Rainfall Nowcasting with Commercial Microwave Links in the Tropics: an early warning perspective

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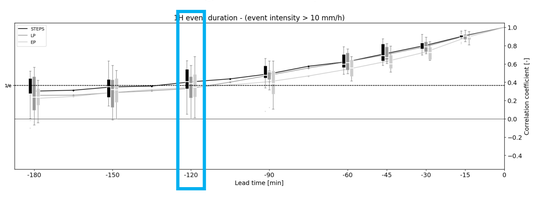
Motivation

Whilst further improvements can be made to CML based rainfall estimates, we think it is high time to explore how far in the future we can accurately predict local rainfall estimates using only CML data. 🚀

Opportunities

High intensity events:
skillful lead time increases to 120 mins for events of average intensity > 10 mmh^{-1}.

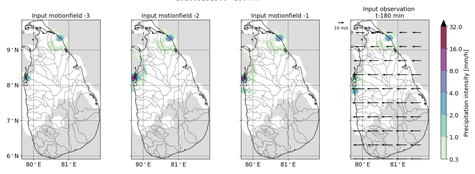


Extrapolation nowcast:
only extrapolating the input image (LP method) shows similar skill to a more complex method (STEPS). This is positive for operational implementation.

Animation of an extrapolation nowcast

Challenges

Motion field determination:
due to the nature of the CML data (temporal resolution of 15 minutes) small changes in rainfall fields can create excessivily large motion fields.



View the effect of a large motion vectors on the nowcast skill

Low intensity events and STEPS:
due to growth and decay of rain cells in the STEPS method it is outperformed, in terms of metrics by Eulerian Persistence for low intensity events.

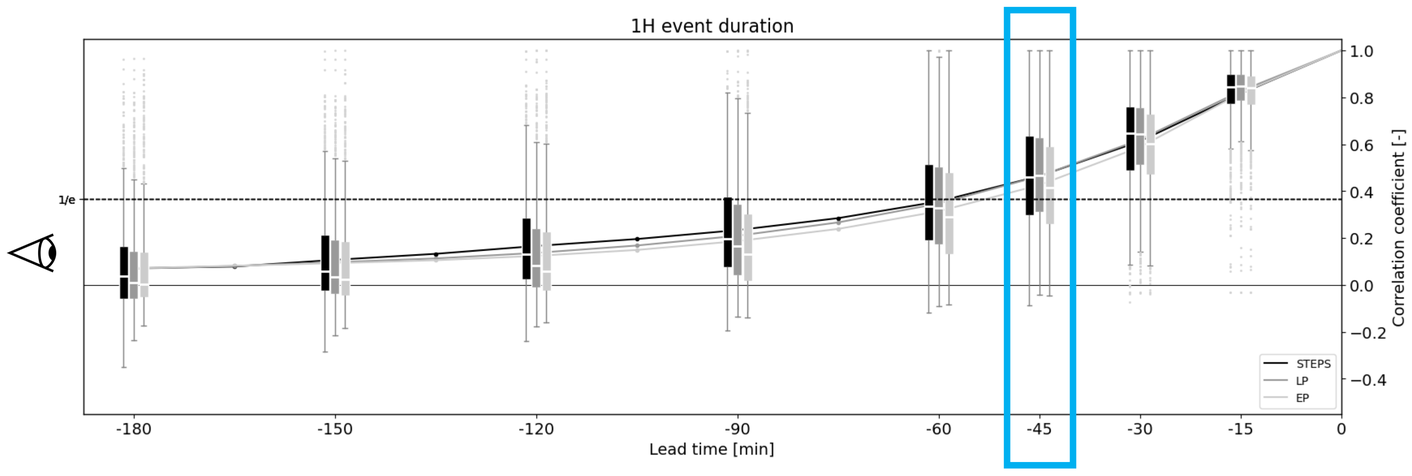
Conclusions

- Accumulated volumes skillfully predicted 2 hrs ahead.
- Skillful prediction of areas with high intensity rainfall for the majority of catchments.
- Accurate calculation of motion fields remains a challenge.

