Comparative analysis of the software tools to process satellite data

D.V. Solomatov

Institute of Atmospheric Optics,
Siberian Branch of the Russian Academy of Sciences, Tomsk

Received September 2, 2006

The paper presents the existing codes intended for primary processing of remote sensing data and their preparation for thematic processing. I have considered a possibility of using the geoinformation systems to solve the problem stated. Comparative characteristics are presented of the systems intended for processing remote sensing data, specialized software tools, and additional utilities and libraries applicable to software production are described. Practical recommendations are given on using the considered software in writing the codes based on free systems for the Microsoft Windows environment.

Introduction

Solution of various problems in remote sensing of the atmosphere and underlying surface is often directly related with the use of the effective software in processing and preparation of satellite information. The development in this research area can be briefly characterized as follows.

At present, a sufficiently large number of software tools has been developed to provide processing of the remote sensing data. Many methods and algorithms have been implemented in geoinformation systems (GIS) and systems of remote sensing data processing, such as ArcGIS, ENVI, and ERDAS. In addition, numerous specialized codes have been developed having narrower application. It takes much time in this situation to collect, systematize, and analyze information about the software products available. It should be noted that there are no publications devoted to a comprehensive comparative analysis of software tools to handle satellite information. Therefore, it is too difficult to select simple, convenient, and most effective software for solution of a particular problem due to the large number of the software products available. This paper presents comparative analysis of the software tools intended for processing remote sensing data (RSD), a brief description of their capabilities, and systematization of this information. For this purpose the information (available via Internet) about software performing reading operation, pre-processing, geometrical correction, conversion, visualization, and statistical analysis of satellite data was used.

The following requirements are presented for the considered software:

– implementation of algorithms for the data pre-processing;

– operation with map projections (data translation from one projection into the other, calculation of coordinates in the projection);

– geographical siting;

– support of main formats used for satellite images such as GeoTIFF and HDF;

– usability;

– export of files to different graphical formats;

– support of the greatest number of various platforms (first of all, OS Windows).

Besides, the pre-processing of satellite data is senseless without their subsequent use. Therefore, much attention was paid to the use of these codes as modules in processing the RSD.

1. Use of the instrumental GIS and GIS-viewers

Nowadays, there are a lot of geoinformation systems providing various means of access, analysis, and processing of spatial information. All of them have similar functionality in the context of this problem, therefore detailed analysis of them is omitted here. In this section, I consider the use of GIS for software production.

The main GIS components:

Data input system provides the means for forming digital representation of spatial objects and phenomena.

Control and data processing system supports data editing, analysis, responding to complex requests, it also provides correct and efficient data storage and conversion. In a certain sense, the basis for GIS building up is a data-base management system (DBMS).

Data analysis system includes the tools for data reception by requests, simulation of the processes, and integration of heterogeneous information.

System for data output includes the functions of producing high-quality maps, diagrams, and tables. The instrumental GIS include the ArcGIS package by ESRI Company, a line of GeoMedia packages (Intergraph, USA), the AutoCAD Map

0235-6880/07/02 156-07 $02.00

package by Autodesk Company, SMALLWORLD (SmallWorld System, Great Britain), MapInfo (MapInfo Corporation, USA), GeoGraph/ GeoDraw.

As a rule, all engineers developing the professional GIS also suggest GIS-viewers, like ArcView3 (ESRI, USA), WinCAT (Simens Nixdorf, Germany).

In the entire flow of GIS versions, the viewers are in the lead providing for scanning data in different projections, such as ER Viewer 2.0 by Earth Resource Mapping; GIS extension, for instance, Power Structure by Benchmark GIS or HTML Image Mapper by alta4 for ArcView GIS; utilities, and, for instance, Topology Manager by TPLG Foundations; the spatial component libraries, for instance, Caris Spatial Fusion by CARIS.

