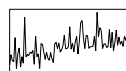


# A Guide to Programs for Calculating Indices of Extremes



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# 1 Steps for Analysis of Extremes

## Overview of Analysis in Workshop

The aim of this workshop is to calculate indices of extremes for the Asia–Pacific region. To achieve this aim, we have provided you with a set of programs that you will use on each of the stations that you have chosen from your country. Most of the programs have flexible settings, but for the workshop we will use fixed settings. These settings are outlined in the next section. You will be able to take the programs back home with you and extend your analyses by using other settings or other data.

## Analysis Steps

To avoid confusion about the process of the analysis, we have outlined below the five steps you should take to analyse your data in this workshop. The steps will guide you on where to store your files, what to name files, which programs to run, what input options to use, and which results you should write down. In Step 1 we save the data onto a computer, in steps 2 to 4 we examine the quality of the data, and in step 5 we calculate the extreme indices. You will need to repeat Steps 2 to 5 for each of your stations. Follow the steps carefully; if you have any problems, just ask!

For each station and meteorological element that you analyse, you should fill in a *Station Information Sheet*. This sheet will help you to keep track of file names, reference stations, and decisions you have made during the analysis.

In this guide, instructions follow the symbol “>”. File names and computer commands are set in Courier New typeface.

### Step 1: Set up data on the PCs

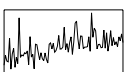
The first step in the analysis is to get all the data onto a PC. The PC you are using should contain a folder (initially) named APN <country> on its desktop. Inside this folder is a subfolder called Original Data.

- > Rename the APN <country> folder with your country’s name (e.g., APN Australia)
- > Copy your data into the Original Data subfolder.
- > Add the extension (or replace the existing extension) .dat to all of your data files. Make sure that you can identify which files contain rainfall data and which contain temperature data (e.g., by using R or T as a prefix).
- > Copy all the data into the APN <country> folder. You will carry out all of the analyses from this folder. The data in the Original Data subfolder is there as a backup, so don’t modify it.

### Step 2: Plot daily time series

The next step is to plot the daily time series so that you can identify and remove outliers, describe long-term trends, and note obvious non-climatic discontinuities.

- > Fill out the header information in the *Station Information Sheet*.
- > Open Excel
- > Open the daily data file and import the data file into Excel. The only tricky



part in this process is to get Excel to recognise the date format of the data. Make sure that in step 2 of the Import Wizard all of the date information in the file is contained in one column. In step 3, highlight the date column, choose the format to be date (DMY).

- > Excel doesn't recognise our format of missing values, so we need to replace them with blanks. Highlight the data column(s) and choose menu options Edit>Replace. Enter -99 in the Find What box, and leave the Replace With box blank. Click on the Replace All button.
- > Plot the series
- > Examine the series and record your observations in Table 1 of the *Station Information Sheet*.
- > Close Excel *without* saving the file.
- > If you have identified any outliers, you will need to remove them from the data file. Double click on the data file in the APN <country> folder (and *not* in the Original Data subfolder). Scroll down to the outlier value and replace it with -99.0. Save the changes and close the file.

*Step 3:  
Convert data to  
MASH format*

In this step you will choose stations that are climatically similar to the station you are working on. These stations will form the reference stations in the homogeneity testing that you will carry out in Step 4.

- > Fill in the names of the stations and the names of their data file in Table 2 on the *Station Information Sheet*. You need no less than two reference stations, and no more than five. If you don't have two station that can be used as reference stations, note this down on the *Station Information Sheet*, and move directly to step 5.
- > Run the program `convert_MASH.exe`. You will find instructions on using this program on page 5. Fill in the rest of the information in Table 2 in the *Station Information Sheet* based on the output of this program. Make sure that you name the output file for MASH with the first eight characters of the station name, as `<station name>.mas`.

*Step 4:  
Run MASH*

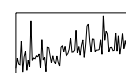
In this step you will test the homogeneity of your station by using the program MASH on your `.mas` file.

