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# Meteorological Waves in the Caspian Sea by MODIS Data

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Data of Moderate Resolution Imaging Spectroradiometer (MODIS) were used for study of meteorological (marine baric) waves in the ocean. Atmospheric processes are known to be a main source of meteorological waves. The major mechanism to transfer the energy of atmospheric processes to meteorological waves is direct mechanical influence of atmospheric pressure or wind stress on the sea surface, just this mechanism is responsible for origination of most high-amplitude waves named meteo-tsunamis. Our experience shows that meteorological waves are basically connected with atmospheric buoyancy waves.

MODIS high resolution data are proved to be a convenient means for research of meteorological waves. Scanners MODIS, installed on Aqua and Terra satellites, provide optical radiance data with spatial resolution of 250 m at two bands: 645 nm (band 1) and 865 nm (band 2). Normalized water leaving radiance nLw of level L2 (corrected to the atmosphere) is known to be originated at the sun light wavelength-dependent depth: nLw_645 nm - in subsurface layer of 1–2 m depth, nLw_859 nm - in a thin topmost layer of about several centimeters due to high absorption of pure water. Our experience shows that meteorological waves of a height less than half of meter are better reproduced by Lwn(859) data than by nLw(645) ones, so in the work we have used only nLw(859) data. Atmospheric waves, modulating a cloud layer, can be reflected on level L1b radiance image (not corrected to the atmosphere) simultaneously with meteorological waves displayed on nLw image.

MODIS nLw data have been generated from L1 radiance data by SeaDAS program packet. A contrast of radiance images of both levels was slightly enhanced for better reveal of wave signatures.

Frequent manifestations of long meteorological waves induced by intense atmospheric waves were recorded in the inner Caspian Sea by MODIS high resolution data. Appearance of long atmospheric waves above the Caspian Sea is caused by specific reasons. It is known that the Caspian Sea represents a depression divided by deep faults and is a region of high seismic activity. Geotectonic processes of the transverse flexure of the Caspian depression along a meridian occur in the southern part of the sea, and the subduction of the Alpine plicate region under the Scythian-Turan plate occur in the central part. Under power atmospheric impacts the edges of lithosphere blocks can set in motion and produce thermal anomalies which uplift, destroy stability of the atmosphere and provoke intense atmospheric waves. Packets of long atmospheric waves and meteorological waves coupled with them were mainly observed near an interface area of the Apsheron rapids and the South-Caspian flexure.

3D properties of meteorological waves were evaluated. Atmospheric waves and meteorological waves, governed by them, were spreading generally westwards. A crest length of long waves reached several hundred kilometers, a wavelength changed from several hundred meters to several kilometers. A height of meteorological waves was defined as a depth-wise displacement at transects across the distributions of sun light penetration depth in the sea 1/ Kd_490, where Kd_490 is a downwelling diffuse attenuation coefficient, being a standard L2 ocean color product with 1-km resolution. Large and intense meteorological waves were shown to have amplitudes up to 1 m. Pairs of level L1b radiance images of atmospheric waves in cloud layer and level L2 radiance images of meteorological waves were superimposed in a difference mode. Combined images revealed prolongations of light stripes, reflecting wave crests, in the cloud layer to those on the sea surface. Such a spatial coincidence was an evidence of resonant nature of atmospheric and meteorological waves.