Fototerra

Optimized Operational Airborne Oil Spill Remote Sensing: POSEIDON the Quantitative Approach

Chevron

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

OSPR/Chevron Oil Spill Response Technology Workshop

February 27th – March 2nd, 2017
Chevron Park, San Ramon, CA

Airborne Remote Sensing

Learning Outcomes

The Needs. Industry and Government Recommendations. The European Way. DWH aftermath. *Call for proactive actions.*

Intelligence on the Scene. POSEIDON Mission System: Multi-Sensors Suite, Real Time Data Processing and Communications Network.

The Quantitative Approach. Capabilities of the first platform operating in the US following a Step by Step Operations.

Benefits. Benefits for Emergency Response, Natural Resources Damage Assessment and Preparedness.

Airborne Remote Sensing Needs

Today, except for WH State, there are no regulations in the US that require aerial remote sensing in support of a oil spill response.

But the O&G Industry and Government Agencies are well aware that aerial remote sensing and intelligence is a fundamental element in a response. It can make the difference between a manageable incident and a uncontrollable catastrophe. The recommendations issued cover:

SENSOR TECHNOLOGY

OIL POLLUTION RESEARCH AND TECHNOLOGY PLAN, 2015
INTERAGENCY COORDINATING COMMITEE ON OIL POLLUTION RESEARCH (ICCOPR)

- LOW VISIBILITY CONDITIONS (E.G., NIGHT, FOG).
- OIL UNDER ICE,
- THICKNESS AND CLASSIFICATION.

SENSOR INTEGRATION

API Technical Report 1144, 2013
Remote Sensing in support of oil spill response

- COMBINATION OF SEVERAL SENSORS AND DATA SETS TO ADDRESS THE SITUATION
- INTEGRATED MULTI-SENSORS PLATFORMS ARE THE ANSWER.

PLANNING

JIP SMV WP 2, 2015
Surface surveillance capabilities for oil spill response using remote sensing.
Oil Spill Response Surveillance, Modelling & Visualization Joint Industry Program Work Package 2. IPIECA - IOGP

- PRO-ACTIVE SURVEILLANCE PROGRAMS,
- EXERCISES AND TRAINING TO ENSURE FAMILIARITY WITH THE EQUIPMENT AND READINESS.
- TIMELY DELIVERY OF INFORMATION,
- REAL TIME DATA ELABORATION

Airborne Remote Sensing Needs

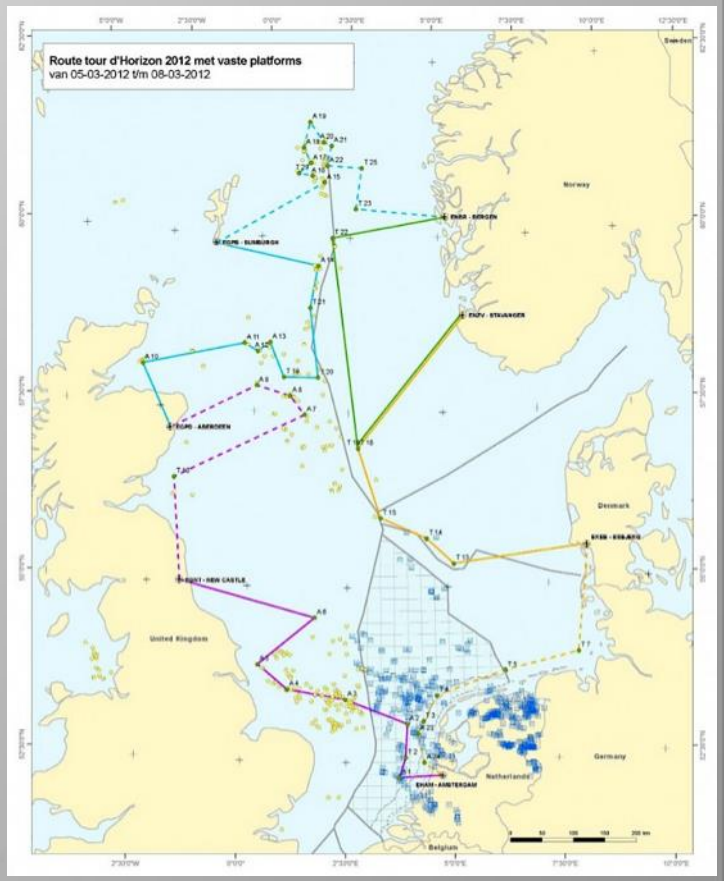
The Bonn Agreement

The Bonn Agreement is the mechanism by which nine Governments of the Greater North Sea, and the European Union, cooperate in dealing with pollution of the North Sea. Area of the basin is approximately the same of the GoM US Continental Shelf.

In order to prevent illegal or accidental pollution the Bonn Agreement Parties undertake **Routine Aerial Surveillance** to enforce maritime pollution rules and standards. And for **Training** and **Exercise** for **Response readiness.**

The Bonn Agreement also operates a coordinated ***Tour d'Horizon*** **Program** for aerial surveillance of offshore oil and gas installations. Patrol flights by individual countries, covering predetermined routes, are coordinated during the year in order to provide maximum coverage.

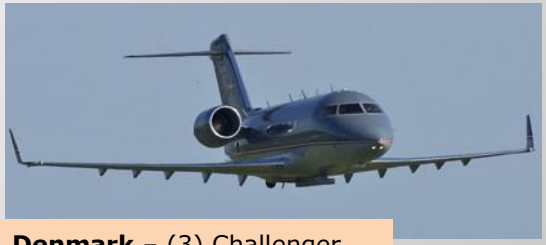
The Bonn Agreement is not the only organization, in Europe there are also the Helsinki Convention, Lisbon Agreement, Barcelona Convention, Bucharest Agreement. In Canada Transport Canada operates a National Aerial Surveillance Program of the Coastal Waters with more than 4,000 hrs flown every year.



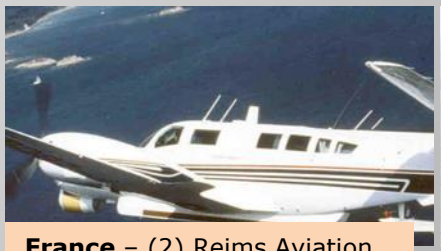
Airborne Remote Sensing Needs

THE BONN AGREEMENT - FLEET

Belgium - Norman Islander - SLAR, IR/UV



Denmark – (3) Challenger SLAR, IR/UV, SATCOM



France – (2) Reims Aviation F406 SLAR, IR/UV, MWR, SAT

UK – (2) Cessna 406 – SLAR, IR/UV, SAT

Germany – (2) Dornier 228 - SLAR, IR/UV, MWR, LFS, SAT

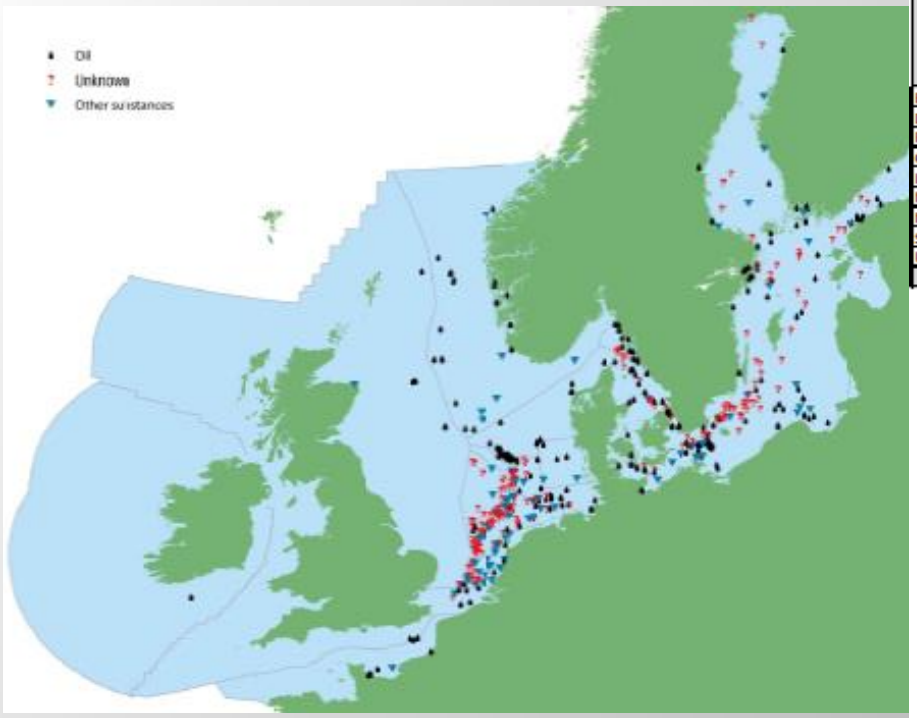
Holland – (2) Dornier 228 - SLAR, FLIR

Sweden – (3) Dash 8 Q-300 – SLAR, IR/UV, SAT

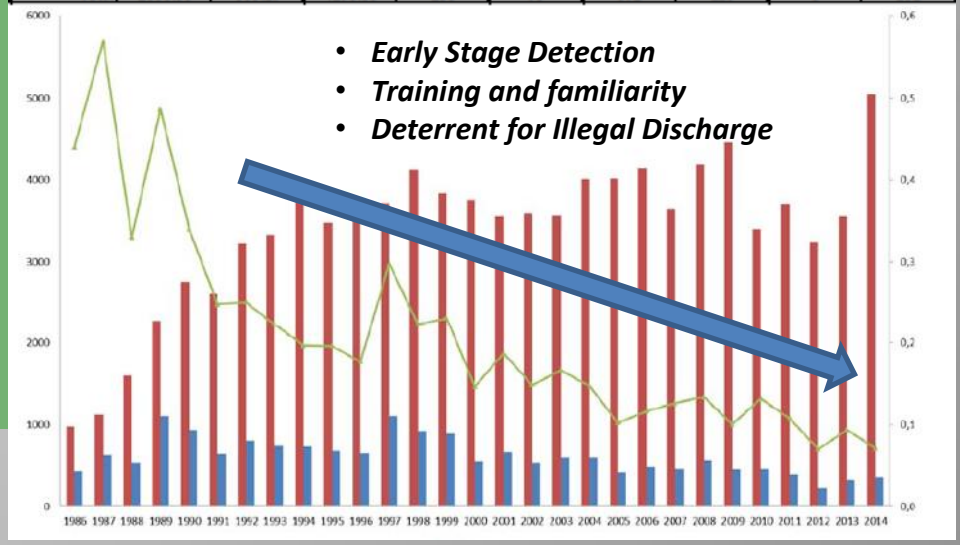
Spain – (3) CASA CR 235 – SLAR, IR/UV, MWR, LFS, SAT

Airborne Remote Sensing Needs

THE BONN AGREEMENT - REPORTS



Country	No. of flight hours			No. of detections inside national EEZ			Detections confirmed / observed as mineral oil spills		
	Daylight	Darkness	Total	Daylight	Darkness	Total	Daylight	Darkness	Total
Belgium	182:20	41:55	224:15	3	1	4	2	0	2
Denmark	171:50	19:52	191:42	76	25	101	61	4	65
France	610:06	80:24	690:30	37	3	40	7	0	7
Germany	529:56	267:26	797:22	26	13	39	13	2	15
Ireland	0:00	0:00	834:42	1	0	1	1	0	1
Netherlands	637:00	145:00	782:00	114	34	148	12	2	14
Norway	438:00	15:00	453:00	22	0	22	17	0	17
Sweden	196:10	35:50	232:00	11	3	14	8	0	8
UK	65:08	0:00	65:08	3	0	3	2	0	2
Total	2830:30	605:27	4270:39	293	79	372	123	8	131



- *Early Stage Detection*
- *Training and familiarity*
- *Deterrent for Illegal Discharge*

(*) Data from the ***Annual report on aerial surveillance for 2014 – The Bonn Agreement***

Airborne Remote Sensing Needs

In the aftermath of Deepwater Horizon Spill, Governmental Agencies, Industry and University got together in order to focus on needs for future technologies to improve oil observations because in the event of an accident, the most critical task is to Timely and Efficiently put resources in the right position - day and night - to recover the oil. The conclusions suggested that for the oil responder community an effective airborne platform should feature:

- Multiple sensors for complementarity/redundancy;
- Classification of Pollutants, no false-positive;
- Identification of oil targets as Recoverable or Non-recoverable;
- Georeferencing the targets and Tracking moving oil;
- Real time information - for tactical and strategic use;
- Data suitable for the Common Operating Picture;
- Expanding the operating window to low-light conditions;
- Readiness of Crew and Platform.

