Airborne Processing Library
Getting started with APL - GUI

ARSF - Data Analysis Node

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This is a tutorial aimed to help new people get started processing data with the Airborne Processing Library, specifically using the Graphical User Interface (GUI). By the end of it you should be able to generate per-pixel latitude

and longitude values and resample the data into a regular grid. Example data is included and can be downloaded from the ARSF Data Analysis Node website. Note that further help can be got from the "help" menu item on the main window.

Note that commands that are designed to be executed are `highlighted.` It is envisaged that the tutorial will take approximately 30 minutes to complete.

1.1 Files required for tutorial: Getting started with APL - GUI

This tutorial requires the file apl_tutorial_data.zip to be downloaded from the ARSF-DAN website from:
http://arsf-dan.nerc.ac.uk/files/apl_tutorial_data.zip
The contents of this file can be found in the appendix in section A.

2 Data description

The example data for this tutorial are in ENVI file formats. ENVI is a commercial image processing package. The data format is very simple and can be read by numerous software including the open source GDAL libraries. The data formats used are BIL (band interleaved by line) and BSQ (band sequential). These are binary file formats with an accompanying text header file that contains meta-data file descriptions.

The example data is contained in an archive structured similarly to how ARSF deliver the hyperspectral data. The layout is as follows.

2.1 Level 1 imagery

The level 1 image data is found in the flightlines/level1b directory. Each flightline has 2 files; one ending with '.bil' and one with '.hdr' as described above. These contain radiometrically calibrated "at sensor radiance" values.

2.2 Level 1 mask

When the raw hyperspectral data is calibrated a mask file is also produced. This contains information about the status of each pixel and whether it has been adversely affected, for example, by saturation or "bad" CCD pixels. The mask data is stored as 1-byte binary data, with the same dimensions as the level-1 file that it applies to. Eagle lines will have 1 mask file whereas

Hawk lines will have 2 mask files. The second mask file for Hawk contains information about which method has been used to identify the bad CCD pixel. Eagle does not suffer from these as it uses a different type of CCD and so does not have the second mask file.

Information on what flag values mean can be found in the .hdr file of the corresponding mask. These are briefly:

0 = Good data.
1 = Underflows.
2 = Overflows.
4 = Bad CCD pixels.
8 = Pixel affected by uncorrected smear.
16 = Dropped scans.

Some of these are sensor dependent, such as '4' will only occur in Hawk data and '8' only in Eagle.

2.3 Level 1 navigation

The navigation data is found in the flightlines/navigation directory. Each flightline has 2 files. These contain the time, position and attitude of the aircraft (including sensor boresight and lever arm information) synchronised to the level 1 image scan lines.

2.4 Digital Elevation Model

A Digital Elevation Model (DEM) is included with the example data in the dem directory. This has been created from ASTER data and covers the area of the included flight lines. The DEM is in APL format - which is a BSQ file with the data in WGS84 Geographic latitude/longitude with heights referenced to the WGS84 spheroid.

2.5 Sensor view vectors

The sensor view vector files are in the sensor_FOV_vectors directory. These are BIL files that contain the sensor CCD view vectors for the full CCD. Note that these may not correspond directly to the level 1 image data as the Eagle instrument CCD also captures data from the FODIS sensor.

3 Procedure description

This tutorial is designed to get new users comfortable with APL. By the end of it we shall have applied a mask to the level-1 data, created an IGM file - which is a file containing per-pixel longitude/latitude/height, reprojected it into a different coordinate projection, and resampled the level 1 data into a regular, mapped grid. This can be summarised as:

- Apply a mask via the GUI to the level 1 data

- Use aplcorr via the GUI to generate per-pixel latitude / longitude data

- Use apltran via the GUI to reproject into the desired projection

- Use aplmap via the GUI to resample the level 1 data into a regular grid.

The following procedure is suitable for using either the linux or Microsoft Windows versions of APL. The graphical user interface (GUI) or command line procedures can be used on either operating system.

4 GUI quick start guide

This section will describe the basic usage of the GUI and go through the steps of creating an IGM file, reprojecting it and finally resampling the level 1 data to a regular mapped grid. By the end of this section you should be familiar with the GUI and be able to navigate around it successfully.

It is assumed that you have downloaded the APL software and installed the GUI. If you have not yet done this please refer to section B in the appendices.

