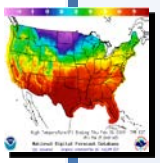
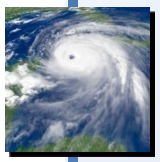
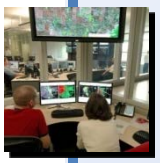
NOAA/NWS
Ohio River Forecast Center

National Weather Service

Protecting Lives and Property







Ohio River Basin Climate Change Project
ORSANCO

Jim Noel

February 13, 2014

Overview - IWR

- USACE Institute of Water Resources (IWR) used over 75 Global Circulation Models (GCMs) for temperatures and rainfall
- This data was vetted with USACE, NOAA and USGS.
- Used an approach similar to Red River of the North climate change study
- Clustered GCM output for time periods of 2011-2040, 2041-2070 and 2071-2099
- Used data output from 9 ensembles most representative of those clusters

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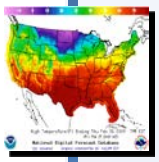

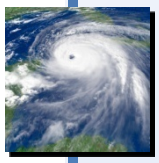

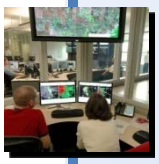

Overview - IWR

- This yielded 9 ensembles for each future period for a total of 27 members covering 2011-2099.
- A restrospective period for each ensemble was run from 1952-2001 as well for a total of 27 retrospective members.

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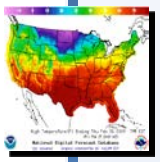
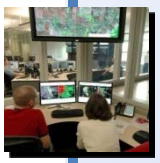
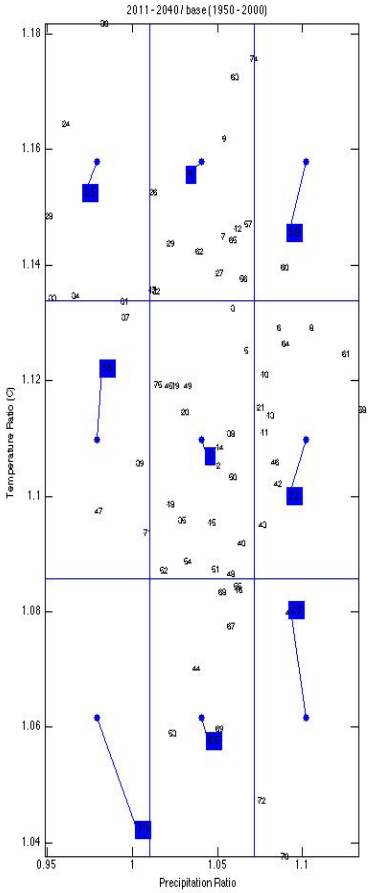
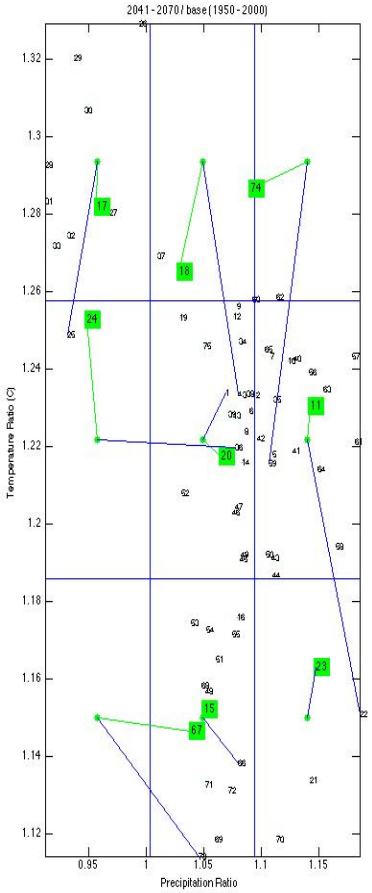


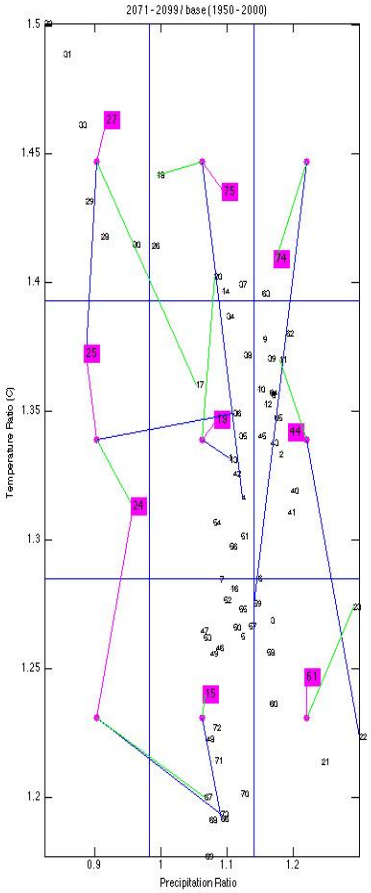


Overview - IWR

- How 9 ensembles were chosen for each future period. Rainfall increase 5%, then another 5% then another 5-10% by the last period.







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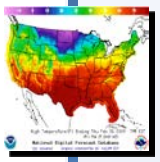
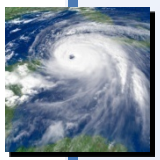
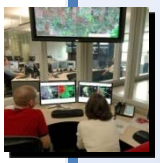




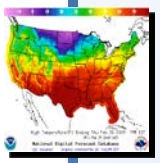


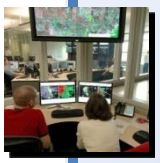
Overview - OHRFC

- OHRFC used the Sacramento Soil Moisture Accounting Hydrologic Model (SAC-SMA) to generate the output
- OHRFC actually has output streamflow, temperatures, precipitation and snow water equivalent.
- OHRFC ran the hydrologic model and output the bottom end of the tributaries as well as the Ohio River.

National Weather Service

Protecting Lives and Property





Datasets

- SHRP1 (Sharpsburg, PA --- lower Allegheny)
- BDDP1 (Braddock, PA --- lower Monongahela)
- BEAP1 (Beaver Falls, PA --- Beaver)
- MCCO1 (McConnellsville, OH --- Muskingum)
- ATHO1 (Athens, OH --- Muskingum)
- ELZW2 (Elizabeth, WV --- Little Kanawha)
- CRSW2 (Charleston, WV --- Kanawha)
- FLRK2 (Fuller Station, KY --- Sandy)
- PKTO1 (Piketon, OH --- Scioto)
- HAMO1 (Hamilton, OH --- Great Miami)
- FFTK2 (Frankfort, KT --- Kentucky)
- INDI3 (Indianapolis, IN --- White)
- PTRI3 (Petersburg, IN --- White/East Fork of White)
- NHRI3 (New Harmony, IN --- Wabash)
- CALK2 (Calhoun, KY --- Green)
- CARI2 (Carmi, IL --- Little Wabash)
- WTVO1 (Waterville, OH --- Maumee)
- NAST1 (Nashville, TN --- Cumberland)
- PTTP1 (Pittsburgh, PA --- Upper Ohio)
- HNTW2 (Huntington, WV --- Upper Ohio)
- CCNO1 (Cincinnati, OH --- Mid Ohio)
- MLPK2 (McAlpine, KY --- Mid Ohio)
- EVVI3 (Evansville, IN --- Lower Ohio)
- GOLI2 (Golconda, IL --- Lower Ohio)
- COLO1 (Columbus, OH --- Upper Scioto)

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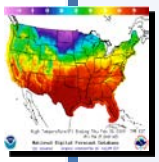

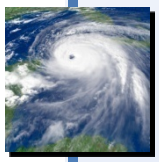

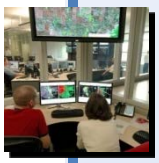

Datasets

- F1 = 2011-2040
- F2 = 2041-2070
- F3 = 2071-2099
- R1 = Restrospective models used for 2011-2040 run back in time from 1952-2001.
- R2 = Restrospective models used for 2041-2070 run back in time from 1952-2001.
- R3 = Restrospective models used for 2071-2099 run back in time from 1952-2001.

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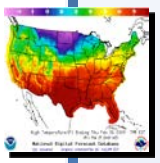

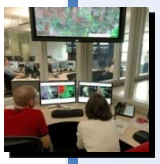

Retrospective vs. Observed

For Pittsburgh:

Time	March Mean (cfs)	October Mean (cfs)	Annual Mean (cfs)
Historical	55,000	17,000	33,000
Retrospective	50,000	13,000	33,000

Annual is within 0%.

For Cincinnati:

Time	March Mean (cfs)	October Mean (cfs)	Annual Mean (cfs)
Historical	183,000	36,000	104,000
Retrospective	181,000	34,000	106,000

Annual is within 2%.

For Golconda/Smithland:

Time	March Mean (cfs)	October Mean (cfs)	Annual Mean (cfs)
Historical	340,000	75,000	185,000
Retrospective	310,000	53,000	182,000
2011_2040 sim	334,000	65,000	196,000

Annual is within 1.7%

National Weather Service

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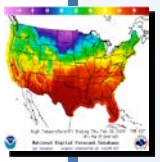
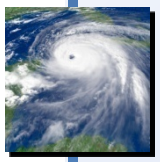
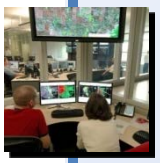
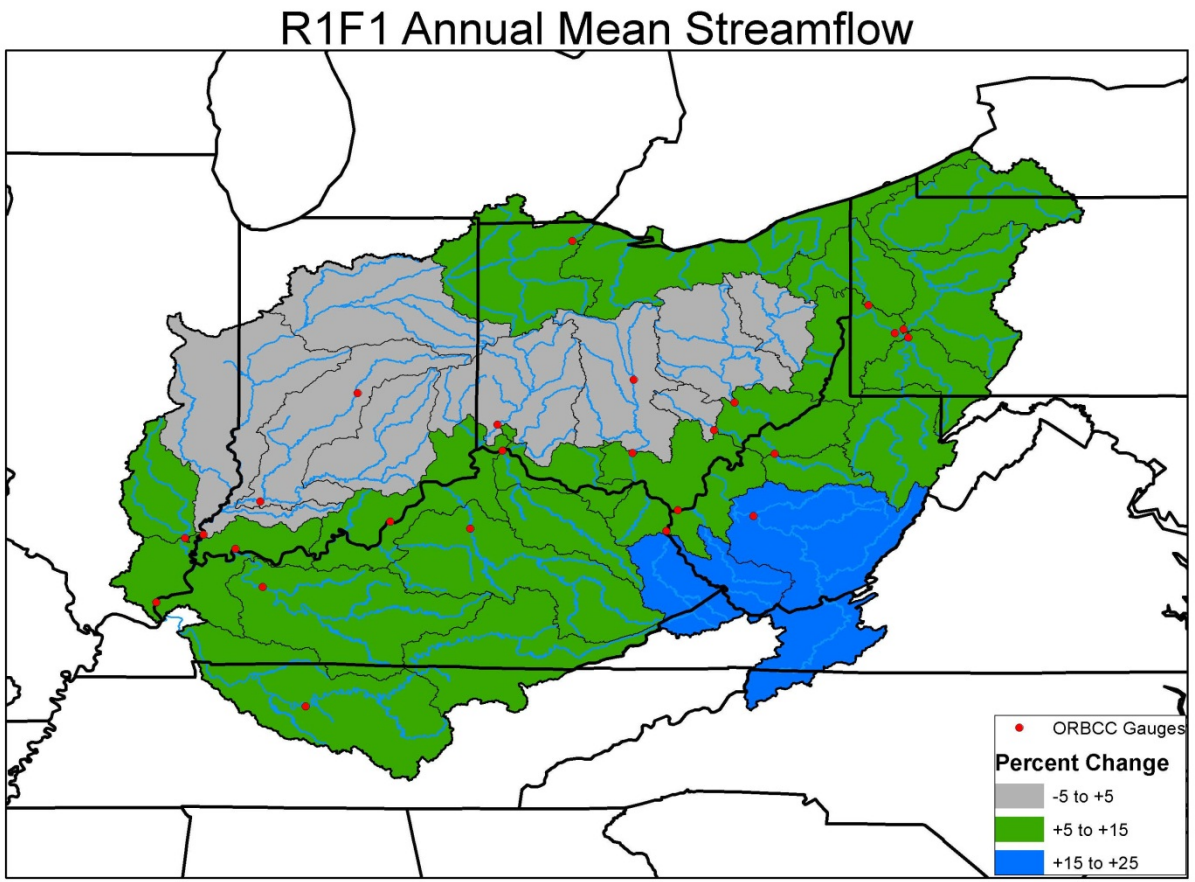






2011-2040 Annual % Change Mean



- **Insignificant changes to slight wetting across most of the basin compared to 1952-2001**

National Weather Service

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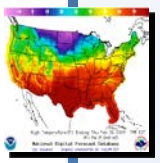
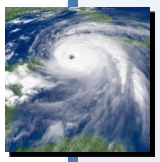
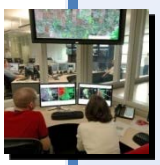
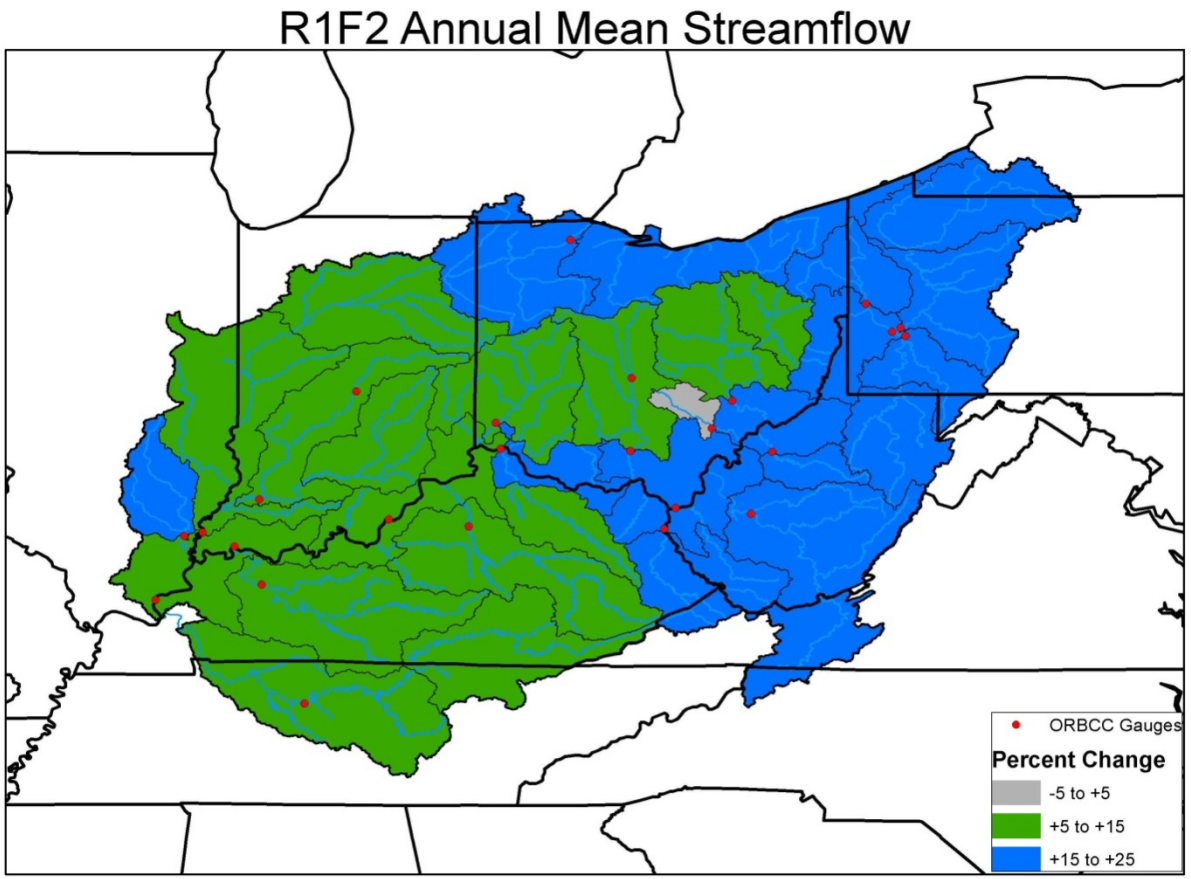






2041-2070 Annual % Change Mean



- **Some wetting across Ohio Valley with biggest increases in eastern basin compared to 1952-2001**

