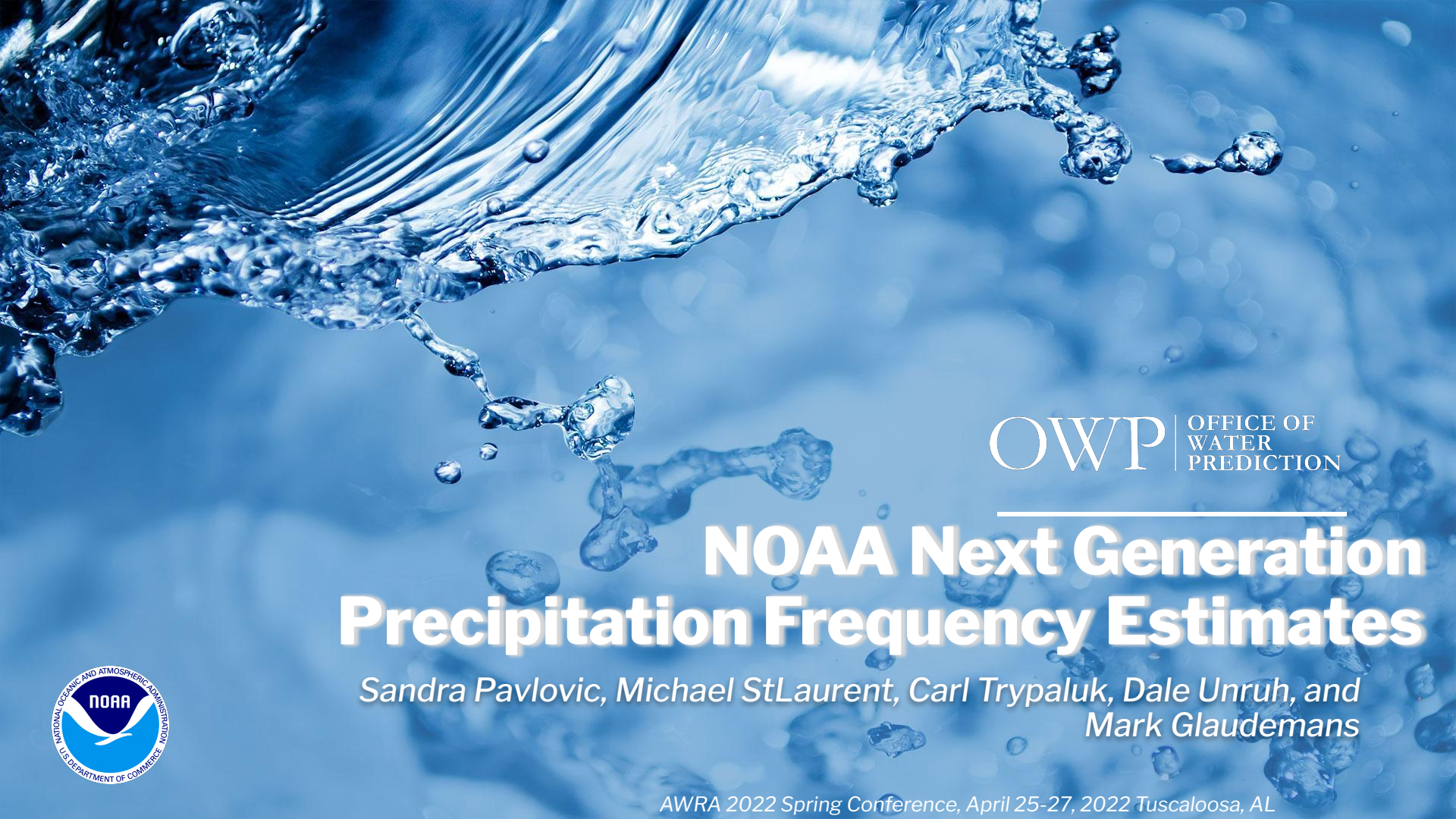

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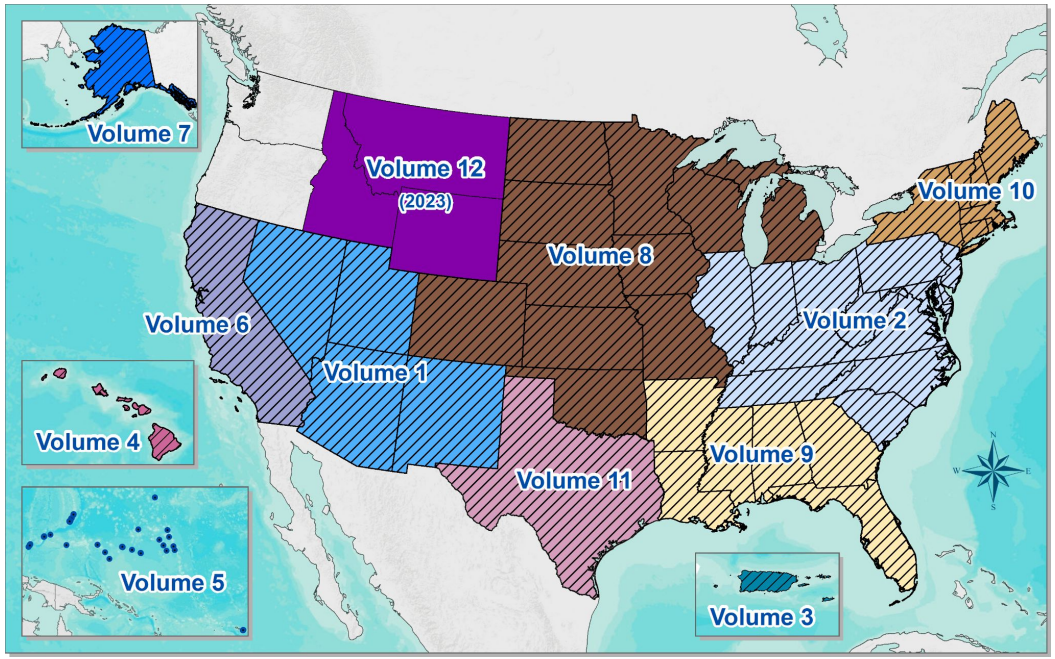
NOAA Next Generation Precipitation Frequency Estimates

Sandra Pavlovic, Michael StLaurent, Carl Trypaluk, Dale Unruh, and Mark Glaudemans

AWRA 2022 Spring Conference, April 25-27, 2022 Tuscaloosa, AL