The following GIS packages were considered: ArcGIS (ESRI),[1] ArcView (ESRI),[2] GRASS GIS,[3] GeoMedia (Intergraph Mapping/GIS),[4] MGE GIS (Intergraph Mapping/GIS),[5] MapInfo GIS (MapInfo),[6] Manifold System (manifold.net).[7]

All the considered GIS have a set of tools for processing satellite data, among them: tools for spatial analysis of data, tools for handling projections, tools for handling data in formats used on satellites, data editing tools, tools for pattern correction, filters, use of masks, visualization tools, tools for grouping and classification.

However, all the above-mentioned GIS tools are formed for solving the general purpose problems, and solution of specific problems (for instance, data processing for a certain satellite) will require a special knowledge and operational experience.

All the considered GIS have the built-in programming aid for writing new modules and adding new possibilities to the system. This GIS property can be used for solution of more specific problems, for adding new algorithms being in the context of the generated system. Nevertheless, there is a problem connected with incapability of modules to operate independently, without GIS. Besides, modules for one GIS will not operate with another one. As a rule, GIS are very expensive and there is no sense in purchasing a GIS for the program that only use a small its part.

It is worth distinguishing the GRASS system among all the considered GIS. It differs from the rest by its free distribution together with the source codes and it has modular structure in the form of a set of utilities and libraries. This GIS is capable of operating in the majority of Unix-compatible platforms, Windows, and Macintosh.

2. Systems for processing data of remote sensing

In this section, I consider systems for processing data of remote sensing. Among those there are such software packages as PCI Geomatica,[8] RSI ENVI,[9] ER Mapper,[10] ERDAS Imagine,[11] Msphinx,[12] Multispec,[13] Image Processing Workbench,[14] ScanMagic,[15] ISIS,[16] and OSSIM.[17]

All the above software products include:

• *Data access controls*. Provide the access to database, operation with different data formats and with remote data.

• *Data management facility*. Allow one to work with projections, distinguishing the spatial regions, and with data layers.

• *Facilities for spatial and spectral image conversion*. Conversion of colors, interpolation/ sampling, image rotation.

• *Facilities for filtration and geometric image correction.*

• *Facilities for processing vector data.*

• *Tools for handling interactive information*. Interactive representation of information on the cursor position, on the region selected, etc.

• *Facilities for image analysis*. Construction of graphs and histograms, measurements of distances, calculation of statistical parameters.

• *Tools for data presentation.* Drawing of graphic primitives, addition of legends.

• *Data visualization facilities*. Construction of 2-d and 3-d images, representation of color palette.

• *Classification facilities*. Algorithms of spectral and spatial classification of data, probability-mapping showing the degree of adequacy of each pixel identification to its class, representation of boundary values by the reference probability to the given class.

• *Map production facilities*. Formation of additional elements (boundaries, coordinate grids, legends, etc.).

This software is capable of operating with most widespread formats of the remote sensing data, such as HDF, HDF-EOS, GeoTIFF, generic graphics formats, GIS-formats, binary and ASCII-files. The majority of the considered systems have the built-in programming languages. Owing to these languages, additional modules were written for extendending these systems. The comparative software characteristics of this group are presented in Table 1.

Systems for processing remote sensing data (RSD) are usually adapted exactly to processing of the satellite information better than GIS.

Besides, owing to a smaller number of functions, this software is more usable and requires less time for users' training. The majority of software in this group is of modular structure and can be supplemented with new blocks, with formation of macros or with additional functions in the built-in programming languages. The disadvantage of this software is high cost. It should be noted that in case of software development, all the users would acquire this software. Among the considered software of this group, there are freely systems, like Multispec, Image Processing Workbench, and OSSIM. They can be used for pre-processing, data analysis, and preparation for the thematic data processing.

