

# **Hybrid Variational–Ensemble Data Assimilation in the NCUM NWP System and IMDAA Regional Reanalysis**

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Hybrid variational-ensemble data assimilation methodology combines the advantages of traditional variational and ensemble data assimilation methods to produce a superior quality analysis for the forecast model. A hybrid 4D-Var/Ensemble Transform Kalman Filter (ETKF) algorithm was implemented for data assimilation in the NCMRWF Unified Model (NCUM) global NWP system in October, 2016 which was a significant milestone in the improvements of data assimilation capabilities at NCMRWF. The hybrid 4D-Var data assimilation system of NCUM merges the background error covariance information from two sources; climatological and flow-dependence forecast errors from the NCMRWF Ensemble Prediction System (NEPS). The initial condition perturbations of the NEPS are generated by ETKF method. A new version of the hybrid 4D-Var data assimilation system for the high resolution (~12 km) global NCUM was made operational in May, 2018. The uniqueness of this new data assimilation system is that it uses the same resolution ensemble forecasts as that of the deterministic model forecast. This presentation provides a brief description of the NCUM hybrid 4D-Var data assimilation system and the results of various experiments carried out with this data assimilation system.

Indian Monsoon Data Assimilation and Analysis (IMDAA) project has generated forty years of high resolution satellite-era regional reanalysis. This 12 km horizontal resolution reanalysis from 1979 to 2018 is produced using a 4D-Var data assimilation system and an advanced version of Unified Model (UM). There is considerable growth and improvement in the atmospheric observing systems during this period which is used in the reanalysis. This presentation aims to draw the attention of the user community to this high resolution reanalysis for the advancement of understanding of weather and climate over the Indian monsoon region.