Quality Control for Rainfall Extremes

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Quality Control

Automated testing

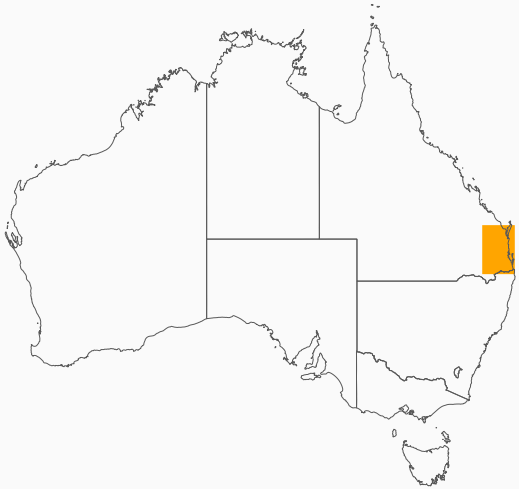
Important for large scale data handling of observations and analysis of extreme events

Sequential checks

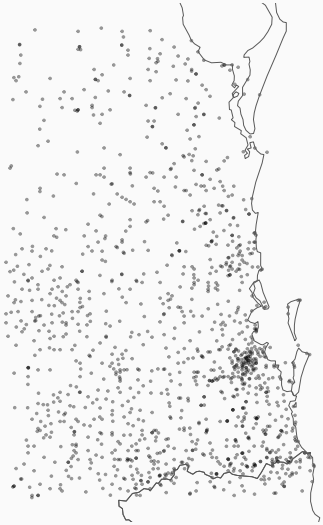
- Identifies duplicated observations
- Checks for abnormally large observations
- Failed spatial consistency check
- Failed temporal consistency check
- Temperature too warm for snow

and so on.

Southeast Queensland



Stations



- 1297 Stations
- Avaiable data ranges from 1750 to 2024
- On average, 102 years of data are available
- 26% of stations have more than 270 years of data

Issues

1. True extremes values dropped as outliers
2. Extreme missings: Data are systematically missing because it is an extreme event
3. Tagged accumulations: rainfalls are not recorded and accumulated to the next (next) day with a tag
4. Untagged accumulations: rainfalls are not recorded and accumulated to the next without a tag
5. Extreme Zeros: Data entries are 0 when it is an extreme event

True extremes values dropped as outliers

- First step in an analysis is commonly to filter the data to remove observations flagged as outlier, but
- **Current outlier test** assumes normality – True extreme observations are being incorrectly flagged as outliers
- People are removing true extreme values from their analysis.

True extremes values are not outliers

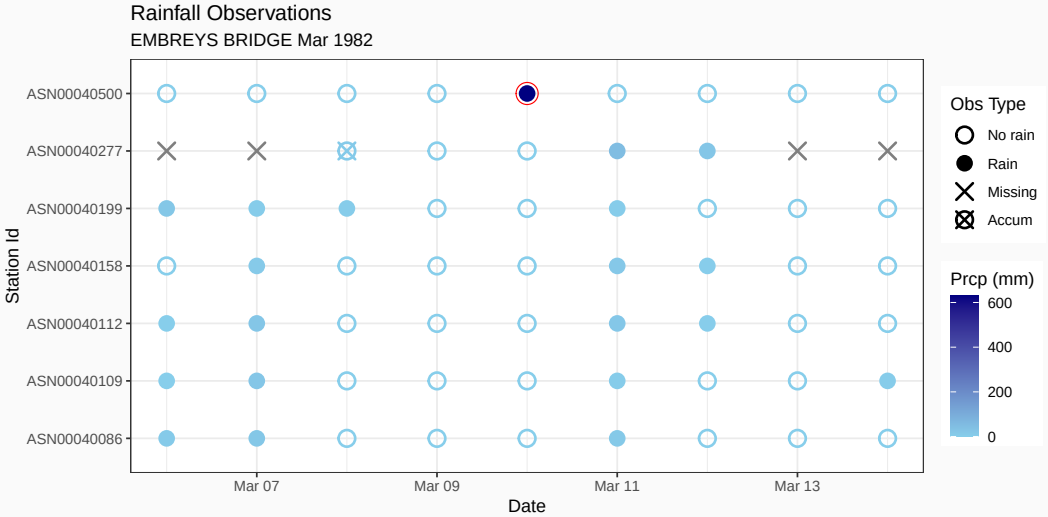
Spatial consistency check

Check if the observation of an “outlier” station is consistent with its neighbouring stations’ observed values.

