What is WRTDS-K and why would one want to use it? Weighted Regressions on Time Discharge and Season – Kalman filter approach

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February 16, 2022

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WRTDS was designed to describe trends. But, sometimes the question is not about trends.

- I want a time series of inputs to a water body to test a deterministic model of conditions in the water body
- I want a time series of outputs from a watershed to test a deterministic model of pollution outputs from the watershed
- I want to do mass-balance calculations for a reach or reservoir (think of Conowingo reservoir – changing trap efficiency)
- I want to produce “nowcasts” for operational use

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I don’t want the flow-normalized flux.

What I want is the best estimate of flux you can give me for a specific day, month, or year.

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What's the main idea?

1. On a sampled day, use the data, not the WRTDS model.

2. For a day just before or after a sample, if flow conditions are not changing very much, use a number that is very close to the sample value.

3. We can learn a lot about what's going on by looking at the residuals (errors) of the WRTDS model – use that to help fill in the record

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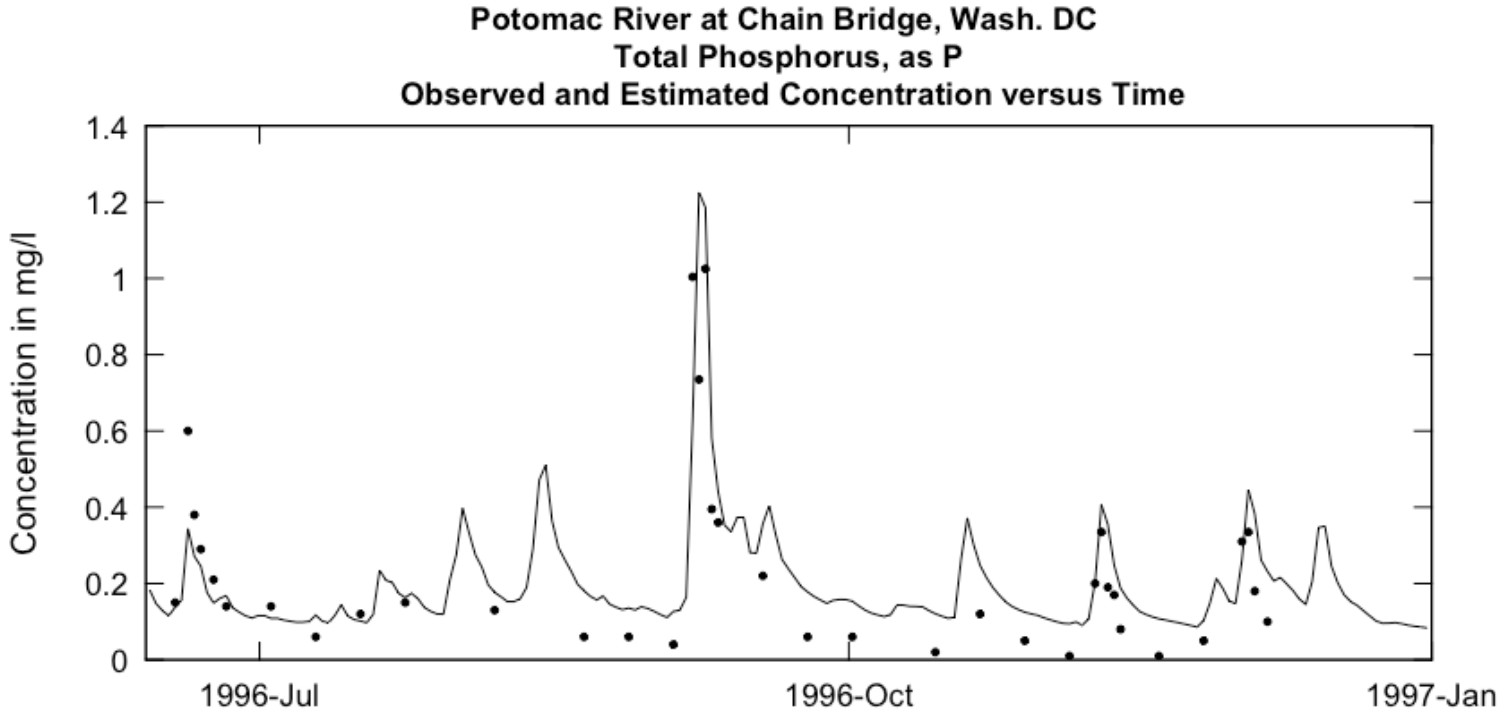
Here we have about 200 days, a piece of a 30-year long record. The line is the WRTDS model for concentration, the dots are the 37 observations we have over these 200 days.



