Airborne
Spectral
Photometric
Environmental
Collection
Technology

ASPECT Air Quality Survey after Hurricane Ida
Baton Rouge, LA
September 11, 2021

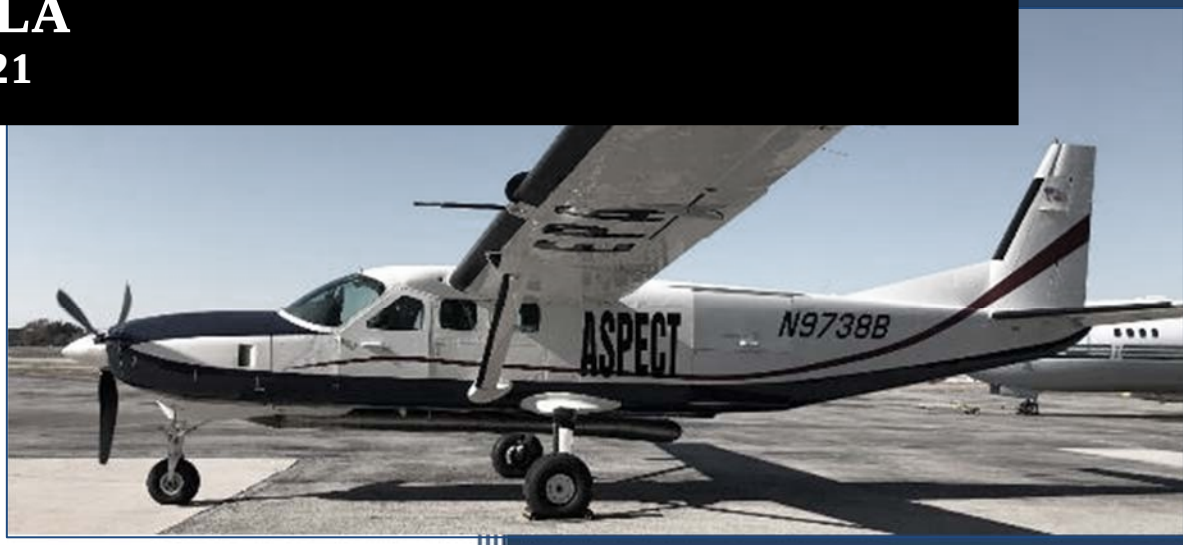

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Table of Contents

Acronyms and Abbreviations

Alt	Altitude (in feet)
AGL	Above Ground Level
cm	centimeter
CDT	Central Daylight Time
DEM	Digital Elevation Model
ESF-10	Emergency Support Function #10 – Oil and Hazardous Materials Response
FEMA	Federal Emergency Management Agency
FTIR	Fourier Transform Infrared Spectrometer
FTP	File Transfer Protocol
igm	Spectral data format based on grams format
IR	Infrared
IRLS	Infrared Line Scanner
jpg	JPEG image format
Kts	Knots
LDEQ	Louisiana Department of Environmental Quality
mph	miles per hour
m/s	meters per second
MSIC	Digital photography file from the Imperx mapping camera
MSL	Mean Sea Level Altitude (in feet)
PAN	peroxyacetyl nitrate
Ppm	parts per million
RMP	Risk Management Plan

Executive Summary

Hurricane Ida made landfall at 11:55 AM CDT Sunday, August 29 as a high-end category-4 hurricane, with maximum sustained winds of 150 mph. The storm moved ashore near Port Fourchon, Louisiana after a period of rapid intensification, tying for the fifth strongest landfalling continental US hurricane on record with Hurricane Laura of 2020, among three other hurricanes. Severe wind and large-scale flood damage have been reported to property and infrastructure in much of southeast Louisiana, including significant damage in New Orleans, Louisiana. In addition, Ida has caused widespread damage across the Mid-Atlantic and Northeast US.

On September 2nd, 2021, the State of Louisiana requested ESF-10 assistance through FEMA and Region 6 asked for the ASPECT plane to be deployed in support of the response to Hurricane Ida. The state wanted assistance monitoring facility emissions in the industrial area between Baton Rouge and New Orleans, where flaring is resulting in the visible emission of black smoke.

ASPECT was tasked to perform remote chemical sensing over target properties to screen for airborne chemicals and take high-resolution photos to provide situational awareness. Potential areas identified for monitoring included: East Baton Rouge, Ascension, Iberville, St. James, St. John, St. Charles, Jefferson, and Orleans. The system conducted one flight mission on September 2 including air monitoring survey collections over the target area with favorable weather conditions for all passes. Although two black plumes were visible over one of the sites, no major emissions were detected with the FTIR.

A continuation of the overall Baton Rouge facility survey was conducted on September 3. Two data collection flights were conducted which bracketed a Presidential temporary flight restriction not allowing any flight activity. A total of 12 active data collection passes were made covering 8 facilities with no chemical plumes or compounds being detected. Other than flares and isolated steam plumes, little process activity was noted in the data.

Flight 5 and 6 were conducted as part of survey operations conducted on September 4. A total of 17 facilities were surveyed. Ammonia was detected and confirmed at a maximum concentration of approximately 14 ppm in addition to ozone and peroxyacetyl nitrate. Analysis of IR imagery indicated that some facilities are showing hot process units.

ASPECT conducted two data collection missions on September 5 with the focus being facilities in St. Bernard, Terrebonne, St. Charles, and St. James areas. A total of 32 active data collection passes were made covering 21 facilities. Imagery collected within impact areas of the storm showed some oil sheen and releases to secondary containment. No compounds were detected on either mission.

Two data collection missions were conducted by ASPECT on September 7 with the primary focus to collect additional data over target surveyed on September 5 (St. Bernard, Terrebonne, St. Charles, and St. James areas). A total of 16 data collection passes (2 test

and 14 active) were made over about half of the target list. Weather conditions complicated the mission with numerous convective cells and low clouds in the area. No compounds were detected on either flight. conducted two data collection missions on 5 September 2021 with the focus being facilities in St. Bernard, Terrebonne, St. Charles, and St. James areas.

ASPECT conducted two missions on September 8 with the primary objective to complete the mission of collecting additional data at facilities assigned on September 7. Weather conditions over the target areas within St. Bernard, Terrebonne, St. Charles, and St. James parishes was marginal due to clouds and convective activity. A total of 21 data collection passes (2 test and 19 active) were required to complete the mission with no detections observed.

ASPECT conducted two oil survey missions on September 11 which included 32 data collection passes (2 test and 30 active). 8 grid areas were developed, and the system was able to survey grids 3 through 8 due to time on station. Oil was detected in four data collection passes in grids 6 and 7. Isoprene was detected on pass 18 at a low level of 0.249 ppm. No other compounds were detected.

ASPECT Air Quality Survey
Hurricane IDA
Baton Rouge, LA
September 11, 2021

Background and Operational Overview

Hurricane Ida made landfall at 11:55 AM CDT Sunday, August 29 as a high-end category-4 hurricane, with maximum sustained winds of 150 mph. The storm moved ashore near Port Fourchon, Louisiana after a period of rapid intensification, tying for the fifth strongest landfalling continental US hurricane on record with Hurricane Laura of 2020, among three other hurricanes. Severe wind and large-scale flood damage have been reported to property and infrastructure in much of southeast Louisiana, including significant damage in New Orleans, Louisiana. In addition, Ida has caused widespread damage across the Mid-Atlantic and Northeast US.

