Evaluation of ClimateBC V5

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Summary

ClimateBC V5 is a software page that produces high spatial resolution estimates of temperature and precipitation and a number of derived climate variables for historic and future climates. ClimateBC V5 is an update of ClimateBC V4 and the BC component of ClimateWNA V472. Changes include a new base layer of PRISM monthly temperature and precipitation at 800 m resolution for the 1971-2000 period, downscaling to specific elevations using lapse rates based on surrounding grid cells, a solar radiation base layer, CMIP5 climate change projections for three normals periods, and monthly time series of selected climate projections.

This report evaluates ClimateBC V5's ability to produce historic monthly climate data. Calculated values are compared to measured climate normals and derived variables (1951-80, 1961-90 and 1971-00 periods) for specific locations (Meteorological Service of Canada weather stations) and to estimates from the previous version of the software. A spatial comparison over BC of ClimateBC V5 and V4 was made for selected variables. Differences in climate of the zones and variants of BC's Biogeoclimatic (BEC) vegetation classification system calculated by Climate BC V5 and ClimateWNA V472 were determined. The testing evaluates the accuracy of the PRISM base layer in combination with the downscaling methodology and the CRU anomaly data used to adjust to different time period than the base period.

The new 1971-00 PRISM layers at 800 m grid provide a slight improvement over the old 1961-90 PRISM layers at 4 km grid in predicting monthly temperature and precipitation of the measured climate of a weather station within the grid cell. As expected, downscaling to the station elevation further improves this prediction. However, the improvements between V4 and V5 are marginal for temperature (using R^2 as an indicator) and there is a slight degradation on precipitation. Bias appears to be reduced for temperature and precipitation. These results are reflected in the derived variables, such as degree days, heat:moisture index and evaporation, which show only small or no improvement.

The strength of PRISM is its estimates of temperature and precipitation in areas far removed from points of measurement. Maps of BC for the difference between ClimateBC V5 and ClimateBC V4 for selected variables were generated at 800 m resolution. In general, the new PRISM results in a warmer interior for BC at high elevations and cooler for the coast. This cooler coastal area was noted in testing of individual station data where it was found that frost free period was underestimated at four lighthouses. There are some areas of northern BC that are cooler. Part of this is due to the fact that a splined data set rather than PRISM was used for northeastern BC in earlier versions of the software. Histogram plots show that most of the estimates of mean annual temperature fall within ± 1°C of previous estimates. The majority of the maximum and minimum temperatures are within ± 3°C of previous estimates. Changes in mean annual precipitation are greatest in coastal BC with some areas drier and other areas wetter than the previous estimates. Histograms show that most points are within 50 mm of previous estimates.

A set of annual variables were determined for the 16 zones and 217 variants of the BEC system. As expected from the above-mentioned spatial analysis, there are differences between the new and past

estimates. Histogram plots indicate most changes are within 20% of previous estimates, but there are a few outliers. The greatest differences are in precipitation.

The solar radiation estimates have not been evaluated against station data. It was found that the data base does not encompass some of the headlands and islets on the coast of BC. A fix for this could be to duplicate the outmost cells of the data base along the coast to ensure all of BC is covered.

In conclusion, the tests indicate that ClimateV5 performs as well as previous versions. It is assumed that the difference seen in the spatial comparisons result from an improvement in resolution brought about by the improvements in methodology and increased data that went into creating the new PRISM data base.

Acknowledgements

Faron Anslow, PCIC, for supplying the PRISM grids and a copy 1971-2000 temperature and precipitation normals. Adrian Walton, BCFLNRO, supplied the BEC grid point file.

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Introduction

ClimateBC V5 is an update to ClimateBC V4 and the BC component of ClimateWNAV472. ClimateBC V5 is a software page that produces high spatial resolution estimates of temperature and precipitation and a number of derived climate variables for historic and future climates. Values for individual points are obtained by interpolation based on latitude, longitude and elevation of a base layer of temperature and precipitation normals (PRISM, Daly etal. 2008). Each grid point at the centre of a PRISM tile has an elevation and a monthly value of temperature and precipitation. The interpolation is done by bilinear smoothing between the grid points and then adjusted to the elevation of a location using lapse rates (Wang et al. 2012). Time periods other than the base period are obtained by the delta method using grids of change in temperature and precipitation from the base period (Climatic Research Unit Time Series, version 2.1 (CRU TS 2.1), Mitchell and Jones 2005, Wang et al. 2012).

This document evaluates ClimateBC V5 ability to produce climate normals and various derived variables for Meteorological Service of Canada weather stations. ClimateBC V5 is also compared to estimates from ClimateBC V5 and the BC component of ClimateWNA V472 for the weather stations and for variants of the Biogeoclimatic Classification Systems. This testing is evaluation the accuracy of the PRISM base layer in combination with the downscaling methodology and the CRU anomaly data used to adjust to different time period than the base period.

Changes to ClimateBC V5

PRISM base layers: The original PRISM, created in 2002, has base layers of the 1961-1990 normals of monthly temperature and precipitation at 4 km resolution. The new PRISM layers are at 800 m resolution for 1971-2000 period. Improved methodology (Daly et al. 2008) and information from a substantially more weather stations in BC were used to generate the base layers. The work was done by Faron Anslow of the Pacific Climate Impacts Consortium in conjunction with Chris Daly's Climate Analysis Group at Oregon State University.

Downscaling temperature to individual locations: Previous versions of the software obtained temperature lapse rates from a BC-wide equation of lapse rates as a function of latitude, longitude and elevation (Wang et al 2006, 2012). ClimateBC V5 uses local lapse rates calculated dynamically based on temperature elevation of grid cells surrounding the point.

Downscaling precipitation to individual locations: Previous versions of the software only had precipitation lapse rates that were inherent in the 4 km grid. No further downscaling was done. ClimateBC V5 uses local lapse rates calculated dynamically based on precipitation and elevation of surrounding grid cells.

Solar radiation: This variable was absent from previous versions of the software. ClimateBC V5 contains a historic solar layer to allow monthly historic time series and adjustment of GCM predictions of solar radiation. The source of the historic solar layer is Hember (2013).

CMIP5 projections of climate change: Previous versions of the software used the AR4 climate change projections and scenarios. ClimateBC V5 includes projections from CMIP5. Also, projected values of solar radiation as well as temperature and precipitation are produced.

Monthly time series for CMIP5 projections of climate change: Previous versions of the software only had climate projections for the 2020s, 2050s and 2080s period normals. ClimateBC V5 adds monthly time series of projections of temperature, precipitation and solar radiation for 2014 to 2100 for three projects from one GCM.

Methods

Comparison with measured data: ClimateBC V5 calculation of climate normals are compared with those based on measurements at Meteorological Service of Canada weather stations. The normals periods were 1951-1980 (the original test data set - Wang et al. 2006, 2012), 1961-1990 (the PRISM base layers for previous versions of the software and reference period for the climate change data) and 1971-2000 (the new PRISM base layers). Monthly and annual temperature and precipitation and derived variables such as degree days, frost free period, and evaporation, were generated with the software via an input file of station identification, latitude, longitude and elevation. The previous versions of the software used were ClimateBCV4 and ClimateWNA V472. The normals for the weather stations were obtained from Environment Canada. There are 562 stations for 1951-80 for ClimateBC V4 and 360 for ClimateBC V5 (does not include adjacent areas in Alberta and the Yukon), 185 for 1961-90 (BC only) and 301 for 1971-00 (BC only).

Comparison of original and new PRISM layers: This was done by running ClimateBC V4 and V5 without any bilinear interpolation between tiles or downscaling to specific elevations. The old layers for 1961-90 period and new layers for 1971-00 where both adjusted using the CRU anomaly data base to the same period of 1951-80. The software was used to generate 1951-80 normals for 360 locations in the Meteorological Service of Canada weather stations.

Spatial comparison: A BC-wide spatial comparison was made of ClimateBC V5 and V4 for selected variables. Maps of the difference between ClimateBC V5 and ClimateBC V4 were generated at 800 m grid for the 1961-90 period. The data were generated via an input file of station identification, latitude, longitude and elevation for each point. These data files were used to create files suitable for input to ArcGIS.

Assessment of how the changes might influence climate descriptions: An extensive amount of work has been published using previous versions of the software. It is useful to see if the current versions produce data that might result in large differences in climatic description of areas of BC. This part of the analysis looks at changes to the estimates of climates within units of the Biogeoclimatic Classification System (zones and variants). Input to the software was a file with 60 points for each of the 217 BEC variants. The points are distributed such that they are at least 100 m from boundaries of other units.

Solar radiation: This test consisted of running the software to ensure that reasonable values were generated. Testing of the solar data is being done by Hember (2013).

CMIP5 projections: This test consisted of running the software to ensure that reasonable values were generated. There are no measured data or previous estimates from earlier versions of the software.

Results

Comparison of original and new PRISM layers: The software was used to generate 1951-80 normals for 360 stations without bilinear smoothing of downscaling. ClimateBC V5 produced a marginal increase in R^2 over ClimateBC V4 for temperature. However, there was a slight decrease in some months for precipitation (Appendix 1). The reason for this is not known. It may be the finer resolution of the new PRISM layers has increased the variability.

Downscaling of PRISM: Each grid point at the centre of a PRISM tile is given with an elevation and a monthly value of temperature and precipitation. The downscaling improves the estimate of the monthly temperature and precipitation (Appendix 2) over using the tile value. The improvements are small because of the small size of the tiles. The improvement was much great for the previous 4 km version of PRISM. In this version there was no improvement by downscaling of precipitation with lapse rates, only the bilinear smoothing was applied.

Monthly and annual temperature and precipitation for 1971-2000: This test evaluates the downscaling and interpolation methods of ClimateBC V5. There is excellent agreement in monthly temperature and precipitation between ClimateBC V5 estimates and station data (Appendix 3). The R^2 values are high, the slope of the line is close to 1 and intercepts close to zero. The annual values and derived variables show similar excellent agreement between measured and ClimateBC V5 values. ClimateBC V5 provides a slight improvement over ClimateBC V4 for temperature, but produces slightly lower R^2 for precipitation. This is consistent with the results noted above comparing the original and new PRISM layes

The earlier version of the software uses 1961-90 as the reference period and this requires and extra step of adjusting these data to a 1971-2000 period using the CRU anomaly data. Figure 1 shows the estimates from ClimateBCV5 and ClimateWNA V4 for mean annual temperature and mean annual precipitation. This can also be seen in the monthly data (not shown). However, as noted for the monthly data the estimation of precipitation is not as good for V5 compared to V472 (Figure 1). ClimateBC V5 tends to underestimate precipitation, which may be a result of the underestimation of September and October precipitation noted above. This underestimation also affects the May to September precipitation total and thus the calculation of the summer heat moisture index (Figure 2). The improvement in estimating temperature can be seen in the temperature-based estimation of evaporation (Figure 2).

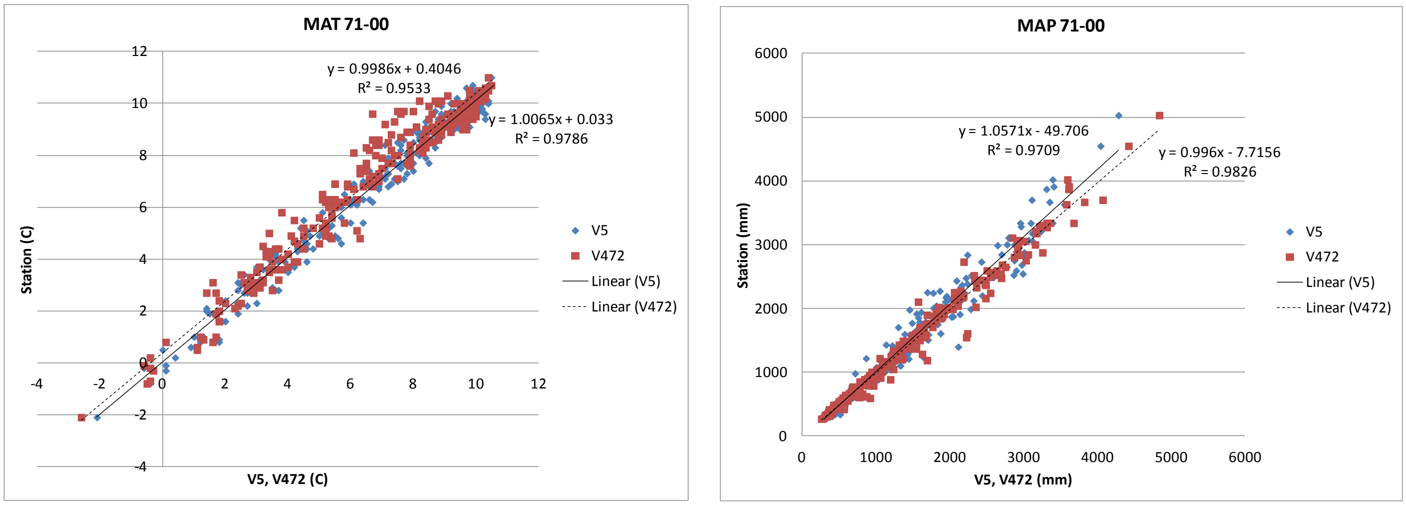

Figure 1: Mean annual temperature(MAT °C) (left panel) and mean annual precipitation (MAP mm) (right panel) for 1971-2000 normals measured at 301 Meteorological Service of Canada weather stations and calculated using ClimateBC V5 (blue squares) and ClimateWNA V472 (red squares). Regression lines generated with Excel.

