WAVELENGTH CALIBRATION TECHNIQUES AND SUBTLE SURFACE AND ATMOSPHERIC ABSORPTION FEATURES IN THE MARINER 6, 7 IRS REFLECTANCE DATA; J.F. Bell III (NRC/NASA Ames, Moffett Field CA), T.L. Roush (San Francisco State University/NASA Ames), T.Z. Martin (Jet Propulsion Laboratory/Caltech), J.B. Pollack (NASA Ames), and R. Freedman (Sterling Software, Palo Alto CA).

1994 marks the 25th anniversary of the Mariner 6 and 7 flyby missions to Mars. Despite its age, the Mariner 6,7 Infrared Spectrometer (IRS) data are a unique set of measurements that can provide important information about the Martian surface, atmospheric, and atmospheric aerosol composition. For certain mid-IR wavelengths, the IRS spectra are the only such spacecraft data obtained for Mars. At other wavelengths, IRS measured surface regions different from those measured by Mariner 9 or Phobos 2 and under different dust opacity conditions. The IRS instrument was described by [1,2] and initial results on surface features were presented by [3], on atmospheric features and topography by [4,5] and on aerosols and polar deposits by [6,7]. For many years after this initial set of papers, the IRS data went ignored.

Recently, a data set restoration was carried out by T.Z. Martin [8-10] and the IRS data have become available in digital form. This has led to several re-examinations of the IRS data using modern computational and spectroscopic techniques [11-14].

We are interested in examining the IRS reflectance data in the 1.8 to 3.0 μm region because there are numerous diagnostic absorption features at these wavelengths that could be indicative of hydrated silicate minerals (*e.g.*, clays, amphiboles, hydroxides) or of carbonate- or sulfate-bearing minerals [*e.g.*, 15]. Groundbased telescopic data and recent Phobos ISM measurements have provided controversial and somewhat contradictory evidence for the existence of mineralogic absorption features at these wavelengths [16-20]. Our goal is to determine whether any such features can be seen in the IRS data and to use their presence or absence to re-assess the quality and interpretations of previous telescopic and spacecraft measurements.

As part of the data set restoration exercise, Martin [8] performed a wavelength calibration of the data using fiduciary spikes in the CVF, atmospheric absorption features, and absorption features detected in a polystyrene film occasionally viewed by the IRS. We have attempted to test the quality of this calibration by comparing the IRS channel 2, left segment (1.8 to 3.6 μm) reflectance data to the Mars atmospheric transmission predicted using a radiative transfer model. We included CO_2, CO, and H_2O in a single layer, no-dust model atmosphere and used the HITRAN line database to derive absorption coefficients at very fine frequency spacing. The absorption coefficients were converted to transmission using the molecular abundance derived from the incidence and emission values provided with the IRS spectra. The modeled transmission data were then convolved to the resolution of the IRS CVFs [2].

An example comparison is shown in Figure 1. The data are raw Mariner 7 spectra 92 and 98 that have not had instrumental artifacts (such as near 3.4 μm) removed. In general, it is apparent that the IRS spectra show both strong and weak Mars absorption features. For example, the CO_2 triplet near 2.0 μm and doublet near 2.7 μm are both well resolved, as are weak CO_2 features near 2.15 and 2.6 μm and the weak CO absorption envelope near 2.35 μm. In all, 9 features were isolated in the spectra to test the nominal wavelength calibration provided by [8]. Figure 2 shows the correlation between the models and the data. The fit is very good near the 2.7 μm CO_2 band but it deviates significantly at shorter wavelengths. The trend in Figure 2 indicates that the spectrum may need to be fit with 2 or 3 independent wavelength calibration segments. This may indicate that the CVF experienced a skip of some kind while rotating or that there were occasional speed changes in the rotation rate.

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This preliminary examination indicates that substantial refinements in the wavelength calibration of the data can be achieved by using model atmosphere wavelengths as tie points in a fitting routine. This is an essential step for the interpretation of weak absorption features seen in the data which have center positions that are very sensitive indicators of composition. Unfortunately, as pointed out in [8], for accurate compositional interpretations it is necessary to perform an independent wavelength calibration for each spectrum. We are currently devising an automated scheme to accomplish this for all of the Mariner 6,7 IRS data in channel 2.

