The ACTS propagation experiment discussion included participants from several companies and universities. As part of the discussion, the following two papers were presented and are included in these proceedings:

Ka-BAND PROPAGATION MEASUREMENTS USING THE ACTS PROPAGATION TERMINAL AND THE CSU-CHILL MULTIPARAMETER RADAR

V. N. Bringi
Colorado State University

SPACE COMMUNICATIONS TECHNOLOGY CENTER FLORIDA PROPAGATION PROGRAM

Henry Helmken
Florida Atlantic University

and

Rudy Henning
University of South Florida

Ka-band Propagation Measurements Using the ACTS Propagation Terminal and the CSU-CHILL Multiparameter Radar

Experimenters

Colorado State University
Department of Electrical Engineering
Ft. Collins, CO 80523

Principal Investigators

V.N. Bringi, Professor
V. Chandrasekar, Assistant Professor
Eugene A. Mueller, CSU-CHILL Radar

Joseph Turk, Research Associate
John Beaver, Ph.D. Candidate

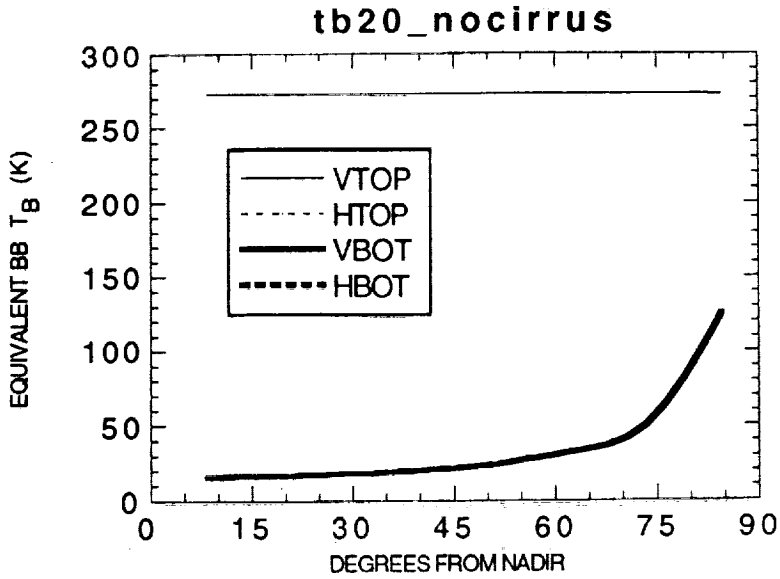
ACTS Propagation Studies Mini-Workshop
June 14, 1993

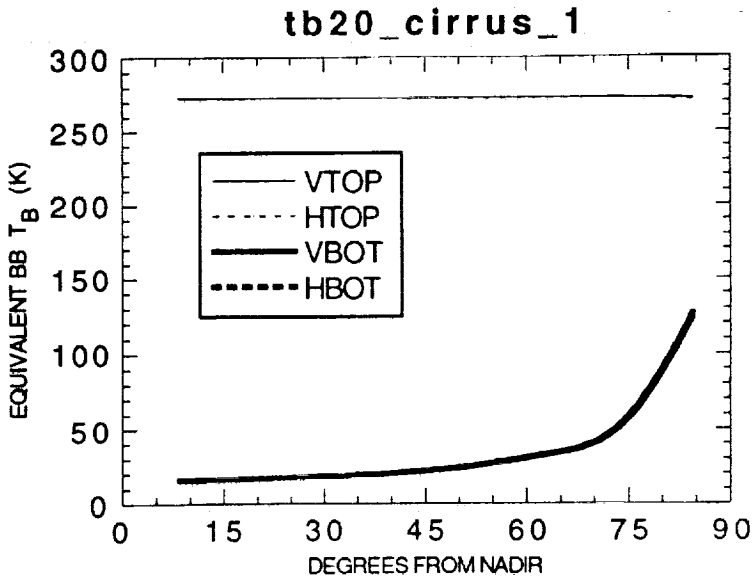
UPDATE AND NEW DEVELOPMENTS

- Proposed rooftop site on the University of Northern Colorado Earth Sciences Building will be re-roofed in August. We may set up the terminal at the CHILL radar site (10 km north) for testing in the summer and then re-install the system on the rooftop site in late August to be ready for the measurements period.
- New reflector to be installed on the CSU-CHILL radar by end of December 1993. This will provide better cross-polar performance and lower sidelobe levels. Installation involves radome removal and some disassembly during October and November.
- NCAR-FAA Winter Icing and Storms Project (WISP-94) field program from January-March 1994. Instrumentation includes NOAA radiometers and Ka-band polarimetric radar, research aircraft. Good opportunity to study ACTS propagation through winter storms.

