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Statistical Methods Applied to Space Weather Science

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All forecasting models of solar phenomena causing geomagnetic storms are based on remote-sensing observations of the Sun and their direct identification in satellite's coronagraphic images. They provide warnings 1 to 4 days in advance of thegeomagnetic storm, even if predictions (often significantly different depending on the model) suffer from large uncertainties.Prediction methods based on in-situ measurements acquired at L1 are nowadays not available, even if this complementaryapproach to forecasting space weather phenomena would allow much more accurate (though shorter) alerts. Statistical studiesbased on Wind in-situ survey data allowed (1) the development of the first in-situ data-based tool for detecting Coronal MassEjections at the Lagrangian point L1 and for forecasting their geo-effectiveness. This provides an alert lying, with a 98% confidence level, between 2 and 8 hours before a geomagnetic storm. In-situ statistical investigation of solar-terrestrialrelationship has led also to two other important results: (2) the derivation of an empirical law for a properforecasting ofthe upper limit of the intensity of any geomagnetic disturbance based on the solar wind energy derived at L1 and(3) thecorrelation between long recovery phases of geomagnetic storms and the presence of Alfvénic turbulentplasma flows followingthe geomagnetic driver. This talk summarizes all the recent results achieved by applying statisticalmethods to space weatherscience.