Hourly gauge data vs. CML nowcast

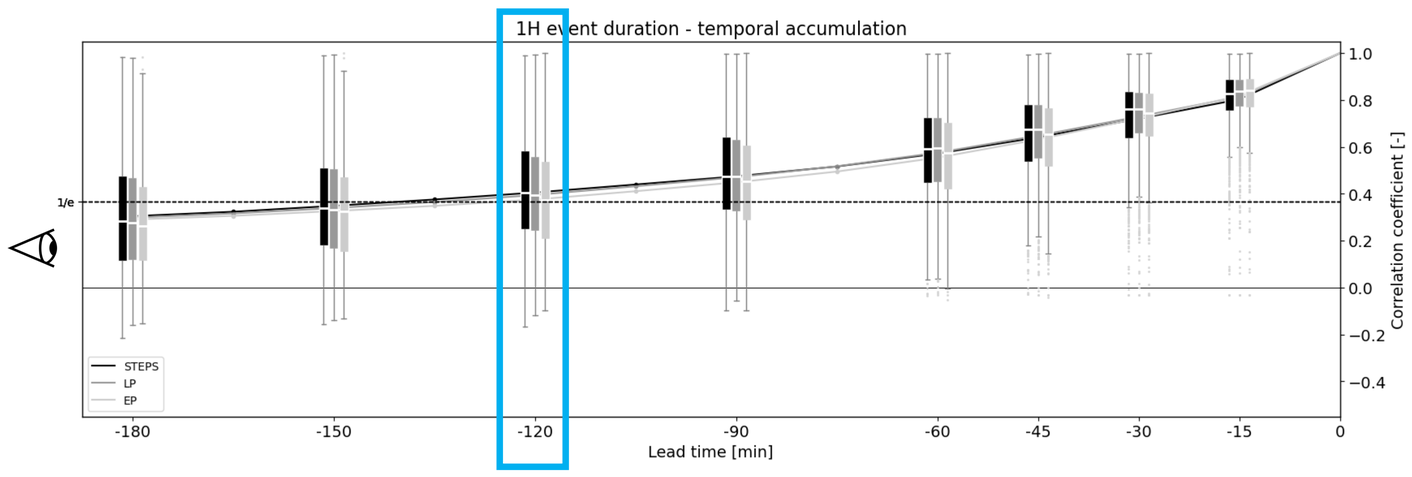
Nowcast method evaluation - PCC

Pearson correlation coefficient (PCC) of each 15-minute interval within the 1H events, for the different nowcast methods. Nowcast methods are all **skillful up to 45 minutes ahead**. Minimal differences between the three methods (STEPS ensemble mean is shown here) indicate dominance of low magnitude motion fields in input data.



