20. Aug. 2013

PC Index – IAGA Endorsement.

Recommendation by the Task Force: Fully recommend endorsement of the PC index.

Members of the taskforce: Michel Menvielle, Heather McCreadie and Crisan Demetrescu.

("We" in this document refers to the task force)

Preamble: It is not the task of the taskforce to reproduce work which has already been validated within the geomagnetic community. We make the following recommendations based on the work of our peers.

One application for endorsement of the PC index was received by the IAGA task force. The institutes involved in deriving the PC indices were encouraged to reach agreement on a single methodology for derivation. This was achieved and the application for endorsement combines both AARI and DTU Space.

The application and supporting documentation was received on February 25, 2013 from

National Space Institute, **DTU Space** and
Att. Dr. Jürgen Matzka
Technical University of Denmark
Elektrovej 327
DK-2800 Kgs. Lyngby
Denmark

Arctic Antarctic Research Institute, **AARI**
Att. Dr. Oleg Troshichev
8 Bering str.
St.Petersburg, 199397
Russian Federation

The PC index being recommended for endorsement at IAGA 2013 Merida, Mexico is that defined by the following publications: Troshichev et al. (2006 and 2009), Janzhura and Troshichev (2008), Janzhura and Troshichev (2011).

We note: the index algorithm for both the northern and southern hemisphere have the same derivation procedure – but because the nature of the ionosphere is different between summer and winter (i.e. the northern and southern hemispheres) it is necessary that the coefficients which identify the index are unique and must be derived for any individual station under the polar cap. The PC index has two parts – PCN and PCS. The PCN is described by a single magnetic station under the northern polar cap and the PCS is described by a single magnetic station under the southern polar cap. "If PC indices in the summer and winter polar caps happen to be inconsistent, it means that actual conditions in the opposite polar caps (ionospheric conductivity or/and field-aligned currents) deviate from the standard conditions. This deviation could be taken into account if the *PC* index was calculated *post factum*. However, polar cap magnetic activity should be evaluated on-line to monitor space weather. That is why we have to deal with discrepancies in the summer and winter *PC* indices and interpret them correctly." (Troshichev and Janzhura (2012) chapter 11)

We recommend: for the above reason, that both the PCN and PCS indices constitute the PC index as requested in the submission of the index.

The name of the index is Polar Cap index (abbreviation PC index) and it is consisting of the Polar Cap North index (PCN index) and the Polar Cap South index (PCS index). Two datasets of the index are provided: A provisional data set and a definitive data set. The definitive data is the final form and supersedes at any time the provisional data set. It is based on definitive geomagnetic observatory data. The provisional data is provided in near real time. It is at the discretion of the institute in charge of the index derivation to update the provisional index after near real time production and prior to publication of the definitive data.
The unit of the PC index is 1 mV/m.

(Document: IAGA_documentation_20130225.pdf)

Endorsement criteria:

Criterion 1
The *PC* index is designated as a value of polar cap magnetic activity. It is deemed a proxy for energy that enters into the magnetosphere during solar wind – magnetosphere coupling.

Polar cap magnetic activity is a geophysical quantity not already described by existing IAGA indices.

References: Chapter 3 especially section 3.5 and Chapters 5 - 10 of Troshichev and Janzhura (2012) and the references therein.

Criterion 1 is satisfied.

Criterion 2
The derivation of the index is described in the following peer reviewed publications:

Troshichev et al. (2006 and 2009)
Janzhura and Troshichev (2008)
Janzhura and Troshichev (2011)

Chapter 4 of Troshichev and Janzhura (2012) describes the derivation of the provisional (near real time) data set.

A very detailed description of the procedure to allow independent reproducibility is given in Appendix A. This description is valid for the definitive data set. (Appendix A is takes precedence over all earlier descriptions.)

(Document: Appendix_A_20130225.pdf)

Calculation of the PCN index is from Qanaaq observatory (THL). Calculation of the PCS index is partly based on data Vostok obersatory (VOS). The data is publicly available at the WDC for Geomagnetism, Edinburgh.

The WDC for Geomagnetism, Copenhagen, will make the program source codes and this appendix available in a permanent and citable form.

