RGPSview: A Tool for RGPS Data Visualization

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1. INTRODUCTION

The Radarsat Geophysical Processor System (RGPS) developed at the Jet Propulsion Lab and operated by the Alaska SAR Facility has significantly advanced the analysis of Arctic SAR imagery. The RGPS combines multiple SAR swaths covering the Arctic Ocean to produce time series products specific to a number of sea-ice research interests including ice motion, open water fraction, backscatter histogram and ice deformation. Since the RGPS is a relatively new system, there are few applications which can ingest RGPS products. This paper describes the development of an interactive RGPS visualization application called RGPSview. Designed to aid researchers using RGPS products, RGPSview utilizes plugin reader modules to add functionality to the application at run-time and is optimized for viewing large data sets with zooming, panning and saving functions in a geographic reference frame. RGPSview has the ability to display the RGPS image, vector and histogram data types as well as image data in LAS format. The design and use of RGPSview are discussed along with example visualizations of RGPS ice motion datasets.

2. RADARSAT-1

Radarsat-1 is an polar-orbiting synthetic aperture radar (SAR) satellite developed by the Canadian Space Agency and launched by NASA in November 1995 [1]. Data downlinked to NASA stations in McMurdo, Antarctica and Fairbanks, Alaska are processed and distributed through the Alaska SAR Facility (ASF) [2]. The Radarsat beam is steerable to allow swath widths from 50 to 500 kilometers with resolutions from 10 to 100 meters. The polar orbit of the satellite covers most of the Arctic in 24 hours and allows the entire Earth to be imaged with the standard 100 kilometer beam every 24 days.

3. RGPS

ASF receives and processes Radarsat imagery for many applications ranging from land mapping to ice motion and ocean wave spectra. The Radarsat Geophysical Processor System (RGPS) is an analysis system which ingests sequences of images and derives a variety of time-dependent geophysical parameters related to sea ice in the Arctic Ocean [3]. The RGPS produces Arctic-wide sea ice information products including ice motion, ice age, ice thickness, open water fraction, and freezing/melting transitions at intervals of 3-6 days for the entire winter season. Full descriptions of all RGPS products and their data formats can be found in [4].

The RGPS products are generated in two different coordinate systems: Eulerian and Lagrangian. The Eulerian coordinate system uses a fixed grid of square cells (usually 50 kilometers). The Lagrangian coordinate system is initialized to an Eulerian grid. Over time the grid cells move and deform so as to remain fixed in the sea ice. New cells may form as new ice forms and cells may disappear in areas where ice melts. Figure 1 shows the deformation of a Lagrangian grid for the ice motion product near the end of the winter season.

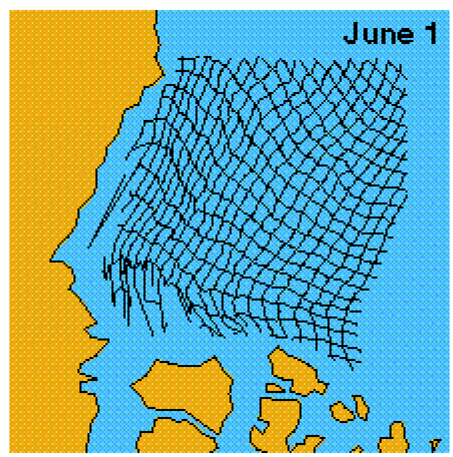

Figure 1: Lagrangian ice motion grid cells [5]

The Lagrangian Ice Motion (LIM) product is a collection of points, each of which has a trajectory over time. By taking only the points at a specific time, one obtains the effect shown in Figure 1. Visualization of the LIM product using RGPSview is discussed below.

4. RGPSVIEW

RGPSview is a visualization application capable of viewing RGPS data sets interactively and allows image files stored in LAS format [6] to be combined with RGPS LIM data in a geographic context. Using subsampling techniques RGPSview is also able to manipulate large Radarsat images stored in LAS format.

