UNDP Climate Change Country Profiles

Documentation

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Contents

1 Introduction

This document describes the contents and method used to construct the UNDP climate change country profiles. The profiles were funded jointly between the National Communications Support Program (NCSP) and the UK Department for International Development (DfID) and were developed to address the climate change information gap in many developing countries by making use of existing climate data to generate country-level data plots from the most up-to-date climate observations and the multi-model projections from the WCRP CMIP3 archive (Meehl *et al.,* 2007). We use a consistent approach for 52 countries (Table 1) to produce an 'off the shelf' analysis of climate data, and also make available the underlying data for each country for use in further research.

Each of the UNDP climate change county profile reports includes:

- A set of maps and diagrams illustrating the observed and projected climates of that country as:
  (a) An area-average time series for each country showing observed climate combined with model-simulated recent and future climate under three SRES emissions scenarios (A2, A1B, and B1). For the models, the series depict the recent climate and future changes as a 'plume' that encompasses the range of the 15 model ensemble under each scenario to demonstrate the degree of model uncertainty.
  (b) maps depicting projected changes for 10-year-average 'time-slices' for the 2030s, 2060s and 2090s under SRES emissions scenario A2[1] on a 2.5 x 2.5 ˚ grid demonstrating spatial variations in change across the country. For each grid box we give the ensemble median change, and also the ensemble range.
- A summary table of observed trends and projected change, averaged over the whole country, 2030s, 2060s and 2090s under SRES emissions scenarios A2, A1B, and B1.
- A narrative summarising the data above, and placing it in the context of the country's general climate and known inadequacies in climate model performance affecting that region.
- A dataset (available from the project website) containing the underlying observed and model data for that country, for use in further research projects. The files are smaller and more manageable than the global fields made available by the PCMDI, and in text format which can easily be read and used with widely available software packages or simple text editors.

[1] For details of emissions scenarios, refer to the IPCC special report on emissions scenarios (Nakicenovic et al., 2000).

The country profiles include analyses of the following climatic parameters on an annual and seasonal basis:

- Mean temperature
- Mean monthly precipitation
- Indices of extreme daily temperatures:
  - Frequency of 'Hot' days
  - Frequency of 'Cold' days
  - Frequency of 'Hot' nights
  - Frequency of 'Cold' nights
- Indices of extreme daily precipitation
  - Proportion of total rainfall falling in 'heavy' events
  - Maximum 1-day rainfall
  - Maximum 5-day rainfall

Definitions of the extremes indices and the units in which they are expressed can be found in Table2.

Important Notes

1. Please note that the data files made available are intended for research purposes only, and those wishing to use these files for commercial purposes must gain prior consent from the climate centres where these data have originated.
2. It should be noted that these reports are not a summary of existing literature on projected climate change or its impacts, but simply a summary of observed data and the results of climate model experiments. The reports represent one source of climate change information, and should be used with reference to other studies which make use of alternative techniques and information.
3. Users of this information should bear in mind that the model data for the future are not predictions of climate, but model *simulations* of future climate under a range of hypothetical emissions scenarios and should be interpreted with due caution.

Table 1 Countries Included in UNDP Climate Change Country Profiles Project.

Africa		**Asia**	**Caribbean**	**Central America**
Angola	Kenya	Afghanistan	Antigua and Barbuda	Belize
Benin	Malawi	Armenia	Barbados	Guyana
Cameroon	Mali	Cambodia	Cuba	Mexico
Cape Verde	Mauritania	Nepal	Dominica	Nicaragua
Chad	Mauritius	Pakistan	Dominican Republic	Suriname
Comoros	Morocco	Vietnam	Grenada	
Equatorial Guinea	Mozambique	Yemen	Jamaica	
Eritrea	Sao Tome and Principe		St Kitts and Nevis	
Ethiopia	Senegal		St Lucia	
Liberia	Tanzania		St Vincent and the Grenadines	
Sierra Leone	Togo		The Bahamas	
Ghana	Uganda		Trinidad and Tobago	
Gambia	Zambia			
Gabon				
Guinea				