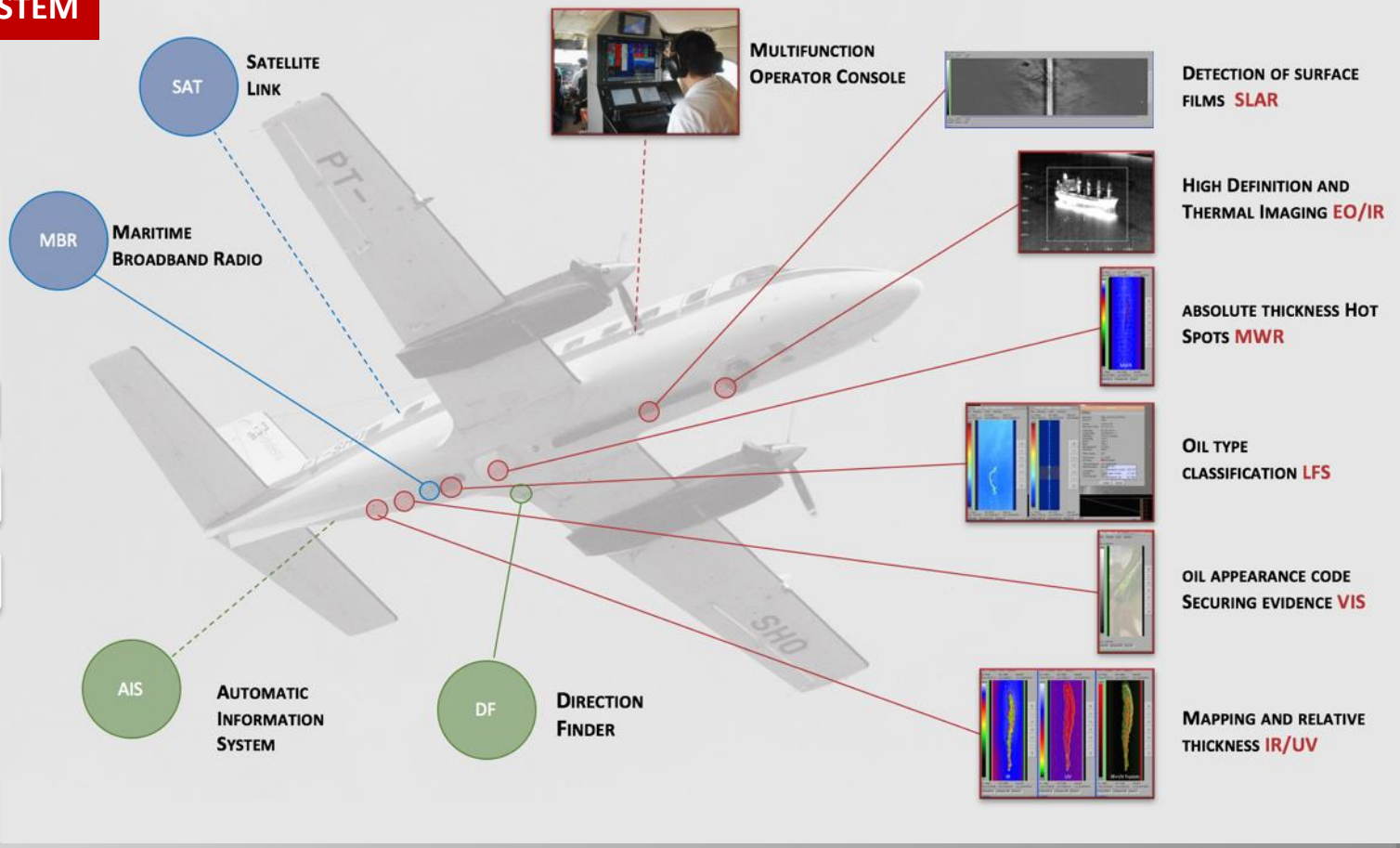
Intelligence on the Scene

POSEIDON MISSION SYSTEM

SENSORS

DATA PROCESSING

COMMUNICATIONS



Intelligence on the Scene

POSEIDON FEATURES

✓	Integrated **Multi-sensor Package** including Far and Near range sensors
✓	Far Range sensing. **Synoptic Overview.** Capability to localize and follow
✓	**High Area Coverage** with far and near range sensors
✓	Absolute **Thickness** measurement and quantitative **Volume** estimation. **Hot-Spots** targeting. Determination of oil as recoverable and non recoverable
✓	Oil type identification and **Classification,** weathering
✓	Complete **On-board Processing** - **Real Time** Capture, Fusion and Analysis of Data
✓	**Georeferenced Data**. Integrated situation map for COP. GIS webserver.
✓	**Real Time Data Communication**. Microwave air-to-ground Com, SATCOM
✓	Low light, **all weather operations**
✓	**False Positive prevention**
✓	**24/7** readiness
✓	**SAR** Capabilities

Intelligence on the Scene

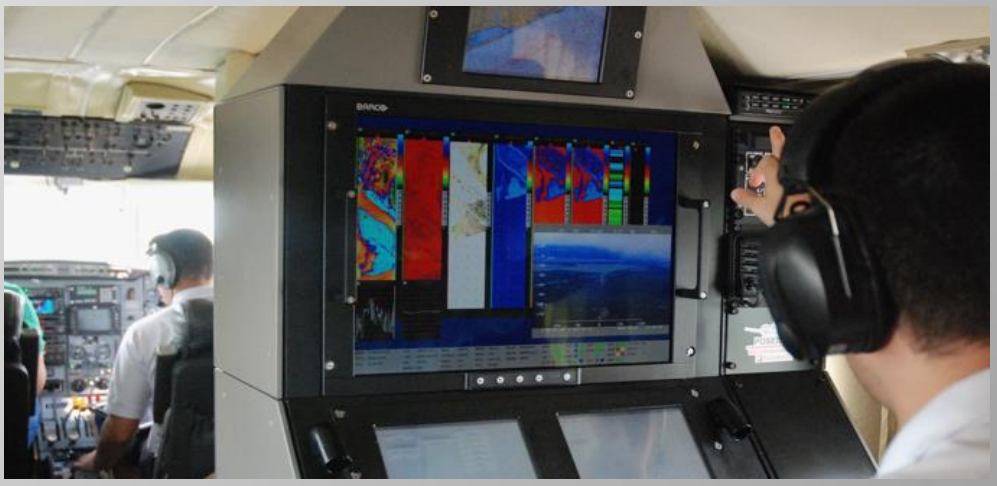
QUANTIFICATION OF

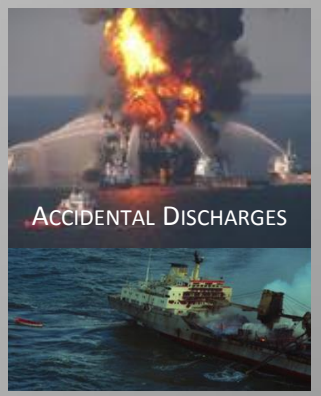
✓	Area (km^2)
✓	Position (Lat, Lon)
✓	Coverage (%)
✓	Thickness Distribution (mm)
✓	Volume (l, m^3)
✓	Hot Spots
✓	Drift, Spreading (km/h, km^2/h)

