

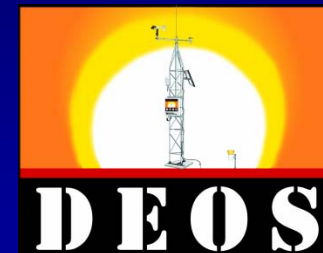
WEMAS/DEWOOS

A WATERSHED ENVIRONMENTAL MONITORING AND ANALYSIS SYSTEM FOR THE DELAWARE RIVER/BAY SYSTEM

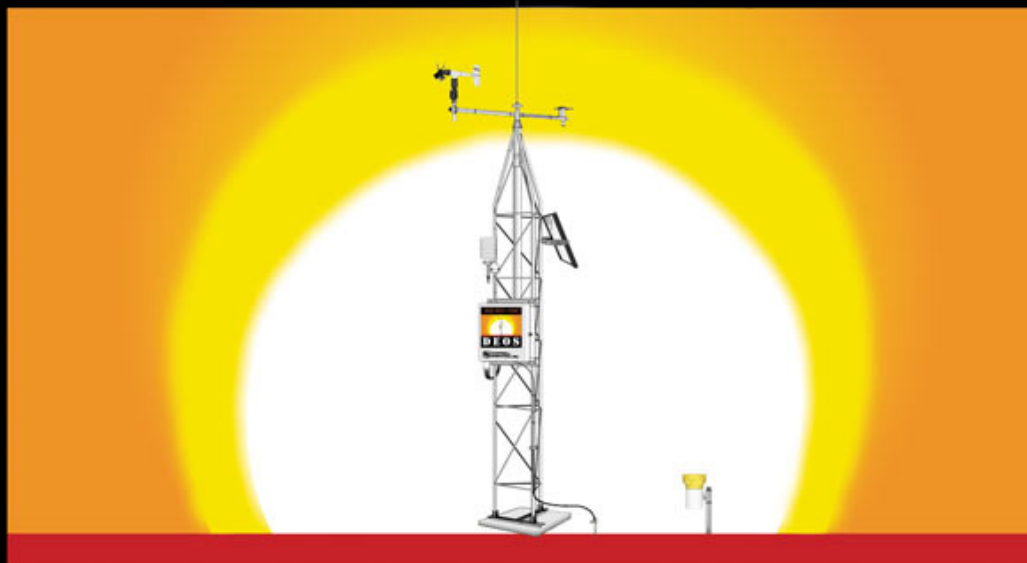
David R. Legates, Daniel J. Leathers, Tracy L. DeLiberty,
Geoffrey E. Quelch, Kevin R. Brinson, and Linda W. Parrish
University of Delaware



Presented at NJWMCC Mtg
September 12, 2008



www.deos.udel.edu



DEOS

www.deos.udel.edu



Delaware *Environmental* *Observing* System



DEOS Is A Partnership Among:



FEMA Region III



DNREC



Mt. Holly, NJ

The University of Delaware

Center for Climatic Research
Office of the State Climatologist
Department of Geography
Delaware Space Grant Consortium



Delaware Geological Survey

Mission Statement



The Delaware Environmental Observing System (DEOS) is a tool for decision makers involved with emergency management, natural resource monitoring, transportation, and other activities throughout the Delmarva Peninsula. DEOS also provides both State agencies and the citizens of Delaware with immediate information as to environmental conditions in and around the State.

The Delaware Environmental Observing System

- **DEOS Environmental Monitoring and Observing Network (DEMON)**
- **DEOS Integrated Visualization and Analysis System (DIVAS)**
- **DEOS Application Systems (DAS)**

DEOS Environmental Monitoring and Observing Network (DEMON)



DEOS Environmental Monitoring and Observing Network is the backbone of DEOS

Observations

Data Ingest and Data Storage

Oracle Database

Data Dissemination

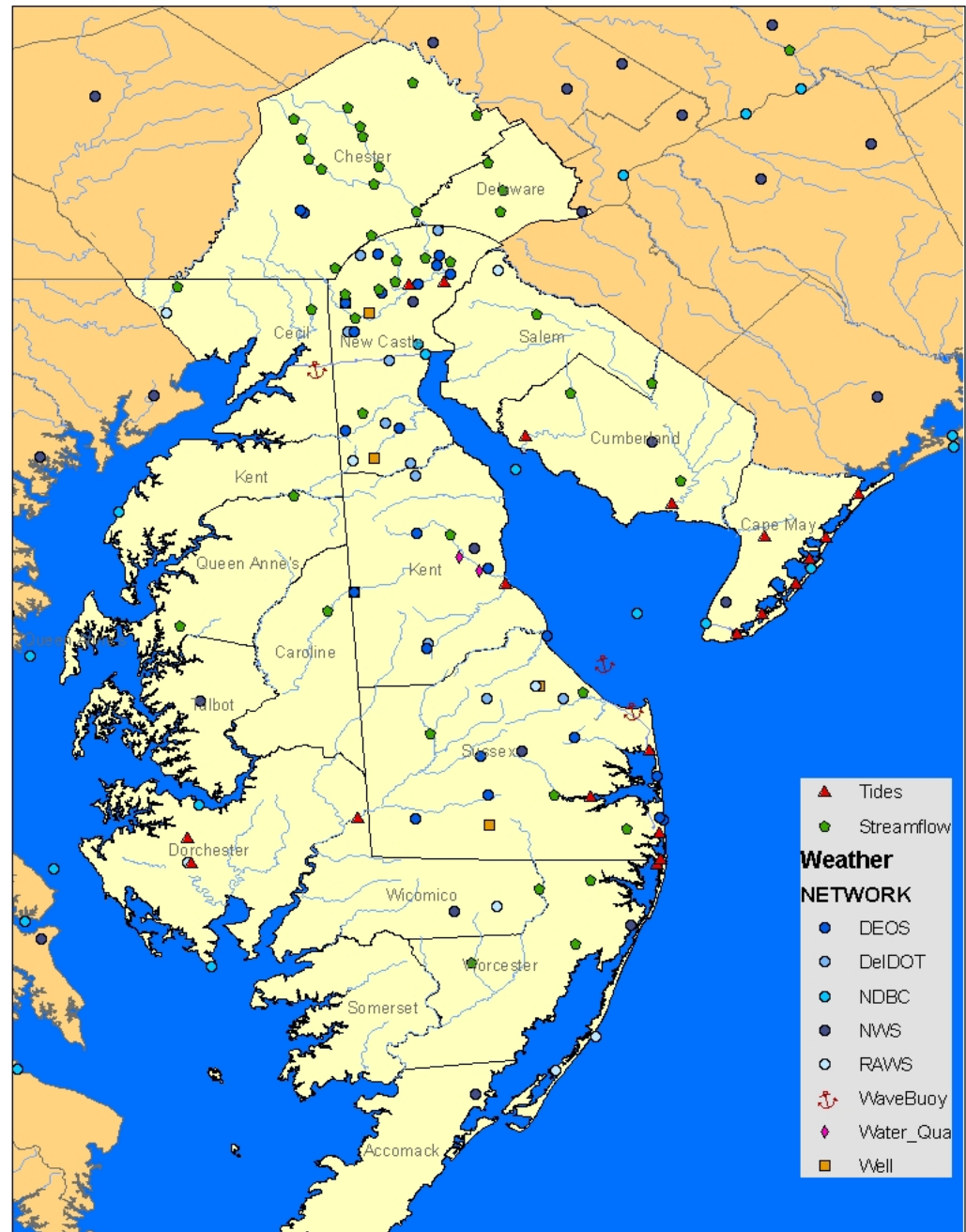


DEOS Environmental Monitoring and Observing Network

- A “one-stop” storage and availability site for all environmental data from in/around the State
- Meteorological Data – 5-min, hourly, daily – precipitation (gage & radar), wind vector, air temperature, humidity, solar radiation, air pressure, DNREC air quality measurements
- Hydrologic Data – USGS & DGS stream gauges, DNREC water quality measurements, well levels, soil moisture and temperature
- Oceanographic Data – USGS & DGS tide gauges, wave height and period, water temperature, buoy and coastal observing systems

Current DEOS Station Distribution

Data available includes over 100 observation platforms providing meteorological observations, stream flow, tidal levels, wave bouy data, water quality and well data.



5-Minute Recording Instruments



Station at Hockessin, Delaware

- Air Temperature
- Rel. Hum. (dew point)
- Wind Speed and Direction
- Atmospheric Pressure
- Precipitation
- Solar Radiation
- Leaf Wetness
- Volumetric Water Content
- Derived Variables
- Real-Time Observations

DEOS Integrated Visualization and Analysis System (DIVAS)





[Home](#)

[Data](#)

[News](#)

[Information](#)

[RSS](#)

[XML](#)

Current Advisories

DEOS Network System Advisories:

9/4/07- DEOS will be performing updates to its system this evening between 6 p.m. and midnight local time. During this time, some portions of the DEOS website will be unavailable. We apologize for an inconvenience this may cause.

DEOS Network Station Problems:

8/6/07- DMRJ (Slaughter Beach, DE) is currently offline due to communication problems with the station.
Expected time of return: Unknown.

News

Dry July Brings Fears of Drought - 08/28/07

Overall the state of Delaware was pretty dry for the month of July. Most places barely received any rain at all. Others saw 2 inches per hour rainfall from short-lived, summertime thunderstorms. To see how much rain fell around the First State, see the [July 2007 Weather Roundup](#).

Data Requests

DEOS has two methods for filling data requests. The preferred method is using our web services, which provide data in an XML neutral format. This is ideal for anyone with recurring data needs. To access our web services, go to the [sign up](#) page to get an account.

If you encounter problems using the web services, or if you have other data questions, go to our [feedback](#) page and send us a message.

Our Mission:

The Delaware Environmental Observing System (DEOS) is a support tool for decision makers involved with emergency management, natural resource monitoring, transportation, and other activities throughout the State of Delaware. DEOS primary goal is to provide both State agencies and the citizens of Delaware with immediate information as to environmental conditions in and around the State.