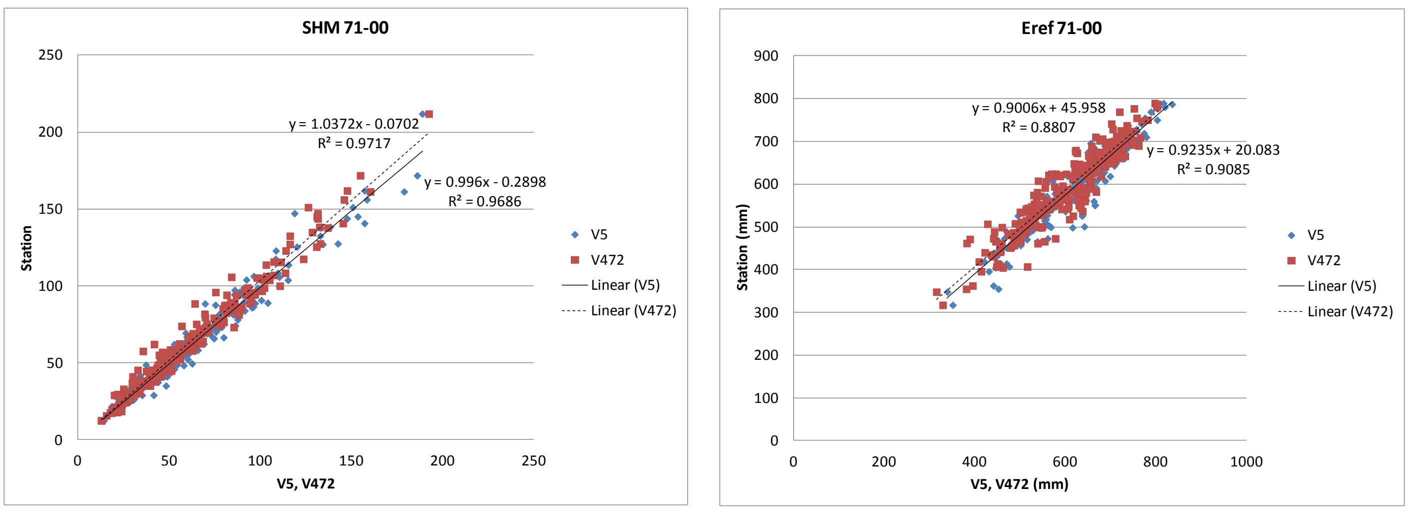

Figure 2: Summer heat:moisture index (SHM left panel) and annual reference evaporation (Eref mm) (right panel) for 1971-2000 normals calculated for 301 Meteorological Service of Canada weather stations, and calculated for ClimateBC V5 (blue squares) and ClimateWNA V472 (red squares). Regression lines generated with Excel.

Annual and monthly temperature and precipitation and derived variables 1951-80 and 1961-90: This test includes an evaluation of the adjustment of the 1971-00 reference period to other periods using the CRU anomalies. As with the 1971-00 normals, for 1951-80 ClimateBC V5 shows a marginal improvement in monthly temperature (greater R^2) for the new PRISM, but a slight degradation for precipitation (Appendix 4) compared to ClimateBC V4. There appears to be a reduction in bias using the new PRISM layers with calculations closer to the 1:1 line and intercept closer to zero.

As with the 1951-90 analysis ClimateBC V5 is a slight improvement over the previous software (in this case ClimateWNA V472) for temperature in 1961-90 (Appendix 5). There is a minor degradation in performance for precipitation. Some outlier precipitation values, e.g., Glacier NP, were corrected. Derived variables such as heat:moisture indices, degree days and evaporation reflect the slight improvements over ClimateWNA V472. The 4 points well above the regression line for the frost free period are lighthouse stations (Appendix 5). This appears to be a result of the new PRISM having cooler temperatures near the ocean that the original PRISM (see next section).

Spatial differences between ClimateBC V5 and ClimateBC V4: It is expected that the software should predict weather station values reliably because these values went into generating the PRISM base layers. The strength of PRISM is its estimates of temperature and precipitation in areas far removed from points of measurement. Maps of BC for the difference between ClimateBC V5 and ClimateBC V4 for selected variables were generated at 800 m grid. Figures 3 and 4 show that the new PRISM produces different climates in some compared to the original PRISM layers. In general, the new PRISM is warmer in the interior and cooler for the coast at high elevations, with differences in mean annual temperature ranging from -4.8 to +3.1°. The cooler areas of northern BC likely result from ClimateBC V4 (and ClimateWNA V472) using splined weather station data (Anusplin) for northeastern BC and northern Alberta rather than the original 4 km PRISM data. It was thought at the time that PRISM minimum temperature data for this area were too warm. This may not have been a valid assumption. Histogram plots show that on annual basis most of the points fall within ± 1°C of previous estimates. The majority of the maximum and minimum temperatures are within ± 3°C of previous estimates (Appendix 6).

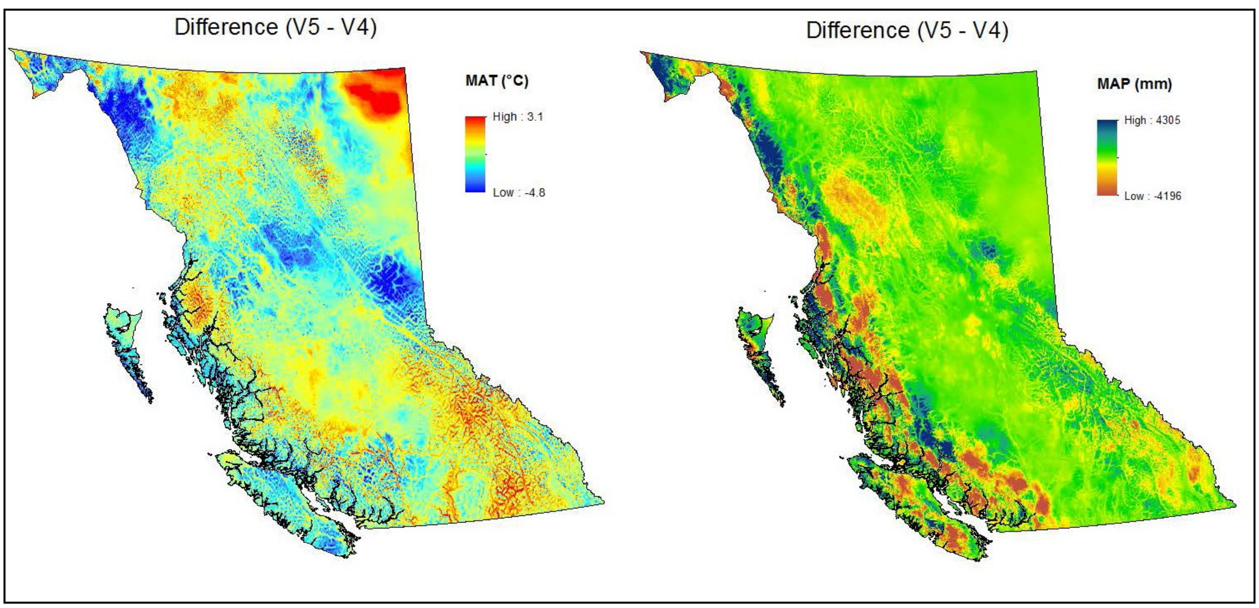

Figure 3: Difference between ClimateBC V5 and V4 for mean annual temperature (MAT °C) (left panel) and mean annual precipitation (MAP mm) (right panel). For MAT red indicates V5 is warmer and blue V5 is cooler than V4. For MAP blue indicates V5 is wetter and brown drier than V4. Yellow and green indicates minor differences for MAT and MAP.

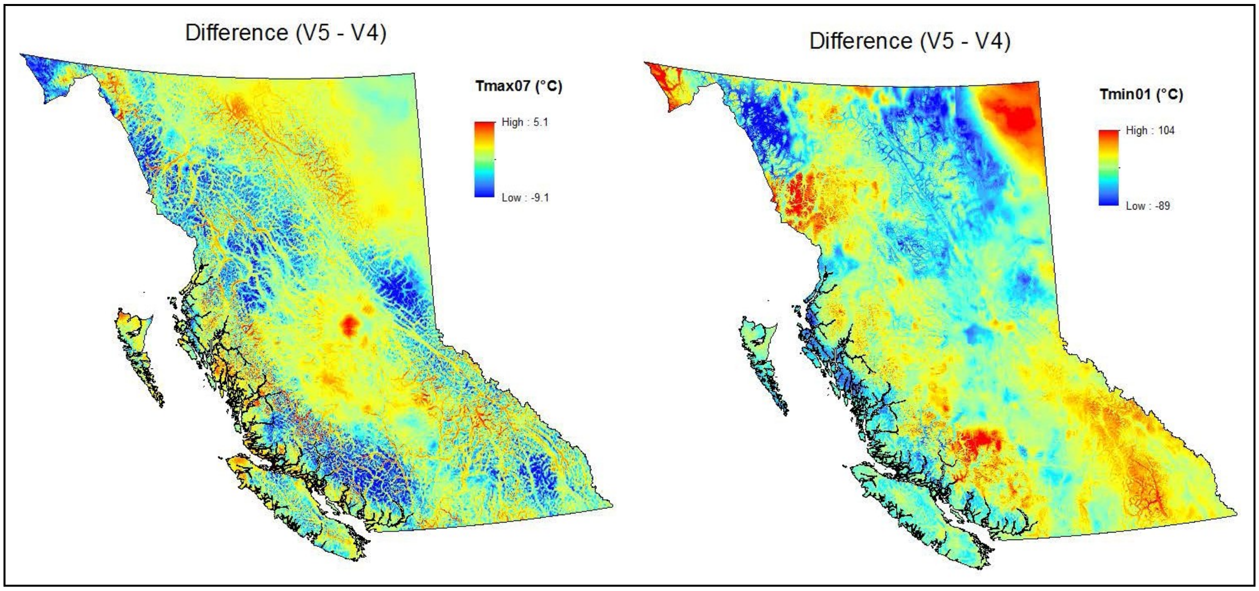

Figure 4: Difference between ClimateBC V5 and V4 for July maximum temperature (Tmax07 °C) (left panel) and January minimum temperature (Tmin01 °C) (right panel). Figure red indicates V5 is warmer and blue V5 is cooler than V4.Yellow and green indicates minor differences.

Changes in mean annual precipitation are greatest in coastal BC with some areas drier and other areas wetter than the previous estimates (Figure 3). Much of the interior has similar values for both versions of the software. The histograms (Appendix 6) show that most points for MAP are within 50 mm of previous estimates.

Impact of changes on climates for BEC units: It is useful to have a comparison of past and current vesion in actual application of ClimateBC. Values for annual variables and differences between ClimateBC V5 and ClimateWNA V472 for zones are presented in Appendix 7. The differences mirror the tendencies shown by the maps in Figures 3 and 4. The greatest differences are in precipitation. Histogram plots of differences for the 217 BEC variants were generated for a selection of the annual variables. Figure 5 indicates that most of the differences in mean annual temperature of a variant are within ±1°C. For mean annual precipitation most changes are within 20% but there are a few outliers.

The mean coldest month temperature (Figure 6) shows a similar distribution of differences to mean annual temperature. There are a few outliers up to 3.5°C different. As was noted earlier, this is a function of the use of splined data for northeastern BC that likely underestimated the minimum and average temperature. Most values for the summer heat:moisture index are within 15% of estimates from earlier versions of the software. Standard deviations on variant and zone means for the two versions of the software are similar.

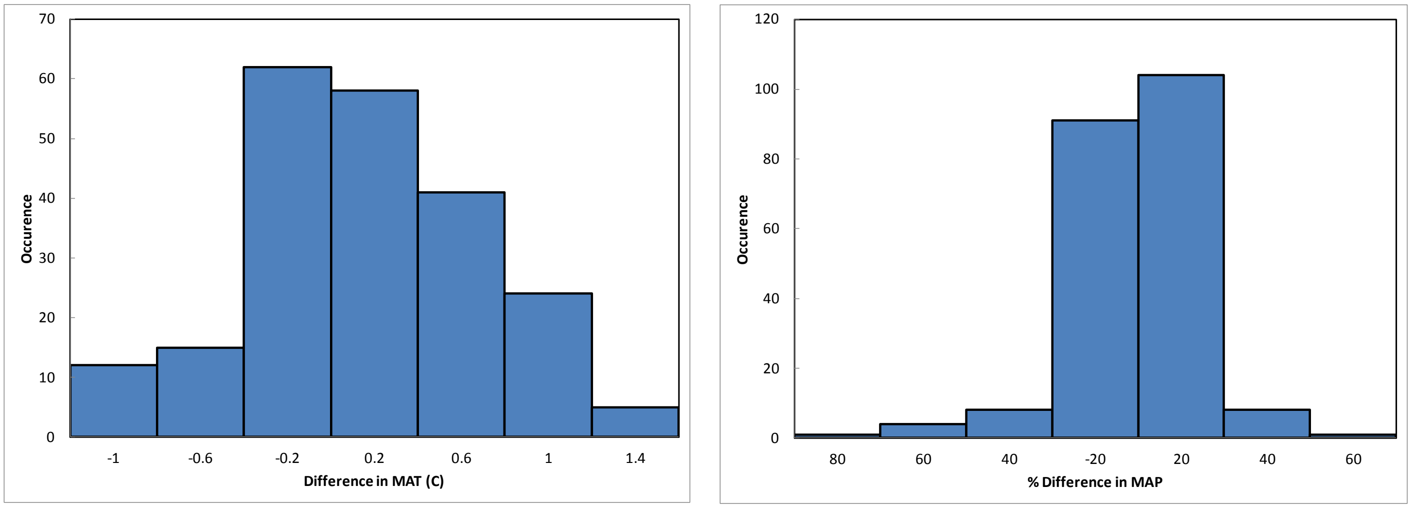

Figure 5: Histograms of difference in mean annual temperature (MAT °C) (left panel) and percentage difference in mean annual precipitation (MAP mm) (right panel) between ClimateBC V5 and ClimateWNA V472 for the 217 BEC variants.

