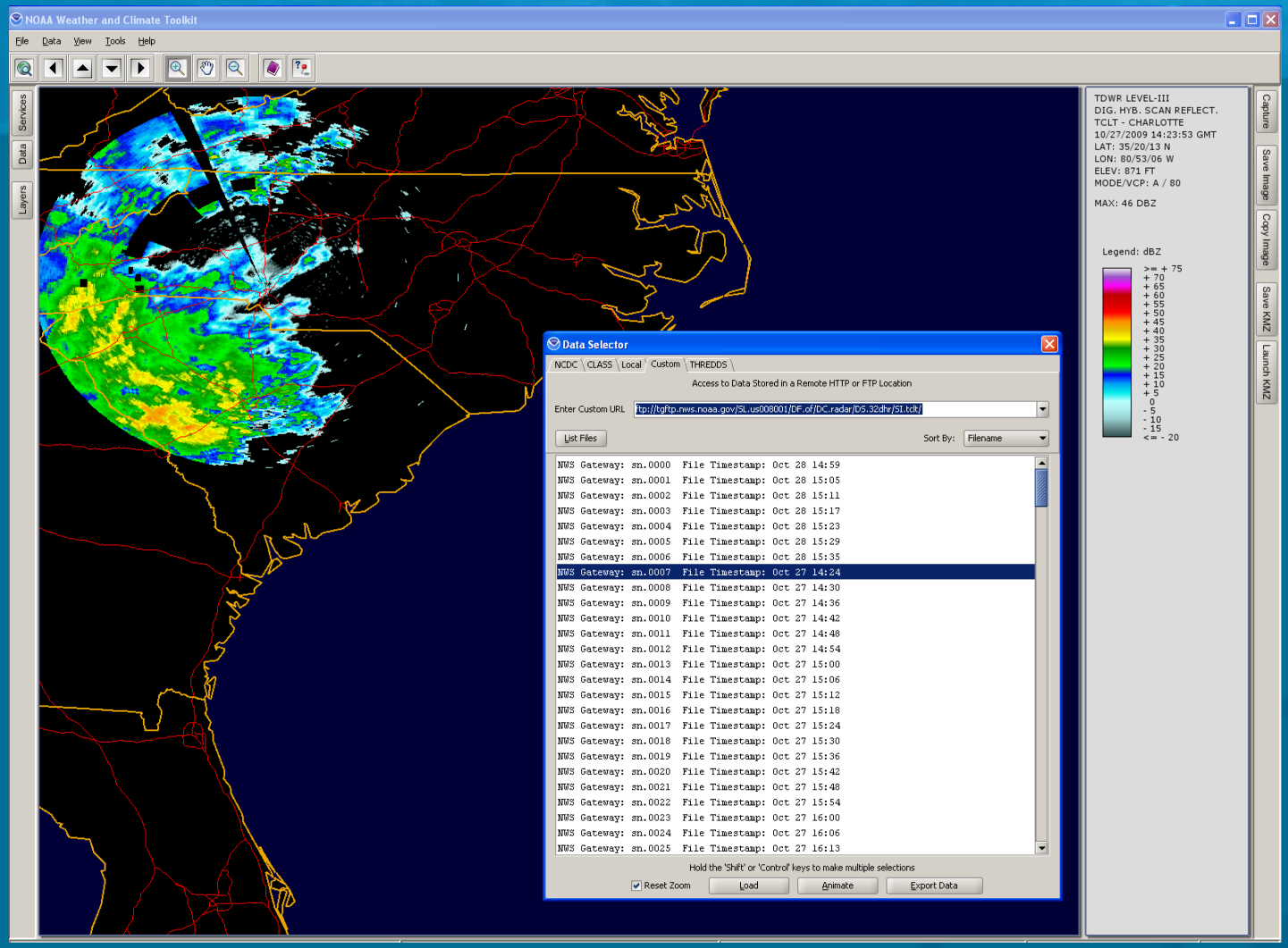
- Basic overlays included (states, counties, etc…)
- Background images from any OGC WMS
  - Shaded Relief, Topo Maps, Landsat, ext…
- Save images and animations to Animated GIF, AVI, KMZ (Google Earth)

