Expression of Interest

FP6 Integrated Project

Solar Activity and Climate in Europe (SACE)

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FP6: Thematic Priority: 1.1.4ii space
1.1.6.3 Global change and ecosystems

1. Aim of the Proposed Integrated Project

Our goal is to:

- Create an integrated network of European solar, solar wind, magnetospheric ionospheric, atmospheric and earth scientists, meteorologists and forecast people.
- Develop knowledge-based intelligent hybrid systems, which forecast climate and weather changes in Europe based on solar activity.
- Compare the results with space based observations and models by meteorologists.
- Implement the forecasts according to what the users want.
- Make a cost-benefit analysis.

2.Background

In early 80-ties a collaboration started, between the power company Sydkraft in Southern Sweden and Lund University, on the effects of Sun's activity on power systems. In a collaboration with Stanford University, California, USA, sun-weather relations were studied, already over twenty years ago.

In the late 80-ties knowledge-based neurocomputing systems started to be used in Lund as a method to develop forecasts of the Sun's influence on Earth's atmosphere, technological systems and human health. Two international workshops were organized on the subject in Lund in1993 and 1997. A third is planned for 2003, with emphasis on climate.

Europe has outstanding records of scientific results within solar-terrestrial physics, i.e. about how the Sun influences conditions of the Earth. When we also include effects on technological systems we talk about "space weather". Europe has the best observatories of the Sun in the world on Canary Islands (Swedish, German, French and Spanish telescopes) and excellent observations of effects on Earth's atmosphere in e.g. Northern Scandinavia. The ESA space probes such as SOHO (SOlar Heliospheric Observatory) and Cluster have totally revolutionized the view on Sun's influence on Earth. Today we understand that we must accept the Sun's influence on Earth and adjust our society to the solar activity.

ESA awarded two European consortia to carry out European Space Weather Programme Studies in competition. The studies resulted in an impressive amount of documents and a network of European scientists was established on the subject. Within the Alcatel Space consortium, Lund developed a real-time forecast prototype in Java and outlined a European Space Weather Center.

However, one thing became also very clear, Europe lacks coordination and integration of research, observations and services. This is what the Integrated Project is about.

3. Need and Relevance for Europe

During Medieval time the climate was warm in Europe. Europe was very prosperous and all the famous cathedrals were built during that time. During the same period the solar activity was high. During the Maunder minimum 1645-1715, when solar activity was very low, it was very cold in Europe. The London's Thames river was frozen during long periods. The agricultural conditions were very severe. The European climate and weather, as well in the whole world, have dramatically changed over the latest 150 years. The sun has also dramatically changed during this time. We are approaching a Gleissberg solar maximum in 2030-2040 with intense solar proton events and a suggested warmer climate. Global monitoring (GMES) of Earth's atmosphere is therefore of vital importance.The new European satellite ENVISAT gives us also possibilities of forecasting climate and weather changes. New results have namely shown that solar activity can influence the climate and weather. The ENVISAT will give us possibilities to make real-time forecasts. The forecasts are of great importance to agriculture, tourism, power industry and the society as a whole.

Figure 1 shows London's Thames river was frozen during the Maunder minimum 1645-1715.

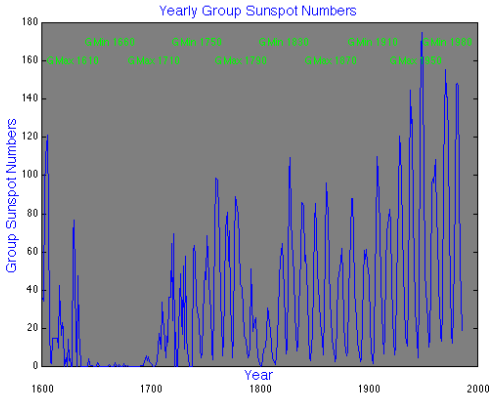

Figure 2 shows the group sunspot number The Gleissberg minima and maxima are marked.The Maunder minimum is clearly visible.

4. Objectives

We have built a European team that will focus on the following objectives

- To find new and improved ways to understand and forecast solar activity.
- To integrate the efforts on understanding and forecasting the sun's influence on the climate and weather.
- To develop new knowledge-based neurocomputing methods of forecasting.
- To integrate the forecast service in Europe done by RWCs and ESA.
- To offer our service and knowledge to society, public and schools.
- To conduct market analysis and cost-benefit analysis in closed collaboration with users.

