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NASA TECH BRIEF

Theory of Refined Earth Model

Refined equations have been derived relating the variations of the earth's gravity and radius as functions of longitude and latitude. Starting from the expansion in spherical harmonics of the geopotential of a rotating three-axial earth model, the three components of the gravity acceleration vector were obtained. The generalized equation for the surface of the earth (also expressed as an expansion in spherical harmonics) was inserted into the equation for the constant surface potential to derive quantitative mathematical relationships between the oblateness coefficients of the zonal and tesseral harmonics and the geometrical and gravitational parameters of the earth. These equations particularly relate the oblateness coefficients of the odd harmonics and the difference of the polar radii (respectively, ellipticities and polar gravity accelerations) in the northern and southern hemispheres. The new theory on which the equations are based may well replace the first-, second-, and third-order theories of the earth's figure developed by Clairaut, G. H. Darwin, Callandreau, Helmert, de Sitter, and Cook.

Starting from the newest values for the oblateness coefficients of the even and odd spherical harmonics up to the 14th degree, given by Y. Kozai in 1964, the new theory gives a mean meridional reciprocal flattening $1/f = 298.17$. The corresponding values for the northern and southern hemispheres are, respectively, 298.43 and 297.91. The difference between the polar radii is 37.8 meters, and the difference between the polar gravity accelerations is 13.4 milligals (1 gal = 1 centimeter per second per second). The equator has an ellipticity of 1.082×10^{-5}, corresponding to a difference of 69.0 meters between the largest and smallest equatorial radii, and a maximum difference of 31.8 milligals between the equatorial gravity accelerations.

Note:

Complete details may be obtained from:

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No patent action is contemplated by NASA.

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Category 02