

# REPORT OF THE FINNISH NATIONAL COMMITTEE OF GEODESY AND GEOPHYSICS 2002

Compiled by H. Nevanlinna

This report can be obtained in pdf-form at [http://www.geo.fmi.fi/iugg\\_fin.html](http://www.geo.fmi.fi/iugg_fin.html)

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## INTERNATIONAL ASSOCIATION OF GEODESY (IAG)

Work done in the Finnish Geodetic Institute  
(Compiled by Markku Poutanen and Matti Ollikainen)

### 1. The Finnish permanent GPS network *FinnRef*<sup>®</sup>

The Finnish permanent GPS network *FinnRef*<sup>®</sup> consists of 12 stations. Station no. 13 at Degerby tide gauge in the Aland Islands was installed. All stations have two-frequency receivers, choke ring antennas, and meteorological sensors. Both the GPS and the meteorological data are collected into receiver memory, and downloaded to the Finnish Geodetic Institute (FGI) once every 24 hours. Metsähovi is a station of the International GPS Service (IGS) network. Joensuu, Metsähovi, Sodankylä, and Vaasa belong to the EUREF Permanent Network (EPN). Metsähovi, Vaasa and Degerby are TIGA stations. All *FinnRef*<sup>®</sup> stations are used in the computation of the joint Nordic GPS network. *FinnRef*<sup>®</sup> forms the backbone for Finnish GPS point densifications and enables the study of the crustal motions of the Earth. Determination of land uplift, and studies on periodic effects on data, as well as deformation studies due to loading effects have been made using the permanent network.

### 2. EUREF-FIN, a national realisation of the ETRF89 reference frame

FGI has participated in national committees and working groups in order to advance the usage and help in practical questions of the new reference frame, EUREF-FIN, in Finland. Observations in the *FinnRef*<sup>®</sup> network are the basis of the EUREF-FIN. Up-keeping and maintaining of the reference frame is the responsibility of the FGI.

### 3. Works as a National Standards Laboratory

The FGI is a National Standards Laboratory (NSL) of length and acceleration of free fall, as prescribed in the law (581/2000). The NSLs in Finland and the quality systems in them have recently been represented by the CMA in the EUROMET QS-Forum. In connection with this, and due to entering the global Mutual Recognition Arrangement (MRA) between the NMIs, the NSLs in the FGI have implemented a new quality system according to the ISO17025 standard, which now guides the metrological activities.

Scale transfer and calibration services for EDM instruments have been maintained at our *Nummela* baselines. The traceability of measurements with the Väisälä Interference Comparator has been greatly improved, since the absolute calibrations of quartz gauges can now be performed (in addition to some NMIs abroad) in the CMA in Finland.

The vertical laser rod comparator as a part of the calibration facilities has been working well and it has been used to calibrate all rods of the FGI used in the Third Levelling. In addition, the invar rods used in Baltic countries and other domestic users have been calibrated. The system calibration comparator to calibrate the digital levels has been designed and is now ready.

#### 4. Precise levelling

The Third Precise Levelling continued in Lapland. About 400 km/year of double-run levelling was performed in 2002 by three field teams using the Zeiss DiNi12 digital leveling instruments, which were taken into use in 2001. The levelling lines in Lapland were completed, except for one connection to the Russian border. In 2002 the Finnish and Russian precise levelling networks were connected at two places in Lapland. The levelling connection was carried out by a Finnish and a Russian levelling team.

A test field built at Metsähovi was used in levelling studies and determination of the precision of the precise levelling instruments. Unexpected temperature-related movements of some bedrock benchmarks were discovered, and the research of the phenomena will continue.

#### 5. Gravity observations

##### 5.1 Absolute gravity observations

Absolute measurements were made in Metsähovi and on three points in Lithuania with the JILAg-5 absolute gravimeter. A new generation absolute gravimeter, FG5 was ordered. Sites for absolute measurements in Ghana were reconnoitred.

##### 5.2 Relative gravity observations

The Finnish part of the land uplift gravity line 63°N was measured in 2002 with four LCR-gravimeters. The work was done in a co-operation with the Estonian Land Board, from where two gravimeters and an observer participated the campaign.

The national gravity survey of Finland by the FGI covers the whole country with a density of 1 point/25 km<sup>2</sup> or better. The Geological Survey of Finland and the FGI, primarily in some geologically interested areas, are densified this network to the level of 2.6 points/1 km<sup>2</sup> in a co-operation. The gravity survey was continued in 2002 near the city of Tampere. Testing of RTK-GPS was done in connection to the densification to study the applicability of the method in this kind of work.

##### 5.3 Superconducting gravimetry

The superconducting gravimeter GWR T020 at Metsähovi, a part of GGP (Global geodynamics project), has been operational since August 1994. In addition, the recordings consist of air pressure, groundwater level and precipitation. Studies of gravity data comprise the gravity spectrum from microseism to Chandlerian period. Now, the research work has been focused on loading effects from air pressure field and the Baltic Sea. Use of the superconducting gravimeter for hydrological studies is investigated in cooperation with the Helsinki University of Technology (Department of Rock Engineering), Finnish Environment Institute, and the Geological Survey of Finland.

