Updating Precipitation Intensity Data for New England: Status Report

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MA Water Resources Commission
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Summary

- Uses for precipitation intensity data
- Historic Standard
- NRCC and NOAA Updates
- Comparing old to new data
- Future precipitation intensity models
- Current uses of data sets
- Discussion

Uses for Precipitation Intensity Data

Engineering design

Runoff calculations

Stormwater management systems

Dam design and management

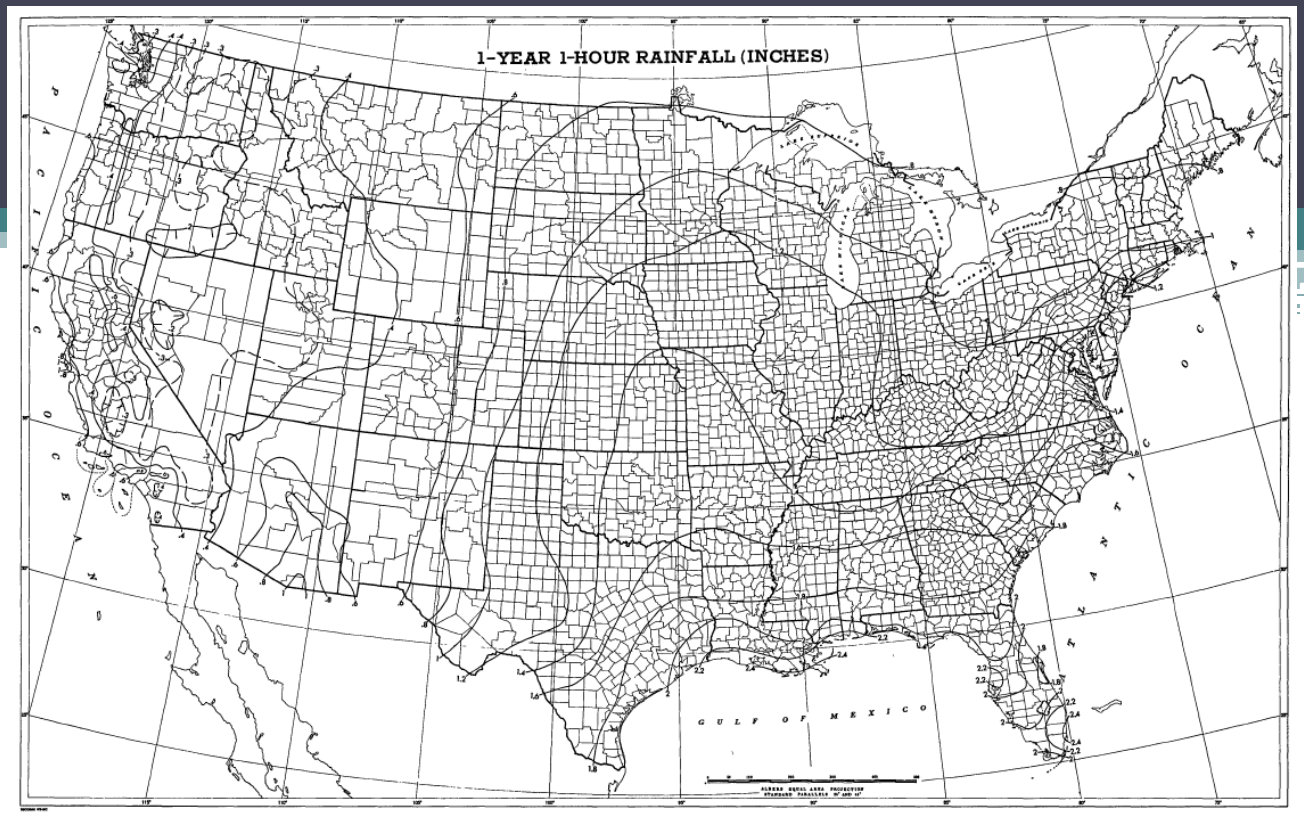
Culvert design

Not = Flood Frequency
Not = Flood Maps

Streamflow recurrence equations for MA are being updated by USGS

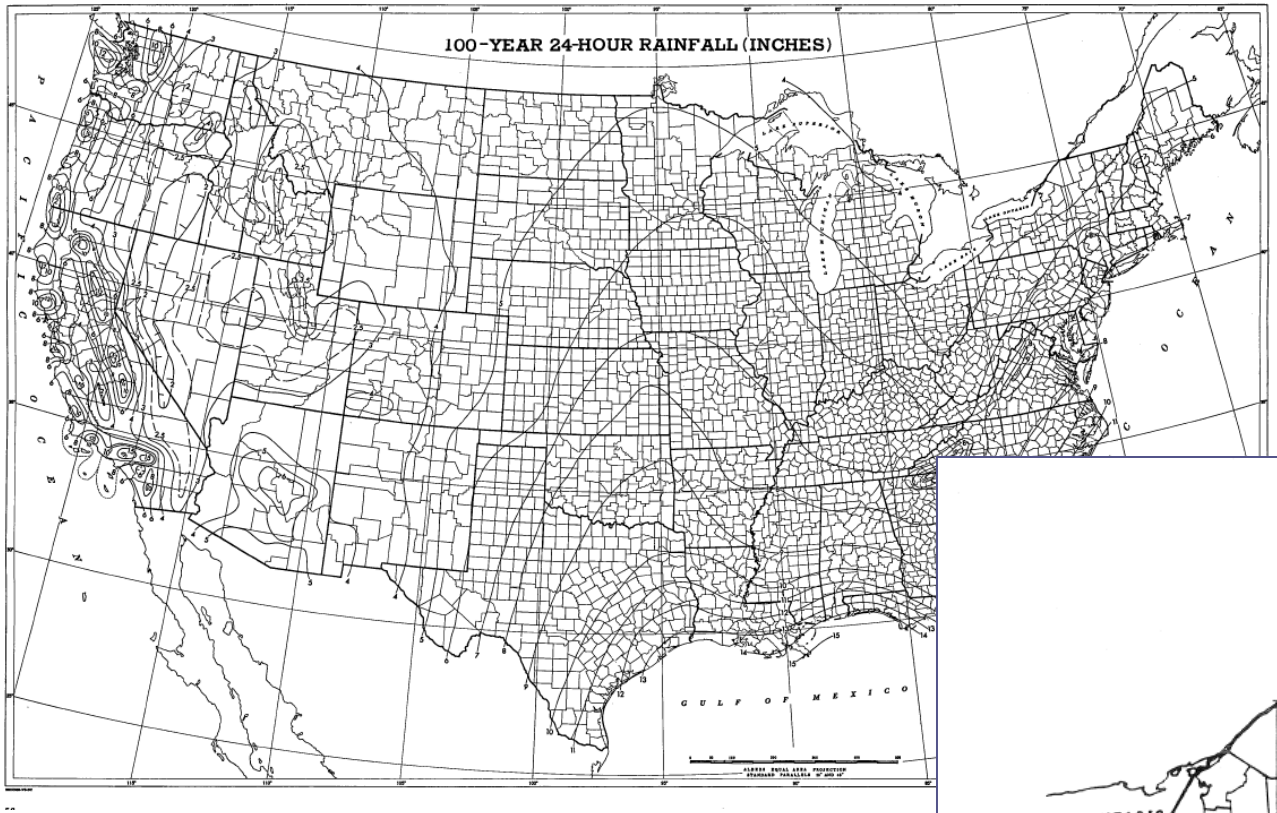
FEMA will subsequently update FIRMS

Historic Standard:
NOAA Technical Paper 40 (1961)
Rainfall Frequency Atlas for the US

