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Why we should expect the 'Backus effect' to be time dependent

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Stern and Bredekamp (1975) work has generally been referred as an observational evidence for the 'Backus effect', mainly because of the large discrepancies found in the sectorial harmonics (n = m) when comparing geomagnetic field models derived from vector and scalar data. Lowes (1975) has given a simple geometrical interpretation for the experimental effect, he called the 'perpendicular error' effect. Nonetheless, some aspects of Stern and Bredekamp (1975) analysis might have remained hidden thus far, as for instance a fair good recovery of truncated Backus sequences for some values of m.

In our study, we compare vectorial and scalar field models using accurate data from recent satellite missions. We use the classical Backus (1970) series to explain the zeroth-order observed discrepancies. A better understanding of higher order terms for these discrepancies should be envisaged, however, in order to make it possible a more efficient usage of scalar data. In a spherical polar coordinate system based on the centered magnetic dipole, we add a small zonal quadrupole perturbation to the dominant zonal dipole contribution for the main geomagnetic field. We then succeed in describing the observed 'Backus effect' error at a closer level.

The 'Backus effect' geometry is closely related to the main field geometry itself. Using Alberto et al. (2004) approach, we can in principle compute the former once we know the latter. But then we can expect to observe a time variation of the 'Backus effect' associated to magnetic field variations. We discuss the practical applications of our study.