4.1 Set up the GUI

Before we start processing with the GUI it needs to set up a couple of parameters. The first thing we should do is tell it where to find the APL executable programs. Start aplgui by either double clicking "aplgui.py", or from a terminal prompt typing "aplgui.py" and you should see the main window as shown in figure 1:

Goto `File > Executable path...`

This will open up a file browser dialog. Navigate to, and select, the directory which contains the downloaded APL executables and click `open.`
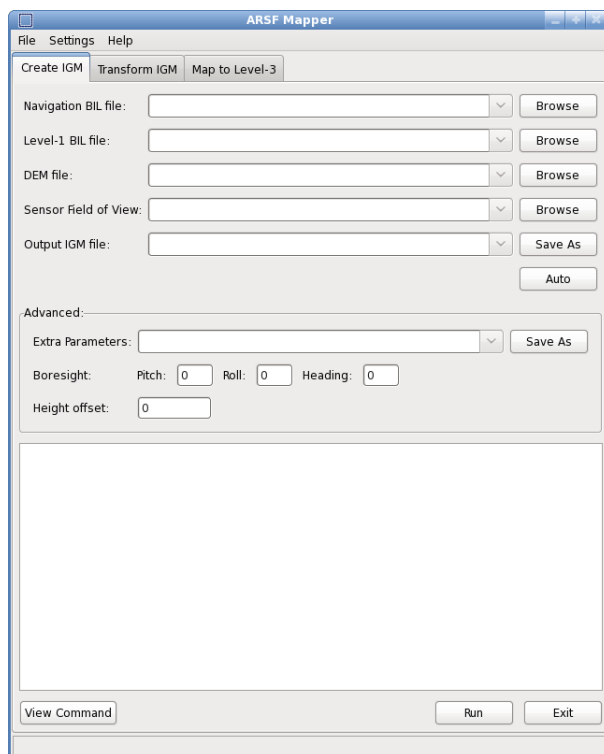
Figure 1: APL main window of GUI.

The next thing we need to set up is tell aplgui where the project data is. As the data for this tutorial are set up in the same structure as all ARSF hyperspectral deliveries, we can use some advanced features of the GUI to make life easier.

Goto `File > Project directory...`

This will open up a different file browser window. Navigate to, and select, the top level of the test data directory and click `open.`

We can also select an output directory that files will be written to. To do this:

Goto `File > Output directory...` and then select the directory that outputs should be saved to.

By default, the advanced controls are displayed on the GUI. Since we will not require these for this tutorial, we can turn them off by deselecting:

`Settings > Show advanced controls`

4.2 Apply a mask with aplmask

The first stage of the processing chain is to apply a mask to the level 1 data. If you do not wish to apply a mask you can proceed to the next stage.

Make sure the "Apply Mask" tab is selected, as shown in figure 2.

Then click the `Browse` button for the Level 1 BIL file. The file browser window should open in the "level1b" directory of the delivery. Select the required level 1 BIL file and click `Open.` The filename should now appear in the Level 1 file box.

Next click the `Browse` button for the mask file. Select the corresponding mask file for the selected level 1 file and click `Open.`

Finally, select an output filename for the masked level 1 data. Click the `Save As` to open the file browser. A suggested name will appear in the file selector or you can give it any name you wish. When finished you click `Save.`

If you do not wish to mask every type of affected pixel then you can select a subset of types to mask using the tick boxes. It is recommeneded to mask out every type of pixel unless you have a specific reason not to.

Click `Run` to start the aplmask program. A progress bar will pop up and display the elapsed and predicted remaining time, and output information is written to the output window. Note that while the progress bar is displayed the main window can not be interacted with.

4.3 Create an IGM with aplcorr

The next stage of the processing is to use aplcorr to generate an IGM file. To do this make sure the tab "Create IGM" is selected as in figure 3.

Then click the `Browse` button for the Navigation BIL file. The file browser window should open in the "navigation" directory of the delivery. Select the navigation BIL file and click `Open.` The filename should now appear in the Navigation BIL file box.

The data for the next 3 boxes can be entered in the same way, by selecting the appropriate browse button. It should also be possible to press the `auto` button to fill these in automatically as the data are in the standard delivery folder structure.

