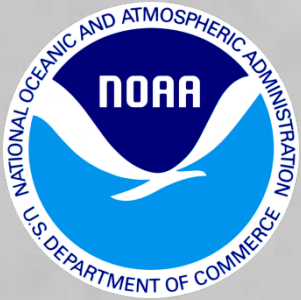


Meteorological Conditions Conducive to Flooding in Indiana and Using a Volunteer Network of Observers to Monitor Precipitation

**Sam Lashley
National Weather Service
Northern Indiana Office**

Sam.Lashley@noaa.gov

<http://www.weather.gov/iwx>



National Weather Service



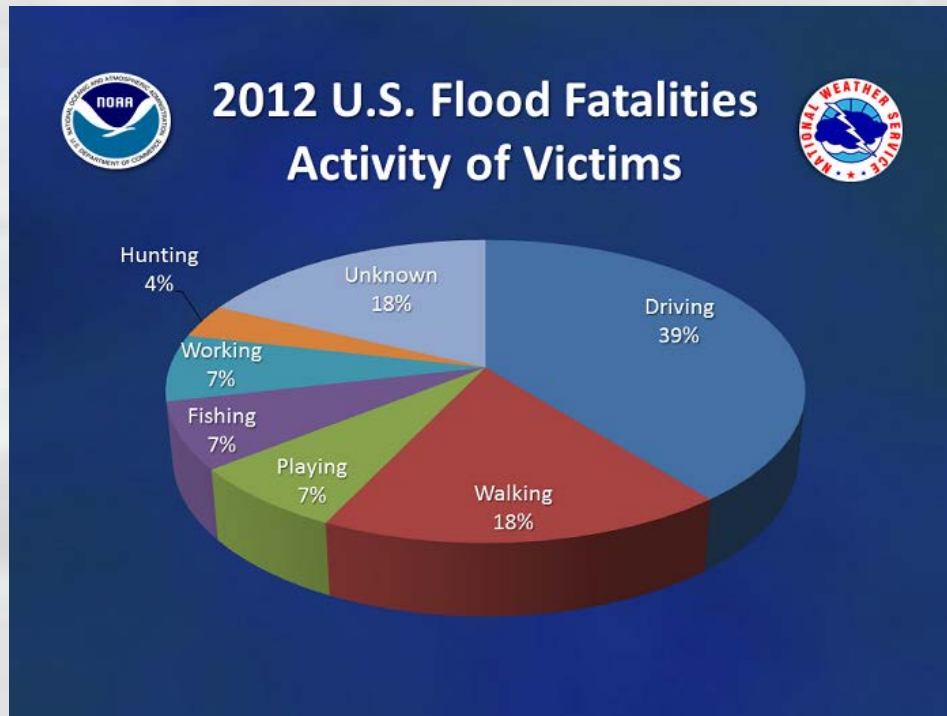
- **The National Weather Service** is a component of the National Oceanic and Atmospheric Administration (NOAA). NOAA is an Operating Unit of the U.S. Department of Commerce.
- **Our Mission** - Provide weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.
- **Our Vision** - A Weather-Ready Nation: Society is Prepared for and Responds to Weather-Dependent Events

<http://www.weather.gov/>



Flooding is Costly and Deadly

- Floods are the #1 natural disaster in the United States
- From 2003 to 2012, total flood insurance claims averaged nearly \$4 billion per year





Factors Affecting Flooding Potential



- Soil type
- Vegetation
- Land use
- Slope of terrain (FF) / channel depth and width (River)
- Meteorological/hydrological and antecedent conditions
 - Heavy and/or prolonged rainfall
 - Deep and/or melting snowpack
 - Frozen ground
 - River and stream levels
 - Saturated ground
 - Drought conditions/dry and hard ground

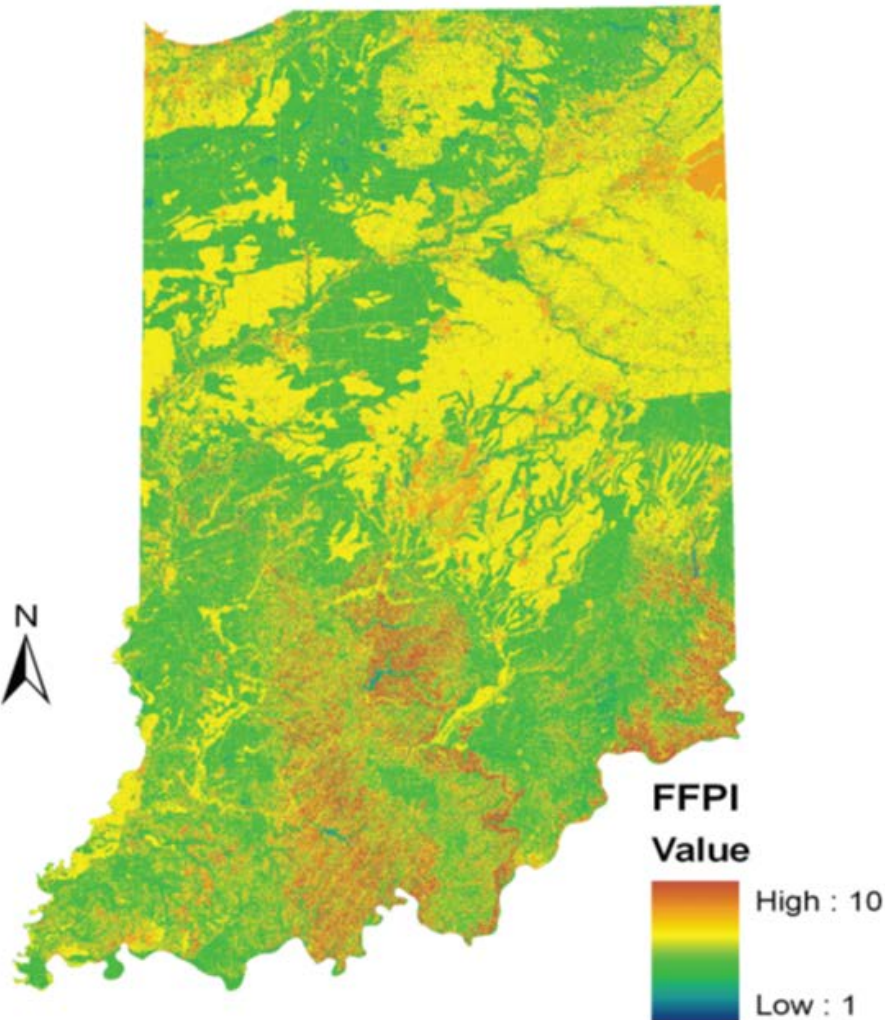




Flash Flood Potential Index



FFPI



The Flash Flood Potential Index (FFPI) was developed to study the effect of Indiana's diverse geography on flash flood likelihood. Factors that affect flash flood potential include:

1. Slope of terrain – how quickly runoff occurs
2. Soil type – Less penetrable soil types will increase flash flood potential
3. Land use – Impervious surfaces (streets, urban areas) will increase flash flood probability
4. Tree cover (forest canopy) – more dense forests will slow rainfall runoff

In December 2010, the NWS Ohio River Forecast Center unveiled a Flash Flood Monitoring Program (FFMP) which incorporated many of these FFPI concepts to previously used flash flood guidance.



Most Common Forms of Flooding in Indiana



- Flash Floods – A flood caused by heavy rain/snow melt, ice jam or dam failure in a short period of time, usually 6 hours or less.
- River/Stream Flooding – Inundation of normally dry areas caused by rising water in an existing waterway. Flooding is longer duration, usually days or weeks.
 - Many record river flood events occur in winter and early Spring and are often due to snow melt and heavy rainfall



Top 5 Flooding Events by River

Through Fall 2013



- St. Joseph (IN/MI)

- 3/8/1908
- 1/6/1993
- 3/21/1982
- 4/5/1950
- 2/24/1985

- Maumee

- 3/26/1913
- 3/17/1982
- 2/27/1985
- 1/1/1991
- 3/24/1978

- Wabash

- 3/26/1913
- 1/1/1750
- 5/18/1943
- 5/3/2011
- 2/17/1883

- White

- 3/25/1913
- 8/3/1875
- 7/10/2003
- 9/1/2003
- 1/15/1937
- 2/1/1916

- East Fork White

- 3/26/1913
- 1/24/1937
- 1/9/2005
- 6/8/2008
- 1/5/1949

- Ohio

- 1/26/1937
- 3/8/1945
- 4/1/1913
- 3/13/1964
- 2/16/1884

13 Records in Winter Months (Dec-Feb)

14 Records in Spring Months (Mar-May)

3 Records in Summer Months (Jun-Aug)

1 Record in Fall Months (Sep-Nov)

18 Records up to 1950

13 Records after 1950



Different Types of Meteorological Events Can Lead to Flooding in Indiana



1. Slow moving thunderstorms with heavy rainfall
2. “Training” Thunderstorms
3. Snow Melt with or without heavy rain
4. Tropical Systems





Importance of Tropical Storms to Indiana Precipitation 1980-2012



The following storms contributed to greater than 50% of the total observed precipitation in the listed climate division during the month of storm passage.

- Erin 1995. Climate Divisions 6, 8, and 9
- Isidore 2002. Climate Divisions 6, 8, and 9
- Ivan 2004: Climate Division 6
- Arlene 2005: Climate Divisions 4, 5, 7, 8, 9
- Katrina 2005: Climate Divisions 5, 6, 7, 8, 9
- Gustav and Ike 2008 (combined storm totals greater than 50% of Sept. 2008 precip. (Over 10 inches in 2 days at SBN): CDs 1, 2, 3, 4
- Isaac 2012: Climate Division 1.



Courtesy of Olivia Kellner
Ph.D. Student, Purdue University
Department of Earth, Atmospheric, and Planetary Sciences
Climate Specialist and Forecaster, Indiana State Climate Office
okellner@purdue.edu



Importance of Tropical Storms to Indiana Precipitation 1980-2012



The following storms **prevented drought conditions** (analyzed at climate division level with drought based on 15% below normal... PDSI conditions) for the month of their passage through the state.

