Canadian Gridded Data (CANGRD)

1. Overview

Gridded historical climate data, also referred to as Canadian gridded data (CANGRD), are datasets of historical gridded temperature and precipitation anomalies, interpolated from adjusted and homogenized climate station data (AHCCD) at a 50km resolution across Canada. The CANGRD is based on AHCCD for historical climate observations from 1948 for all of Canada until the end of the previous calendar year. The monthly, seasonal and annual mean daily maximum and minimum temperature anomalies are computed at each observing station and for each year by subtracting the relevant baseline average (defined as average over 1961-1990 reference period) from the relevant monthly, seasonal, and annual values. The monthly, seasonal and annual total precipitation anomalies are computed similarly. Additionally, the precipitation anomalies are then normalized by dividing by the mean reference period and expressed in percentage to produce normalized precipitation departures. CANGRD trends are also made available. Trend data represents the change in temperature or relative precipitation departure over the period of record.

Table 1. Main Characteristics

Datasets and units	Maximum temperature anomaly (°C) Minimum temperature anomaly (°C) Mean temperature anomaly (°C) Mean temperature trend (°C) Total precipitation anomaly (%) Relative total precipitation trend (%)
Spatial resolution and geographical coverage	50km resolution across Canada
Time period	Temperature anomalies: 1948-2018 Mean temperature trend: 1948-2018 Precipitation anomalies: 1948-2014 Precipitation trend: 1948-2012
Temporal resolution	Anomalies: Monthly, seasonal and annual Trends: Seasonal and annual

2. Datasets and formats

CANGRD provides the monthly, seasonal and annual anomalies for four variables:

- Maximum temperature: based on highest daily values. Units are Celsius degrees (°C).
- Minimum temperature: based on lowest daily values. Units are Celsius degrees (°C).
- Mean temperature: computed as the average of maximum and minimum temperature. Units are Celsius degrees (°C).
- Total precipitation: expressed as percentage (%).

The seasonal and annual trends are provided for two variables:

- Mean temperature: computed as the average of maximum and minimum temperature. Units are Celsius degrees (°C).
- Total precipitation: expressed as percentage (%).

2.1. Canadian Gridded Temperature Anomalies

The Canadian gridded temperature anomaly data consist of gridded monthly, seasonal and annual mean daily maximum and minimum temperature anomalies. The gridded temperature data are interpolated from homogenized temperature (i.e., AHCCD datasets). The anomalies are the difference between the temperature for a given year or season and a baseline value (defined as the average over 1961-1990 as the reference period). The 1961–1990 reference period was chosen because it is recognized by WMO as a standard reference period for long-term climate change assessments. The monthly, seasonal and yearly temperature anomalies were computed for the years 1948 to 2018. The data will continue to be updated every year.

2.2. Canadian Gridded Precipitation Anomalies

The Canadian gridded precipitation anomaly data consist of gridded monthly, seasonal and annual mean daily total precipitation anomalies. The gridded precipitation data are interpolated from adjusted precipitation (i.e., AHCCD datasets). The anomalies are the percentage difference between the value for a given year or season and a baseline value (defined as the average over 1961-1990 as the reference period). The monthly, seasonal and yearly relative precipitation anomalies were computed for the years 1948 to 2014. A reduction in manual weather stations in recent years has resulted in an insufficient number and density of stations to conduct precipitation interpolations. The data will be updated as time permits. It should be noted that generally there is much less precipitation in northern Canada than in southern Canada. As such, a percent departure in the north represents much less precipitation than the same percentage in the south.

2.3. Trend of Mean Temperature for 1948 – 2018 based on Canadian gridded data

Seasonal and annual trends of mean surface air temperature change for 1948-2018 based on Canadian gridded data (CANGRD) are available. Temperature trends represent the change in temperature over the period of record (1948-2018).

