# C-MIST

# USERS MANUAL

# Version 5.0

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## Table of Contents


**1. Introduction ..... 3**
**2. System Overview ..... 6**
a. Logging into the system ..... 6
b. Menu Layout ..... 7
c. Logging out of the system ..... 9
**3. Data Extraction ..... 10**
a. Station Selection ..... 10
b. Downloading Data Directly ..... 12
c. Extracting Data into C-MIST for Data Processing ..... 15
**4. Quality Control of Currents Data ..... 21**
a. Default Quality Control (Trimming Data) ..... 21
b. Custom Quality Control ..... 22
c. After Quality Control ..... 25
**5. Quality Control Plot Generation ..... 27**
a. Standard Plots ..... 28
b. User-defined Plots ..... 31
c. Viewing Plots through My Session ..... 31
**6. Harmonic Processing ..... 33**
a. Analysis Parameters ..... 33
b. Running Data Analysis in Automatic Mode ..... 34
c. Performing a Custom Harmonic Analysis ..... 37
d. Running Data Analysis in Manual Mode ..... 38
e. Viewing Analysis Results in My Session ..... 40
**7. Post Analysis Plots Generation ..... 42**
**8. Performing Non-Harmonic Analysis ..... 45**
a. Selecting a Reference Station for Non-Harmonic Analysis ..... 46
b. Running Rotary Analysis Off of a Reference Station ..... 49
c. Running Reversing Reduction Analysis Off of a Reference Station ..... 51
**9. Data Analysis Report Generation ..... 54**
**10. Storing Analysis Results ..... 60**
a. Committing Analysis Results to the Database for Current Survey Data ..... 60
b. Committing Analysis Results to the Database for Real-Time Currents Data ..... 62
**11. Verifying Analysis Results ..... 65**
a. Running automated verification checks ..... 66
b. Verifying Stored Analysis Results ..... 70
**12. Disseminating Analysis Results ..... 72**
**13. Data Ingestion ..... 78**
**14. Viewing Database Results ..... 81**
a. Viewing stored analysis results and PDF reports ..... 81
b. Viewing constituents in DAS format ..... 86
c. Calculating Greenwich Interval differences between stations ..... 87
d. Generating data files for Tidal Current Table updates ..... 88
e. Generating predictions from stored constituents ..... 88
**REFERENCES ..... 90**
**APPENDIX A: USER ROLES ..... 91**
**APPENDIX B: ACRONYMS ..... 92**

# 1. Introduction

The Coastal and Estuarine Circulation Analysis Team (CECAT) processes current meter data in order to compute harmonic constituents used for generating predictions. These predictions are disseminated to the maritime community for safe navigation of waterways. The Currents Measurement Interface for the Study of Tides, or C-MIST, is a Java based web application that combines new technology with accepted methods of data analysis used by CECAT for processing of currents data. It allows users to extract current survey and real-time PORTS (Physical Oceanographic Real-Time System) data from the Ocean (RIAC) Database and contains modules for both quality control (QC) and harmonic analysis. Modifications made to the database allow users to directly ingest tidal current survey data into the database through C-MIST, while PORTS and other real-time currents data is ingested automatically every six minutes through the Data Ingestion Server (DIS). When analysis is complete, users can generate a summary report and analysis results such as harmonic constituents and Greenwich intervals can be stored in the database for use with C-MIST and other applications.

A suite of plots used for quality control of data can be generated in C-MIST with a click of a button. All plots used in the previous method of QC have been incorporated into C-MIST. Additional plots and algorithms have been developed and implemented to aid in the QA/QC process.

C-MIST uses the accepted FORTRAN legacy routines documented in NOAA Technical Report NOS CO-OPS 0021 Tidal Current Analysis Procedures and Associated Computer Programs [Zervas, 1999]. Control files for these analysis routines are created using a combination of verified metadata entered in the database using a separate Powerbuilder application, and results from previous analyses within the C-MIST user session. This minimizes user input during data analysis, making data processing more efficient, and reduces human error, making analysis more accurate.

Up until 2011, CECAT also create hard copies of all plots and results generated during analysis of a station in addition to keeping electronic copies of data analyses. These were kept in station folders for quick reference. While these station folders were thorough, they took time to put together as they combine output from many sources and needed to be ordered logically for readability. C-MIST contains a module to create a detailed data analysis report containing all relevant plots and analysis results, as well as station metadata. This PDF report contains all the relevant information for the station analysis and can be customized to include analyses for any or all bins. At present, station "packages" are kept electronically on the CO-OPS network. In addition to the PDF report, these packages also contain relevant information such as station logs, ADCP setup files and NOS charts.

Below is a brief outline of the general steps to processing data from a current survey.

1. Instrument is deployed.
2. Instrument is recovered. All necessary recovery and instrument profile information is entered into the database using the PORTS Powerbuilder Application. This is a separate standalone application that is used to add and update metadata in the OceanMD Database.
3. Data is ingested into the database using C-MIST.
4. Raw data is extracted from the database into C-MIST for processing.
5. Data is quality controlled, including trimming bad data at the beginning and end of the data set and generation of various quality control plots. Users have the option of filtering out data based on custom thresholds as well.
6. Data is analyzed using the accepted FORTRAN legacy routines. C-MIST builds the control files automatically.
7. Post analysis plots are generated showing how well predictions match with observed data.
8. If necessary, a reference station is selected and non-harmonic analyses such as rotary or reversing reduction are run and plots of the results are created.

9. A summary report is generated containing plots and results from data analysis.
10. Analysis results are stored in the database; bins containing good data are specified.
11. Stored analysis results are marked as verified in the database by a member of CECAT.
12. A verified analysis result set is set for dissemination to the public by a second reviewer.

For real-time, or PORTS data, this process is similar, however the user is able to process data while an instrument is still deployed, and the user does not need to ingest the raw data through C-MIST. More detailed steps for processing data will be discussed in further sections.

This manual is meant to be a guide to help users navigate the C-MIST web application. This manual is written to the specifications of C-MIST version 5.0, which was implemented on November 9, 2015 along with the database migration known as RIAC.

# 2. System Overview

Covered in this section are:

- Logging in and out of the system.
- Layout of the various menus encountered within C-MIST.

*a. Logging into the system*

C-MIST is a web based application that can be accessed using any web browser, however it formally supports Google Chrome, Internet Explorer and Mozilla Firefox. The C-MIST URL is:

**https://cmist.noaa.gov**

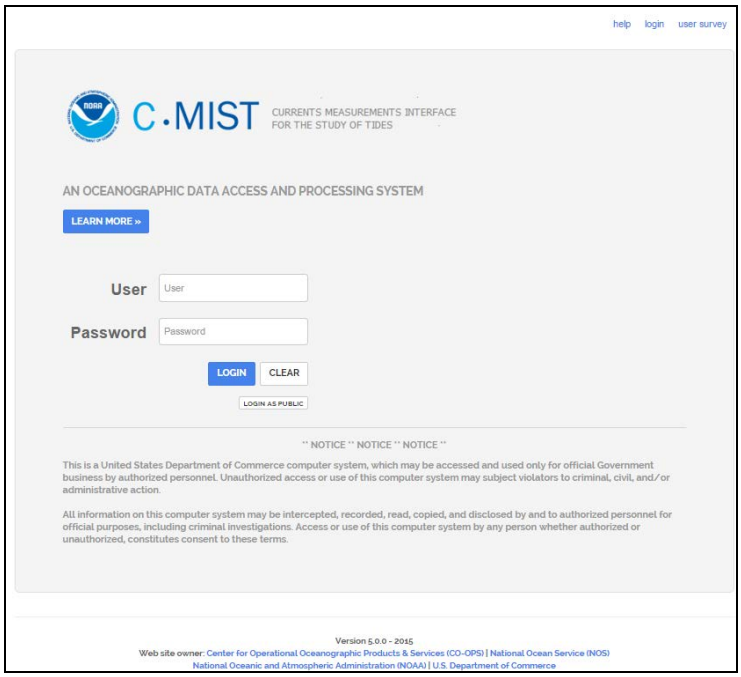



Fig. 2.1: Log in screen for C-MIST, located at https://cmist.noaa.gov. Users can log in with their e-mail (LDAP) username and password or log in as a guest. This page also contains links to information about C-MIST, publications, frequently asked questions, and a feedback form.

This will take users to the C-MIST log in page, shown in Figure 2.1. Users who are configured in the system can log in using their NOAA issued e-mail (LDAP) username (firstname.lastname) and password, or else log in as guest by clicking the link below the login button in the center of the page.

The left side-menu allows users to learn more about C-MIST, view C-MIST publications, frequently asked questions, send feedback or download this user manual.

*b. Menu Layout*

After logging in, users will see the C-MIST main menu (Figure 2.2). At any point after logging in, users can come back to the main menu by clicking on *Home* at the top of the page. When first logging in, the user's login name is displayed in the upper-right section of the page. This is also where the data set (once extracted) will be displayed.

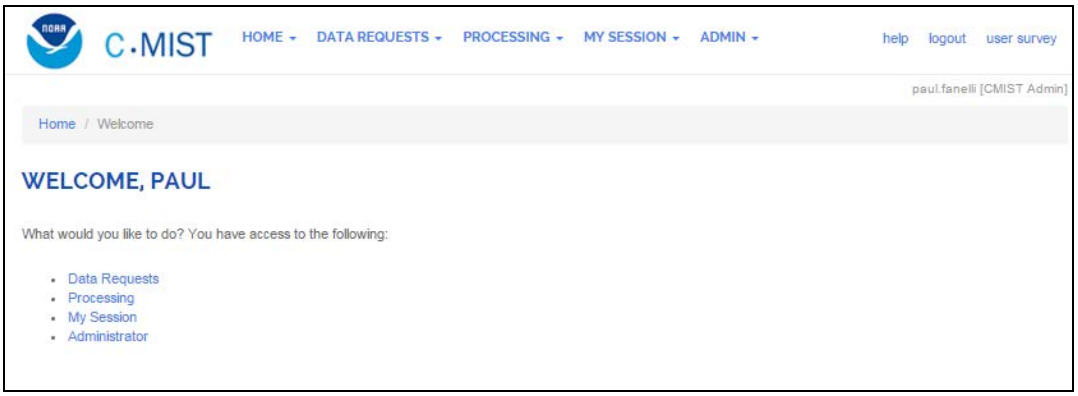



Fig. 2.2: C-MIST main menu prior to data extraction. The left sub-menu shows that there is no data set loaded yet and also shows who is currently logged in. Users can extract data via the Data Requests or Processing links in the top sub-menu or the middle of the page.

Depending on the role of the user, there are several options at the top of the page.

- **Data Requests**: This link will take users to the list of stations, both PORTS and current survey that are stored in the database. Users can download raw data directly from this option.

- **Processing:** In this menu, users can extract data into C-MIST and perform various analyses on the extracted data as well as create plots of the data.
- **My Session:** Users can view plots and analyses created during their current session through this window.

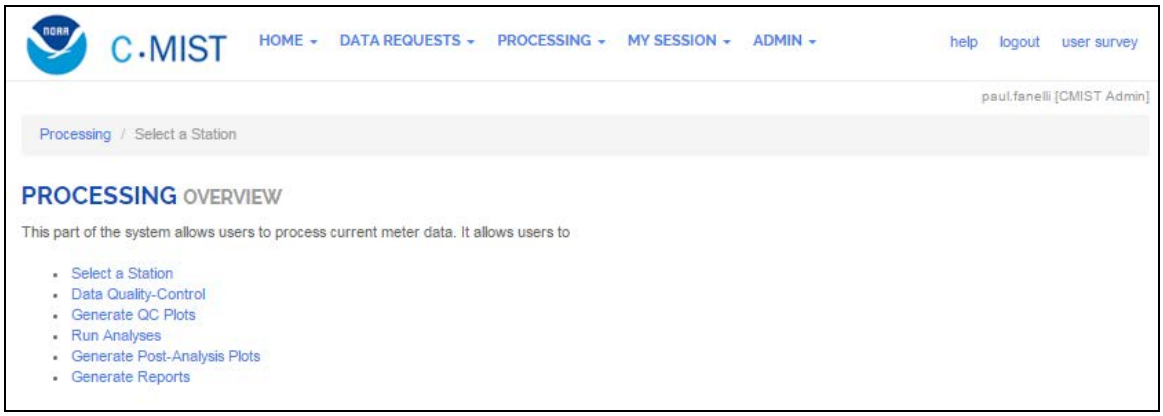



Fig. 2.3: Processing menu within C-MIST. Users can select a station from the database, extract the data, quality-control (trim) the data, create plots and run through harmonic analysis under this menu. Users can also generate data analysis reports when analysis is complete.

Users can now select a station, trim and quality-control data within the extracted period, generate pre-analysis (QC) plots, view analysis parameters, run harmonic analysis, create post-analysis plots or generate data analysis reports. Most of these options are also listed in the center of the Processing screen as well.

**Note that C-MIST allows users to view the raw data and metadata from the last station extracted at any point during their session by clicking the station ID in the upper-right corner (see Figure 2.4). Users have the option to *view data* or *view metadata*.**

Under the My Session window (Figure 2.4), users can view results and plots they have created during their present session. Specifically, users can view plots created, view animations of some of the plots through various depths in the water column, view analysis results, view reports generated, view data ingestion information, and view their session log. These options also show up in the left side-menu. Viewing plots and results through the My Session window will be discussed in later sections.

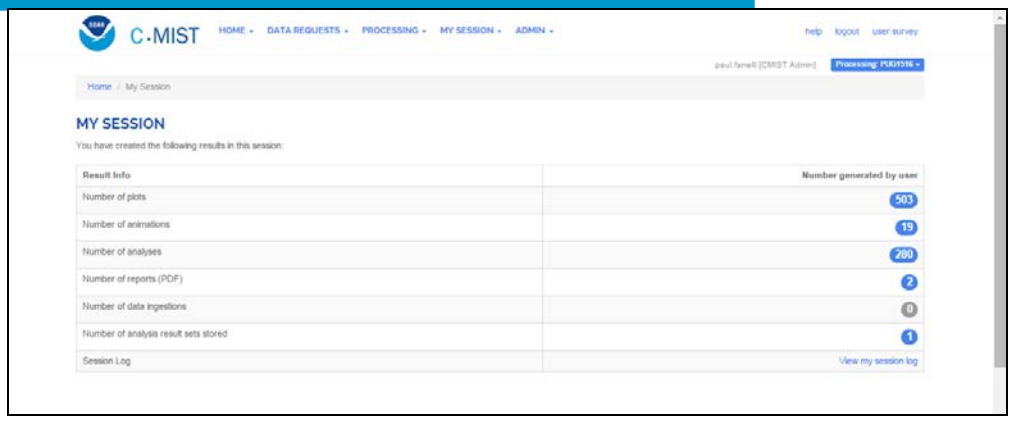



Fig. 2.4: My Session window within C-MIST. Users can view all plots, analysis results, reports generated during their C-MIST session along with their session log. Animations of QA/QC plots over multiple depths can also be viewed here. If the user ingested data into the DATABASE, they can examine information about the data ingestions performed during their log session. Any reports generated can also be accessed here.

Under the My Session window, users also have two more options on the left side-menu.

- The *Keep Me Logged In* action was created to keep users logged in to C-MIST if they are going to be away from their machine for an extended period of time. C-MIST will log users out after one hour of inactivity, but having this option open will keep users logged on indefinitely. **It is recommended that users do not keep themselves logged on overnight unless it is absolutely necessary.**
- The *My Data to Commit* option allows some users the ability to store data analysis results in the database once analysis for a station is complete. They can also view results that are already stored in the database.

*c. Logging out of the system*

At any point during the session, users can log out by clicking *Logout* in the upper left corner. When analyzing more than one data set successively, sometimes it is beneficial to log out and log back in, creating a fresh session. This can improve database speed for C-MIST and other applications. **However, when a user logs out, all information on analyses performed during the session is removed.** Users will have to regenerate analyses if desired. Because of this, users may want to save any important results, plots or reports locally before logging out.

# 3. Data Extraction

The data extraction module provides a means for users to retrieve currents data from both PORTS and survey locations. If users are simply interested in downloading raw data directly, C-MIST allows them to do so under the *Data Requests* menu. If they are interested in extracting data for data analysis, this can be done under the *Processing* menu. Covered in this section are:

- Selecting a station.
- Downloading data directly for user requests.
- Extracting data into C-MIST for data processing.

*a. Station Selection*

To reach the list of current meter stations, users can click on *Data Requests* from the top menu if downloading data directly, or *Processing* from the top menu followed by *Select a Station* if extracting data into C-MIST for data analysis. These processes will be discussed later in this section. Both of these options will bring up a list of current meter stations that presently have station information metadata entered in the database. **Note that some stations may not yet have raw data ingested into the database and for these stations, data cannot yet be extracted.** Figure 3.1 shows an example of the list of stations, which are listed in alphabetical order by station ID. Listed are the station ID, station name, associated project name and project type (e.g. PORTS or current survey) and a link to view a GIS map of the station location. There are 50 stations listed per page and in the upper-right corner of this list, users have the option to move to the next or previous page to browse through the station list.

Users also have the option to search for a station by station ID, station name, project name or project type. Simply type in the keyword(s) in the search box at the top of the page and click search. By default, C-MIST will look for matches in all fields, but users may limit their search to the station ID, station name, project name or project type

individually using the drop-down menu to the right. If users have selected a subset of the stations, they can go back to the full station list by clicking on *All stations.* Users also can view a list of projects only by selecting *All projects* at the top of the list. From here they can select a project name and retrieve a list of stations for that individual project.

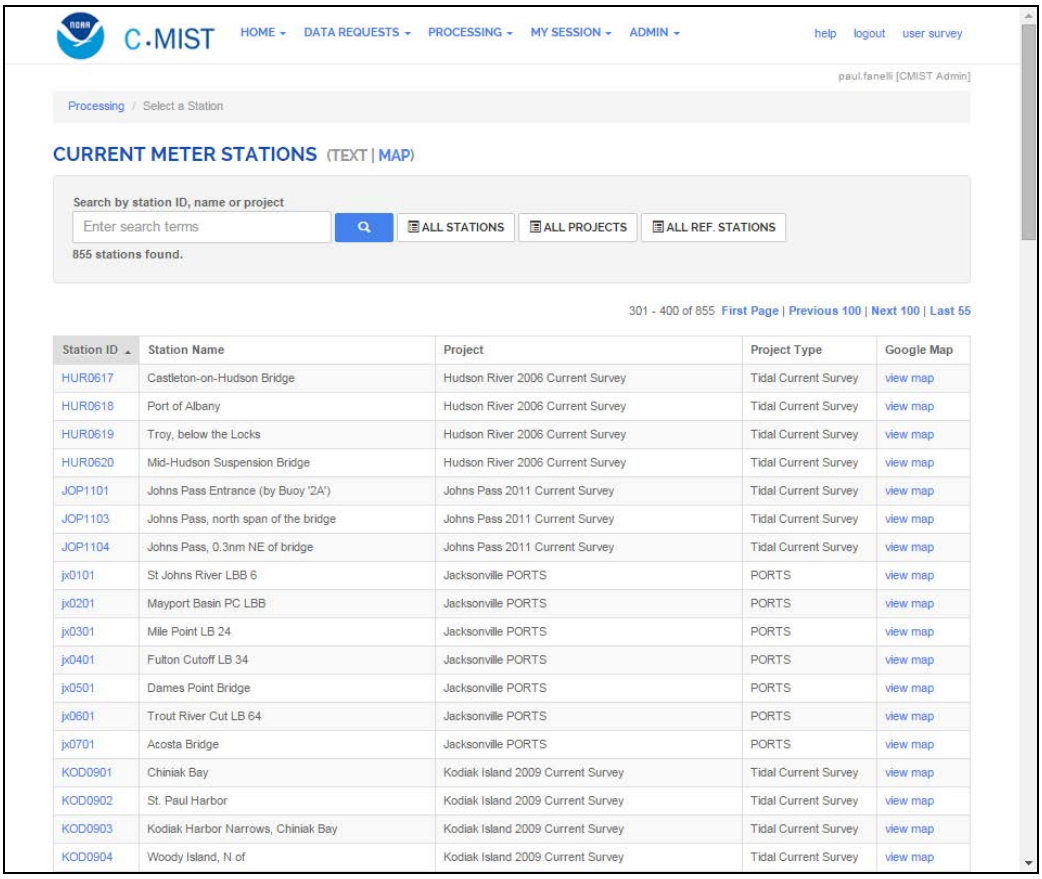



Fig. 3.1: Partial list of current meter stations where users may extract data from the database. Stations are listed 50 per page. Users have the option to search by station ID, station name, project name or project type. Users can also see a list of projects and view a Google map of the station location.

Finally, users also have the option of selecting a station directly from a GIS map by clicking *Map* in the upper left-hand corner. The map will default to a view of the continental United States; however the user can select a region using the drop-down menu in the upper-left corner (Figure 3.2). Users can also zoom in and out using the toolbar on the left-hand side of the map. Users also have the option to toggle on nautical chart information using the drop-down menu in the upper-right.

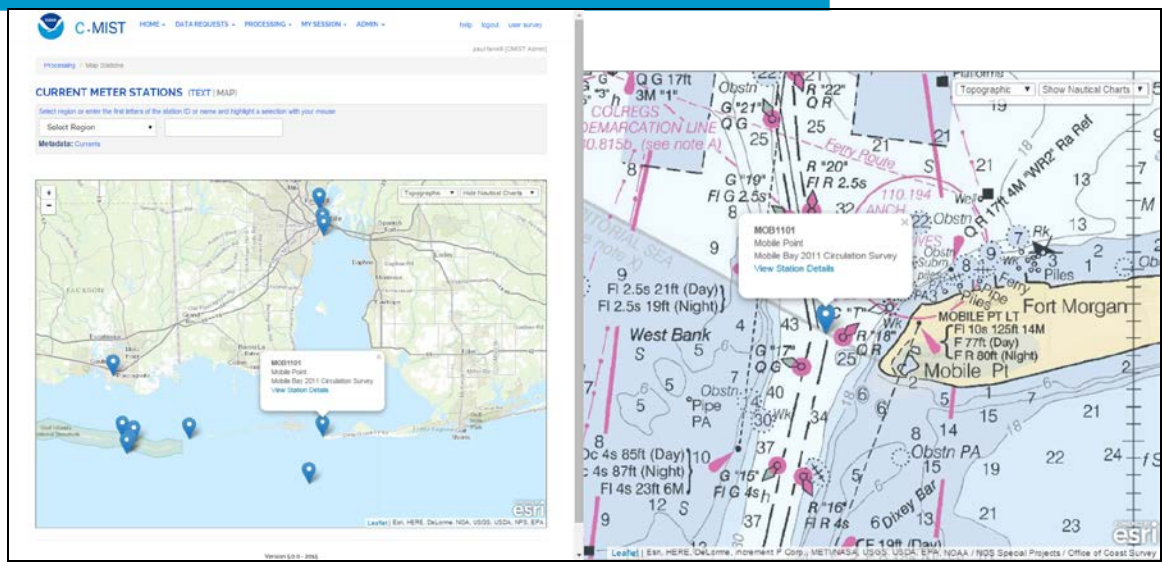



Fig. 3.2: GIS map within C-MIST showing part of Mobile Bay (left). Users can select a region to view or else utilize the search box to find a station by name or station ID. Users have the option to toggle display of nautical chart information (right). Brief station metadata can be viewed by clicking on the flag. Clicking *View Station Details* will bring up all the station metadata and allow the user to extract raw data.

To navigate to a station, click on the station flags within the map. This will display brief metadata such as station ID, station name and project name. Clicking on *View Station Details* will bring up the metadata for the station, just as if it were selected in the textual station list. If users are unsure of a station location, a search box has been provided at the top. Users can enter any part of the station name *or* station ID and C-MIST will automatically list all stations matching the field entered below, updating as the user types. To view that station location, click on the station ID or name within the list that is generated on the fly. The map will pan to the station location and the bubble containing the station ID, name and project will be displayed automatically.

### *b. Downloading Data Directly*

To download data in ASCII format, click on *Data Requests* in the top sub-menu in the C-MIST main menu. Users can select a station from clicking the station ID from the list or map interface. This will bring up a screen with some station metadata including station name, project, and region and provide the user with a default data period to extract as seen in Figure 3.3. This period ranges from the deployment time to the recovery time for survey stations if the data span 90 days or less (for longer deployments, it will default to

the last 90 days of data). Users can also modify the start or end time by clicking the calendar icon to the right of the time field. For PORTS stations with multiple deployments, users can select a deployment at the bottom of the page, however the default selection will be the most recent deployment. In this case, the default extraction period will be the most recent 30 days of data within the deployment selected. Users can also view the location of a particular deployment by clicking on the *View Map* link to the right of each deployment.

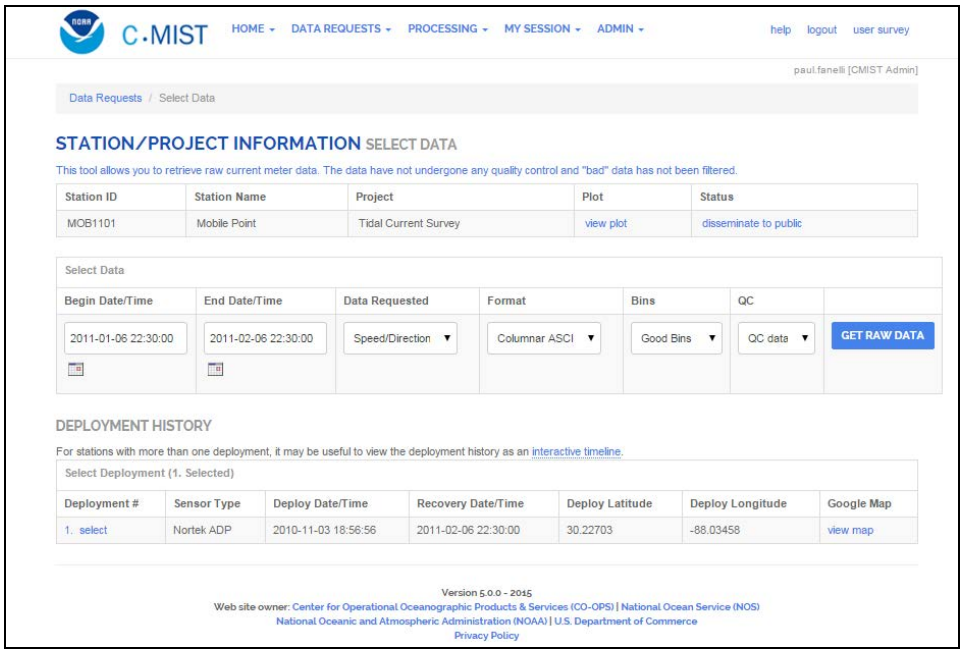



Fig 3.3: Station Metadata menu for downloading data directly for a current survey station. Users can change the date/time range to extract data and view a Google map of the station location. They can choose to just download the speed and direction data only or download the ancillary data (e.g. pressure, echo intensity, etc) along with it.

By default, only speed and direction data will be extracted. Users can also extract the ancillary data such as pressure and echo intensity along other variables by selecting *Speed/Direction/Ancillary Data* from the 'Data Requested' drop-down menu. C-MIST also allows users the ability to retrieve data in either ASCII or CSV (comma delimited) format by selecting the appropriate option under 'Format'. For users with authorized C-MIST accounts, there are two additional options that can be set for retrieving raw data. Under the 'Bins' drop-down, users can either choose to retrieve all bins collected by the instrument or good bins (those bins marked as containing good data in the database).

Under the 'QC' drop-down menu, users can choose to download quality controlled data (if available) or raw data. If *QC* data is selected, only data falling within the quality control thresholds set during data processing will be retrieved. This quality control process will be described in more detail in the next chapter. While the 'Bins' and 'QC' options appear for authorized users, users who log in as Public can only choose the data requested and data formats. By default, public users will get quality controlled data for only the good bins. In addition, while all stations can be accessed for authorized users, only those stations which have raw data set for dissemination can be selected for public users.

