

Prediction of the Geomagnetic K Index at Hermanus based on its previous value

M. Malatji, A. Nel



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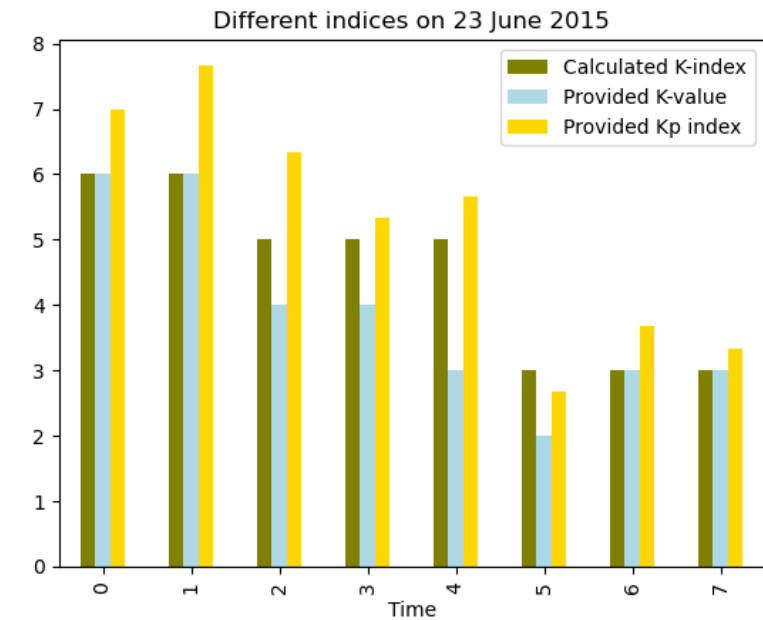


Outline

- ❑ Reason for interest in prediction of K index in Hermanus.
- ❑ Reflections of previous studies relating to predictions within Space Weather.
- ❑ Statistical Analysis of the K index data.
- ❑ Summary.
- ❑ Future work...

Background

- ❑ K index. One of many indices that are used to measure the geomagnetic activity on Earth.
- ❑ Space Weather Forecaster – monitor and report on Space Weather Conditions.
- ❑ SANSA started 24/7 operations in November 2022.
- ❑ Introduction to K values was through a project of calculating K values for a geomagnetic storm by removing solar regular daily magnetic variation from the horizontal components X and Y.
- ❑ Other Space Weather Centres have their own predictions of their local K-values. Could we try something similar?



:Product: 3-Day Forecast
:Issued: 2024 Mar 31 0030 UTC
Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 2 (below NOAA Scale levels).
The greatest expected 3 hr Kp for Mar 31-Apr 02 2024 is 3.00 (below NOAA Scale levels).

NOAA Kp index breakdown Mar 31-Apr 02 2024

	Mar 31	Apr 01	Apr 02
00-03UT	2.00	2.67	2.33
03-06UT	2.00	2.00	3.00
06-09UT	3.00	2.33	2.33
09-12UT	2.00	2.33	2.00
12-15UT	3.00	2.33	1.67
15-18UT	3.00	2.33	1.33
18-21UT	2.00	2.33	2.00
21-00UT	2.00	2.67	2.00

Rationale: No G1 (Minor) or greater geomagnetic storms are expected. No significant transient or recurrent solar wind features are forecast.



