RFP No.: RFP2008DW2801

RFP Name: Gulf 3-D Operational Current Model Pilot

Proposal Title: **GOMEX 3-D Operational Ocean Forecast System Pilot Project**

Name of Offeror (prime contractor):

Portland State University

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Portland, OR 97207-0751

Names of Offeror's subcontractors and other participants:

Dr. Christopher N. K. Mooers, Portland State University (PI)

Dr. Cortis Cooper, CHEVRON (Co-PI)

Mr. David Driver, BP America (Co-PI)

Dr. Yi Chao, Jet Propulsion Laboratory & UCLA

Dr. Ruoying He, North Carolina State University

Dr. Leo Oey, Princeton University

Dr. Dong-Shan Ko, Naval Research Laboratory

Dr. Ann Jochens, Texas A&M University

Dr. Matthew Howard, Texas A&M University

Dr. Steven DiMarco, Texas A&M University

Mr. Richard Patchen, CSDL, National Ocean Service, NOAA

Dr. Hendrik Tolman, NCEP, National Weather Service, NOAA

Amount Requested: $1,248,000 Duration: 30 months Requested Start Date: 1 August 2009

Cost-Sharing: CASE = $ 252K; Chevron = $30K; and BP America = $30K; Total = $312

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TECHNICAL VOLUME

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LIST OF ACRONYMS

BP America – British Petroleum-America

CASE-JIP – a consortium of offshore oil & gas companies

CNMOC – Commander, Naval Meteorology and Oceanography Command

CONOPS - Concept-of-Operations

CSDL – Coast Survey Development Laboratory/NOS

CSL – Coastal Sea Level

CWG – CONOPS Development Group, a subcommittee of SAC

DAS – data assimilation system

GCOOS – Gulf of Mexico Coastal Ocean Observing System Regional Association

GOMEX – Gulf of Mexico

HYCOM – Hybrid Coordinate Ocean Model

IOOS – Integrated Ocean Observing System

JPL – Jet Propulsion Laboratory

LC – Loop Current

LCE – Loop Current (anticyclonic) Eddy (or, Ring)

MAST – Modeling and Analysis Steering Team (MAST)/IOOS

NAVO – Naval Oceanographic Office

NCEP – National Centers for Environmental Prediction/NWS

NCOM – Navy Coastal Ocean Model

NCSU – North Carolina State University

NMFS – National Marine Fisheries Service/NOAA

NOAA – National Oceanic and Atmospheric Administration

NOS – National Ocean Service/NOAA

NRL – Naval Research Laboratory

NWS – National Weather Service/NOAA

OCS – Outer Continental Shelf

PMG – Project Management Group

POM – Princeton Ocean Model

PSU – Portland State University

PU – Princeton University

ROMS - Regional Ocean Modeling System

RPSEA – Research Partnership to Secure Energy for America

SAC – Scientific Advisory Committee, broad community-based advisory committee provided by the project

SEACOOS – Southeast Atlantic Coastal Ocean Observing System

SECOORA – Southeast Coastal Ocean Observing System Regional Association

SOW – Statement of Work

SSH – Sea Surface Height

SST – Sea Surface Temperature

TAC – Technical Advisory Committee, industry-based project oversight committee provided by RPSEA

TAMU – Texas A&M University

UCLA – University of California at Los Angeles

UDW – Ultra Deepwater Program

USCG – United States Coast Guard

Executive Summary (Releasable to Public)

Portland State University (PSU) serves as the prime contractor for the proposed project entitled "GOMEX 3-D Operational Ocean Forecast System Pilot Project". Prof. Christopher N. K. Mooers of the PSU Department of Civil and Environmental Engineering is the designated Principal Investigator, while Dr. Cort Cooper, Chevron and Mr. David Driver, BP America serve as Co-PIs. The project aims to conduct the applied R&D necessary to demonstrate, evaluate, and establish an operational forecast system for ocean currents in the Gulf of Mexico. Such an operational forecast system is comprised of a numerical ocean circulation modeling subsystem, an ocean (satellite and in situ) observing subsystem with real-time components, and a data assimilation subsystem for initializing the forecasts. The project will be conducted in two phases. For the first phase (with a duration of 18 mos), several state-of-the-science, eddy-admitting baroclinic ocean circulation numerical models will participate in a series of forecast experiments for assessment of their skill relative to standard metrics that are applications-based. For the second phase (with a duration of 12 mos), one or more of these models will be advanced as a pilot operational forecasting system in a real-time demonstration. The forecasting systems will be provided by Princeton University, North Carolina State University, University of California at Los Angeles, Naval Research Laboratory, Naval Oceanographic Office, National Ocean Service, and National Weather Service. For skill assessment, they will be joined by Texas A&M University and Portland State University. CASE-EJIP, Chevron, and BP America are providing the requisite "cost share" funding. A Scientific Advisory Committee (SAC) has been formed to (1) review the plans, progress, and prospects of the project; (2) build a broad consensus on the skill of the forecast systems; and (3) recommend a Concept-of-Operations (CONOPS), which defines stakeholders, user requirements, roles and responsibilities, etc. for transitioning the pilot forecasting system to sustained operations. The key deliverables will be (1) manuscripts documenting the skill assessment of the forecasting systems, (2) the pilot operational forecasting system, including a Website with real-time products, and (3) a recommended CONOPS. The operational forecasting system will provide information that can be used to guide marine operations that are affected by transient currents throughout the water column associated with the Loop Current, the eddies it sheds, and

