Exploring the dissolved Orthophosphorus record of the Susquehanna River, at Conowingo, Maryland

Robert M. Hirsch
Research Hydrologist Emeritus, USGS
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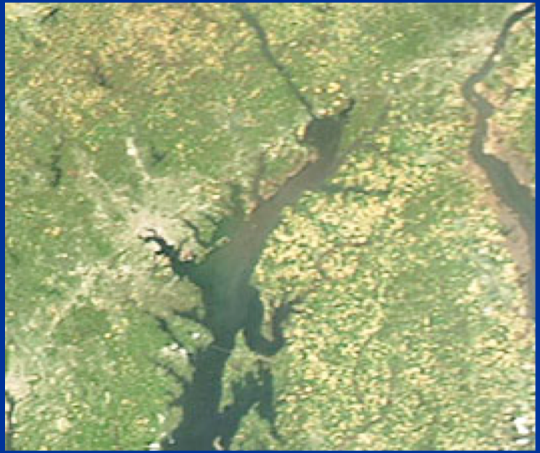
U.S. Department of the Interior
U.S. Geological Survey

USGS trend analyses (published at cbrim.er.usgs.gov) for Orthophosphorus (PO_4) have repeatedly shown large increases for the Susquehanna River at Conowingo.

This is not explained, in any obvious way, by the dynamic equilibrium hypothesis for Conowingo.

PO_4 inputs have been implicated in many severe cyanobacter blooms, including toxic ones. Shallow fresh-water systems. Is the upper Chesapeake Bay next?



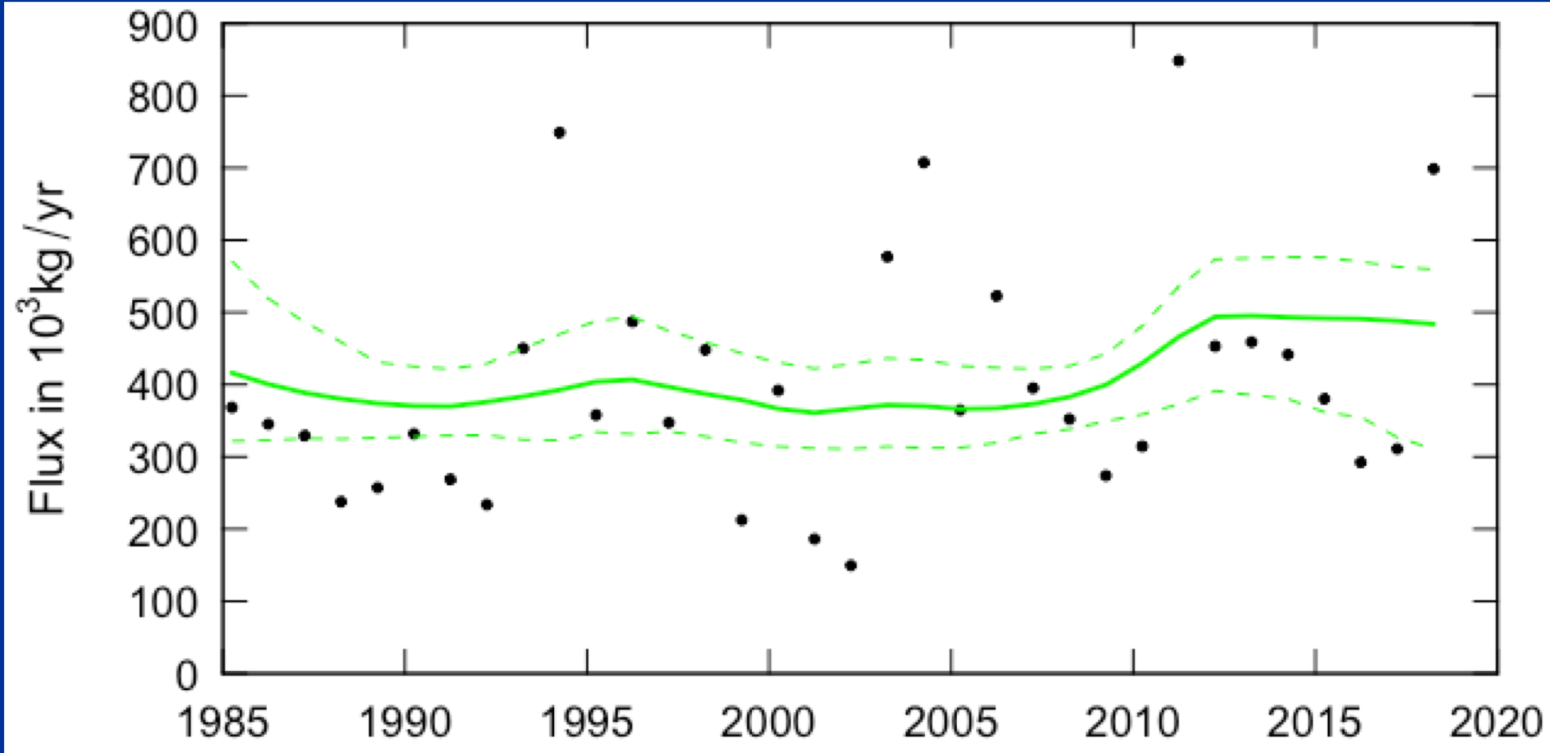
USGS

The data set is 925 samples of Orthophosphorus concentrations, collected by the USGS between October 1985 and September 2018

Filtered water samples, 0.45 micron filtration. Concentrations are reported in mg/L as P

USGS

Green line is Flow Normalized Flux
Dashed lines are the 90% Confidence Intervals
Dots are estimated flux values for the year.