On September 2, 2021, ASPECT was tasked to conduct a wide area air quality screening level assessment of areas populated with Risk Management Plan (RMP) sites and petrochemical facilities using the ASPECT system for detections of any airborne contaminants from ASPECT's 76 chemical detection library in the areas affected by Ida. The Region wanted to know if any detections were found, the location of the detection, and the concentration detected. Sites including Marathon Petroleum Company, Shell Norco Facility, and Phillips 66 pipeline site were surveyed. There were no chemical detections at the sites surveyed. Extremely slow satellite transmission speeds (possibly due to high bandwidth use by other first responders) resulted in long delays in data collection. Some chemical photos were pulled down during flight, with the majority needing to be pulled down with a more high-speed internet connection on the ground.

On September 3 ASPECT was tasked with a continuation of the general Baton Rouge area survey and conducted two flights. 8 locations in the Baton Rouge area were surveyed as part of two flights. A total of 12 active data collection passes were made covering 8 facilities with no chemical plumes or compounds being detected. Other than flares and isolated steam plumes, little process activity was noted in the data.

Two data collection flights were conducted on September 4 focusing on facilities south of Baton Rouge. A total of 29 active data collection passes were made covering 17 facilities. Analysis of IR imagery indicated that some facilities are showing hot process units. Ammonia was detected and confirmed at a maximum concentration of approximately 14 ppm.

ASPECT conducted two data collection missions on September 5 with the focus being facilities in St. Bernard, Terrebonne, St. Charles, and St. James areas. A total of 32 active data collection passes were made covering 21 facilities. Imagery collected within impact

areas of the storm showed some oil sheen and releases to secondary containment. No compounds were detected on either mission.

Due to poor weather, ASPECT did not conduct any flight activities on September 6. ASPECT was tasked with two missions on September 7 consisting largely of revisiting facilities surveyed on September 5 for the purpose of collecting additional data.

ASPECT conducted two missions on September 8 with the primary objective to complete the mission of collecting additional data at facilities assigned on September 7. Weather conditions over the target areas within St. Bernard, Terrebonne, St. Charles, and St. James parishes was marginal due to clouds and convective activity. A total of 21 data collection passes (2 test and 19 active) were required to complete the mission with no detections observed.

ASPECT did not conduct missions on September 9 or September 10 but was tasked with an oil detection mission on September 11. The Louisiana Department of Environmental Quality (LDEQ) and the Louisiana Oil Spill Coordinator's Office (LOSCO) provided several prioritized target areas located in an area encompassing Port Fourchon and north toward New Orleans. Figure 1 shows the target survey areas marked with white boxes.

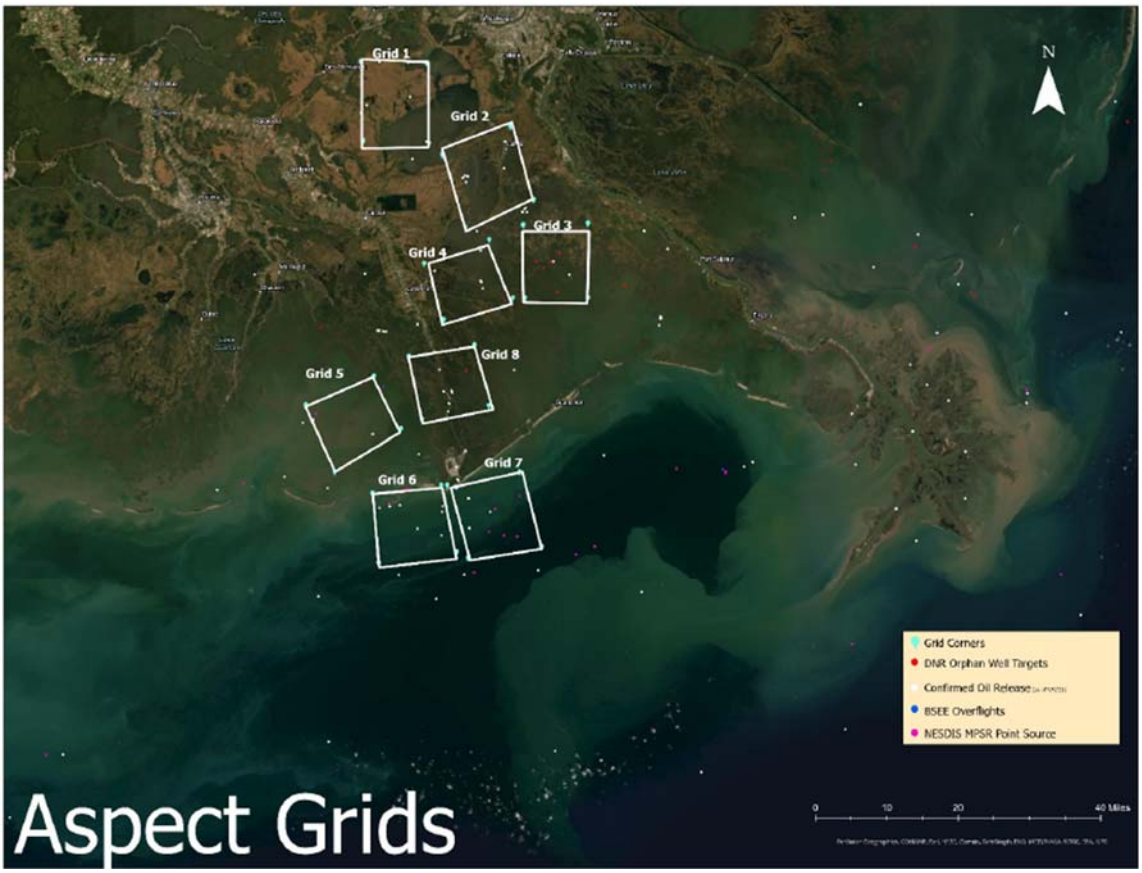

Figure 1. LDEQ Oil Survey Area, September 11, 2021

General Mission Objectives

Once granted access to fly over the sites, the following general mission objectives were employed in conducting data collection with ASPECT:

1. To capture an overall, situational awareness of the incident using aerial photography with:
    - Oblique camera—photos taken by hand from the view/position of the co-pilot, and
    - MSIC photos—advanced camera mounted underneath the plane for a top-down view of the designated sites.
2. To qualitatively locate and characterize any visible and non-visible components of a plume, oil on water, as well as any areas on fire:
    - Using the Infrared Line Scanner (IRLS)
3. To screen for the presence and location of specific chemicals within ASPECT's automated chemical detection library:
    - Using the Fourier Transform Infrared (FTIR) Spectrometer

Flight Conditions and Status

Weather and Site Conditions

Prior to each flight, an updated status of the current and forecasted weather, site conditions and any potential flight obstacles including radio towers impacting safety is assessed by the crew. A summary of the ground weather conditions during the missions can be found in Tables 1 and 2.

