

Climate Projections in Sites: Tres and Rovere della luna (Trentino, Italy)

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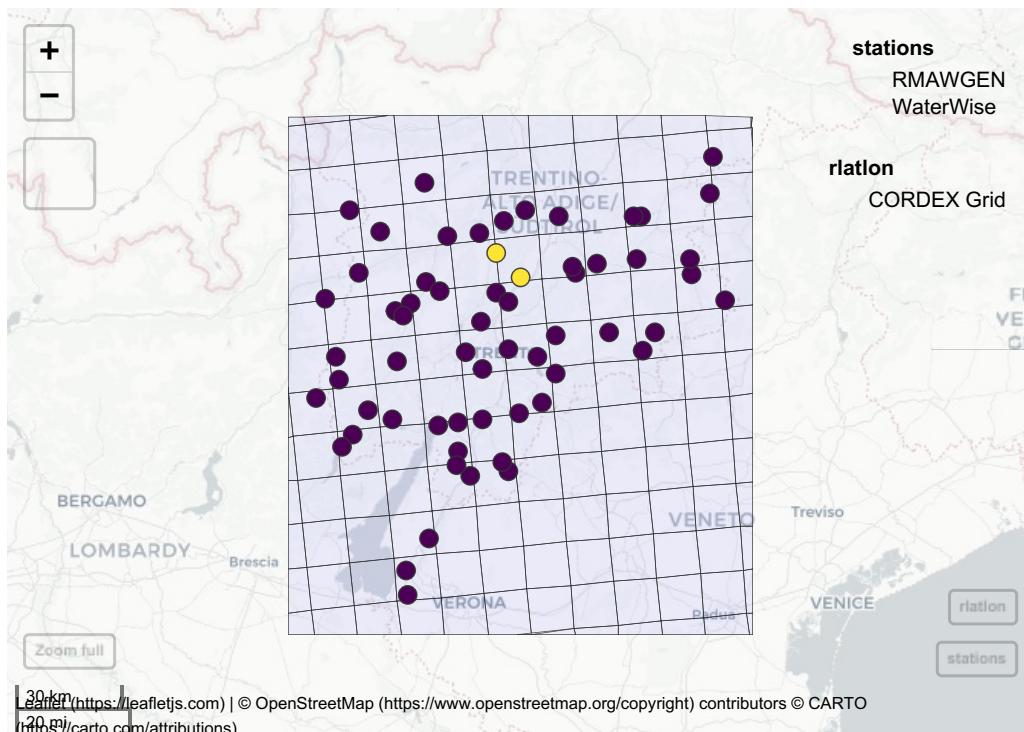
2022-07-24

Trentino Dataset (RMAWGEN)

Trentino daily climate dataset by **RMAWGEN** R package (<https://CRAN.R-project.org/package=RMAWGEN> (<https://CRAN.R-project.org/package=RMAWGEN>) Cordano and Eccel (2017), E. and E. (2016)) contains all information about meteorological stations and instrumental timeseries in 59 sites located in Trentino (Italy) and its neighborood. In particular, it contains daily precipitantion, maximum and minimum temperature. Original data are provided by Provincia Autonoma di Trento (<https://www.meteotrentino.it/> (<https://www.meteotrentino.it/>)), Fondazione Edmund Mach (<https://www.fmach.it> (<https://www.fmach.it>)), Provincia Autonoma di Bolzano/Autome Provinz Bozen (<http://www.provincia.bz.it/meteo> (<http://www.provincia.bz.it/meteo>)), ARPA Lombardia (<https://www.arpalombardia.it/> (<https://www.arpalombardia.it/>)), ARPA Veneto (<https://www.arpa.veneto.it/previsioni/it/html/index.php> (<https://www.arpa.veneto.it/previsioni/it/html/index.php>)). Two more stations (WWRLUN and WWTRRES) provided by the present project are added.

Available Projections (from CORDEX)

The **trentino + 2 more stations** dataset station locations are inserted within the grid provided by CORDEX outcome files (<https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels?tab=overview> (<https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels?tab=overview>)).



List of RCM and GCM models

Here is a list of available combinations of Global Climate Models (GCMs) and Regional Climate Models RCMS Provided by EURO-CORDEX project provided by Copenicus Data Storage in collaboration with ECMWF (<https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels?tab=doc>, <https://confluence.ecmwf.int/display/CKB/CORDEX%3A+Regional+climate+projections> (<https://cds.climate.copernicus.eu/cdsapp#!/dataset/projections-cordex-domains-single-levels?tab=doc>, <https://confluence.ecmwf.int/display/CKB/CORDEX%3A+Regional+climate+projections>), https://climate.copernicus.eu/sites/default/files/2021-03/C3SWebinar1_ErikKjellstrom.pdf (https://climate.copernicus.eu/sites/default/files/2021-03/C3SWebinar1_ErikKjellstrom.pdf) (e.g. Coppola et al. (2021), Vautard et al. (2021), Christensen and Kjellström (2020) <https://link.springer.com/article/10.1007/s00382-020-05229-y>).).

GCMs:

- “CCCma-CanESM2” (Scinocca et al. (2016), Swart et al. (2019)) (<https://climate-modelling.canada.ca/climate-model-data/cgcm4/CanESM2/index.shtml> (<https://climate-modelling.canada.ca/climate-model-data/cgcm4/CanESM2/index.shtml>))
- “ICHEC-EC-EARTH” (Hazeleger et al. (2012)) (<https://www.ichec.ie/partnerships/state-supported/ec-earth-climate-simulations-irelands-contributions-cmip6> (<https://www.ichec.ie/partnerships/state-supported/ec-earth-climate-simulations-irelands-contributions-cmip6>))
- “MIROC-MIROCS” (Watanabe et al. (2010)) (<https://journals.ametsoc.org/view/journals/clim/23/23/2010jcli3679.1.xml> (<https://journals.ametsoc.org/view/journals/clim/23/23/2010jcli3679.1.xml>))
- “MOHC-HadGEM2-ES” (Martin et al. (2011)) (<https://gmd.copernicus.org/articles/4/723/2011/gmd-4-723-2011.pdf>)

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- “MPI-M-MPI-ESM-LR” (Giorgetta et al. (2013))(<https://mpimet.mpg.de/en/science/models/mpi-esm>) ?? (<https://mpimet.mpg.de/en/science/models/mpi-esm>) ??

RCMs:

- CLMcom-CCLM4-8-17
- GERICS-REMO2015
- CLMcom-ETH-COSMO-crCLIM-v1-1
- DMI-HIRHAM5
- KNMI-RACMO22E
- SMHI-RCA4
- UHOH-WRF361H
- CNRM-ALADIN63
- ICTP-RegCM4-6
- MOHC-HadREM3-GA7-05
- MPI-CSC-REMO2009

Climate predictions with GCMs are subsequently downscaled at about-10 km resolutions by RCMs.

Monthly Time Series 1951-2005 (historical); 2006-2100 (RCP85)

Averaged daily maximum and minimum temperature

Extracted monthly predicted time series cover the area of grid cells covering in which the station site is contained. Gridded model values from RCMs are subsequently statistical downscaled and then compared with observations, when available, for the historical period (1951-2005) and the RCP8.5 scenario (https://en.wikipedia.org/wiki/Representative_Concentration_Pathway)

(https://en.wikipedia.org/wiki/Representative_Concentration_Pathway)(2006-2100). Downscaling from the RCM value to the site-scale value has been performed with an ARIMA (p,d,q) model (see *arima* function in R, base **stats** package)(Shumway and Stoffer (2017)), in particular the setting (3,1,1) has been selected. The unknowns is the predicted site-scale values whereas the grid-scale prediction from RCM is used as an external regressor. Before calibrated the ARIMA model, the unknown and the external regressor has been Gaussianized (see *mormalizeGaussian* function in R, **RMAWGEN** package). The ARIMA model has been calibrated for the first 12 years of the time series of observations at WWRLUN and WWTRES. Observation at WWRLUN and WWTRES are available from 2001 to 2022 (March). Downscaled time series with the best fit and tat can be accepted for further analysis are visualized. Scrolling visualization are only available in the HTML of this report.

Godness of fit metrics is based on RMSE (Root Mean Square Error, https://en.wikipedia.org/wiki/Root-mean-square_deviation (https://en.wikipedia.org/wiki/Root-mean-square_deviation)), MAE (https://en.wikipedia.org/wiki/Mean_absolute_error (https://en.wikipedia.org/wiki/Mean_absolute_error)) and KGE (Kling-Gupta efficiency, see *kge* function on **hydroGOF** R package (Mauricio Zambrano-Bigiarini (2020))):

station	variable	model	RMSE	MAE	KGE
WWRLUN	tasmin	observation	0.00	0.00	1.00
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_CLMcom-CCLM4-8-17	2.74	2.11	0.87
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_CLMcom-ETH-COSMO-crCLIM-v1-1	3.01	2.30	0.79
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	2.50	1.96	0.89
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_KNMI-RACMO22E	2.86	2.20	0.85
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.53	1.93	0.87
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009	4.00	3.05	0.61
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_SMHI-RCA4	3.04	2.32	0.83
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_UHOH-WRF361H	7.34	5.94	-0.04
WWRLUN	tasmax	observation	0.00	0.00	1.00
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_CLMcom-CCLM4-8-17	2.82	2.25	0.90
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_CLMcom-ETH-COSMO-crCLIM-v1-1	2.65	2.09	0.92
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	2.74	2.16	0.89
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_KNMI-RACMO22E	3.10	2.43	0.86
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.76	2.19	0.92
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009	3.32	2.61	0.84
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_SMHI-RCA4	3.40	2.67	0.87
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_UHOH-WRF361H	3.77	2.96	0.79
WWRLUN	tasmin	MOHC-HadGEM2-ES_CLMcom-CCLM4-8-17	8.14	6.48	-0.18
WWRLUN	tasmin	MOHC-HadGEM2-ES_CLMcom-ETH-COSMO-crCLIM-v1-1	8.69	7.03	-0.34
WWRLUN	tasmin	MOHC-HadGEM2-ES_DMI-HIRHAM5	8.36	6.72	-0.24

WWRLUN	tasmin	MOHC-HadGEM2-ES_GERICS-REMO2015	8.07	6.44	-0.16
WWRLUN	tasmin	MOHC-HadGEM2-ES_KNMI-RACMO22E	8.63	6.98	-0.32
WWRLUN	tasmin	MOHC-HadGEM2-ES_MOHC-HadREM3-GA7-05	6.84	5.46	0.08
WWRLUN	tasmin	MOHC-HadGEM2-ES_SMHI-RCA4	8.45	6.77	-0.26
WWRLUN	tasmin	MOHC-HadGEM2-ES_UHOH-WRF361H	8.79	7.11	-0.36
WWRLUN	tasmax	MOHC-HadGEM2-ES_CLMcom-CCLM4-8-17	9.33	7.62	-0.06
WWRLUN	tasmax	MOHC-HadGEM2-ES_CLMcom-ETH-COSMO-crCLIM-v1-1	9.94	8.16	-0.81
WWRLUN	tasmax	MOHC-HadGEM2-ES_DMI-HIRHAM5	9.84	8.05	-0.80
WWRLUN	tasmax	MOHC-HadGEM2-ES_GERICS-REMO2015	9.14	7.45	-0.02
WWRLUN	tasmax	MOHC-HadGEM2-ES_KNMI-RACMO22E	10.27	8.46	-0.78
WWRLUN	tasmax	MOHC-HadGEM2-ES_MOHC-HadREM3-GA7-05	9.10	7.46	0.00
WWRLUN	tasmax	MOHC-HadGEM2-ES_SMHI-RCA4	9.26	7.50	-0.05
WWRLUN	tasmax	MOHC-HadGEM2-ES_UHOH-WRF361H	9.85	8.07	-0.79
WWRLUN	tasmin	MIROC-MIROC5_CLMcom-CCLM4-8-17	3.28	2.50	0.84
WWRLUN	tasmin	MIROC-MIROC5_GERICS-REMO2015	2.47	1.99	0.89
WWRLUN	tasmax	MIROC-MIROC5_CLMcom-CCLM4-8-17	3.67	2.83	0.88
WWRLUN	tasmax	MIROC-MIROC5_GERICS-REMO2015	2.87	2.31	0.92
WWRLUN	tasmin	ICHEC-EC-EARTH_CLMcom-ETH-COSMO-crCLIM-v1-1	3.08	2.32	0.74
WWRLUN	tasmin	ICHEC-EC-EARTH_DMI-HIRHAM5	2.80	2.12	0.79
WWRLUN	tasmin	ICHEC-EC-EARTH_KNMI-RACMO22E	3.00	2.29	0.77
WWRLUN	tasmin	ICHEC-EC-EARTH_SMHI-RCA4	3.77	2.89	0.63
WWRLUN	tasmax	ICHEC-EC-EARTH_CLMcom-ETH-COSMO-crCLIM-v1-1	2.83	2.21	0.90
WWRLUN	tasmax	ICHEC-EC-EARTH_DMI-HIRHAM5	2.62	2.03	0.91
WWRLUN	tasmax	ICHEC-EC-EARTH_KNMI-RACMO22E	2.94	2.25	0.92
WWRLUN	tasmax	ICHEC-EC-EARTH_SMHI-RCA4	3.44	2.72	0.86
WWRLUN	tasmin	CCCma-CanESM2_CLMcom-CCLM4-8-17	2.93	2.32	0.88
WWRLUN	tasmin	CCCma-CanESM2_GERICS-REMO2015	2.26	1.72	0.93
WWRLUN	tasmax	CCCma-CanESM2_CLMcom-CCLM4-8-17	3.58	2.73	0.88
WWRLUN	tasmax	CCCma-CanESM2_GERICS-REMO2015	2.79	2.12	0.92
WWTRES	tasmin	observation	0.00	0.00	1.00
WWTRES	tasmin	MPI-M-MPI-ESM-LR_CLMcom-CCLM4-8-17	2.50	1.99	0.82
WWTRES	tasmin	MPI-M-MPI-ESM-LR_CLMcom-ETH-COSMO-crCLIM-v1-1	2.32	1.82	0.87
WWTRES	tasmin	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	2.13	1.67	0.91
WWTRES	tasmin	MPI-M-MPI-ESM-LR_KNMI-RACMO22E	2.58	2.09	0.84
WWTRES	tasmin	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.33	1.76	0.85
WWTRES	tasmin	MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009	2.47	1.97	0.78
WWTRES	tasmin	MPI-M-MPI-ESM-LR_SMHI-RCA4	2.69	2.21	0.76
WWTRES	tasmin	MPI-M-MPI-ESM-LR_UHOH-WRF361H	2.82	2.27	0.82
WWTRES	tasmax	observation	0.00	0.00	1.00
WWTRES	tasmax	MPI-M-MPI-ESM-LR_CLMcom-CCLM4-8-17	4.11	3.35	0.79
WWTRES	tasmax	MPI-M-MPI-ESM-LR_CLMcom-ETH-COSMO-crCLIM-v1-1	3.49	2.75	0.84
WWTRES	tasmax	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	3.24	2.60	0.84
WWTRES	tasmax	MPI-M-MPI-ESM-LR_KNMI-RACMO22E	4.09	3.27	0.78
WWTRES	tasmax	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.71	2.10	0.90
WWTRES	tasmax	MPI-M-MPI-ESM-LR_MPI-CSC-REMO2009	4.36	3.57	0.76
WWTRES	tasmax	MPI-M-MPI-ESM-LR_SMHI-RCA4	4.85	4.03	0.73

