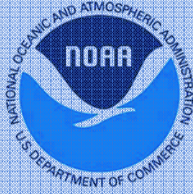
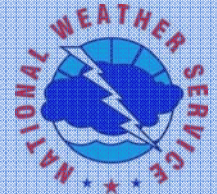


NOAA Atlas 14: Precipitation Frequency Atlas of the United States

Volume 10: Northeastern States



(Connecticut, Maine, Massachusetts, New Hampshire,
New York, Rhode Island, Vermont)



Authors: Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk,
Dale Unruh, Deborah Martin, Orlan Wilhite

Contact: Email: hdsc.questions@noaa.gov
Phone: 301-427-9552

TOPICS

1. NA14 VOL 10 PRODUCTS
2. NA14 VOL 10 DATA AND METHODOLOGY
3. COMPARISON WITH PREVIOUS NWS STUDIES

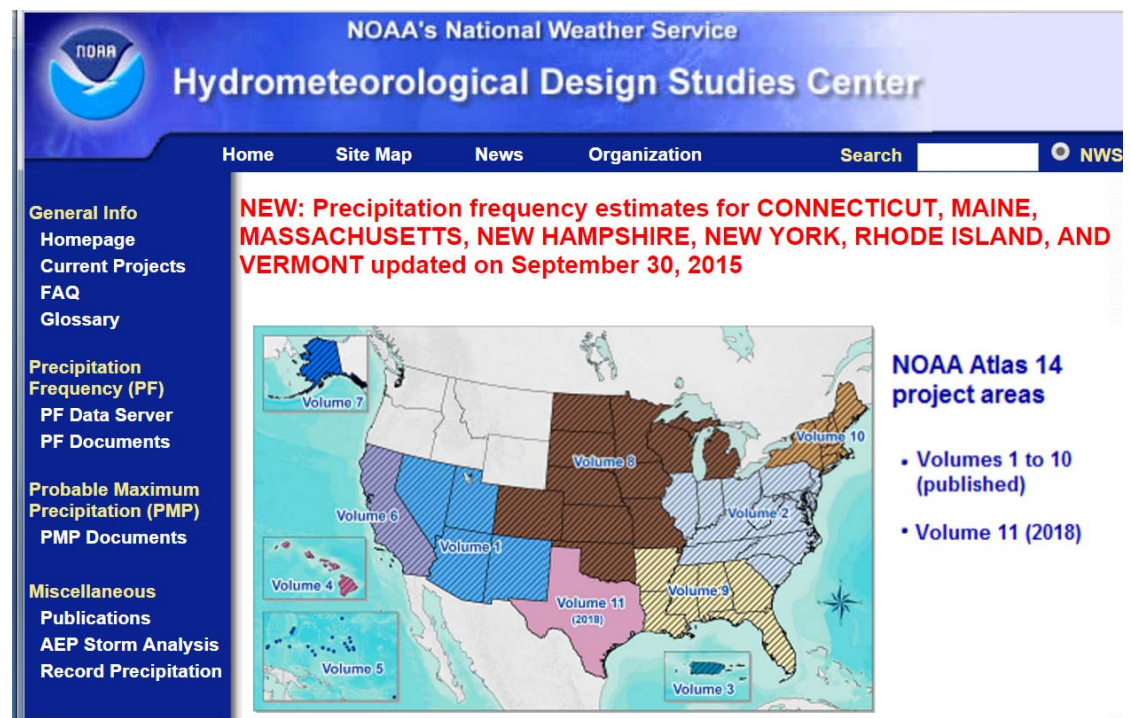
HDSC and NOAA Atlas 14

❑ Hydrometeorological Design Studies Center (**HDSC**)/National Water Center (previously Office of Hydrologic Development)/NWS/NOAA: responsible for updating precipitation frequency (PF) estimates for the U.S. states and affiliated territories.

❑ Since 2004, PF updates are published in Volumes of NOAA Atlas 14

- Vols 1 to 10: published
- Vol 11 (TX): mid-2018
- Vol 12 (OR,WA): mid-2019?
- Vol 13 (ID, MT, WY) : ?

❑ External funding



<http://nws.noaa.gov/oh/hdsc/index.html>

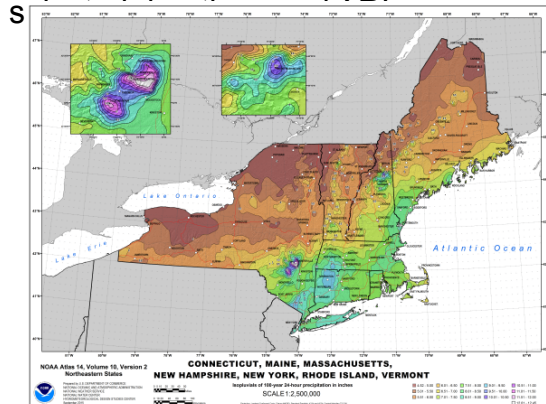
Precipitation Frequency Data Server (PFDS)

Whole project area

PF Data Server

- **PF in GIS Format.** High resolution grids of AMS-based and PDS-based estimates and 90% confidence interval bounds for 5-min to 60-day durations and 1- to 1,000-year ARI (1/2 – 1/1000 AEP)

- **PF Maps.** Cartographic maps for



- **Temporal Distr.**
- **Time Series Data**

PF Documents

Selected location

<http://hdsc.nws.noaa.gov/hdsc/pfds/index.html>

PF estimates for selected location

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: NY

DATA DESCRIPTION

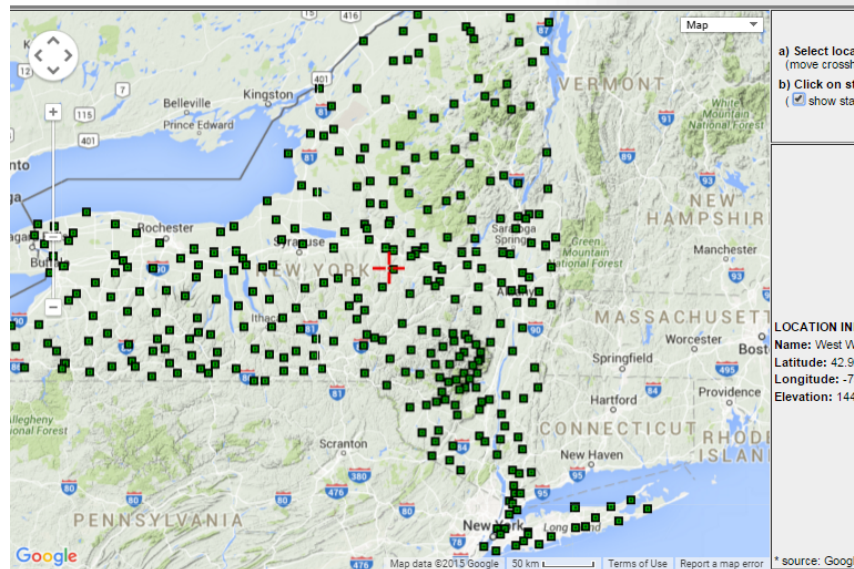
Data type: precipitation depth Units: english Time series type: partial duration

SELECT LOCATION

Manually:

- a) Enter location (decimal degrees, use "-" for S and W): latitude: longitude:
- b) Select station ([click here for a list of stations used in frequency analysis for NY](#)): select station

Use map:



- a) Select location
(move crosshair or double click)
- b) Click on station icon
☒ show stations on map

LOCATION INFORMATION:

Name: West W
Latitude: 42.92
Longitude: -72
Elevation: 144

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 10, Version 2

PF tabular

PF graphical

Supplementary information

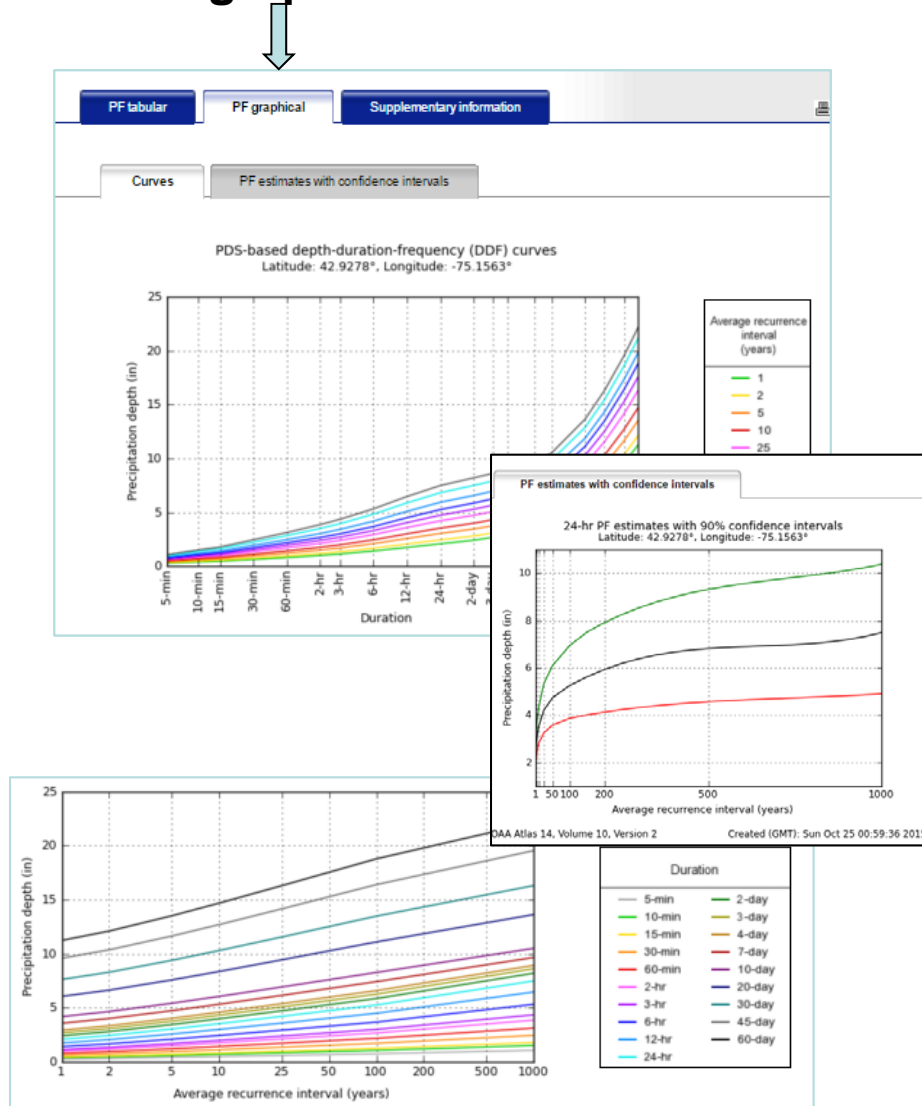
Print Page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)¹

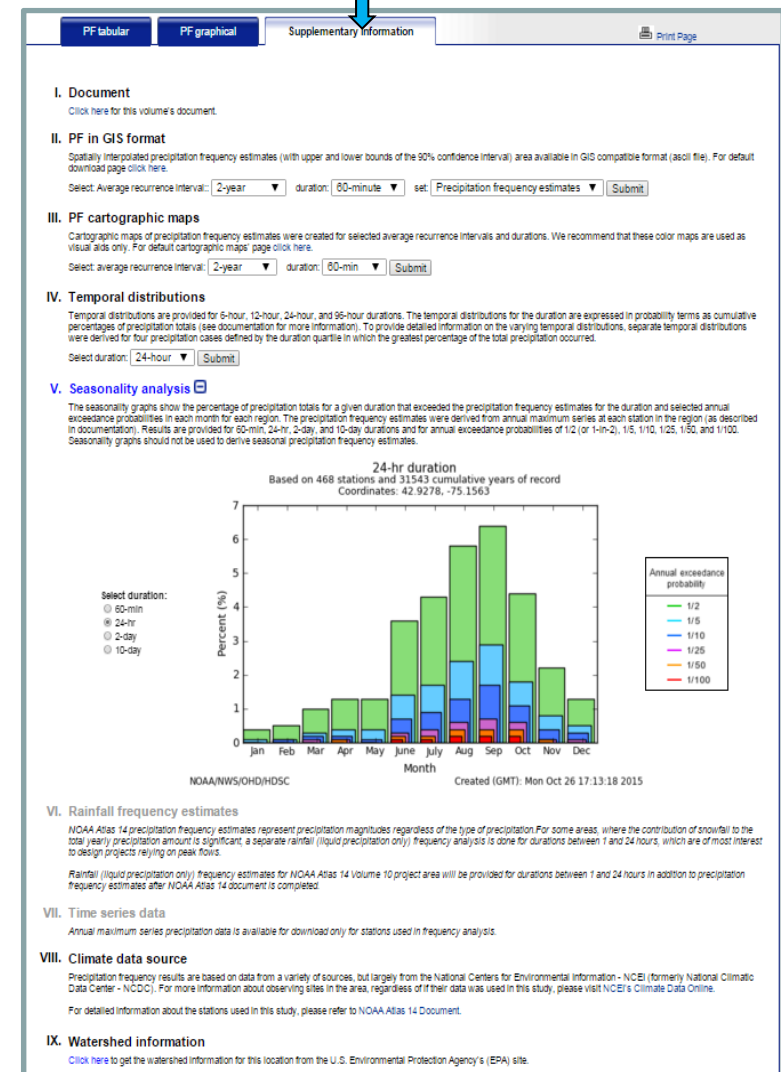
Duration	Average recurrence interval (yr)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.275 (0.215-0.348)	0.330 (0.258-0.417)	0.419 (0.326-0.530)	0.493 (0.381-0.626)	0.594 (0.446-0.779)	0.673 (0.495-0.895)	0.741 (0.531-1.03)	0.847 (0.575-1.17)	0.974 (0.637-1.38)	1.07 (0.684-1.54)
10-min	0.390 (0.305-0.492)	0.467 (0.365-0.590)	0.593 (0.462-0.751)	0.698 (0.540-0.887)	0.842 (0.632-1.10)	0.953 (0.701-1.27)	1.07 (0.761-1.45)	1.20 (0.815-1.66)	1.38 (0.903-1.96)	1.52 (0.970-2.18)
15-min	0.459 (0.359-0.579)	0.550 (0.429-0.694)	0.698 (0.543-0.884)	0.821 (0.636-1.04)	0.991 (0.743-1.30)	1.12 (0.825-1.49)	1.26 (0.891-1.71)	1.41 (0.959-1.95)	1.62 (1.06-2.30)	1.78 (1.14-2.57)
30-min	0.627 (0.490-0.792)	0.752 (0.587-0.950)	0.956 (0.744-1.21)	1.13 (0.871-1.43)	1.36 (1.02-1.78)	1.54 (1.13-2.05)	1.73 (1.23-2.35)	1.94 (1.32-2.68)	2.23 (1.46-3.17)	2.45 (1.57-3.53)
60-min	0.796 (0.622-1.00)	0.954 (0.745-1.21)	1.21 (0.945-1.54)	1.43 (1.11-1.81)	1.73 (1.29-2.26)	1.95 (1.44-2.60)	2.21 (1.58-2.98)	2.47 (1.68-3.41)	2.84 (1.86-4.03)	3.13 (2.00-4.50)
2-hr	0.997 (0.784-1.25)	1.19 (0.934-1.49)	1.50 (1.18-1.89)	1.76 (1.37-2.23)	2.12 (1.60-2.77)	2.40 (1.78-3.17)	2.71 (1.93-3.64)	3.03 (2.07-4.17)	3.50 (2.31-4.93)	3.86 (2.48-5.51)
3-hr	1.13 (0.895-1.42)	1.35 (1.06-1.68)	1.70 (1.33-2.13)	1.99 (1.55-2.50)	2.39 (1.81-3.10)	2.70 (2.01-3.55)	3.03 (2.18-4.08)	3.41 (2.33-4.66)	3.94 (2.60-5.53)	4.35 (2.80-6.18)
6-hr	1.41 (1.12-1.75)	1.67 (1.33-2.07)	2.10 (1.66-2.60)	2.45 (1.93-3.05)	2.93 (2.24-3.78)	3.33 (2.44-4.50)	3.73 (2.60-5.20)	4.13 (2.80-5.80)	4.83 (3.20-6.71)	5.32 (3.45-7.50)
24-hr	1.74 (1.28-2.34)	2.06 (1.47-2.99)	2.57 (1.97-3.43)	3.00 (2.24-4.35)	3.59 (2.62-5.34)	4.21 (3.25-5.34)	5.26 (3.87-6.95)	6.03 (4.57-8.31)	6.82 (4.57-9.31)	7.49 (4.90-10.4)
	2.41	2.81	3.45	3.99	4.72	5.29	5.86	6.57	7.50	8.20