Finally we need to give the IGM a filename for the data to be saved to. To do this, select `Save As` to open the file browser. A suggested name will appear in the file selector or you can give it any name you wish. When finished you click `Save.`

Every selection box on the window should now contain a file name and we are ready to run the command. This is done by clicking `Run` .
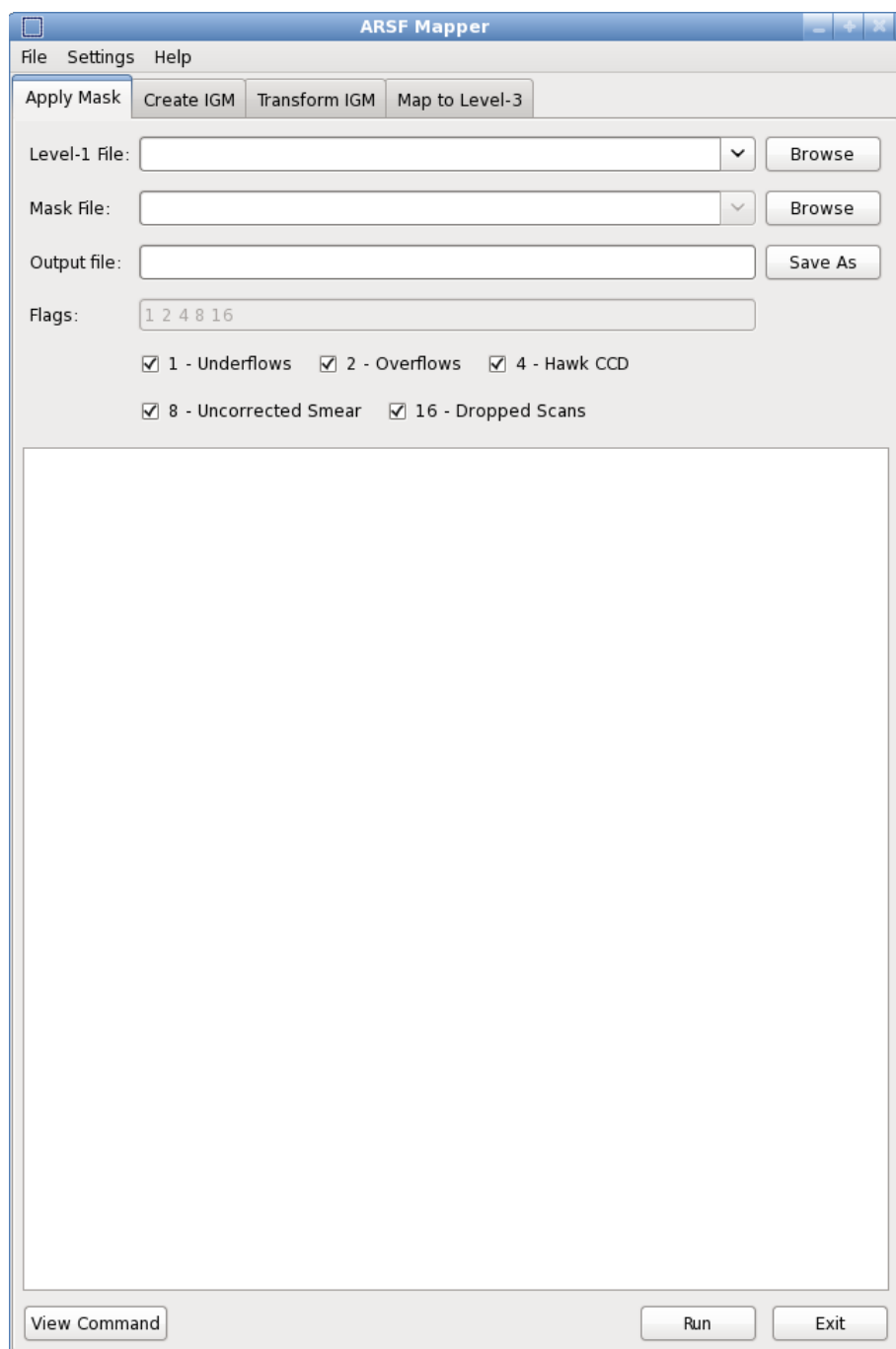
Figure 2: Apply mask tab to mask level 1 data.

