Second International School on
"*Least Squares Approach to Modeling the Geoid*"

After the successful experiences in the determinations and evaluations of precise local geoid models in different countries as well as the very well met First International Geoid School at Yildiz Technical University, Istanbul, in September 2010, we plan to arrange the Second International Geoid School based on the KTH approach. (KTH is a Swedish abbreviation for Royal Institute of Technology, Stockholm, Sweden). The school is planned to be arranged at UTM, from 27 February to 2 March 2012, to be hosted by the Department of Geomatic Engineering, Faculty of Geoinformation and & Real Estate, Universiti Teknologi Malaysia (UTM), Johor Bahru, Malaysia.

The KTH approach to geoid determination is unique in the sense that it uses least squares technique in the spectral domain to combine the data in an optimum way by considering the errors of the EGM, the gravity data and the truncation of Stokes' integral to a cap around the computation point. Another feature that distinguishes the KTH method from others is the way corrections for topography, atmosphere and ellipsoidal shape of the earth are applied: all corrections are added as separate additive corrections. This method was successfully applied in the determination of several regional geoid models: over Sweden, the Baltic countries, Greece, Iran, Sudan, Zambia, Ethiopia, Tanzania and, finally, in the 2009 test project for the comparison of up-to-date methods of geoid modelling in Auvergne, France.

The school will be organized with theoretical lectures in the mornings followed by computer exercises in the afternoons, where the software available at KTH will be used. Computers will be simultaneously available for the exercises. Since the Geoid School has a full-week intensive program, it can be counted as an external full graduate course.

The school is offered only for university students and personnel from public organizations, and the software package is available only for training of students and scientific works.

Why KTH approach?

Many different methods have been proposed through the years for regional geoid determination by gravimetric data, each based on its own technique and philosophy. Today, all such methods combine long-wavelength Earth Gravity Models (EGMs) with local gravity data, and they mainly differ in the way they combine these data sets. The KTH approach is unique in the sense that it uses least squares technique in the spectral domain to combine the data in an optimum way by considering the errors of the EGM, the gravity data and the truncation of Stokes' integral to a cap around the computation point. Another feature that distinguishes the KTH method from others is the way

corrections for topography, atmosphere and ellipsoidal shape of the earth are applied: in contrast to other methods, which all apply these corrections both to the gravity anomaly (direct effects) and to the preliminary computed geoid heights (indirect effects), it only corrects the preliminary geoid heights by so-called additive corrections. Any of the additive corrections can be added afterward at any time when better data are available for its improvement (without the need to repeat all the computations). The method, called Least Squares Modification of Stokes Formula with Additive corrections (LSMSA), is the result of 30 years of research and several M.Sc. and Ph.D. theses at KTH. The LSMSA is an accurate, simple and practical method of determining the geoid. The theoretical and practical aspects of this method have been developed since 1984 to present mainly by and under the supervision of Prof. Lars E. Sjöberg. (See numerous papers, e.g. in J. of Geodesy.) The method has been successfully applied in the determination of several high-resolution regional geoid models in different areas. Through the LSMSA approach, various data, such as a Global Geopotential Model, gravity anomalies and a high-resolution photogrammetric/SRTM Digital Elevation Model are combined to a gravimetric geoid model, and the method can be (and usually is) designed to match with GPS/levelling data by using the least-squares principle. Several of the successful applications are reported in M.Sc. and Ph.D. theses at www.infra.kth.se/geo. Notable among these studies are the applications in very rough topographic areas and in several developing countries with only limited gravity anomaly data. The results of comparisons clearly show that the LSMSA is advantageous to other methods.

Finally, in the recent test project for the comparison of up-to-date methods of geoid modelling with data frome *Auvergne* area in France , no method provided better results than the LSMSA (http://w3.uniroma1.it/Hotine-marussi_symposium_2009/SubAbs.asp).

The lecture notes will be prepared on a CD, which contains also exercises, data sets and software. Each student will receive a copy of the CD, and it will also be sent electronically to students well ahead of the school.

All lectures are followed by computer exercises, where the software available at KTH will be used. For the exercises a computer room will be available to run up the software package simultaneously on up to 25 computers.

This training course provides a good opportunity for the student to familiarize himself with the latest developments in geoid determination, as well as to enhance the international collaboration in gravity field modeling by building contacts to the professionals dealing with geoid determination in various countries.

