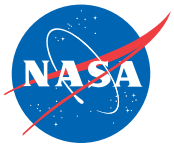
NASA/TM-2003-212236/Rev.1/Vol.5



Topography Experiment (TOPEX) Software Document Series

Volume 5, Revision 1
TOPEX GDR Processing

July 2003

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About the Series

The TOPEX Radar Altimeter Technical Memorandum Series is a collection of performance assessment documents produced by the NASA Goddard Space Flight Wallops Flight Facility over a period starting before the TOPEX launch in 1992 and continuing over greater than 10 year TOPEX lifetime. Because of the mission's success over this long period and because the data are being used internationally to redefine many aspects of ocean knowledge, it is important to make a permanent record of the TOPEX radar altimeter performance assessments which were originally provided to the TOPEX project in a series of internal reports over the life of the mission. The original reports are being printed in this series without change in order to make the information more publicly available as the original investigators become less available to explain the altimeter operation and details of the various data anomalies that have been resolved.

Foreword

This document is a compendium of the WFF TOPEX Software Development Team's knowledge regarding Geophysical Data Record (GDR) Processing. It includes many elements of a Requirements Document, a Software Specification Document, a Software Design Document, and a User's Manual. In the more technical sections, this document assumes the reader is familiar with TOPEX and GDR files.

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Section 1

Introduction

1.1 Purpose

This document provides a detailed description of TOPEX Geophysical Data Record (GDR) Processing at NASA Goddard Space Flight Center's Wallops Flight Facility (WFF). GDR Processing is work-in-progress and this document will be updated to reflect changes in the documented software or procedures.

1.2 Scope

This document is Volume 5 in a series of publications generated by the TOPEX Software Development Team (SWDT) at WFF. Volume 1 is an overview of the project and its processes. Volume 2 documents pre-launch Radar Altimeter System Evaluator (RASE) processing. Volume 3 documents the Altimeter Instrument File (AIF) processing. Volume 4 documents Sensor Data Record (SDR) processing and Volume 6 covers Special Processing which does not fall into any of the other categories. The series is an attempt to document SWDT software and procedures used in support of TOPEX at WFF.

1.3 Organization of Document

Section 2 lists other documents related to this document. Section 3 describes Geophysical Data Record files. Sections 4, 5 and 6 document Daily, Per-Cycle, and Special Processing, respectively. Section 7 details the components of GDR processing. Appendix A contains samples of GDR Standard Products. Appendix B lists programs and software used and developed. Appendix C describes the contents of GDR output files and databases. Appendix D contains t h e change history for the GDR Processing. Appendix E contains significant documents and memos related to GDR Processing.

Section 2

Related Documentation

2.1 Publications

- *TOPEX Project Plan*, July 1989, Jet Propulsion Laboratory (JPL), JPL D-3635, 633-100.
- *TOPEX/POSEIDON Joint Verification Plan*, June 15, 1992, JPL92-9
- *TOPEX Mission Radar Altimeter Engineering Support Plan*, May 1992, NASA GSFC WFF.
- *TOPEX Project Radar Altimeter Development Requirements and Specifications*, August 1988, NASA GSFC WFF 672-85-004.
- *TOPEX Ground System Algorithm Specification Document*, September 1990, JPL D-7075 (Rev. A), TOPEX 633-708.
- *TOPEX Ground System Software Interface Specification (SIS-2) Instrument File*, October 8, 1991, JPL D-7925 (Rev. A), TOPEX 633-731-23-007, Rev. A.
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- *TOPEX Ground System Software Interface Specification, Vol. 2: Design (SIS), Geophysical Data Record (GDR) - GDR Data, Interim Geophysical Data Record (IGDR) - GDR Data*, March, 1993, JPL D-8590 (Rev. C), TOPEX 633-751-23-004, Rev. C.
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- Hancock, D. W., III, 1989, *Studies in Support of The NASA Ocean Topography Experiment (Report 1)*, NASA TM-100766.
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- Marth, P. C., J. R. Jensen, C.C.Kilgus, J. A. Perschy, and J. L. MacArthur of The Johns Hopkins University Applied Physics Laboratory; D. W. Hancock, III, G. S. Hayne, C. L. Purdy, and L. C. Rossi of NASA GSFC WFF; and C.J. Koblinsky of NASA GSFC, *Pre-Launch Performance of the NASA TOPEX/POSEIDON Altimeter*, IEEE Transactions on Geoscience and Remote Sensing, 31(2), pp. 315-332, 1993.
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- Hayne, G.S., March 1993, *Estimating Ku Range Noise*, WFF TOPEX Informal memorandum.
- Hayne, G.S., September 1993, *Current Status of Work on σ^0 Blooms*, WFF TOPEX Informal Memorandum.

- Hayne, G.S., D.W. Hancock III, C.L. Purdy, and P.S. Callahan, 1994, *The Corrections for Significant Waveheight and Attitude Effects in the TOPEX Radar Altimete*r. Draft submitted to Journal of Geophysical Research.

For completeness, selected documents and memos are also included in Appendix E-Attachments.

Section 3

Geophysical Data Record Files

3.1 Definition

Geophysical Data Record (GDR) files are created from Sensor Data Record (SDR) files by the TOPEX Ground System (TGS) at the Jet Propulsion Laboratory (JPL). GDR files provide WFF with the same products as used by TOPEX scientists and researchers.

The flow of altimeter data is depicted in Figure 3-1 “TOPEX ALT Dataflow (GDR Emphasized),” where emphasis is placed on the GDR data flow. The TOPEX Ground System extracts altimeter science and engineering minor frames from the spacecraft telemetry. Common frames are then merged and time-sorted to create Altimeter Instrument Files (AIFs). AIFs and the earth-location data are processed using Telemetry and Science-level algorithms to create once-per-pass (about 56 minutes) SDR files. The SDR files are further processed using Geophysical-level algorithms to create Interim Geophysical Data Records (I/GDR). The processed IGDRs are placed in temporary storage. Once precision orbit data has been received by JPL, the new orbit data is merged into the IGDRs and final GDRs are created. At the end of a 10-day Cycle, the GDR pass files are copied to tape.

For a complete description of the GDR formats, see TOPEX Ground System Software Interface Specification, Vol. 2: Design (SIS-2), Geophysical Data Record (GDR) - GDR Data, Interim Geophysical Data Record (IGDR) - GDR Data.

3.2 Distribution

Individual IGDR pass files are made accessible to WFF via the NASA Science Internet (NSI) using FTP protocols. GDR per-cycle exabyte tapes are mailed to GDR data subscribers. The WFF SWDT receives these tapes and archives them for later use. The SWDT redistributes copies of the GDR tapes to external users if so requested.

3.3 Storage

A single GDR pass file requires approximately 500 kilobytes of disk storage. A full cycle of GDR pass files consumes approximately 125 megabytes of disk space. WFF generally keeps the latest cycle of GDRs in the working area. Every GDR cycle exabyte tape generated has been archived and is available for use at WFF.

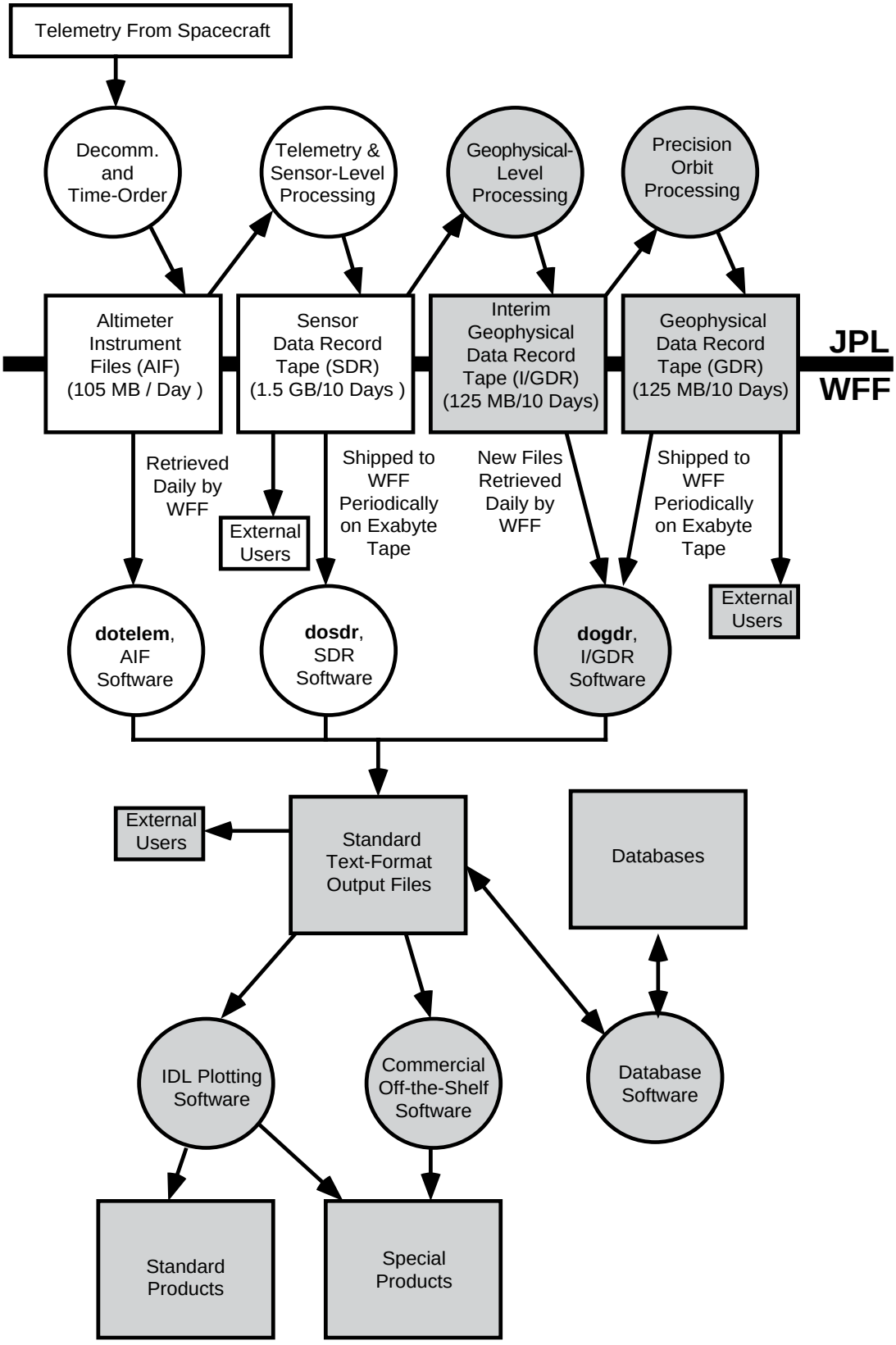

Figure 3-1 TOPEX ALT Dataflow (GDR Emphasized)

Section 4

I/GDR Daily Processing

4.1 I/GDR Daily Processing

Each day, new IGDRs are automatically retrieved from JPL and processed by WFF. Nightly, a VMS script on TGSC, one of the TOPEX VAX systems at JPL, creates a file which contains the names of the GDR files that were created since the last time the script was run. The WFF daily processing script, **autogdr**, is executed each day at 0800 UTC by the UNIX **crontab** facility. **autogdr** retrieves the file of new filenames and transfers each file to WFF, where it is processed and standard products are printed. See Figure 4-1 "TOPEX GDR Daily Processing" on page 4-2. The timing is set up such that when WFF personnel arrive to work, all daily processing is complete and the standard products are available for inspection. **autogdr** performs the following functions (in order).

- Runs **ftpjplbin**, which uses FTP to transfer IGDR files from JPL via the NASA Science Internet (NSI). If the transfer is not successful, the program will retry the copy 300 times with a 180 second timeout between copies. A log is kept of the processing; upon completion, this log is electronically mailed to the user who invoked the process.
- Runs **dogdr**, the primary GDR data reduction program. It creates 10-second science averages and 60-second science database and header database import files. A log file of the processing is maintained.
- Searches the log file for error message “Bad_Initial_Sigma,” and transfers the message to a cumulative log file “BadInitSigma.Log.”
- Concatenates the **dogdr** database files into the corresponding merged IGDR database files in /gen/topex/data/dbase, the database storage area.
- Moves the IGDR files into /gen/topex/data/igdr, the IGDR storage area.
- Runs **igdrpass**, a UNIX script that runs the IDL program **igdrpass.pro** to read **dogdr** science averages file and create IGDR pass plots, a sample of which is shown in Appendix A, Figure A-1.

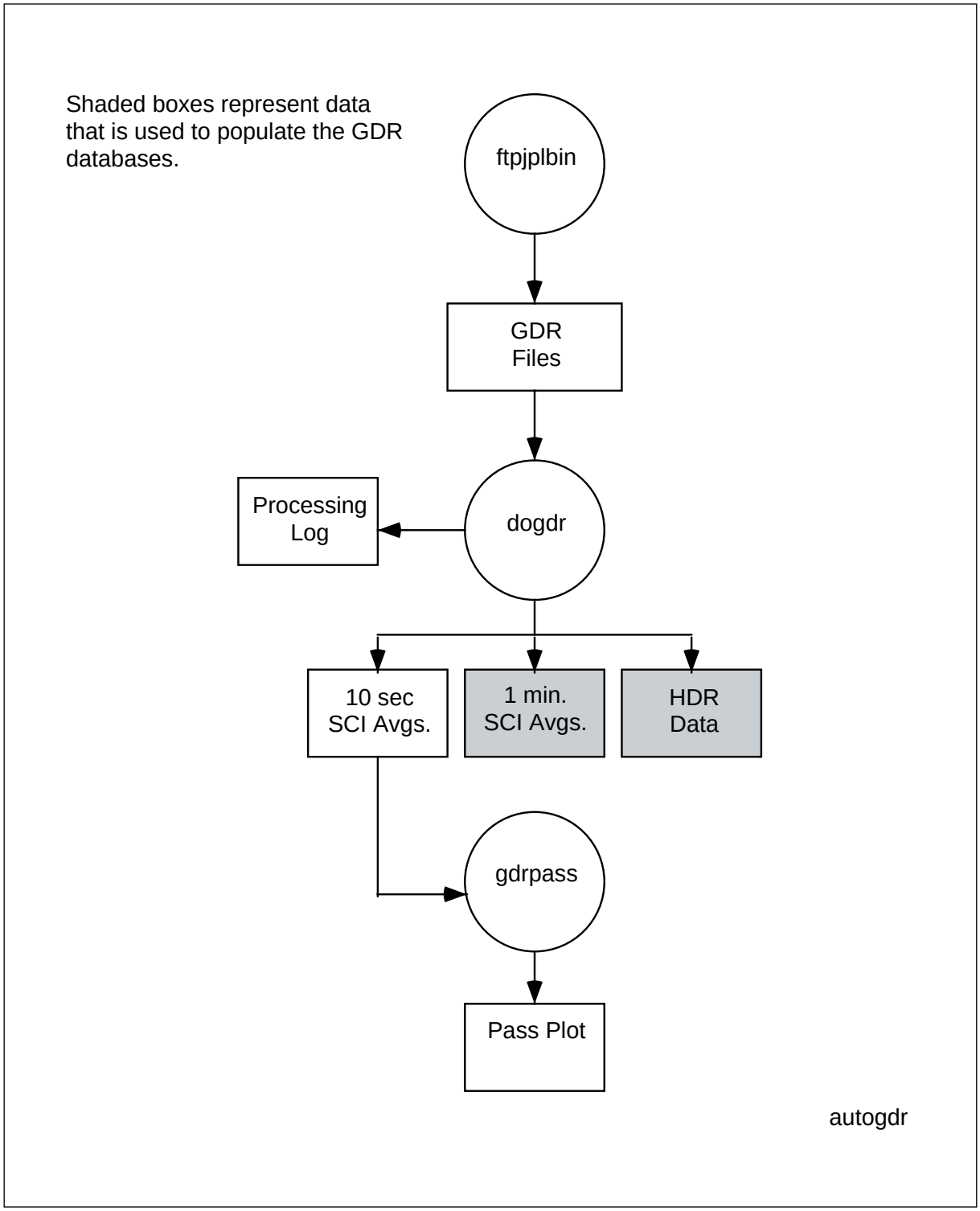

Figure 4-1 TOPEX GDR Daily Processing

Section 5

Per-Cycle Processing

5.1 Per-Cycle Processing

At the end of each 10-day TOPEX cycle, JPL creates tapes of GDRs and distributes these tapes to the GDR data subscribers. When a GDR tape is received by WFF, it is processed and the GDR data replaces the IGDR data in the database. The summary database is updated to reflect the new GDR entries, and the following process is performed to produce per-cycle and launch-to-date trend GDR plots. [The data flow is depicted in "" on page 5-2.]

- **igdrdb**, a UNIX script that runs the IDL program **igdrdb.pro** to read the GDR Science database extraction file is executed. It creates GDR Cycle Summary Plots, a sample of which is shown in Appendix A, Figure A-2.
- **igdrsum**, a UNIX script that runs the IDL program **igdrsum.pro** to read the GDR Summary database extraction file is executed. It creates GDR trend plots, a sample of which is shown in Appendix A, Figure A-3.

