Southeast US Streamflow: A Perspective on Recent Declines

Glenn Tootle, Sahar Sadeghi, Matt Therrell, Emily Elliott, Jon Kam and Bennett Bearden
The University of Alabama

Southeast Waters: Wading Into Our Future

~$2.5 Million in total funding: EPA GoM, NSF P2C2 & INFEWS

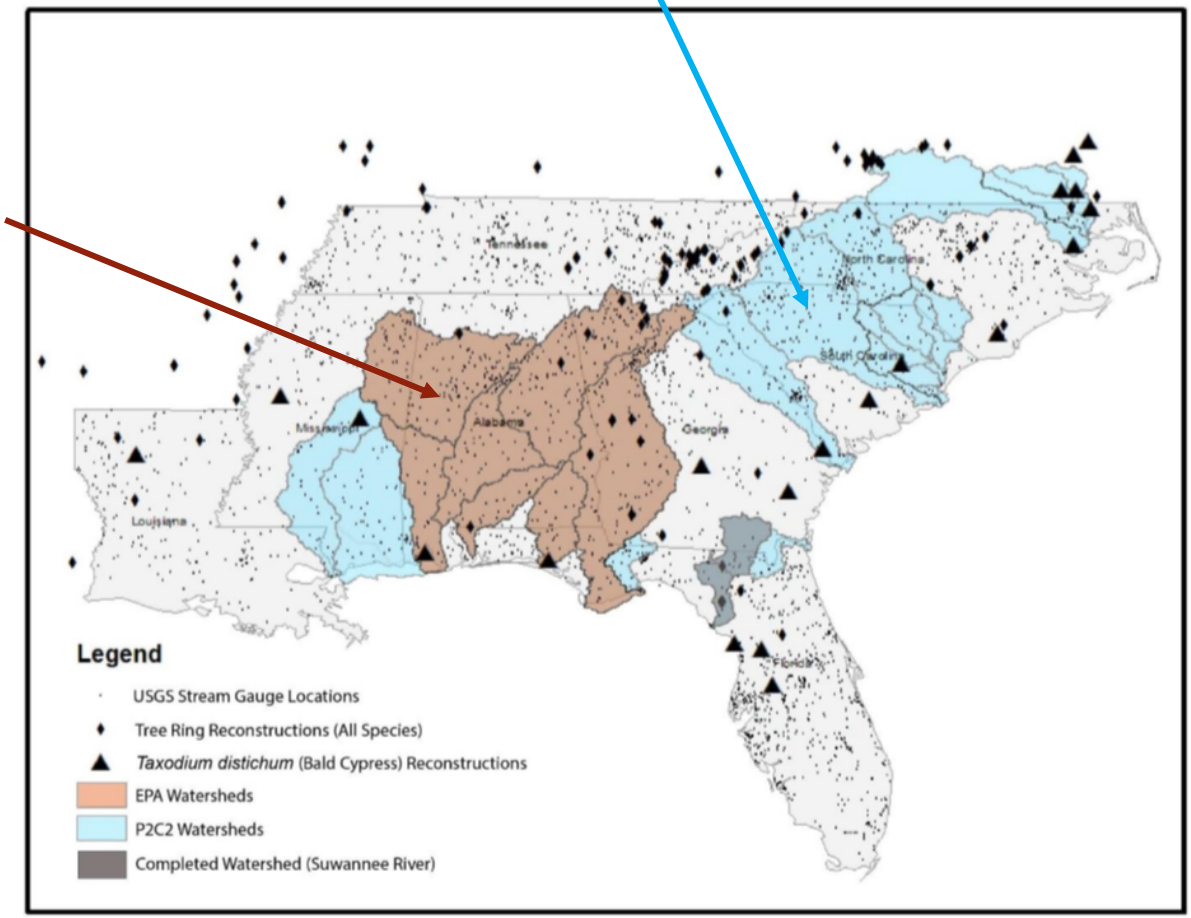
Current Research

Increasing community resilience in coastal watersheds of Alabama by risk assessment of past, present and future trends in hydrologic and hydroclimatic extremes
EPA Gulf of Mexico Program (~$300K)
Matt Therrell (Lead PI)

Collaborative Research: NSF P2C2 - Paleo-perspectives of streamflow variability for Southeastern Interstate Rivers
NSF Paleo Perspectives for Climate Change (P2C2) (~$450K)
Glenn Tootle (Lead PI)

The NSF P2C2 research expands the coverage to interstate streams throughout the SE US.

The EPA Gulf of Mexico research focuses on developing past, present and future streamflow estimates for streams in and adjacent to the State of Alabama (Tombigbee, Coosa, Tallapoosa, Choctawhatchee, Conecuh, Perdido, Chattahoochee)



Journal of Hydrology 576 (2019) 422–429

Contents lists available at ScienceDirect

Journal of Hydrology

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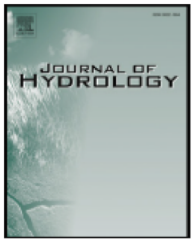

Research papers

Atlantic Ocean Sea Surface Temperatures and Southeast United States streamflow variability: Associations with the recent multi-decadal decline

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[d] Geological Survey of Alabama, United States

Location Map

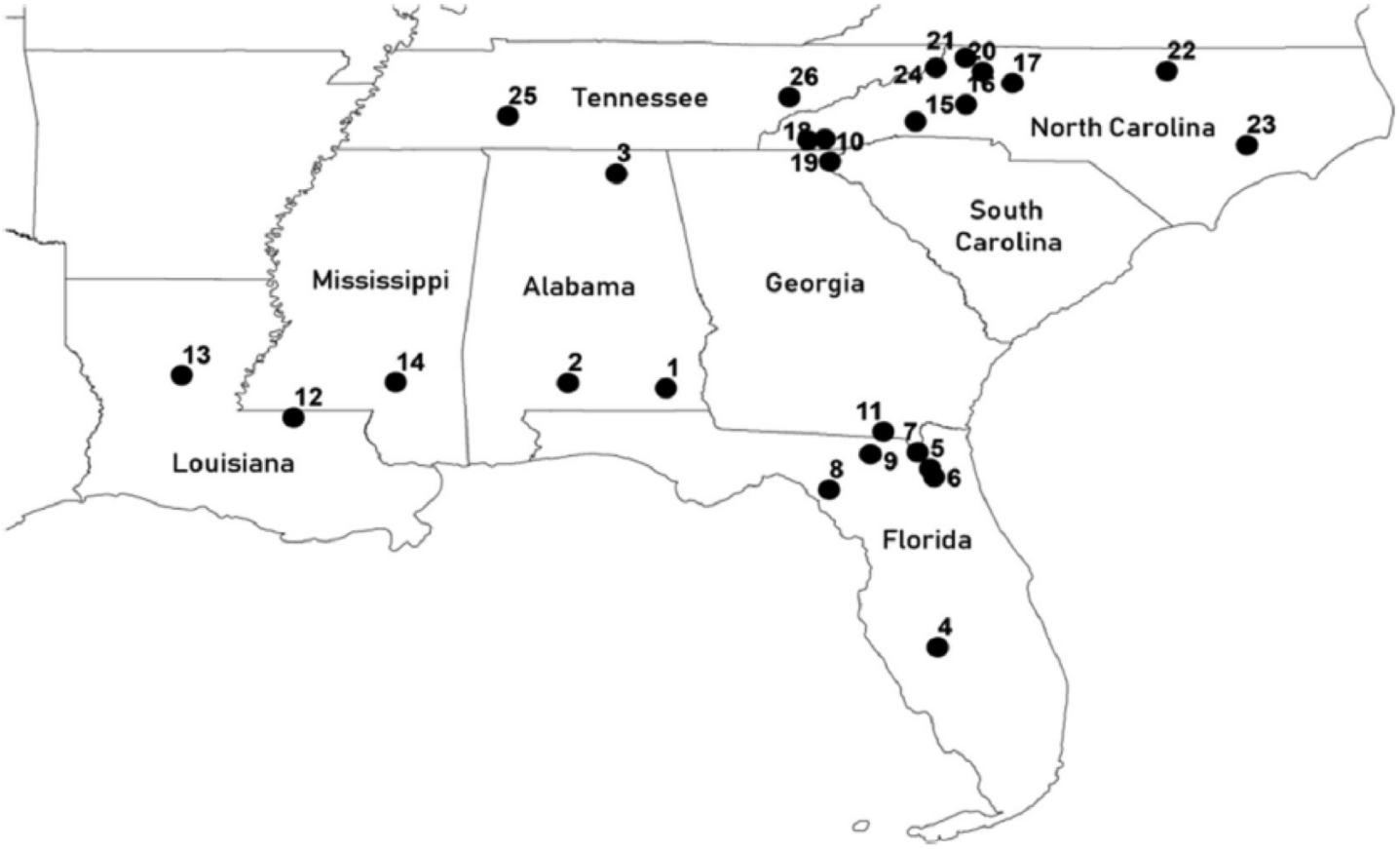


Fig. 1. Location Map of (26) Unimpaired Southeast United States Streamflow Stations.