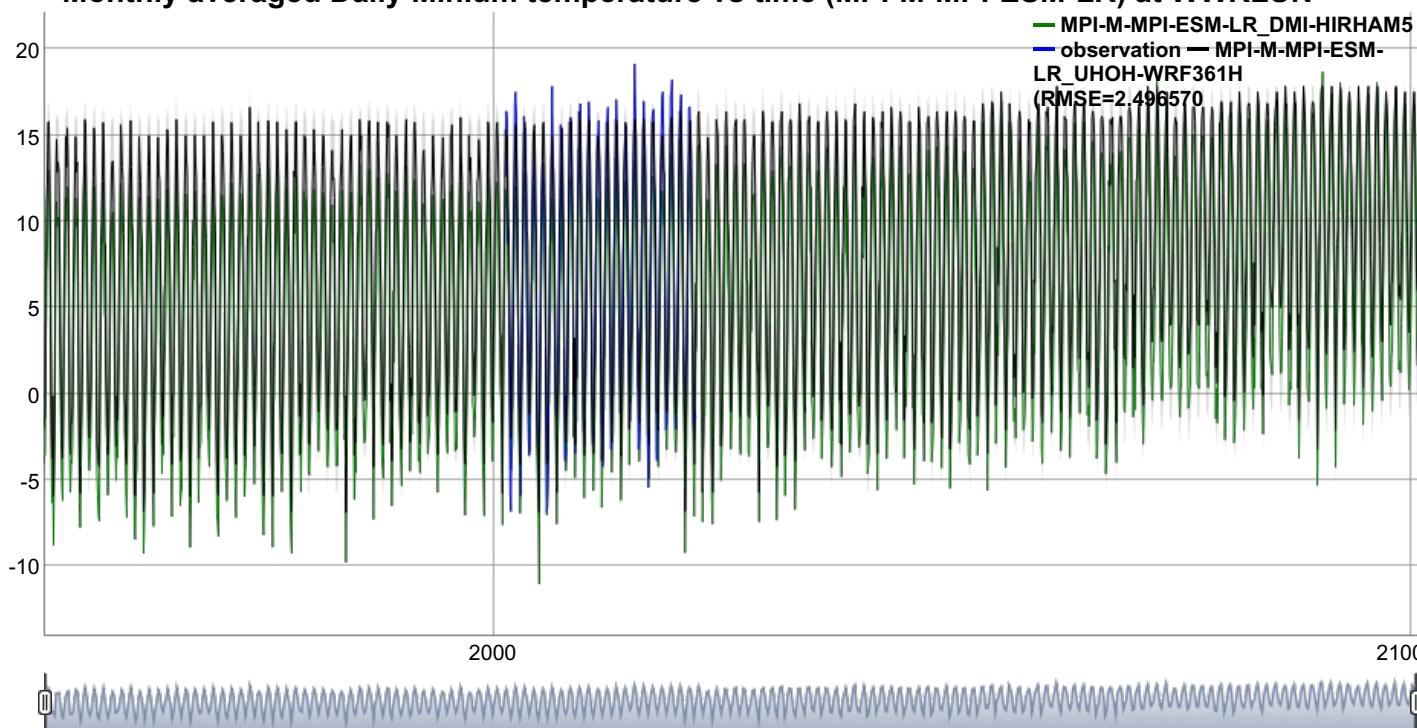
WWTRES	tasmax	MPI-M-MPI-ESM-LR_UHOH-WRF361H	4.49	3.64	0.72
WWTRES	tasmin	MOHC-HadGEM2-ES_CLMcom-CCLM4-8-17	10.89	9.00	-0.80
WWTRES	tasmin	MOHC-HadGEM2-ES_CLMcom-ETH-COSMO-crCLIM-v1-1	11.38	9.38	-1.40
WWTRES	tasmin	MOHC-HadGEM2-ES_DMI-HIRHAM5	11.32	9.49	-0.87
WWTRES	tasmin	MOHC-HadGEM2-ES_GERICS-REMO2015	10.79	8.93	-0.78
WWTRES	tasmin	MOHC-HadGEM2-ES_KNMI-RACMO22E	11.26	9.29	-0.88
WWTRES	tasmin	MOHC-HadGEM2-ES_MOHC-HadREM3-GA7-05	11.08	9.33	-0.82
WWTRES	tasmin	MOHC-HadGEM2-ES_SMHI-RCA4	10.67	8.81	-0.76
WWTRES	tasmin	MOHC-HadGEM2-ES_UHOH-WRF361H	11.30	9.32	NA
WWTRES	tasmax	MOHC-HadGEM2-ES_CLMcom-CCLM4-8-17	14.97	12.93	-0.26
WWTRES	tasmax	MOHC-HadGEM2-ES_CLMcom-ETH-COSMO-crCLIM-v1-1	15.06	12.98	-0.28
WWTRES	tasmax	MOHC-HadGEM2-ES_DMI-HIRHAM5	14.88	12.83	-0.24
WWTRES	tasmax	MOHC-HadGEM2-ES_GERICS-REMO2015	14.89	12.85	-0.24
WWTRES	tasmax	MOHC-HadGEM2-ES_KNMI-RACMO22E	15.31	13.20	-0.32
WWTRES	tasmax	MOHC-HadGEM2-ES_MOHC-HadREM3-GA7-05	14.72	12.75	-0.19
WWTRES	tasmax	MOHC-HadGEM2-ES_SMHI-RCA4	15.04	12.99	-0.28
WWTRES	tasmax	MOHC-HadGEM2-ES_UHOH-WRF361H	15.29	13.19	-0.31
WWTRES	tasmin	MIROC-MIROC5_CLMcom-CCLM4-8-17	3.53	2.72	0.72
WWTRES	tasmin	MIROC-MIROC5_GERICS-REMO2015	2.41	1.88	0.91
WWTRES	tasmax	MIROC-MIROC5_CLMcom-CCLM4-8-17	3.68	2.86	0.87
WWTRES	tasmax	MIROC-MIROC5_GERICS-REMO2015	3.94	3.21	0.82
WWTRES	tasmin	ICHEC-EC-EARTH_CLMcom-ETH-COSMO-crCLIM-v1-1	2.15	1.67	0.91
WWTRES	tasmin	ICHEC-EC-EARTH_DMI-HIRHAM5	2.33	1.77	0.82
WWTRES	tasmin	ICHEC-EC-EARTH_KNMI-RACMO22E	2.42	1.83	0.86
WWTRES	tasmin	ICHEC-EC-EARTH_SMHI-RCA4	2.61	2.12	0.76
WWTRES	tasmax	ICHEC-EC-EARTH_CLMcom-ETH-COSMO-crCLIM-v1-1	3.26	2.60	0.86
WWTRES	tasmax	ICHEC-EC-EARTH_DMI-HIRHAM5	2.58	2.04	0.91
WWTRES	tasmax	ICHEC-EC-EARTH_KNMI-RACMO22E	3.22	2.52	0.88
WWTRES	tasmax	ICHEC-EC-EARTH_SMHI-RCA4	5.03	4.20	0.73
WWTRES	tasmin	CCCma-CanESM2_CLMcom-CCLM4-8-17	2.84	2.20	0.89
WWTRES	tasmin	CCCma-CanESM2_GERICS-REMO2015	2.18	1.63	0.91
WWTRES	tasmax	CCCma-CanESM2_CLMcom-CCLM4-8-17	3.42	2.64	0.88
WWTRES	tasmax	CCCma-CanESM2_GERICS-REMO2015	3.48	2.74	0.85

Considering only the model combinations with RMSE lower or equal than 4 degrees Celsius and KGE greater than 0.8:

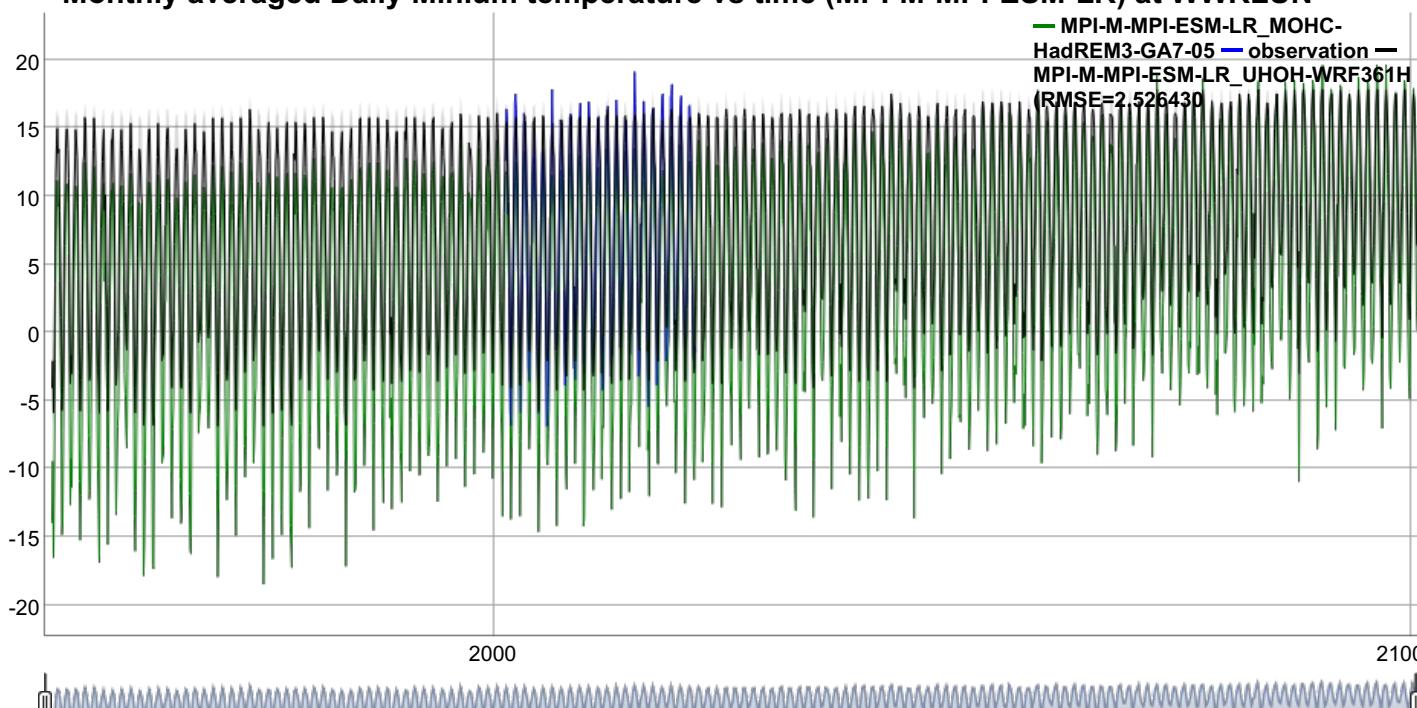
station	variable	model	RMSE	MAE	KGE
WWRLUN	tasmin	observation	0.00	0.00	1.00
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	2.50	1.96	0.89
WWRLUN	tasmin	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.53	1.93	0.87
WWRLUN	tasmax	observation	0.00	0.00	1.00
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	2.74	2.16	0.89
WWRLUN	tasmax	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.76	2.19	0.92
WWRLUN	tasmin	MIROC-MIROC5_GERICS-REMO2015	2.47	1.99	0.89
WWRLUN	tasmax	MIROC-MIROC5_GERICS-REMO2015	2.87	2.31	0.92
WWRLUN	tasmin	CCCma-CanESM2_CLMcom-CCLM4-8-17	2.93	2.32	0.88
WWRLUN	tasmin	CCCma-CanESM2_GERICS-REMO2015	2.26	1.72	0.93
WWRLUN	tasmax	CCCma-CanESM2_CLMcom-CCLM4-8-17	3.58	2.73	0.88

WWRLUN	tasmax	CCCma-CanESM2_GERICS-REMO2015	2.79	2.12	0.92
WWTRES	tasmin	observation	0.00	0.00	1.00
WWTRES	tasmin	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	2.13	1.67	0.91
WWTRES	tasmin	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.33	1.76	0.85
WWTRES	tasmax	observation	0.00	0.00	1.00
WWTRES	tasmax	MPI-M-MPI-ESM-LR_DMI-HIRHAM5	3.24	2.60	0.84
WWTRES	tasmax	MPI-M-MPI-ESM-LR_MOHC-HadREM3-GA7-05	2.71	2.10	0.90
WWTRES	tasmin	MIROC-MIROC5_GERICS-REMO2015	2.41	1.88	0.91
WWTRES	tasmax	MIROC-MIROC5_GERICS-REMO2015	3.94	3.21	0.82
WWTRES	tasmin	CCCma-CanESM2_CLMcom-CCLM4-8-17	2.84	2.20	0.89
WWTRES	tasmin	CCCma-CanESM2_GERICS-REMO2015	2.18	1.63	0.91
WWTRES	tasmax	CCCma-CanESM2_CLMcom-CCLM4-8-17	3.42	2.64	0.88
WWTRES	tasmax	CCCma-CanESM2_GERICS-REMO2015	3.48	2.74	0.85

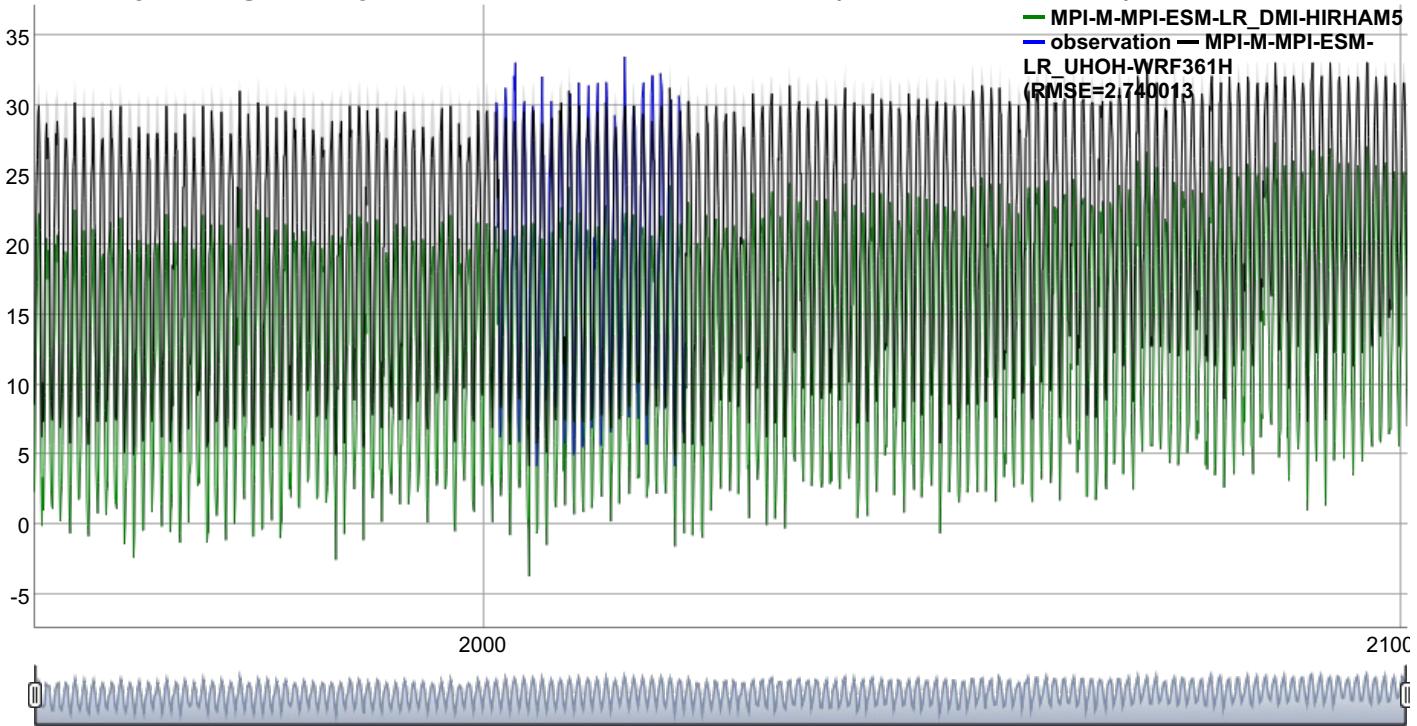
Monthly averaged Daily Minium temperature vs time (MPI-M-MPI-ESM-LR) at WWRLUN



