

The 'Halloween' storm of 2003 was the major 'space weather' event of the past decade. **Alan Thomson** looks at how the Sun's occasional outbursts can spell trouble for Britain's power grid.

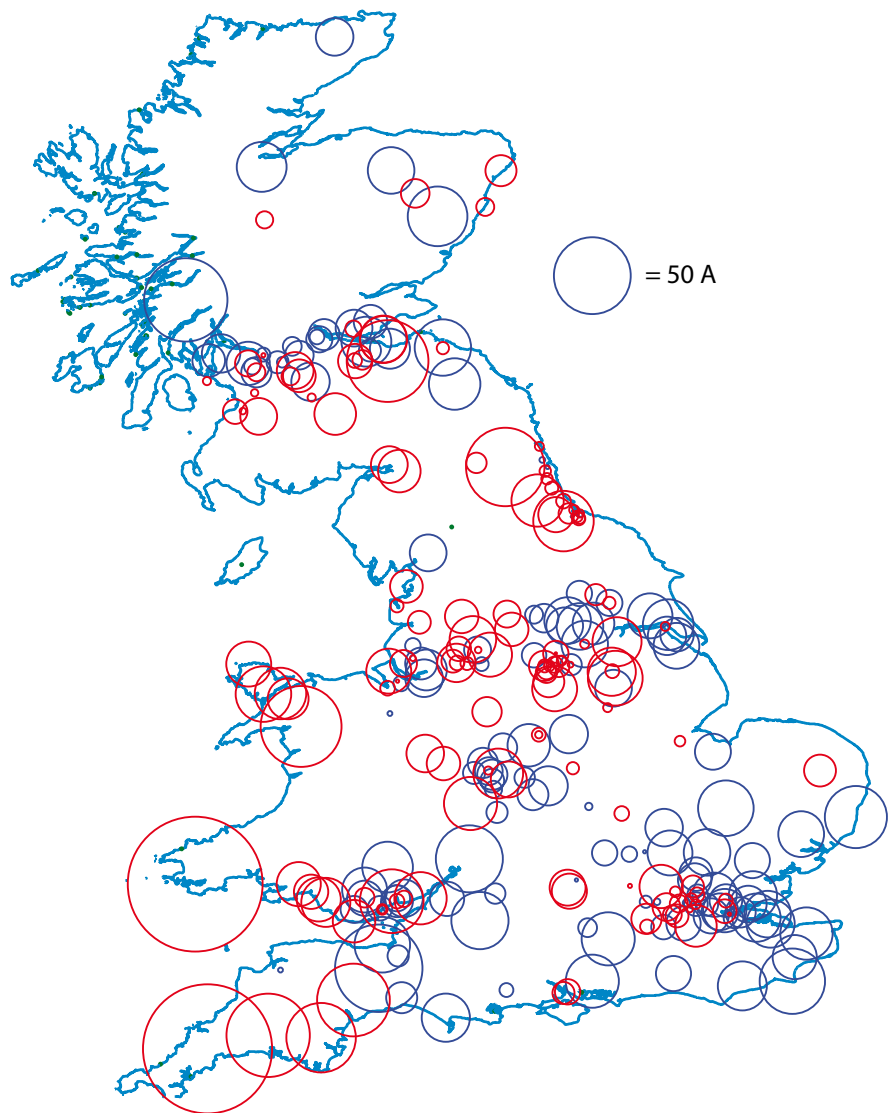
Space weather and power grids

During the Halloween storm the Sun's magnetic field lines stretched and snapped, causing a massive eruption of gas. Crossing 150 million kilometers of space in under a day this space weather storm produced aurorae (normally seen at the Earth's poles) that were visible from Florida.

Space weather can and does affect the Earth resulting in degraded satellite communications; less accurate global positioning; radiation damage to spacecraft; perturbed orbits of low Earth orbit satellites; disrupted polar long-haul air flights; damage to high voltage power grids and corrosion of oil pipelines.

Understanding space weather requires uninterrupted real-time monitoring and modelling of the geomagnetic field — an area of expertise where the BGS is a world leader. The Halloween storm magnetogram shows an offset of four to five degrees because of the magnetic field generated in the Earth's core and from local magnetic rocks. We can subtract these signals using BGS models of the internal field of the Earth. Superimposed on this internal magnetic signal are large and rapid geomagnetic fluctuations due to space weather. At one point the compass direction changes by five degrees in six minutes.