Table 1. Ground Weather for New Orleans, LA, Flight 13
September 11, 2021

Time	1053	1153	1253	1353	1453	1553
Wind direction	45 degrees NE	45 degrees NE	22.5 degrees NNE	45 degrees NE	67.5 degrees ENE	90 degrees E
Wind speed	4.0 m/s (9.0 mph)	4.5 m/s (10.0 mph)	4.5 m/s (10.0 mph)	4.5 m/s (10.0 mph)	4.0 m/s (9.0 mph)	3.6 m/s (8.0 mph)
Temperature	28.3 C	28.3 C	29.4 C	30.0 C	30.6 C	30.0 C
Relative humidity	48	44	42	40	40	45
Dew point	16.1 C	15.0 C	15.0 C	15.0 C	15.6 C	16.7 C
Pressure	1021.4 mb	1021.4 mb	1020.7 mb	1020.4 mb	1020.1 mb	1019.4 mb
Ceiling	Few 4800 Ft	Few 5500 Ft	Few 5500 Ft	Few 5500 Ft	Few 6000 Ft	Scattered 5500 Ft

Table 2. Ground Weather for New Orleans, LA, Flight 14
September 11, 2021

Time	1653	1753	1853
Wind direction	90 degrees E	90 degrees E	90 degrees E
Wind speed	4.5 m/s (10.0 mph)	5.4 m/s (12.0 mph)	3.6 m/s (8.0 mph)
Temperature	29.4 C	28.9 C	27.8 C
Relative humidity	46	49	56
Dew point	16.7 C	17.2 C	18.3 C
Pressure	1019.4 mb	1019.7 mb	1019.7 mb
Ceiling	Few 5500 Ft	Few 5000 Ft	Few 5000 Ft

Data Results

The following data is provided as a summary analysis. All data products are available for the Region to access on a shared FTP site. For a complete list of available products, see Appendix A. The data collected during these missions included a flight path summary, IRLS images, FTIR chemical identification and quantification, high resolution MSIC photos, and oblique photos.

Flight Paths

Wide, slow turns are required to be made in between runs to keep the instruments stable. The blue lines indicate the flight path while the green lines indicate the specific sections of the flight where chemical and oil data was collected and processed. The mission focus consisted of 8 survey areas positions between Port Fourchon, and New Orleans (Figure 2) ASPECT completed 6 of the 8 grids as shown in Figures 3 and 4.

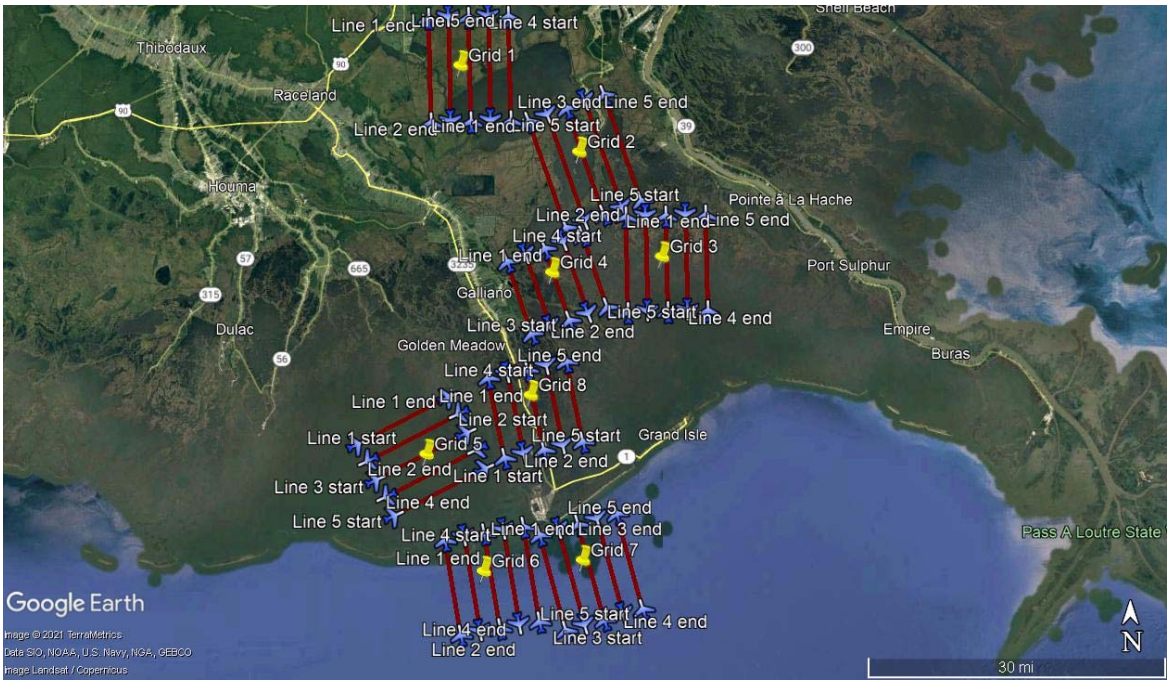

Figure 2. Survey Grid Cells

Figure 3. Oil Survey Flight Path, Flight 13, September 11, 2021

Figure 4. Oil Survey Flight Path, Flight 14, September 11, 2021

Line Scanner Data/Oil Results

A total of 32 data collection runs (2 tests and 30 active) were made over the target grid cells and an infrared line scanner image was generated for each collection run. In addition to the stock IR analysis, Flights 13 and 14 utilized two methods of oil detection analysis.

Oil detection with IR systems is routinely conducted by measuring the temperature difference and emissivity between the water and the oil. This differential is a result of differences between the water and oil emissivity and the subsequent solar heating and cooling of the oil. Oil on water in the open can be detected using the difference in emissivity. Although simple thermal imaging methods can be used in this scenario, a multi-spectral pattern recognition method provides an improved detection with fewer false alarms. An unsupervised method called ISOData (similar to K-means) is employed to cluster data into groups such as sheen, light, or heavy oil on water in open water. Since this method is a pattern recognition approach, natural signatures such as floating vegetation, fresh/saltwater interfaces, and sea foam are not classified as oil. Although the IsoData method is very robust for open ocean conditions, the model does have limitations to thermal gradient changes. For areas in shallow/marsh environments an enhanced detection solution is employed for the wide changes observed for thermal changes to discriminate between signatures including vegetation and land features. To overcome the marsh environment complexities, ASPECT uses a neural network supervised classification method which requires a training set containing oil (called actives) and a set that does not contain oil (inactive). This data set includes examples that have high thermal gradients, land features, and vegetation. The subsequent classification and separation of these two

sets of data provides a high degree of oil detection with low false alarm rates in the shallow environment.

Analysis of all data collection passes for the two missions showed the presence of oil (greater than a sheen) in four collection runs. Figure 5A and 5B shows an oil detection and photo image set collected on Flight 13, pass 6 within Grid 6. Active oil presence is shown by the orange color with the density of the color being proportional to the quantity of oil on the water. A comparison of this image to the aerial images illustrates the contrast of the images and the fact that oil on water in photographic images is complicated by observation angle, sun angle, and the color of the water. Oil was likewise detected in Grid 5 conducted on Flight 14. The locations (image positions) of all oil detections are given in Figure 6. No other significant oil detections were made in Grids 3,4, or 8. Grids 1 and 2 were not surveyed on the missions conducted on 11 September, 2021.

