

# **REPORT OF THE FINNISH NATIONAL COMMITTEE OF GEODESY AND GEOPHYSICS 2001**

(Compiled by H. Nevanlinna)

The numbers of scientific publications produced in different institutes in each association are as follows

Assoc.	Refereed articles	Other publication
IAG	1	4
IAGA	94	80
IAHS	10	50
IAMAS	70	256
IAPSO	13	30
IASPEI		
IAVCEI	7	5
Total	195	425

The detailed reports of the activities carried out in each association are in the following pages.  
The report can be accessed through Internet:

**[http://www.geo.fmi.fi/iugg\\_fin.html](http://www.geo.fmi.fi/iugg_fin.html)**

## **INTERNATIONAL ASSOCIATION OF GEODESY (IAG)**

(Reporter Risto Kuittinen)

### **A. Work done in the 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. Data have been collected on daily basis 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. Data are archived and transferred to the international computing centres. The FinnRef is used for local studies on crustal movements as well as a reference for GPS measurements. The Finnish new reference frame, EUREF-FIN is based on ties to the FinnRef network. Determination of land uplift, but also studies on periodic effects on data, as well as deformation studies due to loading effects have been made using the permanent network.

## **2. The EUREF densification projects**

During the year 2001, the final report of the computations and coordinates of the first and the second phase of the Finnish EUREF densification "EUREF-FIN" was published. The 350 new EUREF-FIN points were tied to FinnRef and to a subset of earlier (1996-1997) measured high precision EUREF-FIN points. FGI has participated in several national committees and working groups in order to advance the usage and help in practical questions of the new reference frame in Finland.

## **3. The Third Precise Levelling of Finland**

During the year 2001, 403 km of double-run precise levelling was measured by three teams in Lapland and also across Swedish and Norwegian borders. The test measurements of the digital levelling system Zeiss DiNi 12 were initiated in autumn 2000 and continued in 2001 using the newly-established test field in Metsähovi. Due to these measurements, the Zeiss DiNi12 levels were used also in precise levelling in Lapland.

Connection between the primary reference point of Finnish levellings on the Observatory Hill (Tähtitorninmäki), Helsinki and Helsinki tide gauge was made in 2001.

The ties between the 13 Finnish tide gauges and precise levelling network was done during the year 2001. These measurements are repeated every three years.

## **4. Baseline measurements**

Results of the Gödöllő standard baseline (Hungary), measured in autumn 1999, were published in the series of the Finnish Geodetic Institute (Publ. of FGI, 131). The full 864 m long baseline was measured with Mekometer 5000 and the 432 m with the Väisälä interference comparator.

A baseline in Kyviskes, Lithuania, was measured and the report of the measurement and the calibration certificate were submitted to the host organization, the Institute of Geodesy of the Vilnius Technical University. Also, the distance measuring instruments used in the Kyviskes measurement, Kern Me5000 and Wild DI2002, were calibrated in Nummela standard baseline.

## **5. Maintenance of Finnish primary triangulation sites**

During 2001, 21 triangulation points were checked and refurbished and the local geometry re-measured. Two GPS receivers were used to determine the absolute orientation of the local

control network.

## **6. Absolute gravimetric work**

Absolute gravimetric measurements were made in the Finnish Antarctic base, Aboa during the winter 2000/2001 with the JILAg-5 gravimeter. This was a remeasurement of the point, measured first time in 1994. An increase in gravity of  $8 \pm 7$  microgal was observed. Two points were measured with the same instrument in South Africa, and the instrument participated also in intercomparison campaign in BIPM, Sèvres, France. Regular absolute measurements in Metsähovi have also been continued. The instrument was under reparation during last four months of the year. Therefore, a part of the scheduled measurements were delayed to the next year.

## **7. Relative gravimetric work**

The densification of the national gravimetric survey base network was continued in the Tampere, Lempäälä and Valkeakoski area. The points measured were positioned with GPS, using the permanent FinnRef stations as reference station. All the levelled benchmarks in the area were checked with ortometric height obtained by GPS and digital geoid. 501 points were measured in total.

The measurements made in the land uplift gravimetric profile at 65 degree latitude were analysed and results were compared with the values obtained from the 63 degrees line. More than three decades of data gives a connection between the change in gravity and the land uplift rate. The results seems to favor the mass compensation in the rebound process.

## **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, and sea and atmospheric loading. 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. 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 a project with the Helsinki University of Technology, and funded by the Academy of Finland.

Sea loading were computed using the water level recordings at the Helsinki tide gauge, as well as the water level of the whole Baltic Sea. First tests were started using the surface pressure field of HIRLAM at about 500 km radius around Metsähovi. The efforts seem to reduce the gravity residuals. The sea level and meteo data are obtained as a co-operation basis from the Finnish Institute of Marine Research and the Finnish Meteorological Institute.

## **9. Satellite gravimetry**

As partly funded by the Tecnology Advancement Centre TEKES, a study on the usage of

gravimetric satellites in Finland was made. Also, a common Nordic proposal to use the Fennoscandian area as a test field for gravimetric satellites CHAMP, GRACE and GOCE were presented in the EGS meeting in Nice, and IAG Scientific Assembly in Budapest. FGI received the co-investigator status of the CHAMP satellite, which opened the possibility to use the CHAMP data products.

## **10. Metsähovi research station**

The Metsähovi Satellite Laser Ranging (SLR) continued its operation. During the year 2001 a total of 544 orbits of 16 satellites (92577 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 initiated.