- > Follow the instructions on using MASH in Section 4 of this guide (pages 6 to 13). If you are analysing a temperature station you will need to run MASH twice: once for Tmin and once for Tmax.
- > As you go, fill Tables 3.1, 3.2 and 3.3 in the *Station Information Sheet*.
- > At the end of the homogeneity analysis, you will need to carefully examine your results, and decide whether this station is of high enough quality to be used in the analysis of extremes.

*Step 5:  
Calculate indices*

We are finally ready to calculate indices of extremes!

- > Run the program WET (page 14) if you are analysing a rainfall station, and the programs HOT and COLD (page 15) if you are analysing a temperature station.
- > Use the default settings of the programs for all the input options (except the input file name); however, the group may decide on other settings.



# 2

# Data Formats

## General Format

The programs in this manual require the data files to be stored in a particular format. Although rainfall and temperature files have a different data format, the structure of the file is the same. Each file should contain the data for one station stored as ASCII text. It is best if you name the file with a `.dat` extension, so that you don't confuse it with the files that will be created by other programs. The format of the file is as follows (words after the `#` are comments, and should not be included in the file):

```
Header          # Station name and number
XXX.XX  YYY.YY  # Location
DDMMYYYY DATA  # Data
. . .          #
```

The header in the first line can contain the name of the station and any other identifying information—such as station numbers. This line can have any format.

The second line contains the location of the station:

```
XXX.XX = longitude in decimal degrees East (0.0 to 360.0)
YYY.YY = latitude in decimal degrees North (-90.0 to 90.0)
```

Each line from the third line to the end contains the data with one day per line:

```
DD is the day (01–31)
MM is the month (01–12)
YYYY is the year
DATA is the data value(s)
```

The format of `DATA` is different for rainfall and temperature. However, missing values of both rainfall and temperature should be left out (by omitting the entire line) or written as `-99.0`.

## Rainfall Data

The format of the data line in the rainfall files is

```
DDMMYYYY AAAA.A
```

where `AAAA.A` is the rain for that day in millimeters. For example,

```
12011950 63.2
```

shows that 63.2mm of rainfall fell on 12 January 1950.

## Temperature Data

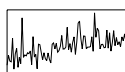
The data line in temperature files has two columns of data. The first column contains minimum temperatures (`Tmin`) and the second contains maximum temperature (`Tmax`):

```
DDMMYYYY AA.A AA.A
```

where `AA.A` is the temperature in degrees C. For example,

```
31031998 23.3 -99.0
```

represents a minimum of 23.3°C and a missing maximum for 31 March 1998



# 3

# MASH Format

## Program convert\_MASH

The program MASH, which we will use to determine the quality of station data, can only use annual or monthly values (totals for rainfall and averages for temperature). It also combines several stations (the candidate station and several reference stations) into one file. We therefore need to use the program `convert_MASH.exe` to convert the original station files into the MASH format.

## Execution

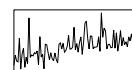
Double click on the file `convert_MASH.exe`. The program will then ask you for the information it needs.

## Input

- > Enter whether you are examining daily data or annual index data (daily would be appropriate for most of your analyses).
- > Enter whether you are examining rainfall or temperature
- > Enter the data file name of the candidate series. This file should have the format specified on page 4.
- > Enter the number of reference stations that you intend to use.
- > Enter, in turn, the data file names of the reference stations (in the order that you filled them in the *Station Information Sheet*). Note that if you type the name incorrectly, the program will ask you to re-enter the name. These files should also be in the format specified on page 4
- > Enter whether you want `convert_MASH` to create annual or monthly data. Initially, you should use annual data to identify inhomogeneities. Later, you may want to identify the timing of a discontinuity more accurately by using monthly data.
- > Enter the output file name as `<station name>.mas`, where `<station name>` is the first eight characters of the candidate station name. If you chose rainfall, you will need to enter one output file name. If you chose temperature, you will need to enter two output file names: one for T<sub>min</sub> and one for T<sub>max</sub>. To differentiate the temperature file, add a prefix to the output file name: `mn` for T<sub>min</sub> and `mx` for T<sub>max</sub>.

## Output

The program will display summary information of the stations used. Note down this information in Table 2 of the *Station Information Sheet*. It will also create the file `<station name>.mas` which you will input into MASH.



