Construction of high spatial resolution climate scenarios for the for the Falkland Islands and southern Patagonia

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Contents

Executive Summary

This principal aim of this report is the construction of high-spatial resolution climate scenarios for the Falkland and also for southern Patagonia. To achieve this requires two sets of data: observed spatial and temporal information about the variability of temperature and precipitation patterns across the regions and secondly, output from Regional Climate Model (RCM) simulations for the future and for the present. The report is split into two halves addressing what is available for the two sets of data for the Falklands first and southern Patagonia second.

The report summarises the available observations of monthly average temperature and monthly total precipitation for the Falklands. At first sight, there appears to be a reasonable coverage of observations across the islands, but many of the records are short in duration for many locations. They are also often records for different periods. The only long records are available from locations near Stanley on East Falkland. To make best use of the available data, we develop a long time series of temperature and precipitation for the Stanley area (basing the record on the new airport site at Mount Pleasant, MPA). Using MPA and the fragmentary records elsewhere on the islands we then develop 1km grids of average climate using regression relationships based on location, elevation and distance from the coast which represent the 1961-90 period. The fragmentary records around the islands are all both near the coast and near to sea level. To produce the 1km grids we needed to assume a temperature lapse rate with elevation by inserting a 'dummy' higher elevation site near to MPA, and for precipitation we had to apply a square root transformation to improve the fit. Failure to do either of these would have resulted in temperature and precipitation gradients with elevation that were unrealistic. We recommend that future work needs to improve the basic input data and this can only come from siting some Automatic Weather Stations (AWSs) at higher elevations on the islands.

Future projections can only come from RCMs and the current work used the latest projections from a recently completed EU project (CLARIS LPB). For the Falkland Islands domain, these RCMs project an increase of temperature of 1.8°C (± 0.68°C for a two Standard Deviation range) increase by the 2080s compared to the 1961-90 period. Annual total precipitation sees very little change when compared to the 1961-90 period. RCMs and the global-scale simulations from Global Climate Models (GCMs) are likely to change in the future as both GCMs and RCMs improve through enhanced spatial resolution, taking advantage of ever-faster computers. Improved simulations are now better co-ordinated globally through the CORDEX initiative. The Falkland Islands are in the South American domain.

Due to the similarity of the climate and the associated plant species, a similar exercise to the Falklands was completed for southern Patagonia. Here there are a few long records, but they are few and far between, so similar spatial interpolation involves greater extrapolation. This region also involves much greater changes in orography than for the Falklands with much larger precipitation gradients on the windward and leeward side of the southern Andes. We again had to assume a temperature lapse rate and position two dummy stations to account for the much greater spatial gradients of orography. We do not recommend the high-resolution data for regions west and south of the main Andean divide. There is potentially more observational station data in southern Argentina that could be used, but we do not have access to these data. Additionally many of the large estancias in the region record their own temperature and precipitation data, but these data are not co-ordinated centrally by the Met Service in Argentina.

1. Precipitation and temperature data – Falkland Islands

1.1 Introduction

Before the latter part of the 20th Century, the measurement of precipitation on the Falkland Islands was mainly sporadic - with the exception of Port Stanley. For temperature measurement, the situation is similar to that for precipitation. In fact, there are fewer observations for temperature than precipitation. Measurement of both variables has been more widely practised after the cessation of the military conflict between the UK and Argentina in 1982. In particular, measurement at Mount Pleasant Airport (MPA, some 30 miles south west of Port Stanley) has superseded that at Port Stanley and has continued since the creation of the airport in 1986. However, the density of measuring sites is not high even in the more recent period – perhaps reflecting the low population density and general lack of development. For details of the observed series that have been located and used, see Appendix F.

For the current study it is necessary to have high spatial resolution (1km x 1km) temperature and precipitation grids for the whole of the land surface of the islands for the period 1961-90, as input for the botanical modelling exercise. An important point to note is that none of the observing locations are at elevations exceeding 75m and most are less than 10km from the sea more (see Table F1). This should be borne in mind when estimates for the one kilometre square are made. The highest point on the Islands is 691m. The method chosen to maximise the use of observed data (as opposed to the use of reanalysis products), in the best way possible and to meet the high spatial-resolution requirement, is summarized below.

- Produce single long and complete monthly series which combine the observations from Port Stanley and MPA (MPA-extended). In the case of temperature, monthly series for maximum (Tmax) and minimum (Tmin) have also been produced for the period 1960-2011. For more information, see below.

- Extract all other available series from various sources and produce monthly averages from these using a minimum threshold of at least five (three) years for precipitation (temperature). That is, a monthly average is only produced if there are at least five (three) monthly values (for the month in focus) in the whole period of record. In addition, a station has to have a full set of all 12 monthly averages to go into the next stage of the process.

- For each candidate station having monthly averages, the equivalent monthly averages for MPA-extended were calculated. That is, the MPA-extended monthly average is produced using the monthly values from the same (year and month) values that went into the production of the mean for the candidate station. The reason for this is to get a true comparison between the candidate station and MPA-extended. The month/year time-stamp ensures that the comparison is being undertaken under the same conditions of overall atmospheric circulation – this favours the capture of differences in precipitation/temperature that are due to orography, exposure of the site and other aspects of the geography/terrain.

- In the case of precipitation, the monthly comparison between candidate station and MPA-extended is undertaken using the ratio of (candidate-station-average)/(MPA-extended-average). This allows the simulation of complete candidate station series for any period within the period of coverage of the MPA-extended series, via the respective monthly ratios. For temperature, the absolute difference (candidate minus MPA-extended) is used instead of the ratio. The absolute difference (increment) can be added to the MPA-extended temperature series so as to estimate the temperature series for the candidate station.

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1.2 The production of the 'reference' MPA-extended series for precipitation and temperature

1.2.1 Precipitation

Antecedents of the MPA (extended via Stanley) precipitation series

Input data for monthly total precipitation have come from a Port Stanley series provided by the United Kingdom Falkland Islands Trust (UKFIT) covering the period 1874-2010. This series had a mostly missing block of data for the period 1884-1903 and had some missing values which were coded as zero during the 1920s. More importantly, for the current Project, there were missing values for the period February 1982-December 1991. However, after attempts to locate further data for the latter missing period, some additional data were located through the involvement of Manfred Keenleyside of the Falkland islands Government (by personal communication). After the new additions, the missing values since 1980 occur between February 1982 and December 1983.

The MPA record, as provided by UKFIT, starts in July 1986 and is continuous to the present time. This means that when the Stanley and MPA records are combined, there are 23 missing months within the period 1982-83 (see Table F4). There are no other records from the Islands that could be used to find substitute values for this period.

Extended series production:

The Stanley and MPA records have been combined – with the Stanley values adjusted to those of MPA using the average ratio of the total annual rainfall for both locations during their overlap period mid-1986-2010 (the Stanley record was not quite complete and the years 1986, 1987 and 1992 did not produce annual totals). The average ratio (MPA/Stanley) of the annual totals is 0.8762 and this is the conversion factor to transform Stanley to MPA. Given that MPA is the series being extended, all available MPA values have been used and all non-overlap Stanley values have been added after multiplication by this adjustment. This leaves some missing values during the period where values are based on Stanley observations and these reflect the missing values as reported in the introduction (above). Figure 1 shows the extended MPA annual precipitation series – note the gaps in the more recent period. Missing values for 1986 were infilled retrospectively from adjusted Stanley data– thus leaving the 1982/83 missing values for estimation.

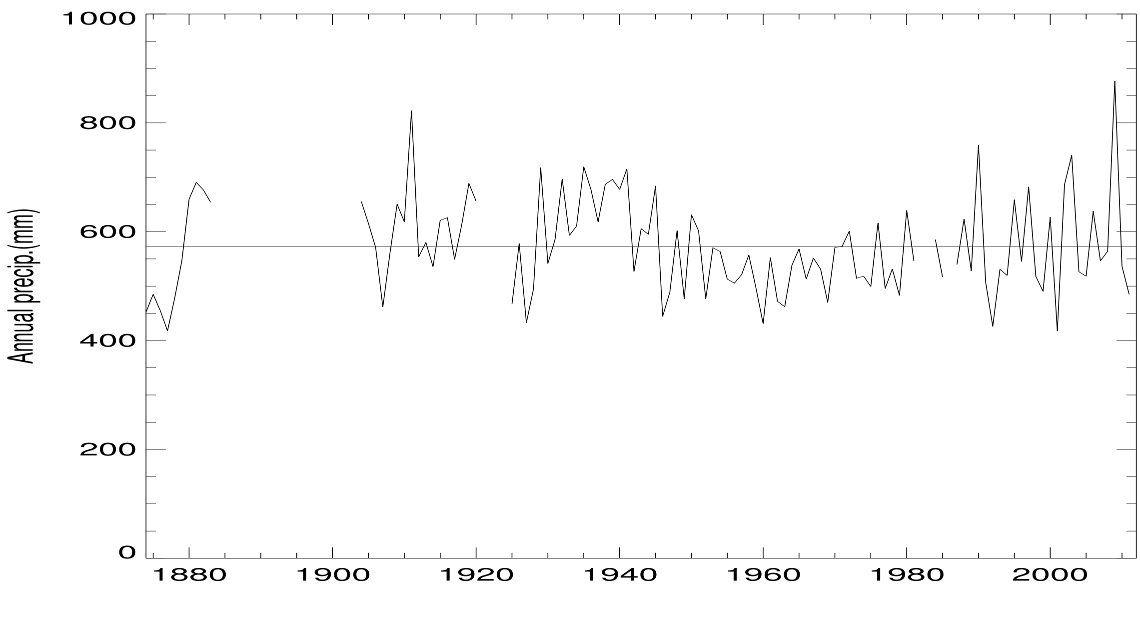

Figure1. Annual total precipitation from the MPA extended (by adjusted Stanley values) series

The missing values during the period 1982-83 need to be filled by some means since this period is crucial for the generation of statistics for the current (UKFIT funded) Project . The absence of any other Island precipitation observations during this period means that the only possible alternative (without resorting to reanalysis output) is to check for any relationships between the MPA-extended series and any suitably long records from the South American region of Patagonia. Possible series include those for Estancia Cullen, Estancia Maria Bahety (both close to the eastern coast of Argentina) and Punta Arenas (further west in Chile). The series have been provided by UKFIT – see Table P1.

After the comparison of annual precipitation anomalies, between the current extended MPA series and the series listed above (over common periods), the correlations were zero or thereabouts. This is probably due to a combination of the disruptive effects of the Andean Range on the westerly circulation and the distance apart (of the order of 400 miles) of the locations having their annual precipitation correlated. Given the latter results, the next option for the estimation of the missing values is the use of reanalysis output. The reanalysis product considered to have the best output is ERA-Interim (see http://data-portal.ecmwf.int/data/d/interim_daily/). Figure 2 compares the annual total precipitation series of the extended MPA series and that from the nearest ERA-Interim grid-box.

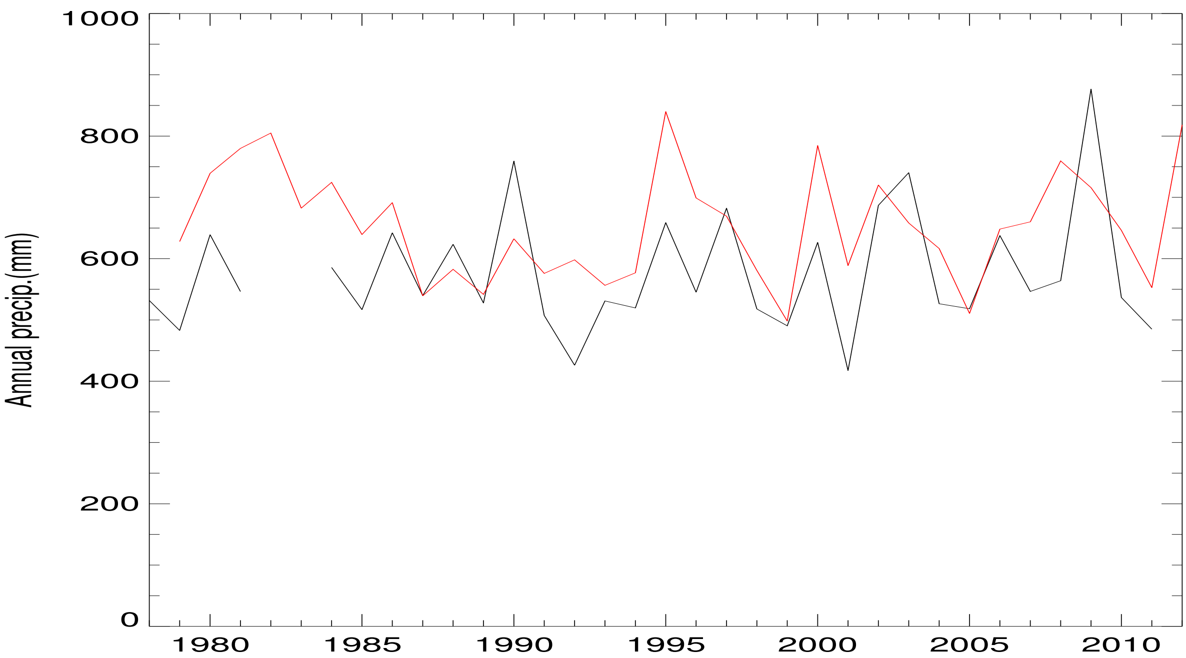

Figure 2. The black line represents the annual precipitation from the MPA extended series since 1978 and the red line represents the ERA-Interim equivalent (starting in 1979).

For the purposes of infilling the missing months of 1982/3, a small adjustment is required to lower the level of the ERA-Interim values to that of the observed series. The adjustment factor (calculated from the ratio of overlap annual totals) is 0.8973. The missing monthly values were thus estimated and inserted into the MPA extended series. Figure 3 (below) shows the extended MPA precipitation series which is now complete for the period 1925-2011. Table F4 shows the antecedents of the MPA-extended monthly precipitation values.