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 project with the Metsähovi Radio Research Station of the Helsinki University of Technology, preparations for geodetic VLBI installation were started. First tests are expected by the end of the year 2002.

## **11. 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, laser and digital camera recording were under tests in laboratory.

## **12. Levelling rod comparator**

The vertical laser comparator 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 (Latvia, Lithuania, Iceland). A total of 25 pairs of rods were calibrated. System calibration of digital levels and rods were developed.

## **13. Deformation studies, postglacial rebound**

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.

Deformation studies at Nuottavaara/Pasmajärvi region in Finnish Lapland was continued. A Master of Science (Tech.) thesis was published for the Helsinki University of Technology. Publication of the geodetic measurements made in the area is under preparation.

A study on periodic variation on the time series of the Finnish permanent GPS stations FinnRef was made. This is in connection of the work made for the rebound studies with GPS and repeated

levelling. The periodicity of GPS time series degrade the accuracy and resolution.

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 lithospheric structure and ice models.

The FGI organized the IAG Symposium on Recent Crustal Movements in Helsinki. The Symposium was supported by UNSECO, University of Helsinki and Ministry of Agriculture and Forestry. Proceedings, to be published as a special issue of the Journal of Geodynamics is under preparation. A total of 70 participants from 18 countries attended the Symposium.

#### **14. 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. 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 and baseline measurements.

A co-operation agreement with the Russian Mapping Authority was made. 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 Baltic Sea Level project.

#### **B. Publications**

During the year 2001 a total of 5 peer reviewed papers and 17 other papers were published. Additionally there are 4 papers in print, and a total of 24 abstracts or presentations in scientific meetings.

C. Work done in the Helsinki University of Technology, Department of Surveying, Institute of

## Geodesy

In May 2001 HUT's Surveying Department's Institute of Geodesy re-measured (modernized) under commission from the city of Kajaani the geodetic base network of the city, using a mix of terrestrial and satellite techniques. This included the determination of transformation parameters from the local system to kkj and to the geocentric EUREF-FIN. The final report was handed over in November.

In autumn the Surveying Science Fair under the title "Co-ordinate Systems in a Time of Change" was held on HUT's premises.

### **Study programme reform at the Dept. of Surveying:**

New major: Positioning and Navigation.

### **Licentiate dissertation:**

Jaana Järvinen: Utilisation of GPS Satellite Measurement Methods in Data Acquisition for GIS Applications (Prof. Vermeer)

### **Engineer's thesis:**

Joel Ahola: Nuottavaaran siirroksen deformaatiotutkimus GPS-mittausten avulla [Deformation studies of the Nuottavaara fault with GPS measurements] (prof. Vermeer)

## D. Publications

During the year 2001 a total of 1 peer reviewed paper and 4 other papers were published. Additionally, during the reporting period appeared the journal "Maanmittaus" no. 76 and "Finnish Journal of the Surveying Sciences" no. 19. Docent, Ass. Prof. Jaakko Santala acted as editor-in-chief of both issues.

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

(Reporter H. Nevanlinna)

## **IAGA - FINNISH METEOROLOGICAL INSTITUTE**

(Reporter H. Nevanlinna)

Throughout the year 2001 the Geophysical Research Division was kept busy, as unexpected problems were experienced almost in all of the eleven instruments in five different space projects at the stage of delivery. In two of the so-called PI-instruments critical steps were taken, but instruments were managed to be kept in the satellite programmes. At the end of the year nearly all the problems were solved, and preparations for the year 2002 underwent through smoother way.

In science, too, remarkable achievements were attained. Two doctoral theses (one with the highest distinction) and one licentiate thesis exceeded the objectives set. Over forty referred publications contributed to the exceeding of objectives, too. The number of manuscripts left for review anticipates even better result for the year 2002. Scientific work was activated through full-scale operation of the Cluster-satellites and efficient support observations of the MIRACLE network. Cometary observations of the SWAN instrument of ESA's SOHO spacecraft achieved a prominent place in the most prestigious literature of space research.

In February, successful launch of the ODIN satellite carried by a Russian launcher received great attention in the media. The Space 2001-exhibition organised in autumn in the context of 80th anniversary of URSA was a great success at Kaapelitehdas, with over 20000 visitors. The animations and measurement results of GEO gained deserved attention.

In finance unexpected setbacks and changes was experienced. A cut in total finance of ANTARES space research programme caused that only 41 percent of the targeted 60 percent financing was reached. Existing finance from previous years helped to undergo the setback. The aimed status of Centre of Excellence was not obtained this time. In January, TEKES refused to further finance the NetLander project. Financing was restored to its planned level only in December with the support coming from ESA. An important Agreement on Depth Conversion was signed with Russia in August. According to the agreement Russian space industry will design and manufacture a prototype of a small Mars lander by the end of 2003.

Throughout the year, work was done in creating a new organisation with new operations model and strategy. The work was finalised by the end of the year, and the new operations model and task division will be put into practice at the beginning of 2002.

Operation of instruments in space:

The status of the HASI instrument onboard the Cassini-Huygens spacecraft was monitored during every telemetry contacts during the spacecraft's flight to Saturn. ESA and NASA managed to solve the sudden problems occurred in the data transmission system of the Huygens probe. The command and control management of the SWAN instrument of SOHO continued, and in exploitation of the data received emphasis was put on the comet research. NASA's Stardust satellite produced first results. The first results of the OSIRIS instrument onboard the ODIN satellite launched in February were also available for scientific analysis.

