Scientific Research Programme Report to SCAR

Interhemispheric Conjugacy Effects in

ICESTAR

Solar-Terrestrial and Aeronomy Research

http://SCAR-ICESTAR.ORG

Expected Overall Programme duration: 2005 – 2009

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Selected ICESTAR Highlights in 2006

- ICESTAR researchers report that conjugate studies of aurora showed that observed asymmetry in the southern and northern locations of simultaneous high-latitude substorm onsets are not symmetric, but can have displacements as much as 10 times larger than the current models prediction. Understanding such difference has important implications for understanding and predicting space weather events that could have deleterious technological impacts. (N. Østgaard , S. B. Mende, H. U. Frey, and J. B. Sigwarth, *Auroral Conjugacy studies based on global imaging*, JASTP, special issue from the 2006 Yosemite Meeting.)

- ICESTAR scientists provided new insights into the seasonal effects of electric currents aligned with Earth's magnetic field lines by comparing simulated and observed seasonal effects in the electric currents aligned with magnetic field lines that couple the magnetosphere and ionosphere over both the Northern and Southern Polar Regions. In addition to seasonal changes in the ambient ionospheric conductivity due to solar illumination, another seasonal dependency needs to be introduced to the auroral precipitation patterns in the sunlit and dark polar caps to compensate the puzzling discrepancy between the MHD simulations and observations of field-aligned currents. (A.J.Ridley, *The effects of seasonal changes in the ionospheric conductances on magnetospheric field-aligned currents*, submitted to *Geophysical Research Letters*, November 2006.)

- ICESTAR scientists provide new insights into the effects of solar energetic particles on middle atmospheric chemistry of NO_2 and O_3. The Earth continuously undergoes precipitation of energetic charged particles originating from the near-earth space. The charged particles enter the Earth's atmosphere causing ionization in the middle atmosphere. The primary effect is confined to the polar cap regions, where the particles are guided by the magnetic field. In the atmosphere, the enhanced ionization leads to increased production of odd nitrogen and odd hydrogen, which take part in catalytic reaction cycles decreasing the amount of ozone. HO_x gases have a short chemical lifetime while the NO_x gases are mainly destroyed by photo dissociation. Hence, during polar winter, when little or no sunlight is available in the atmosphere, the effect of the NO_x cycles can be long lasting and extend outside the polar cap regions though transport processes in the atmosphere. Ozone observations show that ozone loss takes place in the upper stratosphere following the observed NO_x enhancements. (A. Seppälä et al, *Polar Winter NO2 Enhancements 2002-2006 from GOMOS/Envisat*, Trans. AGU, 87*(*52), 2006 Fall Meet. Suppl., Abstract SA24A-04.)

- Satellite observations show that the global rate of merging between interplanetary magnetic fields and Earth's magnetosphere drives near-Earth space weather - in contrast to the long-standing view that space weather could best be predicted by the behaviour of solar wind electric fields. This hypothesis is currently undergoing the thorough testing by ICESTAR researchers in the analyses of ground-based observations at the footprints of the merged magnetic field-lines in the Artic and Antarctic. (P. T. Newell et al., *A Nearly Universal Solar-Wind Magnetosphere Coupling Function Inferred from Ten Magnetospheric State Variables*, Trans. AGU, 87(52), 2006 Fall Meet. Suppl., Abstract SM22A-03.)

- ICESTAR team leaders direct "*Heliosphere Impact on Geospace*" - a core project of the 2007-2009 International Polar Year. This project (ID# 63) will be run by a federation of 29 international research groups from which the ICESTAR and IHY communities will carry the management responsibilities. The kick-off meeting of the IPY project 63 "Heliosphere Impact on Geospace" will be held at the Finnish Meteorological Institute in Helsinki on February 07.

ICESTAR Overview

The ICESTAR Programme will create an integrated, quantitative description of the upper atmosphere over Antarctica, and its coupling to the global atmosphere and the geospace environment. The reasons to embark on the endeavour now are outlined below.

