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Use of EPA's BASINS Modeling System to Assess Watershed Sensitivity to Climate Change

Thomas Johnson
US EPA, ORD National Center for Environmental Assessment

John Kittle Jr., John Imhoff, Mark Gray
Aqua Terra Consultants

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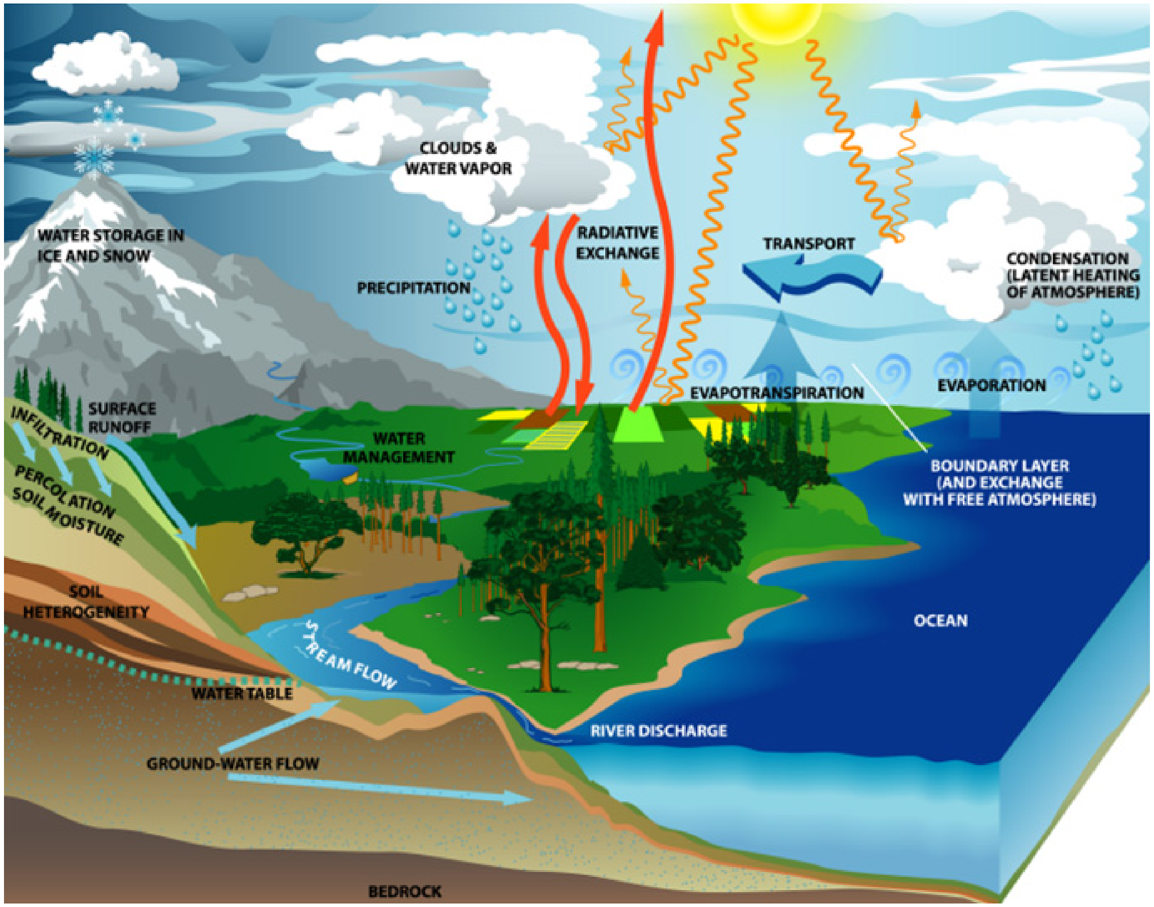
Watersheds are highly climate sensitive



What does this mean for water managers?

- impacts on frequency of floods and droughts
- impacts on water quality
- changes in infrastructure design and operation
- impacts on ecosystems