#### 6. Local deformation studies

Investigation of local crustal motions contained in a contract with Posiva Oy was continued on the candidate sites for final nuclear waste disposal. The local networks

at Olkiluoto, Kivetty and Romuvaara were measured with GPS. An EDM baseline between two GPS pillars was established at Olkiluoto to control the scale of the GPS measurements. The baseline was measured twice with Kern ME5000.

Study on periodic variation on the time series of the Finnish permanent GPS stations FinnRef was continued. This is in connection of the work made for the rebound studies with GPS and repeated levelling and crustal loading effects at the superconducting gravimeter.

An international co-operation in project BIFROST (Baseline Inferences for Fennoscandian Rebound Observations, Sea Level and Tectonics) was continued. This is a co-operation project between the Massachusetts Institute of Technology, University of Toronto, University of Durham, Chalmers University of Technology, National Land Survey of Sweden and the Finnish Geodetic Institute for better understanding the rebound process and to constrain the mantle viscosity and deglaciation models.

#### 7. Water tube tiltmeter

Renovation of the water tube tilt meter system continued. The interferometric water level control system with the fibre-optic, laser and digital camera recording were under tests in laboratory.

#### 8. Navigation and Positioning

In 2001 a new department, Navigation and Positioning started at the FGI. Its research topics are the new Global Navigation Satellite System (GNSS) technologies, intelligent navigation, multi-sensor positioning and real time mapping systems.

In cooperation with the European Space Agency (ESA) a Ranging and Integrity Monitoring Station (RIMS) of the European Geostationary Navigation Overlay Service (EGNOS) is under construction in Virolahti, Finland. The RIMS will be important when developing the ground segment of EGNOS, which will ensure a better navigation service in Finland once the GALILEO satellite navigation system is in operation.

#### 9. GPS levelling campaign

In August 2002 a GPS campaign was arranged with FGI and the Land Survey of Sweden to measure a height connection between Finland and Sweden across the Aland Sea. The GPS observations were made on a total of ten levelling points. Preliminary results were published in the General Meeting of the Nordic Geodetic Commission in October 2002.

#### 10. Maintenance of Finnish primary triangulation sites

During 2002, 21 triangulation points were checked and refurbished and the local geometry re-measured. Two GPS receivers were used at most points to determine the absolute orientation of the local control network.

#### 11. Metsähovi Geodetic Observatory

The Metsähovi Satellite Laser Ranging (SLR) continued its operation. During the year 2001 a total of 735 orbits of 18 satellites (84676 single observations) were observed. The development of the SLR was continued in a co-operation with the University of Latvia, Riga. Preparations for daytime observations were continued.

The Metsähovi GPS station continued as a part of the Finnish permanent GPS network, FinnRef. Data were submitted to the European permanent GPS network computation as well as IGS network. Also, data from Javad/Legacy GPS/GLONASS receiver were submitted to the GLONASS data center for IGEX.

The French Doris beacon continued its operation.

As a co-operation<sup>0</sup> project with the Metsähovi Radio Research Station of the Helsinki University of Technology, preparations for geodetic VLBI installation were continued. A cooled, axially positioned and removable, S/X converter (15 K) and feed was constructed by a Spanish company TTINorte. First tests will be made in the first half of the year 2003.

## 12. International co-operations

FGI participated in the work of the Nordic Geodetic Commission (NKG) as a member of the presidium and the chairman of the satellite geodesy working group. In October 2002 FGI arranged the General Assembly of the NKG. The meeting is arranged every fourth year, in each Nordic country in turn. FGI acted as an active member of the height determination working group where subgroups of levelling adjustment and land uplift were established to coordinate the common Nordic effort in computing the unified height system in the area. Under the name of NKG processing centre, data from the Nordic permanent GPS networks were computed in Onsala Space Observatory. FGI provided the Finnish part of the data.

A co-operation with the Baltic States, Estonia, Latvia and Lithuania was continued, partly funded by the Ministry of Forestry and Agriculture. The co-operation contained works in gravimetry, levelling, tide gauge data, GPS and metrology, including the rod comparisons.

A co-operation with the Russian Mapping Authority was continued. The agreement included e.g. the levelling connection between the Russian and Finnish levelling networks and related data exchange.

Co-operation with the University of Stuttgart continued in the satellite gravimetry project. Researcher exchange between the University of Stuttgart and FGI was funded by the Academy of Finland.

## B. Publications

During the year 2002 a total of 10 peer reviewed papers and 20 other papers were published. Additionally there are 7 papers in print, and a total of 36 abstracts or presentations.

IAG - National Land Survey of Finland

(Marko Ollikainen)

The following densification of National networks were done during the year 2002:  
Densification of EUREF-points: 164 points (densified the network measured by the FGI)

National Map Grid Points: 584 points (can be connected to the EUREF-FIN reference frame)

Levelling points: 622 points

Participation in national committees and working groups in order to advance the usage and help in practical questions of the new reference frame, EUREF-FIN, in Finland.

