New developments with Kp and the new hourly and half-hourly, Kp-like geomagnetic index Hpo (Hp60, Hp30)

Jürgen Matzka[1], Guram Kervalishvili[1], Jan Rauberg[1], Marcos Vinicius Siqueira da Silva[1], Yosuke Yamazaki[2]
[1]GFZ German Research Centre for Geosciences, Potsdam, Germany [2]IAP Leibniz-Institute of Atmospheric Physics, Kühlungsborn, Germany

HELMHOLTZ CENTRE POTSDAM
GFZ GERMAN RESEARCH CENTRE FOR GEOSCIENCES

Kp and Hpo indices at GFZ

GFZ provides the near-real-time (NRT) and definitive geomagnetic Kp-index (Matzka et al., 2021) as well as the new Kp-like Hpo (Hp30 and Hp60) indices described by Yamazaki et al. (2022). The new data portal (**Fig. 1**) includes the following functionality:

- NRT and definitive data download of Kp, Hp30 and Hp60 via
  - User specified web services, API web service (Matlab, Python)
  - HTTPS, FTP
- Back to 1932 (Kp) and 1995 (Hpo)
- Traditional WDC format, musical diagrams (not for Hpo)
- New, easy to use JSON and ASCII formats
- Derived indices ap, Ap, ap30, ap60, Cp, C9
- Solar indices sunspot number SN and solar flux F10.7
- Figures incl. time series, statistics, partly user-definable
- News, documentation, newsletter
- License: CC BY 4.0: free commercial use, attribution mandatory

In **Fig. 2**, we show an example of the NRT timeliness of the GFZ and NOAA Kp and GFZ's Hp60.

