Remote Sensing Solutions, Inc.

PROJECT: Development of Operational SFMR Validation and Processing Tools

NOAA Award Number: NA07OAR4590426

Second Year – Mid Year Interim Report

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Table of Contents

List of Figures

1   Introduction

1.1   Scope

This document serves as the mid-year interim report for the Joint Hurricane Testbed (JHT) project entitled, "Development of Operational SFMR Validation and Processing Tools". It provides a summary of the work performed to date by Remote Sensing Solutions, Inc.

1.2   Applicable Documents

The following is a list of references for citations from within this report:
1. JHT Proposal: "Development of Operational SFMR Validation and Processing Tools"

1.3   Document Breakdown

This document contains three sections. Section 1 contains the introduction. Section 2 reviews the work performed and results obtained to date by Remote Sensing Solutions (RSS) for this effort.

2   RSS - Work Performed & Results Obtained

Remote Sensing Solutions focused on developing, testing and deploying the real-time data display application and associated processing applications during this interim period. These applications enable forecasters to visualize and interact with the high density observations and GPS dropsonde data from the NOAA and Air Force aircraft (URNT15 and REPNT3 data) tools and the high bandwidth data streams coming from the NOAA aircraft (i.e. 1 Hz data stream). The display application is capable of running in a real-time mode, which maintains an update rate of once per second, to ensure the latest data is available to the user. It also allows the user to visualize observations from previous storms in a historical mode, or the current storm at any point in time where data is available. This allows the forecasters to use this tool for post season analysis as well as for gathering real-time information about the system or systems of concern. The entire suite of applications were installed on a server, which has been deployed at NHC with a large (27 inch) LCD display for forecasters to use at their discretion. The PI, James Carswell, worked with Jose Salazar and Brian Mahar to deploy the system at NHC. Feedback from James Franklin and Chris Landsea was sought and modifications to the system were made. Jim Carswell will travel to NHC on 10 October 2008 to solicit feedback on the upgraded application and work with Jose to transition the system to full operation.

The following sections of this report describe the application's capabilities. For a full detailed description of the system, the reader is referred to the Year 1 Annual report and 2008 IHC presentation given by James Carswell.

2.1 Login Graphical User Interface (GUI)

Figure 2 shows the login GUI for the application. It is broken into three panels: Data Selection, Display Configuration and Action.
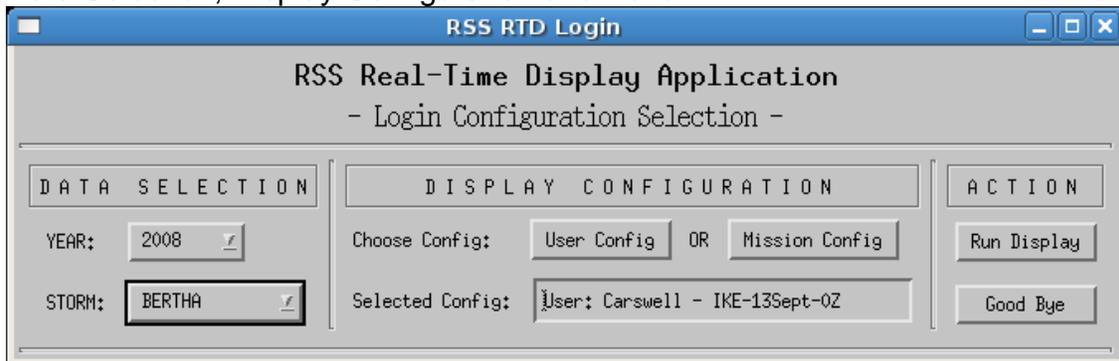

Figure 1: RSS RTD Login Graphical Interface

2.1.1 Data Selection

The Data Selection panel (on the left side of the image) provides users with the ability to select the data (i.e. storm or mission) that they wish to visual and/or interact with. There are two drop down lists, YEAR and STORM. The content of each list is dynamically created based on the data that resides on the server. In this manner, the code base does not need to be manually updated, and the user is always presented with most recent list. Figure 2 shows a screen capture of the login GUI with the Storm dropdown listbox active, displaying available storms. In this instance the user is selecting the data set associated with Hurricane Ike. Note that storms Bertha through Kyle are displayed. Because storms, such as Josephine, were never flown, no data file exists for these storms and they are not listed. The lower listings from "LOW " to "WAVE" are missions that were flown and labeled accordingly in the URNT3 data files. These could be filtered out if desired.