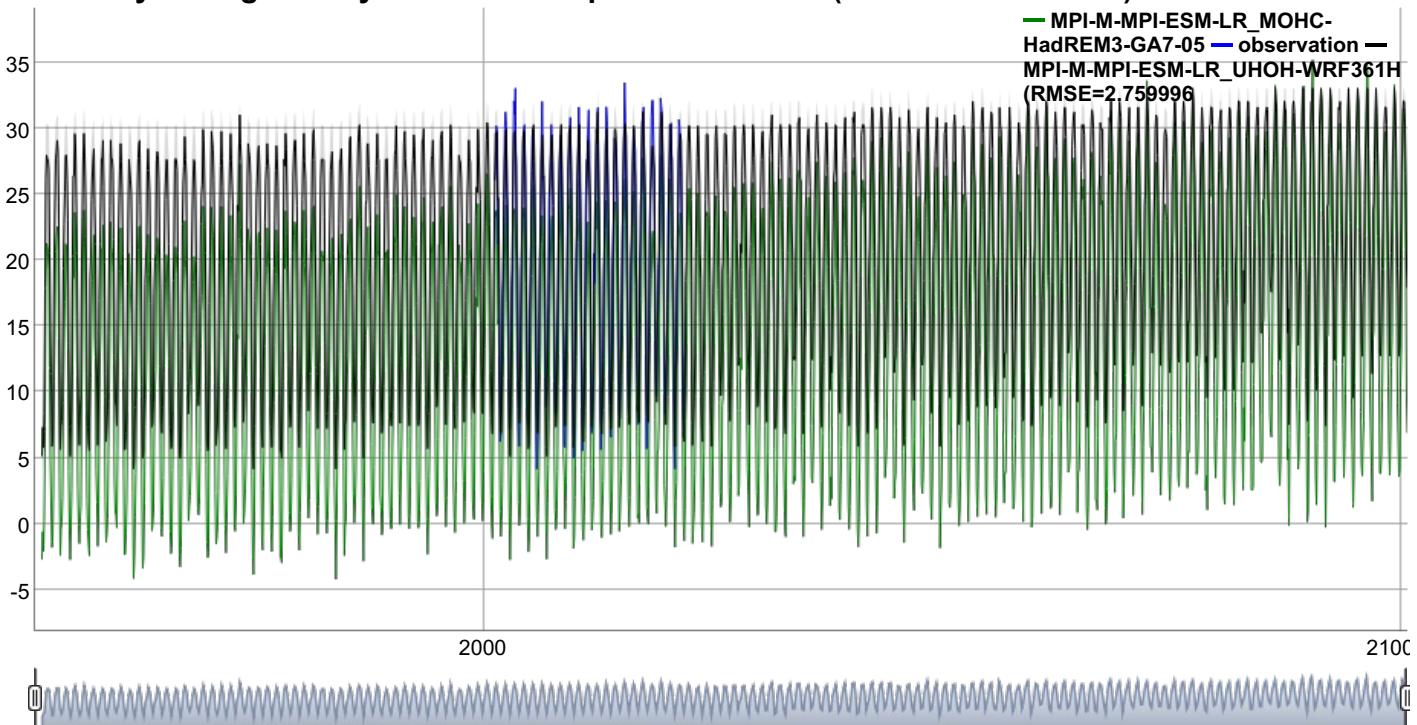
Monthly averaged Daily Minium temperature vs time (MPI-M-MPI-ESM-LR) at WWRLUN



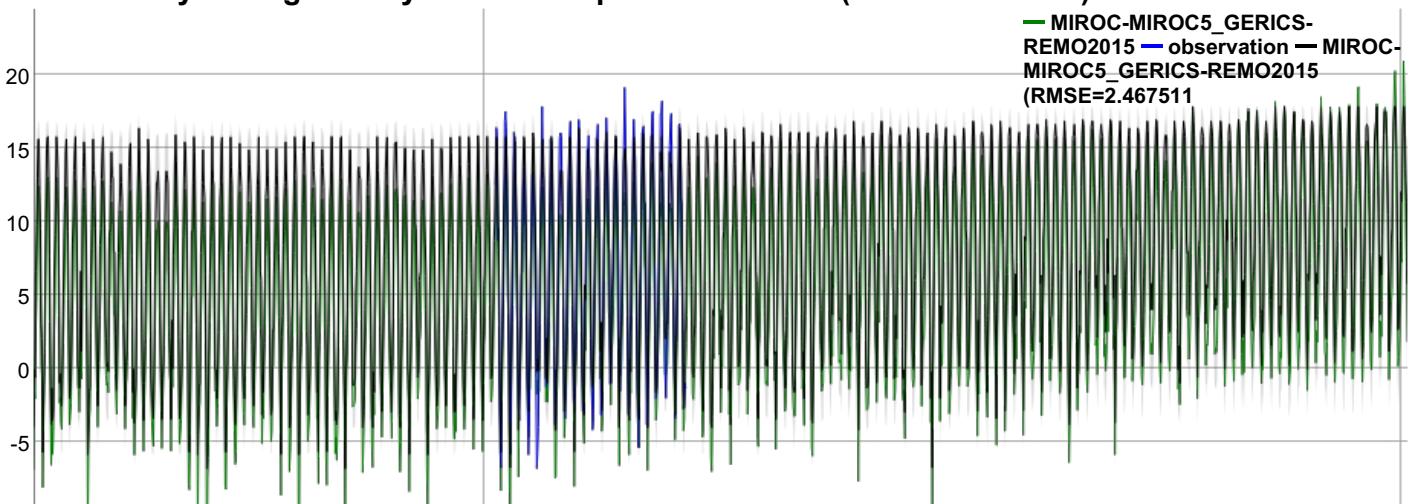
Monthly averaged Daily Maximum temperature vs time (MPI-M-MPI-ESM-LR) at WWRLUN

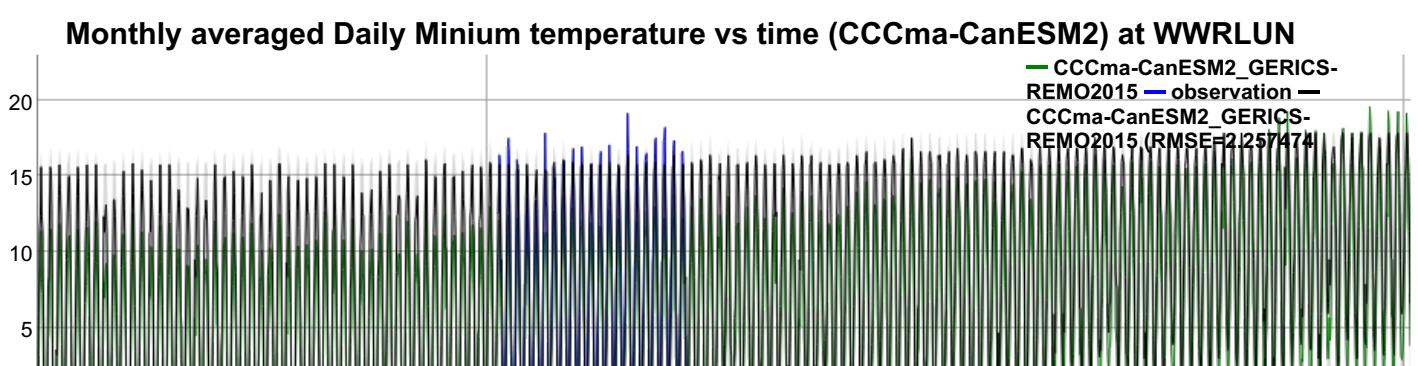
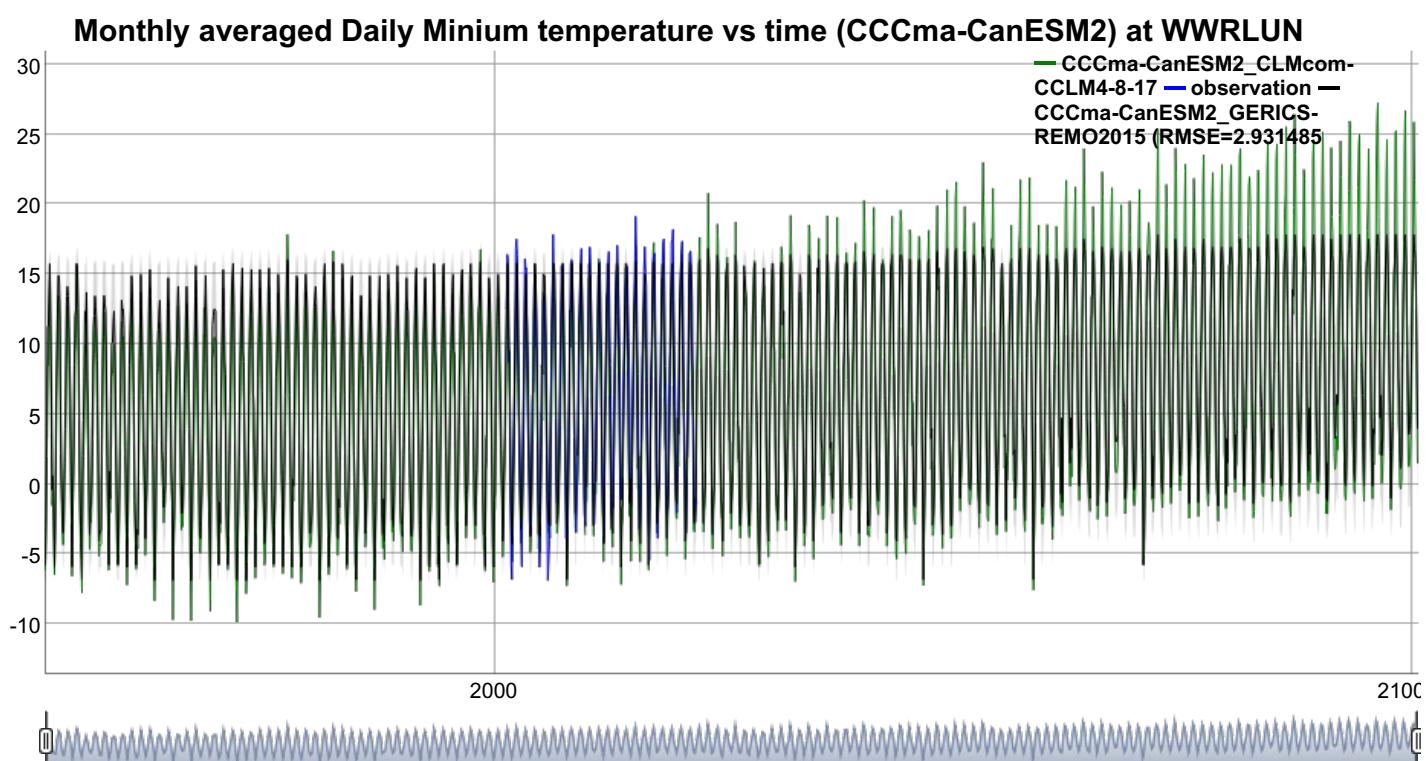
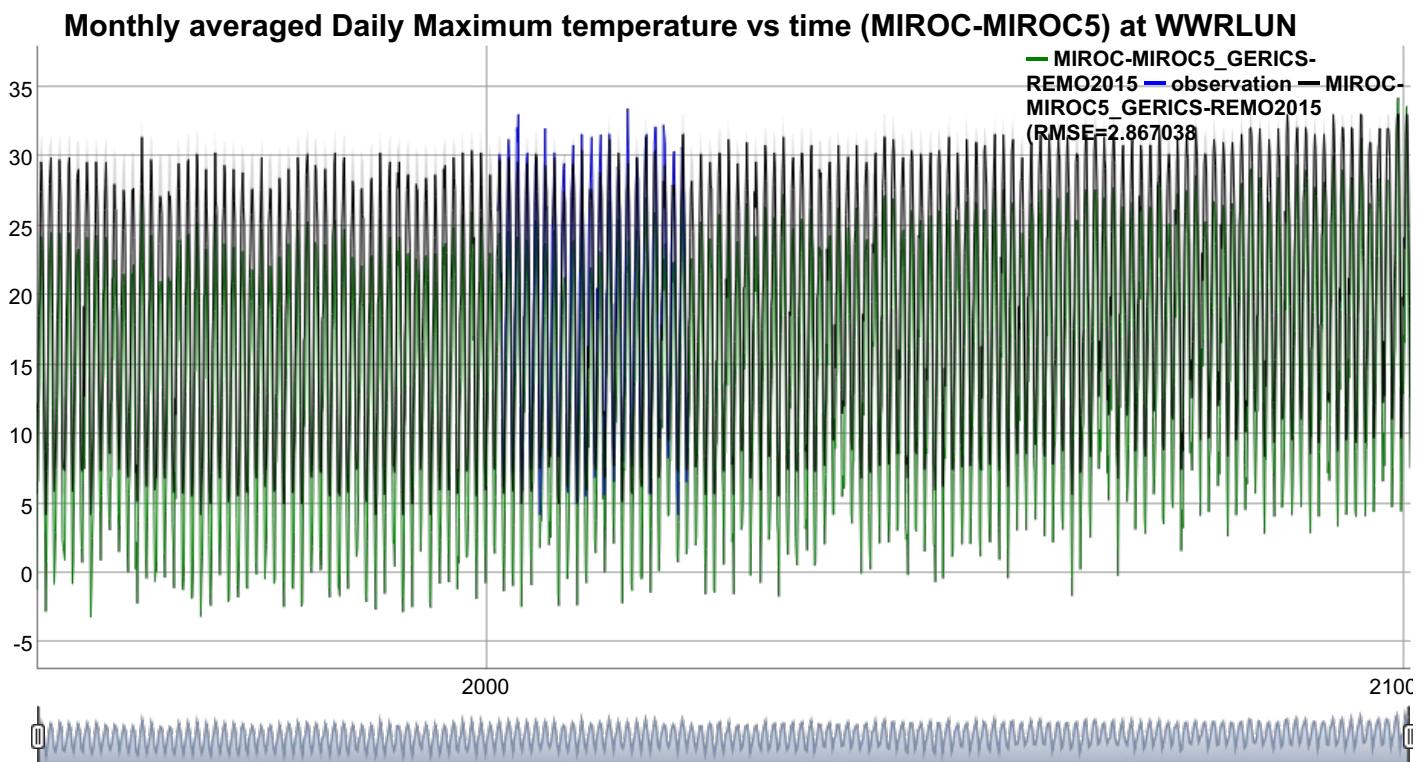


