University of Michigan Space Physics Research Laboratory		
TIDI Data Processing Software **Invert User's Guide**	CAGE No. Drawing No. Project Contract No. Page	0TK63 055-4280 TIDI NASW-5-5049 1 of6

REVISION RECORD			
Rev	Description	Date	Author
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Contents

1. Related Documents

1) Gell, D. "Line of Sight File Format", SPRL File 055-4191.

2) Gell, D. "Profile File Format", SPRL File 055-3532.

3) Gell, D. "File Naming Convention", SPRL File 055-3545.

4) Ortland, D. "Invert Algorithm Description", SPRL File 055-????.

5) Marshall, A. "Invert Design and Maintenance Document", SPRL File 055-4276.

6) Gell, D. "TIDI Activities Plan", SPRL File 055-9999.

2. Introduction

The purpose of this document is to educate the program user about the Invert program so that s/he can:

- Run the program.

- Determine whether an attempted run was successful.

- Recover from any errors which may have occurred.

2.1 Intended Audience

This document assumes that the reader has a reasonable facility with the Unix operating system, and some understanding of the TIDI data system. An understanding of the netCDF file format is also helpful, since most TIDI data files are of this type.

2.2 Typographical Conventions

The following typographical conventions are used for this document:

`normal courier` - font for items to be entered as shown

`italic courier` - font for tokens to be replaced by specific values

`bold courier` - font for prompts

3. Operation of the program

The Invert program consumes the TIDI level 1b Line of Sight (LOS) data which are in a single LOS file (see ref. 1 for the file format), and produces a level 2 Profile file (see ref. 2). LOS files will generally contain data for a 24 hour period beginning at around 00h00 UTC and extending thru the end of the last measurement set of the day (which can be 2-3 minutes into the next day), and are organized sequentially in time, with each 'record' (one value or set of values for each variable) detailing the observation made by a single telescope (of which TIDI has four) for a given time. Each LOS 'record' consists of a measured emission spectrum, and the collection conditions (time, latitude, longitude, altitude, etc.) for the measurement.

Invert collects a 'scan' of data (measurements made with a single telescope during a short time interval as it is moved either up or down to view different altitudes), and processes it (also referred to as inverting it) by using a model of the TIDI instrument ('forward model') to determine what atmospheric conditions (wind, temperature, etc.) would create the spectra like those measured.

The best fitting atmospheric conditions (the winds and temperatures, etc. which produce spectra most like the measurements) are copied into an output structure which is then written to the netCDF formatted Profile file.

3.1 Required files

The follow files are required input to the Invert program:

Los file – This file contains the line-of-sight spectra and collection conditions, which are the results of the Retrieve program processing. Please refer to the TIDI File Naming Convention document (ref. 3) for a discussion of the form of TIDI data filenames.

Day mode control file – This file contains the control parameters used by the Invert program for processing daytime collection modes. Please refer to the Profile File Format Document (ref. 2), global attributes section, for descriptions of the values in the day mode control file.

Night mode control file – This file contains the control parameters used by the Invert program for processing nighttime collection modes. Please refer to the Profile File Format Document (ref. 2), file meta-data global attributes section, for descriptions of the values in the day mode control file.

Atm model file – This file contains model winds, temperatures, and volume emission rates, which are used during test runs in which some of the profiles which could be recovered are being replaced by model data. This is not generally used in production processing.

Initial guess file – This file holds initial guess profiles for winds, temperatures, and volume emission rates, which are used only during testing, not in production processing.

Mode table file – This file contains a description of a common operation mode of the instrument (which emissions are viewed at which tangent heights, etc.) which is used only during test runs in which the input data are being replaced by model data. It is not used in production processing. See calling argument 'm' below.

Cpf – This file, also called the 'Constant Parameter File', holds values which describe the instrument and inversion (like flen, the telescope focal length), as well as various other constants (pi for example). The cpf access routines provide the means for reading the set of these values which applies to a given day of data.

Prf file – This is the output file, produced by the Invert processing. Please see reference 2 for a further description of this file.

3.2 Command to execute program

The Invert program can be executed with the following commands:

/tidi/tidi_software/invert/hpux/invert calling_arguments   (on the HP machines, tidi02, etc.)

/tidi/tidi_software/invert/sun/invert calling_arguments   (on the Sun machine, tidi05)

The following calling arguments are available:

Calling Arguments: (each should be preceeded by a '-')
```
  bt beg_time         (start processing after ut_time=beg_time)
  cd day_control_file    (use day mode control file=day_control_file)
  cdn night_control_file   (use night mode control file=night_control_file)
  cl                 (for prf file, write over any existing file w/ same name)
  et end_time            (end processing with ut_time=end_time)
  i los_file            (input filename=los_file, include directory)
  m                 (use model for input (rather than data read from LOS file) - for testing
                        only)
  o prf_file           (output filename=prf_file, include directory)
  od out_dir           (place prf file in output directory=out_dir, note: include a final '/')
  so                 (turn self-absorption on, default=off)
  v                 (set verbose mode on, no function currently)
  yd year_doy          (process los file for day=year_doy,
                        findtididata gets input los filename, build_tidi_filename gets output prf
                        filename)
```

All calling arguments must be preceeded by a '-', and any number of arguments can be used together.

