

Space Weather and Space Climate

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On 1 September 1859, a strong solar flare was observed. 17 hours later, magnetometers around the world registered a very powerful geomagnetic storm. This was the first observed space weather event, and the first phenomenon, after gravity, linking the Sun and the Earth. In the years and decades to follow, much research was done to understand how various manifestations of solar variability affect the Earth's magnetosphere, ionosphere, and atmosphere, down to the functioning of space-borne and ground-based technological system and even human physiological state – or what we now call space weather. Much progress was made also in understanding the generation of extreme solar events which could have adverse effects on power line networks, pipe lines, radiocommunications.

While space weather describes short-term variations in the different forms of solar activity, and their effects on the near-Earth environment, technology, and life, space climate, analogous to atmospheric climate, deals with long-term changes in the Sun, and their effects in the heliosphere and upon the Earth system. We now have theories, consistent with observational facts, explaining the way the solar dynamo – the driver of solar activity - operates. There are, however, still many unknowns, including some basic solar dynamo parameters, and we don't know how and why these parameters vary in time leading to long-term variations in the strength of the dynamo and consequently long-term variations in solar activity. Also not clear enough are the long-term variations in the Earth system. Solar activity is the driver of geomagnetic activity, but the correlation between the two varies in time. The global climate change registered in the last century posts the question about the reasons for climate variability and the relative impact of anthropogenic versus natural factors.

These questions can only be answered by the joint study of the coupled Sun-Earth system and the heliosphere as a whole. The Earth is a kind of a probe carrying records of past solar activity which can help us better understand solar variability. The solar signal seen in a number of terrestrial processes can shed some light on the long-term climate variability.