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## **INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND AERONOMY (IAGA)**

(Reporter H. Nevanlinna)

IAGA - FINNISH METEOROLOGICAL INSTITUTE

(Reporter H. Nevanlinna)

### **Space research**

Connecting the magnetospheric observation data produced by ESA's cluster 2 satellites with the measurement data of the miracle ground-based network maintained by the Institute constituted an important part of scientific space research. This work supported our space-weather activity, which covers both scientific research about the whole space weather chain of events from the sun to the surface of the earth and the investigation of applications. The Institute was an active participant in producing material related to space weather to the public; examples of this are the Institute's involvement in the preparatory work on a CD-ROM dedicated to space weather and funded by the EU and arranged open-house event. The data relayed by the swan instrument on board the SOHO satellite launched in 1995 enabled significant new results to be obtained, especially in the field of cometary physics. Some unexpected problems arose in satellite equipment projects and tests. Six devices were delivered for the ESA's Rosetta satellite. It was scheduled to be launched in January of 2003 towards the comet Wirtanen, but had to be postponed to a later date. The SPEDE instrument was delivered to ESA's SMART-1 Lunar programme. Instruments for ESA's Mars-Express satellite and the associated Beagle 2 Lander were delivered to await the launch scheduled for May-June of 2003. Preparations were made for the scientific exploitation of the project and at the same time this work provided the basis for participation in the forthcoming Venus Express programme. The Research year 2002 Mars NetLander project co-operation venture with the French was on going despite some funding problems. The Mars MetNet project continued with the Russian partners. Development work on a magnetic calibration and testing laboratory suitable especially for testing space devices continued at the Nurmijärvi observatory

Peer reviewed papers 25

IAGA – UNIVERSITY OF OULU

INSTITUTE OF GEOSCIENCES, DEPARTMENT of GEOPHYSICS

(Reporter: 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 2002 the major activities were:

1. The EUROPROBE / SVEKALAPKO subproject BEAR (Baltic Electromagnetic Array Research) has continued its activities past the official ending of the EUROPROBE Programme. The data were measured in 1998 with an array of 50 MT and 20 magnetometer stations. BEAR presented an invited lecture at a symposium devoted to the memory of Prof. Leonid L Vanyan († Oct 2001), arranged a workshop in Moscow in March 2002, and a miniature workshop at the Oulu University in November 2002. The BEAR Working Group published 8 refereed papers and 20 printed abstracts in 2002. The preparation was started to write a chapter on EM and seismic results of SVEKALAPKO for the book European Lithospheric Dynamics as well as to write a set of papers covering measurements, data processing, source field studies, decomposition analysis and modelling (1D to 3D).
2. Various aspects of electromagnetic modelling and inversion have been studied.
3. The preparation of a 3D crustal model, based on joint inversion of potential field, seismic and EM data has continued jointly with the GSF.
4. The project. "Polar geoscience and climate history: advanced methods of modelling and data analysis", financed by the Thule Institute, has continued experiments with GPR on glaciers under the guidance of dos. John Moore (Arctic Centre, Univ. Lapland) and in cooperation with the National Graduate School on Snow and Ice. Data processing and analysis has continued in combination with ice core electrical profiling. The project has 7 papers in press and the results of the project have been disseminated to the wide public ao. at an exhibition at Arktikum (Rovaniemi).
5. Smaller scale research projects have been performed in co-operation with various research organizations and related to methodological studies for obtaining information about bedrock and overburden structures for demands of civil engineering, groundwater and ore prospecting and environmental research.
6. A new project of Deep EM sounding along FIRE (Finnish Reflection Experiment) lines started at the end of 2002 under the leadership of Prof Pertti Kaikkonen.

Summary of publications:

Refereed:	10
Printed abstracts:	20
Others:	1



## IAGA - SODANKYLÄ GEOPHYSICAL OBSERVATORY (Reporter Tauno Turunen)

Sodankylä geophysical observatory (SGO) is a nationwide institute under the administration of the University of Oulu. The observatory staff consisted at the end of the year 45 persons from which 7 in the Oulu unit and the rest in Sodankylä. All together 26 of these have permanent position. The Space Institute at the University of Oulu was coupled to SGO in the beginning of 2002. The activities of SGO continued normally in 2002.

Among the extensive routine geophysical observatory activities many different projects take place in SGO. The EISCAT project is the oldest active one. From the others one can mention as examples the Marie Curie Training Site educational program "Investigations of the Near-Earth Space by Radio Methods", a co-operative project "Coupling of Atmospheric Layers" and the very extensive LAPBIAT-project (Lapland Atmosphere-Biosphere Facility), which has been coordinated by SGO and had participants from 17 countries in 2002. A space debris measuring project using EISCAT radar system was finalized and a new one negotiated. The Oulu unit has participated among other things in a very extensive project FIRE (Finnish Reflection Experiment).

The research works of SGO were as authors in 29 articles published in refereed journals in addition to 7 articles, which are in press and 21 articles, which were submitted. The number of conference proceeding articles was 16. The number of meeting abstracts was 103.

The total number of daily visitors to the observatory was 1230 in the year 2002 and 175 visitors stayed extended period in the observatory. Most of them were visiting as participants in different research programs.

## IAGA - SPACE PHYSICS AT THE UNIVERSITY OF HELSINKI

(Reporter Hannu Koskinen)

### Space Physics at the University of Helsinki

Space research at the Department of Physical Sciences is distributed among several divisions: Divisions of Atmospheric Sciences, High-Energy Physics, Theoretical Physics, X-ray Physics, and Geophysics. The distributed work is co-ordinated under Space Research Unit directed by Prof. Hannu Koskinen. Here we report on the space physics research related to Solar-Terrestrial Physics, which is closest to the interests of IUGG.