Table 1. Comparative characteristics of the systems for processing remote sensing data

Software	Support of sensors, satellites	Data formats	Extension facilities	Platform, operating system	Distribution conditions
1	2	3	4	5	6
PCI Geomatica	SPOT, LANDSAT, ASAR, MERIS, IRS, AVHRR, ASTER, RADARSAT, JERS, ERS, IRS-P6, IKONOS, QUICKBIRD, EROS, OrbView-3, CBERS, FORMOSAT	Generic Database (GDB) special technology is used , allowing reading directly more than 100 formats of raster, vector, and other data and saving the results in widespread graphics formats	Programming language EASI, possibility of writing macros	Microsoft Windows NT/2000/XP, Sun, Linux, SGI	**Commercial system.** Cost depends on complete set – from $ 3000.
RSI ENVI	QuickBird, IKONOS, OrbView, EROS, IRS, Landsat, SPOT, RADARSAT, MODIS, Terra	More than 100 generic graphic, GIS-, and RSD-formats	Programming language IDL	Majority of Unix platforms (Sun, Dec, IBM, SGI, HP) and Linux, Microsoft Windows 95/98/Me/2000/XP, Apple Macintosh (MacOS 8.1 and higher)	**Commercial system.** Cost of the system depends on complete set – from £ 4000.
ER Mapper	AVIRIS, LANDSAT, SPOT	More than 100 graphic data formats, communication with DB, feed forward with ARC/INFO, Arc/Plot, GeoShare, Genamap, Oracle, ArcView, many vector formats (DGN, DXF) are used without conversions	Built-in macros writing facilities and the high-level programming language	Sun, SGI, HP, Dec, Microsoft Windows 95/98/2000/NT	**Commercial system.** Cost of the system depends on complete set – from $ 3000.
ERDAS Imagine	SPOT, LANDSAT, ASAR, MERIS, IRS, AVHRR, ASTER, RADARSAT, JERS, ERS, IRS-P6, IKONOS, QUICKBIRD, EROS, OrbView-3, CBERS, FORMOSAT, MODIS	More than 100 generic graphic, GIS-, and RSD-formats	Macros language EML (ERDAS Macro Language), SML (Spatial Modeling Language), possibility of writing modules in C	Microsoft Windows 98/NT/2000/XP, Sun	**Commercial system.** Cost of the minimal set is $ 2500.
ScanMagic (Russia, ScanEx)	NOAA, EOSAT, MODIS, Meteor-3M, Resource-O	About 50 generic graphic, GIS-, and RSD-formats	–	Microsoft Windows 98/2000/XP	**Commercial software.** Cost of one license is $ 1300, there is a freely distributed version of the ScanMagic Lite without export and printing
Msphinx	MODIS	HDF, generic graphics formats	Consists of a set of utilities which can be controlled by means of the command file	Apple Macintosh, Linux, Power PC, Intel, Cygwin, Sun, SGI, IBM, HP, DEC	Use for investigation and training; free, commercial use by authors' consent
ISIS (Integrated Software for Imagers and Spectrometers)	MODIS	HDF, HDF-EOS	Communication with IDL and C++	Linux, Sun, Apple Macintosh	distributed by authors' consent
Multispec	Resource-O, Landsat, AVIRIS, MODIS, ASTER	HDF, GeoTIFF, ERDAS Imagine, Fast7A, GeoSPOT	–	Microsoft Windows, Apple Macintosh	Free distribution without the source codes

Table 1 continued

1	2	3	4	5	6
Image Processing Workbench	–	Proper format, generic graphics formats, export/import from some RSD- and GIS-formats	–	Majority of Unix platforms	Free distribution with the source codes
OSSIM (Open Source Software Image Map)	Open system, special modules are used for support of different sensors	Open system, special modules are used for support of different sensors	Represents a library, whose functions can be used from other programs	Linux, Microsoft Windows	Free distribution with the source codes

3. Specialized software products for processing the data of remote sensing

Apart from the general purpose systems of image processing, there are many specialized software packages intended for processing RSD obtained from a concrete device, data of any format, or facilities performing certain functions of image processing systems. Comparative characteristics of these products are presented in Table 2.