UNDERSTAND THE SCENARIO

DECIDE THE ACTIONS

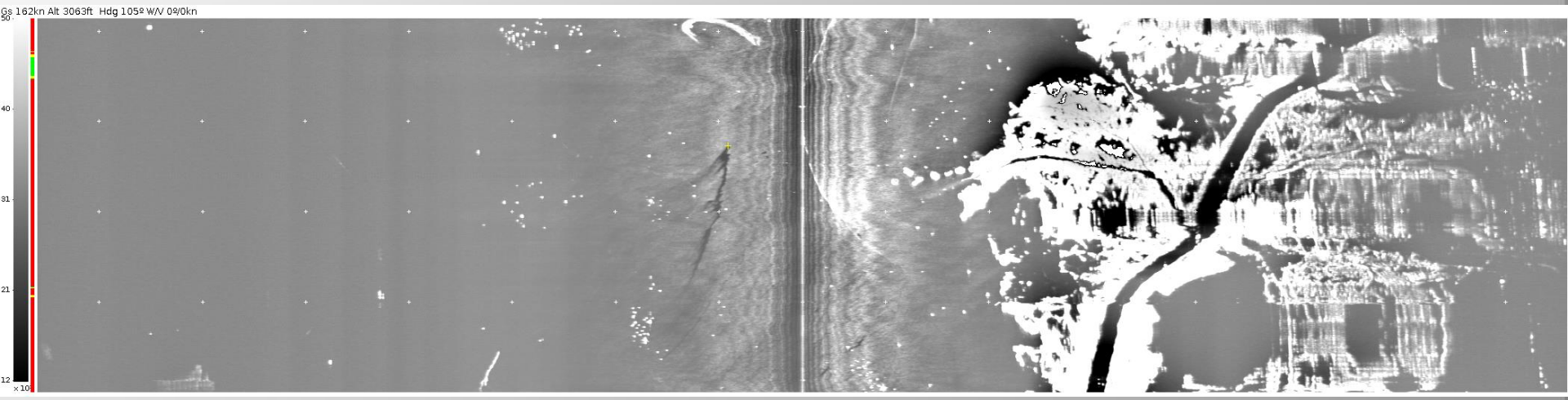
CONTROL THE RESULTS





The Quantitative Approach

STEP 1 - Far Range Detection



The Quantitative Approach

STEP 1 - Far Range Detection

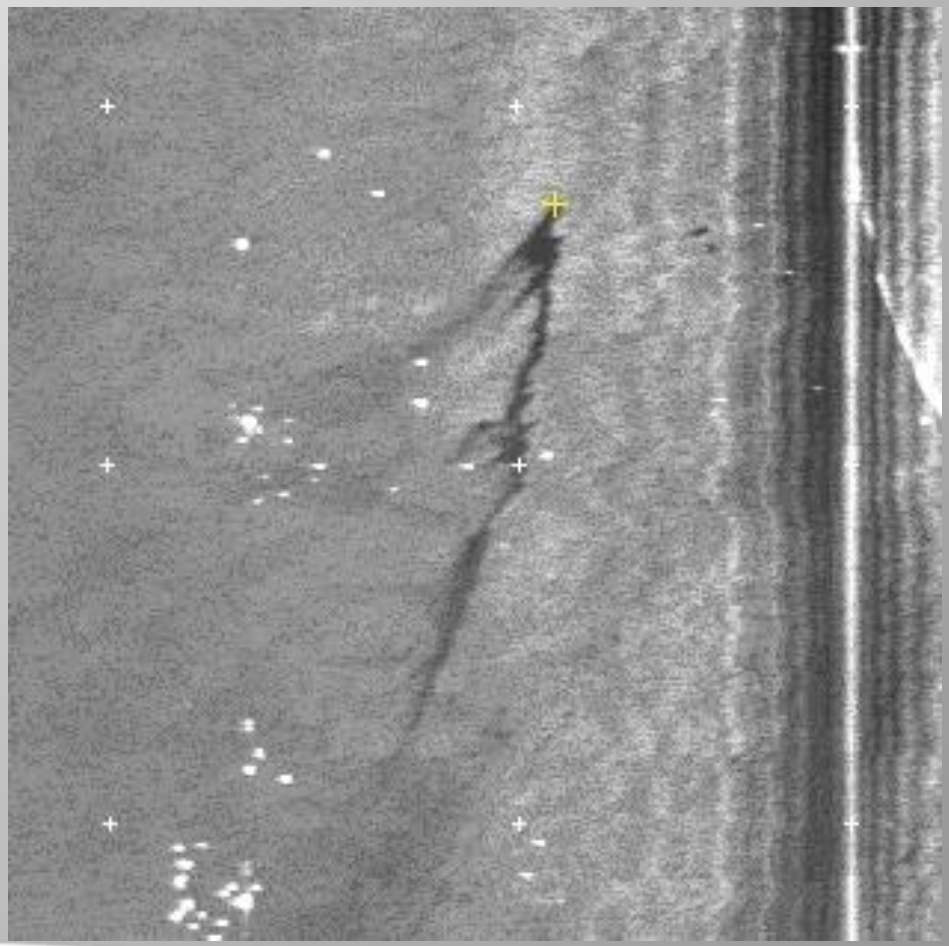
SLAR – Side Looking Airborne Radar

PRIMARY TOOL FOR **SYNOPTIC**, **WIDE COVERAGE** OIL SPILL DETECTION.

CLOUD PENETRATING X-BAND (~9.3GHz) REAL APERTURE RADAR – **50NM** SWATH

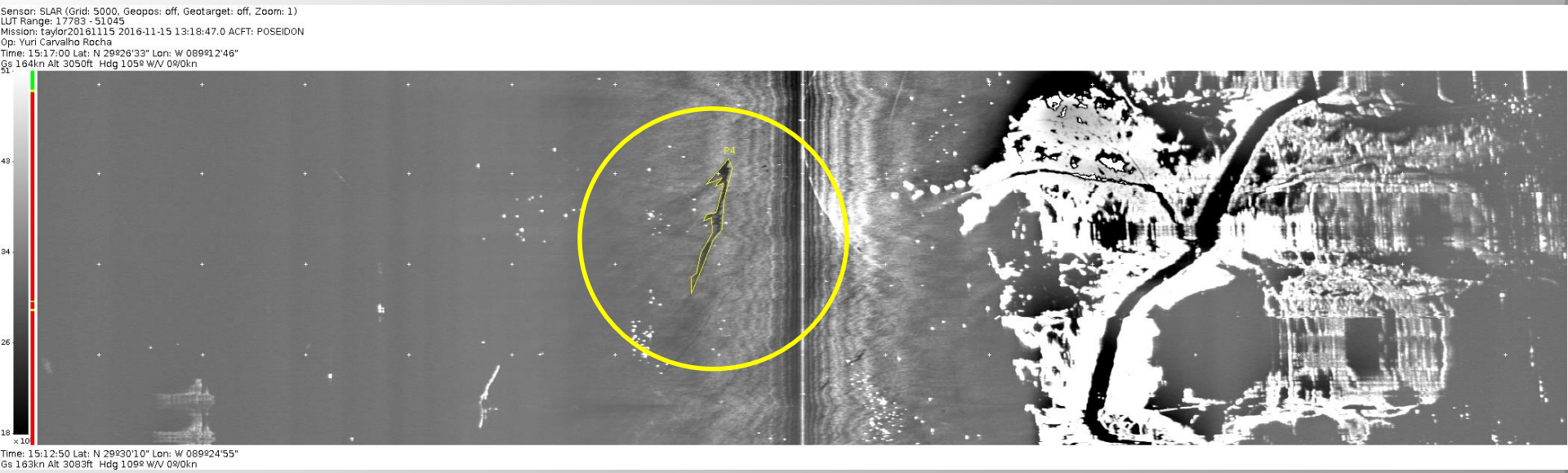
GEOREFERENCING

DATA FUSION OF AIS DATA, SATELLITE IMAGERY, SLAR DATA IN GIS ENVIRONMENT



The Quantitative Approach

STEP 1 - Far Range Detection – Spill Synoptic



REAL TIME INFORMATION

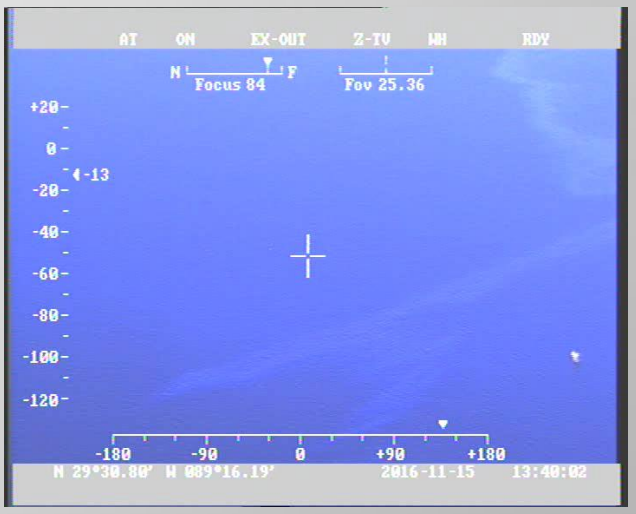
Polygon	Area [km²]	Center Coordinates	Coverage. [%]	Orientation. [°]	Dimension. [NM]
P4	2.639	N 29º30'36" W 089º16'35"	31	299	0.615 / 4.044

The Quantitative Approach

STEP 1 - Far Range Detection

EO/IR – Electro-Optical Infrared

- High Definition and Thermal Imaging
- Visual Assessment of the spill
- Navigation
- SAR support
- Natural Resource Damage Assessment

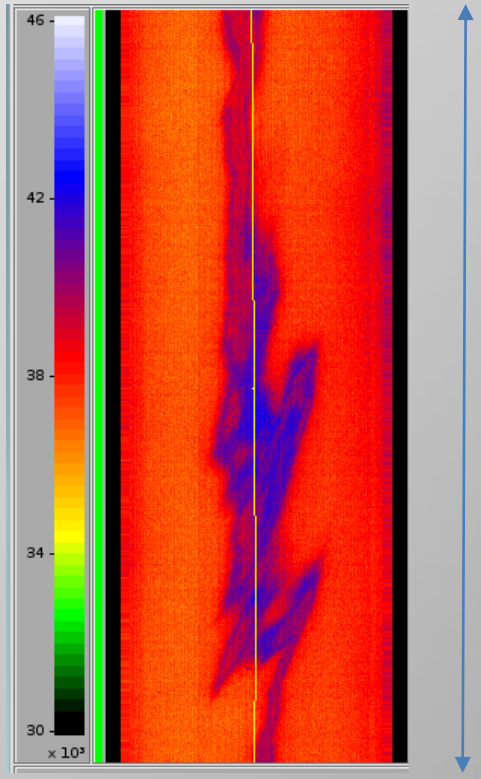


The Quantitative Approach

STEP 2 - Near Range Analysis

Near Range sensors allow for an accurate analysis of the Oil Spill.
Each sensor detects specific features of the spill for a precise target definition.
Swath is twice the altitude.
Sensors include:

- **IR/UV Line Scanner**
- **VIS Line Scanner**
- **Microwave Radiometer (MWR)**
- **Laser Fluorosensor (LFS)**
- **EO/IR**
- **Camera Systems**

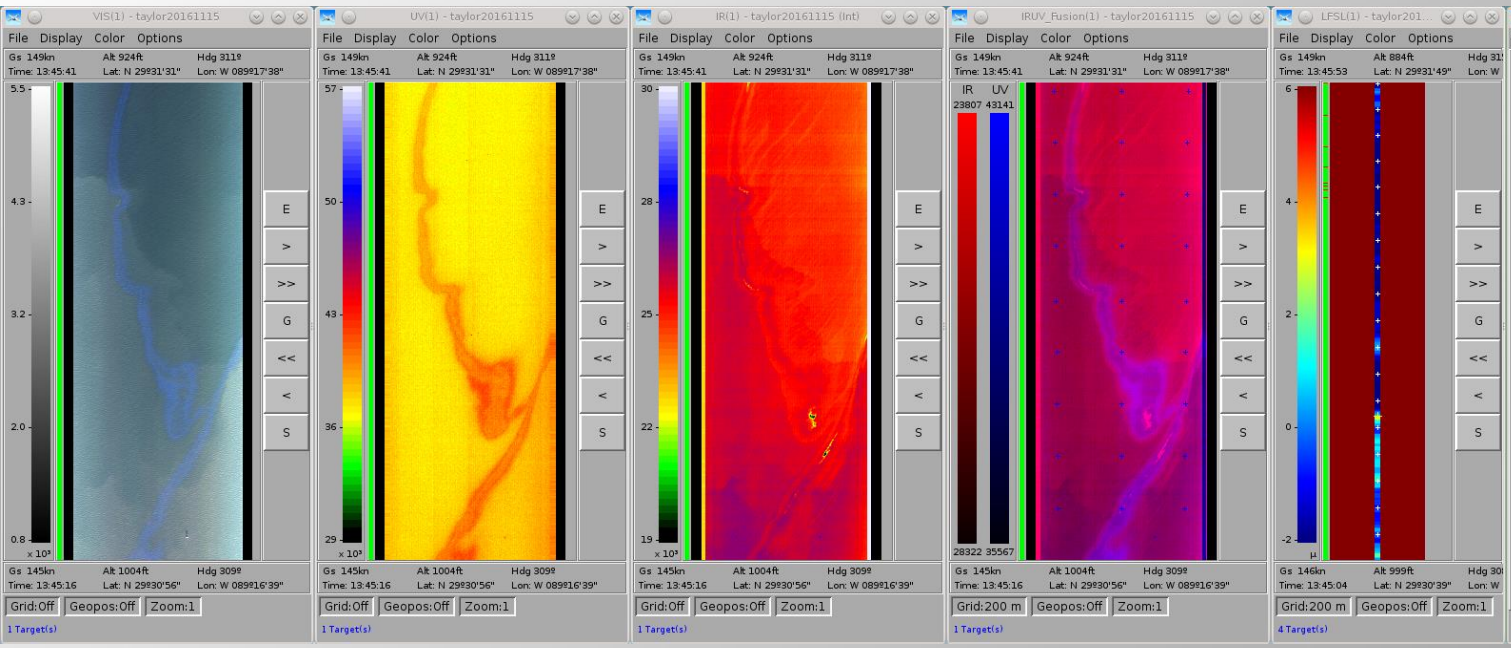


REAL TIME INFORMATION

- Thickness Distribution (µm)
- Volume (l, m^3)
- Hot Spots
- Oil Classification
- Area
- Position
- Coverage
- Drift
- Spreading

