Single Station Data Processing - 2008

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May 29, 2008

On the laptops provided by COAS/OSU, please find C:\MT\ contents below:

bin	*compiled programs used by Matlab processing*
docs	*NIMS documentation*
software	*source codes and Matlab scripts*
surveys	*raw and processed data files*

Before you proceed,

1) Create a directory for the new survey, e.g. C:\MT\surveys\EarthScope.
2) Create a subdirectory 'original' for your survey, e.g. C:\MT\surveys\EarthScope\original.
3) Copy the directory C:\MT\software\EMTF\CF to C:\MT\surveys\EarthScope.
4) Read this document (including the 'important notes' section). It will save you time and frustration later, when something doesn't work like you think it should!

You now have a survey directory set up, with subdirectories 'original' and 'CF'. You are good to go. Start Cygwin+Matlab, by first double clicking the shortcut called 'Start Cygwin X-Windows' (just below 'My Computer' on the Desktop). The icon is clearly marked with an orange key. Black Cygwin bash shell will appear. Then type 'matlab' at the command prompt to start Matlab.

Suppose you have collected new NIMS data and you are holding the flash card in your hands.

1) **Create a subdirectory** for this run in C:\MT\surveys\EarthScope\original using the conventional IRIS 6-digit station/run name. The first two (capital) letters correspond to the US state. The third (capital) letter denotes the latitude in the array. The following two digits denote the longitude in the array. The sixth (lowercase) letter denotes the run number. Examples include ORG07a and IDB11b.

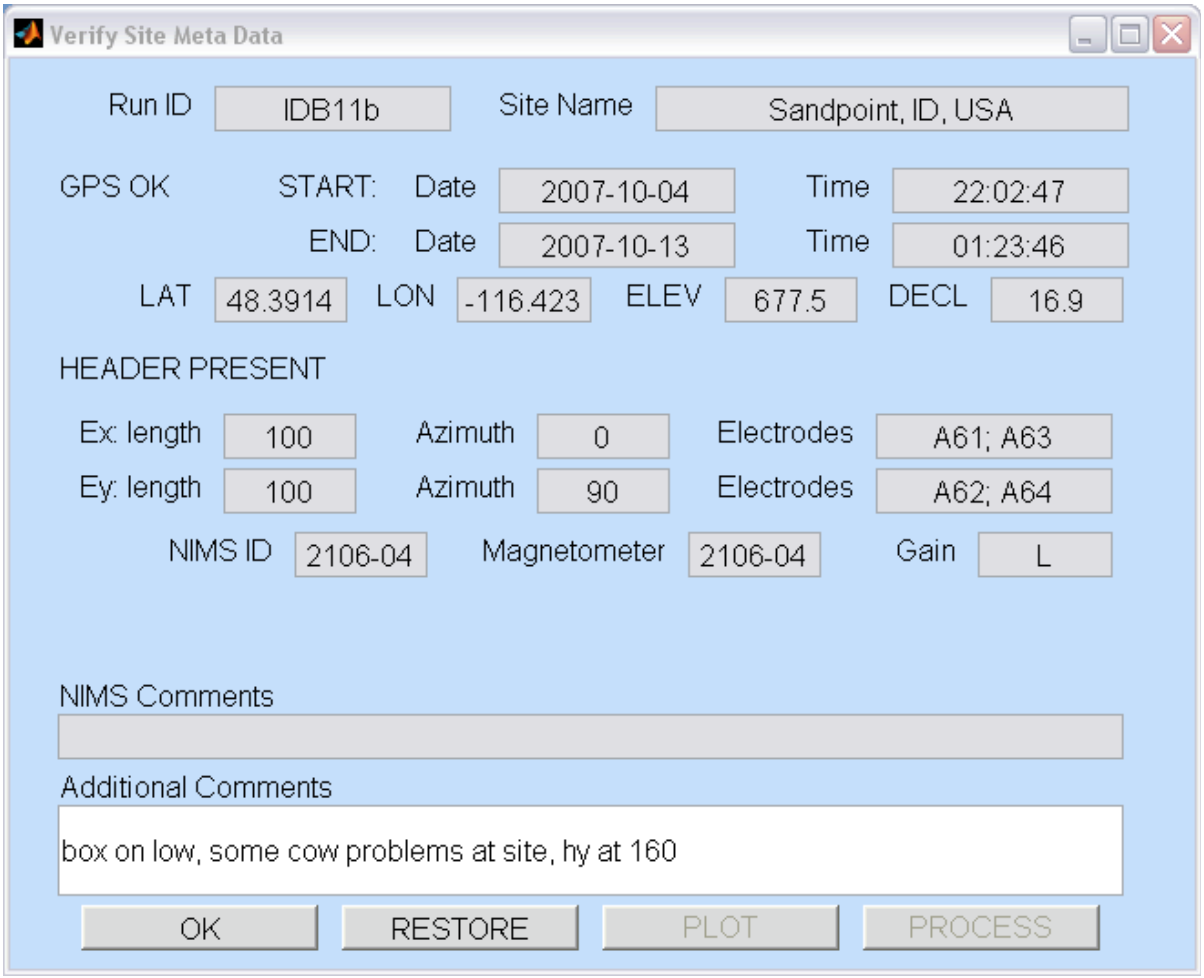
2) **Copy data file** DATA.BIN from flash card into the run subdirectory.