2.1.2 Display Configuration

In the middle panel (Figure 1), the user can select the configuration to be used upon startup of the display application. The user may instead, choose to recall a previously saved configuration. This capability was requested by hurricane specialists during a meeting RSS held at NHC during the spring of 2008. The requirement was that configurations be broken into two categories, "user" and "mission". The user configurations would allow individuals to save their settings so that the display application would startup configured to their previous or desired settings. Likewise, a user could select from a set of default or defined mission settings (i.e. synoptic, ingest, center fix, etc). The configurations are filtered by the main name and then by a secondary tag. The secondary tag allows users to save different settings under separate profiles that he or she creates.

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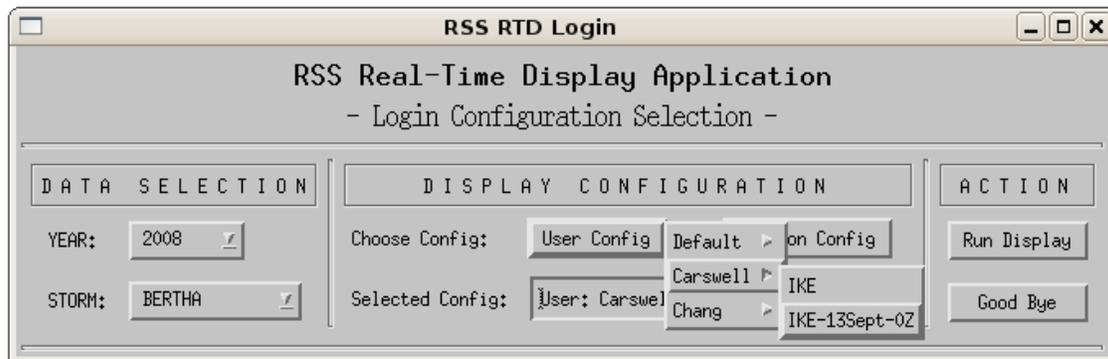**Figure 2: RSS RTD Login Graphical Interface – Storm drop down list.**

Figure 3: RSS RTD Login GUI - User Configuration drop down list.

Figure 3 shows a screen capture with the User Config button depressed. A drop down list presents a list of user configurations (Default, Carswell, Chang). In this example, the user has selected Carswell and is automatically presented with profiles under Carswell (IKE, IKE-13Sept-0Z). Besides allowing a user to immediately bring the display up in a default configuration so that he/she does not have to make changes to the display application's configuration on each visit, a user can save the state of the display he or she is looking at, and then at a later date go back to those settings (i.e. later in the day or during a post season when performing the best track analysis), and immediately display the data again for that particular moment in time and space that he/she was interested in. The settings can also be shared with other users and groups, such as HRD or RSS.

This feature would be useful in the case that an anomaly is spotted with the SFMR sensor. The user can save the configuration of the display application that was employed when this anomaly was spotted. The configuration will in essence automatically document the anomaly and allow RSS and HRD personnel, through the configuration file, to immediately see the anomaly, by simply using the same configuration while viewing the data.

The configuration files are persisted under a version control file system. The ability to commit these files to the repository can be easily added to the application via a button in the control GUI. Then authorized users at RSS and/or HRD can at any point just issue an update command and the configuration files will be updated, and if not originally there, be automatically downloaded without the needed for a person to manually send them.

