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Chesapeake Bay Streamflow Base and Critical Period Diagnostics

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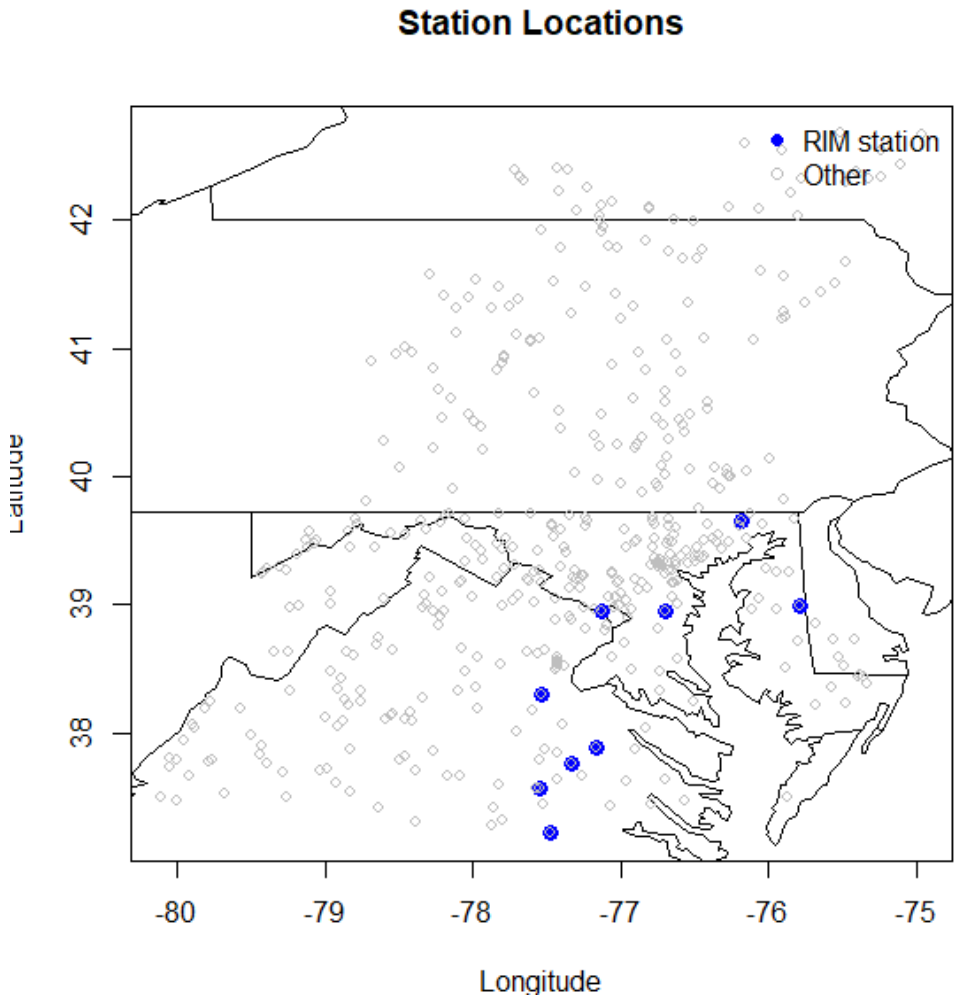
Study Area — RIM and Tributary Flow Gages

- 9 RIM stations monitor direct inputs to the Bay - primary drivers of nutrient and sediment loading

- Interior tributary stations characterize watershed hydrology

- RIM stations weighted **95%** in composite score - consistent with their dominance of Bay inflow

- RIM weights applied using Phase 6 N adjusted ratios



Base Period Scoring: Methodology

- Windows scored by Mean Absolute Percent Difference (MAPD) from long-term statistics

$$MAPD = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{S_w - S_{LT}}{S_{LT}}\right|100$$

