



**IAGA, the International Association of Geomagnetism and Aeronomy**, is the premier international scientific association promoting the study of terrestrial and planetary magnetism and space physics

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## IAGA ON THE WEB

Information on IAGA is regularly updated at the IAGA website: <http://www.iugg.org/IAGA/>

## Foreword



This issue of *IAGA News*, the second one distributed electronically, is mainly devoted to the preparations for the X<sup>th</sup> IAGA Scientific Assembly to be held in Toulouse in July 2005, and to matters dealt with at the IAGA Executive Committee meeting in Paris on 24-25 July 2004, and at planning meetings held in connection with it.

*IAGA News* has in the past contained short articles, reports and announcements from IAGA scientists. We hope this tradition will continue and invite contributions (to be sent to the Secretary General).

*IGA News* is distributed to IAGA National Correspondents and other national representatives we know of, to all IAGA officers, to IAGA scientists who have attended recent IAGA assemblies, and to various research organisations in countries around the world. Nevertheless, we will undoubtedly fail to reach many scientists interested in IAGA activities, and it would be very much appreciated if you, the reader, would forward *IGA News* to persons who may not be on our distribution list. If you are uncertain, it is better that they receive several copies of *IGA News* than none. National policy makers and leaders, whose decisions affect IAGA activities, need to be informed about IAGA, so, please, forward *IGA News* to such persons in your country. (*IGA News*, from Issue 40 onwards is available for download from the IAGA website.)

**Bengt Hultqvist**  
Secretary General

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## Message from the IAGA President



IAGA is making greater use of task groups to undertake specific functions for IAGA. The one that may have the greatest impact on us as an organisation, under the chairmanship of Prof Kathy Whaler (Edinburgh University, UK), is considering the future of IAGA. Like most scientific

organisations, we operate in a world of rapidly changing technology (usually the easiest and most fun challenge to deal with), demographics (aging populations and scientists), more stringent expectations from the governments that fund our science, and competition from other organisations seeking patronage from scientists. Maintenance of past science priorities and structures may not necessarily provide the best basis for ensuring the relevance and effectiveness of IAGA in the future. A closely related "Young Scientists Committee" under the chairmanship of Dr Richard Holme, with Prof Jan Lastovicka as the Executive Committee contact, is addressing similar issues from the perspective of young scientists. This follows the lead of IUGG, which established a committee of young scientists drawn from the seven Associations to report on future geoscience directions. The IUGG committee's report is available at:

<http://www.iugg.org/geosciences.pdf> (6.8Mb).

Our task groups will report at the Toulouse Scientific Assembly in Toulouse next July.

This first year of my term as President has been both rewarding and enjoyable due to the excellent support of the Executive, Divisional and IDC officers, and the many

others who have given of their valuable time to support IAGA business. The greatest load has fallen to our hard working Secretary General, Bengt Hultqvist to whom I owe particular thanks.

**Charles Barton**  
President, IAGA

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## Preparations for the X<sup>th</sup> IAGA Scientific Assembly

### Time and Place

IAGA's X<sup>th</sup> Scientific Assembly will be held in Toulouse, France at the Centre De Congrès Pierre Baudis, 11 esplanade Compans-Caffarelli, from Monday 18 July to Friday 29 July 2005.

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### Local Organizing Committee

IAGA has been invited to Toulouse by the French National Body of IAGA, "Comité National Français de Géodésie et de Géophysique" (CNFGG), which has formed a Local Organizing Committee consisting of the following French scientists: Michel Blanc, Chairman; Roland Schlich, Executive Secretary, CNFGG Treasurer; Michel Menvielle, CNFGG President; Jean-Pierre Barriot, CNFGG General Secretary; Miora Manda and Jérôme Dymont, Relations with IAGA; Pascal Tarits, Public Outreach.

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### The International Commission on the Middle Atmosphere

The International Commission on the Middle Atmosphere ([ICMA](#)) of the International Association of Meteorology and Atmospheric Physics (IAMAS) will hold its biennial Assembly in conjunction with the IAGA Scientific Assembly.

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### Scientific Programme

The joint programme of IAGA and ICMA contains 61 symposia covering all the scientific fields of the two organisations. Descriptions of the symposia, and the time schedule for the two weeks of the Assembly are included in the Appendix. This, and other information on the Assembly and the venue, can be found via the following page at the IAGA website:

<http://www.iugg.org/IAGA/toulouse2005.htm>

Four Association Lectures will be presented during the Assembly: on Tuesday and Thursday of the first week and on Monday and Wednesday of the second week.

They will deal with subjects of interest to all IAGA scientists and also to (parts of) the general public:

- A New Era for Geomagnetism, Jean-Louis Le Mouél
- IGY+50 and the eGY, Daniel Baker
- The Earth's Magnetic Field and Life, David Loper
- Climate and Weather of the Sun-Earth System, Sunanda Basu.

Further details concerning the scientific programme, abstract submission, registration, grants, exhibition, hotels, visa, scientific and tourist attractions etc. will be contained in the printed third circular for the Assembly, which will be distributed widely before the end of 2004.

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## Other Meetings During the Assembly

The highest level of IAGA leadership, the Conference of Delegates of the IAGA Member Countries (CoD), and all bodies within IAGA, as well as ICMA, will hold their business meetings during the Assembly. For the divisions, inter-divisional commissions, and the working groups, one of the most important agenda points will be planning the scientific programme for the next IUGG General Assembly in Perugia in 2007. All business meetings will be held after the end of the oral scientific sessions (1700). The timetable for the business meetings, and other meetings outside of the scientific programme, on the days of the Assembly will be as follows:

### **Monday July 18**

Opening of the Assembly 1530-1700  
Open Reception 1700-1900  
IAGA Executive Committee (EC) Meeting 1 1800-2000

### **Tuesday July 19**

CoD Meeting 1 1730-1930  
ICMA

### **Wednesday July 20**

WGI-1, WGI-3  
WGII-A, WGII-B, WGII-D, WGII-G  
WGV-OBS, WGV-MOD

### **Thursday July 21**

WGI-2, WGI-4  
WGII-C, WGII-E, WGII-F  
VERSIM, WGV-DAT, ICMA

### **Friday July 22**

eGY (electronic Geophysical Year)

### **Monday July 25**

Business meetings of all IAGA divisions and inter-divisional commissions

### **Tuesday July 26**

EC Meeting 2 1730-1900

### **Wednesday July 27**

CoD Meeting 2 1730-1900

### **Thursday July 28**

No official meetings

### **Friday July 29**

EC Meeting 3 1330-1800

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## Report from the Executive Committee Meeting, July 2004

### Deceased IAGA Scientists

The President announced that the following IAGA scientists had died since the Sapporo Assembly in 2003 (in alphabetical order): Jim Carrigan (UK, Dec'03), Jim Dooley (AU, May '04), Elisabeth Essex (AU, Apr '04), William Hess (USA, '04), Rosemary Hutton (UK, Apr. '04), John A. (Jack) Jacobs (UK, Dec. '03), Virginia Lincoln (USA, Aug. '03), Mikhail Pudovkin (Russia, Feb '04), D.R.K. Rao (India, Feb. '04), Lanny Wilson (USA, Nov. '03). For those who had been IAGA officers or had otherwise played important roles for IAGA, short obituaries will appear in *IAGA News*.

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### Procedures of IAGA

It was decided to include all procedural information related to IAGA activities, including the Statutes and By-laws, in the "IAGA Officers' Manual", presently being prepared by Ibrahim Eltayeb. The manual will be renamed "Procedures of IAGA".

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### Temporary Head of the Commission on History

Gurbax Lakhina agreed to act as head of the Commission on History until an election for the position could be held during the Assembly in Toulouse in 2005.

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### IAGA Flyer in Other Languages

Preparatory work is underway for French, Spanish, and Russian editions. The possibilities of Chinese (Mandarin) and Portuguese versions are being investigated.

## IGA Guides

An IGA Guide on "Geomagnetic Indices" is due to be completed in 2005, before the Scientific Assembly in Toulouse. Several other guides are in an early preparatory phase. The Guide on "Noctilucent Clouds" is out of print. It will be put on the IGA website (not reprinted), as will most new IGA guides.

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## IGA Finances

The economic situation of IGA is presently good because only a small fraction of the amount allocated by IGA to IUGG 2003 in Sapporo, mainly for grants to needy IGA scientists (USD 65 000), was used. The reason was that the generous funding supplied by the Japanese hosts covered almost all grants for those applicants who were able to travel to Sapporo. Despite this, IGA will not be in a position to maintain this level of funding for grants to needy IGA participants in the future. To be able to continue the support of participants from developing countries at assemblies in the long term, IGA needs to use all possibilities to increase its income.

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## Gifts of Scientific Books and Journals

IGA is starting a programme to provide gifts of scientific books and journals, unwanted by their owners, to libraries and scientific groups in developing countries. An area of the IGA website will be created to provide information about books and journals available for donation, and about institutions, groups, or individuals who are interested in receiving specific types of books and journals. The objective is to enable donors and potential recipients to make contact with each other; they must then make their own arrangements for transportation. IGA will set aside USD 5000 per year to cover part of the transport costs.

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## Award to IGA Scientists

The Executive Council of the World Meteorological Organisation has conferred the Norbert Gerbier-MUMM International Award for 2005 on Drs G Beig, P Keckhut, R.P Lowe, R.G Roble, M.G Mlynczak, J. Scheer, V.I Fomichev, D Offermann, W.J.R French, M.G Shepherd, A.I Semenov, E.E Remsberg, C.Y She, F.J Lübken, J Bremer, B.R Clemesha, J Stegman, F Sigernes, and S Fadnavis for their paper "Review of Mesospheric Temperature Trends", published in *Reviews of Geophysics* Volume 41, October 2003.

This paper is an output of the IGA-ICMA joint Working Group on long term trends in the mesosphere, thermosphere and ionosphere.

(The purpose of the Norbert Gerbier-MUMM International Award is to reward an original scientific paper on the influence of meteorology in a particular field of the physical, natural or human sciences, or conversely the influence of one of those sciences on meteorology.)

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## eGY and IGY+50

In 2007, fifty years will have passed since the International Geophysical Year (IGY). IGY was the largest and most successful international collaborative research project ever in the geosciences and will be celebrated in several ways by ICSU and its member organisations. "International Years" for many different fields are being prepared to celebrate IGY: the International Heliophysical Year ([IHY](#)), the International Polar Year ([IPY](#)), the International Year of Planet Earth ([IYPE](#)) and the electronic Geophysical Year ([eGY](#)) are examples of the many programmes that are being planned. IGA is a partner in the SCOSTEP programme Climate and Weather of the Sun-Earth System ([CAWSES](#)) that runs until 2008.

The eGY is an initiative of the IUGG, driven by IGA. It aims to exploit the power of modern communications and information management capabilities to accomplish in 21<sup>st</sup> century terms what the IGY achieved through the establishment of a worldwide network of geophysical observatories and World Data Centres – namely open access by the world community to vastly better and more comprehensive information about the Earth and geospace. Additionally, the establishment and coordination of a network of virtual observatories will be a central feature of the eGY.

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## 10<sup>th</sup> Generation International Geomagnetic Reference Field

Calls for candidate models for the 10th Generation IGRF have resulted in four teams making submissions. The models required were, a (non-definitive) main-field model at 2005.0 and a secular-variation model for 2005.0-2010.0. To determine their candidate models, teams made use of data from the Ørsted and CHAMP satellites and from magnetic observatories around the world. Full details of the models are available from the IGA Working Group [V-MOD](#) web page. The final coefficients will be agreed by end of November 2004 and will be available from the same web page. The current IGRF, IGRF9, is valid for 1900.0-2005.0 and is definitive for 1900.0-2000.0. IGRF10 will extend the period of validity to 2010.0. A special issue of the journal "Earth, Planets and Space" is planned and this



will include papers about the IGRF candidate models and their evaluation.

*Contributed by Susan Macmillan and Stefan Maus  
IAGA Working Group V-MOD*

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## Comprehensive Modelling Website

Over the past decade a new approach to modelling the quiet-time, near-Earth magnetic field has been developed jointly between the magnetics groups at the Goddard Space Flight Center (NASA/GSFC) and the Danish Space Research Institute (DSRI).

This approach, known as “comprehensive modelling” (CM) has been developed to address the problem of separating spatial and temporal geomagnetic field variations, and takes into account contributions from the core, crust, ionosphere, magnetosphere, induction, and fields from *in situ* currents at satellite altitude.

We are pleased to announce the availability of the website for Comprehensive Modelling (CM) of the geomagnetic field. This website contains information about CM development, Fortran, Matlab, GMT codes, animations of lithospheric, ionospheric and magnetospheric sources, and much more. It also includes an interactive interface for calculating the geomagnetic field elements from the years 1960 to 2002.

The CM website resides at the web server of the Geodynamics Branch of NASA/GSFC (code921) at:

<http://core2.gsfc.nasa.gov/CM/>.

*Contributed by Katia Nazarova*

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## IAGA and ISO

In 2001 IAGA was invited by the retiring US national representative on the ISO (International Organization for Standardization) TC20/SC14 Working Group WG4, “Space Environment, Natural and Artificial”, to assist in the evaluation of a proposed ISO standard model of the magnetosphere. Discussions were held at business meetings during the IAGA 2001 Assembly and a small “Task Force” of IAGA scientists was set up to participate in the ISO WG4 meetings in Toulouse (October 2001), Noordwijk (May 2002) and Houston (October 2002).

This Task Force also conducted a survey of opinions in the magnetospheric modelling community and reported to the IAGA Executive Committee (EC) at the IUGG General Assembly in July 2003. Prior to this, the Task Force, with support from the EC, expressed concern regarding the magnetospheric “Working Draft” to the authors and to the WG4 secretary. However, the Working Draft was reclassified as a higher level

“Committee Draft” at a WG4 meeting held in Tsukuba in May 2003.

IAGA’s has reservations over the current ISO approach to magnetospheric model standardization. Leading scientists in the field believe that magnetospheric modelling science is still immature, the draft standard is too closely tied to a single magnetospheric model, and a single-model approach has unwelcome consequences. For example, any single magnetospheric model will become obsolete as scientific and technical knowledge in the field advances, the adoption of one particular model may stifle scientific research in magnetospheric modelling, the burden of maintenance of a single model standard is imposed on the model authors, and any single ISO-compliant magnetospheric model that specifically incorporates the IGRF makes the position of the IGRF, with respect to standardization, unclear.

In October 2004 the IAGA President restated the EC concerns in a letter to the secretary of ISO TC20/SC14/WG4. Following the most recent WG4 meeting we await a detailed response. However WG4 has agreed to continue the dialogue with IAGA and suggests that IAGA may wish to convene symposia to discuss space environment standards at future Assemblies. It is noteworthy that WG4 has a wider remit than just the magnetosphere, including: geomagnetic and solar indices, the ionosphere and plasmasphere, and solar irradiance and particle fluence models, all areas of interest to IAGA scientists. The EC and Task Force will, therefore, continue to monitor, and seek to influence, developments.

(See <http://plasma.oma.be/iso/> for more details.)

*Contributed by Alan Thomson  
IAGA Working Group V-DAT*

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## Reports on IAGA-Sponsored Meetings

2<sup>nd</sup> IAGA/ICMA Workshop on Vertical Coupling in the Atmosphere-Ionosphere System, 12-15 July, 2004, Bath, UK

The Second International IAGA/ICMA Workshop on “Vertical Coupling in the Atmosphere/Ionosphere System” was held at the Hilton Hotel in Bath, UK on 12-15 July 2004. The meeting was attended by a total of 65 senior and young scientists from 19 countries. During the 4 days of the workshop the participants presented 60 papers, of which 9 were solicited review papers, 16 other solicited papers, and 35 were contributed oral presentations.

