

How to import Tempest data

In this document we will show how to import Tempest data into Aarhus Workbench in preparation for Tempest data quality control and data processing.

We will go through the creation of the 3 import files. The geometry file, the data file and the xyz format file. Then we create a new workspace and go through the actual import of the Tempest data.

The geometry file

The first import file we need is the geometry file, also referred to as the gex file. This is a text format (.gex) file that describes the system parameters of the used Tempest system. It includes the geometry of the frame, the placement of the instruments, the transmitter waveform, time gate specifications, and so on. Everything that is needed to allow accurate modeling of the system in the inversion.

The geometry file consists of a [General] section and one or more [Channel#] sections. Within each section, related entries have been grouped together, often using a comment line to describe the group. This is not required, the entries just need to be within the right section, but it does improve the readability of the geometry file. Comment lines are indicated with a “/”.

Below we will go through an example TEMPEST geometry file using tables to explain the different keywords within each group. The type can be a string or a specific number of integers or reals. The description details how the keyword is used. The last column shows if the keyword is required (Req.), optional (Opt.) or special enough to be detailed in the description (Spec.).

In general, we use SI-units for the keyword values. The unit for the different keyword values are stated in brackets [].

1. [General] section – Device positions.

Keyword	Type	Description	
Description	String	Line that can be used to describe the geometry file.	Opt.
DataType	String	Here the keyword TEMPEST is used to control what the importer should look for in the geometry file.	Req.
GPSPosition1	3 Reals	Position of the 1 st GPS device on the frame. All device positions are described in X, Y and Z [m] with origin at the center of the transmitter coil and with z positive downward. For TEMPEST the corrections based on the device positions usually have been done before the import of the data, so to avoid doing them a second time, all devices other than receiver are falsely placed at origin.	Req.
AltimeterPosition1	3 Reals	Position of the 1 st altimeter on the frame.	Req.
InclinometerPosition1	3 Reals	Position of the 1 st Inclinometer on the frame.	Req.
RxCoilPosition1	3 Reals	Position of the Z receiver coil on the frame.	Req.

The device positions should be confirmed, but they are normally not changed for different TEMPEST systems.

2. [General] section – Transmitter loop definitions.

Keyword	Type	Description	
LoopType	Real	LoopType used by AarhusInv when inverting the data. This can be either 3 or 31 for TEMPEST. Both describe the TEMPEST system. The difference is that the 31 variant reinstates the primary field using the geometry imported from the data file and include it in the inversion along with an uncertainty on the primary field given by the PrimaryFieldSTD entry below. This can significantly improve the inversion result.	Req.
PrimaryFieldSTD	Real	Primary fields STD. This entry has no effect on the result when not inverting with LoopType 31.	Spec.
NumberOfTurns	Integer	Number of Tx-loop turns used.	Req.

The LoopType and PrimaryFieldSTD depend on the exact TEMPEST system and may need to be updated.

3. [General] section – Waveform definitions.

Keyword	Type	Description	
WaveformPoint01 ... WaveformPointN	2 Reals	For LoopType 3 this is Time [s] and normalized amplitude [0;1] for each of the N waveform points where the waveform must start and end at 0 amplitude. For LoopType 31 this is Time [s] and normalized peak-to-peak amplitude [0;1] for each of the N waveform points where the waveform must start at 0, but end at -0.5 amplitude. This added last leg of the waveform is needed for the reinstated primary field to be correctly used. For a 100% duty cycle waveform like this, it has been shown that the accuracy of the modeling will be improved by including more than just the last half period of the waveform. It is therefore recommended to use 3 or 5 half periods.	Spec.

The waveform definition for TEMPEST should be confirmed.

4. [General] section – Gate time definitions.

Keyword	Type	Description	
GateTime01 .. GateTimeN	3 Reals	Center [s], Open [s] and Close [s] times for each of the N gate. In the included example the zero time is set to be, at the begin	Req.

		of the ramp down. This is not a requirement for the modeling, but the zero time does have to be identical for the gates and the waveform.	
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The gate times table will usually only need to be updated the first time it is used for a given Tempest system, but it should always be confirmed

5. [Channel#] sections – There is one channel description for each moment.

