Caspian Sea Water Satellite Monitoring for Ecosystem Control

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Abstract – The Caspian Sea satellite monitoring that covers sea surface temperature (SST) and water clarity observations is performed by the NTs OMZ in collaboration with the Caspian Research Institute of Fishery (KaspNIRKh) and INFONAR Comany. The sea surface condition assessment, SST determination, sea ice cover edge observations, interpretation of oil product signs at the sea surface, stress conditions for the Caspian Sea biota are performed as well. Following are the fragments of monitoring demonstrating both regional features of the Caspian Sea hydrology and biota living and procedural aspects of satellite monitoring.

Keywords: satellite monitoring, surface water temperature, water transparency, stressfull conditions for a biota.

The features of a surface water temperature

Main part of differences between SST maps produced on base remote sensing and contact observations are stipulated by difference of information water layers. For remote sensing it is the upper micrometer surface layer, for contact – upper 0.5m layer. In conditions of wind mixing of the surface water the difference of temperatures of these layers is not significant (less than 0.5 K) while the temperature difference can be more (up to 3-6 K in summer) during calm conditions. It is stipulated by absorption ~ 10 % of a solar radiation by the upper millimeters water layer [1]. This radiation (the heat) disperses only on increase the temperature upper water layer, evaporation and, as solinization effect, on reinforcement of the saline vertical convection in absence of mixing. Simultaneous mapping of the SST, sea state condition and atmosphere distorting effect evaluation become possible as a result of usage of all complex of the AVHRR/NOAA data for interpretation of different genesis SST anomalies outside of temperature fronts (revealed on the previous information). Warm SST spots are observed in quasi-calm conditions mostly. By the confirmation of this warm spots are results by an overheat of a water surface is the often availability semitransparent clouds above these areas. From the other side the local SST minimums appear under aerosol clouds, as result of an insolation decreasing. The satellite SST maps become similar to maps, constructed on the data of contact observations [2], after the areas with low mixing condition accounting. For example, a comparison of the wind speed [3], a satellite radar (SLR) image [4] shows the local calm area with surface overheat to the South from Mangyshlak peninsula and dark area on SLR image (Fig.1). Low roughness of a water surface and stain of the superheated water, with maculae, found above them, increased integrated contents of a water vapour in an atmosphere, are watched on the data of observations AVHRR/NOAA also at a Kara Bogaz and on a southwest of the sea.

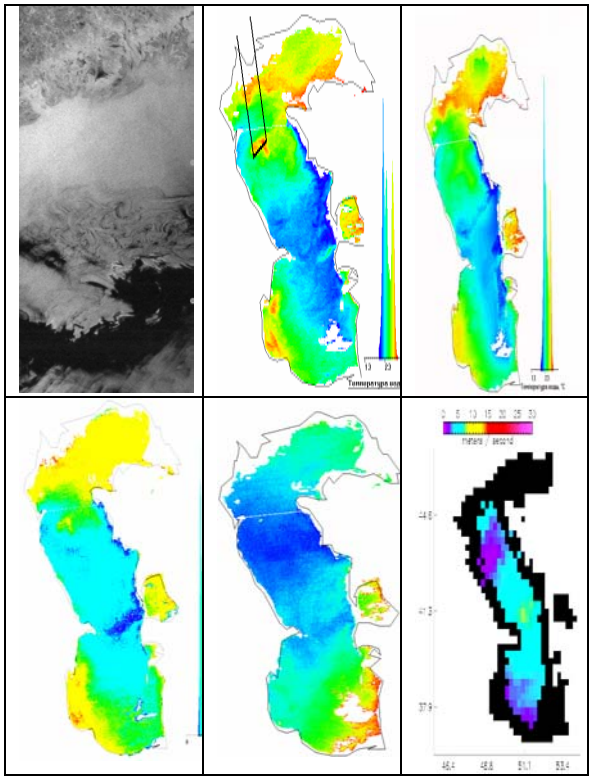

Fig.1. ERS-2 radar image of the Caspian Sea, 11 July 2003 (at the top left [4]); satellite SST map (at the top centre); corrected SST map (at the top right); albedo of sea surface backscattered solar radiation at 0.8 μm in % (at the bottom left); atmospheric integral water vapor content (at the bottom centre); at the bottom right – wind speed [3].