5. Integration of Research in Europe

5.1 Research Relevant to Solar Activity

New exciting results about the solar activity have been obtained from observations with the European and NASA satellite SOHO. In a collaboration with Stanford University in California, Lund studies the Sun's activity and periodicities in an effort to understand and forecast it. Observatoire de Paris-Meudon has studied the solar activity, developed theoretical models and produced forecasts for many years. Max Planck Institute (MPI) of Lindau has studied during many years the solar wind and coronal mass ejections (CMEs), which cause the most severe effects of Earth. During the ESA Space Weather Programme Study it was obvious that Europe has a strong scientific expertise in solar-terrestrial physics. Of great interest is also the European Grid of Solar Observatories (EGSO) (a Grid test-bed funded within the IST programme of FP5).

5.2 Research Relevant to the Solar Wind Magnetosphere-Ionosphere Coupling

Europe has also a long history of studies of the solar wind magnetosphere-ionosphere coupling and expertise in that field. The Scandinavian countries have been especially active due to the closeness to the auroral oval. The study of other planets interactions with the solar wind, such as Mars, has also been studied within IRF amd DSRI. Mars has taught us much new science relevant to climate changes. Mars lost it's atmosphere after Mars' magnetic dynamo stopped. Global warming seems also to occur on Mars.

5.3 Research Relevant to Climate and Weather Changes

In the Öresund region new and exciting results on the solar activity's influence on climate relation have been obtained. The results from Danish Space Research Institute (DSRI) have created great interest worldwide. New results from Lund show that it might even be possible to forecast climate changes, as indicated by the North Atlantic Oscillation (NAO) index, one month ahead from solar and solar wind information. The NAO, i.e. the pressure difference at sea level between Azores and Island, very much controls the European climate and weather. An integration of the work at the institutes in Lund and Copenhagen would therefore be of vital importance. Of vital importance is also to compare the forecasts and results to those found by meteorologists and earth scientists. We also have scientists within our team that can compare the results to climate changes for very long time periods.

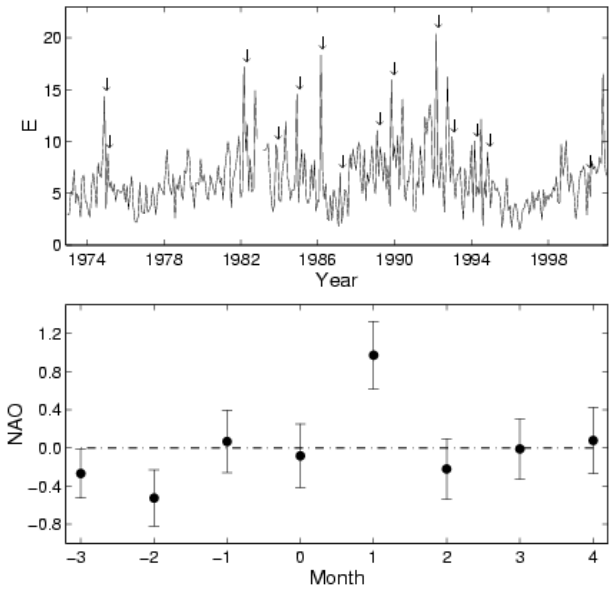

Figure 3 shows the NAO response to enhance solar wind electric field E. A peak is clearly

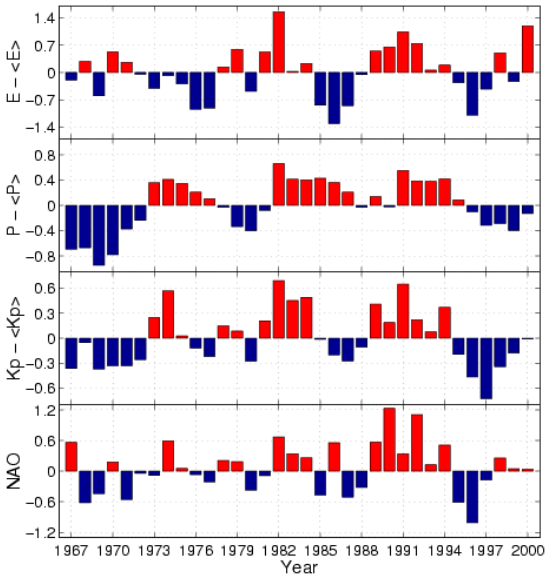

Figure 4 shows yearly averaged solar wind, geomagnetic activity index Kp,

seen one month later. (Boberg and Lundstedt, GRL, Vol.29, No.15, 2002)

and NAO. (Boberg and Lundstedt, GRL, Vol. 29, No. 15, 2002)

