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Multiscale wind cycles and current pulses at the Black Sea eastern boundary

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The goal of the research is to examine meteorological descriptive elements, sea-water properties, regional hydrodynamics and energy conversion fluxes in order to study sea responses to the local and far-field weather system. The Black Sea is situated in the chain of internal basins between the North Atlantic and Central Asia deserts in the marginal interaction zone and, accordingly, is under the influence of the Azores and Siberian anticyclones, Arctic cold-air surges and subtropical desert belt to the south.
The analysis is based on the data of modern oceanographic measuring network "Hydro-physical Polygon" of the Institute of oceanology, using contact and remote sensing methods, weather stations around the Black Sea coasts, including long-term (1938-2014) measurements at the Gelendzhik weather station. Various satellite and Reanalysis databases are used. Currently, there are three long-time measuring moored stations (each contains ADCP and thermistor chain) and scanning profiling system "Akvalog". Hydrological sections and field surveys using towed ADCP and CTD are performed on a regular basis. The data are accumulated in the coastal archive which allows calibration of satellite measurements and testing results of numerical modeling.
Data processing includes data sets preparation, editing, time series statistical calculations using histograms, progressive vector diagrams, traditional Fourier spectral analysis including auto- and cross spectra, auto and mutual wavelet diagrams, moving spectrograms, vector data methods using rotary components, spectral invariants, empirical modes, hodograph and pre-specified spectrum representations on the basis of stochastic models with imposed dynamical assumptions. Due to the intermittent nature of the time rows, spectral representation is misleading, often. In order to identify the individual evolving dynamical phenomenon, typical background (seasonal) three-dimensional structures of the hydrological field, as well as quantified anomalies, associated with different frequency components of variability, such as sub-meso-scale eddies, marginal shelf waves, inertial oscillations, diurnal, semi-diurnal and short-period internal waves, long surface waves, were estimated. Based on estimates of the statistical relationships between the different parameters of hydro-meteorological system, including meteorological elements, sea level, sea temperature and flow fields, space/time scales of the observed fields variability were estimated. Several new features of the physical mechanisms of multiscale hydro-physical processes in the shelf zone of the Black Sea, have been revealed.
In particular, it is shown, that there are wind self-similar cycles at different time scales, each cycle being consisted of a pair of northeast and then southeast winds, which corresponds to the alternative influences of the Azores and Siberian highs(in winter). In the range of decadal (10 years) scale and in macro space view, long-term wind cycles support basic Black Sea circulation(Rim Current).Wind cycles with a time scale of about 20 days give rise to distinct upwellings, appeared with the same frequency. Along with each upwelling, radical hydrological restructuring of the stratification is accompanied by intense advection with high velocities(up to 1 m/s). Kinetic energy is dominated by alongshore currents, the direction being reversed periodically. The vertical structure of currents is rather complicated. When the current speed exceeds some threshold value, the flow gives rise to relaxation oscillations with a period of about 24 hours with counterclockwise velocity vector rotation. All the above mentioned events and current pulses cause significant variations of air-sea fluxes.
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