Water Clarity

The data on chlorophyll content in World Ocean presented by NASA in Internet is not certain every time. For instant, the image segment of chlorophyll content given in Fig. suggests that chlorophyll content is high almost everywhere in shallows and eddy’s structures are observed in central water areas [5]. This is, apparently, due to the following reasons. When water clarity is higher than depth the radiometer records chlorophyll at bottom sediment surface. The sea surface condition is not allowed for. Under fresh and strong wind conditions in-water hydrosol becomes roily towards the sea surface [6]. In this context the value of water-leaving radiance is recorded as high from satellite that is interpreted as high chlorophyll content.Such a situation is exemplified in Fig.2 left when a spot of higher chlorophyll content was observed in the Middle and South Caspian Sea. The shape of the spot suggests that the spot was induced by in-water phytoplankton and other hydrosol layers covered with phytoplankton which are wind-roiled to the water surface. To confirm this assumption there are given the composite maps of hydrosol albedo under free-cloud conditions both for all AVHRR/NOAA observations from August 29 to September 5, 2001 (including events of developed wave) and for cases of undeveloped wind-induced wave (the cases of moderate and fresh wind have been selected). The analysis of the heterogeneity contours in

hydrosol albedo field derived under developed wind conditions (Fig.2, the second left) and of simulated wind field [7] (Fig.2, the last right) confirms the assumption that the study arched spot results from wave mixing. It should be noted that Fig.2 right shows simulated maximum wind speed southward Kara Bogaz, however Fig.2 does not show maximum chlorophyll content because of cloudiness over the sea during this period. The failure to take account of the wind mixing leads to apearance of artifacts on chlorophyll content charts. Using of AVHRR/NOAA data permits the assessment of sea condition (in Beaufort scale) and identification of higher hydrosol content under weak and moderate wind mixing conditions [2].

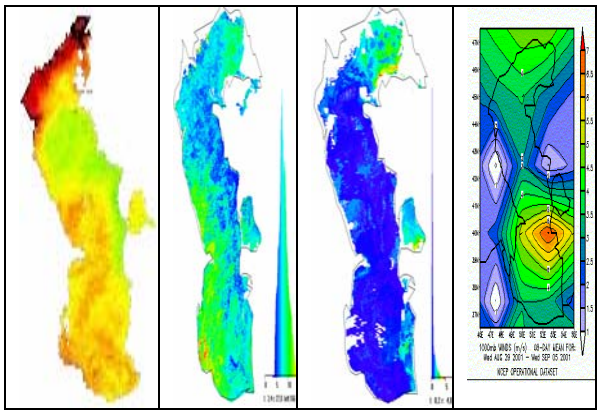

Fig.2. Chlorophyll in the Earth's water in mg/l during the period 29 August-5 September 2001 (on the left); albedo of solar radiation hydrosol scatterers (foam and hydrosol) in % for all wind conditions during the period 29 August-5 September 2001 (second left); hydrosol albedo (without foam) in % under wind conditions from calm to moderate wind during the period 29 August-5 September 2001 (second right); wind speed module during the period 29 August-5 September 2001 (right) [7].

