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Assessing Climate Change Impacts on Streamflow in South Carolina River Basins

cisa
carolinas integrated sciences & assessments

University of South Carolina

Resource Management Concerns

Water supply

SCDNR

Ecological Resources

Water quality

Assessing impacts of climate change on water resources

Top-down climate-analysis based impact assessment

Considerations for using climate projections

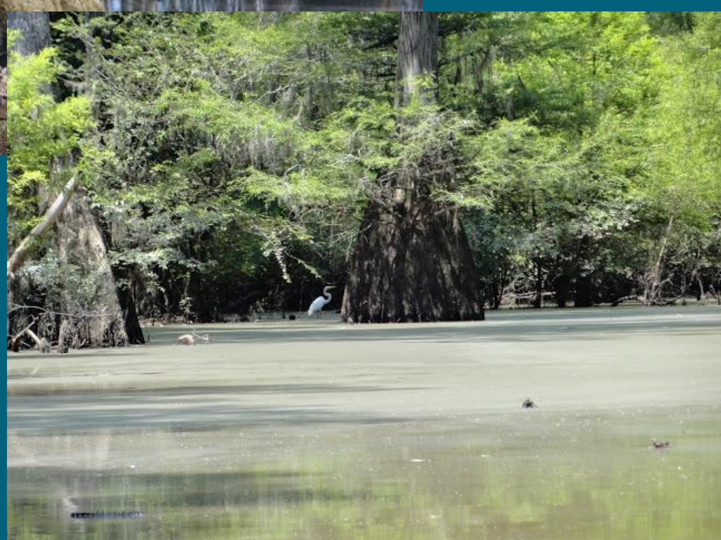
- Choice of GCMs and emission scenarios
- Choice of downscaling methods
- Temporal resolution

Objective

Assess the likelihood and range of variability in streamflow at a catchment scale in SC and NC river basins under several climate scenarios

Resource Management Concerns

- Floodplain ecosystem in the Congaree National Park



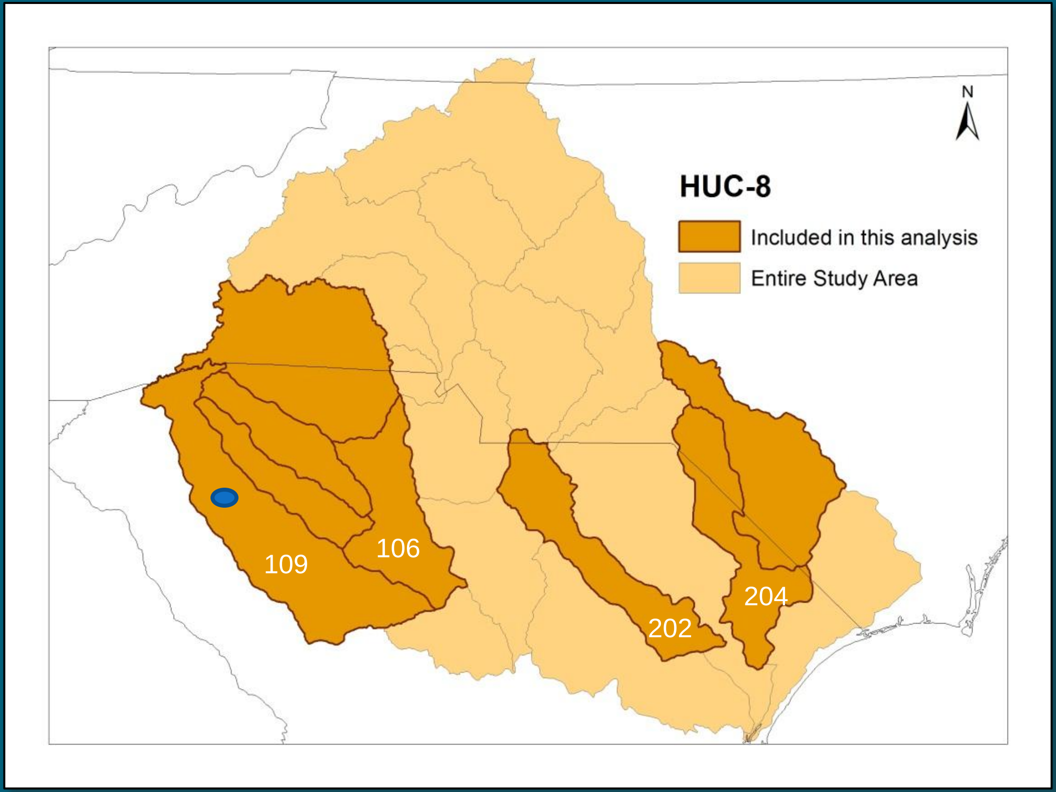
Google Maps, 2012

- Groundwater salinity intrusion in the Winyah Bay

Methodology: Streamflow Calibration

Hydrologic Simulation Program – Fortran (HSPF)

- EPA-BASINS platform
- Continuous simulation watershed model
- Calibrated at sub-HUC8 scale using automated optimization tool, Parameter Estimation (PEST), as well as manually
- Calibrated for daily discharge



Streamflow for Saluda River has only been simulated at Gage 2163500 located upstream of Lake Greenwood

Methodology: Simulating streamflow under climate change scenarios

CCSM3, GFDL CM2.0, PCM, ECHO

Dr. Hayhoe's dataset available from USGS Geo Data Portal project

Downscaled GCM output

A2 Emission Scenario

Max temp
Min temp
Prec

Gridded dataset processed into a point output for each subwatershed

Two intervals:
1981 - 2010 and
2041-2070

Built-in algorithms in BASINS-HSPF

Dissaggregation of met variables

Calculating PEVT from Tmin and Tmax
Disaggregation of T and P from daily to hourly timescale

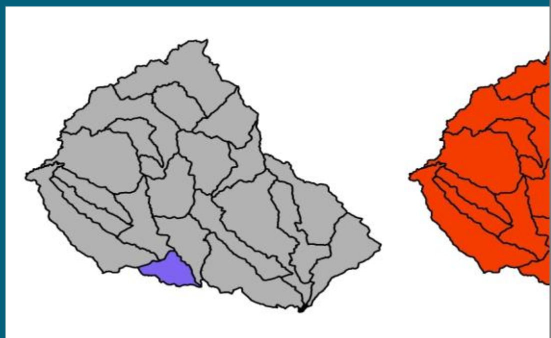
Imported to HSPF model for simulation runs

