Understanding Trends in Load

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Modeling workgroup 7/7/2020

Partners

- Tidal Trends Team
  - Investigating reasons for non-tidal trends
  - Working closely with CBPO group
- Scientific Gap Analysis
  - Watershed group asking the same question about 2025
  - Review of past STAC work

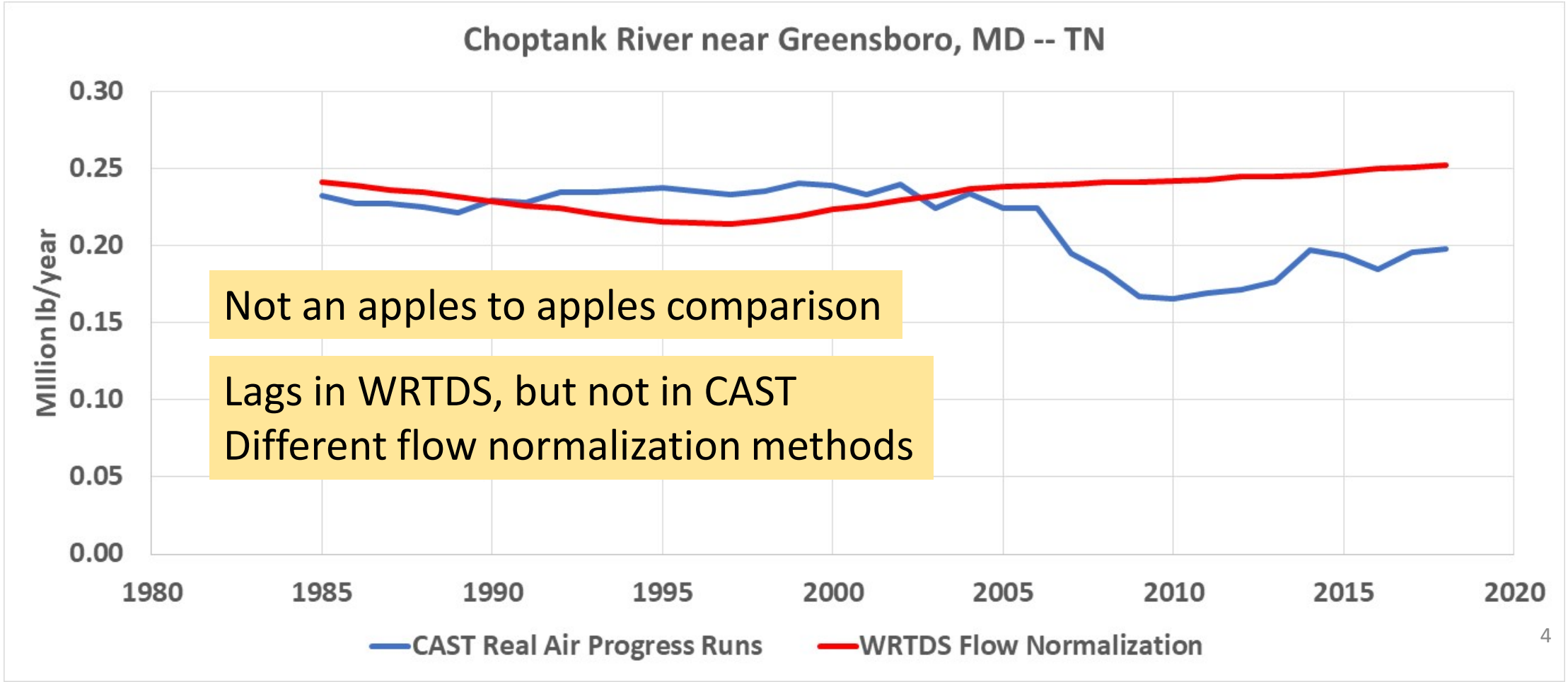
Management Question

- TMDL: Implement the practices by 2025 that will eventually lead to meeting water quality standards

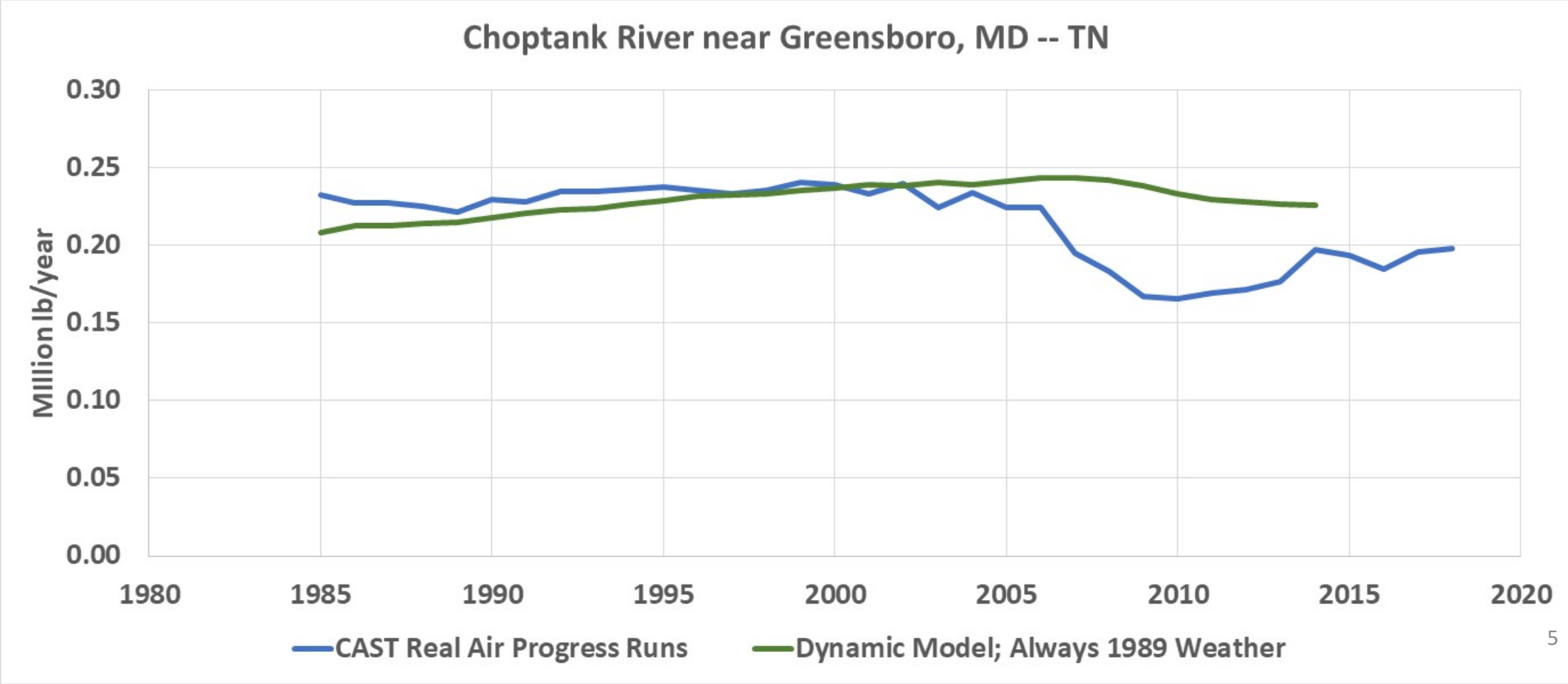
- CAST prediction: What is the long-term load resulting from a given state of the watershed (land use, point sources, management actions, etc)

- Science question: How do we use monitoring data to validate the predictions of CAST

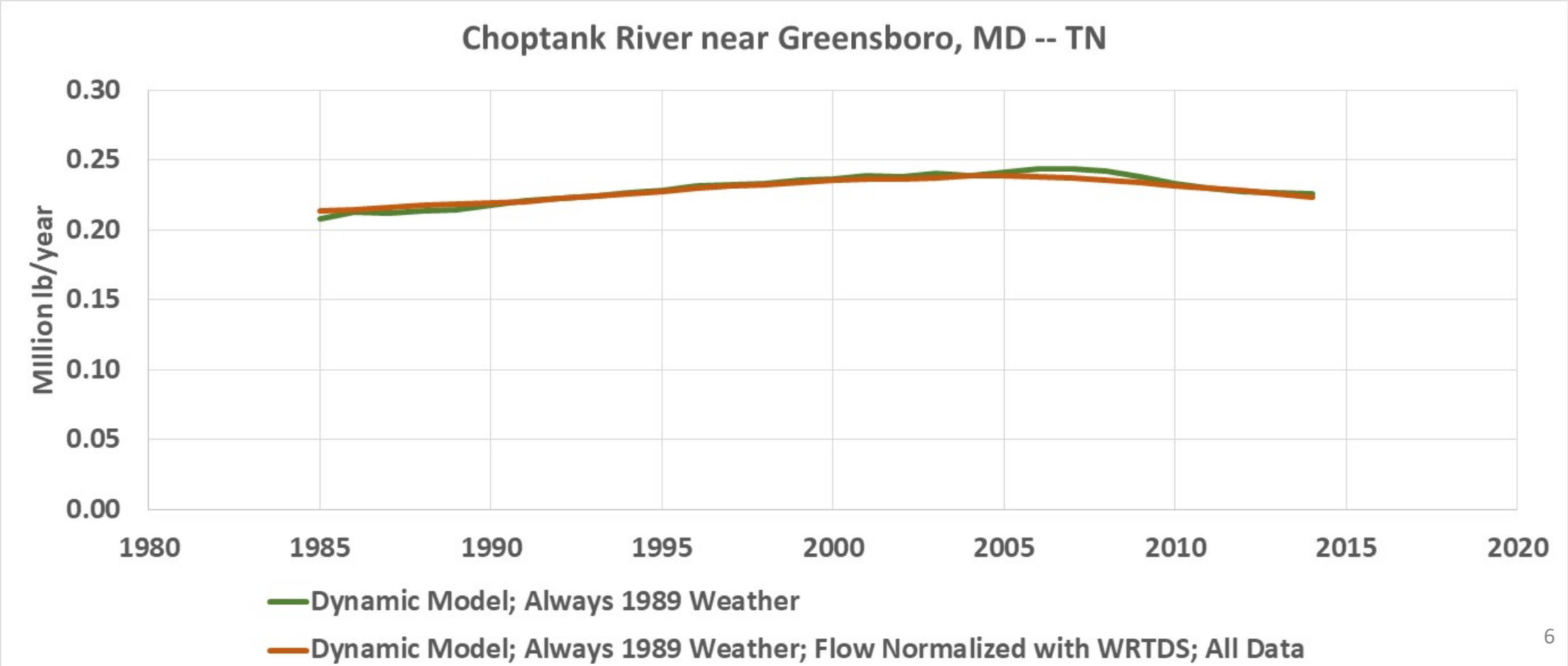
- CAST – trends in management using a long-term average hydrology
- WRTDS Flow Normalized Loads – Regression model based on observations



