Method of safe descent in case of off-nominal on-board situation on Russian perspective manned spacecraft "Federation"

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Descent and landing are well known as most important and dangerous phases of every manned spacecraft flight. A lot of off-nominal situations may occur during of the space flight. Nowadays method of providing safe descent of the modern Russian`s manned spacecraft "Soyuz MC" presupposes the possibility of landing in safety region only once per circle, for example time waiting of brake engine inclusion for safe decent can be 1.5 hours for ISS orbit. In case of off-nominal deorbitation ballistic trajectory usually carried. In this case values of overload can be over 10g. Also scattering of the landing points values are very large, i.e. using ballistic trajectory of descent may pose a threat to health of the crew. This problem can be solved by using modern development of space technologies. But first, the following problems must be solved:

- increase in accuracy landing;
- the use of modern global navigational systems in all phases of descent;
- development onboard digital map containing information about quality of all possible landing points;
- development of algorithms for searching a safe descent trajectory using digital map, which can work in the operational control loop and on-board of perspective manned spacecraft.

One of the main tasks for perspective manned spacecraft is providing possibility of landing to Russia territory at small size regions. For solving this task new terminal guidance algorithms where developed. Using these algorithms we can increase the number of security acceptable landing areas for off-nominal descent. After that we must develop new method of searching safe guided trajectory for off-nominal descent, because modern method of safe descent for manned spacecraft "Soyuz" was based on using ballistic trajectory of descent. For solving this task, new onboard data structure was developed. This is digital map containing information about quality of all possible landing points for current inclination of orbit. All possible landing areas where classify from 1 to 10. Where 1 is the most disadvantaged areas and 10 is the regular areas of landing (fig.1). Also algorithm of searching sighting point on digital map was developed. This algorithm is based on mathematical method of steepest descent. The solution of all these problems allows the off-nominal descent more often than once per circle.

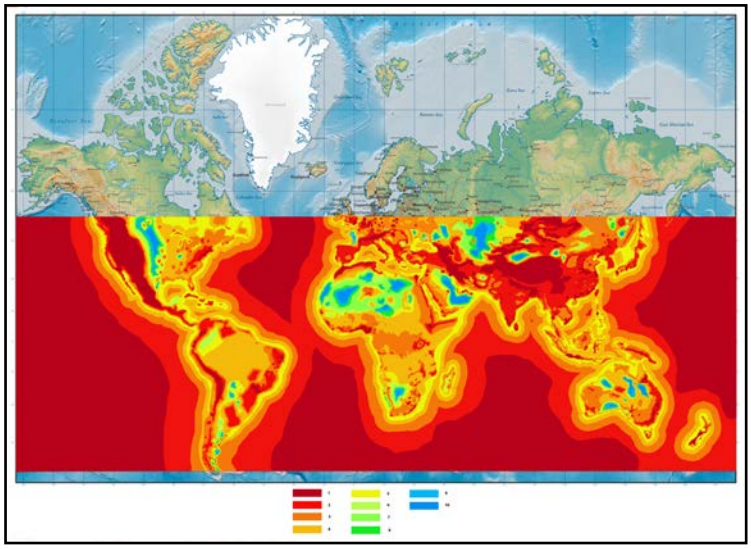

Fig.1. Digital map for ISS orbit