LAB EXERCISE: 3

GNSS Data Processing using Bernese Software
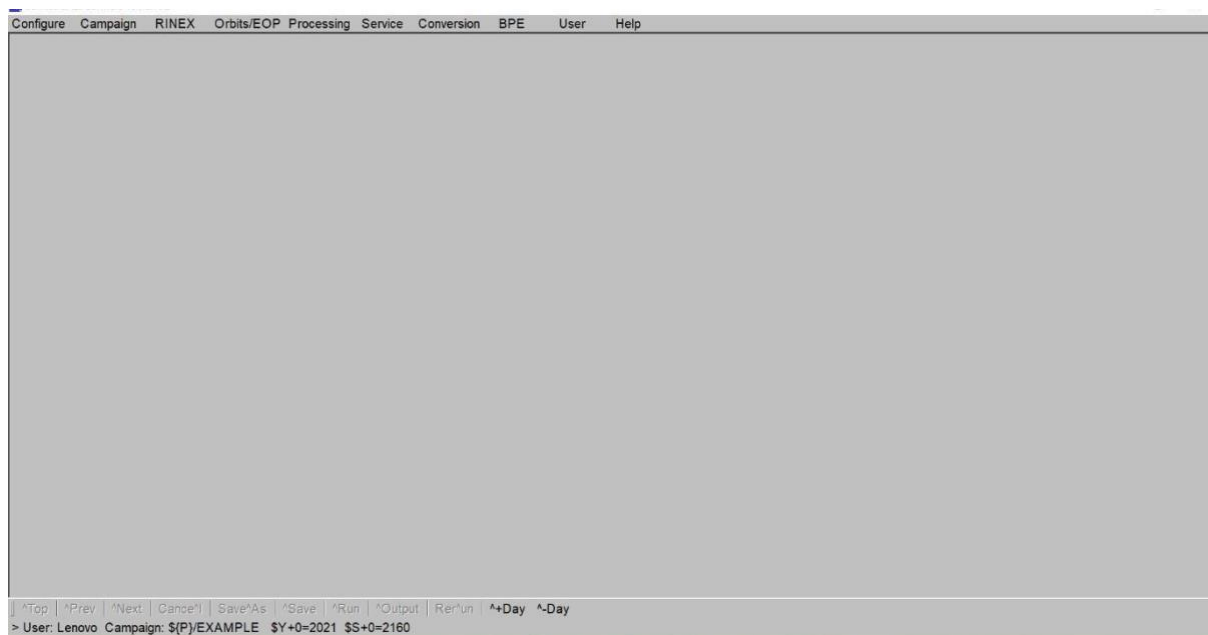

Bernese 5.2 User Interface

Figure: Bernese software interface

Different files used in Bernese:

CRD: Geocentric station coordinates.

VEL: Station velocities information; Velocity information (V_X, V_Y, V_Z in meter per year)

FIX: Selection list of station names for automated processing, e.g., for datum definition, selection of potential reference clock, etc. File contains station name and marker number.

ERP: Pole coordinates, UT1−UTC, UTC−GPS, nutation offsets.

EPH: Final GNSS orbits and clocks for the day of year.

CLK: Satellite and station clock parameters in the official clock RINEX format.

STA: Station related meta information (e.g., station name, equipment, intervals with problematic data)

ABB: Station abbreviation table; 4– and 2–character station abbreviations.

PLD: Tectonic plate assignment of unknown stations.

DPE045.EPH: Information about Planetary and Lunar ephemerides. The Development Ephemerides

DE405 are available from JPL and is in binary format.

DCB: Differential code biases. They are the systematic errors due to hardware delays , or biases, between two GNSS code observations at the same or different frequencies. DCBs are required for code-based positioning of GNSS receivers, extracting ionosphere total electron content (TEC), and otherapplications.

P1P2: Differential (P1-P2) code biases for satellites and receivers (in nanoseconds).

P1C1: Differential (P1-C1) code biases for satellites and receivers (in nanoseconds).

ION: Ionosphere models (represented by sets of TEC parameters). The ionospheric models can be local, global or station specific model.

PCF: Process control files; It defines which scripts should run and in what order they should be executed.

HOI: higher order ionosphere corrections.

SAT_2022.CRX: Known station inconsistencies, i.e., known wrong RINEX header entries for receiver name/number, antenna name/number, or antenna eccentricity.

SNX: Coordinates, velocities, ERPs and other parameters in the Solution Independent Exchange format (SINEX) Version.

CLU: Define cluster of sites depending on correlation between them.

Processing multi day UP CORS data using Bernese software

Current Session and Active Campaign:

A session is the time interval covering all observations to be processed together. The current session can be set by using "*Configure>Set session/compute date*" which provides a date selection dialogue as shown in figure:
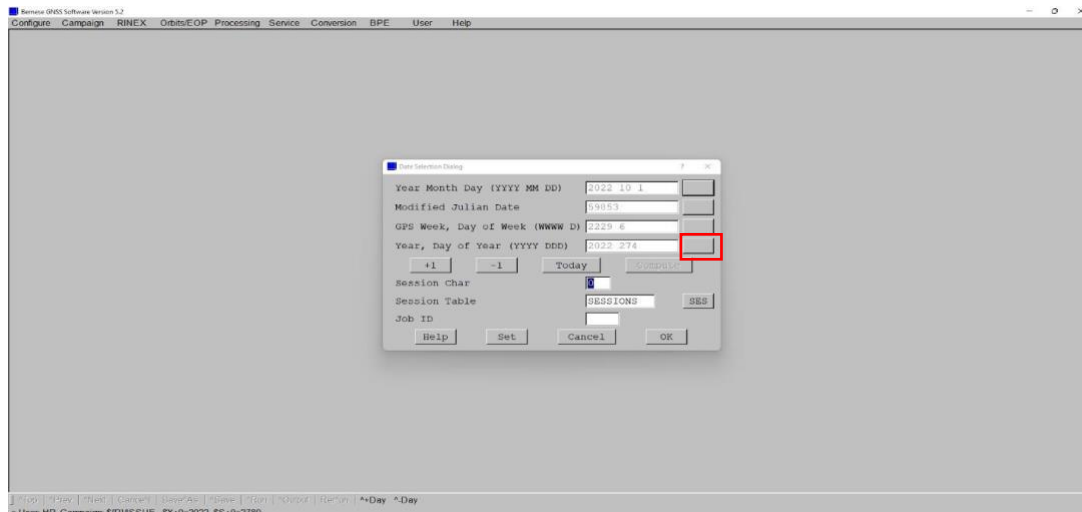

Figure: Date selection dialogue to set the current session

In current session tab, out of the 4 formats (Year Month Day, MJD, GPS Week and Day of week, and Year, Day of Year) you need to write in only one entity and click on compute option. Corresponding other rows will be automatically computed. For processing multi day data, insert the first day of your observation in Date Selection Dialog and the software is intelligent by itself to process the subsequent days of data if it gets the necessary input raw files.

Click OK.

The active campaign is listed in the status bar of the menu. The menu needs to know the campaign you are currently processing. For this, *"Campaign >Edit List of campaigns"*. Click on the plus sign to edit a new campaign and save it as shown in figure below.

NOTE-

1. Newly created campaign is the folder in which you will perform the processing and the output files will be generated in this folder only.

2. In this example, we chose the campaign name as **CORS**. **You can choose any name as per your choice. Don't stick to the name CORS only for naming your campaign, you can choose any 4 letters name for your campaign. As we have chosen CORS as our campaign name we will stick with it throughout our manual.**

3. Make sure that campaign name consists of 4 letters only without any number used (Though it's not mandatory but advised. Creating campaign with its large name will lead to error in later stage of processing)**.**

