

REPORT OF THE FINNISH NATIONAL COMMITTEE OF GEODESY AND
GEOPHYSICS

Compiled by H. Nevanlinna

This is the report for the activities of the IUGG-Associations in Finland in 2000. The numbers of scientific publications produced in different institutes in each association are as follows

Assoc.	Refereed articles	Other publication
IAG	4	19
IAGA	76	77
IAHS	16	60
IAMAS 56	44	
IAPSO	7	23
IASPEI 8	9	
IAVCEI 10	9	
Total	177	241

The detailed reports of the activities carried out in each association are in the following pages.

INTERNATIONAL ASSOCIATION OF GEODESY (IAG)

(Reporter R. Kuittinen)

FINNISH GEODETIC INSTITUTE

1. The permanent GPS network FinnRef

The routine operations of the 12 FinnRef stations continued. The stations collect GPS and meteorological data at 30 seconds interval. Every night 24 hours' worth of data is transferred by dial-up modem line to the FGI. The FGI also has permanent GPS stations in Suurupi, Estonia, and in Xi'an, China and receives data from Svetloe, Russia.

The data is archived and transferred to the international computing centres. Local ties

from antenna ARP to auxilliary markers were measured with a tachymeter at all stations during the summer/autumn 2000. In the IGS/FinnRef network the old Rogue SNR-8100 in Metsähovi was replaced by an Ashtech Z-12. The clock steering is still done with the H-maser of the Helsinki University of Technology Metsähovi Radio Station. The FinnRef is used for local studies on crustal movements as well as a reference for GPS measurements.

2. The EUREF densification projects

During the year 2000, computations of the first and the second phase of the Finnish EUREF densification "EUREF-FIN", the so-called points for practical use, was completed. Observations were made in 1998 and 1999, the total number of points being 350. Report will be published in the beginning of 2001. Computation work was delayed due e.g. to errors in the software used. These 350 new EUREF-FIN points were tied to FinnRef and to a subset of earlier (1996-1997) measured high precision EUREF-FIN points. These 100 high precision points are mainly located at primary triangulation sites. 7 of these, as well as all 12 FinnRef sites, were submitted to the EUREF Subcommittee for certification as Class B points, and certified (1999). A report on this high precision network was published in FGI reports series in 2000 (Publ. of FGI, 129).

3. The Third Precise Levelling of Finland

During the year 2000, 361 km of double-run precise levelling was measured by three teams in Western Lapland near and also across Swedish and Norwegian borders. Because of a big misclosure (-64 mm) in a loop measured in 1999, 153 km out of those 361 km were re-levellings. The rod, refraction and tidal corrections were computed. The misclosures, the lengths of the loops as well as the collaborating countries in the loops where Finnish teams levelled in 2000 were: +5 mm, 124 km, SWE; +8 mm, 138 km, SWE; 0 mm, 24 km, SWE; -1 mm, 214 km, SWE; -16 mm, 188 km, SWE, -35 mm, 729 km, SWE+NOR; -10 mm, 395 km and 26 mm, 319 km. The test measurements of the digital levelling system Zeiss DiNi 12 were initiated in autumn 2000.

4. Väisälä white-light interferometric baseline work

Results of the Chengdu standard baseline (China), measured in autumn 1998, were published in the series of the Finnish Geodetic Institute (Publ. of FGI, 130). The 1999 re-measurement of the Gödöllő standard baseline (Hungary), was computed and the results will be published in 2001. The full 864 m long baseline was measured with Mekometer 5000 and the 432 m with the Väisälä interference comparator. During 2000, the co-operation with the Finnish Centre for Metrology and Accreditation (MIKES) continued in performing absolute calibrations of the one metre quartz gauges used in the Väisälä interferometric method. A joint report (MIKES, FGI, Tuorla Observatory) of the work is in preparation.

5. Maintenance of Finnish primary triangulation sites

During 2000, 20 triangulation points were checked and refurbished and the local geometry re-measured. Two GPS receivers were used to determine the local control network's absolute orientation.

6. Absolute gravimetric work

Regular absolute measurements in Metsähovi with the JILA_g-5 have been continued, typically once or twice per month. In the second UNIGRACE (Unification of gravity systems of Central and Eastern European Countries) campaign, the following stations were occupied in September-October 2000: Krokowa, Jozefoslaw (Poland); Cluj, Belsis, Constanta (Romania); Wetzell (Germany), and the non-UNIGRACE station Borowa Góra (Poland).

7. Relative gravimetric work

The densification of the national gravimetric survey's base network was continued in the Lempäälä and Valkeakoski area. The points measured were positioned with GPS, using the permanent FinnRef station Tuorla as reference station. All the levelled benchmarks in the area were checked with orthometric height obtained by GPS and digital geoid. 350 points were measured in total.

8. Superconducting gravimetry

The superconducting gravimeter has worked continuously, sampling gravity once per second. It participates in the Global Geodynamic Project (GGP), with data exchange and co-operation with 18 other stations.

Recently the work has focused on environmental parameters, especially the near-field hydrology. Groundwater level in two access tubes, one in fractured bedrock a few meters from the gravimeter and one in a swamp at 80 m distance are recorded. In addition, precipitation, and snow cover around and above the station are monitored. The topography and thickness of the soil layers around the laboratory were mapped, and efforts are underway to start the monitoring of soil moisture. In addition, the atmospheric loading effect has been the subject of the interest.

9. Land uplift gravimetric profiles

The land uplift gravimetric profile at 65 degree latitude were remeasured with four LCR-gravimeters same way as it was done 1999. The obtained results confirm the 1999 results.

10. Water tube tiltmeter

The water tube tilt meter system (East-West and North-South tiltmeter in Lohja mine) developed at FGI in 1977 and 1983 renovation started by tube, pot and fluid material tests. The interferometric water level control system with the fibre-optic, HeNe-laser and digital camera recording were under tests in laboratory.

