RWC-SWEDEN

OF INTERNATIONAL SPACE ENVIRONMENT SERVICE (ISES)

North Lund: European Spallation Source (ESS)

Location of RWC-Sweden
at Ideon Science Park

Lund downtown,
1000 years old cathedral

Lund - Copenhagen
(30 min)

Henrik Lundstedt[1], P. Wintoft[1], L. Eliasson[2] and Urban Brändström[2]
Swedish Institute of Space Physics (IRF)
Sweden

1. IRF-Lund and 2. IRF-Kiruna

OUTLINE

Regional Warning Center (RWC) Sweden of ISES

- **History**
- **Service**

Ongoing and Planned Activities

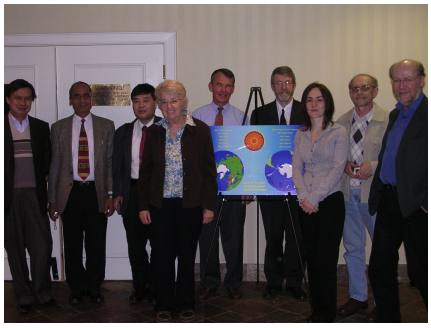
- **Solar storm research**
- **New local and global geomagnetic activity forecasts**
- **EU and ESA collaborations**
- **Agency collaborations**

RWC-SWEDEN OF ISES 2000 -

Boulder, 2002

Ottawa, 2008

ISES, 2000



Boulder, 2005

ISES, 2012

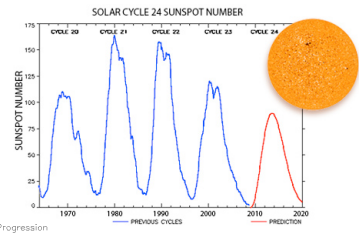
PREDICTION OF THE SOLAR (SUNSPOT) CYCLE

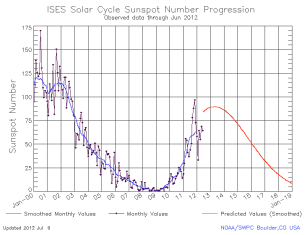
$R_z = k(10g+f)$

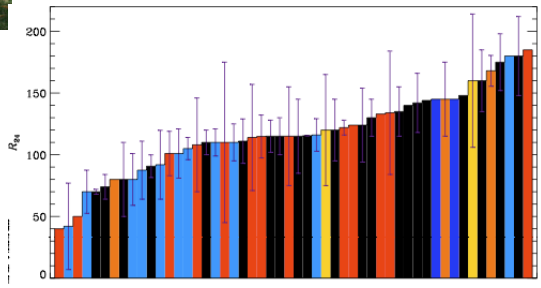
Solar Cycle 24 Prediction
Issued April 2007, updated May 2008:

Min Dec. 2008,
Max 2013 May

R_z=90, weakest since 1928.

