Downscaled regional climate models and future Chesapeake Bay loads

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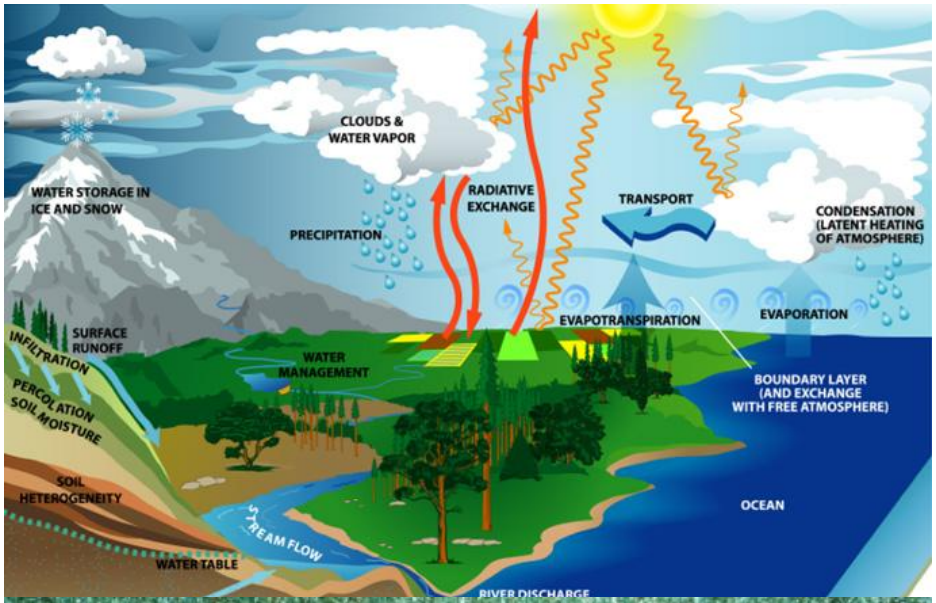
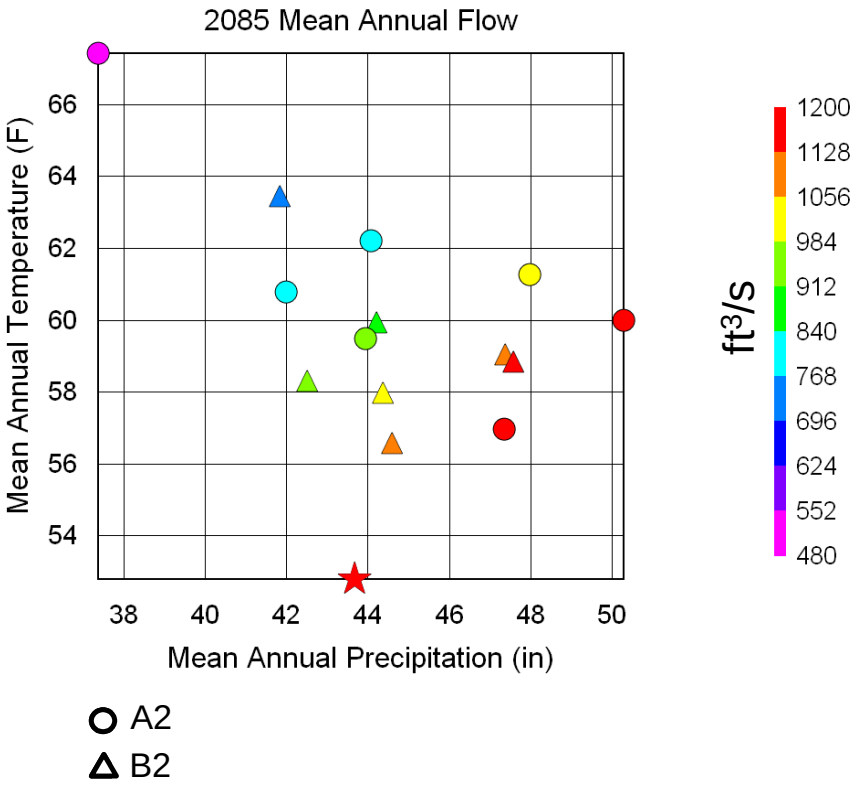
Introduction



- Regional commitment to a Bay-wide TMDL requires substantial implementation of management actions throughout the Chesapeake watershed. The Chesapeake Bay Executive Order calls for an assessment of the effects of climate change on TMDL by 2017.
- The TMDL estimates have been derived from a coupled watershed model (HSPF) and a hydrodynamic-water quality model (CH3D-ICM) with each state/jurisdiction in the basin assigned limits to loads for nutrients and sediments.
- The Chesapeake Bay Program Scientific and Technical Advisory Committee, Pennsylvania State University, U.S. EPA, and U.S. Geological Survey agreed to explore possible changes in loads expected under future climate that has been predicted by the IPCC for the region.

