Accuracy assessment of remote sensing snow cover area data of various spatial and temporal resolutions on the example of the Kamchatka river basin

Avdeevich D.A., Georgievsky M.V.
Saint Petersburg University, Department of Hydrology
E-mail: avdeevich.diana@mail.ru

Introduction. Accumulation and melting of snow cover are one of the main processes of runoff formation on a catchment. One of the most important characteristics in modeling snowmelt process, as well as forecasting the volume of melt runoff, together with meteorological data (air temperature and precipitation), is the area of snow cover. Remote sensing data of the earth's surface nowadays are widely used in hydrometeorology, including modeling the process of snow melting. A separate area of research in this case is the comparison of satellite information products and selection the most representative database of distribution snow cover for the study area.

Description of remote sensing databases used in work

The main criteria for choosing a source of satellite information were free access to data, high spatial resolution, global coverage and using active satellites. According to [Georgievsky M. V. Application of the Snowmelt Runoff Model in the Kuban River Basin by using MODIS satellite images, 2009] MODIS have significant advantages.

Table 1. The main characteristics of remote sensing databases used in work

Attributes	Northern Hemisphere EASE-Grid 2.0 Weekly Snow Cover and Sea Ice Extent, Version 4.1 (NSIDC-0046)	MODIS/Terra Snow Cover, Global 0.05Deg CMG, Version 6 (MOD10C1, MOD10C2)	MODIS/Terra Snow Cover, Global 500m SIN Grid, Version 6 (MOD10A1, MOD10A2)
Land coverage	Northern Hemisphere	Global	Global
Spatial resolution	25 km× 25 km	5 km × 5 km	500 m × 500 m
Data period	1966 – 2015	2000 – until now	2000 – until now
Temporal resolution	7 days	Day, 8 days	Day, 8 days
Satellites	GOES, AVHRR, Nimbus-7 SMMR, DMSP SSM/I-SSMIS	Terra	Terra

NHWSC data cover the longest series of observations: from 1966 to 2015, which makes it possible to use them in the analysis of climate change. A more detailed description of the databases can be found on the website of the National Snow and Ice Data Center (NSIDC https://nsidc.org/).

Comparative analysis of remote sensing data

Seven-day NSIDC-0046 data records about 100% snow cover from November to May (Fig. 1). Snow cover according to MOD10C2 for 2000-2007 observed throughout the year. During the summer period (VI-VIII), snow cover makes up about 13% of the basin's territory. Accumulation of snow cover according to MOD10C2 data is observed earlier: from September, according to NSIDC-0046 data - from October.

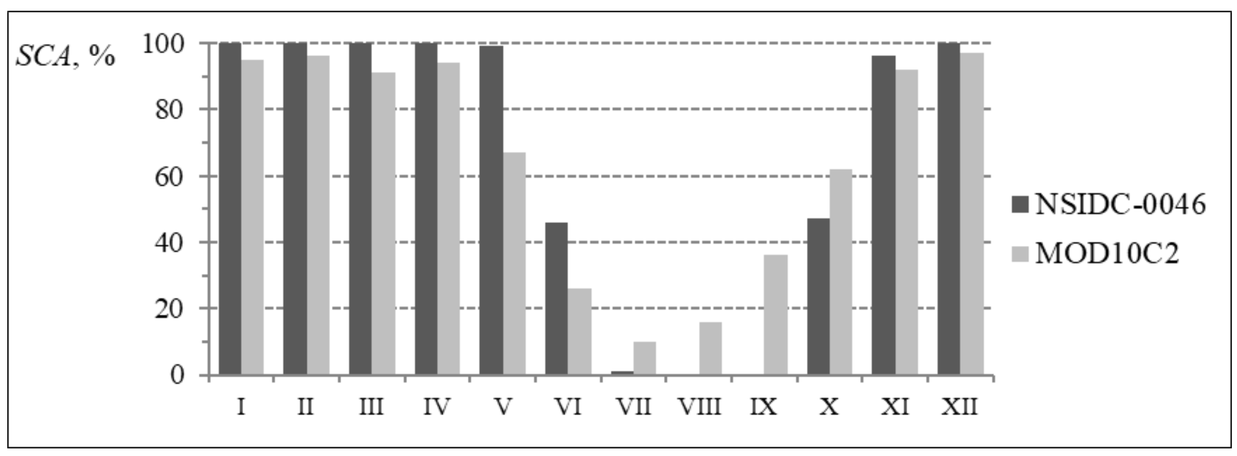

Figure 1. Average monthly values of snow cover area according to NSIDC-0046 and MOD10C2 data for the period 2000-2007 for the Kamchatka river basin

