information for "A World Atlas of Atmospheric Radio Refractivity" (Bean et al., 1966) are also included as Appendix D.

3. DATA PRESENTATION

Scale. Each graph has a dual scale on the ordinate to show both the refractivity gradient in N-units/km and the equivalent effective earth radius factor, "k", which is used to compensate for ray bending in terrain profile analysis of radio links. The factor "k" is related to the refractivity gradient $\Delta N/\Delta h$ in N-units/km by

$$k \simeq \left[1 + 6370 \frac{\Delta N}{\Delta h} \times 10^{-6}\right]^{-1}$$

where 6370 km represents the actual earth radius (Dougherty, 1968).

Time. Prior to 1957 the standard time of RAOBs was 0300Z and 1500Z; since then it has been 0000Z and 1200Z. In this report, all times of observation have been converted to an arbitrary "Local Standard Time" (LST) based on the assumption of zones exactly 15 degrees wide and centered on longitudes of 0°, 15°, 45°, etc. Figure 1 has a scale for comparing the local time of observation with the standard 0000Z and 1200Z observations based on the local time on the Greenwich meridian.

Refractivity Distributions. Unless otherwise indicated, the graphs show the cumulative distribution of the radio refractivity gradients in the ground-based 100-m layer, as calculated from radiosonde observations during the period specified under "Data". The analyses are by ITS, except where other agencies or individuals are referenced below the graph.

Each curve shown is based on all observations in a particular month for the period indicated, and includes data obtained from observations at more than one time of day, if available. For Aden and Nicosia, however, the data were analyzed separately for the different times of observation, and additional graphs are presented which indicate the characteristic differences between observations at different times of day at these stations. For shorter periods, diurnal characteristics are also shown for Calcutta, Clark Field, Tampa, and Tan An.

Three month's data were used in the analyses for each season for Gibraltar, La Coruña, and Palma, and gradients were calculated for the layer between the surface and the next data point on the individual RAOB rather than for the standard 100-m layer. Thus, the layer thickness varied from observation to observation. A study of the sub-refractive gradients included in these data showed that this surface-based layer was always less than 200 meters thick, and more than 50% of the layers were between 60 and 140 meters thick. Thus these analyses probably give a reasonably good indication of the type of gradients likely to occur in a 100-m layer. A similar analysis is shown for Madrid, in addition to the conventional 100-m analysis, but note that the data periods are different.

The distributions for Hannover, Stuttgart, and Brussels are based upon data for all months of the periods indicated, and include two observations per day. The Gross Rohrheim data were obtained from a 60-m meteorological tower equipped with psychrometers for measuring temperature and humidity.

The data for Long Xuyen were obtained with a "high resolution" radiosonde technique, which uses slow-rising balloons and transmits temperature and humidity data simultaneously (rather than in the alternately switched mode of the standard RAOB).

The Cardington data were obtained from psychrometer measurements using a tethered balloon, and show clearly the change in gradient probability as the layer thickness is varied.

Climatic Data. To simplify the presentation, no references are cited on the individual station entries, but the climatic data sources are included in the list of references. The English units used in the source documents have been retained, since the user of this report is likely to be most familiar with climate in such terms.

The following are listed for most stations:

Temperature	-	the average daily maximum and minimum for January and July.*
Mean Dewpoint	-	the mean dewpoint temperature at the surface for January and July.
Precipitation	-	the average annual total, and the average monthly total of the wettest and driest months.

At the ship stations, the "average" temperature is listed, i.e., the average of daily maximum and minimum readings. The dewpoint entry has been omitted at a number of locations where the data were not available. A brief description of the station location is given, and also a general climatic classification. These climatic data are intended only for preliminary comparisons of stations in different climatic regions; reference should be made to more complete climatic analyses when applying the refractivity data to performance estimates or link design.

4. DISCUSSION

The graphs show the percentage of the observations in which various refractivity gradients were found in the lowest 100 meters; they do not indicate the percentage of time in a year that such gradients can be expected. Although the latter statistics are desired for propagation and system performance estimates, the available data are insufficient to make such a determination. The radiosonde package rises through the lowest 100-m layer in less than 30 seconds, and this only twice a day at most stations. Thus, we have available two very brief samplings of atmsopheric structure daily, rather than frequent or continuous measurements. It seems unlikely that the extremes of the diurnal gradient variation would always occur at 0000Z and 1200Z (or 0300Z and 1500Z), therefore the refractivity gradient statistics based on RAOBs can be assumed to show a lower probability of occurrence of the extreme gradients than would be the case if observations were made hourly.

*Note that these are not the extremes for the period of record; for example, at Denver the average daily maximum and minimum temperatures in January are 42° and 15°F, but the extreme (or record) values for the month are 69° and -25°F.