3) **Start the processing/plotting interface** by typing 'SS' in Matlab. The first time you do this, you will also be prompted to choose the Survey directory (in this case, C:\MT\surveys\EarthScope). Then, choose the file to process in the browse window (i.e., the appropriate DATA.BIN file).

The binary NIMS file will be read, and a plot of the full magnetic and electric field time series (blue) and temperature variations (red) will be generated. This provides a first look at the time series. Then a light blue editable window will open, that summarizes any metadata extracted from

the file (see Figure). Information such as the run ID and the length of electrode lines comes from the file header. Start time and location information is extracted from the GPS string.

It is essential that this information is verified. Feel free to modify both of the comments fields. 'NIMS Comments' are intended for any remarks about the system; they are initially extracted from the DATA.BIN header. Any discrepancies with the field notebooks, as well as any additional remarks, should be recorded in the 'Additional Comments' field. For example, 'Gain' character could be H(igh) or L(ow) or (E)X high or (E)Y high. Anything but H(igh) is unusual, and needs to be verified and commented upon.



If there are obvious inconsistencies or omissions in the metadata (e.g., if GPS failed to operate there will be no start time, location, or declination) warning messages will appear. You should fill in/correct any errors or omissions e.g., using field notes from the installation or permitting. Please make sure all the information in the metadata window is correct to the best of your knowledge before proceeding. If some information (e.g., start times) are only approximately known do the best you can, and add a note on the uncertainty to the comments window. You can safely change anything in the editable fields, including the site ID.

Once you click the 'OK' button, several things will happen. The file DATA.BIN gets renamed to (in this case) IDB11b.nim. Also, files IDB11b.xml and IDB11b.mat get written into the same (in this

case, C:\MT\surveys\EarthScope\original\IDB11b\) directory. Also, the information is checked for validity. If valid, 'PLOT' and 'PROCESS' buttons are activated. These could be used for a more careful look at the data.

The XML metadata file, the MAT file and the original NIMS data file are to be sent together to OSU for archiving, retaining the directory structure of C:\MT\surveys\EarthScope\original\.

The 'PLOT' button starts up a plotting program that allows you to examine the time series more closely, plotting shorter segments, zooming in, adjusting scales, etc.

As soon as you click 'PROCESS' you will notice that a bunch of new directories and files are created in C:\MT\surveys\EarthScope. They are only required to compute the single station transfer functions. You do not need to worry about their contents, unless you are experienced with using Gary Egbert's EMTF software. When the processing is complete (this will take 10-20 seconds) the apparent resistivity and phase for the off-diagonal impedance components will be plotted. The impedances are estimated using single station data, and will generally be severely biased (to low values) for periods below 20 s or so.

Now, suppose that you would like a second look at the data you have already processed with SS. In this case, type 'SSM' in Matlab. This opens the identical interface with identical functions, but it will load the saved MAT file instead of the raw NIMS data file. It will only take a fraction of the time that 'SS' took, and it will also load your corrections to the metadata.

Important notes:

- For running the processing/plotting interface, do not access Matlab by clicking on it in the Start menu – the processing system only works when Matlab is started from Cygwin.
- To exit Cygwin X-Windows: use the key combination Ctrl-Alt-Backspace. Alternatively, close the x-term window and right-click on the black cross hidden in the Windows toolbar in the lower left corner of the screen; then click 'Exit'. That closes X-Windows. Simply exiting the x-term without closing the X-Windows properly will result in an error next time you attempt to open Cygwin X-Windows.
- Running SS on a file that has already been processed will not load your changes to the metadata; clicking 'OK' will always overwrite an existing XML file. Use SSM for a second look at the data.
- The original data file gets renamed according to the run ID in the DATA.BIN file header. The file is renamed as soon as the SS interface is. If you then change the run ID using the metadata interface, the file name will also be modified. However, the respective subdirectory in C:\MT\surveys\EarthScope\original\ will not be renamed; you will need to do this manually as appropriate.

- Temperature measurements are not calibrated, but can be used to track any unreasonably large jumps in temperature.

- Software updates should be done by right-clicking on each of the C:\MT\software subdirectories and choosing the option “SVN Update”, while laptops are connected to the internet. Everything should work as before after an update. Updating only takes several seconds, so it is good practice to do that from time to time, particularly if we let you know they contain bug fixes.

- Double-clicking on an XML file should open the file in your default internet browser (such as Firefox or Internet Explorer). It is highly recommended and encouraged to check the contents of these files before sending us the data, and to correct any omissions using ‘SSM’ in Matlab.

