NOAA

Integrated Ocean Observing System (IOOS) Program Office

Data Integration Framework (DIF)

Customer Implementation Project Summary

and

Performance Assessment Plan

Version 1.1

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DIF-IOOS-PERF_PLAN

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Review & Approval

Review History

Reviewer	Version Reviewed	Signature	Date
Charles Alexander/IOOS			

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1 Introduction

1.1 Purpose

The purpose of this document is to:

- Define the objective of DIF customer implementation projects
- Enumerate the challenges and risks identified during the process of defining customer implementation projects, and provide an approach for how challenges and risks will be mitigated
- Describe each DIF customer implementation projects in terms of:
  - Decision making tool/model to be enhanced
  - Overall scope, architecture, and tasks
  - Integrated data sets used to enhance the decision-making tool/model
  - Anticipated benefit
  - Performance assessment methodology, benchmarks, and metrics
- Provide a quick-look summary table of benefits, metrics and assessment methodology

1.2 Background

1.2.1 Overall DIF objectives

The Data Integration Framework (DIF) is an initial operating capability for NOAA's Integrated Ocean Observing System (IOOS). The DIF project was conceived of because currently there is no single overarching operational data management system or capability within NOAA that can assemble data from diverse sources, and meet the geographic coverage, vertical and horizontal resolution, accuracy, timeliness, and data processing requirements and needs of multiple NOAA decision-support tools: ocean models, assessments and forecasts, and other products. The project premise is that data integration and improved management and dissemination of mission-critical ocean-related data will increase the value and effectiveness of these presently disparate data in supporting decision-making tools/ models.

The DIF is envisioned to address gaps in data management services for several selected NOAA decision-support tools such that improvements in accuracy and/ or efficiencies in time and production costs of model outputs, assessments and forecasts, and other products, can be achieved and measured. In addition, the DIF will be designed to be flexible and extensible to allow incorporation of additional decision-support tools, and to be compatible and supportive of NOAA Enterprise Architecture, GEO-IDE plans, and GEOSS implementation. In fact, the DIF is envisioned to be one of the first implementations of the GEO-IDE and of the integration of "systems of systems" featured in GEOSS. As an Initial Operating Capability for NOAA's IOOS, the DIF will be reviewed and assessed for possible expansion during and/or after the end of the three year development period.

1.2.2 Role of Customer Implementation Projects

The DIF project will integrate data for seven (7) core ocean environment parameters from a diverse array of NOAA observation systems and platforms, and some selected non-NOAA sources. These parameters are seawater temperature, salinity, currents, ocean color, water level, winds and waves. The DIF customer implementation projects will be identified in four (4) model/decision-support areas (models, assessments, or products). These areas are Coastal Inundation, Hurricane Intensity, Integrated Ecosystem Assessments, and Harmful Algal Blooms.

The DIF project staff will work closely with key stakeholders in the four decision-support areas to identify the specific model, assessment, or product that will serve as the test bed to measure improvement due to the data integration, and to specify their data requirements for the selected model or product which will guide the design and development of the DIF structure to enable integration and data management services.

1.2.3 Constraints

The customer implementation projects were selected in the context of various DIF project constraints. In some cases, the constraints drove the decisions as to which project was selected, in other cases, constraints were re-evaluated to determine if any flexibility existed to loosen the constraint, and thereby enable implementation of project that might not otherwise have been achievable.

Specific constraints include:

- Cost – the initial budget estimate for customer implementation projects was significantly underestimated. During the course of project identification, it became clear that the cost constraints were significant and could prevent implementation of any meaningful projects. The budget was re-evaluated and funding expanded somewhat to enable some meaningful projects. However, costs constraints remain, limiting the scope of what can be achieved with the customer implementation projects.
- Schedule – the original goal of the DIF project was to produce a report, documenting the value of integrated data in customer projects, by the end of the second quarter of FY10 (February of 2010). This requires that assessment be completed some months in advance of that deadline to allow for compilation of the results into a report. Further, many of the projects address seasonal conditions, such as hurricanes or harmful algal blooms that have specific seasons of high likelihood of occurrence. This further constrains the schedule; project implementation must be completed before the start of the season in order to maximize the ability to measure impact.
- Scope – the objective of the project is to achieve the highest level of integration possible – integrating as data as possible from the maximum number of data providers. However, because the DIF scope is limited to seven variables and four initial data providers, the projects were constrained in scope.

It is important to note that the customer implementation projects are in varying stages of definition, contract and implementation, and the information contained herein may change somewhat based on final project definition, funding, and implementation strategy.

2 Applicable Documents

RD1 NOAA Integrated Ocean Observing System (IOOS) Program Office *Data Integration Framework (DIF) Master Project Plan*

RD2 DIF As-Is Baseline Systems Document (DRAFT Version 0.6) September 19, 2007

RD3 DIF Functional Requirements Document v1.0, November 19, 2007

RD4 DIF Concept of Operations v1.0, April 25, 2008

RD5 Harmful Algal Bloom Customer Meeting Summary, July 19, 2007

RD6 Hurricane Intensity Modeling Draft Report Summary, February 12, 2007

RD7 Hurricane Intensity Customer Meeting Report Summary, July 18, 2007

RD8 Coastal Inundation Modeling Draft Report Summary, January 29, 2007 and February 12, 2007

RD9 Coastal Inundation Customer Meeting Report Summary, July 13, 2007

RD10 Harmful Algal Bloom Modeling – Draft Requirements for the IOOS Data Integration Framework, January 19, 2007

RD11 Integrated Ecosystem Assessments – Draft Requirements for the IOOS Data Integration Framework, February 16, 2007

RD12 IOOS and Integrated Ecosystem Assessments – Data Integration Framework (DIF) Follow-up Meeting Notes, July 11, 2007

3 Objective of Customer Implementation Projects

The DIF Customer Implementation Projects (CIPs) were initially designed to support one of DIF's primary goals and objectives, namely to validate the DIF premise that data integration and improved access via standardized interfaces has a value that can be measured in specific models/decision support tools.

The CIPs are expected to provide the most visible and meaningful results for the integration of the core DIF variables within a relatively short timeframe and limited funding. Apart from validation of the core DIF premise, the CIPs should provide a reasonably simple and evident way of the assessment of their results. In addition, it is desirable that CIPs provide a path to operational implementations and are not limited to experimental projects.

The goal is to identify CIPs that have more than one core variable, and integrate data from at least 2 DIF data providers (ideally from all 3 of them). There is an added benefit if CIPs will also ingest data from other non-NOAA data providers, e.g. regional associations, universities, etc.

A number of candidate projects were investigated and evaluated for use as DIF CIPs. One project was selected in each of the following four model/decision-support areas:

1. Harmful Algal Bloom Forecast System (HAB-FS)
2. Coastal Inundation (CI)
3. Hurricane Intensity (HI)
4. Integrated Ecosystem Assessments (IEA)

These four CIPs that were selected and approved satisfy the requirements to a great extent, and their implementation will mark significant progress toward DIF goals. The most important stage of the CIPs implementation is the performance assessment, which will evaluate the results of each project and provide a metric for DIF success.