During the storm BGS scientists were able to monitor, in near real time, the magnetic variations and consult with colleagues in the UK power industry over the consequences. We also provided



Geomagnetically induced current 'hotspots' in the power system during the Halloween storm (at 21:24 hours, 30 October, 2003). Red/blue denotes current flowing to/from the Earth at 252 major transformers. Circle size is proportional to current.

a website for the public to record observations of the aurora borealis www.geomag.bgs.ac.uk/storm29oct2003.html

These magnetic fluctuations produced an enhanced surface electric field across the country. This field drove electrical currents, called 'geomagnetically induced currents' (GIC), into the UK power network causing over 40 amperes of damaging current at one point. The storm also caused local blackouts in Sweden and transformer damage in South Africa.

Together with previous knowledge of the Quebec power grid blackout in March 1989, the Halloween storm raised awareness and concern within the power industry and government. BGS advice is now sought by UK and European decision-makers and we continue to lead GIC research.

Scientific insights since 2003 are already producing improved hazard models, including a new BGS–Lancaster University model of GIC flow in the UK grid. This is cutting-edge science where we have combined a three-dimensional model of the Earth's electrical conductivity underlying the UK with a two-dimensional, time-varying model of electrical sources in the ionosphere. We



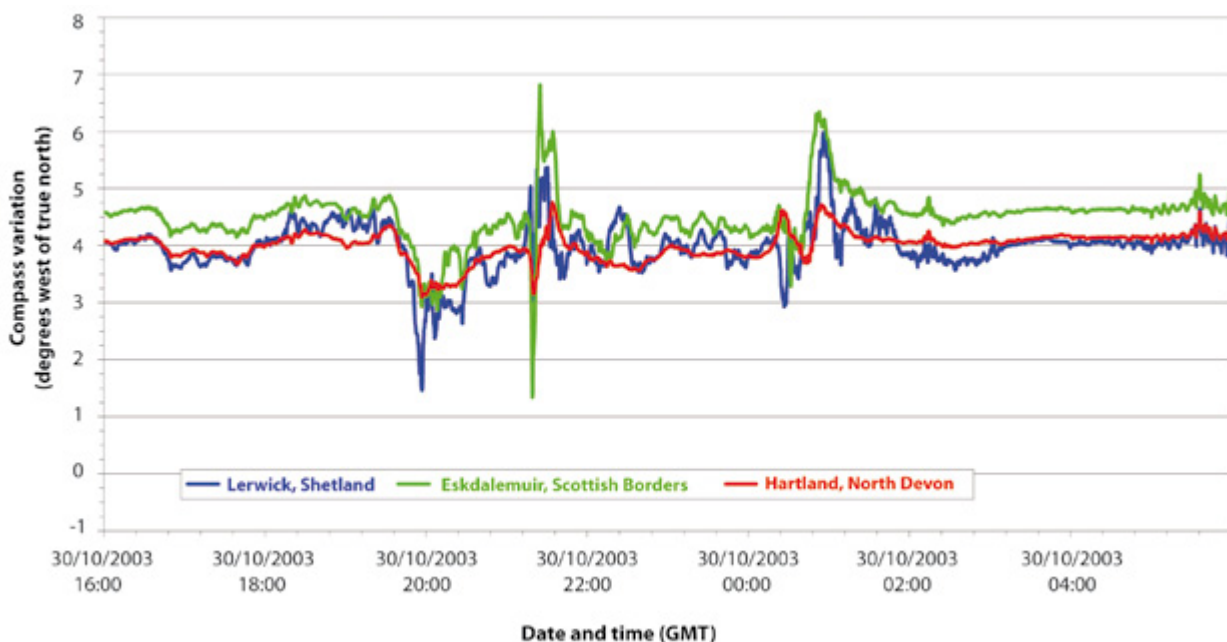
Manual survey during installation of the new BGS magnetic observatory on South Georgia. This observatory will be used to monitor the weakening magnetic field in the 'South Atlantic anomaly', where space weather impacts deeper into the atmosphere.

have coupled this to an electrical model of the UK grid to produce the most realistic picture yet of GIC flow. This new model is timely as the new solar activity cycle has begun and should peak by 2013.

For further information, contact:

Alan Thomson, BGS Edinburgh
Tel: +44(0)131 667 1000
e-mail: awpt@bgs.ac.uk

Acknowledgements. Scottish Power, National Grid, University of Lancaster, South Georgia Government.



The compass variation during 30/31 October 2003 in the UK. Trends and offsets can be removed by highly detailed BGS models of the global internal magnetic field.