11. Levelling staff comparator

The development of the vertical laser comparator in institute was continued and it has been used for calibration of the invar rods used in the Third Levelling of Finland as well as rods of outsiders in Finland and abroad (Lithuania). This research work will continue by developing calibration methods for digital levelling instruments.

12. Other

Deformation studies in Pasmajärvi area: Remeasurement at Nuottavaara fault was made with GPS in June 2000. Measurements were processed together with previous observations made in 1991, 1992 and 1995. Results show no obvious movements in the fault. The research will be published in the beginning of 2001 as a diploma work.

The precise levelling of the Ruokojärvi geodetic networks was carried out on June 2000. High precision relative gravimetric profile measurements across the Pasmajärvi

postglacial fault have been carried out in 1987, 1989, 1991, 1993, and 1995. In September 2000 the measurements were repeated with four LCR-gravimeters. The results do not show any change in the gravity difference.

RTK test: During the summer/autumn 2000 five sets of RTK GPS equipments from different vendors (Javad, Trimble, Leica, DSNP, Geotracer) were tested on two test fields with baselines up to 5 km (55 points in total). The main purpose was to investigate the quality and reliability aspects of RTK measurements. The results will be published in the series of the Finnish Geodetic Institute.

13. Metsähovi research station

The station has measured and delivered GPS data including weather data to the International GPS Service. The satellite laser has been used in measuring altogether 537 orbits of 17 satellites. A new antenna was installed in the DORIS station in October.

FGI has started preparations to get a GeoVLBI in the station together with the Helsinki University of Technology.

IAG - HELSINKI UNIVERSITY OF TECHNOLOGY

On September 1, 2000 the Chair of Geodesy was vacated by Prof. Teuvo Parm by his retirement, and filled by appointment of Prof. Martin Vermeer.

The research project on the utilisation of GPS in traversing, mapping and setting out

measurements (as described in the report for 2000) has been brought to completion and a final report on the results was written. A test net around Espoo and Klaukkala

was used in studying the use of Real Time Kinematic GPS (RTK-GPS) in various environments (urban, forested, various baseline lengths) and in testing communication modems and data storing and handling under field conditions. Also the accuracy of the "Virtual RTK-GPS" concept was investigated. Several transformations of coordinates were carried out between different coordinate systems.

Our multi-theodolite system (Spatial Intersection Method) for 3-D optical precision measurements was further developed, updated and tested. Work on automation in precise height determination was continued and led to one doctoral dissertation.

Research

was done on system calibration of the automatic target recognition of a robotic tacheometer.

INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY (IAGA)

(Reporter H. Nevanlinna)

Divisions

I: Internal Magnetic Fields

- II: Aeronomic Phenomena
- III: Magnetospheric Phenomena
- IV: Solar Wind & Interplanetary Field
- V: Geomagnetic Observatories, Surveys, & Analyses

Institutes in Finland involved with IAGA

(I, II, III, IV, V) divisions represented, [N] approx. number of staff.

University of Oulu

- 1. Sodankylä Geophysical Observatory (I-V) [25]
- 2. Institute of Geosciences (I) [5]
- 3. Department of Physical Sciences (II-IV) [10]

University of Helsinki

- 1. Department of Geophysics (I) [1]
- 2. Department of Physics (III-IV) [1]

Finnish Meteorological Institute

- 1. Geophysical Research Division (I-V) [40]

Geological Survey of Finland

- 1. Geophysics Dept. (I, V) [10]

REPORT 2000

FINNISH METEOROLOGICAL INSTITUTE

Geophysical Research Division

There were a number of important developments in the field of geophysical research. The Academy of Finland launched a new space research programme and a committee appointed by the Ministry of Education recommended that a space research centre be set up as part of the Division. Most importantly, the four Cluster satellites of the European Space Agency (ESA) were successfully launched between July and August. The MIRACLE system operating on the earth's surface and providing support for observations on the magnetosphere by Cluster was also completed. Geophysical Research is responsible for the operations of the system.

Geophysical Research has designed six instruments for the Rosetta satellite that will be launched towards the comet Wirtanen in 2003. The satellite kept the Division busy throughout the year, as there were unexpected problems, most of which had to do with components. Comet research made considerable progress during 2000 as the data gathered by the SWAN instrument of ESA's SOHO spacecraft was studied with the aim of finding more comets. While working on the data, a Division researcher discovered a new comet, which attracted a great deal of international attention. Design work on the SPEDE instrument of ESA's lunar probe

continued.

In addition to the SOHO SWAN, the Finnish Meteorological Institute also has designed two other instruments. NASA's Stardust satellite produced some surprising new findings, which were discussed at an international seminar organized by Geophysical Research in September. ESA's Huygens probe, which is on its way towards Titan, a moon of Saturnus, reached Jupiter. The probe is carrying equipment for measuring the atmosphere of Titan supplied by FMI.

Construction and testing of the Finnish parts for the instruments measuring plasma that will be carried by ESA's Mars Express satellite continued throughout the year. By supplying parts for the British-made Beagle 2 landing craft, FMI was able to get more closely involved in the Mars Express programme. The Finnish Meteorological Institute also plays a major role in the French-led NetLander project, which aims to put four observation stations on the surface of Mars in 2007-2008. This project reached a new stage at the end of the year, when the Finnish companies involved in the undertaking started manufacturing the necessary components. The meeting of the international Mars committee held in Finland in November decided on the strategy for research on Mars extending to 2010. A 400-page book "Towards Mars" compiled in Finland was published during the meeting.

The instruments for the atmospheric OMI ozone programme were completed at the end of the year. The chances of constructing a earth station were examined and invitations to tender submitted. The launch of the Odin satellite was put off until early 2001, but preparations continued all year. Preparations were also made for the launch of the ENVISAT satellite in June. They involved development of the data processing systems of the GOMOS ozone instrument in Helsinki and Sodankylä.

