1996 CEDAR Workshop

Boulder, Colorado
June 16-22, 1996

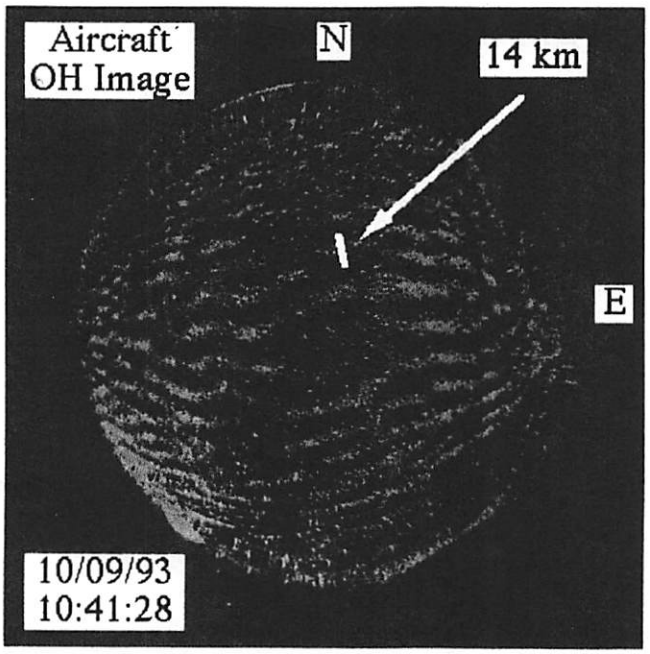
CEDAR Prize Lecture

by Chester Gardner
University of Illinois

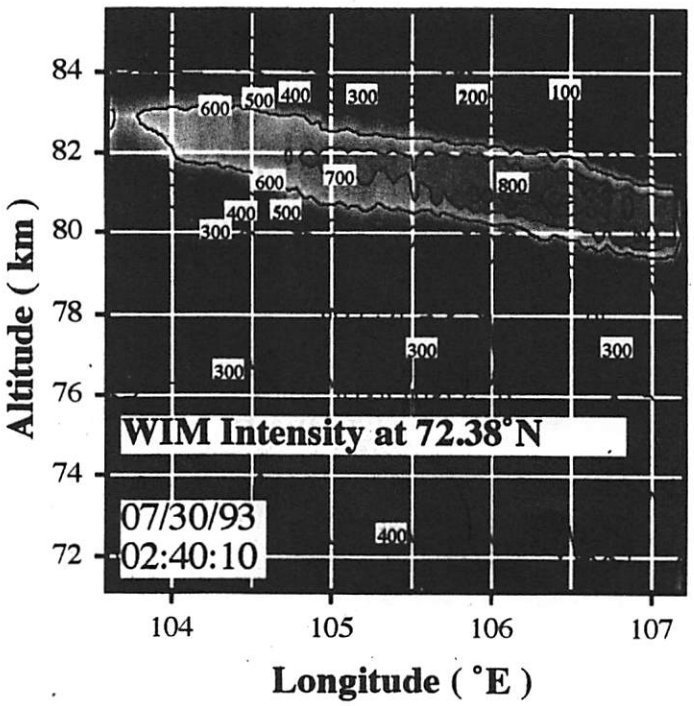
The ALOHA/ANLC-93 Campaigns

The ALOHA / ANLC - 93 Campaigns

ALOHA-93



ANLC-93



1993 Airborne Noctilucent Cloud Campaign

1993 Airborne Lidar & Observations of the Hawaiian Airglow Campaign

ALOHA/ANLC-93 Scientific Goals

- *To study the vertical & horizontal spatial structure of noctilucent clouds & the thermal structure of the mesopause region during NLC displays*

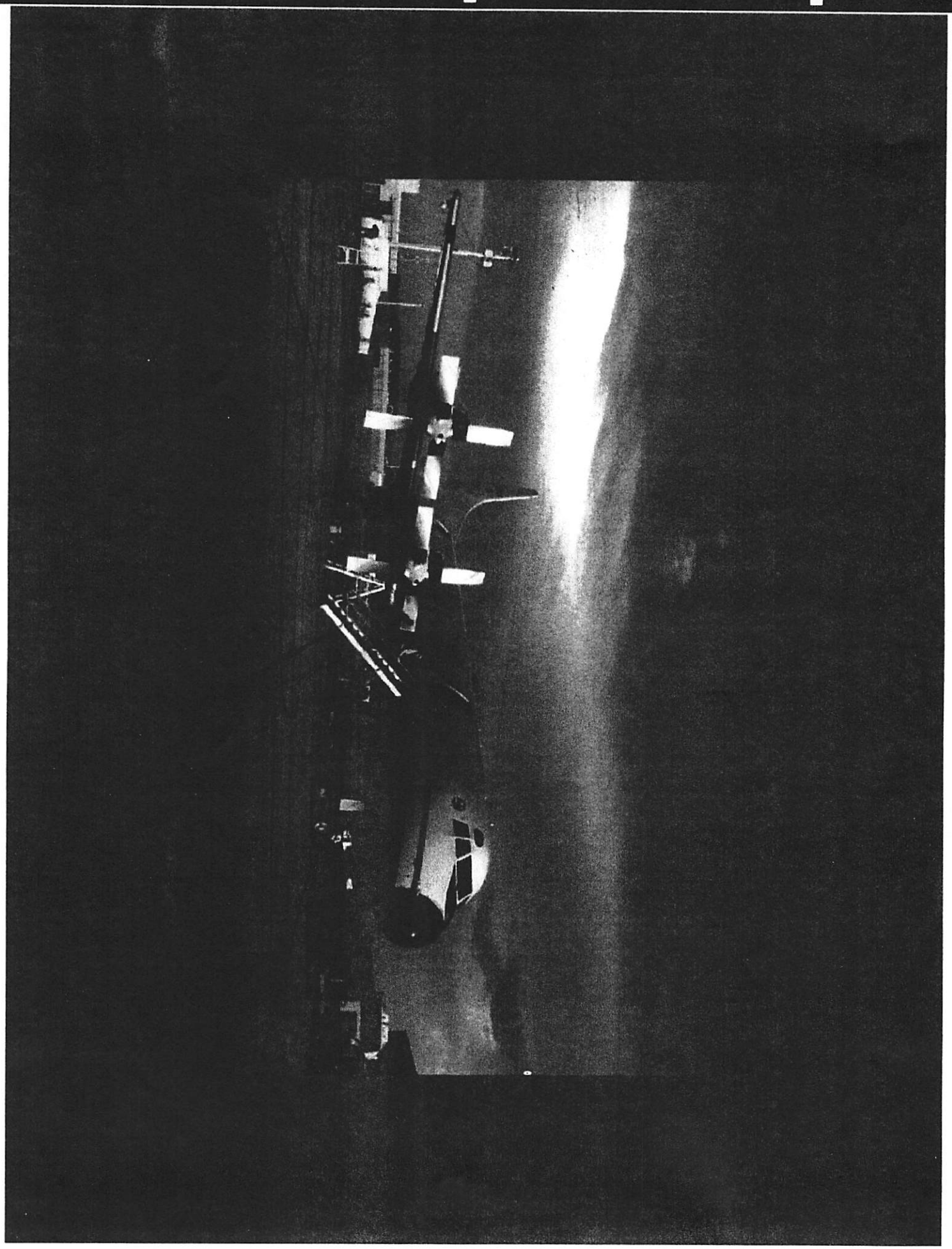
- *To study the intrinsic parameters of monochromatic gravity waves & the spectra of quasi-random wave perturbations*

- *To characterize the thermal & wind conditions accompanying the formation of sporadic Na layers*

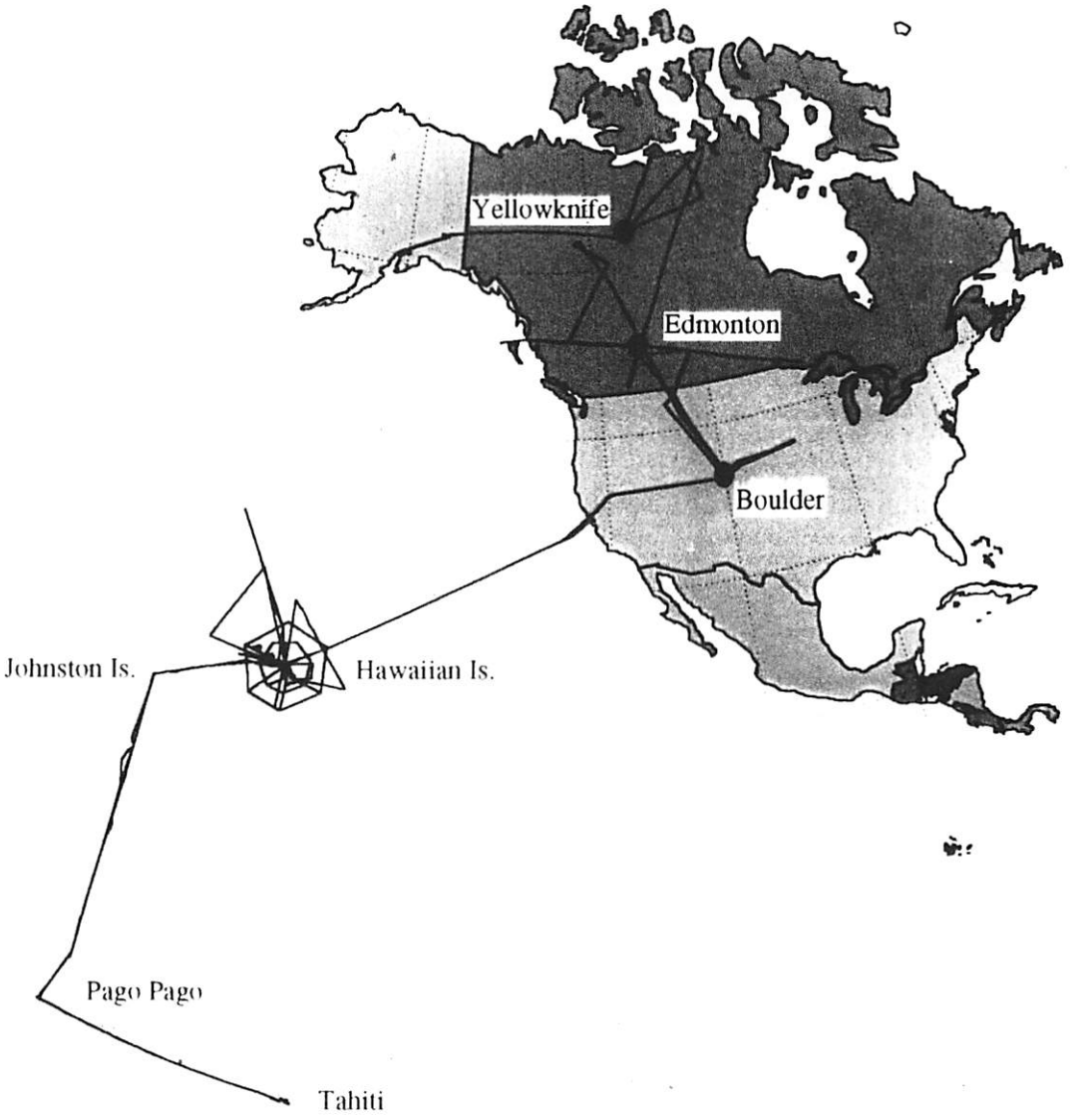
- To study the characteristics of major wave sources such as orography, storm systems, & equatorial convection

