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Interrelation Between In-situ Measured LST and LAT and Landsat Thermal data in the Tunkinskaya Valley

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1. Introduction

LST and LAT are important climate characteristics. They can be evaluated best-attested with the use of meteorological stations data. But meteorological stations in Tunkinskaya intermontane hollow are situated in a flat open places. It is difficult to investigate the climate of mountain regions on the base of this data.

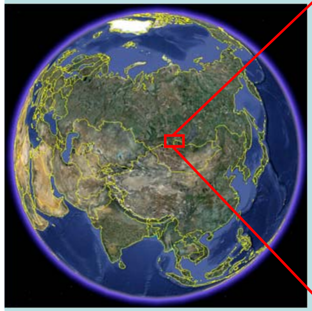
Recently the methods of remote evaluation of land and ocean surface temperature with the use of space images are developing. It makes possible detailed investigation of spatial temperature field at a territory. Ground measurements of temperature at meteorological stations and during field works don't give such possibilities.

Lansat data is used because spatial resolution (60 m) allows to investigate microclimate of a territory on local level.

The final goal is investigation of a temperature regime of different landscapes and spatial-temporal variability of air and surface temperature of a territory using in-situ and remote sensing data.

The aim of current investigation is to compare Landsat and in-situ data about LST and LAT.

2. Study region



The Tunkinskaya intermountain hollow is located in the South of Eastern Siberia

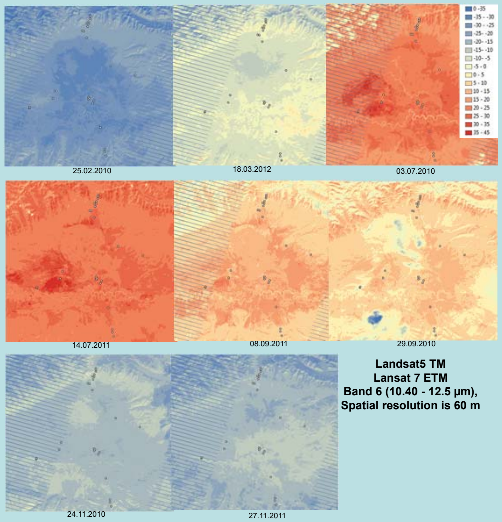
Average annual and monthly air temperature ° C (data of Arshan meteostation)

Month												Average annual temperature
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
-20	-16	-8,4	0,3	7	13	16	13,6	7	-0,1	-11	-19	-1,4

The Tunkinskaya intermountain hollow belongs to the Baikal type of hollows. It includes the valley and its mountainous borders - the Tunkinskie Goltsy Ridge and the Khamar-Daban Ridge

3. Landsat thermal data

18 images for the period from 2010 to 2012



Landsat5 TM
Lansat 7 ETM
Band 6 (10.40 - 12.5 μm),
Spatial resolution is 60 m

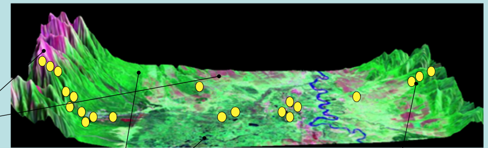
4. In-situ observations (locations of sensors)

Landscapes of the Tunkinskaya Valley

Steppe and pastures

Alpine tundra and goltsy

Peat lands



Electronic temperature sensors (thermochrones) were used for measurement of LAT (20 points, period 2010-12) and LST (2 points for period 2011-12, 7 points for period 2012-13). The sensors recorded air temperature every 3 hours simultaneously with routine measurements at meteorological stations.
Choice of key areas was made taking into account the landscapes characteristics. We study a cross-section through the Tunkinskaya Hollow that includes the bottom of the Hollow and its mountainous border - southern exposure of the Tunkinskiy Ridge. The thermochrones are located at altitudes from 806 to 2119 m a.s.l. The complex landscape study had being conducted along the meteorological observations.

Temperature sensors – Termochrones

Needle-leaved forest (pine and larch)

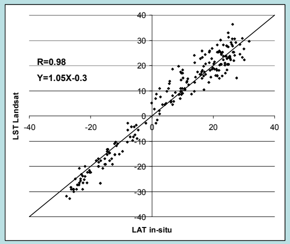
Broadleaved forest (birch and asp)

5. Results

5.1. LAT (insitu) and LST (Landsat) interrelation

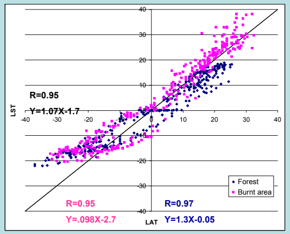
For each point and Landsat survey data d=LST(Landsat)-LAT(in-situ) (for 18 moments of time for 18 points of space for the period from 2010-2012) was calculated
Dependence d from type of land cover from season was investigated

