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On the local operational geomagnetic index K calculation

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There is an ongoing demand for services that can provide real-time assessment of the (global and local) geomagnetic activity and identified as being of importance to the exploration geophysics, radio communications and precise position/navigation practices, space weather research and modelling, etc. Such services depend largely on the reduction of solar, geomagnetic and ionospheric observations to generate activity indices, one of the most widely used being the K index. The K index is a quasi-logarithmic index characterising the 3-hourly range in transient magnetic activity relative to the regular "quiet-day" activity for a single site location. A derivative "planetary" index (Kp), the mean standardized K index from several globally distributed stations, provides a convenient measure of the global geomagnetic activity. Computer-based derivation of K/Kp indices was a major step towards higher efficiency and lower costs. Nowadays, automated data acquisition, processing and generating the index in real time is mandatory for any reliable service. However, Kp may not be accurate enough when monitoring disturbances of smaller scale, so the local K index (derived from the nearest magnetic station/s) might be considered as the better choice. Moreover, the 3-hour time scale is much larger than the shorter characteristic time of localised ionospheric phenomena that are of particular interest to us.

Our experience in developing a novel nowcast system for local operational geomagnetic index K calculation (K-LOGIC) will be presented. The system is based on a fully automated computer procedure for real-time digital magnetogram data acquisition, screening the dataset and removing the outliers, establishing the solar regular (Sr) variation of the geomagnetic field, calculating the K index, and issuing an alert if storm-level activity is indicated. This is a time-controlled (rather than event-driven) system delivering as regular output (time resolution set to 1 hour) the K value, the estimated quality flag, and eventually, an alert.

The regular field variation is determined from the hourly medians of the horizontal components' values obtained during the recent magnetically-quiet days. These Sr values are subtracted from the corresponding instantaneous measurement values (in the latest 3 hours) to determine the components' ranges (maximum minus minimum). Finally, the larger of the 2 horizontal components' ranges is used to determine the K value referring to the limits-of-range-classes table for the particular observatory.

A very important feature of the K nowcast system is the strict control of data input and processing, allowing for an immediate assessment of the quality of output. The key concept of the implemented quality control (QC) procedure is based on the fact that a complete and sound dataset provides the ideal platform for reliable, closest-to-definite index production. In this sense, any gap or outlier in the dataset can erode the quality of the produced output. The QC matrix takes into account both, the total length of data gaps (shorter or no gaps – the better) and the time elapsed from the latest gaps/outliers (more distant in the past – the better). As a result, a QC flag is assigned to each K nowcast value. The above-described control is of crucial importance for the nowcast system operation since it helps minimising the existing possibility of missing an event or issuing a false alert.

The K-LOGIC system's operability, accuracy and precision have been tested with instantaneous measurements from the recent years. A statistical comparison between nowcast and definite index values proves that the average rms error is smaller than 1 K unit. The system is now operational at the RMI Geophysical Centre in Dourbes (50.1N, 4.6E).