Hampshire Avon
Demonstration Test Catchment

Developing a framework for including uncertainty analysis to estimate catchment nutrient fluxes and behaviour.

Charlotte Lloyd

Demonstration
Test
Catchments

Lloyd, C. E.M., Freer, J.E., Collins, A.L., Johnes, P. J., Coxon, G. and Hampshire Avon DTC team.

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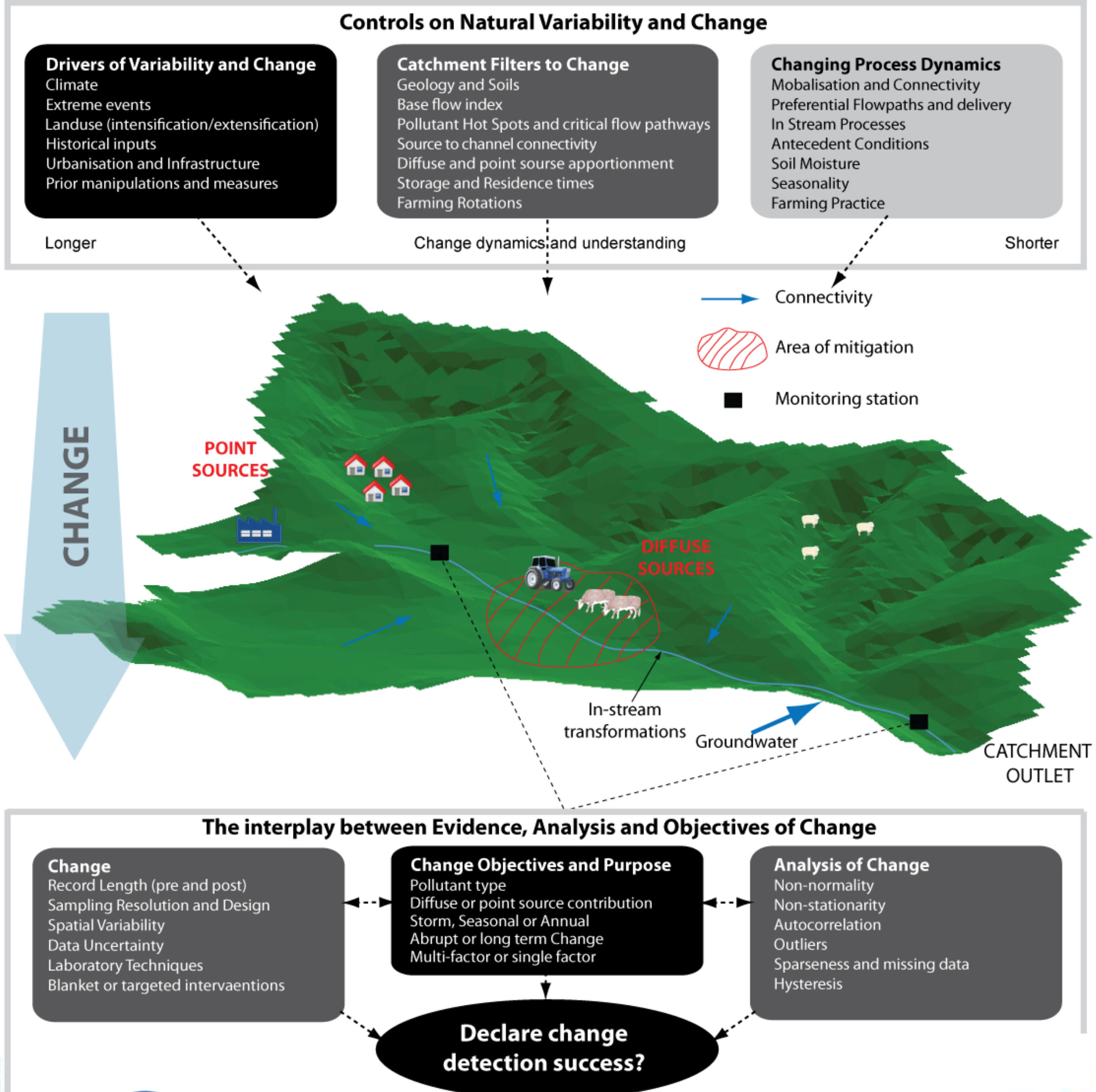
Towards a general analysis framework for robust statistical interrogation of data



Lloyd et al. (2014)
Journal of Hydrology Vol. 514 pp. 297–312

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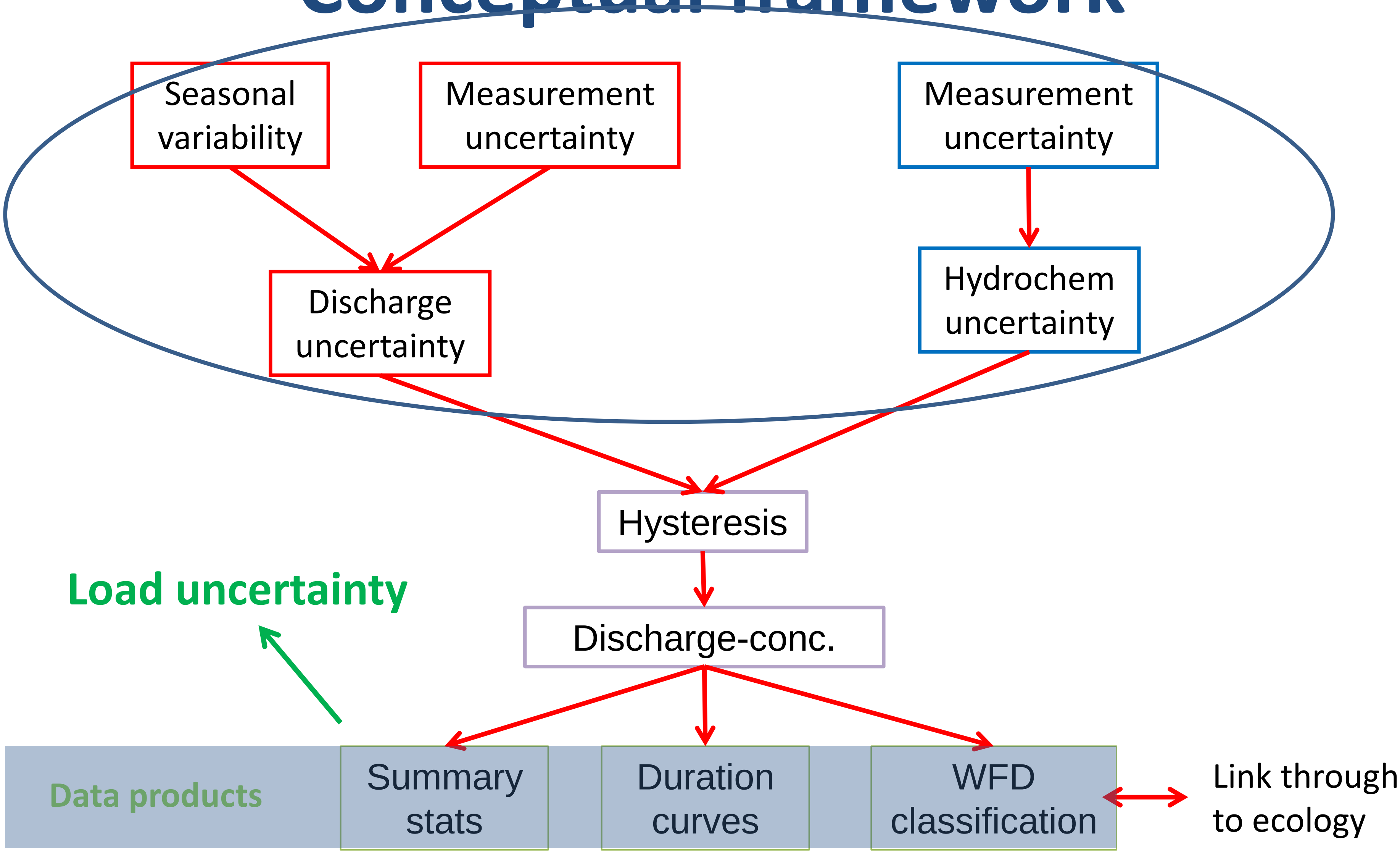
Conceptual framework