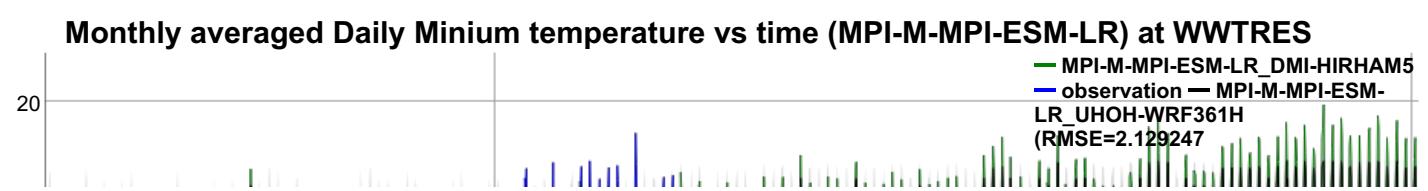
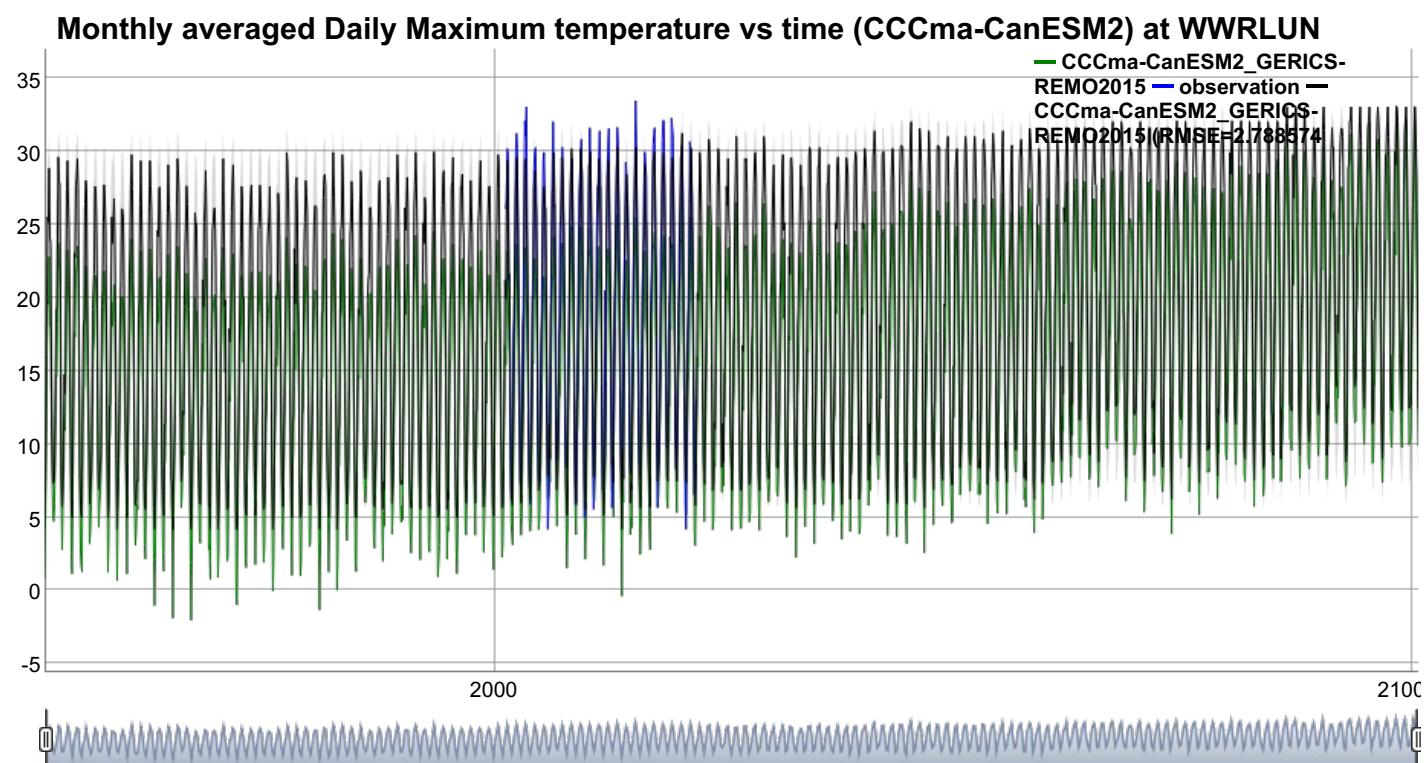
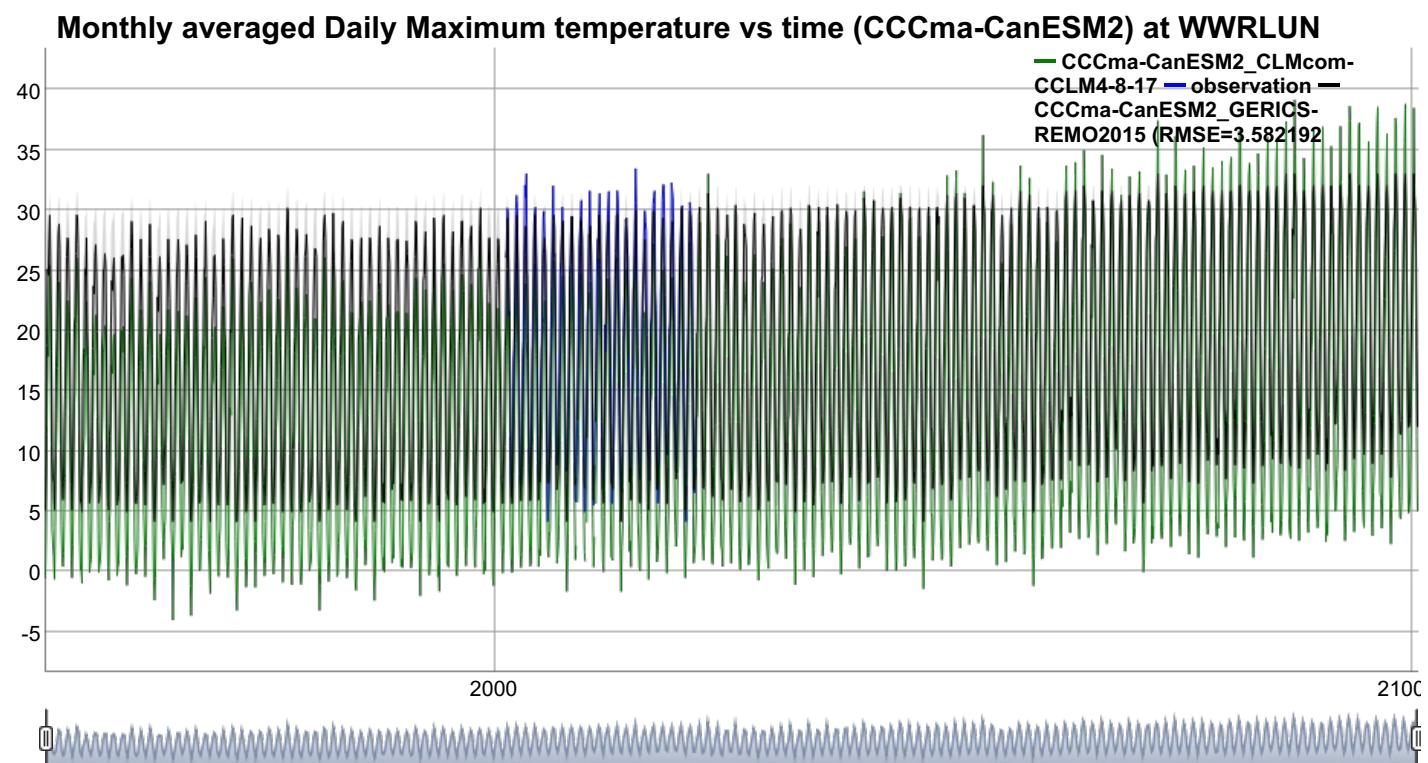
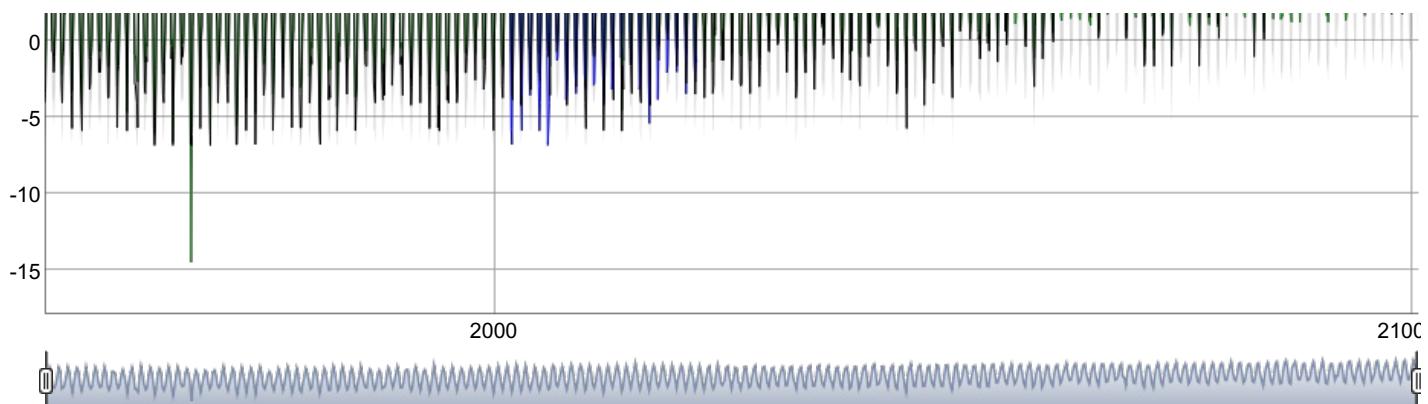
Monthly averaged Daily Maximum temperature vs time (MPI-M-MPI-ESM-LR) at WWRLUN

