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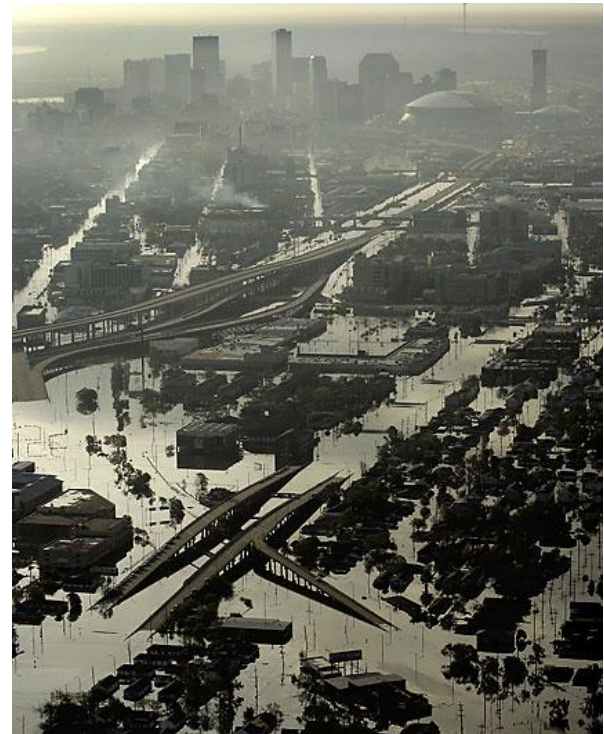
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Using uncertain satellite observations to improve flood mapping and forecasting



Key developments in flood risk management

- Better terrain data
- 2D models
- Bigger models
 - due to faster algorithms, parallel processing and faster computers
- Use of satellite data to constrain model predictions



LiDAR terrain data



Geomatics
Group

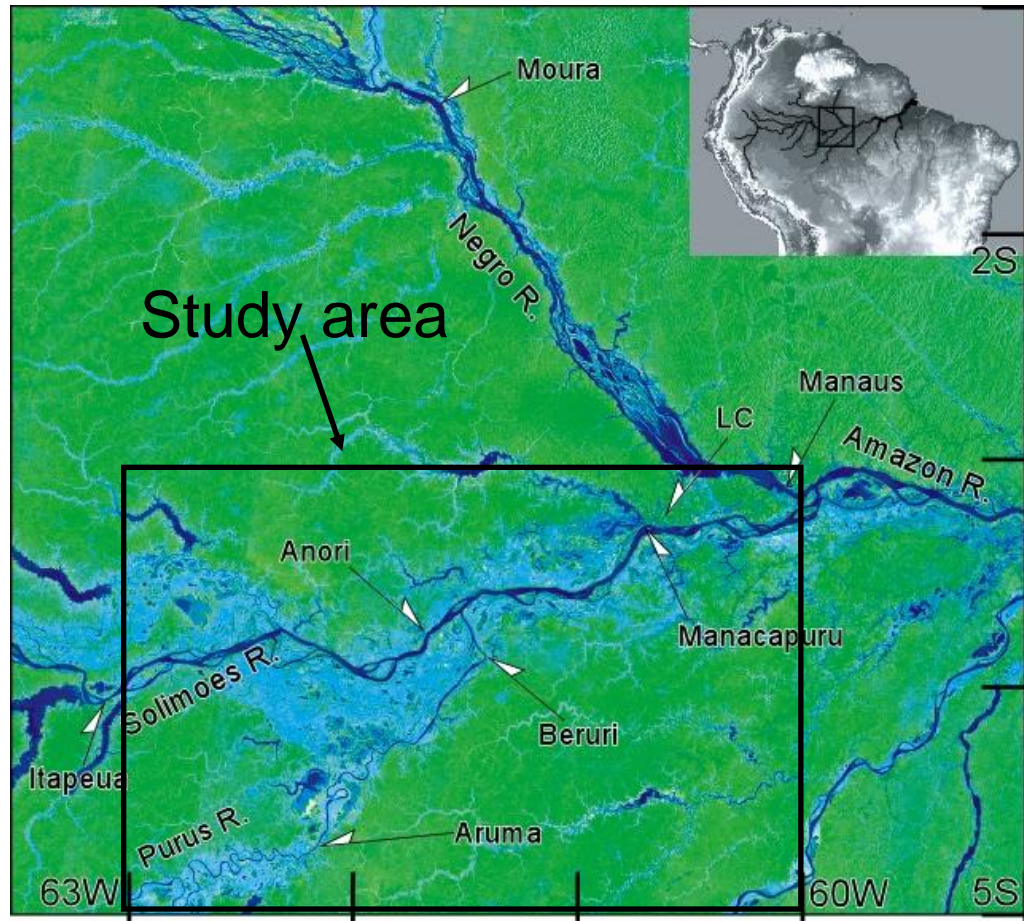
50cm spatial resolution, ~5cm rmse vertical error