Previous Investigations



From Linker et al (Presented ERF '07)

Range of changes

	Min	Max
Temp, F	3.7	15
Precip, %	-14	15
Flow, % w/ all events	-62	-1

Data not plotted

	Min	Max
Flow, % w/ upper 30%	-59	3.5
Flow, % w/ upper 10%	-49	2.8

Downscaled Climate Models

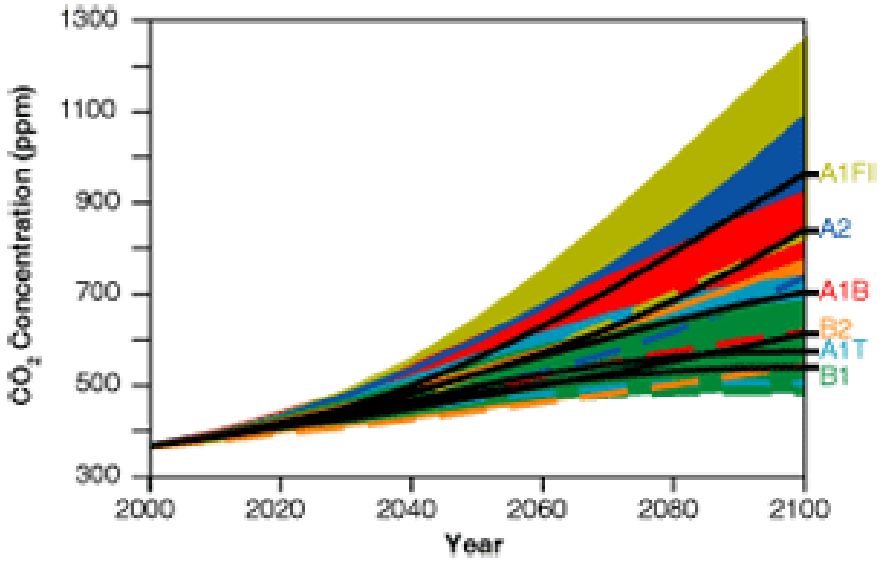
- GCM’s with precipitation, maximum temperature, and minimum temperature available for download on a monthly time step

- 1. BCC-BCM2.0 -- Bjerknes Centre for Climate Research, Norway
- 2. CCSM3 -- National Center for Atmospheric Research, USA
- 3. CSIRO-Mk3.0 – Australia's Commonwealth Scientific and Industrial Research Org., Australia
- 4. CSIRO-Mk3.5 -- Australia's Commonwealth Scientific and Industrial Research Org., Australia
- 5. INM-CM3.0 -- Institute for Numerical Mathematics, Russia
- 6. MIROC3.2(medres) -- National Institute for Environmental Studies, Japan

Downscaling Procedure

- Statistical method employed to capture the mean characteristics of GCM's
- Monthly moving average climate change fields applied to Phase 5.3.0 HSPF-based watershed model
  - Percent change precip
  - Degree change in temperature
  - PET recalculated using Hamon method

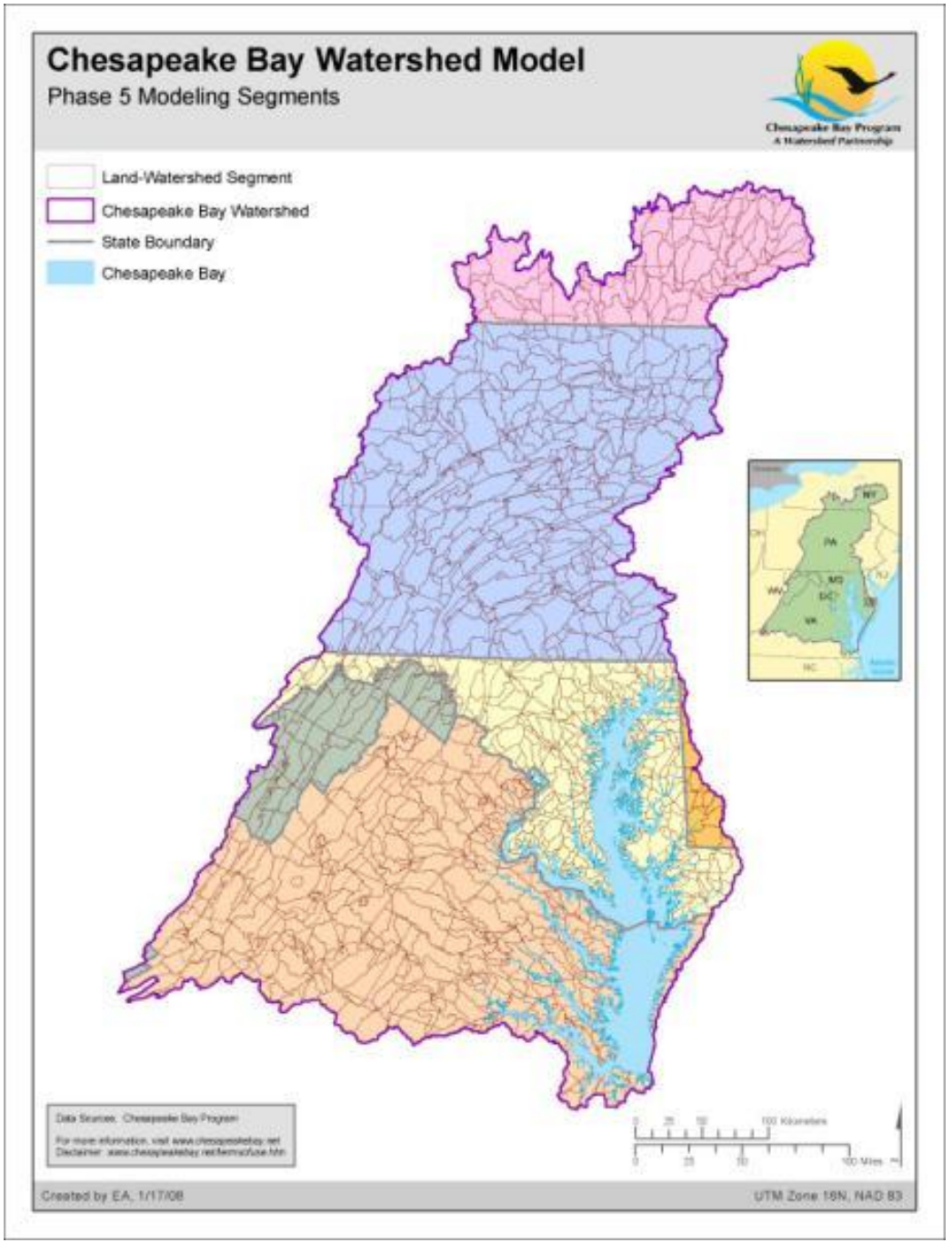
IPCC Scenario



- SRES A2: very heterogeneous world with high population growth
- Slow economic development and slow technological change.
- The first 6 scenarios are the A2 scenarios for the period of years from 2086-2095.

