Russian Federation

JMA/WMO Workshop on Quality Management in Surface, Climate and Upper-air Observations in RA II (Asia)

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Country

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Upper-Air observations in the Russian Federation

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Summary and Purpose of Document

To present the current state, achievements and problems of upper-air observations in the Russian Federation

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A GUIDE TO WRITING A COUNTRY REPORT AND PRESENTATION

Participants from RA II Members are kindly requested to provide written reports (about 8 pages) concerning the following key themes. In addition, participants are expected to give their presentations for specific subjects at the workshop (choose one of subjects, i.e., siting and metadata, sensors/Instruments, QA/QC, training,).

The following items are expected to be described in the country report.

1. Observation networks

~~1.1 Surface observations~~

~~1.1.1 Number of stations: RBSN, RBCN, GSN, manned stations and AWS*~~

~~Table 1 Number of stations~~

	~~RBSN~~	~~RBCN~~	~~GSN~~	~~Manned stations~~	~~AWS *~~
~~number~~					

~~An automatic weather station (AWS) is defined as a "meteorological station at which observations are made and transmitted automatically".~~

~~1.1.2 Station map~~

~~A map showing locations of the RBSN, RBCN and GSN station is expected.~~
~~A map showing locations of the manned station and AWS is also expected.~~

~~1.1.3 Time and frequency of observations~~

~~A description of time and frequency of surface observations is expected.~~

Reference: 2.3.2.11 At synoptic land stations the frequency of surface synoptic observations should be made and reported eight times per day at the main and intermediate standard times in extratropical areas and four times per day at the main standard times in the tropics. (WMO-No. 544)

~~1.1.4 Data flow to users and archives~~

~~Surface observation data flow to users and archives is expected to be described with an illustration.~~

1.2 Upper-air observations

1.2.1 Number of stations: RBSN, RBCN, GUAN, manned stations and automated system stations

According to the official RBSN and RBCN lists (ftp://ftp.wmo.int/wmo-ddbs/RBSN_JUNE2010.xls and ftp://ftp.wmo.int/wmo-ddbs/RBCN_JUNE2010.xls) the Russian Federation has 68 RBSN, 39 RBCN and 10 GUAN upper-air stations in RA II. However, included into RBCN 25954 station at the moment is out of operation[4]:

	RBSN	RBCN	GUAN	Manned stations[5]	Automated system stations
RA II	68	38+1[4]	10	80	None
RA VI	25+1[6]	10+1[6]	1+1[6]	31	None

[4] RA II RBCN upper-station 25954 is mothballed and its revitalization remains so far unclear due to heavy damage in earthquake.

[5] In operation

[6] One RA VI upper-air station 27459, included to RBSN, RBCN and GUAN, is temporarily mothballed till 4th Qr. of 2010.

Total	93+1	49+1	11+1	111	None

Totally, observational program of the Russian continental upper-air network at the moment assumes operation of 111 upper-air stations. This amount doesn't take into account 27459 station (RA VI, silent since August 2009), which is about to resume observations by the end of 2010. Three more mothballed stations in RAII are about to resume their operations by the end of 2010 as well due to installation of new ground systems owing to National Hydrometeorological Modernization Project (see later). Thus we expect our upper-air network to grow up to 115 stations by the end of 2010.

From those 111 stations, operational by June 2010, 106 have to send their data to GTS, but in the 2nd Qr. of 2010 two of them (1 RA II + 1 RA VI) were silent at all due to problems with hydrogen production, one more station in RA II was silent in June due to ground system failure. More details about the fulfillment of the program of observations are brought below,

As well, apart from continental network Russian Federation operates 2 Antarctic upper-stations (they both belong to RBSN, RBCN and GRUAN) and since 2007 organizes expeditionary upper-air observations on the Drifting station "North Pole" expeditions in Arctic. The latter one as well as resuming operation of several polar upper-air stations resulted from efforts undertaken by the Russian Federation during preparation to and implementation of the International Polar Year.

1.2.2 Station map

Figure 1 provides an overall view of the Russian upper-air network, it shows operating (pink), mothballed (light-blue) and closed after 1990 (crosses) upper-air stations.