Visualization



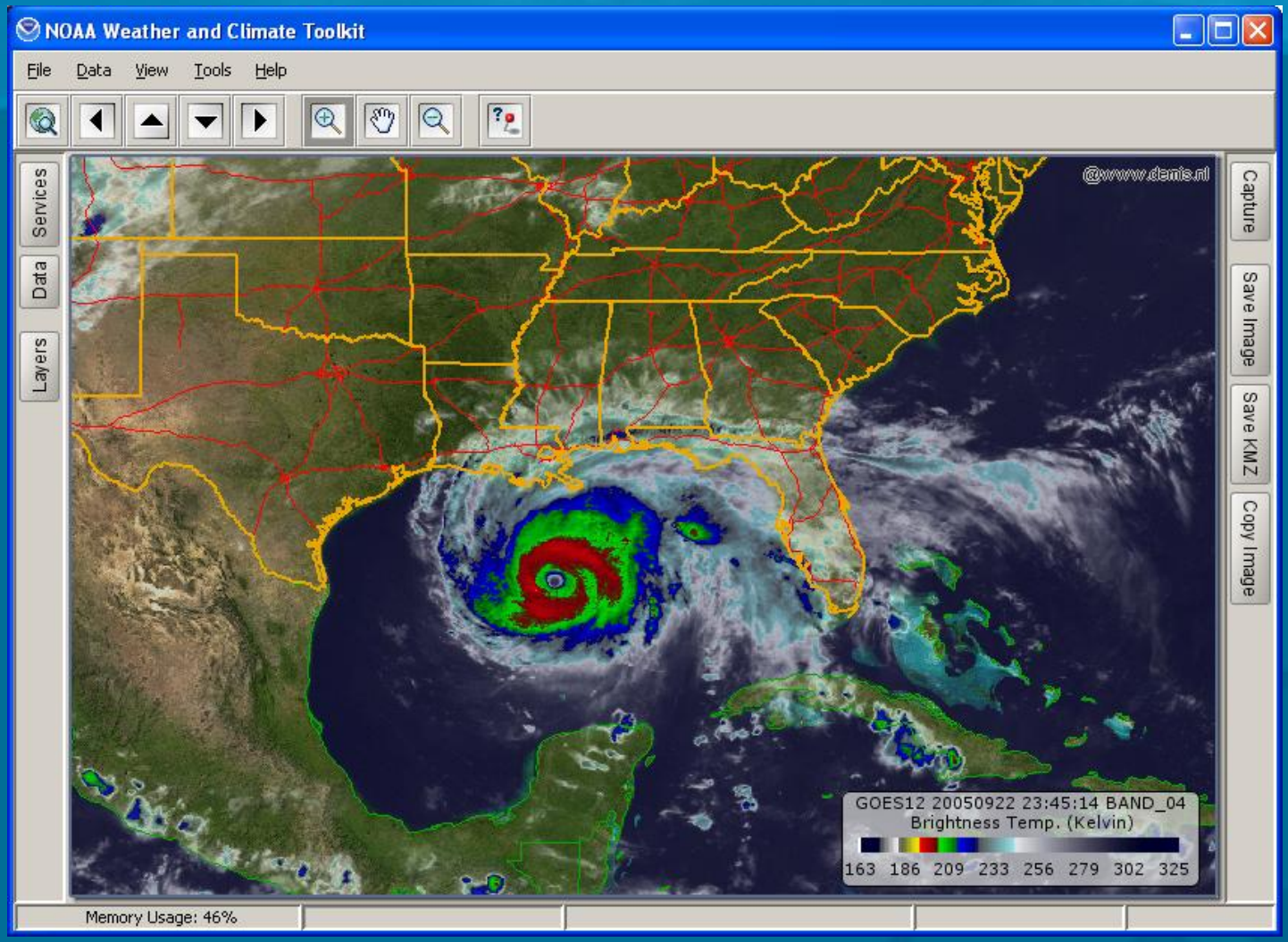
Smoothed NEXRAD Reflectivity Data

Visualization



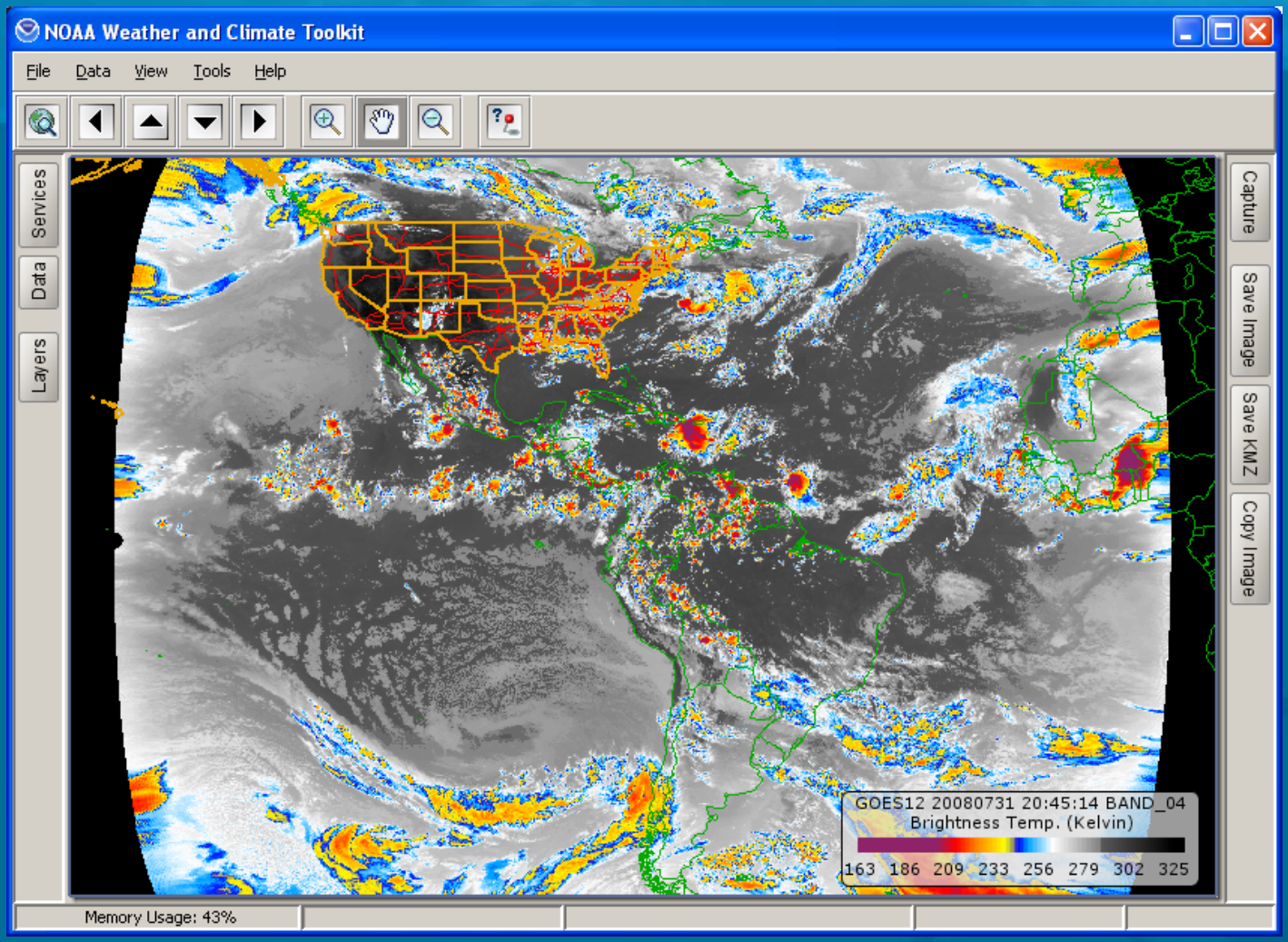
TDWR data displayed in toolkit using near real time data accessed from NWS server