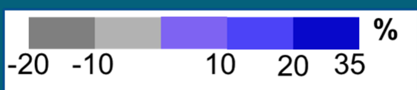
Streamflow variability

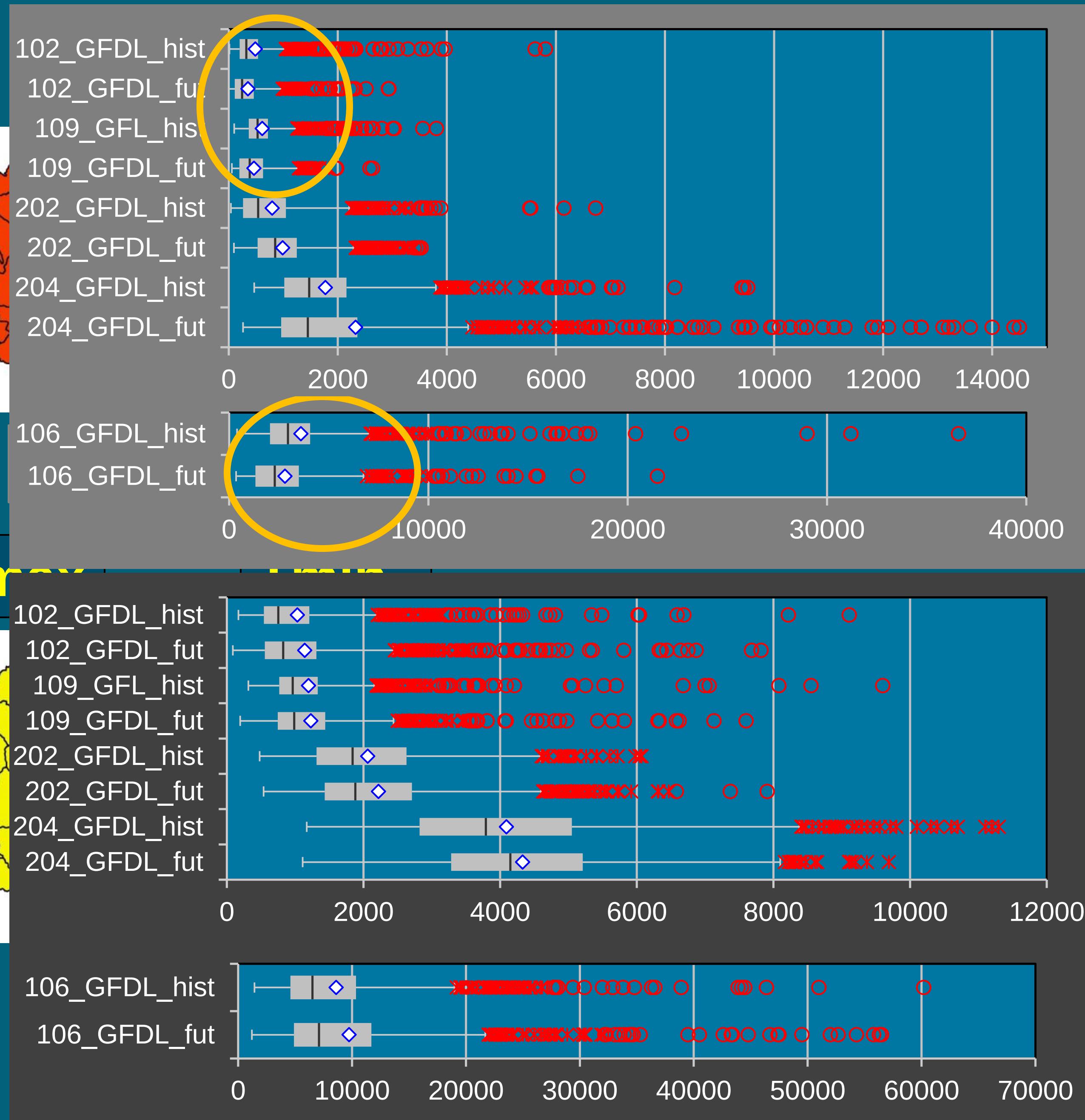
- Comparisons using months of January and July
  - Seasonality
  - Variation among GCMs
  - Variation among watersheds

Daily discharge: GFDL

JULY

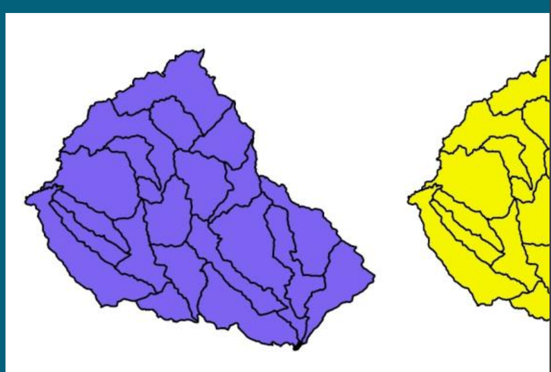






Prec

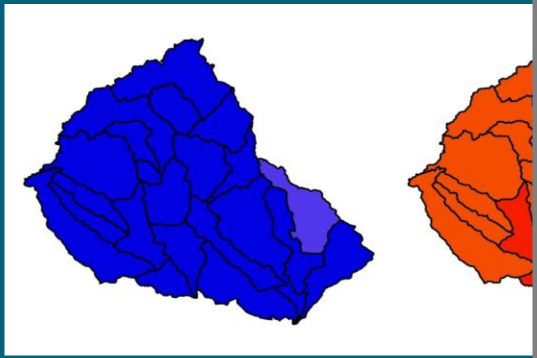
Tmax

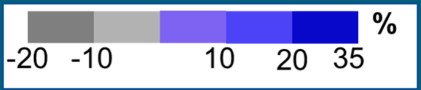


JANUARY

Daily discharge: ECHO

JULY





Prec

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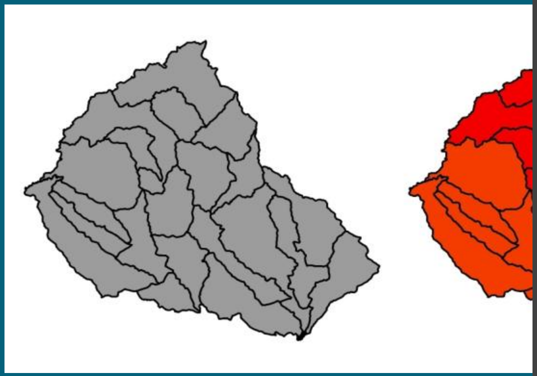