The disadvantage of specialized software systems is their narrow applicability to processing data obtained with a concrete device or data format.

Besides, the set of functions provided is much less, than a set of software functions considered in two first sections. At the same time, just narrow specialization of these programs allows one to take into account specifics of processing the RSD obtained with a concrete satellite device.

Table 2. Comparative characteristics of specialized software products

Software	Basic possibilities	Sensory support	Data formats	Platform, operating system	Distribution conditions
1	2	3	4	5	6
Noesys[18]	Read operation, statistical analysis, data visualization and archiving	–	HDF, HDF-EOS, TIFF, netCDF, GeoTIFF, PICT	Microsoft Windows, Apple Macintosh	**Commercial software**
Windows Image Manager[19]	Visualization, statistical analysis, operation with vector objects, operation with projections, image conversion	SeaWiFS, CZCS, MODIS, GLI, OCTS, NOAA AVHRR, MOS, AMSR-E, QuikSCAT, SSMI	HDF, CoastWatch, Terascan, ERDAS-LAN, NSIDC, raster, NAVOCEANO etc.	Microsoft Windows	**Commercial software**
Intel Array Visualizer[20]	Read operation, editing, and data visualization	–	HDF, HDF5	Microsoft Windows 2000/2003/XP	**Commercial software**
Slice Dicer[21]	Data visualization	–	netCDF, HDF, BMP, DICOM, DIB, JPG, PICT, TIFF	Microsoft Windows 98/Me/2000/NT / XP	**Commercial software**
Tecplot[22]	Data visualization	–	HDF	Microsoft Windows 98/ME/NT/2000 /XP, Linux, Sun, SGI, IBM, Macintosh	**Commercial software**
HDFExplorer[23]	Data visualization and export	–	HDF, HDF-EOS, HDF5, netCDF	Microsoft Windows 98/ME/2000/XP	Lite version is free, Pro version costs $ 95.
HDFBrowse[24]	Data extraction and visualization, «butterfly» effect correction	MODIS, ASTER	HDF, HDF-EOS	Microsoft Windows	Free distribution as binary files
International MODIS/AIRS Processing Package (IMAPP)[25]	Primary processing, geographical siting, data calibration	MODIS, AIRS, AMSU, HSB	HDF-EOS	Sun, SGI, IBM, HP, Linux, there is also implementation for Microsoft Windows, made by ScanEx Company	Free distribution with the source codes, version for Windows by ScanEx Company is free distributed without the source codes