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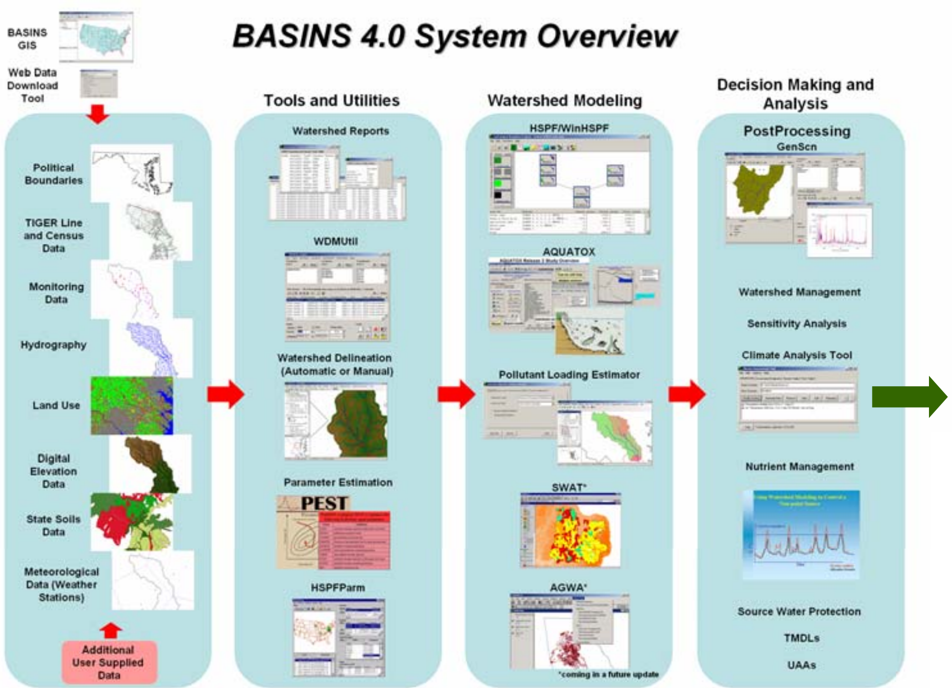
What can be done?

- climate models have limited skill *predicting* future climate (precipitation) at the spatial scales needed by water managers
- given this uncertainty, useful to think about adaptation in the context of risk management
- models are very effective for understanding system behavior
- we can use this understanding to start identifying the ranges of potential impacts and to develop strategies for reducing exposure to risk (increase resilience to future changes)

BASINS Climate Assessment Tool (CAT)

Recent additions to EPA's BASINS watershed modeling system have been developed to facilitate this type of assessment



