Geomagnetic *Kp* index

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1. Licence

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2. Citation

When using the data please cite:

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3. Data Description

Matzka et al. (2021) describe the state of the Kp index 70 years after its introduction and serve as a reference for users of the IAGA-endorsed Kp index as well as for the derived indices ap, Ap, Cp and C9 in their definitive and nowcast version as well as for the International Quiet and Disturbed Days. This dataset is provided by GFZ and derived from indices or near real-time geomagnetic observatory data provided by 13 contributing observatories. Please cite this data publication as well as the accompanying publication (Matzka et al., 2021) when using the Kp index or any of the derived indices obtained from this dataset or from its copies provided by GFZ or other institutions.

3.1. The *Kp* index

The Kp index was introduced by Bartels (1949). We follow here generally the notation of Bartels (1957). A comprehensive list of references on the Kp index is provided in Matzka et al. (2021), which also describes the near real-time distribution of the indices.

3.2. DOI and versioning

With the introduction of the DOI 'https://doi.org/10.5880/Kp.0001' for the dataset, the DOI landing page and the associated FTP server linked to this DOI become the dataset's primary archive (while the other established index distribution mechanisms at GFZ will be maintained in parallel). With the DOI, the dataset can grow with time, but a change of the data, once published, is not possible. If necessity arises in the future to correct already published values, then the corrected dataset will be published with a new DOI (e.g. 10.5880/Kp.0002). Older DOIs and data sets will then still be available. For each DOI, an additional versioning mechanism will be available to document changes to the files such as format changes, which do not affect the integrity of the data. The DOI 10.5880/Kp.0001 identifies the current version.

4. Description of data files

The dataset is organised in yearly files, which, for the current year, are updated on a monthly basis. Typically, during the second week of a month, the data for the previous month is calculated and appended to the current year's file, both for the definitive and nowcast version. While the definitive *Kp* (and derived indices) are calculated from K values provided by the contributing observatories, the nowcast *Kp* (and derived indices) are calculated at GFZ from observatory data.

The data is distributed in ASCII files. All files start with 10 header lines, each starting with a number sign (#, hash) and containing DOI as well as licence information. Note that leading zeroes are not shown, they are represented by blanks. Missing data would be represented by -1.

The folder **'Kp_definitive'** contains, from 1932 onwards, yearly files named Kp_defYYYY.wdc, where YYYY stands for year (4 digits) and wdc indicates the World Data Centre file format. The WDC format is described below.

The folder '**Kp_nowcast'** contains, from 2019 onwards, yearly files named Kp_nowYYYY.wdc, where YYYY stands for year (4 digits) and wdc indicates the World Data Centre file format that is described below.

The nowcast indices can change for some time (typically a day or two) as new data comes in that helps better determine the quiet level back to the previous day, or when contributing observatories deliver

their data with some delay. At the time of the calculation of the definitive Kp, also the nowcast Kp for the previous month has reached a final stage. It will not change any more and is archived here.

The **International Quiet and Disturbed Days** are determined from the *Kp* values of the respective month based on a combination of criteria like the sum of the *Kp* values for a day, the sum of their squares, and the maximum *Kp*. The 10 quiet days are selected and ordered, with the quietest day being labelled Q1 and the least quiet day of these 10 days being labelled Q10. Any of these days can be assigned the letter A if Ap exceeds 6 for this day or the letter K if Ap is smaller or equal 6, but one *Kp* value exceeds 3, or two *Kp* values exceed 2+. The 5 disturbed days are selected and ordered from D1 (the most disturbed day) to D5. An asterisk (*) is assigned to a disturbed day if Ap is smaller 20.

The files are located in the folder **'Quiet_Disturbed_Days'** and begin with the 10 header lines beginning with # and then resemble a table for one year each. After 4 more header lines, each following line represents one month, denoted by the first three letters of the name of the months and the year with 4 digits. This is followed by 15 columns to represent Q1 to Q10 and D1 to D5. Each field in the table contains the day of the month as a one- or two-digit number and, if applicable, the letters A or K or an asterisk. Fields are separated by blanks.

5. Description of the WDC format

Column 1-2
Format i2
Last two digits of the year (1-99)

Column 3-4
Format i2
Month (1-12)

Column 5-6
Format i2
Day of month (1-31)

Column 7-10
Format i4
Bartels solar rotation number (a sequence of 27-day intervals counted from February 8, 1832)

Column 11-12
Format i2
Number of day within the Bartels solar rotation (1-27)

Column 13-28
Format 8i2
Kp indices: the planetary three-hour index *Kp* for the intervals 0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21 and 21-24 UT, see note below

Column 29-31
Format i3
Daily *Kp* sum rounded to thirds, supplied only for historic reasons, use Ap for scientific studies, see note below

Column 32-55
Format 8i3
ap indices: the three-hourly equivalent planetary amplitude for the intervals 0-3, 3-6, 6-9, 9-12, 12-15, 15-18, 18-21 and 21-24 UT, in units of 2 nT

Column 56-58
Format i3
Ap index: the daily equivalent planetary amplitude, the arithmetic mean of the 8 ap values, rounded to integer, in units of 2 nT

Column 59-61
Format f3.1
Cp index: the daily planetary character figure, a qualitative estimate of the overall level of geomagnetic activity for this day determined from the sum of the eight ap amplitudes, ranging, in steps of 0.1, from 0.0 to 2.5

Column 62
Format i1
C9: the contracted scale for Cp with only 1 digit, from 0 to 9

In the original WDC format, there were additional columns 63-71 to represent the sunspot number and the 10.7 cm solar flux that are not present here.

Note on *Kp* and sum of *Kp*: The second of the two integers describing the *Kp* index value can be 0, 3 or 7, but actually represents zero, one, or two thirds, respectively. The following table explains the relationship between the WDC notation, the symbol notation, and the numeric value rounded to one thousand.

WDC	symbol	numeric value
0	0o	0.000
3	0+	0.333
7	1-	0.667
10	1o	1.000
13	1+	1.333
...		
83	8+	8.333
87	9-	8.667
90	9o	9.000

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6.1. Contributing Geomagnetic Observatories

- Brorfelde (BFE) maintained by: Technical University of Denmark (Denmark);
- Canberra (CNB) maintained by: Geoscience Australia (Australia);
- Eskdalemuir (ESK) maintained by: British Geological Survey (UK);
- Eyrewell (EYR) maintained by: GNS Science (New Zealand);
- Fredericksburg (FRD) maintained by: U.S. Geological Survey (US);
- Hartland (HAD) maintained by: British Geological Survey (UK);
- Lerwick (LER) maintained by: British Geological Survey (UK);
- Meanook (MEA) maintained by: Natural Resources Canada (Canada);
- Niemegk (NGK) maintained by: GFZ German Research Centre for Geosciences (Germany);
- Ottawa (OTT) maintained by: Natural Resources Canada (Canada);
- Sitka (SIT) maintained by: U.S. Geological Survey (US);
- Uppsala (UPS) maintained by: Geological Survey of Sweden (Sweden);
- Wingst (WNG) maintained by: GFZ German Research Centre for Geosciences (Germany)

7. References

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Matzka, J., Stolle, C., Yamazaki, Y., Bronkalla, O. and Morschhauser, A., 2021. The geomagnetic Kp index and derived indices of geomagnetic activity. Space Weather, https://doi.org/10.1029/2020SW002641

8. Changelog of data and data description

- 11 March 2021: Publication of Kp Index DOI with kp_index_data_description_20210311.pdf