2D models: Baltimore, USA



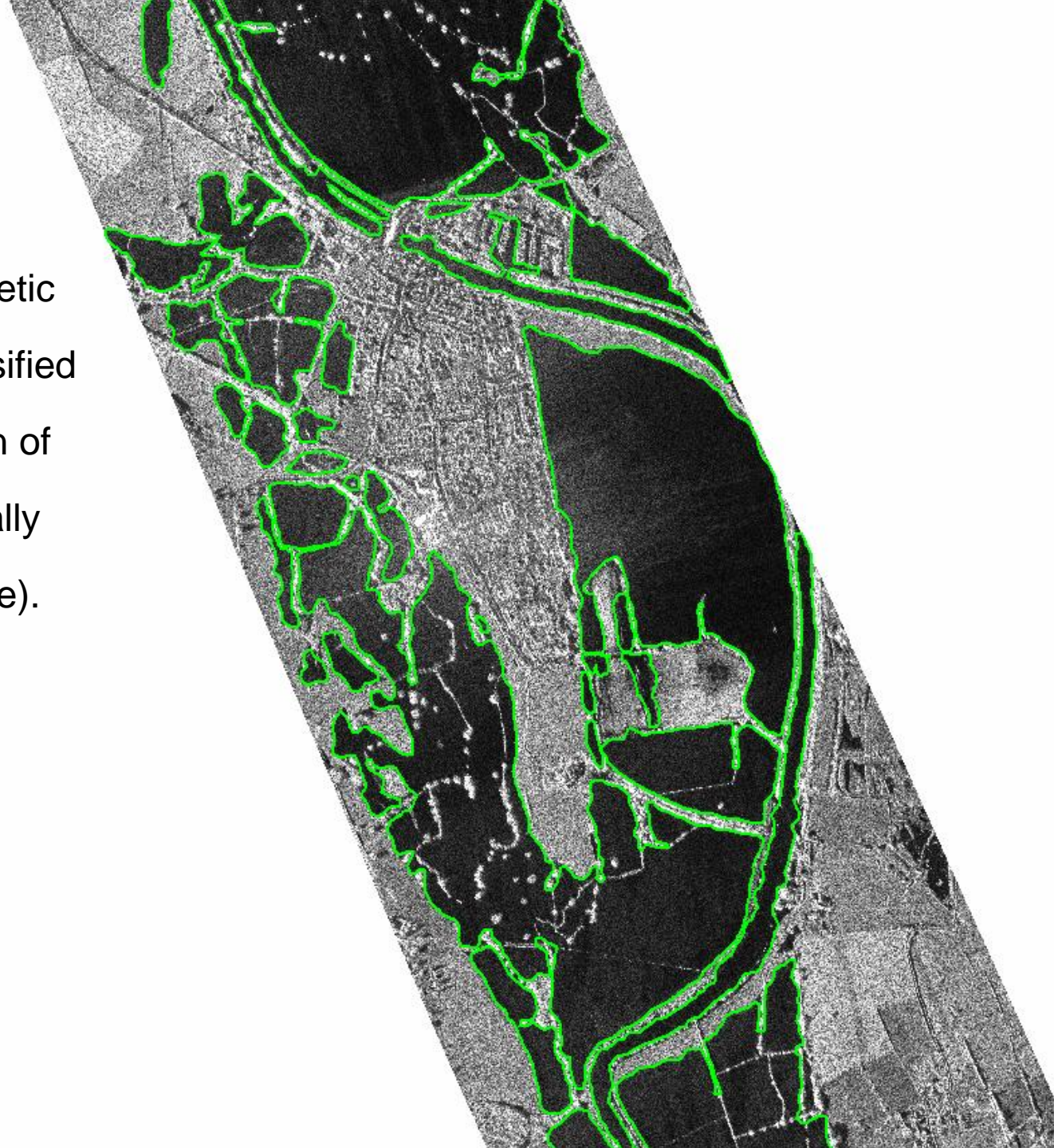
6m model, 700k cells, 3 hour flood, 4 minutes compute time

Bigger models: central Amazon, Brazil

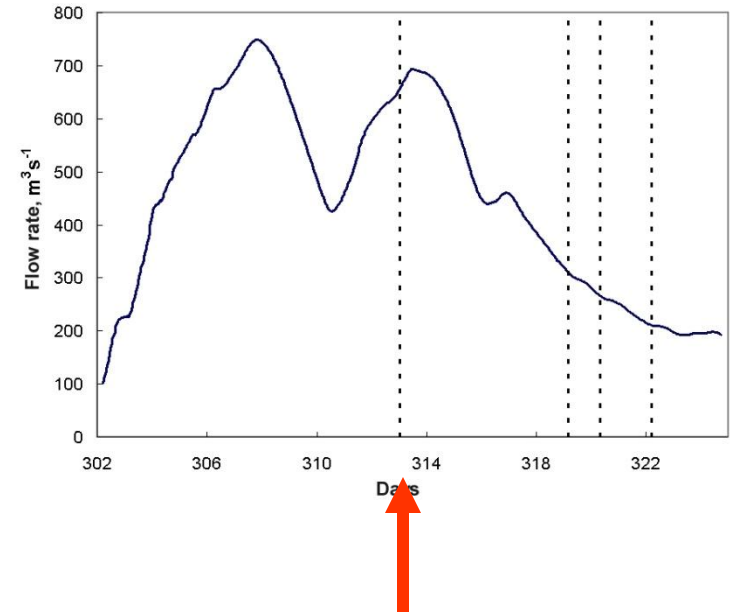
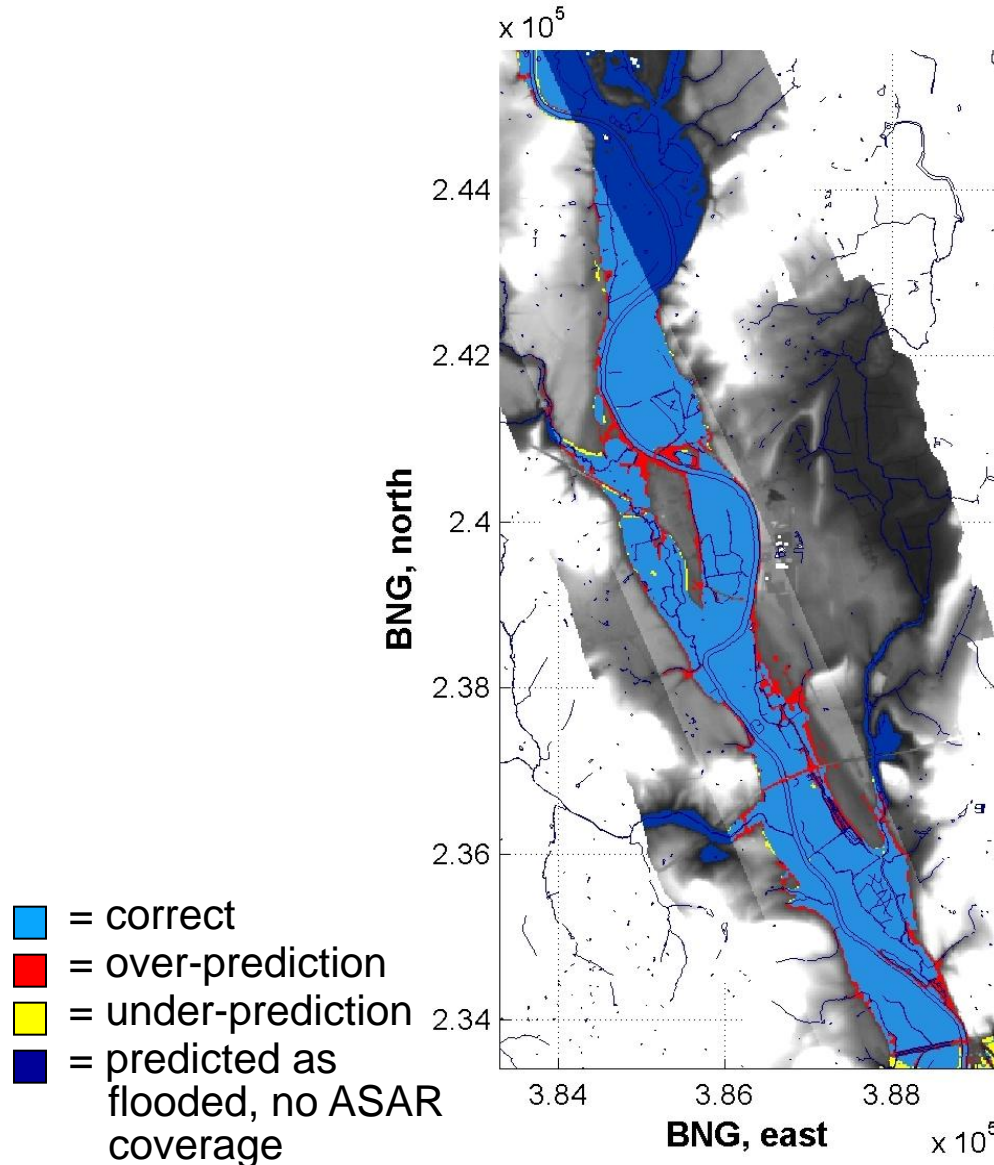