CAT provides new capabilities for creating scenarios and assessing watershed sensitivity to climate change

BASINS CAT capabilities

- *pre-processing* capability to modify historical temperature and precipitation time series to create scenarios reflecting a wide range of potential changes in climate (user-determined)

- *post-processing* capability to calculate hydrologic and water quality endpoints (e.g. mean flow, 100 yr flood, annual N loading)

- manages/automates input to BASINS HSPF watershed model

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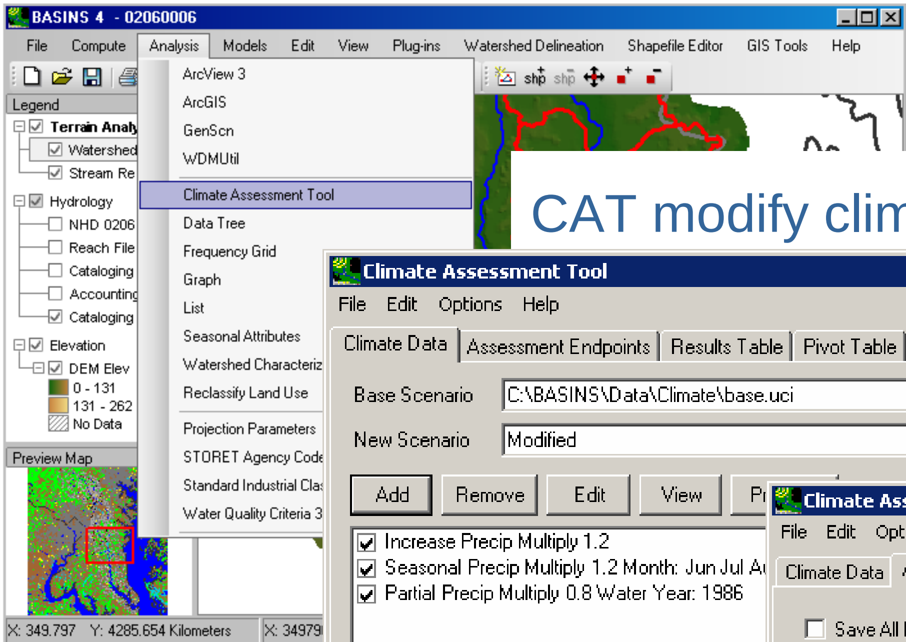
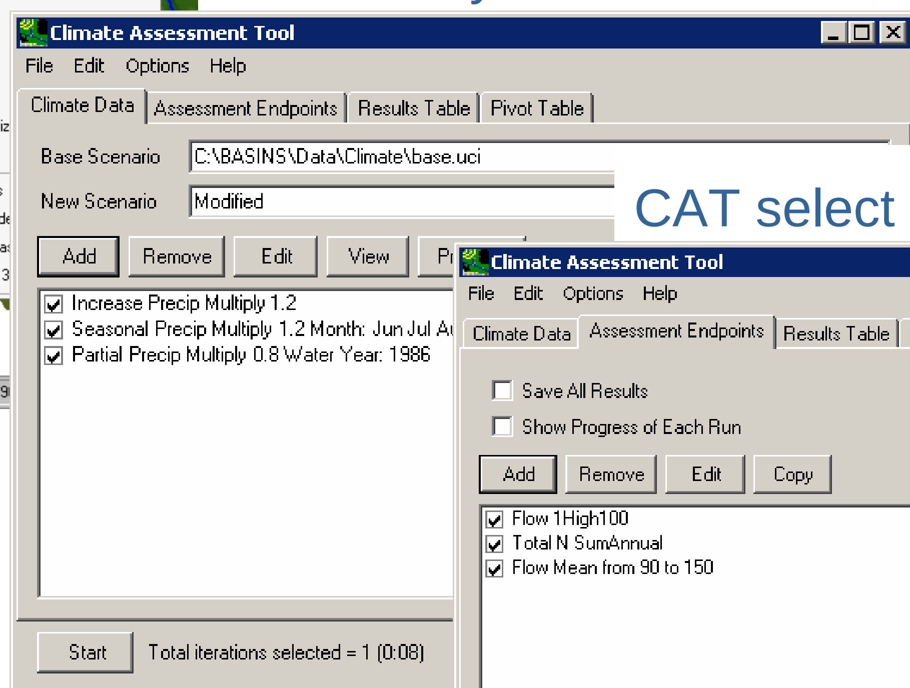
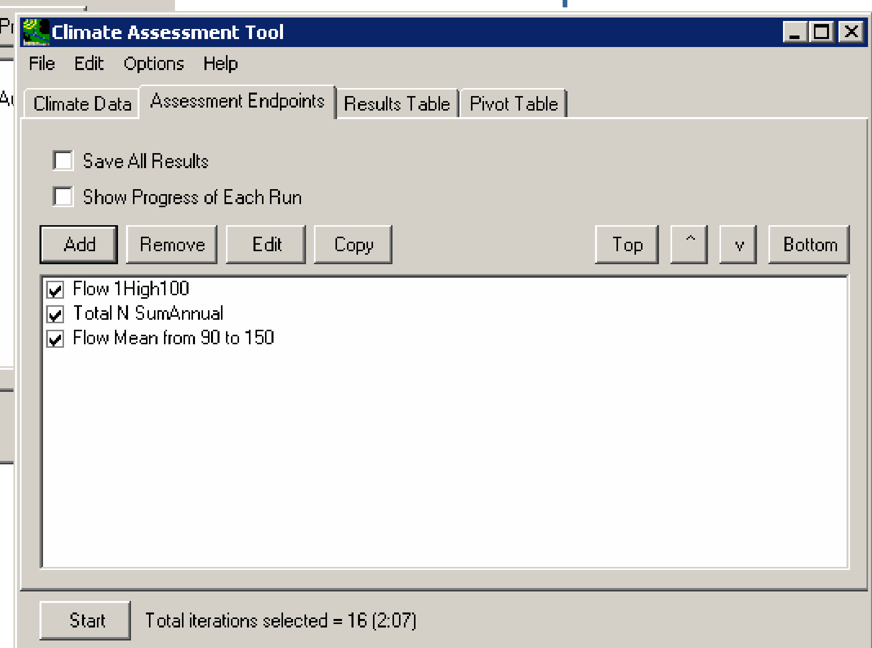
BASINS 4 main screen