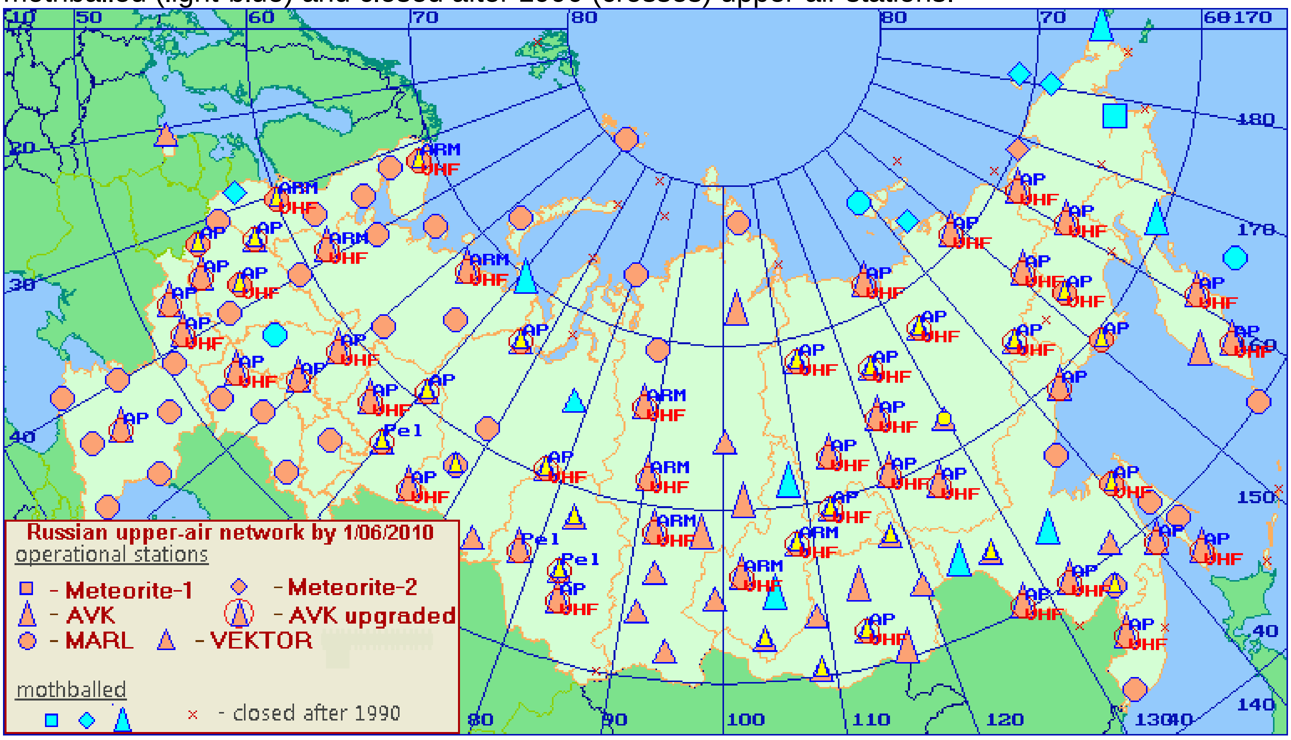


Fig **1.** The Russian Federation upper-air network.

Note variety of ground systems indicated by the legend. It's may be worth to notice here that typical Russian radiosonde system consists of secondary radar and a radiosonde, equipped with transponder; pressure is derived from temperature, humidity and radar height by integration of hydrostatic equation. At the moment there are three major types of radars in operation (with some of them having more than one modification). Each of them is able to operate MRZ-3 like radiosonde of four domestic manufacturers.

Following maps present the RBSN, RBCN and GUAN upper-air stations of the Russian Federation (mothballed stations are shown with orange symbols):

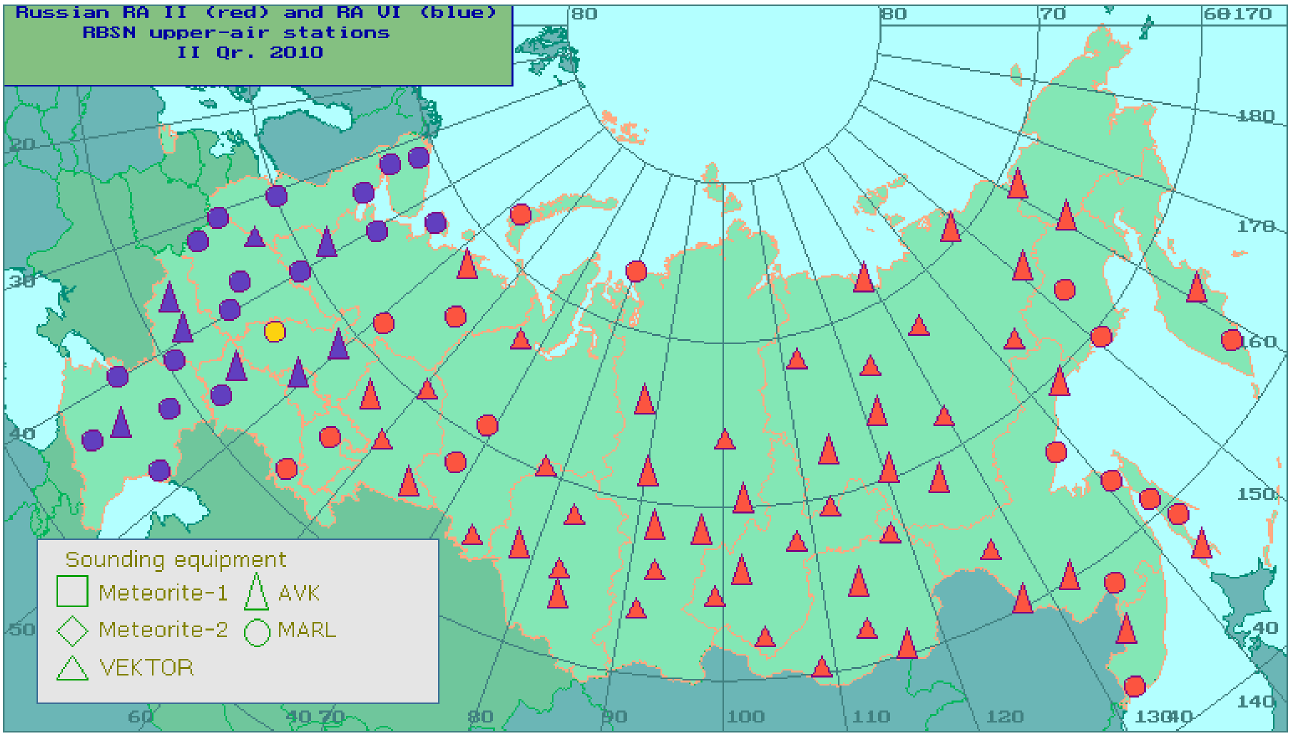


Fig **2.** The Russian Federation RBSN upper-air stations.