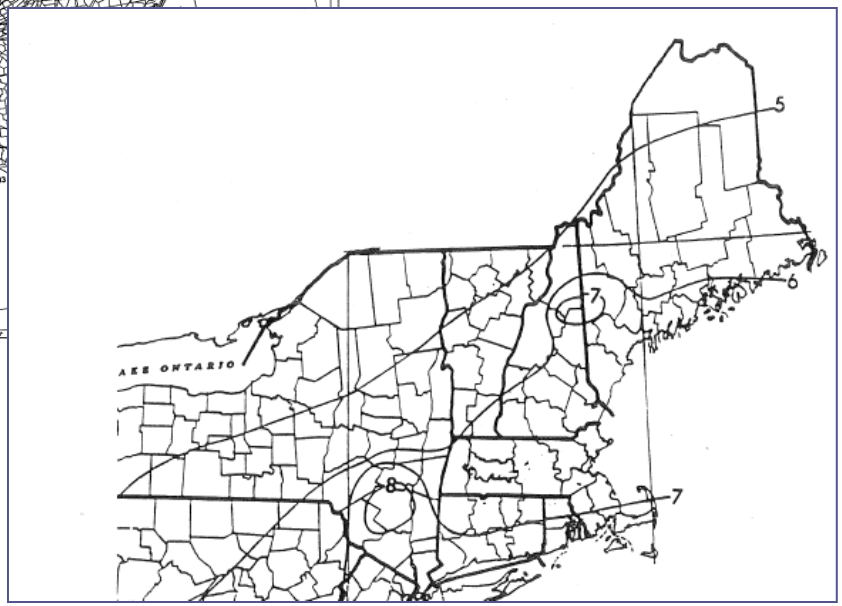


1-Year
1-Hour
Rainfall

TP-40



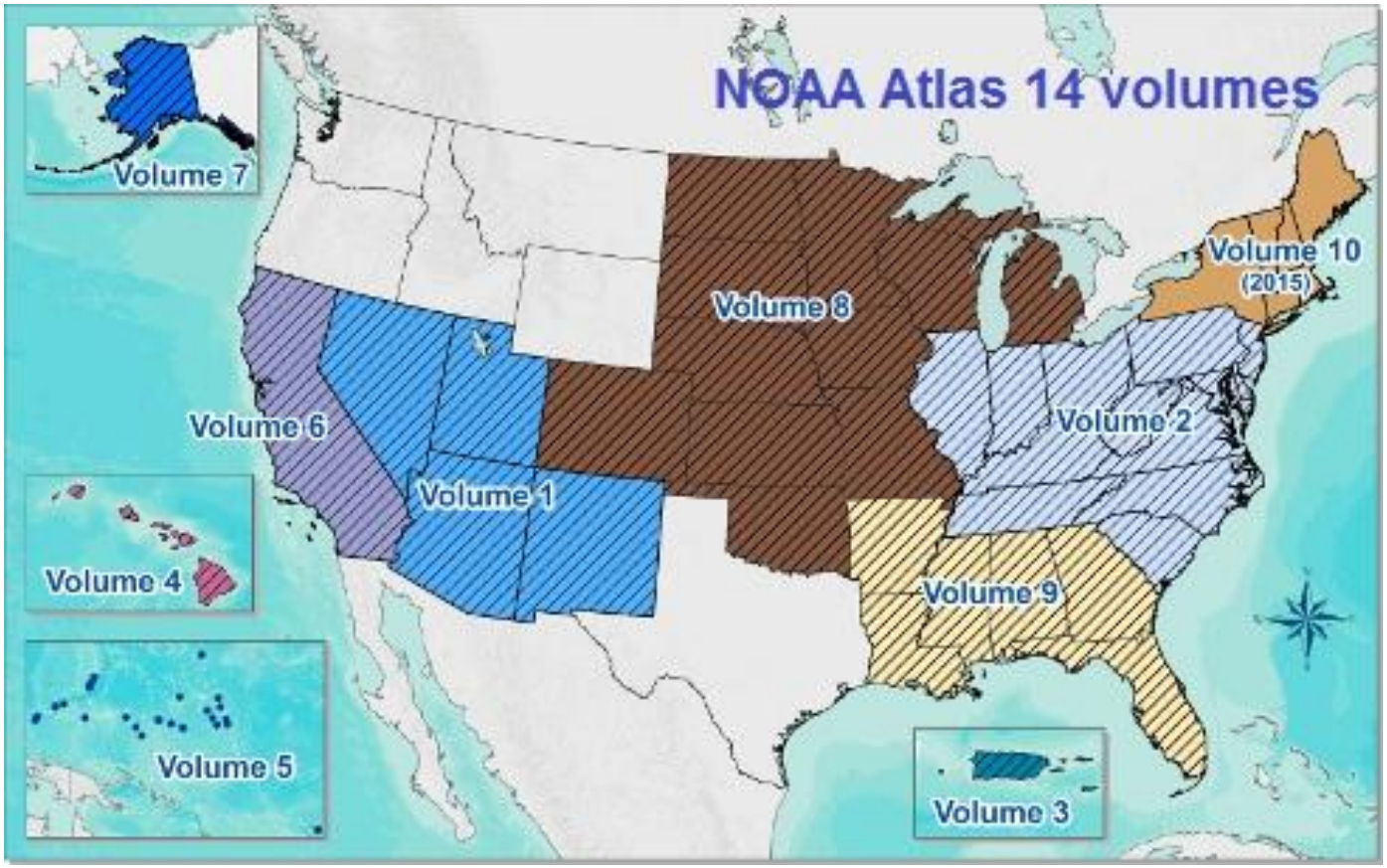
100-Year
24-Hour
Rainfall



NOAA's US Atlas 14

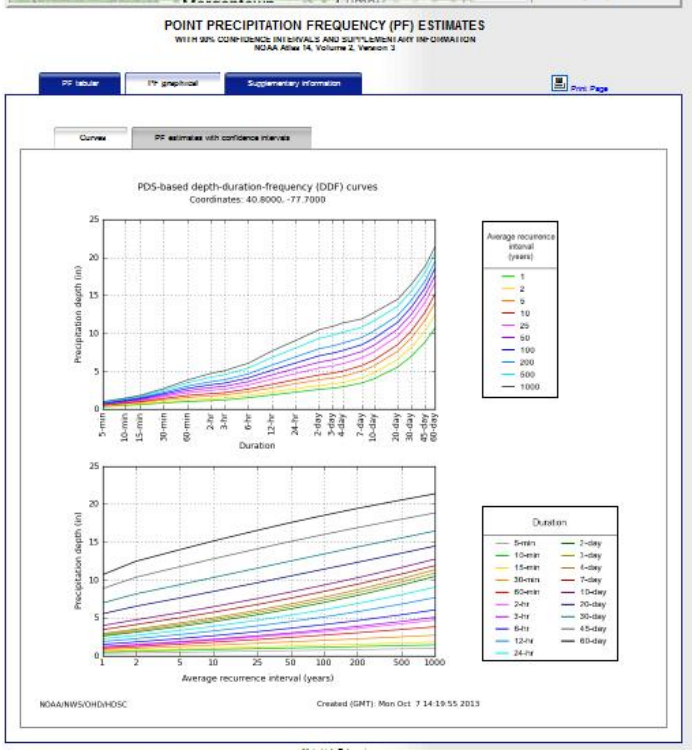
Hydrometeorological Design Studies Center