Now, to select active campaign "*Campaign>Select active campaign*". Select the campaign which you have recently created. Click OK and *neglect the two warning messages*.
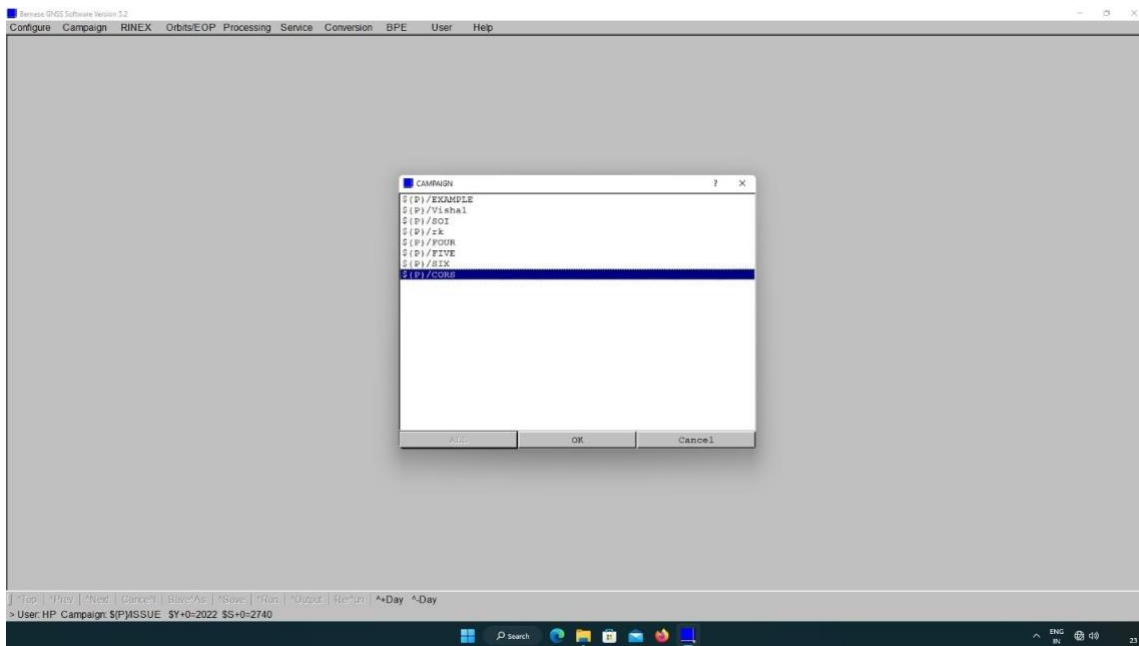
For creating the new campaign, "*Campaign> Create new campaign> Run*".
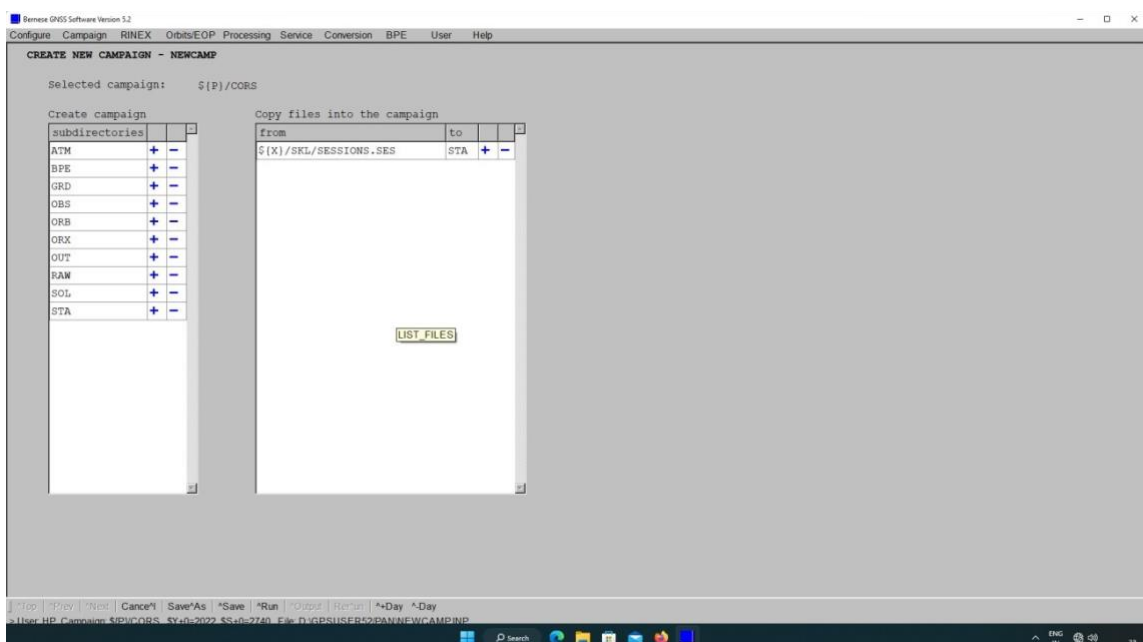
After this step you can see that a folder **CORS** is created in Campaign52 folder.
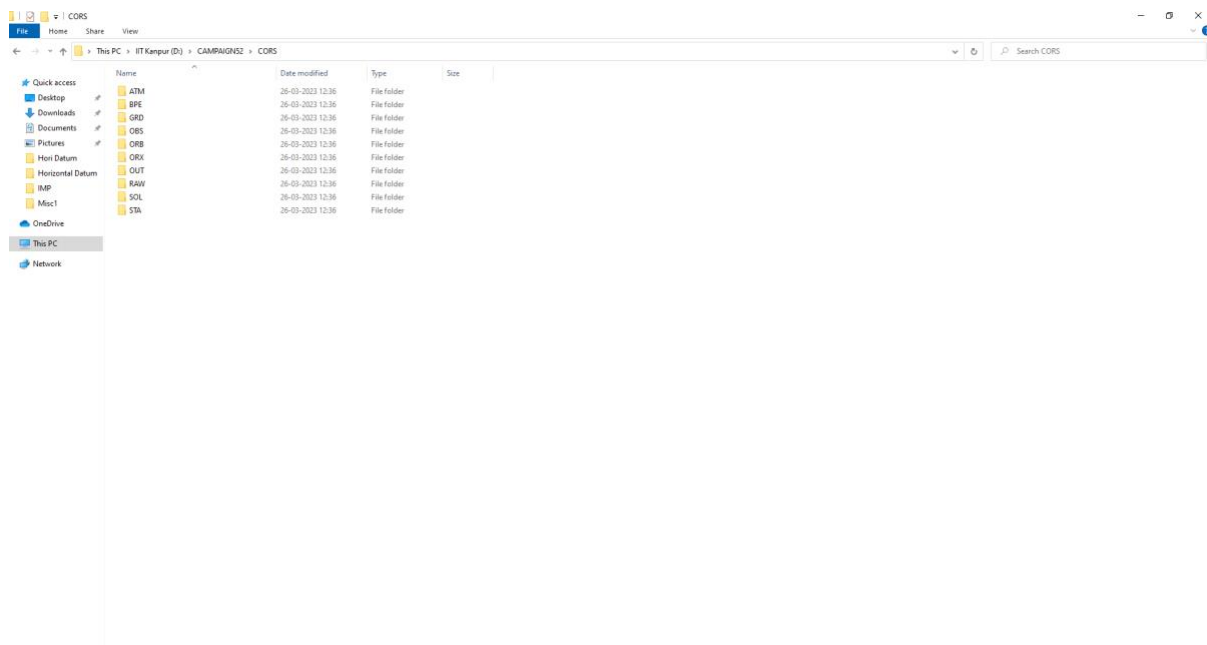
Data Downloading using FTP:

NOTE: Before starting to download the data, you are suggested to create a folder on your desktop, so that initially you can paste all the necessary raw files at one place and later paste in the necessary folders wherever required.

It is important to download the supporting data files using ftp which will be used in processing. For accessing any files using FTP, *make sure that you have your internet connection.*
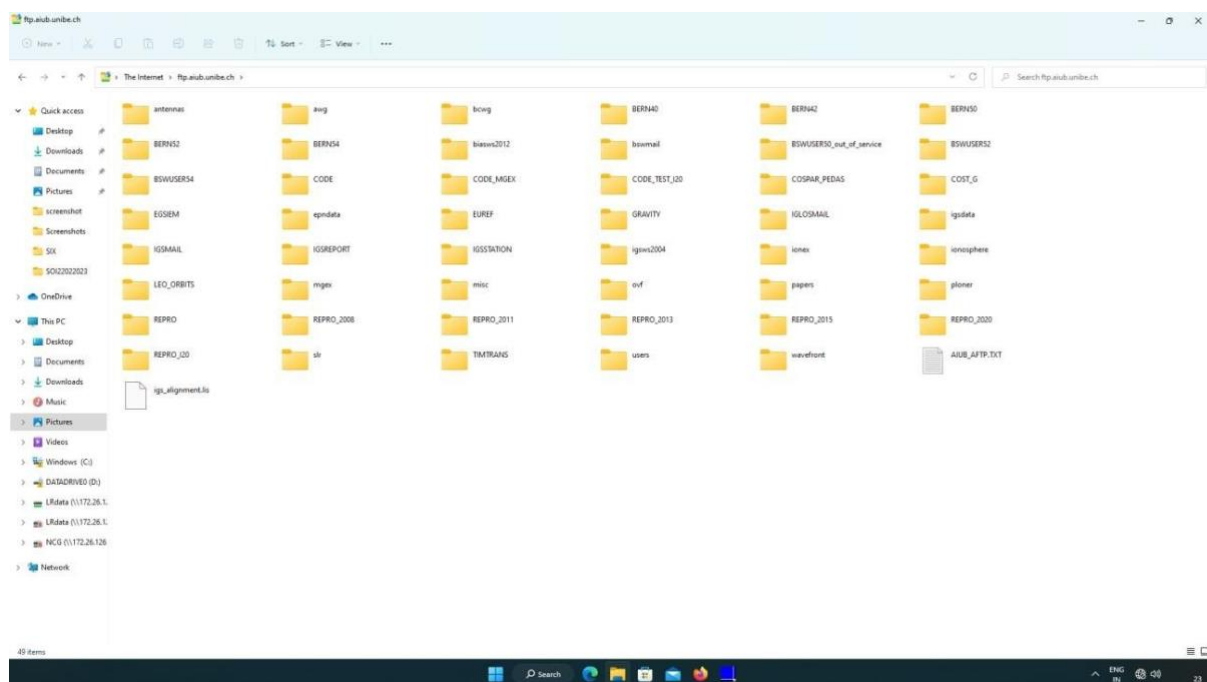
The files to be downloaded using *ftp://ftp.aiub.unibe.ch/* are as follows-

CLK, ERP, EPH, ION, P1C1XXXX.DCB, P1P2XXXX.DCB will be downloaded from - *ftp://ftp.aiub.unibe.ch/>CODE>YEAR (year folder corresponds to the year in which you are processing RINEX data)*

NOTE: For accessing the ftp from AIUB and GARNER (SOPAC) site, instead of writing complete

path it is better to write *ftp://ftp.aiub.unibe.ch/* or *ftp://garner.ucsd.edu/* and then manually access the corresponding folders.

For e.g. The file will be named as, COD22303.CLK for 5st October 2022 where 2230 i.e. first 4 numbers represents GPS week and last digit i.e. 3 here represents Day of Week. Similarly you have to download other necessary files depending on the day which you are processing RINEX data.

NOTE:

1) CLK, ERP, EPH and ION are **daily files**, so download that day file only on which you are processing the RINEX data. The GPS week and day of week can be seen in *Configure>Set Session/Compute date* option.

2) Download the raw files for all 4 days at this moment only.

P1C1 and P1P2 files are **monthly files**. For e.g. P1C1 file October 2022 will be named as P1C12210.DCB. If the file name is P1C12210.DCB.Z, it simply means that the file is zipped.

Download CRD, VEL, FIX and PSD files from *ftp://ftp.aiub.unibe.ch/>BSWUSER52>STA*. The files will be like IGS14.FIX, IGS14_R.CRD, IGS14_R.VEL and IGS14.PSD.