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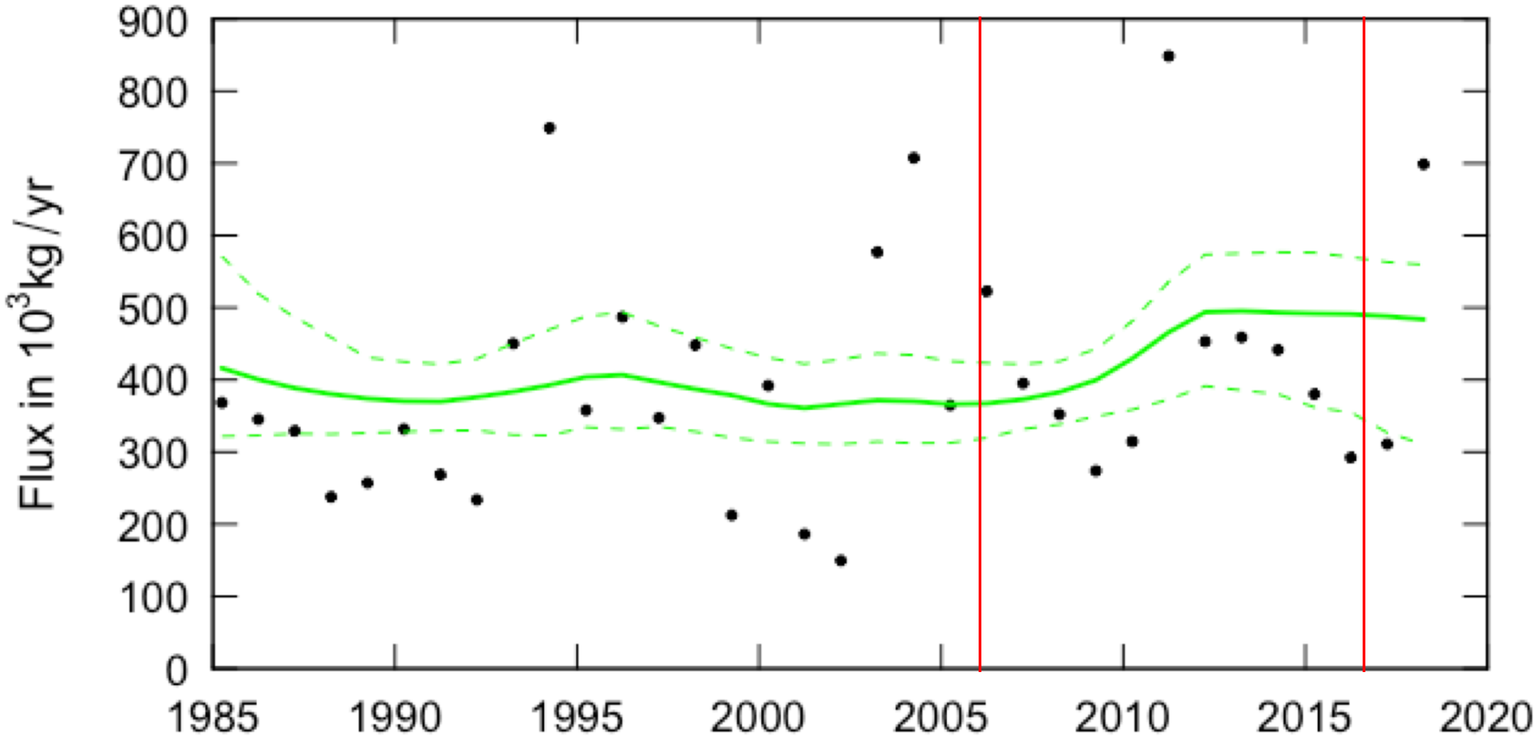
The change from 2006 to 2017 is a 33% increase



