Sea Level Data Exercise

Introduction

TideTool is a sea level data decoder, viewer and analysis package developed by the Pacific Tsunami Warning Center. Tide Tool decodes and displays data broadcast over the Global Telecommunications System (GTS) to provide a tool for sea level data analysis in tsunami warning centers. An additional, related program getTide can be used to review old data offline. Tide Tool and getTide use the same display and analysis procedures. More details can be found in the Tide Tool manual.

In this exercise we shall use getTide to review sea level data recorded after the July 17, 2006 Java earthquake and tsunami.

Installing getTide

1. Copy the "**Tide Tool Install**" folder onto your desktop
2. double click on **ActiveTcl8.4.12.0.226725-win32-ix86-threaded.exe** to install Tcl/Tk on your computer
3. double click on **blt24z-for-tcl84.exe** to install BLT, direct the BLT installation to the Tcl folder created in step 2).
4. From the "Tide Tool Install" folder copy the files and folders "**Test_Meta**", "**getTide.tcl**" , "**Tide_Coeffs**" to the new **\Tcl\bin** folder.
5. In the **\Tcl\bin** folder make a new folder called "**Decoded_Data**"

If you have problems running getTide after installation, refer to the TideTool manual.

Using getTide

getTide reads in a log file of sea level data. This file must be named srJJJYY.log, where JJJ is the 3 digit Julian day, and YY is the 2 digit year (e.g. sr09807.log would be a file starting on the 98th day of 2007).

1. In this exercise we will use data from the 198th day of 2006, this data is in the "Tide Tool Install" folder. Copy the file **sr19806.log** to the **\Tcl\bin** folder.
2. In the \Tcl\bin folder double click on "**bltwish.exe**" to open a console.
3. In the console type: **source gettide.tcl**
4. This will open a window asking for JDAY, YEAR, and SPAN. In the boxes type the Julian day for the data (which is 198), the year (which is 06), and the number of days of data (which must be 1 for this version of getTide):

5. This will open a new window titled "getTide v.5.72", the window contains a number of boxes of 4 letter codes and at the bottom a counter tracking the number of Bytes read. This data is ~7 MB, so reading in the data may take a few minutes:


As well as opening the data in getTide this step writes decoded data (i.e. simple

column data files of time and sea level height values) to the Decoded_Data folder. This decoded data can easily be read into many plotting or spreadsheet programs.

6. The boxes are individual sea level stations. Clicking on one will produce a drop down menu. The bottom option on the menu is always "**Mess**", clicking on this will bring up the raw data message transmitted through the GTS. The option above is always "**Info**", clicking on this will open a display of information on the station. Above Info and Mess is a list of sensors located at that station, the code for these stations depends on the type of sensor:

   - Prs = pressure sensor
   - Pr1 = first pressure sensor, where there are two.
   - Pr2 = second pressure sensor, where there are two
   - Rad = acoustic radar sensor
   - Ra2 = secondary acoustic sensor.
   - Enc = encoder type sensor
   - Enb = secondary encoder sensor
   - Aqu = Aquatrak
   - Bub = Bubbler Sensor

   Clicking on any of these will bring up a window plot of the data recorded on this sensor:
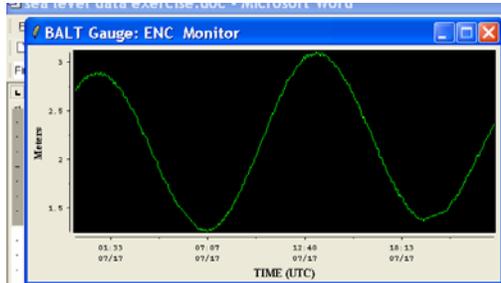
7. **Tide correction**: If a predicted tide correction is available for the station when a senor is selected the window will open 2 data streams, a green line for the raw data and a white line for the tide corrected data. There will also be a box in the top left corner of the window called "Tide", under this menu there are option to switch on or off the two data streams.

