An Enhanced Methodology for Satellite Data Assimilation in a Mars Atmosphere Reanalysis

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Spacecraft observations of the atmosphere of Mars from the Thermal Emission Spectrometer (TES) and Mars Climate Sounder (MCS) instruments enable detailed studies of Martian weather and climate. Using the Local Ensemble Transform Kalman Filter (LETKF) we have assimilated retrieved temperature profiles into the Mars Global Climate Model (MGCM) to create a multi-annual reanalysis of temperature, winds, and surface pressures.

The retrieval process effectively smoothes a true profile in the vertical, then mixes it with a prior profile. However, Hoffman et al. [1] found sensitivity to the choice of prior profile for Mars TES. Therefore we introduce a methodology (outlined in Hoffman [2] and inspired by Rodgers [3]) that removes the influence of the prior, with the goal of using interactive priors and covariance from the data assimilation system. Here, standard retrievals are converted to observations that have zero mean, uncorrelated, and unit variance expected errors. The new observation operator is simply a weighted average of temperatures at retrieval pressure levels, the weights being functions of inputs and outputs of the retrieval process namely the prior and posterior temperature profile and covariances. The technique also makes use of the EOF representation for data compression, data thinning based on vertical degrees of freedom, vertical localization based on weighting functions, representativeness error, and superobservations. We test this approach on Optimal Spectral Sampling (OSS) TES temperature retrievals in our Mars data assimilation system.

References

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