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THE CORRELATION AND COVARIANCE OF SIRS-SONDE
THICKNESS MEASUREMENT DIFFERENCES FOR CERTAIN
PARTIAL THICKNESS BANDS

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THE CORRELATION AND COVARIANCE OF SIRS-SONDE THICKNESS MEASUREMENT DIFFERENCES FOR CERTAIN PARTIAL THICKNESS BANDS.

ABSTRACT

Differences in thickness measurements made by SIRS and colocated radiosondes were examined to determine the correlation and covariance between SIRS-sonde thickness differences for different partial thickness bands.

INTRODUCTION

Correlations and covariances of SIRS-sonde thickness differences can be used to infer various properties of SIRS soundings themselves, and this knowledge can be used to simulate the effects of adding SIRS data to various analysis schemes. It should also allow workers to adopt the most suitable grid spacing etc in forecast models which use SIRS data to supplement meteorological data obtained by more conventional methods.

RESULTS

A radiosonde ascent was colocated with a SIRS sounding if it was no more than the equivalent of 1.5° of latitude distant (ie about 170 km) and the ascent made within 2 hours of the SIRS sounding. Where a given radiosonde station satisfied the distance requirement, but failed to satisfy the time requirement, SIRS sounding was colocated with a synthesised radiosonde "ascent" which was a weighted mean with respect to time of the 0Z and 12 Z ascents for that particular station.

The results shown here are for the following partial thickness bands:-

| | | |
|---------------|---|---------|
| 1000 - 700 mb | - | band 1 |
| 700 - 500 mb | - | band 2 |
| 500 - 300 mb | - | band 3 |
| 300 - 100 mb | - | band 4 |
| 100 - 50 mb | - | band 5 |
| 50 - 30 mb | - | band 6 |
| 30 - 10 mb | - | band 7, |

and the period covered is 22/8/75 to 31/12/75 during which time 371 suitable colocations (ie both profiles complete up to and including 10 mb) were gathered.

Table 1 shows the covariance of the thickness differences, σ_{ij} , of band i with bank j.

Table 2 shows the correlation of the (SIRS-sonde) thickness difference, r_{ij} , for band i with band j.

Table 3 shows a t matrix of the statistic t_{ij} where:-

$$t_{ij} = \frac{r_{ij} \sqrt{n-2}}{1 - r_{ij}^2}$$

where r_{ij} is as in table 2 and n is the number of differences used. For $n = 371$, t_{ij} is approximately normally distributed, and can be used to determine the degree of significance of the various r_{ij} . (For $|t_{ij}| > 1.96$, r_{ij} is significant at the 5% level, for $|t_{ij}| > 2.58$, r_{ij} is significant at the 1% level.)

Table 4 shows the mean (SIRS-sonde) thickness difference for each thickness band.

TABLE 1

Covariances of SIRS-sonde thickness differences for bands i and j.

| Thickness | | 1000-700 mb | 700-500 mb | 500-300 mb | 300-100 mb | 100-50 mb | 50-30 mb | 30-10 mb |
|-------------|------|----------------|---------------|---------------|---------------|--------------|-------------|-------------|
| | Band | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1000-700 mb | 1 | 4.73 | 1.49 | 0.39 | -0.59 | 0.03 | 0.25 | -2.80 |
| 700-500 mb | 2 | 1.49 | 3.71 | 1.11 | -2.50 | 0.72 | 0.14 | -0.98 |
| 500-300 mb | 3 | 0.39 | 1.11 | 7.89 | -2.05 | -0.22 | 2.06 | 4.51 |
| 300-100 mb | 4 | -0.59 | -2.50 | -2.05 | 28.32 | 0.78 | 1.99 | 1.09 |
| 100- 50 mb | 5 | 0.03 | 0.72 | -0.22 | 0.78 | 30.05 | 2.56 | -19.26 |
| 50- 30 mb | 6 | 0.25 | 0.14 | 2.06 | 1.99 | 2.56 | 11.00 | 5.40 |
| 30- 10 mb | 7 | -2.80 | -0.98 | 4.51 | 1.09 | -19.26 | 5.40 | 93.94 |

