



INFORMATION SYSTEMS

Improving Oil Trajectory Models with the Addition of RADARSAT-2 Data

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Outline

- Overview of study objectives
- RADARSAT-2 data
- OSCAR model
- Results
- RADARSAT Constellation Mission for oil slick detection

Introduction

- In general, trajectory models tend to diverge from reality after ~ 24 hours from initialization, but these models can be re-initialized if an external source of data is added, specifically the spatial extent of the spill from satellite imagery.
- To assess of idea of adding satellite imagery, RADARSAT-2 data, acquired at the onset and during the duration of spill that occurred in 2011.
- The oil spill was clearly discernable in the image, with little or no ambiguity as to the spatial extent which resulted in a high degree of confidence that the RADARSAT-2-derived extent was reliable.
- The OSCAR trajectory model was used to model the spill, and the spill extent from the RADARSAT-2 imagery was added to the model with the aim to assess the improvements in the model performance.

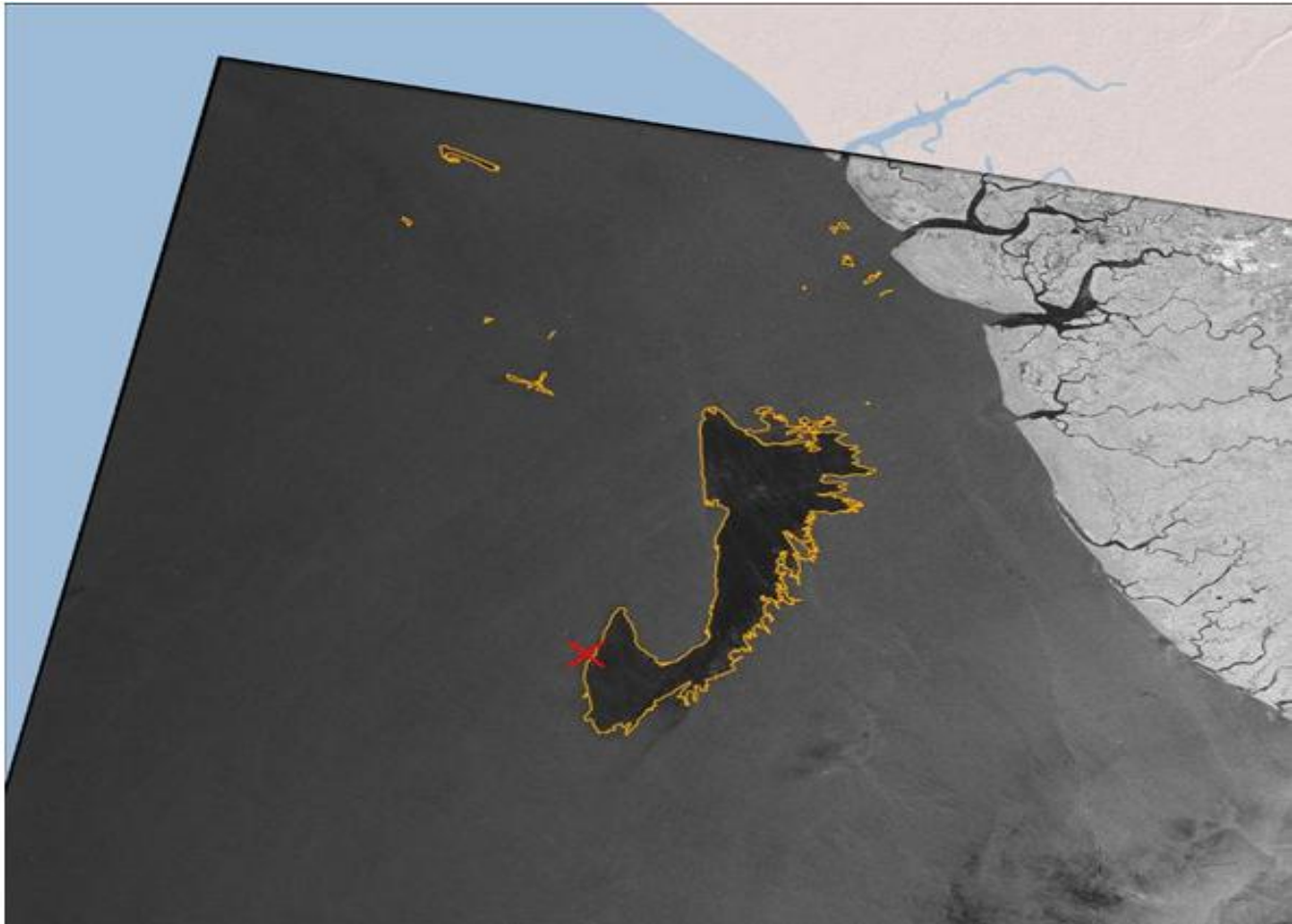
Spill Chronology and Data Acquisition

Date (2011)	Time (UTC)	Event/SAR Data	Time On Surface (hrs)	Comment
Dec 20	03:00	Start of spill	n/a	No imagery
Dec 20	~11:40	Oil reached ocean surface	0	No imagery
Dec 21	05:57	RADARSAT-2	+ 18	
Dec 22	05:28	RADARSAT-2	+41.5	
Dec 22	~12:00	Leak stopped	+48	No imagery
Dec 22	~15:00	Last of oil reached ocean surface	+51	No imagery. The area is the estimated maximum extent of the oil.
Dec 22	18:06	RADARSAT-2	+54	Entire oil spill was not imaged, so the area is less than actual.
Dec 24	06:10	RADARSAT-2	+90	
Dec 25	05:41	RADARSAT-2	+114	First evidence of oil at the shoreline. Entire oil spill was not imaged, so the area was not calculated/

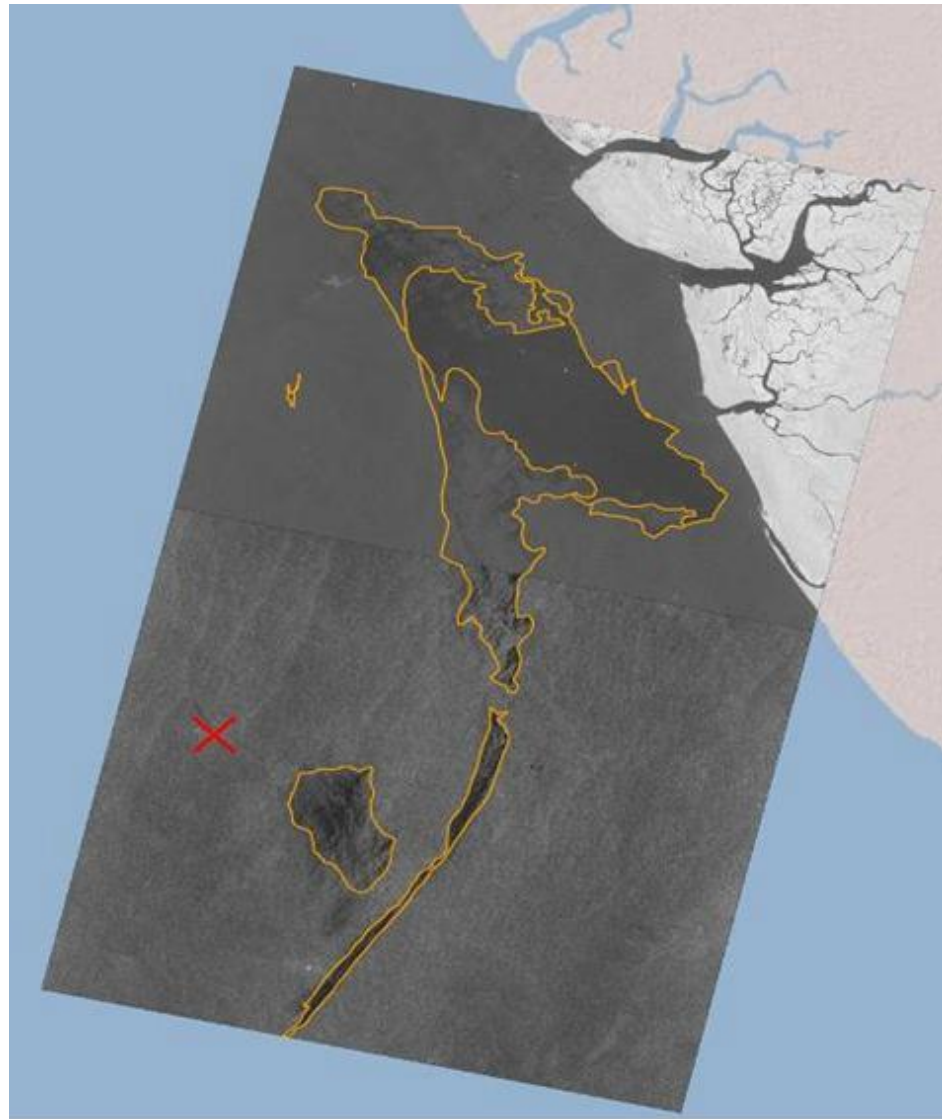
The dates highlighted in yellow were used for the trajectory modelling.