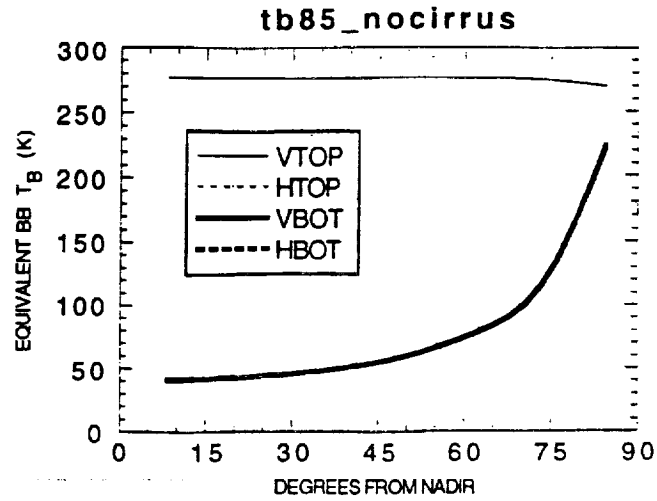
MICROWAVE RADIATIVE TRANSFER AND PROPAGATION MODELS

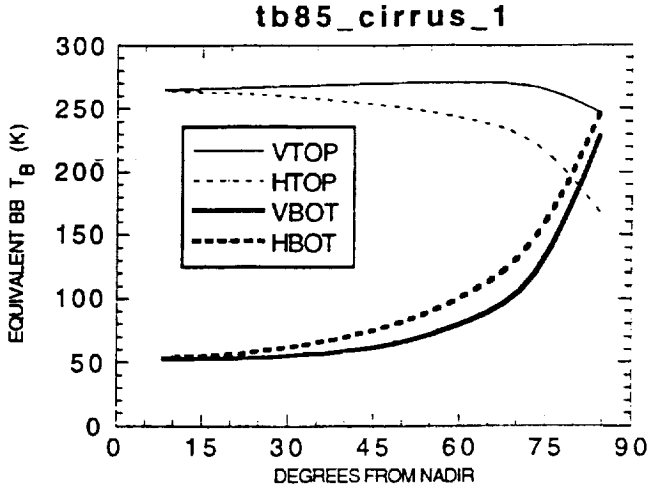
- We have completed development of a plane parallel, polarized radiative transfer model which employs different types of scatterers such as oblate raindrops, conically shaped graupel, ice needles, plates, and columns. The model outputs the up and down H and V T_B for any number of layers.
- We are working with colleagues at NCAR to complete the propagation model which will output the propagation parameters such as attenuation, depolarization, etc. for the same plane-parallel atmosphere as input to the radiative transfer model.
- These two models allow us to compare against the beacon attenuation and brightness temperature as measured by the ACTS station.
- With the CSU-CHILL polarimetric radar data, the vertical structure of the atmosphere can be inferred during rainy or snowy conditions, and this information will be used to initialize the propagation and radiative transfer models.

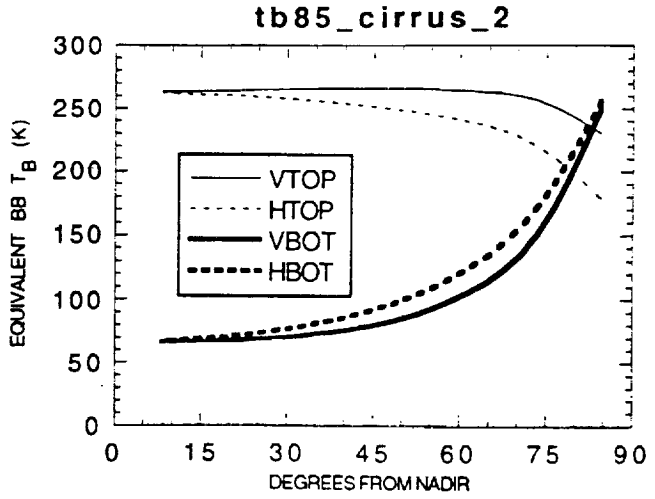




20 GHz up and down equivalent blackbody brightness temperatures T_B as a function of the angle from nadir. V and H refer to the vertical and horizontal T_B components. Top figure is for a standard atmosphere only. Bottom figure is for standard atmosphere + 2 km cirrus ice cloud with density 0.91 g/cm^3 placed between 10-12 km above a land surface. The cirrus cloud water content is fixed at 0.01 g/m^3, with an exponential size distribution of plate shaped particles.