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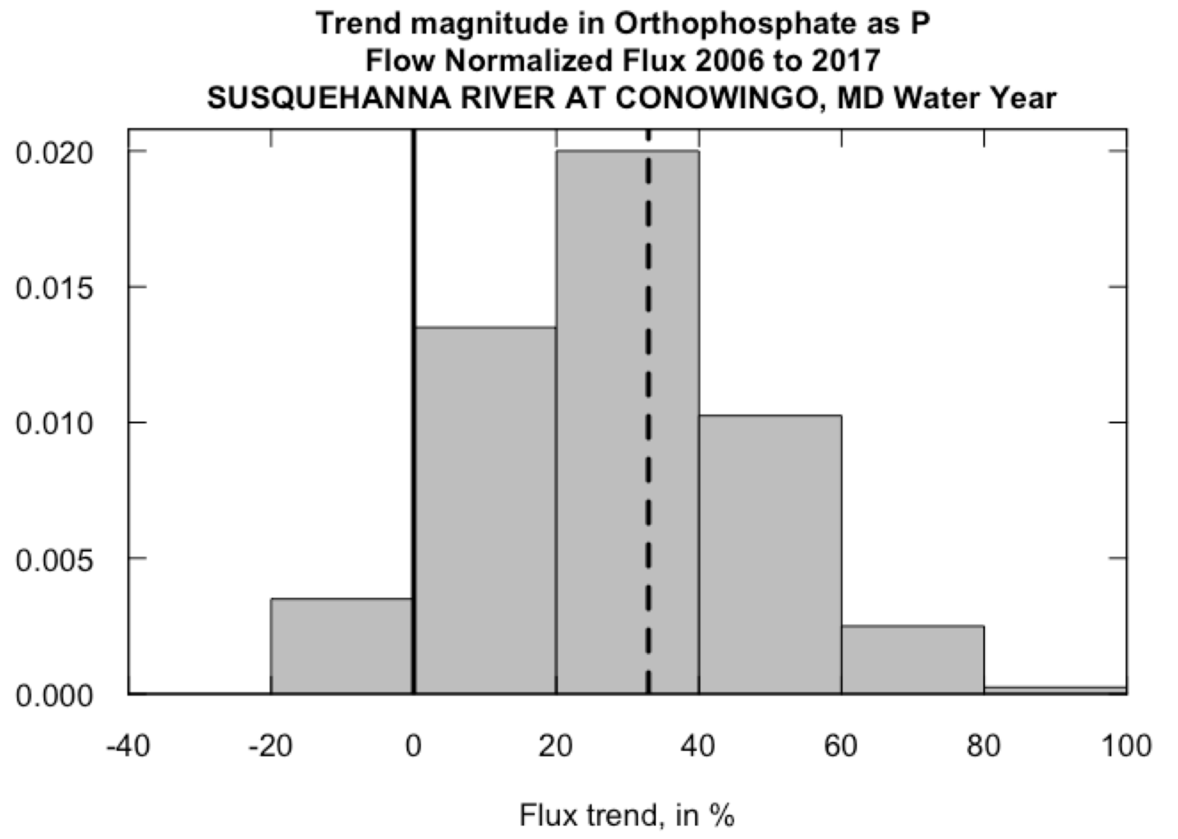
How certain am I about this increase?

We can do a bootstrap uncertainty analysis of the trend

The results tell us:

Likelihood that it is truly an increase is 91%

Likelihood that it is truly a decrease is 9%



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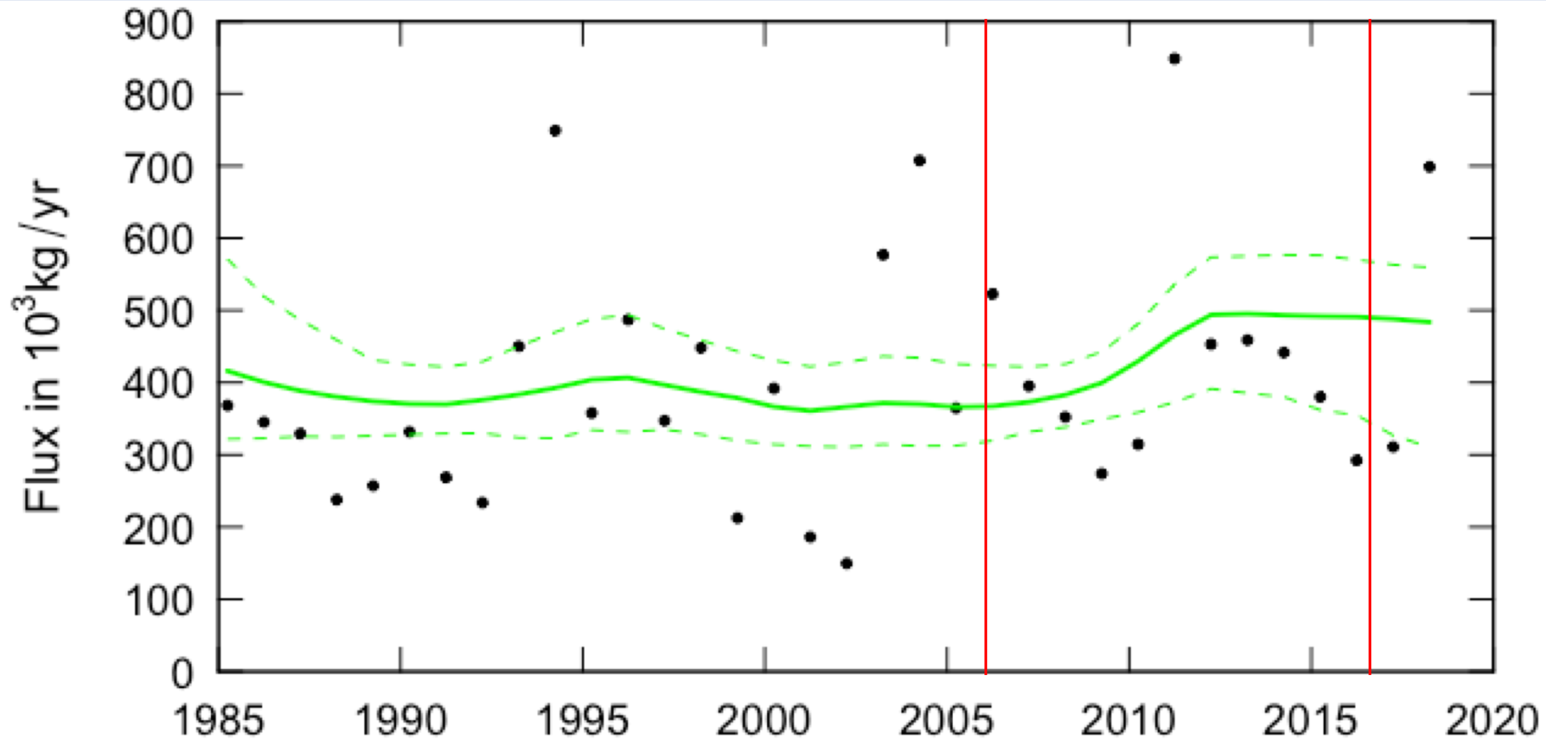
Is the change focused on some particular time of the year?



