

**TSUNAMI WARNING OPERATIONS: SEA LEVEL MONITORING
TIDE TOOL: DISPLAY AND DECODE OF SEA LEVEL DATA TRANSMITTED OVER
THE WMO GLOBAL TELECOMMUNICATIONS SYSTEM
(vers 10.5, Oct 2016)**

Pacific Tsunami Warning Center (NOAA)
International Tsunami Information Center (NOAA-UNESCO/IOC)

Tide Tool is a software application that provides end users with the ability to decode, display, and manipulate sea level data broadcast over the Global Telecommunications System (GTS) of the World Meteorological Organization (WMO). Data download through the internet is also available, but is not recommended because timely, complete delivery of all data packets cannot be guaranteed. Tide Tool is enabled by the Tide.tcl script and region-specific map clients that provide simple-to-use graphical user interfaces to the continuously-incoming sea level data streams; the tool uses the Tcl/Tk software package and its BLT extension. Tsunami travel times can be calculated and a contour map overlaid onto the map client; estimated tsunami arrival times (ETA) at mouse-selected locations are provided. Tcl/Tk is an open source, platform-independent software package offering a powerful shell programming language and graphical toolkit. getTide, also included with Tide Tool, is a BLT script that can be used to read and analyze archived sea-level data log files.

The software application was developed and is supported by the US NOAA NWS Pacific Tsunami Warning Center (PTWC) as an operational tool for the real-time continuous tsunami monitoring in the Caribbean, Indian and Pacific Oceans. The travel time calculation software was developed by Geoware, and its algorithm is used by PTWC. The primary users of Tide Tool and its accompanying tools are National Tsunami Warning Centres, such as the National Meteorological and Hydrological Service (NMHS), or other agencies acting in this capacity, and with a downlink from the GTS or to a data file containing those data formatted in a similar manner. It has been tested under Unix/Linux, Windows 2000/XP/Vista/Windows 7/10 (32- and 64-bit) environments since 2005, and implemented using a non-GTS 'ftp' data transmission protocol in Linux and Windows systems for tsunami centers without GTS links. The 'ftp' method should be considered non-operational if commercial internet service is utilized since connection reliability and timeliness, especially during tsunami emergencies, cannot be guaranteed. A Tide Tool Manual is available providing information on its installation and use.

The primary use of this software is as an operational programme run by tsunami warning centres, or other operational centres, which need to continuously monitor sea levels for tsunamis. Features of the tool include time series display, wave arrival time, height and amplitude measurement, tide prediction removal, de-spiking, and station state-of-health and metadata. Accompanying software calculates predicted tsunami travel times. Users are able to select which stations to receive and display through edits to input files or by mouse-selection from a station map. Mouse-clickable functions include the expansion of the time series to enable easy measurement and logging of the arrival time, wave height and wave period from the incoming signal. Station and data transmission information, raw data packets, and station health reports can be viewed from within Tide Tool. Calculated travel time contours can be overlain.

Requirements:

In order to decode and display the data, the following are required:

- Computer running Tcl/Tk software with BLT extension, or WIZE software package
- Sea level data that are continuously archived into a data file
- Tide.tcl and associated map client software.

Computer and Tcl/Tk software with BLT extension

The software requires the installation of the Tcl/Tk software package and the BLT extension, both of which are freely available for download and easy to install. The software is able to run under Unix/Linux, Windows 2000/XP/Vista/Windows 7/10, and Macintosh OSX (under BSD Unix) operating systems; the preferred platform is Unix or Linux because of its stability. For Windows 7/10, it is recommended to install the WIZE software package, which includes the newer Tcl/Tk v8.5.9. Use on other platforms is possible as it only depends on Tcl/Tk and BLT softwares being available. The software does not require substantial computing power, and can thus run easily on a

Pentium III or higher PC system.

Sea level data

The input is assumed to be a continuously-appended, ascii text file containing transmissions of data from different sea level stations. Each station and its data transmission is described by a unique set of parameters, including a Satellite Product Headers, Station Platform ID, method of transmission and transmission time, and file formats (Figure 1).

