

# Oil & Natural Gas Technology

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## Quarterly Report

October 2009 to December 2009

### Remote Sensing and Sea-Truth Measurements of Methane Flux to the Atmosphere



### (HYFLUX project)

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## Table of Contents

Executive Summary of HYFLUX Program Work .....	1
Progress, Results, and Discussion.....	2
Task 6 and 13 Other Regions Hydrocarbon Seep Inventory .....	2
Task 14 Completion of Bubble Flux Analysis.....	3
Task 15 Completion of Water Sample Analysis.....	3
Task 16 Completion of Water Column Flux Analysis .....	3
Task 17 Completion of Air-Sea Flux Analysis.....	3
Task 18 Completion of Sediment Analysis .....	3
Task 19 Completion of modeling of AOM and Carbonate Precipitation Rates .....	4
Presentations and publications.....	4
Conclusion .....	4
Cost Status .....	5
Milestone Status.....	6
Problems or Delays.....	6

## List of Figures

Figure 1 Gantt chart for 4th Quarter 2009 through anticipated project conclusion.....	1
Figure 2. Portions of ENVISAT SAR images obtained on 10 July (left) and 13 July 2009 and covering the same region of the Gulf of Mexico near GC600.....	2
Figure 3: Expenditures by Quarter. Cumulative projected costs (upper panel) and cost status as of Quarter 4.....	5

# Executive Summary of HYFLUX Program Work

On 1 October 2008, Texas A&M University - Corpus Christi began work on the National Energy Technology (NETL) funded project Remote Sensing and Sea-truth Measurements of Methane Flux to the Atmosphere (HYFLUX). This portion of the project was Budget Period 1. Project management activities during Quarter 1 were dedicated to completing the project management plan and setting up sub-contracts with Scripps Oceanographic Institution, University of California, Santa Barbara, University of Southern Mississippi, and Texas A&M University-College Station. Discussions in relation to planning for the upcoming cruise were completed by email and conference call among the project investigators at the conclusion of Quarter 2. During Quarter 3, preparation for the seatruth cruise was the major focus of effort for all investigators. During Quarter 4, the investigators completed the seatruth cruise, curated the samples and data collected during the cruise, and submitted a report describing the results of the cruise.

Phase 2, budget period 2 for the project was initiated on 1 October 2009. Figure 1 shows a Gantt style chart outlining tasks during the quarterly period October through December 2009. This is the fifth quarter since the initiation of the project. The general work projects during this period were analyses for samples and other data collected during the Sea Truth cruise (tasks 14-18) and the continuation of satellite image acquisition and analysis (tasks 6 and 13). The chart also reports on presentations made at the NETL-sponsored special session of the American Geophysical Union Fall Meeting (Dec in San Francisco, CA).