NOAA Atlas 14



https://www.weather.gov/owp/hdsc

Application

- Used as an input in sizing engineering infrastructure and watershed planning.
- Assessing the severity of the extreme storms events.

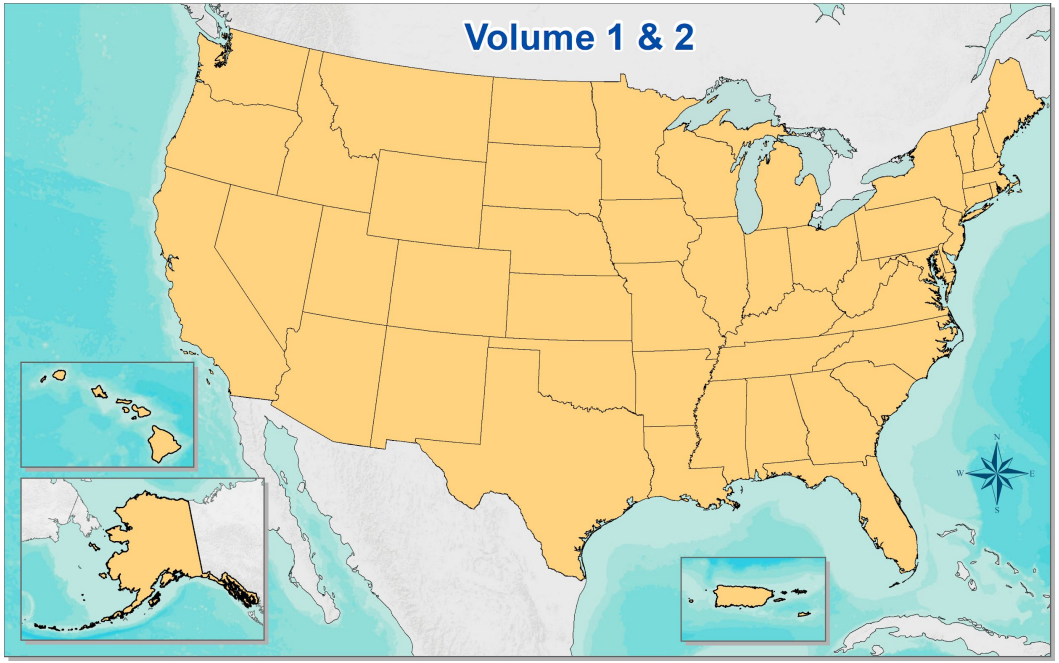
Assumption

- Currently assumes both stationarity in data and methodology.