Typically, the Invert program will be run with a command like:

/tidi/tidi_software/invert/hpux/invert
–i /data/tidi/los/2003/TIDI_PB_2003200_P0400_S0402_D005_R01.LOS
–o /data/tidi/profile/2003/TIDI_PB_2003200_TEST.PRF

which runs the HP version of the invert executable on the LOS file for day 2003200, and creates a PRF file, TIDI_PB_2003200_TEST.PRF,

or a command like:

/tidi/tidi_software/invert/HPUX/invert –yd 2003200 –od /homes/arm/2002/

which will use the procedure findtididata to get the LOS filename for day number 200 of 2003, and use this file as its input. The procedure build_tidi_filename will be use to determine the name of the output file, which will be placed in the directory /homes/arm/2002. Please refer to the TIDI File Naming Convention document (ref. 3) for a discussion of the form of TIDI data filenames.

4.   Determining Success or Failure

Success or failure of the Invert program can be determined from the exit status of the program, messages the program produces as it runs, and from the size and contents of the resultant PRF file.

4.1   Assessment

Invert passes an exit code, which can be used by scripts calling the program to determine whether the execution was successful or not. This exit code is set according to the TIDI standard convention (which is 0=success, any other is a failure). Missing required files, or too many errors reading or writing the input or results files are likely causes of a bad exit code. A 'success' exit code does not guarantee good inverted profiles, only that the program ran successfully.

The Invert program writes a number of messages to the screen if run interactively. In production, these messages are captured in a log file (this can also be done when running the program interactively). The last of these messages should be:

'END OF PROCESSING, WROTE XXX PROFILES, AND HAD YYY INVERSION ERRORS'

where XXX is the number of profiles successfully inverted for the file, and YYY is the number of profiles which were not successfully inverted. In processing a day of TIDI data, typically 2000 to 3000 profiles are present. In most days several inversion errors will occur, typically less than 10. If this message does not appear, an error or failure has caused the processing to terminate abnormally.

For a full day's data in the typical operating modes (science day and night), when the program is recovering winds, temperatures, volume emission rates, and backgrounds, the resulting PRF file is typically about 1 megabyte in size. A smaller PRF file size (or fewer inverted profiles) could indicate a problem, but the TIDI Activities Plan (ref, 6) should first be checked to determine 1) whether TIDI was operating in a 'science mode' the entire day, and 2) if the operating mode of the day would be expected to produce a smaller number of profiles.

A further assessment of a run of Invert can be gained by looking at the actual contents of the resulting PRF file. A plot of the locations of the profiles (variables 'lat' and 'lon' in the PRF file) should show a coverage pattern like that of prior days run in the current mode. Likewise, the 'chi_square' (a measure of the 'goodness of fit' between the forward model and the actual measurements) of the data should resemble that for prior days, with most values being between 0.8 and 2.5 for daytime profiles (1.5 to 3.5 for most nighttime profiles). There are always some scans in a day which are not fit well, particularly those taken in twilight conditions ('sza' near 90 degrees), but if the bulk of the fits are worse than usual, further investigation is warranted.

Please refer to the Invert Algorithm Description (ref. 4) for further detail regarding the inversion.

4.2   Errors and Recovery

In processing a day's worth of data, several error messages are usually encountered in the log and can be safely ignored. They are:

BAD ELOS FOUND FOR LOS IN INIT_GUESS   (found where the volume emission rate initial guess for a measurement is negative – the initial guess is repaired and processing continues)

Error in inverse model   (found when any of several error is encountered in the routine inverse_model – the current set of measurements is ignored, and processing proceeds with the next set)

Any of a large number of hardware problems (lack of memory, disk space, etc.) can cause the program to fail. These errors can usually be recovered from by contacting the system maintenance personnel to correct the problem, and re-running the program. Continuing failures

of the program signal a deeper problem. Ways to attack such a problem include: 1) deleting all the object code for Invert, re-building and testing the program (perhaps the executable was corrupted), 2) re-building the executable so it can be run under the debugger (without optimization) and testing it there, and 3) determining what, if anything is different about the current run from prior successful runs (things to look at include input files, especially the control files). Further problems with the program may need to be solved by changing the program operation itself.

Please refer to the Invert Design and Maintenance Document (ref. 5) for information regarding changes to the program.