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Application of MODIS LST and Aurface Air Temperature Data for Snow Cover Analysis in Georgia

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ABSTRACT

MODIS global Land Surface Temperature (LST) and Emissivity 8-day L3 Global 1 km and surface air temperature data measurements of different meteorological stations were used for analysis of snow cover in Georgia. It was shown that application of snow cover map correction algorithms based only MODIS Snow product data and algoritms with addition of LST and surface air temperatures give almost the same result. It was supposed that for snow cover map correction MODIS snow product data are quite enough and no additional correction is nessesary.

Keywords: aurface air temperature, snow cover, MODIS

The 8-day composite MODIS Terra snow product (MOD10A2) was used for snow cover analysis in Georgia for 14 hydrological years (September 2000- June 2014) [1]. The snow products were generated by the NASA Godard Space Flight Center and made available by the National Snow and Ice Data Center (NSIDC), Colorado, USA [2].In the MODIS Terra snow product (MOD10A2) Snow covered areas are mapped as a Maximum Snow Extent. The second dataset of MOD10A2 files, Eight Day Snow Cover was used to correct contaminated pixels.

It should be noted that the MODIS 8 day composite snow products must be handled carefully. Fig. 1a shows that in the image of snow cover for September, 2010, there are some "contaminated" pixels, corresponding to the snow covered areas in Kolkheti region.Second dataset of MOD10A2 snow data, Eight Day Snow cover Gives possibility to make some corrections. Applied algorithm supposes, that pixels marked as "snowy" with duration of only one day may be marked as "cloudy", i.e. free of snow pixels.

From the other hand, application of discontinuities enhancement Laplace filter (3x3) to the snow cover map detects border of snow cover area. Resulted border may be layed over Terra Aster DEM (preliminary downgraded to MODIS Terra snow product spatial resolution – 500 m).Resulted border was layed over Terra Aster DEMand histogram of border pixel elevation may be obtained. Therefore the stable snow border mean elevation may be determined.

Application "one day snow pixel" algorithm on snowy pixels with elevations less than stable border mean elevation cleans "dirty pixels" and gives much more better result, represented on the Fig. 1.b.

Additional correction may be performed with application of ground measurement data, snow observations and especially air temperature distribution. This kind of correction also gives possibility to filter contaminated pixels and get more correct results.

For this purposeLand surface temperature satellite data and the air temperature ground measurement data were used.MODIS global Land Surface Temperature (LST) and Emissivity 8-day L3 Global 1 km (MOD11A2) data were applied for analysis of land surface temperature fields [3]. Air temperature data measurements of different meteorological stations in the East and West Georgia were used also.

The September-June of 2010-2011 hydrological year Air temperature measurement data of 9 meteorological stations were kindly provided by by the National Environmental Agency of Georgia (NEA). Geographical coordinates, also altitudes of these stations are shown in Table 1.

At all mentioned stations air temperature measurements are provided 8 times per day (00.03.06.09.12.15.18.21 UTC). The MODIS local passing time is about 10:30 and 22:30 and we selected corresponding surface observation data measured at 06:00 and 18:00 UTC.