4.1 Reader Modules

RGPSview supports plugin data reader modules that are called at runtime from within RGPSview with command-line arguments specifying filenames and possible alternative actions. The plugins are independent programs which appear automatically in the RGPSview menus when the plugin is placed in the module subdirectory. If a module follows the RGPSview module conventions it can be used by RGPSview without recompiling the application. All modules accept the following calling formats:

- *modulecall -info* returns module name & data type
- *modulecall -metadata filename* prints out the metadata into the program window
- *modulecall -data filename* returns the product data in block size increments

Data from a plugin is written to standard output and read by RGPSview using a Unix pipe. In data mode the data are sent through a pipe in large blocks to increase data throughput for the reader. The details of transporting the data are determined by RGPSview when it opens a pipe to the reader. The format of metadata output is left entirely to the module designer. Presently RGPSview only supports LAS image and LIM vector data types. With minor modifications the program could also accept histogram data types, which are equivalent to vector-valued images. Until this change is implemented, new modules will need to return data in LAS 6.0 image format [6] or RGPS LIM vector format [7].

To add new modules to RGPSview, the module binary is simply placed into the module directory which is located in the RGPSview directory. If a module is set-up incorrectly, it will not show up properly in the *File->Open->* menu. Because of the simplified output of the module code, nearly any module can be easily programmed as long as one understands the data type. For more information on module design refer to [8].

4.2 Design

RGPSview is written in the C programming language using OSF/Motif to develop the X-Windows interface. The underlying principles of programming in OSF/Motif are quite simple. First, the main window is created with its widgets and callbacks. Callbacks identify the functions to be run when events, such as mouse clicks, happen on certain widgets. RGPSview starts up by entering an event loop that creates the main window and then waits for an event (such as a mouse click) in the application.

4.3 Usage

RGPSview behaves similarly to other generic X-Windows applications. To open files, one goes to the File menu and then selects the Open button. To obtain help or use any other mode, the menus at the top point the way. The other widgets of the main window have specific functions. The first widget is the scrollable window that contains a pixmap of the size 1280 x 1024 pixels. The window can be resized, scrolled and moved to obtain any view. The pixmap itself has three functions: zoom in, zoom out and exit. Zoom in is initiated by the left mouse button, zoom out by the middle mouse button and exit by the right mouse button. These actions only apply in the drawing area. Figure 2 shows a SAR image superimposed on vector coastline data in the image data window. This Radarsat image is from a test dataset located off the north central coast of Canada. The Mackenzie river can be seen on the left.

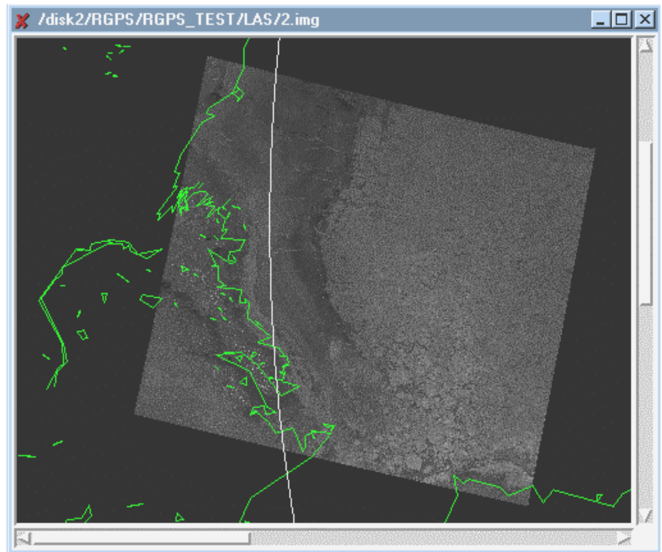

Figure 2. Radarsat image with coastline

When LIM vectors are being displayed in the main window, the 'time on' button can be turned on to activate the time slider controls at the bottom of the window. To view LIM data for a particular time interval, the left bar is set to the beginning time, and the right bar to the ending time.