- Elena 1985
- Gilbert 1988
- Erin and Opal 1995 (Southern 2/3 climate divisions)
- Lili and Isador 2002 (northern 2/3 climate divisions)
- Ivan 2004
- Arlene 2005
- Katrina 2005 (central and eastern climate divisions)
- Gustave and Fay 2008
- Hermine 2012



Courtesy of Olivia Kellner
Ph.D. Student, Purdue University
Department of Earth, Atmospheric, and Planetary Sciences
Climate Specialist and Forecaster, Indiana State Climate Office
okellner@purdue.edu



NWS Information

http://www.weather.gov/



National Weather Service
Advanced Hydrologic Prediction Service

Weather Forecast Office Northern Indiana, IN North Central River Forecast Center

Home News Organization

Local weather forecast by "City, ST"

National Conditions: Rivers, Satellite, Climate, Observed Precip

Local Conditions: Warnings, Weather Forecast Radar

AHPS Documentation: User Guide, User Brochure

What is AHPS?: Facts, Our Partners

Feedback/Questions: Provide Feedback, Ask Questions

Observations courtesy of

TRAIL CREEK AT MICHIGAN CITY
Universal Time (UTC)

21 Z	21 Z	21 Z	21 Z	21 Z	21 Z	21 Z	21 Z	21 Z	21 Z	21 Z
Feb 20	Feb 21	Feb 22	Feb 23	Feb 24	Feb 25	Feb 26	Feb 27	Feb 28	Mar 1	Mar 2

Stage (ft) vs Flow (cfs) graph showing observed values and forecasts. Latest observed value: 2.44 ft at 3:30 PM EST 2-Mar-2014. Another point is marked at 5.75 ft.

Site Time (EST)

TCRI3(plotting HGIRG) "Gage 0" Datum: n/a Observations courtesy of US Geological Survey

Printable Image, About this graph, Tabular Data, XML, RSS, Datum: Not Available, Metadata

NOTE: Forecasts are not available for the Trail Creek at Michigan City. Only observed stages are available for this point.

Return to Area Map

Flood Categories (in feet)
Not Available

Historical Crests
Currently none available.

Low Water Records
Currently none available.



NWS Details Behind Forecast



http://www.weather.gov/

FXUS63 KIWX 080928

AFDIWX

AREA FORECAST DISCUSSION

NATIONAL WEATHER SERVICE NORTHERN INDIANA

427 AM EST TUE JAN 8 2008

.SHORT TERM...

...SIGNIFICANT FLOODING/RIVER FLOODING ACRS NW/NRN INDIANA...

WIDESPREAD FLOOD EVENT IN PROGRESS THIS MORNING AS JULY LIKE STG LL

MSTR FEED CONTS TO IMPINGE INTO COMPOSITE STATIONARY FNTL

BNDRY/CONVECTIVE OUTFLOW OVR NRN INDIANA. SITUATION BAD ALREADY BUT

LOOKS TO GET WORSE AHD OF SECONDARY SFC FNTL WAVE LIFTING OUT OF WRN

MO AND EVEN STRONGER LL MSTR TRANSPORT DVLPNG THROUGH THIS MORNING.

88-D PRECIP ESTIMATES LOOK PRETTY GOOD LINED UP W/GROUND TRUTH

REPORTS SO FAR AND REALLY HIGHLITE NWRN CWA AT MOST RISK. CURRENT

FFA HEADLINE DELINEATION SPOT ON AND WILL BE LEFT ALONE. WILL

THOUGH...GIVEN SHRT TERM MESOSCALE ANALYSIS AND RUC 13

OUTPUT...AUGMENT DY1 QPF MUCH HIGHER. DEEPENING SFC LOW PASSING NW

OF CWA AND RAMPING LL FLW MAY OVERWHELM CURRENT CONVECTIVE BUBBLE

HIGH AND RESULT IN NWD PUSH OF MOST ACTIVE CONVECTION TWD DAYBREAK

AND BORN OUT PER WOLCOTT PROFILER ALTHOUGH EVERYONE WILL SEE HEAVY

RAIN THROUGH THE MORNING WITHIN EXTENSIVE STRATIFORM/EMBEDDED

CONVECTION NORTH OF TRAINING NR SFC BASED CONVECTIVE LINE. PENDING

HOW CONVECTION FURTHER EVOLVES THROUGH THIS MORNING...MAJOR FLOODING

PSBL IN THE KANKAKEE BASIN ESP WITHIN THE UPSTREAM PORTION OF THE

YELLOW RIVER AND ALONG THE KANKAKEE RIVER GIVEN WIDESPREAD 2-3

INCHES WHICH HAD FALLEN OVERNIGHT AND CONSENSUS QPF SOLUTIONS

SHOWING 2-3 INCHES MORE THROUGH THIS AFTN. REMINGTON INDIANA ALREADY

NEARING 5 INCHES.

National Weather Service Weather Forecast Office
Northern Indiana

Home Site Map News Organization Search for: [] NWS All NOAA

Top News of the Day
 Weather Observer search in St. Joe, IN
 Weather observer search in Wabash, IN
 Want to Become a Skywarn Spotter - Free Online Training!

Watches & Warnings Observations Forecast Graphics Rivers & Lakes Climate Marine

Click on the map below for the latest forecast.

Read watches, warnings & advisories
 Zoom Out
 Special Weather Statement
 Hazardous Weather Outlook

Last map update: Thu, Aug 29, 2013 at 11:06:27 am EDT

Weather Story Radar Satellite Weather Map

Quick Access to Text Products
 Choose Product [] Display

South Bend KSRN Current 31 Day Period
 Observed Normal Forecast
 90
 70
 50
 30
 August 2013

Precip Mapping
 Click Here for Daily Precip and Snowfall Maps

Fort Wayne KFVA Current 31 Day Period
 Observed Normal Forecast
 92
 75
 57
 40
 August 2013



Indiana Precipitation Project



- Joint Project between Indiana State Climate Office and NWS Northern Indiana
 - Sam Lashley – NWS Senior Meteorologist
 - Steven Chun – Purdue Student Researcher
 - Dev Niyogi – Indiana State Climatologist
- Studying hourly precipitation observations between May and October
 - 62 years of data from 1950 to 2012
 - Data being broken down into 4 daily periods
- 4 Indiana cities selected
 - South Bend
 - Fort Wayne
 - Indianapolis
 - Evansville
- Work in progress, some interesting preliminary findings