DEOS GeoBrowser:

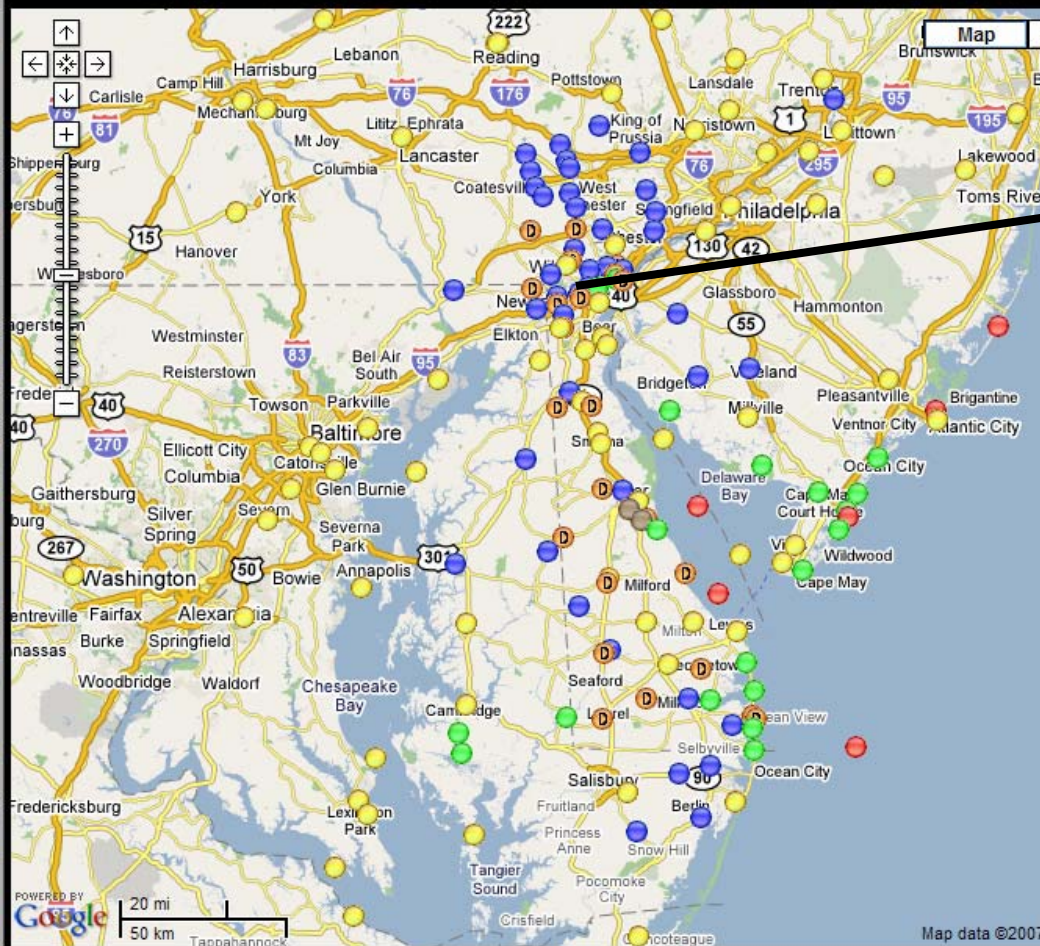
DEOS has a new mapping tool available to its users. This tool utilizes an interface with Google Maps to provide the underlying geographic data, while DEOS generates an overlay of the stations and their data.

Click the image below to go to the GeoBrowser
(Note: This will appear in a new window).





DEOS GeoBrowser



Map Legend

○: 5-minute Weather Stations
●: Other Weather Stations

●: Streamflow Stations
●: Tidal Stations

●: Wave Buoy Stations
●: Water Quality Stations

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Please read the [Data Disclaimer](#) before using any data.
Questions or comments about this page? Click [here](#).

ODD-DIVAS: DHOC Current Data - Windows Internet Explorer

http://www.deos.udel.edu/odd-divas/station_current.php?station=DHOC&network=DEOS&units=er

Hockessin-VFC Station

ID	DHOC	Network	DEOS
City/State	Hockessin/DE	Elevation	329 ft.
Latitude	39° 47' N	Longitude	75° 41' W
Updated	4:55 pm	Date	March 4, 2007

Observations

Data Type	Measurement	Time	Chart	Data
Rainfall	0.00 in	4:55 pm		
24-Hour Rainfall	0.00 in	4:55 pm		
Air Temperature	36.1 °F	4:55 pm		
Wind Chill	30.6 °F	4:55 pm		
Dewpoint Temperature	12.7 °F	4:55 pm		
Relative Humidity	38 %	4:55 pm		
Barometric Pressure	29.94 inHg	4:55 pm		
Solar Radiation	151 W.m ⁻²	4:55 pm		
Wind Speed	6.8 mph	4:55 pm		
Wind Gust	11.9 mph	4:55 pm		
Wind Direction	325.6 ° (NW)	4:55 pm		
Soil Temperature	39.8 °F	4:55 pm		

javascript:popUpGraphic("cact")

Internet

100%



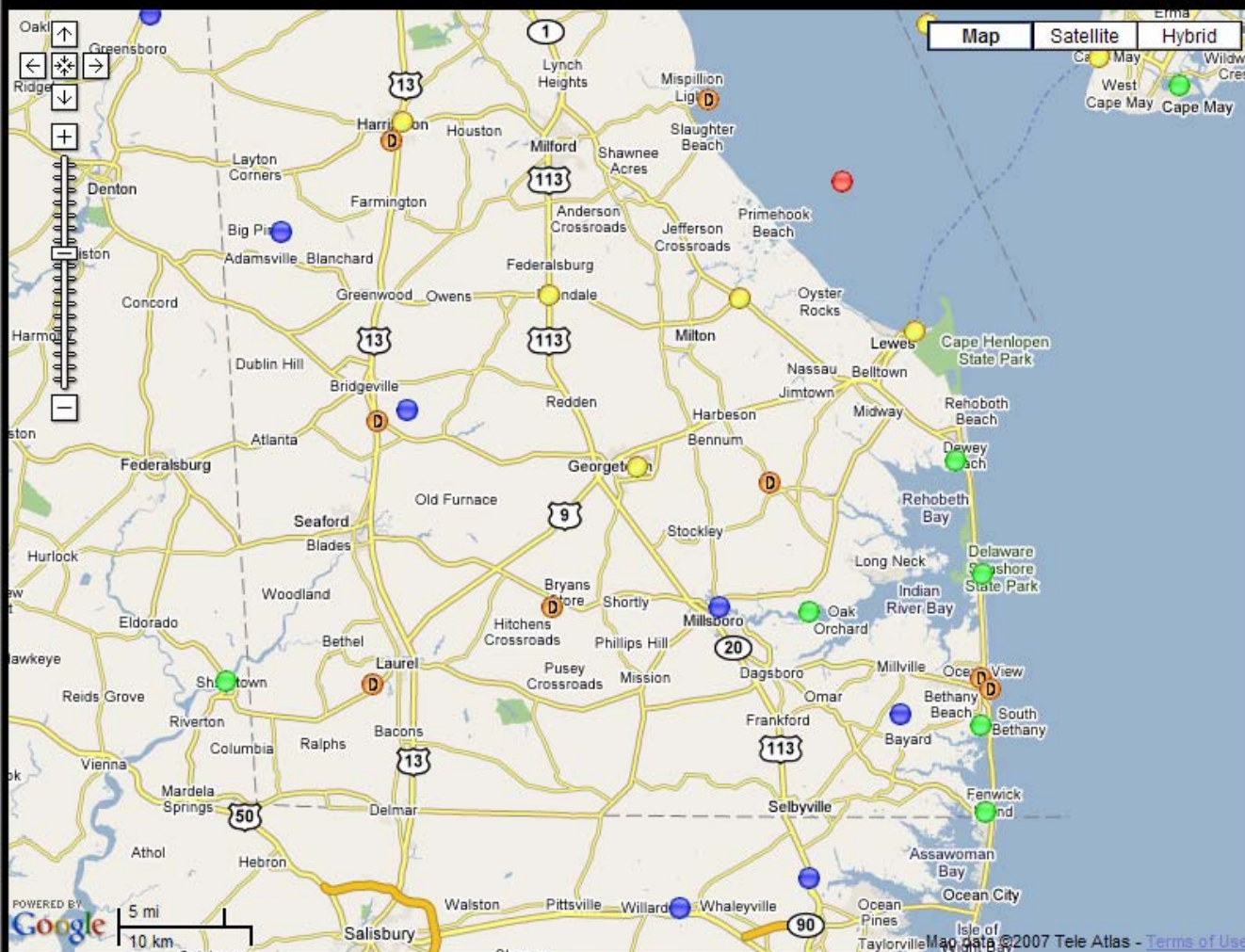
DEOS

DEOS GeoBrowser

Zoom to County:

Sussex (DE)