Table 2. Definitions and units for Extremes indices

Index Name	Acronym	Definition
Frequency of 'Hot' days	*TX90p*	The temperature threshold for a 'hot day' in any region or season is defined by the daily maximum temperature (*TX*) which is exceeded on the 10% warmest of days in the standard climate period (1970-99)[2]. The *TX90p* index is then defined as the frequency with which daily maximum temperature exceeds this threshold in any month, season or year.
Frequency of 'Cold' days	*TX10p*	The temperature threshold for a 'cold day' in any region or season is defined by the daily maximum temperature (*TX*) below which the 10% coldest days in the standard climate period (1970-99) fall. The TX10p index is defined as the frequency with which daily maximum temperature falls below this threshold in any month, season or year.
Frequency of 'Hot' nights	*TN90p*	The temperature threshold for a 'hot night' in any region or season is defined as the daily minimum temperature (*Tn*) which is exceeded on 10% of days in the standard climate period (1970-99). The *TN90p* index is then defined as the frequency with which daily minimum temperature exceeds this threshold in any month, season or year..
Frequency of 'Cold' nights	*TN10p*	The temperature threshold for a 'cold night' in any region or season is defined by the daily maximum temperature (*TN*) below which the 10% coldest days in the standard climate period (1970-99) fall. The *TN10p* index is defined as the frequency with which daily minimum temperature falls below this threshold in any month, season or year.
Proportion of total rainfall falling in 'heavy' events	*R95pct*	A 'heavy' rainfall event is defined by daily rainfall amount exceeded by the 5% of heaviest events in a given region or season. The total rainfall which falls in any events which are greater than this fixed threshold is then totalled, and expressed as a percentage of the total monthly rainfall in that season or year. This is then expressed as an anomaly against the total rainfall falling in 'heavy' events in the standard climate period (1970-99). Thus, an anomaly value of 4% means that an additional 4% of the total rainfall occurs in 'heavy' events, compared with the standard climate period.
Maximum 1-day rainfall	*RX1day*	The magnitude of the annual maximum daily rainfall in a given period of time (mm). These data are expressed as anomalies from the 1970-99 mean.
Maximum 5-day rainfall	*RX5day*	The magnitude of the annual maximum 5-day total rainfall in a given period of time (mm). These data are expressed as anomalies from the 1970-99 mean.

[2] Observed indices TX90p, TX10p, TN90p, TN10p, RX1day, RX5-day and R95pct are based on reference period 1961-90, whilst indices from model data are calculated against reference period 1970-99.

2 Data

2.1 Observational Data

Observational data are taken from a number of datasets, detailed in Table 3.

Table 3. Observational data sources

Monthly Temperature				
Climatic Research Unit (*CRU*)	New *et al.* (2002)	Gridded station data	1961-2000	0.5x0.5˚
University of Delaware (*UDel*)	Matsuura and Willmott (2007a)	Gridded station data	1961-2006	0.5x0.5˚
NCEP	Kalnay *et al*. (1996)	Re-analysis data	1960-2006	0.5x0.5˚
ERA40	Uppala, et al. (2005)	Re-analysis data	1960-2001	0.5x0.5˚
Monthly Precipitation				
Climatic Research Unit (*CRU*)	New *et al.* (2002)	Gridded Station data	1961-2000	0.5x0.5˚
University of Delaware (*UDel*)	Matsuura and Willmott (2007b)	Gridded station data	1961-2006	0.5x0.5˚
Global Precipitation Climatology Centre (GPCC)	Adler *et al*. (2003)	Merged station and Satellite data	1960-1979	2.5x2.5˚
Daily Extremes Indices				
HadEX	Alexander *et al*., (2006)	Gridded Extremes indices based on station data	1960-2003	2.5x3.75˚

2.2 Model Data

The climate models used are a sub-set of 15 from the 22-member ensemble used by the Intergovernmental Panel on Climate Change (IPCC) for their fourth Assessment report, published in 2007. The models included are those which had the most complete availability across the different variables that we required. For further details on these models, and results of their evaluation, see Randall *et al.* (2007).

