Adjoint sensitivity analysis of orbital mechanics: Application to computations of observables' partials with respect to harmonics of the planetary gravity fields

E. Ustinov (1), R. Sunseri (1)

(1) Jet Propulsion Laboratory, California Institute of Technology, California, USA

An approach is presented to the inversion of gravity fields based on evaluation of partials of observables with respect to gravity harmonics using the solution of adjoint problem of orbital dynamics of the spacecraft. Corresponding adjoint operator is derived directly from the linear operator of the linearized forward problem of orbital dynamics. The resulting adjoint problem is similar to the forward problem and can be solved by the same methods. For given highest degree N of gravity harmonics desired, this method involves integration of N adjoint solutions as compared to integration of N^2 partials of the forward solution with respect to gravity harmonics in the conventional approach. Thus, for higher resolution gravity models, this approach becomes increasingly more effective in terms of computer resources as compared to the approach based on the solution of the forward problem of orbital dynamics. The presented theoretical framework is illustrated by results of validation numerical experiments.