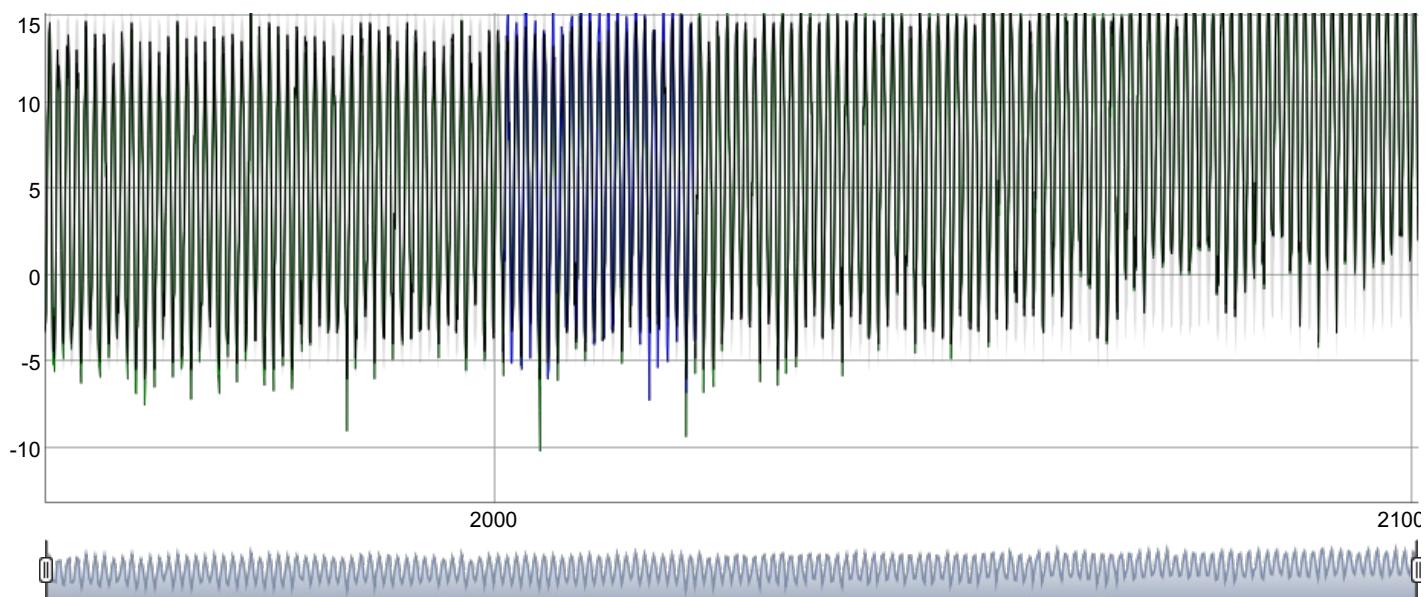


Monthly averaged Daily Minimum temperature vs time (MIROC-MIROC5) at WWRLUN



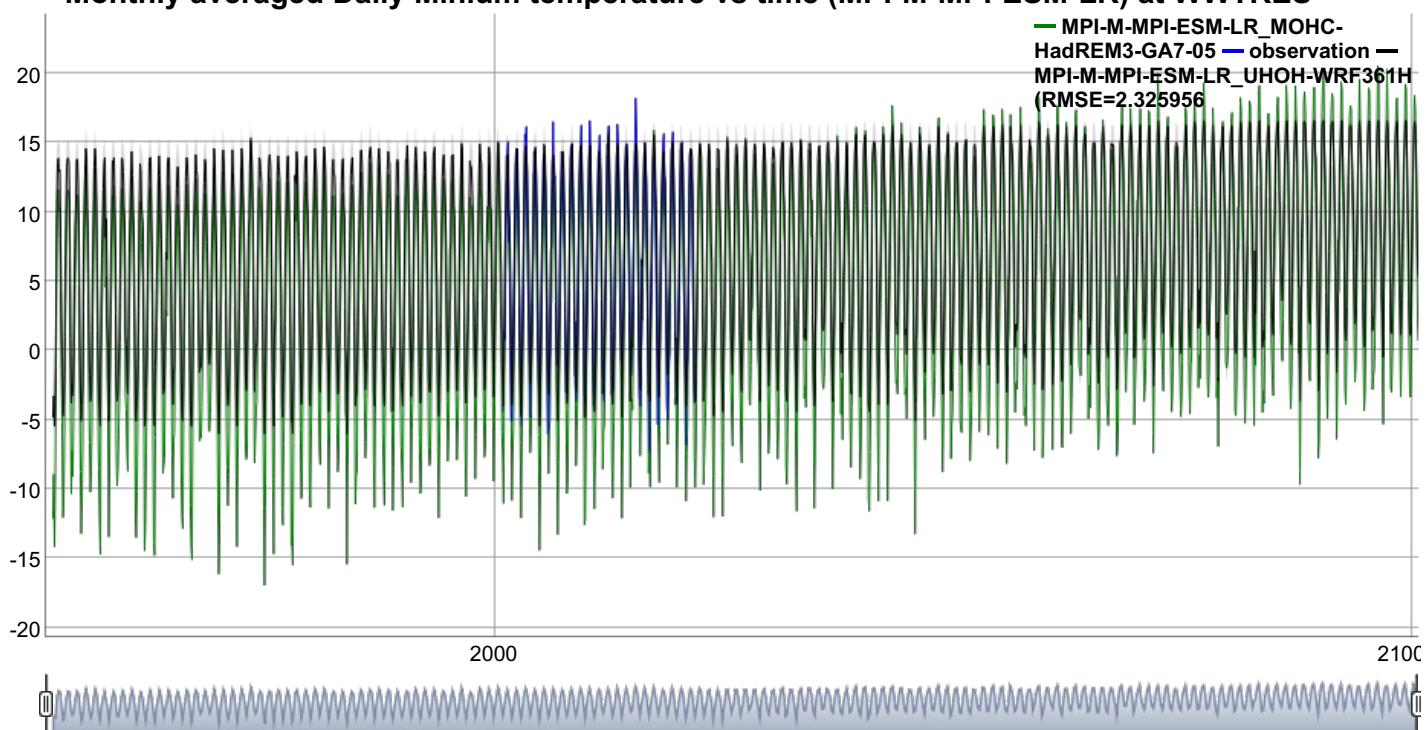






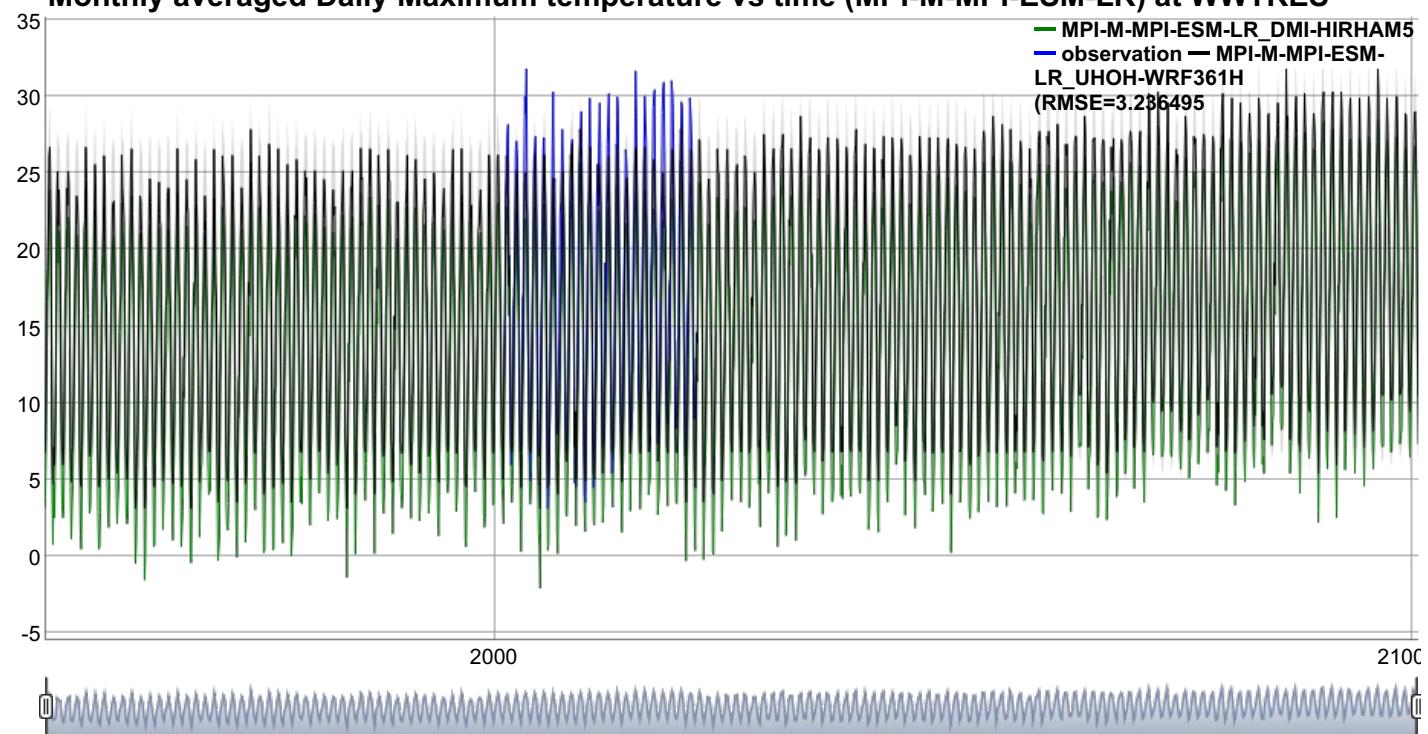
Monthly averaged Daily Minium temperature vs time (MPI-M-MPI-ESM-LR) at WWTRES

MPI-M-MPI-ESM-LR_MOHC
HadREM3-GA7-05 — observation —
MPI-M-MPI-ESM-LR_UHOH-WRF361H
(RMSE=2.325956)

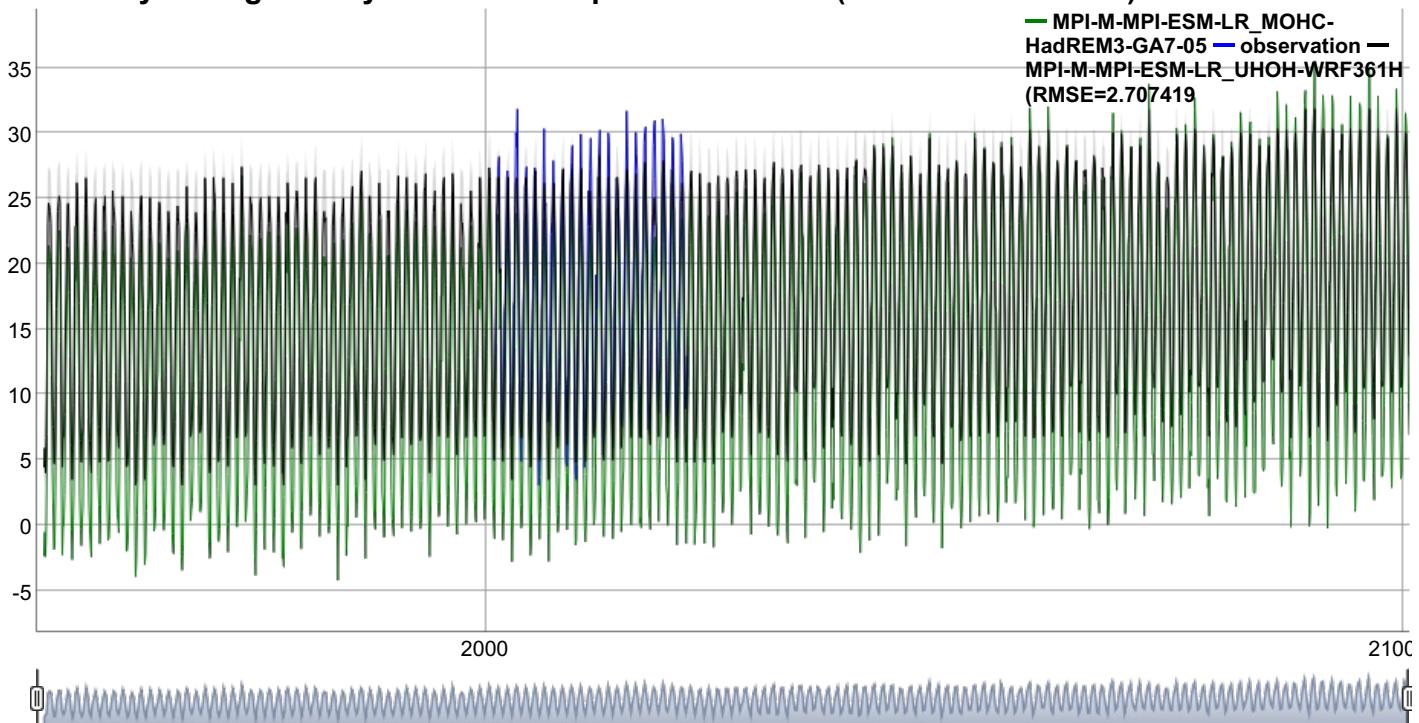


Monthly averaged Daily Maximum temperature vs time (MPI-M-MPI-ESM-LR) at WWTRES

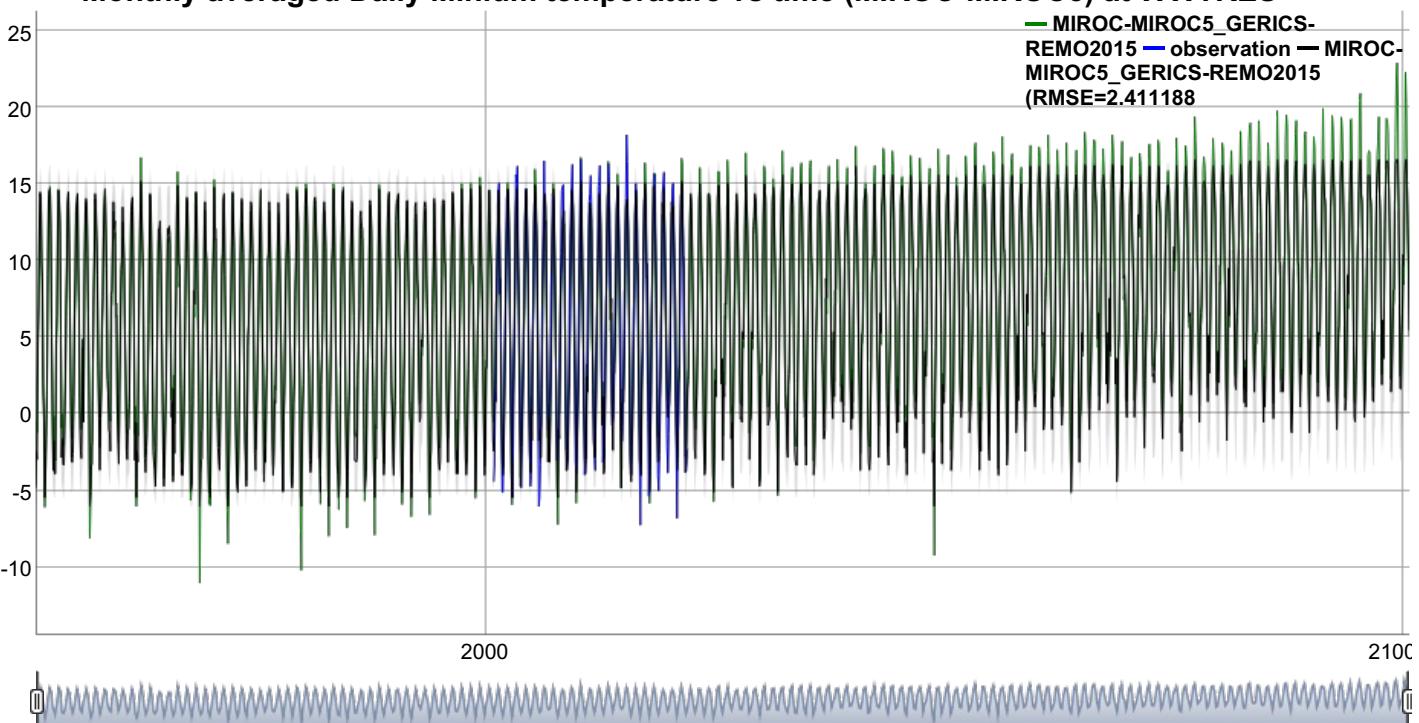
MPI-M-MPI-ESM-LR_DMI-HIRHAM5
observation — MPI-M-MPI-ESM-LR_UHOH-WRF361H
(RMSE=3.286495)



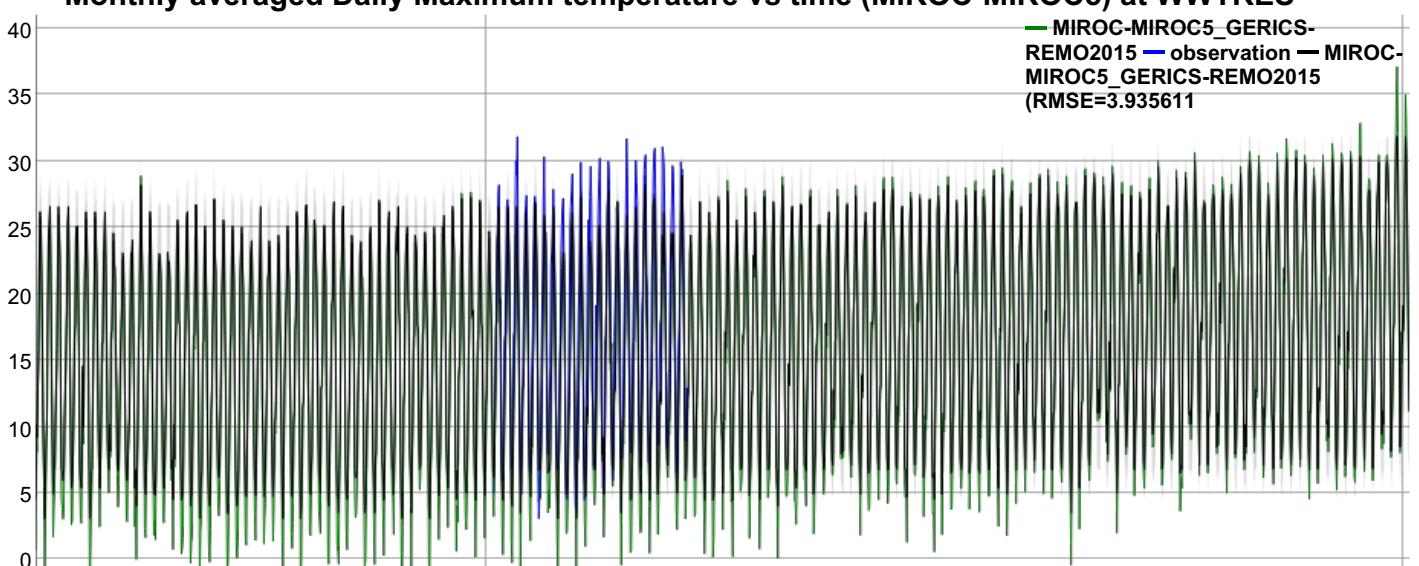
Monthly averaged Daily Maximum temperature vs time (MPI-M-MPI-ESM-LR) at WWTRES