User's Guide



Map Legend

5-minute Weather Stations
 Other Weather Stations

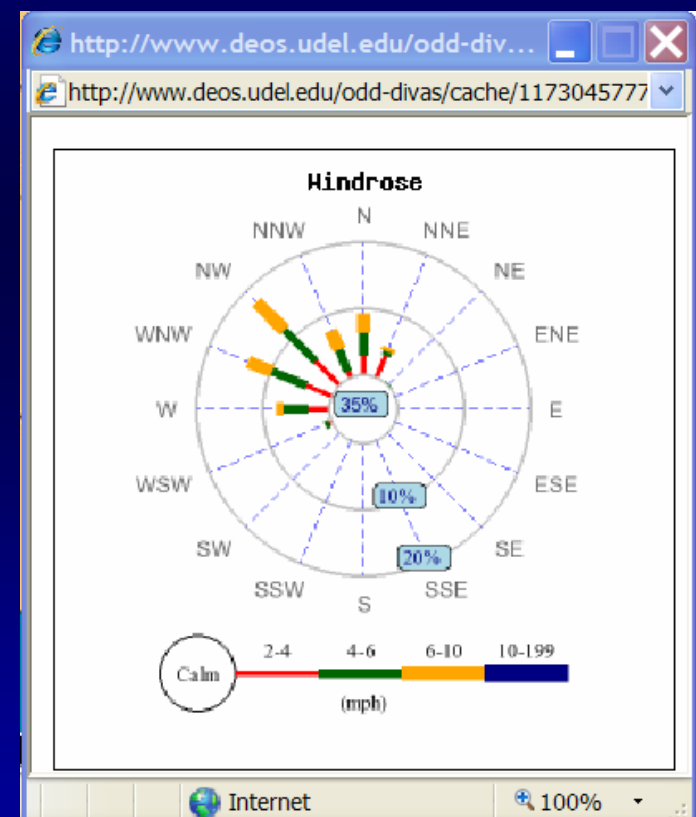
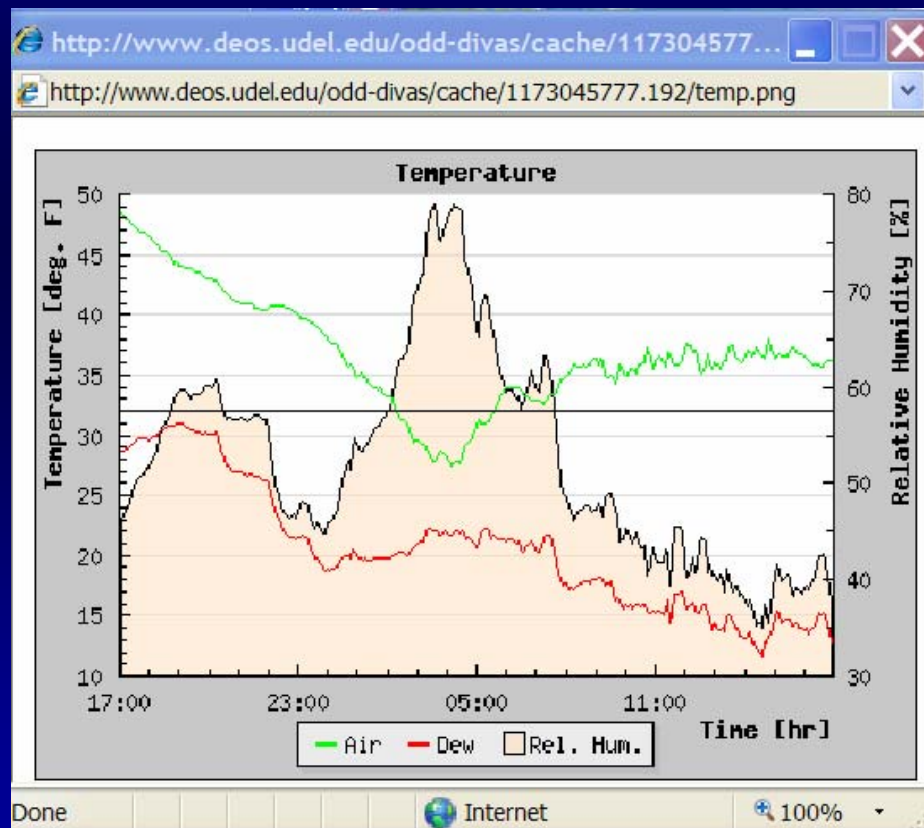
Streamflow Stations
 Tidal Stations

Wave Buoy Stations
 Water Quality Stations

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Please read the [Data Disclaimer](#) before using any data.Questions or comments about this page? Click [here](#).

Click on graph icon to see graphic depiction of last 24 hours of data....



Various summary displays are available for each station...

Monthly summary display...

★ ODD-DIVAS: DBBB Monthly Data

Daily Station Statistics for February, 2007

Day	Avg Temp (°F)	Max Temp (°F)	Min Temp (°F)	HDD (base 65 °F)	CDD (base 65 °F)	Avg Wind Speed (mph)	Avg Wind Dir (°)	Peak Wind Gust (mph)	Rainfall (in)
1	33.1	38.1 (15:05)	25.9 (00:05)	31.9	0.0	1.3	48.4	8.4 (10:22)	0.05
2	37.5	39.4 (19:10)	34.4 (00:10)	27.5	0.0	4.9	167.1	16.3 (02:42)	0.34
3	33.5	37.8 (13:30)	29.7 (07:10)	31.5	0.0	2.0	83.2	9.9 (07:47)	0.00
4	29.6	34.1 (00:05)	25.5 (24:00)	35.4	0.0	3.0	135.5	11.7 (16:15)	0.00
5	19.0	25.3 (00:05)	15.2 (24:00)	46.0	0.0	4.0	102.8	12.8 (10:19)	0.00
6	18.5	23.7 (13:55)	10.3 (07:00)	46.5	0.0	2.7	89.0	9.1 (09:14)	0.00
7	22.7	27.4 (13:45)	18.0 (23:10)	42.3	0.0	2.9	108.1	14.2 (09:23)	0.00
8	22.6	29.6 (10:05)	16.0 (07:05)	42.4	0.0	2.7	92.9	14.2 (13:16)	0.00
9	24.2	31.5 (12:45)	15.7 (03:25)	40.8	0.0	2.0	88.9	10.8 (11:40)	0.00
10	27.6	35.4 (13:25)	18.5 (07:05)	37.4	0.0	2.4	103.9	12.2 (23:41)	0.00
11	27.3	37.5 (15:25)	18.0 (06:15)	37.7	0.0	2.1	91.6	10.3 (09:29)	0.00
12	35.2	46.8 (12:05)	24.8 (03:30)	29.8	0.0	2.4	73.6	11.5 (15:47)	0.00
13	36.3	39.8 (24:00)	32.5 (13:25)	28.7	0.0	15.2	229.1	26.2 (12:26)	0.01
14	35.9	51.0 (08:55)	23.3 (23:55)	29.1	0.0	9.1	113.2	28.0 (06:50)	0.81
15	23.4	30.1 (13:25)	19.6 (06:45)	41.6	0.0	4.1	103.3	12.6 (12:16)	0.00
16	23.7	30.3 (14:20)	17.1 (03:45)	41.3	0.0	3.1	92.8	11.9 (12:06)	0.00
17	31.8	42.7 (15:05)	17.9 (06:10)	33.2	0.0	2.7	45.1	14.6 (11:56)	0.00
18	31.9	36.5 (00:05)	29.4 (05:00)	33.1	0.0	1.2	88.0	6.8 (01:36)	0.00
19	27.1	36.2 (24:00)	17.4 (06:25)	37.9	0.0	4.0	83.8	14.4 (00:43)	0.00
20	46.0	59.2 (15:05)	36.3 (00:05)	19.0	0.0	3.2	42.7	11.7 (04:41)	0.00
21	42.7	49.0 (00:05)	35.2 (24:00)	22.3	0.0	2.8	128.7	12.2 (09:29)	0.04
22	42.0	56.5 (13:30)	32.8 (00:50)	23.0	0.0	2.9	67.2	11.6 (17:27)	0.09
23	35.0	39.8 (00:05)	29.4 (24:00)	30.0	0.0	5.7	113.3	18.3 (11:25)	0.00
24	33.7	44.0 (15:25)	25.0 (06:45)	31.3	0.0	3.9	109.6	13.7 (07:30)	0.00
25	35.6	42.0 (23:05)	32.9 (15:10)	29.4	0.0	5.3	278.9	20.6 (18:41)	0.72
26	37.4	42.9 (13:35)	35.0 (07:00)	27.6	0.0	3.6	141.2	12.9 (00:44)	0.00
27	38.9	47.2 (09:15)	33.3 (06:40)	26.1	0.0	2.6	3.0	10.1 (16:23)	0.00
28	38.9	44.7 (10:35)	33.7 (06:35)	26.1	0.0	3.7	133.1	14.7 (12:50)	0.00

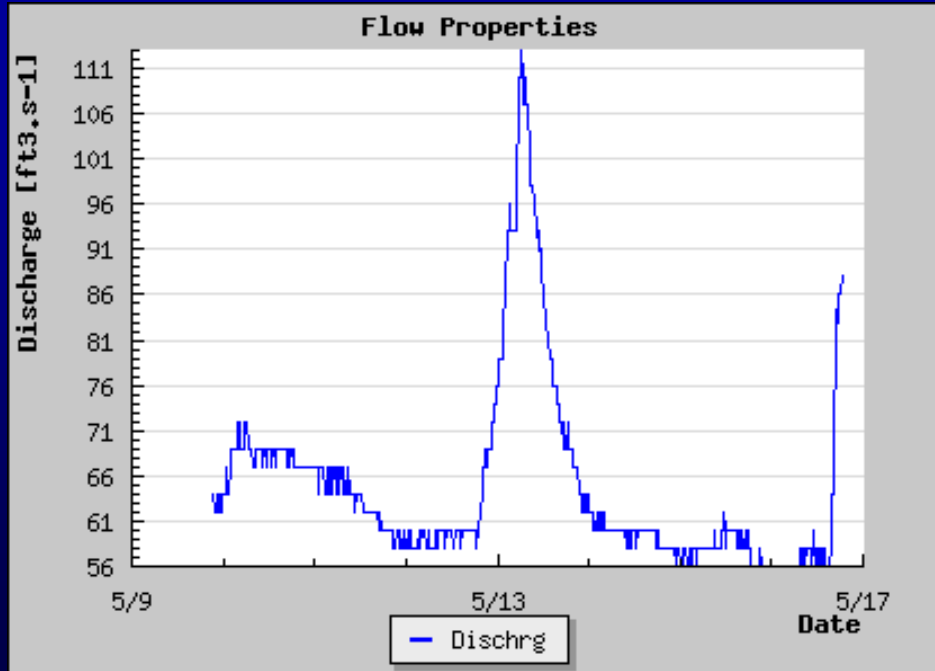
Done

Daily summary display...

