Aufeis flow and assessment of their role in formation of hydrological regime of North-East Russia

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Aufeis are an indicator of the complex interconnection of river and groundwater in the permafrost conditions (Sokolov, 1975) and play important hydrological role. The aufeises may cover from 0.4 to 1.3% of basin areas in the Northeast of Russia reaching 4% in the basins of some rivers. In most cases, the share of the aufeis component of annual river flow is about 3-7%.

We have chosen for our research three catchments with available runoff data and the information on the location and characteristics of the aufeis within the selected catchments: the Charky river (8290 km2), Suntar river (7680 km2) and Anmangynda river (400 km2) belonging to the Yana, Indigirka and Kolyma River basins respectively.

Initial information on aufeis locations within the catchments was adopted from the Cadaster of the aufeis of the North East Siberia of the USSR (1958) and specified by topographic maps and satellite images. Satellite imagery was used also to assess the inter-annual and seasonal dynamics of aufeis within the period of 1999 to 2017. Preliminary comparison of the Cadaster and satellite data at the Charky river basin has shown that some large aufeis are absent in the Cadastre and at the same time there were aufeis which presently are absent in the satellite images. This may indicate the dynamics of aufeis processes in this region which is studied together with meteorological data.

There are no complex hydrological models that take into account the role of aufeis in the river runoff generation in an explicit form. We developed and included such algorithm in the Hydrograph model (Vinogradov et al., 2011). The Hydrograph model is suitable for a remote gauged region such as Arctic domain as it allows for a priori assessment of the model parameters.

The method of Sokolov to calculate aufeis flow was used and adapted. The method makes it possible to calculate the hydrograph of aufeis-runoff for a long period and individual years. The following initial data are required for calculating the aufeis runoff by this method: the dates of the transition of the mean daily air temperature through 0 in the spring and in the autumn; the sum of positive average daily air temperatures for periods of 10 days; the maximum area of aufeis at the end of winter; the altitude of the aufeis location. The limitations of the method are that the refinement of the values of the parameters of the calculation formulas proposed by Sokolov is practically impossible because of the lack of observational data on the aufeis.

As a preliminary result, average calculated values of annual aufeis flow is 13.2 % (31.5 mm) at the Charky river and 9.2 % (17.4 mm) at the Suntar river which puts aufeis on the one level with such important objects in the runoff formation as the glaciers.

We are going to discuss the results of 1) satellite imagery analysis and the assessment of aufeis dynamic and 2) hydrological modelling with the account of aufeis input into runoff generation.