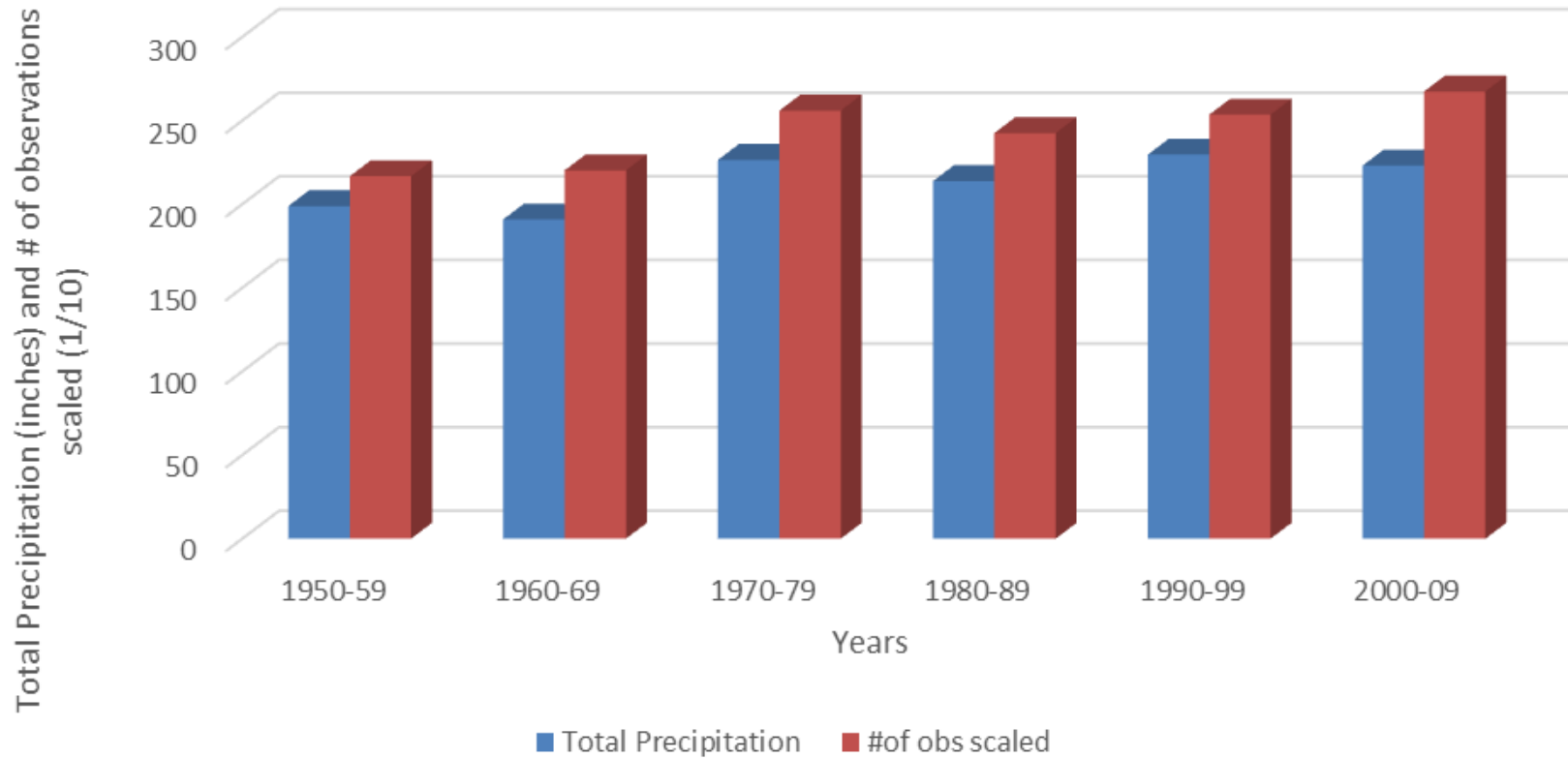


South Bend, IN

Hourly Observations
May - October



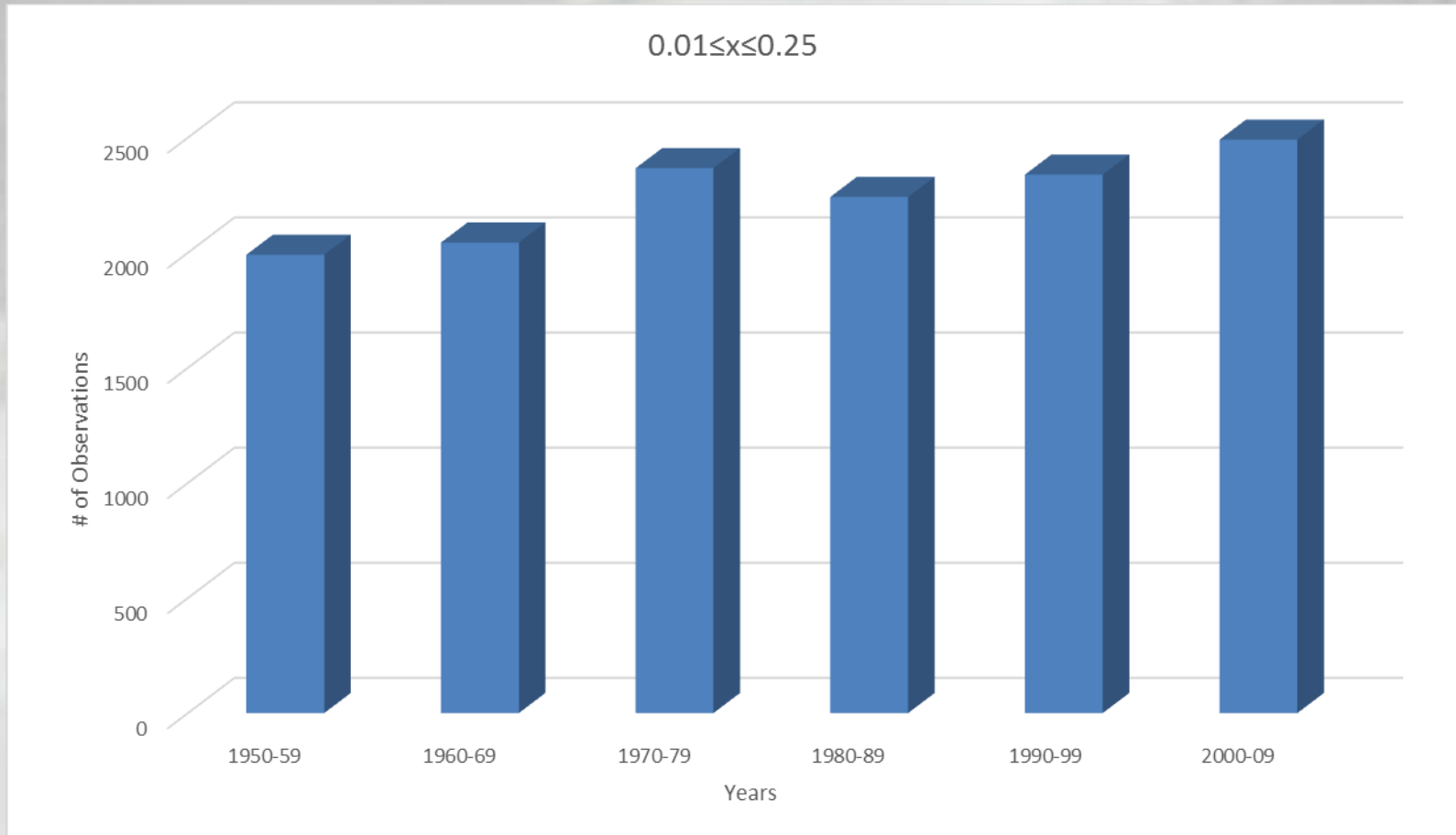
Total Precipitation vs # of Observations(scaled 1/10)