2.1.3   Action

The right panel (Figure 1) contains the action buttons. Depressing "Run Display" will launch the display application with the selected configuration and selected data set. Depressing the "Good Bye" button will terminate the application.

2.2   Display Application

As mentioned, a meeting was held in the spring of 2008 at NHC. James Carswell briefed several hurricane specialists and NHC staff on the potential capabilities of a real-time display application and demonstrated a prototype system. Based on the input from this mini-workshop, RSS created the Real-time Display Application and Control GUI. This application can display the reconnaissance data (URNT15 and REPNT3) and "1 Hz data" from the NOAA aircraft. In the future other data sources could also be integrated.

The display application has several views and many features to allow the users to interact with the data and quickly extract the desired information from the data. The main display is broken into seven panels, three on the right, three on the left and one in the middle. Figure 4 shows the display application (upper section) and user interface GUI that controls display configuration (lower section). The data shown in this screen capture are from NOAA and USAF flights through Hurricane Ike just prior to landfall (6 hour time window around 0Z on 13 September 2008). More details will be given below, but essentially, the left and right panels display data either in a time series or radial view and the center panel presents a GIS view that can show the data based on where the information was collected ("Earth relative view") or in a storm relative view that removes the storm motion from the data to produce a spatial snapshot in time.
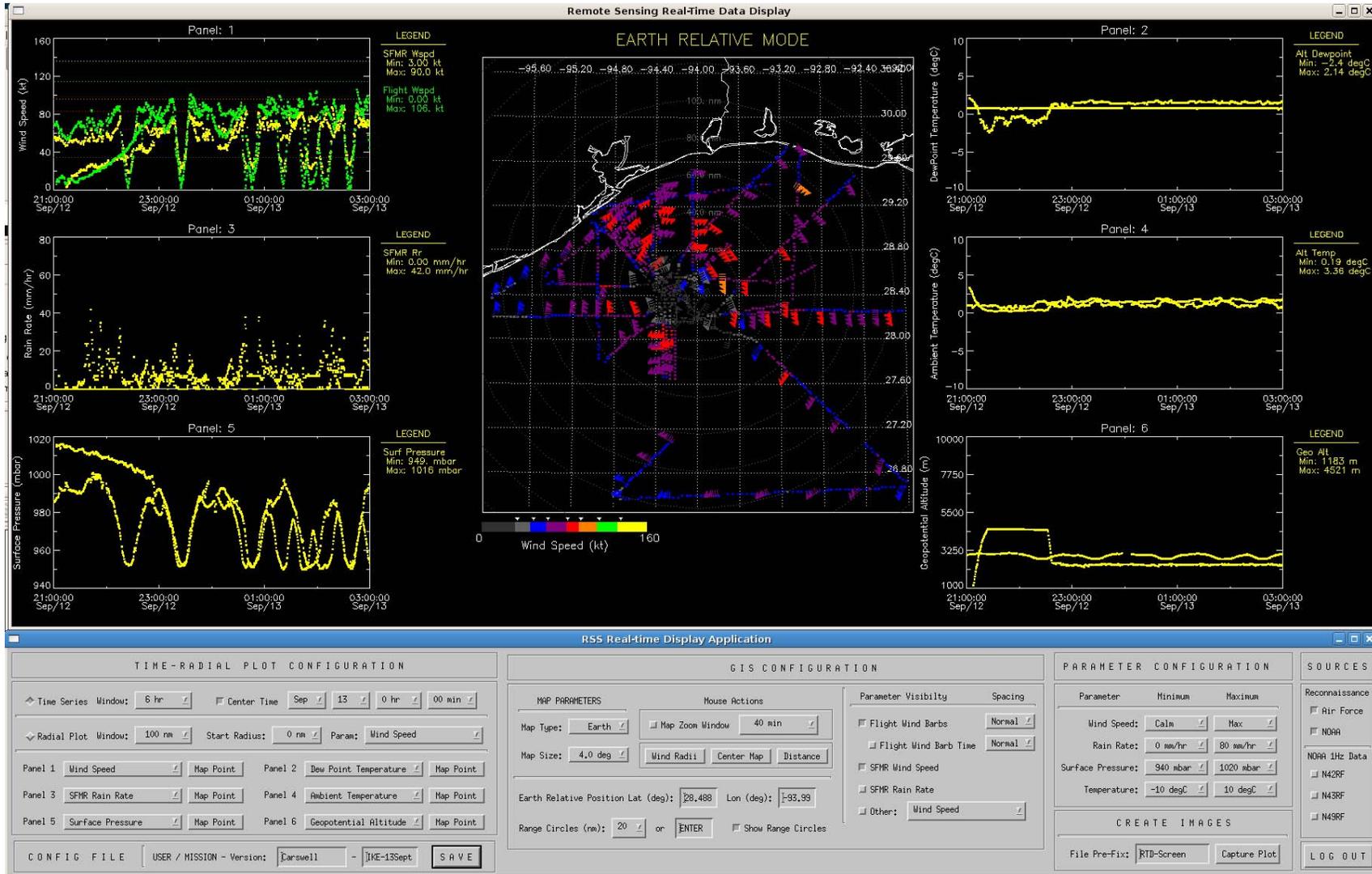
Figure 4: Real-time Display Application - Hurricane IKE on 13 September 2008 at 0Z.