Figure 1. Sample of transmissions from field station Data Collection Platform (DCP) in formats used by the University of Hawaii Sea Level Center, Australia National Tidal Centre, and US National Ocean Service, respectively.

```
SWIO40 RJTD 250015
:ENB 1 #1 M 3908 3908 3910 3909 3911 3909 3912 3910 3913 3913 3917 3917
3917 3917 3915 3918 3914 3917 3912 3913 3913 3913 3912 3913 3911 3908 3908
3905 3909 :ENC 1 #2 3409 3410 3411 3411 3413 3419 3419 3420 3419 3415 3414
3418 3411 3408 3410 3409 3409 3408 3409 3409 3414 3413 3409 3414 3414 3410
3412 3409 3410 3413 :BATTL0AD 0 12.83 :NAME=

91642 46/// /1205 10296 40080 22200 00287
555 77744 A0102 516`3 60029 6315B 03024 83030 00A07 02548 02901 29631 6B090
24520 2400A 13025 90036 00297 317B1 50240 60310 0A190 26230 38002 96317
B2102 37103 100A2 50266 50330 02973 18B27 02331 02800 A3102 70103 10029
8318B 33022 92026 00A37 02736 03401 29831 8B390 22570 2801A 43027 66028
00299 319B4 50222 50230 0A490 27960 34002 98319 B5102 19202 901A5 50282
20380 02983 19B57 02163 03200 BV289 134S1 41249 C0501 22080 00070 23677 44777=

^^33487552
206011307M94168411DZpQ^@rI)0uW@1[Am@~@BsBYB\AG@BrBYBzAM@BqBZCUAB@BoBZCmA@BmBZDMAI@BlBZDrAG@BlBZD?A
D@BkBEtAL@BjBZEwAGABhBZ"@qv@oL3@[DvAI4B[5Ad6a`=OE0uVW>ZAnA|BYBkCRCqCsDWDnER"@us@so0uVV>YCqC?DBctDSD
[DnDxEgEa"@wh@wB
_OLAoP 50+1NN 116W
```

In general, sea level data is digitized and sampled at the field station. Ideally, the data transmitted for tsunami monitoring will be 1-minute (or better) averaged data values that are transmitted at least every 15 minutes, or more frequently for stations in tsunami source zones; currently, stations transmit every 3-60 minutes and data averages are at 1-15 minute sampling intervals. The data are transmitted over a number of different satellites to regional telecommunications hubs of the WMO, and onwards to customers such as the Pacific Tsunami Warning Center, the Japan Meteorological Agency (JMA), and to any requesting National Meteorological and Hydrological Service (Figure 2).

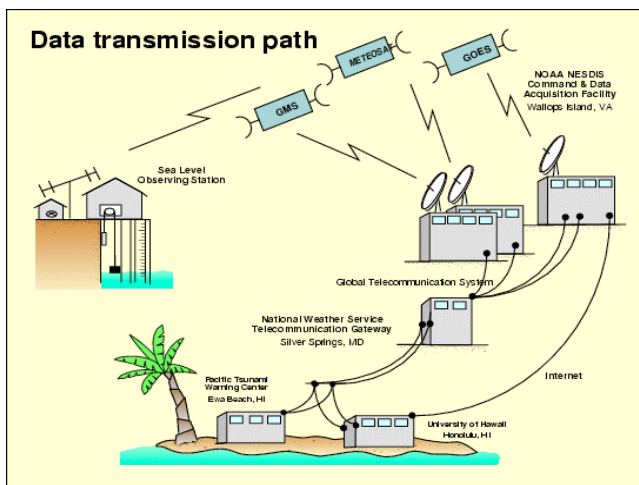


Figure 2. Transmission from the Data Collection Platform at the field station to the warning centres.

In the Indian Ocean, the primary satellites used for transmission from the field station are the Japanese MTSAT for the eastern Indian Ocean and the EUMETSAT operational satellite system for the central and western Indian Ocean. In the Pacific, the US GOES and Japan MTSAT satellite systems are used. The PTWC receives its data through the USA GOES satellite system and the US National Weather Service Telecommunications Gateway (NWSTG) and other dedicated communications links. The satellites are part of the GTS. The GTS is a semi-private, reliable communications system supported by the 187-member WMO for the transmission of environmental data, and information messages and / warnings. The GTS is the primary means by the PTWC and JMA receive sea level data

and issue tsunami advisories and warnings.