Table 4: GCM model data used for UNDP climate change country profiles. For each model climate parameter, the numbers indicate where data are available (1) are not available (0), or where run ~1 has not been available, and substituted with an alternative run of the same model (2), for each of wxyz; 20c3m, sresa2, sresa1b, sresb1.

	Monthly		Daily		
Model	**Precip**	**Temp**	**Precip**	**Maximum temp (Tasmax)**	**Minimum temp (Tasmin)**
bccr_bcm2_0	1111	1111	1111	1111	1111
cccma_cgcm3_1	1111	1111	1111	1111	1111
cnrm_cm3	1111	1111	1111	1111	1111
csiro_mk3_0	1111	1111	1111	1111	1111
csiro_mk3_5	1111	1111	1111	1111	1111
gfdl_cm2_0	1111	1111	1111	1111	1111
gfdl_cm2_1	1111	1111	1111	1111	1111
giss_model_e_r	1121	1111	1111	1111	1111
inmcm3_0	1111	1111	1111	0111	0111
ipsl_cm4	1111	1111	1111	1111	1111
miub_echo_g	1111	1111	1111	1110	1110
mpi_echam5	1111	1111	1111	1110	1110
mri_cgcm2_3_2a	1111	1111	1111	1111	1111
ncar_ccsm3_0	1111	1111	1122	0000	0000
ukmo_hadcm3	1111	1111	1110	0000	0000

3 Interpreting the Figures

3.1 Country-average time series

The time series figures show the climate change, averaged over the whole country, including all data/model grid boxes that fall within, or partially within, the borders of the country.

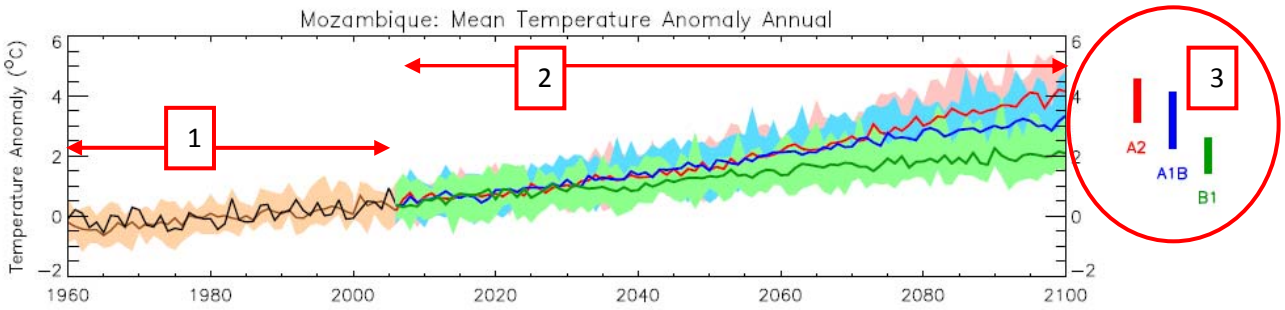

Figure 1: Example time series plot

- Observed climate period
  - Black solid line indicates the mean of all the observed datasets (see Table 3) for list of data contributing to each climate variable / index.
  - Brown solid line, and shading, indicates the median, maximum and minimum of the 20th century control runs (20c3m) of the 15 GCMS.
- Projected climate period
  - The three coloured lines and shading indicate the mean, maximum and minimum of the ensemble of 15 models (see Table 4), under each of three emissions scenarios.
    - Red/pink: SRES A2
    - Blue/pale blue: SRES A1B
    - Green/pale green: SRES B1

    NB. For the extremes indices, the continuous projected climate time series are not available, so only the periods 2046-2065 and 2081-2100 are shown.

  - Bars
    - For each scenario, these bars indicate the ensemble range of the average anomaly across the 15 models for by the 2090s.

3.2 Methods for construction of time series figures

3.2.1 Observed data

1.) Monthly time series at each grid box are averaged to annual and seasonal values
2.) All grid boxes that are fully or partially within the borders of the country are selected and averaged to give a country-average time series for each dataset; for each season[3], and as an average over the whole year.
3.) The country-average time series are converted from their absolute units to anomalies relative to the 1970-99 mean. (NB this stage applies to mean temperature and precipitation, and the precipitation extremes indices, but not the temperature extremes indices)
4.) For each year, the mean anomaly values are taken from across all the datasets.