- To study tidal perturbations in wind, temperature, and airglow emissions in the mesopause region near Hawaii

Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix

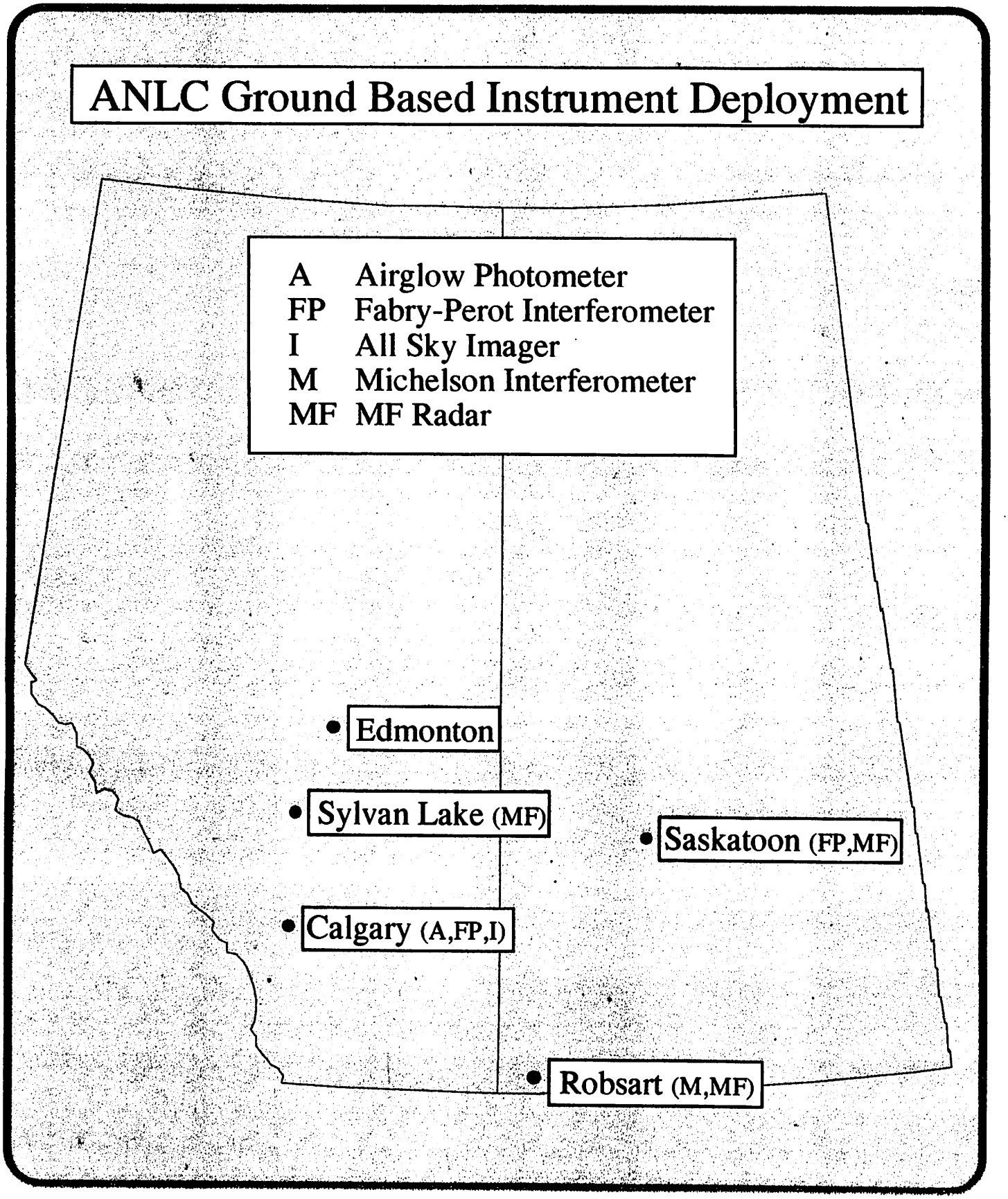


ALOHA/ANLC-93 Flight Paths



ANLC-93 INSTRUMENTS

Instrument	Institution	Location
MF Radar Network	University of Saskatchewan	Saskatoon (52.2°N, 107.1°W) Robsart (49.2°N, 109.3°W) Sylvan L. (52.4°N, 114.1°W)
Fabry-Perot Interferometer All-Sky Imager	University of Calgary	Calgary (51°N, 114.1°W)
Fourier Transform Spectrometer & Scanning Radiometer	University of Western Ontario	Saskatoon (52.2°N, 107.1°W)
Fourier Transform Spectrometer	York University	Robsart (49.2°N, 109.3°W)
Airglow Intensity Photometry	University of Calgary	Calgary (51°N, 114.1°W)
UARS-WINDII	York University	On Orbit - UARS
UARS-HRDI	University of Michigan	On Orbit - UARS
Airglow Imager	Lockheed Corporation	Airborne - NCAR Electra
Fourier Transform Spectrometer	Utah State University	Airborne - NCAR Electra
Na/Rayleigh/Raman Lidar	University of Illinois Clemson University	Airborne - NCAR Electra


ANLC Ground Based Instrument Deployment
A Airglow Photometer
FP Fabry-Perot Interferometer
I All Sky Imager
M Michelson Interferometer
MF MF Radar
Edmonton
Sylvan Lake (MF)
Saskatoon (FP,MF)
Calgary (A,FP,I)
Robsart (M,MF)