the passage of wintertime cold fronts and summertime tropical cyclones. Such current forecasts will also have collateral benefits for marine emergency managers, environmental managers, and ecological managers.

A. TECHNICAL MERIT & VALUE TO PROGRAM

A.1 Proposed Technology/Methodology

The skill of several state-of-the-art Gulf of Mexico numerical ocean circulation forecast model systems will be assessed. For the initialization of forecasts, the model systems use various data assimilation systems together with satellite remote sensing and in situ data. Various applications-based metrics; e.g., the location of the Loop Current front relative to the position of offshore platforms, will be utilized in these skill assessments. After a series of forecast experiments, one or more models will be selected for implementation and demonstration of an operational forecasting capability which is anticipated to be recommended for sustained operations at the end of the project.

A.2 Industry Participation and Support

A. 2.1 Description of Industry Participation. The offshore oil & gas industry will provide support in three basic ways:

1. A cash contribution of $252K from the CASE-EJIP Joint Industry Project (JIP).
2. An in-kind contribution of not less than $60K from two Industry experts, Cortis Cooper of Chevron and Dave Driver of BP.
3. Access to proprietary data sets from the CASE-EJIP archive which originally cost roughly $1 million to acquire.

A. 2. 2 Leverage of Project Funds. As shown in Appendix V, the CASE-EJIP JIP has written a letter of commitment to provide $252K towards the Project. CASE-EJIP is a consortium of 20 oil and gas companies that are active in the deepwater Gulf of Mexico. The goal of the JIP is to fund cooperative research on meteorological and oceanographic (metocean) topics of engineering significance in the deepwater Gulf. The JIP was started in 1983 by making the first synoptic velocity measurements in the Loop Current, and its pioneering efforts continue today on topics ranging from the interaction of hurricane-eddies to studying wave crests during storms. With an annual budget of roughly $300,000, CASE-EJIP has become the focal point of metocean research for the Industry.

Two Industry metocean experts, Dr. Cortis Cooper of Chevron and Mr. Dave Driver of BP, will contribute at least 15 man days ($30 k) each as co-PI's on the Project.

Each has over 25 years of experience in the Industry working on metocean topics of engineering relevance including Loop forecasting, development of operational and extreme criteria, oil spill modeling, etc. Letters of commitment from their respective companies are included in Appendix V., as are their resumes in Appendix I.

Finally, CASE-EJIP will provide access to its proprietary databases which include synoptic current and hydrographic surveys of roughly 10 historical eddies. In addition the JIP will provide a data set of discretized weekly frontal positions spanning roughly 20 years. Such information should prove invaluable during the historical hindcast phase of the Project.

A .3 Expected Impacts and Benefits

A. 3. 1 Impact on Reserves and Production. The Industry looses millions of dollars every year due to drill-rig downtime caused by LC/LCEs. Perhaps more importantly, there have been numerous “near-misses” documented by the Minerals Management Service (MMS) in which rig operators faced potential serious issues. Accurate forecasts could help operators avoid some of these issues through better planning, and avoid potentially dangerous surprises.

Though much effort has been expended in the past 10 years, forecasting of LC/LCEs remains problematic. Yet, the Industry’s need to model these powerful currents becomes even stronger as it ventures further south in the Gulf. While there are many existing models, none have been demonstrated to perform at the level of accuracy required. Besides the LC/LCEs, other applications for current forecasts include providing critical input to strategic and tactical oil spill response and addressing questions involving hypoxia and “produced water”.

A. **3. 2 Environmental Impact.** None is expected due to the numerical prediction nature of the project.

A. **3. 3 Applicability.** The operational oceanography expertise of the Navy and NOAA, and of the value-added environmental industry, is engaged in the project. This expertise will help guide the development of a Concept of Operations that will underpin and sustain the Gulf of Mexico operational forecasting system to be implemented, demonstrated, and recommended in this project.

