ClimateWNA (http://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/): generating high-resolution climate data for climate change studies and applications in Western North America

ClimateWNA is an application written by Dr Tongli Wang (http://cfcg.forestry.ubc.ca/people/tongli-wang/) that extracts and downscales 1961-1990 monthly climate normal data from a moderate spatial resolution (4 x 4 km) to scale-free point locations, and calculates monthly, seasonal and annual climate variables for specific locations based on latitude, longitude and elevation.The downscaling is achieved through a combination of bilinear interpolation and dynamic local elevational adjustment. ClimateWNA uses the scale-free data as baseline to downscale historical and future climate variables for individual years and periods between 1901 and 2100.

## Data sources

### *Baseline data*

The monthly baseline data for 1961-1990 normals were compiled from the following sources and unified at 4 x 4 km spatial resolution:

1. British Columbia: PRISM at 800 x 800 m from Pacific Climate Impact Consortium;

2. Prairie provinces: PRISM at 4 x 4 km from the PRISM Climate Group (http://www.prism.oregonstate.edu/);

3. United States: PRISM at 800 x 800 m from the PRISM Climate Group (Daly *et al*. 2008);

4. The rest: ANUSPLIN at 4 x 4 km

5. Monthly solar radiation data were provided by Dr. Robbie Hember at University of British Columbia.

### *Historical data*

Historical monthly data were obtained from Climate Research Unit (CRU) (Harris et al 2014). The data version is CRU TS 3.23. The spatial resolution is 0.5 x 0.5° and covers the period of 1901-2014. Anomalies were calculated for each year and period relative to the 1961-1990 normals.

### *Future climate data*

The climate data for future periods, including 2020s (2010-2039), 2050s (2040-69) and 2080s (2070-2100), were from General Circulation Models (GCMs) of the Coupled Model Intercomparison Project (CMIP5) included in the IPCC Fifth Assessment Report (IPCC 2014). Fifteen GCMs were selected for two greenhouse gas emission scenarios (RCP 4.5 and RCP 8.5). When multiple ensembles are available for each GCM, an average was taken over the available (up to five) ensembles. Ensembles among the 15 GCMs are also available.

## Climate variables predicted

### *1) Annual variables:*

*Directly calculated annual variables:*

MAT mean annual temperature (°C),
MWMT mean warmest month temperature (°C),
MCMT mean coldest month temperature (°C),
TD temperature difference between MWMT and MCMT, or continentality (°C), MAP mean annual precipitation (mm),
MSP mean annual summer (May to Sept.) precipitation (mm),
AHM annual heat-moisture index (MAT+10)/(MAP/1000))
SHM summer heat-moisture index ((MWMT)/(MSP/1000))

*Derived annual variables:*

DD<0 degree-days below 0°C, chilling degree-days DD>5 degree-days above 5°C, growing degree-days DD<18 degree-days below 18°C, heating degree-days DD>18 degree-days above 18°C, cooling degree-days NFFD the number of frost-free days

FFP frost-free period

bFFP the day of the year on which FFP begins

eFFP the day of the year on which FFP ends

PAS precipitation as snow (mm) between August in previous year and July in current year

EMT extreme minimum temperature over 30 years EXT extreme maximum temperature over 30 years Eref Hargreaves reference evaporation (mm) CMD Hargreaves climatic moisture deficit (mm) MAR mean annual solar radiation (MJ $m^{-2}$ $d^{-1}$)

RH mean annual relative humidity (%)

## *2) Seasonal variables:*

*Seasons:*

Winter (_wt): Dec. (prev. yr) - Feb for annual, Jan, Feb, Dec for normals
Spring (_sp): March, April and May
Summer (_sm): June, July and August
Autumn (_at): September, October and November

*Directly calculated seasonal variables:*

Tave_wt winter mean temperature (°C)

Tave_sp Tave_sm Tave_at

Tmax_wt Tmax_sp Tmax_sm Tmax_at

Tmin_wt Tmin_sp Tmin_sm Tmin_at

PPT_wt PPT_sp PPT_sm PPT_at

RAD_wt RAD_sp RAD_sm RAD_at

spring mean temperature (°C) summer mean temperature (°C) autumn mean temperature (°C)

winter mean maximum temperature (°C) spring mean maximum temperature (°C) summer mean maximum temperature (°C) autumn mean maximum temperature (°C)

winter mean minimum temperature (°C) spring mean minimum temperature (°C) summer mean minimum temperature (°C) autumn mean minimum temperature (°C)

winter precipitation (mm) spring precipitation (mm) summer precipitation (mm) autumn precipitation (mm)

winter solar radiation (MJ $m^{-2}$ $d^{-1}$) spring solar radiation (MJ $m^{-2}$ $d^{-1}$) summer solar radiation (MJ $m^{-2}$ $d^{-1}$) autumn solar radiation (MJ $m^{-2}$ $d^{-1}$)

*Derived seasonal variables:*

DD_0_wt DD_0_sp DD_0_sm DD_0_at

DD5_wt DD5_sp DD5_sm DD5_at

DD_18_wt DD_18_sp DD_18_sm

winter degree-days below 0°C spring degree-days below 0°C summer degree-days below 0°C autumn degree-days below 0°C

winter degree-days below 5°C spring degree-days above 5°C summer degree-days above 5°C autumn degree-days above 5°C

winter degree-days below 18°C spring degree-days below 18°C summer degree-days below 18°C

DD_18_at

DD18_wt DD18_sp DD18_sm DD18_at

NFFD_wt NFFD_sp NFFD_sm NFFD_at

PAS_wt PAS_sp PAS_sm PAS_at

Eref_wt Eref_sp Eref_sm Eref_at

CMD_wt CMD_sp CMD_sm CMD_at

RH_wt RH_sp RH_sm RH_at

autumn degree-days below 18°C

winter degree-days below 18°C spring degree-days above 18°C summer degree-days above 18°C autumn degree-days above 18°C

winter number of frost-free days spring number of frost-free days summer number of frost-free days autumn number of frost-free days

winter precipitation as snow (mm) spring precipitation as snow (mm) summer precipitation as snow (mm) autumn precipitation as snow (mm)

winter Hargreaves reference evaporation (mm) spring Hargreaves reference evaporation (mm) summer Hargreaves reference evaporation (mm) autumn Hargreaves reference evaporation (mm)

winter Hargreaves climatic moisture deficit (mm) spring Hargreaves climatic moisture deficit (mm) summer Hargreaves climatic moisture deficit (mm) autumn Hargreaves climatic moisture deficit (mm)

winter relative humidity (%) winter relative humidity (%) winter relative humidity (%) winter relative humidity (%)

### *3) Monthly variables*

*Primary monthly variables:*

Tave01 – Tave12 TMX01 – TMX12 TMN01 – TMN12

January - December mean temperatures (°C)

January - December maximum mean temperatures (°C) January - December minimum mean temperatures (°C)

PPT01 – PPT12 January - December precipitation (mm) RAD01 – RAD12 January - December solar radiation (MJ $m^{-2}$ $d^{-1}$)

*Derived monthly variables:*

DD_0_01 – DD_0_12 DD5_01 – DD5_12 DD_18_01 – DD_18_12 DD18_01 – DD18_12 NFFD01 – NFFD12 PAS01 – PAS12

January - December degree-days below 0°C January - December degree-days above 5°C

January - December degree-days below 18°C January - December degree-days above 18°C January - December number of frost-free days January – December precipitation as snow (mm)

Eref01 – Eref12 CMD01 – CMD12 RH01 – RH12

# References

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