Table 2 continued

1	2	3	4	5	6
NCAR Command Language (NCL)[26]	Integrated development medium, contains a lot of functions and procedures for processing the multidimensional data sets	–	ASCII, binary, netCDF, HDF, GRIB and NCAR	Dec, HP, IBM, SGI, Sun, Apple Macintosh, Microsoft Windows, Linux RedHat/Debian/ Solaris X86	Free distribution as binary files
MODIS Reprojection Tool[27]	Data extraction, geometrical data conversion, graphic projections	MODIS	HDF-EOS	Sun, SGI, Microsoft Windows 9x/2000/NT/XP and majority of Linux systems	Free distribution with the source codes
MODIS Swatch Reprojection Tool[27]	Data extraction, conversion into image with uniform grid, «butterfly» effect correction	MODIS	HDF-EOS, GeoTIFF	Sun, SGI, Microsoft Windows 9x/2000/NT/XP and majority of Linux systems	The same
McIDAS[28]	Reading of data, visualization, statistical analysis, saving images and graphics	MODIS	McIDAS Area, McIDAS grid, HDF-EOS, netCDF	Microsoft Windows XP/NT, Apple Macintosh, Linux RedHat, Sun, SGI, IBM, HP	Free distribution with the source codes
netCDF Operators (NCO)[29]	Set of utilities for operation with netCDF-data	–	netCDF	Apple Macintosh, FreeBSD, Cray, Dec, IBM, HP, Linux, Microsoft Windows, NEC, SGI, Sun	The same
HDFLook[30]	Data visualization, statistical analysis, export and printing of images	MODIS, AIRS, ASTER	HDF, HDF-EOS	Apple Macintosh, Linux, Sun, SGI, IBM, HP, Dec	The same
LinkWinds[31]	Data visualization, statistical analysis, selection of subsets, data extraction	MODIS	HDF, HDF-EOS	SGI, Sun, HP, IBM, Linux	The same
WebWinds[32]	Reading operation and data visualization, geographical siting, combination of data sets, data extraction	MODIS	HDF, HDF-EOS	Sun/Linux Java, SGI Java, HP Java, Mac Java 1.2, Microsoft Java	The same
EOSView[33,34]	Data visualization, format validity test	–	HDF, HDF-EOS	DEC, HP, IBM, Sun, SGI	The same
HDFView[35]	Data visualization and editing	–	HDF, HDF5	Windows 98/NT/2000/XP, Solaris, Linux, AIX, Irix 6.5 (JDK1.4), MacOSX (JDK1.4), OSF1 (JDK1.4)	The same
GraDS (Grid Analysis and Display System)[36]	Data visualization and data export	–	GRIB, NetCDF, HDF	Dec, Linux, Sun, Apple Macintosh, SGI, IBM, Microsoft Windows	The same
Interactive Visualizer and Image Classifier for Satellites (IVICS[37])	Data visualization	AVHRR, MODIS, VIRS, ASTER, GOES	HDF, GeoTIFF, many formats through the interface GSF (Generalized Satellite Format)	Linux RedHat, Microsoft Windows, SGI, Sun	The same

Such programs can be used as modules at the development of new software for processing satellite data. Besides, a lot of software products of this group is distributed free and do not need for extra costs.

4. Useful utilities and libraries

The HDF-library[38,39] offers facilities for operation with HDF-files. Functions of the HDF-library can be invoked from the user's programs in C or Fortran. The main library contains the general purpose interface and the application level interface for each data type. Each interface of the application level is developed specially for reading operation, recording, and manipulations with data of the same type. The general purpose interface contains functions of input/output operations with files, error handling, memory mapping, and physical storage. There are implementations for Windows, Unix, and Macintosh. This library is distributed free with the source codes.

The NetCDF-library (Network Common Data Form)[40] offers interface for access to the netCDF-data. This library determines the platform-independent format for representation of scientific data; it is distributed free with the source codes and serves as a library for C, C++, and Fortran. There are also implementations for Perl, MATLAB, and Python. The majority of netCDF-utilities can be used with HDF.

The SIMAP software[41] represents a simple utility for operation with MODIS- and AIRS-data. This is a script written in IDL, capable of reading the MODIS- and AIRS-data of L1B and L2-levels. It operates through the command line interface. The maps with physical values (radiation, brightness, temperature) saved as png- or jpeg-images or as binary files are the results of the utility operation. The program is capable of operating at any platform supporting IDL.

The command line utility Hdp[42] is intended for fast display of the HDF-file objects. It can output the contents of HDF-files of different level detailed at different levels. It operates under Unix, Windows, and Macintosh.

A set of NCSA-utilities[43,44] is intended for conversion of the HDF-data into the graphics formats and, on the contrary, for retrieving information out of HDF-files, it contains the program compilation tools in C and Fortran using HDF. It operates under Unix, Windows, and MacOS.

The HDF Java software[44,45] contains:

- Java HDF-Interface (JHI) is the Java-interface, which is the shell for the HDF4-library and used for access to the HDF4-library;
- Java HDF5-Interface (JHI5) is the Java-interface, which is the shell for the HDF5-library and it is used for access to the HDF5-library;
- Hdf-object package is the package, which interprets the objects in HDF-4 and HDF-5 in the object-oriented form and offers general standard API for access to HDF4- and HDF5-files;
- HDFView is the graphical utility for scanning and editing the HDF4- and HDF5-files. This software is distributed free together with source codes and operates under Unix, Windows, and MacOS.