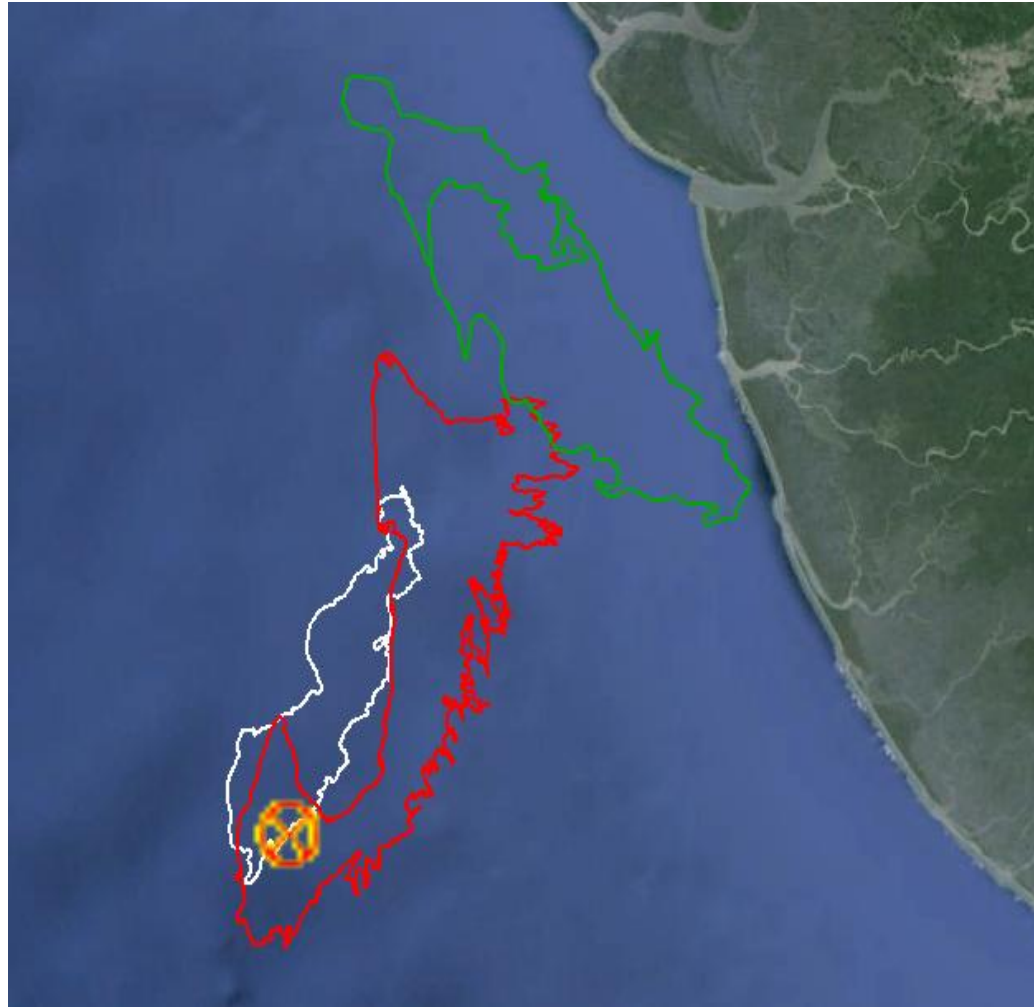
Dec 21 RADARSAT-2 ScanSAR Narrow (50 m res) (05:52 UTC)
Oil on ocean surface for 18 hrs.



Dec 22 RADARSAT-2 ScanSAR Narrow (50 m res)(05:58 UTC)
Oil on ocean surface for 41.5 hrs.



Dec 24 RADARSAT-2 Standard 7 (25 m res) (05:28 UTC)
Oil on ocean surface for 90 hrs.



Spatial extent of the oil from Dec 21, Dec 22, and Dec 24 RADARSAT-2 imagery

OSCAR

- The OSCAR (Oil Spill Contingency and Response) model provides:
 - Response and analysis;
 - Contingency planning;
 - Analysis of biological impacts;
 - Stochastic risk analysis.