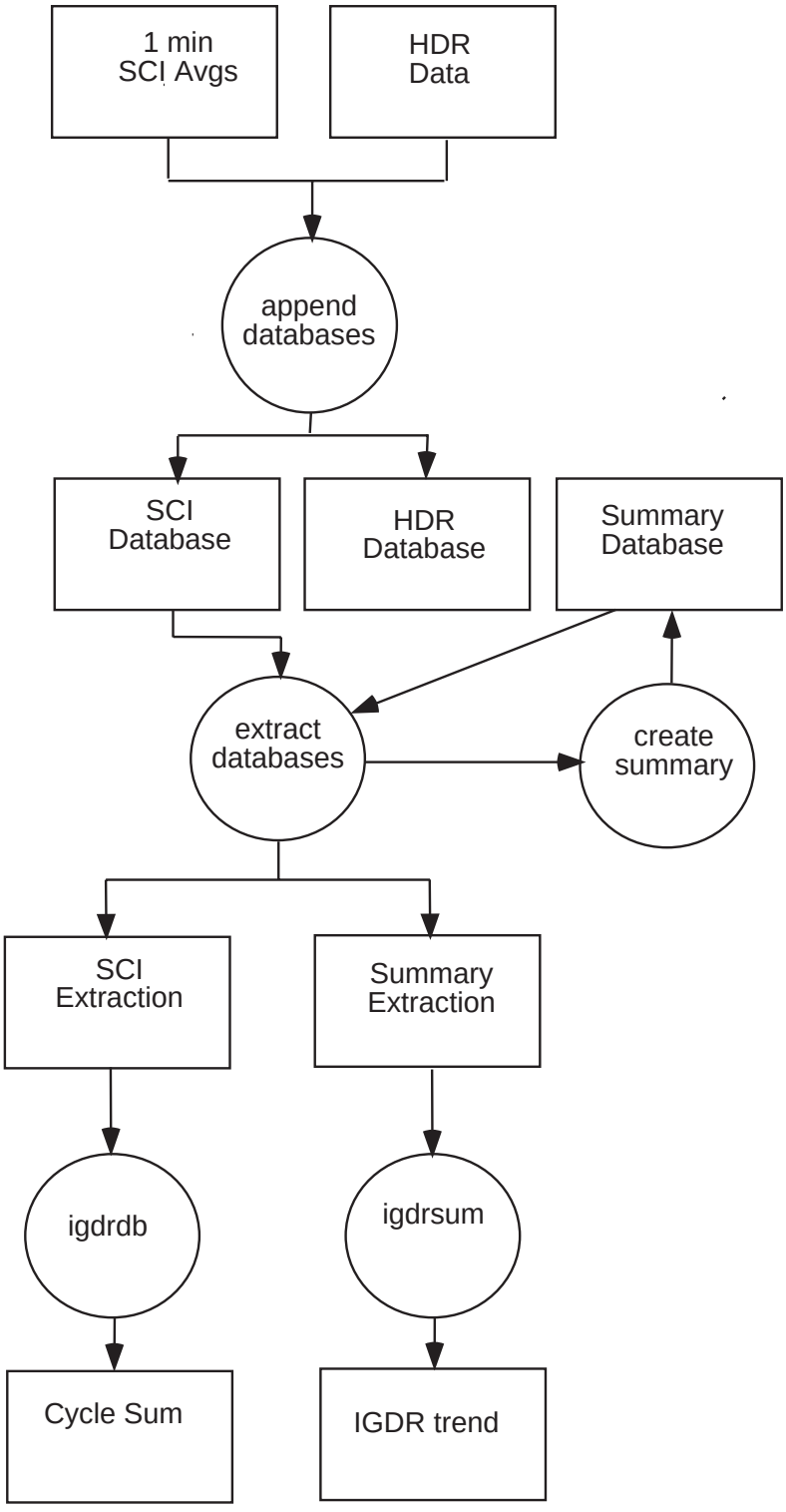

Figure 5-1 TOPEX GDR Standard Processing

Section 6

GDR Special Processing

Special processing is defined as that processing which is not done on a regular chronological basis. Many **dogdr** products can be used for special processing along with commercial-off-the-shelf (COTS) software. Special processing can also be performed using IDL and Database Software. There are many other forms of special processing performed on TOPEX data; this section explains the general methods by which special processing is performed.

6.1 dogdr Special Processing

In general, GDR Special Processing is performed by using **dogdr** to create one or more special output files. The resulting files are then copied to a user for analysis or one of the TOPEX SWDT members uses custom IDL or COTS software to create the desired product. Any **dogdr** option can be used for special processing, but one of the more common ones is Science Averages, a sample of which is shown in Appendix A, Figure A-4.

6.2 IDL Special Processing

Another way to perform special processing is to create special IDL plot programs. This has been done on occasion to create special plots for papers and / or presentations. Many of the standard IDL programs can also be run using non-standard arguments to plot according to custom specifications.

6.3 Database Special Processing

Custom database programs have been written to perform special processing.

Section 7

Components of GDR Processing

Figure 7-1 "I/GDR Processing Dataflow" depicts the four major components of I/GDR processing software: FORTRAN data processing software (dogdr), UNIX scripts (User Input), FoxBase (I/GDR databases), and IDL plotting routines.

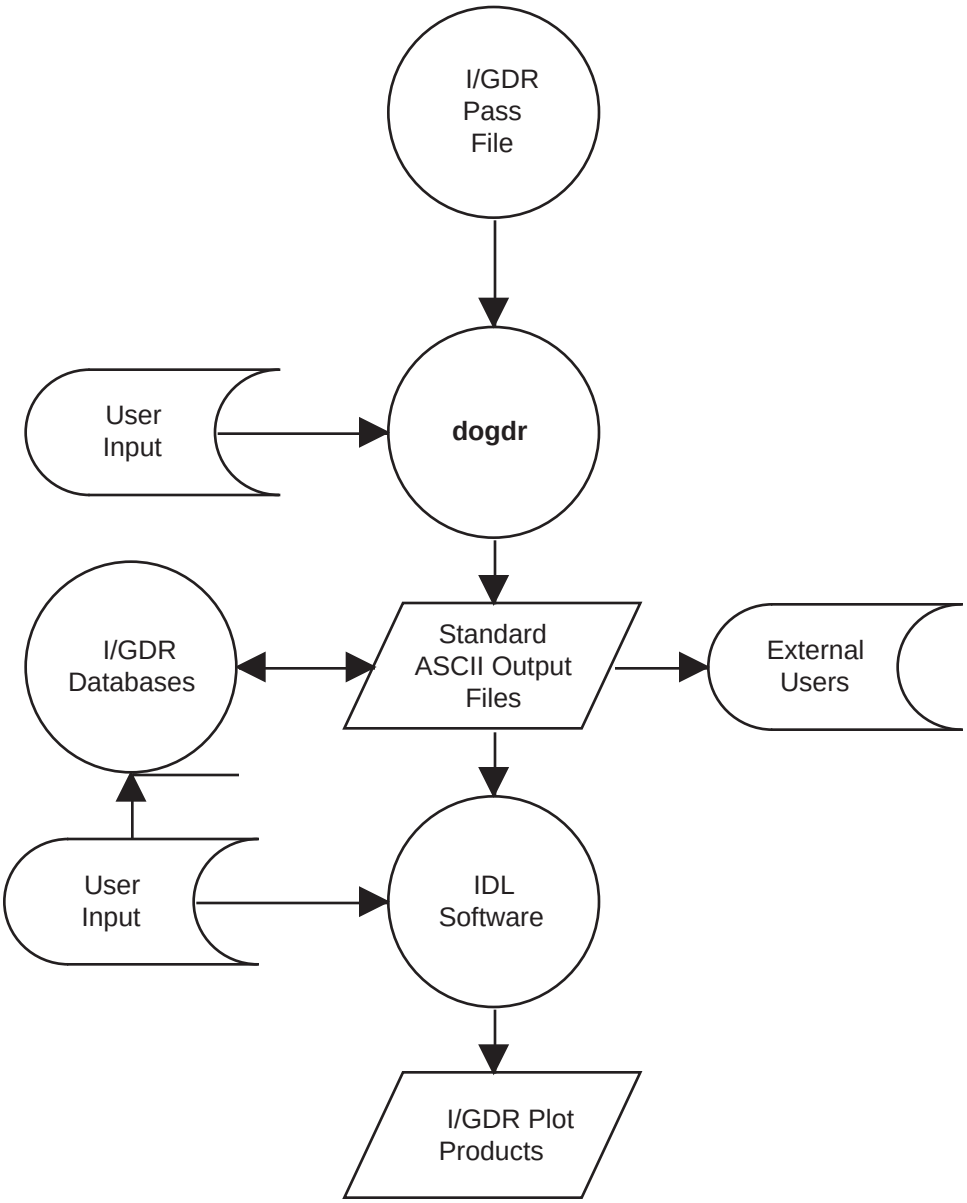

Figure 7-1 I/GDR Processing Dataflow

These components comprise a system that is sufficiently automated to handle standard processing tasks and yet flexible enough to assist in highly-detailed engineering assessment investigations.

7.1 dogdr

dogdr is the FORTRAN program responsible for all GDR data processing. It is highly interactive, allowing the user to choose which process to run and to specify customized parameters for the chosen process. Figure 7-2 "dogdr Startup Screen" depicts the **dogdr** startup screen.

dogdr has three main components: Initialization Module, User Input Module, and the Data Processing Loop. Figure 7-3 diagrams the highest-level **dogdr** processing.

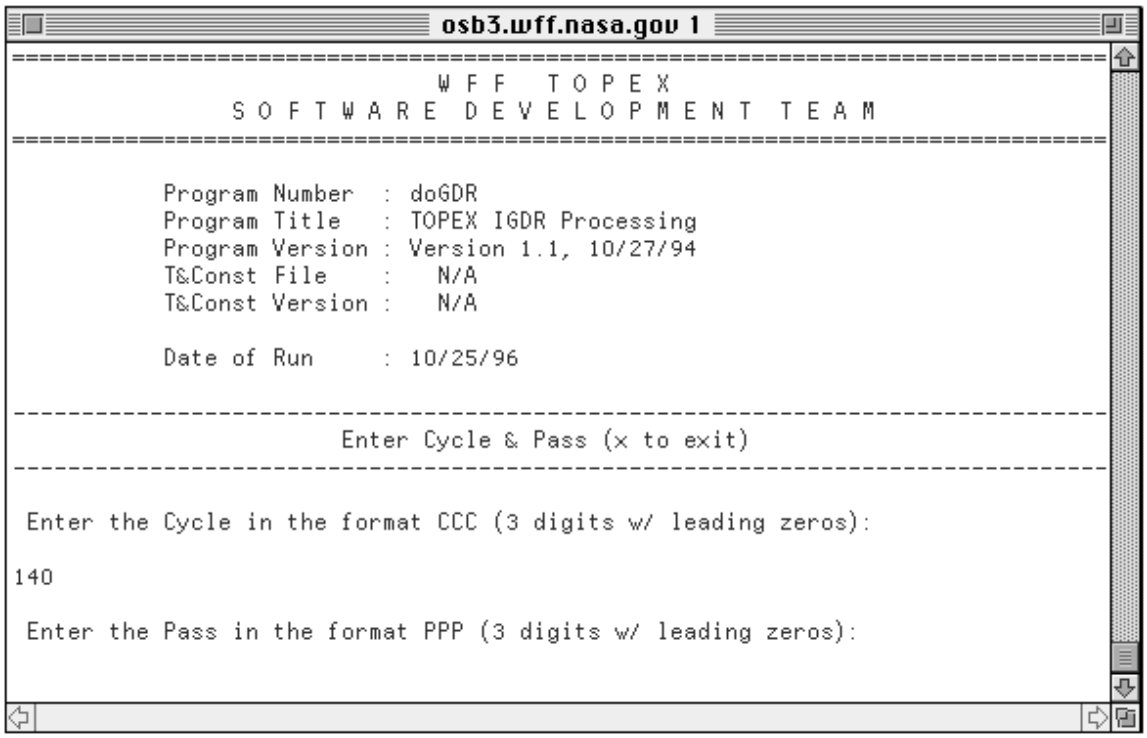

Figure 7-2 dogdr Startup Screen

The software currently runs on **osb3**, a Sun Microsystems Ultra 170 UNIX workstation. However, since **dogdr** was originally coded on the Apple Macintosh platform, and then ported to the Sun environment, the code has been designed to be highly portable.

7.1.1 dogdr Initialization Module

Upon startup, dogdr initializes two byte maps needed to decode and process data. These byte maps are used for easily referencing which bytes in the raw GDR data correspond to which converted engineering units. Table 7-1 "Data Structures Initialized by dogdr" lists the two data structures initialized by dogdr.

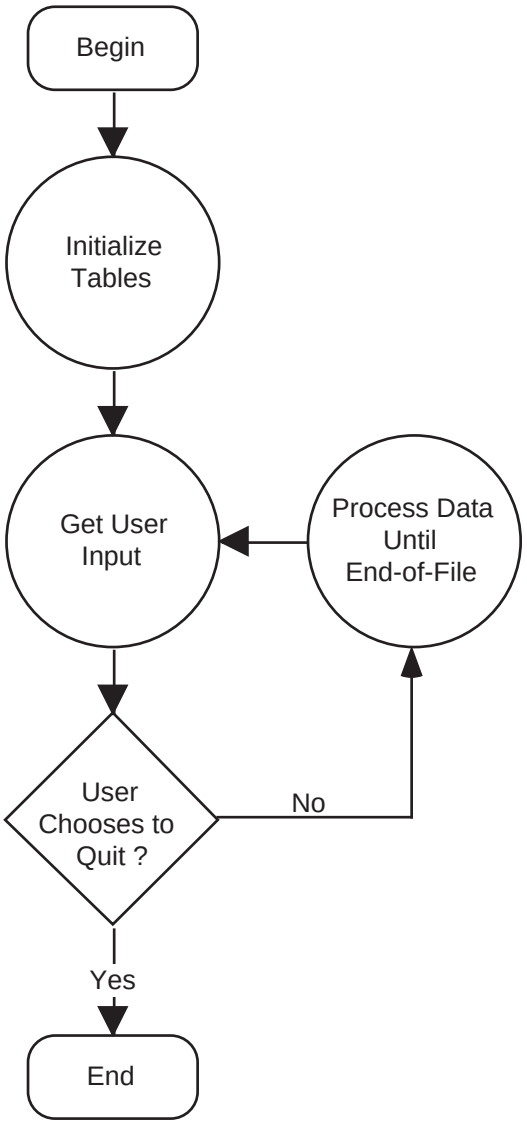

Figure 7-3 dogdr Main Processing

Table 7-1 Data Structures Initialized by dogdr

Structure	Description
IGDRHdrDef	Byte map of data contained in the I/GDR header record.
IGDRDef	Byte map of data contained in the I/GDR data record.

7.1.2 dogdr User Input

dogdr is designed to be highly interactive and offers the user a variety of processing options. The user must enter the Cycle and Pass of the file to process and select a pro-

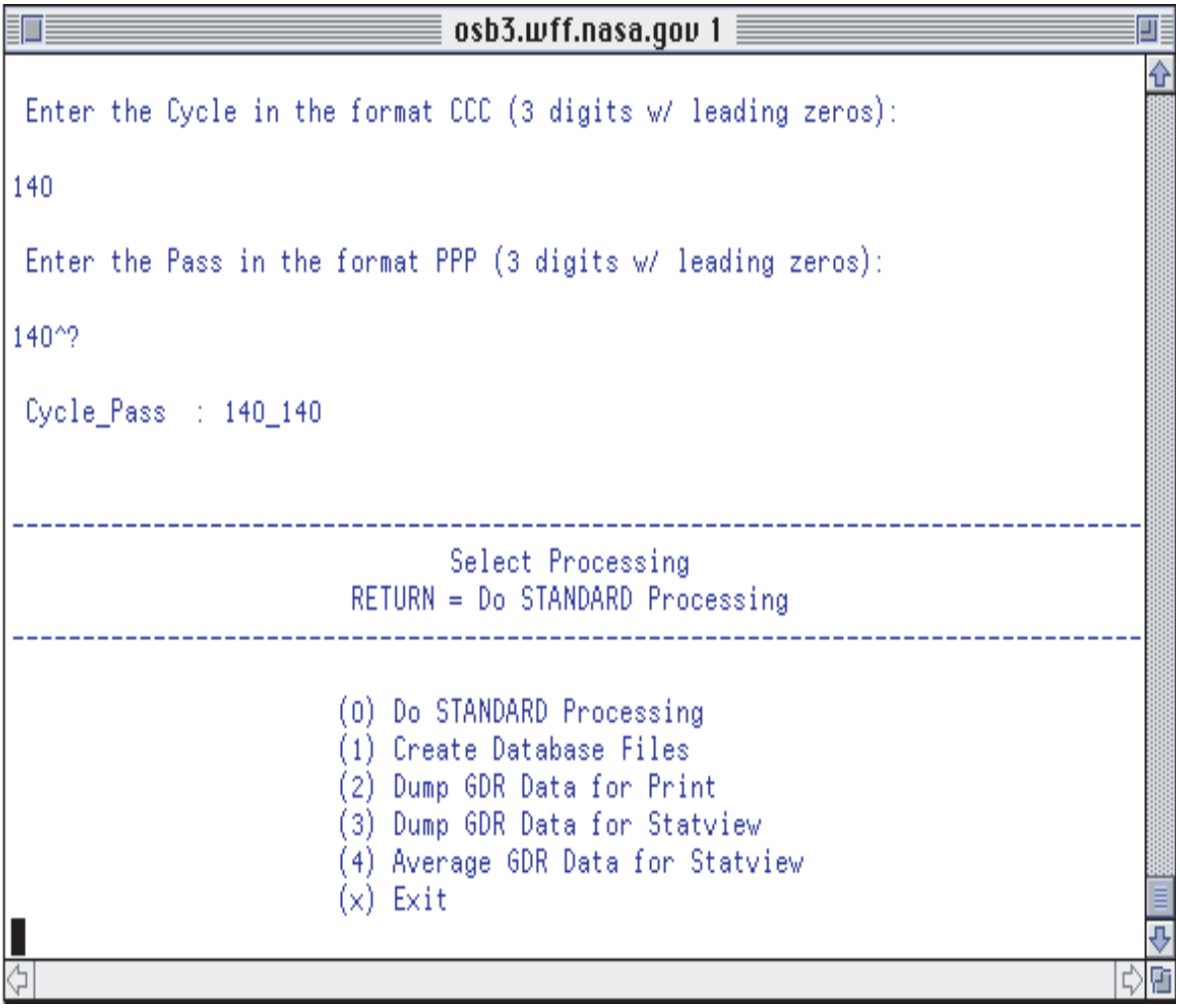

Figure 7-4 dogdr Primary User Input Screen

cessing method. The processing selection screen is shown in Figure 7-4 "dogdr Primary User Input Screen". The user may optionally set custom parameters such as averaging time, mode selection, and parameters to report. Defaults are provided in all cases. Table 7-2 "dogdr Processing Options" lists processing type, options, and defaults. Time selection is available as an option for all processes.

Table 7-2 dogdr Processing Options

Process	Options	Defaults
STANDARD Processing (default process)	none	Create GDR Databases 10 sec Science Averages
Create GDR Databases	none	1 Minute GDR Averages Headers
Dump GDR for Print	Time Selection	Process All Data
Dump GDR for StatView	Time Selection	Process All Data
Create GDR Averages	Seconds to Average Modes to Process Time Selection	1 second Averages All Modes Process All Data

7.1.3 dogdr Processing Loop

After a user has chosen what process(es) to run and what options to use, **dogdr** runs in a processing loop until either all data has been read from the GDR file or a time is detected that is later than a user-specified stop time. **dogdr** branches off the main loop to run those processes that the user has specified.

7.1.4 dogdr Science Unit Conversion

GDR Science data must be converted from GDR data into appropriate science units in order to be used during processing. The process that performs this conversion is **GDRSciConv.f**. All parameters in the GDR Science data record are converted into meaningful science units for processing.

7.1.5 dogdr Standard Processing

Standard Processing is the default process for **dogdr**. Standard Processing calls two processing modules with specific parameters: the process of creating science averages (**GDRAvg.f**) and the creation of science database (**GDRDBAvg.f**). Table 7-3 "Standard Processing Modules and Parameters" lists the modules called and the corresponding parameters supplied. See Appendix C for a list of output file formats for processing.

Table 7-3 Standard Processing Modules and Parameters

Module	Parameters
Average Science	10 Second Averages
DB Science	60 Second Averages
DB Header	1 Per Cycle

7.1.6 dogdr Create GDR Databases

Create GDR Database calls the process module (**GDRDBAvg.f**). Figure 7-5 "GDRD-BAvg Process" illustrates the processing overview. Table 7-4 "Standard Processing Modules and Parameters"lists the modules called and corresponding parameters supplied. See Appendix C, Table C-1 (Header) and Table C-4 (Science) for a list of output file contents and formats.