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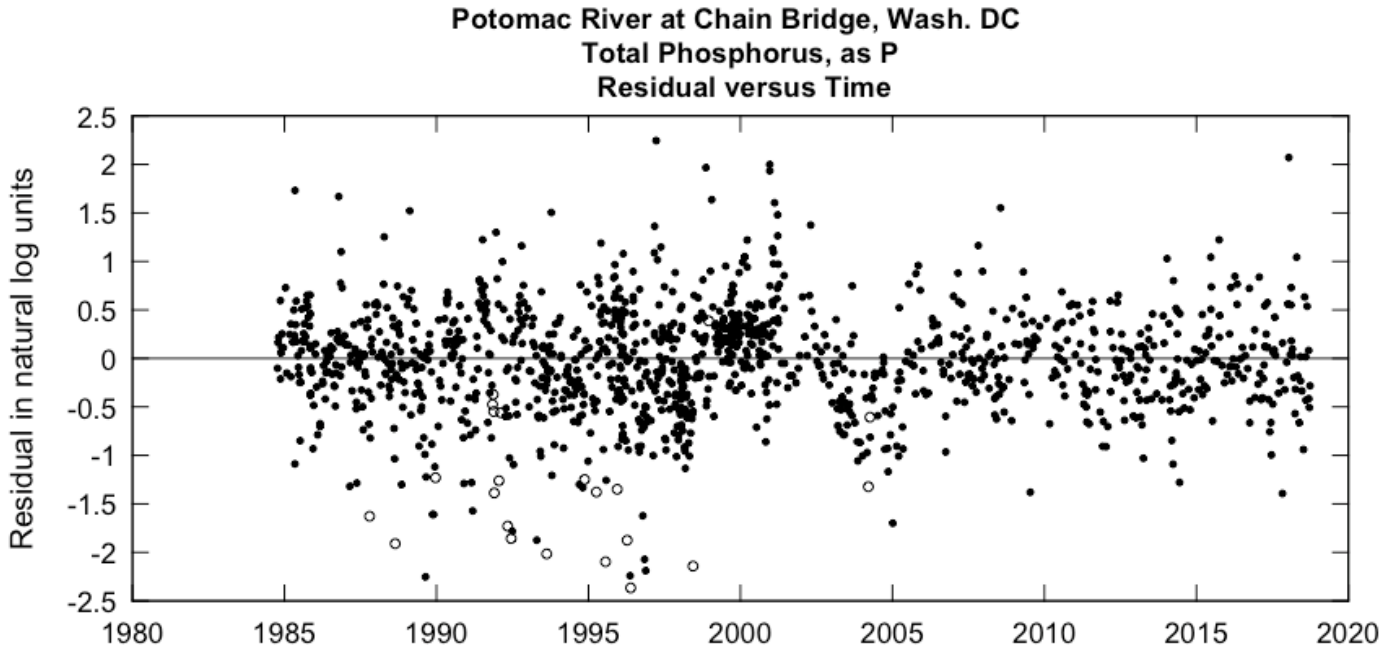
Over the whole period, residuals have a mean near zero, but they clump in time

Why might they be clumpy?



