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Second order analytical theory of the rotational motion of the non-rigid Earth

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Current accuracies in the determination of the Earth orientation force to consider dynamical models of the Earth rotation beyond the simple first order theories. Therefore, it is necessary to undertake a complete analytical reconstruction of the theory of the whole rotational motion of the non-rigid Earth. It must consider a second-order analytical integration of the problem, which includes new small contributions previously disregarded, as well as non-linear second order terms in the sense of perturbation theories.

To this aim we have extended the Hamiltonian theory of Getino and Ferrándiz in a two-fold way. On the one hand, to consider entirely the effects of the dissipation mechanisms one should apply a general perturbation method, what can be achieved by doubling the dimension of the original phase space (e.g. Breedlove 1969, Choi 1970 or Kamel 1971). On the other one, the intrinsic difficulties inherent to second order analytical treatments have been reduced by introducing a matrix formulation that makes easy the computation of the new contributions and would allow a quasi-direct inclusion of additional terms.

Due to the complexity of the problem, it has to be tackled by considering successively approximations to the non-rigid Earth models considered. In this investigation, we present first results concerning a basic non-rigid Earth model composed of a rigid mantle that encloses a fluid core (Poincaré model). With the above mentioned mathematical tools, we work out the analytical expressions at the second order for the nutation, the precession, the polar motion and the length of day of this non-rigid model, giving the numerical representation of these contributions. Finally, these magnitudes are compared with respect to other effects included in the current models, showing the need of developing second order theories in a consistent way.