270m model
750k cells
2 year run
~1 day compute time

Airborne Synthetic Aperture Radar classified at a spatial resolution of 1m, using a statistically active contour (Snake).



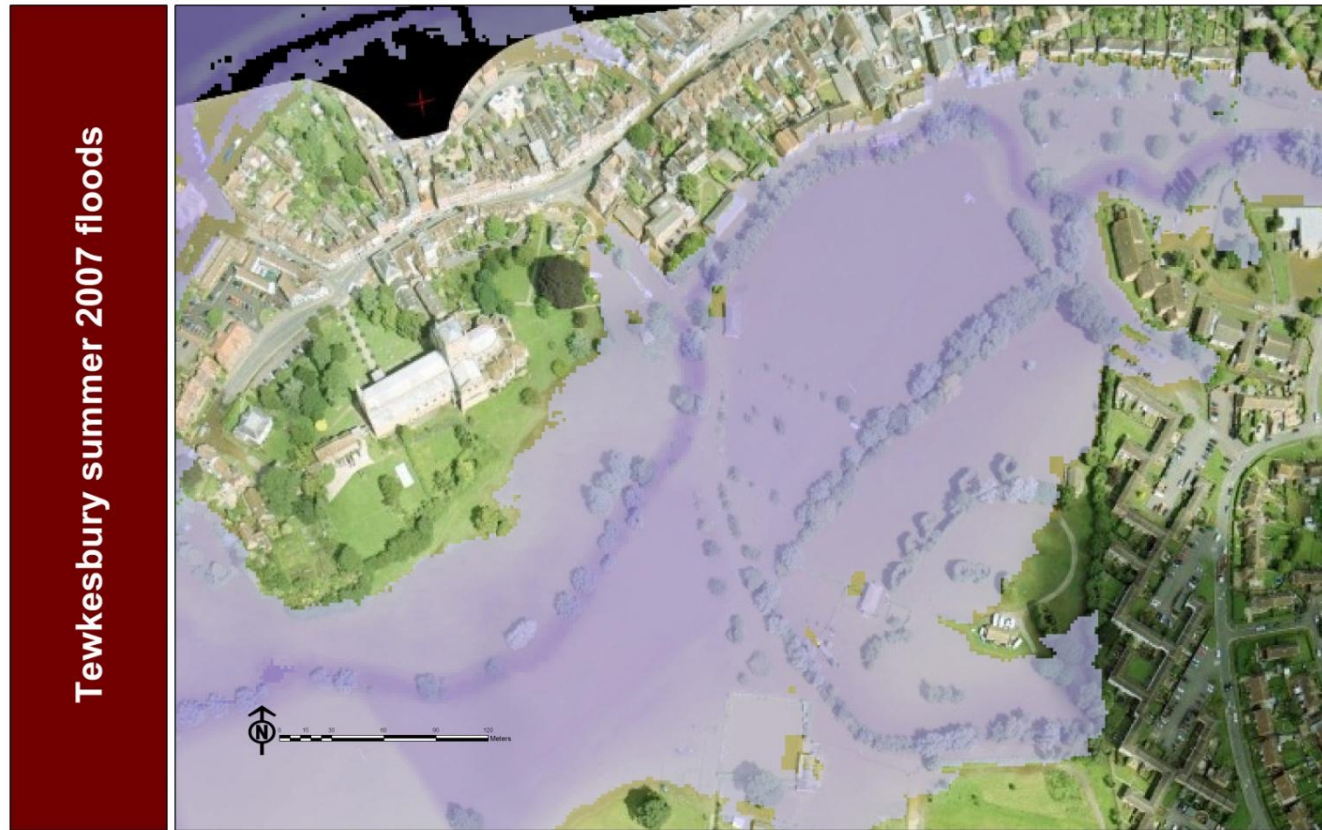
Upton on Severn, UK – 18m model vs airborne SAR