CAT modify climate



CAT select endpoints



A case study in the Monocacy River watershed

- BASINS CAT used to investigate 2 basic questions:
  - general system sensitivity to changes in temperature and precipitation?
  - system sensitivity to GCM projected changes in temperature and precipitation for 2085?

~ 750 mi^2 drainage area
~ 60% ag, 33% forest, 7% urban

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Scenarios created for assessing general sensitivity to changes in temperature and precipitation

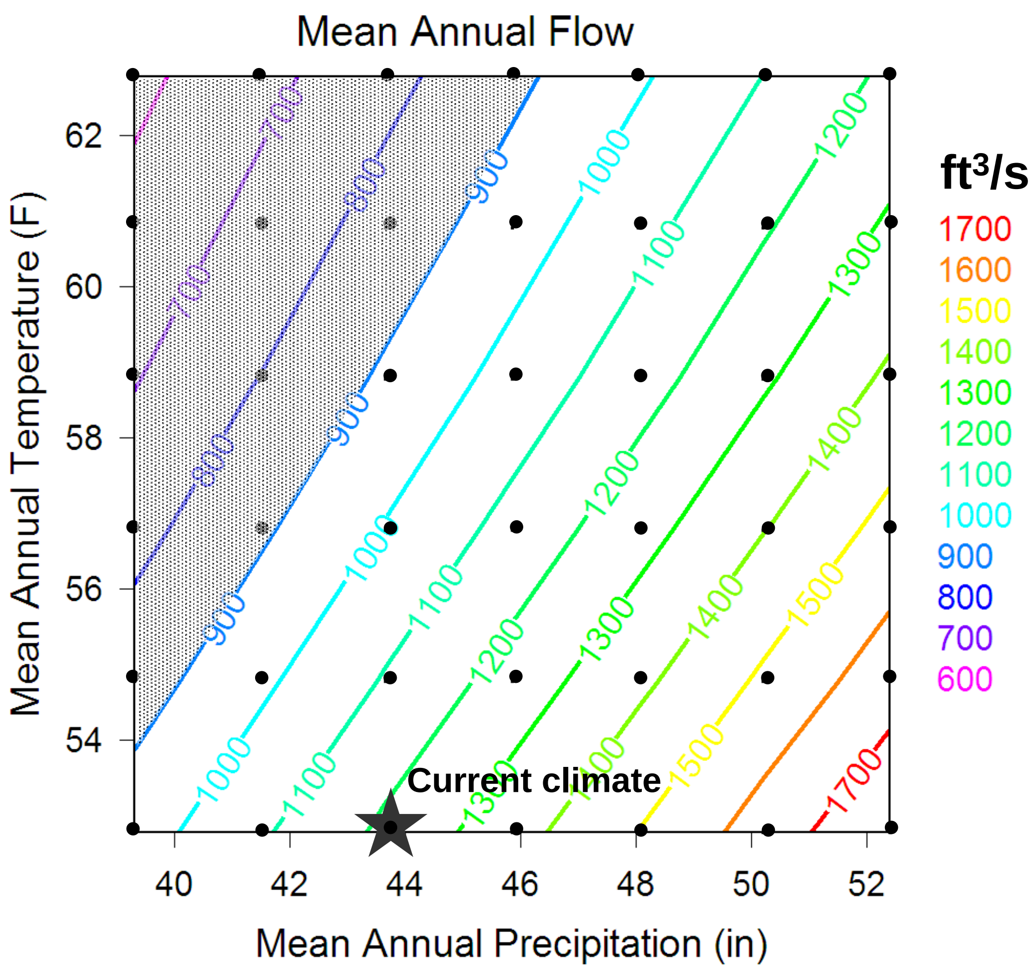
Precipitation Change (%)