The aim of the workshop was to address the physics behind the forcing mechanisms that originate in the lower atmosphere which play an important role in the upper atmosphere and ionosphere. The meeting was designed so that research experts from both the upper neutral atmosphere and ionosphere communities could come together in order to present their work and assess/debate ongoing issues relating to the theoretical, modelling and observational aspects of all kinds of processes which transfer energy and momentum from the lower atmosphere to the upper atmosphere and ionosphere.

The programme focussed on various aspects and topics of neutral dynamics as well as ionospheric electrodynamics and plasma physics. These included: 1) Gravity wave, tidal and planetary wave coupling in the middle atmosphere and impacts on the mesosphere and lower thermosphere; 2) Planetary wave climatology and nonlinear effects in the propagation of planetary waves in the upper atmosphere; 3) Effects on the dynamical and chemical-compositional structure of the MLT region by vertically propagating atmospheric waves as well as solar effect impositions; 4) The role of thunderstorm-related electrical processes coupling the atmosphere and ionosphere; 5) Coupling of neutral dynamics and electrodynamics in the midlatitude thermosphere-ionosphere system; 6) Lower thermosphere forcing effects in the equatorial ionosphere as well as E and F region electrodynamic coupling over equatorial latitudes; 7) Ionospheric topics on the forcing of the ionosphere by waves from below, mid-latitude E region plasma instabilities and irregularities, and F region links with the lower ionosphere.

The workshop brought together a mix of scientists doing mostly independent research in the fields of the MLT neutral atmosphere and the ionosphere, that is, on two collocated "spheres" of the near-Earth environment which remain closely coupled and in continuous interaction. The meeting provided an excellent opportunity for these research communities to interact in a complementary manner in reviewing and debating the progress achieved to date in the field of the upper atmosphere-ionosphere and to come up with suggestions and ideas for further research on the vertical coupling of the atmosphere-ionosphere system.

Financial contributions to the workshop were made by the following organisations: the International Association of Geomagnetism and Aeronomy (IAGA), the International Commission on the Middle Atmosphere (ICMA), the International Union of Geodesy and Geophysics (IUGG), the International Union of Radio Science (URSI), and the US Airforce European Office for Aerospace and Development (EOARD).

The presentations from the Workshop will be published in a special issue of JASTP. The team of Guest Editors

includes Bela Fejer, Rolando Garcia, Robert Vincent, Jan Lastovicka and Dora Pancheva.

*Contributed by Dr. Dora Pancheva  
Chair of the Programme Committee*

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## Analogue Magnetogram Rescue Project

In 2003 IAGA received an award of \$35,000 from the International Council of Science (ICSU) for the proposal "Rescue of old analogue magnetograms by converting to digital images". The project is now complete, and the outcome is that records for 177 station-years, comprising 64,650 historic magnetograms from nine Russian, two Indian, and one German magnetic observatory, have been converted to digital images. The images are available at:

<http://apollo.wdcb.ru/historic/> and

<http://swdcft49.kugi.kyoto-u.ac.jp/film/>.

The stations chosen were selected from a [Catalogue of Analogue Geomagnetic Data](#) compiled for the time period 1841-1960, and the most rare magnetograms (those existing in one copy only) were digitized first. A team at Kyoto University, Japan developed the magnetogram conversion technique.

The hardware purchased for the project is now available for the staff at the World Data Centres in India, Russia, and Japan for the follow-on conversion of analogue magnetograms into digital images in their routine work, as well as for specific rescue projects.

*Contributed by Vladimir Papitashvili, Principal Investigator*

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## Swarm Magnetic Survey Satellite Mission

On 28<sup>th</sup> May 2004 the Earth Observation Programme Board of the European Space Agency (ESA) approved the mission "Swarm: Earth's Magnetic Field and Environment Explorers" for full implementation and launch in 2009 as the fifth Explorer in ESA's Living Planet Programme.

This mission, a constellation of three satellites, represents a major milestone in geomagnetic field research, and the Swarm mission will, during its 4 years operational phase, complete the International Decade of Geopotential Field Research that was announced in a resolutions adopted by IAGA and IUGG and initiated so successfully with the Danish satellite Ørsted.

The ESA website has the [announcement](#) of the decision on the mission and further details about the [Swarm](#) scientific objectives.

*Based on a communication from the Lead Investigator for the mission proposal, Eigil Friis-Christensen*

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## The International Space Environment Service

The International Space Environment Service (ISES) encourages international monitoring and prediction of the space environment to help users reduce the impact of space weather on activities of human interest.

The prime activities of ISES are carried out by Regional Warning Centres (RWCs), which provide space weather forecasts to the scientific and user communities primarily within their own regions. These services usually consist of forecasts or warnings of disturbances in the solar terrestrial environment. Users of the RWC services include: high frequency (HF) radio communicators; mineral surveyors using geophysical techniques; power line and pipeline authorities; operators of satellites and a host of commercial and scientific users. The increasing sophistication and sensitivity of modern technology has resulted in a steadily expanding range of applications where knowledge of the solar terrestrial environment is important.

ISES prepares the [International Geophysical Calendar](#) each year. This calendar gives a list of "World Days" during which scientists are encouraged to carry out their experiments. The World Warning Agency for Satellites, operated by the World Data Center-A for Rockets and Satellites, NASA/GSFC, issues the [Spacewarn](#) Bulletin every month on behalf of COSPAR. The Bulletin provides a listing of launches and brief details of each launch.

*(This article is based on information published in the [ISES 2003 Annual Report](#). The final 2004 International Geophysical Calendar is available via the link given above. The ISES website is: <http://www.ises-spaceweather.org/>)*

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## Obituaries

John Arthur "Jack" Jacobs (1916-2003)

John Arthur "Jack" Jacobs, who was born on 13 April 1916, died on 13 December 2003 aged 87. He played a foremost part in the development of geophysical science throughout Canada before becoming Professor of Geophysics at the University of Cambridge. He will be remembered most for his encouragement and guidance

of the many scientists who worked with him. He was the most approachable of senior professors in the new field of geophysics, to which he made major contributions over half a century, while in other respects he belonged to another era, taking degrees in both mathematics and classics before turning his hand to war work, hydrodynamics and, eventually, the physics of the Earth.

His distinguished undergraduate career in mathematics and athletics at University College London culminated with the award of an MA degree in 1939. His specialization was higher mathematics and hydrodynamics. On the out-break of war in 1939 he worked for two years with the Bristol Aeroplane Company, then served in the Royal Navy, becoming senior lecturer and deputy training commander in the Royal Naval Engineering College, Devonport, with the rank of Lieutenant Commander RN.

In 1946 he became a lecturer in the Mathematics Department at Royal Holloway College, being awarded a PhD in 1949 for his research in plastic flow. In 1951 he was the first of some half dozen of that department (then directed by W H McCrea) to become professor in various Canadian universities.

Jack replaced Leopold Infield in the Department of Applied Mathematics at Toronto, where he came under the stimulating influence of J Tuzo Wilson and took up geophysics. His early work established a model of the Earth in which the liquid core slowly cools and freezes from the centre outwards, thus forming the solid inner core that had been discovered in the 1930s from observations of seismic waves from large earthquakes. This early idea now forms the basis for all modern theories of the origin of the Earth's magnetism. His 1956 Nature paper was an astonishing foresight - it came two decades before plate tectonics and long before anyone had thought of the Earth losing heat by convection in an adiabatic state.

He became the first Professor of Geophysics at the University of British Columbia in 1957, where he created its Institute of Earth Sciences in 1961. There he developed an interest in external geomagnetism, making numerous refined studies of fluctuations of the geomagnetic field and associated phenomena in the upper atmosphere. Jack always had an interest in the development of astronomy in Canada and he successfully fostered the introduction of astronomy into his institute, which in due course became the Department of Geophysics and Astronomy. By 1967 this was one of the most productive departments of geophysics anywhere in the world. He then moved to Edmonton, where as Killam Memorial Professor of Science in the University of Alberta he created another outstanding Institute of Earth and Planetary Physics. This institute has grown and become internationally renowned for work in all aspects of geophysics.



Jack went to Canada at a time when there was no subject of geophysics as we know it today and left it having established two large departments with the highest international reputations in both research and teaching.

When Sir Edward Bullard retired from the professorship of geophysics in Cambridge in 1974, Jack was an inspired and happy choice for his successor. Bullard had a towering reputation and his department had been at the very centre of the plate tectonic revolution in the early 1970s. Jack was very aware, and somewhat nervous, of the responsibility of maintaining excellence at the level of recent years.

His ability to engage with and encourage colleagues and students, and his enthusiasm for all aspects of the subject, gave the Department of Geodesy and Geophysics just the leadership it needed, and it continued its reputation as one of the best environments in the world in which to do research. His administrative skills were also put to good use in defending the department against closure, and he saw through the amalgamation of his department into the new, larger, Department of Earth Sciences. He played an active role in Darwin, a graduate college, where he was vice Master for 1977-82 and a popular figure with the students.

Jack's contributions to geophysics were impressive in number and in range, including nearly 200 scientific papers and seven books. When he was honoured with the John Adam Fleming medal of the American Geophysical Union, given for original research in geomagnetism and atmospheric electricity, he became one of very few medalists who had contributed to both fields covered by the medal. He was outstandingly successful in bringing on younger workers, many of whom have become distinguished scientists in their own right. This was revealed at the meeting held in his honour for his 80<sup>th</sup> birthday, when nearly 50 scientists came at their own expense to Edinburgh. He was elected into the Royal Society of Canada in 1958, received the Centennial Medal of Canada, and both Price and Gold Medals of the RAS, all of which he carried very lightly, remaining boyish and unassuming throughout his life. He had a gift for establishing happy relations with people of the most diverse interests, and particularly with the young.

He had two daughters by his first marriage to Daisy Sarah Ann Montgomerie, who died in 1974. With his second wife Peggy Jones he became owner of the Old Manor House in Hinxton near Cambridge, where with characteristic style they set about the renovation of this remarkable 15<sup>th</sup>-century building. In 1982 he had married his third wife, the distinguished quaternary geologist Dr Ann Grace Wintle, a marriage that brought him much joy. On retirement in 1983 he moved with her to the University of Wales, Aberystwyth, where she was appointed to its faculty. There he remained as active as

ever, writing papers, publishing a book on reversals of the Earth's magnetic field and updating his earlier books, giving lecture courses that were, as always, prepared with meticulous care, attending tea regularly to discuss science with colleagues, and reading voraciously. He is survived by Prof Wintle, one daughter, and three grandchildren.

This obituary was written by David Gubbins and originally published in *Astronomy and Geophysics*, Vol 45, Issue 5, October 2004. It is reproduced by permission of the Royal Astronomical Society.

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## Virginia Lincoln

We are saddened to report that J. Virginia Lincoln, former NOAA NGDC Division Chief, has passed away. Miss Lincoln, whose pioneering career earned her a place in the Colorado Women's Hall of Fame, died of natural causes on 1 August 2003, at the Frasier Meadows Manor Health Care Center, Boulder, Colorado. She was 87. In 1942, Lincoln joined the National Bureau of Standards in Washington, DC, as a physicist in the Interservice Radio Propagation Laboratory working in ionospheric research. She was appointed chief of Radio Warning Services in 1959, the first woman to head a section in the federal bureau. Also in 1959, she was the only woman in the official US delegation to attend a meeting of the International Geophysical Year in the Soviet Union. Later she was Director of the World Data Center A for Solar Terrestrial Physics and the Solar-Terrestrial Physics Division Chief for NOAA's National Geophysical and Solar Terrestrial Data Center in Boulder, Colorado. Lincoln helped create a statistical method for predicting sunspots that is still used in forecasting solar storms, which can disrupt radio communication on Earth. In 1973, she received the U.S. Department of Commerce Gold Medal for Distinguished Service. She was a Fellow of the American Geophysical Union, the Society of Women Engineers, and the American Association for the Advancement of Science. She was inducted into the Colorado Women's Hall of Fame in 2000. She was also a past chair of the Denver Section of the Society of Women Engineers and was active in encouraging girls to study math and science. Survivors include a nephew, Rush B. Lincoln II, a niece Deborah Lincoln Niekraas, four great nieces and a great nephew.

*Contributed by Helen Coffey*

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## Paul Melchior

On the 15th of September 2004, Baron Paul Melchior passed away. He was 78 years old. Recently, he had hip replacement surgery and died painfully from complications.

Paul Melchior was an exceptional person. He contributed immensely to the development of geophysics not only as an outstanding scientist but also as a great leader. From 1973 to 1991, he served as Secretary General of International Union of Geodesy and Geophysics (IUGG), and was the Honorary Secretary General of IUGG until his death. His tenure lasted so long because he had an extraordinary ability to meet the expectations of his colleagues, and it was difficult to find someone who was willing to follow in his footsteps to manage such a demanding position. One of his successes as Secretary General was the admission of China as member of IUGG, for which he showed all his skill in diplomatic matters.

During his long and fruitful scientific career, Paul Melchior had been Director of the International Center for Earth Tides (1958-1995), President of the Commission of Earth Rotation of the International Astronomical Union (1967-1970), and President of CODATA (1974-1978).

Paul Melchior studied mathematics at the Free University of Brussels. His Doctorate in Mathematical Sciences was earned at the same University in 1951. His professional career started as assistant at the Royal Observatory of Belgium in 1949. He became the Director in 1981 and served in that capacity until his retirement in 1990. Paul Melchior had a profound attachment to the Observatory. His contributions to the development of geophysics and geodesy at the observatory are countless and brought great renown to his grateful Institute. For his dedication for science and his international reputation, in 1993 King Baudouin bestowed upon him the title of Baron. Paul Melchior valued this mark of honour above all. He was very attached to his country and its monarchy.

Paul Melchior began his career as an astronomer. Between 1950-1957, he spent long nights observing at the Askania Great Meridian Circle in Uccle. After compiling the data, he published the most precise star catalogue of that time. Soon, he was interested in the Earth's rotation. He then developed the complete theory of the motions of the Earth's rotational axis and its link to Earth's tides. This became his main subject of research. He began measuring Earth tides in 1957 with the Verbaandert-Melchior quartz tiltmeters. In 1958, he was the first to analyze Earth tide observations using an electronic computer, the famous IBM 650. In 1968, Paul Melchior founded, with Johnny Flick, the Underground Laboratory of Walferdange in Luxembourg. In 1969, with Prof. Manfred Bonatz, they installed tiltmeters, gravimeters and a satellite camera in Spitzbergen

(Norway). Thanks to his growing scientific reputation, the US Navy supported him to set up the first permanent Transit Satellite Doppler recording station in Europe, which operated until 1993. In 1973, his skillful and accurate interpretation of Earth tide gravity observations led the US Air Force to entrust his team to carry out Trans World Tidal Gravity Profiles. A total of 127 stations were observed worldwide for at least 6 months. This exceptional data set was used to assess the precision of the oceanic tidal models derived from Topex-Poseidon a few years ago. Always looking for more precise observations in gravimetry, Paul Melchior succeeded in raising funds to install the first superconducting gravimeter in Europe in Uccle.

Paul Melchior was also a Professor at the Catholic University of Louvain. His lectures were gripping due to his tremendous experience and expertise. He directed several Ph. D. students who considered themselves lucky to have him as an advisor. Being absorbed by his scientific and administrative life, he chose to trust his students instead of directing their theses on a daily basis. His door was open at any time to discuss science and he always gave advice without imposing direction. Paul Melchior succeeded in hiring some of his students at the Royal Observatory of Belgium, and helped and supported the others to get positions in academic institutes. In his last years, he was deeply involved in the development of the European Center for Geodynamics and Seismology (ECGS) in Luxembourg. Paul Melchior, one of the founders of the ECGS, was the most active member of the scientific committee.

Although Paul Melchior was very busy, he found the time to write about 300 scientific papers as well as two books published by Pergamon Press. The first one, published a few decades ago, was devoted to Earth Tides. It is still the only one on the subject. He will be remembered as "the Father of Earth tides," and was bestowed during his lifetime with numerous international honours and distinctions. Notable among these (in addition to the title of Baron awarded by the King of Belgium) are his election to the title of "Fellow" of the American Geophysical Union in 1978; his nomination as honorary Professor of the Institute of Geodesy and Geophysics of the Sinica Academy in China; and his nominations as foreign member to various scientific academies in Finland, the Netherlands, Spain, and Romania.