Figure 5A. Oil Detection Image, Flight 13, Run 6, Grid 6, September 11, 2021

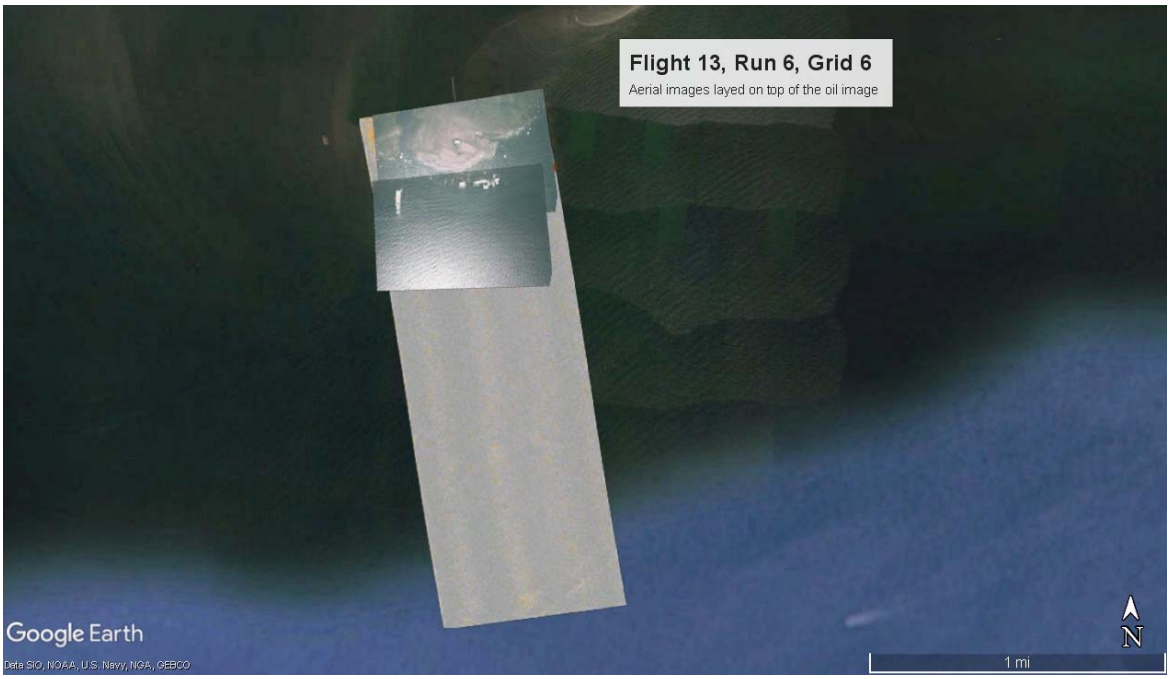

Figure 5B. Oil Photo Image, Flight 13, Run 6, Grid 6, September 11, 2021

Figure 6. Oil Detection Locations for Flight 13, September 11, 2021

FTIR Data Results

FTIR spectral data at a resolution of 16 wavenumbers was collected for each run. ASPECT uses an automated detection algorithm to permit compounds to be automatically analyzed while the aircraft is in flight. Seventy-six chemical compounds are included in the airborne

algorithm library (the list is provided in Appendix C, Table 1). In addition, collected data was also manually quality checked against a collection of published library spectra for each chemical detected.

The only compound that ASTECT detected was isoprene on Flight 13. The location of the detection is given in Figure 7. No compounds were detected on Flight 14. Details of the monitoring results can be found in Tables 3 and 4.

Table 3. Chemical Results Summary
Oil Survey, Flight 13

Pass	Date	Time (UTC)	Chemical	Max Concentration (ppm)
1	2021-09-11	16:13:28	Test	Test
2		16:38:36	ND	ND
3		17:11:11	ND	ND
4		17:19:19	ND	ND
5		17:43:46	ND	ND
6		17:49:20	ND	ND
7		17:58:48	ND	ND
8		18:16:58	ND	ND
9		18:23:18	ND	ND
10		18:33:29	ND	ND
11		18:40:20	ND	ND
12		18:49:38	ND	ND
13		18:57:46	ND	ND
14		19:07:30	ND	ND
15		19:17:19	ND	ND
16		19:24:56	ND	ND
17		19:32:14	ND	ND
18		19:39:57	Isoprene	0.249
19		19:49:07	ND	ND
20		20:00:14	ND	ND
21		20:10:13	ND	ND
22		20:19:17	ND	ND
23		20:27:54	ND	ND
24		20:36:42	ND	ND

Table 4. Chemical Results Summary
Oil Survey, Flight 14

Pass	Date	Time (UTC)	Chemical	Max Concentration (ppm)
1	2021-09-11	22:34:07	Test	Test
2		22:40:31	ND	ND
3		22:49:12	ND	ND
4		22:57:35	ND	ND
5		23:05:35	ND	ND

6		23:15:05	ND	ND
7		23:38:28	ND	ND
8		23:44:38	ND	ND

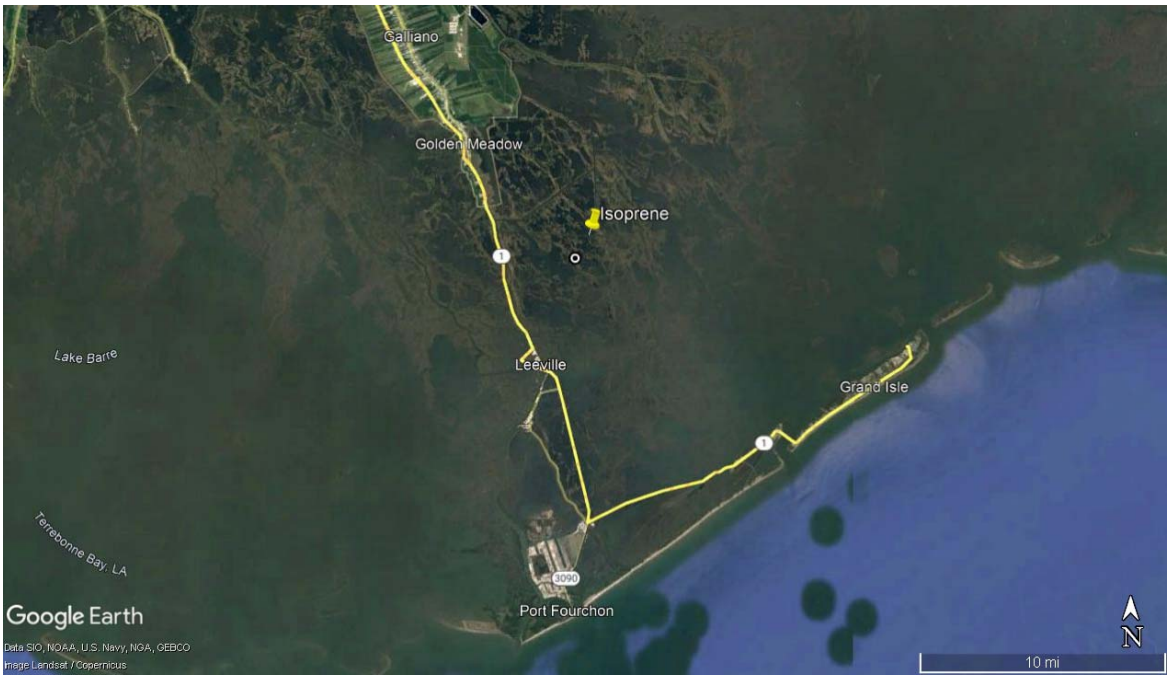

Figure 7. Isoprene Detection Location, Run 18, Flight 13

Aerial Photography Results

A full set of high-resolution aerial digital photography were collected as part of each data collection pass. An aerial image of light sheen observed in grid 7 is shown in Figure 8. Due to the focus of the mission, only a few oblique images were collected on Flight 13 (none on Flight 14). Figure 9 shows one of the oblique images showing a tank battery in the survey area.

