Oil & Natural Gas Technology

DOE Award No.: DE-NT0005638

Quarterly Report

July - September 2010

Remote Sensing and Sea-Truth Measurements of Methane Flux to the Atmosphere (HYFLUX project)

Submitted by:
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Prepared for:
United States Department of Energy
National Energy Technology Laboratory

October 30, 2010

Office of Fossil Energy

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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 seventh quarter and next to last scheduled quarter in the two-year project. During this quarter work on the project has been largely over-shadowed by response to the Gulf of Mexico oil spill particularly for MacDonald, Garcia-Pineda, and Leifer. Kastner was also involved. Consequently, there was a diversion of effort away from project tasks that is being redressed as the quarter comes to a close. A no-cost extension of project deadlines was requested and has been allowed by DOE NETL managers. Anticipated completion

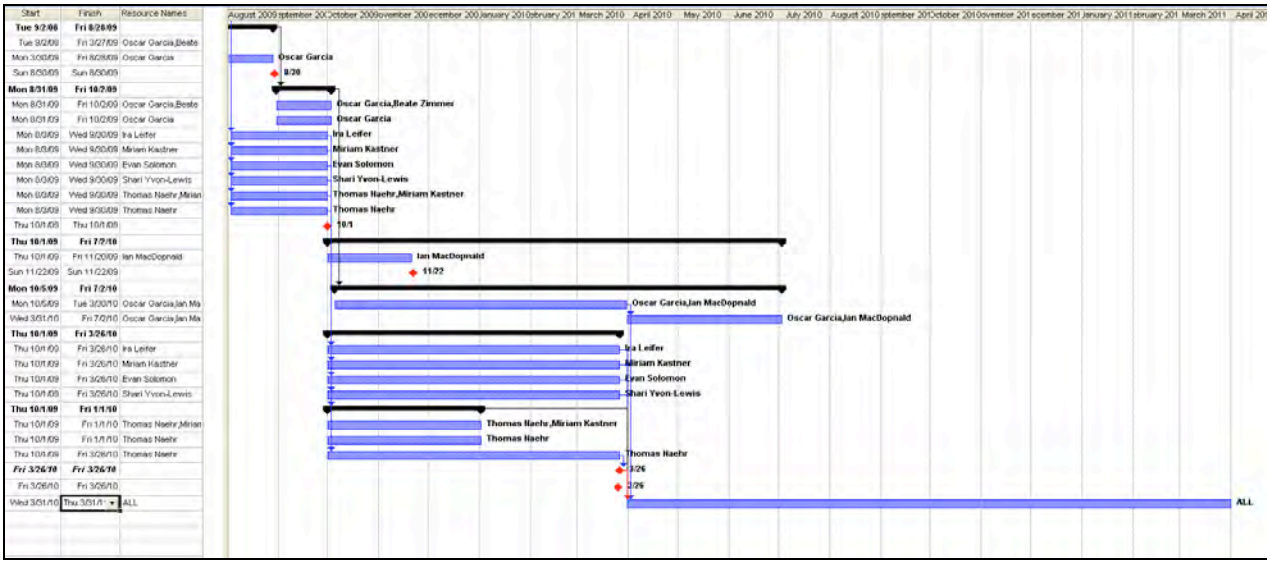


Figure 1: Gantt chart for 4th Quarter 2009 through revised project conclusion.

Progress, Results, and Discussion

Task 6 and 13 Other Regions Hydrocarbon Seep Inventory

Previous effort 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-1platform

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. The team has upgraded the seep detection algorithm for application to ENVISAT SAR images. The spill was actually helpful in this regard, because it provided a steady stream of images during the 90+ days of the spill. These data were used to complete tuning of the TCNNA algorithm for use with ENVISAT and ALOS SAR data.

