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ACTS PROPAGATION CONCERNS, ISSUES, AND PLANS

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ACTS counters fading by resource sharing between the users. It provides a large margin only for those terminals which are at risk by unfavorable atmospheric conditions. A moderate power margin, known as the clear weather margin, is provided to all active users. Each user monitors one of the ACTS beacons continually to assess atmospheric conditions. If a severe reduction in the received beacon power is detected, the network master control station (MCS) is notified via orderwire channels. The MCS responds by instructing the terminal to reduce its bit rate and invoke coding. The MCS will also notify the terminal at the other end of the link as well as the satellite on-board processor. Both measures reduce the error rate in the data flow caused by atmospheric fading. ACTS, as an experimental satellite, provides a 5-dB clear weather margin and 10-dB additional margin via rate reduction and encoding. For the uplink, this margin may be increased by exercising uplink power control.

In achieving these goals, the radiowave propagation community faces a number of challenges. Among them are:

A) The 5-dB clear weather margin will be used for fade condition detection. Is this margin sufficient? Could we reduce this margin? For example, if our research shows that this margin can be reduced to 2 dB, a power saving of approximately 50% will result. This results in substantial reductions in cost for operational systems.

B) To invoke fade countermeasure, the system must determine that a fade is imminent. A conservative approach (delayed decision) will prove detrimental to the link experiencing a fade, whereas, overreaction can overburden an operational system. Hence, we need to develop techniques which can accurately predict fades in real time. Figure 1 depicts two fade scenarios that require two different responses. This figure shows the received signal power as a function of time (note that the time scale has been intentionally left out). The solid line shows a fade which requires a system response to counter the effect of fading, whereas, the dashed line shows a fade which does not require a system response. A 5-dB margin is also marked on Figure 1.

C) To facilitate the resource sharing feature of ACTS, nation-wide fade statistics are needed.

Our studies will focus on two issues: general needs and ACTS-specific needs. The general needs include:

A) Propagation data for VSAT with small power margin

B) Propagation data on short-term fades and fade slope

C) Fade countermeasure techniques

D) Nation-wide fade statistics

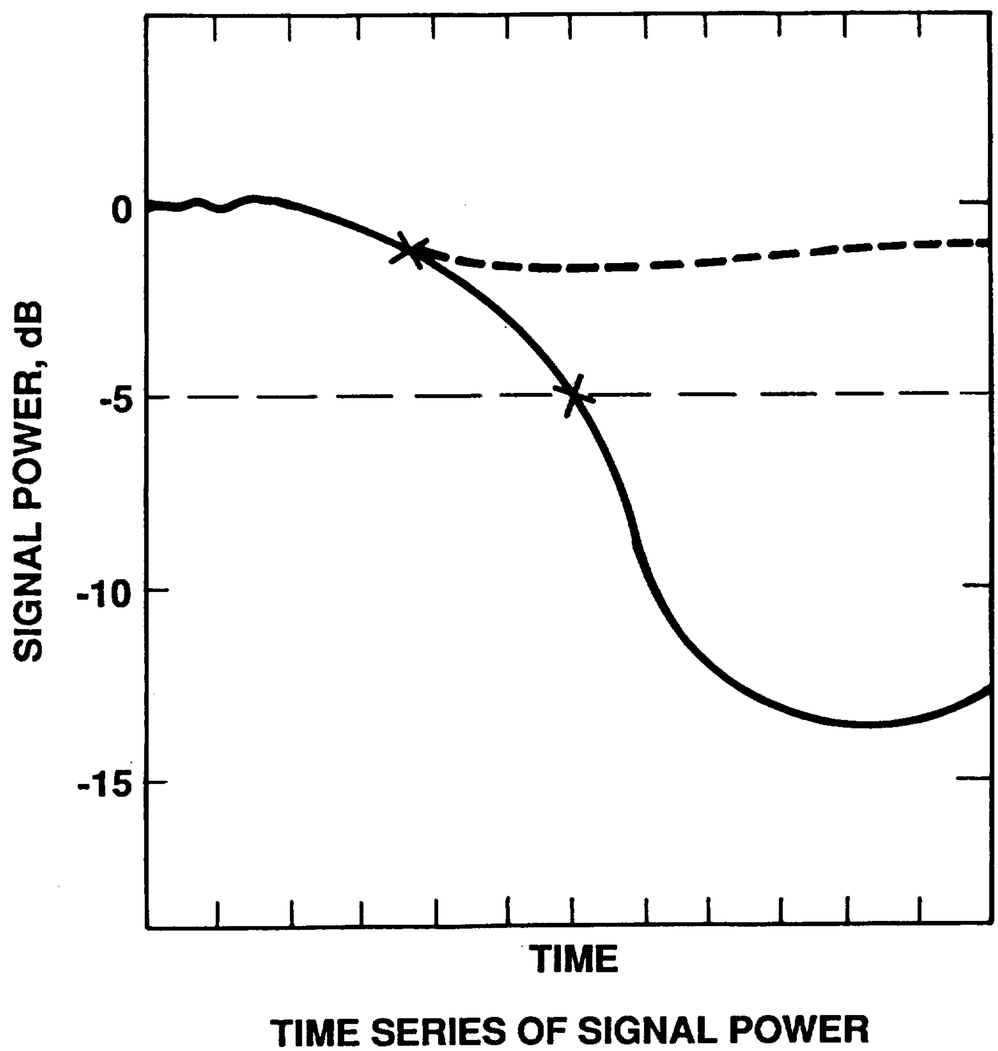


Figure 1. Fade Dynamics

To address ACTS-specific needs, an environment will be cultivated wherein propagation experts can develop, test and refine their models and schemes in a unified fashion. Furthermore, advice and assistance will be given to ACTS users.

What is required in the context of ACTS propagation needs is a convenient environment that propagation experts can conduct propagation studies. This environment should provide the experts with statistically significant observations. Data must be taken in climatologically diverse areas for long time durations. Fade countermeasure schemes must be tested thoroughly. Data collected and analyzed by different centers must be presented with a uniform and consistent format. ACTS experimenters in other areas, i.e., communications, data transmission, protocol, etc., should not be burdened with propagation issues. ACTS users should be able to receive advice and assistance from the ACTS propagation experimenters group. This must be performed in a manner convenient to ACTS users. Although many propagation research centers will participate in this task, a single organization must oversee the effort for cohesiveness of the endeavor.

NASA's Propagation Program is organizing a cohesive effort to respond to ACTS propagation needs. Our plans call for the development of low-cost propagation terminals consisting of beacon receivers, radiometers, and data acquisition systems, which will be loaned to different research centers and universities for data collection and analysis. The Propagation Program has already begun this effort by participating in the Olympus experiment, which is described in the article by Professor Stutzman of Virginia Tech. Table 1 shows the chronological order of events.

Table 1. Chronological Order of Events

Year	Activity
1989	Construct beacon receivers, radiometers, and a data acquisition system for the OLYMPUS experiment
1990	Perform OLYMPUS propagation experiments and collect data
	Design and build a prototype ACTS beacon receiver system
	Build a CODE* terminal
1991	Complete the OLYMPUS experiments
	Evaluate ACTS prototype propagation terminal using OLYMPUS
	Build 8 to 10 ACTS propagation terminals
1992	Start ACTS experiments

*CODE is an acronym for the cooperative OLYMPUS data exchange, a feature which allows an experimenter to exchange data with other OLYMPUS experimenters.

A reasonable question to ask is where should the ACTS propagation terminals be placed. In attempting to answer this question, we note that although ACTS beacons are received anywhere in the U.S. mainland, the spot beams are not available everywhere. To enjoy the potential benefits of proximity to a communications terminal, one may suggest to place the propagation terminals where communications coverage is also available. Of course, selecting a site based on spot beam availability alone is hardly a sufficient reason. Therefore, we note the Global Rain Climate map of the U.S., which includes an overlay of ACTS coverage areas as depicted in Figure 2. The map in Figure 2 is a clue for the answer to the above question.