Note on observed extremes indices: The HadEX observations dataset (Alexander *et al*., 2006) had already been calculated using a 1961-1990 as the standard climate reference period, which is inconsistent with our use of 1970-1999 for the model data. We quote the frequency with which the percentile thresholds are exceeded in the period 1970-99 in the summary tables to indicate how much of a discrepancy this causes.

3.2.2 Model data

1.) Global data fields are re-gridded to a common 2.5 by 2.5˚ grid
2.) Monthly time series at each grid box are averaged to annual and seasonal values for each model
3.) All grid boxes that are fully or partially within the borders of the country are selected and averaged to give a country-average time series for each model; for each season, and as an average over the whole year.
4.) The country-average time series are converted from their absolute units to anomalies from the 1970-99 mean, on a model-by-model basis. (NB this stage applies to mean temperature and precipitation, and the precipitation extremes indices, but not the temperature extremes indices).
5.) For each year, the minimum, maximum and median anomaly values are calculated from the ensemble of 15 models.

[3] All data are presented as annual as well as seasonal means, with seasonal divisions chosen to suit the country's own climate rather than limiting the study to fixed standard 3-month seasons.

Note on precipitation extremes indices:

The magnitude of daily rainfall extremes is not comparable between the observed data and model data due to differences in the spatial scale that is represented by these data. HadEX observations represent point scale (meteorological stations), whilst model output represents areal-averages for model grid boxes. We do not, therefore, overlay observed RX1 and RX5-day rainfalls on the time series figures.

3.3 10-year average time slice maps

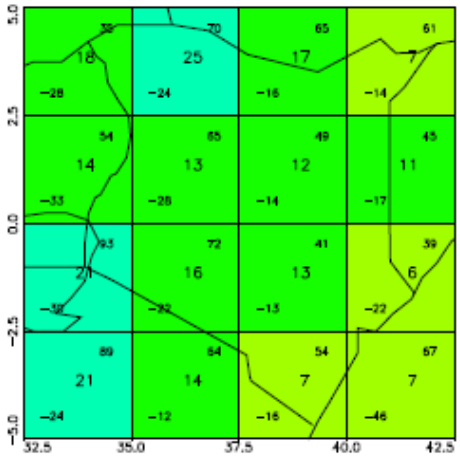

Figure 2: Example 10-year time slice map

The value in the centre of each grid box gives the median value for the ensemble of 15 models, and the values in the top-right and bottom left in a smaller font give the maximum and minimum values of the ensemble.

3.4 Methods for construction of 10-year time slice maps

3.4.1 Model data

1.) Global model data fields are re-gridded to a common 2.5 by 2.5˚ grid
2.) Monthly global data fields are averaged to annual and seasonal values for each model, on a grid-box by grid-box basis.
3.) The 2.5 x 2.5 ° gridded fields are converted from their absolute units to anomalies from the 1970-99 mean, on a model-by-model basis.
4.) The anomalies are averaged over 10-year periods or 'time slices'.
5.) For each grid box and each time slice, each scenario and each season, the minimum, maximum and median anomaly values are taken from across the 15 model ensemble.
6.) A rectangular region incorporating the country is extracted from the global field.

3.4.2 Observed Climatology

We provide observed climatological fields (1970-99) from the CRU datasets in the data files so that the modelled anomalies can be applied to observed climate for each region. The method used for this is as follows:

1.) CRU data fields are re-gridded to the same 2.5 by 2.5˚ grid used for model data.
2.) Monthly global data fields are averaged to annual and seasonal values for each model
3.) A rectangular region incorporating the country is extracted from the global field.

4 Using the Data Files

The underlying data behind the figures and tables for each country is made available for research purposes. The data files are organised by country, with further sub-directories shown in Figure **3**. All files are in a text format which can be easily read with a number of applications.

