

A flexible method for determining decorrelation ranges

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Introduction

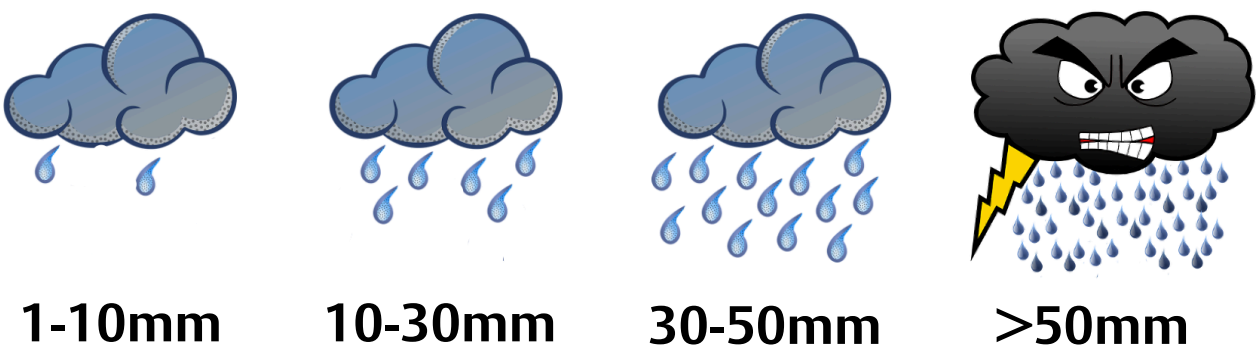
The spatial structure of rainfall events over west Africa is not very well understood, especially not the correlation structure and how this varies with the rainfall intensity. The generally sparse rain gauge network is often limiting the analysis to longer distances than the true correlation distance, an issue we have avoided thanks to a dense gauge dataset provided by GMet. The method presented here estimates and compares the result to the true underlying correlation structure, instead of comparing the measured correlation to some arbitrary low number.

Set up parameters

Before applying the method, 3 parameters need to be selected, depending on the study area and the data availability.

Intensity classes

The intensity classes are the rainfall intervals that are suitable to separate low, normal rainfall from each other. In this study we used 4 classes; **low, moderate, heavy, very heavy**



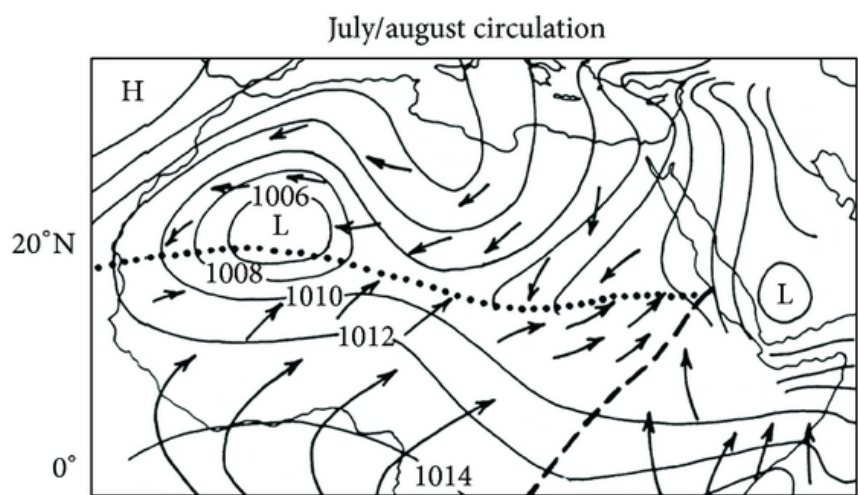
Distance bin width

The distance bin width determines in what interval we calculate the proportion of occurrences. This needs to trade-off the need for enough station pairs within each distance bin with loosing accuracy with too large bins. We selected



Time intervals

The final parameter is the time interval that we average the occurrences over. This will again depend on the data availability. Due to the west African monsoon, we used monthly intervals