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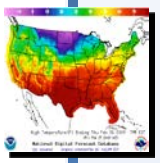
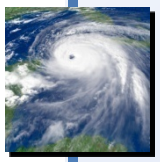
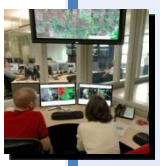
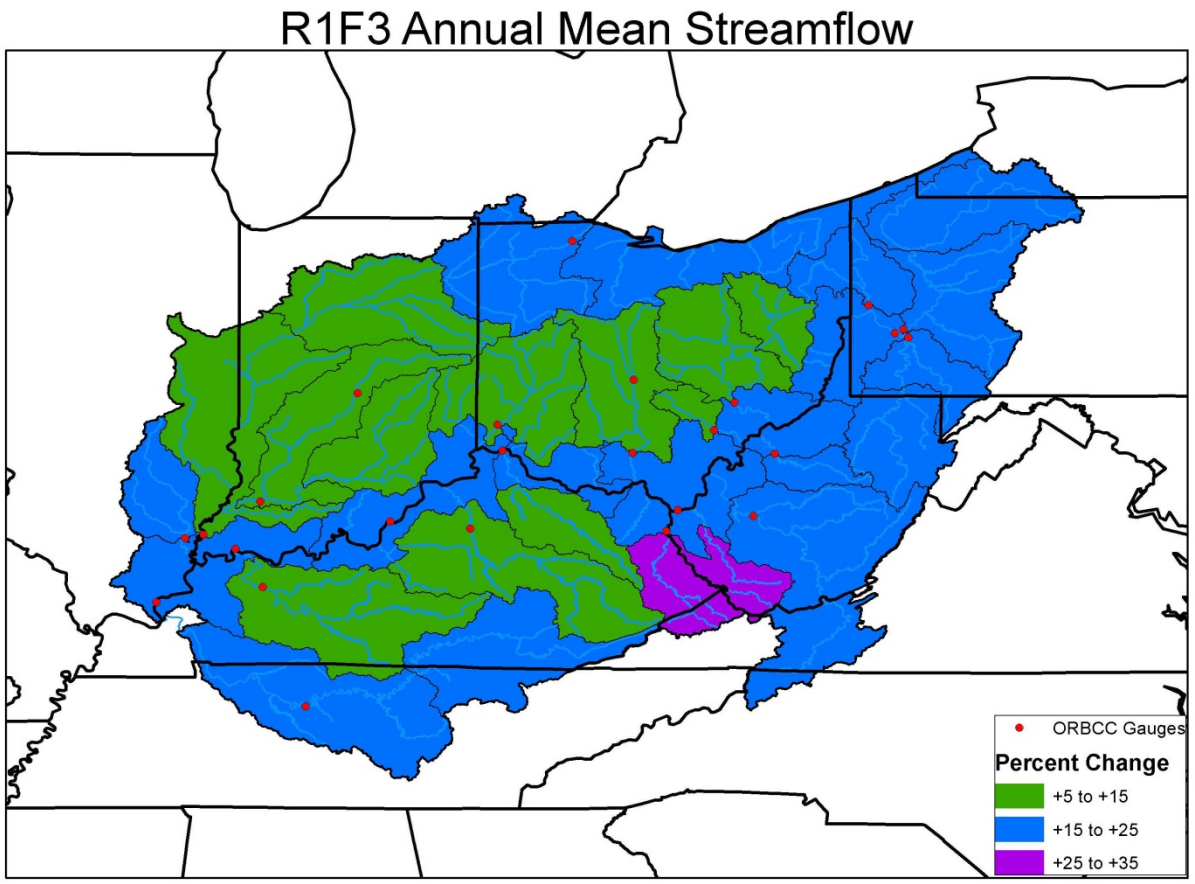






2071-2099 Annual % Change Mean



- **Wetting continues with biggest increases in mean flow in eastern Ohio Valley compared to 1952-2001**

National Weather Service

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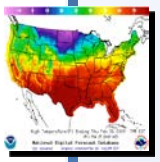
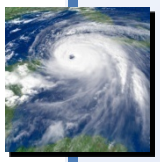
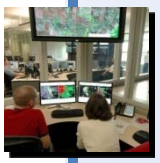
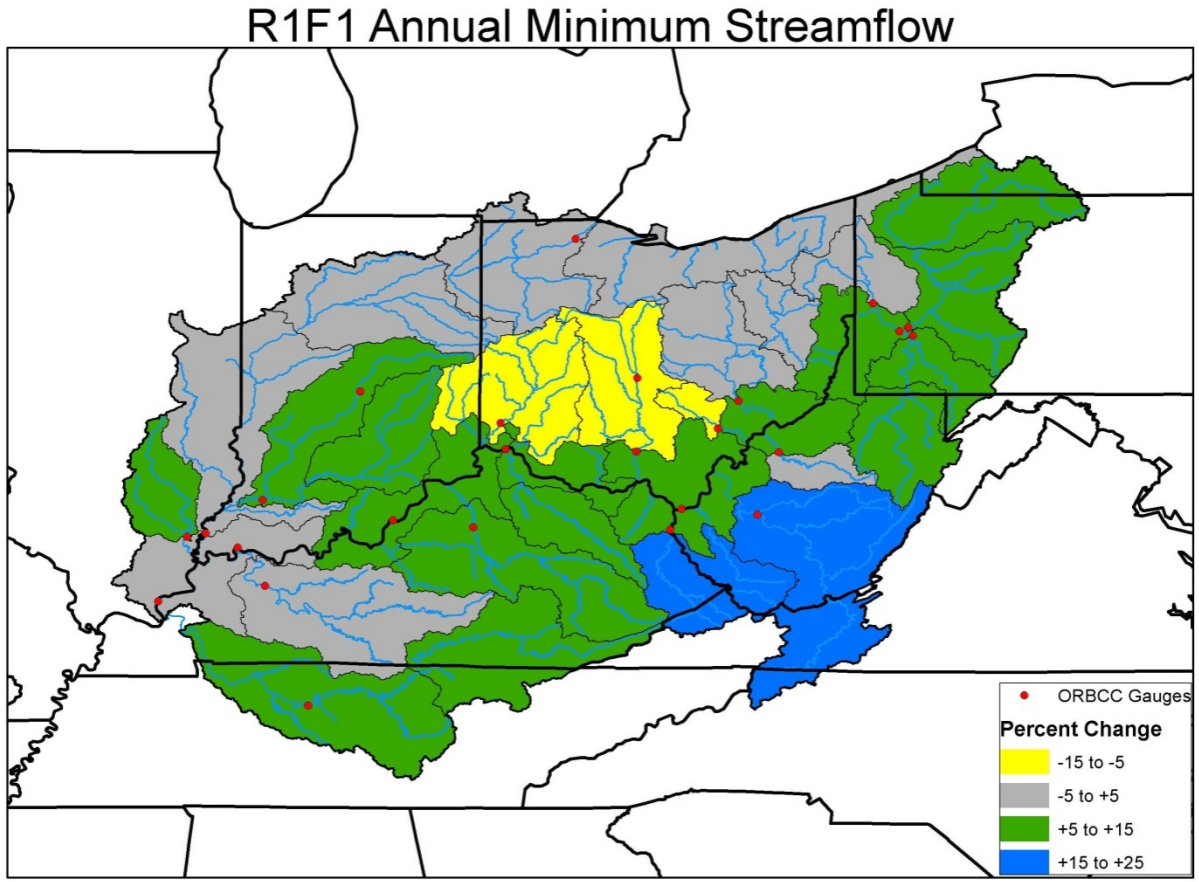






2011-2040 Annual % Change Min



- **Little change across most of the Ohio Valley compared to 1952-2001**

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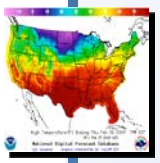
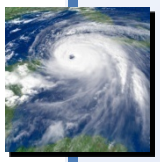
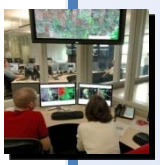
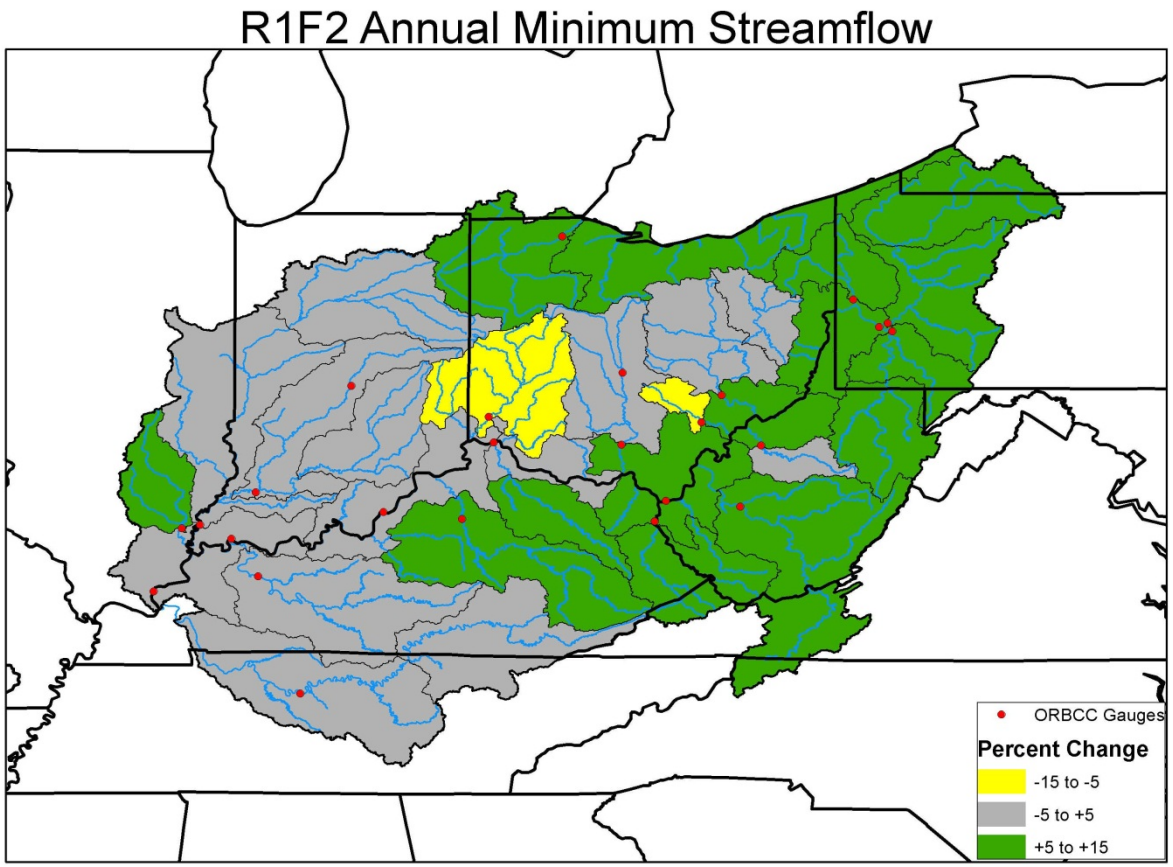






2041-2070 Annual % Change Min



- **Little change across most of the Ohio Valley compared to 1952-2001**

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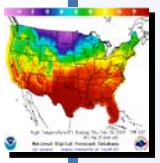
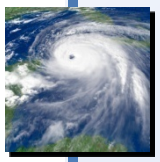
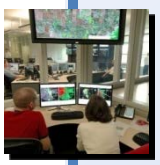
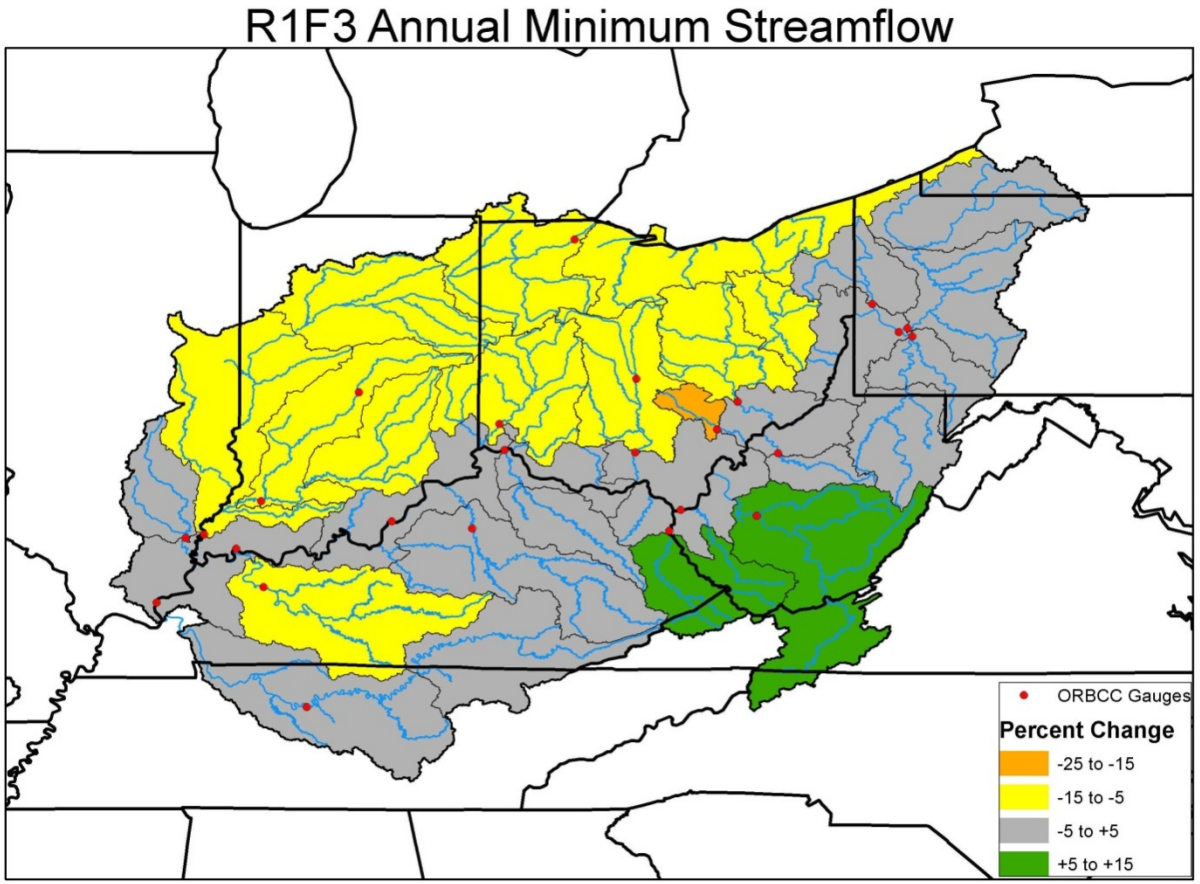






2071-2099 Annual % Change Min



- **Drying occurs in minimum annual flows mainly in the northern Ohio Valley compared to 1952-2001**

National Weather Service

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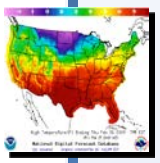
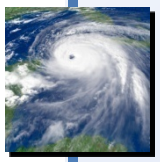
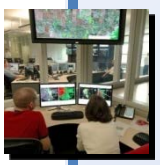
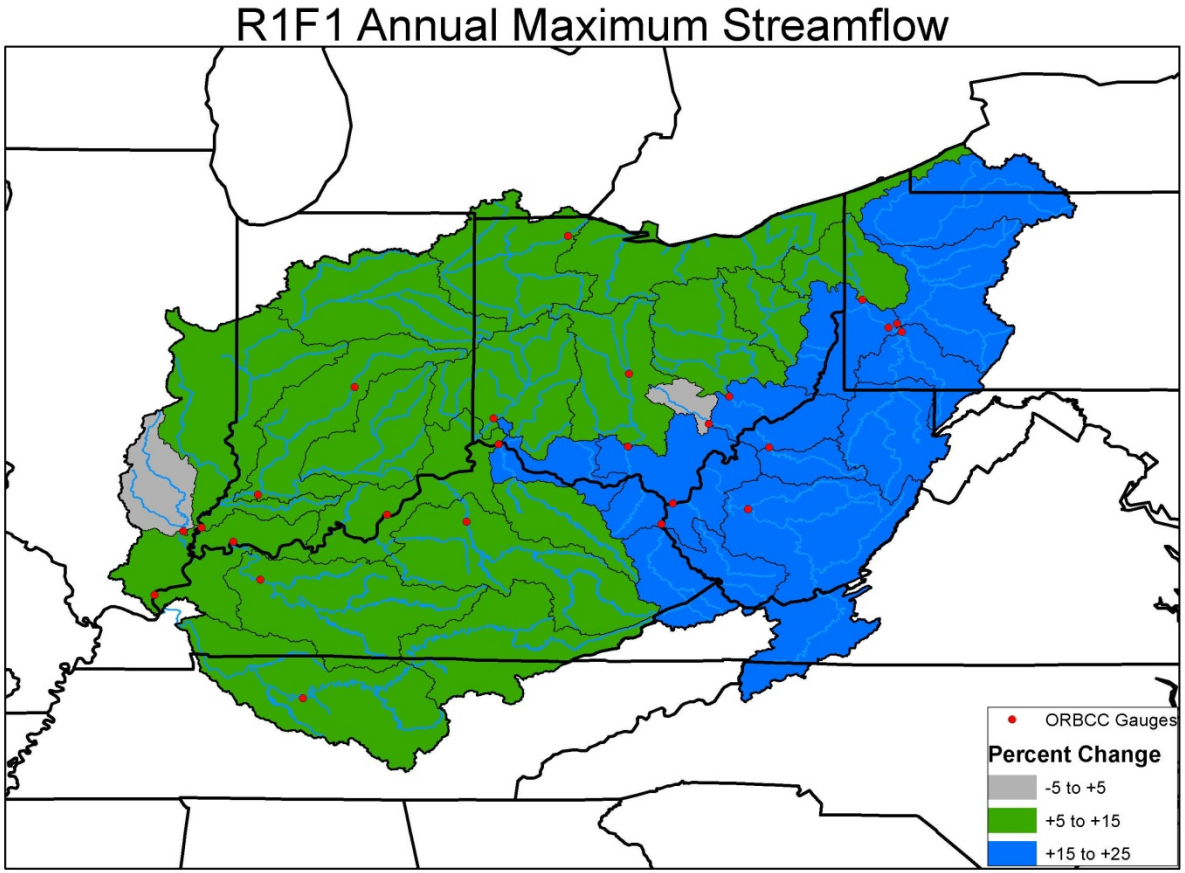