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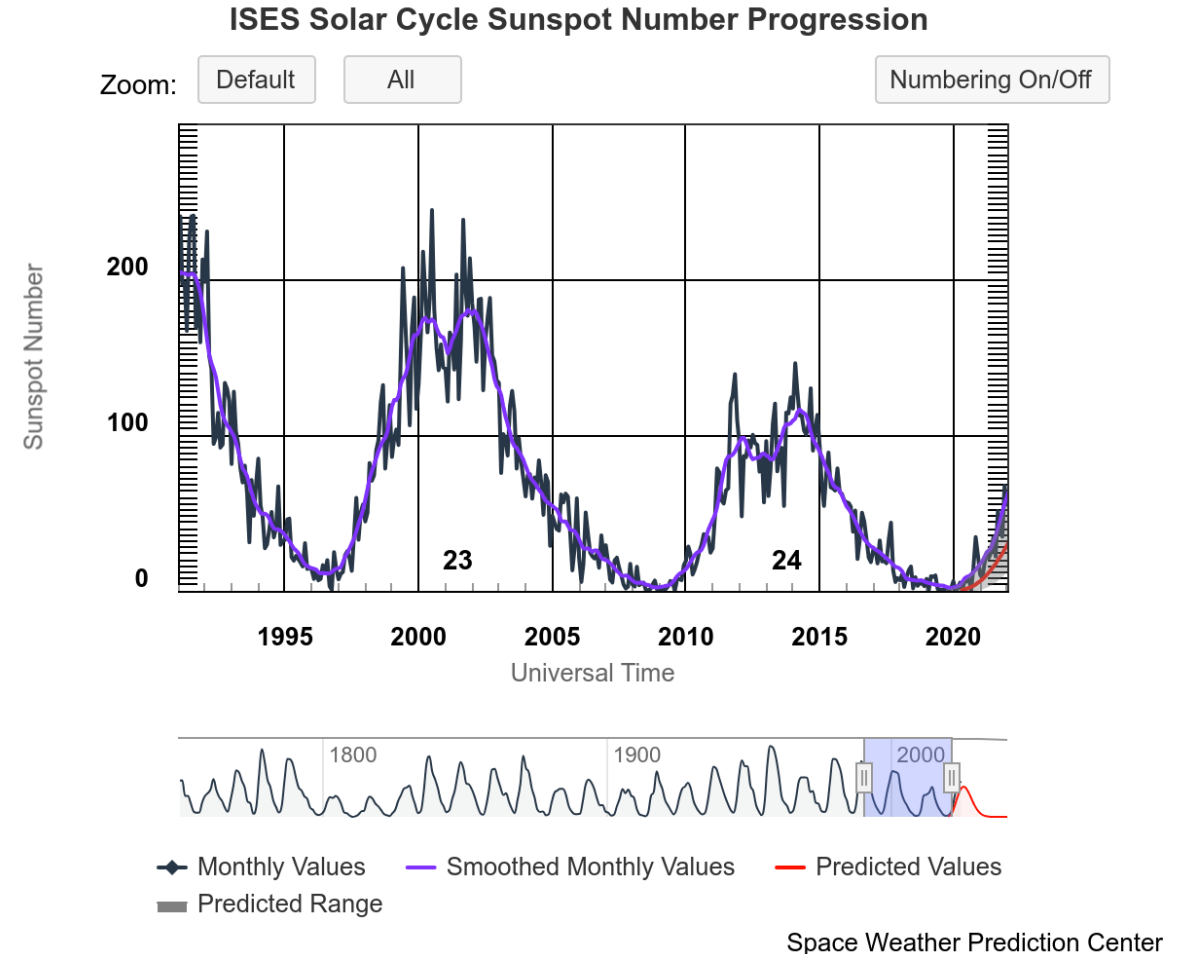
Previous studies.

- ❑ Singer et al, 2001.
 - ❑ Prediction: Analyses of historical data
 - ❑ Forecasting: Predictions issued before the activity takes place.
 - ❑ Nowcast: A model prediction of what is occurring in real-time.
- ❑ “The researcher often knows how an event turns out. The forecaster on the hand uses minute-by-minute observations and model outputs to better synthesize a forecast of future conditions ... before the story unfolds.”
- ❑ Viljanen et al,2008.
 - ❑ Made use of simple prediction of the K Index to develop more accurate predictions of other quantitative activity indicators.
 - ❑ Statistics of K index and statistical prediction of K index.
 - ❑ Conclusion: This method yielded predictions that differed from the simple climatological expectation value, especially when the magnetic activity is high.
 - ❑ Largest failure was that rapid activations of the magnetic field could not be predicted using only the prev. magnetic field recordings.