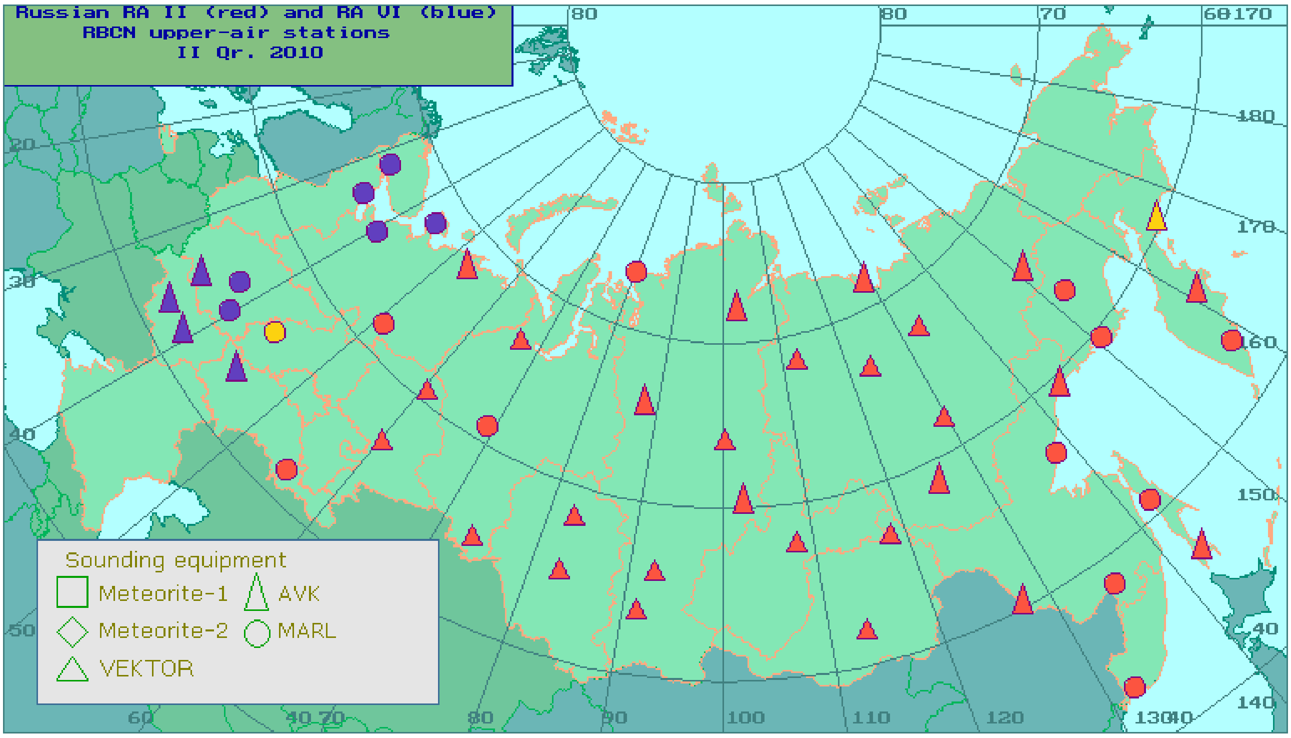


Fig **3.** The Russian Federation RBCN upper-air stations.

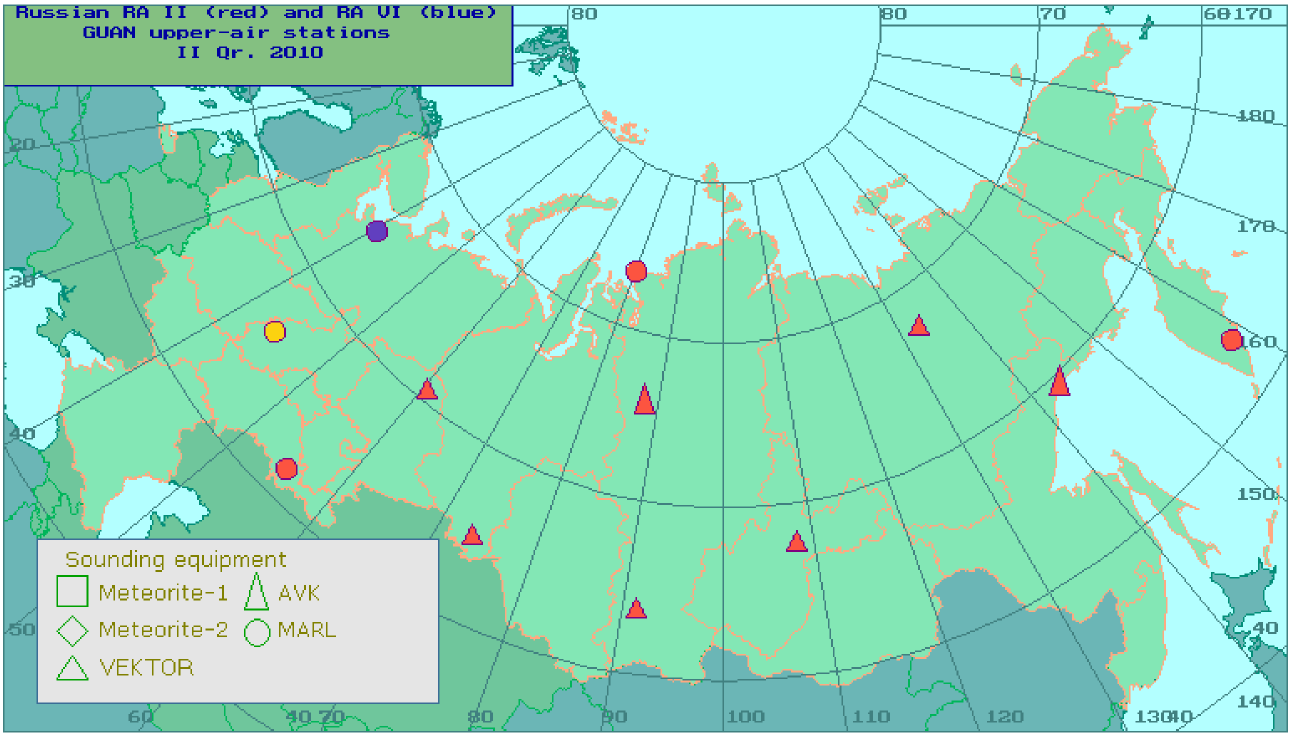


Fig **4.** The Russian Federation GUAN upper-air stations.

