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



Submitted by:
Texas A&M University - Corpus Christi
6300 Ocean Dr.
Corpus Christi, TX 78412

Principal Authors: Ian R. MacDonald and Thomas Naehr

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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 periods August 2009 through October 2010. 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. Some delay in the completion of the final report products may result and a no-cost extension of project due-dates may be needed.

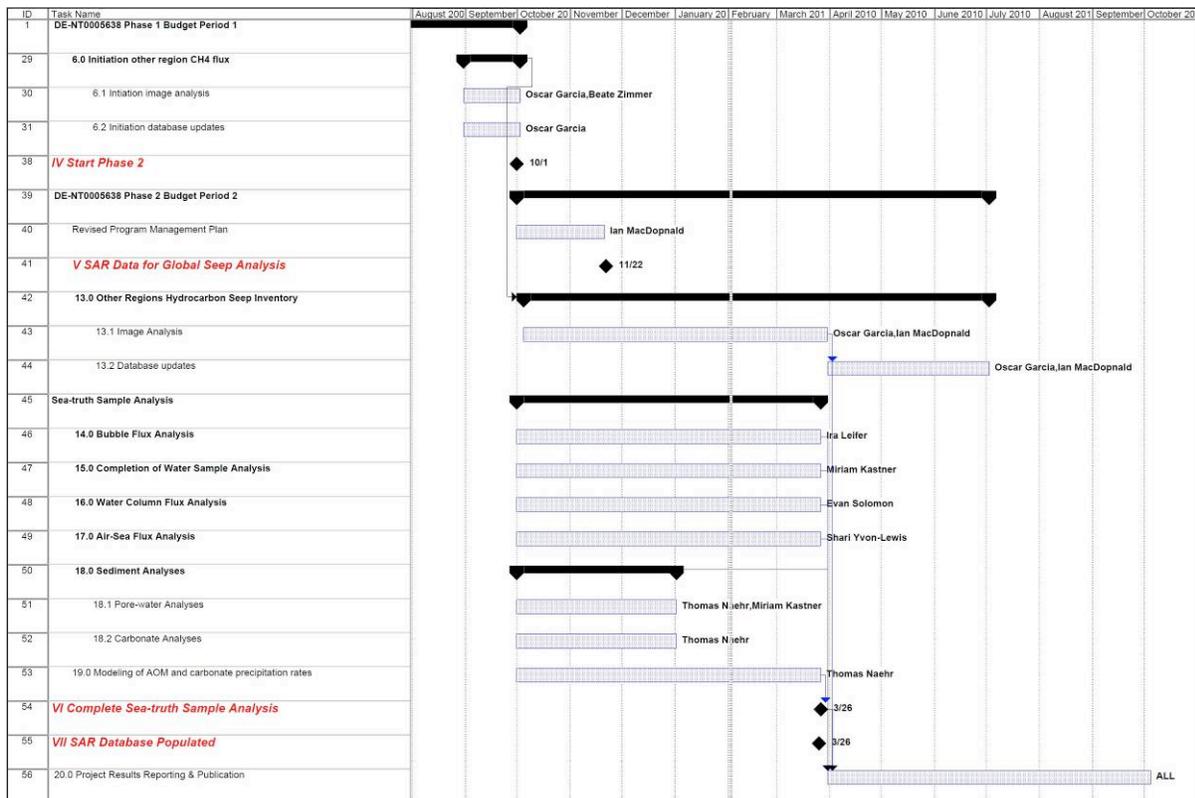


Figure 1: Gantt chart for 4th Quarter 2009 through anticipated project conclusion.

Progress, Results, and Discussion

Task 6 and 13 Other Regions Hydrocarbon Seep Inventory

Previous 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-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. 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 nearly complete. Results indicate that an addition of approximately ten seep sites will be added to the Gulf of Mexico seep database.

Our collaborators in Germany completed a very successful research cruise investigating seeps and suspected gas hydrate sites in the Black Sea. Due to permitting issues, the active oil seeps off the coast of Georgia (northern Black Sea) were not investigated with ROV dives, but AUV surveys completed high resolution maps of the seabed in this region which will be helpful in delineating probably seabed gas hydrate deposits.

Task 13.1 Image Analysis

Macdonald Lab received 69 RADARSAT SAR images covering the eastern Gulf of Mexico, which was previously under-sampled. Extraction of the slick areas is underway. We are seeing unfamiliar oceanic features in this region consisting of large-scale parallel streaks that align with apparent wind direction. Scale and orientation appear to rule out Langmuir Cells. We are seeing oil slick targets that recur in the same area and are therefore probable seafloor seeps. Figure 2 shows two segments of SAR images from the eastern Gulf of Mexico with slick targets within a radius of about 6 km. Water depth at this site exceeds 2500 m so this offset would be consistent with a common seafloor source.