85 GHz up and down equivalent blackbody brightness temperature T_B as a function of the angle from nadir. V and H refer to the vertical and horizontal T_B components. Top figure is for a standard atmosphere only. Middle figure is for standard atmosphere + 2 km cirrus ice cloud with density 0.91 g/cm^3 placed between 10-12 km above a land surface. Bottom figure depicts the case where 0.05 g/m^3 cloud liquid water is included within the cirrus cloud. In all cases the cirrus cloud ice water content is fixed at 0.01 g/m^3, with an exponential size distribution of plate shaped particles.

SPACE COMMUNICATIONS TECHNOLOGY CENTER

(SCTC)

FLORIDA PROPAGATION PROGRAM

HENRY HELMKEN
FLORIDA ATLANTIC UNIVERSITY (FAU)

&

RUDY HENNING
UNIVERSITY OF SOUTH FLORIDA (USF)

June 14, 1993

NASA PROPAGATION TERMINAL STATUS

* UNIVERSITY OF SOUTH FLORIDA
  - Tampa, Florida (28° N, 82.5° W)
  - Severe Weather Area
  - In ACTS Fixed Beam
  - Site of GTE TRIAD Experiments
  - Tampa to have NEXT Radar in Summer 1994.

* SITE LOCATION
  - Roof, USF Engineering Building
  - Site Preparations 75% Complete
  - 5 KW UPS Auxiliary Power Source on Campus

* TERMINAL EQUIPMENT
  - Delivered as of 6/21/93
  - Undergoing Assembly

ACTS CHANNEL CHARACTERIZATION

* GOALS
  - Compare Beacon Signal to 19 - 20 GHz ACTS Channel
  - Channel Amplitude and Phase Characterization
  - Evaluate High Data Rate Transmission Performance

* SIGNALLING
  - Construct Transportable Receive-Only Terminal
  - Transmit from LET Facility at LeRC
  - Assume Constant EIRP Downlink
  - Single and Multi-tone Signals
  - Amplitude and Phase Measurements at Receive Site

* PREPARE FOR ACTS COMPRESSED VIDEO EXPERIMENTS
  - Fade Depths, Rates and Durations
  - Develop Modem Interface to LET and RO Terminals
  - Test 45 Mb/s Fujitsu and EF DATA Modems
  - BER Measurements

FAU RECEIVE ONLY TERMINAL

* SINGLE TONE MEASUREMENTS
  - MSM Linearity Measurements
  - MSM Intermodulation Products
  - Measure via Spectrum Analyzer at 1 Hz rate

* TWO TONE MEASUREMENTS
  - Transmit Two Phased Locked Tones from LET
  - Monitor ACTS Down-link Band vs. Time
  - Record Amplitudes via Spectrum Analyzer at 0.8 Hz rate
  - Record Relative Phase vs. Time

* BER MEASUREMENTS
  - Investigate Burst Error Rates via High Data Rate Modems
  - Develop Channel Characterization Models
  - Prepare for ACTS Compressed Video Experiments

FAU TERMINAL STATUS

* RECEIVE-ONLY TERMINAL
  - Prodelin 1.2 m Dish Ordered and Delivered
  - Front End Downconverter to 3.3 GHz under Assembly
  - Weatherproof Feed Enclosure on Order
  - Additional Rain Gauge on Order
  - Phase Measurement Hardware on Order

* SOFTWARE
  - Single and Two Tone Measuring Software Complete
  - COMDISCO SPW Channel Model under Development

* MODEMS
  - Fujitsu Burst Modem Interface under Development
  - EF Data Continuous Modem Hardware Ready

* PROPAGATION TEST BED

* PURPOSE
  - Test Bed For Link Evaluation
  - FEC Burst Error Algorithm Development
  - Test SCTC Video Compression and FEC prior to ACTS

* HARDWARE PROPAGATION TEST BED
  - Computer Controlled Signal and Noise Channel
  - Real Time Propagation Fading at IF Frequencies
  - Incorporate ACTS Channel Models
  - Evaluate High Data Rate Modem Performance

* DEVELOP COMDISCO SPW SOFTWARE
  - Incorporate ACTS Rain Models
  - Subject of Current M.S. Thesis

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USING THE E-MAIL SYSTEM FOR INFORMATION EXCHANGE

Krisjani Suwitra
Jet Propulsion Laboratory

California Institute of Technology

JPL

E-mail is a quick way to ...