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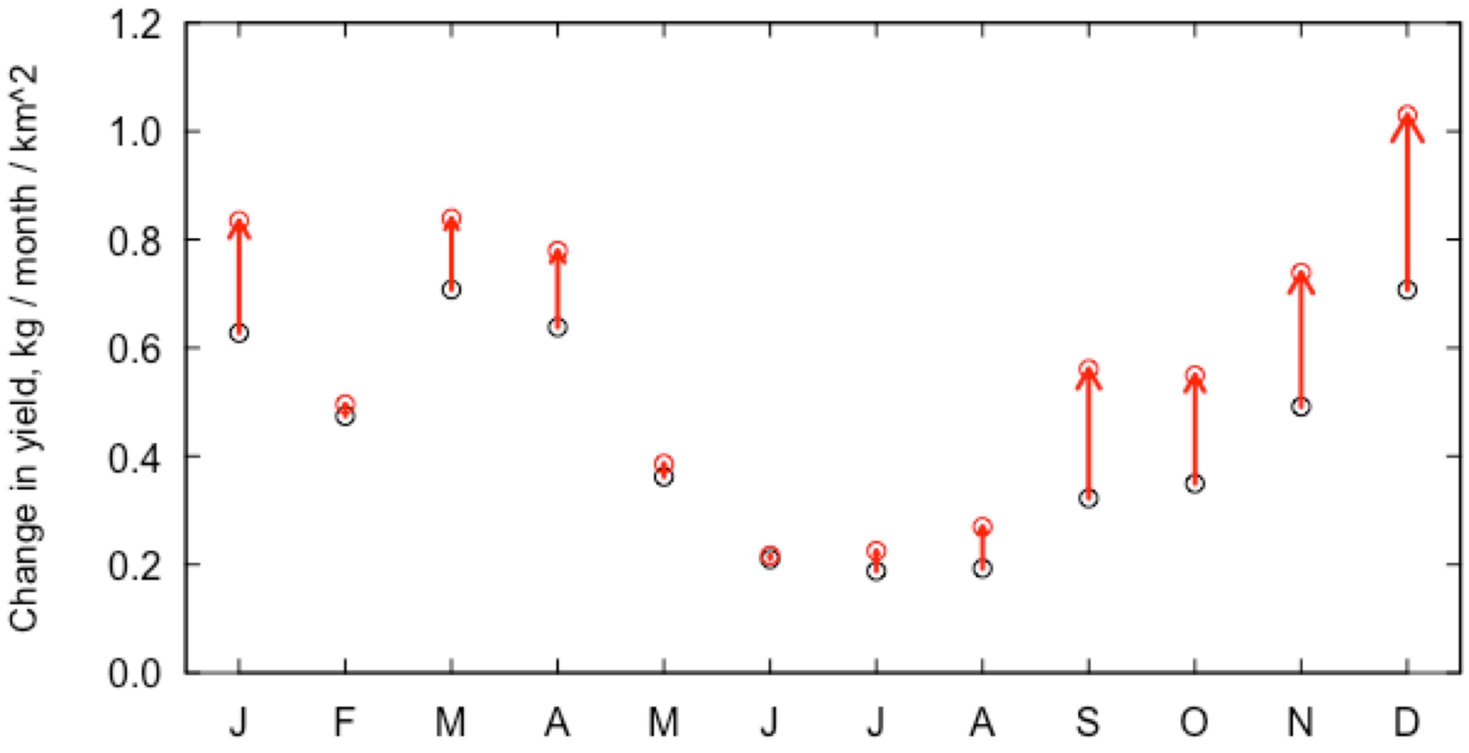
Change in yields, by month