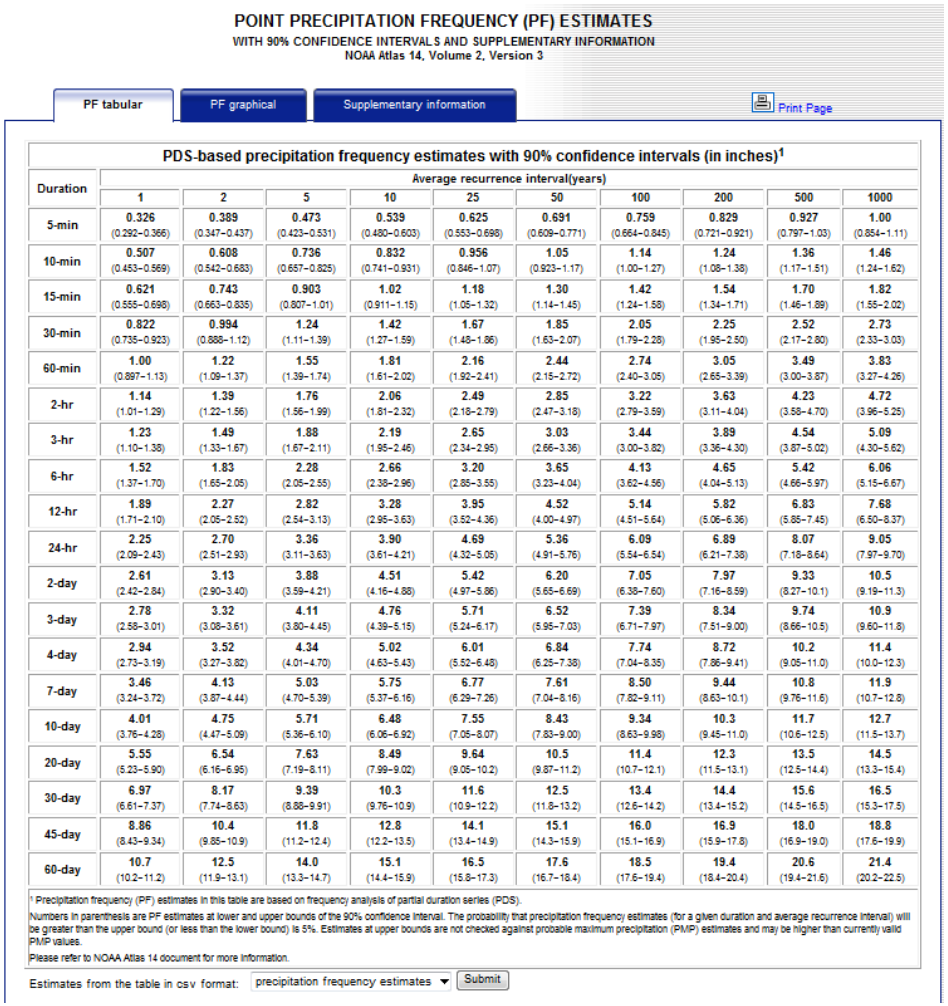
- Precipitation Frequency Data Server



http://dipper.nws.noaa.gov/hdsc/pfs/

NOAA Atlas 14 Data





POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION

NOAA Atlas 14, Volume 2, Version 3

PF tabular | PF graphical | Supplementary information | Print Page

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

Duration	Average recurrence interval(years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.326 (0.292–0.366)	0.389 (0.347–0.437)	0.473 (0.423–0.531)	0.539 (0.480–0.603)	0.625 (0.553–0.698)	0.691 (0.609–0.771)	0.759 (0.664–0.845)	0.829 (0.721–0.921)	0.927 (0.797–1.03)	1.00 (0.854–1.11)
10-min	0.507 (0.453–0.569)	0.608 (0.542–0.683)	0.736 (0.657–0.825)	0.832 (0.741–0.931)	0.956 (0.846–1.07)	1.05 (0.923–1.17)	1.14 (1.00–1.27)	1.24 (1.08–1.38)	1.36 (1.17–1.51)	1.46 (1.24–1.62)
15-min	0.621 (0.555–0.698)	0.743 (0.663–0.835)	0.903 (0.807–1.01)	1.02 (0.911–1.15)	1.18 (1.05–1.32)	1.30 (1.14–1.45)	1.42 (1.24–1.58)	1.54 (1.34–1.71)	1.70 (1.46–1.89)	1.82 (1.55–2.02)
30-min	0.822 (0.735–0.923)	0.994 (0.888–1.12)	1.24 (1.11–1.39)	1.42 (1.27–1.59)	1.67 (1.48–1.86)	1.85 (1.63–2.07)	2.05 (1.79–2.28)	2.25 (1.95–2.50)	2.52 (2.17–2.80)	2.73 (2.33–3.03)
60-min	1.00 (0.897–1.13)	1.22 (1.09–1.37)	1.55 (1.39–1.74)	1.81 (1.61–2.02)	2.16 (1.92–2.41)	2.44 (2.15–2.72)	2.74 (2.40–3.05)	3.05 (2.65–3.39)	3.49 (3.00–3.87)	3.83 (3.27–4.26)
2-hr	1.14 (1.01–1.29)	1.39 (1.22–1.56)	1.76 (1.56–1.99)	2.06 (1.81–2.32)	2.49 (2.18–2.79)	2.85 (2.47–3.18)	3.22 (2.79–3.59)	3.63 (3.11–4.04)	4.23 (3.58–4.70)	4.72 (3.96–5.25)
3-hr	1.23 (1.10–1.38)	1.49 (1.33–1.67)	1.88 (1.67–2.11)	2.19 (1.95–2.46)	2.65 (2.34–2.95)	3.03 (2.66–3.36)	3.44 (3.00–3.82)	3.89 (3.36–4.30)	4.54 (3.87–5.02)	5.09 (4.30–5.62)
6-hr	1.52 (1.37–1.70)	1.83 (1.65–2.05)	2.28 (2.05–2.55)	2.66 (2.38–2.96)	3.20 (2.85–3.55)	3.65 (3.23–4.04)	4.13 (3.62–4.56)	4.65 (4.04–5.13)	5.42 (4.66–5.97)	6.06 (5.15–6.67)