Temperature Change (ºF)

	-10	-5	0	5	10	15	20
10	●	●	●	●	●	●	●
8	●	●	●	●	●	●	●
6	●	●	●	●	●	●	●
4	●	●	●	●	●	●	●
2	●	●	●	●	●	●	●
0	●	●	★	●	●	●	●

42 scenarios created by modifying historical data for period 1984-2000 to reflect different combinations of plausible change

General sensitivity - mean annual streamflow



Changes in flow…

~ 5% per °F

~ 2% per %P

Data also useful for assessing vulnerability of thresholds

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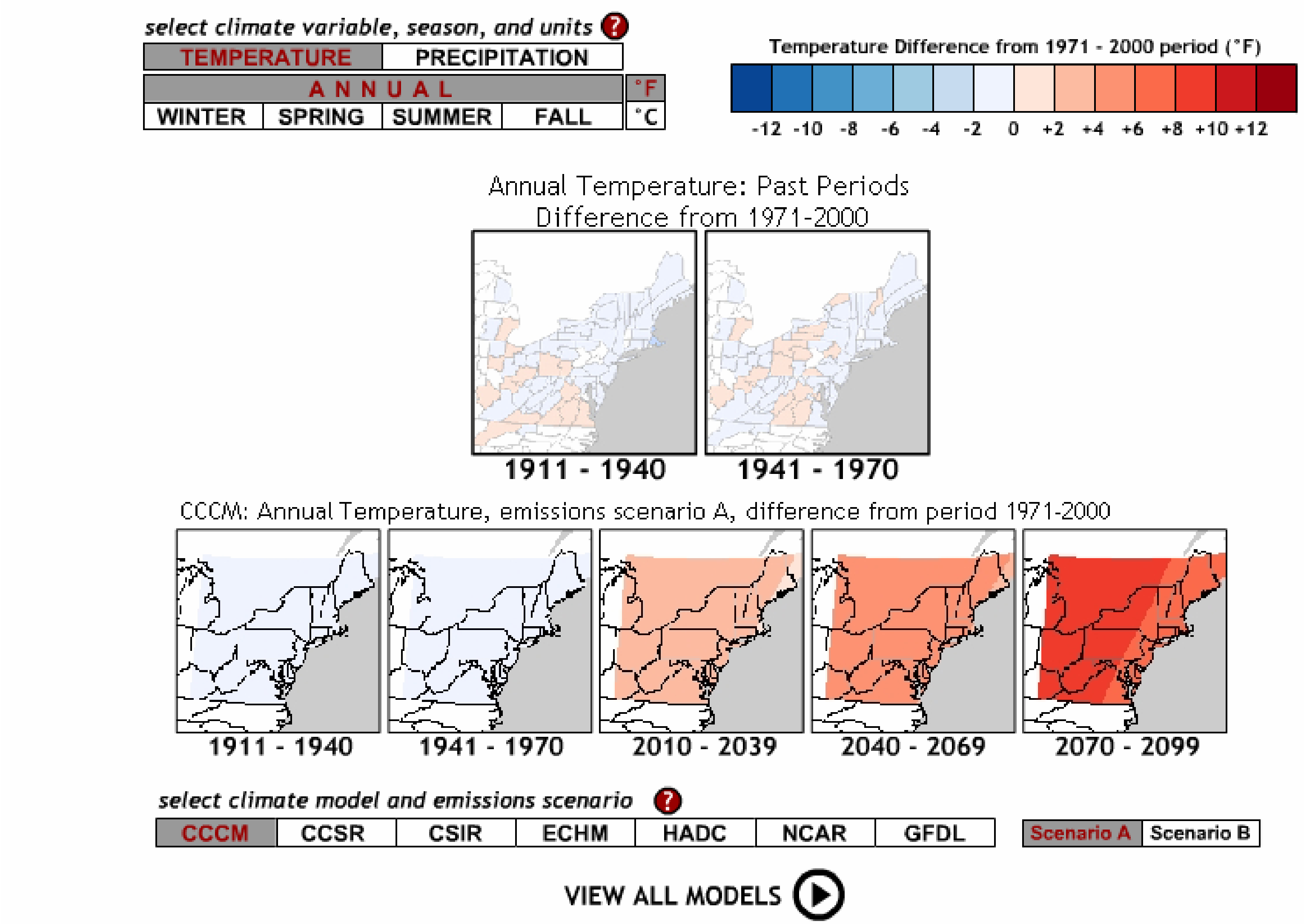
Scenarios created based on climate model projections for 2085