A. 3. 4 Risks. There is a risk that none of the modeling systems can satisfy the metrics required for various applications. There is also a risk that, even if the modeling systems perform satisfactorily, that the stakeholders will not or cannot support the operational system.

B. TECHNICAL APPROACH

B.1 Detailed Work Plan (Statement of Work)

GOMEX 3-D Operational Ocean Forecast System Pilot Project

UDW Project Number 2801

BACKGROUND

Though much effort has been expended over the past decade, forecasting of Loop Current/eddies (LC/LCE) remains problematic. Meanwhile, the Offshore Oil & Gas Industry's need to forecast these powerful currents, which can extend over the full water column, has become even stronger as the Industry ventures further south in the Gulf of Mexico (GOMEX). While there are many existing models, none have been demonstrated to perform at the level of accuracy required. Besides the LC/LCE, other current forecast applications include guiding (1) oil spill response and (2) potential shallow water operations involving hypoxia and produced water.

The Industry looses millions of dollars every year due to drill-rig downtime caused by LC/LCE. Perhaps more importantly, there have been numerous "near-misses" documented by the Minerals Management Service (MMS) in which rig operators faced potentially serious issues. Accurate forecasts could help operators avoid some of these conditions and events through better planning, and avoid potentially dangerous surprises

I. OBJECTIVES.

The general objective is to demonstrate a well-validated operational 3-D modeling system that produces timely, accurate forecasts, nowcasts, and hindcasts of currents across the GOMEX. The aim is to have sufficient accuracy to be useful for a number of applications including LC/LCE forecasts, oil-spill trajectory forecasts, and similar current-dependent forecasts. The numerical products of the modeling system are to be Web-based so that they are, thus, available/accessible to the public and provide substantial benefits to many well-informed users.

More specifically the objectives of this project are to:

- Identify the needs of the user community for various types of prediction outputs.

- Test various methods for quantifying modeling system errors, with special attention on quantifying the errors of relevance to the end users.
- Establish model metrics that will accurately gauge the ability of the modeling system to meet users' requirements.
- Apply model metrics on a routine basis so as to provide a means for continuous monitoring of the modeling system performance in order to help improve the modeling system.
- Better utilize and synthesize on-going observations through data assimilation.
- Develop an archive of hindcasts that can be used for climatological studies, climate change detection, and diagnostic studies of ocean dynamics in the GOMEX.
- Quantify improvements made by single model and multi-model ensemble forecasts.
- Make the modeling system results and ancillary tools easily accessible (Web-based) and usable by subject matter experts.

II. SCOPE OF WORK

The RFP from RPSEA states that the primary project aim is to establish an operational prediction (hindcasting, nowcasting, and forecasting) system for strong currents associated with the Gulf of Mexico (GOMEX) Loop Current (LC) and eddy (LCE) system in support of the oil & gas industry's southward extension of its activities into "ultra deepwater". A full water column capability is required, especially for surface and bottom currents, including those along the lower continental slope and continental rise. Secondary applications include guidance for oil spill response and potential shallow water operations involving hypoxia and "produced water". The offshore oil industry is interested in a forecast horizon of a few months for LC & LCE positions, etc. Past industry experience with forecasting LC & LCE positions has indicated a high degree of dependency on the initial conditions. Thus, attention must be given to assessing the quality of data-assimilative model analyses (or nowcasts) used for initial conditions.

This project is proceeding without the support of IOOS funding at the present time while still trying to help GCOOS (& SCOORA) advance. Collaborative relationships with MMS's ongoing GOMEX modeling and observational activities are anticipated.
The RFP calls for two phases to the project: Phase I (R&D and Selection Project; initial 12 mos) is comprised of two competitive experiments, and Phase II (Demonstration Project; final 18 mos) is comprised of pilot operational prediction system implementation and assessment. [NOTE: the durations of these phases have been reversed in this proposal to be more realistic, given the required effort and the limited resources available.] An early step is to firm-up "user requirements" for a deep-water current prediction system that will have a continental shelf capability, and which, in addition to the oil industry, may include, for example, marine transportation, maritime safety, and commercial and recreational fisheries users. The RFP calls for a user survey; GCOOS and SECOORA will be asked to help in this regard. The "user requirements" will help establish the skill assessment metrics (e.g., Oey et al. (2005)). An exercise in forecasting Loop Current and eddy frontal positions in the Gulf of Mexico, GRL, V32, L12611) to be used in the skill assessments and the overall competition.

