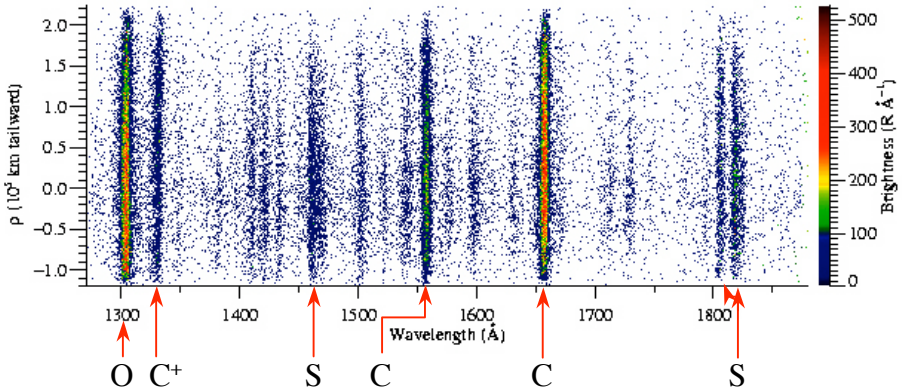
Strongest Ever Carbon Monoxide Production Discovered in Coma of Comet Hale-Bopp

Image of Comet Hale-Bopp, courtesy W. Johnasson.

Comet Hale-Bopp -- 6 April 1997

JHU-NASA Sounding Rocket 36.156 UG

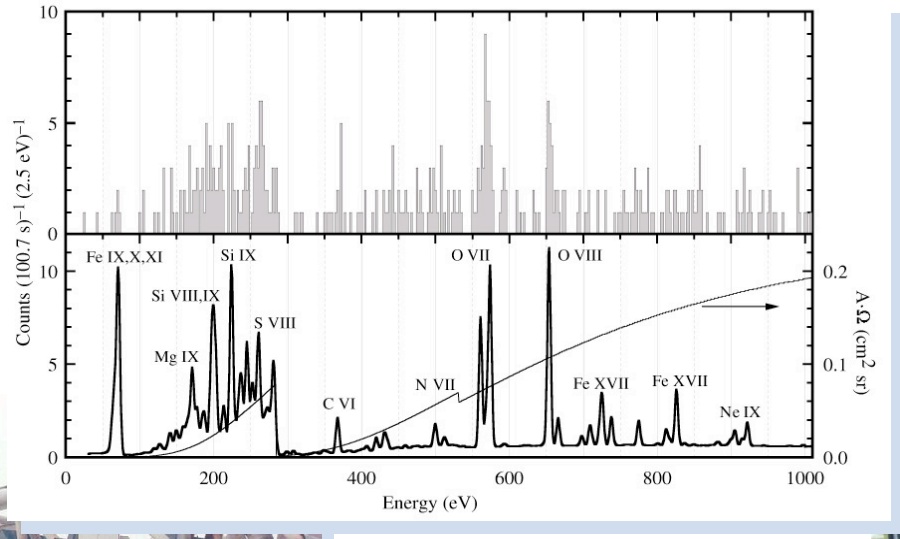


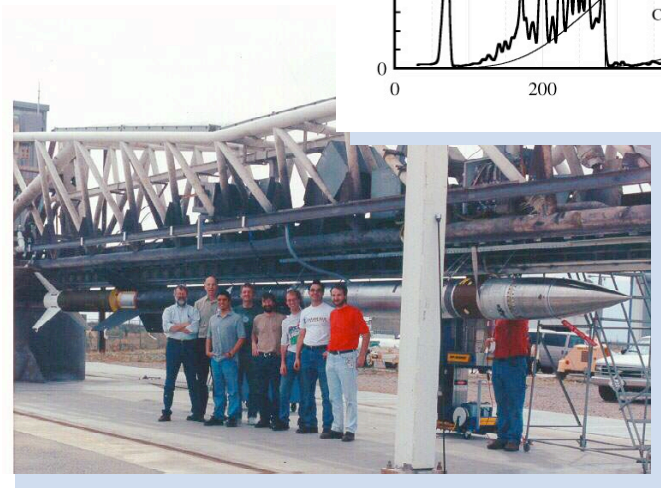
- **Remaining emissions are bands of the carbon monoxide Fourth Positive system.**

- Carbon abundances may simply result from photodissociation of CO.
- Observations gathered very close to perihelion; Comet was very active.