Model fit = 89%

Tewkesbury, UK

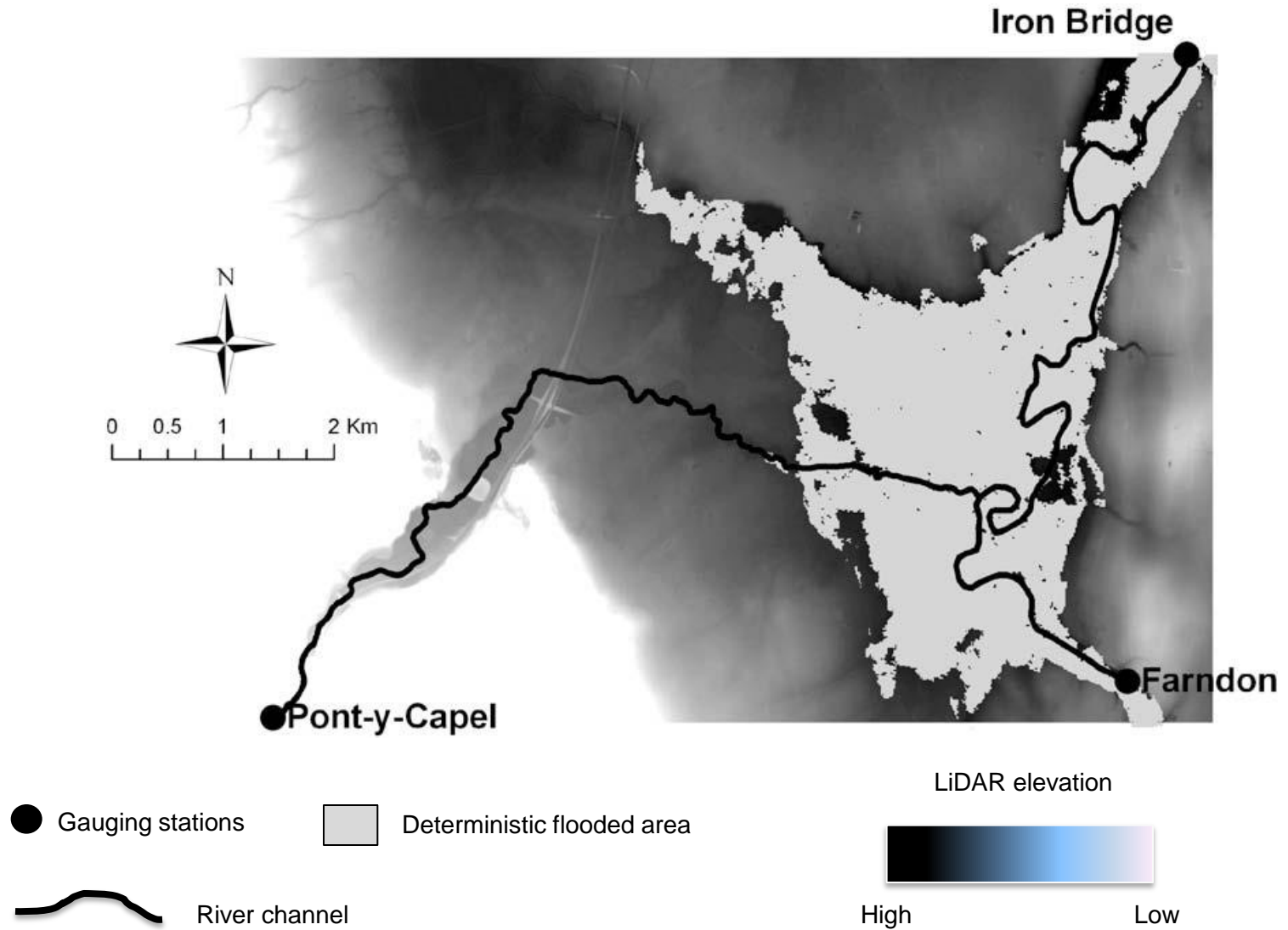
- Whole city flood modelling at 2m resolution, ~4M cells – Tewkesbury, UK
summer 2007



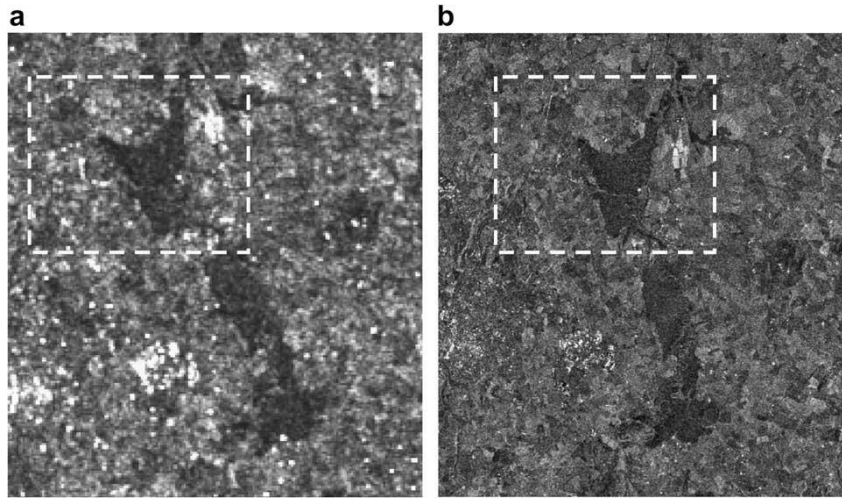
Dealing with uncertainty

- Satellite data often treated as deterministic ‘truth’
- Actually need to account for observation uncertainty to properly use satellite data in the model validation process
 - Uncertain flood patterns
 - Uncertain water elevations
 - Either from altimeters, or from intersecting imaged shorelines with a DEM
- Need methods to compare uncertain models to uncertain data

How might this work: River Dee, UK



Uncertain model-data comparison

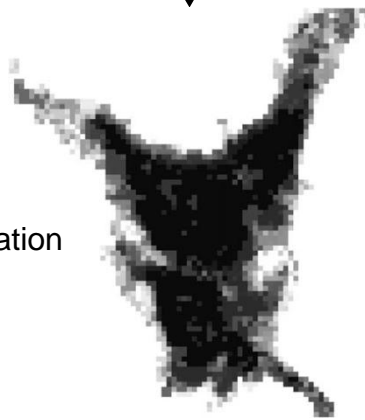


Simultaneous SAR acquisitions over a flood

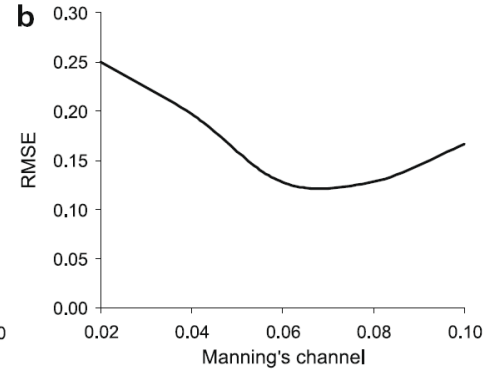
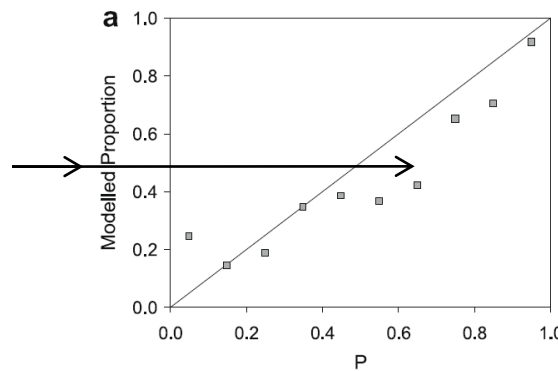
Multiple processing techniques