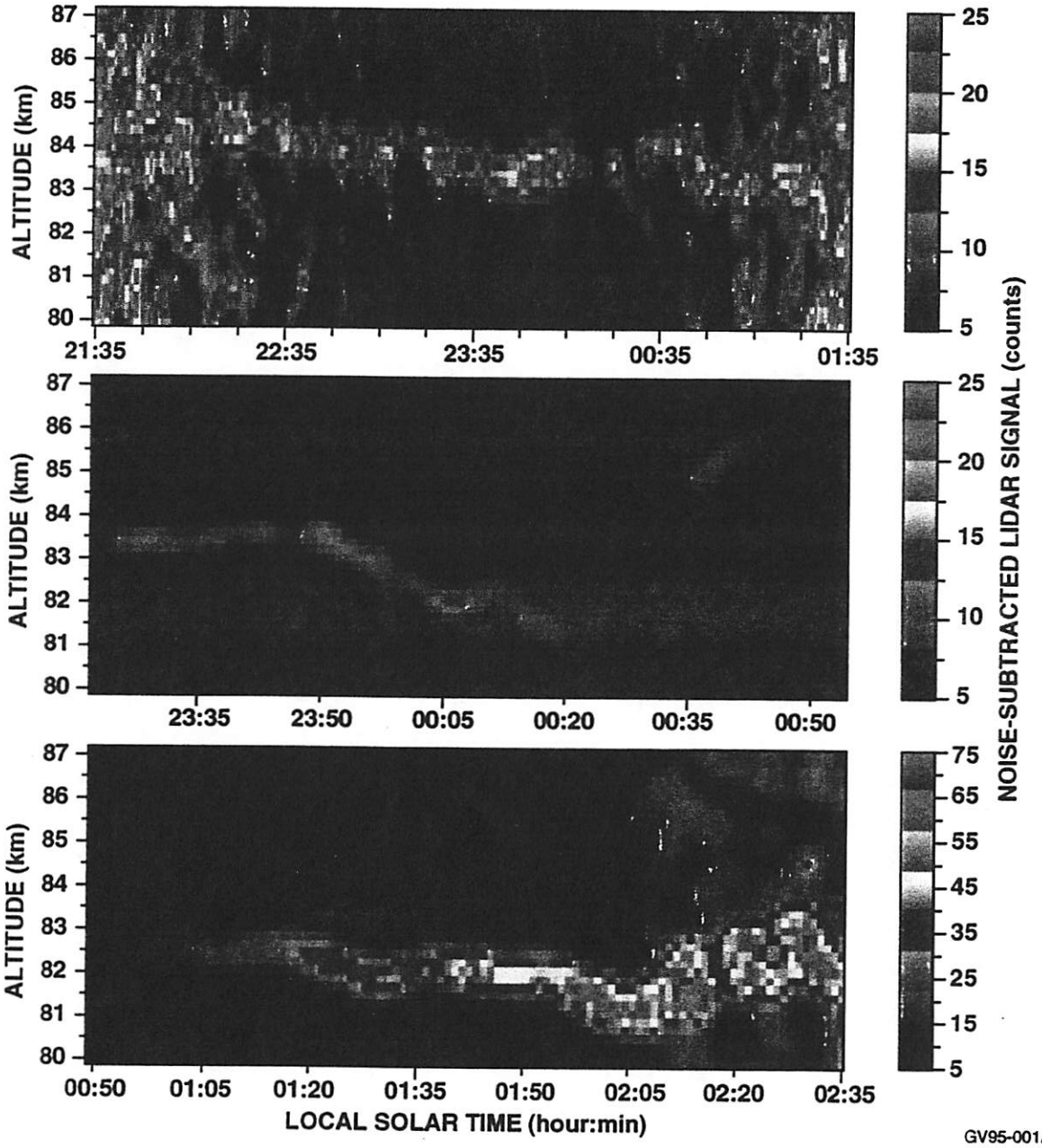
NOCTILUCENT CLOUD OBSERVATIONS

Noise-subtracted signal, uncorrected for range, Δt = 1 min, Δz = 192 m

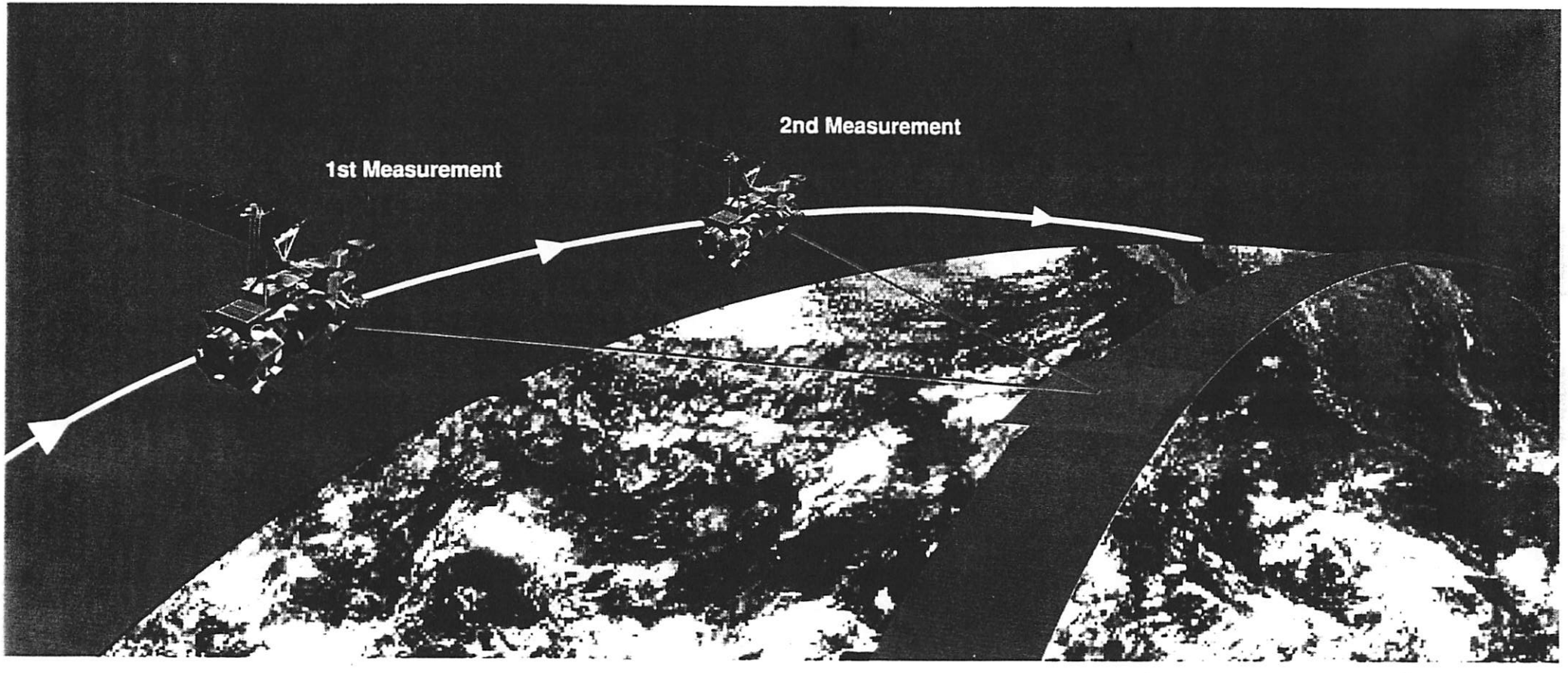
7/29/94

8/01/94

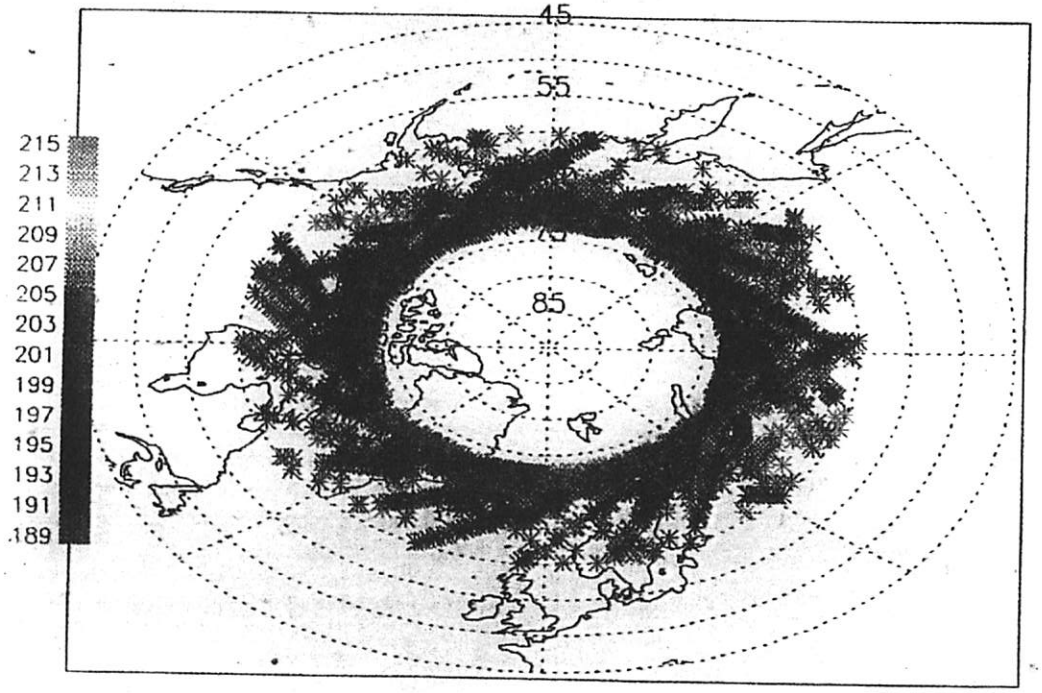
8/04/94

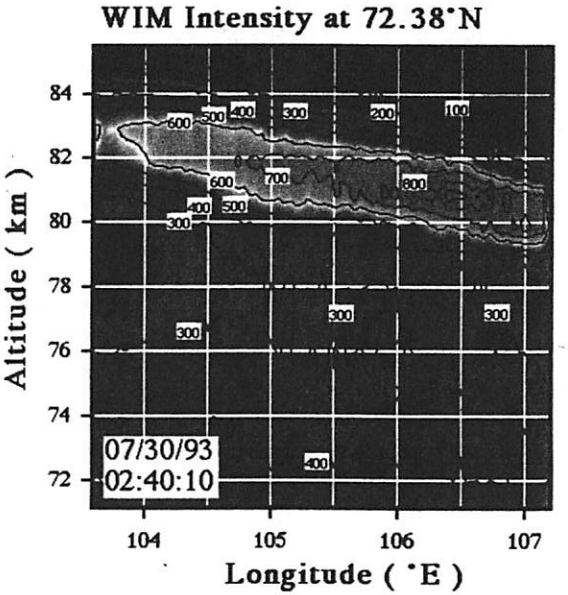


GV95-001/11-VG

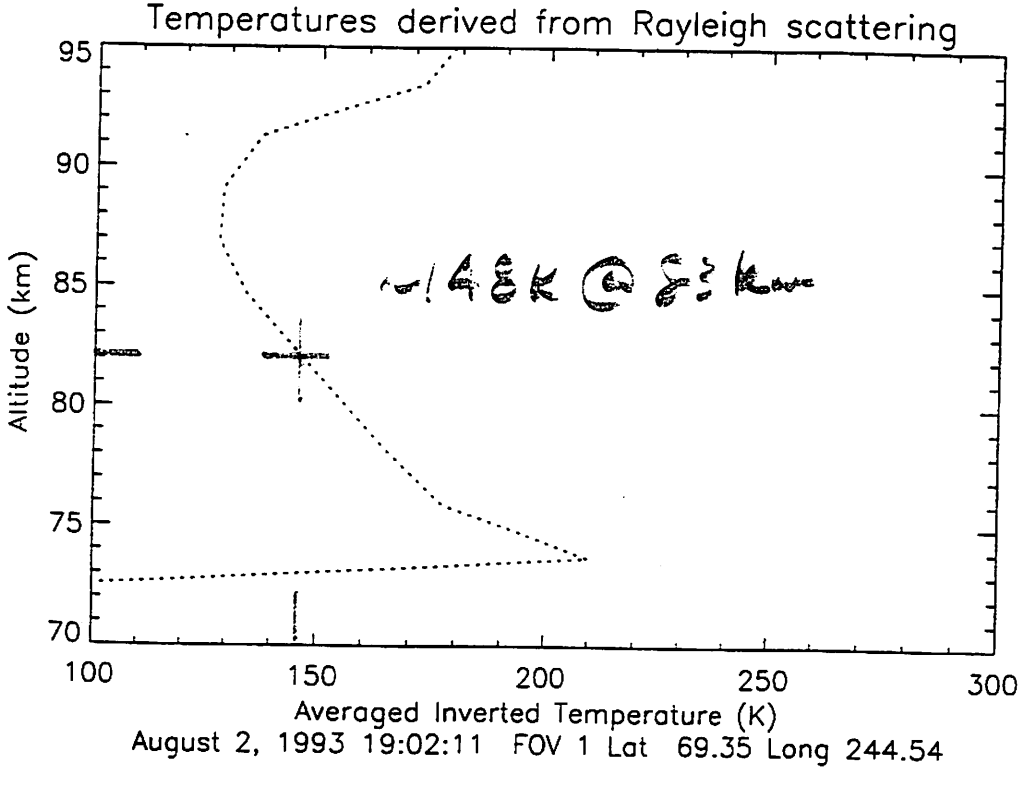

2nd Measurement
1st Measurement

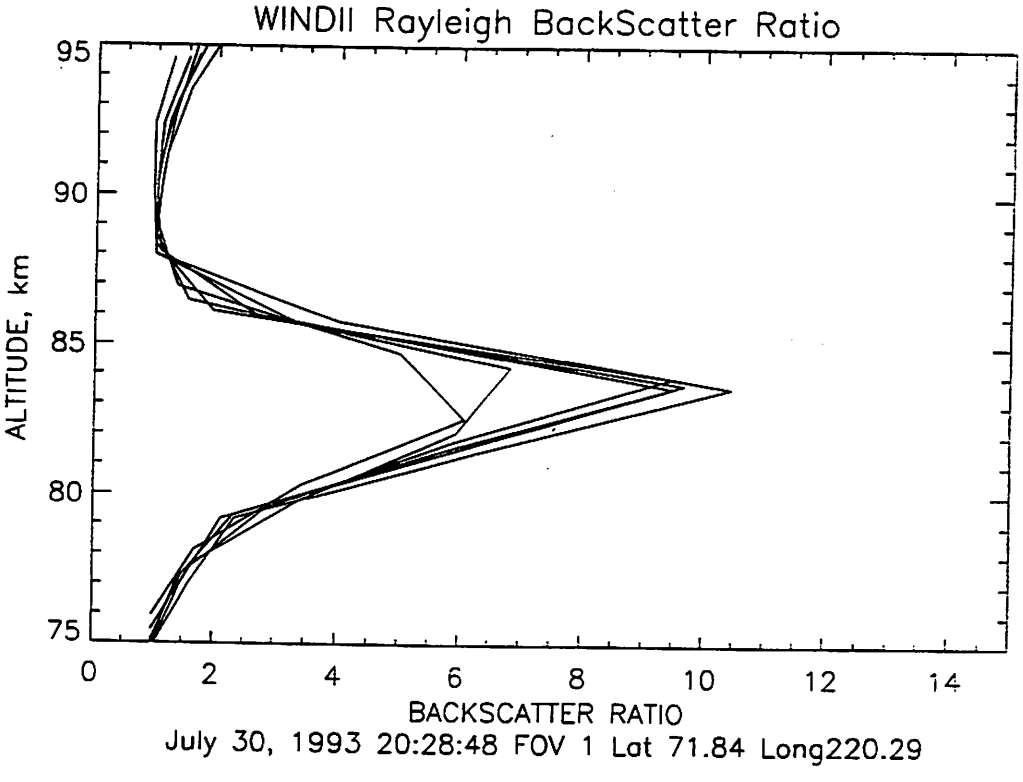
Evans et. al [GRL, 22, 1995]



