https://doi.org/10.55764/2957-9856/2023-4-44-48.23

IRSTI 37.21.03

E. Mailyanova

Civil Aviation Academy, Almaty, Kazakhstan; *maylyanova64@mail.ru*

THE OBSERVATION NETWORK PERFECTION FOR FLIGHT SAFETY IN THE REPUBLIC OF KAZAKHSTAN

Abstract. One of the ways of flight safety improvement and quality air traffic services is perfection the material and technical equipment of the country's observation network. This makes it possible to improve the analysis of the state of the "surface background– atmosphere" system, which is necessary, in particular, to identify hazardous and especially dangerous weather phenomena and to predict them. One of the directions for improving the means of monitoring atmospheric processes is the use of remote sensing methods of the atmosphere, which include meteorological radar. Today, meteorological radar networks have been created in all developed countries: in the United States, the NEXRAD network unites about 150 WSR-88D Doppler polarized S-band radars; in Europe, within the framework of the international OPERA project, about 180 radars from various manufacturers working in various observation programs are networked. Some of them are doppler and polarized. In China, Japan, Australia, radars are also integrated into national networks. In the process of analyzing open sources, we determined the main characteristics of meteorological radar networks in several countries of the world and calculated the required number of radars to cover the territory of the Republic of Kazakhstan.

Keywords: radars, location networks, security, information on the state of the atmosphere.

Currently, there is no network of meteorological locators on the territory of the Republic of Kazakhstan necessary for a more complete understanding of the air situation in order to safely and effectively serve civil aviation. The study of radar networks for the needs of meteorological analysis and forecast in foreign countries will allow us to develop optimal recommendations for the formation of a network of meteorological fibers in the Republic of Kazakhstan.

Until now, Russia has mainly used a very sparse network of meteorological radars, consisting of Russian noncoherent radars MRL-2 and MRL-5.

The Russian radar network MARS, shown in figure 1, is built in such a way that the DMRL-S meteorological radars are installed at a distance of three hundred kilometers from each other. This arrangement is due to the presence of the most dangerous weather phenomena in the warm season and their monitoring does not require the proximity of radar stations, however, a significant overlap of monitoring zones for air routes, significant industrial and agricultural facilities. Economically due to the fact that in areas with low intensity of human activity, the radar field remains quite discrete and does not cover the entire territory [1]. This network was created in recent years and its formation continues.

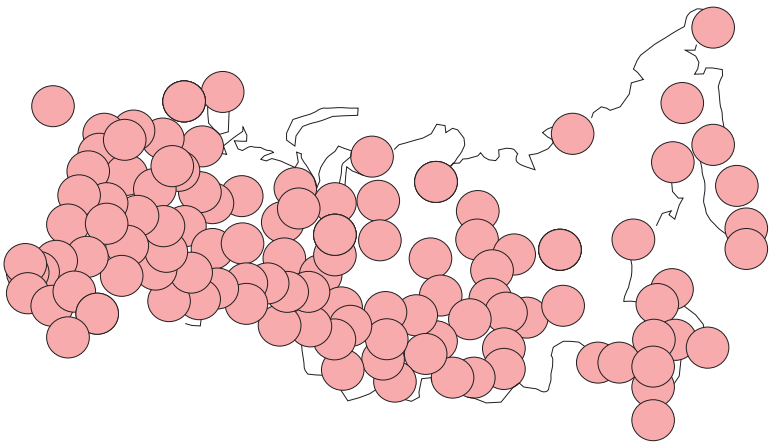

Figure 1 – Map-diagram of the location of the MARS network (Russia)

Figure 2 shows a map of the distribution of WSR-88D DSCM in the United States. This network was created in the period from 1991 to 1997. It includes 138 radars in 48 states of the continental United States, as well as 13 radars in Alaska, Puerto Rico and Hawaii.

