**TESTING MARS ATMOSPHERE THERMAL INFRARED NADIR-SOUNDING TEMPERATURE RETRIEVALS ON GCM-DERIVED SIMULATED RADIANCES.**

T. H. McConnochie\(^1\), and M. D. Smith\(^2\),

\(^1\)University of Maryland, College Park, MD (tmconno@umd.edu) for first author, \(^2\)NASA Goddard Space Flight Center, Greenbelt, MD.

**Introduction:** Thermal infrared (TIR) temperature sounding data sets such as that of Mars Global Surveyor’s (MGS) Thermal Emission Spectrometer (TES) [1] and Mars Reconnaissance Orbiter’s (MRO) Mars Climate Sounder (MCS) [2] are of fundamental importance to our understanding of Mars’s atmospheric dynamics. These data sets are generated by numerically inverting a radiative transfer model to obtain, i.e., “retrieve”, a temperature profile. Motivated by the prospect of future TIR instruments in Mars orbit, especially the Emirates Mars Infrared Spectrometer (EMIRS) [3] on the Emirates Mars Mission (EMM) [4], we experiment here with using general circulation model (GCM) output as an artificial “ground-truth” to evaluate retrieval algorithms. In the process, we can also evaluate the extent to which existing data sets are capable of capturing expected-by-GCM temperature structures.

Here we focus on the TES nadir sounding temperature profile retrieval algorithm presented by [1] and its corresponding Planetary Data System atmospheric profile data set, due to the similarities between TES and EMIRS. Of course this is only one of several quite different retrieval approaches than can and should be considered in the future (c.f. [2], [5]).

**Methodology:** Retrieval algorithm: Our baseline TES algorithm is identical to that used for the TES atmospheric temperature data set stored by the Planetary Data System (PDS) and reproduces (to within numerical precision) the PDS temperature profile data set when used with the original parameters and radiance inputs. Note that aerosol effects are incorporated only in the form of a modified effective surface temperature. Additions to the original code allow us to supply GCM-derived radiances, to perturb those radiances with a Monte-Carlo simulation of instrument noise, and to explore adjusting the \( \gamma \) parameter (equation 6 in [1]), which adjusts the strength of the penalty applied for deviations from the initial guess. (The potential for improving TES retrieval algorithm performance by modifying \( \gamma \) was originally proposed by [5].) We consider

**Results:** Figure 1 shows a MCD GCM profile (blue) compared with a similar profile (black) from the TES PDS database. Retrievals from the corresponding radiances are shown in red for the retrieval performed on GCM-derived radiances and green for the retrieval performed on actual TES radiances that correspond to the PDS database profile. The right-hand panel shows the same profiles, but with the \( \gamma \) parameter used in the retrievals reduced by a factor of 100 to substantially reduce the weight of the initial guess. Figure 2 shows the results of applying the TES baseline retrieval (including the original value of \( \gamma \)) to the full MCD climatology data set. The TES retrieval agrees well with the artificial model ground truth, with differences generally less than 4 K. The major exception is the vicinity of the northern winter polar jet, where errors exceed 15 K. The \( \gamma \) parameter experiment shown in Figure 2 suggests that this systematic mismatch in the polar jet can be improved by a factor of 2 with a better parameter choice, but at the expense of additional sensitivity to instrument noise. This is promising for retrieval performance with future...
measurements, but it remains to be seen whether a smaller $g$ would really be practical for retrievals with the real TES radiance data set.


Figure 2: TES baseline retrieval algorithm applied to Mars Climate Database v5.3 climatology scenario radiance.