7.1.7 dogdr Dump GDR

The telemetry dumping routine dumps all decoded parameters in each science record to output files. The user may specify if all data is dumped or just the first entry of each parameter array. The process that performs the dump for printing is (**DumpIGDRPrnt.f**) and for plotting is (**DumpIGDRStat.f**).See Appendix C, Table C-3, for output file contents and formats.

7.1.8 dogdr Average GDR Data

The averaging process averages (**GDRAvg.f**) specific decoded parameters and selected averaging time. See Appendix C, Table C-2,for a list of output file contents and formats.

7.2 GDR Database Management

The ORACLE Relational Database Management System (RDBMS) is being used to manage the TOPEX I/GDR data. Using this system, I/GDR data can be loaded, extracted, searched, and sorted. Data is stored in database objects called tables.

7.2.1 Database Table Definitions

There are three database tables used in storing the I/GDR data.

GDR_HEADER table contains header information for each pass of a cycle.

GDR_SCIENCE table contains 60-second averaged scientific data records.

GDR_SUMMARY table contains a summarized scientific data record for each cycle.

Table 7-5 “GDR Database Import Files” lists the files required to import data.

7.2.2 Loading Data into the Database Tables

The I/GDR database tables are loaded using the Oracle utilities, **sqlldr**, **sqlplus**, and **PL/SQL**. The **sqlldr** utility loads data into the database tables using a control file, which maps the format of the input datafile to the database table. The **sqlplus** utility and **PL/SQL** procedures are used to perform miscellaneous checks and updates to database tables after loading.

7.2.3 Extracting Data from the Database Tables

The Oracle utilities, **sqlplus** and **PL/SQL** are also used for extracting data from the database tables. These utilities are used to filter data and create output files to be used in further processing.

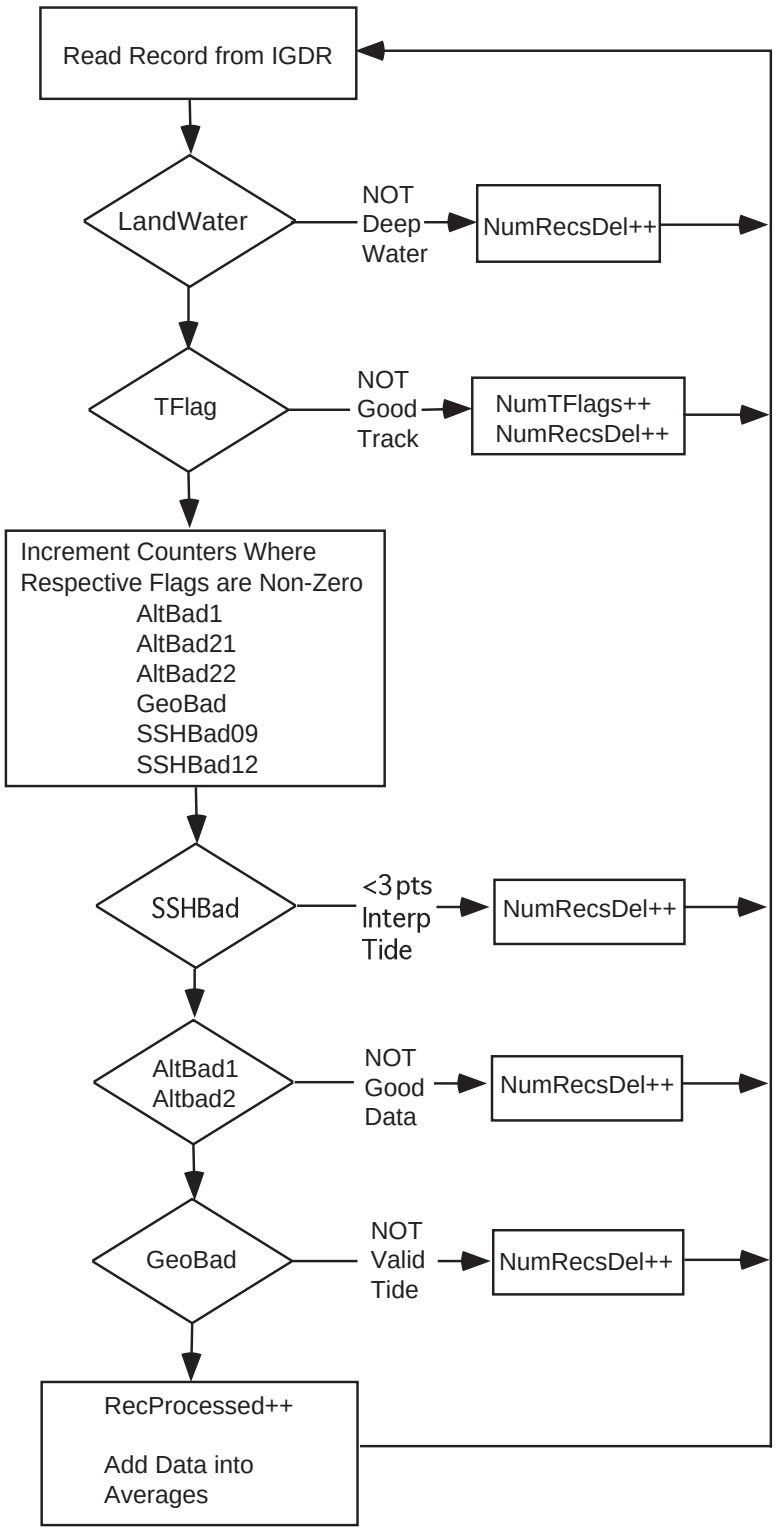

Figure 7-5 GDRDBAvg Process

Table 7-4 Standard Processing Modules and Parameters

Module	Parameters
DB Science	60 Second Averages
DB Header	1 Per Cycle

Table 7-5 GDR Database Import Files

Std. Filename	Database	Description
igdr###.hdr	header	Concatenated files of **dogdr** headers output.
igdr###.sci	sci	Concatenated files of **dogdr** 1-minute science output.

Note: ### denotes Cycle Number

7.3 GDR IDL Software

IDL, Interactive Data Language, is a software package written by Research Systems, Inc. It is an array-based scientific visualization package that enables a programmer to quickly and easily write code to generate highly customized plots and analyses. IDL has allowed the TOPEX SWDT to automatically generate products that were difficult and time-consuming to produce using COTS software.

TOPEX IDL programs generally can read **dogdr** Average files or database export files and produce standardized plots on a PostScript printer. These programs are coded with a set of parameters which may be modified to customize features of the final output without changing the IDL code. Table 7-6 "IDL Parameters" lists the standard parameters that may be modified by the user. Appendix B lists the UNIX scripts which run TOPEX IDL programs.

7.4 UNIX Scripts

UNIX scripts are used to automate common tasks and supply standard parameters to TOPEX GDR software. Shell scripts are invoked by the crontab facility to perform daily processing. Other shell scripts are used for automatically retrieving and processing special data from JPL, for automatically running IDL programs, and for miscellaneous utility functions. Appendix B contains a list of UNIX scripts which are available for use.

Table 7-6 IDL Parameters

Parameter	Default	Description
InputFile	n/a	Test file from which data to be processed is read.
XPlots	varies	Number of plots stacked horizontally per page.
YPlots	varies	Number of plots stacked vertically per page.
Printer	topex2	Printer where output will be printed.
AutoScale	FALSE	Switch to automatically set axis scales by min & max of data, rather than by standard scale values.
LandScape	varies	Switch to print in landscape rather than portrait mode.
DeviceType	‘ps’	Type of device driver to use.(ps = PostScript)
PlotTitle	InputFile	Title of place on plot. May be overridden by program.
Color	TRUE	Switch to define that color should be used for output.
Scale	1.0	Factor by which to scale whole page. Useful for incorporating output in presentations or publications.
Manual	FALSE	Switch to define that printer should be set to Manual Feed mode. Highly printer-dependent.
All	FALSE	Switch to define that all output products should be printed rather than the standard subset. Used by only some programs.

Appendix A
Standard Products

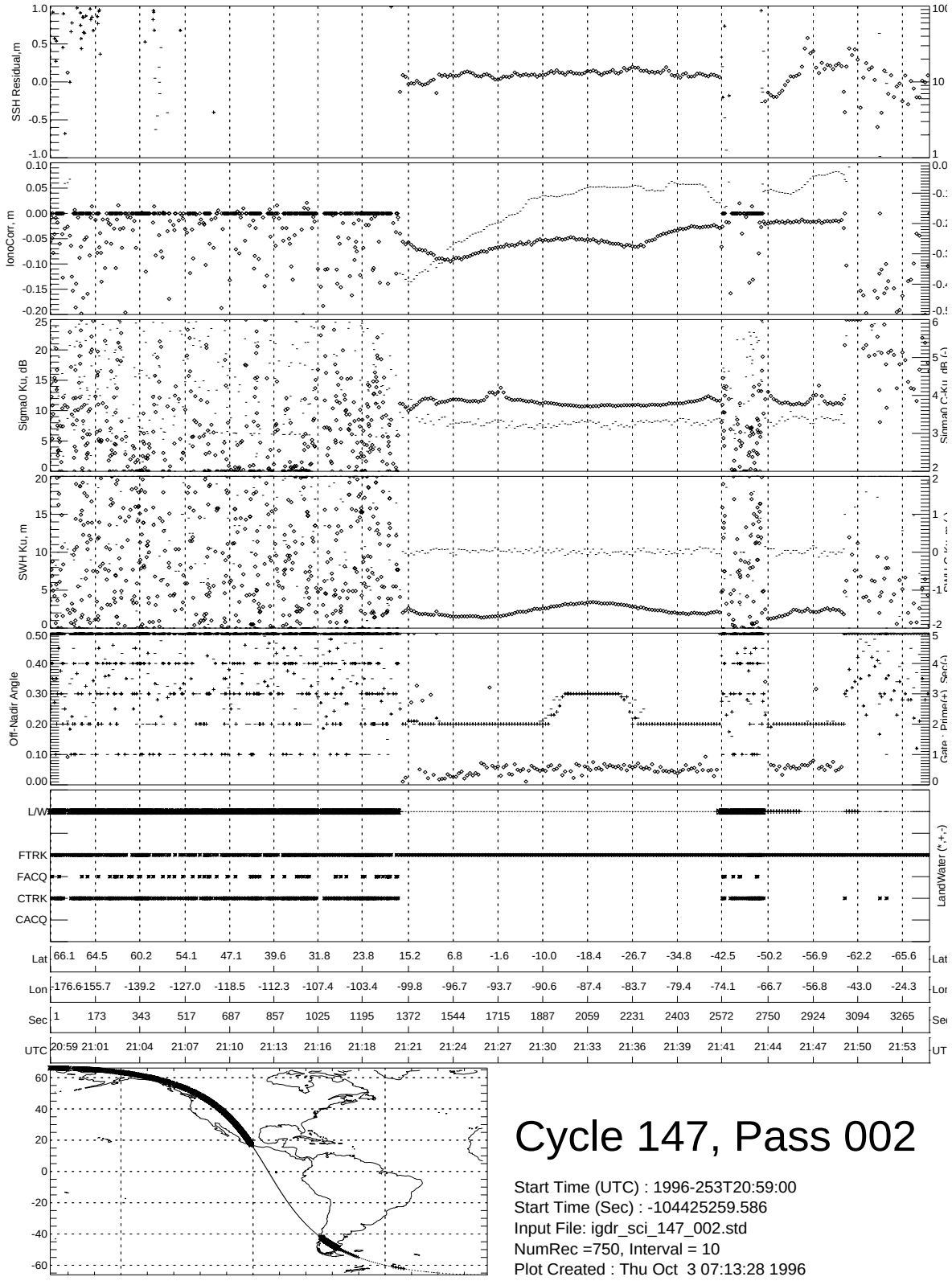

Figure A-1 Pass Plot

I/GDR Cycle Summary : Cycle 140

1-Minute Averages from IGDR Database

Processing Summary

Level 0 : All Data
Records Processed : 468482
Level 1 : Deep Water, TFlag=0
Records Processed : 457401
Records Deleted : 11081 (2.632%)
Level 2 : Level 1, AltBadx=0
Records Processed : 420994
Records Deleted : 36407 (8.648%)
Good Data = Remainder After Removing Level-2 Flagged Data

Flagging Summary

TFlags : Deep Water	11081 (2.632%)
Level 1 : Deep Water,TFlag=0	
AltBad1 Flags :	18598 (4.418%)
KuRangCorr Flags :	10824 (2.571%)
CRangCorr Flags :	11721 (2.784%)
GeoBad Flags :	7687 (1.826%)
SSHBad Flags (10/rec) :	7124 (1.692%)
EMBias Flags (2/rec) :	19 (0.005%)

Dates of Cycle: 1996-184T10:16:42 to 1996-194T08:05:25

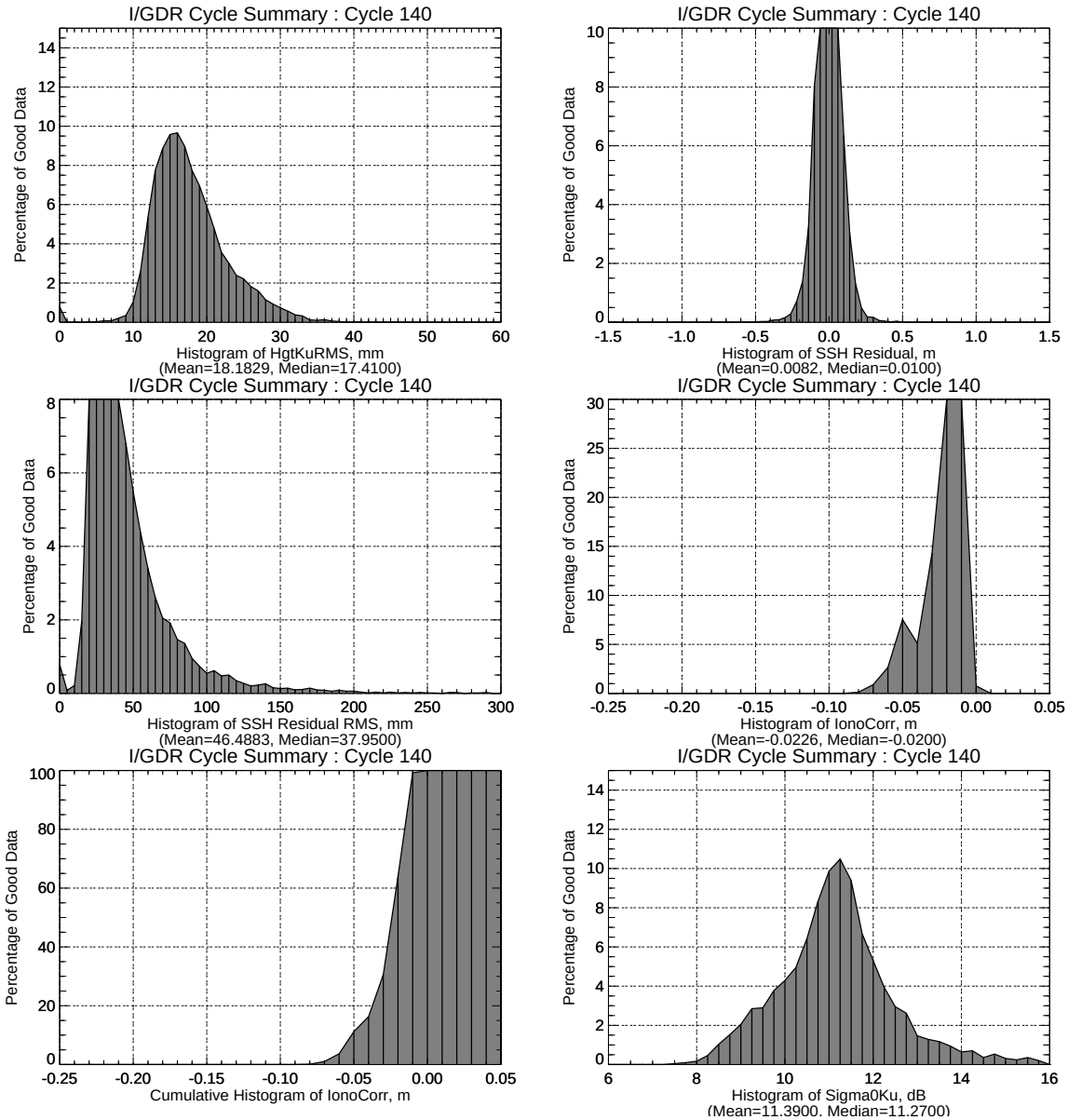

Figure A-2 Cycle Summary Plots

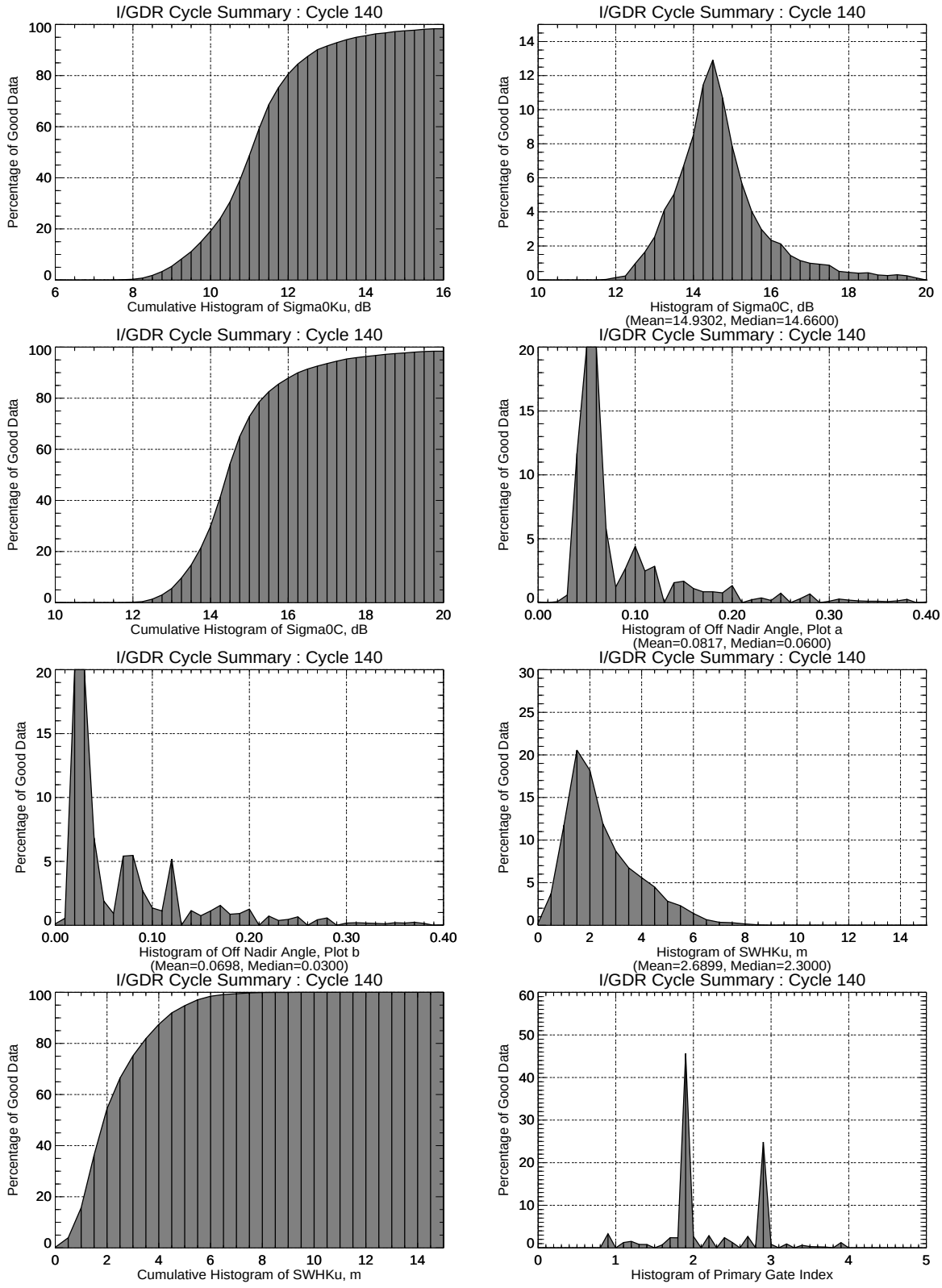

Figure A-2 Cycle Summary Plots (Continued)

