



Streamflow Uncertainty

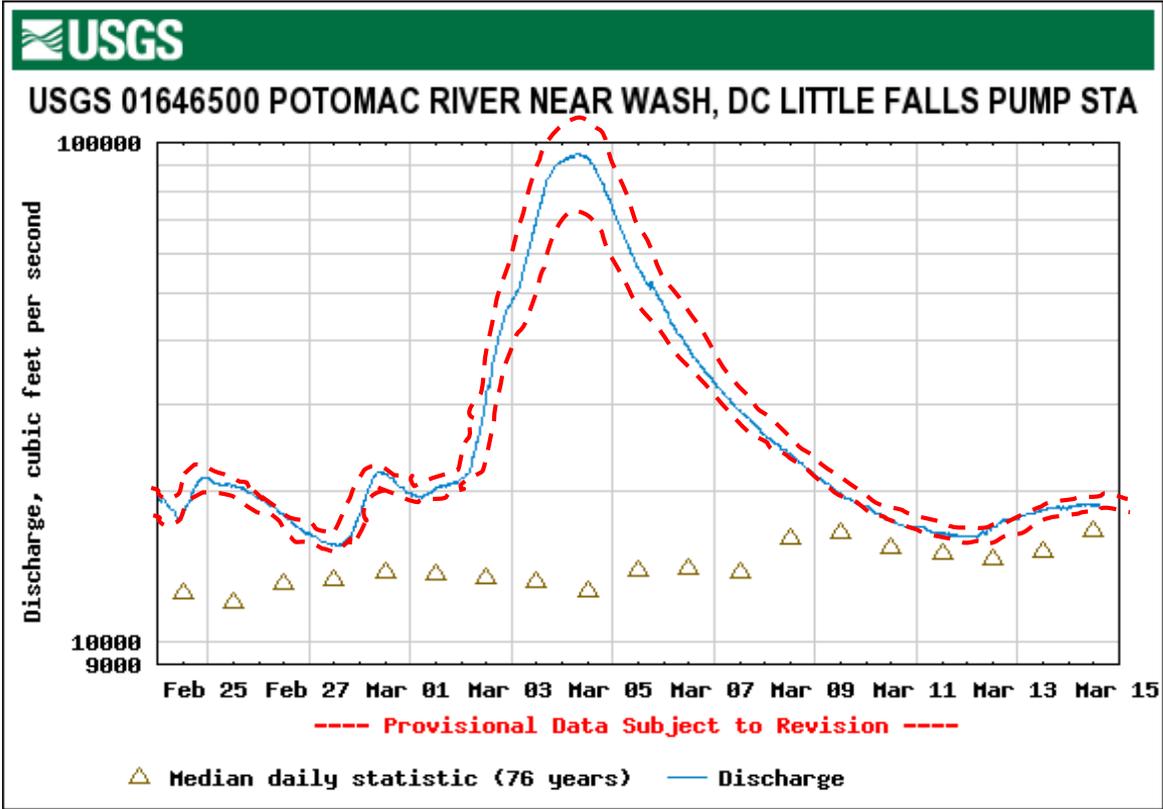
ACWI Streamflow Collaborative

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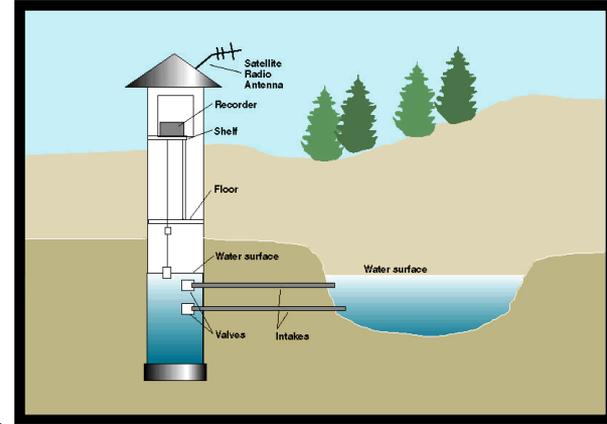
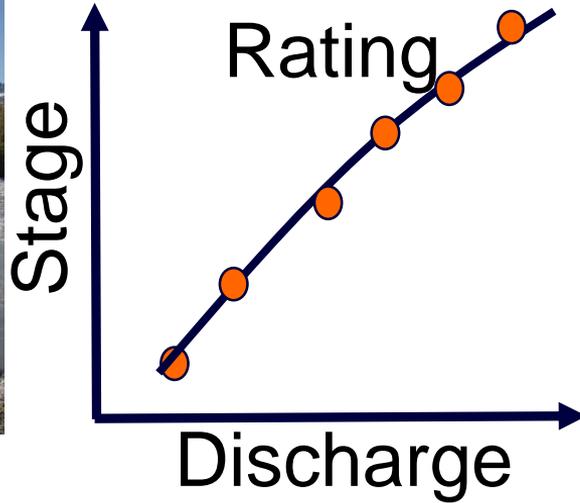
What is uncertainty?