A progress bar will pop up and display the elapsed and predicted remaining time, and output information is written to the output window. Note that
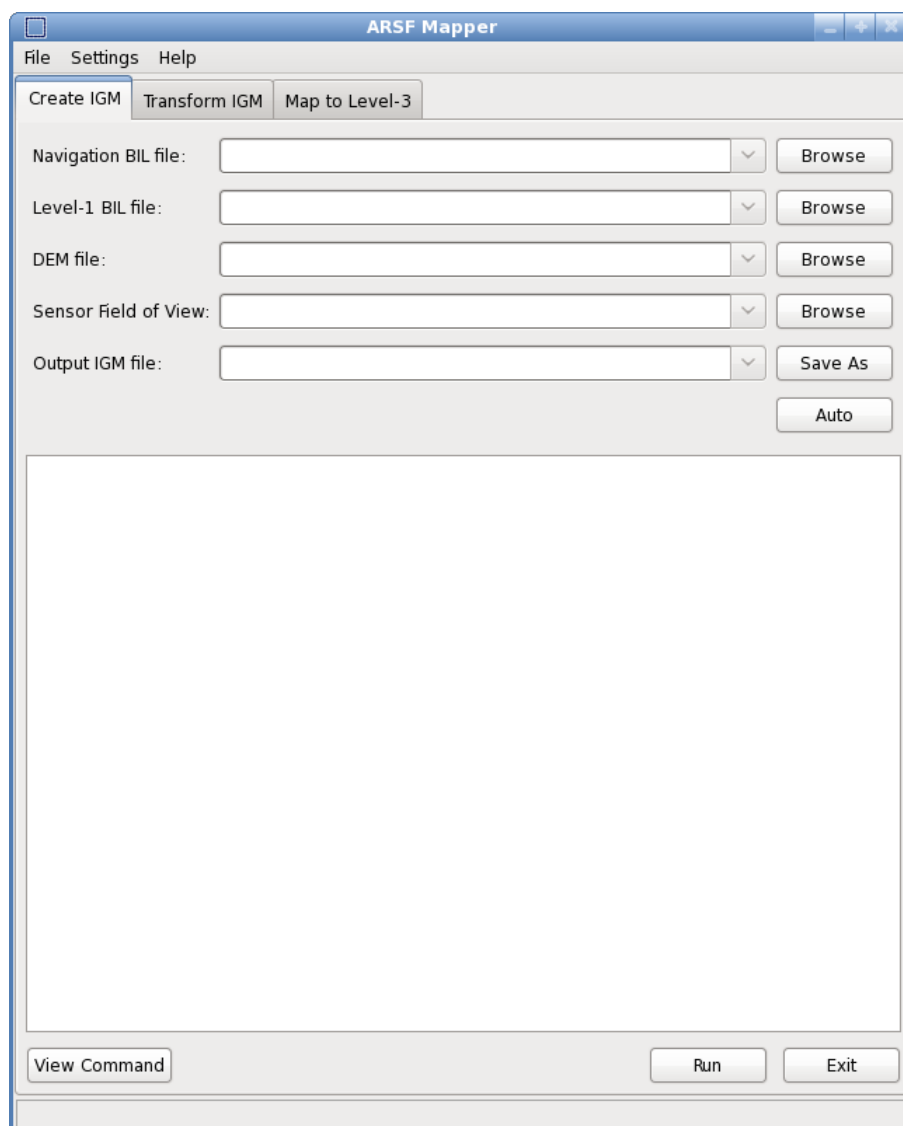
Figure 3: Create IGM tab to generate an IGM file.

while the progress bar is displayed the main window can not be interacted with.

4.4 Reproject an IGM with apltran

The next stage of processing is to reproject the IGM we have just created into the projection we want the final map to be in. The data for this tutorial was collected over an area of the UK, so we will create a map in the Ordnance

Survey National Grid (OSNG) projection. To do this we must first download the OSNG projection files from http://www.ordnancesurvey.co.uk/oswebsite/gps/osnetfreeservices/furtherinfo/ostn02_ntv2.html and unzip them into a directory named "ostn02".