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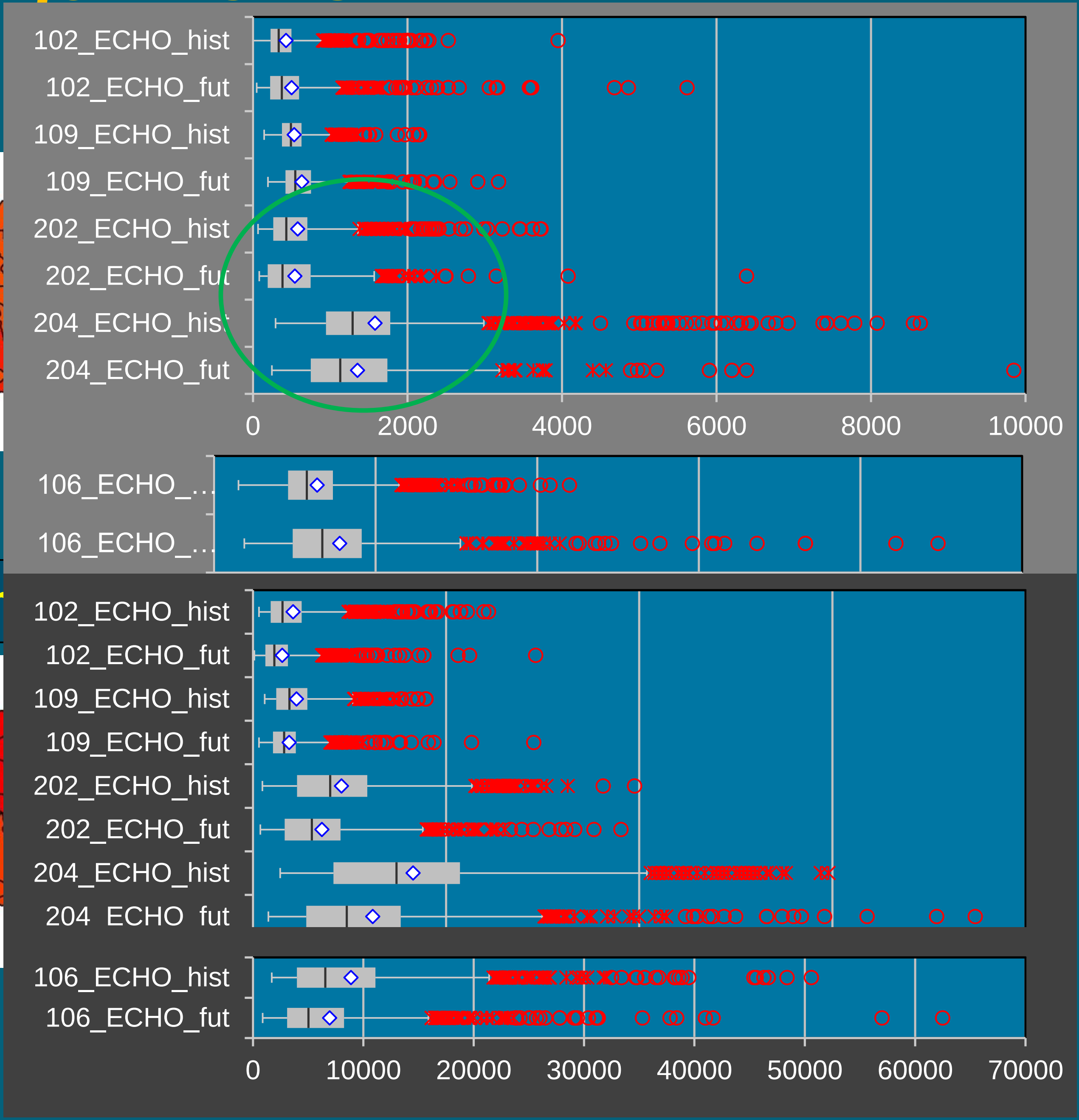
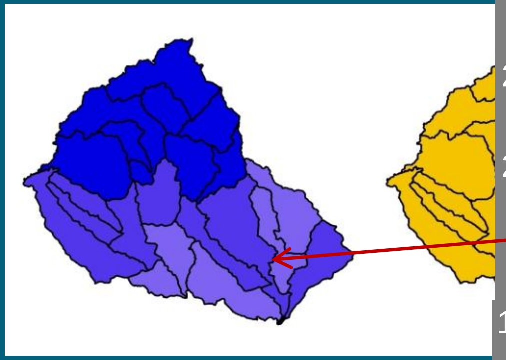
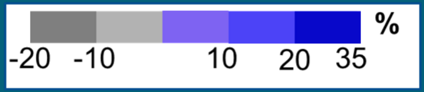
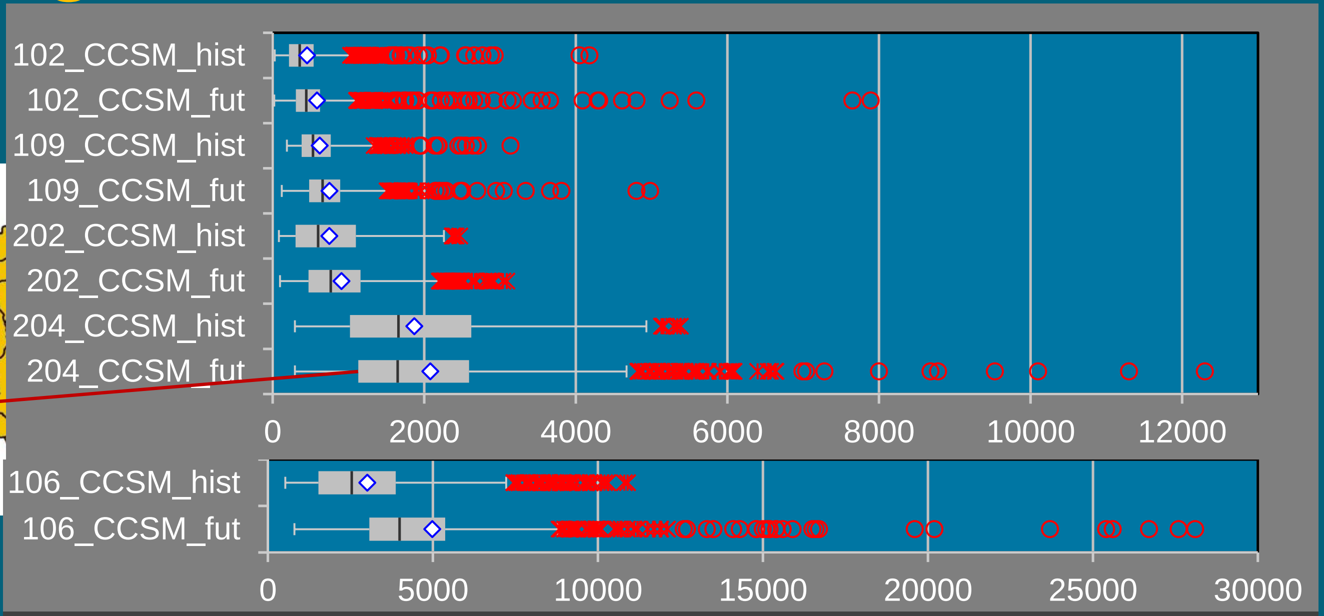