In 2002 the space physics group consisted of Prof. Hannu Koskinen, Dr. Rami Vainio (from 1.8.2002), Dr. Eija Tanskanen (1.2. –30.6.2002), and the graduate students Ville Honkkila, Emilia Huttunen, Noora Partamies and Jussi Lintunen. Eija Tanskanen defended her Ph.D. thesis in March and at the end of the year there were in

total 8 active graduate students in space physics of whom 4 were employed at the Finnish Meteorological Institute (FMI).

The co-operation between the space physics groups at FMI and at the University is very close. 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 research in 2002 focused in particle acceleration in the solar wind, magnetospheric storm drivers, magnetospheric dynamics and in theoretical studies of magnetospheric magnetohydrodynamic simulations.

One of the nation-wide consortia in the Antares space research programme is called Space Weather in the Antares Programme (SWAP). It consists of research groups from the Universities of Helsinki (co-ordination), Turku and Oulu and the FMI. The work is in good progress.

Hannu Koskinen's most significant international posts in 2002:

Member of the Finnish delegation in the ESA Science Programme Committee

Representative of the Academy of Finland in the EISCAT Council

Chairman of the COSPAR National Committee  
- Representative of Finland in the COSPAR Council

Member of the European Space Science Committee (ESSC) of ESF

SCOSTEP Adherent Representative

Member of the S-RAMP Steering Committee

Member of the Rosetta Lander Steering Committee

## IAGA — SOLID EARTH GEOPHYSICS AT THE UNIVERSITY OF HELSINKI

(Reporter Lauri Pesonen)

The Solid Earth Geophysics Group at the Division of the Physical Sciences of the University of Helsinki was established in its recent form in 2000. The group has research activities in four fields of solid earth geophysics:

1. Palaeomagnetic techniques are used to study the evolution of the Fennoscandian Shield and its position in the supercontinent assemblies.
2. The group investigates the intensity of the Earth's magnetic field and its polarity reversals using dated rock samples.

3. Physical properties of meteorites are used to classify meteorites rapidly and to model the geophysical properties of their parent bodies.
4. The subsurface structures and ages of meteorite impacts are investigated with geophysical modelling and with palaeomagnetic dating techniques.

During 2002 the major activities were:

In 2001, the *Solid Earth Geophysics Group* focused in building a new research and teaching laboratory of the solid earth geophysics in the Kumpula Campus of the Helsinki University. A new teaching curriculum of the solid earth geophysics was also launched. The "solid earth geophysics laboratory", with new palaeomagnetic and petrophysical instrumentations, were build during 2001-2001. The laboratory provides a facility to measure physical properties of rocks, minerals and extraterrestrial materials. The laboratory serves also as a teaching laboratory for students.

#### Research projects

The Solid Earth Geophysics Group participated in five international projects in 2002. These were: 1. The EUROPROBE/SVEKALAPKO, 2. The IGCP-440, 3. The ESF-IMPACT, 4. The ICDP, and 5. The GISP-projects, respectively. Lauri Pesonen acted as a co-ordinator of the Finnish IGCP-440 project and as a Finnish representative in the ESF-Impact and in the GISP-projects. Lauri Pesonen acted as a planning member of the EGS rock- and paleomagnetic programmes.

In the IGCP-440 project, the group, in collaboration with the GSF people (Mertanen, S.), tested some of the proposed Precambrian supercontinent assemblies on the basis of global paleomagnetic database. Three international articles were published of the results, and numerous presentations in international meetings were given. In the ESF-Impact programme, several Finnish and other impact structures were investigated with geo-physical modelling techniques. Some of the structures were dated using palaeomagnetic dating methods. We also constructed subsurface models of some impact structures using geophysical modelling techniques. This research is supported by the Academy of Finland.

The group was actively involved in publishing 3 peer-reviewed articles, 4 other articles and 19 conference abstracts in 2002. The group gave 15 oral/poster presentations in domestic and international meetings. Lauri Pesonen supervised four Ph.D-candidates (two in Finland and two in Germany) and two pro-graduate students. He also acted as a Ph.D committee member in a Ph.D defense occasion in Luleå University, Sweden. Moreover, together with Dr. Jüri Plado, Lauri Pesonen completed a new book of "Impact Structures", which will be published by the Springer Verlag in 2002.

#### IAGA - GEOLOGICAL SURVEY OF FINLAND

(Reporters Lauri Eskola and Satu Mertanen)

Aerogeophysical surveys were carried out in Finland and Ireland. Totally 133000 linekilometers were surveyed with two aeroplanes.

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 printed and published as well as magnetic and gravity anomaly maps of the Fennoscandian Shield 1:2,000,000, together with Swedish, Norwegian, Danish and Russian geological surveys and geological surveys of the Baltic countries. Aeromagnetic investigations were applied to structural studies of the bedrock and to gold exploration. The Laboratory of Paleomagnetism continued investigations on Precambrian supercontinent assemblies, together with the University of Helsinki and other international paleomagnetic groups. Local paleomagnetic studies were carried out on one of the geological key areas of Fennoscandia, the Lake Ladoga area, where the syn-post-Svecofennian geological evolution of the Fennoscandian Shield is recorded in multicomponent remanent magnetisations of the rocks. Palaeomagnetic method, coupled with rock magnetic studies was applied to geological investigations on studying vertical tectonic movements within the Fennoscandian Shield and on dating goldmineralisations in northern Finland and shear zones in southern Finland.

8 internationally pre-reviewed publications and 14 other publications or maps.