Keyword	Type	Description	
RemovelInitialGates	Integer	Automatic disable time gate 1 to RemovelInitialGates in the processing.	Req.
UniformDataSTD	Real	Relative uniform STD for all dB/dt gates. 0.05 = 5%	Req.
RepFreq	Real	Repetition frequency.	Req.
ReceiverPolarizationXYZ	String	Receiver polarization. This can be X, Y or Z. The usual setup is to have Channel1 as Z and Channel2 as X.	Req.

The Channel1 and Channel2 sections will usually not have to be changed, but they should still be confirmed. The important values here are RepFreq with the repetition frequency of the system for the two channels.

It can sometimes be relevant to use a slightly higher UniformDataSTD for the gates and it can also on occasion be relevant to use RemovelInitialGates to automatically disable the earliest gates in the processing.

The data file

The second file we need for the import is the raw data file, also referred to as the xyz file. This is a space delimited column file in text format (.xyz). Often the data will be made available as a Geosoft database from where one then can extract the text file with the relevant parts of the data. For Tempest the key database fields we are looking for in the xyz file columns, possible with slightly different names, are:

Line number
 UTMX
 UTMY
 Topography
 Transmitter Altitude
 TxPitch or Pitch
 TxRoll or Roll
 RxHoriSep
 RxVertSep
 RxPitch
 RxRoll
 Gate_01
 ...
 Gate_xx (for both the X and Z channels)

The nominal geometry set with RxCoilPosition1 will be used if RxHoriSep and RxVertSep is not imported. Due to different sign conventions here, RxVertSep should be negative while the z component of RxCoilPosition1 should be positive. With looptype 31 the geometry also used to reinstate the primary field so it is important to use the same geometry as the one that was used to remove the primary field from the data.

When available, the RxPitch and RxRoll will be used as apriori when inverting for these parameters during the inversion, just as it is done with the Transmitter altitude.

It is possible to add columns with:

Date
Time

They are however not required, one can enter a sounding distance and import with a dummy date and time instead. For date `yyymmdd` and `yyyy/mm/dd` formats are supported. For time `hh:nn:ss`, `hh:nn:ss:zzz`, `hh:nn:ss.zzz`, `hh:nn:ss.zz`, `hhnnss.z` and number of seconds formats are supported.

It is also possible to import in a few extra columns and plot them in the processing. These miscellaneous columns will not affect the inversions, but it can still sometimes be practical to have easy access to them in the processing.

In the above the line numbers are unusual in the sense that they don't have to be imported as a column. They can also be imported from Geosoft xyz files where they are placed between blocks of columns.

Related to the data file we also need to know the EPSG or coordinate system and datum of the data. Finally, we need to know the unit of the magnetic data. T, mT, μ T, nT, pT and fT are all supported.

The xyz format file

The third and final file we need for the import is the xyz format file, also referred to as the alc file. This is a text format (.alc) file with just two columns. It is used to map the different columns of the data file into the corresponding database fields used by Aarhus Workbench. The first column is the largely fixed list of database fields such as `utmx` and `utmy`, the second column holds the column numbers of the columns that will be read from the data file into those database fields.

For everything other than line number a -1 means that nothing will be read to this database field, for line number a -1 means the data file should be treated as a Geosoft xyz file with the line number between blocks of columns.

This alc file can either be edited by hand from an existing file, or it can be done using the editor found in the importer. The editor is quite useful when making changes to the import gates column numbers, but minor adjustments can just as easily be done by hand before starting the import.

With this we have all the necessary import files and can start using Aarhus Workbench.

Create a new workspace and import the Tempest data

Now we can open the Aarhus Workbench and select New to create a new workspace. Select a folder for the workspace, add names and select the map coordinate system (EPSG).