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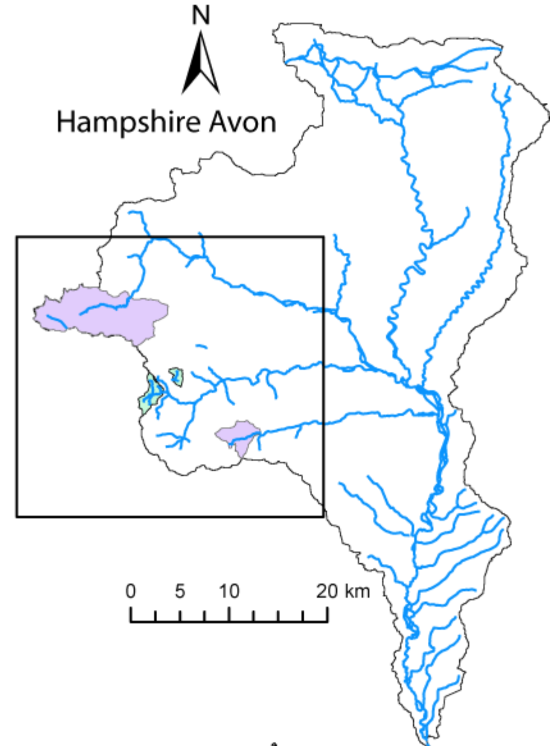
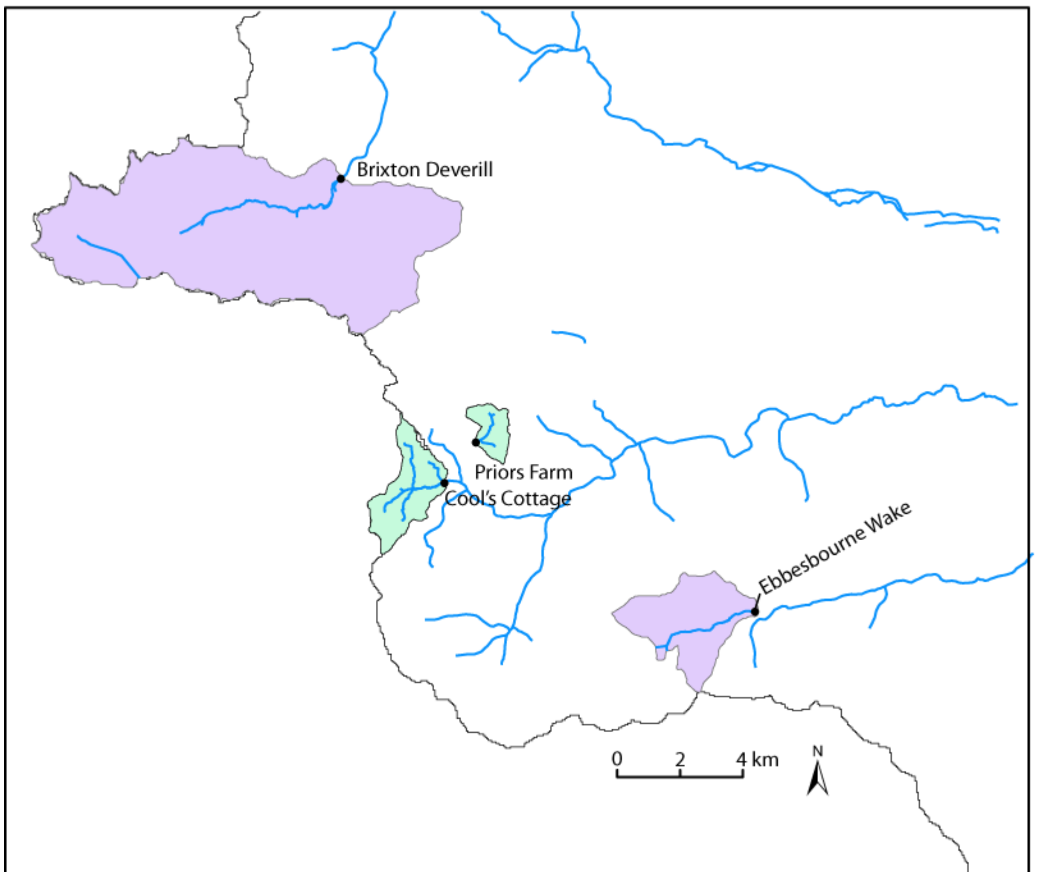
Field sites





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Data

- 15 min paired stage-height and velocity
- 30 min nitrate (Nitratax) and TP (Phosphax)
- Daily nitrate and TP (ISCO and laboratory)