8. **Zooming**: To zoom in on a portion of the data click and hold the right mouse button and drag a box around the area of interest, this will open another window with the magnified data:
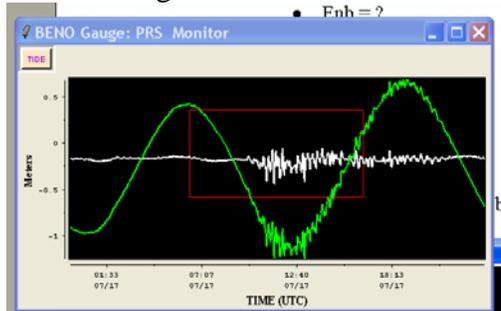
9. **Picking first arrivals**: The first arrive can only be picked in a zoomed in window. Point the cursor at the first arrival and left click, this will place a red cross on the screen and bring up a box with the time of the pick and height in meters. Click on

the "REC" button and "First Arrival" to save the data:
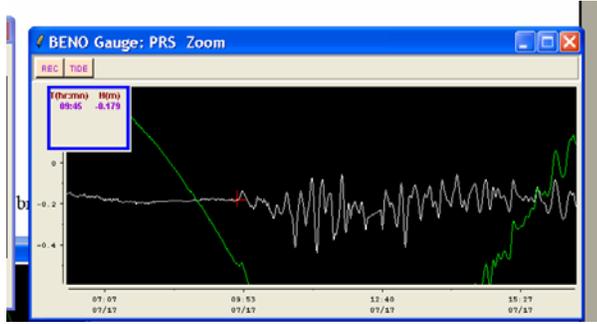
The data are saved to a text file called "**Tide_Tool_LOG**". This file is constantly added to whenever you save a pick (it is never deleted and so can be used to construct timelines of warning center response following a tsunami). In the file the data will be recorded in a format like this:

```
beno   prs   First Arrival   197/06   09:45 2007222 12:58
```

Station Senor   Type of pick   Julian day/year time   Year Julian day time
                                           of picked arrival   data was saved

10. **Picking peak-to-peak amplitude and period**: peak to peak amplitude can also only be picked on a zoomed in window. Click at the top and bottom of the maximum peak to trough cycle to leave 2 red crosses on the data, and bring up a window displaying the time & amplitude of the picks and the difference between the picks. Click on the "REC" button and then on "peak to peak" to save the picks to the "**Tide_Tool_LOG**" file:
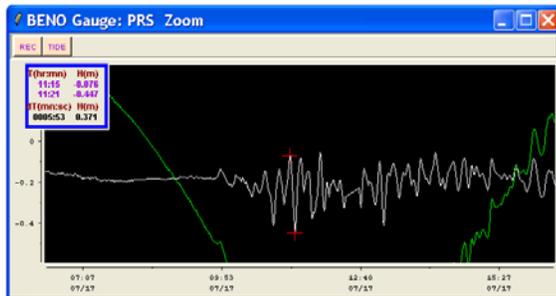
In the Tide_Tool_LOG file the data will formatted like this:
```
beno   prs   Peak to Peak    198/06   11:15 H -0.076   198/06   11:21 H
-0.447  Per 00:05 Amp 00.371 2007222 13:24
```
which is: Station code; Sensor; "Peak to Peak"; Julian day / year of data; time of first pick; "H"; height of first pick; time of second pick; "H"; height of second pick; "Per"; the time between the two picks (NOTE this is the half period not the period); "AMP" ; peak-to-trough amplitude in meters; year and Julian the pick was made, time the pick was made.

Exercise instructions
1) Look through the data and find:

- All stations recording the tsunami. For these stations pick the first arrival and peak-to-peak amplitude in getTide (to store in the Tide_Tool_LOG file) and also complete the table below:

Station	First arrival time	First arrival polarity	Peak-to-peak maximum amplitude	Period of maximum peak-to-peak	Time after first arrival of maximum peak to peak wave

- Examples of problems in the data and enter them into the table below

Potential Problem	Stations
No data transmitted	
Gap in data	
Spike in data	
Very noisy data	
Junk data	

2) Using your answers from 1) consider the distribution of the stations that did and did not record the tsunami (Figure 1), and the amplitude of the waves where they were recorded. Does this fit with expectations on tsunami directionality?

3) Do the polarities of the first arrivals match your expectations for a thrust earthquake generated tsunami?

