RFP V: VERTICAL UPWELLING AND BOTTOM-BOUNDARY LAYER DISPERSAL AT A NATURAL SEEP SITE

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Summary

This document contains a summary of operations, instruments utilized, and data collected in the study that took place in the GC600 block of Gulf of Mexico between June 2017 – Feb 2018.

The intent of this document is to aid anyone who is interested in the details of the data collected in this GoMRI funded study.

In this study we hope to increase our understanding of, 1) the dynamics and role of the vertical transport of methane and oil to the surface from a naturally occurring methane seep and, 2) investigate the turbulent bottom boundary layer dynamics that causes horizontal and vertical dispersal, including resuspension of hydrocarbon-containing deposits.

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Forward:

The study site is the GC600 block in the Gulf of Mexico, near the well-studied Megaplume natural methane and oil seep site, located approximately at: 27.3698 N and 90.5710 W, at a depth of ~1186 m. We contracted Oceaneering International for vessel and an autonomous underwater vehicle (AUV) and remotely operated vehicle (ROV) operations/services. All data collected in our experiment is listed in this document, and is, or will be, uploaded to the GRIIDC website. General information with relation to instruments, data, relevant maps, site descriptions and other supporting documents are found in the General Metadata file accompanied with the data.

Vessel and Cruise Information:

CTD profiles were obtained for each of the 4 cruises listed below, this was done for the purpose of calibrations for the ROV and the ultra-short baseline communication systems.

Jun 18 - 19, 2017: The Oceaneering vessel Ocean Project was equipped with an ROV and a C-Surveyor III AUV. The first task of the experiment was to survey the seafloor and water column using specialized instruments on the AUV. The AUV was flown ~40m above bottom and collected data in a grid pattern (see General Metadata) that covered the local area of interest. The AUV was equipped with three instruments: 1) a multi-beam echo sounder, 2) a sub-bottom chirp profiler, and 3) a side scan sonar. The backscatter intensity from the water column (using the multi-beam) was the primary means of identifying buoyant gasses and oils.

Jun 29 - Jul 1, 2017: Using real-time video from the ROV on the vessel Ocean Project, we surveyed the seeps that were identified from the past cruise from the AUV survey. Two bottom mount video cameras were deployed at the chosen seep site. A failed instrument deployment occurred on 1July2017 causing the ship to return to port.

Sept 1- 4, 2017: The ROV on the Oceaneering vessel Ocean Intervention II was used to recover previously deployed cameras and to visually identify/view the active seep that our study would focus on. Two acoustic Doppler current profilers (ADCP), two digital cameras focused on the seep site and two moorings (~40 m in length) associated with the acoustic scintillation flow meter (ASFM) were successfully deployed. MicroCat CTD's were spaced vertically along the mooring with a separation distance of ~10.2m.

Jan 30 – Feb 2, 2018: The instruments were recovered on Oceaneering's contract vessel Connor Bordelon. Video data from the ROV was collected for bubble plume image processing and for quantifying discharge with a custom build funnel.

Instruments, Data and Measurements:

Four data sets were collected in our experimental program. These include: 1) AUV based acoustic measurements, 2) Hydrographic and ADCP data, 3) the acoustic scintillation flow meter (ASFM), and 4) video imaging data sets. General metadata for each instrument are summarized in this document in the table below.

AUV based acoustic data: The AUV data files submitted to GRIIDC are raw, with basic quality control applied. The file titled: AUV Instrument Descriptions Ocean Project, is found in the General Metadata file, it provides a description of the AUV based instruments and the data preprocessing steps completed by Oceaneering.

AUV data includes: 1) multibeam (Kongsberg EM 2040-200kHz), 2) side-scan sonar (Edge Tech 2200-M 120 & 410kHz) and 3) sub-bottom profiles (Edge Tech Chirp Subbottom Profiler DW106).

We provide common file types for each AUV instrument. Below we have provided examples of software programs that can be used to open or view these data files. We do not promote any particular software, these are simply examples. The multibeam data are in the *.all file format; this file format can be opened by using the software created by Fledermaus (http://www.qps.nl/display/fledermaus/hydrographic). The side-scan sonar files are in the *.xft file format; these can be opened using software created by Chesapeake Technology, Inc.'s SonarWiz 6 software (https://chesapeaketech.com/products/sonarwiz-sidescan/). The subbottom files are in the *.sgy file format; these data files can be opened with HIS Kingdom Seismic and Geologic software (https://ihsmarkit.com/products/kingdom-seismic-geological-interpretation-software.html).