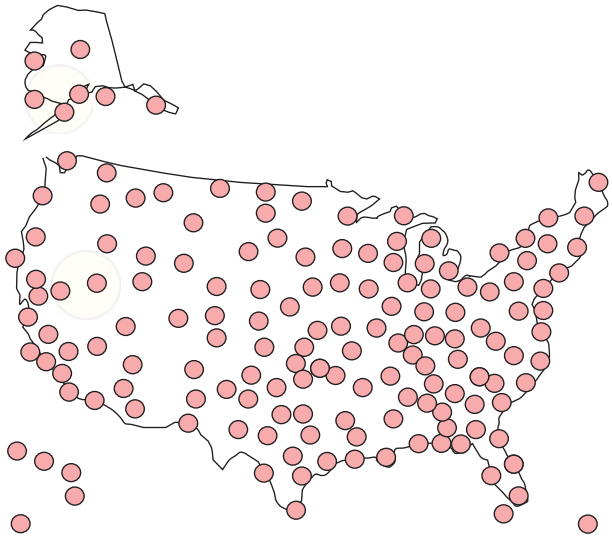

Figure 2 – Map-diagram of the location of weather radars of the NEXRAD network in the United States

The system provides the transmission of baseline data and observation products of all radars to the national meteorological centers in Washington, Kansas City and Miami for the compilation of maps with radar information on the territory of the United States every 30 minutes.

The peculiarity of the NEXRAD radar network for atmospheric monitoring (USA) is that the WSR-88D meteorological radars are installed on the earth's surface in the form of a network covering the entire territory. The height of the lower boundary of the continuous radar field is about three kilometers. The distance between the locators is about four hundred kilometers [2]. However, with such an organization of the network at altitudes of less than three kilometers, the radar field does not give a complete picture of the state of the atmosphere.

In Australia, three types of S BAND, C BAND and Doppler locators are used in the radar network. Australia's radar network is very interesting in terms of its construction. As shown in figure 3, locators are mainly located in coastal Australia, this is very important in conditions of sharply cut coastline.

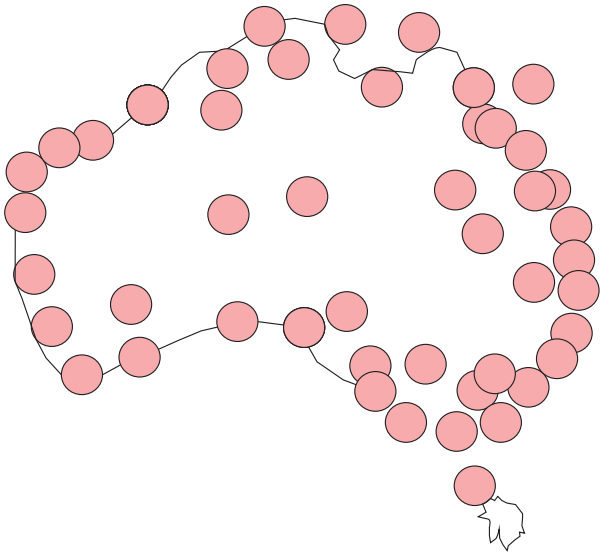

Figure 3 – Diagram of Australia's radar network

In such an interesting place in the atmosphere from the point of view of meteorology, small in length, but intense and multi-directional movements of the atmosphere arise, which contribute to the emergence of wind shear, coastal turbulence, etc. These phenomena complicate the take-off and landing of aircraft, as well as negatively affect the production of small aircraft flights.

A very large Australia is little populated, so a radar network providing full coverage is impractical. Australia's radar network has sixty-three locators, of which 30 maintain regular observations and provide real-time data for forecasts, warnings and thirty-three locators perform wind and weather monitoring functions [3].

Analysis of radar networks shows that unfortunately, most often for economic reasons, radar networks are not built on the basis of a systematic approach to the creation of large systems. The most close to the ideal system is the American radar network. The location networks of most States are not always able to fully realize the capabilities of meteorological locators. This organization of observations does not allow for full radar monitoring of the atmosphere and does not realize its full potential.

To ensure the safety, regularity and economy of air transportation, aviation operations, and improved forecasting of difficult weather conditions in the period from 2020 to 2022, RSE “Kazaeronavigation” and RSE “Kazhydromet” are planning to create a single radar network with the help of which it will be possible to build composite (stitched) maps of remote sensing of the atmosphere using meteorological locators. The application of this technology will provide a sufficiently complete picture of the dynamics of atmospheric processes, weather hazards and the state of the atmosphere for safe flight production, inform interested organizations in advance to quickly prevent the effects of natural disasters with an advance time of 2…3 hours and in some cases even up to 12 hours. It is assumed that the radar network in the Republic of Kazakhstan will consist of about 25 meteorological locators.

Studies on the geometry of radar networks [4] show that the construction of a radar network can proceed in two ways:

– the combination of radars forms a triangle on the ground with the sides of two hundred and fifty, three hundred and even four hundred and fifty kilometers;

– sum-total of radars forms a hexagon on the ground, the distance between radars is equal to the range of the radars.