Streamflow Decline

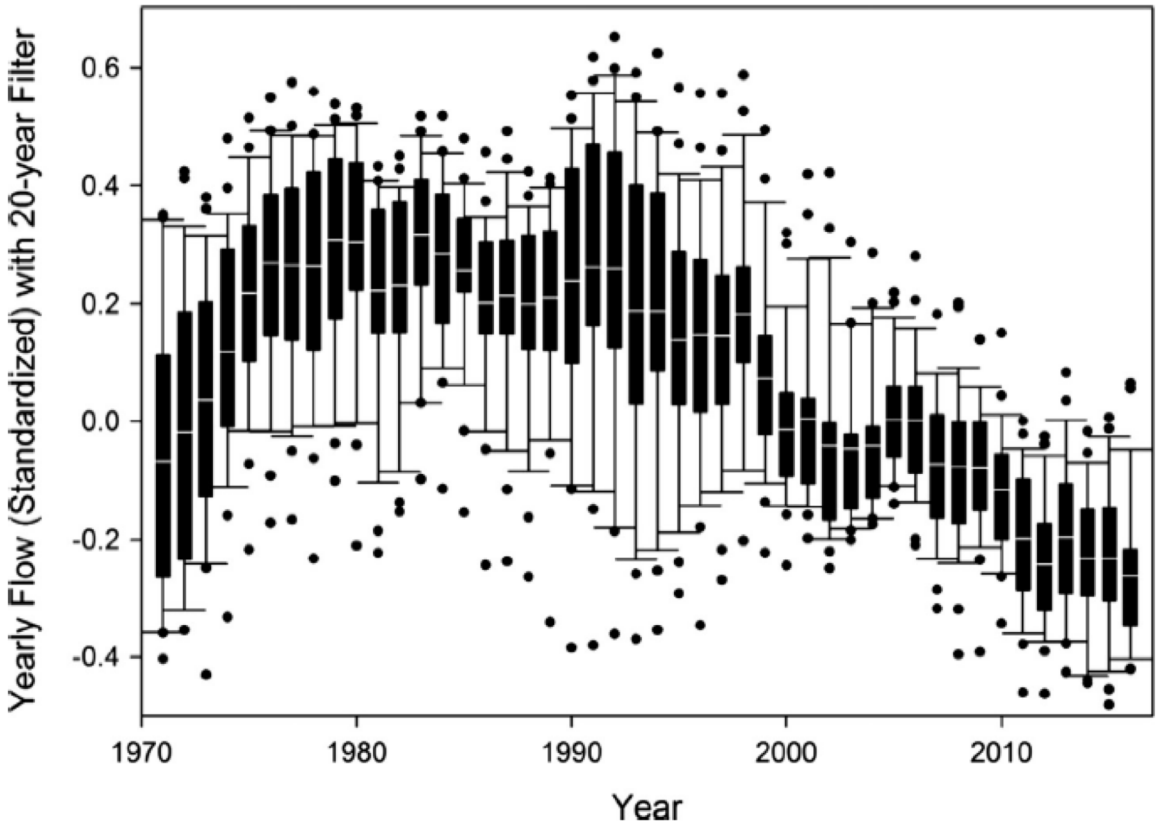
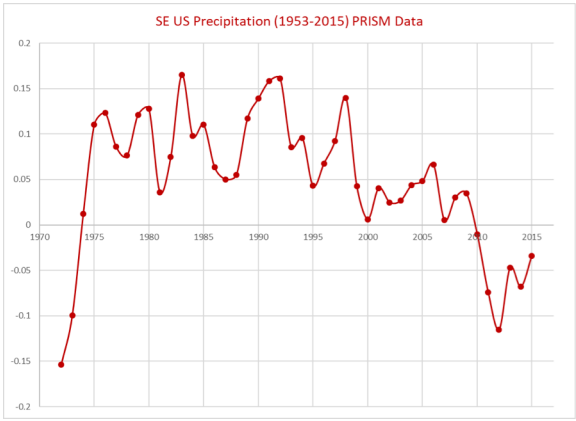


Fig. 2. Yearly standardized flow volumes for twenty-six unimpaired SEUS streamflow stations with 20-year (end-year) filter for 1971 to 2016. The mean is represented by the white line while the lower boundary of the black box represents the 25th percentile while the upper boundary of the black box represents the 75th percentile. The lower whisker represents the 10th percentile while the upper whisker represents the 90th percentile. Outliers are displayed as black dots.



Data Courtesy of Dr. Johanna Engstrom (UA) &
Analysis by Allison (Al) Woodall (UA)

SE USGS Streamflow Gages

Table 1
Station Number, Station ID, Station Name, State, Cumulative Deficit Flow (measured in Standard Deviations) from 2000 to 2016 for (26) Unimpaired SEUS Streamflow Stations. NS represents Not Significant.

#	Station ID	Station Name	State	Cumulative Deficit in Std. (2000–2016)
1	02361000	CHOCTAWHATCHEE RIVER NEAR NEWTON	AL	−6.8
2	02374500	MURDER CREEK NEAR EVERGREEN	AL	−5.3
3	03574500	PAINT ROCK RIVER NEAR WOODVILLE	AL	−6.6
4	02296500	CHARLIE CREEK NEAR GARDNER	FL	−0.4
5	02246000	NORTH FORK BLACK CREEK NR MIDDLEBURG	FL	−7.6
6	02245500	SOUTH FORK BLACK CREEK NR PENNEY FARMS	FL	−6.0
7	02231000	ST. MARYS RIVER NR MACCLENNY	FL	−5.7
8	02324000	STEINHATCHEE RIVER NEAR CROSS CITY	FL	−5.3
9	02315500	SUWANNEE RIVER AT WHITE SPRINGS	FL	−6.5
10	02177000	CHATTOOGA RIVER NEAR CLAYTON	GA	−6.0
11	02314500	SUWANNEE RIVER AT US 441, AT FARGO	GA	−7.5
12	07377000	AMITE RIVER NR DARLINGTON	LA	−7.4
13	07373000	BIG CREEK AT POLLOCK	LA	−4.8
14	02472500	BOUIE CREEK NR HATTIESBURG	MS	−5.3
15	02149000	COVE CREEK NEAR LAKE LURE	NC	−6.9
16	02143000	HENRY FORK NEAR HENRY RIVER	NC	−9.7
17	02118500	HUNTING CREEK NEAR HARMONY	NC	−7.0
18	03500000	LITTLE TENNESSEE RIVER NEAR PRENTISS	NC	−6.7
19	03504000	NANTAHALA RIVER NEAR RAINBOW SPRINGS	NC	−3.5
20	02111500	REDDIES RIVER AT NORTH WILKESBORO	NC	−5.4
21	03161000	SOUTH FORK NEW RIVER NEAR JEFFERSON	NC	−3.6
22	02081500	TAR RIVER NEAR TAR RIVER	NC	−6.2
23	02092500	TRENT RIVER NEAR TRENTON	NC	−0.4
24	03479000	WATAUGA RIVER NEAR SUGAR GROVE	NC	−2.8
25	03604000	BUFFALO RIVER NEAR FLAT WOODS	TN	−3.5
26	03498500	LITTLE RIVER NEAR MARYVILLE	TN	−2.2

AMO Warm & La Nina(s)

WATER RESOURCES RESEARCH, VOL. 41, W12408, doi:10.1029/2005WR004381, 2005

Coupled oceanic-atmospheric variability and U.S. streamflow

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Received 22 June 2005; revised 5 August 2005; accepted 23 September 2005; published 6 December 2005.

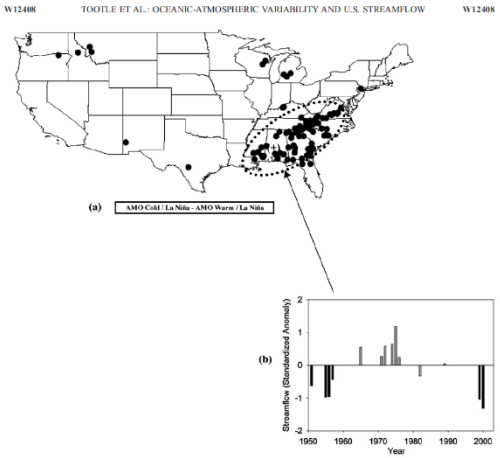
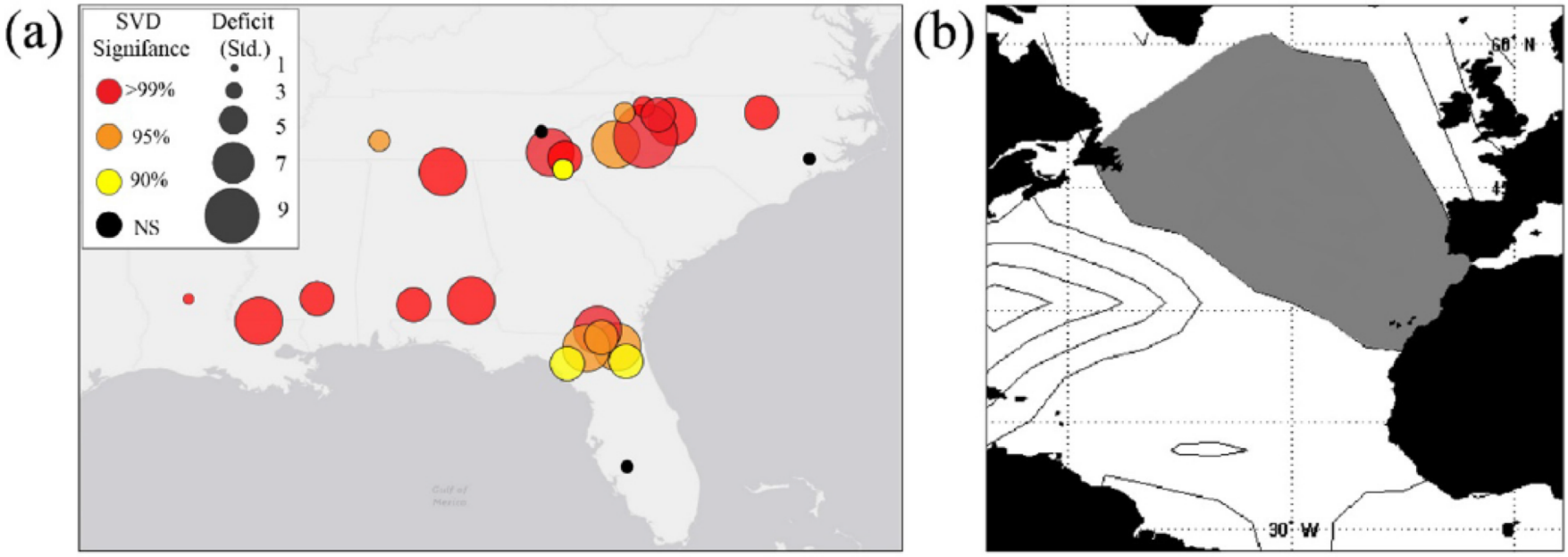