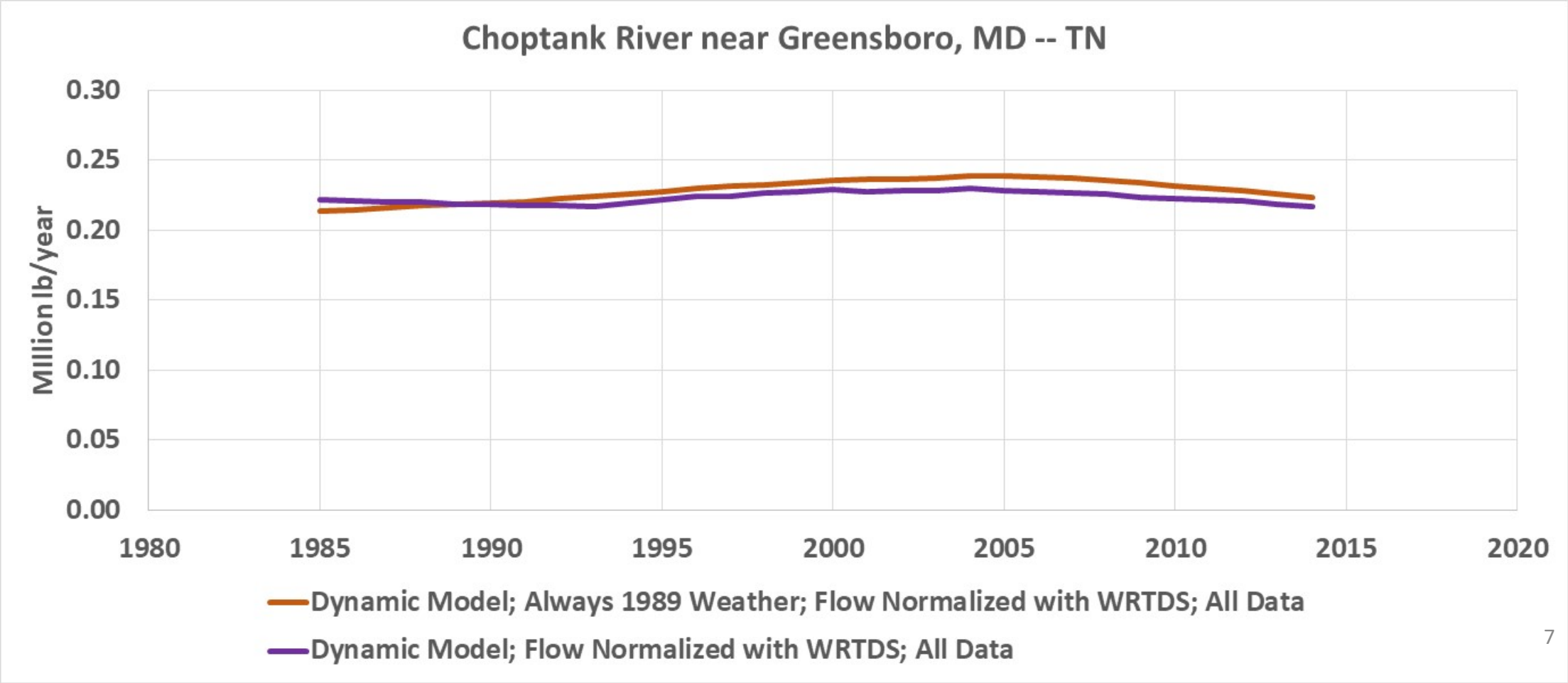
- CAST – long term trends in management
- Dynamic Model; Always 1989 Weather – Hourly simulation with the same inputs as CAST, Repeat 1989 weather for each year
- Lag times account for differences in shape. If CAST and the Dynamic Model were 'correct', the Dynamic Model would be the true flow normalized trend.



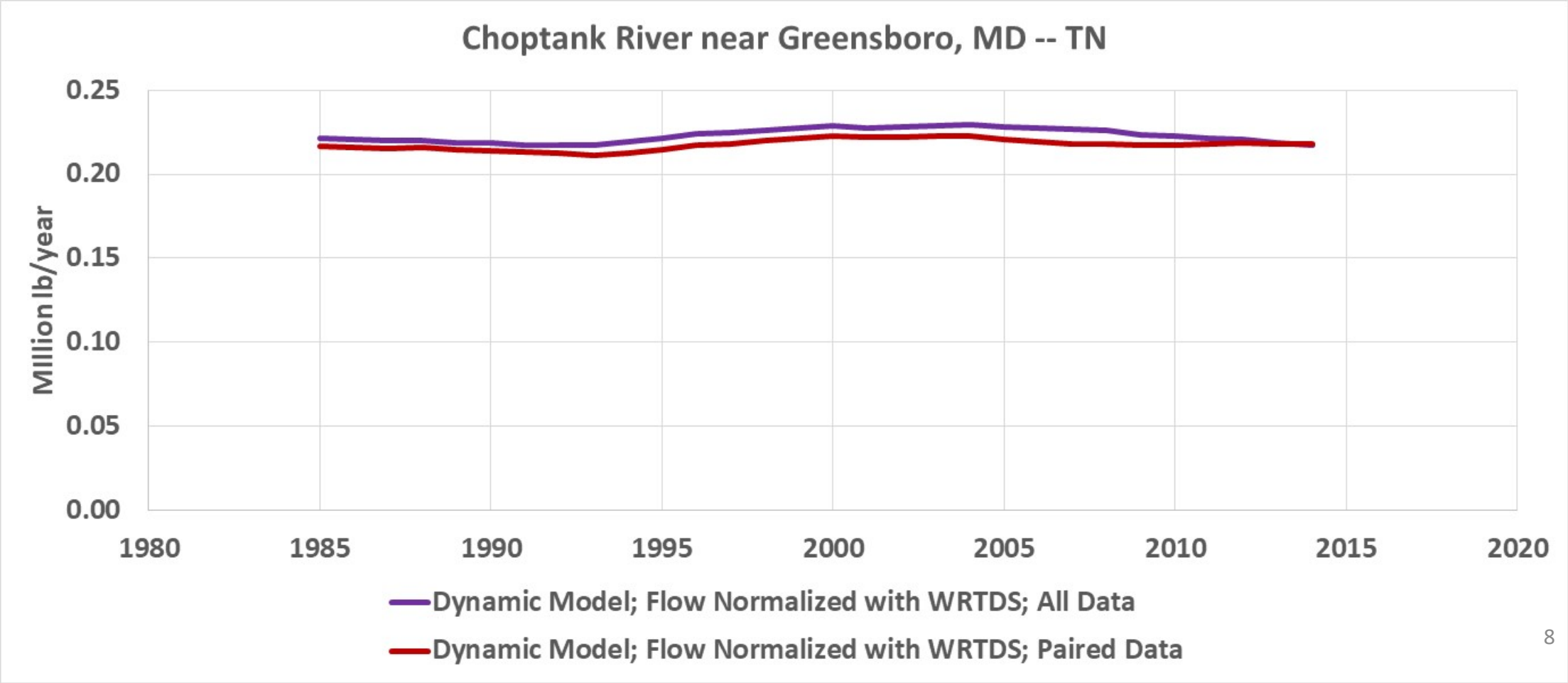
- Dynamic Model; Always 1989 Weather – direct output of flow normalized dynamic model
- Dynamic Model; Always 1989 Weather; Flow normalized with WRTDS; All Data – ran WRTDS flow normalization to see how it replicates a flow-normalized trend
- Assesses smoothing in WRTDS.



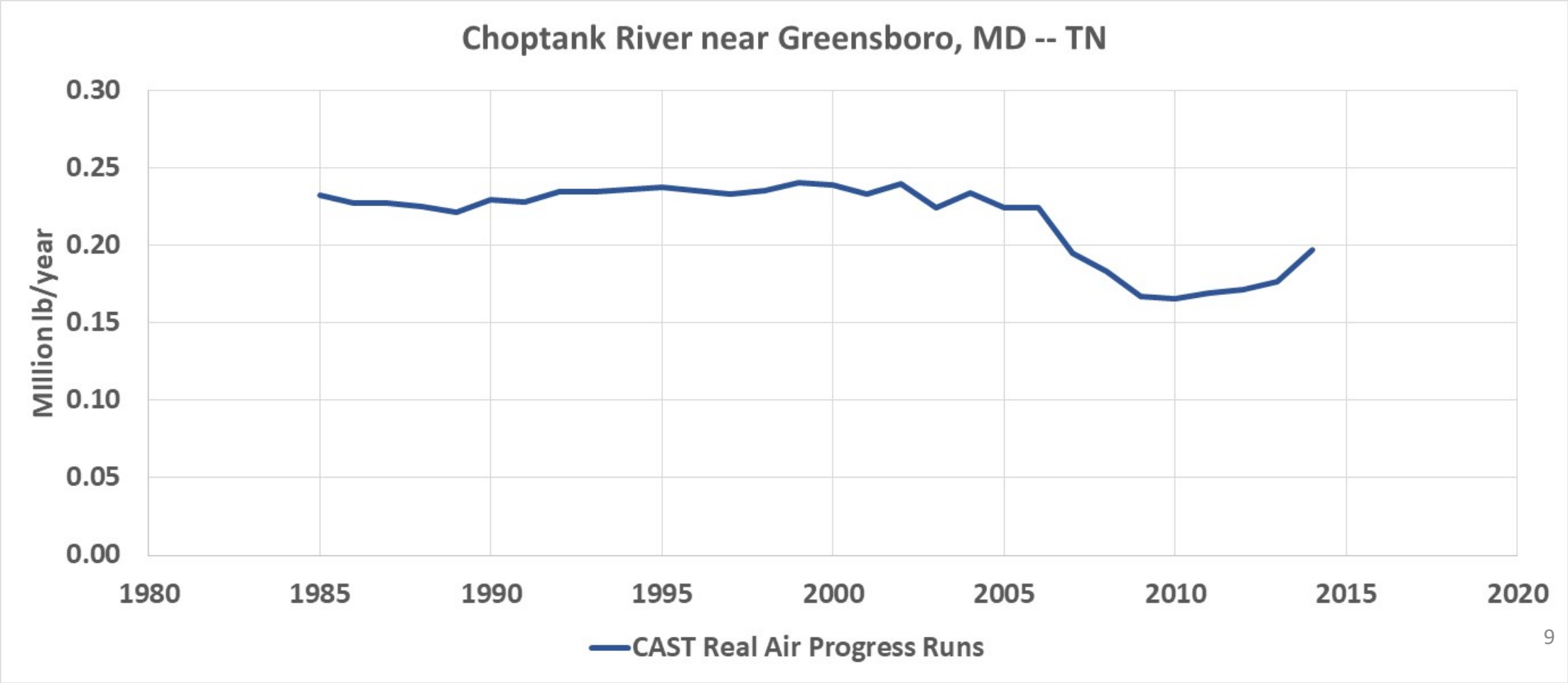
- Dynamic Model; Always 1989 Weather; Flow normalized with WRTDS; All Data – Uses 1989 weather each year
- Dynamic Model; Real weather; Flow normalized with WRTDS; All Data – uses real weather
- Assesses the ability of WRTDS to flow normalize given variable weather. Trends are a little different.