FMI had great success with its applications for the Academy of Finland research programme on mathematic methods and data analysis, though the Institute failed to get beyond the first round in the competition for centres of excellence. The magnetosphere satellite project coordinated by FMI Geophysical Research passed the tough initial round of ESA's project competition, but failed to get selected in the end. However, this success showed that the project was feasible and of importance.

FMI's Geophysical Research plays a major role in ESA's space weather project. Joint research on induction currents observed on earth's surface involving both Finnish and foreign companies was also carried out.

The magnetic mapping of Estonia was completed. The magnetic test laboratory located in the Nurmijärvi observatory became ready for commercial use.

A total of 36 publications undergoing advance international inspection were completed.

THE UNIVERSITY OF OULU

(Reported by Kari Kaila)

1. Ionospheric and Magnetospheric physics

A major topic in the research of magnetic pulsations was the ionospheric Alfvén resonator and its effects on the pulsation observations on the ground level.

Artificial

magnetic pulsations were generated by means of periodic ionospheric heating. The pulsations exhibited spectral resonance structures indicating the effect of the ionospheric Alfvén resonator. Observations of naturally occurring Pc1 pearls were made which suggest that the pearl structure is due to long-period ULF waves rather than due to bouncing wave packets. A new model of IPDP was also proposed, which contains the ionosphere as an active agent forming the IPDP signal on the ground. The increase of the IPDP frequency was explained to be due to the frequency increase

of the magnetospheric wave source and the Alfvén resonator eigenfrequency. Further, the influence of the Alfvén resonator on the altitude distribution of electric and magnetic wave fields of naturally occurring Pc1 waves was studied by numerical calculations using radar measurements of the ionosphere.

The diurnal variation of the Pc1 frequency in different geomagnetic conditions was investigated. During periods of increasing magnetic activity, nonstationary Pc1 pearl

events with variable central frequency were observed, while stationary events were encountered during quiet magnetic conditions.

Practical problems in photometer calibration were studied. A discrete auroral form was investigated using a photometer, an auroral TV camera and the EISCAT radar, and the characteristics of precipitating electrons were determined from these multi-

instrument data. The possibility of investigating gravity wave activity in the mesopause region by means of airglow tomography was studied. Simulations indicate that both horizontal and vertical wave lengths can be obtained from airglow data, provided a sufficiently dense network is available. Observations from a system of two

cameras were used to test the method.

A coupled-map model of the magnetotail was used to study the dynamics of the magnetosphere. With different types of coloured noise as the model input, it was shown that the low-frequency part of the output reflects the input whereas the high-frequency part is intrinsic to the model. The relations of power spectra of the interplanetary magnetic field (input) and the AE index (output) are very similar to those given by the model. This indicates that the magnetosphere acts as a low-pass filter. The dynamics of substorms in the magnetosphere were further investigated.

The

signatures of field-aligned currents at ionospheric heights were studied by means of

ionospheric tomography, ground-based magnetometers and optical satellite images.

Field-aligned plasma enhancements in the topside F layer were observed at regions of

upward current, whereas larger plasma enhancements with an elevated peak altitude were found close to regions of downward current.

The first EISCAT measurements of electron-temperature in artificially heated D region ionosphere were presented. The heater was switched on and off at 5 min intervals. A systematic difference in the measured plasma autocorrelation functions was found between the heated and unheated periods. The effective recombination

coefficient in the lower ionosphere was studied by means of EISCAT observations of impulsive precipitation events and the Sodankylä Ion Chemistry Model. The inclusion of the chemistry model allowed the determination of the NO⁺ and O²⁺ ion concentration ratio.

Both natural and artificial electron density irregularities in the F region were investigated by a new scintillation method. The method is based on amplitude observations of satellite signals at a single site on the ground and it allows the determination of the anisotropy parameters of the irregularities. Orientation of the main axis of the anisotropy was observed to agree with the direction of the F region plasma flow given by the EISCAT radar. Associated with F region electron density depletions due to ionospheric heating, irregularities outside the heating cone were observed which could be explained to have drifted to the observation point from the heating region.

Considerable improvements were made in The Finnish Chain of Pulsation Magnetometers (<http://spaceweb.oulu.fi/projects/pulsations/>) with respect to data availability and data quality. Analogue data recording (from year 1971 onwards!) at OUL was stopped and replaced by a digital data logger. Now all the 6 stations of the chain produce digital data. At 5 stations the sampling rate was increased from 20 to 40 Hz and at 4 stations on-line data retrieval has become possible. Quasi real-time quick-look spectrograms from 4 stations are available from the SGO server, and in a monthly period from the other two stations. At SGO a new A/D converter, a new search-coil-sensor and a new data logger (UNIX) were developed, built and tested. A further upgrading of the chain in 2001/2002 will imply the new components from SGO.

2 Heliospheric physics

The sunspot activity just prior to, during and after the Maunder minimum was investigated using the series of group sunspot numbers and delayed component technique. It was shown that the sunspot activity is concentrated, with a high statistical accuracy, to two intervals around 1658 and 1680. Since the last sunspot maximum before the Maunder minimum was in 1639/1640, this result together with the maximum in 1705 indicates a significant, approximately 22-year periodicity in sunspot activity during the Maunder minimum.

The 1.3-year periodicity in solar wind speed and K_p index was investigated. It was shown that this is actually a quasiperiodicity which occurs during even solar cycles.

During odd solar cycles the periodicity is rather 1.5-1.7 years. It is expected that these periodicities are due to the evolution of coronal holes so that the difference in periodicity implies a difference in the evolution of coronal holes during even and odd cycles.

