A closer look at the Fractions Skill Score

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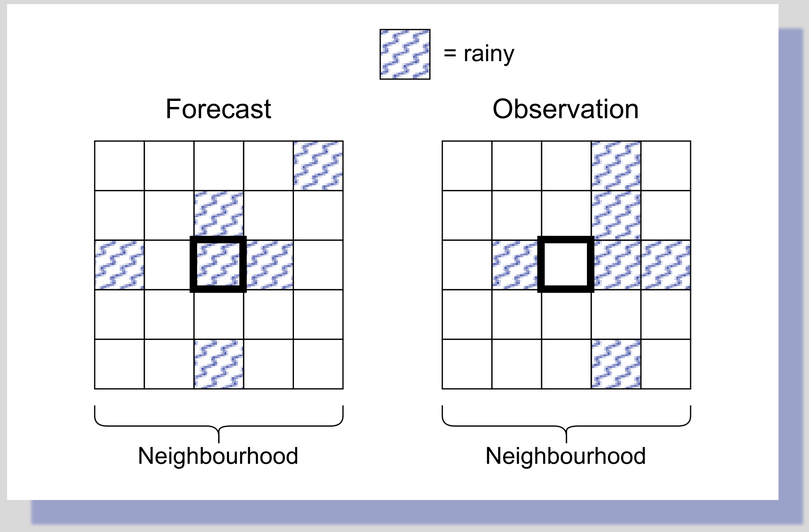
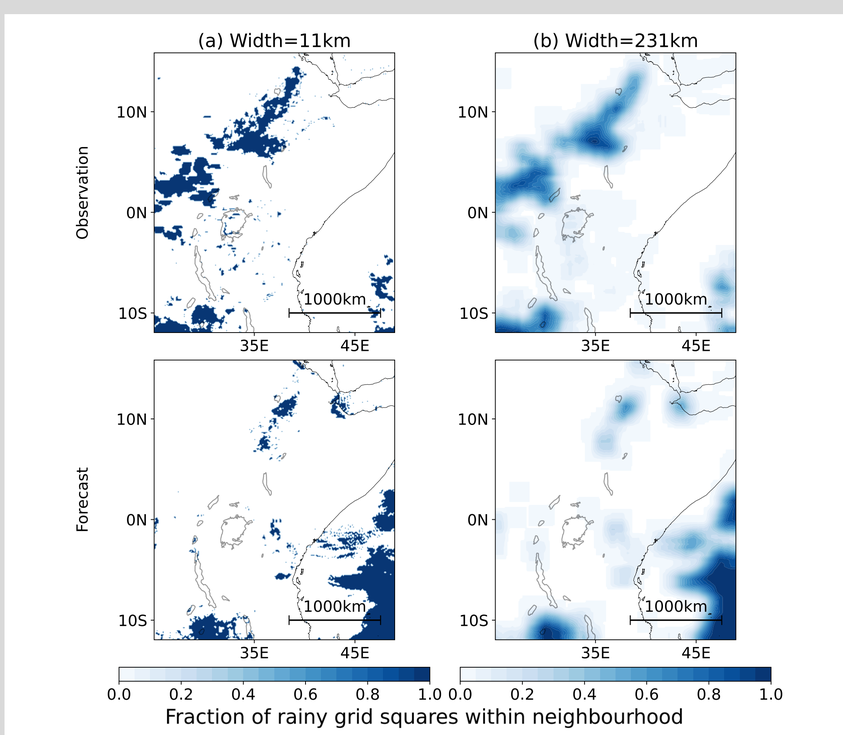
1. Background

- The Fractions Skill Score [1] is a widely used measure of forecast accuracy for rainfall.
- One of several 'neighbourhood' approaches to forecast verification.
- Tries to avoid the 'double penalty' problem of scores like mean-square error, by comparing neighbourhoods of forecast and observations instead.