A general approach to the performance (skill) assessment is to evaluate a value of operating benefits gained by each project due to the data integration; these benefits will be evaluated in reference to the DIF goals and objectives using project specific metrics and benchmarks. For performance assessment purposes all benefits can be divided into three main categories in regard to metric and benchmark availability:

A. Benefit has a quantifiable value, and a historic benchmark is available;
B. Benefit has a quantifiable value but no benchmark is available;
C. Benefit has qualifiable but not quantifiable value, i.e. the improvement definitely brings the tool/model to a qualitatively new and higher level but it cannot be expressed in terms of numbers (e.g. percents skill improvement, etc.), and there is no feasible benchmark.

Each project provides its own distinctive combination of benefit categories, and thus the assessment methodology as well as benchmarks and metrics are also CIP-specific. The benefits, assessment methodology, metrics and benchmarks are explained in more details in the succeeding sections devoted to each CIP.

4 Challenges and Mitigation Plan

From the inception of the DIF project, it was assumed that customer implementation projects could be fairly easily identified and would allow for a quantifiable measurement of the value of DIF's integrated data within the original DIF timeframe. Ideally, CIPs would involve a high degree of integration – the ingest of multiple DIF core variables from multiple DIF data providers. The customer community would enthusiastically embrace the DIF concept for use in their models/decision support tools, and metrics would be readily measured.

Indeed a number of promising projects were identified, and the customer community is enthusiastic about DIF efforts. However, the technical and logistical realities of bringing these projects to fruition within the project constraints posed significant challenges. In spite of the challenges, several meaningful projects were identified and are in various stages of execution. Table in Figure 4.1 below summaries some of the challenges and the approach used to address these challenges.

Challenge/Risk	Approach(es)/Mitigation Plan
1. **Schedule:** The value of integration increases over long-term as more data from multiple providers becomes integrated. Yet DIF needs to show value in the short-term.	Identify projects that can show at least some value in the short term, accept that the level of integration will not be high
2. **Implementation:** NOAA customers are likely already accessing NOAA data in non-DIF formats and methods; investment is required to change models/software to support DIF formats and access methods, yet with marginal benefit since no new data is introduced.	Focus on adding new data or variables into existing models, unless there is high value that comes strictly from the new formats or access methods.
3. **Performance Assessment:** Assessment may take several months and may be dependent on occurrence of weather events (HABs, hurricanes, etc). Also assessment tools and resources not available to measure.	Identify projects that can be completed in time for "season", or focus on hindcasting. IOOS may need to fund some development of assessment tools. Delay final report.
4. **Additional Observations:** Real value for many customers comes through additional observations; challenge is to identify and provide additional observations of appropriate quality, etc	Expedite work with RAs, non-NOAA data providers.
5. **Core variables:** Initial seven (7) variables do not necessarily map to customer needs.	Focus on projects that can make use of existing variables; prioritize additional variables based on customer needs.
6. **Funding:** Resistance to short-term, limited project funding; customers want long-term, sustainable initiatives	Identify projects that will be supported by line offices, minimize IOOS funding of O&M
7. **Operational Systems:** NWS customers require "operational" data.	Identify experimental NWS projects outside of operational data streams, define potential paths to operations.

Figure 4.1 Customer Implementation Project Challenges

5 Harmful Algal Blooms (HABs)

5.1 Decision Tool/Model to Be Enhanced

This project is based on the existing operational model for the Eastern Gulf of Mexico – Harmful Algal Bloom Forecast System (HAB-FS), and the experimental model for the Western Gulf of Mexico. The existing HAB-FS output is in the form of a HAB Forecast Bulletin which contains an operational forecast of bloom extent, transport, intensification, and impact over 0-3 days. This bulletin is used by local decision makers and the general public to inform regional public health and safety decisions.

5.2 Scope, Architecture, and Tasks

This project will test the benefit of an enhancement of the transport model for the HAB-FS. Use of this enhanced transport model requires additional observations and modeled data that will be provided in DIF formats and services. The primary objectives of the project are to:

(a) Ingest and display surface currents data from CO-OPS and NDBC into the existing HAB-FS bulletin software, providing additional data for analysts to use in bulletin creation;

(b) Determine whether HAB nowcast and forecast quality will benefit from an objective and spatially-articulated transport model. This transport model will integrate surface currents data (observed and forecast) in DIF standard formats/services as well as winds (observed and forecast) and ocean color data to augment the forecast;

(c) Assess the operational requirements that DIF-formatted data would need to meet, should this enhanced transport model become operational.

The project is divided into two parts (phases). Phase 1 concentrates on the capability of the existing HAB-FS bulletin software to ingest surface currents data provided by CO-OPS and NDBC using data standards and protocols identified by the DIF. Phase 1 is developed by collaborative efforts of the CSC and CO-OPS teams. Phase 1 will result in reliable access to DIF-formatted surface currents data served by NDBC and CO-OPS, and automatic ingestion and display of that data into the operational HAB-Forecast System bulletin generation application for the western Florida region of the Gulf of Mexico. In the existing operational HABS-FS, analysts consider winds but not surface currents when forecasting a bloom’s transport. The graphical display of surface currents data directly on the HAB-FS display facilitates the assimilation of that additional information into the transport forecast contained in the HABS-FS bulletin.

Phase 2 makes use of the enhanced transport model and additional DIF data - forecasted surface currents from CSDL - to augment the bloom transport forecast. This additional data, along with other data in use by the HAB-FS, will be ingested into a spatially-articulated transport model (not currently in use in the operational HABS-FS) to enhance the HABS-FS.

Because of the project time constraints, Phase 2 will be performed in hindcast mode. Currently, the partners have already identified specific historical bloom events along the West Florida Shelf to be used in the project; the time period is set for August 2004 to March 2005, in which there were at least two distinct large blooms, and possibly several smaller blooms.

CSDL will provide modeled 2-dimensional surface current forecasts for the time period covered by those events. In hindcast mode, the enhanced transport model will be used to determine whether historical HAB nowcast and forecast quality benefits from the new transport model. IOOS/DIF, NCCOS/CCMA, and OCS/CSDL specialists will collaborate to develop Phase 2 of the project, and assess the result.

Phase 2 will make use of the General NOAA Operational Modeling Environment (GNOME) transport model (GNOME was originally developed by the Office of Response and Restoration (OR&R) to predict oil spill trajectories in the marine environment, and HAB and oil spill behavior have demonstrated an apparent similarity). GNOME's "Diagnostic Mode" will be invoked to forecast bloom position along the West Florida shelf, predicting how currents move and spread blooms.

5.3 Data Sets

A list of data sources to be provided through the DIF in Phases 1 and 2 includes the following:

- Surface Current observations from NDBC
- Surface Current observations from CO-OPS
- Modeled Surface Currents from CSDL

Most of data used in this project will be presented in DIF formats, and accessed via DIF standard access services. The project architecture and data flow diagram is presented in Figure 5.3.