The Emergence of New Datasets. The volume of experimental data has been increasing significantly in recent years. In addition, many new datasets are expected to come on-line in the near future. At this time, there are new magnetometer chains, new polar orbiting satellites which allow the simultaneous view of the Southern and Northern polar regions, new ionospheric (SuperDARN, AMISR, and EISCAT) radars, new mesospheric/thermospheric wind measurements (meteor radars, FPIs), new digisonde and TEC data. It is the right time to begin to create tools to examine the entire system as a whole.

Emergence of Grid technology. The 'Grid' is just starting to be defined, and has yet to find a real niche. The seamless sharing of data is one possibility, and is one of the main goals of the ICESTAR programme. The creation of visualization tools that can utilize globally distributed data sets will push the limits of the current technologies and will spark the creation of new Grid functions. In addition, enabling the convergence of data and models is another strong goal of the Grid technology, which is synergistic with the programme goals.

Enable Easy Access to Distributed Data. Many research groups are creating data assimilation tools that require the use of as many data sources as possible. The creation of the ICESTAR data portal and use of the Antarctic Data Master Directory will enable these developments to grow.

Uniqueness of Antarctica. The Antarctic continent offers a unique vantage point for examining the near-Earth space environment, spanning from the top of the troposphere, through the stratosphere, mesosphere, thermosphere, and ionosphere, and into the magnetosphere. Here we underscore some of the similarities and differences between the Arctic and Antarctic:

- Very different underlying neutral atmosphere, e.g., planetary waves and gravity waves morphology is very different, and more intense jet stream exists in the Antarctic;
- Much larger displacement of the magnetic dip pole in the South than in the North, which means it is much easier to separate effects that are controlled by solar radiation;
- The geomagnetic field is weakest in the South Atlantic sector, thus the flux of energetic particles is higher than anywhere else allowing to studying the atmospheric consequences of energetic particle precipitation

Science. The ICESTAR programme will enable focused upper atmosphere scientific research from Antarctica. One goal is to determine how this region of space fits within the global system. No other programme exists which is focused specifically on the quantitative understanding of the upper atmosphere above the Antarctic continent.

International Cooperation: Studies of the polar upper atmosphere fundamentally require international collaboration. Consider first the deployment of instruments across Antarctica. These instruments are either located at manned bases or are remotely deployed and serviced from such bases. From a logistical and financial standpoint, it is not feasible to deploy a network of instrumentation in Antarctica without international collaboration. The problem is even more complex in the Arctic as individual countries there have control over portions of the region. With instruments being deployed and operated by different countries, international collaboration is essential so that data can be exchanged and integrated.

ICESTAR Science Progress in 2006

Selected Invited Presentations and Talks

- *Heliosphere Impact on Geospace - Solar-Terrestrial and Aeronomy Research During the IPY Years*, Session U14: International Polar Year 2007-2008: Global Science at High Latitudes, Weatherwax, A., K. Kauristie, R. Stamper, V. Papitashvili, B. Fraser, N. Ostgaard, M. Candidi, and the ICESTAR/IHY Team, 2006 Fall AGU Meeting, San Francisco, December 11-15, 2006.

- *Developing cyber-infrastructure for addressing grand challenge questions in Sun-Earth system science: First results of a testbed worldwide online conference series*, Session IN14: Exemplifying eGY Principles: eGY Showcase Projects, Kozyra, J. U., R. Barnes, N. J. Fox, P. A. Fox, M. M. Kuznetsova, D. Morrison, D. Pallamraju, V. Papitashvili, A. Ridley, E. R. Talaat, M. Weiss, C. A. Young, and L. J. Zanetti, Fall AGU Meeting, San Francisco, December 11-15, 2006.

- *Investigating the state of the Sun-Earth system during extreme events: First science results of a worldwide online conference series*, J.U. Kozyra et al., *AGU, 87*(52), Fall Meet, 2006.

- *Solar-Terrestrial and Aeronomy Research in Antarctica… and in the Arctic: How Polar Regions Interconnect?* Papitashvili, V. O., Plenary Session 100, SCAR XXIX/COMNAP XVIII, Hobart, Tasmania, July 9-19, 2006.

- *ICESTAR - An IHY/IPY study of interhemispheric relationships in space physics*, Donovan, E., K. Kauristie, R. Harrison, R. Stamper, A. Weatherwax, and V. Papitashvili, Session U34A "International Science Years on the Fiftieth Anniversary of IGY: eGY, IHY, IPY, and Planet Earth", 2006 Spring AGU Meeting, Baltimore, May 23-26, 2006.

