MULTISENSOR APPROACH TO OPERATIONAL OIL POLLUTION MONITORING IN COASTAL ZONES

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1. INTRODUCTION

Results of satellite monitoring campaign conducted in the frame of national and international projects in the Black, Azov and Baltic Seas are presented. The monitoring focused on the detection and analysis of biogenic and anthropogenic pollution of the sea surface and near-surface layer. Detection of oil pollution is among the most important goals of monitoring of coastal zones. Public interest in the problem of oil pollution arises mainly during dramatic tanker catastrophes. However, tanker catastrophes are only one among many causes of oil pollution. Oil and oil product spillages at sea take place all the time. So, the topicality of regular monitoring is caused by increasing of sea transfers, building of new oil terminals, building and exploitation of sea drilling platforms and equipment wear on old platforms.

MULTISENSOR APPROACH

Satellite detection of oil spills with synthetic aperture radar (SAR) has been in quasi-operational use for some time, and is a useful monitoring tool in areas where the risk of pollution is high. SAR data provides reasonably reliable information about the position and extent of surface oil, particularly when the data are interpreted by experts. Nevertheless, detection based only on SAR data is still problematic because of the difficulty in distinguishing oil slicks, especially at lower wind speeds, from other phenomena known as oil "look-alikes" [1]. Experience gained from past monitoring campaigns clearly demonstrates that the best approach for operational monitoring of oil pollution would be quasi-simultaneous employment of different remote sensing instruments operating both in active and passive modes, in different bands (optical, infrared, microwave) and with different look parameters.

MULTISENSOR SATELLITE MONITORING OF SEAWATER STATE IN THE NORTH-EASTERN COASTAL ZONE OF THE BLACK SEA

A remote sensing monitoring of the state of the environment and detection of anthropogenic and biogenic pollution in the Russian sector of the Azov and Black Seas is conducted every year during April – October. Complex satellite observation of these areas is focused on solving the following tasks: operational mapping of parameters of the state and pollution (costal, ship and biogenic) of water, decadal and monthly summary of the results; analysis of meteorological situation and its impact on the evolution, spread and drift of pollutants; investigation of coastal circulation patterns and their impact on the evolution, spread and drift of pollutants; determination of typical cases of pollution distribution in coastal waters. The tasks are closely interrelated since, once in the sea, pollutants become part of the environment and evolve correspondingly under the impact of meteorological and hydrological conditions.

Data in visual, infrared and microwave ranges from 9 satellites provide the basic material for the processing and analysis. These are complimented with ground data from meteorological stations on the shore and results of satellite data processing of previous periods. Over ten information products are elaborated every 10 days and monthly, including maps of sea surface surfactant film pollution, phytoplankton and algae distribution, chlorophyll-a concentration, sea surface temperature, etc. as well as summary maps of sea surface state and pollution.

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The monitoring provides rich material for the study of hydrodynamic processes in the region, in particular for the detailing of water circulation. The effect of water circulation patterns and river outflow intensity on the dynamics of biogenic films is investigated. Three types of pollution drift and evolution patterns depending on local water circulation modes are defined. Areas commonly affected by pollution are determined and usual sources of such pollution are established.
Long-term regular regional satellite monitoring provides grounds for the determination and analysis of typical patterns of pollution distribution, detection of new elements of water circulation contributing to the transport of pollutants and cleaning of coastal waters. Thus, using satellite data, it was discovered that in the Russian sector of the Black Sea, the input of small-scale water circulation into the transport and distribution of water pollutants was comparable to that of the Ring Current and mesoscale eddies [2]. The knowledge of local pollution distribution mechanisms raises the reliability of environmental mapping and forecast.

OPERATIONAL MULTISENSOR SATELLITE MONITORING OF OIL SPILL POLLUTION IN THE SOUTHEASTERN BALTIC SEA

Operational monitoring of the southeastern Baltic Sea was performed in June 2004 – November 2005 on the basis of daily satellite remote sensing (AVHRR NOAA, MODIS, TOPEX/Poseidon, Jason-1, ENVISAT ASAR and RADARSAT SAR imagery) of sea surface temperature, sea level, chlorophyll-a concentration, mesoscale dynamics, wind and waves, and oil spills. This research was initiated by LUKOIL-Kaliningradmorneft Company in connection with the start of oil production on the Russian continental shelf in March 2004 (D-6 oil platform). Complex information on anthropogenic and biogenic pollution of the sea and forecasts of its evolution and drift was produced on a daily basis [3]. Over the period of 18 months, total 274 oil spills were detected based on 230 ASAR ENVISAT images (400x400 km, 75 m/pixel resolution) and 17 SAR RADARSAT images (300x300 km, 25 m/pixel resolution).

NUMERICAL MODELLING

The interactive numerical model Seatrack Web SMHI (The Swedish Meteorological and Hydrological Institute) was used to forecast the drift of detected large oil spills, which is a very important task in the operational oil spill monitoring. This is a powerful operational tool that can be used also for an assessment of ecological risks related to potential oil pollution of every Marine Protected Area and coastal zone in the Baltic Sea resulted from main ship routes, oil rigs, oil terminals and ports. The system uses two different operational weather models ECMWF and HIRLAM and a circulation model HIROMB (driven by the two weather models respectively), which calculates the current field. The model allows to forecast the oil drift for five days ahead or to make a hind cast (backward calculation) for 30 days in the whole Baltic Sea in operational regime. An oil spreading calculation is added to the currents, as well as oil evaporation, emulsification, sinking, stranding and dispersion. This powerful system today is in operational use in all Baltic countries.

CONCLUSION

ASAR/SAR data provides effective capabilities to monitor oil spills, in particular, in the Baltic, Black and Azov seas. Combined with multisensor approach to satellite remote sensing of SST, suspended matter, sea level, chlorophyll concentration, mesoscale dynamics, wind and waves, this observational system, that includes also a Seatrack Web numerical model for oil spill drift, represents a powerful method for operational and long-term monitoring of ecological state over the seas, as well as smaller areas of particular interest, such as marine protected areas.

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