Refraction

1. The Altitude Difference Effect. A plane parallel layer of atmosphere inserted in front of the interferometer introduces the same phase change in one element as in the other. However, if the telescopes are not at the same height above sea level, there is a layer of air in front of the lower telescope which is not in front of the upper. If the southern telescope is H meters lower than the northern, an additional delay of $(n-1)\frac{H}{\lambda}\sec Z$ is introduced into the southern arm of the interferometer. The interferometer function becomes

$$(f(H,\delta) = \cos\{2\pi\frac{D}{\lambda}(\sin d \sin\delta + \cos d \cos\delta \cos(H-h) + a + 2\pi\frac{H}{\lambda}(n-1) \sec Z\}$$

then, for point source with d, δ, h, α well known

$$\Phi = a + 2\pi \frac{H}{\lambda}(n-1) \sec Z$$

so the calculated Φ's should be corrected by $-2\pi (n-1) \frac{H}{\lambda} \sec Z$

for H = 30 m, λ = 10 cm, p = 920 mb, T = 280°K and relative humidity = 50%, this term is 30° sec Z. The variation of this coeff from a hot and muggy summer day, T = 310°, relative humidity = 80% to a cold dry winter day T = 270°, relative humidity = 10% is from $46^\circ\frac{1}{2}$ to $28^\circ\frac{1}{2}$, a factor of more than $1\frac{1}{2}$, most of which is due to the amount of water vapor in the air. To sufficient accuracy,

$$n-1 = 10^{-4}\,(2.55 + 0.30\, e^{0.064\, T_w})$$

where T_w is the wet bulb temperature in °C. It would be nice if a wet bulb thermometer could be installed somewhere high on the structure of 85-2, as that is the air layer in question. For reference, the machine may wish to generate internally

$$H/\lambda = \sin \Phi \, B_1 + \cos \varphi \, B_2 \cos h$$

where φ is the latitude.

Of course

$$\cos Z = \sin \varphi \sin \delta + \cos \varphi \cos \delta \cos H.$$

2. <u>The Spherical Term</u>.

To sufficient accuracy, the total phase delay in the atmosphere is

$$\Delta\varphi = \Delta\varphi_o \sec Z$$

where

$$\Delta\varphi_o = \frac{2\pi}{\lambda} \int_o^\infty (n-1) \, dh$$

$$\sec Z_{85-2} = \sec Z_{85-1} + \sec^2 Z[(\cos \varphi \sin \delta - \sin \varphi \cos \delta \cos H)$$

$$(\varphi_{85-2} - \varphi_{85-1}) - \cos \varphi \cos \delta \sin H(\ell_{85-2} - \ell_{85-1})]$$

where ℓ is longitude. If A is the azimuth of the baseline, and R the radius of the earth, an additional delay of

$$\Delta\varphi = \Delta\varphi_o \sec^2 Z \frac{D}{R}[-(\cos \varphi \sin \delta - \sin \varphi \cos \delta \cos H) \cos A$$

$$- \cos \delta \sin H \sin A]$$

is introduced in 85-2.

For dry air

$$\Delta\varphi_o \frac{D}{R} = 1^\circ\!.15 \, D \text{ for } D \text{ in Km.}$$

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