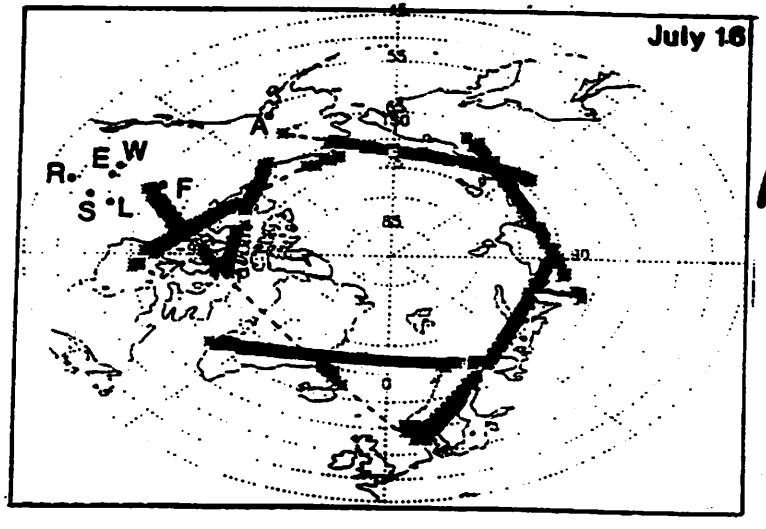


WINDII limb scanning observations were able to identify the locations and altitudes of NLC events over the polar cap during the campaign.

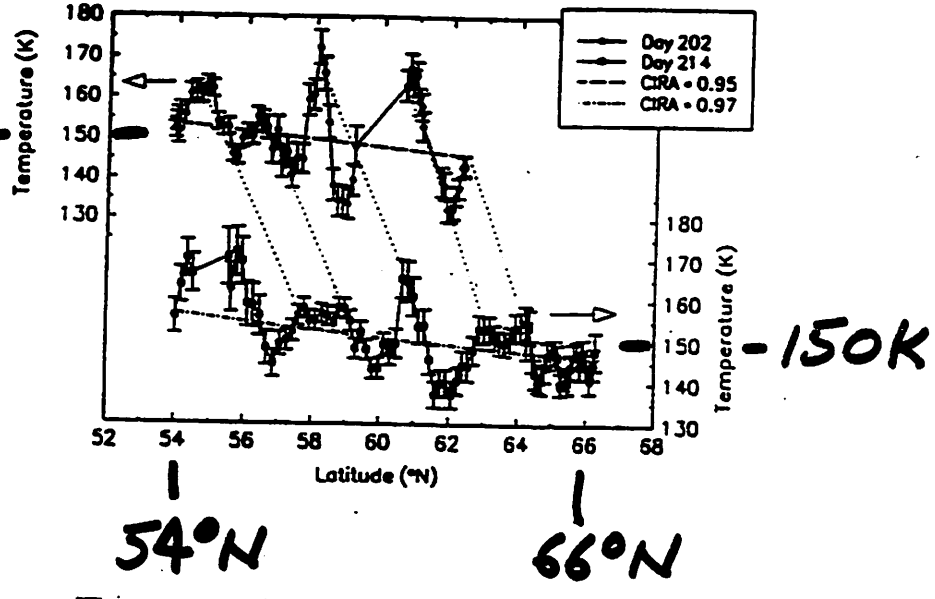




WINDII observations were used to determine the mesopause region temperature profile by analyzing the Rayleigh scattered light & to compute the backscatter ratio of the NLCs [private comm. Marianna Shepherd].