IAGA UNIVERSITY OF OULU

INSTITUTE OF GEOSCIENCES

(Reported by S.-E. Hjelt)

The Department of Geophysics at the Institute of Geosciences, University of Oulu applies electromagnetic techniques in studying the structure composition, dynamics and evolution of the lithosphere and a variety of prospecting and environmental problems as well as investigates properties of modelling and inversion techniques. During 2000 the major activities were:

1. The processing and analysis of the BEAR (Baltic Electromagnetic Array Research) data measured in 1998 with an array of 50 MT and 20 magnetometer stations. BEAR is a subproject of the EUROPROBE / SVEKALAPKO project.

2. The IPEG (Inversion Problems of Electromagnetic Geophysics) project has been a one-year project continuing the NOIGEM project of the TIETO programme of the Academy of Finland. The electromagnetic joint inversion problem and modelling comprised co-operation with the group of prof. L. Päivärinta (Department of Mathematics, University of Oulu) and scientists from the University of Utah) and the NGRI (Hyderabad, India).

3. Properties of inversion of transient EM, VLF and VLF-R data have been studied using also the very fast simulated annealing (VFSA) procedure in a co-operative project with the Indian Institute of Technology/Kharagpur.

4. A reformulation of joint Bayesian inversion of EM and seismic data has been studied by E. Kozlovskaja including fuzzy set formulation and Pareto-optimality.

5. Experiments with GPR on glaciers have been continued under the guidance of doc. John Moore (Arctic Centre, Univ. Lapland) and in cooperation with the National Graduate School on Snow and Ice. The field GPR measurements at the blue ice fields in Antarctica started during the 1999/2000 FINNARP season have been processed and analyzed. New data will be collected during the 2000/2001 season. Ice core electrical profiling has been combined with GPR data.

6. Smaller scale research projects have been carried out in cooperation with the Geological Survey of Finland, the Finnish Road administration and Vihanti Water mainly as academic degree studies. This research aims at developing methodology to obtain information about bedrock and overburden structures for demands of civil engineering, groundwater and ore prospecting and environmental research.

7. Teaching material on the structure and dynamics of the Earth was further prepared and tested both in University and Secondary School environment as a continuation of the MARATON project.

IAGA - SODANKYLÄ GEOPHYSICAL OBSERVATORY
(Reported by Jorma Kangas)

The activities of SGO continued normally. Observatory is divided into seven divisions: Administration, Aeronomy, Geomagnetism, Computing, Technical, EISCAT station and Oulu division. Data from different instruments (magnetometers, riometers, ionosonde, seismometers and neutron monitor) have been distributed by data reports and Internet.

The most important projects funded by external sources were EISCAT program,

GUIDAP (Grand Unified Incoherent Scatter Design and Analysis Package) as a Finnish-in-kind contribution to EISCAT, Inversion project, the Barents- Interegg II project "Investigation of the near-space and atmosphere in the Barents region" , the Meteor Radar project, GUMMO project (Grand Unified Measurement Management Objects), CUPP project (Centre for Underground Physics in Pyhäsalmi) and the Svekalapko project. The Finnish Graduate School in Astronomy and Space Physics was lead by SGO. As new activities a project "Measurements of Small-Size Debris with Backscatter of Radio Waves" funded by ESA and an educational project "Marie Curie Training Site : Investigations of the Near-Earth Space by Radio Methods" funded by EU were started.

IAGA - SPACE PHYSICS AT THE UNIVERSITY OF HELSINKI

(Reporter Hannu Koskinen)

The space physics group at the Department of Physics of the University of Helsinki is a small unit consisting of a professor (Hannu Koskinen) and presently of 8 active graduate students, most of whom are located at the Geophysical Research Division of the Finnish Meteorological Institute (FMI/GEO). The professorship is funded jointly by the University and the Finnish Meteorological Institute and the scientific research is conducted close co-operation with the space physics group at FMI/GEO.

Together the scientific effort at FMI and HU now covers the whole interaction chain from the solar surface through the solar wind to the magnetosphere and ionosphere. At the University the main efforts in 2000 were concentrated in the studies of coronal mass ejections and their efficiency in driving magnetospheric storms and in magnetospheric dynamics.

The main international effort during the year 2000 was the proposal to the ESA flexi-mission programme for a three-spacecraft constellation to study the physics of the inner magnetosphere and magnetic storms, called STORMS. The international proposing team was led by H. Koskinen and he also lead the scientific effort in the assessment study after the mission was selected as one of the main candidates. Although the results of the assessment study were met favourably but finally another mission for solar studies was selected within the solar system missions.

During the last few years the emerging subdiscipline of space physics, space weather has become one of the main drivers of fundamental research in solar-terrestrial physics. This also has led to more practically flavoured studies. In 2000 the second ESA space weather study of the FTMI-HU team was started under the leadership of the Rutherford Appleton Laboratory (UK). This activity is a part in the process, which has made the FMI-HU collaboration one of the leading contributors to the European space weather activity.

The close collaboration with the International Space Science I reference book on Auroral Plasma Physics. H. Koskinen leads the writing of two chapters of the book. Two other scientists from FMI participate in this effort of about 30 persons worldwide.

IAGA - GEOLOGICAL SURVEY OF FINLAND

(Reported by Lauri Eskola)

Aerogeophysical surveys were performed in Finland, Turkey and Ireland in all 104 000 line kilometers.

The upper crustal evolution, geology and structure of the Finnish bedrock were studied by interpreting and correlating geophysical, petrophysical and geological data. The Finnish petrophysical database is continuously updated. Final versions of magnetic maps of Central Finland - Karelia and North Finland - Kola 1:1,000,000, prepared jointly with SC Mineral and Petersburg Geophysical Expedition, were ready for printing. Joint preparation of digital geological, magnetic and gravity maps of the Fennoscandian Shield 1:1,000,000 and their petrophysical correlation and interpretation continued together with Swedish and Norwegian geological surveys and the Northwest Department of Natural Resources of Russia and its subsidiaries: 1:4,000,000 scale maps were presented in the 31st ICG and are ready for printing.