Download SAT_2022.CRX file from *ftp://ftp.aiub.unibe.ch/>BSWUSER52>GEN.*

The RINEX files of different IGS stations which will be used as the known stations for processing can be downloaded from- *ftp://garner.ucsd.edu>pub>rinex*. *(This is an optional step as you already have the IGS RINEX files, if you don't have then you need to download using this ftp site).*
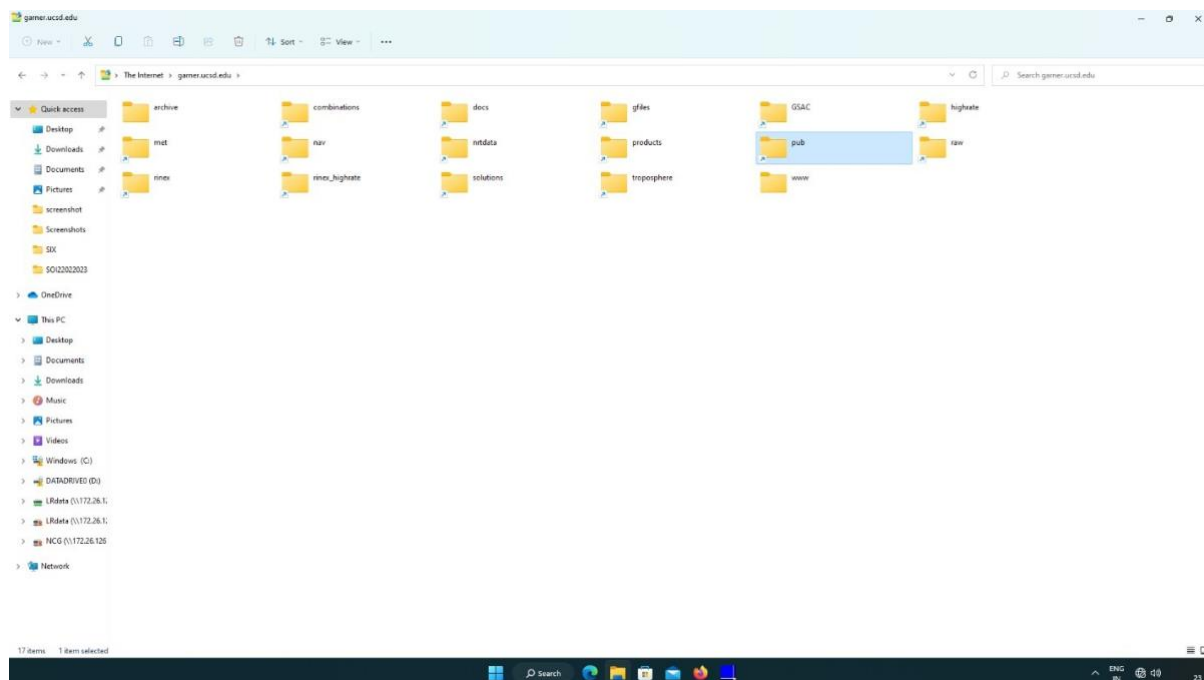
Download the RINEX files of known stations (IISC, HYDE, KIT3, LHAZ, LCK4) corresponding to the day and year needed in .gz format. [For 5st October 2022 – folder will be named as day of the year i.e. 278 in which you can find the RINEX files of all IGS stations.

NOTE: The Bernese software supports both RINEX version 2 and 3 formats. The file should be in uncompressed format i.e. .22o or .rnx. If it is Hatanaka compressed, uncompress the RINEX file using crx2rnx application. Also, the naming convention of version 3 is not supported in Bernese

5.2 and the software doesn't use the RINEX version 3 file which has long naming. Thus, it is required to change the naming of file from version 3 to version 2.

e.g. A file with naming as LCK400IND_R_20222540000_01D_30S_MO.rnx must be changed to LCK42540.22o. Here LCK4 is the name of the station and 254 is the day of the year.

To change the extension of a file. Go to *Menu>File Explorer Options>View>Hide extensions for known file types (Uncheck this option)>Apply.*

This will enable the option to rename the extension too along with renaming the filename.

NOTE: Before renaming a file, make sure that it is unzipped (using winrar or 7Zip tool) and uncompressed using crx2rnx application).

The Planetary and Lunar Ephemerides file (DE405.EPH) is downloaded from JPL NASA website DE405.EPH.

Download the file lnxp1600p2200.405 and rename it to DE405.EPH.

Information about UP CORS RINEX data

The 4 days UP CORS data has already been downloaded by you in TBC lab. The same data has to be used you in today's lab also. The IGS stations will also be same i.e. IISC, HYDE, LCK4, LHAZ, KIT3.

Conversion of files into RINEX format

For converting the Hatanaka to RINEX format use *crx2rnx.exe* application. Open the .22d files using this crx2rnx.exe. The files will be converted into .22o format as shown in the figure below.
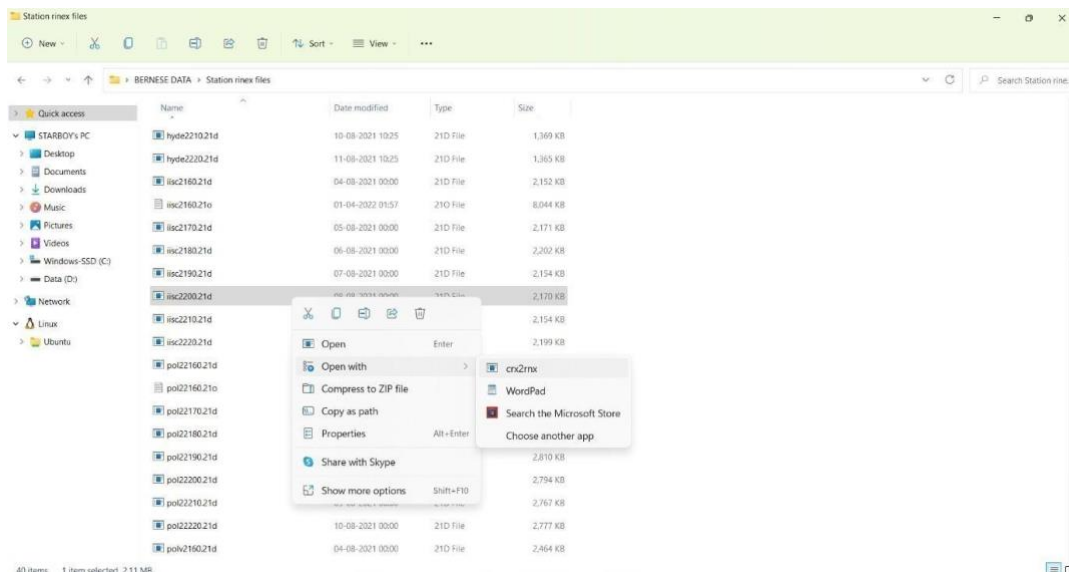
Pasting the data in desired folders

Paste CLK, ERP and EPH to *DATAPOOL>COD*.

Paste ION, P1P2, P1C1 files in *DATAPOOL>BSW52*.

Paste station related file (CRD, VEL and FIX) to *DATAPOOL>DATA*. (You'll have to create DATA subfolder manually if this folder is unavailable in DATAPOOL directory).

Paste CRD, VEL and FIX & PSD file in *DATAPOOL>REF52.*

Paste DE405.EPH in *BERN52>GPS>GEN*.

Paste PSD file in *Campaign52>CORS>STA*.

Paste SAT_2022.CRX to *BERN52>GPS>GEN*

Paste gzip.exe and crx2rnx.exe in *Strawberry>perl>bin* folder (Already done from our end. No need to perform this step).

NOTE: Paste all 4 days .CLK, .ERP, .EPH and .ION files at this time only to the respective folders mentioned above. The parallel BPE processing is possible only if you have pasted the necessary raw files prior to the processing step.

Creating the plate definition file

This file contains the information of plate of our unknown stations.

First paste the IGS14_R.CRD file to *Campaign52>CORS>STA folder*.

The steps for creating the plate definition file are as follows- *Campaign>Edit Station file>Tectonic plate assignment.*

In file name write CORS.PLD and click OK. You will be required to choose IGS14_R.CRD file, open it. Once it is opened, then save it.

Thus, a plate definition file (.PLD) will be created in *CAMPAIGN52>CORS>STA.* The file contains so many stations by default which we need to remove and insert our own CORS unknown stations.

For removing other stations data, open CORS.PLD file in WordPad or Notepad, remove all the station data except 1st station as shown in figure below.

Now, again open tectonic plate assignment in tectonic plate assignment and choose the respective .PLD file and click OK. As 4 CORS stations are unknown for our processing, and we are using 5 IGS stations. We need to include the marker name, marker number and tectonic plate associated with the CORS and IGS stations as shown below:

The Station Name column consists of the information of marker name and marker number of all stations. This information can be retrieved from RINEX file only. The station in India lies on Indian plate (INDI) only. For other stations, it is required to check the plates on which these stations lie.

