Brief annotation of project RSF 14-17-00555 (Cont.)

The goal of the project is to develop and improve the techniques for the retrieval of parameters of sea surface pollution, investigate the impact of dynamic and circulation processes on pollution propagation and assess the ecological state of Russia's seas based on a combined analysis of satellite data, and this goal links the proposed project to Project 2014.

The relevance of estimating the ecological state of the seas bordering Russia is not simply maintained but continuously rising. There are many reasons for that. Risk of oil pollution increases with the expansion of oil and gas industry, construction of new underwater pipelines and growth of ship traffic.

Increased concentration of suspended matter in water leads to higher water turbidity and lower biological productivity. Anomalous algae blooming lasts longer and covers greater areas year-to-year and occurs in regions never affected before. Expanding domestic tourism and marine recreation industry increase risk of anthropogenic pollution of coastal waters. Today, given global and regional climate change, these factors appear hazardous for previously unaffected marine environments, in particular, the coastal zones of the Arctic seas, which more often and for longer time remain iceless.

There is a need for detailed near-real-time information on spatial and temporal distribution of meso- and submesoscale processes (eddies, eddy dipoles, jets, fronts and internal waves) in various regions. Complex current structures associated with these phenomena appear at the sea surface and may be captured by remote sensing sensors from space.

In the course of Project 2014, new tasks to achieve the goal of Project 2017 have emerged. Note, that it was possible to formulate the new tasks largely due the appearance of new satellite data advancing the quality of remote observations of the ocean. The sensors of the newly launched Sentinel satellites provide a continuous flow of high resolution data in various wave ranges of the electromagnetic spectrum. The new dataflow opens the way to: 1) examining finer spatial scales of up to a few meters; 2) comparing radar and optical data obtained almost simultaneously over the same region at similar high spatial resolutions; 3) observing the dynamics of processes due to smaller time intervals between data acquisitions; and therefore 4) comparing satellite observations with model calculations of dynamics and transformation of, for example, oil pollution.

The focus will be on estimating the contribution (direct and indirect) of dynamic processes of small scales (submesoscale eddies and jets, short period internal waves, small scale fronts, etc.) into the process of marine pollution propagation and modeling of the mechanisms through which small scale processes can affect pollution propagation. In the course of Project 2014, we realized the need to reconsider the relative contribution of processes of different scales into propagation of pollution of various types. The presence of submesoscale eddies, jets, small scale fronts, etc. often causes considerable deviations of the results produced by existing models from real situations.

A combined analysis of high resolution satellite data acquired at small time intervals will enable the retrieval of the main parameters and spatial and temporal structure of hydrodynamic processes and phenomena and classification of the observed processes and phenomena into quasi-2D or 3D and therefore forecasting pollution propagation over or under the water surface. A special effort will be devoted to the improvement of the techniques for deriving quantitative metrics of various types of marine pollution from the new generation satellite data.

Using the novel and improved techniques, we will reconstruct the propagation pattern of various pollution types and assess the actual ecological state of the zones of ecological risk of the Black, Caspian and Baltic Seas identified under Project 2014 and test regions of the Arctic seas. A comparison of the new results with those of Project 2014 will reveal the principal trends in the state of these regions.

An essential part of the proposed project is the verification of satellite data based on the results of concurrent in-situ measurements and model calculations.

The scientific novelty of the problems addressed consists in that they draw on the new capabilities of remote investigation of the ocean brought into being over the past few years due to the increasing dataflow from satellite sensors of the new generation. The sensors provide survey data with unprecedented spatial resolution and revisit frequency. Therefore, the task of forecasting the propagation of pollution in marine environment will be for the first time solved taking into account small scale processes and phenomena. Moreover, each object of interest, namely, sub- or mesoscale dynamic structure, oil spill evolution, suspended matter propagation, etc., will be investigated in a wide range of electromagnetic wavelengths, over multiple spatial scales and time intervals.