Daily MODIS CMG data for the period from 2008 to 2009 were analyzed. The distribution graphs of snow cover and cloud cover within the Kamchatka basin are intermittent. Cloudiness on some days reaches 100% and fluctuates within wide limits (Fig. 2), which complicates using MOD10C1 in modeling. Since the MOD10C1 data are based on the MOD10A1 data, a similar conclusion can be made about the daily 500-meter MODIS data (MOD10A1). Thus, it was decided to use the eight-day MODIS data as input for modeling. They reflect maximum distribution of snow cover with minimum cloud effect. Daily snow cover area data were interpolated from eight-day baseline values.

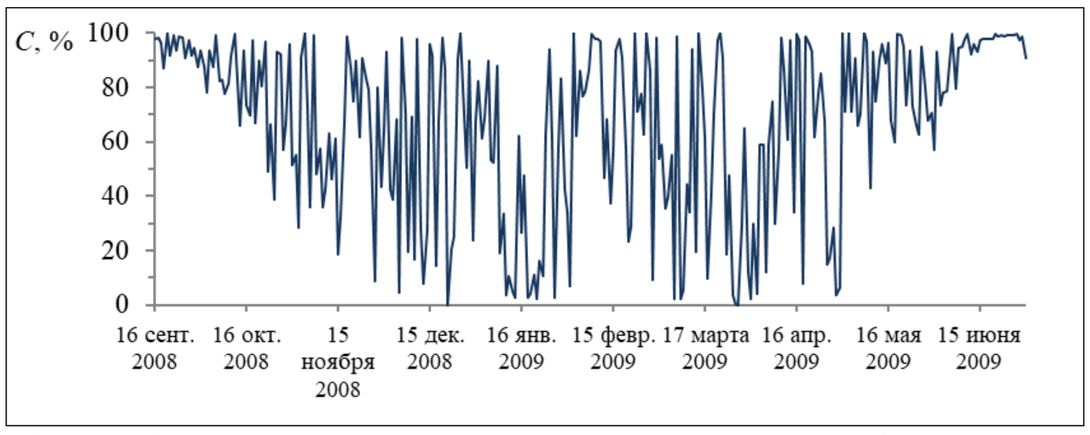

Figure 2. Graph of cloudiness in the Kamchatka river basin according to daily data MOD10C1

Modeling the Kamchatka melt runoff using Snowmelt Runoff Model (SRM)

Figures 3 and 4 show the simulation results based on MOD10A2 and MOD10C2 with the same parameters.

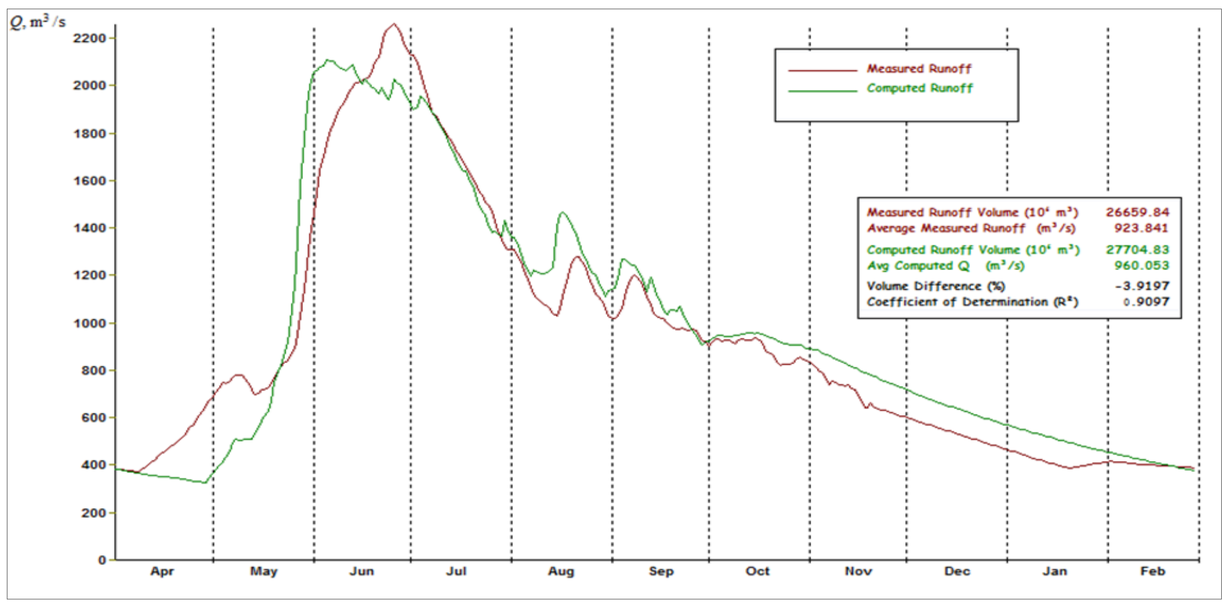

Figure 3. Observed (red) and simulated (green) hydrographs in the Kamchatka - pos. Klyuchi for the period 2005 - 2006 according to MOD10A2 data