(Document: IAGA_documentation_20130225.pdf)

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We note:

1. DTU Space used a different algorithm to AARI prior to December 2012. They have independently reproduced the PCN index obtained at AARI, which uses exactly the same algorithm for the PCN and PCS indices.
2. DTU Space is able to produce near-real time PCN indices the PCN and PCS definitive indices.
3. AARI is able to produce near-real time PCS and PCN indices as well as the definitive PCS and PCN indices.
4. Chapters 5 and 6 of Troshichev and Janzhura (2012) and references therein shows the compatibility of the PCS and PCN indices and Chapter 11 the uniqueness of each. The same algorithm was used to obtain the PCS and PCN indices at AARI.
5. All parameters for producing the PCS and PCN indices – including the derivation of the coefficients - is available from DTU and AARI simultaneously.
6. DTU has recently installed a new magnetic station under the polar cap at Thule Air Base (TAB) about 100 km from Qanaaq (operational since July 2013). In the event that Qanaaq observatory becomes in operational a backup observatory under the polar cap exists for PCN.

We recommend: Criterion 2 is satisfied subject to

1. Appendix A getting its own DOI or being published in a peer reviewed journal

Criterion 3

Calculation of the PCN index is based on the geomagnetic observatory Qaanaaq (earlier name Thule, IAGA code THL) that is member of Intermagnet.

Calculation of the PCS index is based on observatory data Vostok (VOS) that is member of Intermagnet.

The coefficients for both PCN and PCS are derived using the years 1997-2009 (where data are available).

The data for both geomagnetic stations is publicly available at the WDC for Geomagnetism, Edinburgh (currently VOS data are being checked and formatted by the WDC.)

(Document: IAGA_documentation_20130225.pdf)

The homogeneity of the time series is ensured by the institutional assurances by AARI (from December 2012) and DTU Space (from March 2011), both in Appendix B.

(Document: Appendix_B_20130225.pdf)

Criterion 3 is satisfied.

Criterion 4.

Publications which cite PCN_{AARI} after 2006 use the current derivation of the PCN index (definitive). The first publication which was Troshichev et al. (2006 and 2009) and detailed in Janzhura and Troshichev (2008). All publications after 2012 use the current PCN derivation

which is contained in the book by Troshichev and Janzhura (2012) and detailed in Appendix A.

Any publication after 2006 uses the current PCS values unless otherwise stated. The algorithm had no error – just the publication.

The current form of the index has been in use since 2006.

Criterion 4 is satisfied.

Criterion 5.

1. The homogeneity of the time series is ensured by the institutional assurances by AARI (from December 2012) and DTU Space (from March 2011), both in Appendix B.
2. AARI hosts the provisional and definitive PCS index and DTU hosts the provisional and definitive PCN index.
3. The PC index definitive data (PCN and PCS) will be available at ISGI after IAGA endorsement of the index.

(Document: Appendix_B_20130225.pdf)

The geomagnetic data are available at WDCs and the solar wind data are available at the OMNI (NASA) data base. The coefficients are available at both AARI and DTU.

We note: To obtain the near-real time PCS index an email must be sent to AARI and a waiting period ensues. We are aware this is for accounting purposes. This is not the case for PCN which is freely available.

We recommend: Criterion 5 is satisfied subject to

1. AARI install an automated system for data access accounting to make the data immediately freely available to any person who would like it without a waiting period.

Janzhura, A. and Troshichev, O., 2008. Determination of the running quiet daily geomagnetic variation. J. Atmos. Solar-Terr. Phys., 70, 962-972

Janzhura, A. and Troshichev, O., 2011. Identification of the IMF sector structure in near-real time by ground magnetic data. Ann. Geophys. 29, 1491-1500

Troshichev, O., Janzhura, A. and Stauning, P., 2006. Unified PCN and PCS indices: Method of calculation, physical sense, and dependence on the IMF azimuthal and northward components. J. Geophys. Res., 111, A05208, doi:10.1029/2005JA011402

Troshichev, O., A. Janzhura, and P. Stauning (2009), Correction to ‘‘Unified PCN and PCS indices: Method of calculation, physical sense, and dependence on the IMF azimuthal and northward components,’’ J. Geophys. Res., 114, A11202, doi:10.1029/ 2009JA014937.

Troshichev, O. and Janzhura, A., 2012. Space Weather Monitoring by ground-Based Means. PC index. Springer Praxis Books, DOI 10.1007/978-3-642-16803-1,© Springer-Verlag Berlin Heidelberg