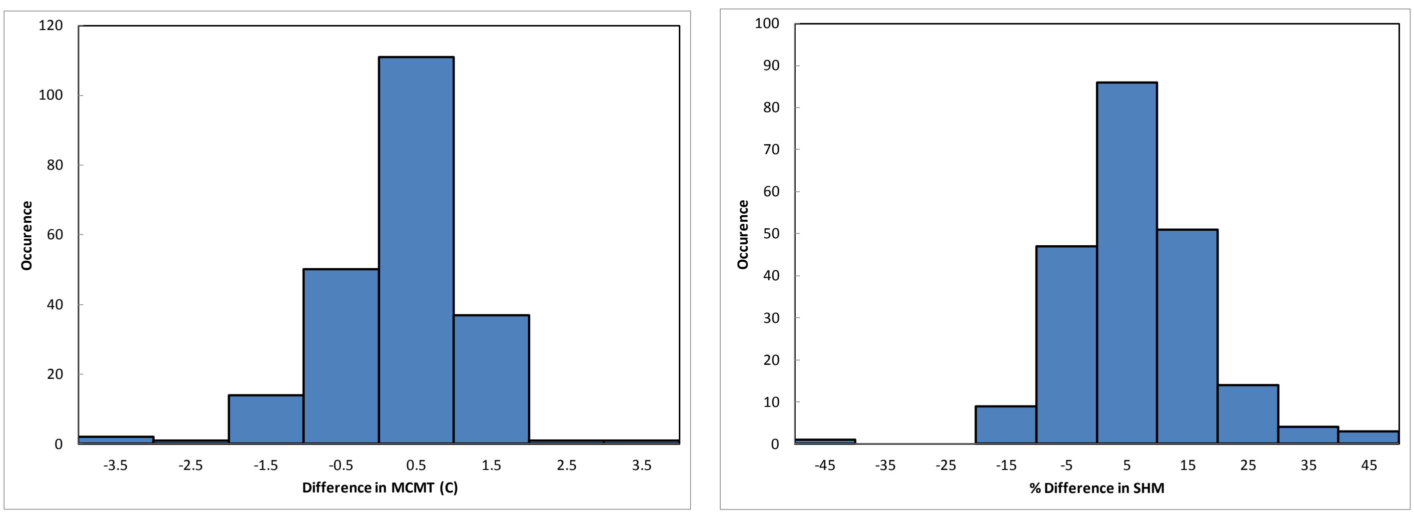

Figure 6: Histograms of difference in mean temperature of the coldest month (MCMT °C) (left panel) and percentage difference in summer heat: moisture index (SHM) (right panel) between ClimateBC V5 and ClimateWNA V472 for the 217 BEC variants.

Solar radiation: The solar data provided does not fully cover BC. Certain coastal headland and islands are missing. This was seen in the inability to predict solar radiation for specific lighthouse stations. A fix for this could be to duplicate the outmost cells of the data base along the coast to ensure all of BC is covered.

Discussion

ClimateBC V5 shows an improvement, though slight, over earlier versions in predicting measured temperatures at weather stations. There appears to be a slight reduction in the accuracy of the

precipitation estimates. Differences are seen between the new and earlier version in the spatial variation across BC and climatic descriptions of ecosystem climate. We believe the new PRISM layers better reflect the climates of these areas that the earlier versions; howver, we have no way to prove this.

References

Daly,C., M. Halbleib, J.I. Smith, W.P. Gibson, M.K. Doggett, G.H. Taylor, J. Curtis and P.P. Pasteris. 2008. Physiographically sensitive mapping of climatological temperature and precipitation across the conterminous United States. *Int. J. Climatol*. DOI: 10.1002/joc.1688.

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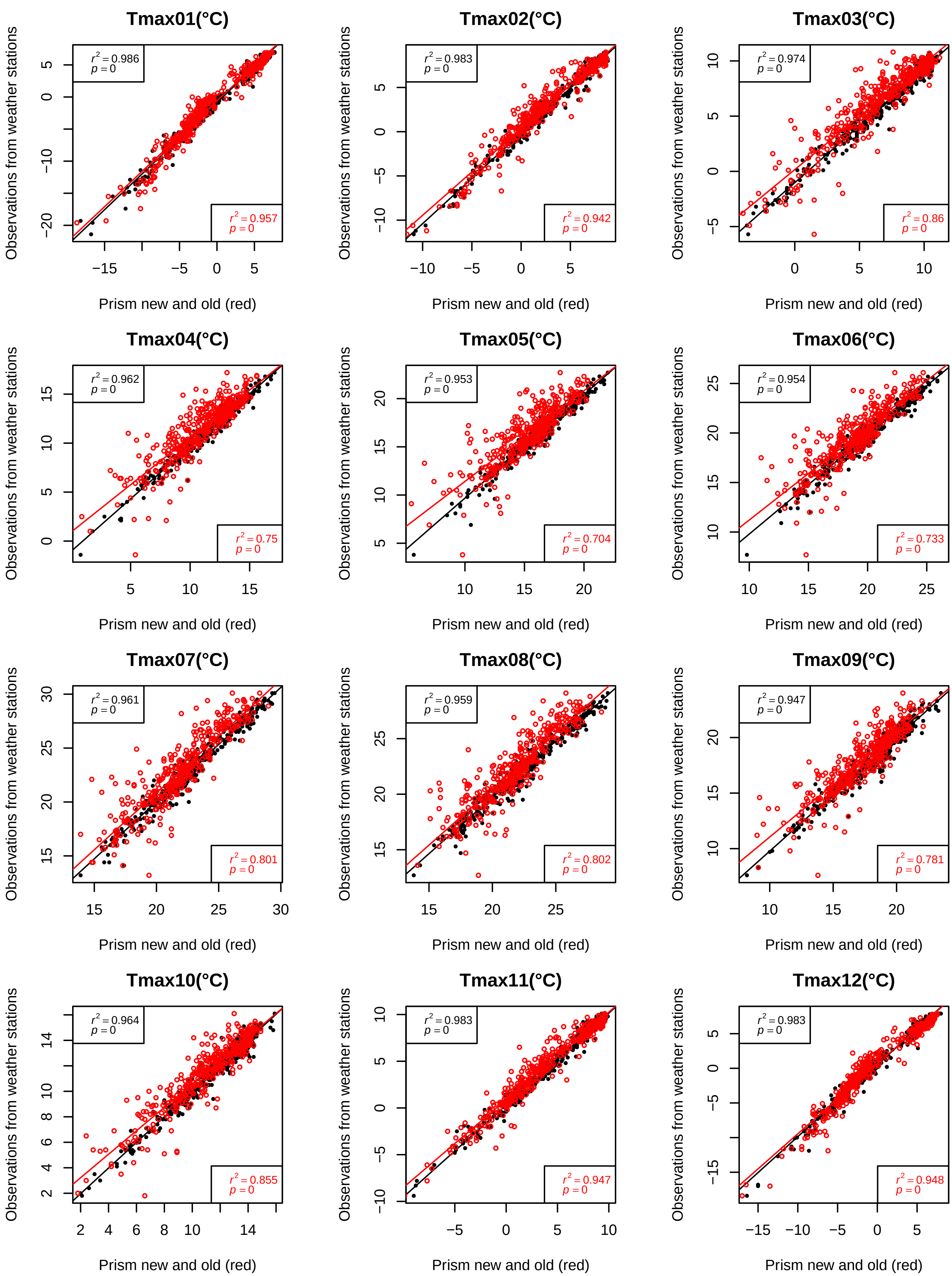
Wang, T, A. Hamman, D.L. Spittlehouse and T.Q. Murdock. 2012. ClimateWNA—High-resolution spatial climate data for Western North America. *J. Appl. Meteorol. Climatol.* 51:16-29.

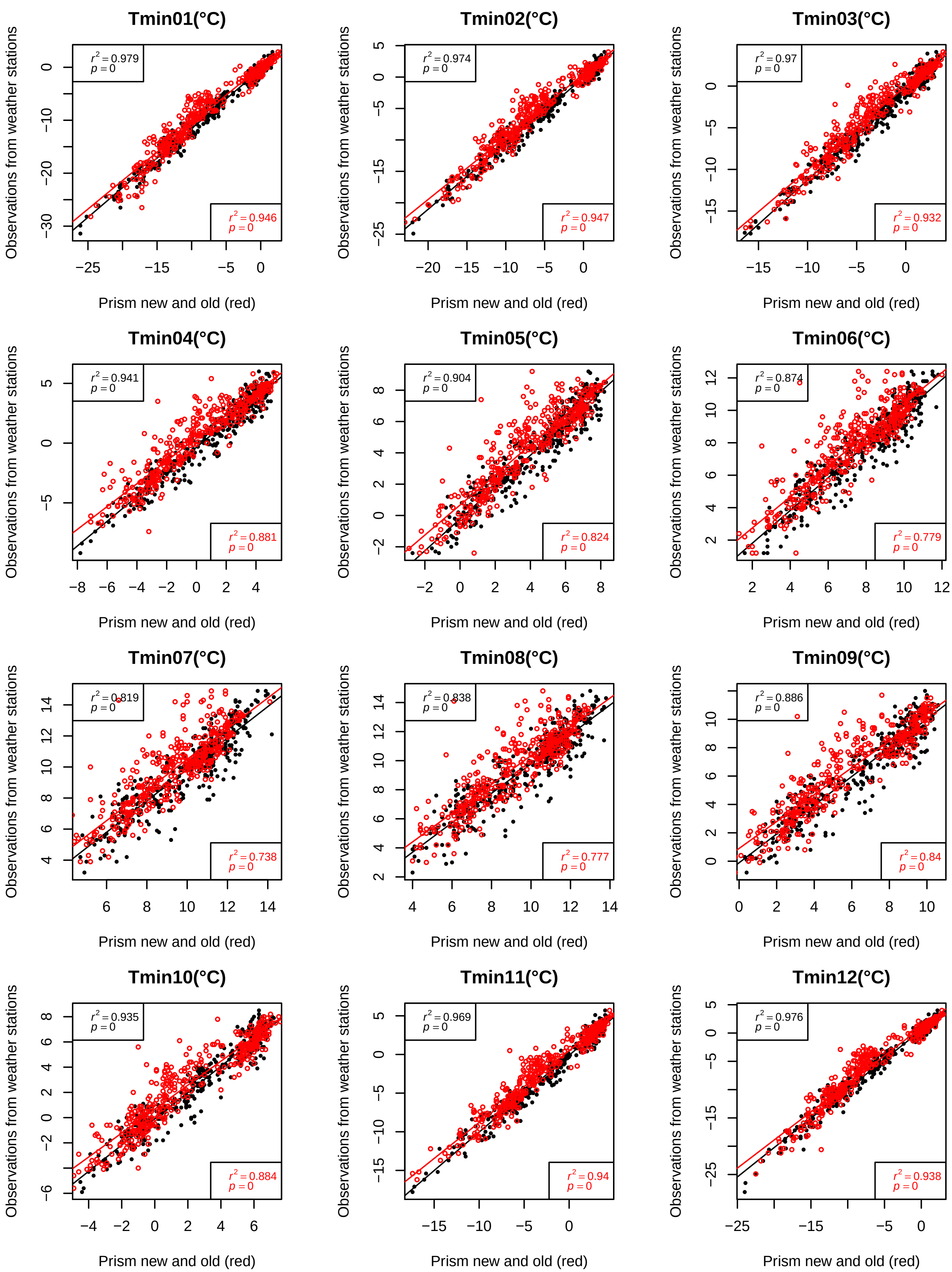
Appendix 1

Monthly temperature and precipitation for 562 Meteorological Service of Canada weather stations (1951-80 normals) for the 4 km grid of the original PRISM (red points) and 360 locations for the new PRISM at 800 m (black points). Bilinear interpolation between tiles or downscaling to the station elevation was not applied.

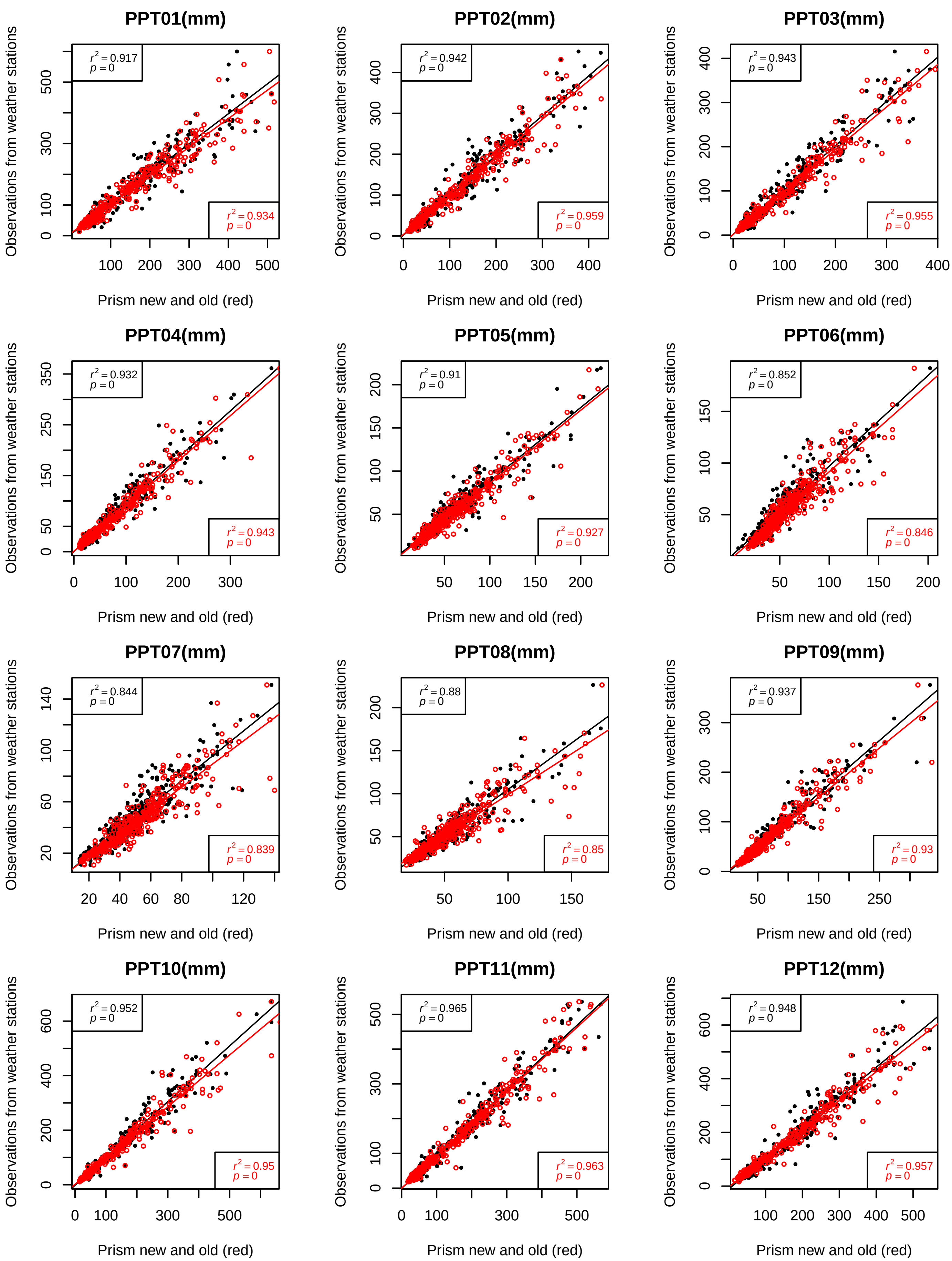
Comparison between Prism new and old (red) for Tmax



