Natural slicks and oil spills in the coastal zones as viewed by satellite radars

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The paper summarizes oil pollution monitoring experience in coastal zones of Black Sea (Novorossiisk – Gelengjick), Caspian Sea (Neftyanye Kamni), and Baltic Sea (Courish lagoon – Gdansk Bay). SAR images from instruments on board ERS-2, Envisat and Radarsat satellites are the core data element. Satellite detection of oil spills with synthetic aperture radar (SAR) can provide reasonably reliable information, but in complex coastal environments it is still a major challenge. Analysis of radar images is basically hampered by the problem of distinguishing between slicks (sea surface smoothing) of natural origin and spilt oil patches, especially in low wind conditions.

The work focuses on the possibilities to improve the discrimination capabilities between oil spills and “look alikes”. This can be done by combining satellite data at optical, infrared and microwave frequencies to monitor water quality, give information on parameters controlling the formation, transport and evolution of oil slicks, and provide more general background information that will help to identify potential oil “look-alikes”.

Theoretical investigations of electromagnetic wave scattering at the sea surface covered with film with thickness reaching several millimeters are conducted. Such films do not include surfactants forming monomolecular layer on the surface. The dependencies of scattering intensity on film thickness are computed. It is shown, that small variations in film thickness may correspond to a very wide range of scattering intensity. Qualitative differences in angular dependencies of scattering at two polarizations for films of different thickness are revealed. It is proved that the long wave component of surface wave field has a significant impact on the radar return signal backscattered from the film.

Physical mechanisms are investigated which are responsible for variations in slick visibility at different electromagnetic frequencies, and particularly the sensitivity of radar and optical signatures of marine surface films to variations of the wind speed and of the wave field and to hydrodynamic phenomena such as swell, internal waves, eddies, and currents.