MAG4 versus Alternative Techniques for Forecasting Active-Region Flare Productivity

David A. Falconer,[1,3] Ronald L. Moore,[1,3] Abdulnasser F. Barghouty,[2] and Igor Khazanov[3]

1. Heliophysics and Planetary Office ZP13 MSFC/NASA, Huntsville Al, 35812
2. Astrophysics Office ZP12 MSFC/NASA,
3. Center for Space Plasma and Aeronomic Research, The University of Alabama in Huntsville

Abstract

MAG4 is a technique of forecasting an active region's rate of production of major flares in the coming few days from a free-magnetic-energy proxy. We present a statistical method of measuring the difference in performance between MAG4 and comparable alternative techniques that forecast an active region's major-flare productivity from alternative observed aspects of the active region. We demonstrate the method by measuring the difference in performance between the "Present MAG4" technique and each of three alternative techniques, called "McIntosh Active-Region Class," "Total Magnetic Flux," and "Next MAG4." We do this by using (1) the MAG4 database of magnetograms and major-flare histories of sunspot active regions, (2) the NOAA table of the major-flare productivity of each of 60 McIntosh active-region classes of sunspot active regions, and (3) five technique-performance metrics (Heidke Skill Score, True Skill Score, Percent Correct, Probability of Detection, and False Alarm Rate) evaluated from 2000 random two-by-two contingency tables obtained from the databases. We find that (1) Present MAG4 far outperforms both McIntosh Active-Region Class and Total Magnetic Flux, (2) Next MAG4 significantly outperforms Present MAG4, (3) the performance of Next MAG4 is insensitive to the forward and backward temporal windows used, in the range of one to a few days, and (4) forecasting from the free-energy proxy in combination with either any broad category of McIntosh active-region classes or any Mount Wilson active-region class gives no significant performance improvement over forecasting from the free-energy proxy alone (Present MAG4).

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