Comparison between Prism new and old (red) for Tmin



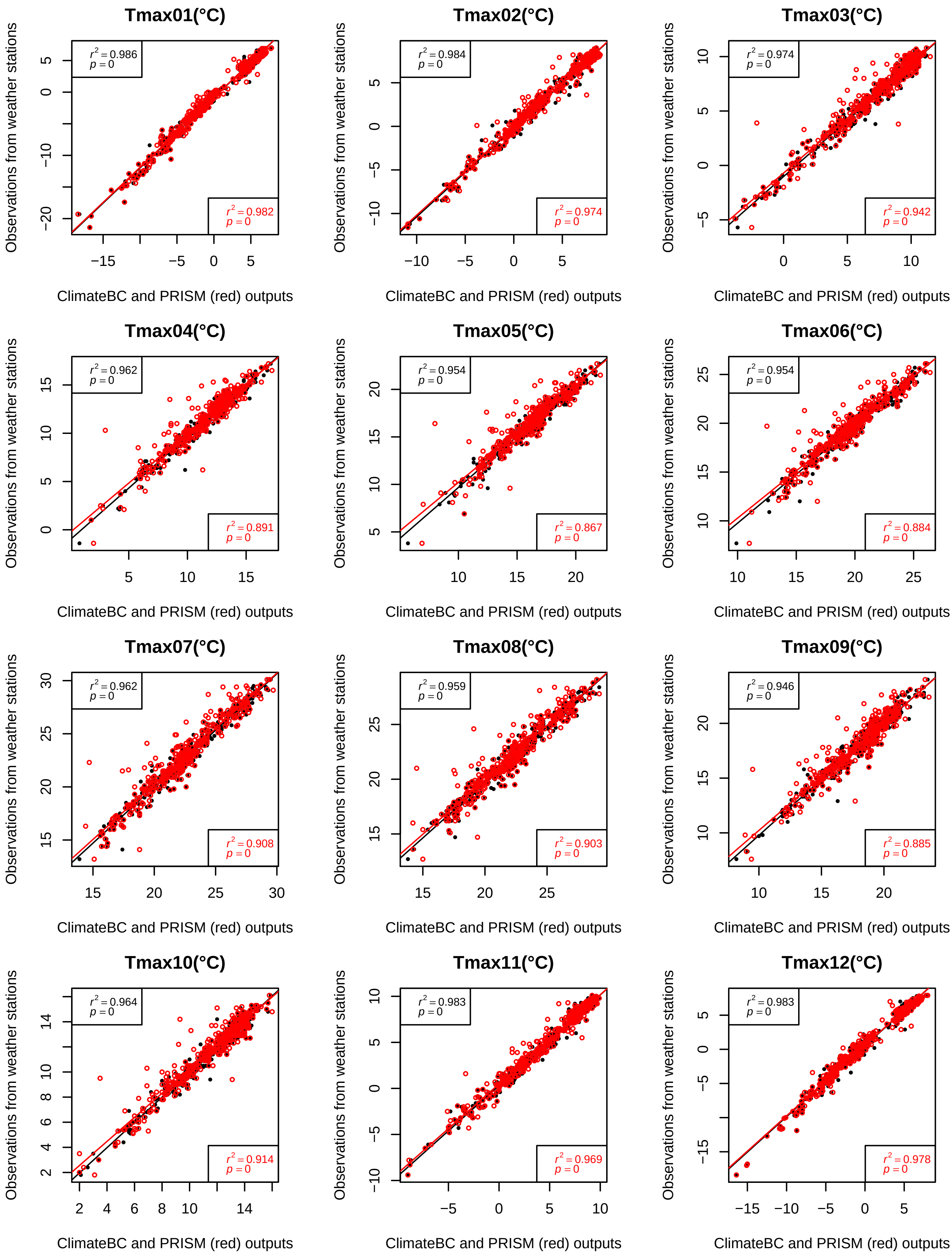
Comparison between Prism new and old (red) for PPT



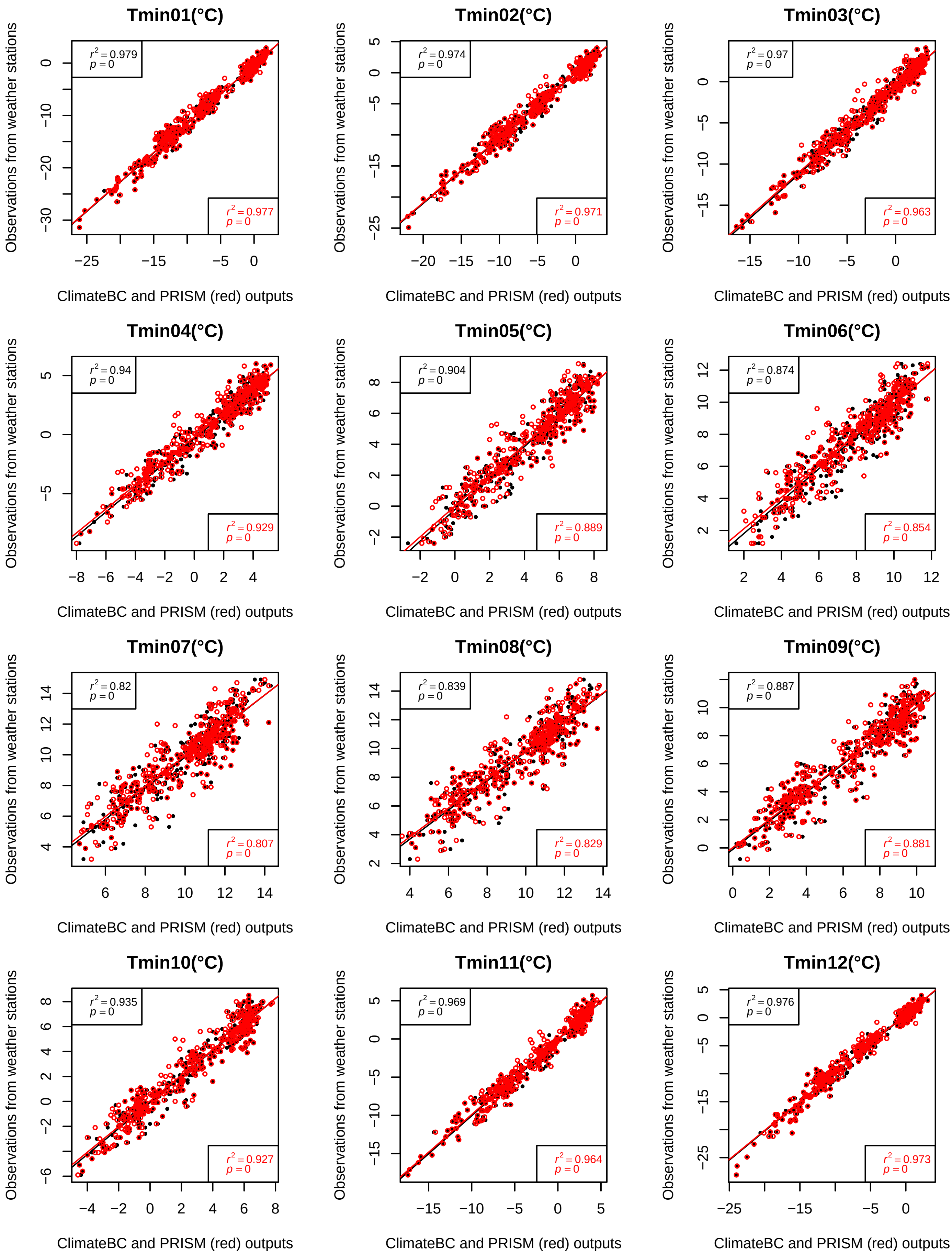
Appendix 2

Monthly temperature and precipitation for 360 Meteorological Service of Canada weather stations for 1951-80 for the 800 m PRISM with no downscaling and with dynamical downscaling to the station elevation with ClimateBC V5 (black points).

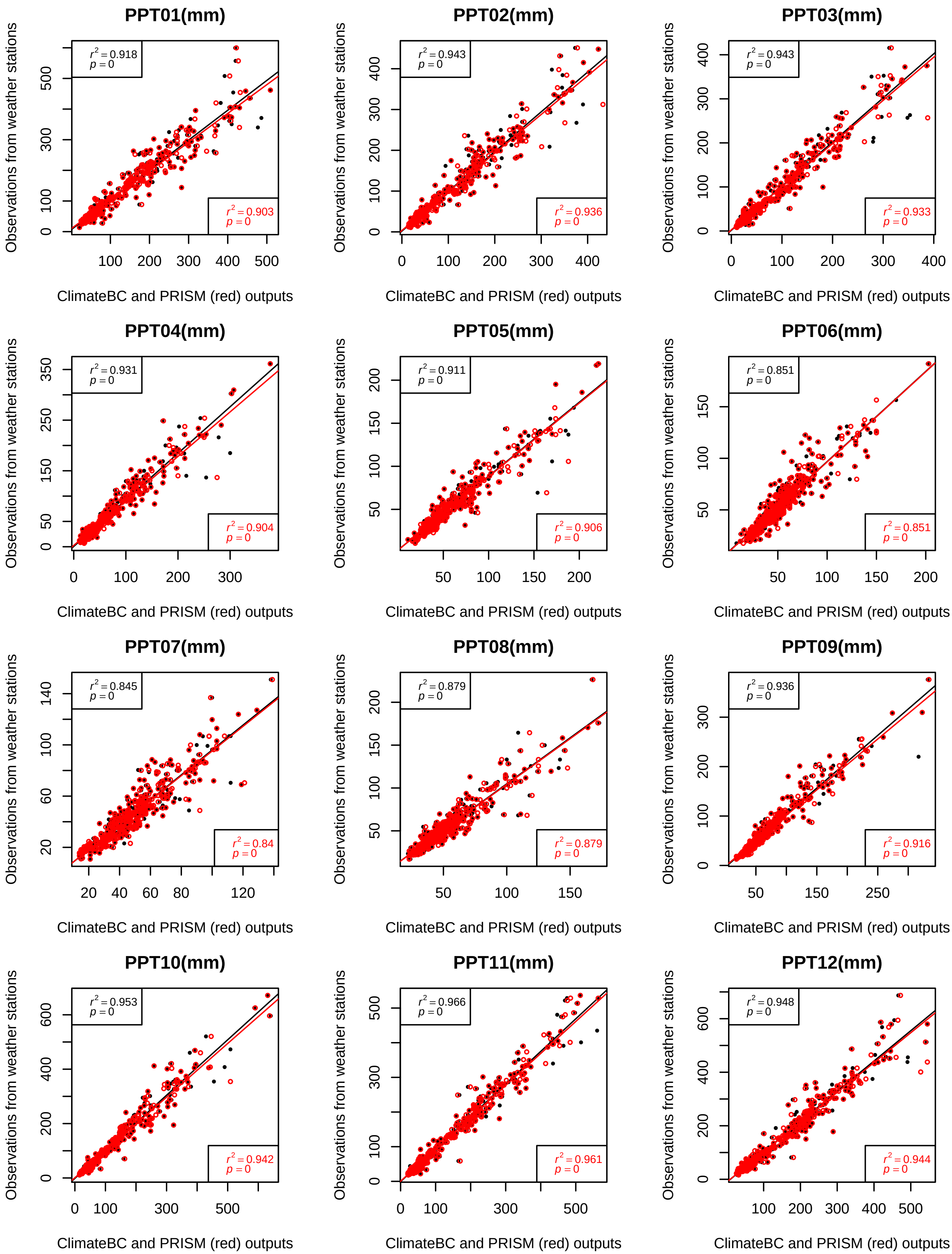
Relationships between predicted and observed Tmax



Relationships between predicted and observed Tmin



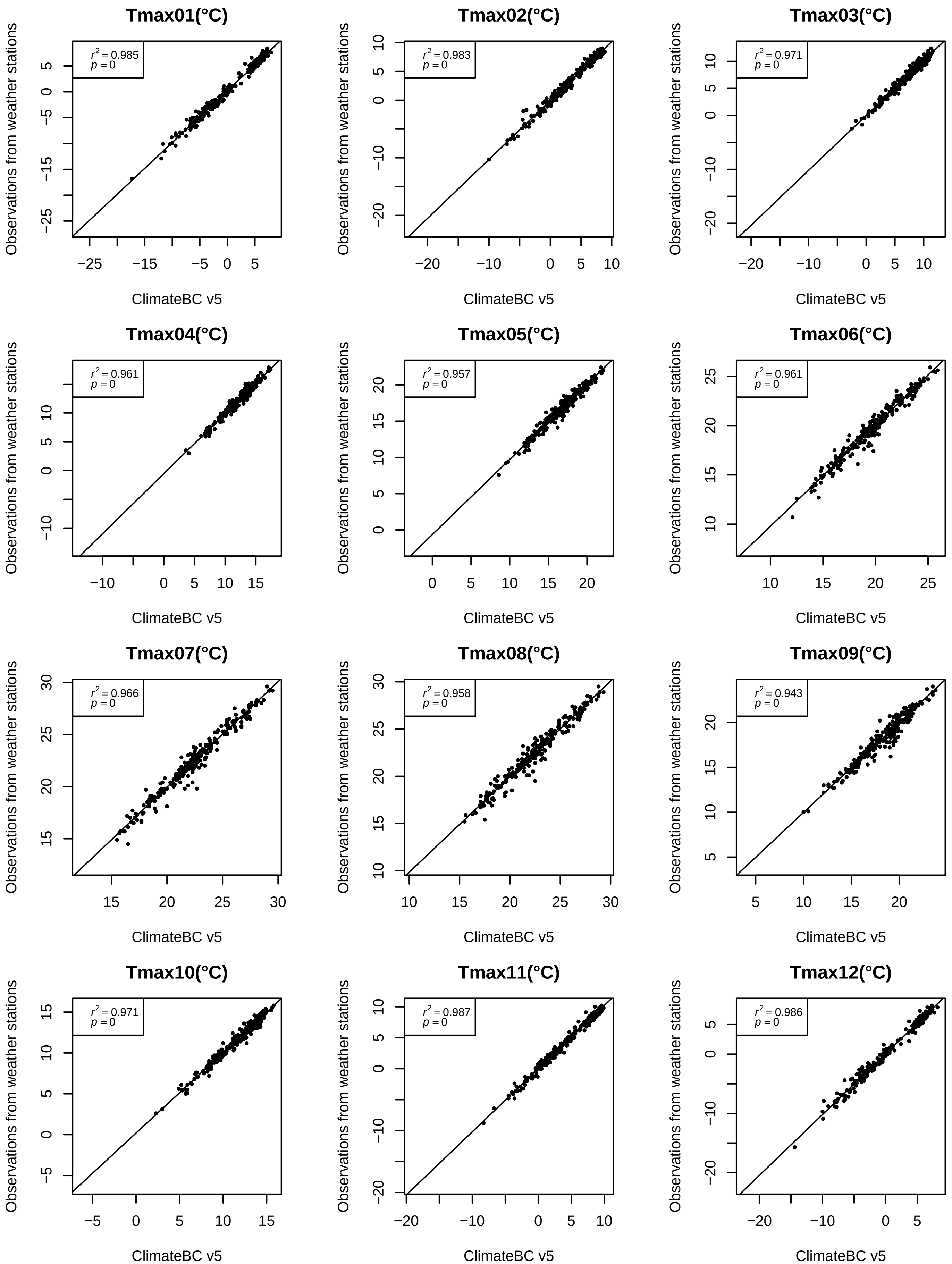
Relationships between predicted and observed PPT