Method

Calculate correlation

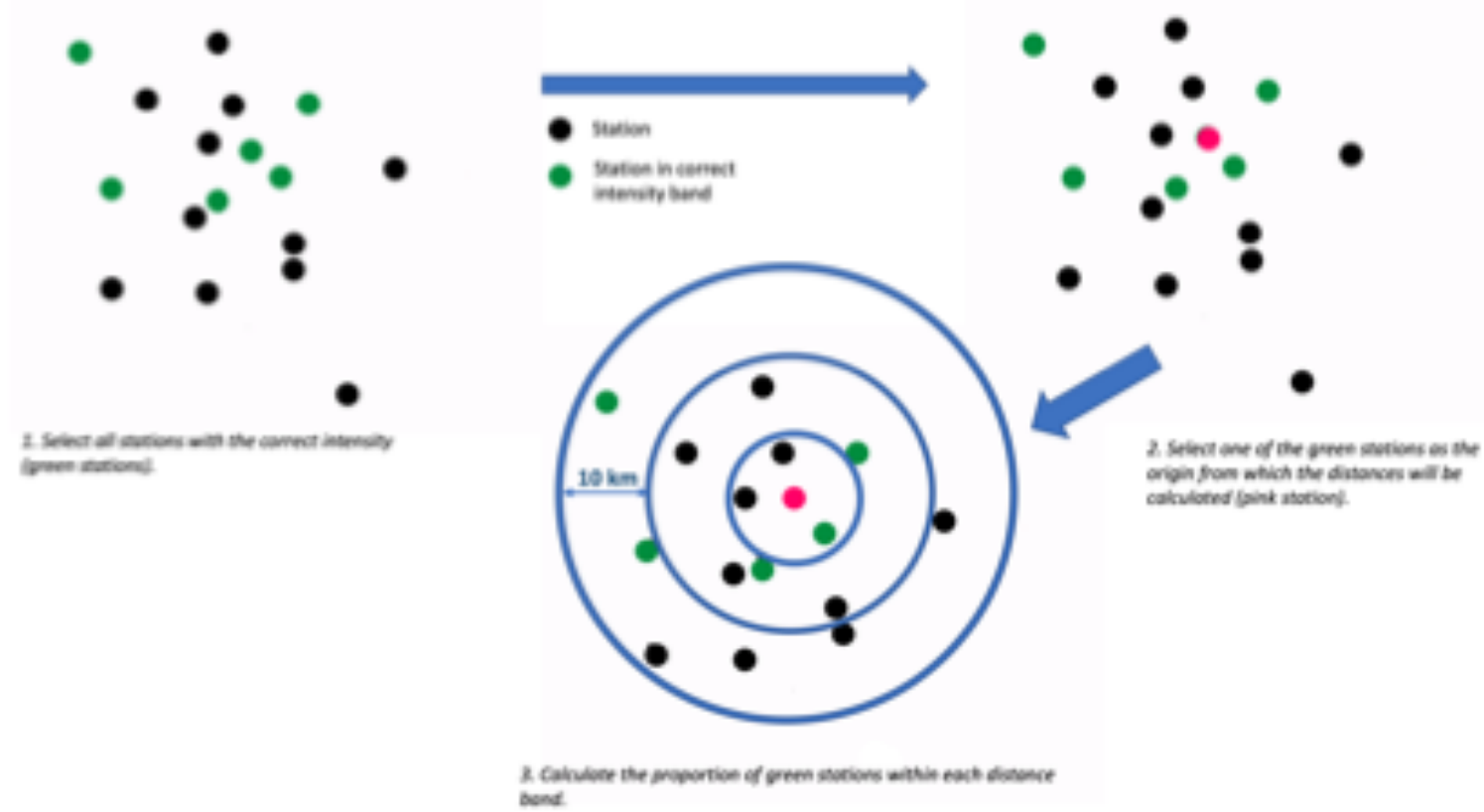


Figure 1. Schematic of algorithm to calculate the correlation for each distance band.

1. Transform amounts within the intensity class to 1 (green dots) else 0 (black dots)
2. Pick a green station as midpoint (pink dot)
3. With each distance bin from the midpoint, calculate the proportion of 1's
4. Repeat from step 2 for each green station, repeat for all days