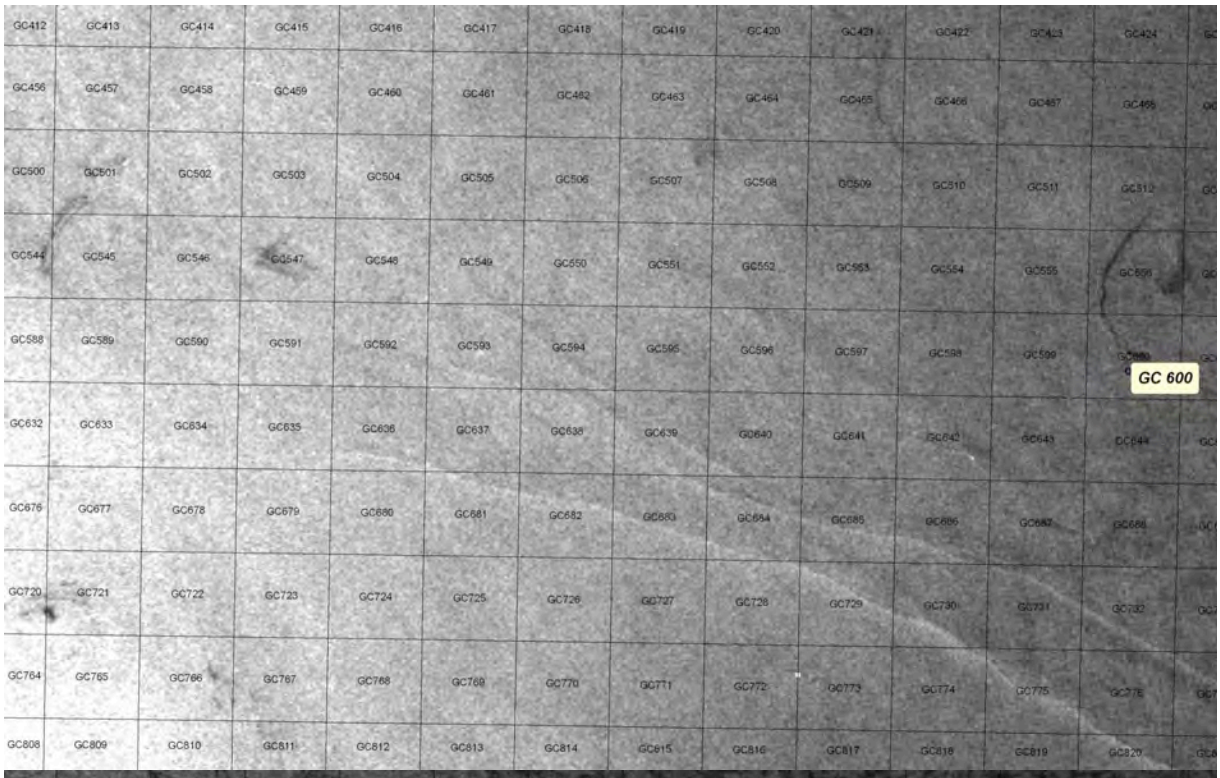
Previous analysis had indicated that the team had under-sampled the eastern Gulf of Mexico with respect to SAR imagery. A total of 69 RADARSAT SAR images were obtained from the ASF to correct this issue. Analysis of these images is complete. Results indicate that an addition of two sites with high certainty and ten seep sites with lesser certainty will be added to the Gulf of Mexico seep database.

MacDonald met with German collaborators and discussed the cooperative work carried out in the Black Sea. The German team encountered difficulty obtaining international permits for seafloor work in the Russian and Turkish sections of the Black Sea and were not able to conduct ROV operations in all the planned sites. However, acoustic profiling of the water column and multibeam mapping of the seafloor were completed together with observation of oil slick in surface waters to confirm active oil seeps from the Batumi region of the eastern Black Sea in close agreement with predictions from SAR remote sensing.

Task 13.1 Image Analysis

An issue for image processing has been the appearance of episodic images that show massive surfactant blooms that appear suddenly. These phenomena include oil possible derived from seep, but also incorporate other surface layers apparently unrelated to natural seepage. (See Figure 2A and 2B for comparison.) In consultation with Dr. Ajit Subramaniam (Columbia University) we are exploring the possibility that some of these events are related to blooms of the cyanobacteria *Trichodesmium*. These organisms are important nitrogen fixers in the marine ecosystem and are well-known from the Gulf of Mexico. However, we had been uncertain whether it contributed to the sudden increase in specularity we have observed in SAR images. By collaborating with Subraminiam's lab, we may be able to verify its contribution to this process. If true, because our algorithms can precisely and quickly determine the area of specular reflectivity, it might be possible to use remote sensing for detection of this form of plankton bloom. This would be a contribution to biological oceanography.