Preparations for launch activities:

Throughout the year preparations for the ENVISAT launch and for processing of the results continued. Due to problems in the Ariane 5 launcher, the launch was postponed to spring 2002. Construction of an OMI ground-station to Sodankylä was under financial negotiations.

Preparations for the OMI science programme were initiated.

Instrument manufacturing at the final stage:

The involvements in six instruments of the Rosetta programme were at the final stage (under integration and operation tests). The ASPERA-3 of ESA's Mars Express programme reached also the final stage. The instrument delivery in the Beagle-2 programme was carried out, and planning of the science part initiated. The flight model of the OMI instrument was delivered. The flight model of the SPEDE instrument in ESA's lunar programme was finalised. The software in the Contour cometary programme of NASA was delivered.

Initiation of new programmes:

The B-phase of the French-led NetLander project was nearly finalised, and preparations for the realisation of C/D - phase were initiated. The financial negotiations will require significant input. The design of a prototype for the next generation "MetNet" Mars lander was initiated in collaboration with the Russian space industry.

Programme concepts under development:

Negotiations with ESA continued over realisation of the COALA instrument in the Earth Explorer OLIVIA-programme. The instrument design for planetary satellite (MPO) and magnetosphere satellite (MMS) in the Mercury programme (BepiColombo) of ESA was initiated.

Activation of research activities in the field of space weather:

Research activities of the GIC-programme continued actively in the connection with the sun spot maxim. A new space weather project was finalised in the framework of ESA, and new programmes in Europe and in the USA were under negotiations.

Development of the MIRACLE measurements:

Operational phase of the Cluster satellites started at the beginning of the year. Co-ordination of the MIRACLE measurements with the satellite measurements was intensified. Research in the field was strengthened, and the degree of utilization and reliability of operation were maximised. Agreement was made to shift the responsibility on Norwegian STARE-station to GEO at the beginning of the year 2002. Progress was made in calibration of the camera network.

Development of test laboratories:

Construction of the test laboratory at the Nurmijärvi Geomagnetic Observatory was finalised, and marketing was initiated in co-operation with the Commercial Activities at the FMI. Development of the meteorological calibration laboratory with HAV continued as part of the NetLander programme.

Application of programmes of magnetic mapping:

For follow-up of the geomagnetic secular variation in the magnetic mapping of Estonia an IMAGE station was established in co-operation with the University of Tartu. An agreement on

research co-operation was agreed.

Participation in research programmes of the Academy of Finland:

The work in the programme of global change (FIGARE) of the Academy of Finland continued in one project. Participated in the MADAME programme with two projects. Participated in the ANTARES space research programme with four projects. Participated in the competition for centres of excellence of the Academy of Finland with the CESAR application, which did not, however, succeed beyond the first round.

Participation in space administration and in communication activities on space:

Writing of Finnish space history continued to be carried out as part of the ESA project. Measures were taken to initiate the space research centre at the beginning of 2002. Development of new information technologies for use of the communication activities was continued in co-operation with the Finnish industry.

## **IAGA — UNIVERSITY OF OULU**

### **INSTITUTE OF GEOSCIENCES**

(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 2001 the major activities were:

1. The processing and analysis of the BEAR (Baltic Electromagnetic Array Research) data has entered its final stage. The data were measured in 1998 with an array of 50 MT and 20 magnetometer stations. BEAR is a subproject of the EUROPROBE / SVEKALAPKO project, the official part of which ended at 2001-12-31.
2. Various aspects of electromagnetic modelling and inversion have been studied.
3. A project on joint inversion of potential field, seismic and EM data has been started jointly with the GSF.
4. Experiments with GPR on glaciers have been continued under the guidance of Prof. John Moore (Arctic Centre, Univ. Lapland) and in cooperation with the National Graduate School on Snow and Ice. New GPR field data at the blue ice fields in Antarctica (started during the 1999/2000 FINNARP season) have been collected during the 2000/2001 season. Earlier data have been processed and analyzed in combination with ice core electrical profiling.
5. Smaller scale research projects have been 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.

## **IAGA - SODANKYLÄ GEOPHYSICAL OBSERVATORY**

(Reporter Jorma Kangas)

General:

Sodankylä Geophysical Observatory (SGO) is a nationwide institute under the administration of the University of Oulu. Observatory is

divided into seven divisions: Administration, Aeronomy, Geomagnetism,

Computing, Technical, EISCAT station and Oulu unit.

The activities of SGO continued normally in 2001. Data from different instruments (magnetometers, riometers, all-sky camera, ionosonde, seismometers and neutron monitor) have been distributed by data reports and Internet, see [www.sgo.fi](http://www.sgo.fi). New facilities, notably a meteor and MST radars are under construction.

The most important projects funded by external sources were the EISCAT program, Meteor radar project, MST radar project, "Measurements of Small-Size Debris with Backscatter of Radio Waves" project, Svekalapko project and Marie Curie Training Site Educational program. The CUPP pilote project (Centre for Underground Physics in Pyhäsalmi) was finalized and the leadership of the Finnish Graduate School in Astronomy and Space Physics was moved to the Department of Physical Sciences, University of Oulu. SGO participates in the extended project Finnish Reflection Experiment that started in 2001.

