Application of Phase 6 Watershed Model to Climate Change

Modeling Workgroup Conference Call – November 2017

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Presentation outline

- Review of inputs for the Year 2025 climate change simulation.
- Estimated changes in the delivery of nutrients and sediment to the Bay.

- **A decision is needed for the selection of temperature inputs.**

STAC workshop report [1]

Page 6, Paragraph 3 & 4

Workshop participants recommended the use of historical (~100 years) trends to project precipitation to 2025 for purposes of the Midpoint Assessment, as opposed to utilizing an ensemble of future projections from GCMs. Shorter term climate change projections using GCMs have large uncertainties because climate models are structured to look further out and at much larger scales. Participants in the workshop shared varied perspectives on the topic of uncertainty and climate projections. One recurring perspective was that uncertainty in some climate change projections is high, particularly for precipitation volumes and intensities across the Chesapeake watershed. There are inherent limitations in projecting precipitation, particularly its intensity, from existing regional statistical and dynamical downscaling of GCMs because they don't take adequate account of mesoscale processes that are important in water dynamics. Furthermore, extrapolating short term trends in precipitation is particularly risky. There are strong cyclic variations associated with climate models that impact shorter term precipitation trends and make longer term projections difficult.

Participants recommended that for long-term assessments (2050 and beyond) the CBP use an ensemble or multiple global climate model approach, selecting model outputs that bound the range of key climate variables (e.g., temperature, precipitation) for the Chesapeake Bay region. The use of multiple scenarios covering a range of projected emissions (representative concentration pathways (RCP) 4.5 and 8.5, as currently being utilized for Fourth National Climate Assessment) was recommended along with the inclusion of the 2 °C emissions reduction pathway (RCP 2.6). Lastly, participants advised the CBP to use an existing system to access

[1] http://www.chesapeake.org/pubs/360_Johnson2016.pdf

STAC recommendations [1]

Page 8, Recommendations

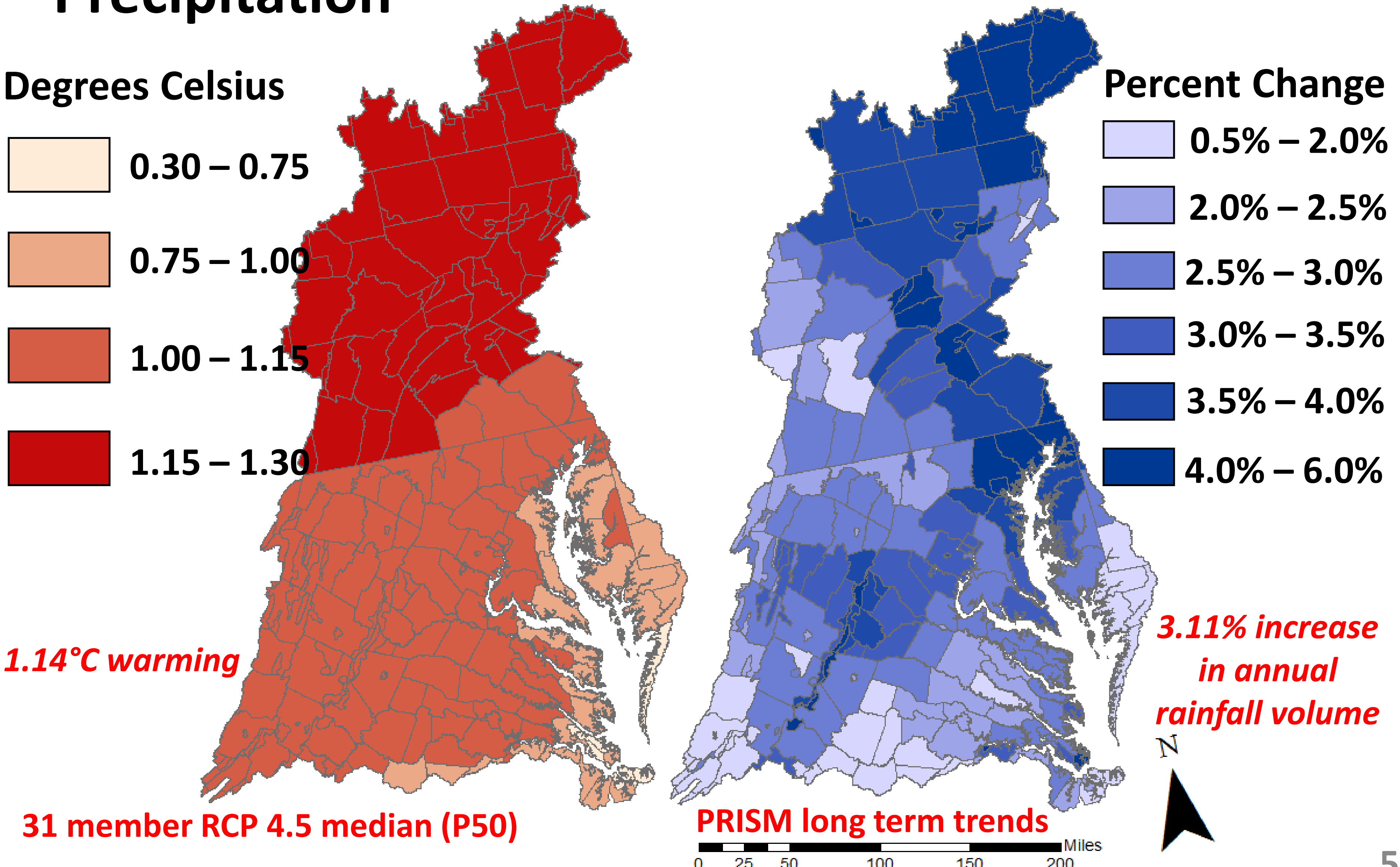
Recommendations

The workshop culminated with the following specific recommendations related to the selection, use, and application of climate projections and forecasts for the 2017 Midpoint Assessment.