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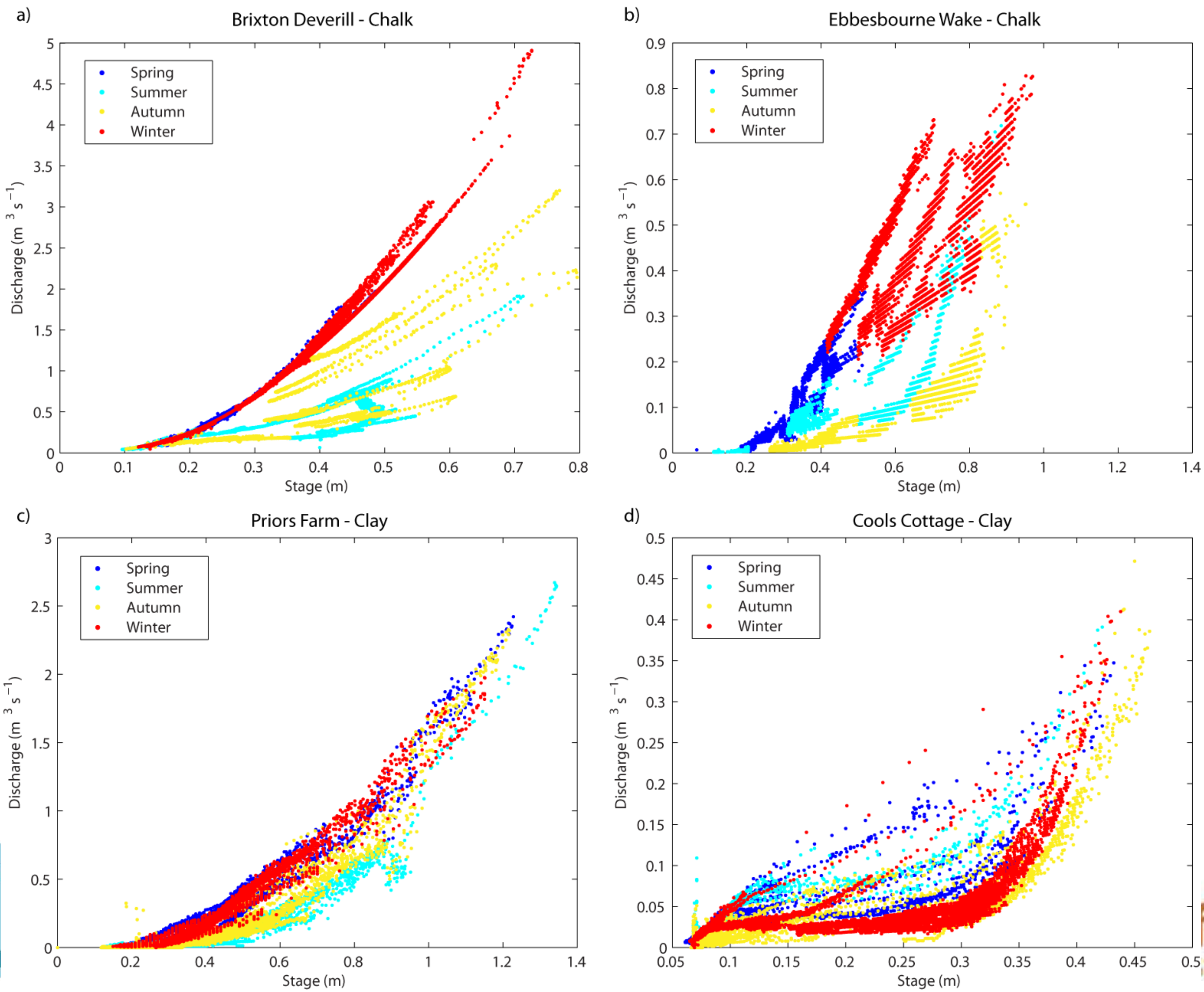
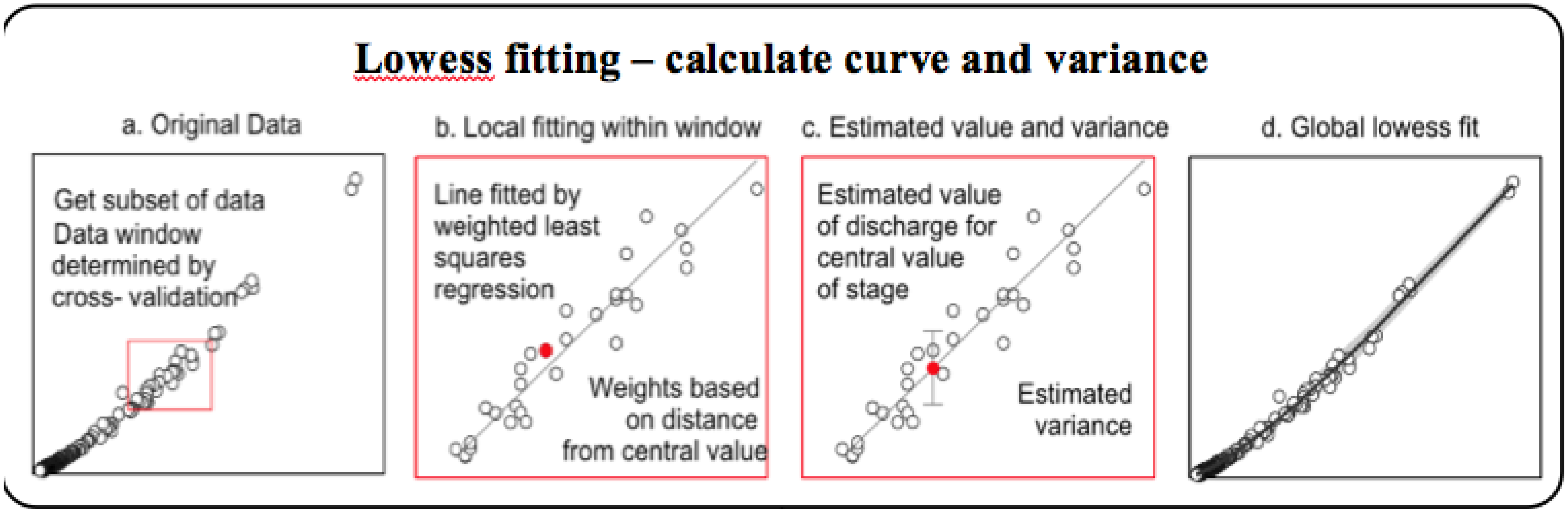
Stage-discharge relationships

