Testing Homogeneity of Temperature & Precipitation Time Series

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What is Homogeneity test?

- Identify and adjust non-climatic variations caused by changes in observing practices, observing time, site relocation, etc.

- These “inhomogeneities” can interfere with the proper assessment of any climate trends and extremes.
Main causes of inhomogeneities

- Changes at the observing site
- Changes in instruments
- Changes in observing practices
- Changes in observing time
- Site relocation

Automation

- Parallel observations can help to determine the difference between two different instruments
Why is it necessary ensuring quality and homogeneity in climatic time-series?

• Climate time-series are the temporal collection of atmospheric observations, which are composed of measurements that could be affected by a number of non-systematic and systematic biases introduced along the whole chain of the observing systems and data management both in the present and in the past.

• To ensure the temporal collection of measurements, climate time-series is only composed of real observations, and its time variations, it only responds to the forcing imposed by weather and climate.

• Robustness of any climate assessment, product or service, highly rely on availability of high-quality time-series of climate observations, which nowadays society requires to better adapt to the impacts of climate variability and climate change.

• Huge potential for climate data services: from station data to gridded and reanalysis products, including models training and validation, which are the basic input for any climate assessment.
Observations, and the derived climate time-series, can contain values that are not true meteorological measurements, if not individual wrong values that can have been introduced by mistake when annotating, digitising and/or transferring the observations into the national databanks (or avoiding non-systematic biases)

Nowadays most of CDMS include some Quality Controls (QC), but be aware: nowadays not in the past. So, climate time-series must be also subjected to more complete QCs, including temporal consistency checks.

Simple and available QC software easily identify data issues, such as data continuity and completeness, potential individual errors, wrong segments (losing of the annual cycle) and potential problems with homogeneity.
Why the application of homogeneity tests and homogenising the series is required?

- Either changes over time in the observing conditions, practices and procedures and an inaccurate data management have the potential to break climate series homogeneity in long, but also short-term climate records. Among common causes breaking homogeneity, to highlight:
  1. Station relocations, instrumentation and exposures changes, including the changeover to modern Stevenson screen in the past and, nowadays, to AWS
  2. Environment changes in stations surroundings (land use/land cover changes
  3. Observing times of daily parameters, monthly mean calculation
  4. Inaccurate data transfer

- All of them having the potential to induce systematic biases masking the real climate signal, since artificial shifts often have at least the same magnitude as the climate signal (e.g. long-term variations, trends or cycles).
- A direct analysis of the raw data series might lead to wrong conclusions about climate evolution, compromising the reliability and robustness of any assessment and application
- Need of accounting for these systematic biases through homogenisation
INTRODUCTION

➢ What is Homogenization
➢ Homogenization in climate research means the removal of non-climatic changes.
➢ Next to changes in the climate itself, raw climate records also contain non-climatic jumps and changes for example due to relocations or changes in instrumentation.

➢ Causes of Inhomogeneity
➢ The best known inhomogeneity is the urban heat island effect. The temperature in cities can be warmer than in the surrounding country side, especially at night.
➢ Other non-climatic changes can be caused by changes in measurement methods. Meteorological instruments are typically installed in a screen to protect them from direct sun and wetting.
➢ Other typical causes of inhomogeneities are a change in measurement location; Changes in the surrounding can often not be avoided.

➢ Impacts of Inhomogeneity
➢ By homogenizing climate datasets, it was found that sometimes inhomogeneities can cause biased trends in raw data; that homogenization is indispensable to obtain reliable regional or global trends.
➢ Other possible bias sources are new types of weather shelters, the change from liquid and glass thermometers to electrical resistance thermometers, as well as the tendency to replace observers by automatic weather stations, the urban heat island effect and the transfer of many urban stations to airports.
INTRODUCTION

➤ Importance of data homogeneity

➤ Data homogeneity is an important part of historical data archival.
➤ Data homogeneity will improve the quality in forecasting.
➤ Time series quality control and homogenization is part WMO guidelines for GFCS & CSIS which is to be implemented by NMHS & RCC

➤ Background of the Study

➤ The concept is to test whether a given data is said to be homogeneous over time. In other words if there is a significant break in trend of particular time series it is classified as inhomogeneous.
➤ These inhomogeneities in historical data will impact the outcome of data analysis and forecasts.
➤ There are several methods and tools are available to test the homogeneity.
➤ An approach to create a homogeneous data series will involve several set of homogeneity tests and exclusion of non homogeneous station until necessary adjustments were made for homogeneity.
B) Statistical tests used in the detection of climate changes...