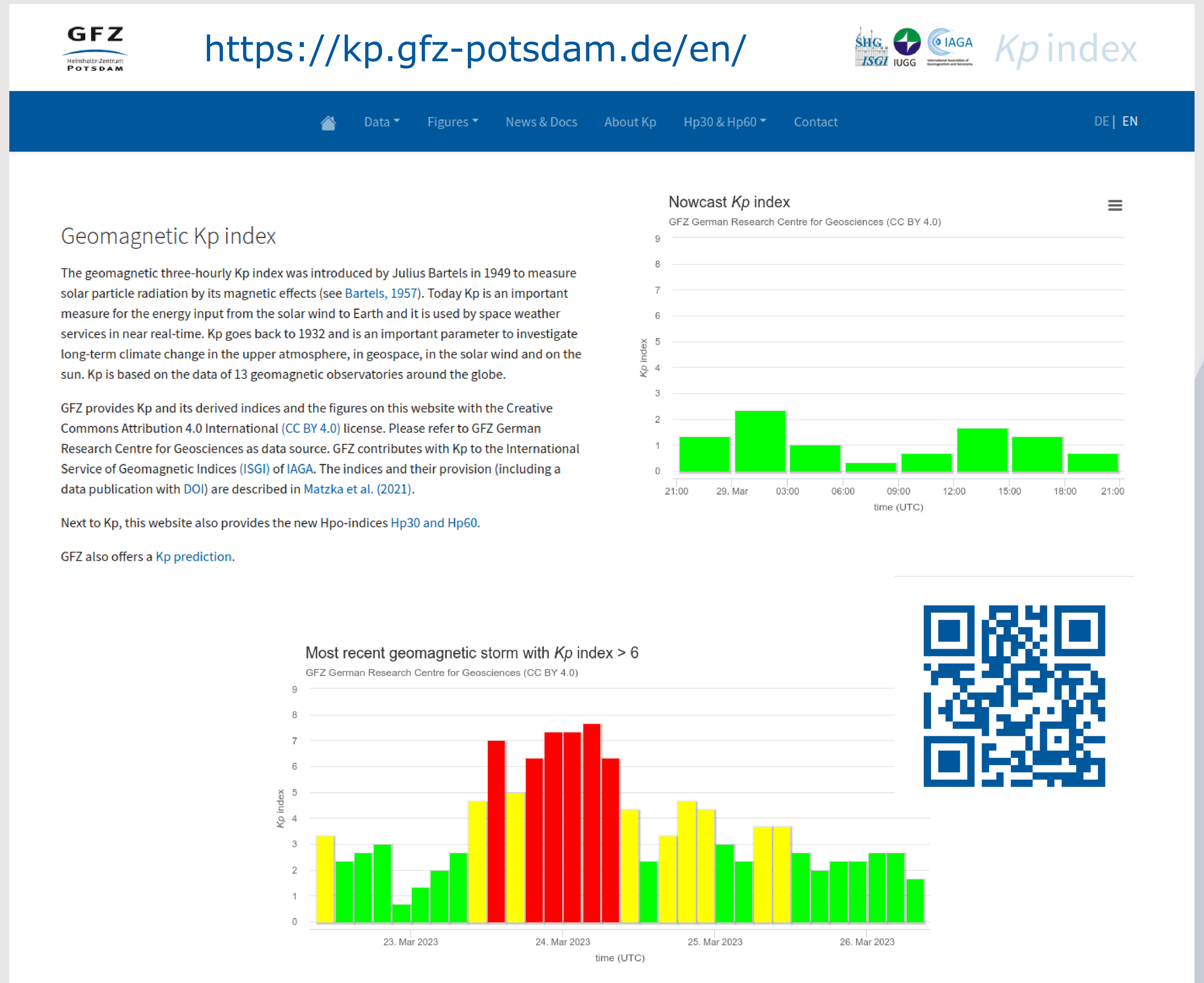

Fig. 1. The new data portal for Kp and Hpo (Hp30 and Hp60) with QR-code to kp.gfz-potsdam.de

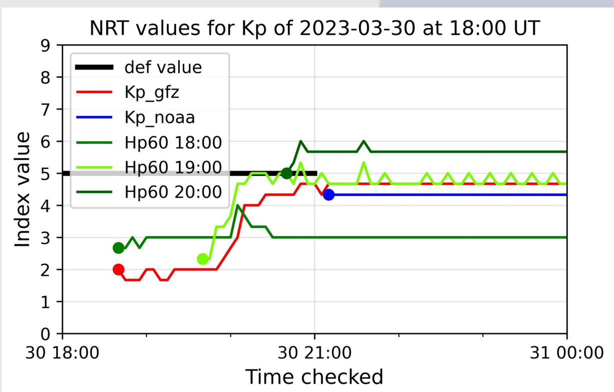

Fig. 2. Time evolution of NRT Kp values from GFZ (red) and NOAA (blue) for 2023-03-30 18-21 UTC. NOAA Kp values are generated after the respective three-hour-interval, while GFZ starts about 40 minutes into the interval. The Hpo indices for 18-19, 19-20, 20-21 (green colors) also start 40 minutes into the interval.

The new Hpo (Hp30 and Hp60) indices

The new Hpo indices come in a half-hourly (Hp30) and hourly (Hp60) version. Their accompanying linear apo (ap30 and ap60) indices are also provided. Only a near real-time version is produced. Values go back to 1995. All products are available through the new portal (see **Fig. 1**).

Kp and Hp30 and Hp60 are similar indices

- Based on the same 13 magnetic observatories
- Based on the same NRT quiet curve removal
- Same input data stream and servers
- Similar frequency distribution (see **Fig. 3**)
- Similar during strong storms (see **Fig. 4**)
- Similar relationship to solar wind parameters, auroral electrojet index and polar cap index, all parameters for energy input from the solar wind (see **Fig. 5**)

→ Operationally equally stable
→ Facilitates use in existing models and services

Advantages of Hp30 and Hp60

- 6x respectively 3x higher time resolution:
  - short events like substorms are better described (see **Fig. 6**)
  - better timing of storm onset
- Open-ended:
  - More nuanced description of very strong events
  - Extension to values >9 relate well to other open ended parameters (solar wind, AE, PC, see **Fig. 5**)
- Potential advantages in NRT production