# **INTERNATIONAL ASSOCIATION OF HYDROLOGICAL SCIENCES (IAHS)**

(Reporter: Pertti Seuna)

## 1. Activities

### 1.1 IAHS - FINNISH ENVIRONMENT INSTITUTE

The national hydrometric monitoring program comprised the following measurements: 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 1300 observation stations. The monitoring program was developed e.g. by improving the technical standard of field stations and increasing real-time data collection. The hydrometric quality system was also developed. Data services to expert organizations and the media formed an important part of the work. The hydrological database was developed and extended in many ways. This browser based system served Internet customers for the first time in 2002. The regional data were included in the common database, which contained after that some 30 million observations from about 3000 stations and basic information from more than 50 000 lakes.

The national watershed modeling system, based on the modified HBV model, covered the whole country, and it was used operationally on daily basis. The system was further developed, e.g. the user interface, reports and data service were improved. The whole system can be operated through the Internet. Integration between the modeling system and the observation database was improved. Information on remote sensing is incorporated in hydrological modeling including regional existence of snow, based on satellite images. Hydrological models were also used extensively for the research. The use of remote sensing data from weather radars and satellites is studied for improving forecasting. Among other research projects climate change impacts on energy production, water resources and dam safety are to be mentioned.

A comprehensive Climate- Water- Energy joint project was initiated by the Icelandic institute Orkustofnun. It will focus on hydropower effects and changes caused by climate change. Regarding climate change effects time series analyses of hydrological long-term series were started. Extremes of hydrological parameters are under special consideration in the Finnish Environment Institute.

Water temperature conditions of lakes and rivers were studied using long-term observation series mainly from the period 1961-2000, but partly dating back to the 1920's. The statistical analysis showed mostly negligible trends in thermal conditions.

Bathymetric mappings of lakes were continued in 2002. By the end of 2002 some 70 % of the Finnish lake area was covered. A large GIS project was started after the two-year pilot phase to produce a national register on rivers and a new version of the national river basin boundary database.

The monitoring of integrated hydrology consisted of small hydrological basins and groundwater monitoring stations, both including water quantity and quality. Both

networks are mainly meant for research purposes, while operational uses are important, too. At the 50 groundwater stations groundwater level and soil moisture were measured and water samples taken for detailed analyses. A comprehensive groundwater database POVET was under final phase of the development, and it will collect most of the governmental groundwater information into one database. In small hydrological basins discharge with measuring weirs, precipitation, snow water equivalent and soil frost were measured, and in fifteen of them water quality was analysed. The catchments were partly included in the international FRIEND- and ERB-Projects. The opportunity for more active participation would be desirable to these projects, calling for special care in the future.

The international evaluation of the small basins monitoring and research made in 2001 recommended the increase of intensified and interdisciplinary investigations, including resourcing, while a slight reduction in the catchment number was regarded sensible. By the end of 2002 the latter part of the recommendations has been carried out. In research a long-term analysis was done. This trend analysis was applied for the influence of sub-drainage of an agricultural small catchment. During the 30 years after the drainage change from open ditches to sub-drainage the percentage of surface runoff increased from 20 to 60 for the mean annual runoff and from 0 to 50 for the summer maximum runoff. This kind of trend could contribute to increased flooding on old sub-drained basins like in central Europe.

Hydrological data were submitted for the Baltex (Baltic Sea Experiment) and FRIEND according to the existing agreements and for numerous customers on request.

The work on the new and updated edition of the environmental dictionary EnDic2000 was started as the Finnish-Estonian co-operation. The new dictionary will contain some 5500 terms in 9 languages: Finnish, Estonian, English, Swedish, German, Russian, Latvian, Lithuanian and French.

Comprehensive co-operation with the Finnish Meteorological Institute in hydrometeorological affairs, including e.g. the transfer of meteorological information for flood forecasting and other hydrological purposes, remote sensing applications etc. continued successfully on the basis of the renewed agreement. Certain observations, made by both the institutes were fit together in order to optimize the input-outcome. Among these evaporation and rainfall water quality can be mentioned.

## 1.2 IAHS - UNIVERSITY OF HELSINKI, DEPARTMENT OF PHYSICAL SCIENCES

A central theme of the geophysical part of the Department of Physical Sciences was snow and ice. This has included ice mechanics and lake ice decay, and optics of ice and snow. Field work has been made in southern Finland and in Estonia. A graduate school titled "Geophysics of snow and ice" has been ongoing with direct funding of 6 PhD students funded by various research projects. This graduate school officially ended in the end of 2002, but the research work continues including e.g. the modeling of the Finnish snow conditions. The project "Snow conditions in Antarctica" is proceeding in co-operation with a Canadian university.

Another priority area has concerned the optical characteristics of natural waters including model applications. The Finnish - Estonian co-operation in this field reached its third phase in 2002. This co-operation has been directed both to some freshwaters of these countries and to the coastal areas of the Gulf of Finland.

Using new climate change scenarios preliminary model runs were done for the Lake Pääjärvi. The shortening of the ice cover period was clearly demonstrated.