4.1 Directory Structure

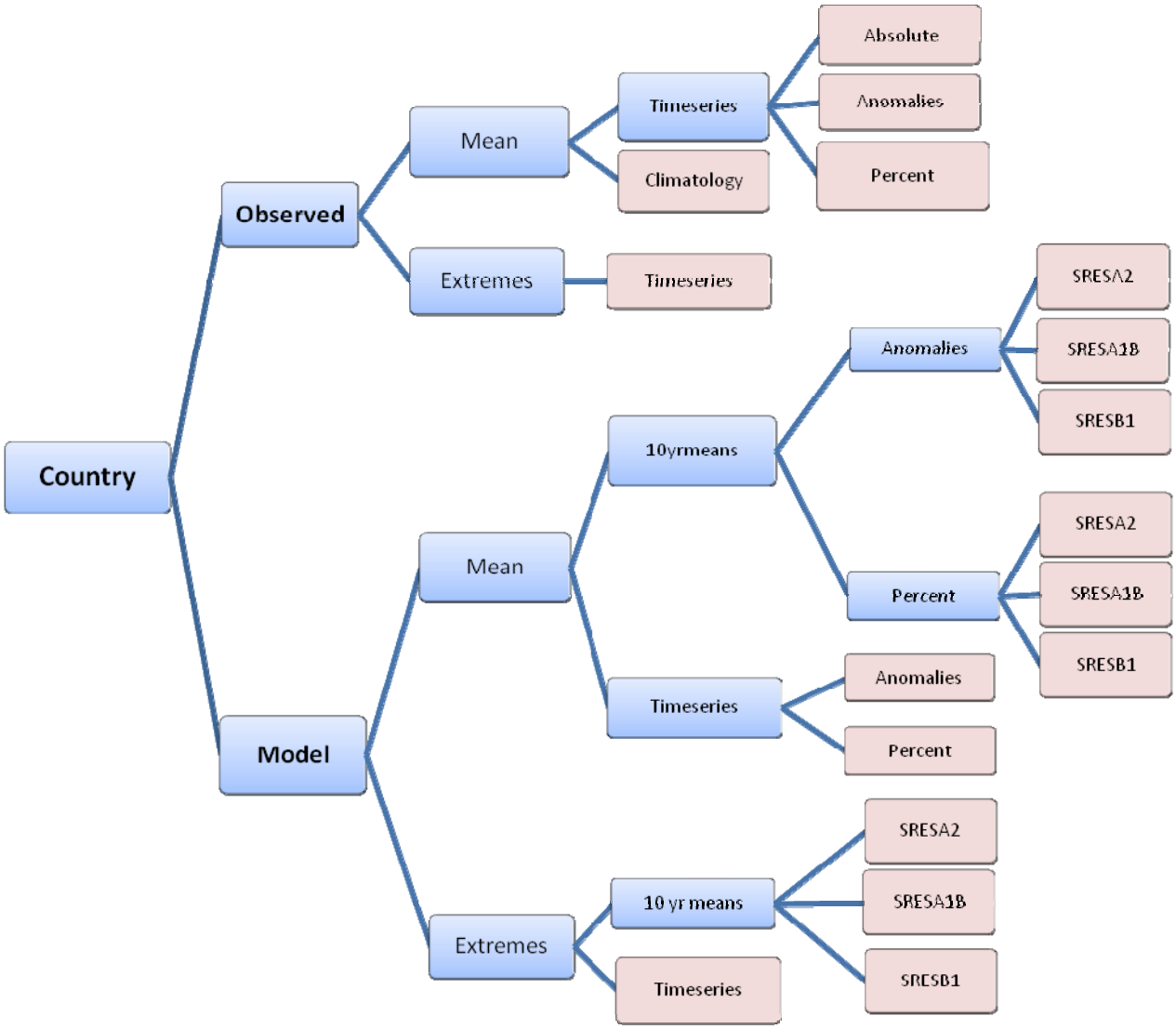

Figure 3: File directory structure for UNDP climate change country profiles data.