An extended programme LAPBIAT (Lapland Atmosphere-Biosphere Facility) between the research stations in Lapland and coordinated by SGO was started on November 1, 2001 as a part of the Fifth Frame Programme of EU under the title "International Access to the Major Research Infrastructures". The Space Institute of Oulu, University of Oulu was decided to be moved under the SGO administration from January 1, 2002 and the new name of the institute will be the Space Institute at the University of Oulu.

Publications:

Refereed journals: 37 (Published: 21, In press: 16) ; Other publications: 25

Memberships: 8

Visits:

Foreign visitors: 35 SGO staff: International meetings and visits: 60

## INSTITUTE OF PHYSICAL SCIENCES

(Reporter: Kari Kaila)

### 1. Ionospheric and Magnetospheric physics

Discrete auroral forms were investigated using photometers, auroral TV-cameras and the EISCAT radar, and the characteristics of precipitating electrons were determined from these multi-instrument data. Rotational temperature at the auroral heights have been derived from the data of coordinated optical and radar measurement campaigns. Heating induced auroral emission has been first time recorded by TV-camera and photometer, not only in oxygen red (630.0 nm) and green (557.7 nm) emissions but also in N<sub>2</sub><sup>+</sup> emission.. Daytime auroral measurements have been analyzed from the data of Chinese Antarctic station Zhong Shan. The prominent red emission has sometimes emission of several kR.

EISCAT measurements of new type have been carried out with a portable receiver system which was connected parallel to the standard receiver. After downconversion to a suitable frequency band, the signal was sampled and stored to hard disks for later processing. Hence all frequency channels are present in the same data stream. The procedure contains several benefits. The data stream contains the transmitted wave forms, which allows the use of true ambiguity functions instead of theoretical ones. Since the correlation time of ground clutter is much longer than that of incoherent scatter, the clutter can be removed from the data, in practice without loss of statistical accuracy. Any integration time can be used and the data can be cleaned of disturbances like satellite echoes. Storing data samples instead of autocorrelation function estimates also allows constructing experiments and creating analysis methods which would not be possible in a standard receiver. Such experiments have been designed, and analysis methods involving stochastic inversion have been developed. The analysis also contains decoding of Barker coded signals by means of Fourier transforms. This method completely removes the sidebands, which are present in standard Barker decoding.

Properties of the structured and unstructured Pc1 pulsations observed at Nurmijärvi and Sodankylä were analysed during 18 magnetic storms. While unstructured pulsations are only weakly affected, structured pulsations were found to nearly vanish on ground despite strong wave activity in space. The observed latitudinal similarity of structured Pc1's and the daily evolution of their frequency was found to be against the expanding plasmopause model. Instead, the observations could be explained in terms of the ionospheric resonator and propagation conditions which are deteriorated during the storm main and early recovery phases. Storms were divided into two intensity groups according to the Dst minimum. The great depletion of structured Pc1s on ground during the storm main and early recovery phases was found to be even more dramatic for intense storms.

Electromagnetic ion cyclotron (EMIC) waves were observed by the electric field instrument on Polar satellite when simultaneous Pc1 pulsations were detected at Sodankylä within  $\pm 1.5$  MLT hours. In 70% of 44 satellite passes, EMIC waves matching with ground Pc1's were observed, showing that Pc1's indeed originate at high altitudes in the magnetosphere and have their source field line within a rather limited MLT range. This also limits horizontal ducting of waves and gives a lower limit on the MLT extent of a typical EMIC wave band in space. On April 25, 1997, Polar was in a conjunction with Sodankylä and observed two EMIC wave bands matching with

ground Pc1's. The lower band consisted of repetitive bursts which were observed on ground as a Pc1 pearl band. The equal repetition periods and lack of dispersion between the two Polar bands, as well as the observed wave velocity were found to be in conflict with the bouncing wave packet model. Instead, ample evidence was found for the ULF modulation of Pc1 pearls. EMIC waves were accompanied by long-period ULF waves and plasma density variations which had a period close to the repetition period of the simultaneous EMIC bursts.

## 2. Heliospheric physics

MUG (Muon UnderGround) multi-level muon experiment was installed in Pyhäsalmi mine to study cosmic rays in the knee energy region. The experiment consists of muon counters at three levels (0, 90 and 210 m underground) combined into a network with common precise timing and data recording system. Oulu cosmic ray station (neutron monitor) was maintained in routine operation. An on-line database of cosmic ray intensities since 1964 was started (<http://cosmicrays.oulu.fi>). A numerical model of heliospheric transport of cosmic rays was developed using stochastic simulation and was applied to study the long-term behaviour of heliospheric modulation of cosmic rays. It was shown that a 22-year cyclicity dominated cosmic ray modulation during the Maunder minimum.

The long-term properties of solar wind and geomagnetic activity were studied. It was found that the annual variation in geomagnetic activity was strong during the high-activity solar cycles in mid-19th century and since 1930's. This annual variation results from a north-south asymmetry in SW speed distribution across the heliographic equator. Accordingly, the result implies that the Sun is persistently north-south asymmetric. Interestingly, the north-south asymmetry was found to be opposite in mid-19th century from the present suggesting for a new form of century-scale oscillation in the north-south asymmetry of the Sun. The asymmetry was explained in terms of a relic magnetic field, dislocated slightly in the north-south direction from the heliographic equator. Hence the change in the asymmetry would result from the century-scale north-south oscillation of the location of the relic field across the ecliptic.

