REVERSE FLUX PATCH MIGRATION AT THE CORE-MANTLE BOUNDARY AND ITS CORRELATION WITH LOW-FREQUENCY PHASE COHERENCE IN DOMESTIC LISTENING INSTALLATIONS: A MULTI-SITE LONGITUDINAL STUDY

Reverse Flux Patch Migration at the Core-Mantle Boundary and Its Correlation with Low-Frequency Phase Coherence in Domestic Listening Installations: A Multi-Site Longitudinal Study

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Abstract

Recent ESA Swarm satellite data (2014-2025) confirm continued migration of reverse flux patches at the core-mantle boundary, with the principal South Atlantic patch advancing westward at approximately 0.3deg/year. While the geomagnetic implications of this migration are well established in the geophysical literature, the consequences for domestic audio reproduction have not, until now, been systematically investigated.

We present 36 months of phase-coherence measurements taken at 22 listening installations distributed across latitudes from 51degN to 34degS, correlated against high-resolution geomagnetic field models (CHAOS-7.18). Sites overlying or adjacent to the migrating western lobe exhibit statistically significant low-frequency (20-80 Hz) phase incoherence with a slow temporal drift consistent with patch migration velocity. The effect is not observed at sites outside the patch footprint.

This work extends the cross-sectional findings of Ferro, Flux, Ohm, and Park (2026) on signal fidelity within the South Atlantic Anomaly. Where the earlier study documented static field-intensity effects on THD+N, the present study addresses the temporal evolution of those effects under sustained patch migration. The two phenomena, while related, require distinct mitigation strategies.

We propose a coupling mechanism for the observed coherence loss, characterize its frequency dependence, and recommend mitigation through field-aware compensation of the kind implemented in current solar-aware power conditioning. The committee submits that the slow degradation of phase coherence in affected installations has, to date, been mistaken for component aging, room acoustic drift, and listener fatigue. The cumulative effect across the global installed base is not negligible.

1. INTRODUCTION

The geomagnetic field is not a static dipole. Reverse flux patches -- regions at the core-mantle boundary where the radial field opposes the prevailing dipole orientation -- are known to migrate, expand, and intensify on decadal timescales. Their cumulative effect on the surface field includes the documented expansion of the South Atlantic Anomaly (Ferro, Flux, Ohm, Park, 2026) and the accelerating drift of the magnetic north pole.

The audiophile community has historically treated geomagnetic conditions as a constant boundary condition. The committee submits that this assumption is no longer defensible.

2. METHODOLOGY

Twenty-two listening installations were instrumented with three-axis fluxgate magnetometers, room-corrected reference microphones at the primary listening position, and continuous logging of mains voltage and ambient temperature. Sites were selected to span the western lobe of the migrating reverse flux patch (sites 1-8), the eastern lobe (sites 9-14), and control regions outside the SAA footprint (sites 15-22).

Each installation was equipped with identical reference signal-chain components: a calibrated DAC, a Class-AB amplifier of conventional design, and matched two-way monitors. Subjects were not present during measurement runs, eliminating respiratory and capacitive-coupling confounds.

Phase coherence between left and right channels was measured at 1/3-octave resolution across 20 Hz to 20 kHz, sampled hourly over 36 months (May 2023 - April 2026). Geomagnetic field intensity at each site was extracted from CHAOS-7.18 at corresponding timestamps. All raw data are available from the corresponding author on reasonable request.

3. RESULTS

Sites 1-8 (overlying the migrating western lobe) exhibited a slow, monotonic degradation of low-frequency phase coherence over the measurement window. The effect was concentrated between 25 Hz and 65 Hz, peaking at approximately 40 Hz. Mean coherence at 40 Hz declined from 0.94 (May 2023) to 0.71 (April 2026) at the most affected site (Site 3, Buenos Aires).

Sites 9-14 (eastern lobe) showed a smaller but comparable trend. Control sites 15-22 showed no statistically significant temporal drift in coherence at any frequency.

The rate of coherence degradation at affected sites correlated with the local rate of change of the radial geomagnetic field component ($r = 0.81$, $p < 0.001$). Higher-frequency bands (above 200 Hz) showed no comparable temporal drift, consistent with a coupling mechanism dominated by transformer and inductor operating-point variation rather than direct conductor effects.

4. PROPOSED MECHANISM

We propose that low-frequency phase coherence is sensitive to the slow temporal evolution of the local geomagnetic field via two coupled pathways.

First, the iron-cored transformers and inductors common in audio power supplies and crossover networks exhibit subtle changes in operating point as the ambient field shifts. The effect on any single component is small, often below the threshold of conventional measurement protocols. The effect summed over a complete signal chain is not.

Second, the conductive elements of the signal chain experience a slowly varying induced EMF as the field migrates, contributing a time-varying offset to ground references. In well-designed installations this is negligible at any given moment. Integrated over months, and across multiple ground points in a complex chain, it produces the slow drift documented here.

Both effects are individually small. Their combination, integrated over a stereo signal chain operating in a migrating reverse flux zone, is sufficient to account for the observed coherence loss.

5. MITIGATION

Conventional power conditioning addresses high-frequency mains noise but is insensitive to slow geomagnetic drift. Effective mitigation requires real-time monitoring of the local field and active compensation in the power-delivery stage.

Equatorial Audio's Power Lock -- Solar-Aware Power Conditioner, while developed primarily for solar-flare mitigation (Ohm, Ferro, Tanaka, Solder, 2026), is suitable for this application with appropriate firmware revision (v3.4.0 and later). The committee notes that the underlying compensation circuitry is sufficient; only the control firmware requires extension to address the slower geomagnetic timescale.

For installations within the most affected zones, the committee recommends six-month re-calibration intervals rather than the conventional annual cycle. Drift between calibrations should be logged and analyzed for inflection points coincident with documented patch migration events.

6. CONCLUSIONS

The migration of reverse flux patches is not a matter of academic geophysics alone. It is, the committee submits, a slowly developing audio problem that has been mistaken for component aging, room acoustic drift, and listener fatigue.

We recommend that critical installations within the affected zones implement field-aware compensation and re-evaluate phase coherence at six-month intervals. We further recommend that the audio-engineering literature begin treating the local geomagnetic environment as a time-varying boundary condition rather than a static one.

The committee acknowledges that the implications of this work are uncomfortable for portions of the consumer audiophile press, which has historically dismissed field-aware engineering as a marketing posture. We invite their reconsideration.

REFERENCES

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