# 4

# Homogeneity Tests

## Overview of MASH

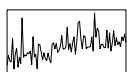
Station climate records often contain discontinuities that reflect changes in the way the observations were taken, rather than changes in the climate. Two common causes of these discontinuities are station moves and changes to the measuring instruments. Because of these discontinuities, we need to know the ‘health’ of the data at a station before we can analyse the climate at the station.

MASH (or Multiple Analysis of Series for Homogenisation) is a set of programs that allow you to detect and (if you wish) correct discontinuities in station data. MASH (currently in version 1.03) was written by Tamás Szentimery.

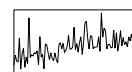
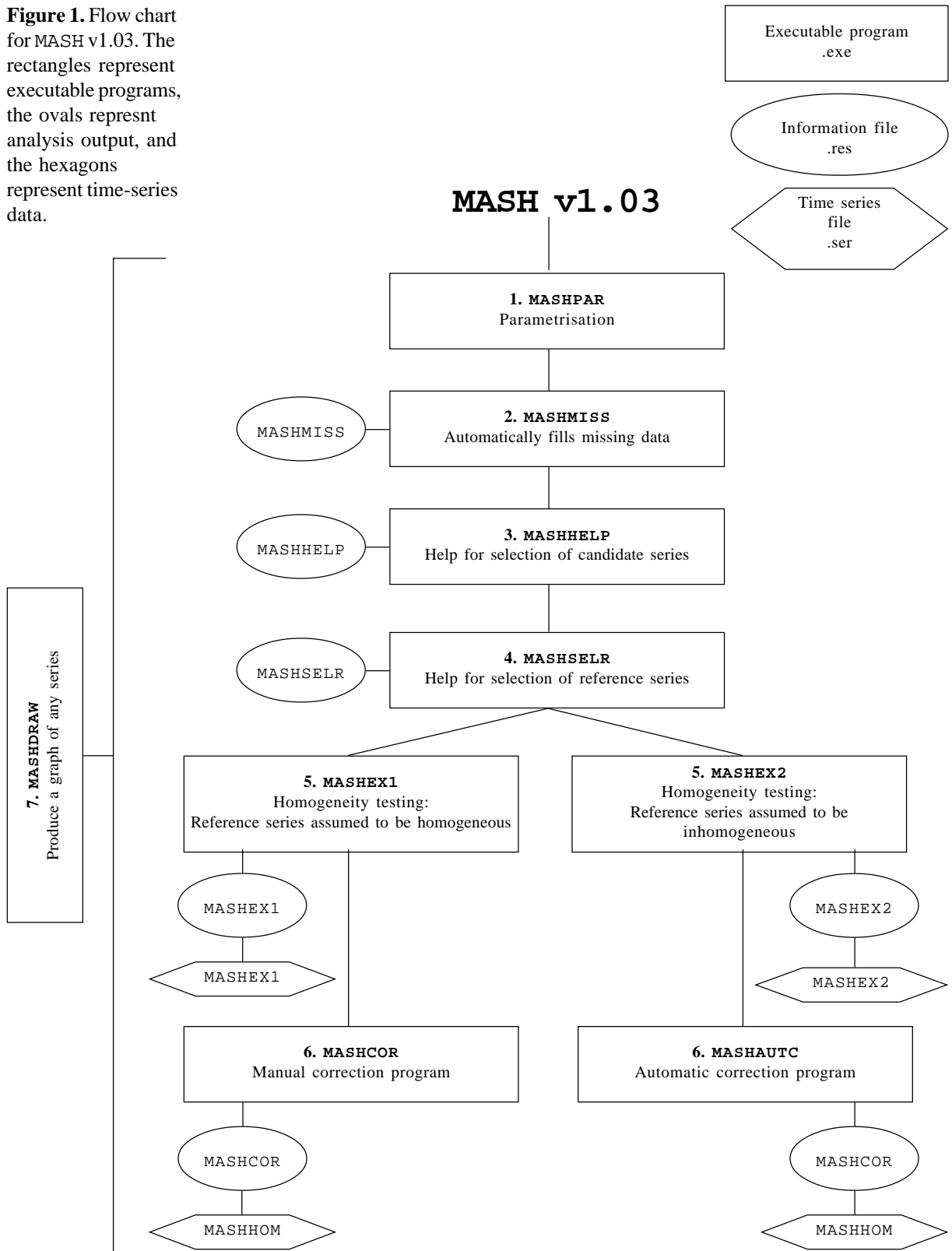
MASH works by comparing the station we want to test (the *candidate* station) to neighbouring stations (or *reference* stations). Stations that come from the same climate region usually have correlated climate records. However, because discontinuities in a record are usually the result of local changes to the station, we would not expect neighbouring stations to have the same discontinuities. Therefore, discontinuities that occur in the candidate station but *not* in the reference stations might point to a problem with the candidate station’s record. MASH can suggest when discontinuities occurred, and by how much they shifted the data.