This information is available on IGS website. Search for the station and click to get the station info. The log file for a station has the information of the tectonic plate in which the station lies.
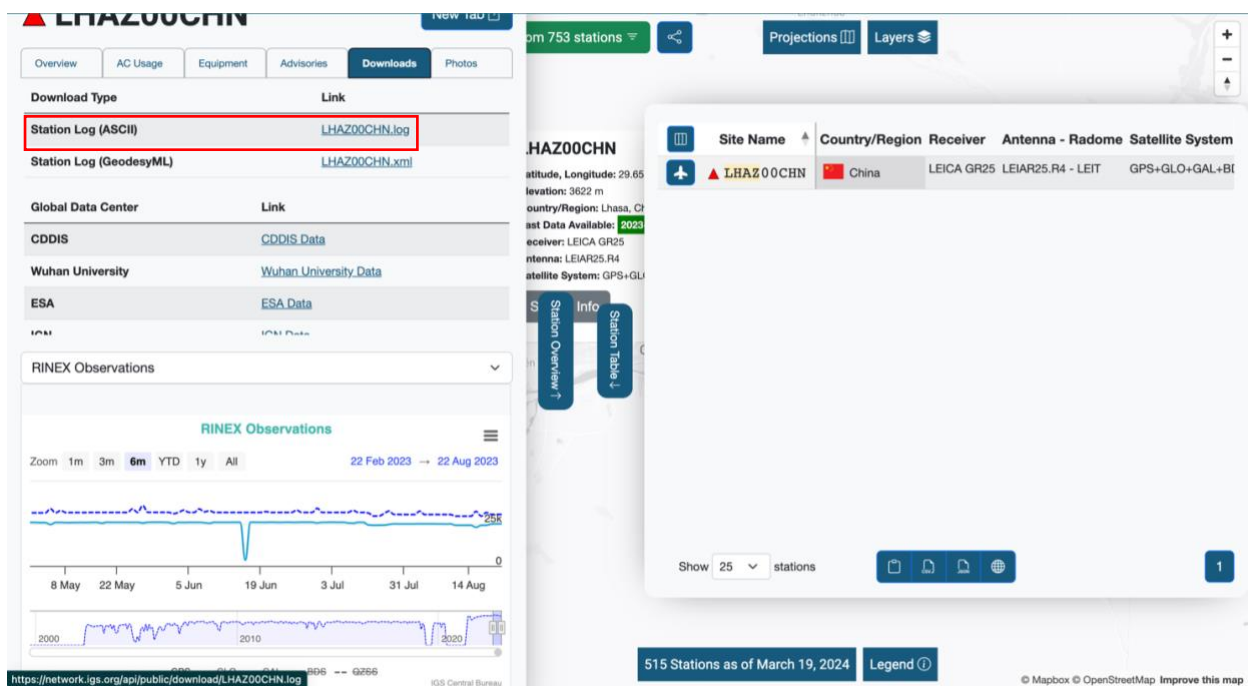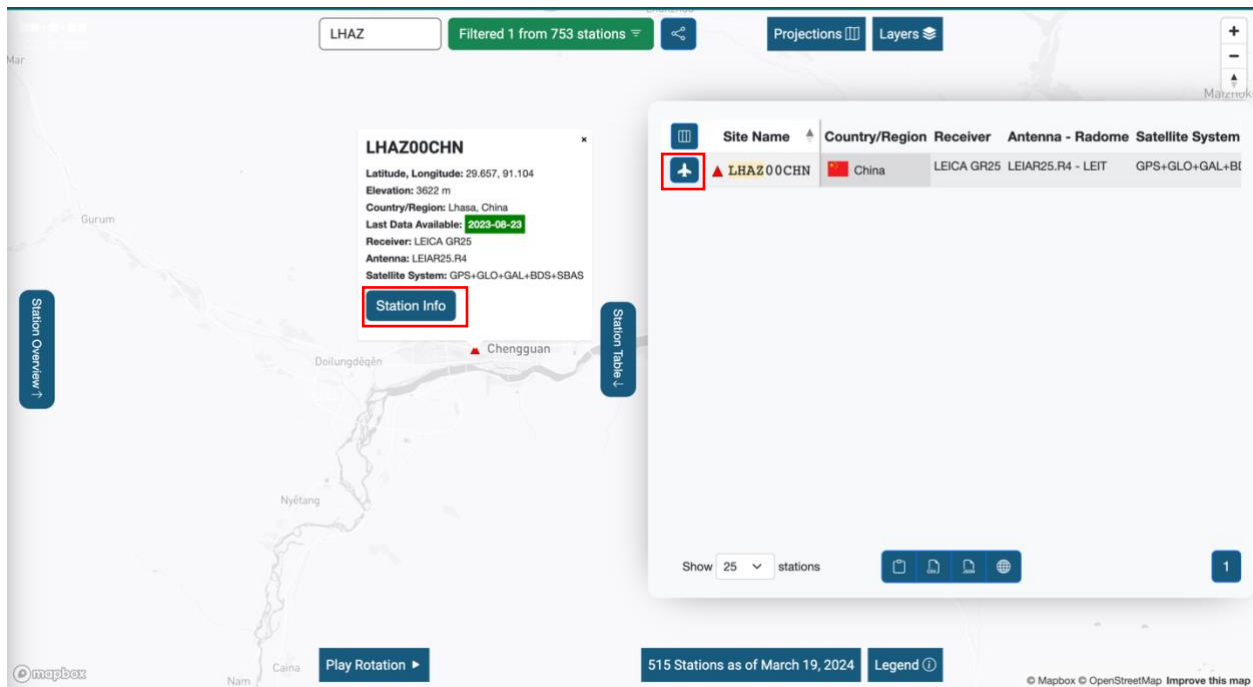
To create station information file:

For creating station information file-

First paste .22o RINEX files [5 IGS station and 4 unknown CORS stations] for all 4 days to *CAMPAIGN52>CORS>RAW* folder.

In BERNESE, go to *Service>Station information file>Extract information from RINEX*

Select all files in Original RINEX observation files and name the Result file as *CORS* as shown below:
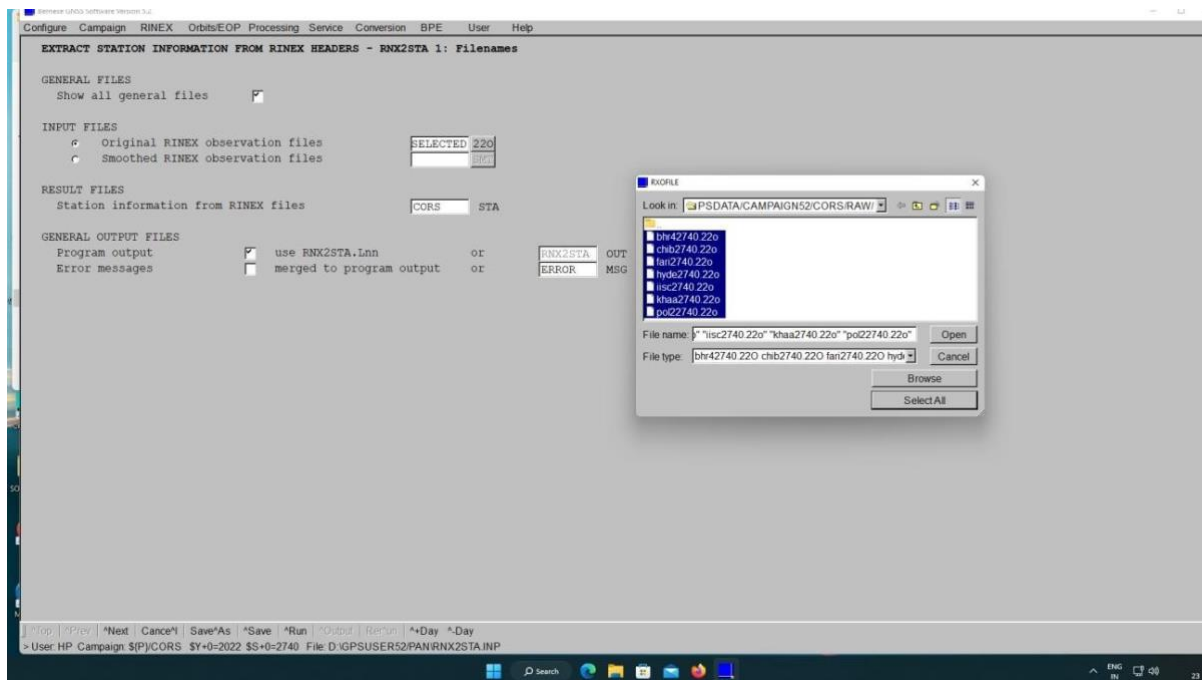
Click next.
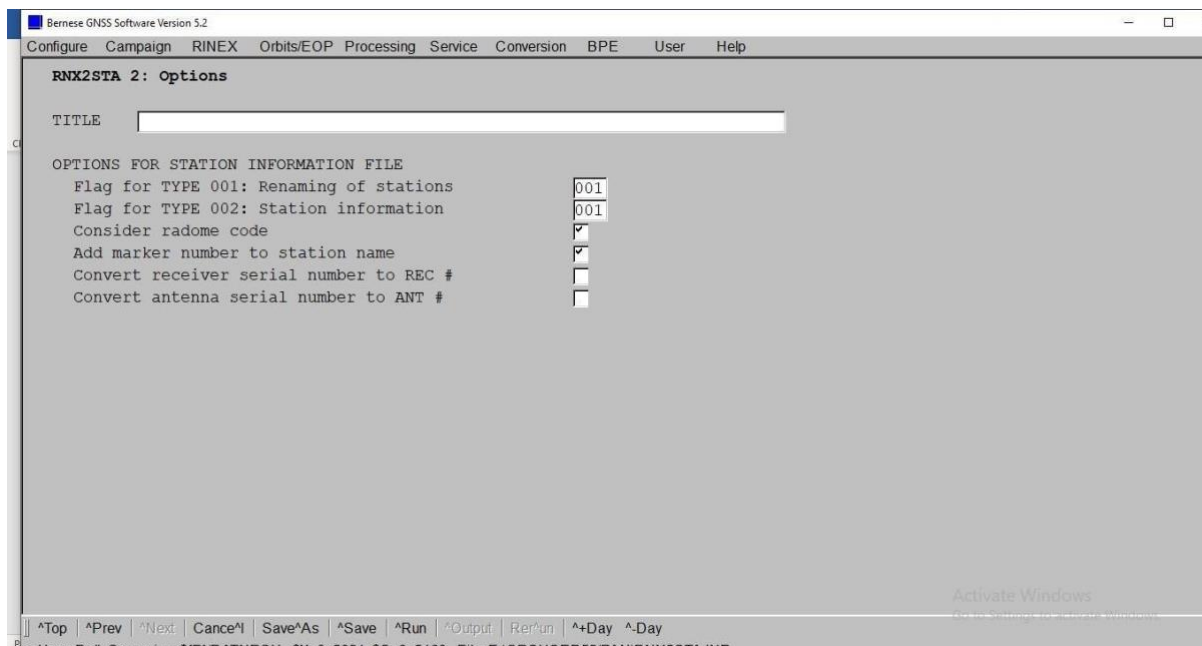
Click Run.

NOTE: At the time of running this command, there may be some warning messages which can come. A warning message is shown with ### message. The warning doesn't hamper your processing and you can proceed to subsequent steps. While if *** message appears, it means there has been some error occurred while you are processing. You can't proceed to further steps without resolving the error.

A CORS.STA file will be created in *CORS>STA* folder.

BPE Processing

We require to paste certain files in certain directories before running BPE.