### 1.3 IAHS - HELSINKI UNIVERSITY OF TECHNOLOGY

The Laboratory of Water Resources at the Helsinki University of Technology provided undergraduate and graduate level education in hydrology, water resources management, and hydraulic engineering. In 2002 the research topics at the laboratory included environmental river engineering, modeling and monitoring of forest hydrology, global change and water resources, contaminant transport, water and nitrogen cycles in agricultural areas, and urban hydrology. In 2002 a particular emphasis in the hydrological research has been directed to small areas exhibiting different land use types. Monitored areas include three sub-urban areas in the city of Espoo, an agricultural field in Kirkkonummi, and a forested site in Siuntio. More information about the laboratory is available in the internet (<http://www.water.hut.fi>).

### 1.4 IAHS - UNIVERSITY OF OULU

Higher hydrological education was given and hydrological research was carried out in the Water Resources and Environmental Engineering Laboratory, which is a part of the Process and Environmental Engineering Department of the University of Oulu. The topics included applied hydrology, hydraulics, contaminant transport, water resources planning, sustainable use of water resources, and environmental geotechnics. Other topics were sanitary and environmental engineering and the chemical treatment of industrial and municipal waters and wastewaters combined with other treatment methods. The research projects included river management and environmental improvement, hydrology of constructed wetlands, water supply and sewerage engineering, retention of contaminants in soils, transport properties of forest soils, lake restoration, and development of technics for landfill protection. The northern dimension is keenly in the focus of the studies.

### 1.5 IAHS - FINNISH GEODETIC INSTITUTE

Use of superconducting gravimeter (SG) in Metsähovi for hydrological studies is investigated in cooperation with Helsinki University of Technology, Department of Rock Engineering, Finnish Environment Institute, and the Geological Survey of Finland. The SG senses (the vertical component of) the variation in the gravitational attraction of the near-field water mass (sub-surface water and snow), and the crustal deformation due to coherent variations in water load over large areas (hundreds of kilometers). The sensitivity of the SG is very high, corresponding to a fraction of millimeter in water storage, but the question is to identify and model the hydrological

contributions to the total signal of gravity variation. So far, efforts have been concentrated on near-field effects.

2. Publications, memberships in international bodies, visits

- a) The number of internationally pre-reviewed publications was 14 and that of the others about 50.
- b) The number of international memberships was about 25.
- c) The number of visits abroad was some 40 and the number of visits to Finland was about 35.



## **INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC SCIENCE (IAMAS)**

(Reporter: Mikko Alestalo)

### **1. ACTIVITIES**

#### **1.1 UNIVERSITY OF HELSINKI, DEPARTMENT OF PHYSICAL SCIENCES, DIVISION OF ATMOSPHERIC SCIENCES**

During 2002, the larger-scale meteorological research (previously within the Department of Meteorology) was made in the three areas of climate studies, numerical modelling and radar meteorology. There is also a group on micrometeorology, studying exchanges of matter and energy within forest and atmosphere.

Studies on climate concentrated on the critical layer reflectivity of mountain effects, using GCM runs and linear steady-state models.

In radar meteorology, applications to environmental issues were studied.

In numerical modelling, the UH 2-D model was used to study local flows around a tropical heat island, and local coastal winds in Finland (the channelling effects). Parametrizations for radiation were further studied, especially in Antarctic conditions. A road weather model was further developed and validated. Parametrizations for rain, especially the Sundqvist scheme, were studied. Mars modelling continued with the UH 1D- and 2D models, and HIRLAM was successfully modified for Mars during 2002. The radiation schemes of the UH models and some Mars GCMs were compared against line-by-line calculations as an international project (lead by UH). The UH schemes were improved based on these inter-comparisons. New effects were introduced, such as two-stream shortwave code for dust and slope effects on direct solar irradiation.

#### **1.2 FINNISH METEOROLOGICAL INSTITUTE (FMI)**

In 2002, research was continued in the areas of atmospheric modelling, climate change, air quality, ozone and UV – radiation, and further development of the use of satellite and weather radar measuring methods.

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. One new item was to clarify the changes in the UV-radiation and the trends in the UV-radiation during the last fifty years. Another central research item was the research of the effects of the ozone depletion to the arctic climate. The ozone soundings in Antarctica were continued as a co-operation between Finland and Argentina. The ozone research group continued to co ordinate the EUMETSAT Ozone

SAF Project for making ozone data available after the launch of the new satellite instruments in 2005.

The development of the HIRLAM (High Resolution Limited Area Model) continued with the goals aiming at the improvement of short-range forecasting and forecasting of severe weather phenomena as well as on regional accuracy in northern conditions. A new surface model has been tested which most probably will increase the accuracy of the springtime temperature forecasts. One new feature is also the use of radar winds in the validation of the numerical weather prediction models and in the initialisation process. Historically a noticeable change was the implementation of the 3D variational data analysis scheme to replace the optimum interpolation method. FMI has the position of Deputy Project Manager in the management team of the international HIRLAM team.

Under the climate change studies the emphasis was on the clarification and understanding of past changes in climate variables. Monitoring of greenhouse gases has also started to follow the present changes. By comparing past data with present observed changes the forecasted global climate change can get the right proportion. FMI has been actively participating in producing input to the FIGARE climate programme report. FMI has also participated in the CLIMTECH project, where the usage potential of renewable energy (e.g. wind, water, peat and biomass) in a time frame of 30 years was studied. FMI continued as the national co-ordinator in the IPCC – climate group.