Paul Melchior had an extremely rich personality. In addition to his scientific career, he was a humanist passionate about history and literature. He also enjoyed national and international politics, which were favourite subjects of discussion. Anyone who had the chance to have dinner with Paul Melchior will never forget an enjoyable time listening to his incredible stories so well told. He is remembered for his taste for good foods, especially Italian cooking.

As a friend, Paul Melchior was trusting and loyal. He enjoyed writing to his friends and his correspondence could easily fill the entire library of the Royal Observatory. Being a stamp collector, one suspected that each time he sent a letter, he was anxious to get a nice stamp on the returning letter.

A man of his calibre could count on a wife of exception. Madame Melchior was literally at the service of the career of her husband. She prepared dinner for so many visiting scientists. She also learned Russian to translate the huge Russian bibliography on Earth Tides for her husband but also for all the readers of the Bulletin d'Informations des Marées Terrestres.

Paul Melchior will be missed not only by his family and friends, but also by his many colleagues, worldwide. His motto was: "In Omnibus Terris Amicus".

*Written by V. Dehant and O. Francis, and originally published in IUGG Electronic Journal Vol. 4, Issue 9b.*

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### Mikhail I. Pudovkin (1933-2004)

Professor Mikhail Ivanovich Pudovkin passed away on February 18, 2004 from a heart attack that occurred in the middle of a discussion of the magnetospheric ring current at a laboratory seminar, where he was one of key speakers.

Mikhail Pudovkin was born on 22 May 1933. After a wartime childhood, he studied at the Leningrad University and graduated in 1954, with a major in geomagnetism. His extraordinary career included a post-graduate research at the Chair of Earth's Physics of the Physics Department of the Leningrad University, wintering as a staff member of the 2<sup>nd</sup> Soviet Antarctic Expedition, and organization of the geomagnetic laboratory in the then newly-created (now well-known) Polar Geophysical Institute near Murmansk. In 1966, he returned back to the Leningrad University where, after having received his doctorate (habilitation) degree in 1968 with a thesis entitled "Morphology and Nature of Polar Magnetic Storms", became a full professor and, for the rest of his life, a head of the new Laboratory of Aeronomy (now Magnetospheric Physics). That was at the dawn of the satellite era, when space physics emerged as an experimental science, and Pudovkin made a very substantial contribution to its growth to maturity. He was a scientist with encyclopaedic knowledge and insatiable quest for unveiling the secrets of Nature, a true pioneer in his work and research.

Areas that benefited from his seminal contributions are extremely diverse: he left his hallmark in many problems of the magnetospheric physics, from the ionospheric wind dynamo versus the interplanetary electric field as the basic drivers of geomagnetic disturbances (1968), to the triggering of substorms by the northward IMF onsets, that he was first to point out in 1970. Among the topics of his continuing interest were the ring current and ionospheric current systems, the magnetospheric

driving of the polar aurora dynamics, magnetic reconnection theory, and its implications for the dynamics of the solar wind streams and their interaction with the magnetosphere. His results (together with A. Chertkov, as early as in 1971) on the relationship of the IMF orientation in the post-flare solar wind streams at the Earth's orbit with the photospheric magnetic field polarity at the site of the flare, should be recognized as one of earliest fundamental contributions to the space weather studies. During the last decade he got deeply interested in the mechanisms of the solar and cosmic ray impact on the Earth's low atmosphere, including effects in the climate, permafrost, seismicity, and others. His and his colleagues' cutting edge research in that field led to interesting and significant results. Pudovkin's style was to work simultaneously on many problems in various fields, and he always generously shared his time, infectious enthusiasm, and innumerable ideas with his colleagues and students.

Equally remarkable was his role as an excellent teacher and the founder of what is now informally and internationally recognized as the St. Petersburg school of space physicists. He was deeply devoted to his teaching activities and put all his efforts into the education of his students until his last day, being always surrounded by young people. Under his guidance, more than 100 students got their master degrees, and 43 got their PhDs. His inspiring lectures, partly included in his 7 published monographs, are difficult to forget for anyone who attended them. His contribution as the editorial board member of the well-recognized international journals *Geomagnetism and Aeronomy*, *Physics of the Earth, Planetary and Space Science*, and as the member of international activities and projects (including the IAGA-related Russian "Sun-Earth" Council) will also be remembered.

For so many of those who knew Professor Pudovkin, St. Petersburg and the University will never be the same without him. We all remember Mikhail Ivanovich with great warmth and affection, and will sorely miss him.

*Contributed by V. Semenov, V. Sergeev, N. Tsyganenko, and A. Usmanov*

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### Notice of Death

#### **Rosemary Hutton**

It is with sadness that we report that Rosemary Hutton, widely known for her work in magnetotellurics, died peacefully on 1 April 2004.

*(A full obituary will appear in the next issue of IAGA News.)*

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## Web Addresses

This issue of *IAGA News* contains hyperlinks to a number of websites. The complete addresses of a selection of these sites are listed here:

The International Commission on the Middle Atmosphere (ICMA):

<http://www.soest.hawaii.edu/%7ekph/ICMA.html>

The International Heliophysical Year (IHY):

<http://ihy.gsfc.nasa.gov/>

The International Polar Year:

<http://www.ipy.org/>

The Electronic Geophysical Year:

<http://www.egy.org/>

Climate and Weather of the Sun-Earth System (CAWSES):

<http://www.bu.edu/cawses/>

IAGA WG V-MOD:

<http://www.ngdc.noaa.gov/IAGA/vmod/>

IAGA WG V-DAT:

<http://www.ngdc.noaa.gov/IAGA/vdat/index.html>

Catalogue of analogue magnetograms used for the magnetogram rescue project:

<http://swdcft49.kugi.kyoto-u.ac.jp/iaga-div-5/1841-1960-Analog.html>

Details on the Swarm mission at the ESA website:

[http://www.esa.int/export/esaLP/ESA3QZJE43D\\_swarm\\_0.html](http://www.esa.int/export/esaLP/ESA3QZJE43D_swarm_0.html)

Spacewarn Bulletins:

<http://nssdc.gsfc.nasa.gov/spacewarn>

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# General Information about IAGA

The International Association of Geomagnetism and Aeronomy is one of the seven Associations of the International Union of Geodesy and Geophysics ([IUGG](#)).

The other IUGG Associations are:

International Association of Geodesy ([IAG](#))

International Association of Hydrological Sciences ([IAHS](#))

International Association of Meteorology and Atmospheric Sciences ([IAMAS](#))

International Association for the Physical Sciences of the Oceans ([IAPSO](#))

International Association of Seismology and Physics of the Earth's Interior ([IASPEI](#))

International Association of Volcanology and Chemistry of the Earth's Interior ([IAVCEI](#))

IAGA supports the following Inter-Association bodies:

Study of the Earth's Deep Interior ([SEDI](#))

Electric and Magnetic Studies of Earthquakes and Volcanoes ([EMSEV](#))

IAGA endorses the activities of [INTERMAGNET](#).

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## IAGA's Mission

The overall purpose of IAGA is set out in the first statute of the Association:

- a) to promote studies of magnetism and aeronomy of the Earth and other bodies of the solar system, and of the interplanetary medium and its interaction with these bodies, where such studies have international interest;
- b) to encourage research in these subjects by individual countries, institutions or persons and to facilitate its international coordination;
- c) to provide an opportunity on an international basis for discussion and publication of the results of the researches; and
- d) to promote appropriate standardizations of observational programs, data acquisition systems, data analysis and publication.

(Link to the complete IAGA [Statutes and By-Laws](#).)

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## Scientific Assemblies

IAGA holds an Ordinary General Assembly every four years in conjunction with each Ordinary General Assembly of IUGG. Between the General Assemblies, IAGA holds a Scientific Assembly, often meeting with one of the other Associations of IUGG.

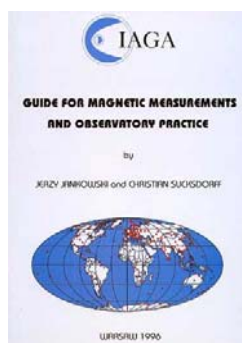
## Participation in IAGA Activities

IAGA welcomes all scientists throughout the world to join in research into Geomagnetism and Aeronomy. IAGA is subdivided into a number of Divisions and Commissions, many of which have working groups for the study of particular subjects in their general areas of interest. On occasion, these internal IAGA groups issue their own newsletters or circulars and many maintain their own websites. At the IAGA Assemblies, the groups organize specialist symposia, invite scholarly reviews and receive contributed papers that present up-to-the-minute results of current research. The IAGA website gives, or provides links to, information on the range of IAGA activities.

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## IAGA Guides

IAGA has published three practical guides to observation. These may be ordered from the Secretary-General.



### ***IAGA Guide for Magnetic Measurements and Observatory Practice***

by J Jankowski and C Sucksdorff, 1996

232 pages

ISBN: 0-9650686-2-5

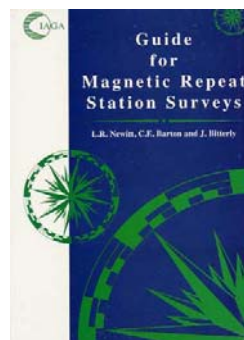
Price: USD 50

This Guide provides comprehensive information about how to organize and run a magnetic observatory and make magnetic measurements. The main topics are:

- A brief description of the Earth's magnetic field
- Selection of observatory sites and layout
- Magnetometers
- Absolute magnetic measurements
- Recording of magnetic variations
- Data processing
- Testing and calibrating instruments

### ***IAGA Guide for Magnetic Repeat Station Surveys***

by L.R. Newitt, C.E. Barton, and J. Bitterly, 1997



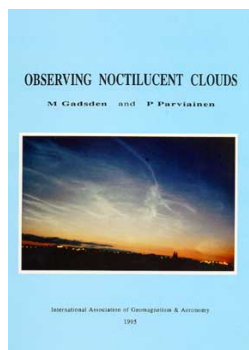
120 pages

ISBN: 0-9650686-1-7

Price: USD 25

This Guide provides a comprehensive description of the theoretical basis, operational details, and instrumentation for making magnetic repeat station survey measurements.





**IGAGuide to Observing Noctilucent Clouds** by M Gadsden and P Parviainen, 1995

ISBN: 0-9650686-0-9  
Price: USD 25

This manual and instruction book was written by a group of active researchers, both professional and amateur. There are chapters giving practical advice for taking visual observations, photographing the clouds with film or with video equipment. A summary of observations from space is included, as well as comments on the connection between noctilucent clouds, seen from the ground, and the polar mesospheric clouds that so far have been measured only from orbit. Noctilucent clouds are seen in the summer months, shining in the poleward sky at nighttime. Measurements show that the clouds are higher than any others. Lying at a height of 80-85 kilometres, the clouds mark a boundary between meteorology and space physics.

This book is beautifully illustrated with photographs, and will help everyone recognize and appreciate these "sailors in the summer night."

*(This Guide is currently out of print. It is intended to produce a digital version and to make this available via the IAGA website.)*

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### IGAG News

IGAG News contains items of general interest to the IAGA community. The main method of distribution for IAGA News is via the IAGA website. If printed copies are required, a request should be made to the Secretary-General who will mail copies free of charge.

Requests to publish short articles, reports and announcements in IAGA News should be sent to the Secretary-General.

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### Meetings Calendar

A calendar of scientific meetings relevant to the interests of IAGA scientists is maintained at:

<http://www.ufa.cas.cz/html/conferences/iaga.html>

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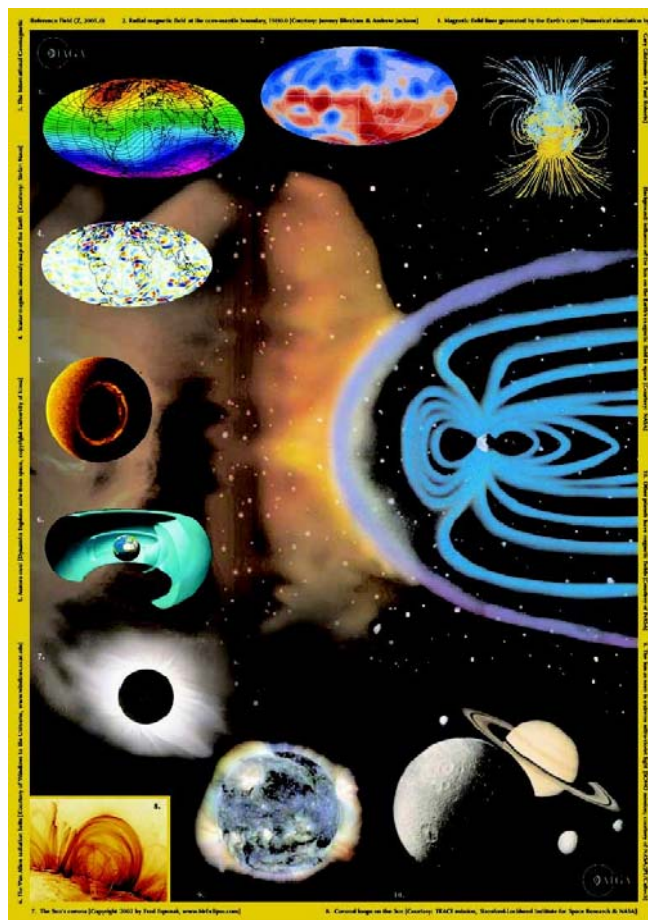
### International Geophysical Calendar

The International Geophysical Calendar for 2005 is available for download, as a [pdf file](#).

The calendar will also be published on the ISES website: <http://www.ises-spaceweather.org/>

### IGAG Flyer

A flyer summarising IAGA scientific interests and activities can be downloaded in pdf format from the IAGA website by clicking on the image below (718kb):



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### The IAGA Website

Information on IAGA can be found at:  
<http://www.iugg.org/IAGA/>

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### Contacting IAGA

The Secretary-General is the main point of contact for all matters concerning IAGA.

### Prof Bengt Hultqvist

The Swedish Institute of Space Physics, Box 812  
S-98128 Kiruna, Sweden  
email: [hultqv@irf.se](mailto:hultqv@irf.se)

# Appendix: The Scientific Programme for the Toulouse Scientific Assembly, 18-29 July 2005

## Joint IAGA & ICMA Symposia

### **JSMA01 Layered phenomena near the mesopause** (ICMA and IAGA Division II)

The mesopause region hosts a number of layered phenomena which are caused by the extraordinary conditions at these altitudes. For example, the lowest temperatures in the entire atmosphere are found at the summer mesopause at high latitudes. Layered phenomena include noctilucent clouds (NLC), polar mesosphere clouds (PMC), polar mesosphere summer/winter echoes, and metal layers. This session aims at presenting new experimental and theoretical results explaining the physics and chemistry of these layers, their mutual interaction, and their relationship to the background atmosphere. New measurements from ground based, satellite borne, and in-situ techniques will be shown and compared with current models of these fascinating phenomena. Various temporal and spatial scales will be considered, from micro-physical modeling of ice particle generation to solar cycle variation of NLC/PMC morphology.

*Convener:* Franz-Josef Luebken, Leibnitz-Institute of Atmospheric Physics, Schloss-Str. 6. 18225 Kuelungsborn, Germany; tel +49-38293-68-0; fax +49-38293-68-50; e-mail: [luebken@iap-kborn.de](mailto:luebken@iap-kborn.de)

*Co-convener:* J.M. Russel III, Hampton University, Virginia, USA

### **JSMA02 Solar variability effects on the middle atmosphere and troposphere** (ICMA and IAGA Divisions II and IV)

The session will focus on observational and theoretical studies of the effects of solar spectral irradiance variability and solar-modulated energetic particle precipitation on chemistry, radiative heating, and dynamics in the mesosphere, stratosphere, and troposphere. Both short-term and long-term (decadal) time scales will be considered. Emphasis will be placed on observations and models that identify and delineate specific physical and chemical processes involved in the atmospheric response to solar variations.