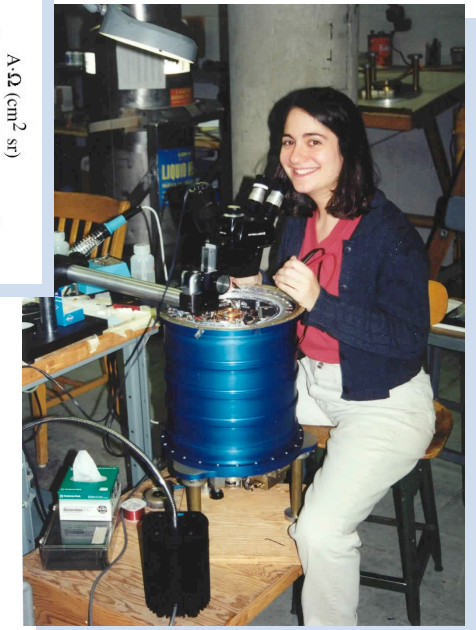
[Data: P. Feldman, Johns Hopkins Univ.; See also J. McPhate, *Ap. J.*, *521*, 920, 1999.]

New X-Ray Detector Developed on Sounding Rockets





Scientists at the launch pad

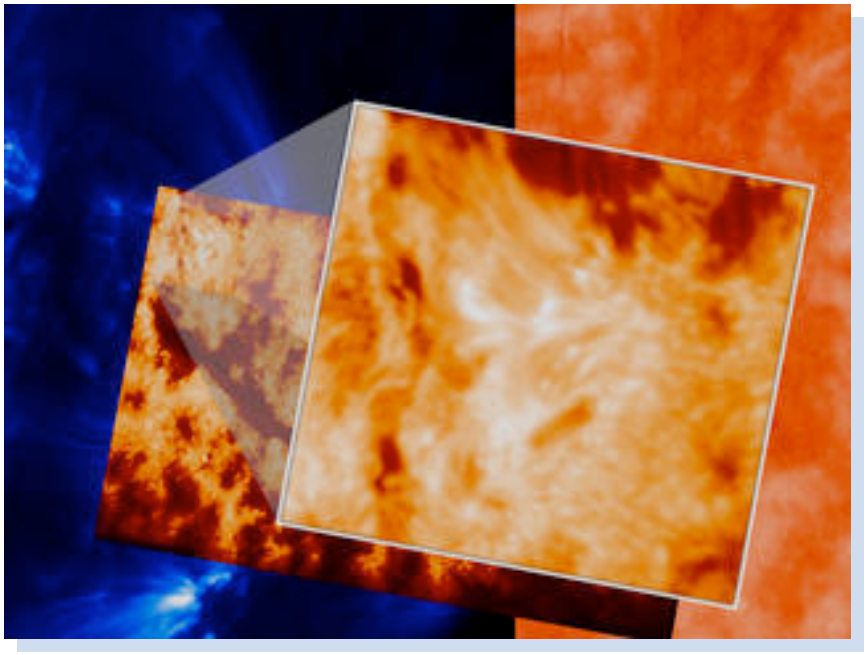


Graduate student checks instrument

- **1st Detection of diffuse emission in 172 A Fe lines**
- **Observations demonstrate soft X-ray background is thermally produced.**
- **Detector to be deployed on Astro-E2, Constellation-X, XEUS**

Data and photos: D. McCammon, Univ. of Wisc.

High Time and Spatial Resolution in Lyman α Reveal New Features of Solar Chromosphere