Paste all .22o RINEX files (5 IGS + 4 CORS for all days) in *DATAPOOL>Rinex.*

Paste CORS.STA & CORS.PLD in *DATAPOOL>REF52.* Click on *BPE>Start BPE Processing.*

The BERNESE interface will appear as shown below:
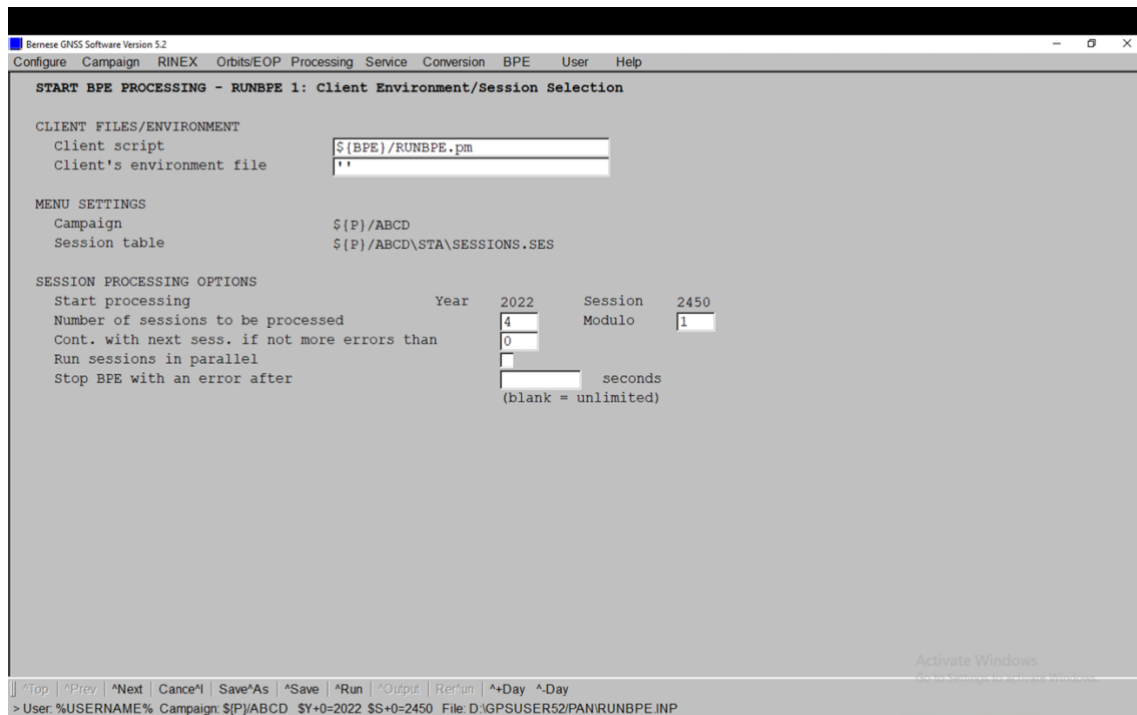
Click next.

In the initial step, the PCF file used is PPP_BAS.PCF. It is primarily used to generate the Precise Point Positioning (PPP) and Single Point Positioning (SPP) solutions. It is also used to generate necessary input files CORS.CRD, CORS.VEL, CORS.ABB which are mandatory files for running RNX2SNX.PCF and generate baseline processing results.
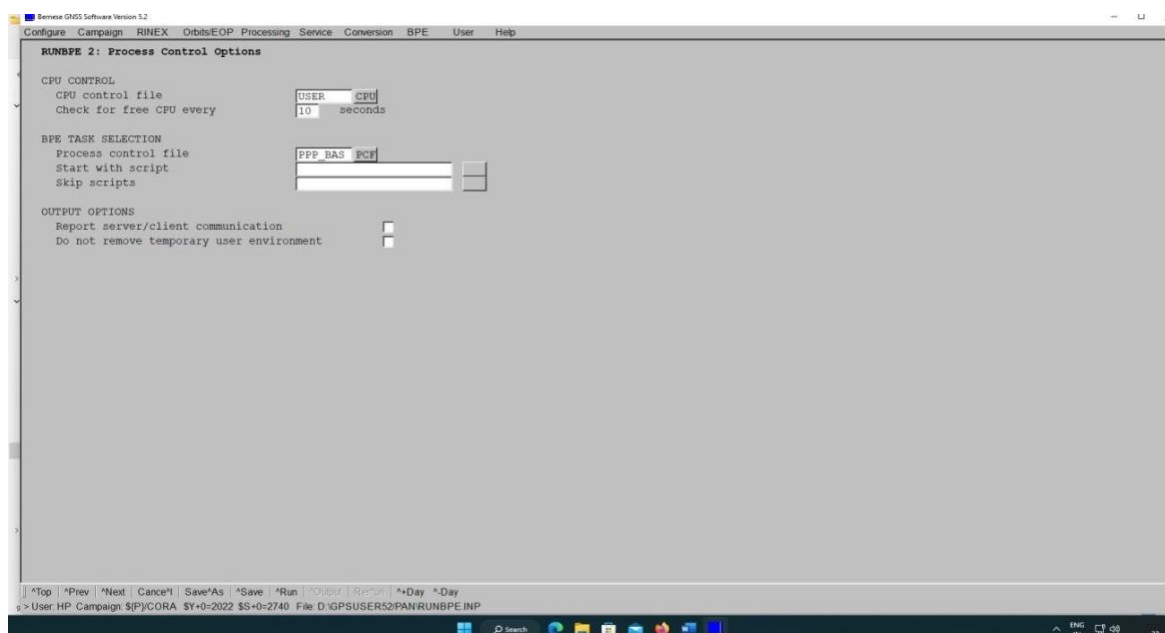
Click next.
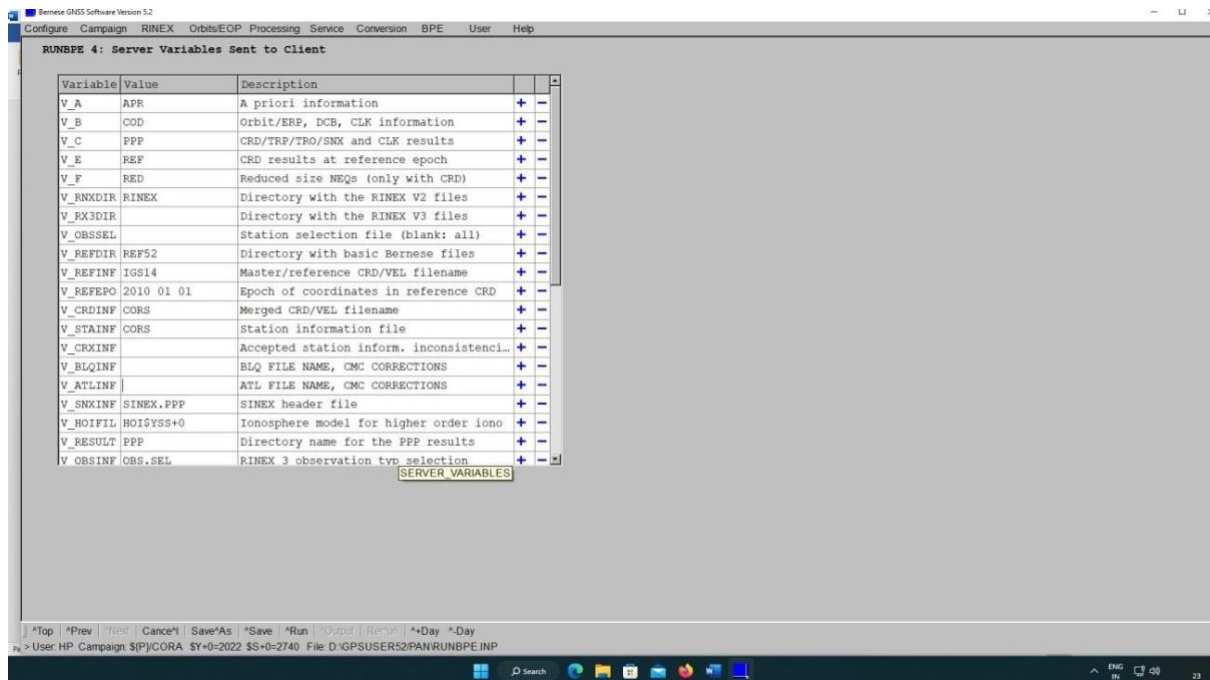
Make changes accordingly as shown in the figure above and click Run.
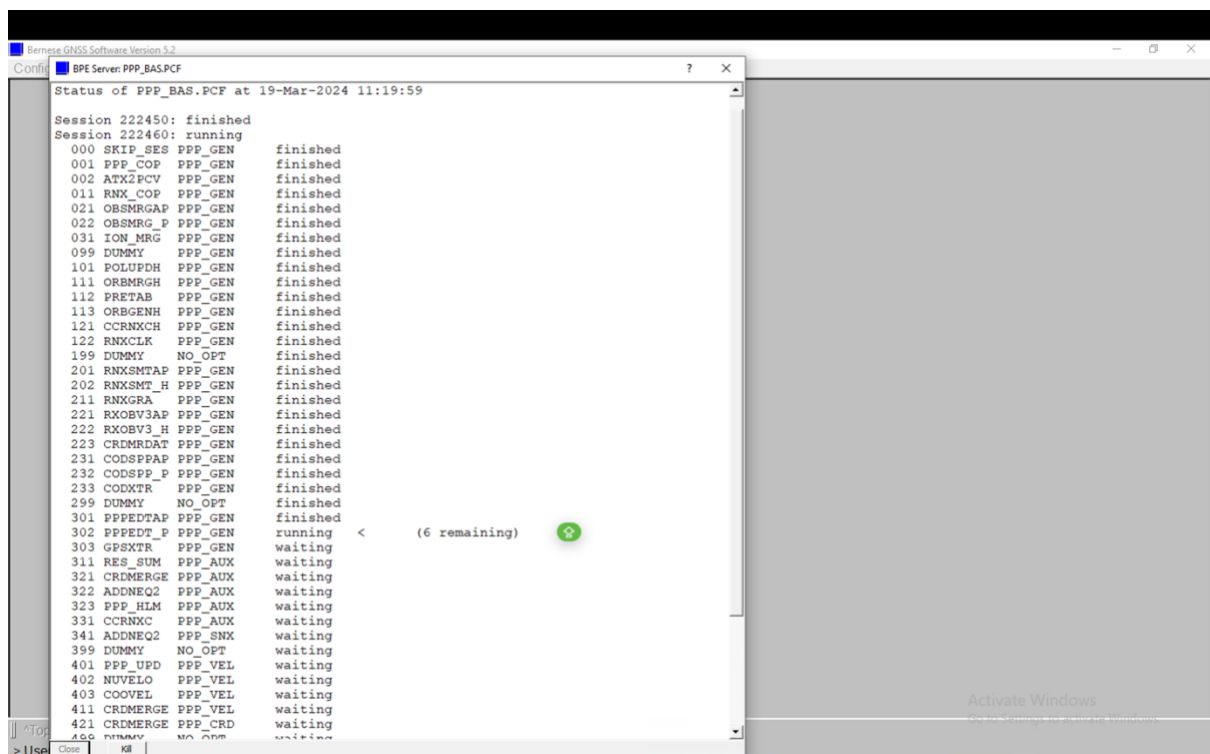
If no error is done in the previous steps, BPE will run successfully and following results can be seen on screen.
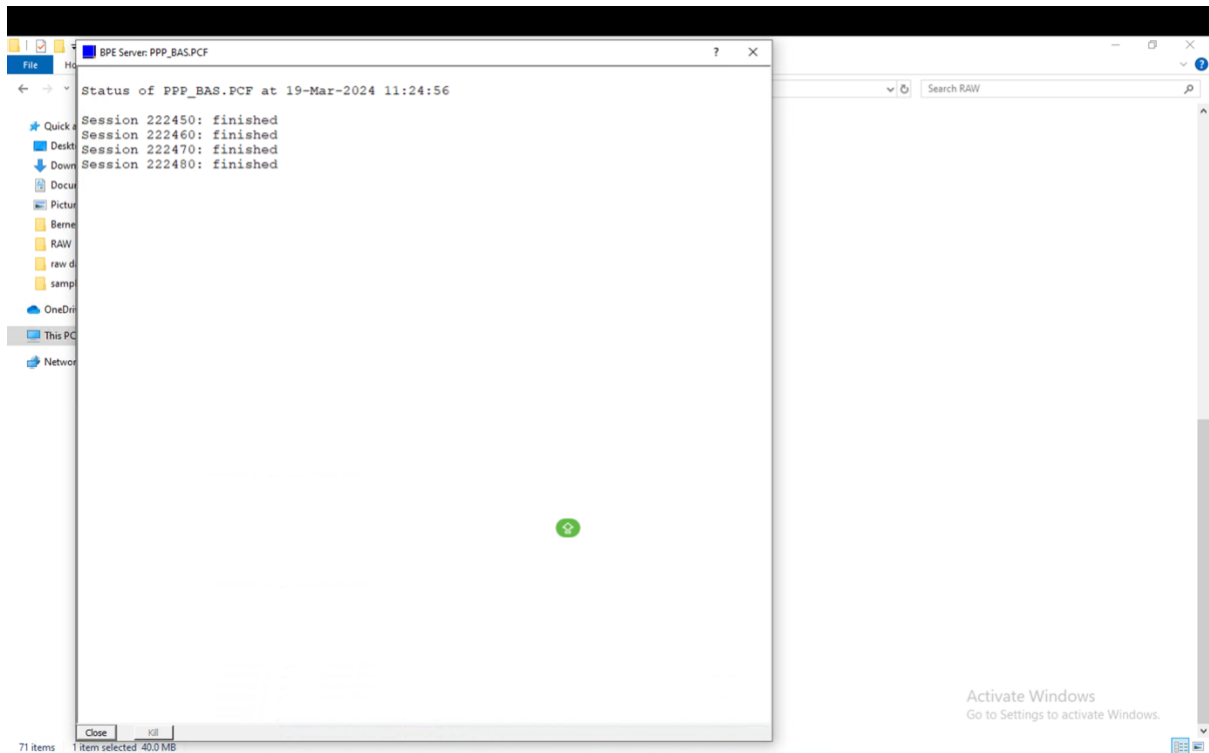
If there is any error during the entire earlier process, then the BPE will fail by showing an error message. In this situation, go to *Campaign52>CORS>BPE.* Use date modified option to know the latest *log file* generated. The log file message tells if any necessary files were missing in desired folder or if there is any other kind of error. An example of log file in BPE section showing the error is given below-