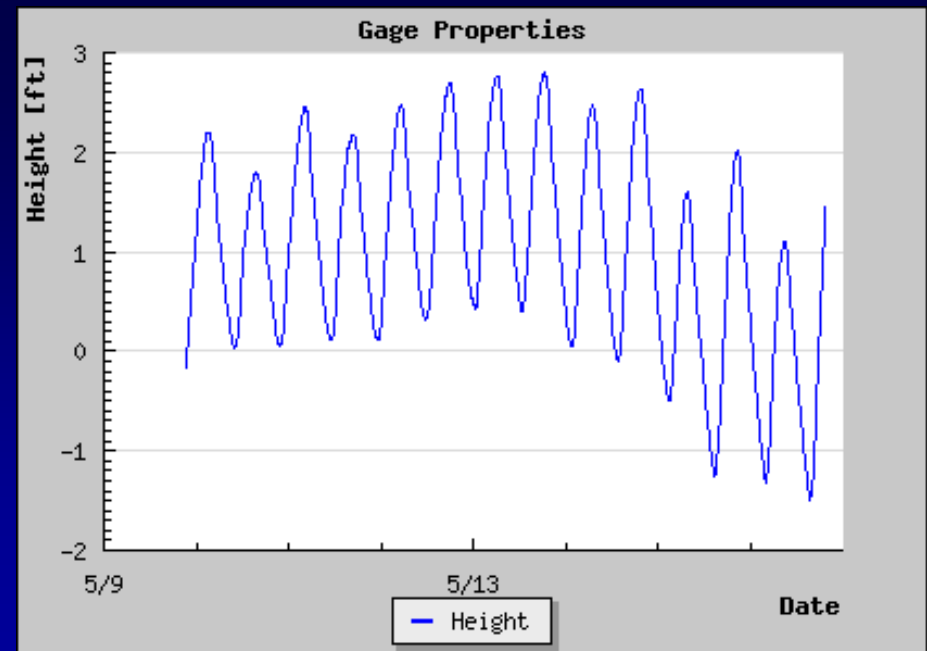
24-Hour Summary for March 2, 2007

Hour	Temp (°F)	Temp (°C)	Dew Point (°F)	Dew Point (°C)	Rel Hum. (%)	Wind Spd. (MPH)	Wind Spd. (m/s)	Wind Gust (MPH)	Wind Gust (m/s)	SLP (mbar)	Sol. Rad. (W/m ²)	Rainfall (in)	Rainfall (mm)
0	50.3	10.2	48.9	9.4	95	5.3	2.4	14.5@01:00	6.5	1008.3	5.1	0.09	2.3
1	47.9	8.8	46.1	7.8	93	9.7	4.4	17.2@01:05	7.7	1006.1	3.5	0.04	0.9
2	46.2	7.9	44.6	7.0	94	12.2	5.5	19.8@03:00	8.9	1004.0	5.4	0.02	0.6
3	46.2	7.9	45.1	7.3	96	14.7	6.6	20.5@03:05	9.2	1002.0	6.3	0.09	2.3
4	45.7	7.6	44.8	7.1	97	16.5	7.4	24.3@05:00	10.9	1000.5	6.3	0.13	3.4
5	48.6	9.2	48.0	8.9	98	12.8	5.7	19.5@05:50	8.7	999.3	4.5	0.19	4.7
6	52.3	11.3	51.3	10.7	97	10.3	4.6	19.1@06:10	8.5	998.2	8.0	0.01	0.3
7	52.4	11.3	51.0	10.6	95	12.6	5.6	25.8@07:35	11.5	996.3	22.9	0.00	0.0
8	54.4	12.4	53.1	11.7	95	8.4	3.7	26.5@08:30	11.8	995.8	41.4	0.01	0.3
9	56.0	13.3	54.7	12.6	95	5.6	2.5	12.8@09:05	5.7	995.5	94.3	0.02	0.6
10	60.4	15.8	58.2	14.6	93	3.5	1.6	10.7@10:05	4.8	995.7	417.9	0.00	0.0
11	66.1	18.9	59.7	15.4	80	4.0	1.8	8.4@11:10	3.8	996.8	345.8	0.00	0.0
12	63.5	17.5	50.5	10.3	63	4.3	1.9	9.2@12:55	4.1	998.1	558.2	0.00	0.0
13	64.1	17.8	46.5	8.1	53	4.1	1.8	8.8@13:10	3.9	998.8	545.2	0.00	0.0
14	64.7	18.1	40.0	4.4	41	3.9	1.7	7.6@14:45	3.4	999.8	495.0	0.00	0.0
15	64.8	18.2	31.5	-0.3	29	3.2	1.4	7.0@15:05	3.1	1000.6	460.8	0.00	0.0
16	63.4	17.4	22.9	-5.0	21	1.7	0.8	5.6@16:05	2.5	1001.7	224.1	0.00	0.0
17	55.0	12.8	28.8	-1.8	39	1.8	0.8	8.6@17:50	3.8	1002.5	15.0	0.00	0.0
18	44.0	6.7	39.9	4.4	86	5.2	2.3	9.4@18:15	4.2	1003.4	1.5	0.00	0.0
19	42.9	6.1	39.9	4.4	89	4.8	2.2	7.4@19:05	3.3	1004.5	3.1	0.00	0.0
20	42.6	5.9	38.7	3.7	86	0.8	0.4	4.1@20:05	1.8	1005.4	2.9	0.00	0.0
21	44.9	7.2	36.2	2.3	72	1.2	0.5	10.1@21:20	4.5	1006.3	1.1	0.00	0.0
22	47.0	8.3	28.7	-1.8	49	0.9	0.4	2.7@22:30	1.2	1007.0	0.1	0.00	0.0
23	48.7	9.3	21.6	-5.8	34	1.7	0.8	4.1@23:35	1.8	1007.0	0.1	0.00	0.0

Streamflow Data



Tidal Data



ODD-DIVAS: 01478000 Current Data - Windows Internet Explorer

http://www.deos.udel.edu/odd-divas/station_current.php?station=01478000&network=USGS-Streamflow&units=english&debug=0

Google

Go

Bookmarks

Popups okay

Check

AutoLink

AutoFill

Send to

ODD-DIVAS: 01478000 Current Data

Christina River at Coochs Bridge, DE Station

ID	01478000	Network	USGS-Streamflow
City/State	Coochs Bridge/DE		
Latitude	39° 38' N	Longitude	75° 44' W
Flood Stage	10.5 ft.	Bankfull	8.9 ft.
Updated	7:15 pm	Date	May 16, 2007

Observations

Data Type	Measurement	Time	Chart	Data
Gage Height	6.88 ft	7:15 pm		
Discharge	121 ft ³ s ⁻¹	7:15 pm		

[Change to SI units](#)

Station updates every 15 minutes

Streamflow data are provided by the USGS in real-time.
This data is preliminary and are subject to revision in accordance with USGS [policy](#).

Note: All observations were obtained from the USGS at:
<http://waterdata.usgs.gov/>

Generated by ODD-DIVAS version 2.1.1-0.

W3C HTML 4.01 ✓ W3C CSS ✓

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Please read the [Data Disclaimer](#) before using any data.
Please direct any questions or comments about this website to [webmaster](#).

Gage Height

Time	Value (ft)
05/16 19:15	6.88
05/16 19:00	6.85
05/16 18:45	6.75
05/16 18:30	6.65
05/16 17:45	6.47
05/16 17:30	5.74
05/16 16:45	4.78
05/16 16:30	4.68
05/16 16:15	4.63
05/16 16:00	4.63
05/16 15:45	4.63
05/16 15:30	4.63
05/16 15:15	4.63
05/16 15:00	4.63
05/16 14:30	4.62
05/16 14:00	4.62
05/16 13:30	4.61
05/16 13:15	4.61
05/16 13:00	4.61
05/16 12:45	4.61
05/16 12:30	4.60
05/16 12:15	4.60
05/16 11:45	4.60
05/16 11:30	4.60
05/16 11:15	4.60
05/16 10:30	4.60

Internet 100%

start Removable Disk... Microsoft Power... 4 Internet Ex... Turbosnap Search with G... 9:10 PM

DEOS Database Control Facility

The DEOS Database Control Facility (DCF) allows users and administrators the ability to view the current status of the network, and set event-triggered alerts. These alerts are user-defined and send e-mails and text messages when exception conditions have been detected.

DEOS Database Control Facility

Username:

Password:



Welcome back, legates!

05/15 8:08:03 A.M.

[Glossary](#)

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[View](#)

[Stations](#)
[View](#)

[Support Settings](#)

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[View](#)

[Unit Types](#)
[View](#)

[Field Types](#)
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Alert Information

Items in **bold** are required.

Description

Heavy Rainfall at Porter

Data Type

0 Radar Precipitation (60) (mm.hr-1)
1 Gage Precipitation (60) (mm.hr-1)
2 Air Temperature (K)
3 Dew Point Temperature (K)
4 Wind Speed (m.s-1)

Comparison

☒ Greater Than ☐ Less Than

Limit Value

75

Station

DLWG (DEOS)
DMRJ (DEOS)
DPTR (DEOS)
DSCR (DEOS)
DSJR (DEOS)

Time Limit

30 mins

Duration

0 mins

[Submit](#) [Reset](#)



Spatial Meteorological Analysis in Real-Time System (SMARTS)

Spatial interpolation of station data products utilizes an interpolating function that:

- ◆ makes little or no *a priori* assumptions about the structure of the variable,
- ◆ is adaptable to different variables,
- ◆ suitable for fields with high spatial variability,
- ◆ can be modified to include elevational gradients and known physical properties,
- ◆ is computationally efficient, and
- ◆ provides an estimate of its efficiency and allows for parameter optimization using a Jackknife approach.

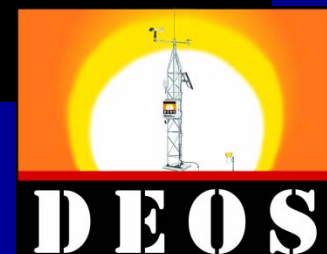
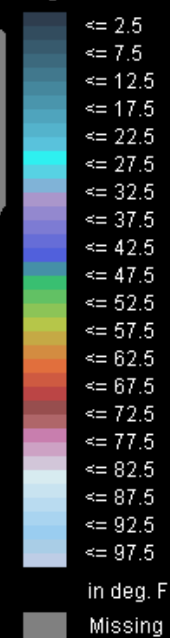
Air Temperature @ 6 AM

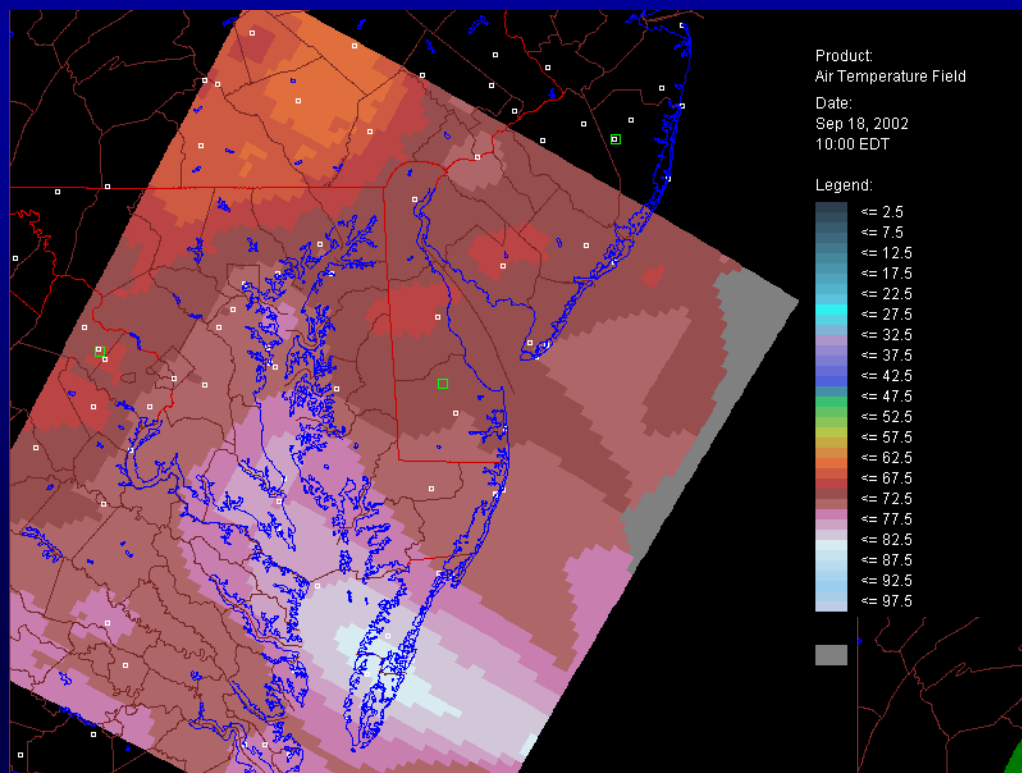
• Bethany Beach	53.7°F
• Blackbird	58.2°F
• Dover AFB	58.0°F
• Georgetown AP	58.0°F
• Kitts Hummock	53.6°F
• London Grove	54.1°F
• Longwood Gardens	55.7°F
• Newark	56.7°F
• Wilmington AP	54.9°F
• Wilmington Porter Res.	55.6°F