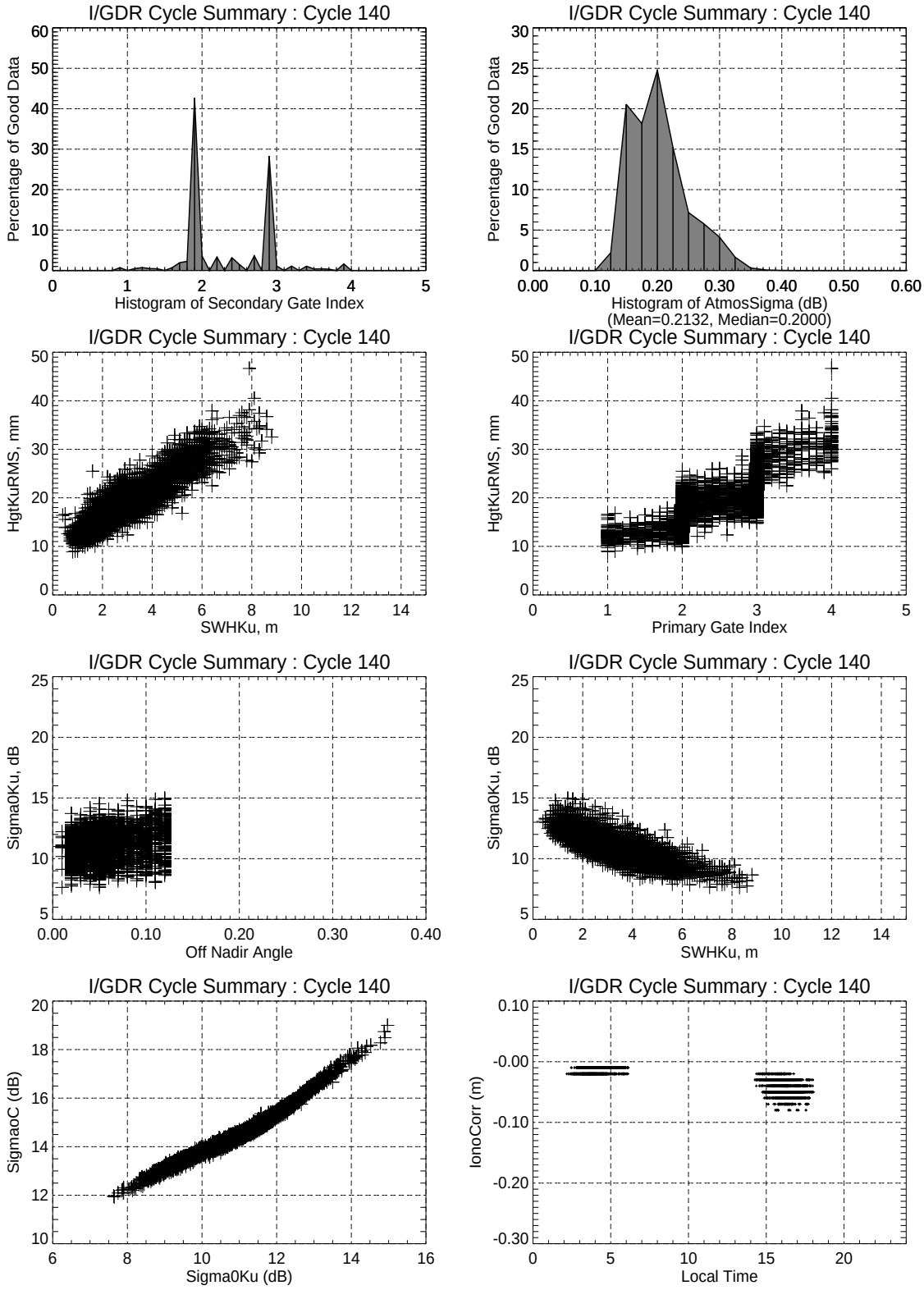

Figure A-2 Cycle Summary Plots (Continued)

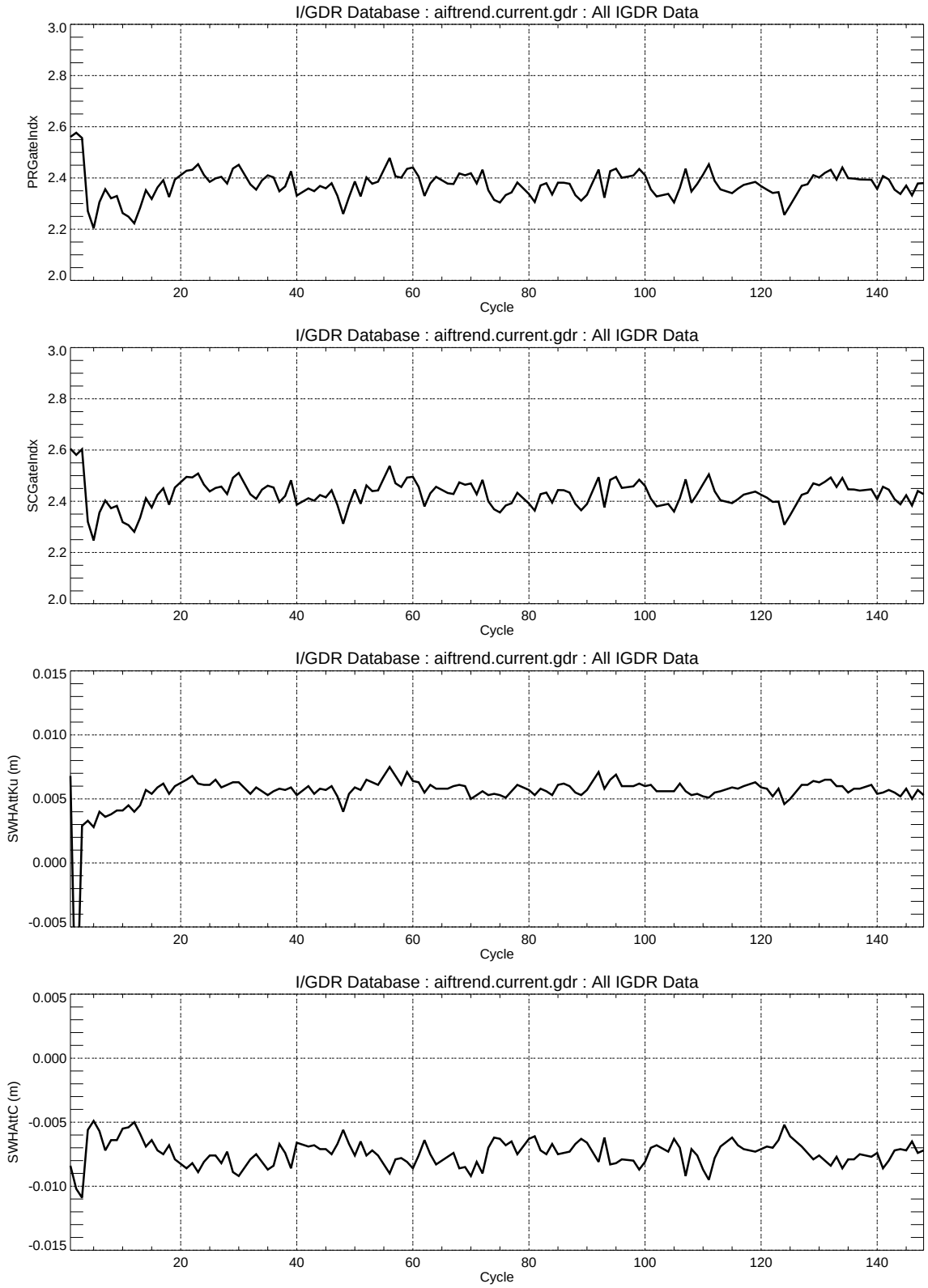

Figure A-3 Trend Plots

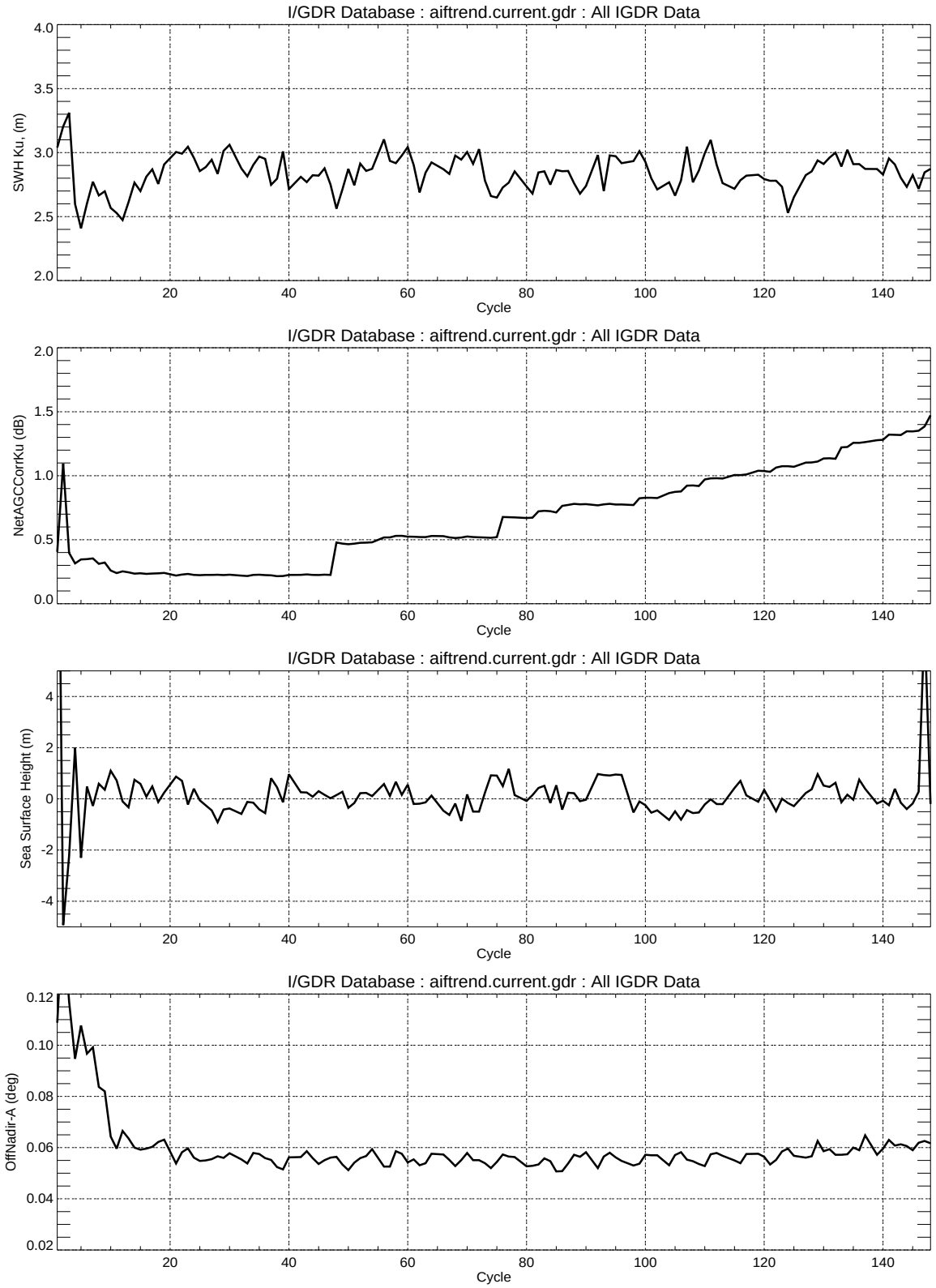

Figure A-3 Trend Plots (Continued)

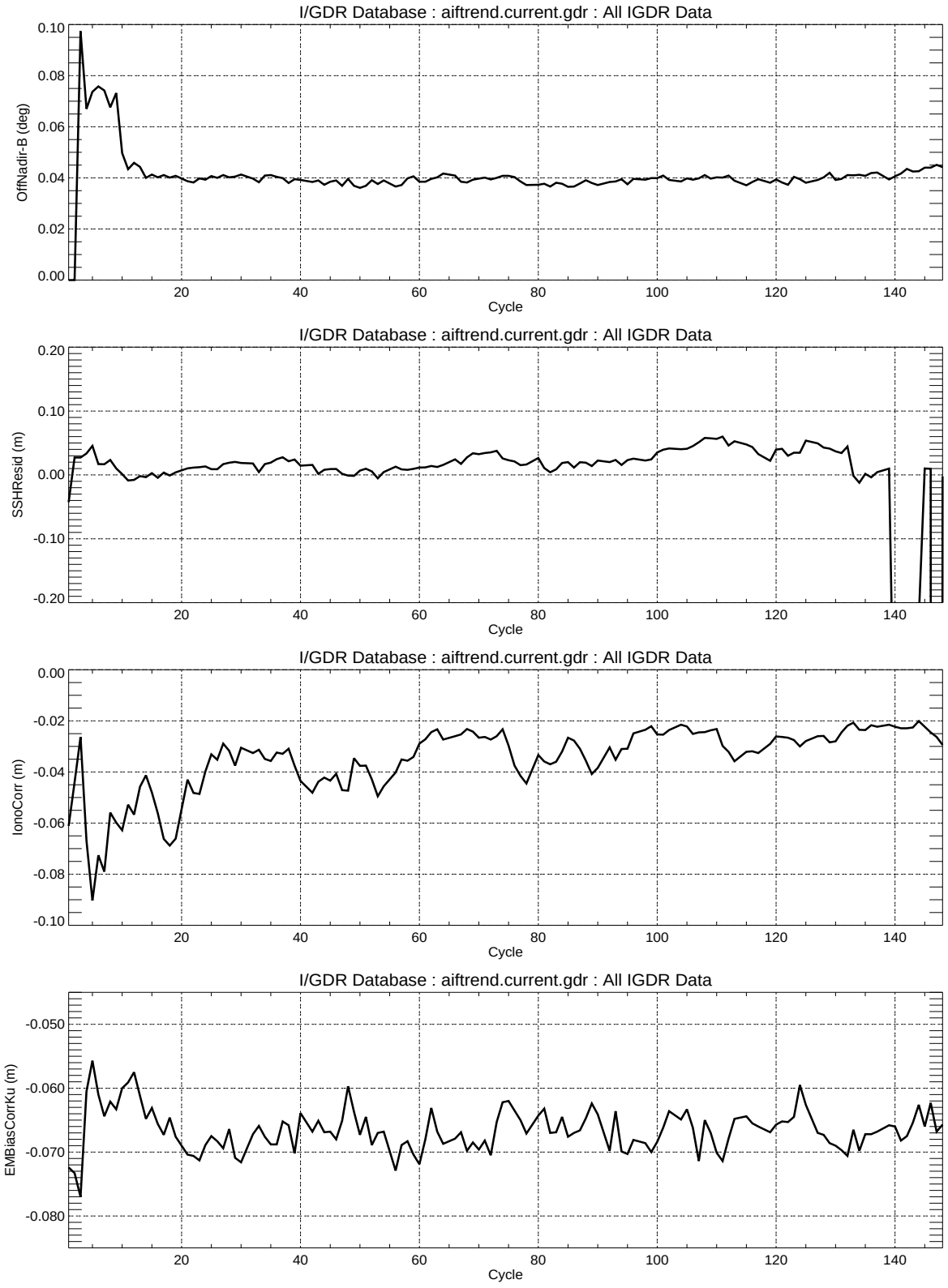

Figure A-3 Trend Plots (Continued)

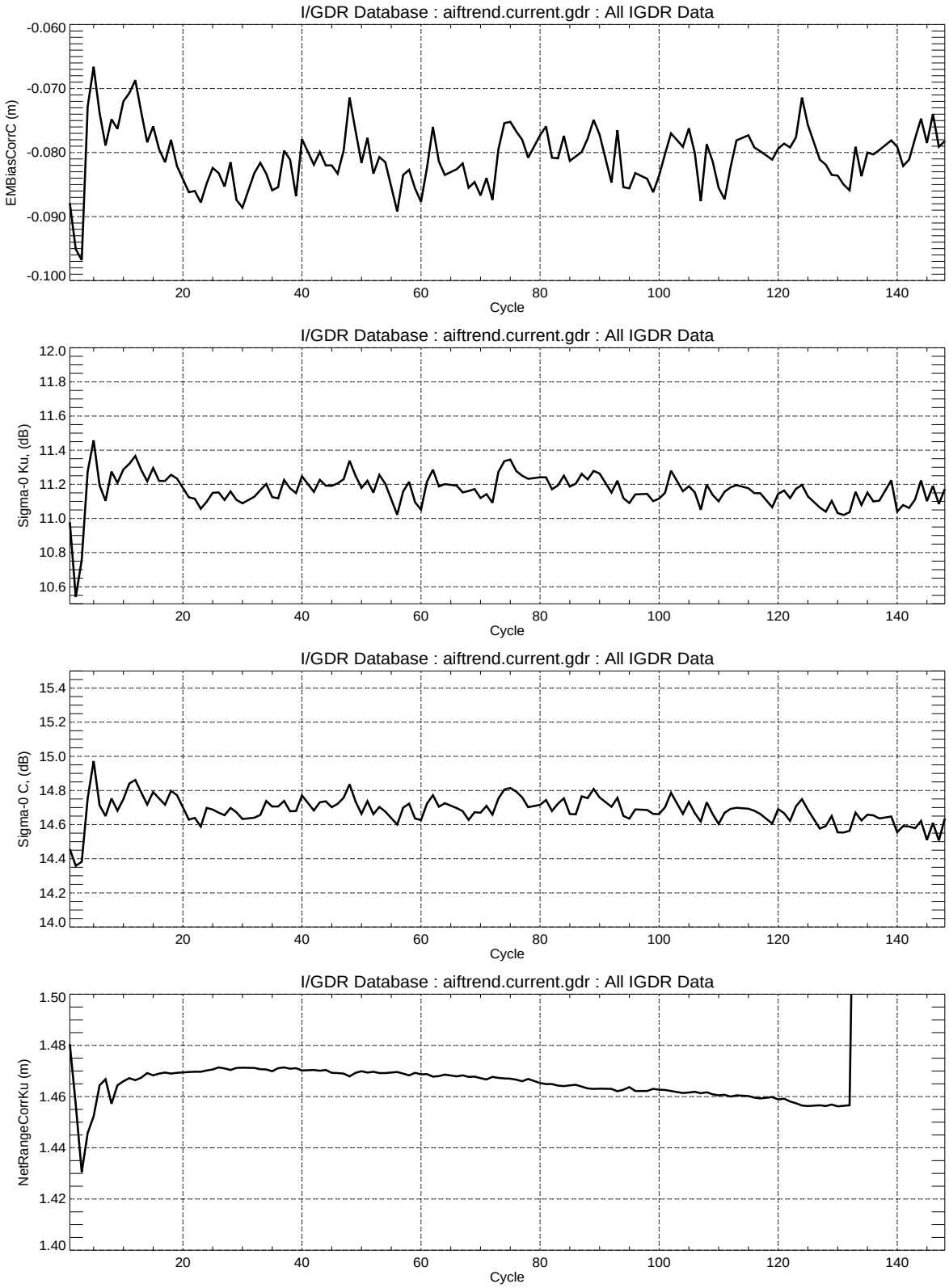

Figure A-3 Trend Plots (Continued)

