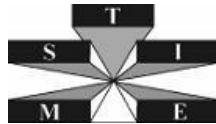


Graphic: NASA



THE INTERNATIONAL EMERGENCY MANAGEMENT SOCIETY - TIEMS

Proceedings of the International Emergency Management Society
(TIEMS)

Oslo Conference

***Space Weather and Challenges for Modern
Society***

Edited by: Snjezana Knezic, Meen Poudyal Chhetri, K. Harald Drager

Oslo, Norway, October 22-24, 2012

**Proceedings of the International Emergency Management Society
(TIEMS)
Oslo Conference**

Space Weather and Challenges for Modern Society

**October 22-24, 2012
Oslo, Norway**

Organised by:

TIEMS, The International Emergency Management Society
Address: Rue Des Deux Eglises 39, 1000 Brussels, Belgium.
Executive Office Postal Address is: Østvangveien 29, 0588 Oslo, Norway.

Editors:

Snjezana Knezic

University of Split, Faculty of Civil Engineering and Architecture, Split, Croatia

Meen Poudyal Chhetri

President of Nepal Center for Disaster Management, Lalitpur, Nepal

K. Harald Drager

TIEMS President

Published by:

TIEMS, The International Emergency Management Society

Address: Rue Des Deux Eglises 39, 1000 Brussels, Belgium.

Executive Office Postal Address is: Østvangveien 29, 0588 Oslo, Norway.

ISBN: 978-94-90297-07-7

Year: 2012

Responsibility for the accuracy of all statements in each paper rests solely with the author(s). Statements contained in the papers are not necessarily representative of, nor endorsed by The International Emergency Management Society (TIEMS).

Permission is granted to copy portions of this publication for personal use and for the use of students provided credit is given to the authors, conference and publication. Permission does not extend to other types of reproduction nor to copying for incorporation into commercial advertising nor for any other profit making purpose.

© 2012 TIEMS, The International Emergency Management Society

Designed by TIEMS

Preface

The proceedings of the TIEMS Oslo Conference is realised under joint effort of TIEMS International and TIEMS Norwegian members. In such a way TIEMS stays strongly on its main mission to bring both scientific findings and practical experience from global level to local emergency management communities. The Proceedings is published electronically, contains full papers, presentations and posters and it is organised through menu-designed user interface. The papers, presentations and posters are organised by topics and were reviewed by TIEMS International Scientific Committee. Presentations containing animations are also presented as macro enabled shows in a separate folder. Two papers and one poster are presented only by their abstracts. Most papers submitted for the presentation at the conference were accepted as those papers were of high standard. The authors and co-authors of the papers were from various universities and professional organisations related to disaster risk reduction.

We believe that the subject matter - particularly the research findings of the research papers will be highly useful to the DRR policy makers, academicians, practitioners, professionals, students and all others who have interest in this field. Lively presentations by the presenters, active participation of the participants and interaction during the presentation at various thematic sessions have added additional value for the grand success of the conference. The qualities of the papers of the conference are invaluable assets indeed. The future steps of all the participants of the conference and other stakeholders should be to implement the lessons and outcomes of the great event to reduce the risk of disasters for the benefit of humanity. We can claim that this conference is a landmark and has thus greatly contributed in the field of DRR.

We are very proud that the Conference attracted many researchers and practitioners from different countries worldwide covering diverse topics and problems in the field of "Space Weather and Challenges for Modern Society".

The Editors of the proceedings would like to thank the members of the TIEMS International Scientific Committee for their assistance in reviewing the abstracts and full papers. Special thanks goes to the authors without whom the conference would not have been successful.

The Editors
Oslo, Norway
October 2012

Foreword from TIEMS President

TIEMS is a Global Forum for Education, Certification and Policy in Emergency and Disaster Management and is dedicated to developing and bringing the benefits of modern emergency management tools and techniques and best practice to society for a safer world, through exchanging information of the use of innovative methods, technologies and operations to improve society's ability to avoid, mitigate, respond to and recover from natural and technological disasters. TIEMS provides a platform for all stakeholders within the global emergency and disaster management community to meet and network, learn about technologies and operational methods, and exchange experience on best practice, and influence policy makers worldwide to improve global cooperation and establish global standards within emergency and disaster management.