A



B

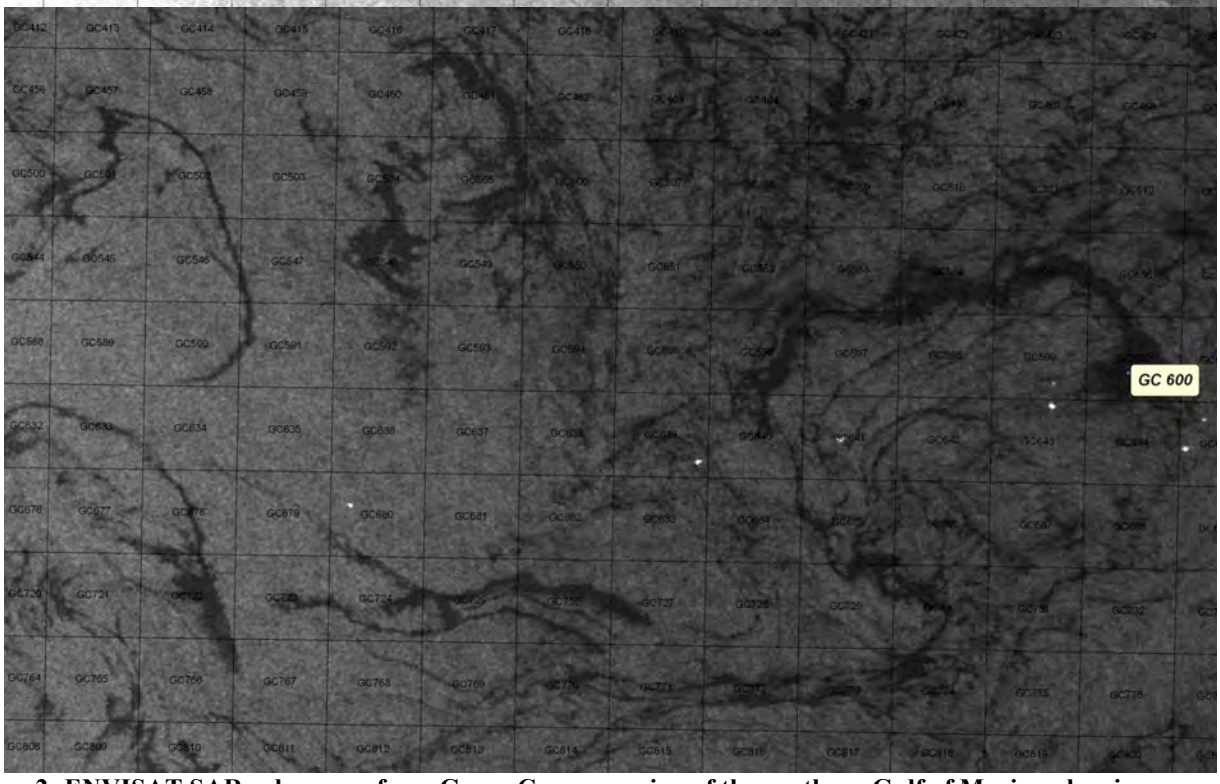


Figure 2: ENVISAT SAR sub-scenes from Green Canyon region of the northern Gulf of Mexico, showing near-identical spatial coverage. A. Scene collected 10 July 2009; B. Scene collected 13 July 2009.

Task 13.2 Database Development and Update

This task requires disseminating interpreted satellite images and locations of probable seeps. A graphical user interface has been 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. This database was consulted extensively during the Gulf of Mexico oil spill as an authoritative indicator of natural seeps as opposed to spill events.

Task 14 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. All of the HD video files have been converted from DVD to files on hard disk and analysis of the visual data in underway with anticipated completion before December 2010.

Task 15 Water Sample Flux Analysis

The analytical tasks have been completed and are presently in QA/QC phase

Task 16 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 by for the MC118 and the GC600 site.