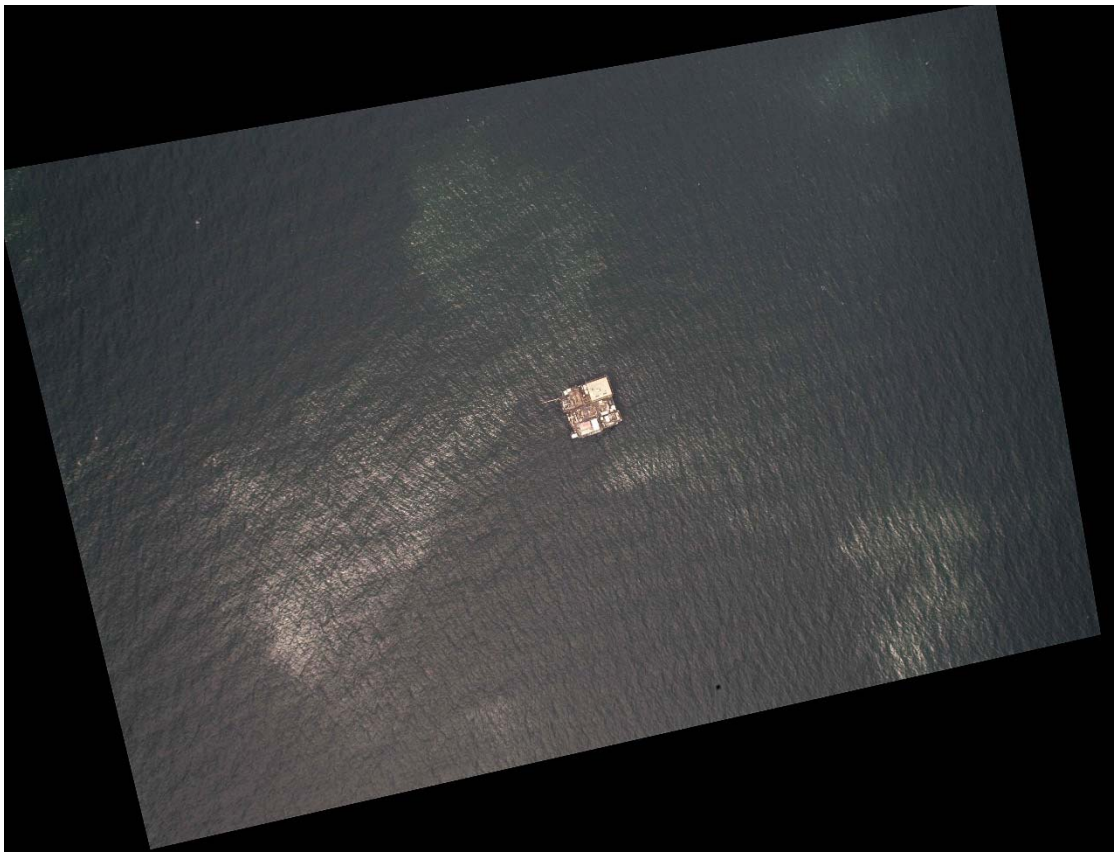

Figure 8. MSIC image of light sheen, Pass 12, Grid 7, Flight 13, September 11, 2021

Figure 9. Oblique photo of a tank battery, Flight 13, September 11, 2021

Conclusion

ASPECT conducted two oil survey missions on September 11, 2021 which included 32 data collection passes (2 test and 30 active). 8 grid areas were developed, and the system was able to survey grids 3 through 8 due to time on station. Oil was detected in four data collection passes in grids 6 and 7. Isoprene was detected on pass 18 at a low level of 0.249 ppm. No other compounds were detected.

Appendix A: File Names of Data Collected During Flight

Oil Survey, Flight 13, September 11, 2021

Run#	Time (UTC)	Altitude (MSL)	Velocity (knots)	MSIC Data Files	FTIR Data Files	IRLS Data Files	Gamma Files
1	16:13:28	2839	108	20210911161334708.jpg 20210911161341073.jpg 20210911161347422.jpg	20210911_161331_A.igm	2021_09_11_16_13_33_R_01 TA=24.9;TB=45.7;Gain=3	
2	16:38:36	2849	110	20210911163842654.jpg 20210911163849018.jpg 20210911163855367.jpg	20210911_163839_A.igm	2021_09_11_16_38_41_R_02 TA=28.4;TB=48.4;Gain=3	
3	17:11:11	2850	104	20210911171116389.jpg 20210911171123643.jpg 20210911171130007.jpg 20210911171136356.jpg 20210911171142705.jpg	20210911_171114_A.igm	2021_09_11_17_11_16_R_03 TA=21.9;TB=41.9;Gain=3	
4	17:19:19	2872	107	20210911171924815.jpg 20210911171932084.jpg 20210911171938434.jpg 20210911171944798.jpg 20210911171951147.jpg 20210911171957496.jpg 20210911172003861.jpg 20210911172010210.jpg	20210911_171922_A.igm 20210911_172001_A.igm	2021_09_11_17_19_24_R_04 TA=21.6;TB=41.5;Gain=3	
5	17:43:46	2886	117	20210911174352859.jpg 20210911174359208.jpg 20210911174405573.jpg 20210911174411922.jpg 20210911174418287.jpg 20210911174424636.jpg 20210911174430985.jpg 20210911174437350.jpg	20210911_174350_A.igm 20210911_174429_A.igm	2021_09_11_17_43_51_R_05 TA=21.9;TB=41.9;Gain=3	
6	17:49:20	2934	111	20210911174926055.jpg 20210911174932404.jpg 20210911174938753.jpg 20210911174946023.jpg 20210911174952372.jpg 20210911174958737.jpg 20210911175005086.jpg 20210911175011450.jpg	20210911_174923_A.igm 20210911_175003_A.igm	2021_09_11_17_49_25_R_06 TA=23.5;TB=42.7;Gain=3	
7	17:58:48	2857	110	20210911175854387.jpg 20210911175900736.jpg 20210911175907101.jpg 20210911175913450.jpg 20210911175919799.jpg 20210911175926164.jpg 20210911175932513.jpg 20210911175939782.jpg	20210911_175852_A.igm 20210911_175930_A.igm	2021_09_11_17_58_53_R_07 TA=23.5;TB=43.7;Gain=3	
8	18:16:58	2876	116	20210911181703851.jpg 20210911181710200.jpg 20210911181716549.jpg 20210911181722914.jpg 20210911181730168.jpg 20210911181736533.jpg 20210911181742882.jpg 20210911181749247.jpg	20210911_181701_A.igm 20210911_181740_A.igm	2021_09_11_18_17_03_R_08 TA=23.3;TB=43.2;Gain=3	
9	18:23:18	2867	110	20210911182324256.jpg 20210911182331510.jpg 20210911182337874.jpg 20210911182344223.jpg	20210911_182321_A.igm 20210911_182401_A.igm	2021_09_11_18_23_24_R_09 TA=23.1;TB=43.2;Gain=3	

