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Modeling geodynamo evolution from 0-100 Ma

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Geomagnetic records show evidence for geodynamo fluctuations over a wide range of frequencies, from sub-annual to geological time-scales. The lowest frequency geomagnetic fluctuations are exemplified by changes in polarity reversal frequency. The sea floor magnetic record shows a progressive increase in the average frequency of geomagnetic polarity reversals since the late Cretaceous. Comparable long term modulations in reversal frequency, including one and possibly two superchrons, have been been identified in the older paleomagnetic record.

In this talk we focus on long time-scale fluctuations in the geodynamo controlled by the thermal interaction between the mantle and core. We present a continuous 200 million year long geodynamo simulation that is initially in a non-reversing superchron state for 20 Myr and evolves over 80 Myr with an increase in reversal frequency similar to the seafloor magnetic record. The model begins with an adiabatic CMB heat flow, where convection is driven by the buoyancy of light elements released at the inner core boundary (ICB), and evolves with a linearly increasing super-adiabatic CMB heat flow in time. The prescribed increase in CMB heat flow corresponds to a 27% increase in buoyancy flux at the inner core boundary over 100 Myr. The simulation is continued for another 80 Myr with a linear decrease in CMB heat flow producing a decrease in reversal frequency. Our results indicate a proportional relationship between core heat flow and polarity reversal rate, and imply that the present-day heat flow from the Earth's core may be anomalously large. Comparing the frequency spectrum of the simulation with the paleomagnetic spectrum we find power over the full range of frequencies modeled. In conclusion, the long-time scale reversal frequency fluctuations found in the paleomagnetic record are consistent with dynamo models with evolving CMB heat flow conditions.