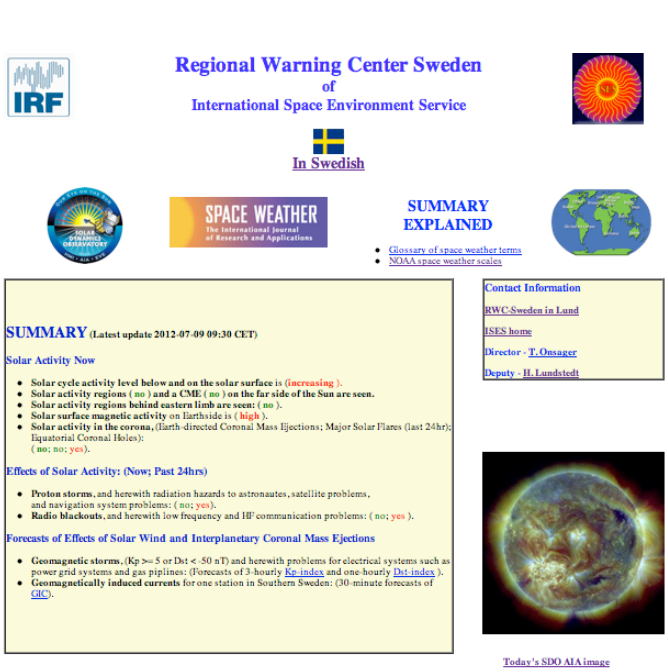


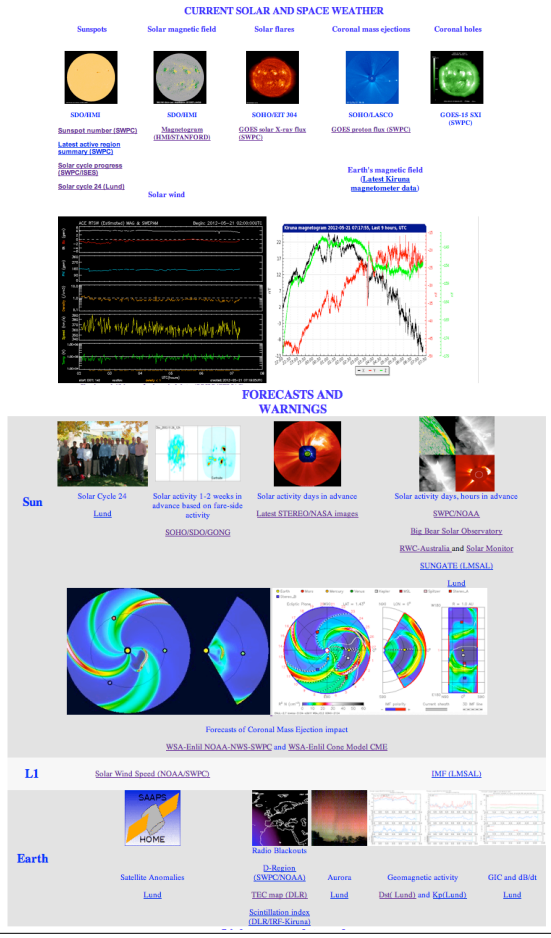




A summary plot (D. Pesnell) of predictions based on "Climatological", "Precursor", "Dynamo model", "Spectral" and "Neural network" methods.

RWC-SWEDEN SERVICE





RWC-Sweden local service:
Real-time **forecasts**:
Kp, Dst, dB/dt, GIC
IRF real-time **data**:
Kiruna/Lycksele magnetogram,
Riometer data, All-Sky camera

RWC-SWEDEN - ONGOING AND PLANNED ACTIVITIES

SOLAR STORMS AND SPACE WEATHER, a research project funded by MSB and IRF

- New solar storm models and forecasts will be developed.
- A workshop on “Solar Storms and Topology” is planned for 2014.
- A magnetometer near Lund is planned for 2013.
- New geomagnetic activity forecasts will be developed.

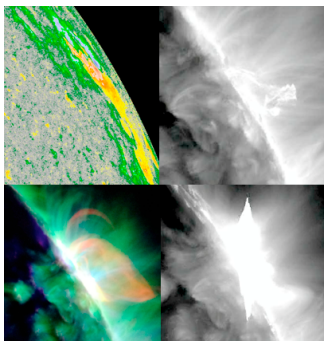
EU FP7 EURISGIC (2011-2014) project

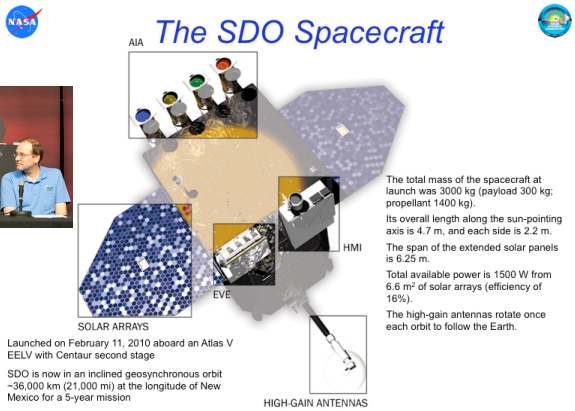
EU COST project “Developing Space Weather Products and Services in Europe” (2008-2012)