Visualization



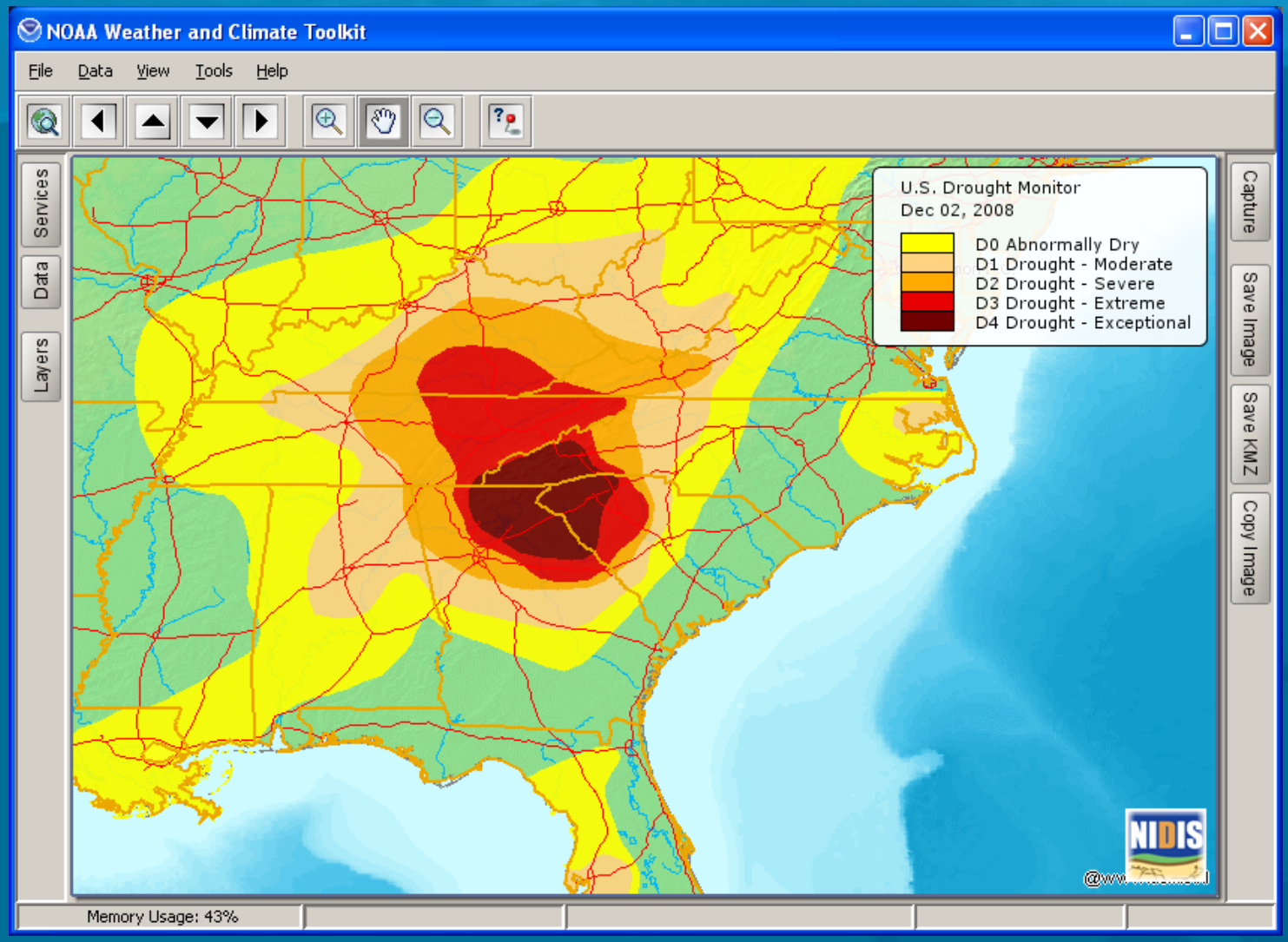
GOES Infrared with Blue Marble Web Map Service (WMS) background map