MASH can also correct the discontinuities that it finds; however, we need make sure that we have a good reason for altering the data. Before we correct any discontinuity that we find, we need to look through the metadata (or history) of the station to see if the discontinuity corresponds to a recorded event (like a station move). If there is no recorded reason for the discontinuity, it is sufficient to note that the station has problems and use it cautiously (or not use it at all). MASH is designed for correcting annual and monthly data, and is not suitable for correcting daily data.

MASH is a set of nine programs that need to be carried out in sequence. The rectangles in Figure 1 describes this sequence. Figure 1 also shows you what output files each step of the analysis produces. The following section gives detailed explanations of how to use these programs in this workshop (except step 6 of Figure 1, as we will not be correcting discontinuities in the data). For further details of the programs you will need to refer to the *Program User’s Guide for MASH*.



**Figure 1.** Flow chart for MASH v1.03. The rectangles represent executable programs, the ovals represent analysis output, and the hexagons represent time-series data.



## Step by Step MASH

This section contains detailed instructions for using MASH to homogenise a station record. You can find all the programs that you will need to use in the APN <Country> folder on the desktop, or in the MASH folder on the CD-ROM that you received in the workshop.

### *Prepare the input data*

Use the <station name>.mas file that you created with the convert\_MASH program (page 5).

### *Parametrise the data using MASHPAR*

The program MASHPAR.exe reads the data from an ASCII file and creates an internal file for the other MASH programs to use.

- > Double click on MASHPAR.exe
- > Enter the data file name (<station name>.mas)
- > Choose the significance level (start off with 0.05)
- > Choose n (no) to the question Do you have a Table of Reference System? (as you will now create one).
- > Choose y (yes) for the suggested series comparisons (this question will be repeated for each reference station in the .mas file).
- > Press Enter
- > Close the window

Instead of using the station names that appear in the .mas file, MASHPAR gives each station an index number. The candidate station will always be series 1. The reference stations are numbered from 2 to the (number of reference station + 1). Note down the index number of each station, as the later programs will refer to stations by their index number.

### *Fill missing values with MASHMISS*

The program MASHMISS.exe uses the method of optimal interpolation to estimate missing values in each time series. This method is based on comparing neighbouring stations. You can find more details about this method in the *MASH User's Guide*.

- > Double click on MASHMISS.exe

The program counts the number of missing values in each series (labelled by its index number).

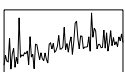
- > Press Enter
- > Close the MASHMISS.exe window

MASHMISS.exe forms a report for each of the missing values and stores it in MASHMISS.res. This file shows when and where missing values occurred, what their estimated value was, which series MASH used for estimating them, and what the standard error in their estimate was.

### *Plot the series using MASHDRAW*

With any time-series analysis, the most important first step is to plot a graph of the data. A graph will allow us to identify trends and outliers. It will also show us how the annual values of the candidate and reference stations compare to each other. We can plot graphs of the time series using MASHDRAW.exe.

- > Double click on MASHDRAW.exe



A table with plotting option appears.

> Enter 1

Option 1 is now highlighted and the program prompts us to enter the index number of the series we want to plot. Below is an example of the commands needed to plot five stations. Modify the commands you use depending on how many you have in the .mas file.