PF estimates for selected location

PF graphical



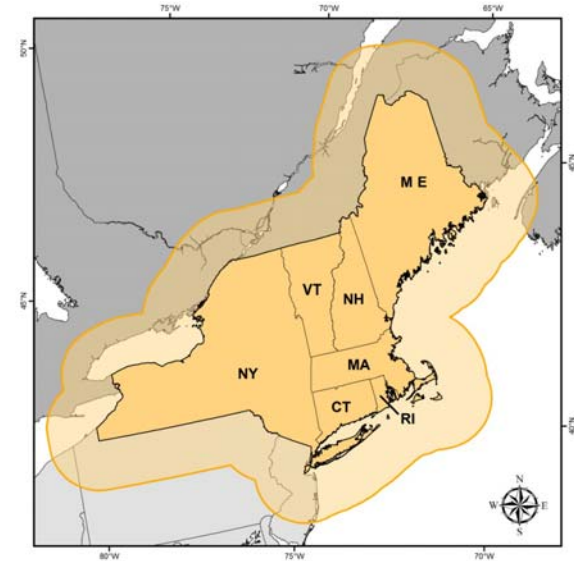
Supplementary information



Data sources

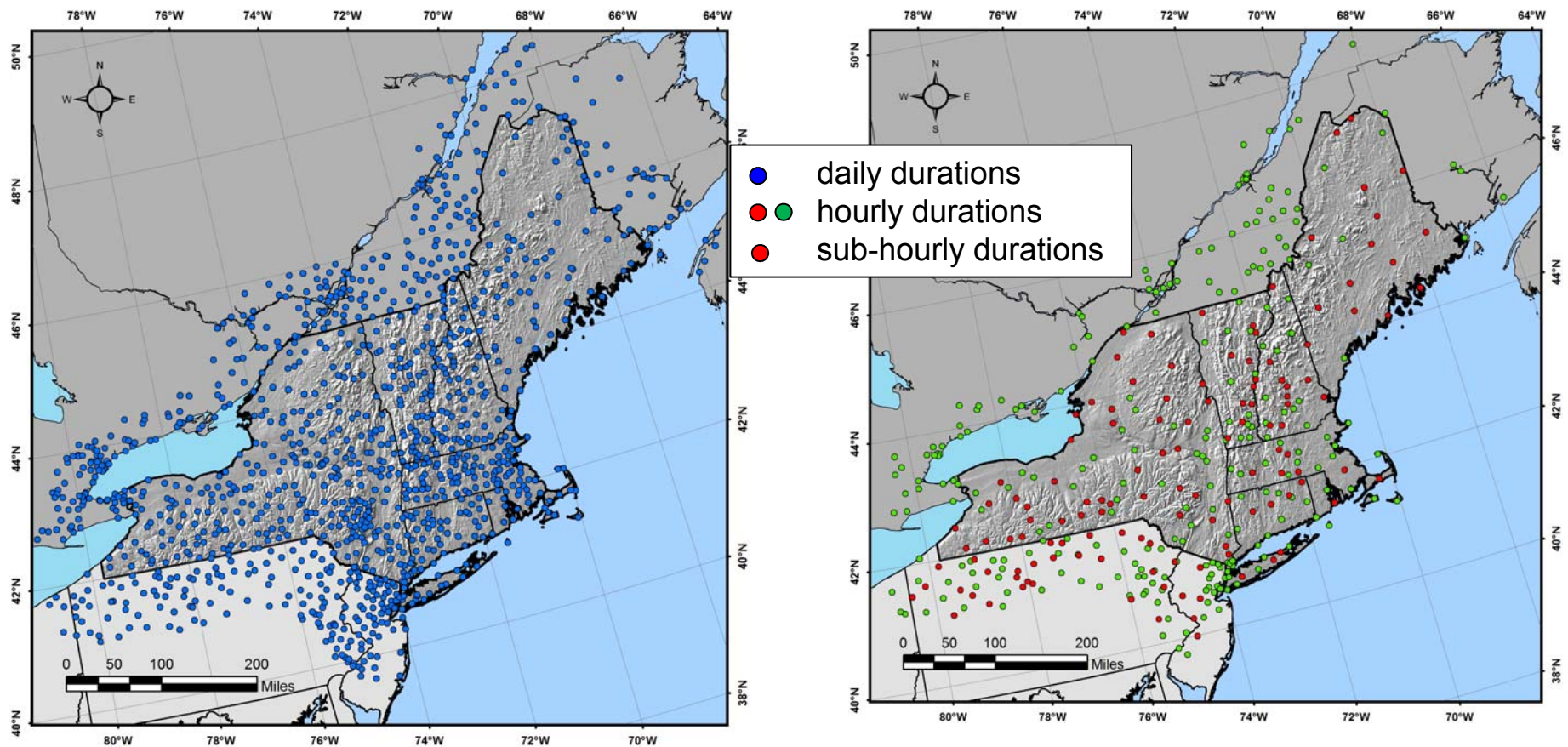
NCEI: ASOS, AWOS, COOP, GHCN, QCLCD, USCRN