Visualization



GOES Full Disk Infrared

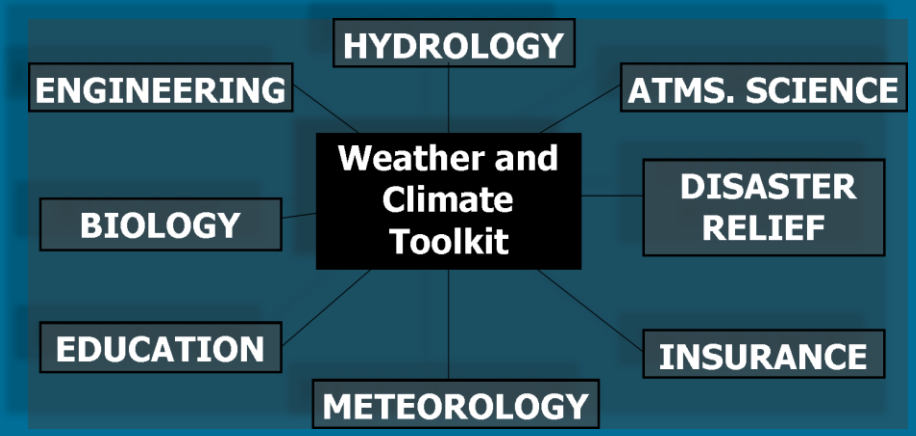
Visualization



U.S. Drought Monitor service from NIDIS/NDMC (National Drought Mitigation Center)

Data Export

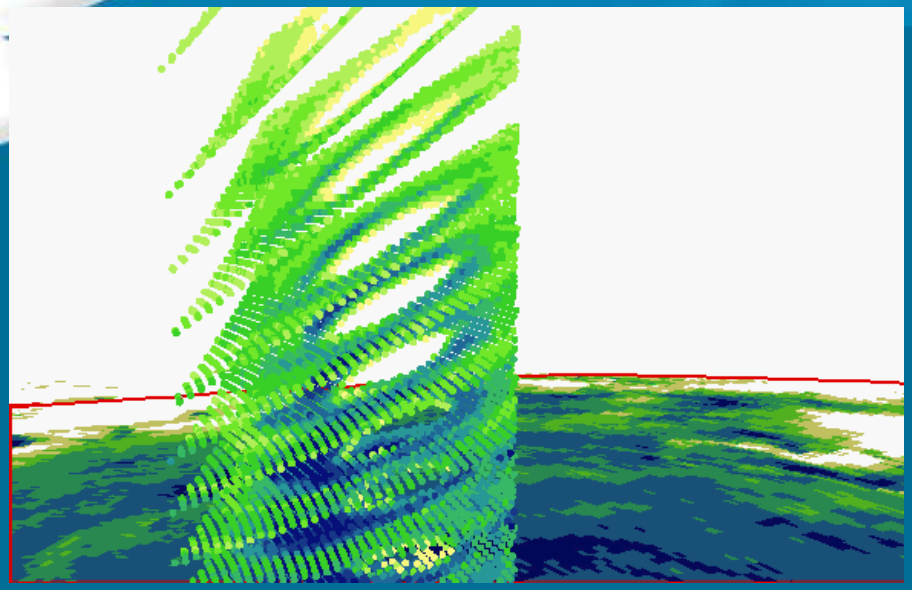
"Bridge" between raw Weather and Climate data and multiple scientific user communities

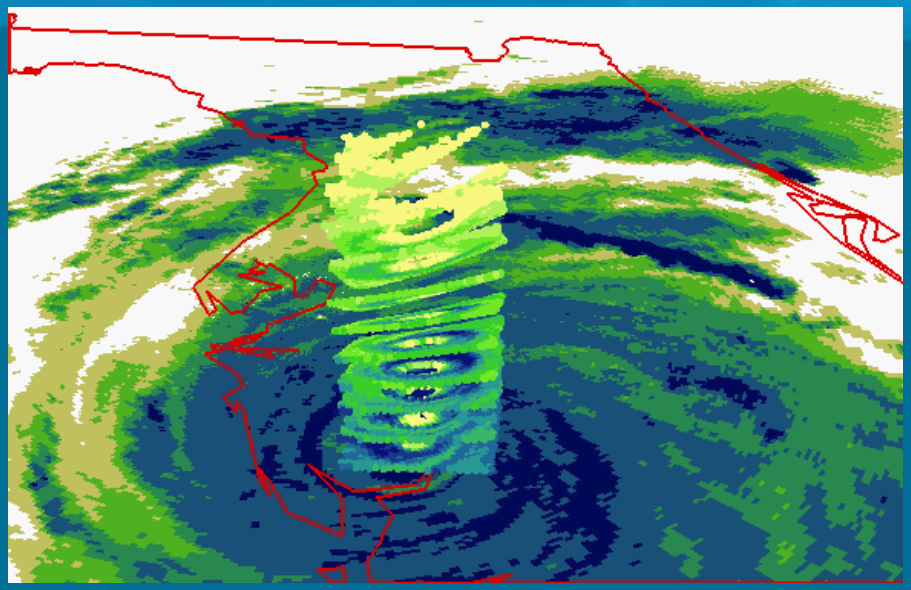


Export Data to:

Shapefile, Well-Known Text, Arc/Info ASCII GRID, Gridded and Raw NetCDF, GeoTIFF and KMZ (Google Earth)