The change is focused in Sept - Dec



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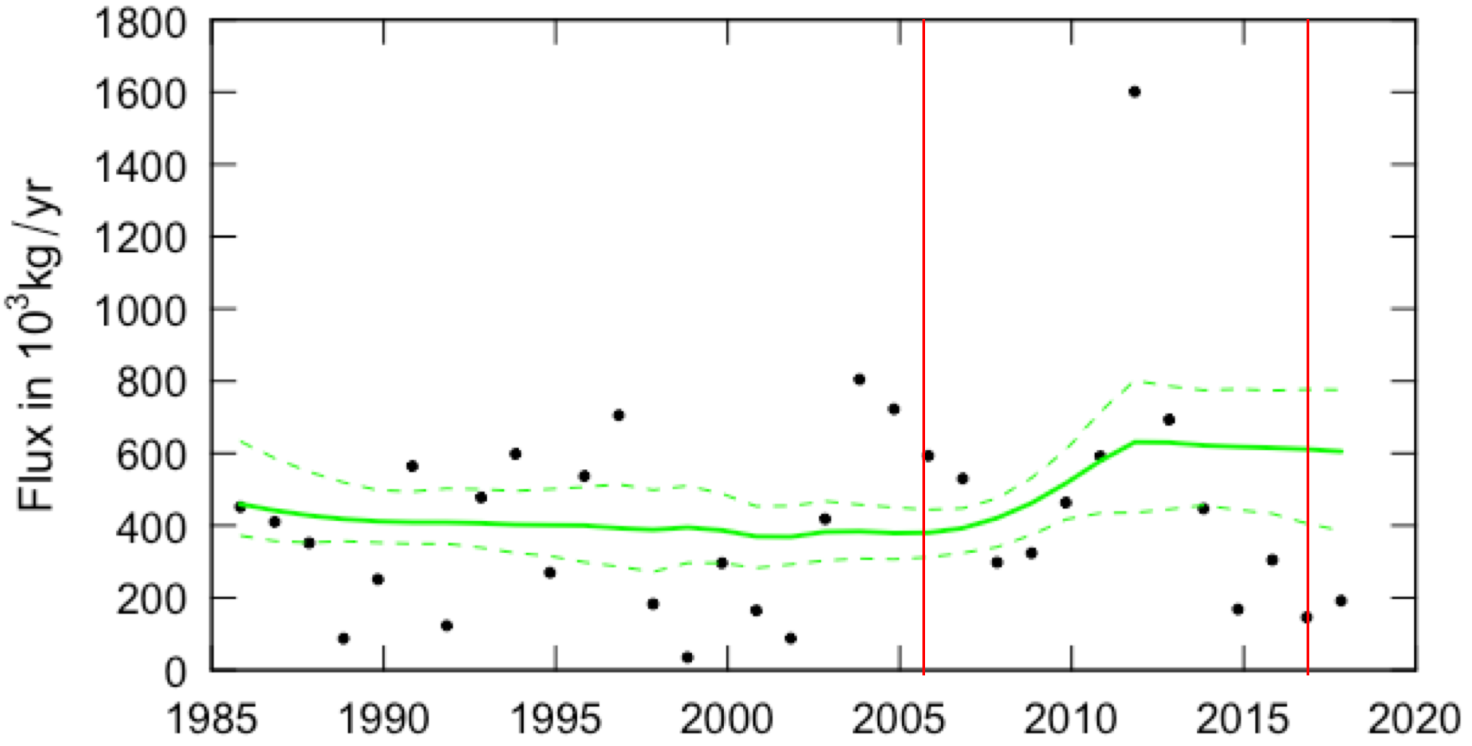
Isolating the change in the September – December part of the year:

The change from 2006 to 2017 is a 54% increase

A note about the scales, the fluxes are a rate and not a mass, so the season flux can exceed the annual