Calculate background correlation

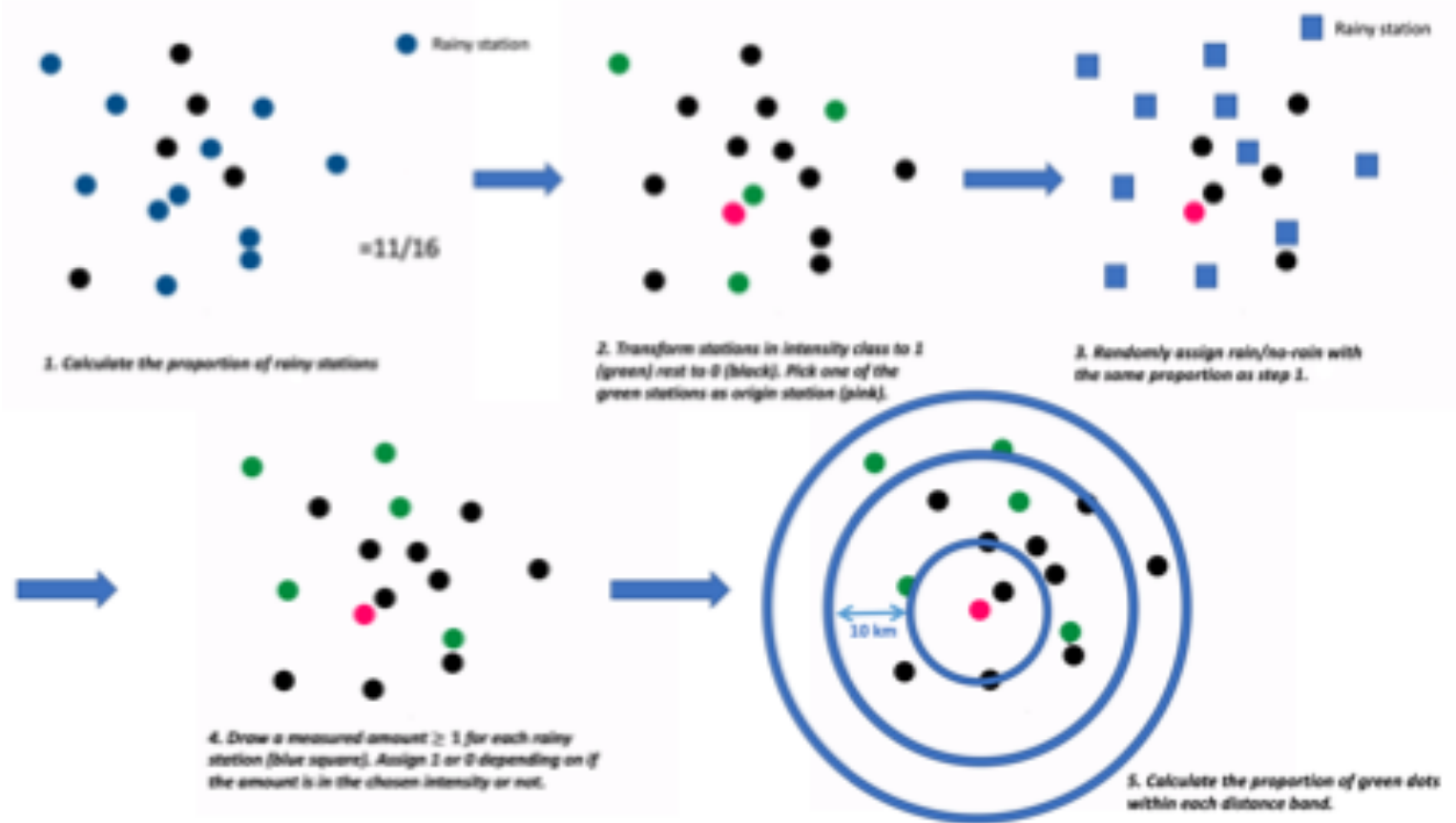


Figure 2. Schematic of algorithm to calculate the background correlation.

1. Determine the proportion of rainy (>1mm) stations
2. Select one station in the correct intensity band as midpoint
3. Randomly assign occurrence to the remaining stations
4. For rainy stations, draw the amount from measured values from that month and stations
5. Calculate the proportion of 1's in each distance bin

Results

Highlights

- There is a clear difference in the annual correlation structure for low rainfall compared to the rest.
- The conditional probability for heavy rainfall does not depend on the time of year.
- The correlation distance (when the distance line reaches the dashed line), varies from around 50-150km for low to heavy rainfall.