Hydrographic and ADCP data: Data from deployed CTD instruments (Seabird MicroCat 37SM) are provided in raw format. Seabird CTD data files provided are *.asc, or *.hex and *.xlmcon. On the ASFM transmitter mooring, on land, the top and bottom microcats were separated by ~36.8 m, this corresponds to a separation of ~9.2 m between each microcat. In the ocean, according to the pressure sensors, the separation was ~40.8 m, this corresponds to a separation of ~ 10.2m between each microcat. This ~4 m difference is reasonable and is likely due to a combination of the initial error of the pressure sensors, as well as the stretch of the nylon rope of the mooring. Using the 10.2 m separation between each sensor, pressures for the 3 inner microcats were input accordingly (to the depths below) as they did not have sensors. Sea floor depth at the transmit mooring is ~1186.5 m. On the mooring, microcats are located at ~4, 14.1, 24.3, 34.5, 44.7 mab (meters above bottom), or depths of 1182.4, 1171.8, 1161.5, 1151.3, and 1141.6 m. Approximately 150 days of microcat data was collected with a sampling interval of 90s.

Another two microcats were housed on each ADCP platform. The microcat on the 600(300) kHz ADCP sits at 1182.4(1173.8) m. The microcat on the 600(300) kHz ADCP sits ~5(70) cm above the seafloor. See General Metadata for images of the ADCP platforms. These mircocats also sampled at 90 s intervals.

We have provided 6 CTD profiles occurring on 18June2017 (2 CTD profiles, a primary and secondary), 29June2017 (2 CTD profiles, a primary and secondary), 2Sept2018 (1 CTD profile), and 2Feb2018 (1 CTD Profile).

Deployed ADCP instruments (Teledyne RDI; 300kHz WH Sentinel & 600kHz WH Monitor) are provided in raw format (.000 file extension – PDO format). Data was collected in beam coordinate mode, single ping data, with 1200 pings per hour. The bin size for the 300(600) kHz

was 8(2) m. Approximately 79(95) days for the 300(600) kHz ADCP was collected. TRDI provides processing/viewing software, such as WinADCP (free) or Vector (not free). WinADCP is a data export/viewing platform. The software Vector is an improved version of WinADCP, with greater functionality, it allows for data manipulation, coordinate transformations, and other user specific needs.

ASFM: The acoustic scintillation flow meter is a specialized acoustic propagation instrument, it is expected that users will have an understanding regarding the theory of wave propagation through a moving random medium and a working knowledge of how the instrument works. See Di Iorio et al (2004) (*https://doi.org/10.1175/JTECH1799.1*) for an overview of the instrument and its application to geophysical flows. Depending upon use it can measure vertical velocity of hydrothermal plumes, oil or methane seeps. The raw data are in a specialized compressed format giving *.ASF data files. We provide a program (Cf2 ASFM Link) that can be installed on a PC computer that can be used to read this compressed raw data and plot the acoustic arrivals for various transmitter and receiver combinations. This software also can be used to decompress the data to binary *.bin data files. Once decompressed, the binary files can be read according to the manual Cf2 ASFM Link Users Guide provided with the installation software. The instrument platform for the ASFM is a mooring pair, there is a transmit and receive mooring. The transmit mooring held five microcats that were equally separated vertically (see Mooring Diagram in Appendix). The instrument was programmed with a burst sampling interval of 15min/hour with a 10 Hz transmission rate. Pulse length and pulse delay were 0.1 ms and 25 ms respectively. The propagation path length was approximately 90 m with an acoustic propagation direction of 20 degT. Transducers on the ASFM were separated by 15 cm and placed ~17 meters above bottom. The ASFM collected ~12 days of data.

Video Imaging: Two deep water cameras (camera A and B) manufactured by Harbortronics, equipped with LED's, placed at the seep site to record the spatial and temporal variability of the oil and methane that emanate from the seep. Unfortunately, the time stamps are not reliable. Before deployment, we took note of the start time and modified the file names to represent the time the files were logged. Between the cameras, we believe there could be a difference in time up to an hour. The cameras, randomly, had an inherent problem of not recording at the set time interval. For the successful instrument deployment occurring in Sept2017, sampling for camera A spans 3Sept2017 - 28Sept2017 (approximately 25 days of data) and was set to log data for 10 s every 3 hours; sampling for camera B spans 3Sept2017-2Feb2018 (approximately 150 days of data) and was set to log data for 10 s every 6 hours. The cameras frame rates are 30 frames per second. These video files are of .MOV type.