Biota Stress Factors

The Caspian Sea fish living is also affected by stress factors causing the biota in particular the amount of sprat – the most important link, to change step-wise. This factors is being searched now. According to one of the hypotheses this is earthquakes in this Region. During earthquakes, underground water and lithospheric gases (radon, hydrogen, carbonic acids, methane, hydrogen sulfide and etc.) escape from the crust fractures. The availability of certain of these gases, even in extremely low concentrations (less than 0.1-1 mg/l.) is incompatible with small fish living [8]. The crust fractures make out clouds of specific shape [9]. The study of report authors show that one is dry dust clouds strip (or clear sky strips in cloud area, becouse no free dast) inside strip areas of local decreasing of difference between Radiation temperatures in 11 vs 12 mkm (T_{11}, T_{12}) range (clear sky ~ water vapor). Natural electromagnetic field distortion in the crust fractures areas due to earthquake can be as main reason of above strip anomalies. In spring 2001 the locations and time of sprat kills correlated with crust fractures running from earthquake sources. Satellite data-based indication of these clouds during the earthquakes allows the KaspNIRKh to assess areas of possible mass fish kill. For instant, on July 13 2004 the specialists from KaspNIRKh observed a fish kill near the eastern shore of the Middle Caspian Sea within the upwelling area; near-bottom water was roiled. This occurred during the upwelling when the probability of oxygen deficiency in water is extremely bad. On July 11 2004 east of Ogurchinsky Island the earthquake took place. The earthquake forerunners of July 11 2004 were specific lined clouds (local minimum T_{11}-T_{12}, a litle albedo clouds 3,7 mkm from AVHRR/NOAA, minimum anythyng water in atmospere [3]) making out the crust fractures that run from the earthquake source to the Middle Caspian Sea.

Another stress factor for biological processes is the critical salinity changes [10]. As a result of non-uniform discharges of waters from the Volgograd dam (growth of volume of discharge on ~ 0.5 cubic km meets increase of a daily water level in Astrakhan more than on ~ 10 cm) along Volga and further on Caspian beach the antropogeneous water level changes (Fig.3, at the topp) are distributed. On satellite Radar images of Northern Caspian Sea these discharges show as wave train running from the Volga sleeves and channels. In superficial waters on the AVHRR/NOAA data the thermal and optical contrasts between river and sea waters become aggravated. Vertical water mixing - even bottom waters salinity sharply falls on 2‰ in less then half an hour. As a result of such antropogeneous influences water with river biota falls on sea biota, and in some hours - days comes back. The water salinity transition through 5-8 ‰ (Fig.3 on the botton) leads to osmotic pressure incompatible to ability to live for spawn and fry [10]. The record number of water discharges ("splash" in the sea over the Volga bars yang of half-passage fishes) was observed during mean water period of the summer-autumn 1999 year (8 instead of usual 0-3 in 1978-2004 [11]). It was by the reason of a loss of an appreciable part of fish generation of 1999.

Above described stress factors revealed on the basis of the analysis of the satellite information, probably also have resulted to undermine of sea forage reserve.

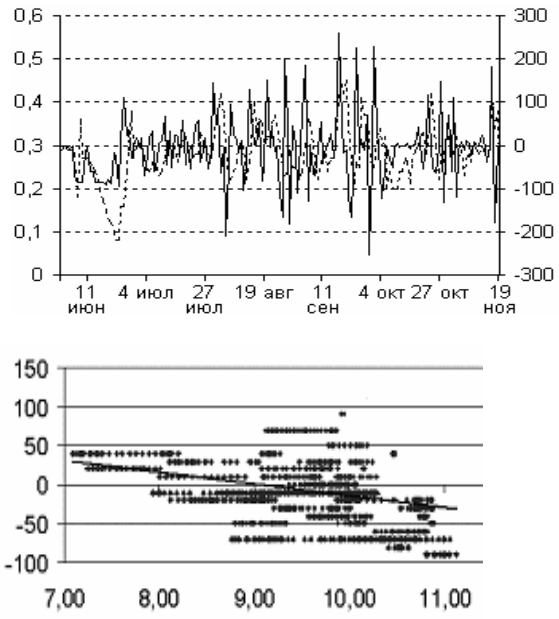

Fig.3. Diurnal variation throw off of water with the Volgograd HYDROELECTRIC STATION and water-level on в/п Astrakhan in 1999 (solid line - change of a level of mm, right scale, dotted line - change throw off of water, cube. km + 0.3, upper scale) [8], at the below; course of a salinity of water at a floor on a beach of eastern sleeves r. Volga depending on diurnal variation of a water-level in Astrakhan (on a horizontal axis - salinity in promil, on vertical - diurnal variation of a water-level in mm, shear on a water-level concerning a salinity - 4 day), on the bottom.

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