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Forbush decreases of cosmic rays: Does the recovery phase depend on energy?

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Forbush decreases are sudden decreases of cosmic ray intensities observed near Earth, followed by a gradual recovery phase. The cause and general shape of Forbush decreases of cosmic rays are relatively well understood, as caused by transient interplanetary phenomena like shocks, CME, magnetic clouds. However, the knowledge of their recovery phase remains rather poor, since the recovery is defined by a complicated 3D dynamic process. Earlier results of theoretical and fragmentary statistical studies are controversial in the sense whether the recovery time does or does not depend on the energy of cosmic rays. Here we present a thorough empirical study of the recovery phase of strong isolated Forbush decreases for the last 43 years. We use based the full database of the World Neutron Monitor Network since 1964 and three ground based muon telescopes since 1973. In total 39 strong Forbush decreases, suitable for the analysis, have been identified for the period 1964–2006, 24 of them depicting a clear energy dependence of the recovery time and 15 consistent with no energy dependence. All analyzed Forbush decreases with magnitudes exceeding 10% demonstrate an energy dependence of the recovery time, while smaller events can be of either type. No apparent relation between the occurrence of energy dependent/independent recovery and the IMF polarity has been found. This result provides an observational constraint for more detailed modeling of the propagation of interplanetary transients and their dynamic effects on cosmic ray transport.