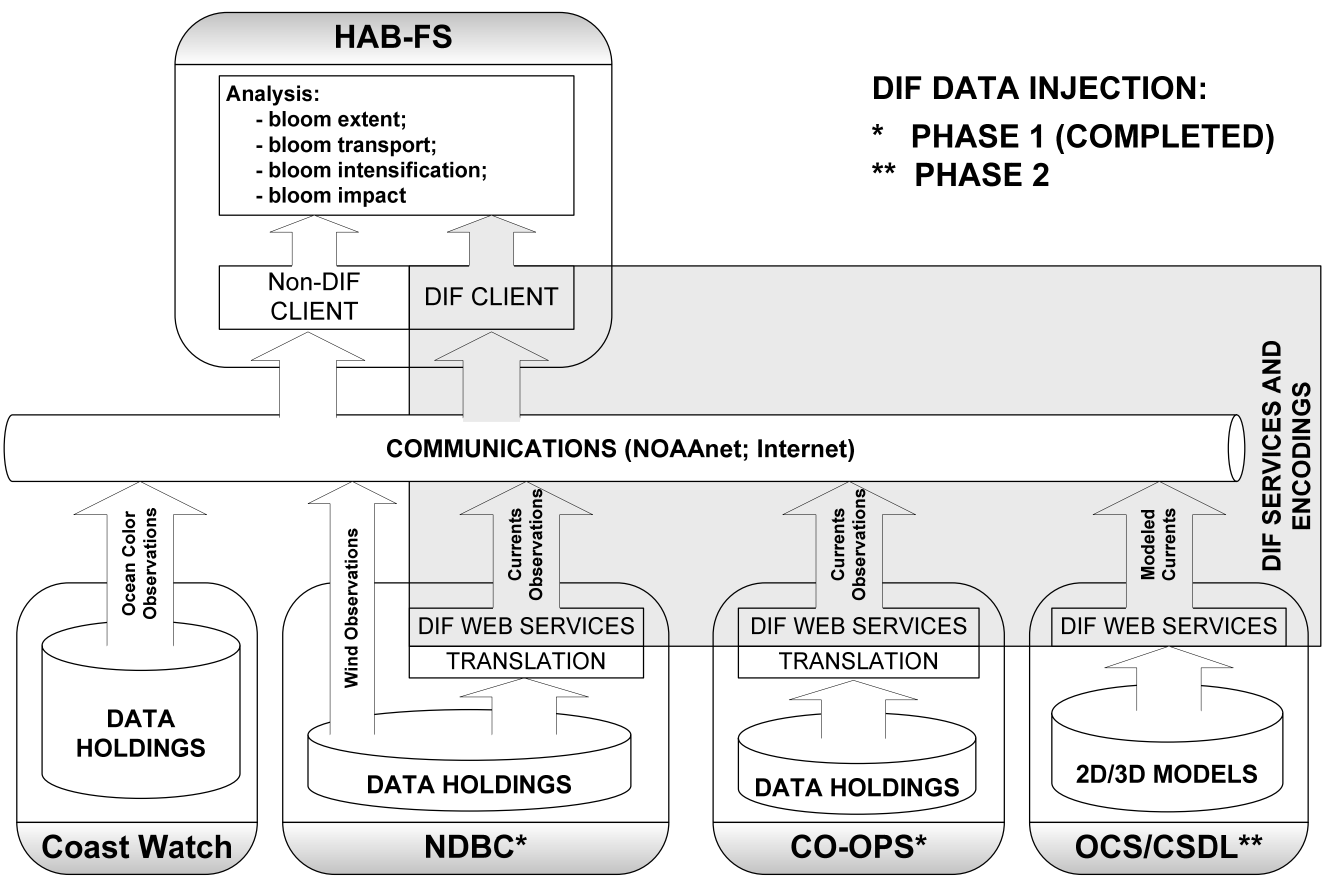

Figure 5.1 HAB-FS Data Flow Diagram

5.4 Anticipated Benefits

A number of benefits are expected as a result of this project; categorized benefits are shown in Figure 5.4 (benefit categories are explained in details in Section 3 of this document).

#	Anticipated Benefit	Category
1	Development of a probability based, spatially-articulated bloom intensification estimate	A
2	A measurable increase in the spatial and temporal accuracy (skill) and precision (reproducibility) of HAB forecasts	A
3	Increased probability of providing an accurate nowcast for the time periods when satellite imagery is not available due to clouds	A
4	Extension of forecast spatial range to the areas where the forecast has been previously unavailable, e.g., Tampa Bay	A
5	Extension of forecast temporal range from 3 days to 5 days and more	A
6	Increased HAB forecast objectivity	C

Figure 5.2 HAB-FS Benefits

5.5 Performance Assessment

5.5.1 Assessment Methods and Benchmarking

The project baseline will be the comparison of the existing HAB-FS bulletins for those periods against the actual HAB observation data. A performance benchmark will be established for each benefit in category A.

The enhanced transport modeling system will be run during the selected historical periods of HABs in the region. A number of hindcast-mode HAB forecasts will be made, using a range of inputs (*e.g.* modeled currents) and combinations of inputs (*e.g.* modeled currents and C-MAN winds). The exact number of runs depends on historical data availability, and will be clearly determined by the end of Q1, FY09. Forecast skill will be assessed, and HAB forecast model sensitivities will also be evaluated to determine the most reliable and accurate forecast method.

The forecast skill of the enhanced modeling system will be compared with the baseline to determine the degree of improvement.

5.5.2 Metrics

Each benefit described above will have a corresponding metric. For consistency with previous HAB-FS skill assessments, the same basic HAB parameters will be used as some of the metrics for the performance assessment. The primary metrics used for HAB-FS skill assessment are:

1. <u>TRANSPORT</u>: the direction (north, south, offshore, onshore, etc.) in which the bloom is likely to migrate.
2. <u>EXTENT</u>: increase or decrease in bloom area.

3. INTENSIFICATION: expected change in HAB concentration (increase, decrease, no change).
4. IMPACT: presence of adverse coastal conditions, including respiratory irritation and presence of dead fish (from no expected impacts to very low, low, moderate or high impact).

The proposed set of metrics, measurement units, and reference to the list of benefits are shown in Figure 5.3. Although the majority of the metrics are well defined and clear, some of them are yet to be more explicitly developed. The explicit set of benchmarks and metrics will be developed by the team and completed in Q3, FY09.

Benefit #	Metric	Measurement Unit
1	INTENSIFICATION forecast availability	Number of cases when INTENSIFICATION nowcast was available
	Gain in INTENSIFICATION accuracy	Percentage skill increase
2	Gain in TRANSPORT forecast accuracy / precision	Percentage skill increase
	Gain in EXTENT forecast accuracy	Kilometers (miles) and/or percentage skill increase
	Gain in EXTENT forecast precision	Percentage skill increase
3	Gain in TRANSPORT forecast availability	Number of cases when TRANSPORT nowcast was available
	Gain in EXTENT forecast availability	Number of cases when EXTENT nowcast was available
4	Forecast availability area growth	Square kilometers (miles) or percentage skill increase
5	Forecast length increase	Days or percentage skill increase
6	Degree of objectivity in HAB-FS	TBD. This may be a subjective or anecdotal result.