12-hr	1.89 (1.71–2.10)	2.27 (2.05–2.52)	2.82 (2.54–3.13)	3.28 (2.95–3.63)	3.95 (3.52–4.36)	4.52 (4.00–4.97)	5.14 (4.51–5.64)	5.82 (5.06–6.36)	6.83 (5.85–7.45)	7.68 (6.50–8.37)
24-hr	2.25 (2.09–2.43)	2.70 (2.51–2.93)	3.36 (3.11–3.63)	3.90 (3.61–4.21)	4.69 (4.32–5.05)	5.36 (4.91–5.76)	6.09 (5.54–6.54)	6.89 (6.21–7.38)	8.07 (7.18–8.64)	9.05 (7.97–9.70)
2-day	2.61 (2.42–2.84)	3.13 (2.90–3.40)	3.88 (3.59–4.21)	4.51 (4.16–4.88)	5.42 (4.97–5.86)	6.20 (5.65–6.69)	7.05 (6.38–7.60)	7.97 (7.16–8.59)	9.33 (8.27–10.1)	10.5 (9.19–11.3)
3-day	2.78 (2.58–3.01)	3.32 (3.08–3.61)	4.11 (3.80–4.45)	4.76 (4.39–5.15)	5.71 (5.24–6.17)	6.52 (5.95–7.03)	7.39 (6.71–7.97)	8.34 (7.51–9.00)	9.74 (8.66–10.5)	10.9 (9.60–11.8)
4-day	2.94 (2.73–3.19)	3.52 (3.27–3.82)	4.34 (4.01–4.70)	5.02 (4.63–5.43)	6.01 (5.52–6.48)	6.84 (6.25–7.38)	7.74 (7.04–8.35)	8.72 (7.86–9.41)	10.2 (9.05–11.0)	11.4 (10.0–12.3)
7-day	3.46 (3.24–3.72)	4.13 (3.87–4.44)	5.03 (4.70–5.39)	5.75 (5.37–6.16)	6.77 (6.29–7.26)	7.61 (7.04–8.16)	8.50 (7.82–9.11)	9.44 (8.63–10.1)	10.8 (9.76–11.6)	11.9 (10.7–12.8)
10-day	4.01 (3.76–4.28)	4.75 (4.47–5.09)	5.71 (5.36–6.10)	6.48 (6.06–6.92)	7.55 (7.05–8.07)	8.43 (7.83–9.00)	9.34 (8.63–9.98)	10.3 (9.45–11.0)	11.7 (10.6–12.5)	12.7 (11.5–13.7)
20-day	5.55 (5.23–5.90)	6.54 (6.16–6.95)	7.63 (7.19–8.11)	8.49 (7.99–9.02)	9.64 (9.05–10.2)	10.5 (9.87–11.2)	11.4 (10.7–12.1)	12.3 (11.5–13.1)	13.5 (12.5–14.4)	14.5 (13.3–15.4)
30-day	6.97 (6.61–7.37)	8.17 (7.74–8.63)	9.39 (8.88–9.91)	10.3 (9.76–10.9)	11.6 (10.9–12.2)	12.5 (11.8–13.2)	13.4 (12.6–14.2)	14.4 (13.4–15.2)	15.6 (14.5–16.5)	16.5 (15.3–17.5)
45-day	8.86 (8.43–9.34)	10.4 (9.85–10.9)	11.8 (11.2–12.4)	12.8 (12.2–13.5)	14.1 (13.4–14.9)	15.1 (14.3–15.9)	16.0 (15.1–16.9)	16.9 (15.9–17.8)	18.0 (16.9–19.0)	18.8 (17.6–19.9)
60-day	10.7 (10.2–11.2)	12.5 (11.9–13.1)	14.0 (13.3–14.7)	15.1 (14.4–15.9)	16.5 (15.8–17.3)	17.6 (16.7–18.4)	18.5 (17.6–19.4)	19.4 (18.4–20.4)	20.6 (19.4–21.6)	21.4 (20.2–22.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