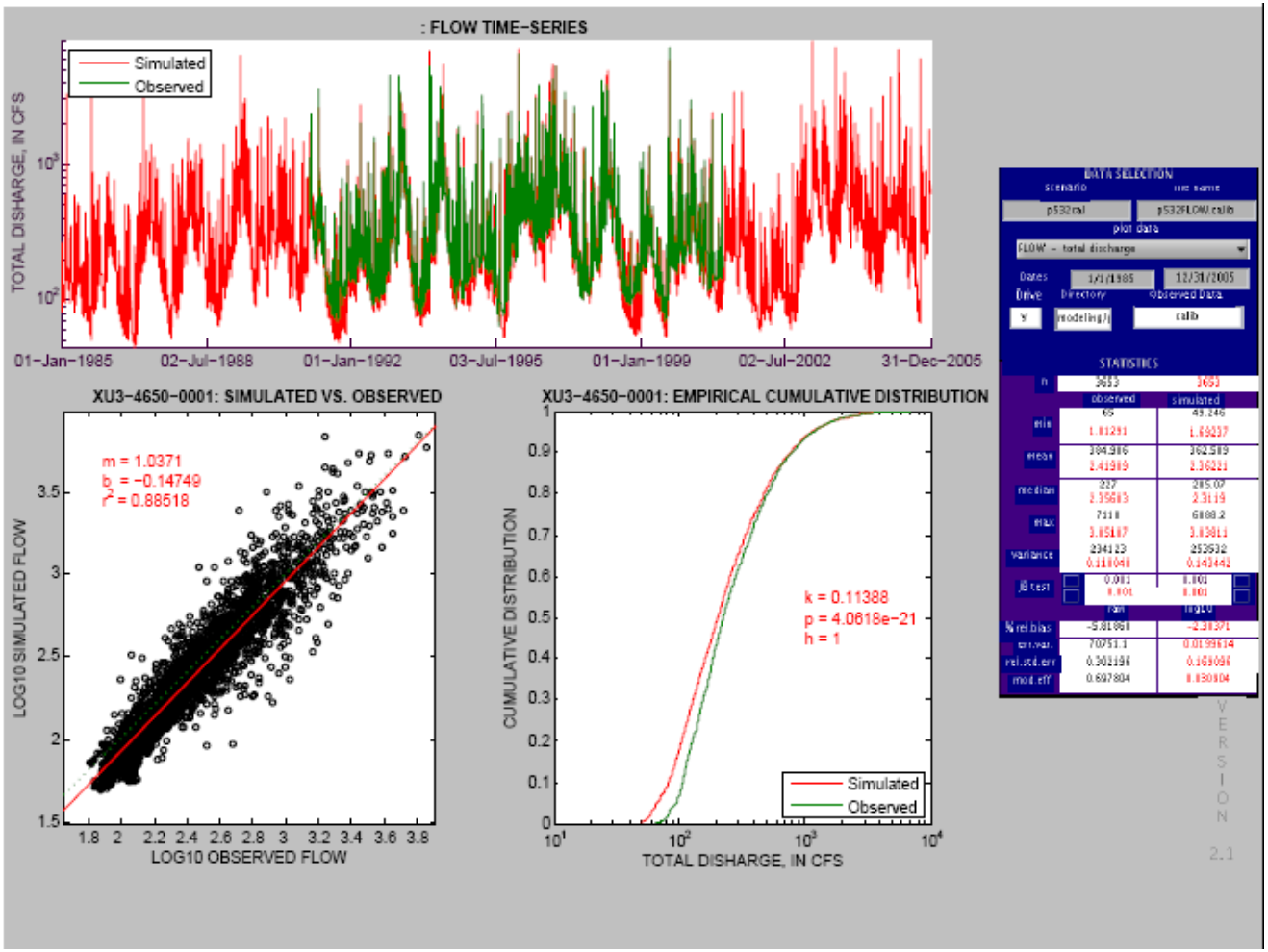
Chesapeake Bay Program Phase 5.3.0 Watershed Model

- Based on HSPF (Hydrological Simulation Program – Fortran)
- Semi-distributed lumped parameter watershed model
- Simulation period of 1984-2005