Figure 5.3 HAB-FS Metrics

6 Coastal Inundation

6.1 Decision Tool/Model to Be Enhanced

SLOSH, which stands for Sea, Lake, and Overland Surge from Hurricanes, is a National Weather Service (NWS) computerized model developed to estimate storm surge depths resulting from historical, hypothetical, or predicted hurricanes by taking into account a storm's pressure, size, forward speed, forecast track, wind speeds, and topographical data. The SLOSH model is run by the Tropical Prediction Center (TPC) every 6 hours starting 24 hours before an anticipated hurricane. The results of SLOSH runs can be displayed and/or recorded in various file formats.

The NWS has run several thousand hypothetical hurricanes for each basin with the SLOSH model, and the resulting flooding data from each run are saved. To reduce this large volume of data the composites from many individual runs were created. Composites are called MEOWs (Maximum Envelopes of Water) or MOMs (Maximum(s) of the MEOWs), and are available for 39 basins.

The SLOSH Display application was developed by NWS' Meteorological Development Lab (MDL) and is used to visualize the SLOSH model output, MEOWs and MOMs. The application is used to assist forecasters in evaluating the threat from storm surge. The SLOSH Display application is used by NWS Weather Forecast Offices (WFOs) to inform their Hurricane Local Statements (HLS'), and by WFOs and the TPC to communicate storm surge information to state and local Emergency Managers to help inform their public safety decisions, including determination of which areas to evacuate. Emergency Managers themselves use the SLOSH Display application during storm preparations.

6.2 Scope, Architecture, and Tasks

The SLOSH Display enhancement project will integrate DIF water level, winds, tide predictions, and Low Astronomical Tide/High Astronomical Tide (LAT/HAT) products into the SLOSH Display application to provide a much more rich and integrated set of surge-related data for users.

For the TPC team, the project will provide a display of IOOS DIF water level observations, tide predictions and other water level products for user selectable locations within the SLOSH basin. TPC users will also benefit from an enhanced visualization of the data for use with media and other users. The SLOSH display was not initially designed to be used in media briefings, but has evolved to become a key communication tool with media and emergency managers in affected communities. These improvements will allow valuable information to be graphically depicted in a simple and clear manner to optimize the effectiveness of the data in local decision making.

For the WFO forecasters, who upload the TPC operational storm surge forecast into the SLOSH Display, this project's enhancements will integrate the IOOS DIF wind, water level observations, tidal predictions, and other water level products with the surge forecast. In addition, the probabilistic surge value in feet (for 10% excess) or % (for the probability products) from the National Digital Guidance Database (NDGD) will also be ingested. This will allow the forecaster to compare the observations to the forecasts and to have additional information to determine total water level, which in turn will assist them with their hurricane local statements.

Critical tasks for this project will be (a) modifications to the SLOSH display that will allow for display of real time, predicted and calculated water level data/products, real-time wind observations, and p-surge's excess values; and (b) the provision of required water level data and products and wind data in consistent DIF formats via standardized access methods.

6.3 Data Sets

The data for the project will be provided in DIF format by CO-OPS and NDBC. CO-OPS will provide real-time observations of water level and winds, as well as tidal predictions and other tidal products. NDBC will deliver real-time wind observations. In addition, the probabilistic-surge excess values will be provided, in non-DIF format, from the NDGD to use as the surge value.

The project data flow diagram is presented in Figure 6.3.

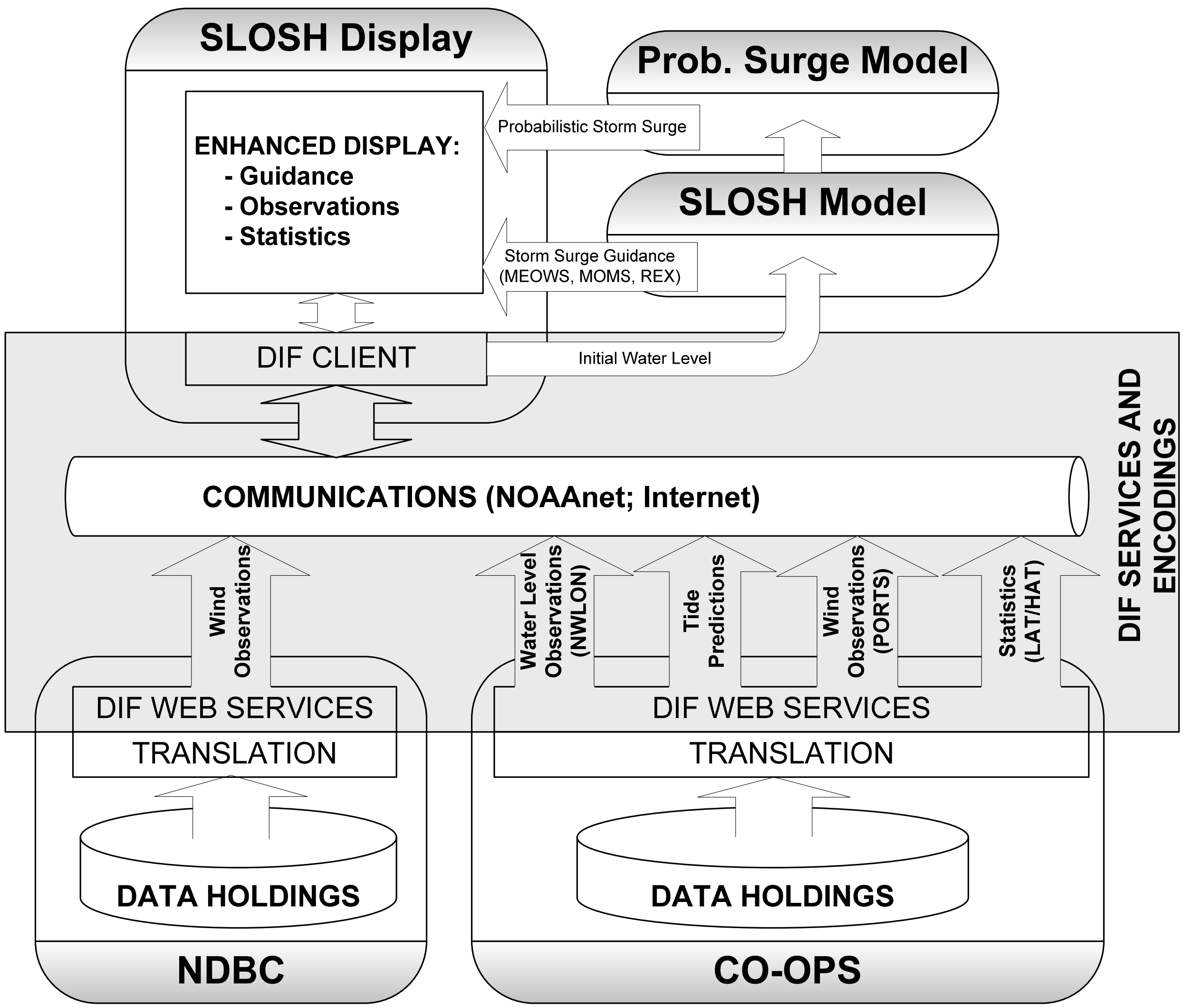

Figure 6.1 CI Data Flow Diagram

6.4 Anticipated Benefits

TPC and regional WFOs are both expected to benefit from the project, however, due to different goals and objectives, the anticipated benefits are somewhat different so are described separately below.