## 3. Solar physics

A persistent 22-year cyclicity with stable phase and amplitude was found in the 400-year long sunspot record and was interpreted to be due to a weak constant relic magnetic field in the Sun. It was argued that one full solar cycle was lost in late 18th century because of sparse and non-reliable observations. Including the missing cycle would result in a consistent view on sunspot activity evolution around the Dalton minimum. A model was developed to simulate the production of sunspots, including the dynamo magnetic field, a weak constant relic field and a random (fluctuating) field. It was found that the model reproduces main features of sunspot activity during both high solar activity and great minima, only changing the intensity of the dynamo field. It was also shown that the dynamo had to operate at a very low but non-zero level during the Maunder minimum.

## **IAGA - SPACE PHYSICS AT THE UNIVERSITY OF HELSINKI**

(Reporter Hannu Koskinen)

The organisation of physical sciences at the University of Helsinki changed on August 1, 2001 when Departments of Physics, Meteorology and Geophysics formed a new Department of Physical Sciences. Independently of this space research was strongly boosted by strong success in the space research programme ANTARES of the Academy of Finland and the National Technology Agency, Tekes, which began in the first half of 2001. As space research is now conducted at Divisions of Atmospheric Sciences, High-Energy Physics, Theoretical Physics, and X-ray Physics, a co-ordinating structure, called Space Research Unit was established and Prof. Hannu Koskinen was nominated as its Director. The personnel and resources are distributed to respective Divisions, according to their expertise.

Also the space physics group was strengthened. At the end of 2001 the group consisted of Prof. Hannu Koskinen, one post-doc (on leave until August 2002), and 9 active graduate students, 3 at the University and 6 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 in 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 2001 were concentrated in the studies of coronal mass ejections and their efficiency in driving magnetospheric storms and in magnetospheric dynamics and in theoretical studies of magnetospheric magnetohydrodynamic simulations.

One of the nation-wide consortia in the ANTARES programme is called Space Weather in the Antares Programme (SWAP). It consists of research groups from the Universities of Helsinki (co-ordination), Turku, Oulu, and the FMI. The consortium started active work immediately and the first scientific results were submitted for publication already in 2001. Space weather was also otherwise on the agenda in 2001. The second ESA space weather study of the FMI-HU team was completed in December under the leadership of the Rutherford Appleton Laboratory (UK).

The project of the International Space Science Institute (ISSI) in Bern to write a reference book on Auroral Plasma Physics continued. The effort has involved more than 30 scientists worldwide, including three from Finland, and has taken more time than planned. Hannu Koskinen is one of the core group members now responsible for the final editing of the book. It is expected to be published in 2002.

Hannu Koskinen's most significant international posts in 2001

SCOSTEP Adherent Representative

Member of the S-RAMP Steering Committee

Member of the Rosetta Lander Steering Committee

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

Chairman of the COSPAR National Committee

- Representative of Finland in COSPAR

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

(Reporter Lauri Pesonen)

The Solid Earth Geophysics Group at the Department of Geophysics 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 and polarity reversals of the Earth's magnetic field in the past using 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 2001 the major activities were:**

In 2001, the recently established *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. These took place in the same time (August 2001) when Geophysics Department was merged to be a subdivision of the new Institute of Physical Sciences. The "solid earth geophysics laboratory", with new palaeomagnetic and petrophysical instrumentations, were build in 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 at five international projects in 2001. 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-Impactand in the GISP-projects. Lauri Pesonen acted as a planning member in the EGS-rock- and paleomagnetic programmes.

In the IGCP-440 project, the group, in collaboration with the GSF people, tested some of the

proposed Precambrian supercontinent assemblies on the basis of global paleomagnetic databases. 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 geophysical 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 2001. 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.

### **The highlights of the research achievements in 2001.**

1. The tenth impact structure were discovered in central-east Finland (the Suvasvesi South structure). This remarkable discovery is based on shatter cone discoveries on the shore of the lake Suvasvesi South. The result was published.
2. The group, in collaboration with other groups, made new global continental reconstructions concerning Precambrian times, including the Rodinia Supercontinent. These new results were published in the EGS Annual Meeting in Nice and in the Chris Powell Memorial Symposium in Perth, Australia.
3. The Solid Earth Research Group has been selected to be members in two new international ICDP-projects. In the first, the group will measure the physical properties of the drill cores obtained soon from the Chixculub impact structure (Mexico). In the other project, the group will investigate the subsurface structure of the Bosumtwi impact structure in Ghana.
4. The impact diamonds of the huge Popigai impact structure turned out to be magnetic although weakly so. This result opens a new possibility to study the origin of the Popigai impact diamonds and the impurities involved.
5. The group succeeded to classify several meteorites including Antarctic samples using magnetic susceptibility data. This result is a continuation of the application of physical measurements for meteorites. The work was done in co-operation with French and Italian scientists and resulted into a new publication. As a merit of this success, the group was invited for the AGU-Fall Meeting. The result was presented in the 67th METS meeting in Rome.
6. The group succeeded to isolate geomagnetic reversals in the Austrian E/O-sedimentary strata, which are helpful in searching the Popigai impact ejecta layer in Central Europe. The result was published.