- Announce a meeting place and date
- Exchange experimental data
- Exchange results/analysis
- Ask questions and answer
- Announce software releases, bugs and improvements
  -
  -
  -

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June 15, 1993

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To be on the list, please contact the ACTS E-mail administrator:
Krisjani Suwitra Telephone: 818-354-9250 FAX: 818-393-0096 E-mail: suwitra@java.jpl.nasa.gov

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A Sample e-mail message

Date: Wed, 17 Mar 1993 15:05:28 -0600
From: bcrane@geohub.gcn.uoknor.edu
To: suwitra@java.Jpl.Nasa.Gov
Subject: A Test

Kris,
This is a test.
Bob Crane

Date: Wed, 17 Mar 1993 15:05:28 -0600
From: suwitra@java.Jpl.Nasa.Gov
To: bcrane@geohub.gcn.uoknor.edu
Subject: Re: A Test

Bob,
I received your test message.
Kris Suwitra

JPL

Sending a message to the mailing list

Date: Mon, 14 June 1993 15:05:28 -0600
From: suwitra@java.jpl.nasa.gov
To: acts@java.jpl.nasa.gov
Subject: A Test

•
•
•

Receiving a message from the mailing list

Date: Mon, 14 June 1993 15:05:28 -0600
From: acts@java.jpl.nasa.gov
To: suwitra@java.jpl.nasa.gov
Subject: A Test

