MOPED

Monitoring of Oil Pollution using Earth Observation Data

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Earth Sciences and the Environment: Water Quality
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- And members of their teams
Overall aim of MOPED

Develop recommendations for a system to use all available information from satellites and independent sources

- To detect and (where possible) quantify oil pollution, whilst reducing the risk of false positives, and
- To provide information for use in models to predict oil spill transport and evolution, or carry out hind-casts to identify sources of observed spills.
Research Objectives

- Collect, analyse, co-locate and archive satellite data from selected case studies (T2)
- Retrieve geophysical parameter influencing oil spill evolution and appearance (T3)
- Improved models for wave damping and backscatter in the presence of surface films (T4)
- Improved forecast model for oil spill drift (T5)
- Develop multi-sensor algorithms (T6)
- Recommendations for a system using all available information to monitor oil pollution (T6)
Main areas:
- Black Sea
- Caspian Sea

Drawing on past work in other areas, particularly the Baltic.
A synergistic use of multi-sensor multi-platform satellite data

- MODIS Terra / Aqua
  - Currents field
  - Mesoscale structures and water dynamics

- NOAA AVHRR data
  - Chlorophyll a concentration

- Sea Surface Temperature

- ERS-2 SAR data

- ASAR Envisat data

- Weather maps
  - Wave height by altimetry data
  - Meteorological data

- Wind Speed by QuikScat

Generalized map of sea surface state
Baltic Sea case studies

Building on Lukoil-Kaliningradmorneft Project

- Satellite monitoring of oil spills
  - NRC and oil-water contrast (ASAR, RADARSAT)
  - Optical data (MODIS 250m)

- Satellite derived geophysical parameters
  - Surface wind field
    (QuikSCAT, + NCEP, ECMWF and MM5 for downscaling)
  - Wave height (along-track altimetry, Topex, Jason)
  - Fronts and mesoscale current dynamics
    - SST (AVHRR, MODIS-Terra and -Aqua)
    - Chlorophyll, radiances (MODIS, SeaWiFS)

- SMHI SeaTrack numerical model (oil spill drift)
  - Meteorological observations
Right: ENVISAT ASAR WSM image from SE Baltic Sea, 30 July 2004, 20:08 GMT.

1. Chain of oil spills in the Bay of Gdansk;
2. Round patch of unknown nature.

Ancillary satellite and meteo information is required for full interpretation
Below: MODIS Terra 250m, 30 July 09:40 GMT
Comparison with model output

- **Forecast:**
  - D-6 for 48 hours with SMHI SeaTrack Web model
  - Oil spills will move south with wind and current fields, towards Vistula Spit.

- **ASAR and MODIS data:**
  - Westward drift along vortex streamlines

- **Reason for discrepancy**
  - meso- and small-scale dynamical features accounted for in model
  - Need to include current field in eddies, dipoles, jets, filaments, meanders, etc.
Daily forecast of oil spill drift from D-6 for 48 hours basing on SMHI SeaTrack Web model
Potential probability of oil spill drift from D-6 oil platform
Black Sea case studies

Analyses of multi-sensor satellite data

- Satellite monitoring of oil spills
  - NRC and oil-water contrast (ASAR, ERS-2, others?)
  - Optical data (MODIS 250m, MERIS FR L1B)

- Satellite derived geophysical parameters
  - Surface wind field
    (QuikSCAT + NCEP, ECMWF and MM5 model for downscaling)
  - Wave height (along-track altimetry, Topex, Jason, RA-2)
  - Fronts and mesoscale current dynamics
    - SST (AVHRR NOAA, MODIS-Terra and -Aqua)
    - Chlorophyll, radiances (MODIS, MERIS, SeaWiFS)

- Black Sea operational model
  (National Space Agency of Ukraine)
Surface velocities calculated by MCC
ASAR and MODIS (in sun glitter pattern) data detect oil pollution by ship discharge

SeaSAR 2008
Frascati, 21-23 Jan.
Surface currents field by Black Sea Operational model output (http://dvs.net.ua/mp)
And predicted daily shift of the oil spill from red to yellow.
Caspian Sea case studies

Analyses of multi-sensor satellite data

- Satellite monitoring of oil spills
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- Satellite derived geophysical parameters
  - Surface wind field
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- 3D hybrid flow/transport model for Caspian Sea
Caspian Sea

- Current stage: collection, prelim. analysis and archiving

VIS (NOAA)

SST (NOAA)

Chl (SeaWiFS)

SeaSAR 2008
Frascati, 21-23 Jan.
Black Sea field experiments

Effect of artificial films on small-scale waves and radar backscatter and Doppler shift

- **Location:** MHI research platform
- **Sensors**
  - IAP: Ka-/X-band Doppler scatterometer, optical spectrum analyzer, digital camera
  - MHI: wire gauge, anemometer
- **Substances**
  - vegetable and olive oil
  - dodecyl alcohol
  - diesel fuel
Apparatus

- X-band scatterometer
- Optical Spectrum Analyzer
- Ka-band scatterometer
Experiment with artificial slicks of 05.10.07

Olive oil – strong damping at X/Ka-bands. Diesel fuel – weak damping

Wind velocity to be checked!
Contrasts in slicks 05.10.07

Low wind conditions

- Dodecyl alcohol slick (film elasticity E=50-70 mN/m)
- Veg. oil slick (film elasticity E=12-15 mN/m)

Camera and OSA data agree, radar contrast larger
Low winds: maximum wave damping at C-band
Strong radar Doppler shift at low winds
Training material

UNESCO Bilko software

- Training lessons based on satellite data of marine oil pollution
- Image processing techniques
  - Filtering, transects, contrast calculations
  - Image co-location
- Guided data interpretation
  - Background information
  - Questions to test student understanding
  - Model answers for student/teachers working alone

SeaSAR 2008
Frascati, 21-23 Jan.
SeaSAR 2008
Frascati, 21-23 Jan.

Unfiltered
Filtered
Threshold 2100
Threshold 2400
Summary of work to date..

- Data base
  - SAR data for Black Sea, Baltic: ancillary data identified
  - Caspian Sea data to be collected and analysed
- Retrieval of geophysical parameters begun
- Preliminary model runs and data analysis
  - Baltic and Black Sea only
- 2 weeks field work: preliminary results
  - Experiments with artificial slicks show wave-damping properties and oil-water contrast in line with expectations
  - Sampled slicks show hysteresis
- Optical algorithm development
  - Work to identify suitable images ongoing
- Oil spill lesson 1 on Baltic case study under review
Website: http://dvs.net.ua/MOPED/