ESA ODI (2009-2012) Database project

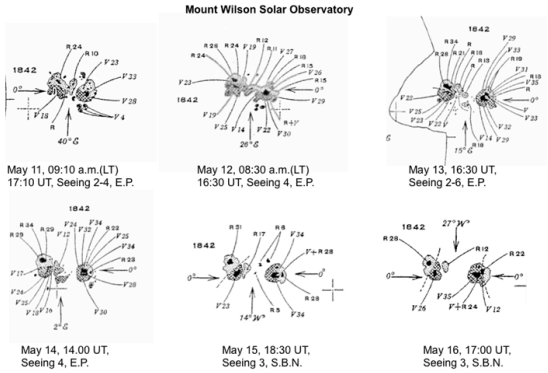
SOLAR STORM RESEARCH

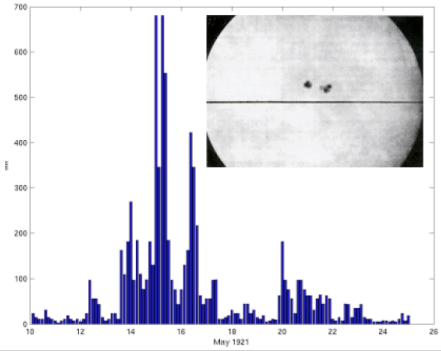
- Moderate solar storms are studied topologically based on SDO observations





- Extreme historical solar storms are compared with SDO data



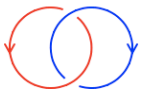


SOLAR STORMS AND TOPOLOGY

Conjecture: Solar storms occur to reduce magnetic field complexity and herewith preserving topoligical invariants

Carl Friedrich Gauss
1777-1855

$$\mathcal{L}_{i,j} = \frac{1}{4\pi} \oint \oint \frac{(\bar{x}_i - \bar{x}_j)\cdot(d\bar{x}_i \times d\bar{x}_j)}{|\bar{x}_i - \bar{x}_j|^3}$$



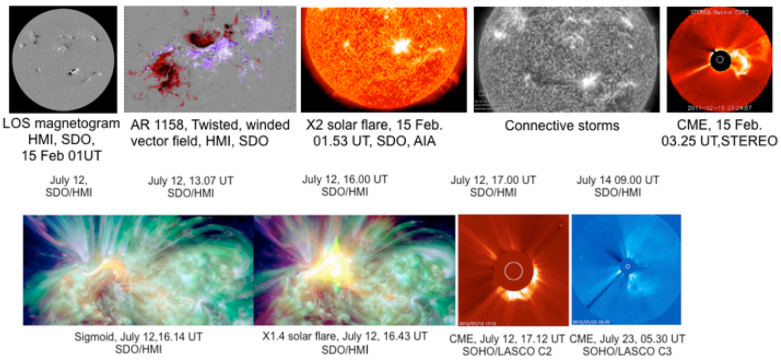
linking number 1

$$H = \int \bar{A} \cdot \bar{B}\, d^3x\,, \quad \bar{B} = \nabla \times \bar{A} \qquad H = -\frac{1}{4\pi} \iint \bar{B}(\bar{x}) \cdot \frac{(\bar{x} - \bar{x}')}{|\bar{x} - \bar{x}'|^3} \times \bar{B}(\bar{x}')\, d^3x\, d^3x'$$

In the case of finite flux tubes, limited to each flux tube i and flux tubes i, j

$$H_m = \sum_{i=1}^{N} T_i\, \Phi_i^2 + \sum_{i=1}^{N} \sum_{j=1, j\neq i}^{N} \mathcal{L}_{i,j}\, \Phi_i \Phi_j$$

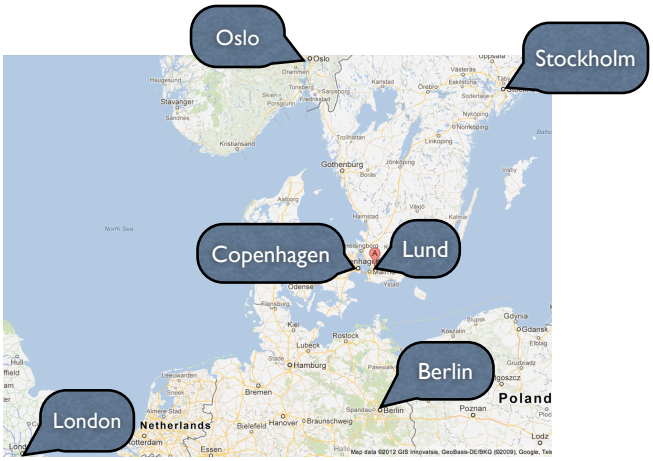
Self helicity (Twist + Writhe) — **Mutual helicity**



Lundstedt, H., Solar Storms and Topology: Observed with SDO, in Proceedings of TIEMS conference Space Weather and Challenges for Modern Society, 22-24 October 2012.

