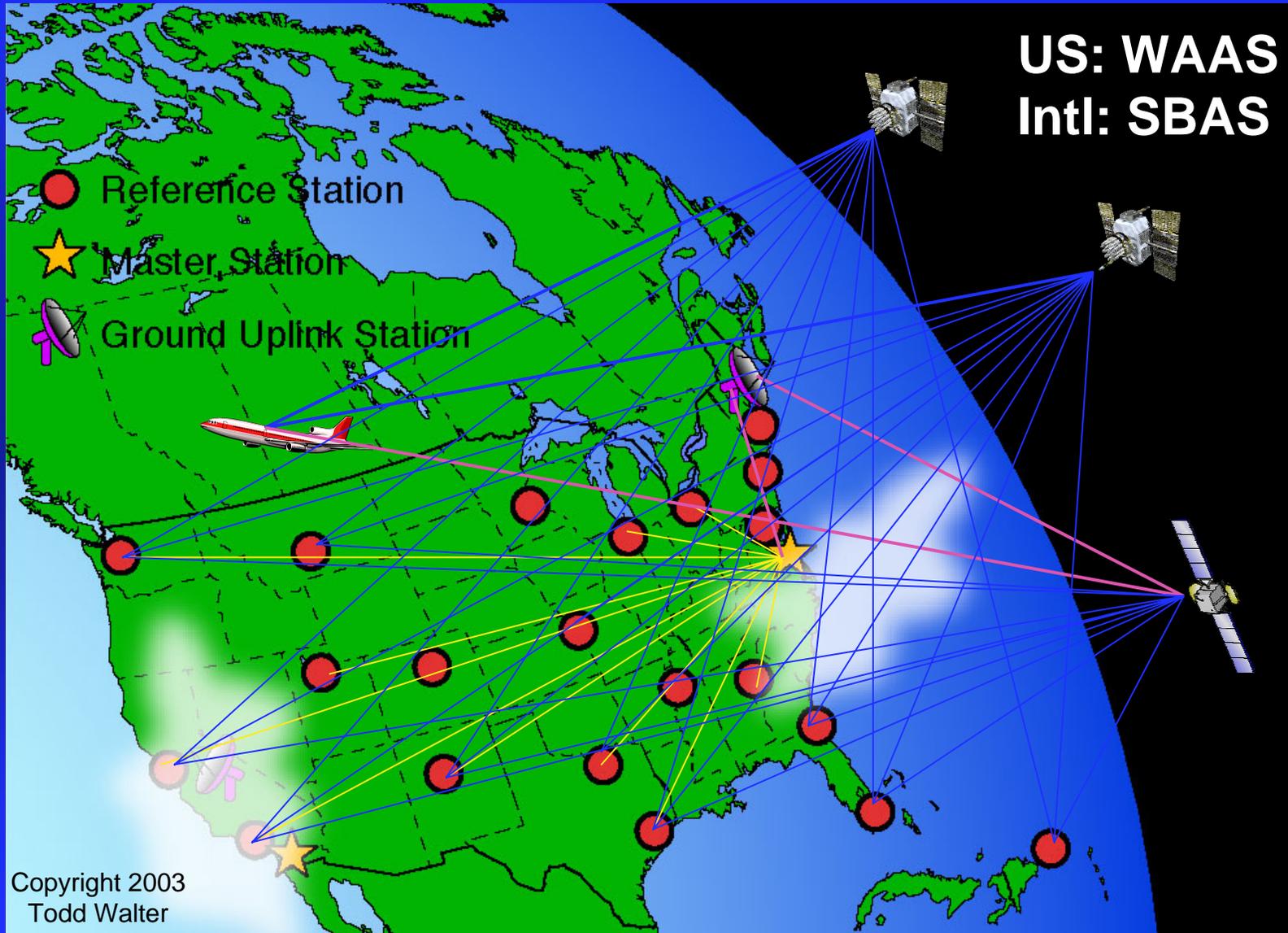

JPL and Satellite-Based Augmentation Systems for Civil Aircraft Navigation

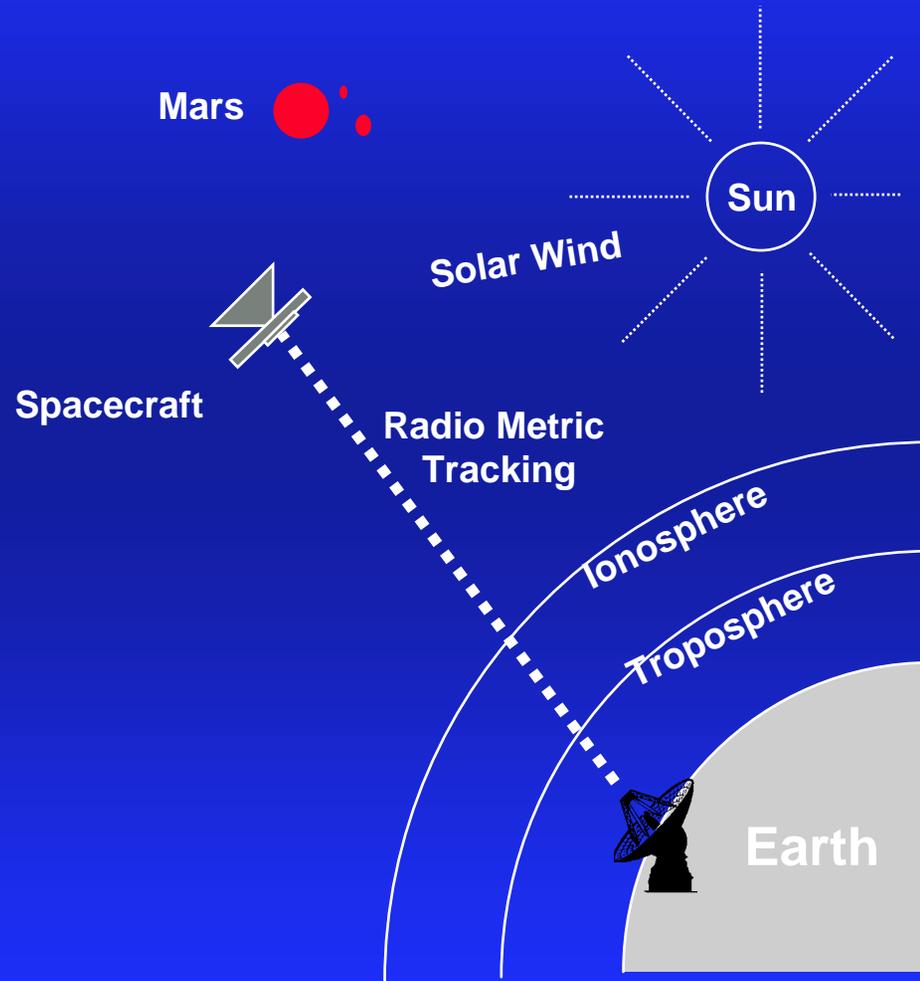
Anthony J. Mannucci
Supervisor

Ionospheric and Atmospheric Remote Sensing Group
Jet Propulsion Laboratory, California Institute of Technology

January 20, 2005

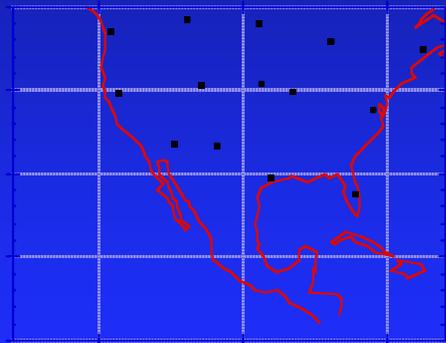


Deep Space Tracking

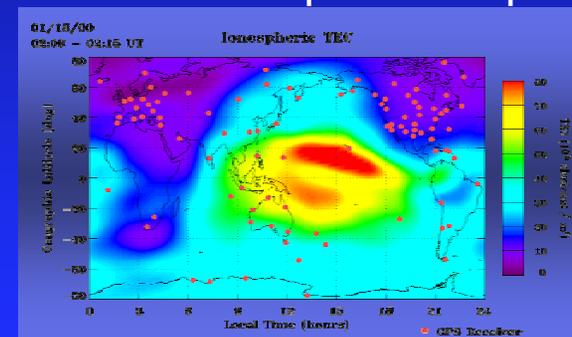


- **1995: JPL algorithms selected by Hughes (Raytheon)**
+ Interagency agreement between NASA and FAA
- **1999: WAAS Integrity Performance Panel formed**
+ JPL develops algorithms, performs data analysis and consults for WIPP/FAA
- **WAAS successfully commissioned in 2003**
- **JPL conducts research and development for Satellite-Based Augmentation Systems (SBAS)**