Task 17 Air-Sea Flux Analysis

Lei Hu and Shari Yvon-Lewis have revised a manuscript describing the fluxes of methane based on surface water and atmosphere concentrations. This text is being reviewed by other members of the team prior to being submitted to Earth and Planetary Science Letters.

Task 18 Initiation of Sediment Analysis

This task is being carried out by Naehr Lab at Texas A&M University-Corpus Christi. The analytical tasks have been completed and are presently in QA/QC phase. Pore water and sediment data are currently being used to model carbonate precipitation rates (see Task 19).

Task 19 Initiation of AOM and Carbonate Precipitation Study

This task is being carried out by Naehr Lab at Texas A&M University-Corpus Christi. Pore water and sediment data are used to model carbonate precipitation rates. We are using data from site GC 600 to model rates of AOM and authigenic carbonate precipitation. Due to some operational difficulties with the C.CANDI modeling software, we are also exploring other modeling approaches (i.e., Ussler & Paull, 2008)[1] to determine AOM and carbonate precipitation rates.

[1]Ussler III, W. and Paull, C.K., 2008. Rates of anaerobic oxidation of methane and authigenic carbonate mineralization in methane-rich deep-sea sediments inferred from models and geochemical profiles. Earth and Planetary Science Letters, 266(3-4): 271-287.

Presentations and publications

MacDonald attended the 10th International Conference on Gas in Marine Sediments 6-12 September 2010. The following presentations described results from the Black Sea investigations and the HYFLUX Gulf of Mexico program.

Körber J.-H. Pineda O. MacDonald I. Sahling H. Bohrmann G.: Analysis and inventory of natural hydrocarbon seepage in the Black Sea using remote sensing techniques.

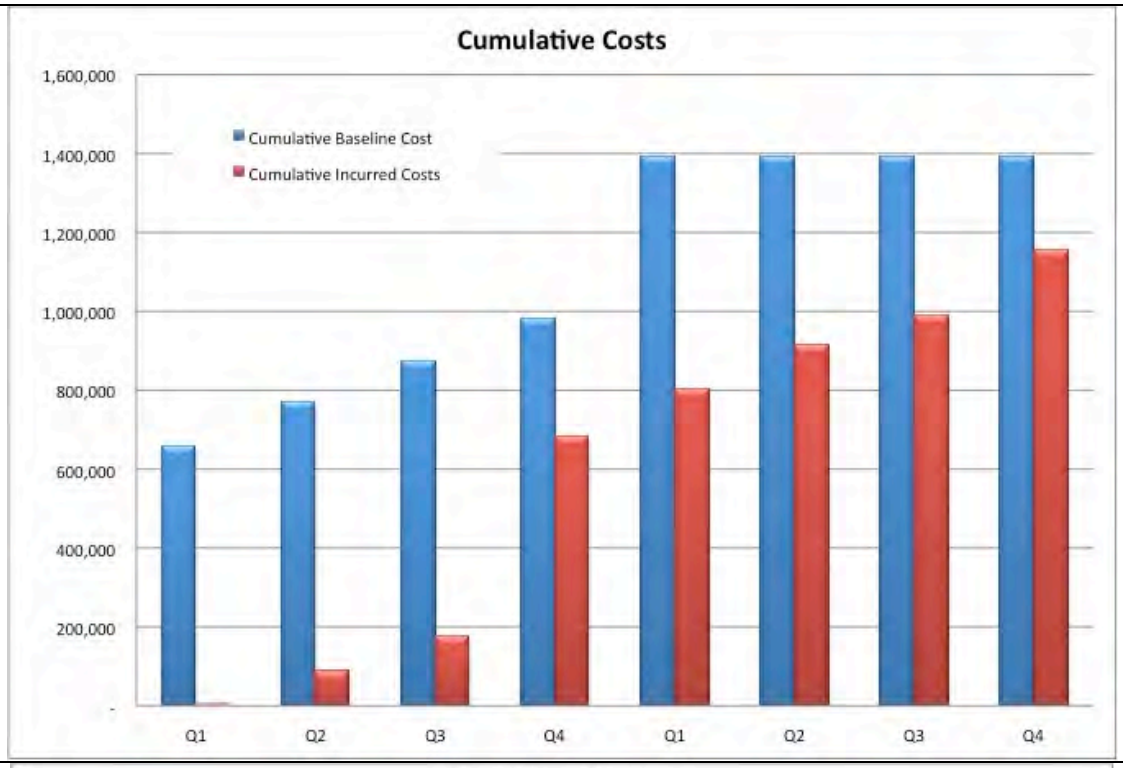
MacDonald I. Garcia-Pineda O. Chanton J. Kastner M. Solomon E. Leifer I. Naehr T. Yvon-Lewis S. Kessler D.: HYFLUX: Remote Sensing and Sea Truth of CH_4 Flux from the Gulf of Mexico Seep System.