Temporal accumulation – PCC

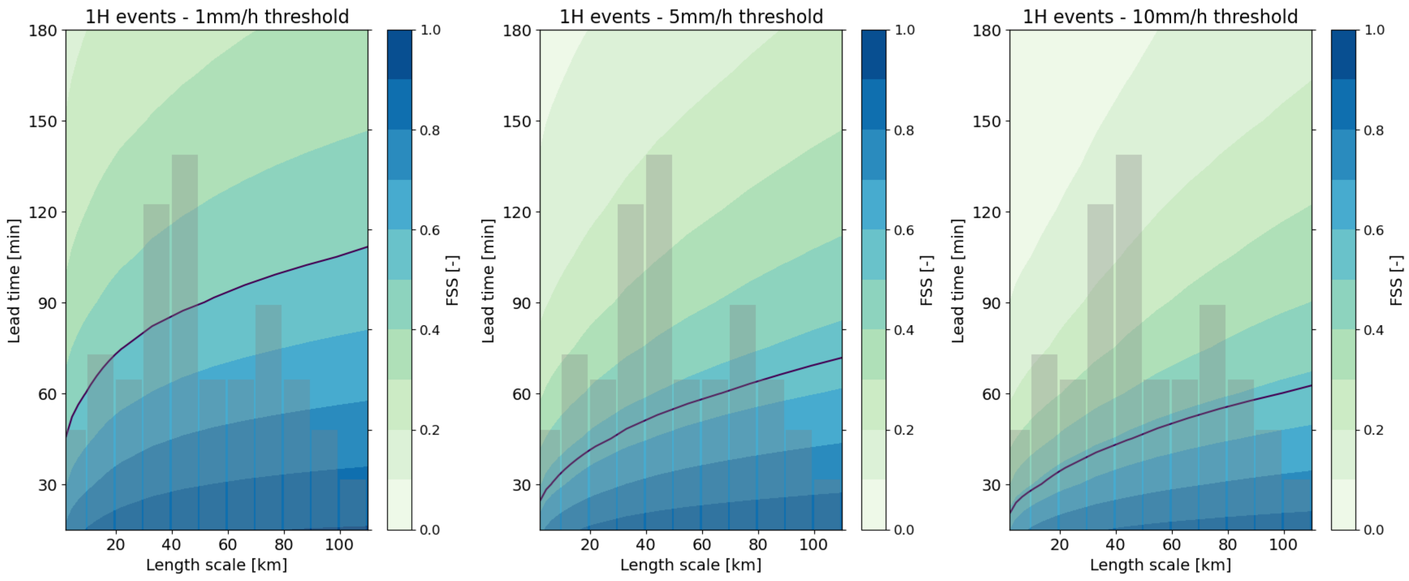
PCC of the rainfall intensity accumulated over the lead time) of each 15-minute interval within the 1H events, for the different nowcast methods. Looking at the predicted accumulated intensity, relevant for hydrological applications, all methods are **skillful up to 120 minutes ahead**.



Spatial comparison - FSS

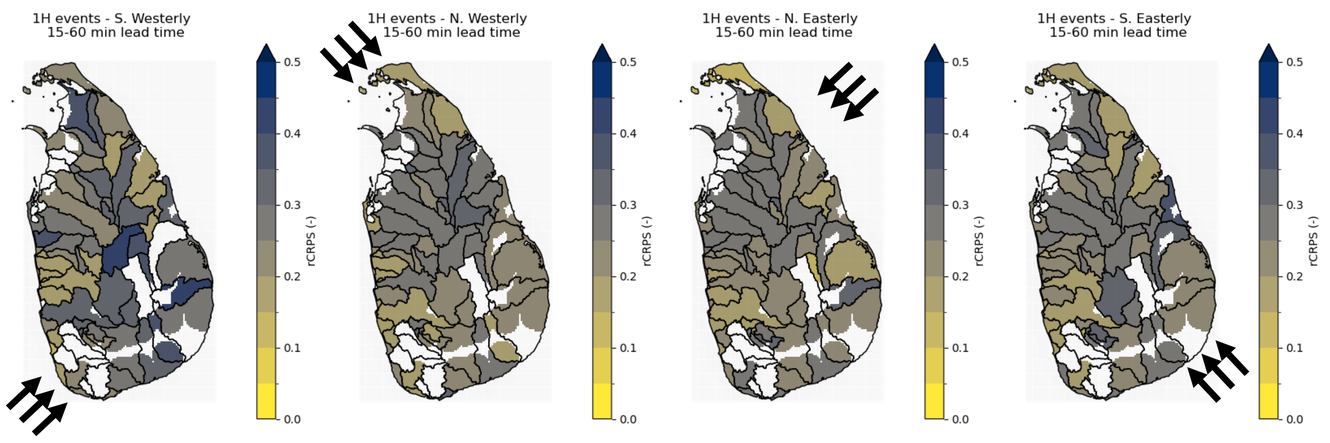
Fraction Skill Score (FSS) of the Lagrangian Persistence (LP) method for all 15-minute interval in the 1H events. The bars in the background show the distribution of the maximum length of the catchments. With **increasing threshold**, the skill **decreases** (↓). With **increasing lead time**, the skill **decreases** (↓). With **increasing lenght scale**, the skill **increases** (↑).