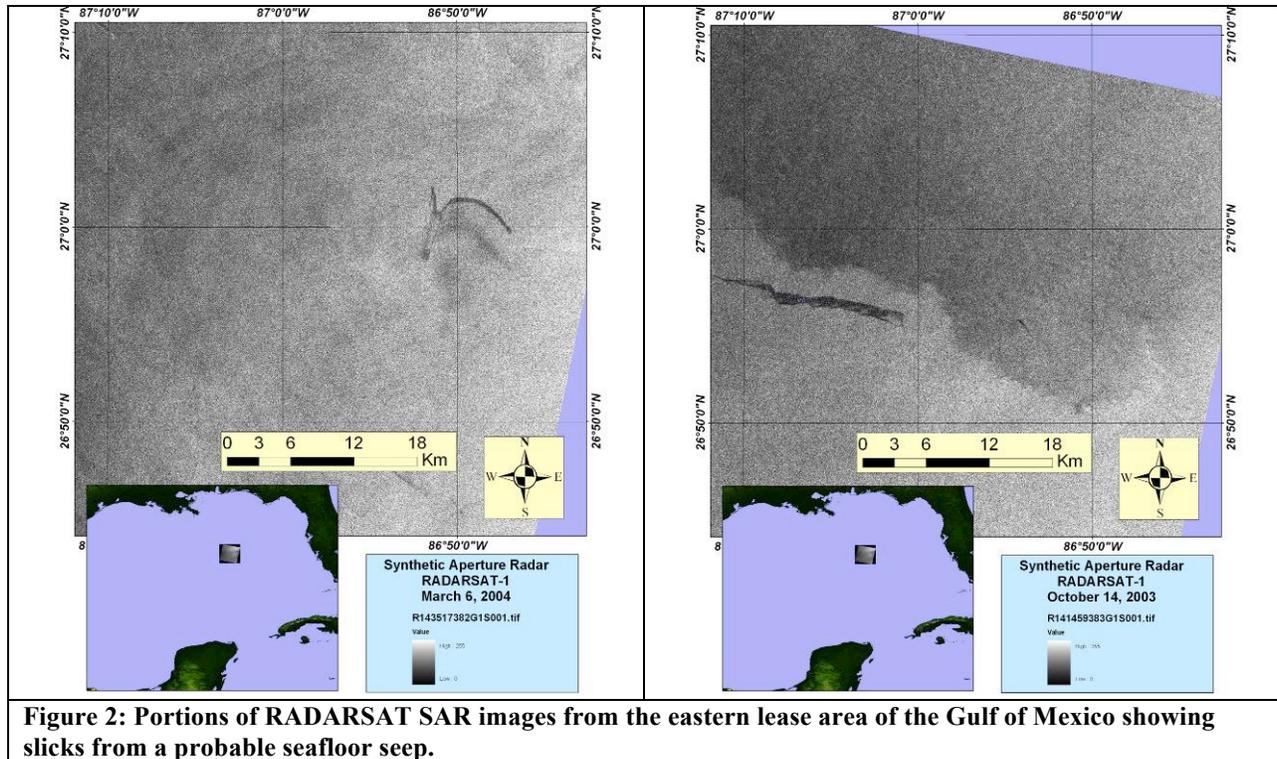


Figure 2: Portions of RADARSAT SAR images from the eastern lease area of the Gulf of Mexico showing slicks from a probable seafloor seep.

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>. 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. Analysis of these data was delayed by difficulty in processing the digital video collected at the three sites. Recently, the digital video has been translated to DVD files and the work is now proceeding.

Task 15 Water Sample Flux 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 and GC600 sites and are expected to soon complete work on the balance of the samples from the GC185 (Bush Hill) site.

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 for the MC118 and are nearing completion for the GC600 site.

Task 17 Air-Sea Flux Analysis

This task has been completed through the collection, analysis, and QA/QC phases. Investigators have completed a manuscript describing the results of this effort, which will be submitted after coordination with the water column and bubble flux groups.

Task 18 Initiation 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 on sediment cores from MC 118, GC 600, and GC 185 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 completed. Samples for total carbon, organic carbon, organic nitrogen, and sulfur were analyzed using an elemental analyzer at TAMUCC. 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. Pore water analyses included measurements of SO_4^{2-} , alkalinity, HS^- , and Ca^{2+} . 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 to determine AOM and carbonate precipitation rates, which may cause slight delays during the reporting phase of the project.