•
•
•

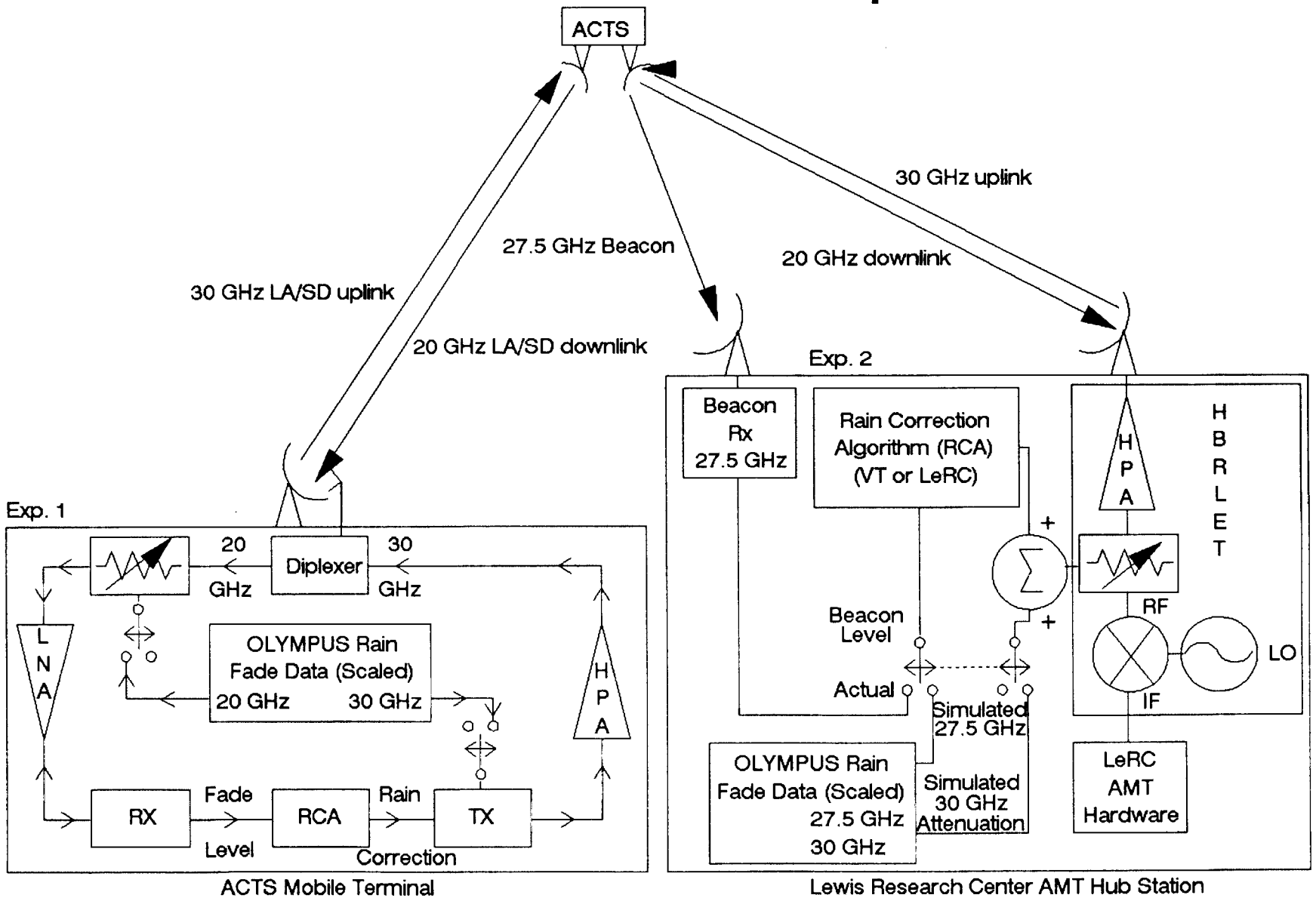
JPL

A reply message to an individual

Date: Mon, 14 June 1993 15:05:28 -0600
From: bcrane@geohub.gcn.uoknor.edu
To: ~~acts@java.jpl.nasa.gov~~ suwitra@java.jpl.nasa.gov
Subject: Re: A Test

-
-
-

VPI & SU ACTS Mobile Terminal Experiment Plan



(An absorptive attenuator at ~ T_{Rain} will accurately simulate rain attenuation including sky noise effects.)

mobile.drw
04/07/93

Warren Stutzman, Virginia Polytechnic Institute & State University

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A PLAN FOR ACQUIRING PROPAGATION DATA FROM ACTS COMMUNICATIONS EXPERIMENTS

A.G.Cha

Jet Propulsion Laboratory
Pasadena, CA

California Institute of Technology

Plan to Use EOA Data

THE STEPS

- Determine what data is available
- Determine what data to collect
- Present the plan at ACTS Propagation Workshop for discussions
- Promote plan at ACTS communications experimenters meeting
  - obtain cooperation of principal investigators
- Work out funding, management, technical, contracting and scheduling liaison details

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Plan to Use EOA Data

DATA CHARACTERISTICS

NRA Class I	EOA
time stamp	time stamp
rain and other climatic data	climatic data usually not available
fade (attenuation) data	fade data
continuous measurement over two years	not continuous; duration can be from weeks to two years

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Plan to Use EOA Data

SOME PROMISING CANDIDATES

1. NASA Ground Station and Master Control Station (NGS / MCS)

- 20 GHz telemetry beacon power level measured on a daily, quasi-continuous basis over the two-year ACTS experiment period
- Data stored at MCS
- Weather data may be available from nearby airport