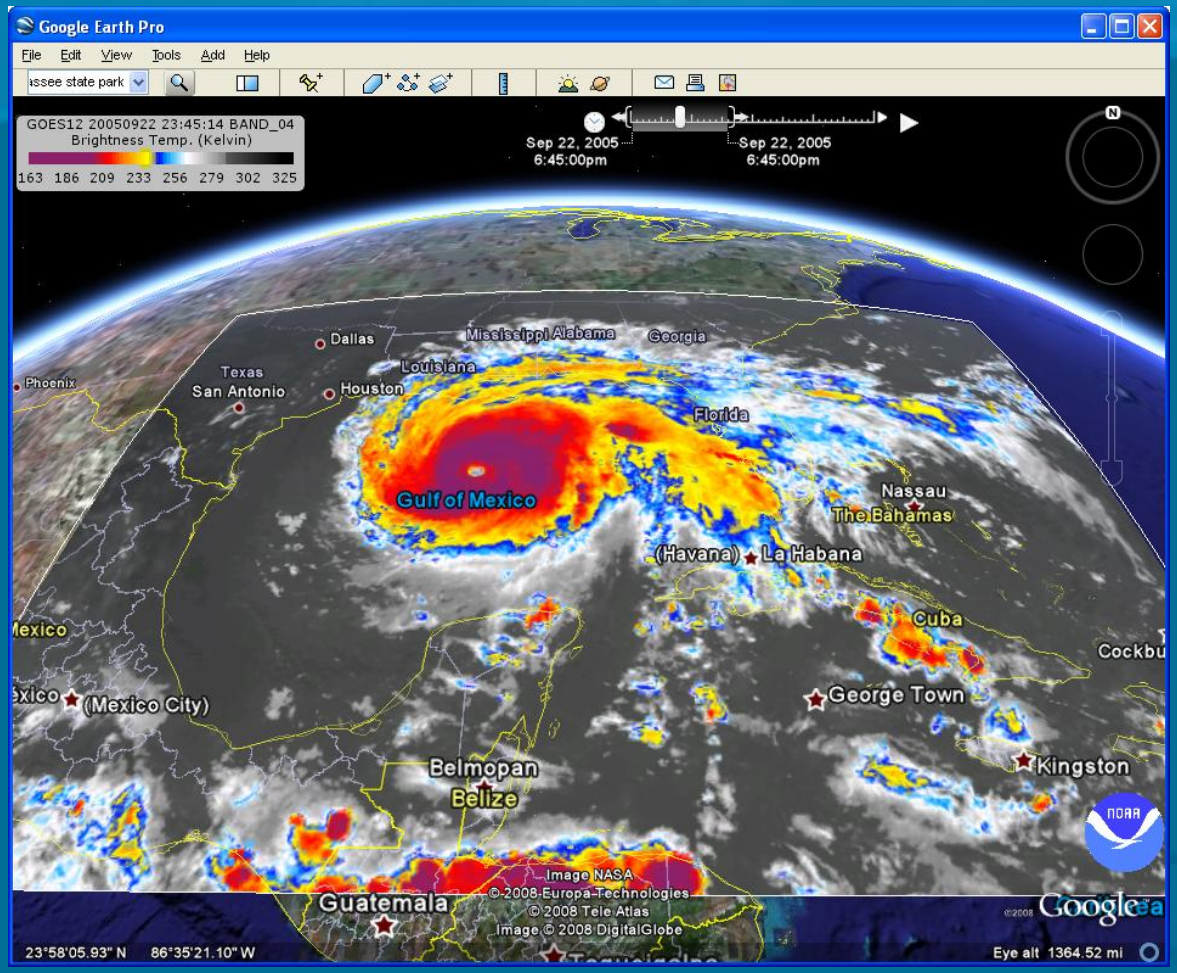
Applications





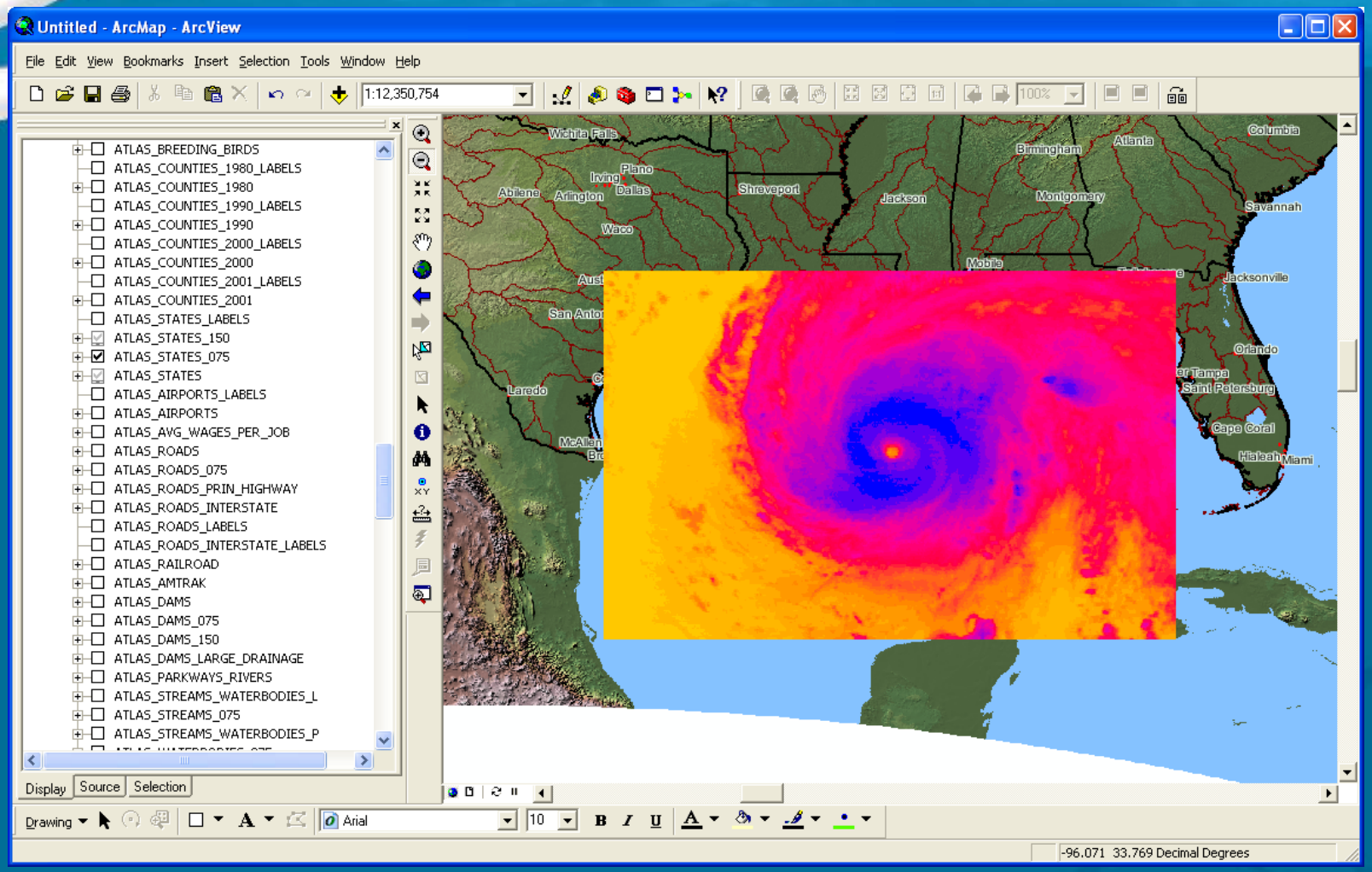
Level-II Reflectivity data from Hurricane Charley in ESRI ArcScene. Data exported to a point Shapefile with an exaggerated height attribute