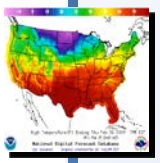
2011-2040 Annual % Change Max

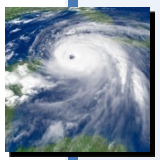


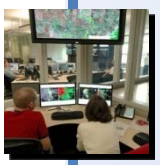
- **Some wetting in maximum monthly flows annually compared to 1952-2001especially in the east**

National Weather Service

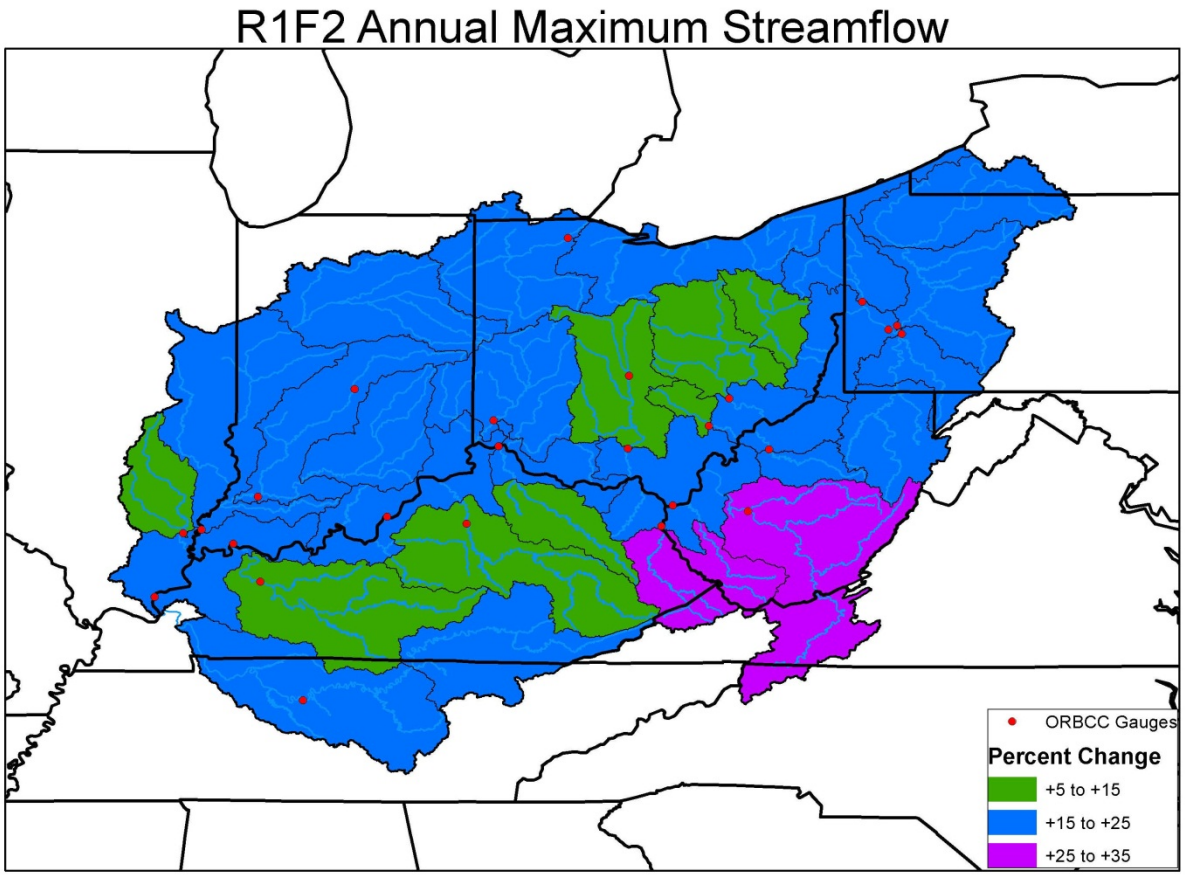
Protecting Lives and Property







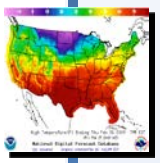
2041-2070 Annual % Change Max

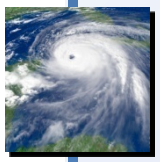


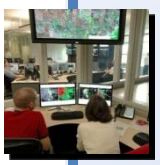
- **Wetting increases compared to 1952-2001**

National Weather Service

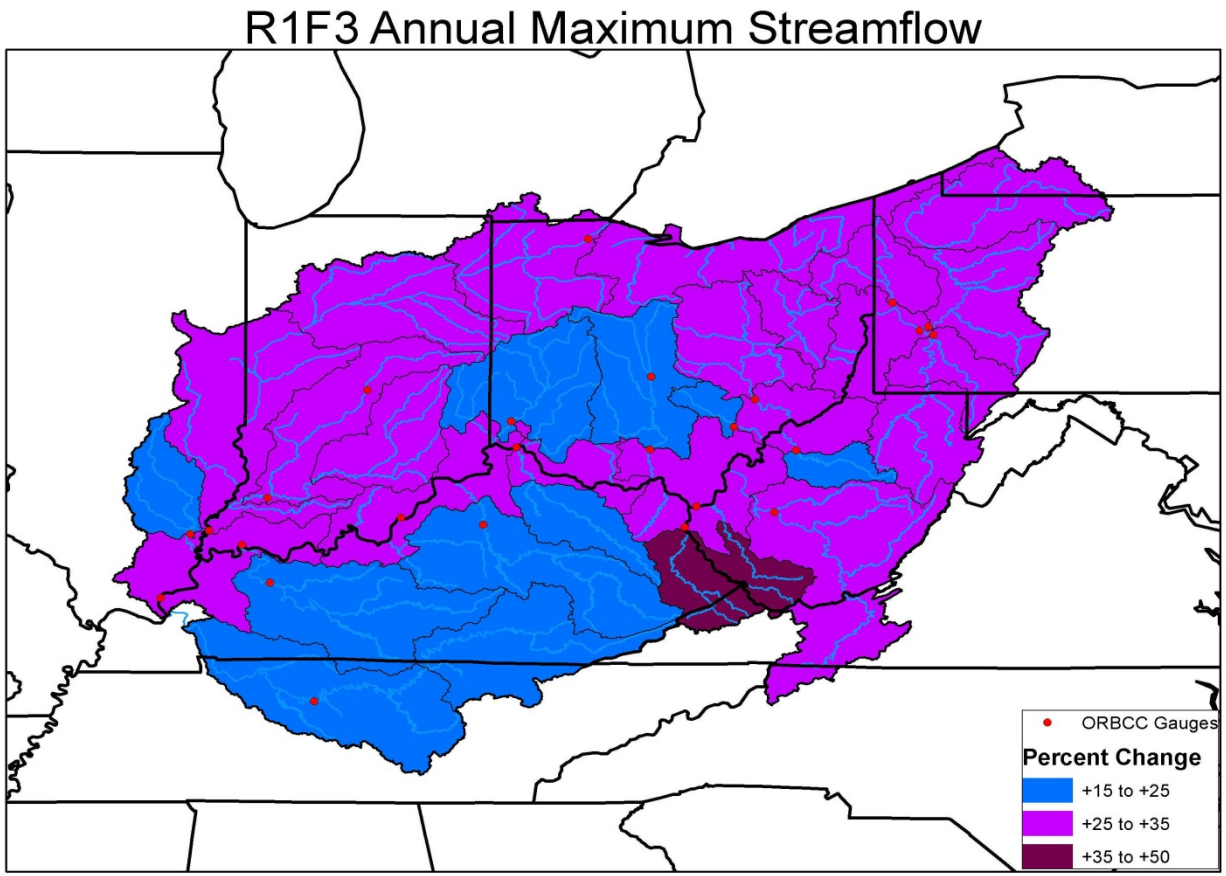
Protecting Lives and Property







2071-2099 Annual % Change Max



- **Substantial wetting occurs for the maximum monthly flow compared to 1952-2001**

National Weather Service

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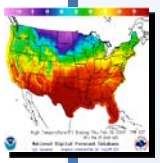
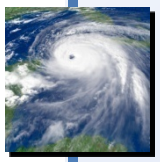
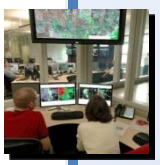
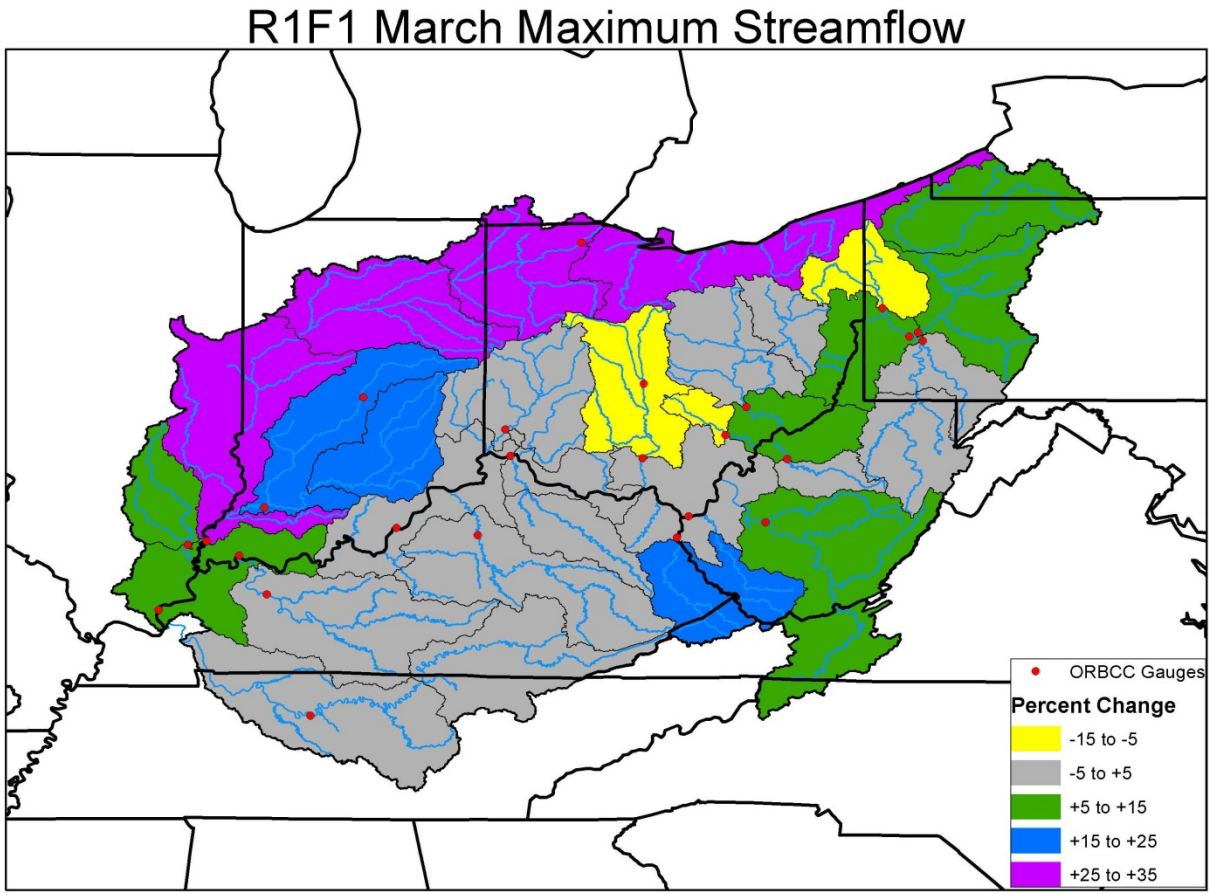






2011-2040 March % Change Max



- **Little change compared to 1952-2001 across most of the Ohio Valley except wetting Wabash/Lake Erie Drainage**

National Weather Service

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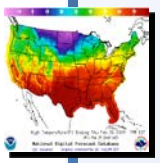
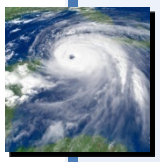
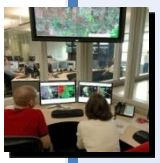
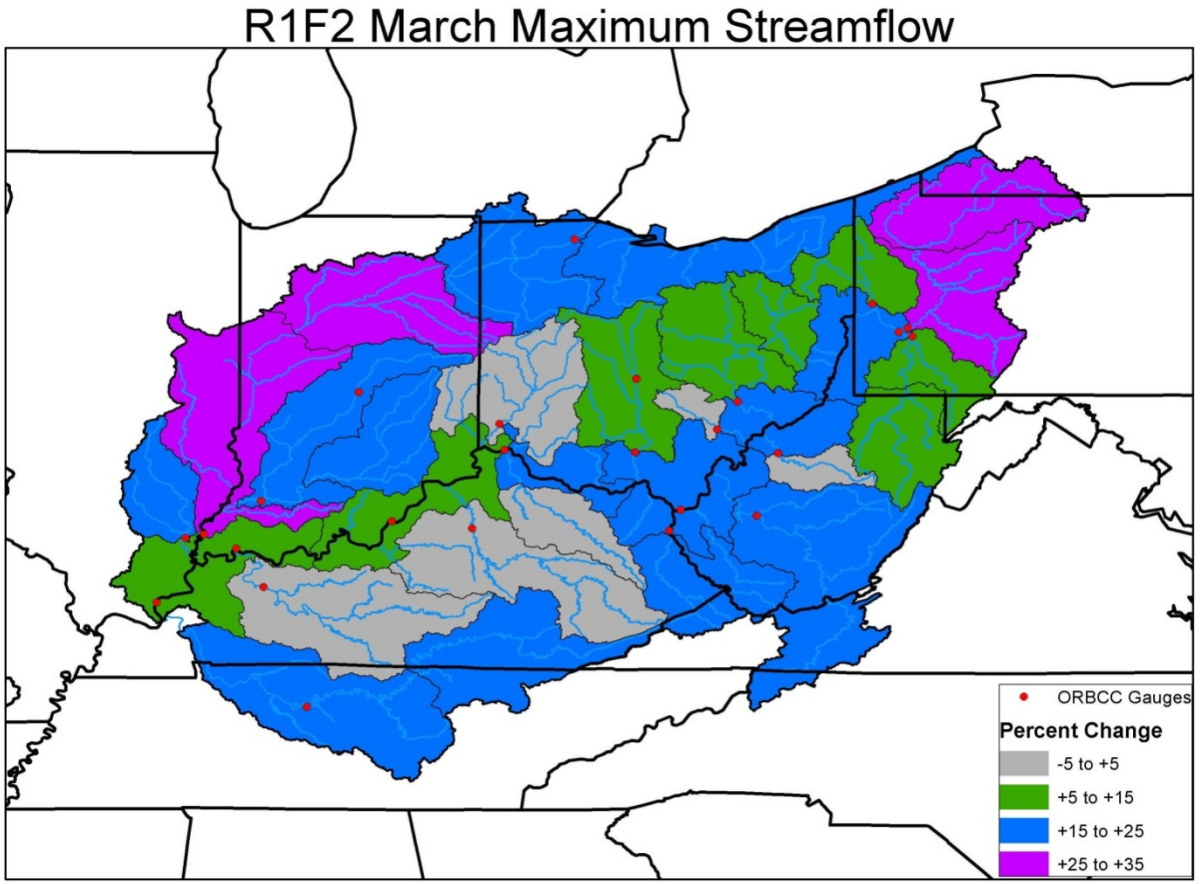