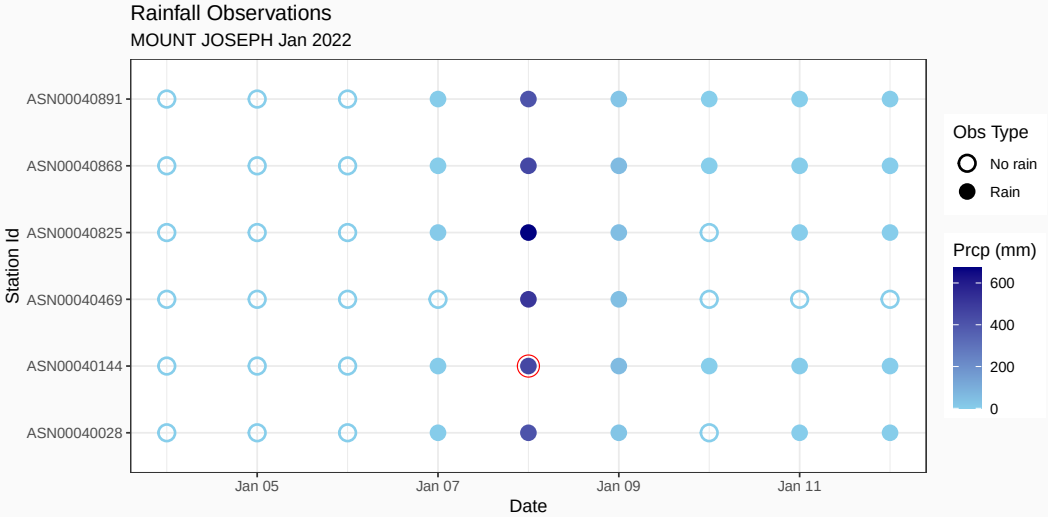
Southeast Queensland

- 60 observations were flagged as outliers and have sufficient neighbours for spatial consistency check
- 37 observations pass the spatial consistency check and should be extreme values and not outliers
- Outlier test has a false-positive rate of 62%

Example 1: Correct outlier flag



Example 2: False outlier (spatially consistent)



Example 3: False outlier (spatially inconsistent)

Solution

Where possible a spatial consistency check should be used, or

just don’t remove outliers.

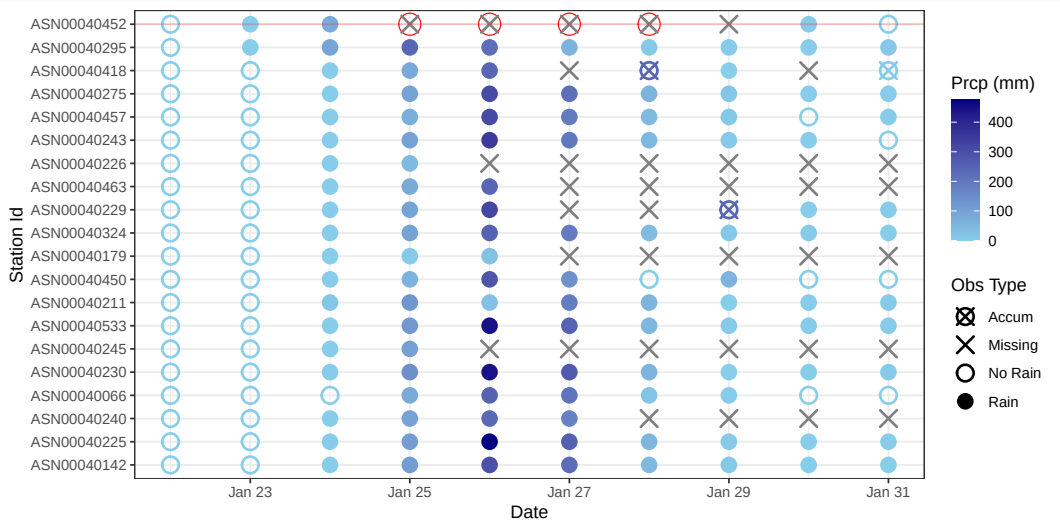
Determine extreme values

For a specific station

1. Find neighbouring stations within a 20 km radius
2. Take the 99-th percentile of the daily rainfalls on rainy days of these neighbouring stations as the threshold
3. On a particular day, if any station among those neighbouring stations has a rainfall record larger than the threshold, we determine that the centre station experiences extreme rainfall on this day

The procedure is repeated for every station.