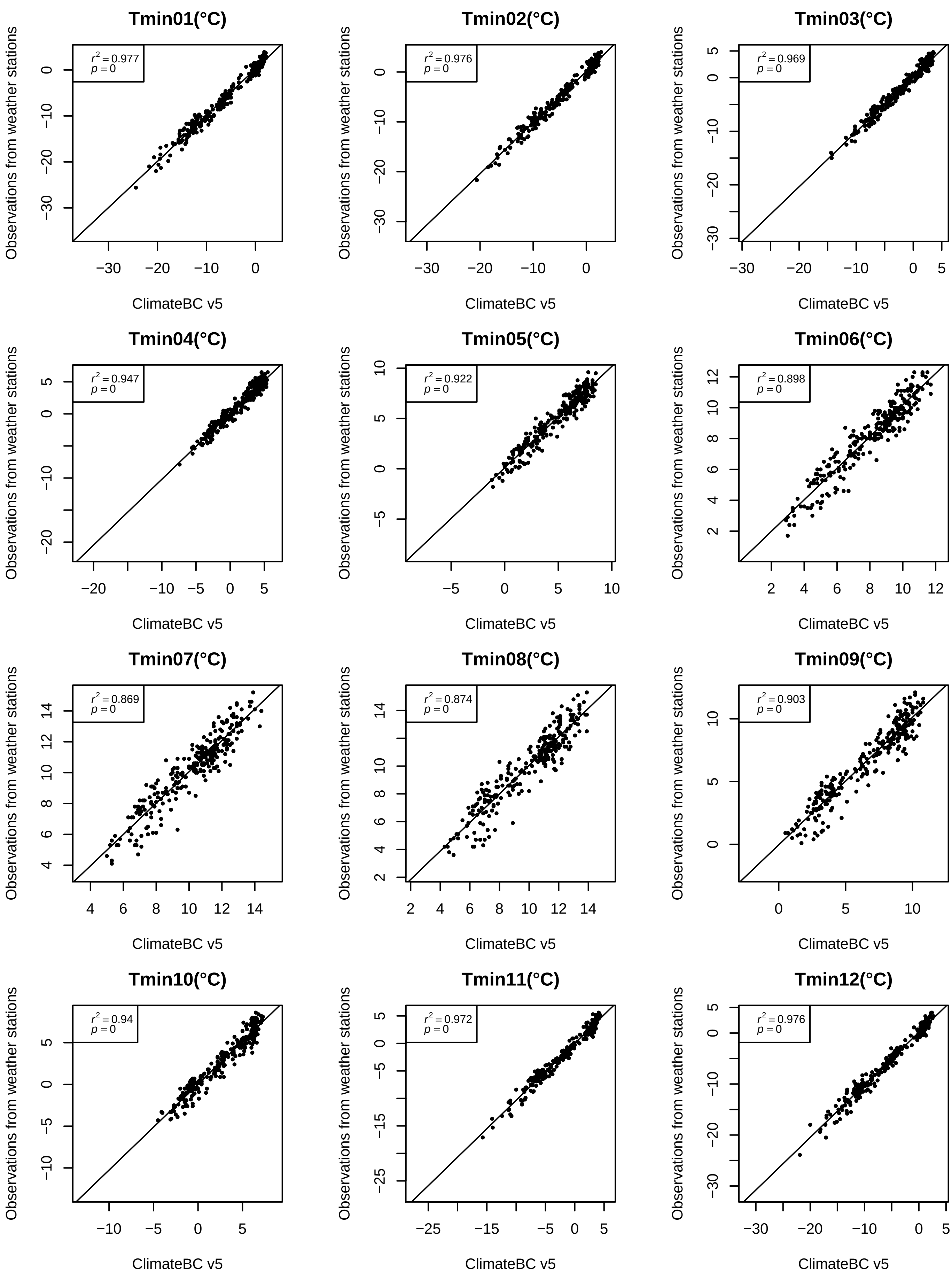
Appendix 3

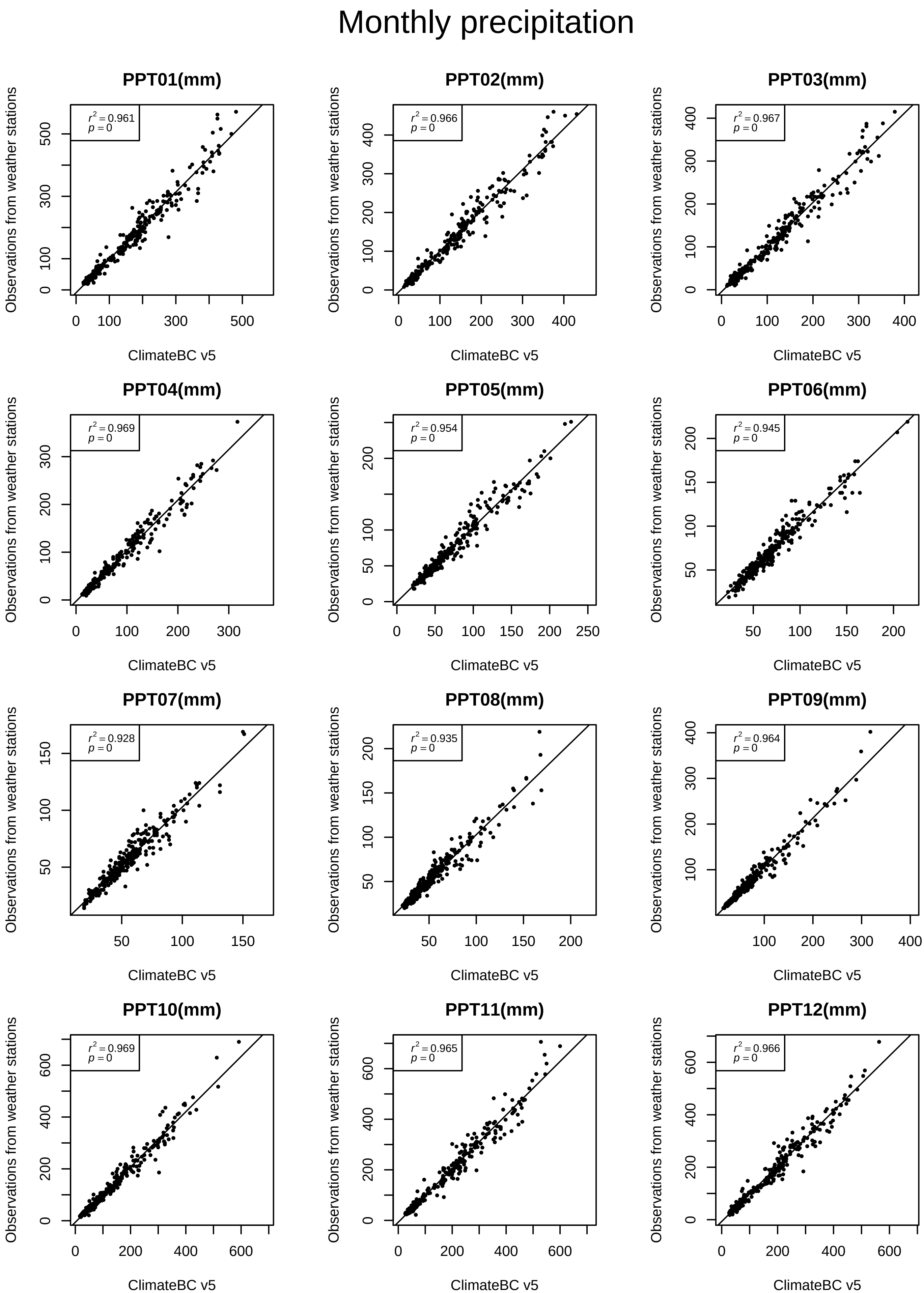
Monthly temperature and precipitation and annual variables calculated with ClimateBC V5 and measured at 301 Meteorological Service of Canada weather stations for the 1971-2000 normals.

Monthly maximum temperatures

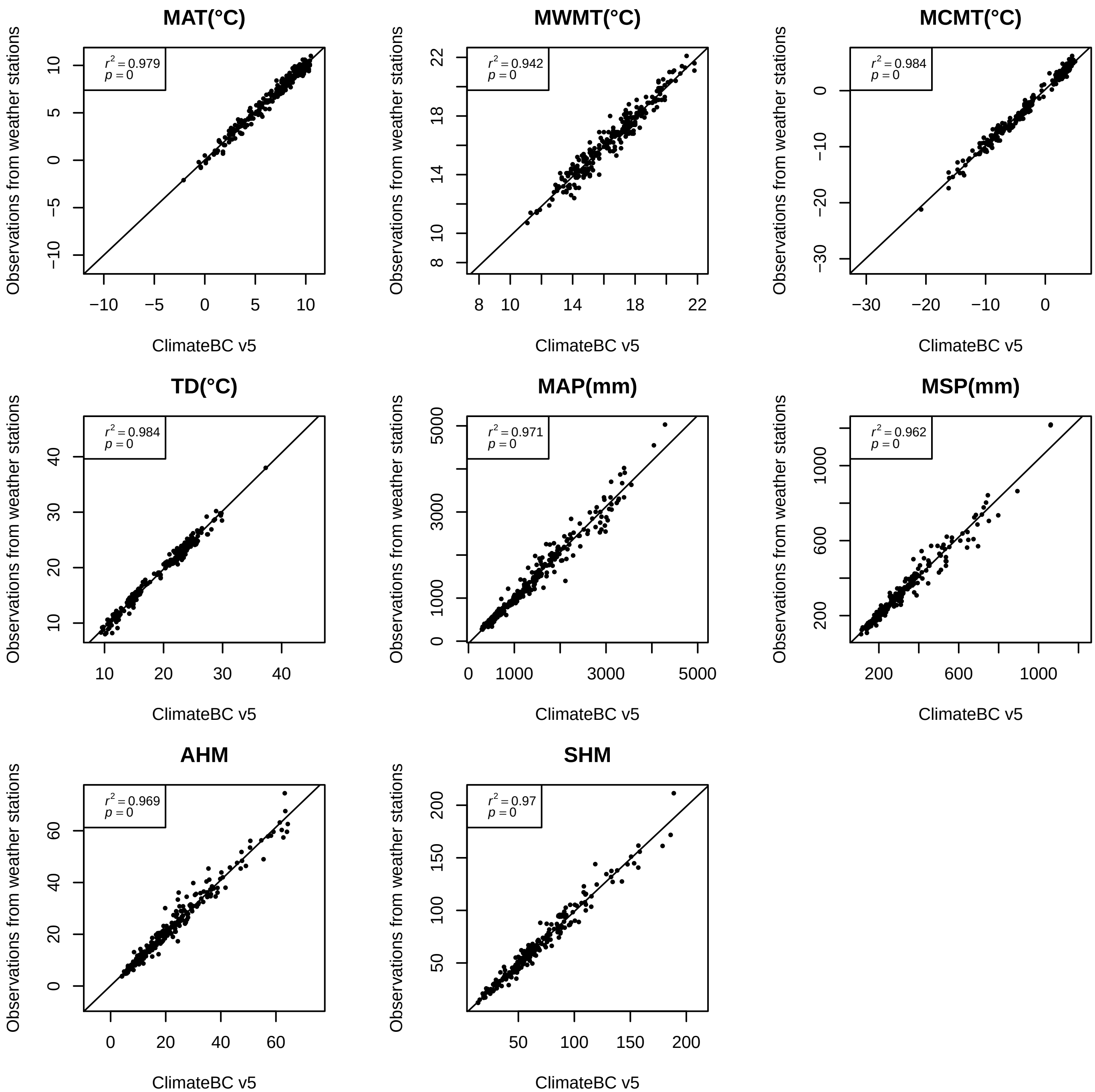


Monthly minimum temperatures




Monthly precipitation
PPT01(mm)
r² = 0.961
p = 0
PPT02(mm)
r² = 0.966
p = 0
PPT03(mm)
r² = 0.967
p = 0
PPT04(mm)
r² = 0.969
p = 0
PPT05(mm)
r² = 0.954
p = 0
PPT06(mm)
r² = 0.945
p = 0
PPT07(mm)
r² = 0.928
p = 0
PPT08(mm)
r² = 0.935
p = 0
PPT09(mm)
r² = 0.964
p = 0
PPT10(mm)
r² = 0.969
p = 0
PPT11(mm)
r² = 0.965
p = 0
PPT12(mm)
r² = 0.966
p = 0
Observations from weather stations
ClimateBC v5