The notion of an "operational current prediction system" is not much developed in the RFP, other than that a Website will be established (to be provided by GCOOS) and kept fresh with forecast products that are meaningful to knowledgeable users. It is not made clear whether the aim is to establish, for example, a federally operated prediction system for the GOMEX as a public service or a for-profit private sector system paid for by the offshore oil industry (and also operated as a public service) or a hybrid. An example of a hybrid system would be the feds providing an operational analysis (nowcast) of the GOMEX on an hourly basis that would be used as initial conditions for a private or academic sector weekly LC & LCE feature model prediction system with a forecast horizon of 3 mos. The RFP allows for the possibility of using multiple models to form ensemble forecasts. In short, a Concept–of-Operations (CONOPS) does not appear in the RFP, so the CWG (a subcommittee of the SAC) will be asked to recommend viable alternatives.

Another early step is to identify a recent "historical or target year" in which interesting LC & LCE events occurred, and for which abundant in situ and remote sensing observational datasets exist. The occurrence of a Northern Gulf land-falling hurricane during the target year would be a bonus attribute. For the first experiment, a forecast will be started at the beginning of each month of the target year and run for a 3-mos period; altogether, there will be 9 three-month forecasts to be skill assessed against GOMEX analyses. (In other words, this activity will serve as something of a de facto predictability experiment for the GOMEX.) For the second experiment, there will be a 3-mos forecasting test in the blind for a future period, again to be skill assessed against GOM analyses. The results of these experiments will be the main determinants in selecting the model (s) for Phase II.

Operational, quasi-operational, and research models and modelers have agreed to participate. For example, the Navy's Global-NCOM and NOAA's RTOFS-Atlantic – HYCOM operational model output will be available. Navy and NOAA are welcome to participate in the multi-week R&D forecast experiments of Phase I and the prototype multi-week operational forecasts of Phase II. As described in the SOWs of Appendix II, Leo Oey (PU/MMS contractor and POM modeler), Yi Chao (JPL & UCLA/DAS developer and ROMS modeler) plus Ruoying He (NCSU & SECOORA/quasi-operational GOMEX ROMS modeler), Dong-Shan Ko (NRL/quasi-operational GOMEX Regional NCOM developer), and Rich Patchen (CSDL/operational GOMEX POM developer) will participate in Phase I (R&D and Selection Project) and compete for Phase II (Demonstration Project). [NOTE: to participate in the proposed project, all of these modelers are, of necessity, leveraging ongoing R&D activities. Also, all of these models already cover the GOMEX Outer Continental Shelf (OCS).] Drs. Ann Jochens, Matt Howard, and Steve DiMarco, TAMU have been engaged to help with accessing the observational databases, archiving the model output, and conducting the skill assessments, together with Ed Zaron and Chris Mooers, PSU.

III. Tasks to be Performed.

Administrative Task Reports:

Task 1.0 - - Project Management Plan (due 30 days after contract award). PSU will develop a Project Management Plan consisting of a work breakdown structure and supporting narrative that concisely addresses the overall project as set forth in the agreement. PSU will provide a concise summary of the objectives and approach for each Task and, where appropriate, for each subtask. PSU will provide schedules and planned expenditures for each Task including any necessary charts and tables, and all major milestones and decision points. PSU will identify key milestones that need to be met prior to the project proceeding to the next phase. This report will be submitted within 30 days of the Award. The RPSEA Contracts/Procurement Manager will have 20 calendar days from receipt of the Project Management Plan to review and provide comments to PSU. Within 15 calendar days after receipt of the RPSEA's comments, PSU will submit a final Project Management Plan to the RPSEA Contracts/Procurement Manager for review and approval.

Task 2.0 - - Technology Status Assessment (due 30 days after contract award). PSU will perform a Technology Status Assessment and submit a summary report describing the state-of-the-art of the proposed technology. The report will include both positive and negative aspects of each existing technology. The report will be no more than five typewritten pages in length. The report will not contain any proprietary or confidential data, as the report will be posted on the RPSEA website for public viewing. The report will be submitted within 30 days of the Award.

Task 3.0 - - Technology Transfer (due 30 days after contract award). PSU will designate 2.5% of the amount of the award for funding technology transfer activities. Throughout the project, PSU will work with RPSEA to develop and implement an effective Technology Transfer Program at both the project and program level. In addition, PSU will provide information requested by RPSEA to support the quantitative estimation of program benefits.

Task 4.0 - - Routine Reports and Other Activities . Upon contract execution, PSU and other project participants will coordinate with the RPSEA Project Manager to plan and schedule a Project Kick-off Meeting. Monthly reports are due to RPSEA on or before the 14th of every month. Report templates are provided by RPSEA on its Website. RPSEA schedules quarterly TAC meetings (4 per year), and PSU will provide a project presentation to update the TAC. PSU may be asked to participate in person, or via Web meeting, at the RPSEA Project Manager's discretion. Planning will be done for a Houston-based meeting, although there may occasionally be a need to meet at PSU. A final project presentation at a quarterly TAC meeting is anticipated following Project completion.

