Military Systems Total Electron Content Requirements

Living With A Star Measurement Requirements Workshop

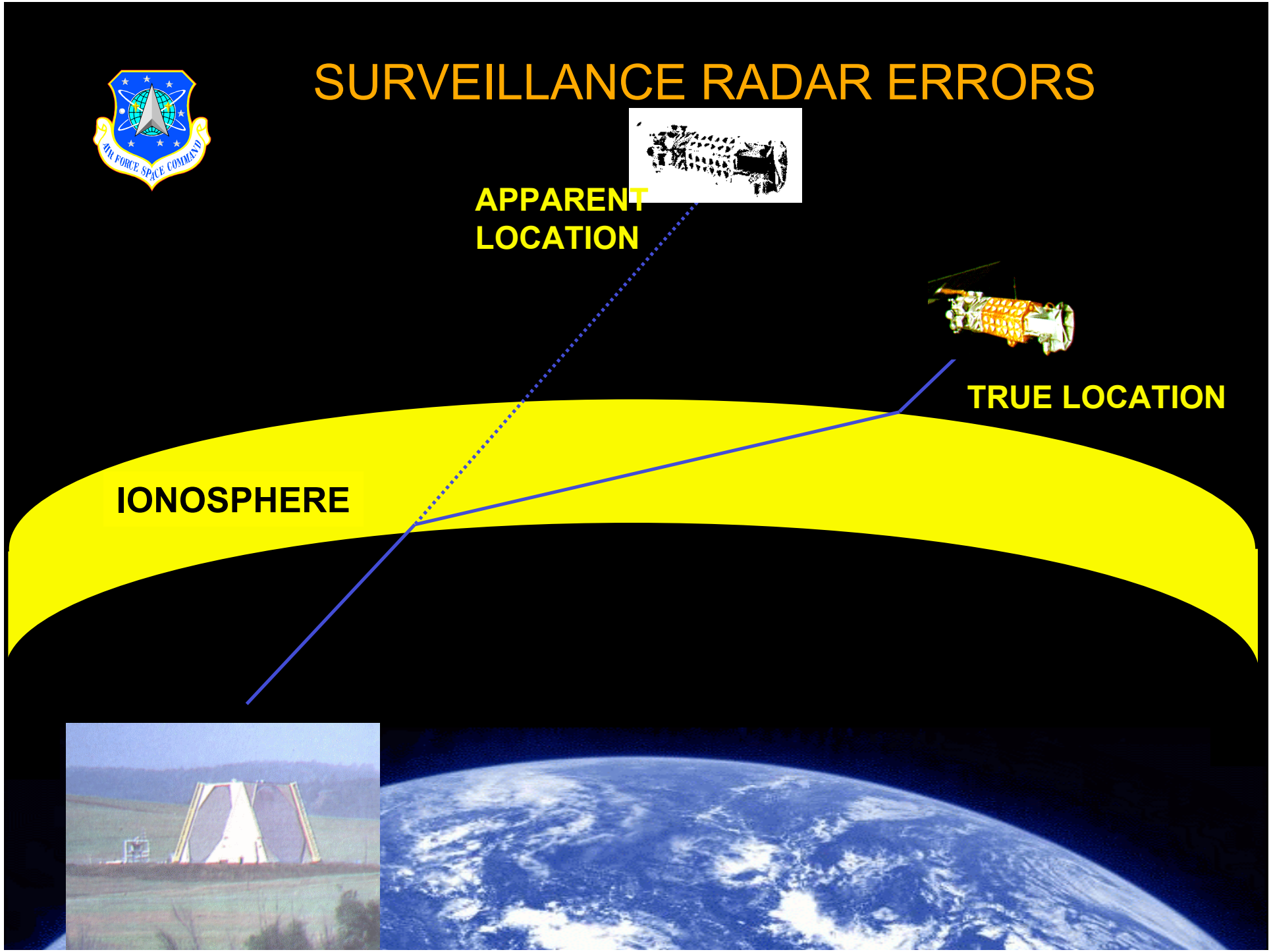
February 9, 2000

Paul R. Straus