Tide.tcl

The program is started by typing wize Tide.tcl. The program decodes the received sea level data that are found in a single data logging file, creates individual station files containing the decoded data, and starts a graphical user interface display that allows each station to be displayed as a plot (Figures 3-5). Map clients for the Atlantic, Caribbean, Indian, and Pacific Oceans display a map from which the user may select several stations to show their time series. A strip chart window displaying multiple stations simultaneously is an option. V10.0 beta enables overlay of calculated travel time contours to graphically show wave propagation from the source. When the mouse is moved over the map, the Estimated Tsunami Arrival time (ETA) is displayed in the lower right (in Zulu time).

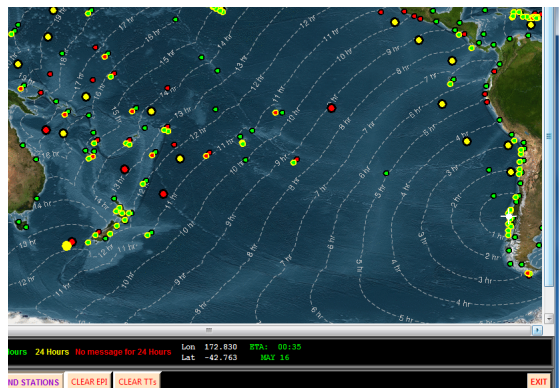
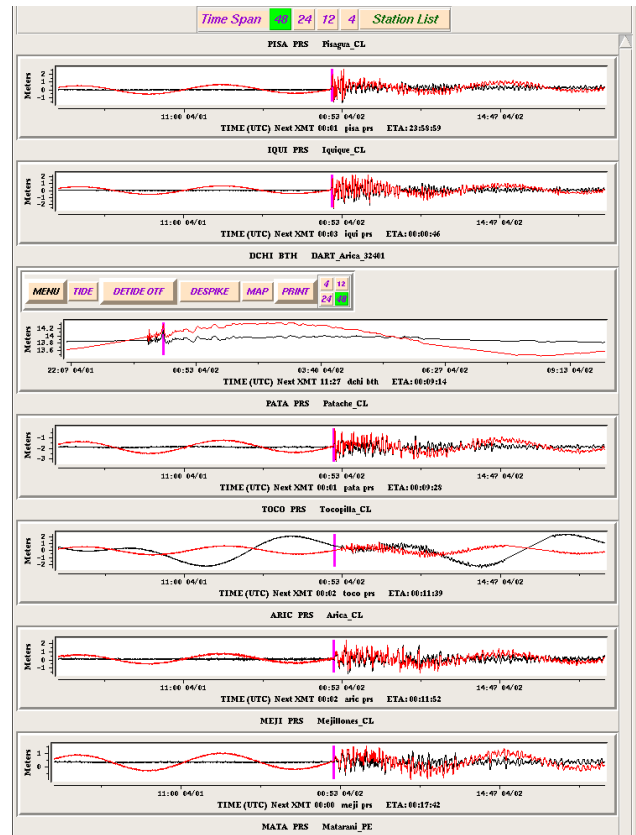
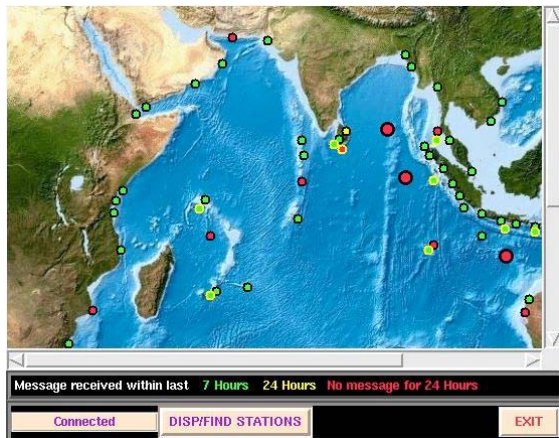
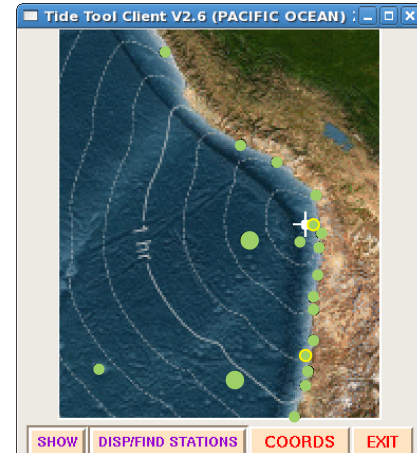
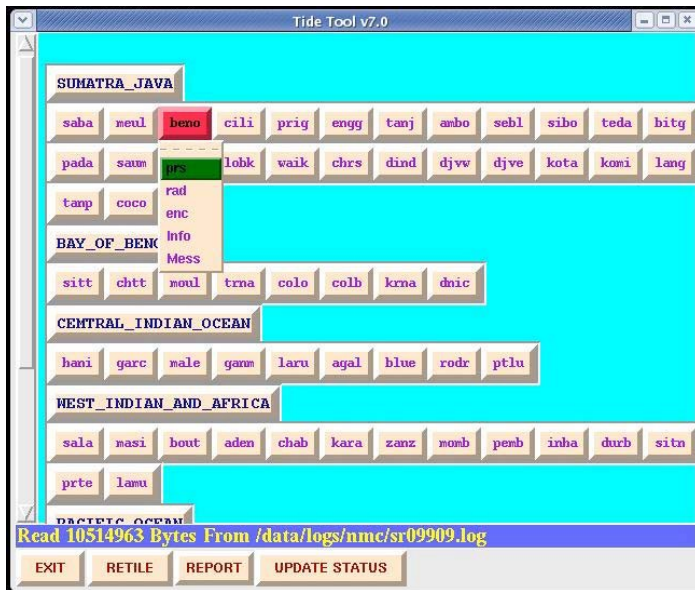