Funding Approach

- Volumes produced in response to stakeholder requests and sponsorship
    - *Discontinuities at volumes' boundaries, and irregular update cycle creates issues for users*

Next Generation NOAA Atlas 15 (moniker)



Application

- Used as an input in sizing engineering infrastructure and watershed planning *under climate change*

Enhancements

- Ability to *model the trend in data* when it exists and integrate *future climate projections* into precipitation frequency analysis

Funding Approach

- Proposed funding support per Infrastructure Investment and Jobs Act (IIJA)

Service Delivery

- Provides estimates for 5 minutes to 60 days duration, recurrence interval 1 to 1000 years

Next Generation NOAA Atlas 15

Next generation estimates to be presented as two national volumes

Volume 1: Precipitation frequency with observed trends

- based on historical precipitation gauge observations,
- integrated terrain information, and
- includes modeled trend in historical observations (when it exists) to account for the short-term non-stationary temporal changes.
    - Non-stationary trends represents a major enhancement from Atlas 14

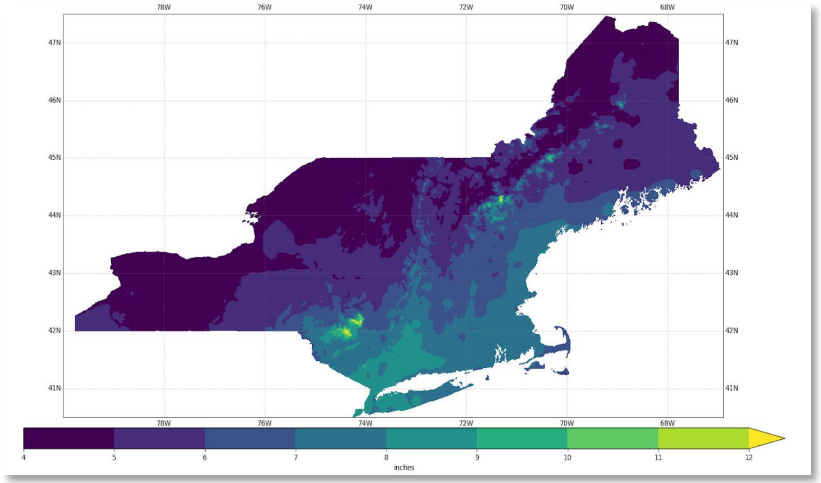
Volume 2: Precipitation frequency with climate projection adjustment factors

- future precipitation informed by global climate models,
- modeled nonstationary temporal changes, and
- provides adjustment factors based on historical observations (Volume 1) to calculate future estimates.
    - Adjustments represent additional non-stationary information beyond Atlas 14

NOAA Atlas 15 Enhancements

- ✔ Work done in collaboration with Penn State University, University of Illinois Urbana-Champaign and University of Wisconsin-Madison
- ✔ Testing done for Atlas 14 Volume 10 project area (Northeastern States)
- ✔ Funding provided by DOT FHWA
- ✔ NWS Assessment Report : ***https://www.weather.gov/owp/hdsc_current_projects***

1-day 100-year



Outcome:

Non-stationary methodology based on local (regional) maximum likelihood approach

Next Gen Atlas 15: Enhancements Part 1

Datasets

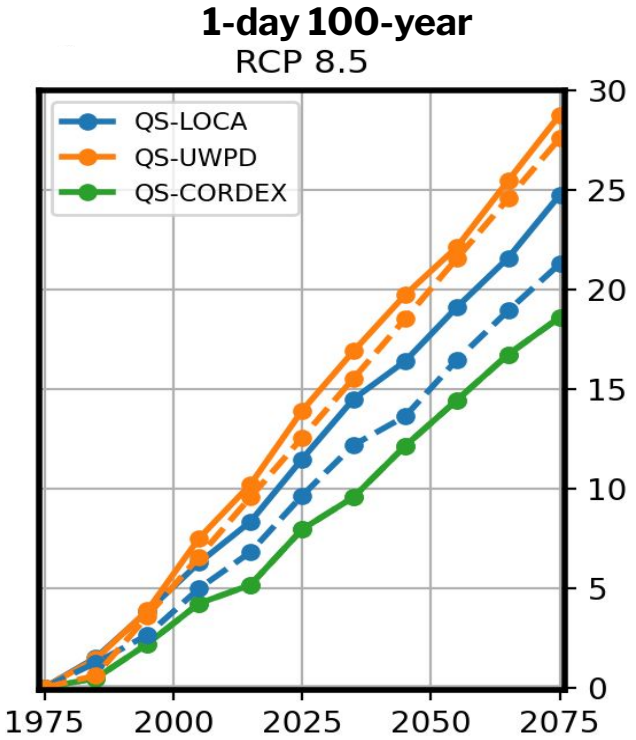
- ✔ CMIP5 LOCA, UWPD, NA-CORDEX, and BCCAv2

Climate model scenarios

- ✔ RCP4.5 and RCP8.5

Findings

- ✔ Climate models are good tool to account for change in the future climate but the model-based precipitation frequency estimates should not be used in design as absolute values.
- ✔ The downscaled datasets could be used as a relative change between the present and the future precipitation frequency estimates.
- ✔ Among the datasets considered, one dataset did not significantly outperform the other datasets considered.
- ✔ Based on the ensemble of results, the variability among future projections should be regarded as significant.



❖ UWPD: https://registry.opendata.aws/noaa-uwpd-cmip5/

Next Gen Atlas 15: Enhancements Part 2

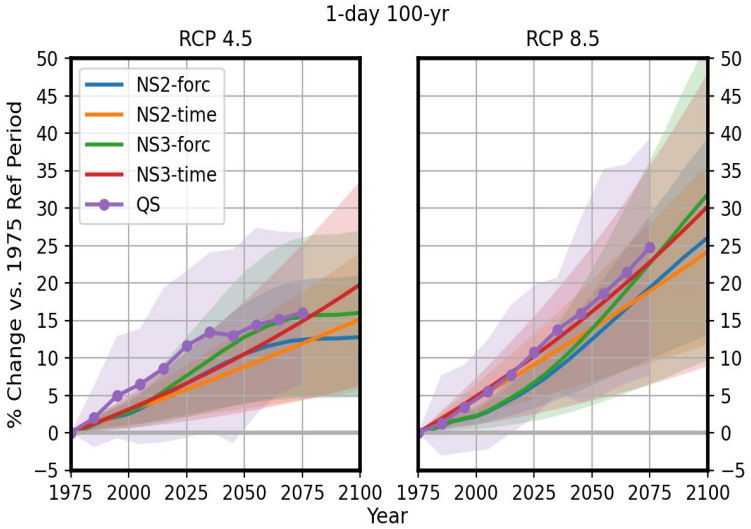
Methodologies

✔ Quasi Stationary (QS) and Nonstationary (NS)

NS – local (regional) maximum likelihood approach.

Method	Emission	Covariates
QS	RCP 4.5/8.5	None
NS2-year	RCP 4.5/8.5	'year'
NS2-forc	RCP 4.5/8.5	RCP delta radiative forcing
NS3-year	RCP 4.5/8.5	'year'
NS3-forc	RCP 4.5/8.5	RCP delta radiative forcing

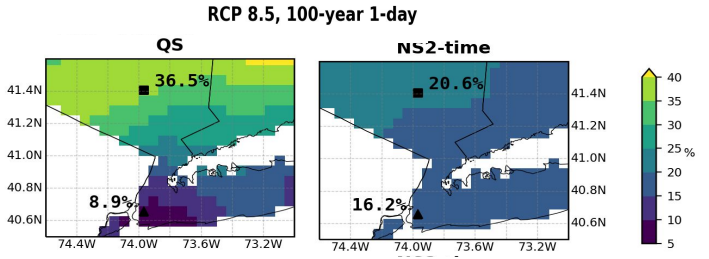
* 1950-2099 LOCA AMS data used



Findings

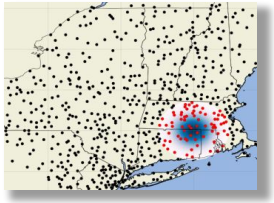
✔ NS model directly integrates nonstationary assumptions in the model development.

