The H2020 Project SWAMI Activity: High Cadence Global Geomagnetic Index

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Introduction

Space Weather Atmosphere Model and Indices (SWAMI)

is a project funded by the European Union's **Horizon 2020** research and innovation programme from 2017 to 2020. The SWAMI objectives related to global geomagnetic indices are:

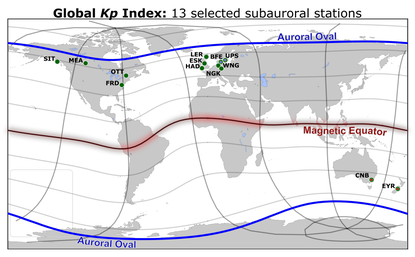
- **Develop and evaluate improved geomagnetic indices**
- Use these improved geomagnetic indices and index predictions as input for the two atmosphere models Unified Model (UM; the UK Met Office operational numerical weather prediction and climate model) and Drag Temperature Model (DTM2013; Bruinsma, 2015)
- Make improved geomagnetic indices available to the space weather community

Geomagnetic activity indices Kp and K

GFZ is in charge of **deriving and disseminating the geomagnetic Kp index** that date back to 1932 and is endorsed by **I**nternational **A**ssociation of **G**eomagnetism and **A**eronomy (**IAGA**). The name **Kp** originates from "***p****lanetarische* ***K****ennziffer*" (= planetary index).

- "*Kp indicates the intensity of geomagnetic activity as an expression of solar corpuscular radiation, for every three-hour interval of the Greenwich day*" – Bartels (1957)

- A three-hourly geomagnetic disturbance (**range**) index with values from 0 (quiet), …, 3+ (moderate active),… to 9 (very active/disturbed)
- Previously derived by hand-scaling of magnetograms and since the early 90's algorithms are used to derive it from 1-minute geomagnetic observatory data



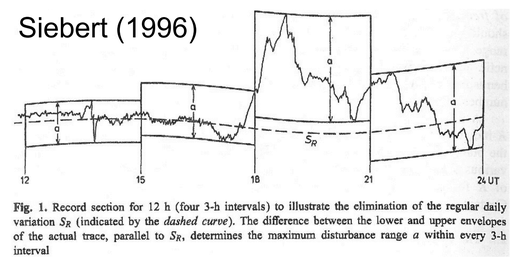


Fig. 1. Record section for 12 h (four 3-h intervals) to illustrate the elimination of the regular daily variation S_R (indicated by the *dashed curve*). The difference between the lower and upper envelopes of the actual trace, parallel to S_R, determines the maximum disturbance range *a* within every 3-h interval

- **The local K** (single station) **index**: the maximum value of the disturbance levels in the horizontal field components observed at 13 selected, subauroral stations
- **The standardized Ks** (single station) **index**: scaled for season and local time
- **The Kp index** is the average of a number of Kp-stations' Ks values:

max(Bx,By) → K → Ks & ∑ **Ks** → **Kp**

Improved (high-cadence) Geomagnetic Indices

Hp indices

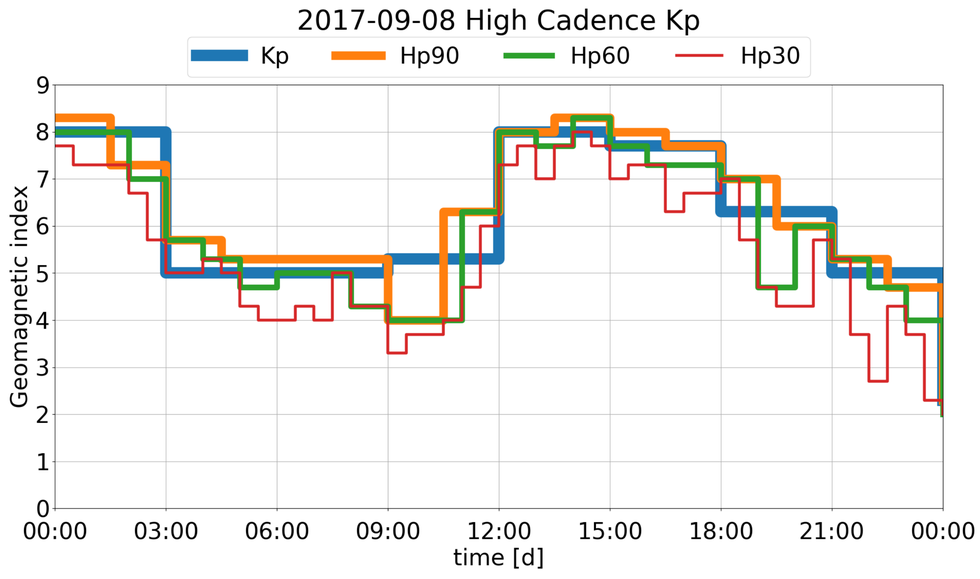
The improved geomagnetic indices are derived by algorithms developed for the 3-hourly Kp and ap indices but will be of higher temporal resolution: **Hp90, Hp60 and Hp30** (90, 60 and 30 denote the Hp index temporal resolutions in minutes). The **ap90, ap60 and ap30** indices are derived the same way from Hp as ap from Kp.

Issues of higher cadence (temporal resolution):

- The range of the variation will on average be smaller than for the 3-hour index while the temporal interval decreases, for which the geomagnetic disturbance, i.e. the range of the variation of the horizontal magnetic field components, is determined
- This will results in higher occurrence of low index values than for the 3-hour index

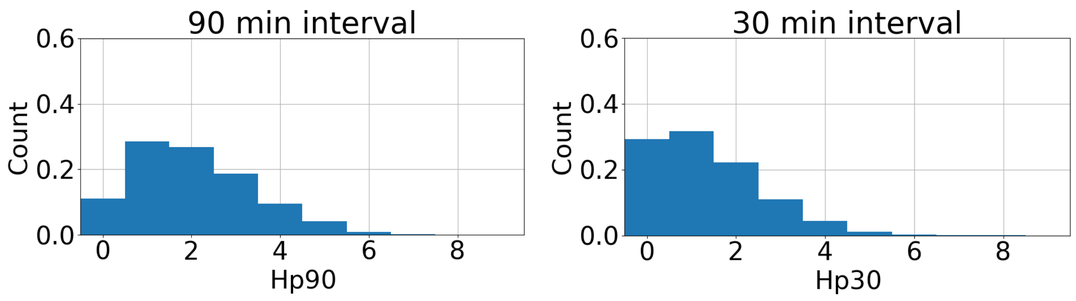
In order to avoid this problem:

- we have rescaled the relationship between the range of variation and the index values by reducing the so-called K9 values (Bartels, 1957) of the contributing geomagnetic observatories

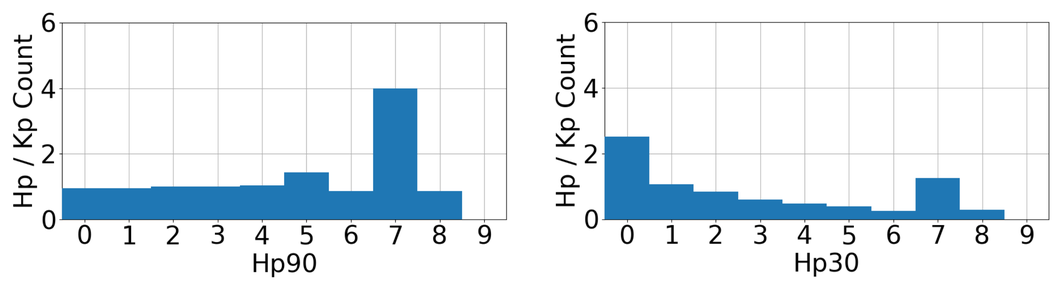


- This method was successful for the Hp90 (90-minute) index, which now has a similar distribution as the Kp (180-minute) index
- Further rescaling will be necessary to produce the Hp30 (30-minute) index with the same distribution as the Kp (180-minute) index