Daily discharge: CCSM

JULY







Prec

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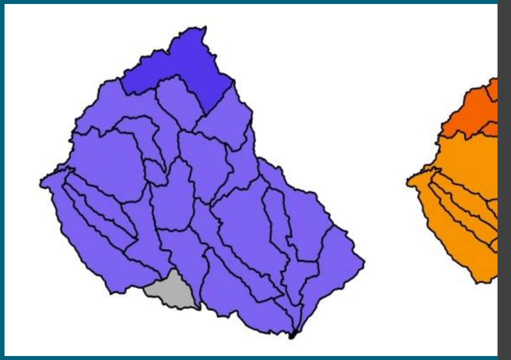

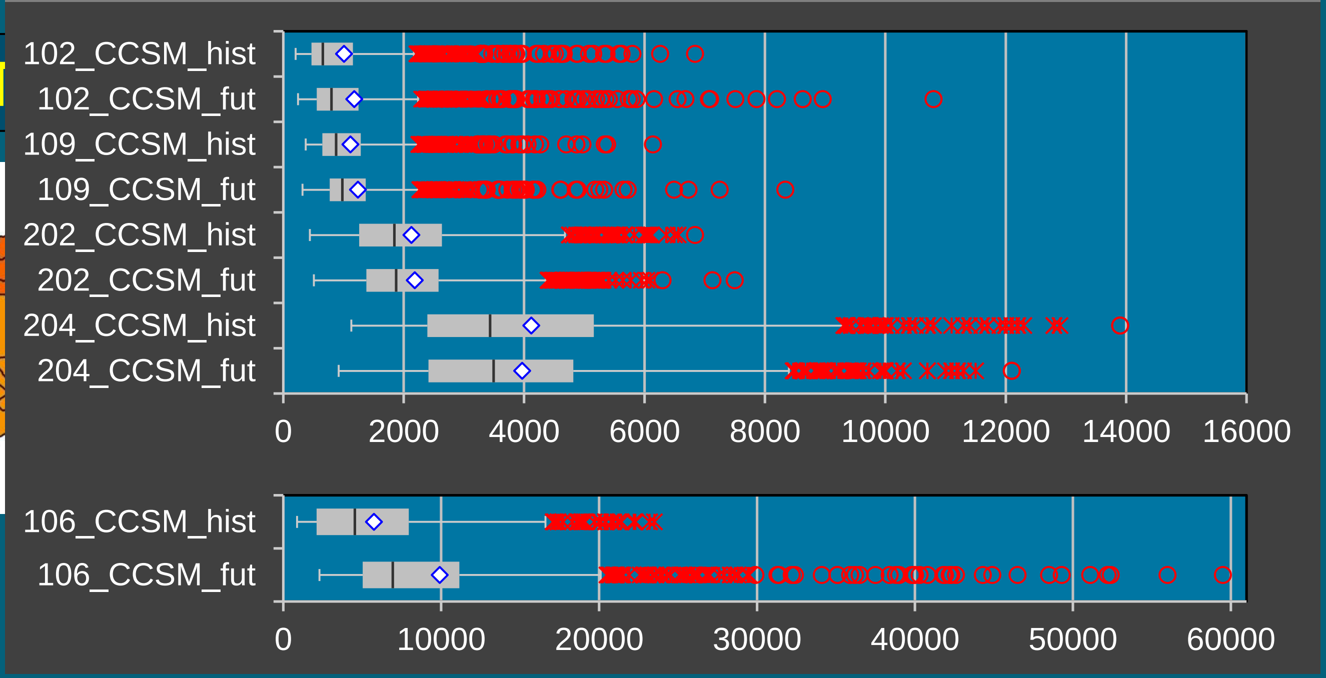

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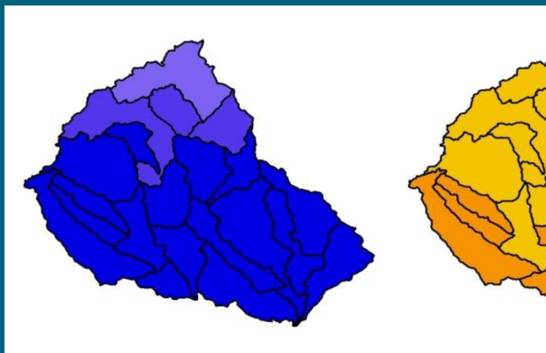
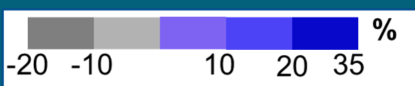
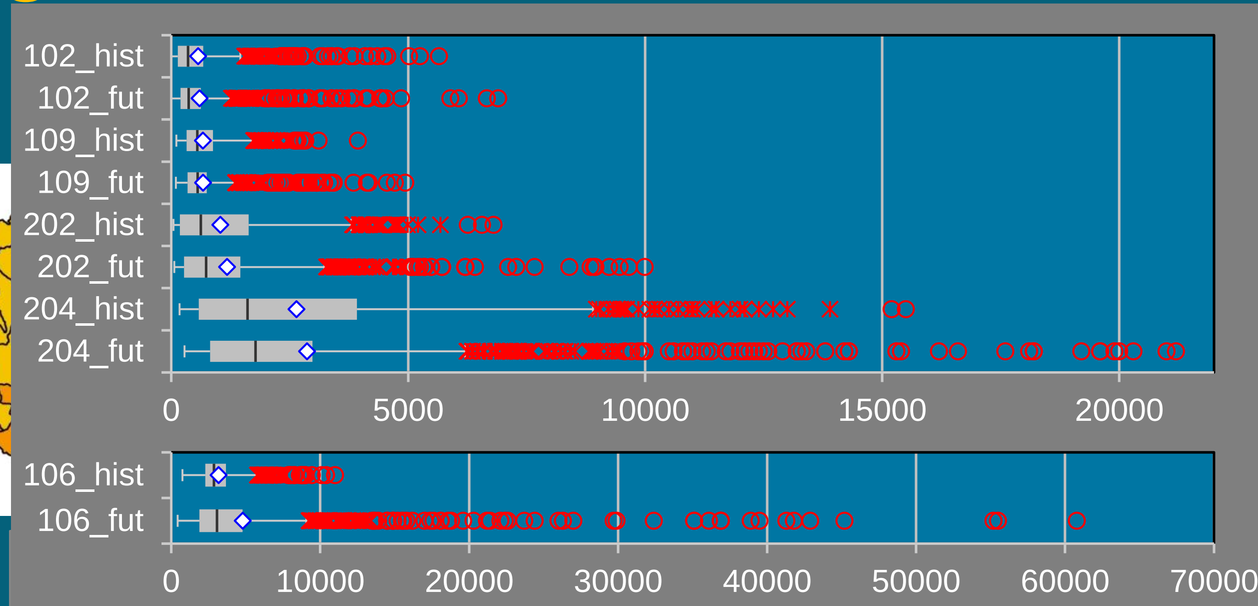
Daily discharge: PCM

JULY

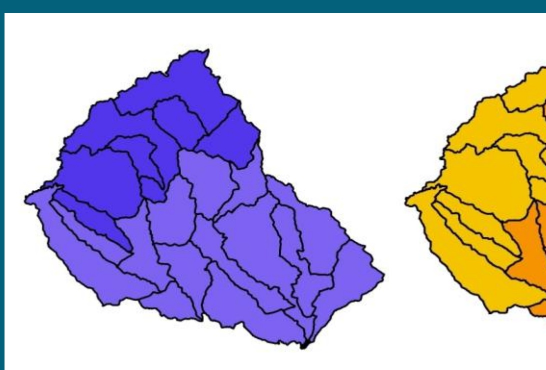


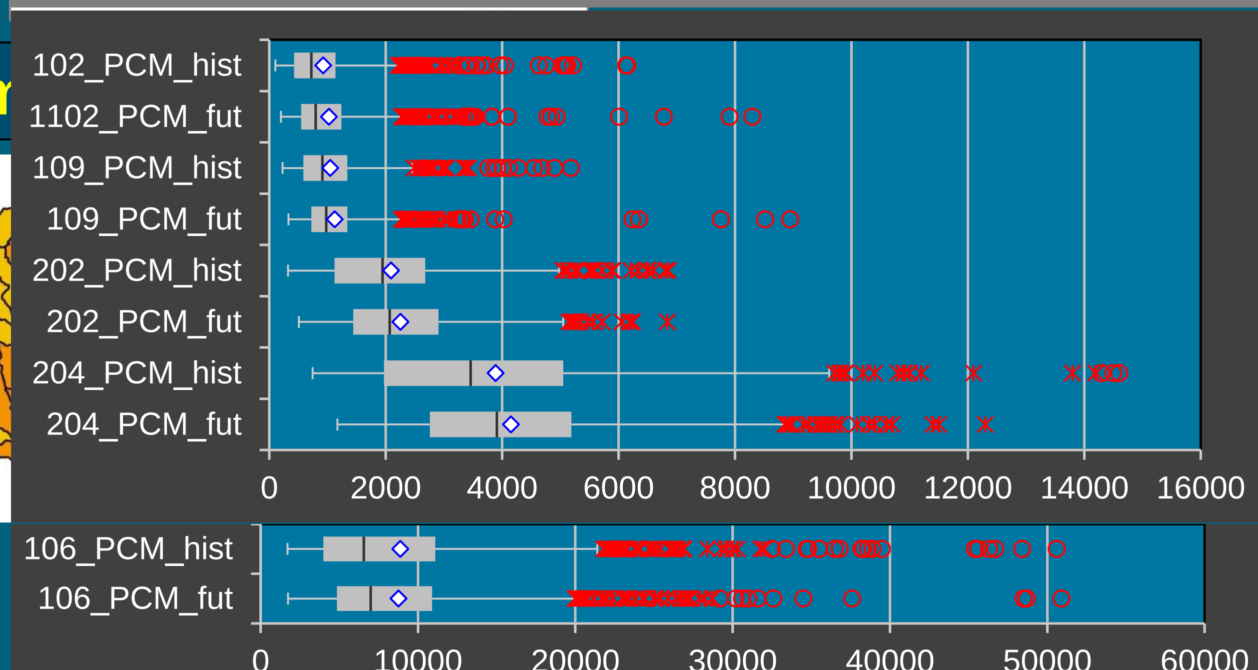




Prec

Tm





JANUARY

In Summary..

- Changes in precipitation more difficult to project at a regional scale
- Temperature alone can influence the hydrologic budget
- Higher precipitation may be more than compensated by very high temperatures
- **Future Research**..
  - Future vs. control climate
  - Storms resulting in very high-flow outliers
  - Variability within watersheds
  - Changes in low-flow regime
  - Using NARCCAP data