*Convener:* L. L. Hood, Lunar and Planetary Laboratory, Kuiper Space Sciences Building, University of Arizona, 1629 E. University Blvd., Tucson, Arizona 85721-0092, USA;

tel +1-520-621-6936; fax +1-520-621-4933; e-mail: [lon@lpl.arizona.edu](mailto:lon@lpl.arizona.edu)

*Co-convener:* U. Langematz, Free University of Berlin, Germany

### **JSMA03 Short-term variability and long-term changes in the lower and middle atmosphere** (ICMA and IAGA Division II)

The measurements of atmospheric constituents from space, airborne and ground based platforms have blossomed in the past two decades and so the atmospheric models. In addition this field is supporting, the development of the chemical weather or numerical environmental forecasting. The main goal of this symposium is to review our current database and knowledge on variability (both natural and human induced) of several atmospheric parameters and related effects on various time scales of hours to decades. In particular, focus would be on climate change and the greenhouse constituents, anthropogenic climate change scenarios, temperature, ozone and pollutants. The natural variations in atmosphere due to seasonal, annual, solar, ENSO, and QBO cycles.

*Convener:* G. Beig, Indian Institute of Tropical Meteorology, Dr. Homi Bhabha Road, Pashan, Pune-411008, India; tel +91-20-25893600; fax +91-20-25893825; e-mail: [beig@tropmet.res.in](mailto:beig@tropmet.res.in)

*Co-convener:* C. Sharma, National Physical Laboratory, India

### **JSII01 Vertical coupling of the atmosphere-ionosphere system and solar effects on it** (IAGA Division II and ICMA)

It is generally accepted now that the Earth's atmosphere as a whole (including the ionosphere embedded in the thermosphere) is a complicated coupling dynamic system. Nevertheless the details of the vertical atmosphere coupling still are a major challenge for the atmospheric physics. The tropospherically forced internal waves (gravity waves, tides and planetary waves) are important in determining both the climatological mean state and the disturbance structure of the middle atmosphere and thermosphere/ionosphere system. The coupling however, depends on the solar and geomagnetic activity as well.

This Symposium will address the recent results obtained concerning the atmospheric coupling (vertical, latitudinal and longitudinal), as more attention will be stressed to the solar-cycle feedback effects on it. The Symposium especially would like to invite investigations related to the downwards control effects transferring from the strongly solar-cycle dependent structure of the thermosphere to the lower atmospheric levels. The results of theoretical modelling and observational investigations of the interaction between small- and large-scale atmospheric phenomena, as waves contribute to the chemical equilibrium and the general circulation through wave leaking, turbulent mixing, etc. are welcome. The character of the ionosphere response to forcing mechanisms originating in the lower atmosphere and the transmission of these effects throughout the

thermosphere-ionosphere system is important as well. The symposium will provide the next opportunity for the international research community to review the progress and suggest some future directions in the investigation of all significant couplings (dynamic and electrodynamic, radiative, transport of atmospheric constituents), trigger mechanisms and feedback processes.

*Convener:* D.V. Pancheva, Department of Electronic & Electrical Engineering University of Bath, Bath, BA2 7AY, UK; tel. +44 (0)1225 386310; fax +44 (0)1225 386305; [eesdvp@bath.ac.uk](mailto:eesdvp@bath.ac.uk)

*Co-conveners:* Ed. Kazimirovsky, Inst. Solar-Terr. Physics, Irkutsk, Russia; L. Hood, University of Arizona, Tucson, USA

### **JSII02 Long-term trends in the upper atmosphere** (*IGA Division II and ICMA*)

Increasing concentration of greenhouse gases in the atmosphere, stratospheric ozone depletion, as well as long-term changes of solar and geomagnetic activity can result in long-term changes and trends in the stratosphere, mesosphere, thermosphere and ionosphere. The symposium is focused on the determination of such long-term trends and changes and the quantification of the role of anthropogenic changes (primarily greenhouse effect) versus Sun's effects in the observed trends. Model interpretation and prediction of trends of greenhouse origin is of high importance, as well. Papers dealing with observational determination of long-term trends as well as those dealing with simulations and theoretical studies of trends are welcome.

*Convener:* J. Lastovicka, Institute of Atmospheric Physics, Acad. Sci. Czech Rep., Bocni II, 14131 Prague 4, Czech Republic; tel +420-267103055; fax +420-272763745; e-mail: [jla@ufa.cas.cz](mailto:jla@ufa.cas.cz)

*Co-conveners:* G. Beig, Indian Institute of Tropical Meteorology, Pune, India

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## ICMA Symposium

### **MA01 Middle atmosphere science**

Papers related to any aspect of the dynamics, chemistry, or physics of the atmosphere from near the tropopause to the lower thermosphere are appropriate for this session. Observational, modelling and theoretical papers are all solicited. Particularly welcome are contributions relating to a number of recent or imminent satellite missions that have the potential to greatly increase our knowledge of the middle atmosphere, including TIMED, ENVISAT, EOS-AURA and COSMIC.

*Convener:* K. Hamilton, International Pacific Research Center, University of Hawaii, Honolulu, Hawaii 96822, USA; tel +1-808-956-8327; fax +1-808-956-9425; e-mail: [kph@hawaii.edu](mailto:kph@hawaii.edu)

*Co-conveners:* D. Marsh, National Center for Atmospheric Research, USA; R. Mueller, Inst. Stratosphaerische Chemie, Forschungszentrum Julich GmbH, Germany.

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## Division I

### **IDI01 The geodynamo: theory, models, observation and experiment** (*Divisions I and V*)

This two-day symposium will cover all aspects of studies on the geodynamo. Theoretical studies addressing different aspects of the geodynamo have been responsible for the main advances in the understanding of the geodynamo. Recent advances in computer technology have enabled researchers to refine models of the geodynamo and to extend their parameter range in their numerical simulations. It is still difficult to obtain convergent convection driven dynamos for low Prandtl numbers, and experimental studies, particularly on low Prandtl number fluids, are used to study this range of Prandtl number dynamics. Observational studies on the whole range of timescales represent an important aspect of dynamo theory and provide comparative studies with theory and experiment. The symposium should provide a stimulating interaction between workers in these four areas of study. There will be invited speakers in the four main areas and contributions in all four areas are welcome. Contributions can either be presented orally or as posters.

*Convener:* I.A. Eltayeb Department of Mathematics and Statistics, Sultan Qaboos University, P.O. Box 36, Muscat 123, Sultanate of Oman. Tel. (968) 515427; Fax (968) 513109; email: [ieltayeb@squ.edu.om](mailto:ieltayeb@squ.edu.om); or [ieltayeb@omantel.net.om](mailto:ieltayeb@omantel.net.om)

*Co-conveners:* Gauthier Hulot, IGP, Département de Géomagnétisme et Paléomagnétisme, Paris, France: Philippe Cardin, (2003-2007) LGIT/ Observatoire de Grenoble, France; R. Holme, Department of Earth and Ocean Sciences, University of Liverpool, UK.

### **IDI02 Investigation of the deep mantle using long period EM data from observatories, cables, long period MT and satellites** (*Divisions I and V*).

The symposium is dedicated to the deep earth electrical structure derived from geomagnetic and geoelectric data obtained at the planet surface and/or from satellite. The increasing number of long period induction data at the regional and global scale provide a new and unique insight of the tri-dimensional structure of the earth mantle. New approaches for processing, analysing and interpreting land and seafloor observatories, submarine cables and satellite data are necessary. A challenge is in the combination of all these data in a single processing and interpretation scheme. The global induction study of the Earth is now entering in a new era. We seek papers illustrating the current state and progress in this domain.



Convener: P. Tarits, UBO - IUEM, UMR "Domaines Océaniques", Place Nicolas Copernic, 29280 Plouzané, France; tel +33 2 98 49 87 63; fax +33 2 98 49 87 60; e-mail: [tarits@univ-brest.fr](mailto:tarits@univ-brest.fr)

Co-conveners: H. Utada, Ocean Hemisphere Research Center, Earthquake Research Institute, University of Tokyo, Japan; N. Olsen, Center for Planetary Science / Danish Space Research Institute, Denmark

### **IDI03 Magneto-petrology and magnetic anomalies**

*(Divisions I and V)*

Magnetic petrology integrates rock magnetism and conventional petrology, and characterises composition, abundance, microstructure and assemblages of magnetic minerals. Based on these data it is possible to assess the processes that create, alter and destroy them. A correlation of magnetic mineralogy, bulk magnetic properties and petrology to observed magnetic anomalies contributes to a better understanding of the geological factors that control magnetic signatures on Earth and may be important for the interpretation of extraterrestrial anomalies. We welcome studies that contribute to these topics including new results on low-temperature magnetometry as well as applications in mineral exploration.

Convener: A. Kontny, Geologisch-Palaeontologisches Institut, University of Heidelberg, Im Neuenheimer Feld 234, D-69120 Heidelberg, Germany; tel +49 6221 546053; fax +49 6221 545503, email: [agnes.kontny@urz.uni-heidelberg.de](mailto:agnes.kontny@urz.uni-heidelberg.de)

Co-convener: S. McEnroe, Trondheim, Norway

### **GAI01 Monitoring earthquakes and volcanic activity by magnetic, electric and electromagnetic methods**

Investigations of electromagnetic (EM) effects generated by the earthquake failure process and by volcanic activity are now currently carried out in many different countries. Self-consistent observations from carefully installed networks have led to the identification of signals clearly related to volcanic and earthquakes activity. The objectives of the session is to provide a forum for discussion and integration of results from multi-disciplinary monitoring of EM transient phenomena in volcanic and tectonic regimes.

Contributions along the following lines are encouraged:

Integrated EM monitoring of active faults and volcanoes  
Cross-correlation between EM phenomena and other geophysical phenomena

Coordinated satellite and ground-based EM experiments

The role of fluids in the EM signal generation

Constraints given by laboratory experiments and EM modelling of various physical processes.

Convener: J. Zlotnicki, Observatoire de Physique du Globe de Clermont-Ferrand, Campus des Cézeaux, 24 av des Landais, 63177 Aubière cedex, France; fax +33 - (0)4 73 40 78 85; e-mail: [jacques.zlotnicki@opgc.univ-bpclermont.fr](mailto:jacques.zlotnicki@opgc.univ-bpclermont.fr)

Co-conveners: M. Johnston, U.S. Geological Survey, USA; Y. Sasai, The Disaster Prevention, Tokyo Metropolitan Government, Japan

### **GAI02 EM imaging of volcanoes and active faults**

The identification of fluids within volcanoes and fault structures has a crucial bearing on the understanding of long term volcanic and seismic activity.

Contributions are therefore invited on both theoretical and experimental studies which use electromagnetic techniques to image the internal electrical resistivity structure of volcanoes and active faults, and which correlate the electrical structure to the presence and movement of fluids.

Convener: M. Ingham, School of Chemical and Physical Sciences, Victoria University of Wellington, PO Box 600, Wellington, New Zealand; tel +64-4-463-5216; fax+64-4-463-5237;

e-mail: [malcolm.ingham@vuw.ac.nz](mailto:malcolm.ingham@vuw.ac.nz)

Co-convener: Y. Ogawa, Volcanic Fluid Research Center, Tokyo Institute of Technology, Japan

### **GAI03 EM modelling and inversion with applications**

Magnetotelluric measurements provide a unique view of the Earth because of the sensitivity of electrical conductivity to temperature, fluids, ore minerals, and lithologic variations. This sensitivity is key in monitoring environmental problems, exploring for energy and mineral occurrences, investigating regions of potential natural hazards (seismic and volcanic), and studying the interior structure of the Earth. The magnetotelluric method allows obtaining the electrical properties of the subsurface at different scales, from near-surface up to lithospheric scale studies. During the last years, the development of new equipments and the progress in numerical 2-D and 3-D methods for interpretation has result in an increase of the application of the magnetotelluric method. This session solicits abstracts concerning the application of the magnetotelluric method at different earth scales. Works presenting a comparison or integration of electrical conductivity with other physical, chemical and/or geological properties are welcome.

Convener: Juanjo Ledo, Departament de Geodinamica i Geofisica, Universitat de

Barcelona, Martí i Franques s/n, Barcelona 08028, Spain; tel +34-934035911; fax +34-934021340; e-mail: [jledo@ub.edu](mailto:jledo@ub.edu)

Co-convener: Sophie Hautot, U. Edinburgh, UK

### **GAI04 The electric continental lithosphere: geodynamical implications**

The spatial distribution of the electrical conductivity within the continental lithosphere reflects some of its petrophysical and structural properties. Highly conducting features may give hints for the existence of graphite, saline water or partial melt which determine some fundamental rheological properties. Therefore it



is necessary to know theoretical resp. empirical relations between the conductivity of rocks and some petrophysical and chemical properties. Thus large scale conductivity structures, e.g. above plumes, shear zones, etc., which are derived from geomagnetic and magnetotelluric soundings will constrain geodynamic modelling.

Contributions within this context are welcome from laboratory experiments, EM field studies and geodynamic modelling.

*Convener:* A. Junge, Institute of Meteorology and Geophysics, Johann Wolfgang Goethe University, Feldberfstrasse 47, D-60323 Frankfurt am Main, Germany; tel +49-69 798-24899; fax +49-69-798-23280; e-mail: [junge@geophysik.uni-frankfurt.de](mailto:junge@geophysik.uni-frankfurt.de)  
*Co-convener:* A. Jones, Dublin Institute of Advanced Studies, Ireland

#### **GAI05 EM studies of intraplate collisional zones**

Electromagnetic (EM) studies throughout the world have shown that elongated crustal conductivity structures are parallel to, and approximately collocated with, collisional orogenic belts. These bodies provide an interesting view of the compressional tectonic processes implicated in their formation. Yet a compelling dynamical paradigm in which to explain the correlation between enhanced conductivity and compressional orogenesis has been lacking.

The purpose of this session is to test further the association between orogenic conductors and structural features at collisional belts. By doing so, the aim is to identify syn-tectonic (or post-tectonic) processes responsible for the geophysical anomalies and to interpret the depth extent (from shallow sedimentary basins to whole crust or even upper mantle structures) and lateral distribution of these processes. By associating conductivity anomalies with one or more particular phases of the orogenic process that resulted in the genesis of the conductor, EM methods present an attractive means to map the internal structure of preserved orogens.

We are looking for contributions both from (i) ongoing collisions such as Alpine-Himalaya, (ii) younger Phanerozoic (e.g. Caledonian/Appalachian) and (iii) older Proterozoic collisional zones (e.g. those in shield areas). Integrative contributions, i.e. those using EM data and other geophysical and geological data, are especially welcome.

*Convener:* T. Korja, Division of Geophysics, Department of Geosciences, University of Oulu, POB 3000, FIN-90014 Oulun Yliopisto, Finland; tel +358 - (0)8 - 553-1415; fax +358 - (0)8 - 553 1484; e-mail: [toivo.korja@oulu.fi](mailto:toivo.korja@oulu.fi)  
*Co-convener:* I. Varentsov, Geoelectromagnetic Research Institute, Russia

#### **GAI06 NRM - reliability, stability and geodynamic applications**

The Natural Remanent Magnetisation (NRM) of rocks provides first order constraints on the drift histories of the continental and oceanic crust on a plate-scale, in addition to providing information on the tectonic evolution of the crust on more regional and local scales. In order to provide such first-order constraints studies need to have an understanding of the process(es) by which the studied rocks have recorded the Earth's magnetic field, and they need to provide evidence for the stability of this record through time. A number of processes can have an effect on the reliability of this record. These processes can include inclination flattening, the filtering effect of the various recording mechanisms in rocks (chemical-, thermal-, or detrital remanent magnetisation), deformation of the rocks, and at times, the wholesale remagnetisation of the studied units. Determining the timing of magnetisation is typically done using relative estimates of the timing of magnetisation, such as the application of fold-, contact- and conglomerate-tests, whereas detection of physical or chemical changes of the magnetic mineralogy of the rocks is often attempted using rock magnetic techniques. We solicit contributions on geodynamic applications of paleomagnetic studies, on global, regional and local scales, especially those where there are good constraints on the timing and mode of origin of magnetization. We are also interested in contributions that provide novel methodologies, or new applications of old methodologies, for assessing the stability and reliability of the magnetic signal recorded in the rock record.