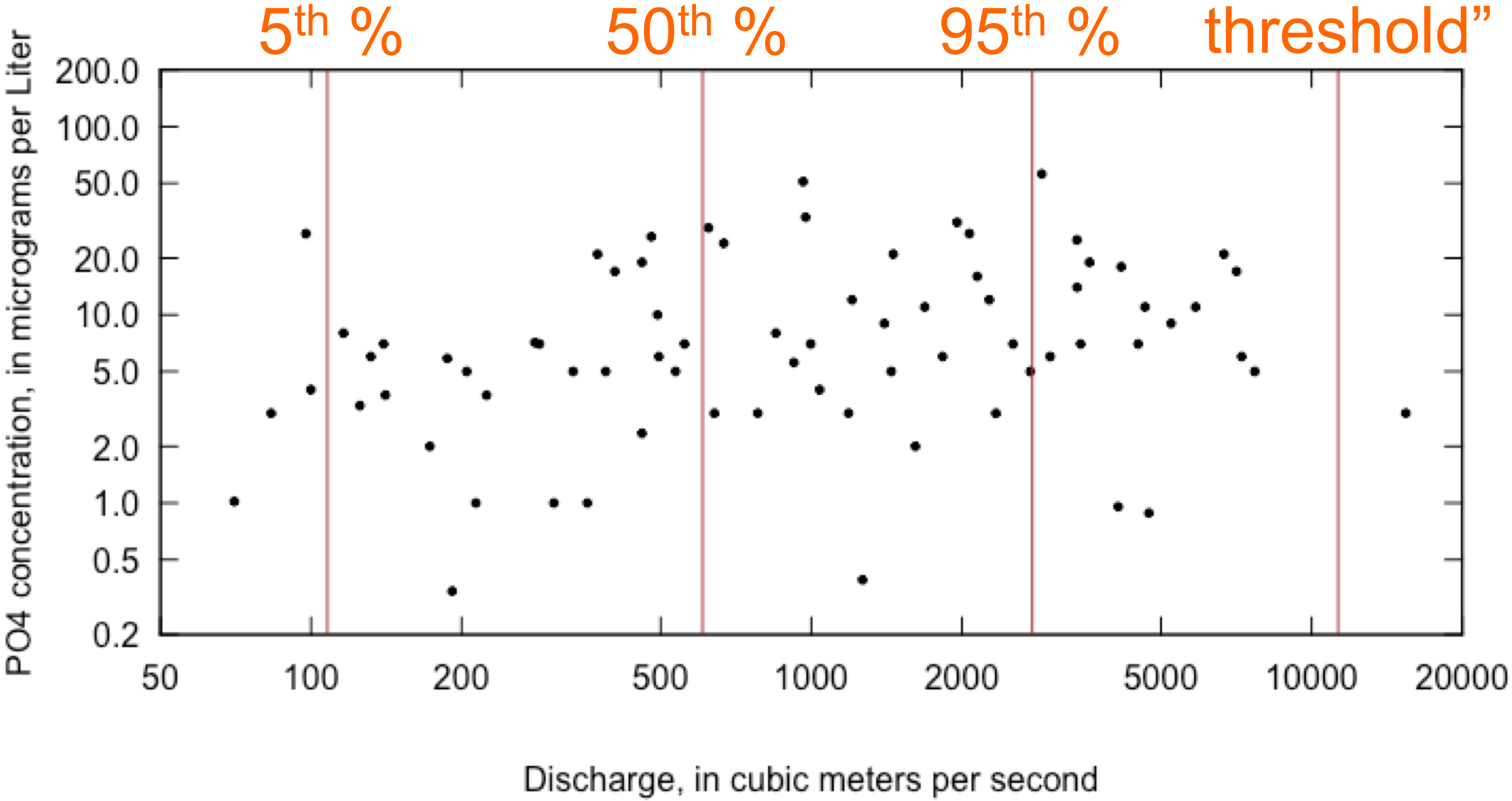


Maybe you aren't keen on the WRTDS Flow-Normalized Results

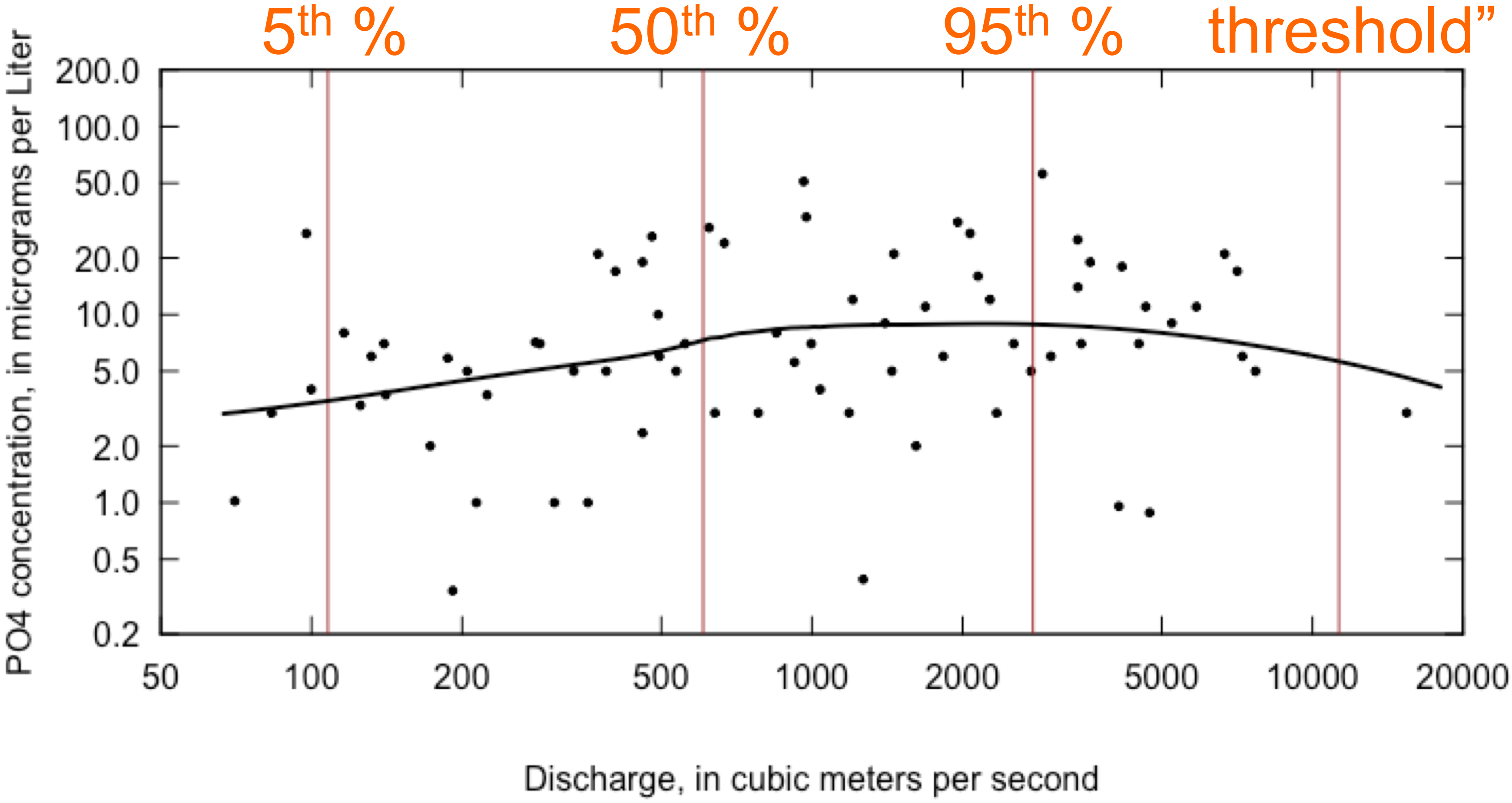
- They have the advantage of removing the variation in concentration or flux associated with year-to-year variations in flow
- They integrate results over all seasons and flow conditions
- It is also very useful to visualize the raw data --