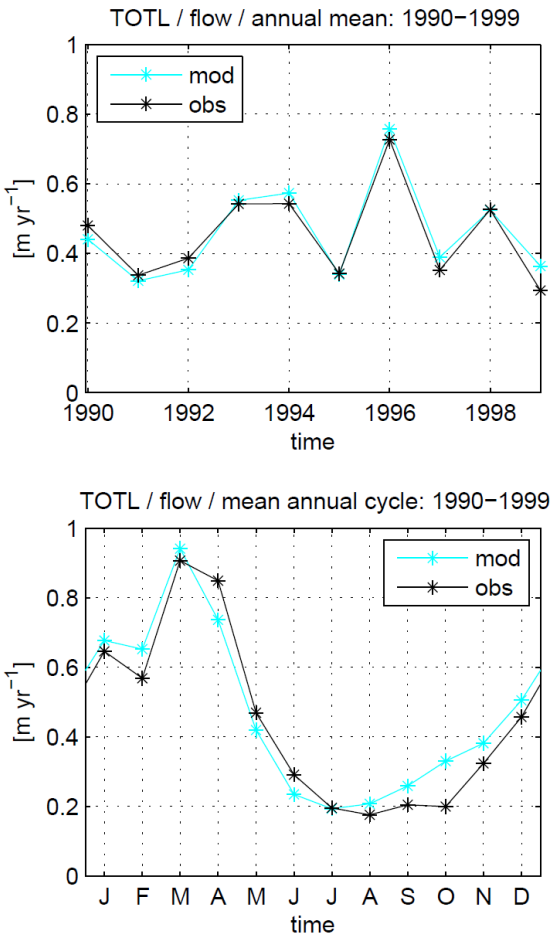


Calibration

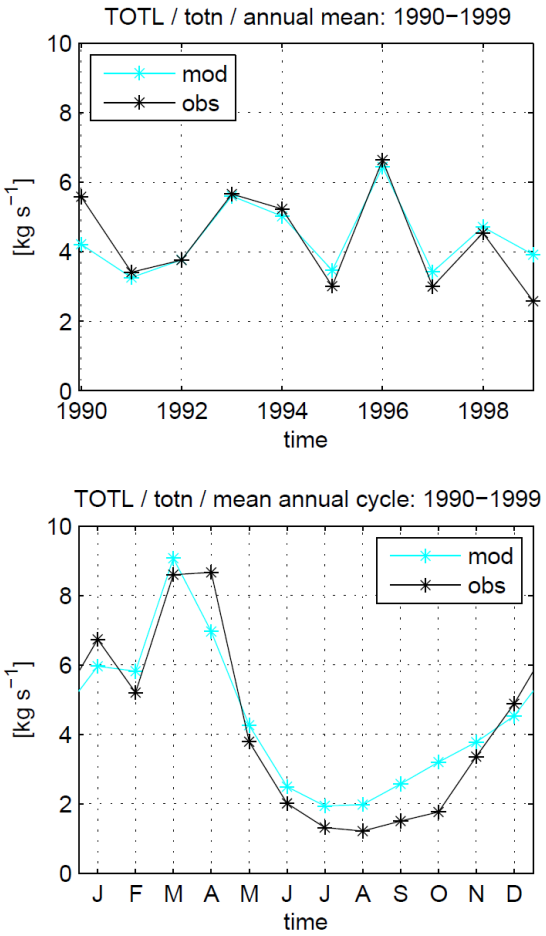
- Calibrated at roughly 300 stations for flow
- Figure: Patuxent River at Bowie, MD
  - Observed timeseries in green, simulated in red