Table 1

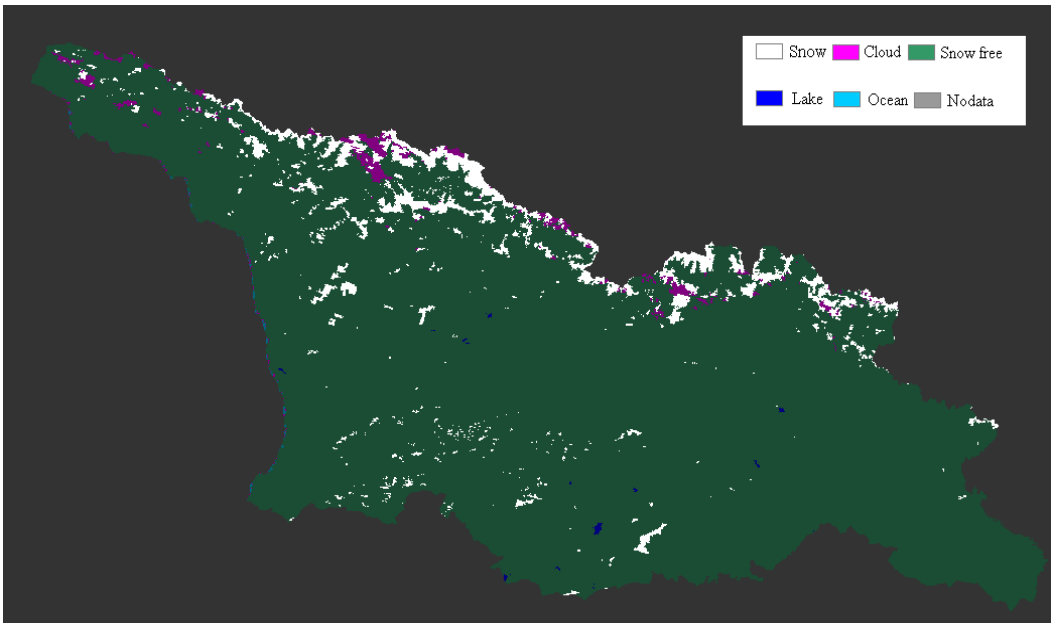
No	Station name	Latitude	Longitude	Elevation
1	Kutaisi	42°16´ N	42°38´ E	116
2	Zugdidi	42°30´ N	41°53´ E	117
3	Tbilisi	41°45´00´´ N	44°46´10´´ E	428
4	Bolnisi	41°27´ N	44°33´ E	534
5	Ambrolauri	42°31´ N	43°09´ E	544
6	Telavi	41°55´41´´ N	45°30´44´´ E	566
7	Gori	41°59´ N	44°07´ E	612
8	Pasanauri	42°21´ N	44°42´ E	1064
9	Mtasabueti	42°02´ N	43°29´ E	1245

Investigation of statistical relationship between 8-day Terra MODIS LST and meteorological data of surface air temperature were performed by using 280 observation data of 9 meteorological stations for September-June period of 2010-2011 hydrological year. Mean air temperature for each 8-day MODIS LST dataset were calculated from daily surface air temperature measurements and only clear sky data were taken into account. Results of Linear regression analysis is given on Fig. 2

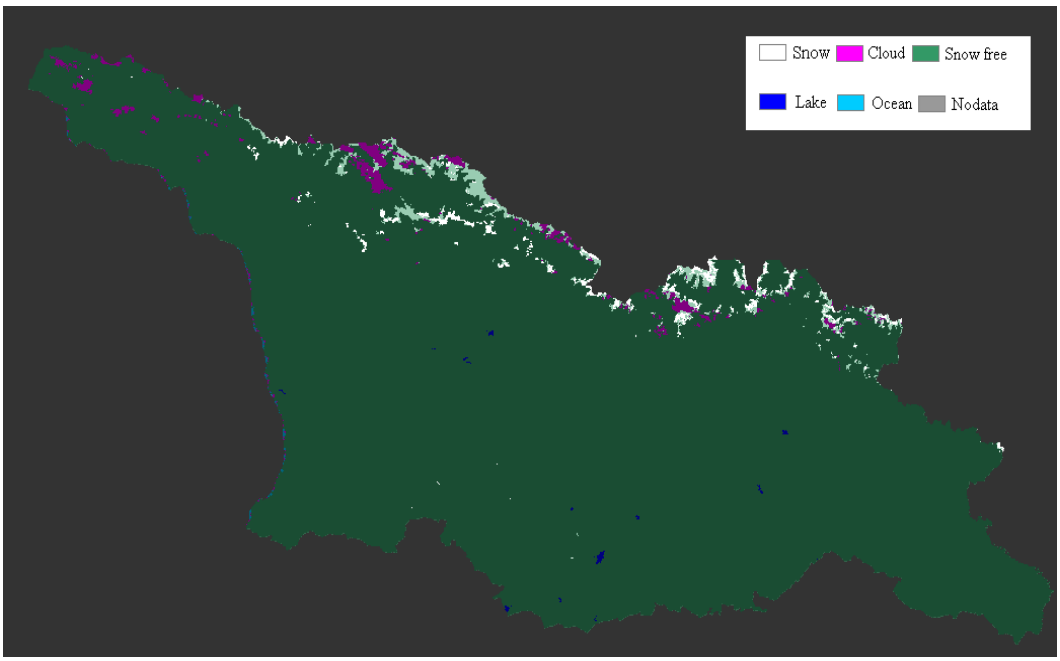
The estimated air temperature values were calculated according to the regression equation and corresponding temperature maps were created. Both MODIS LST and estimated air temperature data were used for snow cover map correction analysis.