Product:
Air Temperature Field
Processing date:
Feb 20, 2002
16:01 EST

Legend:





Air Temperature

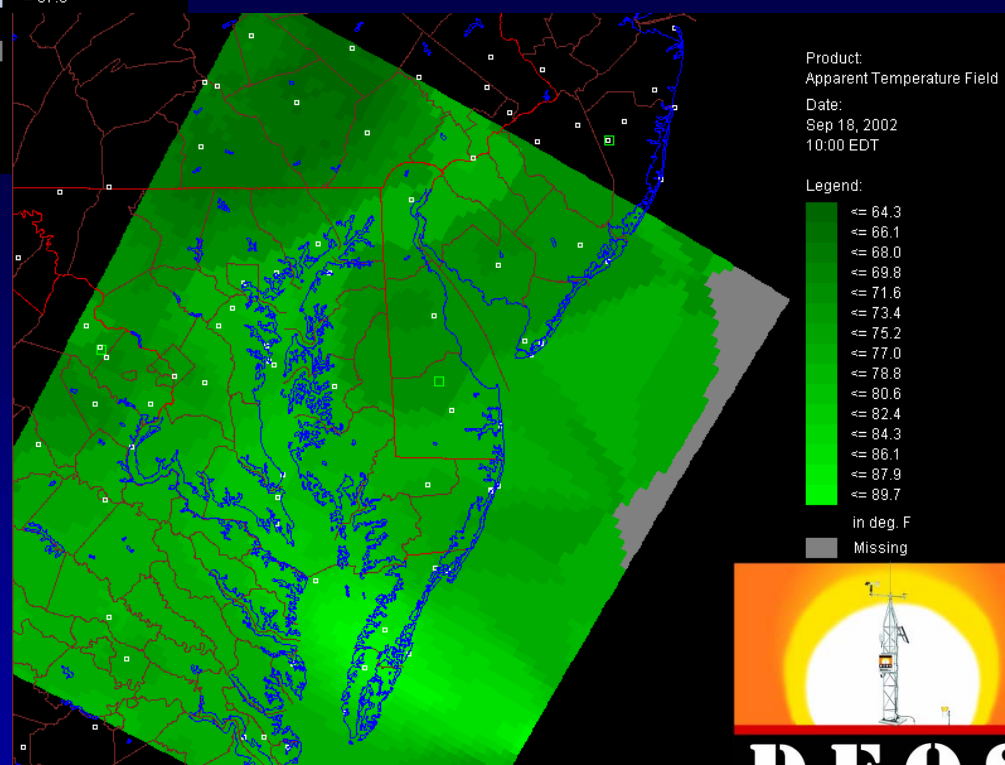
0.02° X 0.02°

Resolution

(≈ 2km x 2km)

Some Example Products

Apparent Temperature



DEOS

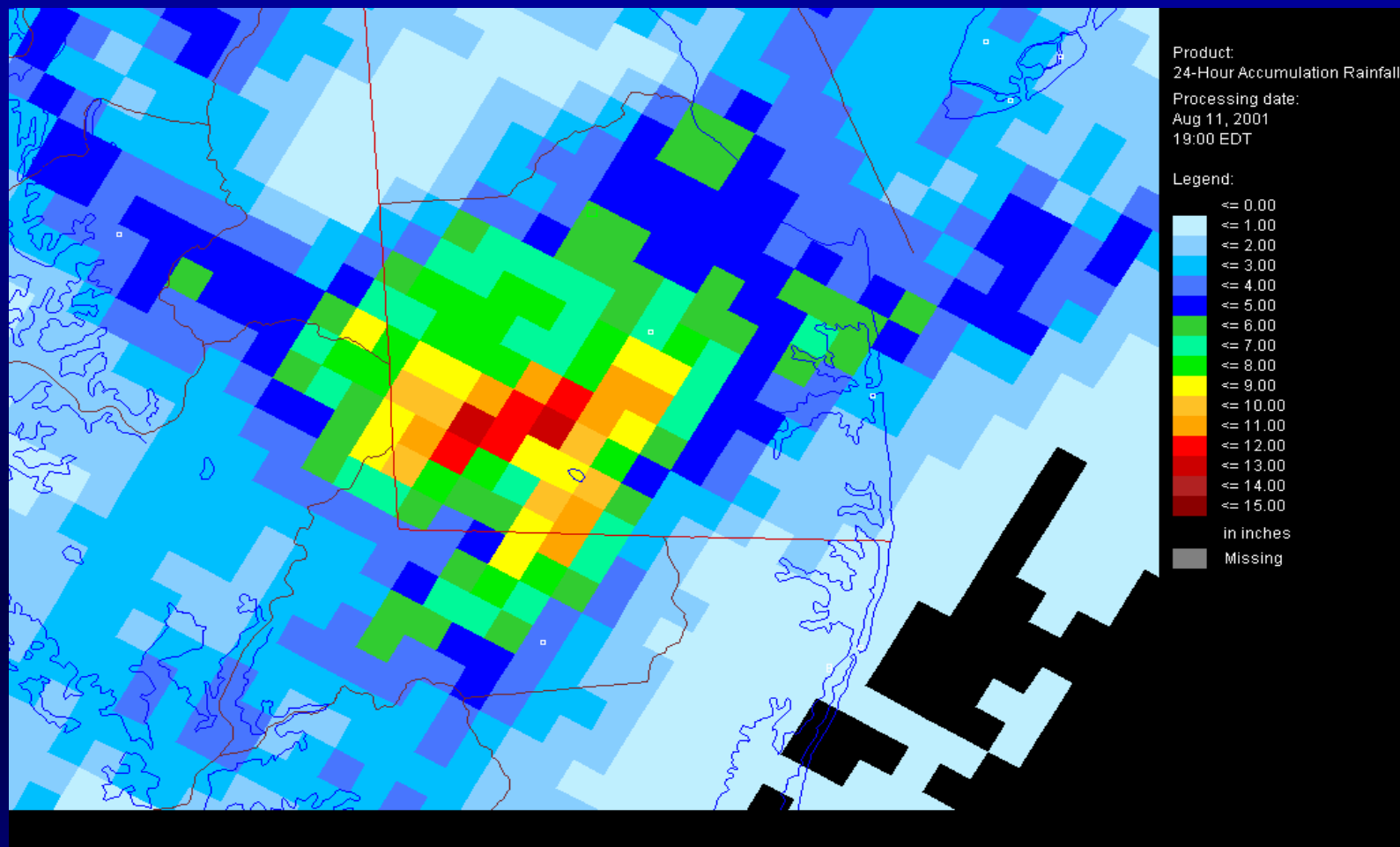


WSR-88D Weather Radars (NEXRAD)