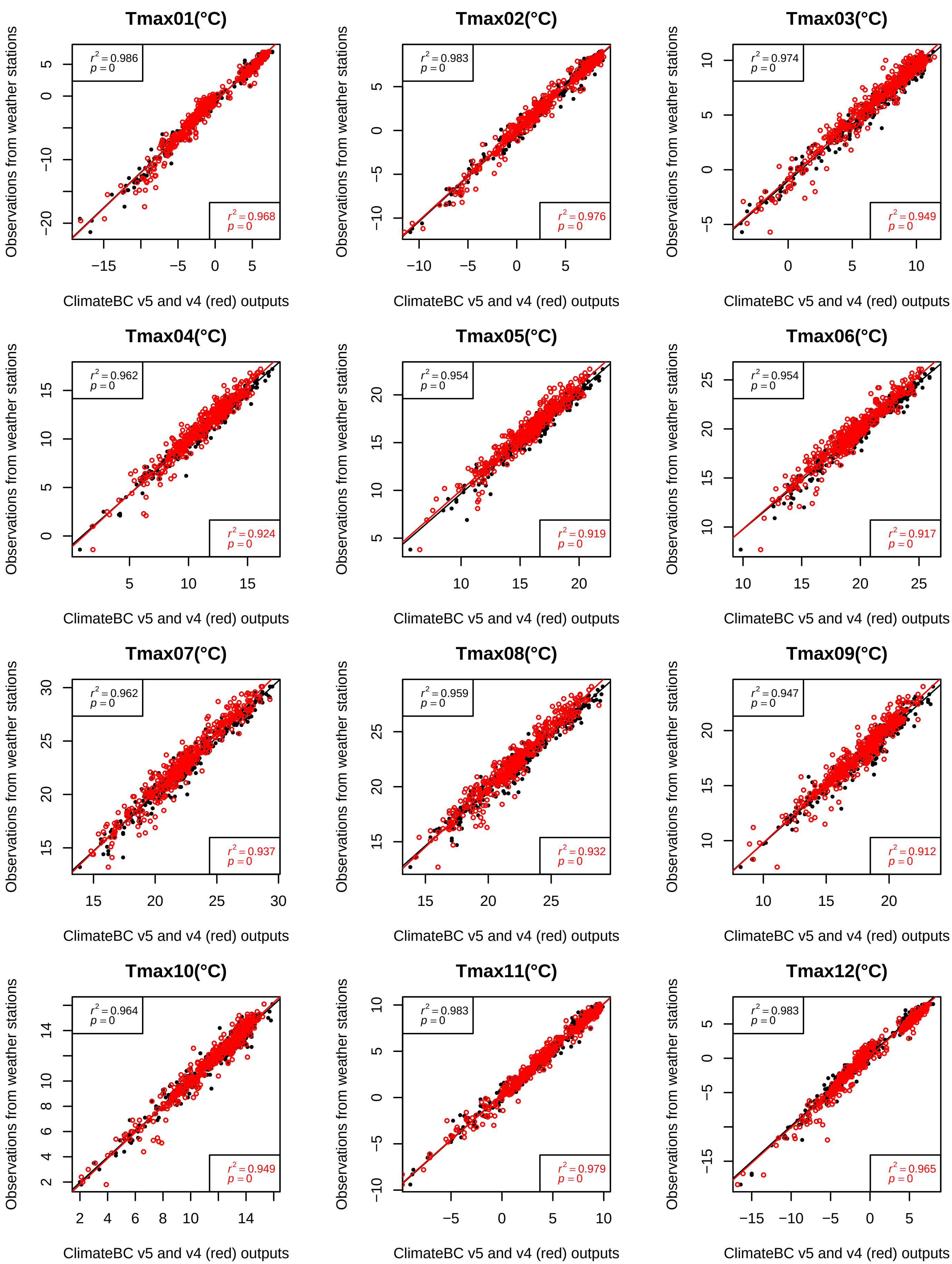
Calculated annual climate variables



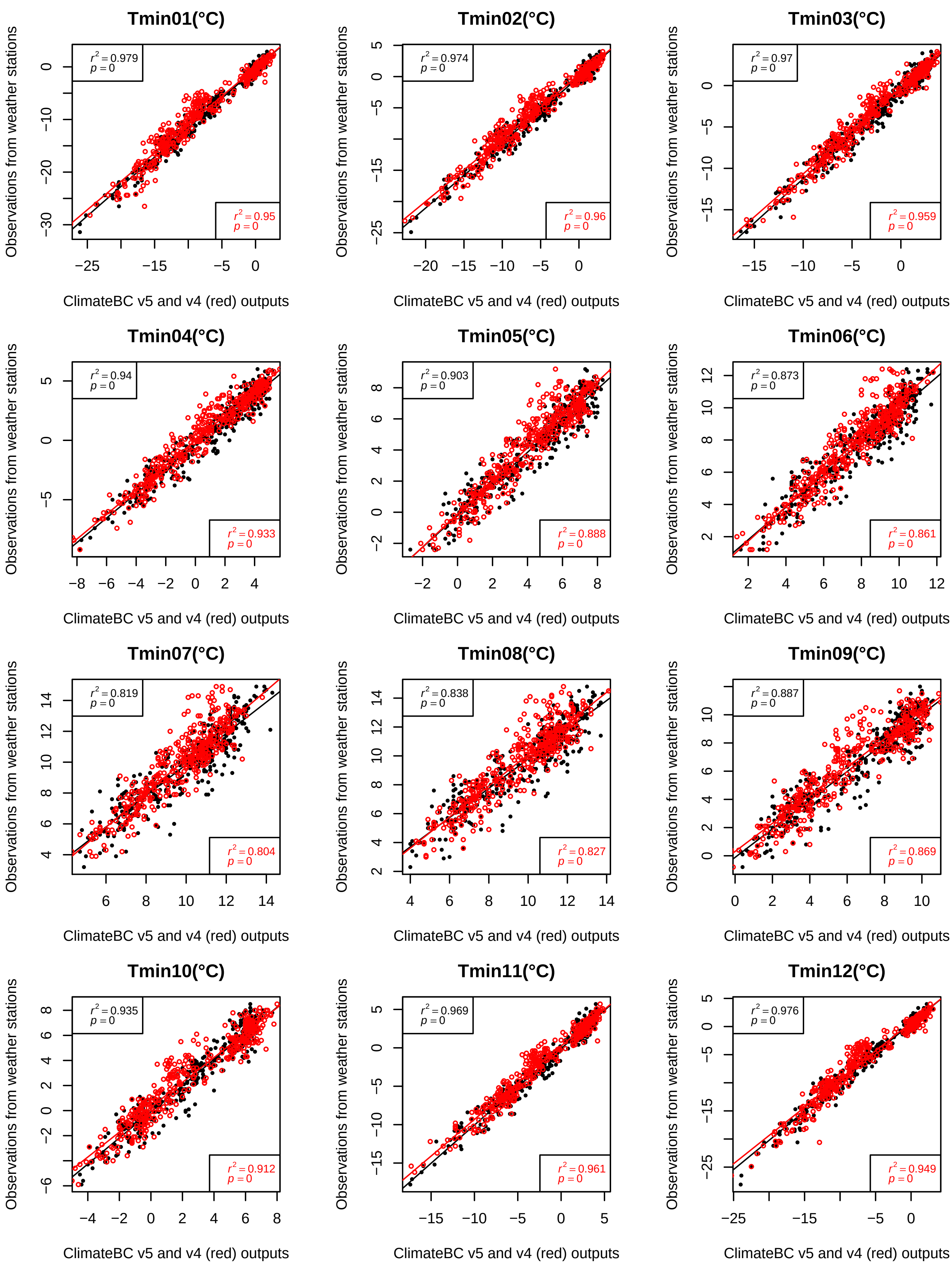
Appendix 4

Comparison of 1951-80 normals of monthly temperature and precipitation from ClimateBC V5 and ClimateBC V4 with values for Meteorological Service of Canada weather stations.

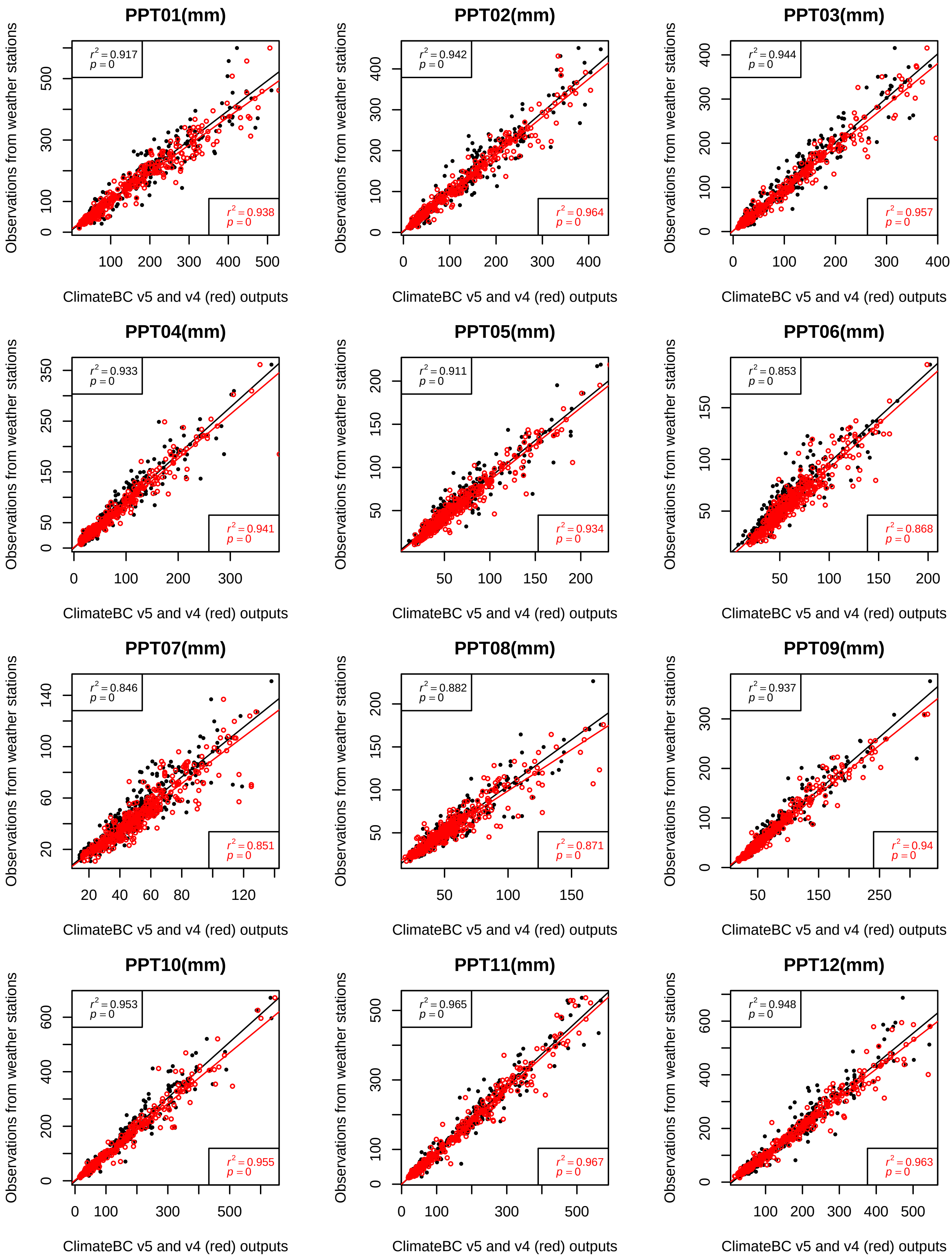
Comparison between ClimateBC v5 and v4 for Tmax



Comparison between ClimateBC v5 and v4 for Tmin



Comparison between ClimateBC v5 and v4 for PPT

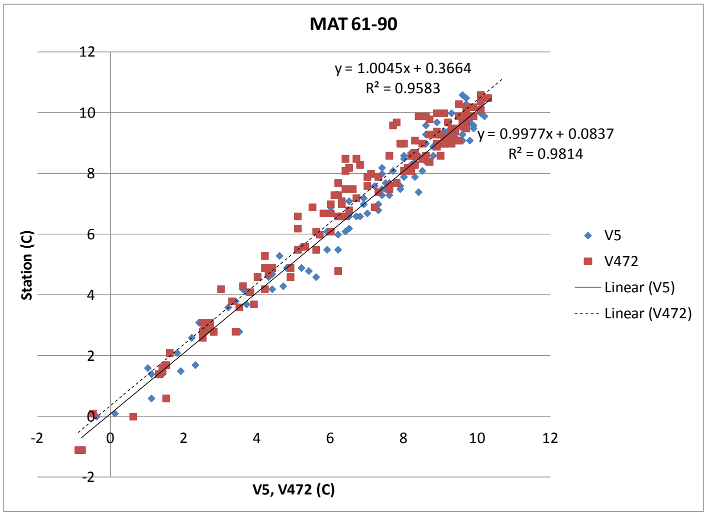


Appendix 5

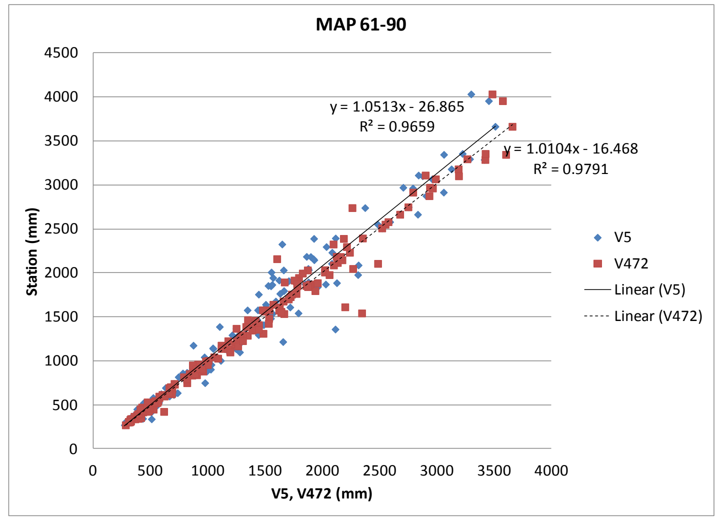
Comparisons of 1961-90 normals of annual variables from ClimateBC V5 and ClimateWNA V472 with values for Meteorological Service of Canada weather stations.