Application of LST and estimated air temperature (T_o) parameters for Snow cover map correction and "dirty pixel" clearing supposes use of "one day pixel" filter for LST > 0 ^oC area. Fig. 3 shows results of all applied corrections.

Comparison of Fig.1, Fig 3 and Fig. 4 shows that there is no significant difference between results of application of "dirty snow pixel" filter algoritms based only Tera MODIS Snow product data and algoritms with addition of Terra MODIS LST and surface air temperature meteorological data.

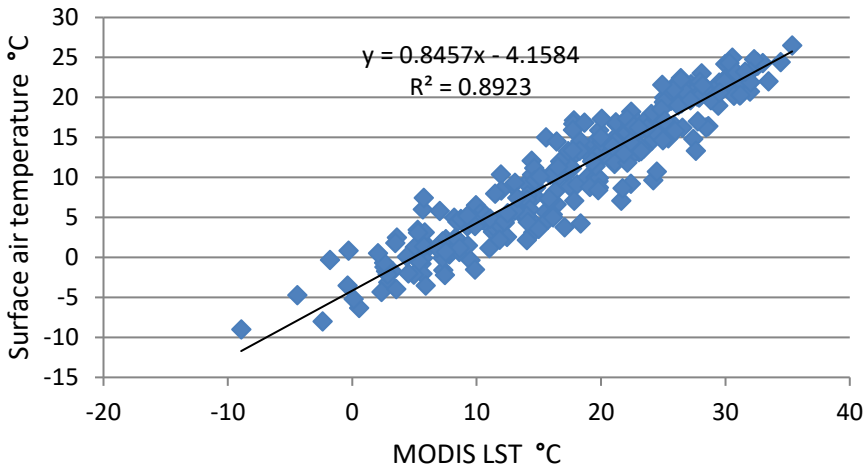


a. Before correction



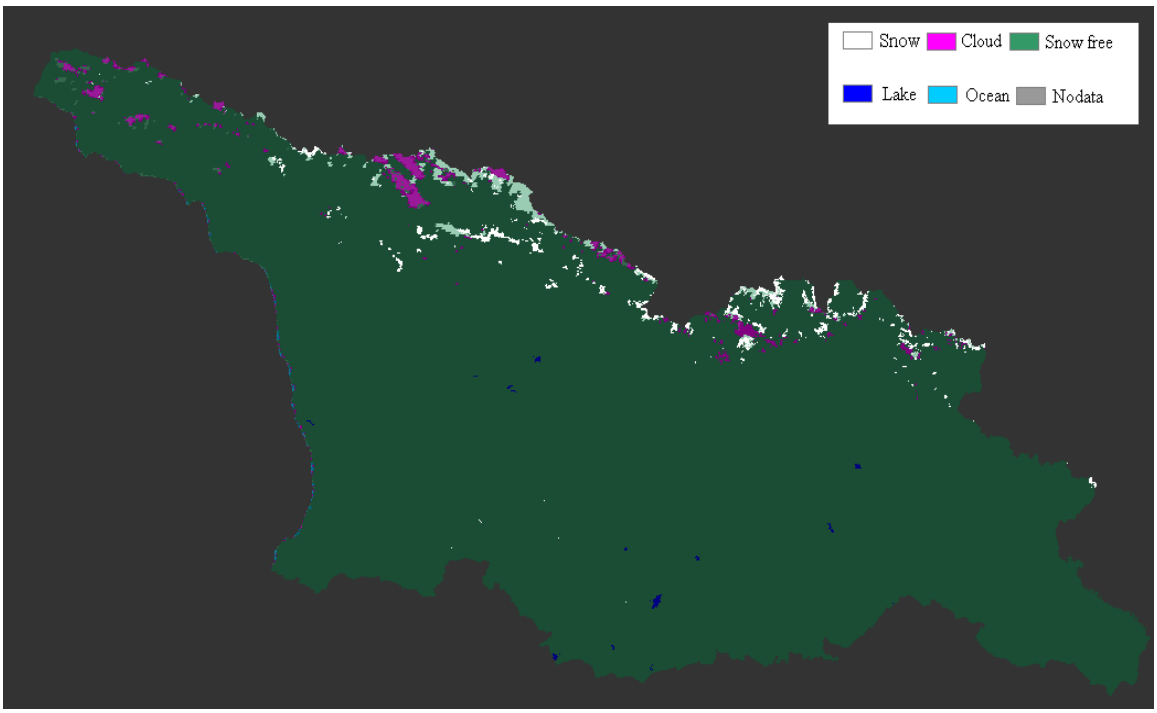
b. After application of "one day snow pixel", "stable snow line elevation" algorithm