✔ NS model provides robust estimates, and provides greater flexibility with modeling the shape parameter, and is faster to implement.



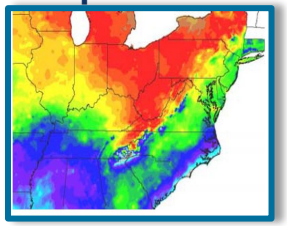
Major Methodology Enhancements

Regionalization



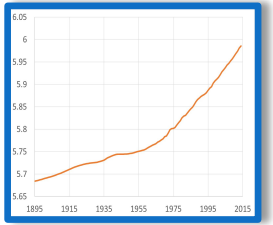
Regional observation ***weighting*** *(eg. triweight kernel)*

Interpolation



Spatial *covariate (eg. PRISM)*

Trend in Data



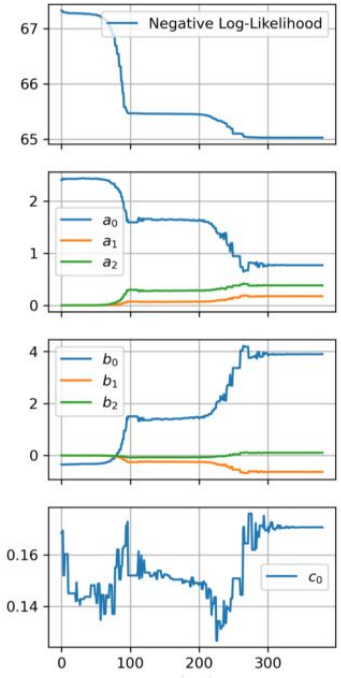
Temporal *Global covariate (eg. ln(CO_2) RCP8.5)*

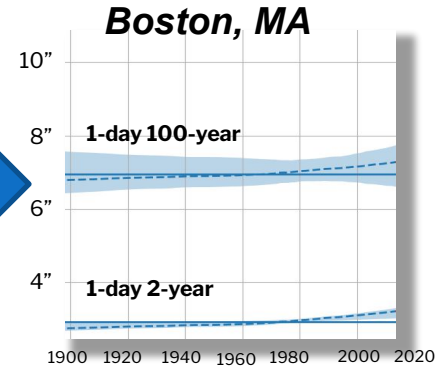
Parametrization @ grid cell

$$loc = a_0 + a_1 * \sqrt{PRISM} + a_2 * RCP$$
$$scale = \exp(b_1 + b_1 * \sqrt{PRISM} + b_2 * RCP)$$
$$shape = c_0$$

Final iteration parameters						
a_0	a_1	a_2	b_0	b_1	b_2	c_0
0.768	0.174	0.383	3.90	-0.632	0.105	0.171

Station	Year	AMS	PRISM	RCP8.5	Weight
4	1955	7.70	45.9	0.584	6.78e-03
4	1956	1.60	45.9	0.592	6.78e-03
4	1957	1.54	45.9	0.599	6.78e-03
4	1958	2.42	45.9	0.607	6.78e-03
4	1959	4.31	45.9	0.614	6.78e-03
...	...	...	...	...	...
1136	2009	2.13	47.75	2.104	7.21e-03
1136	2010	5.32	47.75	2.154	7.21e-03
1136	2011	2.25	47.75	2.205	7.21e-03
1136	2012	1.97	47.75	2.256	7.21e-03
1136	2013	3.23	47.75	2.307	7.21e-03
				Weighted Negative Log-likelihood	65.0269