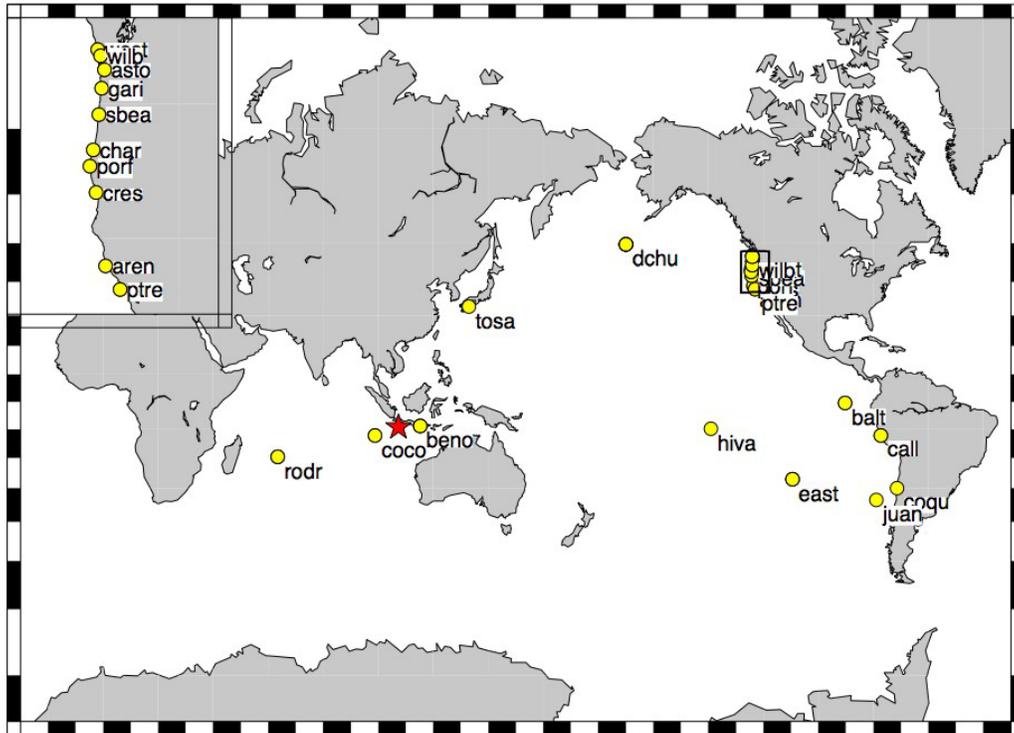4) How variable is the time delay between the first wave arrival and the maximum wave?

Figure 1 Stations recording sea level data (yellow dots) and epicenter of July 17, 2006 earthquake (red star). Enlarged view of northern US coast in top left corner.

Answers to exercise questions

1) Recording of the tsunami:

Station	First arrival time	First arrival polarity	Peak-to-peak maximum amplitude	Period of maximum peak-to-peak	Time after first arrival of maximum peak to peak wave
BENO	09:46	flooding	38 cm	14 min	89 min
COCO	09:52	flooding	5 cm	14 min	15 min
RODR	15:03	flooding	74 cm	14 min	154 min

Examples of problems in the data:

Potential Problem	Stations (sensors)
No data transmitted	AREN, CALL, CHAR, DCHU, PORF, PTRE, SBEA
Gap in data	COCO (~16:00-~18:00 & ~21:00-22:00) EAST (0:00-18:00)
Spike in data	ASTO bwl, CRES bwl, GARI pwl
Noisy data	COQU, CRES, TOSA
Junk data	EAST prs

2) *Using your answers from 1) consider the distribution of the stations that did and did not record the tsunami, and the amplitude of the waves where they were recorded. Does this fit with expectations on tsunami directionality?* The 3 stations in the Indian Ocean all recorded the tsunami, and the stations outside the Indian Ocean did not. This is as expected. However, the COCO station on the Cocos Islands records a smaller tsunami than the RODR station even though it is closer to the earthquake, this is surprising. From directionality of tsunamis we would expect the maximum wave amplitudes 90 degrees to the strike of the earthquake (which is approximately parallel to the Java coast), as there are no stations in this direction we probably do not have a record of the highest amplitude waves.

3) *Do the polarities of the first arrivals match your expectations for a thrust earthquake generated tsunami?* We would expect to see a receding wave first on the stations to the landward side of the trench and a flooding wave on the seaward side. We would therefore expect to see a receding first wave at the BENO station; however the first arrival seems to be a flooding wave. This may be because the amplitude of the first wave is too small to show through the normal wind wave noise, or the first arrival may not be a direct wave from the earthquake source, or this may not have been a 'standard' shaped wave for a thrust earthquake.

4) *How variable is the time delay between the first wave arrival and the maximum wave?* Very, and the maximum peak to trough wave is more than 2 hours after the first wave at one station. Delays to the largest wave similar to this have caused deaths from tsunamis when people return to the coast too quickly after the initial wave assuming that the danger has passed.