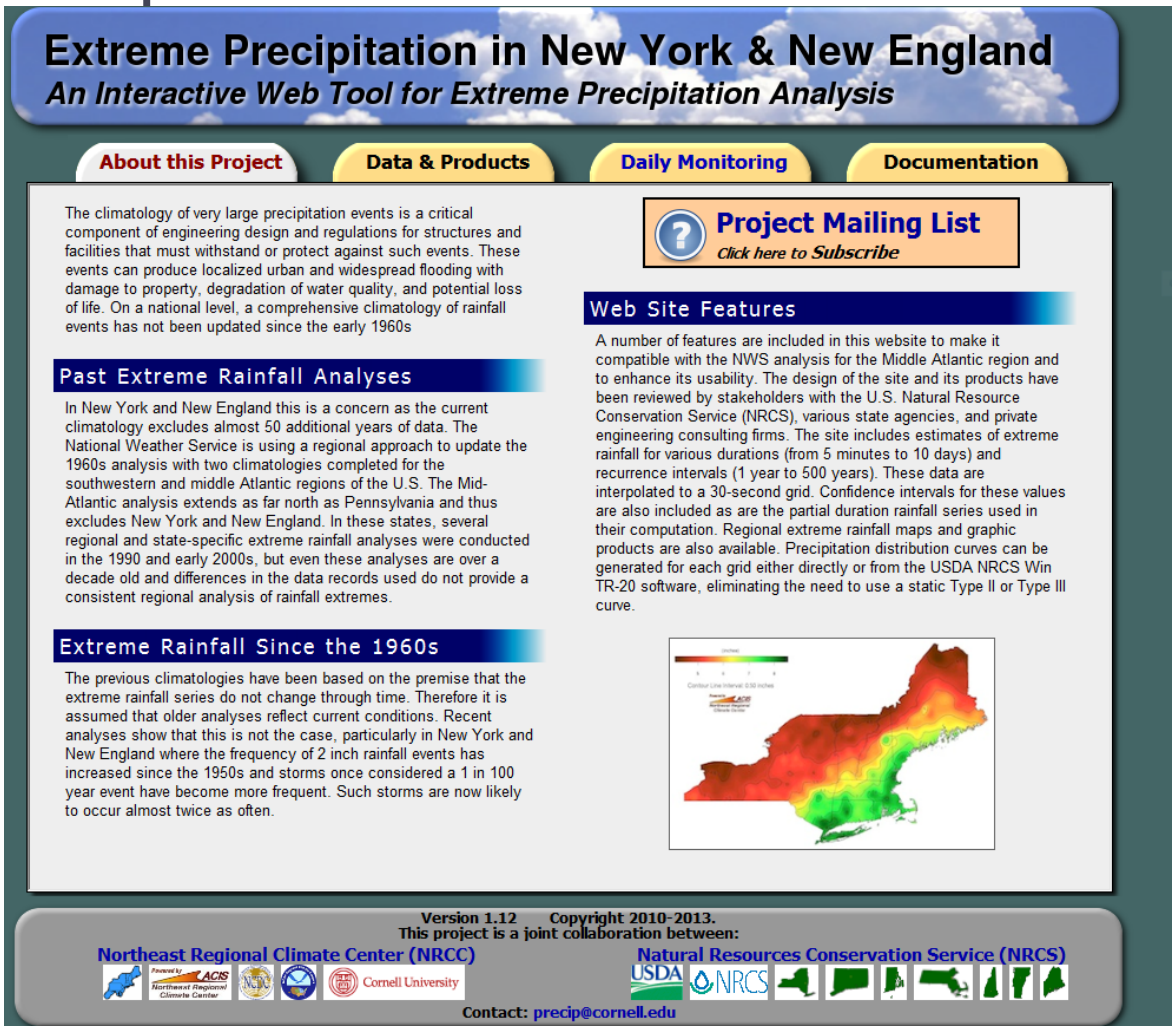
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in csv format: precipitation frequency estimates | Submit

