Modelling of the magnetic field

By M. Kruglanski

The Earth's magnetic field results from the superposition of the internal field, the crustal field and a magnetospheric field.

The internal magnetic field originates in the magmatic flows inside the terrestrial core. It is generally modeled by a spherical harmonics expansion, the first term of which is that of a magnetic dipole (similar to the field of a magnetized bar). Until an altitude of 20000km, the internal field is the main component of the Earth's magnetic field.

The crustal magnetic field is caused by magnetic rocks in the Earth's crust which locally disturb the magnetic field at the Earth surface. The crustal field impact weakens quickly with altitude.

The magnetospheric fields originate outside of the Earth, in the magnetosphere. They result from both the interaction of the geomagnetic field with solar wind, and the movement of charged particles (plasma) in the magnetosphere. Beyond an altitude of 20000km, the magnetospheric fields are dominating and oftenly described by a set of current systems such as :

- a current system at the edge of the magnetosphere (magnetopause) where solar wind interaction occurs;
- a current system within the "neutral layer" which extends in the magnetosphere tail in the opposite direction to the Sun;
- a current system surrounding the Earth in the equatorial plane about an altitude of 20000km.

The magnetospheric fields are complex to model since they strongly vary in time and depend on complicate current systems. The models of the internal, crustal and external parts of the Earth's magnetic field are carried out from several data sources:

- permanent observatories distributed all over the world;
- repetitive measurements at stations of selected sites;
- campaigns of air and naval measurements;
- satellite observations.