10 cm wavelength

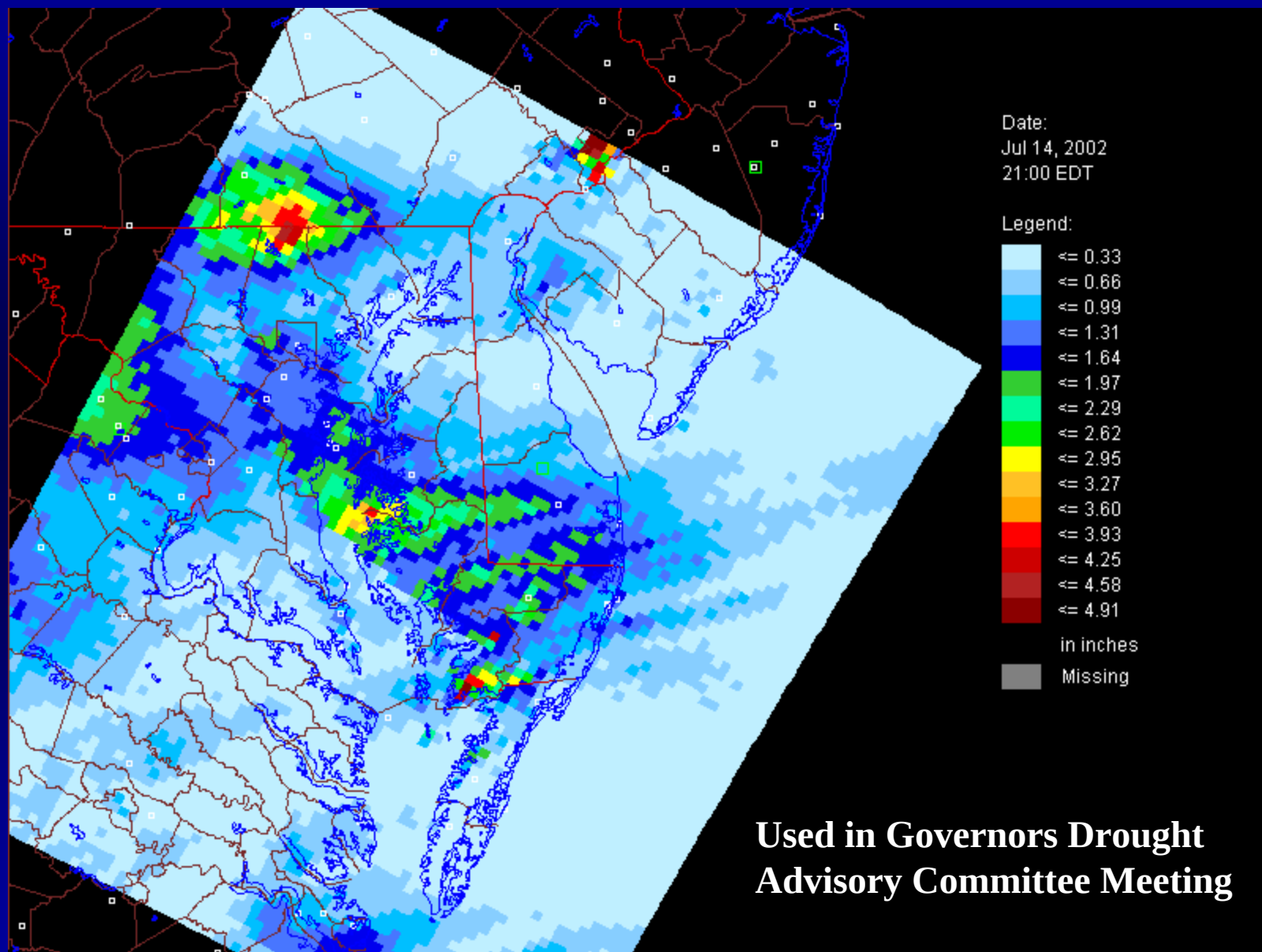
**Ellendale Forest (DAFB)
Delaware**

**Also radars located at
Manchester NJ, Sterling
VA, and Wakefield VA.**



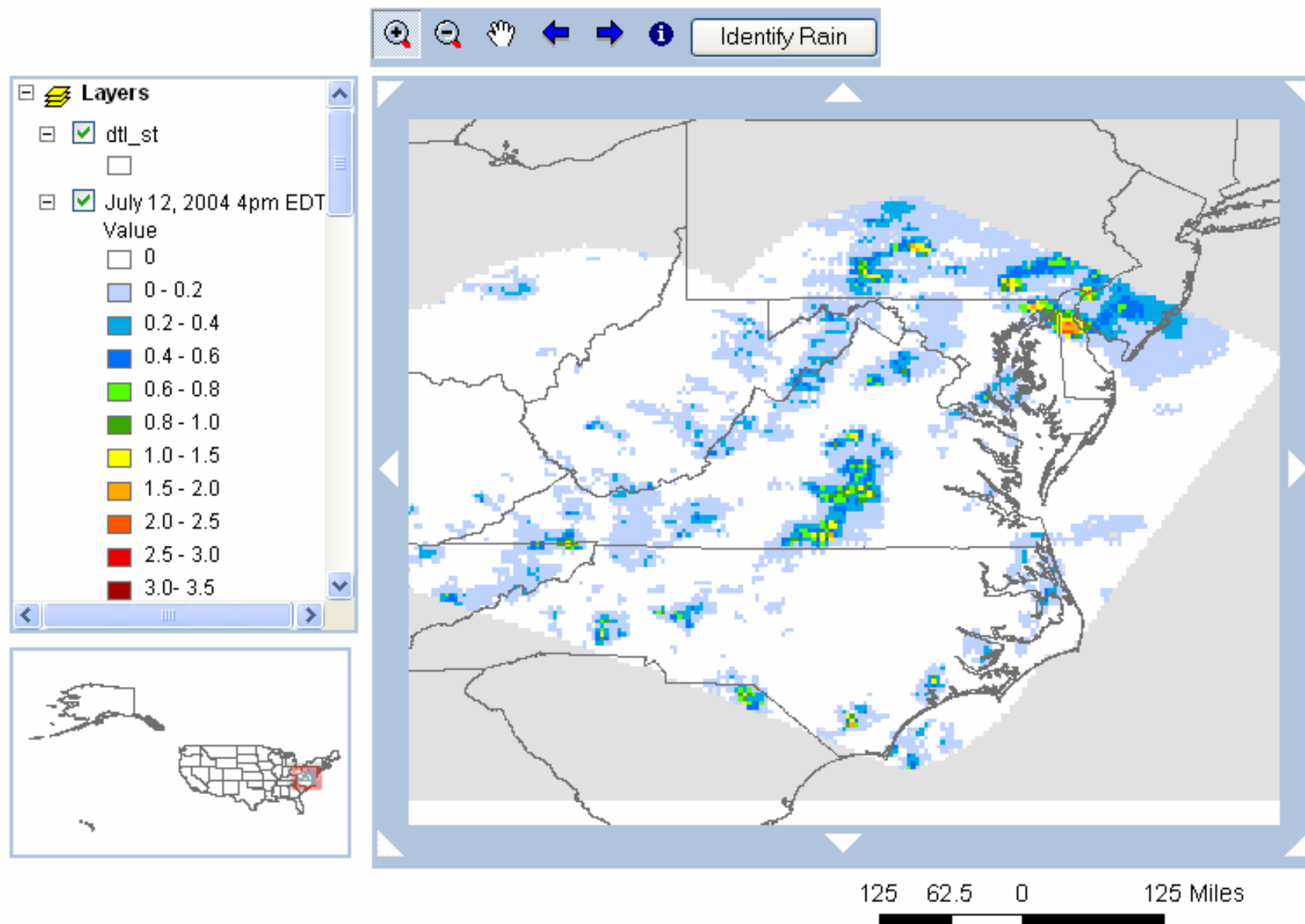
Twenty-four hour precipitation total for central Delmarva on August 11, 2001 at 7PM EDT. This corresponds to the time that a dam at Hearn's Pond near Seaford failed due to excessive rainfall. Rainfall estimates in some locations exceeded 14 inches, although the official gage at Georgetown airport measured less than 5 inches. Note the high spatial variability in rainfall.

Monthly Accumulated Rainfall, July 13, 2002



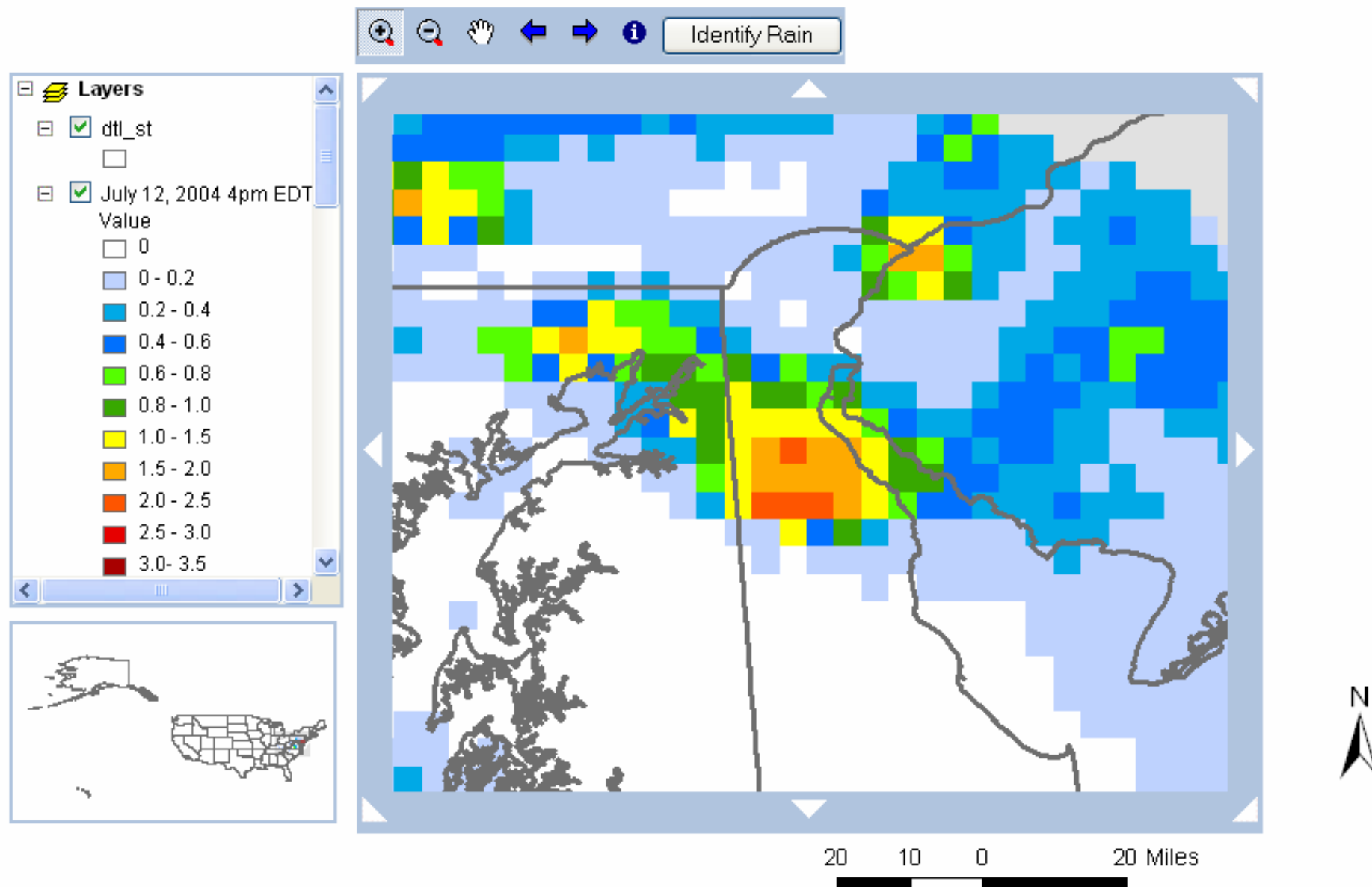


Map Viewer





Map Viewer



Delaware Environmental Observing System

**The combination of the DEMON and the
DIVAS make possible a number of Decision
Support Systems**

**Flooding of Land Under Storm and
Surge – (DAS-FLUSS)**

**Delaware Green Energy Project
Agriculture Weather Page**



The Delaware Environmental Observing System



A Real-Time System Dedicated to
Monitoring Environmental Conditions
Across Delaware

www.deos.udel.edu

DEWOOS

**Delaware Estuary-to-
Watershed-to-Ocean
Observing System**

DEWOOS

- An integrated watershed and coastal environmental system that can be applied to a variety of watersheds across the nation.
- Demonstrate how a cooperative regional monitoring system can be linked to and enhance the National Water Quality Monitoring Network (NWQMN).
- Based on DEOS, which uses an Oracle® Database and ESRI's ArcGIS Server 9.2®.