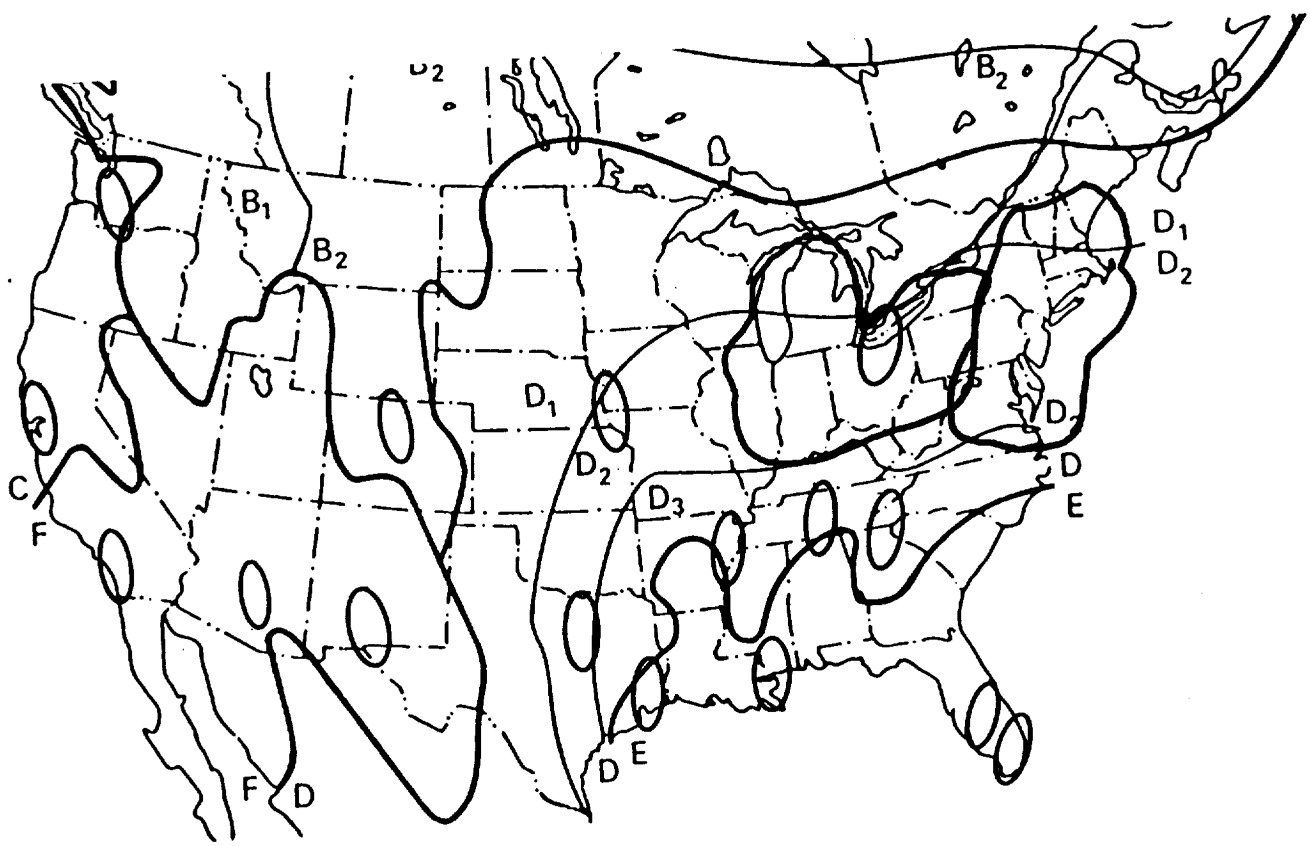
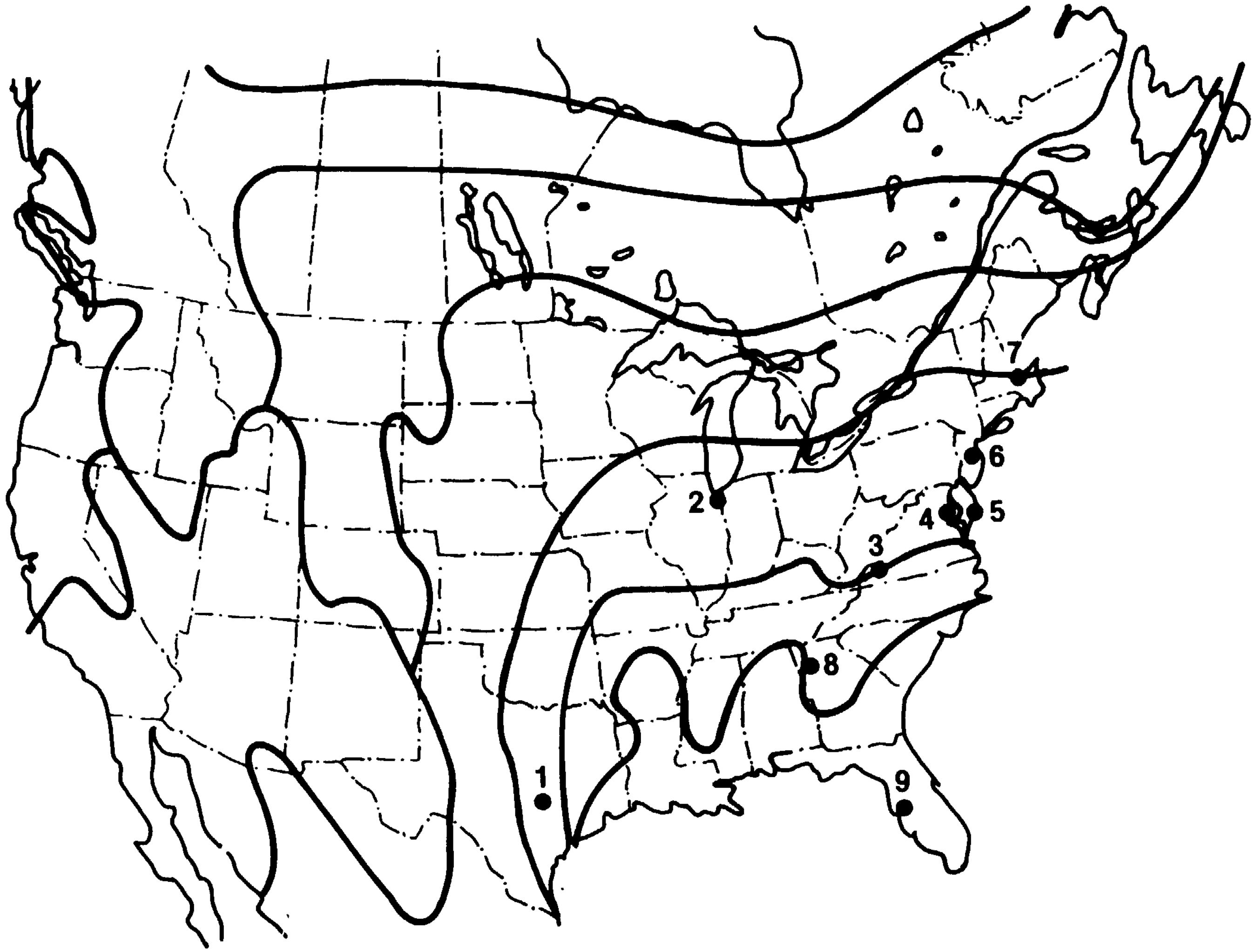