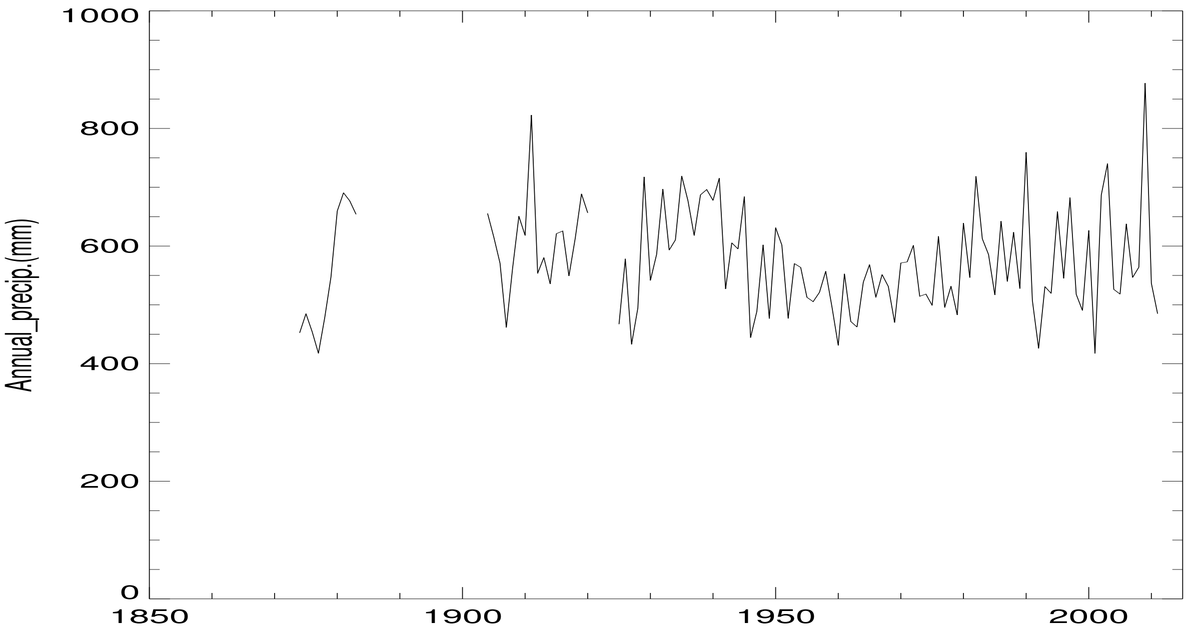

Figure 3. Annual-total precipitation time-series from the MPA extended monthly precipitation series.

1.2.2 Temperature

Antecedents of the MPA (extended via Stanley) monthly Tmean series

Input data for monthly mean temperatures for Port Stanley and Mount Pleasant Airport (MPA) have come from:

Monthly data sent by the United Kingdom Falkland Islands Trust (UKFIT); archived data from the Climatic Research Unit (CRU); and data downloaded from the British Atmospheric Data Centre (BADC). The overall intention is to produce a continuous and homogeneous monthly climate series for the MPA location, extended by observed data from Stanley (adjusted where necessary) and with missing values infilled by estimation.

For Port Stanley, three Tmean data series were compared by subtraction of monthly matrices over a common period 1960-81 (the BADC series matrix being calculated from their Tmax and Tmin series, Tmean = (Tmax+Tmin)/2). It was found that the CRU and UKFIT series were in very close agreement except for a few missing values in the CRU series. There were frequent small and fairly similar differences between BADC and both CRU and UKFIT. For this reason, the UKFIT series was chosen as the best working series. However, a few additional monthly data were present in the CRU series during the period 1982-86 – a period when observations were interrupted by military actions. These values bolstered the numbers of available observations during this period. The number of missing monthly observations during the period 1982 and 1986 was 29 – these have to be estimated.

The principal observing station (at MPA) began operations during 1985. Observations came on stream starting in July 1986. This site has seen continuous operation since July 1986. Monthly Tmean and Tmax/Tmin are routinely generated. Series of Tmean, Tmax and Tmin have been received from UKFIT and these agree with BADC values.

Extending the MPA series:

The ERA-Interim reanalysis temperature series (http://data-portal.ecmwf.int/data/d/interim_daily/) was a likely choice for use as a link between the two observed subsets (allowing the adjustment of Stanley temperatures to MPA in the absence of any overlap between the two, and the means of infilling missing values). However, during the testing process, it appeared that the overlap between ERA-Interim output and the Stanley series from 1979-82, may be insufficient to make an accurate adjustment. Figure 4 shows the need for an upward adjustment of the Stanley subset and also shows that the ERA-Interim and MPA observed series agree very closely particularly in the period 1986-1998. However, the short period of overlap between the Stanley and ERA series is emphasized.

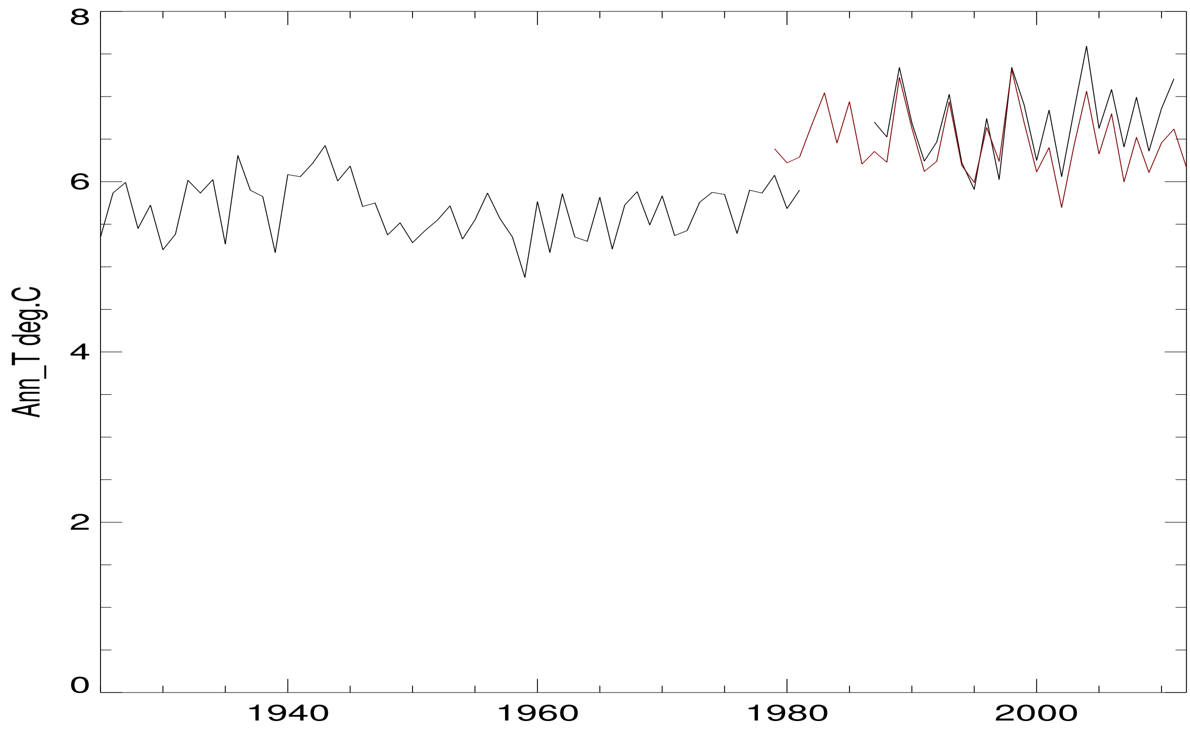

Figure 4. The earlier black line shows the Stanley annual mean temperature series (unadjusted). The later black line represents the MPA annual mean temperature series and the red line represents the annual mean temperature from the ERA-Interim series.

An alternative strategy to link the two observed series and thus produce an accurate adjustment of the Stanley observations to the MPA location uses a gridded sea-surface temperature (SST) database (HadISST – see http://www.metoffice.gov.uk/hadobs/hadisst/).

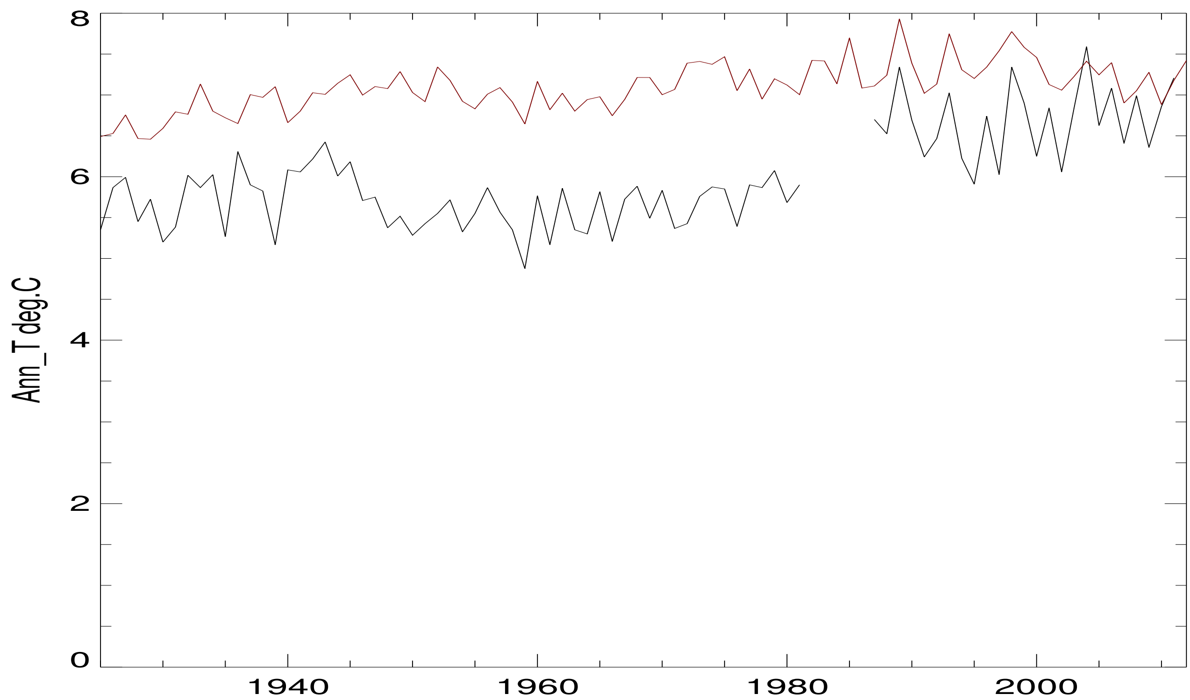

Figure 5. The earlier black line shows the Stanley annual mean temperature series (unadjusted). The later black line represents the MPA annual mean temperature series and the red line represents the annual mean temperature from surrounding HadISST grid-boxes (the mean of a 5 x 5 matrix of 1.0 x 1.0° grid-boxes centred on the Islands).

The latter approach towards the adjustment of the Stanley Tmean series to that of MPA was chosen due to the much greater overlaps between the SST series and the two observed subsets. The adjustment was then possible. Figure 6 (below) gives details of the adjustments used and shows the Stanley series adjusted to MPA and the SST series adjusted to MPA. There is a close relationship between the adjusted Stanley series and the adjusted SST series particularly after ca. 1960 and the relationship between the adjusted SST series and the MPA series is also quite close during the duration of the MPA series. These are positive indicators that the adjusted Stanley series should amount to a close approximation of conditions at MPA before observing at that site began. The infilling of the 29 missing monthly values used the ERA-Interim counterparts as this series was very close to the observed MPA series (Figure 4). For full antecedents of the MPA-extended Tmean series, see Table F5.

Having completed the Tmean series for MPA-extended, it was possible to move on to the production of Tmax and Tmin series for the same location. For the details of this exercise, see below the current section. In addition, see Appendix (Table F6) for precise monthly source details for the Tmax and Tmin series.

The details of the additional precipitation and temperature observational series used to enable the higher-resolution series for precipitation and temperature series to be derived from the MPA-extended series are shown in Appendix F1 – F3.

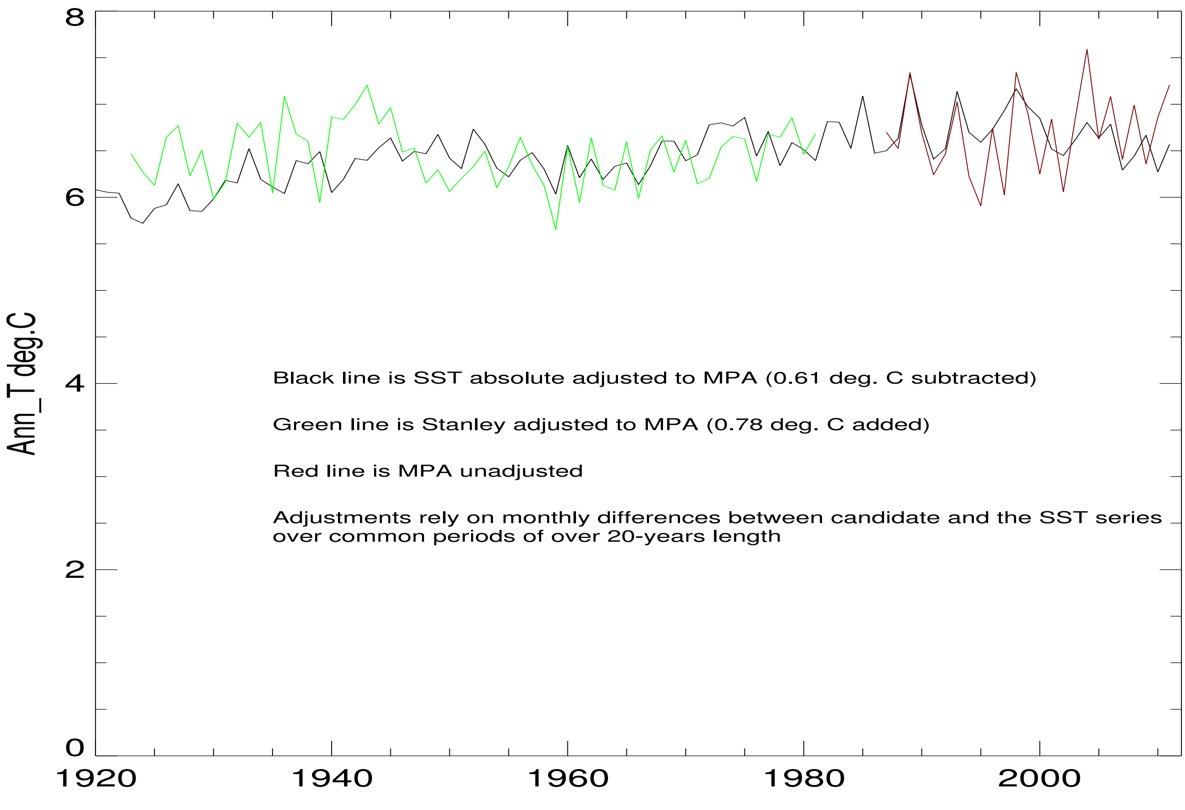

Figure 6. The black line represents the SST annual mean temperature adjusted to MPA. The green line represents the Stanley series adjusted to MPA. The red line shows the MPA series (as observed).