Why uncertainty?

- Value-added information
 - Improved decisions – water management, infrastructure design
 - Improved models – model calibration and validation
- Assessment of operational methods
 - Improve measurement/rating techniques
 - Improve streamgauge network operation
 - Improve efficiency of operations
 - Understand consequences of changing methods

Sources of uncertainty



Measurements

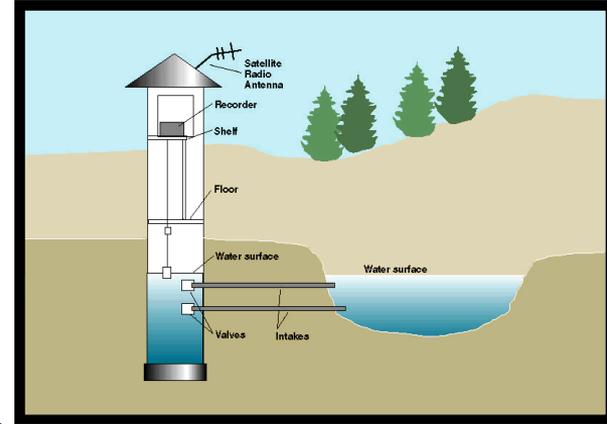
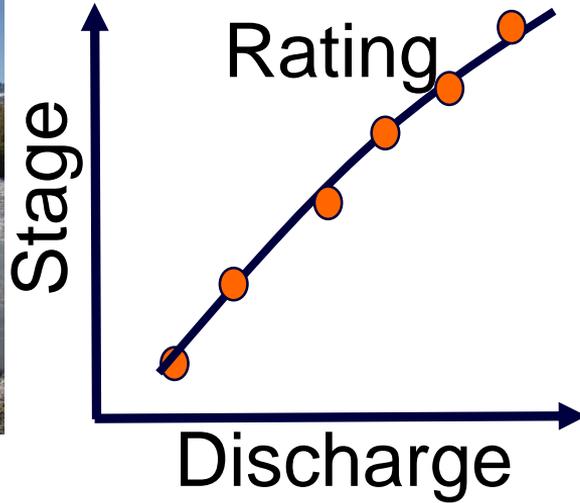
Ratings

Stage time series

Streamflow uncertainty for publication

- Streamflow time series
 - Unit values (15-min data)
- Derived streamflow information
 - Example: mean daily discharge, monthly, annual averages
 - Need to consider serial correlation

Sources of uncertainty

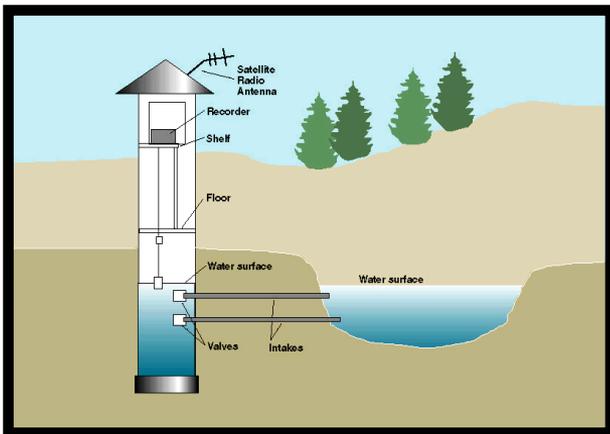


Measurements

Ratings

Stage time series

Qualitative Assessments



Uncertainty in discharge

Excellent	<2% error
Good	<5% error
Fair	<8% error
Poor	>8% error

Current qualitative assessments in use by USGS, based on hydrographer knowledge of the site and conditions.