TIEMS Oslo Conference 2012 focuses on space weather, potential consequences and how to protect critical infrastructure. The conference theme is "Space Weather and Challenges for Modern Society". It is expected that 2012 – 2013 will be years with high solar activity. This can trigger larger solar storms which can generate disturbance on earth. Eruptions on the sun can trigger geomagnetic induced currents (GIC), enhanced UV and X-ray from solar flares can disturb our atmosphere, and high-energy particles can damage satellites. Thus, solar storms can affect the normal operations on specific industrial operations and critical infrastructure that our society depends on (e.g. power grids, oil industry, telecom, navigation systems, etc). The conference focuses on increasing the general knowledge of solar storms, space weather, GIC, etc., and the possible consequences for different industries and critical infrastructure, and look into reasonable means of protection, and consider possible early warning solutions.

I am very pleased to welcome some of the world's best experts on space weather to the Oslo conference, where the program comprises 37 keynote lectures and 18 poster presenters as well as welcome speeches from representatives of the Norwegian sponsors and supporters of the conference; Norwegian Water Resources and Energy Directorate, Statnett and Norwegian Space Centre. Their representatives will outline their organizations role in the Norwegian society concerning space weather threats to modern society. Participants from 19 countries will take part and address how global cooperation can enhance the space weather science and our ability to understand and monitor space weather and also protect critical infrastructure from breakdown due to space weather. A former Norwegian Minister of Justice and Police will also address a politician's reflections on "How to think about the unthinkable without losing your mind" as an introduction to a press conference, where we have invited media to come and listen and ask their questions. It is very important that we can have the media representatives present and to convey facts and figures about this threat to the public.

The conference itself is the results of 1 year's planning and work to decide on and invite the right experts, make up the program and prepare all practical details of the conference. This would not have been possible without the valuable help of the members of the International Program Committee and generous sponsorship and support from their organizations and staff:

- Norwegian Water Resources and Energy Directorate – Roger Steen, Nikoline Gjerstad and Petter Reed
- Statnett of Norway - Alf Olaussen
- The Norwegian Space Centre – Pål Brekke

- The Swedish Institute of Space Physics – Peter Wintoft
- Finnish Meteorological Institute – Risto Pirjola
- Danish Meteorological Institute – Peter Stauning

The TIEMS editors, Snjezana Knezic and Meen Chhetri, have reviewed all papers and put together the proceedings, which contains all valuable keynotes and posters of the conference. These proceedings comprise an important contribution to the understanding of space weather and how to protect critical infrastructure to avoid any disastrous consequences of space weather. I am on behalf of TIEMS very thankful to the organizations and persons above, who have contributed significantly to the success of the conference. I also like to thank Journal of Space Weather and Space Climate and its chief editors, Anna Belehaki and Jean Lilensten, who are inviting all presenters at the Oslo conference to submit their papers for peer review for a special edition of the journal.

I welcome all participants to TIEMS Oslo Conference 22 – 24 October 2012.

Oslo 14th October 2012

K. Harald Drager, TIEMS President

TIEMS International Scientific Committee:

Meen Bahadur Poudyal Chhetri, President
President of Nepal Centre for Disaster Management &
Chairman of Disaster Preparedness Network - Nepal

Pål Brekke, Chairman The Norwegian Space Centre, Norway

Roger Steen, Norwegian Water Resources and Energy Directorate, Norway

Risto Pirjola, Finnish Meteorological Institute, Finland

Peter Wintoft, Swedish Institute of Space Physics, Sweden

Peter Stauning, Danish Meteorological Institute, Denmark

Alf Olaussen, Statnett, Norway

Organisation & International Program Committee:

Pål Brekke, Chairman, The Norwegian Space Centre, Norway

Roger Steen, Norwegian Water Resources and Energy Directorate, Norway

Risto Pirjola, Finnish Meteorological Institute, Finland

Peter Wintoft, Swedish Institute of Space Physics, Sweden

Peter Stauning, Danish Meteorological Institute, Denmark

Alf Olaussen, Statnett, Norway

K. Harald Drager, Secretary, TIEMS President

Greetings from the International Program Committee

Dear Speakers and Participants,

It is our great pleasure to welcome you all to the capital of Norway, Oslo, and to the conference on “Space Weather and Challenges for Modern Society”!

On behalf of the International Program Committee I am very pleased that we have managed to attract so many of the world’s leading experts on the topics of space weather and critical infrastructure protection. As organizers and program committee members, we have spared no effort to assemble an exciting, advanced, and balanced program, where you can listen to high quality lectures on a topic which is probably not yet very well known by stakeholders with responsibilities to protect our infrastructures. This conference will hopefully broaden the awareness of this potential threat to our complex technological societies.