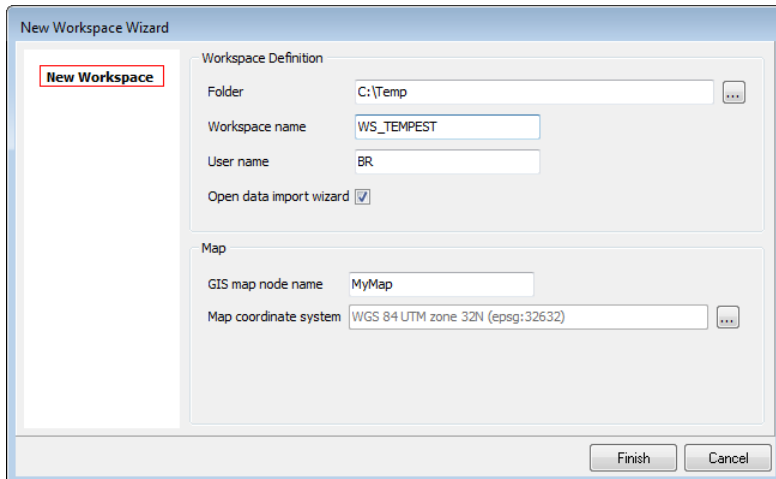


Figure 1. Create the Workspace.

When the workspace has been created, go to the database explorer and select Import on the database ribbon to start the import. If the open data import wizard checkbox was checked before, this wizard will open automatically. Now set the importer to import to a new database and fill out a name. Then go to the Airborne Data tab and select Airborne TEM Processing (TEMPEST).

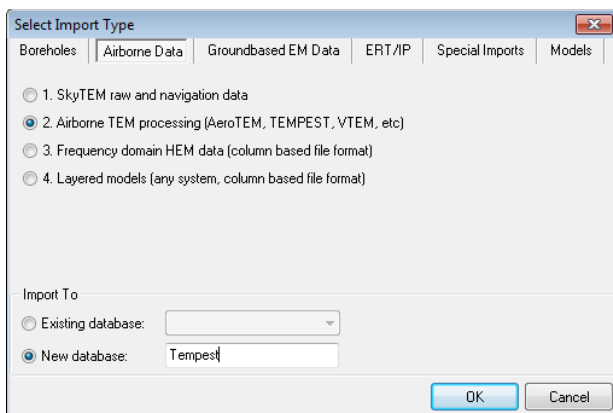


Figure 2. Select the Airborne TEM importer.

This launches the Airborne TEM importer. Select the Tempest importer.

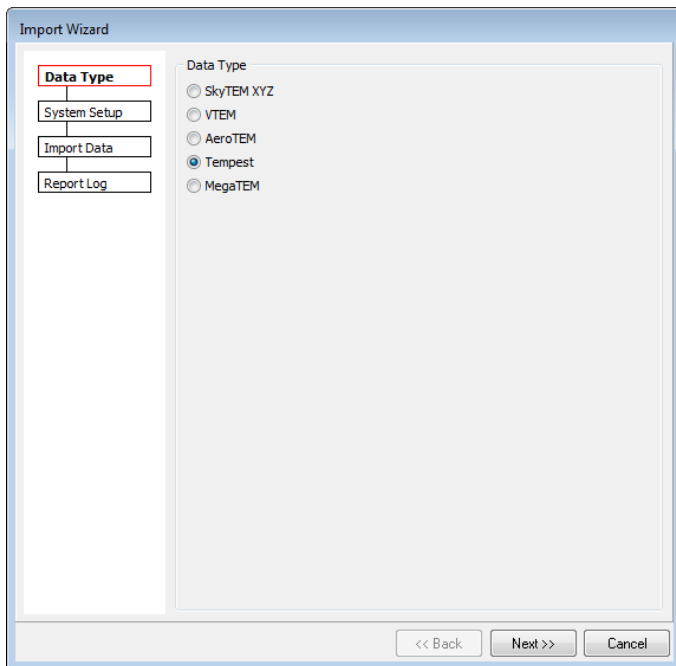


Figure 3. Selecting the Tempest importer.

Here we need to create the new dataset and import the geometry file with the system setup. First name the dataset, then make sure that the right coordinate system has been set, and finally point the geometry file.

In addition to this, it is possible to set several labels related the data processing and the used height system and reference model. None of this affects the inversion of the data, it is just labels in the database.