To retrieve data once users have selected a date range, data requested and appropriate options, they can click on *Get Raw Data*. A progress bar will appear letting the user know data extraction is taking place and data is being written to a file. **While the progress bar may appear to be "frozen" at times, users should not exit the browser or hit the *back* button while processes are running.** It should be noted that users may not extract more than 180 days of PORTS data at a time.

Extracted data will be contained in a zip file. Bin dependent data and header data are split into separate files. These files along with a README file describing the data formats of these files and a metadata file containing all relevant station information are contained within the .zip file. When data extraction is complete, a screen will pop up with information about the format of the data and a link to the file along with its associated file size. Users can save the .zip file by clicking on it and browsing to the appropriate location on their machine. **Note that these raw data have not been subjected to the National Ocean Service's quality control or quality assurance procedures and do not meet the criteria and standards of official National Ocean Service data. They are released for limited public use as preliminary data to be used only with appropriate caution.** This is true both for raw data, and data that has undergone a limited quality control during data processing.

*c. Extracting Data into C-MIST for Data Processing*

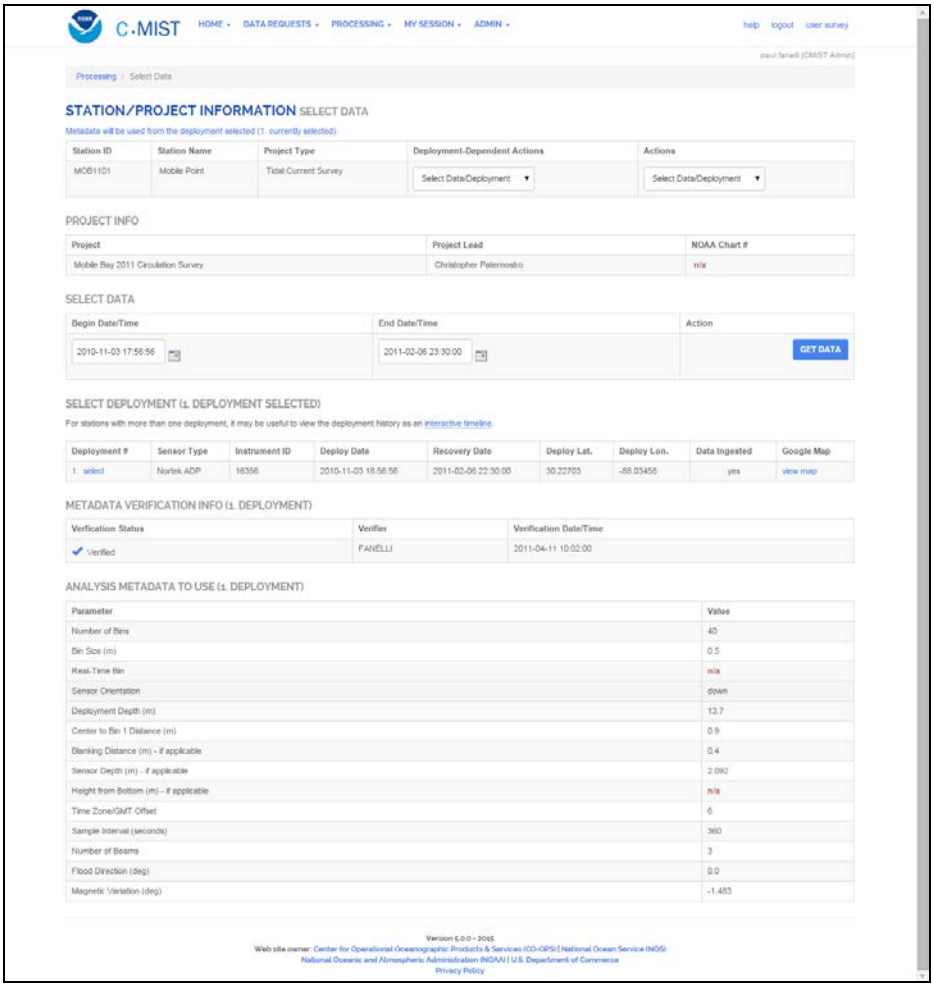



Fig 3.4: Station/Project Information screen, showing some station metadata for the station selected. Using the drop-down menu in the upper right, users can view other station metadata, detailing deployment/recovery and instrument information. Users can click *Get Data* to extract raw data into the C-MIST system.

Users who want to plot and analyze current survey or real-time data can do so by clicking *Processing* from the top menu of the C-MIST and then clicking *Select a Station.* Users can browse to or search for the appropriate station and select it by clicking on the station ID. This will bring up the *Station/Project Information* screen (Figure 3.4), which contains station metadata as it has been entered in the database using the PORTS Powerbuilder Application.

This screen allows the user to see if metadata has been verified and view some deployment and instrument setup information such as the date range, latitude, longitude

and deployment depth as well as bin size, number of bins, blanking distance, sample interval and other instrument setup parameters for each deployment. Users can view other metadata via the drop-down menu under 'Deployment-Dependent Actions' within the top part of the page. Selecting *View Instrument Info* will bring up more detailed information about the instrument and platform setup including ADCP, release and pinger information. Selecting *View Deployment/Recovery Info* will show detailed information about the instrument deployment and recovery such as latitude, longitude of deployment and recovery as well as vessel and crew information. Selecting *View Raw Data Info* brings up information about the data set such as time of first and last ping, number of bins and bin size. Some users also have the option to ingest raw data under this menu. This will be discussed in a later chapter. Additionally, authorized users can also view stored results and reports, verify analysis results or disseminate analysis results using the 'Action' drop-down menu in the far upper-right part of the page. These tasks will also be discussed in later sections.

From the *Station/Project Information* screen, the default start and end date/time for current survey data extraction are one hour prior to deployment and one hour after recovery, respectively. This is done to allow users to easily download data just prior to deployment and just after recovery for quality-control purposes. Users can modify the start or end time by clicking the calendar icon to the right of the time field.

For PORTS or other real-time stations, the *Station/Project Information* screen (Fig 3.5) is set up a little differently. Users can view a list of all deployment periods. Alternatively, users can view the deployment periods as an interactive timeline (Figure 3.6) by clicking the *interactive timeline* link above the deployment list. The bottom panel of the timeline shows a coarse view of the deployment history over multiple years.

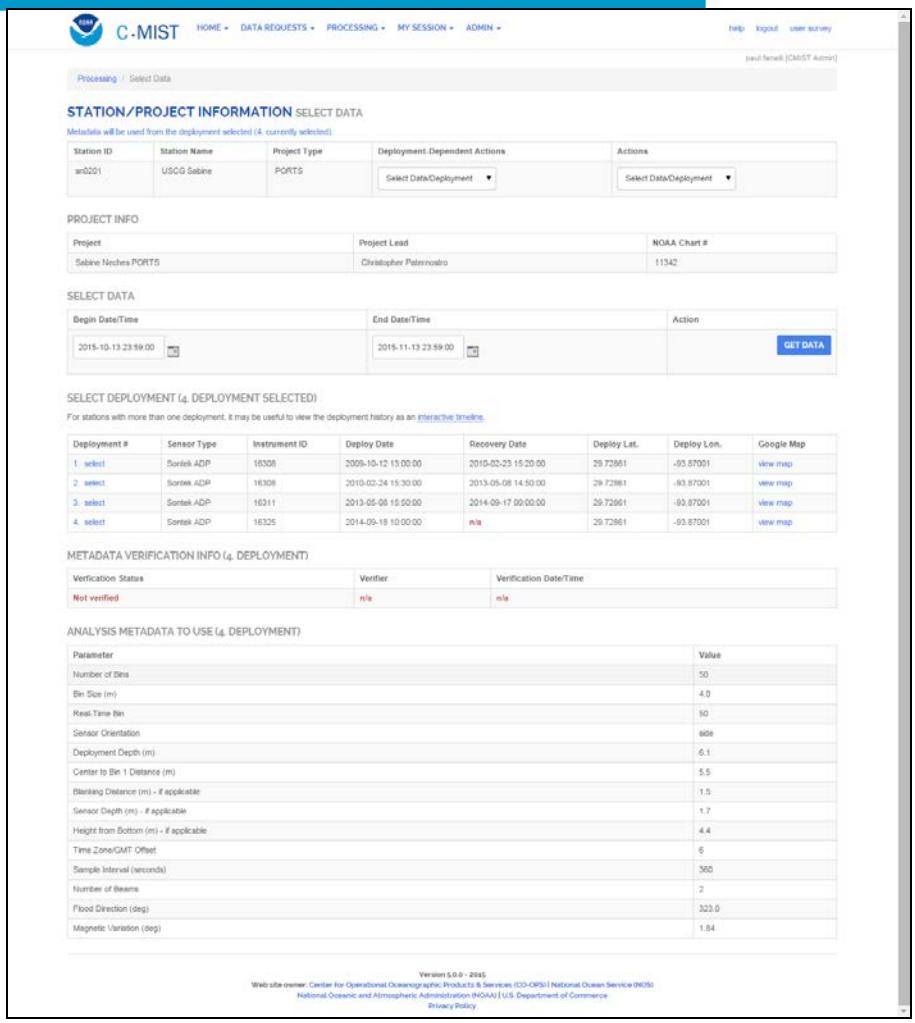



Fig 3.5: Station/Project Information screen for real-time (PORTS) station. This page is similar to the corresponding screen for current survey stations, except users can view metadata for and extract data for multiple deployments. Users can click *Get Data* to extract raw data into the C-MIST system. While users can extract data for multiple deployments, they may not extract data across deployments.

Users can scroll through the deployment history by placing their mouse cursor over the bottom panel, holding down the left mouse button and moving the panel to the right or left. To view a section of the deployment history in more detail in the upper panel (spanning only one year), users can scroll the bottom panel to the left or right such that the period of interest falls within the white area of the bottom panel. Users can also view the deployment and recovery dates of a deployment along with latitude and longitude by clicking on the line representing the deployment in either panel.

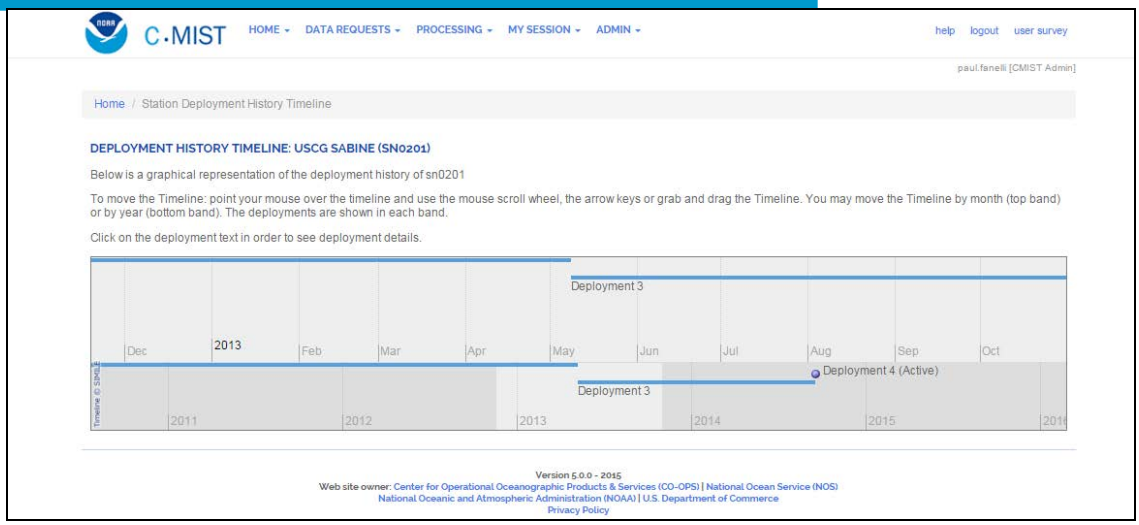


Fig 3.6: Interactive timeline for real-time (PORTS) stations, Users can scroll the bottom panel left or right to view a different, more-detailed period in the top panel. Clicking on the line representing the deployment period will bring up the deployment and recovery date/time as well as latitude and longitude of the deployment.

By default, the metadata displayed on the *Station/Project Information* screen will be from the most recent deployment, however to view metadata from previous deployments, users can click *Select* beside the appropriate deployment they are interested in. The default extraction time period will be all data from the most recent deployment beginning at the deployment date/time if the active deployment spans less than 30 days. If the active deployment is greater than 30 days, the default data selection is the most recent 30 days of data. If the user selects a historic deployment, the default extraction period will be the entire deployment if it spans less than 30 days or the last 30 days of the deployment for larger deployment periods. Again, users can view the location of a particular deployment by clicking on the *View Map* link to the right of each deployment.

Once a date range is selected, users can retrieve data by clicking on *Get Data*. A progress bar will appear letting the user know data extraction is taking place and data is being written to a file. Because C-MIST limits the amount of data users can extract for data processing, an error message will come up stating that data cannot be extracted if the user tries to extract more than 180 days of data. If no data is found, users will also receive an error message stating that no data exists in the database. If no data can be found for a survey station, it usually indicates that the raw data has not yet been ingested

into the database. For real-time stations, routinely there can be large time periods within a deployment where data are not present in the database. This can occur if the database was not configured properly when the data came in or if there were significant communication outages preventing the data from being transmitted to CO-OPS.

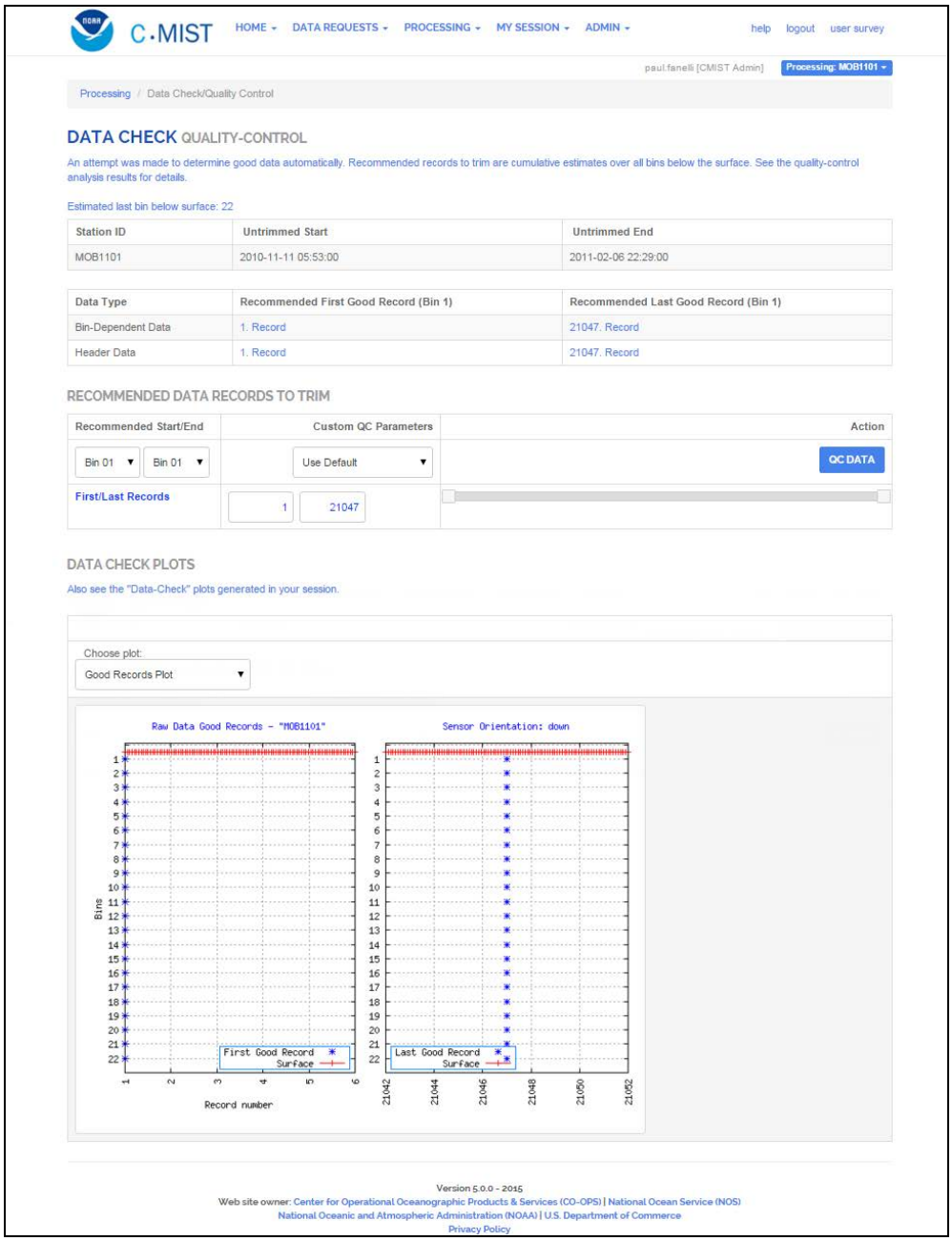



Fig 3.7: Data Check / Quality Control module that allows users to trim or QC bad data. Users can view header and bin-dependent data around the recommended first and last good record via links at the top of the page. Users can also choose whether to use mean lower low water (MLLW) or deployment depth for the bin mapping by selecting the appropriate method in the *MLLW Selection* drop-down menu.

During data extraction, C-MIST will automatically generate a number of pre-analysis plots covering the extraction period of the raw data. C-MIST will create a plot of pitch and roll and for each bin, time series plots of speed/direction, correlation magnitude (RDI current meters only), percent good ping (RDI current meters only), and echo intensity. These plots are used in the report to be used in comparison with data that has undergone quality control, which will be discussed in the next chapter.

After data is extracted, C-MIST will automatically provide an estimate of the location of the surface using various metadata parameters including station depth, platform height (or depth) and bin size. C-MIST will also examine each bin and estimate the first and last good data record for each bin. The results of this analysis can be seen in the *Data Check / Quality Control* screen (Fig 3.7) which is shown after data extraction is complete. This module will be described in the next section.

# 4. Quality Control of Currents Data

In previous versions of C-MIST, following data extraction, users were given the option to trim off data at the beginning and end of the extraction period within the *Data Check / Quality Control* module (see Fig 3.7). This was done primarily to remove data when the current meter was above water but provided only a limited degree of quality control as it does nothing to data collected in the middle of deployments. Beginning with C-MIST 4.0, users now have the ability to set several custom quality control thresholds for different parameters to remove poor data within the extracted data period in addition to trimming off data at the beginning and end of the period. In addition to performing quality control on currents data, this screen allows users to view a profile plot showing the estimated first and last good record for all bins below the estimated surface. Users can switch between this profile plot, and a time-series plot of pressure measured by the instrument. This can be accomplished using the drop-down menu above the plots. Covered in this section are:

- Performing default quality control (only trimming data)
- Performing custom quality control
- After quality control

*a. Default Quality Control (Trimming Data)*

The default option within the *Data Check / Quality Control* module allows users to trim off bad data at the beginning and end of the extracted set. This allows users to remove data collected prior to deployment and following recovery when the instrument may have been out of the water. Users can trim data for all bins based on the first and last estimated good data point at a particular depth. The first and last point to be used for data trimming can be changed by selecting a bin number from the appropriate drop-down menu (which will populate the field with the respective first or last good record for that particular bin). The first and last good data record can also be entered manually or

adjusted using the scroll bar to the right if users want to specify a particular subset of the data to analyze after examining the raw data itself. For upward-looking instruments, users can also select whether to use the mean lower low water (MLLW) calculation or station depth (metadata) value for bin mapping. This is done by selecting the appropriate value in the *MLLW Selection* drop-down menu. By default, C-MIST will use the MLLW calculation to map the bins to corresponding depth values, however if the user knows the pressure data is unreliable, they may choose to use the deployment depth instead. For downward looking and side-looking instruments, the bin mapping algorithm does not use the pressure data.

Data should be sufficiently examined prior to trimming as the default algorithm used may not take into account all parameters that need to be examined for a particular deployment location. To trim the data, click *QC Data*. Data at all depths will be trimmed to the specified records. C-MIST will now automatically perform a gap analysis for all bins and a calculation of mean lower low water (MLLW) if the deployment was an upward or side-looking instrument. C-MIST will also calculate numerous data statistics including minimum, maximum, mean, median and first and third quadrants of each parameter. Once complete, a screen will appear showing a summary of the data quality control. This summary contains the first and end date / time of the trimmed data set, the last bin that falls below the surface, minimum number of days and maximum number of gaps found for data below the surface, recommended harmonic analysis to perform, calculated MLLW and deployment depth. If "Use Deployment Depth" was selected under *MLLW Selection*, the MLLW listed will match the deployment depth since the user is overwriting the MLLW value being used. It will also display the percent data loss by bin.

*b. Custom Quality Control*

If it is known that there is questionable data within the deployment, C-MIST provides the capability to remove data that falls outside of threshold values that can be set for certain parameters. When the option *Use Custom QC* is selected under the 'Custom QC

Parameters' drop-down menu (see in Fig 3.7), several custom QC bounds are displayed below (see Figure 4.1).

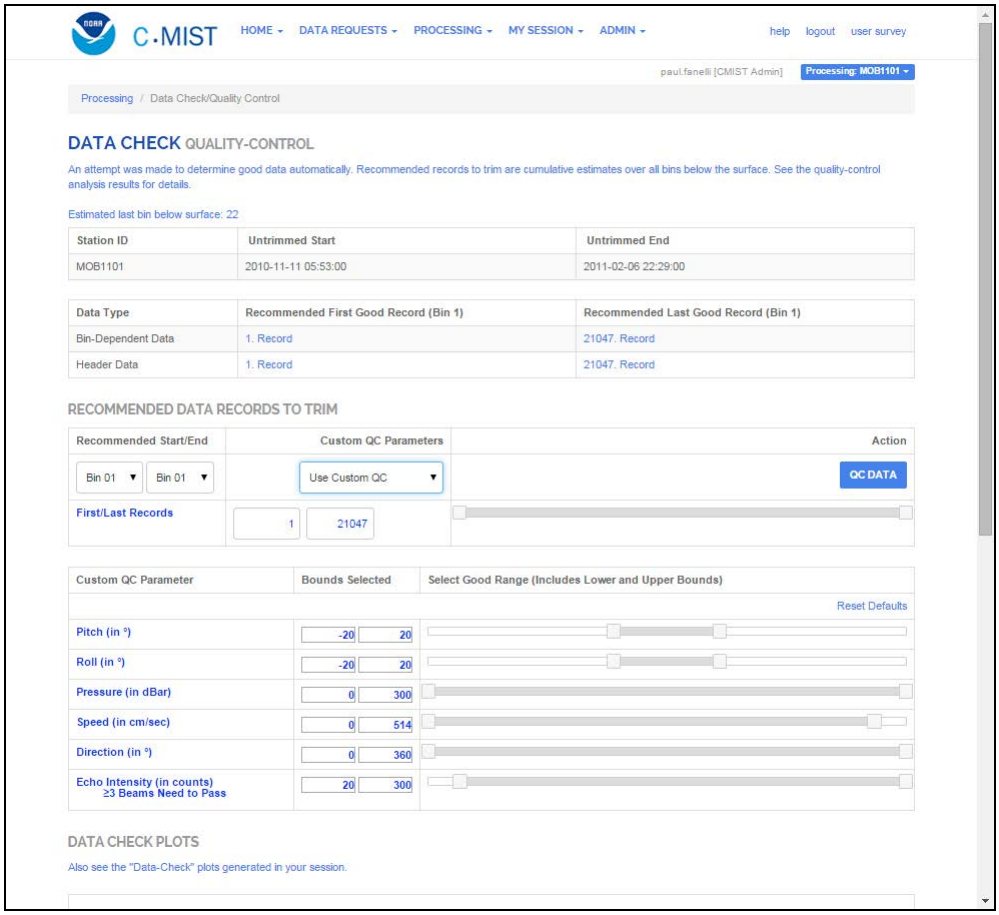



Fig 4.1: Data Check / Quality Control module with custom QC parameters displayed. In addition to setting the first and last record to trim and selecting the mllw method for bin mapping, users can set different threshold values for several parameters. Depths and records where values fall outside the custom thresholds will be removed from the analysis.

There are seven different parameters that can be adjusted, either by typing values directly into the appropriate lower or upper bound box, or by using the sliding bars to the right of the parameter. Each parameter is pre-populated with default lower and upper bounds based on a combination of instrument manufacturer recommendations and CECAT experience with analyzing and verifying currents data. The parameters are as follows:

- **Pitch** – Default bounds: -20 degrees to +20 degrees
- **Roll** – Default bounds: -20 degrees to +20 degrees
- **Speed** – Default bounds: 0 cm/s (0 kts) to 514 cm/s (10 kts)
- **Direction**– Default bounds: 0 degrees to 360 degrees

- **Correlation Magnitude** (RDI only) – Default bounds (≥ 3 beams): 65 counts to 140 counts.
- **Percent Good Ping 3** (% no solution, RDI only) – Default bounds: 0% to 99%
- **Echo Intensity**– Default bounds (≥ 3 beams): 20 counts to 300 counts

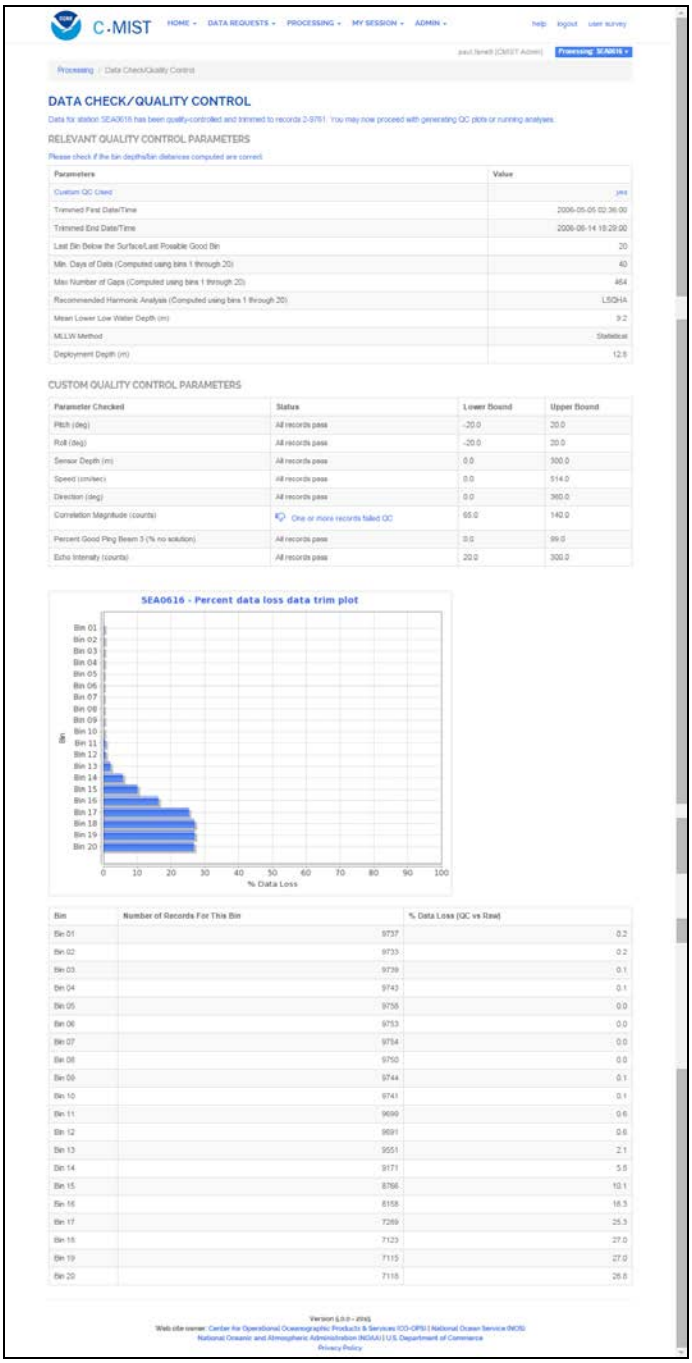



Fig 4.2: Data Check / Quality Control module after custom quality control was performed. Users can view whether any data fell outside the threshold values set and how much data was removed by bin.

