Geophysical Laboratory I/II, academic year 2016/2017
Topics and descriptions of exercises (03.10.2016)

Exercise 1
Two-dimensional numerical modelling of convection in the mantle with variable viscosity
Convection in the Earth's mantle is the primary large-scale dynamic process determining the tectonic and volcanic activities of the Earth. Numerical modeling is an important method for the study of the convection. During the exercise you will: familiarize with the available program, run the program in Windows or Linux, perform some modeling with different viscosity parameters in order to know the behavior of the convection. Moreover, graphical visualization of the results are with the use of typical packages are expected.
Lecturer: Dr. hab. Leszek Czechowski (lczecho@op.pl)

Exercise 25
Numerical modeling of evolution of rivers
Rivers are important factors shaping surface of the Earth. The aim of the exercise is to investigate the evolution of small river of given parameters and determine the criteria which decide about the type of the river (single-channel, multi-channel, meandering, braided). The computer package given for the exercise is an popular package used often for practical applications.
Lecturer: dr hab. Leszek Czechowski (lczecho@op.pl)

Exercise 2
Determination of earthquake location
On the basis of several seismograms should be set the time and place of the earthquake. It will be a case of " close " earthquake allow some simplification. As part of the introduction to the exercise, will be presented the basics of propagation of longitudinal (P) and shear (S) seismic waves, and the method of Wadati spheres to obtain a earthquake location. The task will be to identify the P and S waves on seismograms, to pick their onset time, to determine a time t_0, and to locate an earthquake for the known geometry of positions of seismic stations. Base variant will be based on synthetic data ("no errors") gives the possibility to verify the result with the known location of the source. Extended variant will be based on actual recorded data of an earthquake from seismic catalog. In this case, the comparison will be done with the catalog information, obtained as a result of routine seismological studies by professionals. In both variants a person performing the exercise will have an invation to analyse the errors of calculation of time of the earthquak, the epicenter and the depth of the source.
Lecturer: Prof. Marek Grad (mgrad@mimuw.edu.pl)

Exercise 3
Modelling of seismic crustal structure
The task will be to determine the three models of the Earth's crust: oceanic area and the continental platform and cratons. As part of the introduction to the exercise will be presented the basics of propagation of elastic waves in multilayer medium and simple program for calculating travel-time in 1D structure (program HOD with graphic support PLOT). The data for modelling will be seismic sections (collections of seismograms) obtained from seismic experiments. The task will be to extract waves in these sections, and then fit the three models of the velocity distribution of longitudinal waves for seismic section of the Atlantic Ocean, SW Polish and Baltic Shield. The summary task will be to compare models and comment on the differences in the crustal structure of the three different tectonic areas.
Lecturer: Prof. Marek Grad (mgrad@mimuw.edu.pl)

Exercise 4

Determination of the thermal conductivity of sand by linear probe technology (*exercise easier*)
The exercise is performed by measuring the thermal conductivity of sand without sampling the test material. The measurement is made by linear probe technology. It is used in practice in situations when taking a sample of the material is inexpedient or technically impossible. An example of application of the method is to measure the thermal conductivity of the comet Churyumov-Gerasimenko - the mission Rosetta, the experiment MUPUS.
Lecturer: Dr. Konrad Kossacki (kjkossac@igf.fuw.edu.pl)

Exercise 5
Determination of the thermal conductivity of snow or granular ice by linear probe technology (*exercise harder*)
The exercise is performed by measuring the thermal conductivity of granular snow or ice without sampling the test material. The measurement is made by linear probe technology. It is used in practice in situations when taking a sample of the material is inexpedient or technically impossible. An example of application of the method is to measure the thermal conductivity of the comet Churyumov-Gerasimenko - the mission Rosetta, the experiment MUPUS.
Lecturer: Dr. Konrad Kossacki (kjkossac@igf.fuw.edu.pl)

Exercise 6
Determination Obukhov length by ultrasonic anemometer measuring
Ultrasonic anemometer installed on the measuring platform of the IGF UW registers three velocity components of the air flow and a virtual temperature with a frequency of 32 measurements per second. This allows for the calculation of momentum flux of turbulent flows and heat transfer in the boundary layer of the atmosphere using method of vortex covariance. These values, in turn, allowed to determine the dynamic stability of the layer, which is typically expressed by the so-called Obukhov length. A student will perform a analysis of Obukhov length variation during one day.
Lecturer: Prof. Szymon Malinowski (malina@igf.fuw.edu.pl)

Exercise 7
Determination of the turbulent kinetic energy dissipation by measuring turbulent velocity fluctuations
Measurements of turbulent velocity fluctuations of air (e.g., from an ultrasonic anemometer or plane measurement) will be used to determine the power spectrum and the structure function of these fluctuations. This allows by using the Kolmogorov theory, to determine the value of the dissipation of turbulence kinetic energy, which will be the task of the student.
Lecturer: Prof. Szymon Malinowski (malina@igf.fuw.edu.pl)

Exercise 8
Langley calibration of radiometers MFR-7 and determination of optical thickness of aerosol
The aim of the exercise is calibration of the Langley Multifilter Shadowband Rotating Radiometer and use it to determine a optical thickness of aerosol. Calibration of the instrument requires the selection of an appropriate measurements from database (one day), performing a azimuth correction and linear regression of signals. Parameters obtained from these analyses should be used to determine a optical thickness of aerosol and Ångstroma coefficient.
Lecturer: Dr. hab. Krzysztof Markowicz (kmark@igf.fuw.edu.pl)