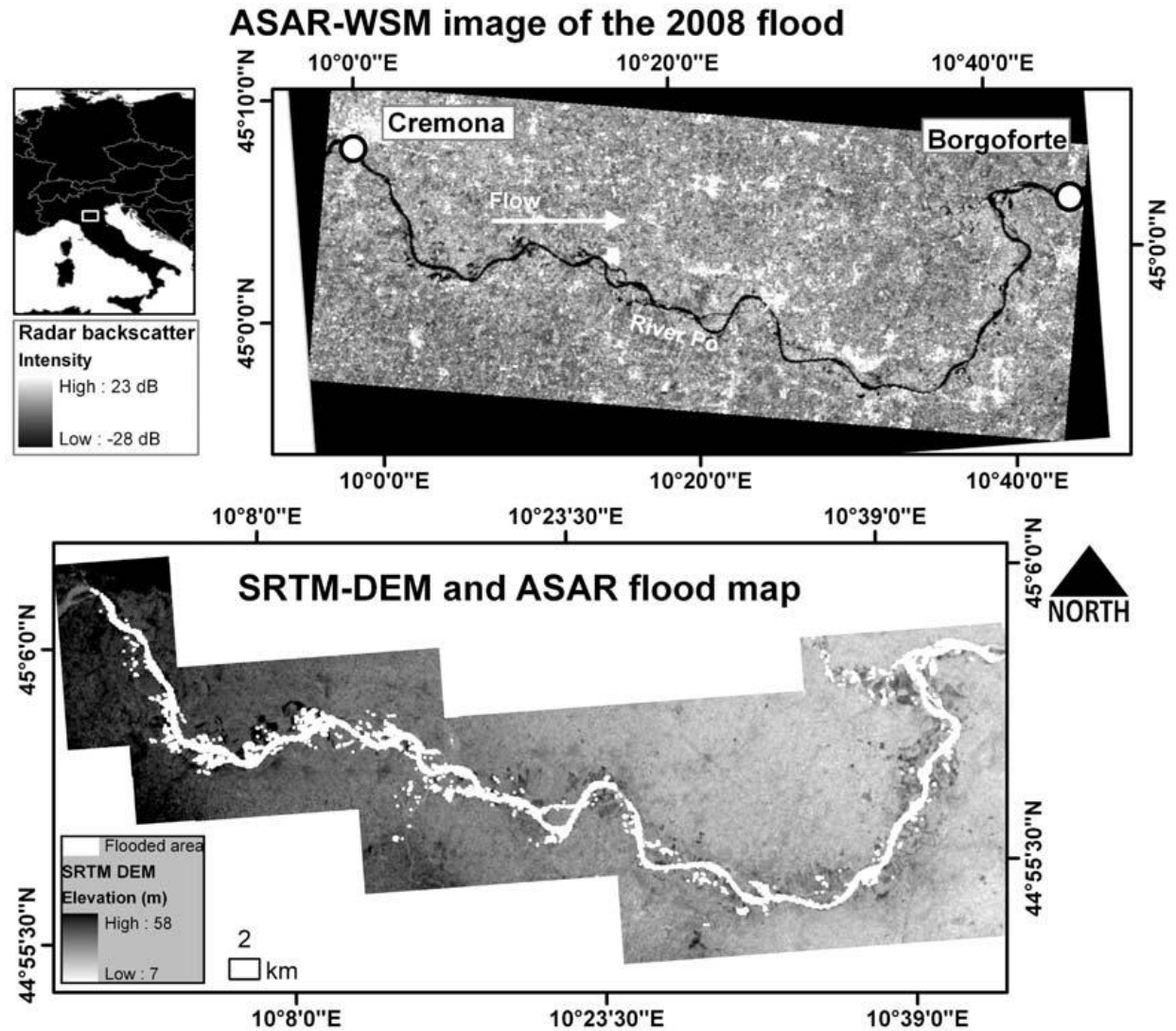
Possibility of inundation map

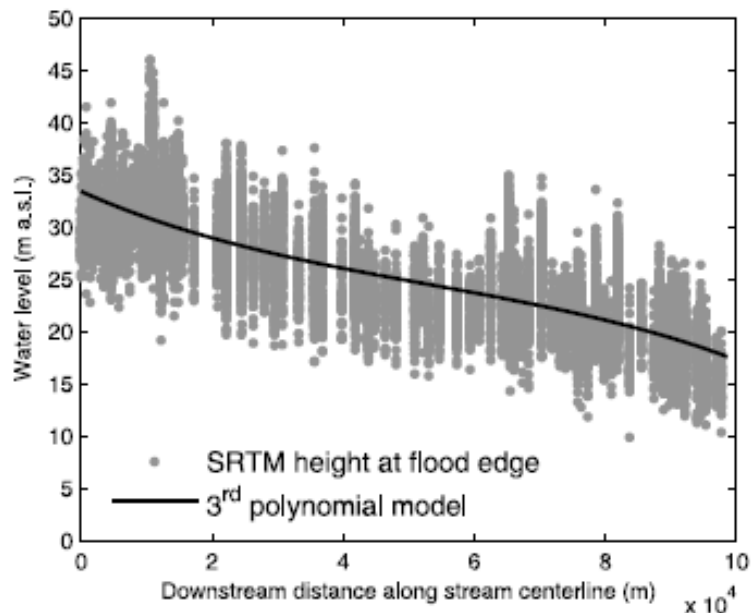
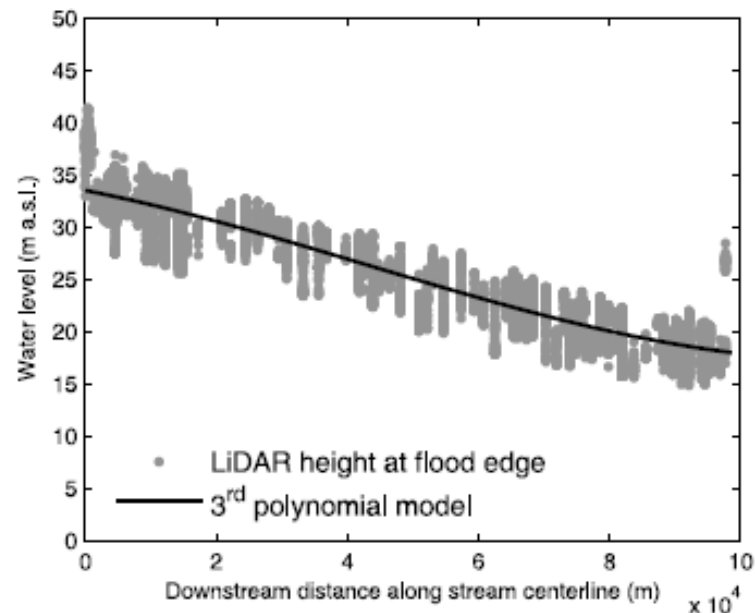
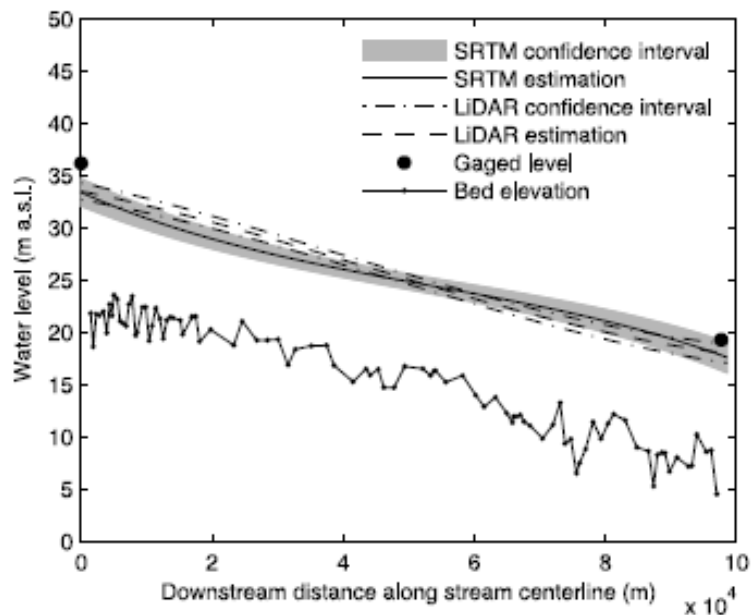
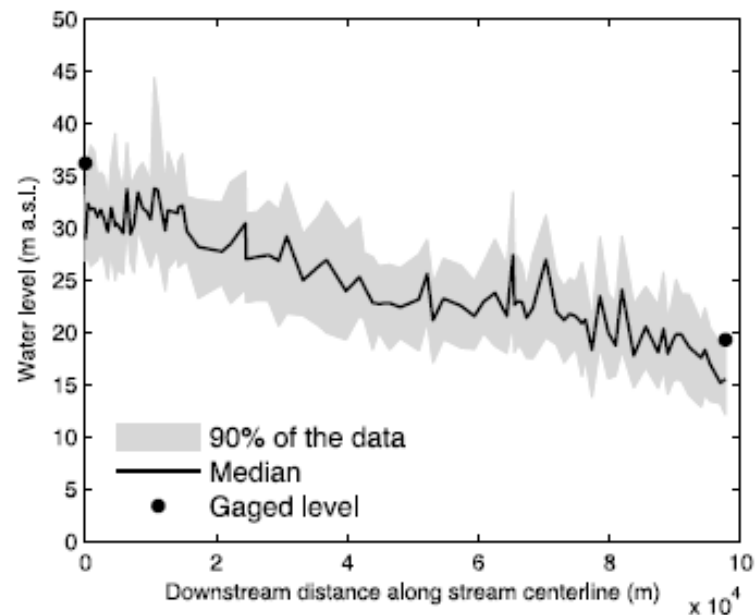


