LEMI-424 Data Processing

You have completed your MT survey using the LEMI-424. Follow the steps in this document to convert the data to miniSEED, reorganize it into station/channel/day volumes, and create metadata in a stationXML format for your experiment using lemi2seed before submitting data to PASSCAL. **Unix commands are indicated with bold print.** Unix commands and any command line arguments are highlighted in yellow. Input files are denoted by <*filename*>. GUI options and menus are highlighted gray. *GUI fields are italicized.*
lemi2seed is installed under a Conda environment. On the PASSCAL field laptops, run **conda activate MT** in the terminal window to activate the MT environment. Once activated you can start using lemi2seed in the 'MT' environment.

Additional documentation can be found on the PASSCAL website:
https://www.passcal.nmt.edu/content/passive-source-seed-archiving-documentation

1. Create an organized directory structure for your data

Start by creating a main directory for the project. Under your main project directory, make a first level directory "RAW" for the raw data that was downloaded directly from the instrument. Create a subdirectory for each station. For example:

mkdir RAW and **mkdir** RAW/STA1.

Move the DATA0??? directories, where ??? is the serial number of the datalogger, into the corresponding station directory. Also move the LEMI_Install_Sheet.xlsx and the LEMI_Credential_Sheet.xlsx for each station into the corresponding station directory. The .def suffixed file, containing calibration coefficient values, generated by the lemi424.exe program is named lemi424.def by default. Rename .def file as lemi424N0???.def where ??? is the serial number of the datalogger and move .def file to corresponding DATA0??? Directories (Figure 1).

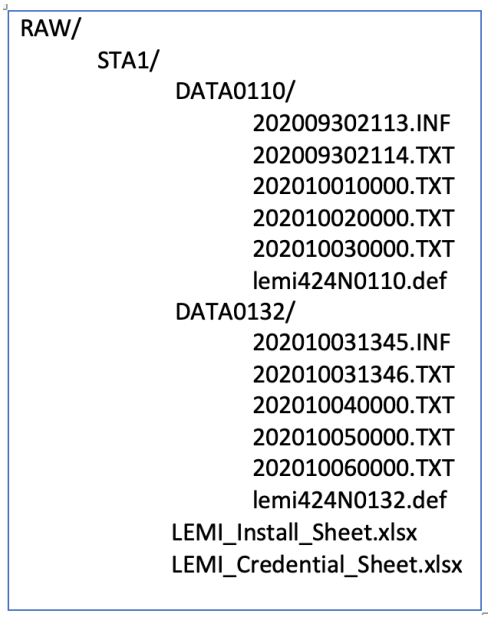

Figure 1

NOTES:

- Each station directory should have one LEMI_Install_Sheet.xlsx and one LEMI_Credential_Sheet.xlsx files. Only one copy of these files is necessary no matter how many DATA???? directories you have. If you have multiple copies of these files in the station directory, only one version of the file will be read.
- Most experiments will only have one DATA0??? directory for each station. You will only have multiple DATA0??? directories if you replaced the datalogger installed at a station.
- The .INF suffixed files within the DATA0??? directory correspond to each time the datalogger is started/restarted, and represent number of *Runs*.

2. Running Lemi2seed

Lemi2seed runs in two primary modes; quality control mode and field sheet & GUI mode. If you are in the field and/or want to quickly convert raw data to miniSEED, then use the quality control mode. For the archiving purpose, and creating metadata in StationXML run it in field sheet & GUI mode.

2a. Run lemi2seed in quality control mode

To assess the quality of your data, you have the option to run **lemi2seed** in quality control mode:

lemi2seed -qc -d RAW/STA1

The (-qc) flag runs **lemi2seed** in quality control mode while the (-d) flag defines the path to the station directory. You will need to run **lemi2seed** for each station in your experiment.

Running **lemi2seed** in quality control mode will bypass the handling of the metadata, allowing you to quickly convert your data into miniSEED files to assess the quality of the data collected. Using the -qc flag is primarily a mode to use while in the field.