Figure 2. Rain Rate Regions for the Continental U.S.: Crane Global Model, 1980

However, before selecting the locations for ACTS propagation terminals we need to consider one more parameter, namely the existing propagation data. For this purpose, we may refer to Figure 3, where the 20/30-GHz data availability in the U.S. is shown. Figure 3 reveals that most of the past data were taken at the east coast and the south. There are no data available from the west, southwest, north, and the Rockies. Hence, we need to make sure that the areas that lack propagation data receive attention.



LEGEND:

1. AUSTIN, TX
2. GRANT PARK, IL
3. BLACKSBURG, VA
4. CLARKSBURG, MD
5. WALLOPS ISLAND, VA
6. HOLMDEL, NJ
7. WALTHAM, MA
8. PALMETTO, GA
9. TAMPA, FL

Figure 3. 20/30-GHz Data Availability

With considerations given to Figures 2 and 3, a suggested set of locations for placing ACTS propagation terminals emerges. Table 2 shows these locations. Note that according to the Global Rain-Zone Model there are 8 rain zones in the U.S. Table 2 suggests one terminal per rain zone with the exception of zone D1, which is allotted two terminals. Also note that with the exception of the terminal in zone B1, all the other terminals are in areas that receive ACTS communications coverage.

The Propagation Program will sponsor a two-day workshop on ACTS propagation in Fall 1989. It is hoped that most of the issues addressed in this article will be discussed thoroughly in the workshop. The theme of the workshop is "Planning ACTS Propagation Studies, and Standardization of Propagation Data Collection and Reduction."

Table 2. Suggested Set of Locations Using Crane's Zones

Zone	Location	Number of Stations
B1	Idaho	1
B2	Denver	1
F	Los Angeles/Phoenix/White Sands	1
C	San Francisco/Seattle	1
D1	New Hampshire/Michigan	2
D2	Blacksburg	1
D3	Atlanta	1
E	New Orleans/Tampa/Miami/Houston	1
	Total	9