The laboratory of Paleomagnetism participated in several international projects, such as EUROPROBE/SVEKALAPKO, IGCP, ESF-network on Impact Craters and IUGG/IAGA data bases. Based on the paleomagnetic databases, investigations of reconstructions of Baltica with other continents and their geological interpretations were continued.

Geophysical modelling of several impact craters in Finland was carried out. New deep drilling was carried out on the Sääksjärvi structure. Projects on the geophysical modelling of the impact structures in Sweden (Dellen) and Estonia (Ilumetsa and Ilyinets) were continued.

INTERNATIONAL ASSOCIATION OF HYDROLOGICAL SCIENCES (IAHS)

(Reporter: Pertti Seuna)

FINNISH ENVIRONMENT INSTITUTE (FEI)

The national hydrometric monitoring comprised the following programmes: areal precipitation, areal snow water equivalent, evaporation (Class A pan), surface water level, river discharge, ice thickness in lakes and rivers, dates of freezing and ice break-up, surface water temperature, and vertical temperature profiles in lakes - a total of 1,300 observation stations. A new quality system for hydrometric observations was completed and taken into use. Bathymetric mappings of lakes covered an area of 150 km² (at present, some 65% of the total lake area, or 20,000 km² is completed). The

first version of a new, Web based hydrological database was taken into operational use. The database contains some 25 million observations from 2 500 stations and basic information from more than 50 000 lakes. The planning of the Finnish river register was started. Analyses on the precipitation and the surface water temperature data-base were started. Apart from this water quality was monitored in some 200 lakes and rivers.

The monitoring of integrated hydrology consisted of small hydrological basins and groundwater monitoring stations, including both water quantity and quality. Both these networks were primarily used for research purposes. In small catchments, 46 together, discharge, precipitation, snow water equivalent and soil frost were measured, and in 15 of them water quality was analysed. Catchments were partly included in the international FRIEND- and ERB- projects. An international evaluation was performed in 2000. It recognised the comprehensive use and outcome of these basins, especially as regards to human impacts, such as forestry and agriculture. Noting the deficit of human resources it also suggested more emphasis and input to be allocated on intensive and interdisciplinary research. Groundwater stations, 53 together, were mainly used for monitoring and studying groundwater quantity and quality. A comprehensive report on these results was prepared until the end of 2000. A national evaluation on the groundwater monitoring was performed in 2000.

Hydrological modelling system covered over 90 % of the country including all important river basins. The HBV-based model was used mainly for flood forecasting, but also for complementing field measurements, such as snowpack data. The model procedure is available from the Internet on the GIS-basis in real time. The users can also directly run the models using their own input data, i.e. weather forecast. The weather radar was implemented into forecasting in 2000 for one catchment, Kyrönjoki river basin.

Hydrological application of remote sensing was developed for measuring snowpack. Microwave radars were used in order to determine the extent of snow cover especially during the melt period. As an advantage to the optical techniques, microwave technique gave information also during cloudy conditions which is important in the weather conditions of Finland. On the other hand, the estimation of the water equivalent of snow still needs research to be measured with remote sensing methods.

UNIVERSITY OF HELSINKI, DEPARTMENT OF GEOPHYSICS

The main theme of the Department of Geophysics in the University of Helsinki is the geophysics of snow and ice. This includes higher education in ice mechanics, lake ice impurities, snow, and sea ice dynamics. Graduate school titled A Geophysics of snow and Ice@ was continued with direct funding of six PhD students and with about five students funded by various research projects. Possibilities of the reorganization of physical faculties were examined.

HELSINKI UNIVERSITY OF TECHNOLOGY

The Laboratory of Water Resources of the Helsinki University of Technology gives higher education and carries out research on the following topics: applied hydrology, hydraulics, water resources planning, limnology, environmental impact assessment, water constructions, as well as irrigation and soil drainage. The ongoing research projects include inflow forecasting, harmful substances in soil, decision support systems, scale models, environmental river engineering, global changes and water resources, and environmental impact assessment.

In August-September a study tour of 13 hydrologists was made to China including several research institutes and the Three Gorges dam construction site.

UNIVERSITY OF OULU

Water resources and Environmental Engineering Laboratory belongs to the Department of Process and Environmental Engineering. The laboratory gives higher education and carries out research among other things in the following topics: applied hydrology, hydraulics, water resources planning, sustainable use of water resources, hydraulic structures and environmental geotechnics. Other topics are sanitary and environmental engineering and the chemical treatment of industrial and municipal waters and wastewaters combined with other treatment methods. The ongoing research projects include river management and environmental improvement, water pollution control of peat production fields and problems of water supply and sewerage engineering in the northern areas. In addition, the transportation and retention of contaminants in soil and the protection and restoration techniques of groundwater are examined.

FINNISH GEODETIC INSTITUTE

Up-to-date information on the extent and properties of snow is needed e.g. for hydrological purposes and hydropower production, especially during the snowmelt season in spring. Since 1997 research has been conducted at the Finnish Geodetic Institute to develop methods for snow mapping using satellite images. The research has been concentrated on method development for optical image interpretation and knowledge-based combination of information from different data sources. A method has been developed to estimate snow cover percentages of an area from NOAA/AVHRR images. Currently research is conducted to further develop the method by accounting for the effect of imaging geometry on the reflectance values in the images. Results from BRDF (bidirectional reflectance distribution function) measurements of snow in the field are applied in the study. Cooperation is made with the Finnish Environment Institute.

INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC SCIENCE (IAMAS)

(Reporter: Mikko Alestalo)

UNIVERSITY OF HELSINKI, DEPARTMENT OF METEOROLOGY (DMUH)

In 2000, research was continued in the three areas of climate studies, numerical modelling, and radar meteorology.