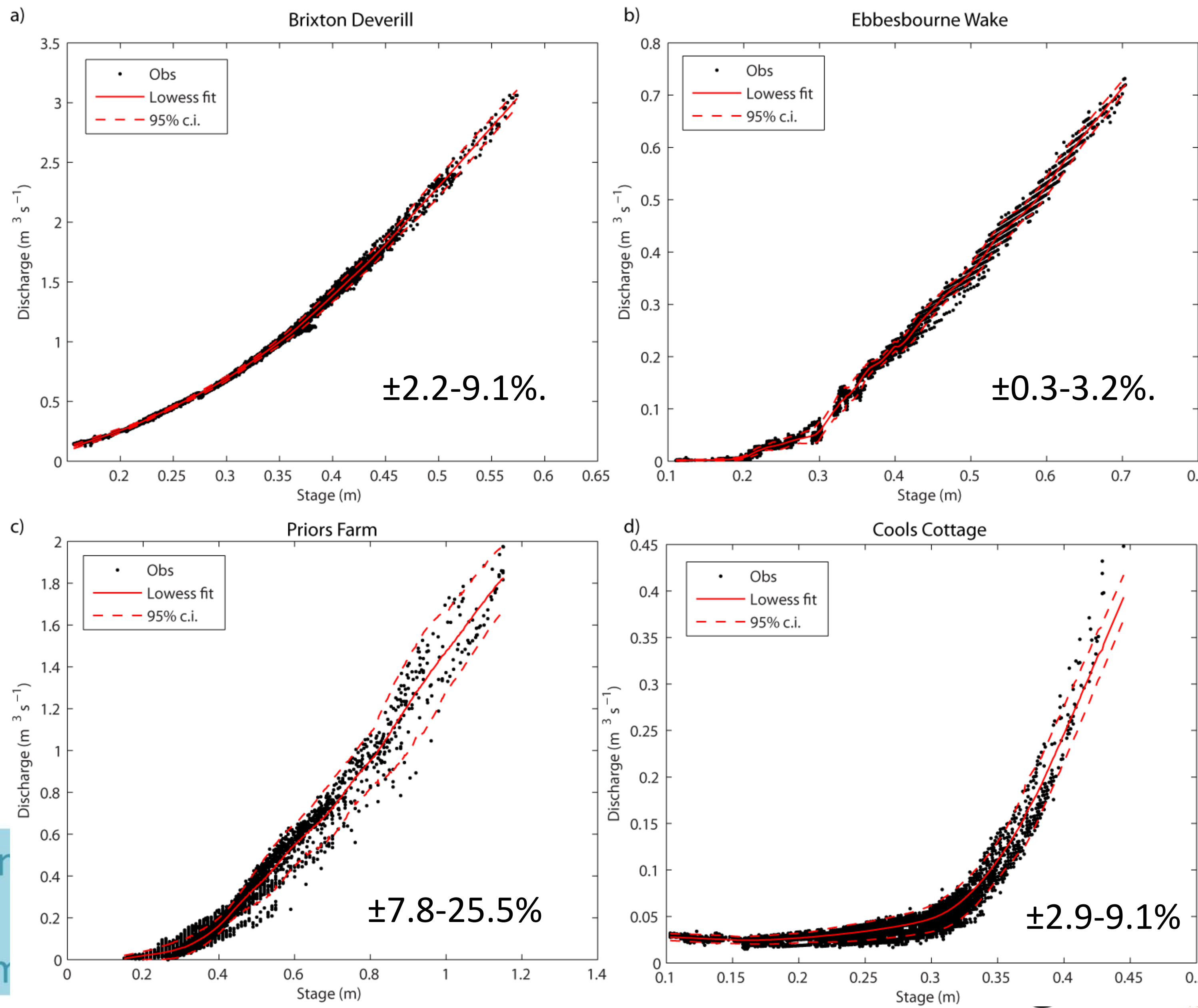


Discharge uncertainty – non-parametric method

Choose a stable period (usually winter) so that uncertainty represents observational uncertainty not structural changes.



Discharge uncertainty



Error modelling

Time series of residuals from uncertainty analysis
→ Calculate lag-1 correlation (α)
→ Generate random noise component (W_k)
→ Scale W_k by standard deviation of residuals at each stage height
→ Add to original time series

1st order autoregressive model

$$q_k = \alpha q_{k-1} + \sqrt{1-\alpha^2}\, W_k$$

where q_k is the error at time k, α is temporal autocorelation and W_k is random white noise at time k.

- α: Lag-1 autocorrelation
- W_k: White noise (scaled by st. dev)

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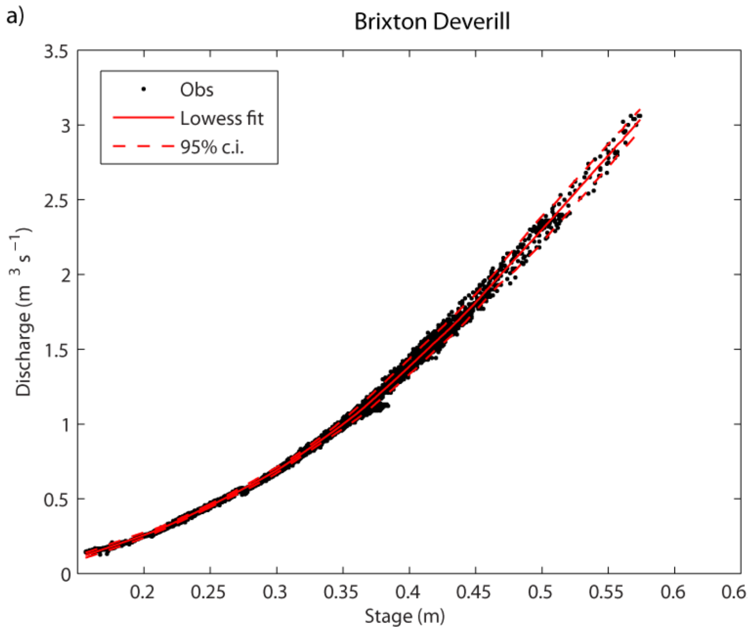
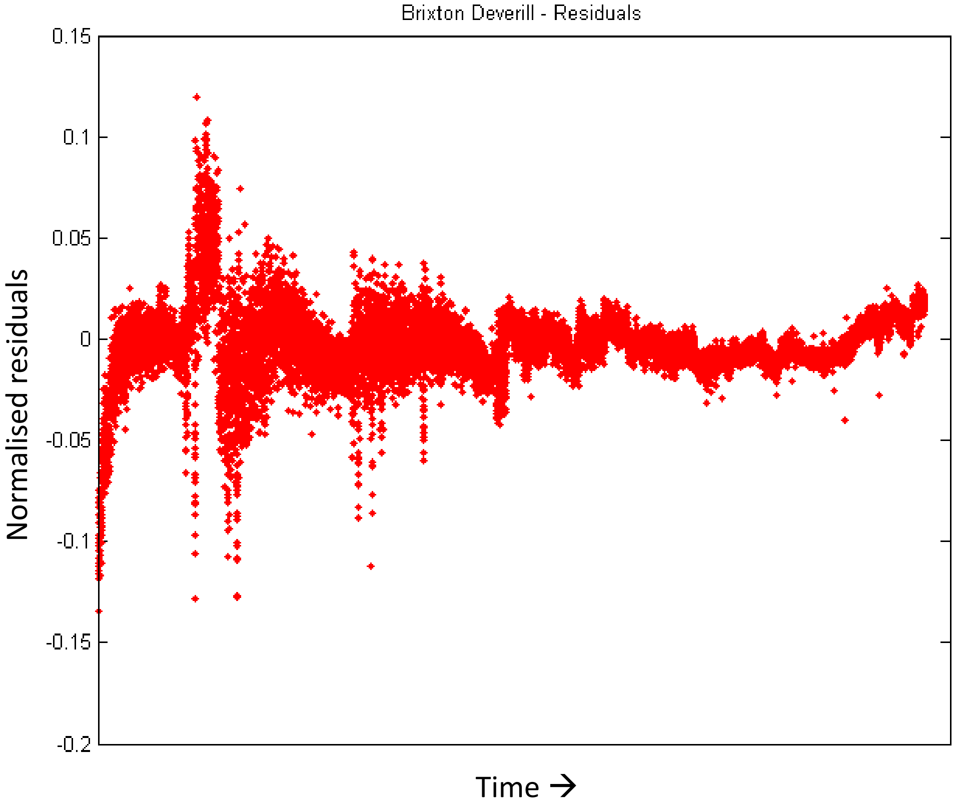
Discharge uncertainty





Residuals have structure over 2 seasons however are independent over short time-scales → represented as random noise.

