AH2923 VT2023

Assignment 3

Models for correction of atmospheric effects

The goal of this exercise is to get acquainted with the effect of troposphere and ionosphere on the GNSS observations. You will apply these effects in the following labs when computing receiver's position from code pseudoranges.

Tropospheric delay

Compute the tropospheric delay for the satellites you used in Assignment 2, use your code from Assignment 1 to compute the zenith angels.
Use the Saastamoinen tropospheric model using equation (5.119) from Hoffmann-Wellenhof et al. page 135 as well as refined model (Equation 5.120). Use standard values for temperature, pressure and humidity: 18°C, 1013 mbar, and 50% (0.5).

The relative humidity, RH, must be converted to partial pressure of water vapor, e_s, using the following expression:

$$e_S = 6.108 \cdot RH \cdot \exp\left(\frac{17.15T - 4684}{T - 38.45}\right)$$

where T is temperature in Kelvin. The unit of e_s as estimated with this expression is hPa.
For station height, use the location you worked with in the Assignment 2 ("approx. position xyz" provided in the header of the RINEX observation file).

Check your implementation of the model using the numerical example provided in the book on page 135.

Investigate how the change in temperature and humidity affects the ZTD (zenith tropospheric delay). Vary the temperature from -30°C to 30°C, humidity from 0 to 100% and plot the computed ZTD.

Ionospheric delay
Estimate the ionospheric delay for the L1 frequency (only the first order effect) using the standard expression given in Lecture 4:

$$d_g = \frac{40.3}{f^2} TEC \times OF_\zeta$$

Where f is the carrier frequency and OF is the obliguity factor:

$$OF_\zeta = \left[1 - \left(\frac{R_E \sin(\zeta)}{R_E + h_I}\right)^2\right]^{-1/2}$$

where h_I is the mean ionospheric height, 350 000 m, R_E is Earth mean radius, 6 371 000 m, and ζ = 90 - elevation angle.

Find an approximate TEC value using the International Reference Ionosphere on:
https://ccmc.gsfc.nasa.gov/modelweb/models/iri2016_vitmo.php

Enter date, time, and geographic coordinates in degrees. Under *Optional Input – Electron content* enter an upper boundary of 2000 km. Under *Select desired output parameters* click Total Electron Content (TEC), then *Submit* and find information on TEC value in the corresponding column of the profile output by the model. The TEC is the same for all levels in the model, because it is the “total” electron content through the ionosphere.

Convert the TEC-value from TEC-units to electrons / m^2.

Remember to correct for the elevation angle.

The report must contain:
A list of the elevation angle, troposheric error in meter and ionospheric error in meter for each of the visible satellites. Also an evaluation of the errors - do they seem reasonable? Finally, include a discussion on how the tropospheric error is affected by changes in the weather.

Matlab code must be submitted separately. Make sure to submit all files necessary for the teacher to run the scripts.