Quality control mode will query the user for basic information about the station as well as which channels should be converted to miniSEED for quality assessment. Input from the user is required for the Network Code, Station Name, number of electrode pairs installed, channel port for electrode pairs, and the non-SOH components recorded at the station, i.e. E1, E2, E3, E4, Hx, Hy, and/or Hz as a comma separated list. You can select all or any of these components depending on which were recorded and how many you want to look at. **lemi2seed** will create day-long miniSEED files into a MSEED/STA1 directory and write the calibration coefficients into a LOGS folder in your current working directory. Calibration coefficients will only be written out if you provided .def file(s).
You can verify quality of your data and visualize your miniSEED files using **sqlx**. Use **fixhdr** to change miniSEED header values. For more information on how to use these tools, refer to the appropriate documentation on the PASSCAL website (see link on the first page).

2b. Run lemi2seed in field sheet & GUI mode

To create a final archivable copy of your data and metadata, run **lemi2seed** in field sheet & GUI mode:

lemi2seed -m RAW/STA1 -d RAW/STA1

The (-m) flag defines the path to the LEMI_Install_Sheet.xlsx and LEMI_Credential_Sheet.xlsx files while the (-d) flag defines the path to the station directory. You will need to run **lemi2seed** in field sheet & GUI mode for each station in your experiment to create a stationXML file and miniSEED day volumes. Running **lemi2seed** in field sheet & GUI mode will convert the data to miniSEED day volumes as well as creating metadata in stationXML format.

Field sheet & GUI mode will ingest the metadata from the LEMI_Install_Sheet.xlsx and LEMI_Credential_Sheet.xlsx files and automatically populate many of the fields in the GUI window that are required for creating the stationXML metadata file. The **lemi2seed** GUI has 4 tabs, Network, Station, Electric and Magnetic. Required fields are denoted by *.

The **lemi2seed** GUI allows you to save your metadata while you are working on it in case you need to close it or continue later.

Select the Save metadata button or go to File >> Save metadata to save an in-progress version of your metadata. This will create a *.pkl* file in the location you specify that can be loaded back into the **lemi2seed** GUI.

To resume working on your saved *.pkl*, bring up the GUI using **lemi2seed** -g -d RAW/STA1. Select the Load metadata button or go to File >> Load metadata to load a *.pkl* file with an in-progress version of your metadata. This will allow you to continue verifying or editing your metadata without needing to repopulate previously filled metadata fields. Alternatively, run **lemi2seed** -g -d RAW/STA1 -s *temp.pkl* to bring up the GUI and your *.pkl* file directly from the command line.

