# An alternative algorithm for fast computation of the gravity acceleration

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Fast computation of ephemeris for numerous objects orbiting the Earth at rather low altitude will become a real need in the next years. We can quote constellations of satellites or space debris. One of the problems to solve in these orbit predictions is the fast and accurate computation of the gravity acceleration. Indeed, because of the low altitude, a very complete gravity model and a short step of integration must be used. But, in spite of increasing performances of computers, computing the gravity acceleration corresponding to such models, for numerous objects, is still a concern.

We propose an alternative method to compute the gravity acceleration and, more generally, any derivative of the gravity potential. This consists in extrapolating values of the derivatives, which have been pre-computed at given points, up to the current point by means of Taylor series expansion. Technically, for a given gravity model, we compute once for all the space derivatives (typically up to order 10) of the potential at points located on a set of spherical grids (typically 180 x 360 points per grid) of different radii. During the orbit computation the only things to do are (i) to search the pre-computed point which is the closest to the current point of the orbit, and (ii) using the derivatives, to extrapolate the value of the acceleration up to the current point. This computation is considerably simpler than computing all spherical harmonics and this is faster as soon as the truncation order of the gravity model exceeds a limit which stands typically around 20. As an example, for an orbit at 300 km of altitude and a gravity model truncated to degree and order 140, we have decreased the time dedicated to the computation of the gravity acceleration by more than a factor 100 while keeping an accuracy at the mm level.