- *Auroral conjugacy studies based on global imaging*, N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, A. Aasnes, J. Weygand, National Institute of Polar Reasearch, Tokyo, Japan, August 2006.

- *Hemispherical asymmetries derived from conjugate auroral imaging,* N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, A. Aasnes, J. Weygand, Western Pacific Geophysical Meeting, Beijing, China, July 2006.

- *Conjugate imaging of substorms.* N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, A. Aasnes., Invited talk at the ICS-8, March, Calgary, 2006.

- *Auroral conjugacy studies,* N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, Yosemite meeting, California, February, 2006.

- *Simulaneous imaging of the reconnection spot in the opposite hemispheres during northward IMF,* N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, IHY European Assembly, January 2006.

- *A Sun-to-Earth Campaign Joining Observations from the Great Observatory with Worldwide Satellite and Ground-Based Resources to Investigate System Science Frontiers*, Kozyra et al., *AGU, 87*(36), Jt. Assem. Suppl., 2006.

Selected Contributed Presentation and Talks

- Approximately forty papers were by ICESTAR team members were presented at the *Open Science Conference* of the 2006 SCAR meeting in Hobart, Australia, ICESTAR team members. Several are cited below, in addition to papers given at other international meetings.

- *International Science Years on the Fiftieth Anniversary of IGY: eGY, IHY, IPY, and Planet Earth,* Donovan, E., K. Kauristie, R. Harrison, R. Stamper, A.Weatherwax, and V. Papitashvili, 2006 Spring AGU Meeting, Baltimore, May 23-26, 2006.

- *Geospace research with optical measurements within the ICESTAR-IHY-IPY Programme***,** Kauristie, K., Partamies, N., Mäkinen, S., and Kuula, R. ICESTAR and IHY Teams, 33rd Annual European Meeting on Atmospheric Studies by Optical Methods, 2006.

- *IPY Data Management - How one can deploy a virtual observatory in cyberspace?* Papitashvili, V. O.,, Session IN05: Data Sources and Management for the 2007-2009 International Polar Year, 2006 Fall AGU Meeting, San Francisco, December 11-15, 2006.

- *Autonomous Low-Power Instrument Platform to enable Remote High Latitude Array Deployment,* Clauer, C. R., S. Musko, K. Arnett, V. Papitashvili, and A. Ridley, Session SM07: Advances in Space Science Instrumentation 2006 Fall AGU Meeting, San Francisco, December 11-15, 2006.

- *ICESTAR: Deployment of Virtual Observatories In Cyberspace Towards Creating the Worldwide Fabric of Geophysical Data*, Papitashvili, V. O., V. G. Petrov, N. E. Papitashvili, Session 610 "Magnetosphere/ionosphere/mesosphere coupling", SCAR XXIX/COMNAP XVIII, Hobart, Tasmania, July 9-19, 2006.

- *Substorm onset asymmetries derived from conjugate auroral imaging*, N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, A. Aasnes, EGU meeting, Vienna, Austria, April, 2006.

- *ICESTAR A connection between IHY and IPY,* N. Østgaard , K. Kauristie, A.Weatherwax, EGU meeting, Vienna, Austria, April, 2006.

- Implementing a Virtual Workshop for Interdiscplinary collaboration on Grand Challenge Issues: Lessons Learned, R.J. Barnes et al., *AGU, 87*(52), Fall Meet, 2006.

- The Global Auroral Imaging Access (GAIA) VxO Program, E. Spanswick et al., *AGU, 87*(52), Fall Meet, 2006.

- *Real-time Data Access From Remote Observatories*, Detrick, D L, L. Lutz, J. Etter, T.J. Rosenberg, and A.T. Weatherwax, *AGU, 87*(52), Fall Meet, 2006.

- *Pc 1-2 Waves and Energetic Particle Precipitation During and After Magnetic storms: Superposed Epoch Analysis and a Case Study*, M. Engebretson et al., *AGU, 87*(52), Fall Meet, 2006.