1. The Partnership should seek agreement on the use of consistent climate scenarios for regional projections of Chesapeake Bay condition and the benefits of an integrated source of climate change projection simulation data that all seven jurisdictions could draw from.
2. For the 2017 Midpoint Assessment, use historical (~100 years) trends to project precipitation to 2025 as opposed to utilizing an ensemble of future projections from GCMs. Shorter term climate change projections using GCMs have large uncertainties because climate models are structured to look further out and at much larger scales.
3. The Partnership should carefully consider the representation of evapotranspiration in Watershed Model calibration and scenarios because the calculation method for evapotranspiration has a strong influence on the strength and direction of future water balance change.
4. Looking forward, the 2050 timeframe is more appropriate for selecting and incorporating a suite of global climate scenarios and simulations to provide long-term projections for the management community, and an ongoing adaptive process to incorporate climate change into decision-making as implementation moves forward.

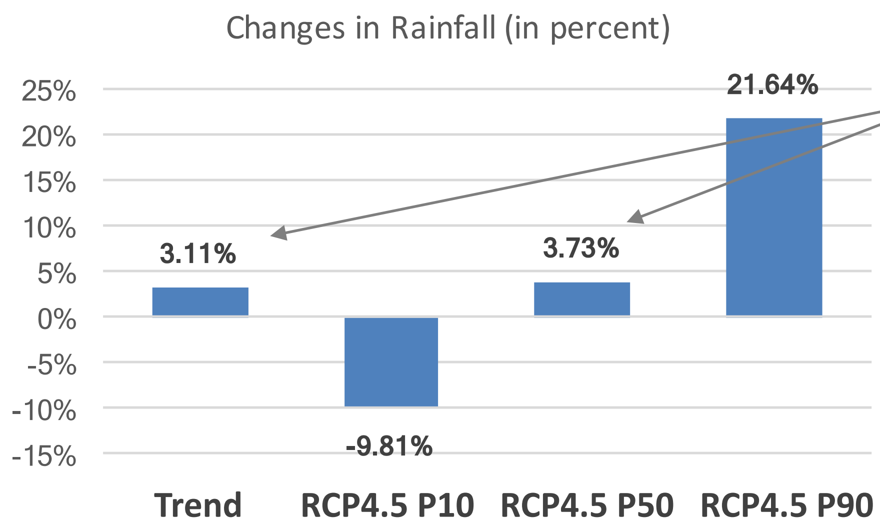
[1] http://www.chesapeake.org/pubs/360_Johnson2016.pdf

Year 2025: Changes[1] in Temperature and Precipitation



Summary of 2025 climatic projections

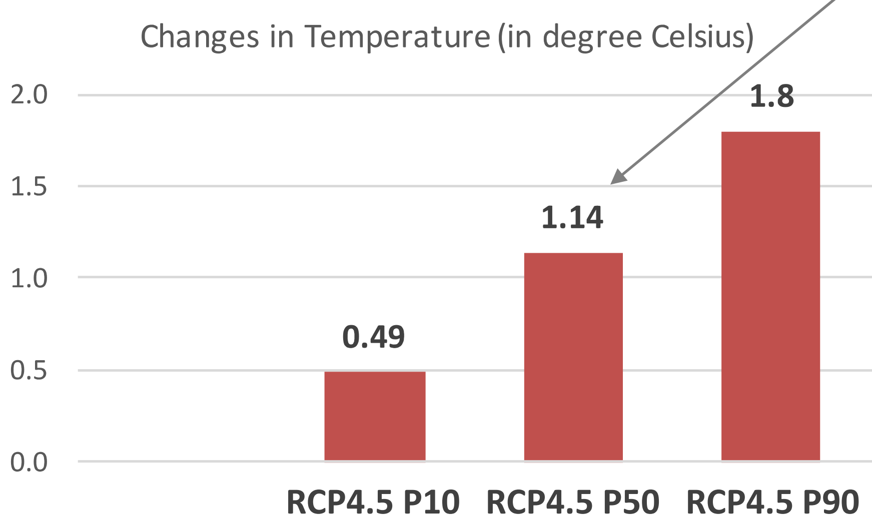
July 2017 MW Quarterly Meeting[1]

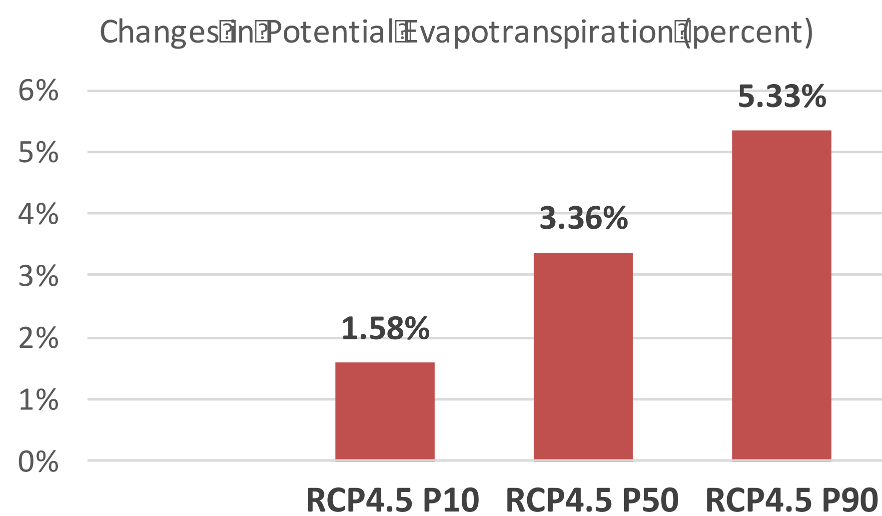


The central tendency of the projections for the changes in rainfall volume based on the 31 member ensemble median, P50, matches well with the extrapolation of PRISM's 88-year trends.

The rainfall uncertainty bounds (P10 and P90) of the ensemble members show wide range.

The central tendency of the temperature increase is potentially bit higher.





