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On the physical meaning of the zonal components of the geopotential

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The MacCullagh equation (1855) is of key importance in the study of the Earth, describes the gravity potential outside a bounding sphere of radius R up to the second degree and zeroth order. It connects the geometrical, and the physical properties of the Earth through the geodynamical shape factor J_2. This second zonal geopotential coefficient is closely related to the flattening and to the angular spin velocity of the Earth as well as to its equatorial (A) and polar (C) moments of inertia. Through these moments of inertia the gravitational potential V is connected to the mass density distribution within the Earth.

The main target of the present study is to obtain a generalized form of the MacCullagh equation for even orders $n \geq 2$ by including the higher order zonal coefficients J_n connected with the higher $(n \geq 2)$ degree moments of inertia C_n and A_n. The higher the degree n, the higher is the weight of the near-surface (i.e. shallow) mass density distribution in J_n. The second part of this contribution deals with the temporal variations of J_n *and* dJ_n/dt .