Technical Tasks:

Task 5.0 - - Identification of User Needs and Development of Model Assessment Criteria. PSU, using a questionnaire, will conduct a survey of a minimum of 10 potential users (e.g., offshore oil & gas industry (for example, CASE-JIP), Horizon Marine Inc., GCOOS, SECOORA, CSDL, NCEP, NOS, NWS, NMFS, CNMOC, NAVO, USCG, and MMS, but the list must be agreed upon by RPSEA). The questionnaire will seek to answer the following key questions:

- What space and time scales, what accuracy, and what forecast horizon are needed to satisfy the user's requirements?
- How frequently should the forecasts be updated?
- In what form do users want the model output -- raw data streams from a server, maps, time series or vertical profile plots, or some alternative format?
- Which models are currently being used to meet, at least partially, these requirements?
- What requirements are not being met by the present models?

- What is the value proposition (quantitative and qualitative) for developing the subject model?

Once PSU has gathered input from the users, a series of model performance goals and quantitative assessment criteria will be developed. The Project will be judged a complete success if it attains all the goals. An example of a useful quantitative skill assessment criterion is given in Oey et al., 2005, which relates forecast accuracy of the LC frontal position relative to the locus of offshore oil rigs. Another example is given by the nowcast (analysis) of the flow through the Yucatan Strait (and Straits of Florida) because the dynamics (and, thus, predictability) of LCE shedding may be related to flow conditions on the open boundaries of the GOMEX. A comprehensive list will need to await further feedback from the user questionnaires. Furthermore, the evaluation metrics are expected to mature as the project progresses. Toward the end of this task, PSU will issue a report summarizing the efforts in this task, plus recommendations for the performance and assessment criteria. This report will be reviewed by RPSEA which must approve the performance and assessment metrics.

Oey et al., 2005, An Exercise in Forecasting Loop Current and Eddy Frontal Positions in the Gulf of Mexico, Geophysical Research Letters, V32, L12611.

Task 6 - Model Inter-Comparisons. There are many existing models and modeling systems; however, none have yet been demonstrated to meet the level of performance required to fully meet user's needs, which will be formally defined in Task 5. Instead of developing a completely new model or modeling system, the purpose of this task is to determine the 'best' (i.e., the ones most closely meeting user needs) of existing modeling systems and then improve and make it (or them) readily and easily accessible in later Tasks 7 and 8. The models and modeling systems proposed by PSU for evaluation are ROMS (JPL/UCLA & NCSU), Regional-NCOM (NRL), Global-NCOM(NAVO), POM (PU), POM (CSDL), and Atlantic-HYCOM (NCEP), as described in their SOWs or emails in Appendix II. However, they will require approval by RPSEA. The selected models will be run for two periods: a recent one-year historical period and a forthcoming period, nominally three months long. {NOTE: these are minimal model runs; if feasible within allocated resources, longer experimental periods will be utilized to improve the representativeness and robustness of the skill assessment statistics.} PSU, with the help of TAMU, will then compare model results with observations and with the other models. The rationale for choosing a historical period is to make sure that the testing period is of adequate length in which there are plenty of observations for comparison and for which there are some interesting events; e.g., when a LCE separates from the LC and propagates westward or when there is a passage of a land-falling hurricane in the Northern Gulf of Mexico. As for the three-month forecasting experiment, it will provide a blind test that mimics a true operational situation.

For the one-year historical period, the forecasts will be re-started at the beginning of each month and run for a 3-month period, producing 9 forecasts out to 3 months. For the 3-month future period, the forecasts will be restarted every two weeks and run to the end of the initial three-month time horizon, producing 1 3-month forecast, 2 21/2- month forecasts, 3 2-month forecasts, and so forth. Error statistics will be calculated, for example, based on the difference between the modeled and observed distance from a set of deepwater sites to the nearest edge of the LC and LCE, as described by Oey et al., 2005, and as noted above in Task 5.

Additional comparisons will be made between observations (e.g., ADCP current profiles from the Offshore Oil Industry array) and model output. A more complete set of observations suitable for model skill assessment will be identified during the process of selecting a "historical year" by reviewing satellite radar altimeter-derived sea surface height anomalies (SSHA), upper layer drifter trajectories, etc.

When the model runs are underway, PSU will provide RPSEA status updates via teleconference and e-mail at least bi-monthly. PSU will forward a summary of those status reports to RPSEA and highlight any difficulties along with a strategy to meet the challenges.

