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Data Assimilation and Machine Learning Science at ECMWF

Tuesday, 6 October 2020 14:00 (30 minutes)

Model error is one of the main obstacles to improved accuracy and reliability in state-of-the-art analysis and forecasting applications, both in Numerical Weather Prediction and in climate prediction conducted with comprehensive high resolution general circulation models. In a data assimilation framework, recent advances in the context of weak constraint 4D-Var have shown that it is possible to estimate and correct for a large fraction of model error in parts of the atmosphere. This has been demonstrated in the stratosphere where the current global observing system is sufficiently dense and homogeneous.

The recent explosion of interest in Machine Learning / Deep Learning technologies has been driven by their remarkable success in disparate application areas. This raises the question of whether model error estimation and correction in operational NWP and climate prediction can also benefit from these techniques. Based on recent results (Bonavita and Laloyaux, 2020) we aim to start to provide answers to these questions. Specifically, we show that Artificial Neural Networks (ANN) can reproduce the main results obtained with weak constraint 4D-Var in the operational configuration of the IFS model of ECMWF. More interestingly, we show that the use of ANN models inside the weak-constraint 4D-Var framework has the potential to extend the applicability of the weak constraint methodology for model error correction to the whole atmospheric column. Finally, we discuss the potential and limitations of the Machine Learning / Deep Learning technologies in the core NWP tasks. In particular, we reconsider the fundamental constraints of a purely data driven approach to forecasting and provide a view on how to best integrate Machine Learning technologies within current data assimilation and forecasting methods

Thematic area

1. Machine Learning for Data Assimilation - Including Model Error Estimation and Correction, Parameter estimation, Fast linearised models for DA, Hybrid DA

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