USING DUAL-FREQUENCY PRECIPITATION RADAR AND RADIOMETER DATA FOR SEA ICE MAPPING

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Modern orbital radars are actively used for operational monitoring of the Earth’s surface. One of the tasks of remote sensing is to monitor the formation and destruction of sea ice cover. This information is crucial to ensure the safety of navigation, used in the preparation of meteorological forecasts and analysis of climate change. Currently, a number of methods has been developed for mapping of ice cover using radiometers, scatterometers, synthetic aperture radar and optical images. In the paper, we propose an algorithm for mapping of sea ice cover using space-borne dual-frequency precipitation radar data. It operates at low incidence angles, in a wide swath width, and has a resolution of 5 km.The dual-frequency precipitation radar, installed on the Global Precipitation Measurement core spacecraft operates at the two frequencies in Ku and Ka-bands. Measurements are carried out at incidence angles of less or equal to 18 degrees for Ku-band, and less or equal to 9.5 degrees for Ka-band. With an orbit altitude of about 400 km, the bandwidth is about 245 km, and spatial resolution is about 5 km. In the Northern regions, the frequency of observation of the same territory is approximately 1-2 days. The clouds do not affect the backscatter radar cross section, and pixels with presence of precipitation are excluded from the further analysis. It was shown in [1, 2] that the dependences of the backscatter radar cross section on the incidence angle for the water surface and ice cover have qualitative differences. During processing at the first stage of the algorithm, the type of dependence of the backscatter radar cross section on the incidence angle is analyzed [in the direction perpendicular to the direction of the motion], and the type of underlying surface is determined: water or ice. Exact determination of the boundary between water and ice is performed for each incidence angle, which corresponds to the direction along the track. The method used for image processing [3] and adapted for a one-dimensional problem is used to localize the "jump" position of the backscatter radar cross section. If the incidence angles are close to zero, the magnitude of the "jump" of the backscatter radar cross section is comparable to the noise level, therefore the position of the water-ice boundary in this area is interpolated. As a result, each element of the resolution in the swath is assigned with a status: water or ice. At this stage, we have analyzed individual tracks of the satellite over the Okhotsk Sea in December 2016. The marking of each track was carried out according to the algorithm described above, in total about 120 tracks were marked. The algorithm is validated using data from a radiometer onboard Global Precipitation Measurement core spacecraft, as well as optical images. A qualitative comparison of the ice cover boundaries obtained from dual-frequency precipitation radar data and radiometer measurements, as well as from optical images, confirmed the effectiveness of the new algorithm. In the future, it is planned to accumulate radar data for several days for ice cover mapping, as well as to obtain quantitative estimates of the quality of the algorithm.
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REFERENCES

1. Frank D. Carsey. Microwave remote sensing of sea ice, American Geophysical Union, 1992.

2. Karaev V.Yu., M.A. Panfilova, E.Yu. Meshkov, etc. Using of Dual-frequency precipitation radar data for

monitoring of formation and destruction of the Baikal Lake ice cover in Autumn-Summer period of 2015-2016, Sovremennye problemy distantsionnogo zondirovaniya Zemli iz kosmosa 2018. Vol. 15. N. 1.pp. 206-220.

3. J. Canny. A computational approach to edge detection, IEEE Transactions on pattern analysis and machine intelligence, vol. PAMI-8, November 1986.

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