Geophysical Research Abstracts
Vol. 18, EGU2016-7860, 2016
EGU General Assembly 2016

On the applicability of Backus' mantle filter theory

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Geomagnetic jerks are sudden changes of trend in the geomagnetic secular variation. The Earth's mantle behaves as a filter for the jerks, causing a delayed and a smoothed signal at the Earth's surface. Backus' mantle filter theory relies on approximating the impulse response function (IRF) of the mantle by a Gaussian. The advantage of this theory is the linear relation between jerks' delay times and the mantle electrical conductivity, as expressed by kernels. However, the limitations of this theory arise when negative delay and/or smoothing times occur. The applicability of the mantle filter theory is examined by analysing the validity of the Gaussian as an approximation for the composite IRF (CIRF) at a given location. We show that the electrical conductivity of the lower mantle is mostly responsible for the jerk delay time. Alternating sign CIRFs might cause negative delay and/or smoothing times which prevents the use of the mantle filter theory. Adequate/inadequate Gaussian approximations to the CIRFs give small/large differences in the convolved jerk occurrence times. Most observatories yield positive time constants, but in most cases the difference in the jerk occurrence times exceeds 0.5 yr.