1.2.3 Time and frequency of observations

Figure 5 presents observational program of The Russian Federation upper-air network. All except two (in RA II) upper-air stations in the Russian Federation make their observations according to the rigid schedule twice per day, at 00 and 12 UTC. According to the national practice, the actual release of a radiosonde is carried out half an hour prior to nominal synoptic time, i.e. 23:30 and 11:30 UTC.

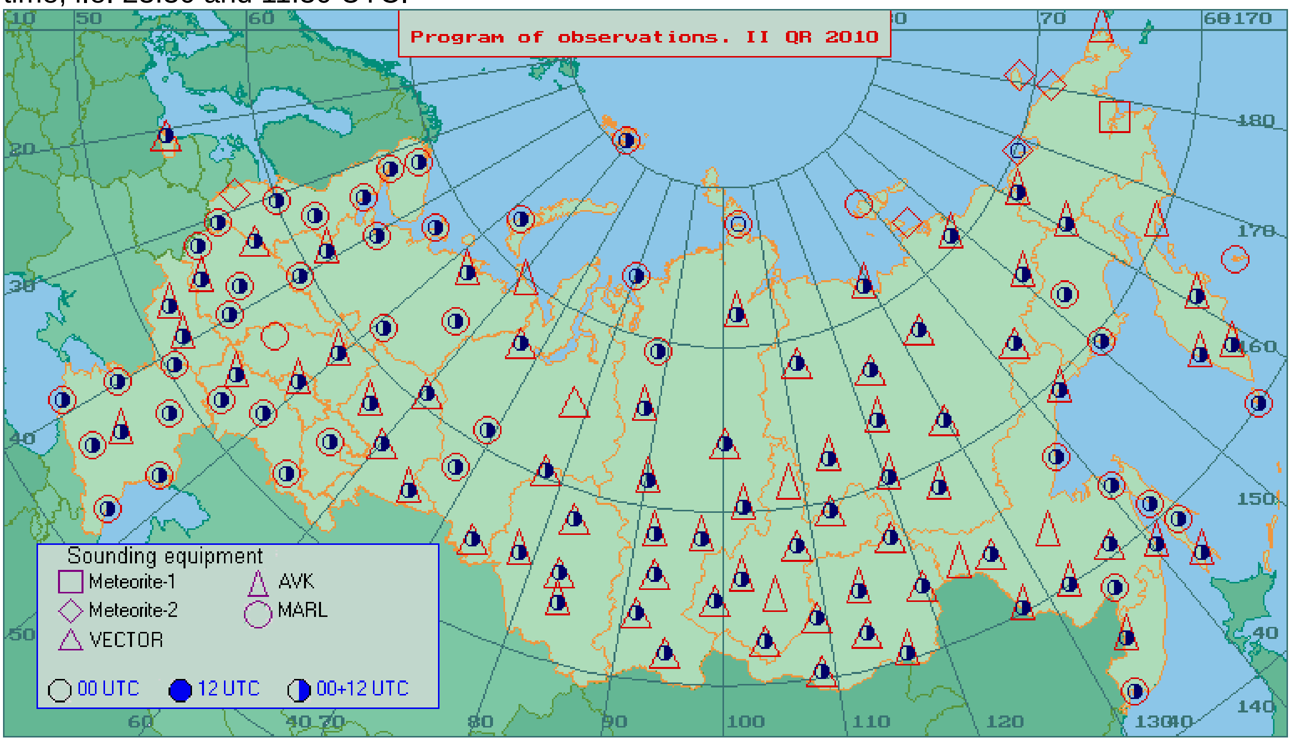


Fig **5.** The Russian Federation upper-air network observational program.

Actual fulfillment of observational program (for 00 and 12 UTC) is presented on Figure 6. Average percentage for the Russian Federation in the 2[nd] Quarter of 2010 is 95% (for 00 and 12 UTC and for both time). Total amount of observations within this period was 19031, i.e. 209.2

daily ascents. The main reasons of non-fulfillment of the plan are ground equipment failures and shortage of chemicals for hydrogen production (logistics issues).