The Quantitative Approach

STEP 2 - Near Range Analysis



VIS UV IR Fusion IR/UV LFS

The Quantitative Approach

STEP 2 - Near Range Analysis

IR/UV – Infrared Ultraviolet Line Scanner

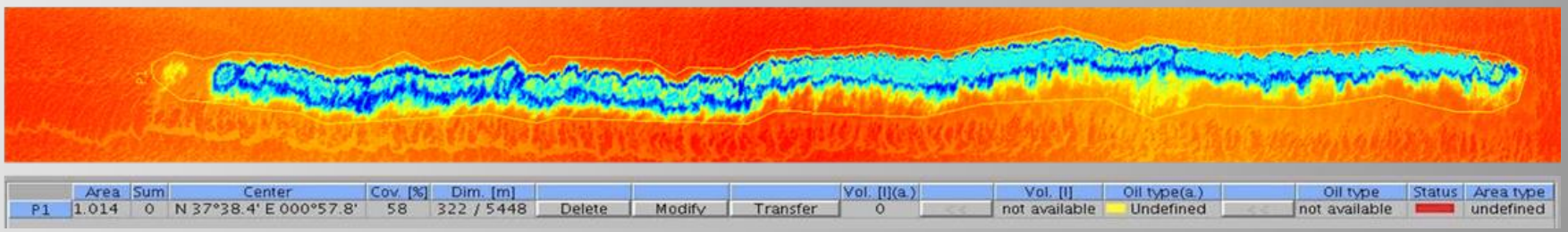
- Day and Night spill detection.
- Operational Altitude 1000-3000 ft;
- High precision measurements and hot-spots analysis;
- Sensitive above 0.01 µm layers (UV) and 2 µm layers (IR).

Direct Quantification of:

- Area
- Position
- Coverage %
- Dimensions
- Relative Thickness

Extrapolation of:

- Drift
- Spreading
- Volume

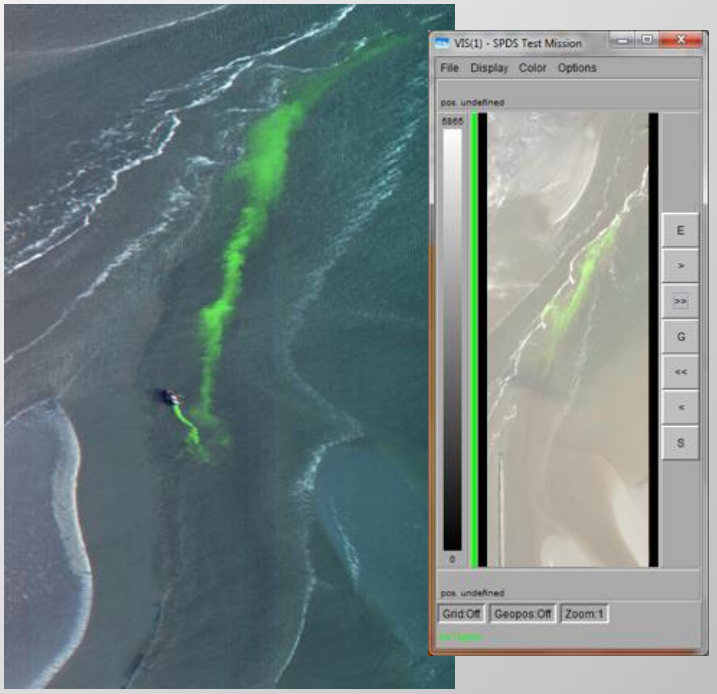


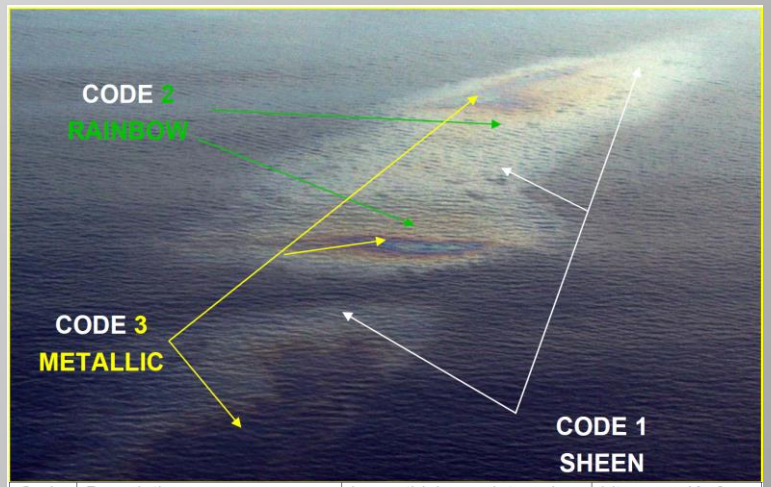
	Area	Sum	Center	Cov. [%]	Dim. [m]				Vol. [l](a.)		Vol. [l]	Oil type(a.)		Oil type	Status	Area type
P1	1.014	0	N 37°38.4' E 000°57.8'	58	322 / 5448	Delete	Modify	Transfer	0		not available	Undefined		not available		undefined

The Quantitative Approach

STEP 2 - Near Range Analysis

VIS – VISUAL RGB LINE SCANNER





Code	Description - appearance	Layer thickness interval (µm)	Litres per Km²
1	Sheen	0.04 to 0.30	40 – 300
2	Rainbow	0.3 to 5.0	300 – 5000
3	Metallic	5.0 to 50	5000 – 50 000
4	Discontinuous True Oil Colour	50 to 200	50 000 – 200 000
5	Continuous True Oil Colour	More than 200	More than 200 000

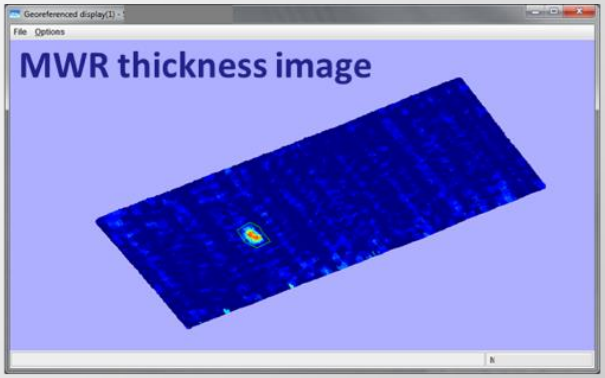
Bonn Agreement Oil Appearance Code (BAOAC)

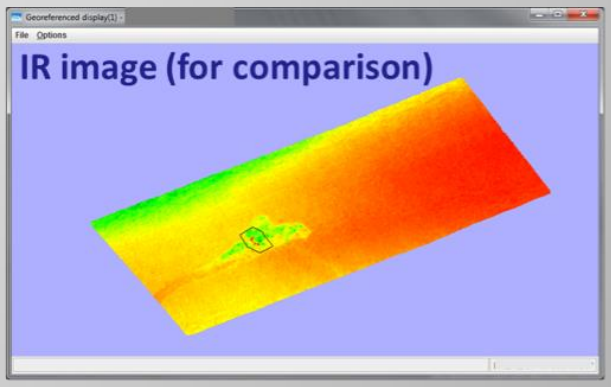
The Quantitative Approach

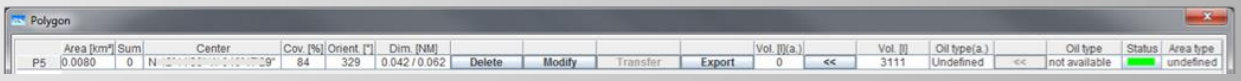
STEP 2 - Near Range Analysis

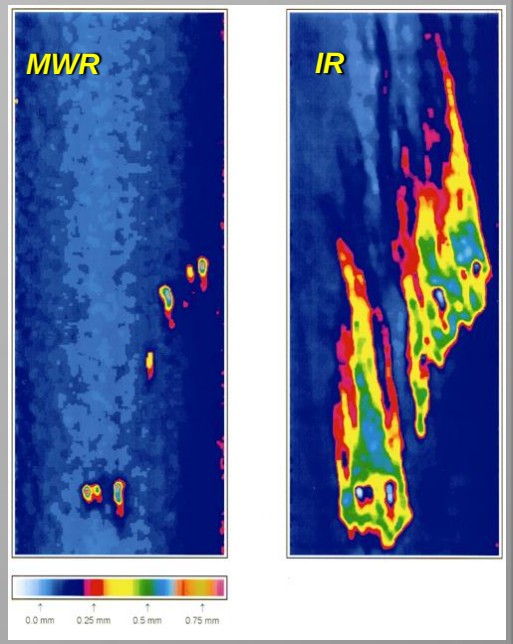
MWR– Microwave Radiometer

- Day and night / all-weather spill detection, thickness (50 µm to 3mm) measurement and volume estimate
- Used to analyze very thick spills
- Operational aircraft altitude: 1,000-3,000 ft