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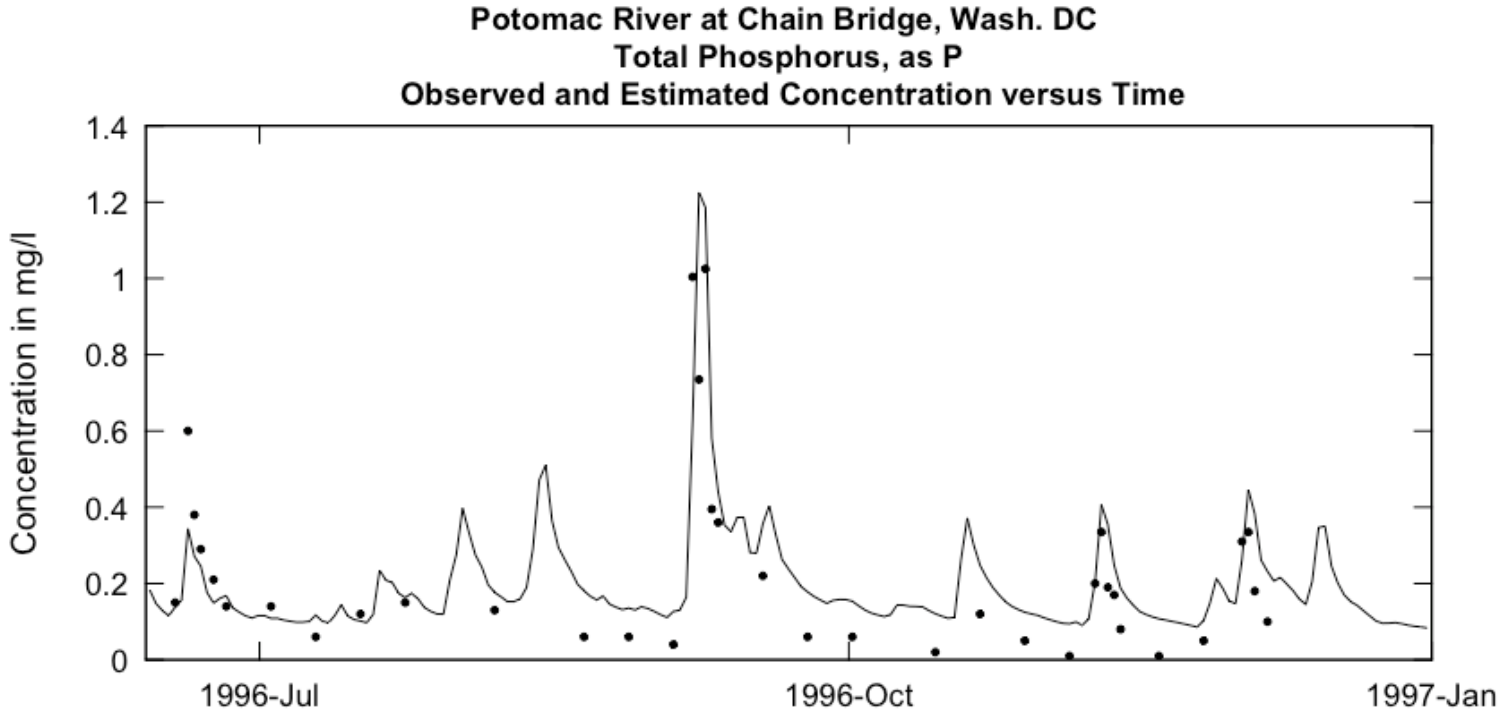
The errors tend to be persistent.

How would you construct the most accurate daily time series from this information?



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Two basic rules

1. If you have an observation on a given day, use it and not the model estimate. Reality is better than any model.
2. For non-sampled days, use a mixture of three pieces of information:
   a) The preceding sample
   b) The next sample
   c) The WRTDS model

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What's happening in math terms

1. WRTDS gives us a model of the mean and variance for each day.

2. Between observations, the residuals are modeled as an autoregressive lag-1 process with correlation coefficient typically 0.9