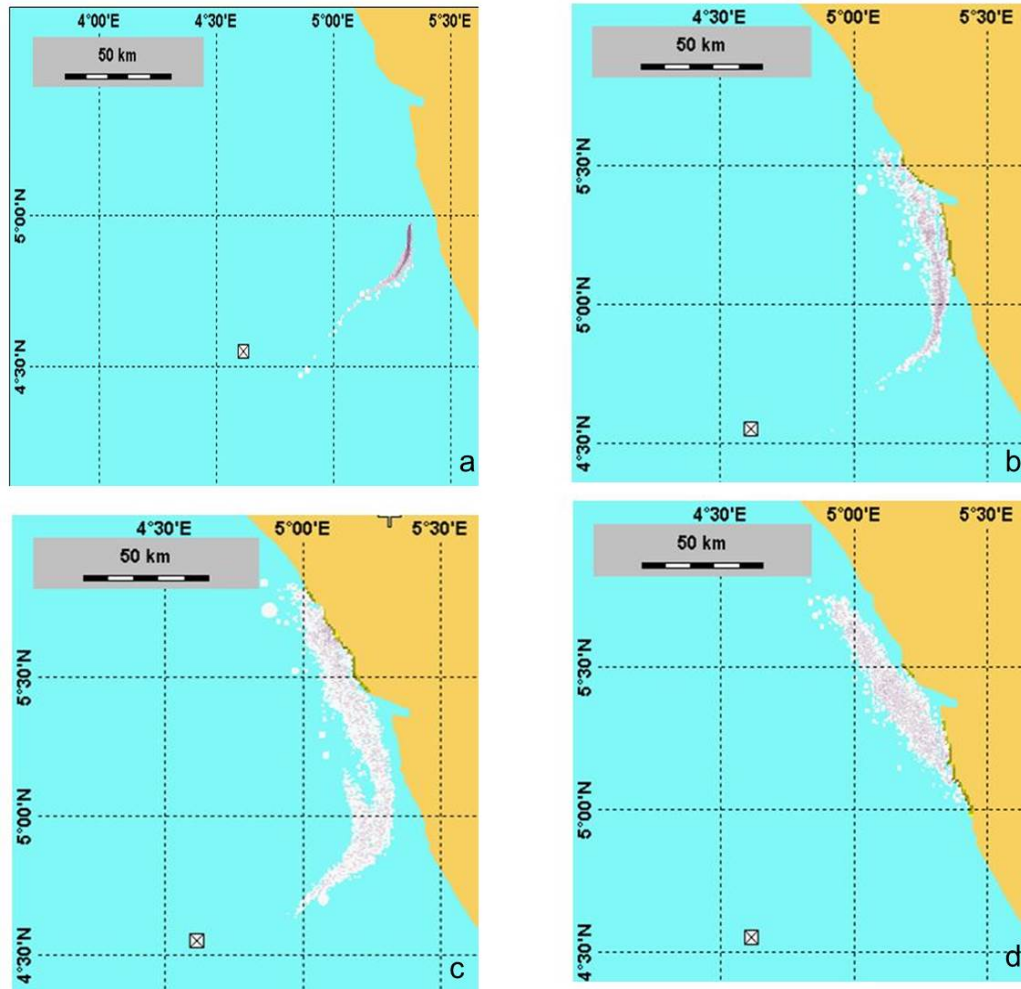
- Model input parameters include:
 - Spill details (time, volume, etc.)
 - Oil characteristics
 - Ocean currents
 - Wind

OSCAR in Action

- The OSCAR model was run using four different scenarios. Run 1 was without RADARSAT-2 data, but for each subsequent run, a RADARSAT-2 image was added, and the model-run continued
- The model started on Dec 20 at 14:00 UTC and finished on Dec 25 at 14:00 UTC

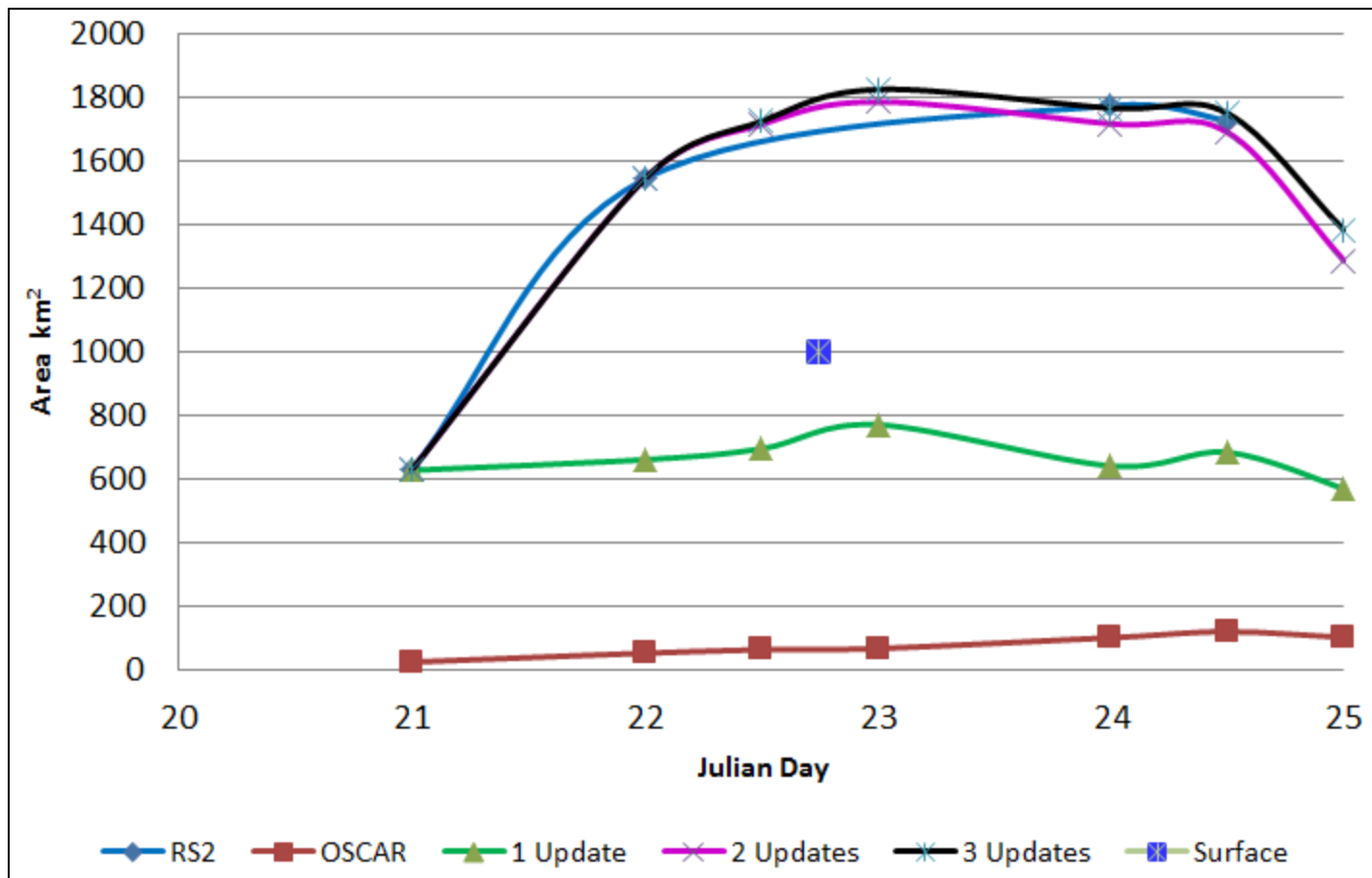
Run	RADARSAT-2 Oil Spill Extent	OSCAR Inputs
1	No RADARSAT-2 data	<ul style="list-style-type: none"> - Metocean data: wind, currents, etc. updated with forecasts - Oil properties
2	December 21 at 05:58 UTC	<ul style="list-style-type: none"> - Same as above.
3	December 21 at 05:58 and December 22 at 05:28 UTC	<ul style="list-style-type: none"> - Same as above
4	December 21 at 05:58, December 22 at 05:28, and December 24 at 06:10.	<ul style="list-style-type: none"> - Same as above

