Title: Detection of Natural Oil Seeps in the Atlantic Ocean using MODIS

Conference Venue: International Symposium on the A-Train Satellite Constellation 2010

Abstract Category: aerosols, clouds, hydrological cycle, and radiation

Abstract Format: Poster

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Abstract:

Natural oil seepage is the release of crude oil into the ocean from fissures in the seabed. Oil seepage is a major contributor to the total amount of oil entering the world's oceans. According to a 2003 study by the National Academy of Sciences (NAS), 47 percent of oil entering the world's oceans is from natural seeps, and 53 percent is from human sources (extraction, transportation, and consumption). Oil seeps cause smooth oil slicks to form on the water's surface. Oil seeps can indicate the location of stores of fossil fuel beneath the ocean floor. Knowledge of the effect of oil seepage on marine life and marine ecosystems remains limited. In the past, remote sensing has been used to detect oil seeps in the Gulf of Mexico and off of the coast of southern California. This project utilized sun glint MODIS imagery to locate oil slicks off of the Atlantic coast, an area that had not previously been surveyed for natural oil seeps using remote sensing. Since 1982, the Atlantic Ocean has been closed to any oil and gas drilling. Recently, however, the U.S. Minerals Management Services (MMS) has proposed a lease for oil and gas drilling off the coasts of Virginia and North Carolina. Determining the location of seepage sites in the Atlantic Ocean will help MMS locate potential deposits of oil and natural gas, thereby reducing the risk of leasing areas for petroleum extraction that do not contain these natural resources.

DEVELOP

Mid-Atlantic Water Resources and Ecological Forecasting

Detection of Natural Oil Seeps in the Atlantic Ocean using MODIS

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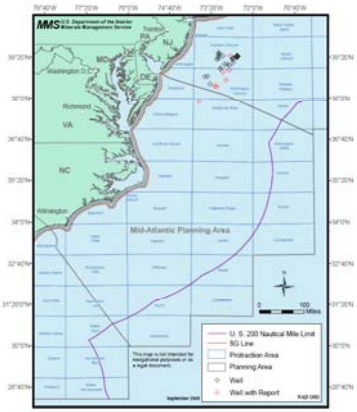
STUDY AREA

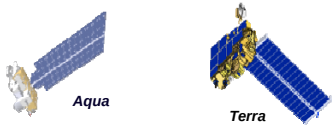


Map Credit: Minerals Management Service (MMS)

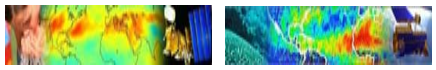
GOALS

- Provide enhanced methods for detecting natural oil seeps in the Atlantic Ocean using MODIS imagery
- Aid in the creation of an Environmental Impact Statement for the Minerals Management Service
- Create maps showing the location of natural oil seeps in the Mid-Atlantic Planning Area
- Demonstrate the usefulness of NASA EOS in oil seep detection

NASA MISSIONS



NATIONAL APPLICATIONS



Water Resources | Ecological Forecasting

ACKNOWLEDGEMENTS

Dr. Kenton Ross
Mr. Joe Spruce
Science Systems and Applications, Inc.
Dr. Alexis Lugo-Fernandez
Minerals Management Service

ABSTRACT

Natural oil seepage is the release of crude oil into the ocean from fissures in the seabed. Oil seepage is a major contributor to the total amount of oil entering the Atlantic Ocean. According to a 2003 study by the National Academy of Sciences (NAS), 47 percent of oil entering the world's oceans is from natural seeps, and 53 percent is from human sources (extraction, transportation, and consumption). Oil seeps cause smooth oil slicks to form on the water's surface and can indicate the location of stores of fossil fuel beneath the ocean floor. Knowledge of the effect of oil seepage on marine life and marine ecosystems is limited. In the past, remote sensing has been used to detect oil seeps in the Gulf of Mexico and off of the coast of southern California. This project utilized similar techniques with MODIS sun glint imagery to locate oil slicks off of the Atlantic coast, an area that had not previously been surveyed for natural oil seeps using remote sensing. Since 1982, the Atlantic Ocean has been closed to any oil and gas drilling. Recently, however, the U.S. Mineral Management Services (MMS) proposed a lease for oil and gas drilling off the coasts of Virginia and North Carolina. Determining the location of seepage sites in the Atlantic Ocean would help MMS locate potential deposits of oil and natural gas, thereby reducing the risk of leasing areas for petroleum extraction that do not contain these natural resources.