[1] https://www.chesapeakebay.net/channel_files/24720/20170725_-_bhatt_-_cbp_-_mwqm_-_draft_phase_6_applications.pdf

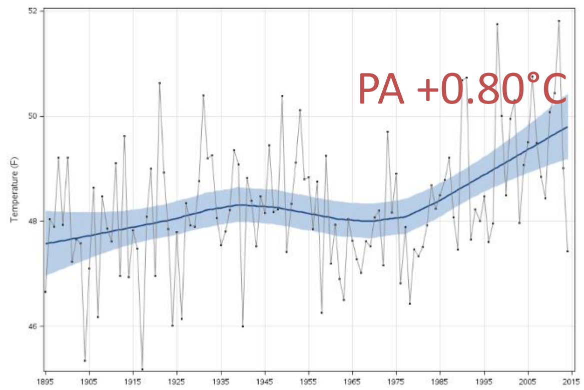
Annual temperature trends for the 6 states

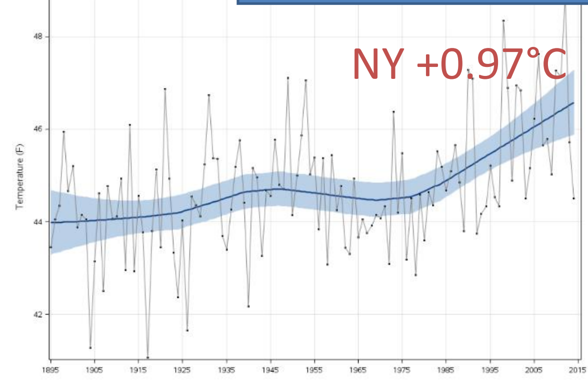
Annual temperature for 1895 to 2015 are shown.

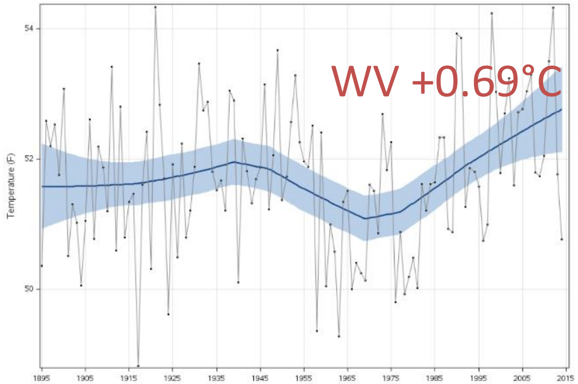
Annual Temperature

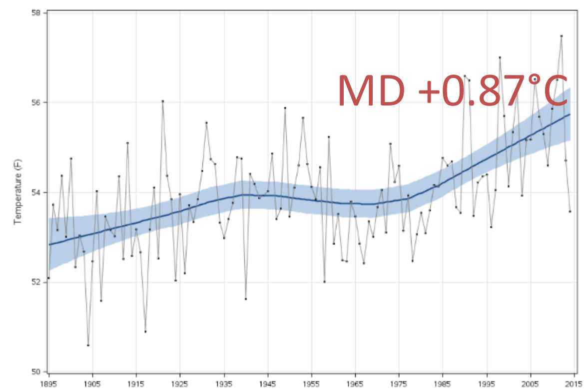
Trend Line

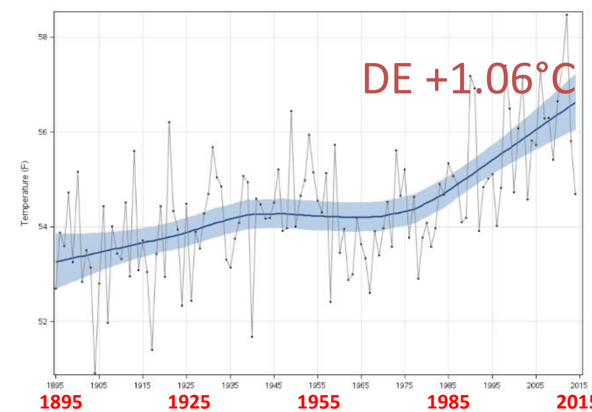
95% Confidence Limits

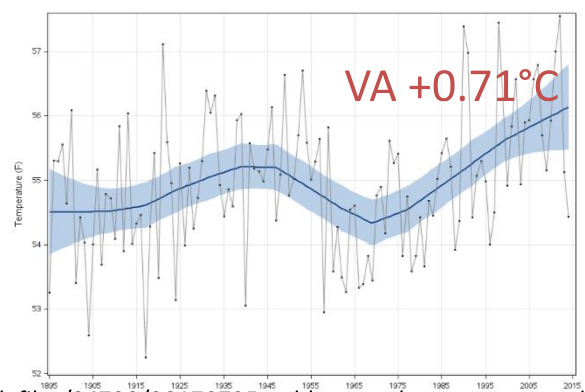












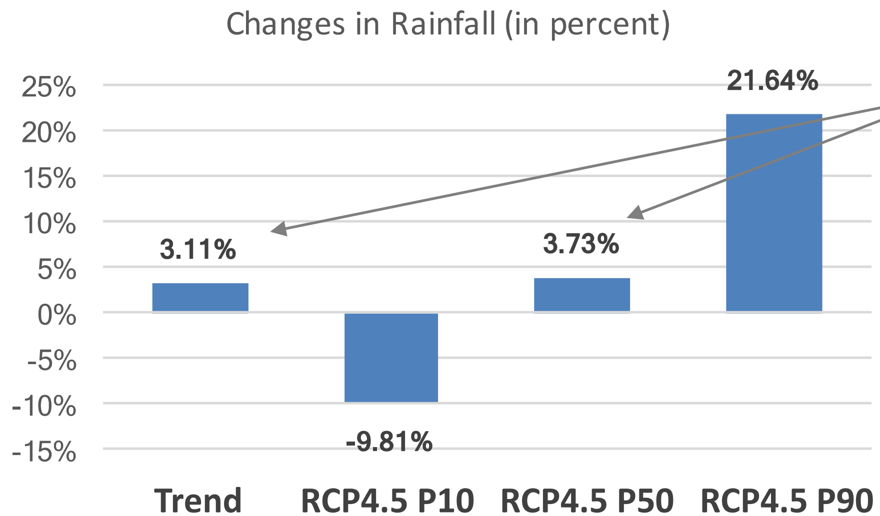
Approx. increases over the last 30 years based on the trend line are shown.