				20210911182350573.jpg 20210911182356937.jpg 20210911182403287.jpg 20210911182409651.jpg 20210911182414191.jpg			
10	18:33:29	2871	115	20210911183335261.jpg 20210911183341610.jpg 20210911183347975.jpg 20210911183354324.jpg 20210911183400673.jpg 20210911183407038.jpg 20210911183413387.jpg 20210911183419752.jpg	20210911_183331_A.igm 20210911_183411_A.igm	2021_09_11_18_33_34_R_10 TA=23.0;TB=43.2;Gain=3	
11	18:40:20	2872	111	20210911184026525.jpg 20210911184032890.jpg 20210911184039239.jpg 20210911184045604.jpg 20210911184051953.jpg 20210911184059207.jpg 20210911184105572.jpg 20210911184111921.jpg	20210911_184023_A.igm 20210911_184102_A.igm	2021_09_11_18_40_26_R_11 TA=23.3;TB=43.2;Gain=3	
12	18:49:38	2833	109	20210911184944881.jpg 20210911184951246.jpg 20210911184957595.jpg 20210911185003945.jpg 20210911185010309.jpg 20210911185016659.jpg 20210911185023023.jpg 20210911185029373.jpg 20210911185035722.jpg	20210911_184942_A.igm 20210911_185021_A.igm	2021_09_11_18_49_44_R_12 TA=23.1;TB=43.2;Gain=3	
13	18:57:46	2854	108	20210911185752427.jpg 20210911185758776.jpg 20210911185805141.jpg 20210911185811490.jpg 20210911185818744.jpg 20210911185825109.jpg 20210911185831458.jpg 20210911185837823.jpg	20210911_185749_A.igm 20210911_185828_A.igm	2021_09_11_18_57_52_R_13 TA=23.4;TB=43.3;Gain=3	
14	19:07:30	2828	111	20210911190736196.jpg 20210911190742546.jpg 20210911190748902.jpg 20210911190755267.jpg 20210911190801616.jpg 20210911190807981.jpg 20210911190814330.jpg 20210911190820679.jpg	20210911_190733_A.igm 20210911_190812_A.igm	2021_09_11_19_07_35_R_14 TA=23.0;TB=43.0;Gain=3	
15	19:17:19	2847	111	20210911191725419.jpg 20210911191731768.jpg 20210911191738133.jpg 20210911191744482.jpg 20210911191750847.jpg 20210911191757196.jpg 20210911191803546.jpg 20210911191809910.jpg 20210911191813530.jpg	20210911_191722_A.igm 20210911_191802_A.igm	2021_09_11_19_17_24_R_15 TA=23.0;TB=43.0;Gain=3	
16	19:24:56	2844	108	20210911192502998.jpg 20210911192509351.jpg 20210911192515700.jpg 20210911192522059.jpg 20210911192528424.jpg 20210911192534773.jpg	20210911_192459_A.igm 20210911_192538_A.igm	2021_09_11_19_25_02_R_16 TA=22.0;TB=41.9;Gain=3	

				20210911192541122.jpg 20210911192547487.jpg			
17	19:32:14	2869	108	20210911193220600.jpg 20210911193227870.jpg 20210911193234219.jpg 20210911193240568.jpg 20210911193246933.jpg 20210911193253282.jpg 20210911193259647.jpg 20210911193305996.jpg	20210911_193218_A.igm 20210911_193258_A.igm	2021_09_11_19_32_20_R_17 TA=22.7;TB=42.7;Gain=3	
18	19:39:57	2864	105	20210911194003624.jpg 20210911194009989.jpg 20210911194016338.jpg 20210911194022687.jpg 20210911194029052.jpg 20210911194035401.jpg 20210911194041750.jpg 20210911194049020.jpg	20210911_194000_A.igm 20210911_194039_A.igm	2021_09_11_19_40_03_R_18 TA=22.0;TB=42.0;Gain=3	
19	19:49:07	2861	103	20210911194912896.jpg 20210911194919261.jpg 20210911194926515.jpg 20210911194932880.jpg 20210911194939229.jpg 20210911194945578.jpg 20210911194951943.jpg 20210911194958292.jpg	20210911_194911_A.igm 20210911_194949_A.igm	2021_09_11_19_49_13_R_19 TA=22.4;TB=42.4;Gain=3	
20	20:00:14	2838	108	20210911200020207.jpg 20210911200026556.jpg 20210911200032906.jpg 20210911200039270.jpg 20210911200045621.jpg 20210911200051970.jpg 20210911200058335.jpg 20210911200105589.jpg 20210911200111953.jpg	20210911_200017_A.igm 20210911_200057_A.igm	2021_09_11_20_00_20_R_20 TA=23.0;TB=43.0;Gain=3	
21	20:10:13	2831	107	20210911201019409.jpg 20210911201025758.jpg 20210911201032120.jpg 20210911201038469.jpg 20210911201044828.jpg 20210911201051193.jpg 20210911201057542.jpg 20210911201103891.jpg	20210911_201015_A.igm 20210911_201056_A.igm	2021_09_11_20_10_19_R_21 TA=22.6;TB=42.4;Gain=3	
22	20:19:17	2835	106	20210911201923231.jpg 20210911201929596.jpg 20210911201935945.jpg 20210911201942310.jpg 20210911201948659.jpg 20210911201955928.jpg 20210911202002278.jpg 20210911202008627.jpg	20210911_201920_A.igm 20210911_201959_A.igm	2021_09_11_20_19_23_R_22 TA=22.8;TB=42.8;Gain=3	
23	20:27:54	2829	104	20210911202759825.jpg 20210911202807094.jpg 20210911202813444.jpg 20210911202819808.jpg 20210911202826158.jpg 20210911202832507.jpg 20210911202838872.jpg 20210911202845221.jpg	20210911_202756_A.igm 20210911_202837_A.igm	2021_09_11_20_28_00_R_23 TA=22.8;TB=42.8;Gain=3	
24	20:36:42	2812	107	20210911203648221.jpg 20210911203654570.jpg	20210911_203644_A.igm 20210911_203725_A.igm	2021_09_11_20_36_49_R_24 TA=23.1;TB=43.1;Gain=3	

				20210911203701843.jpg 20210911203708192.jpg 20210911203714557.jpg 20210911203720906.jpg 20210911203727255.jpg 20210911203733620.jpg			