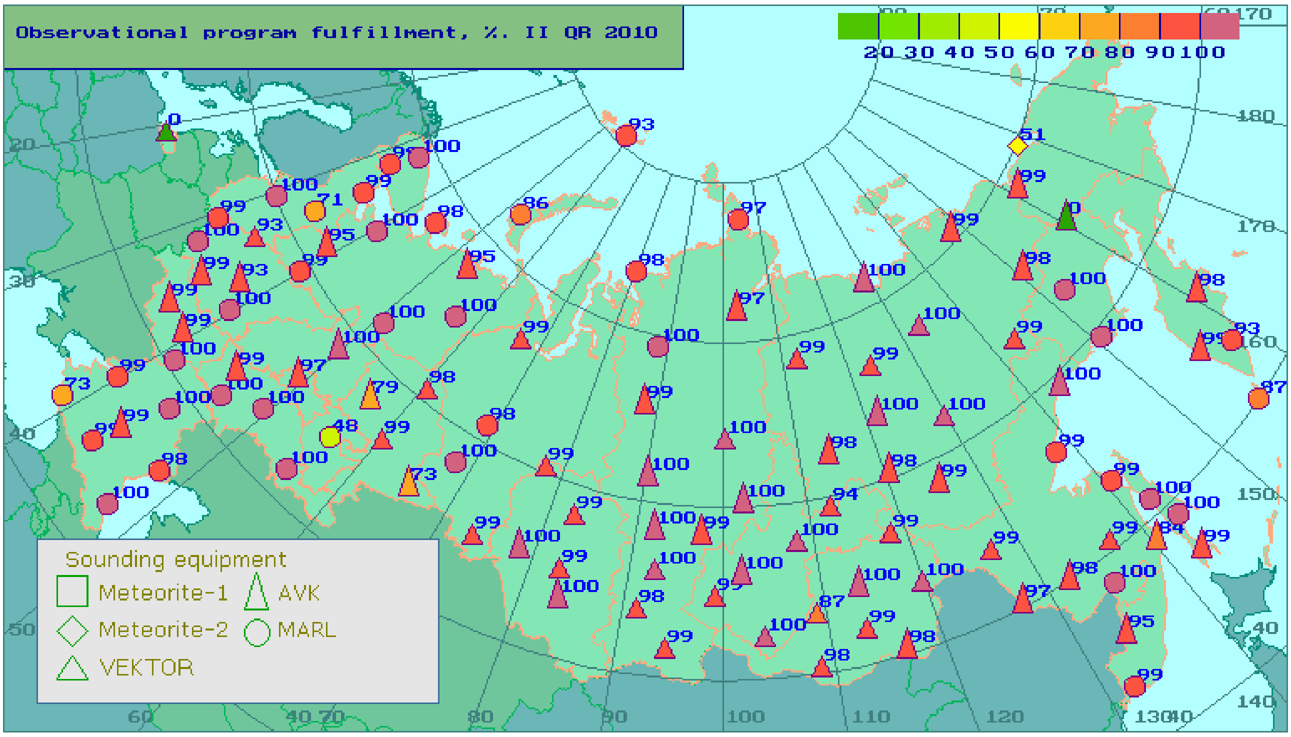


Fig **6.** The Russian Federation upper-air network observational program fulfillment.

As well the Russian Federation upper-air network took part in the experiment related to adaptive observation strategy: 37 upper-air stations of 11 Regional Roshydromet Administrations took part in the Winter T-PARC THORPEX field campaign during 07.01.2009 - 28.02.2009 and made totally 603 irregular adaptive ascents within 33 periods of intensive observations (IOPs).In each IOP an individually selected subset of the participating stations has been performing additional 06 and 18 UTC ascents following special DTS Observation requests.

Requests were sent by Senior Duty Meteorologist of NCEP NOAA Central Operations to WMC/RTH Moscow by e-mail ~30 hours prior to additional ascent 06 UTC and were promptly disseminated to upper-air stations via Roshydromet telecommunication network. Results of additional observation were transmitted operationally to the WMO GTS as conventional FM35 TEMP messages.

Upper-air network is a multi-purpose and expensive observing system. Its optimizing (unless reducing amount of sites would be justified by availability of alternative observing platforms) is very challenging task due to very high dimension and lot of imposed constrains. For many practical reasons a redesign with changing site locations seems almost unrealistic. Adaptive observation strategies, or targeting, are expected to be a solution by improving forecast skill and minimizing operational expenditures.

The experiment has proved the ability of the operational upper-air stations to perform adaptive observations on condition that proper logistics and procurement are provided. Nonetheless they require much more sophisticated organization and logistics. Therefore unless full launch automation isn't implemented, labor component of expenditures remains significant and benefit from targeted observations must be clearly demonstrated.

1.2.4 Data flow to users and archives

The backbone of upper-air observation data flow is the telecommunication network of Roshydromet. Roughly streams of operational upper-air observation data look like on Figure 7. Beside of providing operational data to WMO GTS, WMC/RTH, two RTH and each regional/provincial communication centre provides data to local users such as Hydrometeorological centre of Russia (WMC "Moscow"), regional hydrometeorological centers and other organizations supplying end-users with various products. Russian Research Institute for Hydrometeorological Information – World Data Center (RIHMI-WDC) in Obninsk, which is responsible for the maintaining of the Russian State Fund of data on hydrometeorology and monitoring of environment, as well has its own communication centre and receives all routine operational upper-air data (TEMP FM 35 and PILOT FM 32) in near real time. The system works rather fine and fluently in relation to traditional TEMPs and PILOTs but makes an obstacle for the further development.