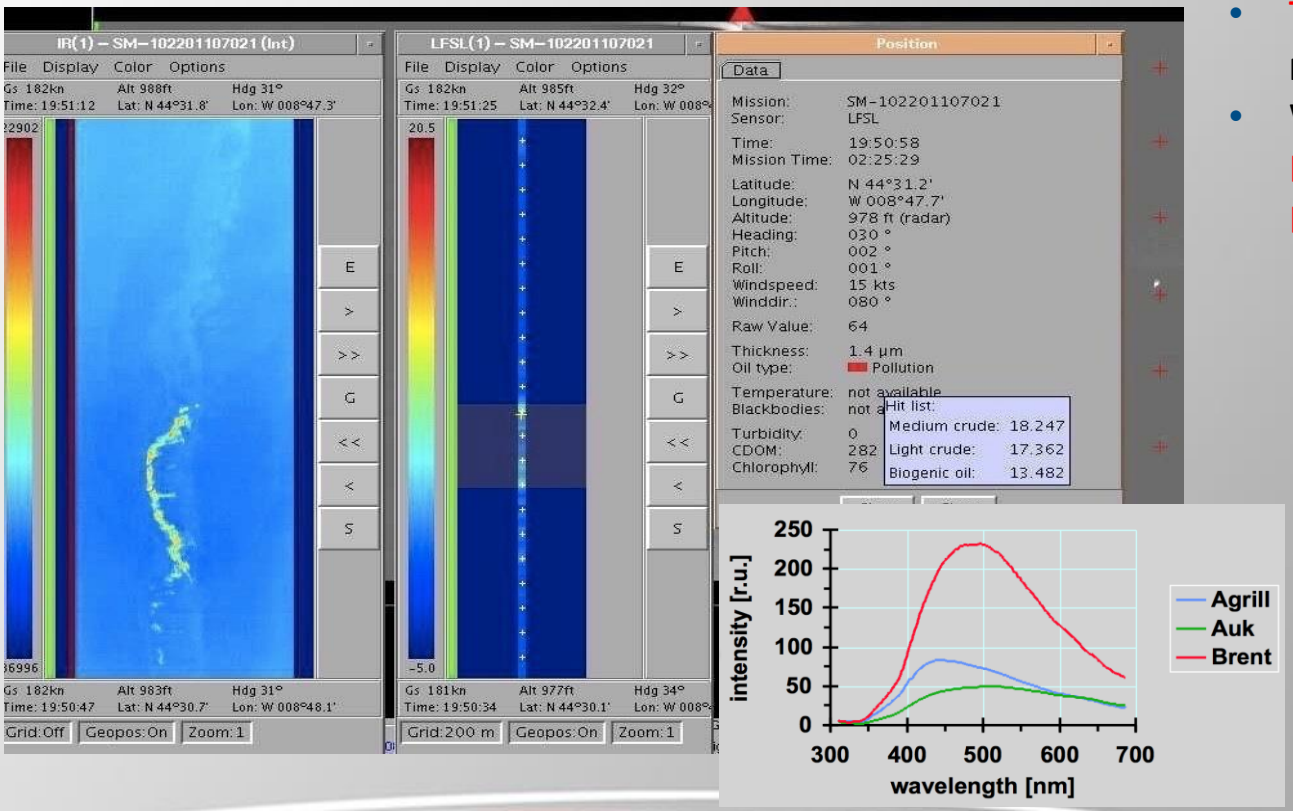


***90% of the Volume** of the oil is concentrated in **10% of the Area** covered by oil*

The Quantitative Approach

STEP 2 - Near Range Analysis

LFS – Laser Fluorosensor

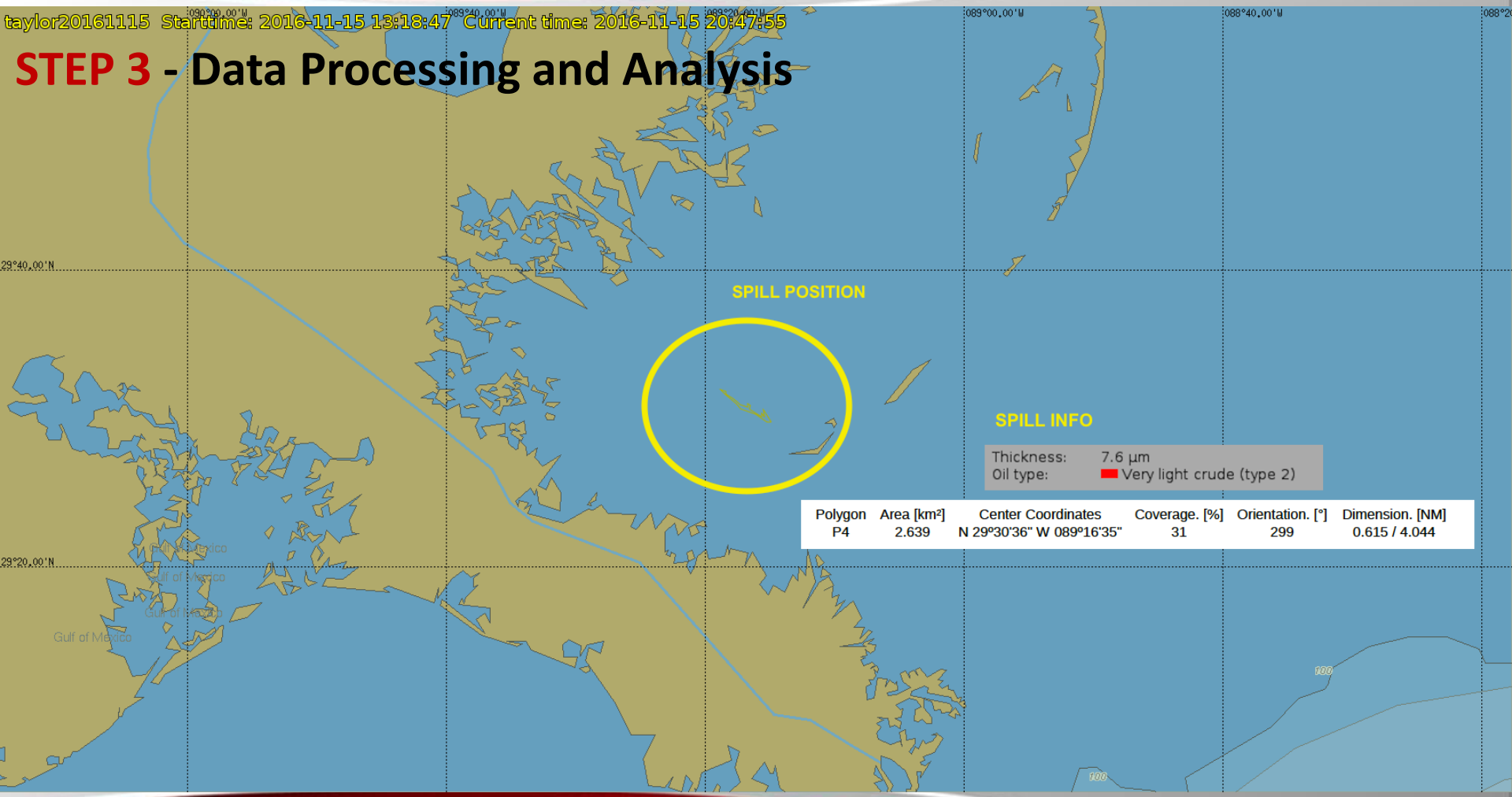


- Day and night / all-weather
- Classification of Oil Type based on the fluorescence of the substances
- Thickness (0.1 µm to 20 µm) measurement and volume estimate
- Weathering info to support Dispersant application and in-situ Burning

BILGE OIL
DIESEL
LUBRICATING OIL
LIGHT REFINED
VERY LIGHT REFINED
VERY LIGHT CRUDE (TYPE I)
VERY LIGHT CRUDE (TYPE II)
LIGHT CRUDE
MEDIUM CRUDE
HEAVY CRUDE
SEA WATER
TURBIDITY
BIOGENIC OIL
CHLOROPHYLL *A*