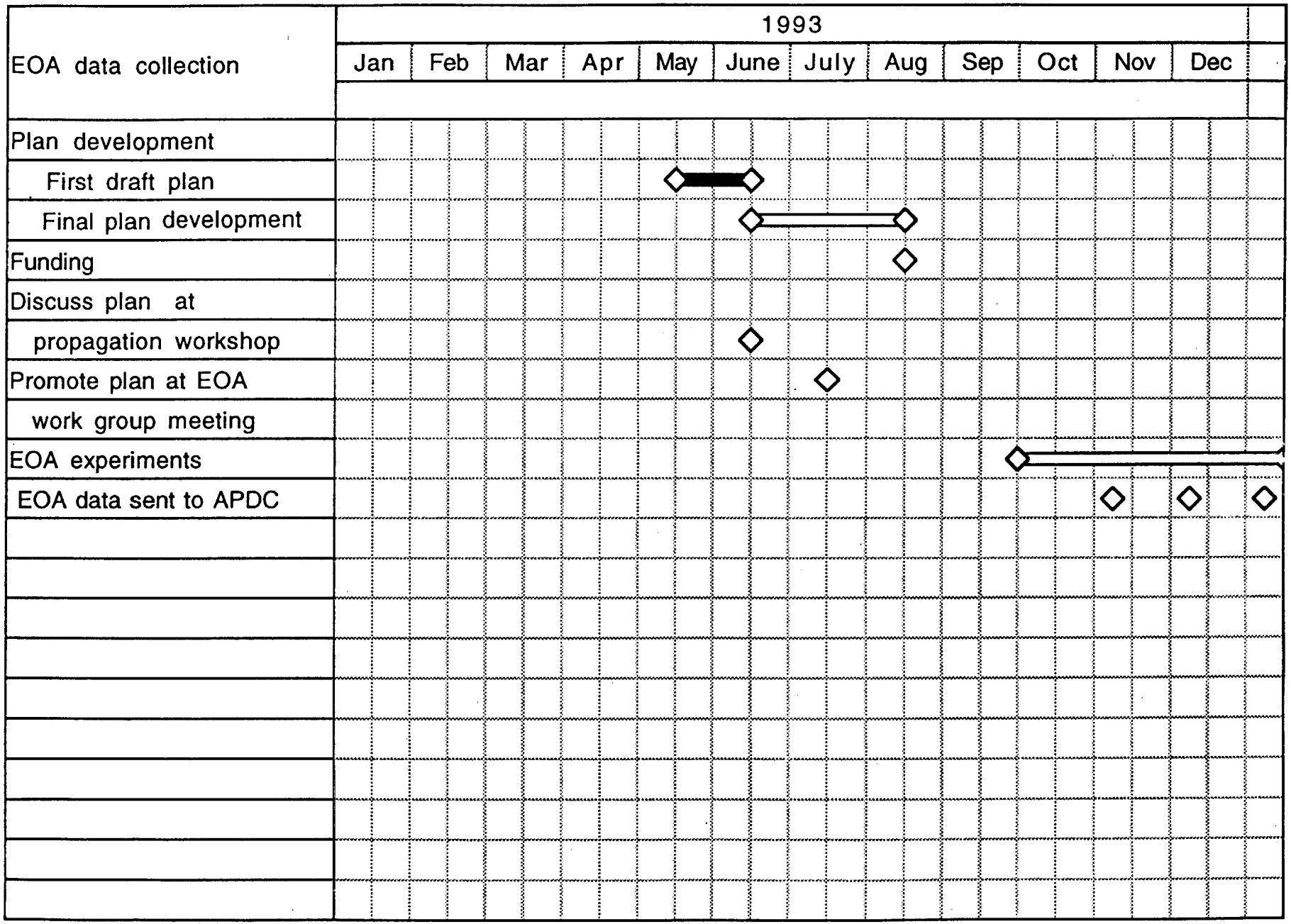
Assessment : This looks like a Class I experiment for the Cleveland area.

2. VSAT's

- Fade data is deposited and stored at MCS
- Individual terminals : Look closely at terminals which will be at the same location for one year or longer and which will be used frequently and fairly uniformly over the year.
- The ensemble of all VSAT's :
  The data is deposited at MCS. The data aggregate represents the average fade statistics of the lower 48 states over two years.

3. Mobile terminals

- Data in mobile environment is valuable and should be deposited at APDC.



Thursday, June 10, 1993

Report of the Working Groups Joint Meeting

D. V. Rogers and R. K. Crane

In Session II of the ACTS Miniworkshop held on June 14, 1993, the Science and Systems Working Groups met jointly to conduct deliberations per the agenda listed in the Table of Contents of this publication. A brief report on this meeting and on the status of Action Items from the previous ACTS Propagation Studies Workshop (APSW IV) is provided here.

Action Items

The following Action Items, with responsible individual(s) noted, resulted from discussions at APSW IV. The status of each is briefly summarized.

1. E-Mail Status Reports/Computer Bulletin Board - Bob Bauer

   Krisjani Suwitra, the ACTS E-mail Administrator, described the benefits of the E-mail system for the ACTS propagation program, which is already operational. A list of E-mail addresses of the ACTS propagation experimenters is in preparation. Addresses for this list should be supplied to Krisjani Suwitra (suwitra@java.jpl.nasa.gov).

   An ACTS computer bulletin board is in preparation by NASA Lewis Research Center, and is expected to be operational by early August. Satellite ephemeris data will be supplied to experimenters for antenna pointing calculations. As ACTS is intended to be station-kept in a small (± 0.05∞) box, effects of pointing errors should be small for the ACTS propagation terminals.

2. Rain-Gauge Siting/Maintenance/Operation - Julius Goldhirsh

   J. Goldhirsh delivered two technical reports for dissemination. The first is titled "Operation, Calibration and Data Acquisition for Capacitive and Tipping Bucket Rain Gauges", by N. E. Gebo and J. Goldhirsh, and the second is "Comparative Assessment of R.M. Young and Tipping Bucket Rain Gauges", by J. Goldhirsh and N. E. Gebo. A 3.5 inch floppy disk of data acquisition and processing software for tipping bucket and capacitive rain gauges was also provided. The information is to be disseminated by VPI & SU.