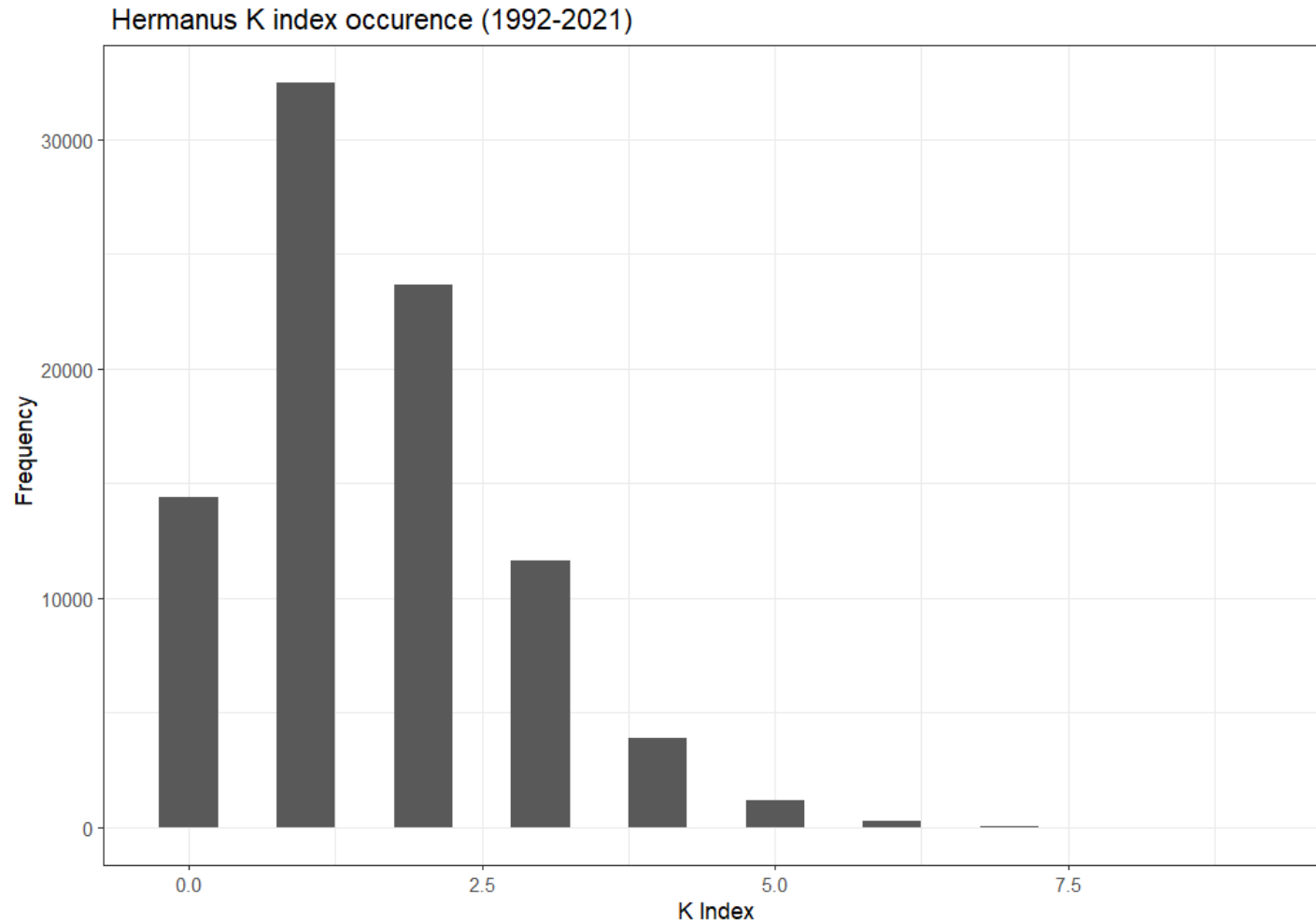


Purpose of the study

- ❑ This study aims to make use of a simple procedure to predict the geomagnetic activity by means of K index based on the available magnetic data.
- ❑ The Hermanus INTERMAGNET observatory, which is one of the 13 INTERMAGNET observatories that are used to calculate the Kp index, has a rich source of K index data from magnetometers dating back to 1941.
- ❑ This study will make use of data from 1992 - 2021 to be used as a proxy for predicting future indices. Exploratory data analysis shall be conducted and applied to the 2022 data to examine how the mean diurnal variation ("climatological average") compares to the observed values in 2022.