The second method has a clear advantage since it provides a reduction of dead zones, reduces the height of the lower boundary of the radar field, which makes it possible to monitor the boundary and ground layers of the atmosphere. It is also important that in case of possible failure of one or more locators, the space will overlap due to the operation of other radars.

This method of forming a radar network also allows obtaining an economic effect in terms of economical energy consumption without reducing the quality indicators of atmospheric monitoring. It is also important to note that with this method of building a network, the quality of observations is quite high, and the impact on the environment is reduced. With a decrease in the range of the radar, less energy is emitted into space and the dangerous effect of electromagnetic radiation on people is reduced.

When analyzing developments in this area, we find it most interesting to use a hexagon-shaped radar network in the Republic of Kazakhstan.

The territory of Kazakhstan is diverse in weather conditions, relief and population. Obviously, the radar network cannot be built at the same time. This is a long work on the selection of locator installation sites and training of specialists in their maintenance, etc. Thus, the network building program should be centralized and should have a sufficient time period for its implementation. The creation of a workable network cannot be limited to 2022, since in modern conditions of stagnation of the world economy; this project cannot be implemented in a short time. This project should be phased.

Figure 4 shows the diagram of the radar network in the Republic of Kazakhstan. The location of the functioning meteorological locators is indicated in pink. Not completed DMR installation works are highlighted in green color. The creation of a radar network for monitoring the atmosphere on the basis of a hexagonal version of the location of objects would solve a lot of weather forecasting tasks for both aviation and the national economy.

Figure 4 – Map-diagram of real location of DMRL

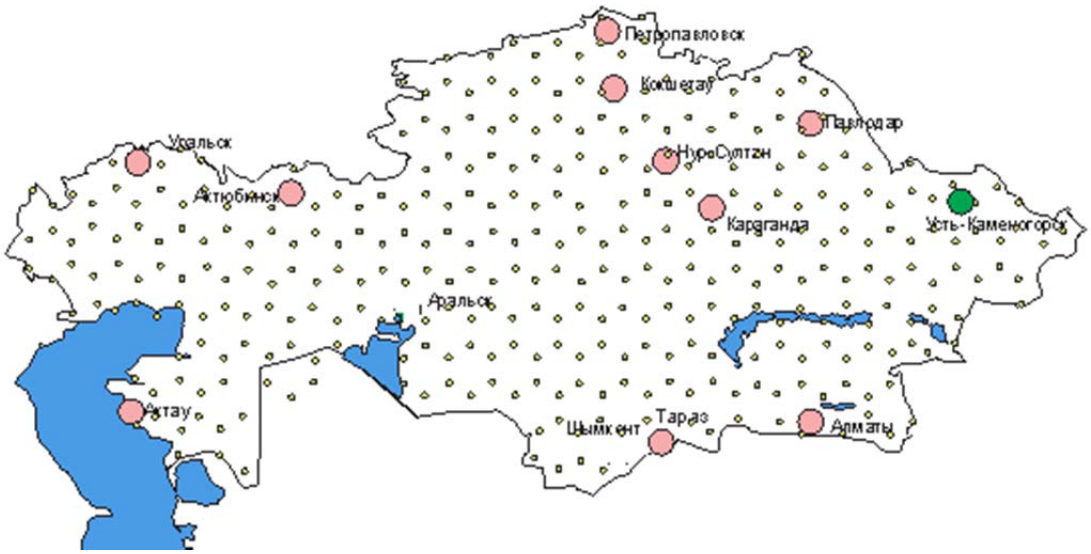

Figure 5 – Map diagram of the ideal prospective location of the DMRL for full coverage of the territory

Figure 5 shows the layout of the DMRL according to the hexagon rule in the territory of the Republic of Kazakhstan. In yellow, additional meteorological locators are shown to obtain a continuous radar field. In total, according to preliminary estimates, in addition to the installed, about three hundred DMRL are required to create a network with locators located at a distance of about one hundred kilometers to enable monitoring of the lower atmosphere, energy saving, as well as to have as little impact on the environment as possible.

REFERENCES

[1] Bazlova T.A., Bocharnikov N.V., Brylev G.B., Kuznetsova L.I., Linev A.G., Malanpchsv S.A., Olenev V.A., Parkinen T.V., Solonin A.S., Ustinov V.K., Frolov V.I., Chetverikova E.S., Yakimainen N.A. Meteorological emergency radar networks. SPb.: Gidrometeoizdat, 2002. 331p. (in Russ.).

