Spatial scale evaluation of forecast flood inundation maps with SAR data

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Hereford. Image: Dave Throup EA

River Wye valley. Image: Photo by Christopher Furlong/Getty Images

Hereford. Image: Border Telegraph

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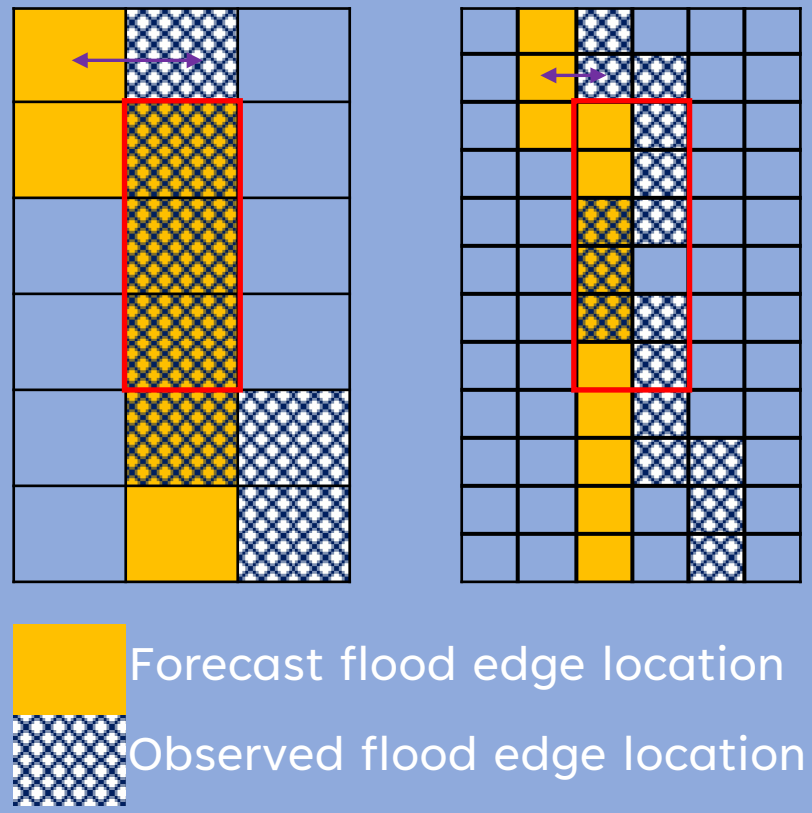
The trouble with conventional binary performance measures

Which forecast is more accurate?

Spatial scale = 50 m
CSI = 0.40, HR = 0.57
FAR = 0.27, PSS = 0.30

Spatial scale = 25 m
CSI = 0.12, HR = 0.19
FAR = 0.18, PSS = 0.01



Forecast flood edge location

Observed flood edge location

- Spatial scale dependent
- Flood magnitude biased
- Domain averaged
- Mask flood edge accuracy

The solution: scale-selective Fraction Skill Score (FSS)