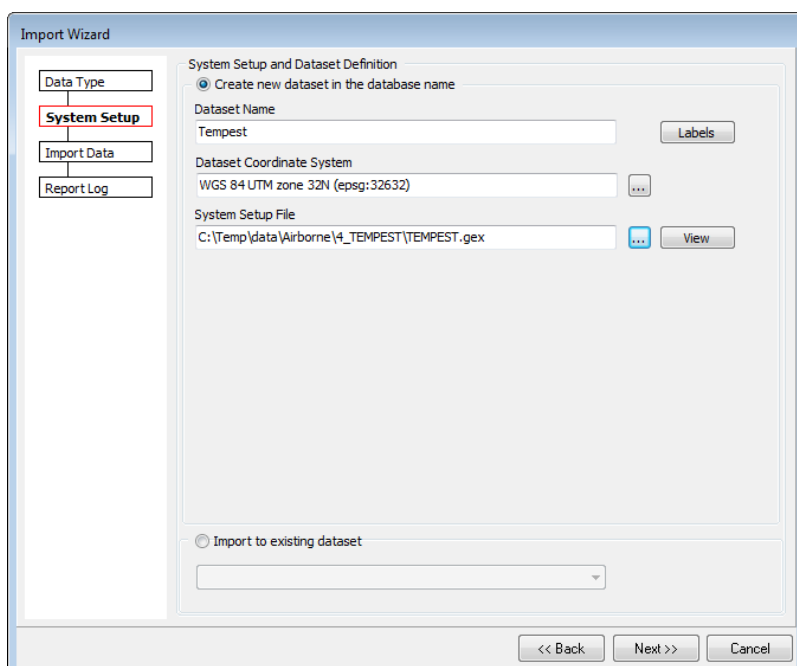


Figure 4. Create the dataset and import the geometry file.

Now we can import the data to the dataset. Point to the xyz file with the data. Then point to the xyz format file with the information about how the data from xyz file should be imported. It is here that it is possible to edit the xyz format file. The editor is great for changing the columns of the gates, but for other minor edits we can also easily update the column numbers directly in the file.

We often don't have the times in the data file. Then the time settings can be used to set an artificial starting point with a sounding distance, so that the data can be imported with dummy times.

For Tempest the only unit settings that needs to be set is the magnetic unit of the imported gates. When the magnetic unit is given as ppm of the primary field, it is also necessary to set the dipol moment of the system. This allows the primary field to be recalculated from the geometry (using the receiver coil position or if set the horizontal and vertical separation) so that data can be converted to the usual units. Keep in mind that if the primary field was removed with a nominal geometry, it should also be reinstated with a nominal geometry.

It is possible, but in general not recommended, to skip the log form and go directly to automatic processing by pointing to a processing settings file here.

Finally, we have the option of doing decimation on the data and skip some of the data during the import.