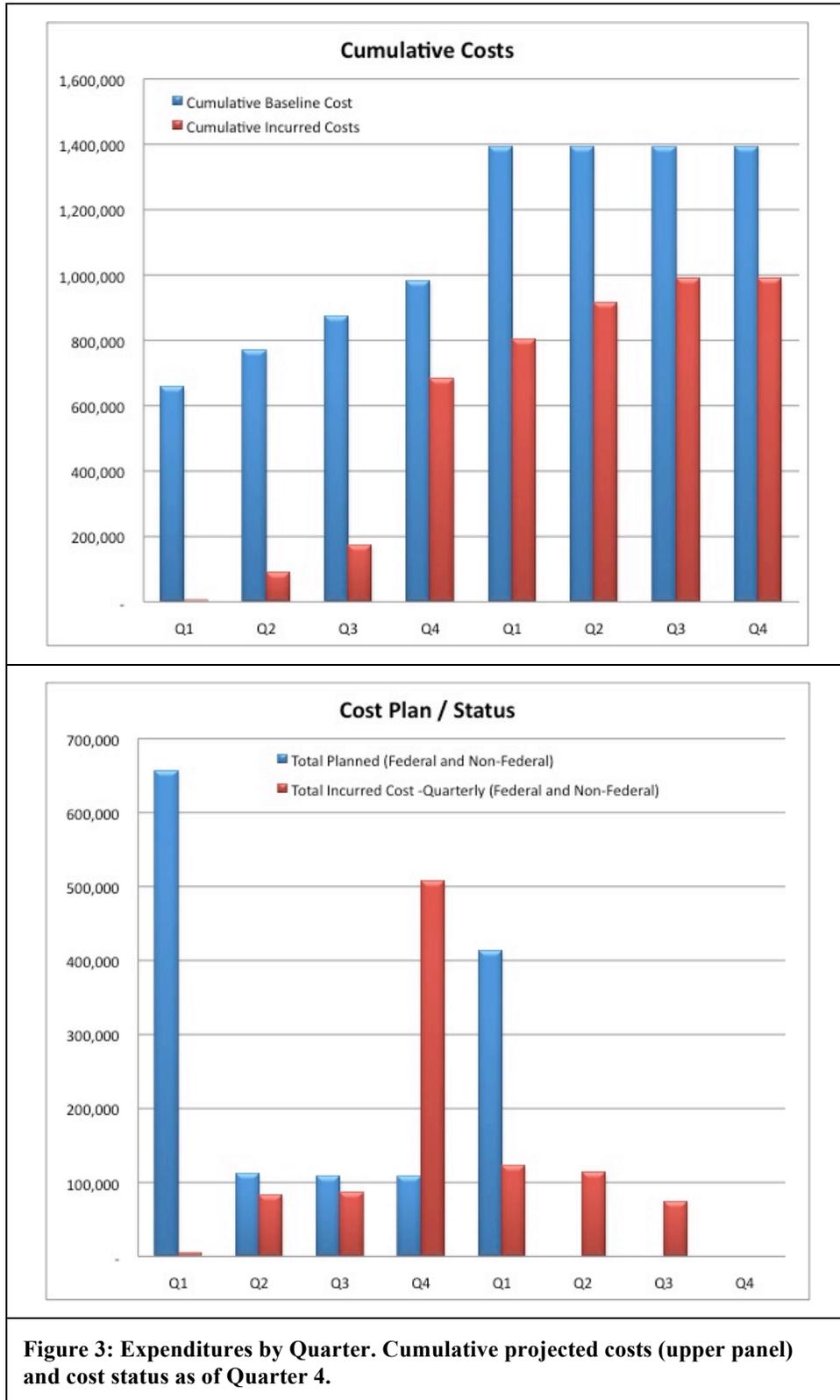
Presentations and publications

No new presentations or publications during this reporting period.

Conclusion

The HYFLUX project has concluded its relatively higher risk field portion and is nearing completion of the analytical phase. Reporting may be delayed due to issues arising from the Gulf of Mexico oil spill.

Cost Status



Milestone Status

No new milestones achieved during this reporting period.

Problems or Delays

Given the time frame of the project, the quantitative analysis of seepage in other areas (outside the Gulf of Mexico) will be restricted to the results from the Black Sea. Qualitative results from the Pakistan Margin and the West Coast of Africa will be reported, but full inclusion in the seep database will not be possible.

Depending on progress in the next two months, a no-cost extension for completion of the peer-reviewed manuscripts and elements of the final report may be required.

National Energy Technology Laboratory

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

One West Third Street, Suite 1400
Tulsa, OK 74103-3519

1450 Queen Avenue SW
Albany, OR 97321-2198

2175 University Ave. South
Suite 201
Fairbanks, AK 99709

Visit the NETL website at:
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