Preliminary Program

Days	Lecture (Morning)[1)]	Lecture (Afternoon)[2)]
1	-Opening of the school. Lecture 1 -Basic Physical Geodesy -Modification of Stokes' formula (Part 1) *Lecturer: Prof. Lars Sjöberg*	- Gravity data snooping and gridding - Gravity field determination by global geopotential models. *Dr. Ramin Kiamehr*
2	Lecture 2 -Modification of Stokes' formula (Part 2) -Additive corrections (Part 1) *Lecturer: Prof. Lars Sjöberg*	Digital Elevation Models and Geoid *Dr. Ramin Kiamehr*
3	Lecture 3 -Additive corrections (Part 2). *Lecturer: Prof. Lars Sjöberg*	KTH GEOLAB Software Sample Full Project Workshop (Part1) *Dr- Ramin Kiamehr*
4	Lecture 4 -LSMSA vs. the RCR-Technique -Some practical experiences (e.g., from recent Ph.D. theses at KTH) *Lecturer: Prof. Lars Sjöberg*	KTH GEOLAB Software Sample Full Project Workshop (Part2) *Dr. Ramin Kiamehr*
5	Lecture 5 KTH GEOLAB Software Sample Full Project Workshop (Part3) -Fitting the Gravimetric Geoid to GPS on Benchmarks. (Including Exercises) *Dr. Ramin Kiamehr*	-Summary of the course and Final Discussion -Closing the school *Lars Sjöberg & Ramin Kiamehr*

[1)] Morning lectures 9-12 am

[2)] Afternoon lectures 1-4 pm

The Venue

The school will be held at Geomatic Computing Laboratory, Department of Geomatic Engineering, Faculty of Geoinformation & Real Estate, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.

Registration

The registration fee is €350 / RM1400 (to be paid upon arrival to the school) plus an entry fee (to be paid upon registration). Send the filled-in and scanned registration form (see below) to Mr. M. Bagherbandi (mohbag@kth.se) and pay the entry fee (not refundable) of €50 (paid before 1 December 2011) or €100 (paid later; if still possible; check with contact persons).

The registration fee includes lecture notes, preliminary software manual, a CD with the LSMSA software package, opening reception, lunches, coffee/tea at breaks and a social dinner.

Notification of your interest to participate in the school

Please, send an email to Mr. M. Bagherbandi (mohbag@kth.se) as soon as you know that you are likely to participate.

Accommodation

Participants are offered in-campus accommodation at the UTM Guest House at charging rates of about 14 Euro, 20 Euro or 40 Euro (depending on the room type chosen). All accommodations consists two-bed rooms with attached bathroom, TV, etc.

The UTM Guest House is located at Block U9, UTM Campus. Distance from Senai International Airport is about 16 km and about 21 km from Johor Bahru city. The UTM Guest House General Office contact number is 607-5535197. See also http://web.utm.my/hep2/scholars-inn.html.

More information

Contact the organizers or Mohammad Bagherbandi (mohbag@kth.se) for additional questions.

Organizers

The geoid school is lead by;

Lars E. Sjöberg
Head of Geoid School

Division of Geodesy and Geoinformatics
Royal Institute of Technology
SE- 100 44 Stockholm
SWEDEN
Email: lsjo@kth.se

Zainal Abidin Md Som
Head of Local Organizing Committee

Dept of Geomatic Engineering
Universiti Teknologi Malaysia
81310 Skudai Johor
MALAYSIA
Email: zainalabidin@utm.my

REGISTRATION FORM – IGS 2012, Johor Bahru, Malaysia
27 February-2 March, 2012

Please send by e-mail or fax this registration form to:
Royal Istitute of Technology, Division of Geodesy (Teknikringen 72, SE-100 44, Stockholm, SWEDEN). E-mail: mohbag@kth.se; Fax: +46 8 7907343

Registration Form:

Name:
_____
Organization:
_____
Address:
_____
Country:
_____
E-mail:
_____
Tel:
_____
Fax:
_____

Entry Fee (paid until 1 Dec.):	☐ €50
Entry Fee (paid after 1 Dec.):	☐ €100

The remaining registration fee of €350 and entry fee include lecture notes, preliminary software manual, a CD with LSMSA software package, opening reception, lunches, coffee/tea at breaks and a social dinner.

Payment:

The entry fee must be paid to

ROYAL INSTITUTE OF TECHNOLOGY/KTH
Division of Geodesy and Geoinformatics
Teknikringen 72
SE-100 44 Stockholm

by bank transfer to

NORDEA BANK AB, STOCKHOLM
IBAN: SE 05 9500 0099 6034 0015 6539
ACCOUNT NO: 156 53-9
SWIFT:

NDEASESS

Please make a note: AGC/your name