3. Sample OPEX E-Mail Reports/Sample Data Set - Tim Pratt

   Samples of OPEX E-mail status reports were supplied by T. Pratt to R. Bauer for consideration in instituting a similar system for the ACTS program.

   A sample data set for use during experimenter training was prepared and applied for this purpose.

4. Experimenter Guide/Data Processing Outline - R. Crane and D. Rogers

   R. Crane discussed requirements for sophisticated data processing in the presentation, "Measurement Needs Beyond CCIR", which addressed CCIR needs, interannual and seasonal variability in statistics, measurement procedures, and comparisons of measurements with model predictions and among different

observations (e.g., comparison of beacon and radiometric data). Important for the assurance of propagation data quality is the identification of the cause of each observed outage or attenuation event (e.g., attenuation caused by rain or cloud, signal-level reduction caused by scintillation, loss of signal due to equipment malfunction, loss caused by antenna misalignment, wet snow on the antenna, graduate student in front of the antenna feed, etc.). During discussions generated by this presentation the need for specific systems information (diurnal distributions of fading, rates of fading, fade durations, etc.) was also noted.

An outline of a "strawman" guide for experimenters is planned for the next ACTS Propagation Studies Workshop. Per intentions stated during APSW IV, the guide would be prepared after experimenters have collected several months of ACTS propagation data. In preparation for discussions at the next ACTS workshop, experimenters are encouraged to: compare the monthly cumulative distributions of attenuation observed at one frequency with those predicted from observations at the other frequency using one or more models for frequency scaling; compare attenuation observations with predictions from radiometer observations using one or more models for medium temperature; and compare attenuation observations with predicted attenuations based on the rain rate distribution for the month (using all data, not just observations simultaneous with beacon measurements) and one or more models for attenuation prediction given the rain rate distribution. In addition, comparisons should be made between rain accumulation estimates tallied from the rain rate observations, accumulations estimated from nearby NWS and other cooperative observer reports, and climatologically-expected monthly accumulations.

Other Issues

Several other important issues were discussed during the Joint WG Meeting. The main issues were the following:

1. ACTS Field Support

The degree of field support to be provided by NASA for ACTS Class I propagation experimenters was unclear and the cause of some concern. The NASA representative stated that some form of site support was still intended, but that it remained to be seen who would provide it.

Several experimenters commented on this issue, noting that the satellite launch was imminent, and that there are bound to be hardware and software bugs discovered after installation of the propagation terminals. Some means to quickly and reliably diagnose problems confronted in the field and to supply remedies was deemed essential by the experimenters.