- Builds on previous analysis (appendix F):
- Nearly double the candidate period (1970-2024)
- Added Q05, Q95, CV

where:

S_w = statistic for 10-year window

S_{LT} = long-term mean statistic

n = number of metrics and gages

Computed across: mean Q, SD, CV, Q05, Q95

Phase 6 Load Effectiveness Weights (N Adjusted Ratios)

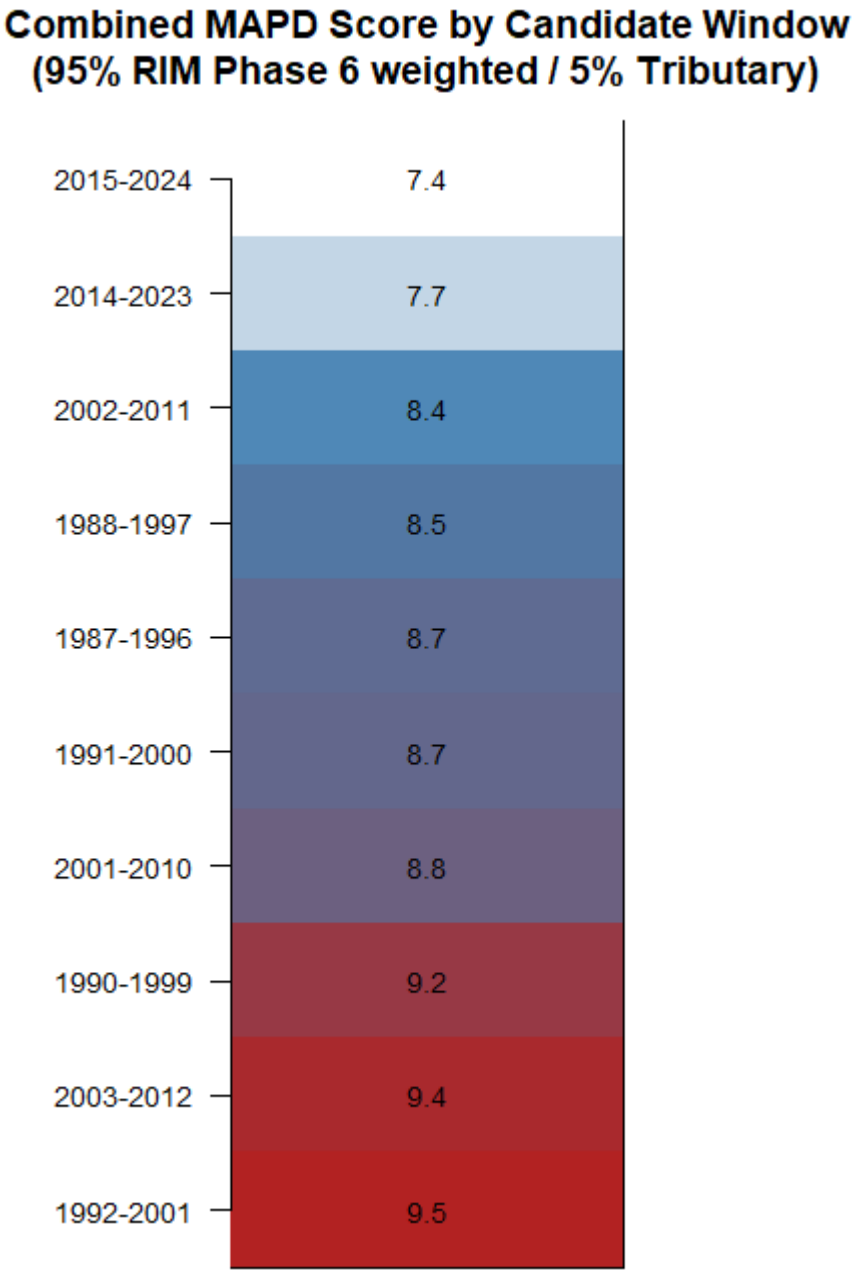
- Weights reflect tributary effectiveness at reducing Bay hypoxia - not flow contribution alone
- Derived from Phase 6 model - improved over Phase 5 TMDL (Table G-2)
- Susquehanna and Potomac dominate effective nitrogen delivery

Major basin multiplier and adjusted ratio based on Phase 6 geo-runs for the mid-point assessment[1].