2.2.1   Time/Radial Panels

The left and right panels, labeled Panel 1 through Panel 6, present the selected data in a time series or radial plot format. The basic controls for these panels fall on the left side of the control GUI (lower section of the display) under the label, "Time-Radial Plot Configuration" and towards the right under "Parameter Configuration". In the current example shown in Figure 4, the panels are configured to display time series data. This is accomplished by setting the "Time Series" button in the control GUI.

The data are filtered in time. There are essentially two modes, real-time and historical, that can be toggled between. If the "Center Time" button is selected, the data will be filtered in time around the time specified by Center Time fields in the control GUI. The time window is set by the "Window" field and is centered on the center time. In real-time mode, all data falling within the time window of the last data point collected are displayed. In Figure 4, "Center Time" has been selected and the center time set to 0Z on 13 September 2008. The time window is set to 6 hr, so all data collected between 21 Z on 12 Sept 2008 and 3 Z on 13 Sept 2008 are shown. Wind speed (flight level and SFMR) is plotted in Panel 1, dewpoint temperature in Panel 2, SFMR rain rate in Panel 3, ambient temperature in Panel 4, surface pressure in Panel 5 and geopotential altitude in Panel 6. In the last panel, it can be easily be seen that two aircraft are present during the time window selected.

For each panel plot, the minimum and maximum values are displayed in the legend. These values are automatically calculated and updated as new data comes in, or the data filtering is changed. Note in the case where center time is not selected (i.e. real-time mode), as new observations arrive, the plots are updated within one second of the data arrival. This ensures that the display content is current.

