

## COMMENTS ON TOVS TRANSMITTANCES

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### 1. TOVS Transmittance Calculations

Assuming that a substantial improvement of TOVS results, if possible at all, can only be achieved by improved physical methods, we have started with a comparison of line-by-line and TOVS transmittances in the 15  $\mu\text{m}$  region. These comparisons are restricted insofar as the exact spectral response functions of the HIRS spectral channels are generally not known by the user community. We demonstrate the effect that an undefined spectral response function has in Figure 1 for the worst case (Spänkuch and Dohler, 1979), the center channel (HIRS channel 1), taking the figures for central wavenumber and half-power bandwidth quoted by Schwalb (1978). Table 1 shows the line-by-line calculations corresponding to procedure 1. The differences in transmittances are about 0.01 for a central wave number shift from  $668.5 \text{ cm}^{-1}$  to  $667.92 \text{ cm}^{-1}$  and about 0.1 for an increase in the half-power bandwidth from  $\Delta\nu = 3 \text{ cm}^{-1}$  to  $\Delta\nu = 4 \text{ cm}^{-1}$ . For the other channels, the differences are considerably smaller but they still are .005 to .01 larger for line-by-line than TOVS transmittances (McMillin et al., 1980). To determine the influence of the uncertainty of spectroscopic line data and of the numerical approximations used, two different line-by-line procedures and spectroscopic sources were applied for the midlatitude summer standard atmosphere. Their main characteristics are summarized in Table 1.

The differences in transmittances from the top of the atmosphere to the pressure levels of the ordinate are shown in Figure 2 for HIRS channel 6 ( $\nu$  at  $733.20 \text{ cm}^{-1}$ ) for zero zenith angle. The differences are larger than  $.01^{\circ}$  within the whole troposphere and, hence, an order of magnitude larger than for the technique used in producing TOVS transmittances (Weinreb et al., 1981). Table 2 gives the mean absolute (averaged for all pressure levels) and the maximal absolute differences between the two line-by-line procedures for other 15  $\mu\text{m}$  HIRS channels together with the lower pressure level concerning the last one.

### 2. Conclusion

In conclusion, the differences in line-by-line calculations of atmospheric transmittances are larger than in the McMillin-Fleming (1976) approximation. Therefore, if there is a need for improvements in atmospheric transmittances, priority should be given to basic spectroscopic investigations as initiated by the IRC WG on Remote Sensing (Spectroscopy).

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Table 1: Spectroscopic line data and details of line-by-line calculation

|                           | Procedure 1                           |              | Procedure 2                         |              |
|---------------------------|---------------------------------------|--------------|-------------------------------------|--------------|
| line data                 | Drayson 1973                          |              | AFGL 1976                           |              |
| half-width/               | const.                                |              | variable                            |              |
| $\nu$ [cm <sup>-1</sup> ] | $\alpha_{Lo}$ [cm <sup>-1</sup> ]     | line profile | $\nu$ [cm <sup>-1</sup> ]           | line profile |
| 660-662                   | 0.08                                  | $f_v$        | 660-670                             | $f_{BKM}$    |
| 662-671                   | 0.07                                  | $f_v$        | 670-710                             | $f_v$        |
| 671-708                   | 0.08                                  | $f_v$        | 710-770                             | $f_{BKM}$    |
| 708-715                   | 0.07                                  | $f_{BKM}$    |                                     |              |
| Integration               | .01 for $p < 100$ mbar                |              | const = .005 cm <sup>-1</sup>       |              |
| step                      | .02 for $100 \leq p \leq 500$ mbar    |              | for all pressure levels             |              |
| [cm <sup>-1</sup> ]       | .04 for $p > 500$ mbar                |              |                                     |              |
| cut-off                   | 10 cm <sup>-1</sup> from the interval |              | pressure dependent                  |              |
|                           | border independent of $p$             |              | maximum cut-off 15 cm <sup>-1</sup> |              |

$\alpha_{Lo}$ : Lorentz half-width at normal conditions,  $f_v$  Voigt profile,  $f_{BKM}$  Benedict profile with constant corresponding to Kunde and Maguire (1974).