The Quantitative Approach

STEP 3 - Data Processing and Analysis



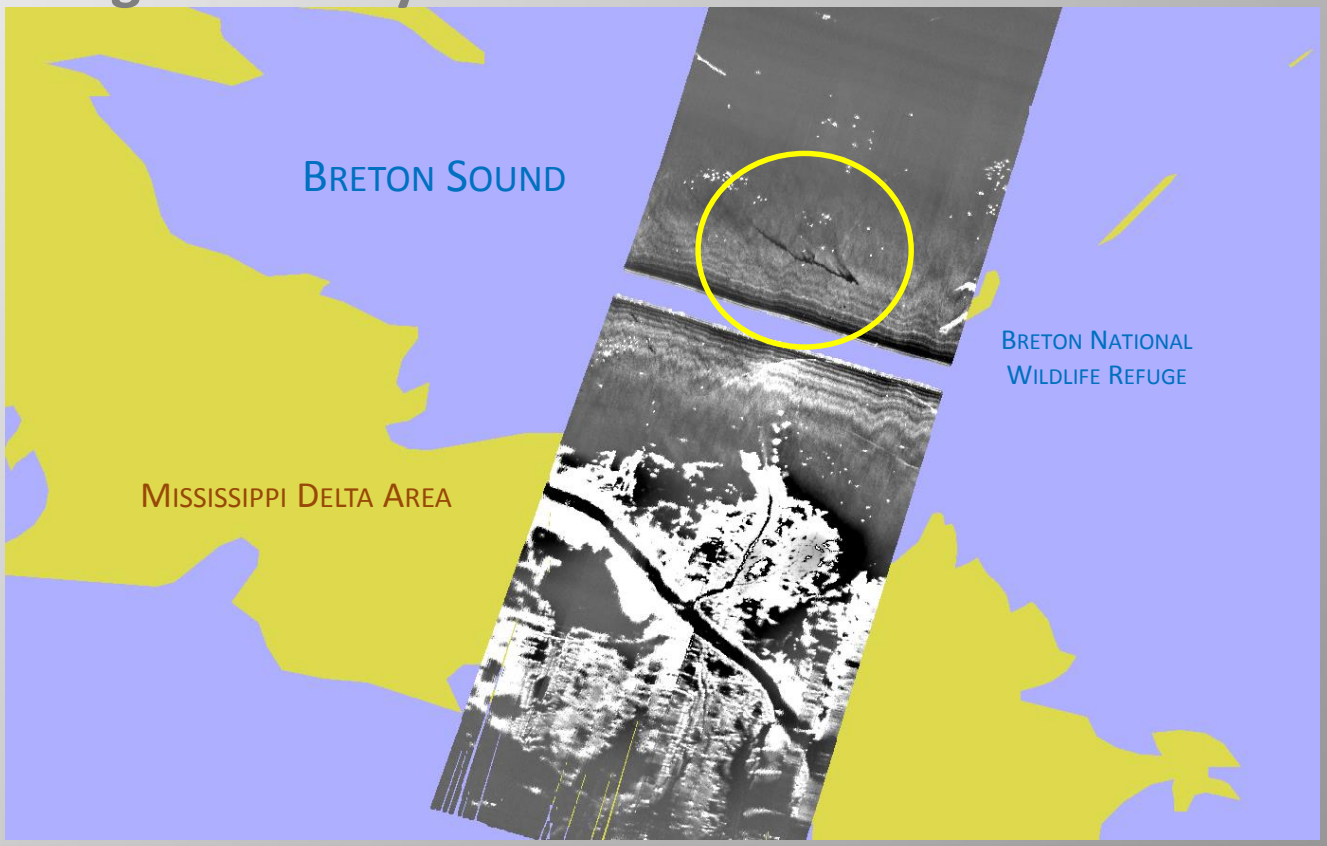
The Quantitative Approach

STEP 3 - Data Processing and Analysis

GEOREFERENCING

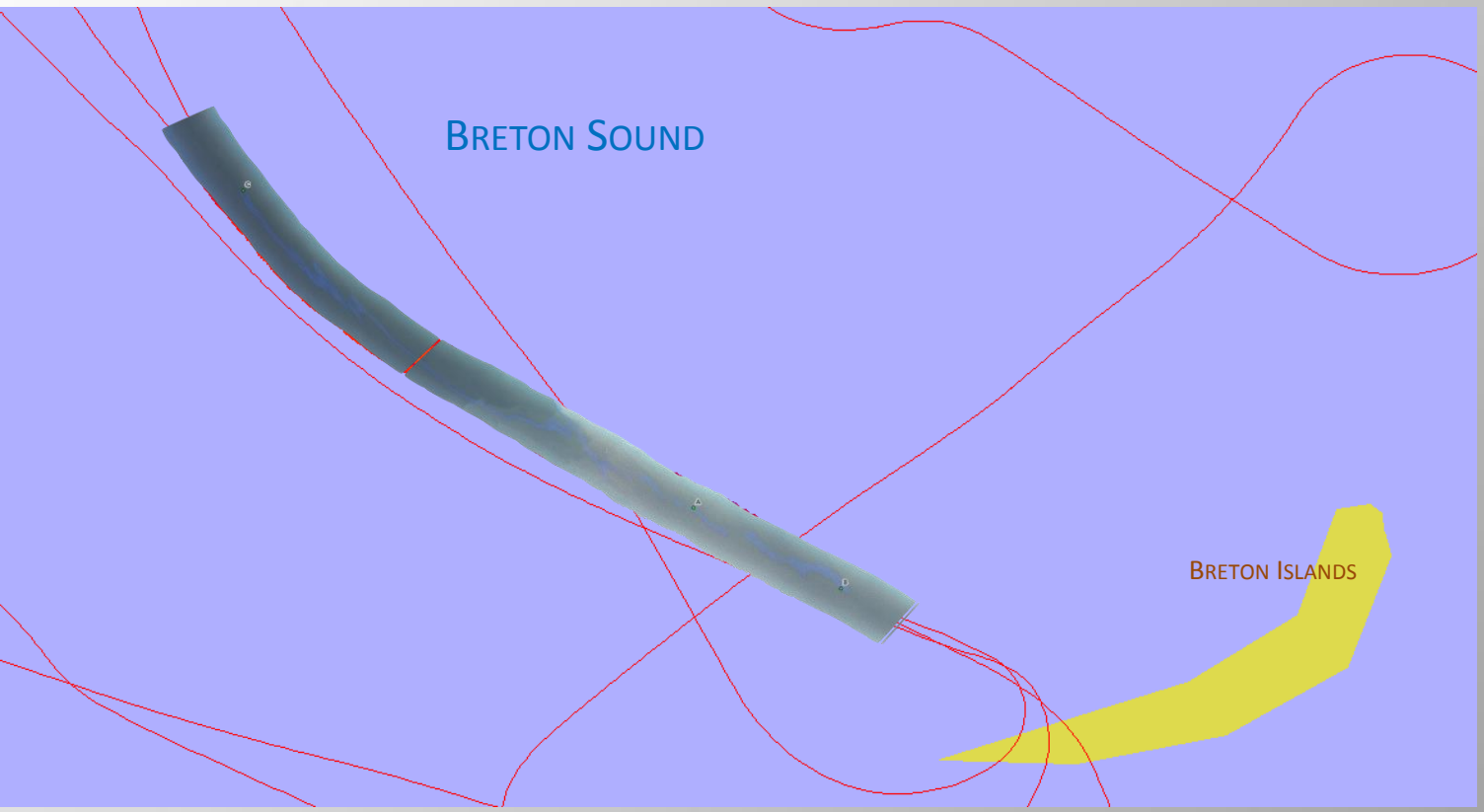
DRIFT / SPREADING ANALYSIS

DATA FUSION OF AIS DATA, SATELLITE IMAGERY, SLAR DATA IN GIS ENVIRONMENT



The Quantitative Approach

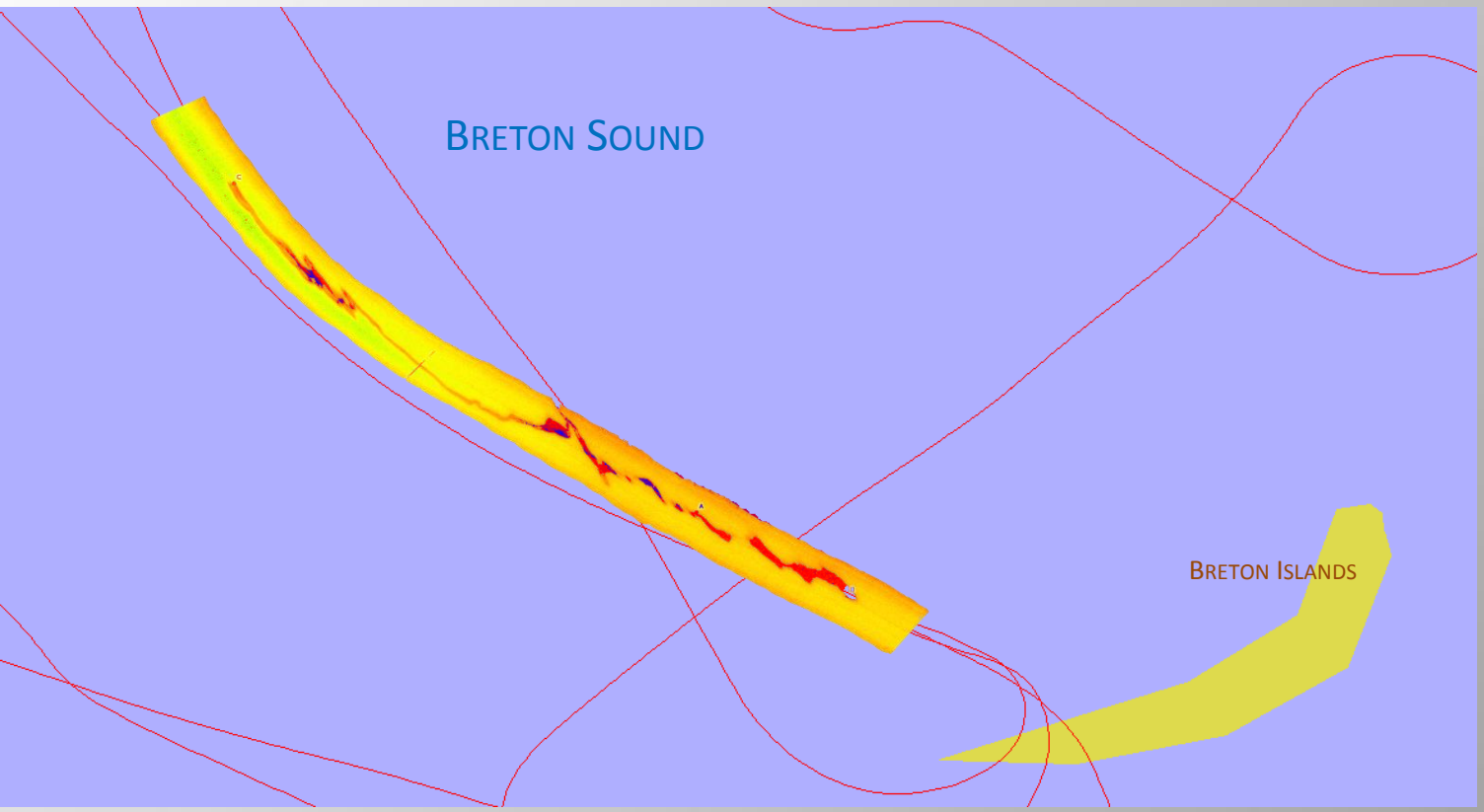
STEP 3 - Data Processing and Analysis



- Georefering and Geopositioning of all sensor Data.
- This is the **VIS** image of the actual spill geopositioned along the route.

The Quantitative Approach

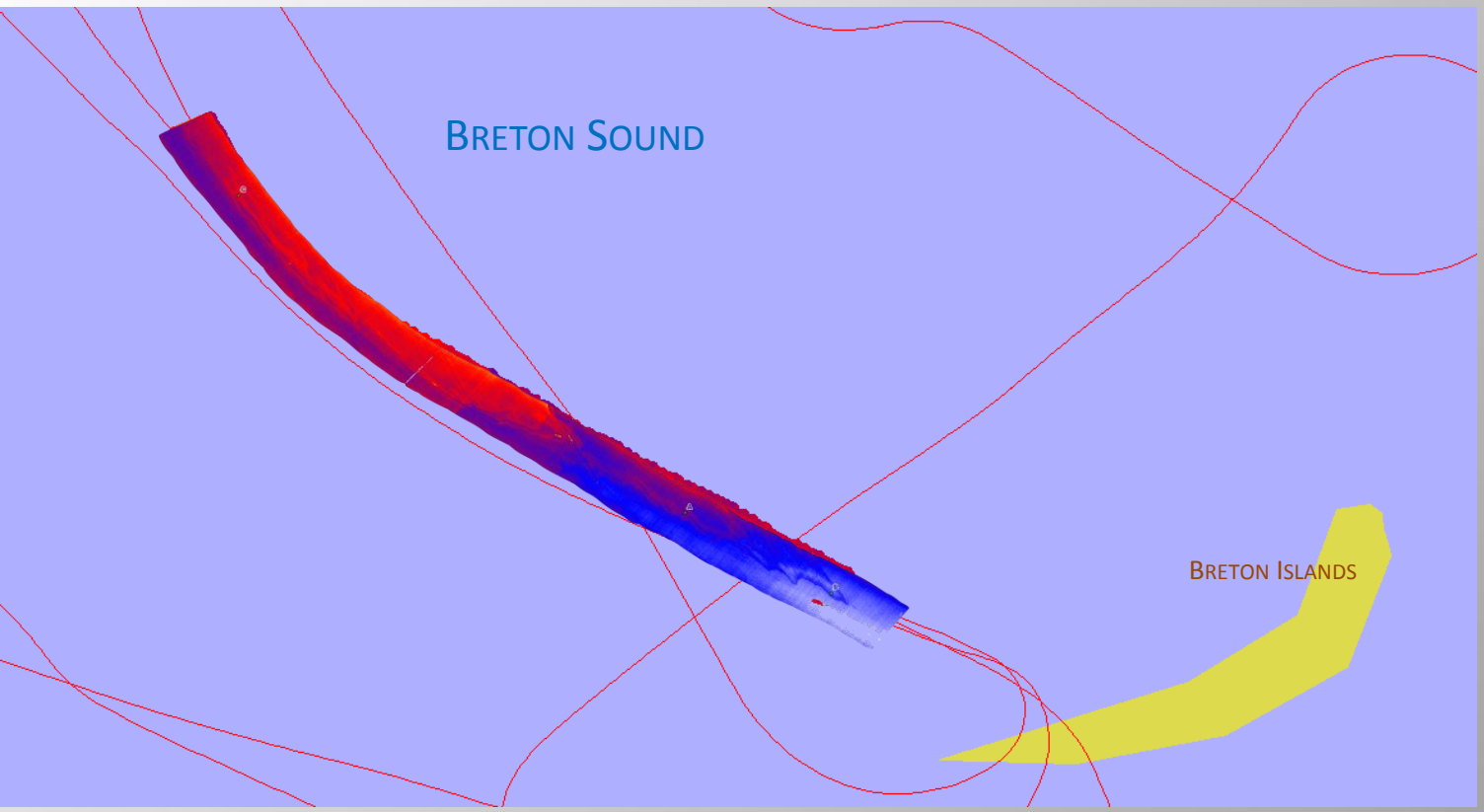
STEP 3 - Data Processing and Analysis



- Georefering and Geopositioning of all sensor Data.
- This is the **UV** image of the actual spill geopositioned along the route.