Once you have selected the appropriate bounds, click *QC Data*. C-MIST will now automatically filter out data based on the set thresholds. As is the case when default quality control is selected, C-MIST will perform a gap analysis for all bins and a calculation of mean lower low water (MLLW) if the deployment was an upward or side-looking instrument (or calculate bin mapping using Deployment Depth if that option was selected). C-MIST will also calculate numerous data statistics including minimum, maximum, mean, median and first and third quadrants of each parameter. Once complete, a screen will appear (Fig 4.2) showing a summary of the data quality control, including the thresholds set and whether any records failed the QC checks. Also displayed will be the percent data loss by bin, as both a profile plot and a table.

Data that were filtered out based on the custom QC thresholds set are not removed from the database and also are not flagged as bad data, however they will be removed from the analysis within the user's session.

*c. After Quality Control*

The recommended harmonic analysis is determined using the number of days of data and the largest number of gaps, since some bins may have more gaps than others. If one or more bins contain gaps, a LSQHA analysis is recommended. This is almost always the case for PORTS data as issues such as communication outages frequently cause gaps in the data and will often be the case when the Custom QC option is used. The HARM15 and HARM29 analyses cannot handle data with gaps. In the absence of gaps, the number of days will determine the recommended harmonic analysis. For data sets greater than 35 days in length, C-MIST will recommend LSQHA. For data spanning between 29 and 35 days, HARM29 is the recommended analysis type. For data sets between 15 and 29 days in length, HARM15 will be the recommended analysis type.

If at any point forward during the analysis phase, users want to un-trim or un-quality control the data, they can do so by clicking on the *Untrim Data* option within the *Processing* menu at the top. This will bring up a window showing the first and last date

and time of the trimmed data set and provide a button for users to un-trim the data set. After the *Untrim Data* button has been clicked, a pop-up message will tell the user that "Data for station *station_ID* untrimmed". Users may re-trim or re-quality control the data by once again clicking on *Data Quality-Control* in the left side sub-menu when under *Processing*, which will bring up the original *Data Check / Quality Control* page. All results including statistics generated when users select *QC* Data can be viewed by clicking on *My Session* at the top and the navigating to *view my analyses*. The My Session area will be discussed further in a later chapter.

# 5. Quality Control Plot Generation

This module provides a means for the user to assess the quality of the data collected by creating and viewing plots of variables such as percent good ping, echo intensity and correlation magnitude. It also allows the user to create and view time series and scatter plots of the raw speed and direction data. The module allows the user to create the standard set of plots used by CECAT for quality assurance and quality control, but also allows the user to create custom plots using the manual mode. Covered in this section will be:

- A brief description of the standard quality control plots used by CECAT.
- Generating the standard plots.
- Generating custom data plots.
- Viewing plots.

Once data has been extracted, users can navigate to the Quality Control Plots module by clicking on *Processing* in the top-menu and then clicking on *Generate QC Plots*. Alternatively, if users are already in the *Processing* section, they may click the *QC Plots* link in the left side sub-menu. Figure 5.1 shows the Quality Control Plots menu. Note that there are separate sub menus for generating the standard set of QA/QC plots, and generating user defined plots of both bin dependent and independent data. Both methods will be described below. When data are extracted, a number of the standard QC plots are created automatically. After data is trimmed or quality controlled, most of these plots are then created off of the quality controlled data, which allows for easy comparison between the raw and QC'ed data.

*a. Standard Plots*

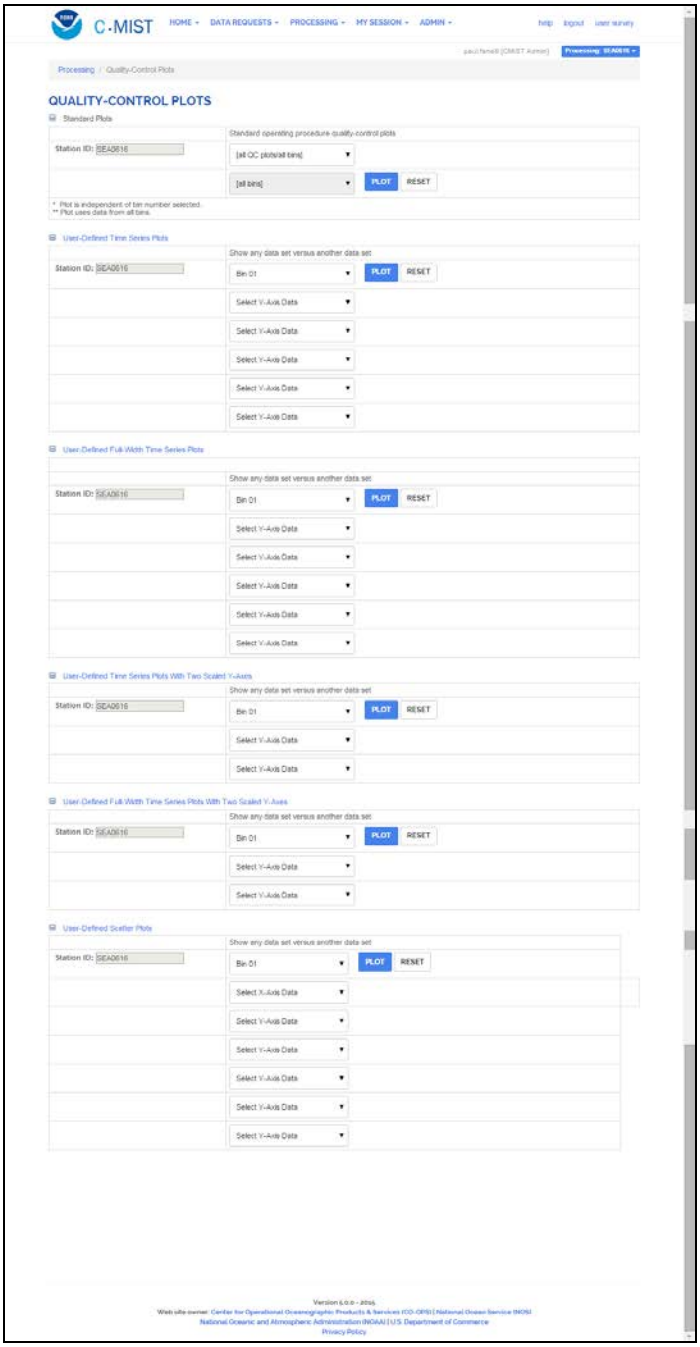



Fig. 5.1: Quality Control Plots main menu with all sub-menus expanded. Top menu allows users to create standard plot(s) for all or one bin. The remaining menus allow users to create user-defined time-series plots of up to 5 dependent variables, scrollable time-series plots of up to 5 dependent variables, time series plots of two dependent variables with multiple y-axes displayed, scrollable plots of two dependent variables with multiple y-axes displayed and scatter plots of up to 5 dependent variables. The *Reset* button will reset the selection if the *Plot* button is grayed out after the user navigates to this menu via their browser's back button.

The upper menu in the Quality Control Plots module can be used to generate one or all of the standard set of plots for either one bin or all bins of data. The plots generated are briefly described below:

- **Velocity north/east scatter** – Scatter plot of the north and east velocity component.
- **Speed/direction scatter** – Scatter plot of the direction versus velocity magnitude.
- **Percent good ping time series** – Time series plot of percent good ping for the 3-beam solution, transformations rejected, greater than 1 beam bad, and good 4-beam solution.
- **Echo intensity time series** – Time series plot of the echo intensity for beams 1-4.
- **Velocity north/east time series** – Time series plot of the north and east velocity components.
- **Correlation magnitude time series** – Time series plot of the correlation magnitude for beams 1-4.
- **Speed/direction time series** – Time series plot of the speed and direction.
- **Echo intensity count plot** – Profile plot of the echo intensity range by bin over the data period.
- **Pitch and roll/heading time series** – Time series plot of the pitch and roll of the instrument, as well as instrument heading (bin independent).
- **Temperature/depth time series** – Time series plot of the water temperature and depth recorded by the instrument (bin independent).
- **Echo intensity contour** – Contour plots of the echo intensity for beams 1-4 for 3 day periods at the beginning, middle and end of the data set (all bins).
- **Velocity north/east contour** – Contour plots of the north and east components of velocity for a 3-day period falling in the middle of the data set (all bins).
- **Speed/direction contour** – Contour plot of the speed and direction for a 3-day period falling in the middle of the data set (all bins).

- **Percent good ping contour plot** – Contour plot of the percent good ping for the four solutions described above for a 3-day period falling in the middle of the data set (all bins).
- **Correlation magnitude contour** – Contour plot of the correlation magnitude for beams 1-4 for a 3-day period falling in the middle of the data set (all bins).

Within the first-sub-menu, to create all standard plots for all bins users can click *Plot*. To create all plots for one bin, select the bin from the second drop-down menu and then click *Plot*. To create a single plot for all bins, select the plot type from the first drop-down menu and then click *Plot*. Once the *Plot* button is clicked, a progress bar will appear that will let users know what plots are presently being generated. Creating all plots for all bins for a month of data should take a couple of minutes. When plotting is complete, the first plot for the first bin selected will be shown (see Figure 5.2). Note that the start and end time that has been plotted can be found on the bottom of the plot. Users may click *Next* to view the next plot or view plots in *My Session* (described later in this section). Users also have the option of saving the plot by clicking *Save File*.

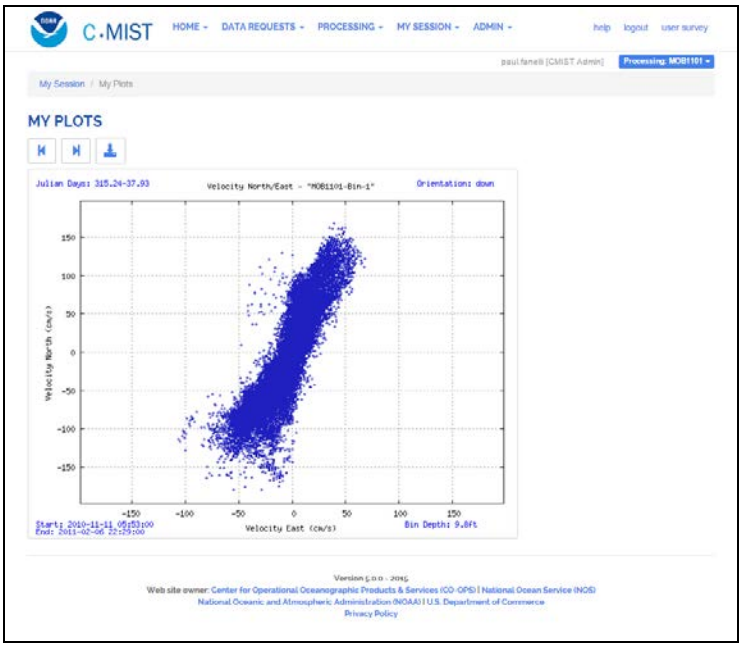



Fig. 5.2: My Plots screen showing the first plot generated when users select *All Plots* and *All Bins* under the Standard Plots sub-menu. Users can click *Next* to view the next plot in the list or save the plot by clicking *Save File*.

*b. User-defined Plots*

In addition to the standard plots, users can create personalized plots that allow them to plot up to five dependent variables at once. The second menu in Figure 5.1 allows the user to plot a time-series of up to 5 different dependent variables. This allows users to overlay, for example, current velocity and pressure. The third menu is similar to the second; however users can generate a scrollable version of the plot so they can view the time-series plot in a more detail. The fourth menu lets users create overlapping time series plots of two variables on different y-axis scales. The fifth menu is similar to the fourth; however users can create a scrollable version of the plot so they can view the plot in a more detail. The last menu allows users to plot a scatter plot of up to 5 variables against one independent variable.

User-defined plots can only be created for one bin at a time. Users select a bin from the drop-down menu at the top of the sub-menu. They can then select x-axis data if creating a scatter plot (x-axis data is automatically set to Julian date for time-series plots) and up to 5 variables to plot on the y-axis, depending on which plot-type is being created. To create a plot, users can click *Plot* or to clear the selections, users may click *Clear*. Users are encouraged to save any custom plots as only the standard set of plots will be included in the station report. Users have the ability to generate a report containing all custom plots generated during their C-MIST session. This will be discussed in a later chapter.

*c. Viewing Plots through My Session*

Users may not want to browse through their plots one at a time, especially when a large number of plots are created. For this reason, users can view a list of all plots generated during their session by clicking on *My Session* at the top and then *My Plots*. The plots are listed in the order that they were created and are displayed in groups as shown in Figure 5.3.

Links at the top and bottom of the list allow users to view the next 50 plots, previous 50 plots, or go to the first page or last page. Users also have the option to jump to a specific plot ID number. Finally, users can search for a plot by analysis phase, station ID, bin number or plot description using the search box at the top. To view a plot, users can click *view* to the right of the plot within the list. Both standard plots and any user-defined plots created are included in this list.

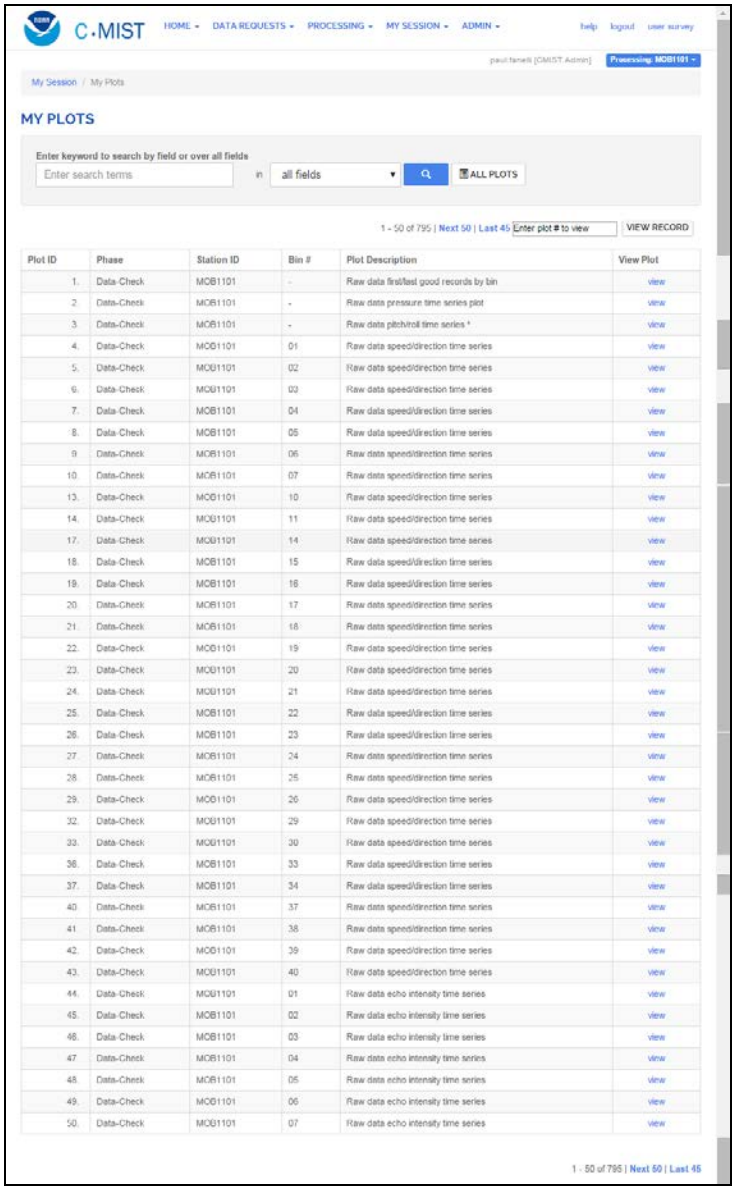



Fig. 5.3: First page of the list of plots generated for a current deployment. Plots are arranged in the order they were created. Users can page through the list and view individual plots. This list displays the plot ID, type of plot, station ID, bin number, plot description and a link to view the individual plots. Users can search for plots using the search box at the top.

# 6. Harmonic Processing

C-MIST supports both the Fourier (HARM29 and HARM15) and least squares (LSQHA) harmonic analysis methods presently used by CECAT to estimate harmonic constituents from tidal current data [Zervas, 1999]. C-MIST allows users to run both a standard set of analyses in automatic mode or customize the analysis in manual mode. Both of these methods will be discussed below. Covered in this section are:

- A general description of the Analysis Parameters screen before and after harmonic analysis is completed.
- Performing data analysis in automatic mode.
- Performing a Custom Harmonic Analysis
- Performing data analysis in manual mode.
- Viewing analysis results.

To run harmonic analysis on a data set, users must first extract data into C-MIST and running the *QC Data* option. While it is not required to generate QC plots prior to performing harmonic analysis, it is strongly encouraged that users create these plots so that they may thoroughly examine the data prior to analysis.

*a. Analysis Parameters*

Users can view some of the parameters used in the control files for the analysis routines by clicking on *Processing* and then clicking *Analysis Parameters* in the top menu. Figure 6.1 shows the Analysis Parameters screen after data analysis has been performed. The screen is divided into two sections, one for bin independent data and one for bin dependent data. Many values in the bin-independent section are populated from station metadata and include bin size, estimated flood direction, GMT offset and (transducer) height from bottom. Parameters such as mean lower low water (MLLW), estimated last good bin and number of days of data are populated from analysis performed automatically after data was trimmed. Parameters in the bin-dependent section include

number of gaps, bin depth and principal current direction. Some parameters in the bin-dependent section require certain analysis routines to be run. These include principal current direction, azi direction and u and v mean speed. These 4 parameters require the principal current direction routine to be run.

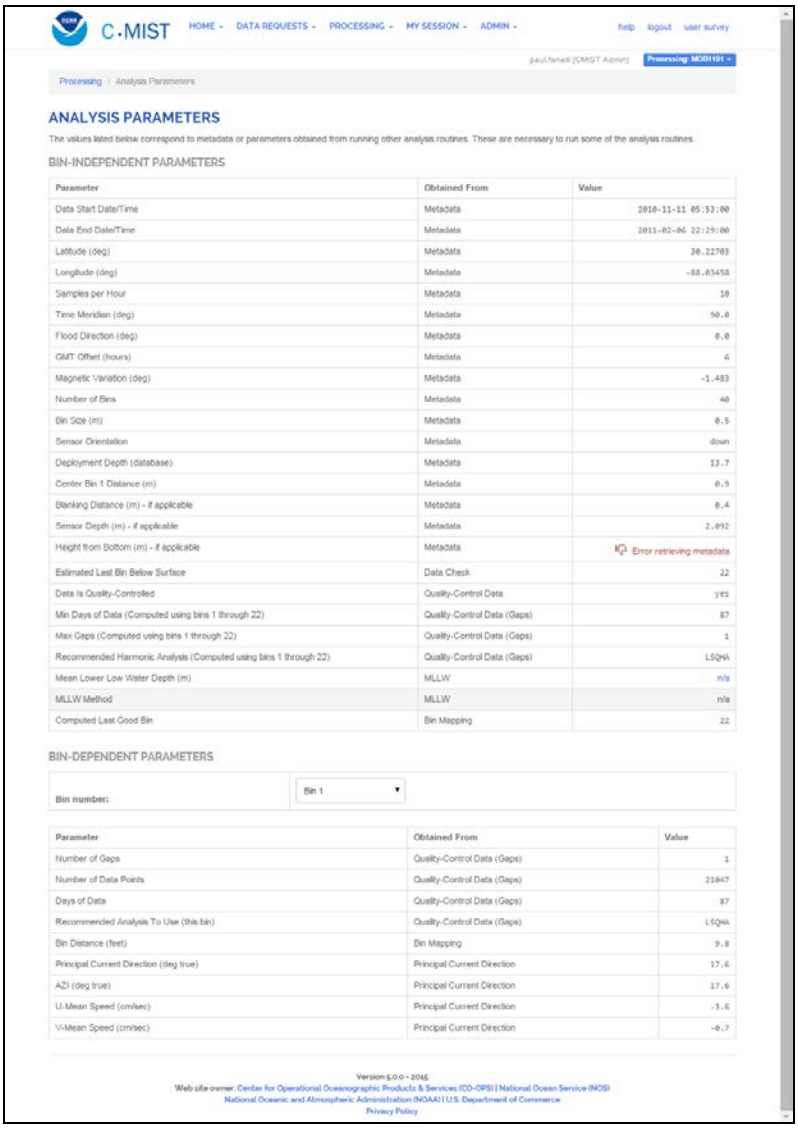



Fig. 6.1: Analysis Parameters screen after all analyses have been run for station MOB1101. Many values are populated from the station metadata or preliminary analyses run automatically after data was trimmed. The principal current direction, azi direction and u and v mean speed require the principal current direction routine to be run.

### *b. Running Data Analysis in Automatic Mode*

Users can navigate to the Run Analyses screen seen in Figure 6.2 after extracting and performing quality control on a data set by clicking on *Processing* and then *Run Analyses* from the left sub-menu.

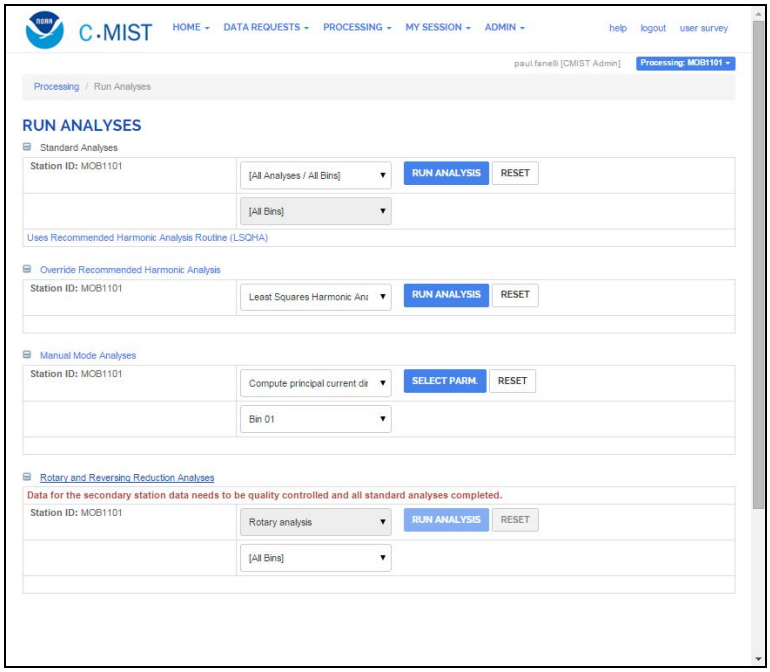



Fig 6.2: Run Analyses menu in C-MIST. Users here can select whether they want to run data analysis in automatic or manual mode. For automatic mode, users can either run all analyses for all bins or individual analyses for all bins. Users also have the option of overwriting the default analysis type using the bottom drop-down menu. If a gap analysis has already been performed, the default analysis type will appear to the left of the last drop-down menu. The *Reset* button will reset the selection if the *Run Analysis* button is grayed out after the user navigates to this menu via their browser's back button.

From this menu users have the option of running data analysis in automatic or manual mode. We will focus on automatic mode for now as manual mode will be discussed in the next section. Under automatic mode, users have the option of running all or one analysis for all bins. The control files are populated automatically using metadata and results from previous analyses (these parameters can be viewed by clicking *Analysis Parameters* from the left sub-menu). The analyses completed when *All Analyses / All Bins* are selected are listed below in the order that they are run.

- **Compute principal current direction:** Takes in speed and direction data and determines the principal axis between 0 and 180 degrees.

- **Compute Greenwich intervals (raw data):** Takes in the raw speed and direction, filters this data and calculates GI, speed and direction of MFC, SBE, MEC and SBF of the filtered data set.
- **Perform harmonic analysis:** Calculates amplitude and phase of specified constituents using LSQHA, HARM29 or HARM15.
- **Detide time series:** Generates predictions using the constituents generated during harmonic analysis for the period of raw data collected. These predictions are compared with the raw data and a residual is computed.
- **Generate predictions:** Creates predictions for the year 2011 from 01/02 00:00 to 12/31 23:54 UTC using the constituents resulting from harmonic analysis. These predictions are used for Greenwich Interval calculations.
- **Compute Greenwich intervals (predictions):** Takes in the 2011 predicted speed and direction and calculates GI, speed and direction of MFC, SBE, MEC and SBF of the filtered data set. The mean Greenwich Intervals from the predicted data are used for the Tidal Current Tables.
- **Convert tidal current constituents:** Converts the tidal constituents into a form used by the Products and Service Division. Also calculates tidal ellipse parameters.

After selecting *All Analyses / All Bins* or an individual analysis type under automatic mode, click *Run Analyses* and a progress bar will appear. When data analysis is complete, the results from the first analysis and first bin run will appear. Users can go through each analysis by using the arrows in the upper-left part of the page or select individual analysis results by clicking *My Session* from the top sub-menu and the clicking on *My analyses.* Viewing analysis results will be discussed in more detail towards the end of this section.

**Note that *All Analyses / All Bins* must be run in order for a cumulative data analysis report to be generated and for analysis results to be stored in the database.**

*c. Performing a Custom Harmonic Analysis*

C-MIST will select an appropriate harmonic analysis based on the length of data and whether or not the data have gaps, however the system also allows users to customize the analysis if the default analysis method is not sufficient (for example, if constituents need to be added or subtracted, or if it is necessary to change the speed threshold that defined a maximum flood or ebb event. To perform a custom analysis, select the appropriate analysis type from the drop down in the second section shown in figure 6.2. There are 4 options, Lease Squares Harmonic Analysis (LSQHA), 29-Day Harmonic Analysis (HARM29), 15-Day Harmonic Analysis (HARM15) and LSQHA Custom. The options for LSQHA, HARM29 and HARM15 will just simply overwrite the default harmonic analysis method chosen by C-MIST and C-MIST will run all analyses in automatic mode using the default settings. If a user selects LSQHA Custom, they have the option to select certain analysis parameters and adjust the threshold by which MFC and MEC currents are flagged, as seen in Figure 6.3.