5.4 Knowledge-Based Neurocomputing (KBN) and Forecasting Service

Two workshops about Artificial Intelligence Applications in Solar-Terrestrial Physics have been held in Lund in1993 and 1997. A third is planned for 2003 focused on forecasting solar activity, climate and weather changes. IRF-Lund is a Regional Warning Center of International Space Environment Service (ISES). IRF-Lund offers real-time forecasts of the solar activity, space weather and effects. Lundstedt is the Deputy Director of ISES. Meudon Observatory of Paris has also a long experience of forecasting solar activity.Within the ESA Space Weather Programme a prototype real-time knowledge-based neurocomputing forecast service of space weather and effects has been developed by the Lund group. This prototype can now be implemented for users of climate and weather forecasts.

5.5 Integration of Activities

The strength of this project is that we have expertise and capabilities to study the whole chain of events from the Sun to Earth's climate and weather. We will offer forecasts to defined users, users who benefit from using the forecasts. A network of scientists and representatives of power companies for the Nordic countries started by IRF-Lund 1999: The "Nordic Geomagnetically Induced Current (GIC) Network". From this experience a network will be established within the field of solar and climate changes: The European Solar Climate Network (ESCN). Members of the Nordic GIC network are also interested in participating in the ESCN.

6. Added Value for Europe

The society is of course enormously influenced by climate and weather changes. The oil consumption related to heating in Norway varies by 30% in good correlation with the North Atlantic Oscillation index. Correlation with precipitation, results in variability in hydropower generation. Power companies trade energy based on forecasts of the climate. In our team we have expertise in that field

Other obvious areas depending on good forecasts of climate and weather changes are agriculture and tourism. Records back to 1600 century show how the harvest time of wine follows the solar cycle and herewith temperature. During the warm medieval time wine could be produced in England and even in Scandinavia.

Cost benefits and market analysis of using the forecasts will also be carried out.

The study will also help European politicians to make the right decisions on which climate changes are due to natural variation and which are due to human activities. Large programs have already started to decrease the influence of human activities on climate. However, we still don't know how much of the variation is due to natural variation. This EoI will address that.

Name	Organization	Country	Relevant Expertise
Ass. Prof. Henrik Lundstedt	Swedish Institute of Space Physics, Lund	Sweden	Solar physics, solar-terrestrial physics and KBN
Dr. Peter Wintoft	Swedish Institute of Space Physics, Lund	Sweden	Solar-terrestrial physics and KBN

Prof. Brigitte Schmieder	Observatoire Meudon, Paris	France	Solar physics and solar activity
Prof. Rainer Schwenn	Max Planck Institute, Lindau	Germany	Coronal mass ejections and solar wind physics
Prof. Rickard Lundin	Swedish Institute of Space Physics, Kiruna	Sweden	Space physics, solar system physics and magnetospheric physics
Prof. Ingrid Sandahl	Swedish Institute of Space Physics, Kiruna	Sweden	Space physics, magnetospheric physics and aurora
Prof. Eigil Friis-Christensen	Danish Space Research Institute	Denmark	Solar system physics and solar-climate relations
Prof. Thierry Dudok de Wit	LPCE-CNRS, Orléans	France	Space physics and magetospherics physics
Dr. Johanna Haigh	Imperial College of Science, Technology and Medicine, London	UK	Solar variability and climate
Prof. Sami Solanki	Max Planck Institute, Lindau	Germany	Solar variability and climate
Prof. Karin Labitzke	Institut für Meteorologie, FU Berlin	Germany	Atmospheric,stratospheric physics and climate
Prof. Widbjörn Karlén	Department of Physical Geography, Stockholm University	Sweden	Paleoclimate, long-term climate variations
Dr. Lars Axell	Swedish Meteorological Hydrological Institute	Sweden	Climate and weather
CEO Jonas Abrahamsson	Sydkraft Energy Trading (SET) AB	Sweden	Climate's influence on power industry

Table 1 Expertise available.

7. Management Plan

Within the project team we have people that have successfully managed several ESA projects with the production of monthly reports, user requirements documents, technical notes, software, and, research and user networks. We expect to manage this project in a similar way.

A third workshop on Solar-terrestrial physics and forecasting with AI techniques will be held in Lund 2003. This time it will be much focused on solar and climate variations.