Implication: the majority of catchments have a maximum length larger than 40 km. In these catchments areas with 10 mmh^{-1} or higher rainfall intensity can be skillfully predicted up to 45 minutes ahead.



Error magnitude - rCRPS

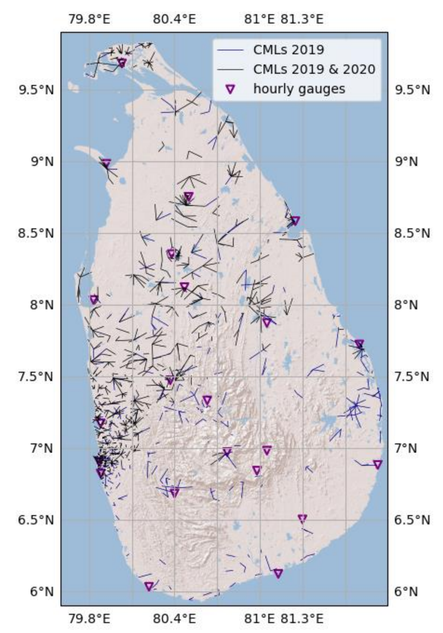
Reduction Continuous Ranked Probability Score (CRPS / σ) of the STEPS nowcast for all 15-minute intervals in the 1H events, split by direction of the motion field. Only the average error in the first hour is shown. **The vicinity of the catchments to the land – sea border (i.e. the presence or density of CMLs) does not appear to significantly influence the error in the nowcasts.**



Dataset

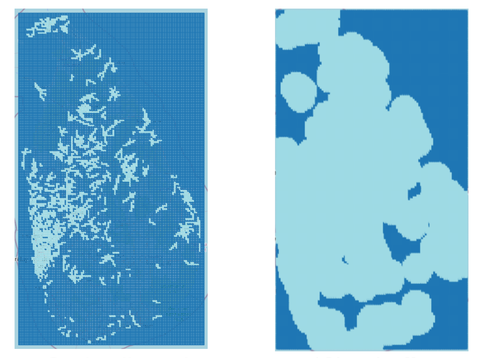
Sri Lanka

- 15-minute min. and max. RSL
- Sept. 2019 – Dec. 2020
- 2570 sub-links across 1328 unique link paths
- **OK interpolation** on a 2x2 km grid



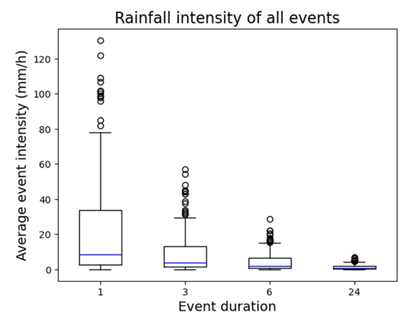
Method

Mask areas with no data



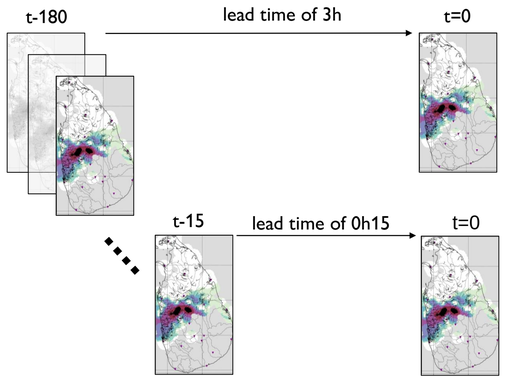
Grid cells with CMLs | 18km buffer around CMLs

Select events to nowcast
Per catchment (67),
↳ season (FIM, NEM, ,SWM, SIM)
↳ and event duration (1, 3, 6, 24hrs)
↳ select 2 events:
- max. catchment average
- max. cell value in catchment



pySTEPS nowcasting methods
3 nowcasting methods:
- STEPS - extrapolates the input image and includes growth and decay of rain cells, contains 20 ensembles
- LP: extrapolates the input image
- EP: is the input image

We evaluate the nowcasts from an early warning perspective:
How long before an event takes place can we skillfully predict it?



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