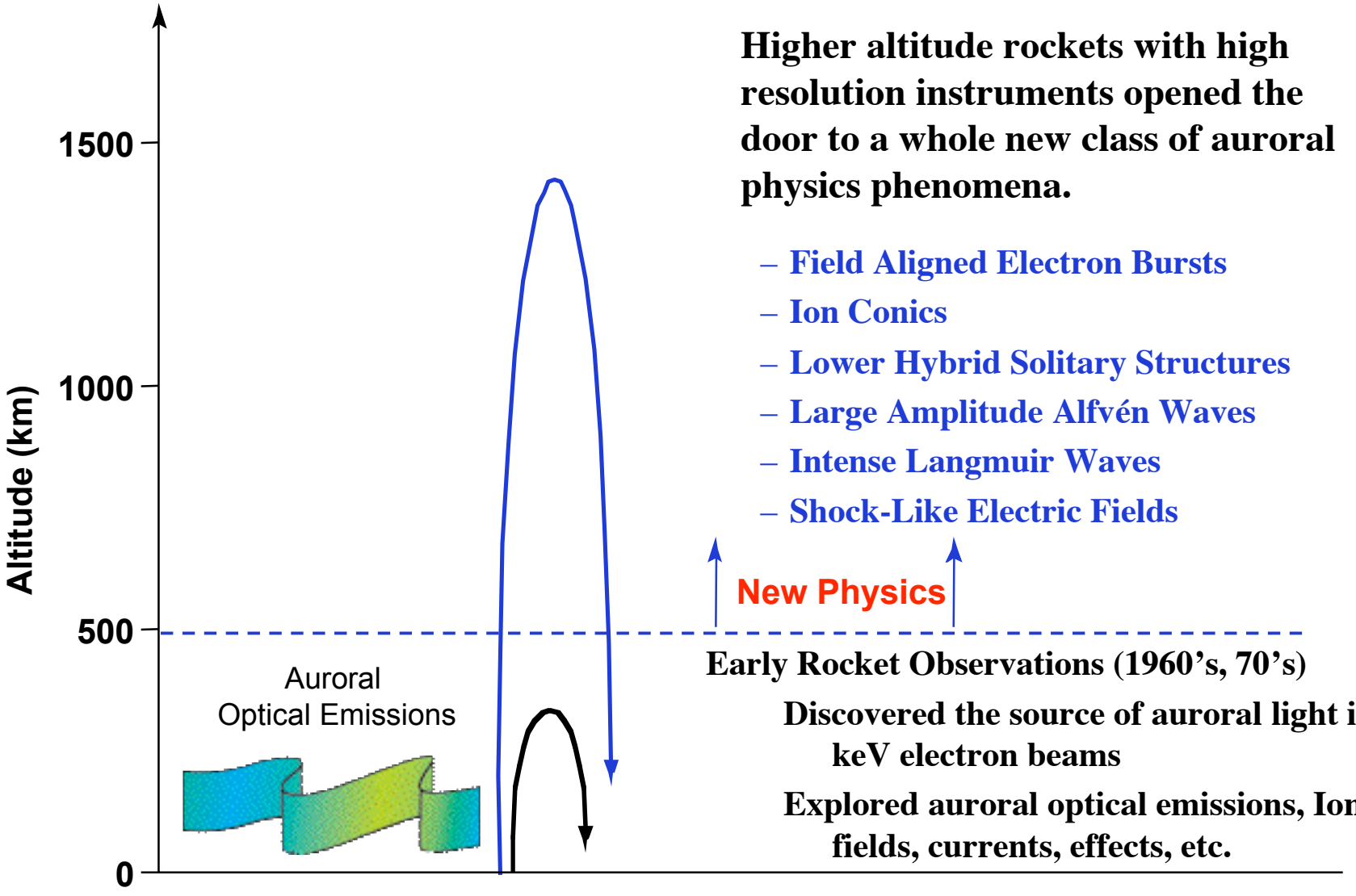


- **Highest Spatial resolution achieved to date (<0.3 arc sec)**
- **Simultaneous measurements with SoHo, TRACE enable different layers of the sun to be observed of the same region**

Very high Angular resolutions ULtraviolet Telescope (VAULT), Naval Research Lab

Data: C. Korendyke, NRL

Auroral Physics on Sounding Rockets: Understanding Particle Acceleration in Nature



Higher altitude rockets with high resolution instruments opened the door to a whole new class of auroral physics phenomena.

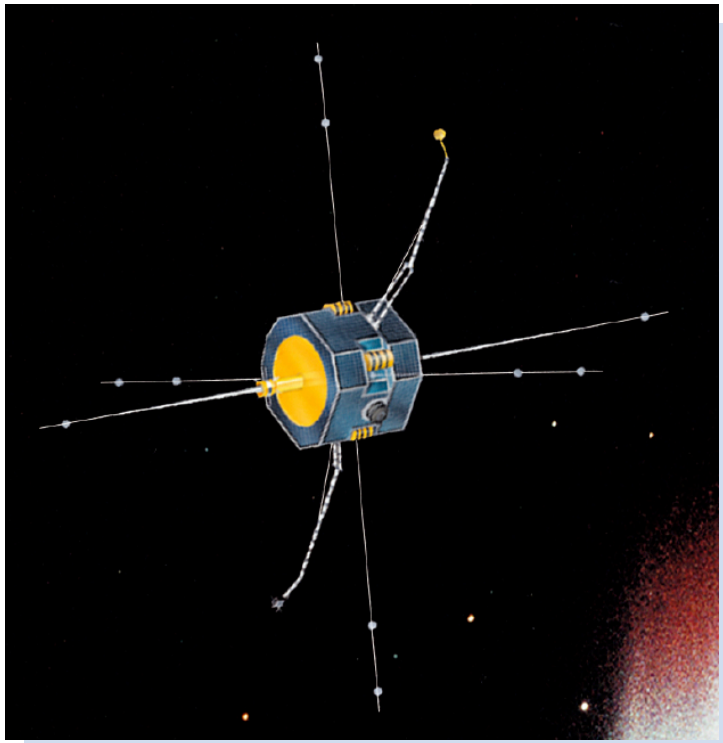
- **Field Aligned Electron Bursts**
- **Ion Conics**
- **Lower Hybrid Solitary Structures**
- **Large Amplitude Alfvén Waves**
- **Intense Langmuir Waves**
- **Shock-Like Electric Fields**

Early Rocket Observations (1960's, 70's)