2. Motivation

- The FSS is typically interpreted relative to a `useful' criterion [1].
- However, there can be considerable skill for forecasts that do not meet this criterion [2], and it is not derived in a way that provides obvious meaning [3].
- We therefore derive a new useful criterion, as the score that a random forecast achieves.



3. Decomposing the FSS

First, we decompose the FSS in terms of the mean, standard deviation, and correlation of the binary forecasts and observations.

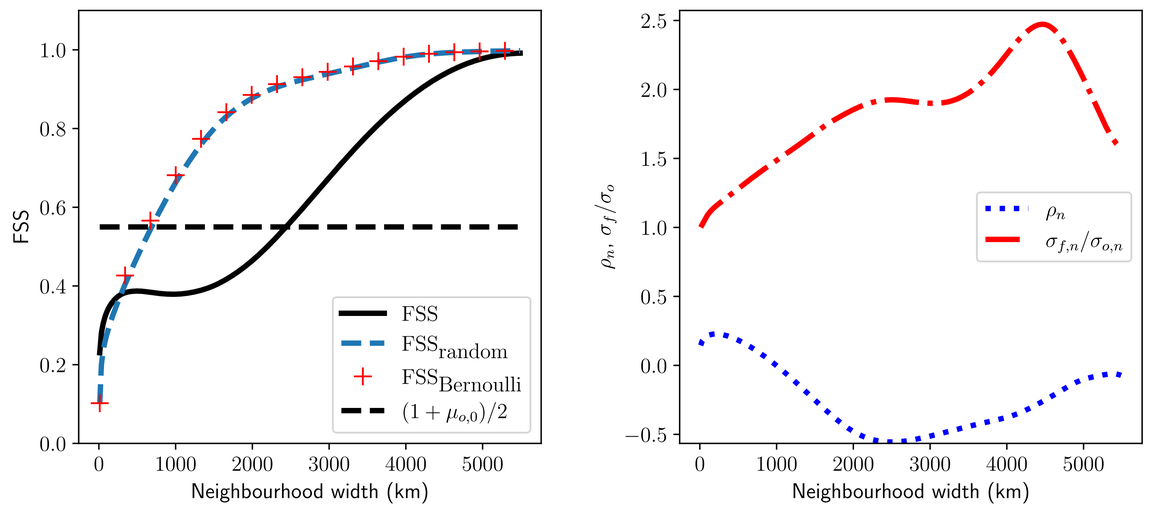
$$\mathrm{FSS}(n) = \frac{2(\mu_{o,n}\mu_{f,n} + \sigma_{o,n}\sigma_{f,n}\rho_n)}{\mu_{o,n}^2 + \mu_{f,n}^2 + \sigma_{o,n}^2 + \sigma_{f,n}^2}$$

4. Extracting Skill from the FSS

- We then derive a new criterion, that identifies where the forecast performs better than a random forecast [4]

$$\mathrm{FSS}_{\mathrm{random}}(n) = \frac{2\mu_{o,n}^2}{2\mu_{o,n}^2 + \frac{1}{(2n+1)^2}\mu_{o,0}\left(1-\mu_{o,0}\right) + \sigma_{o,n}^2}$$

- This new criterion aligns precisely with the score achieved by a random forecast.
- In many cases, this fundamentally changes how the FSS is interpreted.



5. Additional work

Comparing the FSS to other neighbourhood verification measures, including the Brier Divergence Skill Score, and Structural Similarity Index (in preparation).

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References

[1] Roberts, N. M., & Lean, H. W. (2008). Scale-selective verification of rainfall accumulations from high-resolution forecasts of convective events. *Monthly Weather Review*
[2] Nachamkin, J. E., & Schmidt, J. (2015). Applying a neighborhood fractions sampling approach as a diagnostic tool. *Monthly Weather Review*,
[3] Skok, G. (2015). Analysis of fraction skill score properties for a displaced rainband in a rectangular domain. *Meteorological Applications*,
[4] Antonio, B., and Aitchison, L. (2023) How to derive skill from the Fractions Skill Score, https://arxiv.org/abs/2311.11985