LIGHTNING LOCATION NETWORK ON THE EUROPEAN TERRITORY OF RUSSIA

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ABSTRACT

In 2010-2013 Voeikov A.I. Main Geophysical Observatory developed Lightning location Network on European territory of Russian Federation. 45 Lightning Sensors effectively receive, process lightning emitted signals and transmit information to computing center "Alwes 9.07". Central Servers in real time receive data from the sensors, calculate lightning strikes coordinates, transfer results to SQL DataBase, control network, overlay lightning location and meteorological radar data. Lightning detection efficiency achieves 90%, positioning accuracy is about 1 km within the network.

In the 2014-2020 MGO is planning to expand the network to the territory of the Urals, Siberia and the Far East.

For building up a Lighting location Network of Federal Service of Russia on Hydrometeorology and Monitoring of the Environment (Rosgidromet of Russia) the Thunderstorm Sensors «Alwes 7.04» (Sensor) are used. The Sensors location map is given in the Fig.1. The sensors ensure the registration of the waveforms of EMP of lightning strikes in the very low frequency range at the distance up to 1000 km, the affixment to the GPS time signals, the signal amplitude measurement, estimating the polarity and the length of the leading edge and the length of the first half-wave.

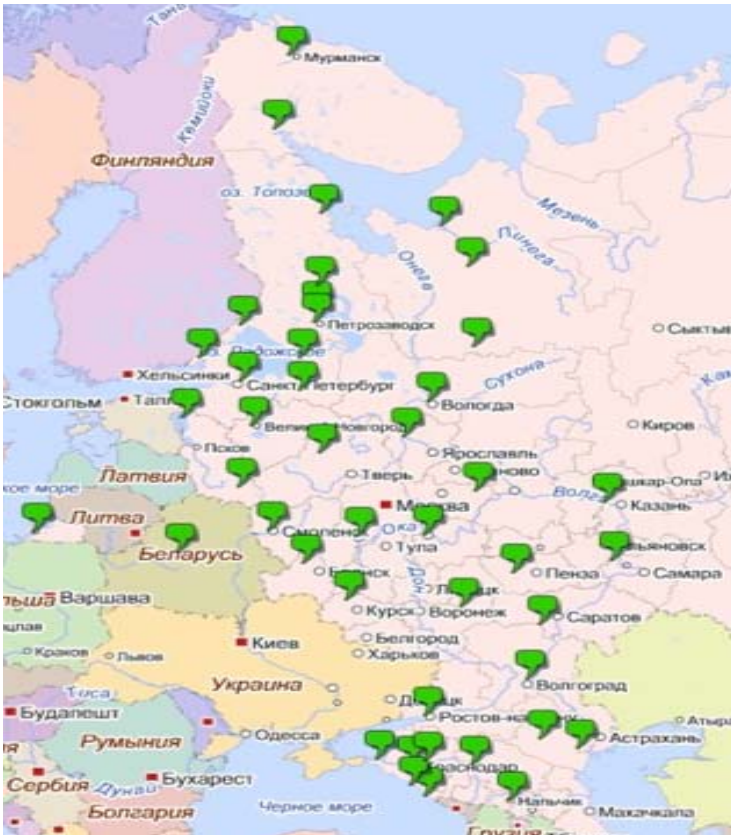

Fig.1. Sensors location map on the European part of Russia.

The network includes 45 Sensors, the computing center «Alwes 9.07» with special software. The software «Server 9.3.03» carries out the data collection from the Sensors, calculates the geographic coordinates of the lightning strikes, passes them on to the SQL-server and displays the Sensors status.

The software «Server 9.5.03» is meant for providing the information from outsourced manufacturers (WSR, AES) to the MS SQL Server and the MySQL server of the web site www.lightnings.ru, and also for performing some extra service functions. The software «Client 9.7.03» is meant for the visualization of the thunderstorms registration data. For the calculation of the coordinates of the lightning strike the time of arrival method is used.

Fig.2. shows the field research data on the effectiveness of the detection of the lightning strikes by the Lightning Network

depending on the distance between two points. The diagram shows that the probability of detecting the lightning strikes when the distance between two sensors is up to 300km is more than 90%.