Applications



GOES Satellite Imagery from Hurricane Rita landfall in Google Earth

Applications

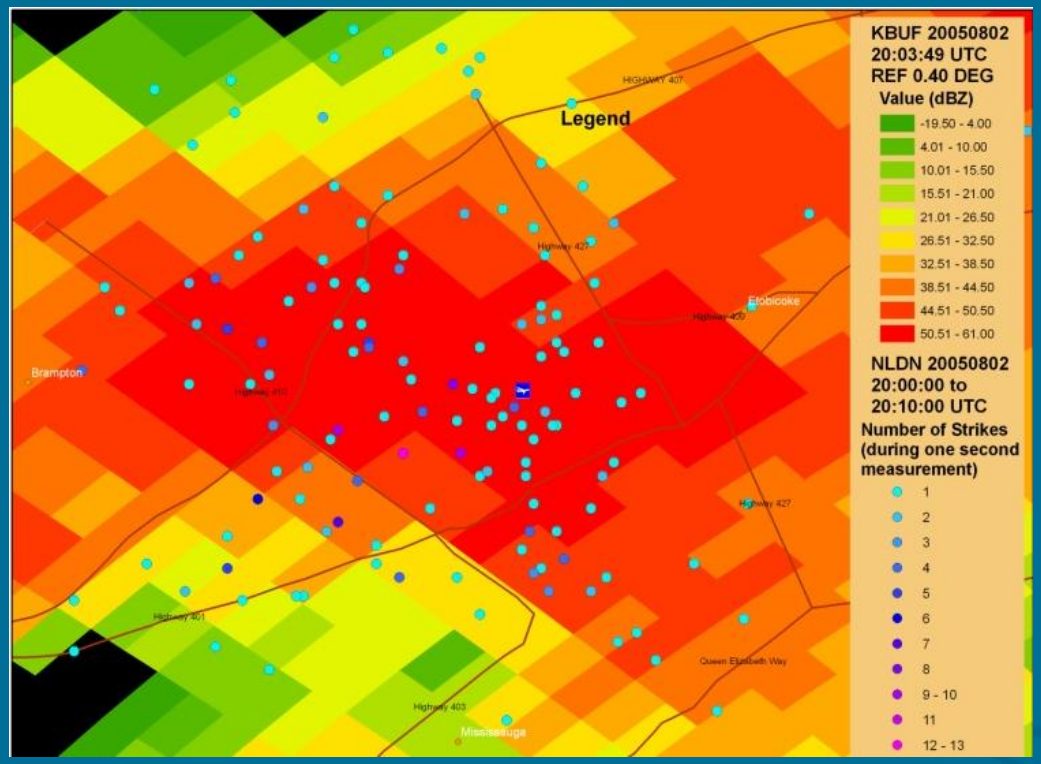


GOES Satellite Imagery from Hurricane Rita landfall, exported as ASCII GRID, in ArcGIS