Once the constituents and Greenwich Interval threshold have been set, users can run through the analysis by clicking Run Analyses. C-MIST will then run through all analyses, just as the system does when analyzing data using the default harmonic analysis. In addition to allowing users to customize analyses under normal circumstances, the LSQHA Custom menu is also the only way by which users can analyze less than 15 days of data. If there are less than 15 days of data, C-MIST will display a message stating that there are too few data to run harmonic analysis. Users can still navigate to LSQHA Custom and select the constituents they wish to solve for (by default, no constituents are checked). **While performing a harmonic analysis on less than 15 days of data will not yield constituent values that are reliable, there are times when an analysis of a short data set may be necessary.**

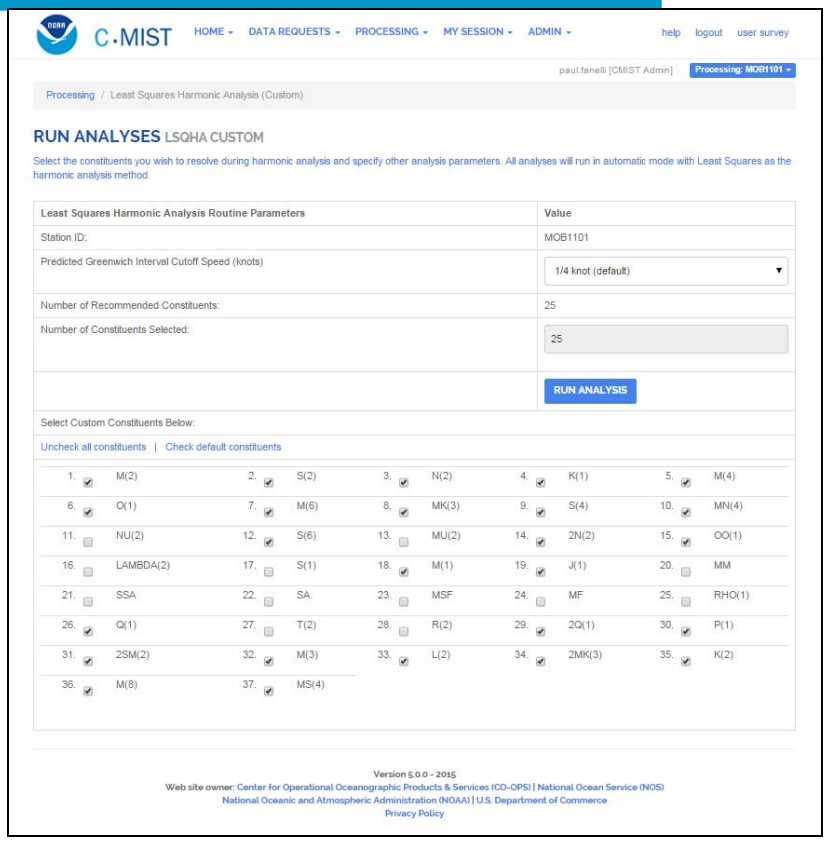



Fig 6.3: LSQHA Custom menu in C-MIST. The default constituents are pre-selected based on the length of data. Users have the option to change which constituents are solved for. Users can also adjust the Predicted Greenwich Interval Cutoff Speed from the default value of ¼ knot, which is useful for areas where currents are rather weak, but tidal.

### *d. Running Data Analysis in Manual Mode*

C-MIST allows users to customize the individual analyses by entering control file parameters to overwrite default selections by C-MIST. Users can run individual analyses for one bin at a time, specifying input parameters for each analysis. Default values are already populated from station metadata and output from prior routines. Described below are the parameters that users are able to modify for each routine.

**Compute principal current direction:** No parameters to modify.

**Compute Greenwich intervals (raw data):** Users can choose whether or not to filter the data, filter type, filter cutoff periods, whether or not to add back the mean current after filtering, and principal flood direction.

**lsqha analysis:** Users can modify the flood (azi) direction and select these constituents individually.

**harm29/harm15 analysis:** Users can modify the flood direction and number of data points to skip.

**Detide time series:** Users can modify the flood direction.

**Generate predictions:** Users can modify the beginning and end date and time for predictions and number of samples per hour.

**Compute Greenwich intervals (predictions):** Users can modify the flood direction.

**Convert tidal current constituents:** No parameters to modify.

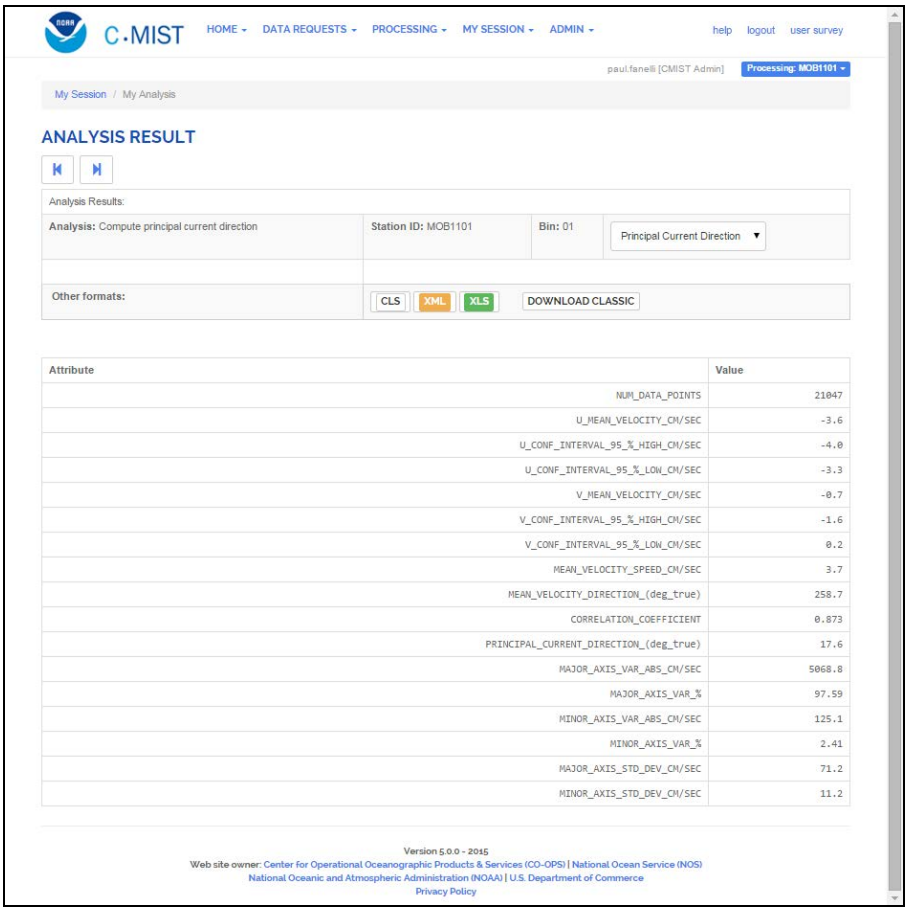



Fig. 6.4: Results screen after all analyses for all bins have completed for MOB1101. The default screen contains results for the first analysis and first bin run, which will be principal current direction results for bin 1. When individual analyses are run in manual mode, the Analysis Result screen shows the results for that specific analysis and bin

Users should run these analyses in the proper order as some routines require output from previous analyses. If users are running these analyses one-at-a-time, and they try to call a routine that requires output from an analysis that is yet to be run, an error message will pop up telling the user to perform the required analysis first. As a general rule of thumb, analyses that contain bins run in manual mode should not be stored in the database.

*e. Viewing Analysis Results in My Session*

Upon completion when running all analyses for all bins in automatic mode, a screen containing results from the first analysis run (bin 1 results from the *Compute principal current direction routine*) will appear as seen in Figure 6.4. When performing individual analyses, a screen containing the results from the specific analysis run will appear upon completion.

Users can view all results within the My Session window. Users can click *My analyses* from the left sub-menu or click the folder icon to the right of the number of analyses. This will bring up a list of analysis results (Figure 6.5), similar to the list of plots found in My Session discussed in section 4. The results are listed in the order that they were created. Users can page through results, and hyperlinks on the right hand side that allow users to view individual analysis results.

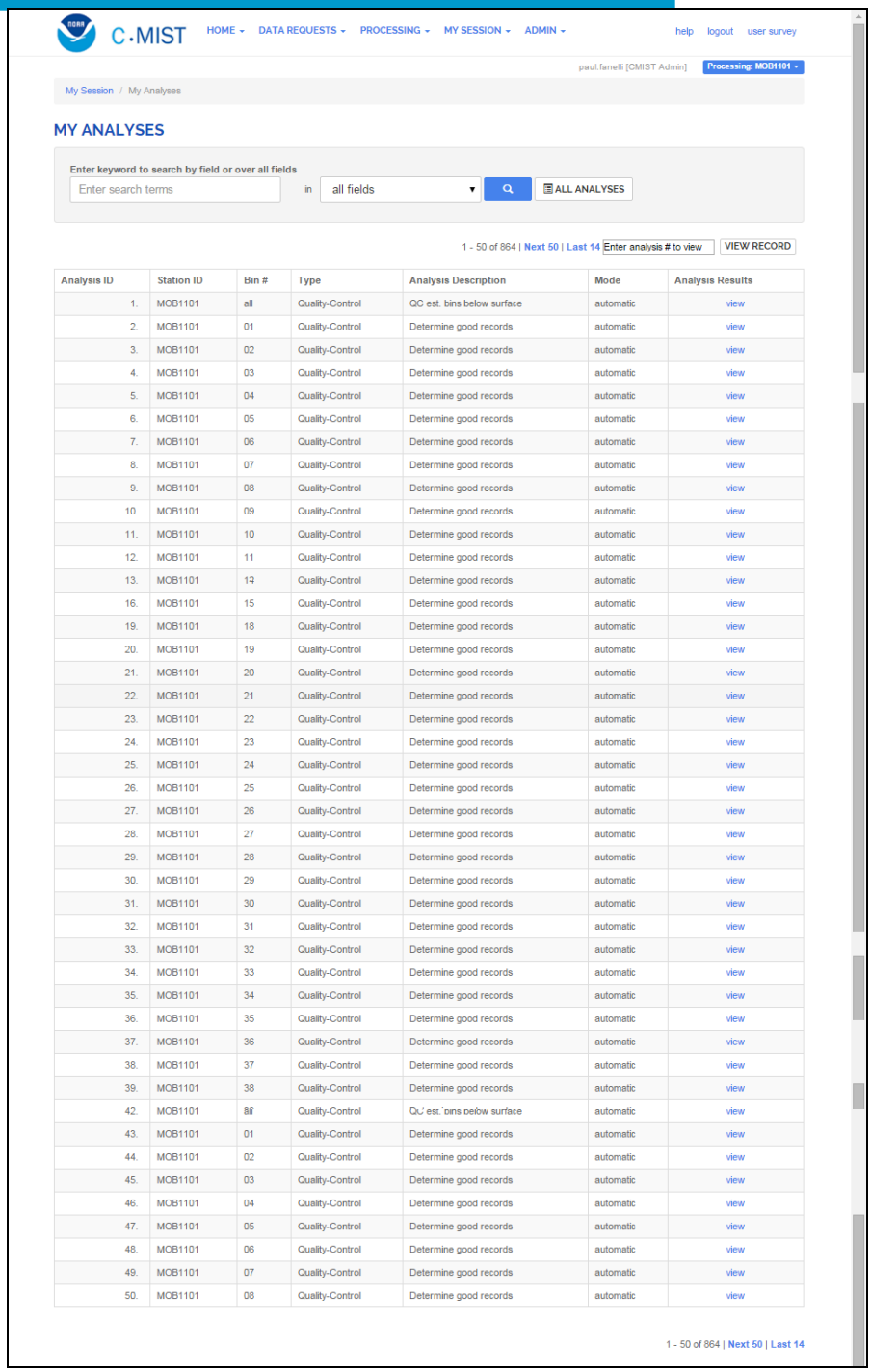



Fig. 6.5: First page of the list of analysis results found within the My Session window after all analyses for all bins have been completed. Results are listed 50 per page. Users can page through and view individual results by clicking on *view* on the right hand side.

# 7. Post Analysis Plots Generation

Whereas plots generated prior to analysis give users a view of the quality of the raw data, users have the option of creating some post analysis plots that give an idea of the quality of the harmonic analysis results. As part of the SOP for processing current data, CECAT produces detide plots, which plot the predicted current time series over the observed time series and also contain a time series of the residual. This gives users an idea as to how close the predictions match the observations graphically. These plots have been incorporated into C-MIST along with a few other plots utilizing results from the detide routine. Covered in this section are:

- Generating post-analysis (detide) plots.
- Viewing post-analysis plots.

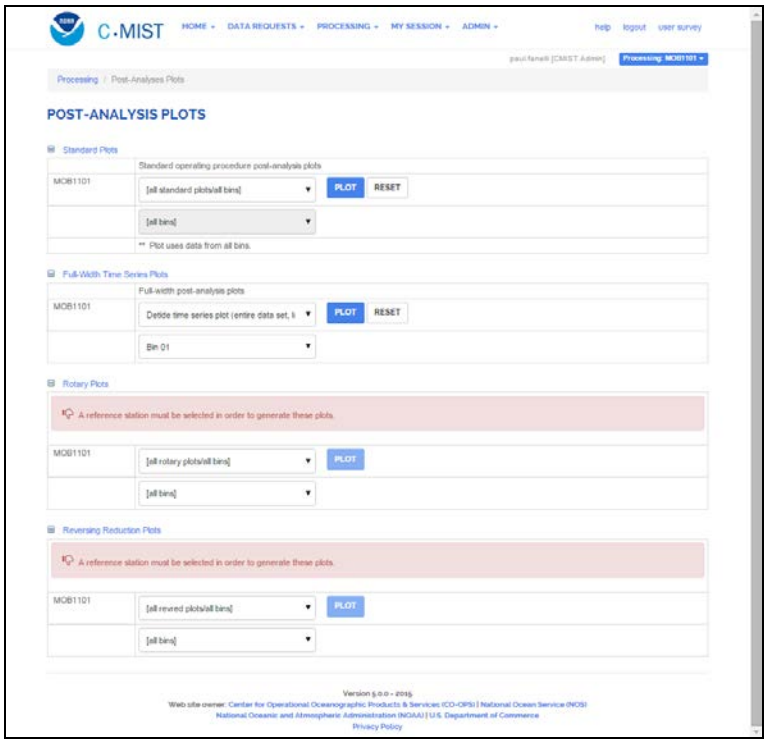



Fig. 7.1: Post-Analysis Plots main menu. Users can create the suite of post-analysis plots for all bins. Users may also create only one plot for all bins or a specific bin.

Users can navigate to the Post-Analysis Plot menu (Figure 7.1) by clicking on *Post-Analysis Plots* from the Processing main menu or left sub-menu. Users have the option of creating the following plots:

- **Velocity profile plot:** Profile plot of mean velocity along the major and minor axis.
- **Detide time series plot:** Plot of predicted data using the harmonic constituents generated during analysis overlaid over observed data. A time series of the residuals is also included. These plots are created for the entire data range and subsets of the beginning, middle and end of the data set.
- **Predicted vs. Observed scatter plot:** Plot of the predicted data using the harmonic constituents versus the observed data. The closer the ratio falls to 1:1, the better the predictions.
- **Detide residual statistics:** Plot of the RMS of the residual and observed data by bin. This plot gives users an idea of the relative size of the residual compared with observed variables. Plots are created for major and minor axes.
- **Predicted time-series plot:** Plot of the predictions generated during analysis. For standard analyses, this would be the 2011 predictions. If the user generated a different year of predictions using manual mode-analysis, the specified prediction year will be displayed. Plots are generated for the beginning, middle and end of the year.

As was the case with the pre-analysis plots, users may create all plots for all bins, or individual plots for one or all bins. Users can choose the plotting option in the top drop-down menu and the bin(s) in the bottom drop-down menu. When a selection is made, users can click *Plot* to create the plot(s) or *Clear* to clear the selections. After the *Plot* button is clicked, a progress bar will appear and when the routine is complete, the first plot generated will be displayed, as seen in Figure 7.2. When creating all plots for all bins the first plot created is the detide plot for the middle of the time series for bin 1. Users can view the plots one-by-one by clicking on *Next* or select plots to view by

clicking on *My Session* and then *View my plots*. The post-analysis plots will be appended to the end of the list of plots already generated, in the order that they are created.

In addition to generating the standard plots, users can also generate full-width plots for individual bins using the second menu in Figure 7.1. A scrollable plot can be generated for a specified bin, allowing the user to view the plot in greater detail than the standard post-analysis plots. Users can create full-width detide plots or full-width prediction plots for one of four periods: January-March, April-June, July-September & October-December. For the standard analysis, these plots will be of 2011 predictions. If the user generated a different year of predictions using manual mode-analysis, the specified prediction year will be displayed. Due to the size of these scrollable plots, they are only viewable in C-MIST and will not be included in any standard or custom reports. The rotary and reversing reduction plots seen in the third and fourth menus will be discussed in the next chapter.

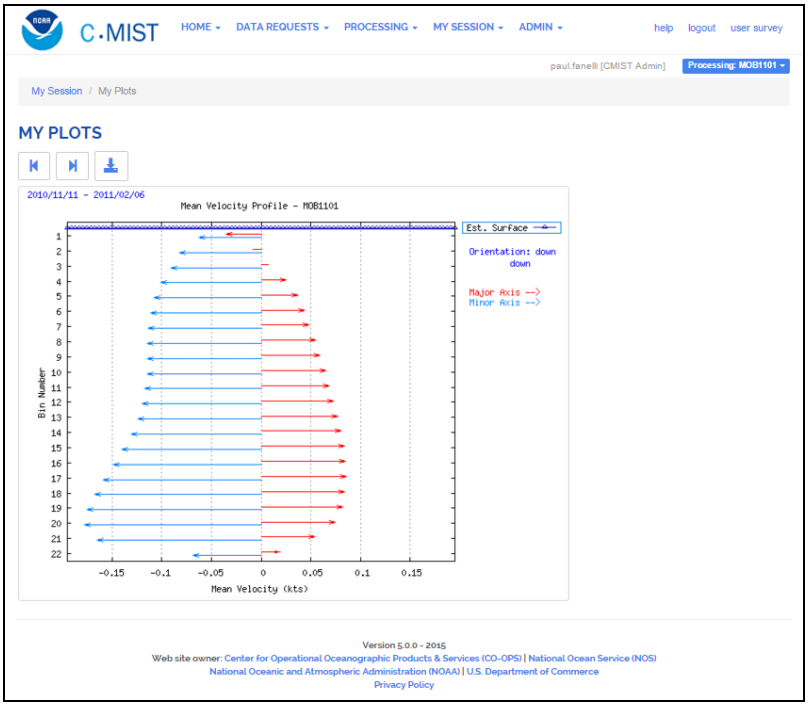



Fig. 7.2: First plot generated when *All Plots / All Bins* is selected when creating post-analysis plots. This is a vertical profile of permanent current along the major (red) and minor (blue) axis. Users can select individual plots under the My Plots screen or view plots one-by-one by clicking on *Next*.

# 8. Performing Non-Harmonic Analysis

Under certain circumstances, data sets need additional processing for inclusion in the Tidal Current Tables. Typically, for stations that are rectilinear, the mean Greenwich Intervals obtained from predicted data at both a reference station and secondary station are compared to calculate time differences of tidal phases. Users can also run a routine called **Reversing Reduction** to perform a similar comparison using different methodology. Unlike the standard GI comparison method, reversing reduction compares the time differences of individual tidal phases between a reference and secondary station throughout the predicted time period. The routine will then calculate statistics of these time differences to obtain mean and standard deviation values. The reversing reduction routine does fail under certain current regimes including currents that are close to weak and variable (< ¼ knot) and currents where double-floods and double-ebbs are present.

Stations that are not very rectilinear (major axis variance < 80%) cannot be described accurately by simply time offsets and speed ratios of the tidal phases. These stations are listed in Table 5 of the Tidal Current Tables which display the mean current of a secondary station at hourly intervals following maximum flood at a reference station. To do this, users must run **Rotary** analysis on the station. This routine takes secondary station predictions and computes a mean current over a certain time interval following a certain reference station tidal phase (typically maximum flood). Once the routine has mean current values for each time intervals, it can calculate Greenwich intervals for the secondary station if GI's for the reference station are provided. Because of this, rotary analysis can be used as an alternative method of calculating Greenwich Intervals for rectilinear stations. Unlike the standard method and the reversing reduction method, rotary analysis does not eliminate maximum flood and ebb values falling below a certain threshold (e.g. < ¼ knot) from calculations. Covered in this section are:

- Selecting a reference station for comparison
- Performing reversing reduction analysis

- Performing rotary analysis
- Generating and viewing reversing reduction and rotary plots

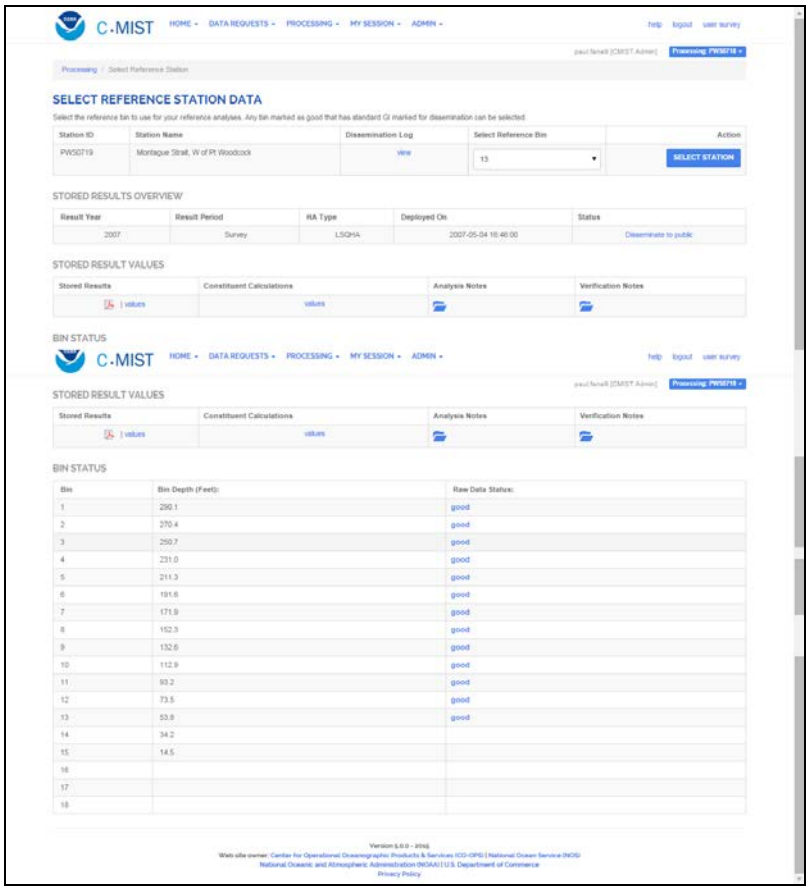



Fig. 8.1: Select Reference Station Data screen. Users can view reference station information such as analysis and verification notes, PDF report and analysis results as well as view which bins were marked as good. Users select a reference station depth by choosing a bin from the drop-down menu and clicking "Select Station".

### *a. Selecting a Reference Station for Non-Harmonic Analysis*

**As a prerequisite for non-harmonic analysis to be run, users must extract secondary station data, perform quality control (trimming) of the data and run all standard analyses.** Once these steps are complete, users must select a reference station and perform ncp2 analysis before rotary or reversing reduction analysis can be performed. The prediction program ncp2 takes in a control file containing constituents for a station. The routine then calculates daily maximum (MFC, MEC) and slack (SBF, SBE) currents

along the major axis only. Because of this, ncp2 is typically used only for stations that are very rectilinear. The standard output allows for 5 extreme (MFC or MEC) current events in a day. In some locations where double-flood and double-ebb currents are present, a station may have more than 5 extreme events in a given day. When this happens, that particular day is referred to as a "trouble day" and all the currents of that day are output in a separate file.

To select a reference station, users have two options. Users can click *Processing* from the top menu and then *Select a Station*. Users can navigate to a list of potential reference stations by clicking the *Select reference station* link in the top-right corner. Users can also navigate to this list directly by clicking the *reference station* link under *Processing >> Run Analyses >> Rotary and Reversing Reduction Analyses*. Users can select a reference station by clicking on the station ID. This will bring them to the Select Reference Station Data screen (Figure 8.1). Users can view the analysis and verification notes for the station and which bins have good data. It should be noted that only stations that have results marked for dissemination with at least one bin having standard Greenwich Intervals disseminated are populated in the list. Furthermore, for stations that have multiple result types marked for dissemination, only those bins with standard GI's being disseminated are eligible to be used as a reference station for non-harmonic analysis.

Users select a station by choosing a bin from the drop-down menu at the top and clicking *Select Station*. C-MIST will then automatically build the ncp2 control file using constituents stored in the database. The ncp2 routine is run and the user is taken to the results page seen in Fig. 8.2. Here, users can view more reference station information such as analysis and verification notes, PDF report and Greenwich Intervals. Users can also view the ncp2 predictions by clicking the *view* link at the top-right part of the page. If any trouble days were output by the ncp2 routine, a warning message is shown at the top of the page and the individual trouble days can be viewed below the reference station GI's. Once the reference station has been selected, it is viewable on the left side-menu below the secondary station data and metadata links. If users click the *view info* link

under the reference station ID at any time, they will be returned to the screen shown in Figure 8.2.

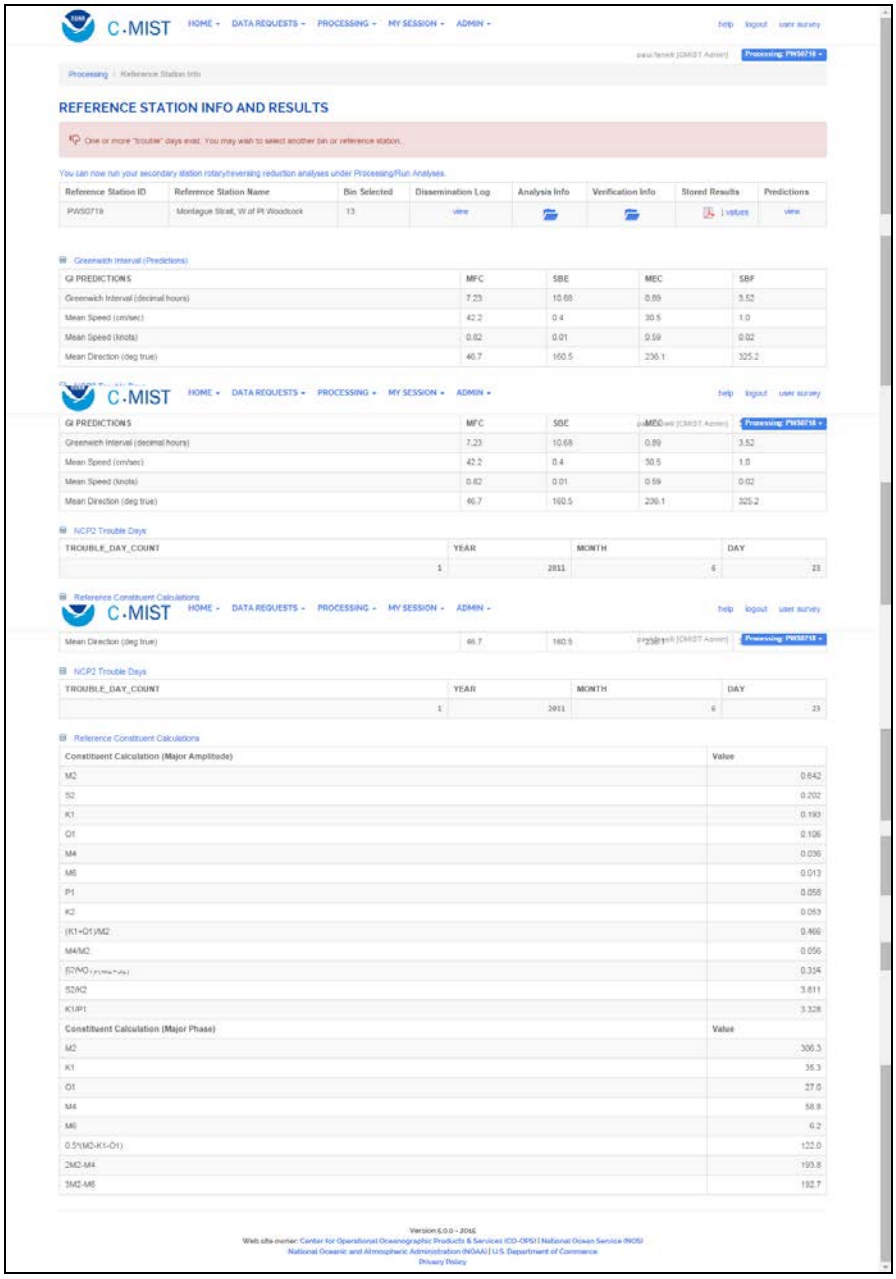



Fig. 8.2: Reference station Info and Results screen after PWS0719 bin 13 was selected as a reference station depth. Users can view reference station Greenwich Intervals, constituent calculations along with predictions and trouble days (if applicable) resulting from the ncp2 analysis routine.