We hope all lecturers and participants use the opportunity, during the many coffee breaks and poster sessions, to discuss how to reduce the vulnerability of today’s infrastructures, and also focus on how to avoid introducing new vulnerabilities in technologies of tomorrow.

Aside from giving you this cutting-edge research and best practice from different parts of the world, our conference offers an unparalleled venue for establishing new contacts, renewing professional relationships, for networking, and for remaining up-to-date of what is happening in the field of protecting vital functions from threats from space.

Our host city, Oslo, is an undiscovered jewel and a wonderful location for this conference. If we are really lucky we may experience Northern Lights even in the capital area. We are also very pleased that the city of Oslo has decided to invite all participants for a Reception in the wonderful City Hall. We recommend that you use the opportunity to see the city.

We look forward to enjoying the pleasure of your company in Oslo.

Warmest regards,

The International Program Committee:

Pål Brekke, The Norwegian Space Centre, Norway, Chairman

Roger Steen, Norwegian Water Resources and Energy Directorate, Norway

Risto Pirjola, FMI, Finland & NRCan, Canada

Peter Wintoft, Swedish Institute of Space Physics, Sweden

Peter Stauning, Danish Meteorological Institute, Denmark

Alf Olaussen, Statnett, Norway

K. Harald Drager, TIEMS President, Program Organizer and Program Committee Secretary

CONTENTS

Introduction to Space Weather

Per Sanderud

[The Authority's Role and Responsibility in Preparedness](#)

Alf Olaussen

[GIC in Norway – Past, Present and Future](#)

Bo Andersen

[Space Weather and the Role of Norway in the Polar Regions](#)

Pål Brekke

[The Stormy Sun - From Kristian Birkeland to Space Weather Hazards](#)

Terrance G. Onsager

[Focusing International Cooperation on Improving Operational Space Weather Services](#)

Juha-Pekka Luntama

[European Space Weather Activities within ESA](#)

Joseph M. Davila

[Space Weather Activities within NASA](#)

Anna Belehaki

[The European Space Weather COST Action ES0803](#)

Stormy Sun - Our Current Knowledge

Rainer Schwenn

[Coronal Mass Ejections – the Drivers of Space Weather](#)

Henrik Lundstedt

[Solar Storms and Topology: Observed With SDO](#)

Leif Svalgaard

[Solar Activity – Past, Present, Future \(A Personal Journey\)](#)

Effects on Satellites, Navigation and Telecommunication

Norbert Jakowski

[Space Weather Impact on Satellite Navigation and Positioning](#)

Knut Stanley Jacobsen

[Impact of a Geomagnetic Storm on the GNSS-based Positioning Service CPOS](#)

Anna Belehaki

[Space Weather Effects on Communications](#)

Richard B. Horne

[Forecasting the Earth's Radiation Belts with SPACECAST to help Protect Satellites on Orbit](#)

Predictions of Solar Storms, Warnings, Preparedness - Measures and Response

Terry Onsager

[NOAA Experience – Present Products and Services and Plans for Future Improvements](#)

David Berghmans, E. Robbrecht and R. Van der Linden

[The SIDC, a European Prediction Center](#)

David H. Boteler

[Hazard Assessment and Real-Time Simulation of Geomagnetically Induced Currents](#)

Richard Marshall

[Space Weather and Critical Infrastructure in the Australian/New Zealand Region](#)

Alan Title

[Remote Triggering of Energetic Events](#)

Expectations and Effects on Electric Power Supply and Oil and Gas Exploration Activity

Trevor Gaunt

[Reducing Uncertainty - an Electricity Utility's Response to Severe Solar Storms](#)

Mark G. Lauby, John N. Moura, Eric Rollison

[Effects of Geomagnetic Disturbances on the North American Bulk Power System](#)

Chunming Liu and Yunlong Li

[Observation and Modeling of GIC in The Chinese Large-scale High-voltage Power Networks](#)

Andrew Richards

[The GB Electricity Transmission Network: Modeling, Monitoring and Mitigation](#)

Inge Edvardsen

[How to Deal With Geomagnetic Storms in Directional Drilling](#)

Industries Preparedness and Protection Measures

Trond M. Ohnstad

[GIC Experience in Norway, Risk Assessment and Mitigation in View of Existing and Future Transmission System](#)

Shinichi Watari

[GIC Measurements in Japan](#)

Luis Marti

[Hydro One GMD Preparedness Plan for Cycle 24](#)

A Super Storm - What can happen and how to prepare for and handle it?