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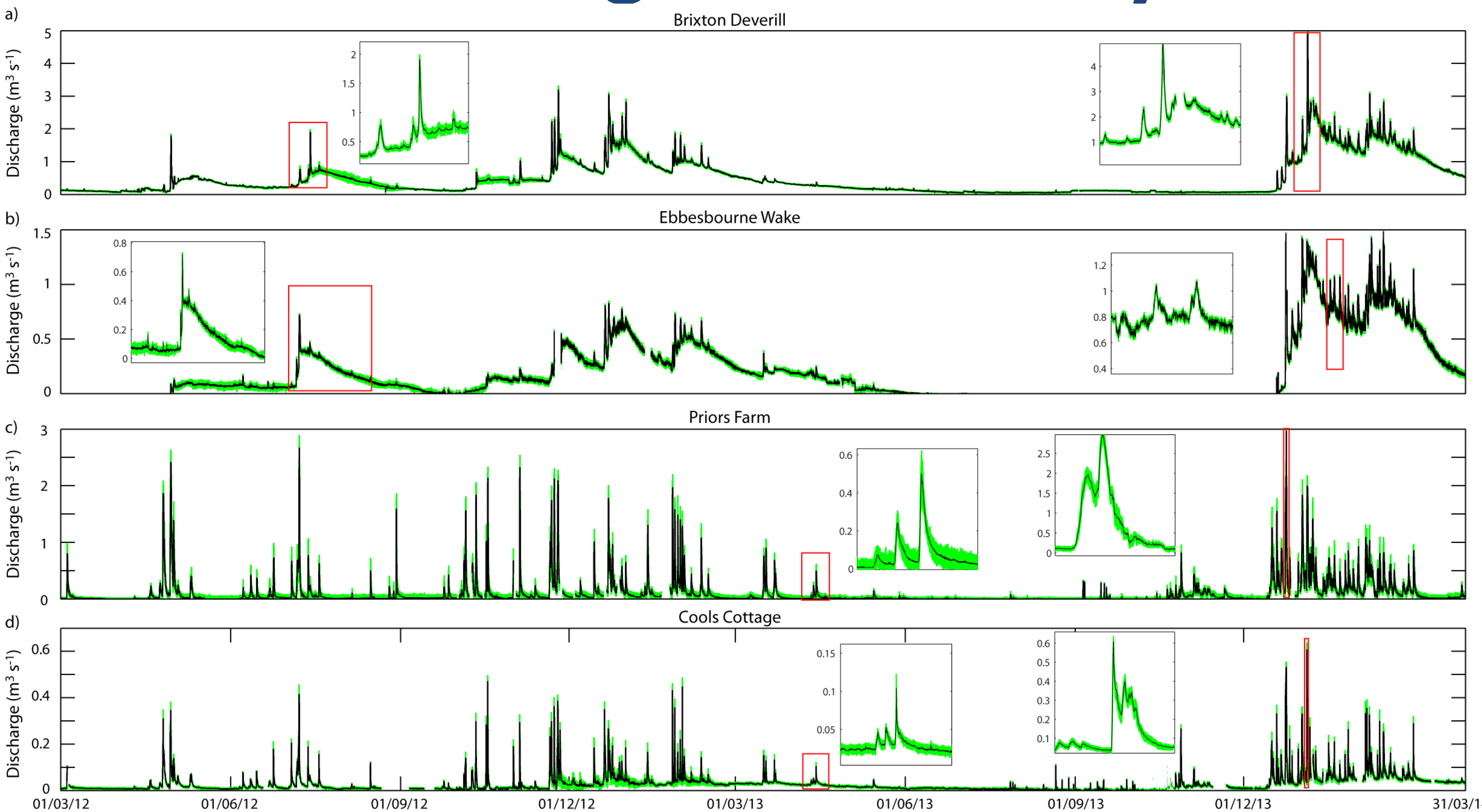
Discharge uncertainty



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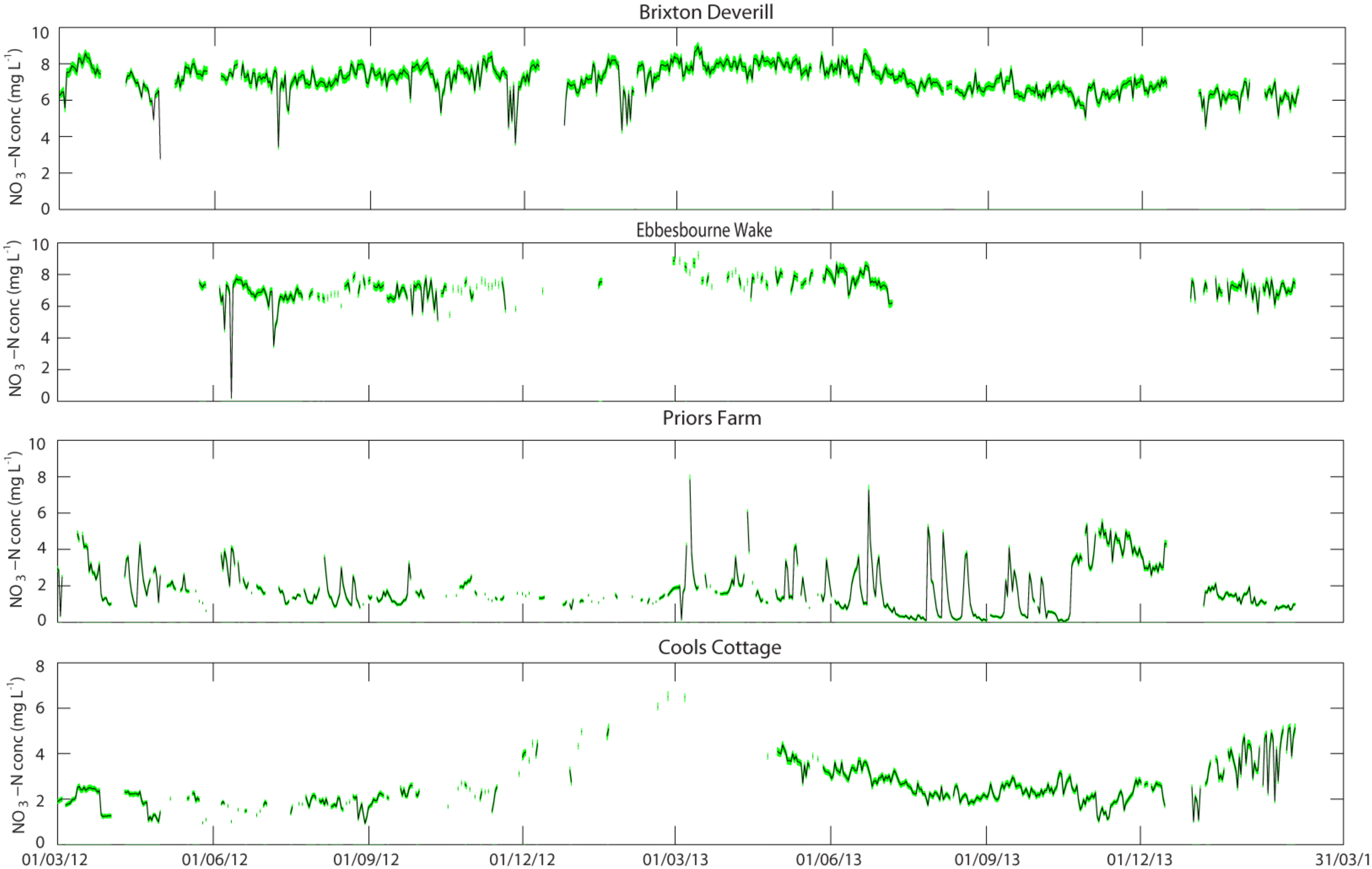
Nutrient uncertainty - Lab