n = 3

1	1	1
0	0 (n ≡ 1)	0
1	1	1

Forecast fraction flooded

$M_{1ij} = 0$

$M_{3ij} = 6/9$

0	0	1
1	1	1
0	0	1

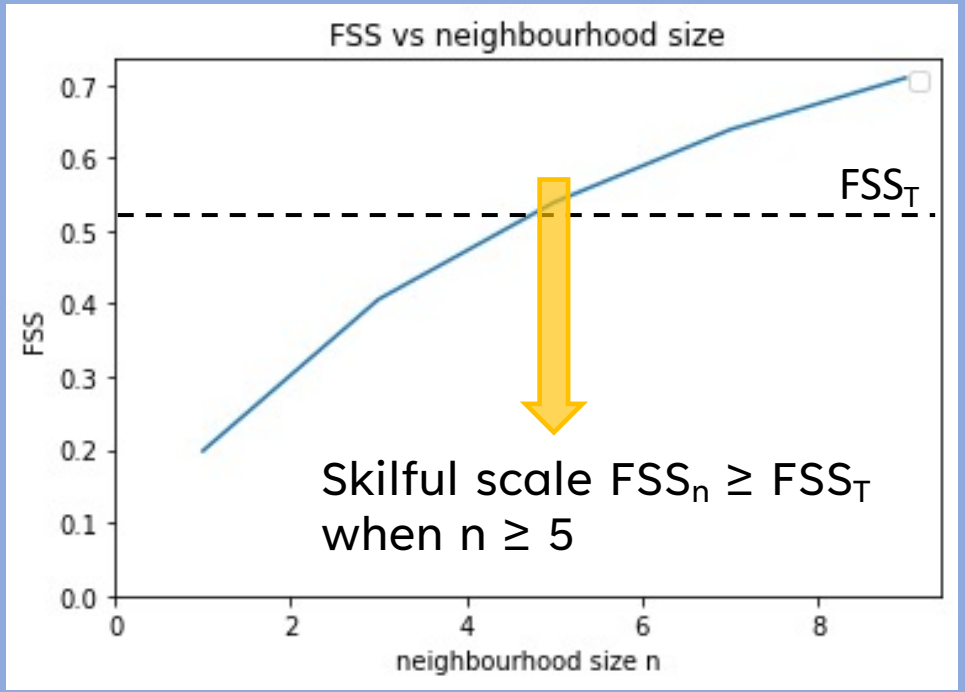
Observed fraction flooded

$O_{1ij} = 1$

$O_{3ij} = 5/9$

$FSS_1 = 0$, $FSS_3 = 0.92$

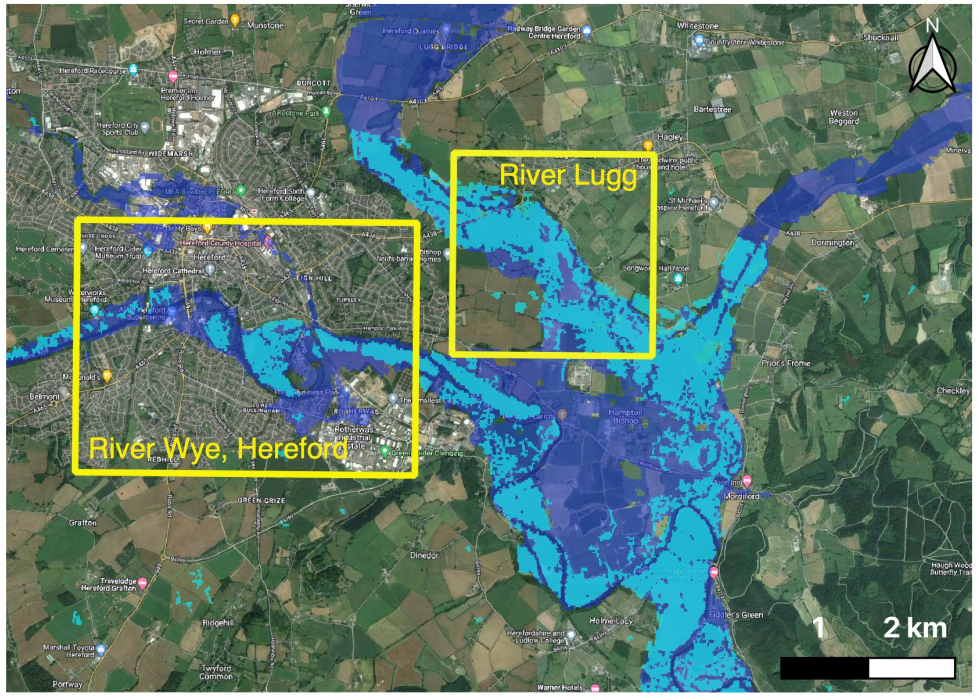
Example flood edge verification

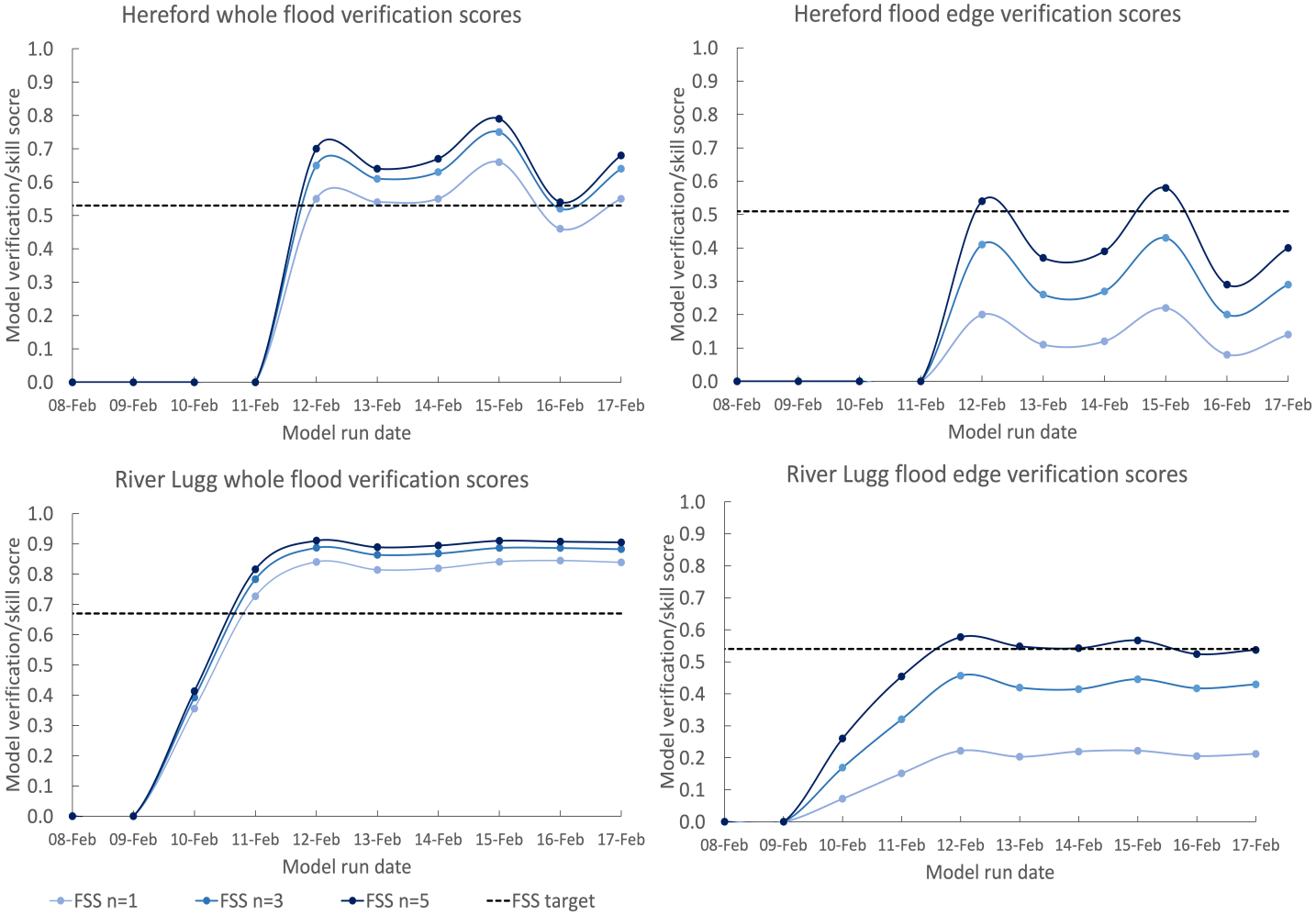


$$FSS_{TARGET} = 0.5 + \frac{observed\ fraction\ flooded}{2}$$

Roberts and Lean, 2008

Results: UK flooding following Storm Dennis, February 2020

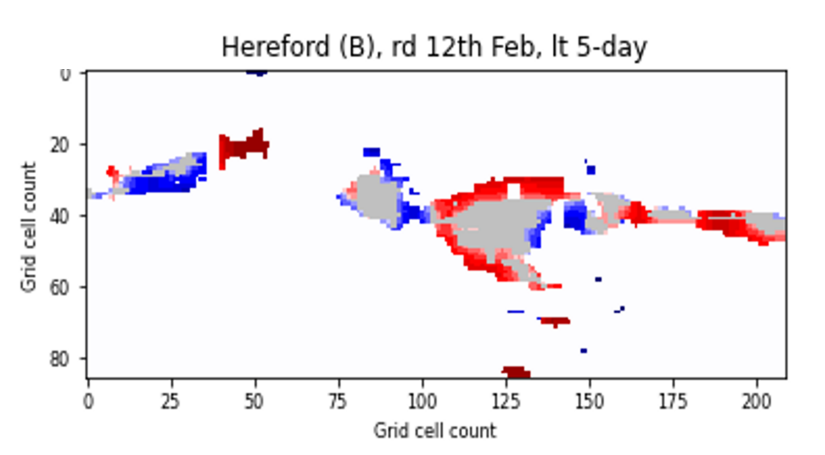




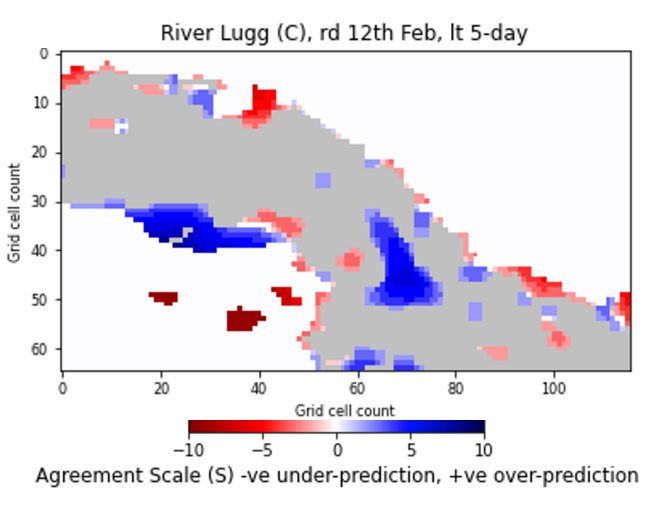
River Lugg flood edge skilful scale at $FSS_n \geq FSS_T$ at n = 5
Displacement distance $D_T = 2n_T$ = 2.5 grid cells (62.5 m)

Results: Categorical Scale Maps

River Wye, Hereford



River Lugg



- A location specific skilful scale can be calculated at each grid cell.
- Combining this with a contingency map creates a new categorical scale map.

Dey et al., 2014

Summary and benefits of scale selective evaluation

- With emphasis on scale, rather than score, we can compare across different flooding scenarios, spatial scales and forecast systems.
- The skilful scale determined for the flood edge location provides a physically meaningful measure of forecast accuracy.
- Categorical scale maps allow location specific model improvements.

EGU Abstract

References

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- Hooker, H., Dance, S. L., Mason, D. C., Bevington, J., and Shelton, K.: Spatial scale evaluation of forecast flood inundation maps, doi.org/10.31223/X5DG9C, 2022.
- Roberts, N. M. and Lean, H. W.: Scale-selective verification of rainfall accumulations from high-resolution forecasts of convective events. Monthly Weather Review, doi.org/10.1175/2007MWR2123.1, 2008.