Discovered the source of auroral light is due to keV electron beams

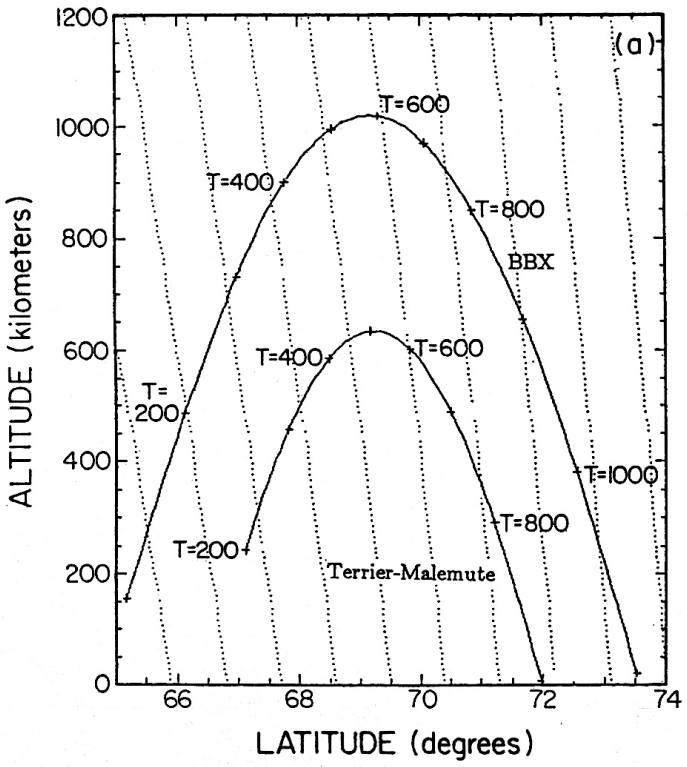
Explored auroral optical emissions, Ionosphere fields, currents, effects, etc.

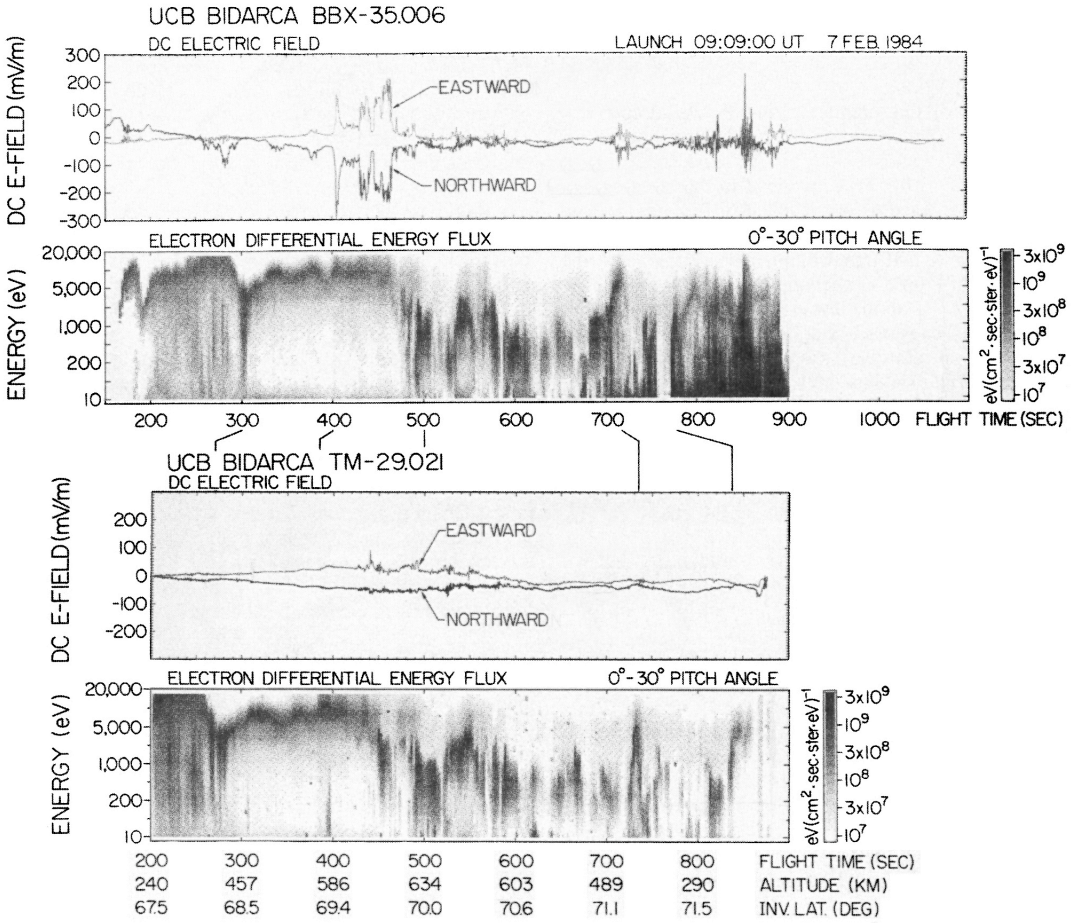
Auroral Zone Rocket Discoveries Formed the Springboard for NASA's FAST Satellite