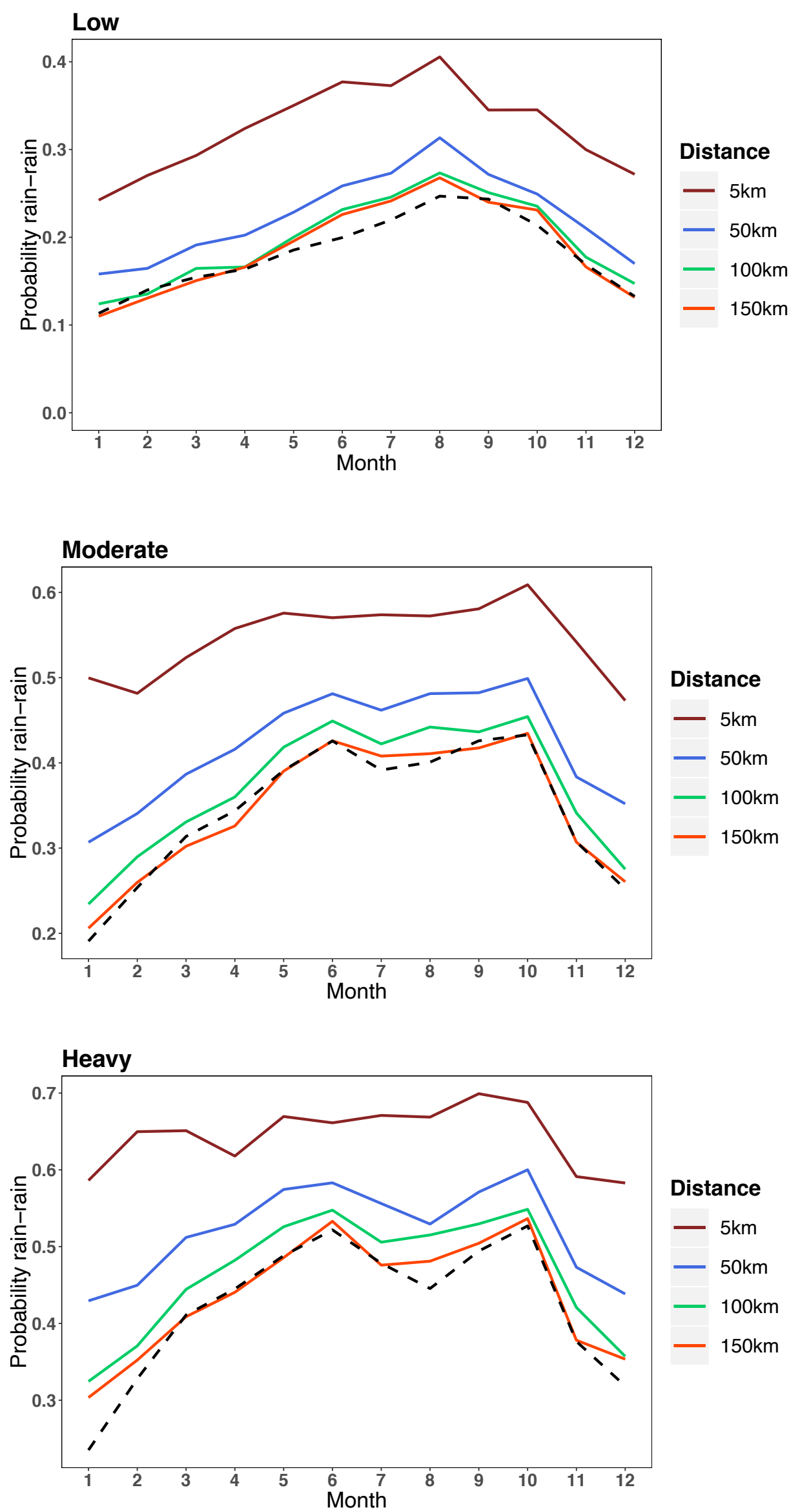


Figure 3. Correlation for each month of the year. The title intensity is the midpoint, but all values lower are treated as occurrences for the proportion counting. Dashed line is the background correlation

Anisotropy at short time scales

To extend the correlation structure understanding, we investigated the directional structure of rainfall by estimating the covariance for each square in a lattice. We aggregated the rainfall amount in 2, 3 and 5 day aggregates to reduce the noise.