NOAA National Climatic Data Center

https://www.ncdc.noaa.gov/temp-and-precip/state-temps/

[1] https://www.chesapeakebay.net/channel_files/24720/20170725_-_bhatt_-_cbp_-_mwqm_-_draft_phase_6_applications.pdf

Summary of 2025 climatic projections



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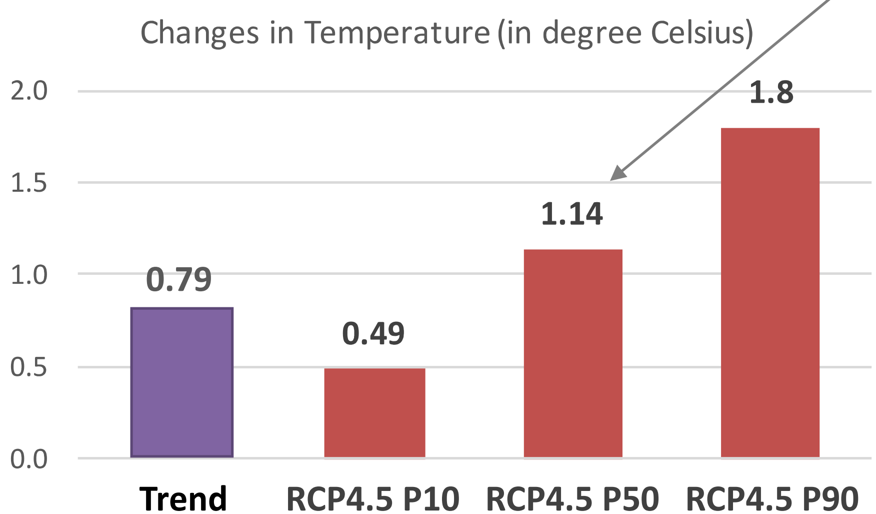
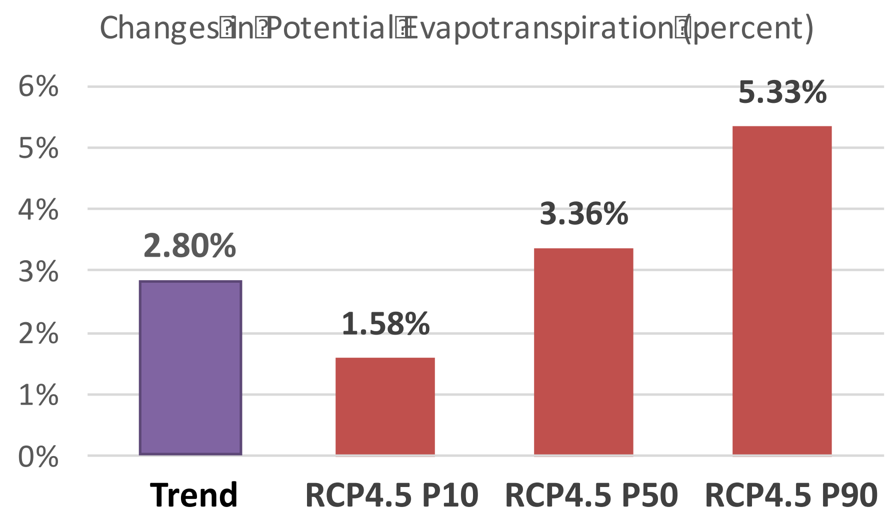
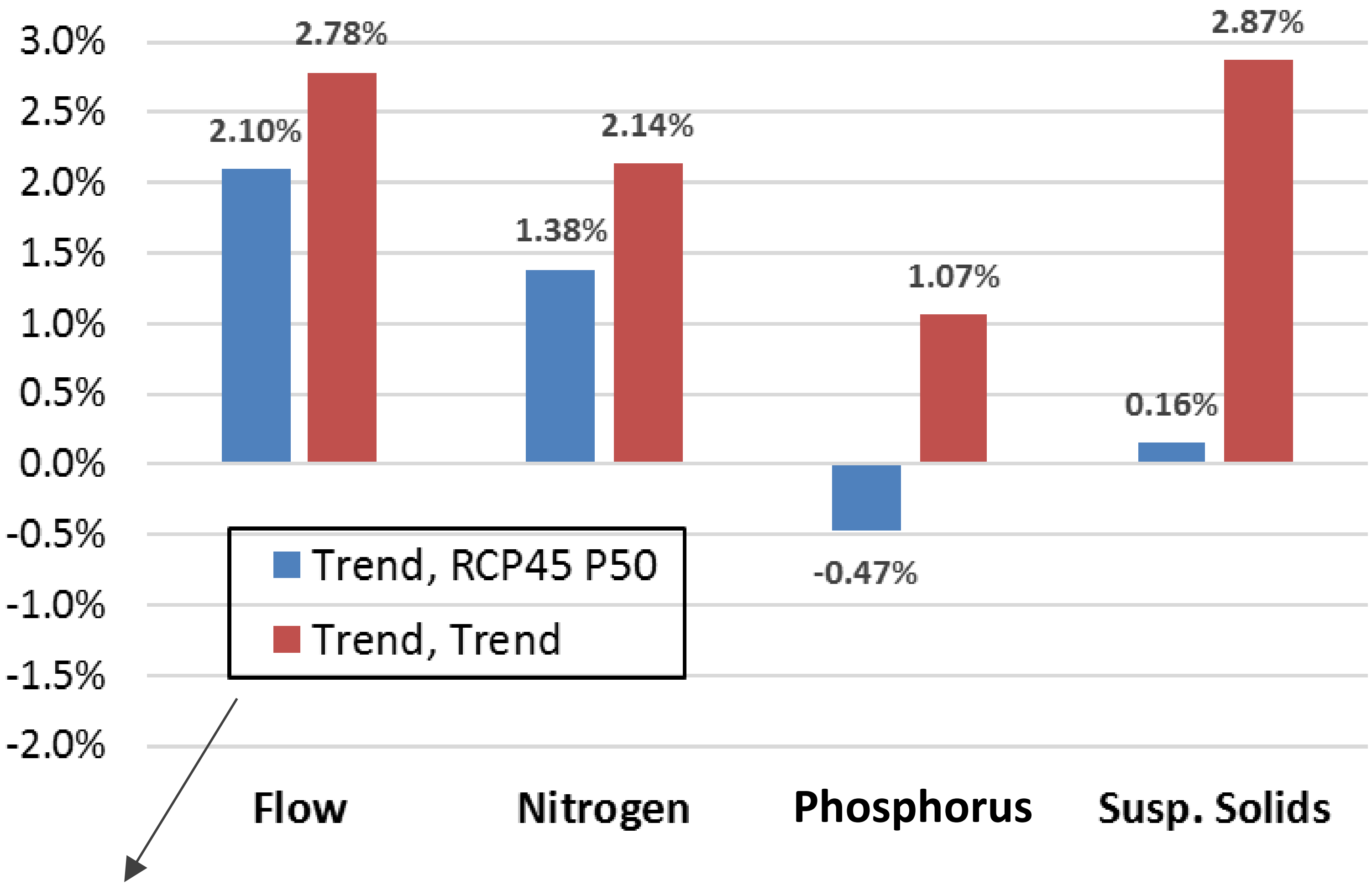