Figure 6. (a) Significant (95%) difference in streamflow medians for AMO cold/La Niña – AMO warm/La Niña. Positive (negative) significance is represented by solid (open) circles. (b) La Niña year streamflow (standardized anomaly) averaged for all stations in the region Southeast. Gray (black) bars represent La Niñas during AMO cold (warm) years.

[28] The significant difference in La Niña streamflow in the Southeast region (Figure 6a) is displayed in Figure 6b. For the 14 La Niñas in the period of record, eight occurred during an AMO cold phase while six occurred during an AMO warm phase. For the Southeast region, during the AMO cold phase, seven of eight La Niñas resulted in above normal streamflow while during the AMO warm phase, all six La Niñas resulted in below normal streamflow. For this region, the average streamflow (i.e., standardized anomaly) for the AMO cold La Niñas was +0.40 while the average streamflow for the AMO warm La Niñas was −0.89 (almost one standard deviation below normal). For all La Niñas the average streamflow was −0.16. Given the current AMO warm phase, the development of a La Niña could severely impact (i.e., drought) the southeastern United States.

SE US Q and Atlantic Ocean SSTs



Singular Value Decomposition (SVD) identifies relationships between two temporal, spatial fields

SE US Q and Atlantic Ocean SSTs

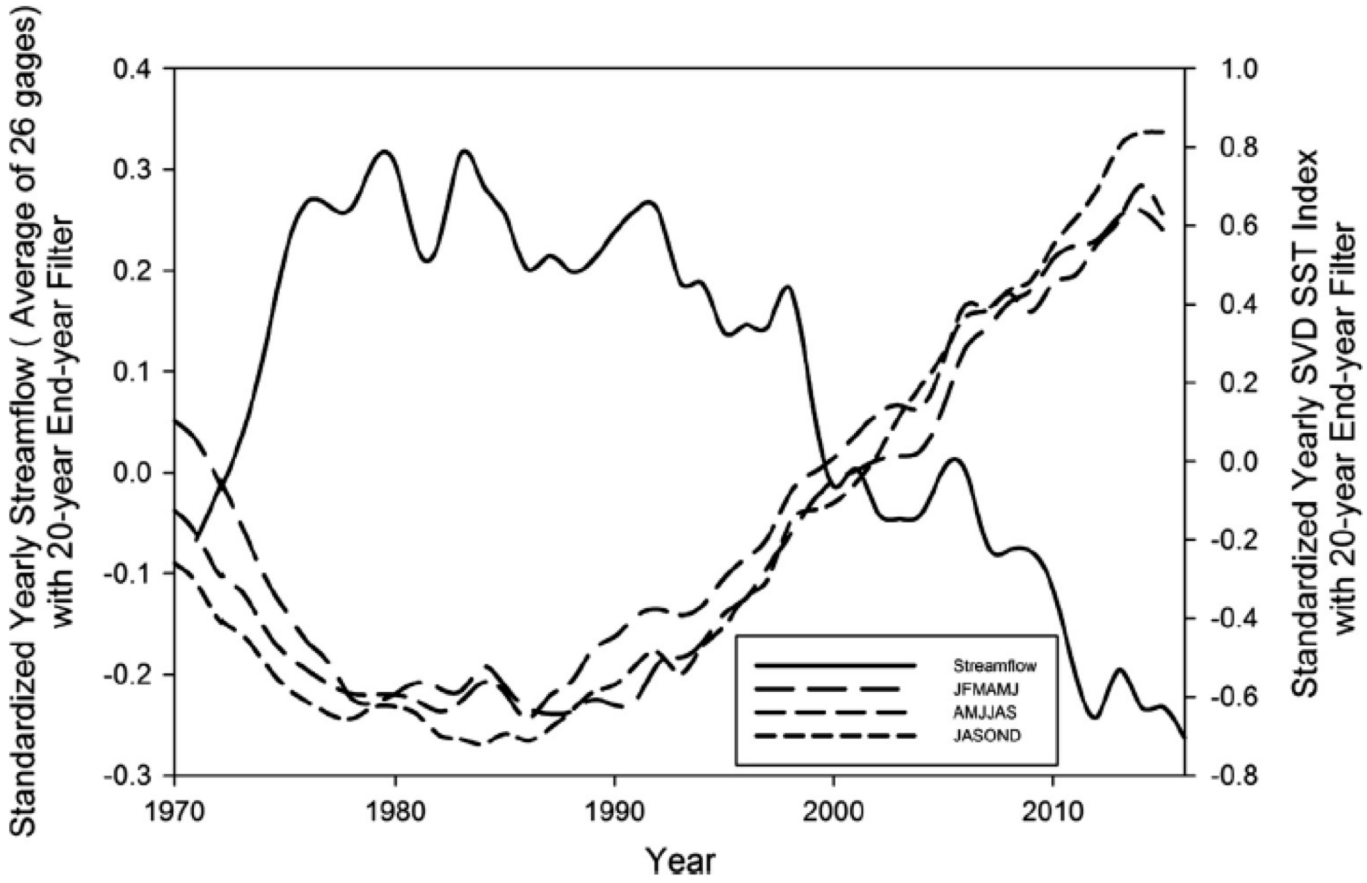


Fig. 4. SVD SST Index (JFMAMJ, AMJJAS and JASOND) with 20-year filter and Average (Twenty-six stations) Annual Streamflow with 20-year filter.

Cooling Atlantic Ocean SSTs?

SCIENTIFIC REPORTS

Article | Open Access | Published: 11 September 2017

Emerging negative Atlantic Multidecadal Oscillation index in spite of warm subtropics

Eleanor Frajka-Williams, Claudie Beaulieu & Aurelie Duchez

Scientific Reports **7**, Article number: 11224 (2017) | Download Citation

Abstract

Sea surface temperatures in the northern North Atlantic have shown a marked decrease over the past several years. The sea surface in the subpolar gyre is now as cold as it was during the last cold phase of the Atlantic Multidecadal Oscillation index in the 1990s. This climate index is associated with shifts in hurricane activity, rainfall patterns and intensity,

#	Gage	Station Name	Cumulative Deficit in Standard Deviations (2000 to 2016)	Cumulative Surplus in Standard Deviations (2017 to 20118)
1	02361000	CHOCTAWHATCHEE RIVER NEAR NEWTON, AL.	-6.8	
2	02374500	MURDER CREEK NEAR EVERGREEN AL		
3	03574500	PAINT ROCK RIVER NEAR WOODVILLE AL	-6.6	
4	02296500	CHARLIE CREEK NEAR GARDNER FL		
5	02246000	NORTH FORK BLACK CREEK NR MIDDLEBURG, FL	-7.6	2.0
6	02245500	SOUTH FORK BLACK CREEK NR PENNEY FARMS, FL		
7	02231000	ST. MARYS RIVER NR MACCLENNY, FL	-5.7	0.8
8	02324000	STEINHATCHEE RIVER NEAR CROSS CITY, FL	-5.3	
9	02315500	SUWANNEE RIVER AT WHITE SPRINGS, FL		
10	02177000	CHATTOOGA RIVER NEAR CLAYTON, GA	-6.0	
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16	02143000	HENRY FORK NEAR HENRY RIVER, NC	-9.7	0.6
17	02118500	HUNTING CREEK NEAR HARMONY, NC	-7.0	1.4
18	03500000	LITTLE TENNESSEE RIVER NEAR PRENTISS, NC	-6.7	0.4
19	03504000	NANTAHALA RIVER NEAR RAINBOW SPRINGS, NC	-3.5	1.3
20	02111500	REDDIES RIVER AT NORTH WILKESBORO, NC		
21	03161000	SOUTH FORK NEW RIVER NEAR JEFFERSON, NC	-3.6	3.6
22	02081500	TAR RIVER NEAR TAR RIVER, NC		
23	02092500	TRENT RIVER NEAR TRENTON, NC	-0.4	5.0
24	03479000	WATAUGA RIVER NEAR SUGAR GROVE, NC	-2.8	3.3
25	03604000	BUFFALO RIVER NEAR FLAT WOODS, TN	-3.5	
26	03498500	LITTLE RIVER NEAR MARYVILLE, TN	-2.2	