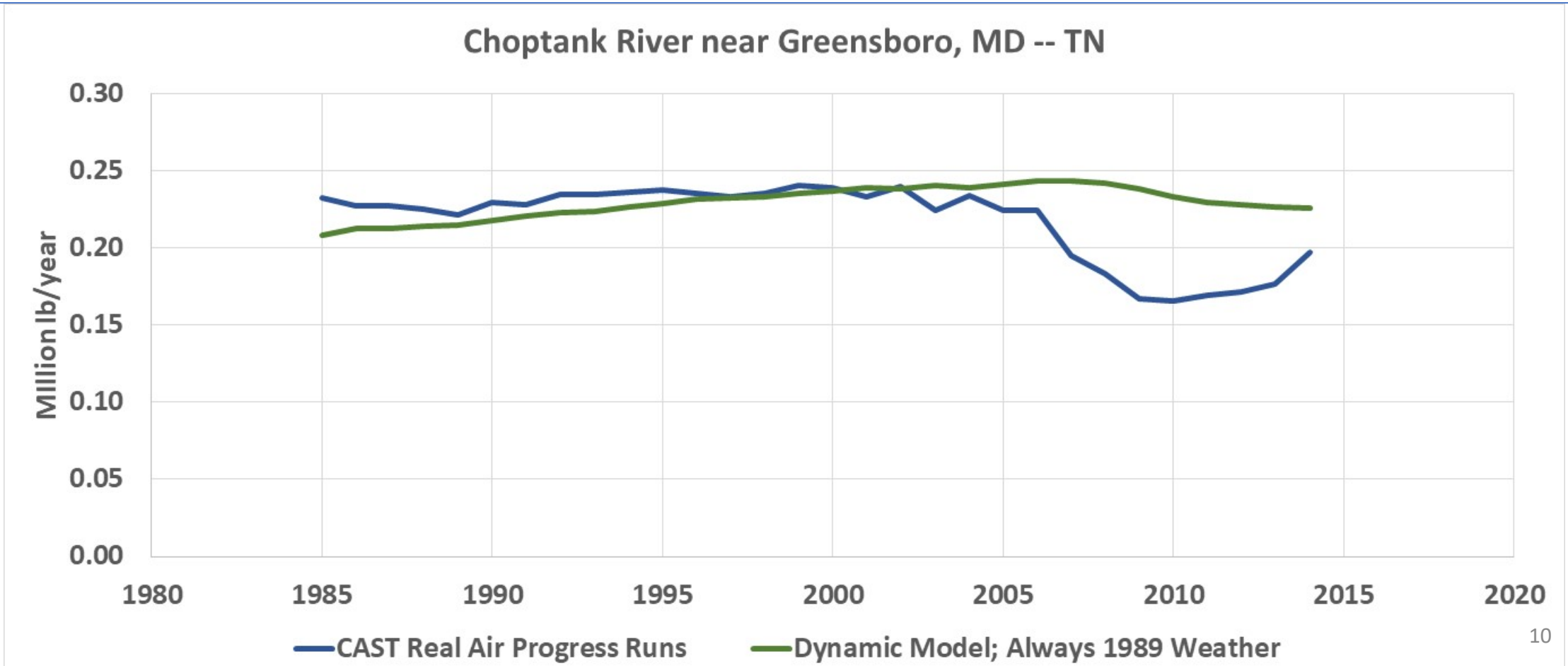
- Dynamic Model; Real weather; Flow normalized with WRTDS; All Data – uses all daily data
- Dynamic Model; Real weather; Flow normalized with WRTDS; Paired Data – uses data just on days where there was a USGS observation
- Assesses the ability of WRTDS to flow normalize given sparse data



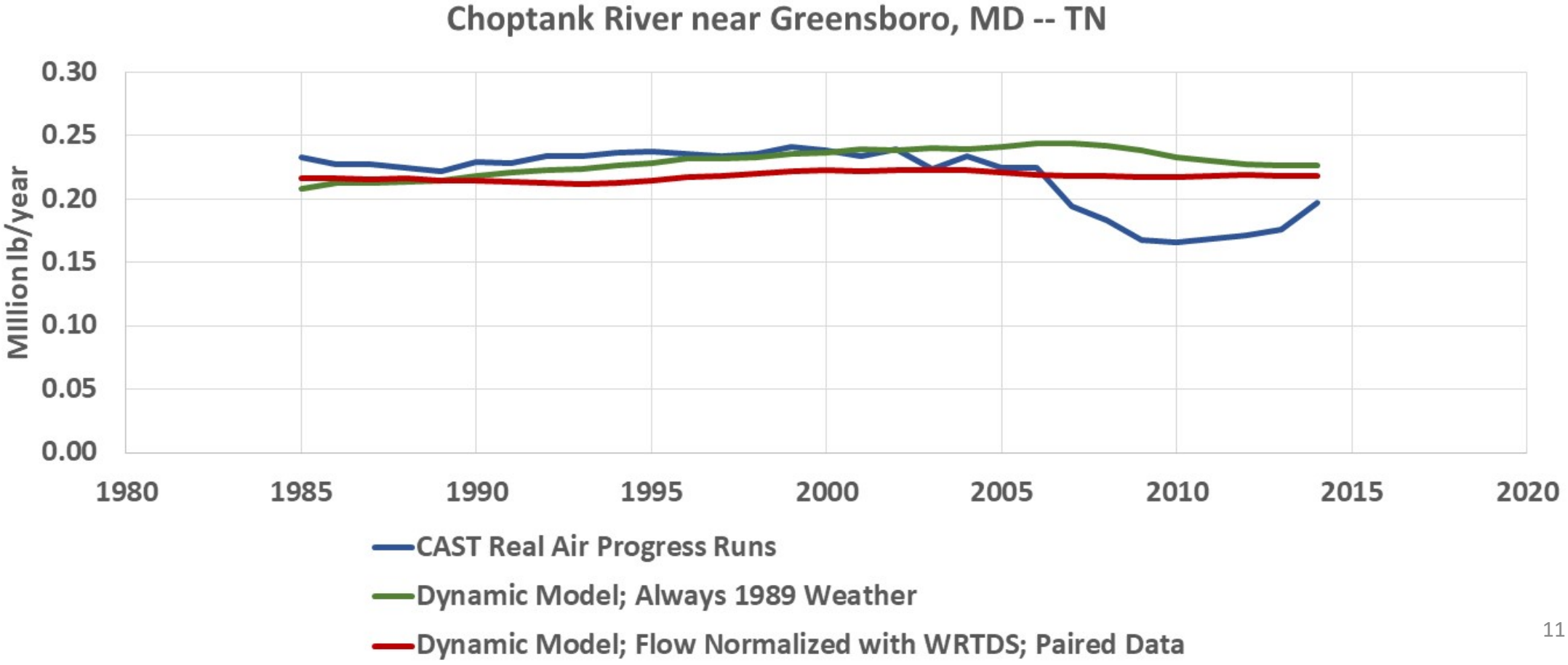
- Building a useful comparison
- CAST – long term flow-averaged loads based on annual state of management



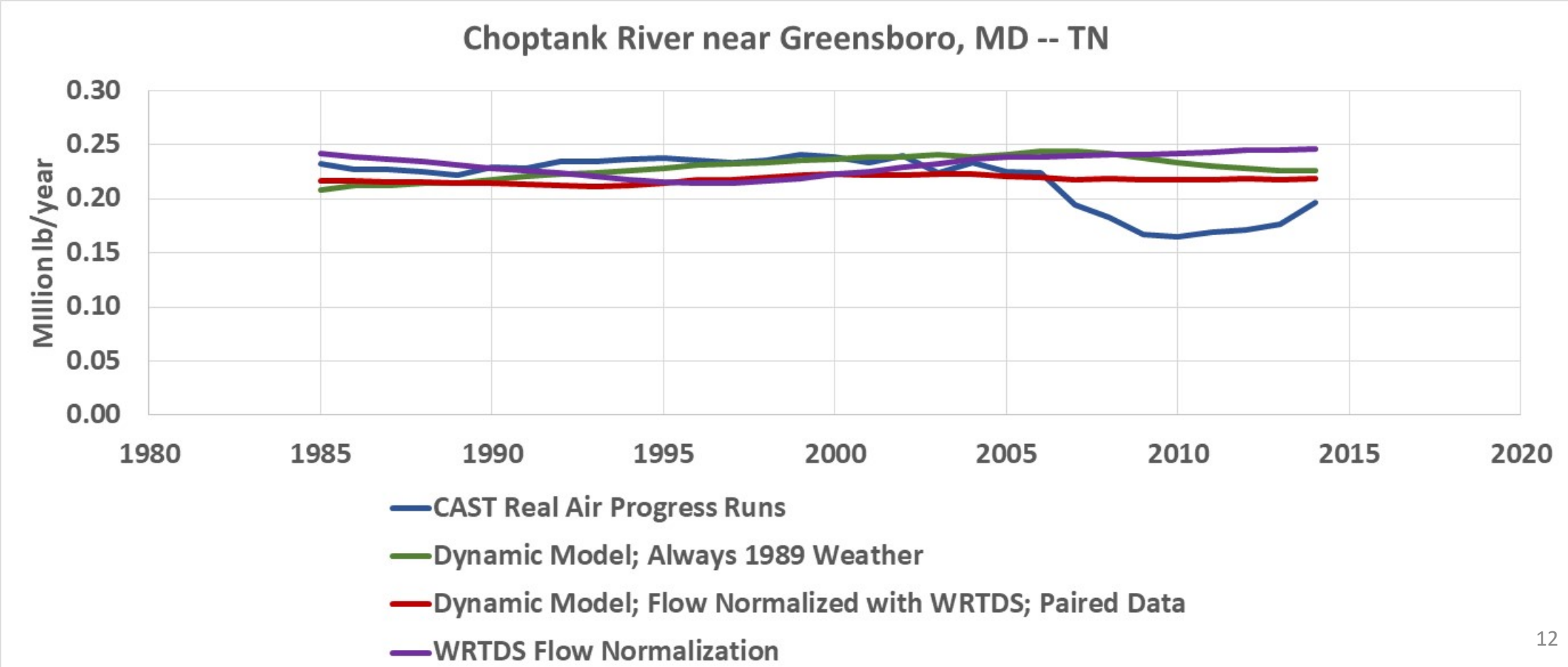
- Building a useful comparison
- Dynamic Model; Always 1989 Weather – The ‘true’ flow normalized loads if CAST and the DM were ‘correct’

