

Ground-Based Instrumentation for Space Weather Observations in Geospace

Peter Stauning

Danish Meteorological Institute, Lyngbyvej 100, DK-2100 Copenhagen, Denmark
[pst@dmi.dk]

Abstract

On the 1st of September 1859 a unique event took place. The British astronomer Robert C. Carrington watched on the telescope a solar flare eruption in progress. The next day a giant magnetic storm struck the Earth causing beautiful auroras but also disruptions of hundreds of telegraph circuits around the world. However, the close relation between solar flares and geomagnetic disturbances was not realized until Julius Bartels published his analysis in 1937.

Now we have a more comprehensive, but far from complete knowledge of the intimate relations between solar activity and geospace disturbances. At the same time the modern world has become much more vulnerable to adverse space weather conditions, which may harm people and systems in space, degrade our global communication and navigation systems and even threaten our vital power grids. Thus we have to take appropriate measures comprising forecast, nowcast, and posterior analysis of adverse space weather events and their effects. Ground-based instrumentation constitutes an important part of the toolbox available to support efforts to make progress in all three issues.

The first section of the lecture shall describe the large-scale current systems in the ionosphere and magnetosphere sustained by the solar wind impact, their geophysical effects and their geomagnetic signatures detectable by the worldwide array of magnetometers from some of which data are available on-line in real-time. Further, the lecture shall explain the derivation and the importance of geomagnetic indices such as the planetary disturbance index, Kp, the ring current index, Dst, the auroral electrojet indices, AU, AL and AE, and the polar cap indices, PCN and PCS. Special attention shall be devoted to the description of “Geomagnetically Induced Currents” (GIC) that are caused by strongly varying ionospheric currents and constitute a serious threat to power grids near the auroral regions.

The second section of the lecture shall focus on the description of ionospheric disturbances that may affect radio wave propagation. Such disturbances comprise radio wave absorption events at high frequencies (HF) or very high frequencies (VHF) related to enhanced ionization caused by high-energy radiation entering the lowermost regions of the ionosphere in the auroral and polar regions. Typical examples are polar cap absorption (PCA) events caused by the radiation of high-energy solar protons emitted from eruptive flares and auroral substorm absorption events of various types caused by the precipitation of high energy electrons from the Earth’s radiation belts. Such events are detectable from the ground by riometers and radiowave sounding instruments. Another group of disturbances comprise ionospheric scintillations that may cause irregular amplitude and phase variations of radio wave signals over a wide frequency range. Among other effects

ICTP - EC COST Action ES0803 - EC FP7 Project SOTERIA – INAF - ESA
International Advanced School on Space Weather Modelling and Applications

such scintillations can give deterioration of high-frequency signals such as those used in GPS or Galileo navigation systems during disturbed conditions.

If time permits then the lecture shall include visits to web sites with on-line real-time displays of current observations and activity indices for a nowcast assessment of the actual space weather conditions.

Date: Thursday 21 October 2010
Time: 15:00-17:00
Room: Informatics Laboratory @ Adriatico Guest House

Peter Stauning

Senior Research Scientist (emeritus)

Danish Meteorological Institute
Lyngbyvej 100, DK-2100 Copenhagen Ø
Phone: + 45 39157473
E-mail: pst@dmi.dk
Home page: www.dmi.dk/fsweb/solar-terrestrial/staff/stauning/homepage.html



Research areas:

- Solar Wind - Magnetosphere - Ionosphere interactions
- Polar ionospheric convection and field-aligned currents
- Auroral substorm processes
- Radiation in Space
- Wave propagation in the Ionosphere

Current Research projects:

- Project scientist for the Ørsted satellite 2001-2009.
- PI for the CPD instrument at Ørsted (since 1991)
- PI for the "External Field and Space Weather" research at DMI (since 1997)
- PI for polar imaging riometer observations (since 1990)
- Space Weather investigations

Publications (lists available in home page):

- 104 scientific publications in refereed journals, books and proceedings
- 165 conference talks and poster presentations
- numerous popular, educational and news articles

Reviewer for

- Journal of Geophysical Research, Geophysical Research Letters
- Annales Geophysicae, Radio Science, Earth, Planets and Space
- Journal of Atmospheric and Solar-Terrestrial Physics
- Advances in Space Research, Polar Upper Atmosphere Research
- US National Science Foundation, NASA (Research proposals)

Additional comments.

As of 31 July 2009 I have retired from my position at DMI. However, I have obtained an agreement with the Institute (by the DMI director, Peter Aakjær), to still have an office, computer, e-mail and telephone (the above) at DMI as well as full access to archived and current geophysical data. It is my plan to continue working on current research projects concerning, among others, Ørsted satellite data analyses and Space Weather investigations. Thus, I am member of the "Space Weather Working Team (SWWT) and active in contributing to Space Weather projects particularly concerning monitoring and forecasting GIC and high-energy radiation effects. I have submitted presentations for 2 of the sessions arranged for the "Space Weather Week" held in Brugge on 16-20 November 2009.