*b. Running Rotary Analysis Off of a Reference Station*

Once a reference station and bin is selected, users can run rotary analysis by selecting *Processing >> Run Analyses* (Figure 6.2) and clicking on *Rotary and Reversing Reduction Analyses*. Users must select *Rotary Analysis* from the drop-down menu and choose whether to run the analysis on all bins or select one bin for analysis. Users can then click *Run Analysis* to start the routine. When the routine is completed, the mean total current speed & direction results for the first bin run are displayed (Figure 8.3). Users can also view the mean tidal current speed & direction, Greenwich Intervals, error log and control file by selecting the appropriate option from the drop-down menu at the top. Just as with any analysis result, users can view rotary results for a given bin by navigating to *My Session >> My Analyses* and searching for "Rotary analysis" within the Analysis Description column.

Once rotary analysis is complete, users can generate plots of the results by navigating to *Processing >> Post-Analysis Plots* and clicking on *Rotary Plots*. Users have the option to generate a polar plot and a speed/direction plot of the rotary total current for one or all bins using the drop-down menus. When users have made their selection, they can click *Plot* to generate the figures. When C-MIST is finished, the first plot generated will be displayed. If *all plots* and *all bins* were chosen, the rotary mean total current polar plot for bin 1 will be displayed (Figure 8.4 shows this plot for bin 10). As with other plots, users can view them by using the arrows above the plot or navigating to *My Session >> My Plots* and searching for "Rotary" in the Plot Description column.

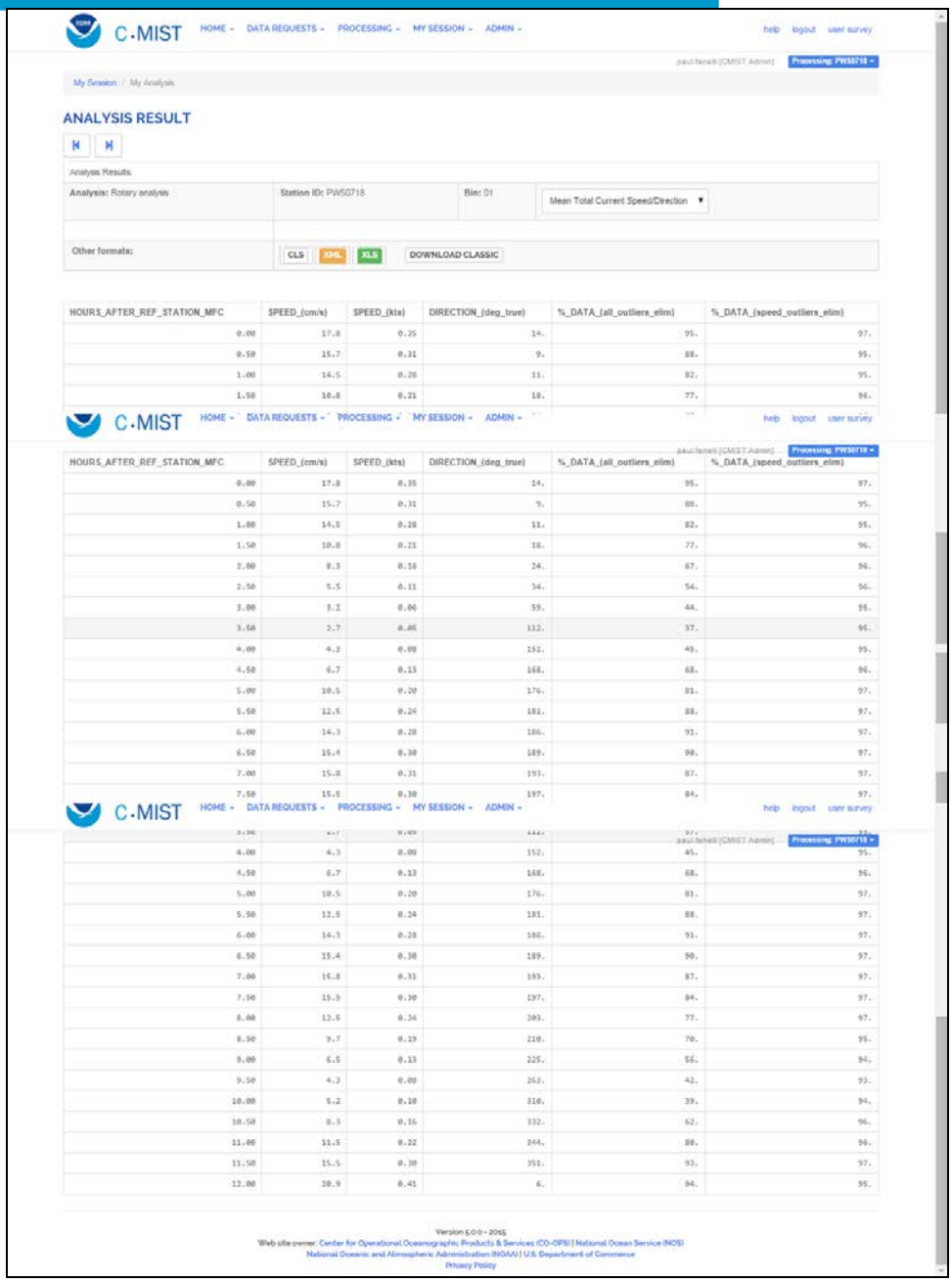



Fig. 8.3: Rotary total current speed & direction for PWS0718 bin 1 using PWS0719 bin 13 as a reference station. Users can view additional results using the drop-down menu at the top or view additional bins using the arrows at the top-left part of the page.

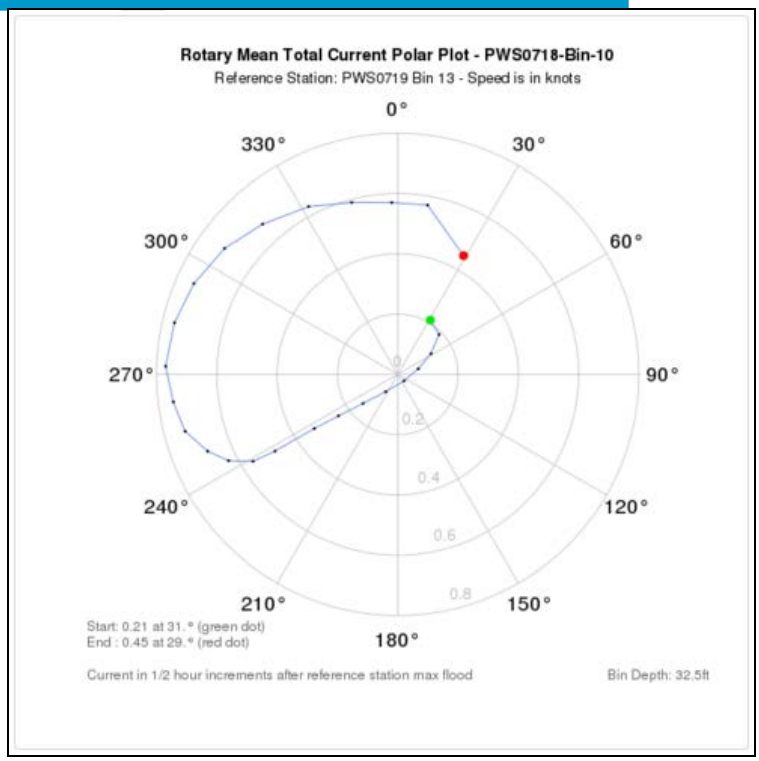



Fig. 8.4: Rotary total current polar plot for PWS0718 bin 10 using PWS0719 bin 13 as a reference station. Users can view additional plots using the arrows at the top-left part of the page or navigating to *My Plots* under *My Session*.

### *c. Running Reversing Reduction Analysis Off of a Reference Station*

Reversing reduction analysis requires the same prerequisites as rotary analysis. Once a reference station is selected, users can run reversing reduction by selecting *Processing* >> *Run Analyses* (Figure 6.2) and clicking on *Rotary and Reversing Reduction Analyses*. Users must select *Reversing Reduction Analysis* from the drop-down menu and choose whether to run the analysis on all bins or select one bin for analysis. The reversing reduction analysis will compare tidal phase times between the reference and subordinate stations and create a mean time difference and speed ratio (MFC and MEC only). By default, the routine will factor in all tidal phase "pairs" in calculations, regardless of their time difference. Under certain circumstances, users may want to only consider tidal phases at a subordinate station that fall within a certain time period of the reference station in the calculations as a way to eliminate outliers. By selecting *Reversing reduction analysis (Custom)*, users can choose the range of acceptable time differences

between reference and subordinate stations (for example, ± 2 hours) for each tidal phase. Once users have selected their option, they can perform reversing reduction analysis by clicking *Run Analysis*. When the routine is completed, the Greenwich Intervals of the reference and subordinate station for the first bin analyzed are displayed (Figure 8.5).

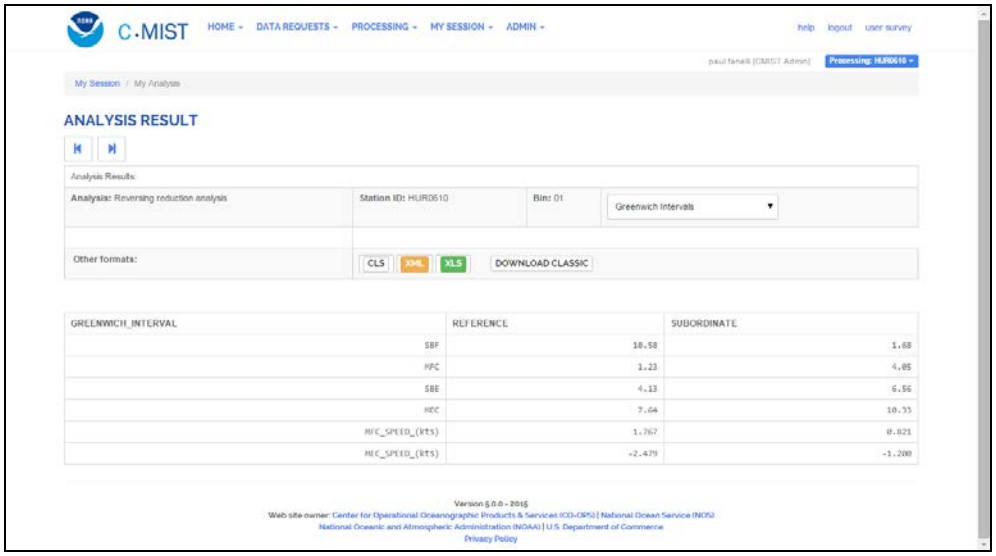



Fig. 8.5: Greenwich Intervals obtained from reversing reduction analysis. Using the drop-down menu at the top, users can also view the daily maxes and slacks for the subordinate station, statistical output, error log and control file. Users can view results for additional depths using the arrows at the top-left part of the page or navigating to *My Analyses* under *My Session* and searching for "Reversing reduction analysis" under Analysis Description.

In addition to the Greenwich Interval output, users can also view the daily maxes and slacks of the subordinate station, statistical output, error log and control file by using the drop-down menu at the top of the page. Users can view reversing reduction results for a given bin by navigating to *My Session* >> *My Analyses* and searching for "Reversing reduction analysis" within the Analysis Description column. Users can generate plots of the results by navigating to *Processing* >> *Post-Analysis Plots* and clicking on *Reversing Reduction Plots*. Users have the option to plot the speed ratio of MFC or MEC between the reference and subordinate station for each tidal phase. Users can also plot the time differences of each tidal phase over the prediction period. When users have made their selection, they can click *Plot* to generate the figures. When C-MIST is finished, the first plot generated will be displayed. If *all plots* and *all bins* were selected, a plot of MFC speed ratio for bin 1 will be displayed. Figure 8.6 shows one of the reversing reduction plots, for MFC time differences.

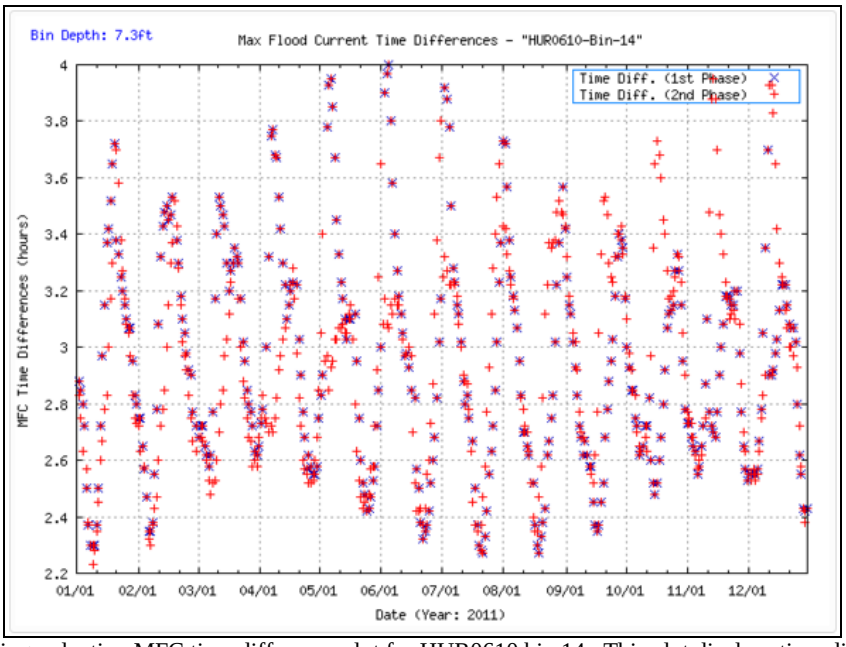



Fig. 8.6: Reversing reduction MFC time difference plot for HUR0610 bin 14. This plot displays time differences between subordinate station and reference station MFC. Users can view additional plots using the arrows at the top-left part of the page or navigating to *My Plots* under *My Session*.

Users can view all the reversing reduction plots by using the arrows above the plot or navigating to *My Session* >> *My Plots* and searching for "Reversing Reduction" in the Plot Description column.

# 9. Data Analysis Report Generation

After users have successfully run through data analysis including all pre and post-analysis plots, they have the option to generate a cumulative data analysis report, summarizing the results. This report contains much of the information that CECAT includes in station binders and was developed to replace these notebooks. Analysis results may also be stored in the database through C-MIST once a report has been generated (discussed in a later chapter). Covered in this section are:

- How to generate data analysis reports on C-MIST.
- A general overview of the contents of the cumulative data analysis report.

Users can generate a data analysis report by clicking on *Generate Reports* from the Processing main menu. This will bring up the Generate Reports menu, shown in Figure 9.1. Users can create individual reports with results from specific analyses, or a cumulative report with results for all analyses. Here, users can customize which bins will be included in the report and add analysis notes.

Users can select the report they wish to generate with the first drop-down menu. The Cumulative Data Analysis Report is the default selection, however users also have the option of creating the following reports individually:

- Station Background Information
- Project Stations Report
- Bin Mapping/Mean Lower Low Water Report
- Data Quality Control Report
- Data Gap Report
- Principal Current Direction Report
- Greenwich Interval (Raw) Report

- Harmonic Analysis Report
- Detide Analysis Report
- Greenwich Intervals (Predictions) Report
- Convert Report
- Reference Station/NCP2 Predictions Report (if applicable)
- Rotary Analysis Report (if applicable)
- Reversing Reduction Analysis Report (if applicable)
- Control Files Report

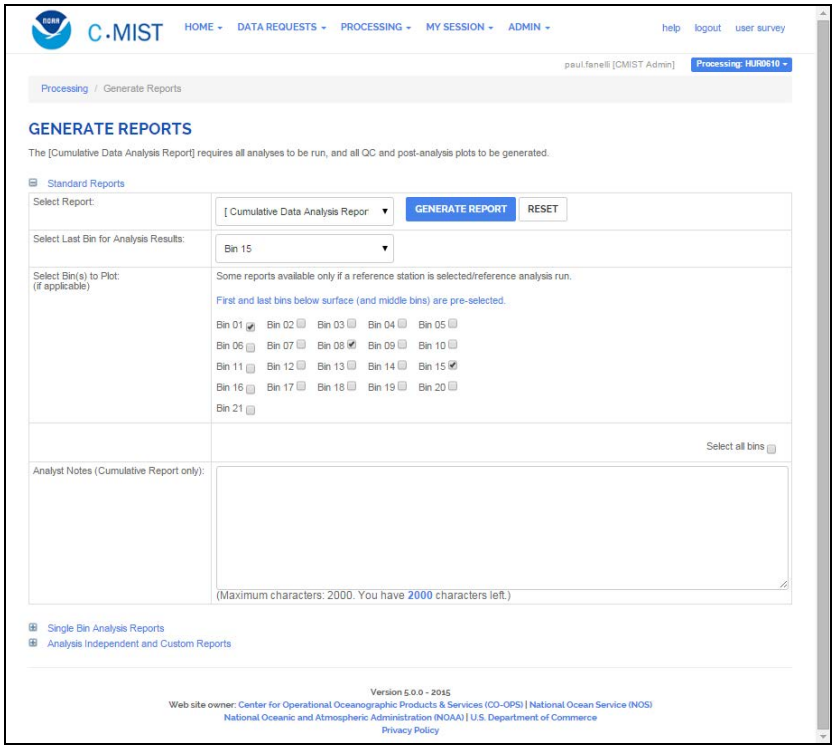



Fig. 9.1: Generate Reports screen on C-MIST. Users can select the uppermost bin for analysis results and the individual bins for plots to be included in the report. Users can also enter any analysis notes in the *Analyst Notes* section. Users also have the option of creating reports for a single bin or generating reports with custom QC plots, data statistics and list of current meter stations in the database.

Users can select the uppermost bin for output of analysis results using the second drop-down menu. Analysis results starting at bin 1 for all bins up to and including the selected bin will be included in the report. Below this drop-down menu, users can select individual bins for plots to be included in the report by clicking the appropriate checkboxes. The default selections are the estimated first and last good bins and one bin

located in the middle. Below this option, a field exists for users to enter analysis comments to be included in the report. Users also have the option of creating the above reports including the cumulative data analysis report for a single bin under the 'Single Bin Analysis Reports' menu.

Users have the option of creating additional reports under the 'Analysis Independent and Custom Reports' menu. Here, users can generate a report of all custom QC plots generated for a station and report containing data statistics calculated when data was trimmed. Users can also create a report listing all the stations presently stored in the National PORTS database.

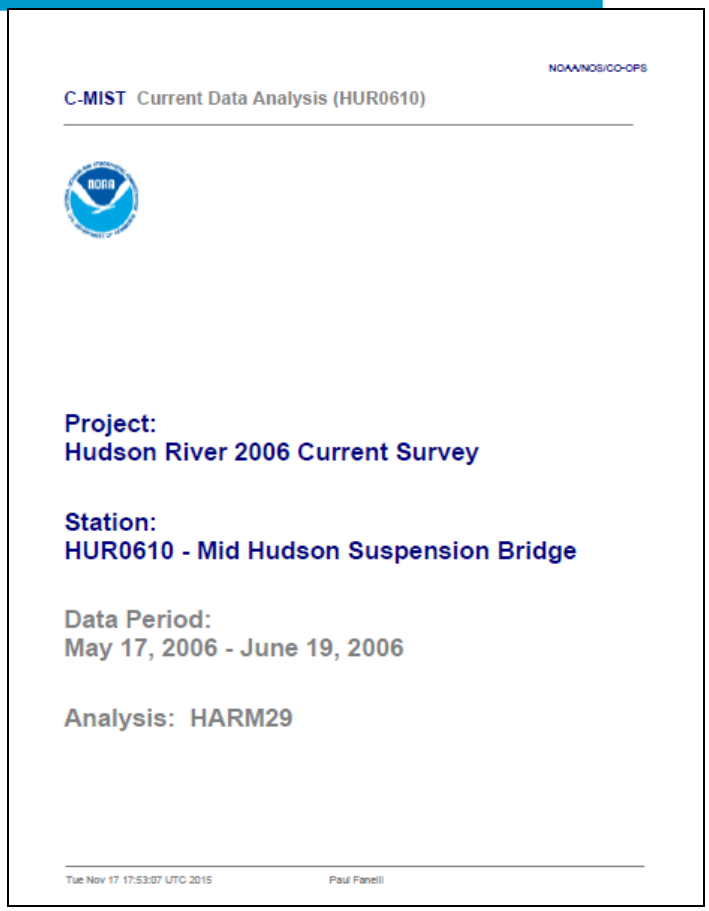
When the options have been set, users can generate the report by clicking the *Generate Report* button to the right of the first drop-down menu. A progress bar will appear, however report generation takes only a few seconds. A page will then appear with a link to the report, where users have the option of viewing or saving the report. The report is in PDF format and the default name given if saving, will be **station_ID.pdf**, regardless of the report chosen.

When the Cumulative Data Analysis Report is selected, the format of the report is as follows:

- Cover page (Figure 9.2), containing station name, station ID, current survey and deployment period. If a custom harmonic analysis or custom quality control was used, it will be displayed.
- Report Overview, containing a list of the included sub reports, harmonic analysis used and analysis notes added.
- Summary Report, displaying important analysis results for all bins included in the report. Results include AZI (flood) direction, major axis variance %, cumulative correlation %, residual variance, Detrich ratio and Greenwich Interval time, speed and direction.

- Station Background Information, containing relevant station metadata.
- Bin Mapping/Mean Lower Low Water (MLLW) Report, containing the results of mean lower low water calculated from the pressure data and a table outlining the depth and height above bottom of the bins below the surface according to mllw.
- Data Quality Control Report, containing QA/QC plots for all *plotting* bins. If custom quality control was used, the thresholds will be displayed on the first page. The order of the plots is as follows:
    - Pitch and Roll (degrees) time series
    - Temperature & Pressure time-series
    - Percent Data Loss profile
    - Echo Intensity profile
    - Echo Intensity (beams 1-4, counts) time series
    - Contour plots of echo intensity (beams 1-4, counts)
    - Correlation Magnitude (beams 1-4, counts) (RDI Only) time series
    - Percent Good Ping (3 beam solution, transformations rejected, greater than 1 beam bad, good 4 beam solution) (RDI Only) time series
    - Velocity north/east scatter plot (cm/s)
    - Velocity north & east time series (cm/s)
    - Speed/Direction scatter plot (cm/s)
    - Speed & Direction time series
- Analysis Plot Report, showing post-analysis plots such as predictions versus observations (detide) for all plotted bins.
- Data Gap Report, containing results from the data gap analysis for all analysis bins.
- Harmonic Analysis Report, containing results from the harmonic analysis routine (lsqha, harm29, harm15) for all analysis bins. Included are results formerly contained in the .cons and .out files. The constituents are listed in tabular and classic format.
- Constituent Calculations Report, containing various constituent ratios commonly used to characterize currents at a station or compare stations with one another.

- Greenwich Interval (Predictions) Report, containing results from the **gi** routine for the 2001 predicted data for all analysis bins.
- Detide Analysis Report, displaying tabular results from the detide routine.
- Reference Station/NCP2 Predictions Report (optional), containing information about the reference station used if non-harmonic analysis was performed on the station.
- Rotary Analysis Report (optional), containing the results from rotary analysis including tabular data and plots.
- Reversing Reduction Analysis Report (optional), containing the results from reversing reduction analysis including tabular data and plots.
- Trimmed Data Check Report, contains header and bin-dependent data for 5 records before and after the first and last good record where data were trimmed. Bin-dependent data is shown for all bins for which analysis results are displayed in the report.
- Principal Current Direction Report, containing results from the **prcmp** FORTRAN routine for all analysis bins.
- Convert Report, containing ellipse results from the **convert** routine for all analysis bins.
- Greenwich Interval (Raw) Report, containing results from the **gi** routine for the raw data for all analysis bins.
- Control File Report, containing control files from all the routines.
- Index.



NOAA/NOS/CO-OPS

C-MIST Current Data Analysis (HUR0610)

Project:
Hudson River 2006 Current Survey

Station:
HUR0610 - Mid Hudson Suspension Bridge

Data Period:
May 17, 2006 - June 19, 2006

Analysis: HARM29

Tue Nov 17 17:53:07 UTC 2015 Paul Fanelli

Fig. 9.2: Cover page for the Cumulative Data Analysis Report, created in C-MIST. Station name, ID, survey and data period are listed.

In the above description of the contents of the report, **plotting bins** represent the individual bins selected for plots to be included in the report and **analysis bins** represent bins 1 through the uppermost bin selected for analysis results to be included in the report. Rotary and reversing reduction reports will only include plots for bins that were selected as plotting bins.

Users can view all reports generated in a C-MIST session under *My Session* and *View my reports*.

# 10. Storing Analysis Results

C-MIST gives some users the ability to store data analysis results to the database. This process differs somewhat between current survey data and PORTS data. Covered in this section are:

- Committing analysis results to the database for current survey data
- Committing analysis results to the database for real-time currents data

*a. Committing Analysis Results to the Database for Current Survey Data*

In order for results to be successfully stored in the database, all QA/QC plots and all analyses have to be completed and a report generated. The report does not need to be saved locally in order to be uploaded to the database, as it is saved in the user's C-MIST session. To commit the analysis results to the database, users need to click *My Session* from the top menu and then *My Data to Commit*. This will bring up the Ingest Analysis Results screen, seen in Figure 10.1.

The top of the Ingest Analysis Results screen shows which analyses, if any, have results already stored in the database and the status of the stored results (e.g. whether or not they are verified). **Presently, only one set of analysis results per analysis type can be stored in the database under each "analysis period".** Users who subsequently commit a set of analysis results from an analysis type already stored in the database will supersede the previous analysis results. The previous results will still be visible, however they cannot be restored as the "official" analysis results. Furthermore, once a set of analysis results are set as verified (accepted), no more analyses of any type can be stored in the database for a particular analysis period (see Figure 10.1). If a set of results is verified, a flag is set in the status column of the table at the top of the page and the *Store Results* button will be disabled. Note that there are 3 analysis periods available for current surveys: Survey; Custom 1; and Custom 2. This allows up to 3 different analyses of the same type to be stored for a survey station.

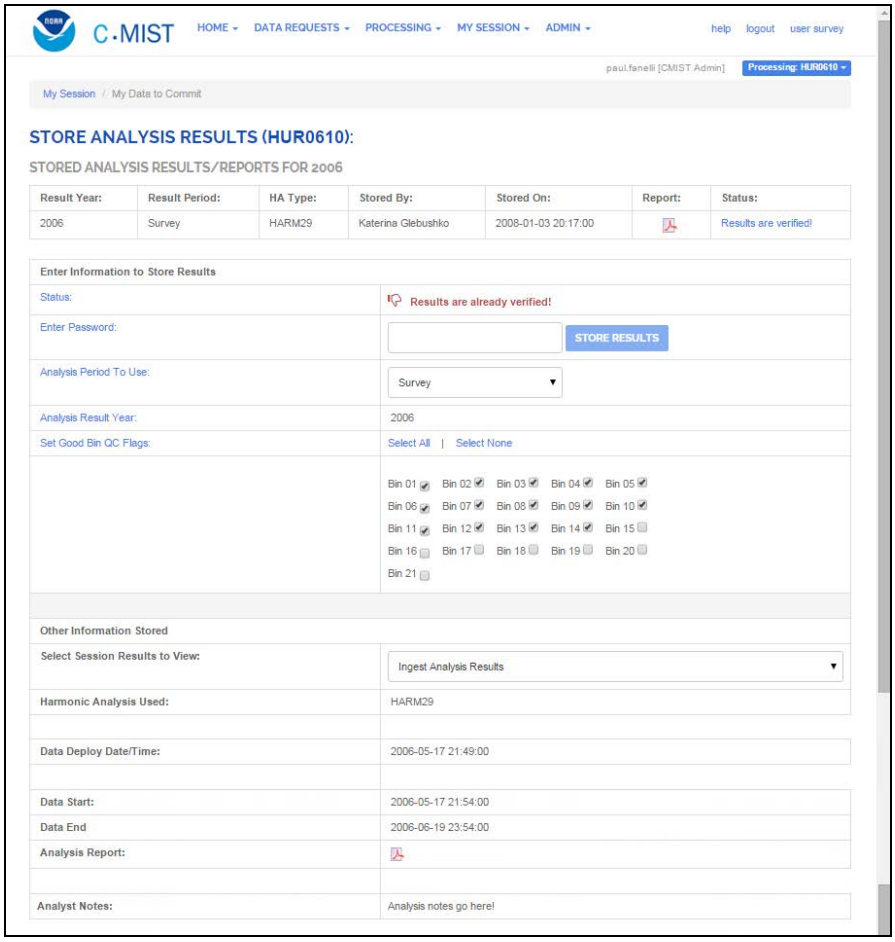



Fig. 10.1: Store Analysis Results screen in C-MIST. Users can see if data results have already been stored for the station analyzed. Users also have the option to view the PDF report, revisit analysis notes and set the good bin QC flags. In this example, lsqha results that were previously stored have already been verified and another analysis cannot supersede it. Once an analysis is verified, no more results can be written to the database for that station and analysis period.