Figure 3a. Caribbean, Indian, and Pacific Map clients showing the coastal and DART stations, with color indicating when data last received (green = data received within last 7 hrs). Travel time contours overlayed on Pacific Map, with ETA shown in lower right. Sea level records can be plotted by mouse-selecting the station and choosing the sensor to plot, or by enabling a US NOAA PTWC, UNESCO-IOC/NOAA ITIC

'zoom' client to choose and automatically plot several close-by stations. Station names can be displayed on the map if desired.

Figure 3b. Tide.tcl GUI showing all stations that were decoded, arranged by region. Station sensor types, station metadata, and the raw data packet can also be viewed.



Each time series can be displayed with or without the tidal signal removed, can be manipulated using a mouse in order to zoom/enlarge the time series and to pick an amplitude or wave period (Figure 4a), and can be 'despiked' to remove spurious 'bad' points (Figure 4b). A postscript plot of the time series window can be made and printed.

Figure 4a. Sea level time series showing observed and tide-removed time series. A mouse is used to select the part that should be enlarged to pick the arrival time.

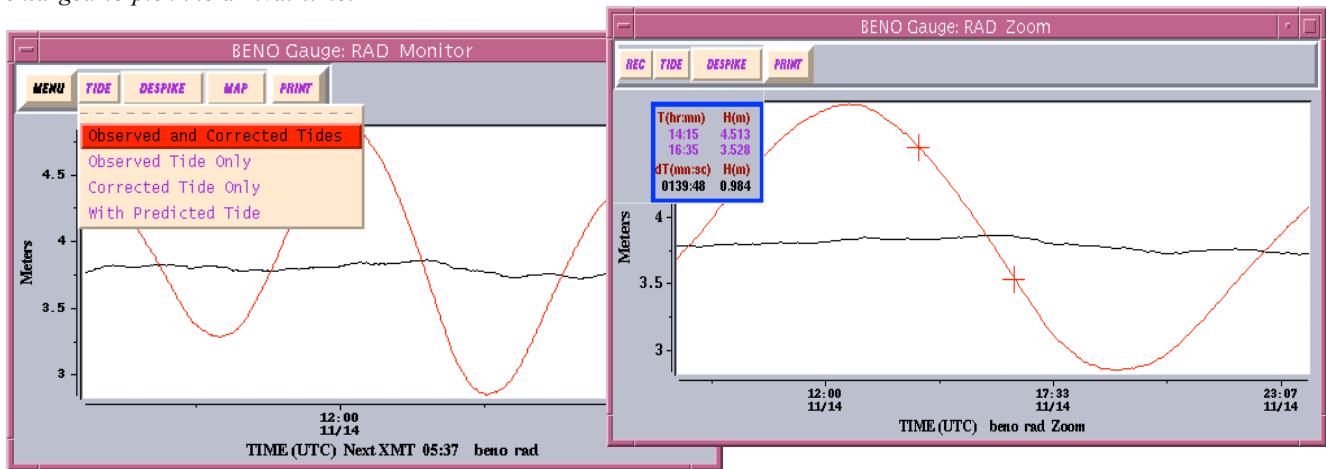
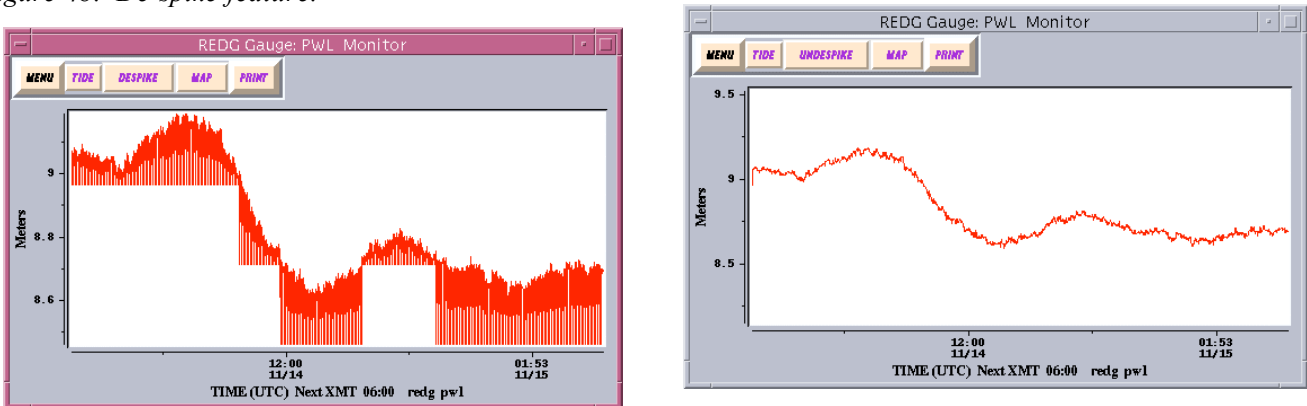


Figure 4b. De-spike feature.



BENO Station Data

Station Data For BENO

Location: Bena
WMO Header: SXXX32
Platform ID: 22856700
Transmission Interval: 15mins
SENSORS:
Sensor Type: prs Sample Rate: 1mins Unit: .001M
Sensor Type: rad Sample Rate: 3mins Unit: .001M
Sensor Type: enc Sample Rate: 15mins Unit: .001M
Lat: -8.7666 Long: 115.2166

