Computing Lab: Linear Regression

Hand in the fully commented MATLAB scripts, along with corresponding figures and answers to questions posed in the exercises (text or word document file). Remember to label all of your plots and include units both in text and plot labels.

The Breathing Hekla Volcano

*Use the MATLAB editor to create a new script (**yourname_Hekla.m**). All of your MATLAB commands will be in this script which is to be submitted with the results (answers to questions, plots and values).*

Iceland lies on the Mid-Atlantic Ridge, the divergent boundary between the North American and Eurasian plates. High magmatic activity and relatively dense volcano monitoring has allowed various studies of magmatic plumbing systems with geodetic techniques. The Hekla volcano (shown left) is one of the most active volcanoes in Iceland. The most recent eruption occurred from 26 February to 8 March 2000 when about 0.19 km^3 of magma was erupted. Deformation data from multitemporal analyses of synthetic aperture radar (SAR) images acquired between 1993 and 2008 revealed a broad area of inflation around the volcano (radius about 20 km), with satellite line-of-sight (LOS) shortening. Ofeigsson et al., 2010 attributed this signal as the result of pressure increase in a deep-seated magma chamber. In this exercise you will use the time-series of the line-of-sight to compute the LOS average rate of shortening.

i) Load the data file **HeklaBreath.txt** into MATLAB. The first column represents the year and the second column represents the satellite's measure of the line-of-sight displacement in mm. The time series includes the year 2000 eruption and most of the interruptive period between the 1991 and 2000 eruptions, as well as 8 years following the 2000 eruption. Calculate and plot the line of best-fit to the data and estimate the line-of-sight displacement rate (mm/yr). What is the Pearson's regression coefficient for this fit? The square of the Pearson's coefficient is the amount of variance that the regression line explains; how much of the variance is explained by this fit?

ii) Calculate the critical **two-tailed** 95% confidence t-distribution value (degrees of freedom = n-2). Is the regression significant? Now compute and add the corresponding 95% confidence bands to your plot. Using this information do you think this LOS rate is a good estimate over this period – why or why not?

iii) The eruption of 2000 is clearly visible in the LOS displacement data. Now break apart the time series into two data sets by computing the regression line for LOS before the eruption and another regression line for after the eruption. ***HINT: MATLAB's find command will come in handy for this***. Plot these two lines on the same plot with the full time-series. What are the two sets of LOS displacement rates?

Compute the corresponding Pearson's regression coefficients and their squares. Did the fit improve? – support your conclusion. Now add the 95% confidence bands for the two segments.

iv) Using the two sets of regression lines, compute the total displacement of the LOS (in mm), i.e. the "deflation" of the volcano, during the eruption of 2000.