COORDINATION PROCEDURE FOR RADIO RELAY AND COMMUNICATION SATELLITE SERVICES

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When the communication satellite service was established in the early 1960s, the frequency bands allocated were shared in common with the microwave relay service, which is the widespread network of terrestrial microwave line-of-site links. The problem of interference between receivers and transmitters of the microwave relay service on the ground and the communication satellite service was anticipated; and rules, called siting criteria, were established for siting ground stations.

In 1963 at the International Telecommunications Union Extraordinary Administrative Radio Conference, the sharing criteria for these services was based on the then available propagation data, which considered only troposcatter and ducting type mechanisms. The very important mechanism of rain scatter was not well enough in hand, and because of this technology gap the drafters of the regulations omitted precipitation-scattered interference from inclusion in the regulations.

It was anticipated that at the next World Administrative Radio Conference in 1971 the procedures would be updated. The Office of Telecommunications Policy in 1968 requested that NASA establish a large program to develop the models and perform the experimental verification to demonstrate that the models were correct, so that there could be such a modification of the siting criteria.

Figure 1 shows how this is handled. The siting criteria, which includes rain, is quantitatively described by a coordination distance. This is a contour around a ground station, such that relay links outside this contour are unlikely to provide interference signals above some desired level for a given percent of the time.

The ingredients in this "rain" coordination procedure which was established required a rain storm cell size, a statistical description of the rainfall rate within the cell valid for most of the earth's surfaces. Also required was the use of certain approximations, for instance, Rayleigh scatter, constancy of the precipitation with altitude, and an analytic relation between radar reflectivity and rain rate.

One of the very important parts of the coordination procedure model was the global rain rate statistic model. This was the key to linking the propagation statistics to measurable meteorological statistics. Data from ten years and 67 National Weather Service rain gauge network stations were statistically analyzed. We found that we could divide the United States into five climate regions, based on total yearly rainfall, number of thunderstorm hours per year, and so on.

When we extended this model globally, we divided the world, as seen in Figure 2, into the five types of climate regions where the parameters were the same as in the U.S. Finally, in each climate region, numbered 1, 2, 3, 4, 5, you see the surface rainfall for clock-minute surface rainfall rates in millimeters per hour, versus percent of the time in which that rainfall rate is exceded.

In Figure 3 I've shown a typical plot from the coordination procedure as it was adopted at the World Administrative Radio Conference last year; this is for Rain Climate Region 2, which is the one we live in. Frequency is along the abcissa. The parameter shown on the curves is the transmission loss; and the coordination distance required for this frequency is shown on the ordinate.

Hearings are being held by the FCC for the procedure's adoption into the domestic satellite regulations; Office of Telecommunications Policy is considering adopting this for the Department of Defense Systems.

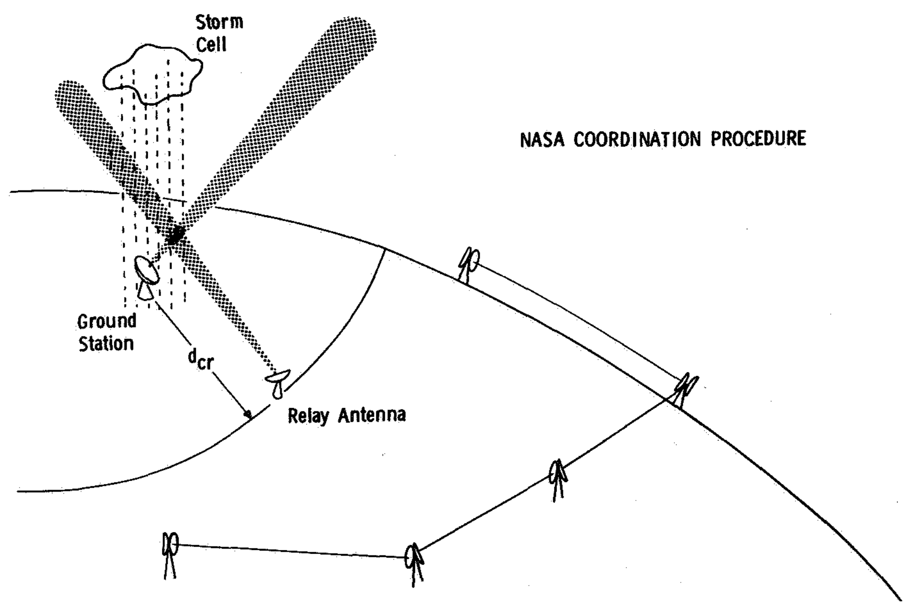
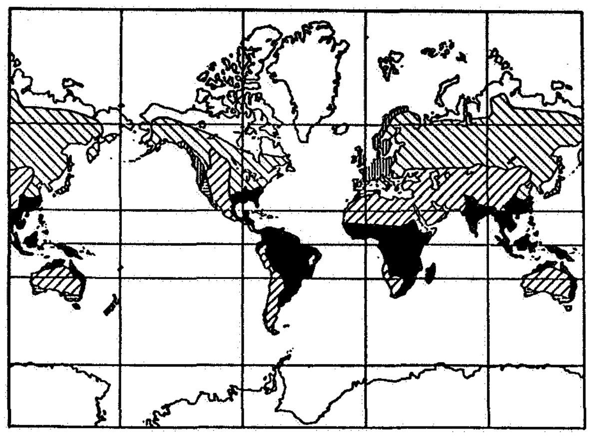


Figure 1. A coordination procedure which includes the effect of precipitation was developed in an extensive program by NASA at the request of OTP. This procedure has been adopted by the WARC.