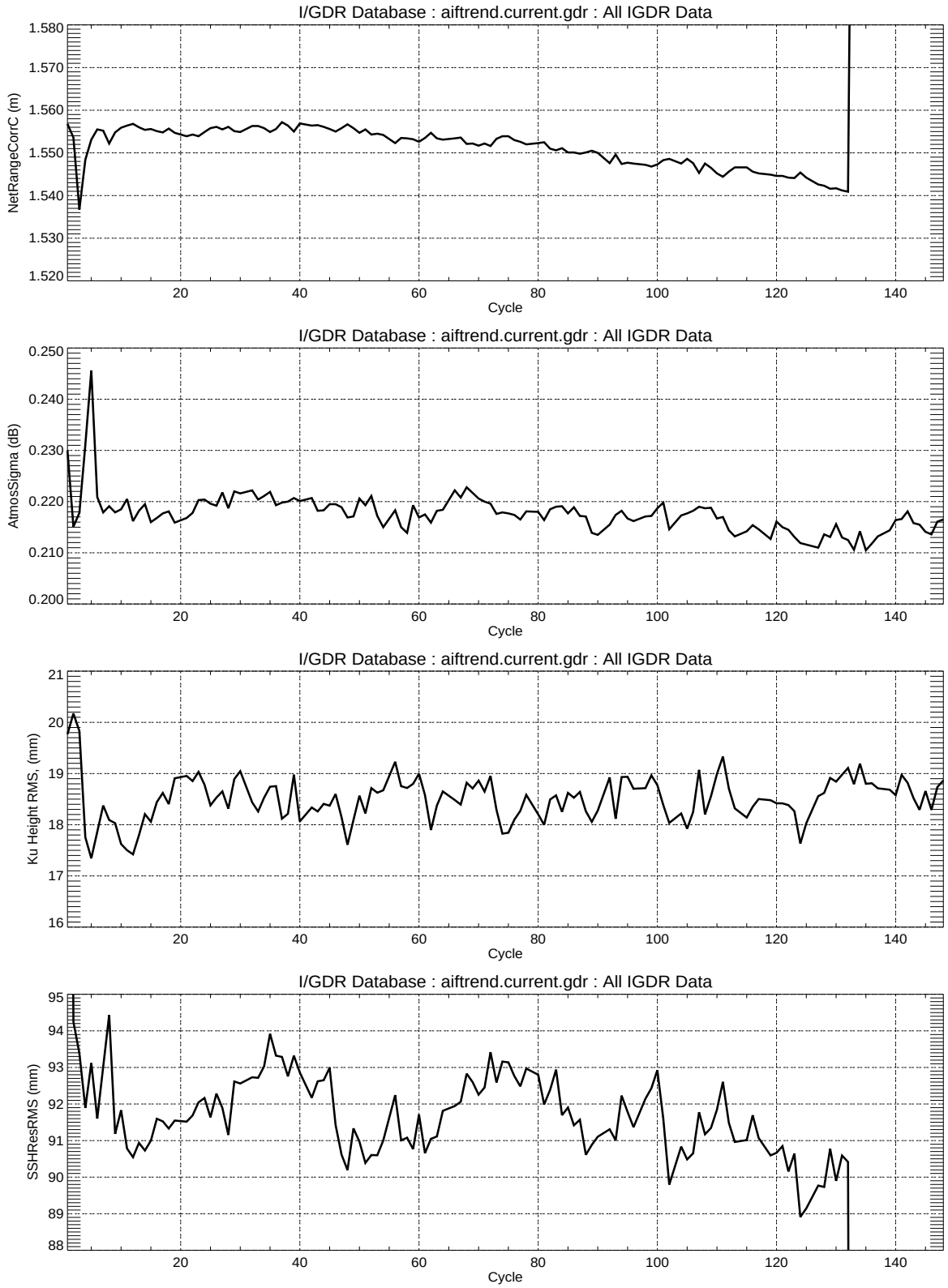

Figure A-3 Trend Plots (Continued)

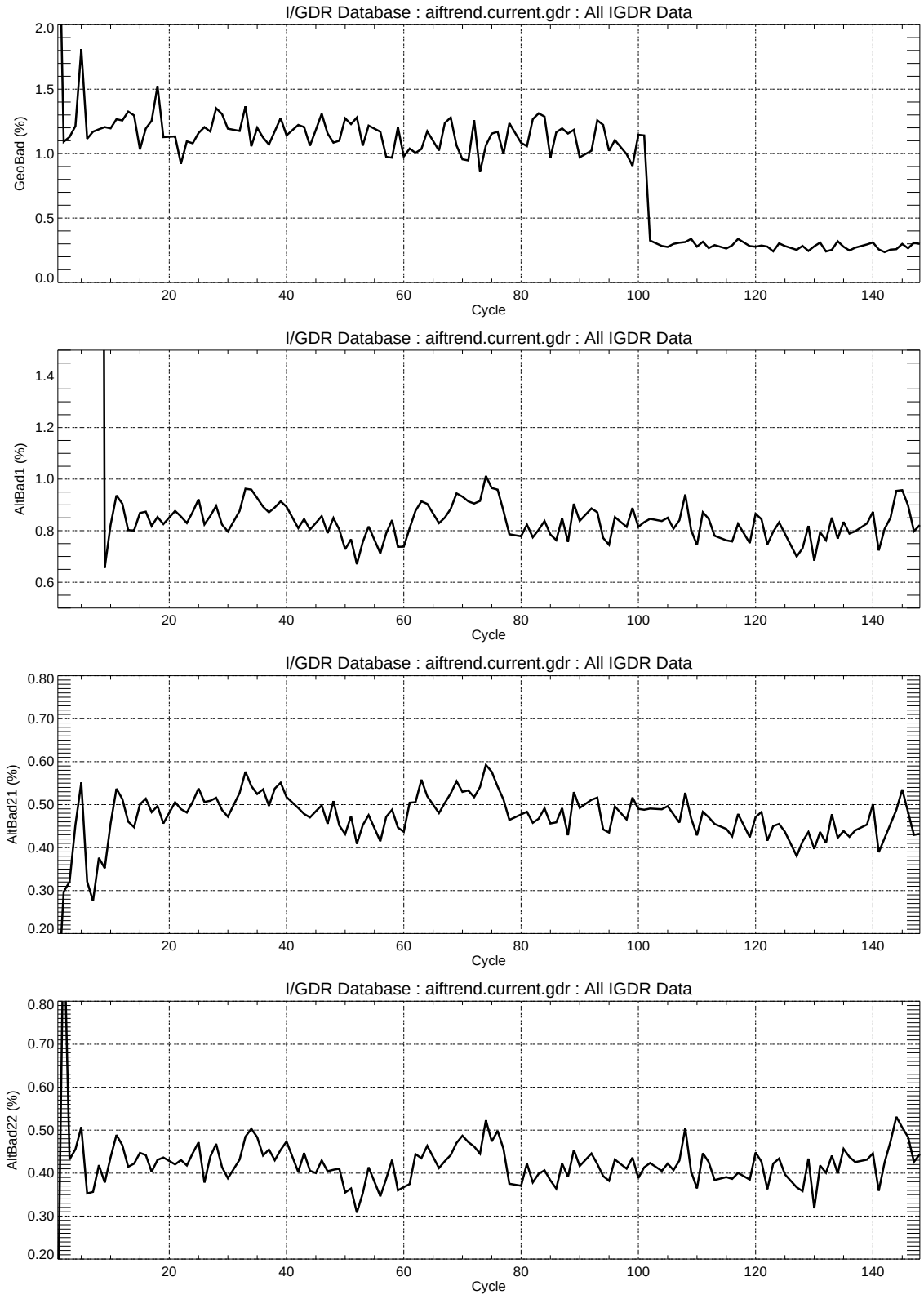

Figure A-3 Trend Plots (Continued)

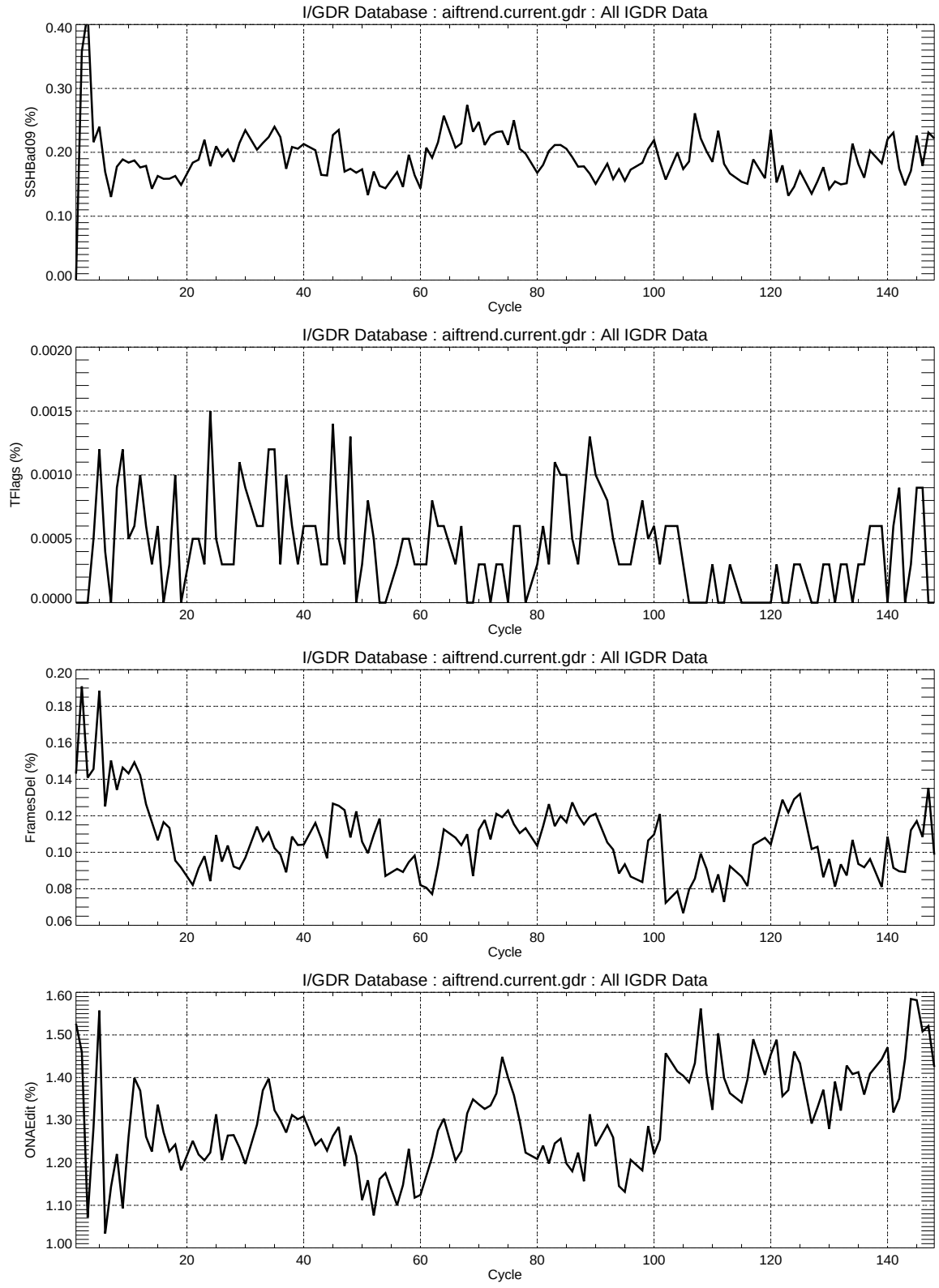

Figure A-3 Trend Plots (Continued)

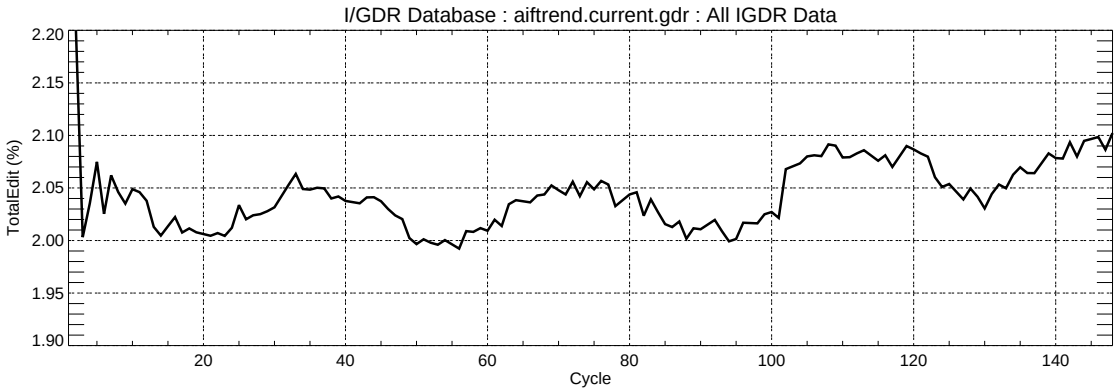

Figure A-3 Trend Plots (Continued)