How could be described climate change from the statistical point of view?

(1) Change in mean

(Source IPCC, 2007)

“change points”

“upward” shift point
Changes in **mean** (1) and **variance** (2)

(source: IPCC; 2007)
Climate change detection

1. present

what?

2. future

A. changes in mean;
B. changes in variance;

how?

Statistical tests

C. detection of trend
A statistical (hypothesis) test is a method of making statistical decisions using experimental data;

- these decisions are almost always made using null-hypothesis tests;
  - the null hypothesis represents what we would believe by default, before seeing any evidence;

- assuming that the null hypothesis is true, what is the probability of observing a value for the test statistic that is at least as extreme as the value that was actually observed?
Type of tests

Non-parametric test

- tests that do not make assumptions about the population distribution;

Parametric test

- tests that are based upon the assumption that the data are sampled from a Gaussian distribution.
...changes in the mean values-Pettit test

• $X_1, X_2, ..., X_T$ is a time series of a given variable, $T$ is the length of the time series;

are the features of the variable before and after a time $t$ significantly different?

Formulate the hypothesis of the test...steps 1+2+3+4...
Steps 1

$H_0 = \text{no change} \quad \text{in the mean};$

$H_1 = \text{change} \quad \text{in the mean at \textquotedblleft} t\text{	extquotedblright \ moment}$

Steps 2 - independent samples

$x_n, \quad n=1, \ldots, t \quad \text{has a common distribution function } F_1(x),$

$x_n, \quad n= t+1 \ldots, T \quad \text{has a common distribution function } F_2(x),$

and $F_1(x) \neq F_2(x)$
Original data series

Homogeneity tests

Visual analysis

break dates

break dates

Analysis

there are non-climatic breaks

Correction procedure

Corrected data series

all breaks are climatic

Homogenized data series

Metadata

Climatic forcings
METHODOLOGY

- Most Common types of Homogeneity Tests
  - Pettit’s Test
  - Standard Normal Homogeneity Test (SNHT)
  - Buishand’s Test
  - Von Neumann Ratio
- P Value Approximation

The basis of these tests correspond to the alternative hypothesis of a single shift. For all tests, p-values are being calculated using Monte Carlo resampling.

If p is smaller than the specific significance level, e.g. 0.05, the null hypothesis is rejected. In other words, if a significant change point exists, and the time series is divided into two parts at the location of the change point.
Von Neumann Ratio Test (Non-Parametric Test)

In this test the null hypothesis is that the data are independent identically distributed random values; the alternative hypothesis is that the values in the series are not randomly distributed. The von Neumann ratio $N$ is defined as the ratio of the mean square successive (year to year) difference to the variance (von Neumann, 1941):

$$N = \frac{\sum_{i=1}^{n-1} (Y_i - Y_{i+1})^2}{\sum_{i=1}^{n} (Y_i - \bar{Y})^2}$$

Hereafter, for each of the test descriptions, $n$ is the data set length, $Y_i$ is $i^{\text{th}}$ element of the data set, $\bar{Y}$ is the mean value of the data set. When the sample is homogeneous the expected value is $N = 2$. If the sample contains a break, then the value of $N$ tends to be lower than this expected value. If the sample has rapid variations in the mean, then values of $N$ may rise above two (Klein Tank, 2007). This test gives no information about the location of the shift.