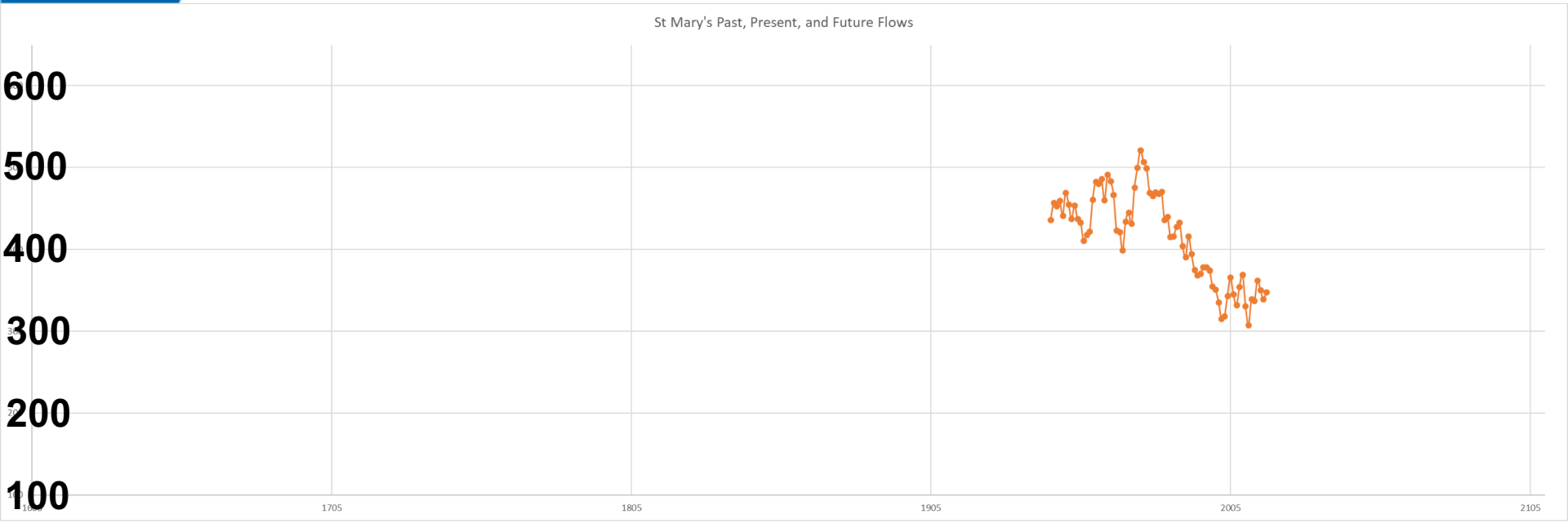
Table Courtesy of Sahar Sadeghi (UA) PhD Candidate

https://www.nature.com/articles/s41598-017-11046-x

Conclusions

- Recent multi-decadal declines in SE US Streamflow are perhaps the lowest in the observed record
- SE US Precipitation appears to follow a similar pattern
- Northern Atlantic Ocean SST variability was associated with SE US Streamflow variability
  - Warming SSTs = Declining Streamflow
- Observations of recent cooling of Northern Atlantic SSTs
  - May be associated with recent increases in SE US Streamflow

St. Mary's River (March-October Volume MCM) with 20-year End-year Filter



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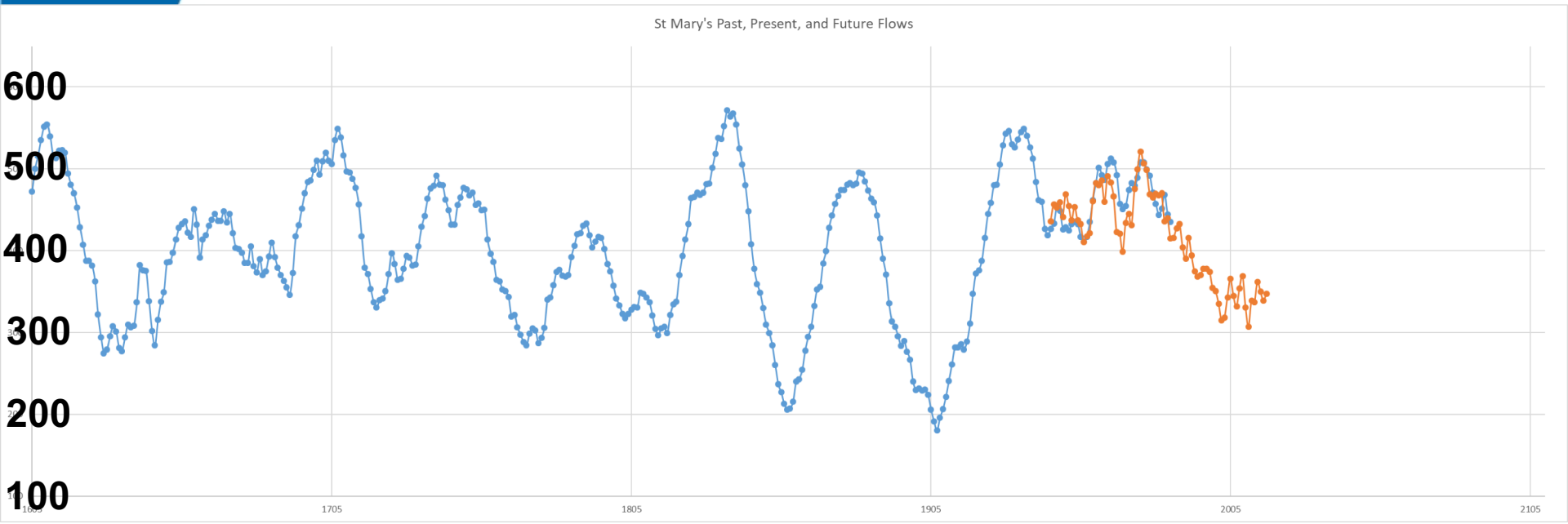

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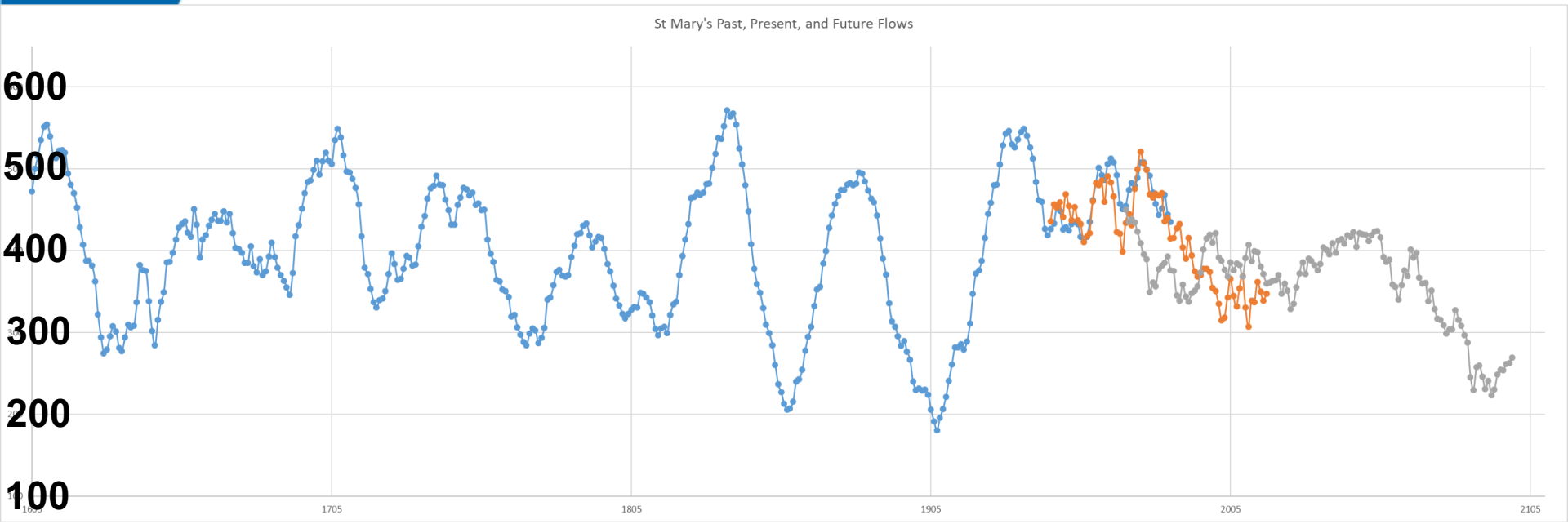

