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6 February 1963

Dr. A.J.Dessler
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Dallas 5, Texas, USA

Dear Dr. Dessler,

Thank you for sending me a pre-copy of your paper with Dr. Fejer on Kp etc. I have something to remark:

My conception of Kp as a measure of P-Radiation has always been based on the assumption that strong K P is never so steady that it would not exhibit strong irregularities occurring in the course of 3 hours. In other words: I try to measure the strength of the solar wind by its turbulence. This was the reason for choosing a three-hour interval for K , because I believed (inferring from magnetograms) that P is never quite steady within the course of 3 hours, at least in its geomagnetic effects. When I introduced the Q-index, it was necessary to change that definition. I quote from my paper with Fukushima (Ein Q-index ..., Abhandl. Akad. Wiss. Göttingen, Math.-Phys. Klasse, Sonderhaft 2, Göttingen 1956, page 5, translated)

"In the case of the K-indices, the definition by an amplitude was possible, because it practically never occurs that, in a geomagnetic disturbance, a deviation from the normal value is constant over three hours without fluctuation. On the contrary, even if the deviation is one-sided, the fluctuations within three hours are so big that the amplitudes are sufficient as a measure for the disturbance intensity - just this has been the reason to choose three-hour-intervals, and no shorter intervals. For quarter-hourly intervals, however, amplitudes do no longer suffice as a measure of activity ... " Then, deviations from the normal course are proposed as a basis for Q.

You see, I realized all the time that Kp is a measure of a time-rate. Of course, I see your point, but I think it is still to be proved that Kp = 0 can occur during a strong, but steady solar wind (I know now, of course, that polar distrubance, inside the auroral zone, may occur and persist during Kp=0, but even that is always turbulent in its appearance).

I quite agree that an M-region storm is a stream of turbulence in the solar wind (your page 11). In all, I have no objection to raise, except that I should like the quotation at the beginning to be toned down a little. I still think that a high Kp signifies an intense solar-wind flux, but this is your opinion, I should not oppose it, but it is perhaps preferable to change the wording "this simple interpretation is incorrect" to something like this "With our present knowledge of the conditions in the magnetosphere, we believe this statement should be changed to say that Kp is a measure ..." The reason for this preference is simple: So many people are engaged to derive K-indices, and I should not want them to think that all that routine work is no good.

Yours truly J.Bartels

J.Bartels

February 12, 1963

Dr. Jules Bartels
Geophysikalisches Institut
Max Planck Institut fur Aeronomie
and Institut fur Stratospharenphysik of the
Universitat, Gottigen
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Germany

Dear Dr. Bartels:

Thank you very much for your letter of 6 February. After conversation with Dr. Fejer, we revised the introduction to our paper on the K_p Index in general accordance with your suggestion.

A point that deserves some clarification is that we are really only quibbling over the meaning of the K_p Index and not its value. I personally would be willing to write a testimonial as to the value of the K_p Index for geomagnetic research at any time.

Thank you again for your comments.

Yours truly,

A. J. Dessler

AJD:abj

1. This is the origin of the idea of a CIR (although we did not call it that).
2. I don't know why we did not mention Bartels in our Acknowledgement.

Planet. Space Sci. 1963, Vol. 11, pp. 505 to 511. Pergamon Press Ltd. Printed in Northern Ireland

AJD
5 July 2019

INTERPRETATION OF K_p INDEX AND M-REGION GEOMAGNETIC STORMS*

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(*Received* 11 *February* 1963)

Abstract—It is argued that the traditional interpretation of the K_p index is no longer tenable. The K_p index, generally taken to be a measure of the strength of the solar-wind flux, may be more acceptably interpreted as a measure of the time rate of change of the sum of plasma plus magnetic pressure acting on the magnetosphere. The stability of the magnetospheric surface in the solar wind is demonstrated theoretically when reasonable assumptions are made for the plasma density just inside the magnetosphere. The magnetic irregularities that have been observed outside the magnetosphere do not appear to be hydromagnetic waves, but most likely are quasi-static irregularities that are swept past the detectors by the solar-wind flow. As a corollary to this new interpretation of K_p it is proposed that M-region geomagnetic storms are due to sheets of turbulence or irregularities that are generated by the collision of a region of high solar-wind velocity with a low velocity region.

1. INTRODUCTION

The K_p index is basically a summary of the worldwide (or planetary) magnetic activity as measured by the range of fluctuations shown in individual observatory magnetograms. It is now quite generally thought that a high K_p signifies an intense solar-wind flux. We believe that this simple interpretation should be revised in light of our present knowledge of the interplanetary medium and the magnetosphere. We propose that K_p is a measure of the fluctuations of the sum of plasma plus magnetic pressure acting on the outer boundary of the magnetosphere.