Oil Survey, Flight 14, September 11, 2021

Run#	Time (UTC)	Altitude (MSL)	Velocity (knots)	MSIC Data Files	FTIR Data Files	IRLS Data Files	Gamma Files
1	22:34:07	2822	109	20210911223413567.jpg 20210911223419932.jpg 20210911223426281.jpg	20210911_223409_A.igm	2021_09_11_22_34_11_R_01 TA=24.9;TB=44.8;Gain=3	
2	22:40:31	2854	116	20210911224037607.jpg 20210911224043971.jpg 20210911224050321.jpg 20210911224056670.jpg 20210911224103939.jpg 20210911224110289.jpg 20210911224116653.jpg 20210911224123010.jpg	20210911_224035_A.igm 20210911_224113_A.igm	2021_09_11_22_40_35_R_02 TA=21.4;TB=41.5;Gain=3	
3	22:49:12	2896	99	20210911224918738.jpg 20210911224925103.jpg 20210911224931452.jpg 20210911224937801.jpg 20210911224944166.jpg 20210911224950515.jpg 20210911224956878.jpg 20210911225003227.jpg 20210911225006855.jpg	20210911_224916_A.igm 20210911_224955_A.igm	2021_09_11_22_49_17_R_03 TA=21.8;TB=41.7;Gain=3	
4	22:57:35	2842	108	20210911225741713.jpg 20210911225748062.jpg 20210911225754427.jpg 20210911225800776.jpg 20210911225807141.jpg 20210911225813496.jpg 20210911225819845.jpg 20210911225826204.jpg	20210911_225738_A.igm 20210911_225817_A.igm	2021_09_11_22_57_39_R_04 TA=21.7;TB=41.7;Gain=3	
5	23:05:35	2891	97	20210911230541079.jpg 20210911230547444.jpg 20210911230553793.jpg 20210911230600152.jpg 20210911230606501.jpg 20210911230612860.jpg 20210911230619210.jpg 20210911230625574.jpg	20210911_230537_A.igm 20210911_230616_A.igm	2021_09_11_23_05_38_R_05 TA=21.0;TB=41.2;Gain=3	
6	23:15:05	2774	104	20210911231511236.jpg 20210911231517601.jpg 20210911231523950.jpg 20210911231530299.jpg 20210911231536664.jpg 20210911231543918.jpg 20210911231550283.jpg 20210911231556632.jpg	20210911_231508_A.igm 20210911_231547_A.igm	2021_09_11_23_15_09_R_06 TA=21.2;TB=41.4;Gain=3	

7	23:38:28	2571	105	20210911233834842.jpg 20210911233841200.jpg 20210911233847549.jpg 20210911233853910.jpg 20210911233900260.jpg 20210911233906618.jpg 20210911233913888.jpg 20210911233920237.jpg	20210911_233831_A.igm 20210911_233911_A.igm	2021_09_11_23_38_33_R_07 TA=22.1;TB=42.3;Gain=3	
8	23:44:38	2646	104	20210911234444365.jpg 20210911234450714.jpg 20210911234457064.jpg 20210911234503428.jpg 20210911234509778.jpg 20210911234516127.jpg 20210911234522492.jpg 20210911234528841.jpg	20210911_234441_A.igm 20210911_234521_A.igm	2021_09_11_23_44_42_R_08 TA=21.6;TB=41.7;Gain=3	

Appendix B: Priority Sites Provided by EPA Region 6 & Louisiana Department of Environmental Quality

Facility_Name	Latitude	Longitude	Parish
Deltech LLC - Baton Rouge Facility	30.552892	-91.200536	East Baton Rouge
ExxonMobil Chemical Co - Baton Rouge Plastics Plant	30.551419	-91.175611	East Baton Rouge
ExxonMobil Baton Rouge Chemical Plant	30.484336	-91.169644	East Baton Rouge
Marathon Petroleum Co LP	30.068394	-90.596364	St. John the Baptist
Westlake Vinyls Co LP	30.209167	-91.017222	Ascension
Valero Refining - Meraux LLC - Meraux Refinery	29.930222	-89.944917	St. Bernard
Cornerstone Chemical Company	29.964722	-90.264722	Jefferson
Chalmette Refining LLC	29.937903	-89.969903	St. Bernard
ExxonMobil Chemical Company - Baton Rouge Chemicals North Plant	30.50465	-91.173219	East Baton Rouge
Equilon Enterprises LLC - Norco Refinery	29.995372	-90.410167	St. Charles
The Dow Chemical Company - Louisiana Operations	30.313927	-91.240586	Iberville
Rubicon LLC - Geismar Facility	30.20139	-91.01222	Ascension
BASF Corp - Geismar Site	30.18425	-91.002778	Ascension
Union Carbide Corp - St. Charles Plant	29.982289	-90.455622	St. Charles
Phillips 66 Co - Alliance Refinery	29.68406	-89.98145	Plaquemines
Axiall LLC - Plaquemine Facility	30.267167	-91.184258	Iberville
ExxonMobil Fuels & Lubricants Co - Baton Rouge Refinery	30.484392	-91.169444	East Baton Rouge
Equilon Enterprises LLC dba Shell Oil Products US - Convent Refinery	30.107684	-90.890796	St. James
Marathon Petroleum Company LP - Louisiana Refining Division - Garyville Refinery	30.061322	-90.593528	St. John the Baptist
BASF Corp - Zachary Site	29.547603	-90.523231	East Baton Rouge
Occidental Chemical Corporation - Geismar Facility	30.18819	-90.98188	Ascension
St Rose Refinery LLC - St Rose Refinery	29.950875	-90.328497	St. Charles
ExxonMobil Chemical Co - Baton Rouge Polyolefins Plant	30.56215	-91.20387	East Baton Rouge
Shell Chemical LP - Norco Chemical Plant West Site	30.004925	-90.422381	St. Charles
NOVA Chemicals Olefins LLC - Geismar Ethylene Plant	30.230619	-91.052884	Ascension
Roehm America LLC - MMA Plant	29.9575	-90.265833	Jefferson
Valero Refining - New Orleans LLC - St Charles Refinery	29.985781	-90.3955	St. Charles
Shell Chemical LP - Norco Chemical Plant - East Site	29.995556	-90.409722	St. Charles
BASF Corp - North Geismar Site	30.20594	-90.99195	Ascension
Stolthaven New Orleans, LLC - Braithwaite Facility	29.870919	-89.949339	Plaquemines
Shintech Louisiana LLC - Shintech Plaquemine Plant	30.273611	-91.173333	Iberville
Denka Performance Elastomer LLC	30.053928	-90.524792	St. John the Baptist