Mean annual temperature (°C)
Mean annual precipitation (mm)
Mean warmest month temperature (°C)
Mean coldest month temperature (°C)
May to September precipitation (mm)
Precipitation as snow (mm)
Annual heat:moisture index
Summer heat:moisture index
Degree days below 0 °C (days)
Degree days above 5 °C (days)
Degree days below 18 °C (days)
Degree days above 18 °C (days)
Frost free period (days)
Beginning of frost free period (day of year)
End of frost free period (day of year)
Continentality (°C)
Reference evaporation (mm)
Climatic moisture deficit (mm)

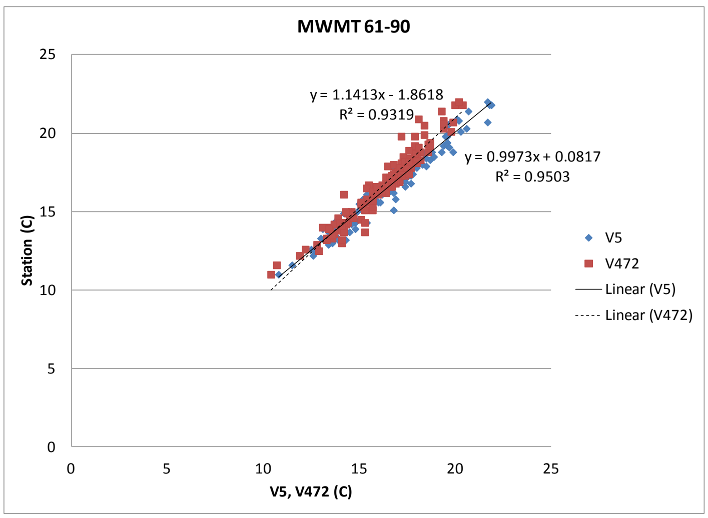
Other annual variables were not available for the weather stations.



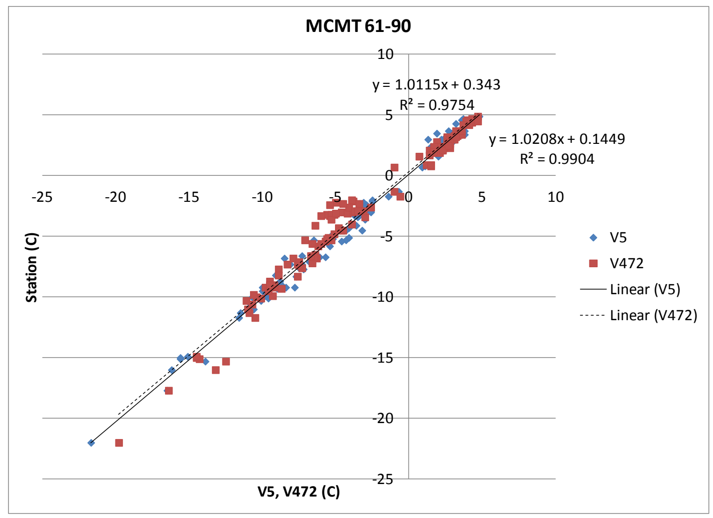
Mean annual temperature (C)



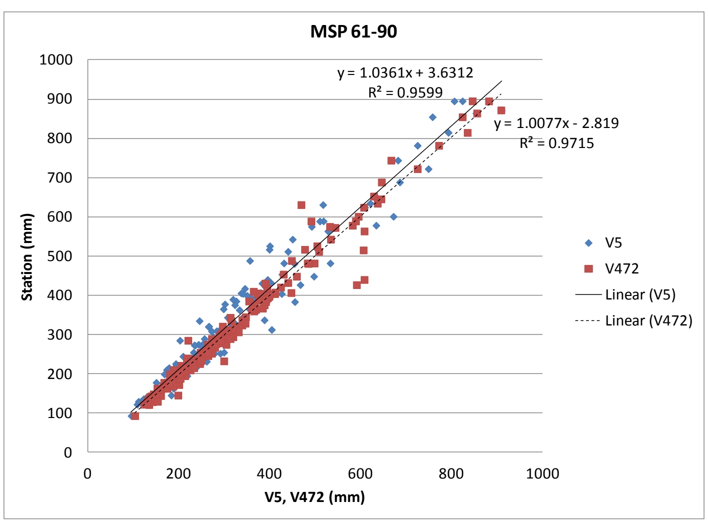
Mean annual precipitation (mm)



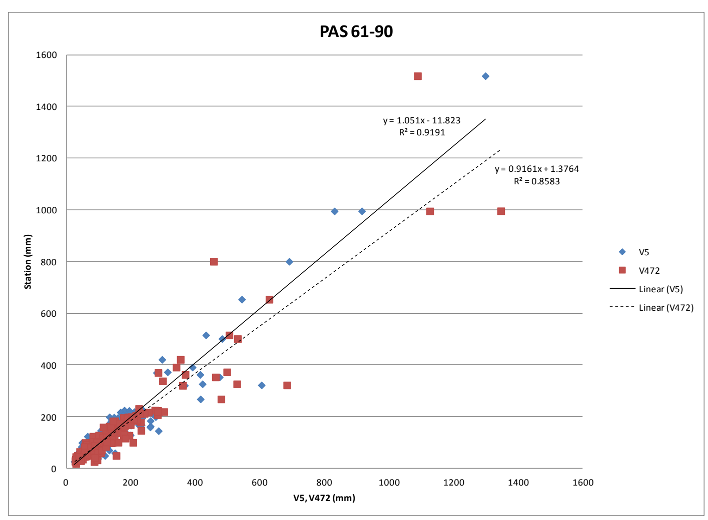
Mean warmest month temperature (C)



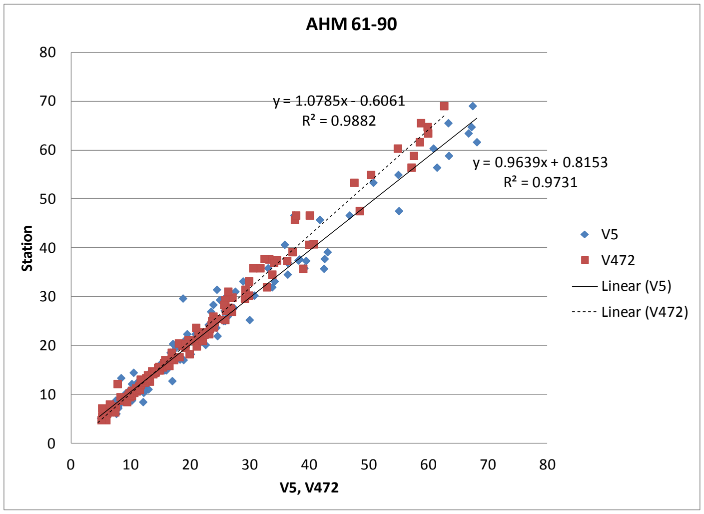
Mean coldest month temperature (C)



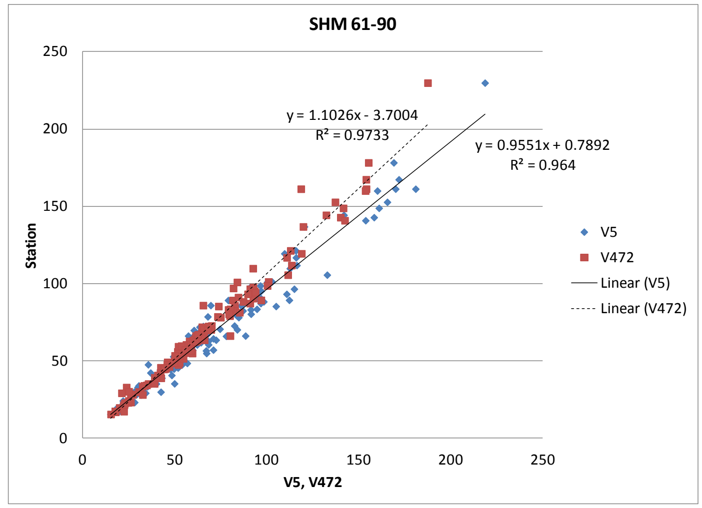
May to September precipitation (mm)



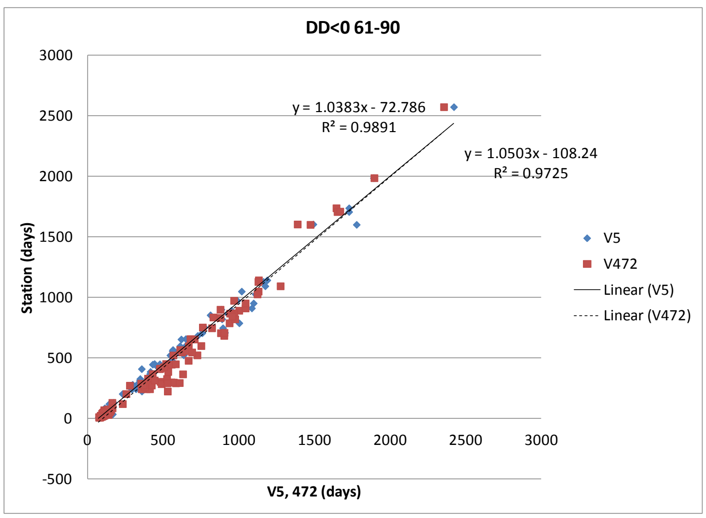
Precipitation as snow (mm)



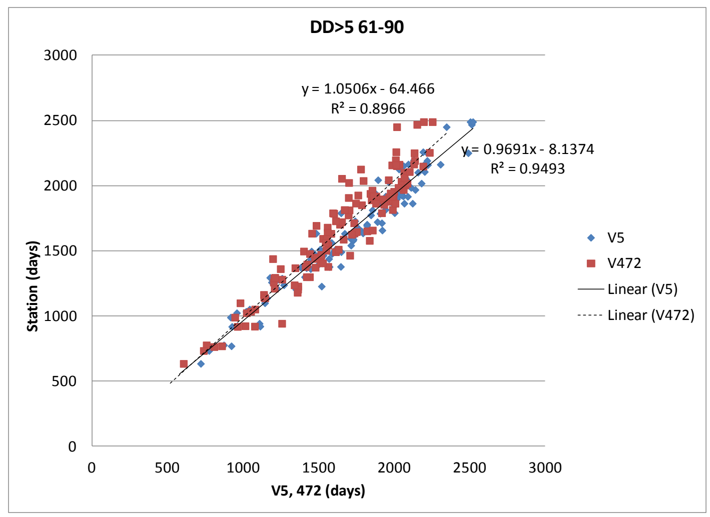
Annual heat:moisture index.



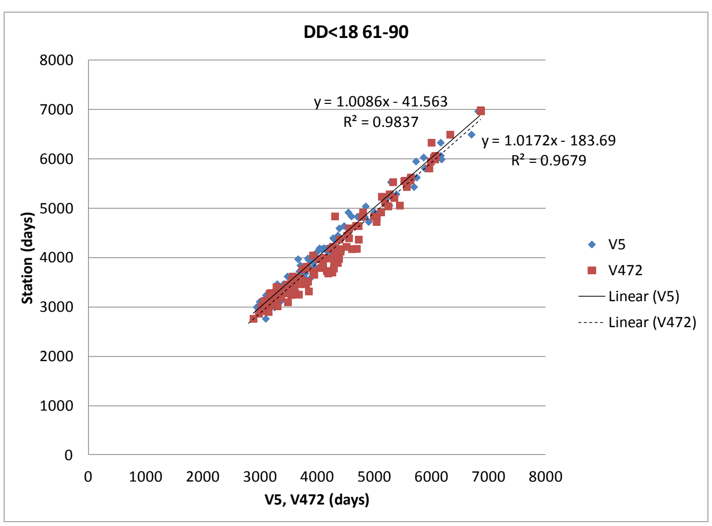
Summer heat:moisture index



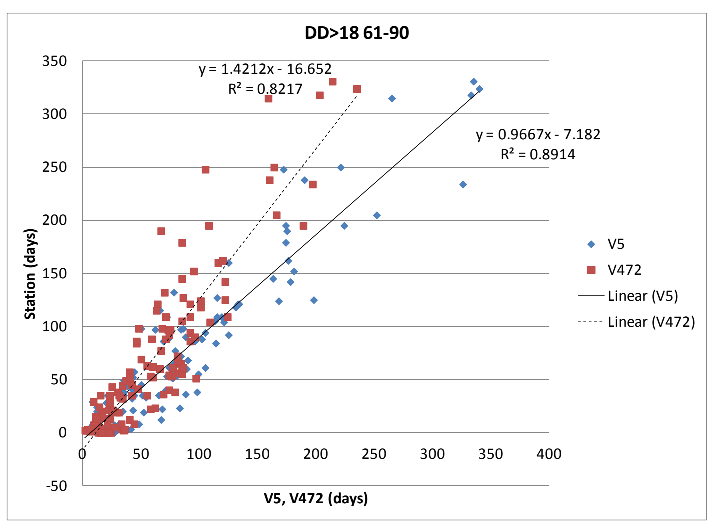
Degree days less than 0°C (days)



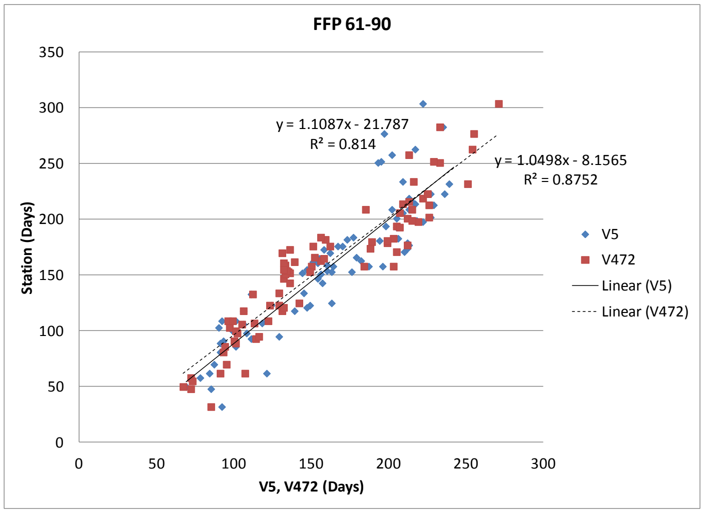
Degree days above 5°C



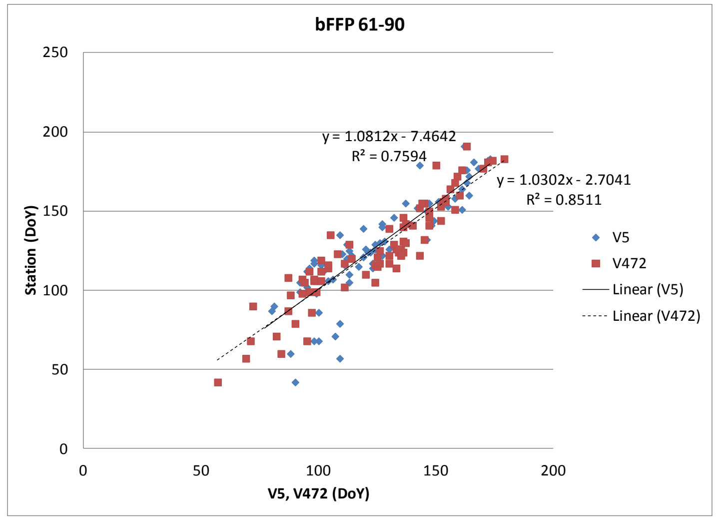
Degree days less than 18°C (days)