Model results



Rainfall projection, Temperature projection

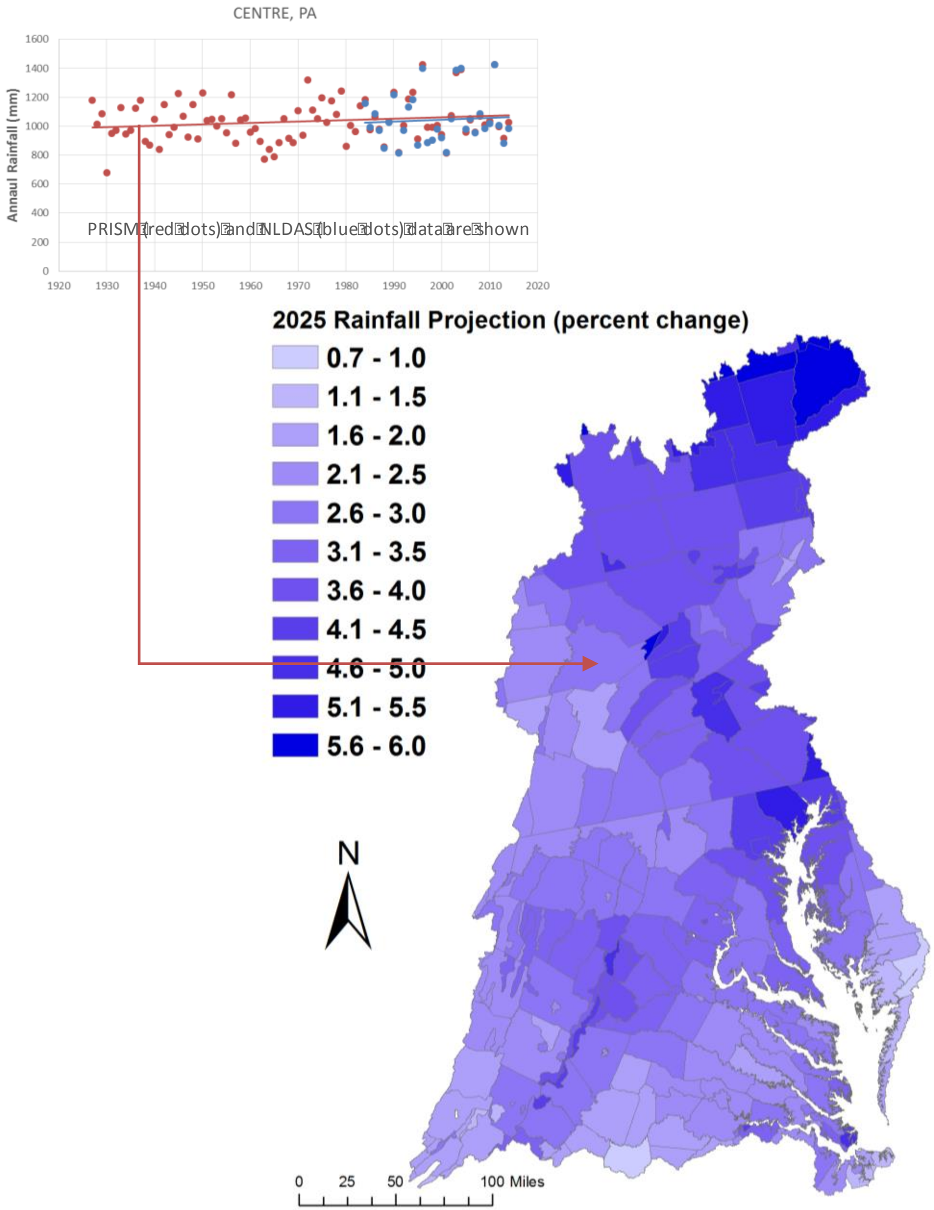
Summary and Conclusions

- STAC has recommended the use of past trends for the estimation of near-term, year 2025 rainfall inputs.
- The ensemble median of GCMs suggests wetter and warmer projections for year 2025 as compared to information derived from past trends.

- There are two alternatives for the estimation of temperature change for 2025 climate change scenario:
  - Ensemble median (P50) of 31 GCMs (RCP4.5)
  - Based on observed trends (NOAA NCDC seasonal trends)

Appendices

Rainfall projections using 88-years of annual PRISM[1] data trends



Change in Rainfall Volume 2021-2030 vs. 1991-2000

Major Basins	PRISM Trend
Youghiogheny River	2.1%
Patuxent River Basin	3.3%
Western Shore	4.1%
Rappahannock River Basin	3.2%
York River Basin	2.6%
Eastern Shore	2.5%
James River Basin	2.2%
Potomac River Basin	2.8%
Susquehanna River Basin	3.7%
Chesapeake Bay Watershed	**3.1%**

[1] Parameter-elevation Relationships on Independent Slopes Model

Ensemble analysis of GCM projections

- An ensemble analysis of statistically downscaled projections were used from **BCSD CMIP5[1]** dataset.
- Change were calculated as differences in 30-year averages.