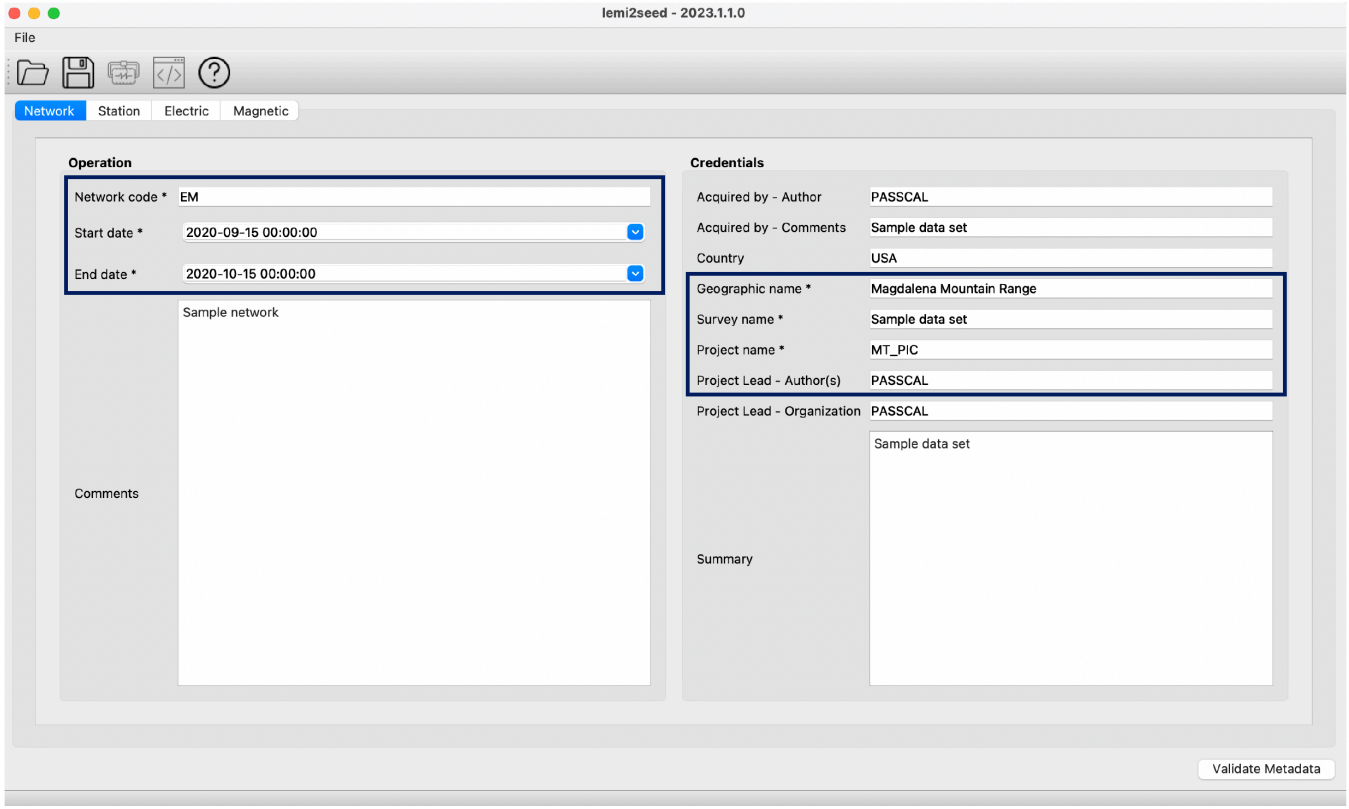

Figure 2

3. Verify the network metadata is correct

In the Network tab (Figure 2), confirm that the *Network code, Start date* and *End date* are correct. In addition, verify that the *Geographic name, Survey name* and *Project name* fields are populated.

4. Verify the station metadata is correct

In the Station tab (Figure 3), confirm that the metadata is correct. In particular, check the fields in the Operation section and confirm that the *Start time (UTC), End time (UTC)* and location fields are correct (*Latitude, Longitude* and *Elevation*). If you have more than one Run, utilize same as run option to populate fields and edit fields accordingly.