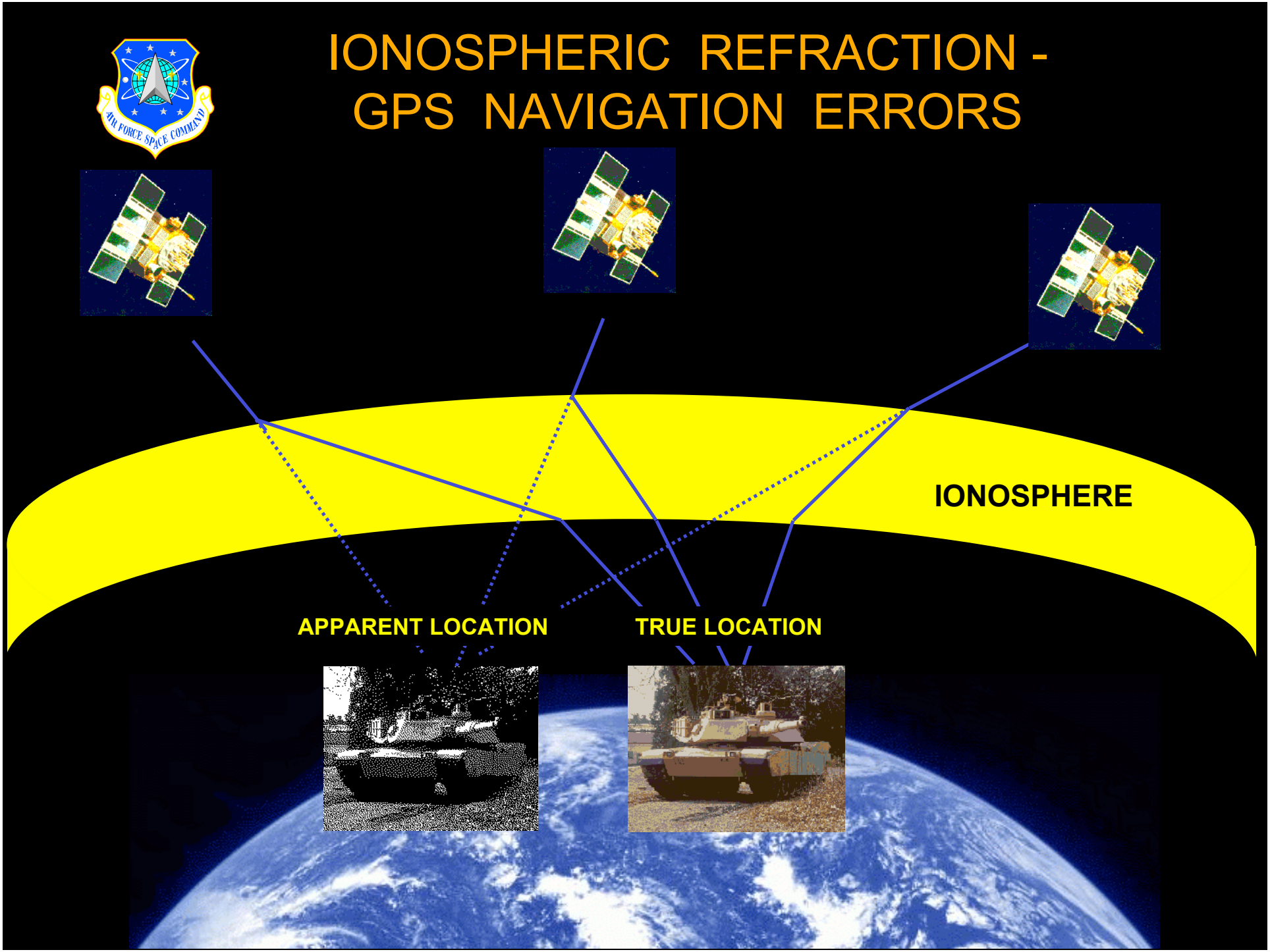
The Aerospace Corporation

Space Environment Applications Laboratory

SURVEILLANCE RADAR ERRORS

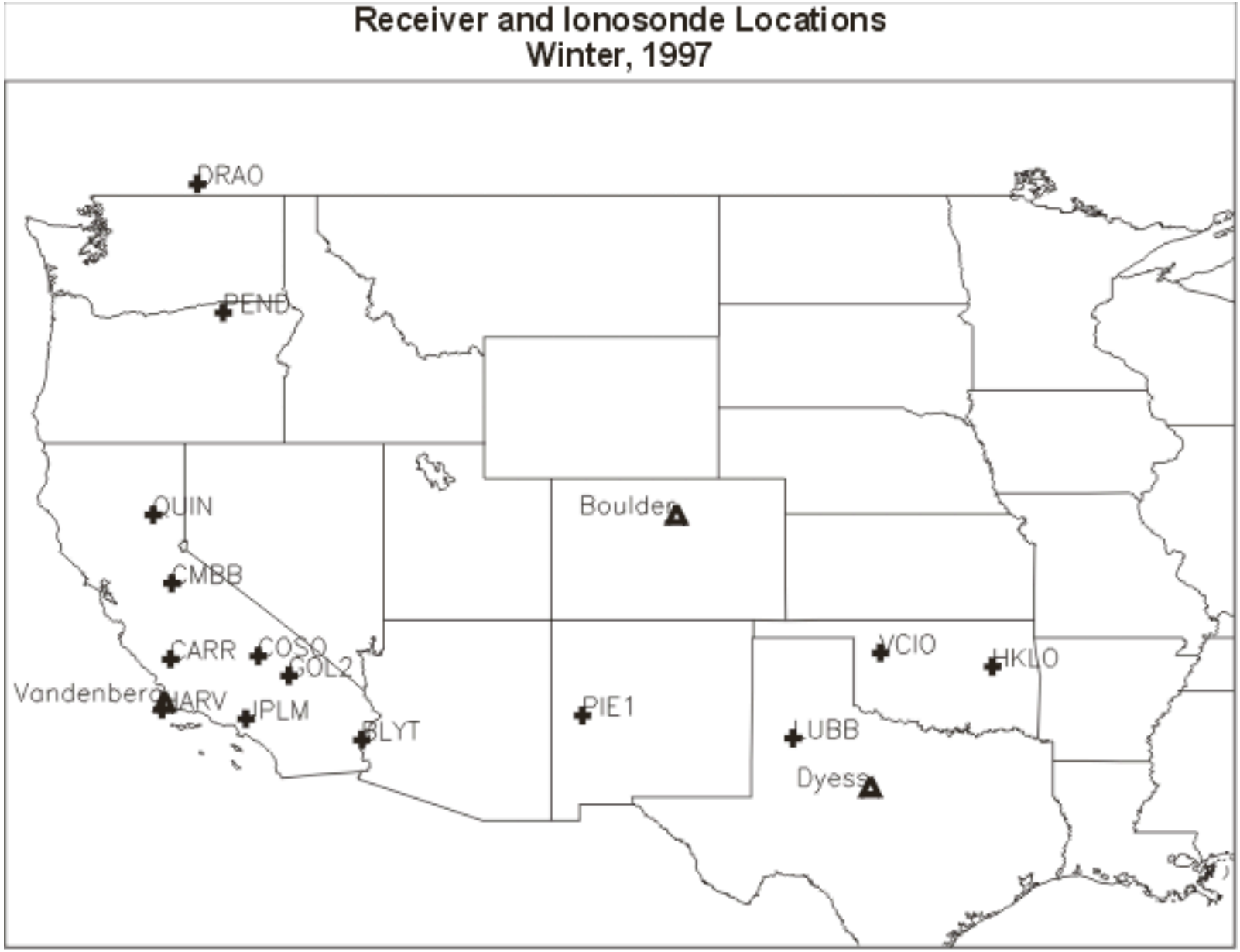


IONOSPHERIC REFRACTION - GPS NAVIGATION ERRORS