When the model runs are complete, PSU, with the aid of TAMU, will assess and compare them using the evaluation criteria and performance goals identified in Task 5. PSU, together with its subcontractors, will explore the feasibility of performing multi-model ensemble averaging using results from various combinations of the above model runs. If this multi-model ensemble averaging proves feasible, the results will be assessed for the incremental increase in accuracy achieved compared to individual models. PSU will document the inter-comparison results in a written report. The report will also outline a way forward to set up, enhance, and operate the selected modeling system(s) for the remainder of the project as well as addressing a way forward for ensuring third-party access to the modeling system for use in a long-term "operational" mode.

Once this effort is completed in YR2/Q2, PSU will host the model selection meeting in Houston for the SAC and TAC/RPSEA to review in detail the inter-comparison results. With input from PSU, RPSEA will exclusively choose the modeling system(s) to utilize in Phase II. PSU will then extend the appropriate subcontracts accordingly.

Task 7 - - Operational Modeling System Implementation and Initial Evaluation.

PSU will be responsible (with the help of the subcontractors) to automate many of the essential processes in publishing a routine forecast. The specific roles in this task will be determined by PSU prior to launching Phase II. At a minimum, this automation should include:

- Assimilation of observed data (satellite-based SSTs and SSHs, current profile observations, and other such data) from key sources. Assimilation of some of the Offshore Oil Industry's observations is expected, though considerable QA/QC will be needed.

- Utilization of the user-friendly GCOOS Website to provide access to forecast fields and graphical summary products; e. g., surface velocity vector snapshots at user-specified time intervals. A critical purpose of the Website will be to encourage user feedback.

- Implementation of nowcast and forecast archives.

- Evaluation of forecast skill on a monthly basis, with results posted to the GCOOS Web site.

Forecasts will be posted in real-time on the GCOOS Website and made available for review and analysis by the RPSEA TAC. (A user base of approximately 20 will be assumed). The update frequency and time horizon of the forecasts is expected to evolve as experience is accumulated and issues/problems are resolved. PSU will begin with relatively infrequent (bi-weekly) forecast updates and short (½ to 1 month) time horizon and migrate toward more frequent (semi-weekly) forecast updates and longer time horizons (1 to 2 months) generating quantitative comparisons using the evaluation metrics established in previous tasks.

In YR3/Q1, PSU will host a stakeholder & user workshop with the SAC and RPSEA TAC. The workshop goal will be to solicit comments, assess modeling system performance, prioritize a list of modeling system improvements including products, consider any suggested improvements in evaluation metrics and performance goals, and identify alternatives on how best to implement a permanent operational model, based on the recommendations of the CWG. PSU will document the workshop findings in a brief final report.

Task 8 - - Model Finalization and Technology Transfer.

In the last quarter of the project, PSU (together with its subcontractors) will implement the improvements identified towards the end of Task 7 and will scope out a long-term "operational system" with the aid of the CWG. The word "system" is emphasized because for an operational model to be a success all major components must be considered, including the model, DAS, observing system network, data access software, data filtering software, Web posting software, documentation, staffing, computational and communication resources, stakeholders, users, and funding requirements and sources. PSU will solicit advice from the SAC, RPSEA TAC, and other recognized experts. PSU will identify several organizations that could lead the operational center and consider their technical abilities, infrastructure, and funding sources.

PSU (together with its appropriate subcontractors) will write a final report including comprehensive documentation for the model such that it could potentially be set up and run by another entity with some limited consulting assistance. Technology Transfer activity will include papers to be presented at conferences and at least one journal article submission, the GCOOS Website material, and the Stakeholder and User Workshop.

Additional Considerations. This operational model will be capable of far more than just LC/LCE forecasting. More specifically, the model will also be useful for forecasts across the Outer Continental Shelf (OCS). Hence, it will help the Offshore Oil Industry calculate pollutant transport, search and rescue trajectories, etc. that depend upon forecasts of ocean currents and ocean temperature and salinity structure. The expanded potential user base will enhance the long-term prospects for maintaining the operational model. Thus, it is important to note that all of the models engaged in this project already cover the OCS of the Gulf of Mexico, though to varying degrees of adequacy depending upon horizontal resolution, etc.

B.2 Project Schedule and Milestones

In the below GANTT Chart, Phase I (experimentation, evaluation, and selection) is covered by the initial six quarters, while Phase II (implementation, demonstration, and evaluation) is covered by the final four quarters.