Studies on climate dynamics concentrated on the upper boundary conditions and critical layers in a linear stationary wave model, and on weather conditions during the cold spring of the famine year 1867.

Parameterization methods, especially for radiation, were further developed. Cloud diffusion growth and drizzle-formation were also studied in view of simple parameterizations for NWP. The DMUH mesoscale model was applied in case studies utilizing observations made in various EU projects. A study of urban heat island circulation was finalized. Mars modelling continued.

In radar meteorology, mesometeorology and cloud physics, application to environmental issues were studied with a dissertation (Kirsti Jylha) about wet deposition coefficients.

FINNISH METEOROLOGICAL INSTITUTE (FMI)

The main research areas in 2000 were atmospheric modelling, climate change, air quality and further development of the use of satellite and weather radar measuring methods.

The development of the HIRLAM-model (High Resolution Limited Area Models) continued with the goals aiming at the improvement of short-range forecasting and regional accuracy in northern conditions. The FMI got during the year the position of Deputy Project Manager in the management team of the international HIRLAM team. The co-operation with the Tartu Observatory was increased when two Estonian researchers financed by Finland joined the international HIRLAM team.

The research on ozone and UV radiation continued to have a high profile and was composed of several international projects getting financial support by EUMETSAT and the EU. The ozone soundings in the Antarctic were continued as a co-operation between Finland and Argentina.

Under the climate change studies, the emphasis was on the impacts of the anticipated climate change on wintertime traffic conditions in Finland.

During the year, a decision was made to strengthen the role of the Sodankylä Observatory as an Arctic Research Centre.

In addition, in air quality research topics related to climate change have been given special attention. Fluxes of greenhouse gases between the atmosphere and different ecosystems have been studied in the Finnish Lapland. At the WMO/GAW (Global Atmosphere Watch) station Pallas-Sodankylä, extensive measurement programmes have been performed.

The conventional air quality research has been focused on tropospheric ozone, particulate matter in the lower troposphere and toxic substances, e.g. benzene. These topic areas are in agreement with the needs on air quality research addressed by

UN/ECE and EU/EEA. In projects financed by the Academy of Finland the high competence of FMI in measuring aerosols has been used both in the Arctic, at Spitzbergen, and in an international expedition to the Antarctic.

INTERNATIONAL ASSOCIATION FOR THE PHYSICAL SCIENCES OF THE OCEAN (IAPSO)

(Reporter: Pentti Mälkki)

FINNISH INSTITUTE OF MARINE RESEARCH

The studies focused on dynamics, hydrography, waves and ice studies of the Baltic Sea and on air-sea interaction and dynamics of the polar seas.

Within BALTEX/DIAMIX project, the data from the previous field experiments was analyzed. An extensive experiment was carried out in the Eastern Gotland Basin.

Research has been conducted within the frame of the VEINS (Variability of Exchanges in the Northern Seas) Programme and aimed at to determine on how different regions of the Arctic Mediterranean Sea, the Arctic Ocean, Fram Strait, and the Nor-

dic Seas, contribute to the East Greenland Current and to the Denmark Strait Overflow Water (DSOW), and how the overflow plume evolves and interacts with the ambient water, as it sinks down the Greenland continental slope into the Irminger Basin.

In collaboration with IfM Hamburg and CEFAS Lowestoft FIMR maintains a current meter array at the Greenland continental slope south of the Denmark Strait to monitor

the transport and water mass characteristics of the overflow plume. The array is re-

placed every year in connection with a hydrographic survey of the western Irminger Sea. This year the survey was made with RV Poseidon from Hamburg, and one scientist from FIMR participated on this cruise. In addition to field work, studies have fo-

cused on analysis of hydrographical data from the region and EOF analysis of current

mooring data. VEINS ended in 2000 and the final report is under production. The work on the upstream conditions of the East Greenland Current and the relative contributions from the Arctic Ocean and the Nordic Seas to the DSOW was presented as lecture and posters on the European Geophysical Society XXV General assembly in Nice.

Studies of wave atmosphere coupling continued in co-operation with University of Uppsala and University of Miami as well as studies of directional wave effects in the

Gulf of Finland and Gulf of Lions together with CETP (Centre d'Etudes des Environnements Terrestre et Planetaire).

Coupled HIRLAM-WAM wave model in the Baltic Sea was completed. This is the first fully coupled wave model in the Baltic Sea that uses a very short (two minutes)

time step. FIMR participates in a large intercomparison of directional wave measur-

ing instruments and analysing techniques in COST 714 action. Experimental and modelling studies of the physical processes of the Baltic Sea were devoted to 3D-modelling and verifications of the model results using measurements of hydrographical parameters and currents in the Baltic Sea.

Studies of trends in sea level variations in the Baltic Sea continued, partly within FINSKEN project. These studies have shown the connection between NAO and the long-term water balance in the Baltic Sea. Global Change related sea level variation and marine weather studies were carried out under the Finnish Global Change program FIGARE and FIMR participated actively in evaluation and commenting of the Third IPCC Assessment.

In the Baltic Air-Sea-Ice Study (a BALTEX project), data analyses were made based on the field experiments of winters 1998 and 1999. The analyses concentrated on the surface roughness lengths and transfer coefficients over sea ice. Modelling work was made addressing the energetics and dynamics of on-ice and off-ice air flows, as well as sea ice thermodynamics. Air-ice- sea process studies and process modelling were conducted and finalized in BALTEX-BASIS (Baltic Air-Sea- Ice Study of BALTEX/GEWEX program), in the EC funded study, which is coordinated by FIMR.

Arctic Radiation and Turbulence Interaction Study focused on modelling work, addressing the atmospheric boundary layer during on-ice and ice-parallel flow conditions. The sensitivity of the boundary-layer heat budget to the information on sea ice concentration was studied.