150K



150K

54°N

66°N

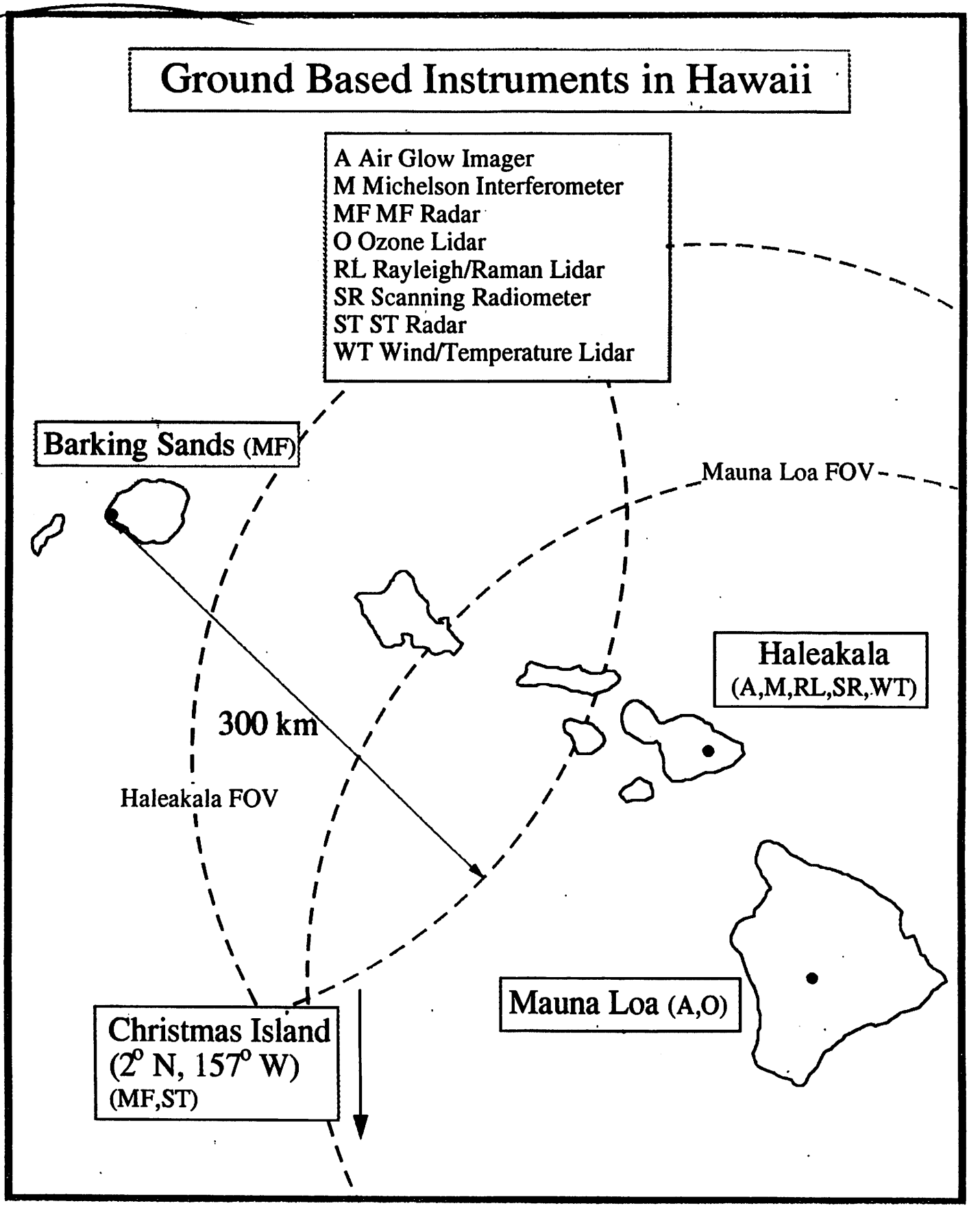
Weins et al.[*GRL*, 22, 1995]

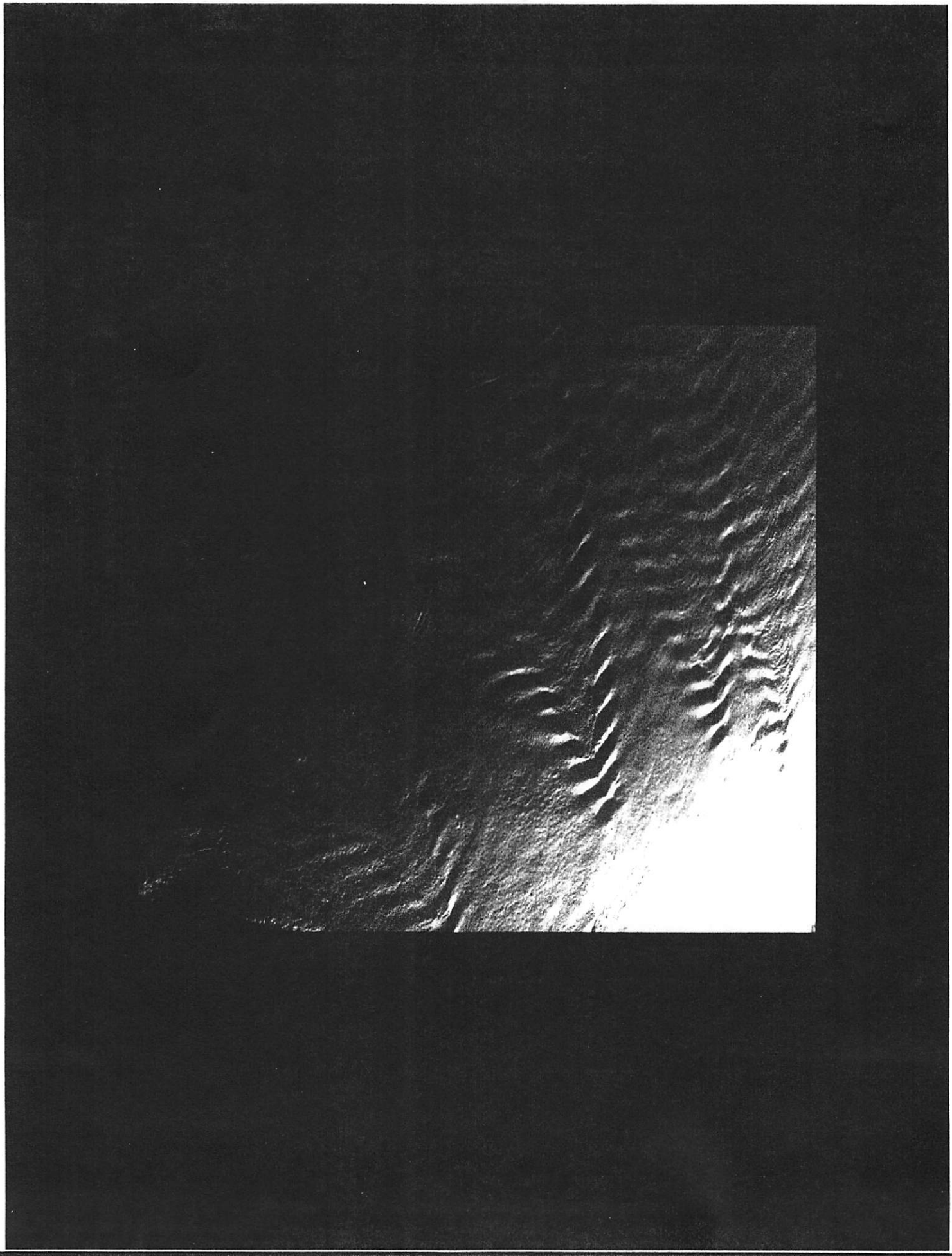
Espy et al.[*GRL*, 22, 1995]

When the aircraft flew in the vacinity of NLC displays the rotational temperatures measured by Pat Espy's Michelson interferometer were quite cold ~150 K and the horizontal structure of the temperature field appeared to be related to planetary wave activity.

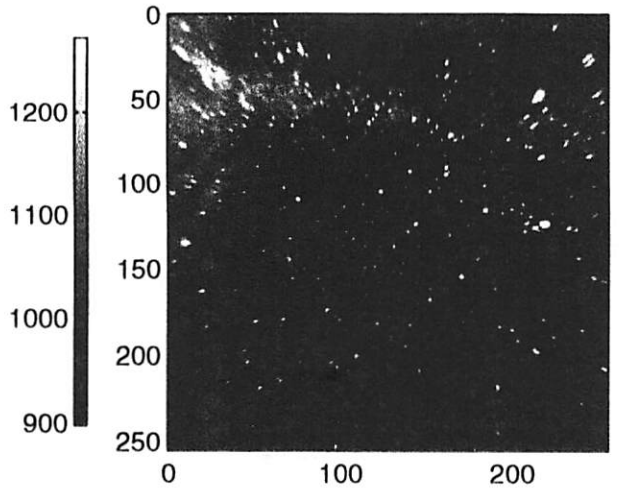
ALOHA-93 INSTRUMENTS

Instrument	Institution	Location
MF Radar	University of Colorado	Barking Sands (22°N, 160°W)
MF Radar	University of Adelaide	Christmas Island (2°N, 157°W)
ST Radar	University of Colorado	Christmas Island (2°N, 157°W)
Airglow Intensity & Temperature Imager	Aerospace Corporation	Haleakala (21°N, 156°W)
Airglow Intensity Imager	Utah State University	Haleakala(21°N, 156°W)
Fourier Transform Spectrometer Scanning Radiometer	University of Western Ontario	Haleakala (21°N, 156°W)
Infrared Spectrograph	Royal Observatory, UK	Mauna Kea (19.8°N, 155°.5W)
Rayleigh/Ozone Lidar	Jet Propulsion Laboratory	Mauna Loa (19.5°N, 155°W)
Airglow Imager	Lockheed Corporation	Mauna Loa (19.5°N, 155°W)
Rayleigh/Raman Lidar	Phillips Laboratory	Haleakala (21°N, 156°W)
Na Wind/Temperature Lidar	University of Illinois	Haleakala (21°N, 156°W)
UARS-WINDII	York University	On Orbit - UARS
UARS-HRDI	University of Michigan	On Orbit - UARS
Airglow Intensity Imager	Lockheed Corporation	Airborne - NCAR Electra
Erbert-Fastie Spectrometer	Johns Hopkins APL	Airborne - NCAR Electra
Fourier Transform Spectrometer	Utah State University	Airborne - NCAR Electra
Na/Rayleigh/Raman Lidar	University of Illinois Clemson University	Airborne - NCAR Electra

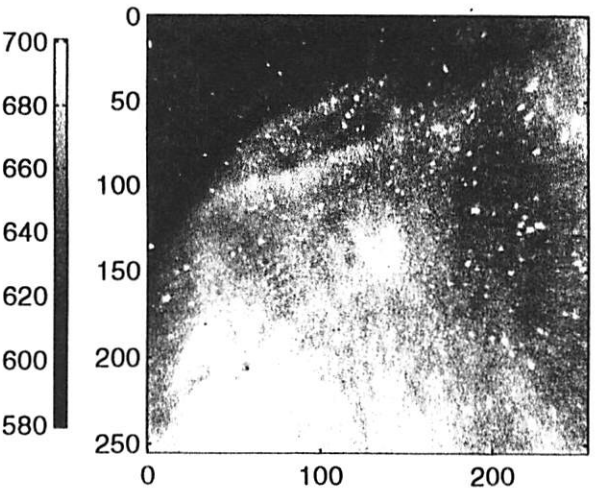

Ground Based Instruments in Hawaii
A Air Glow Imager
M Michelson Interferometer
MF MF Radar
O Ozone Lidar
RL Rayleigh/Raman Lidar
SR Scanning Radiometer
ST ST Radar
WT Wind/Temperature Lidar
Barking Sands (MF)
Mauna Loa FOV
Haleakala
(A,M,RL,SR,WT)
300 km
Haleakala FOV
Mauna Loa (A,O)
Christmas Island
(2° N, 157° W)
(MF,ST)



