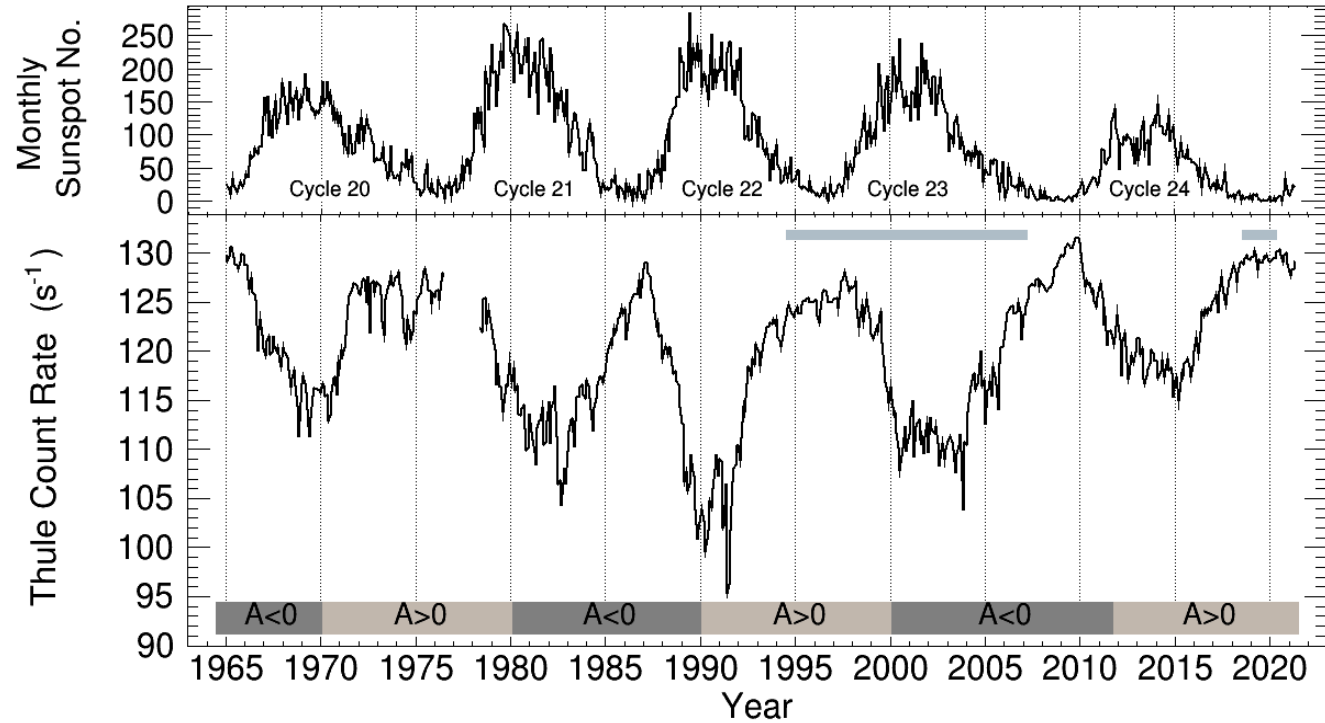
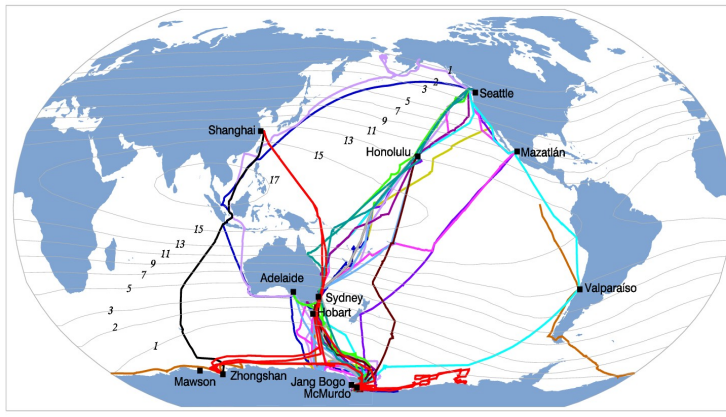
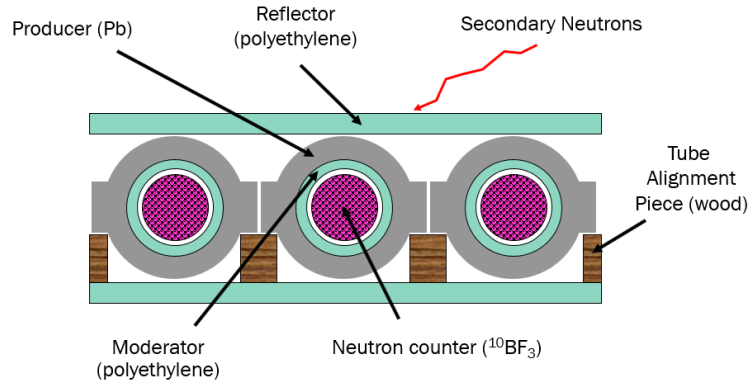
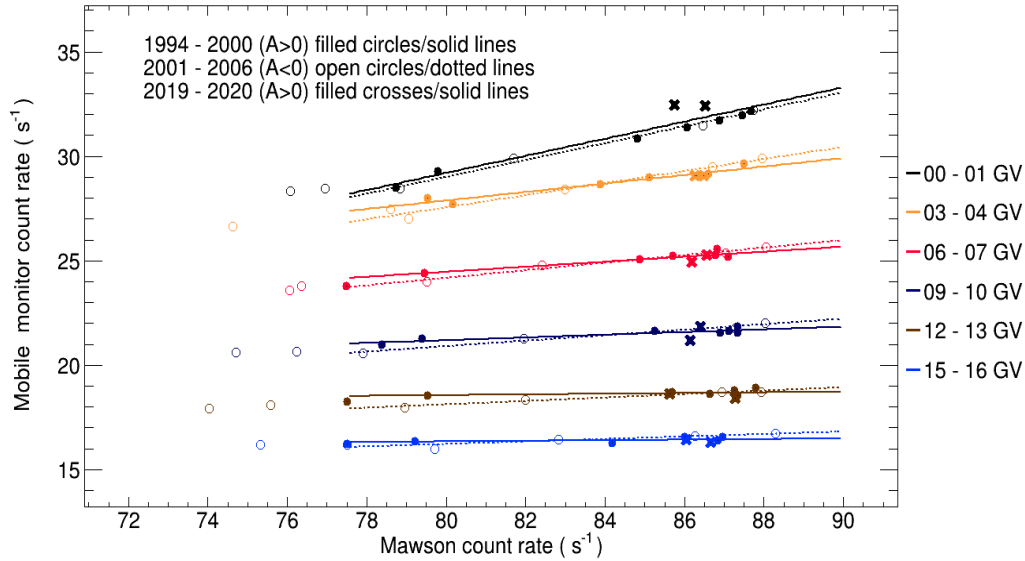