- **Auroral physics discovered on sounding rockets formed the basis of FAST Small Explorer Satellite**
- **FAST in-situ instruments were developed on rockets (e.g., "Top Hat" electrostatic detectors, plasma wave Interferometers)**
- **FAST experimenters, including P.I., had extensive prior experience with sounding rockets**

Dual-Rocket Observations of Electrostatic Shocks in the Auroral Zone

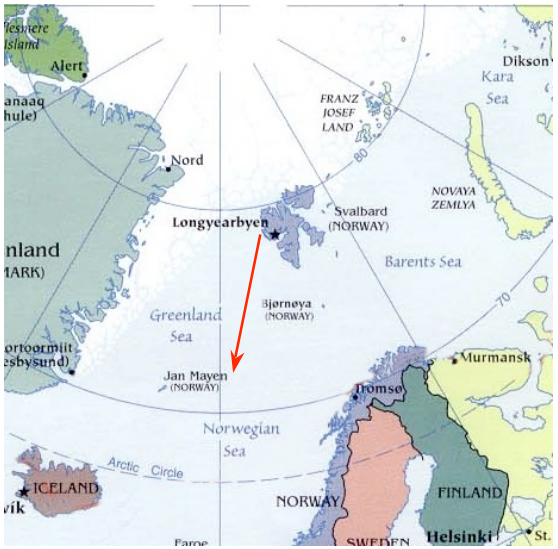


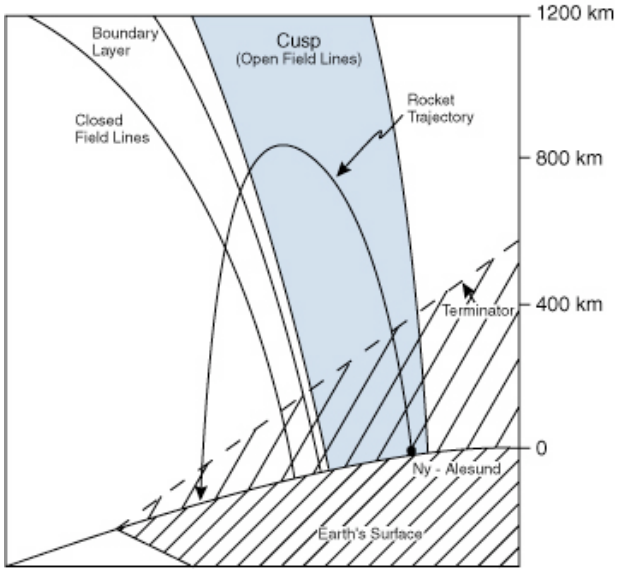


[Boehm et al., JGR, 1990]

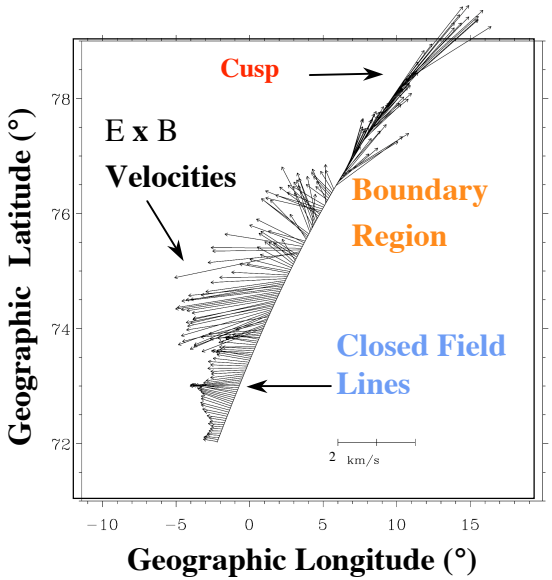
Direct Measurements in the Cusp from Spitzbergen

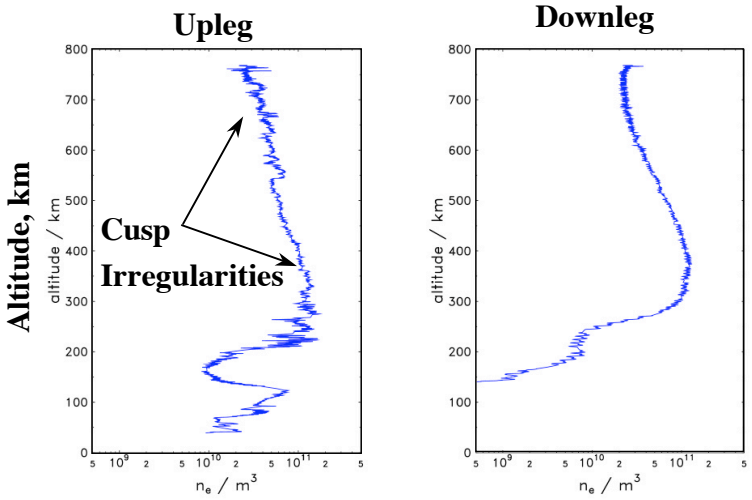
Experiment Location and Geometry:





Electric field, plasma density reveal complex electrodynamics at open/closed magnetic field line boundary.