- Repeated lab standards at a variety of concentrations
- Calculate the mean error and standard deviation of error
- No temporal autocorrelation in the errors as samples run in a random order
- Errors were heteroscedastic → larger st. dev errors (%) at lower concentrations

Nutrient uncertainty



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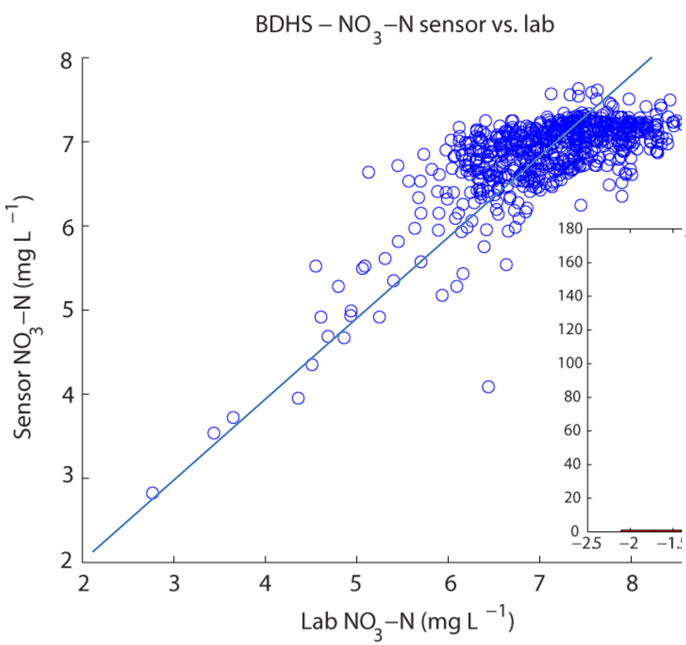
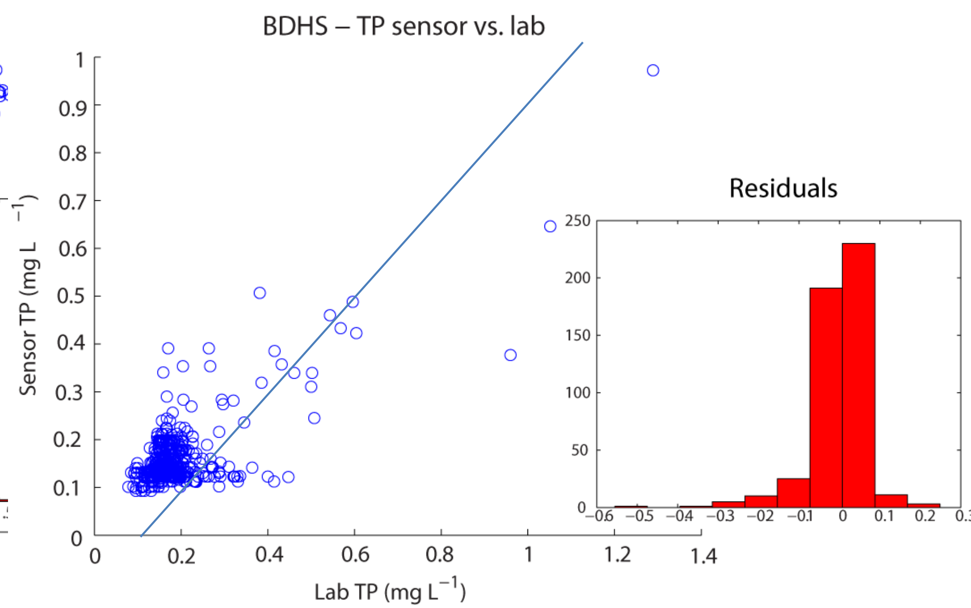
Nutrient uncertainty
- Sensor

- Sensor data series paired with lab samples (within 5 mins)
- All 100 iterations of lab data used to calculate error statistics for sensor data → uncertainty cascaded through analysis





