OFFSHORE OIL SEEPAGE VISIBLE FROM SPACE: A Synthetic Aperture Radar (SAR) based automatic detection, mapping and quantification system

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Even though natural seeps are estimated to be the largest marine oil source, very few seep locations and their seepage fluxes are known and reported. These sites are hosts to some of the most unique marine ecosystems with many chemosynthetic communities. The importance of discovering different offshore oil seep sites is not just for geological and ecological reasons, but also to set a background against which the excess anthropogenic sources of marine oil can be checked, providing an estimate the 'contamination' of marine waters. A fundamental step in offshore seepage estimation is the location of the seeps, located mostly by hydroacoustic surveys of oceans. When bubbles or cracks occur at these seep locations, oil coated gas bubbles may seep out, and making their way through the water column, reach the sea surface where the oil forms a slick. These are visible in satellite and air-borne images appearing different depending on the sensor used, and appear as dark features in Synthetic Aperture Radar (SAR) images due to the reduced backscattering of the returning microwave signal.

Slicks emerging from the same seep site usually appear around the same location. Hence by clustering temporally and spatially recurrent slicks, the seep location can be estimated. This is mostly done manually by the human eye by analysing SAR images visually to locate the slicks. Semi-automatic algorithms also exist in which dark objects in SAR images are segmented automatically after which those corresponding to slicks are distinguished from the other dark objects visually. The main task in automatic slick detection is the discrimination between slicks and other dark objects called look-alikes and their correct classification. The first ever fully Automatic Seep Location Estimator, named ASLE, was created during the course of this PhD thesis. This system was successfully tested to find oil seep locations in the Black Sea from ENVISAT SAR data. More recently, the ASLE was used, not only to detect oil slicks from seeps and estimate the seep location, but also to quantify the seepage rate from various seeps in the southern Gulf of Mexico.