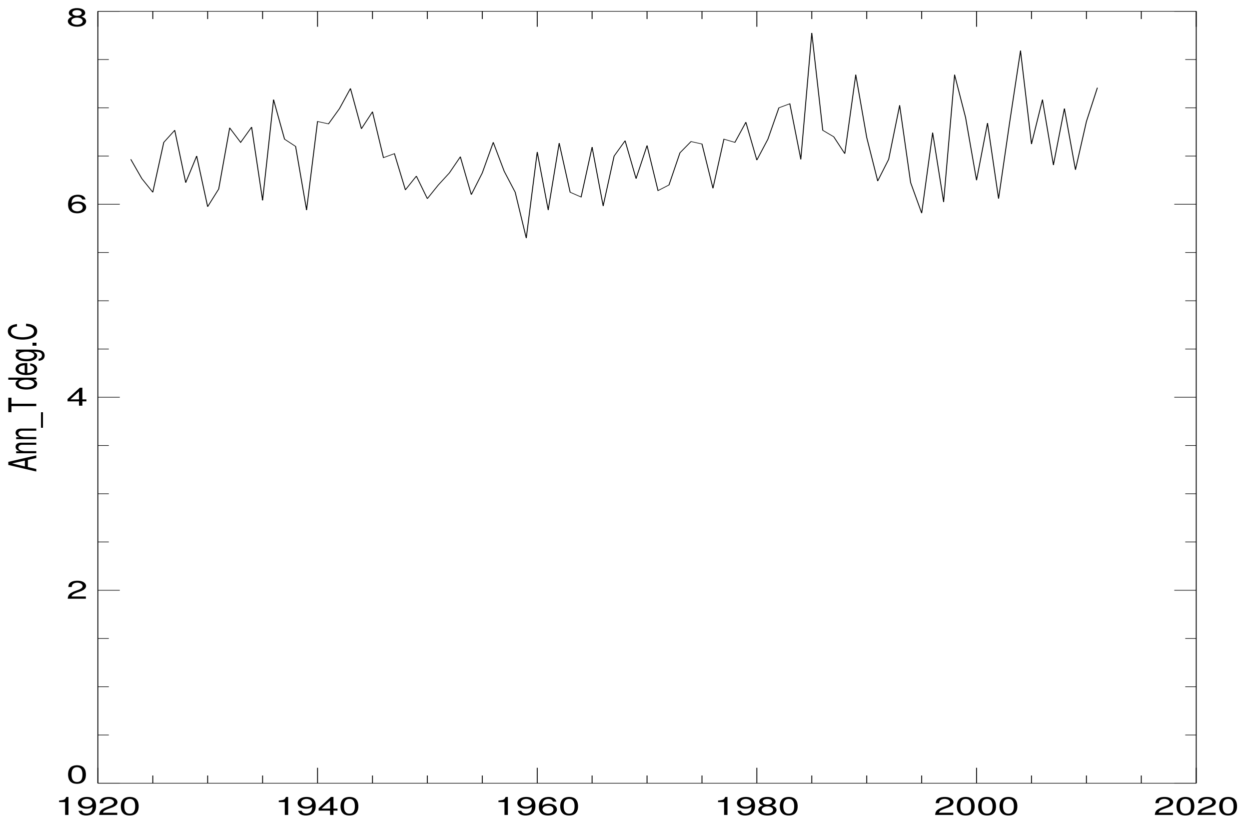

Figure 7. The annual mean-temperature time-series from the extended/infilled MPA monthly series.

Antecedents of the MPA (extended via Stanley) monthly Tmaximum (Tmax) and Tminimum (Tmin) series

Background:

All values in the Tmax and Tmin subsets have been derived from the extended MPA Tmean series (for details of the composition and derivation of the Tmean values, see above). Given the continuity and apparent good homogeneity status of the Tmean series, the use of diurnal temperature range (DTR=Tmax-Tmin) avoids the need to check the homogeneity status of individual Tmax and Tmin series. In addition, the constructed series are likely to inherit the good homogeneity status from Tmean. The calculation of the increments to add or subtract to get Tmax and Tmin values divides the DTR values by two (e.g. Tmax=Tmean+DTR/2).

Tmax and Tmin series construction:

It should be noted that monthly DTR values are not the same at Stanley as those at MPA, when long-term mean values are compared. This is due to the proximity of the sea (for Stanley) and other aspects of local geography. The different DTR characteristics between the two sites require that the Stanley 1960-81 Tmax and Tmin derived values require a further adjustment to make them compatible with the MPA subset. These adjustments are calculated from the comparison of monthly average DTR values for the two respective sites (over different periods).

Observed Tmax and Tmin series for Stanley were located in British Atmospheric Data Centre (BADC see http://badc.nerc.ac.uk/home/index.html) archives. Since the observed DTR values have only been located for the Stanley series for the period 1960-81, the sporadic Stanley Tmean observations between 1982 and June 1986 have no observed DTR for the generation of Tmax and Tmin values. The monthly average values of DTR for MPA have been used to generate the monthly Tmax and Tmin values from Tmean for this period. For the MPA record, observed DTR values are available from the UKFIT supplied data.

Figure 8 shows the distribution of the observed series that have been used for the Falkland Islands. Data from some other stations were made available but minimum threshold criteria were not satisfied and the series were not used.

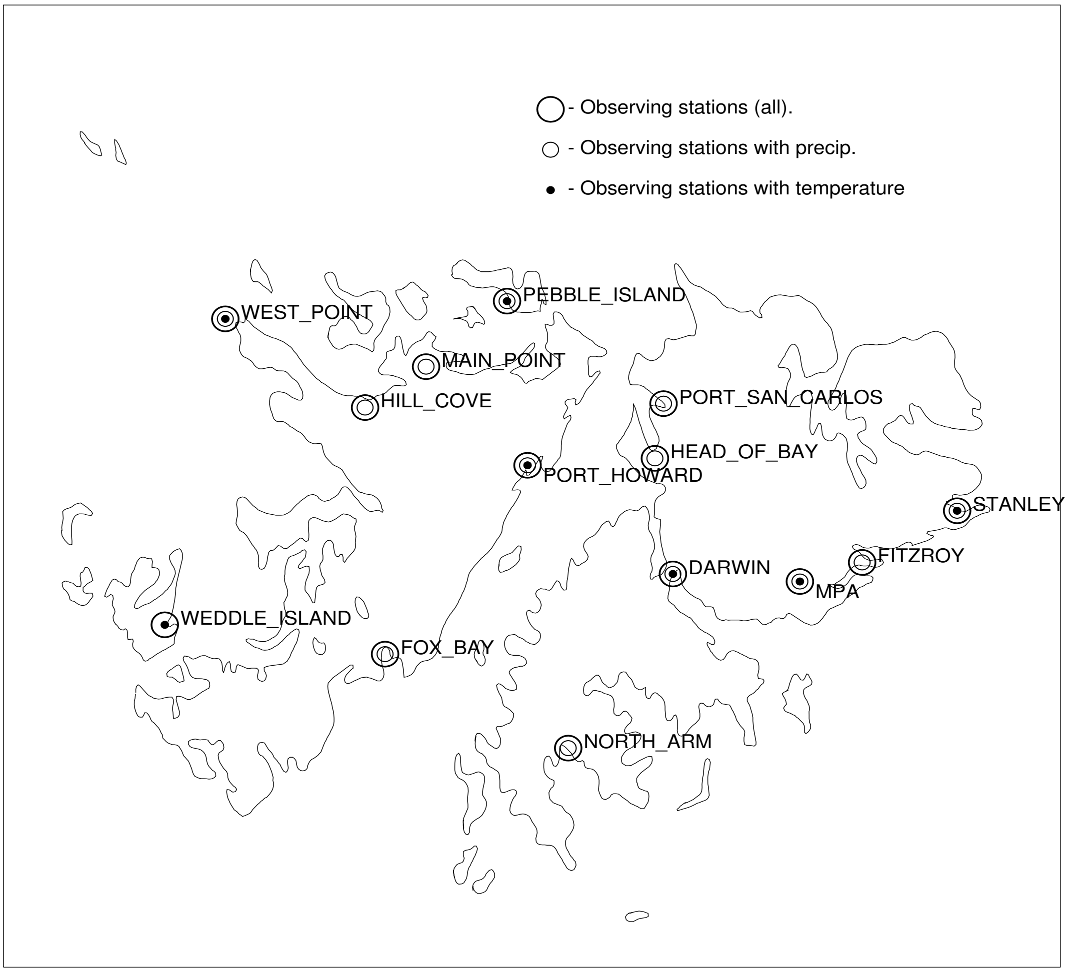

Figure 8. Observed series used in the generation of high spatial-resolution climate grids for the Falklands

2. Falklands RCM data

The following RCM models used are from the CLARIS LPB (Boulanger et al, 2010; Clivar Exchanges, 2011) project:

Rossby Centre RCM (RCA)

(1) EC5OM-R1 1961-1990; 2011-2040; 2041-2070; 2071-2100
(2) EC5OM-R2 1961-1990; 2011-2040; 2041-2070; 2071-2100
(3) EC5OM-R3 1961-1990; 2011-2040; 2041-2070; 2071-2100

Prognostic at the Mesoscale (PROMES)

(4) HadCM3-Q0 1961-1990; 2011-2040; 2041-2070; 2071-2100

MM5 Pennsylvania-State University NCAR nonhydrostatic Mesoscale Model - CIMA version (MM5)

(5) HadCM3-Q0 1961-1990; 2011-2040

ICTP Regional Climate Model (RegCM3)

(6) EC5OM-R1 1961-1990; 2011-2040; 2071-2100
(7) HadCM3-Q0 1961-1990; 2011-2040; 2071-2100

MPI-M Regional Model (REMO)

(8) EC5OM-R3 1961-1990; 2011-2040; 2041-2070; 2071-2100

Two of the available models (not listed above) did not have the required data. To avoid confusion the numbering and acronyms (in parentheses) given above are used in output file naming. The output files contents refer to cell numbers, the RCM 5 by 10 grid cells and the grid-cell numbering system is shown in Figure 9. The RCM grid was available at 0.5^{O} x0.5^{O} resolution.

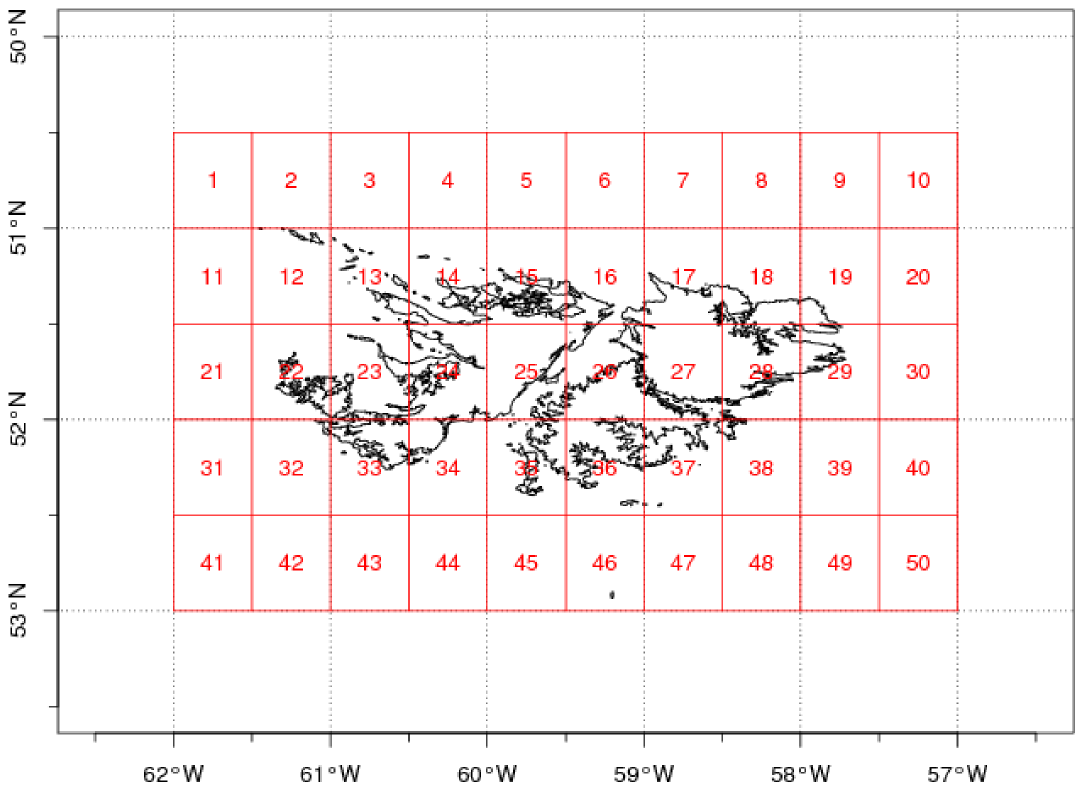

Figure 9. The Falklands 5 by 10 RCM grid.

Three of the modelling centres produced a continuous 1961-2100 simulation whilst others only provided 30-year climate periods which were often not contiguous, consequently to facilitate comparison all files were processed into the four common climate periods (1961-1990; 2011-2040; 2041-2070; 2071-2100). As listed above, some models do not have all four periods and not all periods are complete and may contain missing values towards the end of the series (particularly those ending in 2100). After the RCM data had been extracted and reformatted it was run through 'R' software to calculate the bioclimatic variables.

Figure 10 shows annual maximum temperature, diurnal temperature range (DTR; Tmax-Tmin) and precipitation for cell 26. This cell was used in preference to cell 29 which actually overlays Stanley because of the strong ocean influence in the models to cells bordering the sea. The central cells were in better agreement with observed temperature, particularly DTR. The plots show the wide range produced by the different models which is likely to be indicative of how much influence in the model the Falklands was given as a land mass. For some of the models the DTR is not much higher than that for the ocean. In order to circumvent this disagreement in the RCMs we have calculated monthly average changes between the control period (1961-1990) and the scenarios in the following way:

For maximum and minimum temperature:

$$\text{Delta} = \text{scenario} - \text{control}$$

For precipitation (expressed as a % change):

$$\text{Delta} = (\text{scenario}/\text{control})*100$$

The deltas were then applied to the observed 1961-1990 series to provide future scenario series which are free from bias. "RCM_deltas_all_models.zip" contains the deltas for each RCM model calculated as described above.