Major basin	Multiplier[2]	N Adjusted ratio[3]
Appomattox	2.647	0.035
Choptank	11.244	0.150
James	2.647	0.035
Mattaponi	4.630	0.062
Pamunkey	4.630	0.062
Patuxent	10.931	0.145
Potomac	14.045	0.187
Rappahannock	8.065	0.107
Susquehanna	16.325	0.217

MAPD Results
Combined Score by Window

- Lower score = closer match to long-term hydrology
- **Recent windows lead** : 2015–2024and 2014–2023 score best
- 2002–2011 is third : transitional period between recent and historical candidates
- Historical window 1988–1997 fourth : still competitive
- Score range across top 10 is narrow



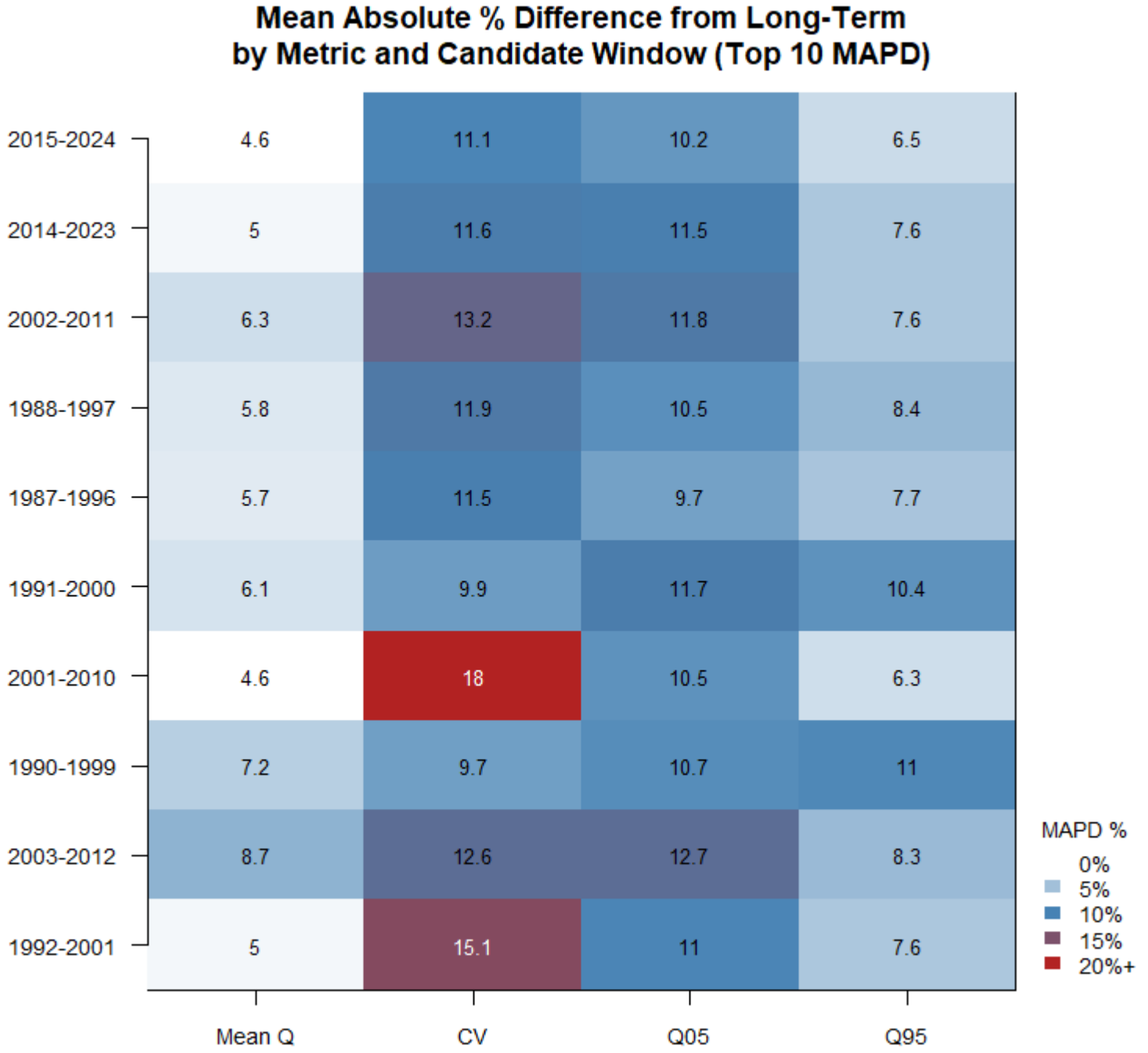
MAPD by Metric
Top 10 Candidate Windows

- **Mean Q and Q95 consistently pale** (mean and high flows well-matched across all windows)

- **CV is the most variable metric** 2001–2010 shows worst score (18%) driven by 2002 drought period

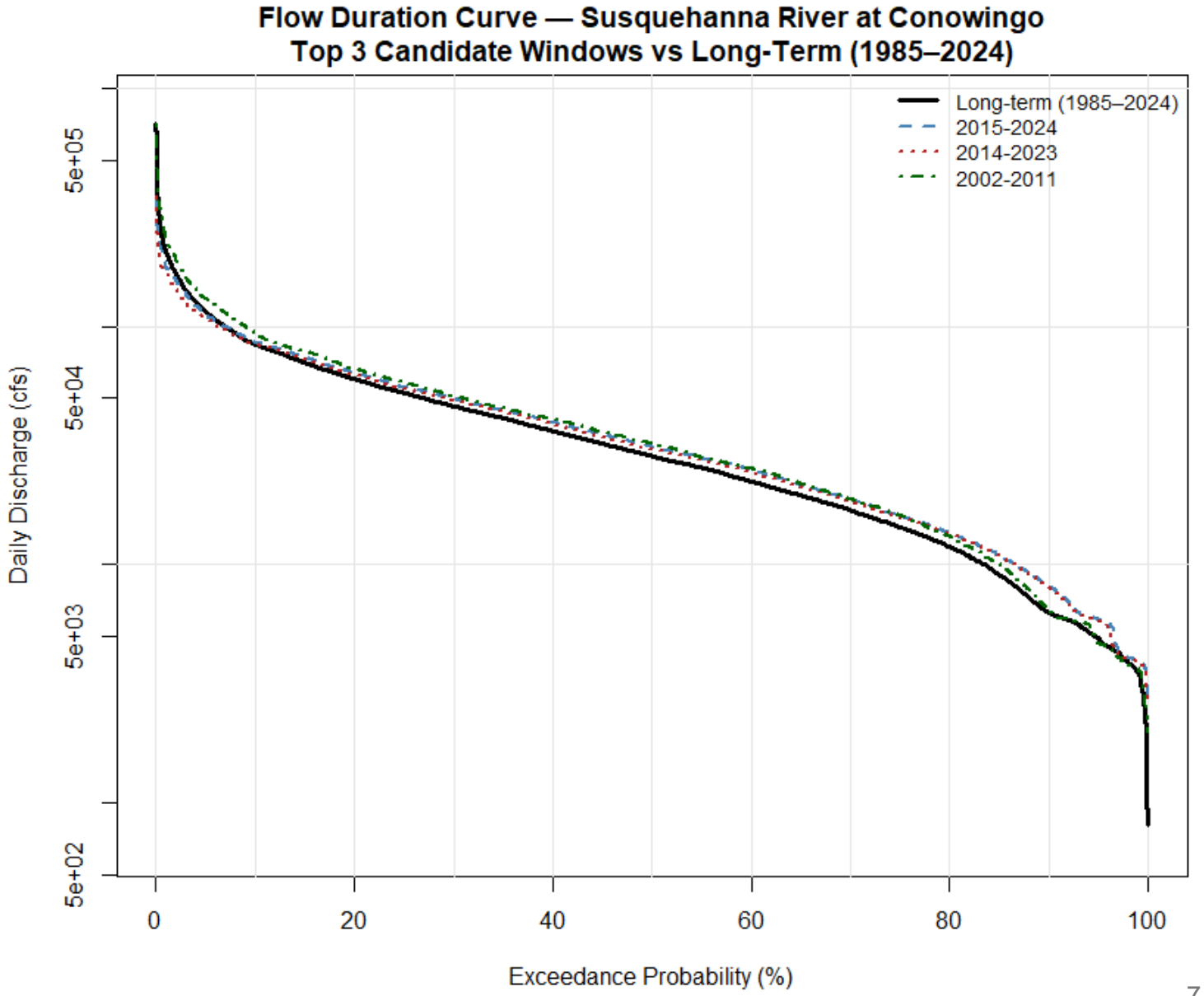
- Recent windows score best on Mean Q but carry moderate CV and Q05 penalties