6.4.1 Benefits to TPC

The list of categorized benefits to TPC is shown in Figure 6.4.1 (benefit categories are explained in details in Section 3 of this document).

#	Anticipated Benefit	Category
1	Increased efficiency and reliability of access to real-time water level data for SLOSH model initialization (using DIF services to automatically retrieve the data from the CO-OPS site instead of "web scraping" it).	A
2	Ability to display real-time water levels in the SLOSH Display program, particularly useful during TPC briefings to external users during the 24 hours before landfall. This will help communicate the actual situation to emergency managers and general public as the storm progresses (currently, TPC does not communicate real-time water levels to external audiences).	B
3	Visualization enhancement to the SLOSH Display to facilitate communication will dramatically improve the presentation of the information provided, to better inform emergency managers and external users.	B

Figure 6.2 CI Benefits to TPC

6.4.2 Benefits to WFOs

The list of categorized benefits to WFOs is shown in Figure 6.4.2 (benefit categories are explained in details in Section 3 of this document).

#	Anticipated Benefit	Category
4	The enhanced display and graphics will help better communicate the potential coastal inundation impact to local emergency managers.	C
5	The integration of real-time water-level observations into the SLOSH display will allow forecasters to adjust the surge portion of their HLS (Hurricane Local Statement), providing more up-to-date and accurate guidance.	C

Figure 6.3 CI Benefits to WFOs

6.5 Performance Assessment Methodology

6.5.1 Assessment Methods and Benchmarks

Benefit #1 is the only anticipated benefit that can be quantifiable benchmarked and assessed (Category A). The existing method of collecting real-time observation data, tide predictions, and statistics (typically by going to multiple web sites and performing manual calculations) takes a significant amount of time. This is expected to decrease with the integration of all the data into the SLOSH Display. The benchmark for this benefit will be the amount of time it currently takes to perform this data. A direct comparison of the demonstrated improvement using the enhanced SLOSH Display with the established benchmark will be used to assess the benefit.

The Category B benefits, #2 and #3, result from completely new functionality that has never existed before. The numerical baseline for such results cannot be determined and established. However, these benefits do have quantifiable measures, which will be obtained in direct usability evaluation of the newly introduced functionality. TPC does not currently display water levels in their media briefings; the quantifiable measure could be the number of times in a season that the water level observations are displayed. Similiarly, the visual enhancements of the SLOSH Display are new, the quantifiable measure could be the number of times in a season that the visual enhancements are used in media briefings.

Category C benefits, #4 and #5, are largely subjective and are difficult to benchmark. Theoretically it should be possible to benchmark the accuracy of a Hurricane Local Statement (benefit #5), and then perform a skill assessment on HLSs that took advantage of the enhanced SLOSH Display. A comparison could be made to determine if the HLS accuracy increased due to the enhanced SLOSH Display. There are two major obstacles to doing this:

- HLSs are issued at least every six hours, and as often as every 2 to 3 hours when a tropical storm or hurricane is close to the coast. The HLS is a long and detailed product that requires a significant time to prepare. It is not operationally possible to create two separate HLS products to assess the impact of the SLOSH Display.
- WFOs do not routinely perform skill assessment on their HLSs, so there is no benchmark data on HLS accuracy.

Therefore, benefits #4 and #5 are expected to be assessed only in a qualitative fashion. However, it is an ongoing project activity to determine another form of the performance assessment that can provide a quantifiable value; in case of a positive result of that activity a new baseline will be established.

It is anticipated that, in addition to the benchmarks and methodologies described above, there will be anecdotal feedback regarding the value of the enhancements.

6.5.2 Metrics

The proposed set of metrics along with the measurement units in reference to the list of benefits is shown in the Figure 6.5.2. As it was mentioned in a previous section, the metrics for WFOs' benefit assessment are yet to be more explicitly developed; the process will be completed by Q3, FY09, when the test of the enhanced product starts.

Benefit #	Metric	Measurement Unit
TPC #1	Improved availability of real-time observations and tide predictions	Percentage improvement
	Decrease of time required for data collection and processing for model initialization	Hours or percentage improvement
TPC #2	Presentation of real-time observation data, tide predictions, and statistics to the external audience through the season.	Number of events
TPC #3	Presentation of enhanced display to the external audience through the season	Number of events
WFOs #4	Improvement in HLS forecast due to additional SLOSH Display data	Qualitative assessment
WFOs #5	Improved communication with local emergency managers in pre-storm time frame	Qualitative assessment

Figure 6.4 CI Metrics

7 Hurricane Intensity

7.1 Decision Tool/Model to Be Enhanced

This project is focused on improving a NOAA/NWS's National Centers for Environmental Prediction (NCEP) operational hurricane prediction model, which contains two components: the atmosphere component – Hurricane Weather Research and Forecasting (HWRF), coupled to the ocean component – Hybrid Coordinate Ocean Model (HYCOM). The project will allow additional ocean observations in DIF format to be ingested in the Real-time Ocean Forecast System (RTOFS-Atlantic) – the operational system at NCEP, which provides oceanic boundary and initial conditions to that coupled system.

7.2 Scope, Architecture, and Tasks

Research indicates that tropical cyclones intensify over warm mesoscale features located in the open ocean. The two-fold purpose of this project is to evaluate this effect by ingesting new ocean temperature data into air-sea numerical model and to assess the operational requirements of DIF-formatted data for these purposes.

The goal of this project is to evaluate the benefits of integration of ocean data in DIF standards into an air-sea numerical model, to aid the scientific and operational community to improve Atlantic hurricane intensity forecasts. Although tropical cyclones are formed in several basins, this work will concentrate in the Gulf of Mexico and Caribbean Sea. This work will produce prompt results and analysis to aid the scientific and operational community in their effort to reduce the error in the forecast of intensity of tropical cyclones.

If successful, the same tools and methodologies applied in this effort could be applied to improve the forecast of tropical cyclone intensity in all basins where tropical cyclones occur.

NOAA/NWS's NCEP will collaborate with NOAA/OAR's Atlantic Oceanographic Marine Laboratory (AOML) to conduct a series of hindcasts for three Category 4-5 hurricanes from 2005 – Rita and Wilma in the Gulf of Mexico and Emily in the Caribbean Sea – to evaluate forecast accuracies with and without the new temperature data.