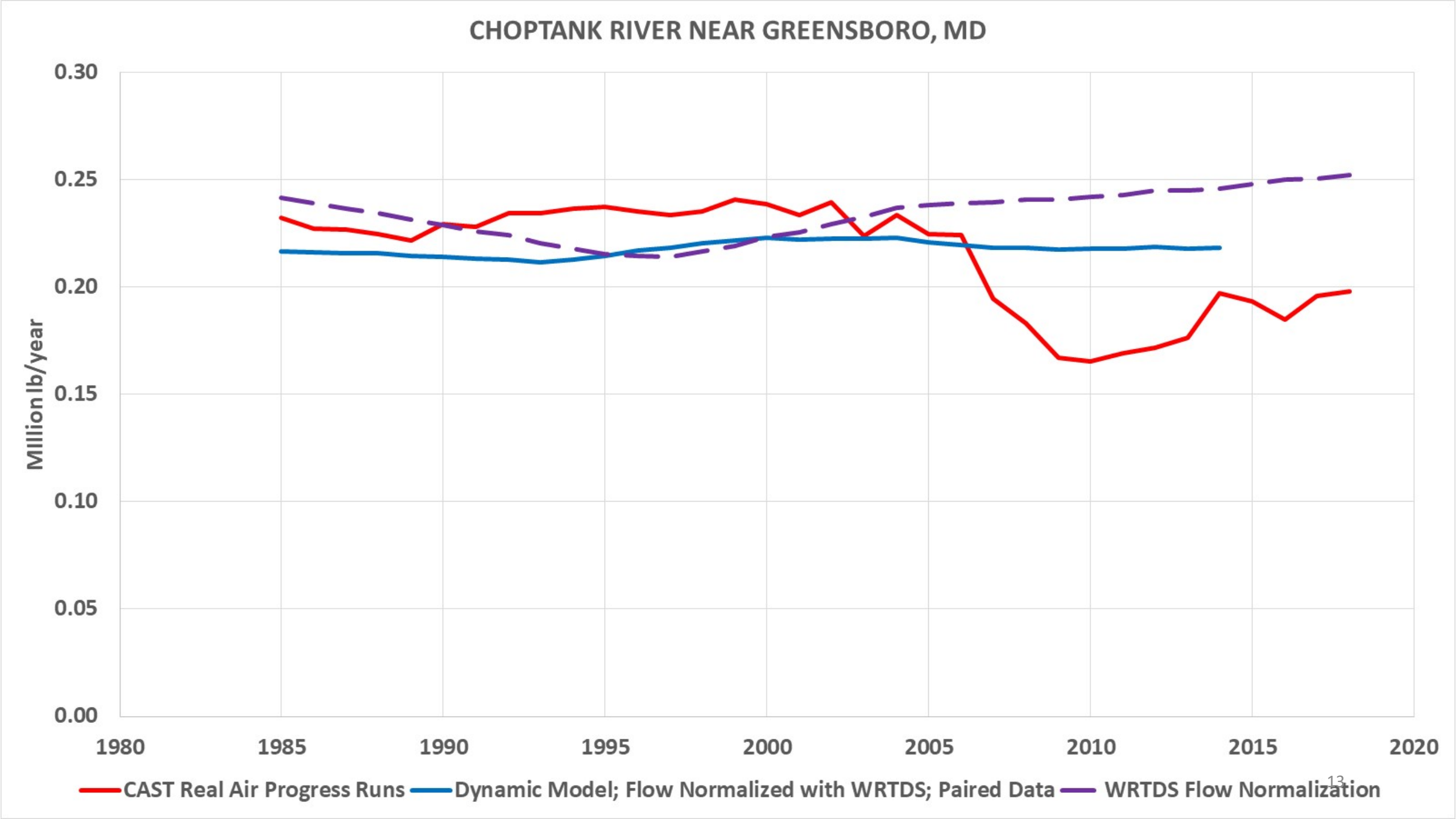


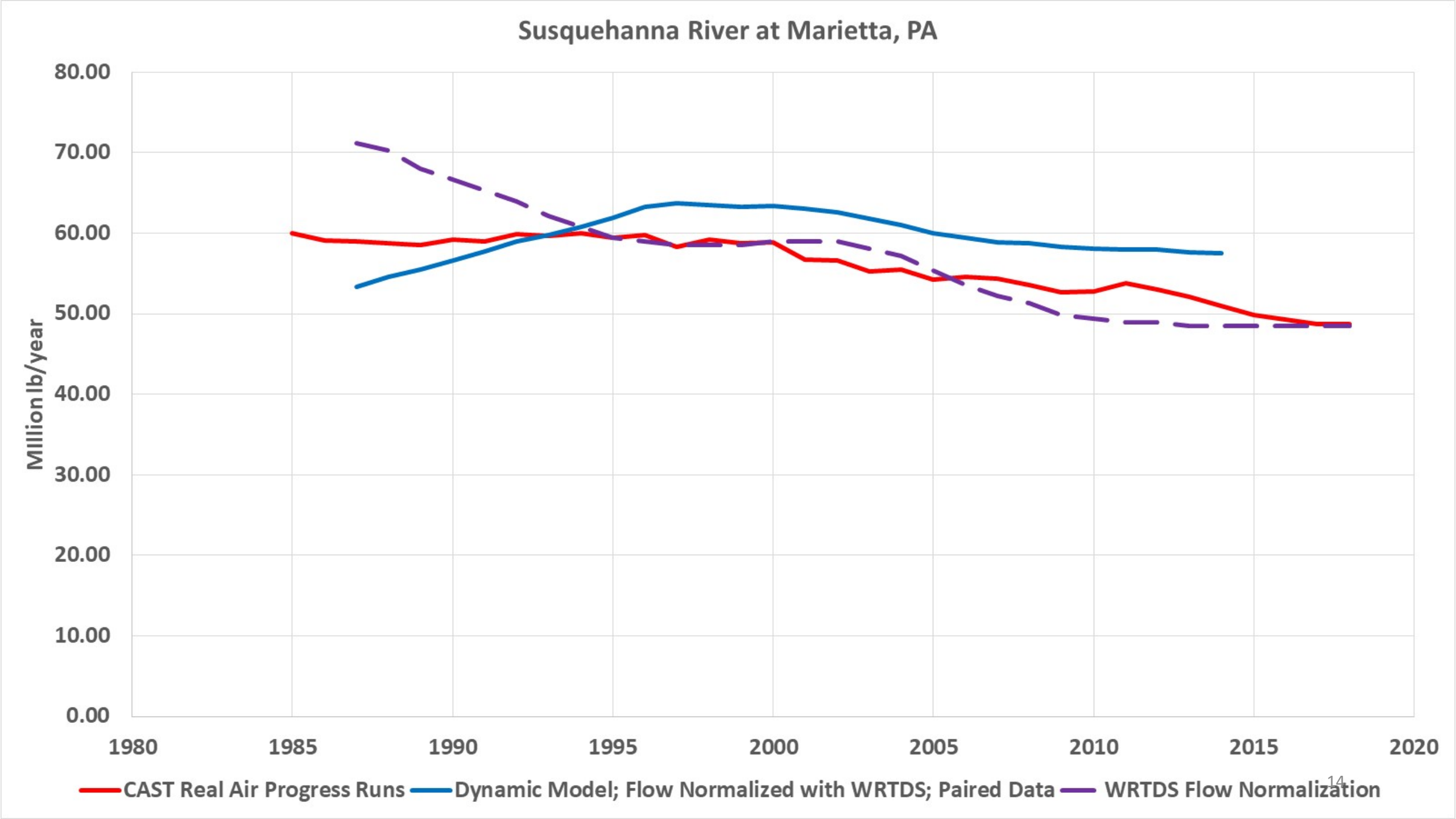
- Building a useful comparison
- Dynamic Model; Real weather; Flow normalized with WRTDS; Paired Data – What WRTDS-FN would see if the models were 'correct'