Applications

Integrated radar, lightning and hail data animation

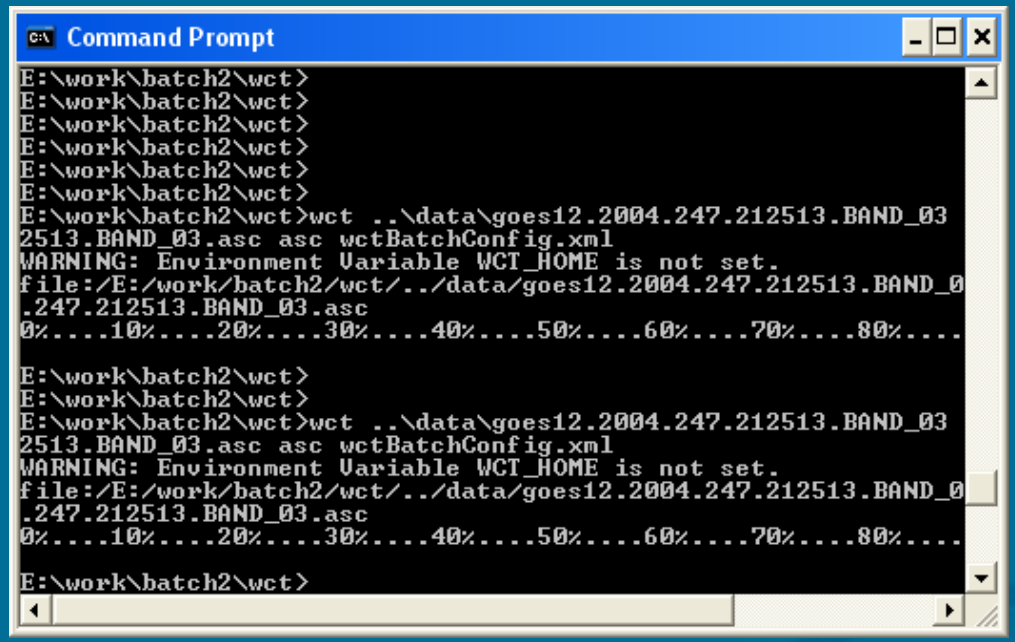
View Movie



Toronto A.P. August 2, 2005 data exported to SHP file and displayed in ESRI GIS software

Applications

```
<?xml version="1.0"?>
<wctExportBatchOptions version="2">
   <!--
      Logging options: These can be 'SEVERE', 'WARNING', 'INFO',
   -->
   <logging> WARNING</logging>



      <!--  ================================================
      <!--  Grid Section - decoding and filtering options
      <!--  ================================================
   <grid>
      <gridFilter>
         <!--
            Geographic Extent Filter units of decimal degrees
         -->
         <minLat> NONE</minLat>
         <maxLat> NONE</maxLat>
         <minLon> NONE</minLon>
```



Command-line batch processing of data export

Applications

Public domain / open source API

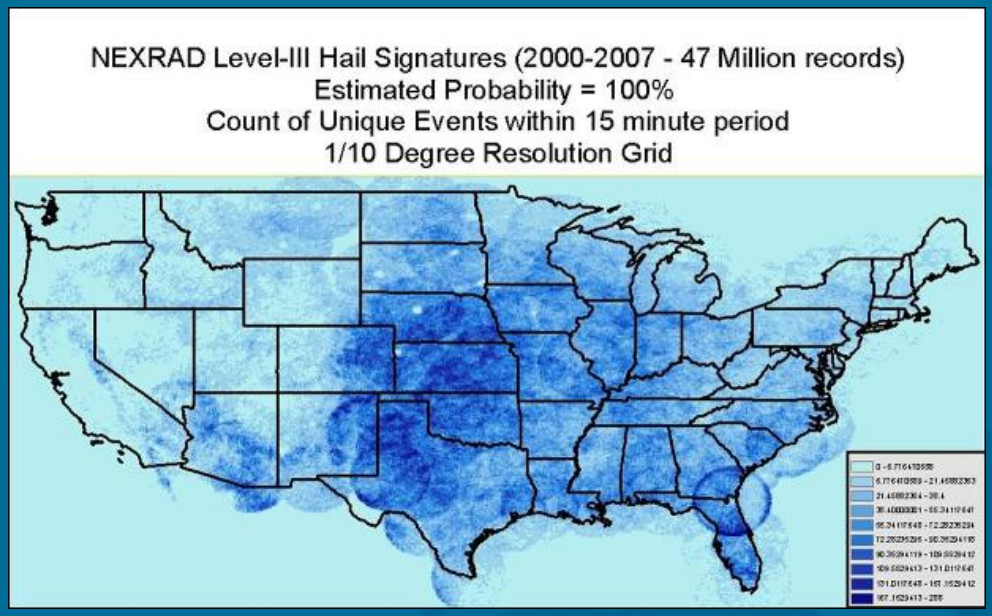
```
String source =
    "E:\\work\\goes\\katrina\\goes12.2005.241.144513.BAND_04";


GoesRemappedRaster goes = new GoesRemappedRaster();
goes.setHeight(500);
goes.setWidth(500);

Rectangle2D.Double bounds =
    new Rectangle2D.Double(-102.0, 17.0, 24.0, 24.0);

goes.process(source, bounds);

System.out.println("WRITING ASCII Grid");
WCTRasterExport rasterExport = new WCTRasterExport();
rasterExport.saveAsciiGrid(new File(source+".asc"), goes);
```

Geospatial DB of severe weather records

- NEXRAD Level-III point features describing general storm structure, hail, mesocyclone and tornado signatures

- NWS Severe Thunderstorm, Tornado, Flash Flood, Preliminary Local Storm Reports and Special Marine warnings

- Google-maps based web page or REST URL-based web service
  - Data download in CSV, XML, Shapefile and KMZ