*Convener:* C. Aubourg, Tectonique 7072, Dept. Earth Sciences, U. Cergy Pontoise, 8, Le Campus, 95031 Cergy, France; tel +33-1-3425-4981; fax +33-1-3425-4904, e-mail: [charly.aubourg@geol.u-cergy.fr](mailto:charly.aubourg@geol.u-cergy.fr)  
*Co-conveners:* C. MacNiocaill, Oxford Univ., UK; A.B. Weil, Univ. Michigan, USA

#### **GAI07 Magnetic Anisotropy: problems and answers?**

Magnetic anisotropy and in general the analysis of magnetic fabrics has become a well-known technique in the analysis of mineral fabric. It is used in many geological and geodynamical contexts as a useful tool to address a large variety of geological and paleomagnetic problems. However, the interpretation is not straightforward and many techniques and measurement routines have been developed. We invite our colleagues to report original magnetic anisotropy case studies that would help solve geological or methodological problems. We encourage contributions that would improve magnetic fabric interpretation using magnetic mineralogy considerations. Particularly welcome are any contributions presenting new analytical techniques (separation of subfabrics, microwave demagnetization

in anisotropy measurements, partial remanence anisotropies, measurements at low temperature, ...) or interpretations of magnetic anisotropy at the transition between different deformation states (weakly deformed sediments, mantle rocks, lava flows, shear zones, etc). Mathematical methods interpreting the orientation of magnetic minerals and/or their correlations with minerals fabrics are also welcome.

*Convener:* J. L. Bouchez, Université Paul-Sabatier / OMP, Laboratoire des Mécanismes de Transfert en Géologie, UMR CNRS 5563 / Equipe de Géodynamique (Pétrophysique), 38 rue des 36-Ponts, 31400 Toulouse, France; tel +33 5 61 55 64 40; fax +33 5 61 52 05 44; e-mail: [bouchez@lmtg.ups-tlse.fr](mailto:bouchez@lmtg.ups-tlse.fr)

*Co-conveners:* F. Martín Hernández, Paleomagnetic Laboratory "Fort Hoofddijk", Utrecht, The Netherlands; Prof. K. Kodama, Department of Earth and Environmental Sciences, Lehigh University, USA

### **GAI08 Magnetic dating**

With greater frequency, near- bottom magnetic surveys of sea floor, properties of the natural remanence of rocks and archeomagnetic materials (such as direction, intensity, or geomagnetic polarity), and magnetic properties (such as susceptibility) are used as chronological tools for correlation, absolute or relative dating, time scale calibration, and/or estimation of sedimentation or accumulation rates. These applications range from well established to experimental. Both, innovative and case history type contributions to the broad application of magnetic dating are invited to this symposium.

*Convener:* R. S. Molina Garza, Centro de Geociencias, Campus Juriquilla UNAM, Carretera, San Luis Potosí km 13, Queretaro, Mexico 76230; tel +52-442-2381104 ext. 126; fax +52-442-2381100; e-mail: [rmolina@geociencias.unam.mx](mailto:rmolina@geociencias.unam.mx)

*Co-conveners:* A. Chauvin, University of Rennes, France; R. Zhu, Beijing, China

### **GAI09 Rock magnetism applied to environmental problems**

Rock magnetic methods can be successfully applied to a wide range of environmental problems. This symposium aims to bring together different areas of applicability of rock magnetic investigations. We welcome contributions dealing with all aspects of environmental studies, including palaeoclimate and palaeoenvironmental reconstructions derived from terrestrial and marine sediment records; sediment provenance studies; rock magnetic signatures of different types of soils; and magnetic records of recent and historical anthropogenic pollution. We especially encourage contributions involving novel and/or multi-disciplinary approaches (combining magnetic and non-magnetic methods) for solving environmental issues. Studies that can demonstrate the use of rock magnetic parameters as proxies for environmental processes

(e.g., soil erosion, anthropogenic pollution, etc.) will be highly appreciated.

*Convener:* Neli Jordanova, Sofia, Bulgaria, Acad. Bonchev str., bl.3, 1113 Sofia; tel. ++359 2 979 39 58; fax: ++359 2 971 3005; email:[vandedi@geophys.bas.bg](mailto:vandedi@geophys.bas.bg)  
*Co-conveners:* A.P. Roberts, Southampton, U.K.; .J. Orgeira, Buenos Aires, Argentina

### **GAI10 Theories, models and experiments in rock magnetism**

Rock magnetism is the physical foundation of many diverse topics discussed in Division I symposia. Paleomagnetism, magnetic anisotropy, magnetic dating, environmental magnetism and paleointensity determination, they all depend on often detailed knowledge of the involved magnetic minerals and their properties and each subject leads to its own specific rock magnetic problems. Yet, basic theoretical questions and experimental procedures are common to all applications. New experimental possibilities in the last years considerably enlarged the rock magnetictool box, but also created a large need for theoretical investigation and calibration by models or measurements. We invite presentations focussing on such fundamental themes as physical theories of magnetic parameters in dependence of grain size or mineralogical variation, micromagnetic or phenomenological modelling of magnetization processes or new experimental techniques of wide applicability in rock magnetism.

*Convener:* Karl Fabian, FB Geowissenschaften, Universitaet Bremen, Postfach 330440, 28334 Bremen, Germany, tel and fax: +49 421 218 7008, e-mail [kfabian@zfn.uni-bremen.de](mailto:kfabian@zfn.uni-bremen.de)  
*Co-conveners:* A. Newell, Santa Barbara, USA; P. Rochette, Aix-en-Provence, France

### **GAI11 Paleointensities - techniques and observations**

This session invites contributions dealing with paleointensity investigations of the geomagnetic field at all geological timescales. We welcome abstracts focused on relative and absolute paleointensity records on both archaeological and geological time scales, and studies involving paleointensity determinations across geomagnetic reversals and excursions. Contributions dealing with methodological aspects and new techniques are particularly welcomed.

*Convener:* Mireille Perrin, Laboratoire Tectonophysique, UMR CNRS-UM2 5568, Université Montpellier II CC49, 34095 Montpellier Cedex 05, FRANCE; tel +33 4 67 14 39 32; fax +33 4 67 14 36 03; e-mail [perrin@dstu.univ-montp2.fr](mailto:perrin@dstu.univ-montp2.fr)  
*Co-conveners:* M. Hill, Liverpool University, UK; Y. Yamamoto, Geological Survey of Japan, Tsukuba, Japan

## **GAI12 Open poster session on paleo-, rock and environmental magnetism**

This open session, which will be organized solely as a poster session, is intended to bring together not only the presentations which do not fit to any other magnetic session, but mainly to provide space to results which are in certain way provoking, puzzling, ambiguous or challenging in the general sense of the word. Therefore, revise your drawers and folders and present your results which deserve more thorough international discussion. For instance, presentations dealing with novel interpretations of hotspots, resolved magnetic dating, intriguing paleoclimatic events, less known minerals as carriers of magnetic signal, applications to extraterrestrial bodies, etc., are mostly welcome. Besides that, we are looking for contributions presenting an integral, multidisciplinary approach to the problems that we are facing in paleo, rock and environmental magnetism.

*Convener:* E. Petrovsky, Geophysical Institute, Bocni II/1401, 141 31 Prague 4, Czech Republic; tel +420-2-67 103 333; fax +420-2-67 103 332; e-mail [edp@ig.cas.cz](mailto:edp@ig.cas.cz)

*Co-convener:* D. Rey, University of Vigo, Spain and H. Oda, University of Utrecht, Netherlands

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## Division II

### **IDII01 Low latitude atmosphere - ionosphere - magnetosphere coupling, dynamics and energetics (including small scale coupling) (Divisions II and III)**

This symposium will address recent results on the dynamics and energetics governing the atmosphere-ionosphere- magnetosphere- interplanetary coupling processes of the equatorial region. Upward transport of wave energy and momentum due to gravity, tidal and planetary waves from below and extra-tropics control the phenomenology of the equatorial atmosphere - ionosphere system. The observed large zonal, day-to-day and interannual variability in the system dynamics stems from these processes, while large variability arises also from magnetospheric/interplanetary forcing through disturbance electric fields and energy deposition at high latitudes with the consequent coupling to equatorial latitudes. The objective is to better understand the possible causes of these variabilities on different time scales, and in function of longitude. Results will be welcome from ground based and satellite borne experiments, and from modeling/theoretical investigations, on the dynamics, electro dynamics, manifestations of coupling process in terms of small and large structures, and variabilities in winds, temperatures, waves, plasma drifts, electric fields and currents, in general, and especially, those related to the major phenomena of the region: Equatorial plasma bubbles/Spread F, Electrojet and Ionization Anomaly.

*Convener:* M. A. Abdu, Instituto Nacional de Pesquisas Espaciais - INPE, Ave. dos Astronautas 1758; 12201

970, São Jose dos Campos, SP, Brazil; tel +55 12 345 6797; fax +55 12 345 6990; e-mail: [abdu@dae.inpe.br](mailto:abdu@dae.inpe.br)

*Co-conveners:* Takuji Nakamura, Radio Science Center for Space and Atmosphere (RASC), Kyoto University, Japan; B. T. Tsurutani, Jet Propulsion Laboratory, USA

### **IDII02 Conjugate and interhemispheric polar studies (Divisions II, III and V)**

The Earth's magnetosphere is an electrodynamic system that couples the northern and southern polar ionospheres, each with different geophysical and electrodynamic properties. The unique physical characteristics of the northern and southern polar regions must be considered in models of the fully coupled, global, dynamic geospace system. For example, the separation of geomagnetic and rotation poles, magnetic field strength, and conductivity structures are different in the two polar regions. Further, the solar wind electrodynamic coupling to the northern and southern hemispheres can be very different depending upon the orientation of the interplanetary magnetic field (IMF). New instrument arrays in both hemispheres and the possibility of simultaneous auroral imaging from satellites over both polar regions provide new tools and opportunities to investigate interhemispheric coupling. This symposium solicits the results from research that contrasts and/or considers the coupled, interhemispheric, global system, including consideration of when the two polar ionospheres may not be coupled. Results from observational, theoretical and computer simulation investigations are welcome.

*Convener:* C. R. Clauer, University of Michigan, Center for Space Environment Modeling, 2455 Hayward, Ann Arbor, MI 48109-2143, USA; tel +1-734-476-6248; fax +1-734 763-0437; [rclauer@umich.edu](mailto:rclauer@umich.edu)

*Co-conveners:* A. S. Rodger, British Antarctic Survey, U.K.; M. Freeman, British Antarctic Survey, U.K.; H. Yamagishi, National Institute for Polar Research, Japan; V. Pilipenko, Institute of the Physics of the Earth, Russia

### **IDII03 Space weather effects on the ionosphere (Division II and IDCDC)**

Space weather studies have become important due to the adverse effects on satellites and disruptions in radio communications caused by severe scintillation associated with some of such events occurring in solar terrestrial system. Anomalies in electron density distribution may also lead to errors in satellite based navigation. The session will highlight the effect of space weather events on ionosphere at low, middle and high latitudes. Studies dealing with the charged particle precipitation at high latitudes and in the region of south Atlantic Magnetic Anomaly will also be covered. The session will also cover magnetosphere-high latitude-low latitude coupling under geomagnetic quiet and disturbed conditions. Contributions on the



space weather effects on thermosphere at different latitudes are also welcome.

*Convener:* H Chandra, Physical Research Laboratory, Navarangpura, Ahmedabad 380 009, India; tel +91-79-26302129 ext. 4556; fax +91-79-26301502; e-mail:

[hchandra@prl.ernet.in](mailto:hchandra@prl.ernet.in)

*Co-convener:* Santi Basu, Air Force Research Laboratory, Hanscom AFB, USA

#### **IDII04 Electrodynamic processes in the equatorial and low latitudes: Coupling with the global system (Division II and IDCDC)**

Theoretical as well as experimental contributions related to electrodynamic processes which play important roles in the transfer of energy to and from the equatorial and low latitude ionospheric regions and in the generation of plasma irregularities in these regions are welcome.

Special emphasis will be given to contributions that deal with the coupling of these processes with the large scale global system of fields and currents.

*Convenor:* Dr. P. Muralikrishna, Instituto Nacional de Pesquisas Espaciais - INPE, C. P. 515, 12 201-970, São José dos Campos-SP, Brazil; tel. +55 12 3945 7148 ; fax: +55 12 3945 6990; e-mail:

[murali@dae.inpe.br](mailto:murali@dae.inpe.br)

*Co-convener:* Dr. Archana Bhattacharya, Indian Institute of Geomagnetism, Mumbai, INDIA

#### **GAI01 Electrical energy deposition processes in the middle and upper atmosphere**

This session is intended to investigate the processes, which deposit electrical energy in the middle and upper atmosphere, and their consequences on the local, regional and global scale. Topics of particular interest are transient luminous events such as sprites, elves and jets, and their environmental initiation conditions. For example, thunderstorm development, lightning activity, gravity- and planetary waves, and the atmospheric conductivity. Consequences of interest are atmospheric chemical composition changes, ionospheric modification, infrasonic wave generation, troposphere/ionosphere coupling and the impact on the global circuit.

*Convener:* M. Füllekrug, Institut für Geophysik, Universität Frankfurt am Main, Feldbergstrasse 47, D-60323 Frankfurt am Main, Germany, tel: +49 69 798 23959, fax: +49 69 798 23280, email:

[fuellekr@geophysik.uni-frankfurt.de](mailto:fuellekr@geophysik.uni-frankfurt.de)

*Co-conveners:* Fernanda T. São Sabbas, Aeronomy Division (DAE), Instituto Nacional de Pesquisas Espaciais (INPE), São José dos Campos, Brazil; Elisabeth Blanc, Laboratoire de Detection et de Geophysique, Commissariat a l'Energie Atomique (CEA), Bruyeres le Chatel, France.

#### **GAI02 Planetary ionospheres and thermospheres**

Planetary ionospheres and thermospheres constitute the outer layer of the planets' upper atmospheres through which they interact with their space environment. In the long term, these layers partly control the loss of chemical species and therefore the evolution of planetary atmospheres. All of these phenomena depend on a diversity of factors : planetary gravity, heliocentric distance, atmospheric/ionospheric species sources and losses, magnetic field intensity and geometry etc. Planetary exploration reveals this diversity in unprecedented detail. This symposium will welcome all contributions to new observations, interpretations and models of planetary thermospheres and ionospheres contributing to the exploration and improved understanding of this diversity and of the underlying "universal" laws controlling the planets' upper atmospheres. New results on the Mars, Saturn and Titan upper atmospheres provided by the Mars and Cassini/Huygens missions will be particularly welcome.

*Convener:* M. Blanc, Observatoire Astronomique Marseille Provence, 2 place Le Verrier, 13248 Marseille Cedex 04, France ; tel. + 33 4 95 04 41 59 ; fax + 33 4 95 04 41 58 ; e-mail : [blanc@oamp.fr](mailto:blanc@oamp.fr)

*Co-Conveners:* H. Waite, Southwest Research Institute, USA; G. M. Keating, George Washington University, Virginia, USA

#### **GAI03 Data assimilation techniques for the ionosphere-thermosphere-magnetosphere system**

Over the past decade, data assimilation models have become a dominant tool for specifications and forecasts in meteorology and oceanography. However, in the field of space physics these models are only emerging, largely due to the lack of suitable data in the past. However, this situation is changing rapidly with the significant increase in the number of data that will become available over the next decade. This data, which will come from a variety of sources, will be available in real-time for assimilation into physics-based specification and forecast models. In order to adapt modern data assimilation techniques developed in meteorology and oceanography to the near-Earth space regimes, a rigorous examination of the statistical properties of the system is necessary. Papers dealing with data sources, data quality issues, and data assimilation models and techniques are welcome.