- No window is uniformly pale. tradeoffs exist across all metrics for every candidate



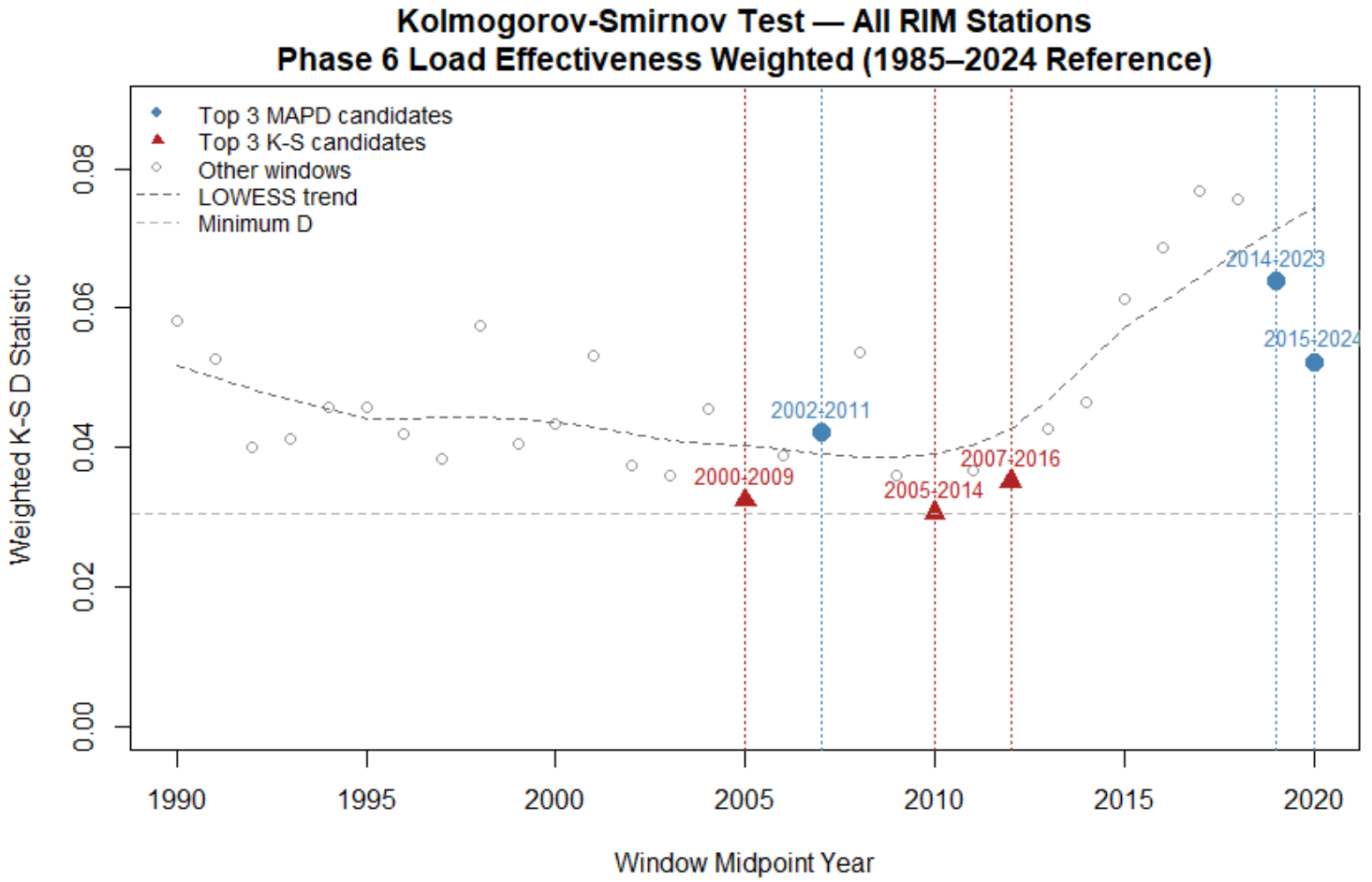
Flow Duration Curve : Susquehanna River at Conowingo