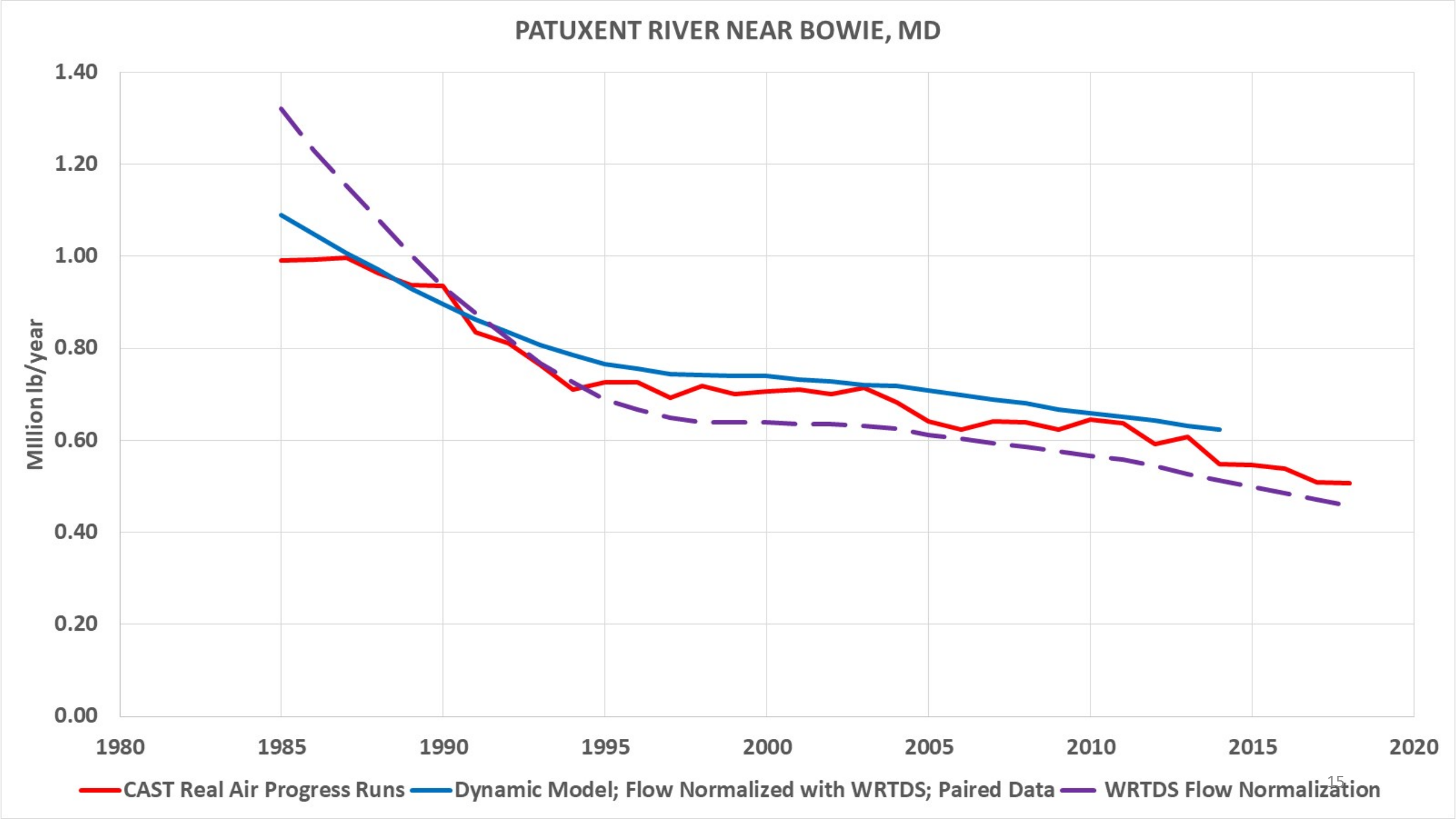


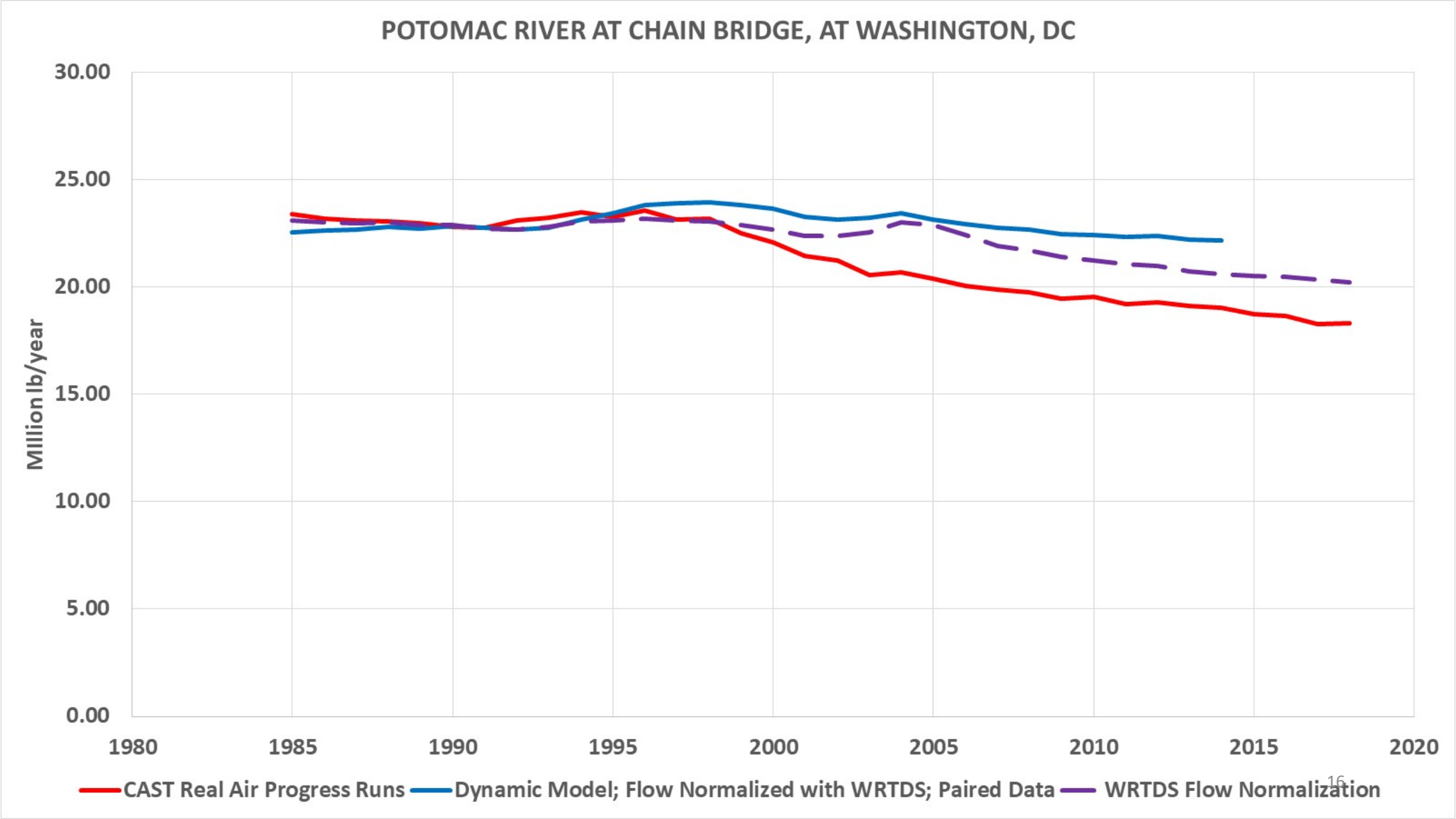
- Building a useful comparison
- WRTDS-Flow Normalized – What is analyzed from observed data

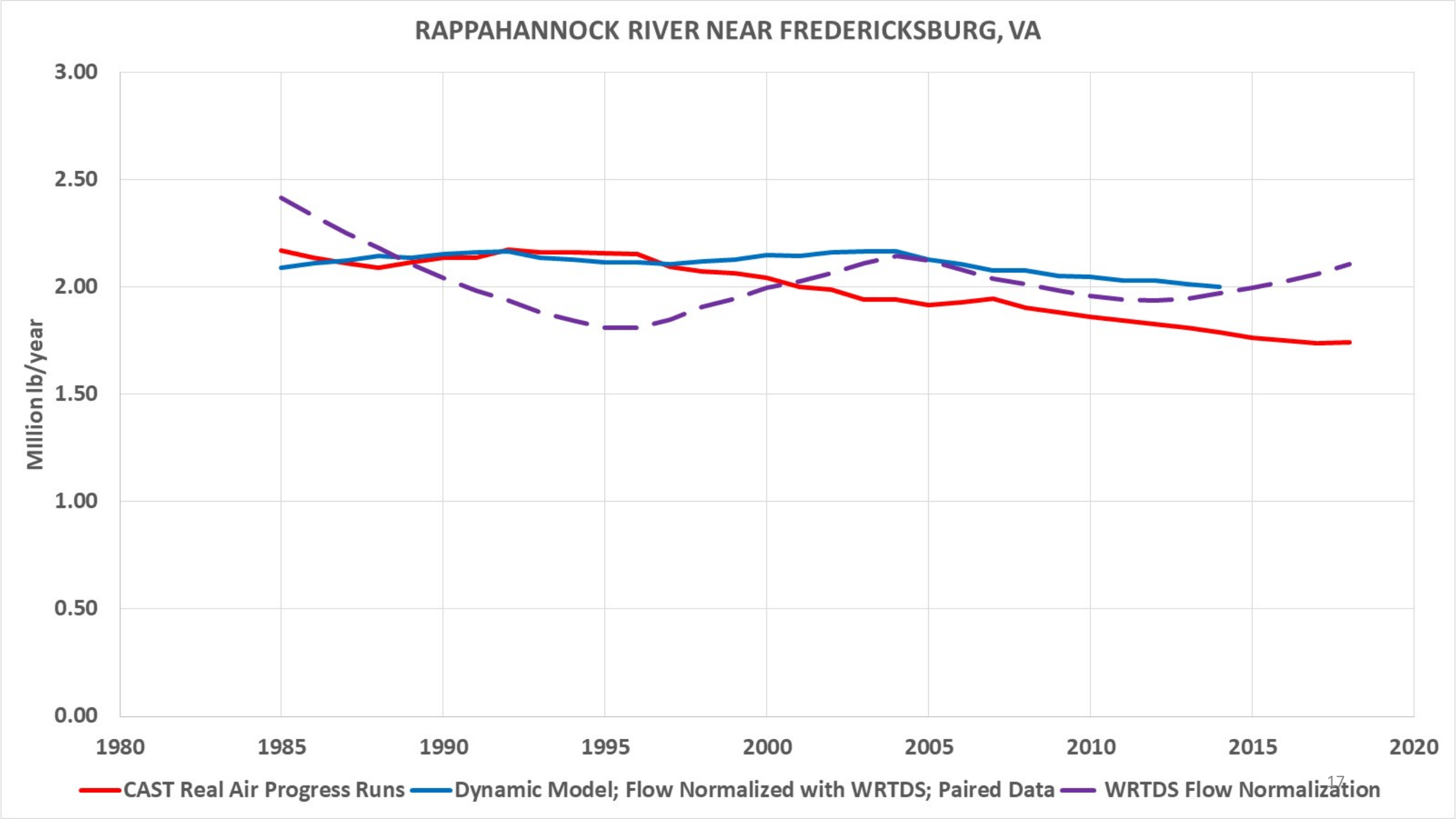


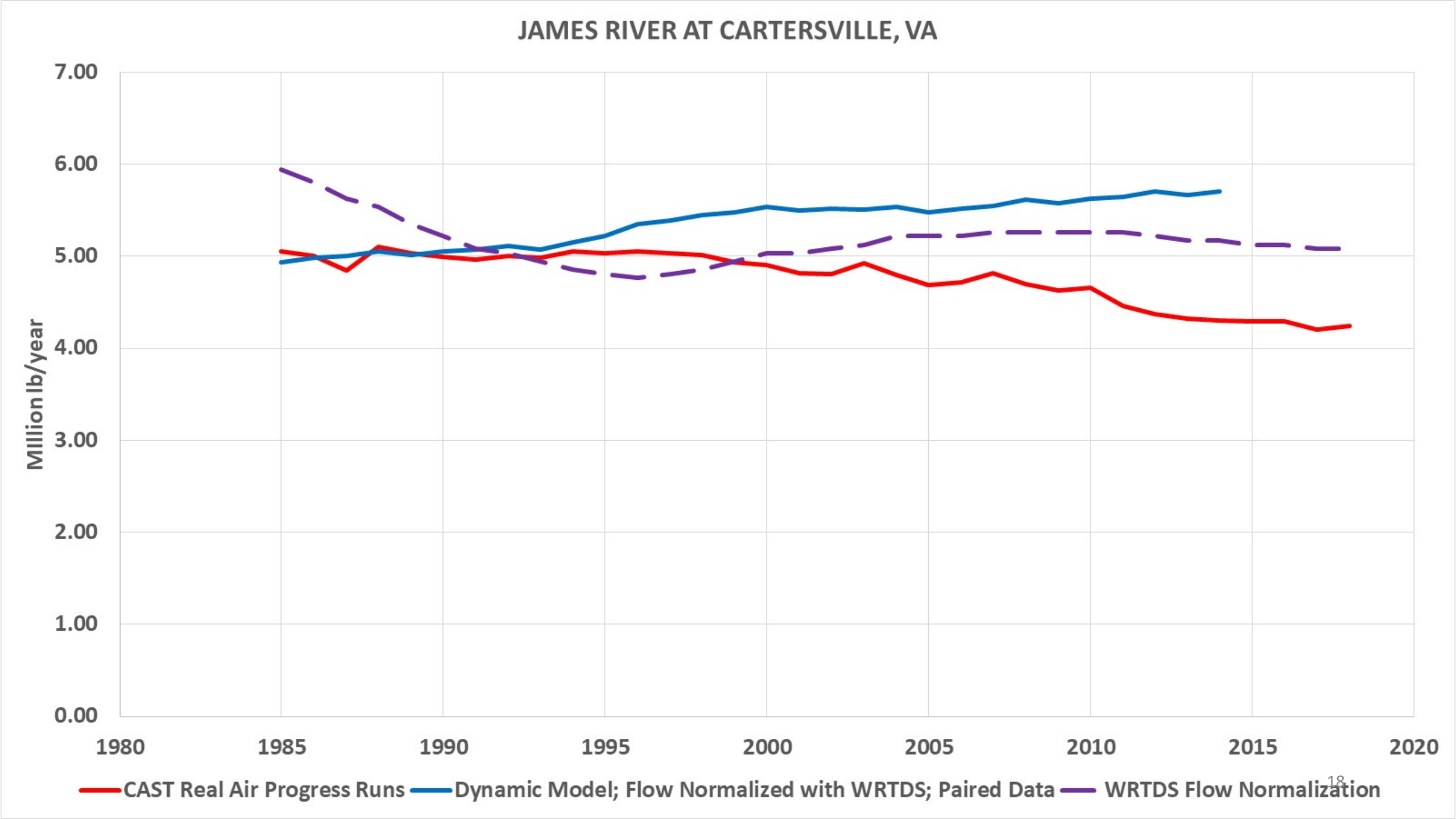

CHOPTANK RIVER NEAR GREENSBORO, MD
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

