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Data Assimilation using Artificial Neural Networks for the global FSU atmospheric model

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Data assimilation is the process by which measurements and model predictions are combined to obtain an accurate representation of the state of the modeled system. Uncertainty is the characteristic of the atmosphere, coupled with inevitable inadequacies in observations and computer models and increase errors in weather forecasts. Data assimilation is a technique to generate an initial condition to a weather or climate forecasts. This paper shows the results of a data assimilation technique using artificial neural networks (ANN) to obtain the initial condition to the atmospheric general circulation model (AGCM) for the Florida State University in USA. The Local Ensemble Transform Kalman filter (LETKF) is implemented with Florida State University Global Spectral Model (FSUGSM). The ANN data assimilation is made to emulate the initial condition from LETKF to run the FSUGSM. LETKF is a version of Kalman filter with Monte-Carlo ensembles of short-term forecasts to solve the data assimilation problem. The model FSUGSM is a multilevel (27 vertical levels) spectral primitive equation model with a vertical sigma coordinate. All variables are expanded horizontally in a truncated series of spherical harmonic functions (at resolution T63) and a transform technique is applied to calculate the physical processes in real space. The LETKF data assimilation experiments are based in *synthetic* observations data (surface pressure, absolute temperature, zonal component wind, meridional component wind and humidity). For the ANN data assimilation scheme, we use Multilayer Perceptron (MLP-DA) with supervised training algorithm where ANN receives input vectors with their corresponding response or target output from LETKF scheme. An automatic tool that finds the optimal representation to these ANNs configures the MLP-DA in this experiment. After the training process, the scheme MLP-DA is seen as a function of data assimilation where the inputs are observations and a short-range forecast to each model grid point. The ANNs were trained with data from each month of 2001, 2002, 2003, and 2004. A hind-casting experiment for data assimilation cycle using MLP-DA was performed with synthetic observations for January 2005. The numerical results demonstrate the effectiveness of the ANN technique for atmospheric data assimilation, since the analyses (initial conditions) have similar quality to LETKF analyses. The major advantage of using MLP-DA is the computational performance, which is faster than LETKF. The reduced computational cost allows the inclusion of greater number of observations and new data sources and the use of high resolution of models, which ensures the accuracy of analysis and of its weather prediction