DEWOOS

Four data type platforms:

- Standard 'station-based' data where an observing platform remains in a fixed position and records data on a regular basis (DEOS-type stations).
- Research-specific measurements taken for a short time period. Data are probably not available in real-time but may be of interest to researchers and data managers for event analysis.

DEWOOS

Four data type platforms:

- Lagrangian observations from observing platforms that move, either by self-propulsion or drift with the currents. Ferry (e.g., Cape May-Lewes Ferry) or bus/truck (e.g., DelDOT) platforms can be used to provide data for transects across water or land areas. Ship surveys of the Delaware River and Bay provide transient data of water conditions at the time of the ship transect. Unmanned submersibles have also been used to provide assessments of the vertical and spatial structure of the Delaware Bay.

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Four data type platforms:

- Gridded data acquired by remote sensing technology and spatial interpolation methodologies. Weather radar, satellite platforms (in both geostationary and low-Earth orbits), and HF-Radar scanning the water surface provide a highly detailed spatial structure to the field they measure. These data can supplement observations and provide spatial fidelity that cannot be obtained through ground-based measurements. Similarly, sophisticated spatial interpolation techniques which use GIS-enhanced methods can provide a clearer spatial picture of various fields measured at a number of locations (e.g., air or water temperature).

WEMAS: Watershed Environmental Monitoring and Analysis System - Mozilla Firefox

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Watershed Environmental Monitoring and Analysis System (WEMAS)

DEOS | DRBC | MACOORA



WEMAS - Watershed Environmental Monitoring and Analysis System

WEMAS is a prototype developed by the Delaware Environmental Observing System (DEOS) to demonstrate the potential for a regional data management and visualization system for the Delaware River Basin. To this end, WEMAS provides a web-based GIS interface to real-time environmental data throughout the basin. Initially, data will include US Geological Survey streamflow and water quality data, National Weather Service meteorological data, and DEOS meteorological data.

The Delaware River Basin

The Delaware is the longest un-dammed river east of the Mississippi, extending 330 miles from the confluence of its East and West branches at Hancock, N.Y. to the mouth of the Delaware Bay where it meets the Atlantic Ocean. The river is fed by 216 tributaries, the largest being the Schuylkill and Lehigh Rivers in Pennsylvania. In all, the basin contains 13,539 square miles, draining parts of Pennsylvania, New Jersey, New York, and Delaware. Included in the total area number is the 782 square-mile Delaware Bay, which lies roughly half in New Jersey and half in Delaware.



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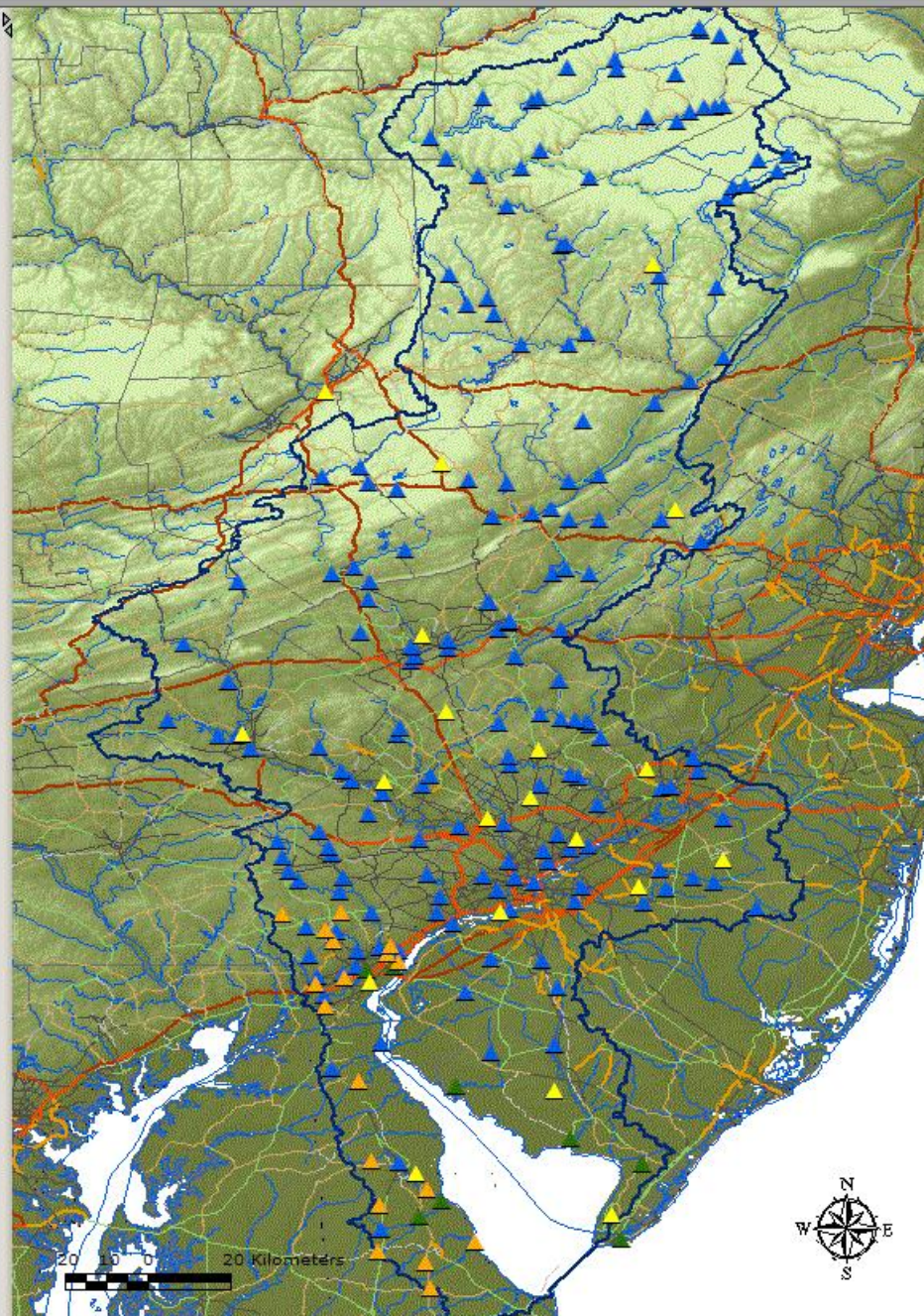
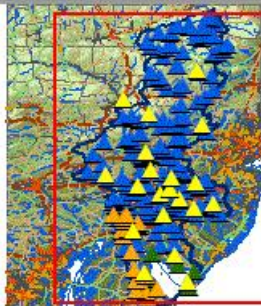
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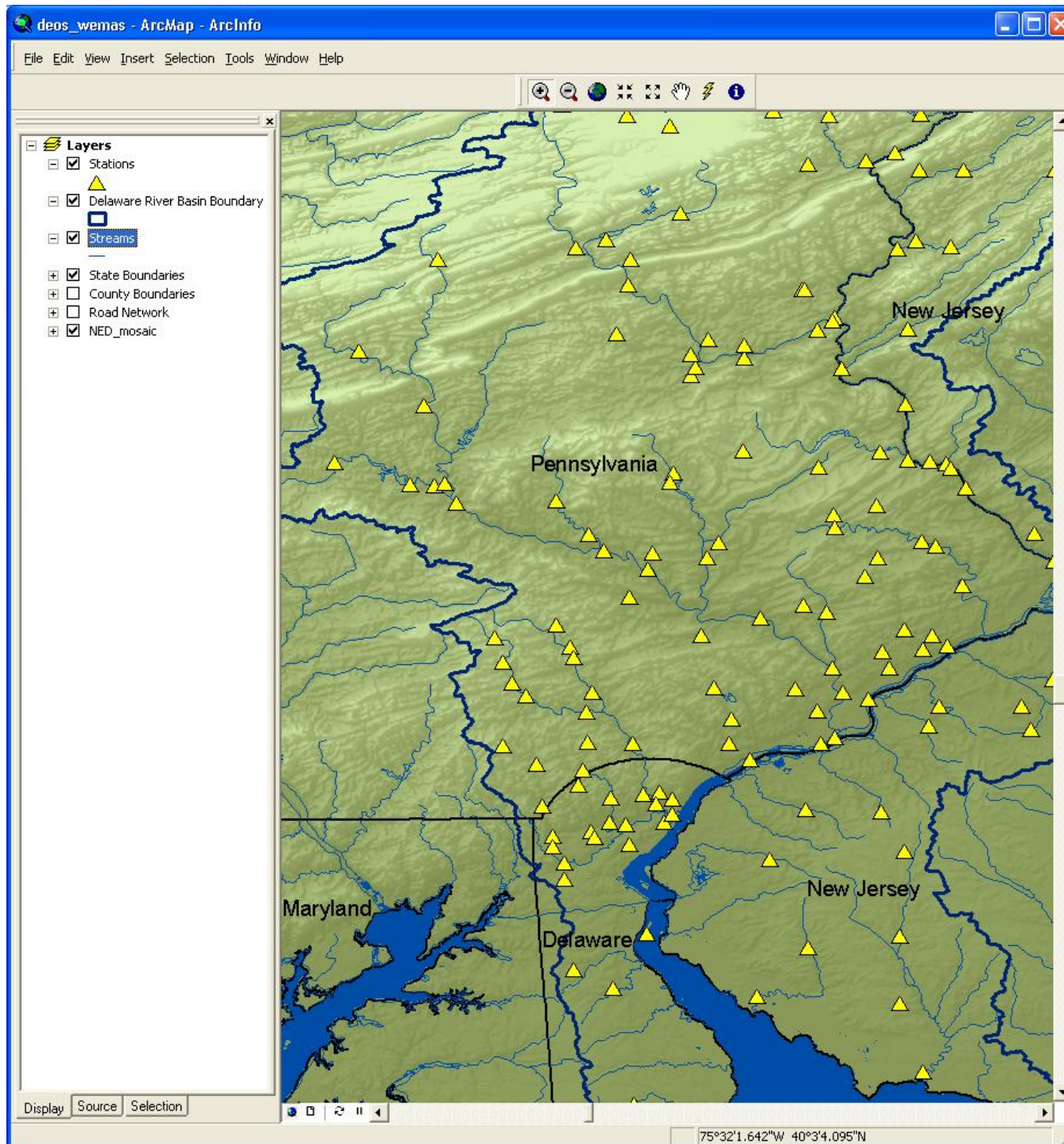
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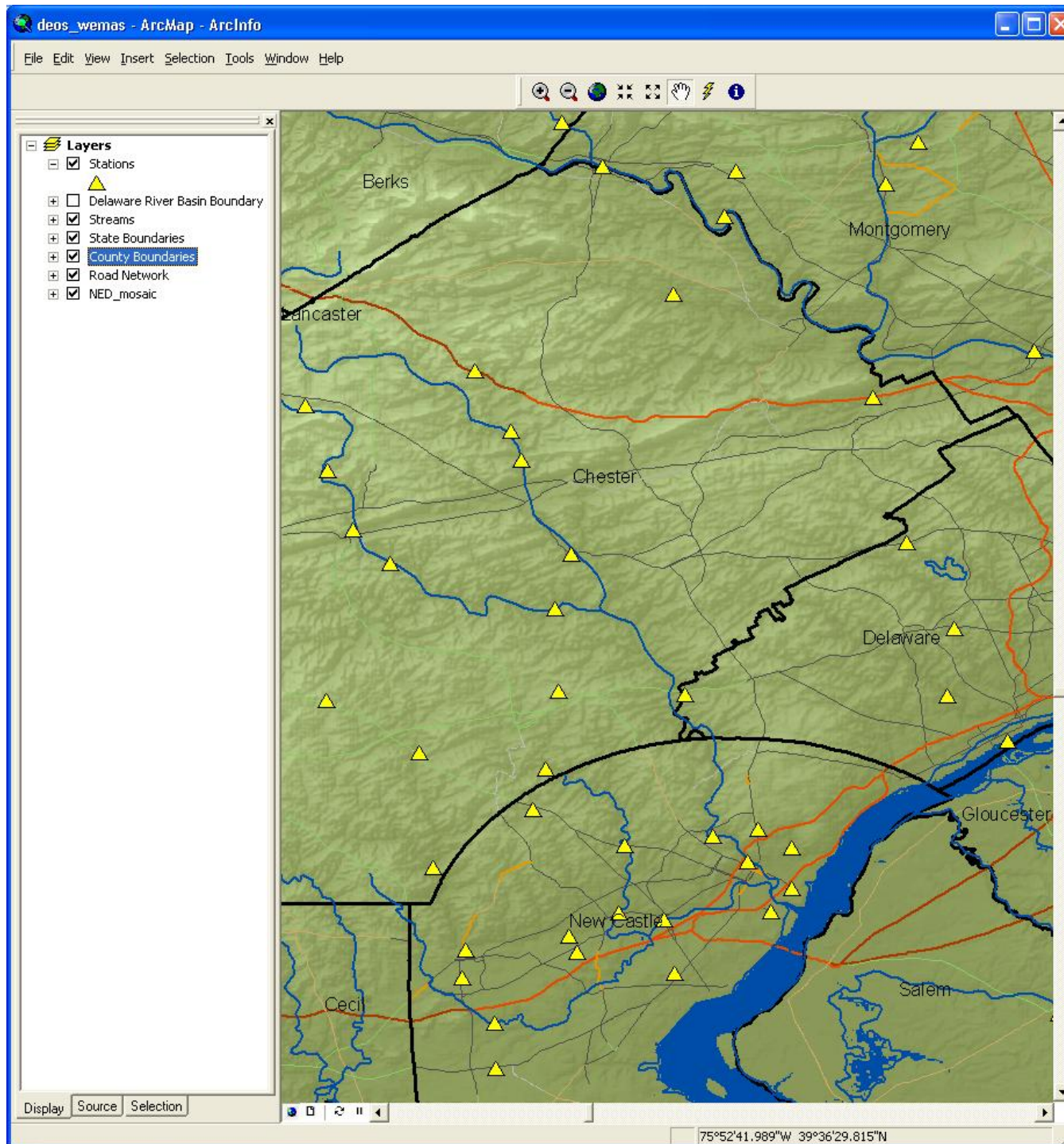
DEWOOS Web Mapping Application