South Bend, IN

Hourly Observations
May - October



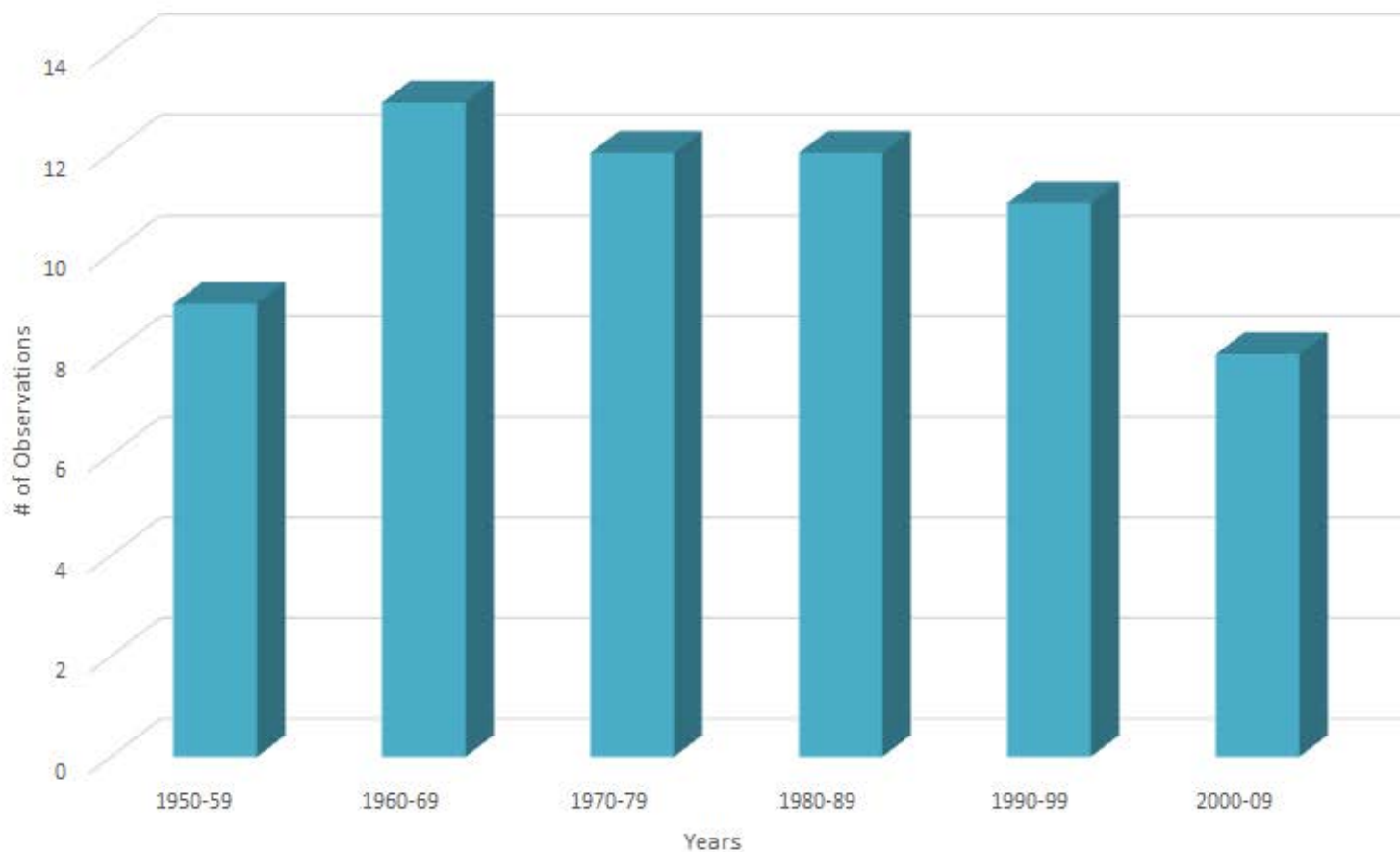


South Bend, IN



Hourly Observations
May - October

$1.00 < x \leq 2.00$

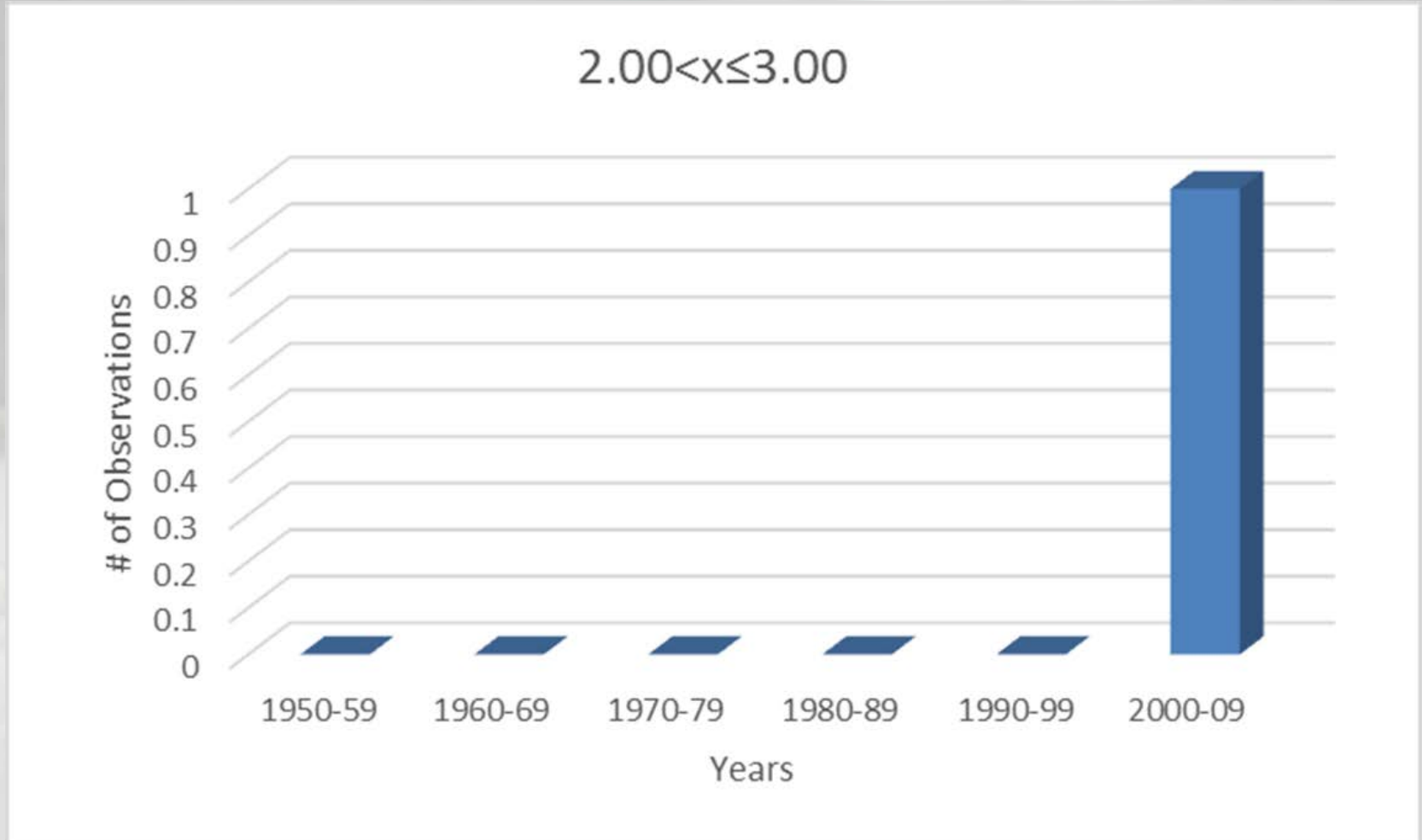




South Bend, IN



Hourly Observations
May - October





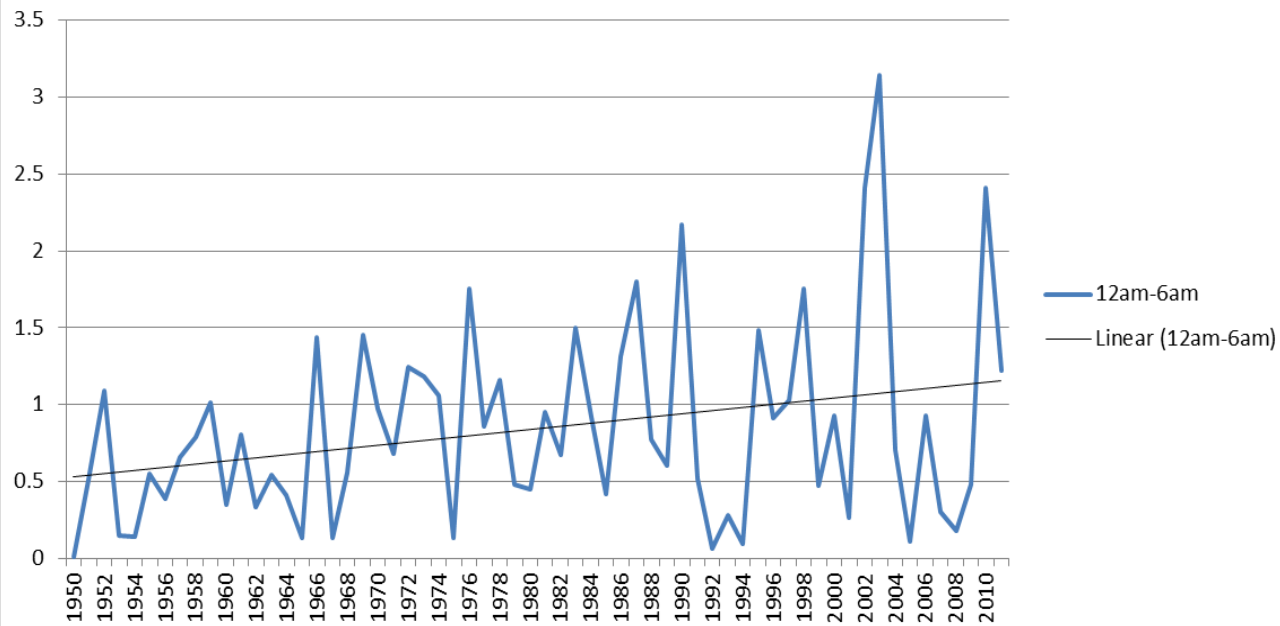
South Bend, IN

Greatest 1 hour Rainfall Since 1950

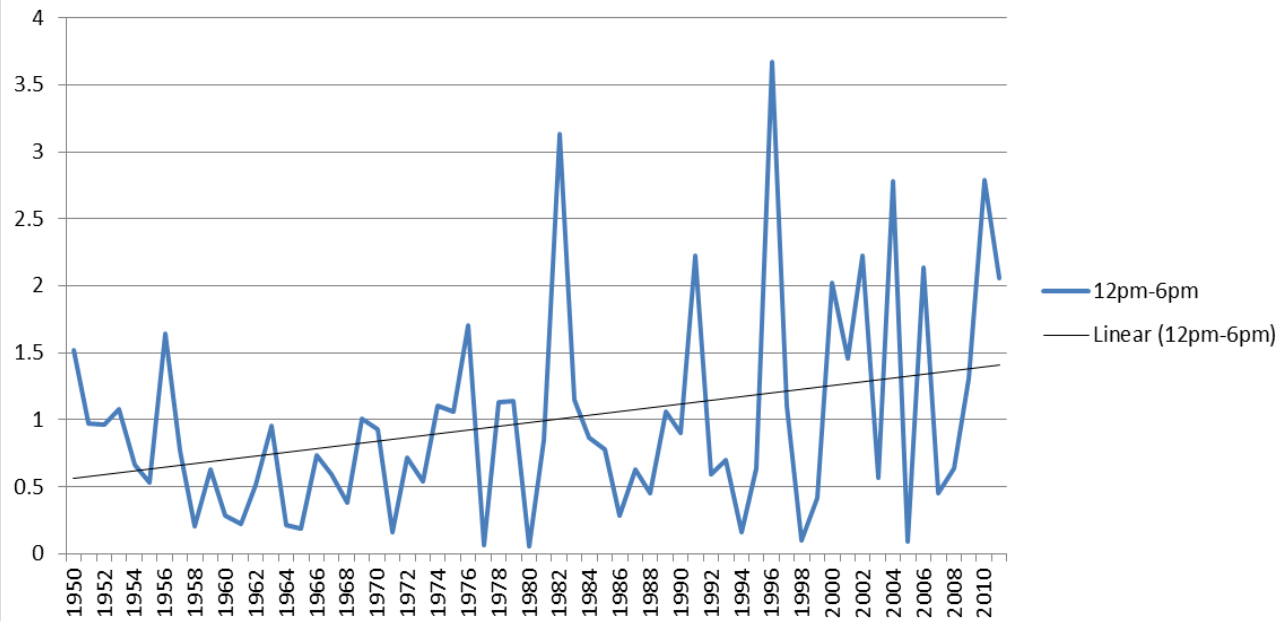


1:56 AM	75.2 °F	66.2 °F	73%	30.08 in	3.0 mi	North	35.7 mph	44.9 mph	0.00 in	Rain , Thunderstorm	Light Thunderstorms and Rain
1:58 AM	71.6 °F	66.2 °F	83%	30.10 in	1.8 mi	North	23.0 mph	44.9 mph	0.02 in	Rain , Thunderstorm	Light Thunderstorms and Rain
2:01 AM	68.0 °F	66.2 °F	94%	30.11 in	0.8 mi	NNE	28.8 mph	44.9 mph	0.24 in	Rain , Thunderstorm	Light Thunderstorms and Rain
2:14 AM	66.2 °F	66.2 °F	100%	30.03 in	0.5 mi	ENE	17.3 mph	36.8 mph	1.49 in	Fog , Rain , Hail , Thunderstorm	Heavy Thunderstorms with Hail
2:18 AM	66.2 °F	66.2 °F	100%	30.01 in	0.8 mi	ENE	23.0 mph	35.7 mph	1.69 in	Rain , Hail , Thunderstorm	Heavy Thunderstorms with Hail
2:26 AM	68.0 °F	66.2 °F	94%	30.04 in	1.5 mi	East	13.8 mph	29.9 mph	1.98 in	Rain , Hail , Thunderstorm	Heavy Thunderstorms with Hail
2:28 AM	68.0 °F	66.2 °F	94%	30.05 in	2.0 mi	East	15.0 mph	26.5 mph	2.02 in	Rain , Hail , Thunderstorm	Heavy Thunderstorms with Hail
2:37 AM	68.0 °F	68.0 °F	100%	30.08 in	3.0 mi	ENE	10.4 mph	-	2.12 in	Rain , Thunderstorm	Heavy Thunderstorms and Rain
2:43 AM	68.0 °F	68.0 °F	100%	30.06 in	2.5 mi	East	13.8 mph	-	2.23 in	Rain , Thunderstorm	Heavy Thunderstorms and Rain
2:54 AM	68.0 °F	68.0 °F	100%	30.05 in	3.0 mi	ESE	13.8 mph	-	2.42 in	Rain , Thunderstorm	Thunderstorms and Rain