Extreme missings



Extreme missings

Southeast Queensland

- 6396 missing observations are flagged as extreme values
- Ranging from 1750-02-01 to 2023-12-24
- From 753 stations

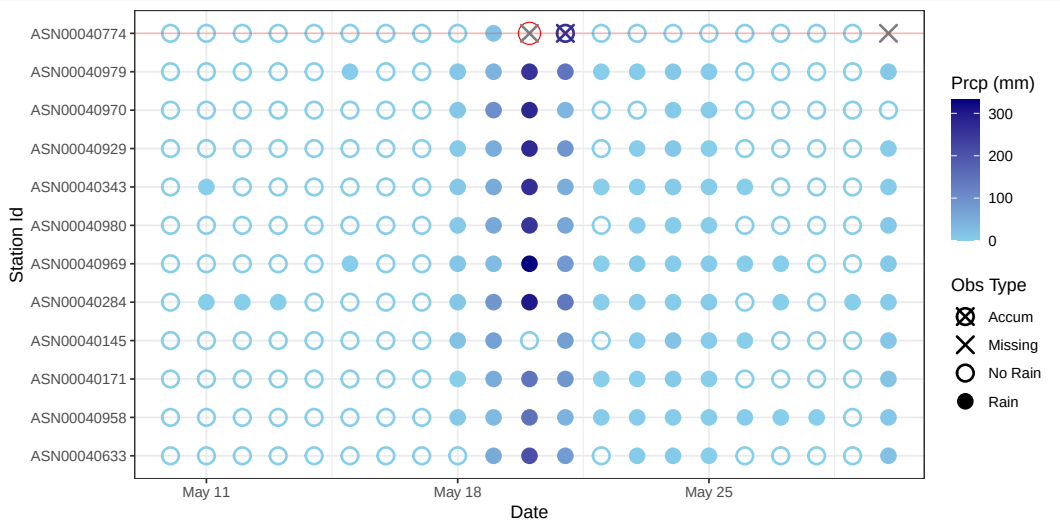
Tagged accumulation

Essentially the same as extreme missings with an additional accumulation tag.

Southeast Queensland

- 5804 missing observations are flagged as extreme values
- Ranging from 1892-04-02 to 2023-11-21
- From 622 stations

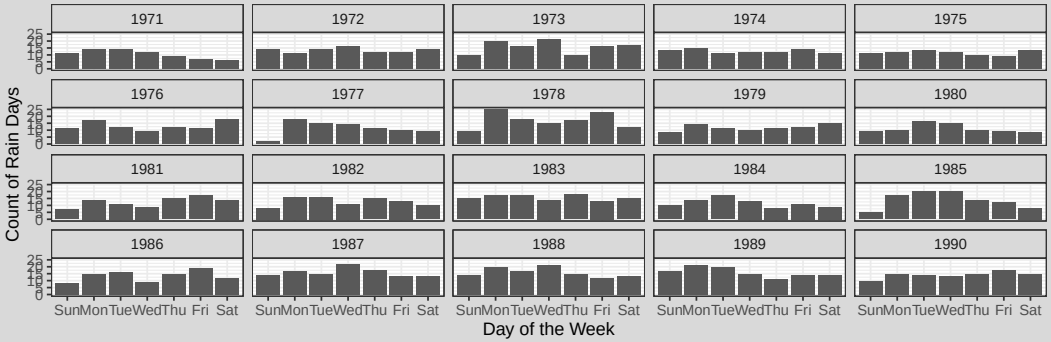
Tagged accumulation



Untagged accumulations

Rainfall observations on Sundays are often recorded on Mondays without being noted by the observer in the records

Sunday-Monday untagged accumulations



Untagged accumulation

Identification

Use Pearson's chi-squared test to check if each day of the week has equal probrobility of having extreme rainfall for a station.