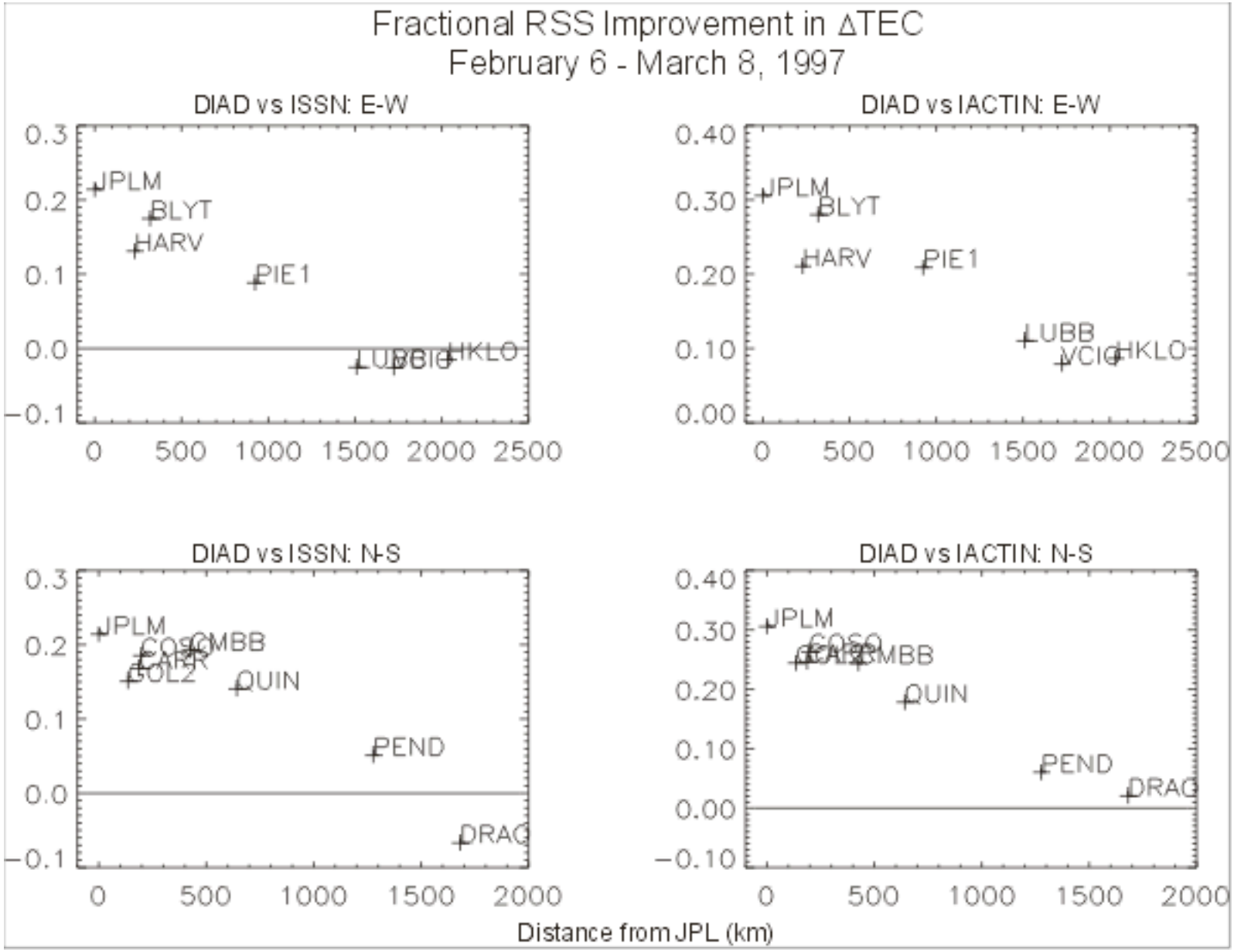


National Programs Requirements

- Arbitrary Slant Path TEC Specification
  - Accuracy: 3 TECu (threshold)/ <1 TECu (goal)
  - Coverage: Global
  - Timeliness: Near-Real Time
  - Spatial Resolution: TBD
- Specification of Arbitrary Path Implies Need for 3D Electron Density Profile Knowledge
- Near Real Time Specification Implies "Now-Casting" Solution