If the user depresses the "Map Point" button for a panel, he/she can click on a data point in any panel. The value(s) will be shown in the legend and the location of the observation(s) shown on the GIS view. Figure 5 illustrates this. In this example the user clicked on a wind speed measurement in panel 1 (wind speed time series) where two aircraft were present in the storm at the same time but different locations. The lower wind speed profile was clicked on. In the panel the values are displayed in the legend (73 kt SFMR wind speed and 77 kt flight level). The location of these observations is shown in the GIS view (southwest side of the hurricane) with a cross hair and labeled with the panel number. In this manner multiple locations from multiple panels can be shown at once. Each selected value remains for approximately 20 seconds (programmable). This provides the user just one way to see the temporal and spatial relationships of the observations.
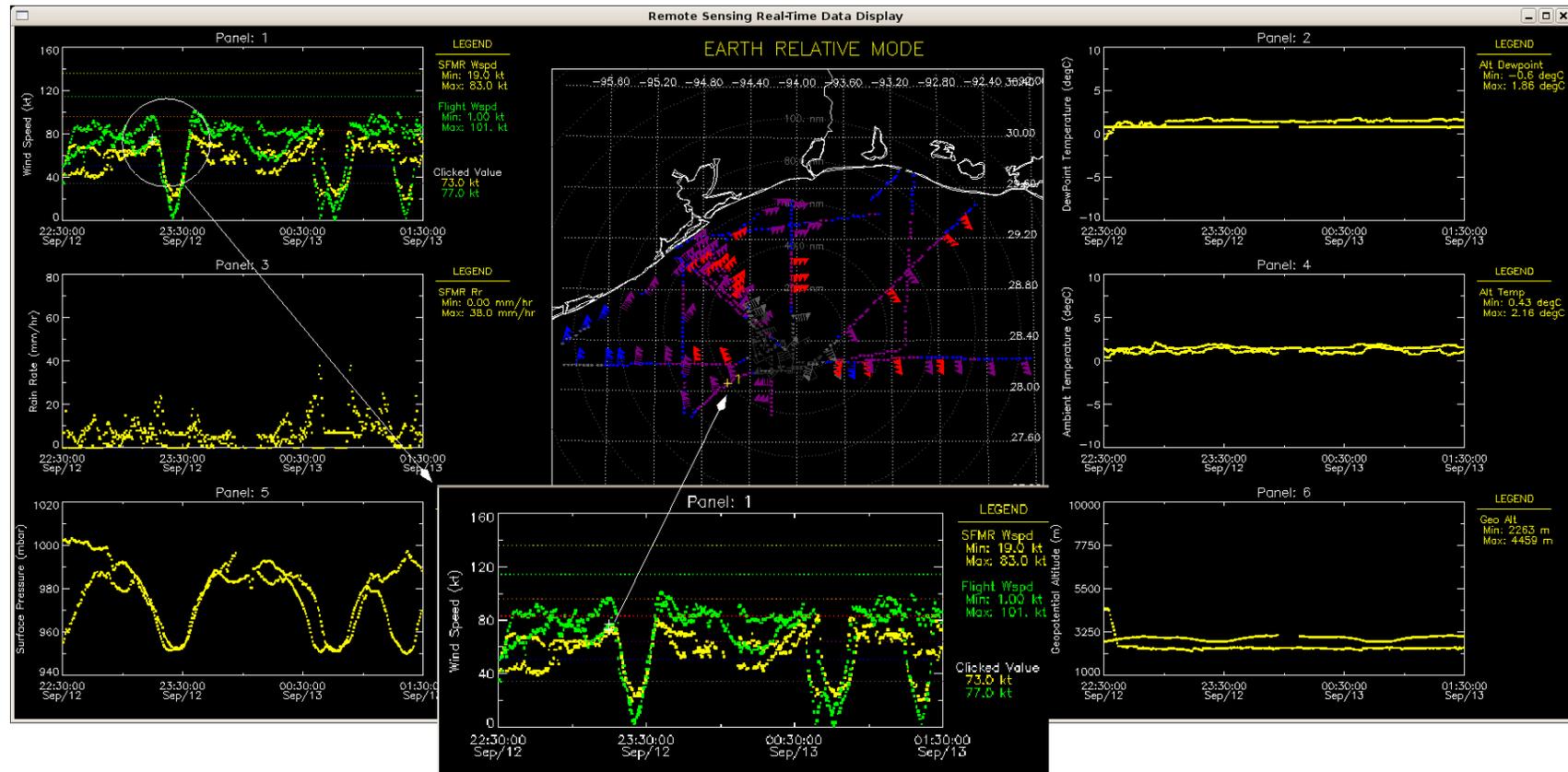
Figure 5: Real-time Display Application - Hurricane Ike on 13 September 2008 at 0Z. Example of "Map Point" feature. Using Map Point, Panel 1 data is clicked on (cross hair). The value of the selected data are shown in legend and the location of the observations shown on the GIS Map. Because same can be done for each panel, the panel number on the GIS view is also shown.

