REAL-TIME MAGNETIC ACTIVITY INDICES - TWO EXAMPLES IN DAILY USE

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IAGA-IASPEI Joint Scientific Assembly 24th August 2001 Session G5.06

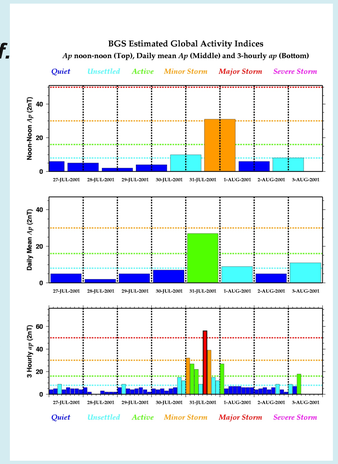
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

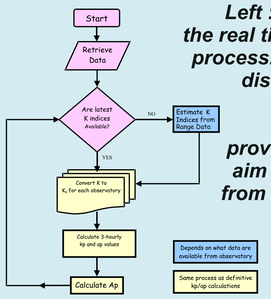
Two different examples of real-time indices that are both provided and used by the British Geological Survey (BGS) are described here. The first is a "quick-look" estimate of both the well established and much used 3-hourly planetary index (*ap*) and the daily planetary index (*Ap*). In order to mimic the definitive indices, these estimates are derived using data from as many of the official *Ap* magnetic observatories as possible. They are available in real-time and are currently used by BGS when making short-term forecasts of geomagnetic activity. Results are shown as to how well the BGS estimated values correspond to the definitive *Ap*. The second example is the hourly standard deviation (*HSD*) in the North (*X*) and East (*Y*) components of the geomagnetic field. This index was chosen by BGS as an appropriate measure of geomagnetic activity for work being carried out on the analysis and monitoring of geomagnetically induced currents (GIC) in power grids in the UK. Simple to compute in real-time, *HSD* is a realistic proxy for the power in magnetic field variations driving GIC.

Real Time Estimates of the *ap* and *Ap* Indices - *Monitoring Global Geomagnetic Activity*

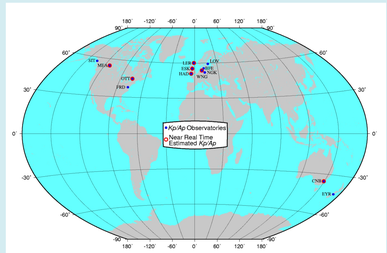
An example of the real time display available to BGS staff. Estimates of ap and Ap are up-dated hourly. Predicted Ap for today is determined from all available ap to date.

The main use for real time values of ap and Ap is in forecasting of geomagnetic storms. They are a valuable aid when making predictions and are also used to determine the accuracy of the most recently made predictions.





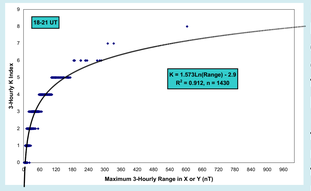
Left : A summary of the real time production process. Right: Global distribution of the the magnetic observatories providing data. The aim is to use data from as many of the definitive Kp observatories as possible



