ICTP DIPLOMA PROGRAMME IN EARTH SYSTEM PHYSICS 2013-14

SYLLABUS

Physics of the Solid-Earth - {12 Lectures = 18 hours} A. Aoudia, C. Braitenberg

1- Goals of the course. Importance of Physics of the Earth. Relevance of determining Earth Physical Parameters. Physical parameters and the method to determine them. Units for all fields and physical parameters relevant for earth investigation. Age of Earth. Definition Cratons. Define Midocean spreading center. Mid Atlantic Ridge. Magnetic anomalies parallel to mid-atlantic ridge: explanation. Reconstruction of plate movement through magnetic anomalies. Plate movement at Caraibic plate. Haiti Earthquake.

2- Global Lithosphere Structure. Quantitative knowledge of range of physical parameters Vp, Vs, density. Main discontinuities inside earth. Principal geophysical techniques of investigation (gravity, magnetic, seismics, magnetotellurics, electric, heat flow), physical parameters used to describe lithosphere, average structure of continental and oceanic crust. CRUST 1.0 model. Number of layers describing model, range of variation for Vp, Vs and density.

3- Local isostatic compensation model (Airy). Quantitative analysis of: vertical movement due to erosion. Uplift response to melting. Compressive topography building. Definition shortening. Relative sea level change along Italian coasts. Model for sea level trend calculation. Variability of trend: dependence on length of time interval on which it is calculated. Relative trend Venice, Genova, Trieste. Observation of sea surface from satellite altimetry. Principle of measurement. Spacing of tracks of Topex-Poseidon and Jason satellites.

4- Measurement of the Earth gravity field. Gravimeter; principle of measurement for absolute and relative measurements; definition gravity gradient, units. Things to consider when planning a field campaign, Public database for data retrieval. Case history Grotta Gigante: size of signal. Model of signal through Laser scan acquisition. Case history Andes: size of signal. Sigbal due to crustal thickening and signal due to sedimentary basin.

5- Spherical harmonic expansion: main properties. Degree and order of expansion. Nodal lines for different degree and order. Tesseral, zonal and sectorial harmonics. Expansion of gravity potential field. Definition geoid, gravity anomaly, gravity disturbance. International reference ellipsoid WGS84. Four parameters that define WGS84. The earth's gravity field and potential-theory, Stokes coefficients, geoid, reference elliposid, dynamic form factor, earth flattening, Disturbance potential, gravity anomaly, normal gravity, height correction normal gravity, normal gravity at pole and equator, ellipsoidal height, normal height, Bouguer plate, geoidal undulations. Different reference surfaces: geoid and ellipsoid. Ellipsoidal height and normal height. Normal gravity.

6- Spherical harmonic expansion, problems in averaging terrestrial observations, base functions, Associated Legendre polynomes, resolution of the field and maximum degree and order of expansion, zonal, sectorial, tesseral harmonics, number of nodal lines of the harmonics, expansion of the gravity potential, degree variances, error degree variances, degree error curves, complementarity of missions CHAMP, GRACE, GOCE.

7- New data from satellite missions CHAMP, GRACE, GOCE, principle of measurement, essential improvement through continuous position measurement (high-low) and acceleration measurement, gradient measurement, properties of satellite GOCE.

8- Achievements from satellite gravity. Expected signal in hydrology. Define expected variations. Define Equivalent Water Height, Unit. Expected signal size. Ice mass balance in Greenland and Antarctica. Change of signal in time. Application in Oceanography: mean dynamic topography, definition. Application solid earth. What is observed gravity anomaly due to.

Textbooks of reference:

Watts A.B. – Isostasy and Flexure of the Lithosphere, Cambridge University Press, 2001.

Blakely R.J. – Potential theory in Gravity and Magnetic Applications, Cambridge University Press, 1996.

Textbooks contained in the ICTP library that are useful:

1-Earth Science (Foster) (for geology definition, geology part)

2-The Earth System (Lee R. Kump, etc)(chapter7)

3- Applied Geophysics (W.M. Telford, etc) (for gravity concepts and

equations, chapters 1,2,3)

4- An introduction to Geophysical Exploration (Philip Kearey, etc)