Discharge measurement uncertainty



Discharge measurement uncertainty

- Velocity-area method

- ISO method
- IVE method (USGS, Cohn et al)
- Despax et al (France)

- ADCP moving-boat method

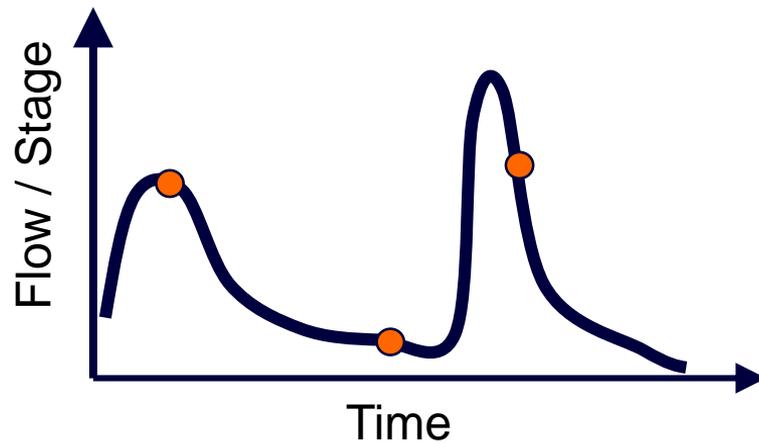
- QRev (USGS, Mueller et al)
- QUant (Environment Canada)
- OURSIN (France)
- Muste et al.

Based on propagation of uncertainty from multiple identified sources.

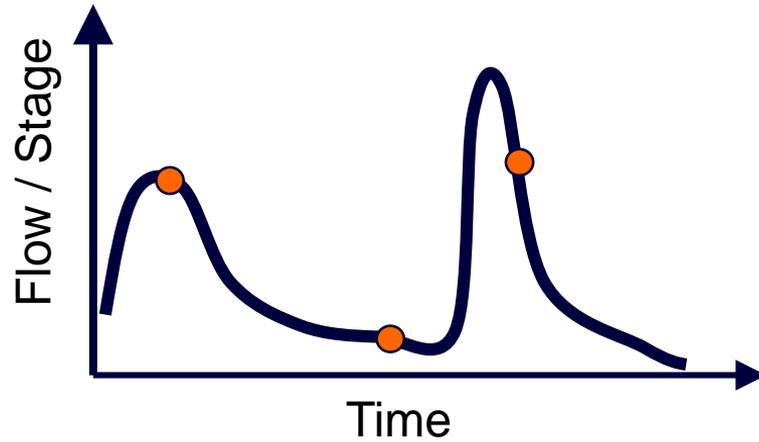
Rating curve uncertainty - if our databases could talk...



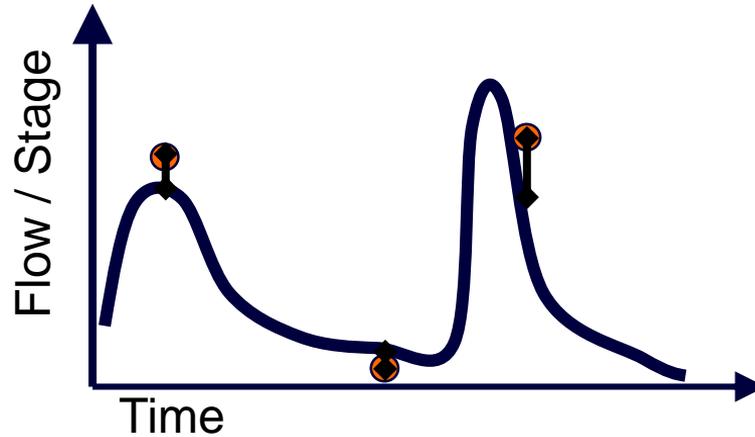
If measurements
and rating curve
were perfect...