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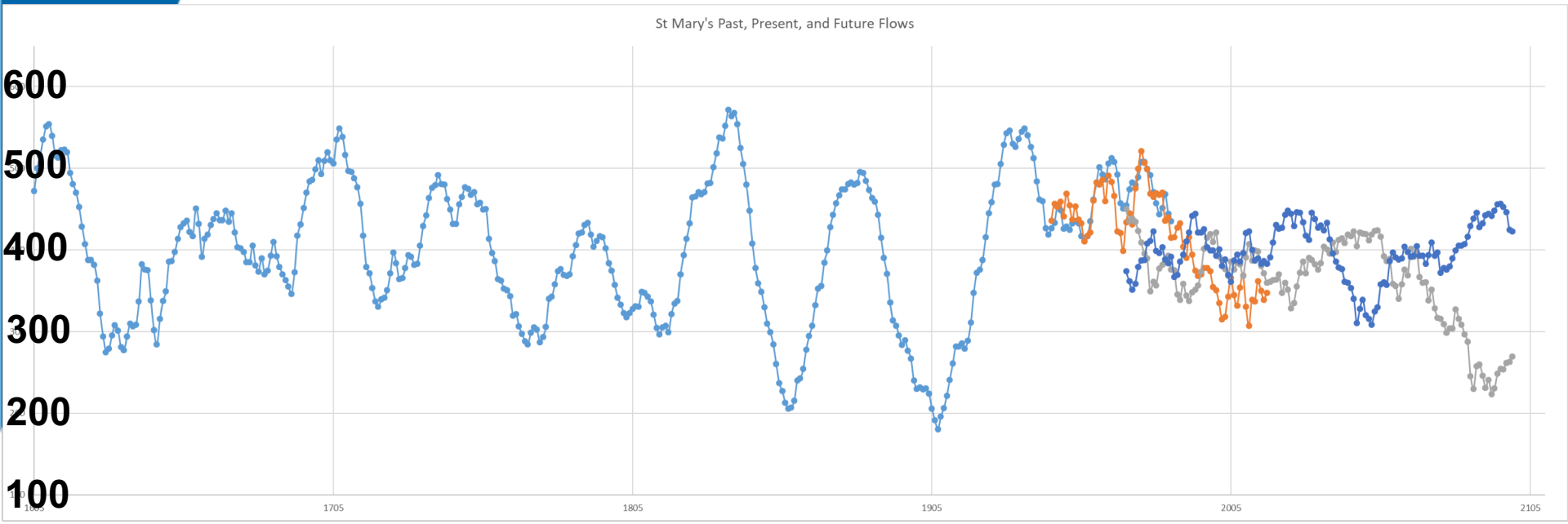

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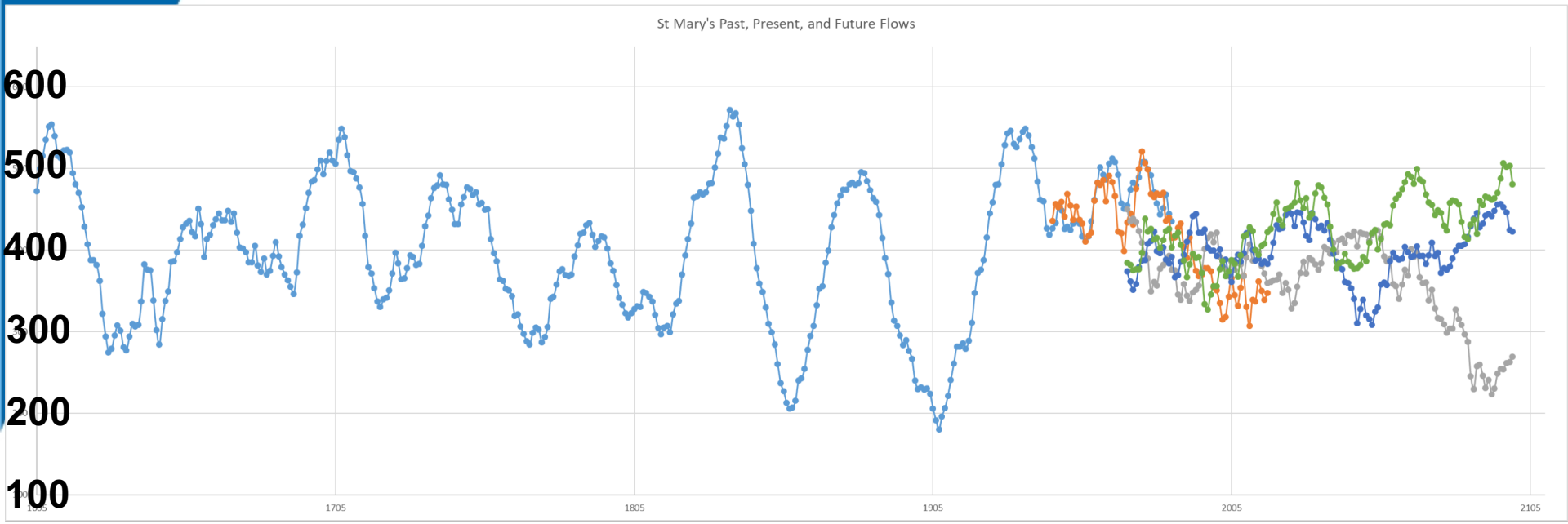

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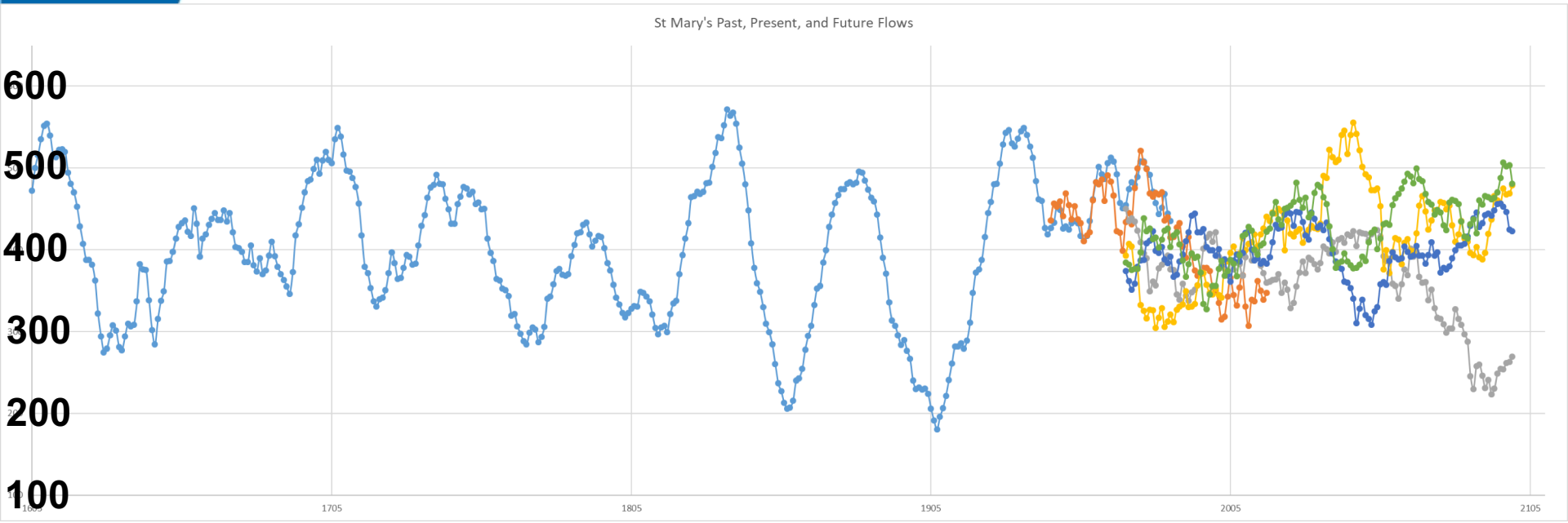

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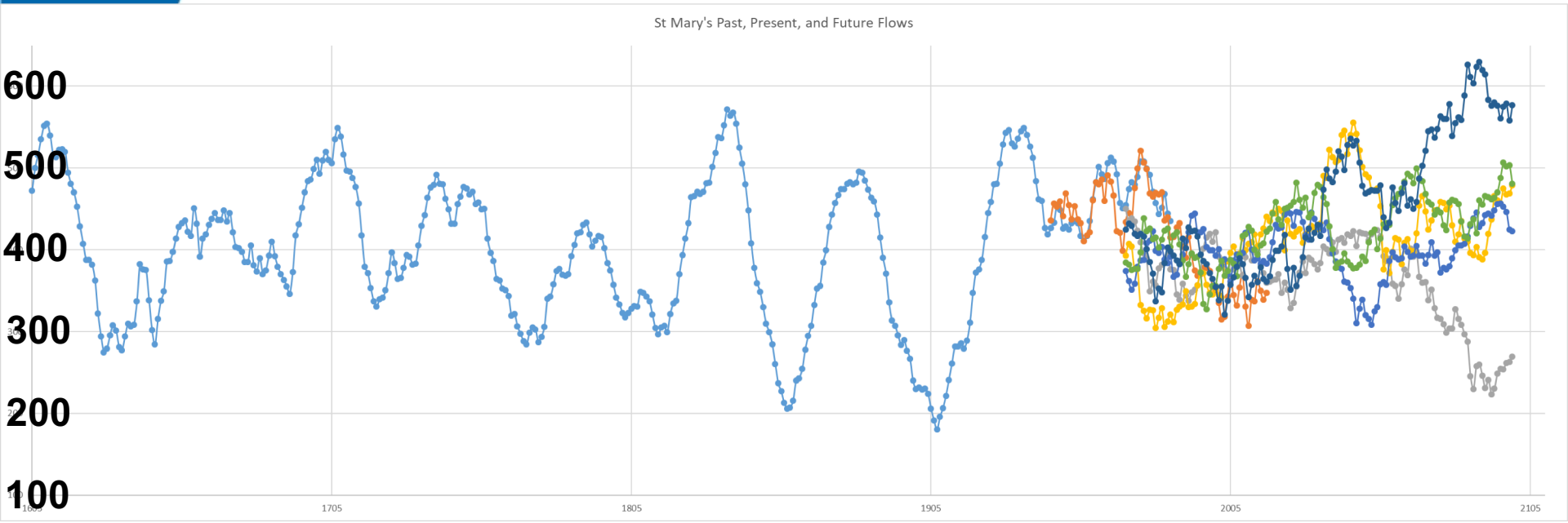

