A current program at Vostok

Ever wondered what happens to the current that flows in lightning displays during thunderstorms? Well some of it sneaks back to Earth at Vostok, Antarctica. These events form part of the global electric circuit.

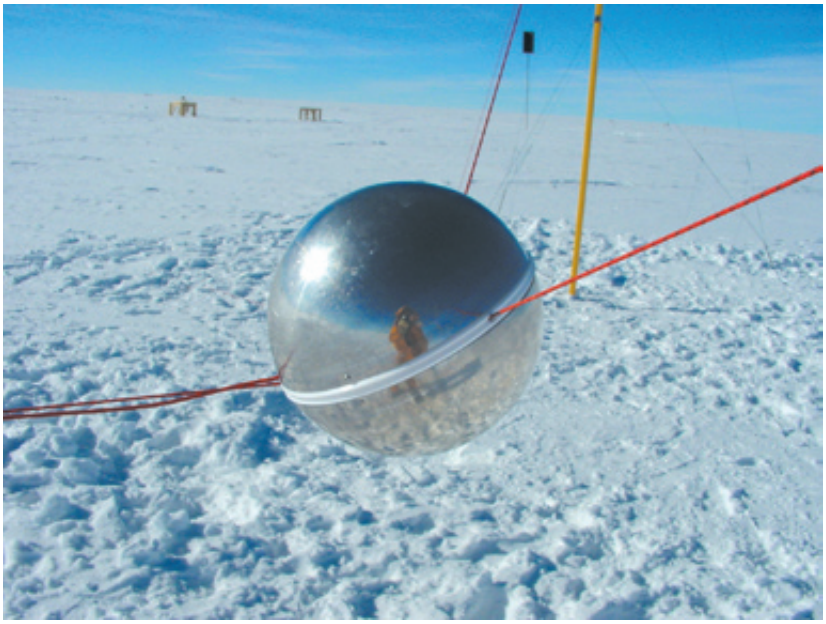
In excess of 1000 thunderstorms at any one time are the batteries of this circuit. Charge is separated from air molecules and ice particles in the strong up-welling drafts at the core of thunderclouds, similar to that achieved by the friction of a comb through hair. The thundercloud accumulates an excess of negative charge at its base and positive charge at its crown. Eventually, the accumulation of charge at the cloud base generates lightning.

The Earth's atmosphere is so densely packed near the ground, that once electric charge has been lifted above 3 km, the 'path of least resistance' to complete the circuit is initially upwards. The charge travels from the top of the thundercloud (~10 km) to the lower reaches of the ionosphere (~80 km) where it spreads around the globe and leaks back to the Earth's surface over the 99% of the globe where thunderstorms are not active at that time. Optical confirmation of the linkage between thunderclouds and the ionosphere was obtained as recently as 1995 with the imaging of 'sprites'.

Changes in the sun directly influence the global electric circuit. Cosmic rays control the ease with which current can flow through the atmosphere and these are modulated by changes in the solar wind. In total energy terms, solar variability can have negligible influence on the weather, but the leverage gained via the global electric circuit yields possible mechanisms for meteorological and climatic influence. The aim of our research is to determine the viability of such links.

Vostok is an ideal site to measure the global circuit. It is on a high (3500 m) plateau which improves the linkage to the ionosphere by over 50% compared with sea-level sites. Minimal variation in station weather on time-scales of less than a day is also vital for relating the measurements to the global circuit.

Since 1998, an international research program has been undertaken at Vostok in collaboration with Drs Oleg Troshichev and Alexandr Frank-Kamenetsky of the Russian Institute of Arctic and Antarctic Research in St Petersburg, Dr Edgar Bering from the University of Houston and Dr Volodya Papitashvili of the University of Michigan. We have been able to show an influence of solar variability on measurements of the vertical electric field of the global circuit at this site.



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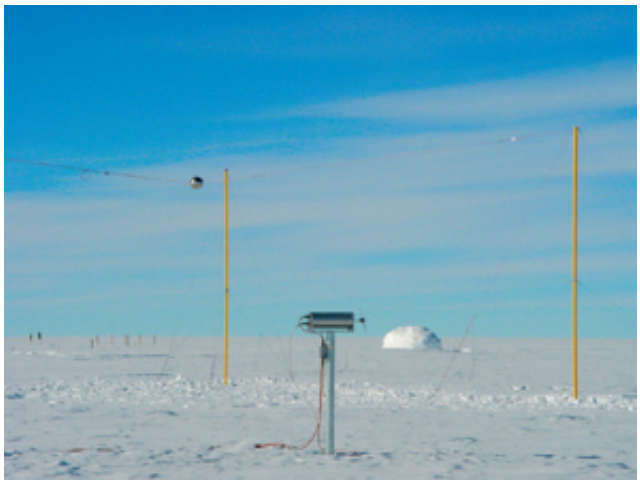

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Above: The air-earth current meter ball.
Right: The electric field mill (operating since 1988) in the fore-ground and the air-earth current meter in its deployed position.

A more difficult measurement to make, but one more directly related to the global electric circuit, is of the miniscule current (~3 pico-amps per meter squared, world-wide) that flows from the ionosphere to the ground in regions remote from thunderstorm activity. With the assistance of Dr Edgar Bering, the Australian Antarctic Division Science Technical Support group has developed a split-sphere to measure this current. This instrument was deployed at Vostok on the 28th January 2003 by Peter Jansen utilising United States Antarctic Research Program logistics, via New Zealand. At Vostok, the current through the Air-Earth Current Meter is approximately 160,000,000,000 times smaller than current through a 60 watt light-bulb!

Subsequent to our deployment, a delay has intervened. Vostok was closed and our instruments turned off. It had proved impossible to supply sufficient fuel from Mirny to sustain the winter operation of the station. Our Russian colleagues plan to re-open Vostok in November 2003 and we look forward to resuming our investigations of the global electric circuit.

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