Using of Airborne LIDAR for Research Carrying Out in the Interest of Fisheries Oceanography Information Providing

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Abstract – This paper is presented some aspects of airborne LIDAR technical methods in carrying out of fisheries oceanography research. Here will consider possibilities using this remote sensing methods not only for oceanography (picnocline depth, plankton and chlorophyll "a" concentrations, transparency), but for pelagic fish schools recognizing.

Keywords: Norwegian Sea, LIDAR, fisheries oceanography, airborne, mackerel.

1. INTRODUCTION

At present requirements on truth and accuracy initial data in the interests of fisheries oceanography information providing is increased. Also it is very important to get complex data from great sea area for short time. One way of that, in the first for above is using of airborne remote sensing data from different type remote sensing equipments, and next is using new type equipments. Therefore during last several years PINRO uses for fisheries oceanography information providing new remote sensing method, which is base on using of LIDAR systems. Name of it's come from English words abbreviation - **LI**ght **D**etection **A**nd **R**anging. This system is installed and operated onboard of two engine research aircraft "Antonov-26" (An-26), named "Arktika" At present PINRO specialists have a great experience using LIDAR during oceanography airborne research in the Norwegian Sea.

2. WHAT IS LIDAR MEHTOD FOR FISHERIES OCEANOGRAPHY USING?

One of optic electromagnetic radiation range peculiarities is capacity to extend at the water environment and air (laser location), that allow to LIDAR to carry out of water sounding through line between air and water, penetrating at the sea closely surface layer. Depth of laser impulse is dependent on water transparency. Besides, if laser sounding impulse has linear polarization and has two receiving and recording channels, which are intended for recording of two echo-signal components with reciprocally orthogonal polarization has possibility to make identification of displayed object in echo-signal analyze.

Therefore laser location (LIDAR) method is based on analyze of intensity, spectral, polarization, angular and temporal characteristics of reflected echo-signal appears to sound of water subsurface layers by short strong laser impulse.

This circumstance showed that laser location data based on the analysis of sea water optical characteristics allows to determine its transparency, the depth of optical heterogeneities (OH) in the subsurface layers of the sea identifying as picnocline, plankton and pelagic fish schools (mackerel, in the first) as well as the location of oceanographic fronts and difference water masses edge.

Above tasks have been realized for polarization aviation LIDAR (PAL-1) with success and effectiveness. It was designed and manufactured by "MULITECH" Company from S.-Petersburg. PAL-1 has not analogues in the Russia in modern stage for carrying out of air research in the interests of fisheries oceanography.

3. PAL-1 BRIEF TECHNICAL DESCRIPTION

PAL-1 was installed and has been exploited onboard the two engine aircraft Antonov-26 (An-26) named "Arktika". LIDAR transmitting and receiving unit is placed in the photo-camera hatch closed by flat illuminator made of optical glass. LIDAR optical unit was set at the angle of 17^{o}.

Solid-state pulse laser on YAP:Nd was used as source of sounding radiation. Two echo-signal components (orthogonal/cross polarization and normal/co-polarization) are recorded by two identical photo-detectors in the inlet of the optical systems of which the analyzers on the basis of Polaroid film are set. PAL-1 main technical specifications are following:

- wave length – 532 nm,
- pulse duration – 12.5 ns,
- pulse energy – 120 MJ,
- pulse frequency – 140 Hz,
- patch diameter on sea surface – approx. 1 m,
- diameter of optical receiver – 10 cm,
- polarization vector – normal and cross.

There's also fluorescent channel set in the system of cross-polarization receiving (in the cross-channel), where scattered light passing through interference filter with 685 nm wave length gets photomultiplier tube (PMT), that allowed to get information about initial biological productivities (chlorophyll "a" of phytoplankton) concentration on sea surface.

4. PAL-1 USING DURING FISHERIES OCEANOGRAPHY COMPLEX AIR SURVEYS CARRYING OUT AND SOME LIDAR DATA

Laser location with PAL-1 using is one element of complex fisheries and oceanographic airborne research in the first for feeding mackerel in the Norwegian Sea. At present the maximum of PAL-1 signal penetration in the Norwegian Sea is 45 meters and it is dependent on sea water transparency. During airborne complex research usually carry out LIDAR sounding, Microwave and Infrared Radiometry (MWR, IR), including Infrared scanning, digital photo- and video surveys, synthetic aperture radar (SAR) sounding. Also onboard of "Arktika" installed satellite navigation system – GPS and onboard computer system (OCS). The aircraft is equipped with four blisters that allow observers to register fish schools, plankton strips, hydrodynamics effects and phenomena on sea surface, including carrying out observation on marine mammals and sea birds.

LIDAR sounding is the best effective and reliable from 150-200 m altitude of aircraft flight with the average speed about 85 m/s and the sea wave no more than 4 (height < 1.5 m). Each PAL-1 pulse relates to the sounding point determined using GPS in the space and time. The comments of observers, sea surface temperature (SST), MWR data, PMT voltage, laser power and some others are also recorded in LIDAR file.

PAL-1 information is processed in two stages:

- onboard of "Arktika", in the real time, with the using special LIDAR onboard mathematic calculations and software;
- so-called post-processing data calculation after the each flight, when more detailed analysis is made and air remote sensing data are interpreted, as well as new algorithms and software are evaluated.

After LIDAR (PAL-1) using in the complex air surveys we get following information as mapping in GIS presentation:

- transparency spatial distribution,
- chlorophyll "a" of plankton spatial distribution,
- information about picnocline depth,
- positions of area with high level of subsurface plankton concentration.

Also usually after several flights calculate so-named "Lidarogramma" with purpose of pelagic fish schools, in the first mackerel, identification. "Lidarogramma" is the same as acoustic echo-grammas.

5. CONCLUSIONS

PAL-1 using in complex airborne fisheries oceanography research carry out showed good results, quality and effective in the several cases higher than during vessels surveys in the first for feeding mackerel in the Norwegian Sea. Nevertheless in the future time is need to carry out series experimental works and research with using the scheme "aircraft – vessel" and special investigations in the checked conditions at one of the PINRO experimental bases.