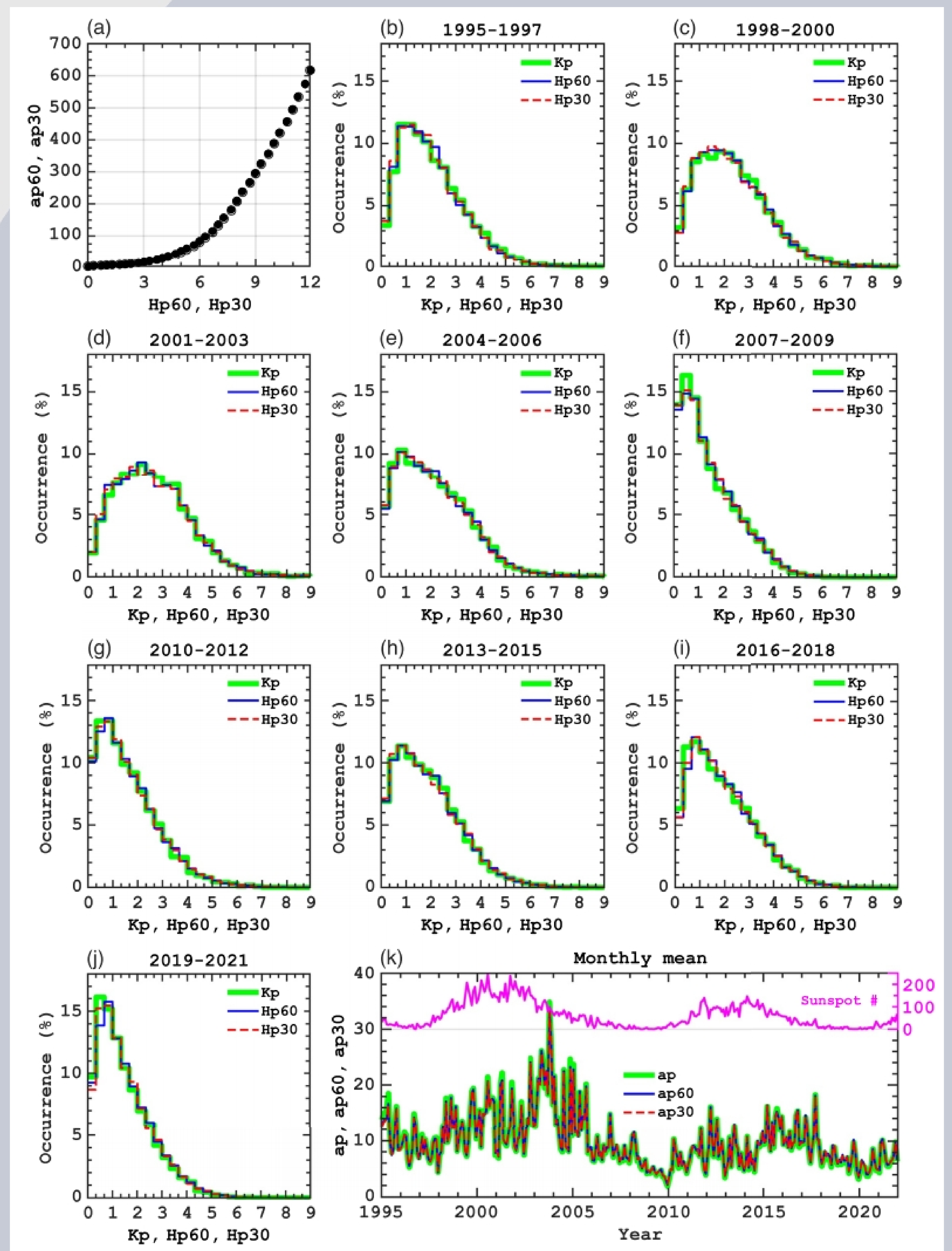

Fig. 3. (a) Relationship between Hpo and apo up to Hpo = 12. (b-j) Frequency distribution of Kp, Hp60 and Hp30 values for different years, i.e. solar cycle phases. (k) Monthly mean values of ap, ap60, ap30 and total sunspot number for 1995 to 2020

