Oil spill monitoring and damage assessment via polSAR measurements

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Classification and needs

- Various pathways.

- Various pathways:
  - Illegal oil spills.
  - Accidental oil spills.
  - Oil seeps.
  - Tanker disasters.
  - Natural sources.
  - Undefined.
  - Effluent, atmosphere, drilling rigs 45%.
  - Shipping 35%.
  - Natural sources 10%.
Classification and needs

- Various pathways.
- Illegal oil spills.

- Estimates range from 70 to 210 million gallons/year
- Mainly from illegal tanker discharges and stormwater drainage.

All-day and all-weather observations with a dense revisit time is needed.

SURVEILLANCE
Classification and needs

- Various pathways.
- Illegal oil spills.
- Accidental oil spills.

- Less than 10% of the total.
- Mainly from tankers and oil platforms.

Detailed info on the pollutant (type, extent, thickness...) and its forecasting.

REMEDIATION
Classification and needs

- Various pathways.
- Illegal oil spills.
- Accidental oil spills.
- Oil seeps.

Hydrocarbon exploration is a high risk investment.

Visible surface features such as oil seeps provide basic evidence of hydrocarbon generation.

A system allowing an effective identification of oil seeps is needed.
Motivation

PolSAR model

Experiments

Conclusions

PolSAR

Synthetic Aperture Radar (SAR)

- All-weather and day & night observations.
- Fine spatial resolution and wide swath coverage.
- SAR is the key tool for oil at sea observation.
- Recently, many polSAR missions have been launched.
- Dense revisit time under constellation of constellations.
PolSAR in a nutshell

A PolSAR sends and receives in H or V polarization states (for example, one can send an H-polarized wave and receive a V-polarized wave).

The basic types of polarimetry are:

- HH or VV (single-polarized)
- HH and HV, VV and HV, or HH and VV (dual-polarized)
- HH, VV, HV, and VH (quad-pol).

New polarimetric architectures (compact polarimetry) are also available that ensure larger swaths.
Polarimetric Synthetic Aperture Radar (PolSAR)

To exploit the constellation of constellations physically-based techniques, instead of blind image processing, are need to observe oil at sea by SAR imagery.
PolSAR models/techniques to observe oil at sea

By introducing em modeling we proposed a new paradigm for oil at sea observation

- Full-resolution SAR data;
- Robust;
- Effective;
- Oils vs look-alike;
- Damping properties.
A polarimetric model has been developed that gives an understanding of sea surface scattering with or without surface slicks in terms of some polarimetric features.

- **Dual-pol**
  - CPD;
- **Quad-pol**
  - Mueller filter;
  - Entropy;
  - Degree of polarization;
  - Unpolarized backscattering.
Distinguishing actual oils from look-alikes

Both surveillance and exploration call for unsupervised procedures that allow distinguishing actual oils from look-alikes in SAR imagery.
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Oil slick: ALOS-PalsAR - August 27, 2006
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Look-alike: ALOS-PalSAR - March 10, 2007
Oil seeps: RS2, 2010 - Gulf of Mexico
Oil seeps: RS2, 2010 - Gulf of Mexico
Waste water: RS2 - Fort Lauderdale, FL - July 10, 2010
Under low to moderate wind conditions and at intermediate incidence angles, polarimetric features allow a rough classification of the surfactant’s damping properties.
Deepwater Horizon: UAVSAR - June 23, 2010
PolSAR measurements, once an electromagnetic model is available, have been shown to be useful to assist both oil detection and remediation.

- An “intelligent” processing is possible.
- They are very robust and effective.
- They allow discriminating oil slicks from weak-damping look-alikes (Oil/Seeps detection).
- They allow providing rough info on the surfactant’s damping properties (Remediation).