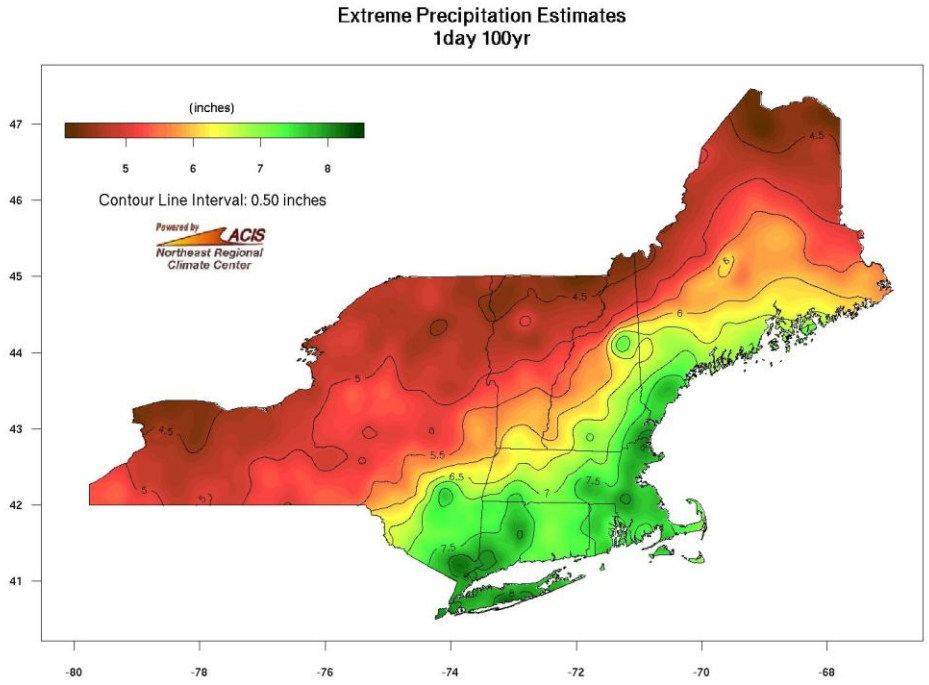
2010 NRCS/NRCC

Extreme Precipitation in New York and New England



http://precip.eas.cornell.edu

NRCC Data



Extreme Precipitation Tables

Northeast Regional Climate Center

Data represent point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	Massachusetts
Location	
Longitude	72.312 degrees West
Latitude	42.342 degrees North
Elevation	0 feet
Date/Time	Mon, 7 Oct 2013 10:30:59 -0400

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.29	0.45	0.55	0.73	0.91	1.14	1yr	0.78	1.05	1.31	1.63	2.03	2.53	2.78	1yr	2.24	2.67	3.10	3.77	4.39	1yr
2yr	0.35	0.54	0.67	0.88	1.11	1.39	2yr	0.96	1.27	1.60	1.98	2.44	3.00	3.36	2yr	2.65	3.23	3.74	4.46	5.10	2yr
5yr	0.42	0.65	0.82	1.09	1.40	1.76	5yr	1.21	1.58	2.03	2.50	3.06	3.73	4.26	5yr	3.30	4.09	4.70	5.53	6.28	5yr
10yr	0.47	0.75	0.94	1.28	1.67	2.11	10yr	1.44	1.88	2.44	3.00	3.65	4.41	5.09	10yr	3.90	4.89	5.59	6.51	7.35	10yr
25yr	0.57	0.90	1.15	1.58	2.10	2.67	25yr	1.81	2.35	3.09	3.79	4.59	5.49	6.46	25yr	4.86	6.21	7.03	8.08	9.05	25yr
50yr	0.64	1.03	1.33	1.86	2.50	3.22	50yr	2.16	2.79	3.72	4.55	5.47	6.49	7.74	50yr	5.74	7.45	8.37	9.53	10.60	50yr
100yr	0.74	1.20	1.55	2.19	2.99	3.86	100yr	2.58	3.32	4.47	5.45	6.52	7.68	9.28	100yr	6.79	8.93	9.96	11.25	12.43	100yr
200yr	0.86	1.40	1.82	2.60	3.58	4.63	200yr	3.09	3.94	5.35	6.52	7.75	9.08	11.14	200yr	8.04	10.71	11.87	13.25	14.57	200yr
500yr	1.04	1.71	2.23	3.24	4.54	5.90	500yr	3.92	4.96	6.82	8.27	9.78	11.35	14.18	500yr	10.05	13.64	14.97	16.50	18.00	500yr

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.37	0.45	0.60	0.74	0.87	1yr	0.64	0.85	1.06	1.36	1.74	2.38	2.52	1yr	2.10	2.42	2.80	3.44	3.93	1yr
2yr	0.34	0.52	0.64	0.86	1.07	1.25	2yr	0.92	1.22	1.43	1.84	2.35	2.89	3.24	2yr	2.56	3.12	3.62	4.31	4.95	2yr
5yr	0.38	0.58	0.72	0.99	1.26	1.48	5yr	1.09	1.45	1.67	2.15	2.71	3.41	3.90	5yr	3.02	3.75	4.34	5.11	5.85	5yr
10yr	0.41	0.63	0.78	1.09	1.41	1.66	10yr	1.22	1.62	1.87	2.41	3.01	3.88	4.50	10yr	3.43	4.33	4.97	5.79	6.62	10yr
25yr	0.46	0.70	0.88	1.25	1.65	1.92	25yr	1.42	1.88	2.19	2.78	3.45	4.56	5.43	25yr	4.03	5.22	5.98	6.89	7.83	25yr
50yr	0.50	0.76	0.95	1.36	1.83	2.13	50yr	1.58	2.08	2.44	3.09	3.80	5.18	6.25	50yr	4.58	6.01	6.90	7.86	8.90	50yr
100yr	0.54	0.82	1.03	1.48	2.03	2.35	100yr	1.76	2.30	2.73	3.43	4.20	5.88	7.24	100yr	5.20	6.96	7.97	9.00	10.13	100yr
200yr	0.58	0.88	1.11	1.61	2.25	2.58	200yr	1.94	2.52	3.04	3.79	4.63	6.70	8.36	200yr	5.93	8.04	9.25	10.30	11.57	200yr
500yr	0.65	0.97	1.24	1.81	2.57	2.88	500yr	2.22	2.82	3.48	4.30	5.25	7.97	10.16	500yr	7.05	9.77	11.27	12.39	13.82	500yr

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.32	0.49	0.60	0.81	1.00	1.17	1yr	0.86	1.15	1.34	1.72	2.24	2.69	3.00	1yr	2.38	2.88	3.32	4.01	4.72	1yr
2yr	0.36	0.56	0.69	0.94	1.16	1.36	2yr	1.00	1.33	1.53	1.97	2.52	3.13	3.51	2yr	2.77	3.38	3.90	4.63	5.30	2yr
5yr	0.46	0.71	0.88	1.21	1.54	1.77	5yr	1.33	1.73	2.00	2.55	3.21	4.09	4.66	5yr	3.62	4.48	5.09	6.01	6.78	5yr
10yr	0.56	0.85	1.06	1.48	1.91	2.18	10yr	1.65	2.13	2.47	3.12	3.87	5.02	5.78	10yr	4.44	5.56	6.24	7.30	8.16	10yr
25yr	0.72	1.10	1.37	1.95	2.56	2.89	25yr	2.21	2.83	3.27	4.09	4.98	6.54	7.71	25yr	5.79	7.41	8.15	9.46	10.45	25yr
50yr	0.87	1.33	1.65	2.37	3.20	3.60	50yr	2.76	3.52	4.05	5.04	6.03	8.02	9.58	50yr	7.10	9.21	9.98	11.49	12.55	50yr
100yr	1.07	1.61	2.02	2.92	4.00	4.49	100yr	3.45	4.39	5.03	6.23	7.32	9.84	11.92	100yr	8.70	11.46	12.19	13.95	15.12	100yr
200yr	1.30	1.96	2.49	3.60	5.02	5.60	200yr	4.33	5.48	6.25	7.72	8.89	12.05	14.82	200yr	10.67	14.25	14.89	16.92	18.18	200yr
500yr	1.72	2.56	3.30	4.79	6.81	7.53	500yr	5.88	7.36	8.37	10.30	11.51	15.78	19.80	500yr	13.97	19.04	19.39	21.86	23.18	500yr