Critical values for $N$ for different data set lengths are given in Table IV.
Buishand’s Test (Parametric Test)

This test supposes that tested values are independent and identically normally distributed (null hypothesis). The alternative hypothesis assumes that the series has a jump-like shift (break). This test is more sensitive to breaks in the middle of time series (Costa and Soares, 2009). The test statistics, which are the adjusted partial sums (Buishand, 1982), are defined as,

\[ S_0^* = 0 \quad \text{and} \quad S_k^* = \frac{n \sum_{i=1}^{k} (Y_i - \bar{Y})}{\sum_{i=1}^{n} (Y_i - \bar{Y})^2}, \quad k = 1, 2, \ldots, n \]

When series are homogeneous, the values of \( S_k^* \) will fluctuate around zero because no systematic deviations of the \( Y_i \) values with respect to their mean will appear.

**Q-statistics:** if a break is present in year \( K \), then \( S_k^* \) reaches a maximum (negative shift) or minimum (positive shift) near the year \( k = K \).

\[ Q = \max_{0 \leq k \leq n} S_k^* \]

**R-statistics (Range Statistics) are,**

\[ R = (\max_{0 \leq k \leq n} S_k^* \quad \text{---} \quad \min_{0 \leq k \leq n} S_k^*) \]

Buishand (1982) gives critical values for \( Q \) and \( R \) for different data set lengths.
SNHT is one of the most popular homogeneity tests in climate studies. The null and alternative hypotheses in this test are the same as in the Buishand test; however, unlike the Buishand test, SNHT is more sensitive to the breaks near the beginning and the end of the series (Costa and Soares, 2009). Alexandersson and Moberg (1997) proposed a statistic $T(k)$ to compare the mean of the first $k$ years of the record with that of the last $(n-k)$ years:

$$T(k) = k\bar{z}_1^2 + (n-k)\bar{z}_2^2$$

where,

$$\bar{z}_1 = \frac{1}{n} \sum_{i=1}^{k} (Y_i - \bar{Y})$$

and

$$\bar{z}_2 = \frac{1}{n-k} \sum_{i=k+1}^{n} (Y_i - \bar{Y})$$

$$S = \frac{1}{n} \sum_{i=1}^{n} (Y_i - \bar{Y})$$

If a break is located at the year $K$, then $T(k)$ reaches a maximum near the year $k = K$. The test statistic $T_0$ is defined as

$$T_0 = \max_{1 \leq k \leq n} T(k)$$

The null hypothesis is rejected if $T_0$ is above a certain level, which is dependent on the sample size. Critical values for different data set lengths are given in Table II.
Pettit’s Test (Non-Parametric Rank Test)

The null and alternative hypotheses in this test are the same as in the Buishand test, and this test is also more sensitive to the breaks in the middle of the series (Costa and Soares, 2009). The ranks \( r_1 \ldots r_n \) of the \( Y_1 \ldots Y_n \) are used to calculate the statistics (Pettit, 1979):

\[
X_k = 2 \sum_{i=1}^{k} r_i - k(n + 1) \\
, \quad k = 1,2,\ldots,n
\]

If a break occurs in year \( K \), then the statistic is maximal or minimal near the year \( k = K \):

\[
X_K = \max_{1 \leq k \leq n} |X_k|
\]

Critical values for \( X_K \) for different data set lengths are given in Table I
## Types of Homogeneity Tests – Critical Values

### Table I. 1% and 5% critical values for $X_K$ of the Pettitt test as a function of n;

<table>
<thead>
<tr>
<th>n</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>70</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>71</td>
<td>133</td>
<td>208</td>
<td>293</td>
<td>488</td>
<td>841</td>
</tr>
<tr>
<td>5%</td>
<td>57</td>
<td>107</td>
<td>167</td>
<td>235</td>
<td>393</td>
<td>677</td>
</tr>
</tbody>
</table>

### Table II. 1% critical values for the statistic $T_0$ of the single shift SNHT as a function of n

<table>
<thead>
<tr>
<th>n</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>70</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>9.56</td>
<td>10.45</td>
<td>11.01</td>
<td>11.38</td>
<td>11.89</td>
<td>12.32</td>
</tr>
<tr>
<td>5%</td>
<td>6.95</td>
<td>7.65</td>
<td>8.10</td>
<td>8.45</td>
<td>8.80</td>
<td>9.15</td>
</tr>
</tbody>
</table>