Comparison of Spill Location at End of Model Run



Final location of the oil spill on December 25 (end of model run) for (a) no RADARSAT-2 image, (b) one image, (c) two images, and (d) three images.

Spill Area from Model Runs

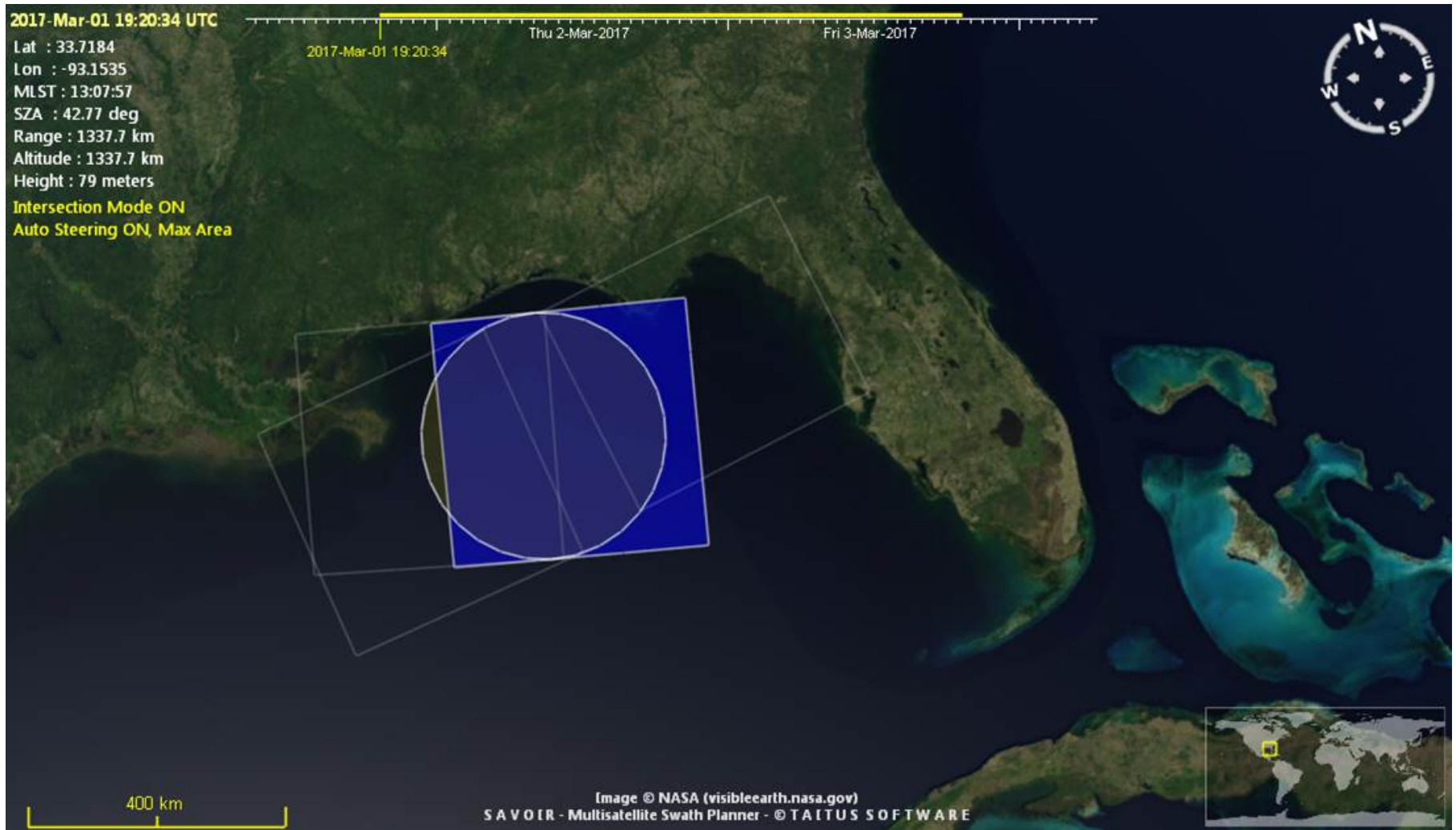


- RADARSAT-2 (RADARSAT-2 data only)
- OSCAR (model only from Dec 20 14:00 UTC to Dec 25 14:00 UTC)
- Surface: estimated time when all oil had reached the surface

Looking Forward

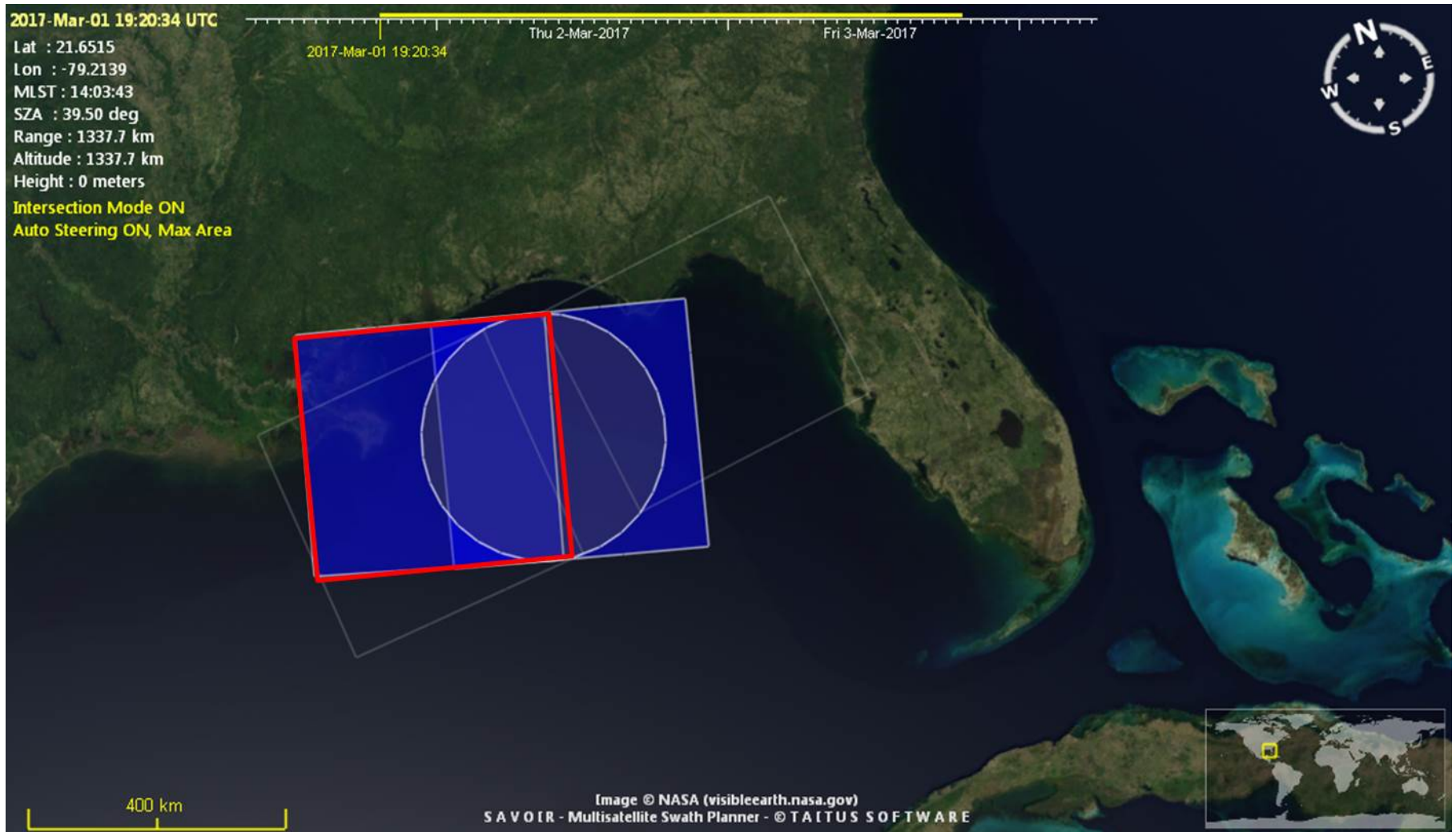
- The RADARSAT Constellation Mission (RCM) is the next generation of Canadian SAR satellites that has a strong focus on maritime surveillance
- A constellation of three RADARSAT-2 like SAR satellites scheduled for a July 2018 launch → three at once, so all or nothing!
- Benefits for oil spill detection and monitoring:
 - Compact polarimetry modes that provide increased polarimetric information with-respect-to dual polarized modes, but without a reduction in swath width;
 - Doppler grid so ocean currents can be extracted;
 - Daily imaging at the equator and more frequent imaging with increasing latitude, so better than every 2-3 days for RADARSAT-2 at mid-latitudes.