METHODS

Image Acquisition

- Level 1B data was obtained from LAADS Web (Level 1 and Atmosphere Archive and Distribution System) for 2008 and 2009.
- Level 1B products came calibrated and geolocated with 500m and 250m spatial resolutions.

Image Processing

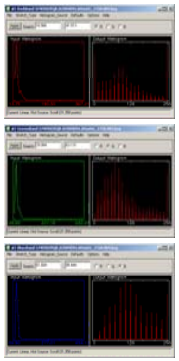
Matlab was used in conjunction with MRTSwath to automate the following tasks:

- Projecting to UTM Zone 18 North
- Resampling 500m pixels to 250m pixels
- Subsetting imagery to study area
- Layer stacking visible bands
- Masking cloud pixels

Image Analysis

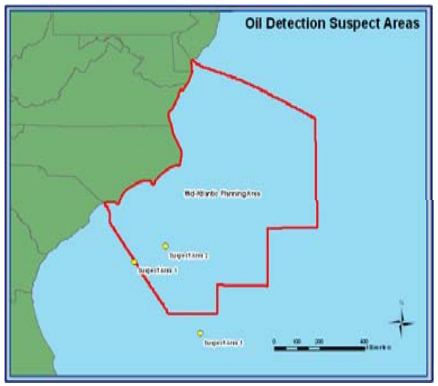
- ENVI Software was used for image display and interpretation.
- Contrast enhancement was applied to each scene.

Terra MODIS true-color composite image from April 4, 2009, with contrast enhancement applied. Black features represent cloud-masked pixels.



Example of histogram adjustments used in contrast enhancement

RESULTS



Suspect Area #1

Terra MODIS – April 25, 2009

Suspect Area #2

Terra MODIS – April 27, 2009

Suspect Area #3

Aqua MODIS – June 12, 2008

CONCLUSIONS

- No conclusive visual indications of natural oil seeps were detected.
- At least one ship trail oil slick was identified: *Aqua* MODIS – June 12, 2008
- Several images showed features which could be oil, but after analysis, none were identified with certainty as oil.

LIMITATIONS

- Frequent and extensive cloud cover over study area
- Seasonality of sun glint occurrence
- Coarse spatial resolution of the MODIS sensors
- Incomplete coverage of scene with sun glint

Terra MODIS true-color composite image from April 9, 2009.
Note the extent of black pixels, which have been masked due to cloud cover.

FURTHER RESEARCH

- Utilize spaceborne synthetic aperture radar data
- Apply the study to locations with known natural oil seeps in order to fine tune oil seep detection techniques

RELATED STUDIES

Adamo, M., G. De Carolis, V. De Pasquale, and G. Pasquariello (2007), Exploiting Sunglint signatures from MERIS and MODIS imagery in combination to SAR data to detect oil slicks. Proceedeings of "Envisat Symposium 2007," Montreaux, Switzerland.

Brekke, Camilla and Anne H.S. Solberg (2005), Oil spill detection by satellite remote sensing, *Remote Sensing of Environment*, 95 (2005) 1 – 13.

Hu, C., X. Li, W.G. Pichel, and F.E. Muller-Karger (2009), Detection of natural oil slicks in the NW Gulf of Mexico using MODIS imagery, *Geophys. Res. Lett.*, 36, L01604, doi:10.1029/2008GL036119.

NAS (2003), Oil in the sea III: inputs, fates, and effects. National Academy of Sciences, National Academy Press, Washington, D.C.