From Prag, et.al., IES 1999



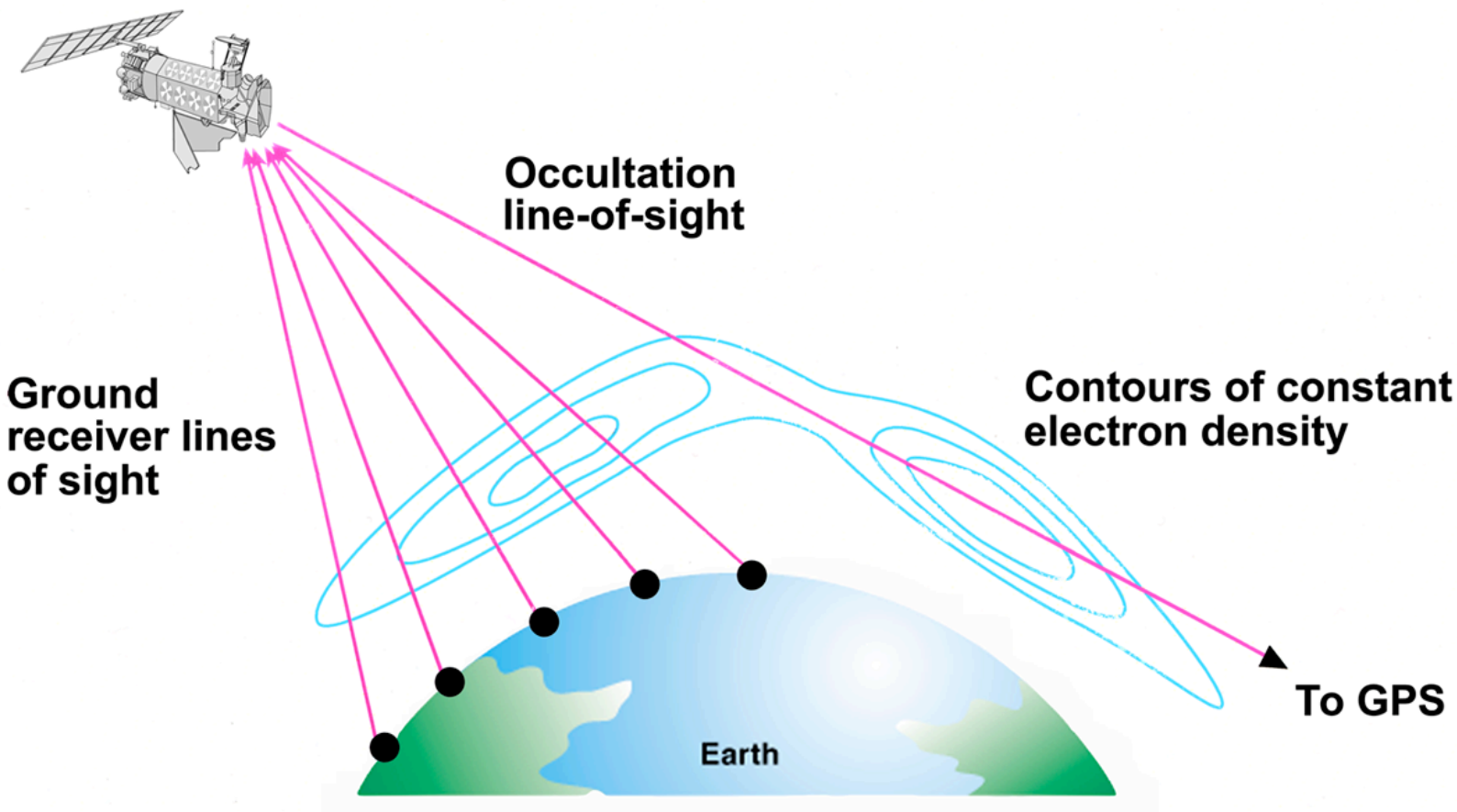
From Prag, et.al., IES 1999

THE AEROSPACE CORPORATION

Aerospace Ionospheric "Weather" Activities

- Requirements Studies for AF Program Offices
- Investigation of Ionospheric Remote Sensing Techniques
  - GPS Occultation
  - FUV/EUV Airglow
    - PI for GUVI sensor on NASA TIMED mission
- Work Towards Incremental Improvement of AF Capabilities

PICOSat: Tomographic Combination of GPS Occultation & RF Beacon Data



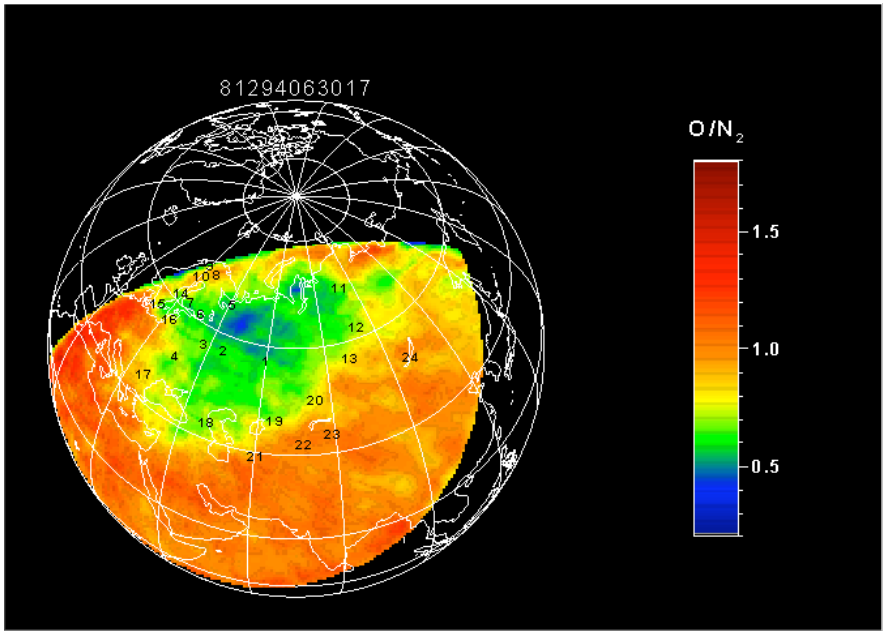
Issues/Drivers For Ionospheric Variability