*Convener:* L. Scherliess, Utah State University, Center for Atmospheric and Space Sciences, Logan, UT 84322, U.S.A; tel. +01 435 797 7189; fax +01 435 797 2992; e-mail [ludger@gaim.cass.usu.edu](mailto:ludger@gaim.cass.usu.edu)

*Co-convener:* T. Matsuo, National Center for Atmospheric Research, USA



## Division III

### **GAllI01 The magnetospheric particle accelerator**

Energetic particles in the magnetosphere produce fascinating aurora phenomena as well as magnetic storms, and highly energetic particles nowadays cause satellite anomalies or failure. Interest in the energetic particles has been increasing, which stimulates deep scientific understanding when, where and how particles are accelerated in the magnetosphere. This session "magnetospheric particle accelerator" will cover reconnection, aurora, plasma sheet, ring current and radiation belt, and this session further aims to unify the discussion of acceleration processes. Thus we invite papers on recent measurements of the auroral region, plasma sheet, and inner magnetosphere and the theoretical papers by means of advanced computer simulations on particle acceleration in the magnetosphere.

*Convener:* T. Obara, Applied Research and Standards Department, National Institute of Information and Communication Technology, 4-2-1, Nukuikita, Koganei. Tokyo 184-8795, Japan; tel +81-42-327-6431; fax +81-42-327-6661; e-mail: [t.obara@nict.go.jp](mailto:t.obara@nict.go.jp)

*Co-conveners:* A. Chan, Rice University, Dept. of Physics and Astronomy, USA; J. Birn, Los Alamos National Laboratory, Los Alamos, New Mexico, USA; W. Lotko, Dartmouth College, Hanover, New Hampshire, USA

### **GAllI.02 Electrodynamics of Aurora**

Recent Observations from FAST, Polar, and Cluster as well as sounding rocket missions have continued to make progress in the understanding of the electrodynamic processes that give rise to the aurora. It is useful to organize auroral acceleration into upward current, downward current, and Alfvénic acceleration regions, each of which has their own characteristics. Coordination of data obtained from different satellite missions, ground observations and optical imaging of the aurora is giving an improved picture of the global structure and dynamics of the auroral acceleration process. Theory and modeling efforts emphasizing the dynamics of this region are now becoming sophisticated enough to study the details and time-dependence of auroral acceleration. Papers that emphasize the dynamic interactions that produce the aurora are especially encouraged for this session.

*Convener:* R. L. Lysak, School of Physics and Astronomy, University of Minnesota, Minneapolis, MN, 55455, USA; tel +1-612-625-1323; fax +1-612-626-2029; e-mail: [bob@aurora.space.umn.edu](mailto:bob@aurora.space.umn.edu)

*Co-conveners:* R. E. Ergun, Laboratory of Astrophysics and Space Physics, University of Colorado, USA; G. Marklund, Alfvén Laboratory, Royal Institute of Technology, Sweden

### **GAllI03 Magnetic reconnection: conditions and mechanisms**

Since the open magnetosphere model was proposed a wealth of research has provided evidence to show that magnetic reconnection plays a critical role in geospace and that it is the dominant means by which solar wind energy is transferred to the magnetosphere and ionosphere. But the accurate prediction of when, where, how and at what rate reconnection will occur still remains elusive. Papers addressing these issues, in any region of the magnetosphere, are welcome; those that combine observations (from spacecraft or ground-based) with theory/modelling are strongly encouraged. Such papers might examine the relative roles of anti-parallel vs. component merging or the key mechanisms occurring in the diffusion region.

*Convener:* M. Pinnock, British Antarctic Survey, High Cross, Madingley Rd., Cambridge CB3 0ET, UK; tel +44 1223 221534; fax +44 1223 221534; e-mail: [mpi@bas.ac.uk](mailto:mpi@bas.ac.uk)

*Co-conveners:* M. Øieroset, Space Sciences Laboratory, University of California, Berkeley, USA; M. Shay, Institute for Research in Electronics and Applied Physics, University of Maryland, USA.

### **GAllI04 Structure and dynamics of the magnetopause and its boundary layers**

The structure and dynamics of both the low- and high-latitude magnetopause and its associated boundary layers are the focus of much active interest as these are the prime sites of mass, momentum and energy transfer from the solar wind into the magnetosphere. In situ and remote sensing observations of these regions continue to be returned from a number of ongoing spacecraft missions, such as Polar, Cluster and Image. These observations are being supplemented by new datasets, such as those from the DoubleStar spacecraft, and are further supported by observations from ground based observatories and the results of MHD, hybrid and kinetic simulations.

We welcome contributions on a wide range of magnetopause related topics, including observations of the structure of the magnetopause current layer, its boundary layers and their transient variations, the signatures of the various forms of plasma interactions, such as magnetic reconnection, at the magnetopause and their relevance to solar wind magnetosphere coupling, and the interaction of solar wind disturbances with the magnetosphere. Multi-spacecraft and/or ground based observations which relate the magnetopause signatures to phenomena observed inside the magnetosphere or in the ionosphere are particularly welcome, as are modelling and simulation studies which complement the observations or allow them to be placed in a more global context.

*Convener:* C.J. Owen, Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking, Surrey, RH5 6NT, UK ; tel +44 1483 204281; fax +44 1483278312; e-mail:

[cjo@mssl.ucl.ac.uk](mailto:cjo@mssl.ucl.ac.uk)

*Co-conveners:* P. Escoubet, ESA, France; J. Berchem, UCLA, USA; Z.-X. Liu, CSSAR, China

### **GAI05 Physics of substorms and current sheet in the near-Earth and mid-tail region**

Thanks to new instruments on board GEOTAIL, POLAR and WIND, much progress has been made recently on the dynamics of the thin current sheets developing in the central region of the geomagnetic tail. More recently, multi-satellite missions have provided major advances via the new observational capabilities such as those now available on Cluster. At the time of the symposium the Cluster tetrahedron will have successively explored a range of scales (from 200 to 10000 km inter-spacecraft separations). The symposium provides a forum for discussion of the relevant scales for current sheet dynamics and identification of key issues to be addressed with future multipoint missions (MMS, THEMIS, SCOPE....). Contributions on dynamics of thin current sheets and their relation to substorms are solicited. Priority will be given to near Earth and mid-tail regions.

*Convenor:* A. Roux, CETP/UVSQ 10-12 Avenue de l'Europe, 78140 Vélizy, France; tel +33 1 39 25 48 99; fax +33 1 39 25 48 87; e-mail: [alain.roux@cetp.ipsl.fr](mailto:alain.roux@cetp.ipsl.fr)  
*Co-conveners:* T. Nagai, Tokyo Institute of Technology, Japan; C. Cheng, Princeton University, USA

### **GAI06 Magnetosphere-ionosphere coupling dynamics**

The dynamical evolution of magnetosphere-ionosphere systems is closely related to processes that mediate the exchange of mass, momentum, and energy. Energetic particle fluxes, currents, and Poynting flux associated with magnetospheric flows, plasma populations, and waves carry energy from the magnetosphere into the ionosphere. These dynamical processes can modify ionospheric conductivity and ionospheric current systems; excite plasma instabilities; and dissipate energy through collisional and wave-induced heating processes. Moreover, ionospheric modifications feed back on the magnetosphere through alteration of the current system, radiation/reflection of waves, outflow of plasma, and development of parallel electric fields to maintain quasineutrality. This symposium will focus on the following broad topics: (a) how do magnetospheric flows and current systems evolve when coupled to the ionosphere?, (b) what is the temporal evolution of the global ionospheric current system in the context of M-I coupling? (c) what are the processes involved in plasma inflow/outflow and how do they couple the magnetosphere and ionosphere?, and (d) what role do waves and plasma instabilities play in M-I coupling?

*Convenor:* J. R. Johnson, Princeton University, Plasma Physics Laboratory, Princeton, NJ 08543, USA; tel +1-609-243-2603; fax +1-609-243-2662; email: [jrj@pppl.gov](mailto:jrj@pppl.gov)

*Co-conveners:* A. Yoshikawa, Kyushu University, Japan; S. Wing, Applied Physics Laboratory, USA

### **GAI07 Geomagnetic disturbances, storms and radiation belts**

Storms and other geomagnetic disturbances are manifestations of enhanced solar wind - magnetosphere coupling, whose effects can be detected as configurational changes and high temporal variability especially in the inner magnetosphere. Solar wind disturbances and southward-oriented interplanetary magnetic field enhance the ring current and radiation belts, distort and disturb the electromagnetic fields, and strongly increase the ionosphere - magnetosphere interaction. This session concentrates on the details of the driver - response relationship, e.g., on the enhancement of the radiation belt electron fluxes, acceleration and decay of the ring current, and the interplay between magnetotail dynamics and the evolution of the inner magnetosphere in response to the solar wind driver. Papers addressing these questions using ground-based and space-borne observations, modeling and simulation techniques, or theoretical analysis are all welcome.

*Convenor:* T. I. Pulkkinen, Finnish Meteorological Institute, POBox 503, FI-00101, Helsinki, Finland, tel. +358-9-19294654, fax +358-9-19294603, e-mail: [tuija.pulkkinen@fmi.fi](mailto:tuija.pulkkinen@fmi.fi)

*Co-conveners:* R. B. Horne, British Antarctic Survey, UK; M. G. Henderson, Los Alamos National Laboratory, USA

### **GAI08 Global scale synthesis from models and distributed observations**

The dramatic and ongoing improvements in both ground-based and space based observational capabilities are being motivated and facilitated in a number of ways. Technological advancements in data storage, retrieval, and communications, new space-based imaging techniques, and ever more cost effective and efficient sensors make collecting more data from more platforms, and the integration of that data into the framework of worldwide virtual arrays an increasingly easy task. Advances in data mining, visualization, and analysis make utilizing these large data sets a manageable though challenging task. The international modeling community, motivated by numerous programs such as CAWSES, GEM CEDAR, ILWS and others, are constantly improving the capacity to integrate data from disparate types of instruments and the assimilation of the resulting product into physical and empirical models. Finally, the practical needs to build predictive physical models for space weather forecasting have led to programs that target specific science questions, and now more than ever needs global data for closure of those science questions.

This symposium will highlight activity relevant to global ground-based and space based data and global models. In particular, we will focus on synoptic observations provided by Mesoscale and global arrays of space science instrumentation, and the integration of these data to provide as complete as possible a specification of the spatio-temporal evolution of the magnetosphere and of ionospheric electrodynamics and precipitation. Together with this observational theme, we will explore the closely related global models, and the assimilative use of data in these models to improve the accuracy of global simulations of actual events.

*Convener:* E.F. Donovan, Department of Physics and Astronomy, University of Calgary, Calgary, Canada, T2N 1N4; tel +1-403-220-6337; fax +1-403-289-3331; e-mail: [eric@phys.ucalgary.ca](mailto:eric@phys.ucalgary.ca)

*Co-conveners:* M. Lester, Department Physics and Astronomy, University of Leicester, UK; R. Clauer, Space Physics Research Lab., Univ. of Michigan, USA

### **GAll09 Plasma sources, sinks, and transport**

This session is devoted to the study of the magnetospheric plasma sources, sinks, energization, and transport using experimental and simulation means. The ionosphere and the solar wind are considered as sources of equal importance. Either one is capable of supplying the observed magnetospheric plasma over a broadband of energy spectrum. Plasma is transported into the magnetosphere from these sources through a variety of mechanisms. The ionosphere supplies plasma through the polar wind, the cleft ion fountain, the auroral region, the cusp ionospheric foot point, the polar cap and the plasmaphere. The solar wind sources are the high latitude cusp, the polar rain, the plasma mantle, the low latitude boundary layer, the distant tail. Furthermore, observations indicate that a boundary layer of magnetosheath-like plasmas can be found just inside all regions of the magnetopause including the nightside equatorial magnetopause. And observations within the magnetotail lobes tend to indicate that plasma continues to enter the magnetotail throughout its entire length.

This session also deals with the wide variety of processes involved in the coupling of energy from the solar wind to the (extended) ionosphere, which produces heating and acceleration of ionospheric ions and electrons and the transfer of solar wind mass into the magnetosphere, the escape of magnetospheric particles into the magnetosheath, and the transport of plasmaspheric material to the Mantle, LLBL and plasma sheet.

The processes of plasma transport and losses are also relevant to this session, including transport in the distant tail, escape of particles through the flanks and plasma flow out of the distant tail, chaotic scattering and acceleration, fast plasma flows in the plasma sheet, formation of the ring current and radiations belts, as well as losses by charge exchange, wave-particle interactions, coulomb collisions.

*Convener:* J.-A. Sauvaud, CESR, B.P. 4346, 9, Avenue Colonel Roche, F-31029, France; e-mail:

[Jean-Andre.Sauvaud@cesr.fr](mailto:Jean-Andre.Sauvaud@cesr.fr)

*Co-conveners:* K. Seki, STEL, University of Nagoya, Japan; T.E. Moore, Goddard Space Flight Center, USA; V. Sergeev, University of St Petersburg, Russia

### **GAll10 Characterizing and forecasting space environment hazards**

A key task of the space physics community in the space weather efforts is to provide reliable forecasting schemes for hazardous conditions based on up-to-date scientific understanding of space weather phenomena. At the same time the community running space weather-sensitive systems needs to collect accurate information about various hazards from the relatively unarmful to the really serious. Finally these two approaches have to be put together in order to issue scientifically sound warnings with grading of the severity of the expected problems. To this symposium we solicit contributions on various methods of forecasting space environmental conditions that are hazardous to both space-borne and ground-based systems and on studies of actual hazards and their relationships to the environmental conditions.

*Convener:* H.E.J. Koskinen, University of Helsinki, Department of Physical Sciences, P.O.Box 64, FIN-00014 University of Helsinki, Finland; tel +358 9 191 50675; fax +358 9 191 50610; e-mail:

[Hannu.Koskinen@fmi.fi](mailto:Hannu.Koskinen@fmi.fi)

*Co-conveners:* R.L. McPherron, UCLA, USA

### **GAll11 Spacecraft-plasma environment interactions**

Active and passive spacecraft systems interact with the plasma environment via various processes which may lead to changes of electrostatic potential, electrical currents, induced plasma, sparks, torques and forces. On one hand these effects can be a limiting factor for certain space plasma measurements and for the operation of space systems. On the other hand, they can be exploited to control the electrostatic environment, generate thrust and power or to investigate new classes of plasma phenomena in space. Topics to be covered include, but are not limited to, spacecraft electrostatic sheath, spacecraft charging, in-flight plasma instrument calibration and data correction, spacecraft borne particle emitters, tether systems, artificial magnetospheres, active plasma devices and experiments in space.

*Convener:* Alain Hilgers, ESA-ESTEC, 2200AG Noordwijk, The Netherlands; e-mail:

[Alain.Hilgers@esa.int](mailto:Alain.Hilgers@esa.int)

*Co-conveners:* Andrew Coates, Mullard Space Science Laboratory, UK.



### **GAI112 Monitoring and specification of magnetospheric dynamics using ULF waves**

Magnetospheric disturbances such as geomagnetic storms and substorms generate ULF waves, which are detected both on the ground and in space. Through observation of the waves we can monitor the changes of configuration of the magnetosphere and the associated energy and mass transport processes. In the context of space weather programs there is increased need for monitoring the magnetosphere continuously and with great accuracy. This symposium focuses on detection and interpretation of ULF wave signals in relation to the dynamic behaviour of the magnetosphere. Papers describing recent development in ground-based multipoint measurements, radar and optical remote sensing techniques, ground-satellite conjunction observations, and calibration of ULF wave techniques against global simulations and satellite-based global images are encouraged for the symposium.