Publications

- Auroral Conjugacy studies based on global imaging, JASTP, special issue from Yosemite 2006, N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, A. Aasnes, J. Weygand. in press, 2006.

- Conjugate imaging of substorms, N. Østgaard , S. B. Mende, H. U. Frey, J. B. Sigwarth, A. Aasnes, J. Weygand. Proceedings from the ICS 8 in Banff, Canada, 2006.

- A Virtual Global Magnetic Observatory: VGMO.NET, Papitashvili, V. O., A. B. Saxena, V. G. Petrov, C.R. Clauer, and N.E. Papitashvili, Earth, Planets and Space, 58, No. 6, 765, 2006.

ICESTAR Accomplishments in 2006

Coordinate Research Activities between ICESTAR, IHY and IPY

The first concrete attempt to link the IHY, IPY and ICESTAR research activities took place in October 2006. The IHY CIP coordinators under the theme of ionized atmospheres (Ian McCrea and Kirsti Kauristie) inspected CIP proposals and the IPY Expression of Interest letters and compared their scientific objectives with the ICESTAR science programme. Opportunities for synergy were found at least in nine different research topics:

- Radio wave propagation in the ionosphere - observations and models
- Universality of Auroras
- Plasmaspheric Dynamics
- Cosmic ray fluxes and their atmospheric effects
- Atmospheric research with VLF-equipment
- Physics of 630 nm emission
- Dayside geospace phenomena
- Interhemispheric comparison studies
- Antarctic Space Weather Service

For each cluster the leaders of the projects were contacted and introduced with each other and some help with communication and data retrieval issues were offered.

Website

- ICESTAR continues to update and manage a website.
- The URL was changed in 2006 to http://scar-icestar.org.

Education and Public Outreach

For direct communication with the general public ICESTAR-IHY-IPY will establish an outreach programme which aims to coordinate parallel semi-annual media events in all participant countries during the IPY years. These events will be realized as press releases and popular lectures summarizing the recent scientific findings of the project. For the audience keen on observing the environment several research groups will put up web-interfaces to show real-time data from their instrumentation. The public understanding of geospace science will be expanded also in collabo-

ration with national research councils. The IPY 2007 Space Science Symposium and the "Life on Icy Worlds" conference, respectively, planned to be arranged in Greenland and in Alaska will be important forums for educating national science administrators and teachers about historical and forth coming research activities with the perspectives from Arctic natives, Antarctic scientists, and solar system explorers.

To educate next generation of geospace scientists ICESTAR-IHY-IPY will together with space science centres provide plenty of material for interesting and challenging exercises and thesis works. Students will participate in the measurement campaigns and in the development of the modern data-sharing systems. The easily accessible data-archives will provide important reference material for observational and theoretical investigations.

Newsworthy issues are listed below:

- **Effects of Solar proton events on mid-atmospheric chemistry**
  - Multinational campaigns with versatile instrumentation (Scandinavia-Alaska-Antarctica)
  - Continuous systematic radar observations of atmospheric flows and temperatures at different altitudes
  - Homogenenous data sets for modelling work

- **Space weather effects on technology**
  - Distributed GPS-receiver networks → Global picture of the ionospheric electron content and scintillation effects on navigation systems
  - Meridional chains of magnetometers → Remote sensing of radiation belt dynamics around the geostationary orbit

- **New innovations in measurement technology**
  - Test balloon flights for the NASA Jupiter Icy Moons Orbiter mission
  - Feasibility studies for next generation incoherent scatter radars
  - Network of automatic meteo-magnetic stations: Do strong cyclones affect ionospheric currents?

Virtual Observatories and Data Portals

In the first ICESTAR workshop in July 2005 Toulouse, data sharing issues were discussed for the first time among a wider community including representatives of some of the most widely used existing geospace data servers (e.g. SPIDR and CDAWeb, for more details see the notes of this meeting in http://scar-icestar.org. It was decided in the workshop that special attention in the first phase will be paid to three data servers: VGMO (magnetometer data), GAIA (auroral precipitation data), and Madrigal (Incoherent scatter radar data). The aim is to build or upgrade these systems so that they have easily adoptable interfaces both to the direction of the users and the data providers. A more ambitious goal will be to make the systems to communicate electronically.