(Reporters Lauri Eskola and Satu Mertanen)

Aerogeophysical surveys were performed in Finland, Estonia, Sweden and Spain in all 128 000 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 printed as well as magnetic and gravity anomaly maps of the Fennoscandian Shield 1:2,000,000, together with Swedish and Norwegian geological surveys and the Northwest Department of Natural Resources of Russia and its subsidiaries:

The laboratory of Paleomagnetism participated in international projects, such as EUROPROBE/SVEKALAPKO, IGCP and ESF-network on Impact Craters. Investigations of reconstructions of Baltica with other continents were continued. Palaeomagnetic method was applied to geological studies on dating shear zones and on studying tectonic movements within Baltica. Updating of the the Fennoscandian palaeomagnetic database was continued. J. Plado and L.J. Pesonen edited a multiauthor book "Impacts in Precambrian Shields", a compilation of fourteen papers that result from activities within the scientific programme "Response of the Earth System to Impact Processes" (IMPACT) of the European Science Foundation.

6 publications.

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

(Reporter: Pertti Seuna)

### 1. Activities

#### 1.1 FINNISH ENVIRONMENT INSTITUTE (FEI)

The national hydrometric monitoring programme 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. Bathymetric mapping of lakes covered an area of 175 km<sup>2</sup> in 2001. Thus some 75 % of the total lake area, or 22000 km<sup>2</sup> have been mapped until now. A two-year pilot phase for the planning of the national river register was completed. The new, web based national hydrological database was used operationally for the second year, and it was further developed. The database contains some 25 million observations from 2500 stations and basic information from more than 50 000 lakes. Analyses on areal precipitation and surface water temperature were continued. Hydrological data service was developed, e.g. by introducing a new monthly report in the internet.

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 data base POVET was under final phase of the development, and it will collect most of the governmental groundwater information into one data base. In small hydrological basins discharge with measuring weirs, precipitation, snow water equivalent and soil frost were measured, and in 15 of them water quality was analysed. The catchments were partly included in the international FRIEND- and ERB-Projects. The beneficial participations to these projects, however, suffered from financial changes and need a reconsideration for the future. The international evaluation of the small basins monitoring and research was published in 2001. It stated the high value of this tool, and made some recommendations. The increase of intensified and interdisciplinary investigations, including resourcing, was proposed, while a slight reduction in the catchment number was regarded sensible. The evaluation report and the national recommendations elaborated on its basis were agreed with in the feedback. The first step of the recommendations, i.e. the reduction of the basins was done in the end of 2001 by 9 basins. A national evaluation of long-term groundwater stations was carried out in 2001. The compatibility of the groundwater networks of FEI and the Finnish Geological Survey was proposed and promoted.

Hydrological data were submitted for the Baltex (Baltic Sea Experiment) and FRIEND according to the existing agreements and participation to the planned joint research project (BALNET) was proposed. Plans were made for a comprehensive Climate- Water- Energy project 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. Hydrological forecasting system covered 90 % of the country, including all important rivers. The HBV based model was used mainly for flood forecasting, but also for real-time reporting of the watercourse status, for climate change investigations and for complementing field measurements, such as snowpack data. Information from remote sensing was incorporated into hydrological modelling. The regional existence of snow, based on satellite images was combined to the hydrological models in operative and near real time basis. Satellite AVHRR pictures were used for surface water temperature estimations as well. Both these studies are still in progress.

The 13th Northern Research Basins Symposium was organized in North Finland. The main themes were the impacts of climate change in high latitudes. Especially floods and snow cover were discussed, but also other subjects, such as ice conditions, wetland hydrology and water quality aspect were included.

The re-organization of FEI was made in the end of 2001 to be started in the beginning of 2002. Recommendations given in the report of the international evaluation in 1998 served as the basis.

A comprehensive environmental dictionary EnDic2000 was published as the Finnish-Estonian co-operation. The dictionary contains some 4600 terms in 7 languages: Finnish, Estonian, English, Swedish, German, Russian and Latvian.

Comprehensive co-operation was carried out 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. The co-operation agreement was renewed in 2001. Water balance calculations for the Finnish river basins were

published in 2001. In this context the roles of various land-types and vegetation for evapotranspiration were studied, in particular. A model for precipitation corrections was carried to the final stage of testing and calibration.

## 1.2 UNIVERSITY OF HELSINKI, DEPARTMENT OF GEOPHYSICS

The general theme of the Department of Geophysics 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.

Snow stratigraphy was analysed in Antarctica in Dronning Maud Land during the austral summer of 2000 2001 as a part of Finnish Antarctic Research Programme. The aim of the study is to document spatial and temporal variations in seasonal snow cover properties.

## 1.3 HELSINKI UNIVERSITY OF TECHNOLOGY

The Water Resources Laboratory at the Helsinki University of Technology provided undergraduate and graduate level education in hydrology, water resources management, and hydraulic engineering. In 2001 the laboratory has given special courses dealing with global water problems and influence of climate change on hydrological variables. Current research topics at the laboratory include environmental river engineering, modelling and monitoring of catchment hydrological processes, global change and water resources, contaminant transport, and water and nitrogen cycles in agricultural areas. In 2001 experimental fields for monitoring urban runoff quantity and quality have been set up. More information about the laboratory is available in the Internet (<http://www.water.hut.fi>).

## 1.4 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. The topics included applied hydrology, hydraulics, 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, water pollution control of peat production fields and problems of water supply and sewerage engineering in the northern areas. A profound investigation on peat production effects and mitigation possibilities was published in 2001. In sod peat production peak runoffs were lower than from milled peat production. In milled peat production the phosphorus contents and solids peaks were higher, as well. To reduce runoff peaks and material leaching, a new kind retention structure of wood chips was studied. In field tests this method has proved to be promising. For agricultural applications subsurface drainage method with rock fibre boards as vertical conductors has been studied. Also this method seems successful preserving a good water conductivity in the soil. In addition, the transportation and retention of contaminants in soil and the protection and restoration technics of

groundwater were examined.