The Quantitative Approach

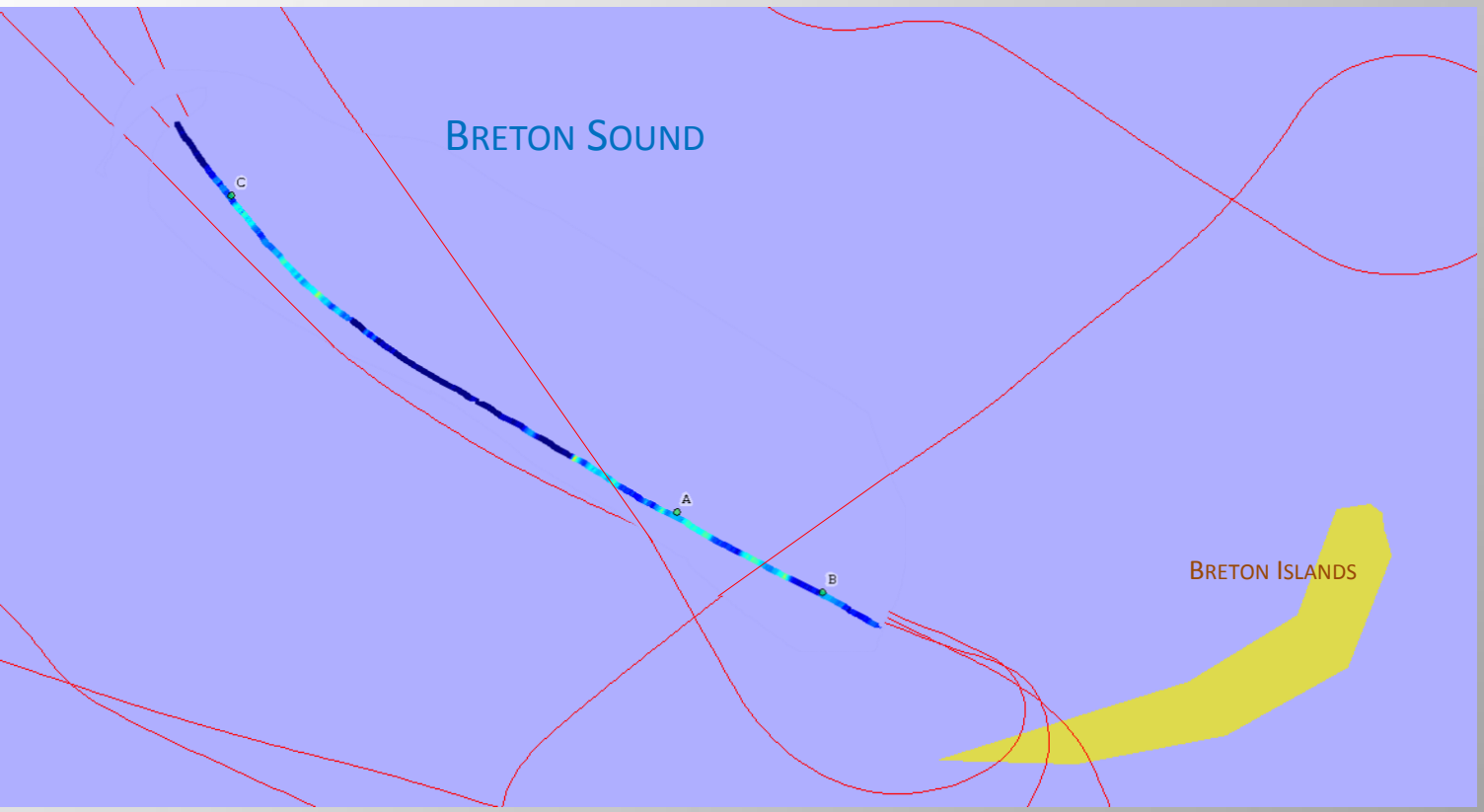
STEP 3 - Data Processing and Analysis



- Georefering and Geopositioning of all sensor Data.
- This is the **IR** image of the actual spill geopositioned along the route.

The Quantitative Approach

STEP 3 - Data Processing and Analysis

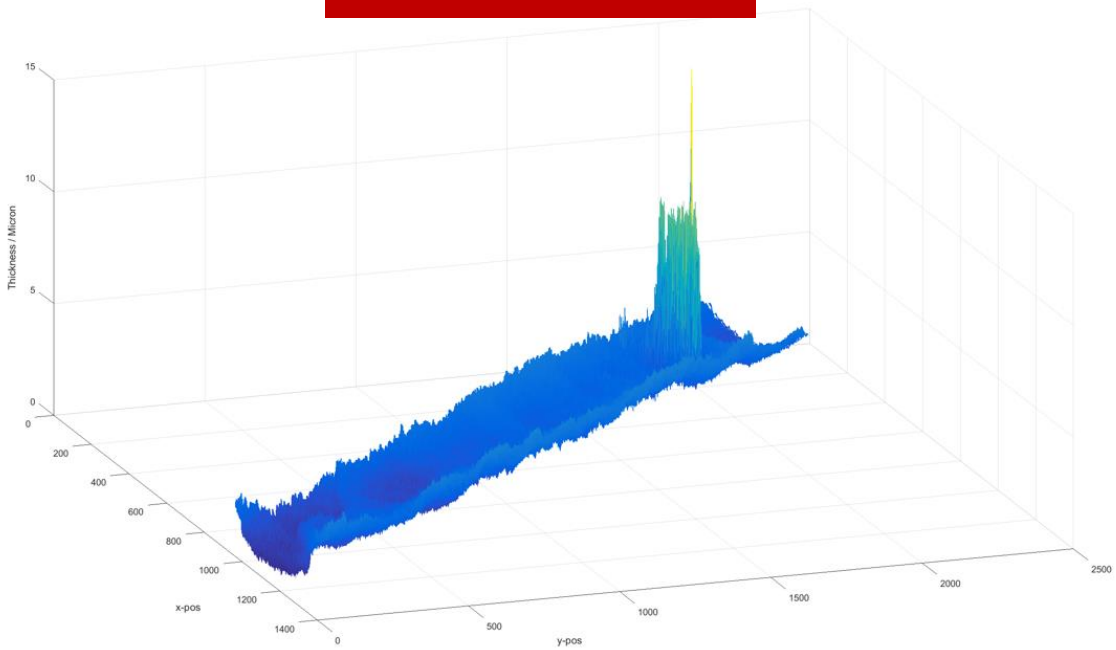


- GEOREFERING AND GEOPOSITIONING OF ALL SENSOR DATA.
- THIS IS THE **LFS** IMAGE OF THE ACTUAL SPILL GEOPOSITIONED ALONG THE ROUTE.

The Quantitative Approach

STEP 3 - Data Processing and Analysis

3D Thickness Map



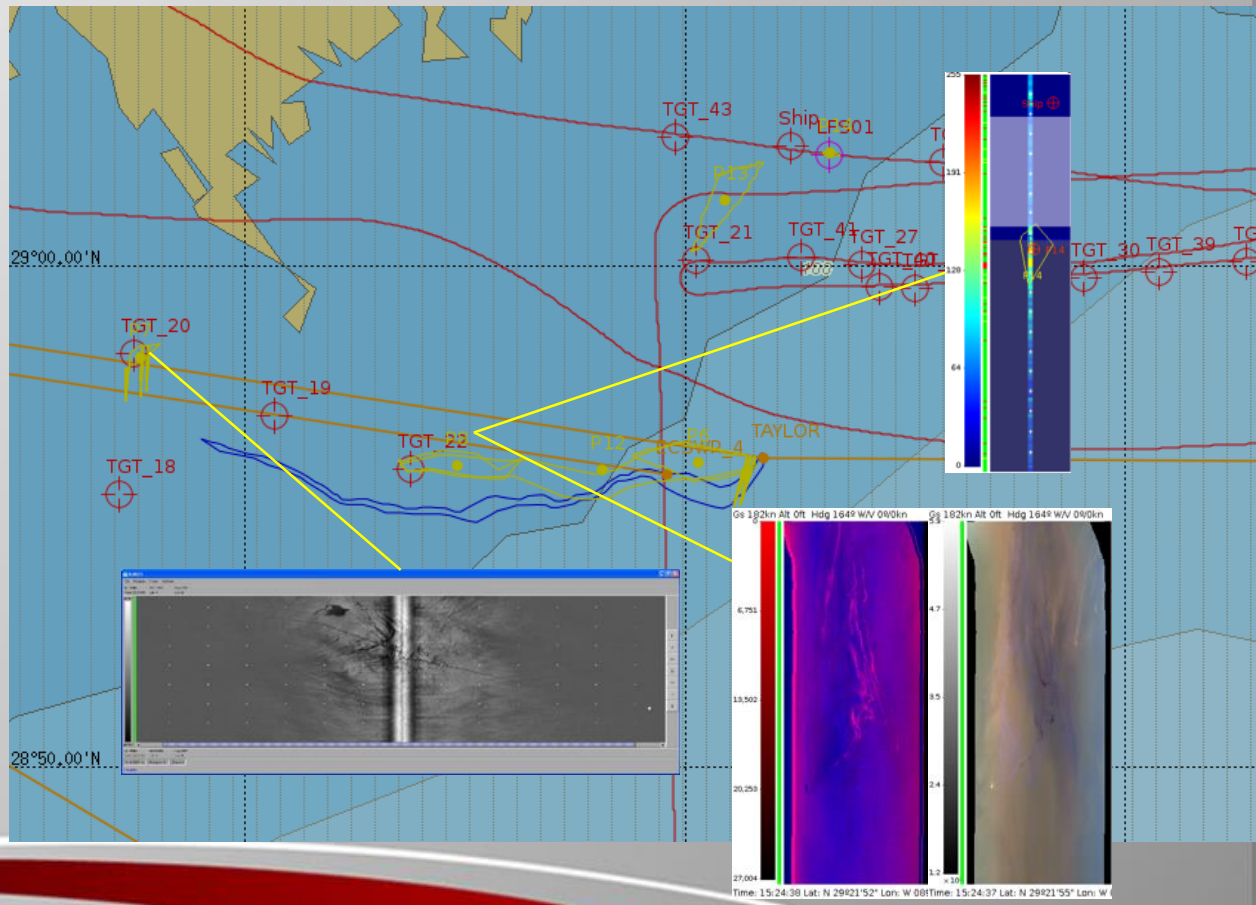
- The thickness map is originated with data acquired with **IR/UV, MWR** (20Hz scan frequency) and **LFS** (10Hz repetition rate) that measured the absolute thickness.
- Thickness data point are acquired every 4-9m (12-30ft).

