USING SAR TO ESTIMATE SPATIAL AND TEMPORAL VARIABILITY OF OIL OUTPUT FROM NATURAL HYDROCARBON SEEP FORMATIONS

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Introduction

Synthetic Aperture Radar (SAR) images have proven to be a reliable tool for localizing natural seepage of hydrocarbons [1]. Detection of oil in SAR data is sensitive to weather conditions and to sensor configurations. However, the archive of SAR data provides replicated coverage under similar weather and sensor configuration over areas of interest for investigating geology and ecology of natural hydrocarbon seeps. For this study, we used a Texture Classifier Neural Network Algorithm (TCNNA) [2,3] and a geostatistical clustering analysis, to understand SAR potential capabilities and limitations to detect different surfactant types from very well known seep sites (Figure 1). In addition a time series analysis is conducted to analyze temporal variability of oil output from natural hydrocarbon seep formations

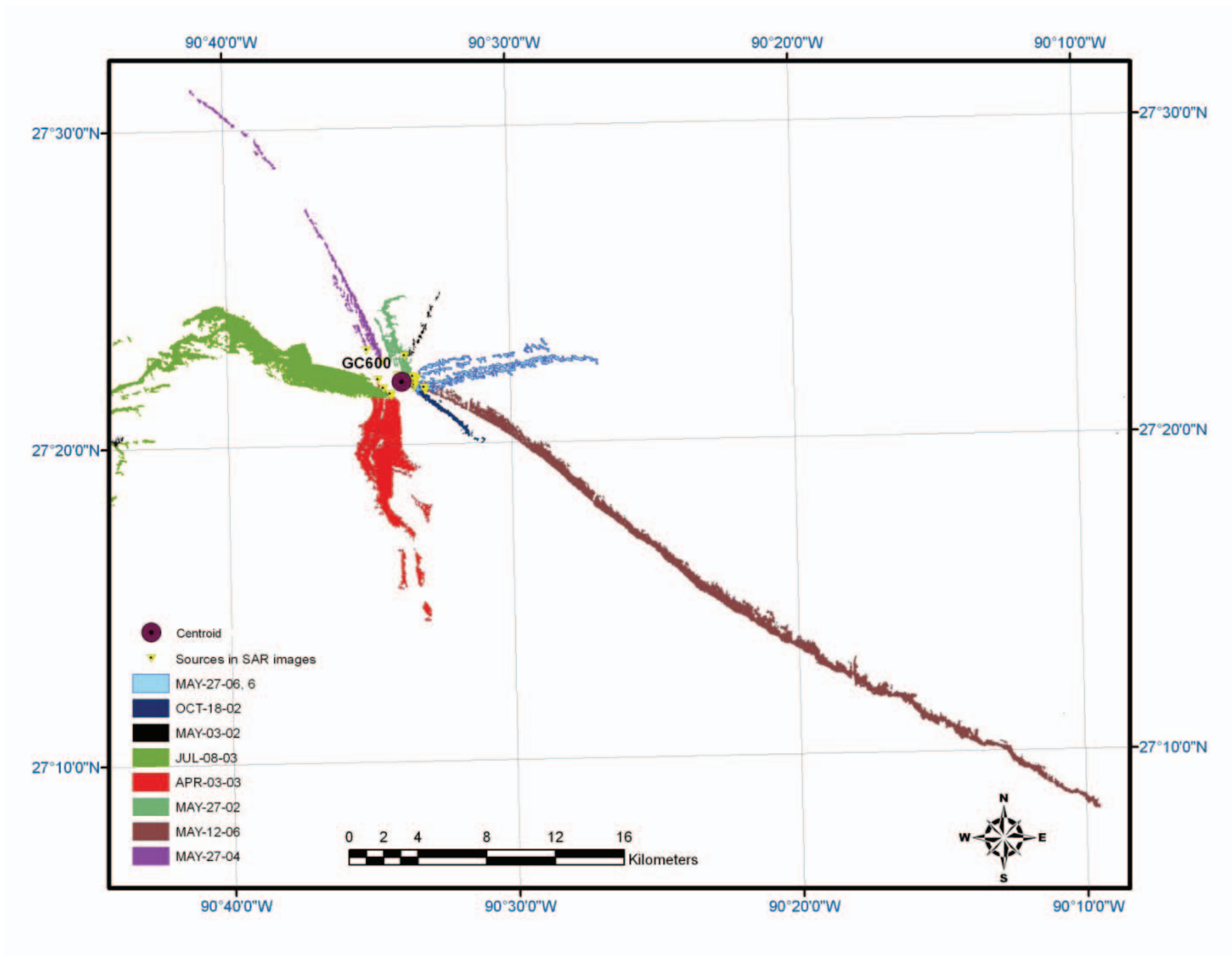

Figure 1. TCNNA outputs from multiple SAR images that covered GC600.

Seepage Flux and Cluster Analysis

In previous studies, with use of TCNNA, it was possible to search for floating oil slicks released from active seep formations by analyzing a large number SAR images from the Gulf of Mexico [4]. Persistent sources represent geologic formations defined by migrating hydrocarbons that may include multiple separate vents. A total of 559 formations were defined by repeated imaging; these comprised a maximum of 1995 and a minimum of 1263 individual vents. This total was distributed between U.S. territorial waters, with 481 formations, and Mexican territorial waters, with 78 formations. In many cases these sites could be compared to sites containing geophysical anomalies believed to be caused by focused fluid migration, i.e. seep formations. One of the most active seepage formation sites was detected inside the boundaries of MMS lease block GC600. In contrast, episodic releases of oil were detected inside the boundaries of MMS lease block MC118. These two sites have been subject to multi-year investigations using geophysical data, geochemical data, and ground truth observations with submersibles.

For this study, meteorological data, oceanographic data, TCNNA outputs, and geostatistical analyses of clusters of oil slicks and Oil Slick Origins (OSOs) are used to investigate the spatial and temporal variability of oil output from these two seep formations (MC118 and GC600). Our results indicate that the wind and incidence angle thresholds for natural hydrocarbon seepage detection it is dependent on the viscoelastic properties of the surfactant, therefore detection conditions vary from one seepage site to others, with lighter hydrocarbons able to be detected only within a narrower range of environment conditions. We can conclude that active oil seeps that can be detected with SAR represents only a subset of the total array of geophysical features generated by hydrocarbon migration on the northern continental slope of the Gulf of Mexico.

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[2] O. Garcia-Pineda, I. R. MacDonald, and B. Zimmer (2008), "Synthetic Aperture Radar Image Processing Using The Supervised Textural-Neural Network Classification Algorithm," *Proceedings of the IEEE 2008 International Geoscience and Remote Sensing Symposium (IGARSS'08), Boston, USA, 7-11 July. Vol. 4*. Issue 4. 1265-1268.

[3] O. Garcia-Pineda, B. Zimmer, M. Howard, W. G. Pichel, X. Li and I. R. MacDonald, "SAR Image Segmentation and Delineation of Oil Slicks with a Texture Classifying Neural Network Algorithm," *Canadian Journal of Remote Sensing*, in press, 2009.

[4] O Garcia-Pineda , I.R. MacDonald , B. Zimmer, W. Shedd, and M. Frye. Satellite SAR inventory of Gulf of Mexico oil seeps and shallow gas hydrates. Geophysical Research Abstracts, Vol. 11, EGU2009-11633, 2009. EGU General Assembly 2009.