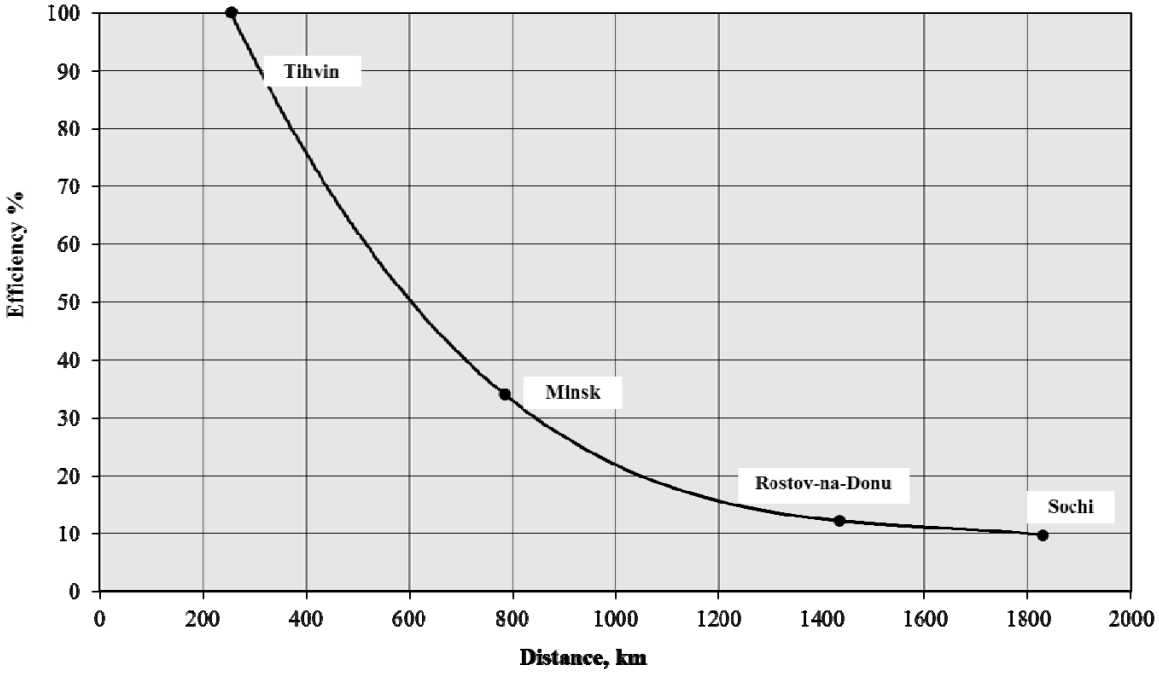

Fig.2. Dependence between the probability of detecting lightning strikes and the distance between two sensors.

Fig.3. shows the results of the field research on the coordinates of the lightning strikes measuring errors.

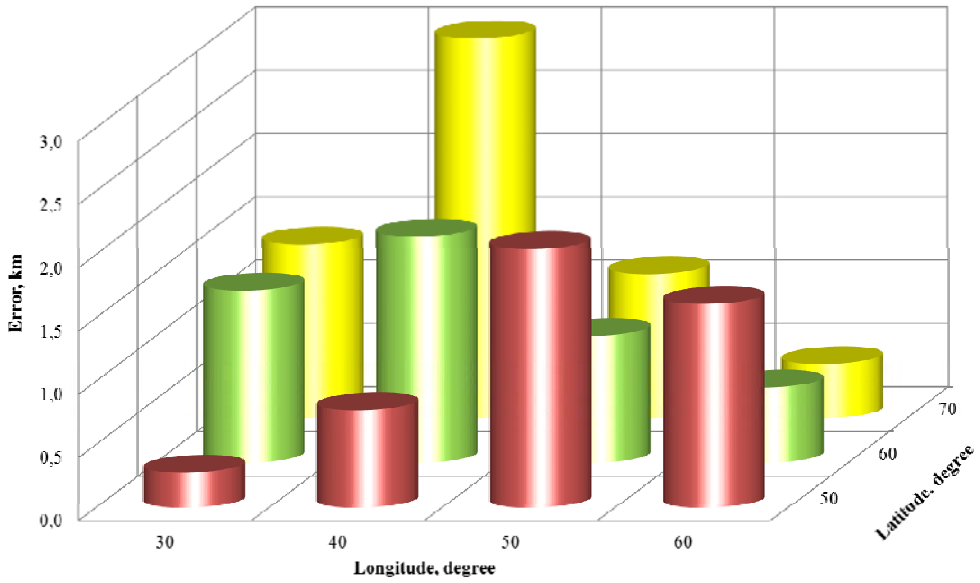

Fig. 3. Lightning strikes measuring errors on the ETR.