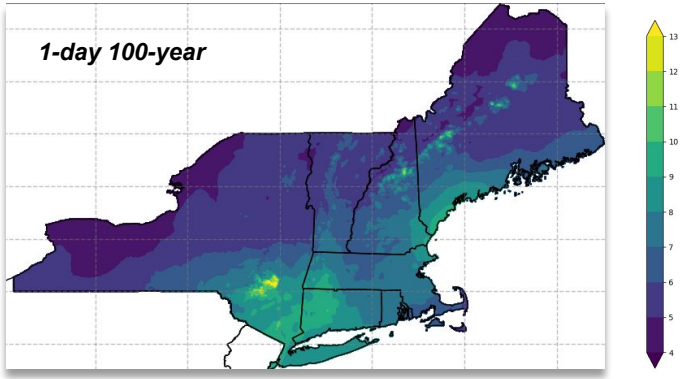
#Preliminary Results

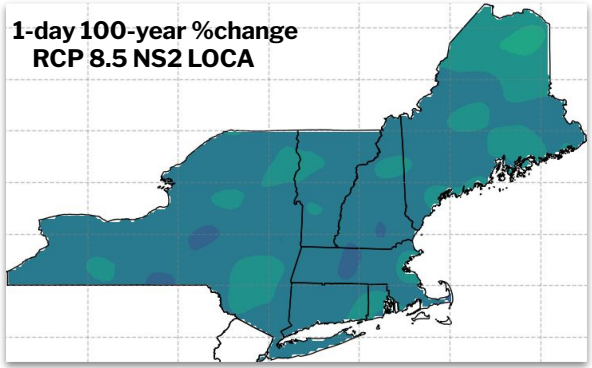
Next Gen Atlas 15

Volume 1

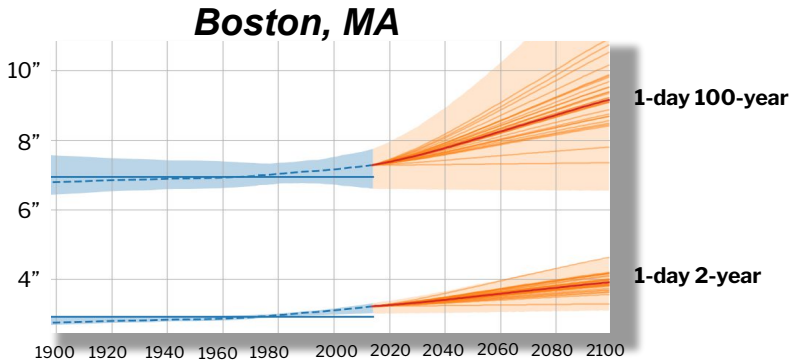
Volume 2

1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030 2040 2050 2060 2070 2080 2090 2100 2110 2120



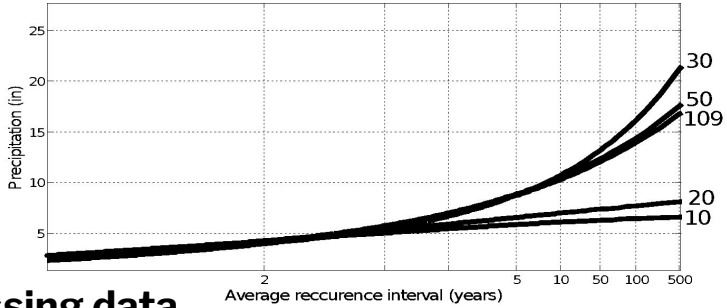


MULTI-MODELS

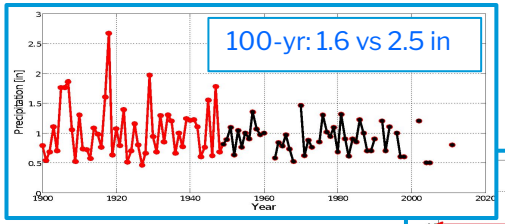


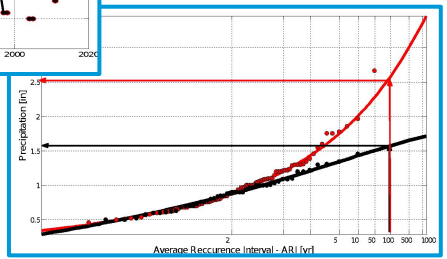
Major source of Error: Data!