If measurements
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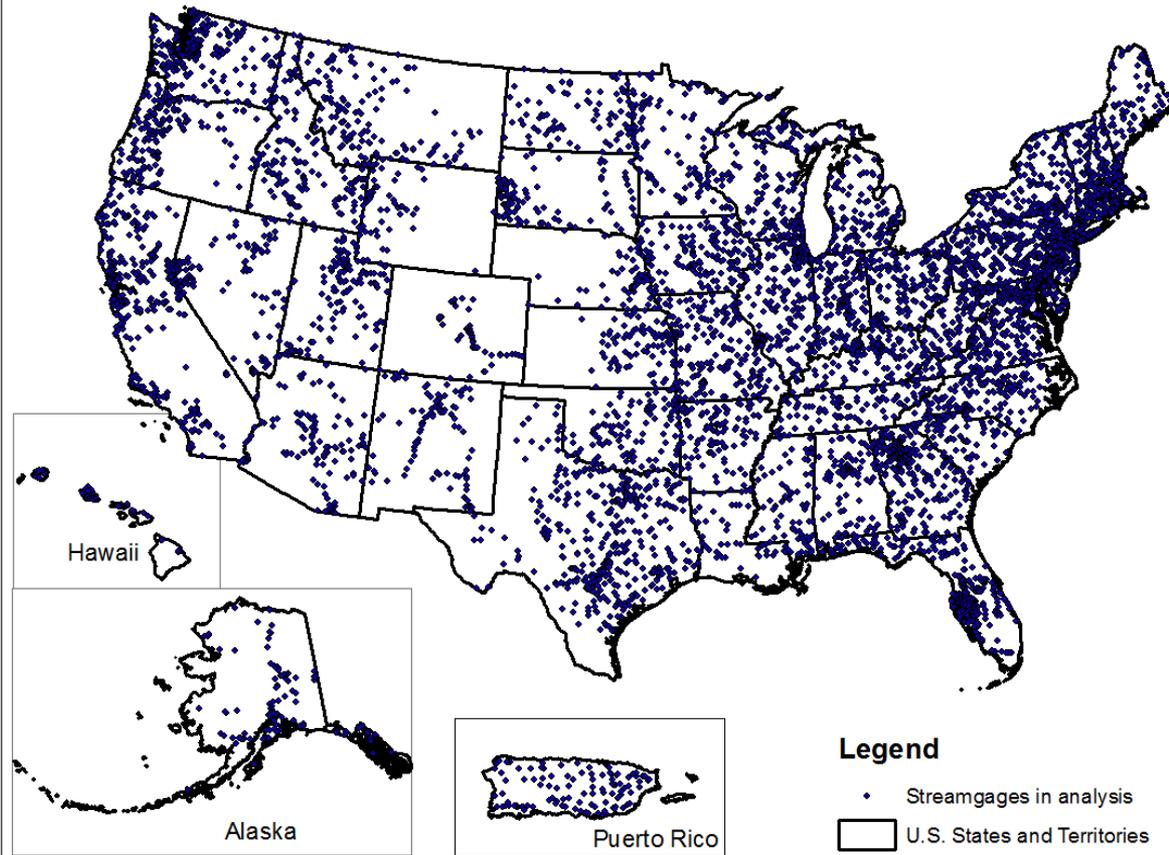


Can we learn
something from
the actual
observed
differences?



USGS Streamgages

 USGS



Measurement dataset

59,696 measurements from March 2012-December 2014

Filters:

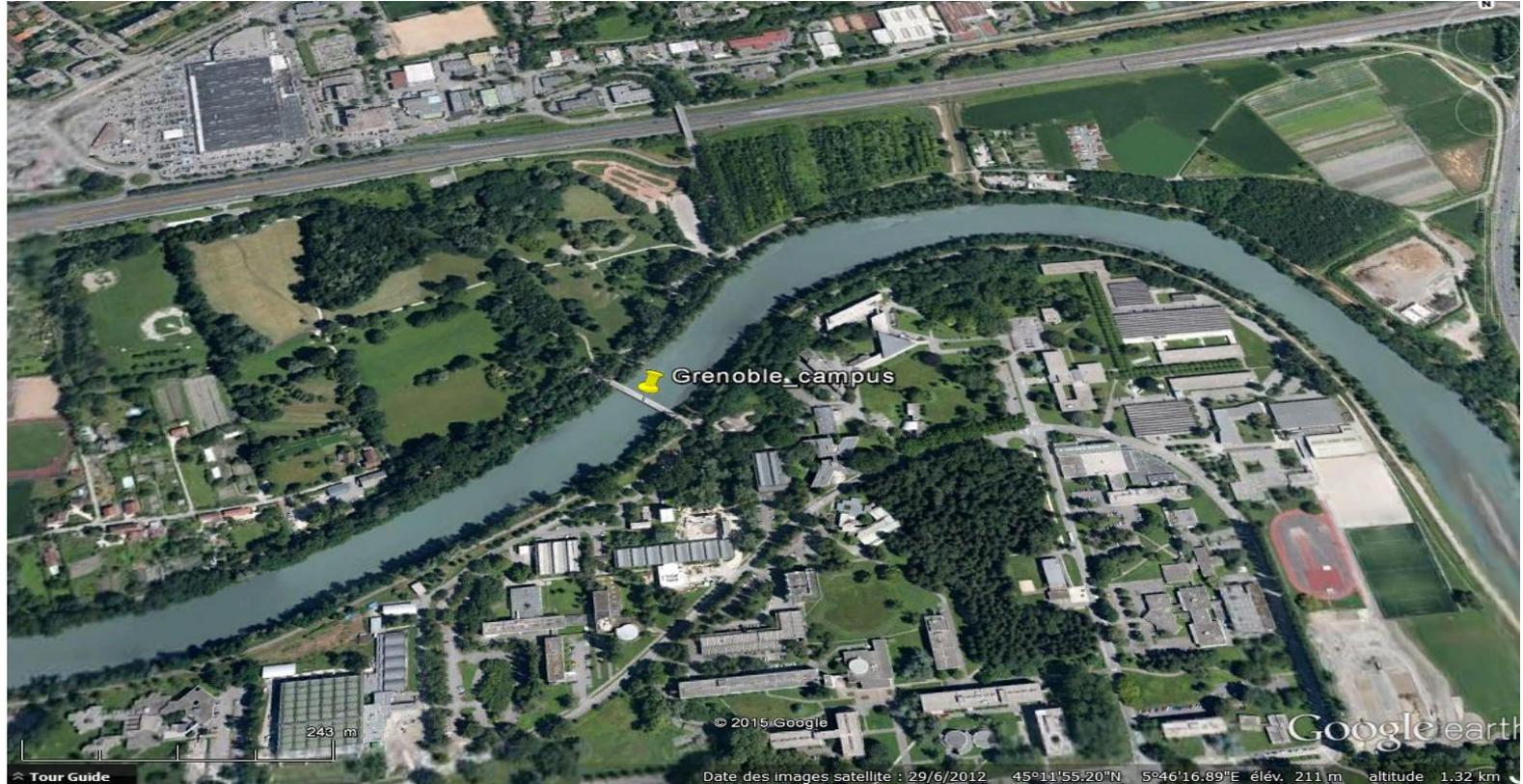
- Must have a qualitative assessment of flow
- Discharge greater than 1 cfs
- No computed differences greater than 500%

→ 53,580 measurements

Rating curve uncertainty: a comparison experiment...