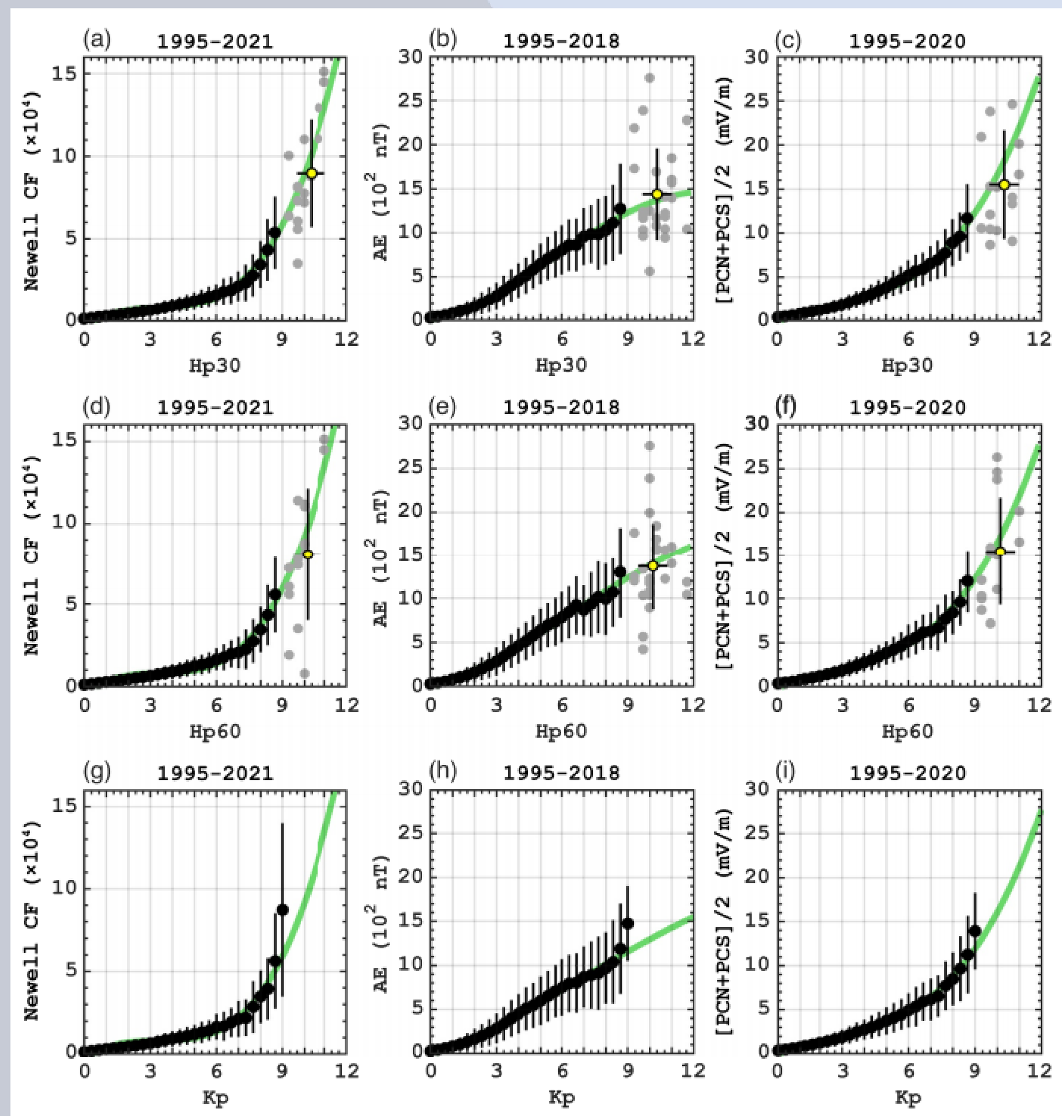

Fig. 5. Dependence of (a–c) Hp30, (d–f) Hp60, and (g–i) Kp on (a, d, g) Newell's solar-wind coupling function [5] (b, e, h) AE index, and (c, f, i) PC index. Black dots indicate their average value at each Hpo or Kp value (0o, 0+, 1−, …, 9−), the green curve gives their third-order polynomial fit. Individual data points for Hpo ≥9o in (a-f) are shown in gray and their average in yellow. Error bars give the standard deviation.

