CHARACTERISTICS OF ERRORS IN RETRIEVED VERTICAL TEMPERATURE

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1. INTRODUCTION

It is important to know the characteristics of errors in vertical temperature sounding for the future improvement of the data processing sytem. In this work we study the dependence of errors on the cloud amount and scan angle.

2. EFFECT OF CLOUD

The observed radiance I of a HIRS channel is written as

$$I = (1 - n)R + nI_c$$
$$= R + n(I_c - R), \qquad (1)$$

where R is the clear radiance, n the cloud amount and I_c the cloudy radiance. In MSC the method for the clear radiance retrieval is stochastic using the initial values for R and $Q = n(I_c - R)$, and the error statistics of the measured quantities I and initial guesses of R and Q. The cloud amount of a HIRS spot is known by counting the cloudy pixels of AVHRR contained within it and Q is estimated from AVHRR radiance data. The clear radiances of HIRS channels are determined from adjacent four spots of HIRS assuming the clear radiance is constant in the area of these four spots (Aoki, 1982a).

It is expected that for the better estimation of clear radiances the cloud amount in the four HIRS spots concerned are desired to be greatly different with each other. From this point of view, a quality index to the retrieved clear radiance has been defined as

$$\gamma = (1 - \bar{n})^2 + n_{max} - n_{min}, \qquad (2)$$

where $\bar{n}$ is the average cloud amount for four HIRS spots concerned, n_{max} the maximum cloud amount and n_{min} the minimum cloud amount. We call 'clear case' when $\gamma \geq \gamma_c$ and 'cloudy case' when $\gamma < \gamma_c$ ($\gamma_c = 0.4$).

