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PREFACE

The topical issue of “Space Climate: Direct and Indirect Observations of Long-Term Solar Activity” is based on contributions presented at the First International Symposium on Space Climate which was organized in Oulu, Finland in June 20 –23, 2004. The Scientific Organizing Committee of the Symposium was co-chaired by professors J.-P. Rozelot and K. Mursula. Some 110 participants were gathered in the sunny capital of Northern Finland at the Bothnian Bay of the Baltic to enjoy the new emerging science of Space Climate in endless sunlight.

The concept of Space Weather was launched some 10 years ago to describe the short-term variations in the different forms of solar activity, and their effects in the near-Earth environment and technoculture. As an analogy with the relation between the weather and climate of the neutral atmosphere, the concept of Space Climate was introduced more recently to extend the time span covered by Space Weather to the longer-term variations in solar activity, as well as their long-term effects on the heliosphere, near-Earth space, neutral climate and many other related systems.

While the time span of Space Weather can roughly be defined to extend up to a few solar rotations, i.e., the time until when reasonable day-to-day forecasts of Space Weather can be made, Space Climate would span time scales longer than this. The time scales of Space Climate can roughly be divided into three groups based on the available data and observations. First, from the last few tens of years we have several uniform data sets of extensive ground-based and space-based observations of the Sun, the heliosphere and the near-Earth space that allow us to have a better understanding of the full chain of effects from the Sun to the Earth. Second, from the last few centennia we have more limited and less uniform data sets of direct observations of the Sun, as well as some related proxies like geomagnetic activity. Third, in the millennium and longer time scales we have some less direct but still very useful proxy data sets like those on cosmogenic isotopes.

It is clear today that the Sun is a variable star. However, we are still far from fully understanding what and how causes this variability. After the beginning of the magnetically active Sun, why does it continue to go on, obviously without much damping? Why is the level of activity different from one cycle to the other? Why and how is solar irradiance changing? What is exactly the shape of the Sun? What causes the systematical asymmetries between solar hemispheres? The list of open questions is long and we will not close it in the near future.

One of the main tasks for Space Climate is to better understand the various forms of solar variability and, in particular, the observed long-term extremes and possible repeatable patterns of this variability. Several contributions presented during the Space Climate Symposium, some of which are included in this Topical Issue, discussed these issues and presented interesting new results, e.g., on the centennial increase in solar activity and on the recently found systematic patterns in solar and heliospheric magnetic fields and their hemispheric and longitudinal asymmetries. The large increase in solar activity during the last 100 years dramatically emphasizes the existence and our lack of understanding of fundamental solar processes that produce such rapid changes in solar magnetism. On the other hand, the newly observed systematic patterns give interesting new information on solar dynamo modes and relate to similar systematic patterns on other, Sun-like stars.

Another important task for Space Climate is to better understand the complicated relationships between the Sun, the heliosphere and the many proxies of long-term solar activity so that the different proxy data on long-term solar activity could be fully exploited for a better understanding of solar changes on the longest possible time scales. Several contributions in the symposium, some of which are included in this topical issue, concentrated on the methods and recent results obtained, e.g., from different cosmogenic isotopes (^{10}Be, ^{14}C, ^{44}Ti), atmospheric nitrates and geomagnetic activity.

A third important task for Space Climate is to better understand the long-term effect of the changing Sun on the near-Earth environment, in particular on global climate. Although this wide research area is not the main focus of the Topical Issue, several contributions present interesting new results demonstrating that long-term solar variability is an essential factor in forming the neutral climate and its various elements (cloud patterns, ocean streams, winds, draughts, etc.). However, these results are often still based on quite elementary, though mostly reliable methods and data, and require more sophisticated treatment and analysis in the future. This work is only in the beginning as we do not yet fully understand the formation of present climate, not to talk about the situation during quite different solar activity, say, only 100 years ago.

The long-term climate variations, e.g., during the last thousand years, seem to correlate quite well with changes in solar activity. Being slightly provocative and viewing the global change from a different viewpoint, we would like to note that the times of high solar activity seem to have been ultimately beneficial for life on Earth and thereby for mankind and culture! Also, the recent period of exceptionally high solar activity marks a time of an unprecedented global welfare of mankind. Is this merely a coincidence?

The main goal of Space Climate must be that we can understand the structure, dynamics and history of the Sun so well that we can make reliable long-term predictions for the future development of solar activity, at least a couple of solar cycles ahead. Taking into account the dramatic effects of solar activity on near-Earth environment, such predictions would have phenomenal practical and economical importance for mankind and nature. The possibility of being able to make such reliable predictions in the future validates to maintain a strong reseach program in Space Climate now and in the future.

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