Observatories Used for Definitive and Estimated *ap*

Estimating *K* Indices

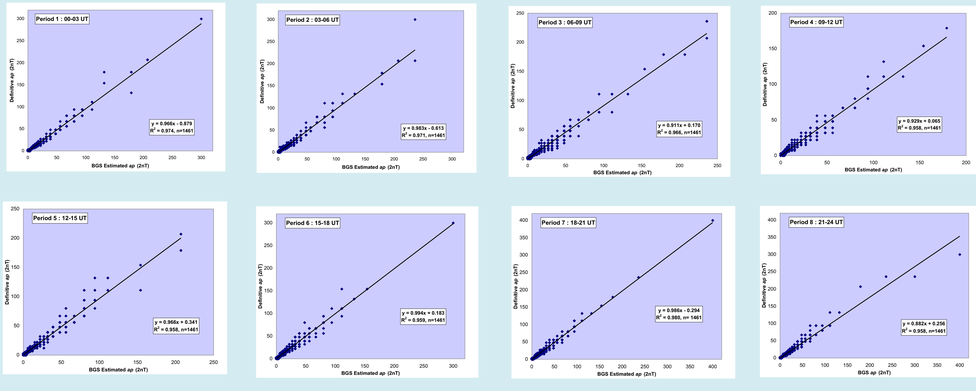
The accuracy of each *ap* estimate not only depends on which observatories are used, but also on the availability of their *K* indices or, when these are not available, on the accuracy of estimated *K* values from curves such as the one on the right.



Using data from 1997 to 2000, a logarithmic regression curve was derived for each 3-hour period for each observatory to give the *K* value from the maximum horizontal range. The plot to the left is one example. This method was then used to derive *K* from the range when this was less than the normal lower bound for *K*=4. For *K*=4 to 9 the normal lower bound for the range for each index value was used. This avoids the obvious misfit shown when *K*>5.

Accuracy of Estimations

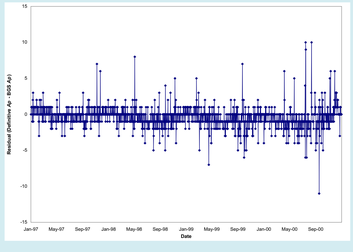
Estimated 3-Hourly ap (available at 02:30 UT the following day) compared with definitive ap during the years 1997 to 2000.



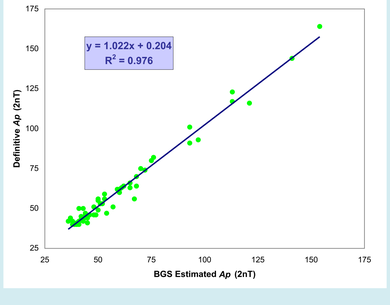
Plots show different correlation depending on UT. Some of these should be improved by using a better distribution of observatories.

The Estimated Daily Ap

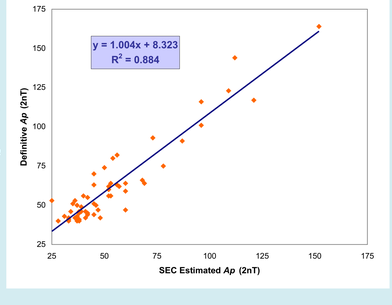
The residuals between the estimated and definitive daily Ap show no bias over time



Comparison of BGS Estimated Daily *Ap* (below left) with the SEC Estimate (below right)



Only values of *Ap* >= 40 are shown. The SEC estimated *Ap* are the values that were made available by 02:30 UT. The BGS estimates have been created retrospectively using the data that would have been available at this time. Improvements are made later in the day when more *K* indices become available.



FUTURE IMPROVEMENTS

Increase the number of observatories used to match those used in the definitive *Ap* calculations.

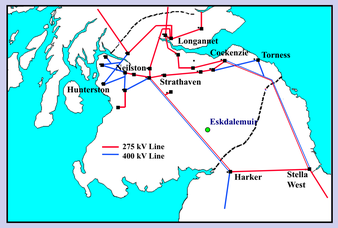
Improve the technique for estimating the *K* indices.

***Acknowledgements.* BGS would like to thank the following data providers: The Natural Resources of Canada, Geological Survey of Canada; Wingst Observatory, GeoForschungsZentrum, Potsdam; and the Australian Geological Survey Organisation.**

Hourly Standard Deviations - *Monitoring Local Geomagnetic Activity and Geomagnetically Induced Currents*

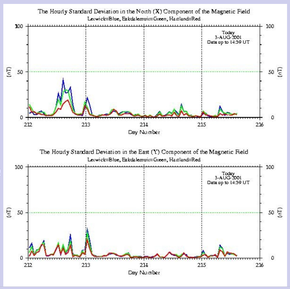
Why use an hourly standard deviation?