2041-2070 March % Change Max



- **Wetting increases across much of the basin compared to 1952-2001**

National Weather Service
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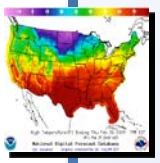
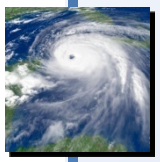
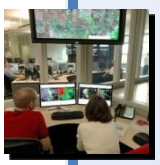
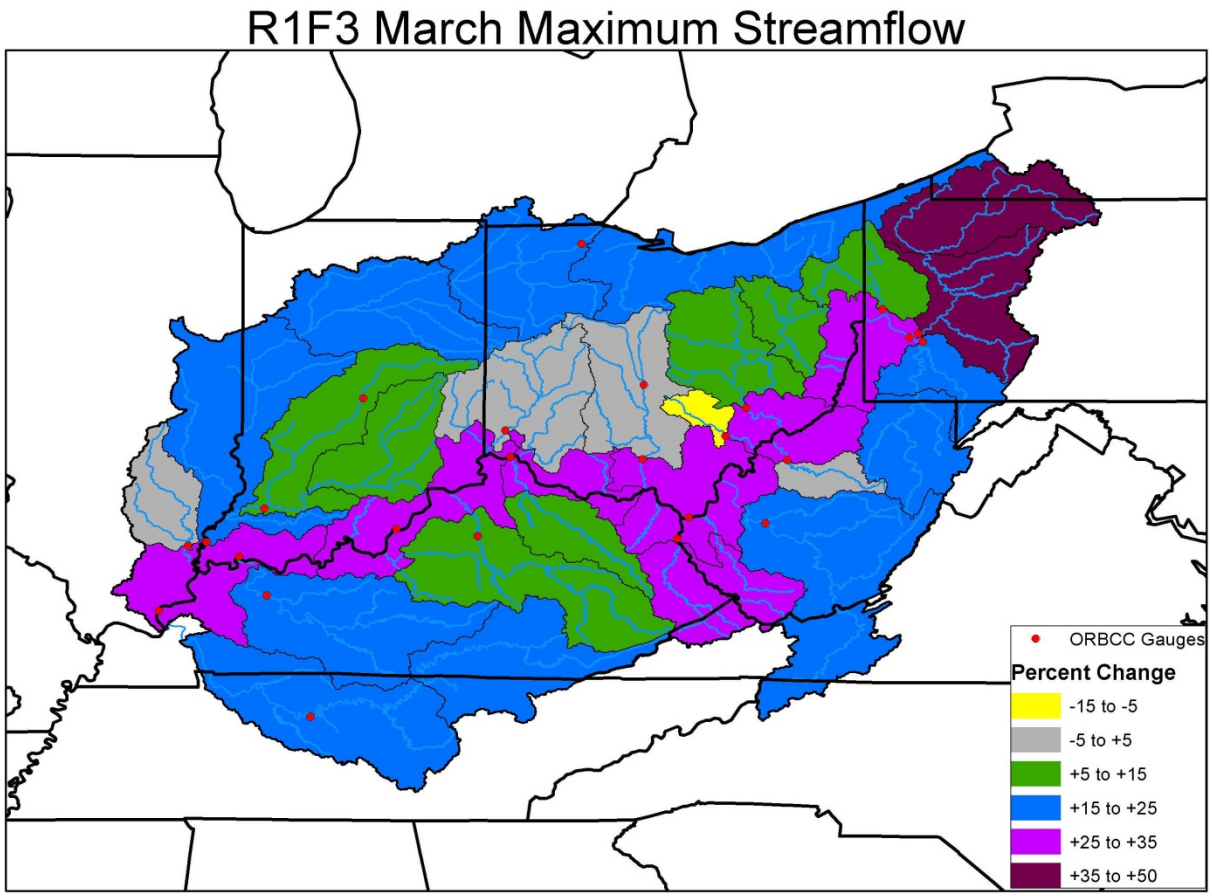




2071-2099 March % Change Max



- **Biggest increases in maximum flows occurs in the 3rd period for the March period compared to 1952-2001**

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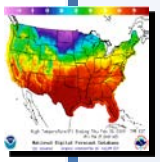
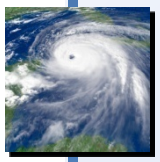
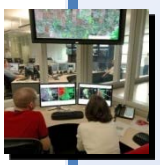
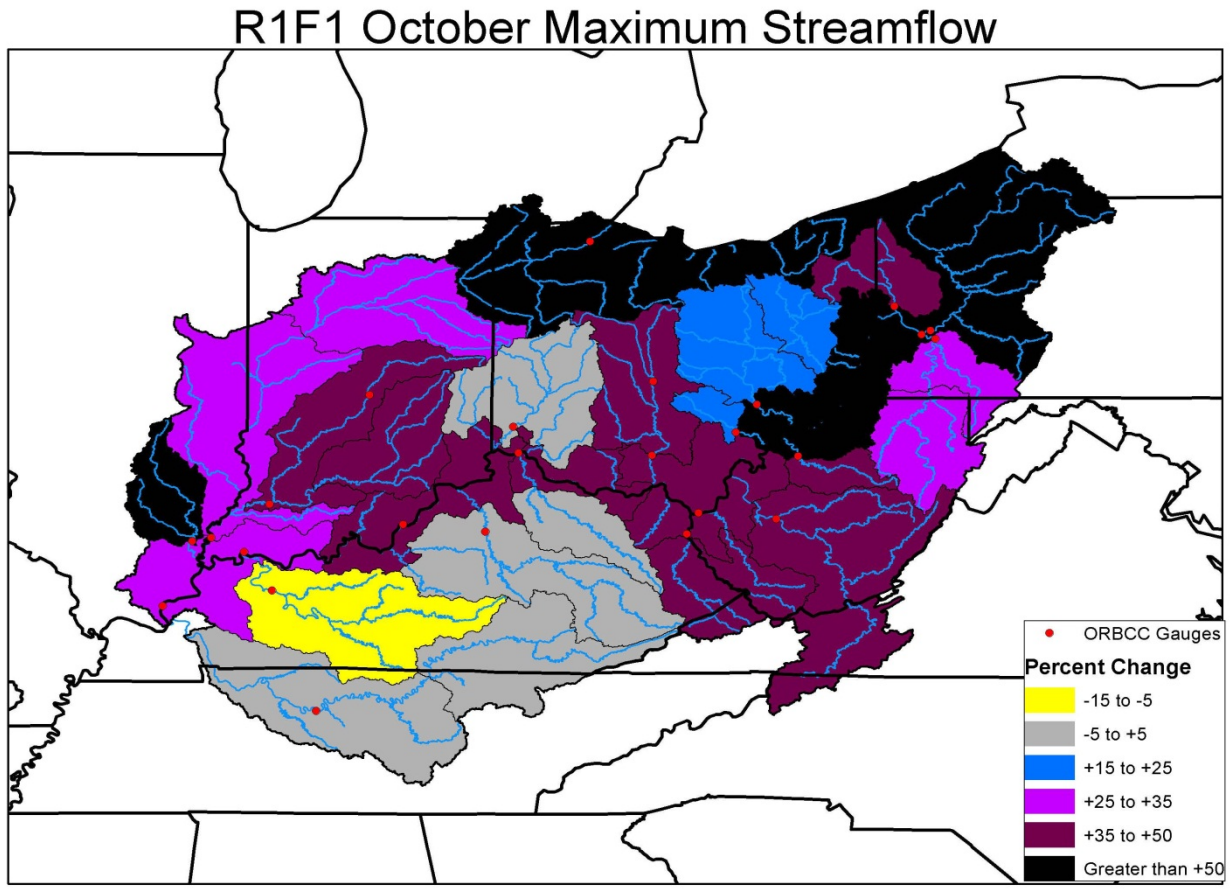






2011-2040 October % Change Max



- **Large maximum increases occur mainly north of Ohio River and eastern basin, low flows allow for bigger percentage changes**

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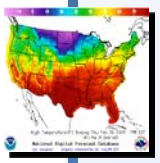
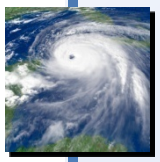
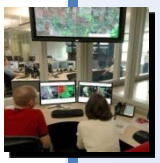
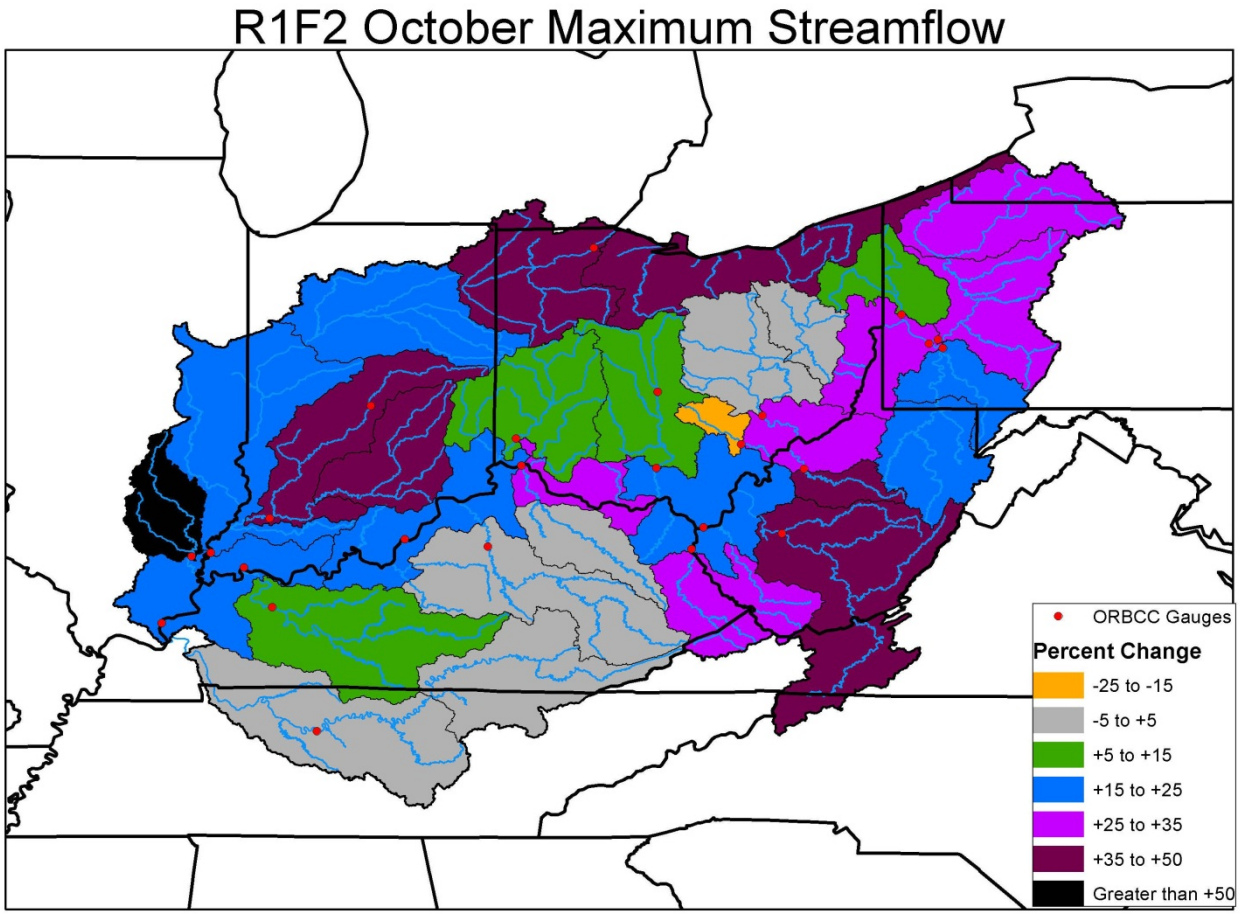






2041-2070 October % Change Max



- **Wetter conditions relax some compared to 1952-2001, especially in central basin**

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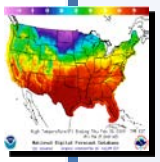
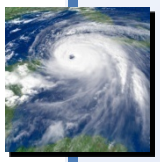
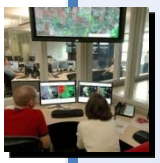
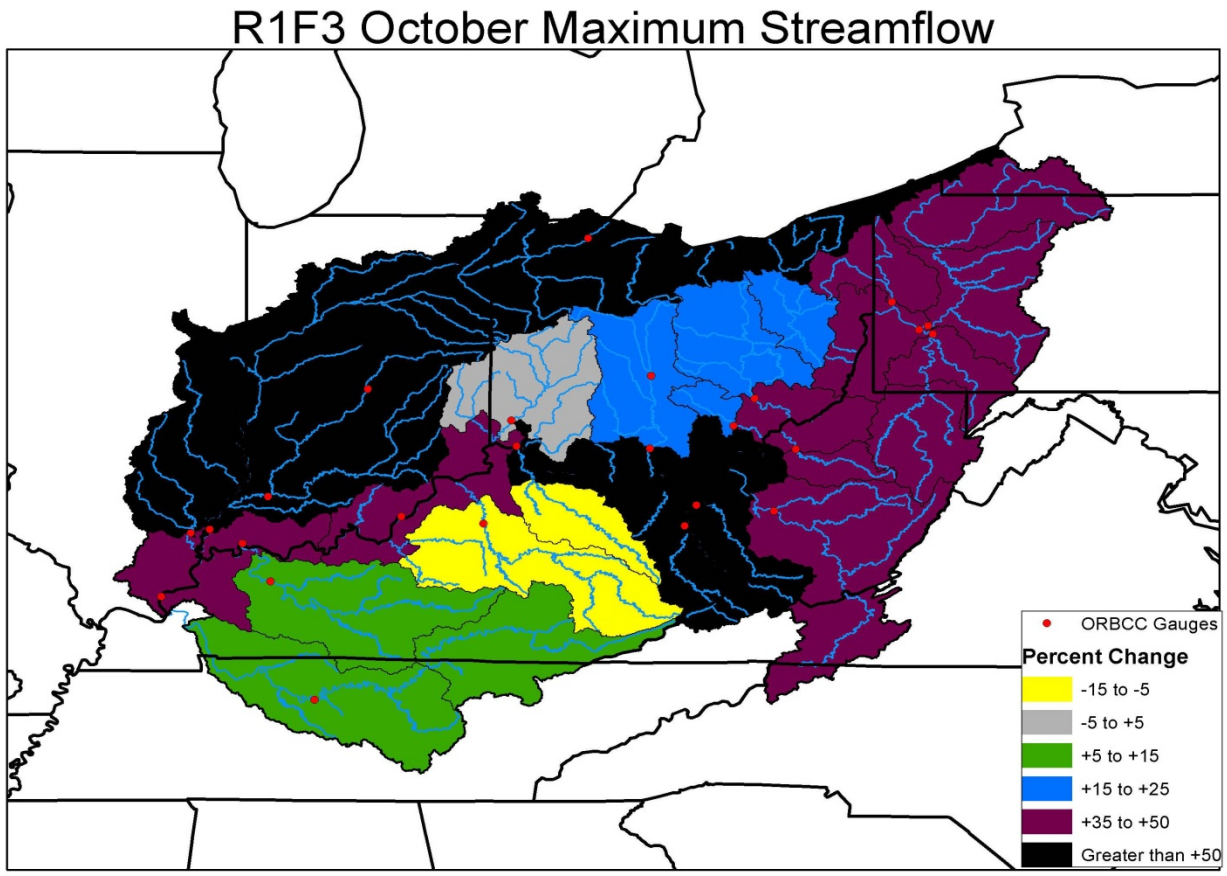






2071-2099 October % Change Max



- **Wetter conditions roar back with least in central basin compared to 1952-2001**

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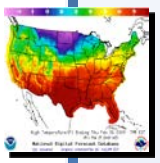
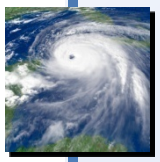
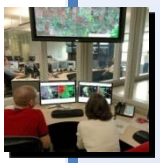
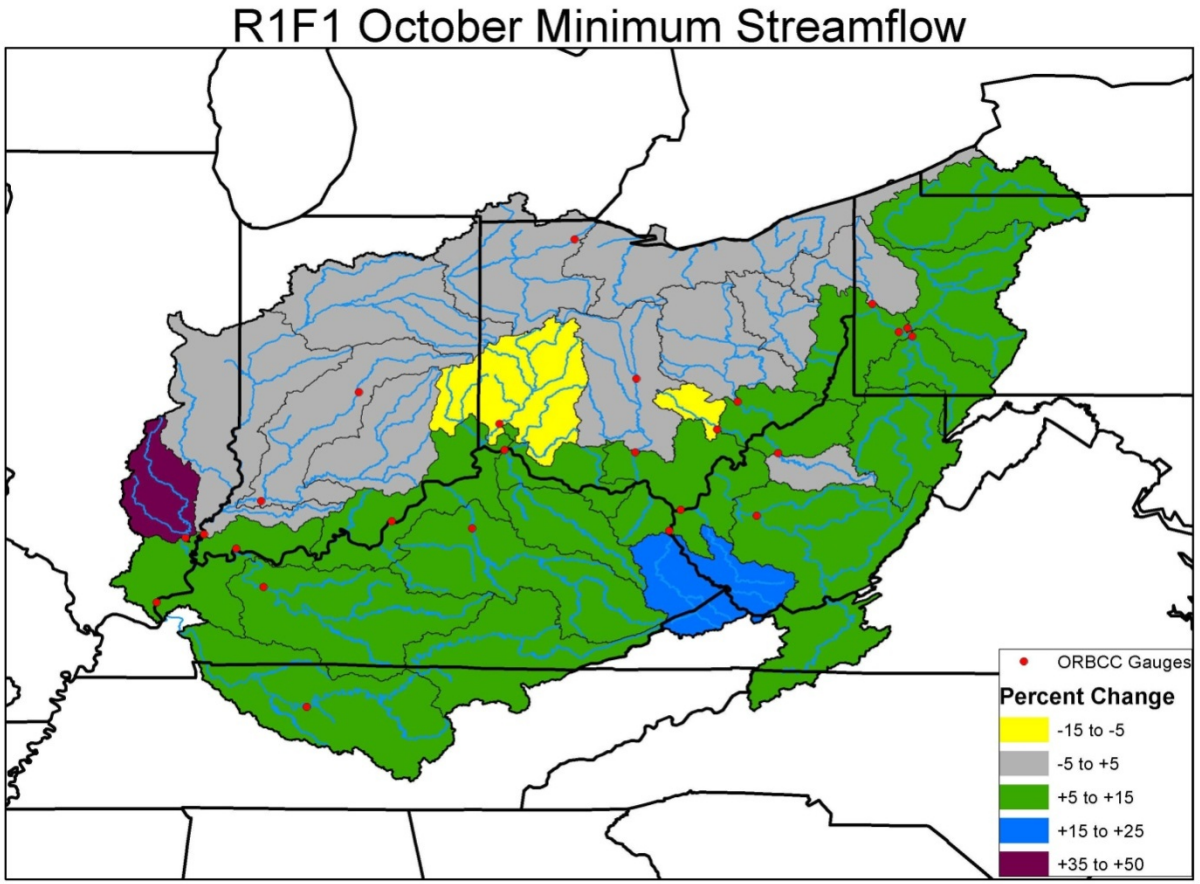