*Convener:* Kazue Takahashi, Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723-6099, USA; tel. +1-240-228-5782; fax +1-240-228-0386; e-mail: [kazue.takahashi@jhuapl.edu](mailto:kazue.takahashi@jhuapl.edu)

*Co-convener:* Colin Waters, School of Mathematical and Physical Sciences, University of Newcastle, Australia

### **GAI113 Fundamental processes: lessons from other magnetospheres**

While the terrestrial magnetosphere shares many common features with planetary magnetospheres, it is their differences we propose to highlight with reports in this session. Our focus will be on lessons learned from remote and in situ investigations of Jupiter and Saturn that impact our understanding of Earth's magnetosphere and perhaps suggest broader themes relevant to astrophysical systems. Given that planetary magnetospheres can have satellites, rings, dust, and high densities of neutral gas imbedded deep within them, there is much to be gained in asking how processes of transport, auroral generation, and others are maintained in these different environments and which processes are unique only to Earth or to some planets. This session will provide a review of the theoretical, modeling, and data analysis results which emphasize a comparison with Earth. We suggest these ideas are topical for the upcoming Messenger and BepiColombo missions to Mercury and the Pluto/Kuiper Belt Missions.

*Convener:* J. Woch, Max-Planck-Institut für Sonnensystemforschung, Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany; tel. +49 5556 979447; fax +49 5556 979240; e-mail: [woch@linmpi.mpg.de](mailto:woch@linmpi.mpg.de)

*Co-conveners:* C. Paranicas, Johns Hopkins University Applied Physics Laboratory, USA; R. J. Walker, Institute of Geophysics & Planetary Physics, University of California at Los Angeles, USA.

### **GAI114 Reporter reviews**

This session is composed of talks reviewing important topics from the research areas covered by Division III.

*Convener:* M. Fujimoto, Tokyo Institute of Technology, Department of Earth and Planetary Sciences, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8551 Japan; tel +81 3-5734-3535; fax +81 3-5734-3537; e-mail: [fujimoto@geo.titech.ac.jp](mailto:fujimoto@geo.titech.ac.jp)

## Division IV

### **IDIV01 Solar-terrestrial connections: International Living With a Star (Divisions IV and III)**

International Living With a Star (ILWS) is the primary vehicle by which the space agencies and equivalent space authorities in nearly 30 countries coordinate activities and projects on Solar-Terrestrial Science. ILWS has a broad scientific coverage encompassing all current research interests, from solar dynamo theory to potential climatic effects of solar variability. In between, classical space plasma problems such as collisionless shocks, magnetic reconnection, substorms, particle acceleration, auroral physics, and magnetosphere-ionosphere-thermosphere coupling make for an exceedingly rich and intrinsically multidisciplinary program. This session will feature presentations by leading scientists from ILWS member countries on how to tackle outstanding problems in Sun-Earth Connection, utilizing modern experimental and theoretical techniques and extant synergy in the international community.

*Convener:* W. Liu, Canadian Space Agency, 6767 route de l'Aéroport, Saint-Hubert, Québec J3Y 8Y9, Canada; tel +1-613-262-1355; e-mail: [William.liu@space.gc.ca](mailto:William.liu@space.gc.ca)

*Co-conveners:* H. Opgenoorth, ESTEC, the Netherlands; M. Guhathakurta NASA HQ, USA; T. Kosugi, ISAS, Japan; L. Zelenyi, IKI, Russia.

### **GAIV01 The Sun: Its interior, atmosphere and wind**

Continuous ground- and space-based observations of the Sun have provided detailed information on the solar interior, extended corona and solar wind. These observations offer a unique capability to investigate the physical processes responsible for the dynamic nature of the Sun. The combination of these observations with realistic modeling is reshaping our understanding of the solar magnetic field and solar activity, and the mechanisms by which the corona is heated and the solar wind is accelerated. The symposium invites contributions covering observations, theory and modeling of the different aspects of the Sun, including its interior, dynamo, magnetic field, atmosphere, and wind. This broad scope is aimed at stimulating exchange and promoting discussion on physically connected phenomena which are seldom discussed in a single meeting.



*Convener:* M. P. Miralles, Harvard-Smithsonian Center for Astrophysics, 60 Garden St., MS-50, Cambridge, MA 02138, USA; tel: +1 617-496-7925; fax: +1 617-495-7455;

email: [mmiralles@cfa.harvard.edu](mailto:mmiralles@cfa.harvard.edu)

*Co-conveners:* J. Sanchez Almeida, Instituto de Astrofísica de Canarias, Spain; K. Shibata, Kwasan Observatory, Japan

### **GAIV02 Physics of the interplanetary medium: From micro- to mesoscales**

The interplanetary medium is characterized by a multiplicity of scales, ranging from short-scale, high-frequency fluctuations to low-frequency MHD scales to solar rotation and solar cycle scales. These scales interact in a variety of ways such as, for example, cosmic ray modulation, which results from scattering by low-frequency turbulence, and is strongly mediated by the solar cycle. Other examples are the interaction of the solar wind with the local interstellar medium, the acceleration and transport of energetic particles such as solar energetic particles, the evolution and dynamics of turbulence in the interplanetary medium, emission processes, the characteristics of collisionless shock waves, etc. This session solicits contributions that explore the coupling of multiple scales and physical processes in the context of the interplanetary medium.

*Convener:* G. Zank, Institute of Geophysics and Planetary Physics, University of California, Riverside, CA 92521, USA; tel +1 909 787 4508; fax +1 909 787 4324 or 4509; email: [zank@ucr.ac1.ucr.edu](mailto:zank@ucr.ac1.ucr.edu)

*Co-conveners:* T. Terasawa, Graduate School of Science, University of Tokyo, Japan; I. Veselovsky, Institute of Nuclear Physics, Moscow State University, Russia

### **GAIV03 Foreshock, shock, and magnetosheath physics for collisionless shocks**

The session invites contributions of observational and theoretical studies of the basic physical mechanisms of the energy transfer through collisionless shocks, characteristic temporal and spatial scales of the shock front structure, role of the fine spatial structure in the shock thermalization process, generation of waves and their role, as well as the particle acceleration process in the vicinity of the bow shock and interplanetary shocks. Recently, direct in situ measurements of high frequency wave fields in the electron foreshock region allowed to better understand the nature of wave activity observed. Multi-satellite measurements in the magnetosheath combined with new techniques of data analysis provides new impetus to the identification of wave characteristics and their role in ion thermalization process. These and other similar topics, are the primary objectives of this session, namely, to put together recent "in situ" measurements from different space projects with theoretical work and models.

*Convener:* V. Krasnoselskikh, LPCE/CNRS, Orleans, France; tel +33 (0)2 38 25 52 75; fax +33 (0)2 38 63 12 34; e-mail: [vkranos@cnrs-orleans.fr](mailto:vkranos@cnrs-orleans.fr)

*Co-convener:* S. D. Bale, Space Sciences Laboratory, University of California, Berkeley, USA

### **GAIV04 Interaction of fast flowing plasmas with the neutral environments of unmagnetized bodies**

This session will summarize recent progress in the space plasma physics of solar system bodies without measurable dynamo magnetic field, including new results from Mars Global Surveyor and Mars Express at Mars and from Cassini around Saturn's moon Titan. The interaction of Mars with the solar wind is mainly of the atmospheric type like Venus with strong modifications of the local ionospheric structure by the crustal fields, and their exosphere makes these planets also share common physical processes with comets. The interaction of Titan with the fast co-rotating plasma inside the magnetosphere of Saturn is another example of such interaction. Numerous open issues include upstream waves, plasma boundaries and their dynamics, atmospheric and ionospheric escapes, etc. Recent results in data analysis and theoretical results, including numerical simulations are encouraged. Papers related to forthcoming space missions (Venus-Express and Rosetta) are also welcome.

*Convener:* Christian Mazelle, Centre d'Etude Spatiale des Rayonnements, CNRS / University of Toulouse / Observatoire Midi-Pyrénées, 9, Avenue du Colonel Roche, BP 4346, 31029 Toulouse Cedex 4, France; tel. +33 5-6155-7775; fax +33 5-6155-6701; e-mail: [christian.mazelle@cesr.fr](mailto:christian.mazelle@cesr.fr)

*Co-conveners:* Dave L. Mitchell, Space Sciences Laboratory, University of California, Berkeley, USA; W. Ip, Institute of Astronomy, National Central University, Taiwan.

### **GAIV05 International Heliophysical Year: A program of global research**

In 1957 a program of international research was organized as the International Geophysical Year (IGY) to study global phenomena of the Earth and geospace. The IGY involved about 60,000 scientists from 66 nations, working at thousands of stations, from pole to pole to obtain simultaneous, global observations on Earth and in space. There had never been anything like it before. The fiftieth anniversary of the International Geophysical Year will occur in 2007. We propose to organize an international program of scientific collaboration for this time period called the International Heliophysical Year (IHY). Like its predecessors, the IHY will focus on fundamental global questions of Earth science via the following goals: 1) Obtain a coordinated set of observations to study at the largest scale the solar-generated events and their effect life and climate on Earth, 2) Document and report the observations and provide a forum for the development of new scientific results utilizing these observations, 3) Foster international cooperation in the study of Heliophysical phenomena now and in the future, and 4) Communicate the unique scientific

results of the IHY to the interested scientific community and to all the peoples of Earth.

The objective of the IHY is to discover the physical mechanisms at work which couple the Earth to events from the Sun and heliosphere. The systematic global study of this connection is to be the central theme of the IHY. This special session will focus on research and campaign efforts which lay the groundwork for the IHY. This session will be used as a forum for discussion of the nature of the IHY, and to solicit suggestions and ideas from the community.

*Convener:* J. M. Davila, Code 682, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA; tel +1 301 286-8366; fax +1 301 286-1617; e-mail:

[joseph.m.davila@nasa.gov](mailto:joseph.m.davila@nasa.gov)

*Co-conveners:* R. A. Harrison, Rutherford Appleton Laboratory, UK; R. Jain, Physical Research Laboratory, Ahmedabad, India; I. S. Veselovsky, Institute of Nuclear Physics, Moscow State University, Russia.

#### **GAIV06 Reporter Reviews**

This session contains reviews of recent advances, both theoretical and observational, on the Sun, solar wind, and heliosphere. Given by active researchers, these reviews will cover a comprehensive range of topics in a manner that is accessible to researchers from other IAGA Divisions, while offering synthesis and context to Division IV scientists. All talks in this session are by invitation only.

*Convener:* I.H. Cairns, School of Physics, University of Sydney, NSW 2006, Australia; tel +61 2 9351-3961; fax +61 2 9351-7726; e-mail: [cairns@physics.usyd.edu.au](mailto:cairns@physics.usyd.edu.au)

### Division V

#### **IDV01 Geomagnetism and geospace climatology**

*(Divisions V and III)*

Long-term variations in the magnetic environment of the Earth due, for example, to solar variability and secular change in the Earth's core-generated dynamo may be seen in geomagnetic and space physics data records. In this session we invite contributions that illustrate these changes and provide insights into the evolution of geospace. Contributions that address the consequences of the evolution of geospace are also welcomed.

*Convener:* A W P Thomson, British Geological Survey, West Mains Road, Edinburgh EH9 3LA, UK; tel +44 131 650 0257; fax +44 131 668 4368; e-mail:

[a.thomson@bgs.ac.uk](mailto:a.thomson@bgs.ac.uk)

*Co-conveners:* K.-H. Glassmeier, Institute Geophysik & Meteorology, Braunschweig, Germany; M. Nose, Kyoto University, Japan

#### **IDV02 Magnetic anomalies at low latitude** *(Division V and IDCDC)*

Analysis of magnetic data has been complicated by the changing inclination of the main geomagnetic field. Interpretational tools developed for the analysis of high

latitude magnetic anomalies are not directly applicable to low-latitudes; the analysis of low latitude magnetic anomalies needs special attention. Papers dealing with magnetic anomaly map generation, analysis and interpretation of low latitude and equatorial regions are sought. Papers dealing with magnetic anomalies derived from ground based, aeromagnetic, satellite based or marine magnetic data are welcome.

*Convener:* Mita Rajaram, Indian Institute of Geomagnetism, New Panvel (W), Navi Mumbai 410218, India; tel +91 22 27480760; fax +91 22 27480762; e-mail [mita@iigs.iigm.res.in](mailto:mita@iigs.iigm.res.in)

*Co-conveners:* Y. Cohen, IPGP, France; Carlos Mendonca, IAG, Brazil

#### **IDV03 Swarm - Earth's magnetic field and environment explorers**

The European Space Agency, ESA, has approved the mission Swarm - Earth's Magnetic Field and Environment Explorers for full implementation and launch in 2009 as Explorer number 5 in its Living Planet Programme. During the 4-year operational phase the Swarm mission will complete the International Decade of Geopotential Field Research that was announced in a resolution adopted by IAGA and IUGG and initiated so successfully with the launch of the Danish satellite Ørsted in February 1999, followed by the German satellite, CHAMP and the Argentinean satellite, SAC-C in 2000.

The objective of the Swarm mission is to provide the best ever survey of the geomagnetic field and its temporal evolution, in order to gain new insights into the Earth system by improving our understanding of the Earth's interior and its electrodynamic environment. After release from a single launcher, a side-by-side flying lower pair of satellites at an initial altitude of 450 km and a single higher satellite at 530 km will form the Swarm constellation. High-precision and high-resolution measurements of the strength, direction and variation of the magnetic field, complemented by precise navigation, accelerometer and electric field measurements, will provide the necessary observations that are required to separate and model various sources of the geomagnetic field.

This short session will be dedicated to a suite of invited talks to provide the science community with adequate information about the mission, the science objectives, the instruments, and the expected data products that will be made available to the users.

*Convener:* E. Friis-Christensen, Danish Space Research Institute, Juliane Maries Vej 30DK-2100 Copenhagen OE, Denmark; tel: +45 35325707; fax: +45 35362475; e-mail: [efc@dsri.dk](mailto:efc@dsri.dk)

*Co-conveners:* R. Haagsmans, ESA, ESTEC, Noordwijk, Netherlands

### **GAV01 Magnetic observatories: measurements, quality analysis, and data dissemination**

High-quality data from magnetic observatories and repeat stations are crucial to the understanding of the evolution of the geomagnetic field on a variety of time-scales from seconds to centuries. This Symposium aims to bring together those who are involved in all aspects of data collection as well as those researchers analyzing and interpreting these measurements.

New contributions on magnetic observatory instrumentation, data collection and measurement practices, as well as the scientific evaluation of these observations will be especially welcomed.

*Convener:* P B Kotzé, Hermanus Magnetic Observatory, Box 32, Hermanus 7200, South Africa; Tel. +27 28 3121196, Fax. +27 28 3122039; e-mail: [pkotze@hmo.ac.za](mailto:pkotze@hmo.ac.za)

*Co-conveners:* P Hejda, Geophysical Institute, Prague, Czech Republic; S Macmillan, British Geological Survey, Edinburgh, UK; M Manda, Institute de Physique du Globe, Paris, France.

### **GAV02 Indices and algorithms for detecting geomagnetic and space weather events**

Up until now SSC, SFE and bays, etc. have been catalogued by experts either, visually analysing the records, or using semi automatic data processing techniques. Due to current demands by users for near real-time analysis of these data, new automatic processes and signal analysis techniques are being developed. The aim of this symposium is to provide the opportunity for the international research community to review the progress and suggest future directions in these investigations of event detection. Papers describing techniques to detect geomagnetic events on regional or global-scale, using ground and/or satellite data are especially welcome. Defining the distinctive signatures of the geomagnetic events which are significant in the solar and geophysical variability and those having applications in space-weather predictions would be of particular interest. Papers related to the automatic or quasi-automatic derivation and use of geomagnetic indices are also welcome.