SATLOC
Ground
Network



Global Ionosphere Maps

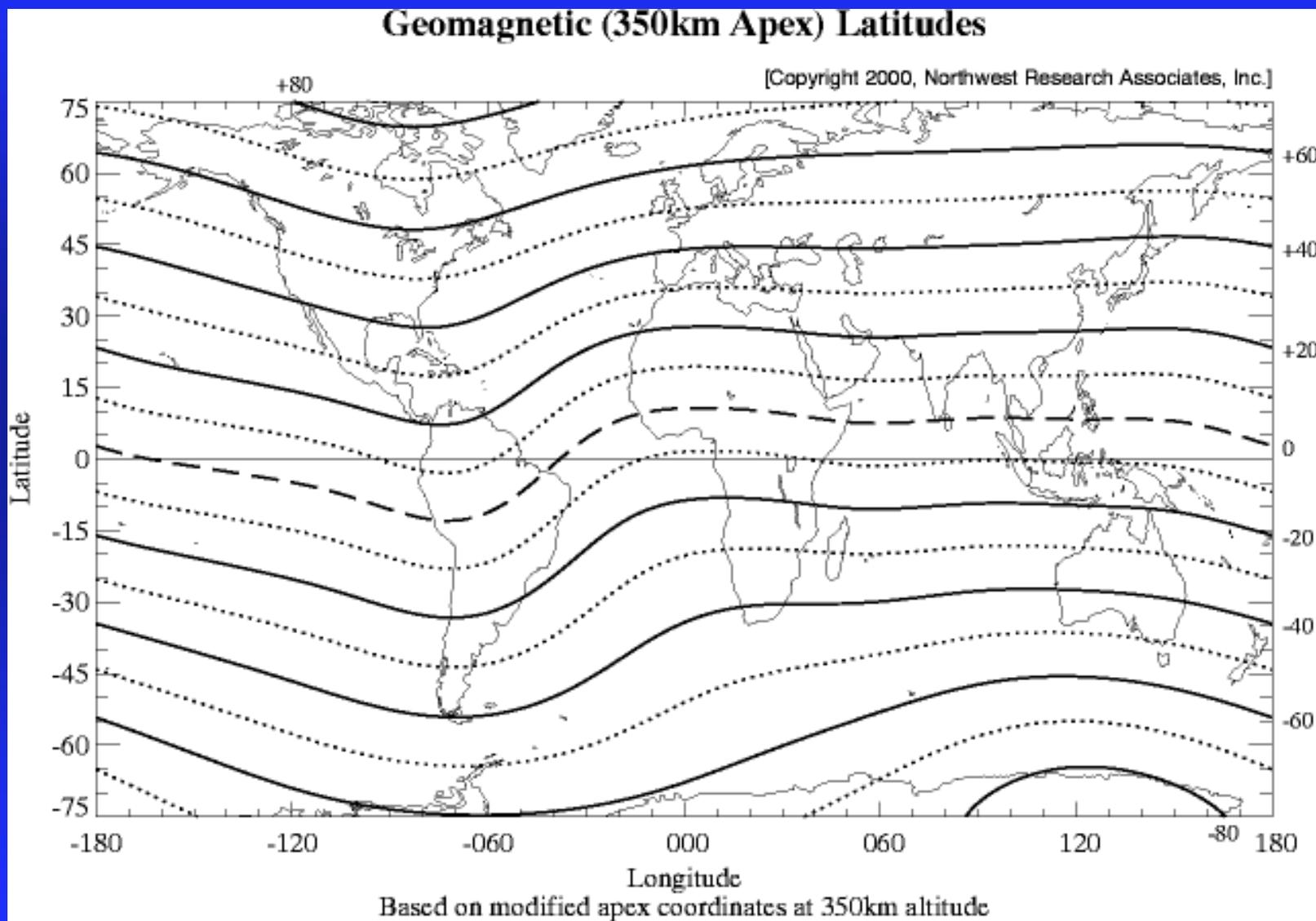




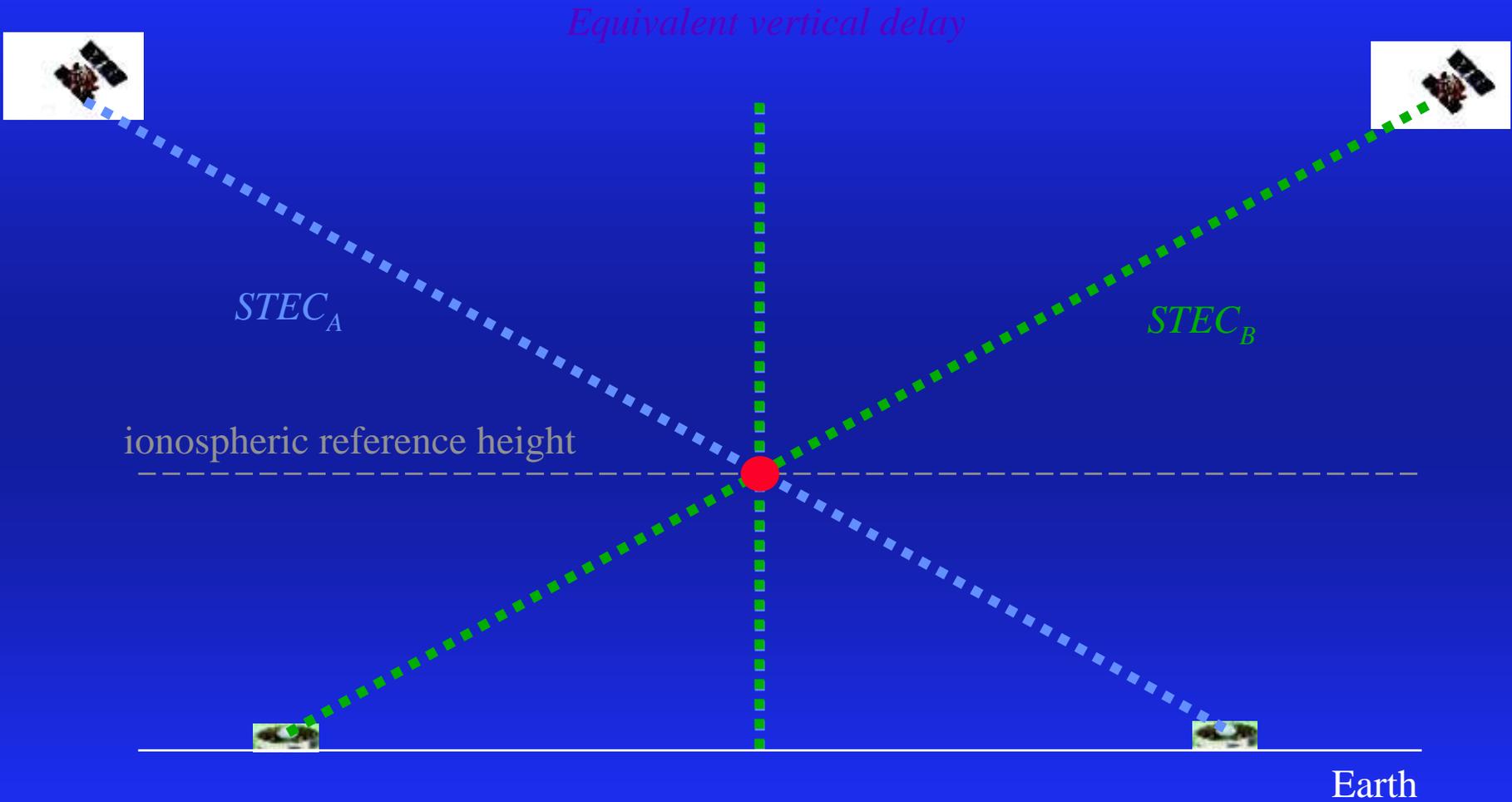
