Tracking the split: a non-linear iterative approach to the monitoring of recent SAA evolution

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Still today vaguely defined, the South Atlantic Anomaly (SAA) is the vast geographic region where the Earth’s magnetic field is weakest relative to an ideal Earth-centered dipole field, and the inner radiation belt comes closest to the planet. Nonetheless it represents a major concern to the space science community, since the local reduced magnetic intensity often results in satellite outages and radiation hazard to humans, especially in geomagnetically disturbed periods.

Since 1958, relentless investigation of the various morphological and dynamic features of the SAA has been taking place, robustly relying on field, plasma and particle measurements from Low-Earth-Orbit (LEO) satellites since the late 1970s.

New readings provided by magnetometers operating at LEO altitudes show that, within the past decade, an apparent second center of minimum field intensity has begun to be clearly resolved southwest of Africa, suggesting a possible rapid splitting of the SAA into two cells. In addition to magnetic determinations, the tracking of fluxes of sub-MeV electrons that are lost to the atmosphere when drifting into the SAA due to its increased bounce loss cone, offers a specular view of the same phenomenon. This multi-messenger approach from different platforms is best suited to catch fine details of the splitting.

Directly stemming from the data-adaptive Empirical Mode Decomposition (EMD) developed at NASA in the 1990s for the analysis of non-stationary signals, the Fast Iterative Filtering (FIF) class of signal mode decompositions is recently taking center stage due to enhanced rigorous formalization in terms of convergence and stability. Multidimensional and Multivariate FIF (MMFIF) is a brand-new extension that handles multidimensional and multichannel datasets. The application of MMFIF techniques to magnetic-field and particle data from an ensemble of LEO satellites has allowed us to best characterize the dynamic evolution of the SAA lobes in the 2010s, and compare it to analogous data in
the literature from the previous decades.