A Reanalysis of the Martian Atmosphere Using Ensemble Data Assimilation

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A reanalysis of the weather and climate of the planet Mars is generated using a Martian Numerical Weather Prediction system composed of an ensemble data assimilation system and the GFDL Mars Global Circulation Model (MGCM). Spacecraft observations of temperature profiles and dust opacities from the Thermal Emission Spectrometer (TES) and Mars Climate Sounder (MCS) are assimilated using the Local Ensemble Transform Kalman Filter (LETKF) to create a climate record spanning several Mars years. The reanalysis is evaluated by comparing forecasts to observations not yet assimilated, the Mars Analysis Correction Data Assimilation (MACDA) reanalysis from the UK, as well as to independent radio science (RS) profiles. Several techniques led to an improvement in performance of the reanalysis, including adaptive inflation, empirical bias correction, and enhancing the representation of dust in the ensemble. Features of the atmospheric circulation, including traveling waves, the polar vortex, and dust distributions, are compared to freely running model simulations. Ensemble spread and bred vectors give insights to uncertainties in the reanalysis and the predictability of the atmosphere.

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