The IGM reprojection is done using the middle tab of the GUI titled "Transform IGM". Selecting this tab should show a window as in figure 4:
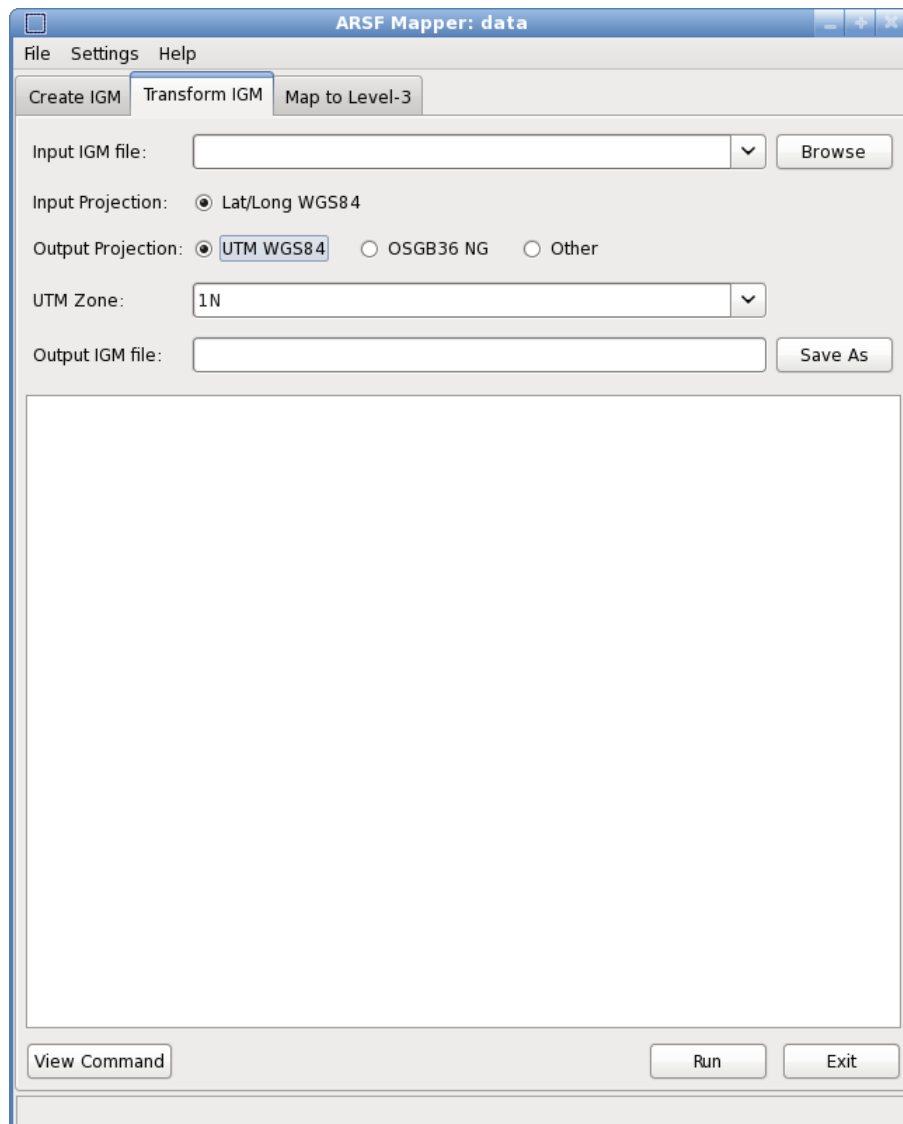

Figure 4: Transform IGM tab, used to reproject the IGM files.

First we select the IGM file that we wish to reproject. This is the one saved from the previous step. You can either copy/paste the filename from

the previous tab or click `Browse` and select the required IGM file.

Next, select the output projection. We wish to use the OSNG projection so select the `OSGB36 NG` option. Note that this has changed the box below the output projection to allow the grid shift file to be entered. Select the `Browse` button and navigate to the ostn02 folder where we just unzipped the downloaded files. Select the `'.gsb'` file and click `Open`.

Finally, click `Save As` and enter a filename for the new IGM, or use the suggested name, and click `Save`.

Everything is now set up for this stage so click `Run` to start the processing. Again, a progress bar will pop up and display the predicted time left until the processing is complete.

4.5   Resample level 1 with aplmap

The final stage of the processing is to resample the level 1 data to the mapped grid defined by the IGM data. This is done using the final tab, which is titled "Map to Level-3". Selecting this tab should display a window as in figure 5.

The first thing to do is enter the required input files; the IGM and Level-1 file. This is done by selecting the appropriate `Browse` button. For the IGM we select the one which is in OSNG projection.

Then we give the mapped image a name by selecting `Save As` and entering a file name or using the suggested one.