South Bend IN - May Pcpn 12 AM-6 AM LST

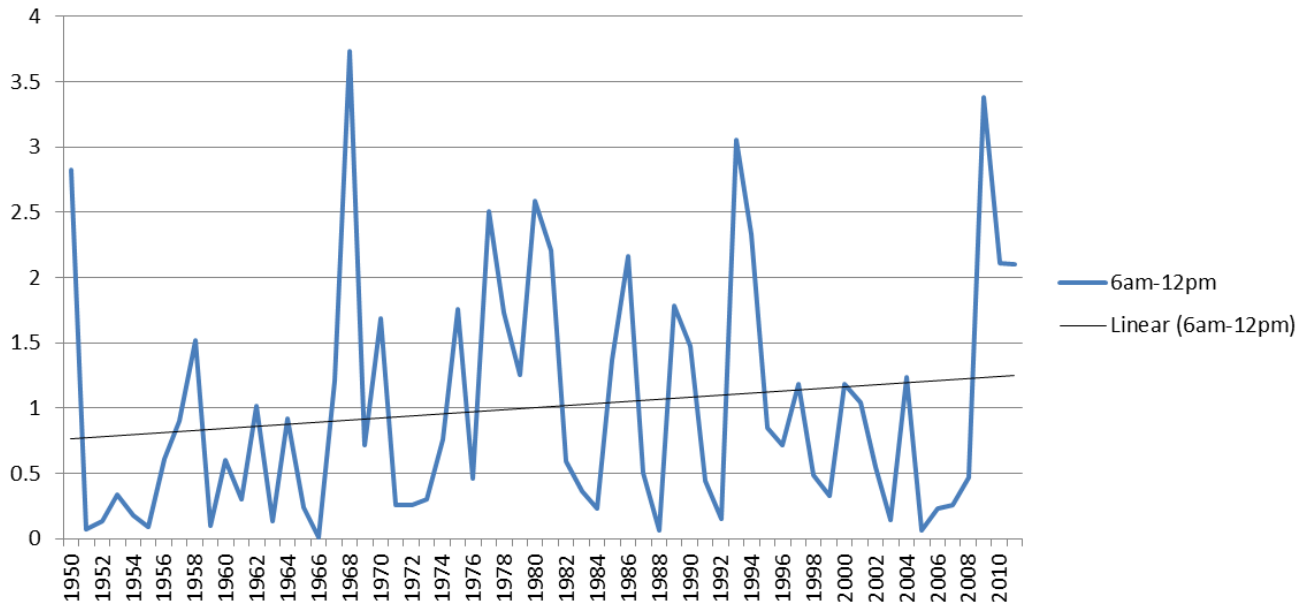


South Bend IN - May Pcpn 12 PM-6 PM LST

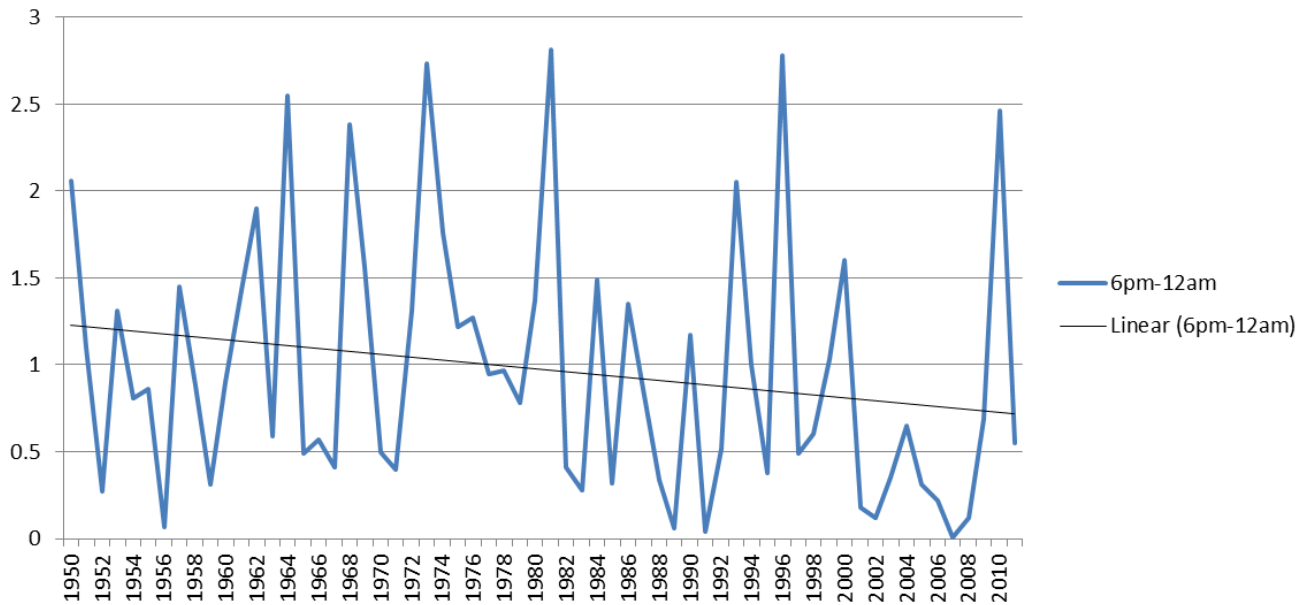




South Bend IN - June Pcpn 6 AM-12 PM LST

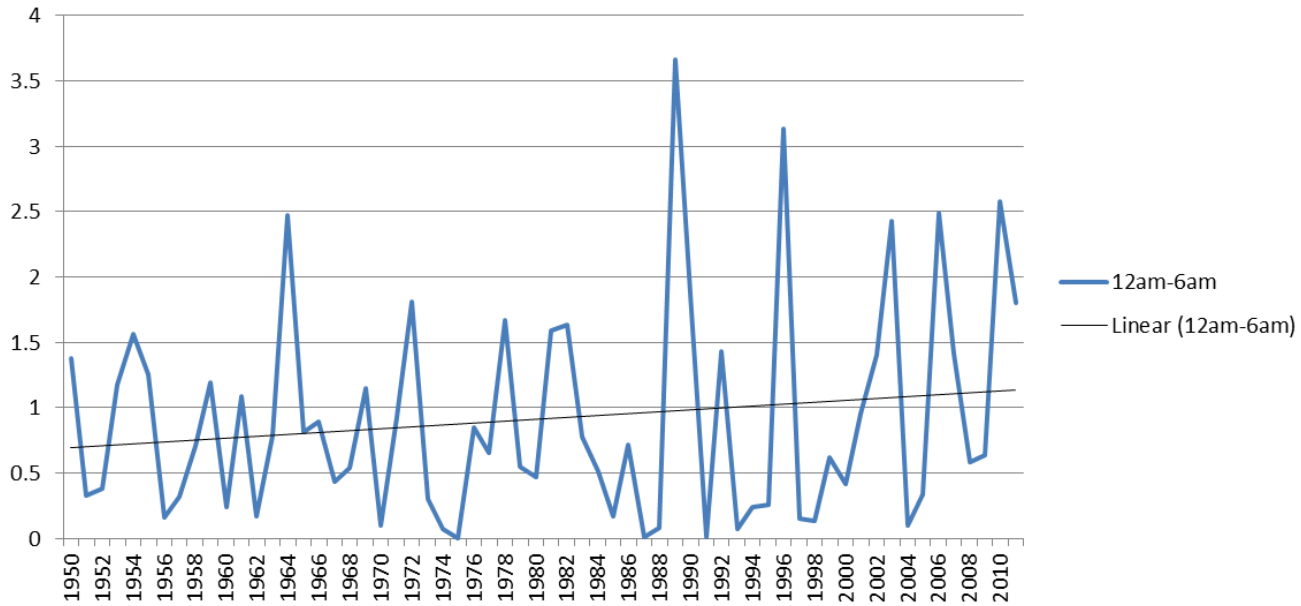


South Bend IN - June Pcpn 6 PM-12 AM LST

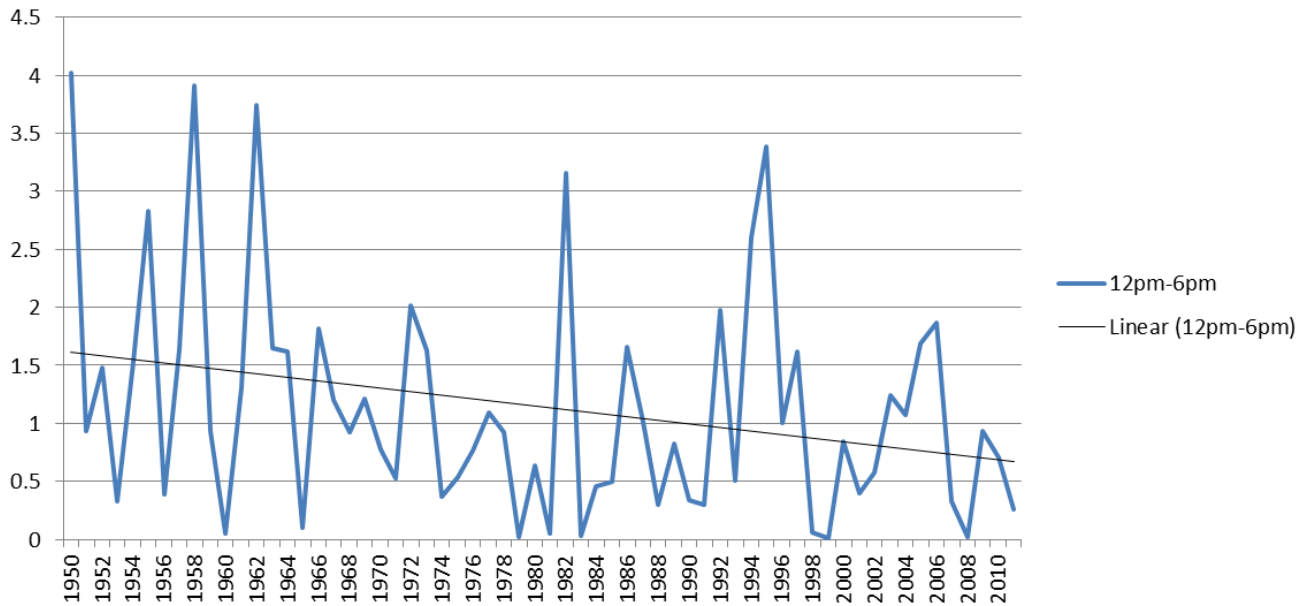




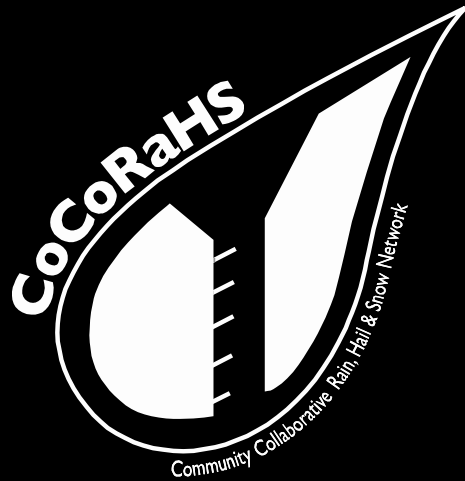
South Bend IN - July Pcpn 12 AM-6 AM LST



South Bend IN - July Pcpn 12 PM-6 PM LST



Using a Volunteer Network of Observers to Measure and Monitor Precipitation Trends



CoCoRaHS

Volunteer Precipitation Observations:
Providing Valuable Information in Extreme Rainfall Events



CoCoRaHS was born in response to the 1997 Fort Collins, Colorado Flood



STORM TOLL

Deaths - 5 confirmed
Injuries - 40
Missing - 16
Rescued - 160

Damages - Tens of millions of dollars at Colorado State University, \$1.5 million to \$2 million to city roads and bridges; \$1 million to city parks and trails; no estimate for private property.

Source: Emergency Officials
All information as of 1 a.m. today

Wednesday



July 30th 1997



The Community Collaborative Rain, Hail and Snow Network

CoCoRaHS is a grassroots, high-density, precipitation network.

