The method of increasing the accuracy of coordinates of the contaminated area and water surfaces during environmental monitoring

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Abstract. One of the methods for increasing the accuracy of compiling pollution maps based on the results of air and ground monitoring of environmental monitoring of territories is considered. It has been substantiated that for the study of large areas it is advisable to install equipment for monitoring the state of the environment on aircraft. To improve the accuracy of determining coordinates in difficult conditions, it is proposed to use a quasi-differential mode of operation of navigation equipment placed on an aircraft in the developed method. The aircraft is equipped with various equipment and moves at high speed, conducting research on large areas of the territory. At an aircraft speed of more than 250 km / h, the accuracy of determining the coordinates of 30 m for drawing up an ecological map on a large scale suits the services responsible for environmental safety. Based on these data, additional environmental monitoring is carried out only in areas where pollution is detected. This reduces the time for complete environmental monitoring and saves material resources.

1. Introduction
In the modern world there is a constant deterioration of the ecological situation [1-13]. All objects of wildlife, as well as soil and vegetation, are exposed to technogenic stress [12-24]. It should be noted that pollution often travels in the atmosphere over long distances [19, 20, 25-31]. Therefore, it is necessary to carry out environmental monitoring over large areas [20, 24, 25, 26, 32-34]. This is due to the fact that the express control of the territory during environmental monitoring covers a small area and an extremely costly event [13-17, 28, 31, 34, 35].

One of the most effective methods of environmental monitoring is aerospace monitoring from various optical and radar systems [36–45]. To organize aerospace monitoring, it is necessary to place instruments on aircraft, for example, airplanes (Fig. 1). This arrangement allows research to be carried out over a large area. With the help of aerial photographs and radar, it is possible to track environmental changes in the observed area, the appearance of pollution objects and their dynamics of development [36-40, 44, 45-48].
Figure 1. Aircraft use for environmental monitoring.

The effectiveness of detection, prevention and prevention of adverse environmental situations directly depends on the accuracy of determining the coordinates of one or another source of pollution that affects the environment.

2. Methods
To increase the reliability of the results of air monitoring, especially in areas with a complex electromagnetic environment, it is necessary to improve the accuracy of determining coordinates due to the operation of navigation equipment. For this, it is proposed to use a quasi-differential mode in the aircraft navigation equipment.

There are absolute and relative methods for determining coordinates [30-32]. The absolute fact is that the receiver independently determines its location using the signals of several satellites or ground stations. Relative, it is also differential, involves the measurement of coordinates relative to a point with known coordinates. Determination of the error at a point with known coordinates and the propagation of this error to the local zone is limited by the uniformity of the underlying surface. This correction is transmitted to the consumer receiver and adjusts its pseudo-range. The quasi-differential mode implies the determination of corrections to measurements from PPRNS signals using coordinates determined using the SRNS receiver, which in this case are defined as reference ones. Further, when the SRNS signals disappear, these corrections can be used by the PPRNS receiver to increase the accuracy of determining the location of a moving object [30-32].

The receiver coordinates obtained using the SRNS are considered as reference ones. The receiver determines the coordinates of the master and slave stations in a pulse-phase mode. The distances from the receiver to the master and slave stations are calculated. Then the differences of the obtained ranges are formed. The number of slave stations determines the number of differences. Difference data is a reference because it is calculated using the reference coordinates of the receiver. In addition, the receiver in the pulse-phase mode determines its coordinates, the distances to the master and slave stations and generates differences similar to those described above. Such differences are called radio navigation parameters (RNP) or pseudo-range. After that, differences in reference ranges and pseudo-ranges are formed. The resulting value is an amendment to RNP.
The received amendments must be recalculated with the receipt of new coordinates from the SRNS and pseudo-range from the PPRNS.

3. Result and discussion
To confirm our proposal for the use of a quasi-differential mode in navigation equipment, studies were carried out for two cases. In figure 3 shows the measurement results when the satellite signal disappears after PPRNS and SRNS work together and operation continues with the last correction.

Legend on the graphs: Y-axis: dFi sns, dLa sns - coordinate errors when operating in quasi-differential mode according to PPRNS signals with continuous correction according to SNS data; dFi ppr, dLa ppr - coordinate errors when operating in quasi-differential mode only for PPRNS signals, taking into account corrections to the propagation speed of radio waves, calculated when the data from the SRNS were available; dFi, dLa - coordinate errors when working only on PPRNS signals. X-axis: time in hours: minutes format.
The results show that the use of such an algorithm reduces the error in determining the location from 300 to 30 meters, which makes the accuracy of PPRNS comparable with the accuracy of SRNS.

4. Conclusion
The obtained experimental results confirm the effectiveness of the developed algorithm for the quasi-differential mode and the expediency of its use in PPRNS for problems using SRNS for tasks requiring a short time. For example, to determine the coordinates of an object affecting the environment with short-term navigation losses from the SRNS. The time during which this correction will be in effect depends on the change in the underlying surface and the speed of the moving object. The use of a quasi-differential mode makes it possible to reduce the time for determining the coordinates of an object potentially hazardous to the environment, thereby reducing potential damage to the environment.

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