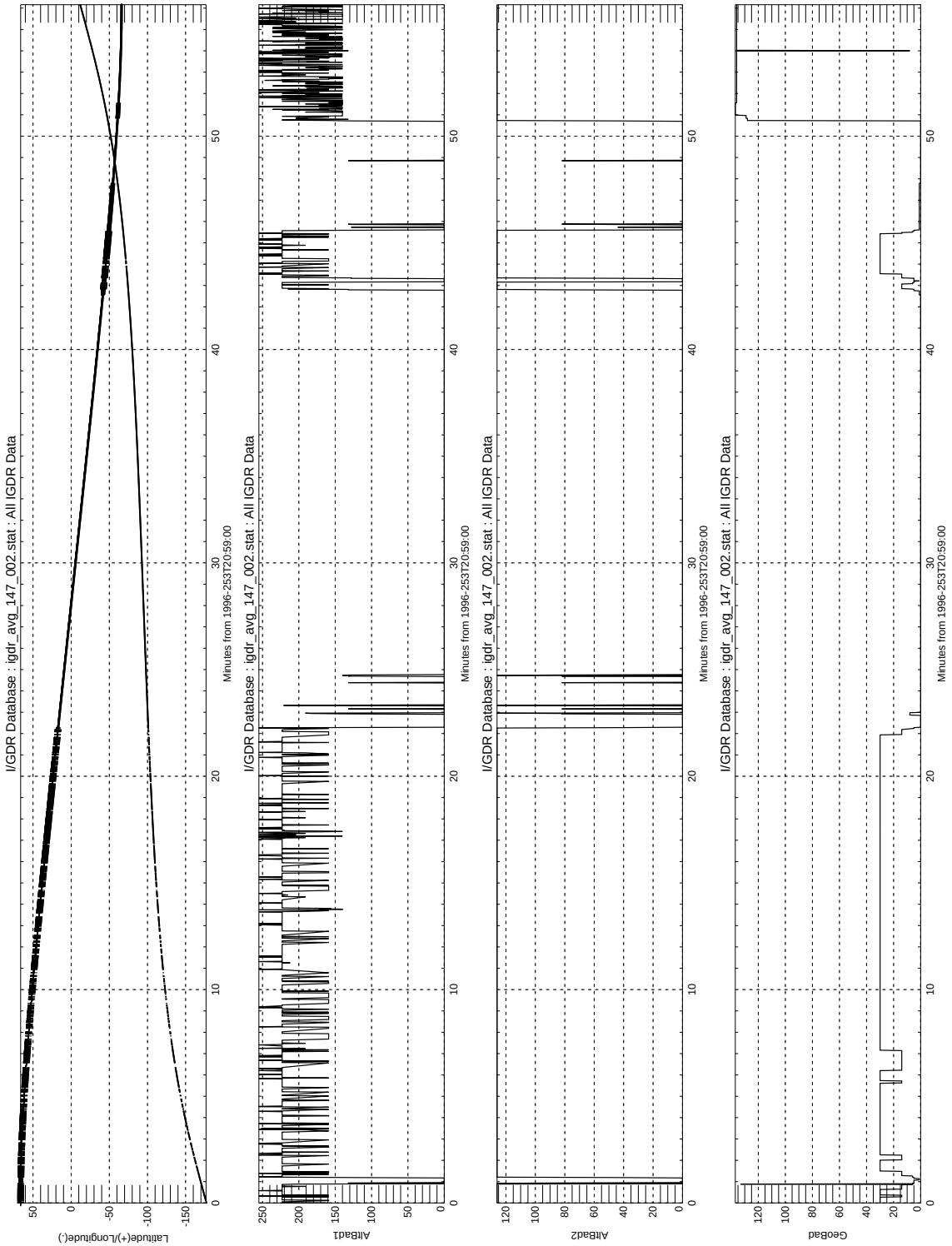

Figure A-4 I/GDR Average Plots

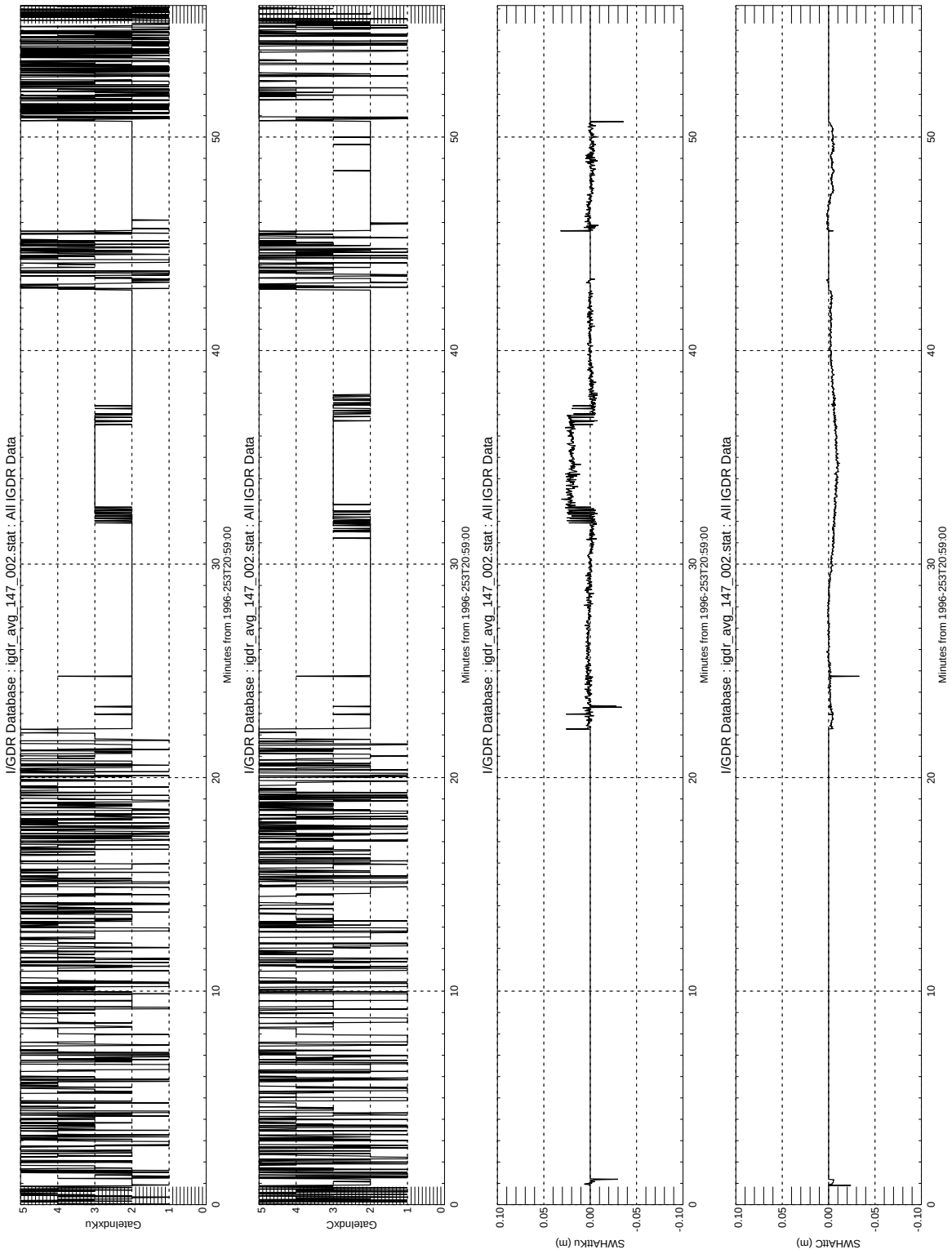

Figure A-4 I/GDR Average Plots (Continued)

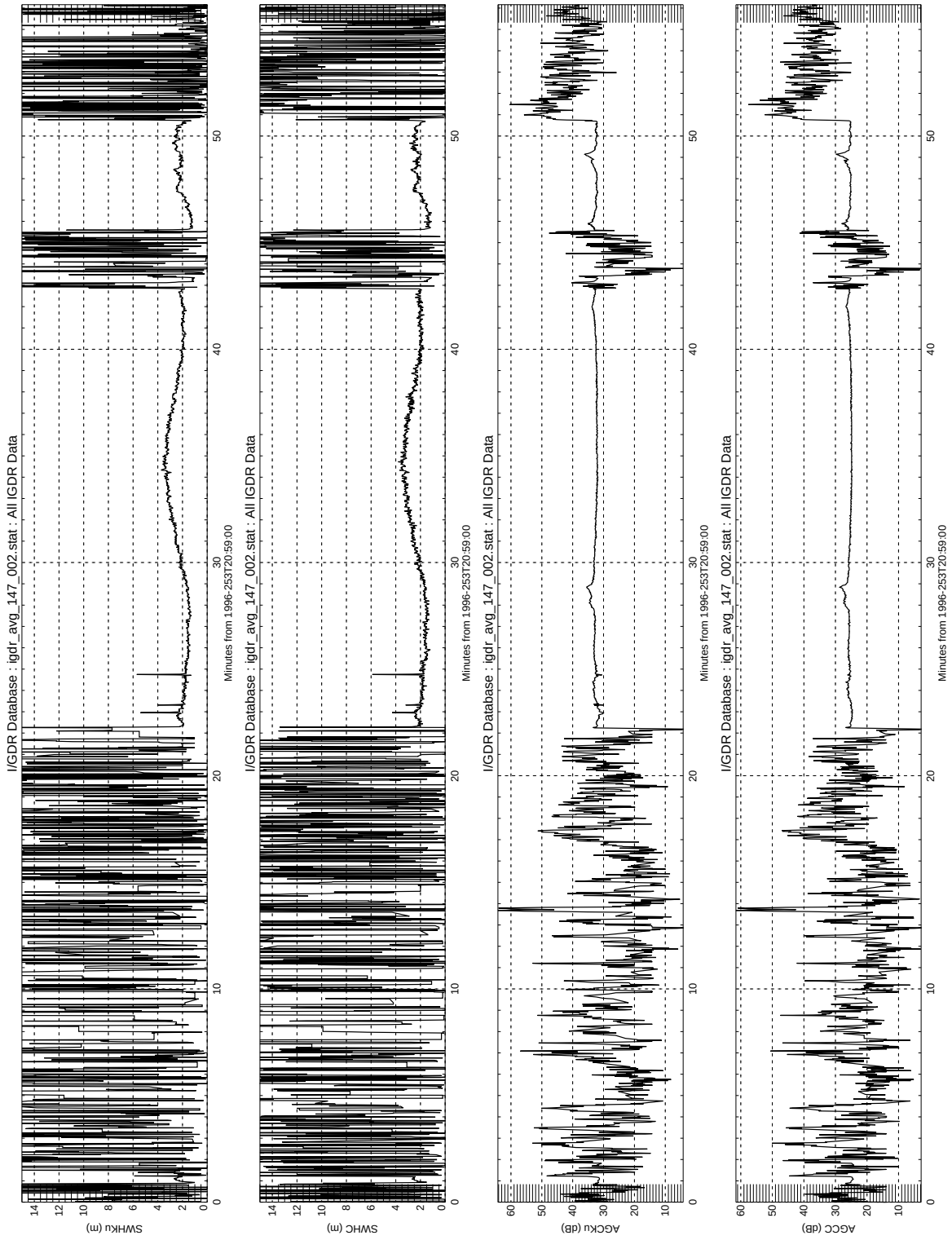

Figure A-4 I/GDR Average Plots (Continued)

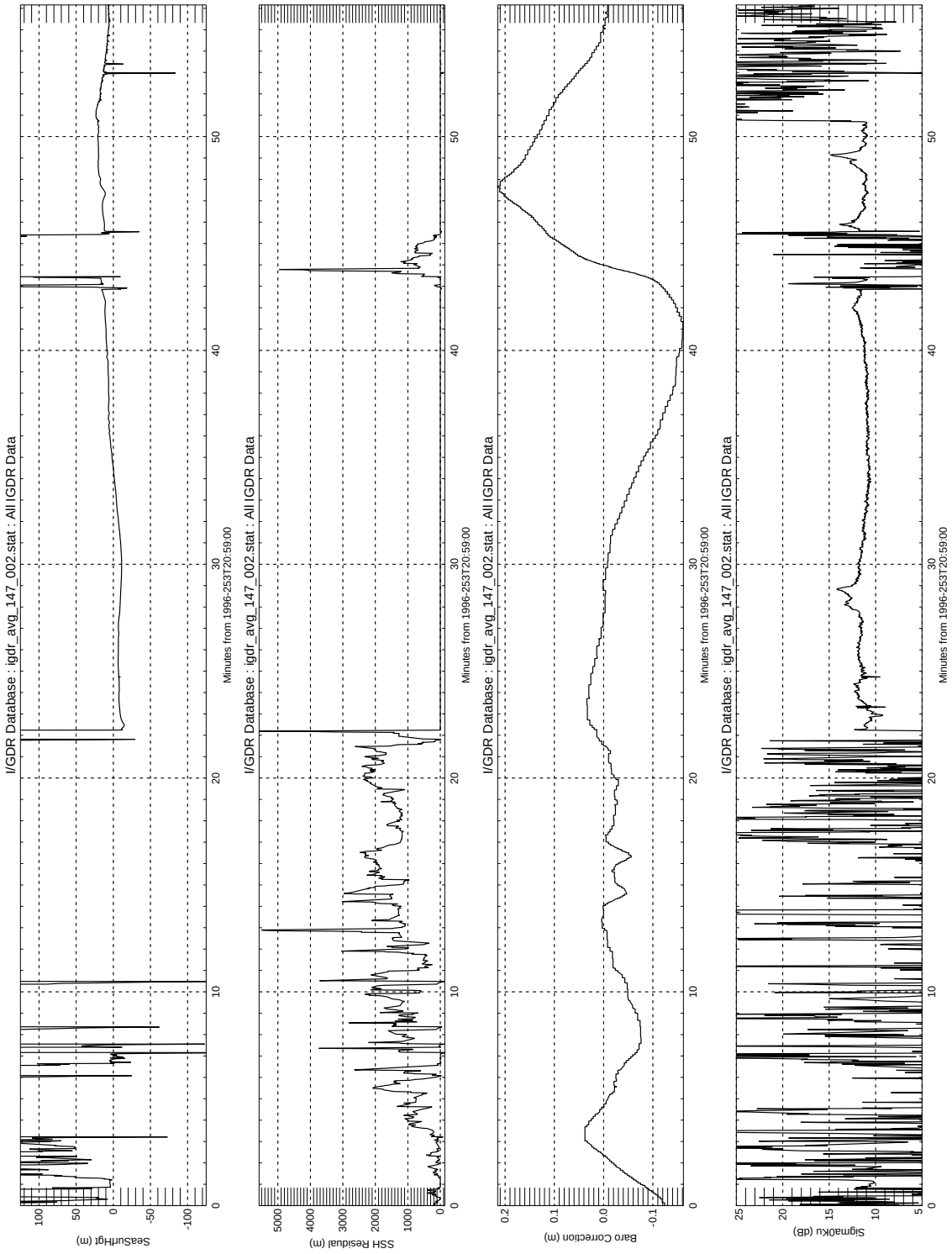

Figure A-4 I/GDR Average Plots (Continued)

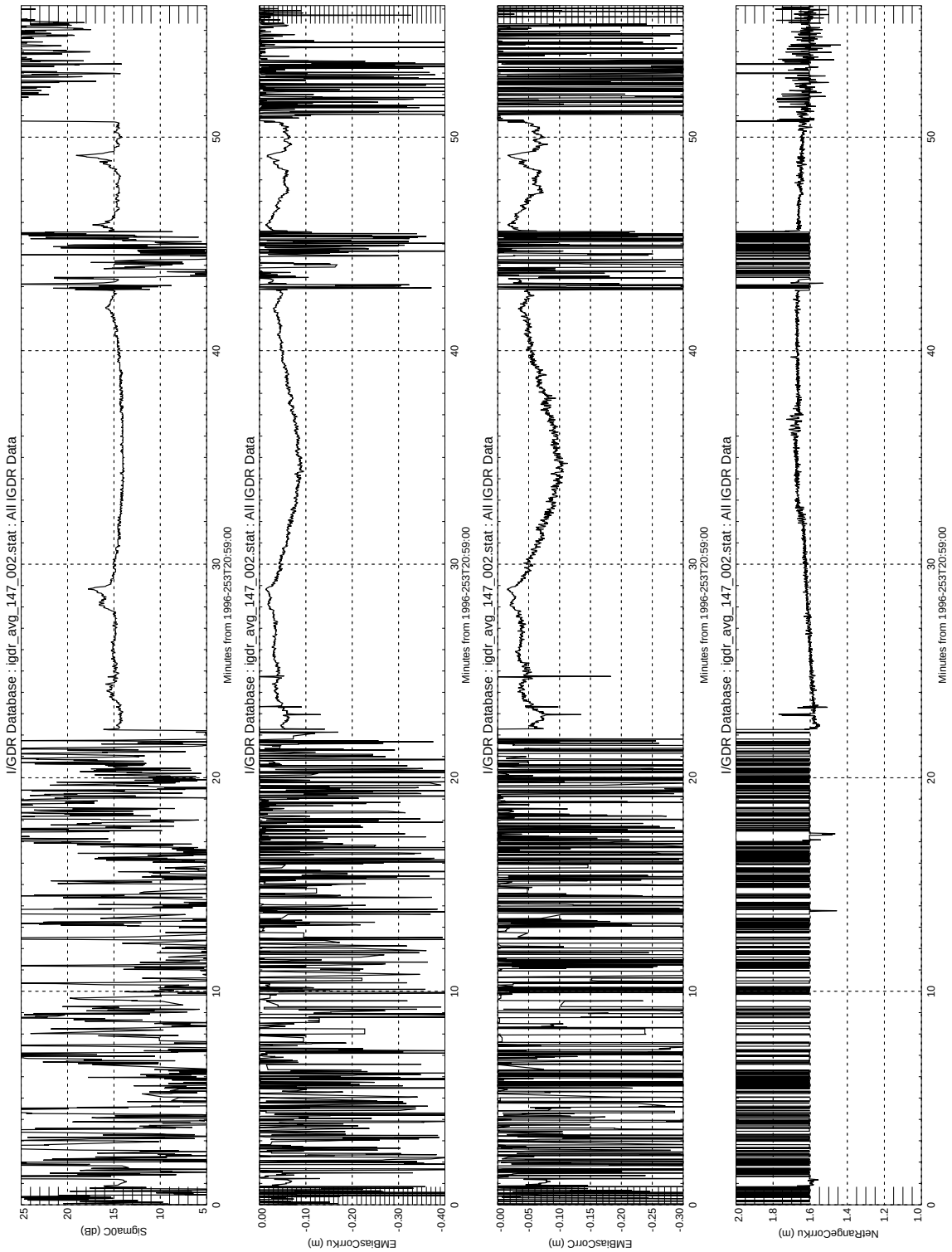

Figure A-4 I/GDR Average Plots (Continued)

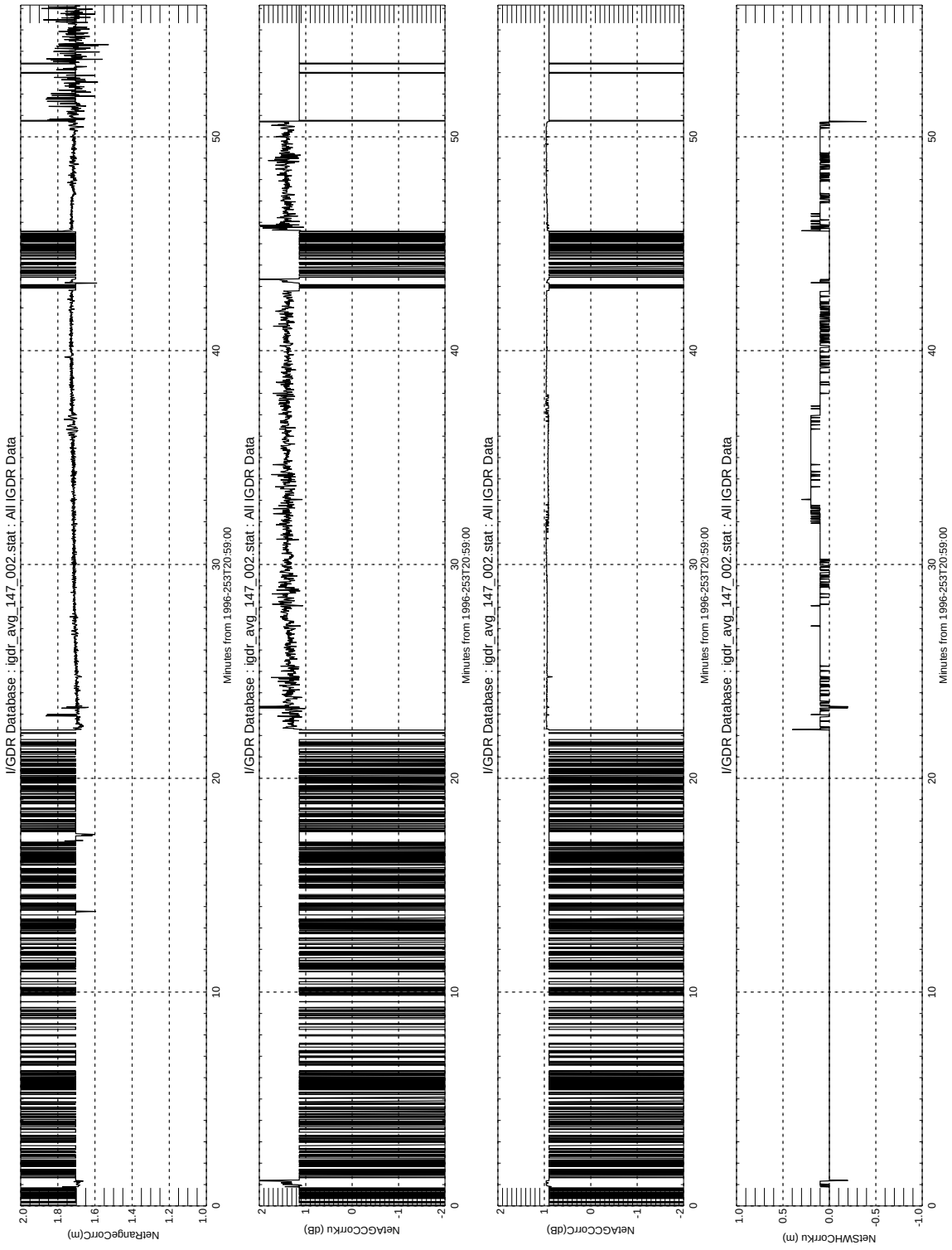

Figure A-4 I/GDR Average Plots (Continued)

