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Approximate formulas for the transformation between Swiss projection coordinates and-WGS84

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These formulas have a reduced accuracy and are thought to be used mainly for navigation purposes. They must not be used for cadastral surveying or geodetic applications!

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1 Approximate formulas for the transformation of ellipsoidal WGS84 coordinates to Swiss projection coordinates

(Precision in the order of 1 metre)

After: [H. Dupraz, Transformation approchée de coordonnées WGS84 en coordonnées nationales suisses, IGEO-TOPO, EPFL, 1992]

The parameters were re-determined by U. Marti (May 1999). In addition, the units were changed so that the parameters are comparable to the values published in [Bolliger 1967].

1. Convert the ellipsoidal latitudes φ and longitudes λ into arcseconds ["]
2. Calculate the auxiliary values (differences of latitude and longitude relative to Bern in the unit [10000"]):

   $\varphi' = (\varphi - 169028.66")/10000$
   $\lambda' = (\lambda - 26782.5")/10000$

3. Calculate projection coordinates in LV95 (E, N, h) or in LV03 (y, x, h)

$$
\begin{aligned}
E\,[m] = {} & 2600072.37 \\
& + 211455.93 \cdot \lambda' \\
& - 10938.51 \cdot \lambda' \cdot \varphi' \\
& - 0.36 \cdot \lambda' \cdot \varphi'^2 \\
& - 44.54 \cdot \lambda'^3
\end{aligned}
$$

$$y\,[m] = E - 2000000.00$$

$$
\begin{aligned}
N\,[m] = {} & 1200147.07 \\
& + 308807.95 \cdot \varphi' \\
& + 3745.25 \cdot \lambda'^2 \\
& + 76.63 \cdot \varphi'^2 \\
& - 194.56 \cdot \lambda'^2 \cdot \varphi' \\
& + 119.79 \cdot \varphi'^3
\end{aligned}
$$

$$x\,[m] = N - 1000000.00$$

$$
\begin{aligned}
h_{CH}\,[m] = {} & h_{WGS} - 49.55 \\
& + 2.73 \cdot \lambda' \\
& + 6.94 \cdot \varphi'
\end{aligned}
$$

4. Numerical example

given:	φ = 46° 02' 38.87"	λ = 8° 43' 49.79"	h_{WGS} = 650.60 m
→	φ' = -0.326979	λ' = 0.464729	
→ LV95	E = 2 699 999.76 m	N = 1 099 999.97 m	h_{CH} = 600.05 m
→ LV03	y = 699 999.76 m	x = 99 999.97 m	h_{CH} = 600.05 m
Reference:	y = 700 000.0 m	x = 100 000.0 m	h_{CH} = 600 m

The precision of the approximate formulas is better than 1 metre in position and 0.5 metres in height everywhere in Switzerland.

Remark on the heights:
In these formulas, one is supposed to work with ellipsoidal heights as obtained by GPS measurements. If 'heights above sea level' are used, the heights are the same in both systems on the 1 metre level. Therefore, no transformation is necessary.

2 Approximate formulas for the direct transformation of Swiss projection coordinates to ellipsoidal WGS84 coordinates

(Precision in the order of 0.1")

These formulas were derived by U. Marti in May 1999, based on the formulas in [Bolliger, 1967]

1. Convert the projection coordinates E (easting) and N (northing) in LV95 (or y / x in LV03) into the civilian system (Bern = 0 / 0) and express in the unit [1000 km]:

$$E' = (E - 2600000\ m)/1000000 = (y - 600000\ m)/1000000$$
$$N' = (N - 1200000\ m)/1000000 = (x - 200000\ m)/1000000$$

2. Calculate longitude λ and latitude φ in the unit [10000"]:

$$\lambda' = 2.6779094 + 4.728982 * y' + 0.791484 * y' * x' + 0.1306 * y' * x'^2 - 0.0436 * y'^3$$

$$\varphi' = 16.9023892 + 3.238272 * x' - 0.270978 * y'^2 - 0.002528 * x'^2 - 0.0447 * y'^2 * x' - 0.0140 * x'3$$

$$h_{WGS}\ [m] = h_{CH} + 49.55 - 12.60 * y' - 22.64 * x'$$

3. Convert longitude and latitude to the unit [°]

$$\lambda = \lambda' * 100 / 36$$
$$\varphi = \varphi' * 100 / 36$$

4. Numerical example

given:	E = 2 700 000 m	N = 1 100 000 m	h_{CH} = 600 m
→	y' = 0.1	x' = -0.1	
→	λ' = 3.14297976	φ' = 16.57588564	h_{WGS} = 650.55 m
→	λ = 8° 43' 49.80"	φ = 46° 02' 38.86"	
Reference:	λ = 8° 43' 49.79"	φ = 46° 02' 38.87"	h = 650.60 m

The precision of the approximate formulas is better than 0.12" in longitude, 0.08" in latitude and 0.5 metres in height everywhere in Switzerland.

Remark on the heights:
In these formulas one is supposed to work with ellipsoidal heights as obtained by GPS measurements. If 'heights above sea level' are used, the heights are the same in both systems on the 1 metre level. Therefore, no transformation is necessary.