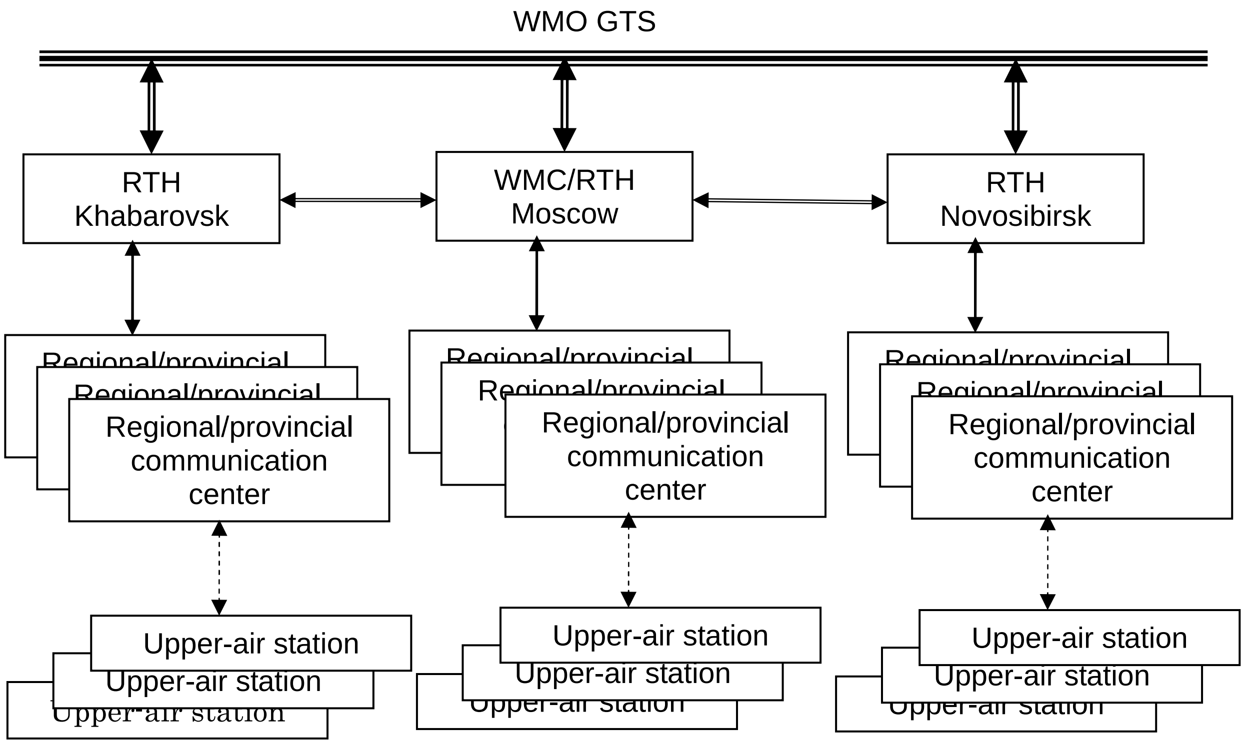


Fig **7.** Upper-air observation operational data flow.

The main shortcoming is the “last mile” bottle-neck – many stations still submit their observations using teletypes equipment. This prevents on many sites a migration to TDCF data representation which provides lot of advantages to data users as well as network operators. Now it’s the major challenge in maintaining data flow. One of possible solutions is using CREX upper-air data representation with same content as in TAC TEMPs and PILOTs where sending binary BUFR messages is impossible due to technical limitations. Another issue is inevitable introduction of typing errors.

Except one all stations have automatic data processing and from latter ones only 5 have no ability to save raw data and processed results on external storage, thus there is a potential possibility to obtain and transmit operationally high-resolution upper-air data using e.g. B/C 25 WMO TDCF template. However, until recently only limited size printouts were collected and these hardcopies were archived on monthly basis in the Regional hydrometeorological administrations. Of course, they have very limited value for the further processing. Therefore, since 2010 it was started quarterly “off-line” collection in CAO and RIHMI of all files, produced by PC-based automatic, to make a basis to create a national high-resolution upper-air data archive. Some positive experience in this respect was received in Winter T-PARC experiment with retrospective processing of collected for each IOP raw data files resulted in obtaining detailed upper-air profiles with vertical resolution about 100 m.

2. Siting and metadata

Although upper-air observations are generally less affected by an environmental change a site selection is not arbitrary. Apart from basic principles, there are specific requirements to Russian upper-air sites resulted from usage a radar like necessity to have low takeoff angles (clear horizon); when station is located near a settlement it's desirable for a radiosonde to move off from apartment buildings after release. As well, a place for radiosonde release should be selected so that under prevailing winds a radiosonde moves off from radar after release.

Upper-air instrumentation is quite volatile and WMO Code Table is not able to take into account all changes in radiosonde design, software upgrades, equipment modernization etc. Since 1998 till 2006 it was lot of equipment modernization and data-processing software upgrades on the Russian upper-air network, respective metadata information was collected but still is not published.

The optimal solution seems to be a keeping as much as possible metadata information (radiosonde serial ID, balloon type, free lift, software and firmware versions, angle adjustments and so on and so on) along with each sounding data archive.

3. Instruments, sensors, upgrade, maintenance, instrument intercomparisons and traceability

In 1989 AVK radar with MRZ-3 radiosonde successfully took part in the 3rd WMO Radiosonde systems intercomparison and was recognized as meeting WMO requirements to upper-air data performance requirements.

Since the end of 80-s AVK radar remained a backbone of the Russian upper-air network. With design service time as long as 10 years many of them are still in operation (either as the only one or as reserve ground system) due to numerous modernization like replacing non-durable electro vacuum devices in receivers by solid-state microwave modules to ensure better telemetry reception and radiosonde tracking, replacing built-in firmwared minicomputer with PC-based data acquisition and processing system and some others less significant (There were several versions of hardware and software modifications from several manufacturers and it took lot of efforts to document all this variety and provide required support).