2011-2040 October % Change Min



- **Little or no change north of the Ohio River to some increase to the south compared to 1952-2001**

National Weather Service

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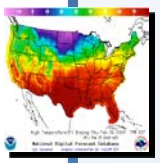
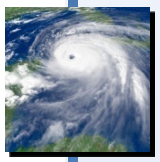
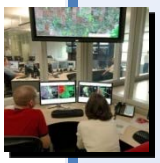
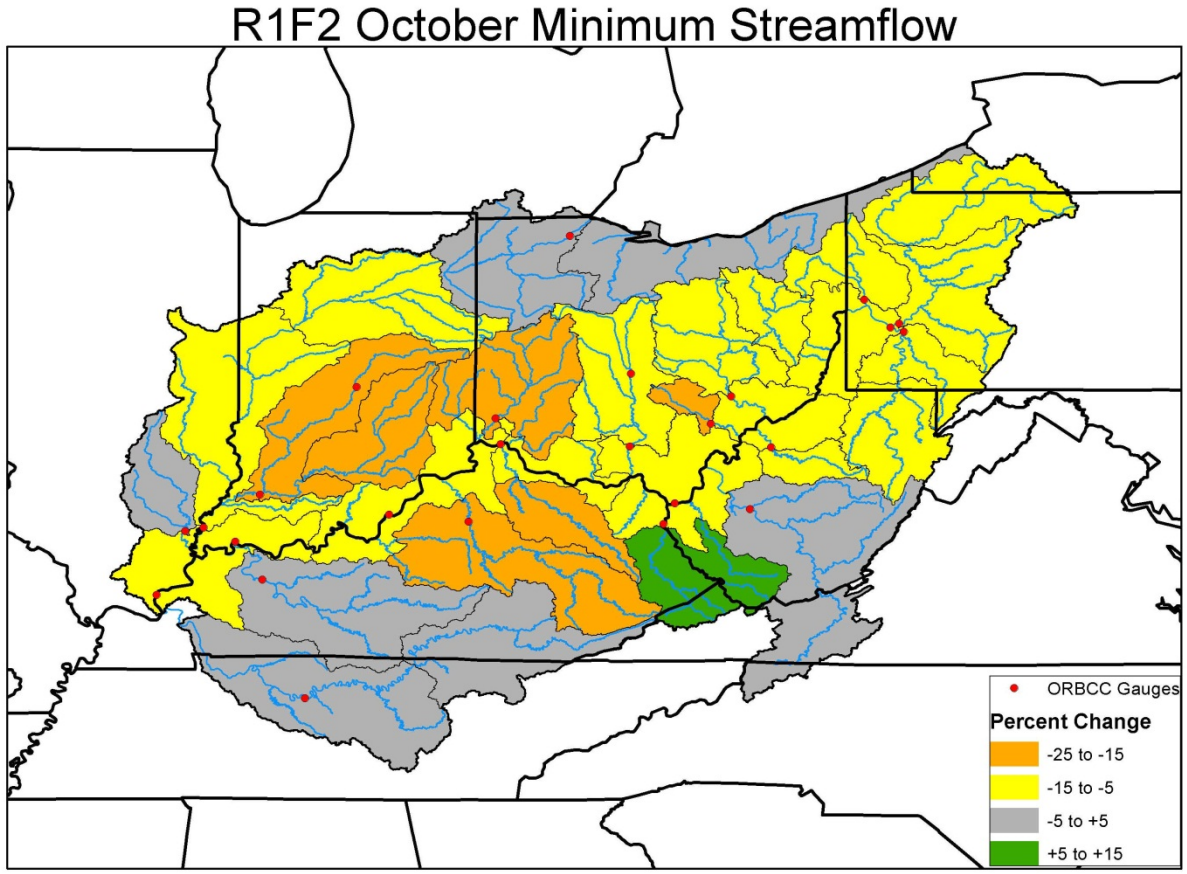






2041-2070 October % Change Min



- **Drier minimum autumn flows compared to 1952-2001 across much of the region**

National Weather Service
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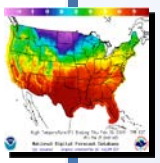
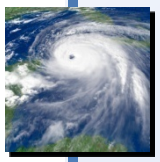
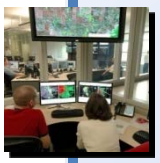
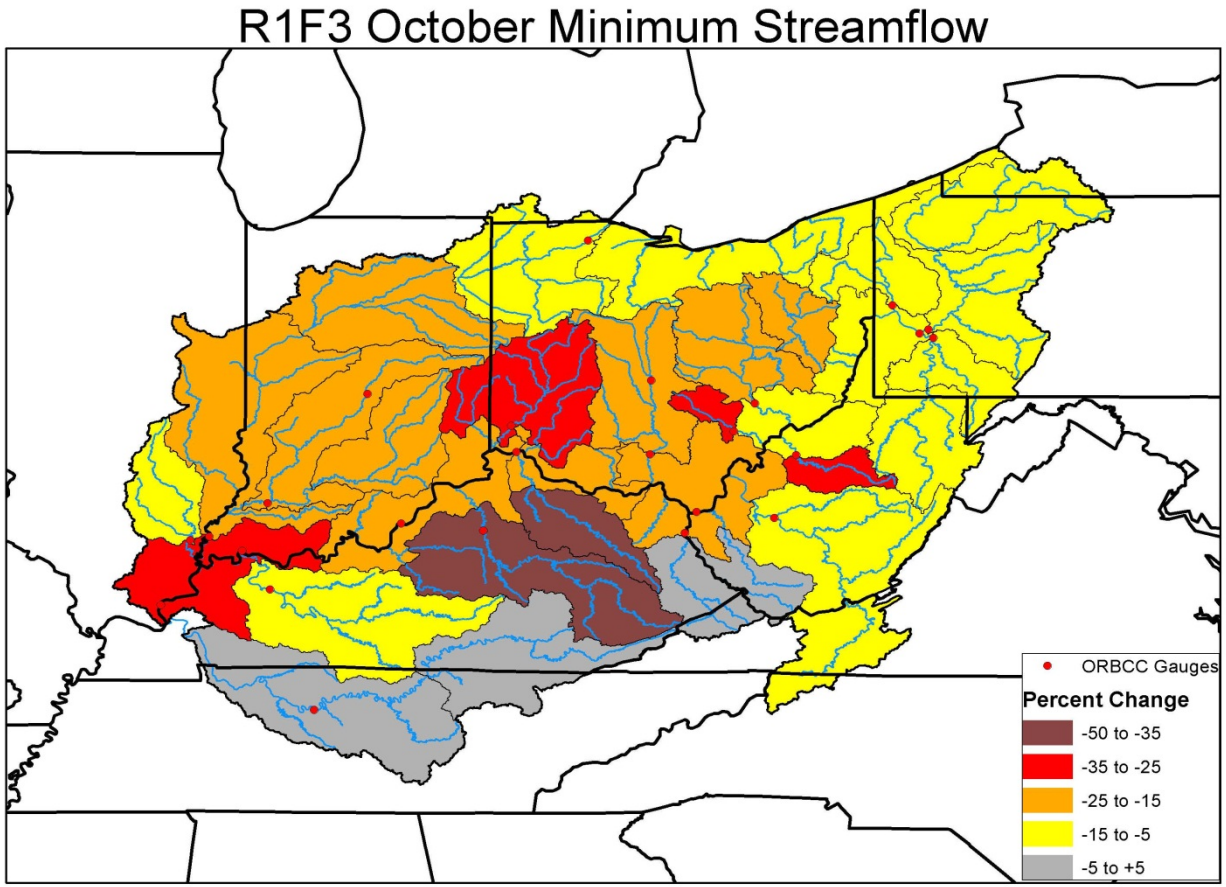




2071-2099 October % Change Min



- More extremes and drying really sets in for minimum flows across most of basin.

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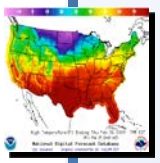
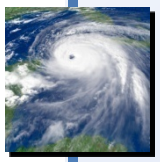
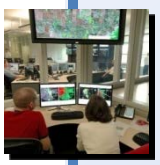
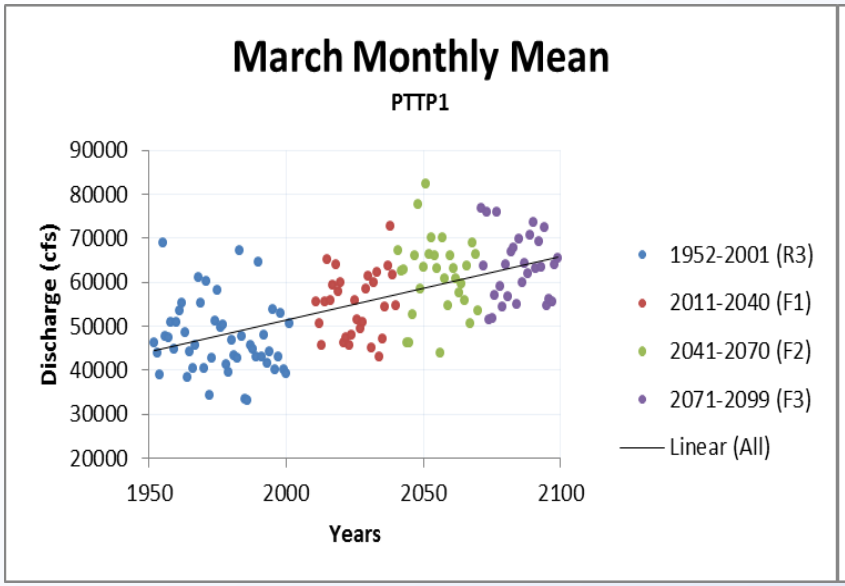
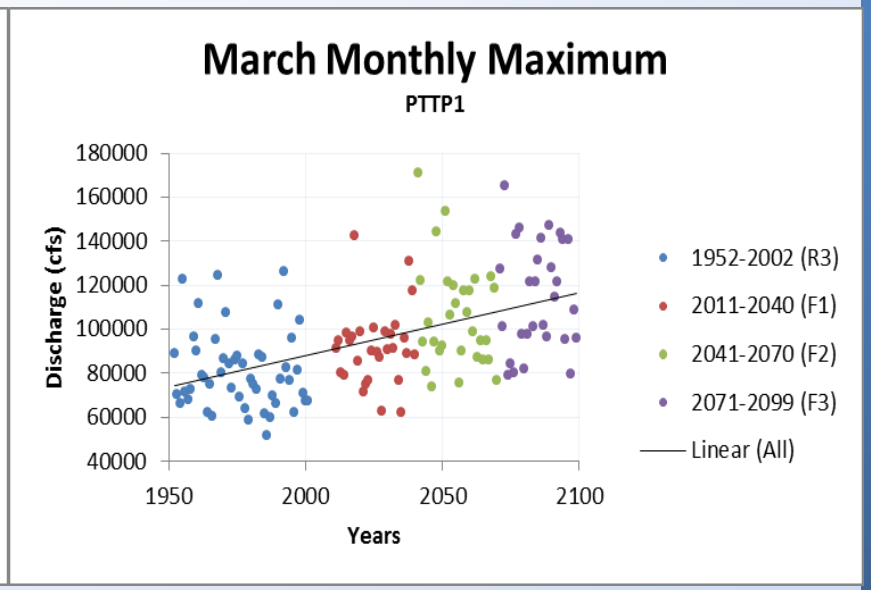




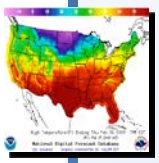


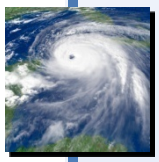
Review Streamflow Projections

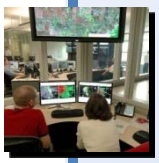




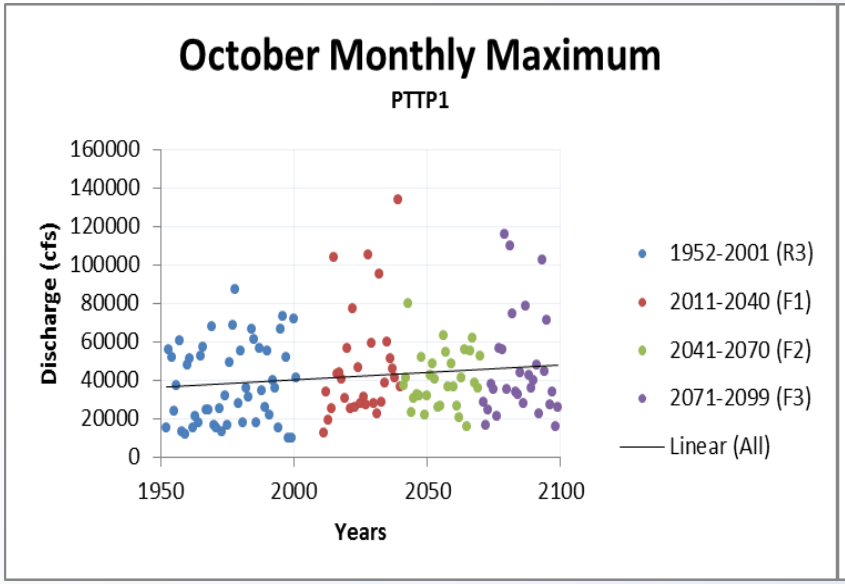
- Pittsburgh Mean March (Cool Flood Season Peak) flows increase steadily.
- Minimums similar to past until 2041 then increase.
- Maximums similar to past until 2041 then increase.