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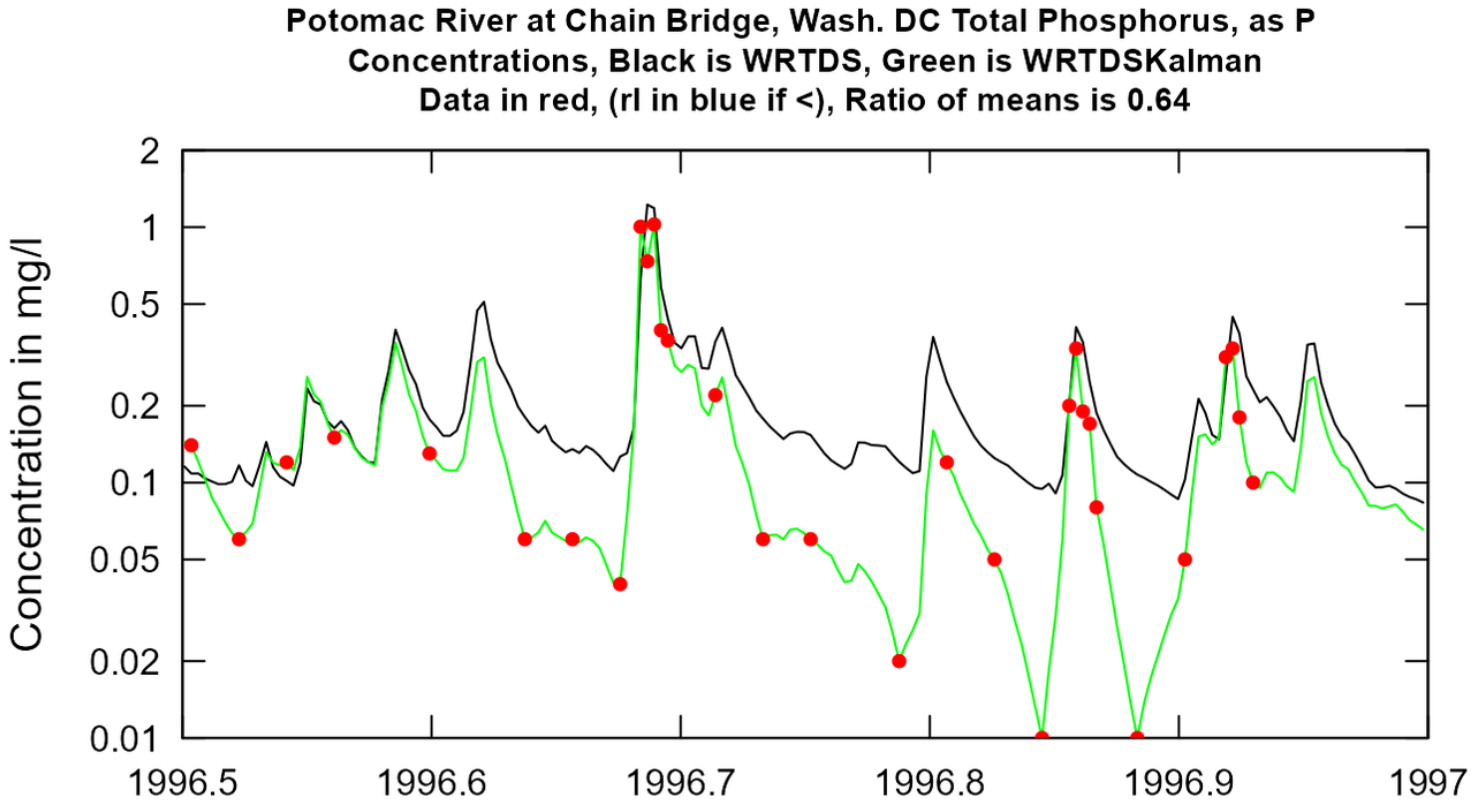
```
plotTimeSlice(eList_K, start = 1996.5, end = 1997, conc = TRUE)
```



```
plotTimeSlice(eList_K, start = 1996.5, end = 1997, conc = FALSE)
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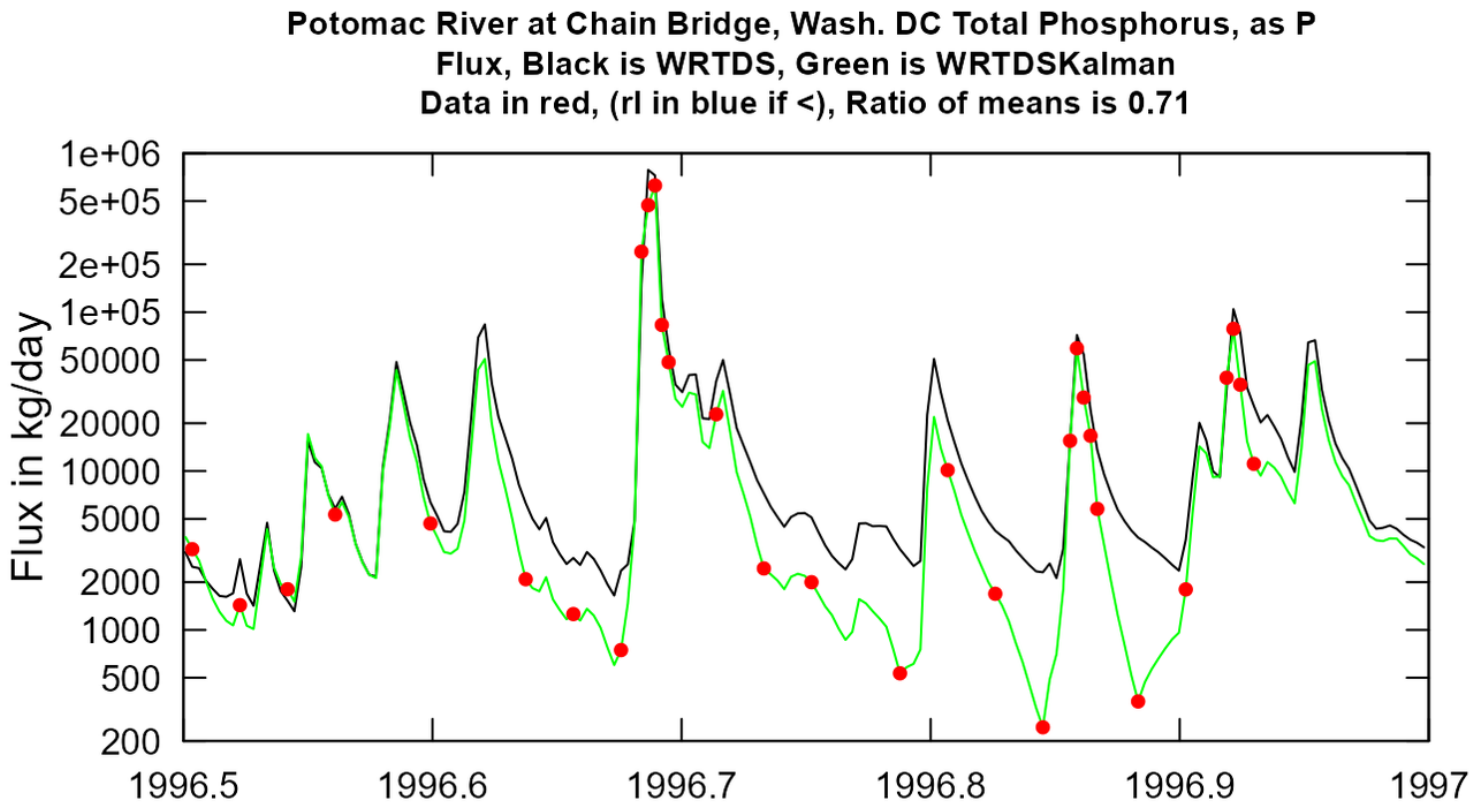
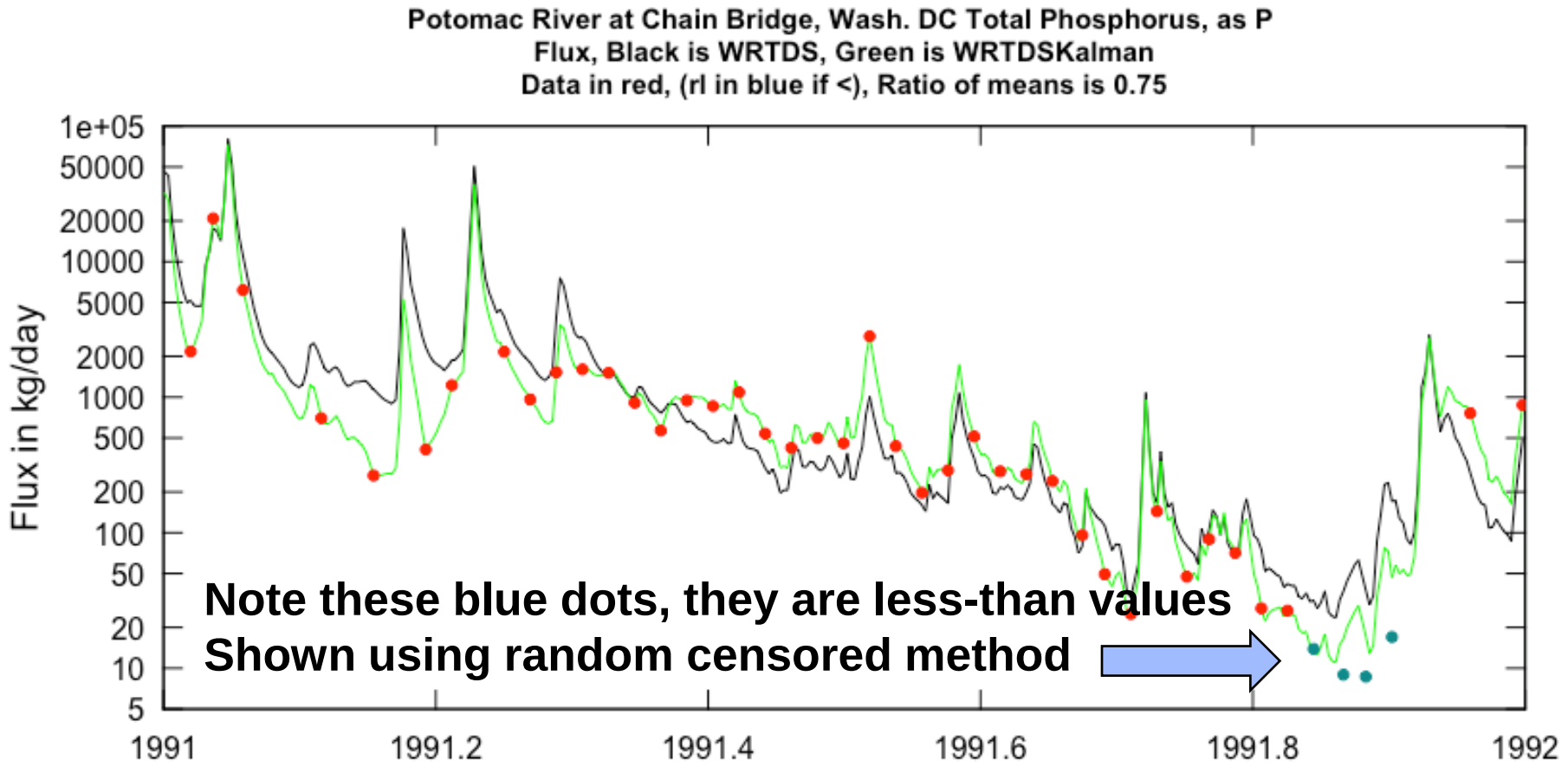


Here is a more typical case, alternating bunches of positive & negative departures



2 publications deriving the math, evaluating the method, and providing guidance

References

Lee, C.J., Hirsch, R.M., and Crawford, C.G., 2019, An evaluation of methods for computing annual water-quality loads: U.S. Geological Survey Scientific Investigations Report 2019–5084, 59 p., https://doi.org/10.3133/sir20195084.

Zhang, Q. and Hirsch, R.M., 2019. River water-quality concentration and flux estimation can be improved by accounting for serial correlation through an autoregressive model. Water Resources Research. https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2019WR025338

In some cases, it makes a big difference in flux estimates and others it is minor, but experimental studies show it to generally be better than the regular WRTDS estimates.

Remember: this is not for trend studies, rather, it is about having the best possible record of what happened on any given day, month or year.

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