> Enter 1  
> Enter y (we want to plot all the series on one graph)  
> Enter 2  
> Enter y  
> Enter 3  
> Enter y  
> Enter 4  
> Enter y  
> Enter 5  
> Enter n  
> Enter n

The graph appears on the screen.

> Press Enter to escape the graph  
> Close the MASHDRAW.exe window

(You can also plot the graphs in Excel. This option gives you more flexibility in plotting and allows you to save the plot. To plot the data, open the file MASHDAT.ser in Excel.)

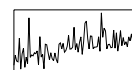
*Select the candidate and reference series using MASHHELP and MASHSELR*

The MASHHELP.exe program helps you to determine which station is best to use as a candidate station. However, you have already decided which station to use as a candidate station so you don't need to run this program.

In the steps taken to create the .mas file, you have used your knowledge of the candidate station to decide which are the climatically similar reference stations. The program MASHSELR.exe checks this choice statistically. The program calculates a test statistic (TS) that shows which reference station 'stick out' from the rest. The higher the value of TS, the more different a station is from the rest of the reference stations—and should therefore not be used as a reference station.

> Double click on MASHSELR.exe  
> Enter 1 for the candidate series  
> Enter 0 (don't ignore any series)  
> Enter the suggested maximum number of stations

A table appears with the series and their associated TS. Series that are not included as reference series are marked with an asterisk (\*). Examine the TS



values of all the reference stations. If a station (or stations) has a TS values that is much higher than the others, note the index number of the station, as you will need to remove it in the next step.

- > Enter *n* if you have no stations you wish to remove, close the MASHSELR . exe window, and move to the next step in the MASH analysis.
- > Enter *y* if you wish to remove one or more of the stations.
- > Enter 1 for the index of the candidate station
- > Enter the number of reference stations you wish to remove
- > Enter the index numbers of the reference stations to exclude
- > Enter the suggested maximum number of applied reference stations

Examine the TS values again, and repeat the process if necessary. At any stage you may come back to this point, change which reference stations you include and exclude, and see how the results are affected.

*Identify discontinuities in the data using MASHEX2*

We have now reached the stage where we are ready to examine whether the candidate series contains discontinuities. MASH identifies discontinuities in the candidate series by examining a *difference* series. The difference series is made from the candidate series minus a weighted combination of the reference series.

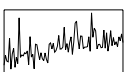
There are two types of examinations MASH can perform: When you can assume that the reference series are homogeneous, you should use MASHEX1 . exe. If you can't assume that the reference series are homogeneous (which is the case for most of the stations you will be looking at), you will need to use MASHEX2 . exe.

- > Open MASHEX2 . exe
- > Enter 1 (the candidate series)
- > Enter 0 (we don't want to exclude any series)
- > Enter the suggested maximum number of stations
- > Press Enter
- > Close the MASHEX2 . exe window

The results of this analysis are contained in the file MASHEX2 . res .

- > Open MASHEX2 . res

If your candidate station contains inhomogeneities, the file you have just opened should be similar to the output on the following page.



CANDIDATE SERIES: Busse1 (Index: 1)

NUMBER OF DIFFERENCE SERIES: 2

REFERENCE SERIES, WEIGHTING FACTORS, VARIANCE OF DIFFERENCE SERIES

	August	Bridge	Variance	Deviation
Busse1	.48206	.51794	.33303	.57709
	Donnyb		Variance	Deviation
Busse1	1.00000		.22776	.47725

NO FORMER ESTIMATED BREAKS

EXAMINATION OF DIFFERENCE SERIES

1. DIFFERENCE SERIES

OUTLIERS ( critical value: 8.08 )

	Date	Stat.	Jump	Conf. Int.
1	1932	13.88	-1.49	[ -2.15, -.83]
2	1979	17.31	1.67	[ 1.01, 2.33]
3	1994	36.91	2.43	[ 1.77, 3.09]

BREAK POINTS ( critical value: 21.60 )