Figure 11 shows the scenario periods for the observed + deltas series, the models are now in much closer agreement. For Tmean a couple of the models show a larger increase in temperature while for DTR and precipitation the models indicate little change for the future climate periods. A summary of the eight RCMs for mean temperature is included in Table A and for annual precipitation totals in Table B.

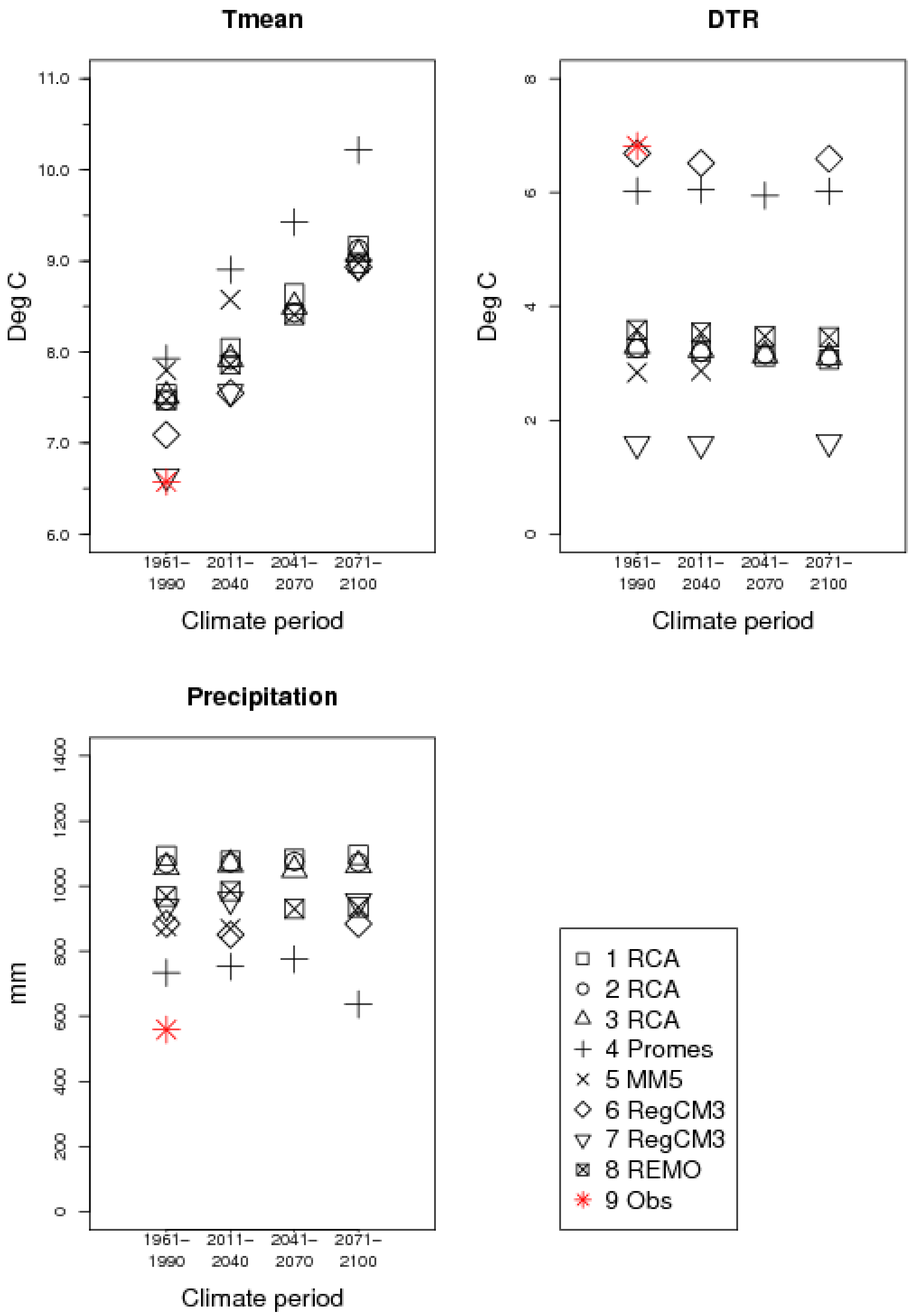

Figure 10. RCM bioclimatic variables Tmean, DTR and Precipitation (bio1, bio2 and bio12) compared for the various models using cell 26. The same variables for the observed series (1961-1990) are shown in red.

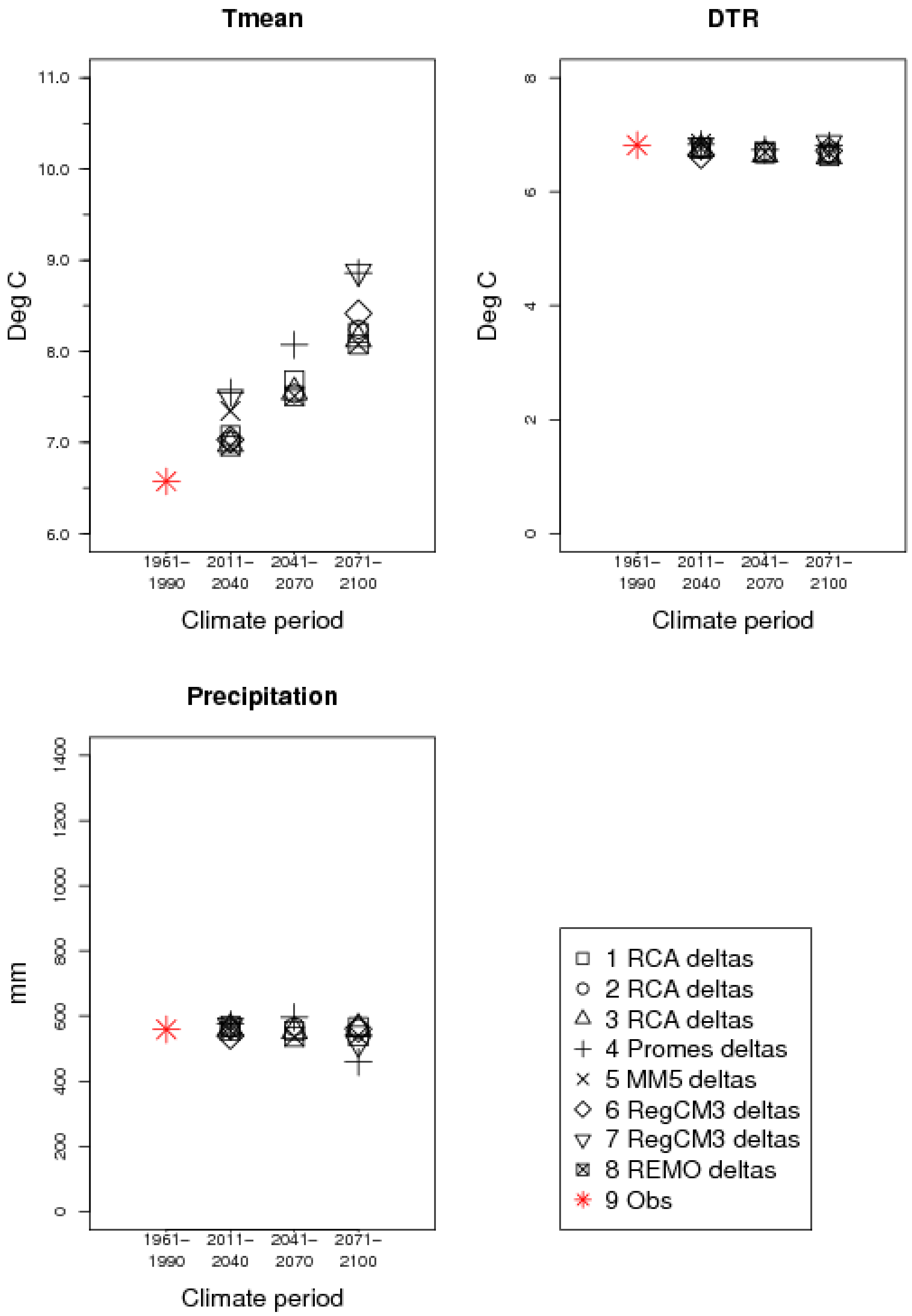

Figure 11. As Figure 10 but for Observed + deltas bioclimatic variables.

Table A. Summary of the average temperatures for the 1961-90 base period and the projected changes for each of the RCMs for the Falkland Islands domain.

	Mean annual temperature			
Regional climate model	**1961-1990**	**2011-2040**	**2041-2070**	**2071-2100**
1	na	7.08	7.68	8.20
2	na	7.02	7.54	8.24
3	na	6.98	7.55	8.13
4	na	7.55	8.07	8.86
5	na	7.35	na	na
6	na	7.03	na	8.42
7	na	7.50	na	8.87
8	na	6.96	7.51	8.08
observations	6.57	na	na	na
Mean prediction		**7.18**	**7.67**	**8.40**
S.D		0.24	0.23	0.34
Mean predicted temp increase		0.61	1.10	1.83
Upper bounds of predicted increase		0.85	1.33	2.16

Table B. Summary of the annual precipitation totals for the 1961-90 base period and the projected changes for each of the RCMs for the Falkland Islands domain.

	Mean annual precipitation total (mm)			
Regional climate model	**1961-1990**	**2011-2040**	**2041-2070**	**2071-2100**
1	na	554.8	554.4	566.1
2	na	561.5	567.3	561.8
3	na	562.3	553.6	562.8
4	na	575.1	596.6	459.0
5	na	555.0	na	na
6	na	539.6	na	560.6
7	na	570.9	na	518.5
8	na	568.8	536.1	539.8
observations	559.2	na	na	na
Mean prediction		**561.0**	**561.6**	**538.4**

3. Interpolation to a 1km grid (Falklands)

In order to produce a 1km grid, linear regression was implemented using four predictor variables: latitude, longitude, elevation and distance to the sea for each station (see Tables 1 and 2 for precipitation and temperature respectively). The predictands are the monthly station normals for 1961-1990. A set of regression coefficients could then be derived for each month. Unfortunately there were no temperature stations at higher elevations, the highest being MPA at 75m, which resulted in an inverted relationship giving spurious values at higher elevations. In order to rectify the problem a "dummy" station refered to as Mnt Usbourne was introduced with a temperature record calculated by rescaling the MPA values based on a decrease of 6^{o}C per Km (which provides a reasonable estimate). Precipitation overestimated amounts at higher elevation so a squre root transform was applied to the elevation predictor; this resulted in far more realistic values. The distance to sea figure is based on a distance to actual ocean (rather than inlets), since only the coast adjacent to ocean currents will receive the influence.

By applying the coefficients to the predictors for each 1km grid point the monthly climate normals at each gridpoint could be generated. By comparing these predictions with MPA normals, ratios for precipitation and differences for temperature could be calculated and then applied to the MPA monthly time series at each gridpoint to enable the climate variables to be calculated on an annual basis and for each climate period. For the scenario periods change factors (as described previously) were applied depending on which RCM cell the 1km gridpoint lies in.

Table 1. Predictors used for precipitation.

Station	Longitude	Latitude	Elevation (m)	Dist to sea (m)
Main Point	59.91W	51.43S	34.00	8365.19
Darwin	58.96W	51.81S	8.00	18801.50
Hill Cove	60.14W	51.51S	56.00	4424.35
Port Howard	59.52W	51.61S	19.00	4685.09
Fox_Bay	60.07W	51.95S	13.00	6625.13
Fitzroy	58.23W	51.79S	9.00	6964.18
North Arm	59.36W	52.12S	24.00	15173.60
Port San Carlos	58.99W	51.50S	26.00	15173.60
MPA	58.47W	51.82S	75.00	12240.20
Stanley	57.86W	51.69S	41.00	5107.54
Head of Bay	59.03W	51.60S	21.00	8287.41
Pebble Island	59.60W	51.32S	8.00	6600.91
West Point	60.68W	51.35S	23.00	2547.40

Table 2. Predictors used for temperature.

Station	Longitude	Latitude	Elevation (m)	Dist to sea (m)
West Point	60.68W	51.35S	23.00	2547.40
Port Howard	59.52W	51.61S	19.00	4685.09
Darwin	58.96W	51.81S	8.00	18801.50
Stanley	57.86W	51.69S	41.00	5107.54
MPA	58.47W	51.82S	75.00	12240.20

Weddle Island	60.92W	51.90S	28.00	3808.98
Pebble Island	59.60W	51.32S	8.00	6600.91
Mnt Usbourne	58.84W	51.69S	667.00	21967.40

4. Precipitation and temperature data – southern Patagonia

4.1 Introduction

The spatial and temporal density of sites where routine weather observations have been/are made in the southern Patagonian region is low. This reflects the low population densities and low levels of economic development. The United Kingdom Falkland Islands Trust (UKFIT), through their contacts in Chile and Argentina have been able to supply some observed series of temperature and precipitation. In addition, the Climatic Research Unit (CRU) holds global archives of monthly temperature and monthly total precipitation. Some of the archive series are from stations in Patagonia.

For the current study it is necessary to have high spatial resolution (1km x 1km) temperature and precipitation grids for the whole of that land surface that can be related to (in terms of climate and flora), to the Falkland Islands that lie more than 300 miles to the east - at similar latitudes. The high spatial resolution resource is required for the period 1961-90, as input to the botanical modelling exercise. The method chosen to maximise the use of observed data (as opposed to the use of reanalysis products), in the best way possible and to meet the high spatial-resolution requirement is summarized:

- Produce single long and complete monthly series which use the observations from a number of stations close to Punta Arenas covering the period 1888-2011. In the case of temperature, in addition to the Tmean series (as just referred to) monthly series for maximum (Tmax) and minimum (Tmin) have also been produced for the period 1961-2011. For more information, see below.
- Use all other available series from UKFIT and CRU resources and produce monthly-averages (normals) for Tmean, Tmax, Tmin and precipitation for the period 1961-90. It should be noted that not all series used have the full 30-year complement of annual-values (for full details, see below). This is a departure from the method used for the Falkland Islands where it was necessary to maximize the use of a number of very short series.
- Since it has been possible to construct monthly normals for all observing sites in this region, there is no need for the step of relating the candidate series to a 'standard' series in that same way as that for the Falklands. It was hoped that the selection of Tmax and Tmin normals would be sufficient to interpolate to a grid directly through multiple regression. However, the numbers of series having both Tmax and Tmin normals was only four. The number of series having Tmean normals is seven. For this reason, the Tmean normals have been interpolated to a grid by multiple-regression and the diurnal temperature range (DTR) will be assumed to follow that of Punta Arenas as a step to the calculation of a grid holding Tmax and Tmin.

