May 7, 2024

GMT312 - GLOBAL NAVIGATION SATELLITE SYSTEMS
SPRING 2023/24

ASSIGNMENT IV

Due: May 18, 2024 – 23:59

Computation of ionospheric and tropospheric delays for a given GPS signal

Please calculate the ionospheric and tropospheric delays for the C/A signal of the first GPS satellite at the reception epoch specifically assigned to you. You will also need to compute the azimuth and zenith angles and slant distance in the local ellipsoidal coordinate system of the receiver (MERS).

<u>Steps:</u>

1) Application day is March 1, 2024. The observation files with observation sampling rate of 30 seconds "*mers0610.24o*" or "*MERS00TUR_R_20240610000_01D_30S_MO.rnx*" besides combined IGS precise ephemeris file "*IGS0OPSFIN_20240610000_01D_15M_ORB.SP3*" and navigation data file "*brdc0610.24n*" should be used for the assignment. You will need to uncompress the unix compressed (.Z or .gz) and the Hatanaka compressed files.

2) Compute the observation epoch (reception time) which will be used for the calculations (seconds of the day):

$t_{rcv}^{reception}$ = (*the sum of all digits of your school ID*) *870 sec. (between 0-86400).

If the reception time is a common multiple of 900, add 720 seconds to it.

If there are not any available GPS satellites with C/A observations in the reference epoch which is assigned to you, please add 720 seconds to your epoch.

3) You will use the functions that you wrote within the previous assignments to compute signal emission time, final satellite coordinates with SP3 data for the signal emission time, and azimuth and zenith angles for the satellite whenever needed.

4) Considering the previous assignments, you need to write one additional function (in MATLAB or Python). The detailed description of the function is given below:

* **[*az, zen, slantd, IonD, TrD, TrW*] = atmos(*doy, trec, trecw, C1, rec, sp3, alpha, beta*)**

This function will manage all processes and call other functions.

Inputs:	*doy*	Day of year for the observation	Integer
	trec	Reception epoch assigned to you	(seconds of day)
	trecw	Reception epoch in seconds of week	(seconds of week)
	C1	C/A (C1) observation for the first GPS satellite at the observation (reception) epoch	(Meter)
	rec	Approximate receiver coordinates (3x1)	(Meter)
	sp3	A matrix (or correspondent array) composed of the time tags (t); corresponding satellite coordinates (X, Y, Z); and the satellite clock corrections for ten consecutive epochs (five epochs after and before the reception time) which are obtained from the related precise ephemeris	10x5 matrix
	alpha	ION ALPHA (or GPSA) parameters from the header of the navigation file	1x4 matrix
	beta	ION BETA (or GPSB) parameters from the header of the navigation file	1x4 matrix

Outputs	*az*	azimuth angle in degree [-180,180]	(Degree)
	zen	zenith angle in degree [-90,90]	(Degree)
	slantd	slant (radial) distance	(Kilometer)
	IonD	Ionospheric delay for the related signal	(Meter)
	TrD	Tropospheric dry (hydrostatic) delay for the related signal	(Meter)
	TrW	Tropospheric wet delay for the related signal	(Meter)

Within this function:
- Compute the corrected signal emission time and final coordinates of the satellite. You can use the functions written within the previous assignment for this step.
- Calculate their azimuth and zenith angles, and slant distance using the functions "***local***" and "***xyz2plh***" functions from the first assignment.
- Calculate the ionospheric and tropospheric delays for the related azimuth and zenith angles computed for the corresponding satellite. When computing the ionospheric and tropospheric delays, please employ the functions given together with the assignment, which are "***Ion_Klobuchar.m***" or "***Ion_Klobuchar.py***" and "***trop_SPP.m***" "***trop_SPP.py***". The descriptions for input/outputs of these functions are provided within the corresponding function. Note that you can use the ellipsoidal height (instead of orthometric height) to call "***trop_SPP***". Besides, please be careful that the related angles should be input in "radians" for the "***Ion_Klobuchar***" function.

Notes:

- Please be careful about the function structures (inputs, outputs etc.). Try to avoid or minimize repetitions of similar codes in your functions.
- Be careful about the units for all steps.
- At the very beginning of each function (after the first line) place comment lines to introduce its functionality besides inputs and outputs. Also put comment lines within your codes to explain the main steps.
- Refer to related file formats (RINEX navigation and SP3c) whenever needed.
- **As a part of this assignment, please deliver a report providing the details and results of the calculations in addition to the MATLAB or Python functions**.
- Assignments should be submitted via HADİ platform only.
- Collaboration for the homework is strictly disallowed. Please submit your own work. Collaborated submissions will be downrated significantly.
- Constants:
  Velocity of light $c = 299792458\ m/s$
  Earth's gravitational constant (WGS84) $\mu = 3.986005.10^{14}\ m^3/s^2$
  Earth's rotation rate (WGS84) $w_E = 7.2921151467.10^{-5}\ rad/s$
  Semi-major axis of the ellipsoid (WGS84) $a = 6\ 378\ 137.0\ m$
  Flattening Factor (WGS84) $1/f = 298.257223563$
  Eccentricity $e^2 = 2f - f^2$