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Advances in Space Research 37 (2006) 194–198

ADVANCES IN SPACE RESEARCH
(a COSPAR publication)

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The TIGER (thermospheric–ionospheric geospheric research) program: Introduction

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Received 1 September 2004; received in revised form 14 February 2005; accepted 16 February 2005

Abstract

In 1998, the long-term TIGER Program was established within the framework of the SCOSTEP International Solar Cycle Study Working (ISCS) Group 1, Panel 2. The primary objective of this initiative is to determine the variable solar extreme ultraviolet/ultraviolet (EUV/UV) and X-ray fluxes to improve the existing and future thermospheric–ionospheric (T/I) models and to derive EUV/UV indices or proxies for various applications in space research and space-related fields such as navigation and communication. In 2004, the 5th TIGER Symposium was held as a session of COSPAR. The science topics are summarized in the following sections.

Keywords: Solar EUV/UV and X-ray fluxes; Solar variability; EUV/UV radiation modelling; Modelling of the thermosphere/ionosphere

1. The TIGER program

To make continuous progress in understanding and modelling the T/I processes, it is necessary to envisage timescales ranging from minutes (flares) to years (solar cycles). This can be done in the space weather to global change context by making use of a broad range of worldwide existing resources with respect to manpower, experience, hardware, methods, flight opportunities, and funding resources. The TIGER program aims to facilitate the coordination of these existing and planned activities and to help define missing links for achieving the scientific goals. The latter ones are dealt with at regularly organized symposia (Schmidtke, 2000):

1st TIGER Symposium in Freiburg/Germany (1998).
2nd TIGER Symposium in St. Petersburg/Russia (1999).
3rd TIGER Symposium in Boulder/USA (2001).
4th TIGER Symposium on the Internet (2002).
5th TIGER/COSPAR Symposium in Paris/France (2004).
6th TIGER/COSPAR Symposium in Bejing/China (2006).

The topics and subtopics of the scientific program of the 5th TIGER Symposium were:

1. Measurement of solar EUV/UV radiation.
   1.1 Results from recent missions.
   1.2 XUV monitoring missions.
   1.3 Intercomparison of EUV/UV measurements.
   1.4 EUV/UV data base.
   1.5 Are there solar XUV precursors to space weather activities?

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0273-1177/$30 © 2006 Published by Elsevier Ltd on behalf of COSPAR.
doi:10.1016/j.asr.2005.02.088

2. EUV/UV space instrumentation and its calibration.
   - 2.1 Calibration standards.
   - 2.2 Common use of calibration equipment/ procedures.
   - 2.3 Effects causing efficiency changes in EUV/UV instruments.
3. Modelling of solar EUV/UV radiation.
   - 3.1 Empirical modelling of the solar EUV/UV irradiance.
   - 3.2 Physical modelling of solar EUV/UV emissions.
   - 3.3 Intercomparison of results from EUV/UV models.
   - 3.4 Definition and needs of/for solar EUV/UV indices.
   - 3.5 Is the use of the MgII index an improvement over the $F_{10.7}$ index?
   - 3.6 ISO solar irradiance standard.
   - 3.7 Can a XUV Space Weather index be derived?
4. Modelling of the thermosphere/ionosphere.
   - 4.1 General circulation modelling.
   - 4.2 Semi-empirical modelling.
   - 4.3 Photochemical and airglow modelling.

2. Measurement of solar EUV/UV radiation

Quasi-continuous satellite-based measurements from the total solar disk play a key role in the determination of the highly variable EUV/UV fluxes relevant to upper atmospheric physics of the solar system planets. A recent review of solar EUV irradiance measurements is published by Woods et al. (2004). Though many missions have been conducted in the past (see Fig. 1 demonstrating the time/wavelength coverage), our knowledge still has to be improved strongly to achieve the accuracy of the results and the solar cycle coverage as needed for modern upper atmospheric and solar physics and their various applications in T/I and EUV/UV modelling, climatology, satellite orbit prediction, navigation and communication. Based on the recent improvements of the complex EUV/UV optical technology as well as the semi-empirical EUV/UV modelling, a threefold philosophy has been developed that is already applied and will further be applied in the frame of the TIGER program in order to optimize the limited resources available in international and national space programs: first, satellite missions with sophisticated instrumentation such as spectrometers to be added by missions with low-cost broadband instruments are providing the primary data sets; second, in order to derive these data with highest possible accuracy, re-calibration of the space instrumentation is one of the central activities; and third, semi-empirical EUV/UV modelling represents the data sets as derived from the measurements and tests the compliance of data from different missions. These three points are discussed in the corresponding topics of the symposium.

The application of these results in the various fields is of special interest for T/I modelling as the large number of talks in Topic 4 underlines the importance.

3. EUV/UV space instrumentation and its calibration

EUV/UV calibration procedures are well established in the laboratory at accuracy levels of a few percent. However, due to various surface effects on the optical components of satellite instrumentation in a vacuum, and by interaction with EUV/UV and particle radiation in space, the instruments' efficiencies change with time in unpredictable ways thus decreasing the reliability of the detected data. For this reason calibration of the instru-

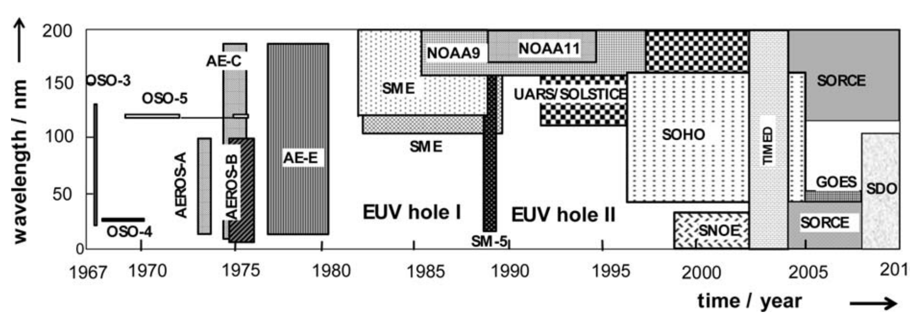

Fig. 1. Time/wavelength coverage of solar flux measurements from satellites: In the spectral region from 100 to 200 nm satellites flown are providing a good temporal coverage of the solar fluxes starting with the mission of the Atmospheric Explorer C. At shorter wavelengths there are substantial gaps (EUV holes I and II). OSO, Orbiting Solar Observatory (Timothy, 1977); AEROS, aeronomy satellite (Lämmerzahl and Bauer, 1974); AE, atmospheric explorer (Hinteregger et al., 1973); SME, solar mesospheric explorer (Mount and Rottman, 1983); NOAA, National Oceanic and Atmospheric Administration: satellites (see NOAA homepage); SM, San Marco satellite (Schmidtke et al., 1985); UARS/SOLSTICE, (Woods et al., 1996); SOHO, Solar and Heliospheric Observatory (Pauluhn et al., 2002); SNOE, students nitric oxide explorer (Solomon et al., 2001); TIMED, thermospheric–ionospheric–mesospheric energetics and dynamics (Woods et al., 2005); SORCE, solar radiation and climate experiment (Woods et al., 2000); GOES, geostationary satellite server (see GOES homepage); SDO, Solar Dynamics Observatory (see SDO homepage).