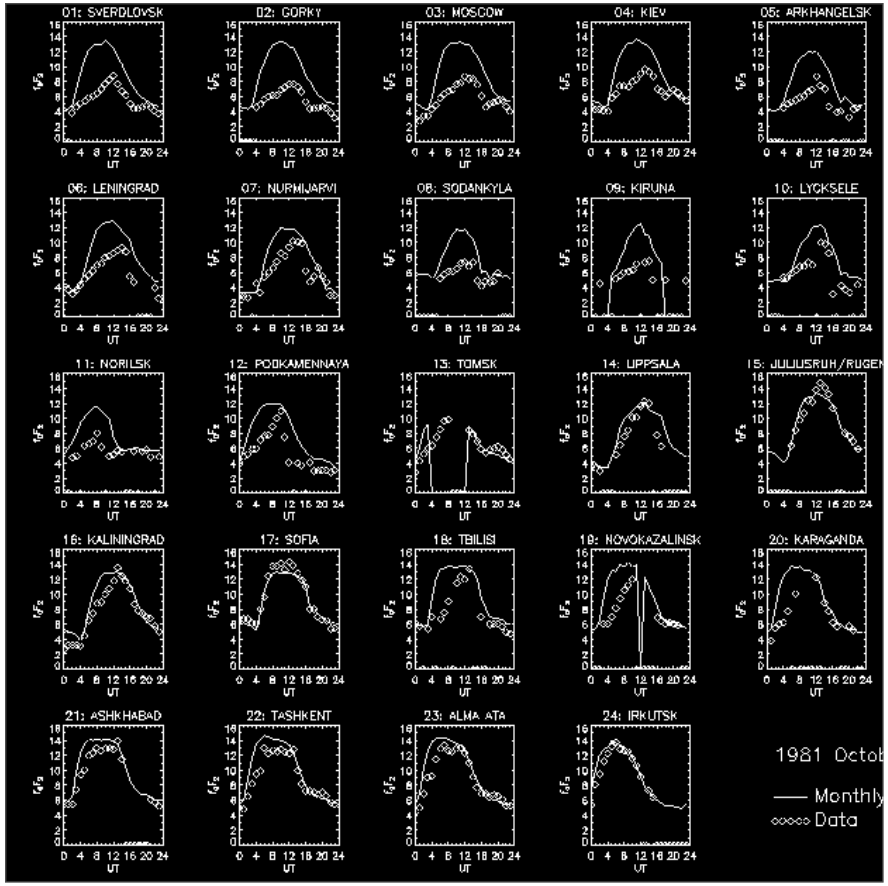
- Traveling Ionospheric Disturbances (TIDs)
- Neutral Atmospheric Composition Changes
- Plasma Turbulence & Associated Depletions
- Neutral Winds
- Electric Fields
- Plasmaspheric TEC

THERMOSPHERIC/IONOSPHERIC STORM OVER SCANDINAVIA & RUSSIA ON OCTOBER 21, 1981

DE-1 SAI-based O/N_2

0630 UT





Courtesy D. Strickland, Computational Physics, Inc.

How Can LWS Help?

- NASA Applications Oriented Research Can Provide A Solution to Military "Chicken & The Egg" Problem
- Answer The Question:
  - What kind/density of measurements are required to meet operation thresholds/goals for TEC?
- Provide an Extensive and Global Database of Ionospheric Measurements for Model Development/Validation
  - Measurements providing a global perspective are particularly useful

Relevant Sun-Earth Connections Missions

- Geospace Electrodynamic Connection (GEC)
- Geospace System Response Imagers (GRSI)
  - "Pole-sitting" continuous auroral imaging
  - Plasmaspheric tomography
- ITM Waves Probe
  - Gravity waves & TID's
  - "Seeding" of equatorial instabilities
- Sun-Earth Energy Connector (SEEC)
  - 91.1 nm ionospheric imaging (full disk)
  - Plasmaspheric imaging
  - Dayside neutral composition (full disk)

“Ionospheric Mappers” Suggestions

- Both Horizontal & Vertical Structures Must Be Mapped
  - Microsatellite constellation employing some combination of GPS occultation sensors and topside sounders
  - Full disk ionospheric imaging (ala SEEC)
  - Continuous auroral imaging (ala GRSI)
- “Mapping” Must Also Include Ancillary Ionospheric Information
  - E-fields, neutral densities, etc.