The Quantitative Approach

STEP 3 - Data Processing and Analysis

GIS Web Platform

- The data from Poseidon are converted into GIS usable formats like shape files (lines, polygons, points) and GeoTiff (images). Other formats are available.
- Poseidon data are made continuously available in a WebMap server;



The Quantitative Approach

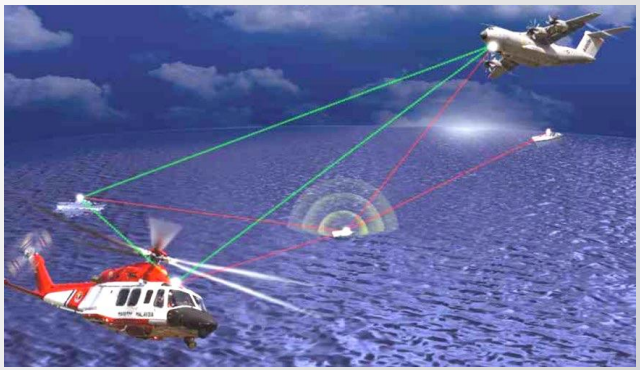
STEP 4 – Information Delivery

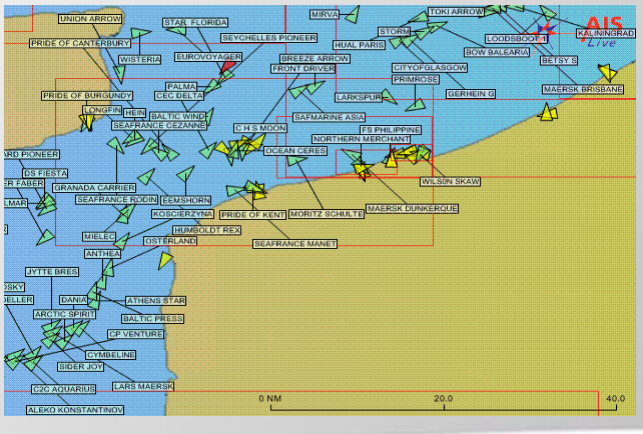
COMMUNICATION NETWORK

- HIGH-SPEED AND HIGH CAPACITY DIGITAL RADIO LINK – MBR
- SATELLITE LINK

The Quantitative Approach

SAR - Search and Rescue support





Poseidon integrates unique capabilities to assist in airborne search-and-rescue (SAR) missions. Including

- **DF** - Direction Finder
- **AIS** - Automatic Identification System
- **EO/IR** - Electro Optical Infrared
- **SLAR** - Side Looking Airborne Radar

- Mission management
- High Speed Data Link
- SatCom
- Maritime/Aero Radio

The Quantitative Approach

Aircraft Platform

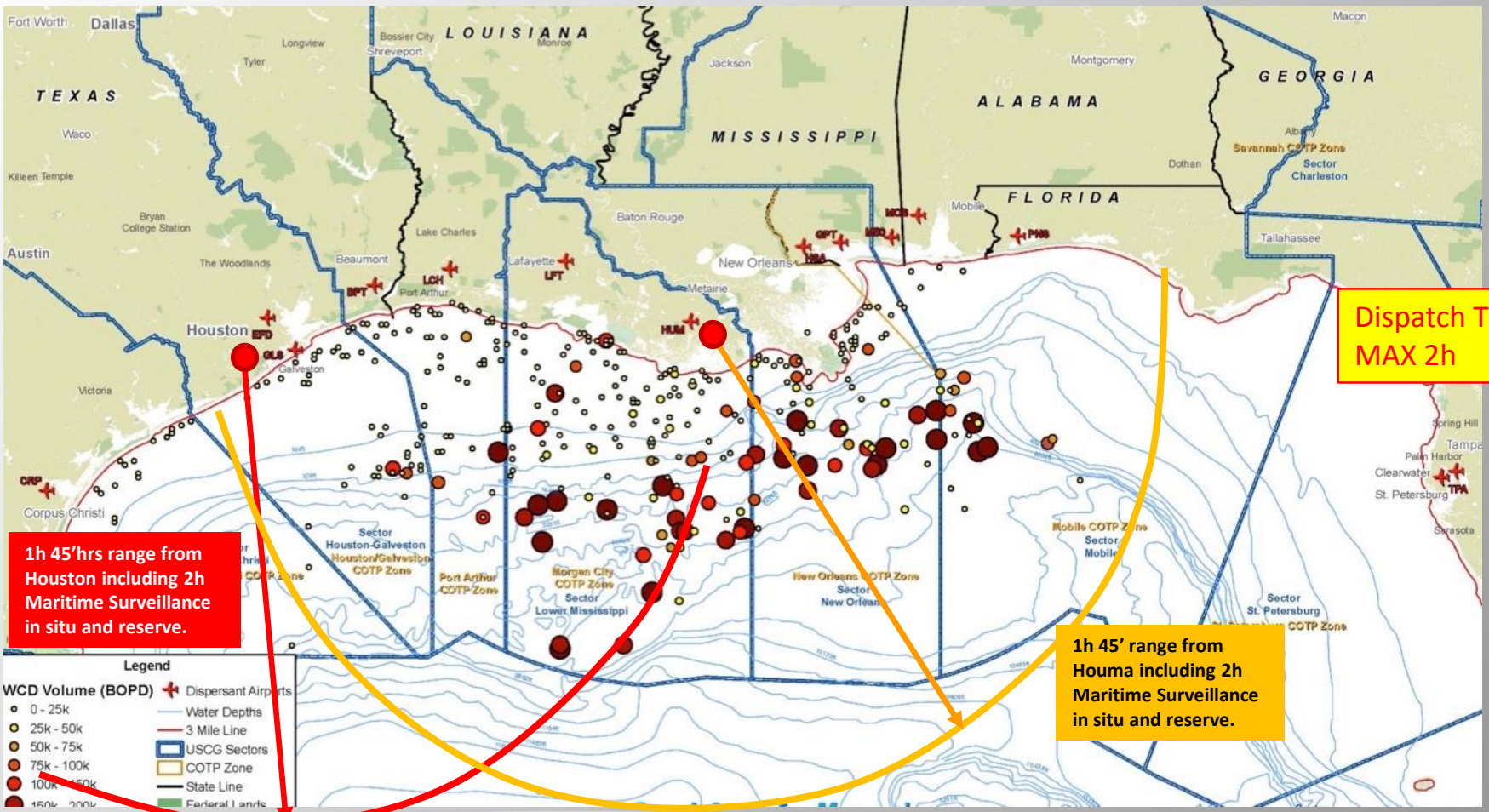
- Dispatch time **2 hrs**.
- Total Time on Mission **5h.**
- Capability to fly up to **1500 hrs per year**.
- The aircraft operational from **Houston, TX**.
- Redeployment in less than **8 hours** everywhere in US

	Embraer EMB 110 P1
Length	49 FT 6½ IN
Wingspan	50 FT 3½ IN
Empty Weight	7,480 LB
Max TO Weight	12,500 LB
Cruise Speed	184 KTS
Range with 45' reserve	900 NM
Service ceiling	21,500 FT
Powerplant	2 X PW PT6A-34 TURBOPROP 750 SHP EACH

The Quantitative Approach

Range of Operations

The Quantitative Approach



The Quantitative Approach

PRODUCTIVITY

FAR RANGE DETECTION

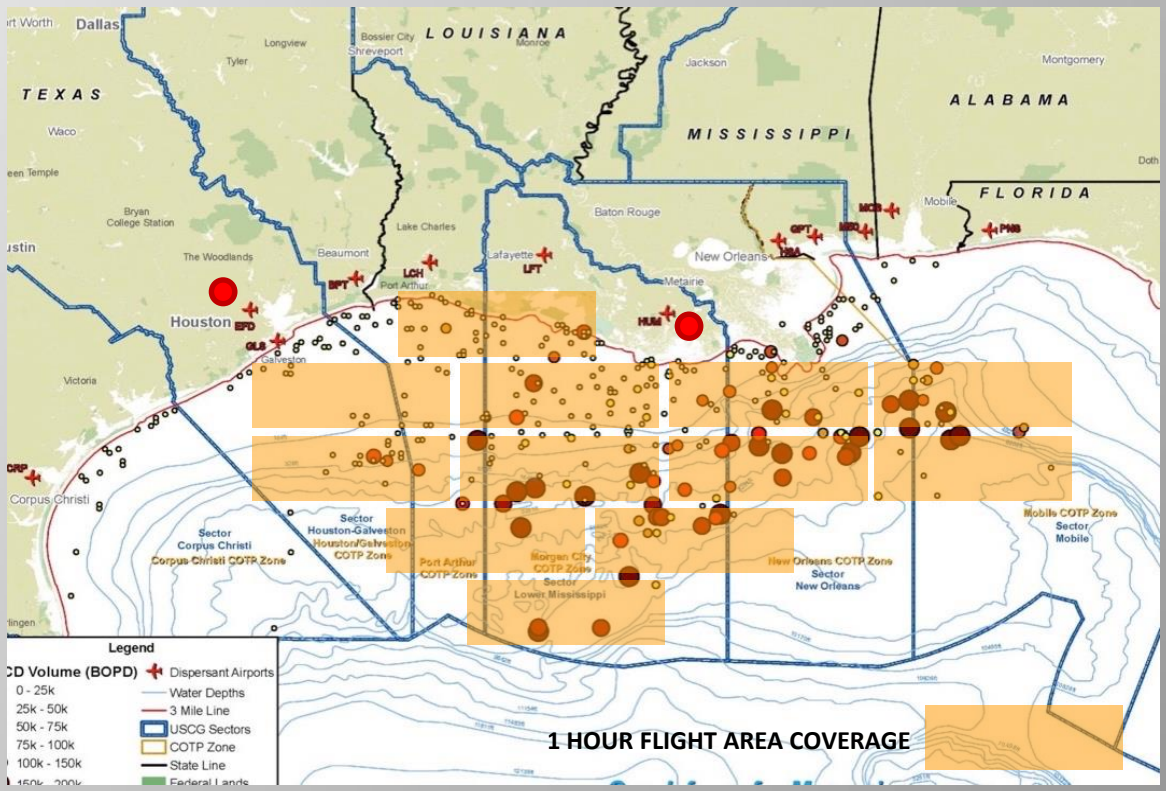
AIRBORNE PLATFORM
ca.50 NM @ 150 kts
7500 Sq NM/hr

VESSEL
ca.3.5 NM @ 10 kts
35 Sq NM/hr

NEAR RANGE ANALYSIS

AIRBORNE PLATFORM
Swath 2-6000 ft @ 150 kts
45-150 Sq NM/hr

VESSEL
Stationary – 2NM radius max



Fototerra

THANK YOU !

Alessandro Vagata | *Director of Operations – Fototerra Aerial Survey LLC*
alessandro@fototerra-survey.com | +1 (832) 318-3314

Benefits

Response

- Multi-sensor, Far/Near Range Aerial observation allows to obtain a clear, **quantitative picture of the scene, based on facts**.
- Availability of Real time, processed, quantitative information allows the responders to build a **Common Operating Picture**, to understand the scenario, to develop the best strategies and tactics to respond, and to control the outcomes.
- Accurate information allows responders to pinpoint the response, therefore **Reducing Costs** and **Improve Safety** through timely and effective utilization of the assets on the scene;
- Enforcement actions based on **objective**, **quantitative information**. RP can present **facts** in Legal Disputes.
- Natural Resource Damage **Assessment** and **Verification** of effectiveness of restoration plans.

Benefits

Preparedness

- Periodic and planned surveillance flights allow assessment and quantification of oil spills in the **early stages**.
- Pro-active surveillance programs provide response staff with **familiarity** on the capabilities and limitations of the methods employed.
- Exercises involving airborne platforms help to **insure readiness** and **increase the confidence** that the responder community is prepared to respond immediately and effectively in the event of a spill.
- Monitoring of coastal water or ship traffic discharges to **secure evidence** in legal disputes.
- Showing of **Leadership** adopting the most advanced technologies to manage potential significant risks for the human health and the environment.