Correction of the Interferometer Phase for the Altitude Difference Effect

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Clark (1964) has described how a phase delay is introduced into the interferometer output because the telescopes are at different heights above sea level. A correction for this effect of 19.6 sec Z, where Z is the zenith distance, has been made in the DDP 116. Such a correction is appropriate for a cool dry day. I have attempted to include a more detailed correction in the 360 program IEDIT, by using the meteorological data available in the A/D records.

The outside temperature TDRY, the dew point temperature TDEW, and the atmospheric pressure PMB are found in words 35, 36, and 37, respectively, of the analogue-digital record. I have calibrated these lines on the basis of measurements during the week November 20-27, 1967, in which TDRY varied from +13° to -11° C, TDEW from +3° to -12° C, and PMB from 927 to 908 mbar. If the output of the appropriate line is V volts, then

$$\text{TDRY} = -19.32 * V(35) + 214.26 \ ^\circ\text{K}$$

$$\text{TDEW} = -19.34 * V(36) - 59.86 \ ^\circ\text{C}$$

$$\text{PMB} = -37.13 * V(37) + 817.0 \text{ millibar}$$

The relationship between the dewpoint temperature and the water vapour pressure is approximately $T \alpha \ln p$. I have approximated the detailed relationship (cf. reference 3) as follows:

$$\text{For TDEW} \geq 10 \quad p = \exp((\text{TDEW} + 33.5)/17.34)$$

$$\text{TDEW} < 10 \quad p = \exp((\text{TDEW} + 22.8)/13.1)$$

Then, the refractive index is given by (cf. Beam & Dutton)

$$10^6(n - 1) = \frac{77.6}{TDRY} \left(PMB + \frac{4810}{TDRY} [p]\right)$$

The altitude difference is obtained directly from the baseline parameters. Thus if ϕ is the latitude, then

$$\frac{\Delta H}{\lambda} = \sin \phi * BZ + \cos \phi * BX$$

and $$\cos Z = \sin \phi \sin \delta + \cos \phi \cos \delta \cos H,$$

where Z is the zenith distance, H the hour angle, and δ the declination of the source.

Finally, the phase errors, in radians, for correlators one and two, are given by the expression

$$\Delta\Theta = 2\pi \left(\frac{\Delta H}{\lambda} * (n - 1) - \frac{19.6}{360} \right) \Big/ \cos Z$$

and for the third correlator,

$$\Delta\Theta = 2\pi \frac{\Delta H}{\lambda} (n - 1) \Big/ \cos Z$$

where the expressions for $\frac{\Delta H}{\lambda}$ and $(n - 1)$ are as above. The corrected interferometer phase is then

$$\Theta_{corr} = \Theta_{116} - \Delta\Theta$$

References

1) Clark, B.G. "Refraction" NRAO Report, December 1964.

2) Bean, B.R. and Dutton, E.J. Radio Meteorology, National Bureau of Standards Monograph 92.

3) Berry, F.A., Bollay, E., and Beers, N.R. 1945 Handbook of Meteorology, p. 70.