TASK	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
1. Project Management Plan & "Kick-Off" Meeting	X									
2. Technology Status Assessment	X									
3. Technology Transfer Plan	X									
4. Routine Reports and Other Activities	X	X	X	X	X	X	X	X	X	X
5. Identify user needs	X	X								
5.1 Gather input from users	X									
5.2 Develop model performance specs and evaluation criteria	X	X								
5.3 Write Task 5 final report	X	X								
6. Model Selection	X	X	X	X	X	X	X	X	X	

6.1 Initiate modeling work and evaluate results	X	X	X	X	X	X	X	X	X	
6.2 Write report summarizing results and final recommendations					X	X				
6.3 Run model inter-comparisons		X	X	X	X					
6.4 Evaluation of results from models		X	X	X	X	X	X	X	X	
6.5 Meeting with RPSEA and then RPSEA selection of operational model					X	X				
7. Setup operational forecasts							X	X	X	X
7.1 Setup basic infrastructure							X	X		
7.2 Issue routine forecasts							X	X	X	X
7.3 Evaluate and improve performance							X	X	X	X
7.4 Workshop with users, GCOOS & SECOORA, and RPSEA										X
7.5 Summarize workshop findings in a final report										X
8. Model Finalization and Technology Transfer									X	X
8.1 Implement final improvements and document									X	X
8.2 Demonstrate a sustained operational model									X	X
8.3 Write Task 8 final report; thoroughly document model use									X	X

B.3 Proposed Travel

The proposed travel falls into three categories: (1) attendance at the three meetings/workshops planned (see Appendix IV), (2) site visits to subcontractors and no-cost participants by the PI, and (3) attendance at the three planned meetings/workshops by Prof. Mooers and Dr. Zaron.

(1) The venue for the three meetings/workshops is planned to be Houston, TX; each will have a duration of 1 ½ days. The subcontractors are responsible for their travel expenses. The SAC members will be reimbursed for their travel and per diem. As part of the cost-sharing, it is planned for CASE to contract with Beeline Inc. to reimburse travel expenses for SAC members, plus Rich Patchen, CSDL/NOS; consulting fees for academic members; and meeting facility costs. These costs are outlined below:

There are 7 agency (including Rich Patchen), 4 academic, and 3 industry SAC members for a total of 14, plus 3 PMG members.

Travel and per diem will be provided 14 members for three meetings, each 1 ½ days in duration.

Assume average roundtrip airfare will be $500. Hence, the subtotal for travel is 14 x 3 x $500 = $21K.

Assume average per diem (hotel, meals, taxis, misc.) will be $250, and assume two hotel nights for each meeting. Hence, the subtotal for per diem is
14 x 3 x 2 x $250 = $21 K.

Then the total for travel and per diem will be $42K, plus Beeline 5% fee ($2.1K) = $44.1K.

[NOTE: meeting room, A/V, coffee, etc. costs need to be added, perhaps $2.5K per meeting for a total of $7.5K. Assume a Beeline 5% fee ($0.375K); hence, **the total would be $7.875K**]

The 4 academics will be paid consulting fees of $750 per day. They will charge for 1 ½ days of review preparation and 1 ½ days of attendance for each meeting. They will charge another 1 day for review of the final report, making a total of 4 x (3 x 3 + 1) days x $750 per day = $30K.

Then the total consulting fees will be $30K, plus Beeline 19% fee ($5.7K) = $35.7K

Altogether, travel and per diem, meeting facilities, and consulting fees will yield a Grand Total = $44.1K + $7.875K + $35.7K = $87.675K.

Due to many uncertainties, $100K has been set aside for CASE to manage with Beeline, Inc.

(2) Prof. Mooers plans to visit each of the subcontractors for two days twice for coordination and in-depth progress reviews:
Portland, OR to Raleigh, NC (NCSU)
Portland, OR to Princeton, NJ (PU)
Portland, OR to Silver Spring, MD (CSDL) and College Park, MD (NCEP)
Portland, OR to Stennis Space Center, MS (NRL & NAVO)
Portland, OR to College Station, TX (TAMU)
Portland, OR to Pasadena, CA (JPL/UCLA)
Obviously, there is potential to combine some of these trips for efficiency and economy. Roughly, then this potential translates into a travel expense of about 2 x 3 trips at $1K each = $6K, and a per diem expense of 2 x 6 x 2 days x $250 p.d. = $6K for a total of $12K.
(3) Prof. Mooers and Dr. Zaron will participate in the three planned meetings, which will cost about $6K using the cost estimates in (1) above. Hence, the PSU travel budget [(2) + (3)] totals $18K.

C. TECHNICAL AND MANAGEMENT CAPABILITIES

C.1 Organizational Capabilities and Experience Portland State University (PSU) was established over 60 years ago and is now Oregon's largest (enrollment 27,500). It has gained renown as an urban university engaged with regional and global sustainability. It manages about $40M per year in sponsored research. The Department of Civil and Environmental Engineering is one of five departments in the Maseeh College of Engineering and Computer Science (CECS), which has an annual research budget of about $7M. The CESC has a track record of delivering applied R&D results to Intel, etc.