4.2 File Content

4.2.1 Observed data

4.2.1.1 Mean

i. Time series (*country*.ts.obs.*parameter*.*dataset*.*unit*.dat)

Yearly time series, as an average of all grid boxes that lie within, or partially within, the country borders. *Absolute* files contain a simple list of values for each year and season. *Anomaly* files also contain the 1970-99 climatological average value from which the anomalies were calculated. *parameter* is 'temp' or 'precip', and *dataset* is 'cru',' udel', 'gpcc', 'era40', 'ncep', 'ensemblemean', (mean value across all datasets), 'ensemblemax' (maximum value across all datasets), or'ensemblemin' (minimum value across all datasets), *unit* is 'abs' (absolute), 'anom' (anomalies) or 'pct' (percent anomalies).

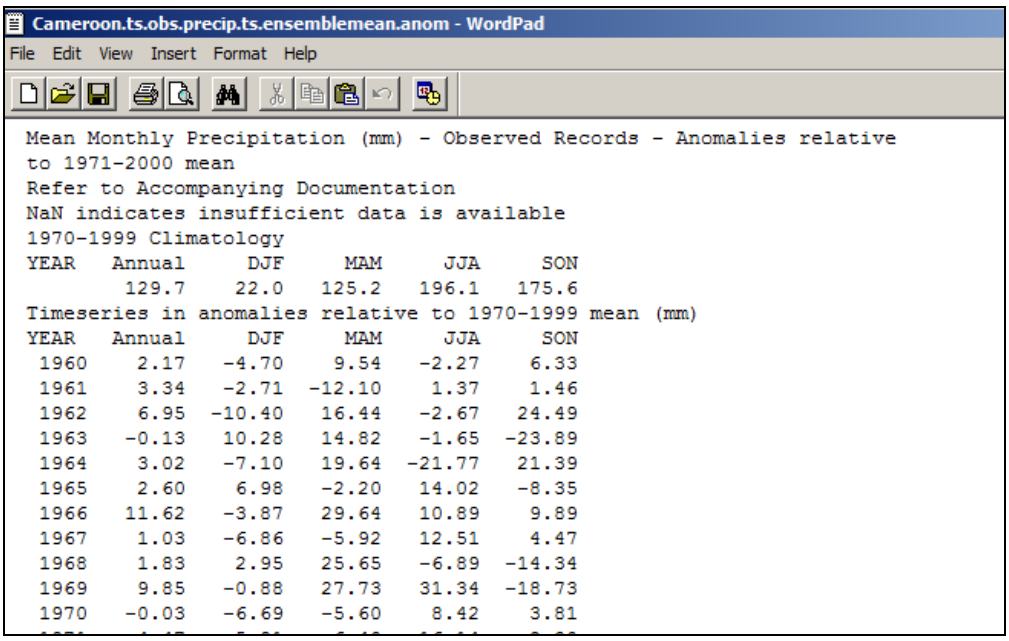

Figure 4: Example of Observed Time series data file.

ii. Climatology (*country*.clim.obs.*param*.cru.abs.txt)

Gives the 1970-99 average climatology, based on the CRU dataset only, on the same 2.5 x2.5˚ grid as the 10yr model data, for a rectangular set of grid-boxes containing the country. File header includes the longitudes of each grid column and latitudes of each grid row (centre point), and then the climatological values for each grid box, for each season.