Statistical Analysis



- ❑ K index over Hermanus is positively skewed with conditions usually being between K-index values of 0-2 (Quiet conditions).
- ❑ Issue: Histogram “hides” the occurrence of higher K-values.
- ❑ Subset the data to find that there were
 - 3 occurrences of K=9 in 2001 and 2003
 - 10 occurrences of K=8 in 1998, 2000, 2003, 2005, and 2015



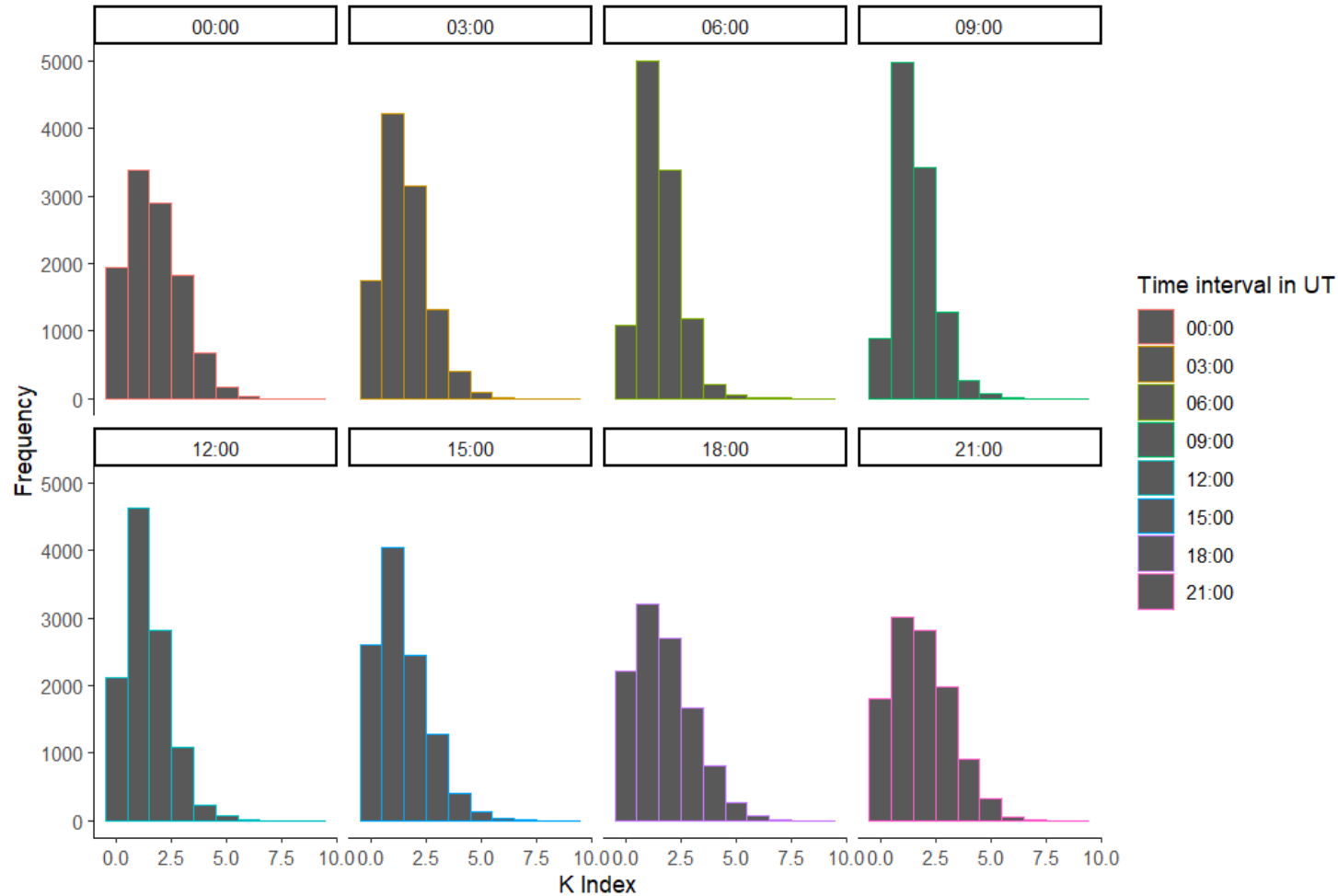
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Statistical Analysis