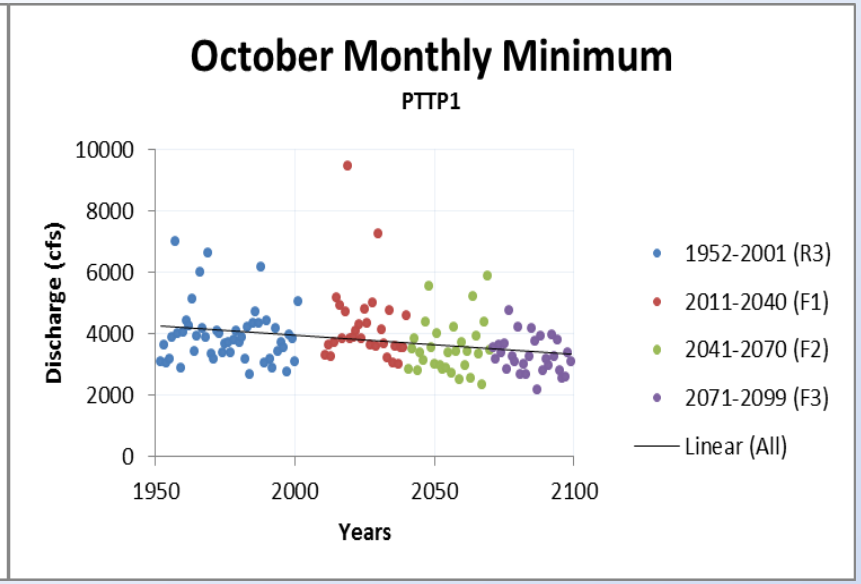






Review Streamflow Projections





- Pittsburgh Mean October (typical water season minimums) flows steady with increasing spread.
- Minimums slow decreasing trends
- Maximums slow increasing trends
- More wet or dry periods upper Ohio Valley in future

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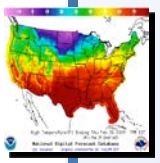
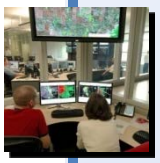
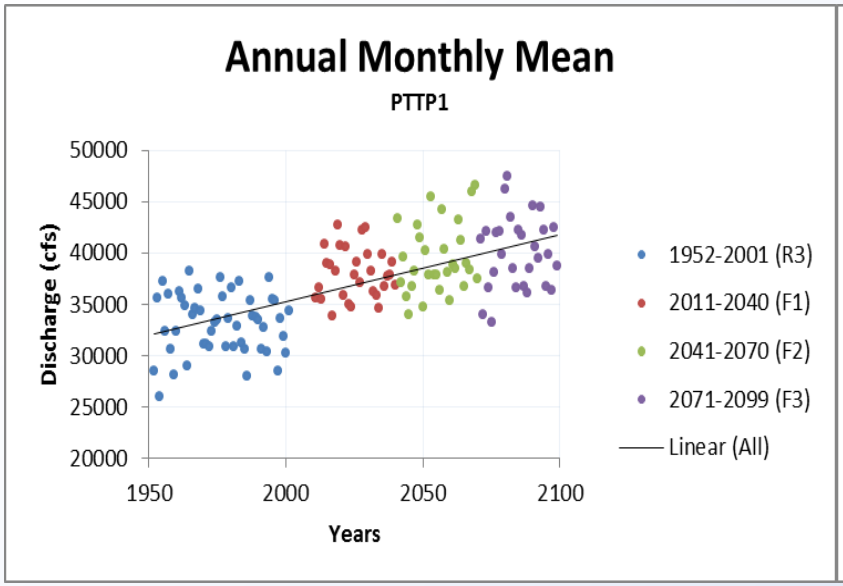
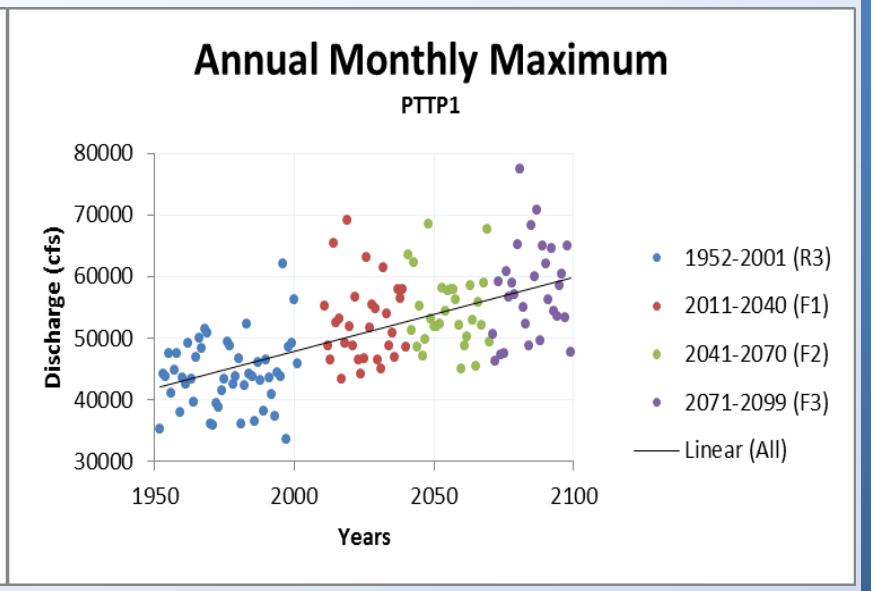




Review Streamflow Projections





- Pittsburgh Mean Annual flows increase
- Annual minimum flows increase
- Annual maximum flows increase
- Mean flows increase, low flows become lower in dry season especially after 2041 and peak flows increase but not until after 2041 in peak flood season.

National Weather Service

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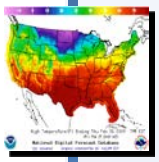
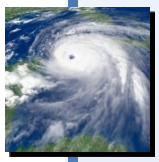
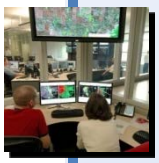
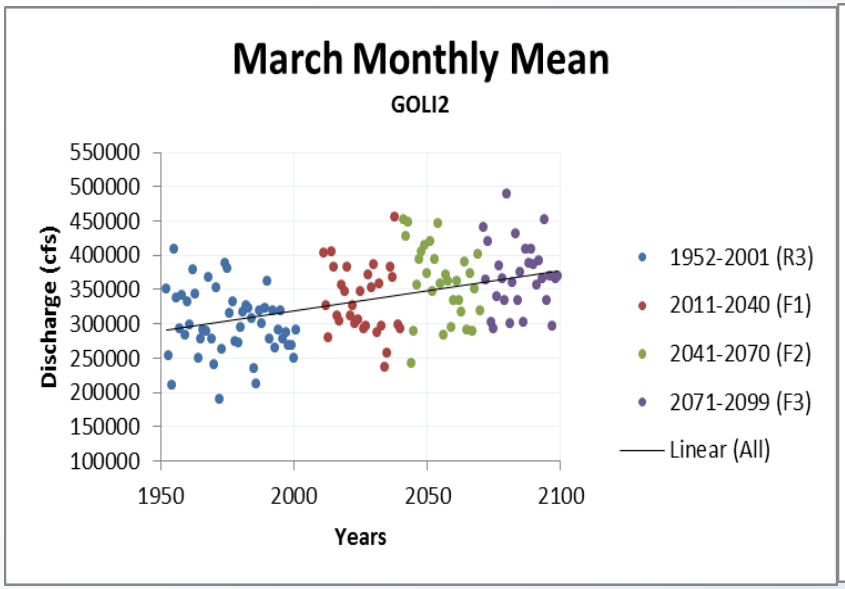
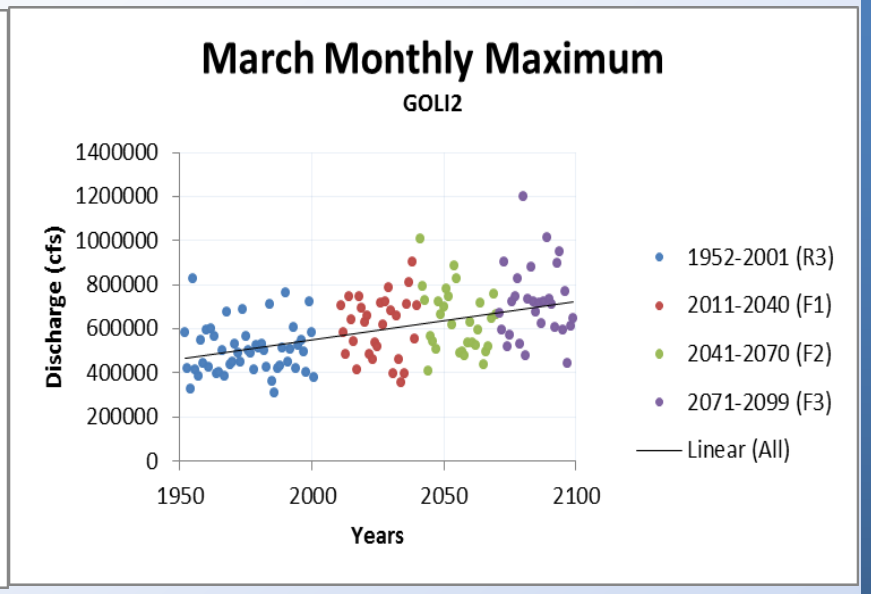






Review Streamflow Projections





- Golconda Mean March (Cool Flood Season Peak) flows increase steadily.
- Minimums similar to past entire period.
- Maximums similar to past until 2041 then increase.

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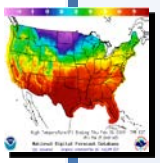
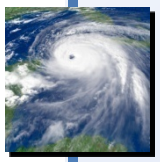
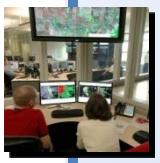
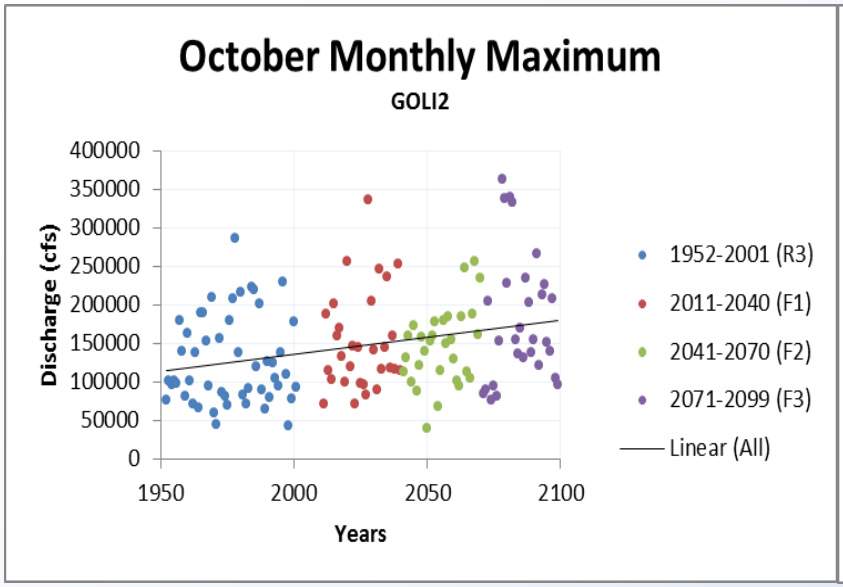
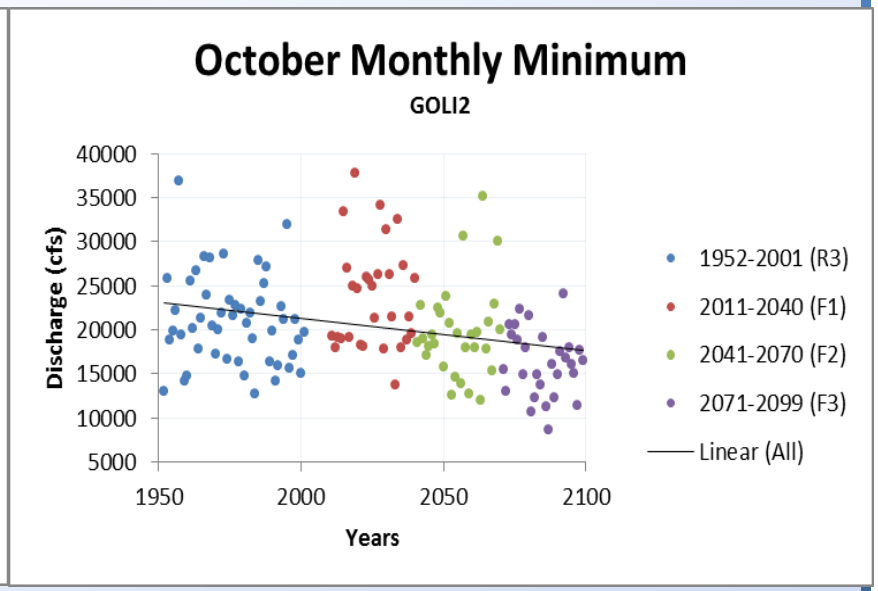




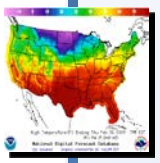


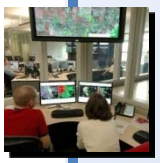
Review Streamflow Projections



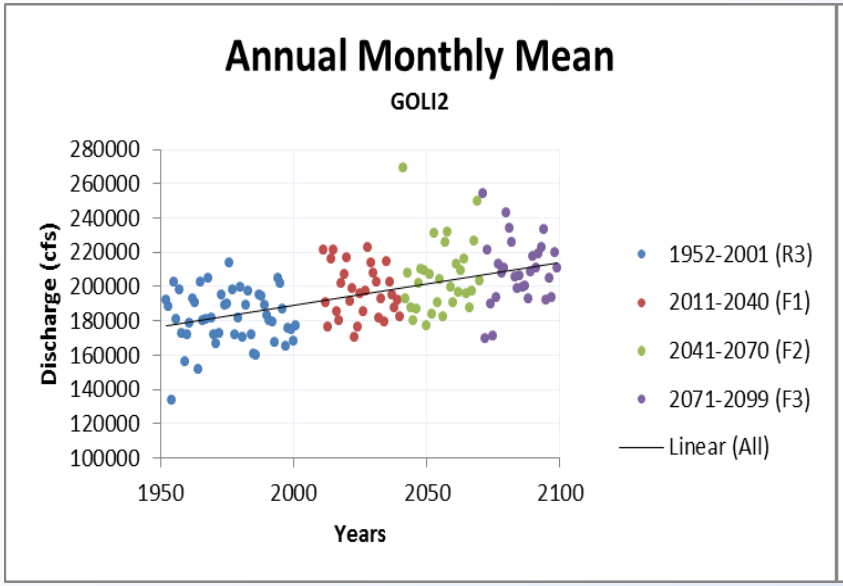


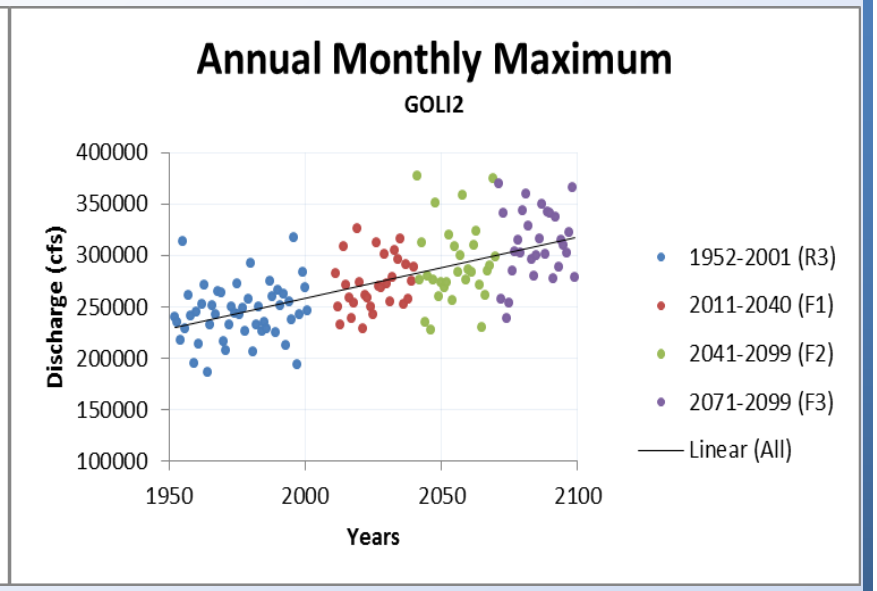
- Golconda Mean October (typical water season minimums) flows steady entire period
- Minimums slow decreasing trends
- Maximums slow increasing trends. Western basin becoming wetter with time in Indiana and Illinois.





Review Streamflow Projections





- Golconda Mean Annual flows increase
- Annual minimum flows flat
- Annual maximum flows increase
- Mean flows increase, low flows flat and peak flows increase mainly after 2041 in peak flood season. Similar to Cincinnati.

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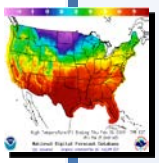
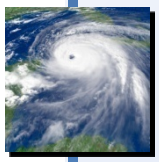
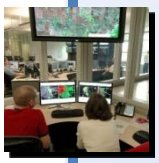
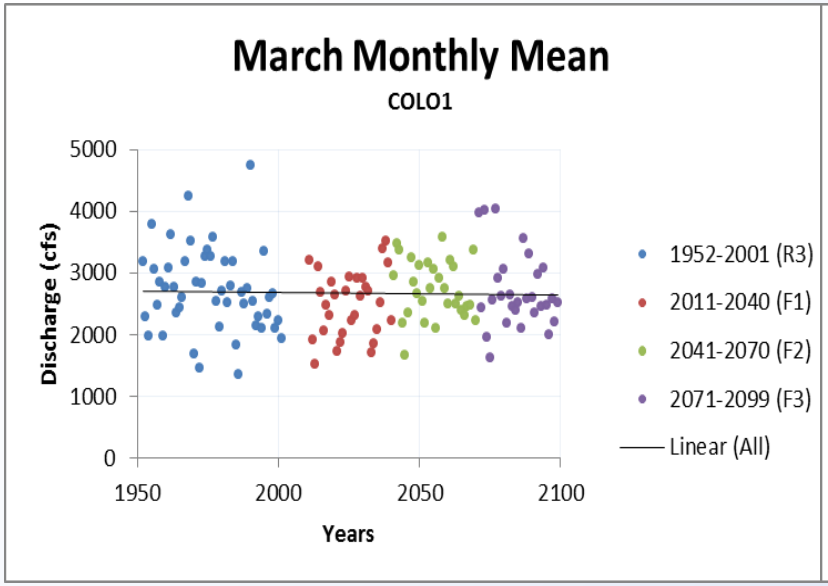
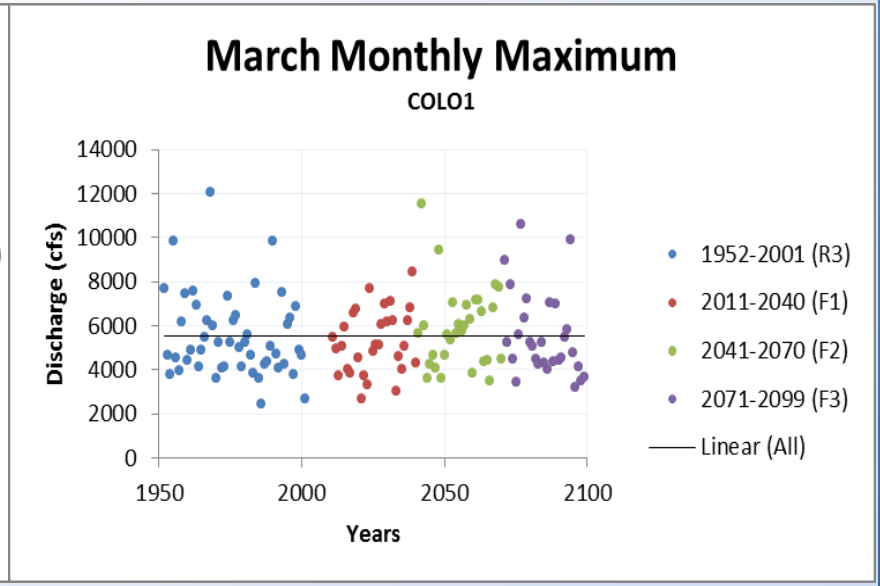






Review Streamflow Projections





- Columbus Mean March (Cool Flood Season Peak) flows flat.
- Minimums decrease slightly.
- Maximums flat.