Comparison of predicted probability of flooding given uncertainty over friction parameters using reliability diagrams

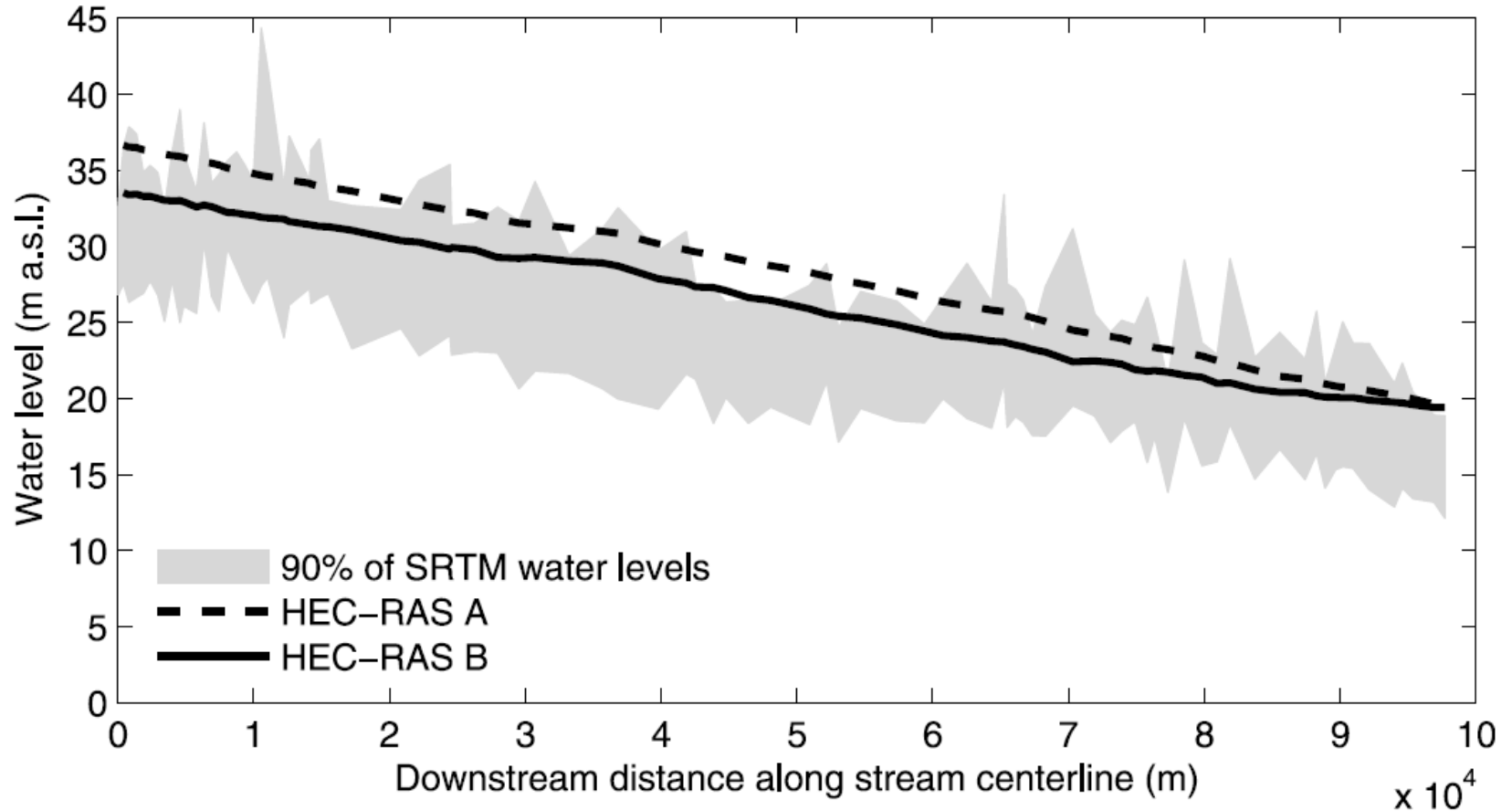


Uncertain water levels: River Po, Italy