Test statistic before homogenization of diff. s.: 1180.08

	Date	Conf. Int.	Stat.	Shift	Conf. Int.
			14.23	-	
1	1954	[1939,1963]	38.42	-.48	[ -.75, -.21]
			9.86	-	
2	1972	[1967,1973]	32.86	.96	[ .41, 1.68]
			.89	-	
3	1975	[1975,1976]	83.00	1.70	[ 1.05, 2.35]
			20.52	+	

Test statistic after homogenization of diff. s.: 20.52

2. DIFFERENCE SERIES

OUTLIERS ( critical value: 8.08 )

	Date	Stat.	Jump	Conf. Int.
1	1979	8.30	1.28	[ .55, 2.01]
2	1994	13.79	1.65	[ .92, 2.38]

BREAK POINTS ( critical value: 21.60 )

Test statistic before homogenization of diff. s.: 589.00

	Date	Conf. Int.	Stat.	Shift	Conf. Int.
			11.36	-	
1	1913	[1911,1913]	26.76	1.46	[ .59, 2.97]
2	1914	[1914,1922]	22.07	-1.36	[ -2.70, -.41]
			18.92	+	
3	1932	[1932,1932]	24.62	-.54	[ -3.06, -.54]
			12.44	-	
4	1961	[1949,1963]	49.70	-.76	[ -1.19, -.41]
			.98	+	

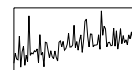
Test statistic after homogenization of diff. s.: 52.51

Result series (diff.s. with inhom.s.): MASHEX2.SER

Graphic result series: MASHDRAW.EXE

Automatic Correction: MASHAUTC.EXE

Non-Automatic Correction: MASHCOR.EXE



Because MASHEX2 assumes that the reference stations are not homogeneous, it creates two difference series based on alternative combinations of the reference stations. The MASHEX2 program can detect different discontinuities from each of the two difference series. Hence the MASHEX2 .res results file contains two tables: one based on each difference series. It also contains information about each shift value—such as the confidence interval on the date of the shift, and the confidence interval on the magnitude of the shift.

Each of these shift values could possibly represent a true inhomogeneity in the candidate series. However, we need to consult the metadata for this station and any other information we can obtain about the station before we can qualify each shift. Table 1 compares the discontinuities MASH has identified in the record of a Western Australian station called Busselton with the discontinuities identified in another study (Torok and Nicholls, 1996). We can see that there is good agreement between MASH and the study for some of the discontinuities, although the year and the size of the shift don't always agree.

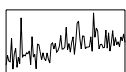
**Table 1.** Comparison between the shifts identified by MASH and the shifts identified in a study of Busselton.

Temperature Adjustments				
MASH		Torok & Nicholls (1996)		Reason
Year	Shift (°C)	Year	Shift (°C)	
1913	+1.46			
1914	-1.36			
1932	-0.54	1932	-1.2	Median range test
		1933	+1.0	
1961	-0.76	1958	-0.3	Screen move
1972	+1.06			
1975	+1.57	1976	+2.0	Composite site move
1985	-0.99	1981	+0.5	Screen move
1989	+1.32			

*Plot the difference series using MASHDRAW*

Finally, let's plot difference series and shift values.

- > Open MASHDRAW . exe
- > Enter option 5 (results of Examination 2)
- > Enter 1
- > Enter y (we want to open the shift values as well)
- > Enter 2
- > Enter y
- > Enter 3
- > Enter y
- > Enter 4
- > Enter n
- > Enter n