The data windows behave exactly like the main window except for the effect of the right mouse button click on the pixmap and the escape key. When the right mouse button is clicked on a data window, the data in the window is sent back to the main window and overlaid with the other data in the main window. The escape key is used to close a data window without saving the data to the main window.

Products initially viewed in the data window are not necessarily scaled to actual pixel size, but are resized to fit the window. For example, a LAS image which is larger than the image data window will be subsampled to the size of the window. If a user attempts to zoom in beyond the full pixel resolution of the image, RGPSview will inform the user that the image is displayed at full resolution.

5. ICE MOTION VISUALIZATION

Figure 3 demonstrates the power of the RGPSview application. Sixteen LIM test data products covering a 10 day period in November, 1996 (orbital cycle 16) are displayed with coastline data and user-selected latitude/longitude annotation. The data are displayed in polar stereographic coordinates with the North Pole located in the lower right of the window and Alaska on the left side.

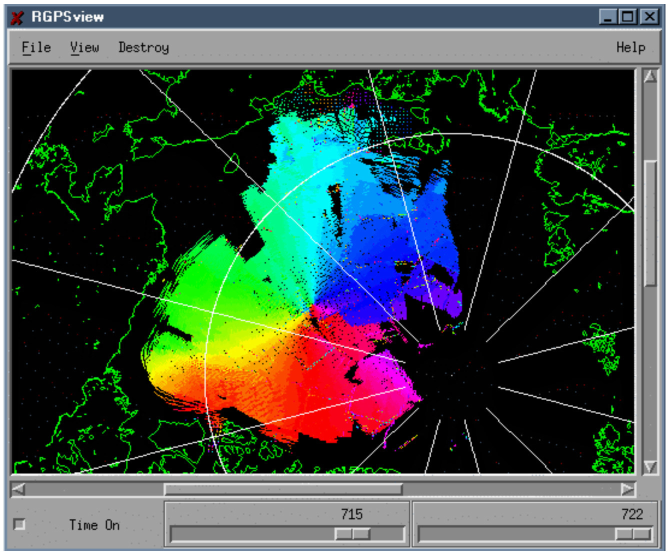

Figure 3. Cycle 16 ice motion visualization

The ice motion vectors for the LIM data in Figure 3 are color-coded by direction of motion. The color coding scheme is based on the color circle shown in Figure 4, which has fully saturated hues around the edge of the circle blending to white at the center of the circle. The direction of a radial vector is coded by the color to which it points at the edge of the circle. For example, motion from right to left is shown in red. The relative magnitude of a vector is shown by the degree of saturation of the color of the vector. White denotes a zero length vector representing stationary ice.

The visualization in Figure 3 shows a large-scale clockwise rotation of sea ice in the Arctic Ocean. The rotation is centered at the point where the hues converge, slightly below the center of the window. The uniformity of the rotation is apparent from the similarity of color-coded sea ice to the original color circle. The sea ice coloring replicates the color circle with a 90 degree rotation which corresponds to the velocity of a clockwise rotating radial vector.

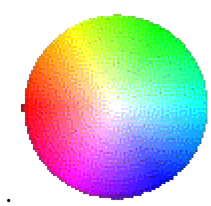

Figure 4. Ice motion vector color coding

Figure 3 was created by simply opening all of the available cycle 16 LIM data products and sending them back into the main window one at a time. The zoom and window size were adjusted to show all of the data in one window. The menu item *View->Load Only* feature of RGPSview was turned on after the first data product was loaded to bypass the data window visualization in order to increase the display speed.

6. CONCLUSIONS

RGPSview is a new tool in a field where tools of this sort are few and far between. RGPSview provides many of the essential capabilities for interactive viewing of RGPS LIM data. Vector and image data can be displayed together quickly and accurately in a geographic context which permits the data to be studied by interactive zooming and panning. The use of plugin reader modules allows new products to be processed simply by creating an appropriate reader module.

7. ACKNOWLEDGMENTS

The authors wish to thank the Alaska SAR Facility for supporting the development of RGPSview.

8. REFERENCES

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