Table 2: Mean absolute and maximal absolute differences in line-by-line transmittances, calculated corresponding to the procedures of Table 1. (p is the lower pressure level for the maximum differences).

| Central wave number<br>$\nu_0 / \text{cm}^{-1} /$ | half power<br>bandwidth<br>$/ \text{cm}^{-1} /$ | $\Delta\tau$ | $\Delta\tau_{\text{max}}$ | p/mbar/ |
|---|---|--------------|---------------------------|---------|
| 679.21  | 10  | .007         | .0185                     | 100     |
| 691.56  | 12  | .002         | .0034                     | 200     |
| 704.63  | 16  | .001         | .0034                     | 300     |
| 715.05  | 16  | .009         | .0357                     | 200     |
| 733.16  | 16  | .008         | .0163                     | 500     |

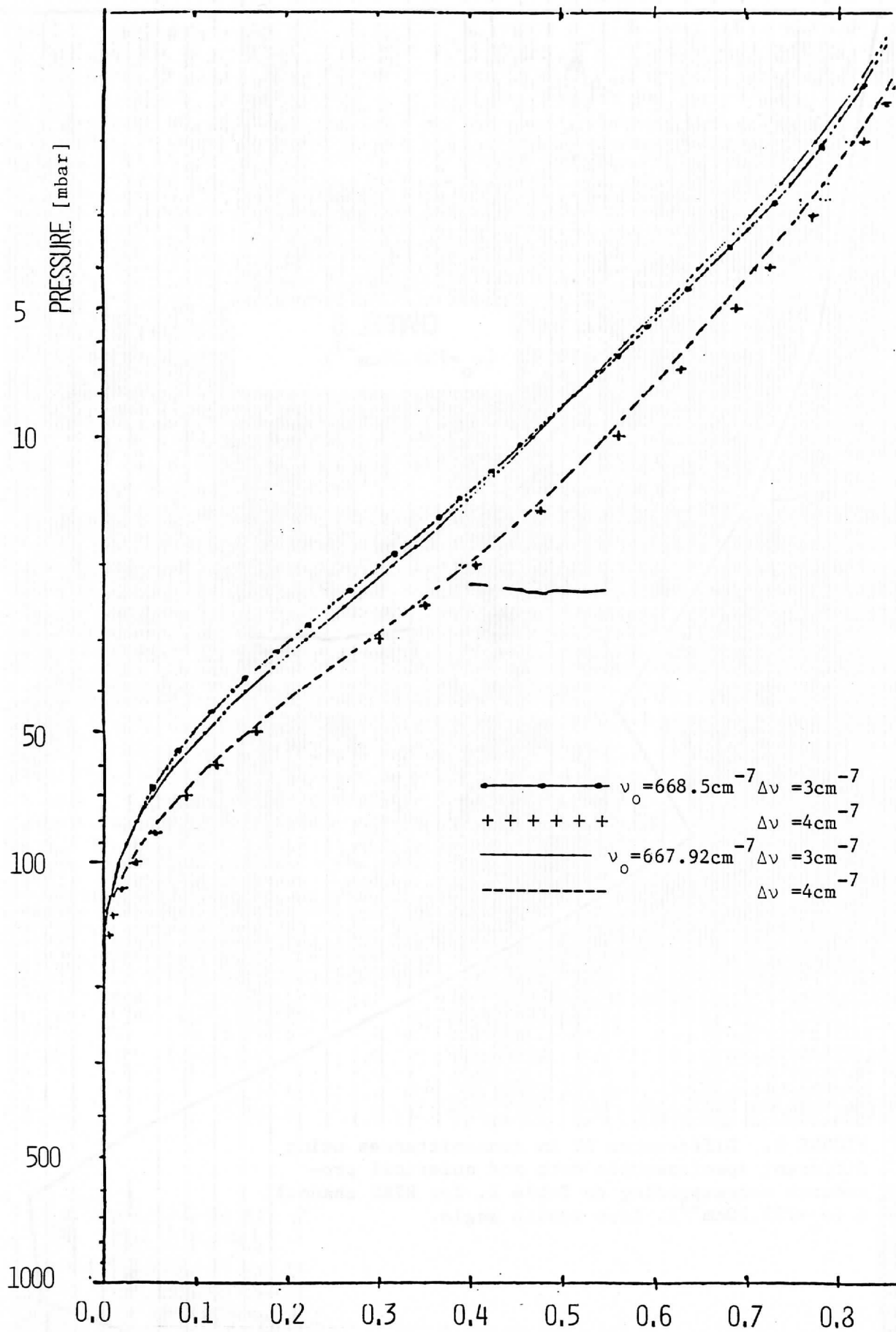


FIGURE 1. Line-by-line calculation of atmospheric transmittance for HIRS channel 1 for different spectral response characteristics. Zero zenith angle. Procedure 1 (see Table 1).