It is made up of over 15,000 volunteers of all ages and backgrounds who take daily precipitation measurements in their own backyards each morning

CoCoRaHS has quickly become the largest source of daily precipitation measurements in the United States

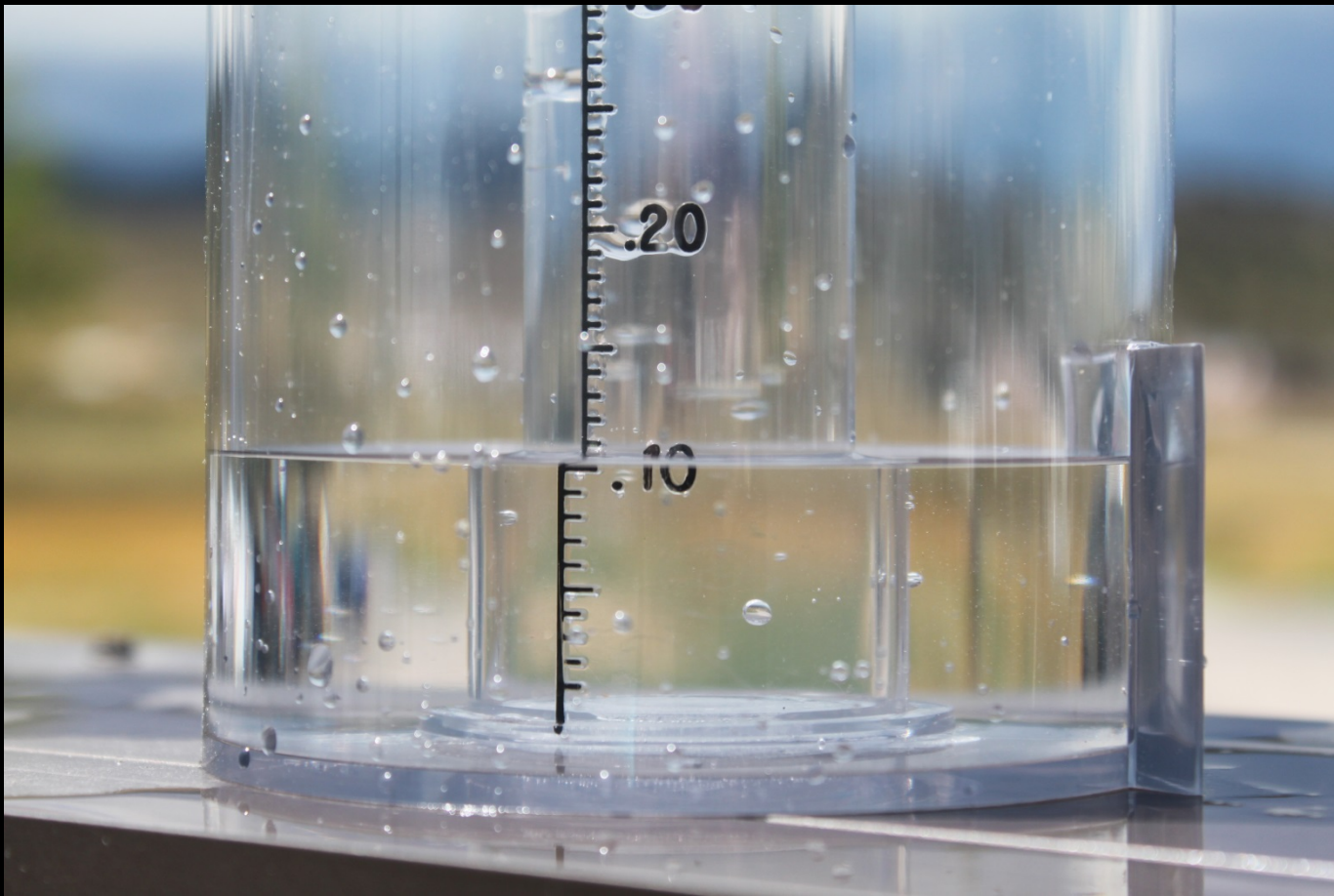


The four-inch diameter high capacity plastic rain gauge

Cost less than \$30



Gauge measures to the hundredth of an inch. Holds eleven inches.



CoCoRaHS' s goal is to provide:

*High Quality Precipitation Measurements
and
Educational Resources and Outreach*

Snow Data

CoCoRaHS



CoCoRaHS Volunteers measure both snowfall depth (new and accumulated), as well as the water content of the snow (SWE)

Our volunteers report their daily observations on our interactive Web site:
www.cocorahs.org

CoCoRaHS COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK
"Because every drop counts"

Home | States | View Data | Maps | My Data | My Account | Admin | Logout

Welcome to CoCoRaHS! "Volunteers working together to measure precipitation across the nation."

Main Menu

- Home
- About Us
- Join CoCoRaHS
- Contact Us
- Donate

Resources

- FAQ / Help
- Education
- Training Slide-Shows
- Videos
- Drought Impacts
- Volunteer Coordinators
- Hail Pad Distribution/Drop-off
- Help Needed
- Printable Forms
- The Catch
- Message of the Day
- Data Analysis
- CoCoRaHS Blog
- Web Groups
- State Newsletters

CoCoRaHS 'STATE CLIMATES' SERIES

6,556 daily precipitation reports received today as of 10/4/2011 4:20 PM EDT

Daily Precipitation (inches x.xx) USA 10/4/2011

0.0
Trace
0.00 - 0.18
0.18 - 0.36
0.37 - 0.90
0.91 - 2.17
2.18 - 3.26
3.27 - 3.63
















JOIN COCORAHHS

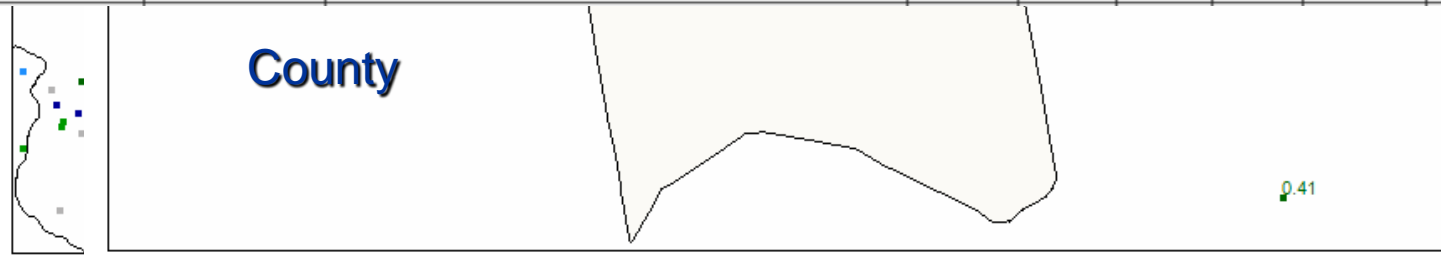
TRAINING SLIDE-SHOWS

Things to know about...

- Rain
- Hail
- Snow

Purchase an official CoCoRaHS 4" Rain Gauge

		Map Type	Map Location	Date	Colors				
Date	Time	Station Number	Station Name	Total Precip in. ▲	New Snow in.	Total Snow in.	State	County	View
2/20/2014	12:30 PM	IN-PT-44	Crown Point 7.6 ESE	1.39	NA	12.0	IN	Porter	
2/20/2014	7:45 AM	IN-PT-79	Lakes Of The Four Seasons 0.5 ESE	1.35	NA	NA	IN	Porter	
2/20/2014	7:00 AM	IN-PT-90	Valparaiso 5.7 WSW	1.33	0.0	13.0	IN	Porter	
2/20/2014	10:50 AM	IN-PT-92	Hebron 1.2 NW	1.32	NA	NA	IN	Porter	
2/20/2014	6:00 AM	IN-PT-12	Valparaiso 4.3 SW	1.31	NA	NA	IN	Porter	
2/20/2014	8:40 AM	IN-PT-63	Valparaiso 1.8 NW	1.31	0.0	11.0	IN	Porter	
2/20/2014	7:00 AM	IN-PT-60	Lakes Of The Four Seasons 1.5 NNE	1.22	NA	10.0	IN	Porter	
2/20/2014	5:00 PM	IN-PT-126	Hebron 0.6 NE	1.22	0.0	4.0	IN	Porter	
2/20/2014	7:00 AM	IN-PT-99	Valparaiso 1.8 N	1.12	0.0	8.5	IN	Porter	
2/20/2014	7:00 AM	IN-PT-8	Valparaiso 0.6 SE	1.10	0.0	9.0	IN	Porter	
2/20/2014	7:00 AM	IN-PT-32	Portage 0.9 ESE	0.80	0.0	10.5	IN	Porter	
2/20/2014	6:40 AM	IN-PT-18	Hebron 3.7 NE	0.79	NA	NA	IN	Porter	
2/20/2014	7:15 AM	IN-PT-69	Porter 0.6 S	0.77	NA	5.5	IN	Porter	
2/20/2014	7:15 AM	IN-PT-110	Chesterton 1.4 ENE	0.73	NA	9.5	IN	Porter	
2/20/2014	7:30 AM	IN-PT-83	Valparaiso 6.2 NW	0.73	NA	NA	IN	Porter	

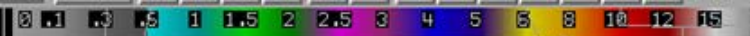


Volunteer's observations are immediately available for the public to view.