The data of the Lightning location Network is used for detecting zones of the thunderstorm activity together with the meteorological radars (fig.4) and satellites data (fig.4).

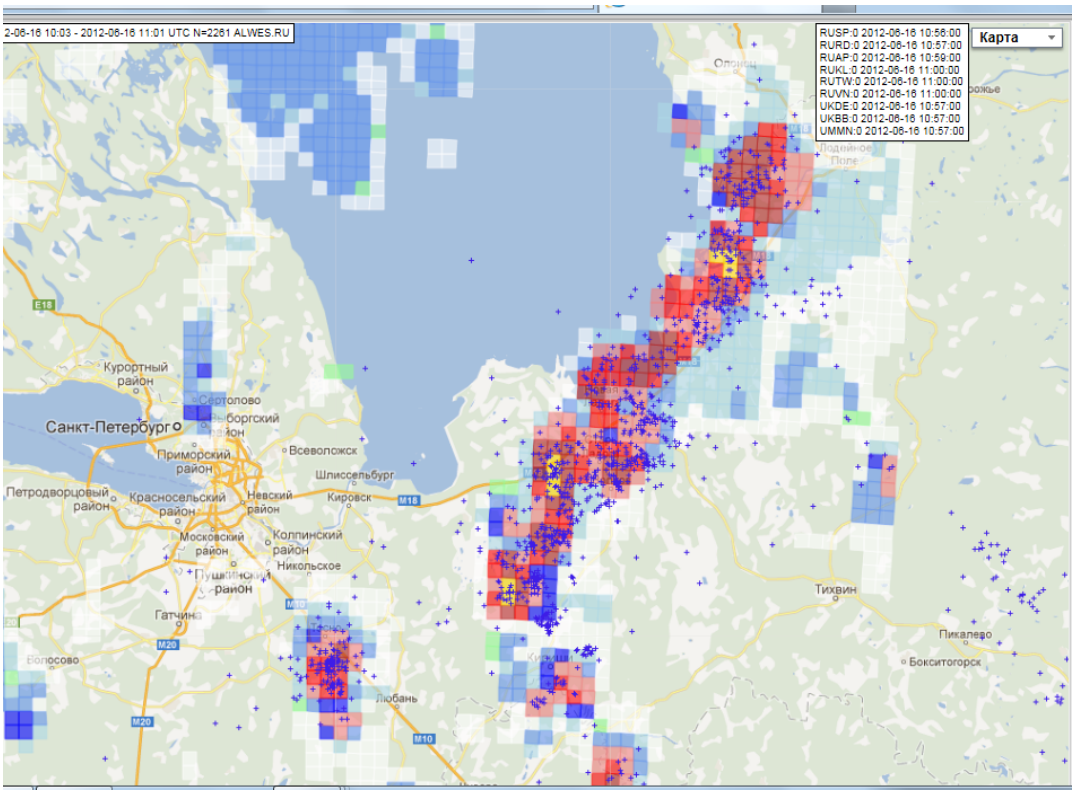

Fig.4. The example of incorporation of the data on lightning strikes coordinates (blue crosses) in the period from 10.03 till 11.01 UTC and the reflectivity data according to Doppler weather radar of Pulkovo airport (data for the 10.10 UTC (blue and red tones zone) 16th June, 2012).

