

# **Canadian Digital Surface Model Product Specifications**

**Edition 1.1**

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**RELEASES HISTORY**

<b>Date</b>	<b>Version</b>	<b>Description</b>
2013-04-01	1.1	Plane coordinate projection option upon data extraction
2013-04-01	1.1	Reference to SRTM as source

**ACRONYMS**

CDED	Canadian Digital Elevation Data
CDSM	Canadian Digital Surface Model
CGVD28	Canadian Geodetic Vertical Datum of 1928
DEM	Digital Elevation Model
GDB	Geospatial Data Base
ISO	International Organization for Standardization
MHWL	Mean High Water Level
MSL	Mean Sea Level
NAD83 (CSRS)	North American Datum of 1983 (Canadian Spatial Reference System)
NHN	National Hydro Network
NTDB	National Topographic Data Base
NTS	National Topographic System
SRTM	Shuttle Radar Topographic Mission

## TERMS AND DEFINITIONS

### Canadian Geodetic Vertical Datum of 1928 (CGVD28)

Official height reference system in Canada The reference frame for the CGVD28 is the 1928 mean sea level at six tide gauges located on both the Pacific and Atlantic Oceans as well as on the St-Lawrence River.

### CDSM Mosaic

Dataset corresponding to a subset of the CDSM, as extracted for a pre-defined or user-defined extent.

### Contour line

An imaginary line on the ground connecting an infinite number of points of equal elevation recorded in metres or feet relative to mean sea level based on the North American Datum 1983 horizontal reference datum.

### Digital Elevation Model (DEM)

A digital representation of relief composed of an array of elevation values referenced to a common vertical datum and corresponding to a regular grid of points on the earth's surface. These elevations and can be either ground or reflective surface elevations.

### Mean sea level (MSL)

The average sea level for a particular geographical location, obtained from numerous observations, at regular intervals, over a long period of time.

### Metadata

Information about the source data used to produce CDSM. The information is formally structured according to the *North American Profile of ISO 19115:2003 – Geographic information – Metadata*.

### North American Datum 1983 (NAD83)

The horizontal control datum for the U.S., Canada, Mexico and Central America, based on the Geodetic Reference System 1980 (GRS80) geocentric reference ellipsoid. The Canadian Spatial Reference System (CSRS) reflects the integration of the Canadian geodetic network to the NAD83.

### National Topographic System (NTS)

Official division and identification system for the base topographic maps of Canada.

### NHN Work Unit

Polygon which delimits the drainage area covered by a National Hydro Network (NHN) dataset.

### Orthometric elevation

Height of a point related to the geoid, usually determined by horizontal levelling and gravimetry, and presented in general as an MSL elevation.

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## 1. Overview

These product specifications apply to the Canadian Digital Surface Model (CDSM). The CDSM is part of Natural Resources Canada's altimetry system designed to better meet the users' needs for elevation data and products.

The 0.75-second (~20 m) CDSM consists of a derived product from the original 1-second (30 m) Shuttle Radar Topographic Mission (SRTM) digital surface model (DSM). The CDSM provides a complete coverage of the Canadian territory south of latitude 60 degrees North. In these data, the elevations are captured at the top of buildings, trees, structures, and other objects rather than at ground level.

In short, the SRTM data were re-processed as follows: the data was void-filled using the Canadian Digital Elevation Model (CDEM); the Vertical Datum was changed to CGVD28; the data was smoothed for noise removal; the data was aligned to the 0.75-second CDEM grid resolution; and the waterbodies were re-flattened. (See section 7.2 for more details)

A CDSM mosaic can be obtained for a pre-defined or user-defined extent. Derived products such as slope, shaded relief and colour shaded relief maps can also be generated on demand.

The coverage and resolution of a mosaic varies according to the extent of the requested area. The North American Datum 1983 (NAD83(CSRS)) is used as the reference system for horizontal coordinates.<sup>1</sup> Elevations are orthometric and expressed in reference to mean sea level. (Canadian Geodetic Vertical Datum of 1928 (CGVD28)).

The CDSM plays a role comparable to that of contours and relief shading on conventional paper maps. The CDSM serves as key data in a range of applications including: the rendering of three-dimensional visualizations, the creation of relief maps; telecommunication studies, line of sight analysis, flight simulation, and viewshed analysis and visualization.

## 2. Data Identification

### 2.1 Spatial Resolution

The base spatial resolution is the same for all the area covered by the CDSM. However, resolution may vary according to the extent of the area requested by the user.