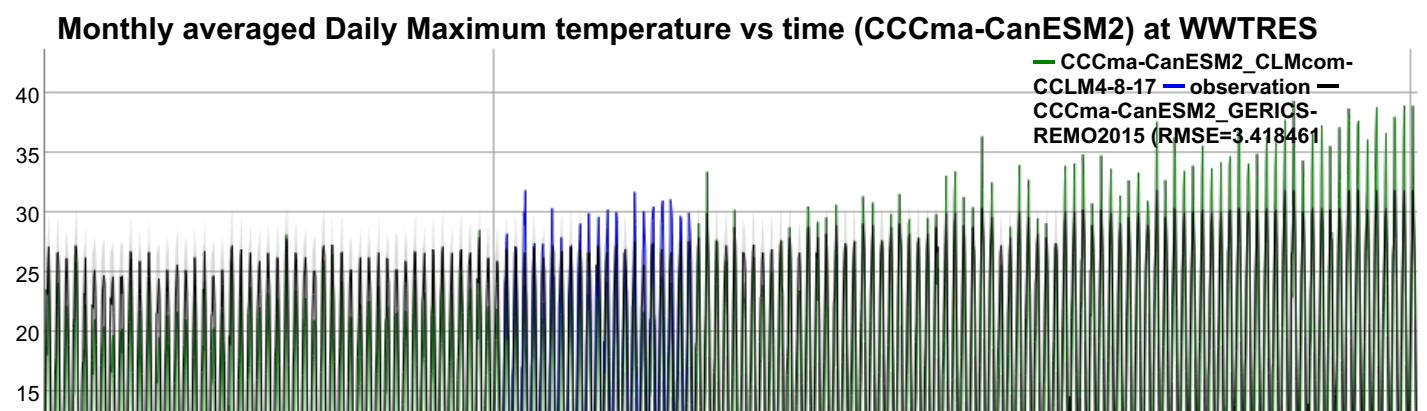
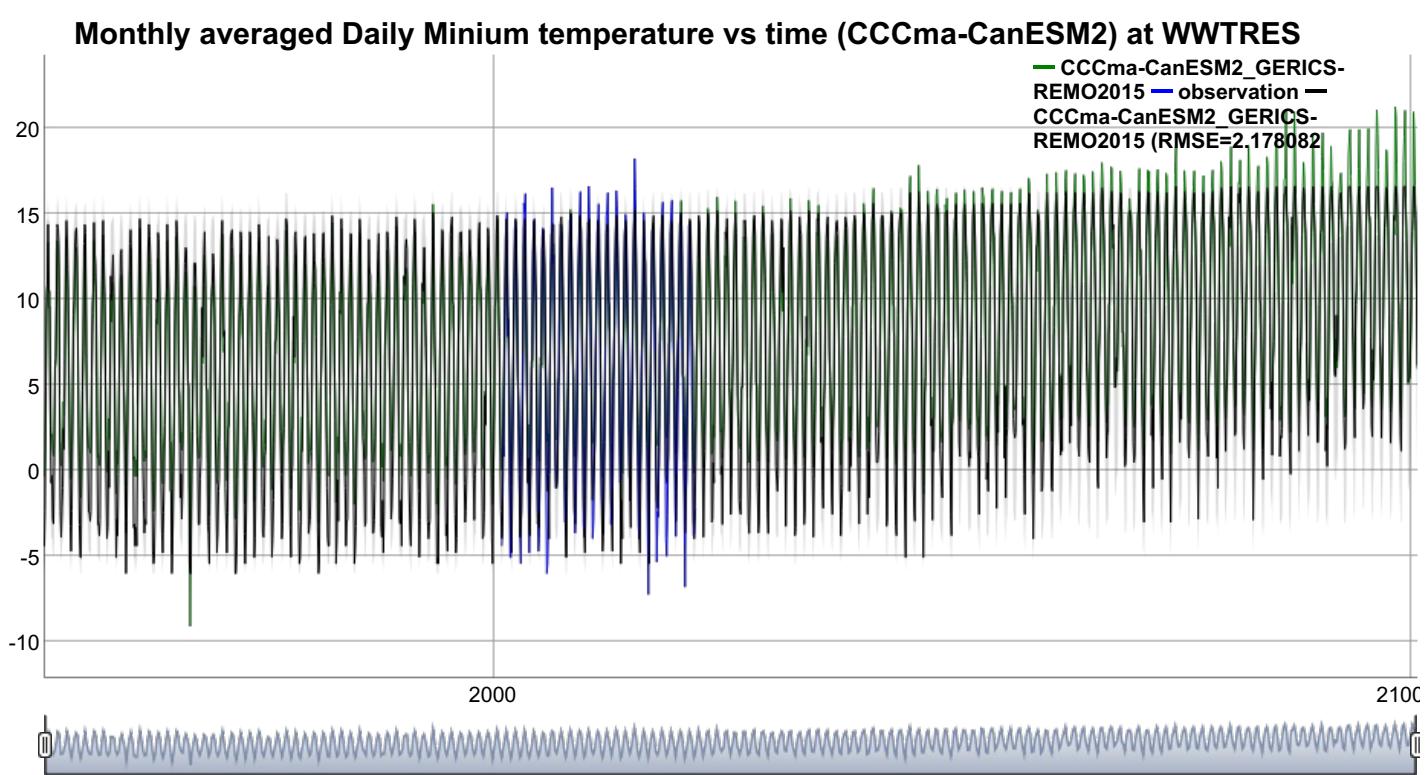
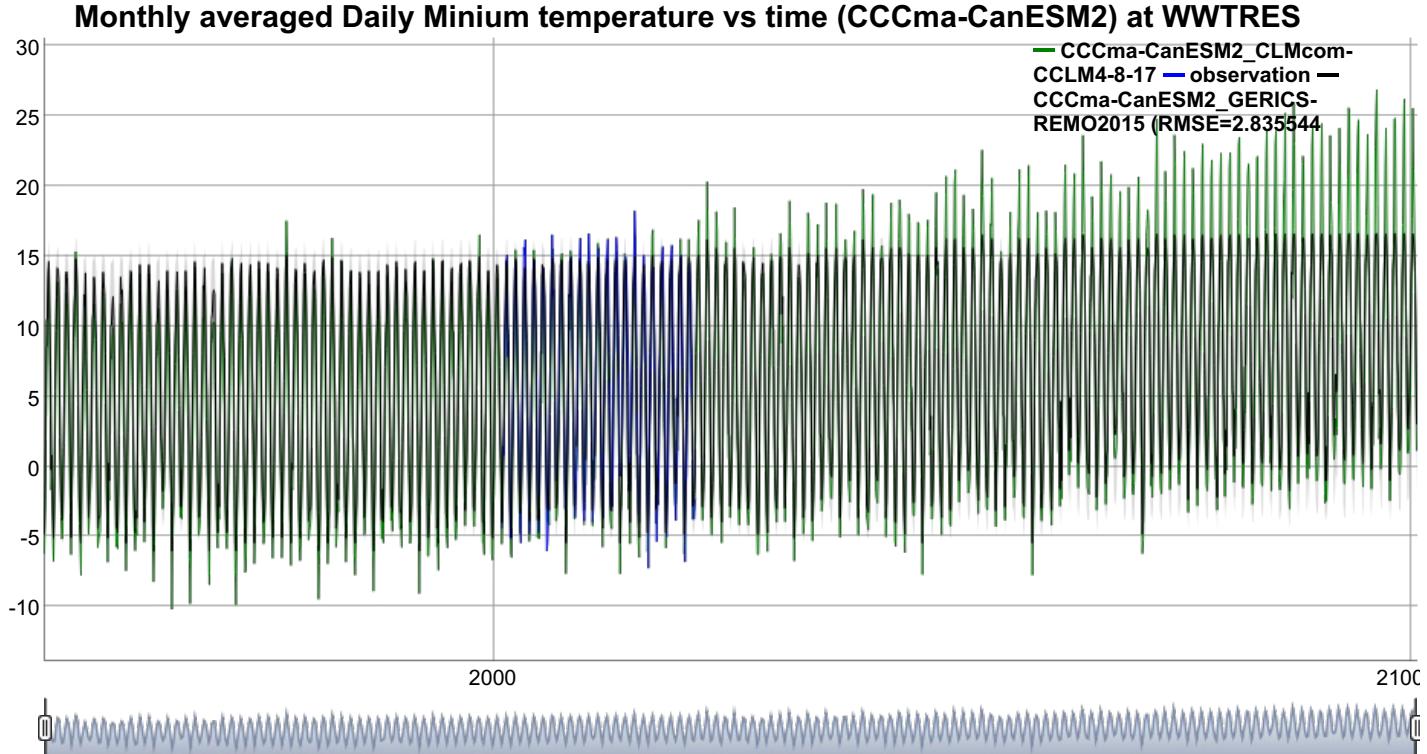
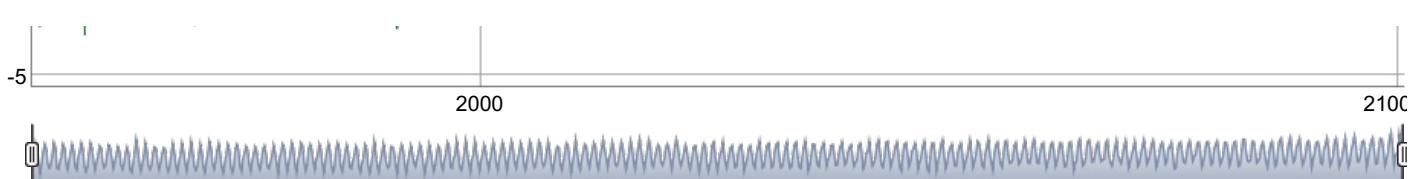


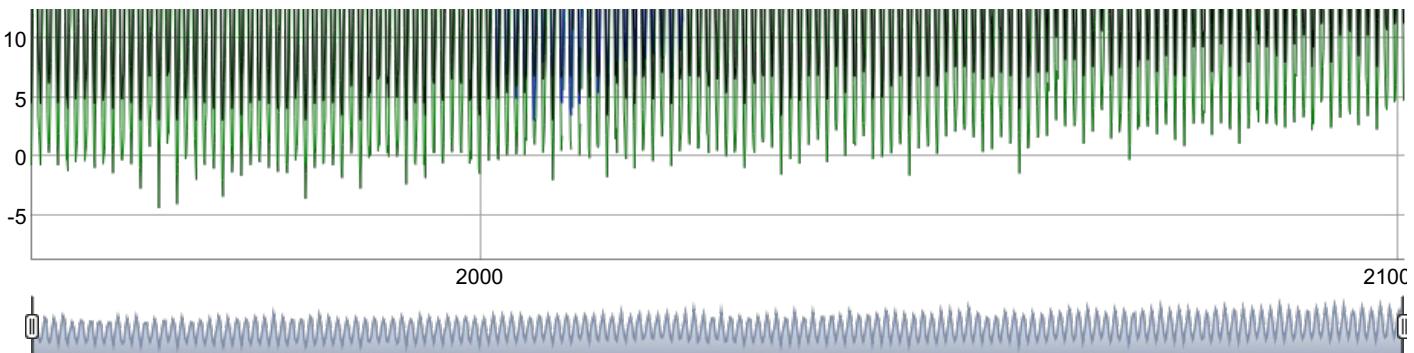
Monthly averaged Daily Minimum temperature vs time (MIROC-MIROC5) at WWTRES



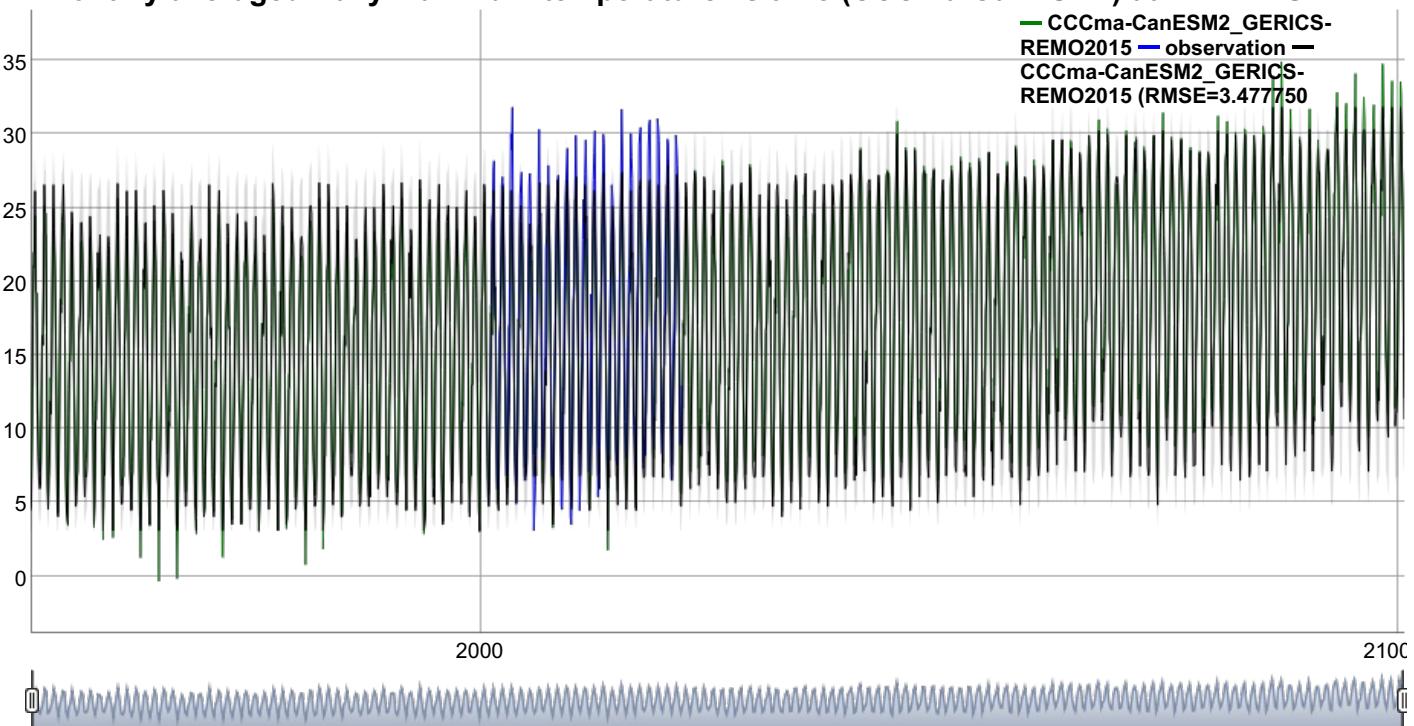
Monthly averaged Daily Maximum temperature vs time (MIROC-MIROC5) at WWTRES







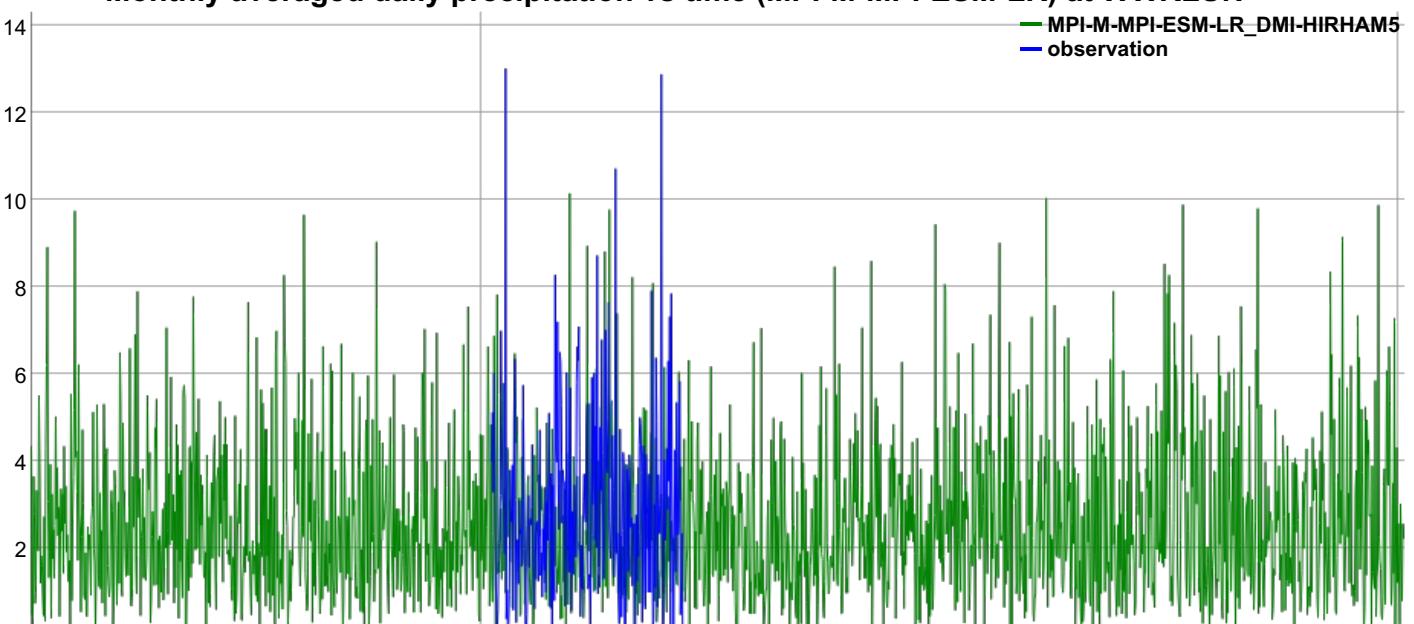
Monthly averaged Daily Maximum temperature vs time (CCCma-CanESM2) at WWTRES