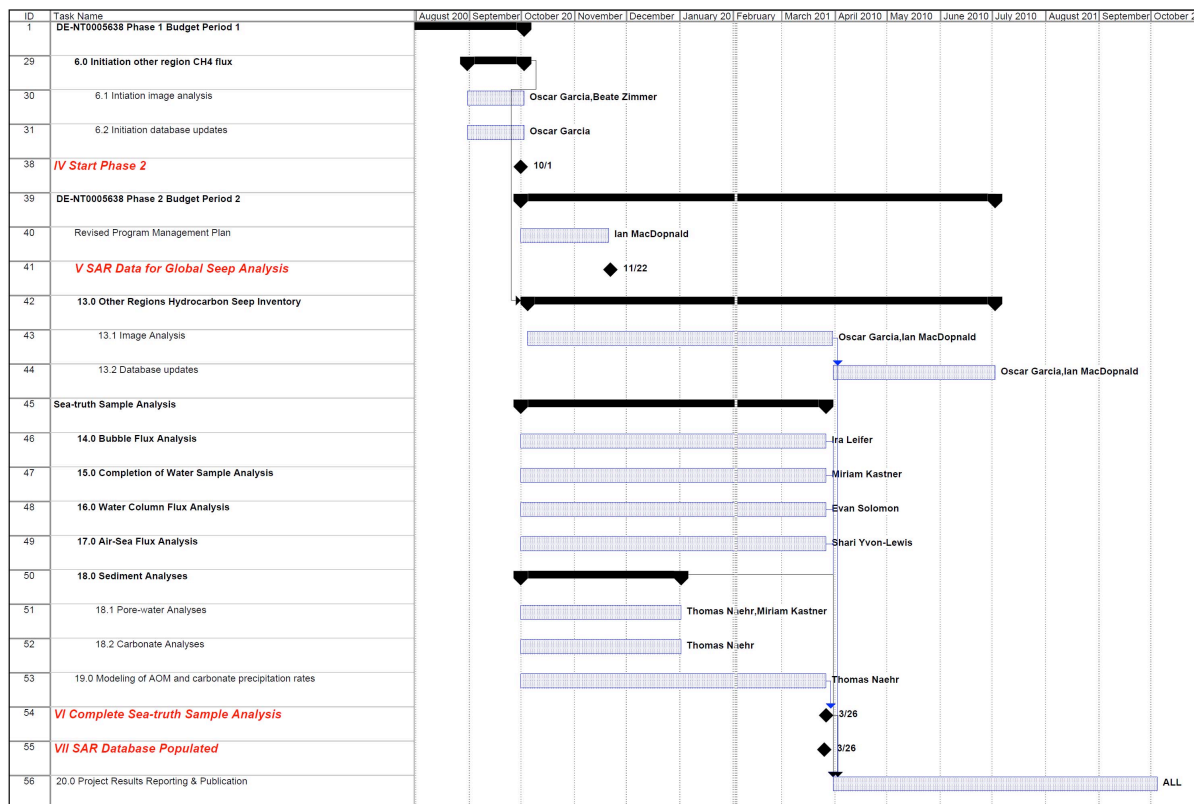


Figure 1 Gantt chart for 4th Quarter 2009 through anticipated project conclusion.