ACCESS1-0	FGOALS-g2	IPSL-CM5A-LR
BCC-CSM1-1	FIO-ESM	IPSL-CM5A-MR
BCC-CSM1-1-M	GFDL-CM3	IPSL-CM5B-LR
BNU-ESM	GFDL-ESM2G	MIROC-ESM
CanESM2	GFDL-ESM2M	MIROC-ESM-CHEM
CCSM4	GISS-E2-H-CC	MIROC5
CESM1-BGC	GISS-E2-R	MPI-ESM-LR
CESM1-CAM5	GISS-E2-R-CC	**MPI-ESM-MR**
CMCC-CM	HadGEM2-AO	MRI-CGCM3
CNRM-CM5	HadGEM2-CC	NorESM1-M
CSIRO-MK3-6-0	HadGEM2-ES	
EC-EARTH	INMCM4	

31 member ensemble

Data unavailable

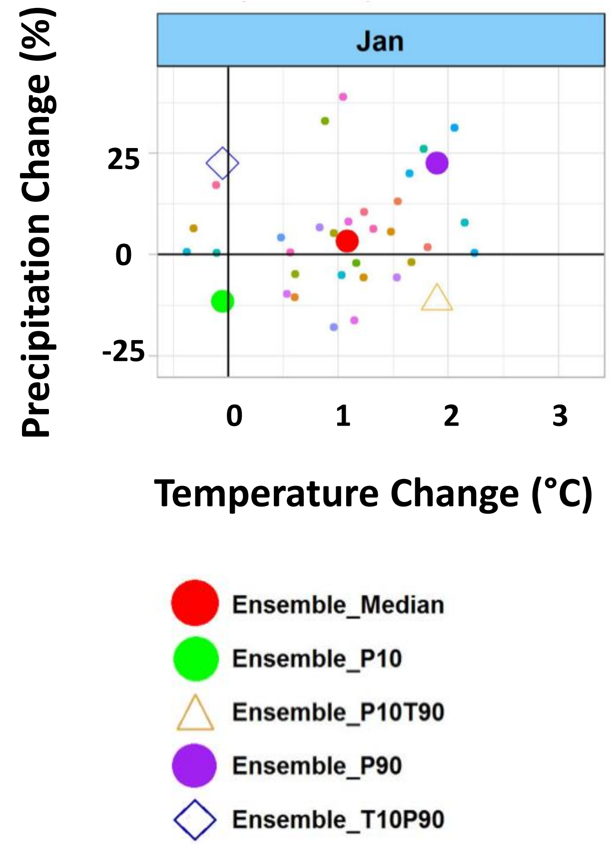
GCM Used

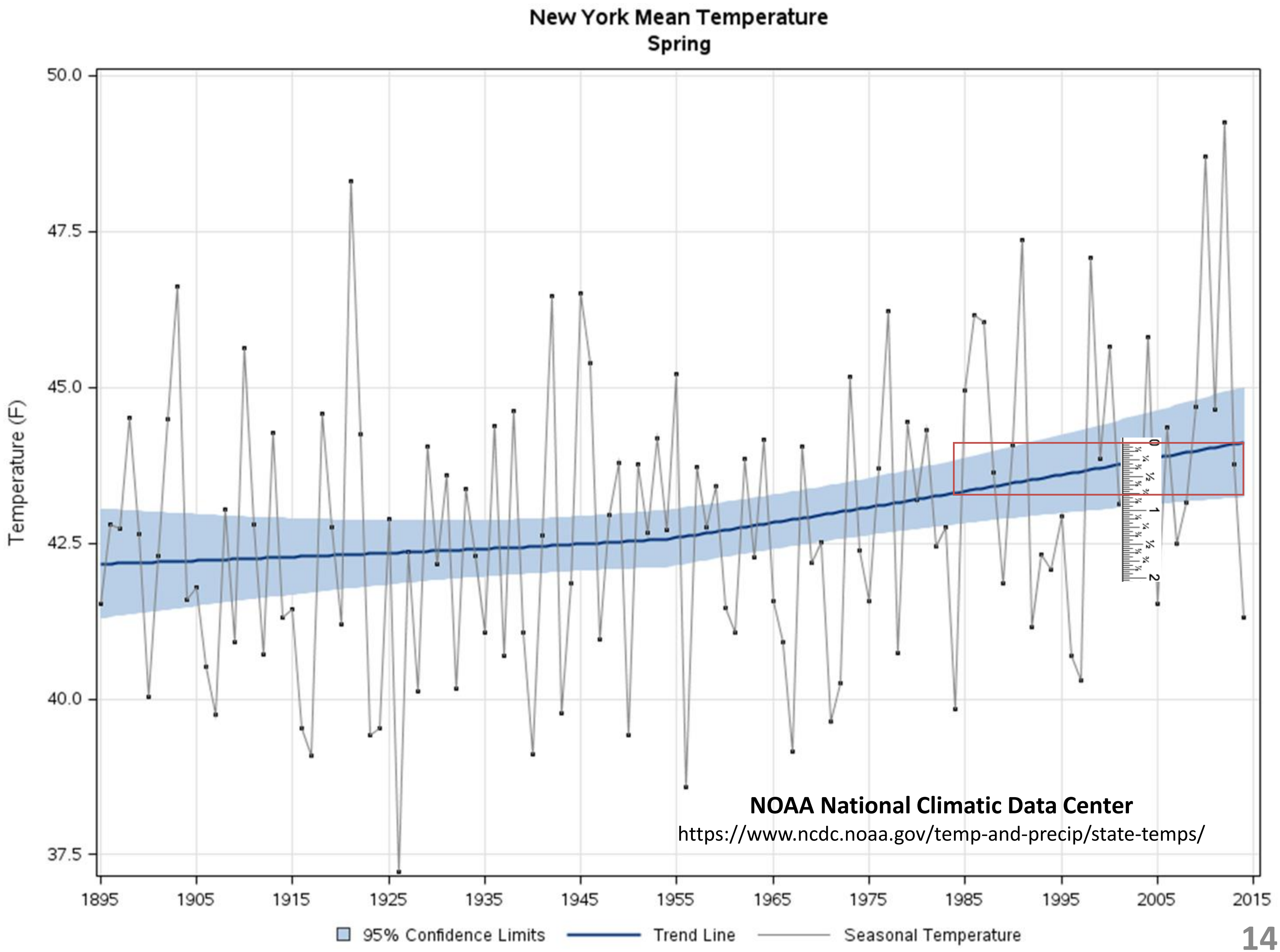
Selection updated

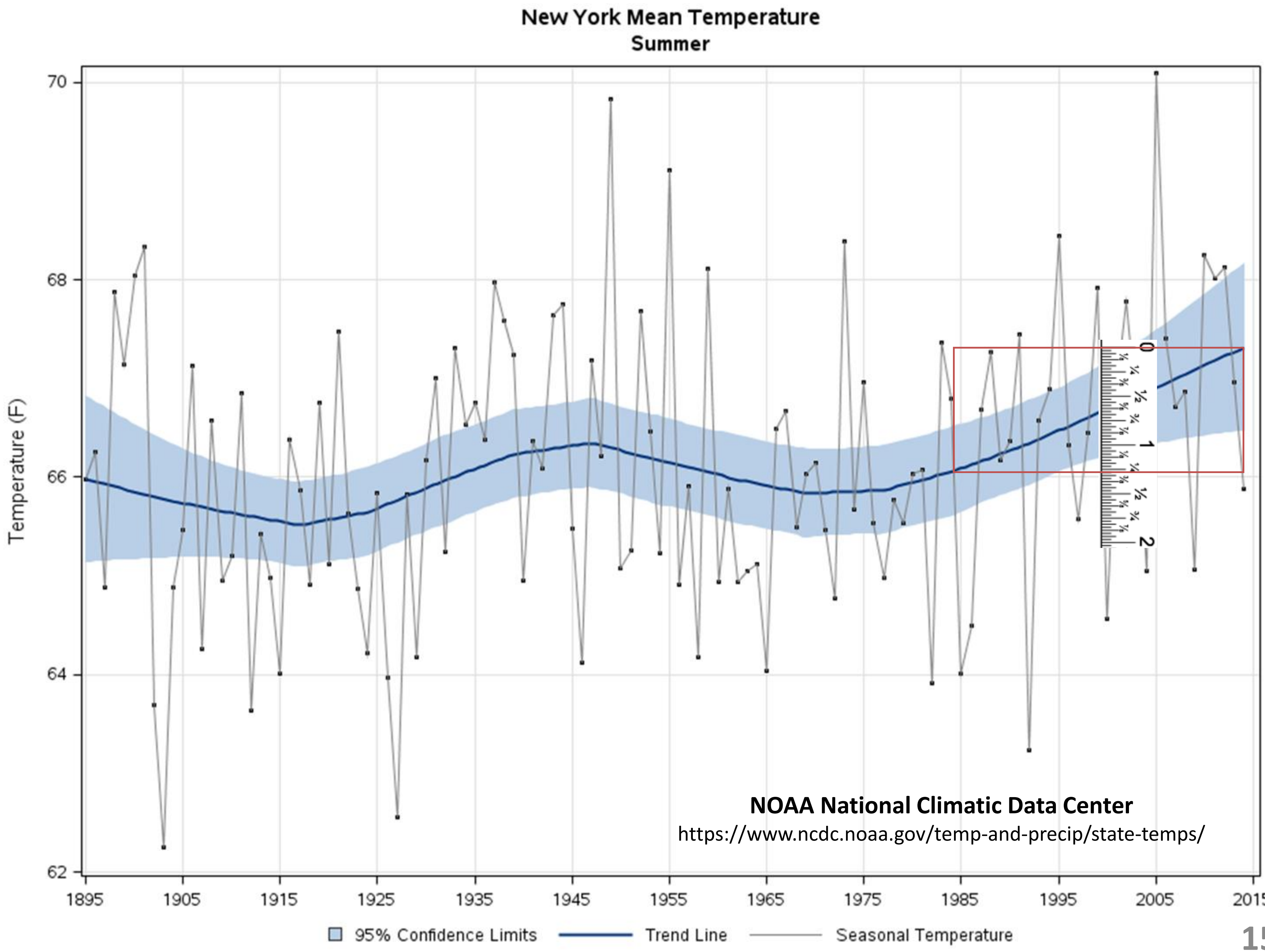
[1] Reclamation, 2013. 'Downscaled CMIP3 and CMIP5 Climate and Hydrology Projections: Release of Downscaled CMIP5 Climate Projections, Comparison with preceding Information, and Summary of User Needs', prepared by the U.S. Department of the Interior, Bureau of Reclamation, Technical Services Center, Denver, Colorado. 47pp.

[1] BCSD – Bias Correction Spatial Disaggregation;
[1] CMIP5 – Coupled Model Intercomparison Project 5

P90 – 90th percentile
P50 – median ensemble
P10 – 10th percentile




New York Mean Temperature
Spring
Temperature (F)
50.0
47.5
45.0
42.5
40.0
37.5
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
95% Confidence Limits
Trend Line
Seasonal Temperature
NOAA National Climatic Data Center
https://www.ncdc.noaa.gov/temp-and-precip/state-temps/