The base resolution for CDSM is 0.75 arc seconds in both the south-north and the west-east direction. Nevertheless, because of file size constraints, resolution may also have to be lowered beyond that of the base resolution, at the time of extraction, depending on the extent of the region to be extracted. See Section 3.4 for further details.<sup>2</sup>

### 2.2 Language

NOT APPLICABLE

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<sup>1</sup> The CDSM data are stored in geographic coordinates but can be converted to a plane coordinate projection at the time of extraction.

<sup>2</sup> When a user chooses a plane coordinate projection at the time of extraction, the data are resampled using a regular grid approaching the resolution of the selected area in geographic coordinates. Refer to table 2, section 3.4 for more details.



## 2.3 Character Set

NOT APPLICABLE

## 2.4 Topic Category

According to the Global Change Master Directory thesauri, CDSM data can be classified into science key words structured using a 4-level hierarchy: Category>Topic>Term>Variable

CDSM data are classified by:

Science Keywords > Land Surface > Topography> Contours

Science Keywords > Land Surface > Topography> Terrain Elevation

Science Keywords > Land Surface > Topography> Topographic Relief

## 2.5 Geographic Box

The geographic box or minimum-bounding rectangle delineating the CDSM coverage is:

- West-bounding coordinate: 140° West (or -140°)
- East-bounding coordinate: 52° West (or -52°)
- North-bounding coordinate: 60° North (or 60°)
- South-bounding coordinate: 41° North (or 41°)

## 2.6 Geographic Description

The geographic area comprises lands and waters falling under Canadian jurisdiction to the south of latitude 60 degrees North.

## 2.7 Extent

The vertical domain of the dataset identifies the lowest and highest vertical extent contained within the data. The vertical extent is expressed in metres and can vary from -10 to 4,659 metres in Canada.

## 2.8 Supplemental Information

### 2.8.1 Elevations

Elevations are orthometric and expressed in reference to mean sea level (Canadian Geodetic Vertical Datum 1928 (CGVD28)). CDSM elevations are recorded as reflective surface elevations (top of buildings, trees, structures) or as bare ground elevations, when no obstacles are present.

### 2.8.2 Waterbodies

Canada's coastline, oceans and estuaries at mean sea level, are assigned an elevation value of zero metre.

Waterbodies are considered as naturally occurring areas of constant elevation (lakes) or having a small slope (rivers). Waterbodies are assigned their known or estimated elevation. Lakes are represented flatter and lower than the surrounding terrain and the shore is made clearly discernible. In general, a waterbody of unknown elevation is assigned an interpolated elevation that is lower than the contour elevation surrounding its shoreline. Rivers and streams are continuous (no gaps), have constant water flow and a descending order of z-values. Waterbodies (lakes) may not have a constant elevation. They may have a small slope to indicate the direction of the water flow.

### **2.8.3 Void Areas**

Void areas (areas where there is no data) are represented by elevation values of -32,767.

CDSM data contain void areas when they include lands or waters outside Canada's borders.

CDSM data are clipped to include a 500-metre buffer zone beyond the international boundary.

The international boundary, available on the GeoBase portal, is used for the purpose of clipping or merging CDSM data.

### **2.8.4 Quality Control**

Quality control assures that the CDSM data is smooth within the grid and continuous from one elevation point to the next, except at natural break points such as streams, cliffs, and craters.

The CDSM quality control process ensures that the watercourse direction of flow and the flatness of the water surface and surrounding area are considered.

## **3. Geospatial Characteristics**

### **3.1 Spatial Representation Type**

A grid format is used to represent the elevation data.

### **3.2 Spatial Representation**

CDSM mosaics contain a variable number of nodes (elevations), depending on the extent of the selected area and the chosen resolution. Hence, each mosaic holds a variable number of profiles. All profiles are oriented south-north.

### **3.3 Coverage and Continuity**

The CDSM provides a complete coverage of the Canadian territory located to the south of latitude 60 degrees North.

### **3.4 Resolution**

Within the CDSM the base resolution is 0.75 arc second both in the south-north direction and the west-east direction.

At the time of extracting a CDSM mosaic, another resolution can be selected if desired (see Table 1 hereafter). Also, because of file size constraints, resolution upon extraction may have to be lowered beyond that of the base resolution, depending on the extent of the region to be extracted.

		( Lat. < 60° )
<b>RESOLUTION</b> (latitude and longitude in arc seconds)	<b>Base:</b>	0.75" x 0.75"
		1.5" x 1.5"
		3.0" x 3.0"
		6.0" x 6.0"
		12.0" x 12.0"

**Table 1 – Available Resolutions of CDSM Data**

Furthermore, although CDSM data are stored in geographic coordinates, they can be converted to a plane coordinate projection at the time of extraction. In the case where the users chooses this option, the data are resampled using a regular grid approaching the resolution of the selected area in geographic coordinates.

