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Assimilation of historical and paleomagnetic data into dynamo models - reanalysis and predictions of the geomagnetic field

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The Earth's magnetic field displays a rich spectrum of variations spanning from a few months to millennia. Decadal to centennial variations, often called secular variation (SV), are generated by induction due to convective motions of the Earth's liquid core. They are at the heart of the current displacements of the South Atlantic Anomaly (SAA), decrease of the axial dipole and the rapid acceleration of the North magnetic pole. Although modern satellite and observatory measurements only span the past century, historical records can improve our knowledge of the dynamics causing the SV for the past 500 years and paleomagnetic data for the past millennia. Focusing on the last millennium, we attempt at reconstructing the magnetic field using 3D dynamo simulations as background models and combining them with historical and paleomagnetic data through a Data Assimilation (DA) framework. We use an Ensemble Kalman Filter and explore covariance localization methods that can allow both for stability and small ensemble sizes. We also explore the impact of the underlying dynamo model characteristics in reconstructing core flows and magnetic structures both in synthetic and real DA scenarios. Finally, we aim at presenting a reanalysis of the dynamo state over the past millennium as well as predictions for the next one, with focus on the SAA, dipole evolution and magnetic pole trajectories.