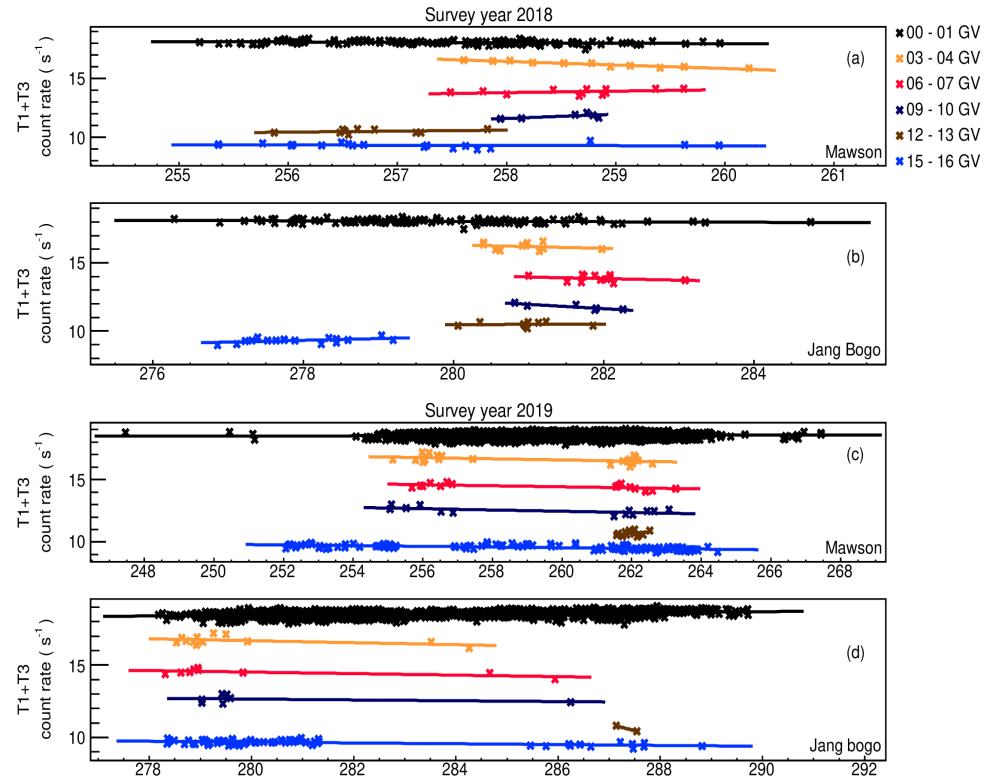
Solar Magnetic Polarity Effect on Neutron Monitor Count Rates from Latitude Surveys Versus Antarctic Stations