### Table III. 1% and 5% critical values for Q of the Buishand range test as a function of n

<table>
<thead>
<tr>
<th>n</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>70</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>1.60</td>
<td>1.70</td>
<td>1.74</td>
<td>1.78</td>
<td>1.81</td>
<td>1.86</td>
</tr>
<tr>
<td>5%</td>
<td>1.43</td>
<td>1.50</td>
<td>1.53</td>
<td>1.55</td>
<td>1.59</td>
<td>1.62</td>
</tr>
</tbody>
</table>

### Table IV. 1% and 5% critical values for N of the Von Neumann ratio test as a function of n.

<table>
<thead>
<tr>
<th>n</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>70</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>1.04</td>
<td>1.20</td>
<td>1.29</td>
<td>1.36</td>
<td>1.45</td>
<td>1.54</td>
</tr>
<tr>
<td>5%</td>
<td>1.30</td>
<td>1.42</td>
<td>1.49</td>
<td>1.54</td>
<td>1.61</td>
<td>1.67</td>
</tr>
</tbody>
</table>
Testing Homogeneity

- For homogeneity tests the null hypothesis is that a time series is homogenous between two given times. The variety of the tests comes from the fact that there are many possible alternative hypotheses: change in distribution, changes in average (one or more times) or presence of trend. Alternative Hypothesis is that there is break/jump in time series.

- The time series analysis for homogeneity tests will give the information on P value (depends on what level of significance is used), the year where a significant break in a trend and trend hypothesis $H_a$ (i.e. Break) or $H_0$ (No break, homogeneous) for corresponding station.

- This information will be given for all number of tests being used at given time and further based on how many have rejected the null hypothesis, will be subjected to selection criteria using two step approach.
Selection Criteria (Two Step Approach)

The outcomes of the four tests for annual rainfall amount and annual temperature series are grouped together. A classification is made depending on the number of tests rejecting the null hypothesis.

- **Class A: Useful** - The series that rejects one or none null hypothesis under the four tests at 5% significance level are considered. Under this class, the series is grouped as homogeneous and can be used for further analysis.

- **Class B: Doubtful** - The series that reject two null hypotheses of the four tests at 5% significance level is placed in this class. In this class, the series have the inhomogeneous signal and should be critically inspected before further analysis.

- **Class C: Suspect** - When there are three or all tests are rejecting the null hypothesis at 5% significance level, then the series is classified into this category. In this category, the series can be deleted or ignored before further analysis.

- For the stations that are classified into “suspect’ will be excluded until necessary homogeneity corrections are made to adjust the data.
Selection of Reference Station

- Influence of spatial variation and eventual inhomogeneity’s in the reference series will be reduced by using more than one reference series. In the present testing’s, one to three reference series were used.

- The reference series that correlated best with the test series were chosen, with certain restriction on the geographical distribution.

- Consequently, a weighted mean of the series from the reference stations was used, and the ratio $q$ between test and reference series was redefined accordingly.
Ratio between test and reference series

Generally, the ratio $q$ in a specific year $i$ may be denoted as,

$$q_i = \frac{f(P_i)}{g(Q_{ij}, j = 1, k_i)}$$

Here $f$ is a function of precipitation $P_i$ at the test station, $Q_{ij}$ is the precipitation at the $j^{th}$ reference station, and $g$ is a function of the precipitation at all the $k_i$ reference stations. In the present study, the functions $f$ and $g$ were defined as,

$$f(P_i) = \frac{P_i}{P} \quad g(Q_{ij}, j = 1, k_i) = \frac{\sum_{j=1}^{k_i} V_j \frac{Q_{ij}}{Q_i}}{\sum_{j=1}^{k_i} V_j}$$

Here $V_j$ is a weight factor for reference station $j$. In the present testing's, the square of the correlation coefficient between the test series and the $j^{th}$ reference series was used as the weight factor.