4.2 The production of Punta Arenas precipitation and temperature (reference) series

4.2.1 Precipitation

Antecedents of Punta Arenas precipitation series

The Climatic Research Unit (CRU) holds a global database of monthly precipitation totals. There is a series in the archive for Punta Arenas (53.0°S, 70.9° and elevation 37m). The series is complete throughout the period 1888-2011. Figure 12 shows a time-series of annual total precipitation for the whole period.

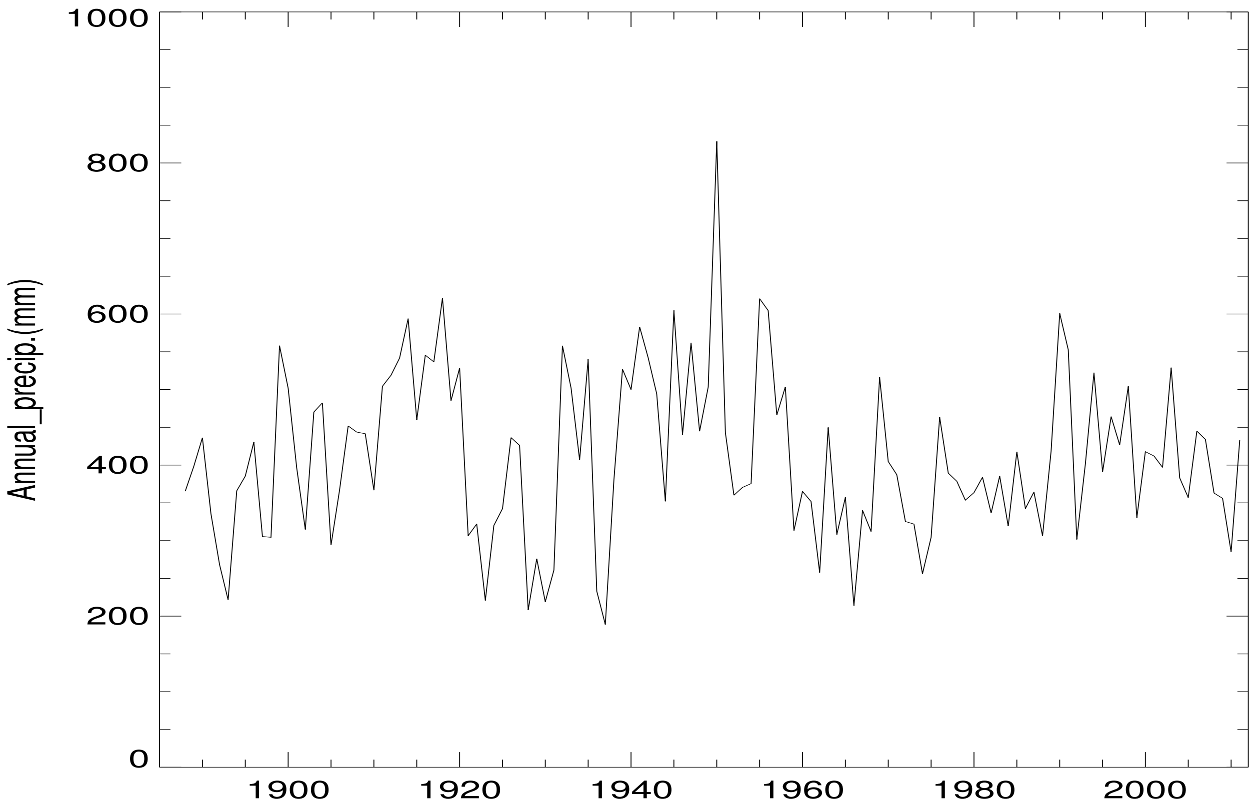

Figure 12. Annual precipitation totals for Punta Arenas from the CRU monthly series.

4.2.2 Temperature

Antecedents of Punta Arenas Tmean series

A complete series for Tmean was received from Nicolas Butorovic of the University of Magallanes *via* UKFIT, covering the period 1888-2012. This was compared with a series held by CRU. Discrepancies were seen particularly during the years before 1964. This is due to a homogeneity adjustment made to the CRU series (due to a station location change.) For details of the monthly adjustments made, see the antecedents of the Punta Arenas Tmax and Tmin series (below). Closer examination of the later discrepancies shows that there are generally quite small differences after 1970. It is believed that the CRU series relates consistently to the station Ibanez Airport after 1970 and there are no missing values beyond that point. The source of the Butorovic series for the same period is uncertain.

The two Tmean series were thus combined with all data coming from the CRU file, with the exception of the missing values in the CRU subset that were infilled with those from Butorovic – with appropriate monthly homogeneity adjustment (see section below). Figure 13 shows the annual mean temperature time-series from the compiled monthly series. For the locations of all stations having precipitation and temperature in SE Patagonia, see Figure 14 and Table P1.

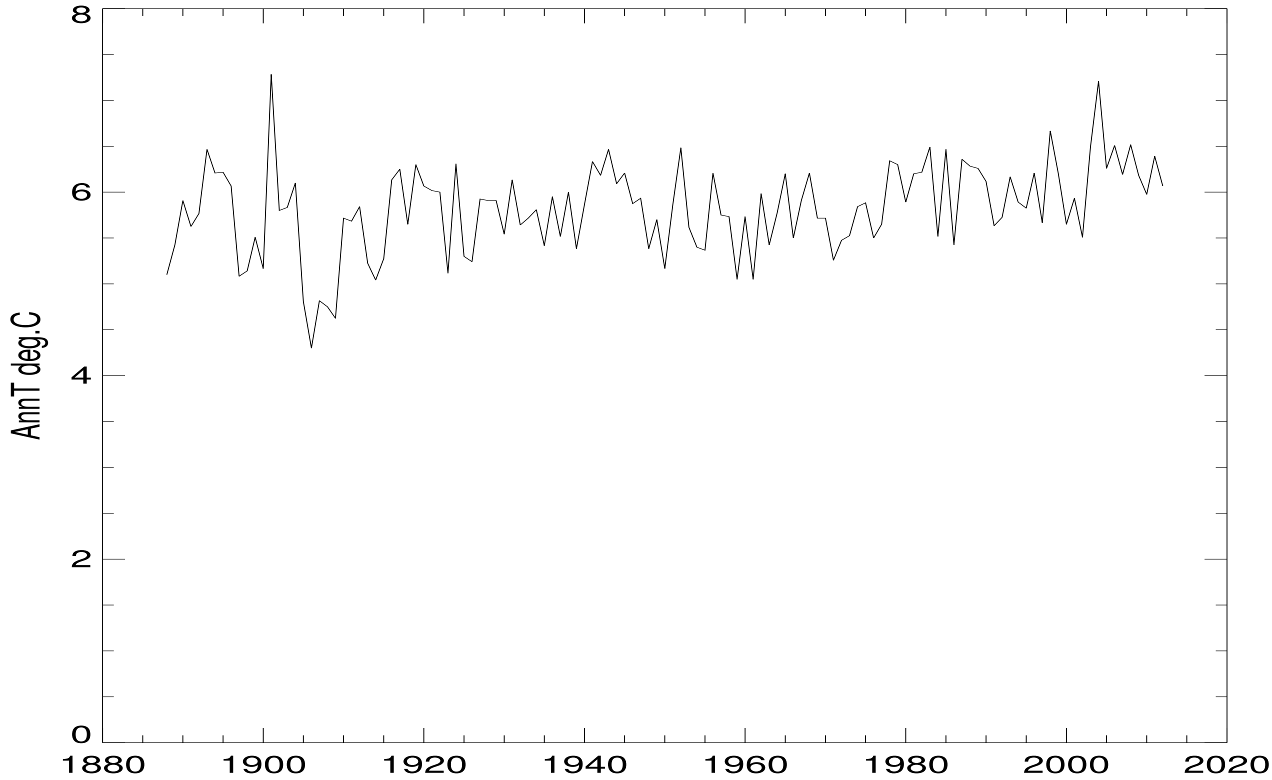

Figure 13. Annual mean-temperature from Punta Arenas from the combined CRU/Butorovic sources

Antecedents of the Punta Arenas temperature (Tmax and Tmin) series

The United Kingdom Falkland Islands Trust (UKFIT) was unable to supply appropriate temperature data for Punta Arenas. The monthly series supplied held absolute monthly extreme values as opposed to the required mean of daily extremes. This led to searches for appropriate data and included Climatic Research Unit (CRU) archives. Series of Tmax and Tmin for Punta Arenas were located but these were series that started in 1905 and ended in 1999 and have several missing blocks of data in the period after 1960 – the period of particular focus for the current Project. In addition to the CRU archive holdings, climate series for Chile were located in a series of year books produced by the Chilean National Met. Agency (NMA) and held as .pdf files at http://164.77.222.61/climatologia/ .

Production of Tmax and Tmin series for the period 1961-2011:

After sample checks on the different annual subsets found in the NMA sources for Punta Arenas, it was found that the CRU series and the series from the NMA appeared to refer to different observing stations in the Punta Arenas area – at least in some parts of the period after 1960. The idea of filling missing values in the CRU series with values from the NMA sources was abandoned. Instead, the NMA record (Tmax and Tmin) was transcribed for the period 1971-2011. Figure 14 shows the CRU Tmax and Tmin series (black) and the transcribed NMA series are shown in red and blue (Tmax and Tmin, respectively). For the period 1961-70, the CRU Tx and Tn series were used with some adjustment for the period 1961-62. There were no data for 1963 and these monthly values were estimated using monthly averages of the previous and following two years (see below). There was no adjustment for the period 1964-70 – see following paragraph.

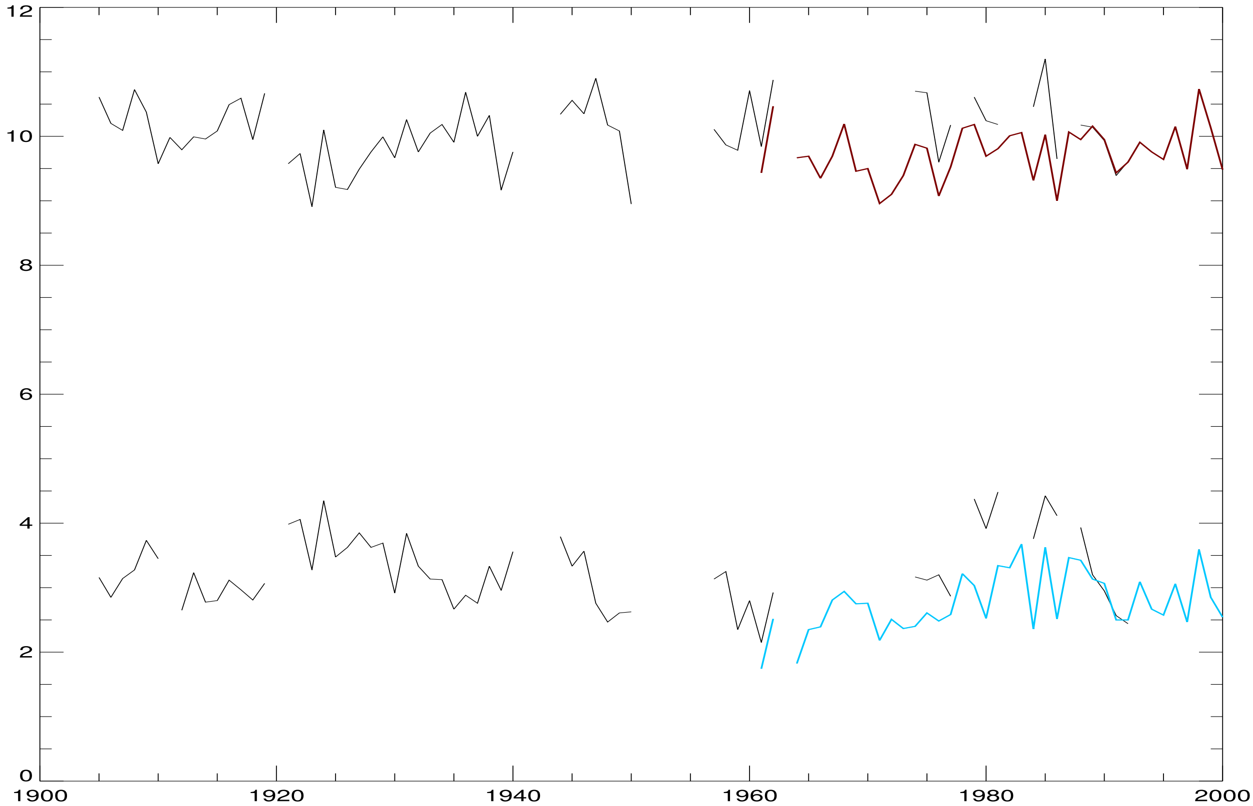

Figure 14. The upper and lower black lines represent the CRU annual mean Tmax and Tmin series (respectively). The red and blue lines show the NMA transcribed Tmax and Tmin series.

Checks with the NMA year books, World Weather Records (WWR) publications and metadata relating to the CRUTEM4 series of mean temperatures for Punta Arenas (see http://www.cru.uea.ac.uk/cru/data/temperature/), reveal useful information on the sources of the CRU archived data and the equivalent data held in the NMA books and thus guide the need for homogeneity adjustments for the Punta Arenas Tmax and Tmean series as outlined above:

- In the year books, the values for 1961-62 come from station Bahia Catalina (53.1°S, 70.9°W and elevation 2m). In the CRUTEM metadata it is shown that during the 1980s work in CRU, the Punta Arenas series had a homogeneity adjustment for the period before and including 1963 - see Jones *et al*. (1985). The monthly increments to be added are: -0.7, -0.8, -0.5, -0.7, -0.7, -0.9, -1.1, -0.9, -0.8, -0.6, -1.2, -0.9. Spot checks on CRUTEM values with the adjustments reversed agree with the values in the NMA books. Thus, in the interests of homogeneity, the CRUTEM adjustments were applied to the NMA data for the years 1961-62 using the Tmean adjustments.