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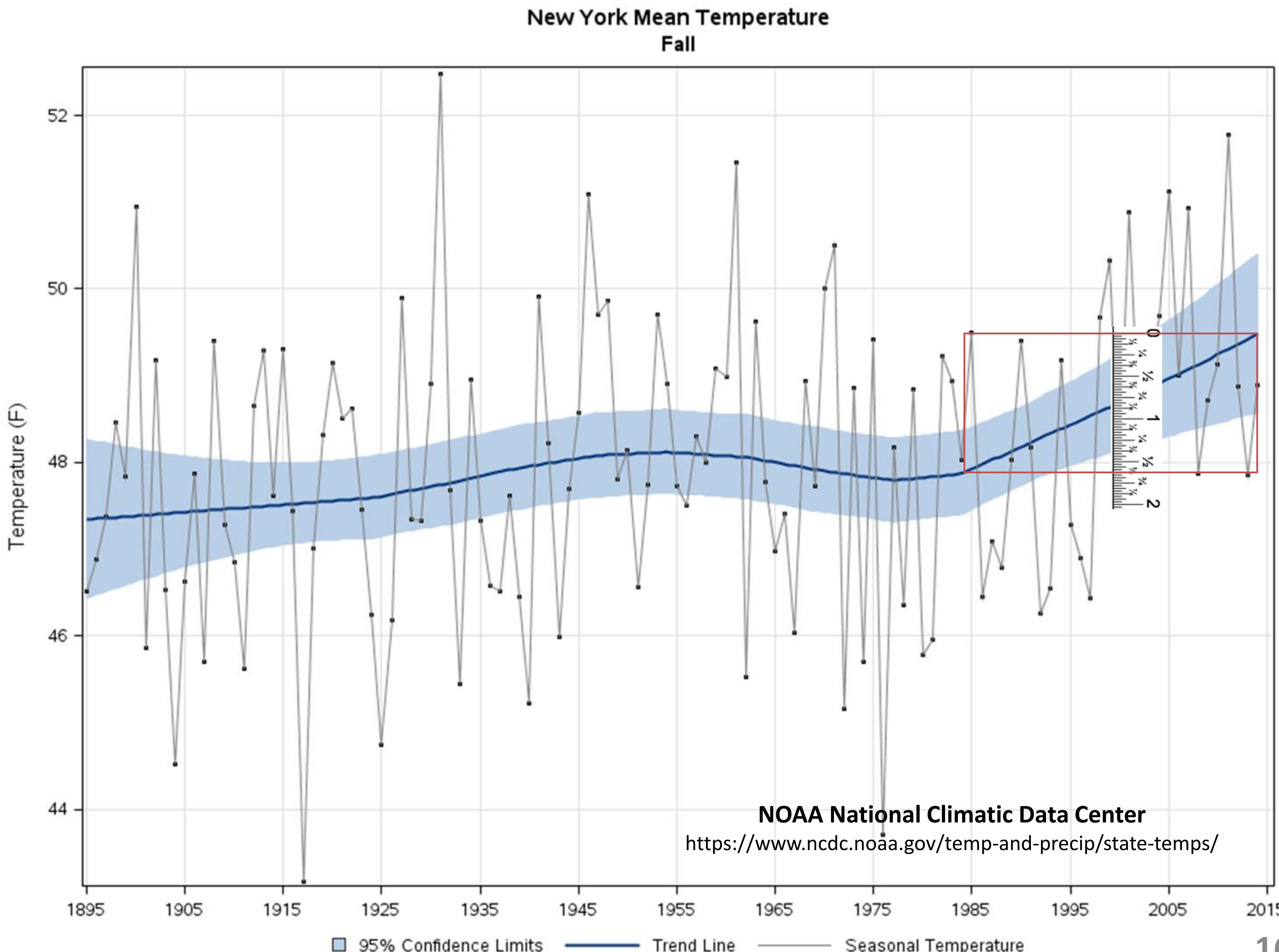

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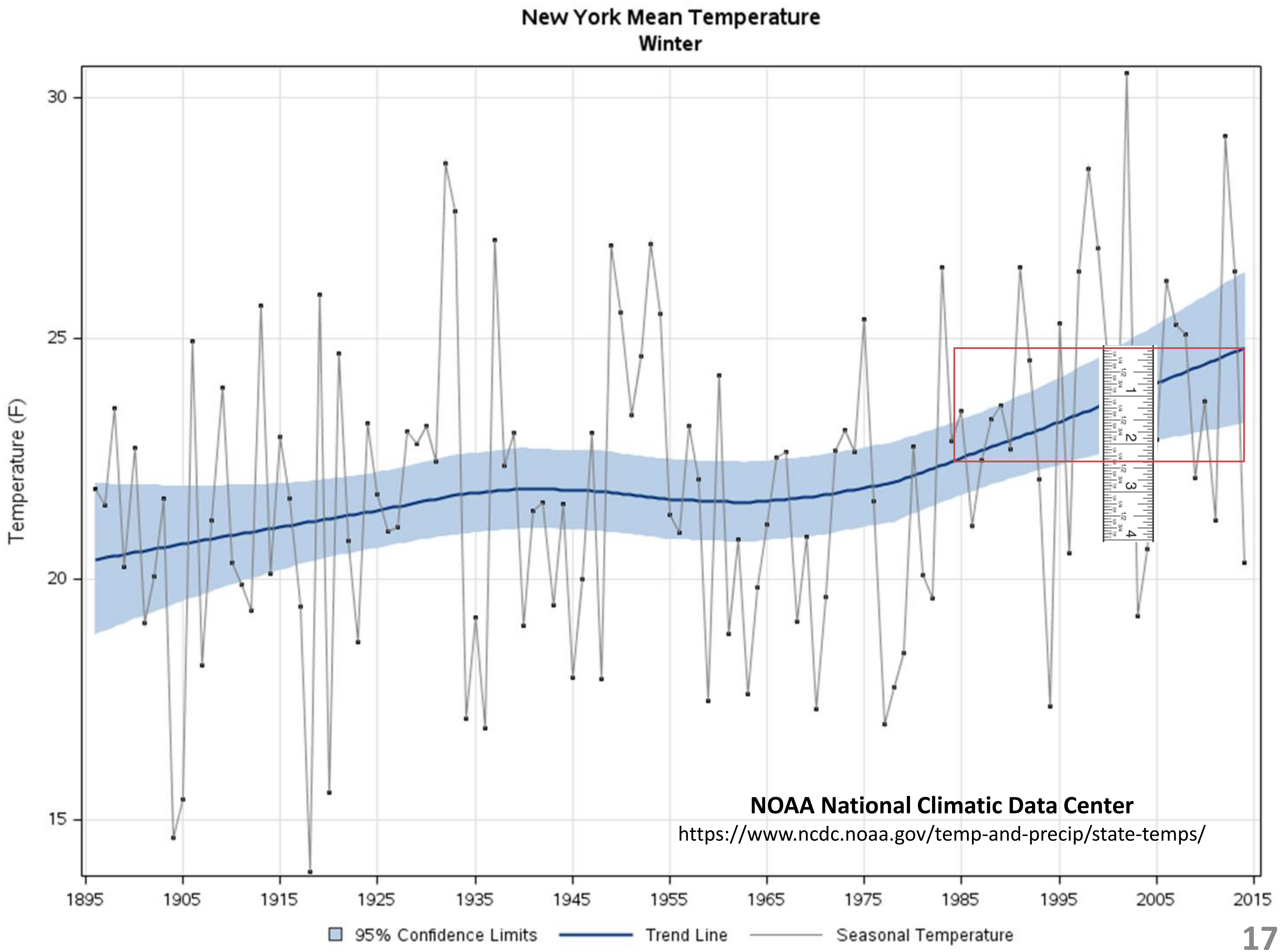

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