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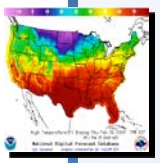
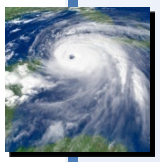
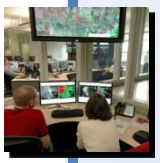
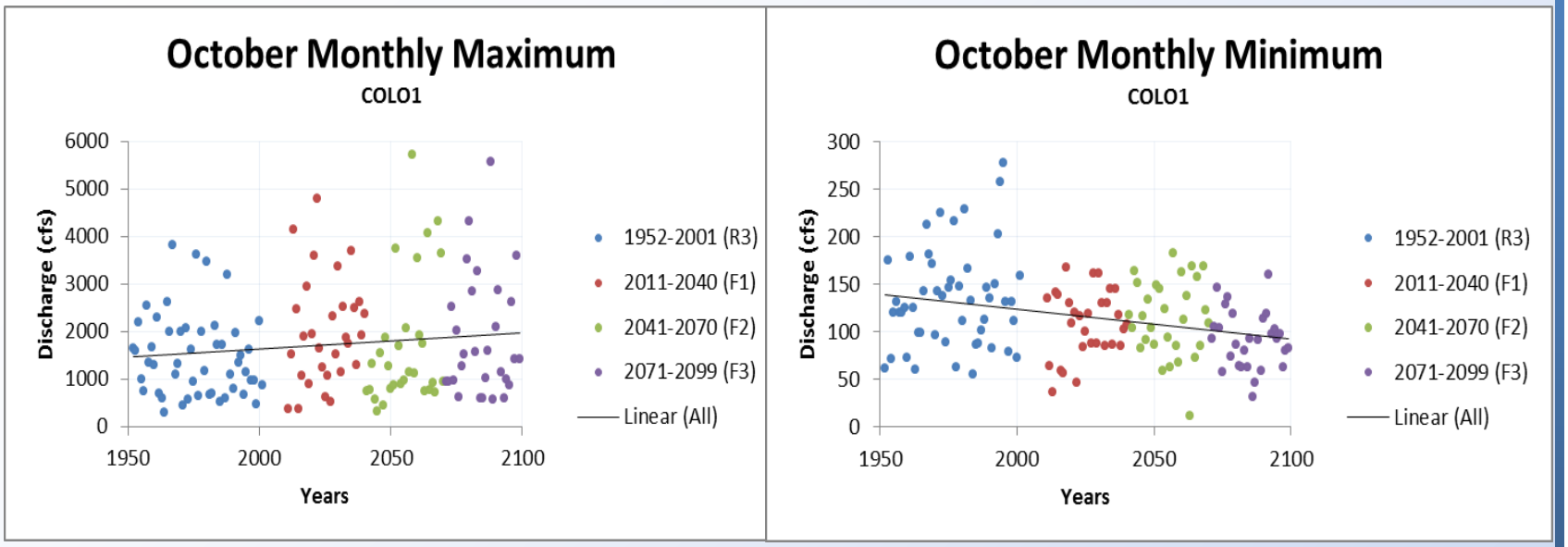


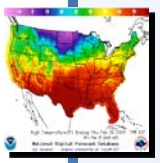


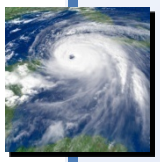


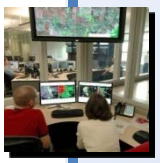
Review Streamflow Projections



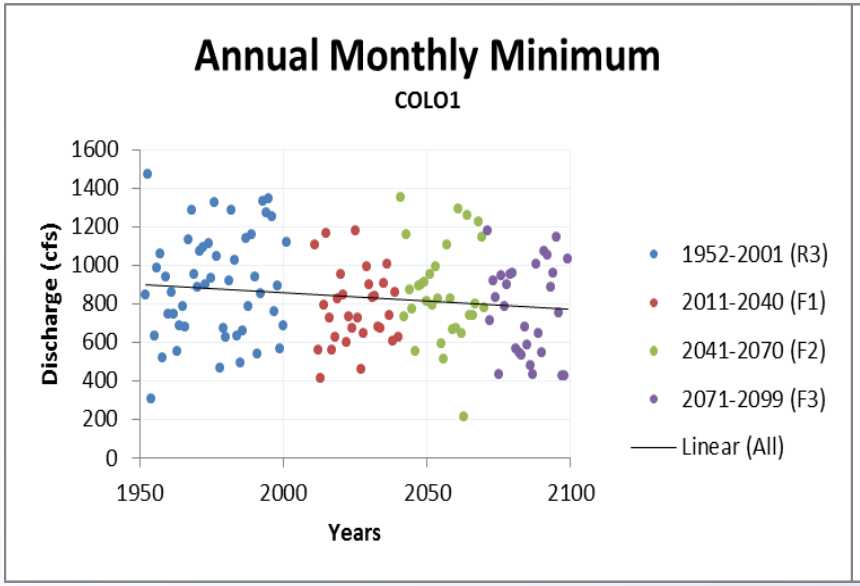
- Columbus Mean October (typical water season minimums) flows steady entire period
- Minimums slow decreasing trends
- Maximums slow increasing trends.

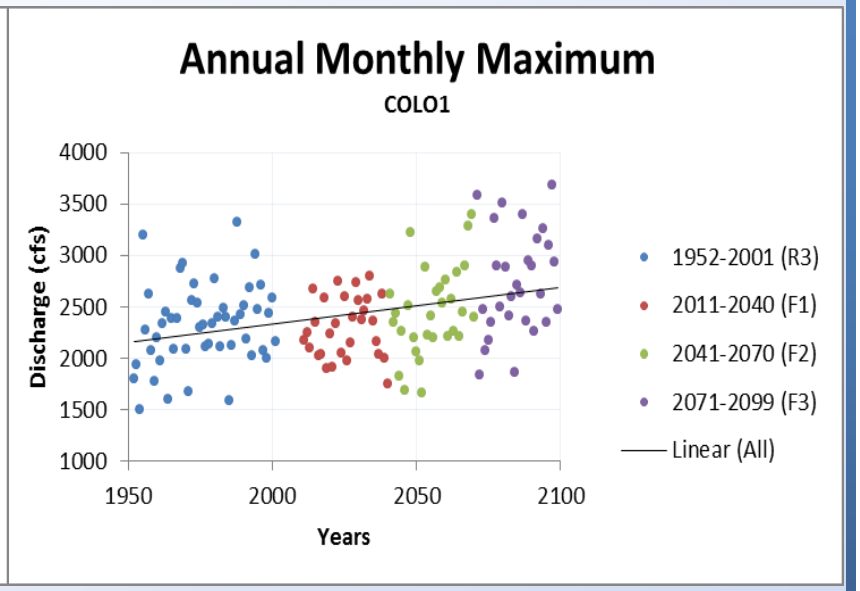






Review Streamflow Projections





- Columbus Mean Annual flows increase slightly
- Annual minimum flows decrease
- Annual maximum flows increase especially after 2060
- Columbus annual mean and maximum flows increase similar Ohio and west but minimum flows decrease similar to points east.

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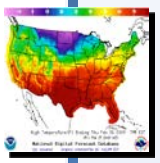
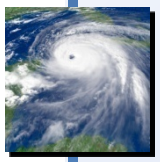
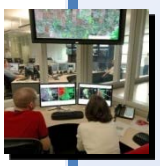
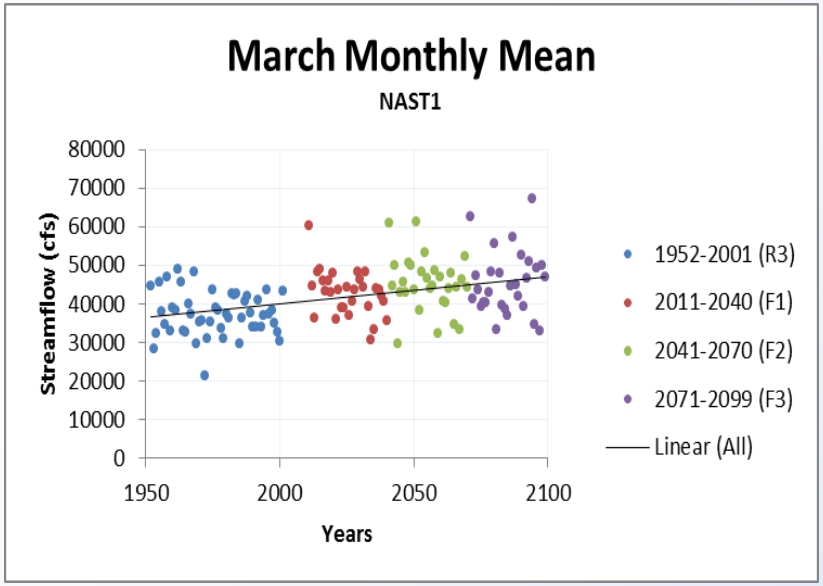
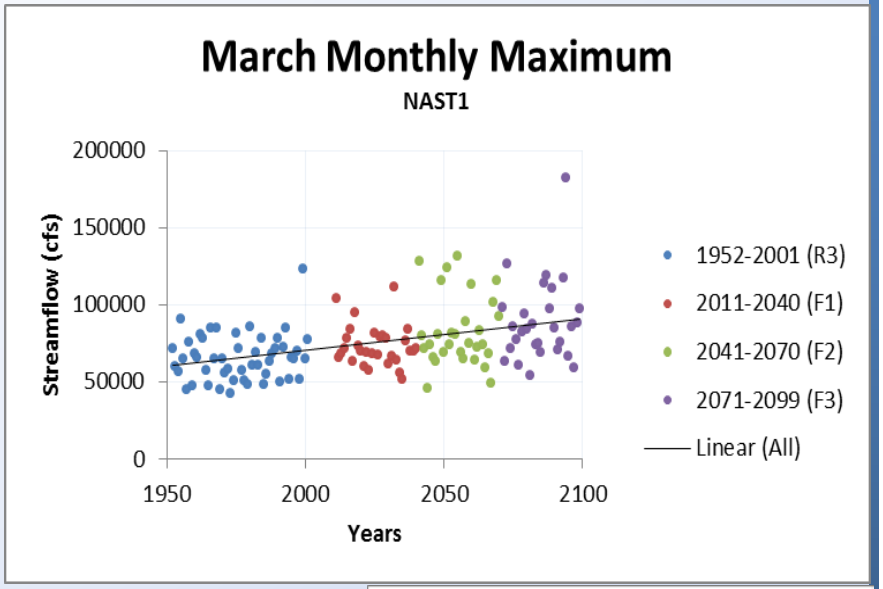




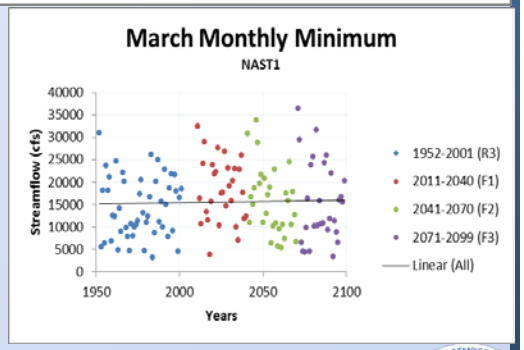


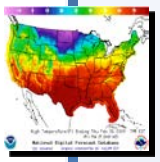
Review Streamflow Projections

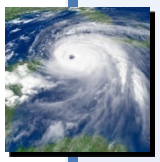


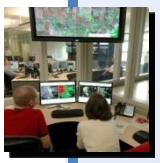


- Nashville Mean March (Cool Flood Season Peak) flows flat to slightly up through 2040 then increase.
- Minimums flat.
- Maximums flat to slightly down through 2050 then increase









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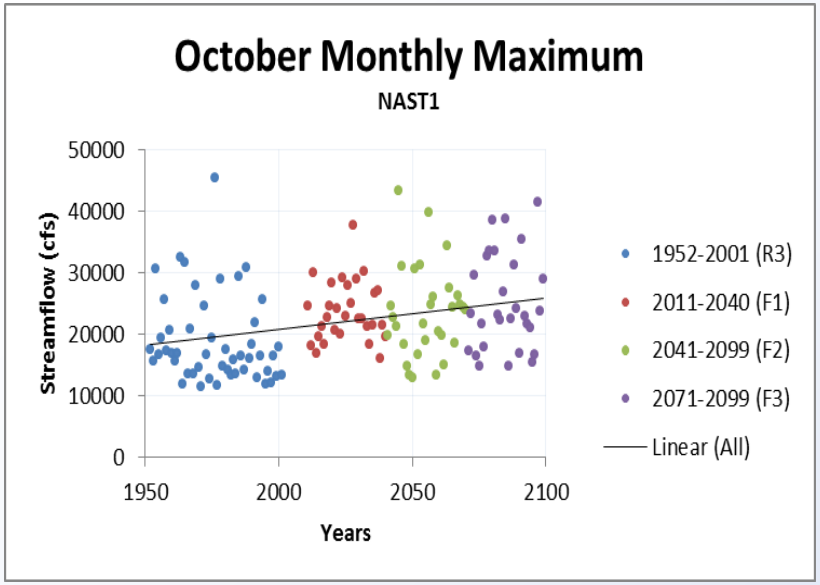
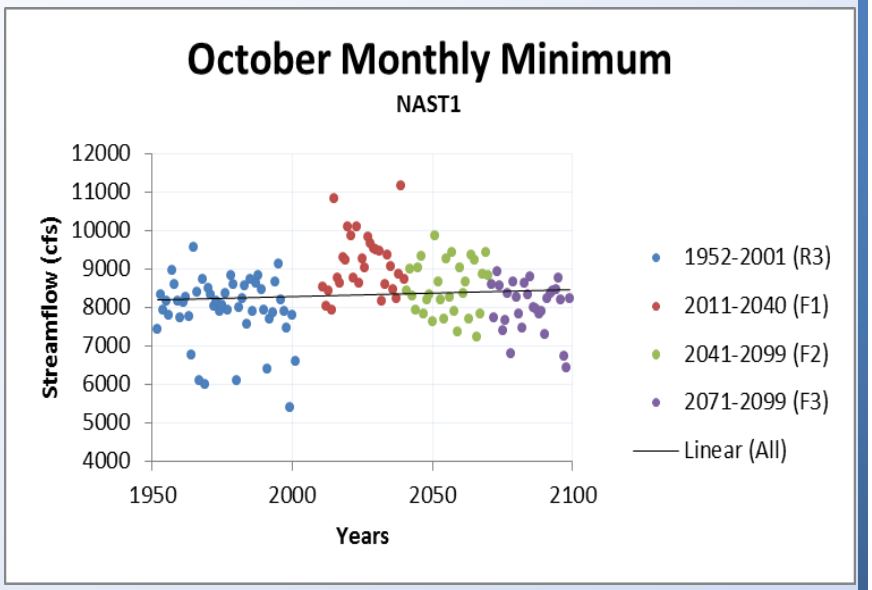
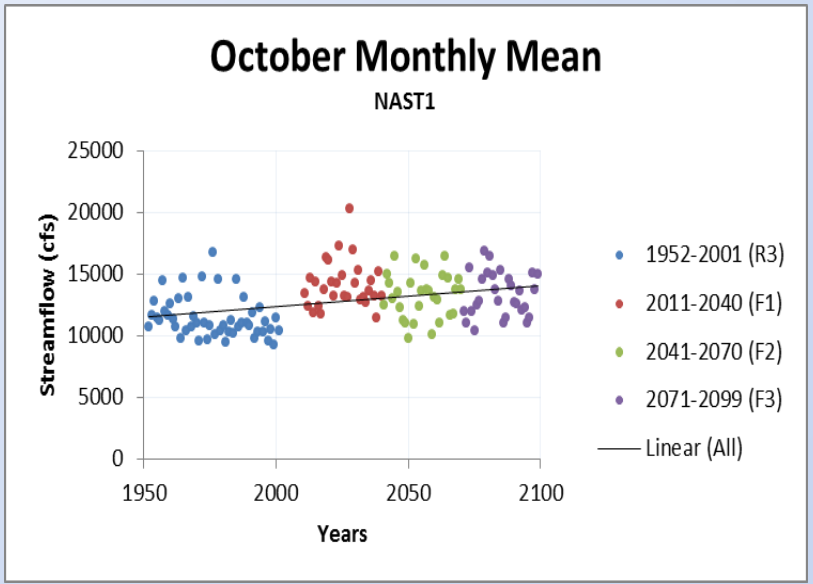
Review Streamflow Projections