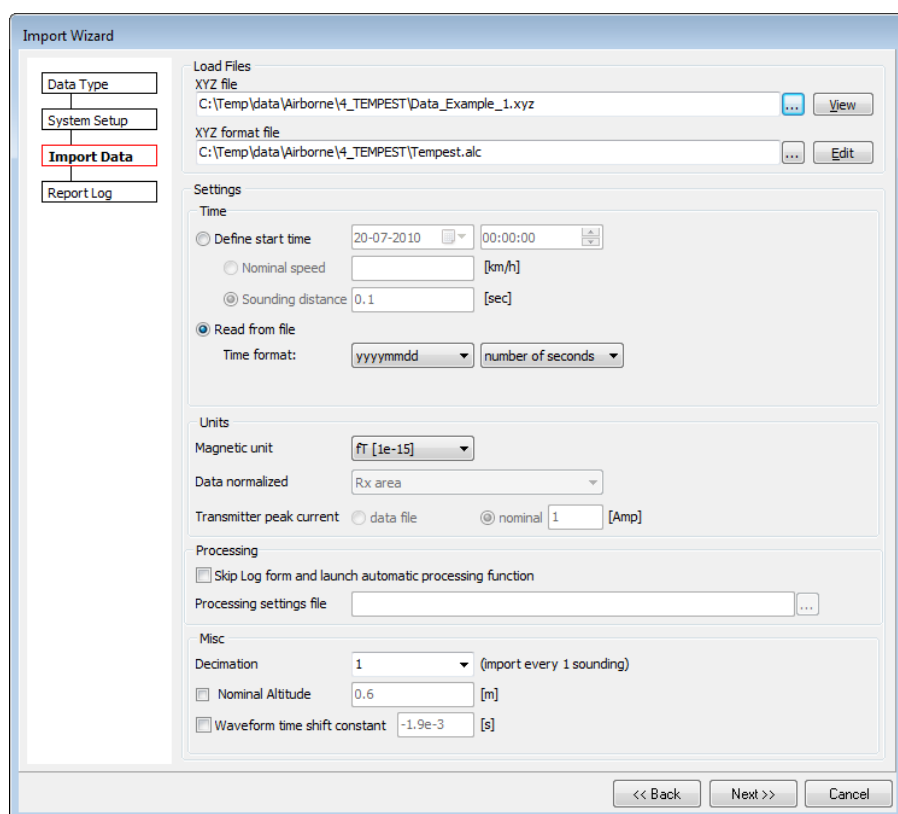


Figure 5. Import the data.

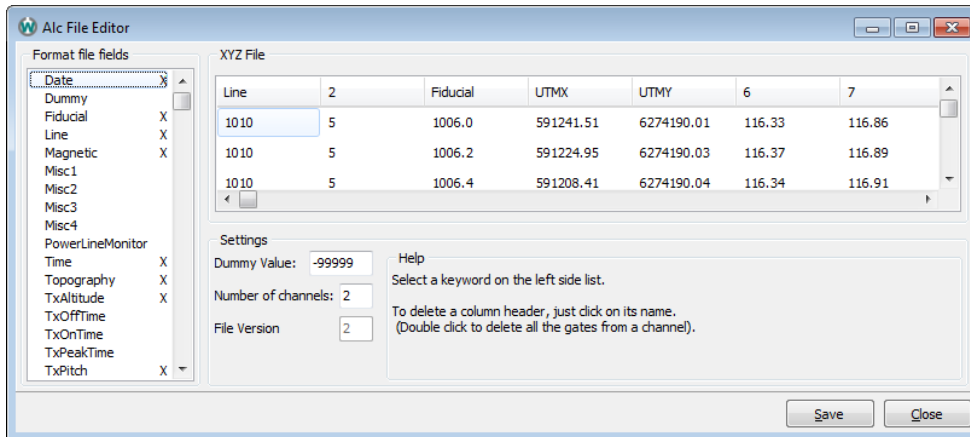


Figure 6. The alc file editor. For gates there is an option to click on the first gate and then the last gate, it can then fill out the gate column numbers of the gates in-between. To adjust an already existing gate setup, first click on begin and then any of the already assigned gates to reset the selection.

When everything has been imported check the log. If everything looks fine, it is time to create the data node. For that go to Data Processing and select Data (create new processing) and then select the database in the dropdown and processing type Airborne TEM. Then there is a dataset selector where we just need to say ok and a name for the processing node that needs to be filled out, before the data node will be created.

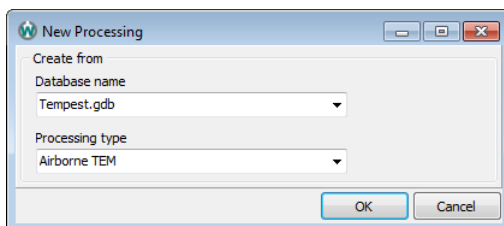


Figure 7. Create new data processing.

We will then be asked to also create a processing node. Here just click ones on each side of the data we want to include. If needed, click the button in the upper right corner of the form to reset. If the full dataset is very large or very dense, it is suggested to limit the size of the processing nodes. Larger nodes will be slower to work with in the processing. The more manual processing one expects to do, the more important it becomes to limit the size of the processing nodes. When doing so, it can be advantageous to enter the from and to times manually to get more exactly defined processing nodes that doesn't leave out any data. The create automatic interval feature is unfortunately not useful when using faked times.