a**b****c****d**

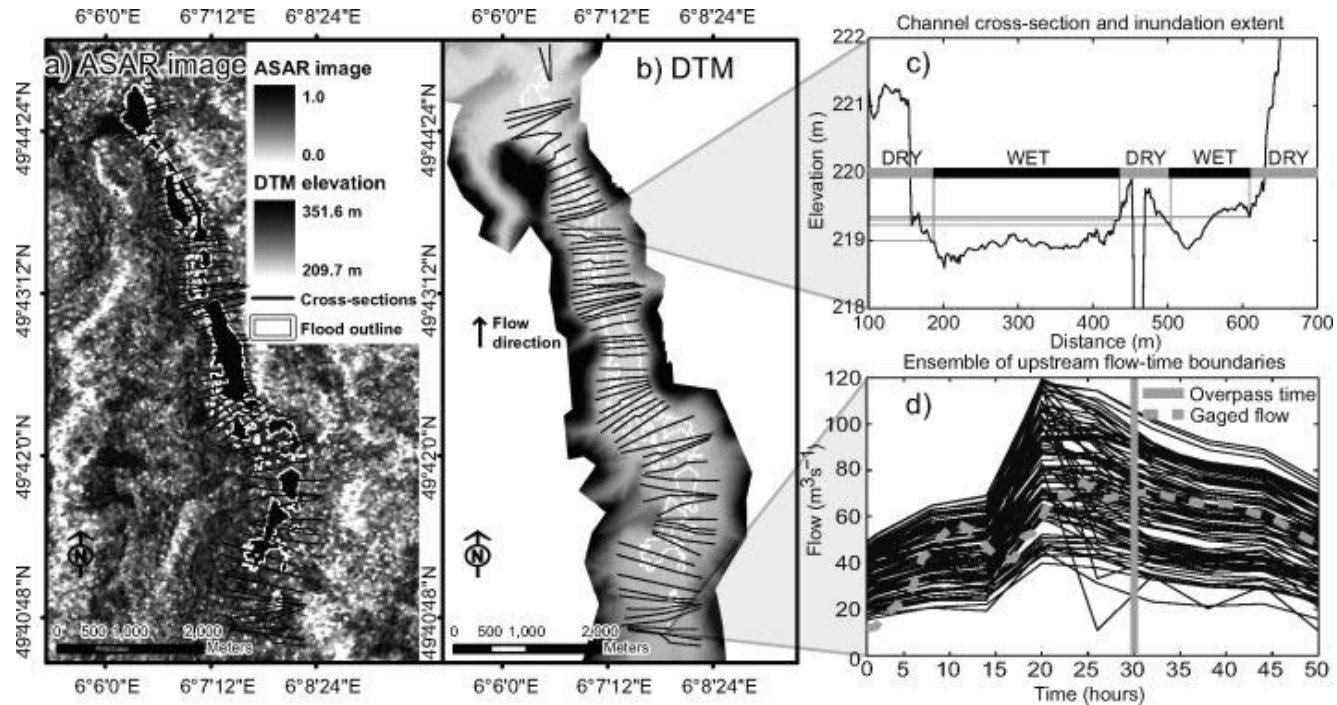
Can these data discriminate between hydraulic models?



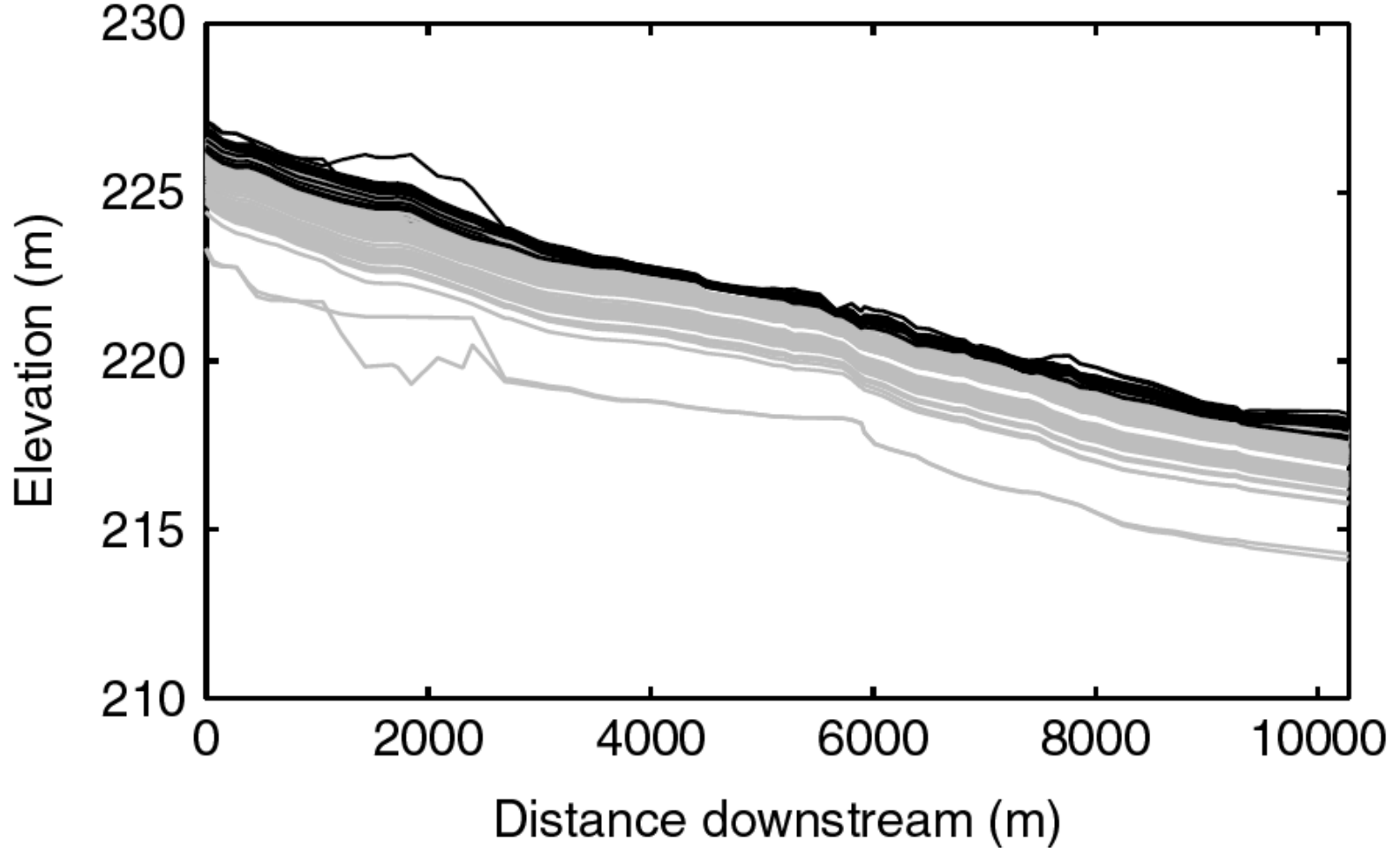
A: model calibrated on a high flow event

