

AT 329 Cold region field investigation

Exercises in use of differential GPS



GRUPPE 3

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Exercise 1 Heights

We didn't have a Garmin GPS reading so we have chosen to use the Sysseلمان point as example.

Point	Latitude	Longitude	N (UTM)	E (UTM)	Height (elips)
Sysseلمان	78°13'17.21883''	15°37'46.06754''	8683206.013	514280.690	66.801

This is given with ED50.

From the geopotential model EGM96 we read off that in Longyearbyen the geoid is approximately 33 m above the ellipsoid GRS80. The height given by a GPS, is the ellipsoidal height. Thus, the height from the point to the geoid, orthometric height, is the difference between the ellipsoidal height and the geoidal height: 66,801 m - 33 m \approx 34 m. A margin of error in this answer is the difference between ED50 and GRS80.

The height above sea level depends on how sea level is defined (high/low/mean tide), but is close to the geoidal height, namely 34 m.

Exercise 2 Coordinates

a) and b)

We transform the coordinates from Spherical to Cartesian in Matlab. The program is given underneath. Note that we have used slightly different notation – see figure below.

```
clear all, close all
format compact
format long
```

```
lat = 78+9/60;
lon = 15+40/60;
h = 220;
RN = 6398684.45 + h;
a = 6378000;
b = 6357000;
```

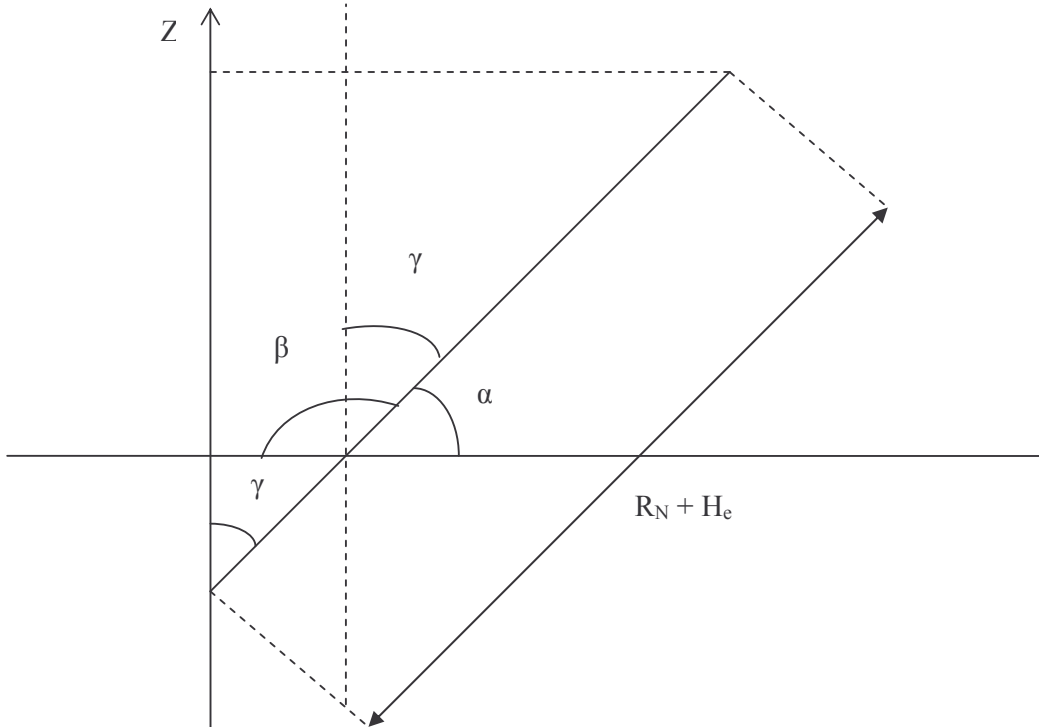
```
alfa = lat*pi/180;
betha = lon*pi/180;
gamma = (pi/2)-alfa;
```

```
X = RN*sin(gamma)*cos(betha)
Y = RN*sin(gamma)*sin(betha)
Z = ((b/a)^2)*RN+h)*sin(alfa)
```

=====

Out put:

```
X = 1.265199285427844e+006
Y = 3.548373905851051e+005
Z = 6.221578138317017e+006
```



The answers are checked against the coordinates produced by Wsktrans:

Velg Fra-system EU89-Geodetisk	<input checked="" type="checkbox"/> NGO1948-Gauss-K	<input type="text"/> N =	<input type="text"/> E =	<input type="text"/> Akse	Gilakse
	<input type="checkbox"/> ED50-UTM	N = 8675404	E = 515346	Sone	Sone 33
	<input type="checkbox"/> ED50-Geodetisk	Br = 078 08 58.53	Ln = 015 40 9.82		
	<input checked="" type="checkbox"/> EUREF89-UTM	N = 8675197	E = 515282	Sone	Sone 33
<input checked="" type="checkbox"/> Sone-Sone					
	<input type="checkbox"/> Høyde i NN1954	H =			
	<input checked="" type="checkbox"/> Ellipsoidisk høyde	h =	220		
	<input checked="" type="checkbox"/> Differanse N = h · H	N =			
	<input type="checkbox"/> EUREF89-XYZ	X =	1265199	Y =	354837
		Z =	6220612		

c) The ellipsoid is constructed to optimally fit the shape of the earth. The shape of the ellipsoid can be expressed by a line going normal to the surface with the length of: 6398684.45 m. The “end” around which R_n will rotate, will due to the length that differs from the center as given by the long and short axis of the earth (6378 and 6357 km respectively) not rotate within the center of the earth.

d) This radius will better describe the shape (curvature) of the earth “below” Norway and its end (R_n) will thus not be centered in the center of gravity of the earth.

Exercise 3 Processing and transforming data sets

We want to process the data from Bogerbreen using SKI-Pro. The coordinates at Syssemmannen is set as a control point, and the coordinates at the reference point at Bogerbreen is then found.

Results – Baseline

syss - ref 2

Project Information

Project name:	Bogerbreen
Date created:	03/08/2005 16:22:30
Time zone:	1h 00'
Coordinate system name:	Oppdal S
Application software:	Leica SKI-Pro 3.0
Processing kernel:	PSI-Pro 1.0
Processed:	03/11/2005 14:01:32

Point Information

	Reference: syss	Rover: ref 2
Receiver type / S/N:	SR530 / 36906	SR530 / 35990
Antenna type / S/N:	AT502 Pillar / -	AT202/302 GP / -
Antenna height:	0.0750 m	0.7900 m
Initial coordinates:		
X:	1258066.1429 m	1266188.0179 m
Y:	351822.1898 m	353959.7996 m
Z:	6222062.6719 m	6220732.5114 m

Processing Parameters

Parameters	Selected	Used	Comment
Cut-off angle:	15°	15°	
Ephemeris type:	Broadcast	Broadcast	
Solution type:	Automatic	Phase	
Frequency:	Automatic	Automatic	
Fix ambiguities up to:	80 km	80 km	
Min. duration for float solution (static):	5' 00"	5' 00"	
Sampling rate:	Use all	10	
Tropospheric model:	Hopfield	Hopfield	
Ionospheric model:	Automatic	Computed	
Use stochastic modelling:	Yes	Yes	
Min. distance:	8 km	8 km	
Ionospheric activity:	Automatic	Automatic	

Satellite Selection

Manually disabled satellites: None

Ambiguity Statistics

Total number of ambiguities:	1864
Number of fixed ambiguities:	16
Number of independent fixes:	1
Avg. time between independent fixes:	1' 20"
Percentage of fixed epochs (L1):	7%
Percentage of fixed epochs (L2):	7%
Percentage of fixed epochs (overall):	6%

Final Coordinates

	Reference: syss	Rover: ref 2	
Coordinates:			
X:	1258066.1429 m	1266403.0253 m	
Y:	351822.1898 m	353950.1832 m	
Z:	6222062.6719 m	6220691.1521 m	
Solution type:	Phase		
Frequency:	L1 and L2		
Ambiguity:	Yes		
Quality:	Sd. X: 0.0011 m Posn. Qlty: 0.0022 m	Sd. Y: 0.0014 m Hgt. Qlty: 0.0069 m	Sd. Z: 0.0070 m Sd. Slope: 0.0014 m
Baseline vector:	dLat: -0° 04' 40.53251" Slope: 8712.8084 m	dLon: -0° 00' 30.73341"	dHgt: 419.4108 m
DOPs (min-max):	GDOP: 2.3 - 6.6 PDOP: 2.0 - 5.6	HDOP: 0.8 - 1.7	VDOP: 1.9 - 5.4

The coordinates are given in WGS84, but transformed to ED50 in Wsktrans 5.0:

Velg Fra-system

EU89-Geodetisk

NG01948-Gauss-K

N =

E =

Akse Gi akse

ED50-UTM

N =

E =

Sone Sone 33

EUREF89-UTM

N =

E =

Sone Sone 33

ED50-Geodetisk

Br =

Ln =

EUREF89-Geodetisk

Br =

Ln =

Sone-Sone

Høyde i NN1954

H=

Ellipsoidisk høyde

h=

Differanse N = h · H

N=

Following the same procedure, the coordinates of the 15 points registered around Syssemmannen can be found.

Exercise 4 Orthometric correction

Orthometric height (height above the geoid) is transformed from the ellipsoid height (given by the GPS) by subtracting the elevation difference between the ellipsoid and the geoid (geoidal height). The same geoidal height as in exercise 1 is used, but the error of margin might be a bit different due to the different datums.

Point	Ellipsoidal height	Geoidal height	Orthometric height
Syssemmannen	66.801 (ED50)	≈ 33	≈ 34
Bogerbreen	484.6739 (WGS84)	≈ 33	≈ 452