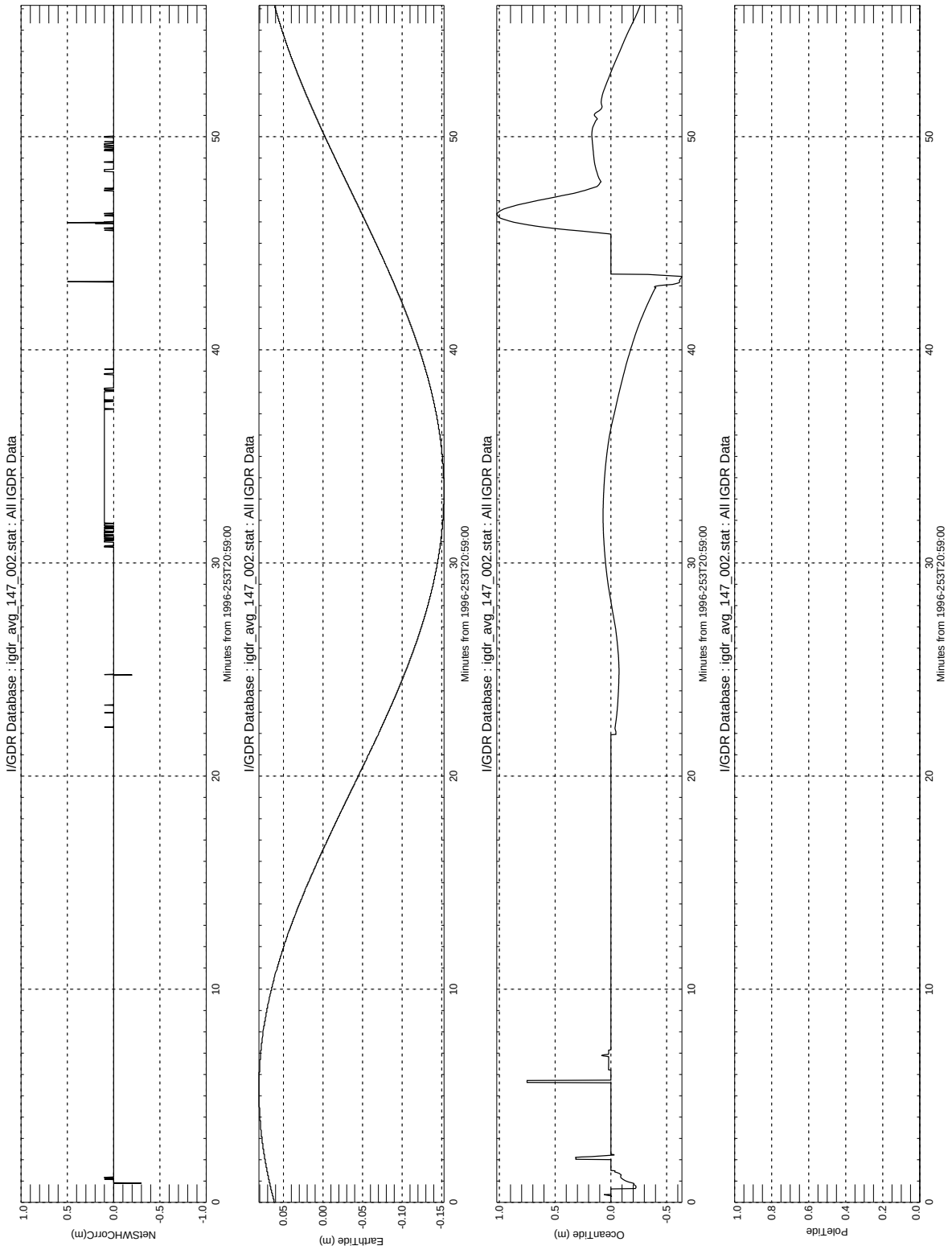

Figure A-4 I/GDR Average Plots (Continued)

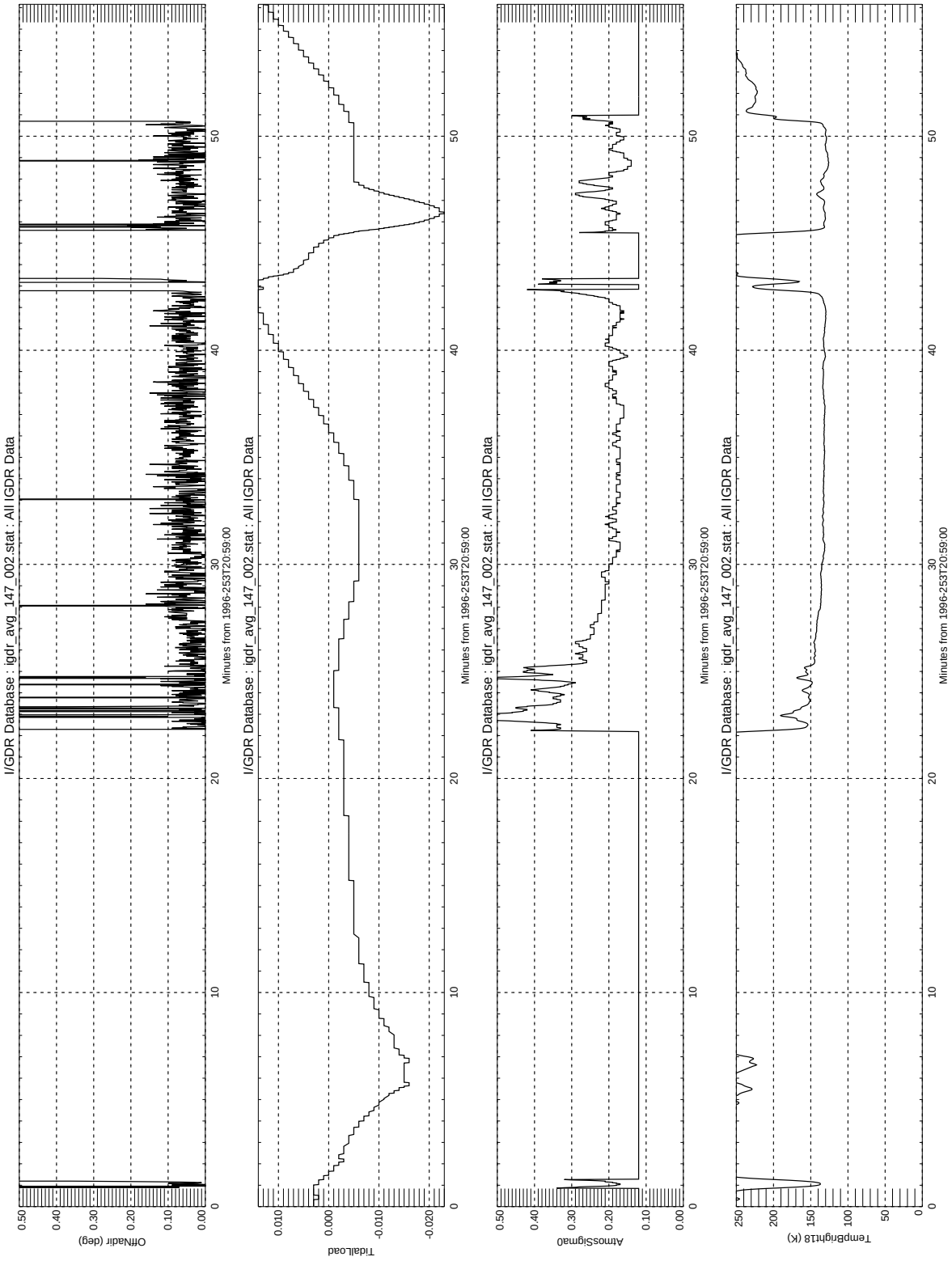

Figure A-4 I/GDR Average Plots (Continued)

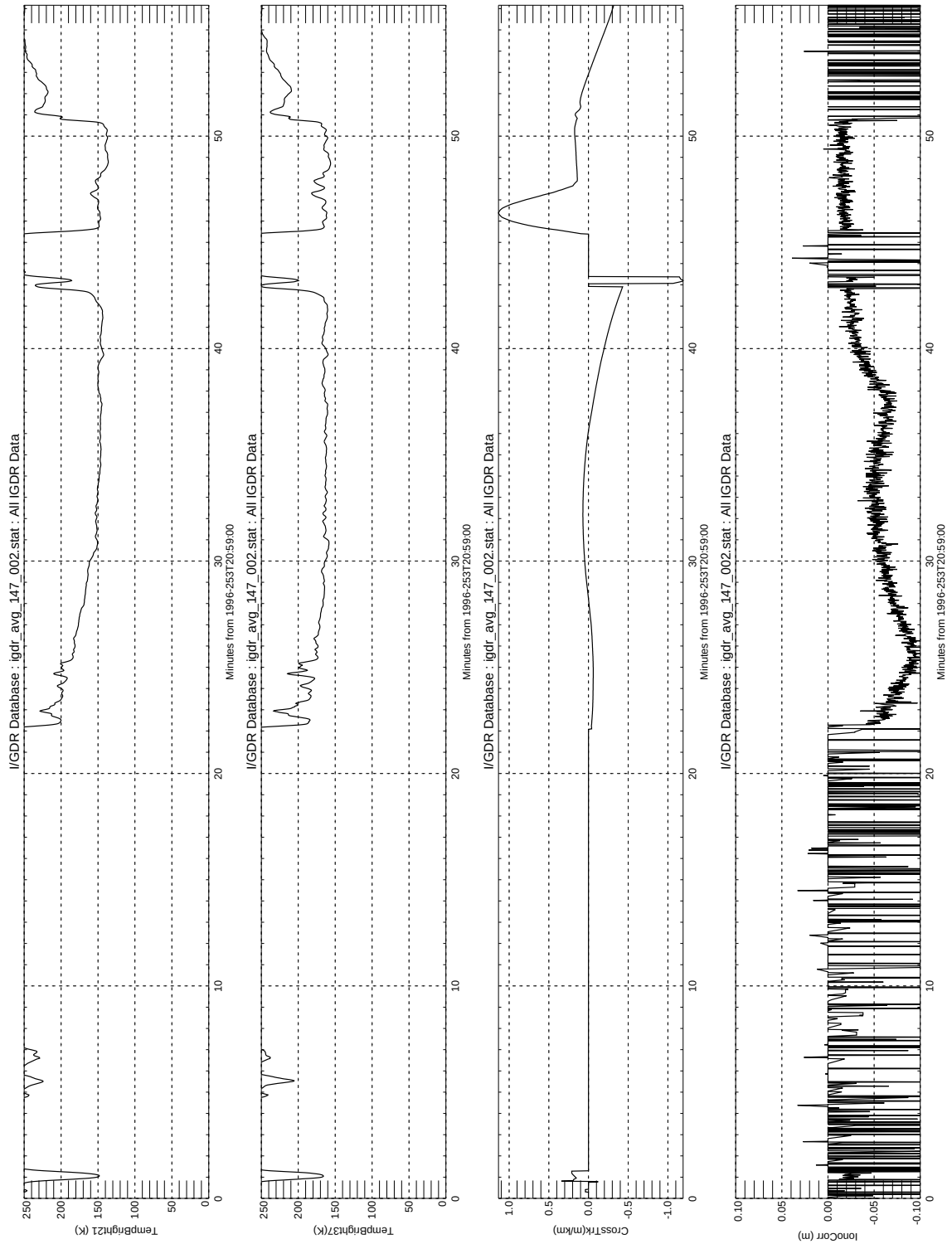

Figure A-4 I/GDR Average Plots (Continued)

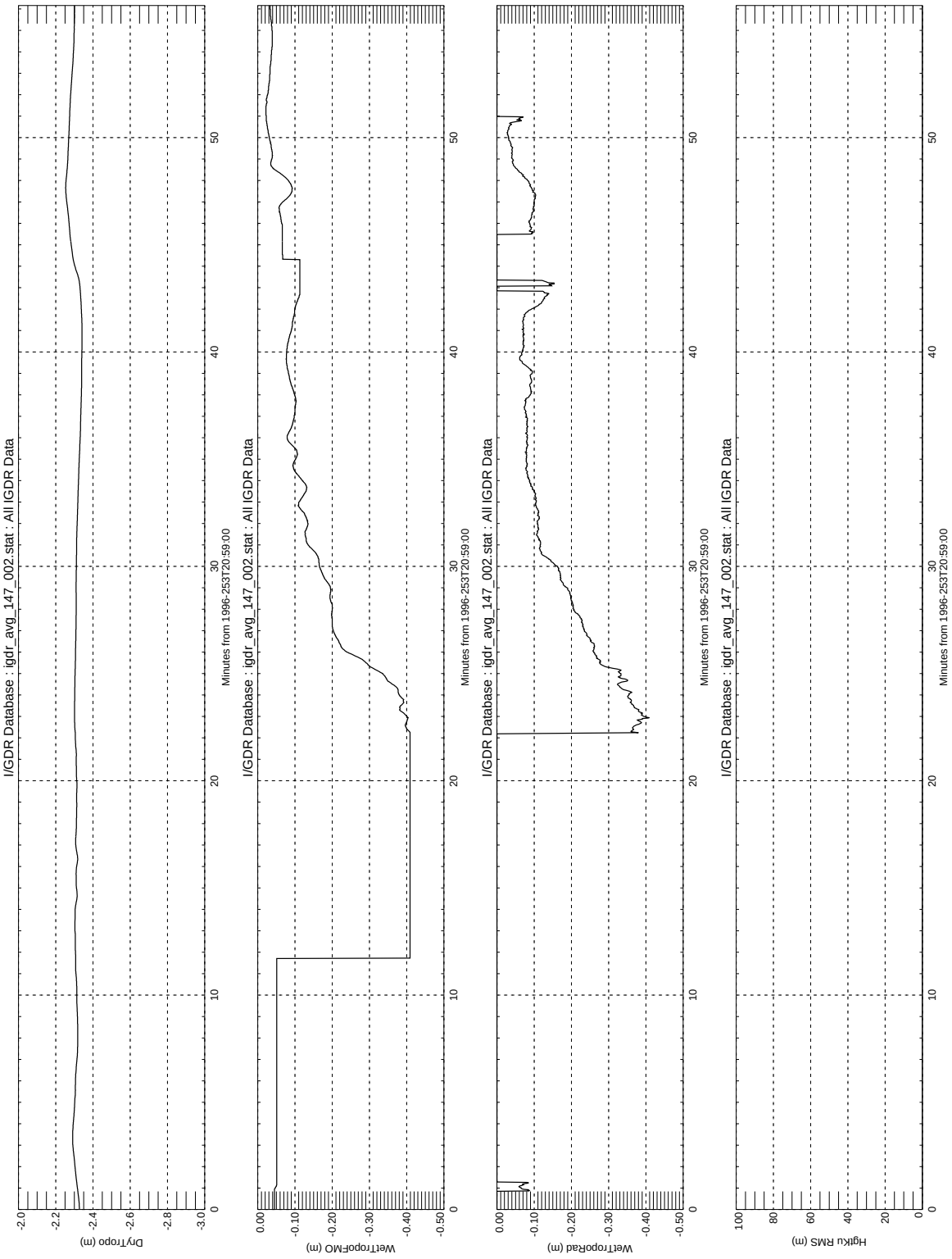

Figure A-4 I/GDR Average Plots (Continued)

Appendix B
Software Matrix

Table B-1 GDR Software Matrix

Software	Data Source	Products	Description
dogdr	I/GDR Files	DB Header DB Science Dump Science Print Science Avg Science	Main TOPEX WFF I/GDR Processing program. Coded in FORTRAN.
igdrpass	Science Avg	I/GDR Pass Plot (Figure A-1)	Unix Script that runs IDL igdrpass.pro.
autogdr	I/GDR Files	DB Header DB Science I/GDR Pass Plot	Unix Script that does Automatic Retrieval + Daily I/GDR Files from JPL.
igdrsum	Avg Science	Cycle Launch-to-Date Trend Plot (Figure A-3)	Unix Script that runs IDL igdrsum.pro.
igdrdb	DB Science	Cycle Summary Plot (Figure A-2)	Unix Script that runs IDL igdrdb.pro.
igdrdbfilter	DB Science	Cycle Summary Plot using Specific Filter	Unix Script that runs IDL igdrdb.pro.
igdravg	Avg Science	Science Avg Plot (Figure A-4)	Unix Script that runs IDL igdravg.pro.

Appendix C
Format File & Database Contents

Table C-1 GDR Header Database Format

Field	Fmt	Units	Description
DBCycleNum	a3	###	Cycle Number
DBPassNum	a3	###	Pass Number
KuOn	a3	On	Ku Band Status
COn	a3	Off	C Band Status
AltOper	a1	A	Altimeter A/B Operating
DBCalibRCorrK	a7	###	Altimeter Bias Ku Band Correction from Calib ration Correction
DBCalibRCorrC	a7	###	Altimeter Bias C Band Correction from Calibration Correction
DBPODQual	a20	###	Quality of Precision Orbit Determination ‘Interim GDR’
DBSensorName	a20	###	Name of the Instrument or Hardware Used
DBGenSoftName	a18	###	Name of the Program Generating the Data Product
DateRun	a9	###	Date the ‘dogdr’ was Run at WFF

Table C-2 GDR Average Format

Field	Fmt	Units	Description
TEpochSec	f16.3	sec	Time past Epoch
ATB	a17	sec	Time in ASCII
RecCount	f8.2	###	Number of Frames Averaged
LandWater	f8.2	###	Altimeter Surface Flag 0=Water 1=Land
WorstMode	a4	FTRK	Current Mode Bits 0-3
BestMode	a4	FTRK	Current Mode Bits 0-3
PRGateIndx	f16.3	###	Primary (Ku) Gate Index
SCGateIndx	f16.3	###	Secondary (C) Gate Index

Table C-2 GDR Average Format (Continued)

Field	Fmt	Units	Description
Latitude	f16.3	deg	Latitude
Longitude	f16.3	deg	Longitude
SWHAttK	f16.3	m	DR (SWH/ATT)Ku
SWHAttC	f16.3	m	DR (SWH/ATT) C
SWHK	f16.3	m	Significant Wave Height K Band
SWHC	f16.3	m	Significant Wave Height C Band
AGCK	f16.3	db	Automatic Gain Control K Band
AGCC	f16.3	db	Automatic Gain Control C Band
SSHgt	f16.3	m	Height of Sea Surface above Ellipsoid
MeanSS	f16.3	m	Height of Sea Surface above Ellipsoid from a High Resolution Mean Sea
SSHres	f16.3	m	Sea Surface Height Residual
BaroCorr	f16.3	mm	Inverse Barometer Effect Based on Dry-Tropo and Latitude
SatAlt	f16.3	m	Altitude of Satellite above the Reference Ellipsoid
Geoid	f16.3	m	Geoid Height above the Reference Ellipsoid
SigmaOK	f16.3	db	Sigma Zero Ku
Sigma OC	f16.3	db	Sigma Zero C
EMBiasCorrK	f16.3	m	EM Bias Correction Ku
EMBias CorrC	f16.3	m	EM Bias Correction C
NetRngCorrK	f16.3	m	Net Instrument Range Correction K Band
NetRngCorrC	f16.3	m	Net Instrument Range Correction C Band
Net AGCCorrK	f16.3	db	Net Instrument Automatic Gain Control Correction K Band
NetAGCCorrC	f16.3	db	Net Instrument Automatic Gain Control Correction C Band
Net SWHCorrK	f16.3	m	Net Instrument Significant Wave Height Correction K Band
NetSWHCorrC	f16.3	m	Net Instrument Significant Wave Height Correction C Band
EarthTide	f16.3	mm	Height of the Solid Earth Tide
OceanTide	f16.3	mm	Height of the Elastic Ocean Tide