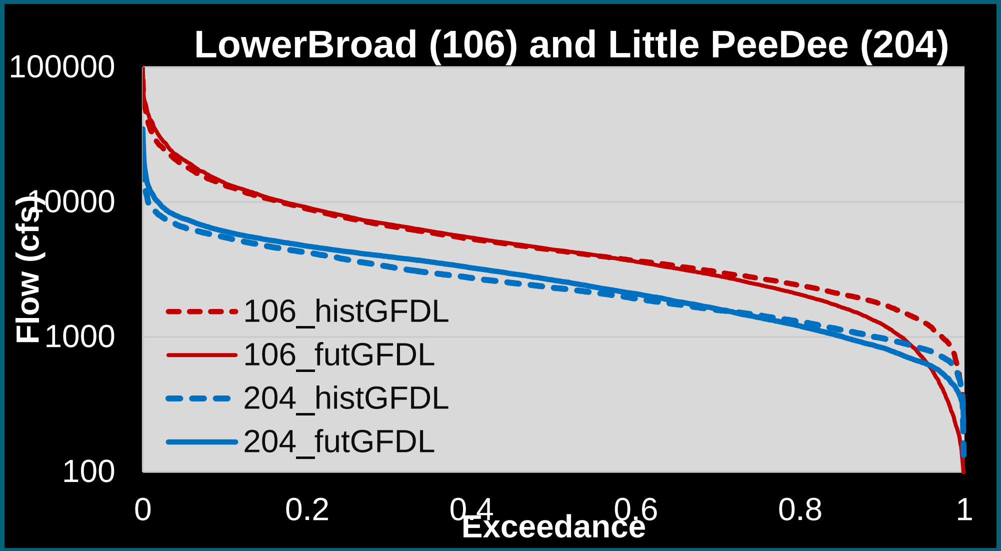
Questions??

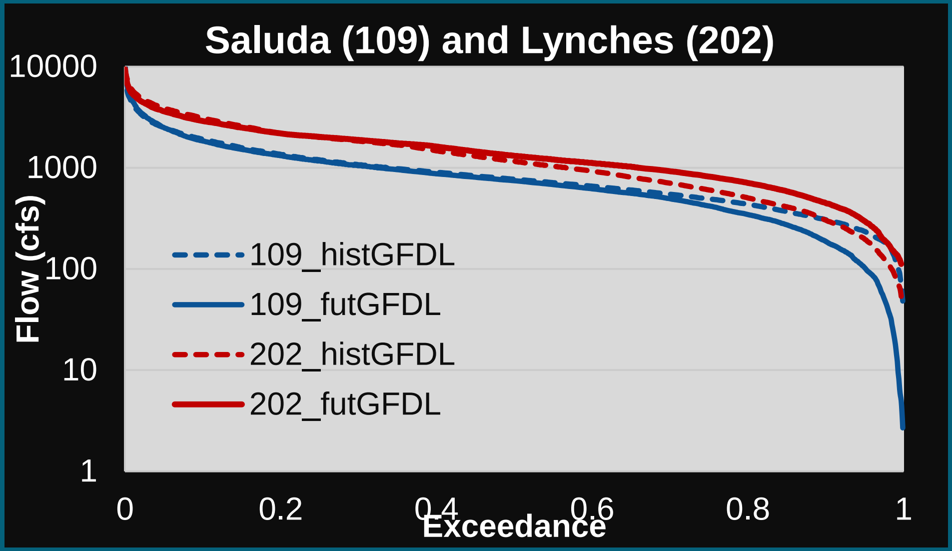
GFDL

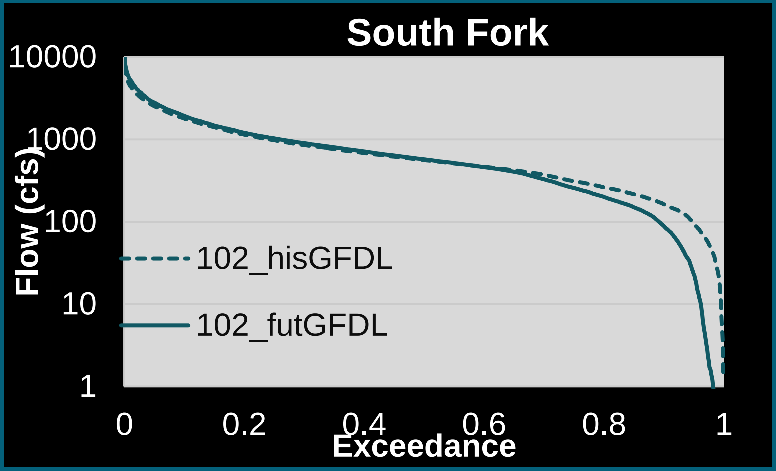
Tmin:

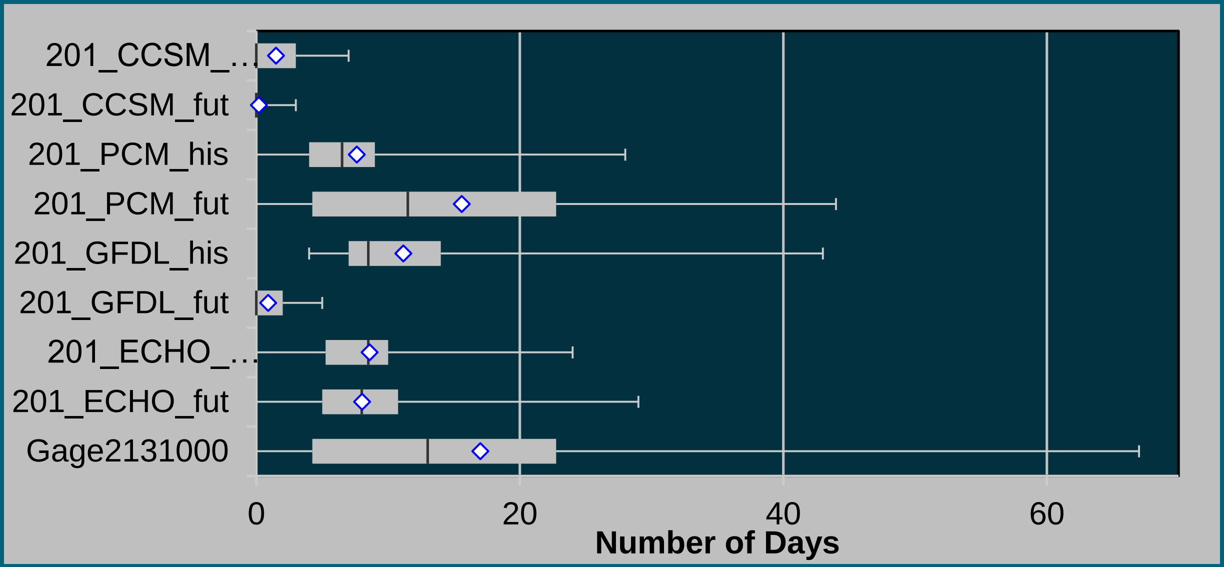
Tmax:

Prec:



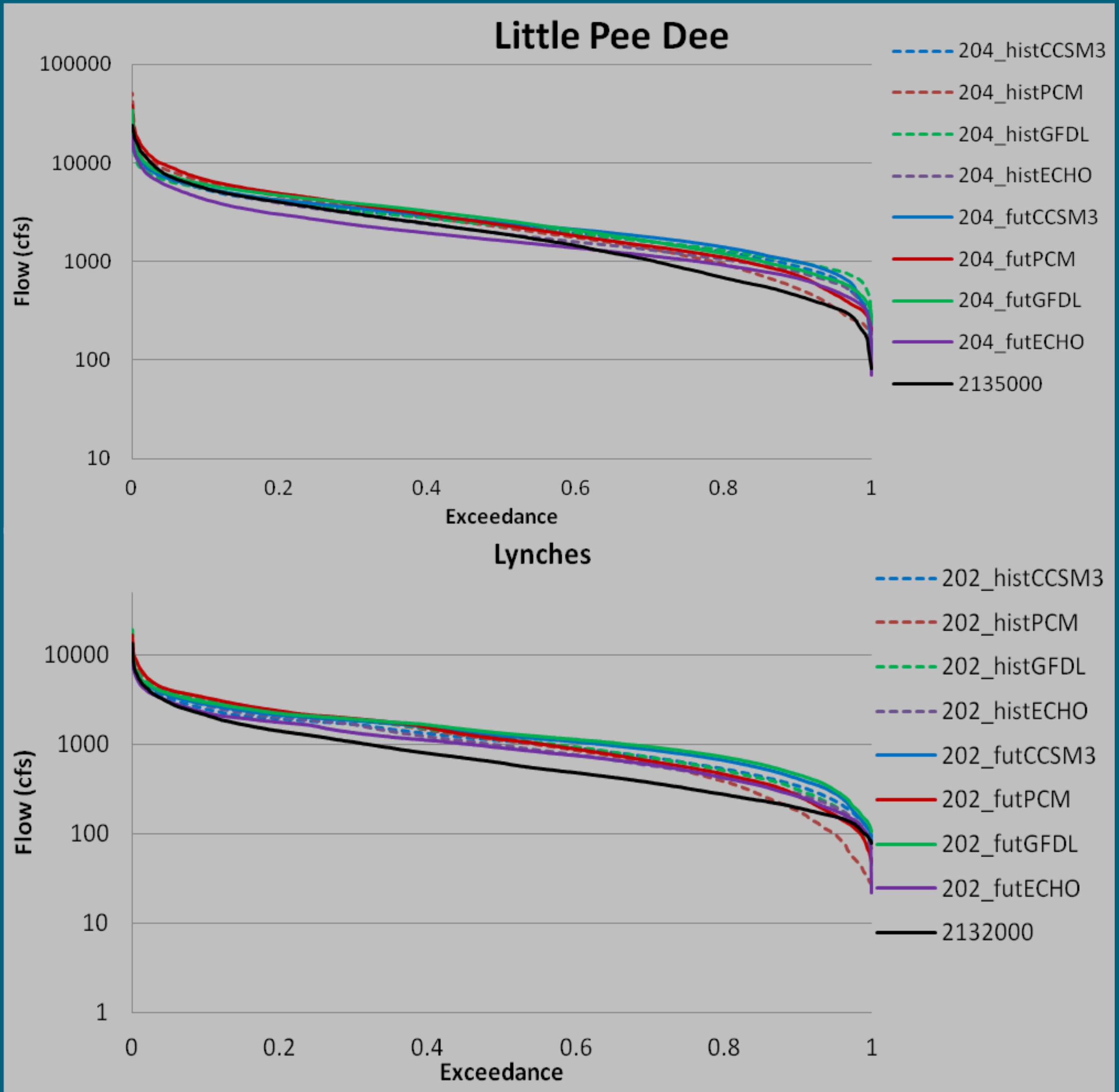






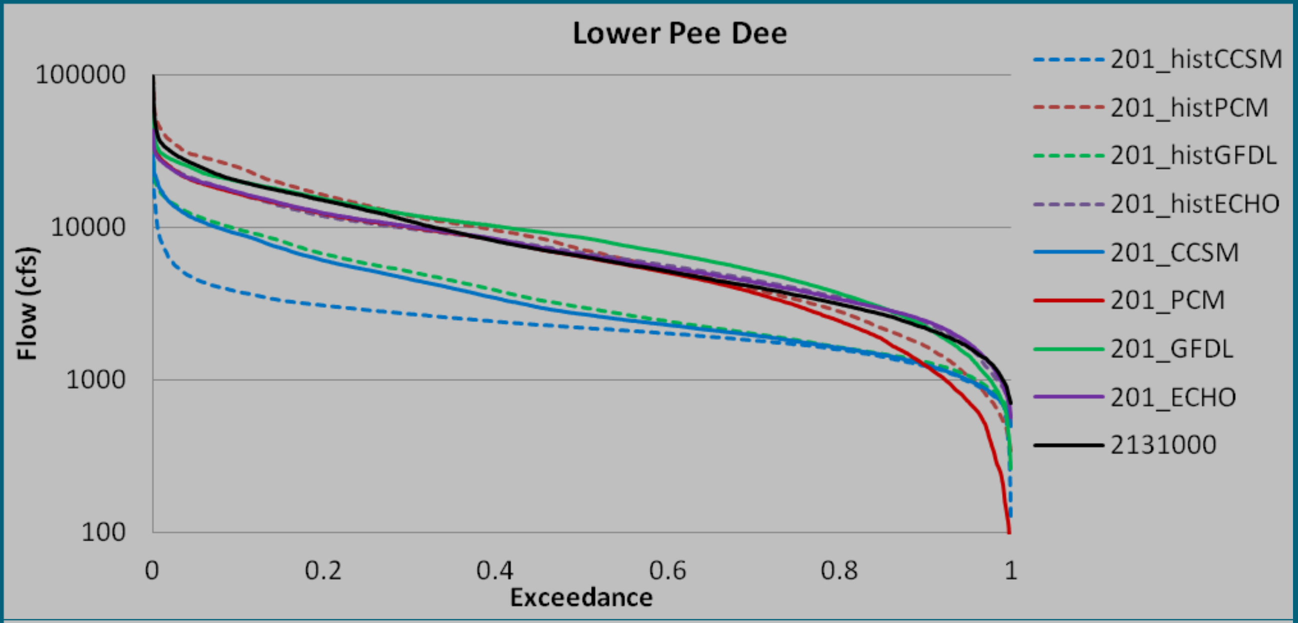
201_CCSM_...
201_CCSM_fut
201_PCM_his
201_PCM_fut
201_GFDL_his
201_GFDL_fut
201_ECHO_...
201_ECHO_fut
Gage2131000
0
20
40
60
Number of Days