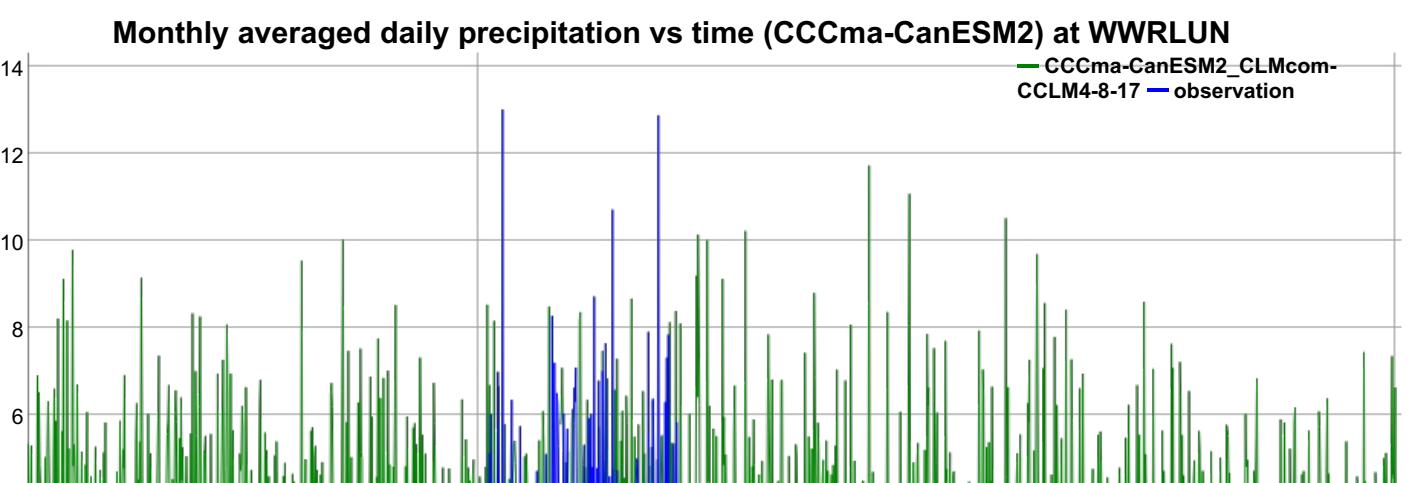
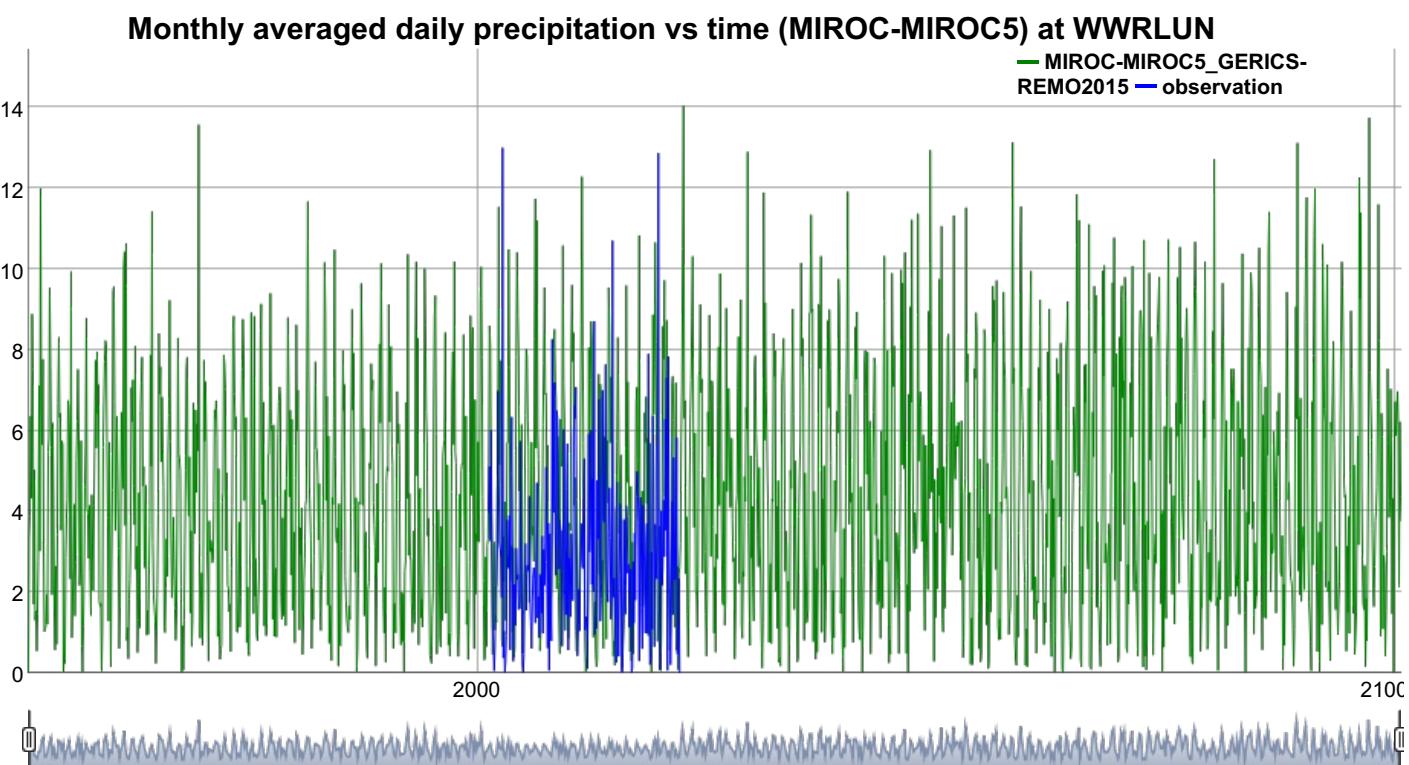
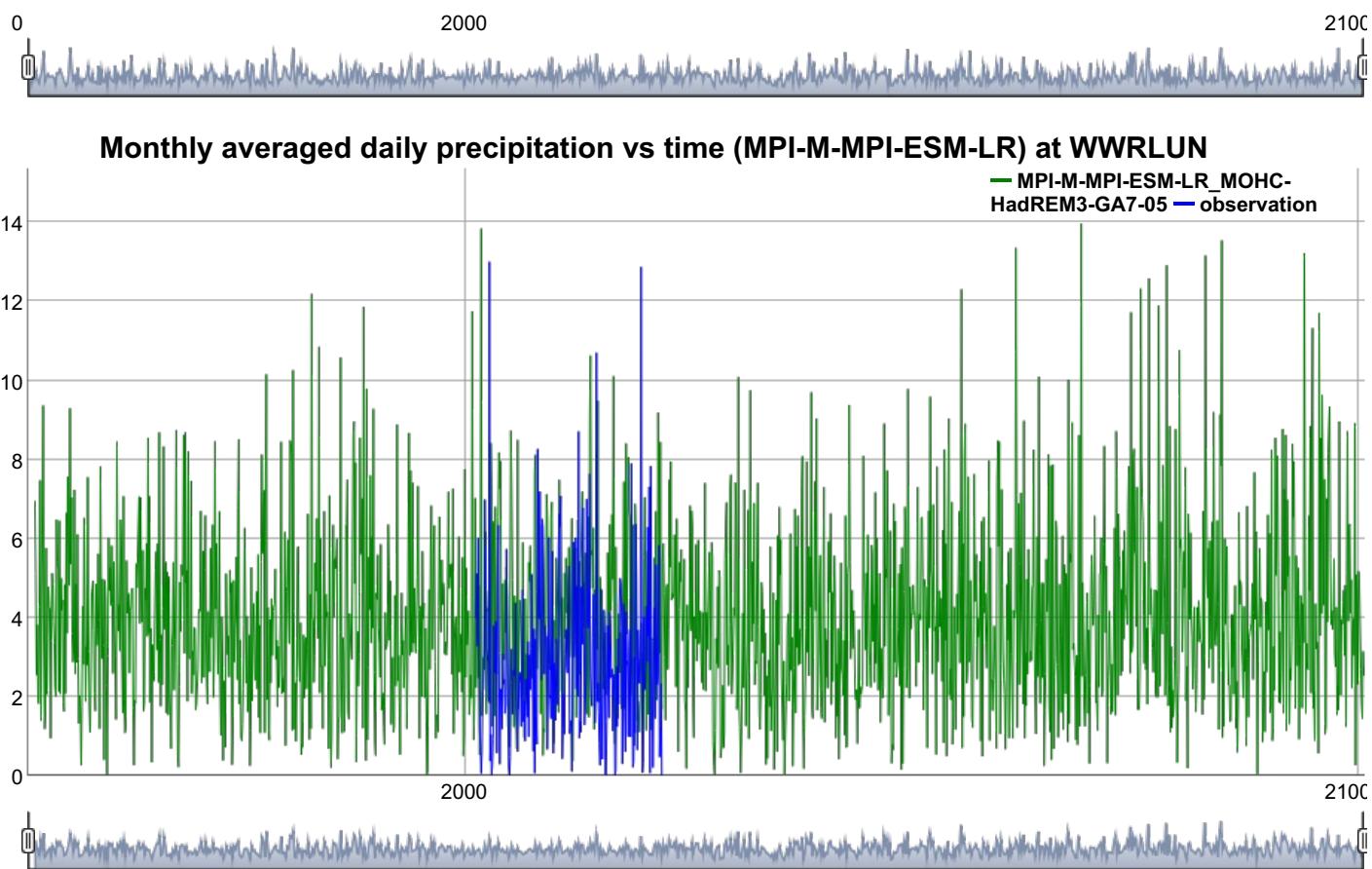


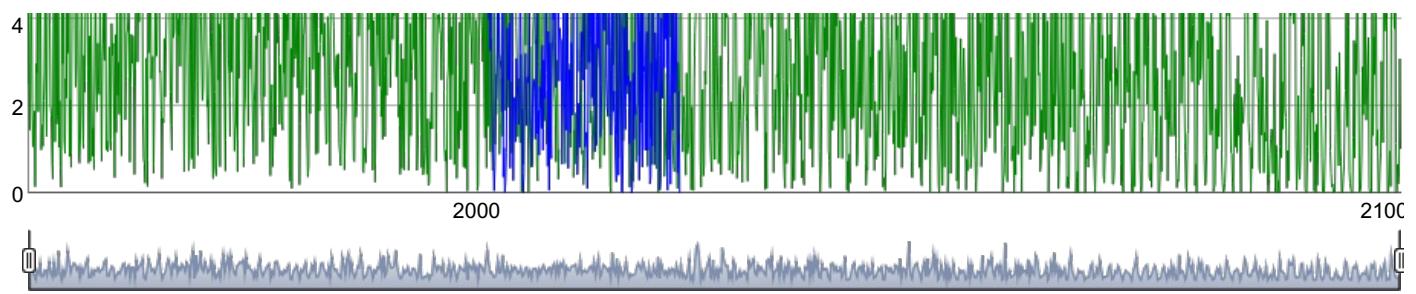
Averaged daily precipitation

Whereas temperature is increasing with a significant trend. Nevertheless, the behavior of precipitation is intermittent and discontinuous, than it is more difficult to analyze and predict. Some recent studies applied to the Mediterranean area shows a slightly decrease (e.g. Mascaro, Viola, and Deidda (2018)) with an impact of water resources, especially snow (e.g. Senatore et al. (2022)). As concern the site WWTRES and WWRLUN monthly time series is presented in the following. Time series were visualized in the HTML version of this report. Actually model simulated monthly averaged daily precipitation differs from the observed values and are not suitable to downscale with a auto-regressive model like ARIMA. Anyway, in terms of monthly average, precipitation value would vary in the future with a low or insignificant trend. Further studies are difficult to find in literature and required more detailed analysis. Moreover, even if monthly average precipitation tends to maintain around values similar to the current and historical ones, precipitation distribution (high intensity event, dry spell duration) over time will significantly change in the future as the global air temperature increases.