Global Ionosphere Features



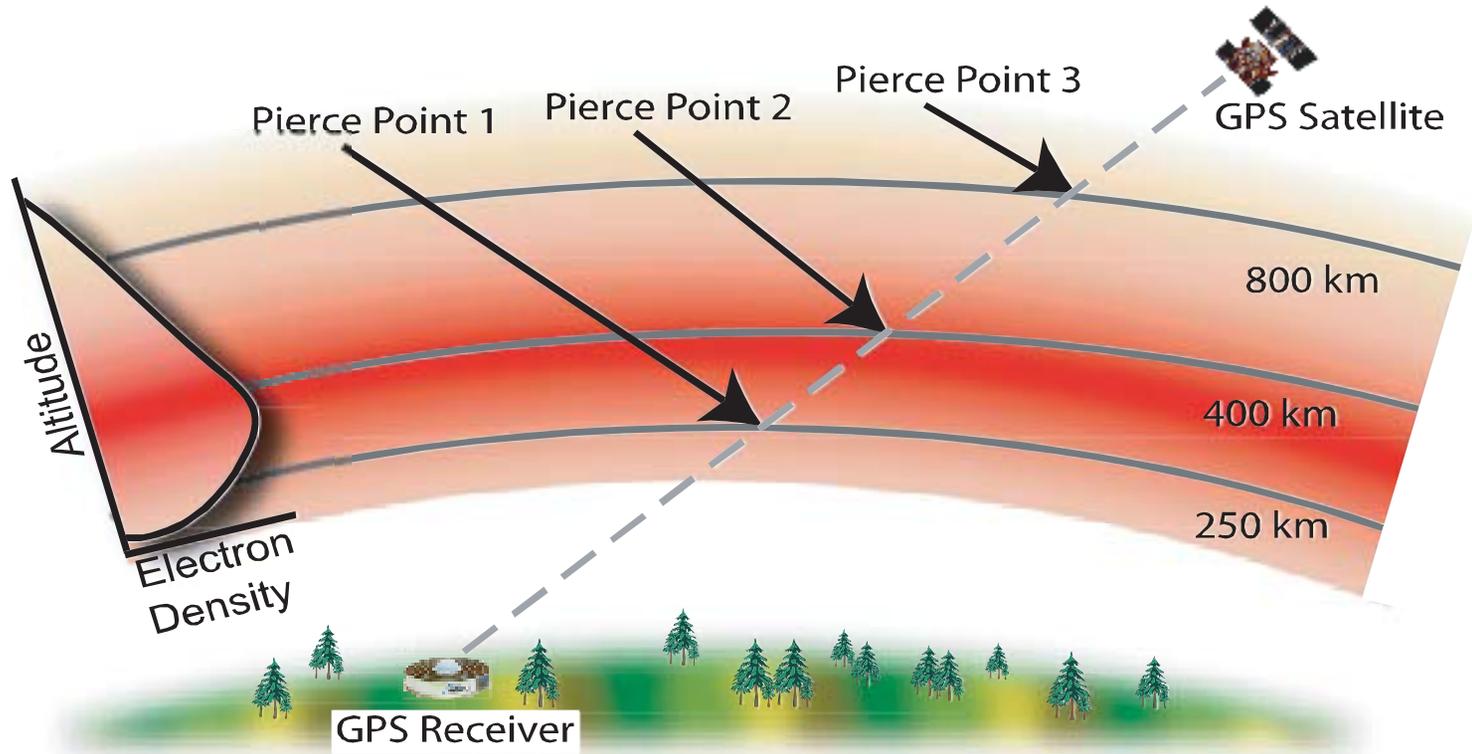
QuickTime™ and a