- 42 scenarios created based on output from:
  - 7 GCM models, 2 emissions storylines (A2/B2)
  - planning horizon 2085
  - data from PSU CARA project (IPCC 3rd Assessment modeling experiments)
- Scenarios created by modifying historical data for period 1984-2000

Climate projection data from the Consortium of Atlantic Regional Assessments (CARA) web site



http://www.cei.psu.edu/cara/GCM/climate_change.html

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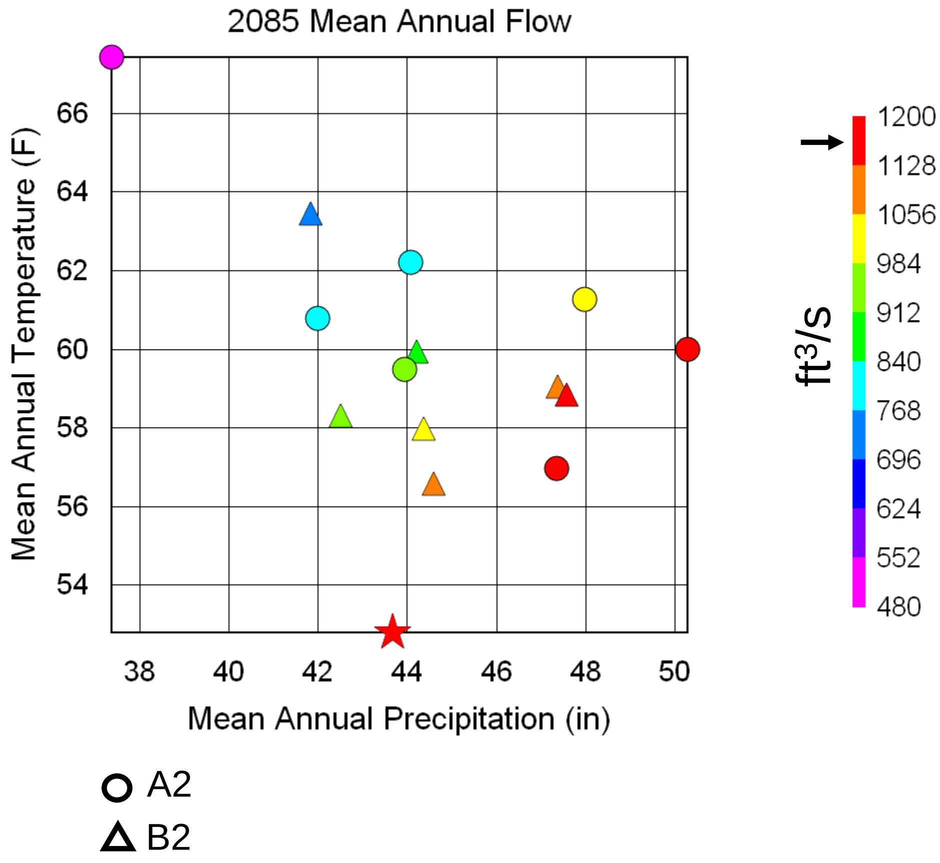
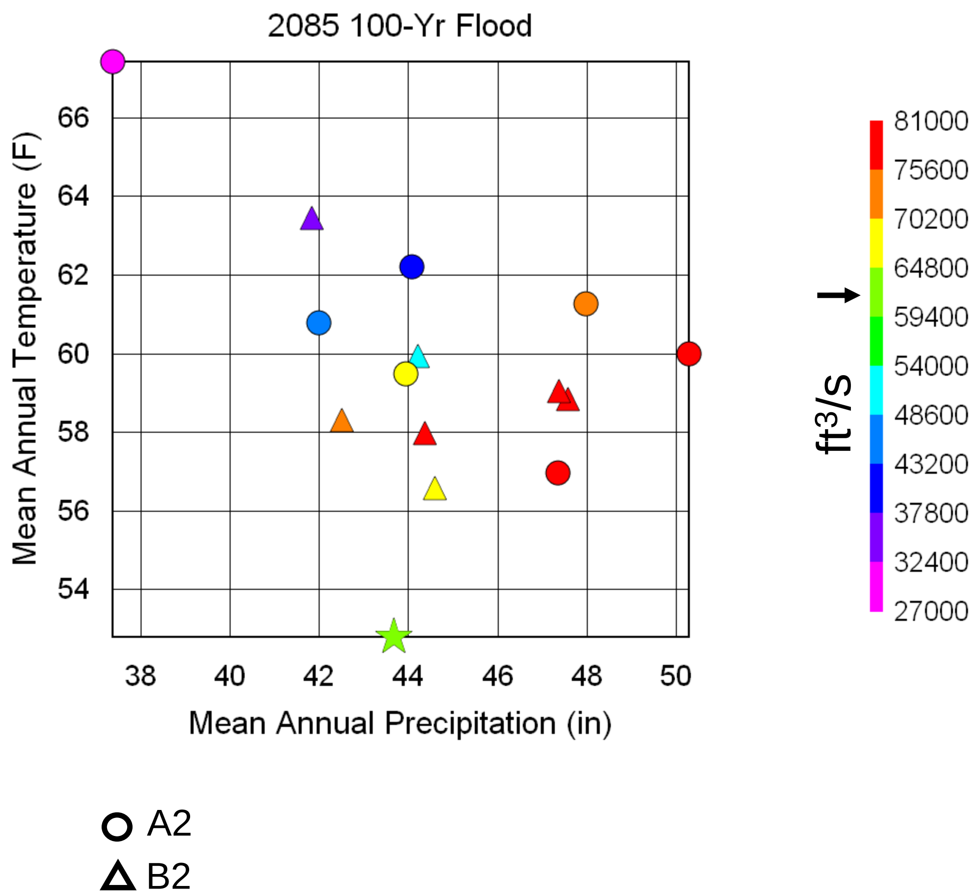
2085 projected mean annual streamflow



