

Supplementary Material 3

Per-CV POD Ceilings and Youden-Optimal Thresholds for the STRI Flash-Flood Trigger

A standardized rainfall extremity index for equitable flash-flood warning in South Korea

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S3.1. Overview

This Supplementary Material tabulates the per-CV POD ceilings and Youden-optimal thresholds for the flash-flood-trigger analysis of the main text. The nine-CV POD figure originally provided here has been moved into the main text (Fig. 9); the tables of Sec. S3.2 and the operational interpretation of Sec. S3.3 remain the primary content of this document.

POD is defined as a function of the warning threshold z^* : an alarm is issued whenever $\text{STRI} \geq z^*$ on the standardised-normal STRI scale. The analysis below characterises POD across the full feasible range $z^* \in [-3.72, 3.72]$ rather than prescribing a single operational value; the choice of z^* is left to local calibration informed by the per-CV positive base rate. We adopt the POD-vs.- z^* representation rather than a conventional ROC display (Jolliffe and Stephenson, 2012) because the GPD branch, by construction, returns $\text{STRI} = \text{NA}$ for damage-day events whose transformed observation does not exceed the POT cutoff u (main text Sec. 2.2). These below-threshold events—21.3% of the damage-day sample—are non-extreme by the POT definition and cannot trigger an alarm at any z^* . The maximum POD attainable by GPD-STRI is therefore bounded above by the fraction of damage-day events with a defined $\text{STRI}(\text{GPD})$, an information-bearing ceiling that the ROC display reduces to an apparent (and easily misread) premature truncation.

S3.2. Per-CV POD Ceiling and Youden-Optimal Threshold

This section reports the per-CV POD ceiling already discussed in Section 4.5 of the main text together with the Youden-optimal warning threshold z^* at each CV and the corresponding POD and false-alarm ratio (FAR). Because damage events are rare in the candidate alarm pool (positive base rate $\approx 0.4\%$), the Youden-optimal threshold shifts to low z^* values. The per-CV operational threshold should be calibrated against the local positive base rate; the table below provides the comparison baseline of the GEV and GPD branches.

Supplementary Table S49. Per-CV POD ceiling and Youden-optimal warning threshold z^* (full 9-CV grid).

CV (mm)	GEV: Ceiling	GEV: z^*	GEV: POD@opt	GEV: FAR@opt	GPD: Ceiling	GPD: z^*	GPD: POD@opt	GPD: FAR@opt
10	1.000	-3.62	0.954	0.962	0.894	-3.72	0.894	0.945
20	1.000	-3.67	0.949	0.952	0.805	-3.72	0.805	0.926
30	1.000	-3.22	0.978	0.951	0.754	-3.72	0.754	0.898
40	1.000	-2.72	0.987	0.944	0.794	-3.07	0.794	0.880
50	1.000	-2.02	0.978	0.924	0.751	-2.37	0.751	0.857
60	1.000	-2.07	0.989	0.927	0.725	-3.22	0.725	0.834
70	1.000	-1.62	0.981	0.912	0.689	-3.17	0.689	0.813
80	1.000	-1.72	0.987	0.918	0.665	-3.72	0.665	0.788
90	1.000	-1.47	0.984	0.903	0.609	-3.72	0.609	0.767

Note: “Ceiling” is the upper bound of POD attainable in that (CV, model) combination, equal to the fraction of damage-day events with a defined STRI. “ z^* ” is the warning threshold that maximises the Youden index (POD – FPR). “POD@opt” is the probability of detection at z^* . “FAR@opt” is the false-alarm ratio at z^* , defined as $FP/(FP+TP)$. The GEV POD ceiling lies near 1.00 at most CVs, with only minor reductions arising from cells lacking a regular L-moments fit. The GPD POD ceiling declines monotonically with CV (from 0.89 at CV = 10 to 0.61 at CV = 90), reflecting the increasing fraction of below-threshold events at the more selective POT cutoff.

S3.3. Operational Interpretation

This Supplementary Material underlines that STRI should not be deployed at a single global threshold. At a conventional warning threshold of $z^* = 2$, GPD-STRI yields a false-alarm ratio of about 83% at CV = 30 mm and 74% at CV = 60 mm, with POD near 0.03. This is a generic consequence of severe class imbalance in rare-event detection (Jolliffe and Stephenson, 2012) and is appropriately assessed in the POD/false-alarm trade-off space rather than at a fixed z^* cutoff. In operational practice the index would be deployed as one component of a multi-criterion alarm logic, with per-CV thresholds tuned to the local positive base rate.

Main-text Figure 9 now presents the POD curves for all nine CVs directly. In particular, the CV-dependent structural ceiling of the GPD model—POD curves saturate not at unity but at a CV-dependent upper bound as z^* decreases—declines monotonically over the full 9-CV grid, supporting the main-text finding that the declining ceiling is a structural property of the POT construction rather than a deficiency of the index. Operational application of GPD-STRI requires calibration of z^* to the locally available positive base rate, and this supplementary figure provides the diagnostic information that serves as a starting point for that calibration.

S3.4. Supplementary References

- Jolliffe, I. T., & Stephenson, D. B. (2012). Forecast verification: A practitioner's guide in atmospheric science (2nd ed.). Wiley.
- Youden, W. J. (1950). Index for rating diagnostic tests. *Cancer*, 3(1), 32–35.