Highlights

- The influence of west-ward propagating systems can be seen already at a 2-day time scale.
- The covariance increases as we increase the aggregation period.
- The covariance increases more in the E-W direction compared to the N-S when increasing the aggregation period

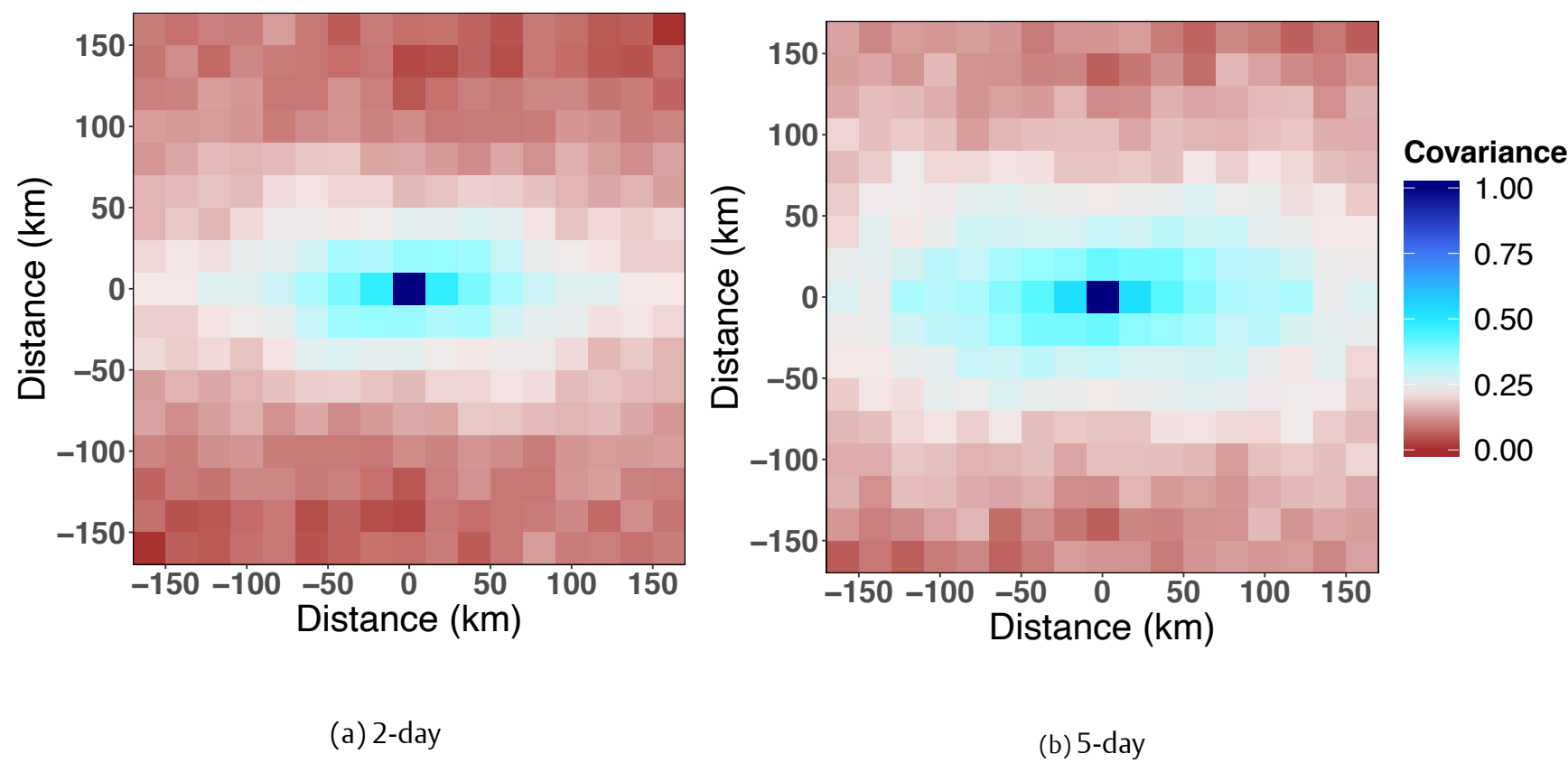


Figure 4. Covariance map for (a) 2-day and (b) 5-day aggregated June amounts..

Reference

1. Israelsson et al., 'The spatial correlation structure of rainfall at the local scale over southern Ghana', *Journal of Hydrology: Regional Studies*, 2020, doi: [10.1016/j.ejrh.2020.100720](https://doi.org/10.1016/j.ejrh.2020.100720)

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