TABLE 2

Correlations between SIRS-sonde thickness differences

| Thickness | | 1000-700 mb | 700-500 mb | 500-300 mb | 300-100 mb | 100-50 mb | 50-30 mb | 30-10 mb |
|-------------|------|----------------|---------------|---------------|---------------|--------------|-------------|-------------|
| | Band | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1000-700 mb | 1 | 1.00 | 0.36 | 0.06 | -0.05 | 0.00 | 0.03 | -0.13 |
| 700-500 mb | 2 | 0.36 | 1.00 | 0.20 | -0.24 | 0.07 | 0.02 | -0.05 |
| 500-300 mb | 3 | 0.06 | 0.20 | 1.00 | -0.14 | -0.01 | 0.22 | 0.17 |
| 300-100 mb | 4 | -0.05 | -0.24 | -0.14 | 1.00 | 0.03 | 0.11 | 0.02 |
| 100- 50 mb | 5 | 0.00 | 0.07 | -0.01 | 0.03 | 1.00 | 0.14 | -0.36 |
| 50- 30 mb | 6 | 0.03 | 0.02 | 0.22 | 0.11 | 0.14 | 1.00 | 0.17 |
| 30- 10 mb | 7 | -0.13 | -0.05 | 0.17 | 0.02 | -0.36 | 0.17 | 1.00 |

TABLE 3

t matrix of significance of correlations in table 2

| Thickness | | 1000-700 mb | 700-500 mb | 500-300 mb | 300-100 mb | 100-50 mb | 50-30 mb | 30-10 mb |
|-------------|------|----------------|---------------|---------------|---------------|--------------|-------------|-------------|
| | Band | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1000-700 mb | 1 | 0.0 | 7.84 | 1.23 | -0.98 | 0.04 | 0.65 | -2.60 |
| 700-500 mb | 2 | 7.84 | 0.0 | 4.10 | -4.99 | 1.32 | 0.41 | -1.02 |
| 500-300 mb | 3 | 1.23 | 4.10 | 0.0 | -2.68 | -0.28 | 4.47 | 3.28 |
| 300-100 mb | 4 | -0.98 | -4.99 | -2.68 | 0.0 | 0.51 | 2.20 | 0.41 |
| 100- 50 mb | 5 | 0.04 | 1.32 | -0.28 | 0.51 | 0.0 | 2.76 | -8.02 |
| 50- 30 mb | 6 | 0.65 | 0.41 | 4.47 | 2.20 | 2.76 | 0.0 | 3.32 |
| 30- 10 mb | 7 | -2.60 | -1.02 | 3.28 | 0.41 | -8.02 | 3.32 | 0.0 |

Note t_{ii} has been nominally set to zero

Note: Some authors suggest $t' = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$ should be used instead of $t = \frac{r\sqrt{n-2}}{1-r^2}$. Since $t = \frac{t'}{\sqrt{1-r^2}}$, t will indicate that a given correlation coefficient is more significant than t' would indicate. However, as most of the correlation coefficients discussed here are small the difference will not be great.

TABLE 4

Mean (SIRS-sonde) thickness differences for
each partial thickness band

| THICKNESS | BAND | MEAN | S.D |
|-------------|------|-------|-----|
| 1000-700 mb | 1 | 0.7 | 2.2 |
| 700-500 mb | 2 | 0.1 | 1.9 |
| 500-300 mb | 3 | 0.3 | 2.8 |
| 300-100 mb | 4 | - 1.3 | 5.3 |
| 100- 50 mb | 5 | - 0.9 | 5.5 |
| 50- 30 mb | 6 | - 0.5 | 3.3 |
| 30- 10 mb | 7 | 3.6 | 9.7 |

Conclusions

The numerical values of the individual correlations obtained by comparing (SIRS-sonde) thickness differences for different thickness bands are low. However, by consulting the table of t_{ij} it can be seen that 11 of the 21 possible distinct intercomparisons give rise to correlations which are significantly different from zero at better than the 1% confidence level. Of these 11 significant correlations, 5 are between contiguous thickness bands, with only one pair of contiguous thickness bands showing a non-significant correlation. Significant correlations between contiguous thickness bands are not unexpected due to the breadth of the SIRS weighting functions. Only 5 of the 15 possible comparisons using non-contiguous thickness bands exhibited correlations significant at the 1% level and 1 significant at the 5% level, showing that, in general, as the thickness bands compared are more widely separated, the correlations become less significant.

Some similar work was carried out using the same data, but with smaller partial thickness bands. This confirmed the above results, but with higher correlations

between contiguous thickness bands as expected. Again the correlations between thicknesses decreased as the separations between the bands increased. In both pieces of work, contiguous thicknesses exhibited larger correlations in the lower part of the atmosphere.

It has been suggested that there is a possibility that SIRS soundings are processed differently above and below 100 mb, and it is interesting to note that the only two contiguous thicknesses where the (SIRS-sonde) differences are not significantly correlated are the 300-100 mb thickness and the 100-50 mb thickness. However a more probable explanation for this lack of correlation is the fact that the tropopause lies in the 300-100 mb thickness band, making (SIRS-sonde) thickness differences rather unpredictable in that band.

Table 4 shows that a change of sign from positive to negative occurs in the mean (SIRS-sonde) thickness difference for the 300-100 mb thickness. This is probably caused by SIRS tending to smooth the tropopause somewhat.

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