- **Nashville maxes increase, minimums increase and means increase.**



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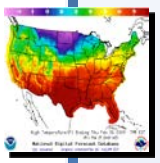
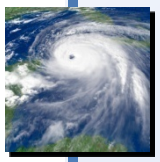
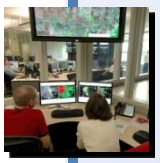
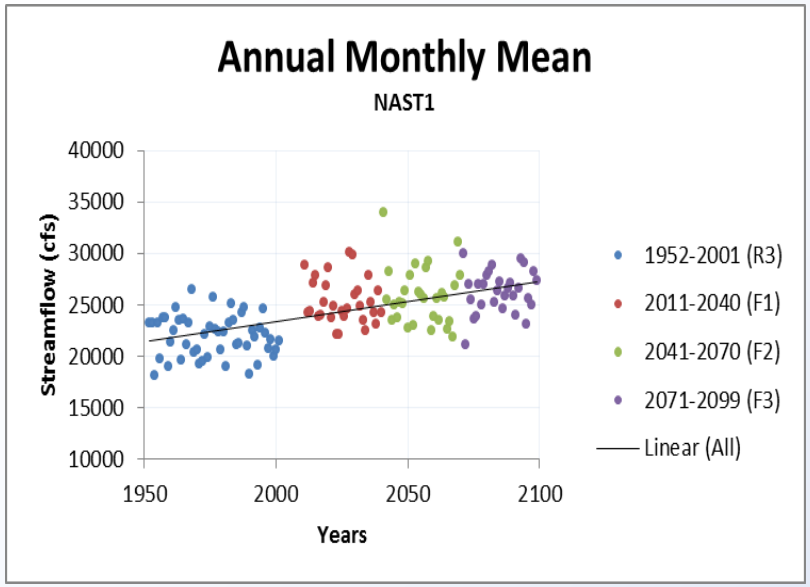
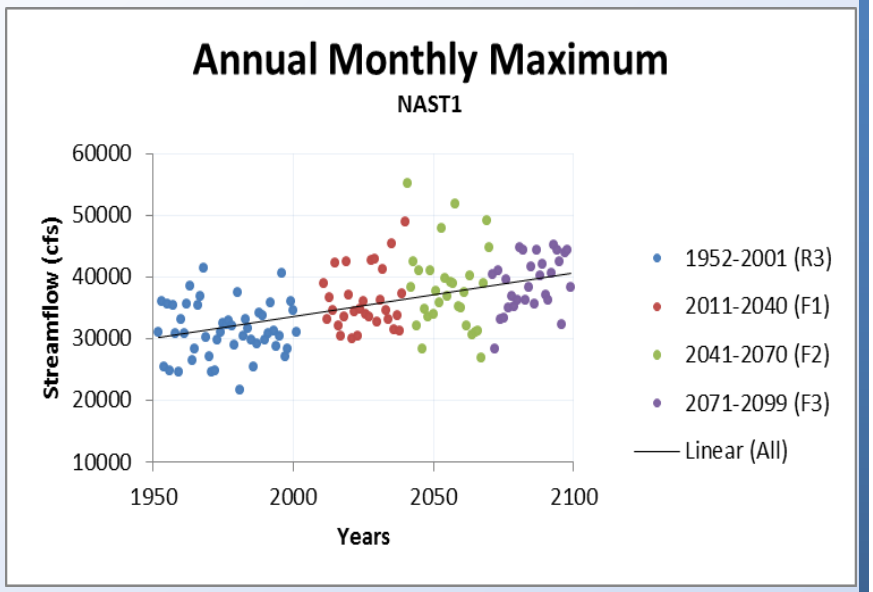




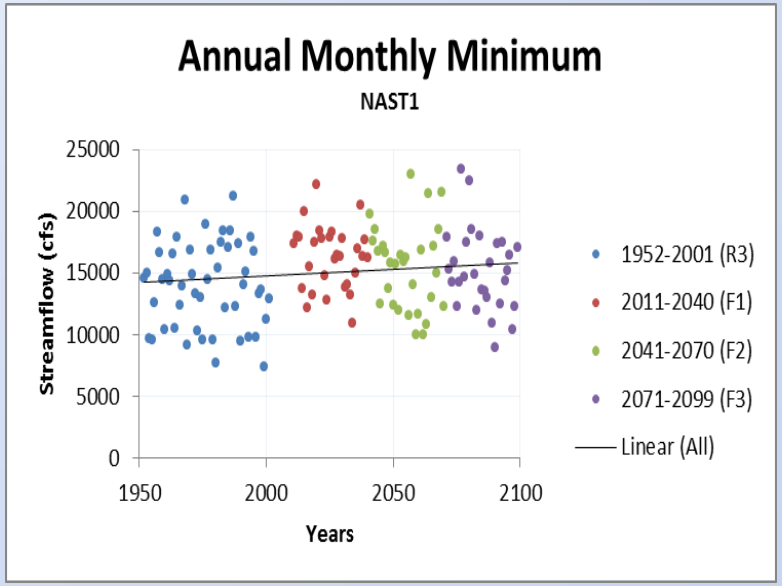


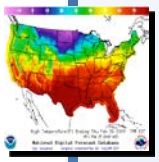
Review Streamflow Projections

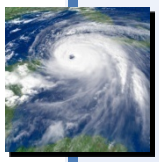


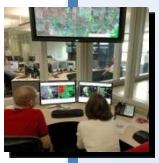


- Nashville mean and maximums increase.
- Minimums fairly flat.









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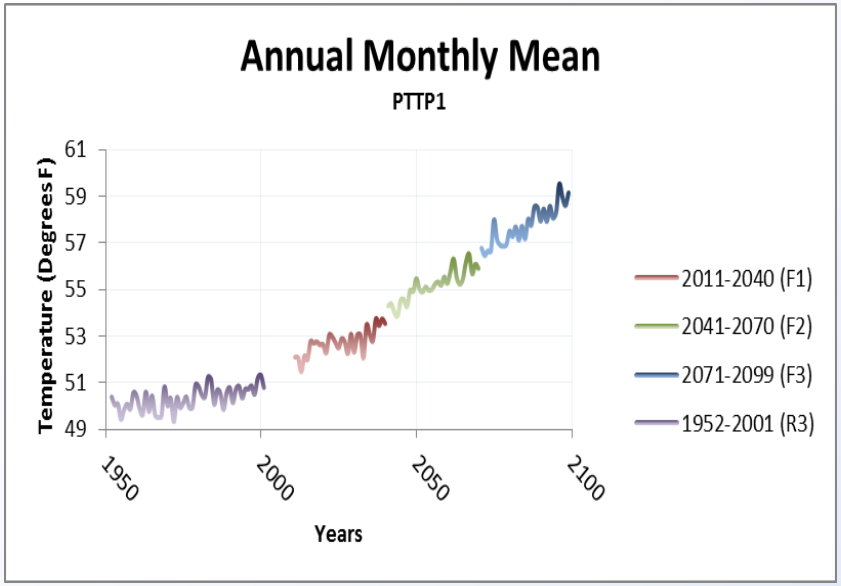
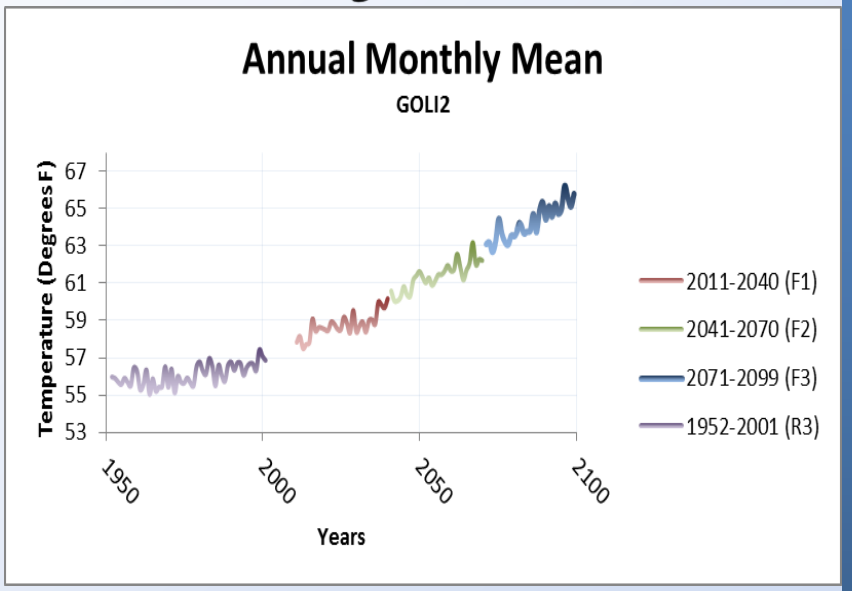
Review Temperature Projections





- Pittsburgh (upper Ohio Valley) and Golconda (lower Ohio Valley) show a similar trend about +0.5F per decade then increases about +1F per decade from 2050 to 2099. The faster increase likely leads to increasing evapotranspiration and increasing spread and uncertainty.
- I-64 temperatures shift to I-70 temperatures this century.

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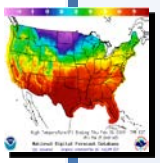
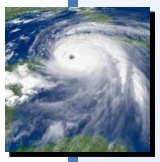
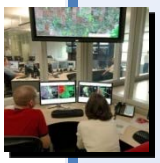
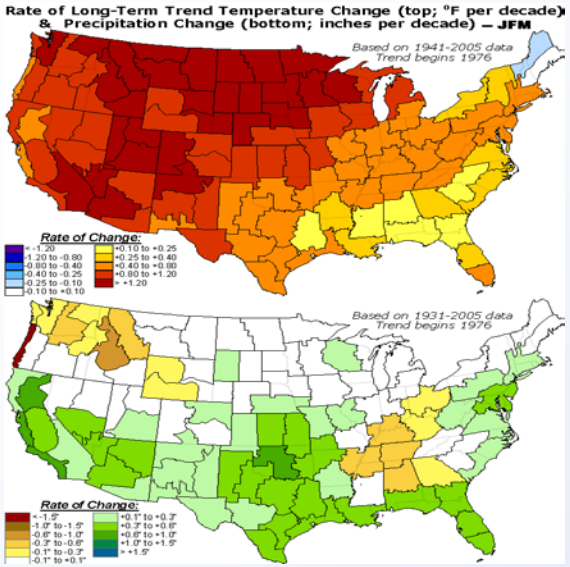
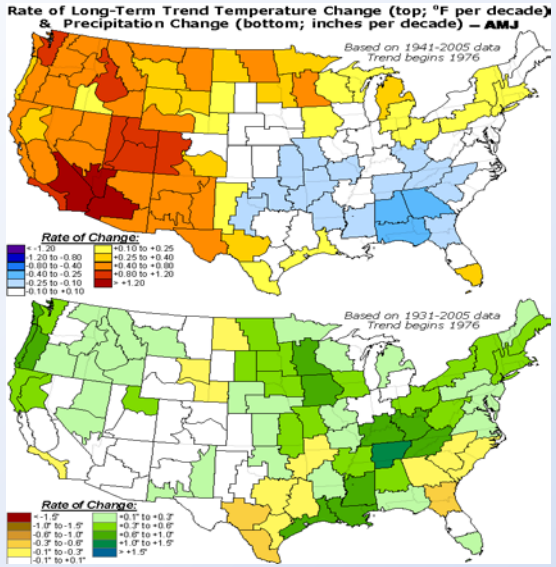


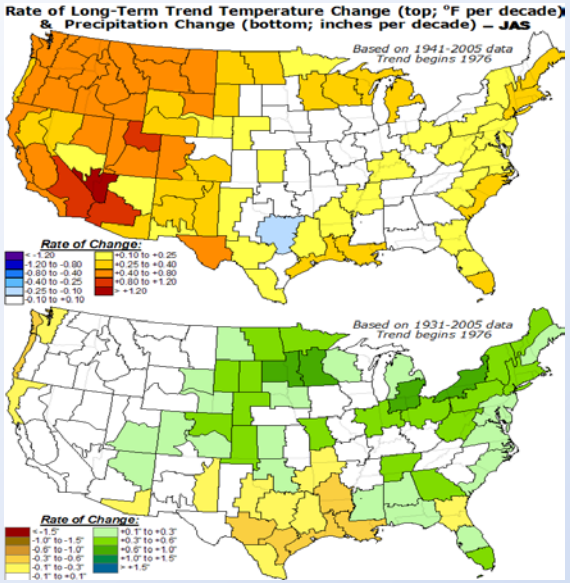


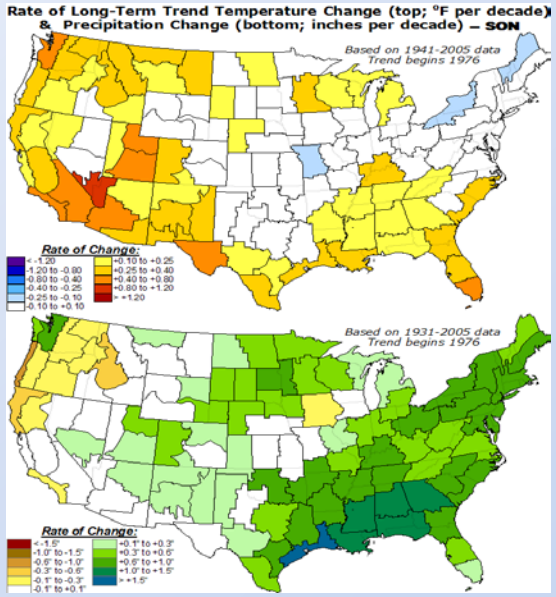


Summary/Trends Since 1976









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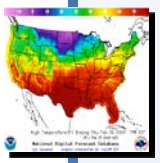

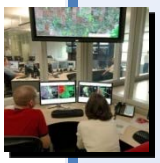

Summary/Trends Since 1976

- Observed trends show most observed warming is in winter in the region.
- Observed trends show most wetting is occurring from late summer into autumn and early winter.
- Observed trends show peak floods remain within the historical record.
- Observed trends show no change in droughts.

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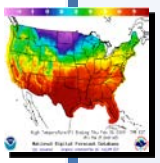

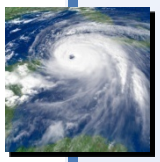

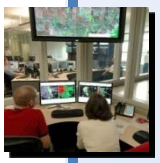

Summary

- The ensemble climate models overall suggest mean, maximum and minimum flows will generally be within the range of history through 2040 except during the autumn season.
- Beyond 2040 through 2099, increases occur in the mean and maximum flows generally in the 10-40% range with some higher especially in the northern and eastern Ohio Valley and especially in autumn (really from late summer to early winter)

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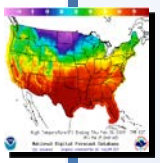

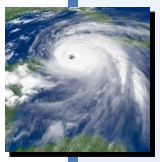

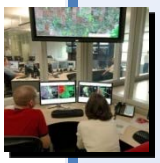

Summary

- Minimum flows decrease in most periods especially heading from 2040 past 2071.
- Peak spring flood season sees maximum flows increase especially beyond 2040.
- Autumn season experiences the greatest variability with minimum flows decreasing with time and maximum flows increasing with time (influenced by lower overall typical flows)

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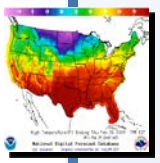

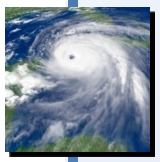

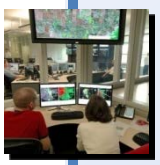

Summary/Impacts

- Climate models suggest 1976-present trends likely to persist through 2040.
- The autumn increases in maximum flows may enhance early cool season flood events in late autumn/early winter?
- Spring flooding could worsen beyond 2040?
- Droughts could lengthen or shift more between spring, summer and autumn beyond 2040?
- Variability is likely to increase with time.

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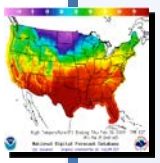

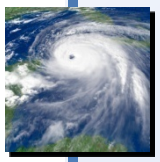

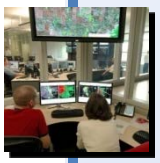

Questions?

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