Poster ID: 259



Repeat the regression analysis of Nuntiyakul et al., 2014 using Mawson in place of McMurdo.



The regression analysis of Nuntiyakul et al., 2014 to the new survey data, comparing the mobile data both to Jang Bogo and Mawson.

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Solar Magnetic Polarity Effect on Neutron Monitor Count Rates from Latitude Surveys Versus Antarctic Stations

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Introduction

Galactic cosmic rays (GCRs) are high energy particles from outside the solar system arriving at the Earth. When GCRs enter the heliosphere, they encounter a turbulent magnetic field, causing significant variations in their intensity and energy. The influence of the sun on the intensity of GCRs is referred as Solar modulation. The GCR spectrum varies with the sunspot cycle and the solar magnetic cycle. It is clearly seen in Figure 1 that the neutron monitor count rate is related to solar activity with 11-year cycle.

A mobile neutron monitor can record data rapidly through a wide range of geomagnetic cutoffs in a so-called latitude survey [1]. Latitude surveys in previous work [3, 2] view an intersection of the two spectra, called the "cross-over". The cross-over can also be seen from the correlation of latitude survey neutron monitor count rates and count rates of fixed neutron monitors such as that at McMurdo station [2]. A regression analysis found a consistent trend with slopes that change with solar magnetic polarity flips, most likely due to a systematic change in the interpretive diffusion coefficient for cosmic rays.

In recent years the neutron monitor at McMurdo has been moved to the Jang Bogo station, and the mobile neutron monitor has been reconfigured. The series of 13 annual latitude surveys from 1994 to 2007 used by [2] therefore cannot be directly extended. In this work we repeat the analysis using neutron monitor data from the existing neutron monitor stations, Mawson, instead of McMurdo's station and confirm the cross-over. We also analyze two recent latitude surveys in 2019 and 2020 with a monitor similar to the 3NM64 in the previous survey, but without the lead producer surrounded the central tube, the so-called "semi-leaded neutron monitor". We present this analysis using both the Mawson and Jang Bogo neutron monitor stations.

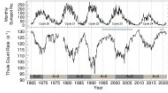


Figure 1. Annual activity rate (top panel) and neutron monitor count rates (bottom panel) from 1994 to 2020. The top panel shows the activity rate with a clear 11-year cycle. The bottom panel shows count rates for various stations, with a similar cycle.

Observation

Thirteen survey years, 1994-2007. We use count rate data corrected for pressure but uncorrected for short-term modulation variations with McMurdo count rate. We exclude times with significant detector drifts (not documented in [2]).

Two survey years, 2019-2020. We use two recent standard neutron monitors flanking one lead-free neutron monitor. For the whole survey data in 2019 and only the southbound data in 2020, the count rate data processed in [4]. For additional data, we obtain it from Neutron 14 (in preparation).

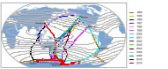


Figure 2. The track of the neutron monitor latitude survey stations in 1994-2007 and 2019-2020.

Fixed neutron monitor stations

Jang Bogo neutron monitor. The 18-tube NM64 is installed near the cosmic ray lab. The data are available from the NMDB website <https://www.nmdb.ch/en/>, but several months of frequent missing data in 2020. This yields a small amount of data appearing in Figure 6b.

Mawson neutron monitor. From 1986 to October 16, 2002, a total of six neutron monitors were placed in the station. After October 17, 2002, the system was upgraded to four 18-tube counter tubes. Analysis of Mawson data is complicated because of changes in the number of counter tubes. Therefore, we explain some details for Mawson data processing in detail at [2].