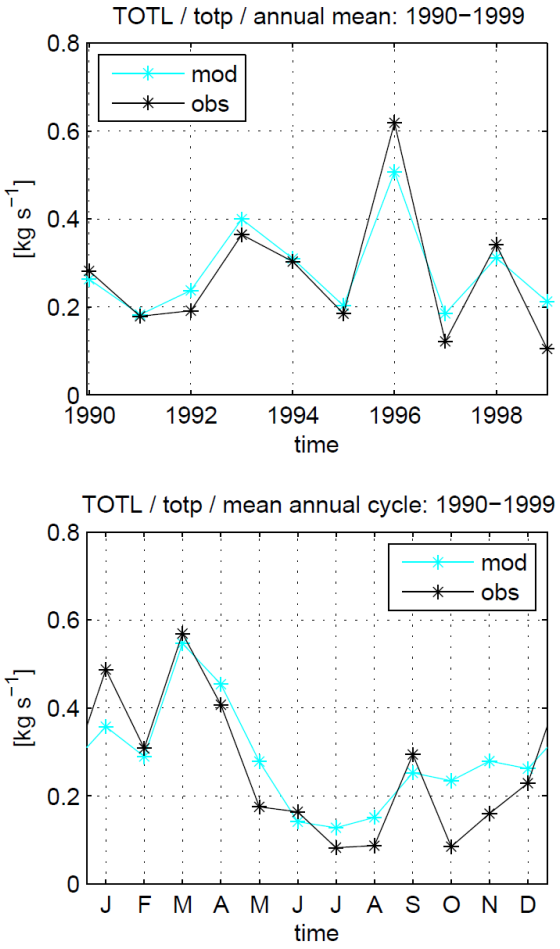
Model Evaluation - Streamflow



Model Evaluation – Total Nitrogen

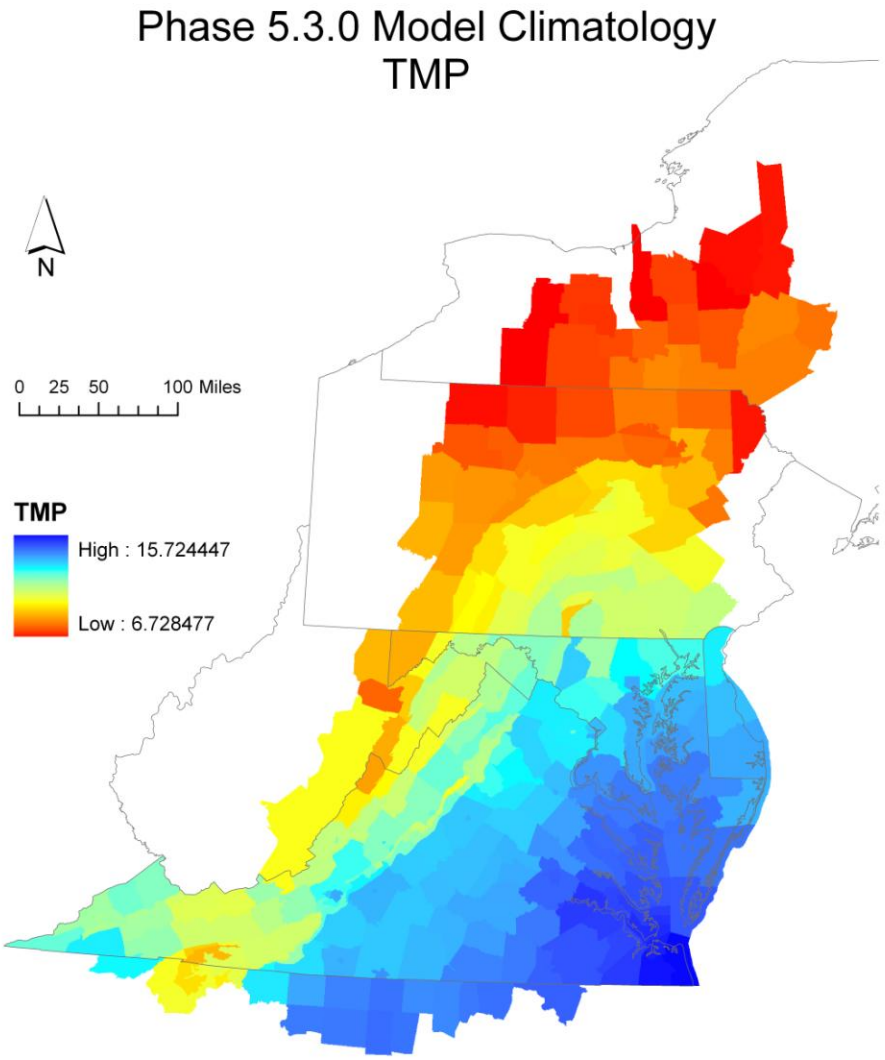


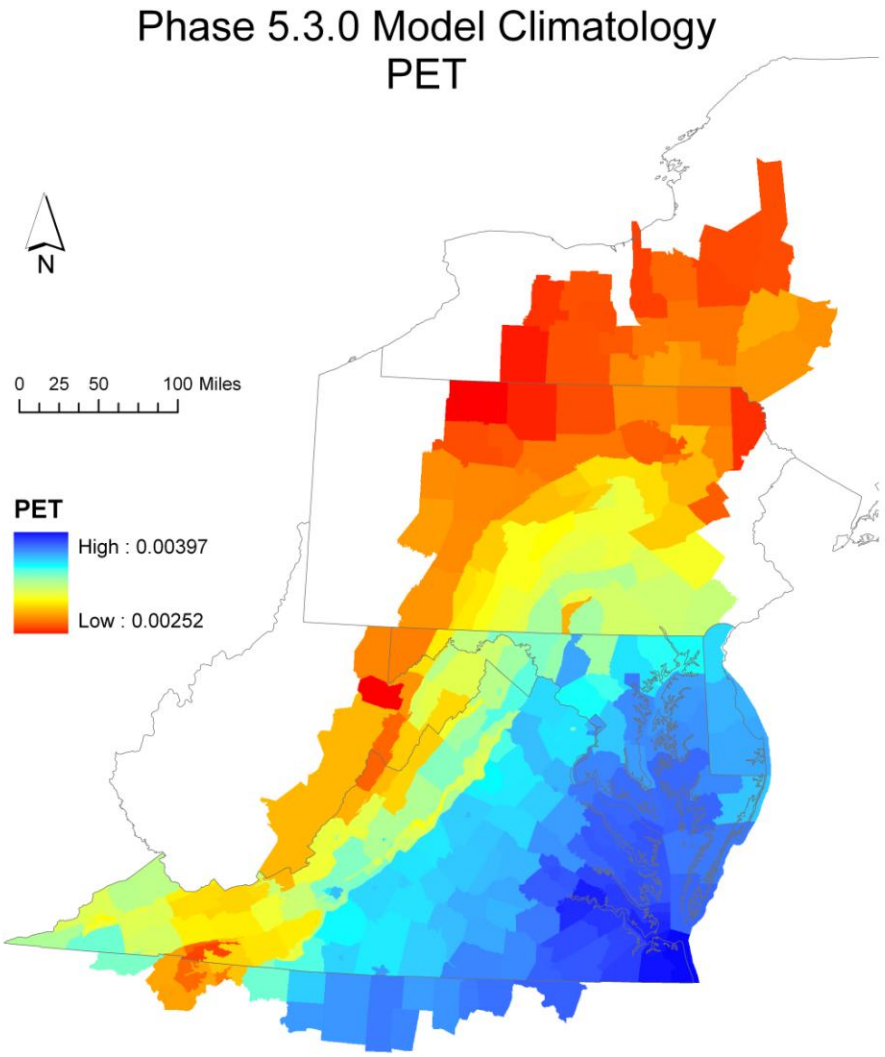
Model Evaluation – Total Phosphorus



Model Climatology: Temperature

