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A Gaussian Model for Simulated Geomagnetic Field Reversals

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Reversals are the most spectacular changes in the geomagnetic

field but remain little understood. Paleomagnetic data primarily constrain the reversal rate and provide few additional clues. Reversals and excursions are characterized by a dipole moment low that can last for a few 10 kyr. Some paleomagnetic records also suggest that the field decreases much slower before a reversals than it recovers afterwards and that the recovery phase may show an overshoot in field intensity. Here we study dipole moment variations in several extremely long dynamo simulation to statistically explored the reversal and excursion properties. The numerical reversals are characterized by a switch from a high axial dipole moment state to a low axial dipole moment state. When analysing the respective transitions we find that decay and growth have very similar time scales and that there is no overshoot. Other properties are generally similar to paleomagnetic findings. The dipole moment has to decrease to about 30% of its mean to allow for reversals. Grand excursions during which the field intensity drops by a comparable margin are very similar to reversals and likely have the same internal origin. The simulations suggest that both are simply triggered by particularly large axial dipole fluctuations while other field components remain largely unaffected. A model at a particularly large Ekman number shows a second but little Earth-like type of reversals where the total field decays and recovers after some time.