Progress in 2006 the development of the GAIA VO:

- GAIA is presently being developed by research groups at the University of Calgary, Lancaster University, and the Finnish Meteorological Institute.
- A prototype of the VO for optical data (browser for quicklook data) was released
- See http://gaia-vxo.org.

- The observatory has already tools for browsing summary images from all-sky imagers, meridional scanning photometers, riometers and satellite borne global imagers.
- The system shows summary images (more than 10 000 000 images) from the MIRACLE, NORSTAR, THEMIS ASI, IRIS, and OMTI networks.
- Currently plan for the elements of the final system:
  - the data base of metadata and summary images and keograms (development ongoing);
  - browsing tools (ongoing);
  - tools for integrating data from different instruments together to increase the scientific usefulness of that data (being proposed in 2007);
  - pattern recognition and content based image retrieval tools (being proposed in 2007);
  - a system to provide access to full-resolution data (being developed in 2007).

Progress in 2006 the development of VGMO.NET:

- A prototype of the VO for magnetometer data, VGMO.NET, was released: see http://mist.engin.umich.edu/mist/vgmo/vgmo.html.
- See: *A Virtual Global Magnetic Observatory: VGMO.NET*, Papitashvili, V. O., A. B. Saxena, V. G. Petrov, C. R. Clauer, and N. E. Papitashvili, Earth, Planets and Space, 58, No. 6, 765-774, 2006.

Proposed Work Plan for the Next 2 Years

Collaboration between Ionospheric and Meteorological Research Groups

The multidiscipline IPY project POLENET (meteorology, glaciology, volganology, seismology) will build and maintain an extensive Antarctic network of dual-frequency GPS receivers. Data of this network would be invaluable for the ICESTAR-IPY community which also maintains several GPS receiver stations in the Antartic for ionospheric research. In the SCAR Cross-Linkages workshop (arranged in November 2006 in Rome) the POLENET and ICESTAR communities agreed to start collaboration in the development of GPS data sharing systems. A dedicated Working Group with POLENET, ICESTAR, and SSG-GS representatives will start the preparatory work in early 2007.

Special Issue JASTP

A special issue of JASTP will focus on the IPY #63 project objectives “ICESTAR/IHY - Heliosphere Impact on Geospace” – will be discussed at the kick-off meeting in Helsinki (February 5-9, 2007) with a publication target in the first part of 2008.

ICESTAR and IPY: "Heliosphere Impact on Geospace"

The ICESTAR community submitted an Expression of Intent to the call of IPY Core projects in January 2005. As response the IPY Joint Committee suggested ICESTAR to join with the IHY community (IHY= International Heliophysical Year) and to form an umbrella for 22 other projects which will address geospace and polar area aeronomy research topics. ICESTAR and IHY submitted the second round proposal with the title "ICESTAR/IHY – Interhemispheric Conjugacy in Geospace Phenomena and their Heliospheric Drivers" in June 2005 for IPY JC reconsideration. At the beginning of December the proposal received IPY's final endorsement after which the programme has still been expanded with seven additional sub-projects according to the suggestions of IPY JC. Consequently, today the programme includes 29 multinational consortia and appears as the project number 63 ("Heliosphere Impact on Geospace") in the official IPY Planning Chart.

Science of the ICESTAR-IHY-IPY programme

The scientific goals of the ICESTAR-IHY-IPY programme can be categorised under the following three main themes:

(i) *Coupling processes between the different atmospheric layers and their connection with the solar activity*: E.g. effects of mid-atmospheric circulation and extreme solar activity on the content of stratospheric ozone and minor constituents, variations of the cosmic ray fluxes above the polar areas and South Atlantic Anomaly, energy transfer from powerful weather fronts to geospace heights and using novel technology for stratospheric magnetic field measurements.

(ii) *Energy and mass exchange between the ionosphere and the magnetosphere:* E.g. multiscale and tomographic studies of ionospheric phenomena (auroral precipitation, convection, turbulence and electron content) as driven by magnetospheric and solar activity, remote-sensing of the radiation belts, and balloon-borne radio soundings of the ionosphere in conjunction with ground stations and satellites as pilot studies for future NASA missions.