In the joint project on Coupled Models (with FM), verification of the HIRLAM model was made with the R/V Aranda rawinsonde soundings as a reference. Analyses of the Aranda weather station data from the Baltic Sea in 1991-1999 was under work. Special attention was given to coupling of an ocean- and sea ice model with the high-resolution atmospheric model (European HIRLAM), together with the Finnish Meteorological Institute. The aim of the project is an improved forecasting of marine weather (wind, temperature,..) and wind waves and sea ice conditions.

A three-year CEC shared cost IWICOS (Integrated Weather, Sea Ice and Ocean Service System) project (IST-1999-11129) started in January 2000. The consortium consists of NERSC (Norway) (co-ordinator), FIMR and VTT (Finland), DMI and DCRS/DTU (Denmark) and IMO (Iceland). The main objective of IWICOS is to develop a prototype marine system, which will provide a single-entry access to meteorological, sea ice and oceanographic data and products in electronic form provided by weather forecasting, ice and research centres. The FIMR will concentrate to develop systems and sea ice, wave and water level information products in the Baltic Sea. In year 2000 system and product design phase has been completed and development and modification of new sea ice and oceanographic products have been started. System Design and User Requirement Report has been completed.

The TEKES shared cost ESSI (ENVISAT and Sea Ice Properties in the Baltic Sea) project has been started. The consortium consists of FIMR (co-ordinator), HUT/AVA, VTT/AUT and VTT/TTE. The ESA has also accepted the ESSI AO sent by the consortium, and thus able to receive ENVISAT SAR data free of charge. The main objective of ESSI is to ensure that the ENVISAT data could be used in sea ice monitoring in the Baltic Sea during the total life expectancy of the satellite. Special objectives for the FIMR are to validate and calibrate the ENVISAT data to low-salinity ice, improve automatic SAR image classification and deliver in real-time ENVISAT data and data products in use of the ice service, icebreakers and merchant vessels for vali-

dation of data and usability of image information products. In year 2000 SAR image classification algorithm development for ENVISAT data has been started.

On sea ice remote sensing analysis, statistical methods to retrieve sea ice parameters from SAR data were developed. In particular research and development of algorithms for automated and semi-automated sea ice information retrieval from SAR images of the Baltic Sea area.

UNIVERSITY OF HELSINKI, DEPARTMENT OF GEOPHYSICS

A new project "Arctic snow, sea-ice and glaciers in a changing climate" was begun. The project in a consortium together with Dos. John Moore (UL/Arctic Centre) and a part of the Finnish Climate Change programme FIGARE. UH/GPH contribution aims at an improved description of sea-ice in climate models and numerical simulations and analysis of the variability of the Arctic sea-ice mass. In addition to the pan-Arctic simulations, attention is paid on the high-resolution modelling of the Barents and Russian shelf seas.

Modelling work is done in collaboration with Prof. Achim Stössel (Texas A&T University, USA) and with his guidance the Hamburg ocean general circulation model HOPE, was implemented on the Finnish supercomputer. In the first simulation, a response of the ocean circulation on the varying boundary condition on the polar regions was studied. First Arctic sea-ice simulations with the Helsinki ice model (HIM) were also accomplished.

Analysis of the future ice conditions in Baltic Sea were studied in collaboration with Dr. Markus Meier (Rosaby Center, Sweden). Two independent climate models of the Baltic Sea were used for the estimation of the climate change effect on the ice conditions. Two 10-year time slice experiments have been performed and results of atmospheric climate model simulations were used as forcing of the Baltic Sea models. Model results were realistic in simulating present ice conditions. Similar changes in the ice extent, thickness and the duration of the ice season were calculated by the models. The decrease in ice extent in the scenario run is dramatic. This ice is thinner with less snow on top. The mean number of ice days decreases significantly too. In the fast ice zone of the Bothnian Bay (Kemi) the ice season is about a month shorter in the scenario than in the control simulation. The shortest simulated ice covered period was still more than four months long. The climate change signal of the ice season is simulated similar with both models, although they are quite different, showing the robustness of the applied dynamical downscaling method.

In a framework of BALTEX/BRIDGE programme, a measurement campaign in Tvärminne and Hailuoto were done. This study is mainly carried by the students of the department of Geophysics and the research is part of their studies. A thermistor chain was deployed off the Tvärminne archipelago. It continuously measured tem-

perature profile from surface to 50 meters depths during the whole year. Evolution of the sea-ice conditions was monitored by the digital video camera in Hailuoto from January to May. In addition, sea-ice characteristics were mapped on March.

INTERNATIONAL ASSOCIATION OF SEISMOLOGY AND PHYSICS OF THE EARTH'S INTERIOR (IASPEI)

(Reporter: Pekka Heikkinen)

UNIVERSITY OF HELSINKI, INSTITUTE OF SEISMOLOGY

Research of the subcommission in 2000 focused on the deep seismic refraction, reflection and tomographic studies, on the methods detecting the underground nuclear tests, on studies of local earthquakes, as well as lithospheric thermal modelling and geothermal measurements including studies of palaeoclimatic and hydrogeological effects and heat production of rocks.

Researchers at the Institute of Seismology of the University of Helsinki and at the Sodankylä Geophysical Observatory and Department of Geophysics of the University of Oulu took part in the data processing and interpretation of the data of the SVEKALAPKO deep seismic tomography experiment aiming to study the lithosphere-asthenosphere boundary beneath the Fennoscandian Shield. The project is the part of the SVEKALAPKO multidisciplinary research project (EUROPROBE program). They also participated in interpretation of the DSS data from the POLONAISE profile in Poland as well as the EUROBRIDGE'96 and EUROBRIDGE'97 profiles within the framework of the EUROPROBE/ EUROBRIDGE multidisciplinary study aiming to recover the deep structure of one of the most important discontinuities in the East European Craton, the Fennoscandia-Sarmatia junction zone.