2.4. Trend of Total Precipitation for 1948 - 2012 based on Canadian gridded data

Seasonal and annual trends of relative total precipitation change for 1948-2012 based on Canadian gridded data (CANGRD) are available. The relative trends reflect the percent change in total precipitation over the period of record (1948-2012).

3. Methods

3.1. Interpolation

The station values of temperature anomalies from the baseline average are interpolated to the evenly spaced (50 km) grid boxes using the Gandin's Optimal Interpolation (OI) (Gandin, 1965; Alaka et al., 1972; Bretherton et al, 1976). Values for grid boxes over large bodies of water such as Hudson Bay are excluded. The grid box values of mean temperature departures are the average of those for daily minimum and maximum.

The station values of the normalized precipitation departures from unevenly distributed stations are interpolated to the evenly spaced (50 km) grid boxes using the Gandin's Optimal Interpolation (OI) (Gandin, 1965; Alaka et al., 1972; Bretherton et al, 1976). Values for grid boxes over large bodies of water such as Hudson Bay are excluded.

The CANGRD grid is in polar stereographic projection with a 50 km spatial resolution. The grid is a 125 (columns) by 95 (rows) matrix, where the SW corner (0,0) is at 40.045°N latitude and 129.85°W longitude. The projection is true at 60.0°N and centered on 110.0°W. Only grid points located within Canadian boundaries should be used.

3.2. Calculation of CANGRD trends

The trend datasets consist of gridded seasonal and annual trends of mean surface air temperature change from 1948-2018 and relative total precipitation change from 1948-2012. A Kendall linear trend is fitted to the temperature departures from the baseline value and to the normalized precipitation departure from the baseline value. It is still possible to have missing values for certain grid points in any given year, and even more recently, because of insufficient data for interpolation.

4. Application

The CANGRD dataset was created to assess long-term and spatial trends in Canada's climate, and are used to produce the Climate Trends and Variations Bulletin (CTVB). Trends serve as indicators of long-term change over the period of interest. Using departures from a mean reference period as opposed to actual observations are better suited for trend analyses of average conditions over an area, as it makes data more compatible across the country. Similarly, the normalization of the precipitation values are better suited to compare relative change in precipitation conditions. These values are better for national and regional assessments.

5. Limitations

It should be noted that the CANGRD dataset consist of temperature and precipitation anomalies, not actual temperature and precipitation values. In addition, CANGRD dataset are gridded datasets. If you require site-specific datasets, please consider using the adjusted and homogenized Canadian climate data (AHCCD). AHCCD are climate station datasets that incorporate adjustments (derived from statistical procedures) to the original historical station data to account for discontinuities from non-climatic factors, such as instrument changes or station relocation.

6. Other Considerations

It should be noted that ongoing research may result in future revisions of the CANGRD dataset (e.g., updated methodologies) to provide a better spatial and temporal representation of the climate trends in Canada.

7. Use limitation

Open Government Licence - Canada (http://open.canada.ca/en/open-government-licence-canada).

8. Contact Information

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9. References

Alaka, M. A., & Elvander, R. C. (1972). Optimum interpolation from observations of mixed quality. Mon. Weather Rev. 100(8): 612–624.

Bretherton, F.P, Davis, R.E., & Fandry, B. (1976). A technique for objective analysis and design of oceanographic experiments applied to MODE-73. Deep Sea Research, 23: 559-582.

Environment and Climate Change Canada (2018). Canadian Gridded Temperature Anomalies CANGRD. Accessed August 16 2018. Website: https://open.canada.ca/data/en/dataset/3d4b68a5-13bc-48bb-ad10-801128aa6604

Gandin, L.S. (1965). Objective analysis of meteorological fields (Israel Program for Scientific Translations, Trans.). Jerusalem, Israel: S. Monsoon. (original work published in 1963).

Mekis, É., & Vincent, L. A. (2011). An overview of the second generation adjusted daily precipitation dataset for trend analysis in Canada. Atmosphere-Ocean, 49(2), 163-177.