- NMA and CRU data for the period 1964-70 appear to come from station Chabunco (53.0°S, 70.8°W and elevation 34m). There was no homogeneity adjustment in the CRUTEM for the transition to Chabunco

- NMA data for the period 1971-2011 come from station Ibanez Airport (53.0°S, 71.0°W and elevation 37m). This is also the source of recent data in the CRUTEM series. It is possible that Chabunco was the former name for the Ibanez Airport site and the observation location changed within the airport site in 1971.

The final series for Tmax and Tmin are shown in Figure 15. For the source data for all monthly values in the Punta Arenas Tmax and Tmin series, see Table P2 in Appendix P. For the locations of all stations having precipitation and temperature for SE Patagonia, see Figure 16 and Table P1. The only station with significant elevation is Lago Argentino, which is also the only station that is not relatively close to the sea.

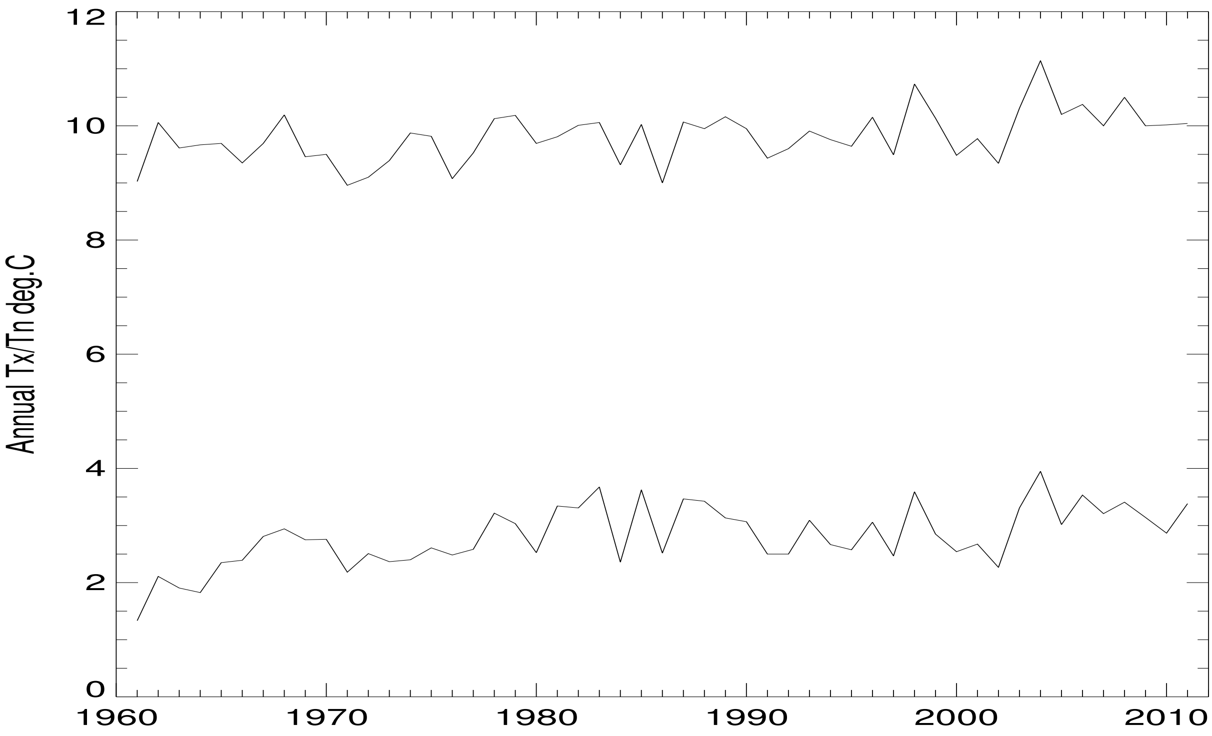

Figure 15. The two lines represent Punta Arenas Tmax and Tmin annual time-series produced from the monthly time-series.

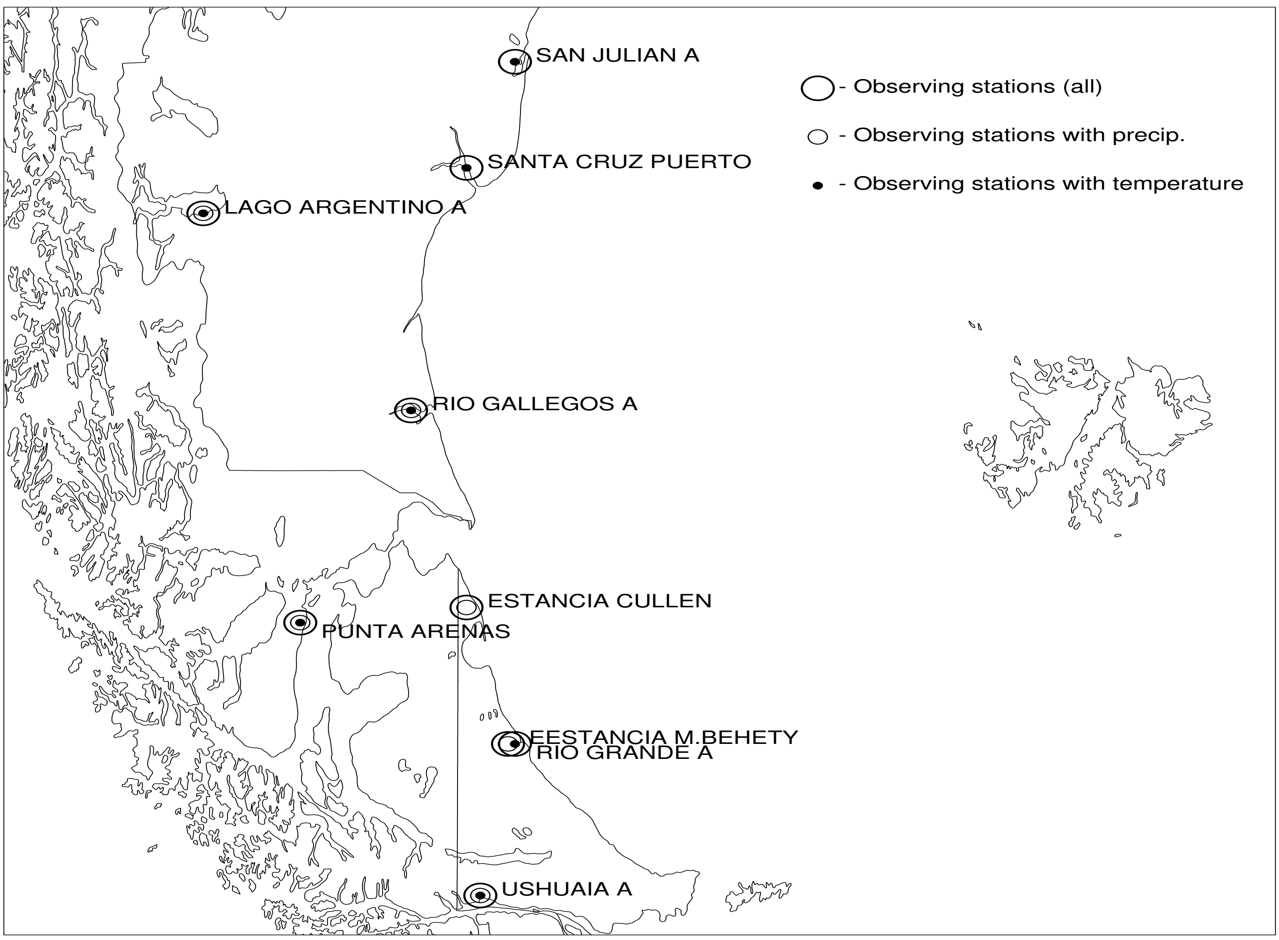

Figure 16. Stations having useable observation series (temperature and precipitation) in SE Patagonia

5. Southern Patagonia RCM data

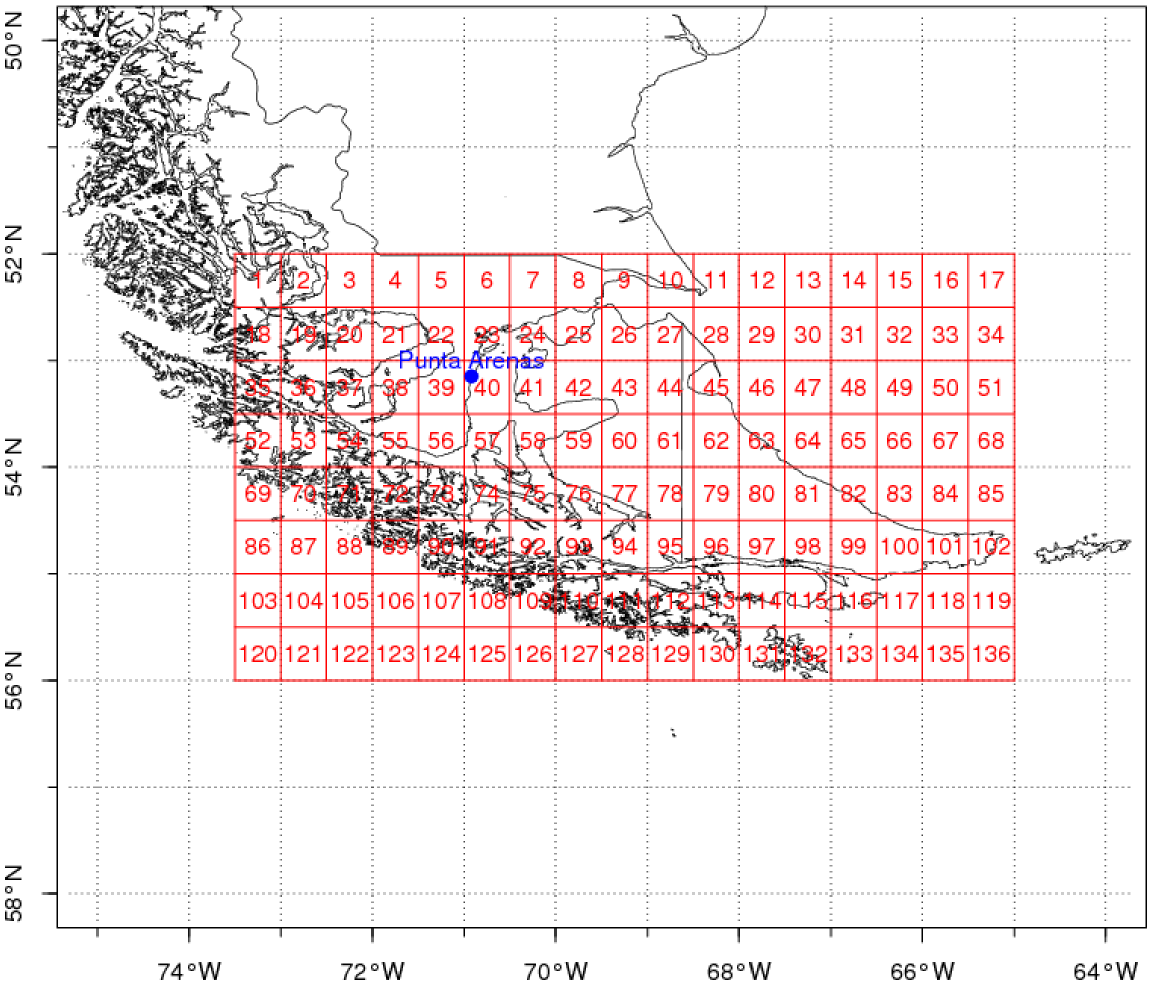

Figure 17. Patagonia 8x17 RCM grid.

Figure 17 shows the RCM grid used for S. Patagonia. The method used is identical to that described for the Falklands. Figure 18 shows the key biovars for the overlying cell 40 (mainly consisting of water), however this cell does not model temperature as well as cell 39 shown in Figure 19 so it was decided to use that cell. Comparison of the changes for the two cells revealed that there is actually very little difference in the deltas. Figure 20 shows the observed plus deltas.

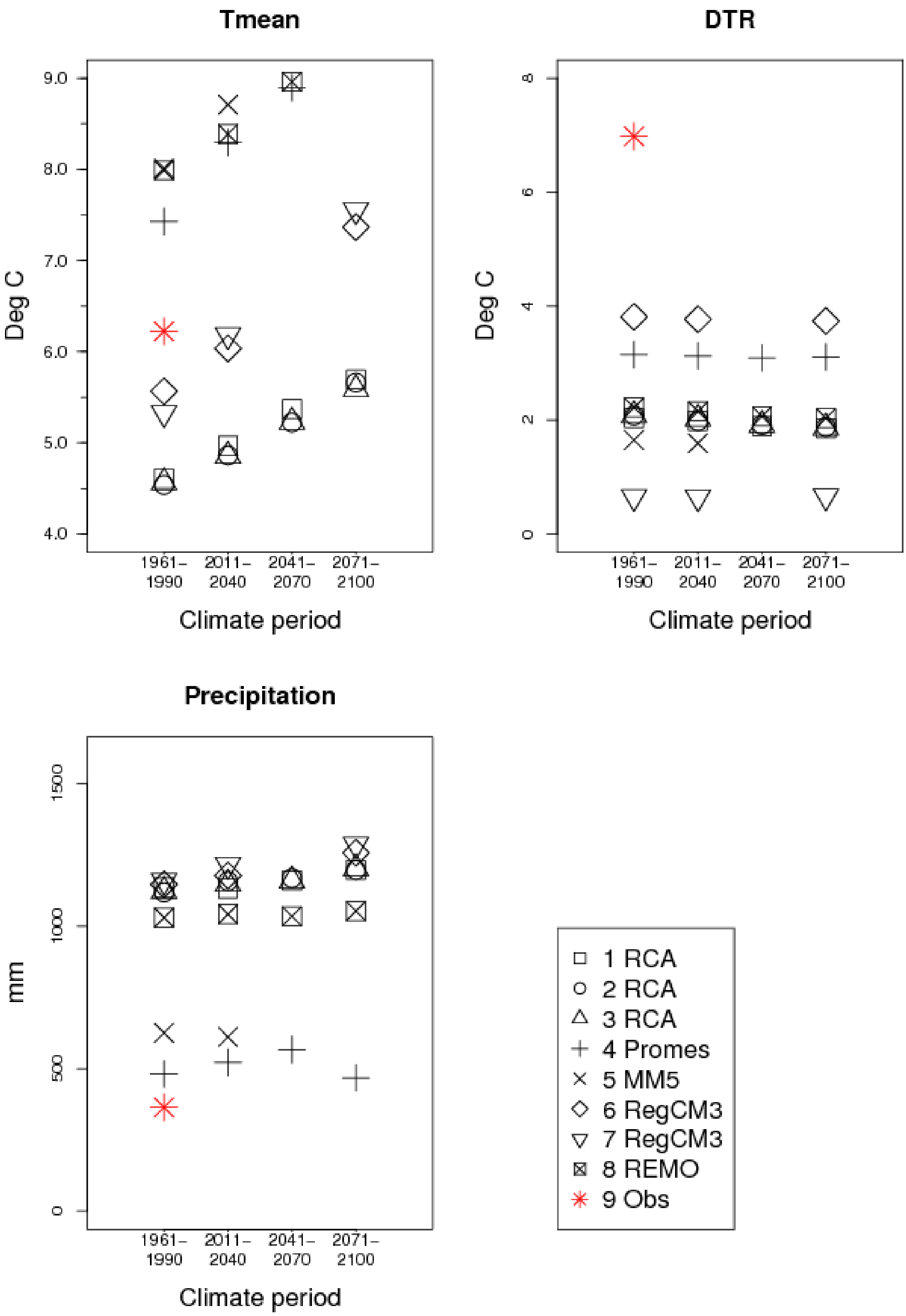

Figure 18. RCM bioclimatic variables Tmean, DTR and Precipitation (bio1, bio2 and bio12) compared for the various models using cell 40. The same variables for the observed series (1961-1990) are shown in red.