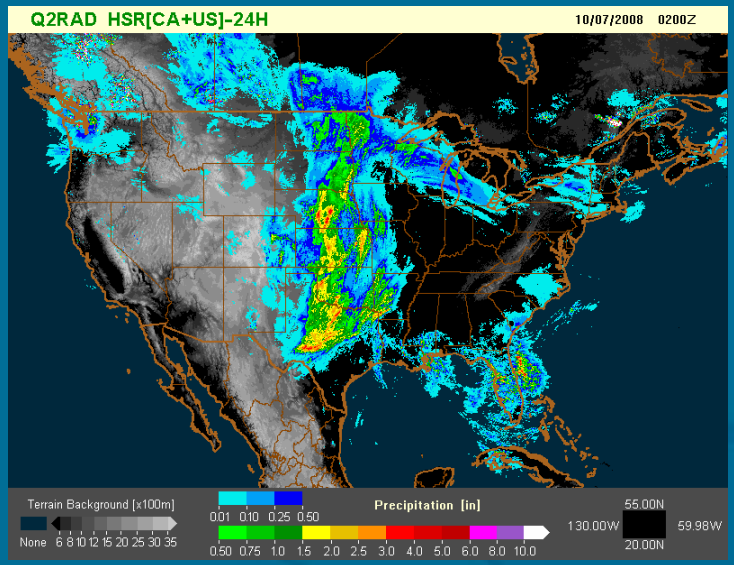


http://www.ncdc.noaa.gov/swdi

Next Generation QPE (Q2)

Precipitation re-analysis using Q2

- NCDC is collaborating with the National Severe Storms Lab, North Carolina State Univ and RENCI to produce precipitation re-analysis products
- Q2 is a high resolution precipitation product with 1km spatial resolution & 5 minute temporal resolution
- Goal is to derive Climatology by running Q2 algorithms against 10 years of NEXRAD base data
- As project scales current processing on NCDC Blade Center will move to RENCI or ORNL Super Computing Facility



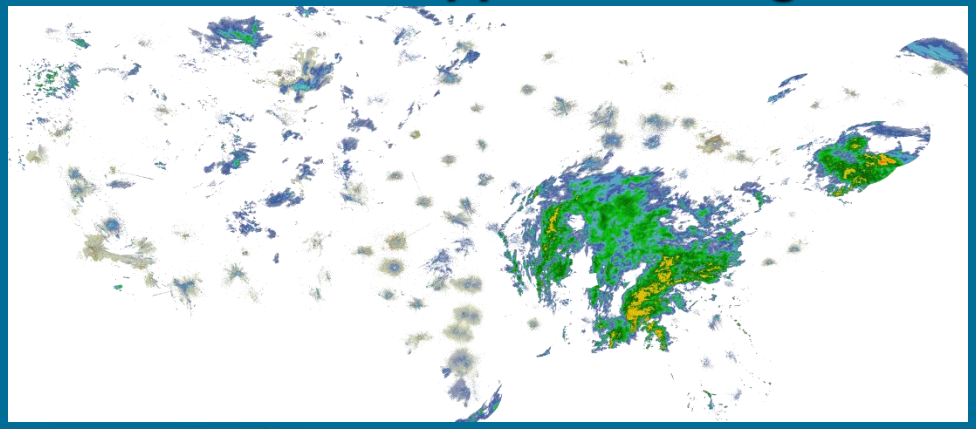
RIDGE Mosaics

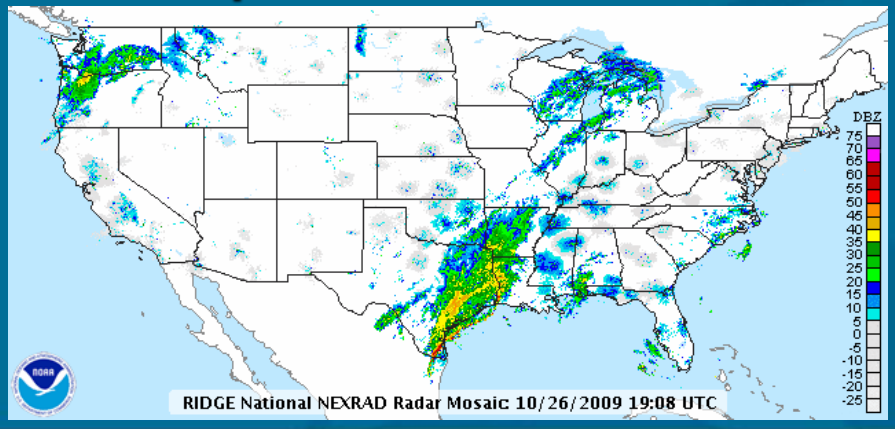
- The NWS RIDGE mosaics are available on-line & cover latest hour
http://www.srh.noaa.gov/ridge/Conus/

- Data older than one hour is available from NCDC
http://www.ncdc.noaa.gov/oa/radar/radardata.html

- The radar images can be animated and layered with geospatial elements http://www1.ncdc.noaa.gov/pub/data/nexrad/ridge

- OGC WMS support for Ridge2 under development





Contacts

- Stephen Del Greco: Chief, Satellite Services Branch Stephen.A.Delgreco@noaa.gov
- Steve Ansari: W&C toolkit developer Steve.Ansari@noaa.gov
- Brian Nelson: Radar Scientist Brian.Nelson@noaa.gov
- Alan Hall: IT Specialist Alan.Hall@noaa.gov