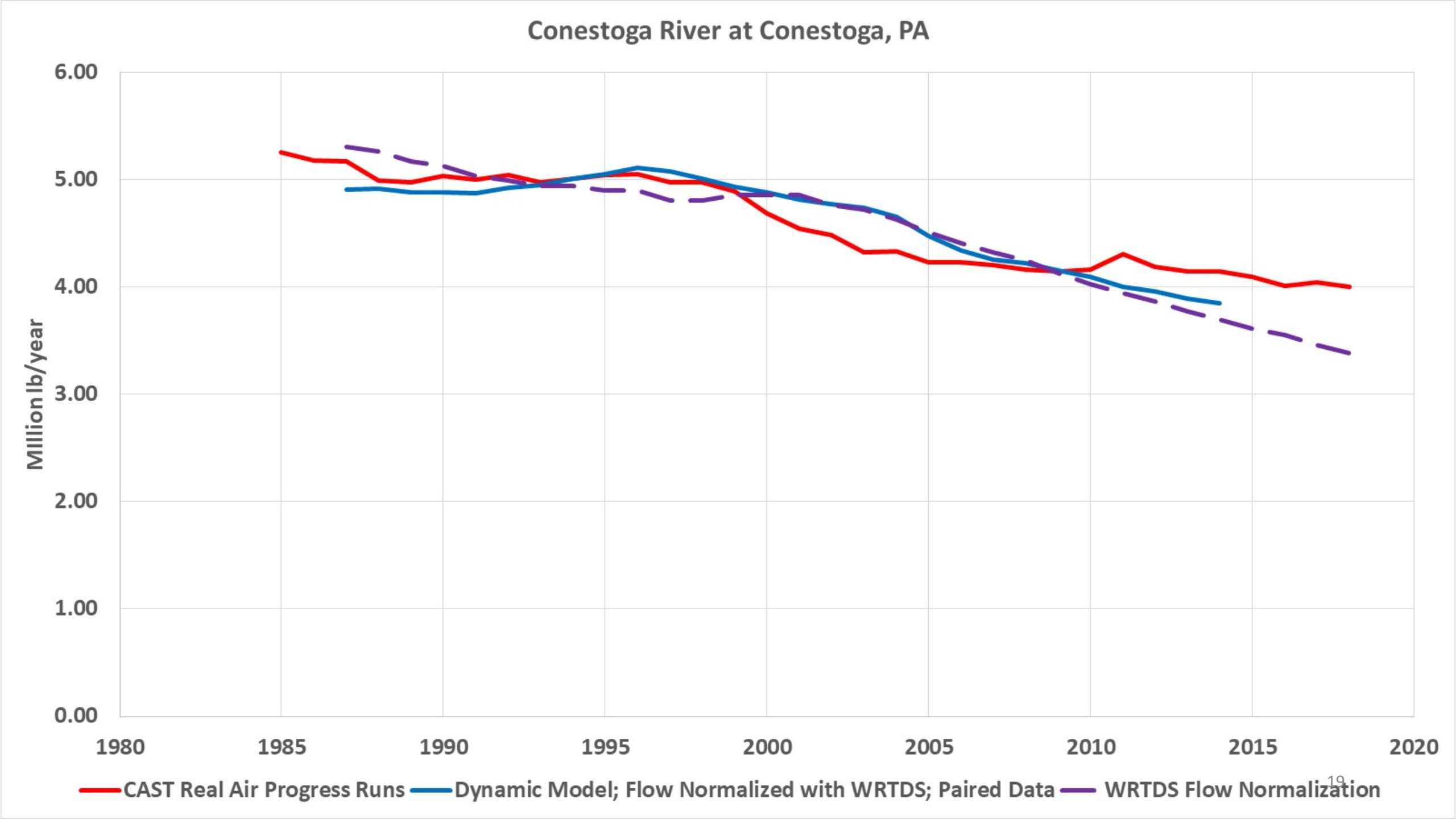

Susquehanna River at Marietta, PA
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


PATUXENT RIVER NEAR BOWIE, MD
Million lb/year
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


POTOMAC RIVER AT CHAIN BRIDGE, AT WASHINGTON, DC
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

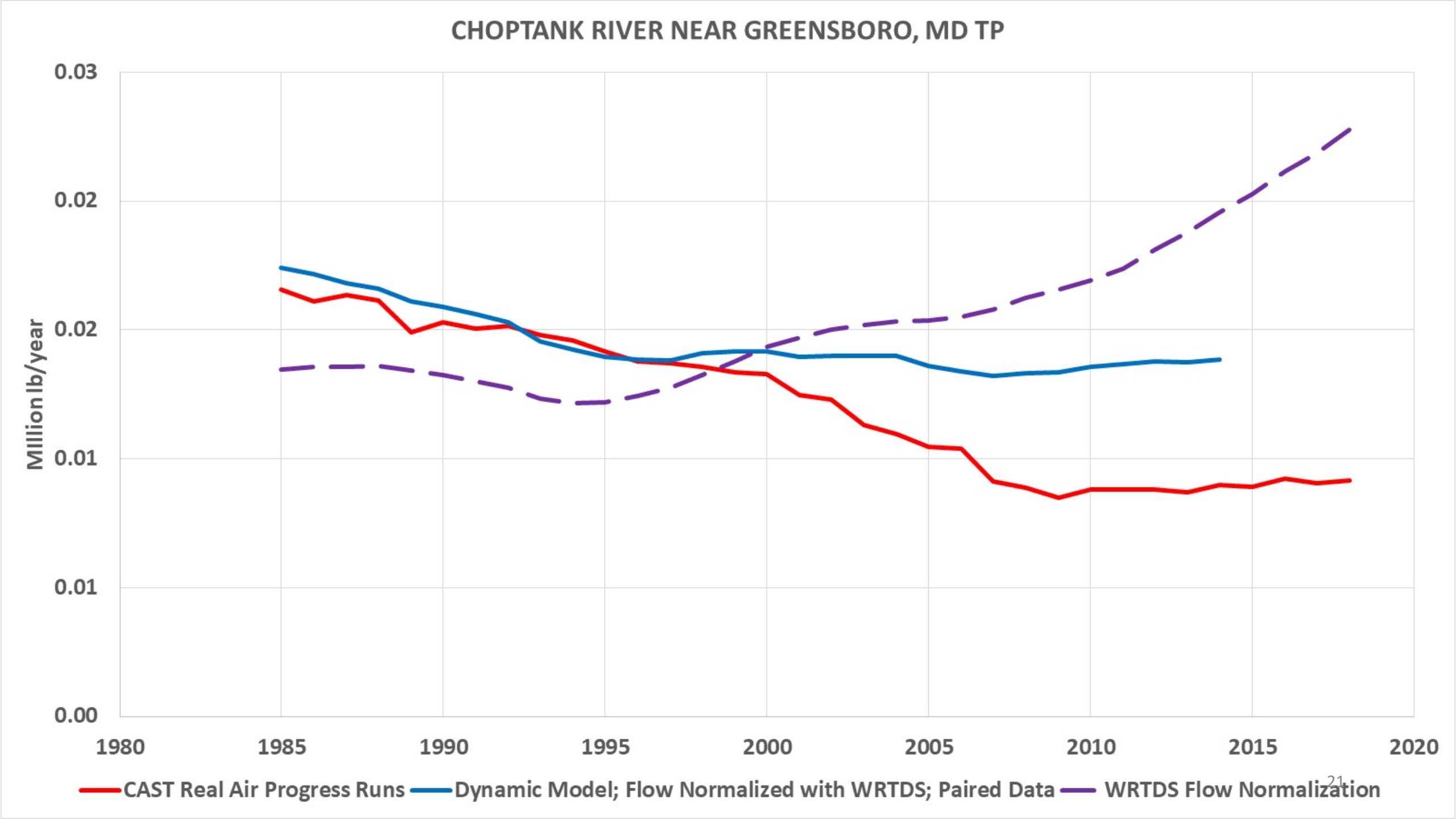

RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

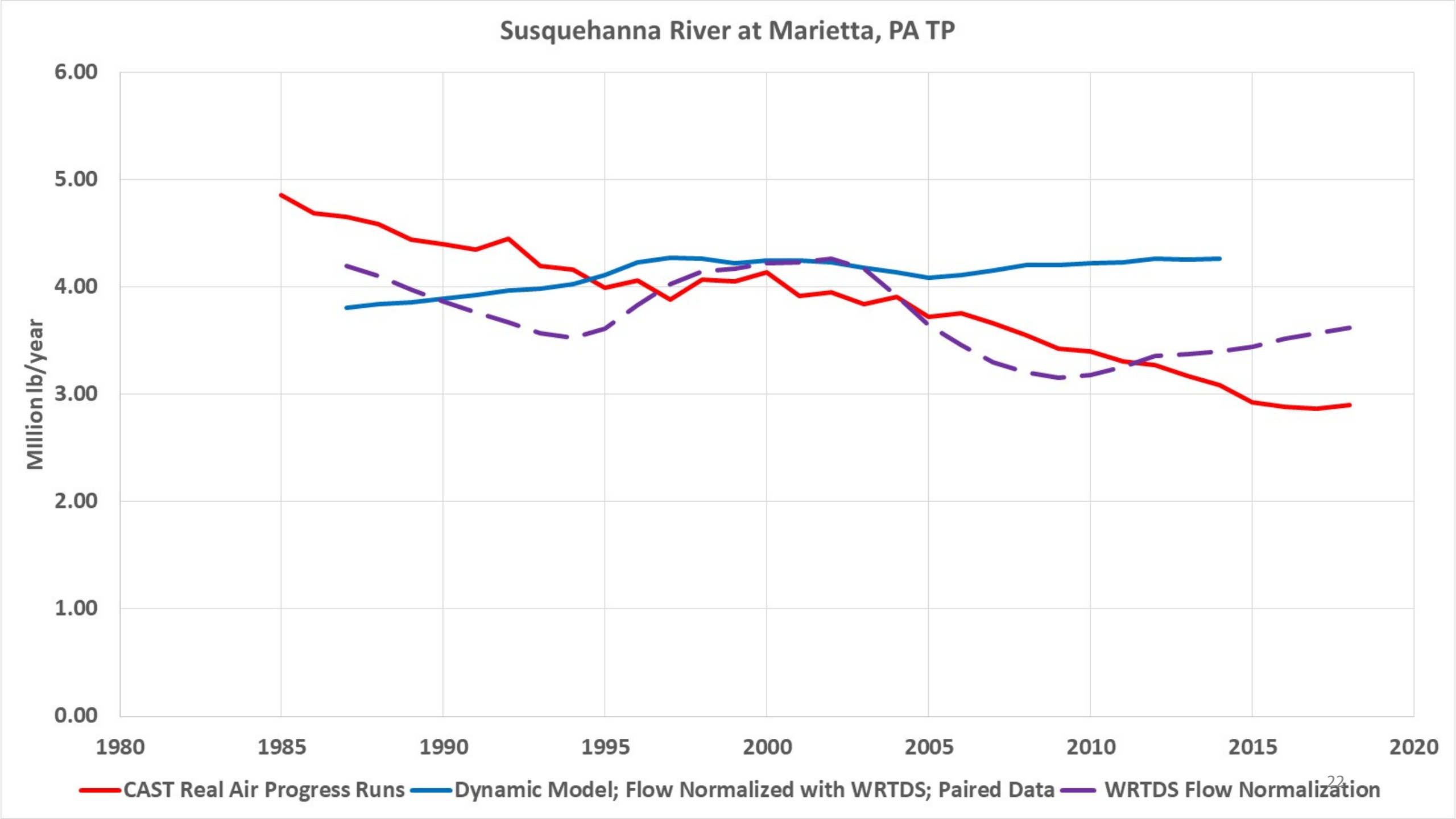

JAMES RIVER AT CARTERSVILLE, VA
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