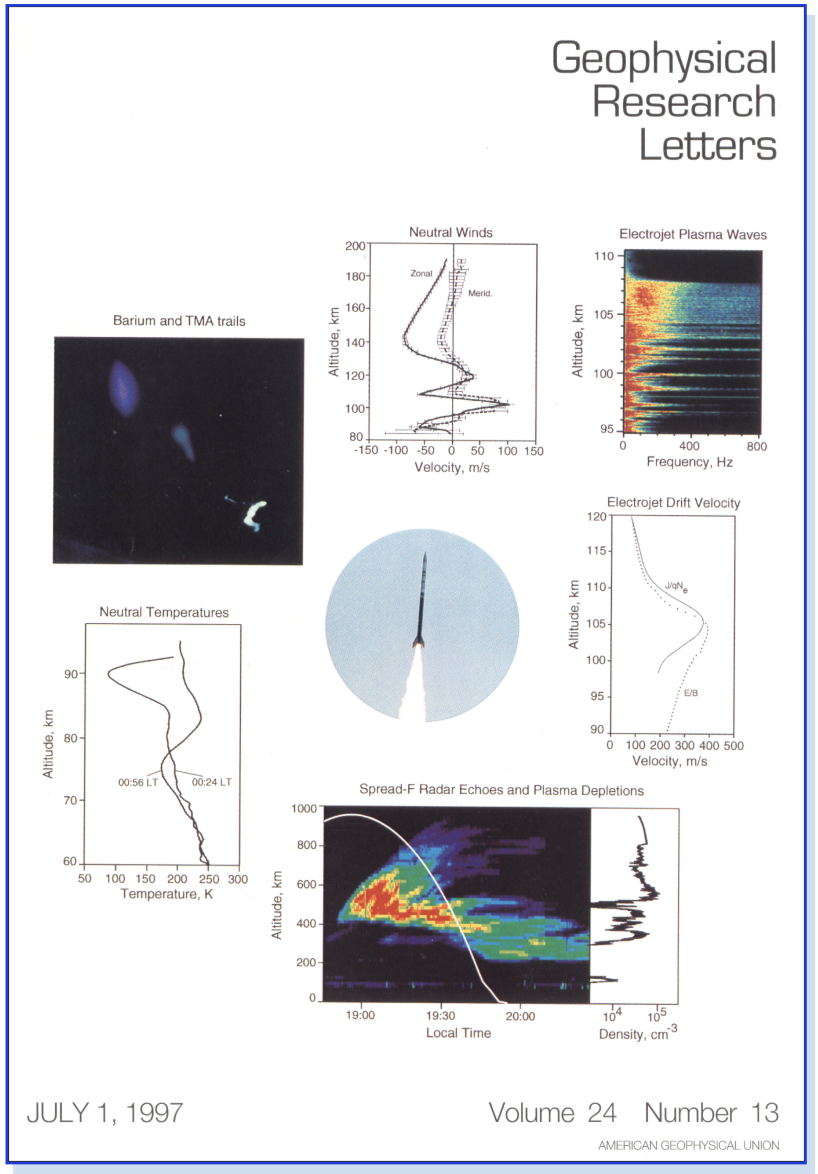


Plasma Density

Data: R. Pfaff, GSFC

NASA Guará Campaign

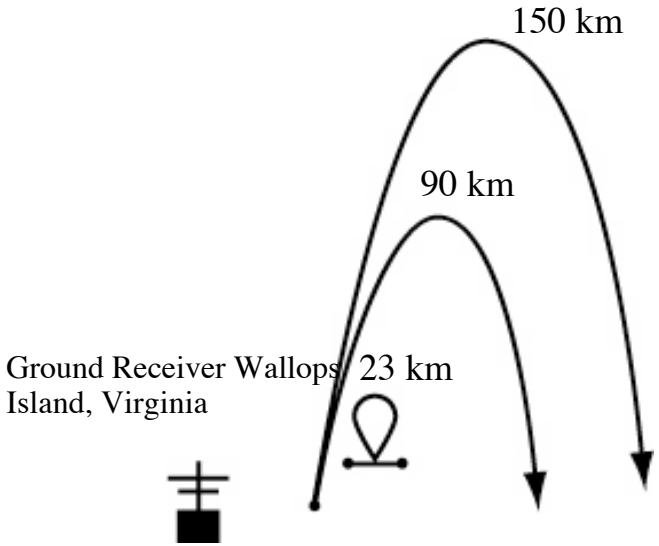
13 Rocket Launches at the Magnetic Equator in Brazil