7.3 Data Sets

AOML will obtain temperature data from various sources, combine and translate data into DIF formats, and provide them to NCEP. New temperature data provided by AOML will consist of temperature profiles obtained from regional XBTs, AXBTs, profiling floats, thermistor chains, and moorings. Some of these data are archived at NODC, while other data are available from AOML.

In addition, AOML will develop synthetic sea temperature and salinity profiles using historical statistical relationships between sea surface level change and deep-sea isotherm distribution. The sea surface level data will be obtained from all available satellite-based altimeter sources, including NASA's Jason-1, ESA's Envisat, and US Navy's GFO. Synthetic data output will be provided in DIF standards as well.

The project data flow diagram is presented in Figure 7.1.

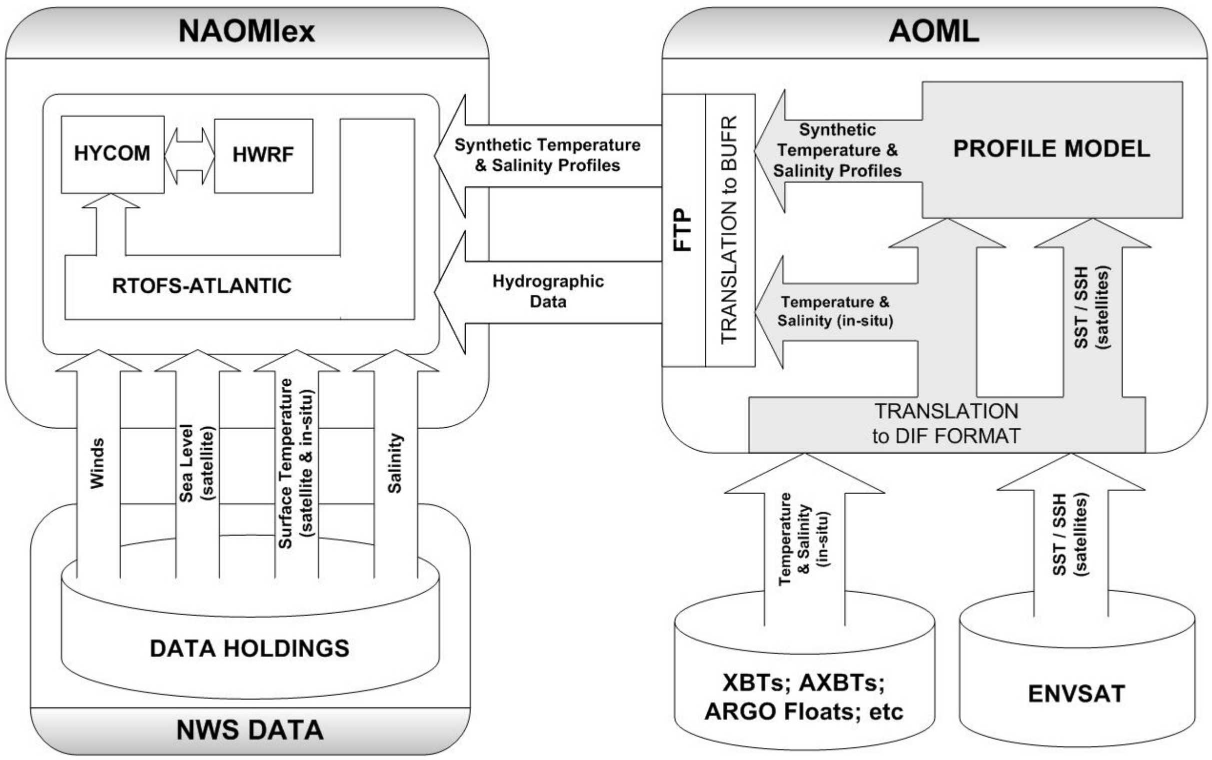

Figure 7.1 HI Data Flow Diagram

7.4 Anticipated Benefits

The project is expected to prove the critical importance of ocean data in tropical cyclone intensity prediction, as existing data does not describe mesoscale features, which are vital for hurricane intensification modeling. Additional synthetic temperature and salinity profiles will introduce mesoscale features to the model thus providing a new capacity that has not been available before. In addition, operational requirements will be determined for the DIF-formatted data to inject it into the NWS operational model.

The list of categorized benefits is shown in Figure 7.2 (the categories are explained in details in Section 3).

#	Anticipated Benefit	Category
1	Improvement of hurricane intensity and track forecasts.	A
2	Information on how to improve the ocean observing system for tropical cyclone prediction studies.	C
3	Identification of operational requirements for DIF formatted data	C

Figure 7.2 HI Benefits

7.5 Performance Assessment Methodology

7.5.1 Assessment Methods and Benchmarks

In regard to benefit #1, the improvement of hurricane intensity and track forecast, the project will assess the results of the RTOFS–Atlantic runs for 3 major hurricanes from 2005 with and without the integrated data.

The benchmark for hurricane intensity and track will be the historical forecasts issued for these 3 major events. The numerical model results will constitute a series of hindcasts, which will then be directly compared against the benchmark data.

This project will provide valuable information on how to improve the ocean observing system to benefit tropical cyclone prediction studies. However, that benefit is primarily qualitative and does not have an established baseline. Thus, the benefit has been attributed to Category C.

In the project, the DIF formatted data will be injected in an NWS operational model, and as such, the operational requirements for the data will be identified. It will facilitate ingestion of ocean observation data in DIF format by other NWS models in the future. It is not possible to benchmark this benefit; it has been attributed to Category C, and will be assessed only in a qualitative fashion.

7.5.2 Metrics

The proposed set of metrics along with the measurement units in reference to the list of benefits is shown in the Figure 7.3.

Benefit #	Metric	Measurement Unit
1	Error reduction in hurricane intensity and track forecast	Percentage skill improvement
2	Value of new information regarding improvement of the ocean observing system for tropical cyclone prediction studies.	Qualitative assessment
3	Value of operational requirements for DIF formatted data	Qualitative assessment

Figure 7.3 HI Metrics

8 Integrated Ecosystem Assessments (IEAs)

8.1 Decision Tool/Model to Be Enhanced

This project focuses on enhancing tools to aggregate and transform various data to and from DIF standards and by achieving improved integration of selected data sets to serve the Integrated Ecosystem Assessment (IEA) community. An IEA is a formal synthesis and quantitative analysis of existing information on relevant natural and socio-economic factors in relation to specified ecosystem management objectives.

This project enhances the ERDDAP tool. ERDDAP is the tool designed by Environmental Research Division (ERD) of the National Marine Fisheries Service's Southwest Fisheries Science Center that can read from a variety of the most common data transport standards, and can output the data in a wide variety of formats used by a number of analysis and visualization applications. It acts as a data collector and translator; providing unified access to data of interest to IEAs in standardized formats.