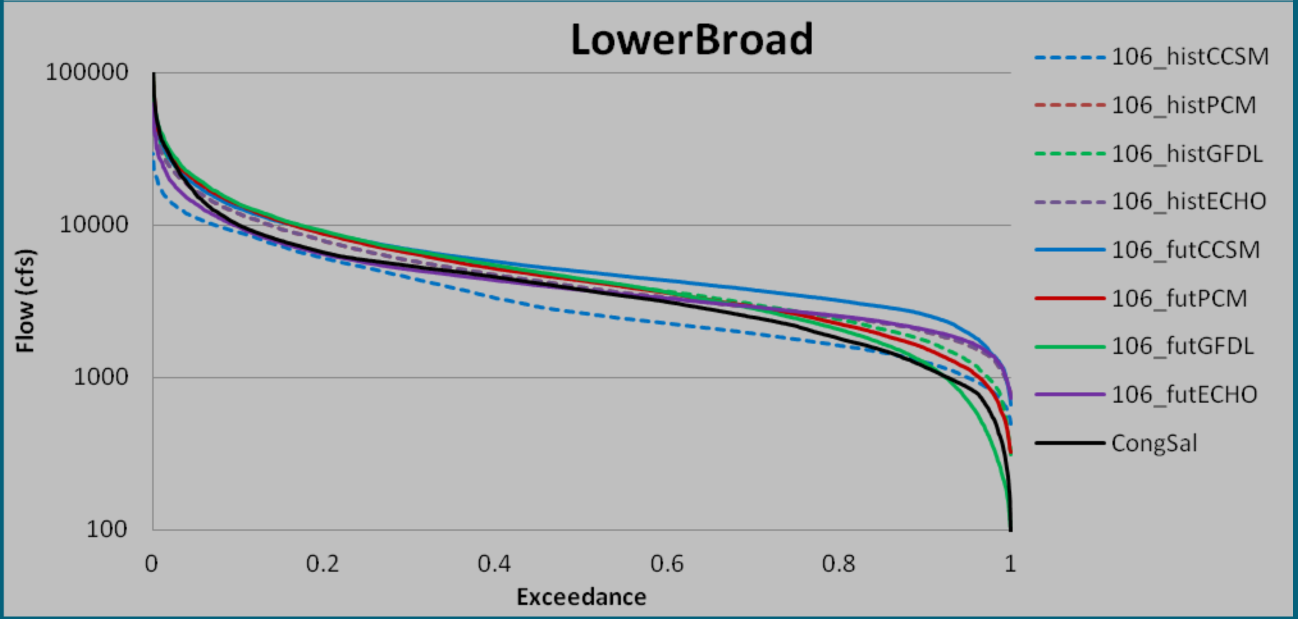
Flow Duration Curves



Hist – 1981 to 2010
Fut – 2041-2070

Flow Duration Curves





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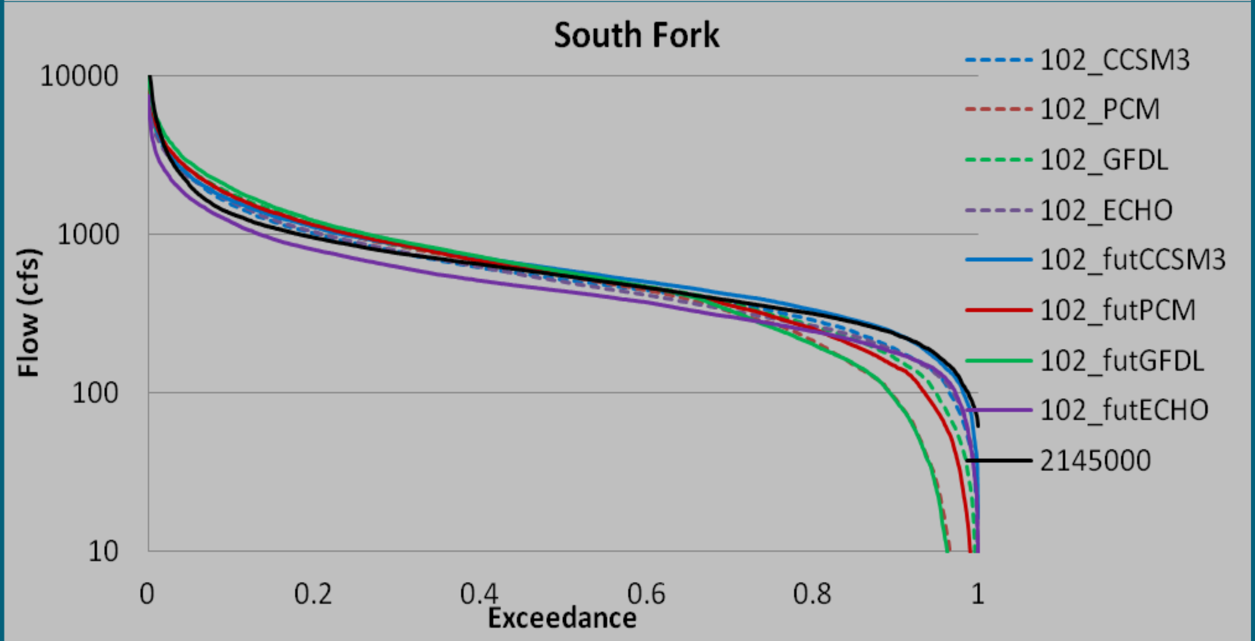
Flow Duration Curves



Future of each GCM mostly lower at low flows

Hist – 1981 to 2010
Fut – 2041-2070

The A2 storyline assumes greater emphasis on national identities. Population growth slows but does not come to a peak by the close of the century. Technological growth is slower, and economic growth per capita is less than in A1. The B1 and B2 scenarios place greater emphasis on sustainability and environmental protection. B1 is characterized by a world economy that emphasizes reduced material demand and clean and efficient technologies. Global population peaks mid century. B2 is characterized by greater regionalization. Technological development is slower than in B1, and global population rises throughout the 21st century, though at a slower rate than in A2

Acknowledgments

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carolinas integrated sciences & assessments

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