Cosmic rays' impact on climate is likely caused by cloud formation mechanisms

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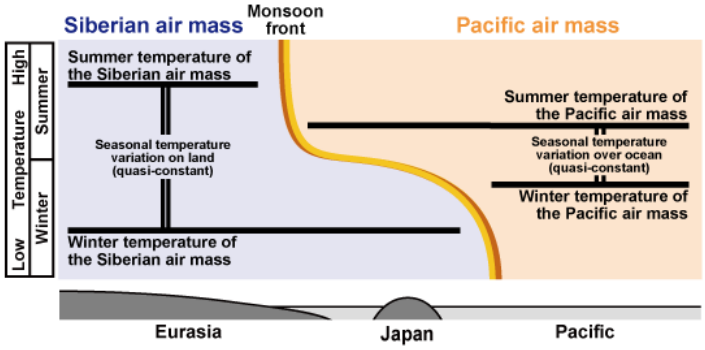
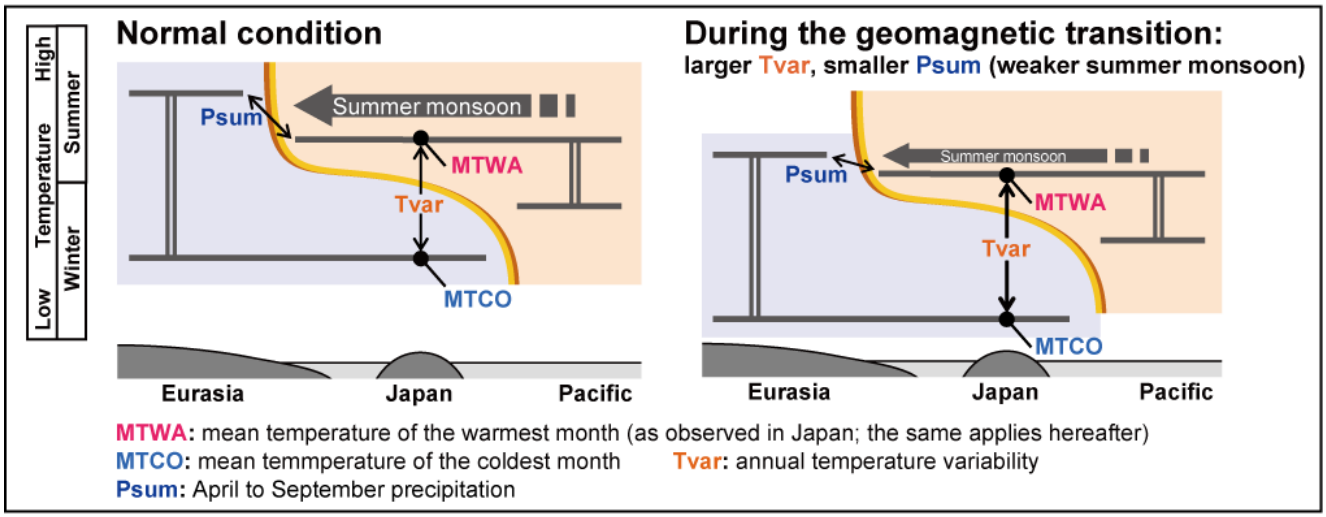
On geological time scales, the galactic cosmic ray (GCR) flux at the Earth's surface has increased significantly during many short time intervals. There is a growing body of evidence that suggests that climatic cooling occurred during these episodes. Cloud formation by GCR has been claimed as the most likely cause of the linkage. However, the mechanism is not fully understood due to the difficulty of accurately estimating the amount of cloud cover in the geologic past.

Our study focused on the geomagnetic field and climate in East Asia. The Earth's magnetic field provides a shield against GCR. The East Asian climate reflects the temperature balance between the Eurasian landmass and the Pacific Ocean that drives monsoon circulation.

Two geomagnetic polarity reversals occurred at ca. 780 ka and ca. 1,070 ka. At these times the geomagnetic field decreased to about 10% of its present level causing a near doubling of the GCR flux. Temperature and rainfall amounts during these episodes were reconstructed using pollen in sediment cores from Osaka Bay, Japan. The results show a more significant temperature drop on the Eurasian continent than over the Pacific, and a decrease of summer rainfall in East Asia (i.e. a weakening of East Asian summer monsoon). These observed climate changes can be accounted for if the landmasses were more strongly cooled than the oceans. The simplest mechanism behind such asymmetric cooling is the so-called 'umbrella effect' (increased cloud cover blocking solar radiation) that induces greater cooling of objects with smaller heat capacities.

Keywords: galactic cosmic ray, umbrella effect, cooling, East Asian monsoon, geomagnetic reversal, paleoclimatology





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