<b>RESOLUTION</b>	<b>Base:</b>	20 m
		50 m
		90 m
		200 m
		400 m

**Table 2 – Resolution of CDSM data in plane coordinates**

### 3.5 Data Segmentation

NOT APPLICABLE

### 4. Data Model

NOT APPLICABLE

### 5. Data Dictionary/Feature Catalogue

NOT APPLICABLE

### 6. Reference System

#### 6.1 Horizontal Reference System

North American Datum 1983 (NAD83 (CSRS)).

### **6.1.1 Horizontal Coordinate System**

Data is stored in geographic coordinates (longitude ( $\lambda$ ) and latitude ( $\phi$ )). However, it can also be offered in a plane coordinate projection (X and Y) at the time of extraction. Definition for the coordinate system can be found in the metadata.

### **6.1.2 Horizontal Unit of Measure (coordinate system axis units)**

The unit of measure for storing horizontal data is decimal degrees. Meters will be used, however, if a plane coordinate projection is selected at the time of extraction.

## **6.2 Vertical Reference System**

Elevations are orthometric and expressed in reference to mean sea level (Canadian Geodetic Vertical Datum 1928 (CGVD28)).

### **6.2.1 Vertical Unit of Measure (coordinate system axis units)**

The unit of measure for storing vertical data is the metre. Elevations are expressed as floating point values.

## **7. Data Quality**

### **7.1 Scope**

NOT APPLICABLE

### **7.2 Lineage**

The 0.75-second (~20 m) CDSM consists of a derived product from the original 1-second (30 m) Shuttle Radar Topographic Mission (SRTM) digital surface model (DSM). The SRTM data were re-processed from their original form as follows: 1) the data was void-filled using the Canadian Digital Elevation Model (CDEM) with the Delta Fill Surface method from Grohman et al. (2006); 2) the Vertical Datum was changed from EGM96 to CGVD28; 3) the data was projected to UTM using cubic convolution; 4) the data was smoothed using the Denoise algorithm from Sun et al. (2010); 5) the data was re-projected from WGS84 to NAD83 and aligned to the 0.75-second CDEM grid resolution using cubic convolution; and 6) the waterbodies for which new elevations were calculated due to the change of vertical datum were re-flattened.

The horizontal reference system is the North American Datum of 1983 (NAD83 (CSRS)); the vertical reference system is the Canadian Geodetic Vertical Datum of 1928 (CGVD28).

Metadata describing the source data and the product generation process is made available when extracting a CDSM mosaic.

### **7.3 Completeness**

NOT APPLICABLE

### **7.4 Logical Consistency**

NOT APPLICABLE

### **7.5 Positional Accuracy**

Please see the CDSM metadata record for the horizontal and vertical positional accuracy reports.

## 7.6 Temporal Accuracy

NOT APPLICABLE

## 7.7 Thematic (attributes) Accuracy

NOT APPLICABLE

## 8. Metadata

Each CDSM mosaic has a corresponding metadata record that complies with the *North American Profile of ISO 19115:2003 – Geographic information – Metadata*. The metadata is supplied at the time of extracting a CDSM mosaic.

The CDSM mosaic metadata contain the following information:

1. Identification Information
2. Data Quality Information
3. Spatial Data Organization Information
4. Spatial Reference Information
5. Entity and Attribute Information
6. Distribution Information
7. Metadata Reference Information

## 9. DATA Portrayal/Data Transfer Format/Physical Model

NOT APPLICABLE

## 10. Data Capture and Maintenance

NOT APPLICABLE

## 11. CDSM Data Delivery

### 11.1 Format Information

The digital data exchange format for the CDSM data is GeoTIFF. The GeoTIFF format specification can be obtained from: <http://www.pubdoc.org/fileformat/rasterimage/tiff/geotiff.pdf> and <http://geotiff.maptools.org/spec/geotiffhome.html>.

### 11.2 Medium Information

NOT APPLICABLE

### 11.3 Data Use and Restrictions

Information regarding the use of the data is defined in the Open Government Licence Agreement for Unrestricted Use of Digital Data which can be found at: <https://open.canada.ca/en/open-government-licence-canada>.

## 11.4 Data Extraction

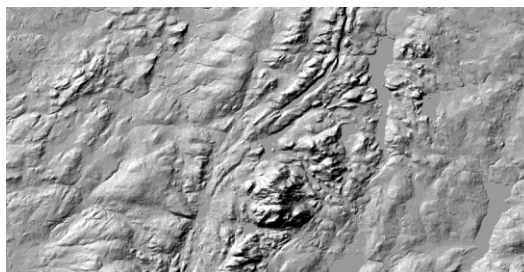
CDSM data can be extracted in the form of mosaics. A CDSM mosaic can be obtained for an extent defined by the user through a web interface or for a pre-defined extent such as an NTS sheet, an NHN Work Unit or a Landsat image ground trace.