Observations include several significant "Firsts":

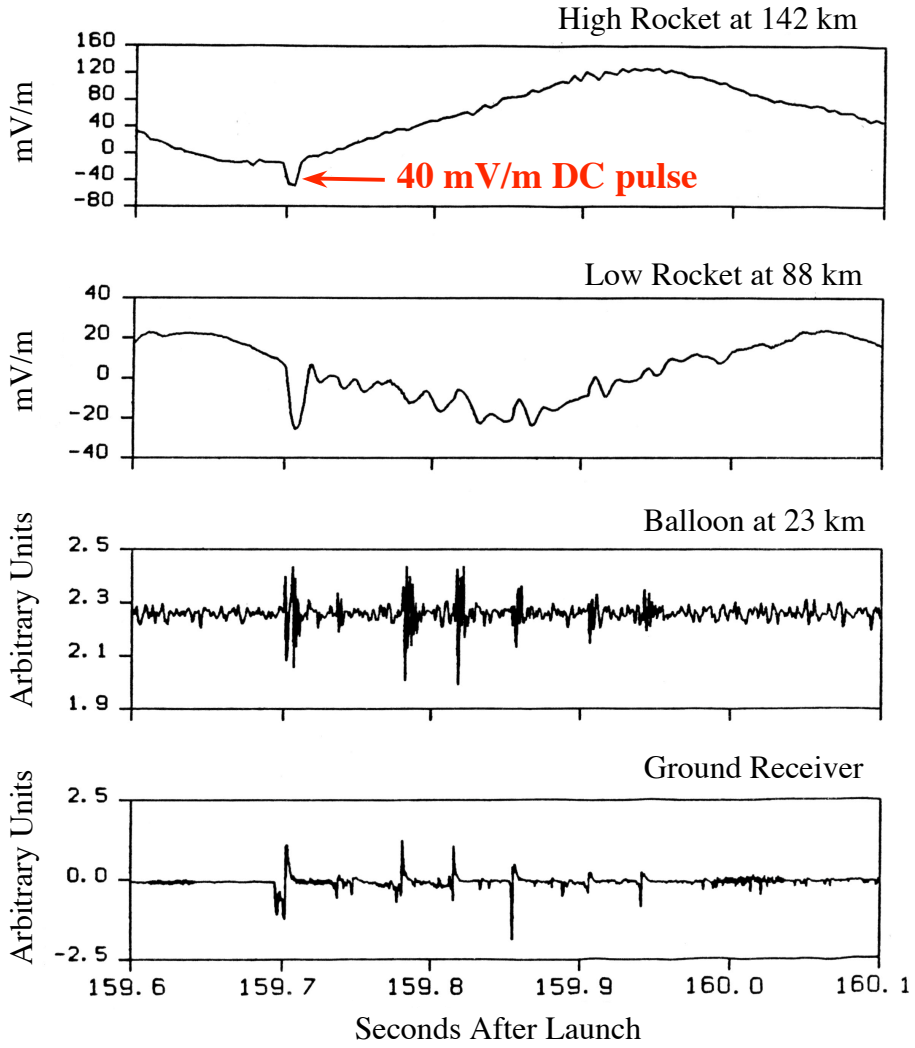
- **Polarization DC electric field that drives the equatorial electrojet**
- **High altitude (>800 km) DC and wave electric fields gathered in a Spread-F plume**
- **Neutral wind gradients associated with enhanced E-fields at sunset**
- **Gravity wave breaking in the equatorial mesosphere**
- **Primary two-stream wave spectra and phase velocities in electrojet.**

Direct Penetration of Lightning Electric Fields in the Ionosphere: Dual Rocket Experiment