Hermanus K index occurrence from 1992-2021

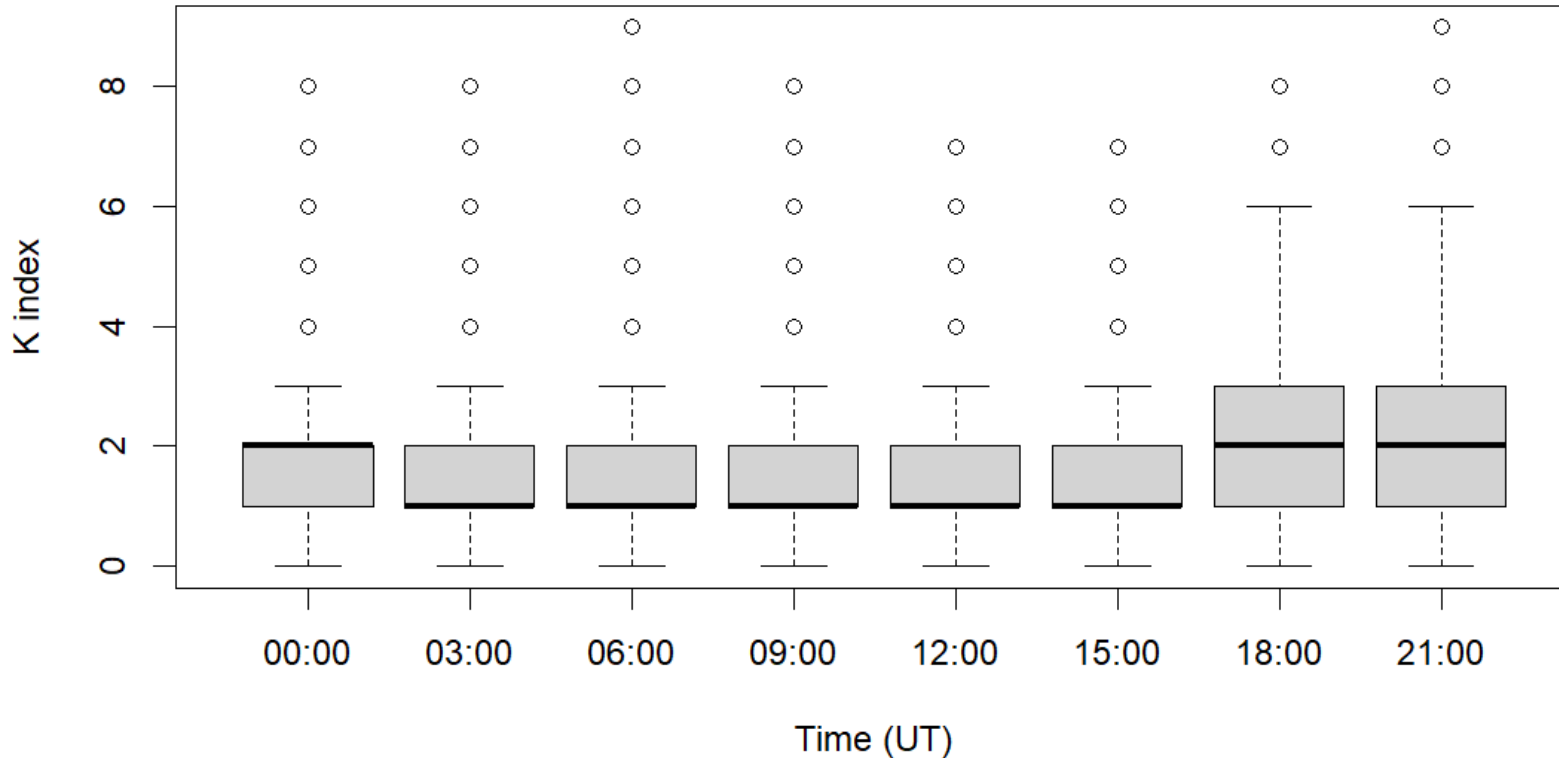


- ❑ Although skewed to the right throughout the different time intervals, the time intervals of 18:00-21:00 and 21:00 – 00:00 stood out, as the intervals that didn't have the K=1 (quiet) stand out from the other values.
- ❑ These intervals had more K=4 (active) intervals observed.
- ❑ The time interval 00:00-03:00 also has a similar structure as that of 18:00-21:00 and 21:00 – 00:00



Statistical Analysis

Distribution of K index (Hermanus)



- ☐ K-values of 4 and above for all intervals except 18:00-21:00 and 21:00 -00:00 appear to be outliers.
- ☐ The time intervals of 18:00-21:00 and 21:00 -00:00 have the K-values more dispersed than the other intervals.
- ☐ The medians for the intervals 00:00-03:00, 18:00-21:00 and 21:00 UT are almost similar.
- ☐ The other intervals are positively skewed but 00:00-03:00 is negatively skewed.

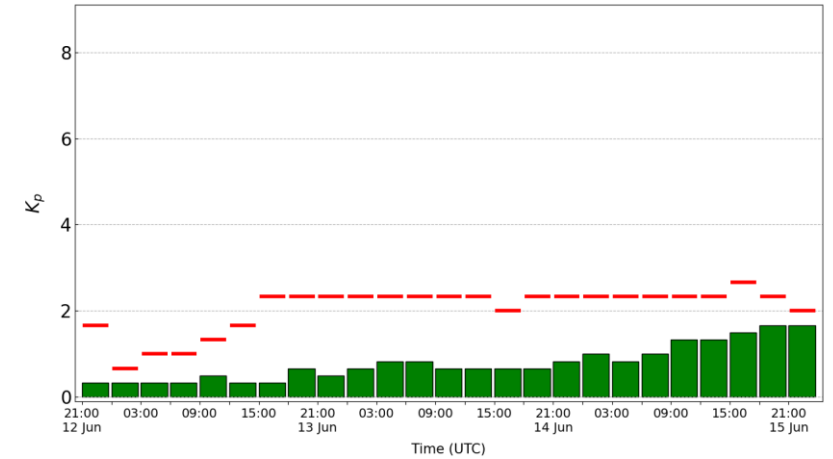
- ☐ Did my analysis with time as a **factor** instead of **POSIXct** class.

Summary

- ❑ There were relatively few events with Hermanus K index value of above 7 during this study period.
- ❑ Higher K index (Geomagnetic storm) values are more likely to be observed between the 18:00-21:00, and 21:00-00:00 UT intervals over Hermanus.
- ❑ K index values of above 4 are outliers during most of the intervals. Serve as support for why forecast quiet to unsettled conditions, unless anticipating a significant geomagnetic activity.
- ❑ Still a new project

Future work

- ☐ Make use of inferential statistics to formally test hypotheses and make estimates about the K-index values over Hermanus.
- ☐ If so. How do I proceed?
- ☐ Read up more literature and projects.
- ☐ Work towards improving my skills to see the project to completion.
- ☐ Adding other parameters.



*Something like this,
but for the Hermanus
K index.*

References

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South African National Space Agency



South African National Space Agency (SANSA)

Email: mmalatji@sansa.org.za



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