The scale of each panel is control by the parameter scales. This control is under "Parameter Configuration" in the control GUI. Similar to the other lists shown in this GUI, these can easily be altered by simply changing the lists in the application. In the next version of the display, the lists will be read from a configuration file so that the person maintaining the application can simply manipulate a text based configuration file to update the application rather than be required to change the source code.

Instead of viewing the data in a time series format which can be confusing, the upper four panels can be switched to radial plots with a click of the button. Panel 1 represents the Northwest quadrant, Panel 2 represents the Northeast quadrant, Panel 3 represents the Southwest quadrant and Panel 4 represents the southeast quadrant. Panels 5 and 6 remain as time series plots. In radial mode, only one parameter is shown at a time. Figure 6 displays an example. The same data that was shown in Figure 4 is now plotted in radial format. The user can toggle between these displays by clicking the radial and time series buttons and the display is updated in less than one second. The parameter being plotted is selected by the user in the radial plot row of the control GUI. The user can apply additional filtering by specifying the radial window, in this case set to 100 nm. The start radius can also be selected. As with the time series plots, the minimum and maximum values are displayed in the legend for each quadrant.

2.2.2   GIS View

As already mentioned, the center panel displays the selected data on a latitude-longitude map. The following features can be controlled:
- Map window: Sets the map size in degrees.
- Earth Relative Position: Allows the user to set the center of the map when in Earth Relative mode.
- Range Circles: The visibility and radius interval of range circles can be set.
- Visibility: Visibility of the data on a parameter basis may be turned on and off.
- Density: The sampling of the flight level wind barbs in terms of display can be set.

This display contains a few mouse actions as well. The user can re-center the map by depressing the "Center Map" button and click on the new center with the mouse. The user can also click on the map to determine and display wind radii or distances between points on the map. The user can zoom the panel plots on to a portion of the flight track by clicking on the "Map Zoom Window" button and clicking on a data point. Based on the selected time window for the map zoom feature, the panel plots are re-filtered and only data falling within the time window from the data point click on in the GIS view will be displayed in the panel plots. This holds true for both the time series and radial plots. This feature enables users to see the details of the observations in a spatially selected area.

Finally the GIS view can be placed in a "Storm" relative mode. In this mode, data is plotted on the GIS view based on the center fix time and the north and east distance the observation was from the center of the storm at the time the data was collected. In this manner, the storm motion is removed and a spatial snapshot of the data at the specified time can be shown. Figure 7 shows the same data plotted in Figure 4 but in storm relative coordinates (note that radial plotting is also selected in this example). In this display, the user can more easily determine the storm structure, wind radii and compare the data with models and/or satellite data that are collected almost instantaneously in time over very large regions.

2.2.3   User Settings

A user can uniquely save his/her settings at any time by selecting the save button. The name of the configuration (or profile) can be changed by altering either the name or tag or both (lower left box in control GUI). When logging in again, the user will be presented with the new configuration file(s) that he/she created. This can also be used to document that state of the observations so that the user can come back at another time and pull the data display up in the exact same manner as when previously viewed.

2.2.4   Data Sources

At the upper right corner of the control GUI, the user can turn the recon data from the NOAA and Air Force on or off. Likewise, the real-time 1 Hz data from the NOAA aircraft can be turned on or off.