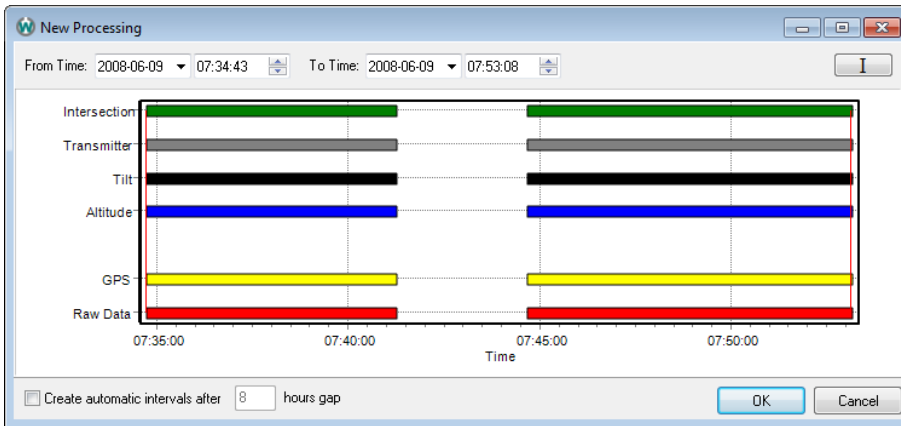


Figure 8. Processing node creation. Select the beginning and end of the data needed.

Lastly, we will be asked to give that node a name (this name must include a letter) and then we get to the processing filters. That will be covered in greater details later, for now just use default values. This was the last part of the import.

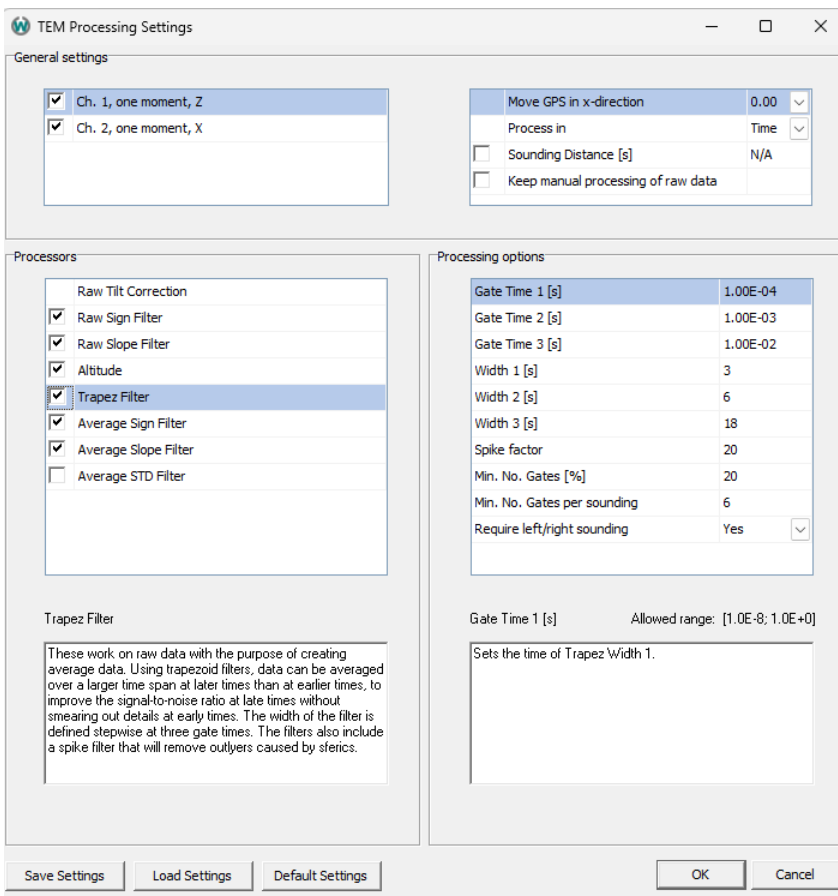


Figure 9. Processing filters with default settings.

If it was necessary to cut the processing into multiple node, additional processing nodes should be made by selecting the data node and then selecting Process Data. This open a window where we can select Create new processing node(s) which will return us to the Processing node creation. This is important as this

allows us to create multiple processing nodes under the same data node rather than under a new data node.