- Boston Water and Sewer Commission
- Citizen Weather Observers Program
- Community Collaborative Rain, Hail and Snow Network (CoCoRaHS)
- Earth Networks
- Eastern New York Observing Network
- Environment Canada
- Illinois State Water Survey: NADP
- Lyndon State College, Lyndonville, VT
- Massachusetts Department of Conservation and Recreation
- Mid-Atlantic River Forecast Center: IFLOWS
- Midwestern Region Climate Center: 19th Century Forts and Voluntary Observers Database
- Mount Washington Observatory
- Narragansett Bay Commission
- National Resources Conservation Service: SCAN
- New Hampshire Department of Transportation
- New York City Department of Environmental Protection
- Office of the New Jersey State Climatologist at Rutgers University: NJ Mesonet & NJ SafetyNet
- Rhode Island Department of Environmental Management, Office of Water Resources
- U.S. Department of Agriculture, Agricultural Research Service
- U.S. Forest Service: RAWs
- U.S. Geological Survey: ME Water Science Center (WSC), MA-RI WSC, NH-VT WSC, NY WSC



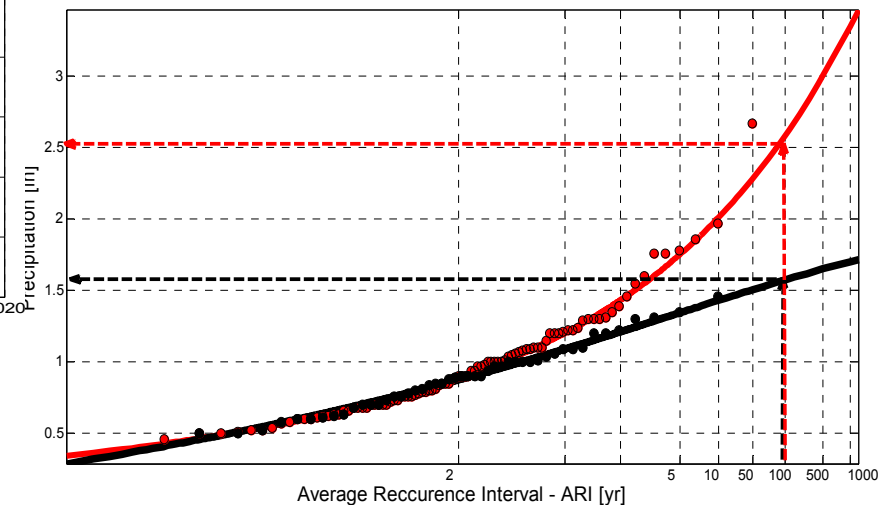
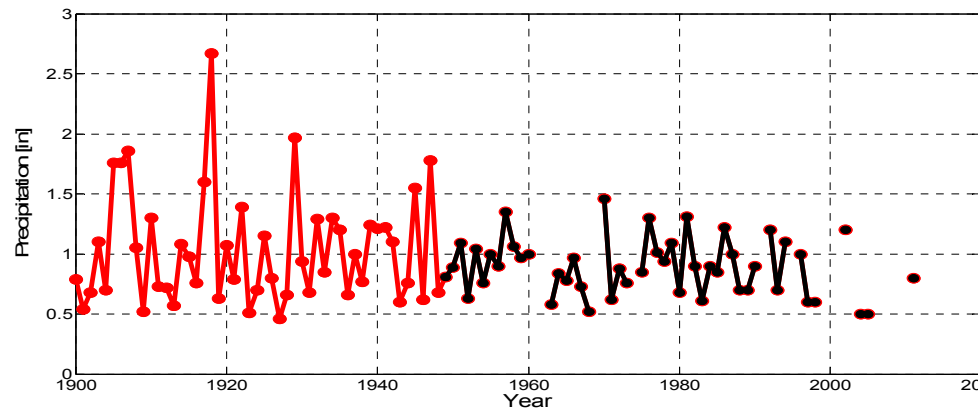
Stations used in frequency analysis

Duration (D)	Number of stations	Record length (data years)		
		average	median	range
Daily ($1\text{-day} \leq D \leq 60\text{-day}$)	1,218	66	62	30 (9) – 173
Hourly ($1\text{-hr} \leq D < 24\text{-hr}$)	370	42	40	30 (9) – 122
Sub-hourly ($D < 60\text{-min}$)	127	27	26	20 (14) – 46