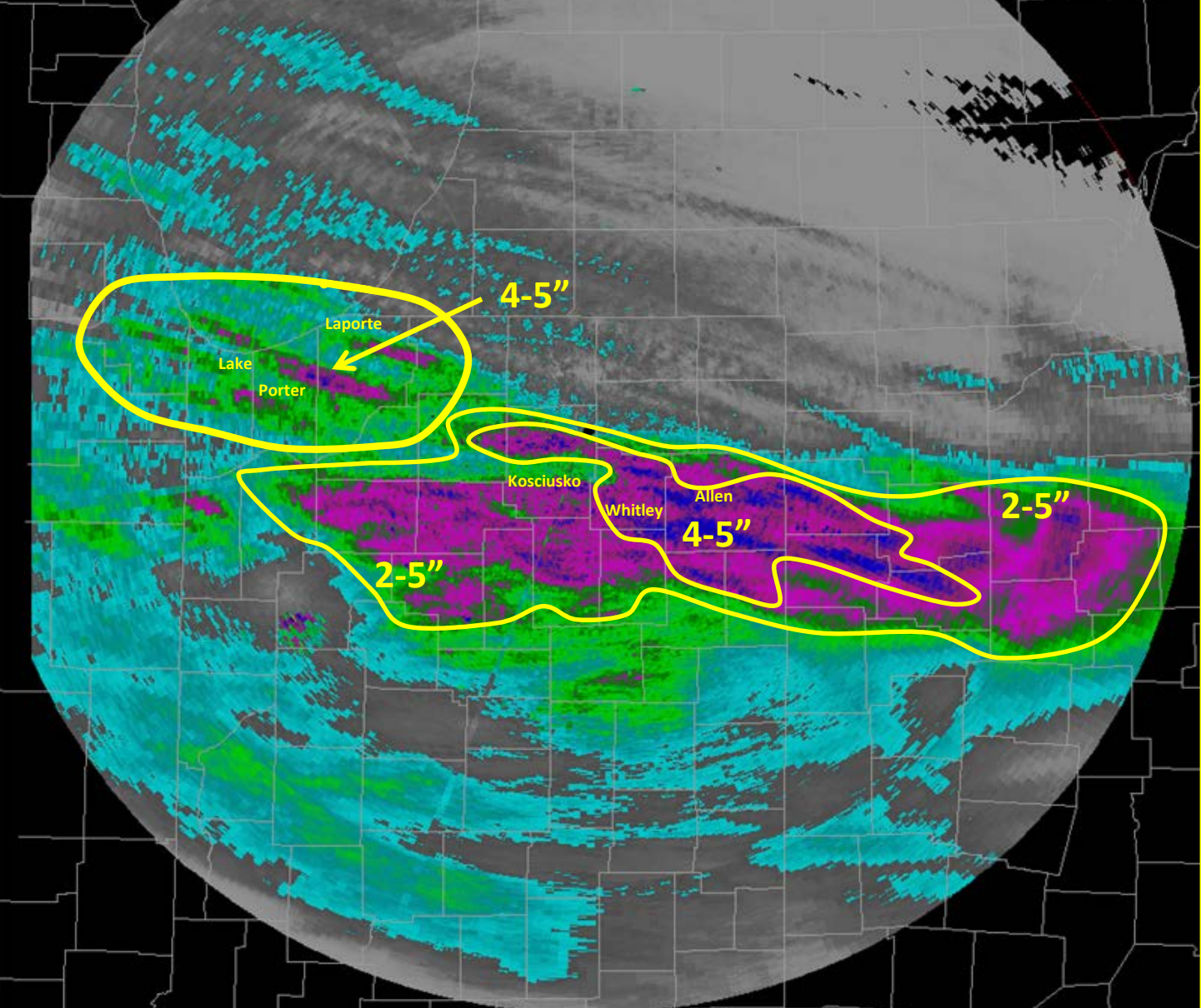


August 2nd, 2013 Heavy Rainfall Event

**Using NWS Dual Polarization Radar
Precipitation Estimates with CoCoRaHS
Observations**



VCP 12
0.25 km
MX: 8.63h
BIAS: 1.00
BEG: 02.0555
END: 03.1000

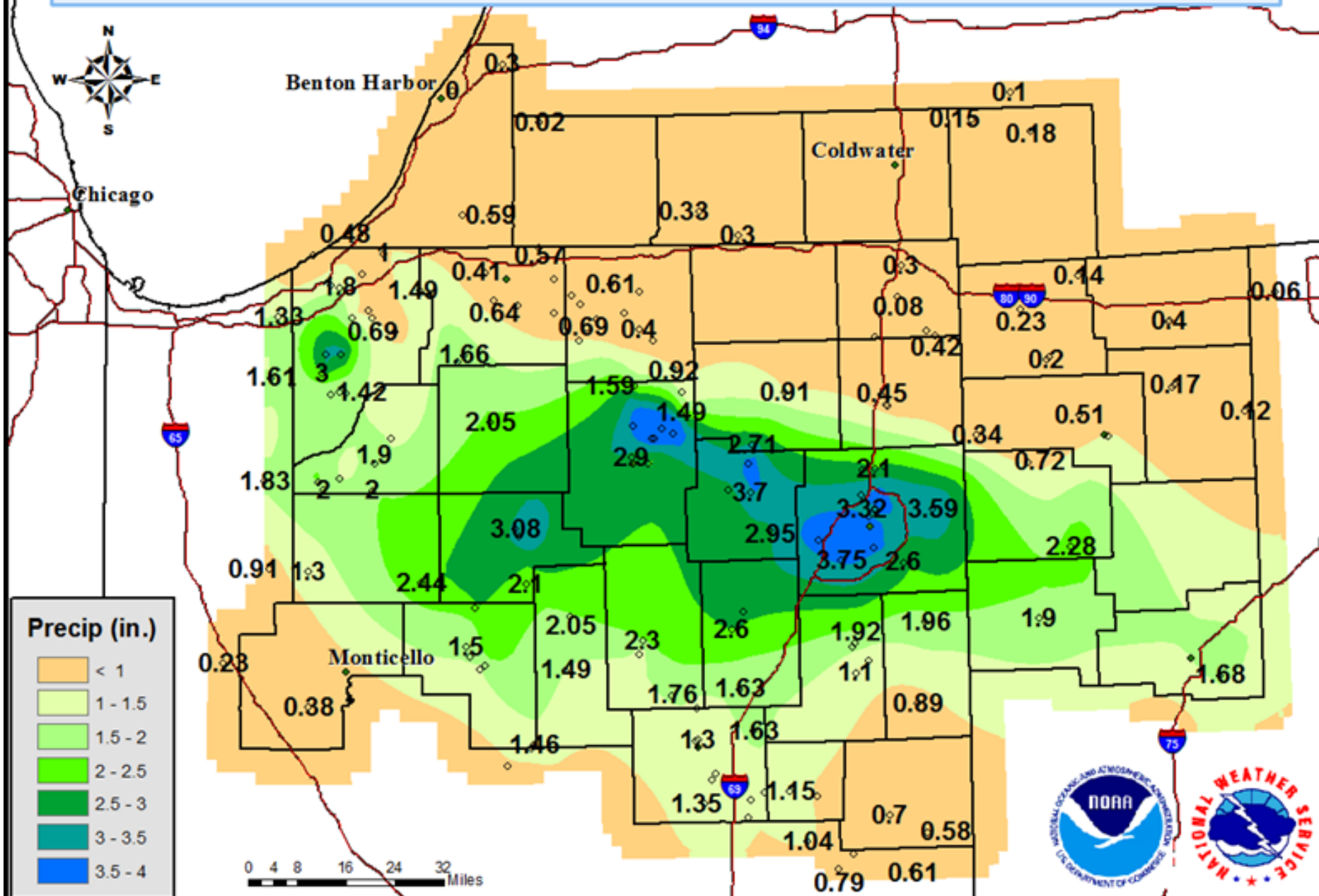


kiwx Dual Pol Storm Total Accum (in) - 8bit Sat 09:59Z 03-A

Radar: [arrow]

Frames: 64 Time: 20:35 Z 03

24 Hr Precip Ending ~9a 08/03/13



Map Type

Map Location

Date

Colors

Precipitation

Indiana

LP - La Porte

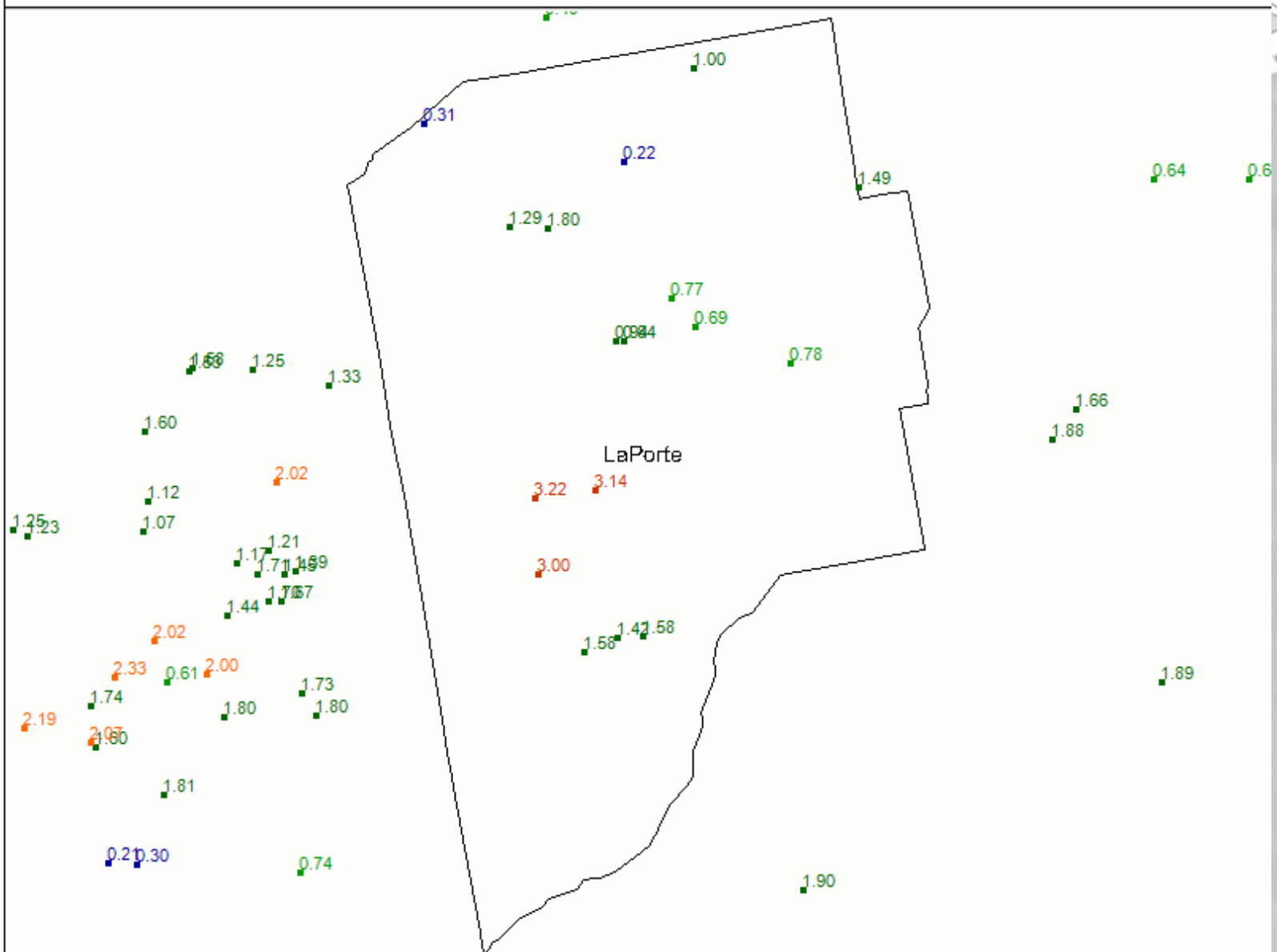
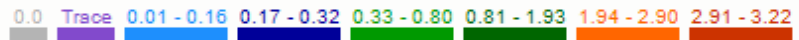
8/3/2013