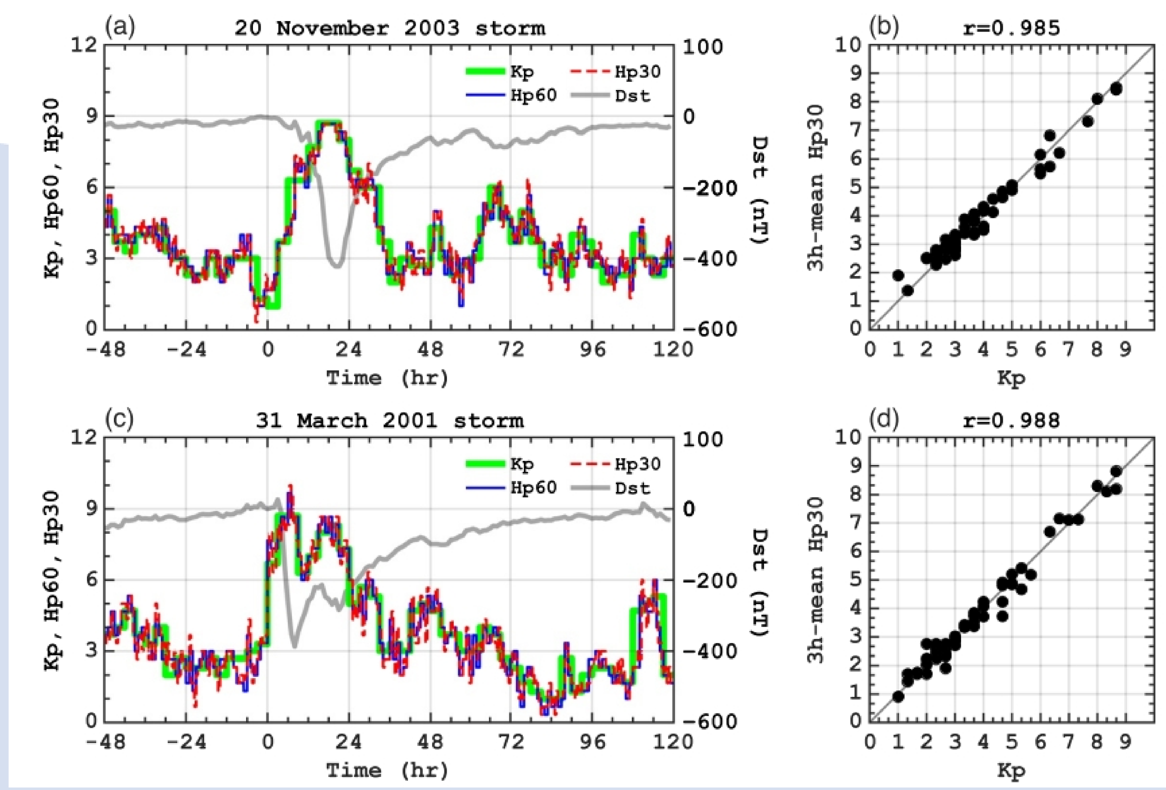

Fig. 4. (a, c) Time series of Kp, Hp60, Hp30, and Dst over a 7-day interval during two strong geomagnetic storm events. Zero in the horizontal axis gives 00 UT of the day with the storm main phase. (b, d) Comparison of Kp and three-hourly average of Hp30 during these strong geomagnetic storm events, r is the correlation coefficient.