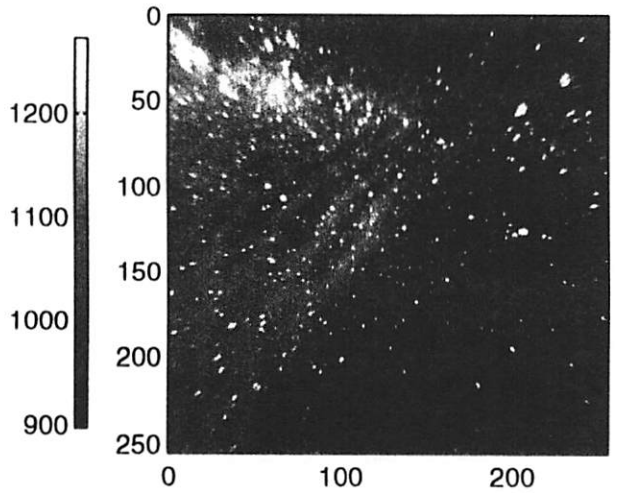
Aloha Observations Oct. 10,1993



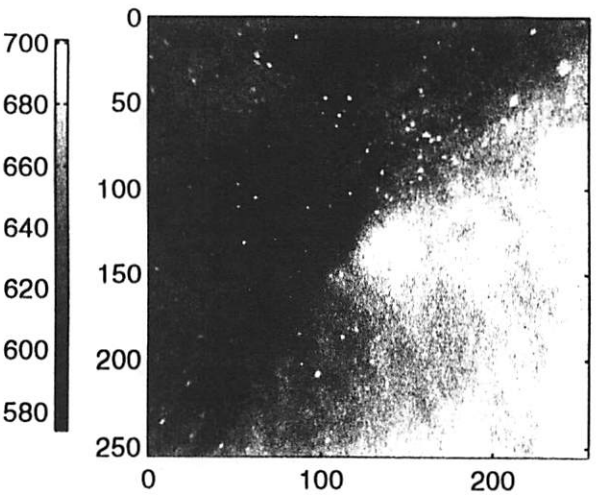
(OH) 10:30:32 UT



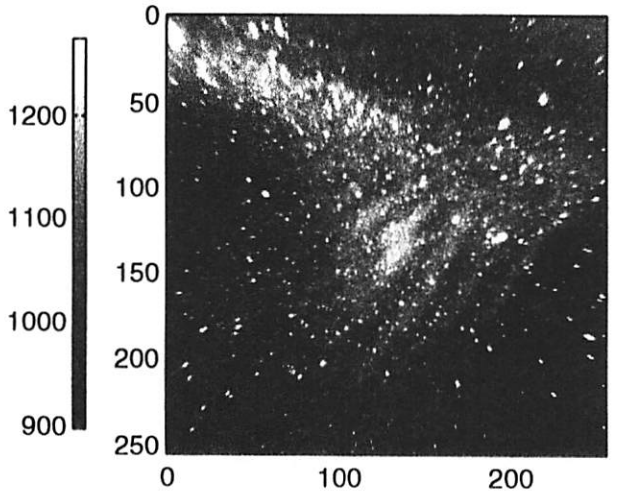
(5577) 10:30:05 UT



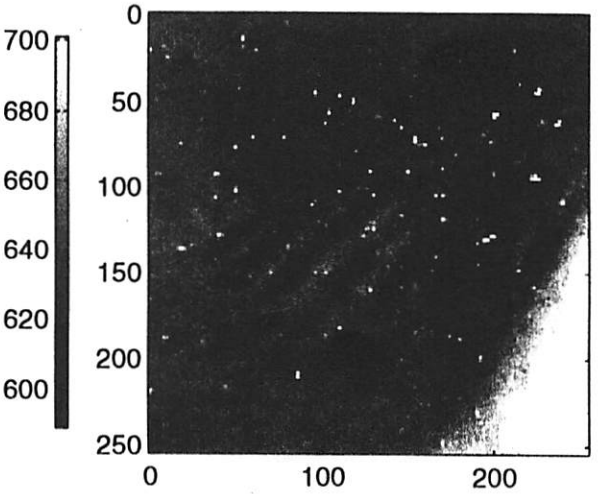
(OH) 10:48:28 UT



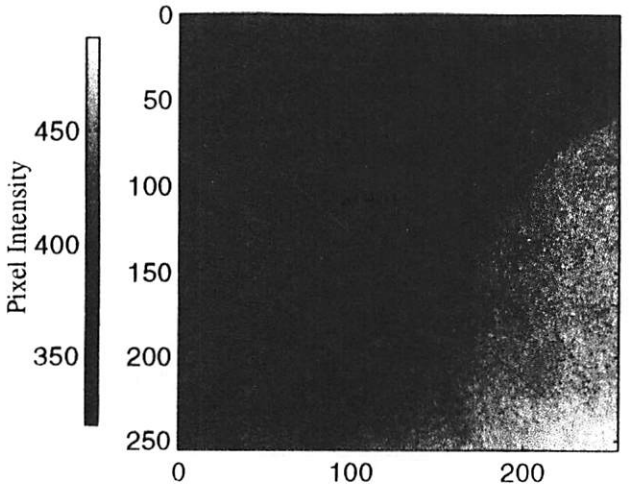
(5577) 10:48:02 UT



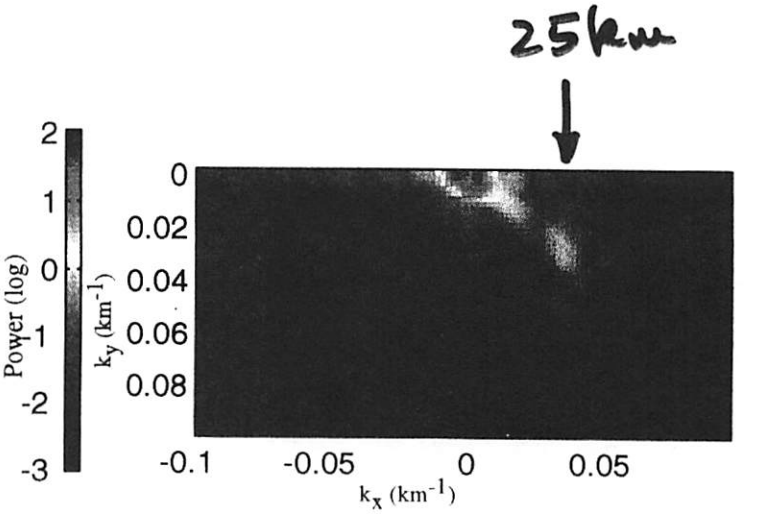
(OH) 11:06:25 UT



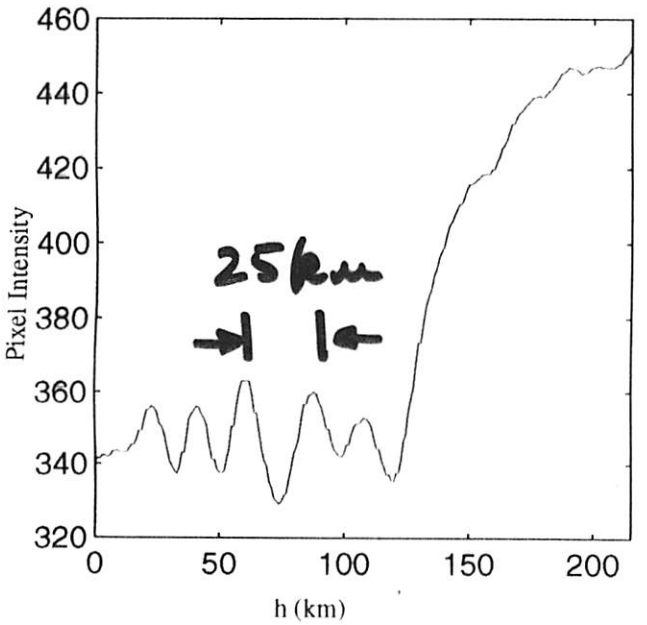
(5577) 11:09:37 UT



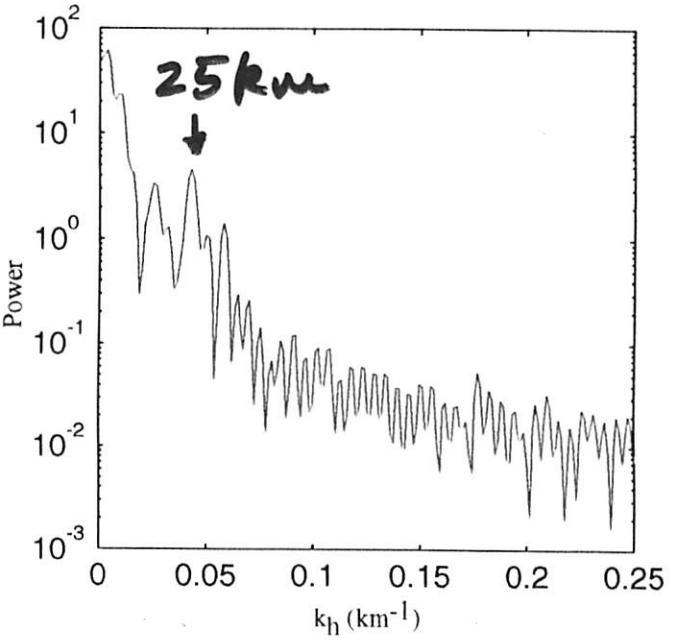
(5577) 10:57:00 UT



Magnitude of 2-D FFT

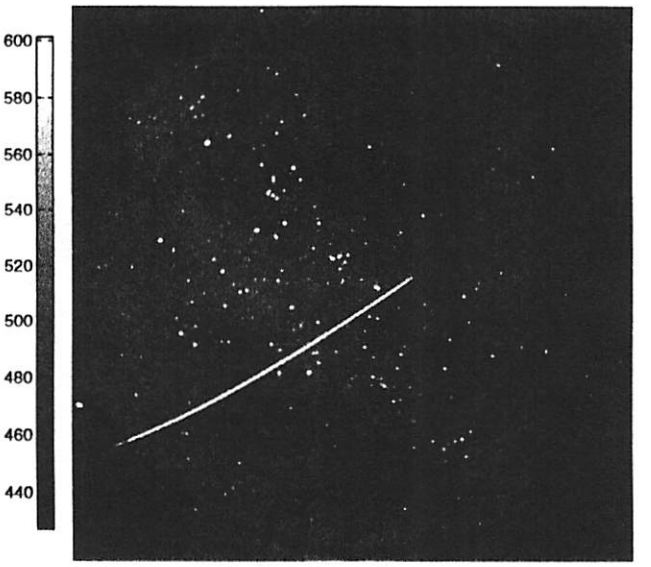


Intensity Scan



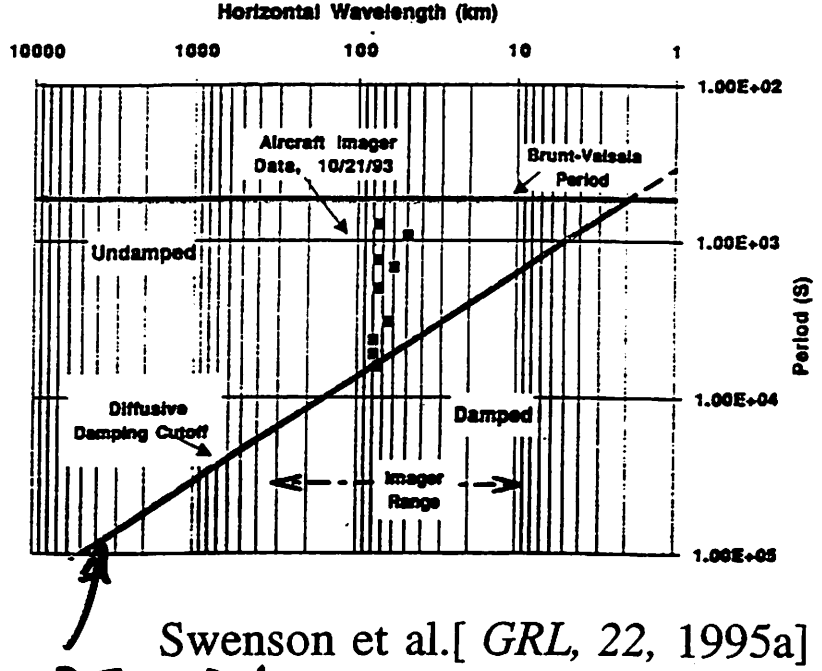
1-D Power in Scan

$$c_h = \frac{\lambda_h}{T} \qquad T = \frac{\lambda_h}{c_h} \qquad \lambda_B = \frac{T_B}{T}\lambda_h$$