We also provide footage from the ROV camera (conducted on the 4th and final cruise) where we conducted a test to measure the flow and volume rate of the seep output using a custom made funnel for this purpose. The ROV camera frame rate is also 30 frames per second. These video files are of .wmv type.

Metadata for all data collected in our experiment:

Number	Instrument Type	SN	Position	Depth (m)	First Valid Time Entry	Last Valid Time Entry

1	AUV Multibeam: Kongsberg EM 2040-200kHz	NA	See Appendix	NA	18June2017	18June2017
2	AUV Side-Scan Sonar: Edge Tech 2200-M 120 & 410kHz	NA	See Appendix	NA	18June2017	18June2017
3	AUV Sub-Bottom Profiles: Edge Tech Chirp Sub-bottom Profiler DW106	NA	See Appendix	NA	18June2017	18June2017
4	ADCP: 600kHz TRDI WH Monitor	NA	UTM (m); 15R E: 740,170.55 N: 3,029,760.37 Lat: 27.3700 Lon: -90.5717	1182.4	2Sept2017	6Dec2017
5	ADCP: 300kHz TRDI WH Sentinel	NA	UTM (m); 15R E: 739,979.3 N: 3,029,878.96 Lat: 27.3711 Lon: -90.5736	1173.8	2Sept2017	20Nov2017
6	Mooring MicroCat: 4 mab	14734	UTM (m); 15R E: 740,219.21 N: 3,029,699.92 Lat: 27.3695 Lon: -90.5712	1182.4	2Sept2017	2Feb2018
7	Mooring MicroCat: 14.1 mab	3357	Same as above	1171.8	2Sept2017	2Feb2018
8	Mooring MicroCat: 24.3 mab	1535	Same as above	1161.5	2Sept2017	2Feb2018
9	Mooring MicroCat: 34.5 mab	14732	Same as above	1151.3	2Sept2017	2Feb2018
10	Mooring MicroCat: 44.7 mab	14733	Same as above	1141.6	2Sept2017	2Feb2018
11	600 kHz ADCP MicroCat: 5 cm above bottom	12113	UTM (m); 15R E: 740,170.55 N: 3,029,760.37 Lat: 27.3700 Lon: -90.5717	1182.5	2Sept2017	2Feb2018

12	300 kHz ADCP MicroCat: 70 cm above bottom	12114	UTM (m); 15R E: 739,979.3 N: 3,029,878.96 Lat: 27.3711 Lon: -90.5736	1173.8	2Sept2017	2Feb2018
13	CTD Profile 1 SBE-19	3171	UTM (m); 15R E: 743,178.91 N: 3,029,717.71 Lat: 27.3709 Lon: -90.5414	NA	18June2017	18June2017
14	CTD Profile 2 SBE-19	3171	UTM (m); 15R E: 742,320.41 N: 3,028,477.84 Lat: 27.3599 Lon: -90.5503	NA	29June2017	29June2017
15	CTD Profile 3 AML Profiler	50112	UTM (m); 16R E: 354,633.24 N: 3,047,354.90 Lat: 27.5452 Lon: -88.4722	NA	2Sept2018	2Sept2018
16	CTD Profile 4 AML Profiler	50096	UTM (m); 15R E: 755,801.59 N: 3,105,207.96 Lat: 28.0476 Lon: -90.3977	NA	2Feb2018	2Feb2018
17	Deepwater Camera A	NA	UTM (m); 15R E: 740,236.93 N: 3,029,743.53 Lat: 27.3698 Lon: -90.5710	1186	3Sept2017	28Sept2017
18	Deepwater Camera B	NA	Same as above	1186	3Sept2017	2Feb2018
19	ROV Camera	NA	Same as above	1186	2Feb2018	2Feb2018
20	ASFM	NA	UTM (m); 15R E: 740,219.21 N: 3,029,699.92 Lat: 27.3695 Lon: -90.5712	1164	2Sept2017	14Sept2017