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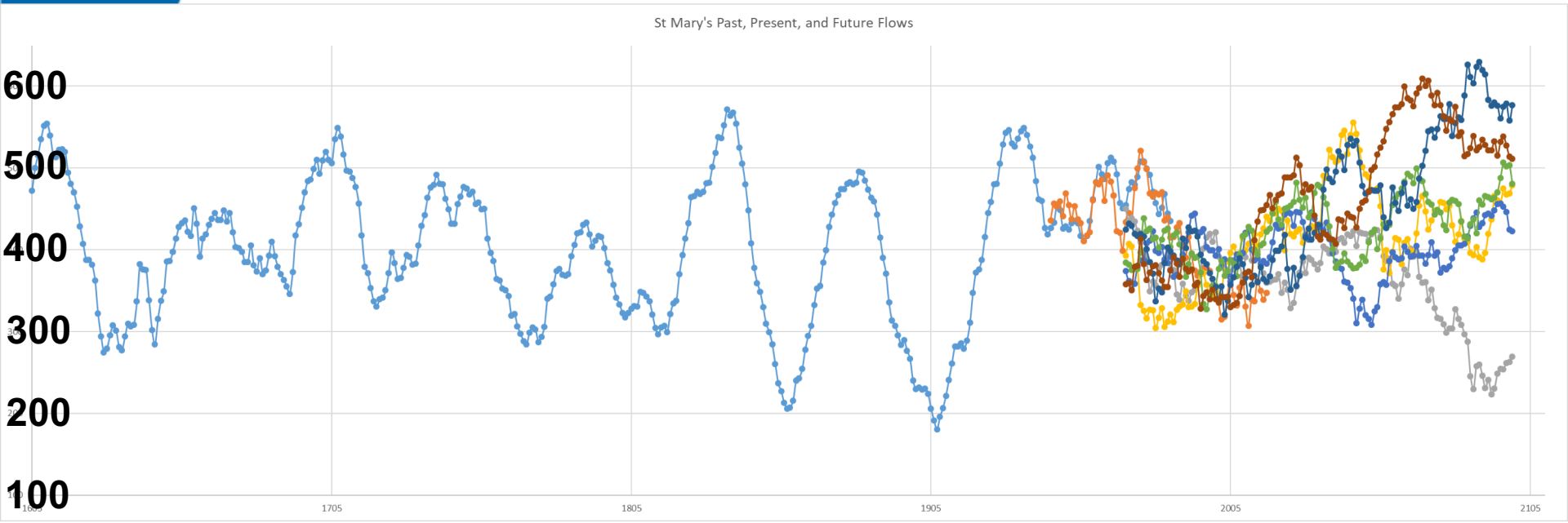

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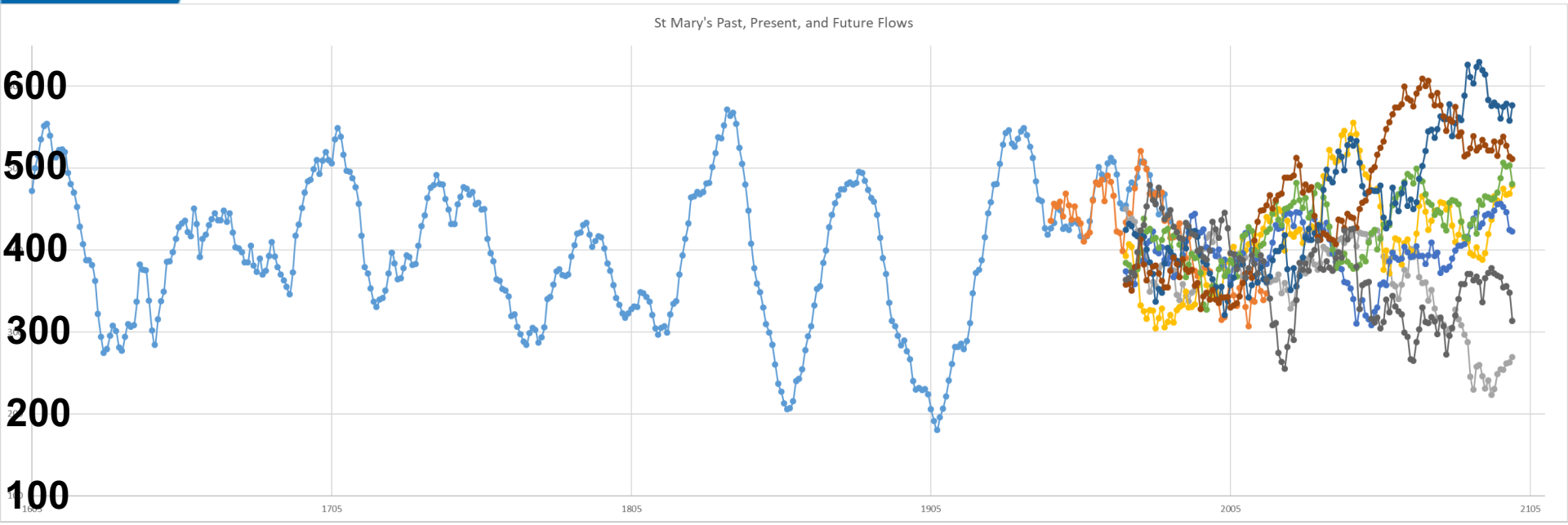

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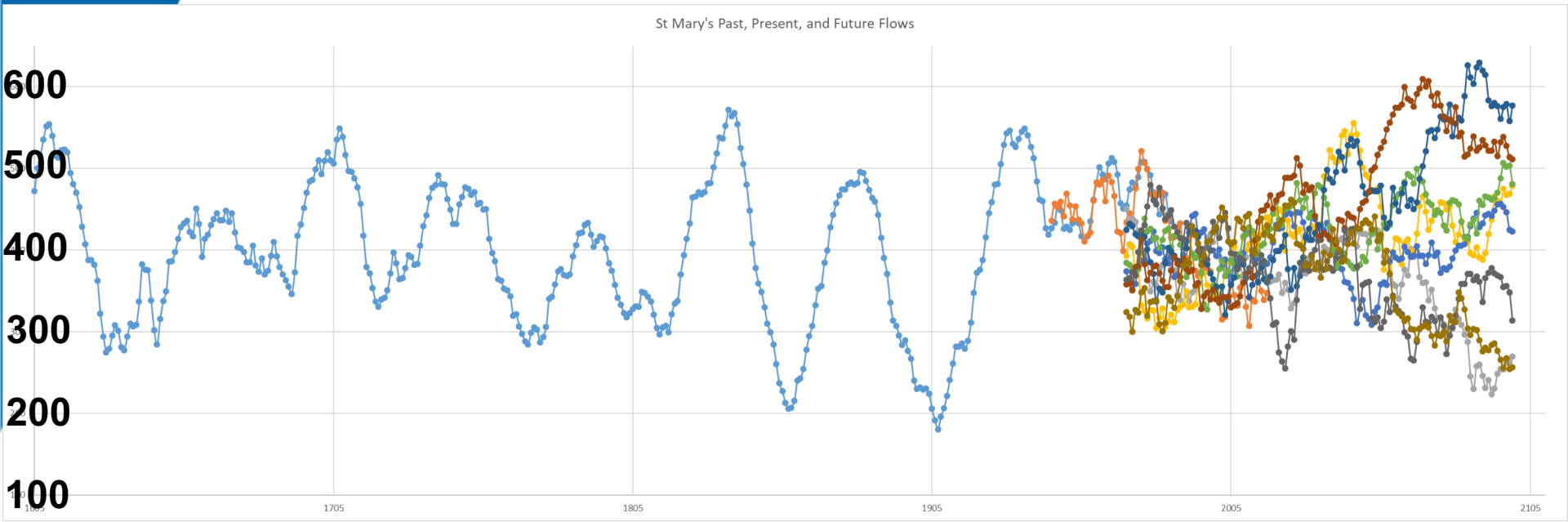