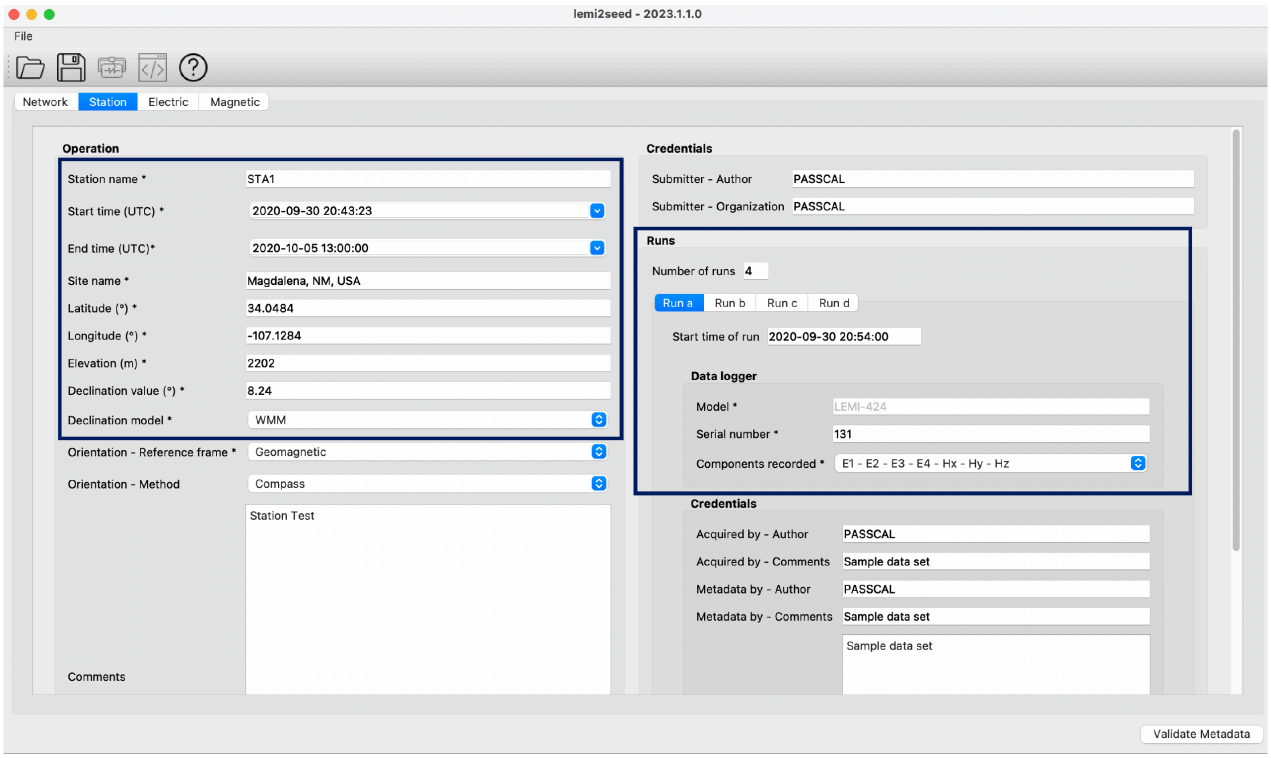

Figure 3

In the Runs section of the Station tab, for each Run (a, b, c, d) that was performed verify that the *Model, Serial Number*, and *Components Recorded* are correct.

5. Verify that information in the Electric and Magnetic tabs is correct

In the Electric tab (Figure 4) confirm that the information for the electrode pairs has been populated correctly. Start by verifying that the correct number of electrode pairs is specified by the *Number of electrode pairs* dropdown menu (either 2 or 4 pairs). For each electrode pair that was installed *Channel Port, Azimuth, Tilt, Dipole Length, Electrode – Specs, Direction* and *Serial Number* (for both the positive and negative electrode) are required. Check the tabs for each Run that was performed to confirm the required fields are correct.