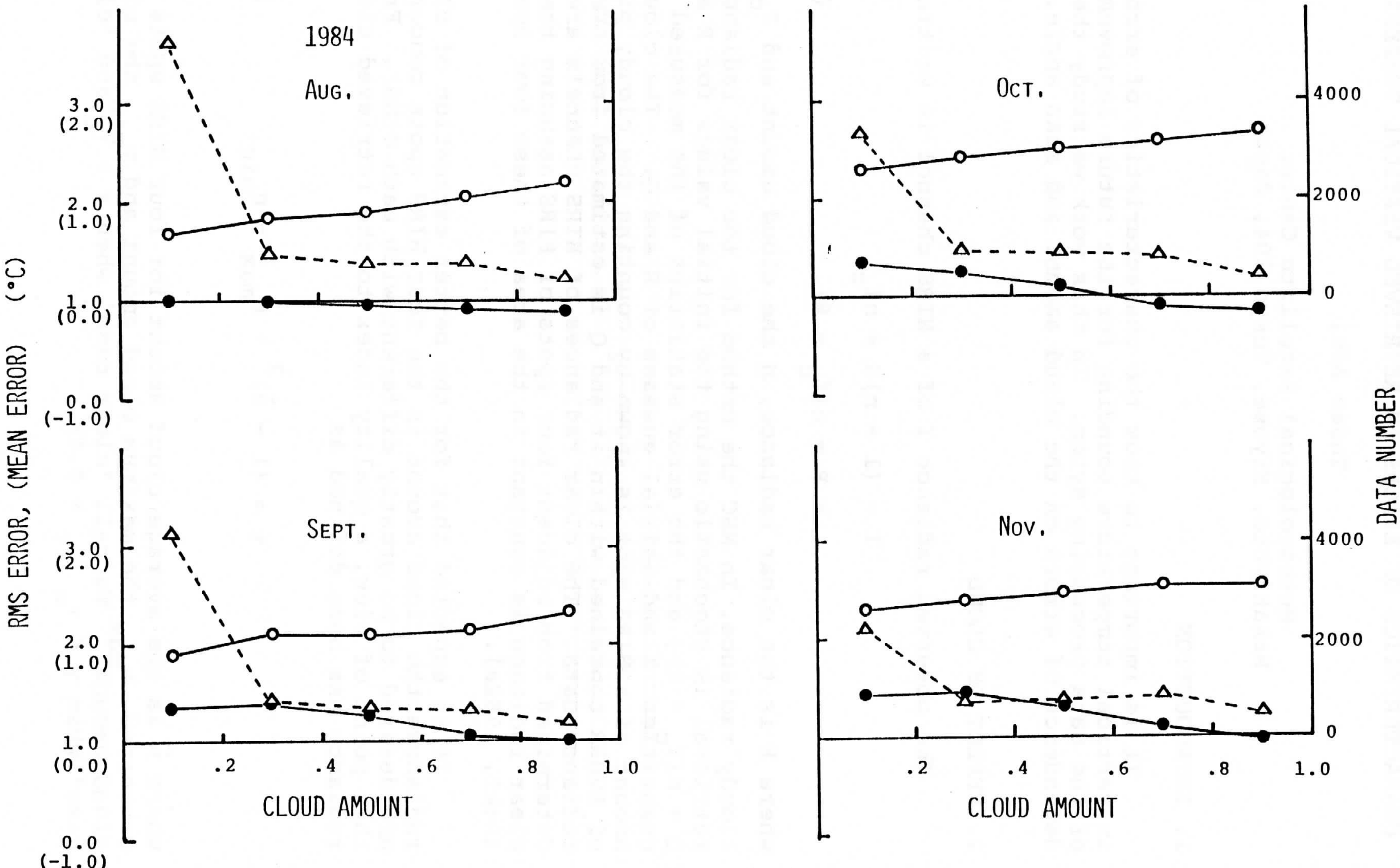

Fig.1 Cloud amount dependence of rms(white circle) and mean(solid circle) errors of retrieved vertical temperature averaged over 14 standard pressure levels. Data number(triangle) are also shown.

Fig.1 shows the dependence of the error of the vertical temperature on the average cloud amount $\bar{n}$ in 'clear case'. The rms and mean errors are averages for 14 standard pressure levels from 20 to 1000 mb. It can be seen that errors are slightly dependent on cloud amount. Positive values of bias error especially for small cloud amount may be explained by the fact that in the season examined here regression coefficients are determined from the data of warmer season preceding the time when the coefficients are used. It seems, however, this effect does not influence in the case of higher cloud amount. The reason is not clear at this stage.

3. EFFECT OF ANGULAR CORRECTION

In MSC the effect of the scan angle θ are corrected by fully empirical procedure. The correction is made to the regression coefficient rather than to the radiance. The temperature T is obtained by the equation

$$T = C(\mu)R(\mu), \tag{3}$$

where C is the regression coefficient and $\mu = 1/\cos\theta$.

The regression coefficient C at $\mu = \mu$ and j-th height z_j is obtained by

$$\begin{aligned} C_{ji}(\mu, z_j) &= C^{\circ}_{ji}(\mu^{\circ}, z_j + \delta) \\ \delta &= \eta_i \Delta\mu \\ \Delta\mu &= \mu - \mu^{\circ} \end{aligned} \tag{4}$$

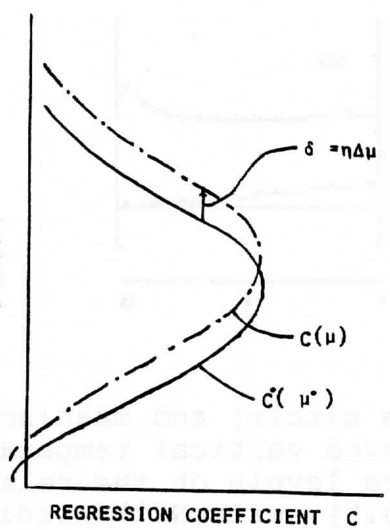

Fig.2 Relationship between the curves $C(\mu, z)$ and $C^{\circ}(\mu^{\circ}, z)$.

where η_i is constant for the i-th channel and $\mu°$ is the at a reference scan angle. C° and η are empirically determined (Aoki, 1982b). The procedure of this angle correction is illustrated in Fig.2.

Fig.3 shows the angular dependence of the rms and mean error of the retrieved vertical temperature averaged over all pressure levels as in Fig.1. Somewhat large error especially in September may be suggesting that it is difficult to apply the angular correction mentioned above over full range of scan angle θ(about 0 - 60°degree). Thus coefficients C° and η were seperately determined for two angle ranges, about 0 - 30 and 30 - 60°degree. The errors for this two angle range method are shown in Fig.4 being compared with single angle range method. It can be seen a significant improvement of accuracy is retained by the two angle range method.

4. REFERENCES

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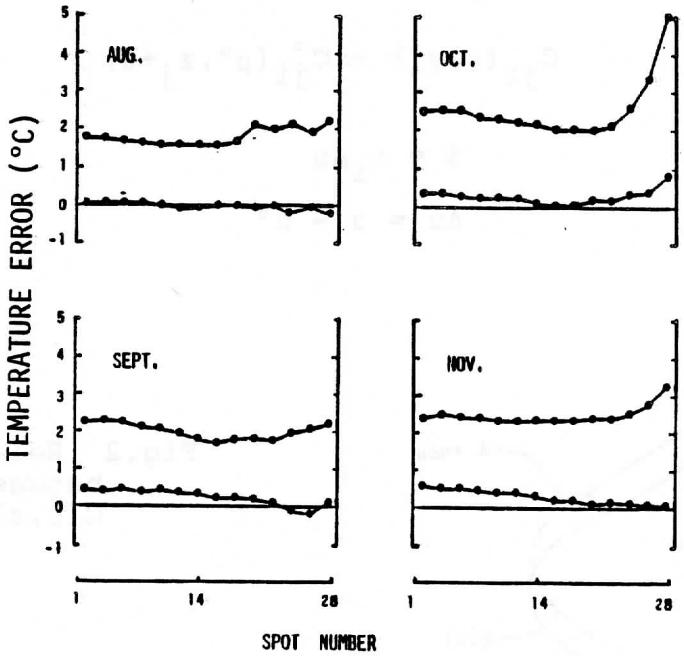