The HDFNOW-library[46] handles HDF-data, offers facilities for operation with data via net. It is an addition to the basic HDF SD-interface (Scientific Data) and uses the MPI (Message Passing Interface) technology for communication between the processes. It is distributed free together with source codes.

The h5utils-package[47] contains the utilities for data extraction out from HDF5-files. This package contains utilities for conversion of the HDF5-data into ASCII and graphics formats. It is distributed free together with source codes.

The package of MODIS LDOPE[48] is a set of separate executable files operating in the command line mode. This package is intended for data extraction from HDF-EOS-files, for different geometrical operations with these data and for calculation of statistical characteristics. Operates under Unix and Windows and it is distributed free together with source codes.

The pyhdf-package[49] is an interface in Python to the HDF4-library. It allows control over the HDF-files of the programs in Python in using the object-oriented model. It is distributed free together with source codes.

The HEG utility[50,51] is intended for translation of the EOS products in HDF-EOS into GeoTIFF, binary format and the HDF-EOS-grid. This utility is also characterized by redesigning, oversampling, partitioning, collection, and creation of metadata. The utility operates through the command line interface or through the user's graphical interface. The platforms Sun, SGI, and Windows are supported. At present, it operates with data from MODIS (Aqua and TERRA), ASTER, MISR, AIRS, and AMSR-E in HDF-EOS format.

The HEW-program[52] is intended for sampling of subsets of the HDF-EOS data sets. A subset can be selected by latitude and longitude, by time, by data values. The utility can operate through the Web-interface.

The ASTER Data Opener-utility[53] is used for translation of ASTER-data in HDF into a separate channel or into a BSQ. It operates under Windows and it is distributed free with source codes.

GeoGateway (or GDB)[8,54,55] is the technology allowing the programs to get access to the files of many formats of RSD by means of the uniform interface. It allows reading images, vectors, attributes, projections, and other information. Each format supported by GeoGateway, has the implemented module in the GeoGateway-library. New formats compatible with basic model can also be added to this library.

The SPOT utility[56] is the control facility of the HDF-EOS-files, the supporting program for HEW.

Conclusion

In selecting the above-considered software tools for generating the software blocks intended for data pre-processing, one should take into account the concrete sensors, data formats, platforms, operating systems, computer requirements, software distribution conditions, their efficiency, and usability.

1. For successful use of the complex and expensive GIS-systems in processing satellite data, it is necessary to have a sufficient experience of practical work with these systems. Besides, for solving a concrete problem on processing satellite data, necessity may arise of using additional facilities or writing new program modules that would require studying special programming languages.

2. The main disadvantage of the majority of systems for processing RSD (Part 2) is their complexity, a certain redundancy of functions, relatively high cost. As concerning systems for processing satellite data available, the free distributed MultiSpec or OSSIM can be selected as a basis at software implementation for Microsoft Windows. This software can be extended by means of the GDB, HDF, and netCDF-libraries (for access to the files of a greater number of formats) and other utilities from Part 4.

3. As to the problem on creating simple and effective software block for operation with MODIS satellite information, one can choose the following list of software products as an alternative for complex systems (presented in Parts 1 and 2). For pre-processing the data from MODIS, it is advisable to use the IMAPP-package, for correction of these data and conversion of projections — MODIS Reprojection Tool and MODIS Swatch Reprojection Tool, for visualization and statistical analysis — McIDAS software.

4. Software products from Part 4, do not have the general purpose properties of complex GIS-systems and systems of processing satellite data, however, these can be successfully used as additional modules extending the basic capabilities of these systems (support of new formats and sensors, additional functions). In particular, in implementing the software block for the MODIS data processing on the basis of IMAPP, MODIS Reprojection Tool, and MODIS Swatch Reprojection Tool packages, it is expedient to add the following software to this list: a) a set of NCSA-utilities; b) HDFNOW-utility; c) MODIS LDOPE-utility; d) GDB-library.