The Lightning Network allows to estimate the distribution of the thunderstorm activity on the ETR during different observation intervals. The example of the distribution of thunderstorms can be seen in fig.6

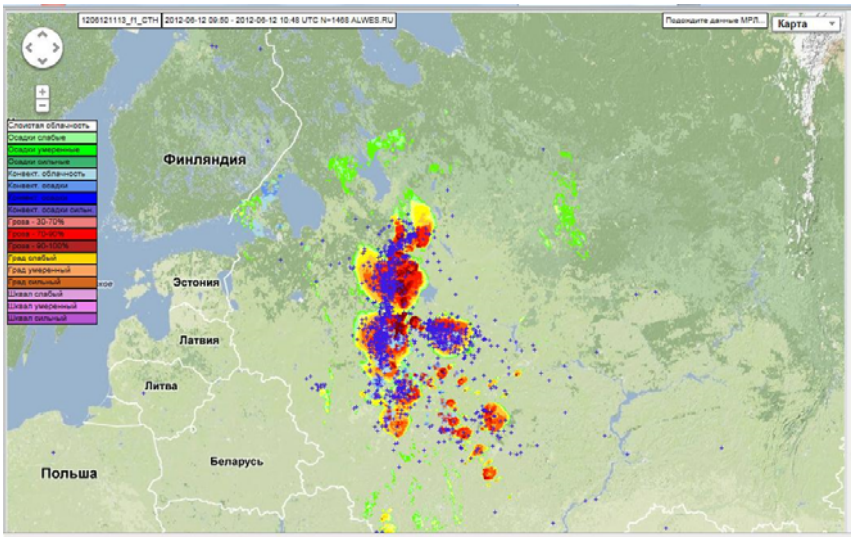

Fig.5 The example of incorporation of the data on lightning strikes coordinates (blue crosses) in the period from 9.50 till 10.48 UTC and the height of the convective clouds (yellow-green and orange zones) according to weather satellite data on 12th June, 2012.

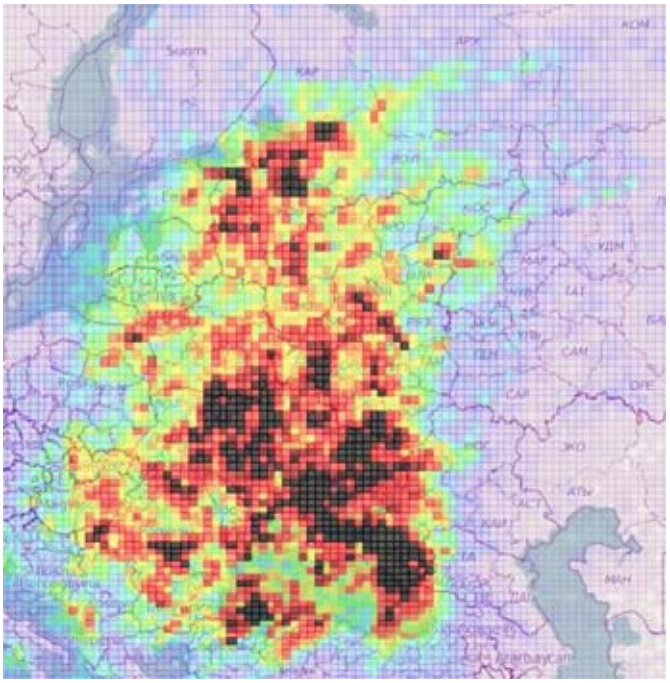

Fig.6 Distribution of thunderstorms in 2010.

Lightning Network allows to carry out experimental investigations of the parameters of EMR (atmospherics) of lightning strikes (atmospherics amplitudes (Ez), the leading edge time (Tf), the first half-wave length (Tpp) and polarity) in the near zone and in different physico-geographical conditions. Tables 1-3 show the results of measuring the above mentioned parameters for the period of 15th-23rd July and 29th July, 2012.

Table 1 Mean values/standard deviation of parameters of the atmospherics with negative first half-wave

Date	Ez/σ relative unit		Tf/σ mks		Tpp/σ mks		Number of cases
15.07.12	-118,6	61,3	16,2	13,1	33,7	16,9	217
16.07.12	-116,1	110,6	15,7	11,7	34,1	15,8	782
17.07.12	-193,7	206,2	17,0	12,4	34,6	15,9	559
18.07.12	-163,6	184,7	16,4	10,9	34,6	16,0	624
19.07.12	-143,3	129,4	16,2	11,4	33,9	14,9	340
20.07.12	-149,5	180,7	16,9	11,9	34,4	15,7	232
21.07.12	-214,1	239,1	15,5	11,7	33,4	16,4	801
22.07.12	-122,7	119,0	14,9	12,3	33,3	19,0	724
23.07.12	-256,1	221,8	17,3	14,0	35,0	23,1	64
29.07.12	-185,0	220,3	18,2	15,8	37,0	23,2	5449
Mean value			**16,4**	**12,5**	**34,4**	**17,7**	