2.2.5   Image Capture

The user can create an image of the display at any time by specifying a name and clicking on the create image button. This process creates a screen capture of the current view and saves it to the local disk.
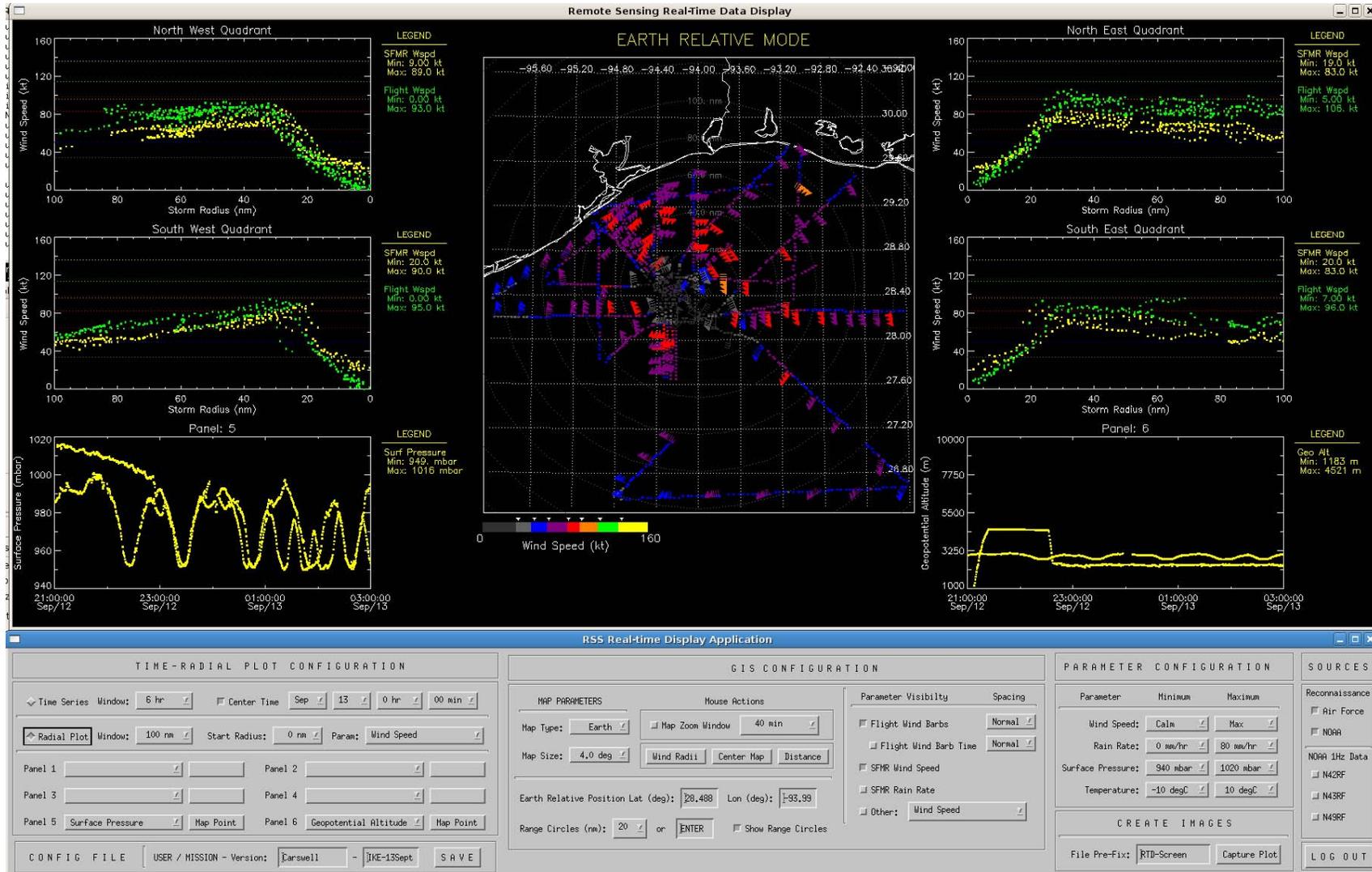