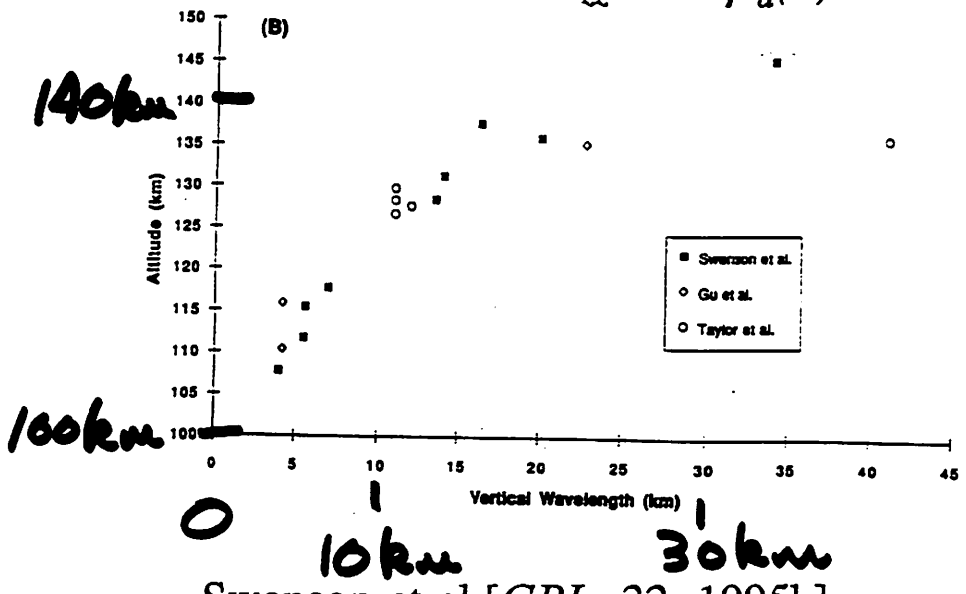
(Na) Oct. 12, 1993 13:12:31 UT

Gravity waves are severely damped when the vertical diffusion velocity mD_{zz} exceeds the intrinsic phase velocity $\omega/m = \lambda_z/T$.



Swenson et al.[*GRL, 22,* 1995a]

$D_{zz} \sim 1/\rho_a(z)$



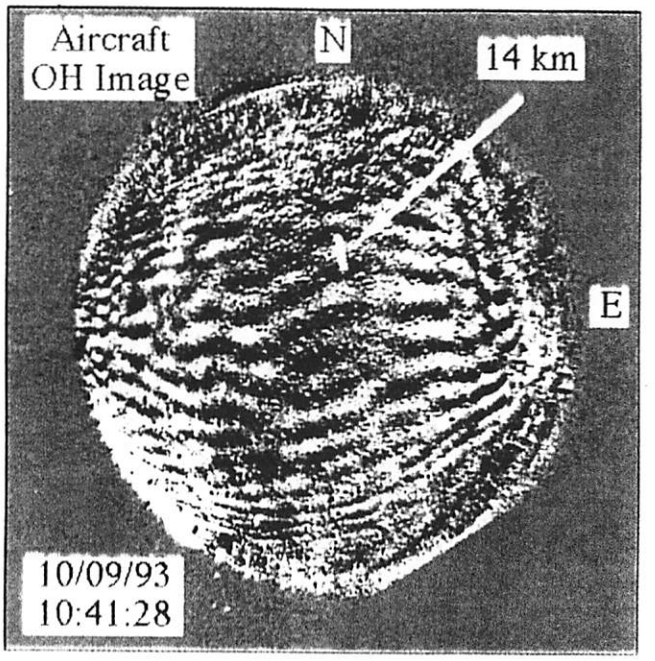
Swenson et al.[*GRL, 22,* 1995b]

$D_{zz} = 350\ m^2/s$

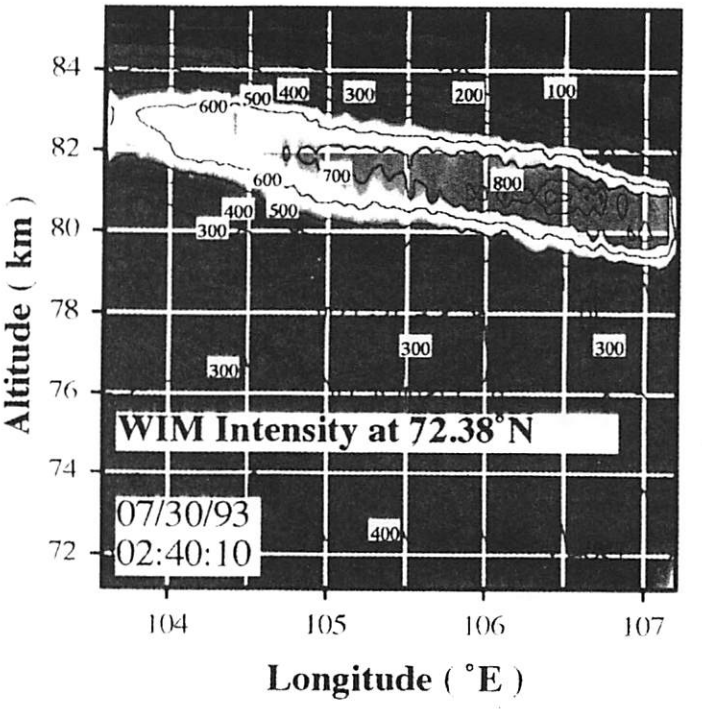
The imager data has been combined with the Kauai MF radar & Haleakala lidar observations to determine gravity waves intrinsic parameters. The results are being used to study the effects of diffusive damping on the wave spectrum & the maximum altitudes the waves can reach in the presence of molecular diffusion.