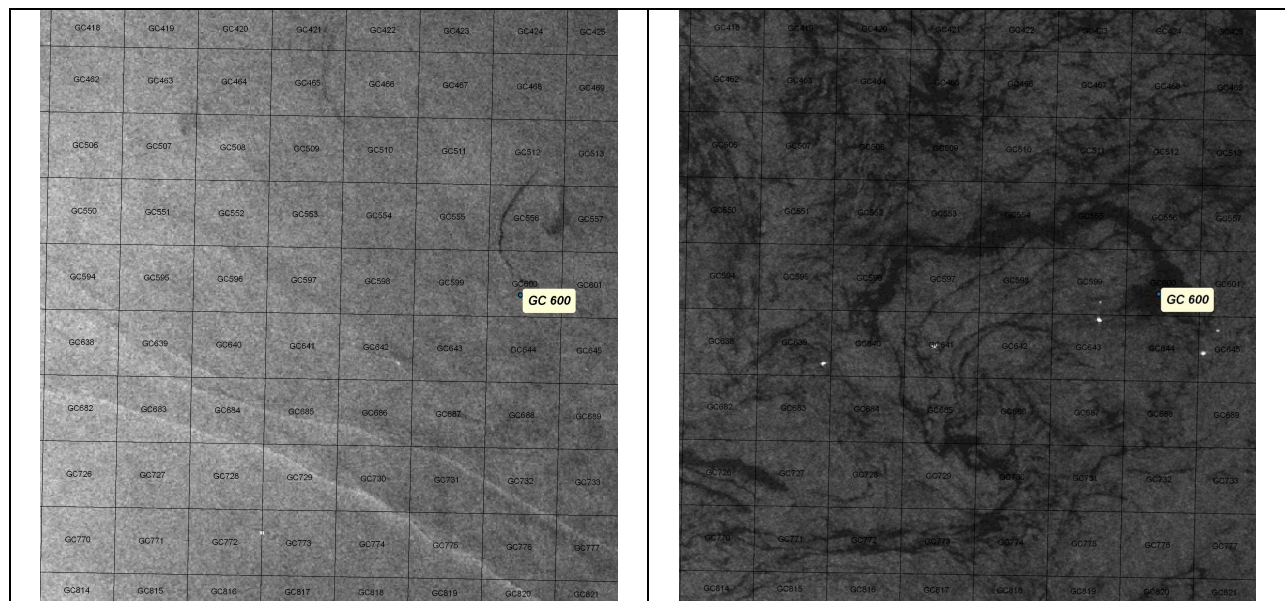
# Progress, Results, and Discussion

## Task 6 and 13 Other Regions Hydrocarbon Seep Inventory

Previous efforts in this area involved the acquisition, review, and analysis of over 600 synthetic aperture radar (SAR) images. These images had been collected with the RADARSAT-1 platform and were archived in the Alaska Satellite Facility at the University of Alaska, Fairbanks. The ongoing effort is intended to extend the methodology of detecting the location of natural seeps and probably gas hydrate deposits to other coastal margins. Currently the team is targeting margins in the Black Sea, the Pakistan Margin, and the West Coast of Africa. The RADARSAT-1 platform has reached the end of its operational lifespan. To expand ongoing access to SAR images from other regions, the HYFLUX team at Florida State University (MacDonald lab) has sought access to data from other satellites and image collection programs. On 28 October, FSU was granted Category 1 Data Use status by the European Space Agency (ESA) following acceptance of a cooperative proposal submitted with the University of Bremen, Germany. This agreement will provide access for research purposes to a number of SAR satellites including ENVISAT.

### Task 13.1 Image Analysis

This task requires obtaining images of satellite synthetic aperture radar (SAR) data and performing a series of image processing steps to identify floating oil layers released from natural sources. To date, the FSU team has accessed over 100 ENVISAT SAR images. New routines for georectification have been developed and the Texture Classifying Neural Network Algorithm that was used for processing RADARSAT images is being adapted for use on the new image types. This effort has yielded results applicable to the SeaTruth results. Figure 2 shows two ENVISAT SAR images obtained on 10 and 13 July 2009, respectively, while the research ship was operating near the GC600 site. Comparison shows marked differences in the quantities of oil being release in the region. Further analysis is required to understand this result.



**Figure 2. Portions of ENVISAT SAR images obtained on 10 July (left) and 13 July 2009 and covering the same region of the Gulf of Mexico near GC600.**

### **Task 13.2 Database Development and Update**

This task requires disseminating interpreted satellite images and locations of probable seeps. A graphical user interface is being developed to aid extraction of images and results from the existing ArcGIS database of results and extracted images from the Gulf of Mexico. The project has received significant assistance from the NOAA satellite group, which made collections of new SAR data during the sea-truth cruise and is supporting GUI development by sharing processing routines and procedures. A first generation public database has been placed online at <http://www.sarsea.org>.

### **Task 14 Completion of Bubble Flux Analysis**

This task is being carried out by Leifer Lab at University of California, Santa Cruz. The bubble flux group deployed acoustic and visual-based instruments for determining bubble flux from gas venting. The acoustic results appear to be inconclusive due to problems with the equipment. However, extensive visual data were collected from each of the study sites. Analysis of these data has been delayed by difficulty in processing the digital video collected at the three sites.

### **Task 15 Completion of Water Sample Analysis**

This task is being carried out by Kastner Lab at Scripps Oceanographic Institution. To date, they have completed laboratory analysis of samples collected from MC118 site and are continuing work on the balance of the samples.

### **Task 16 Completion of Water Column Flux Analysis**

This task is being carried out by Evan Solomon at University of Washington in association with Kastner Lab. To date, preliminary flux calculations have been completed for the MC118 site.

### **Task 17 Completion of Air-Sea Flux Analysis**

This task has been completed through the collection, analysis, and QA/QC phases. Investigators are developing publications describing their results and comparing their results with other components of the project.