Range of changes

	Min	Max
Temp, F	**3.7**	**15**
Precip, %	**-14**	**15**
Flow, %	**- 62**	**-1**

2085 projected 100-year flood

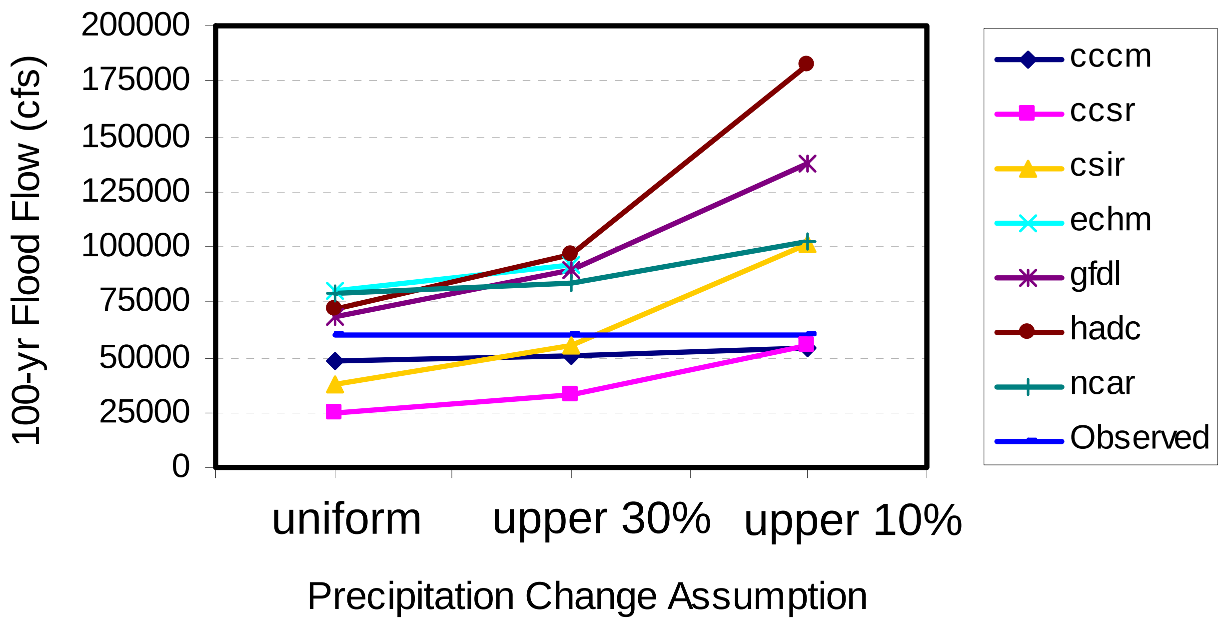


Range of changes

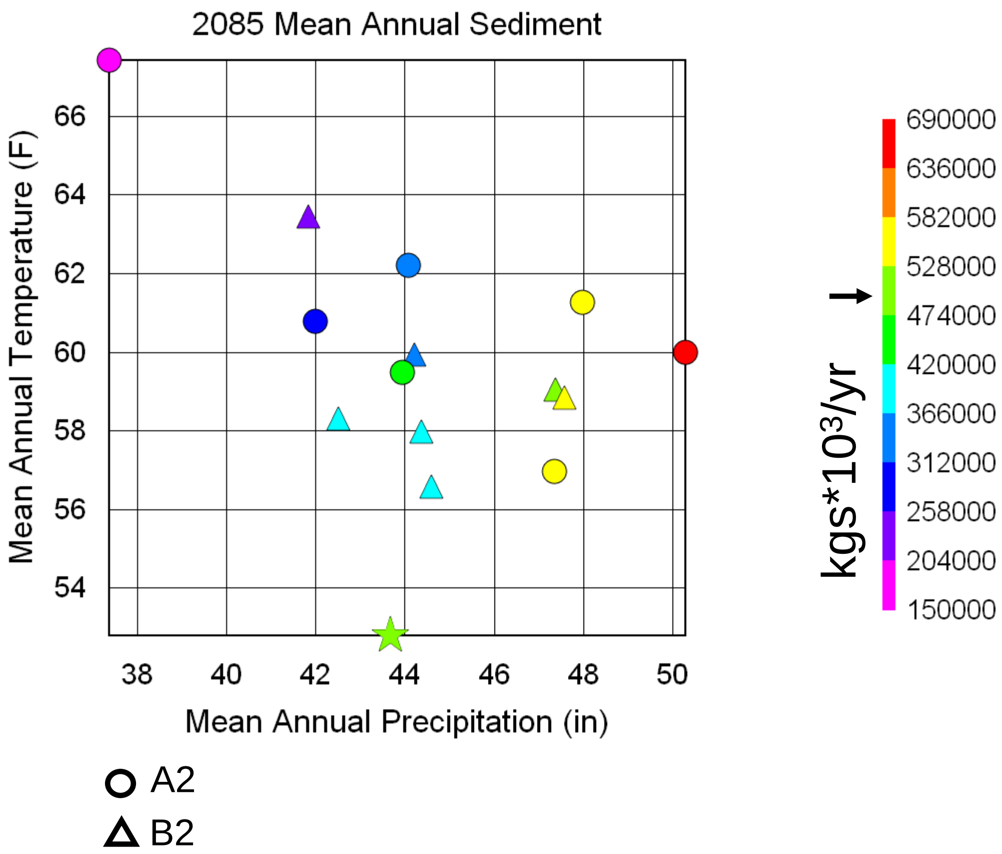
	Min	Max
Temp, F	**3.7**	**15**
Precip, %	**-14**	**15**
100YR, %	**-60**	**37**

2085 projected 100-year flood: effects of changes in precipitation intensity

Scenarios created reflecting 3 assumptions about precipitation changes (A2):
- distributed to all events (as a percent)
- distributed to 30% largest events
- distributed to 10% largest events