5. In addition, for implementation of algorithms for processing RSD, one can successfully use IDL (Interactive Data Language),[57] which contains a set of specialized functions and procedures. The processing medium of IDL is a commercial software product, however, for executing programs written in IDL, the free IDL Virtual Machine program can be used.

Internet–sources

1. http://www.esri.com/software/arcgis/index.html
2. http://www.esri.com/software/arcview/
3. http://grass.itc.it/
4. http://www.intergraph.com/geomedia/
5. http://www.intergraph.com/mge/default.asp
6. http://www.mapinfo.com/
7. http://www.manifold.net/
8. http://www.pcigeomatics.com/
9. http://www.ittvis.com/envi/
10. http://www.ermapper.com/
11. http://gi.leica-geosystems.com/
12. http://www-loa.univ-lille1.fr/Msphinx/
13. http://cobweb.ecn.purdue.edu/~biehl/MultiSpec/
14. http://www.icess.ucsb.edu/~ipw2/
15. http://www.scanex.ru/ru/site/software/default.asp?submenu=scanmagic&id=index
16. http://wwwflag.wr.usgs.gov/ISIS/
17. http://www.ossim.org/
18. http://www.ittvis.com/NOeSYS/index.asp
19. http://www.wimsoft.com/
20. http://www.intel.com/cd/software/products/asmo-na/ eng/compilers/226277.htm
21. http://www.slicerdicer.com/
22. http://www.tecplot.com/
23. http://www.space-research.org/
24. http://eostation.scanex.ru/software.html
25. http:// cimss.ssec.wisc.edu /~gumley/IMAPP/IMAPP.html
26. http://www.ncl.ucar.edu/
27. http://edcdaac.usgs.gov/landdaac/tools/modis/index.asp
28. http://www.ssec.wisc.edu/mcidas/
29. http://nco.sourceforge.net/
30. http://daac.gsfc.nasa.gov/tools/HDFLook/index.shtml
31. http://www.openchannelfoundation.org/projects/LinkWinds/
32. http://www.openchannelsoftware.com/projects/WebWinds/
33. http://gcmd.nasa.gov/records/EOSView.html
34. http://www.hdfeos.org/Docs/EOSView_3.1_ug_jan_2000.pdf
35. http://www.hdfgroup.com/hdf-java-html/hdfview/
36. http://www.iges.org/grads/
37. http://www.nsstc.uah.edu/ivics/
38. http://hdf.ncsa.uiuc.edu/
39. http://hdf.ncsa.uiuc.edu/HDF5/
40. http://www.unidata.ucar.edu/software/netcdf/
41. http://daac.gsfc.nasa.gov/MODIS/simap/
42. http://disc.gsfc.nasa.gov/tools/
43. http://www.ncsa.uiuc.edu/
44. http://www.hdfeos.org/
45. http://www.hdfgroup.com/hdf-java-html/
46. http://www.hdfgroup.com/Parallel_HDF/HDFNOW/hdfnow.html
47. http://ab-initio.mit.edu/wiki/index.php/H5utils
48. http://edcdaac.usgs.gov/landdaac/tools/ldope/
49. http://pysclint.sourceforge.net/pyhdf/
50. http://daac.gsfc.nasa.gov/MODIS/documentation/tutorials/21_HEG.pps
51. http://edcdaac.usgs.gov/landdaac/tools/heg/heg_summary.asp
52. http://subset.itsc.uah.edu/hew2k/
53. http://aster.indomicrowave.com/softwares.htm
54. http://www.pcigeomatics.com/products/geogateway.html
55. http://www.pcigeomatics.com/products/gdb_formats.html
56. http://subset.itsc.uah.edu/sds-spot.html
57. http://www.ittvis.com/idl