## 11.5 Derived Products

Besides digital elevation models per se, CDSM data can be extracted as one of the following derived products:

### 11.5.1 Shaded Relief (or Hillshade)

A relief representation which enhances the illumination and shadow variations, according to elevation and slope, as created by a light source located at a specified height and in a specified direction. The resulting 8-bit greyscale raster image provides a realistic terrain visualization.



#### Optional parameters

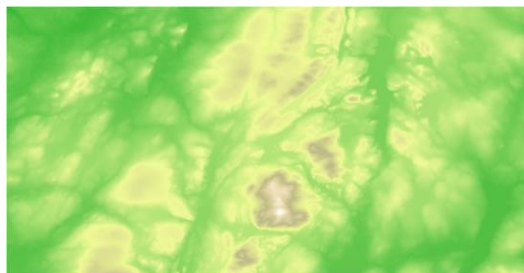
**Azimuth** Direction of light source, between 0 and 360, measured in degrees, clockwise from the north.  
Defaults to 315.

**Altitude** Vertical direction of light source, from 0 (horizon) to 90 degrees (zenith).  
Defaults to 45.

**zFactor** Vertical exaggeration factor.  
Defaults to 5.

### 11.5.2 Color Relief

A relief representation in which the elevations are assigned different colours according to their value. The resulting product is a 3-band (RGB) raster image where the colours are blended gradually to depict elevations, according to a pre-defined correspondence table.



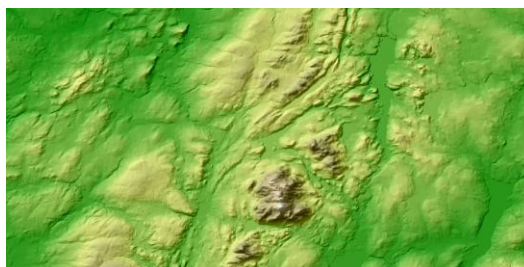
### 11.5.3 Color Shaded Relief

A relief representation combining a Color Relief image, in which the elevations are assigned different colours according to their value, and a Shaded Relief image, in which lighting enhances elevation and slope. The resulting product is a 3-band (RGB) raster image where colour intensity varies to provide a realistic terrain visualization.

#### Optional parameters

**Azimuth** Direction of light source, between 0 and 360, measured in degrees, clockwise from the north.  
Defaults to 315.

**Altitude** Vertical direction of light source, from 0 (horizon) to 90 degrees (zenith).



Defaults to 45.

zFactor Vertical exaggeration factor.

Defaults to 5.

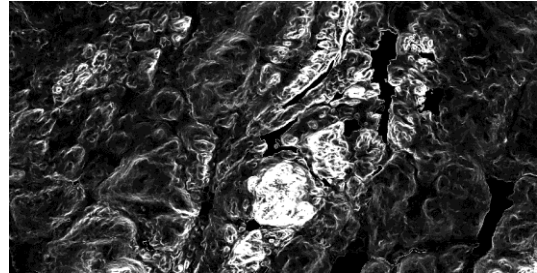
#### 11.5.4 Slope Map

A relief-derived representation in which every pixel is attributed the value of the greatest slope (the measure of change in elevation over distance, in degrees from the horizontal or as a percentage) at the corresponding point of the represented surface. The resulting product is a 32-bit raster image of slope values.

##### Optional parameter

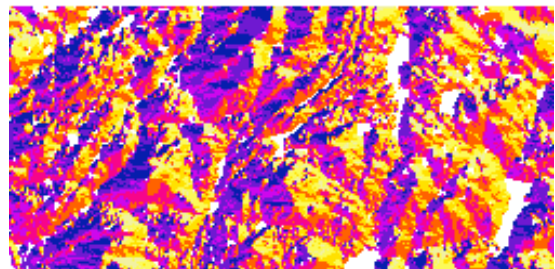
Slope type : Choice of degrees or percent slope.

Default : degrees.



#### 11.5.5 Aspect Map

A relief-derived representation in which every pixel is attributed the value of the azimuth which the slope is facing. Such azimuth value is comprised between 0 and 360, measured in degrees, clockwise, from the north. The value -9999 can also be used in flat areas where the slope value is zero. The resulting product is a 32-bit raster image of azimuth values.



#### 11.5.6 Point Data

Point data consist of sets of elevation points extracted from cells, or pixels, of digital elevation or digital surface data. They correspond to the coordinates (x, y) and altitude (z) of the center of every pixel from the elevation data for the chosen area. The resulting ASCII file is in CSV format and is composed of three columns: x, y and z. The column separator is a comma.