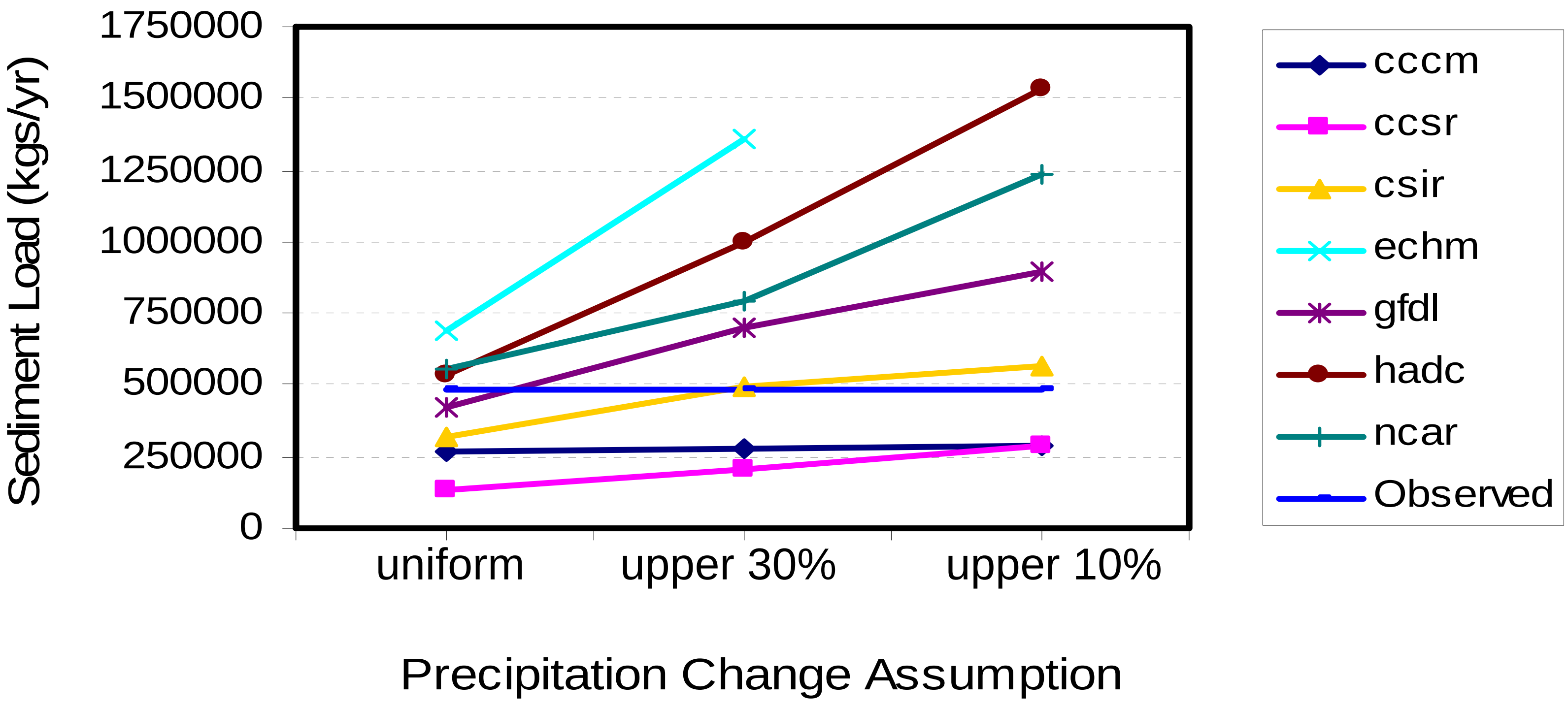
2085 projected mean annual sediment



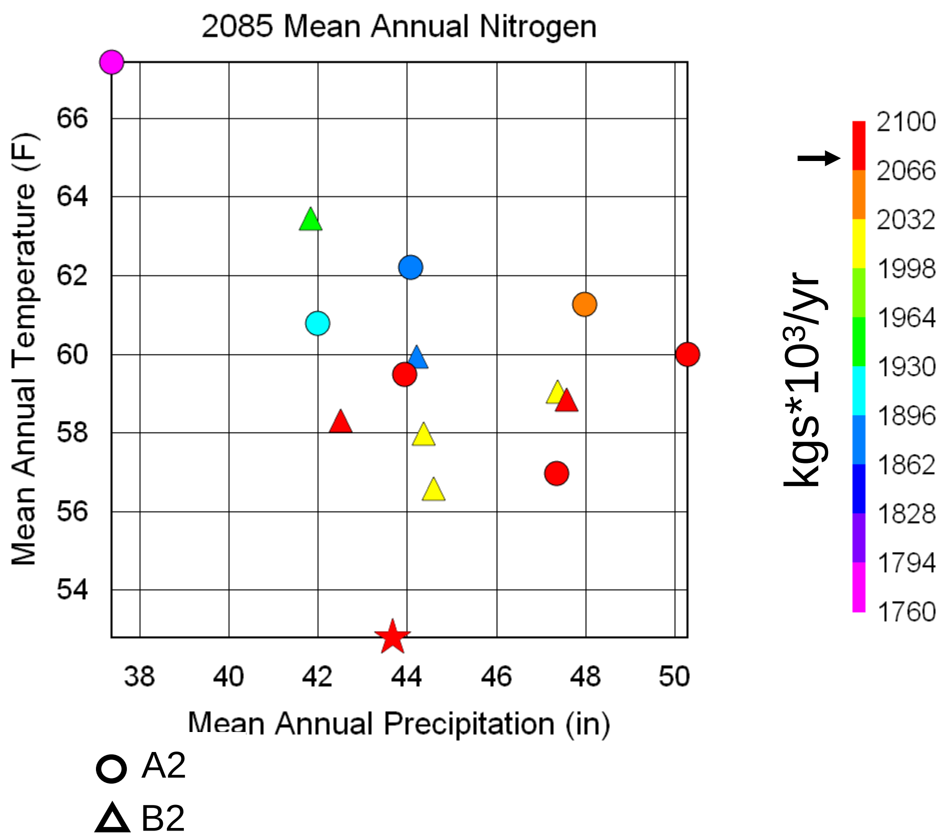
Range of changes

	Min	Max
Temp, F	**3.7**	**15**
Precip, %	**-14**	**15**
Sediment, %	**-71**	**44**

2085 projected sediment loading: Effects of precipitation intensity (A2)



2085 projected mean annual nitrogen



Range of changes

	Min	Max
Temp, F	3.7	15
Precip, %	-14	15
Nitrogen, %	-15	1.8

Closing comments

- although subject to uncertainty, we know enough about future climate change to start identifying the range of potential impacts and, if necessary, developing strategies for reducing exposure to risk
- recent additions to EPA's BASINS system can facilitate this type of assessment
  - also developing/considering similar capabilities for other models (e.g. WEPP, SWAT, SWMM)
- currently working on assessing the combined impacts of climate and landcover change in the Monocacy watershed

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