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Special Issue "Global data systems for the study of solar-terrestrial variability"

Takashi Watanabe[1*], Toshihiko Iyemori[2], Kazuo Shiokawa[3], Jie Zhang[4], Shrikanth G. Kanekal[5] and Nozomu Nishitani[3]

This special issue includes selected papers presented in the "SCOSTEP–WDS Workshop on Global Data Activities for the Research of Solar-Terrestrial Variability," which was held at the National Institute of Information and Communications Technology (NICT), Tokyo, Japan, on September 28–30, 2015 (http://isds.nict.go.jp/scostep-wds.2015.org/). This workshop was promoted by the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) and the World Data System (WDS), both of which are Interdisciplinary Bodies of the International Council of Science (ICSU). The principal objective of the workshop was to stimulate interaction among data providers, data scientists, and data-oriented researchers participating in the SCOSTEP's current research program VarSITI (Variability of the Sun and Its Terrestrial Impact, http://www.varsiti.org/). The long-term preservation and provision of quality-assessed data and information will be common objectives for both SCOSTEP and WDS. The development of advanced data systems to enable scientists to perform multidisciplinary data analysis will be another common target. Data analysis of selected solar-terrestrial events was another important component of the workshop. The principal topics of the workshop were: (1) application of information technologies to data activities; (2) data systems for VarSITI; (3) data analysis of VarSITI Campaign Intervals and others; and (4) data-oriented collaborations between SCOSTEP and WDS. The total number of participants was 71 (53 Japanese and 18 foreign participants). In the workshop, 51 papers were presented (four keynote presentations, 21 papers on the data analysis of solar-terrestrial phenomena, and 26 technical papers on data systems).

For topic (1), the technical report by Ritchel et al. (2017) explores the use of a semantic web-based mashup of appropriate data and models to enable interdisciplinary usage of data and information. This approach will be important for the data-oriented study of space weather and solar–climate connections in which multidisciplinary data analysis is inevitable because the majority of data are not well documented and tend to be suitably structured for machine-based combination.

For topic (3), five papers are included in this issue. Among them, two papers discuss solar–interplanetary phenomena relating to the intense geomagnetic storm that initiated on March 17, 2015, widely known as the St. Patrick's Day Event. This geomagnetic storm was associated with a partial halo coronal mass ejection (CME) occurred on March 15, 2015, which was associated with a C9.1/1F flare (S22W25). This storm's minimum Dst reached − 228 nT (provisional) on March 18, and this was the first super geomagnetic storm of solar cycle 24. This event attracted considerable interest from the VarSITI community because the worldwide network of space weather agencies did not expect such a strong geomagnetic storm to be associated with the relatively minor solar flare (e.g., Kamide and Kusano 2015; Baker et al. 2016). As reported in this issue, Wu et al. (2016a, b), basing on detailed data analysis of solar and interplanetary observations, showed that the storm was caused by subsequent arrivals of an interplanetary shock sheath, carrying the southward interplanetary magnetic field (IMF), and a large magnetic cloud (MC) with a strongly southward IMF. Marubashi et al. (2016) fitted a flux-rope model to the temporal change of IMF near the Earth, and they concluded that the observations are most consistently explained by a toroidal flux rope with the torus plane nearly parallel to the ecliptic plane and that the observations are characterized by the peculiar location of near-Earth spacecraft, staying on the east-side flank of the flux-rope loop throughout its passage.

The second strong geomagnetic storm discussed in the workshop was that occurred on June 21–24, 2015, with

*Correspondence: takashi.watanabe@icsu-wds.org
[1] ICSU World Data System International Programme Office, C/O NICT, Koganei, Tokyo 184-8795, Japan
Full list of author information is available at the end of the article

the minimum Dst of – 204 nT (provisional). This event is known as the Summer Solstice 2015 Event and was the result of at least three prominent coronal CMEs and associated interplanetary shocks, which subsequently hit the Earth's magnetosphere (Baker et al. 2016). Cherniak and Zakharenkova (2017) analyzed data from ~ 5800 ground-based GNSS stations, observing GPS and GLONASS radio signals to study high-latitude ionospheric disturbances during the geomagnetic storm. From this case study, they demonstrated the advantage of such "multi-constellation measurements" to monitor high-latitude ionospheric irregularities.

Two papers on long-term data analysis of solar-terrestrial phenomena are also included in this issue. Watari (2017) discussed the weakness of solar-terrestrial activity in the rising-maximum phase of the current solar cycle (24). He showed that the low geomagnetic activity in this cycle is caused by the weak dawn-to-dusk solar wind electric field. It was also reported in this paper that the majority of the 17 geomagnetic storms with minimum Dst indices of less than – 100 nT that occurred in 2009–2015, including the previously mentioned strong geomagnetic storm in March 2015 and June 2015, were caused by relatively slow CMEs. Araki and Shinbori (2016) studied the local-time variation of the characteristics of storm sudden commencements (SSCs) based on the global geomagnetic database of 1953–2003. They concluded that the SC amplitude at 4–5 h local time of middle- and low-latitude stations most directly reflects the dynamic pressure effect of the solar wind. Based on this finding, they re-estimated the amplitude of the three largest SCs observed since 1868.

In summary, the data-analysis papers in this special issue provide us with current progress in the understanding of solar-terrestrial phenomena observed in the VarSITI interval and in the wider time span. These studies mainly depend on databases provided by research groups, data centers, and data networks. International collaboration of these data providers will be important to ensure long-term data management because the majority of data providers are operated under more or less unstable conditions. In addition, owing to the inherently multidisciplinary character of SCOSTEP-led research programs, collaboration with the informatic community is inevitable for effective data usage, such as introducing the advanced technology of data mining, data processing and data presentation. Further collaboration between SCOSTEP and WDS will be important in these aspects.

Finally, we wish to inform the SCOSTEP community of the sudden demise of Prof. Shi-Tsan Wu [Alabama University in Huntsville (Fig. 1)] on May 21, 2017, at the age of 83. He was internationally recognized for his works on the solar-terrestrial relationship, particularly for the pioneering works on numerical magnetohydrodynamic (MHD) modeling of CMEs. He had submitted a presentation on the data-driven MHD simulation of CMEs (e.g., Wu et al. 2016b), to be presented at the WDS Asia-Oceania Conference 2017 held in Kyoto, Japan, on September 27–29, 2017 (http://wdc2.kugi.kyoto-u.ac.jp/wds2017/), which was planned to be a follow-up of the SCOSTEP–WDS Workshop. His paper was presented at the conference by one of his colleagues. He will be sorrowfully missed by his friends and colleagues.

Fig. 1 Prof. Shi Tsan Wu (1933–2017)

Authors' contributions

All authors of this article served as guest editors for this special issue. TW prepared this preface with the agreement of the other authors. All authors read and approved the final manuscript.

Author details

[1] ICSU World Data System International Programme Office, C/O NICT, Koganei, Tokyo 184-8795, Japan. [2] WDC for Geomagnetism, Kyoto, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan. [3] Institute for Space-Earth Environmental Research, Nagoya University, Nagoya 464-8601, Japan. [4] Department of Physics and Astronomy, George Mason University, 4400 University Drive, Fairfax, VA 22030, USA. [5] Goddard Space Flight Center, NASA, Washington, DC, USA.

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