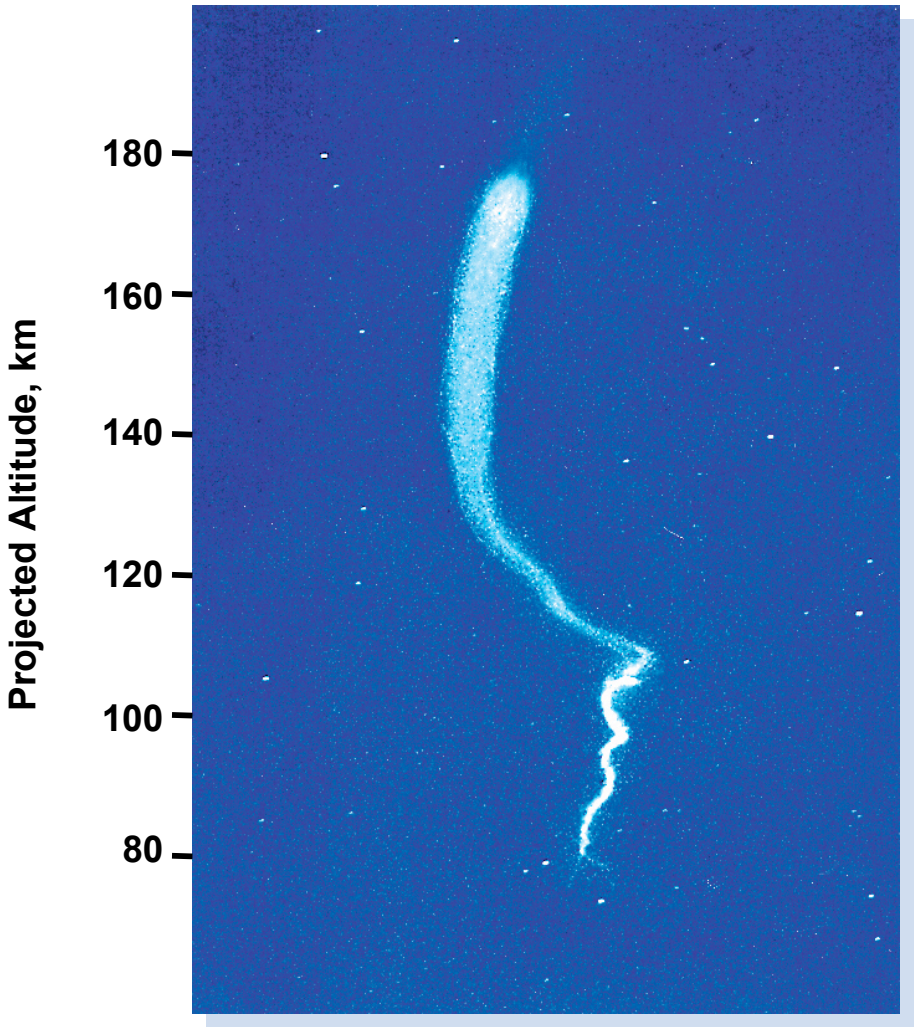


[Kelley et al., JGR, 1985]

Thunderstorm Electric Fields



Luminous Trails Reveal Ionospheric Neutral Winds, Vortex Structures, and Instabilities



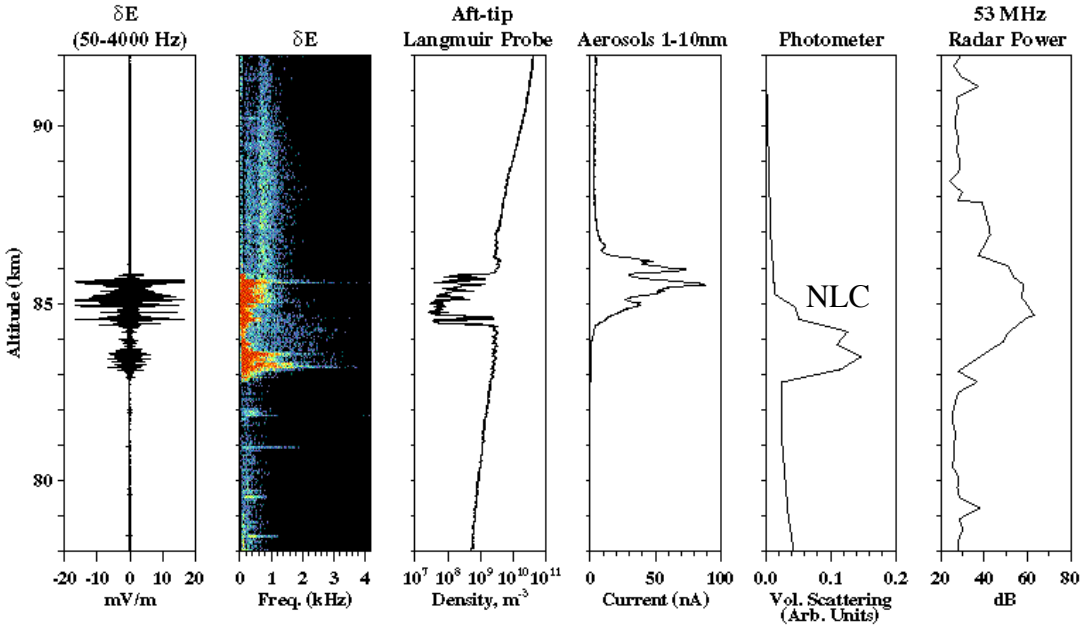
Poker Flat, Alaska

[Courtesy of M. Larsen/Clemson Univ.]

Rocket Measurements of Noctilucent Clouds (NLC): A Near-Earth Icy, Dusty Plasma

- NLC located in high latitude summer mesosphere.
- Lowest neutral temperatures in atmosphere.
- Possible indicators of anthroprogenic change
- Region of very intense radar echoes
- Complex aerosol chemistry, dynamics, electrical charge distributions.

Data from rocket flight into NLC with intense radar echoes from Andoya, Norway



[see Goldberg et al., GRL, 2001.]