Adjustment Factor

Inhomogeneous series were adjusted by multiplying the precipitation values for the period before the inhomogeneity with adjustment factor $AF$:

$$AF = \frac{q_a}{q_b}$$

Here $q_a$ and $q_b$ are the mean values of $q_i$ after and before the inhomogeneity, respectively. The exact year for the break was decided by refereeing to station history whenever possible.
Figure 1. Homogenization procedure. Top – main procedure. Bottom – correction procedure for known non-climatic breaks.
Suppose for a inhomogeneous series the break is detected in year 1970; lets call it $t_{\text{break}}$.

Now, select equal time interval before & after break year which will be minimum of 20 years; lets call it $\Delta t$.

Next, for monthly data take average of each month for all years. For e.g. take average of January’s of all year then February’s of all years and so on. Do this procedure for before & after break year separately; let’s call it $dT$.

Now, make smoothing 12 monthly $dT$ by taking 3-month adjacent running average to achieve reasonable variation of $dT$ throughout the year. For e.g. to take 3-month running average of January, take average of $(D+J+F)/3$ and for February take average of $(J+F+M)/3$ and so on. Do this procedure for before & after break year separately; let’s call it $SDT$.

Here, adjustment factor for each month can be achieved by subtracting 3-month running average $SDT$ of month before break from respective month after break year. For e.g. $AF = SDT_{\text{after}} - SDT_{\text{before}}$. Do this for all 12 months $SDT$ individually.

Finally, we have 12 adjustment factors, each for every month. To correct the series add this AF to original monthly series before the break year. Take the annual series from this corrected monthly data and test again with XLSTAT to check whether the series is useful, doubtful or suspect for further use. This is difference methodology for Temperature series.
Practicals

- **Using XLSTAT**
  - XLSTAT is a statistical software for data and time series analysis.
  - XLSTAT is useful to Prepare data, visualize, explore, analyse, take decisions and predict patterns.
  - XLSTAT offers Homogeneity tests for time series test which allow to detect a change along a time series.
  - XLSTAT also offers various correlation tests, parametric & non parametric tests; it is also useful tool to visualising, analysing and modelling data.
  - Some of the time series analysis tests offered by XLSTAT are
    - Mann-Kendal trend test, homogeneity tests, Durbin-Watson test, Cochrane-Orcutt model, Heteroscedasticity test, including spectral analysis and Fourier transform, etc.
### Testing Homogeneity

Following table shows the homogeneity test results for Temperature series of few stations in Maharashtra state at 5% LOS

<table>
<thead>
<tr>
<th>Station</th>
<th>Pettit’s Test</th>
<th>SNHT</th>
<th>Buishand’s Test</th>
<th>VNR</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aurangabad</td>
<td>0.0005</td>
<td>1995</td>
<td>Ha</td>
<td>&lt;0.0001</td>
<td>2002</td>
</tr>
<tr>
<td>Mumbai Colaba</td>
<td>0.0003</td>
<td>1995</td>
<td>Ha</td>
<td>0.1040</td>
<td>1995</td>
</tr>
<tr>
<td>Mumbai Santacruz</td>
<td>&lt;0.0001</td>
<td>1986</td>
<td>Ha</td>
<td>0.0001</td>
<td>1986</td>
</tr>
<tr>
<td>Kolhapur</td>
<td>0.2397</td>
<td>2008</td>
<td>H0</td>
<td>0.4439</td>
<td>2009</td>
</tr>
<tr>
<td>Pune</td>
<td>0.0008</td>
<td>2002</td>
<td>Ha</td>
<td>0.0003</td>
<td>2006</td>
</tr>
<tr>
<td>Raigad Alibag</td>
<td>0.0005</td>
<td>1992</td>
<td>Ha</td>
<td>0.3630</td>
<td>2007</td>
</tr>
<tr>
<td>Nashik</td>
<td>0.0931</td>
<td>1976</td>
<td>H0</td>
<td>0.1367</td>
<td>1973</td>
</tr>
</tbody>
</table>
### Testing Homogeneity

Following table shows the homogeneity test results for Precipitation series of few stations in Maharashtra state at 5% LOS