8.2 Scope, Architecture, and Tasks

The project goal is to augment the ERDDAP software to provide enhanced integration with selected IOOS DIF data services and, in collaboration with the Ecosystem Goal Team, to prototype the implementation of these services into the IEA model for the Gulf of Mexico and California Current Regions. The proposed enhanced version of ERDDAP will allow it to use IOOS DIF data formats as both a source and an output, and to integrate these capabilities with existing tools developed to support IEAs.

NOAA's National Coastal Data Development Center (NCDDC) is developing Regional Ecosystem Data Management (REDM) system as the underlying data management and discovery system for IEA efforts under the Ecosystem Observation Program. The REDM architecture contains several services to collect, transform and provide access to data, and ERDDAP will become a component within the REDM architecture.

The project tasks involve better integrating of the Web services related to providing data for IEAs with the developing IOOS DIF standards as well as better integrating with REDM architecture:

1. ERDDAP will be updated to remain operational as a client with OOSTethys and DIF SOS services.
2. ERDDAP will be updated to serve as an OGC Web Mapping Service (WMS) service, for greater interoperability with the GIS world and so that the graphical output can be accessed by the WMS clients.
3. ERDDAP will be updated to output data in NetCDF4/HDF5 format following the “Common Data Model” being developed by Unidata.
4. ERDDAP will be updated to translate data from other services into files consistent with DIF XML schemas in order to also become an IOOS DIF SOS server.
5. Tools will be developed for a user customizable dynamic IEA in order to
    a. use ERDDAP for the data delivery mechanism, similar to what can be done with iGoogle;
    b. integrate ERDDAP with the subscription-service based architecture underlying the REDM system.

8.3 Data Sets

The data set that the project operates with is pre-defined by the IEA requirements and DIF boundaries. IEAs operate with 5 out of 7 core DIF variables, which are served by 3 IOOS data providers – NDBC, CO-OPS and Coast Watch – in standardized DIF formats. Apart from them, the data can be served by a number of non-NOAA providers such as WMO GTS, USGS, EPA STORET, etc. All data from different sources should be converted by ERDDAP into formats appropriate to IEAs.

The project data flow diagram is presented in Figure 8.1.

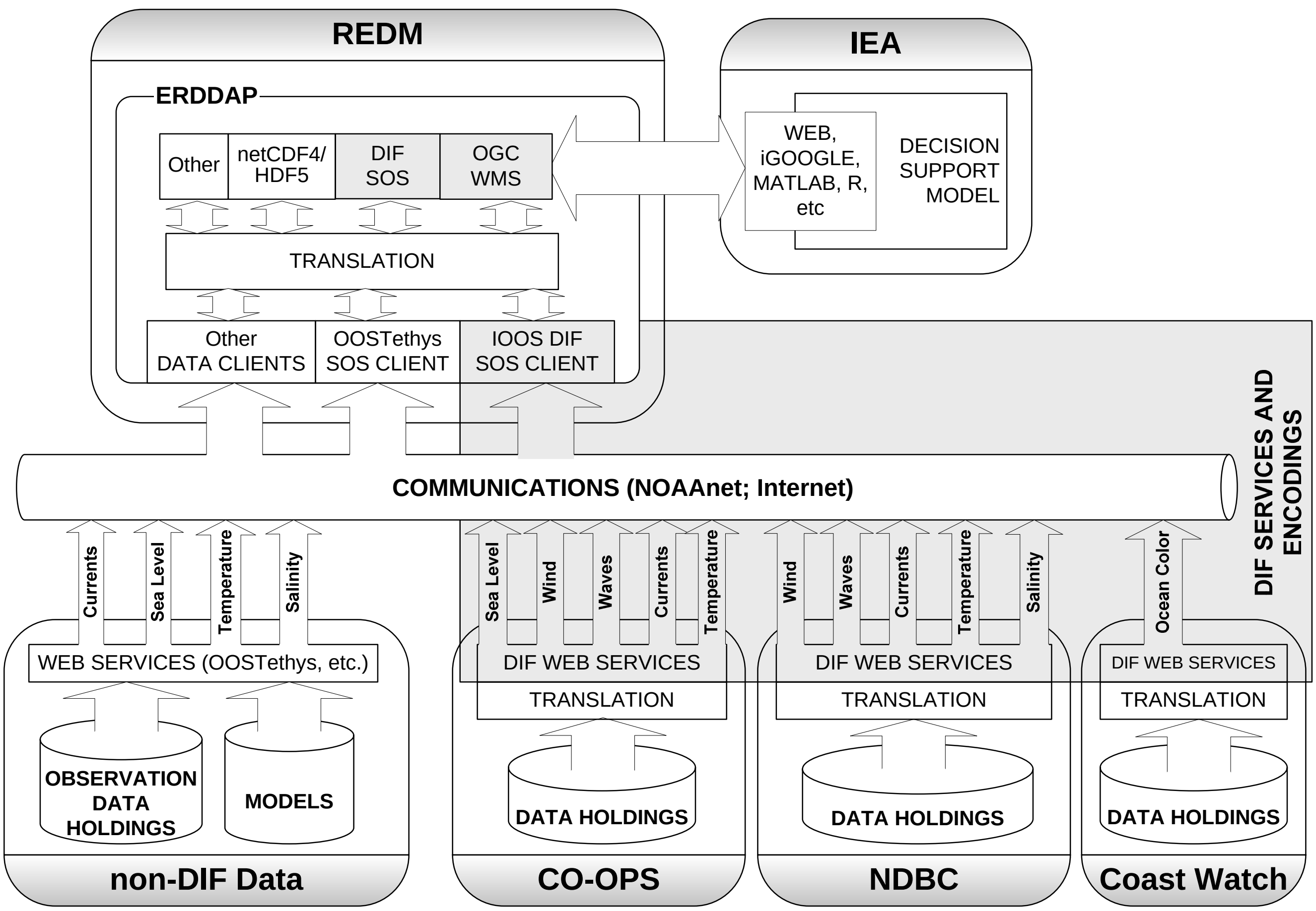

Figure 8.1 IEA Data Flow Diagram

8.4 Anticipated Benefits

It is expected that this enhancement of ERDDAP will expand the seamless access to the data being served by NOAA providers as well as any provider that serves data via any Web SOS service. That will benefit IEAs, as more data will be available to use in models, calculations and assessments.

A definitive benefit of ERDDAP usage by IEAs will likely include the resulting social and/or economic gain of IEA, which is anticipated to be significant. However, that kind of result is IEA type dependant and at this point that level of discovery and full exposure of such benefits are out of scope of the DIF project due to the cost and schedule constraints.

However, ERDDAP development and integration into the REDM architecture will improve the capacity of IEA by adding a number of new capabilities. These new capabilities are direct short-term benefits of the ERDDAP enhancement and implementation. As an example of such benefit a set of visualization tools will be developed, which becomes available to IEA developers through ERDDAP.

The list of these initial short term benefits is shown in Figure 8.2 (benefit categories are explained in details in Section 3 of this document). Because this project is in the fairly early stages of development, the definition of anticipated benefits, benchmarks, and assessments methodologies are still in progress.