Fig.3 Dependence of rms(white circle) and mean(solid circle) errors of retrieved vertical temperature averaged over 14 pressure levels on the relative spot number, [|N-28.5|+0.5], with N the ordinary HIRS scan spot number.

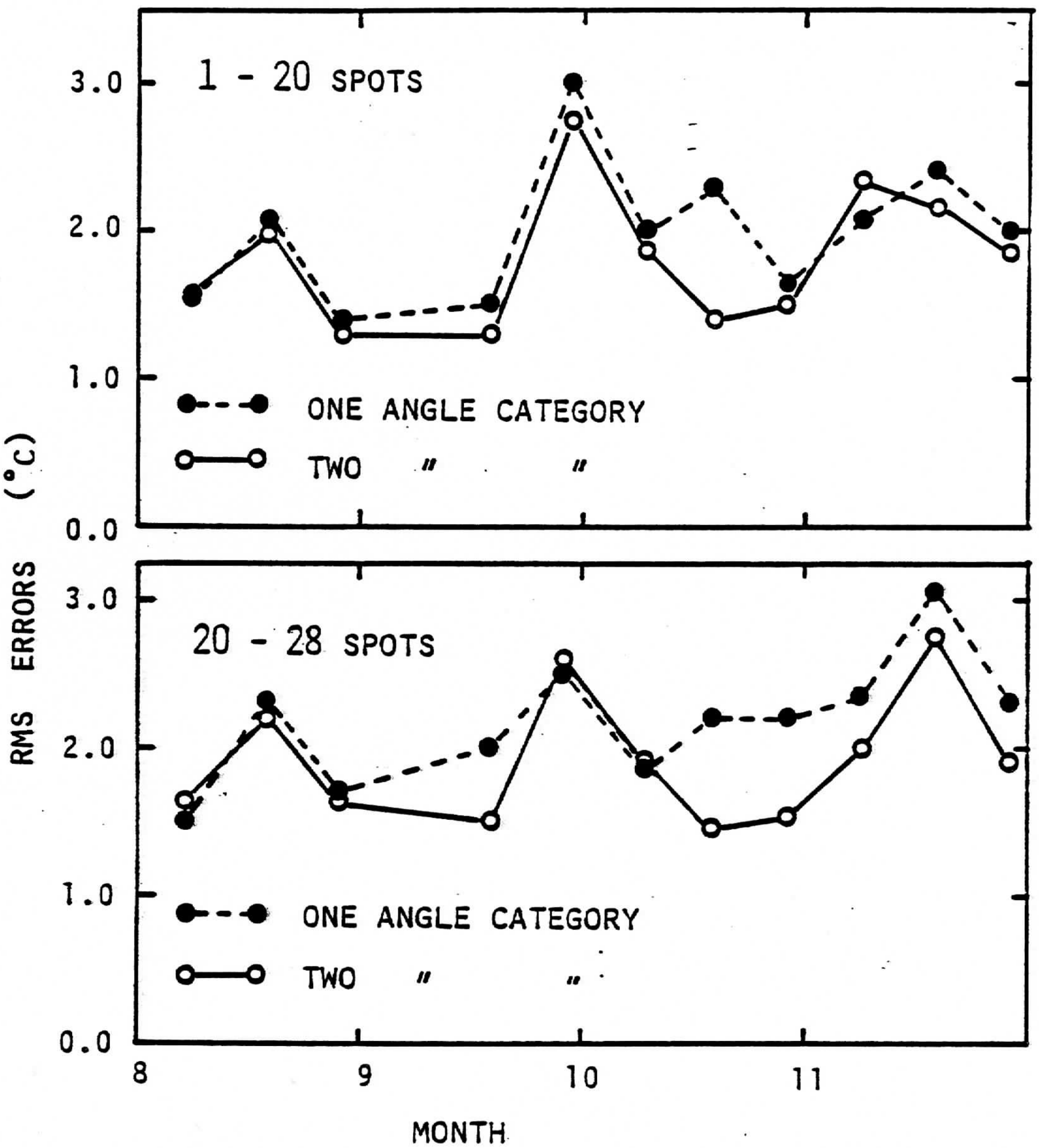

Fig.4 Comparison of rms errors for one and two angle categories. Upper part is for HIRS relative spot number 1-20 and lower is for 20-28.

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