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Satellite SAR inventory of Gulf of Mexico oil seeps and shallow gas hydrates

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Satellite synthetic aperture radar (SAR) images from the RADARSAT platform were used to detect and inventory persistent layers of oil released from natural seeps in the Gulf of Mexico. Previously published inventories of natural oil seeps in the Gulf have been limited in scope and have relied on manual interpretation of satellite images (Mitchell et al. 1999; De Beukelaer et al. 2003). We developed a texture classifying neural network algorithm (TCNNA) to rapidly identify floating oil-layers in a semi-supervised operation. Oil layers, known as slicks, were recognized as long (10 km), narrow (100 m), often curvilinear streaks with distinct points of origin where oil reaches the ocean surface. After training the TCNNA over known seep areas and under a range of environmental and viewing conditions, the procedure was applied to 426 separate images that covered ocean areas of 100x100 km (Standard Beam Mode), 102 images that covered ocean areas of 450x450 km(ScanSAR Wide Beam Mode), and 84 images that covered ocean areas of 300x300 km (ScanSAR Narrow Beam Mode). This image data-set was collected between 1994 and 2007. It covered the entire Gulf of Mexico with a repeat rate of 4 to109, with the highest concentration over the continental slope.

This effort identified a total of 4957 slicks among all the images. Of these, 287 appeared a single time in isolated locations and may therefore be false targets. The remaining slicks appeared in groups of up to 9 separate features, clustered in areas of 1 to 6.5 km across. When slicks appear within the same area in repeated images, they are judged to have a persistent source—a bubbling vent on the seafloor (MacDonald et al. 2002). 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. The formations were ground-truthed against a comprehensive database of 3D seismic cubes that cover the entire northern Gulf of Mexico (Frye 2008). Formations defined by SAR slick targets were consistently associated with gas hydrate prone regions of high surface amplitude and migration features in the sub-bottom. Many of the isolated slicks also appeared to be associated with migration features in the seismic data. Temporal variation among the slicks includes examples of intermittent individual vents within a single formation and broad-scale off-again, on-again appearance of slicks over entire images covering the same areas.

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