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Science City Davos

## Solar protons and life on Earth

A weak Earth's magnetic field does not protect us from the Sun

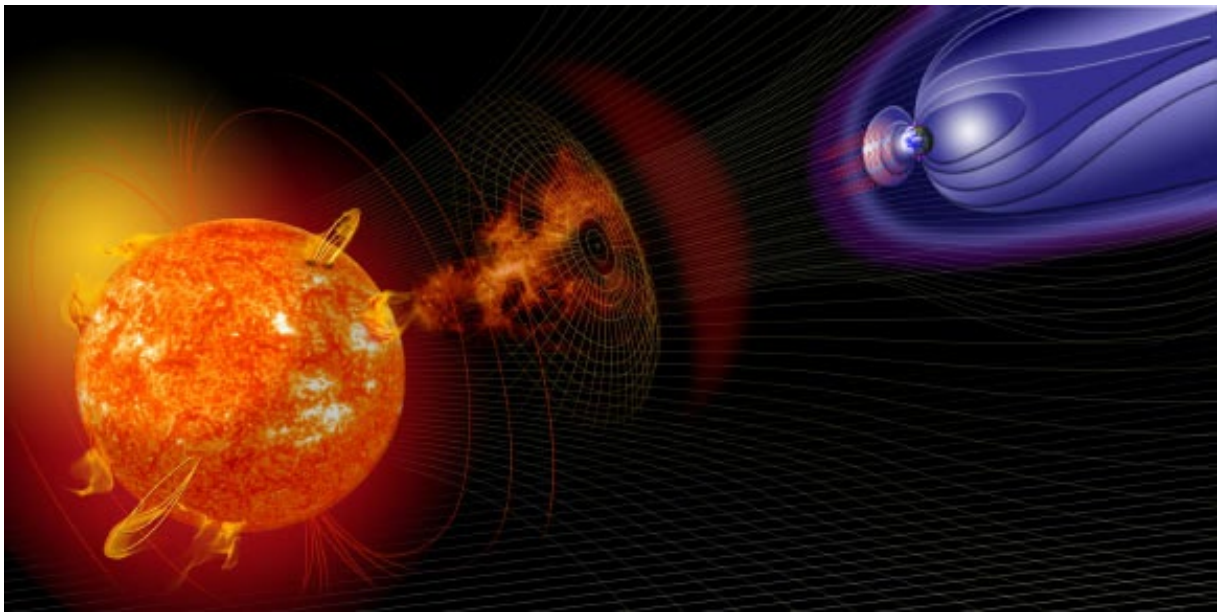

Illustration of solar protons moving towards Earth, shielded by geomagnetic field. Credit: NASA.

The Earth is frequently irradiated by protons generated during explosive events on the Sun. This phenomenon is well-studied and does not pose a significant danger to the Earth's ozone layer. However, historical data suggest that every few thousand years an extremely explosive event occurs, sending a stream of protons toward Earth with energy levels exceeding previous events by a hundred or even a thousand times. One of the most recent extreme proton events occurred in the year 774 AD and has been detected through isotope measurements in tree rings and ice cores. Could such a phenomenon seriously damage the ozone layer and increase ultraviolet radiation at the Earth's surface to hazardous levels?

### Dependence on the geomagnetic field

A climate research group from PMOD/WRC, supported by the Swiss National Science Foundation and the Karbacher Fonds Graubünden, collaborated with scientists from Austria, Germany, Finland, and Australia to analyze the potential consequences of such a super event. Using a modern climate model, they demonstrated that under the current state of the Earth's magnetic field, even a super-strong proton event would not cause dangerous changes in the ozone layer. However, the situation changes dramatically if the geomagnetic field weakens and loses its ability to shield the atmosphere from the stream of super-strong protons. They found that in such a case, severe and long-lasting ozone damage occurs: ultraviolet radiation worldwide increases by up to 25 percent, and Sun-induced DNA damage rises by nearly 50 percent.

**Geomagnetism in the past and future**

How likely is a weakening of the geomagnetic field? Geological data indicate strong fluctuations in the configuration and intensity of the geomagnetic field. These data also show extended periods when the geomagnetic field was very weak or even absent. One of the most recent periods of a weak magnetic field, known as the Laschamp Event, began approximately 41,000 years ago and lasted around 1,000 years. Various paleo data suggest that during this time, several major environmental catastrophes occurred, such as the disappearance of the last Neanderthals in Europe and the extinction of megafauna in Australia.

Currently, the Earth's geomagnetic field is strong and protects us. However, it is also changing: the magnetic North Pole is shifting southward from Canada at a speed of about thirty kilometers per year, and its field strength is noticeably weakening. Combined with increased solar activity, this results in a shift of the auroral oval southward and more frequent occurrences of auroras even in lower latitudes, such as in Davos.

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**PMOD/WRC**

The Physical Meteorological Observatory in Davos performs observational and research activities in the areas of Earth radiation, solar physics, solar-terrestrial relations, ozone layer evolution, and climate change. The climate group of the institute develops, maintains, and exploits a world-level Earth system model, allowing to study the impacts of various anthropogenic and natural factors on the Earth environment. The group collaborates with many teams internationally and closely with ETH Zurich, by using their computational cluster Euler and deeply involving students in its research. www.pmodwrc.ch