Sahling H. Bohrmann G. Pape T. Bruening M. Roemer M. Wagner-Friedrichs M. Spiess V. Artemov Y.: Submarine gas emissions offshore Georgia, Black Sea.

Conclusion

The HYFLUX project concluded its relatively higher risk field portion and has reached >85% completion of the analytical phase. Completion of reporting phase was delayed due to issues arising from the Gulf of Mexico oil spill.

Cost Status



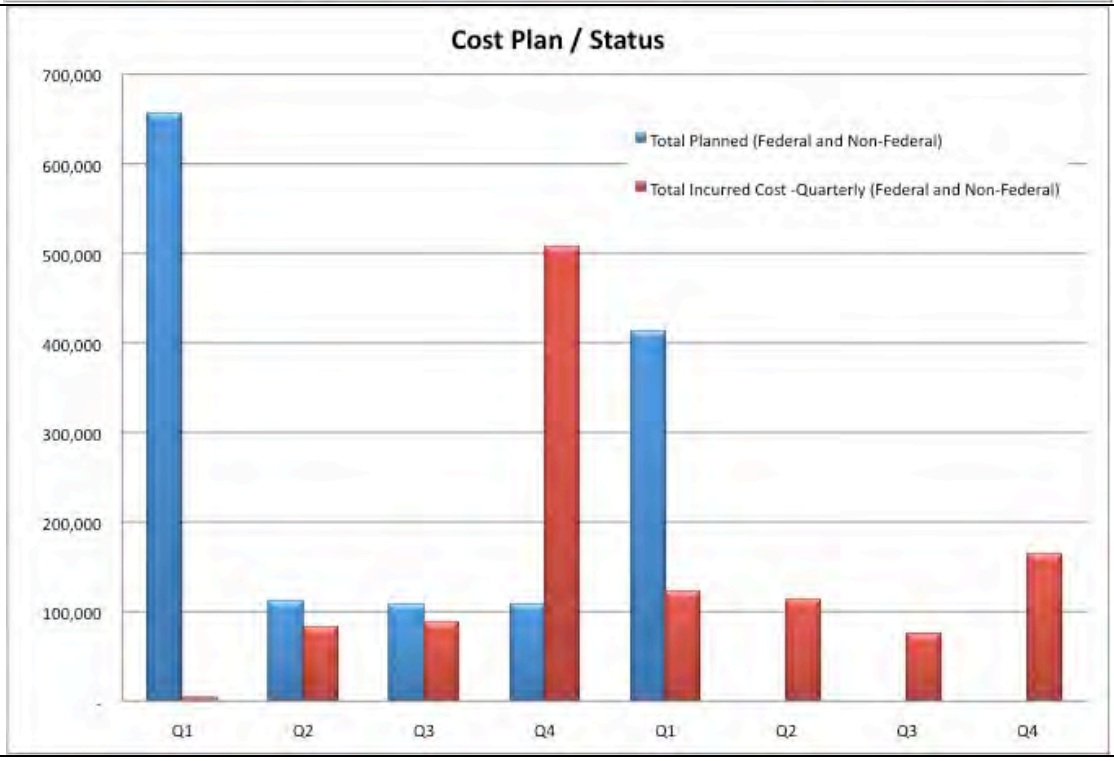


Figure 3: Expenditures by Quarter. Cumulative projected costs (upper panel) and cost status as of Quarter 4

Milestone Status

No Milestones achieved during this reporting period.

Problems or Delays

A no-cost extension of the project was granted. Final reporting will be completed prior to 31 March 2011.

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