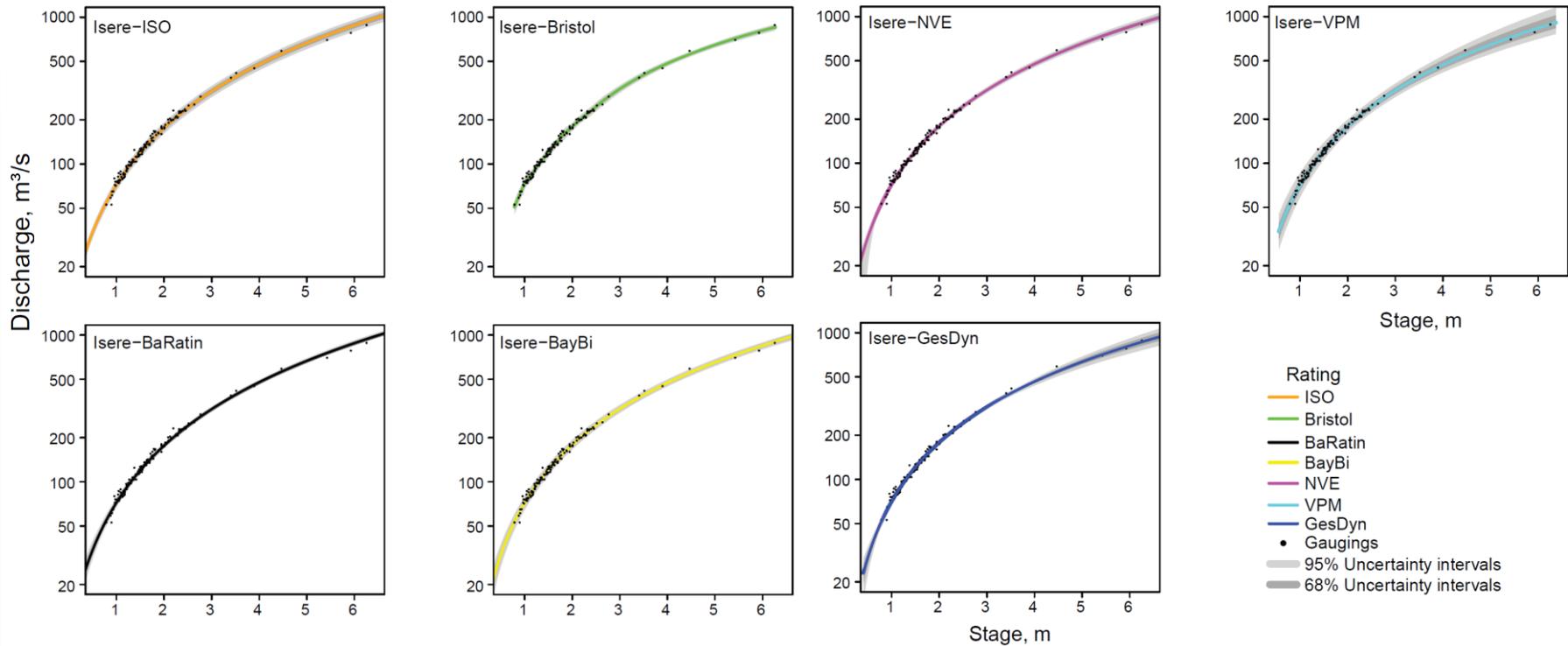
Iserre River at Grenoble



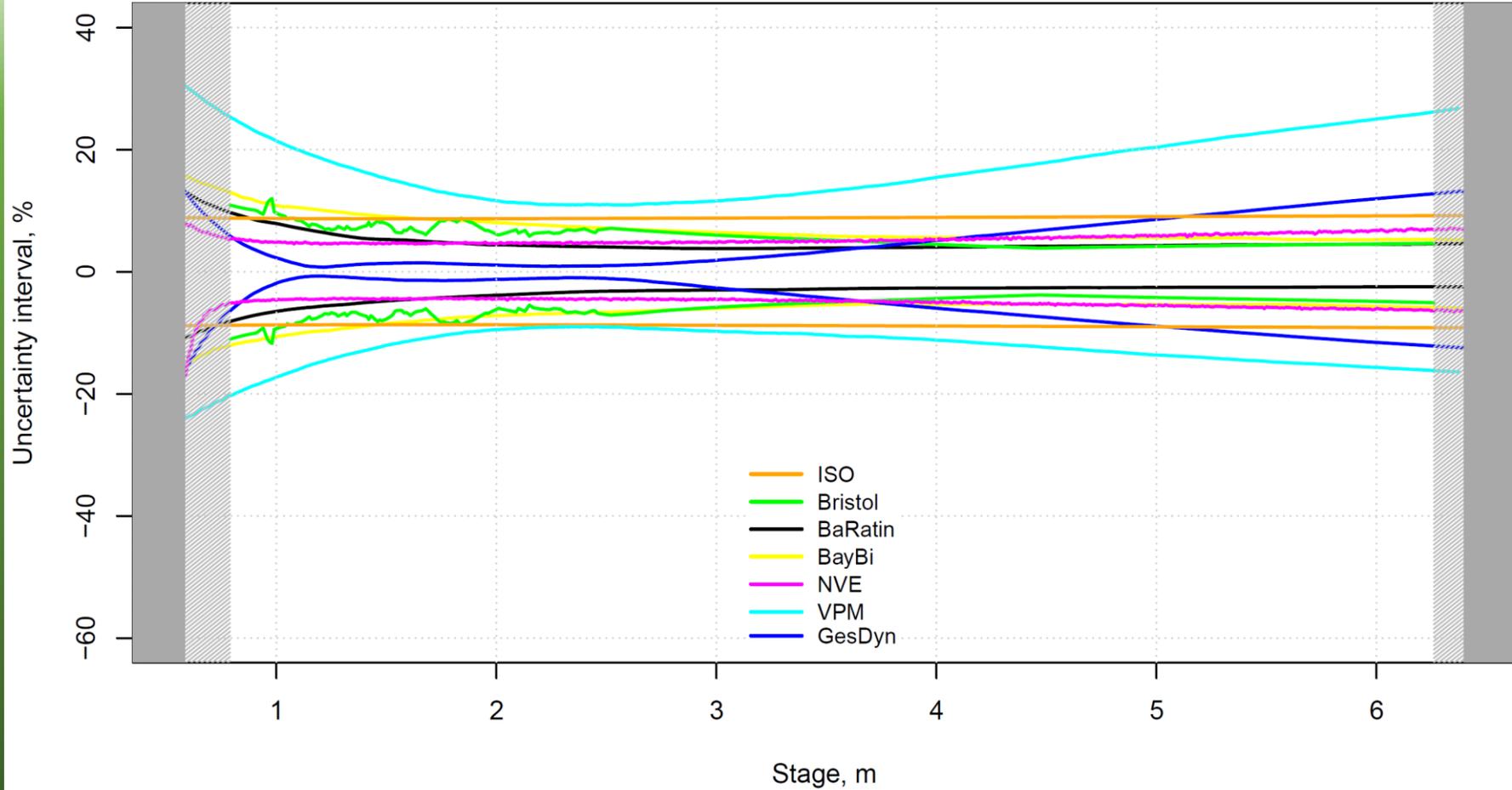
Kiang, J.E., Gazoorian, C., Mcmillan, H., Coxon, G., Le Coz, J, Westerberg, I, Belleville, A, Sevrez, D, Sikorska-Senoner, A, Petersen-Øverleir, A, Reitan, T, Freer, J, Renard, B, Mansanarez, V, & Mason, R. (2018). A Comparison of Methods for Streamflow Uncertainty Estimation. *Water Resources Research*. 10.1029/2018WR022708.



25/03/2009



Iserre 95% Uncertainty Intervals



Summary of comparison experiment results

- Uncertainty estimates varied widely for the various methods, and especially at high and low flows.
- Assumptions matter -- careful description of the assumptions behind uncertainty methods is needed.
- Minimum data required:
 - information on channel and controls (stable section, natural weir, etc.)
 - measurements with dates
- Additional information are also useful in constraining the discharge uncertainty estimates (photos, known changes to channel, etc.)

Rating curve uncertainty methods – possible criteria

- Objective calculation
- Can be applied to thousands of gages – ability to automate
- Flexible across widely varying rivers and streams
 - Sensitive to hydraulic control type and conditions
 - Sensitive to number and distribution of flow measurements in stage and time
 - Complements existing USGS streamflow computations for shifting ratings
- Considers difference in uncertainty for different stage
- Considers time varying nature of streams and associated ratings

Considerations...

- Computing uncertainty of rating curves and their outputs may imply the adoption of new rating development methods
- Some methods may merge well with current work methods and capacity, others may require a greater transition and adaptation
- The typical rating developer may not be an expert in all scenarios and complexities! How to normalize decisions?
- The investments must also be weighed against operational gains and user benefits. This should be clarified and serve as work objectives.

Summary of work and next steps

- Discharge measurement uncertainty

- ADCPs: QRev and QUant
- Velocity Area: IVE

Next steps: incorporation into database; continued collaboration with others to develop and test methods

- Stage-discharge rating uncertainty

- Data-mining effort
- Methods comparison

Next steps: More testing of select methods at USGS sites, expand project.

- Stage Uncertainty

Next steps: Project kicking off in fall

Hoping for larger USGS investment starting in Fall 2019.

Communication of Uncertainty



Discussion