<table>
<thead>
<tr>
<th>Station</th>
<th>Pettit’s Test</th>
<th>SNHT</th>
<th>Buishand’s Test</th>
<th>VNR</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
<td>Year</td>
<td>Trend</td>
<td>P</td>
<td>Year</td>
</tr>
<tr>
<td>Aurangabad</td>
<td>0.1256</td>
<td>1986</td>
<td>H0</td>
<td>0.1648</td>
<td>1986</td>
</tr>
<tr>
<td>Mumbai Colaba</td>
<td>0.0001</td>
<td>1941</td>
<td>Ha</td>
<td>&lt;0.0001</td>
<td>1952</td>
</tr>
<tr>
<td>Mumbai Santacruz</td>
<td>0.4226</td>
<td>1963</td>
<td>H0</td>
<td>0.2648</td>
<td>1959</td>
</tr>
<tr>
<td>Kolhapur</td>
<td>0.0079</td>
<td>1981</td>
<td>Ha</td>
<td>0.0214</td>
<td>1967</td>
</tr>
<tr>
<td>Pune</td>
<td>0.4963</td>
<td>1972</td>
<td>H0</td>
<td>0.5021</td>
<td>2003</td>
</tr>
<tr>
<td>Solapur</td>
<td>0.2405</td>
<td>1945</td>
<td>H0</td>
<td>0.6795</td>
<td>1945</td>
</tr>
<tr>
<td>Ratnagiri</td>
<td>&lt;0.0001</td>
<td>1929</td>
<td>Ha</td>
<td>&lt;0.0001</td>
<td>1925</td>
</tr>
</tbody>
</table>
SUMMARY OF RESULTS

- Testing Homogeneity
- Change Point Detection (Temperature)

Pune Station (Suspect)

Mumbai Colaba Station (Doubtful)
SUMMARY OF RESULTS

- Testing Homogeneity
- Change Point Detection (Precipitation)
### Testing Homogeneity

#### Homogeneity Test Results

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Total Stations</th>
<th>Station Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Class A : Useful</td>
</tr>
<tr>
<td>Temperature</td>
<td>29</td>
<td>12 (42%)</td>
</tr>
<tr>
<td>Precipitation</td>
<td>39</td>
<td>31(79%)</td>
</tr>
</tbody>
</table>
SUMMARY OF RESULTS

- Adjustments for Homogeneity
  - Homogeneity correction for Precipitation series at Mumbai Colaba
## SUMMARY OF RESULTS

- **Adjustments for Homogeneity**
- **Homogeneity correction for Precipitation series at Mumbai (Colaba) and Kolhapur**

<table>
<thead>
<tr>
<th>Station</th>
<th>Pettit’s Test</th>
<th>SNHT</th>
<th>Buishand’s Test</th>
<th>VNR</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solapur</td>
<td>0.2405</td>
<td>0.6795</td>
<td>0.3027</td>
<td>0.1592</td>
<td>Useful</td>
</tr>
<tr>
<td></td>
<td>1945</td>
<td>1945</td>
<td>1945</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>H0</td>
<td>H0</td>
<td>H0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mumbai Colaba [B]</td>
<td><strong>0.0001</strong></td>
<td><strong>&lt;0.0001</strong></td>
<td><strong>&lt;0.0001</strong></td>
<td><strong>0.0002</strong></td>
<td>Suspect</td>
</tr>
<tr>
<td></td>
<td>1941</td>
<td>1952</td>
<td>1941</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ha</td>
<td>Ha</td>
<td>Ha</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mumbai Colaba [A]</td>
<td>0.964</td>
<td>0.974</td>
<td>0.853</td>
<td>0.757</td>
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<td><strong>0.006</strong></td>
<td><strong>0.027</strong></td>
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<td>0.092</td>
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“Homogeneity Test on Daily Rainfall Series for Malaysia” by Norlee Hainie Ahmad and Sayang Mohd Deni.


WMO annex to the Implementation Plan of the GFSC – CSIS Component

XLSTAT Statistical Software Tutorials for Homogeneity Tests.

AnClim Statistical Software Tutorials for Homogeneity Tests