Record length



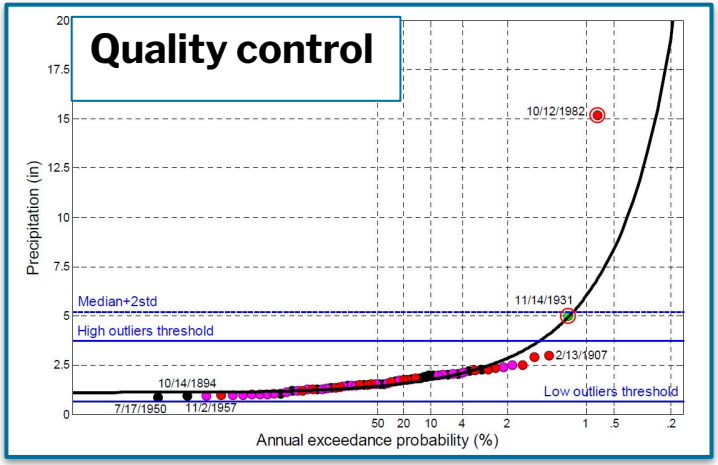
Missing data



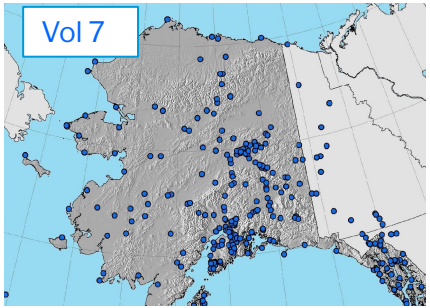


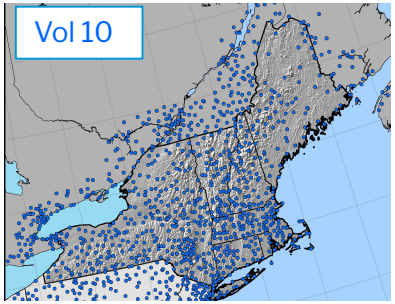
ITHACA, NY. *Hourly record extended 49 years (pre-1948) through digitization*

Quality control



Spatial coverage





Major source of Error: Methods!