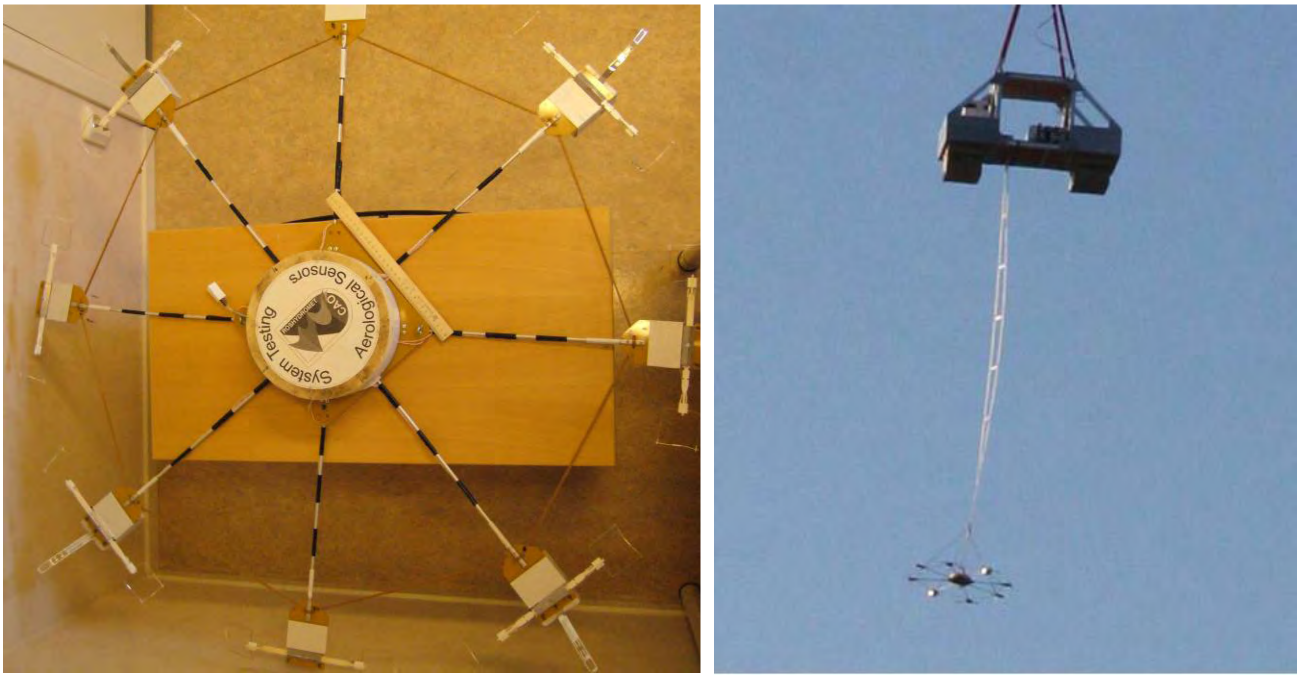
MRZ-3 now is not the only radiosonde in use, there are several alternative types with telemetry compatible to MRZ-3, same temperature and alternative humidity sensors. Although the type of thermistor, which serves as sensitive element of the temperature sensors, remains the same, it's known that earlier used anti-radiation enamel is out of production. For temperature sensors from different manufacturers a calibration may differ as well as slight variations in the design of sensor mounting and anti-radiation coating may affect thermal equilibrium. Therefore, radiation correction may require modification. So, both temperature and humidity sensors again require intercomparison. Its worth to mention that around 1995-2005 it was in use an alternative radiosonde RF95 with temperature and humidity sensors of world-recognized Vaisala RS80 radiosonde. However, at the moment production of RS80 was ceased and new generation of Russian radiosonde with sensors of Vaisala RS92 radiosonde is not ready yet.

For investigation of compatibility of radiosonde temperature sensors from various Russian radiosonde manufacturers in free atmosphere it was developed a lightweight platform (see Figure 8) to be deployed as an autonomous piggy-back payload to high-altitude stratospheric balloons during various international research programs. It allows simultaneous registration of up to 16 thermistors during ascent, drift and descent of a balloon. As well, it can carry out a pair or two of Vaisala RS80 and RS92 radiosonde sensor. 5 test flight were undertaken during experiments with stratospheric balloons of 2009-2010 performed by CNES, France, in Swedish Space Corporation ESRANGE Space Center in Kiruna, Sweden. Totally 76 temperature sensors from two manufacturers (38 pcs from each one) were tested, the very first results will be presented on WMO TECO-2010 in Helsinki. It is considered a possibility to use the platform for intercomparison of humidity sensors.

Since around 2005 a new generation domestic upper-air radars MARL and Vektor became available. Owing to National Hydrometeorological Modernization Project, co-sponsored by International Bank for Reconstruction and Development and the Government of Russian Federation as well as to preparation to IPY new radars were installed at more than 60 stations (6 mothballed stations resumed their operations). Improved procurement resulted in increase in observational program fulfillment and soundings height. Not everything went smooth but the tendency is apparently positive. Major remaining issues regarding upper-air ground system are following:

1.1 Maintenance of worn-out AVK radars and further replacing them with new generation radars to make upper-air observations sustainable;

1.2 compatibility and skill of new radars data-processing software;
1.3 uncertain reliability of one of new upper-air radar.



a) b)

Fig **8.** System for Testing Aerological Sensors - on the ground (a) and in a flight (b).

Most of the Russian upper-air stations use chemical method for producing hydrogen and it's desirable to replace them with electrolytic generator for many reasons. 12 new domestic electrolytic generators were delivered to the network however their reliability and safety were found to be insufficient and manufacturer was requested to remedy defects.

4. Quality assurance / quality control (real-time, non-real time)

Upper-air QC and quality management in the Russian Federation is a multi-tier system of near real-time observation error checks and medium- and long-range QC and performance monitoring:

At upper-air stations:
- operational quality control during flight until message reporting**;**
- next-day re-check;
- cross-check by station engineer-aerolog.

At Regional administrations – spot-check of observations raw and processed data, connecting upper-air stations and lead centre (verification of rejected data), periodical site inspections.

At Hydrometeorological centre of Russia (WMC "Moscow") – operational upper-air data QC within regular data assimilation cycles.

At Russian Research Institute for Hydrometeorological Information – World Data Center (RIHMI-WDC) in Obninsk – QC of archived upper-air data.

At Central aerological observatory – monthly and long-term upper-air network performance monitoring based on products from Hydrometeorological centre of Russia. The main function of Central aerological observatory in the QC/QM system is providing feedback to upper-air stations and requesting remedial actions: periodical inspections of upper-air observations in the Regional administrations, maintenance requests, site inspections, requests to radiosondes, ground equipment and software manufacturers, guidelines and consultations.

At the Roshydromet level: the yearly best stations national contest based on reports from the Regional administrations and Central aerological observatory.