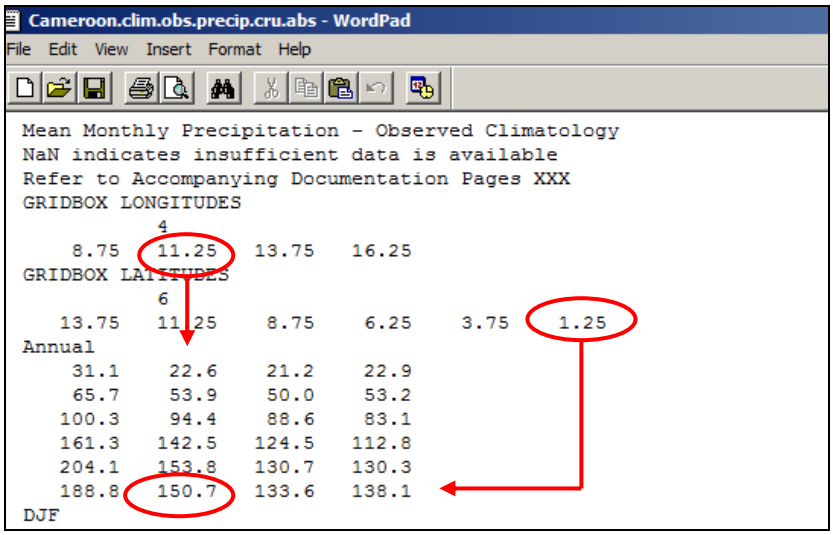

Figure 5 Example of Observed Climatology data file. Data are arranged in a longitude (columns) by latitude (rows) grid with the central longitudes and latitudes of each grid box given in the header. For example, the value for the grid box at 11.25E, 1.25N is 150.7.

4.2.1.2 Extremes

i. Time series (*country*.ts.obs.*param*.hadex.*unit*.txt)

Files contain the climatological average (1970-99) and listed values for every season per year. *param* is one of 'TN90p', 'TX90p', 'TN10p',' TX10p', 'R95pct', 'RX1day', 'RX5day' (see section 3 for definitions of the parameters). Files are in a similar format to those for mean climate (Figure **4**).

4.2.2 Model data

4.2.2.1 Mean

i. Time series (*country*.ts.*param.model.unit*.txt)

Each file contains the model climatology (1970-99) for each season, 20th century time series (1960-2000) and projections (2000-2100) under 3 emissions scenarios– SRESA2, SRESA1B, SRESB1. *param* is 'precip' or 'temp', *model* is any of those listed in Table 2, or 'ensemblemedian', 'ensemblemin' or 'ensemblemax'.

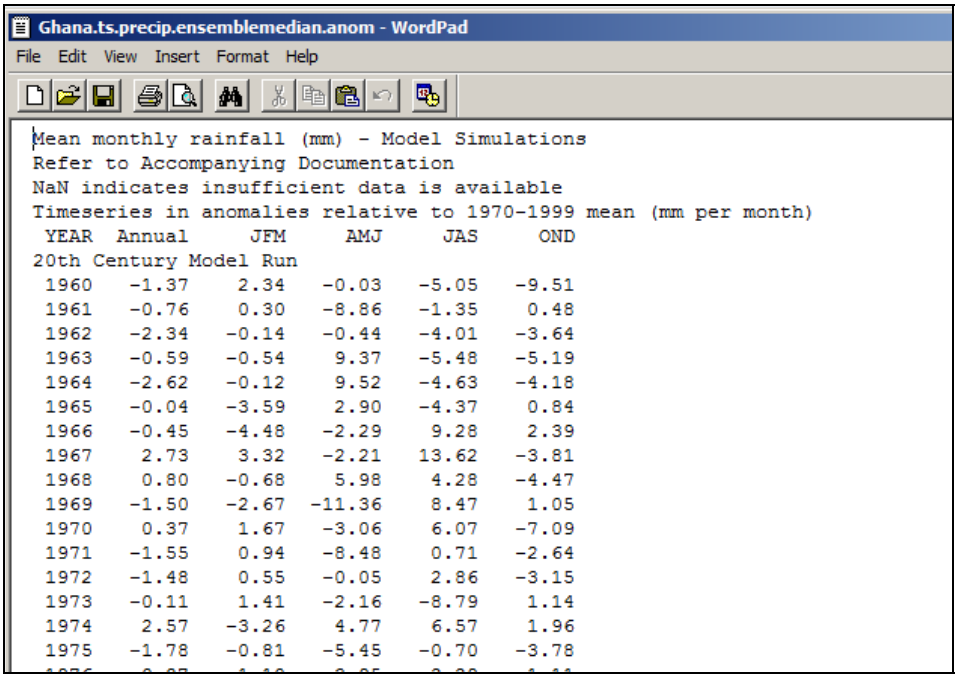

Figure 6: Example of Model time series file.