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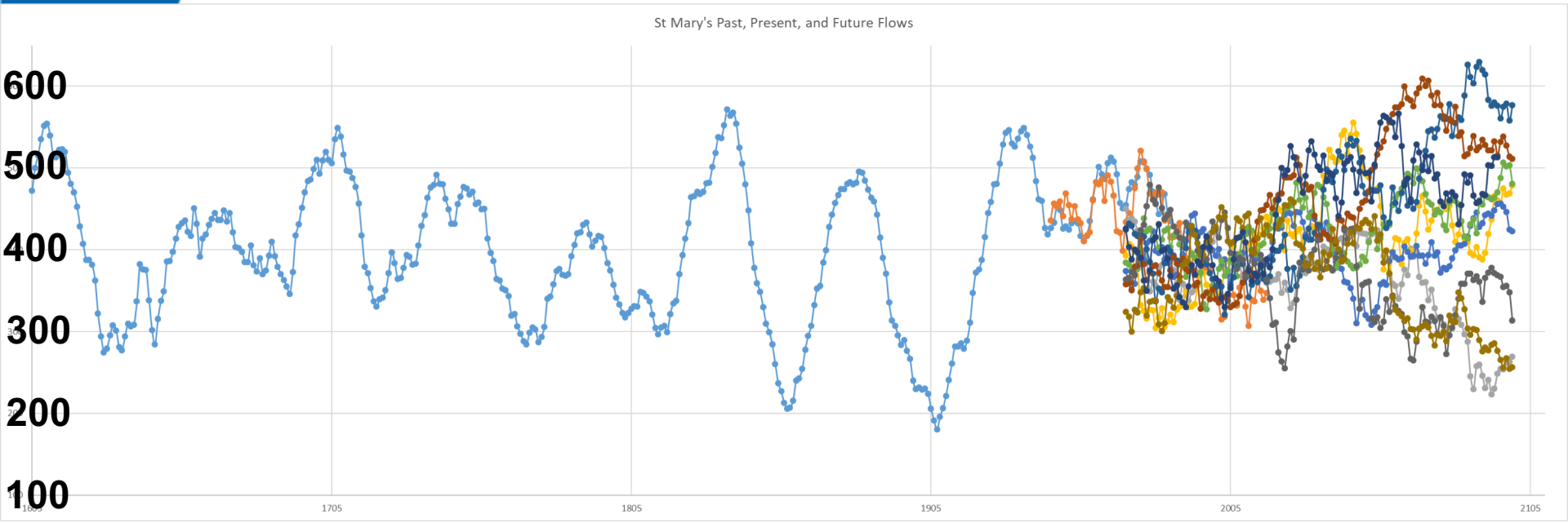

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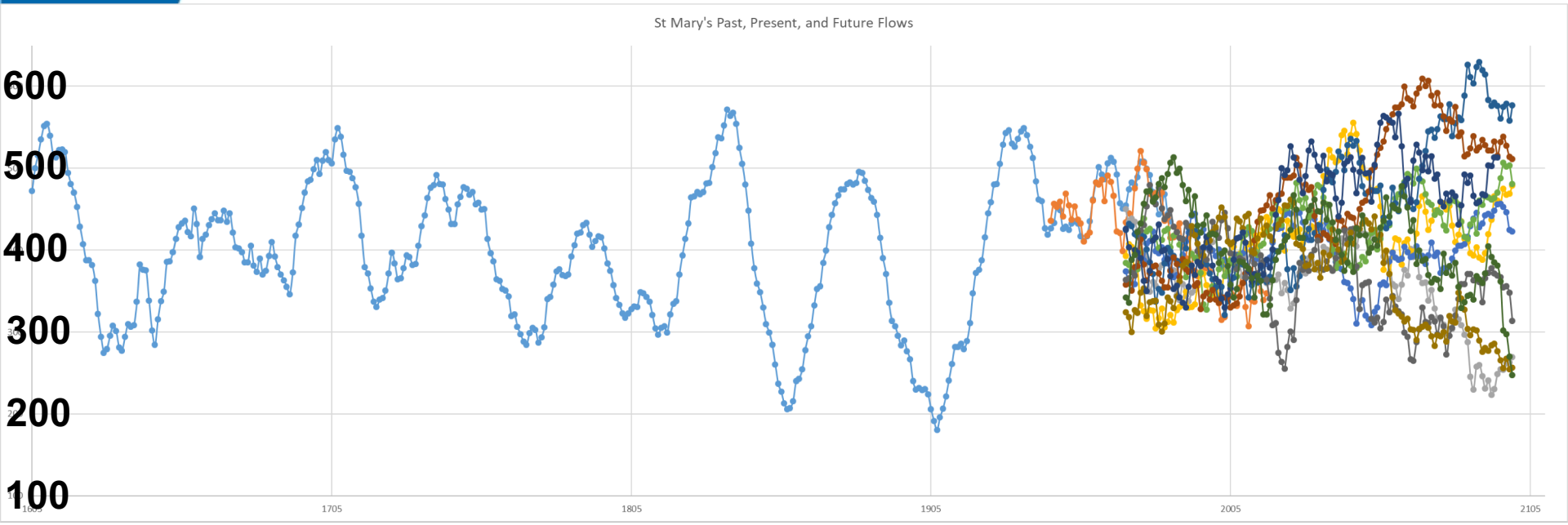

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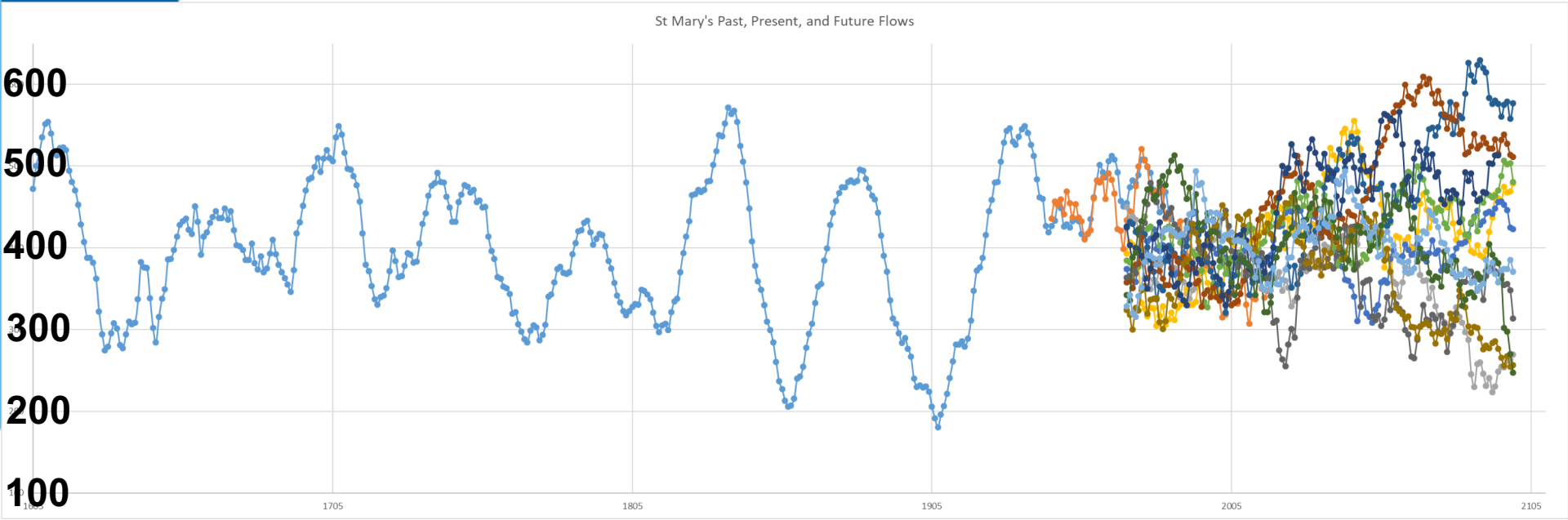

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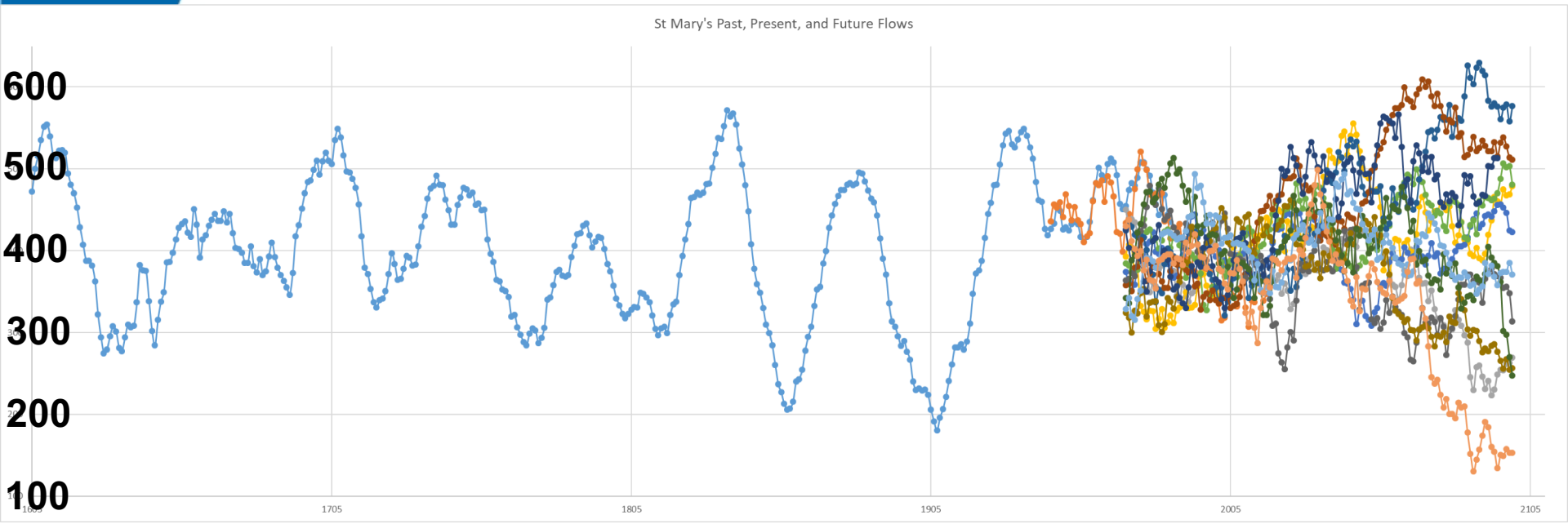