Under the header 'Enter Information to Store Results' users can view the status of the present analysis to be stored. Initially, users will have to set the analysis period to use for storing results before they can commit the data. For current survey data, there are only three options; however PORTS stations will have many different options as will be described later in this chapter. If the analysis is complete and the Analysis Period to Use is set to Survey, the status of the present analysis will read "*Ready to store analysis results* or *Results will be superseded!"*, depending on whether or not analysis results already exist for that analysis type and period. If the present analysis is incomplete it will state in red, *Analysis results are incomplete, report not generated or several HA used!*

Finally, users can set the good bin QC flags which have default selections based on results from the bin mapping routine described in the Harmonic Analysis Processing section. **It is important that the correct bins be set as good prior to storing analysis results since these flags determine which bins will have raw data and analysis results disseminated to the public.** When users are done setting the above parameters, they can ingest the analysis results into the database by clicking on *Store Results*. This will bring up a progress bar and when ingestion of analysis results is complete, users can view the status of the constituent and bin-dependent results to see if all were stored correctly. If custom quality control was used, the user-defined threshold values are stored in the database along with analysis results.

In the 'Other Information Stored' section, users can view their session results before storing the analysis results. The options are Analysis Results Overview, Bin-Dependent Analysis Results, Constituent Results and if necessary, Rotary and/or Reversing Reduction results. Below this drop-down menu, users can view the deploy date and time, analysis result year, start and end date/time of the analysis to be stored and view the PDF report generated. Finally, users can view analysis notes entered during report generation.

*b. Committing Analysis Results to the Database for Real-Time Currents Data*

Unlike current survey data which has a finite beginning and end analysis period (usually close to the deployment and recovery date/time), PORTS data is real-time. C-MIST users can extract any subset of PORTS data they wish to analyze. Users may want to store analysis results for different time periods, but same analysis type. Therefore an enhanced *Commit Data* module was developed to handle the storing of analysis result sets from different periods for the same real-time deployment period. Just as was the case with current survey stations, users must run through all analyses prior to analysis results being committed to the database.

Users can store the results in the database by clicking *My Data to Commit* under *My Session*. Figure 10.2 shows the 'Store Analysis Results' module for PORTS station

cb0701. Users can see which analyses are stored at the top of the screen and view the PDF reports for each. Results are stored based on a unique year, result period and analysis type. The screen is set up similar to the module to store survey results, however users must choose a finite analysis period to store a result set. If data spans multiple years, the user will also have to choose which year to store the analysis result set. The analysis periods are as follows:

- Monthly (January-December)
- Seasonal (Spring, Summer, Fall, Winter)
- First, middle and last 6 months of the year
- First 30 days, 3 months or 6 months of the deployment

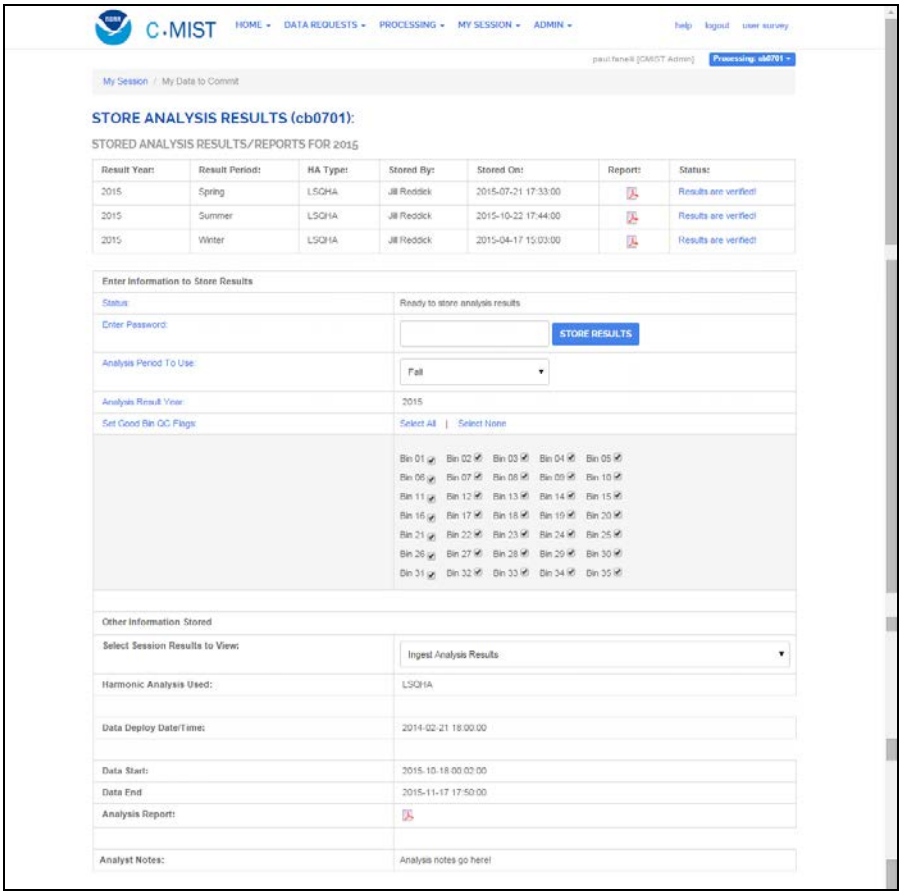



Fig. 10.2: Store Analysis Results screen in C-MIST for PORTS data. This screen is similar to the corresponding screen for survey data, and users must select a finite analysis period to store results. Users can see if data results have already been stored for the station. Users also have the option to view the PDF report, revisit analysis notes and set the good bin QC flags.

Two custom slots are also available for analysis periods that do not fall in one of these categories. The choice of analysis period can be subjective so users should choose the period that most represents the data set chosen. After the year and data period have been selected, users can store analysis results by entering their password and clicking *Store Results*. Once the process is complete, users can view if all bins were stored correctly.

# 11. Verifying Analysis Results

After currents data are analyzed, they undergo two sets of checks before data and analysis results can be used for products such as the Tidal Current Tables. First, someone other than the data processor will perform a first check of the data quality and analysis. Once this check is completed and any issues are addressed by the processor, the data set is said to be **verified**. A second, final check is done to the analysis results. After this final check, the analysis results are said to be **disseminated**. C-MIST provides certain users the ability to verify stored analysis results for both current survey and real-time data. Covered in this section are:

- Running automated verification checks
- Verifying stored analysis results for current survey and PORTS data.

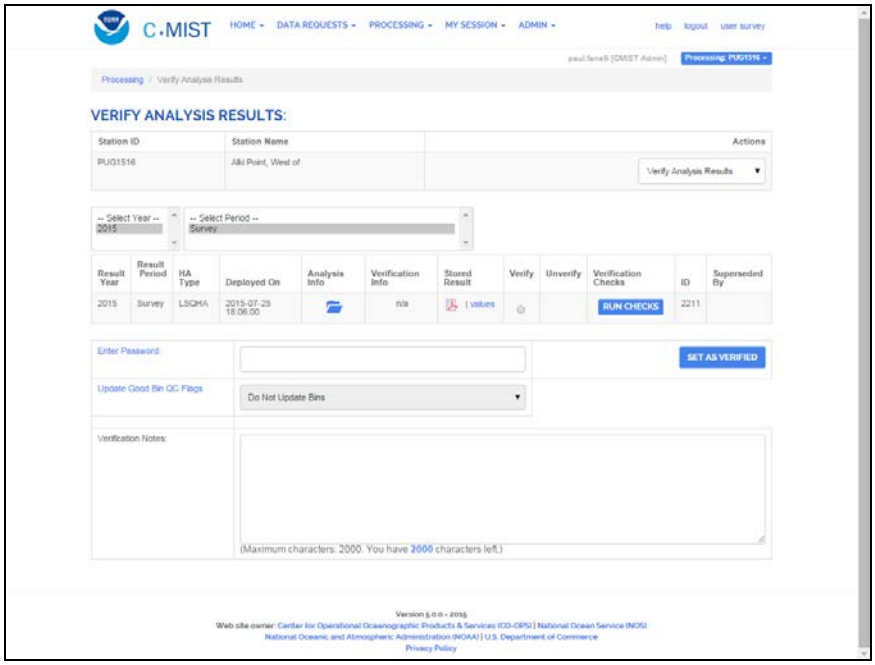



Fig. 11.1: Verify Analysis Results screen in C-MIST. Users must select a year and period to view which analyses are stored in the database. For survey stations, there is generally just one choice for year and period, but at times multiple analyses are stored.

*a. Running automated verification checks*

After logging into C-MIST, data reviewers can verify analysis results by clicking on *Processing* and then *Select a Station*, where they can navigate to the station that they are to examine. Clicking the station will bring up the Station/Project Information screen described in the Data Extraction section and pictured in Figure 3.4. Users with adequate permissions have an option *Verify Analysis Results* in the *Action* drop-down menu in the upper right hand corner. Selecting this option will bring up the Verify Analysis Results screen, shown in Figure 11.1.

Users must select a year and analysis period before any analysis results are shown. For current survey stations the year will always be the year of analysis and the period will always be *Survey*. For PORTS stations, there may be several years and analysis periods for which results have been stored in the database. Once these two parameters are selected, C-MIST will display the results stored as seen in figure 11.2.

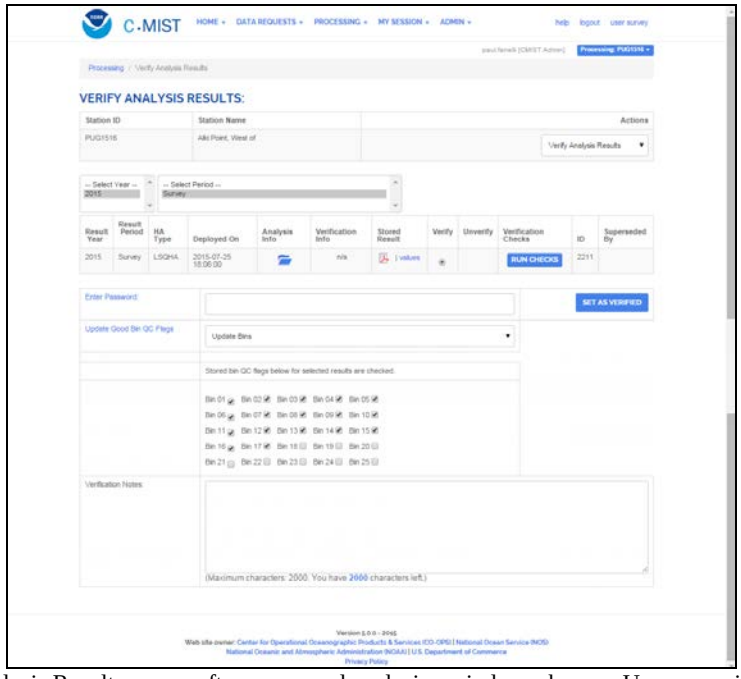



Fig. 11.2: Verify Analysis Results screen after a year and analysis period are chosen. Users can view which analysis types are stored in the database for a particular station and set an analysis as accepted. Users can enter verification notes and view the PDF report or certain stored analysis results using the links under the *Stored Results* column header. They can also modify the bins marked as good in the database if needed.

Under this screen, users can view the station ID, station name and deploy date/time for the station to be verified. Below this, users can see which harmonic analyses have results stored in the database and review the full data analysis report for each analysis. Users can also view some results directly by clicking on *Values* under the *Stored Results* column.

There is also an option to run automated verification checks of the analysis results. This can be accomplished by clicking on the *Run Checks* button, which will bring up the Verification Analysis Overview screen, seen in figure 11.3.

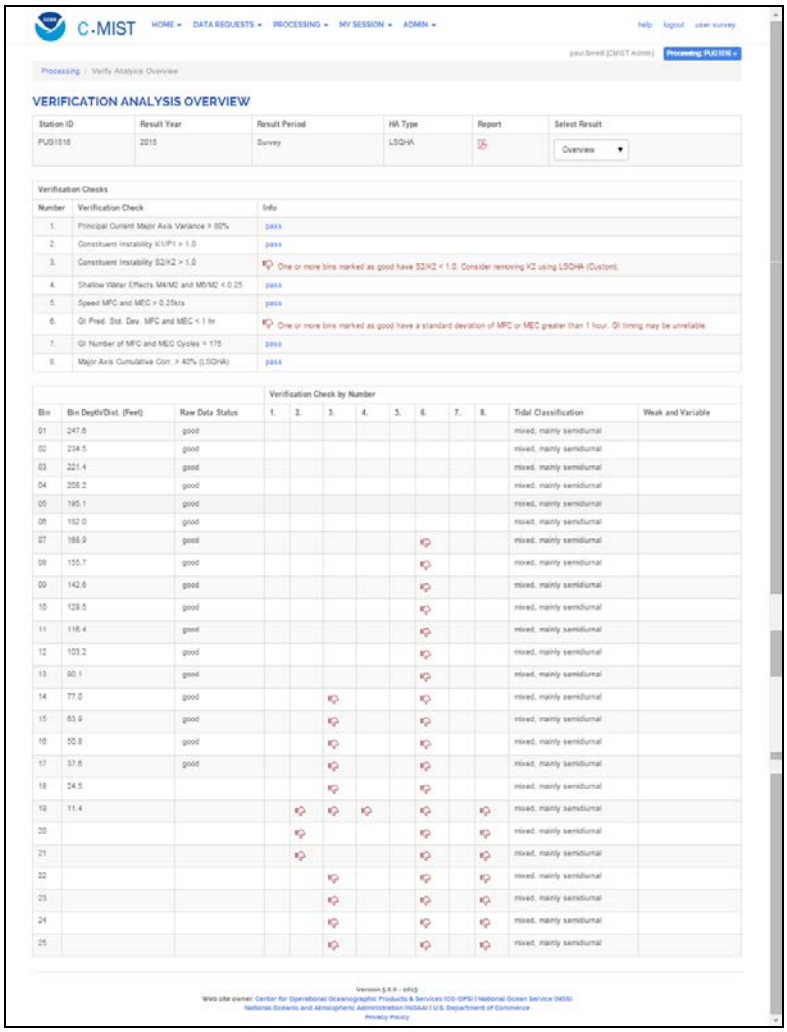



Fig. 11.3: Verification Analysis Overview screen after automated quality checks were run. Users can view whether certain checks passed or failed by bin and also over the water column (defined by the good bins set in the database). A number of profile plots and analysis results by bin can be viewed by selecting the appropriate item in the drop-down menu in the upper-right.

The Verification Analysis Overview screen (Figure 11.3) contains a lot of information. The top box displays whether or not 1 or more good bins failed one of the following automated quality checks built in to C-MIST:

- **Principal Current Major Axis Variance > 80%** - Indicates whether or not the current is highly rectilinear
- **Constituent Instability K(1)/P(1) > 1.0** – Indicates whether or not P(1) should be removed from the analysis
- **Constituent Instability S(2)/K(2) > 1.0** – Indicates whether or not K(2) should be removed from the analysis
- **Shallow Water Effects M(4)/M(2) and M(6)/M(2) < 0.25** – Indicates whether or not the station exhibits shallow water effects (which usually result in less accurate timing of maximum flood and ebb.
- **Speed MFC and MEC > 0.25 kts** – Indicates whether or not currents may be weak and variable
- **GI Predicted Standard Deviation of MFC and MEC < 1 hour** – Indicates whether or not the timing/speed of maximum flood, ebb or slack may be unreliable.
- **GI number of MFC and MEC Cycles > 175** – Indicates whether or not enough maximum flood or ebb events were predicted over a year to create an accurate mean speed and time.
- **Major Axis Cumulative Correlation > 40%** - Indicates whether or not a significant enough amount of energy was resolved by the constituents during LSQHA analysis.

The top box ignores failures in bins that were not marked as good in the database. The bottom part of this page highlights in a table, each bin/depth and which checks failed, if any. A failure is displayed as a red exclamation mark and users can hover over the mark to see which check failed, or cross reference the number at the top of the column with the number in the upper box. In addition, the bottom table indicates the tidal classification (based on the Detrich Ratio [K(1)+O(1)]/M(2)) and whether or not a bin/depth may be weak and variable.

In addition to the verification checks, C-MIST also generates a number of profile plots detailing the results across the water column. These plots can be accessed via the drop-down menu in the upper-right (Fig 11.4).

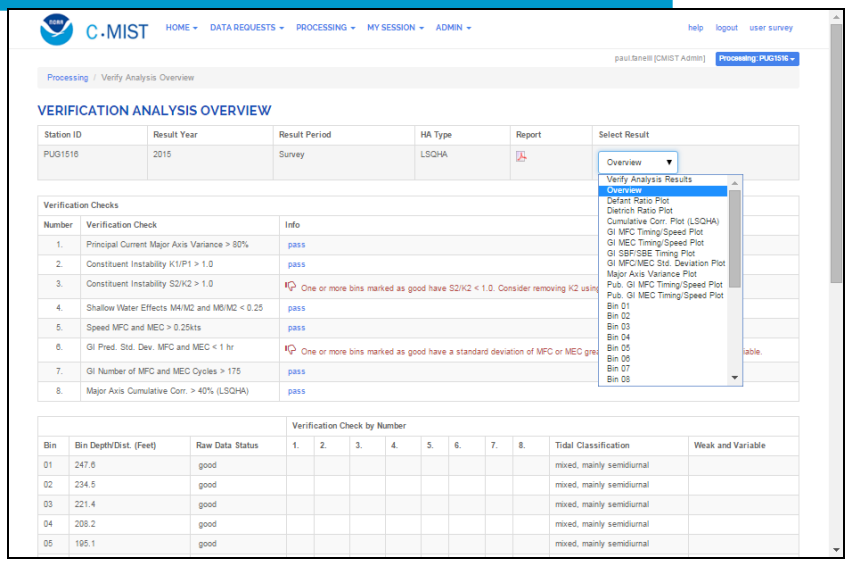



Fig. 11.4: Verification Analysis Overview screen highlighting the drop-down menu where detailed analysis results by bin and profile plots of certain results can be viewed.

Profile plots available include:

- **Defant Ratio [K(1)+O(1)]/[M(2)+S(2)]** – tidal classification (e.g. semidiurnal, mixed, diurnal)
- **Detrich Ratio [K(1)+O(1)]/M(2)** – tidal classification (e.g. semidiurnal, mixed, diurnal)
- **Cumulative Correlation** – Measure of how much tidal energy was resolved by the analysis
- **GI MFC Timing/Speed** – Average timing and speed of maximum flood
- **GI MEC Timing/Speed** – Average timing and speed of maximum ebb
- **GI SBF/SBE Timing** – Average timing of slack before flood/ebb
- **GI MFC/MEC Standard Deviation** – Standard deviation of MFC/MEC timing
- **Major Axis Variance** – Measure of how rectilinear currents are

Figure 11.5 provides an example of one a profile plot of MFC timing and speed. Depths that are marked as good are in blue and depths that are not marked as good are in red. Profile plots of MFC and MEC speed/timing are also provided for only good bins for publications (Figure 11.6)

In addition to these profile plots, detailed analysis results and a summary of the verification checks by bin can also be viewed. The goal of the automated verification checks is to cut down on the amount of time it takes to verify analyses of currents data and provide additional information to more easily compare results over the water column.

A PDF report is automatically generated containing the all the data and plots mentioned above and is available at the top of the Verification Analysis Overview page (Fig 11.3)

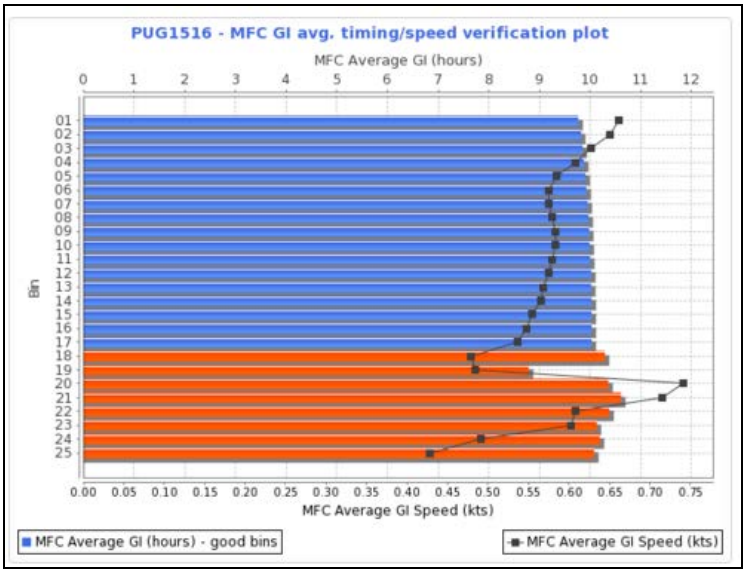



Fig. 11.5: Profile plot of the average timing and speed of maximum flood current from analysis of currents at station SFB1214. Bins with good data are in blue and bins that do not contain good data are in red.

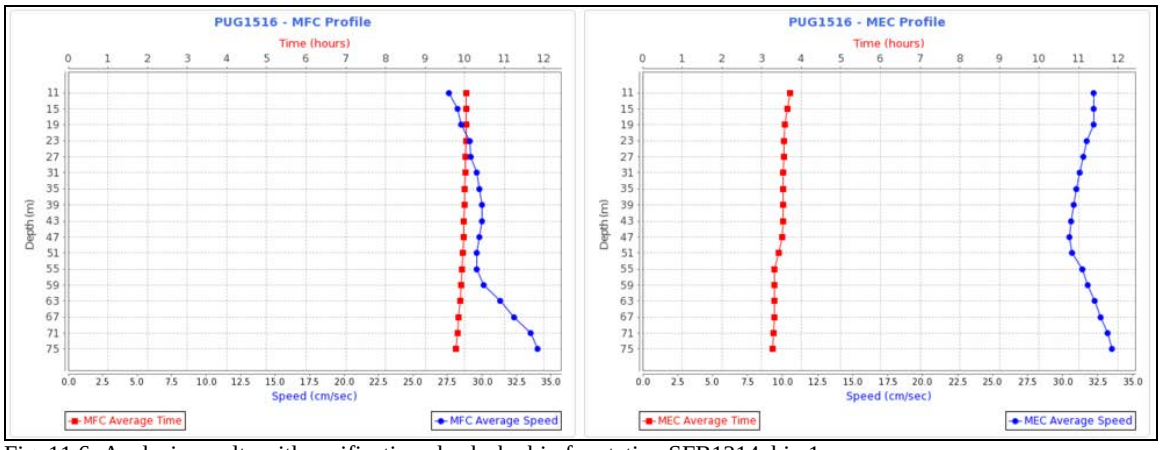



Fig. 11.6: Analysis results with verification checks by bin for station SFB1214, bin 1.

*b. Verifying Stored Analysis Results*

Users can verify a set of analysis results from the Verification screen shown in Figure 11.2. To verify data, click the button under *Verify* in to the right of the analysis results you wish to verify. If users wish to modify the good bins marked by the data processor, they can select "Update Bins" under the *Update Good Bin QC Flags* drop-down menu.

When this is complete, users must enter their password and click *Set As Verified*. This will bring up a message stating *Analysis results have been set as verified.* Users can no longer verify an analysis set, but still view the stored results and verification notes as seen in figure 11.7. Users can also still run the verification checks after a station is verified.

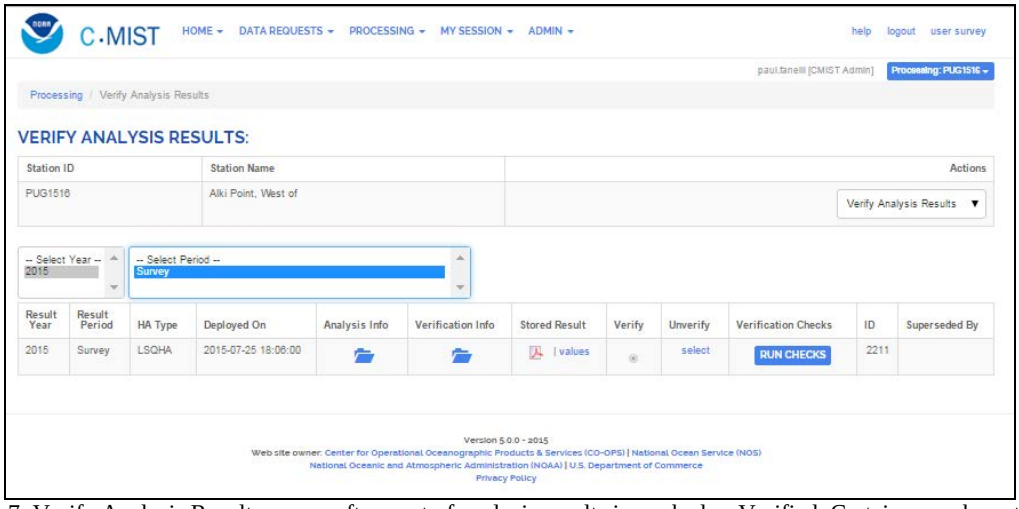


Fig. 11.7: Verify Analysis Results screen after a set of analysis results is marked as Verified. Certain users have the ability to unverify an analysis set.

Once analysis results have been verified, users cannot store more results to the database for any analysis type for current survey data. Users are prevented from storing any more analysis results since the *Store Results* button is disabled and the status reads *Results are already verified!* (see Figure 10.1).

**Once a current survey analysis has been flagged as verified, no more results of any analysis type can be committed to the database for that station.** If an analysis is erroneously set as verified, it can be unverified by a C-MIST administrator. It should be noted that the verification process is the same, regardless if you are looking at current survey or PORTS data. However, unlike for current survey stations, PORTS stations can have more than one verified set of analysis results since data analyses can be performed on many different subsets of data during a deployment. Therefore, the verification of one analysis will not prevent users from storing additional analysis results.

# 12. Disseminating Analysis Results

Once a set of analysis results are verified, they go through one more set of checks to ensure that the results and data quality are sound. This is done by someone other than the processor or verifier. After this final check, the analysis results are said to be disseminated. At this point, data and analyses are made available for other CO-OPS products (some automatically, some through manual processes). For real-time stations, since there may be several sets of verified analysis results for different time periods, users have the ability to select one of the verified data sets to be disseminated.

- Setting a verified data set for dissemination.