Regions corresponding to rainfall rate distributions of Fig. 3

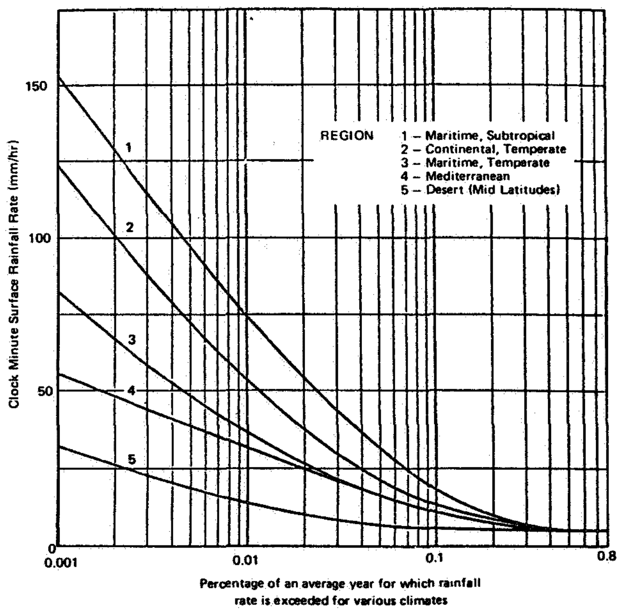


Figure 2. This global rainfall statistics model is an important element of the model on which the coordination procedure was based.

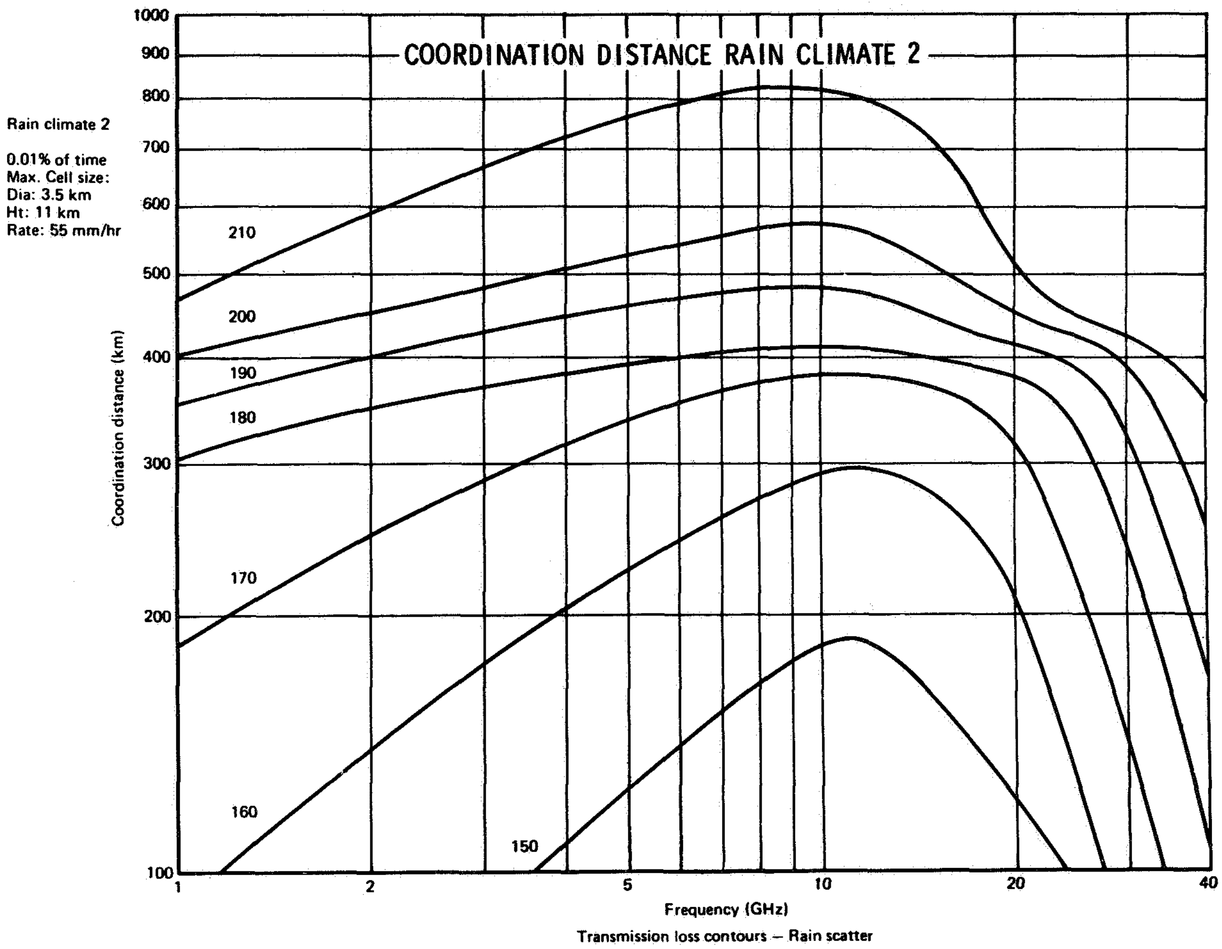


Figure 3. The analytical procedure upon which the coordination procedure was based is conservative, resulting in reduced chances for interference between services.