Fig. 1. Snow Cover images 2010, 16 of October, before and after correction

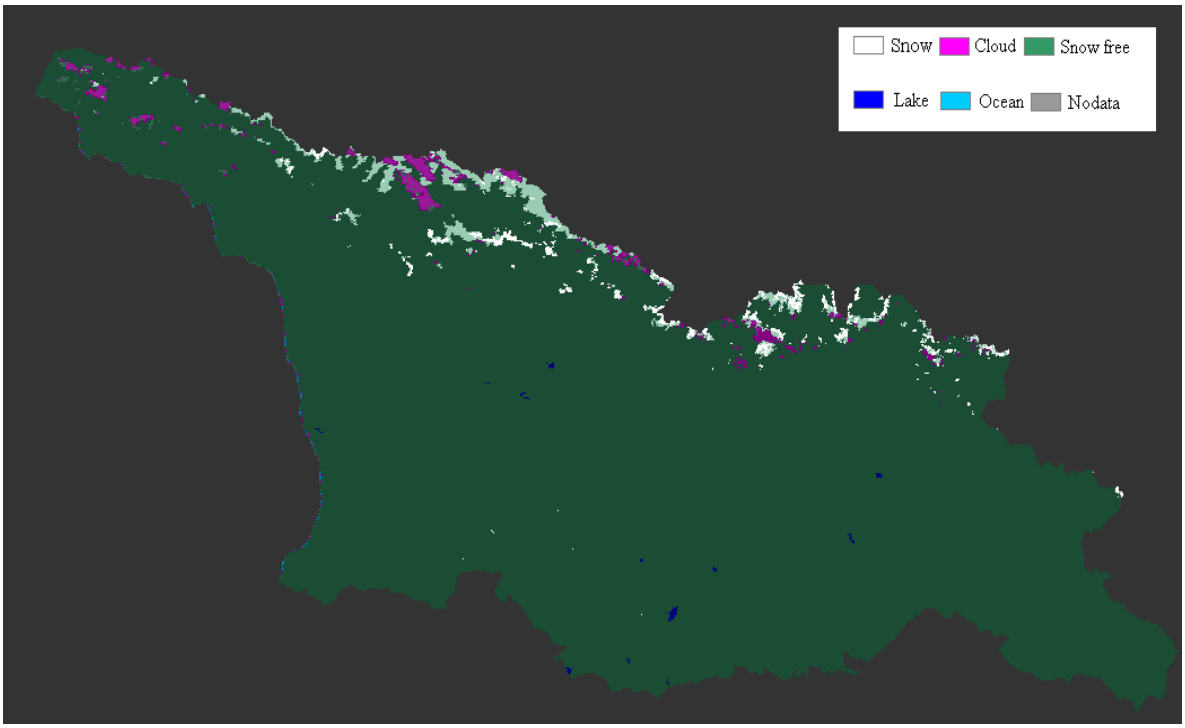


Regression Statistics	
Multiple R	0.9446 34
R Square	0.8923 33
Adjusted R Square	0.8919 46
Standard Error	2.6014 37
Observations	280