Now we need to select which bands we wish to map. By default this is the keyword "ALL" which will map all the bands. We shall only map the first 3 bands of the file. Click the `...` button which opens up the band picker dialog. Here we can add / remove bands from the list that we will map, either by using the wavelength of the data for this band or the band number. The bands that will be mapped appear in the list on the left of the dialog. Select bands 1, 2 and 3. For this data set we can either click `All` and then select 4 in the list and click `Remove`. Or we could click `Clear` and then select bands 1, 2 and 3 in turn and click `Add` after each one. When finished click `Ok`. You should now see that the bands selected have appeared in the box as a space separated string.

Now we also need to enter a pixel size for the final mapped product. The size must be given in the same units as the input IGM file. Here we are using the OSNG projection which is in metres. You can get an estimate of spatial resolution for Eagle and Hawk data using the calculator at: http://arsf-dan.nerc.ac.uk/pixelsize/pixelsize.html. Here we are going to use a square pixel size of 2 metres. In each of the `X` and `Y` boxes enter 2.
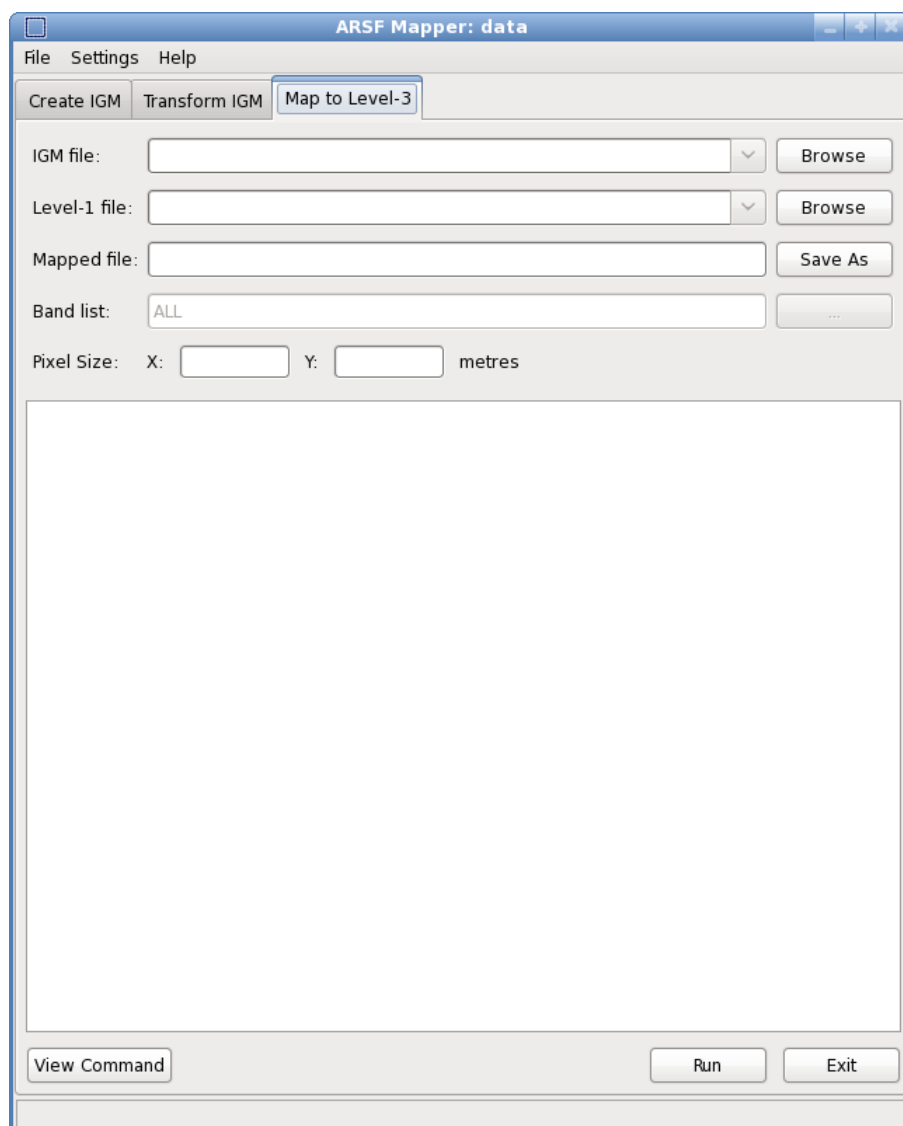
Figure 5: Map to Level-3 tab, used to resample the level 1 data to the grid defined by the IGM file.

