Peeking into the future geomagnetic field via geomagnetic data assimilation

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Assimilation of surface geomagnetic observations with numerical geodynamo modeling is perhaps the best approach to improve our estimation of the actual dynamic state ("true state") in the Earth's core that is important for understanding the mechanisms of the geomagnetic secular variation, and for forecasting future secular variations based on current and past observations and geodynamo models. In the past several years we have developed the first geomagnetic data assimilation framework, MoSST_DAS, which includes the MoSST core dynamics model (for geodynamo modeling), an data assimilation component based on the optimal interpolation algorithm and ensemble error covariance estimations, and several geomagnetic/paleomagnetic field models (CALS7K, GUFM1, CM) which provide global main field models over the past 7000 years. Our assimilation results (based on the OI algorithm) with this framework demonstrate clearly that we can consistently predict accurately the geomagnetic field at the Earth's surface over 20 year periods (for the past 100 years). In particular, the 5-year forecasts of the geomagnetic field and geomagnetic secular variation are very accurate: the correlation between the forecasts and the observations is above 0.997 for the magnetic field, and above 0.91 for the secular variation over the past 25 years. Similar agreement can be observed over the past 100 years. These results are better than the IGRF from 1975. Currently, we are benchmarking and validating the ensemble covariance based algorithm. We expect better assimilation results with the improved assimilation algorithm.