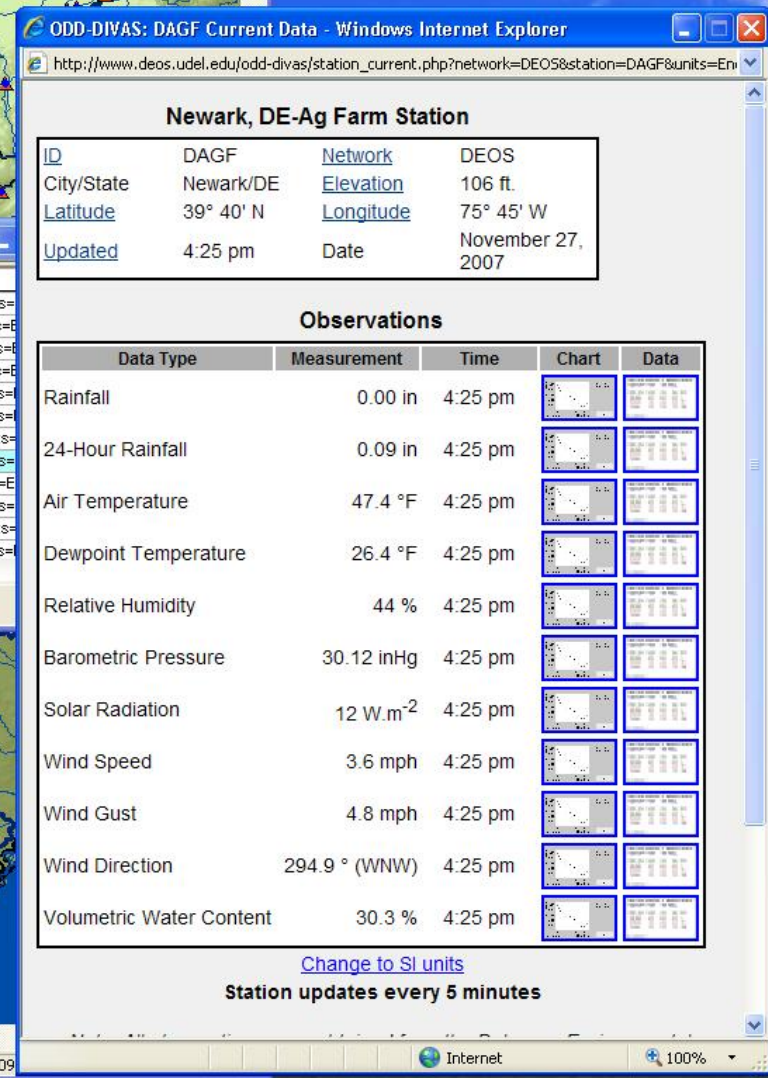
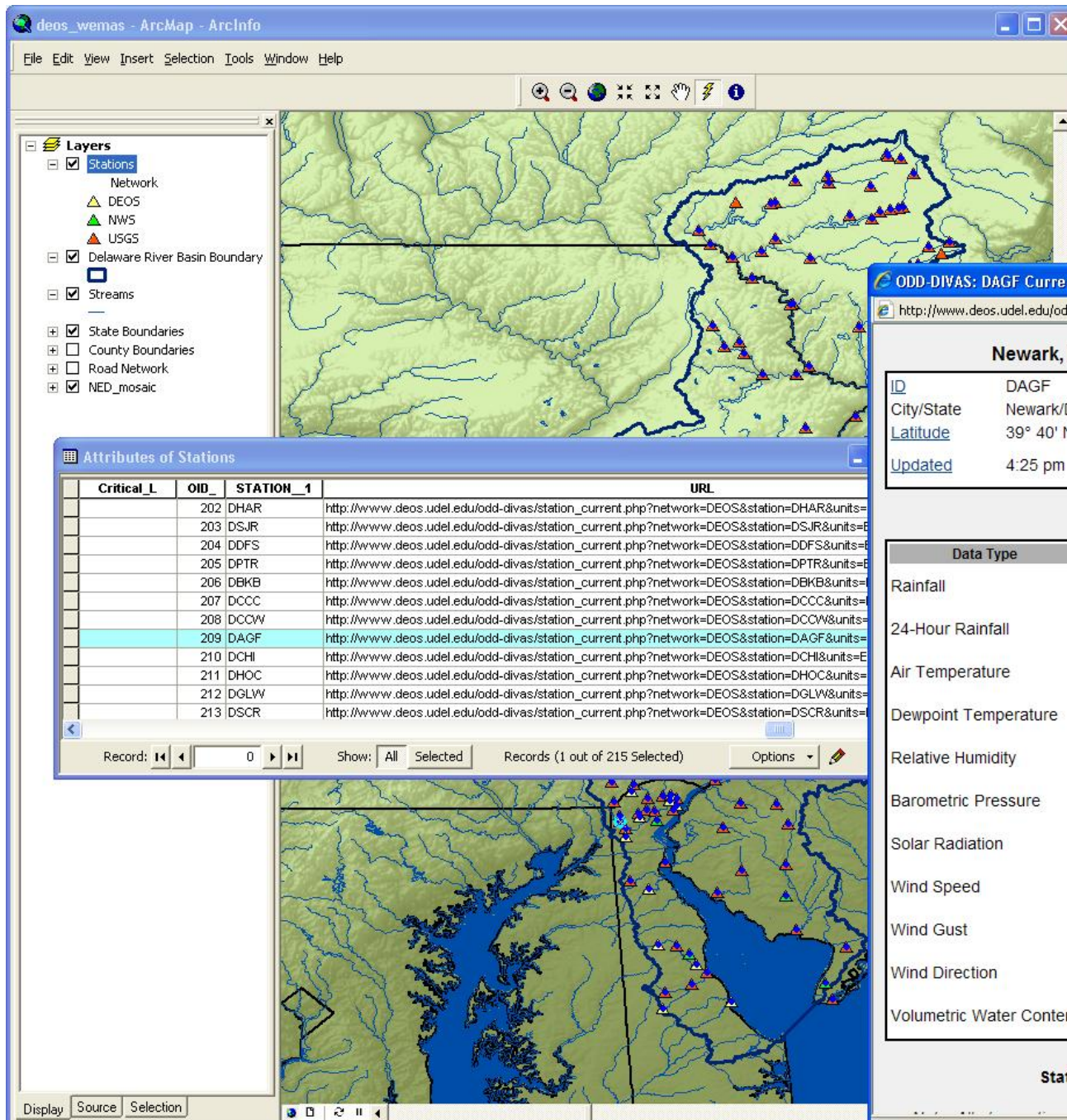


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WEMAS/DEWOOS

A WATERSHED ENVIRONMENTAL MONITORING AND ANALYSIS SYSTEM FOR THE DELAWARE RIVER/BAY SYSTEM

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