

Geomagnetic indices

Kp, Dst, Ap, SymH and AE data analysis and interpretation

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Presentation format

1. Introduction to magnetic indices
2. Data analysis and interpretation

Introduction to magnetic indices

- ▶ Space Weather - Effects imposed by the time-varying earth's atmospheric conditions that may be hazardous to technological systems and human life (Ganushkina et. al., 2017).
- ▶ Solar eruptions and energetic solar events like CMEs, flares and solar winds, directed towards the earth, are key contributors to the time-varying phenomena in the earth's atmosphere.
- ▶ The earth's magnetosphere - Important region in the earth's atmosphere where the time-varying phenomena/perturbations are very significant.
- ▶ Large scale disturbances/perturbations in the earth's magnetosphere due to the influence of these solar related phenomena - Geomagnetic Storms (Gonzalez et. al., 1994).

Introduction to magnetic indices Cont'd

- ▶ Quantifying geomagnetic storm disturbances is therefore a major concern for space scientists.
- ▶ Geomagnetic indices have been developed to account for different geomagnetic storm conditions, and scales have equally been defined for the different indices.
- ▶ Commonly used geomagnetic indices include;
 1. Disturbed Storm Time - Dst index
 2. Symmetrical Horizontal - SymH index
 3. K-Planetary - Kp index
 4. Amplitude Planetary - Ap index
 5. Auroral Electroject - AE index

Data analysis and interpretation

Dst and SymH indices;

- ▶ The Dst is a geomagnetic index, which provides a quantitative measurement of geomagnetic disturbances at low latitudes with a 1 hour resolution (Sugiura and Kamei, 1991).
- ▶ The SYM-H index quantifies the geomagnetic disturbance field at mid-latitudes with a 1 min resolution (Sugiura and Poros, 1971).
- ▶ Both Dst and SymH indices are designed to measure the strength of storm time "Ring Current", whose associated magnetic field is in opposition to the earth's horizontal magnetic field.
- ▶ Ring current - Toroidal electric currents flowing westwards around the earth with variable density at geocentric distances between $2R_E$ and $7R_E$ (Stomer, 1907 and Schmidt, 1917).

Dst and SymH data analysis and interpretation

- ▶ There are many sources from which geomagnetic data for Dst and SymH indices can be obtained.
- ▶ One such source for dst index is https://wdc.kugi.kyoto-u.ac.jp/dst_final/index.html
- ▶ The threshold values for these geomagnetic storm indices have commonly been set as follows (Palacios et. al., 2018);
 1. - 75 nT for moderate storm times
 2. - 150 nT for intense storm times
 3. - 300 nT for extreme storm times
- ▶ SymH index data can be obtained from wdc.kugi.kyoto-u.ac.jp/aeasy/index/html

The K-indices

- ▶ The K-index is a quasi-logarithmic measure, ranging in steps of 1 from 0 to 9, of the range of geomagnetic disturbance at a geomagnetic observatory in a three-hourly UT interval (Bartels et. al., 1939).
- ▶ K-index values are 0 1 2 7 8 9, with 0 indicative of quiet storm conditions and 9 extreme storm conditions
- ▶ Kp is the mean standardized K-index obtained from 13 geomagnetic observatories between 44 degrees and 60 degrees northern or southern geomagnetic latitude and is designed to measure solar particle radiation by its magnetic effects.
- ▶ The Kp index scale is from 0 to 9 expressed in thirds of a unit as 0o 0+ 1- 1o 1+ 2- 2o 2+ 3- 8- 8o 8+ 9- 9o, where "-" means subtract a third, "o" means do not add anything and "+" means add a third.

The K-indices

- ▶ Corresponding Kp index values in decimal are 0.00 0.33 0.67 1.00 1.33 1.67 2.00 2.33 2.67 7.67 8.00 8.33 8.67 9.00
- ▶ The Kp-index value equal to 5 marks the departure from quiet storm conditions to stormy conditions.
- ▶ When the 3hourly K-index values are converted to their linear scale, they yield a new index referred to as the ap-index. This is a measure of the planetary amplitude of the earth's magnetic field.
- ▶ The calculated ap indices corresponding to the respective Kp indices are; 0 2 3 4 5 6 7 9 12 15 18 22 27 32 39 48 56 67 80 94 111 132 154 179 207 236 300 400.
- ▶ Hence, a day with Kp indices 4- 4+ 5o 5+ 5- 6o 4o 3+ has corresponding ap indices 22 32 48 56 39 80 27 18.

The K-indices

- ▶ The daily averages of the ap-index values gives the Ap-index for the day. In the example $A_p = (22 + 32 + 48 + 56 + 39 + 80 + 27 + 18)/8 = 40.25$.
- ▶ $A_p > 40$ is indicative of a stormy condition.
- ▶ Kp-, ap- and Ap-index values can be obtained from wdc.kugi.kyoto-u.ac.jp/kp/index.html

The AE-indices

- ▶ The Auroral Electrojet (AE) indices characterize the magnetic disturbance in the auroral zone due to the increase in currents in the ionosphere along the boundary of the auroral oval.
- ▶ The term "AE indices" is usually used to represent these four indices (AU, AL, AE and AO).
- ▶ AU index (auroral upper) corresponds to the maximum positive deviation of H component of the magnetic field from the average quiet level for all observatories of the auroral zone.
- ▶ AL index (auroral low) corresponds to the maximum negative deviation of H component of the magnetic field from the average quiet level for all observatories of the auroral zone.
- ▶ $AE = AU - AL$ and $AO = (AU + AL)/2$

The AE-indices

- ▶ The AU, AL, AE and AO index values can be obtained via `wdcb.ru/stp/data/geomagn.ind/ae/ae_wdc/ae_hv/`

THANK YOU FOR LISTENING