Sort out the errors by using information from log file and then again run the BPE. If the error is resolved, then the BPE will run without showing any error.

The output files can be seen in *Campaign52>CORS>OUT* where you can get the PPP and SPP

results for known IGS stations and unknown CORS stations as shown in figure below:

The CORS.CRD, CORS.VEL, CORS.ABB files will be found in *Campaign52>CORS>STA* folder as shown in figure below.

The file CORS.CLU is also a mandatory file for running RNX2SNX.PCF. The file is already provided to you on mookit. .CLU file define the cluster of stations which have same correlation. We will assume the stations have same correlation between them.

Paste CORS.CLU files in *DATAPOOL>REF52* folder.

Run BPE again. *BPE> Start BPE Processing*
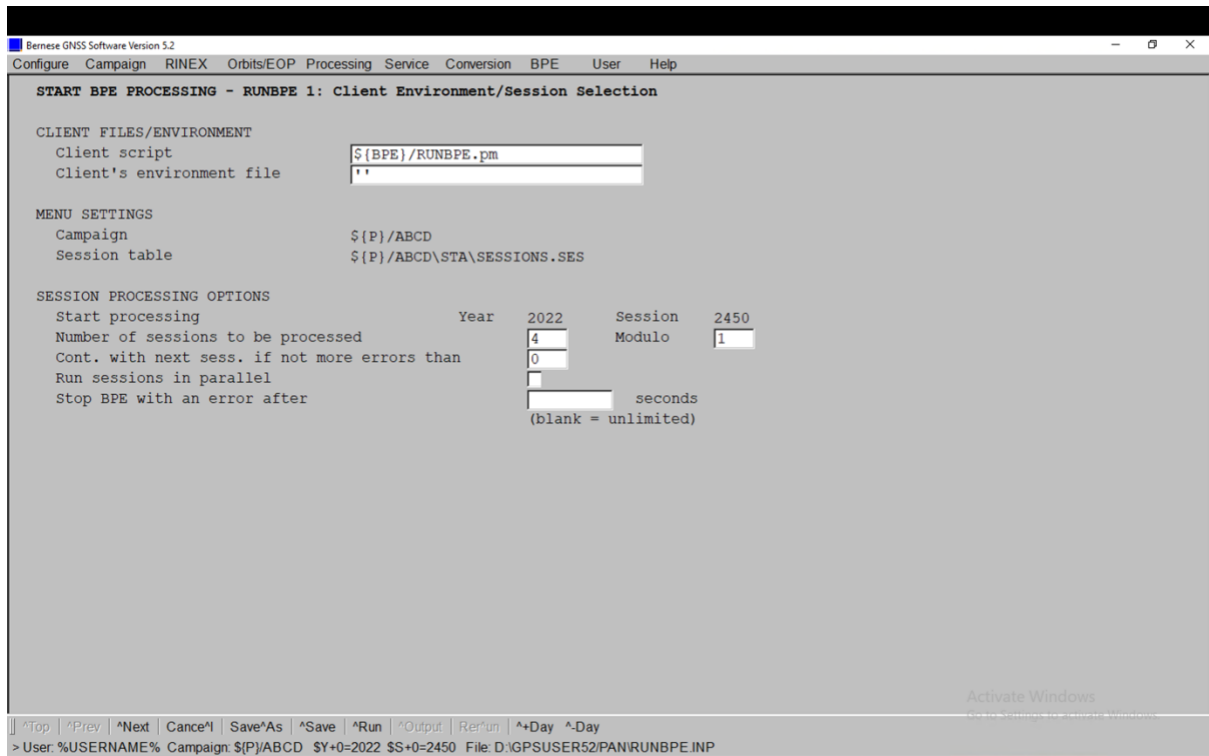
Choose the CPU control file as USER.CPU and Process control file as RNX2SNX.PCF as shown:
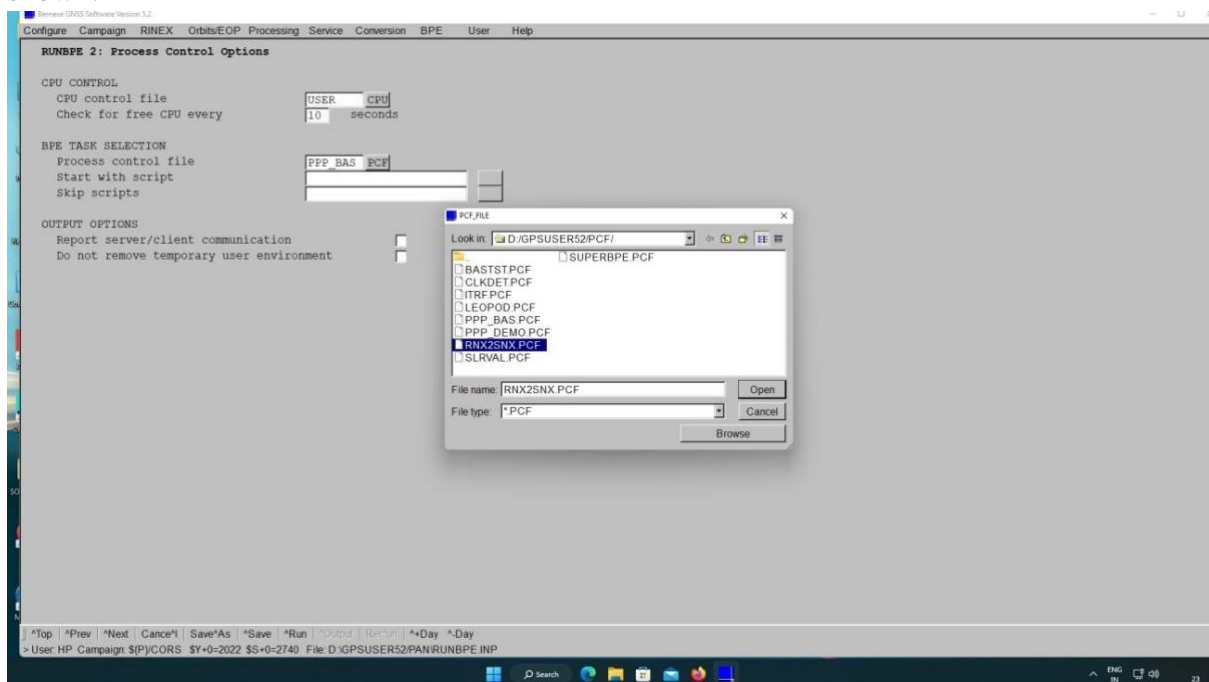
Click next.

Choose Task ID as 1 and click next.