Geophysical
Research
Letters

ALOHA-93



ANLC-93

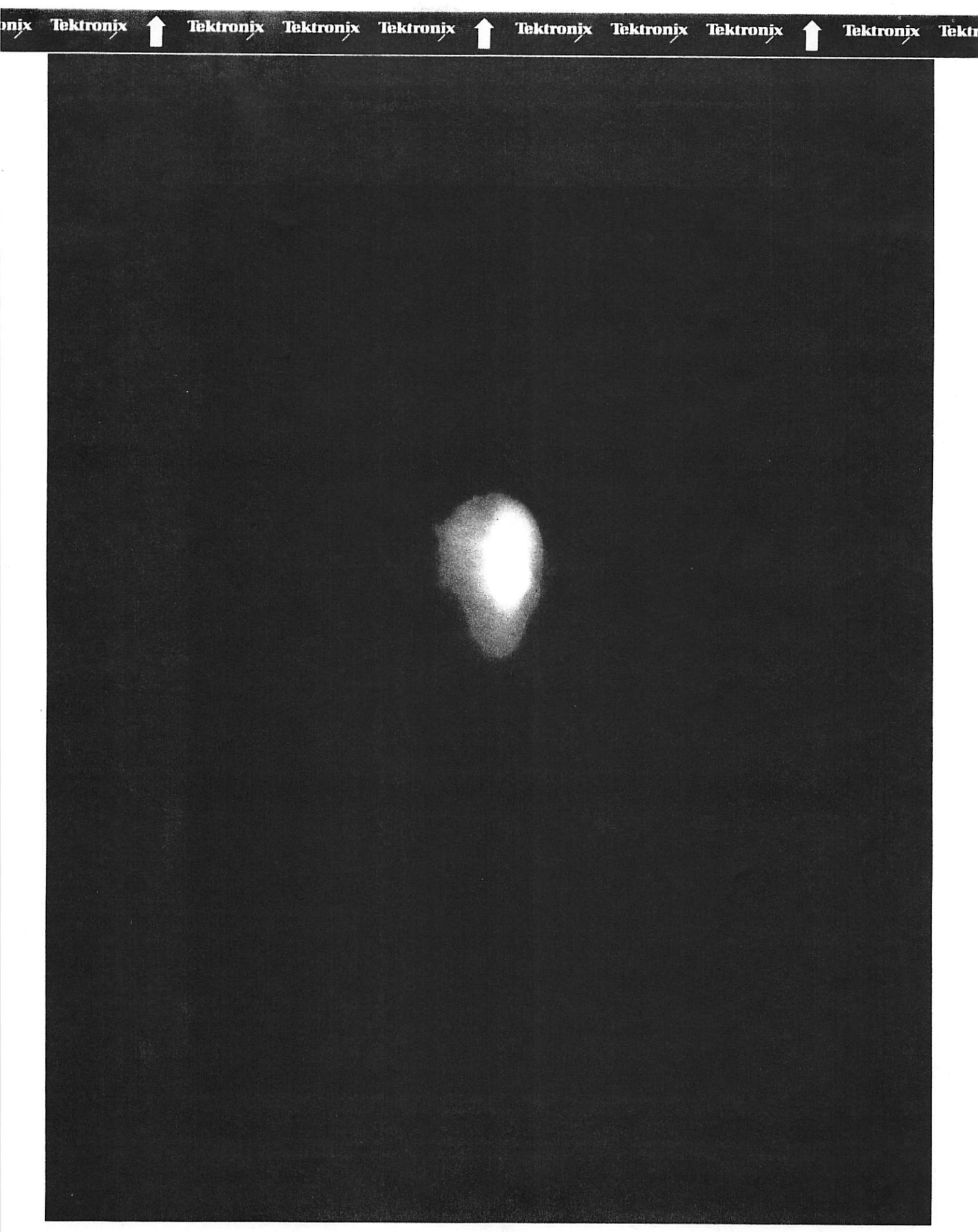


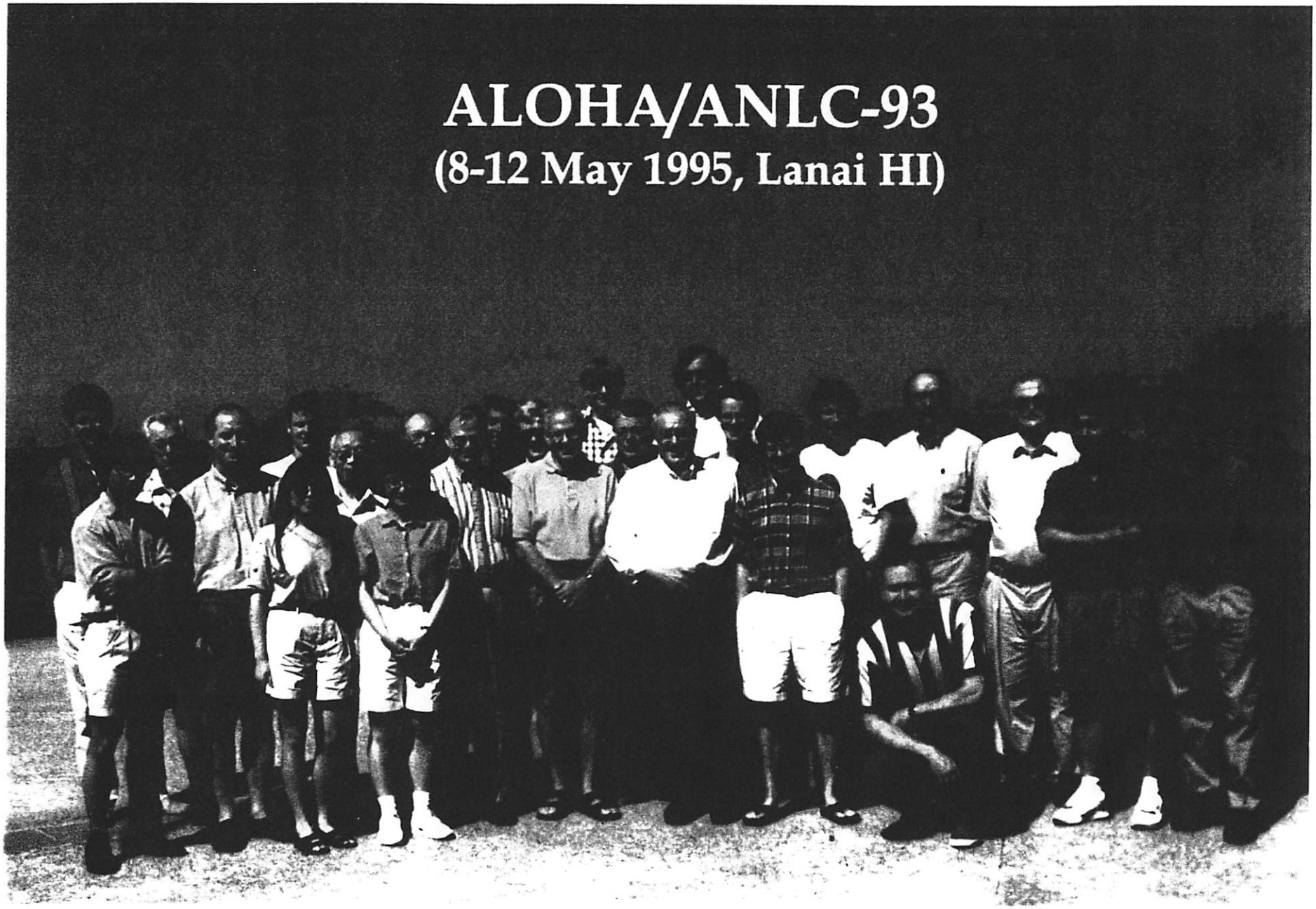
OCTOBER 15, 1995 Volume 22 Number 20

AMERICAN GEOPHYSICAL UNION

ALOHA/ANLC-93 PARTICIPANTS & ANALYSTS

Jack Albetski, Thermo Electron Technologies
Susan Avery, University of Colorado
Herb Carlson, Phillips Laboratory
Mark Coble, University of Illinois
Leroy Cogger, University of Calgary
Phan Dao, Phillips Laboratory
Ed Dewan, Phillips Laboratory
Patrick Espy, Utah State
Wayne F. J. Evans, Trent University
Dave Fritts, University of Colorado
Greg Garbe, University of Calgary
Francisco Garcia, Cornell University
Yiyun Gu, University of Illinois
Paul Hays, University of Michigan
Jim Hecht, Aerospace Corporation
Mike Hickey, Univ of Alabama Huntsville
Susan Ramsay Howat, Univ of Edinburgh
Joseph Isler, University of Colorado
Ted Kreifels, Phillips Laboratory
Bob Lowe, University of Western Ontario
Usama Makhlouf, Stewart Radiance Lab
Alan Manson, University of Saskatchewan
Stu McDermid, Jet Propulsion Lab
Donald McEwen, University of Saskatchewan
John Meriwether, Clemson University
Gamini Munasinghe, University of Cincinnati
George Papen, University of Illinois
Dick Picard, Phillips Laboratory
John Plane, University of East Anglia
Jun Qian, University of Illinois
Larry Radke, NCAR
Ray Roble, NCAR
Y. Sahai, Instituto Nacional de
Pesquisas Espaciais, São Paulo, Brazil
Gordon Shepherd, York University
Dale Simonich, Instituto Nacional de
Pesquisas Espaciais, São Paulo, Brazil
Xin Tao, University of Illinois
Mike Taylor, Utah State
T. F. Tuan, University of Cincinnati
Dave Turnbull, Univ of Western Ontario
Bob Vincent, University of Adelaide
Richard Walterscheid, Aerospace Corporation
Rudy Wiens, York University
Sam (J.H.) Yee, Johns Hopkins APL
Henry Boynton, NCAR pilot
Jerry Tejcek, NCAR pilot


Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix Tektronix


ALOHA/ANLC-93
(8-12 May 1995, Lanai HI)