Old to New Comparison

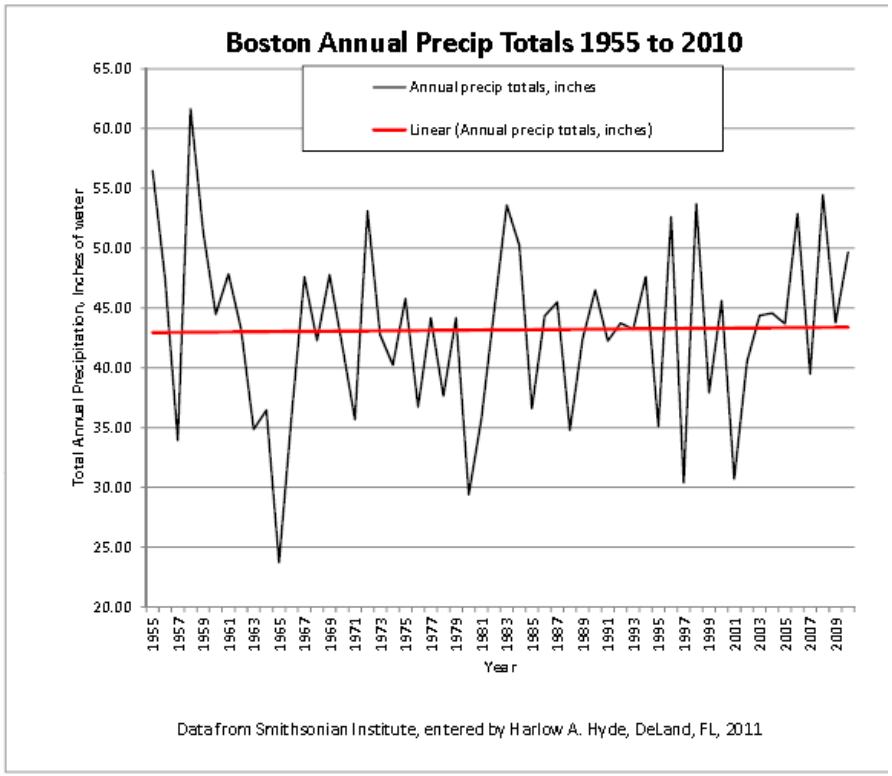
TP-40 used ~200 data stations for the entire US!

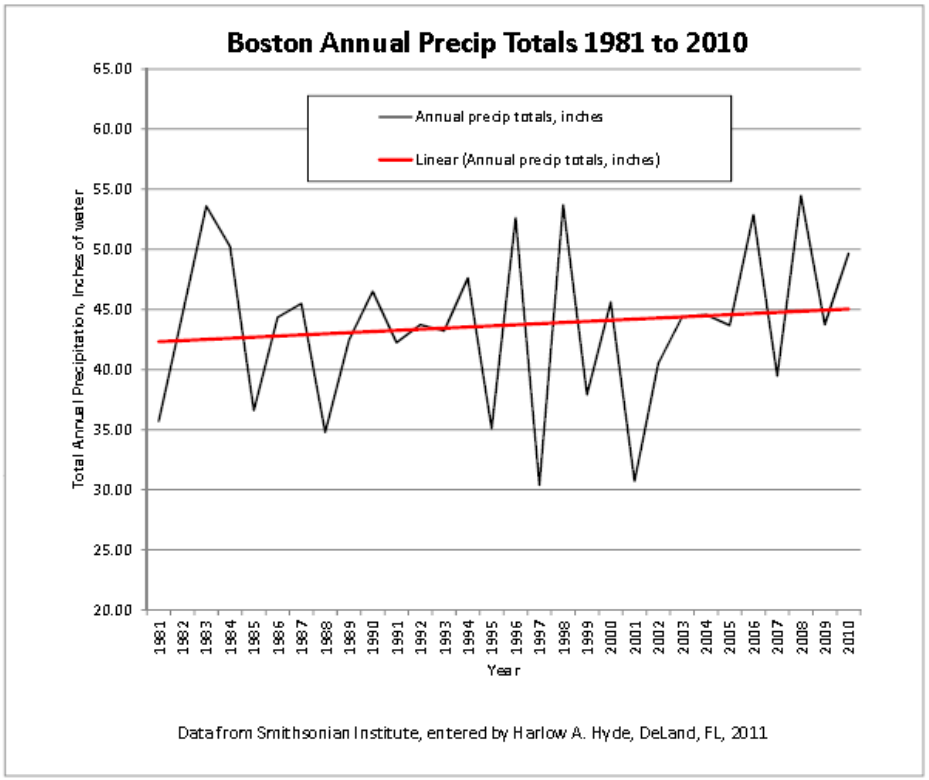
Effects of climate change difficult to tease out with data differences

Time frame of “lookback” period affects trend results

- 1960’s Drought not included in TP-40
- 1955 Hurricanes flatten the trend in long-term analysis

Effect of time period on trend





NRCC to NOAA Atlas 14 Comparison

NRCC analyzed mid-Atlantic US area using their method and NOAA Atlas 14 method

Smaller storms (2-year):
NRCC values < NOAA Atlas 14
(NRCC underestimates smaller storms)