In RUNBPE 4 fill the entries in same way as shown below:
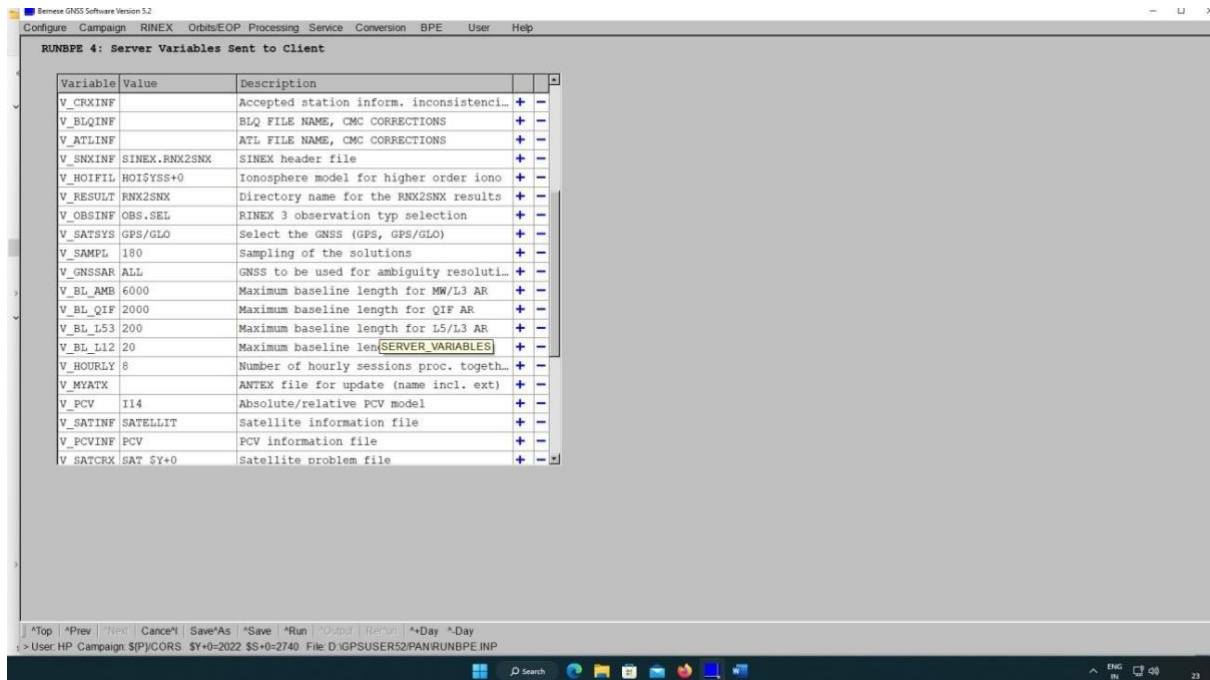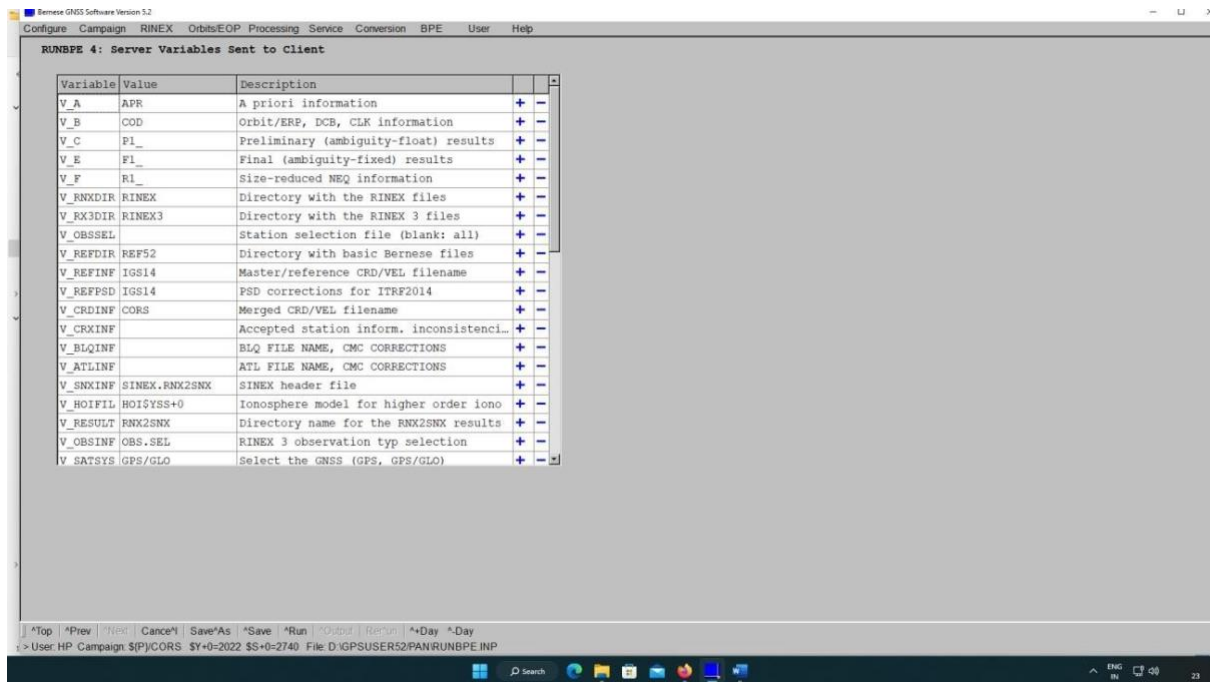
Click Run.

The BPE will start to run and if there are no errors in previous steps, the process gets finished after running for all days.
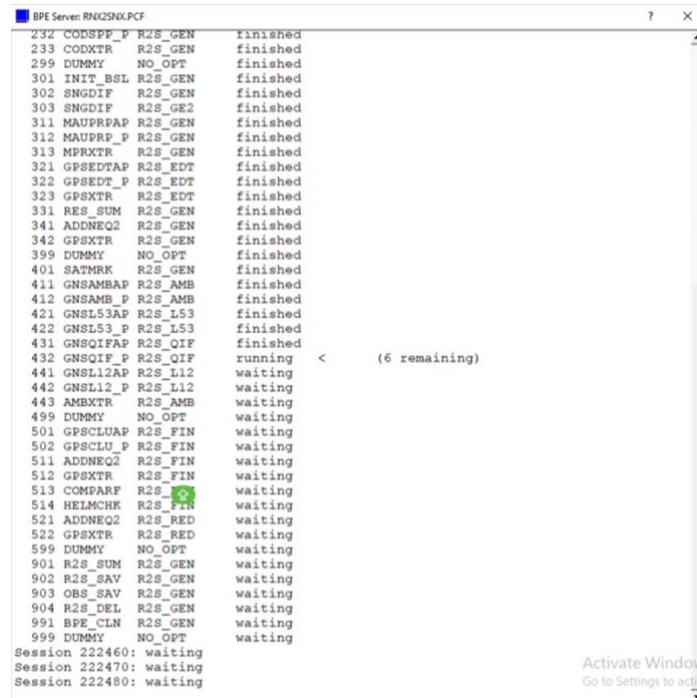
Wait till BPE is finished.

Click *Campaign52>CORS>OUT* to see the output of baseline processing. Click on date modified to find the result having name F1_....OUT.
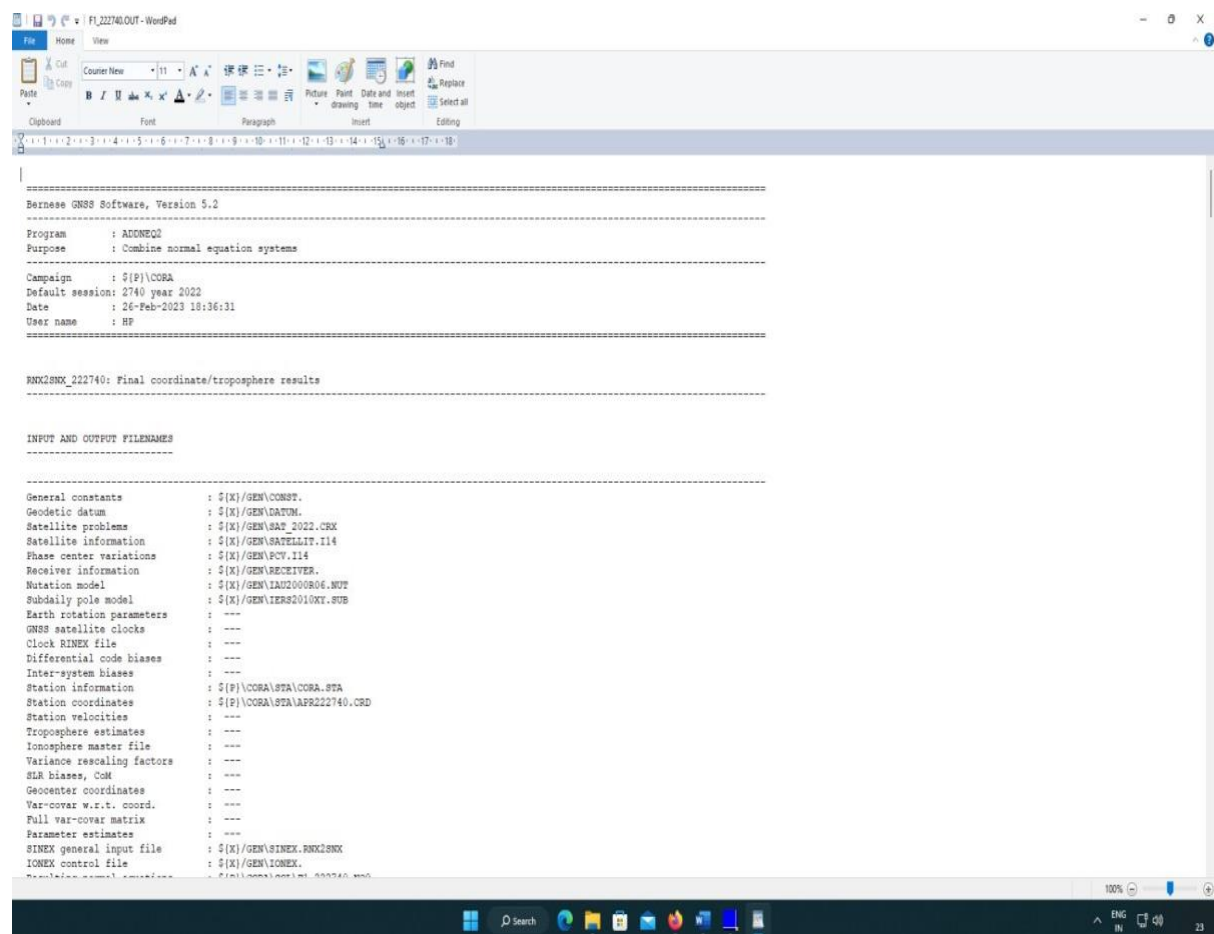
Scroll down to get adjusted coordinates of unknown stations.

Extrapolation of coordinates to same epoch: The final coordinates obtained after daily data processing and adjustment refers to mid-day epoch of that particular day in which data has been processed. Refer to F1_22DOY0.CRD files in STA folder.