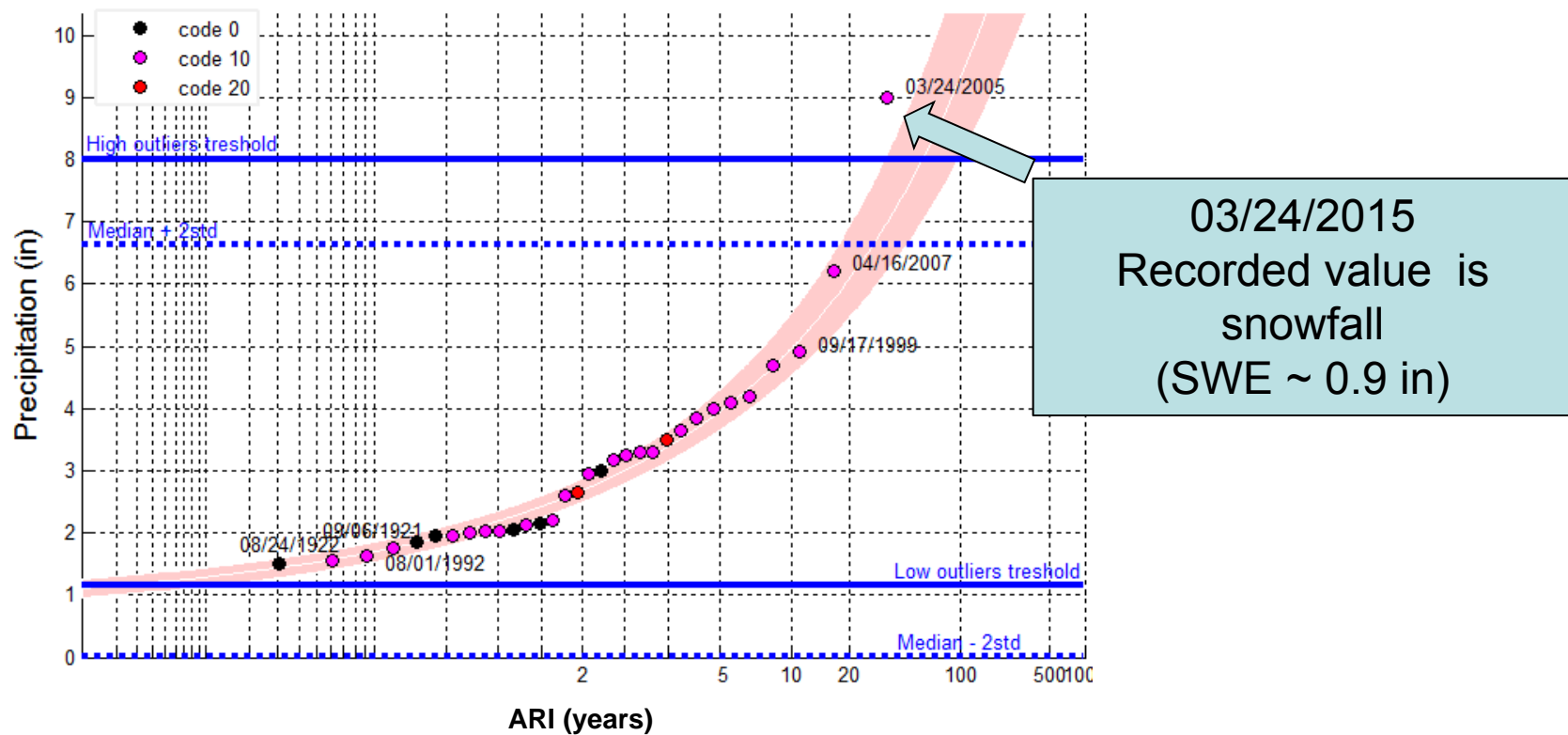
Data digitizing

- Digitized additional data for 78 stations (on average 35 years of data) from
 - New York City Environmental Protection Bureau of Water Supply (NYCEPBWS)
 - Massachusetts Department of Conservation and Recreation (DCR)
 - NCEI's Climate Database Modernization Program (CDMP).
- Example: 1hr AMS for ITHACA, NY. Hourly record extended 49 years (1900-1948).*



AMS extraction and QC

- AMS extracted and QC-ed for 17 durations from 15-min to 60-day
- Example: 24-hr AMS for Rhinebeck 4SE, NY (30-7035)



AMS adjustments

■ Adding missing significant events:

Station	Date	Amount	Source
Westerly, RI (37-8911)	16-17 Sep 1932	12.13 in/24hr	NCEI State Climate Extremes Committee: state record
Sanford, ME (17-7479)	21 Oct 1996	8.19 in/1day	0.19 in digitized in observer form
Barre Falls Dam, MA (19-0408)	12-22 Sep 1938	11.38 in/1day 18.71 in/10days	USGS: <i>Hurricane Floods of September 1938</i>
Brattleboro, VT (43-0841)	6-7 Aug 1856	11.80 in/2days	D. Ludlum: <i>The Vermont Weather Book</i>
Tannersville, NY (30-8403)	21 Mar 1980	7.76 in/1day	J. Thaler: <i>Catskill Weather</i>
Peekamoose, NY (30-6479)	22-24 Aug 1933	11.6 in/1day 16.0 in/3days	Corps of Engineers: <i>Storm Studies – NA 1-24</i>
Saratoga Springs, NY (30-7484)	25 Jun 1966	3.74 in/1hour	U.S Dept of Commerce: <i>Storm Data – June 1966 (8/6)</i>

■ Manually adjusting constrained AMS values:

Station	Date	Constrained (unconstrained) 1-day	Unconstrained 24-hour
East Jewett, NY (30-2366)	28-29 Aug 2011	6.70 (7.37) in/day	12.85 in/day
Rhinebeck 4 SE, NY (30-7035)	28-29 Aug 2011	4.20 (4.62) in/day	8.27 in/day
MT Mansfield, VT (43-5416)	28-29 Aug 2011	3.62 (3.98) in/day	6.84 in/day
Poughkeepsie(NY (30-6821)	11-12 Jun 1903	5.10 (5.61) in/day	8.16 in/day
NYC Central Park, NY (30-5801)	8-9 Oct 1903	7.33 (8.06) in/day	11.17 in/day
Binghamton Greater AP(30-0687)	June 17, 1960	1.50 (1.62) in/hr	2.92 in/hr

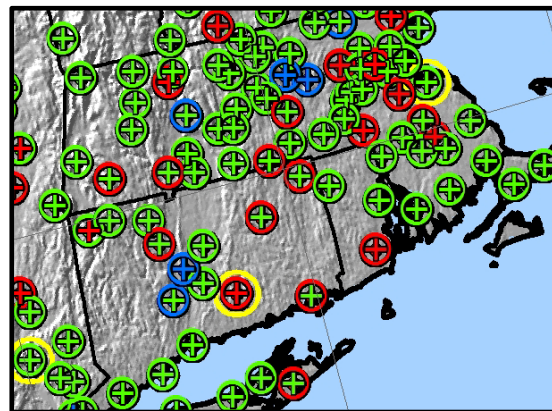
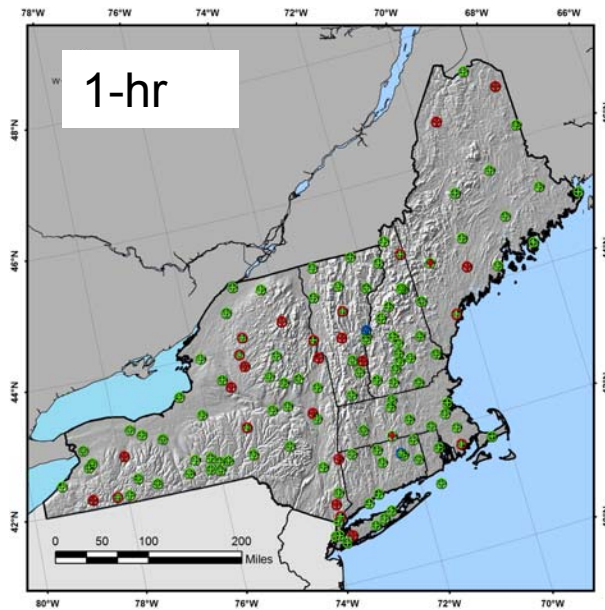
AMS trend analysis

□ At-station analysis

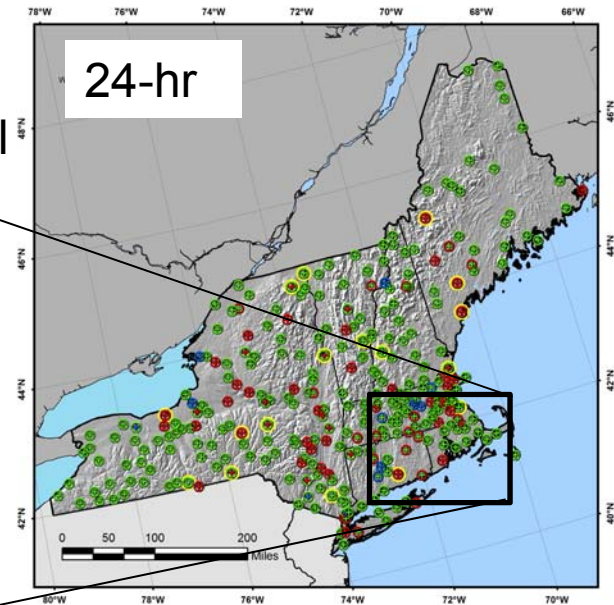
- Test for trends & investigate spatial patterns