Larger storms (100-year)
NRCC values > NOAA Atlas 14

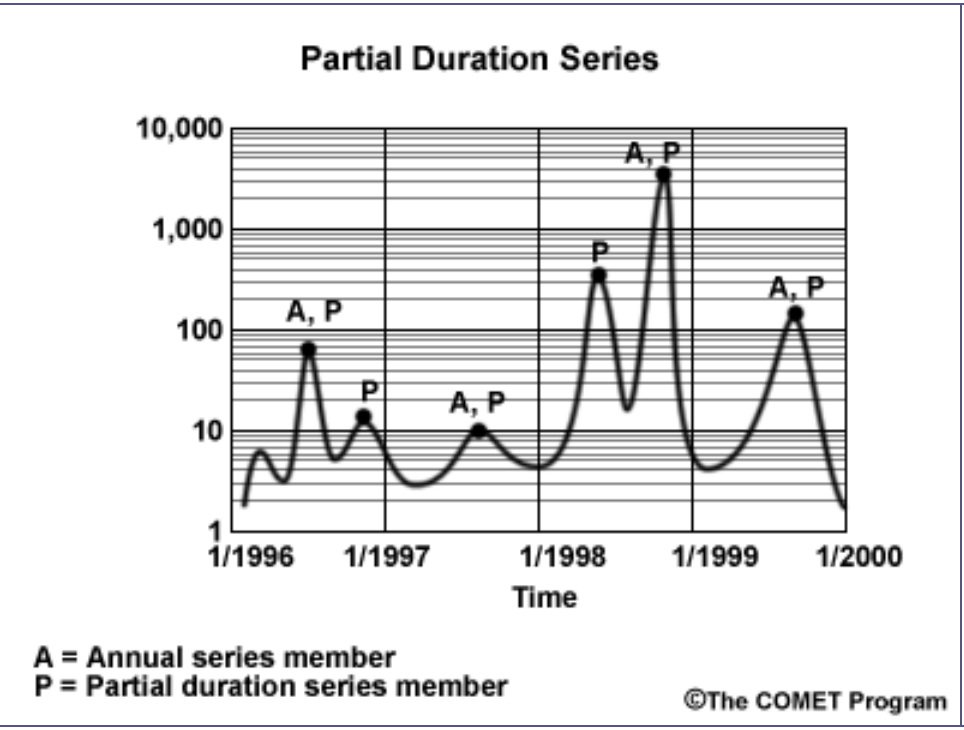
In both cases, results are within NRCC confidence intervals!

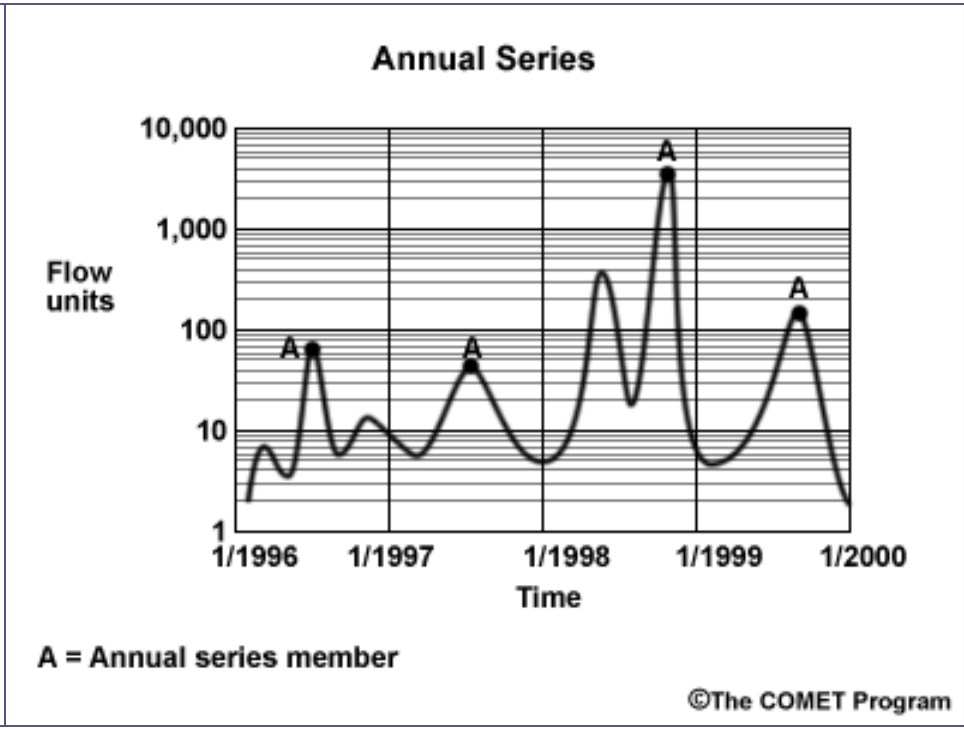
Differences in 2 methodologies

- NRCC Partial Duration Series (PDS):
  - Uses all precipitation events to calculate frequencies

- NOAA Atlas 14 Annual Maximum Series (AMS) with PDS
  - Uses a single value of maximum precipitation for each year– excludes some extreme events

Partial Duration Series vs Annual Maximum Series





Future Precipitation Intensity

- NRCC estimated future changes in NY state based on climate modeling
- Compared “current” (1970-1999) to “future” (2040 to 2069) and (2081 to 2100)
- Predict up to a 25% increase in small (2-year) storms
- Predict 10 to 30% increase in larger (100-year) storms

Use of the new Precipitation Intensity Data

TP-40 remains the Federal standard until NOAA Atlas 14 Update

- NRCC requires use of NRCC results
- Federal Highway projects use TP-40
- MA DCR Engineering requires use of NRCC
- DEP Stormwater uses TP-40

Additional Points/Issues

- Prudent engineering design includes consideration of NRCC values
- Engineering safety factors could be sufficient to cover the increases
- Unlikely small towns are using NRCC values in culvert design
- Use of new (higher) values will result in increased construction costs
- Adopt 2010 NRCC values temporarily or wait until 2015 for NOAA Atlas 14?
- Frequency of Updates?

Discussion