Table 2 Mean values/standard deviation of the atmospherics with positive first half-wave

Date	Ez/σ relative units	Tf/σ mks	Tpp/σ mks	Number of cases

15.07.12	176,2	153,9	13,5	10,0	30,5	23,0	223
16.07.12	102,9	82,1	16,5	11,0	35,0	14,7	715
17.07.12	129,7	95,2	16,2	10,6	33,7	13,1	653
18.07.12	119,8	113,4	14,8	9,1	32,9	13,5	585
19.07.12	112,3	78,6	16,2	12,2	34,1	14,8	380
20.07.12	113,0	88,7	14,9	10,4	30,5	14,0	199
21.07.12	121,4	101,5	15,1	10,5	32,5	16,7	556
22.07.12	119,0	125,6	14,7	11,6	31,6	17,3	689
23.07.12	146,2	74,2	12,8	7,9	27,7	12,5	37
29.07.12	138,8	165,5	17,8	13,9	36,1	18,2	6711
Mean value			**15,3**	**10,7**	**32,5**	**15.8**	

20549 atmospherics were processed in total, including 9792 (47,7 %) with negative and 10748 with positive polarity. Table 3 shows percentage ratio of the atmospherics with the first wave of negative and positive polarity.

Table 3. percentage ratio of the atmospherics with the first wave of negative and positive polarity.

Date	15.07.12	16.07.12	17.07.12	18.07.12	19.07.12	20.07.12	21.07.12	22.07.12
Negative polarity %	49,3	52,2	46,1	51,6	47,2	53,8	59,0	51,2
Positive polarity %	50,7	47,8	53,9	48,4	52,8	46,2	41,0	48,8

In 2014-2015 it is planned to install 25 thunderstorm registration stations in the Northern and Eastern parts of Northwestern Federal District and on the territory of the Ural Federal District (fig.7).

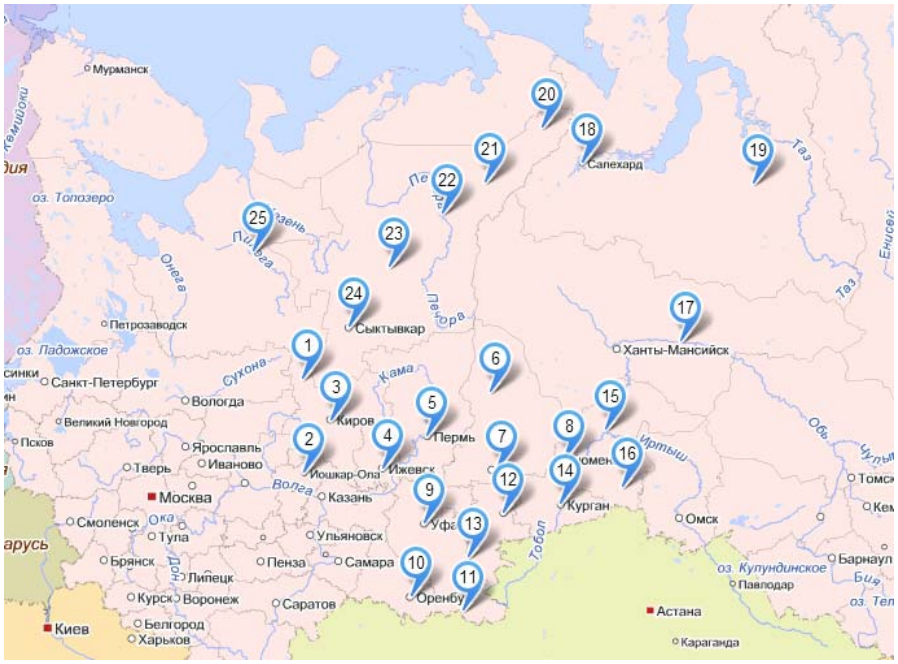

Fig.7. Map of the Lightning Sensors location of the Lightning Network of Rosgidromet in 2014-2015