Measurements to determine the concentrations and budgets of carbon dioxide were conducted in several locations in Finland within projects financed by the Academy of Finland and the EU. A new flux-measurement tower was constructed at the Pallas-Sodankylä station to supplement the extensive greenhouse gas measurements carried out as part of the WMO/GAW (Global Atmosphere Watch) monitoring programme. In addition, development of a remote sensing method for assessing forests as carbon sinks was launched in co-operation with the European Space Agency. Observations of organic compounds released by ecosystems and the modelling of their air chemistry and ability to particle formation were also connected to climate change research.

The conventional air quality research has been focused on tropospheric ozone, organic compounds, particulate matter and toxic substances such as benzene. In particular, measurements were carried out to study the toxicology of fine particles, and methods were developed for estimating people's exposure to airborne pollutants in urban areas. These topic areas are in agreement with the needs on air quality research addressed by UN/ECE and EU/EEA.

## 2. PUBLICATIONS

There were 71 refereed publications, and 255 other scientific publications published in 2002.

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

(Reporter: Pentti Mälkki)

### 1. ACTIVITIES

Finnish Institute of Marine Research

Studies in the FIMR focused on the following objectives:

- Studies on the dynamics and thermodynamics and remote sensing of sea ice;
- Air-sea-ice interaction dynamics and its modelling.
- Impact of climate change on the Baltic and Arctic seas.
- Generation of wind waves and development of operational coupled atmosphere-wind wave models,
- Dynamics of circulation in the Baltic Sea and development of numerical circulation models,
- Studies of the Arctic Ocean fluxes.

FIMR participated in CEC shared-cost R&D IWICOS project (Integrated Weather, Sea Ice and Ocean Service System). The project aims to develop digital one-entry system and information products for the users at sea. The System was demonstrated e.g. in the Fram Strait area in March, when Radarsat images, ice drift buoy data and weather forecasts were delivered to Finnish research vessel Aranda in an area with limited communication possibilities.

On dynamics and thermodynamics of sea ice, improvements have been made on of the high-resolution numerical sea ice dynamic model and on development of the numerical thermodynamic sea ice model. The model control runs have been carried out. The results have been analysed. The operational numerical sea ice model in the Finnish Ice Service has been updated. The updated model has been tested and the sensitivity studies have been carried out. A manuscript has been prepared and submitted. As a part of the work, a PhD thesis was completed in early May, 2002.

On remote sensing of the sea ice, analysis of remote sensed data, in particular SAR images has as an objective to develop new statistical methods to classify sea ice radar images. In addition, methods have been developed for compacting sea ice information in Radarsat-1 SAR images.

. Data analyses and modelling studies of air-sea interaction were mostly related to the field measurements gathered under two recently finished EC projects (BALTEX-BASIS and ARTIST). The data-analyses addressed the large-scale roughness parameters of a broken sea ice cover and the marine meteorological conditions over the Baltic Sea in the period 1991-1999. The modelling studies dealt with (1) interaction of sea ice thermodynamics and warm-air advection and (2) boundary-layer over the Arctic sea ice. The three-dimensional non-hydrostatic mesoscale model MM5 was also taken to use, with the objective to couple it with various marine models.

Connected with the investigations of the atmosphere and ocean interaction, studies from local physical processes and process scale modelling up to regional to global scale were carried out. In the former ones, special attention was paid on the thermal sea ice modeling as well as modelling of the atmospheric surface layer forcing above the sea and sea ice. On the regional to polar scale our main attention was given to the sea ice climatology and effect of the atmospheric forcing on sea ice conditions. The studies were carried out in two international EC funded projects. In February- March 2002, an arctic expedition FRAMZY- 2002 to the Fram Strait was performed by the FIMR research vessel Aranda, as an international co-operation with German and UK institutions. The main goal of the expedition was to investigate the mechanisms of the arctic sea ice transport via Fram Strait, out from the Arctic Ocean.

The study on HIRLAM verification over the Baltic Sea was finished. The surface radiation budget over some Antarctic stations was studied as well as the effect of clouds and heat advection on the near-surface air temperature over the Arctic Ocean in winter.

Experimental and modelling studies of the physical features of the Baltic Sea were carried out. The studies are focused on three-dimensional hydrodynamic modelling and process studies of the physical environment of the Baltic Sea.

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). Instrumentation to measure both waves and surface stress by correlation method on board R/V Aranda was used for the first time.

Studies on the source terms of the WAM wave model begun in co-operation with Alcyon bv (Netherlands).

These studies take advance the special conditions in Gulf of Finland that have revealed deficiencies in the model. Coupled HIRLAM-WAM wave model in the Baltic Sea was operative for the second year. Studies of trends in sea level variations in the Baltic Sea continued, partly within FINSKEN project that was completed in 2002.

FIMR participates in a working group preparing a book on directional wave measuring instruments and analysing techniques in COST 714 action. The book is under external review, internal review has been completed.

In project HYMNE, funded partly by EU commission, the effects of the river Neva discharge to the salinity along the Finnish coast in the Gulf of Finland was studied. The project ended in October and a report has been written.

In project AICSEX, partly funded by EU commission, the ice conditions in the Baltic Sea have been studied. Especially the reflection of the weather/climatic conditions in the Polar Regions to the conditions in the Baltic Sea has been under focus.

Dynamics of wind-forced diapycnal mixing in the stratified ocean (DIAMIX) project: the data analysis was carried out and an introductory report was published in Boreal Environment Research together.