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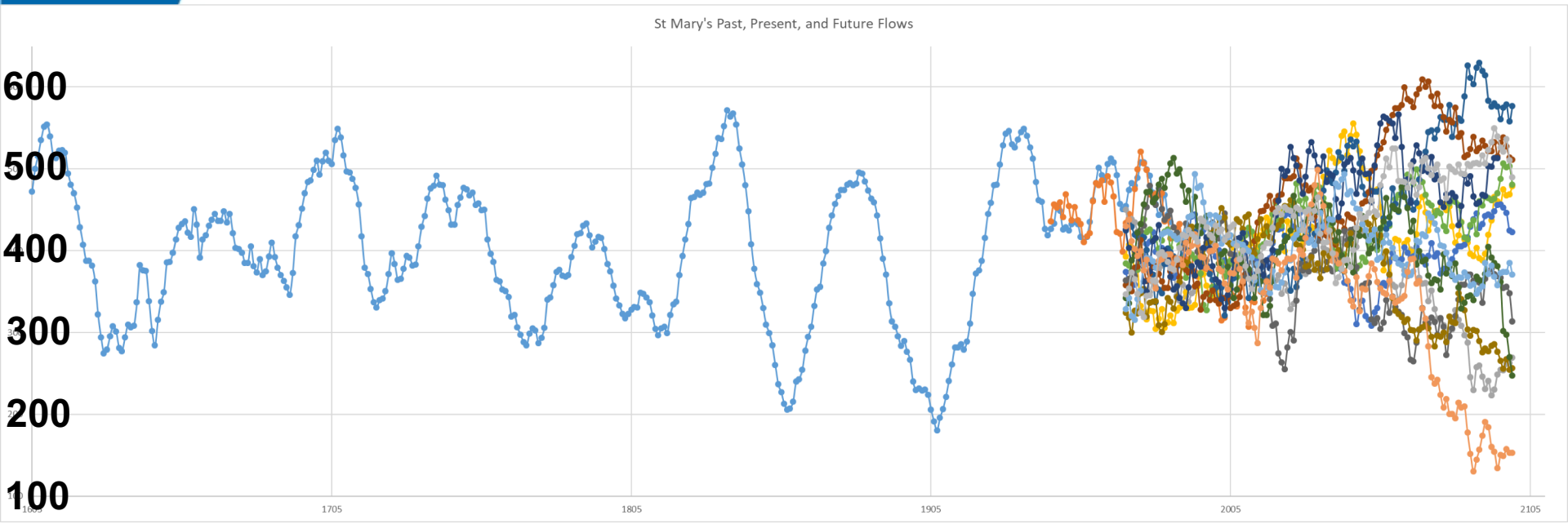

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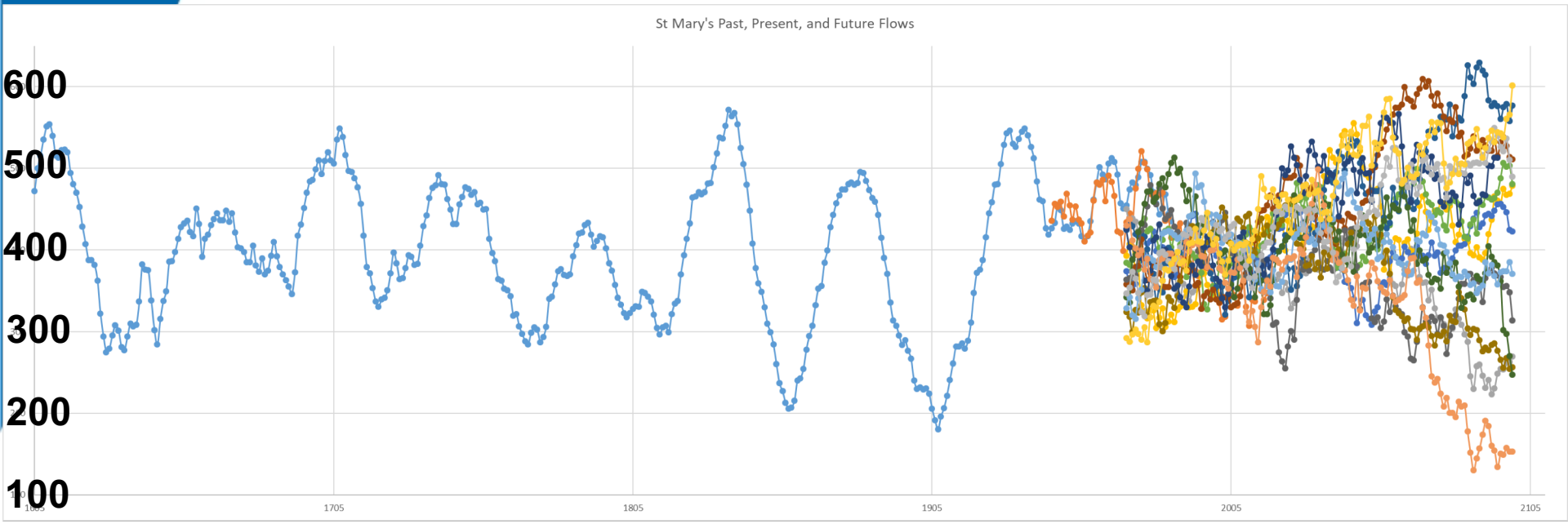

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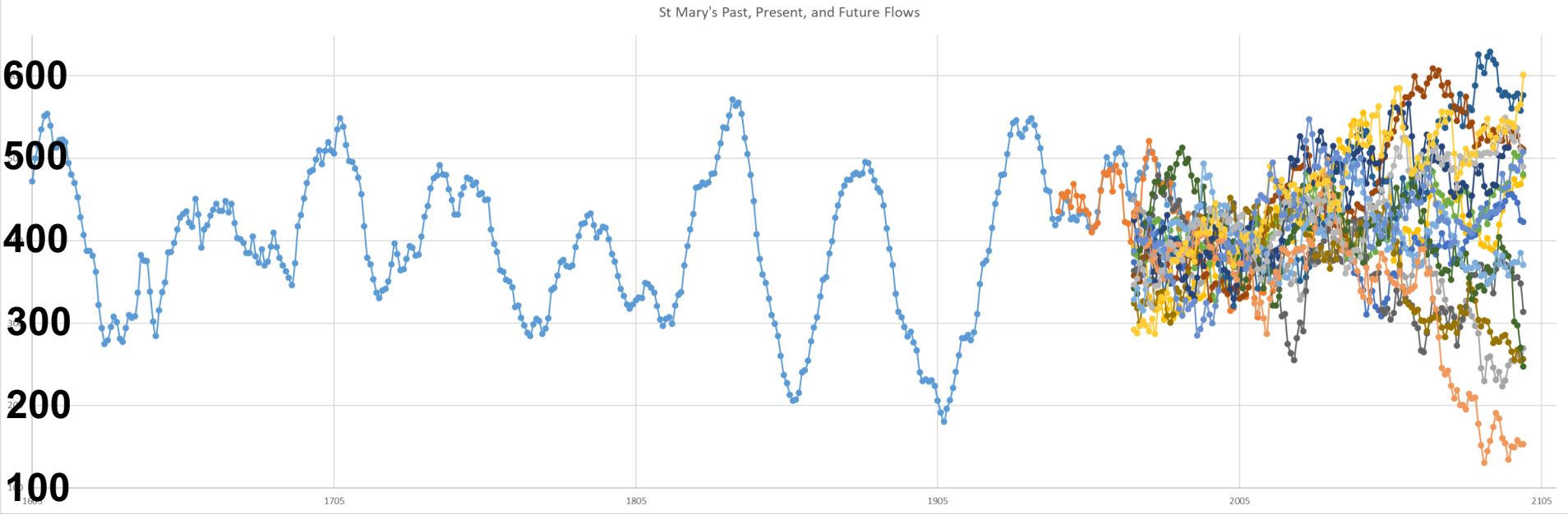

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