NEW GEOMAGNETIC ACTIVITY FORECASTS

- Install a magnetometer close to Lund
- Develope new neural network forecasts of dB/dt and GIC

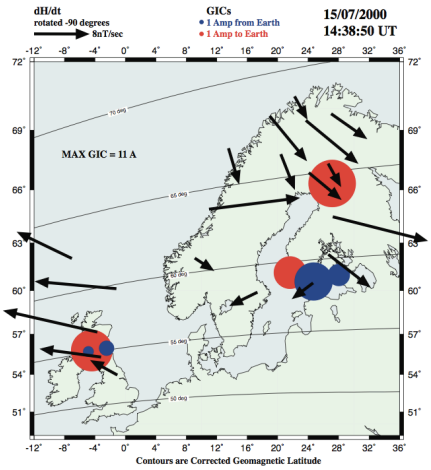


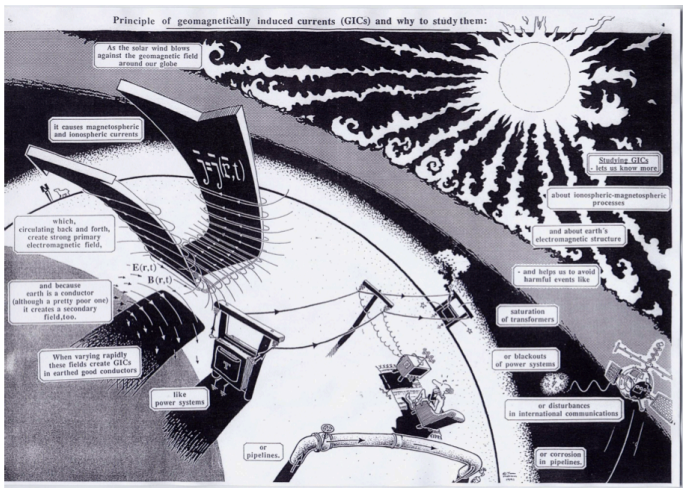
A magnetometer
close to Lund

P. Wintoft, H. Lundstedt, M. Wik, and L. Eliasson, Data Driven Models Forecasting Levels of Geomagnetic Disturbance Related to GIC, in Proceedings of TIEMS conference Space Weather and Challenges for Modern Society, 22-24 October 2012.

FORECAST PROTOTYPE OF GIC FOR WHOLE EUROPE

FP7: EURISGIC (2011–2014) EUROPEAN RISK FOR GIC



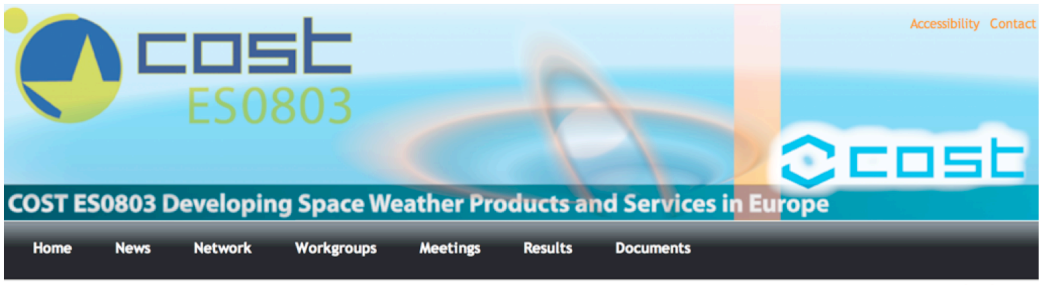


Coordinator: Finnish Meteorological Institute (FMI)

