The Newell et al. (2007) Kp prediction equation is based on a solar wind magnetosphere and ionosphere that can affect satellites, airplanes, communication, power grids, navigation and human health.

In this study we performed persistence, this assumes the forecast for the next synoptic period is the same as the current Kp value.

A geomagnetic storm is a disturbance in the magnetosphere caused by a solar event such as a coronal mass ejection, and high speed solar wind streams.

The Kp index is a measure of geomagnetic disturbances in the magnetosphere such as geomagnetic storms and substorms. The index is produced every 3 hours with values ranging from 0 to 9 from weak to severe.

The index value corresponds to the maximum of the horizontal component of the Earth’s magnetic field at magnetometer ground stations during each 3 hour synoptic period and is a measure of how disturbed the magnetosphere is.

The CCMC predicts the Kp index using the Newell et al. (2007) equation to give 1 hour advance notice of the intensity of a storm in real time. The relation uses ACE and DSCOVR data at L1 (235 R$_E$ ahead of Earth) as input.

It is important to quantify Kp forecast performance so that NASA missions have confidence in the space weather forecast and understand its limitations.

In this study we performed validation on the Newell et al. (2007) Kp prediction equation from December 2010 to July 2017.

Persistence: Provides a reference forecast to compare performance against. Persistence assumes the Kp index for the next synoptic period is the same as the current synoptic period (no change in value).

The observed Kp index has a time cadence of 3 hours while the Kp forecast has a cadence of roughly 1 minute. For this reason, the forecast was reduced to a single number every 3 hours by computing the average, minimum, and maximum for each 3 hour synoptic period.

Forecast verification:
- Persistence is taken as the reference forecast, this assumes the forecast for the next synoptic period is the same as the current Kp value.
- Next we computed the Kp error for each forecast (average, minimum, maximum) and each synoptic period: Kp error = Kp forecast - Kp observed
- To quantify forecast performance we computed the mean error, mean absolute error, root mean square error, multiplicative bias and correlation coefficient.
- We also computed a contingency table for each forecast and produced skill scores. The results are compared to the perfect score and reference forecast skill score.

Skill Score Results

Contingency Table: Is used to organize and describe the associated outcomes between four combinations of predicted and observed.

<table>
<thead>
<tr>
<th>Observed Occurred</th>
<th>Observed Did Not Occur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hit (H) (1100)</td>
<td>False Alarm (FA) (624)</td>
</tr>
<tr>
<td>Miss (M) (4608)</td>
<td>Correct Rejections (CR)</td>
</tr>
</tbody>
</table>

Skill Score: The forecast verification skill scores assess the quality of the forecast, by comparing it to observations.

Conclusions
- Skill score and error results show that the minimum of the predicted Kp over each synoptic period from the Newell et al. (2007) Kp prediction equation performed better than the maximum or average of the prediction.
- Persistence (reference forecast) outperformed all of the Kp forecasts (minimum, maximum, and average).
- While the persistence forecast beats the Newell Kp forecast, the forecast still has a reasonable mean absolute error of less than 1, but has overall bias towards overprediction.
- Future work: compare with persistence forecasts constructed with a lag larger than 1 day.

References

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