MEAN: parametric t -test; non-parametric Mann-Kendal

VARIANCE: Levene test

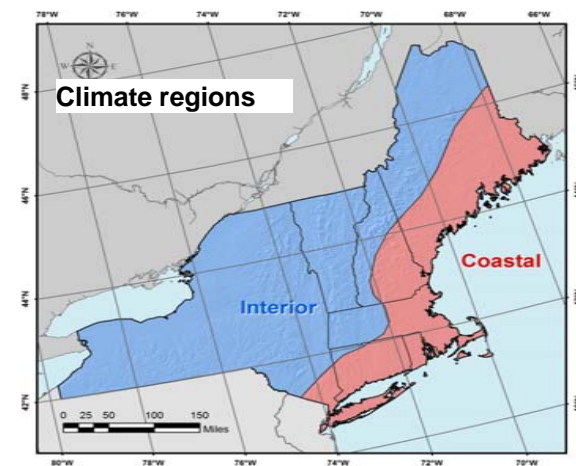


positive trend
negative trend
no trend



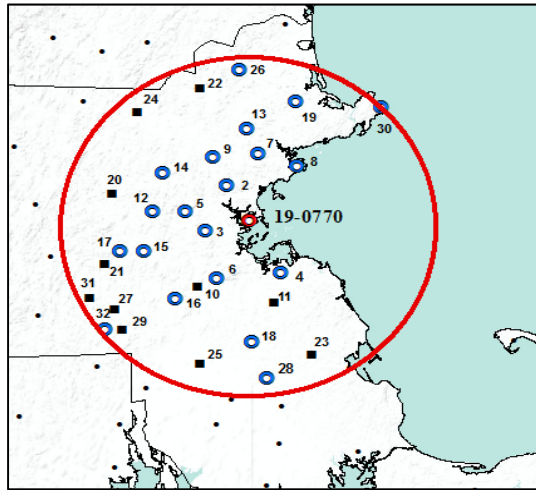
□ Regional analysis:

- AMS normalized and regressed against time.
- Test H_0 : no serial correlation at 5% level



Regionalization

NA14 METHOD: Regional frequency analysis approach based on L-moment statistics.

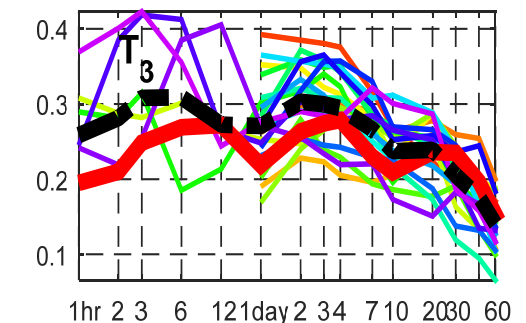
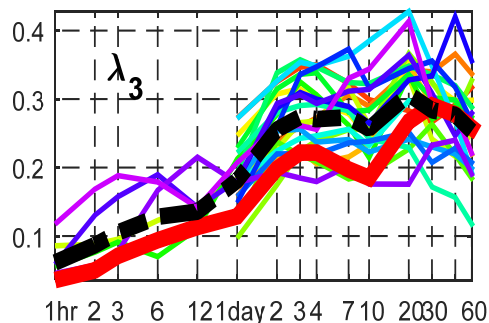
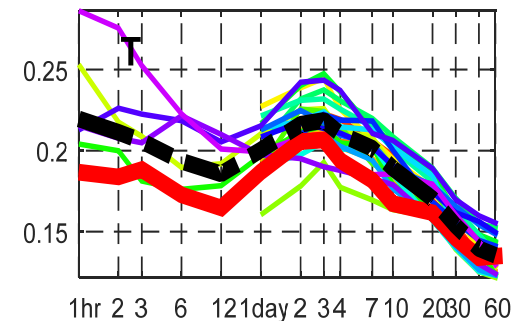
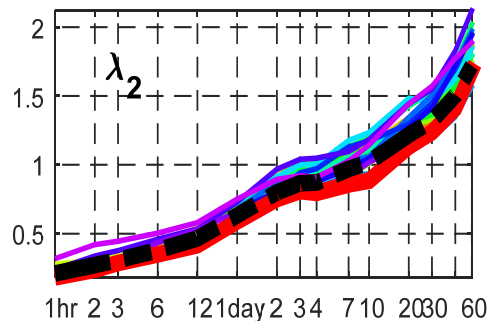
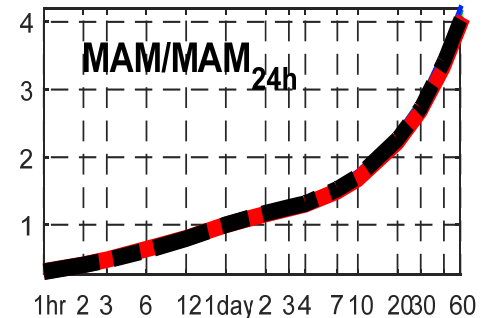
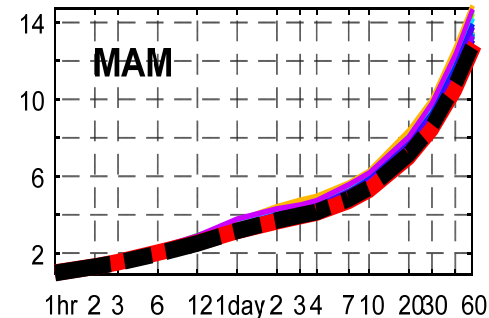


REGIONAL ANALYSIS FOR STATION 19-0770

i	ind	site_id	dist(mi)	elev	elev_diff	stdt	enddt	mam24hr	mam_diff	max1hr	max6hr	max2
Deleted stations												
31	97	19-4760	29.12	270	258	1885	2014	3.46	0.31	NaN	NaN	8.5
29	73	19-2997	28.21	250	238	1905	2014	3.36	0.21	NaN	NaN	10.7
Backup stations												
10	147	19-6012	14.39	50	38	1931	2014	3.23	0.07	NaN	NaN	6.8
22	90	19-4105	24.68	50	38	1893	2014	3.15	-0.00	NaN	NaN	7.7
21	52	19-0218	24.58	230	218	1893	1969	3.45	0.30	NaN	NaN	8.4
20	94	19-4580	22.60	205	193	1893	2014	2.92	-0.23	NaN	NaN	6.6
11	150	79-0028	15.07	161	149	1945	1996	3.04	-0.11	NaN	NaN	6.9
10	147	19-6012	14.39	50	38	1931	2014	3.23	0.07	NaN	NaN	6.8
Selected stations												
32	139	96-0003	30.33	304	292	1948	2013	3.77	0.62	3.46	6.55	10.4
30	113	19-6977	28.96	79	67	1902	2013	3.32	0.17	1.86	4.75	7.8
28	59	19-0840	28.20	40	28	1940	2014	3.39	0.24	3.30	7.37	9.1
...												
5	136	54-0129	10.57	58	46	1889	2010	3.08	-0.07	NaN	NaN	9.6
4	82	19-3624	10.51	35	23	1936	2014	3.67	0.52	NaN	NaN	8.0
3	64	19-1447	7.38	121	109	1884	2013	3.24	0.08	NaN	NaN	7.9
2	116	19-8030	7.20	171	159	1904	1977	3.30	0.15	NaN	NaN	11.0
1	143	19-0770	0.00	12	0	1851	2014	3.15	0.00	2.19	5.51	8.3

total number of years: 1879 346

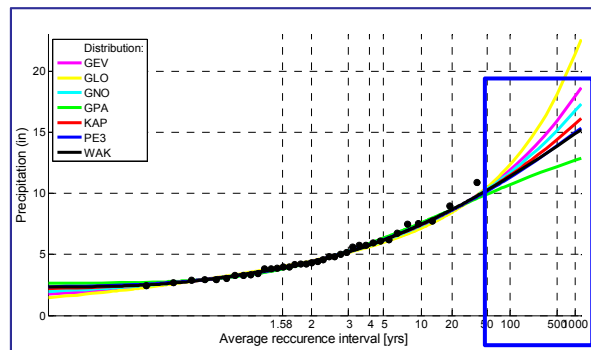
Enter index *i* from table for station you want to remove or add:



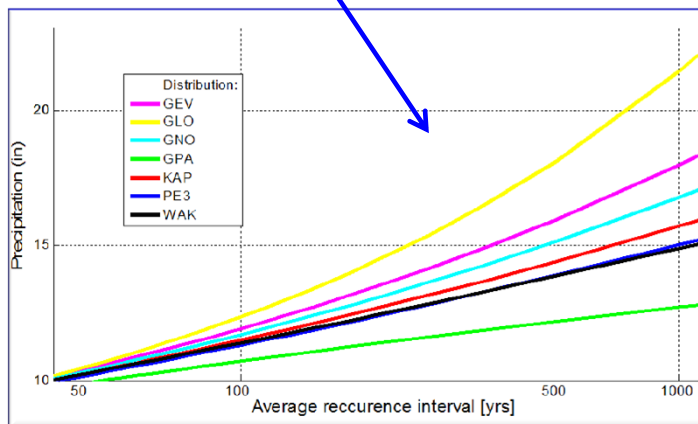
Distribution fitting

Distributions tested for 15-min to 60-day durations:

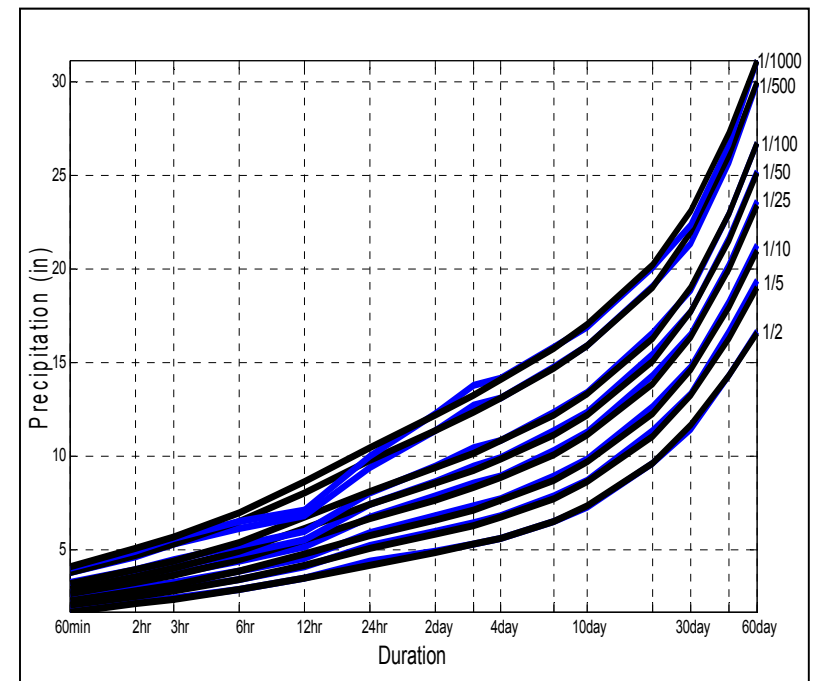
- Generalized Extreme Value (GEV)
- Generalized Normal
- Generalized Pareto
- Generalized Logistic
- Pearson Type III
- Kappa
- Wakeby



ARI (years)	Potential PF range
100	11-13 in
1000	13 -22 in
10000	14 - 38 in

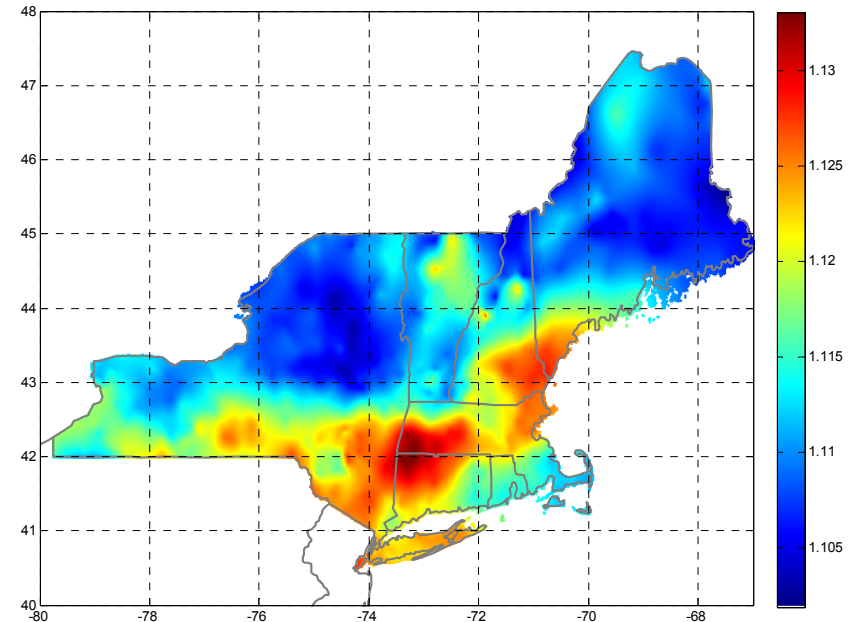
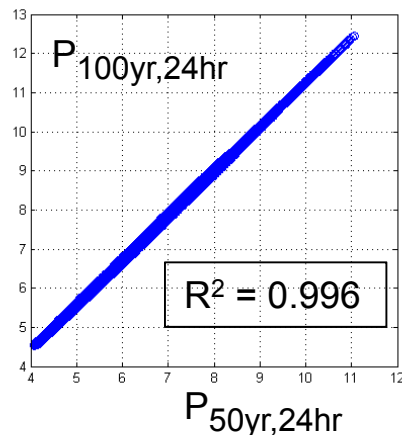