Ari has also studied the Global Change and its effects to the Baltic Sea ice cover.

On the study of Arctic fluxes main field work during 2002 was the participation in the international Arctic Ocean – 02 expedition with IB Oden in spring to the northern Fram Strait and to the East Greenland Current. FIMR co-ordinated the physical oceanography programme. The cruise lasted 45 days. The planning for the ASOF (Arctic – Subarctic Ocean Flux array) programme continued and three separate EU programme, forming a cluster, were eventually supported and will begin in 2003. FIMR will participate in the ASOF-N in Fram Strait and in the ASOF-W in Denmark ram Strait. The work on the hydrography of the upper layers of the Arctic Ocean has continued. General presentations of the Arctic Ocean circulation have been given on an international symposium: C flux and Climate Change: the Nordic contribution to a Panarctic perspective, Sigulda, Latvia and on a Nordic workshop: The bioproduction and energy transfer in the Nordic Seas, the role of key zooplankters in a system of rapid climate change, Sandgerdi, Iceland. FIMR has also taken part in the planning of a trans-Arctic Ocean oceanographic section to be carried out from Oden in connection with the Swedish initiated Beringia programme 2005.

University of Helsinki, Institute of Physical Sciences

In the framework of the Finnish global change research program (FIGARE) a new advanced sea ice model applicable for climate research has been developed. The model resolves sea ice thickness distribution for arbitrary numbers of undeformed and deformed sea ice thickness categories. The sea ice model has been implemented in the ocean circulation model, MPI-OM-1, developed in the Max-Planck Institute of Meteorology. The MPI-OM-1 model is global, however it employs curvilinear coordinates which allows modelling coastal regions and adjacent seas of the Arctic Ocean with a high horizontal resolution, which are known to be vital regions for a sea-ice production.

Ten-years simulations have been made with the global model and the evolution of the sea ice thickness distribution in the Arctic has been analysed. The temporal behaviour and horizontal extension of the deformation regions was largely dependent on the synoptic scale wind field. Deformed ice production regions were concentrated in coastal regions, particular important regions were found to be the Lincoln Sea, the Beaufort Sea and the Northern regions of the Spitsbergen, Franz Josef Land and the Severnaya Zemlya.

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

(Reporter: Pekka Heikkinen)

To be compiled later

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

(Reporter: Ilmari Haapala)

### **IAVCEI - GEOLOGICAL SURVEY OF FINLAND**

The Geological Survey of Finland has carried out petrological, geochemical and isotopic studies on the komatiitic (ultramafic) lavas of the Paleoproterozoic Central Lapland Volcanic Belt as Finnish-Australian and Finnish-American collaboration. Permian – Triassic komatiites of Vietnam have been studied as Vietnamese-Finnish-American-Russian collaboration. The studies on the ophiolite-type serpentinites and associated rocks of the Outokumpu – Kainuu area have continued. The diamond-bearing kimberlites of the Kuhmo, Kaavi and Kuopio areas have been studied, in part as international collaboration, to obtain more detailed information on the age, composition and structure of the lithospheric mantle.

### **IAVCEI - UNIVERSITY OF HELSINKI**

The Department of Geology launched in January 2002 a new research project GILDA (Geochemical and Isotopic Project on Lithospheric Evolution of Dronning Maud Land, Antarctica) . The project is an extension of Department's earlier work on the Jurassic basalts, their intrusive correlatives and spatially associated lamproite dykes in the same region. In 2002, the studies were focused on isotope geology of ferropicrite dykes, mineralogy of gabbros and hydrothermally altered basalts, and experimental geochemistry of lamproites. Results were published and presented at Gondwana 11 meeting in New Zealand. Two researchers participated in Finnarp 2002 expedition to Antarctica.

Department's long-term field and laboratory studies on bimodal, rift-related granite-basalt magmatism in Finland, New Mexico, Brazil, and Namibia have been continued as international collaboration. Petrologic and geochemical studies on the Cretaceous granites of Namibia, which are related to mantle plume and continental rifting, have been completed and presented in a doctoral dissertation.

### **IAVCEI - UNIVERSITIES OF TURKU AND ÅBO AKADEMI**

The Department of Geology, University of Turku, has studied the geochemistry, petrology and tectonic evolution (arc and back-arc basin environment) of the 1.90 – 1.88 Ga Svecofennian volcanites of southeastern Finland, and the results have been presented in a doctoral dissertation. The petrological studies on the postorogenic 1.80 Ga granites have been continued. The Department of Geology, Åbo Akademi, studies the Svecofennian volcanites of the Pellinge area in southern Finland, and the rapakivi granite - anorthosite association of Åland.

### **IAVCEI - UNIVERSITY OF OULU**

The Department of Geology has studied, in collaboration with the Geological Survey of Finland and the University of Helsinki, the petrogenesis and ore potential of the

2.45 Ga layered mafic intrusions and associated felsic rocks of Koillismaa, northeastern Finland, by utilizing field research as well as geochemical and isotopic methods.

#### IAVCEI PUBLICATIONS

Refereed articles: 13

Other publications : 6



**TABLE.** The number of scientific publications produced in 2002 by different institutes in each association is as follows

Assoc.	Refereed articles
IAG	10
IAGA	66
IAHS	14
IAMAS	71
IAPSO	27
IASPEI	
IAVCEI	13
Total	201