### **Task 18 Completion of Sediment Analysis**

This task is being carried out by Naehr Lab at Texas A&M University-Corpus Christi. Detailed sampling for high-resolution physical property (water content and porosity) and geochemical analysis of the sediments was carried out in 2-cm increments while paying special attention to high-resolution sampling across the sulfate-methane interface. Percent carbonate, bulk sedimentary carbonate ( $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$ ) and bulk sedimentary organic matter ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) analyses are currently being conducted in coordination with all co-investigators. Samples for total carbon, organic carbon, organic nitrogen, and sulfur have been prepared and are currently being analyzed using an elemental analyzer at TAMUCC. Foraminifera radiocarbon ( $^{14}\text{C}$ ) measurement will be conducted to constrain the age of the sediments. Pore fluid analyses on sediments collected using push cores, piston cores and gravity cores in areas of active seepage have been completed in collaboration with M. Kastner's lab. Samples were analyzed for total alkalinity,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{SO}_4^{2-}$ , sulfide,  $\text{K}^+$ ,  $\text{Na}^+$ , and  $\text{NH}_4$ . Pore water and sediment data will be used to model carbonate precipitation rates using the numerical model C.CANDI (see Task 19).

## **Task 19 Completion of modeling of AOM and Carbonate Precipitation Rates**

This task is being carried out by Naehr Lab at Texas A&M University-Corpus Christi. Pore water and sediment data will be used to model carbonate precipitation rates using the numerical model C.CANDI. The investigators have acquired and installed the software, and compiled it for use in a PC environment. Test runs of the model are currently being conducted with published data to work out details of the modeling procedure.

### **Presentations and publications**

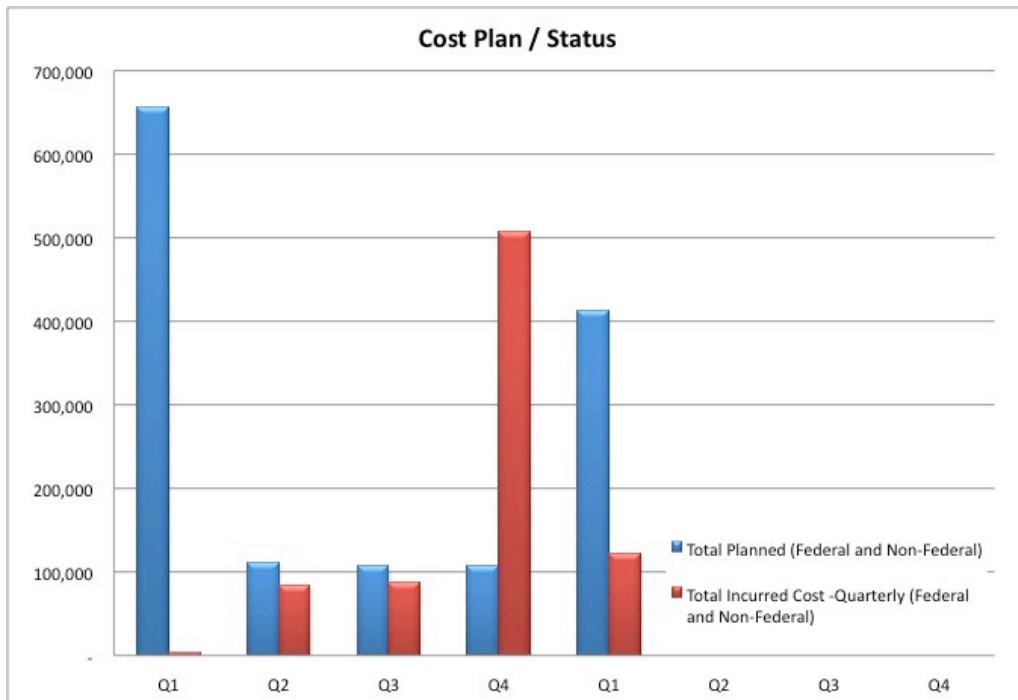
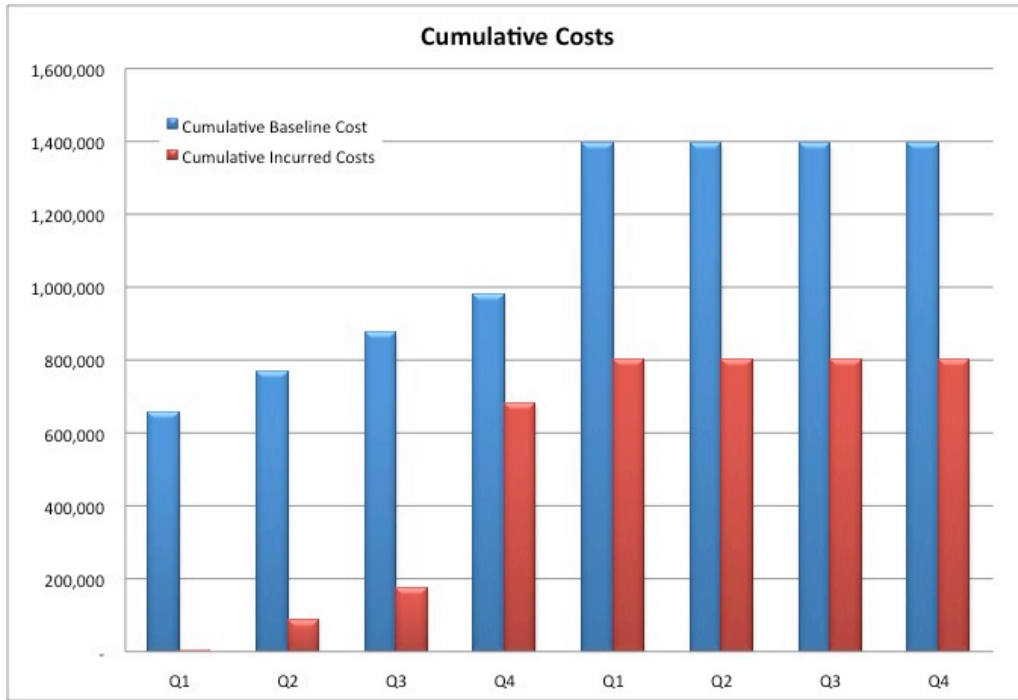
Members of the HYFLUX team attended the and presented result in session OS23B, Gas Hydrates: Results of Recent Field Investigations I. Citations for these presentations are given below:

- Garcia-Pineda, O.G., MacDonald, I.R., Shedd, W., and Zimmer, B., 2009, HYFLUX: Satellite Exploration of Natural Hydrocarbon Seeps and Discovery of a Methane Hydrate Mound at GC600: Eos Trans. AGU, 90(52), p. OS31A-1185 Poster.
- Hu, L., Yvon-Lewis, S.A., Kessler, J.D., and MacDonald, I., 2009, Air-Sea Flux of Methane from Selected Marine Hydrate/Seep Sites in the Northern Gulf of Mexico During HYFLUX: Eos Trans. AGU, 90(52), p. OS23B-04.
- MacDonald, I.R., Garcia-Pineda, O.G., Chanton, J., Kastner, M., Solomon, E.A., Leifer, I., Naehr, T.H., Yvon-Lewis, S.A., and Kessler, J.D., 2009, HYFLUX: Satellite Inventory and Sea-Truth for Gulf of Mexico Gas Hydrate System: Eos Trans. AGU, 90(52), p. OS23B-03.
- Shapiro, R.A., Naehr, T.H., MacDonald, I., Kastner, M., Robertson, G., and Solomon, E.A., 2009, Pore Water Data From Three Gas Hydrate Sites in the Gulf of Mexico: First Results from the HyFlux Project: Eos Trans. AGU, 90(52), p. OS31A-1186 Poster.
- Solomon, E.A., Kastner, M., and Leifer, I., 2009, Ethane and Propane Emissions to the Ocean and Atmosphere from 550-1200 m Seeps in the Gulf of Mexico: Eos Trans. AGU, 90(52), p. OS31A-1182 Poster.

### **Conclusion**

The HYFLUX project has concluded its relatively higher risk field portion and is proceeding on-schedule with the analytical and reporting phase.

# Cost Status



**Figure 3: Expenditures by Quarter. Cumulative projected costs (upper panel) and cost status as of Quarter 4.**

## **Milestone Status**

No Milestones achieved during this reporting period.

## **Problems or Delays**

The only significant deficit from the anticipated collections was the failure of the acoustic bubble-flux measurements. Adequate results should be available from careful analysis of visual data collected.



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