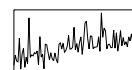
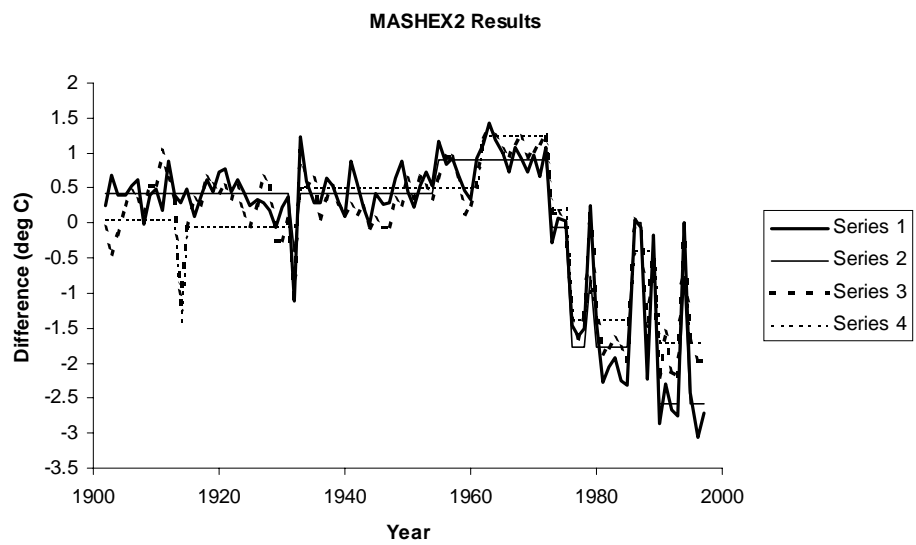


The plot of the difference series now appears (see Figure 2). Series 1 is the first difference series and series 2 contains the shift values identified from this difference series. Similarly, series 3 is the second difference series, and series 4 shows the shift values identified from this series. Note the two large negative shifts starting at 1972.

- > Press Enter
- > Close MASHDRAW.exe

(You can also plot these series using Excel. They are stored in the file MASHEX2.ser.)

**Figure 2.** The difference series and the shift values identified by MASH for Busselton. This plot was created with Excel, not MASHDRAW.



# 5

# Indices of Extremes

## Rainfall: Program WET

The program WET calculates annual values of four indices of extreme daily rainfall:

1. Frequency (R99F): Frequency of daily rainfall exceeding the 1961–1990 mean fourth highest annual (99th percentile) value
2. Intensity (R99I): Average intensity of the four highest events
3. Percent (R99P): Percent of total annual rainfall falling in the top four events
4. DRY: days with rainfall less than 2mm

These indices reflect several aspects of extreme rainfall: how often it occurs, its average magnitude, and how it compares with ordinary rainfall. WET also outputs several general indices of rainfall that might help us interpret changes in extreme rainfall.

## Execution

Double click on WET. The program will then ask you to enter the information it needs.

## Input

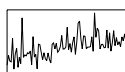
- Input file: The name of the file containing the data. The data file should be formatted according to the instructions on page 4.
- Output file: The name of file to which the results will be written. If you press `Enter` without specifying a name, the program will use the default name `<input file name>.wet`.
- Start year: The initial year of the analysis. The default value is the starting year of the data.
- End year: The final year of the analysis. The default value is the final year of the data.
- Percentile: A percentile value (0–100) for determining the threshold of extreme rainfall. The default value is 99.

## Output

The output file has the name specified in the input to the program. The first two rows of the file are the same as the first two rows of the input file. The third and fourth rows contain the trends and significance levels of each of the indices, respectively. The fifth row contains the names of the columns. The rows from the sixth row contain the output. The file contains the following columns:

- Year: Year of the result
- Total: Total rainfall (mm)
- Miss: Probability that one of the top four events is missing. If the probability is greater than 0.5, the indices of extremes will be set to missing (-99.0).
- Raindays: Number of days with rainfall greater than 2mm
- Percentil: Annual 99th percentile (fourth highest annual value) (mm)
- Intensity: Intensity index (mm/day)
- Frequency: Frequency index (days/year)
- Percent: Percent index (%)

You can plot these indices by opening the output file in Excel.



## Temperature: Programs HOT and COLD

The programs HOT and COLD calculate indices of extreme minimum and maximum daily temperature:

1. Hot days (THX): Frequency of Tmax above the mean 99th percentile
2. Hot nights (THN): Frequency of Tmin above the mean 99th percentile
3. Cold days (TCX): Frequency of Tmax below the mean 1st percentile
4. Cold nights (TCN): Frequency of Tmin below the mean 1st percentile

The program HOT calculates the number of days above a threshold, whereas the program COLD calculates the number of days below a threshold.