#	Anticipated Benefit	Category
1	DIF expansion through ERDDAP: integration of additional data sets from non-DIF data providers by translation them into DIF format and services through ERRDAP	A
2	Enhancement of IEA development through tools developed by ERDDAP/REDM \	A to C*

* Real benefit categorization is not clear at the moment, and depends on further research of IEAs that could be used as test cases

Figure 8.2 IEA Benefits

8.5 Performance Assessment Methodology

8.5.1 Assessment Methods and Benchmarks

Because this project is in the fairly early stages of definition, the identification of anticipated benefits, benchmarks, and assessments methodologies have not yet been completed.

8.5.2 Metrics

Because this project is in the fairly early stages of definition, the metrics are still under development. However, the metric for the benefit to the DIF (#1 in Figure 8.2) would likely be an increased number of DIF data sets, and a description of additional capabilities that will become available through ERDDAP.

The description of tools that become available to IEA developers due to the ERDDAP enhancement could serve as one of the metrics for Benefit #2. A qualitative report would likely be a result of skill assessment in that case.

A preliminary set of metrics with corresponding measurement units are presented in Figure 8.3.

Benefit #	Metric	Measurement Unit
1	Number of data sets relevant to DIF and IEA, and served in DIF format through ERDDAP	An absolute number of new data sets or percentage skill improvement
2	Tools available to IEA developers through ERDDAP, and their value	Qualitative assessment

Figure 8.3 IEA Metrics

9 Summary of benefits

The table below provides a compilation and summary of the anticipated benefits, metrics, and assessment methods for the four DIF decision support/model areas.

Benefit	Metric	Assessment method
HARMFUL ALGAL BLOOM		
1. Development of a probability based, spatially-articulated bloom intensification estimate	Increased HAB Intensification availability & accuracy	Hindcast vs. actual HAB-FS bulletins and observations
2. A measurable increase in the spatial and temporal accuracy (skill) and precision (reproducibility) of HAB forecasts	Improved HAB Transport & Extent accuracy / precision increase	Hindcast vs. actual HAB-FS bulletins and observations
3. Increased probability of providing an accurate nowcast for the time periods when satellite imagery is not available due to clouds	HAB Transport & Extent availability increase	Hindcast vs. actual HAB-FS bulletins and observations
4. Extension of forecast spatial range to the areas where the forecast has been previously unavailable, e.g., Tampa Bay	Forecast availability area growth	Hindcast vs. actual HAB-FS bulletins and observations
5. Extension of forecast temporal range from 3 days to 5 days and more	Increased forecast span	Hindcast vs. actual HAB-FS bulletins and observations
6. Increased HAB forecast objectivity	Degree of objectivity increased	TBD. This may be a subjective or anecdotal result.

Benefit	Metric	Assessment method
COASTAL INUNDATION		
1. Increased efficiency and reliability of access to real-time water level data for SLOSH model initialization	Reliability of data transfer and time required for input data processing	Quantitative measure: enhanced method vs. legacy method
2. Ability to display real-time water levels in the SLOSH Display program	Number of presentations to the external audience through the season	Direct count
3. Data visualization quality improvement - TPC	Number of presentations to the external audience through the season	Direct count
4. Data visualization quality improvement - WFOs	Number of presentations to the external audience through the season	Direct count
5. Accuracy and reliability increase of local water surge guidance (HLS')	Degree of improvement	Qualitative assessment
HURRICANE INTENSITY		
1. Improvement of hurricane intensity and track forecast	Error reduction in hurricane intensity and track forecast	Hindcast vs. original forecast vs. actual data
2. Information on how to improve the ocean observing system for tropical cyclone prediction studies	N/A	Qualitative assessment
INTEGRATED ECOSYSTEM ASSESSMENT		
1. Increase in the number of data providers serving DIF data	Degree of increase	Direct Count
2. Expansion of the DIF data served by ERDDAP	Degree of increase	Direct Count

Appendix A Acronyms and Definitions

ADCIRC	Advanced Circulation Hydrodynamic Model
ADCP	Acoustic Doppler Current Profiler
AUV	Autonomous Underwater Vehicles
AWIPS	Advanced Weather Interactive Processing System
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CDMO	Centralized Data Management Office
CI	Coastal Inundation
CIP	Customer Implementation Project (DIF)
C-MAN	Coastal-Marine Automated Network
CODAR	Coastal Ocean Dynamics Applications Radar
COMPS	Coastal Ocean Monitoring and Prediction System
CO-OPS	Center for Operational Oceanographic Products and Services
CSC	Coastal Services Center
CSDL	Coast Survey Development Lab
CTD	Conductivity, Temperature, Depth
DIF	Data Integration Framework
DMIT	Data Management Integration Team
EPA	Environmental Protection Agency
ETSS	Extratropical Storm Surge
FGDC	Federal Geographic Data Committee
FIPS	Federal Information Processing Standards
FTP	File Transfer Protocol
GOM	Gulf of Mexico
GSFC	Goddard Space Flight Center
GTS	WMO Global Telecommunications System
GTSPP	Global Temperature and Salinity Profile Program
HAB	Harmful Algal Bloom
HDF	Hierarchical Data Format
HF	High frequency (radar)
HI	Hurricane Intensity
HTTP	Hyper Text Transfer Protocol
HWRF	Hurricane Weather Research and Forecasting
HYCOM	Hybrid Coordinate Ocean Model
IDS	Required Data Sets
IEA	Integrated Environmental Assessments
IGOSS	Integrated Global Ocean Services System
IMS	Information Management System
IOC	Initial Operating Capability
IOC	Intergovernmental Oceanographic Commission

IODE	International Oceanographic Data and Information Exchange committee
IOOS	Integrated Ocean Observing System
IT	Information Technology
JCOMM	Joint Commission on Oceanography and Marine Meteorology
MEDS	Canada's Marine Environmental Data Service
MMS	Minerals Management Service
MODIS	Moderate Resolution Imaging Spectroradiometer
NAM	North American Mesoscale
NCCOS	National Centers for Coastal Ocean Science
NDBC	National Data Buoy Center
NEP	National Estuary Program
NERRS	National Estuarine Research Reserve System
NESDIS	National Environmental Satellite, Data, and Information Service
netCDF	Network Common Data Form
NGOM	Northern Gulf of Mexico
NIST	National Institute of Standards and Technology
NODC	US National Oceanographic Data Center
NOS	National Ocean Service
NWLON	National Water Level Observation Network
NWS	National Weather Service
NWSTG	NWS Telecommunications Gateway
OPeNDAP	Open-source Project for a Network Data Access Protocol
POM	Princeton Ocean Model
PORTS®	Physical Oceanographic Real-Time System®
QA	Quality Assurance
QC	Quality Control
RD	Reference Document
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SLOSH	Lake, and Overland Surges from Hurricanes
TABS	Texas Automated Buoy System
TGLO	Texas General Land Office
USF	University of South Florida
USGS	United States Geological Survey
WMO	World Meteorological Organization