(iii) *Inter-hemispheric similarities and asymmetries in geospace phenomena*: Science goals as above but under this theme special emphasis will be put on using both Arctic and Antarctic observations. In addition to several magnetometer and optical instrument networks bipolar data will be available also from HF-radars, riometers, digital ionosondes, dynasondes, dual-frequency GPS receivers and LEO satellite beacon receivers.

Each project in the combined proposal has a set of project-specific scientific objectives, but the interrelationships between the studied processes mean there is significant synergy between the projects. The result is that the overall proposal will be able to address topics with far-reaching scientific impact and of importance to society at large. For example, a practical benefit will be improved prediction of space weather phenomena which adversely affect spacecraft operations, humans in space, and satellite-based positioning systems; on the scientific side, global scale coordination of observing networks will allow us to study conjugate and multi-scale geospace phenomena in fundamentally new ways.

Instrumentation and measurement campaigns

The groups of the programme already run a large body of instrumentation in both the Arctic and the Antarctic polar regions to support their research projects. Several consortia are also proposing

to install new instruments to significantly improve the spatial coverage and resolution and to provide pairs of geomagnetically conjugate observations from both the hemispheres. A wide range of instrumentation with anticipated lifetimes beyond 2007 is proposed for installation in both polar regions including: HF radars, magnetometers, riometers, auroral imagers, GPS scintillation and dual frequency receivers, a VLF beacon transmitter, MST radars, radiometers, autonomous meteo-magnetic stations and balloon-borne radio sounders. Below we list some examples of institutes and/or research groups who have expressed their intentions to arrange measurement campaigns or to build permanent instrumentation in the polar regions:

Institute	Instrument/Campaign	Comments
British Antarctic Survey, UK	Radiometers, mesospheric imagers, Lidars	Collaboration with ALOMAR and EISCAT facilities
IFSI/INAF, Italy	Antarctic SuperDARN radar	
University of Calgary, Canada	THEMIS optical instrumentation	Data sharing will take place via the GAIA Virtual Observatory
University of La Sapienza, Italy	Balloon campaigns measuring the cosmic microwave background and magnetic field in the Arctic stratosphere	Collaboration with the Andoya Rocket range.
The EISCAT Association, Sweden	Continuous measurements with the EISCAT Svalbard radar	
NASA, USA	Balloon campaigns to test instrumentation for the NASA mission "Jupiter Icy Moons Orbiter"	
National Institute of Polar Research, Japan	Antarctic MST/IS radar (PANSY)	The radar will start operation during the IPY years
National Institute of Geophysics and Volcanology, Italy	GPS scintillation and dual frequency receivers both permanent stations and campaigns (Antarctic research vessel)	
GLORIA-team, several countries	New Arctic and Antarctic Imaging riometers	
Stanford University, USA	VLF transmitter and receivers in Antarctica	
University of Saskatchewan, Canada	Artic SuperDARN radars	The PolarDARN extension of SuperDARN
National Academy of Science, Ukraine	Antarctic automatic meteo-magnetic stations	
Polar Research Institute of China	Magnetometers, Antarctic SuperDARN radar	

The IHY community will coordinate an overarching synoptic observation programme and will provide systems and assessment processes for coordinating and facilitating dedicated campaigns in order to reap the advantages of interdisciplinary observations. The sub-projects within the ICESTAR-IHY-IPY programme projects have been encouraged to register their activities for-

mally with the IHY either as Coordinated Investigation Programmes (CIPs) or as Synoptic Programmes. Seven of the sub-projects have made their CIP proposal already. The proposals will be reviewed by IHY Science Working Groups (SWGs) , organised by discipline and consisting of experts in the field. For the projects coming together for IPY there is typically already a commitment of resources. The role of the SWGs will therefore, in this case, largely be confined to identifying synergies between proposals; in general, they will also liaise with observatory representatives and IHY national coordinators to assess the feasibility of proposals and negotiate the use of observatory facilities.