Fig. 2 statistical relationship between 8-day Terra MODIS LST and meteorological data of surface air temperature

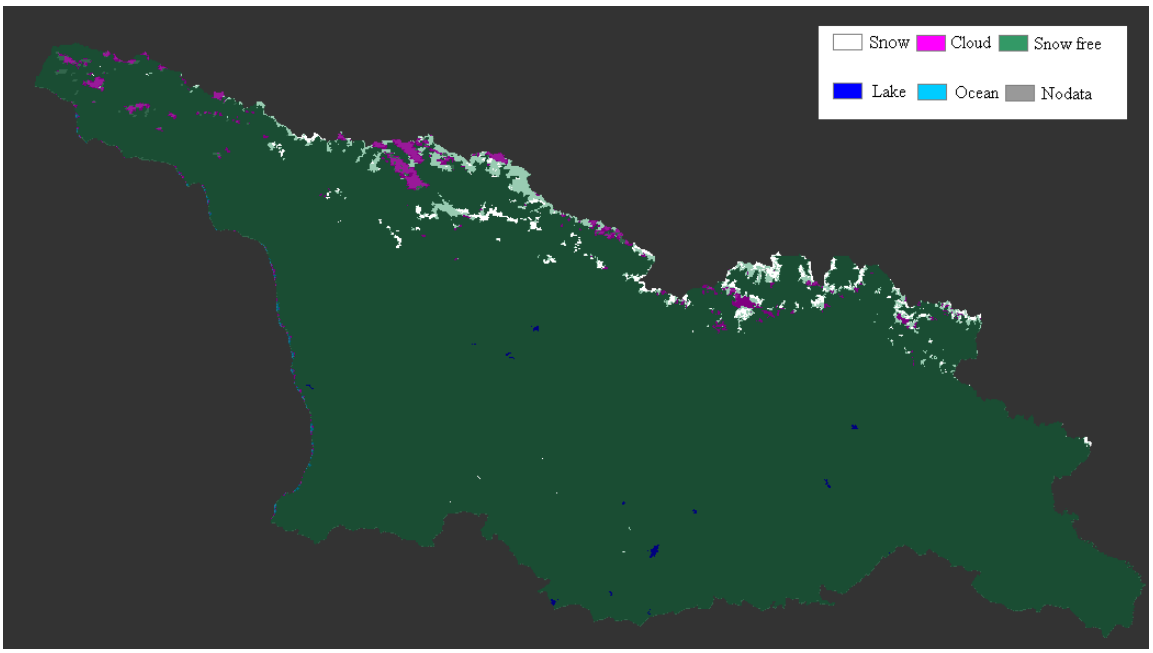


a. “One day snow pixel”, “LST > 0 ºC”