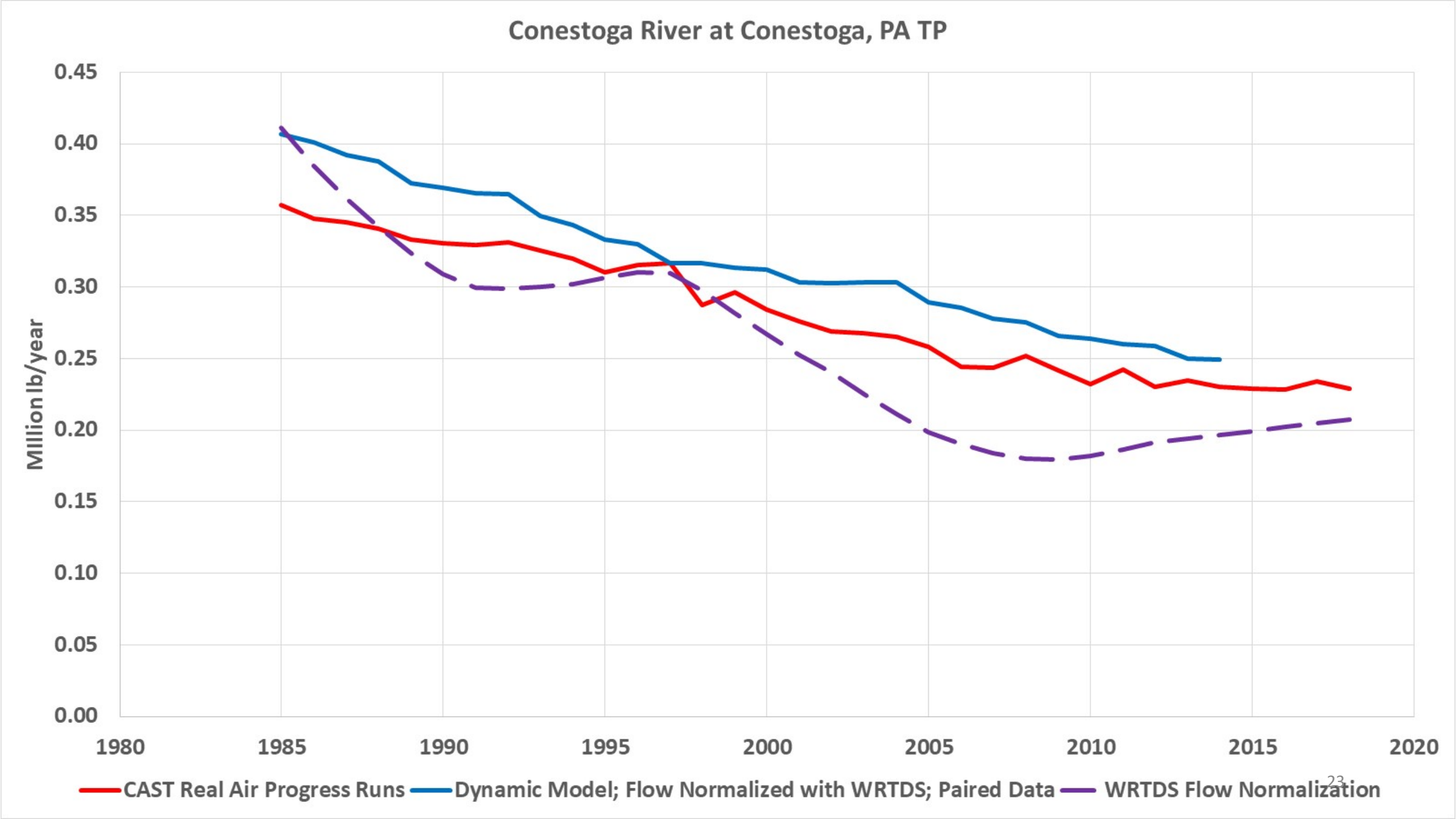

Conestoga River at Conestoga, PA
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

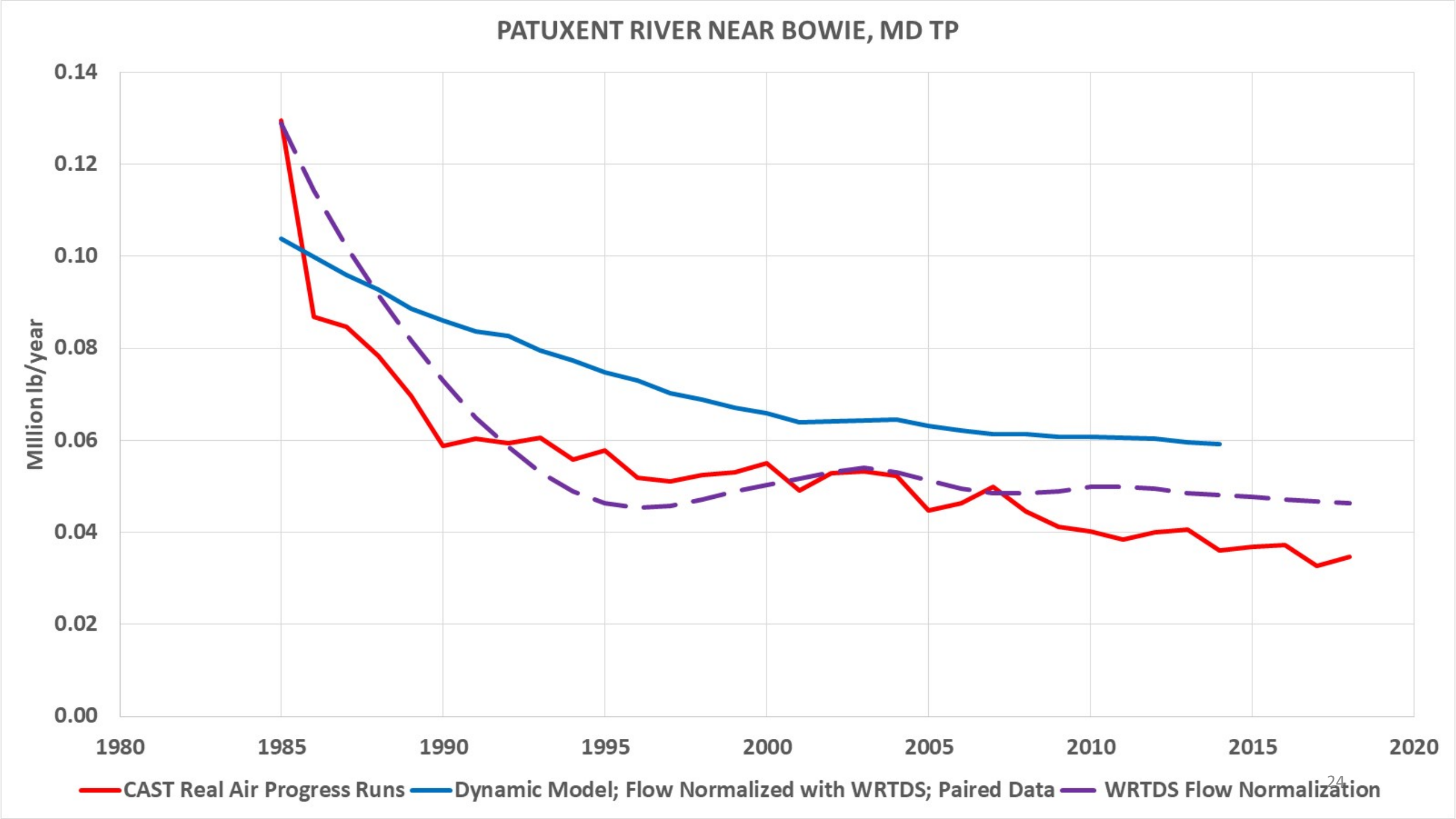
General observations for TN

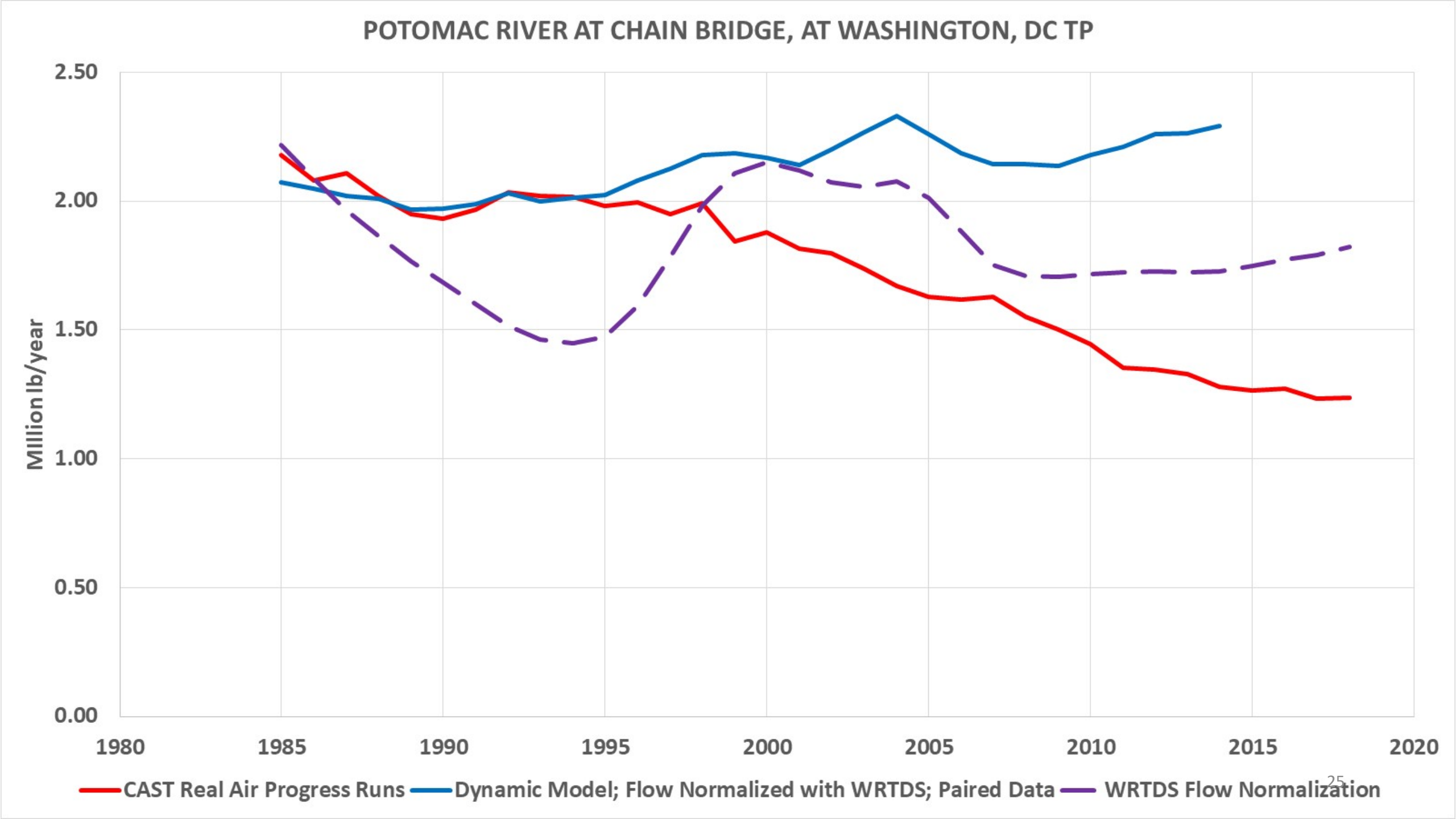
- WRTDS flow normalized observed loads are not that different from what is expected.
- WRTDS observed has a reduction in the first decade in many basins that is underestimated by the dynamic model