Standard

Get Map

Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am

La Porte County, Indiana 8/3/2013

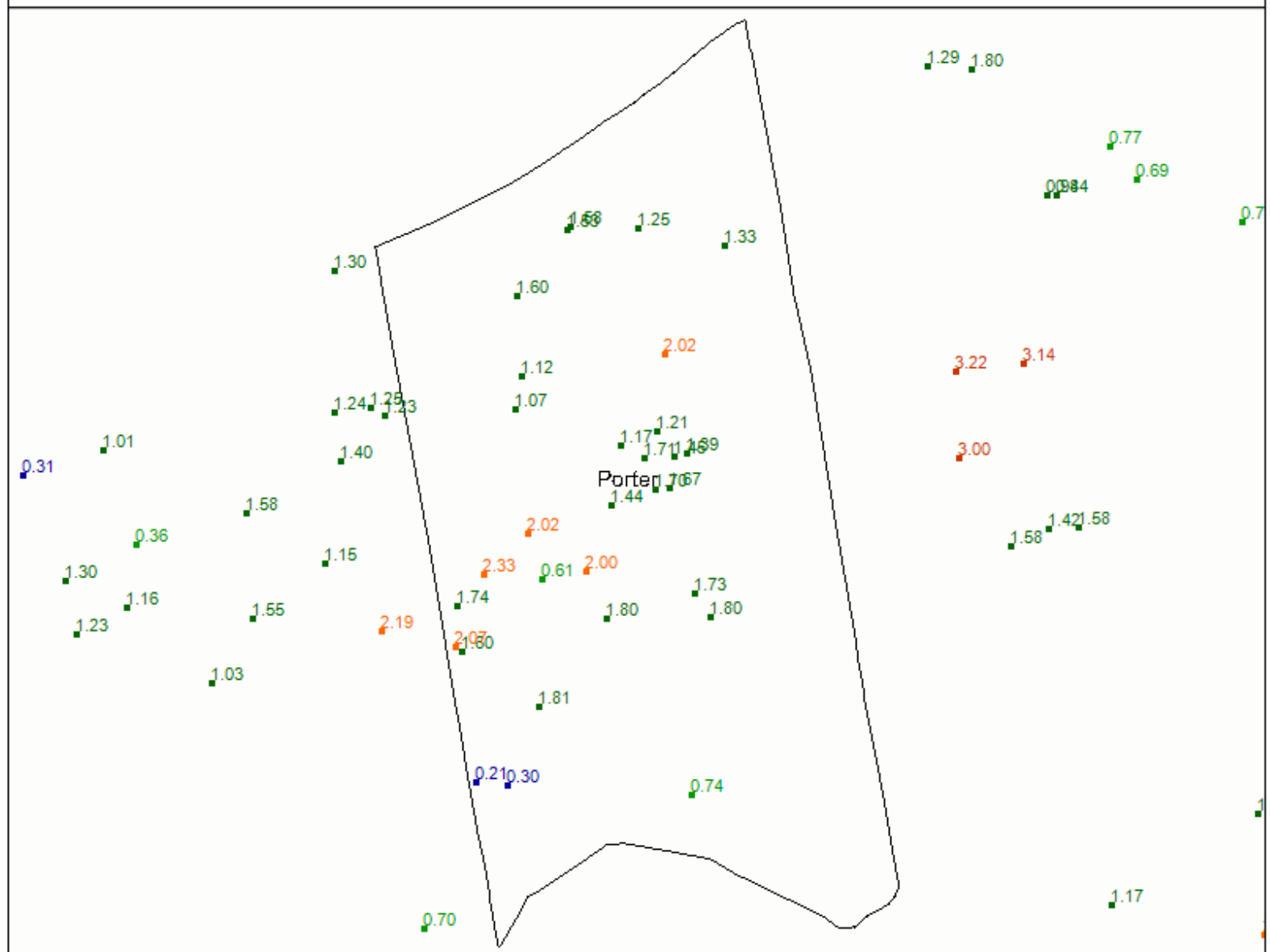
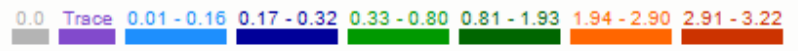




Map Type	Map Location	Date	Colors
Precipitation	Indiana	PT - Porter	8/3/2013
			Standard
			Get Map

Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am

Porter County, Indiana 8/3/2013



Map Type

Map Location

Date

Colors

Precipitation

Indiana

LK - Lake

8/3/2013

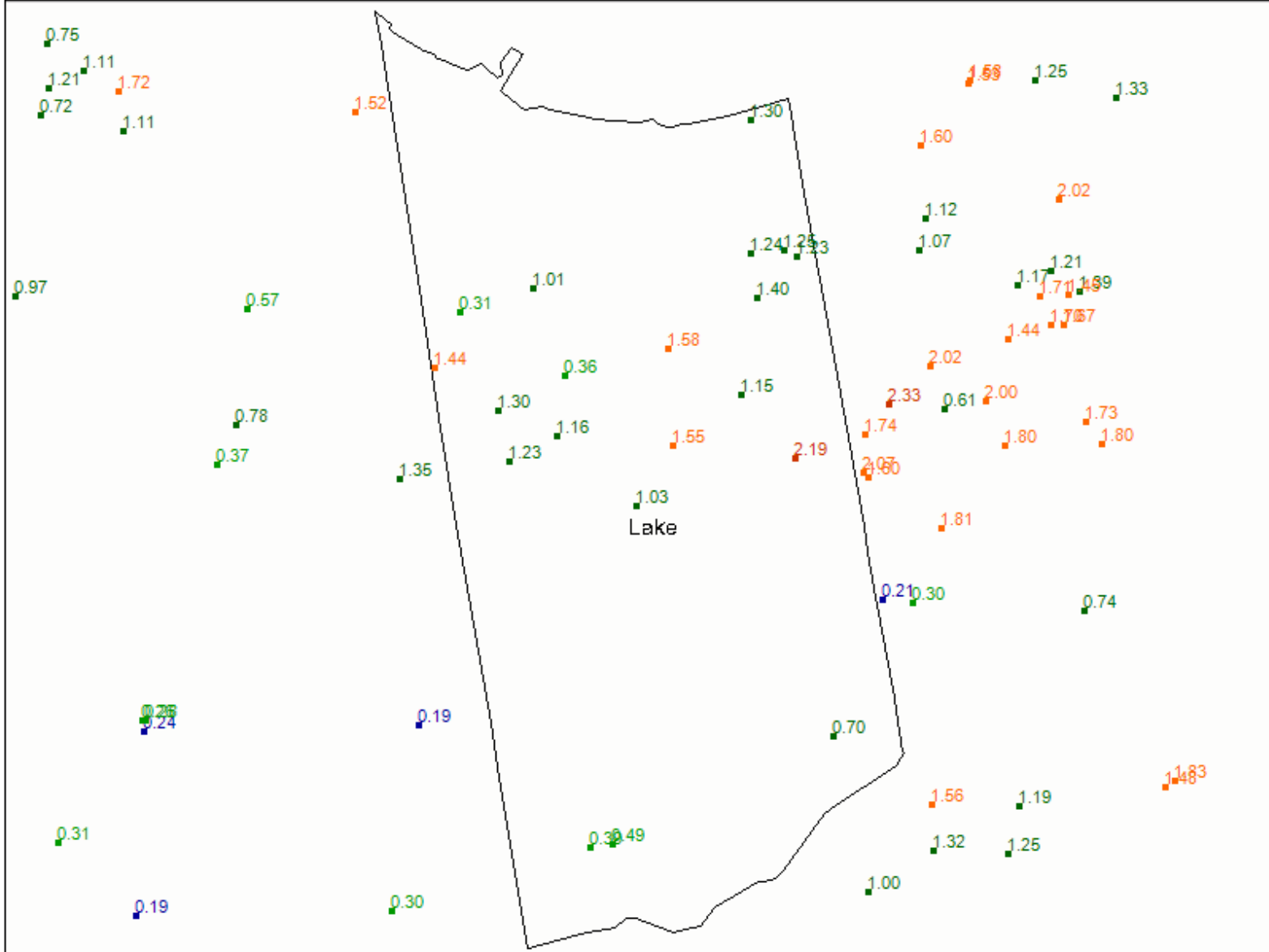
Standard

Get Map

Daily Precipitation (inches x.xx), for the 24 hour period ending ~7:00 am

Lake County, Indiana 8/3/2013

0.0	Trace	0.01 - 0.12	0.13 - 0.24	0.25 - 0.59	0.60 - 1.41	1.42 - 2.11	2.12 - 2.33
-----	-------	-------------	-------------	-------------	-------------	-------------	-------------



CoCoRaHS data is used regularly

NOAA's National Weather Service

NOAA's River Forecast Centers

NOAA's National Hurricane Center

NOHRSC – National Operational Hydrologic Remote Sensing Center

Indiana State Climatologist

Denver's Urban Drainage and Flood Control District

engineers

city/county planners

universities

local municipalities

flood control districts

urban drainage organizations

broadcast meteorologists

conservation districts

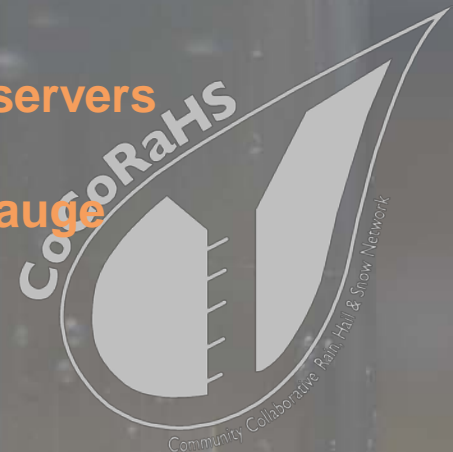
floodplain managers

How can your organization benefit from this complementary citizen science network?

- Real-Time extreme precipitation data – can be integrated into your system
- Archived data free and exportable

For those who do not have a network in their area, feel free to use CoCoRaHS

- Infrastructure for reporting, mapping, data extraction already there
- Free QC'ed high quality daily data
- Tutorials and educational components provided for your observers
- Only cost to the observer is the price of a 4" diameter rain gauge



For further information:



www.cocorahs.org

Sam Lashley - NWS Northern Indiana - Sam.Lashley@noaa.gov

Teresa M. Bals-Elsholz – Assistant Professor Valparaiso - Teresa.Bals-Elsholz@valpo.edu

Bryan K. Overstreet – Jasper Co. Extension Educator - boverstreet@purdue.edu