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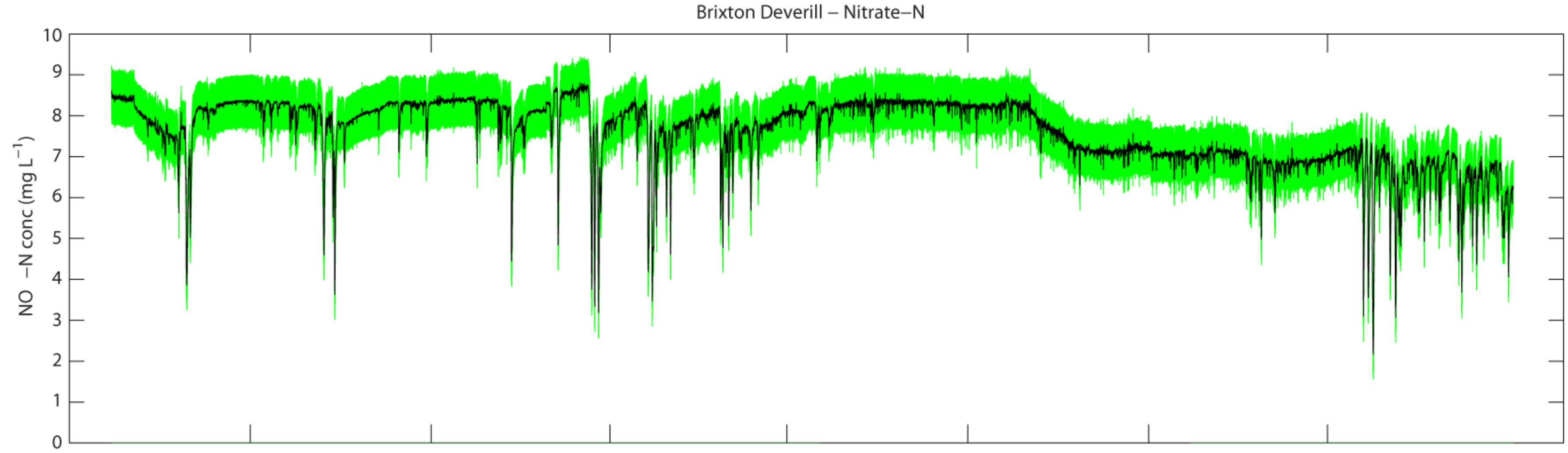
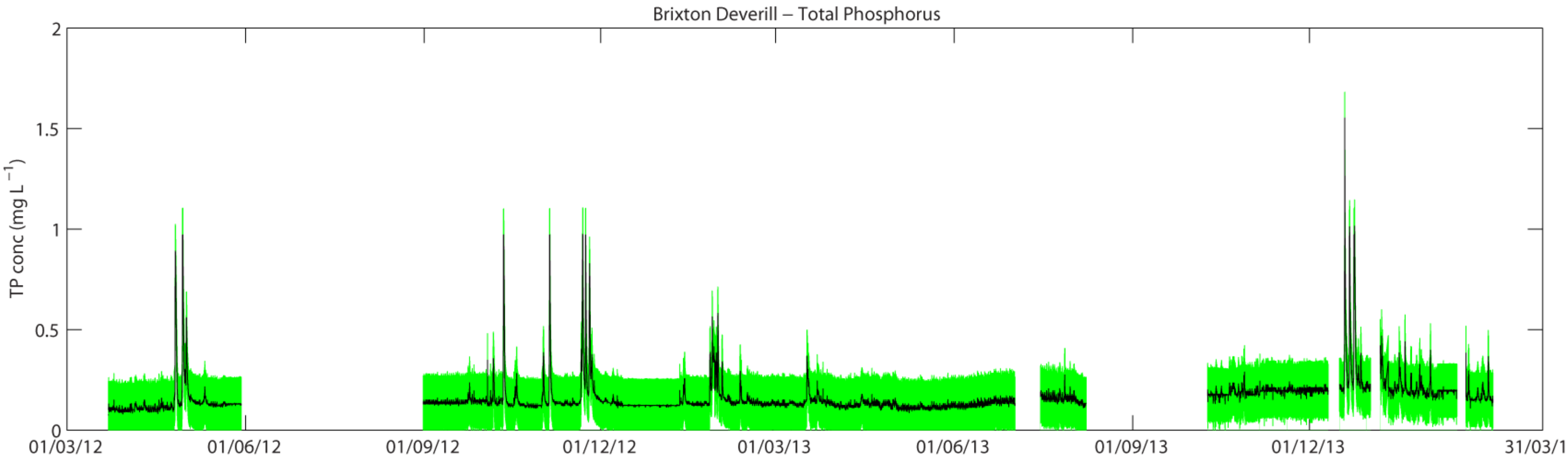
Nutrient uncertainty- Sensor





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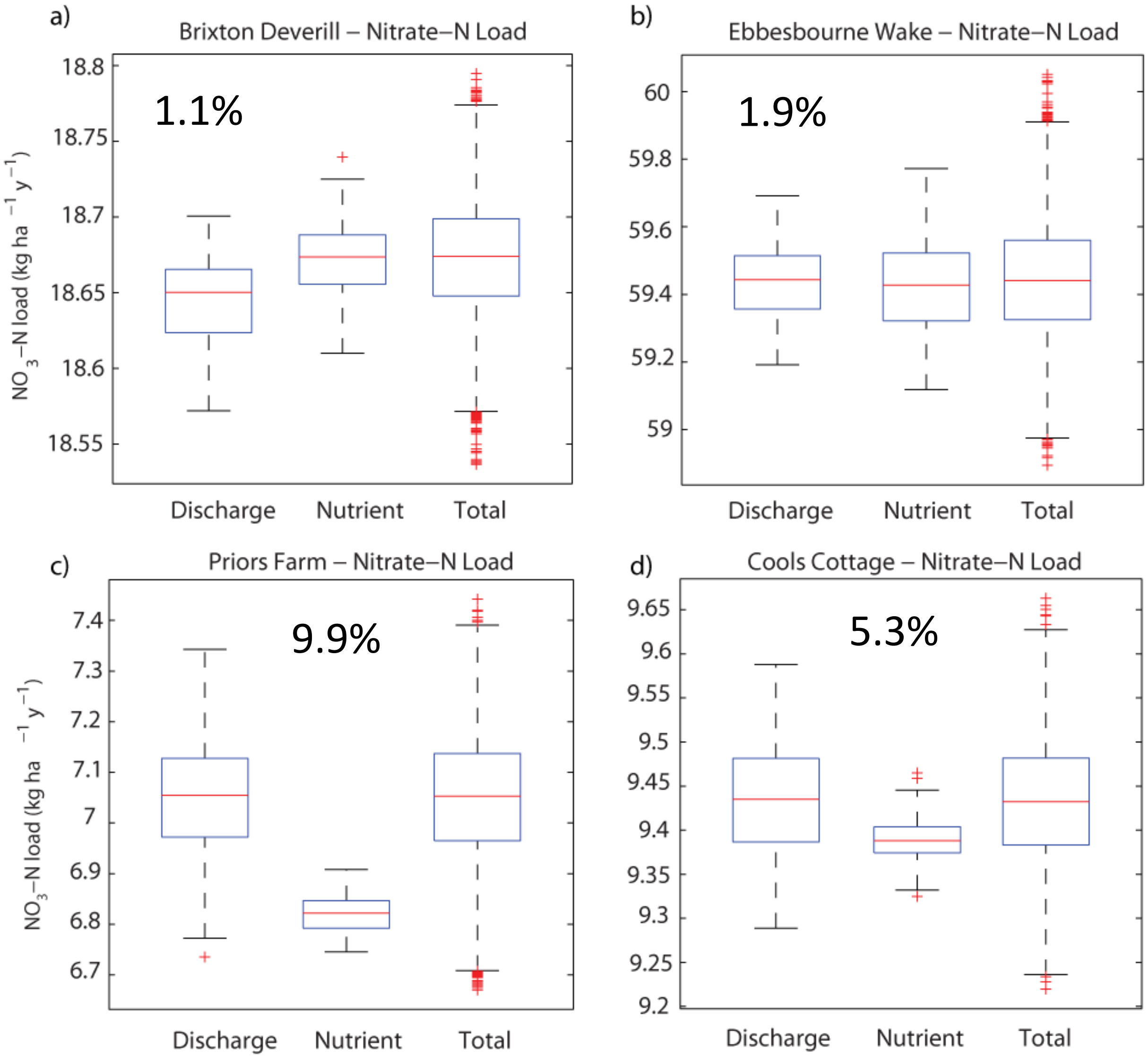
Impact on load estimation