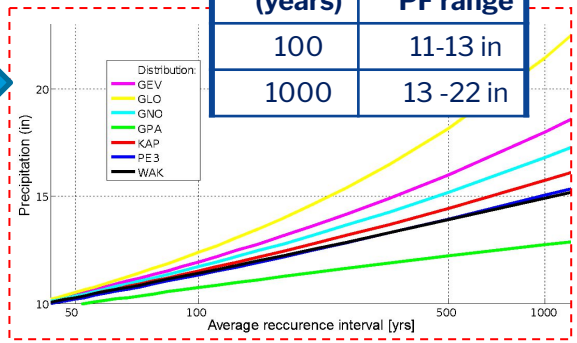
Distribution fitting

Distribution selection

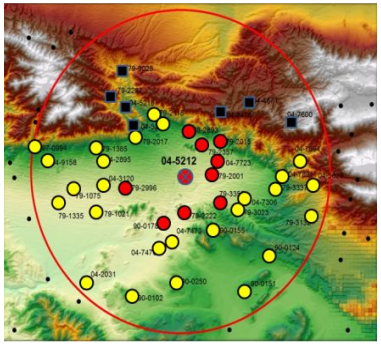
Parameterization method

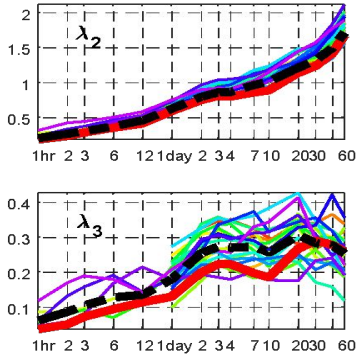
Stationary vs non-stationary

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

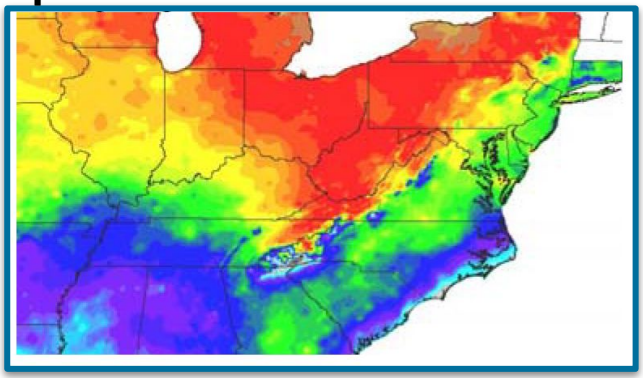


Regionalization

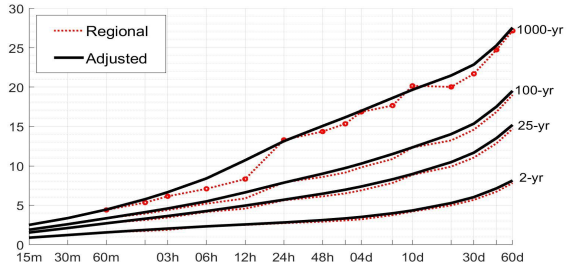




Interpolation

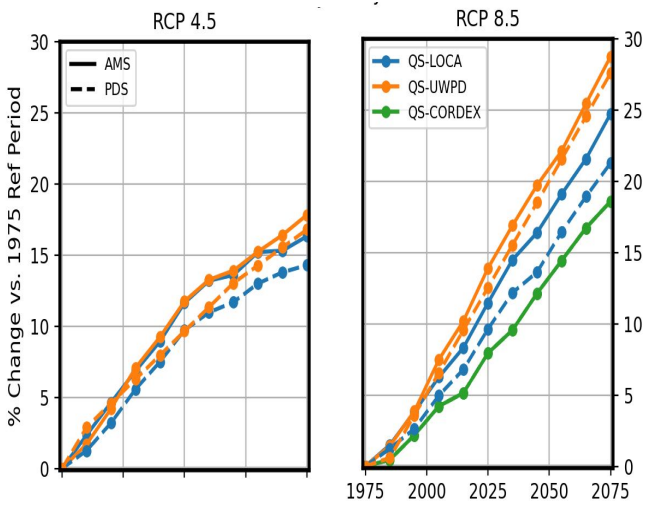


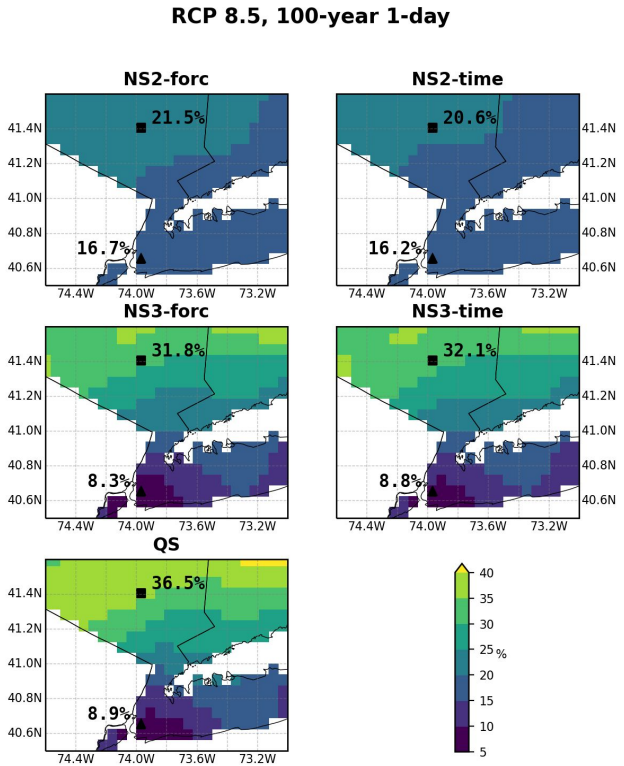
Optimization & consistency checks



Additional uncertainties…

- ✔ Emission scenarios
- ✔ Climate models
- ✔ Downscaling techniques

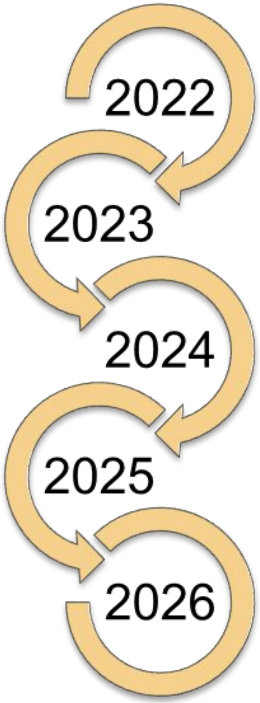




- ❖ **Climate models continually evolving**

✔ NS Methodologies

WHERE WE ARE GOING



- Establish peer-reviewed techniques
- Compile national QC'ed precipitation gage data repository
- Comprehensive evaluation of the climate projections
- Develop and execute end-to-end workflows
- Complete comprehensive peer review
- Adjust based on peer review feedback
- Develop estimates and publish

Thank You!

Sandra Pavlovic

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https://water.noaa.gov

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