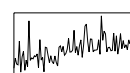
Double click on either COLD or HOT. The programs will then ask you to enter the information they need.

- Input file: The name of the file containing the data. The data file should be formatted according to the instructions on page 4,
- Output file: The name of file to which the results will be written. If you press Enter without specifying a name, the programs will use the default file names: <input file name>.col for COLD and <input file name>.hot for HOT.
- Start year: The initial year of the analysis. The default value is the starting year of the data.
- End year: The final year of the analysis. The default value is the final year of the data.
- Percentile: A percentile value (0–100) for determining the threshold of extreme temperature. The default value for COLD is 1, and the default value for HOT is 99.

The output files of HOT and COLD have the names specified in the input to the programs. The first two rows of the file are the same as the first two rows of the input file. The third and fourth rows contain the trends and significance levels of each of the indices, respectively. The fifth row contains the names of the columns. The rows from the sixth row contain the output. Both types of output files contain the following columns:

- Year: Year of the result
- Min\_Miss: Probability that one of the four most extreme Tmin events is missing. If the probability is greater than 0.5, the indices of extremes will be set to missing (-99.0).
- Min\_Pile: Annual 99th percentile of Tmin (fourth highest value) (°C)
- Min\_Freq: Cold-nights index (COLD) or hot-nights index (HOT) (days/year)
- Max\_Miss: Probability that one of the four most extreme Tmax events is missing. If the probability is greater than 0.5, the indices of extremes will be set to missing (-99.0).
- Max\_Pile: Annual 99th percentile of Tmax (fourth highest value) (°C)
- Max\_Freq: Cold-days index (COLD) or hot-days index (HOT) (days/year)

You can plot these indices by opening the output file in Excel.



# 6

# More Information

## People

The following two people will be able to help you if you have any problems or questions about the programs in this guide:

- MASH: Paul Della-Marta (email: p.della-marta@bom.gov.au)
- Extremes indices: Malcolm Haylock (email: m.haylock@bom.gov.au)

## References

There are many references on data quality and indices of extremes. Here are some important ones that are particularly relevant to this workshop:

- Data quality:  
Chatfield. C. (1996). *The analysis of time series: An introduction*. 5th ed. Melbourne: Chapman & Hall.  
Peterson. T.C, D. R. Easterling, T. R. Karl, P. Groisman, N. Nicholls, N. Plummer, and S. Torok (1998). Homogeneity adjustments of in situ atmospheric climate data: A review. *Int. J. Climatol.* **18**: 1493-1517.  
Szentimrey, T. (1998). *Multiple Analysis of Series for Homogenization (MASH v1.03): Program user's guide*.  
Szentimrey, T., T. Faragó, and S. Szalai (1991). Window technique for climate trend analysis. *Climate Dynamics*, **6**: 127–135.
- Indices of extremes: Reports from the CLIVAR/GCOS/WMO Workshop on Indices and Indicators for Climate Extremes, Asheville, NC, USA, 3–6 June 1997.  
Karl, T. R., N. Nicholls, and A. Ghazi (1999). Workshop summary. *Climatic Change*, **42**: 3–7.  
Trenberth, K. E. and T. W. Owen (1999). Breakout group A: Storms. *Climatic Change*, **42**: 9–21.  
Nicholls, N. and W. Murray (1999). Breakout group B: Precipitation. *Climatic Change*, **42**: 23–29.  
Folland, C. K., C. Miller, D. Bader, M. Crowe, P. Jones, N. Plummer, M. Richman, D. E. Parker, J. Rogers, and P. Scholefield (1999). Breakout group C: Temperature indices for climate extremes. *Climatic Change*, **42**: 31–43.

## Web Sites

Here are some useful and interesting web sites that you might like to check out:

- Asia–Pacific Network for Global Change Research (APN): <http://www.apn.gr.jp/index2.htm>
- Bureau of Meteorology (Australia): <http://www.bom.gov.au/>
- National Climatic Data Center (NCDC, USA): <http://www.ncdc.noaa.gov/>
- Intergovernmental Panel on Climate Change (IPCC): <http://www.ipcc.ch/>