Most sources of operational information used for national upper-air network performance monitoring in Central aerological observatory were recently upgraded and now include:

- 00 and 12 UTC de-coded radiosounding results from parts A, B, C and D of TEMP messages, there were added sections 3, 4 and 7;

• results of upper-air data complex quality control for data on standard pressure levels and significant points, performed operationally by the Hydrometeorological Centre of Russia data assimilation system;

• geopotential, temperature and wind first-guess (FG) fields, based on 6-h forecast, for all standard pressure levels from 1000 to 30 hPa and pressure at sea level, interpolated to the station's locations;

• time of arriving parts A, B, C and D of TEMP and PILOT messages to the Hydrometeorological Centre of Russia;

• NIL messages (the messages from Russian and some other stations use extended NIL code for providing additional information on reasons of absence for each missed radiosonde observation, such as routine maintenance, lack of consumables, failure of ground equipment, absence of energy, severe weather conditions, ATC ascent ban, communication problems etc).

All above information is received by FTP-protocol with dedicated software.

Some information is still collected off-line: quarterly statistics of radiosonde pre-flight and in-flight failures, monthly statistics of ascent heights (with separation of cases with balloon burst and all other cases). It is compiled on stations (in most cases so far manually) and regional administrations and is sent to CAO by e-mail.

Different aspects of upper-air network performance under monitoring include fulfillment of program of observations, reasons of stations downtime, completeness and quality of observations. Developed software allows generation in operational mode different kinds of monthly, quarterly and annual reports for stations, regional administrations and member states of the Intergovernmental Council for Hydrometeorology of the Commonwealth of Independent States, e.g.:

- detailed monthly list of soundings and reasons of observations absence;
- statistics of program of observations fulfillment for 00 and 12 UTC and both terms;
- statistics of soundings heights;
- reasons of failure of observations statistics;
- rejected data statistics;
- (OB-FG) geopotential and wind statistics and their distributions and lists of suspected stations for geopotential and wind observations (according to WMO No.485).

Some of results are presented on the monthly, quarterly and yearly web reports at http://cao-ntcr.mipt.ru/monitor (English version available at http://cao-ntcr.mipt.ru/monitor/monitorrese.htm) in tabular forms, as diagrams (see Figure 9) and maps (see Figure 6).

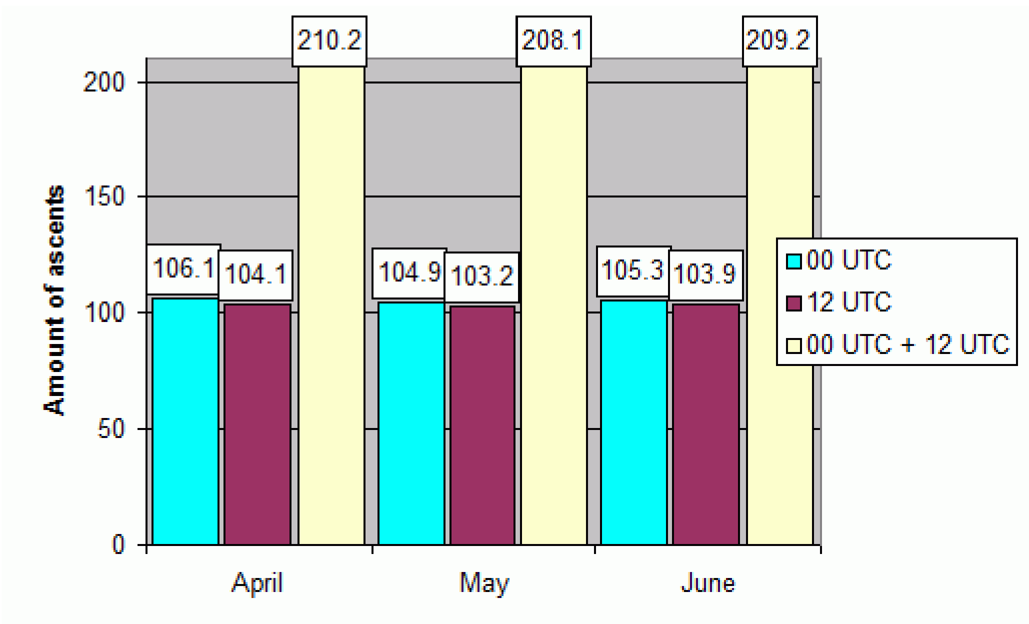


Fig **9.** Daily amount of ascents on the Russian Federation upper-air network. II Qr. 2010.

5. Training

There are an institute and several technical schools providing higher and high hydrometeorological education.

Due to lack of resources for trainees travel and accommodation training activity is mainly limited to episodic courses related to new equipment introduction. Last Roshydromet workshop on upper-air observation issues took place in 2004.

Web-conferencing is studied as a potential platform for discussions and training. The problem for communication is the amount of time zones in the Russian Federation, so a platform to choose must provide possibilities both for online and offline conversation.

6. Statistics and applications

RIHMI-WDC in Obninsk has the Aerological department dealing with all aspects of upper-air data processing. It has two thoroughly checked data sets of global upper-air data: the AEROSTAB data (uper-air observations obtained through communication channels) and the Comprehensive Aerological Reference Data Set (CARDS), developed in cooperation with NCDC in Asheville. Various derived products for boundary layer and free atmosphere are available: long term monthly means, variability and extremes, auto- and cross-correlations, trends and so on.

7. Current issues and future plan

Remaining major issues are: Out-of-repair ground systems at some stations, unstable performance of some new ground systems, unstable reliability of radiosondes, staff recruitment and motivation, manual input of upper-air messages to teletypes on many stations, sometimes lack of chemicals and power supply, radio interference (esp. with cellular networks) issues.

Problems for quality monitoring result from heterogeneity of the network (various ground systems and radiosondes could be in use at the particular station simultaneously). Now we realized separate monitoring of different ground systems (i.e. separate OB-FG statistics for a new and alternative ground systems) and are about to present to the public the first results for July. In plans there is also separate monitoring for various radiosonde type that will provide as a tool for feedback to procurement policy.

There is also a need to present our new ground systems to comprehensive intercomparison with world-wide modern upper-air systems.