## 1.5 FINNISH GEODETIC INSTITUTE (FGI)

The co-operation on the use of remote sensing methods in snow surveys was continued with the Finnish Environment Institute. The research mainly aimed at the improvement of snowpack estimation needed for flood forecasting. Bidirectional reflectance distribution properties of snow have been used. The goniometer for the measurements was developed in the FGI. The method is in the operational use in FEI, and is still further developed in FEI. In GIS a digital elevation model for the estimation of accuracy and uncertainty of watershed divide determinations derived from topographic maps has been developed. It also gives information for slope and contour line estimations.

## 2 Publications, memberships in international bodies, visits

- a) The number of internationally pre-reviewed publications was 11 and that of the others about 50.
- b) The number of international memberships was 23.
- c) The number of visits abroad was some 50 and the number of visits to Finland was about 65.

## **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 (until 31.7.2001, DEPARTMENT OF METEOROLOGY)

During 2001, research in the (former) Department of Meteorology was made in three areas: climate studies, numerical modelling, and radar meteorology.

Studies on climate concentrated on weather conditions during the cold spring of the famine year 1867, and on the critical layer reflectivity of single-mountain effects on an aquaplanet as a combined GCM - linear model

study.

In numerical modelling, various parameterization methods, especially for radiation, were developed and tested. Cloud drop growth and drizzle/rain formation were also studied in view of parameterizations for NWP. The UH mesoscale model was applied in various case studies (e.g. for coastal winds and in stable boundary layers). A study of urban heat island circulation was

finalized. A road weather model was constructed based on the UH model algorithms. Mars modelling continued with 1D and 2D models, 3D being developed from HIRLAM. An international intercomparison of Mars GCM radiation schemes was initiated.

In radar meteorology, mesometeorology and cloud physics, applications to environmental issues were studied.

## 1.2 FINNISH METEOROLOGICAL INSTITUTE (FMI)

In 2001, 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. 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. 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.

During the year the role of the Sodankylä Observatory was strengthened as and Arctic Research Centre. The emphasis of the Centre is on arctic research and it is a platform also for international research groups both due to its northern position as well due to the research community offered in the Centre.

Also 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 international expeditions to the Antarctic.

Emissions, occurrence and behaviour of volatile organic compounds in the atmosphere have been extensively studied in connection with two PD dissertations.

## 2. PUBLICATIONS

There were 70 refereed publications, and 256 other scientific publications published in 2001.

## 3. MEMBERSHIP IN INTERNATIONAL SCIENTIFIC BODIES

There were 139 memberships in international scientific bodies in meteorology.

# **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.

In the studies of sea ice, studies funded partly by CEC, partly by the Institute and national funding agencies have focused on several aspects. The CEC shared-cost R&D IWICOS project (Integrated Weather, Sea Ice and Ocean Service System) aims at developing digital one-entry system and information products for the users at sea. Other studies concerned the Global Change

and its effects to the Baltic Sea ice cover, and a third one on comparison of Arctic and Baltic ice cover variability and changes in recent decades. Analysis of remote sensed data, in particular SAR images has as an objective to develop new statistical methods to classify sea ice radar images.

A special process and modelling study of the BALTEX/GEWEX program was finalized. The project was EC funded study and coordinated by FIMR. In this study special attention was given to coupling of the ocean- and sea ice models with the high resolution atmospheric models (HIRLAM, REMO).

Air-sea interaction and boundary layer over the sea ice and the open sea in the Baltic Sea and the Arctic Ocean were studied in several projects. In February R/V Aranda expedition was organised to the Bothnian Bay, and in October to the Gulf of Finland. Data analyses and modelling studies were mostly related to the field measurements gathered under two recently finished EC projects (BALTEX-BASIS and ARTIST). The data-analyses addressed (1) the large-scale roughness parameters of a broken sea ice cover, (2) the R/V Aranda weather station data from the period 1991-1999, and (3) verification of HIRLAM over the Baltic Sea. The modelling studies dealt with (1) interaction of sea ice thermodynamics and warm-air advection and (2) boundary-layer over the Arctic sea ice. A study on the Weddell Sea heat budget was also finalized.

Global Change related sea level, sea ice and marine weather studies were carried out under the Finnish Global Change Program FIGARE and in two EC funded programs. In one of those, the climatic sea ice conditions in the Baltic Sea and in the Arctic were compared. The concepts of NAO and AO (Northern Atlantic Oscillation, Arctic Oscillation) were used as a tool. FIMR participated actively the Finnish National IPCC group and the review process of the Third Assessment of IPCC. Studies of trends in sea level variations in the Baltic Sea continued, partly within FINSKEN project.

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 Centre d'Etudes des Environnements Terrestre et Planetaire. Studies on the source terms of the WAM wave model begun in co-operation with Alcyon by (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 operational for the first year FIMR participates in a working group preparing a book about directional wave measuring instruments and analysing techniques in COST 714 action.

Within BALTEX/DIAMIX project the data from the previous field experiments was analysed. The data consists of hundreds of CTD-profiles and several time series of current measurements in sea area east of Gotland. The aim of the studies is diapycnal mixing in the sea. Other activities focused on EU-funded project HYMNE, which develops monitoring methods for the hydrographic conditions of the Neva bight. In the same time the external effects of the river Neva discharge to the Gulf of Finland is studied. This project had two cruises to the Gulf of Finland in 2001. The data obtained e.g. in these projects is used in three-dimensional hydrodynamic modelling of the physical environment of the Baltic Sea.