It is easy to compute from the one minute mean data. Physically it relates to the power in the *B*-field spectrum that drives the *E*-field which causes geomagnetically induced currents (GIC), through the magnetotelluric relation. A time scale of one hour is also appropriate for substorm phenomena. Maximum rate of change per hour is an alternative, however when dealing in real time data spikes are then an issue.



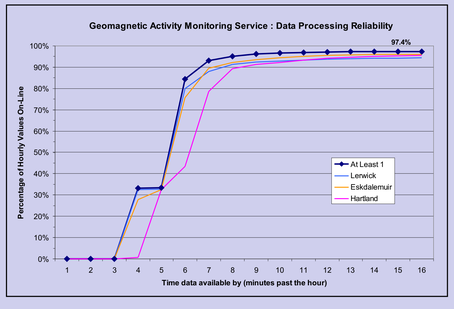
How is the HSD index used?

Scottish Power plc access the index every hour to corroborate any observation of DC currents at their four monitoring sites on transformers at Neilston, Hunterston, Strathaven and Torness (see left). On the right is a typical near real time plot on display at BGS.



Delivery Provision

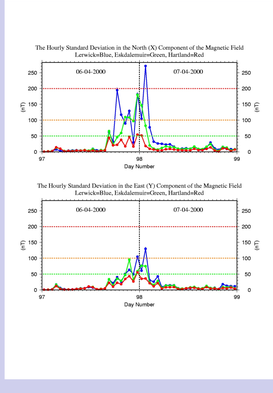
Data are supplied to Scottish Power from BGS in Edinburgh or directly from the observatories (see below right). The reliability steadily improved from the commencement of the service over the initial year. The overall reliability of the primary service is shown below left. The secondary service, based at the observatories was established to bring the reliability up to 100%.

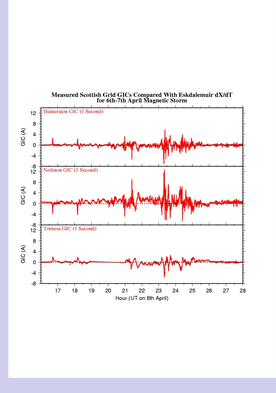


Provision of *HSD* data	Geomagnetic Observatory System	Communication to PC in Edinburgh	Data Processing and QC on SUN Server (*mhub*)	Communication to Scottish Power (grid control)
Primary Service	GAUSS (main system)	Esk : every 2 minutes via public INTERNET Ler, Had : every 4 minutes via Integrated Services Digital Network (ISDN)	Data plotted every 10 minutes. *HSD* data derived hourly after automatic quality control (QC) procedures. If necessary (during office hours only) manual QC procedures to replace any bad or missing data (see below)	Dedicated modems and specially written software to allow secure logins to personal account on BGS unix node *mhud*
	FLARE*plus* (backup system)	Four times per day (or as required) via Public Switched Telephone Network (PSTN)	QC plots produced automatically every day and when required (during office hours only) if FLARE data required to replace GAUSS data	N/A
Secondary Service	FLARE*plus* (backup system)	N/A	N/A	Modems and specially written software on observatory system PC

HSD during the magnetic storm of 6th-7th April 2000

The rapid rise and fall of the *HSD* index is evident. The horizontal lines denote activity thresholds. Here the activity exceeds "severe storm" at Lerwick. Activity is usually greatest at Lerwick and least at Hartland. Historically, when *HSD* at Eskdalemuir exceeds that of Lerwick (i.e the electrojet lies over central UK) the strongest GIC are reported in Central Scotland. In this example, *HSD* at Eskdalemuir rises and falls with the recorded GIC even though the GIC are recorded at a much higher rate.





***Acknowledgements.* BGS would like to thank Scottish Power plc for their support of this project.**