- Model average hourly temperature 1984-2005



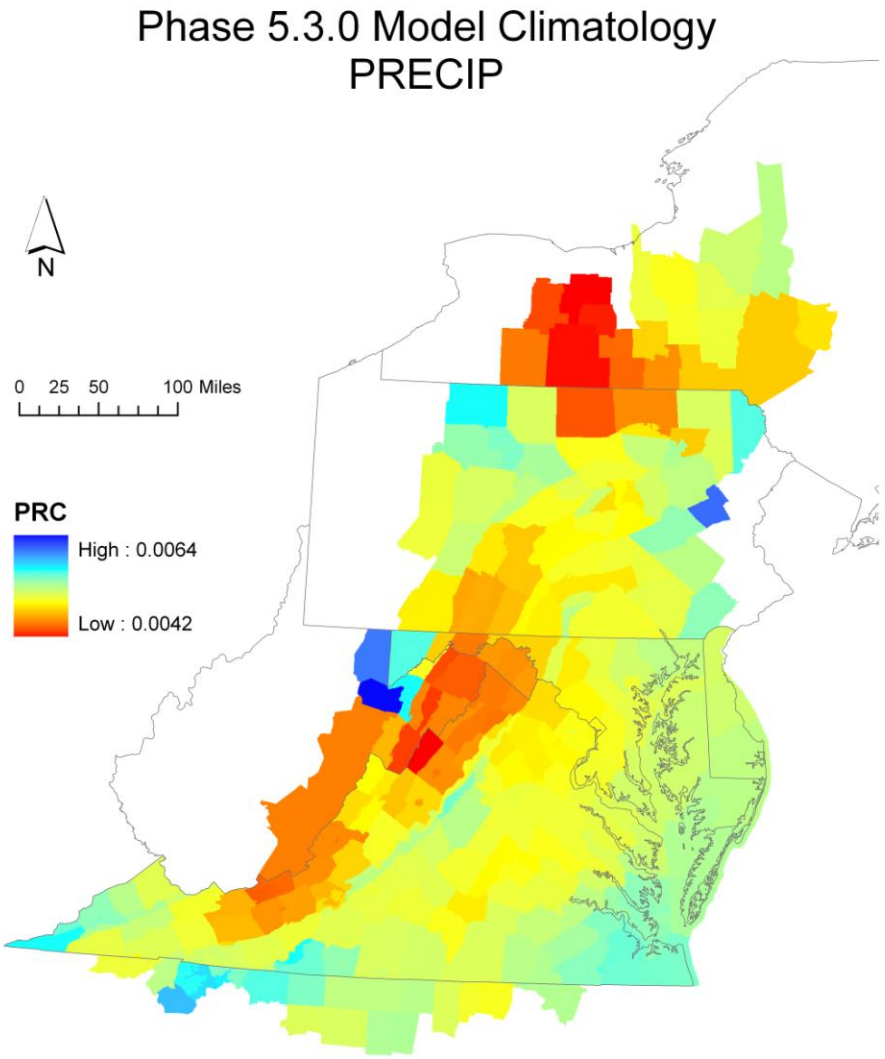


Model Climatology: PET

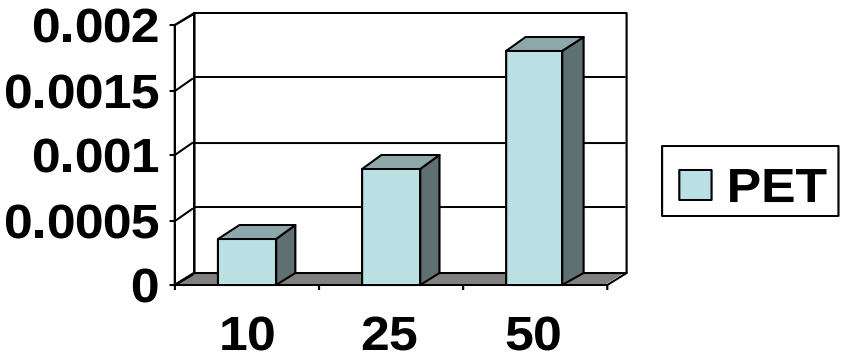
- Model average hourly PET 1984-2005
- Trend matches temperature trend
- PET calculated using the Hamon method