EISCAT IPY Campaigns

The EISCAT Association maintaining the network of incoherent scatter radars in the Fennoscandian mainland and Svalbard has received some extra funding for conducting continuous measurements during the IPY years (at least for the first year). The association has started the discussions about the template for the IPY runs. Current plans assume

- Field-aligned measurement with 42 m VHF antenna in Svalbard, time resolution 15 min, altitude range from as low an altitude as possible up to 600 km.
- Promptly analysed data will be distributed via Madrigal which can be linked with VOs.
- The aim of the run is to leave as a legacy a continuous data set which can be used for a variety of synoptic and statistical applications also outside the EISCAT community.

ICESTAR-IHY-IPY Management

The ICESTAR-IHY-IPY programme will be organised as a federation of subsidiary projects, each with a large degree of autonomy but with coordinating oversight from a steering committee. The constituent projects will have their own management bodies typically consisting of the instrument PIs and representatives from the funding parties, so that the best available expertise is close to the everyday activities. The umbrella steering committee will consist of representatives from the subprojects, with the lead being taken by IHY and ICESTAR, and including experts for the scientific issues, for the data-sharing procedures and for public and educational outreach. This committee will identify where the constituent projects have the potential to collaborate on observations or logistics. In this context it is important to note that some of the projects are already consortia with well-established procedures for coordination (e.g. the EISCAT and SuperDARN communities). The detailed networking and collaboration plan will be finalized in the ICESTAR-IHY-IPY kick-off meeting which will be arranged in Helsinki (Finland) at the beginning of 2007.

ICESTAR Deliverables

The ICESTAR programme will deliver a wide variety of products ranging from a better scientific understanding of the polar atmosphere to a data portal that will enable scientists to create a systems-view of the polar region. Specifically, the ICESTAR programme will focus on delivering:

- A data portal linking together a large number of polar sites with diverse datasets. This data portal will have visualization and data translation modules that will allow users to examine the data and download it in formats that they can easily understand. The following data types will be provided to the portal by the associated groups: magnetometers, HF and MST radars, lidars, passive optical instrumentation, digisondes, riometers, VLF/ULF receivers, TEC measurements, and atmospheric electric field observations.

- Quantification of the role of seasonal differences in polar ionospheric conductance and the effects on magnetospheric, ionospheric, and thermospheric dynamics.
- Constraints on models based on conjugate remote sensing of inner magnetospheric dynamics.
- Characterization of the spatial and temporal properties of mesoscale convection in the ionosphere.
- Characterization of the basic state of the polar middle atmosphere.
- Quantification of the AC and DC global atmospheric circuit and its effects on the ionospheric state.

Supporting Information

Implementing the multi-national ICESTAR programme requires careful management. The Steering Committee, led by two Co-Chairs and guided by the SSG/PS leadership *ex officio*, will provide the overall management and guidance of the programme.

- **Co-Chair:** Allan Weatherwax, Siena College (U.S.A.)
- **Co-Chair:** Kirsti Kauristie, Finnish Meteorological Institute (Finland)
- Brian Fraser, University of Newcastle (Australia)
- Martin Fullekrug, University of Bath (U.K.)
- Ruiyuan Liu, Polar Research Institute (China)
- Nikolai Østgaard, University of Bergen (Norway)
- Scott Palo, University of Colorado (U.S.A.)
- Aaron Ridley, University of Michigan (U.S.A.)
- Natsuo Sato, National Institute of Polar Research (Japan)
- Eftyhia Zesta, University of California - Los Angeles (U.S.A.)
- Maurizio Candidi, SCAR SSG/PS (Italy), *ex officio*

The Steering Committee will meet every year to determine the programme progress and outline the venues for international collaboration. ICESTAR will hold scientific workshops either separately or in conjunction with the biennial SCAR Science Meetings. Specifically, ICESTAR will have four working groups that will focus on the following broad science objectives:

- Quantifying the atmospheric consequences of the global electric circuit and further understanding the electric circuit in the middle atmosphere as guided by the electric fields generated at the solar wind--magnetosphere interface;
- Quantifying the effects on the polar ionosphere and atmosphere of the magnetospheric electromagnetic fields and plasma populations, from the radiation belts to the tail plasma;
- Quantifying and understanding the similarities and differences between the Northern and Southern polar upper atmospheres, under the varying influence of the solar electromagnetic radiation and of the solar wind;
- Creating a data portal that will integrate all of the polar data sets and modeling results. This data portal will enable the research to be conducted by the other working groups.