Since real-time currents data is collected year-round and different analyses can be performed on different subsets of the data, a means of marking one set of verified analysis results as the data CO-OPS will disseminate to the public is needed. Certain users have the ability to choose a verified data set to be disseminated so that there is no confusion which constituents and other results are the most accurate. This process is different from verifying since with real-time data, you may want to update the constituents for a station to have the most accurate and up-to-date predictions available to the public. For current survey stations where there is only one verified analysis, the dissemination step provides a critical second look at the results to be certain that they are accurate.

The dissemination process also provides the ability to select by bin which analysis results can be disseminated to the public. This can be useful for both real-time and current survey stations for a number of reasons (for example, if currents are non-tidal or the characteristics of the currents change with depth). The *Select analysis Results for Dissemination* screen can be reached from the *Station/Project Information* screen. For users with adequate permissions, the option to *Disseminate Analysis Results* can be found

in the drop-down menu in the upper right corner of the station information page under 'Action'. The dissemination module is shown in figure 12.1.

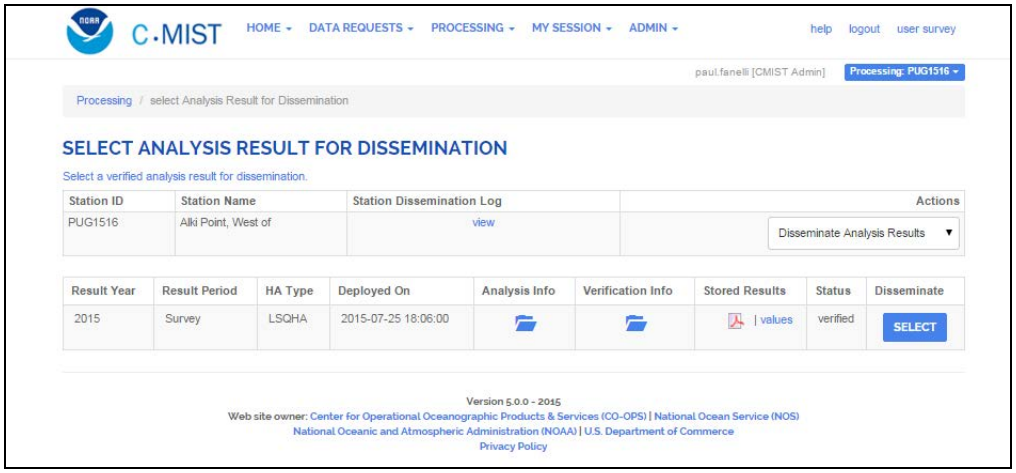



Fig. 12.1: Select Analysis Result for Dissemination screen for station PUG1516. From this screen, users can select a set of verified analysis results to disseminate or undisseminate. Note that because this is a current survey station, only one result set is marked as verified. A link at the top lets users view a dissemination log, which keeps track of the dates and notes for each time the dissemination flag is changed.

Users can view analysis results and reports for all verified analyses in this screen for comparison. Verification notes and analysis information are also available by clicking the appropriate icon under 'Analysis Info' and 'Verification Info'. To disseminate a set of analysis results, users can click the *Select* button beside the result set they wish to disseminate. This will take them to a screen to select the results to disseminate by bin, shown in Figure 12.2.

For each bin that was marked as good when the analysis results were stored (Figure 10.1), raw data is automatically selected for dissemination. In addition, for these bins, users can select whether or not to disseminate the constituent results. Users can also choose whether to disseminate the standard Greenwich Intervals. If rotary analysis results were stored, users can choose to disseminate the rotary Greenwich Intervals or rotary mean total current data instead of the standard Greenwich Intervals. If reversing reduction analysis results were stored, users can choose to disseminate the Greenwich Intervals from reversing reduction instead of the standard Greenwich Intervals. Users are

free to choose to not disseminate any Greenwich Interval or constituent results for a given bin.

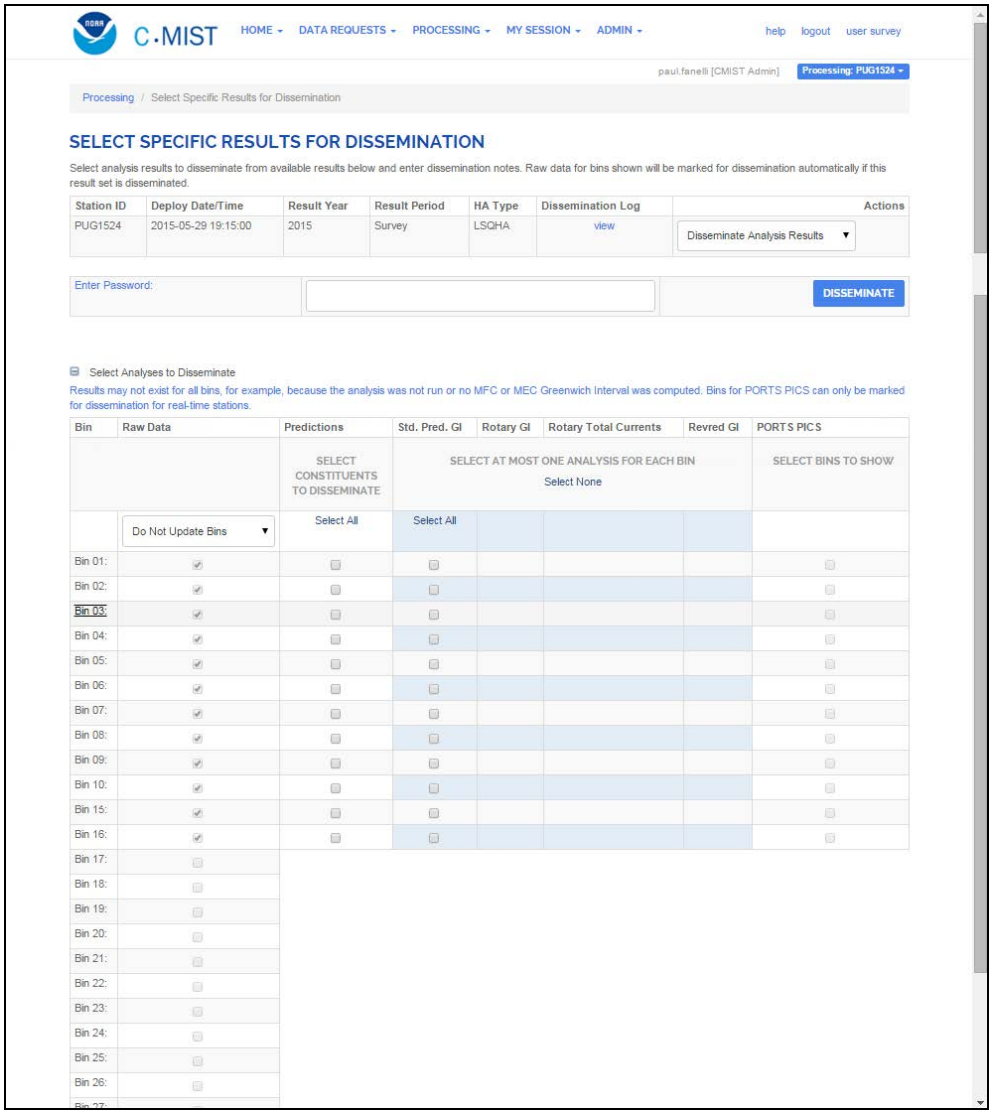



Fig. 12.2: Set Specific Results for Dissemination screen for station PUG1524. Users can select whether or not standard constituents should be disseminated for all prediction bins. Users can also check whether to disseminate standard Greenwich Intervals or rotary Greenwich Intervals, rotary total current or reversing reduction Greenwich Intervals if these results were stored with the standard results. Users can also adjust the good bins for raw data.

The Set Specific Results for Dissemination page is slightly different for real-time (PORTS) stations (Figure 12.3). An additional column allows users to select the bins to be included in PORTS products. Typically these will be the three bins displayed on the '3 Days Currents Plot'. When a set of analysis results for a real-time station is marked

for dissemination, MyPORTS products will automatically adjust the 3 Days Currents product to display the 3 bins selected in this column. Figure 12.2 shows this column is grayed out as this field is not applicable for current survey stations.

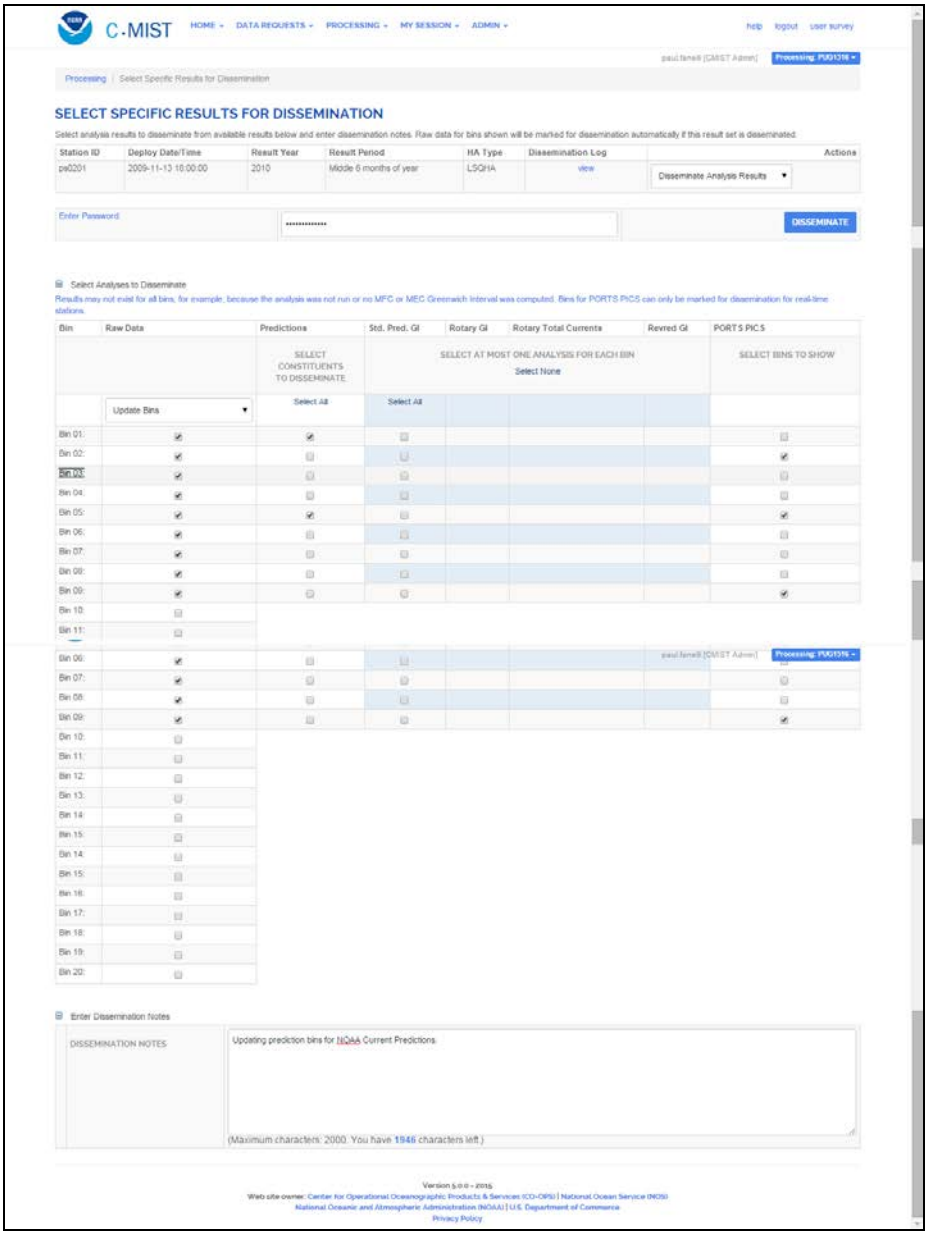



Fig. 12.3: Set Specific Results for Dissemination screen for station cb1201. In addition to setting the constituent and Greenwich Interval/Rotary results for dissemination, users can also check the bins to be displayed on the PORTS products.

Users have the ability to enter dissemination notes to add any other information about the station. When users are ready to set the results to be disseminated, they must enter their

password and click *Disseminate*. When C-MIST is finished setting the flags, the user is taken to a screen summarizing the results disseminated. At any time, users can view this screen for a station by navigating to the station information page and selecting *View Stored Results/Reports* from the drop-down menu. The disseminated results by bin can be viewed by clicking *values* for the disseminated analysis result set and navigating to *Results Disseminated* within the drop-down menu at the top.

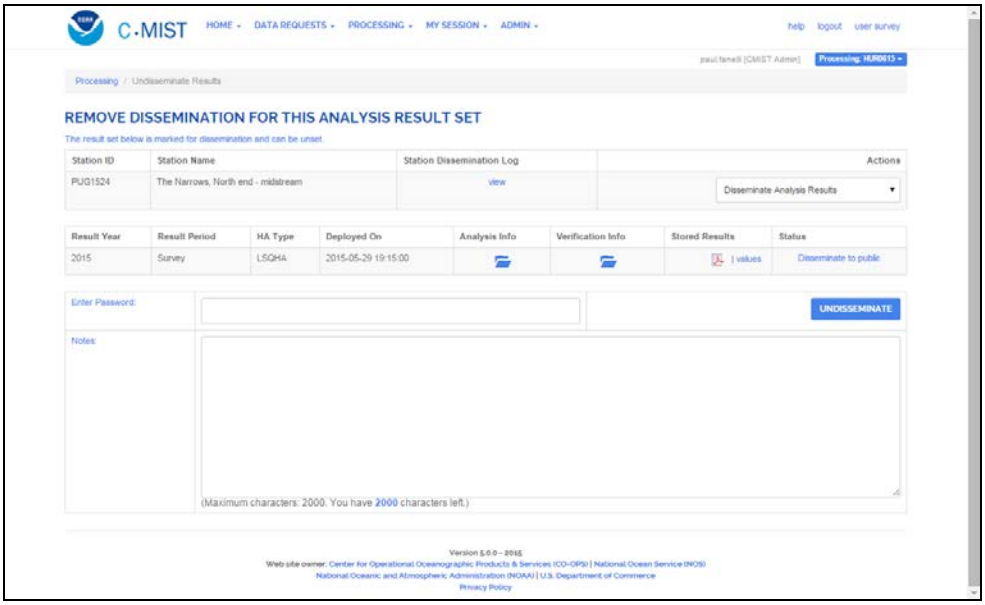


Fig. 12.4: Withdraw Dissemination for this Analysis Result Set screen for station PUG1524. Users can undisseminate a station and provide notes as to why the station is being undisseminated.

C-MIST also provides authorized users the ability to unset a station for dissemination. Routinely, real-time data is analyzed and a new set of analysis results will supersede the existing set of accepted results. Unsetting the dissemination flag is similar to setting it in that users must enter notes to explain why they are un-disseminating the station and also enter their password. To un-disseminate a station, users can navigate to the *Disseminate Analysis Results* option on the Station Information page. This will take users to the screen in Figure 12.4 which provides a way for users to withdraw the dissemination of a set of analysis notes and provide notes as to why they are doing so. C-MIST keeps a dissemination log so users can view when the dissemination status for a station has changed. Users can view the dissemination history of a station by clicking on *view*

under “Station Dissemination Log” at the top of the page. An example of the dissemination log is shown in figure 12.5. Users can see when analysis results were disseminated, by whom and view any dissemination notes entered.

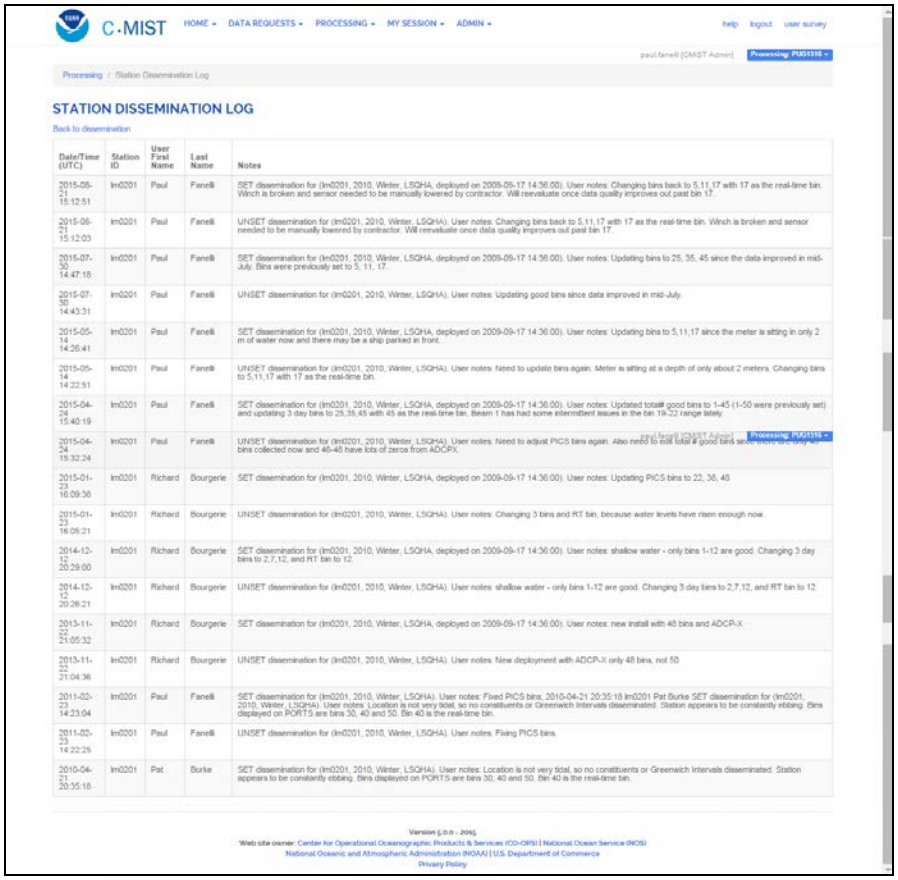


Fig. 12.5: Station Dissemination Log for PORTS station lm0201. Users can see the date/time when the dissemination flag was changed and who made the change. Dissemination notes can also be viewed in this screen.

# 13. Data Ingestion

While PORTS and other real-time data are populated in the database automatically through stored procedures, current survey data need to be ingested into the database directly. Station metadata needs to be complete and verified before data ingestion can commence. Metadata can be entered through the PORTS Powerbuilder database application. Covered in this section:

- Ingesting raw data into the National PORTS Database through C-MIST.

To reach the data ingestion module, users should navigate to the Station/Project Information screen by clicking on *Processing*. They can then click *Select a Station* and navigate to the station that they wish to ingest. Note that unless deployment metadata is entered, the station will not show up in the table shown in Figure 3.1. Clicking on the station will bring up the Station/Project Information screen (Figure 3.3). From this screen, in the 'Action' drop-down menu in the upper right corner, users can select *Ingest Raw Data*, which is denoted in blue. This will bring up the data ingestion module shown in Figure 13.1.

Users can view some station metadata through this screen and see whether or not data has been ingested already. If data already exists in the database, the *Browse* and *Ingest* buttons will be disabled and it will state in red *Data already ingested* to the right of the *Ingest* button.

To select the file, users can click the *Browse* button, where they can search their local network or hard drive for the raw data file. C-MIST can handle data ingestion directly of RDI binary files. ASCII data from SonTek ADP and Nortek Aquadopp current meters can be ingested following some pre-processing outside of C-MIST. When the appropriate file is selected, users should hit *Ingest* and the 'Confirm Data Ingestion' screen will

appear (Figure 13.2) showing the file to be ingested and giving users one last chance to verify station metadata before data ingestion.

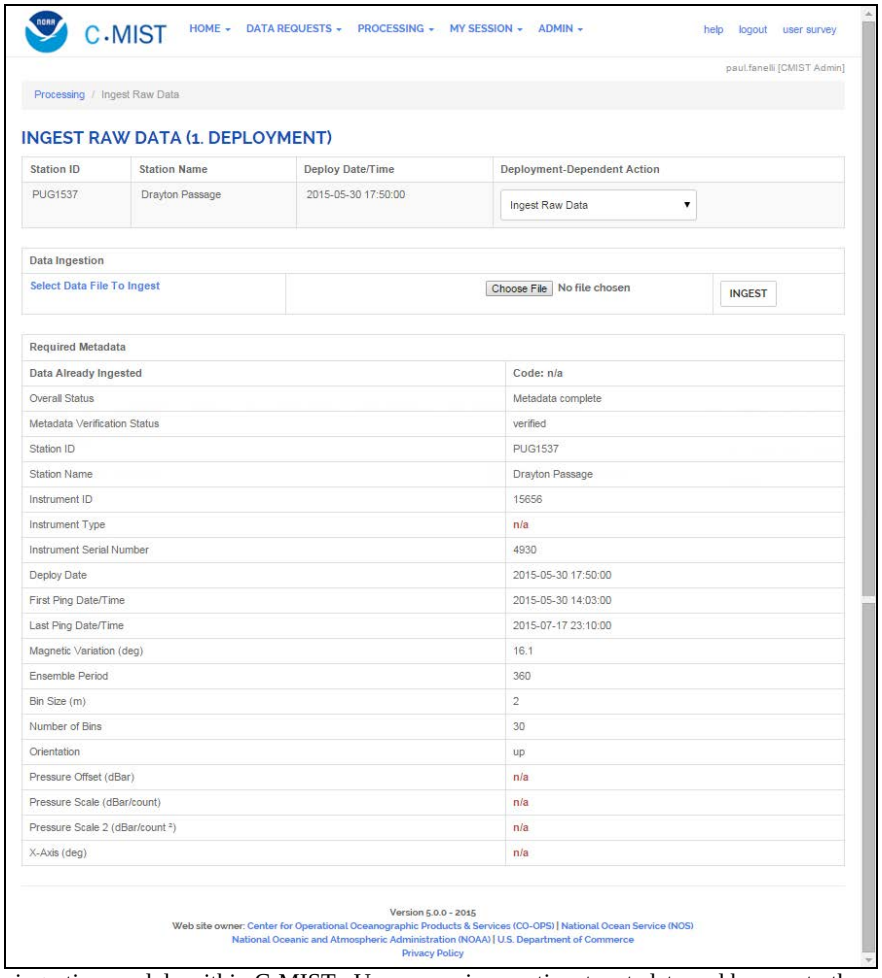



Fig. 13.1: Data ingestion module within C-MIST. Users can view pertinent metadata and browse to the raw data file they wish to ingest to the database.

Users then must enter their password in the box at the top of the screen and hit *Ingest* a second time. This will bring up a progress bar showing the percentage completed and any warnings/errors that the process encounters (Figure 13.3). **While data is being ingested, users should not close their browser as this may interrupt the data ingestion process.** When ingestion is complete, a screen will appear showing that all ingestion processed passed. Users should view the error log or extract the ingested data to verify that all records were ingested properly into the database.

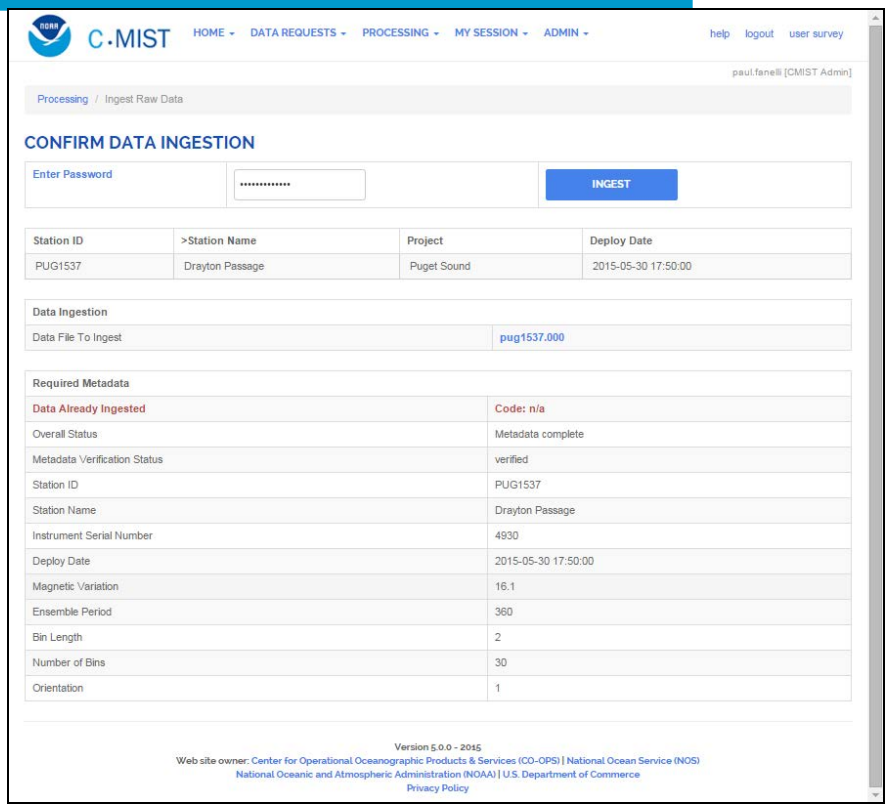



Fig.13.2: Confirm Data Ingestion screen in C-MIST. Users must enter their password before clicking *Ingest*.

Fig. 13.3: Data Ingestion and Progress screen. Users can view how far along the ingestion process is through a progress bar and viewing the latest timestamp ingested. Any warnings and errors encountered can be viewed as well. The browser window needs to remain open during the entire data ingestion.

# 14. Viewing Database Results

Once results are stored in the database, they can be viewed through C-MIST without the original station data being extracted. This allows users to quickly extract constituents and Greenwich Intervals in a variety of formats to be used for reference or for other CO-OPS programs or tools. Users can also generate a predicted time series off of stored constituents. Covered in this section:

- Viewing stored analysis results and PDF reports
- Viewing constituent results in DAS format
- Calculating Greenwich Interval differences between stations
- Generating data files for Tidal Current Table updates
- Generating predictions from stored constituents

*a. Viewing stored analysis results and PDF reports*

All users that have a C-MIST account have access to stored analysis results. To access these results, click on the *Processing* tab and select a station. The option to view analysis results is found under the *Action* drop-down menu (see Fig 14.1). Here, users can view the analysis and verification notes, dissemination status, Cumulative Data Analysis Report generated during data processing and database values of analysis results. Selecting *values* will bring you to the Analysis Results Overview page for the station (Figure 14.2). This page will give an overview of the analysis period, station depth (MLLW) used and depths of all bins falling below the surface. The Raw Data Status indicates which bins were marked as containing good data.

The options for viewing analysis results are contained within the *Select Result* drop-down menu at the top. Selecting *Standard Bin-Dependent Results* will bring you to a page showing results that depend on the depth of the data (Figure 14.3). Here, users can view the principal flood direction, bin depth, major and minor axis permanent current, detide

results and Greenwich Intervals. Users can change the bin number using the drop-down menu at the top. Only bins that were marked as good are available.

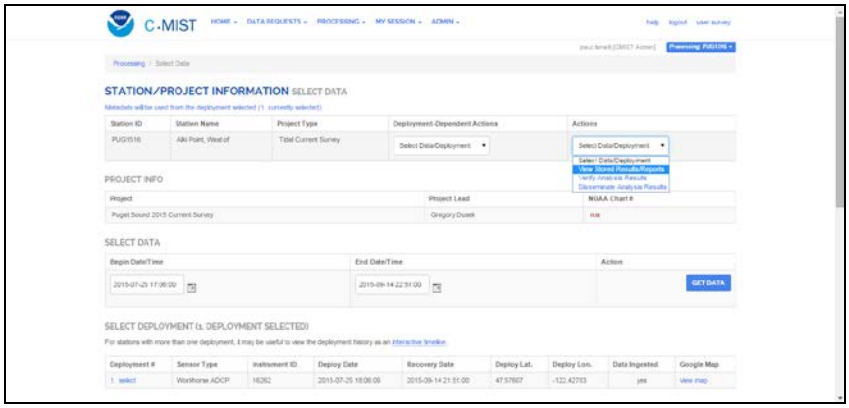



Fig. 14.1: Location of View *Stored Results/Reports* option within the *Action* drop-down menu.