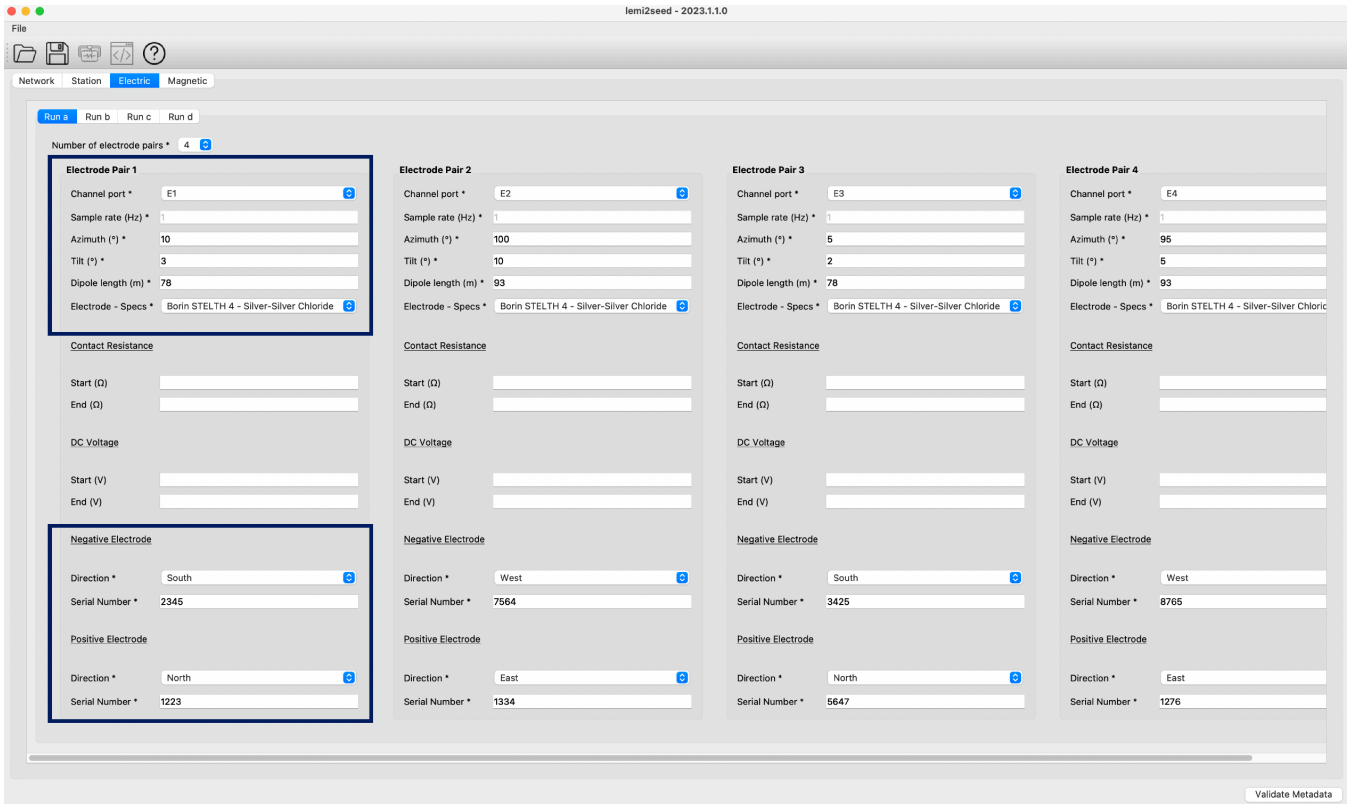

Figure 4

In the Magnetic tab (Figure 5), confirm that the *Azimuth, Tilt, Fluxgate – Specs*, and *Fluxgate – Serial Number* fields are populated correctly. Check the tabs for each Run that was performed to confirm the required fields are correct.

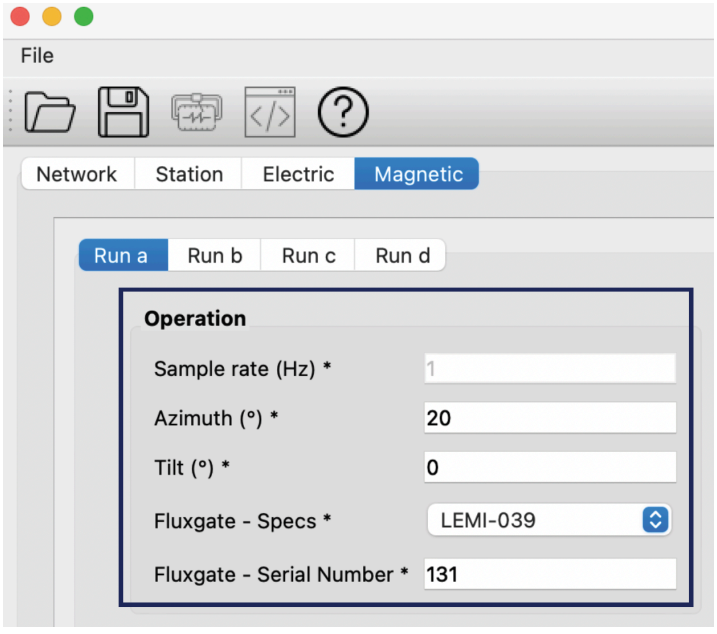

Figure 5

6. Validate the metadata

Once you have confirmed that all required fields in the GUI are complete and accurate, select the Validate Metadata button in the bottom right corner of the GUI. The validate function will give feedback in the command line window if there are any issues with validation of the metadata (Figure 6).

```
2022-09-08 12:31:58 - INFO - -------------------- Start - Validation of metadata entry set --------------------
2022-09-08 12:31:58 - ERROR - Invalid number of electrode pairs (run 'b')! The number of electrode pairs does not match the
 number of electric channels in your list of recorded components at the station/run level.
2022-09-08 12:31:58 - INFO - -------------------- End - Validation of metadata entry set --------------------
2022-09-08 12:32:16 - INFO - -------------------- Start - Validation of metadata entry set --------------------
2022-09-08 12:32:17 - INFO - -------------------- End - Validation of metadata entry set --------------------
2022-09-08 12:32:32 - INFO - All required metadata have been properly filled out by the user. Data and metadata conversion
actions have been enabled.
```

Figure 6

If any errors or warnings are reported as in the example above, return to the GUI and fix the red-highlighted issues before selecting Validate Metadata again. Once the validate function has been run without any errors, you will get an affirmative message in both the command line and a pop-up window (Figure 7).