Development of DDF curves



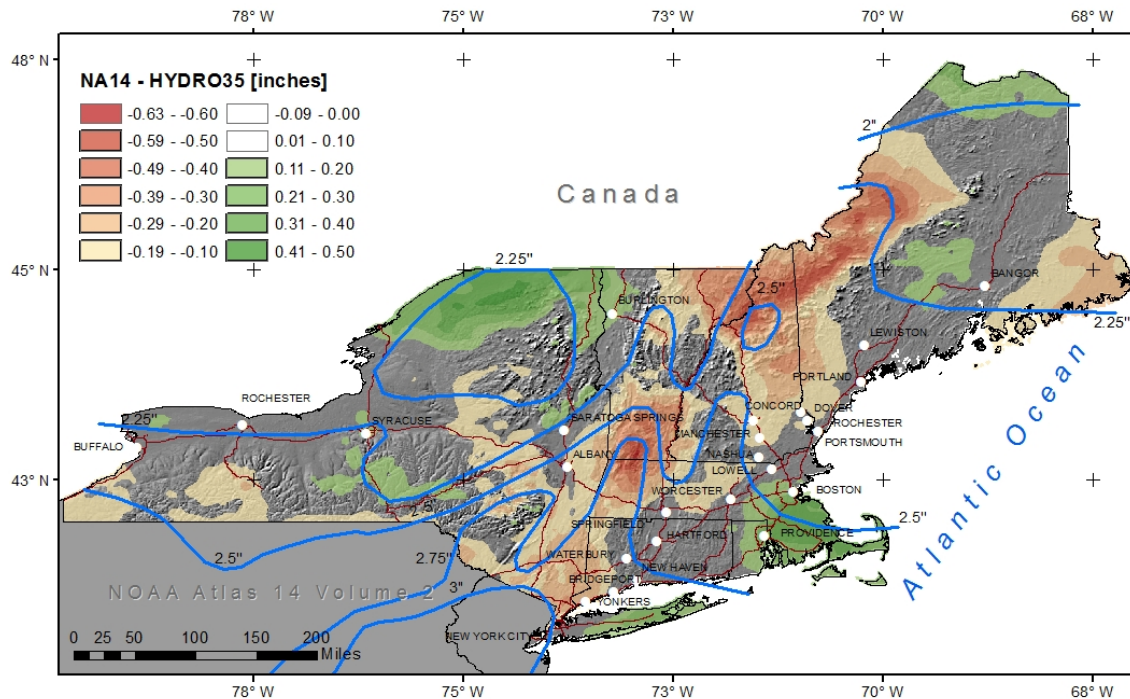
Spatial interpolation

- ❑ Mean annual maximum (MAM) precipitation grids are basis for deriving PF grids.
- ❑ PRISM statistical-geographic approach for mapping climate data used to derive MAM grids for 15-min to 60-day durations.
- ❑ Evolution of frequency-dependent spatial patterns is independent for each duration
- ❑ 5-min and 10-min grids derived from 15-min grids
- ❑ Process utilizes spatially interpolated ratios of precipitation frequency estimates for consecutive ARIs (natural neighbor interpolation - Delauney triangulation).
- ❑ Similar method used for confidence intervals

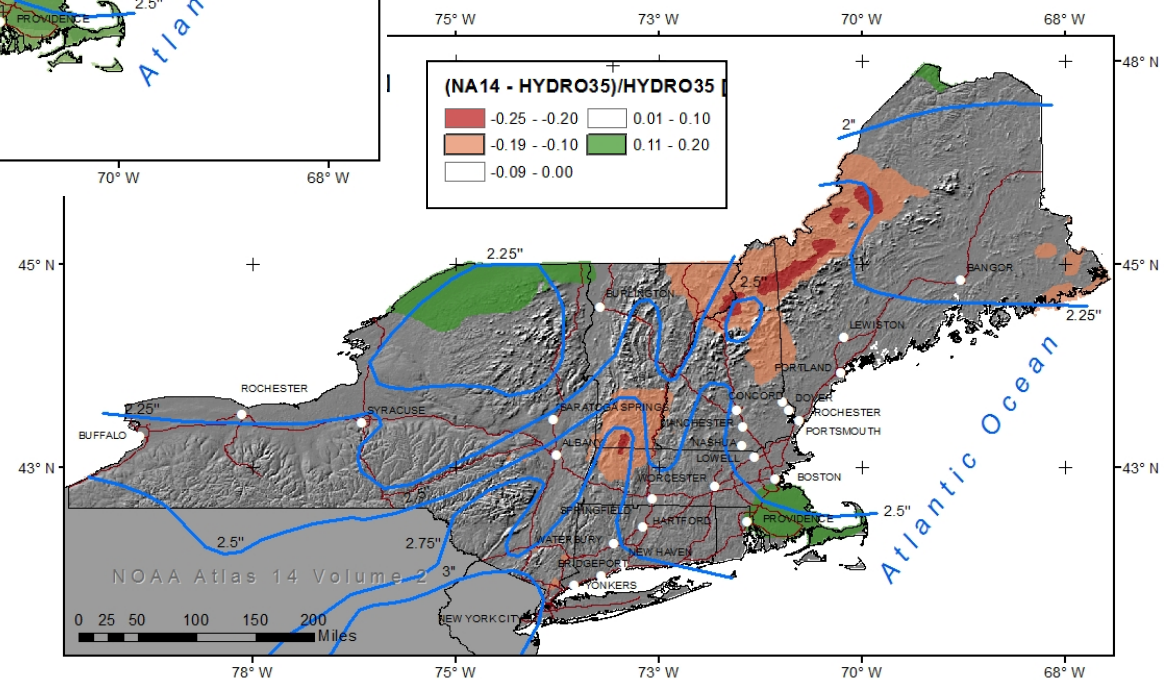


COMPARISON

Differences in 100-year 60-minute estimates from NA14 and HYDRO35 (1977)

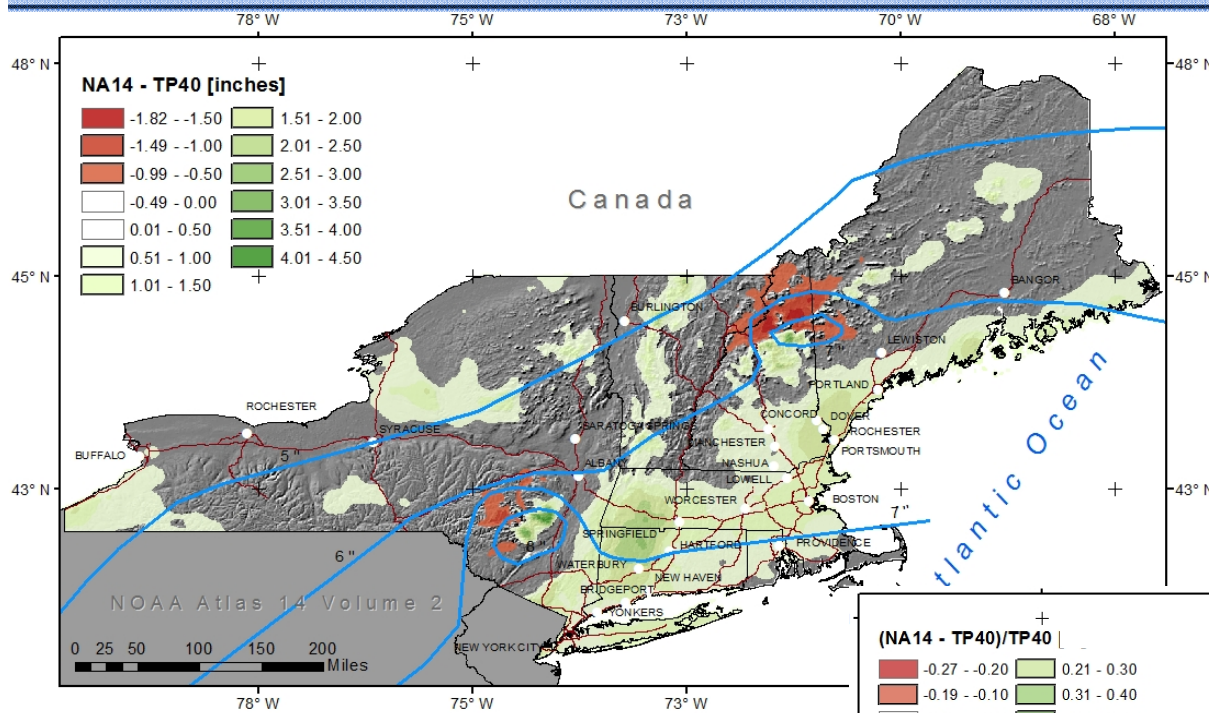


Superimposed blue lines are isopluvials from HYDRO35



COMPARISON

Differences in 100-yr 24-hr estimates from NA14 and TP40 (1961)



Superimposed blue lines are isopluvials from TP40.