As a result of which the final coordinates of data refer to the different days. It is important to extrapolate the final coordinates of all days to a common epoch of a common date. This can be done by extrapolating the coordinates.

The option can be fetched from *Service>Coordinate tools>Extrapolate coordinates*.

Input F1_22DOY0.CRD file, the particular DOY velocity file. Give a common reference epoch, it is suggested that out of your 4 day dataset, the extrapolation can be done to 3rd day of your dataset at mid day epoch (12 00 00). Give the name of your result file and click run.

Do the same step for rest of the other 3 days .CRD files.
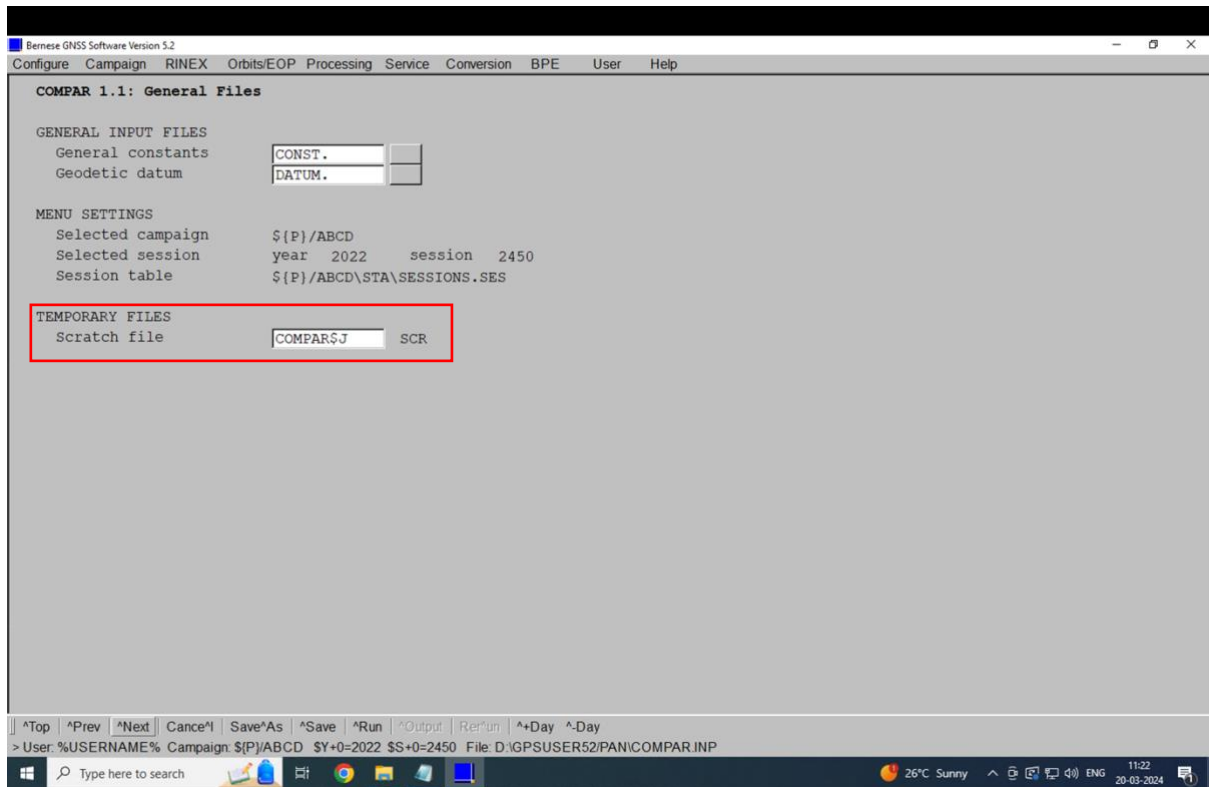
Comparison of coordinates:

It can be done based on the differences between the coordinates and the RMS associated with it.

Go to *Service>Coordinate tools>Coordinate comparison.*

Select the extrapolated coordinates of 4 days computed from the last step.
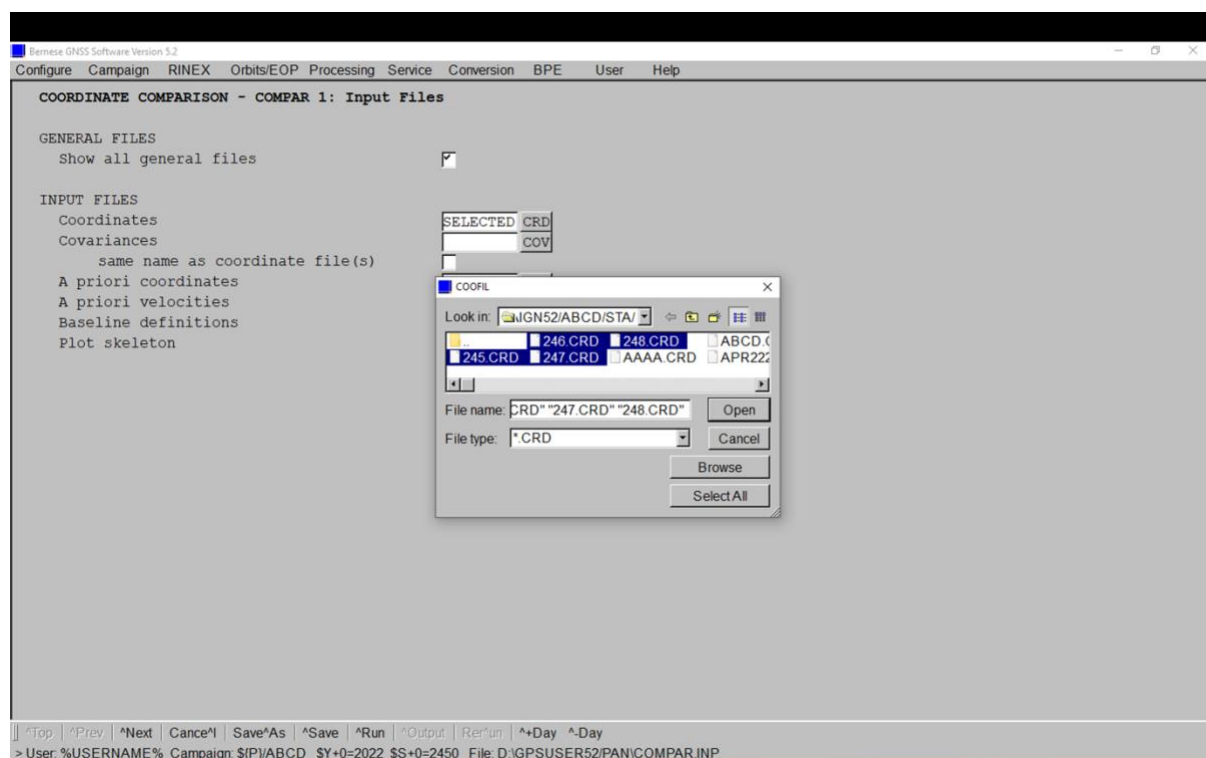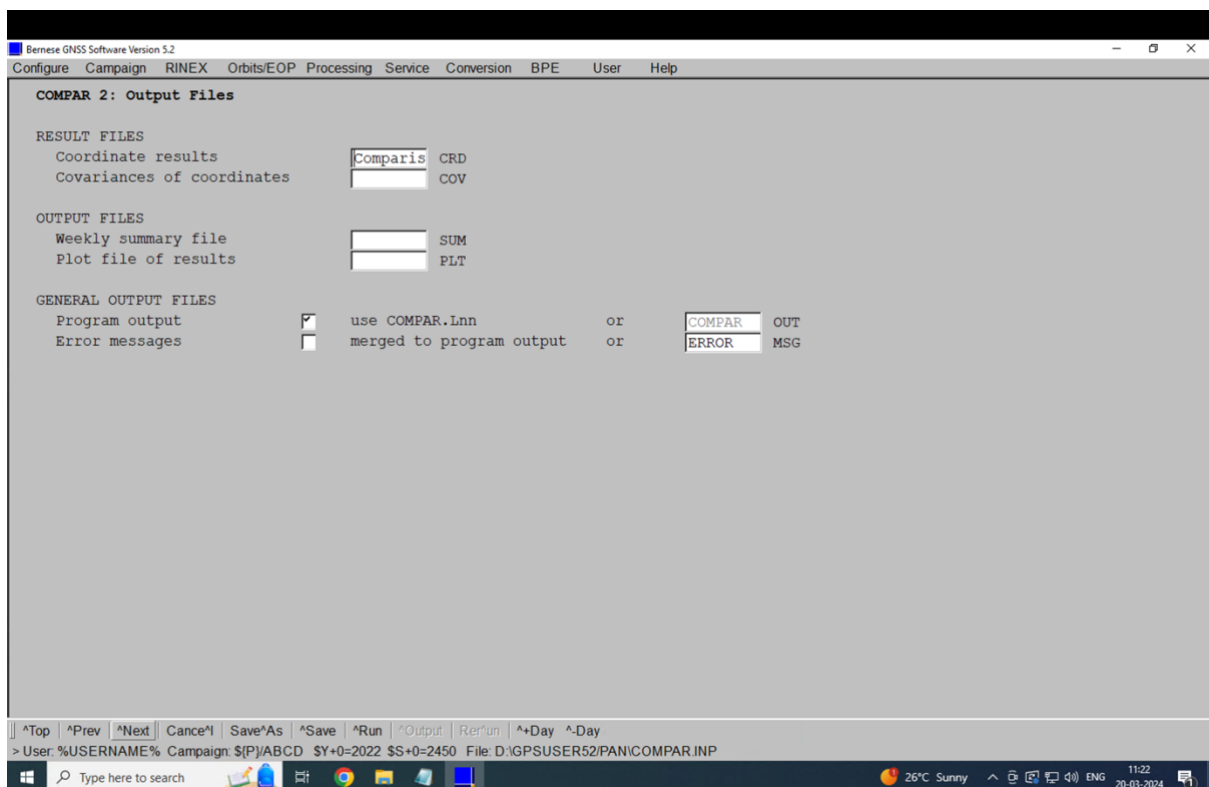

Next.

Next.

Give the name of output file.

Run.

There will be two outputs. One comparison file COMPAR.L0X which have the information about the comparison between coordinates of a station for different days. The other file is the Comparison.CRD present in STA directory which contains the final coordinates for all stations by combining 4 days of coordinates.