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Reconstruction of historic solar magnetic field using proxy data

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The reconstruction of the open solar flux from historic geomagnetic activity observations was made possible by the discovery by the Ulysses spacecraft team that the radial component of the heliospheric field is independent of heliographic latitude at all phases of the solar cycle. This allowed understanding of the local heliospheric field near Earth to be converted into a global solar measure. A second key realisation was that some unknown variables that influence geomagnetic activity, such as the orientation of that field, averaged to constant values if sufficiently long (annual) timescales were used. The availability of coincident data on geomagnetic activity and the near-Earth heliospheric field from 3 solar cycles allowed the reconstruction method to be developed. Subsequently, such data has been obtained for a fourth solar cycle and this provides a stringent test of the algorithm because it contained a much weaker solar minimum than had been seen hitherto during the space age. Immediate support for the reconstruction was found in fully-independent data on cosmogenic isotopes stored in terrestrial reservoirs. The reconstruction algorithm has subsequently been improved to make better allowance for the effect of longitudinal solar structure and to exploit the differences between range and hourly mean geomagnetic data to reconstruct both the solar wind speed and the open solar flux. Debate about the validity of the reconstructions was largely centred on the accuracy and intercalibration of the historic geomagnetic data. In this context, the extraordinarily far-reaching work of 1832 by Carl Friedrich Gauss and Wilhelm Weber was vital in allowing the establishment of a global network of well-calibrated geomagnetic observations and this debate has been ended by the addition of data from other stations which support the original data employed. However, we noted a worrying tendency for later scientists to re-calibrate historic data based on their own theories and expectations but not to properly document the re-calibrations. This tendency makes understanding the provenance of any one dataset vital. It also demonstrates how important it is for datacentres to store both the original data and full metadata relating to re-calibrated datasets.