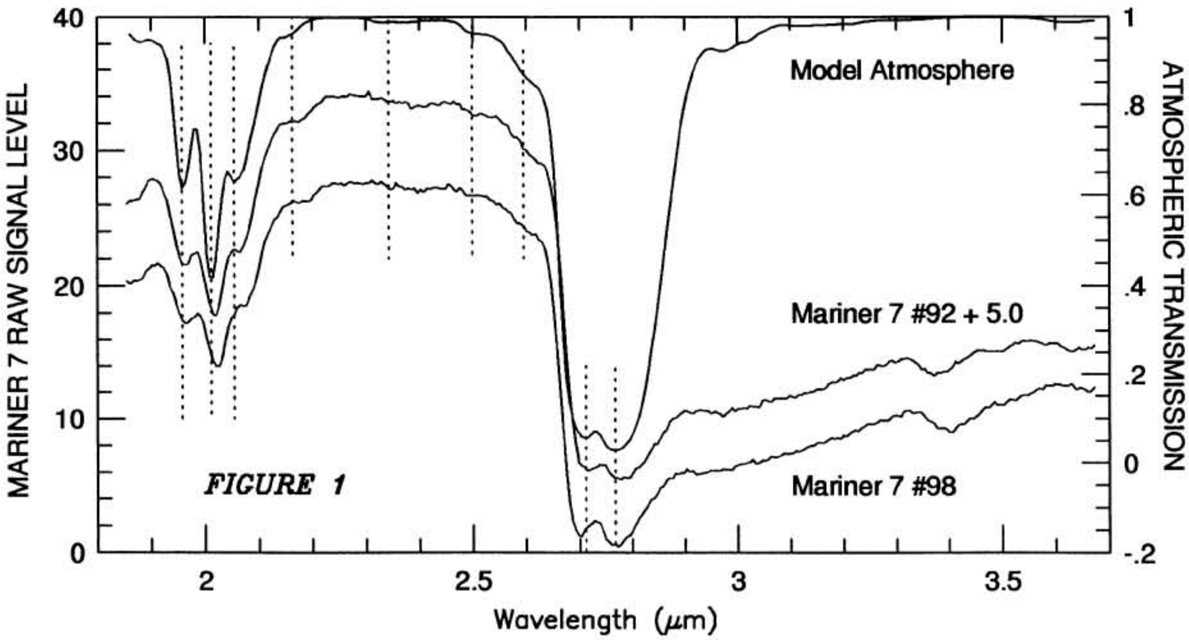
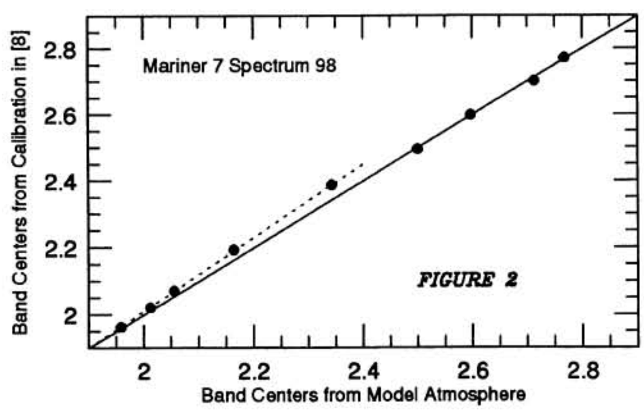


Figure 1 (top) shows Mariner 7 spectra 92 and 98 (with the wavelength calibration provided by Martin [8]) compared to a model atmosphere spectrum calculated at the same viewing geometry. Dashed lines indicate model band centers. Figure 2 (right) shows the correlation between band center wavelengths for spectrum 98 in Fig. 1 to those derived from the radiative transfer model. The solid line represents 100% correlation; the dashed line demonstrates a typical level of difference (or error) between the wavelengths derived by the two methods.



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