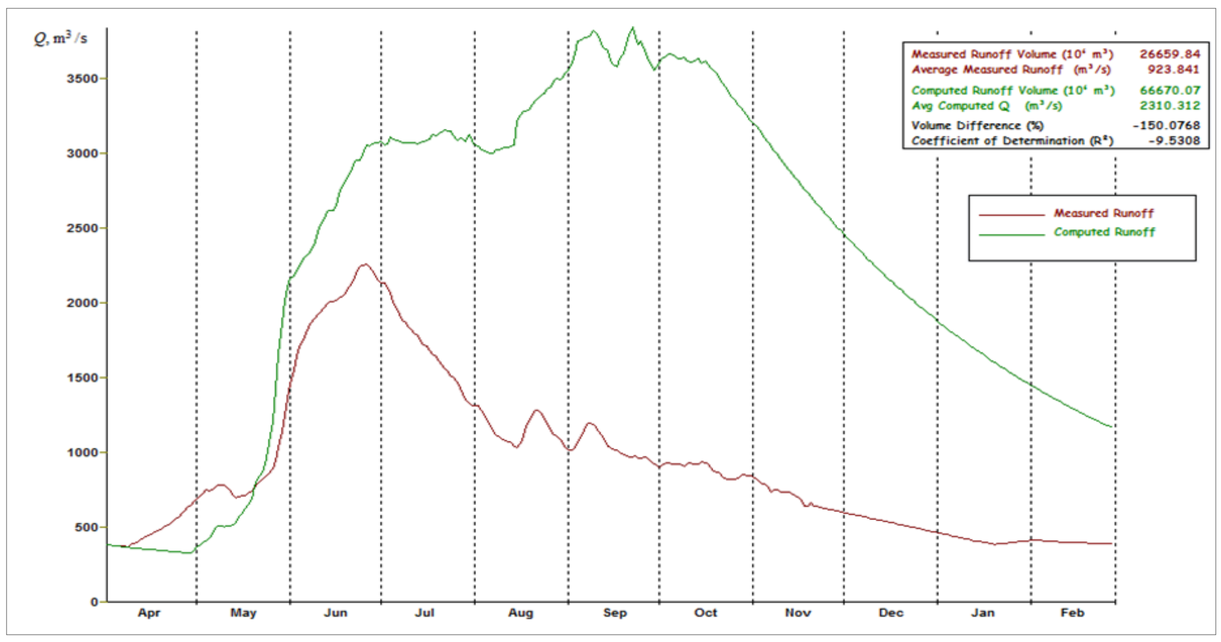

Figure 4. Observed (red) and simulated (green) hydrographs in the Kamchatka - pos. Klyuchi for the period 2005 - 2006 according to MOD10C2 data

On the second hydrograph there are two peaks of high water: summer (June-July) and autumn (September). The increased water availability in summer is related to the MODIS CMG registration of snow cover throughout the year, including in June-July 2005. At the same time, the accumulation of snow according to MOD10C2 begins in August, and according to MOD10A2 from September to early October (Fig. 5). The air temperature drops below 0 ° C in October. Snow recorded by MOD10C2 data from August to October is perceived by the model as precipitation facilitating runoff and forms a second autumn peak due to the melting process.

Figure 5. Graphs of daily snow cover area according to MOD10A2 and MOD10C2 data and air temperature for the simulated period 2005 - 2006

A significant percentage of snow cover in May and June according to NSIDC-0046 data provides a high peak flood in early July. The beginning of snow accumulation according to NSIDC-0046 match with the transition of air temperature through 0 ° C and occurs in October.

Conclusion. Comparative analysis and simulation results showed that higher spatial resolution (500 m) eight-day MODIS data (MOD10A2) are preferred for the SRM model. A more detailed analysis of remote sensing data, stages and features of modeling, as well as an assessment of snow cover together with climatic changes analysis for the Kamchatka river basin are presented in the thesis: Snowmelt modeling in the Kamchatka river basins in the current climate change conditions.