				Dates of Landsat survey																		
In-situ points			year	2010											2011					2012		
			day	16	9	25	30	1	3	11	19	27	29	24	1	14	8	2	27	25	18	
			month	1	2	2	4	6	7	7	7	7	9	11	4	7	9	10	11	8	3	
			$d_{j\,aver}$	3,4	3,3	2,9	4,3	4,0	2,8	3,3	3,6	5,1	2,0	1,5	4,5	2,7	3,3	0,9	0,9	3,1	2,5	
			dij min	0,7	1,3	0,1	1,0	1,4	0,2	1,1	0,3	0,5	0,2	0,1	0,2	0,3	0,1	0,2	0,7	0,4	1,0	
			dij max	9,8	6,5	5,4	7,1	9,9	6,3	10,2	7,2	12,6	7,1	4,2	11,8	5,8	11,0	8,3	1,0	9,4	4,9	
point	Height	points description	NDVI	The difference (d) between Landsat LST and in-situ LAT data																		
T15	996	aspen forest	0,80112	-4,0	-6,5	-5,4	-1,1	2,1	-0,7	-2,1	7,2	5,3	-0,7	-4,2	-1,7	-4,5	1,4	-0,4	-3,9	1,2	-4,1	d<1
T14	1064	aspen forest	0,797347	-4,6	-3,1	-0,2	1,5	2,9	-1,1	-1,8	5,4	4,8	-0,2	-3,3	1,9							1<d<3
T24	920	aspen-larch forest	0,781566										-1,3	0,1	4,6							d>3
T13	1203	larch forest	0,727458	-4,3	-3,7	-2,4	-6,6	1,6	-2,4	-2,8	-6,9	-12,6	-2,2	3,8	3,3	-4,8	-1,4	-1,2	-2,7	-1,5	-2,3	
T23	763	pine forest	0,673342										1,2	-0,8	3,3							
T10	1690	siberian cedar forest	0,647472	-2,0	2,9	1,8	-4,0	4,9	2,8	1,1	-3,1	5,5	2,0	-0,2	5,5	0,3	5,0	7,3	-1,1	2,7	2,4	
T 11	1040	pine forest	0,643183	-2,4	-1,3	-4,8	2,5	1,4	0,5	10,2	-1,8	4,9	-0,4	1,2	4,7	-1,8	1,6	-0,8	-6,4	0,4	-4,3	
T20	803	pine forest	0,643012	-2,4						3,4	6,3	7,0										
T8	1145	betula forest	0,620141										-1,0	0,1	5,7	-1,8	0,5	0,3	-1,6	1,4	1,6	
T22	775	pine forest	0,607351										0,3	0,5	-0,2	-3,0	0,1	-0,4	-0,8	3,8	-1,1	
T7	928	betula forest	0,604813	0,7	-1,5	-2,1	-1,0	-1,4	-2,0	-2,8	7,0	-6,2	-2,2	1,3	1,1	3,4	-1,0	0,2	-0,8	-0,9	-1,1	
T1	791	pine forest	0,498893	3,1	-2,9	-2,9	3,2	4,5	3,7	1,2	-1,3	4,2										
T6	787	pine forest	0,461422	-2,4	-1,8	0,1	6,9	1,8	3,9	3,5		3,7										
T4	1386	pine-larch sparse forest	0,726893										1,0	1,5	7,2	-1,0	1,6	3,0	-1,0	0,8	-1,0	
T9	1923	siberian cedar sparse forest	0,570283	3,5	-2,2	-1,4	4,2	7,8	6,9	3,2	3,8	0,5	2,2	1,1	0,4	2,3	7,9	7,0	0,5	7,2	1,6	
T5	737	meadow ground	0,716981	-1,2	3,4	4,3	6,9	3,6	3,6	2,6	-0,4	4,1										
T16	737	steppe	0,656763	3,5	6,0	4,6	7,1	8,2	3,2	2,3	-1,6	4,5	7,1	0,5	11,8	-0,4	11,0	8,3	-0,7	9,4	4,9	
T17	722	sandy area	0,28469	9,8	4,1	4,5	6,6	9,9	6,9	6,1	-0,3	-2,2				3,3	8,2	4,7	3,3	6,7	2,3	

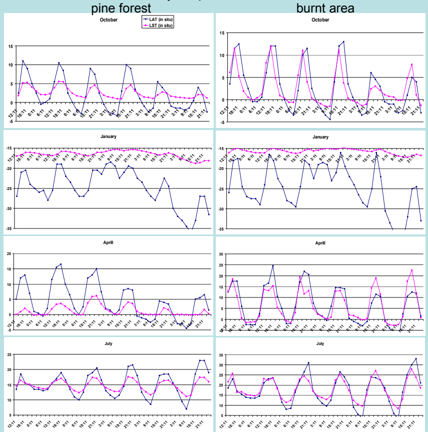


5.2. LAT (in-situ) and LST (in-situ) interrelation

Analysis for 2 points for period 2011-12

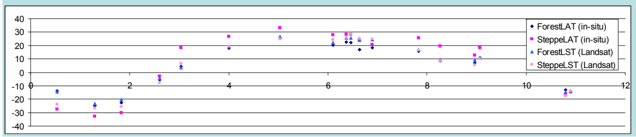


Daily temperature variations

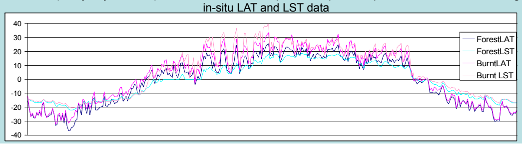


Year temperature variations

For 18 moments of time for 2 points of space for period from 2010-2012 using in-situ LAT and Landsat LST data



For 365 (every day at 12:00) moments of time for 2 points of space for period from 2011-2012 using in-situ LAT and LST data



6. Summary and research perspectives

- Dependence between LST(Landsat) and LAT(in-situ) are complex and specific for each season and landscape. d changes from 0 to 12 degrees. Average *d* for all points and dates is about 3 degrees and varies from 0,9 to 12. Minimum values d (1-3) are in autumn, winter and early spring, maximum values d (3-5,5) are from April till September. Territorial analysis shows that maximum values d (7-12) are in opened places (steppe, sand, goltsy).
- Difference between in-situ LST and LAT more for forest area and for winter period.
- Difference between LST(Landsat) and LAT(in-situ) are connected with: 1) difference between LST(in-situ) и LAT(in-situ); 2) emissivity; 3) other reasons.
- Future work: 1) measuring LST in-situ; 2) measuring brightness in-situ temperature; 3) calculating and considering of emissivity.

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