C.2 Qualifications of Key Personnel Short CVs or Resumes are provided in Appendix I for all the personnel mentioned below.

The project PI is Prof. Christopher N.K. Mooers, PSU who has nearly 30 years experience with ocean prediction research, nine years experience as a department or division chair, and three years experience as a laboratory director. He will participate with three months supported and three months contributed over the project duration. In addition to project coordination and management, he will work on skill assessment with Dr. Ed Zaron, PSU, who has 15 years experience with DAS, six months effort.

The project Co-PIs are Dr. Cort Cooper, Chevron and Mr. David Driver, BP America; they each have over 25 years of experience with environmental matters in the offshore oil industry context. They will participate with at least one-half month effort over the project duration. The PI and two Co-PIs will constitute a Project Management Group (PMG) for month-by-month management of the project.

The subcontractors are

Dr. Leo Oey, PU ocean modeler with about 30 years experience with running POM and DAS development, 1 1/2 month effort.

Dr. Yi Chao, JPL/UCLA ocean modeler with about 10 years experience with running ROMS and DAS development, 1 month effort (no-cost).

Dr. Ruoying He, NCSU ocean modeler with about 8 years experience with running ROMS, 1 month effort (no-cost).

Dr. Dong-Shan Ko, NRL ocean modeler with about 20 years experience running POM and DAS development, 3 months effort.

NOTE: these modelers will supervise postdocs working on this project.
Drs. Ann Jochens, Matt Howard, and Steve DiMarco, TAMU ocean data analysts and/or data managers each with 20 or more years experience, 2 ½, 4 ½, and 1month (s) effort, respectively.
In addition, Dr. Rich Patchen, NOS ocean modeler with over 20 years experience running POM and DAS development, 3 months (no-cost) effort.

The PI has been previously involved in Gulf of Mexico model skill assessment activities sponsored by MMS. The Co-PIs have been involved in previous model skill assessment studies sponsored by the offshore industry. The PI only recently moved from the University of Miami to Portland State University. In Miami, he had been deeply involved in the Gulf of Mexico modeling community. For example, in the summer of 2007, he chaired the USA-Mexico Workshop on the Deep Water Physical Oceanography of the Gulf of Mexico. As another example, he ran the East Florida Shelf Information System (EFSIS) that provided a quasi-operational nowcast/forecast system for the Straits of Florida for several years as part of the SEACOOS Program. Among the subcontractors and other participants, Drs. Leo Oey/PU, Dong-Shan Ko/NRL, and Mr. Rich Patchen/CSDL have been recognized as leading modelers of the Gulf of Mexico for many years, and as sponsored by MMS, Navy & NASA, and MMS, Navy, & NOS, respectively. Dr. Ruoying He/NCSU has become recognized for his modeling of the West Florida Shelf and beyond in the SEACOOS and SECOORA programs. Their Gulf of Mexico modeling has treated the LC and LCEs, and it has dealt with wind-forcing, river runoff-forcing, and, in some cases, tidal forcing. Dr. Yi Chao/JPL & UCLA brings to the Gulf of Mexico a record of innovation in data assimilation, and successful experience in modeling the California Current regime and North Pacific, as sponsored by NASA and Navy. Drs. Ann Jochen, Matt Howard, and Steve DiMarco/TAMU bring experience with Gulf of Mexico field programs, data analysis, and data management. They, like Dr. Cort Cooper, play integral roles in GCOOS. The technology transfer approach in this project consists of several components: (1) transitioning a forecast system from R&D to operations, (2) making real-time forecasts available on the Web, and (3) conducting a stakeholder/user workshop. Dr. Ko and Mr. Patchen, in particular, have experience with

(1); Dr. Howard is providing the Website via GCOOS for (2); and Prof. Mooers has convened and chaired innumerable workshops, which pertains to (3).

C.3 Quality and Suitability of Facilities, Equipment and Materials Due to the computational nature of this project, the participants utilize computational systems available within their institutions. These computational systems range from work stations at PSU and TAMU to major super computer centers at Princeton, JPL/UCLA, NRL & NAVO/Navy, and NOS & NWS/NOAA. There are no other infrastructural resources significantly involved.

D. QUALITY AND HEALTH, SAFETY & ENVIRONMENTAL (HS&E) Due to the computational nature of this project, there are no deleterious quality and health, safety & environmental issues associated with it. On the contrary, the operational ocean forecast system under development will provide ocean current information helpful to managers charged with the safety of marine operations and the efficiency of search-and-rescue and spill mitigation. This information will also help environmental and ecological managers make wise decisions affecting fisheries recruitment, waste disposal, harmful algal blooms, etc.