Exercise 9
Determination of optical properties of aerosol based on synergy measurements performed by aethelometer and polar nephelometer
Aethalometer and polar nephelometer are used to measure a coefficient of absorption and scattering bu aerosol, respectively. In both cases, due to the measurement methodology, calculation these parameters requires many corrections. As an exercise, these corrections are expected to be carried

out to calculate a single scattering albedo.
Lecturer: Dr. hab. Krzysztof Markowicz (kmark@igf.fuw.edu.pl)

Exercise 10
Determination of the components of the balance of radiation and energy balance
The exercise involves the use of measurements of solar radiation flux and long-term measurements using pyranometer , pyrheliometer and pyrgeometer to determine the components of the radiation balance. In addition, the effective heat flux contributing to the energy balance will be determined using an ultrasonic anemometer.
Lecturer: Dr. hab. Krzysztof Markowicz (kmark@igf.fuw.edu.pl)

Exercise 11
Determination of the distribution of size of the aerosol on the basis of measurements of the spectral optical thickness
Based on the optical thickness measurement using the aerosol sun photometer Microtops, we determine the aerosol size distribution. Aerosol size distribution will be approximate by a two log-normal distributions by minimizing the cost function. During the minimization two or four parameters are determined which describe the size distribution.
Lecturer: Dr. hab. Krzysztof Markowicz (kmark@igf.fuw.edu.pl)

Exercise 12
Determination of broadband aerosol optical depth from pyrheliometer observation.
Pyrheliometer is a device to measure the direct solar flux between UV and near IR. Computation of the broadband aerosol optical depth requires taking into account the effect of absorption of solar radiation by water vapour and ozone. Reduction of surface solar direct flux by the both gases can be done based on the radiative transfer model.
Lecturer: Dr. Krzysztof Markowicz **(**kmark@igf.fuw.edu.pl**)**

Exercise 13
Estimation of aerosol radiative forcing based on solar flux measurements and radiative transfer simulation.
The purpose of this exercise is to compute the direct aerosol radiative forcing at the Earth's surface from observation of total solar flux and simulation of total solar flux for atmosphere without aerosol. To simulate the solar flux the Fu-Liou code will be used.
Lecturer: Dr. Krzysztof Markowicz **(**kmark@igf.fuw.edu.pl**)**

Exercise 17
Determination of optical properties of atmospheric profiles from ADR lidar
The aim of the exercise is to retrieve profiles of the optical properties of atmosphere from ADR lidar signals. The student will use for this purpose available lidar measurements and radiosounding profiles. The student will write a numerical program to recover the extinction coefficient profiles and backscatter profiles in the atmosphere and estimate measurement errors of the methods.
Lecturer: Dr. Iwona Stachlewska (iwona.stachlewska@igf.fuw.edu.pl)

Exercise 18
Determination of depolarization profiles of atmospheric from ADR lidar
The aim of the exercise is to retrieve atmospheric profiles of atmospheric depolarization from signals of ADR lidar. The student will use for this purpose available lidar measurements and mechanical calibration tools. The student will write a numerical program to retrieve profiles of depolarization of radiation in the atmosphere for the VIS and UV wavelengths and estimate measurement errors of the method.
Lecturer: Dr. Iwona Stachlewska (iwona.stachlewska@igf.fuw.edu.pl)

Exercise 19

Numerical advection experiments in one dimension using libmpdata++

Numerical solutions of advection equation are characterized by different kinds of error depending on the algorithm used and the shape of transported signal. In this exercise one will use the C++ library libmpdata++ implementing MPDATA scheme to solve advection equation in one dimension. For a given initial condition consisting of signals of different shape the dependence of the result on various variants of the algorithm is investigated. The aim is to discuss and visualize different kinds of error observed.

Lecturer: Mgr. Maciej Waruszewski (mwarusz@igf.fuw.edu.pl)

Exercise 20

Comparison of different algorithms for calculating the terminal velocity of gravitational settling of cloud droplets

Calculation of terminal velocity of cloud droplets is necessary in cloud models that take into account growth of droplets by collision-coalescence. Terminal velocities depend on the geometric size of the droplets as well as on atmospheric conditions. The aim of this exercise is to compare selected approximate formulae describing this dependency with the experimental data.

Lecturer: Mgr. Maciej Waruszewski (mwarusz@igf.fuw.edu.pl)

Exercise 21

GPS measurements using geodetic reference station CHC X20-B

The exercise consists of the measurements of the position of the selected point using a geodetic reference station CHC X20. Then a student will do post-processing of recorded data to obtain a horizontal position accuracy of the order of millimeters.

Lecturer: Dr. Monika Wilde-Piórko (mwilde@igf.fuw.edu.pl)

Exercise 22

The measurements of the magnetic field with field proton magnetometer

The exercise involves the measurement of total magnetic field value of the area of the minimum dimension 50x50m with the field proton magnetometer, and then use the differential GPS position measurement to plot magnetic anomaly map of the studied area and their qualitative interpretation.

Lecturer: Dr. Monika Wilde-Piórko (mwilde@igf.fuw.edu.pl)

Exercise 23

Determination of distribution of travel-time residuals of seismic waves

The exercise involves the determination of travel-time residuals of direct longitudinal (P) and shear (S) teleseismic waves recorded by seismic stations of international passive seismic experiment PASSEQ 2006-2008, compared to the reference model iasp91. The result should be present as a 2D map and results should be comment.

Lecturer: Dr. Monika Wilde-Piórko (mwilde@igf.fuw.edu.pl)

Exercise 24

Determination of Q coefficient of seismic waves in the subsurface soil layers

The exercise involves the measurements of ground vibrations caused by a hammer by seismic stations spaced along a straight line (a profile). Then a Q coefficient in the subsurface layers of soil in the study area will be calucate based on recorded seismograms.

Lecturer: Dr. Monika Wilde-Piórko (mwilde@igf.fuw.edu.pl)