2. System-Application Requirements

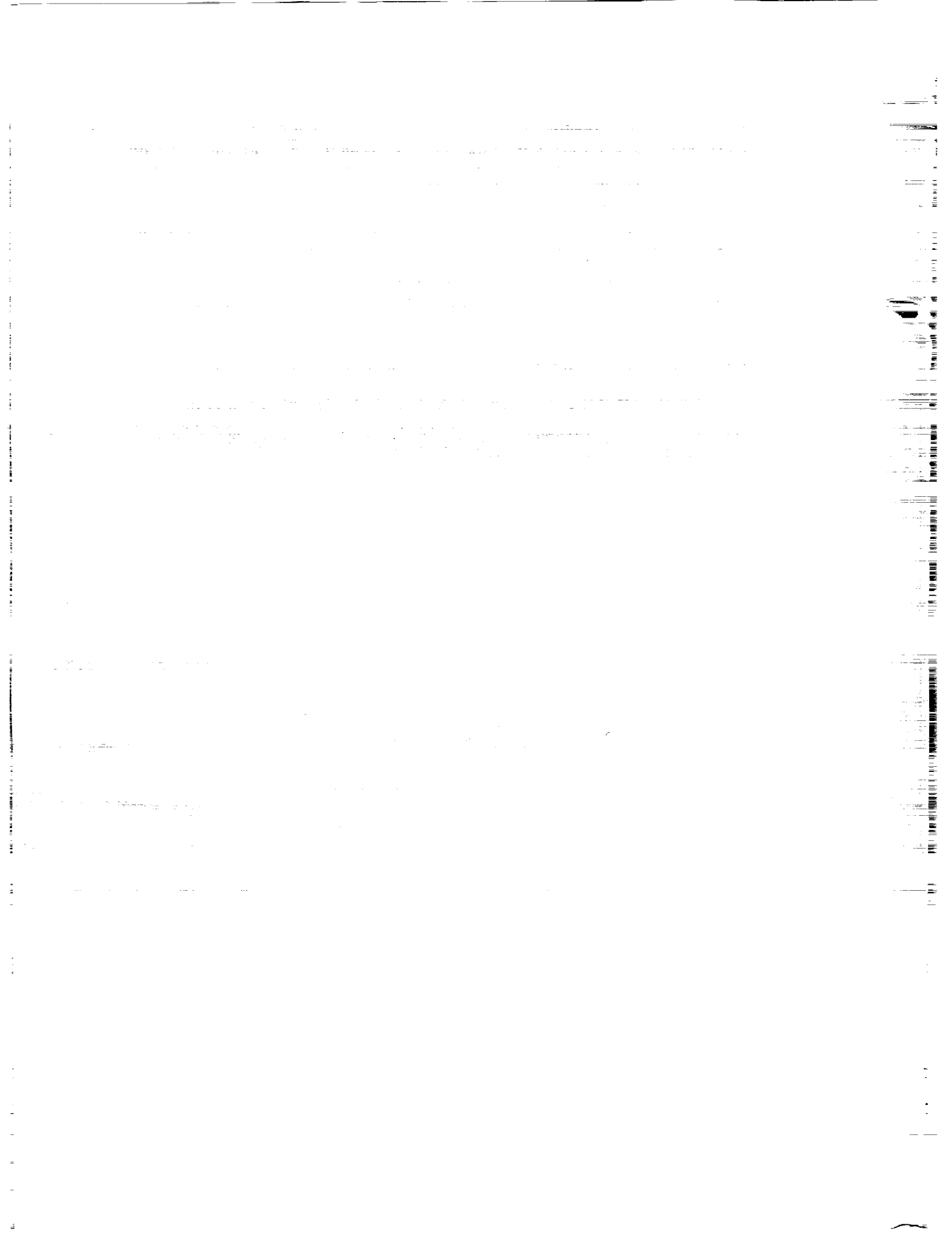
Several system designers and users participated in the ACTS Miniworkshop and expressed some systems concerns and requirements during the meeting.

Cloud losses, snow (whether on the propagation path or the antenna), light rain, and other usually-small propagation effects were recognized as important for small-margin telecommunication systems and possibly for propagation impairment-mitigation technologies. Designers of satellite systems are

furthermore concerned with net impairments confronted by the system (e.g., snow on an earth-terminal antenna may be even more important that snow on the path), and would prefer prediction models that can account for all such weather-related effects.

However, propagation experimenters have difficulty in identifying and treating nonpath effects, which are often unique to local parameters (such as antenna type) and difficult to classify for modeling applications. If categorization is incomplete (e.g., if the prediction methods are purely empirical), there is little prospect for developing site-specific prediction capabilities. This problem is deserving of more attention and additional discussion at future meetings, particularly as to how the system needs can be addressed during the ACTS propagation experiments.

Interest was also expressed regarding "integration" of the results from the ACTS propagation experiments into suitable formats for system needs. The answer offered was that this process would occur collectively within the propagation community in collaboration with systems experts. A mechanism to ensure that those system needs that can be addressed via the ACTS propagation results are accommodated in the studies may be necessary.



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15. Supplementary Notes

16. Abstract

The NASA Propagation Experimenters Meeting (NAPEX), supported by the NASA Propagation Program, is convened annually to discuss studies made on radio wave propagation by investigators from domestic and international organizations. NAPEX XVII was held on June 15, 1993, in Pasadena, California. Participants included representatives from Canada, Japan, Germany, the Netherlands, Portugal, England, Switzerland, Italy, and the United States, including researchers from universities, government agencies, and private industry. The meeting was organized into two technical sessions. The first session was dedicated to slant path propagation studies and experiments. The second session focused on propagation studies for mobile and personal communications. In total, nineteen technical papers and some informal contributions were presented.

Preceding NAPEX XVII, the Advanced Communications Technology Satellite (ACTS) Propagation Studies Miniworkshop was held on June 14, 1993, to review ACTS propagation activities with emphasis on ACTS experiments status and data collection, processing, and exchange. Ten technical papers were presented by contributors from government agencies, private industry, and university research establishments.

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