The above-listed objectives will be the focus of four Thematic Action Groups (TAGs) established to coordinate research activities:

TAG-A: Quantification of the coupling between the polar ionosphere and neutral atmosphere from the bottom-to-top and the global electric circuit.
Leader: Martin Fullekrug, University of Bath (U.K.)

TAG-B: Quantification of the inner magnetospheric dynamics using remote sensing techniques.
Leader: Eftyhia Zesta, UCLA (U.S.A.)

TAG-C: Quantification of the state of the upper atmosphere, ionosphere, and magnetosphere over the Antarctic continent and how it differs from the Northern hemisphere during a wide range of geophysical conditions.
Co-Leader, Nikolai Østgaard, University of Bergen (Norway)
Co-Leader, Scott Palo, University of Colorado (U.S.A.)

TAG-D: Creation and management of the data portal.
Leader: Aaron Ridley, University of Michigan (U.S.A.)

Each TAG will establish and maintain liaison with the National Antarctic Programs through SCAR and its relevant scientific groups and committees: ADD (Antarctic Digital Database), MAGMAP (Magnetic Anomaly Map), and READER (Reference Antarctic Data for Environmental Research). The programme goals and objectives will be detailed together with the SSG/PS Expert Group on Solar-Terrestrial Processes and Space weather (STEPS) and the relevant Action Groups APTIC (Antarctic Peninsula Troposphere - Ionosphere Coupling) and MADREP (Middle Atmospheric Dynamics and Relativistic Electron Precipitation). Similar collaboration will be established with relevant projects of the International Arctic Science Committee (IASC; http://www.iasc.no). The ICESTAR activities will also be coordinated with the Working Group on Polar Research of the International Association of Geomagnetism and Aeronomy (IAGA) and with the new international programmes Climate and Weather in the Sun-Earth System (CAWSES) sponsored by SCOSTEP and International Heliospheric Year (IHY) endorsed by COSPAR, IAU, and by UN Office for Outer Space Affairs. Finally, the proposed period for ICESTAR (2005-2009) overlaps the planned research activities in the framework of fourth International Polar Year (IPY, 2007-2008), during which ICESTAR and IHY together will coordinate the research of 29 multinational consortia to form a geospace focused core programme in the IPY network.

The following key solar-terrestrial physics and polar aeronomy questions provide a sound scientific background for the ICESTAR TAG team leaders to help address:

- How is Earth's magnetosphere different qualitatively and quantitatively under extreme, moderate, and quiet solar wind conditions?
- What is common and what is different in the solar-terrestrial and aeronomical phenomena observed over both the Arctic and Antarctic?
- Does auroral activity during substorms arise from instabilities in the ionosphere or does this aurora simply mirror plasma motions in the outer magnetosphere?
- How much do dark and sunlit ionospheres control polar substorm dynamics?
- To what extent are the ionized and neutral high-latitude upper atmospheric regions affected by mechanical and electrodynamic inputs from the lower atmosphere?
- How does the global electric circuit affect the ionosphere state?
- How is the global electric circuit closed between the low and high latitudes?

It is important and timely to act now to study the polar-regions in their interhemispheric context from observations in space and over the Arctic and Antarctic. The ICESTAR TAG team leaders will provide international guidance in addressing these, and other, important problems.

Budget Request for the Next Biennium

Estimated SCAR funding required for the next two years is approximately $ USD, as budgeted in the original proposal. The SCAR funds will enable ICESTAR to run the following three meeting:

Dates	ICESTAR Sponsored Meeting	Amount
Winter 2007	ICESTAR-IHY-IPY coordination meeting in Helsinki, Finland.	$20,000
Spring-Fall 2007	Travel/Workshops etc.	TBD
2008	Workshops	TBD

ICESTAR will further continue to provide travel to support for researchers worldwide to participate and present ICESTAR related papers at scientific meeting and workshops. Approximately $5,000 is budgeted for such expenses.

Outputs/Deliverables

- **ICESTAR Website**: Established to facilitate international communication.
  - Http://scar-icestar.org
- **ICESTAR-IHY-IPY Website*:*** *Heliosphere Impact on Geospace*
  - http://www.space.fmi.fi/ipyid63/