Formosa Plastics Corp Louisiana	30.501722	-91.185944	East Baton Rouge
DuPont Specialty Products USA LLC - Pontchartrain Site	30.05388	-90.52472	St. John the Baptist
Occidental Chemical Corp - Taft Plant	29.987222	-90.454722	St. Charles
Syngenta Crop Protection LLC - St Gabriel Plant	30.246728	-91.103508	Iberville
Mosaic Fertilizer LLC - Faustina Plant	30.083914	-90.91345	St. James
Mosaic Fertilizer LLC - Uncle Sam Plant	30.037222	-90.8275	St. James
LBC Baton Rouge LLC - Sunshine Terminal	30.294444	-91.148333	Iberville
Occidental Chemical Corporation - Convent Facility	30.055885	-90.830594	St. James
TOTAL Petrochemicals & Refining USA Inc - Carville Polystyrene Plant	30.229786	-91.073631	Iberville
Targa Midstream Services LLC	29.237034	-89.384977	Plaquemines
EnLink LIG Liquids LLC - Plaquemine Gas Processing Plant	30.236389	-91.241389	Iberville
EnLink LIG Liquids LLC - Gibson Gas Processing Plant	29.643056	-90.961944	Terrebonne
NuStar Logistics LP - St James Terminal	30.030065	-90.843463	St. James
Enterprise Gas Processing LLC - Norco Fractionation Plant	30.015411	-90.402958	St. Charles
Lone Star NGL Refinery Services LLC - Geismar Fractionation Plant	30.218889	-91.035833	Ascension
INEOS Oxide - A Division of INEOS Americas LLC	30.313889	-91.240278	Iberville
Discovery Producer Services LLC - Discovery Paradis Fractionation Plant	29.858889	-90.453333	St. Charles
Plains Marketing LP - St James Terminal	30.004341	-90.848449	St. James
Methanex USA Services LLC - Geismar Methanol Plant	30.206667	-91.020833	Ascension
Dyno Nobel LA Ammonia LLC - Ammonia Production Facility	29.964789	-90.264625	Jefferson
Kinder Morgan Liquids Terminals LLC - Geismar Methanol Terminal	30.205389	-91.023792	Ascension
South LA Methanol LP - St James Methanol Plant	30.039917	-90.863819	St. James
YCI Methanol Plant	29.97481	-90.86775	St. James
IGP Methanol LLC - Gulf Coast Methanol Complex	29.625453	-89.926611	Plaquemines
KMe St James Holdings LLC - Methanol Terminal	29.990919	-90.841239	St. James
Kemira Chemicals Inc	29.964722	-90.264722	Jefferson
PHILLIPS 66 PIPELINE LLC	29.923889	-90.482498	St. Charles
CF INDUSTRIES	30.08328	-90.957665	Ascension

Appendix C: ASPECT Systems

The US EPA ASPECT system collects airborne infrared (IR) images and chemical screening data from a safe distance over the site (about 3,000 ft AGL). The system consists of an airborne high-speed Fourier Transform Infra-Red (FTIR) spectrometer coupled with a wide-area IR Line Scanner (IRLS). The ASPECT IR systems can detect chemical compounds in both the 8-to-12-micron (800 to 1200 cm-1) and 3 to 5 micron (2000 to 3200 cm-1) regions. List of chemicals and detection limits are listed in Table 1. The 8 to 12 micron region is typically known as the atmospheric window region since the band is reasonably void of water and carbon dioxide influence. Spectrally, this region is used to detect carbon - non-carbon bonded compounds. The 3 to 5 micron region is also free of water and carbon dioxide but typically does not have sufficient energy for use. This band does show use in high-energy environments such as fires. The carbon - hydrogen stretch is very common in this region.

An Imperx mapping camera (29 mega pixels; mapping focal plane array) is concurrently operated as part of all chemical collections. These images are often digitally processed in lower resolution, so they can be transmitted via satellite communication. All imagery is geo-rectified using both aircraft attitude correction (pitch, yaw, and roll) and GPS positional information. Imagery can be processed while in flight or approximately 600 frames per hour can be processed once the data are downloaded from the aircraft. The high-resolution images (>20 MB each) are pulled from the ASPECT after the sortie and are available later.

All aerial photographic images collected by the ASPECT system are ortho-rectified and geospatially validated by the scientific reach back team. In general, this consists of conducting geo-registration using a USGS Digital Elevation Model (DEM) which promotes superior pixel computation and lessens topographic distortion. The image is check by the team (using a Google Earth base map) for proper location and rotation.

Airborne radiological measurements are conducted using three fully integrated multi-crystal sodium iodide (NaI) RSX4 gamma ray spectrometers. Each RSX4 spectrometer contains four 4”x2”x16” doped NaI crystals each having an independent photomultiplier/ spectrometer assembly. One RSX unit is configured with an additional upward NaI crystal utilized to provide real-time cosmic ray correction. Count and energy data from each crystal and pack is combined using a self-calibrating signal processor to generate a virtual detector output. All radiological spectrometer “packs” are further combined using a signal console controlled by the on-board central computer in the aircraft. Altitude correction data is provided by a radar altimeter with internal GPS systems within the packs serving as a backup. It should be noted that no radiological measurements were conducted on this mission.

Data is processed using automated algorithms onboard the aircraft with preliminary results being sent using a satellite system to the ASPECT scientific reach back team for QA/QC analysis. Upon landing, preliminary data results are examined and validated by the

scientific reach back team.

Table 1. ASPECT Automated Compounds

This table contains ASPECT's library of automated compounds.
Detection limits are for each chemical is found in parenthesis in units of parts per million (ppm)

Acetic Acid (2.0)	**Cumene (23.1)**	**Isoprene (6.5)**	**Phosphine (8.3)**
Acetone (5.6)	**Diborane (5.0)**	**Isopropanol (8.5)**	**Phosphorus Oxychloride (2.0)**
Acrolein (8.8)	**1,1-Dichloroethene (3.7)**	**Isopropyl Acetate (0.7)**	**Propyl Acetate (0.7)**
Acrylonitrile (12.5)	**Dichloromethane (6.0)**	**MAPP (3.7)**	**Propylene (3.7)**
Acrylic Acid (3.3)	**Dichlorodifluoromethane (0.7)**	**Methyl Acetate (1.0)**	**Propylene Oxide (6.8)**
Allyl Alcohol (5.3)	**1,1-Difluoroethane (0.8)**	**Methyl Acrylate (1.0)**	**Silicon Tetrafluoride (0.2)**
Ammonia (2.0)	**Difluoromethane (0.8)**	**Methyl Ethyl Ketone (7.5)**	**Sulfur Dioxide (15)**
Arsine (18.7)	**Ethanol (6.3)**	**Methanol (5.4)**	**Sulfur Hexafluoride (0.07)**
Bis-Chloroethyl Ether (1.7)	**Ethyl Acetate (0.8)**	**Methylbromide (60)**	**Sulfur Mustard (6.0)**
Boron Tribromide (0.2)	**Ethyl Acrylate (0.8)**	**Methylene Chloride (1.1)**	**Sulfuryl Fluoride (1.5)**
Boron Triflouride (5.6)	**Ethyl Formate (1.0)**	**Methyl Methacrylate (3.0)**	**Tetrachloroethylene (10)**
1,3-Butadiene (5.0)	**Ethylene (5.0)**	**MTEB (3.8)**	**1,1,1-Trichloroethane (1.9)**
1-Butene (12.0)	**Formic Acid (5.0)**	**Naphthalene (3.8)**	**Trichloroethylene (2.7)**
2-Butene (18.8)	**Freon 134a (0.8)**	**n-Butyl Acetate (3.8)**	**Trichloromethane (0.7)**
Carbon Tetrachloride (0.2)	**GA (Tabun) (0.7)**	**n-Butyl Alcohol (7.9)**	**Triethylamine (6.2)**
Carbonyl Fluoride (0.8)	**GB (Sarin) (0.5)**	**Nitric Acid (5.0)**	**Triethylphosphate (0.3)**
Carbon Tetraflouride (0.1)	**Germane (1.5)**	**Nitrogen Mustard (2.5)**	**Trimethylamine (9.3)**
Chlorodifluoromethane (0.6)	**Hexafluoroacetone (0.4)**	**Nitrogen Trifluoride (0.7)**	**Trimethyl Phosphite (0.4)**
Chloromethane (12)	**Isobutylene (15)**	**Phosgene (0.5)**	**Vinyl Acetate (0.6)**