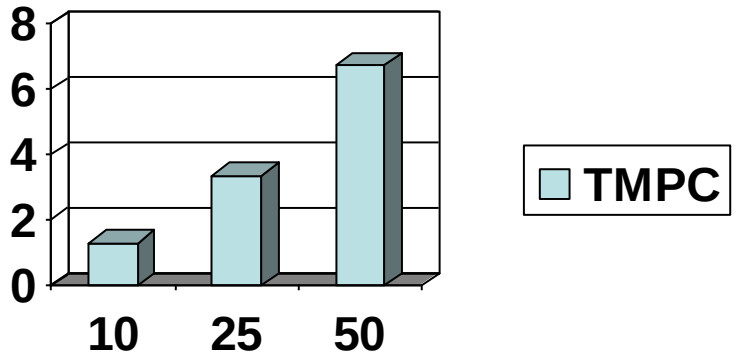
Model Climatology: Precipitation

- Model average hourly precipitation 1984-2005



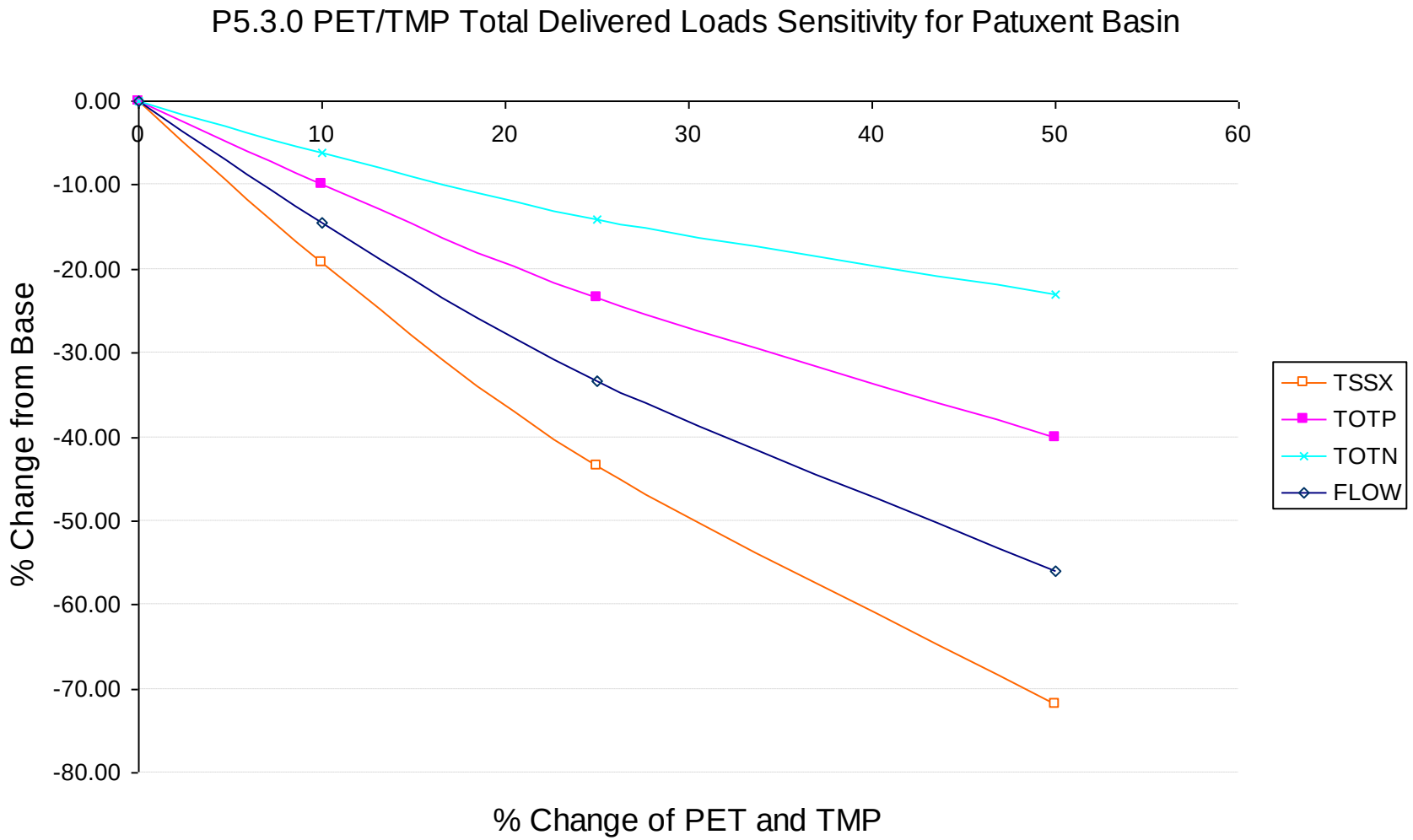
Preliminary Sensitivity Analysis



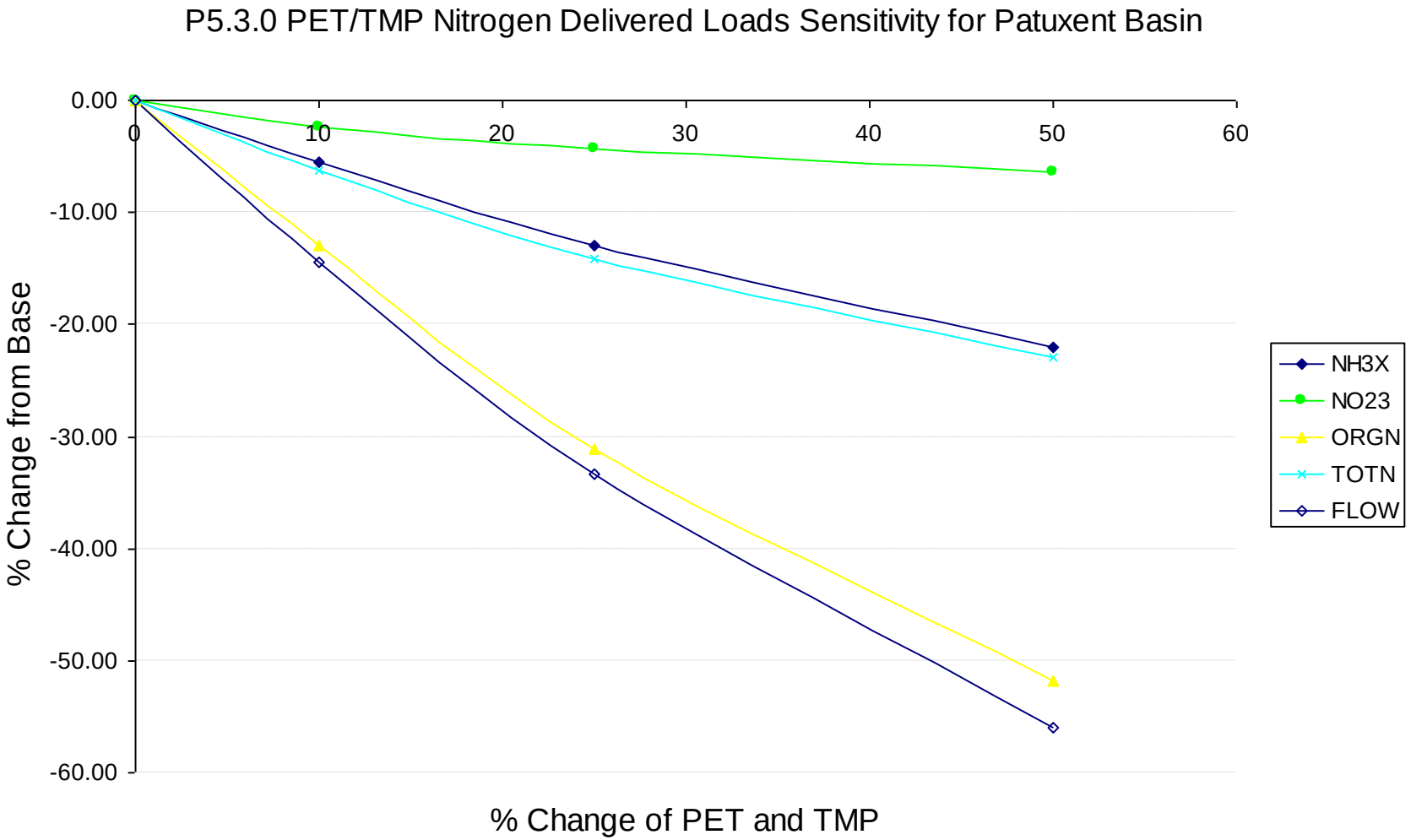


- Increased TMP (deg C) and PET uniformly in time and space 10, 25, and 50 percent of their respective mean values
- Shows rates of parameter sensitivity to specific components of larger climate change simulation scheme being implemented