*Convener:* J.J. Curto (Spain), Observatori de l'Ebre CSIC-URL, Horta Alta, 38, 43520 Roquetes (Sapin); tel +34 977 500511; fax +34 977 504660; e-mail: [jjcurto@obsebre.es](mailto:jjcurto@obsebre.es)

*Co-conveners:* M. Kunitake, Japan; E. Clarke, UK; R. Lukianova, Russia

### **GAV03 High resolution marine magnetics: new techniques and experiments**

All contributions addressing recent advances in marine magnetics are welcome. Presentations of new techniques, including a variety of newly developed instruments (sea-surface or deep-sea operated, scalar or vector) and the methods required to interpret their data are encouraged. Results of recent experiments designed to investigate, among others, the magnetic

structure and properties of the oceanic crust, the magnetic signature of faults and hydrothermal activity, the magnetization of seamounts, the time variations of the geomagnetic field, the high resolution dating of the seafloor, would be particularly appreciated. Marine magnetic studies about continental margins or in shallow water environments are also very welcome.

*Convener:* J. Dyment, Institut de Physique du Globe, 4 place Jussieu, 75005 Paris, France; tel +33 1 44 27 28 21; fax +33 1 44 27 99 69; e-mail: [idy@ipgp.jussieu.fr](mailto:idy@ipgp.jussieu.fr)

*Co-conveners:* S.M. Lee, Seoul National University, Republic of Korea; T. Fujiwara, Japan Marine Science and Technology Center, Japan

### **GAV04 World Magnetic Anomaly Map: anomaly definition and calculation**

The first edition of the global digital magnetic anomaly map is aimed to represent such a component of the Earth's magnetic field that is caused by the magnetized uppermost part of the lithosphere, as if it were observed a few km above the Earth's surface. The anomalies are supposed to be calculated using as similar principles as possible everywhere. Further, the definition and anomaly calculation should allow transforming the digital map to another reference system in future. Well knowing the difficulties caused by temporal variation of the recorded magnetic field and great heterogeneity in quality and information density of available data sets the Task Force of WDMAM of IAGA invites papers to present anomaly definitions and practical calculation methods for major data sets. Poster presentations are invited to display major anomaly sets reduced and compiled by controlled methods.

*Convener:* Juha V. Korhonen, Geological Survey of Finland, P.O.Box 96, FI-02151 Espoo, Finland; Phone. +358 20 550 2275; Fax +358 20 550 12; e-mail: [juha.korhonen@gtk.fi](mailto:juha.korhonen@gtk.fi)

*Co-conveners:* Dhananjay Ravat, Southern Illinois University C'dale, USA; Colin Reeves, ITC, The Netherlands

### **GAV05 International Decade for Geopotential Research: Advances in understanding the geomagnetic field**

The 'Decade of Geopotential Research', inaugurated with the launch of Ørsted and SunSat in February of 1999, and continuing with CHAMP, is an international effort to promote and coordinate a continuous monitoring of the geopotential (magnetic and gravity) field variability in the near-Earth environment. Following 20 years without satellite magnetic coverage, the first seven years of the 'Decade of Geopotential Research' have provided the geomagnetic community with a wealth of high quality data from several near-Earth satellites. Combined with ground based data, this has opened numerous opportunities for studies ranging from core flow, mantle



conductivity, lithospheric composition and ocean flow to the dynamics of ionospheric and magnetospheric currents. Contributions to these topics and the new satellite missions are solicited for this session.

*Convenor:* B. Langlais, Laboratoire de Planétologie et Géodynamique de Nantes, CNRS UMR 6112, Faculté des Sciences et Techniques, Université de Nantes, 2 rue de la Houssinière, 44322 Nantes cedex, France; tel +33 (0) 251 125 497 ; fax +33 (0) 251 125 268 ;

[Benoit.Langlais@chimie.univ-nantes.fr](mailto:Benoit.Langlais@chimie.univ-nantes.fr)

*Co-convenor:* K. Whaler, Institute of Earth Science, University of Edinburgh, UK; S. Maus, GeoForschungsZentrum, Potsdam, Germany; P. Stauning, Danish Meteorological Institute, Copenhagen, Denmark.

### **GAV06 Uses and applications of geomagnetic field models**

The aim of this symposium is to bring together users and modellers so as to foster better interaction and mutual understanding. Have YOU an application that modellers have not thought about? What do users want from models of the internal and external fields and what are the problems users have in applying models? How does truncation level affect you? Do you have a need for a truly continuous, rather than piece-wise continuous, internal model? Would you prefer to use a more accurate model, even if it meant waiting to get some model parameters (such as Dst) which are available only after considerable delay? We need to hear from YOU about YOUR problems/preferences. This session is for users and modelers alike, and we specifically encourage examples of the techniques used in the application of these models to benefit science and society. We welcome examples by users from both the external and internal geomagnetic communities.

*Convenor:* F.J. Lowes, Physics Department, University of Newcastle, Newcastle upon Tyne, NE1 7RU, UK; tel +44(0)1912227413; fax +44(0)2227361;

[f.j.lowes@ncl.ac.uk](mailto:f.j.lowes@ncl.ac.uk)

*Co-convenor:* M.A.Shea, CSPAR, University of Alabama in Huntsville, Huntsville, USA.

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## Inter-Divisional Commission on Developing Countries

### **IDDC01 Signatures of low-latitude and equatorial geomagnetic variations**

The symposium will provide an open forum to present all aspects of geomagnetic variations at the equatorial and low latitude regions. Papers describing the variability of equatorial electrojet on global-scale, using ground and/or satellite data are especially welcome. Distinctive signatures of the equatorial magnetic field that signify solar and geophysical forcing and have applications in space-weather predictions would be of particular interest.

*Convenor:* Nguyen Thi Kim Thoa, Institute of Geophysics, 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam; tel +84 48 363238; fax +84 48 364696; e-mail: [nkthoa@fpt.vn](mailto:nkthoa@fpt.vn)

*Co-convenors:* B.R. Arora, Wadia Institute of Himalayan Geology, India; Heather McCreadie, Kyoto University, Japan

### **IDDC02 Recent advances in the investigation of equatorial aeronomic processes**

Contributions related to recent advances in theoretical and experimental investigations on (i) Equatorial Electrojet (ii) Dynamical Processes and Coupling of the E and F-region and (iii) Plasma Irregularities, with special emphasis on the equatorial and low latitude regions are welcome. The main emphasis of the session will be on obtaining an integrated view of the physical, chemical and electro-dynamic processes that occur in the equatorial and low latitude E and F regions and thereby on working out specific future plans of coordinated observations especially in the developing countries in order to solve the still unresolved problems in the area. Contributions on recent advances that can widen the existing data base on the equatorial and low latitude upper atmosphere and ionosphere are also most welcome.

*Convenor:* Polinaya Muralikrishna, Instituto Nacional de Pesquisas Espaciais, C.P.515, 12.201-970 Sao Jose Dos Campos, Sp, Brazil; tel +55123456841; fax +55124356990; e-mail: [murali@dae.inpe.br](mailto:murali@dae.inpe.br)

*Co-convenors:* Christine Amory-Mazaudier, CETP, Paris, France; Vafie Doumouya, Université de Cocody, Cote d'Ivoire

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## Inter-Divisional Commission on History

### **IDH01 Historical events and people in aeronomy, geomagnetism and solar-terrestrial physics**

This interdisciplinary session seeks to describe and explore the varied and powerful history of aeronomy, geomagnetism and solar-terrestrial physics by considering many aspects of this development during past decades. Papers and posters are welcome to biographical studies, history of institutions and research program (e.g. First and Second Polar Year), specific topics in geophysical research.

*Convenor:* Wilfried Schroeder, Geophysical Institute, Hechelstrasse 8, D-28777 Bremen, Germany; e-mail: [Geomoppel@t-online.de](mailto:Geomoppel@t-online.de)

*Co-Convenors:* A. Brekke, Institute Physical Sciences, University of Tromsø, Tromsø, Norway; J.B. Cao, Center for Space Research, Chinese Academy of Sciences, Beijing, China; M. Schulz, Lockheed, Los Angeles, USA



# Timetable for Toulouse 2005 – Week 1

The duration of the oral sessions is a full day unless stated otherwise

|  | Monday July 18   | Tuesday July 19   | Wednesday July 20   | Thursday July 21  | Friday July 22  |
|--|--|---|---|---|---|
| <b>Association lectures</b>                                |  | <b>Ass. Lect. No 1:</b> A new era for geomagnetism                              |   | <b>Ass. Lect. No 2:</b> IGY+50 and the eGY  |   |
| <b>Joint symposia IAGA&amp;ICMA</b>                        |  |   | <b>JSII02</b> Long-term trends in the upper atmosphere  | <b>JSMA03</b> Short-term variability and long-term changes in the lower and middle atmosphere                   | <b>JSII01</b> Vertical coupling of the atmosphere-ionosphere system and solar effects on it |
| <b>Division I symposia</b>                                 | <b>IDI01</b> The geodynamo: theory models, observation & experiment.                   | <b>IDI01</b> The geodynamo: theory models, observation & experiment.            | <b>IDI02</b> Investigation of the deep mantle using long period EM data from observatories, cables, long period MT and satellites (1/2d am) | <b>GAI01</b> Monitoring earthquakes and volcanic activity by magnetic, electric and electromagnetic methods     | <b>GAI02</b> EM imaging of volcanoes and active faults (1/2d am)                            |
|  | <b>GAI07</b> Magnetic anisotropy: problems and answers?                                | <b>GAI08</b> Magnetic dating (1/2d pm)  | <b>GAI01</b> Monitoring earthquakes and volcanic activity by magnetic, electric and electromagnetic methods (1/2d pm)                       | <b>GAI09</b> Rock magnetism applied to environmental problems (1/2d pm)   | <b>GAI10</b> Theories, models and experiments in rock magnetism                             |
| <b>Division II symposia</b>                                | <b>GAI01</b> Electrical energy deposition processes in the middle and upper atmosphere |   |   | <b>GAI03</b> Data assimilation techniques for the ionosphere-thermosphere-magnetosphere system                  |   |
| <b>Division III symposia</b>                               | <b>GAI01</b> The magnetospheric particle accelerator                                   | <b>GAI14</b> Reporter reviews   | <b>GAI03</b> Magnetic reconnection: conditions and mechanisms   | <b>GAI04</b> Structure and dynamics of the magnetopause and its boundary layers                                 | <b>GAI05</b> Physics of substorms and current sheet in the near-Earth and mid-tail region   |
| <b>Division IV symposia</b>                                | <b>GAI02</b> Physics of the interplanetary medium: From micro- to mesoscales           | <b>GAI02</b> Physics of the interplanetary medium: From micro- to mesoscales    | <b>GAI04</b> Interaction of fast flowing plasmas with the neutral environments of unmagnetized bodies                                       | <b>GAI04</b> Interaction of fast flowing plasmas with the neutral environments of unmagnetized bodies (1/2d pm) | <b>GAI05</b> International Heliophysical Year: A program of global research (1/2d am)       |
|  |  |   |   |   | <b>GAI06</b> Reporter reviews (1/2d pm)   |
| <b>Division V symposia</b>                                 | <b>IDV01</b> Geomagnetism and geospace climatology                                     | <b>IDV02</b> Magnetic anomalies at low latitude (1/2d pm)                       | <b>GAV04</b> World Magnetic Anomaly Map: anomaly definition and calculation (1/2d pm)   | <b>GAV02</b> Indices and algorithms for detecting geomagnetic and space weather events                          | <b>GAV03</b> High resolution marine magnetics: new techniques and experiments               |
|  |  | <b>IDV03</b> Swarm - Earth's magnetic field and environment explorers (1/2d am) |   |   |   |
| <b>Inter-Divisional Commission on Developing Countries</b> |  | <b>IDDC01</b> Signatures of low-latitude and equatorial geomagnetic variations  | <b>IDDC02</b> Recent advances in the investigation of equatorial aeronomic processes  |   |   |
| <b>Inter-Divisional Commission on History</b>              |  |   |   |   |   |
| <b>ICMA</b>  | <b>MA01</b> Middle atmosphere science  | <b>MA01</b> Middle atmosphere science   | <b>MA01</b> Middle atmosphere science   | <b>MA01</b> Middle atmosphere science   | <b>MA01</b> Middle atmosphere science   |

## Timetable for Toulouse 2005 – Week 2

The duration of the oral sessions is a full day unless stated otherwise

|  | Monday July 25   | Tuesday July 26   | Wednesday July 27   | Thursday July 28  | Friday July 29  |
|--|--|---|---|---|---|
| <b>Association lectures</b>                                | <b>Ass. Lect. No 3:</b> The Earth's magnetic field and life                                    |   | <b>Ass. Lect. No 4:</b> Climate and weather of the Sun-Earth system   |   |   |
| <b>Joint Symposia IAGA&amp;ICMA</b>                        | <b>JSMA01</b> Layered phenomena near the mesopause   | <b>JSMA02</b> Solar variability effects on the middle atmosphere and troposphere  |   |   |   |
| <b>Division I symposia</b>                                 | <b>GAI03</b> EM modelling and inversion with applications                                      | <b>IDI03</b> Magneto-petrology and magnetic anomalies (1/2d am)   | <b>GAI04</b> The electric continental lithosphere: geodynamical implications (1/2d pm)  | <b>GAI06</b> NRM - reliability, stability and geodynamic applications                             | <b>GAI05</b> EM studies of intraplate collisional zones (1/2d am) |
|  | <b>GAI11</b> Paleointensities - techniques and observations                                    | <b>GAI12</b> Open poster session on paleo-, rock and environmental magnetism (1/2d pm)                                  |   |   |   |
| <b>Division II symposia</b>                                | <b>IDII02</b> Conjugate and interhemispheric polar studies                                     | <b>IDII04</b> Electrodynamical processes in the equatorial and low latitudes: Coupling with the global system (1/2d am) | <b>IDII01</b> Low latitude atmosphere - ionosphere - magnetosphere coupling, dynamics and energetics (including small scale coupling) | <b>IDII03</b> Space weather effects on the ionosphere   |   |
|  |  |   | <b>GAI02</b> Planetary ionospheres and thermospheres  |   |   |
| <b>Division III symposia</b>                               | <b>GAI03</b> Monitoring and specification of magnetospheric dynamics using ULF waves (1/2d pm) | <b>GAI06</b> Magnetosphere-ionosphere coupling dynamics (1/2d pm)   | <b>GAI08</b> Global scale synthesis from models and distributed observations  | <b>GAI09</b> Plasma sources, sinks, and transport   | <b>GAI02</b> Electrodynamic of aurora (1/2d am)                   |
|  | <b>GAI11</b> Spacecraft-plasma environment interactions (1/2d pm)                              | <b>GAI13</b> Fundamental processes: lessons from other magnetospheres   | <b>GAI10</b> Characterizing and forecasting space environment hazards   | <b>GAI07</b> Geomagnetic disturbances, storms and radiation belts                                 |   |
| <b>Division IV symposia</b>                                | <b>IDIV01</b> Solar-terrestrial connections: International Living With a Star                  | <b>IDIV01</b> Solar-terrestrial connections: International Living With a Star   | <b>GAI03</b> Foreshock, shock, and magnetosheath physics for collisionless shocks   | <b>GAI01</b> The Sun: Its interior, atmosphere and wind   | <b>GAI01</b> The Sun: Its interior, atmosphere and wind (1/2d am) |
|  |  |   | <b>GAI01</b> The Sun: Its interior, atmosphere and wind (1/2d pm)   |   |   |
| <b>Division V symposia</b>                                 | <b>GAV01</b> Magnetic observatories: measurements, quality analysis, and data dissemination    | <b>GAV05</b> International Decade for Geopotential Research: Advances in understanding the geomagnetic field            | <b>GAV05</b> International Decade for Geopotential Research: Advances in understanding the geomagnetic field                          | <b>GAV06</b> Uses and applications of geomagnetic field models                                    |   |
| <b>Inter-Divisional Commission on Developing Countries</b> |  |   |   |   |   |
| <b>Inter-Divisional Commission on History</b>              |  |   |   | <b>IDH01</b> Historical events and people in aeronomy, geomagnetism and solar-terrestrial physics |   |
| <b>ICMA</b>  |  |   |   |   |   |