

Multi-spectral polarimetric SAR/SLR airborne studies of saline and fresh-water ice in the Russian Arctic

Vladimir Melentyev, Marina Shubina, Stein Sandven, Vladimir Chernook
NIERSC

vladimir.melentyev@niersc.spb.ru

The paper demonstrates some examples of the retrieving of ice cover parameters in the Arctic and sub-Arctic by using airborne multi-frequency polarimetric radar measurements. The research aircraft PINRO "Pomor" was equipped by following SLR/SAR instruments: 3,9 cm; 23,0 cm; 68 cm and 254 cm (all four devices allow to apply the different combination of polarization: VV, HH, VH, HV). This multi-spectral complex was testified as a prototype of future radar devices that should be installed onboard the Soviet Space Station "Almaz". Another multi-spectral SLR/SAR complex that was installed onboard research aircraft PINRO in 1980-90s was equipped by following radar instruments: 0,8 cm (VV, HH); 3,0 cm (VV); 23 cm (VV, HH, VH, HV) and 180 cm (VV, HH, HV polarizations). This multi-spectral complex was testified onboard the aircraft PINRO also for future installation onboard the different Soviet satellites (the "Okean" series). Now, at the beginning of XX1 century, the flying laboratory PINRO Antonov-26 "Arktika" is equipped by two-channel SAR instrument (L = 23,0 and 4,0 cm). The thematic interpretation of multi-frequency polarimetric radar data demonstrates the additional advantages of this information: it allows recognizing more numbers of ice types and fixing documentary variability not only first-year (FY) but also to reveal variability of the parameters of multi-year (MY) ice. Multi-frequency radar data open the possibility of sub-surface sounding of MY ice and reveal the vertical heterogeneity of sea ice at the second part of winter season (ice breccia). The airborne experiments in controlled conditions were provided in the central part of the Russian Arctic close to the border FY-MY ice (Frantz-Joseph Archipelago). The opportunity of revealing of origin of ice and history of ice formation and development as well the dividing of rafted and ridged ice zones inside the polynya will be demonstrated. Multi-frequency airborne polarimetric radar survey of the coastal zones in the Barents and the White Sea allows revealing the water masses arrangement as well to fix the frontal zone and eddy circulations. Special interest represents the examples of the revealing by SAR of the river-bed and continuation of river stream flow at the coastal zones of the Arctic marginal seas. This opportunity of application use of multi-spectral SAR open the perspective for study winter hydrology of the shallow waters and for optimization of minerals extraction on the shelf (these shallow waters are located at a distance from the routes traditionally used for navigation and are poorly studied as to ice conditions). The same situation is existed also with the knowledge of ice regime of inland water bodies during the freeze-up period. Our airborne SAR/SLR multi-spectral studies deal with the retrieving of the parameters of new ice and nilas type of lake ice. In absence of the in situ instrumental measurements of these types of ice it can be stated that in a number of involved productions the SAR survey advantages can be realized. The radar signatures of frazil ice, grease ice, slush, shuga, nilas (dark and light) and rind ice were investigated and classified during the initial stage of freeze-up season at the inland water bodies. Large advantage of airborne multi-spectral radar studies for the different limnological applications is the revealing of the manifestations of Langmuir circulations and fixing the fall-winter thermo-bar phenomena (the opportunity of remote diagnosis of last mentioned event has the fundamental meaning for limnology). The results of thematic decoding of airborne multi-frequency polarimetric radar observations will be accompanied and arranged by the present-day ERS/RADARSAT/Envisat SAR satellite data from NERSC/NIERSC/PINRO archive as well by and in situ measurements of ice cover parameters. It will be presented as a composite ice maps (CIMs), annotated legends and descriptions of the ice condition by the moment of SAR survey and in some cases with the retrieved history of ice formation.