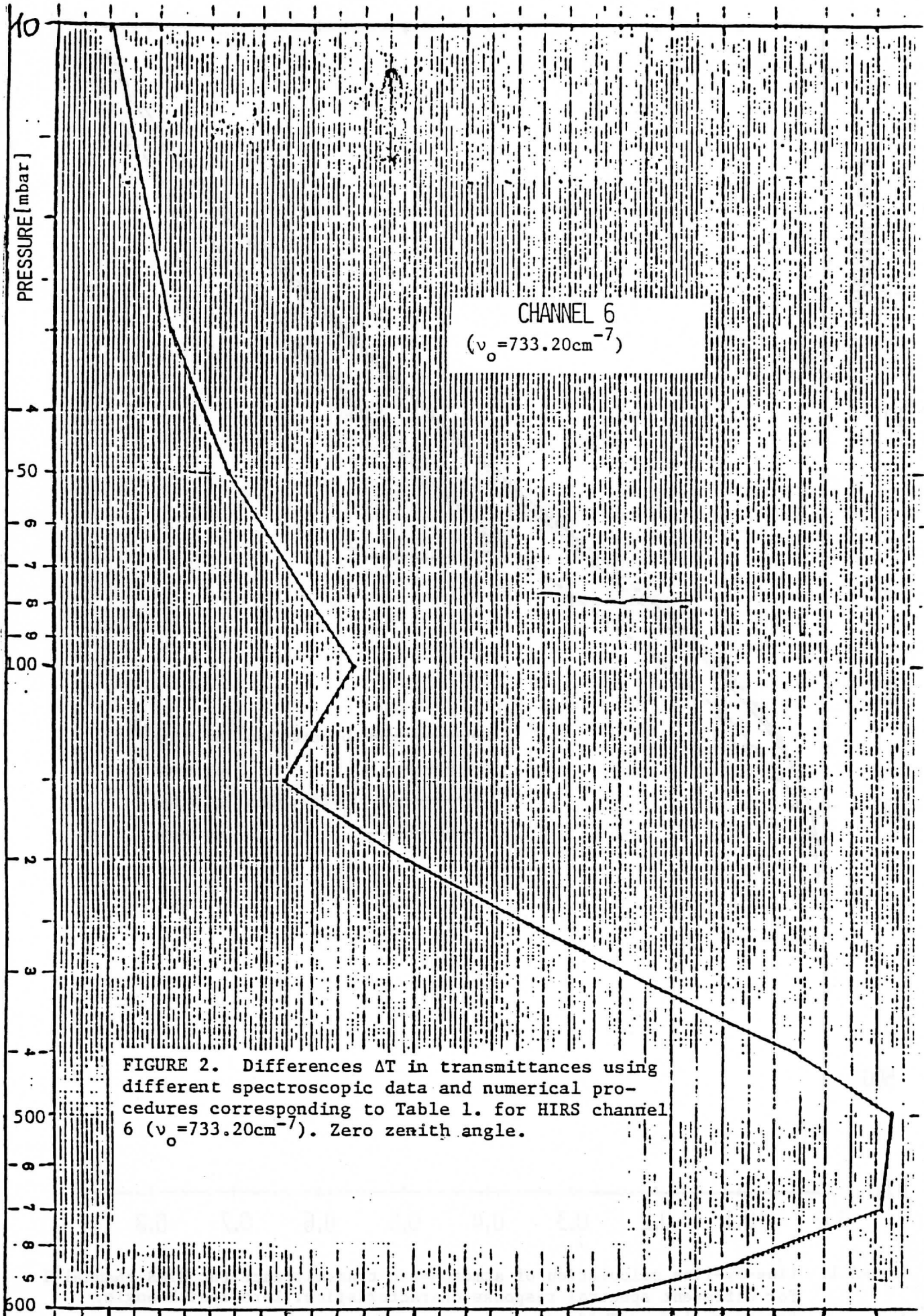


FIGURE 2. Differences  $\Delta T$  in transmittances using different spectroscopic data and numerical procedures corresponding to Table 1. for HIRS channel 6 ( $\nu_0 = 733.20 \text{ cm}^{-1}$ ). Zero zenith angle.

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