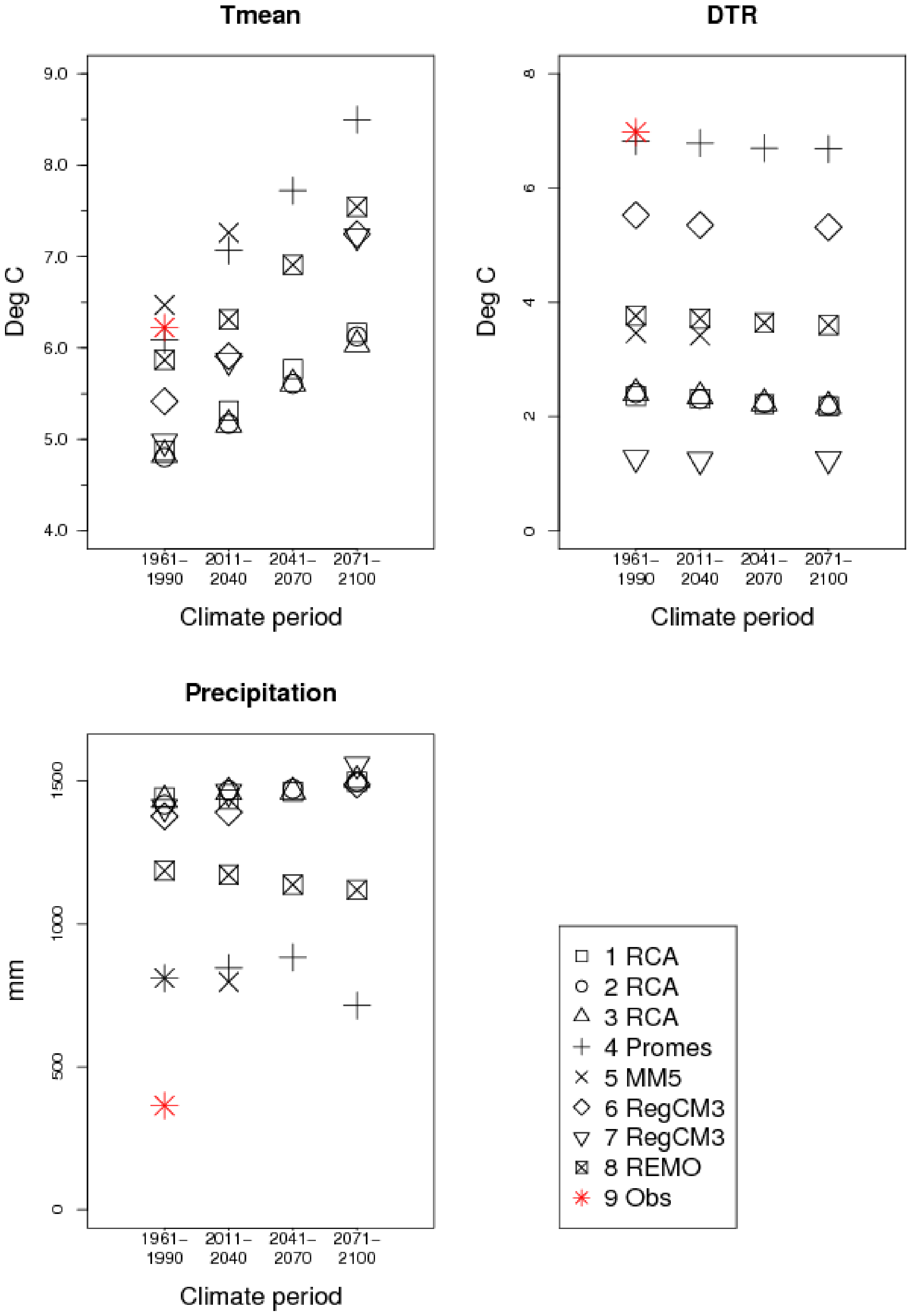

Figure 19. As Figure 14 but for grid cell 39.

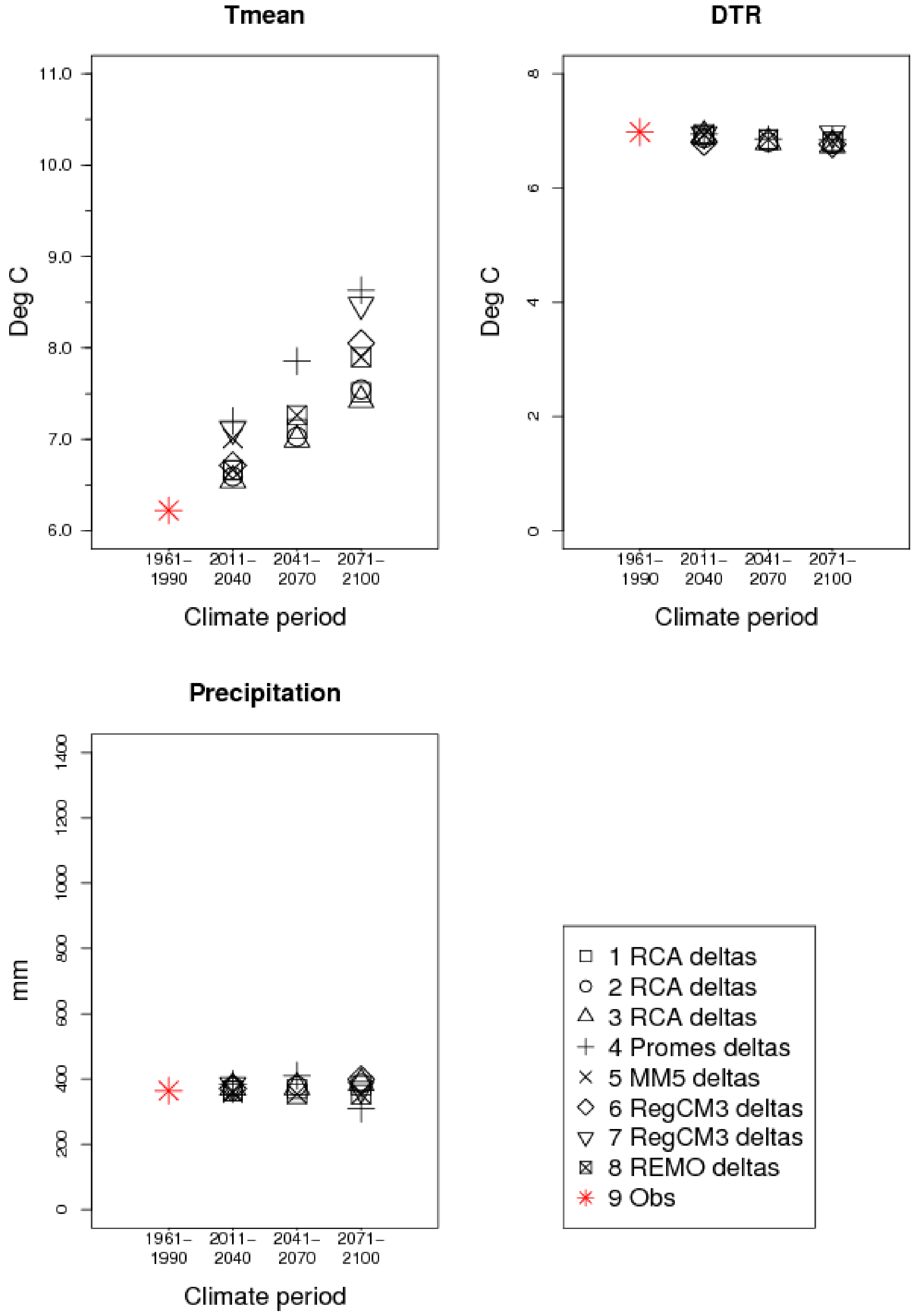

Figure 20. As Figure 14 but for Observed + deltas (using grid cell 39) bioclimatic variables.

6. Interpolation to a 1km grid (Patagonia)

In order to produce a 1km grid, linear regression was implemented using four predictor variables: latitude, longitude, elevation and distance to the sea for each station (see Tables 1 and 2 for precipitation and temperature respectively). The predictands are the monthly station normals for 1961-1990. A set of regression coefficients could then be derived for each month. Unfortunately, once again,there were no temperature stations at higher elevations, the highest being Maria Behety at 30m, which resulted in an inverted relationship giving spurious values at higher elevations. In order to rectify the problem “dummy” stations refered to as Punta Hills and Ushuaia Hills were introduced with a temperature record calculated by rescaling the Punta Arenas values based on a decrease of 6^{o}C per Km (which provides a reasonable estimate). Precipitation also had problems with an inverted relationship so Punta Hills was introduced using approximate values for the area.

By applying the coefficients to the predictors for each 1km grid point the monthly climate normals at each gridpoint could be generated. By comparing these predictions with Punta Arenas normals, ratios for precipitation and differences for temperature could be calculated and then applied to the Punta Arenas monthly time series at each gridpoint to enable the climate variables to be calculated on an annual basis and for each climate period. For the scenario periods change factors (as described previously) were applied depending on which RCM cell the 1km gridpoint lies in.

Table 1. Predictors used for precipitation.

Station	Longitude	Latitude	Elevation (m)	Dist to sea (m)
Gallegos	69.28W	51.62S	19.00	22256.00
Punta Arenas	70.88W	53.13S	6.00	1078.48
Ushuaia	68.32W	54.83S	11.00	294.53
Maria Behety	67.94W	53.79S	30.00	11599.19
Cullen	68.45W	52.89S	18.00	4997.47
Lago Argentino	72.05W	50.28S	223.00	161579.00
Punta Hills	71.13W	53.14S	556.00	13761.88

Table 2. Predictors used for temperature.

Station	Longitude	Latitude	Elevation (m)	Dist to sea (m)
Ushuaia	68.30W	54.80S	16.00	686.77
Rio Gallegos	69.30W	51.60S	20.00	22256.00
San Julian	67.80W	49.30S	58.00	13342.00
Punta Arenas	70.88W	53.13S	6.00	1078.48
Lago Argentino	72.05W	50.28S	223.00	161579.00
Santa Cruz Puerto	68.58W	50.02S	12.00	21496.00
Rio Grande	67.75W	53.79S	18.00	2000.00
Punta Hills	71.13W	53.14S	556.00	13761.88
Ushuaia Hills	69.60W	54.65S	2515.00	5979.81

7. Conclusions and Recommendations:

The work discussed in this report represents what has been possible within the constraints of what data are available from the Islands and from Patagonia. For the Falkland Islands, we have developed one long series of monthly precipitation totals and average temperatures for the combined records from Mount Pleasant Airport (MPA) and Stanley. A shorter record of monthly maximum and minimum temperatures was also derived from 1961. We have infilled the few missing months in the precipitation and temperature series, during the early-mid 1980s, using ERA-Interim and we have used the Met Office Hadley Centre's sea surface temperature dataset (HadISST) to join the Stanley and MPA temperature series. These latter exercises were essential to have a complete record with which to use the shorter records taken across the Islands.

By using paired observations with MPA, we've been able to make best use of these records to enable derivation of temperature and precipitation records for each one kilometre square (by regression). The drawback of this approach is that all the observing sites are at a relatively low elevation and most are from coastal locations. To improve the situation for future studies, we recommend setting up a couple of Automatic Weather Stations (AWSs) at much higher elevations to improve the regression relationships we have used. In this study, we have had to use square root transformations for precipitation and a dummy station for temperature to ensure reasonably realistic estimations for the higher parts of the Islands.

For Patagonia, we have followed the same principles, developing a long record for Punta Arenas. The number of precipitation and temperature records from the region is sparser than on the Falklands, but the lengths of record are longer. However, a similar situation with the observing sites arises with all but one being at relatively low elevation and close to the coast. Again, we have had to use dummy stations to prevent an inverted relationship with elevation and so ensure the data are well behaved when we extrapolate temperature and precipitation data to the higher elevation parts of the region. The dummy station for precipitation was given an annual precipitation of 720mm which is consistent with the amounts typically received on the eastern slopes of the mountain range. However the interpolation cannot distinguish between eastern and western slopes where because of prevailing wind direction high orographic precipitation amounts can be received (approximately in the region of 1000-7000mm annually). Consequently the precipitation amounts for the region to the west of the mountain peaks cannot be relied upon. To model this area accurately would require comprehensive station coverage on both sides of the mountain chain.

More temperature and precipitation data are available for this region, but they are not centrally co-ordinated by the Argentine and Chilean Met Services. Instead, records do exist on many of the large estancias in the region, but it is necessary to go to each to gain access. We are aware of colleagues from Mendoza doing some work along these lines some years ago for the two southernmost provinces of the Argentina mainland.