Participants: British Geological Survey (BGS), NeuroSpace, Swedish Institute of Space Physics (IRF), Geodetic and Geophysical Research Institute (GGRI), Polar Geophysical Institute (PGI), Catholic University of America (CUA)

The Lund group work on a GIC forecast prototype for whole Europe

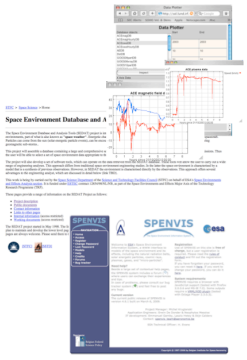
EU COST 0803 and ESA ODI projects



ODI
Open Data Interface

SAAPS/SEDAT/SPENVIS

- Spacecraft Anomaly Analysis and Prediction System (SAAPS)
  www.lund.irf.se/saaps
- Space Environment Database and Analysis Tool (SEDAT)
  www.ukssdc.ac.uk/sedat/
- Space Environment Information System (SPENVIS)
  www.spenvis.oma.be/



Peter Wintoft, Lars Eliasson, Jan Karlsson
Swedish Institute of Space Physics
Daniel Heynderickx
DH Consultancy
Hugh Evans
Estec

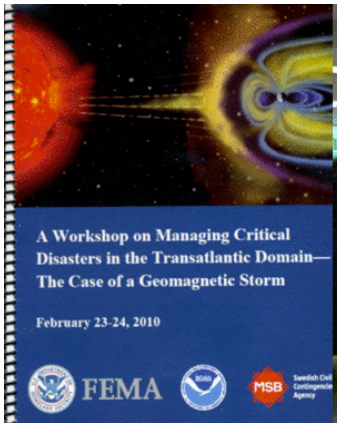
- Create a common database to hold data from:
  - SAAPS
  - SEDAT
  - SPENVIS
- Compliant with CDF/ISTP/PRBEM.
- Update SAAPS/SEDAT/SPENVIS to access data from the common database.
- Shall be possible to ingest data in both text format and CDF format.

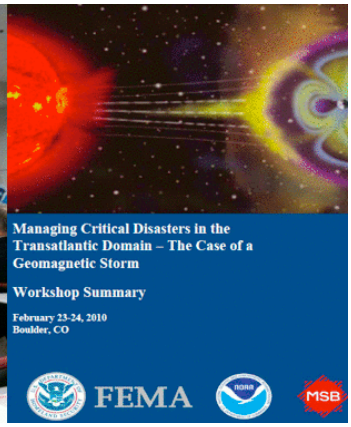
SOLAR STORMS/SPACE WEATHER AND SOCIETY

The meeting and report that really changed agencies interest for solar storms and space weather effects -

"A Workshop on Managing Critical Disasters: The Case of a Geomagnetic Storm"

NAS report





1. **Helena Lindberg**, Director-General, Swedish Civil Contingencies Agency (MSB)
2. **William Craig Fugate**, Administrator, FEMA
3. **Thomas J. Bogdan**, Director, SWPC, NWS, NOAA

The ISES presentation was given by H. Lundstedt

AGENCIES INFORMATION ABOUT SOLAR STORMS - RISKS AND THREATS AND APPROVED RESEARCH PROJECTS

Welcome to Krisinformation.se - the national website for emergency information

The Swedish government has instructed MSB (the Swedish Civil Contingencies Agency) to provide a national website for emergency information, directed at the general public and the media, in collaboratic with other emergency management authorities.

Krisinformation.se

MSB

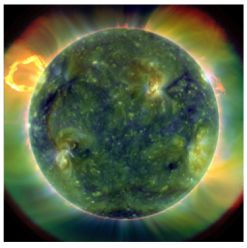
Myndigheten för samhällsskydd och beredskap
Swedish Civil Contingencies Agency

RWC-Sweden gave updated warnings (e.g. downgraded GIC effects) to MSB and Svenska Kraftnät for 2012 January and March solar storms

Solstormar och rymdväder
Projektbeskrivning

Henrik Lundstedt och Peter Wintoft
Institutet för rymdfysik (IRF)

14 februari 2011



Approved research project: "Solar storms and space weather"