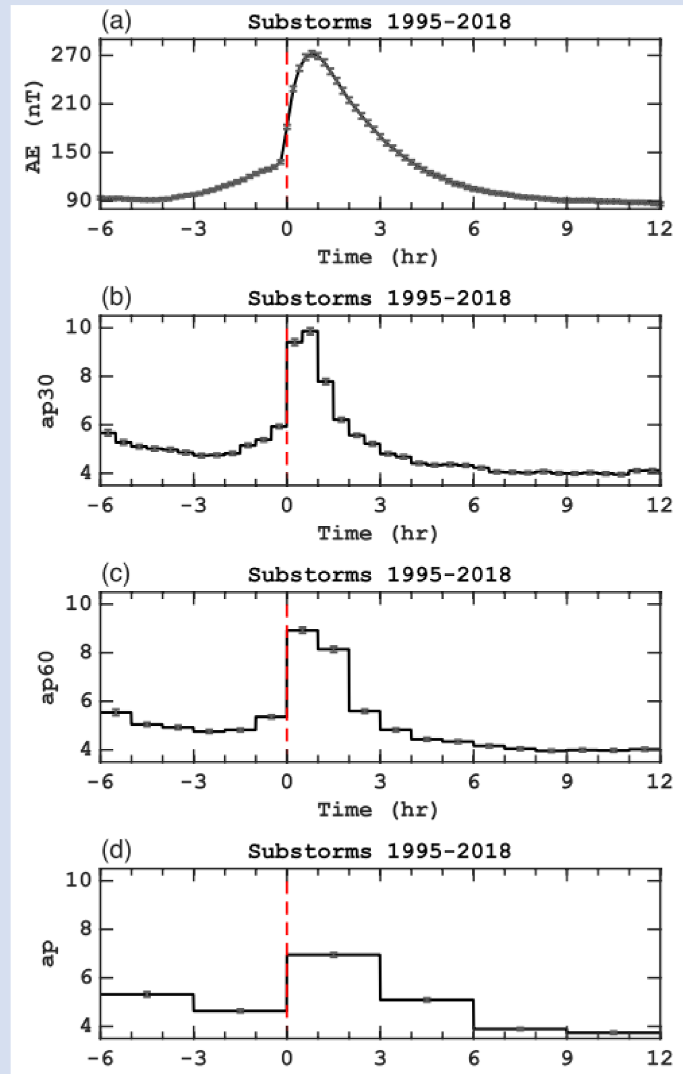

Fig. 6. Superposed epoch analysis of (a) AE, (b) ap30, (c) ap60, and (d) Kp for 1947 isolated substorm events [6] identified during 1995 to 2018. Error bars represent the standard error of the mean. Zero hours corresponds to the substorm onset.

References (QR code to publication)

Matzka, J., Stolle, C., Yamazaki, Y., Bronkalla, O., and Morschhauser, A., 2021. The geomagnetic Kp index and derived indices of geomagnetic activity. Space Weather, 19, e2020SW002641, https://doi.org/10.1029/2020SW00264

Yamazaki, Y., Matzka, J., Stolle, C., Kervalishvili, G., Rauberg, J., Bronkalla, O., Morschhauser, A., Bruinsma, S., Shprits, Y.Y. and Jackson, D.R., 2022. Geomagnetic Activity Index Hpo. Geophys. Res. Lett., 49, e2022GL098860, https://doi.org/10.1029/2022GL098860

Acknowledgement

We thank the 13 geomagnetic observatories that contribute to Kp and Hpo: EYR, CNB, UPS, BFE, WNG, NGK, LER, ESK, HAD, OTT, FRD, MEA and SIT. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776287.

HELMHOLTZ