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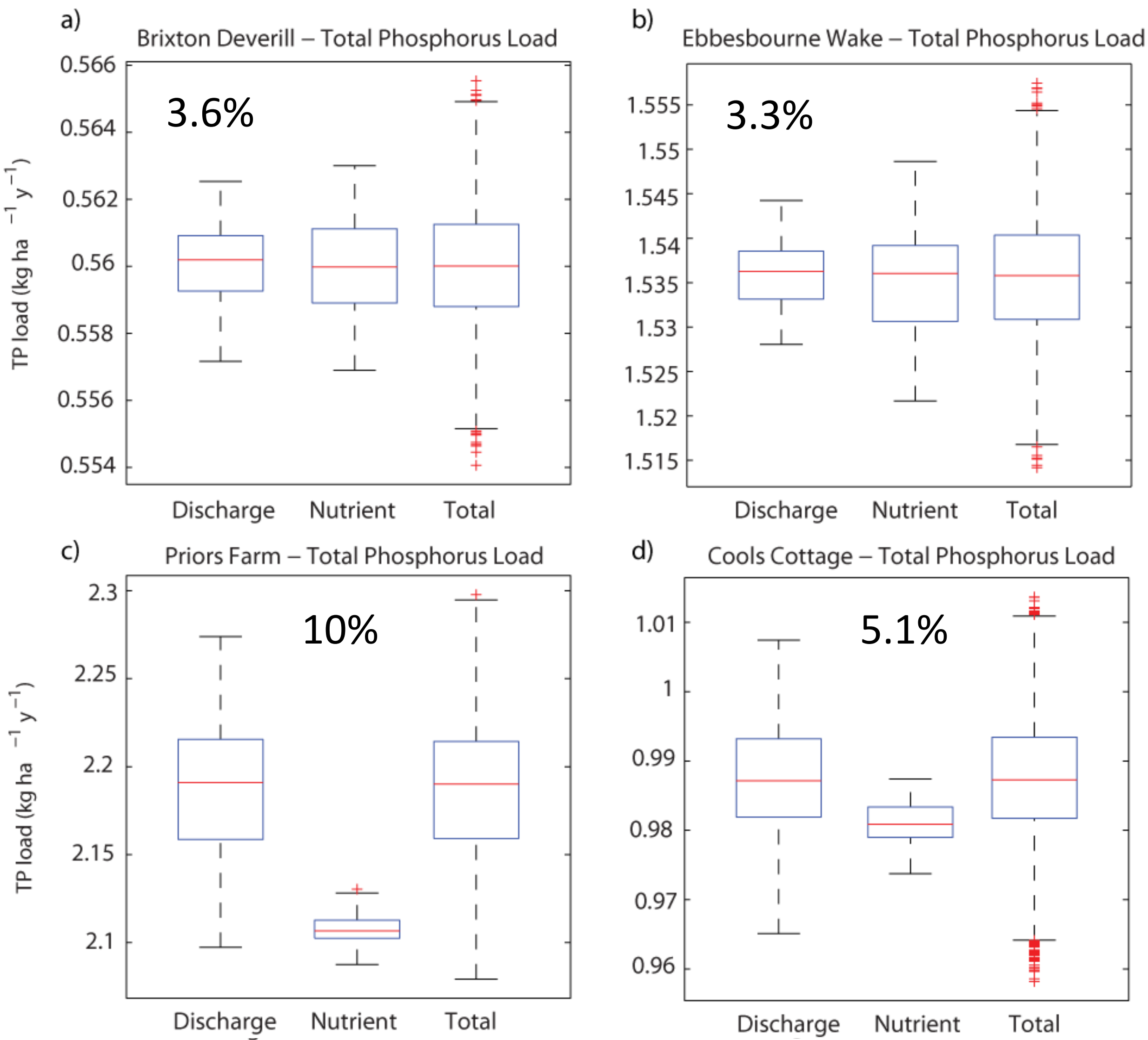
Impact on load estimation



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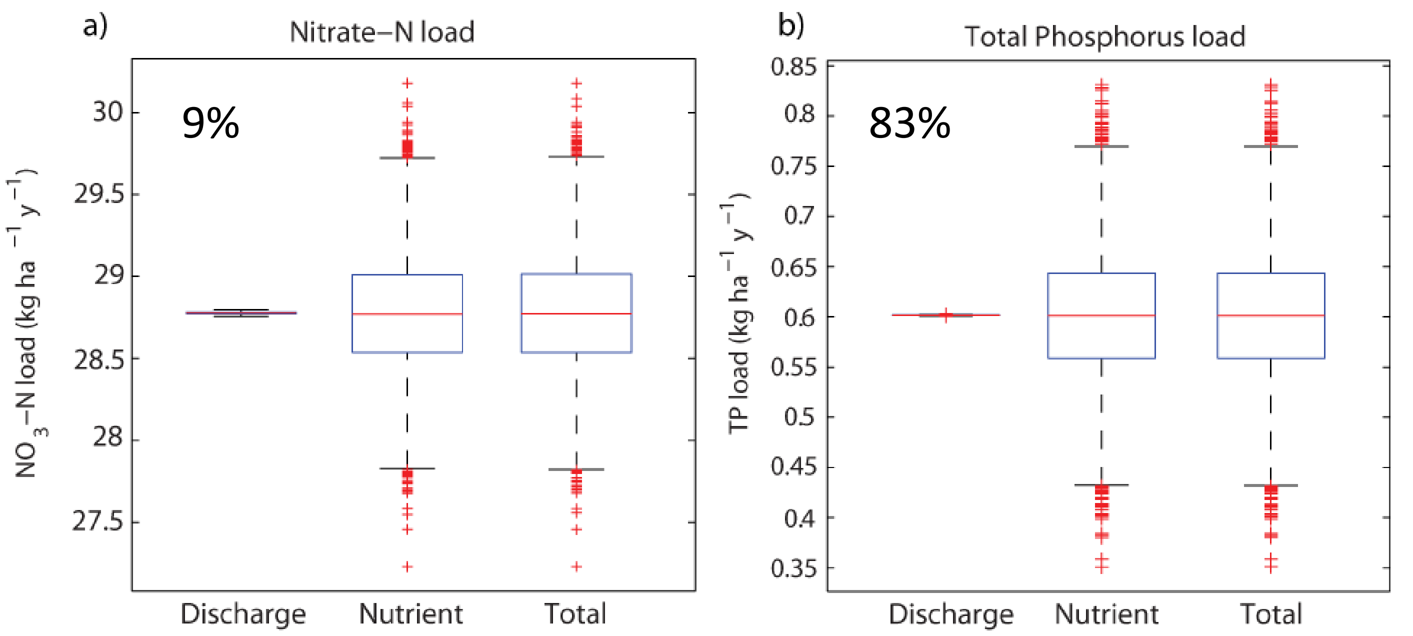
Impact on load estimation - sensor



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Summary

- Using sensors to gain new insights into catchment processes
- Many challenges associated with sensor data collection and management
- Challenge the notion that high-resolution data is always better
- Highlights issues associated with the use of single rating curves
- Proposed a new methodology using non-parametric techniques which are more flexible
- Allows heteroscedasticity and temporal correlation to be taken into account
- Which is better: frequent but fuzzy data or infrequent and precise?

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