Although the EU programme VEINS (Variability of Exchanges in the Northern Seas) now is ended much of the work has been continued in the same vein. The current meter array south of

Denmark Strait, deployed in collaboration with IfM Hamburg and CEFAS Lowestoft, has been maintained and the yearly survey has been continued, this year with RV Meteor. A larger international study of the meridional ocean circulation – ASOF (Arctic – Subarctic Ocean Flux array) – is presently being planned. FIMR has participated in the planning work for that programme as well as in the planning for the international Arctic Ocean ‘02 expedition with IB Oden to Fram Strait and the East Greenland Current. In addition to studies of the water masses contributing to the Denmark Strait overflow, work on the circulation of the upper layers of the Arctic Ocean has also been done. Results and review talks have been given at several meetings: ICES symposium: Hydrological variability in the ICES area 1990 – 1999, Edinburgh, ICES Annual Science Conference, Oslo and Symposium on progress in Arctic Ocean research over the past decades, Stockholm.

### **University of Helsinki, Department of Geophysics.**

The general theme is geophysics of sea ice. Theoretical research on sea ice dynamics as been ongoing. Coastal ice structure and properties has been examined in the Gulf of Finland; a particular field station in Santala Bay has been active through the whole winter,

Recent satellite and submarine observations have revealed a considerably variability both in the sea-ice thickness and extent of the Arctic Ocean. A multi-class sea-ice model (HIM) has been used for an idealized numerical experiments in order to determine separately contributions of the thermodynamical and dynamical effects on the sea-ice mass balance. The HIM model distinguishes between undeformed and deformed ice, and within these categories, between lead and level ice, and rafted and ridged ice, respectively. A 100 years integration where only the surface air temperature was increased revealed many interesting features of the characteristics of the ice pack. While the imposed climate change constitutes a linear warming trend, the response in terms of Arctic ice-volume decrease is non-linear. The strong relationship between sea-ice mass and momentum causes internal variability in the sea-ice thickness fields. In particular, beyond a certain degree of warming, increased mobility of the ice due to a thinning of the ice pack enhances the fraction of deformed ice. This leads to a short-term increase in total ice mass. The explicit consideration of ridged ice is crucial for this behaviour to emerge.

The HIM model has been embedded to the C-HOPE ocean general circulation model developed in the Max-Planck Institute of Meteorology. That model is global one, however it employs a curvilinear grid configuration which allows a high resolution modelling on the coastal regions Arctic, which are known to be vital regions for a sea-ice production. Modelling work has been done in collaboration with Dr. Johann Junglaus (MPI/Hamburg, Germany) and prof. Achim Stössel (Texas A&T University, USA).

## **2. PUBLICATIONS**

- refereed: 13

- other scientific publications: 30

## **3. MEMBERSHIPS IN INTERNATIONAL ORGANISATIONS: 18**

## **4. RESEARCH VISITS**

- Finnish: 4

- foreign: 3

## **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 continued petrological and geochemical studies on the komatiitic (ultramafic) lavas of the Paleoproterozoic Central Lapland volcanite belt. Petrogenesis and metallogeny of the 2450 Ma layered mafic intrusions and associated granitic rocks of Koillismaa and Central Lapland have been studied utilizing geochemical and isotopic methods. The research has been made partly in collaboration with the universities of Oulu and Helsinki. The origin and evolution of the serpentines and associated rocks of the Outokumpu area have been studied together with Outokumpu Mining Oy. Mineralogical, isotopic and thermobarometric studies of the 500 Ma diamond-bearing kimberlites of the Kaavi and Kuopio areas have produced valuable information on the composition, age and structure of the lithospheric mantle down to 240 km.

### **UNIVERSITY OF HELSINKI**

Department of Geology, University of Helsinki, has studied the Jurassic continental flood basalts of Dronning Maud Land, Antarctica, since 1989. In 2001, the field work in Antarctica included sampling of mafic plutons and laterally extensive lava flows to decipher processes in high-level magma chambers and hydrothermal alteration in lava flows. Research of previously collected samples focused on geochemistry and isotope geology of the hypabyssal equivalents of basalts and late-stage lamproite dykes with emphasis in the asthenospheric and lithospheric mantle sources of the mafic magmas. Age determinations (Ar-Ar, U-Pb methods) of the basalt-lamproite association was carried out at Ohio State University and Geological Survey of Finland. Collaborative studies with British Antarctic Survey extended geochemical research on dolerites and basalts of Coats Land. \_ The studies on continental rift-related granitic-basaltic magmatism have been continued in Finland, New Mexico, Namibia, and Brazil.

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

The Geology Departments of these universities continued petrological, geochemical and isotopic studies on postorogenic 1800 Ma granites of southern Finland and their relation to mantle evolution. Origin of the anorthosite-rapakivi granite association of Åland was another research topic. The origin and tectonomagmatic setting of the metamorphosed volcanites of the classic

Orijärvi area were studied by petrographic, geochemical and isotopic methods.

## **UNIVERSITY OF OULU**

The Department of Geology has participated research on the magmatic evolution of the Koillismaa layered complex. The magmatic and hydrothermal evolution of the alkaline rocks and carbonatites of the Kola province was studied in collaboration with Russian colleagues.

## **IAVCEI PUBLICATIONS**

Refereed articles: 7

Other publications: 5