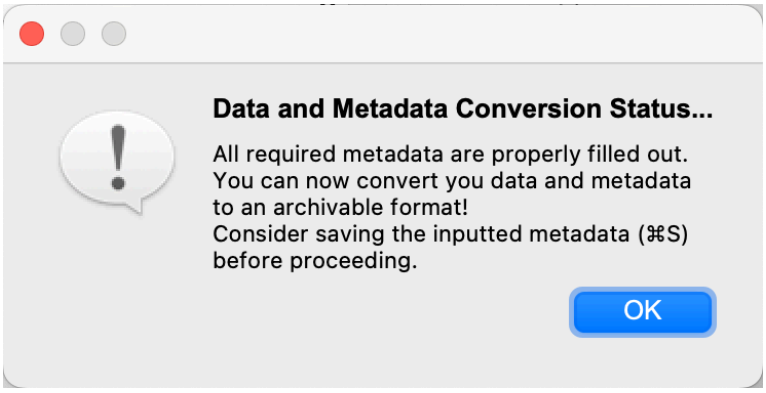

Figure 7

7. Convert the data and metadata

After your metadata has been validated you can convert the data to archivable miniSEED day volumes and write your metadata out into a stationXML file. The below buttons will not be enabled until all provided metadata fields pass validation.

Select the Write MiniSEED button or go to File >> Write MiniSEED. This will convert your data into miniSEED day volumes in a folder named MSEED in the directory where you ran **lemi2seed**. Write MiniSEED will also write out the calibration coefficients into a log file into a LOGS directory in the same folder if you provided .def file(s). The miniSEED data will be organized into station folders so if you write data out from multiple stations it will be in separate subfolders of the MSEED folder. If you select Write MiniSEED more than once

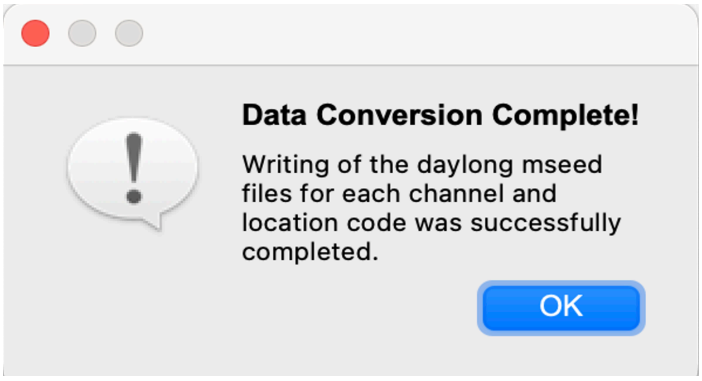

Figure 8

or have a previous copy of the data that was created by running **lemi2seed** in QC mode, **lemi2seed** will not duplicate the data.

Select the Write StationXML button or go to File >> Write StationXML. This will write out your metadata into a stationXML format file that will be in a folder named STATIONXML in the directory where you ran **lemi2seed**. Name the stationXML file with the network code, station name, experiment name, and today's Julian date. For example: EM.STA1.PasscalTestNet.2023036.xml
You will get an affirmative message in both the command line and a pop-up window once both conversions are completed (Figure 8 and 9).

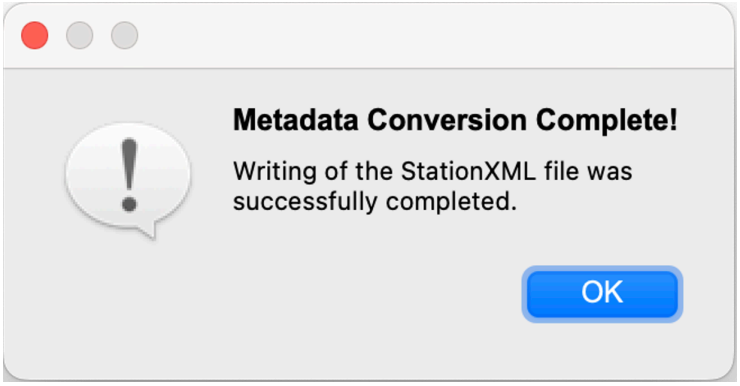

Figure 9

8. Send miniSEED data to PASSCAL
Please drop a note, with your PASSCAL project name in the subject line to, data_group@passcal.nmt.edu before sending the data so that we can set up a receiving area. Attach the stationXML for all your stations to this email unless it is larger than 5Mb. You can use our tool **data2passcal** to automatically send the data: **data2passcal** <directory containing day-long miniSEED files>