Table C-2 GDR Average Format (Continued)

Field	Fmt	Units	Description
PoleTide	f16.3	mm	Geocentric Pole Tide Height
OffNadir	f16.3	deg	Odd Nadir Angle
TideLoad	f16.3	mm	Ocean Loading Effect on Tide
AtmosSigma0	f16.3	db	Atmosphere Sigma0 Correction
TB18	f16.3	k	Corrected Brightness Temperature, 18 GHz
TB21	f16.3	k	Corrected Brightness Temperature, 21 GHz
TB37	f16.3	k	Corrected Brightness Temperature, 37 HGHz
XTrackSurf	f16.3	mm	Height of the Elastic Ocean Tide #2
IonoCorr	f16.3	m	Ionospheric Correction
DryTropo	f16.3	mm	Correction for Dry Tropospheric Delay
WetTropoFMO	f16.3	mm	Correction for Wet Tropospheric Delay from French Met Office
WetTropoRad	f16.3	mm	Correction for Wet Tropospheric Delay from Radiometer Data
IonoCorrRMS	f16.3	mm	RMS of Ionospheric Delay K Band
AltBad1	f16.3	###	Bit Flags on Altimeter Sensor Corrections
AltBad2	f16.3	###	Bit Flags on Pointing/Seastate Conditions
GeoBad	f16.3	###	Bit Flags on Land Flags and Geophysical Conditions
FHgtFlagKu	f4.2	###	Number of Fine Height Flags Ku
FHgtFlagC	f4.2	###	Number of Fine Height Flags C

Table C-3 GDR Dump Format

Field	Fmt	Units	Description
TEpochSec	f16.4	sec	Time past Epoch
TEpochUTC	a24	sec	UTC Time in ASCII
NetTimeTagCorr	f16.4	sec	Net Time Tag Correction = Altimeter Internal Delay + Height D
TimeMFD	f16.4	sec	Time Shift Midframe
LandWater	i4	###	Altimeter Surface Flag 0 = Water 1 = Land
Mode(1)	a4	FTRK	Current Mode Bits 0-3

Table C-3 GDR Dump Format (Continued)

Field	Fmt	Units	Description
Mode (2)	a4	FTRK	Current Mode Bits 0-3
Sigma0k	f16.4	db	Sigma Zero Ku
Sigma0C	f16.4	db	Sigma Zero C
OffNadir	f16.4	deg	Off Nadir Angle
SatAlt	f16.4	m	Altitude of Satellite above the Reference Ellipsoid
EMBias CorrK	f16.4	m	EM Bias Correction Ku
EMBiasCorrC	f16.4	m	EM Bias Correction C
Geoid	f16.4	m	Geoid Height above the Reference Ellipsoid
PoleTide	f16.4	mm	Geocentric Pole Tide Height
SWHAttK	f16.4	m	DR (SWH/ATT)Ku
SWHAttC	f16.4	m	DR (SWH/ATT)C
TideLoad	f16.4	mm	Ocean Loading Effect on Tide
NetRngCorrK	f16.4	m	Net Instrument Range Correction K Band
NetRngCorrC	f16.4	m	Net Instrument Range Correction C Band
SWHPtsAvg	i4	###	Number of Points used in Average
AGCPtsAvg	i4	###	Number of Points used in Average
NetAGCCorrK	f16.4	db	Net Instrument Automatic Gain Control Correction K Band
NetAGCCorrC	f16.4	db	Net Instrument Automatic Gain Control Correction C Band
AGCRMSK	f16.4	db	RMS of Alt AGC Ku Data about AGC Ku Value
AGCRMSC	f16.4	db	RMS of Alt AGC C Data about AGC AGC C Value
EarthTide	f16.4	mm	Height of the Solid Earth Tide
AGCK	f16.4	db	Automatic Gain Control K Band
AGCC	f16.4	db	Automatic Gain Control C Band
SWHK	f16.4	m	Significant Wave Height K Band
SWHC	f16.4	m	Significant Wave Height C Band
OceanTide	f16.4	mm	Height of the Elastic Ocean Tide
NetSWHCorrK	f16.4	m	Net Instrument Significant Wave Height Correction K Band

Table C-3 GDR Dump Format (Continued)

Field	Fmt	Units	Description
NetSWHCorrC	f16.4	m	Net Instrument Significant Wave Height Correction C Band
SWHRMSK	f16.4	cent	RMS of Alt SWH Ku Data about SWH Ku Value
SWHRMSC	f16.4	cent	RMS of Alt SWH C Data about SWH C Value
PRGateIndx	i2	###	Primary (Ku) Gate Index
SCGateIndx	i2	###	Secondary (C) Gate Index
Latitude	f16.4	deg	Latitude
Longitude	f16.4	deg	Longitude
SSHgt	f16.4	m	Height of Sea Surface above Ellipsoid
MeanSS	f16.4	m	Height of Sea Surface above Ellipsoid from a High Resolution Mean Sea
BaroCorr	f16.4	mm	Inverse Barometer Effect based on Dry_Tropo and Latitude
SSHres	f16.4	m	Sea Surface Height Residual
DryTropo	f16.4	mm	Correction for Dry Tropospheric Delay
WetTropoFMO	f16.4	mm	Correction for Wet Tropospheric Delay from French Met Office
WetTropoRad	f16.4	mm	Correction for Wet Tropospheric Delay from Radiometer Data
IonoCorr	f16.4	m	Ionospheric Correction
SSRMS	f16.4	m	RMS of Sea Surface Height Rate
XTrackSurf	f16.4	mm	Height of the Elastic Ocean Tide #2
AtmosSigma0	f16.4	db	Atmosphere Sigma0 Correction
TB18	f16.4	k	Corrected Brightness Temperature, 18 GHz
TB21	f16.4	k	Corrected Brightness Temperature, 21 GHz
TB37	f16.3	k	Corrected Brightness Temperature, 37 HGHz
SSPtsAvg	i4	###	Number of Points used in Average
AllGeoBad	i4	###	All Bit Flags on Land Flags and Geophysical Conditions
AllSSHBad	i4	###	All Bit Flags on Invalid Sea Surface Height Points
AllIonoBad	i4	###	All Bit Flags on Ionospheric Corrections Out of Range

Table C-3 GDR Dump Format (Continued)

Field	Fmt	Units	Description
AllAltBad1	i4	###	All Bit Flags on Altimeter Sensor Corrections
AllAltBad2	i4	###	All Bit Flags on Pointing/Seastate Conditions

Table C-4 GDR Science Database Format

Field	Name	Units	Format	Description
1	TEpochSec	sec	F16.3	Converted to 2000 Epoch
2	ATB	date	A17	UTC Time
3	Cycle	#	A3	Cycle = 9.92 days
4	Pass	#	A3	Pass = 3372.885 seconds
5	RecCount	#	F4.1	Nbr frames used in 60 sec avg
6	PRGateIndx	#	F4.2*	Primary Gate Index
7	SCGateIndx	#	F4.2*	Secondary Gate Index
8	Latitude	deg	F7.3*	Geodetic Latitude
9	Longitude	deg	F7.3*	East Longitude
10	SWHAttK	m	F8.3*	DR(SWH/Att) Ku
11	SWHAttC	m	F8.3*	DR(SWH/Att) C
12	SWHK	m	F5.2*	SWH Ku
13	SWHC**	m	F5.2*	SWH C
14	NetAGCCorrK	db	F7.3*	Net Instr AGC Correction Ku
15	NetAGCCorrC**	db	F7.3*	Net Instr AGC Correction C
16	NetSWHCorrK**	m	F7.3*	Net Instr SWH Correction Ku
17	NetSWHCorrC**	m	F7.3*	Net Instr SWH Correction C
18	SatAlt**	m	F12.3*	Altitude of Satellite
19	SSHgt	m	F8.3*	Height of Sea Surface above ellipsoid
20	OffNadir	deg	F5.3*	Off Nadir Angle
21	SSHres	m	F9.3*	= SSHgt - OceanTide - SolidTide - PoleTide - BaroCorr - MeanSSH
22	IonoCorr	m	F8.3*	Range Correction for Ionosphere
23	EMBiasCorrK	m	F8.3*	Range Correction for EM Bias Ku
24	EMBiasCorrC	m	F8.3*	Range Correction for EM Bias C

Table C-4 GDR Science Database Format (Continued)

Field	Name	Units	Format	Description
25	Sigma0K	db	F6.3*	Sigma 0 Ku
26	Sigma0C	db	F6.3*	Sigma 0 C
27	NetRngCorrK	m	F8.3*	Net Instr Range Correction Ku
28	NetRngCorrC	m	F8.3*	Net Instr Range Correction C
29	AtmosSigma0	db	F5.3*	Atmospheric Correction to Sigma 0
30	IonoCorrRMS	mm	F7.3*	RMS of IonoCorr (used as HeightKuRMS)
31	SSHresRMS	mm	F7.3*	Linear fit to SSHres
32	NumGeoBad	#	I3	Count nbr All bits Geo_Bad
33	NumAltBad1	#	I3	Count nbr All bits Alt_Bad1
34	NumAltBad21	#	I3	Count nbr ibits(Alt_Bad2,1,1)
35	NumAltBad22	#	I3	Count nbr ibits(Alt_Bad2,2,1)
36	NumSSHBad09	#	I3	Count nbr ibits(SSH_Bad,0,9)
37	NumSSHBad12	#	I3	Count nbr ibits(SSH_Bad,11,2)
38	NumTFlags	#	I3	Count nbr ibits(Alt_Bad1,3,1)
39	NumFramesDel	#	I3	Count nbr Frames Deleted
40	NumFineHtKFlg	#	F5.3*	Avg from ibits(Iono_Bad,13,1)
41	NumFineHtCFlg	#	F5.3*	Avg from ibits(Iono_Bad,14,1)

* New Resolution
** New Variable

Table C-5 GDR Summary Table Format

Field	Name	Units	Format	Description
1	TEpochSec	sec	F16.3	Average TEpochSec
2	ATB	date	A17	Average ATB
3	Cycle	#	A3	Cycle
4	RecCount	#	F9.4	Total RecCount
5	PRGateIndx	#	F9.4	Average PRGateIndx
6	SCGateIndx	#	F9.4	Average SCGateIndx
7	SWHAttK	m	F9.4	Average SWHAttK
8	SWHAttC	m	F9.4	Average SWHAttC

Table C-5 GDR Summary Table Format (Continued)

Field	Name	Units	Format	Description
9	SWHK	m	F9.4	Average SWH K
10	SWHC*	m	F9.4	Average SWH C
11	NetAGCCorrK	db	F9.4	Average NetAGCCorrK
12	NetAGCCorrC*	db	F9.4	Average NetAGCCorrC
13	NetSWHCorrK*	m	F9.4	Average NetSWHCorrK
14	NetSWHCorrC*	m	F9.4	Average NetSWHCorrC
15	SatAlt*	m	F14.4	Average SatAlt
16	SSHgt	m	F9.4	Average SSHgt
17	OffNadirA**	deg	F9.4	Average OffNadirA
18	OffNadirB**	deg	F9.4	Average OffNadirB
19	SSHres	m	F9.4	Average SSHres
20	IonoCorr	m	F9.4	Average IonoCorr
21	EMBiasCorrK	m	F9.4	Average EMBiasCorrK
22	EMBiasCorrC	m	F9.4	Average EMBiasCorrC
23	Sigma0K	db	F9.4	Average Sigma0K
24	Sigma0C	db	F9.4	Average Sigma0C
25	NetRngCorrK	m	F9.4	Average NetRngCorrK
26	NetRngCorrC	m	F9.4	Average NetRngCorrC
27	AtmosSigma0	db	F9.4	Average AtmosSigma0
28	IonoCorrRMS	mm	F9.4	Average IonoCorrRMS)
29	SSHresRMS	mm	F9.4	Average SSHresRMS
30	GeoBad	%	F9.4	Total GeoBad / RecCount * 100.0
31	AltBad1	%	F9.4	Total AltBad1 / RecCount * 100.0
32	AltBad21	%	F9.4	Total AltBad21 / RecCount * 100.0
33	AltBad22	%	F9.4	Total AltBad22 / RecCount * 100.0
34	SSHBad09	%	F9.4	Total SSHBad09 / RecCount * 100.0
35	SSHBad12	%	F9.4	Total SSHBad12 / RecCount * 100.0)
36	TFlags	%	F9.4	Total TFlags / RecCount * 100.0
37	FramesDel	%	F9.4	Total FramesDel / RecCount * 100.0
38	ONAEdit	%	F9.4	Total OffNadir Deleted/ RecCount * 100.0

Table C-5 GDR Summary Table Format (Continued)

Field	Name	Units	Format	Description
39	TotEdit	%	F9.4	Total remaining after filter / RecCount * 100.0

* New Variable

** OffNadir A: if it were an ascending pass in the northern hemisphere (>5 deg and <60 deg latitude) OR if it were a descending pass in the southeren hemisphere (<-5 deg and >-60 deg latitude); in either event, the range-rate is positive. OffNadir B: if it were a descending pass in the northern hemisphere (>5 deg and <60 deg latitude) OR if it were an ascending pass in the southern hemisphere (<-5 deg and >-60 deg latitude); in either event, the range-rate is negative.

Appendix D
I/GDR Software Change History

Table D-1 GDR Software Change History

Date	First Date Effective	Related Requests	Software Components	New Version	Description
4/01/94	(I)GDR Processing Officially Placed Under Control, Memo April 1, 1994, Hayden Gordon				
6/02/94	Cycle 62	94/076	IGDREUConv.f	n/a	SSH Residual Correction
9/02/94	Cycle 70	n/a	igdrdb.pro igdrsum.pro	n/a	SSHResRMS Plot Scale Change
9/16/94	Cycle 70	n/a	igdrpass.pro	n/a	Pass Plot Correction
9/23/94	Cycle 73	n/a	igdrdb.pro	n/a	Certain Editing Criteria Modifications on Summary Database
2/15/95	n/a	95/046 95/017 95/026	igdrsum.pro	n/a	Modify Vertical Scales on Launch-to-Date Plots
9/11/95	Cycle 109	95/149	GDRDBAvg.f	1.2, 9/11/95 doGDR.f	GEO_BAD Flagging of Non-Zeros
8/26/96	Cycle 133	96/010 96/146	GDRDBAvg.f GDRAvg.f IGDRREUConv.f readigdr.pro readigdravg.pro	1.3, 8/26/96 doGDR.f	Per Change Requests for SDS GDR Upgrades from JPL

Appendix E
Attachments

Table E-1 Attachments

Date	Author(s)	Subject
December 8, 1992	R.L. Brooks	(I) GDR Summary Plots and Data Base Definition
June 1, 1993	H. Gordon	Current State of SWDT Software
September 17, 1993	H. Gordon	Some Suggested Standard IGDR Database Products
September 24, 1993	R.L. Brooks	Contents of (I)GDR Data Base
February 15, 1994	J. Lee	Re: Request 95/046
March 29, 1994	D.Lockwood, J. Lee	I/GDR Processing
April 1, 1994	H. Gordon	Change Control Status for (I)GDR Processing Module
April 11, 1994	H. Gordon	Change to (I)GDR Processing Module: SSH Residual Correction
May 4, 1994	R. Brooks	SSH Residual Computations
May 23, 1994	R. Brooks	Reference for Rapp Modification to Mean_Sea_Surf
June 2, 1994	H. Gordon	EA S/W Chg 14:SSH Residual Correction
August 10, 1994	R. Brooks	Changing the Scale of the SSH Residual RMS Histogram within the (I)GDR Cycle Summary
August 10, 1994	R. Brooks	Change in (I)GDR Data Base
August 10, 1994	R. Brooks	Applying Calibration Corrections to (I)GDR Data Retrieval Products
August 10, 1994	R. Brooks	Change in Summary (I)GDR Data Base
August 11, 1994	R. Brooks	Changing the Scale of the SSHResidualsRMS Plot Within the (I)GDR Launch-to-Date Summary
August 12, 1994	H. Gordon	Change to (I)GDR Processing Module: SSHResRMS Plot Scale Changes
August 12, 1994	H. Gordon	Change to (I)GDR Processing Module: Apply CAL Corrections

Table E-1 Attachments (Continued)

Date	Author(s)	Subject
August 12, 1994	H. Gordon	Change to (I)GDR Processing Module: Database Additions
September 9, 1994	H. Gordon	Change to (I)GDR Processing Module: Pass Plot Correction
September 9, 1994	H. Gordon	EA S/W Chg 18: SSHResRMS Plot Scale Changes
September 9, 1994	H. Gordon	EA S/W Chg 16: Summary Database Additions
September 21, 1994	H. Gordon	EA S/W Chg 21: (I)GDR Pass Plot Correction
September 21, 1994	H. Gordon	Change to (I)GDR Summary Database: 10 Editing & Scale Revisions
October 28, 1994	D. Lockwood, J. Lee	GDR Cycles 1-8 Absence
October 31, 1994	H. Gordon	GDR Cycles 1-8, Clarification
February 3, 1995	R. Brooks	TOPEX Software Modification
March 15, 1995	H. Gordon	Request #95/046 - GDR Launch-to-Date Cycle Summary Plot Scale Change
September 29, 1995	H. Gordon	Request #95/149 - Geo_Bad Bits
December 21, 1995	P.S. Callahan/JPL	Change Requests for SDS GDR Upgrades
March 14, 1996	D. Lockwood, J. Lee	Request #96/010 - GDR s/w Change Study
March 29, 1996	D. Lockwood, J. Lee	Addendum to Request #96/010 GDR s/w Change Study
September 5, 1996	D. Lockwood, J. Lee	Change Request 96/146 - Software Change Requests

Abbreviations & Acronyms

AIF	Altimeter Instrument File
ADP	Algorithm Development Plan
ADT	Algorithm Development Team
AGC	Automatic Gain Control
APL	Applied Physics Laboratory
CAL	Calibration Mode or Calibration Mode data
CSC	Computer Sciences Corporation
CNES	Centre National d'Etudes Spatiales
COTS	Commercial Off-The-Shelf
EM	Electromagnetic
ENG	Engineering Data
EU	Engineering Unit
FTP	File Transfer Protocol
GDR	Geophysical Data Record
GSFC	Goddard Space Flight Center
HDR	Header data
IGDR	Intermediate Geophysical Data Record
IDL	Interactive Data Language
JPL	Jet Propulsion Laboratory
NASA	National Aeronautics and Space Administration
NSI	NASA Science Internet
RASE	Radar Altimeter System Evaluator
SCI	Science Data
SDR	Sensor Data Record
SDS	Science Data System
SIS	Software Interface Specification
SDT	Science Definition Team
SEU	Single Event Upset
STR	Selected Telemetry Record

SWDT Software Development Team

SWH Significant Wave Height

TGS TOPEX Ground System (TGSA, TGSB, & TGSC VAX Cluster)

TMR TOPEX Microwave Radiometer

TOPEX Ocean Topography Experiment

UTC Universal Time Coordinated

WFF Wallops Flight Facility