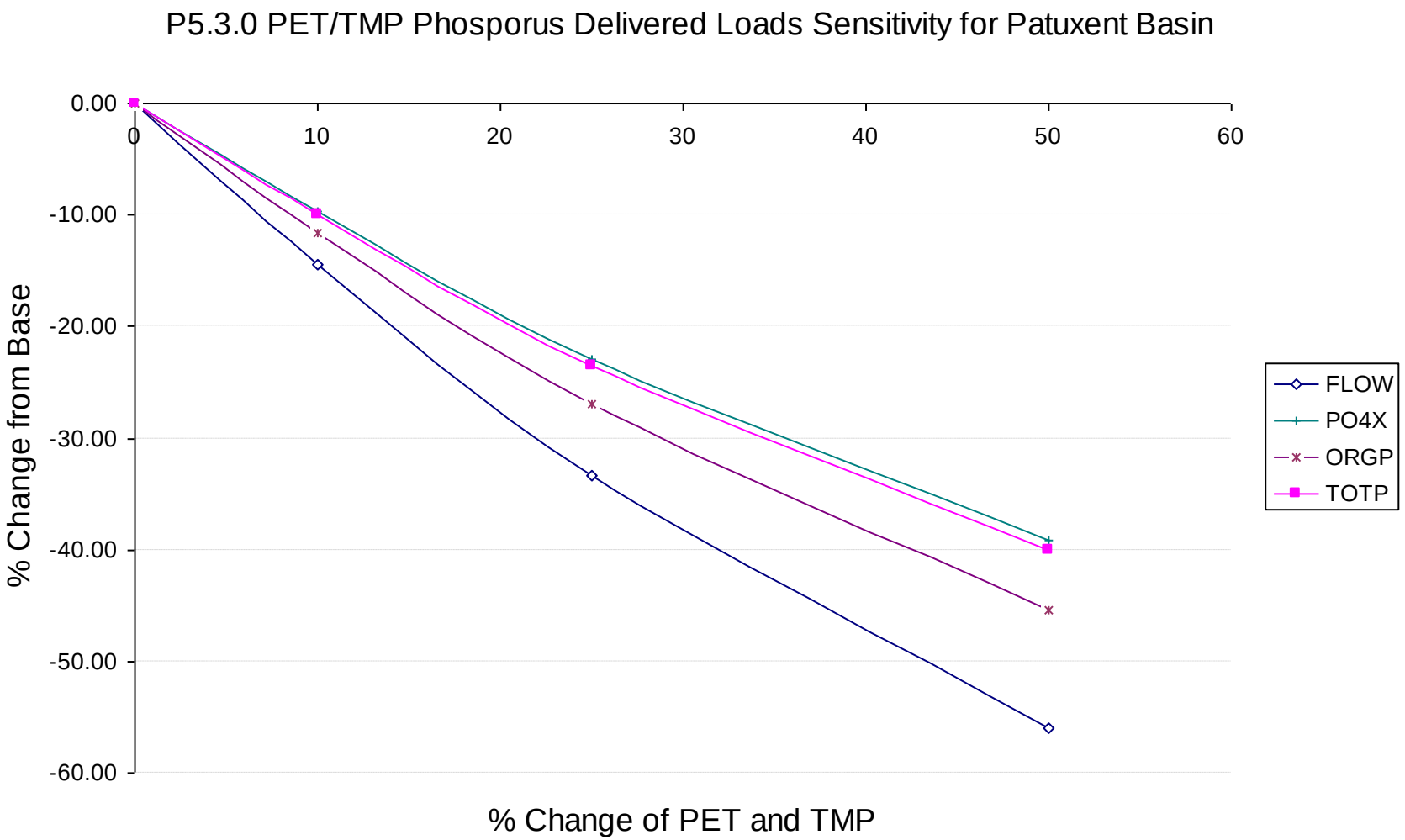
Totals


P5.3.0 PET/TMP Total Delivered Loads Sensitivity for Patuxent Basin
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
0
10
20
30
40
50
60
% Change from Base
% Change of PET and TMP
TSSX
TOTP
TOTN
FLOW

Nitrogen


P5.3.0 PET/TMP Nitrogen Delivered Loads Sensitivity for Patuxent Basin
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
0
10
20
30
40
50
60
% Change from Base
% Change of PET and TMP
NH3X
NO23
ORGN
TOTN
FLOW

Phosphorus


P5.3.0 PET/TMP Phosporus Delivered Loads Sensitivity for Patuxent Basin
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
0
10
20
30
40
50
60
% Change from Base
% Change of PET and TMP
FLOW
PO4X
ORGP
TOTP

Future Work

- Complete application of downscaled GCM input in updated Phase 5.3.2 model
- Use more sensitivity analysis to examine potential vulnerabilities and characteristics of model simulation
- Examine ways to refine representation of climate change effects within experimental design

Questions?

Photo Credit: Mike Land