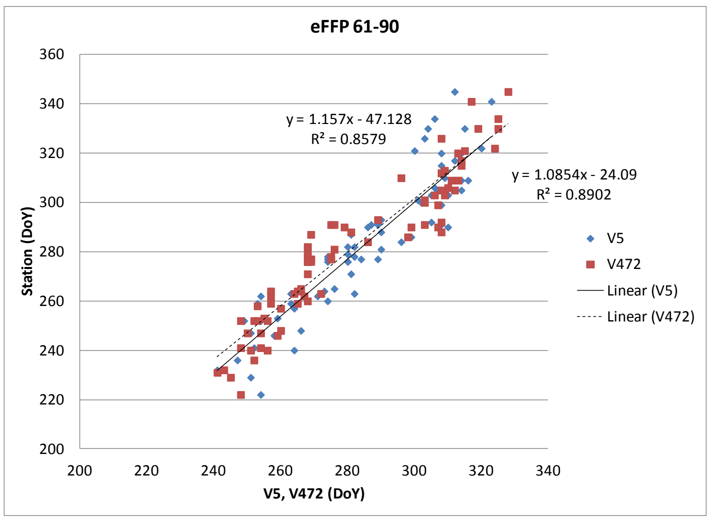
Degree days above 18°C (days)



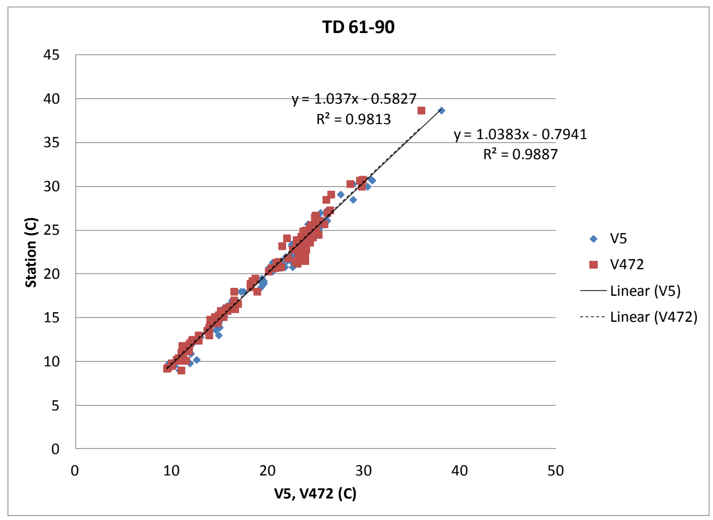
Frost free period (days)



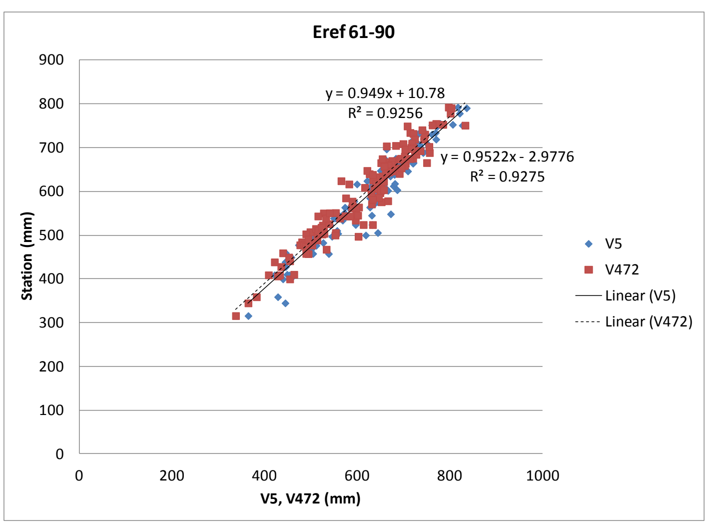
Start of frost free period (day of year)



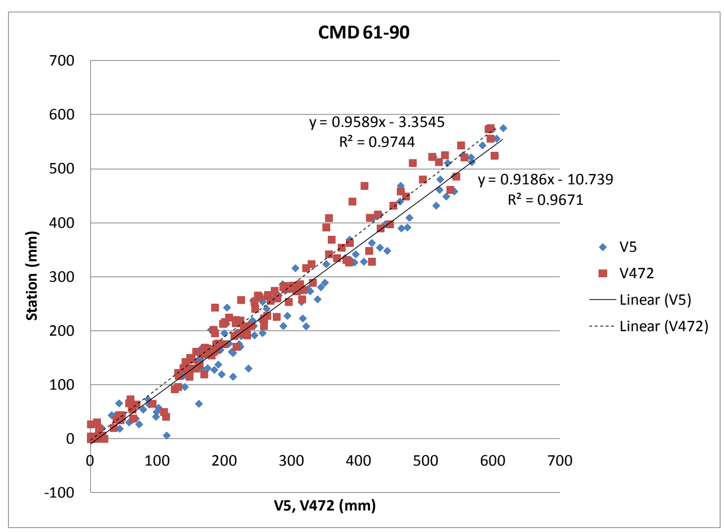
End of frost free period (day of year)



Continentality (MWMT-MCMT) (°C)



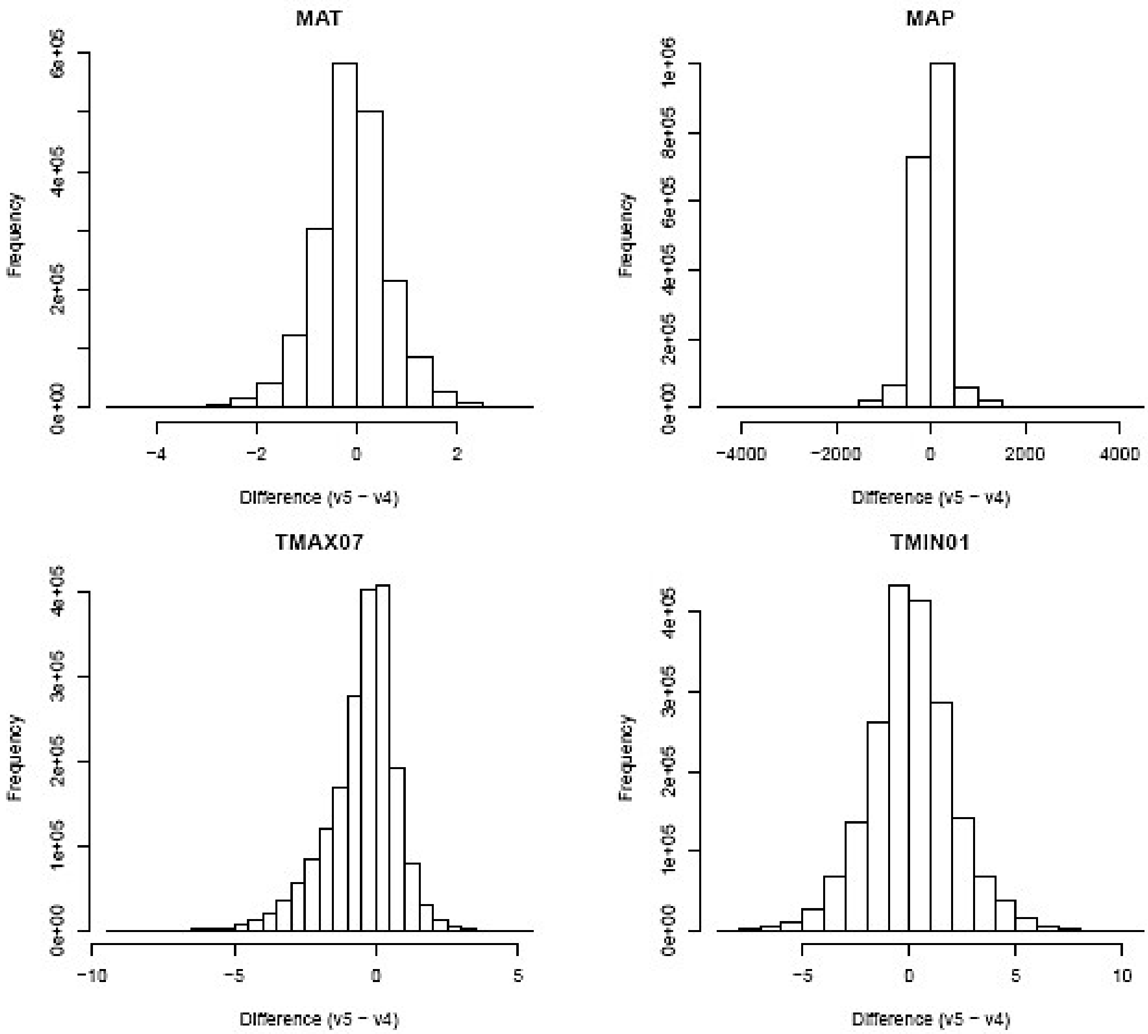
Reference evaporation (mm)



Climatic moisture deficit (mm)

Appendix 6

Histograms of differences between ClimateBC V5 and ClimateBC V4/ClimateWNA V472 for 4 variables for 1951-80 normals. Variables are mean annual temperature (MAT °C), mean annual precipitation (MAP mm), July maximum temperature (Tmax07 °C) and January minimum temperature (Tmin01 °C).



Appendix 7

Selected annual variables (1961-90 normals) for BEC zones determined with ClimateBC V5 and their difference from values calculated by ClimateBC V472. Zonal averages are based on means for the variants within the zone.

Table A5.1: 1961-80 normals for climate variables from ClimateBC V5

	MAT	MAP	MSP	SHM	DD5	PAS	FFP	EMT	Eref	CMD
BAFA	-2.7	993	437	21.8	357	589	51	-46.3	293	18
BG	6.2	341	160	116.8	1709	88	128	-35.2	707	484
BWBS	0.1	667	338	42.2	900	277	89	-45.2	424	96
CDF	9.5	1118	210	84.5	1986	48	211	-17.1	655	262
CMA	0.1	3221	821	14.9	511	1972	63	-39.5	374	16
CWH	6.1	2423	530	33.6	1337	478	152	-25.8	541	83
ESSF	0.5	1172	390	31.5	656	688	70	-41.7	432	72
ICH	3.2	896	338	46	1127	398	99	-39.1	554	166
IDF	4.4	535	207	77.9	1313	198	105	-37.2	622	343
IMA	-1.1	1565	457	22.8	457	1035	54	-43.3	362	43
MH	3.1	3386	842	16.3	821	1270	108	-31.8	435	13
MS	2.4	768	250	55	917	383	80	-39.4	531	225
PP	6.4	385	166	112.6	1726	103	129	-34.2	724	482
SBPS	1.8	497	238	55.2	868	204	64	-43.4	539	252
SBS	2.3	673	294	49.2	1020	287	92	-41	513	180
SWB	-0.9	1004	422	30.4	615	528	77	-44.6	342	40

Table A5.2: Difference between ClimateBC V5 and ClimateWNA 4.72

	MAT	MAP	MSP	SHM	DD5	PAS	FFP	EMT	Eref	CMD
BAFA	-0.4	159	-13	-2.5	-76	182	-4	0.8	-21	-1
BG	0.7	-21	-14	15.8	176	-11	12	1.4	19	30
BWBS	-0.2	108	7	-0.8	-48	76	-7	0.4	1	3
CDF	0	-2	-5	2.2	16	4	0	-0.1	0	10
CMA	-0.3	-49	-119	0.2	-52	70	15	0.6	-55	-6
CWH	0	-118	-41	3.5	18	-9	2	-0.4	0	18
ESSF	-0.1	-18	-44	2.4	-39	20	8	1.4	-32	1
ICH	0.6	-2	-24	5	88	-14	10	1.9	5	23
IDF	0.4	-12	-16	7.9	75	-6	8	1	7	18
IMA	-0.6	5	-70	1.3	-122	96	8	2.1	-61	-3
MH	-0.4	285	1	0.7	-58	269	4	-1.1	-39	5
MS	0.2	-21	-22	3.1	11	-4	7	0.6	-6	9
PP	0.6	-12	-9	9.7	133	-10	13	1.6	3	12
SBPS	0.2	33	-12	2.6	33	28	6	-0.1	-1	9
SBS	0	6	-21	2.9	-1	21	-2	-0.2	4	19
SWB	-0.3	124	-2	-1.8	-103	108	-10	0.8	-12	5

MAT = Mean annual temperature (°C), MAP= Mean annual precipitation (mm), MSP= May to September precipitation (mm), SHM= Summer heat:moisture index, DD5 = Degree days above 5°C (days,. PAS = Precipitation as snow (mm), FFP = Frost free period (days), Eref = Reference evaporation (mm), CMD = Climatic moisture deficit (mm).

BAFA = Boreal Alti Fescu Alpine, BG = Bunch Grass, BWBS = Boreal White and Black Spruce, CDF = Coastal Douglas-fir, CMA = Coastal Mountain-heather Alpine, CWH = Coastal Western Hemlock, ESSF = Engelmann Spruce Sub-alpine Fir, ICH = Interior Cedar Hemlock, IDF = Interior Douglas-fir, IMA = Interior Mountain-heather Alpine, MH = Mountain Hemlock, MS = Montane Spruce, PP = Ponderosa Pine, SBPS = Sub-Boreal Spruce Pine, SBS = Sub-Boreal Spruce, SWB = Spruce Willow Birch.