Southeast Queensland

- 97 stations are identified to contain possible untagged accumulations
- 13429 observations are flagged as extreme values from stations containing possible untagged accumulations.

Untagged accumulation

Issues

- The number of observation at each day of the week is not large enough to assume asymptotic properties of the test
- All records of a suspicious statioin are flagged
  - Good records (not untagged accumulation) are also flagged
  - No way to identify each individual untagged accumulation
- Not accurate

Extreme zeros

Southeast Queensland

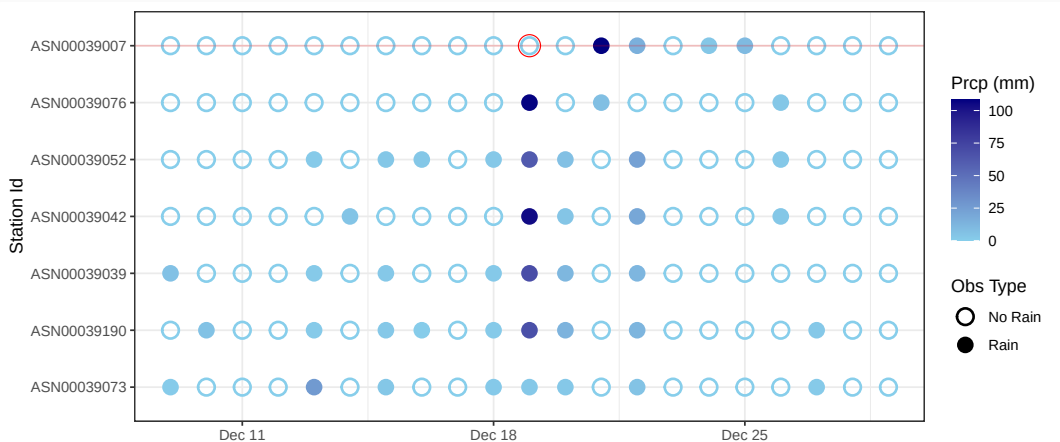
- 14287 zero observations are flagged as extreme values
- Ranging from 1750-03-15 to 2023-12-26
- From 1145 stations

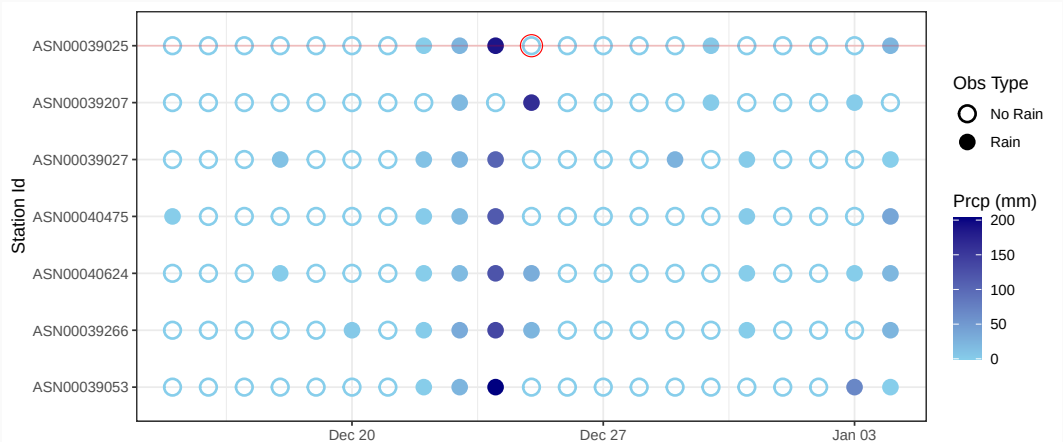
Issues

Usually combined with other problems, especially untagged accumulation, which makes it difficult to further categorise different types of extreme zeroes.

Extreme zeros with untagged accumulation

The zero value that is identified as extreme value is silently accumulated to days later



Extreme zeros with untagged accumulation

The zero value that is falsely identified as extreme value because of untagged accumulation in a neighbouring station