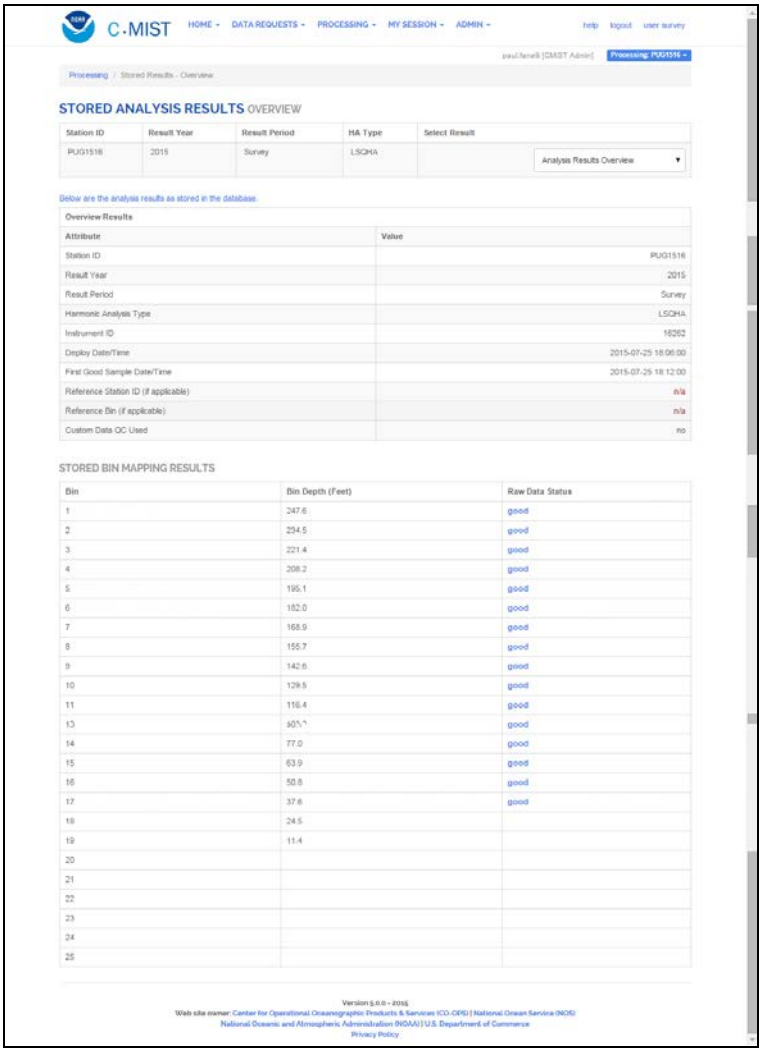



Fig. 14.2: *Analysis Result Overview* screen. Analysis period and bin depths are shown.

Selecting *Constituent Results* will bring up a tabular listing of constituent amplitude (knots) and phase (degrees) for both the major and minor axis (Figure 14.4). Again, users can select which bin they would like to see results for using the drop-down menu at the top.

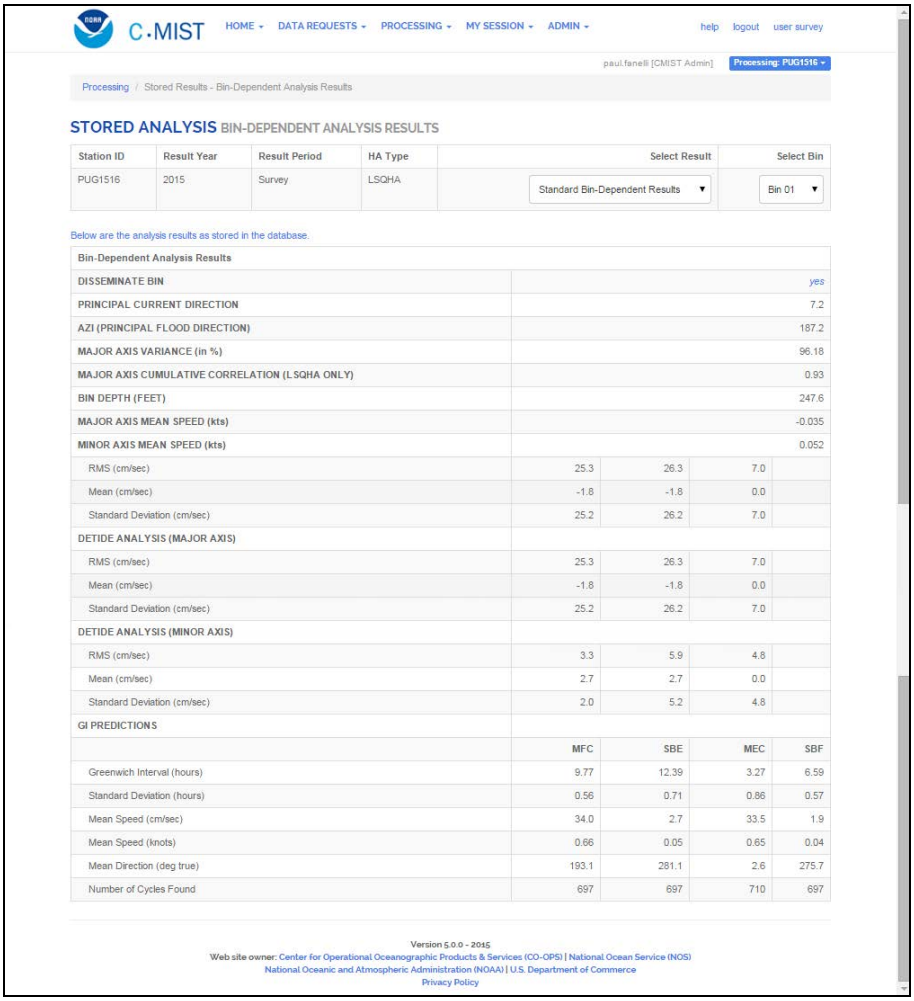



Fig. 14.3: *Bin Dependent Analysis Results* screen. Analysis results such as Greenwich Intervals, flood direction and cumulative correlation are displayed here.

Users can view some commonly used constituent ratios and calculations by selecting *Constituent Calculations* from the drop-down menu (Figure 14.5). Here, users can view such calculations as [K(1)+O(1)]/M(2), M(4)/M(2), M(6)/M(2), S(2)/K(2) and P(1)/K(1).

If rotary analysis was run on the station, *Rotary Results* will be listed in the *Select Result* menu. Selecting this result will display the rotary total current and rotary Greenwich Intervals, by bin (Figure 14.6).

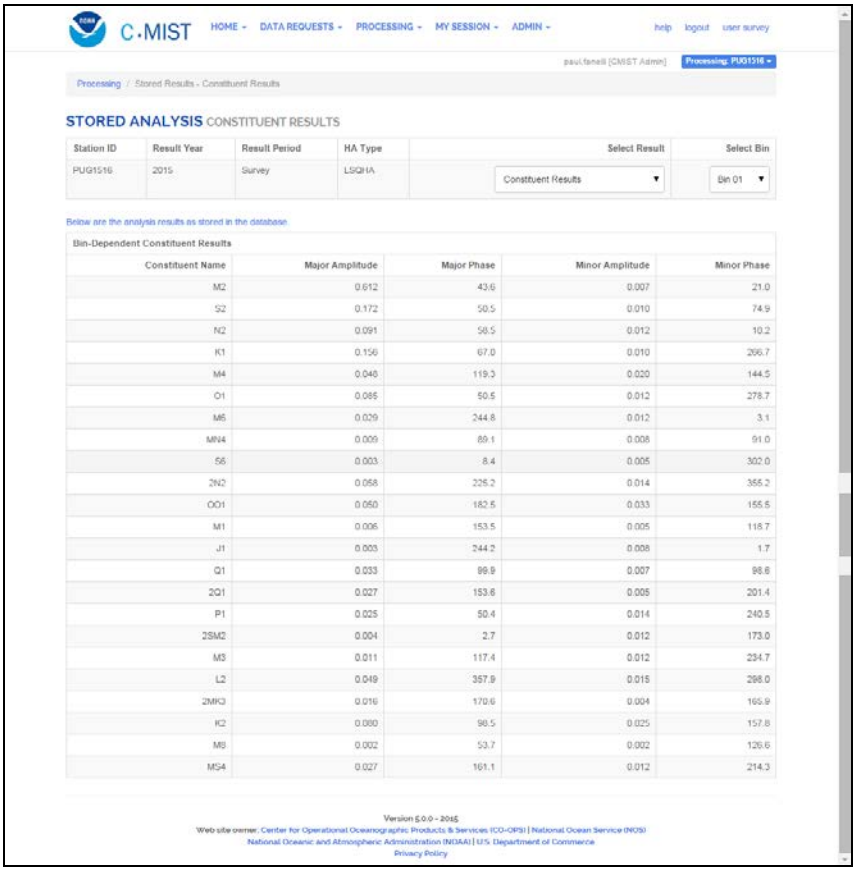



Fig. 14.4: *Constituent Results* showing amplitude and phase for the major and minor axes.

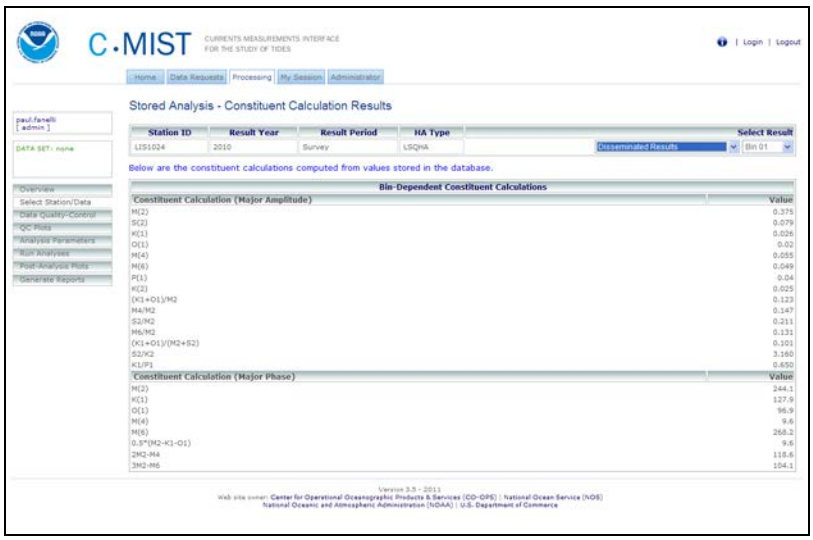



Fig. 14.5: *Constituent Calculations*, showing some commonly used constituent ratios.

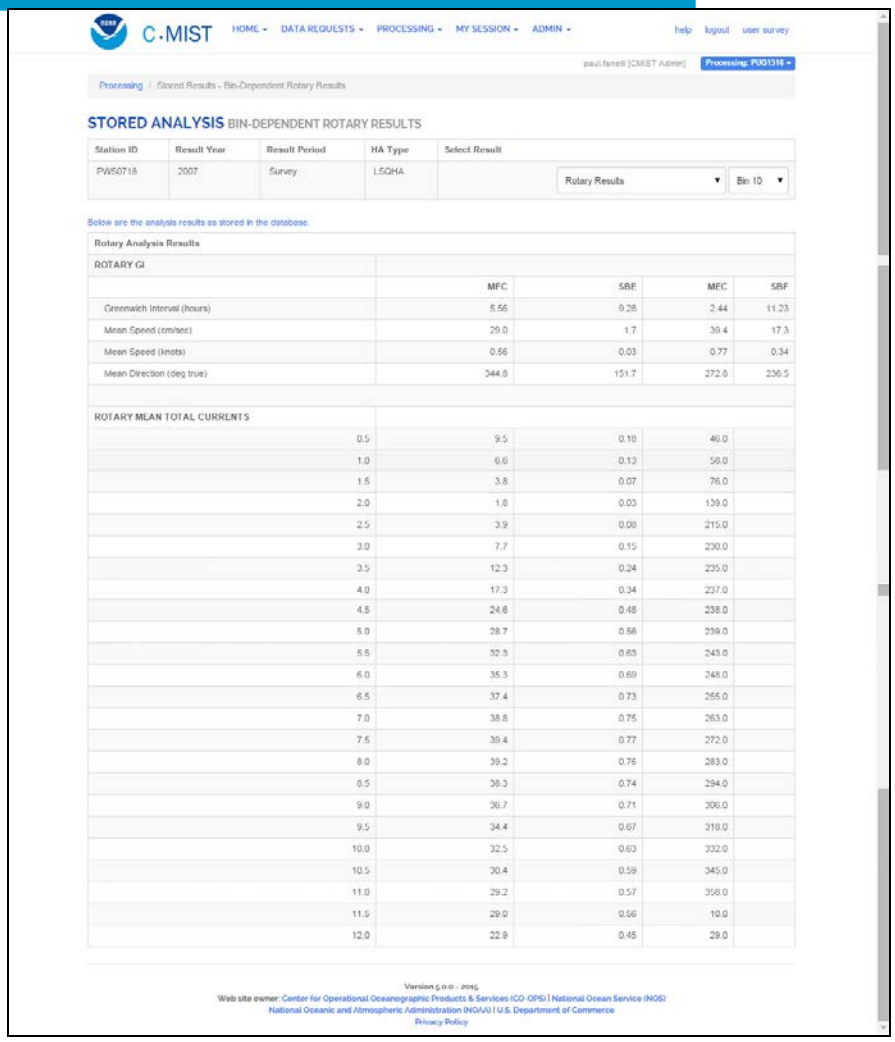



Fig. 14.6: Rotary results by bin. Rotary mean total current and Greenwich Intervals are displayed.

Finally, if a station is set for dissemination, users can view which results were disseminated by selecting *Disseminated Results*. This screen, shown in Figure 14.7, lists all bins marked as good in the database, and whether constituent results and if either standard Greenwich Intervals, rotary Greenwich Intervals, rotary total current or reversing reduction Greenwich Intervals were disseminated for each good bin. For real-time stations, users can also view which bins were selected for PORTS 3 Day Currents plot here.

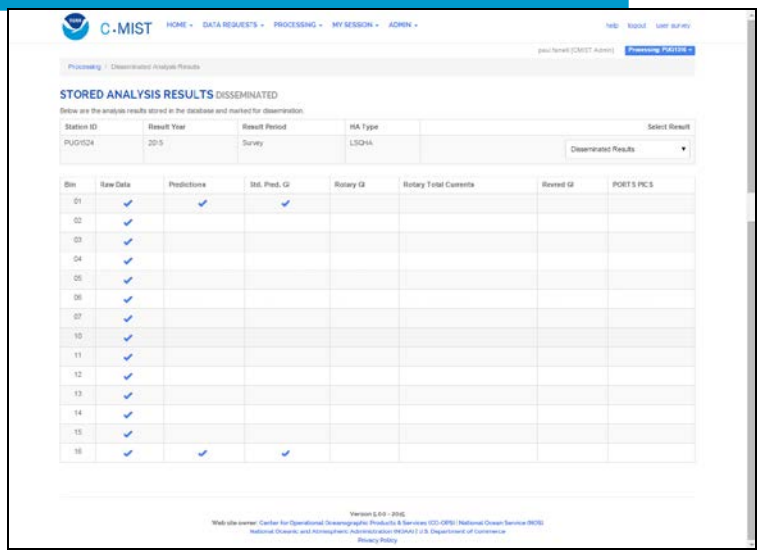



Fig. 14.7: Disseminated results screen. Users can view whether constituents and which Greenwich Interval results were set for dissemination.

### *b. Viewing constituents in DAS format*

Real-time currents stations that have a prediction line displayed on PORTS products for the real-time bin must have the corresponding constituents file in a certain format to be read by the prediction routine. C-MIST provides this constituent file under *Constituent Results (DAS Format)* within the *Select Result* drop-down menu (Figure 14.8).

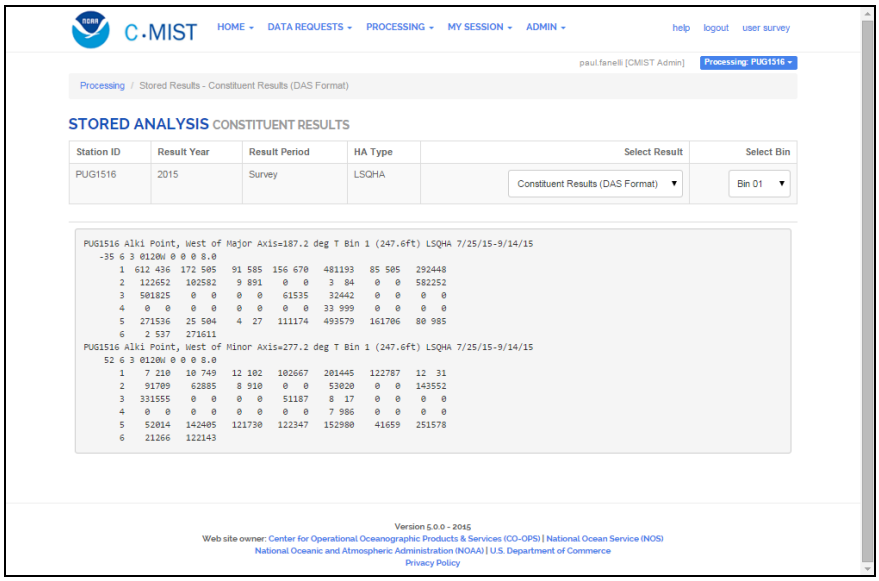



Fig. 14.8: Viewing constituent results in DAS format. These can be copied and pasted into Notepad and then uploaded to the appropriate DAS.

This file contains the appropriate flags needed to successfully generate predictions for the website. After choosing the correct bin, users can copy the data within the text box to Notepad. They can then transfer the file to the appropriate DAS using SFTP to have it uploaded to the production server. Note that after copying the file to the DAS, the **dos2unix** command must be run on the file, or predictions will not be generated.

*c. Calculating Greenwich Interval differences between stations*

C-MIST provides the capability to choose a reference station and a subordinate station and calculate the time difference and speed ratios of the Greenwich Intervals. To compare these GI values, first select a reference station under the *Processing* tab and navigate to the stored analysis results. Select *values* and under the *Select Result* drop-down menu, navigate to *GI Difference Calculations*. Select an appropriate secondary station and you will be taken to a page displaying the reference and secondary station Greenwich Intervals for the bins selected, along with the GI time difference (secondary minus reference) in decimal hours and speed ratio (secondary/reference) between the two stations (Fig 14.9). You can adjust the bins for each station at the top of the page.

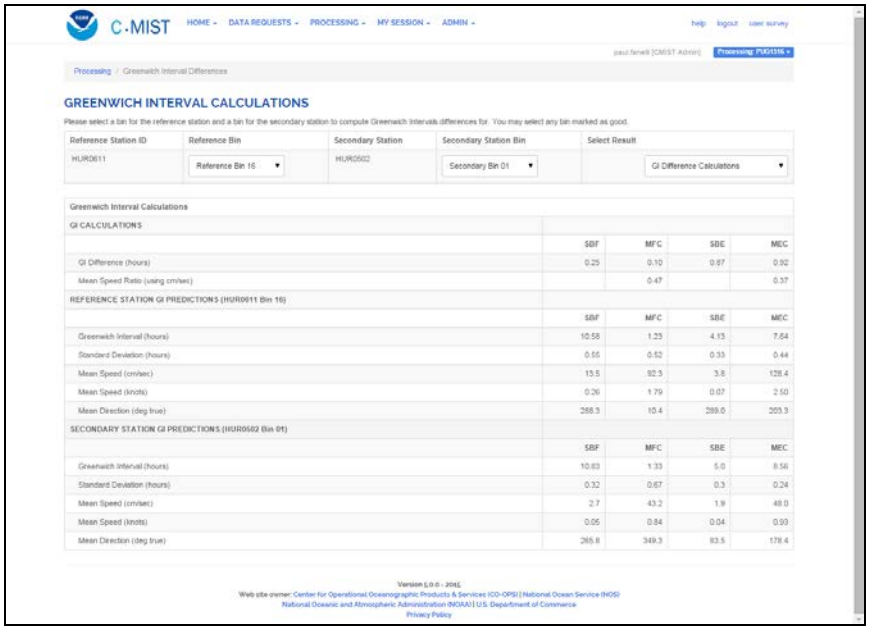


Fig. 14.9: Greenwich Interval difference calculations between reference and secondary stations in Cook Inlet, Alaska.

These difference calculations are analogous to the Table 2 offsets and speed ratios within the Tidal Current Tables.

### *d. Generating data files for Tidal Current Table updates*

CECAT provides relevant station metadata and analysis results for all prediction bins to User Services. This information is automatically pulled from the database and included within a file called Tidal Current Table Info. To retrieve this file, select a station through the *Processing* tab and navigate to the stored results. Under *values*, select *Tidal Current Table Info* within the *Select Result* drop-down menu. After selecting the appropriate bin the file will be automatically generated (Figure 14.10). This file can be saved using the diskette icon at the top.

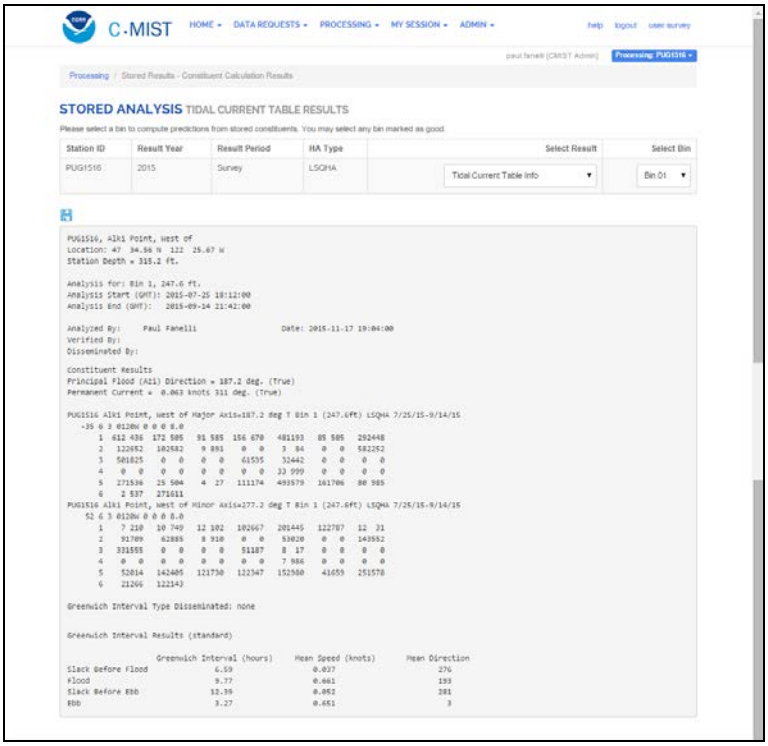


Fig. 14.10: Tidal Current Table Info file highlighting constituent and Greenwich Interval information.

### *e. Generating predictions from stored constituents*

C-MIST allows users to generate predictions on-the-fly from stored constituents from any station with results stored in the database and marked for dissemination. To generate predictions, select a station through the *Processing* tab and navigate to the stored results.

Under *values*, select *Generate Predictions* within the *Select Result* drop-down menu. This will take you to a menu where you can set the control file parameters (Figure 14.11). Users can select whether they want predictions in knots or cm/s, local time or GMT and select the prediction period. By default, predictions will be generated in knots, GMT and for the present year. Predictions can only be run for one bin at a time and they are not stored in the C-MIST user session.

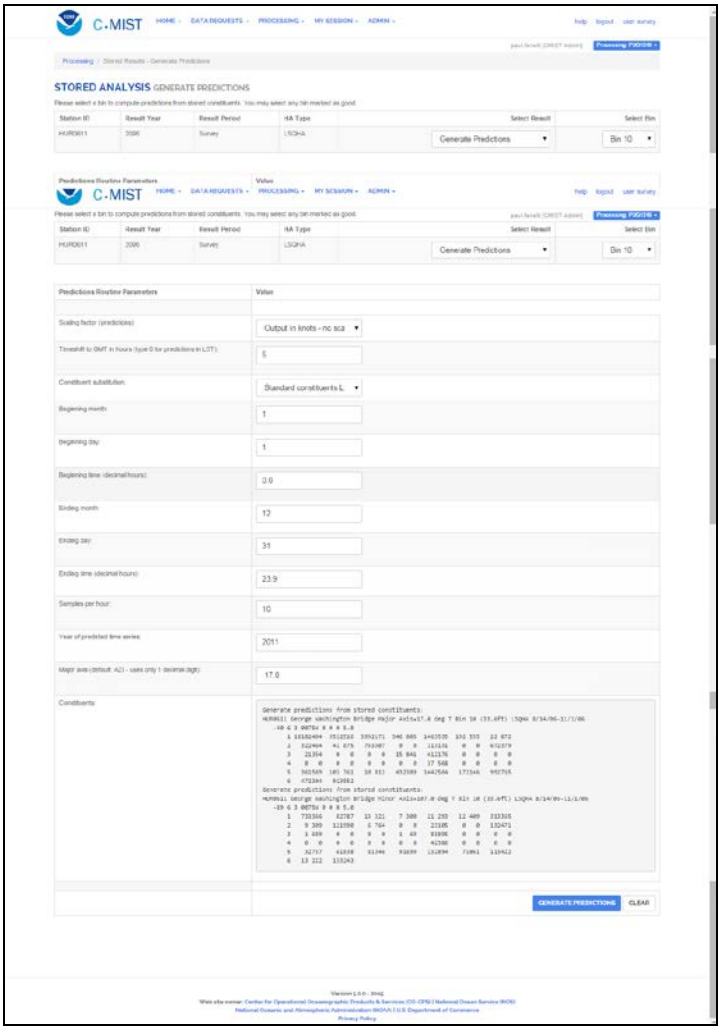



Fig. 14.11: C-MIST control parameters for generating predictions off of stored constituents.

After generating predictions, they should be saved by clicking on the diskette icon at the top of the predicted time series or else they will be lost, even if the user does not log off C-MIST.

# REFERENCES

Zervas, C. E., 1999. Tidal Current Analysis Procedures and Associated Computer Programs, NOAA Technical Report NOS CO_OPS 021, Center for Operation Oceanographic Products and Services, NOS, NOAA, Silver Spring, MD, 101 pp.

# APPENDIX A: USER ROLES

There are a number of different user roles within C-MIST that allow different types of access to the system and the National PORTS Database. These will be discussed below.

- **Guest:** Users can extract data from the DATABASE and save locally through the Data Requests menu.
- **User:** In addition to guest privileges, users also have the ability to extract data into C-MIST for data processing. Users have access to My Session screen to view plots and results.
- **Analyst:** In addition to user privileges, users can ingest raw data into the DATABASE and analysis results to the database.
- **Lead:** In addition to analyst privileges, users have the ability to verify and disseminate a set of analysis results in the DATABASE.

# APPENDIX B: ACRONYMS

| | |
|---|---|
| CECAT | Coastal and Estuarine Circulation Analysis Team |
| C-MIST | Currents Measurement Interface for the Study of Tides |
| CO-OPS | Center for Operation Oceanographic Products and Services |
| FORTRAN | Formula Translator |
| GI | Greenwich Interval |
| MEC | Maximum Ebb Current |
| MFC | Maximum Flood Current |
| PORTS | Physical Oceanographic Real-Time System |
| QA | Quality Assurance |
| QC | Quality Control |
| RMS | Root Mean Squared |
| SBF | Slack Before Flood |
| SBE | Slack Before Ebb |
| SOP | Standard Operating Procedure |
| TCT | Tidal Current Tables |