The Regional Climate Model (RCM) data used have recently become available from the EU-funded CLARIS LPB project. The RCM simulations were produced at a number of modelling centres in Argentina, Brazil, Spain and Sweden. This South American domain is part of the CORDEX project (http://wcrp-cordex.ipsl.jussieu.fr/) which is part of the World Climate Research Programme (WCRP). This project will continue for some years, but it is a co-ordinated action project and not specifically well supported financially. It is likely that over the next few years more modelling centres will run simulations for South America. CLARIS LPB provided resources for this to be done, but it is unlikely that South America will be as well co-ordinated until there is further specific funding. The UK Met Office would be unlikely to run their RCM for South America without being involved in some sort of collaborative project.

Acknowledgements

This work has been supported by the UK Falklands Islands Trust (UKFIT). We thank the support of UKFIT and in addition Manfred Keenleyside and Owen Summers (from the Falkland Islands), Jim McAdam and staff at Kew Gardens (Justin Moat, Rebecca Upson and Tim Wilkinson) for their help with the Bioclimatic Variables and the high-resolution elevations and distances from the sea for the Falklands and SE Patagonia. The RCM scenario data was developed by the European Community's Seventh Framework Programme (FP7/2007–2013) under Grant Agreement 212492 (CLARIS LPB: A Europe–South America Network for Climate Change Assessment and Impact Studies in La Plata Basin).

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WWR – see Smithsonian (above)

Appendix F (Falklands)

Table F1. Station series (locations, coordinates, elevations and total period of availability) used in the production of high spatial-resolution precipitation and temperature series for the Falklands – see also Tables F2 and F3). Please note that there may be missing blocks of data within the total period of availability. The grey shaded stations have both temperature and precipitation.

Station name	Latitude	Longitude	Elevation (m)	Overall period
Main Point	51.43° S	59.91° W	28	1965-1977
Darwin	51.81° S	58.96° W	0	1949-2010
Hill Cove	51.51° S	60.14° W	46	1965-1971
Port Howard	51.61° S	59.52° W	22	1950-2010
Fox Bay	51.95° S	60.02° W	5	1947-1978
Fitzroy	51.79° S	58.23° W	12	1948-1987
North Arm	52.12° S	59.36° W	21	1945-1966
Port San Carlos	51.50° S	58.99° W	24	1952-1968
MPA	51.82° S	58.47° W	65	1986-2011
Port Stanley	51.69° S	57.86° W	13	1874-2010
Head of Bay	51.60° S	59.03° W	18	2005-2010
Pebble Island	51.32° S	59.60° W	15	1949-2010
West Point	51.35° S	60.68° W	15	1953-1978
Weddell Island	51.90° S	60.92° W	18	1994-2000

Table F2. Stations used in the work towards the production of high spatial-resolution precipitation series for the Falklands – the values are the MPA-extended monthly conversion ratios

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Main_Point	0.77	1.10	0.94	1.20	1.08	0.99	1.15	0.99	1.13	0.96	0.97	0.76
Year count	12.00	12.00	12.00	12.00	12.00	12.00	13.00	13.00	13.00	13.00	13.00	13.00
Darwin	0.80	0.86	0.87	0.86	1.00	0.95	0.82	0.81	0.95	0.89	0.89	0.76
Year count	24.00	25.00	31.00	30.00	28.00	27.00	26.00	26.00	28.00	28.00	28.00	25.00
Hill_Cove	0.92	1.23	0.96	1.22	1.30	1.28	1.23	1.07	1.43	1.01	1.01	0.80
Year count	16.00	16.00	16.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	16.00
Port_Howard	1.09	1.18	1.21	1.18	1.37	1.37	1.42	1.36	1.42	1.15	1.32	1.00
Year count	31.00	31.00	31.00	30.00	29.00	29.00	30.00	30.00	30.00	30.00	30.00	30.00
Fox_Bay	0.76	0.84	0.78	0.83	0.78	0.89	0.80	0.74	0.78	0.71	0.84	0.64
Year count	29.00	27.00	27.00	27.00	28.00	28.00	27.00	28.00	27.00	28.00	28.00	28.00
Fitzroy	0.77	0.86	0.95	1.24	0.77	0.94	1.00	1.08	0.98	1.16	0.84	0.85
Year count	22.00	21.00	20.00	22.00	21.00	21.00	21.00	21.00	21.00	20.00	22.00	21.00
North_Arm	0.68	0.77	0.73	0.86	0.81	0.71	0.77	0.78	0.82	0.87	0.67	0.69
Year count	22.00	21.00	21.00	21.00	21.00	20.00	20.00	20.00	21.00	21.00	21.00	21.00
Port_San_Carlos	1.01	1.34	1.15	1.14	1.25	1.25	1.22	1.20	1.34	1.06	1.11	0.96
Year count	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	17.00	17.00	16.00	17.00
MPA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Year count	25.00	25.00	25.00	25.00	25.00	25.00	26.00	26.00	26.00	26.00	26.00	26.00
Stanley	1.15	1.14	1.13	1.15	1.16	1.15	1.14	1.16	1.15	1.14	1.12	1.13
Year count	112.00	111.00	111.00	111.00	111.00	109.00	110.00	110.00	111.00	111.00	111.00	109.00
Head_of_Bay	0.81	0.96	1.03	0.95	0.97	0.84	0.61	1.07	0.79	0.85	0.78	0.81
Year count	6.00	6.00	6.00	6.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Pebble_Island	0.84	0.86	0.72	0.68	0.95	0.87	0.66	0.93	0.83	0.65	0.80	0.58
Year count	13.00	12.00	13.00	13.00	13.00	13.00	13.00	13.00	12.00	13.00	13.00	13.00
West_Point	0.67	1.16	0.76	0.81	1.33	1.04	1.12	1.16	0.97	0.76	0.91	0.67
Year count	9.00	9.00	9.00	9.00	8.00	9.00	9.00	9.00	9.00	9.00	9.00	6.00

Table F3. Stations used in the work towards the production of high spatial-resolution temperature series for the Falklands – the values given are the monthly conversion increments (°C) to be added to MPA-extended values

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
West Point	0.24	-0.20	0.10	1.46	1.73	2.66	2.27	1.47	0.78	-0.47	-0.33	0.09
Year count	8.00	9.00	9.00	9.00	9.00	9.00	9.00	8.00	8.00	7.00	7.00	7.00
Port Howard	-0.46	-0.67	-0.76	0.11	0.67	1.22	0.94	0.13	-0.19	-0.51	-0.58	-0.88
Year count	7.00	7.00	7.00	7.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Darwin	-0.37	-0.83	-0.94	0.19	-0.10	0.73	0.39	-0.28	-0.40	-1.17	-0.75	-0.33
Year count	6.00	6.00	9.00	11.00	12.00	12.00	12.00	12.00	11.00	12.00	12.00	8.00
Stanley	-1.50	-1.30	-1.30	-0.60	-0.60	0.20	0.10	-0.20	-0.40	-1.10	-1.30	-1.30
Year count	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00
MPA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Year count	25.00	25.00	25.00	25.00	25.00	25.00	26.00	26.00	26.00	26.00	26.00	26.00
Weddell_Island	-0.33	-0.50	-0.13	0.40	0.99	1.43	1.50	0.94	0.28	-0.08	-0.50	-0.06
Year count	6.00	6.00	7.00	7.00	7.00	6.00	6.00	5.00	5.00	5.00	6.00	5.00
Pebble_Island	-0.10	0.02	0.28	0.60	1.41	1.20	1.16	0.66	0.10	-0.46	-0.55	-0.36
Year count	6.00	6.00	6.00	6.00	7.00	6.00	5.00	5.00	5.00	5.00	6.00	5.00

Table F4. Detailed source-code information for the extended MPA (with some estimation of missing values during the period 1982-83) monthly precipitation series:

Codes used:

ST_adj - Port Stanley values scaled to those of MPA via their incomplete 1990-2010 overlap (20 yrs)

ERA_if - Value infilled by that from ERA-Interim reanalysis scaled via the 1979-2011 overlap between
the infilled (using ST_adj where where available) MPA extended series and ERA-Int - actual overlap=31 years

MP_obs - The observed value from Mount Pleasant Airport
NO_val - A missing value with no means of estimation
The conversion factor Stanley>MPA=0.8762
The conversion factor ERA-Int>MPA=0.8973

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1874	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1875	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1876	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1877	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1878	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1879	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1880	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1881	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1882	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1883	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1884	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1885	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1886	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1887	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1888	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1889	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1890	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1891	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1892	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1893	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1894	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1895	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1896	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1897	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1898	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1899	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1900	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1901	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1902	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1903	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1904	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1905	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1906	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1907	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1908	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1909	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1910	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1911	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1912	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1913	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1914	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1915	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1916	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1917	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1918	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1919	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1920	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1921	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1922	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val
1923	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	ST_adj	ST_adj	ST_adj	ST_adj
1924	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	NO_val	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1925	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1926	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1927	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1928	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1929	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1930	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1931	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1932	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj

1933	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1934	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1935	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1936	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1937	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1938	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1939	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1940	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1941	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1942	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1943	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1944	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1945	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1946	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1947	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1948	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1949	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1950	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1951	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1952	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1953	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1954	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1955	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1956	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1957	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1958	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1959	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1960	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1961	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1962	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1963	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1964	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1965	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1966	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1967	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1968	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1969	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1970	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1971	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1972	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1973	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1974	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1975	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1976	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1977	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1978	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1979	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1980	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1981	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1982	ST_adj	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if
1983	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if
1984	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1985	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1986	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1987	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1988	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1989	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1990	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1991	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1992	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1993	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1994	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1995	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1996	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1997	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1998	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1999	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2000	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2001	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2002	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2003	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2004	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2005	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2006	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2007	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2008	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2009	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2010	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2011	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2012	MP_obs	MP_obs	MP_obs	MP_obs	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val	NO_val

Table F5. Detailed source-code information for the extended MPA (with some estimation of missing valueus during the period 1982-86) monthly temperature series

Codes used in the sources Table:

ST_adj – Port Stanley values adjusted to the MPA location
ERA_if – ERA-Interim values used to infill missing values
MP_obs – Observations from Mount Pleasant (not adjusted)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1923	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1924	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1925	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1926	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1927	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1928	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1929	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1930	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1931	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1932	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1933	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1934	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1935	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1936	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1937	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1938	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1939	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1940	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1941	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1942	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1943	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1944	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1945	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1946	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1947	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1948	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1949	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1950	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1951	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1952	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1953	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1954	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1955	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1956	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1957	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1958	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1959	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1960	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1961	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1962	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1963	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1964	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1965	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1966	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1967	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1968	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1969	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1970	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1971	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1972	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1973	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1974	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1975	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1976	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1977	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1978	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1979	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1980	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1981	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1982	ST_adj	ST_adj	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if
1983	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if
1984	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1985	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1986	ST_adj	ST_adj	ST_adj	ST_adj	ERA_if	ERA_if	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1987	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1988	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1989	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1990	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs

1991	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1992	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1993	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1994	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1995	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1996	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1997	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1998	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1999	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2000	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2001	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2002	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2003	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2004	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2005	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2006	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2007	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2008	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2009	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2010	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2011	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs

Table F6. Detailed source-code information for the extended MPA Tmax and Tmin 1960-2011 series (with some estimation of missing valueus during the period 1982-86).

Codes used (two tiers of coding where necessary):

The primary codes used are the same as those used for the Tmean series – i.e.

ST_adj - Port Stanley values scaled to those of MPA via their incomplete 1990-2010 overlap (20 yrs)

ERA_if - Value infilled by that from ERA-Interim reanalysis scaled via the 1979-2011 overlap between the infilled (using ST_adj where where available) MPA extended series and ERA-Int - actual overlap=31 years

MP_obs - The observed value from Mount Pleasant Airport

The secondary tier of coding:

Tmax and Tmin values are further adjusted to take account of different DTR characteristics (as above)

Monthly-mean DTR (as opposed to observed) values have been used to generate Tmax and Tmin.

1960	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1961	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1962	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1963	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1964	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1965	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1966	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1967	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1968	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1969	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1970	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1971	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1972	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1973	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1974	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1975	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1976	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1977	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1978	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1979	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1980	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1981	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1982	ST_adj	ST_adj	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if
1983	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if
1984	ERA_if	ERA_if	ERA_if	ERA_if	ERA_if	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1985	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj	ST_adj
1986	ST_adj	ST_adj	ST_adj	ST_adj	ERA_if	ERA_if	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1987	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs

1988	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1989	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1990	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1991	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1992	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1993	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1994	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1995	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1996	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1997	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1998	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
1999	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2000	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2001	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2002	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2003	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2004	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2005	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2006	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2007	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2008	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2009	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2010	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs
2011	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs	MP_obs

Appendix P (Patagonia)

Table P1. Station series (locations, coordinates, elevations and total period of availability) used in the production of high spatial-resolution precipitation and temperature series for the Falklands – see also Table P2. Please note that there may be missing blocks of data within the total period of availability. The grey shaded stations have temperature .

Station name	Latitude	Longitude	Elevation(m)	Overall period
San Julian Airport	-49.3	-67.8	58	1951-pres
Santa Cruz Puerto	-50.0	-68.5	12	1903-91 (1901-pres)
Lago Argentino	-50.3	-72.3	223	1961-pres
Rio Gallegos Airport	-51.6	-69.3	20	1928-pres (1931-pres)
Estancia Cullen	-52.9	-68.5	24	1908-2010
Punta Arenas	-53.0	-70.9	37	1888-prec (1882-pres)
Estancia M. Behety	-53.8	-67.9	30	1958-2009
Rio Grande Airport	-53.8	-67.9	22	1973-2012
Ushuaia Airport	-54.8	-68.3	16	1876-pres

Table P2. Source code for each monthly value in the final Punta Arenas monthly series for both Tmax and Tmin:

The codes used are:

CR_adj – values from the CRU archive of Tmax and Tmin that have been adjusted for homogeneity
CR_est – values estimated from CRU archives using data from previous and following two years
CR_dat – values directly from the CRU archives of Tmax and Tmin
NM_obs – values taken from the Chilean NMA yearbooks

1961	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj
1962	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj	CR_adj
1963	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est	CR_est
1964	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1965	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1966	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1967	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1968	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1969	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1970	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat	CR_dat
1971	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1972	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1973	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1974	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1975	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1976	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1977	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1978	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1979	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs

1980	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1981	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1982	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1983	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1984	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1985	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1986	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1987	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1988	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1989	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1990	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1991	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1992	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1993	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1994	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1995	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1996	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1997	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1998	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
1999	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2000	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2001	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2002	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2003	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2004	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2005	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2006	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2007	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2008	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2009	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2010	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs
2011	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs	NM_obs