Example of Three-Satellite Coverage for 36 Hours



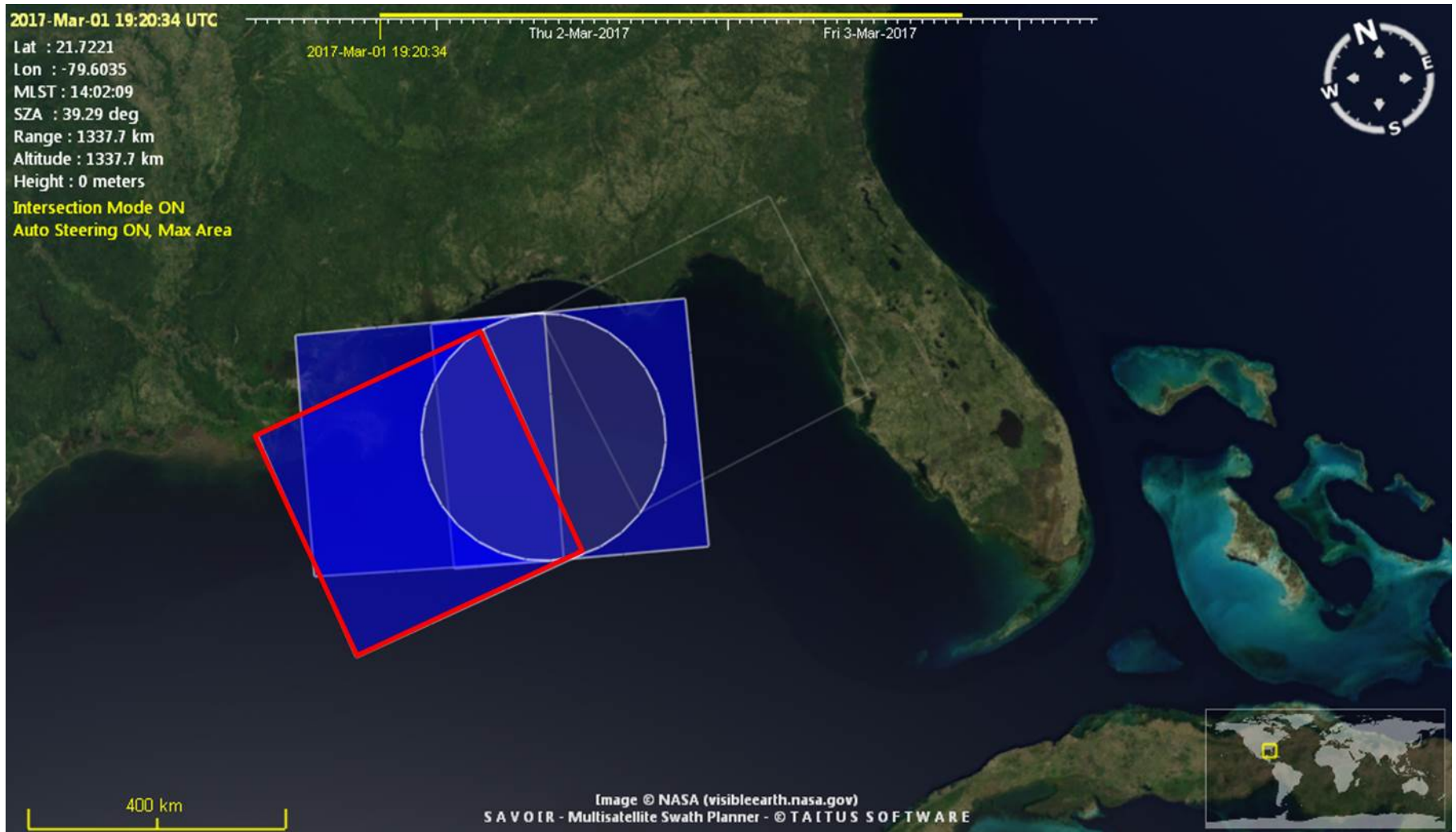
March 1 23:58 UTC

Example of Three-Satellite Coverage for 36 Hours



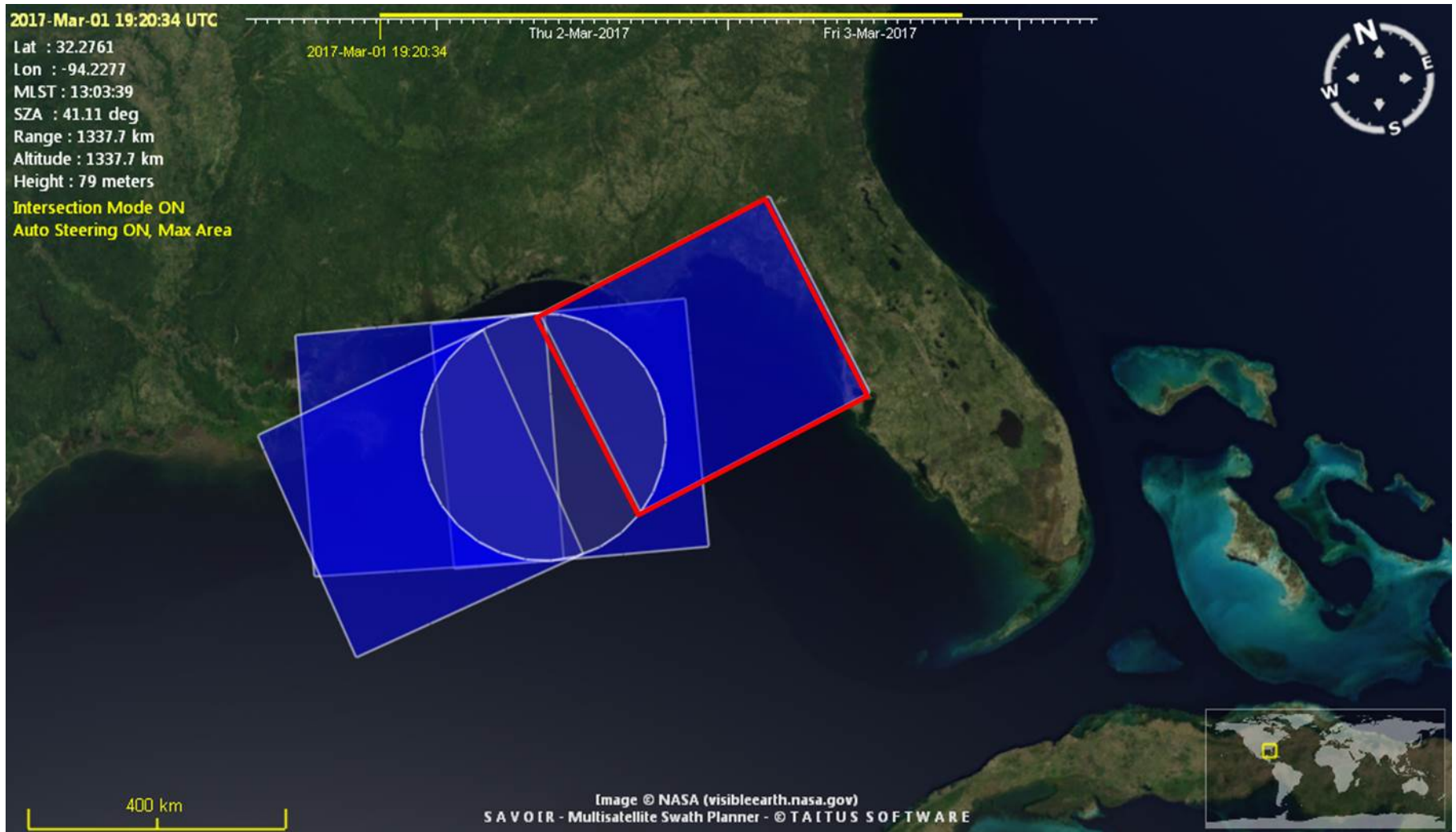
March 2 11:48 UTC

Example of Three-Satellite Coverage for 36 Hours



March 2 23:35 UTC

Example of Three-Satellite Coverage for 36 Hours



March 3 11:56 UTC

Summary

- The OSCAR model was initialized with the oil properties, wind, and currents and allowed to run for 5 days with and without the addition of the spill extent derived from RADARSAT-2.

- At the end of the 5 days, the spill area using 2 or 3 mages was similar to the area derived from RADARSAT-2, but significantly greater than using 1 or no images. The results suggest that:
 - The addition of satellite imagery improved the model performance;
 - The addition of imagery at the beginning of a spill can help to “tune” the model for local conditions;

- The forthcoming RADARSAT Constellation Mission provides enhanced capability to support oil spill response, but even with increased imaging, there may be gaps in spatial coverage hence the need to combine models and radar imagery.

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