In June, same institutes participated in Poland in the field work of DSS-project CELEBRATION2000, which is the largest DSS-work, which has been ever done in EUROPE. Profiles were situated in Poland, Slovak Republic, Czech Republic, Hungary, Austria, Germany and shots also in Russia and Belarus. The total length of the profiles was 8900 km.

The researchers of Oulu University interpreted the data of DSS profile in the Barents Sea and in one line of the BABEL experiment as Finnish-Russian co-operative works in collaboration with Russian scientists. They also made an integrated interpretation of the seismic and gravity data complemented by the results of petrophysical studies along the EUROBRIDGE'96 profile in Belarus and EUROBRIDGE'97 profile in the Ukraine.

At the Institute of Seismology the lithospheric structure and dynamics were studied using seismic and geologic interpretation of the BABEL marine deep reflection data, deep seismic sounding data from the profiles BABEL 1, BALTIC, SVEKA81,

SVEKA91 and FENNIA.

The institute of Seismology participated in a shallow marine seismic reflection study in the northern Baltic Sea carried out with the University of Hamburg.

Studies on local seismicity, including macroseismic surveys of pre-instrumental and recent earthquakes, seismotectonics and seismic hazard were carried out as post-graduate studies at the Institute of Seismology. At the Institute of Seismology, studies focused on designing automated methods to discriminate industrial and underwater explosions from regional earthquakes were conducted.

The Institute of Seismology also participated in EC-project "Earthquake Parameters and Standardized Information for an European-Mediterranean Bulletin (EPSI)". The objective of this project is to provide the European scientific community with standard procedures for a number of fundamental earthquake parameters.

As the Finnish contribution to the study and development of effective seismic verification methods for nuclear test ban, the Finnish Research Project on Seismological Verification of Nuclear Tests was run at the Institute of Seismology.

Geothermal research at the Geological Survey of Finland includes temperature loggings of boreholes, measurements of thermal parameters of rocks in laboratory, lithospheric thermal modelling, studies of palaeoclimatic and hydrogeological effects on the subsurface thermal field as well as studies of heat production of rocks.

In 2000, many of the activities were related to EUROPROBE project 'Svekalapko'. Geothermal measurements measured in 1996-97 in the central Kola Peninsula area were processed in co-operation with the Kola Science Centre of the Russian Academy of Sciences. Stochastic Monte Carlo techniques were developed and applied in forward and inverse thermal modelling of the lithosphere.

Thermobarometric data on kimberlite-hosted mantle xenoliths which were combined already earlier with numerical thermal modellings of the lithosphere in eastern Finland close to the Proterozoic-Archaeon boundary, were further applied in a study of a rheological models of the lithosphere combined with deep electromagnetic data. The results have general implications on models of thick lithosphere in the area, and particularly on the volatile content of the upper mantle. The PT-data from xenoliths was also applied geothermal inversion modelling of the thick lithosphere in the central Fennoscandian Shield. Xenolith derived geotherm was used to calculate upper mantle seismic velocities in the central part of the shield.

I.T. Kukkonen continued as the chairman of the International Heat Flow Commission of the IASPEI for the period of 1999-2003. IHFC sponsored geothermal meetings and sessions in Evora, Portugal and in the 31st International Geological Congress, Rio de Janeiro, Brazil during 2000.

INTERNATIONAL ASSOCIATION OF VOLCANOLOGY AND CHEMISTRY OF
THE EARTH'S INTERIOR (IAVCEI)

(Reporter: Ilmari Haapala)

GEOLOGICAL SURVEY OF FINLAND

The Geological Survey of Finland has studied since 1997 the diamond-bearing kimberlites found by Malmikaivos Oy in the Kuopio-Kaavi area, eastern Finland. The 0.5 Ga old kimberlites are situated in the border zone between the Archaean 3.2-2.6 Ga craton and the Svecofennian 1.9 Ga orogenic belt. The kimberlites and their country rock fragments have provided new information on the age, composition, structure, and pressure-temperature conditions in the upper mantle and deep crust. The studies further indicate that the lithosphere was more than 230 km thick. Studies on the tectonic setting and petrogenesis of Palaeozoic mafic dykes and ophiolites of northern and eastern Finland have been continued. The mafic layered intrusions and associated granites of Koillismaa have been studied in collaboration with the universities of Oulu and Helsinki.

UNIVERSITY OF HELSINKI

Department of Geology, University of Helsinki, has studied since 1989 the Jurassic basalts of Dronning Maud Land, Antarctica. In 2000, an extensive synthesis, presented in the form of a doctoral thesis, was completed on the origin of the basalts.

Detailed geochemical and isotopic studies show that the basalts were originally connected to the Karoo basalts of southern Africa but they have separated during the initial stages of break-up of Gondwana. The studies enable more precise reconstruction of the Jurassic supercontinent. The isotopic and geochemical studies have also been used to decipher the origin and magmatic evolution of the continental flood basalts.

The studies of rapakivi granites and related rocks have been continued in Finland, New Mexico, Brazil, and Namibia.

UNIVERSITIES OF TURKU AND ÅBO AKADEMI

The Geology Departments of these universities have continued studies on the post-orogenic granites and lamprophyre dykes as well as on the bimodal rapakivi granite-anorthosite-diabase association in South Finland. Studies have also been continued on the Archaean komatiites and their ore potential.

The Department of Geography, University of Turku, has made geological and morphological mapping of lava flow fields by remount-sensing in northeastern volcanic zone of Iceland. This work is part of the project "Land Degradation on Iceland with Special Emphasis on Detection and Quantification of Natural and Anthropogenic Processes (LANDIS), funded by Nordic Arctic Research Programme (NARP) and European Space Agency (ESA).

At the Nordic Volcanological Institute, Reykjavik, one Finnish stipendiate has studied recent volcanism of Iceland. Geology students of Åbo Akademi had one week's course in volcanology in Santorini, Greece.