ii. 10yrmeans (*country.*slice.*param.model.scenario. season. unit*.txt)

Files are for each season and scenario. The file header includes the longitudes of each grid column and latitudes of each grid row (centre point). Each file contains the model climatology (1970-99), followed by 10-year average 'time slices' for projections under the three scenarios SRESA2, SRESA1B and SRESB1. *season* is in the format 'DJF', 'MAM' etc

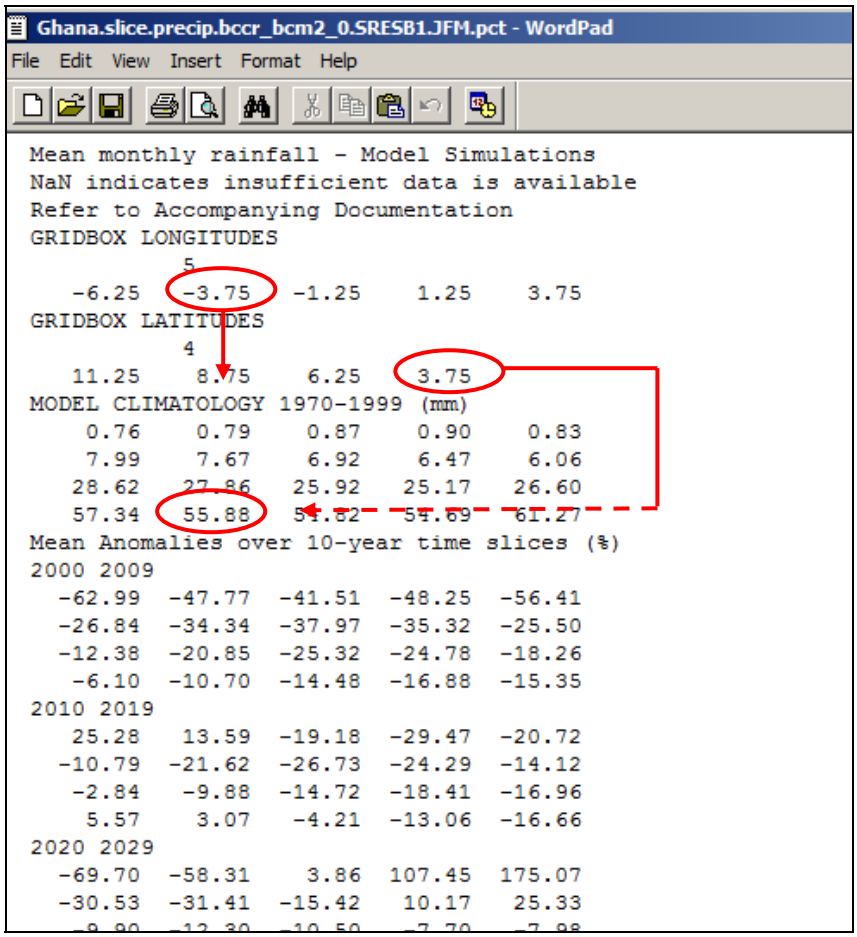

Figure 7: Example of Model 10yr time slice file. . Data are arranged in a longitude (columns) by latitude (rows) grid with the central longitudes and latitudes of each grid box given in the header. For example, the value for the grid box at 3.75W, 3.75N is 55.88.

4.2.2.2 Extremes

i. Time series (*country.ts.param.model.* unit.txt)

Each file contains the model climatology (1970-99) for each season, 20th century time series (1960-2000) and projections (2000-2100) under the 3 emissions scenarios– SRESA2, SRESA1B, SRESB1.

ii.10yrmeans (*country.*slice.*param.model.scenario.season.unit.* txt)

Files are for each season. Each file contains the model climatology (1970-99), followed by 10-year average 'time slices' (for 60s and 90s only) for projections under the three scenarios SRESA2, SRESA1B and SRESB1.

NB: Daily model data on which the extremes indices are based is only available from the IPCC for the periods 2046-65 and 2081-2100. For the '60s' in 10yr time slice data for extremes, the data used are actually 2056-2065.

5 References

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