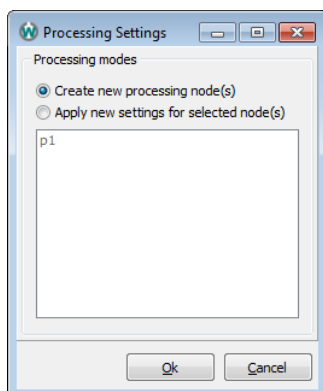


Figure 10. Creating additional processing nodes from the same data node.

All TEMPEST data from a survey should be imported through a single import, unless different geometry files make it necessary to split the survey into multiple imports.

If additional data from the same survey need to be imported later, it should be imported into the same dataset. The only exception would be if parts of the survey was flown using a different geometry file, then import it into a new database. To import additional data of a different type, simply import it into a new database.

When importing to the same dataset, go into import as before. Since the database already exist we can adjust the Import To setting to points to the existing database.

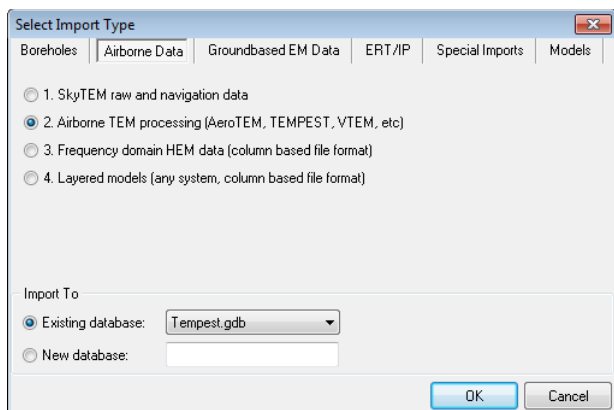


Figure 11. Importing to an existing database.

The dataset has also already been created, so we can select the import to existing dataset option and point the existing dataset. The rest is done just like before, just point to the new xyz file with the data. There is one little thing however that we need to remember here, if we are using an artificial starting point, one should move the date ahead here so that we don't import to the same time. When done additional processing node can be made just as described earlier.

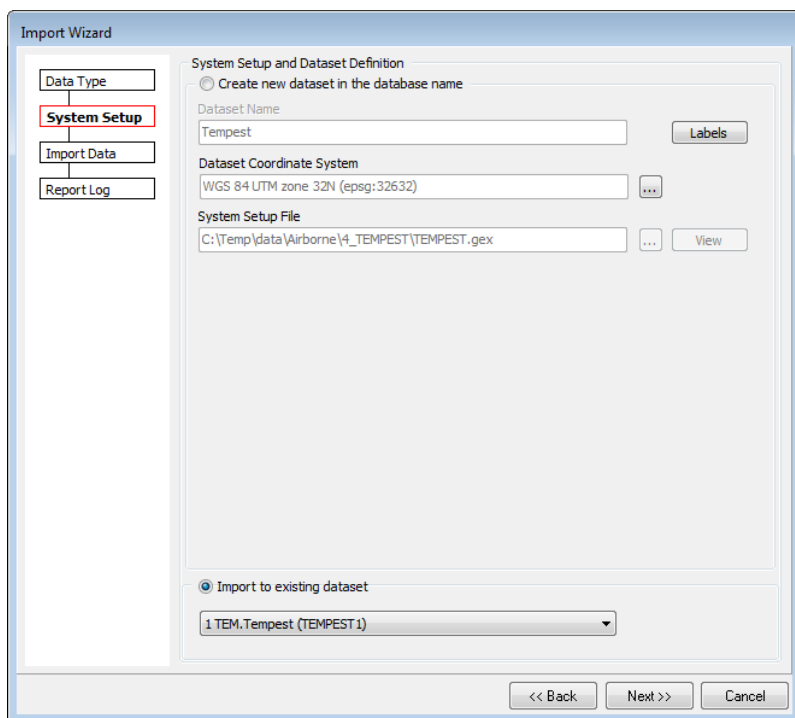


Figure 12. Import additional raw data to existing dataset.