Exercises for Reference Frames and Basic Units

1. Find the changes in (ϕ, λ, h) at the point $\phi = 57°$, and $\lambda = 10°$ when we shift by $(t_x, t_y, t_z) = (-87, -98, -121)$, deminish a by 251 m $(da = -251)$ and change f by $df = 1/297 - 1/298.257223563$.

   Realize that this is the transformation from ED 50 to WGS 84. Hint: Use datumch.

2. Which changes do we experience for the point with coordinates $\phi = 56°$, and $\lambda = 10°$.

3. The datum ED 50 is based on the international ellipsoid of 1924 with $a = 6\,378\,388$ m. The datum WGS 84 has $a = 6\,378\,137$ m. Adding the 251 m to the semi-axis a, changes the position $\phi = 57°$ North, and $\lambda = 10°$ East. But loosely how?

4. The different position of ED 50 with respect to WGS 84 is decribed by the translational vector $t = (-87, -98, -121)$. Can you loosely describe the influence of t on the position $\phi = 57°$ North, and $\lambda = 10°$ East.

5. Given a point with $(\phi, \lambda, h) = (57°, 10°, 60\,\text{m})$ in WGS 84. Find the Cartesian coordinates (X, Y, Z). Hint: Use geo2cart.

6. Given a point with the (X, Y, Z) from Ex. 5.

   Find the geographical coordinates of the point in WGS 84. Hint: Use cart2geo.

7. Given the same (X, Y, Z) as in Ex. 5, but compute the geographical coordinates now relative to the international ellipsoid 1924. Comment the result! Hint: Use cart2geo.

8. Find the length along a meridian from Equator to a point at latitude $\phi = 57°$ in WGS 84.

9. Find the length along a meridian from Equator to a Pole in WGS 84.

10. Direct problem. Given a point with $\phi = 57°$, $\lambda = 10°$, $A_1 = 45°$ and three different values of $s = 1000$ m, 10 000 m, and 30 000 m.

    Compute (ϕ_2, λ_2) and A_2 for all three cases using WGS 84. Hint: Use bessel_1.

11. Inverse problem. Given the results from Ex. 10: (ϕ_2, λ_2) and A_2.

    Find the distances s and azimuths between (ϕ_1, λ_1) and (ϕ_2, λ_2) using WGS 84. Hint: Use bessel_2.

12. Convert the coordinates $X = 3429122.662$, $Y = 604646.845$, and $Z = 5325950.420$ into (N, E) in UTM, zone 32. Hint: Use cart2utm.

13. Convert $N = 6318036.28$, $E = 560828.13$ into geographical coordinates (ϕ, λ). Hint: Use utm2geo.

14. Convert $\phi = 57°$, $\lambda = 10°$ into (N, E) in UTM, zone 32. Hint: Use geo2utm.

15. Convert the UTM coordinates $N = 6317972.081$, and $E = 560749.622$ into geographical coordinates. Hint: Use utm2geo.

16. Compute how scale and meridian convergence change as functions of position. As illustration, plot the pertinent grid or ellipses at some predefined points. The ellipses are oriented according to the grid and the size depict the change in scale.