← change #1

M-region magnetic storms are relatively weak storms that show a 27-day recurrence that generally persists for several solar revolutions (often more than 10). The M-region (magnetically effective region)[1] was pictured as an active region that emitted a solar-wind beam of 10° to 30°, and occasionally as small as 4°, angular width. As the Sun spun around on its axis, the beam swept past the Earth, "much like water from a rotating garden-hose[2]." No positive identification of an M-region as a feature on the solar surface that is reproducible from storm to storm has ever been made although a tentative correlation has been proposed between solar UM regions and M-region storms.[3] As in the traditional interpretation of K_p, it was thought that the mere presence of a solar-wind beam sweeping past the Earth was sufficient to generate a magnetic storm. As with our objection to the traditional interpretation of K_p, we do not believe that this simple interpretation can be correct; rather, we propose that the M-region storm is due to a sheet of turbulence or irregularities in the solar wind.

← Note change #2

The original interpretations of K_p and of the nature of M-regions were justified because, at the time they were put forth, it had been thought that the ambient interplanetary space and the outer part of the geomagnetic field were a vacuum. Now we can be more certain that the solar wind is continuous[4,5] and rarely if ever has a velocity been below about 100 km/sec

* This work was supported by the National Aeronautics and Space Administration under Grant NsG-269-62.

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thought he would like it, so his letter surprised me. ajd 5 July 2019

This is the paper Bartels was complaining about. I

Refereed Journal Publications

Ahluwalia, H. S. and A. J. Dessler, Diurnal variation of cosmic radiation intensity produced by a solar wind, *Planet. Space Sci.*, **9**, 195-210, 1962.

First explanation of CR diurnal variation that was on the right track. Contained two careless errors, one by me and one by Ahluwalia, corrected by Parker and Axford. so this paper got little credit.

Dessler, A. J., Further comments on stability of interface between solar wind and geomagnetic field, *J. Geophys. Res.*, **67**, 4892-4894, 1962.

Again, no Kelvin-Helmholtz instability.

Axford, W. I., A. J. Dessler, and B. Gottlieb, Termination of solar wind and solar magnetic field, *Astrophys. J.*, **137**, 1268-1278, 1963.

This paper, among other things (such as an evaluation of a terminal shock – it had been predicted by Clauser in 1960, but we were unaware of his paper), caused Chamberlain to give up on his "Solar Breeze" theory. It showed that the solar wind must have a speed greater than 100 km/sec, or there cannot be a steady outflow.

Dessler, A. J. and J. A. Fejer, Interpretation of Kp index and M-region geomagnetic storms, *Planet. Space Sci.*, **11**, 505-511, 1963.

Prediction of forward and reverse shocks in the solar wind and the CIR (Corotating Interaction Region). The word, "magnetosheath" was introduced here, as well as the idea of a CIR.

Dessler, A. J. and G. K. Walters, Hydromagnetic coupling between solar wind and magnetosphere, *Planet. Space Sci.*, **12**, 227-234, 1964.

The prediction of asymmetry in flow around the magnetosphere has been verified, but the idea of the tail wagging is wrong. The Walters paper applies to the nose of the heliosphere, where the first published paper (by a French group) had it all wrong.

Maer, K., Jr. and A. J. Dessler, Comment on paper by C. W. Snyder et al., 'The solar wind velocity and its correlation with cosmic-ray variations and with solar and geomagnetic activity,' *J. Geophys. Res.*, **69**, 2846, 1964.

Parker, E. N. and A. J. Dessler, Discussion of paper by E. J. Stegelmann and C. H. von Kenschitzki, 'On the interpretation of the sudden commencement of geomagnetic storms', *J. Geophys. Res.*, **69**, 3745-3748, 1964.

Dessler, A. J., Length of magnetospheric tail, *J. Geophys. Res.*, **69**, 3913-3918, 1964.

I argued that the Johnson teardrop model was unstable and that either hm radiation pressure or solar wind leaking into the magnetopause would cause the tail to be torn open. I did not appreciate magnetic merging without collisions, however, so the tail is too long.

Ness used Fig 1 of this paper in his paper on the discovery of the magnetospheric tail. For "theory" he drew a dipole field. He cited my paper among a list of others interested in magnetospheres, but he gave no credit for my prediction. I had sent him a prepublication preprint. A modified version of this drawing is used on the Arcowski Medal (see also Fig. 4 of Dessler and Juday, 1965).

"We get too ~~soon~~ soon old and too late smart."

ajd 12 July 2019

Also, I did not respond adequately. I should have added a sentence along the lines of, "The Kp index is a vital tool for magnetospheric physics"