Histogram distribution of **Hp** values

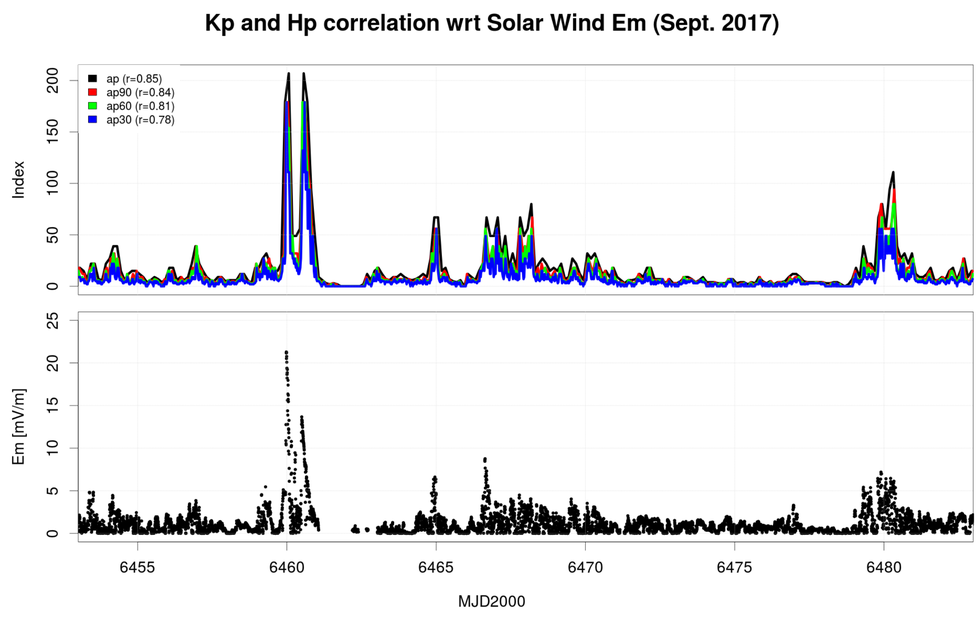


Histogram distribution of **Hp – Kp** values

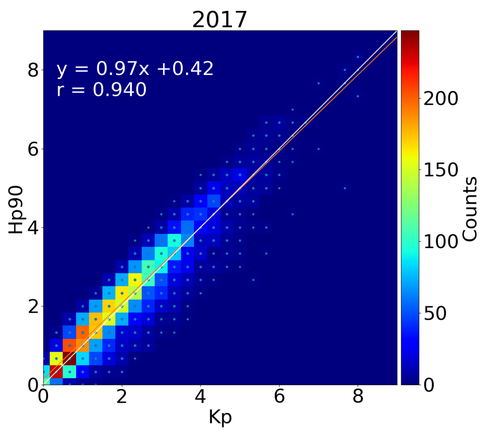


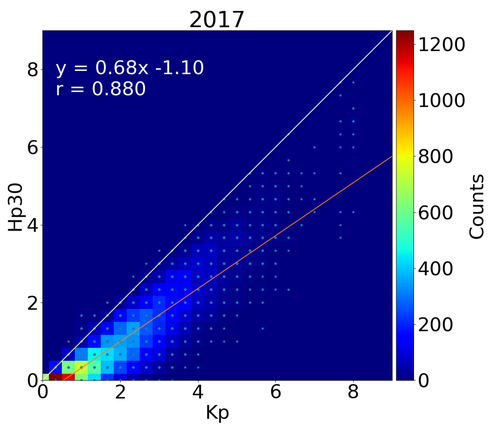
- Modified rescaling is needed for higher Hp values
- Hp90 fits very well but to many 0 values for Hp60 and Hp30

Comparison to solar wind



Correlation analysis





Next Steps

- Scientific verification of Hp values in at the example of DTM parameterization
- Dissemination of Hp indices to the user community

Contact

- More information about Kp and the related geomagnetic indices can be found at https://www.gfz-potsdam.de/en/kp-index/
- Email: juergen.matzka@gfz-potsdam.de, guram.kervalishvili@gfz-potsdam.de

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