Data cleaning based on ratios of count rates. From October 17, 2002, the number of counter tubes at Mawson increased from 6 to 18. The data is the sum of the count rates for 6 tubes in the same section. We cleaned the data based on ratios of total count rates for each section.

Mawson normalized with McMurdo. To study the change between the counting rates calculated from the mobile monitor and the fixed neutron monitor of different stations, we calculate Mawson count rates with McMurdo count rates because data from 13 survey years has been normalized with McMurdo [2]. Here, we applied a normalization factor of 1.0033 to the uncorrected Mawson count rate (shown in red in Figure 3) from January 1, 2003, until the survey year 2006, ended. Black data points in Figure 3 are the data that we use for analysis throughout this work.



Figure 3. The ratio of the count rates between McMurdo and Mawson for 13 survey years from 1994-2002 at different location neutron monitor stations. (Left: Mawson, Right: McMurdo). Black data points in this plot indicate the data after normalization. Red dots represent the data before normalization.

Consolidation of latitude survey data to study solar magnetic polarity effect

Recent Surveys. As there is no lead producer surrounding the central tube in these two surveys, we neglect data of this data and use only the standard NM64s (11T3) flanking the central tube for the analysis. We compare the dip-borne data to the two stationary stations Mawson and Jang Bogo, as the dip-borne is close to those stations (see Figure 2). Figure 4 shows the regression of the T1+3 count rates against the Mawson and Jang Bogo neutron monitor count rates for every third rigidity bin. The data in Figure 4 indicate the two count rates of the neutron monitors. Our results demonstrate that the regression of semi-leaded neutron monitor count rates in survey years 2019-2020 vs. fixed station neutron monitor count rates can also be fitted by a straight line. Because Jang Bogo data are missing at various periods when it coincided with the dip-borne data, we then focus on the only analysis of Mawson data for the present surveys.

Earlier Surveys. We used 1994-2007 data from [2] corrected for pressure and uncorrected for short-term variation and also removing detector count events. Mobile monitor count rate data were divided into 1 GV width bins in apparent cutoff rigidity and plotted against the count rate of Mawson neutron monitor as shown for every third rigidity bin in Figure 3 including all the survey years for both solar magnetic polarity states. Figure 3 should be compared with Figure 10 in [2]. The regression for each rigidity bin against Mawson can be fitted by a straight line. We confirm the change in the slope before and after solar polarity reversal in the year 2000.

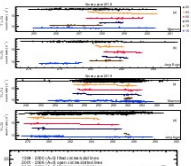


Figure 4. (a) Regression of mobile monitor count rates (1 GV) against T1+3 rigidity bin. (b) Regression of mobile monitor count rates (2 GV) against T1+3 rigidity bin. (c) Regression of mobile monitor count rates (3 GV) against T1+3 rigidity bin. (d) Regression of mobile monitor count rates (4 GV) against T1+3 rigidity bin. (e) Regression of mobile monitor count rates (5 GV) against T1+3 rigidity bin.

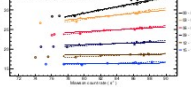


Figure 5. Regression of mobile monitor count rates (1 GV) against McMurdo count rates (1 GV) for different geomagnetic cutoffs. (a) Regression of mobile monitor count rates (2 GV) against McMurdo count rates (2 GV). (b) Regression of mobile monitor count rates (3 GV) against McMurdo count rates (3 GV). (c) Regression of mobile monitor count rates (4 GV) against McMurdo count rates (4 GV). (d) Regression of mobile monitor count rates (5 GV) against McMurdo count rates (5 GV).

Result and Discussion

To compare the two tubes in the recent survey years to the 3NM64 in a 13-year survey, we apply a normalization factor of 1.183 for the survey year 2019 and that of 1.73 for the survey year 2019 to T+13. We obtain two data points for each rigidity bin which have been added to Figure 5. Our results confirm linear trends between count rates at different geomagnetic cutoff rigidity and changes in slope before and after the polarity reversal in 2000, an effect of solar magnetic polarity similar to the results shown in [2]. Results from two recent latitude surveys are consistent with the previous conclusions.

Acknowledgments

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Discussion: Presenter Forum 1
- Evening | All Categories
18:00-19:30 (GMT+2)
16 July 2021