

# Computation of nutations incorporating new coupling mechanisms at the outer core boundaries and second-order boundary conditions 'Earth sciences – nutations' - BL/33/C18

(Geographic) study area (country/region):

Data used:

Satellite imagery used (if applicable):

## Context and objectives

The Earth's nutations are changes of orientation of the rotation axis of the Earth in space as induced by the gravitational attraction of the Moon, the Sun and eventually the other planets. They are **Earth orientation parameters** which link the space inertial reference frame and the terrestrial reference frame on which our astronomy observation is based. These nutations can be observed by geodetic techniques like the Very Long Baseline Interferometry (observation of the position of distant celestial objects like quasars which can be considered fixed in space). They can also be computed from a model considering precise modelling of the interior of the Earth, such as electromagnetic coupling at the fluid outer core boundaries. Therefore, nutation study is very important in astronomy, geophysics and astronautics. The present project was in that context. It aims at incorporate electromagnetic core-mantle coupling in the theoretical computation of nutations. Both institutes, the Royal Observatory of Belgium (ROB) and the Shanghai Astronomical Observatory (SHAO) have developed codes allowing these computations. We have revisited the theoretical background, recomputed the equations and their corresponding solutions, and incorporated them in the codes.

## Methodology

Both teams have computer codes available for computing nutation models, with different options, and, it was of interest to both teams to incorporate electro-magnetic coupling into the computer programs. In addition, when working on the fine details during their cooperation, Huang and Dehant have observed the existence of instabilities in the solutions. They suspected that these instabilities are related to the existence of normal modes in the fluid outer core influencing the solutions.

The methodology used by the teams was thus to compare and work out together the theoretical background and to compare the behavior of the solutions from the different codes in order to better interpret the results. They have as well incorporated new internal models coming from seismology as input for the rheological properties of the interior of the Earth.

## Results

In the frame of a bilateral sino-bel agreement ROB and SHAO have been working together on different improvements of the numerical modeling for getting nutations:

1. The effects of possible differential rotations among Earth's three parts on the Earth nutation, normal modes and the displacement fields of the Earth interior are calculated, and the possibility to detect the differential rotation from the nutation observation is discussed. (presented & published in international symposium's proceeding (Huang & Dehant, **2002**)).
2. Derival of a complete set of scalar equations of infinitesimal elastic-gravitational motion in the fluid outer core in an explicit and ready-to-program format. This result has been published in Geophys. J. Int. (Huang et al., **2004**).
3. Computation of the electromagnetic coupling effect in the numerical integration program by first deriving the equation that must be used in the frame of our numerical approach (Huang et al., **2005**), and then by computing the effect (Huang et al., **2007**, in preparation).

Huang C.L., Dehant V., 2002, "Is the differential rotation detectable from Earth nutation?", in: Proc. `Journées des Systèmes de Référence Spatio-temporels 2001', Observatoire Royal de Belgique, September 2001, ed. Capitaine N., pp. 20-27.

Huang C.L., Dehant V., Liao X.H., 2004, "The explicit equations of infinitesimal elastic-gravitational motion in the rotating, slightly elliptical fluid outer core of the Earth.", Geophys. J. Int., 157, 831-837, DOI: 10.1111/j.1365-246X.2004.02238.x.

Huang C., Dehant V., Liao X., de Viron O., Van Hoolst T., 2005, "The coupling equations between the nutation and the geomagnetic field in GSH expansion.", in: Proc. Journées Systèmes de Référence Spatio-temporels 2004, Paris, France, September 2004, pp. 88-93.

Huang C., Dehant V., Liao X., de Viron O., Van Hoolst T., 2007, "On the coupling between magnetic field and nutation in a numerical integration approach.", J. Geophys. Res., to be submitted soon.

## Products and services

Not applicable

## Execution

**Period:** 2005-2006

**Laboratory/network:** **ROB** (Royal Observatory of Belgium) - [y.dehant@oma.be](mailto:y.dehant@oma.be)  
**SHAO** (Shanghai Astronomical Observatory,  
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## Discipline

General Earth observation  
Astronomy  
Geophysics  
Earth rotation, reference frames