Orbit Tuning of Planetary Orbiters for Accuracy Gain in Gravity-Field Mapping

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Nomenclature

\( A \) = design matrix of the linear model

\( \alpha \) = mean semimajor axis of the satellite orbit, m

\( \bar{C}_l, \bar{S}_l \) = normalized Stokes parameters

\( D \) = density of the ground tracks at the equator, m

\( GM \) = planetocentric gravity constant, \( \text{km}^3 \text{s}^{-2} \)

\( g \) = radial acceleration for a Mars orbiter, \( \text{m} \text{s}^{-2} \)

\( I \) = mean orbit inclination, deg

\( J_2 \) = zonal second-degree harmonic coefficient (Stokes parameter) related to the polar flattening of the planet in unnormalized form

\( L_{\text{max}} \) = maximum degree of Stokes parameters or their time variations

\( M_0 \) = mean anomaly (and its time derivative, the rate of \( M_0 \)), deg

\( n \) = satellite’s mean motion (revolutions per day)

\( n_{\text{obs}} \) = number of observations in the experiments with covariance matrices

\( n_{\text{par}} \) = number of solved-for parameters in the experiments with covariance matrices

\( o \) = circumference of the planet around the equator, m

\( P_l(\cos \theta) \) = normalized associated Legendre functions of the first kind

\( R \) = radius or best fitting (rotational) ellipsoid (expressing the shape of the planet), m

\( r \) = radius vector of the satellite, m

\( \dot{S} \) = rotational speed of the planet (revolutions per days on the planet)

\( \text{SP} \) = normalized Stokes parameters, \( \bar{C}_l \) and \( \bar{S}_l \)

\( T_{\text{sc}} \) = the second radial derivative of the geopotential, \( \text{mE} \)

\( \alpha \) = nodal days (number of revolutions of the planet with respect to the orbital plane)

\( \beta \) = nodal revolutions (number of satellite revolutions around the planet with respect to the ascending node)

\( \theta \) = colatitude of the satellite, deg

\( \lambda \) = longitude of the satellite, deg

\( \psi_{\perp pq} \) = phase in Lagrange planetary equations (degree \( l \), order \( m \), other indices \( p \) and \( q \), deg

\( \Omega \) = ascending node (and its time derivative, the rate of \( \Omega \)), deg

\( \omega \) = distance of periapsis from the ascending node (and its time derivative, the rate of \( \omega \)), deg, deg/day

1. Introduction

EARTH artificial satellites are a very useful tool to study the gravitational field of the Earth due to their worldwide and continuous observations by various methods. Their orbit determination and consequent computation of the harmonic geopotential coefficients (Stokes parameters) defining the Earth’s gravitational field enable the creation of so-called Earth gravitational (or geopotential) models (EGMs) [1,2].