EXIT

Messages For Station YAPI

Exit Print

```

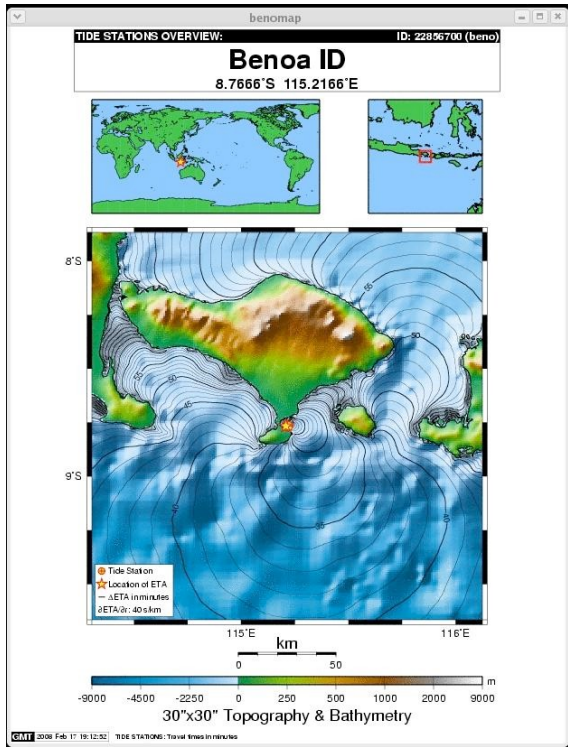
SWPA41 RJTD 160005 0647 0647 0647 0647 0647 0647 0647 0646 0646 0647 0647 0647
0647 0647 0646 0646 0647 0647 0647 0647 0647 0646 0646 1134 1134 1134
1134 1134 1134 1133 1133 1133 1134 1134 1134 1134 1133 1133 1133 1134 1134
1134 1134 1134 1133 1133 0666 0667 60 60 00 00 13.23 13.40 13.19
13.07=

SWPA41 RJTD 160017 0647 0647 0646 0646 0647 0647 0647 0647 0647 0646 0646
0646 0646 0646 0645 0645 0645 0644 0644 0644 0644 0644 1134 1133 1133
1133 1134 1134 1134 1134 1134 1134 1133 1133 1133 1133 1132 1132 1132 1131
1131 1131 1131 1131 1130 0667 0664 60 60 00 00 13.40 13.39 13.07
13.27=

SWPA41 RJTD 160029 0646 0646 0646 0645 0645 0645 0644 0644 0644 0644 0644 1133 1133 1132
0644 0643 0644 0644 0644 0643 0643 0642 0642 0643 0644 1133 1133 1132
1132 1132 1131 1131 1131 1131 1131 1130 1130 1130 1129 1129 1128 1128 1130
1129 1129 1128 1128 1129 1130 0664 0662 60 60 00 00 13.39 13.60 13.27
13.25=

SWPA41 RJTD 160041 0644 0643 0644 0644 0644 0643 0643 0643 0642 0642 0643 0644
0644 0643 0642 0642 0643 0644 0644 0643 0643 0643 1130 1130 1130 1130 1130
1130 1130 1129 1129 1129 1128 1128 1128 1129 1130 1129 1129 1128 1128 1130
1129 1129 1128 1128 1129 1130 0664 0662 60 60 00 00 13.27 13.25

```



Transmission Report For Last 12 Hours

Exit Print

Station	Received	Expected	%Rec
saba	048	048	100%
neul	048	048	100%
beno	048	048	100%
cili	047	048	097%
prig	047	048	097%
engg	044	048	091%
tanj	048	048	100%
ambo	048	048	100%
sebl	044	048	091%
sibo	047	048	097%
teda	047	048	097%
bitg	048	048	100%
pada	048	048	100%
saum	048	048	100%
sade	047	048	097%
lobk	047	048	097%
waik	048	048	100%
chrs	238	240	099%
dind	000	002	000%
djvw	000	002	000%
djve	004	002	200%
kota	033	048	068%
komi	000	048	000%
lang	048	048	100%
tanp	038	040	095%
coco	011	012	091%
cocb	231	240	096%
sitt	047	048	097%

Figure 5. Station metadata, as well as recent raw data transmissions of the sea level messages and a station transmission report, are available. A location map and tsunami travel times near the station are also provided for reference.

Tide.tcl operates continuously once started. It will check every 20 seconds to see if any new data has arrived, and if so, it will decode and update the station time series that is plotted. When Tide.tcl is started it will read data from the current day data log. Tide.tcl will keep up to 24 hours of data. As more data arrives beyond what Tide.tcl is supposed to hold, it will discard the older data to make room for the new. For each station, multiple sensors are often available and decoded. The sensor code is given by three letters, where prs stands for pressure sensor, bub indicates bubbler, rad indicates radar.

Tide Tool can also be used to viewing older or archived data log files.

To obtain the software, and for further information and questions, please contact Stuart Weinstein, Asst Director, NOAA Pacific Tsunami Warning Center (stuart.weinstein@noaa.gov), or Laura Kong, Director, UNESCO/IOC-NOAA International Tsunami Information Center (laura.kong@noaa.gov).