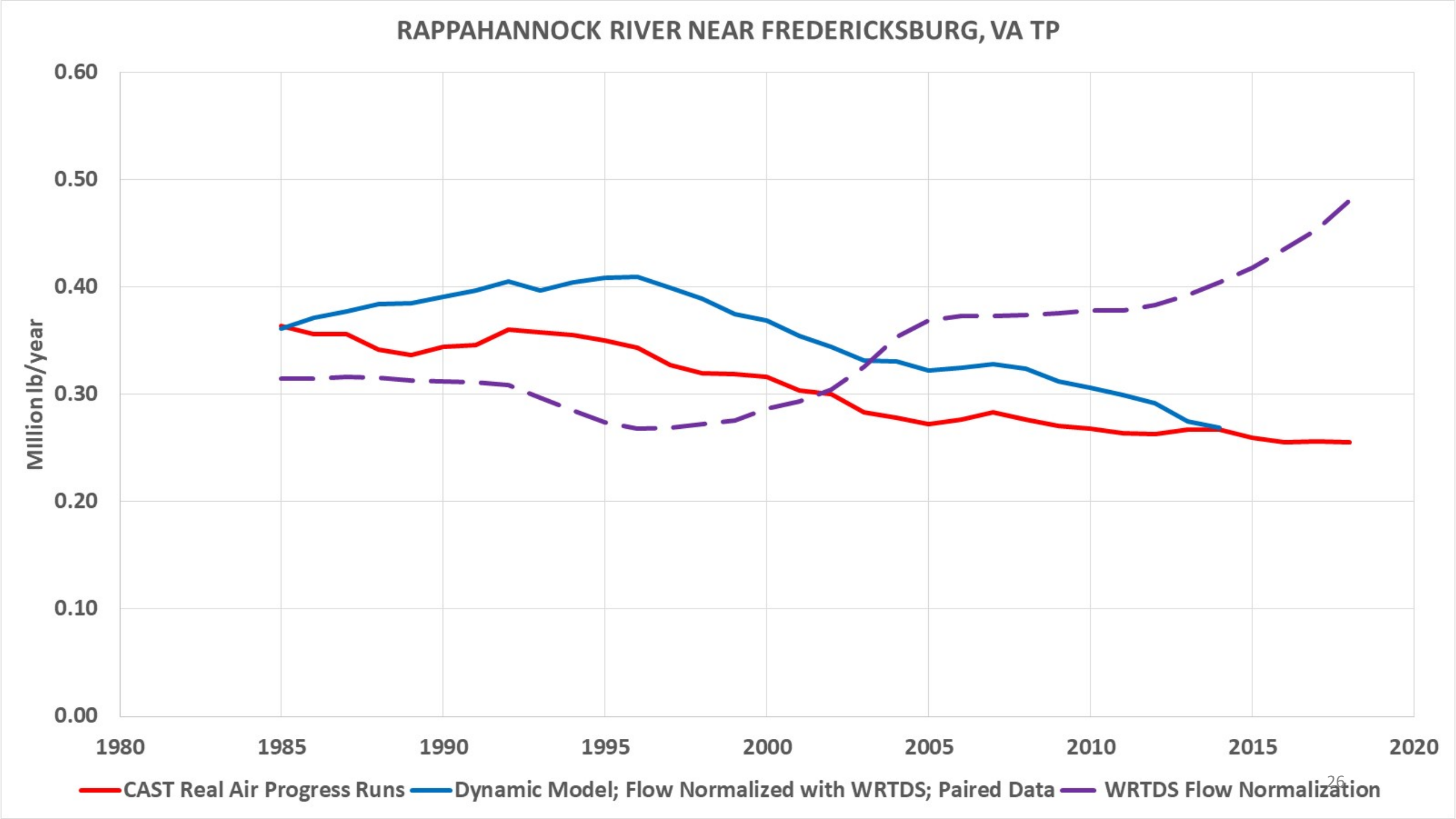

CHOPTANK RIVER NEAR GREENSBORO, MD TP
0.03
0.02
0.02
0.01
0.01
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

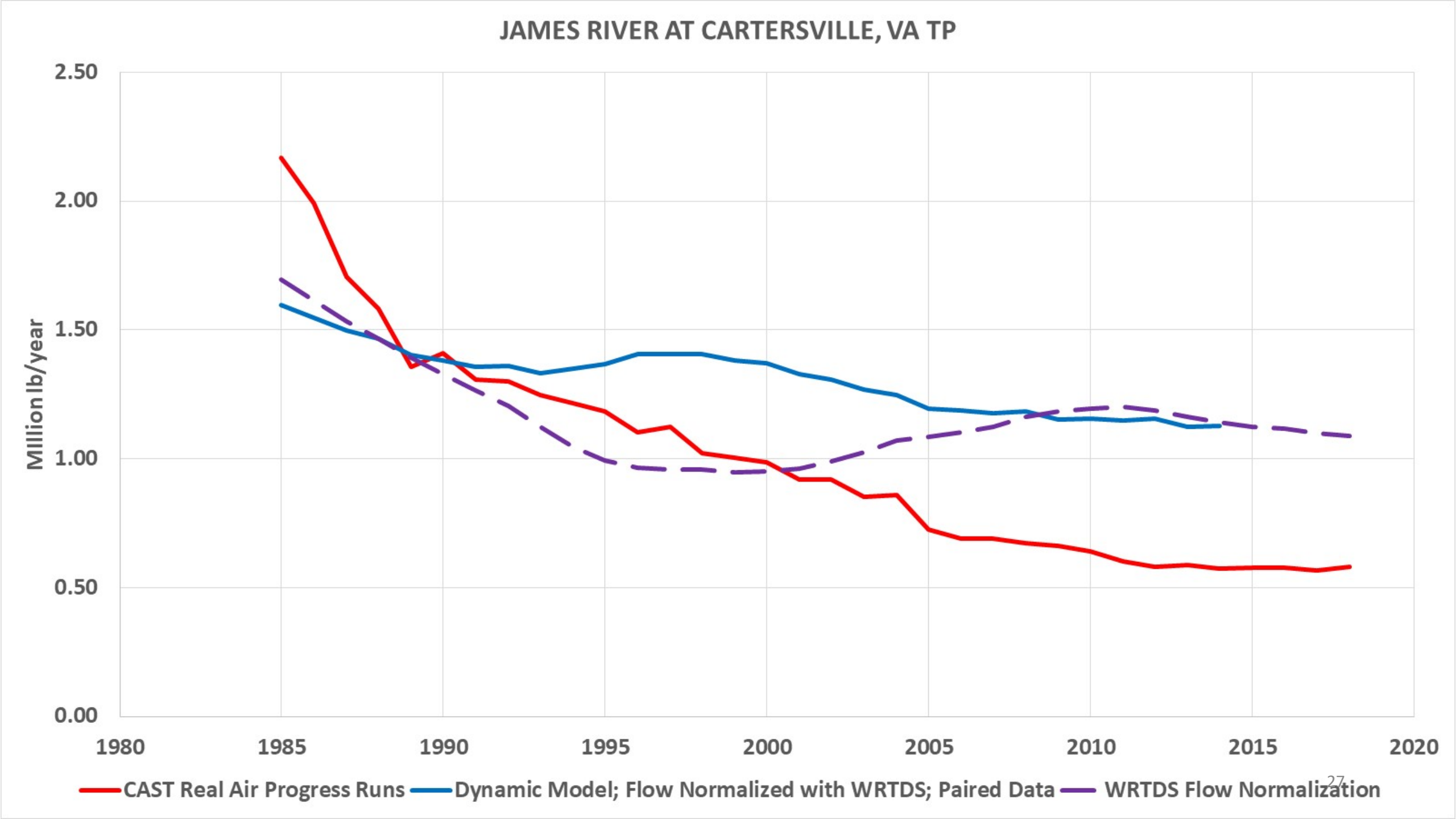

Susquehanna River at Marietta, PA TP
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


Conestoga River at Conestoga, PA TP
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


PATUXENT RIVER NEAR BOWIE, MD TP
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


POTOMAC RIVER AT CHAIN BRIDGE, AT WASHINGTON, DC TP
2.50
2.00
1.50
1.00
0.50
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


RAPPAHANNOCK RIVER NEAR FREDERICKSBURG, VA TP
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization


JAMES RIVER AT CARTERSVILLE, VA TP
2.50
2.00
1.50
1.00
0.50
0.00
Million lb/year
1980
1985
1990
1995
2000
2005
2010
2015
2020
CAST Real Air Progress Runs
Dynamic Model; Flow Normalized with WRTDS; Paired Data
WRTDS Flow Normalization

General observations for TP

- CAST expecting significant decline in the long term
- Dynamic Model expecting slower steady decline
- WRTDS showing ‘humps’ at 1980, 2000, and perhaps 2020 as well as long-term trends
  - Virginia humps out of phase

CBPO research question: considering that the Phase 6 model is the sum of what the partnership thinks we know about the watershed:

- Where and when does it fail
- What information is incorrect or missing
- How do we make it better
- Suppose we get to 2025 and the partnership has implemented the WIPs, but the bay is not meeting water quality criteria. We will want to know how much of that is due to:
  - Lag time
  - input data uncertainty
  - model uncertainty

Next steps

- Assemble the data
  - Investigate effect of spin-up time in the dynamic model
  - Put together time series of land use, BMPs, and inputs above each station
  - Estimate uncertainty in WRTDS
- Crystalize the question
  - Do management effects of flow relate to this work?
  - What about BMP effectiveness lags?
- Build a statistical model to look for patterns
  - Decade
  - Land use
  - Nutrient source
  - Source
  - Region
  - Management
  - …