Edward W. Cliver

[A Super Storm: Current Limits of Extreme Space Weather](#)

David H. Boteler

[Consequences of Super Storms on Power Grids – Examination of the March 13, 1989, Magnetic Storm](#)

Society's Ability to Withstand Short and Long Term Shut Down of Critical Infrastructure

Sven Ullring

[Critical Infrastructure Protection – Are we willing to try a Disaster?](#)

Brandon Wales

[Risk Analysis of Severe Space Weather Events to U.S. Critical Infrastructure](#)

Carolus J. Schrijver and S.D. Mitchell

[Estimating the Economic Impact of Disturbances in the U.S. Electric Grid Associated with Geomagnetic Activity](#)

Edward P. Borodzicz

[Two Cans of 'Coca-Cola' and a Piece of String: Developing Standards for Non Standard Events](#)

Authorities Handling Strategies and Contentious Level

Bengt Sundelius

[Building Capacity for Preparedness](#)

Genevieve Fisher

[Preparing the U.S. to Respond to Space Weather Events](#)

Timothy Cook

[Severe Space Weather NATO Relevance](#)

Brage W. Johansen

[Crisis Management Tools as Common Ground for Space and Energy](#)

Future Developments and Expectations

Juha-Pekka Luntama

[Effects of a Super Storm on Vital Satellite Systems, and other Critical Infrastructure - How do we maintain Public Awareness and Improve our Protection?](#)

Mike Hapgood

[Building Space Weather Preparedness and Resilience in Europe](#)

POSTERS

Ari Viljanen, Eija Tanskanen, Yaroslav Sakharov, Juri Katkalov and Risto Pirjola
[Nowcast Server for Geomagnetically Induced Currents](#)

Sebastian Schäfer and Knut S. Jacobsen
[Real Time Scintillation Observation at the Norwegian Mapping Authority](#)

Øyvind August Rui, Evald Sætre and Trond Ohnstad
[Measurement Of GIC in the Norwegian High Voltage Grid](#)

Peter Stauning
[High-Voltage Power Grid Disturbances During Geomagnetic Storms](#)

E.I. Tanskanen, D. Pitchford and A. Pulkkinen
[Space Weather Analysis and Novel Browser-based Tools](#)

Eija I. Tanskanen
[Substorm Zoo, a browser-based tool for research, teaching and social data analysis](#)

Brynjar Hansen
[Reduction of Vulnerability for Safety-critical GNSS Applications](#)

Green, J.C, W. Denig, J. Rodriguez, T. Onsager, W. Murtagh, R. Rutledge, J. Stankiewicz, J. Kunches and D.Wilkinson
[New NOAA Data, Products, and Research Safeguarding the Satellite Infrastructure from Space Weather](#)

Brage Førland and Jesper Gjerloev
[SuperMAG: The Global Ground Magnetometer Network](#)

Henrik Lundstedt, Peter Wintoft, Lars Eliasson and Urban Brändström
[RWC-Sweden of International Space Environment Service \(ISES\)](#)

Jone P. Reistad, Nikolai Østgaard and Kjellmar Oksavik
[How the Solar Wind Dynamo Affects the Two Polar Regions Differently](#)

Rico Behlke, Beate Kvamstad, Erlend Bjørdal, Fred Sigernes and Dag Lorentzen
[Maritime Radio Systems Performances in the High North \(MARENOR\)](#)

Z. Bouya, M. Terkildsen, M. Francis and R.Marshall
[New Space Weather Service for Monitoring and Forecasting Regional Ionospheric Perturbations over Australia Based on GNSS Techniques](#)

Magnar Gullikstad Johnsen
[Near Real-time Geomagnetic Data Provider for Space Weather Applications in the European Sector](#)

Dave Neudegg and R. Marshall

[Active Region AR1429 March 2012 - Case Study of Space Weather Consequences](#)

Lars P. Dyrud, Brian Anderson, Jonathan T. Fentzke, Gary Bust, Rebecca Bishop, Paul O'Brien and Marcin Pilinski

[AMPERE and GEOscan: Utilizing Commercial Space Infrastructure for Disaster Mitigation, Planning and Response](#)

Jøran Moen

[In-situ Investigations of SATCOM/GNSS Outage Regions](#)

Peter Wintoft, Henrik Lundstedt, Magnus Wik and Lars Eliasson

[Data Driven Models Forecasting Levels of Geomagnetic Disturbance Related to GIC](#)

Sponsored & Supported by



Statnett

