Problem Set #2 - How Fast?

Use the time series on class web page for Problem Set #2 "P130.pbo.snf01.ps". This file is similar to what you used before but has a header section, plus more data columns. Its the same station as from the last homework but is more recently downloaded and so has more data. Its also in the standard PBO format provided by UNAVCO for EarthScope. You can either delete the header info lines manually or using the MATLAB "textscan" function specify the number of "Headerlines" needed to not read in the header into MATLAB.

The data columns in this file are:
`YYYYMMDD HHMMSS JJJJJJ X Y Z sxx syy szz sxy sxz syz  N E U Ndel Edel Udel snn see suu sne snu seu quality`

Also see:
http://pboweb.unavco.org/dmsdocs/Root%20Folder/Data%20Management/Data%20Product%20Documentation/gps_timeseries_format.pdf

Solve for rates of motion in the x,y,z and n,e,u components, and their uncertainties. Provide plots that show the model (straight line) that fits the time series best. Provide a table of the rates for this GPS site.

<u>Assignment</u>

Step 1. Read in data to get your MATLAB variables set up.

Step 2. Set up a matrix equation in MATLAB by building the ***G*** and ***d*** matrices.

$$\boldsymbol{G}\,\boldsymbol{m}=\boldsymbol{d}$$

where ***d*** contains the data (coordinates) and ***G*** contains the coefficients to the model equation, and ***m*** will contain the two model parameters you are solving for in each time series.

Solve this system for ***m*** using MATLAB solving tools or the solution to the overdetermined least squares inversion :

$$\boldsymbol{G}^{-g}=(\boldsymbol{G}^T\boldsymbol{G})^{-1}\boldsymbol{G}^T$$

$$\boldsymbol{m}_{est}=\boldsymbol{G}^{-g}\boldsymbol{d}$$

You can get the predicted values for the data using the estimated model parameters

$$\boldsymbol{d}_{pred}=\boldsymbol{G}\,\boldsymbol{m}_{est}$$

and the residual is

$$\boldsymbol{r}=\boldsymbol{d}-\boldsymbol{d}_{pred}$$

Step 3. Compute the uncertainties in these model parameter estimates.

$$cov\,\boldsymbol{m} = \boldsymbol{G}^{-g}\, cov\,\boldsymbol{d}\, \boldsymbol{G}^{-gT}$$

Step 4. Make a table that clearly lists the estimated values and their uncertainties (you can use MATLAB "fprintf", do it by hand, or whatever). This table should include the covariances.

Step 5. From your x,y,z rates, compute vn, ve, vu using vxyz2veu.m. *Do you get the same thing as when you compute the rates directly from the n,e,u time series?*

Step 6. Make plots similar to those you made for problem set #1. Except now include a line (in a different color preferably) that represents the model for this time series. Also plot the residual to each model, these time series are called "detrended".

Is the model a good model?

Step 7.

Try a weighted inversion using:

$$\boldsymbol{G}^{-g} = (\boldsymbol{G}^T \boldsymbol{W}\, \boldsymbol{G})^{-1} \boldsymbol{G}^T \boldsymbol{W}$$

where $\boldsymbol{W}$ is a square matrix that has weights for each observation on the diagonal. You want observations with small uncertainties to have more weight, so use $\frac{1}{\sigma_i^2}$ as your weights. *Does this approach make a difference in your velocity estimate?*

Step 8.

Email your table, plot files and responses to questions (preferably all in one file) to *whammond@unr.edu* in some format I can read (.pdf, .ps, Word, Open Office, etc.)