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Global Hydrocarbon Exploration and Monitoring: Current Possibilities and Projections for the Near Future and Beyond

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Direct remote sensing detection and mapping of liquid and gaseous petroleum hydrocarbon (HC) seepages in onshore and offshore basins are still operational challenges due to the varying scale of HC shows and the mix of spectral signatures of HCs with water and mineral substrates. Field and laboratory spectroscopy and remote sensing imagery have had an important role in the prospecting and exploration of new petroleum hydrocarbon (PHC) reservoirs. These techniques can be also useful for monitoring hazardous waste problems in refineries, pipeline sites, oil fields, and other industrial areas, as showed in several studies focused on PHC leaks and spills. Liquid and gaseous PHCs can be detected in a number of ways, as a direct detection in the surface and as an indirect detection by measuring its effect on local rocks, soils and vegetation. Methods used to detect PHCs include the study of their reflected spectra in the visible and near infrared (VNIR) and short wave infrared (SWIR) wavelengths (350-2500 nm) and emitted spectra in the thermal infrared (7000-14000 nm) (TIR) region. The objective of this work is to provide an overview of modern, successful case studies on PHCs onshore and offshore detection using sensors aboard multiple airborne and orbital platforms currently operational (e.g., ProSpecTIR, AVIRIS, HyMap, SEBASS, HyTES; WorldView-3, Sentinel-2, ASTER, Landsat-8) and to address their limitations. The study also considers other platforms that should be launched in the near future with global coverage (e.g., EnMap, HyspIRI, HISUI, Boeing-HRS) and their potential in qualifying and quantifying PHC shows. The work further provides an analysis on the needs not yet addressed in current and planned missions that could be considered in projects under conception.