[2] Enterprise Electronics Corporation, USA. Weather radar solutions for today and tomorrow. A tech.-sys. Company: Prospects. 1999.

[3] Golden J.H. The prospects and promise of NEXRAD: 1990's and beyond // COST 73. 1989. P. 17-36.

[4] Perelygin B.V. A method of creating a radar network for hydrometeorological monitoring of the atmosphere // Radio engineering. 2019. Issue 196. P. 38-45 (in Russ.).

Е. Майлянова

Азаматтық авиация академиясы, Алматы, Қазақстан; *maylyanova64@mail.ru*

ҚАЗАҚСТАН РЕСПУБЛИКАСЫНДАҒЫ РАДАРЛЫҚ ЖЕЛІНІҢ ҰШУ МӘЛІМЕТТЕРІН ТАЛДАУ ЖӘНЕ ЖИНАҚТАУ ФУНКЦИЯЛЫҒЫ

Аннотация. Ұшу қауіпсіздігін және әуе қозғалысына сапалы қызмет көрсетуді жақсартудың бір жолы – елдің бақылау желісінің материалдық-техникалық жабдықталуын жақсарту. Бұл «астыңғы қабаты – атмосфера» жүйесінің жай -күйіне талдауды жақсартуға мүмкіндік береді, бұл, атап айтқанда, қауіпті және аса қауіпті ауа райы құбылыстарын анықтауға және оларды болжауға қажет. Атмосфералық процестерді бақылау құралдарын жетілдіру бағыттарының бірі – метеорологиялық радарды қамтитын атмосфераның қашықтықтан зондтау әдістерін қолдану. Бүгінде барлық дамыған елдерде метеорологиялық радиолокациялық желілер құрылды: АҚШ-та NEXRAD желісі шамамен 150 WSR-88D доплер поляризацияланған S-диапазонды радарларын біріктіреді; Еуропада халықаралық OPERA жобасы аясында шамамен 180 радар түрлі бақылау бағдарламаларында жұмыс істейтін әр түрлі өндірушілер желіге қосылған. Олардың кейбіреулері доплерлік және поляризацияланған. Қытайда, Жапонияда, Австралияда радарлар да ұлттық желілерге біріктірілген. Ашық көздерді талдау барысында біз әлемнің бірнеше елдеріндегі метеорологиялық радиолокациялық желілердің негізгі сипаттамаларын анықтадық және Қазақстан Республикасының аумағын қамту үшін қажетті радар санын есептедік.

Түйін сөздер: локаторлар, орналасу желілері, қауіпсіздік, атмосфераның жағдайы туралы ақпарат.

Е. Майлянова

Академия гражданской авиации, Алматы, Казахстан; *maylyanova64@mail.ru*

ЦЕЛЕСООБРАЗНОСТЬ РАДИОЛОКАЦИОННОЙ СЕТИ В РЕСПУБЛИКЕ КАЗАХСТАН ДЛЯ АНАЛИЗА И СБОРА ПОЛЕТНОЙ ИНФОРМАЦИИ

Аннотация. Одним из путей повышения безопасности полетов и качественного обслуживания воздушного движения является совершенствование материально-технического оснащения наблюдательной сети страны. Это позволяет улучшить анализ состояния системы «подстилающая поверхность – атмосфера», необходимого, в частности, для выявления опасных и особо опасных явлений погоды и их прогнозирования. Одним из направлений совершенствования средств контроля за атмосферными процессами является использование дистанционных методов зондирования атмосферы, к которым относится метеорологическая радиолокация. Сегодня метеорологические радиолокационные сети созданы во всех развитых странах: в США сеть NEXRAD объединяет около 150 доплеровских поляризационных радиолокаторов S-диапазона WSR-88D, в Европе в рамках международного проекта OPERA в сеть объединяются около 180 радиолокаторов различных производителей, работающих по разным программам наблюдений. Часть из них является доплеровскими и поляризационными. В Китае, Японии, Австралии радиолокаторы также объединены в национальные сети. В процессе анализа открытых источников мы определили основные характеристики сетей метеорологических локаторов в нескольких странах мира и произвели расчет необходимого количества локаторов для покрытия территории Республики Казахстан.

Ключевые слова: локаторы, локационные сети, безопасность, информация о состоянии атмосферы.