We are now ready to run this stage of the processing. Click the Run button. Again, a progress bar will pop up and display the predicted time left until the processing is complete.

The procedure is now complete and we have a BIL file which contains the mapped level 1 data for bands 1, 2 and 3 using a pixel size of 2 metres.

This concludes the tutorial. There is a second flight line, a hawk one, included in the example data for you to try and process following the above

procedure.

5   Review

We have gone through the 3-step procedure of mapping ARSF level 1 data using APL, and also applied a mask to the level 1 data. You should now be confident in using APL to map data to basic pre-defined projection systems, using the GUI approach. You can now:

- Use aplgui to apply a mask to the level 1 data

- Use aplgui to generate an IGM file containing latitude and longitude data

- Use aplgui to reproject the data using one of the pre-defined projection keywords

- Use aplgui to resample the level 1 data to a regular gridded product

If you wish to check your processed data you can download the file apl_basic_tutorial_data_processed.zip which contains all the files that should have been created in this tutorial.

This concludes the first tutorial in basic APL usage. For further advanced tutorials please check the ARSF-DAN website.

A   Appendix - File list

Table of files contained in apl_tutorial_data.zip .

Filename	Description
`test-site.dem`	Digital Elevation Model made from ASTER data. In WGS84 latitude / longitude and referenced to WGS84 spheroid surface.
`test-site.dem.hdr`	Header file containing meta-data relating to test-site.dem.
`eagle_line.bil`	Level 1 processed Eagle imagery
`eagle_line.bil.hdr`	Header file containing some meta-data relating to eagle_line.bil
`eagle_line_mask.bil`	Mask file for level 1 Eagle imagery
`eagle_line_mask.bil.hdr`	Header file containing some meta-data relating to eagle_line_mask.bil
`eagle_line_nav_post_processed.bil`	Navigation synced to eagle_line.bil data
`eagle_line_nav_post_processed.bil.hdr`	Header file containing some meta-data relating to eagle_line_nav_post_processed.bil
`eagle_fov_fullccd_vectors.bil`	Eagle full CCD view vector file. Contains the Eagle CCD view vectors.
`eagle_fov_fullccd_vectors.bil.hdr`	Header file containing meta-data relating to eagle_fov_fullccd_vectors.bil.
`eagle_line.xml`	XML meta-data relating to eagle_line.bil.
`hawk_line.bil`	Level 1 processed Hawk imagery
`hawk_line.bil.hdr`	Header file containing some meta-data relating to hawk_line.bil
`hawk_line_mask.bil`	Mask file for level 1 processed Hawk imagery
`hawk_line_mask.bil.hdr`	Header file containing some meta-data relating to hawk_line_mask.bil
`hawk_line_mask-badpixelmethod.bil`	CCD detector method mask file for level 1 processed Hawk imagery
`hawk_line_mask-badpixelmethod.bil.hdr`	Header file containing some meta-data relating to hawk_line_mask-badpixelmethod.bil
`hawk_line_nav_post_processed.bil`	Navigation synced to hawk_line.bil data
`hawk_line_nav_post_processed.bil.hdr`	Header file containing some meta-data relating to hawk_line_nav_post_processed.bil
`hawk_fov_fullccd_vectors.bil`	Hawk full CCD view vector file. Contains the Hawk CCD view vectors.
`hawk_fov_fullccd_vectors.bil.hdr`	Header file containing meta-data relating to hawk_fov_fullccd_vectors.bil.
`hawk_line.xml`	XML meta-data relating to hawk_line.bil.

B Appendix - Installation

Visit the ARSF-DAN website and download a copy of APL for your computer system from here: http://arsf-dan.nerc.ac.uk/trac/wiki/Downloads/software

Unzip the file contents into a directory. The windows build comes with the PROJ library included, if you are running under linux then please make sure you have PROJ installed on your system. The 4 APL files aplmask, aplcorr, apltran and aplmap need to have executable rights to run them.

Next download the GUI from the same place, selecting the appropriate one for your system. Windows users can either download pre-built binaries or use the executable installer. Note that the latter requires administration rights.

The GUI requires python 2.7 to run together with the python wx libraries. These are included with the pre-built and windows installer methods, but may be required to be installed separately if you use the (linux) source version.