Figure 6: Real-time Display Application – Hurricane IKE on 13 September 2008 at 0Z (radial panels).
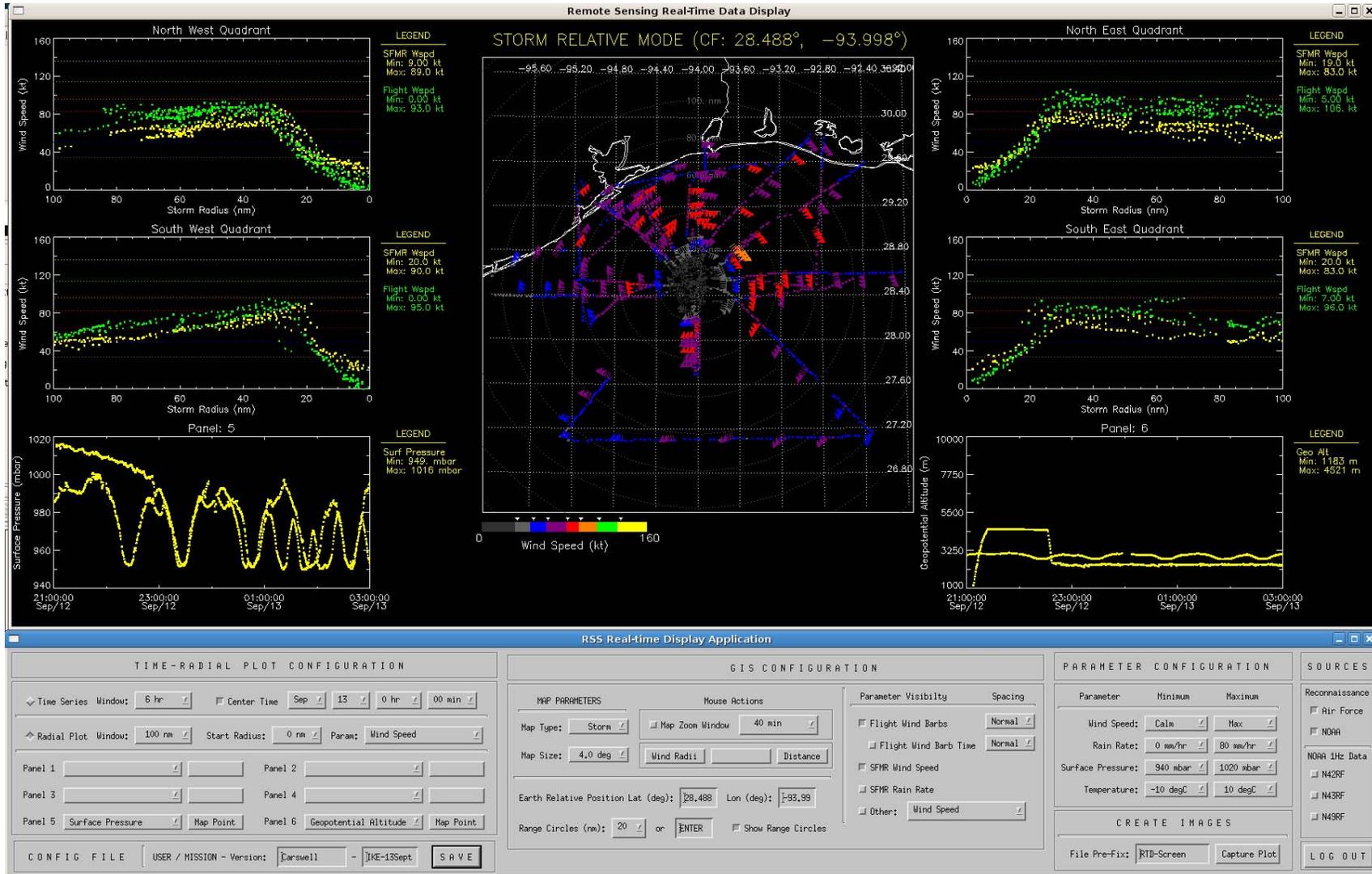
Figure 7: Real-time Display Application – Hurricane IKE on 13 September 2008 at 0Z (radial panels and storm relative GIS).