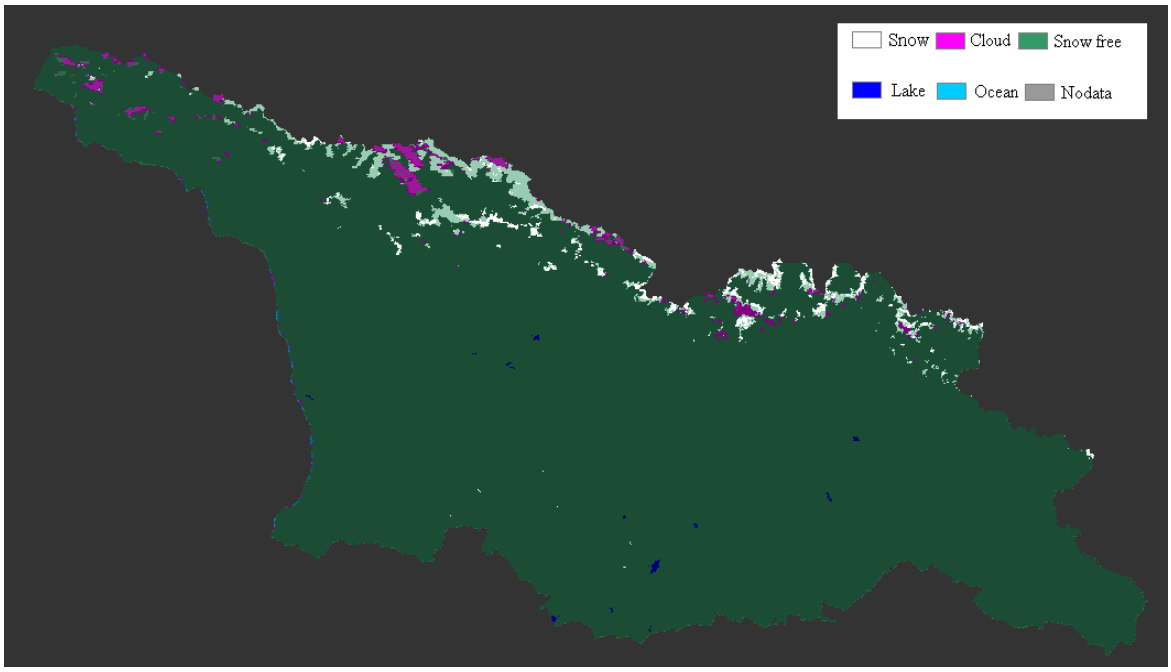


b. “One day snow pixel” and “T_o> 0 ºC”

Fig. 3. Result of application of “one day snow pixel”, “LST > 0 ºC” and “T_o> 0 ºC” algorithms on 2010, 16 of October snow cover image



a. “One day snow pixel”, “stable snow line elevation” and “LST > 0 ºC”



b. “One day snow pixel”, “stable snow line elevation”, “LST > 0 ºC” and “T_o> 0 ºC”

c.

Fig. 4. Result of application of “one day snow pixel”, “stable snow line elevation”, “LST > 0 ºC” and “T_o> 0 ºC” algorithms on 2010, 16 of October snow cover image.

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MODIS სენსორის ქვეფენილი ზედაპირის ტემპერატურისა და ჰაერის ტემპერატურის მეტეოროლოგიური მონაცემების გამოყენება საქართველოს თოვლის საფარის ანალიზისათვის

გ. თვაური, ნ. ლომიძე, ტ.ჯინჯოლია, კ. ქორიძე

რეზიუმე

საქართველოს თოვლის საფარის ანალიზის მიზნით გამოყენებული იქნა MODIS სენსორის ქვეფენილი ზედაპირის ტემპერატურისა და გამოსხივების 8-დღიანი გლობალური L3 დონის 1 კმ სივრცითი გარჩევითობის და აგრეთვე მეტეოროლოგიური სადგურების ჰაერის ტემპერატურის გაზომვის მონაცემები. ნაჩვენები იქნა, რომ მხოლოდ MODIS სენსორის თოვლის საფარის მონაცემების საფუძველზე განხორციელებული კორექტირების ალგორითმები და ქვეფენილი ზედაპირისა და ატმოსფერული ჰაერის ტემპერატურის გამოყენებაზე დაფუძნებული ალგორითმების შედეგები თითქმის არ განსხვავდება ერთმანეთისაგან. მიღებული შედეგების თანახმად, თოვლის საფარის კორექტირების მიზნით MODIS სენსორის თოვლის საფარის მონაცემების გამოყენება სავსებით საკმარისია და დამატებითი კორექტირება აუცილებელი არ არის.

Применение данных температуры подстилающей поверхности MODIS и метеорологических данных температуры воздуха для анализа снежного покрова Грузии

Г.А. Тваури, Н.Н. Ломидзе, Т.Д. Джинджолия, К.Дж. Коридзе

Резюме

Для анализа снежного покрова Грузии были использованы данные MODIS LIST и метеорологические данные измерений температуры атмосферного воздуха у земной поверхности. Было установлено, что результат применения алгоритмов коррекции карт снежного покрова, основанных только на данных дистанционного зондирования и алгоритмов с применением данных температуры подстиляющей поверхности земли и температуры воздуха у поверхности земли незначительно отличаются. Было предположено, что для коррекции карты снежного покрова вполне достаточно применение только данных MODIS и нет необходимости в проведении дополнительной коррекции.