- All three candidate windows track the long-term FDC closely across the full flow range
- Small divergence at high flows (left tail) : candidate windows slightly below long-term peak flows
- Visual confirmation that top MAPD candidates are genuinely representative of long-term hydrology



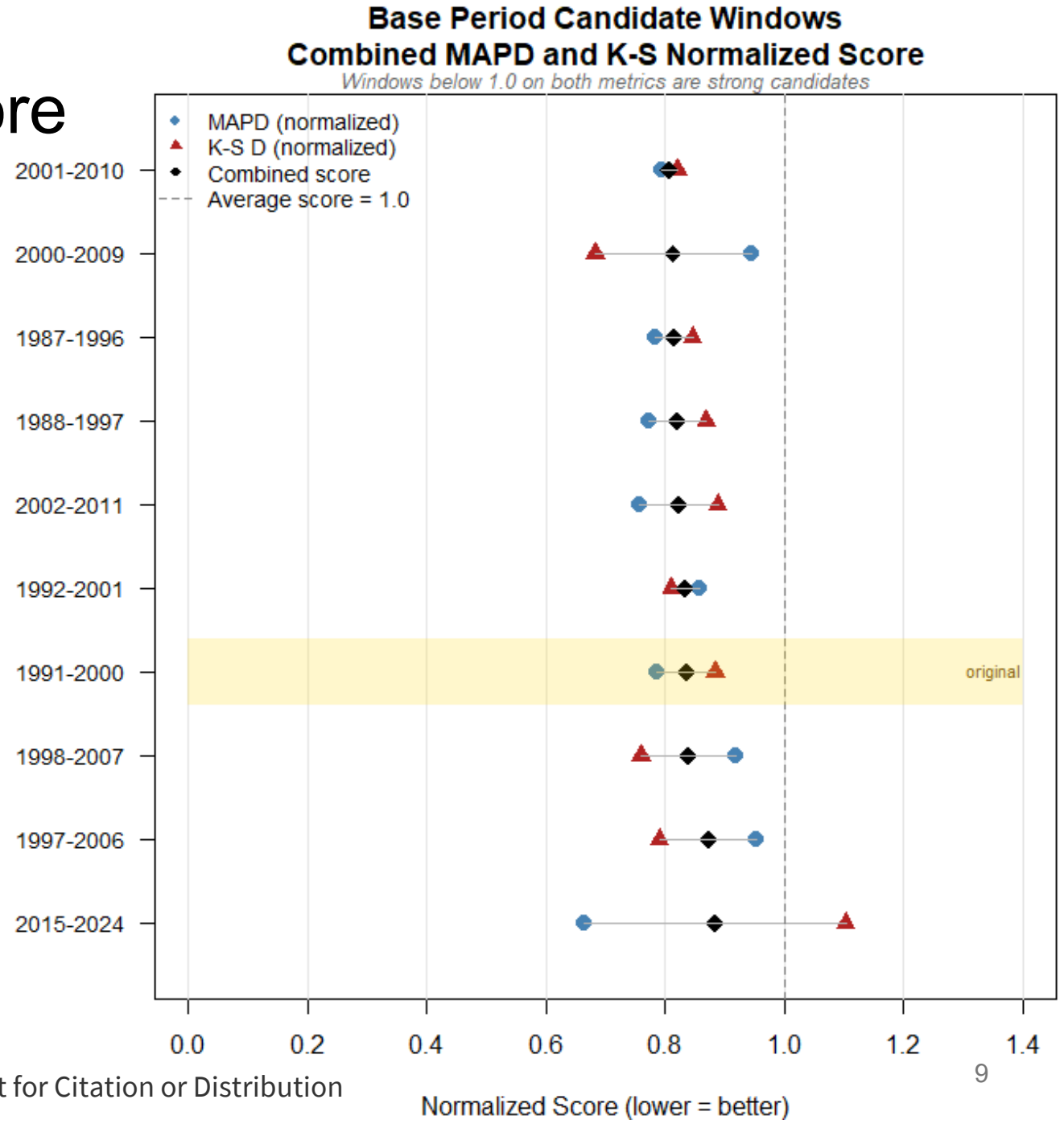
K-S Test Results : All RIM Stations (Phase 6 Weighted)

- Lower D = better distributional match to long-term reference
- **K-S minimum occurs ~2005–2014** (distinct from MAPD winners)
- Top MAPD candidates (2002–2011 competitive; 2014–2023 and 2015–2024 score poorly on K-S)
- Recent windows show increasing D : flow regime diverging from long-term reference distribution
- MAPD and K-S point to different optimal windows : motivates combining both methods



Combined MAPD + K-S Score Final Candidate Windows

- **2001–2010 is the combined winner :** below average on both MAPD and K-S simultaneously
- 2000–2009 has best distributional fit (K-S) but weaker flow statistics (MAPD)
- 2015–2024 best on MAPD but poorest K-S Original 1991–2000 base period near average on both metrics
- **Final selection requires policy judgment** model period constraints and temporal relevance must be considered



Base Period Analysis :
Summary of Assumptions and Decisions

Data period:

- Reference period: 1985–2024 - consistent with Phase 6 model simulation start year
- 40 years of record across 9 RIM and ~300 tributary stations

Scoring methodology:

- MAPD and K-S test normalized and averaged - consistent with Appendix F
- Four flow metrics: Mean Q, CV, Q05, Q95

Station weighting:

- RIM stations weighted 95%, tributaries 5%
- RIM stations weighted internally by Phase 6 N load effectiveness ratios (R. Tian, CBPO)

Open items pending group confirmation:

- Phase 6 model end year - determines eligibility of 2015–2024 window
- Equal metric weighting - group may prefer higher weight on high flow metrics

Preliminary recommendation:

- **2001–2010** - combined MAPD + K-S winner
- **2015–2024** - MAPD winner, most temporally relevant, pending model period confirmation

Next steps:

- Address any group concerns on base period assumptions
- Begin critical stress period analysis - 3-year high flow window following Appendix G methodology

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