NIMS Operation Manual 2008 - Appendix I - Status and GPS Bytes

The MT01 Compact Flash [CF] data logger records all data and header information in a single file named DATA.BIN. With the MT01 powered and a CF card then inserted into its socket the MT01 will begin by formatting the CF card for a single file which fills the entire card, and is all zeroes. A small exception is that there will exist a second small file, HEADER.TXT, which is unused and can be ignored. (The HEADER.TXT file is NOT written to the CF Card for Rev 2 versions of the datalogger – e.g. the EMSCOPE NIMS use Rev 2.)

If SETUP.BAT is used to start the MT01 recording the first part of DATA.BIN will be a copy of HEADER.TMP, or only its first 1024 bytes. All characters in this part will be printable, ASCII characters.

After the header magnetotelluric data will follow in records 131 bytes long, and at a rate of once per second.

The data block format is as follows:

Byte 1	01h SOH - start of message
Byte 2	83h message length
Byte 3	Status byte - see below.
Byte 4	GPS byte - see below.
Byte 5	Sequence byte - see below.
Byte 6,7	Electronics unit temperature - two's complement
Byte 8,9	Head temperature – two's complement
Bytes 10,11,12	Hx, sample 1, MSB, 2ndB, LSB, two's complement
Bytes 13,14,15	Hy, sample 1, MSB, 2ndB, LSB, two's complement
Bytes 16,17,18	Hz, sample 1, MSB, 2ndB, LSB, two's complement
Bytes 19-27	Hx,Hy,Hz, component sample 2 as per 10-18
Bytes 28-36	Hx,Hy,Hz, component sample 3
Bytes 37-45	Hx,Hy,Hz, component sample 4
Bytes 46-54	Hx,Hy,Hz, component sample 5
Bytes 55-63	Hx,Hy,Hz, component sample 6
Bytes 64-72	Hx,Hy,Hz, component sample 7
Bytes 73-81	Hx,Hy,Hz, component sample 8

BYTES 19-27 are NOT produced for 1-Hz versions of the NIMS, such as the EMSCOPE NIMS

Byte 82	logical redundancy check (XOR of bytes 1-81)
Bytes 83,84,85	Ex, sample 1, MSB, 2ndB, LSB, two's complement
Bytes 86,87,88	Ey, sample 1, MSB, 2ndB, LSB, two's complement
Bytes 89-94	Ex,Ey component sample 2 as per 83-88
Bytes 95-100	Ex,Ey component sample 3

Bytes 101-106	Ex,Ey component sample 4
Bytes 107-112	Ex,Ey component sample 5
Bytes 113-118	Ex,Ey component sample 6
Bytes 119-124	Ex,Ey component sample 7
Bytes 125-130	Ex,Ey component sample 8

BYTES 89-130 are not produced for 1-Hz versions of the NIMS, such as the EMSCOPE NIMS.

Byte 131 04h trailer byte.

Status byte format:

Bit 0 (LSB)	General alarm bit. This is the OR of bits 4,5,6 and 7.
Bit 1	X-ranging: The X-component has changed bins at the beginning of this data block.
Bit 2	Y-ranging: The Y-component has changed bins at the beginning of this data block.
Bit 3	Z-ranging: The Z-component has changed bins at the beginning of this data block.
Bit 4	X-out of range: magnetometer cannot home
Bit 5	Y-out of range: magnetometer cannot home
Bit 6	Z-out of range: magnetometer cannot home
Bit 7	1 Hz clock not valid for this data block

GPS byte:

After a GPS synchronization the NIMS acquires two sentences from the GPS, then removes its power. The GPS ASCII data are subsequently placed into this byte, one byte per second. A typical sequence of bytes starts

… C7h c7h 00h 18h ffh 24h <ASCII-$> 47h <ASCII-G> ….

The 00h indicates that the NIMS has completed acquiring the GPS sentences, and is about to begin scrolling these data. The next 18h is the value of the NIMS' internal 8Hz state clock, immediately prior to the GPS synchronization. The next ffh is the value of the NIMS' internal 2048Hz divider state and with the 8Hz byte the user may determine how much time drift has occurred between GPS synchronizations. After that are the bytes from the GPS sentences, which make up an ASCII text string beginning with $GPRMC,… these include a time and date stamp for the time of the lock.

When GPS data are not being scrolled through this byte, it is used to display other information, mainly the state of the telluric amplifier gain settings. A summary of possible byte values follows:

00h	power-on initialization prior to first GPS lock and synchronization
C7h	power has been applied to the GPS receiver for a NIMS resynchronization

C8h	High gain, both telluric channels
CCh	Low gain, both telluric channels
D3h	power has been applied to the GPS receiver, for an Almanac download [2000 seconds]
D8h	High gain on X, and low gain on Y channels
D9h	Low gain on X, and high gain on Y channels

Sequence byte format: - Data block sequencing number

At reset, 00h, for first data block transmission after an initialization. Incremented by 01h for each subsequent data block transmission (modulo 256).