

**Instructions**

Please save your code for the following exercises to an m-file and send it to me by email (mwei@ucsd.edu). To help you get started, lab7start.m has a few lines of code.

**Part I: Radar Altimeter Waveform**

A radar altimeter emits a short pulse that reflects from the ocean surface and returns to the antenna. The recorded power is the convolution of the outgoing pulse with the ocean surface height distribution (i.e. waves), which is well approximated by a Gaussian function. The form of the return power is an error function, which is the integral of a Gaussian function. A simple model for the expected power versus time is

$$M(t, t_o, \sigma, A) = A \left[ 1 + \operatorname{erf} \left( \frac{t - t_o}{\sqrt{2}\sigma} \right) \right]$$

where  $t$  is the time since the pulse was transmitted,  $t_o$  is the arrival time of the half power point,  $\sigma$  is the rise time parameter and  $A$  is the amplitude of the returned waveform. Since the pulse travels from the satellite to the ocean surface and back again, the altitude of the satellite is

$$r = \frac{ct_o}{2}$$

where  $c$  is the speed of light.

1) The file waveforms.dat (download at <ftp://topex.ucsd.edu/pub/class/rs/LAB7>) is a file of 20 altimeter waveforms collected by the ERS-1 satellite altimeter. The first column of the file is time in nanoseconds since the altimeter started recording ( $5.3 \times 10^{-3}$  seconds). The second column is the recorded power. Load the data and plot these waveforms as points.

2) Generate a model waveform from the function above and plot it over the waveform data. Estimate the three unknown parameters  $A$ ,  $t_0$ , and  $\sigma$ . What is the altitude of the satellite in meters? What is the standard deviation of the ocean wave height in meters?

Part II: Using altimetry data.

Durmid Hill is a small uplifted region of the mostly below-sealevel Imperial valley. Until about 300 years ago, the entire Imperial valley was flooded under a freshwater lake called Lake Cahuilla, and Durmid Hill was just high enough to be an island. When the lake was no longer being fed by river water, it slowly dried up over 50 years, leaving annual (1 per year) recessional terraces around Durmid Hill that look a little like bathtub rings. By measuring the elevation of successive terraces, we can estimate the recession rate of the lake.

3) Go to <ftp://topex.ucsd.edu/pub/class/rs/LAB7/> and download the files DurmidHill.kmz and durmid.dat. Open the kmz file in Google Earth and get a feel for the regional context of Durmid Hill and Lake Cahuilla. Can you see the recessional terraces around Durmid Hill in the shaded altimetry? Can you see them in the Google Earth imagery?

4) Load the topography data into Matlab and look at it with `imagesc()`. Look at a histogram of the data using Matlab's `hist()` function with 1000 bins (you will first need to reshape the data into a single column, as in Lab6). Can you see regularly spaced peaks? The elevation of these peaks corresponds to the elevation of the recessional terraces. Why? Identify the elevation of several of these peaks. What is the recession rate of Lake Cahuilla? (i.e., how fast did the waters recede?)