B: model calibrated on the 2008 event

Quantifying uncertainty reduction using data assimilation: River Alzette, Luxembourg

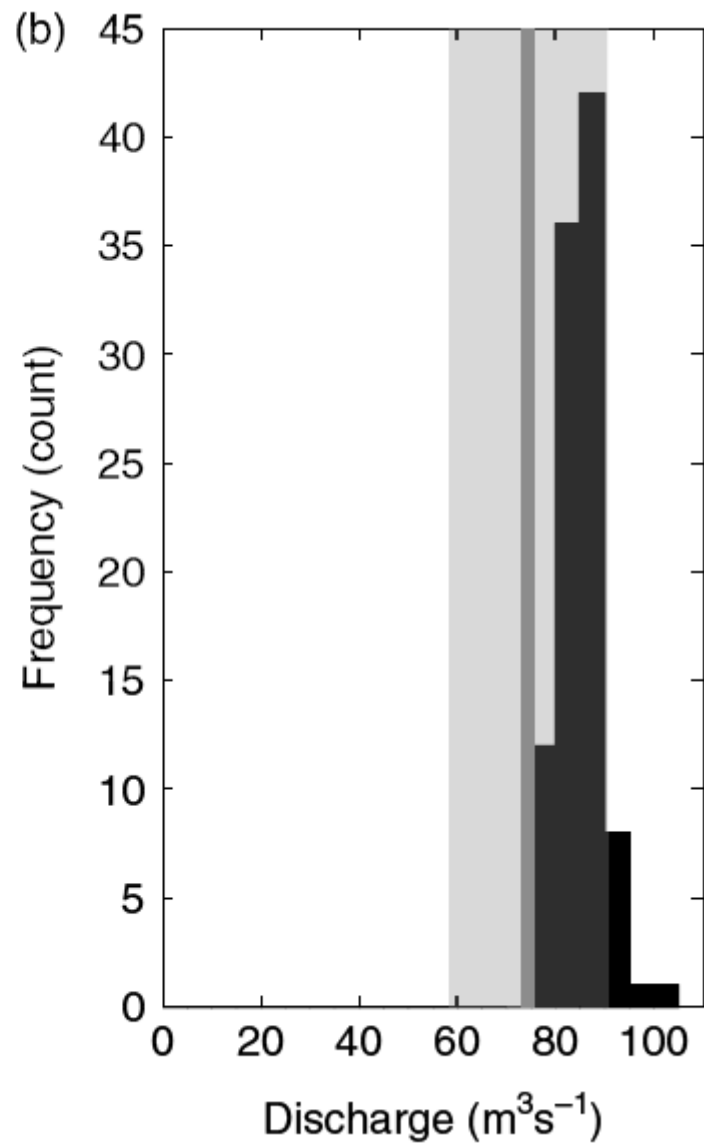
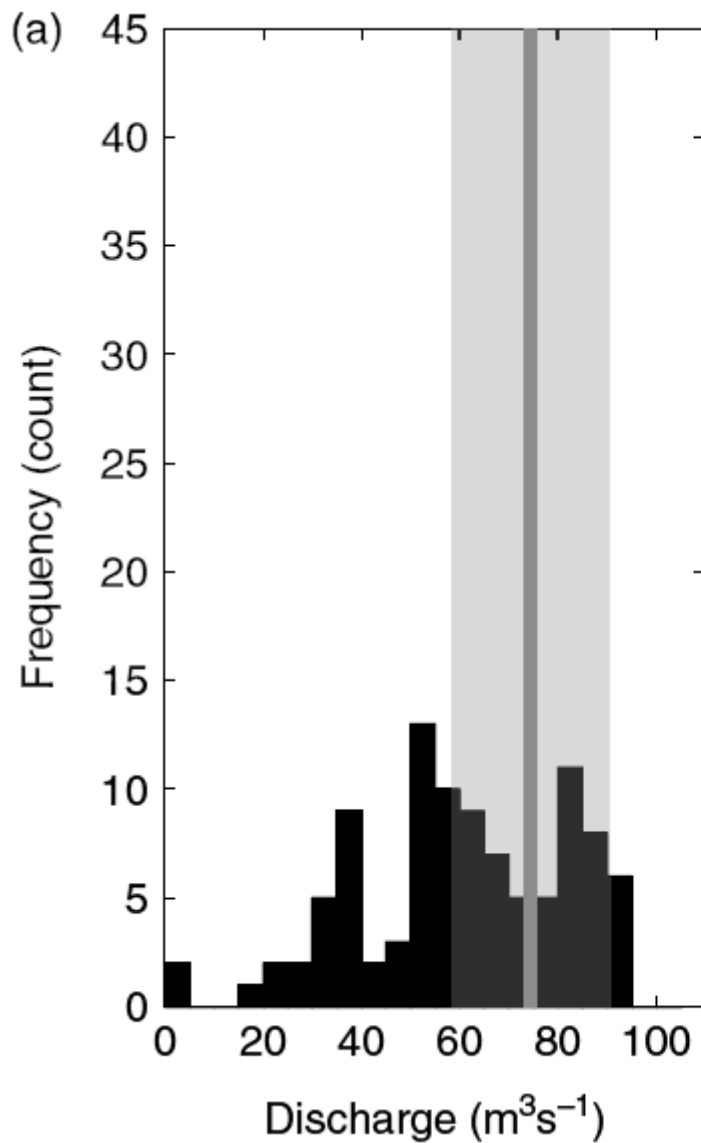


(a) ASAR image of 2003 flood event on the River Alzette with flood outline and river cross-section locations; (b) DTM and cross-section locations; (c) illustration of water level extraction method from inundation extent and cross sections and (d) ensemble of upstream boundary conditions from a simple hydrological model



Light lines: ensemble before assimilation

Dark lines: ensemble after assimilation



Results

- Even quite noisy water elevation and inundation pattern data can map flood waves from space and discriminate between hydraulic models
- Such data when assimilated reduce the error in discharge estimates in a corrupted ensemble
- SWOT should be much better than this and thus have great potential for transforming our ability to model surface water flows.