Monthly averaged daily precipitation vs time (MPI-M-MPI-ESM-LR) at WWRLUN

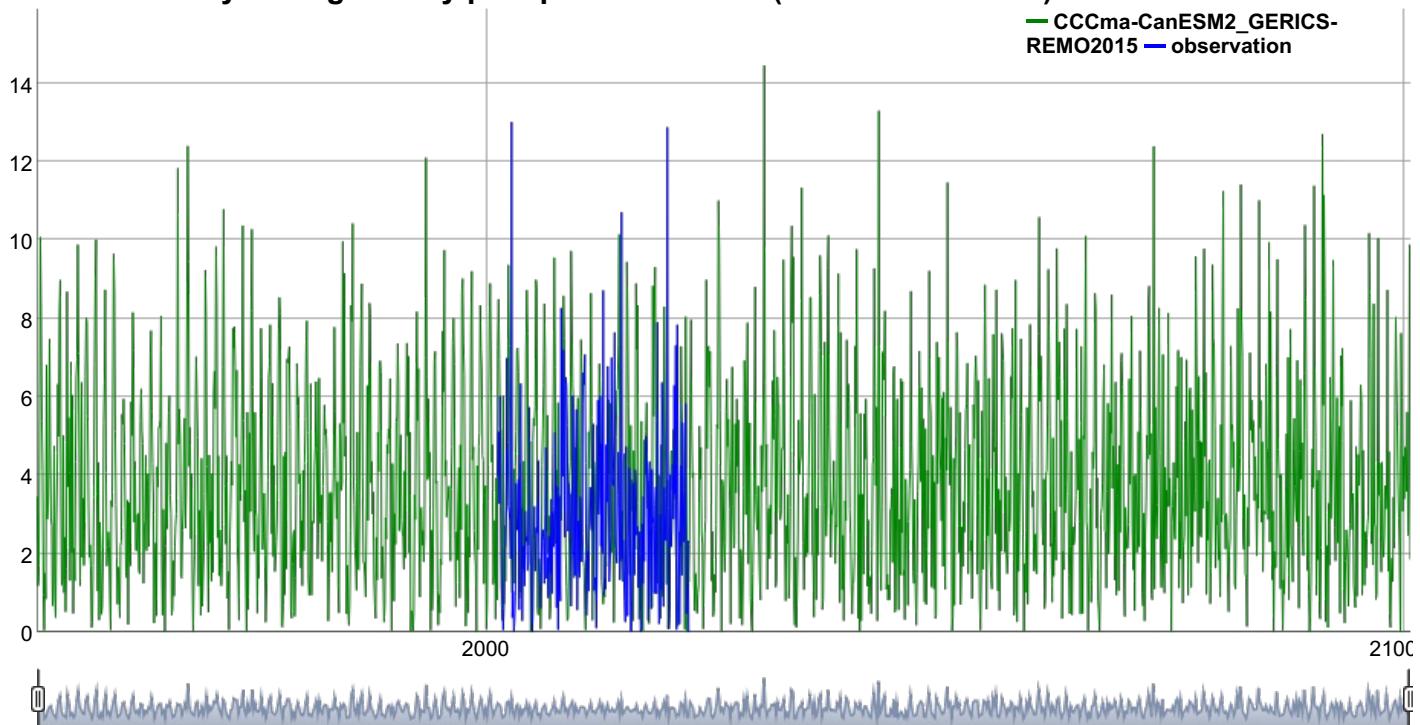






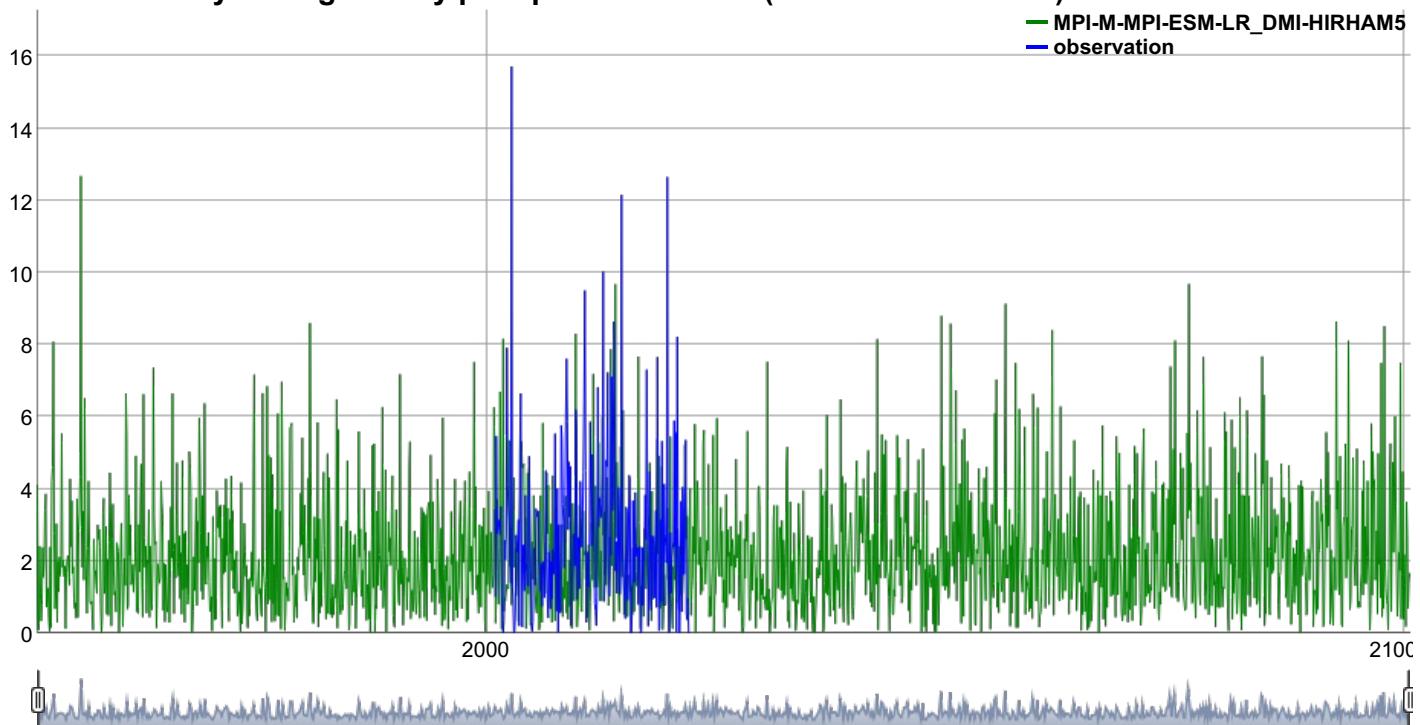
Monthly averaged daily precipitation vs time (CCCma-CanESM2) at WWRLUN

CCCma-CanESM2_GERICS-
REMO2015 — observation



Monthly averaged daily precipitation vs time (MPI-M-MPI-ESM-LR) at WWTRES

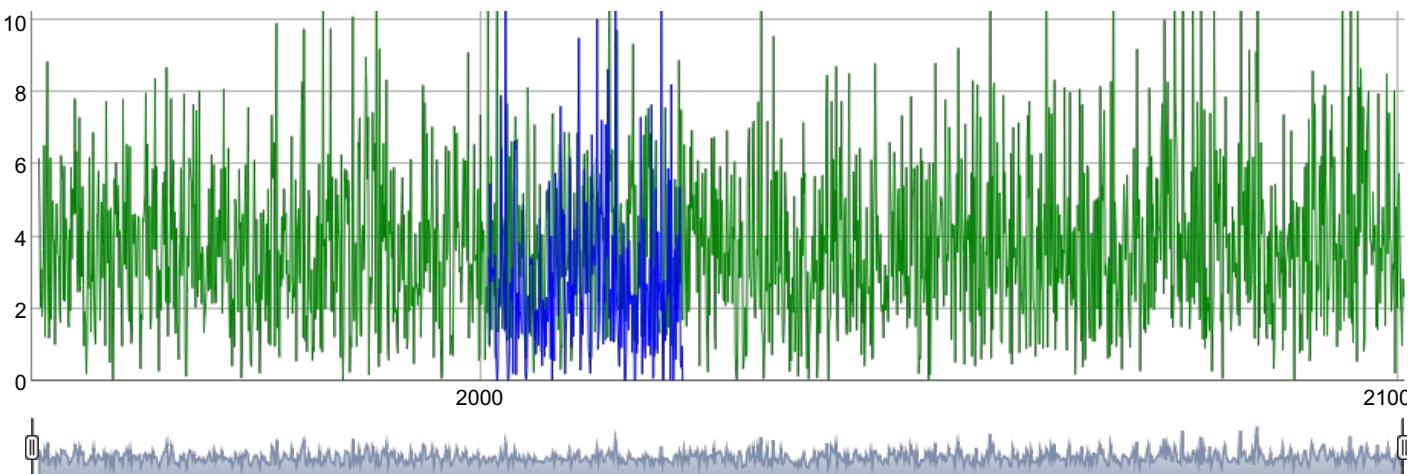
MPI-M-MPI-ESM-LR_DMI-HIRHAM5
— observation



Monthly averaged daily precipitation vs time (MPI-M-MPI-ESM-LR) at WWTRES

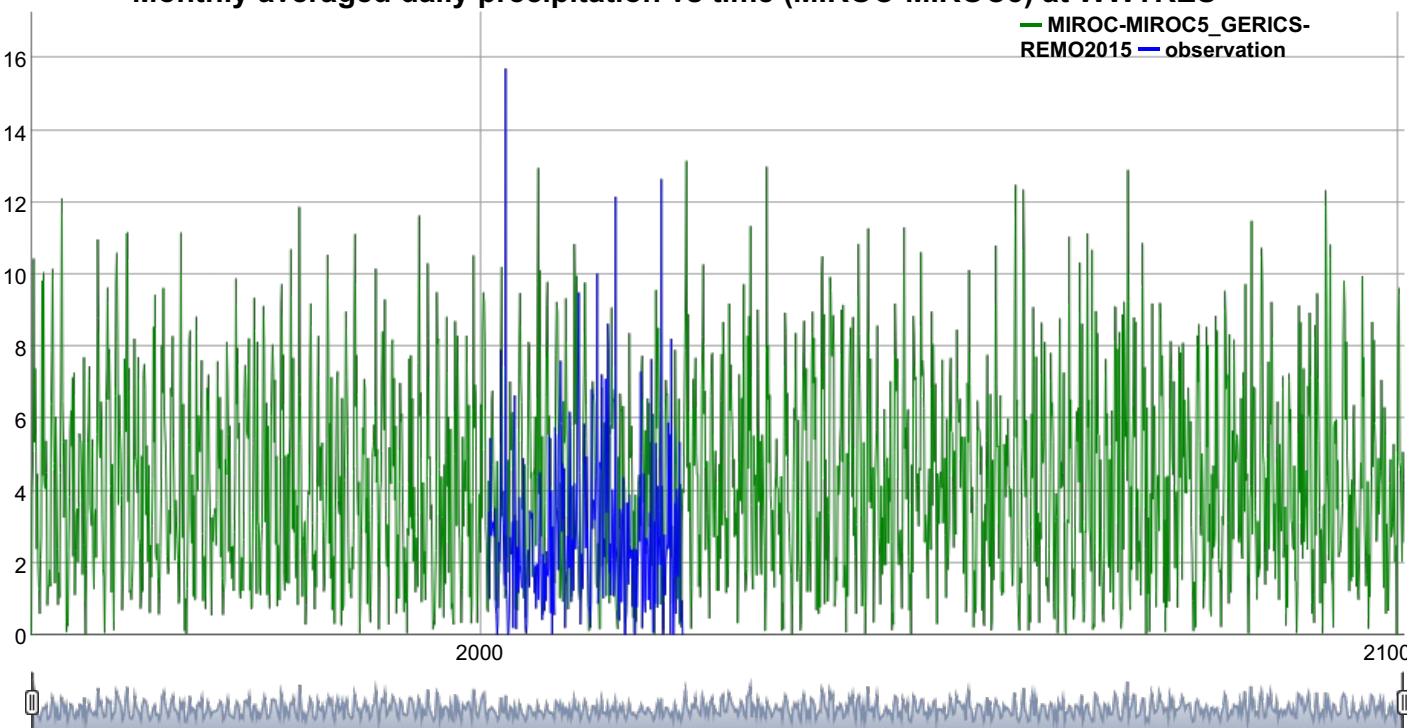
MPI-M-MPI-ESM-LR_MOHC-
HadREM3-GA7-05 — observation





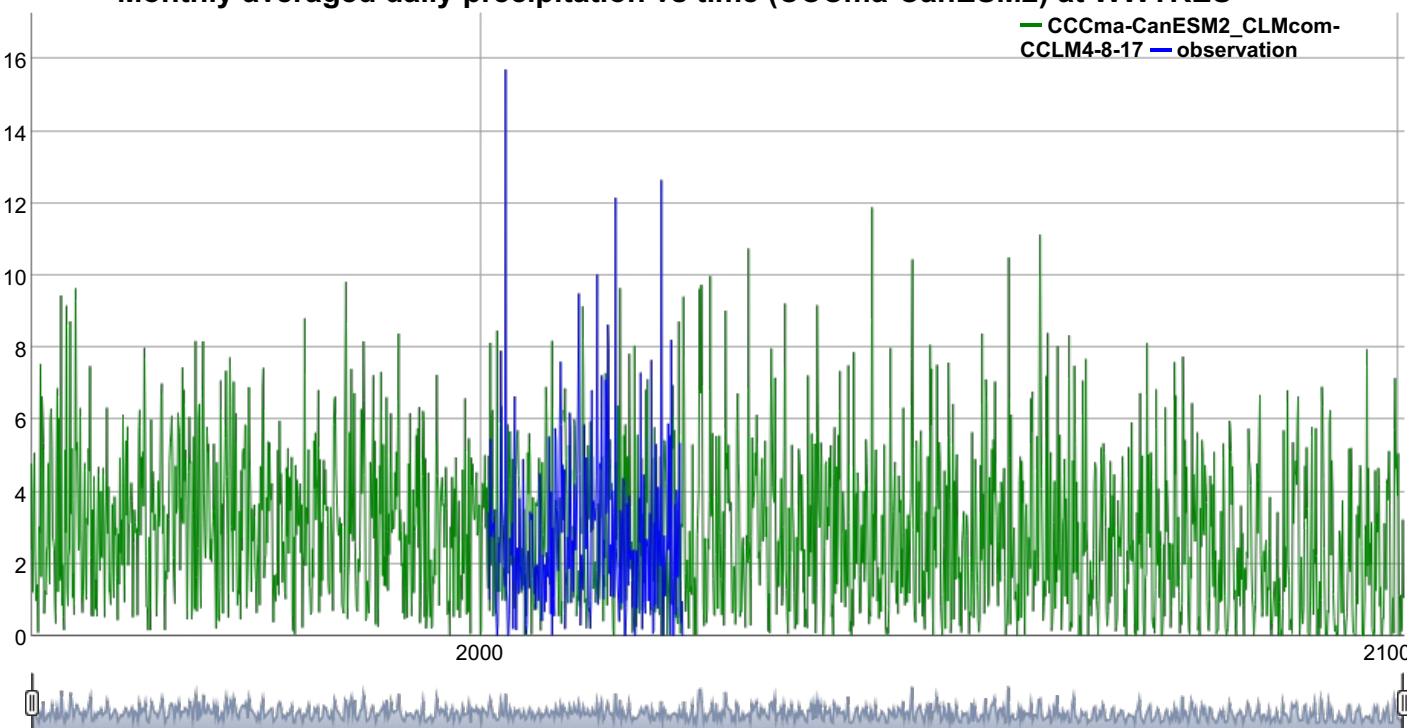
Monthly averaged daily precipitation vs time (MIROC-MIROC5) at WWTRES

— MIROC-MIROC5_GERICS
— REMO2015 — observation



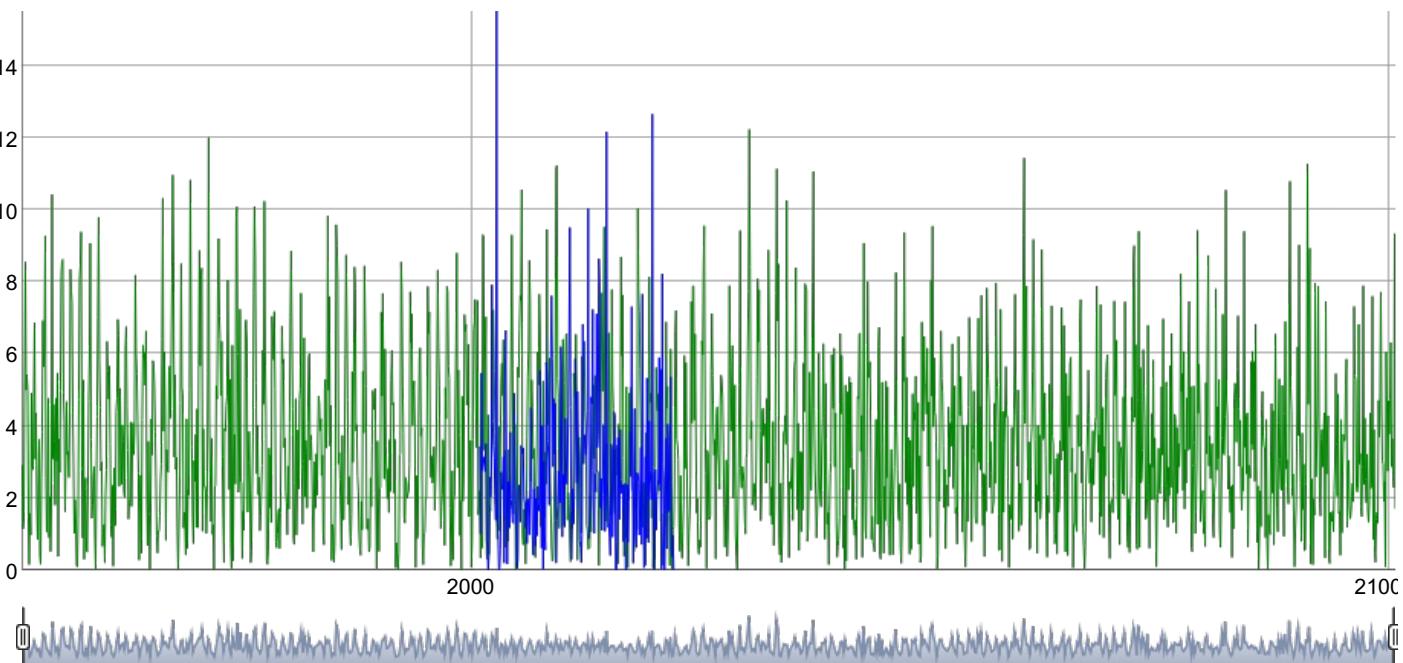
Monthly averaged daily precipitation vs time (CCCma-CanESM2) at WWTRES

— CCCma-CanESM2_CLMcom
— CCLM4-8-17 — observation



Monthly averaged daily precipitation vs time (CCCma-CanESM2) at WWTRES

— CCCma-CanESM2_GERICS
— REMO2015 — observation



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