USGS

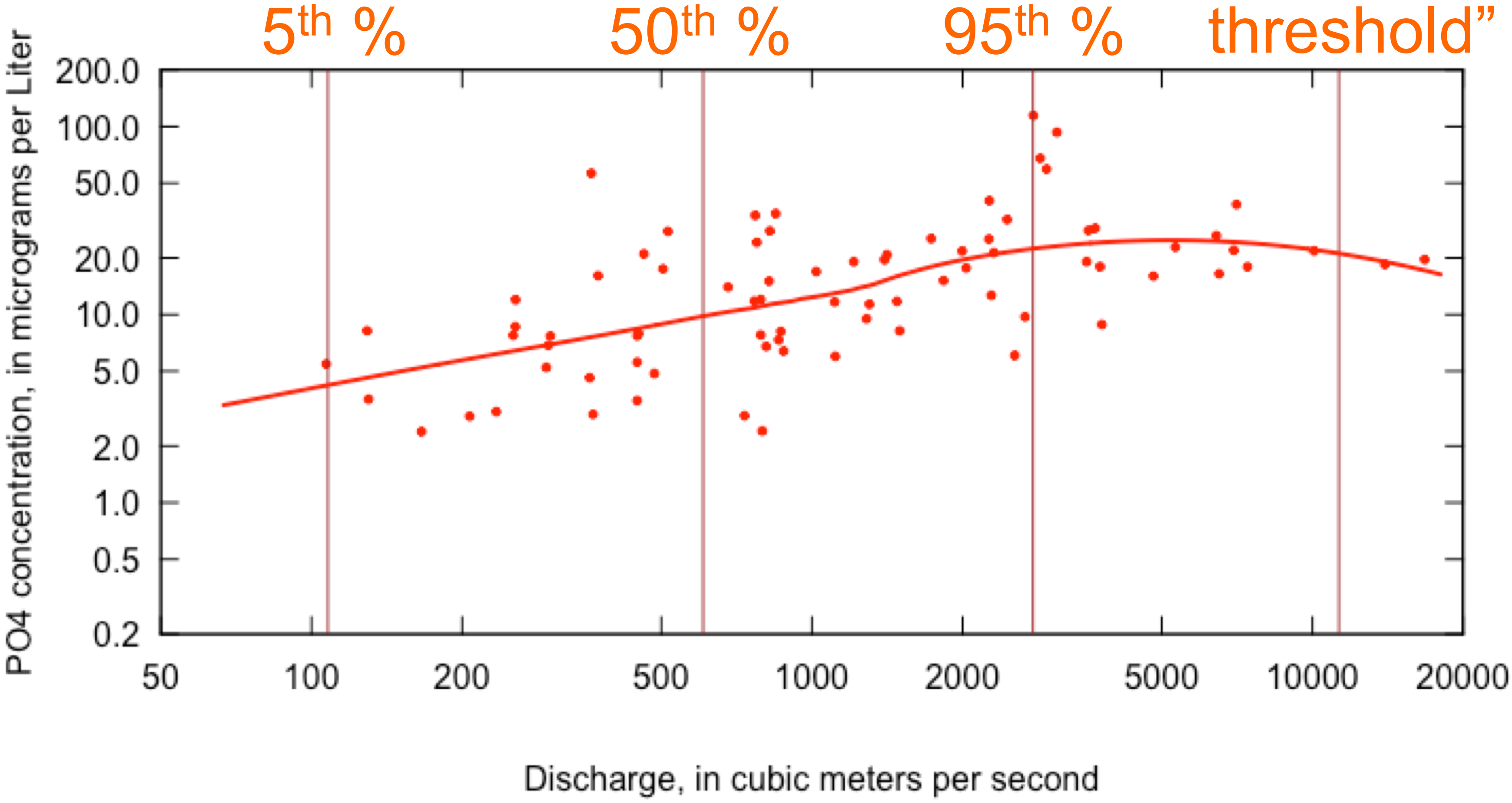
All the Sept-Dec data from 1995 - 2005



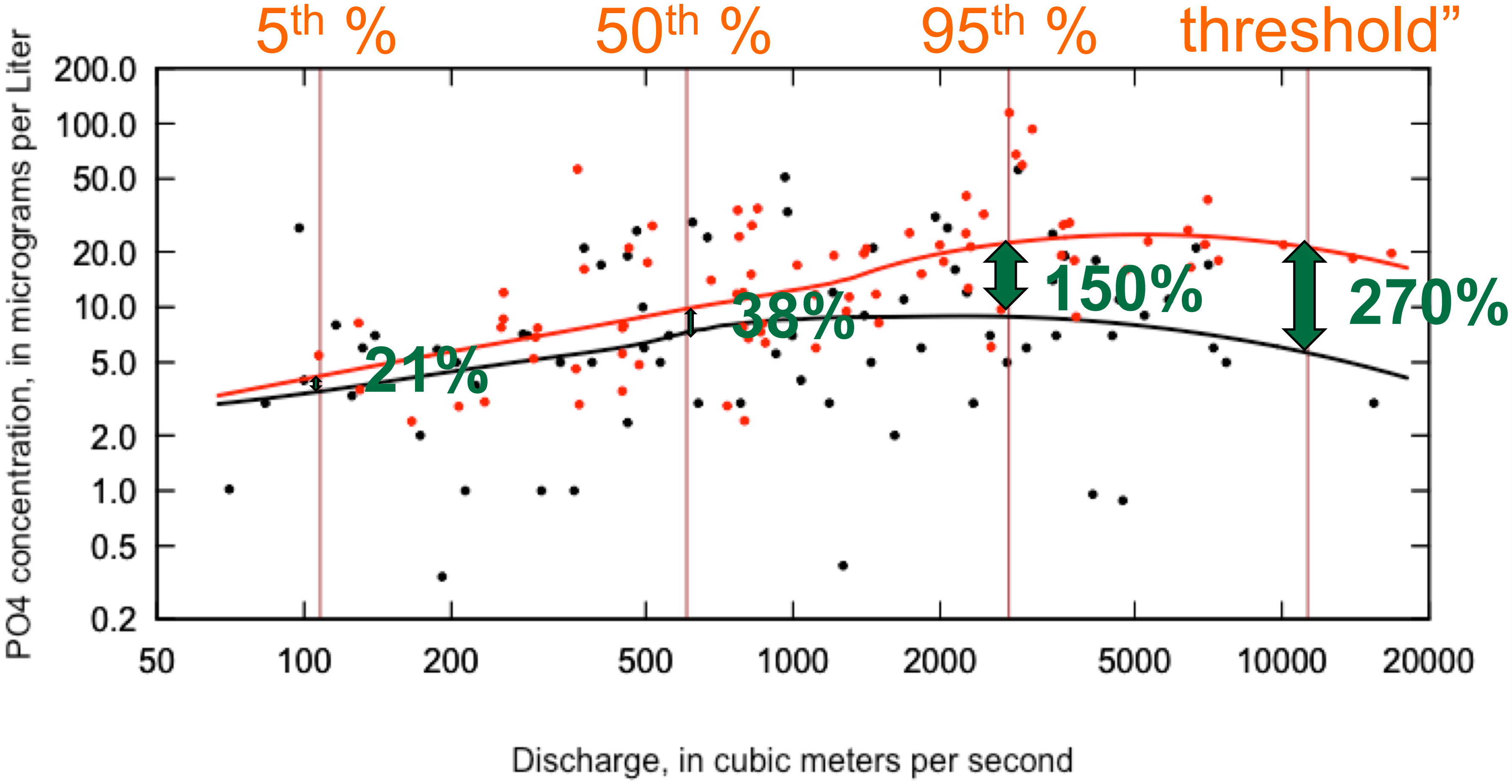
All the Sept-Dec data from 1995 - 2005



All the Sept-Dec data from 2006 - 2018



All the Sept-Dec data from 2006 - 2018



What do we know?

- Since about 2006, the dissolved PO_4 concentrations and fluxes to the Bay appear to have increased (after removing the effect of interannual flow differences).
- The change is focused in the months of September through December
- The change is more pronounced at higher flows, but is true across the whole range of flows

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What might be the reasons?

- A result of trends in inputs from upstream – this appears to be unlikely.
- Increased exchange between the bed and water column, related to possible changes in conditions near the bed (temperature, DO, pH, carbon, biological activity, velocity).
- Related to scour (mini-scour events) bringing high P sediments into contact with the flowing water.

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Why should we care?

- New understanding of threats to the Bay ecosystem
- Needs to be considered in the models of the watershed and of the Bay
- Implications for any engineered actions related to Conowingo sediments (e.g. dredging)

My hope is

- STAC should identify this as an issue of concern for the Bay, along with other observed trends in PO_4 (see Fanelli et al. 2019; Kleinman et al., 2019)
- STAC should be thinking about what kind of science is needed. (Data collection, data analysis, discovery older data on reservoir conditions, experimentation, . . .)
- The Bay Program and the individual agencies involved should invest in that science.

USGS

Thanks for listening

rhirsch@usgs.gov

All of the WRTDS-related analysis and graphics are done in the EGRET and EGRETci R-packages

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