YUV420 codec decompressor
are needed to see this picture.

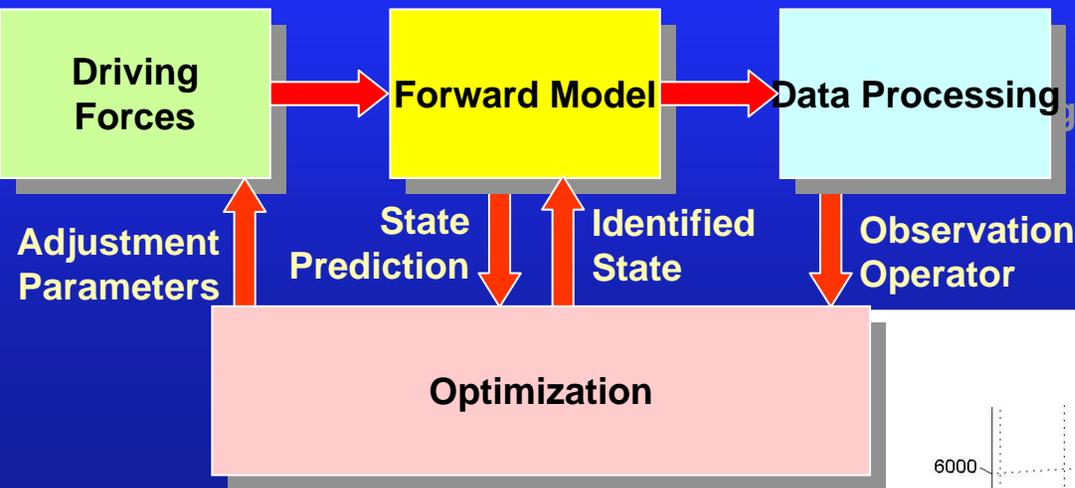


Single Shell Error

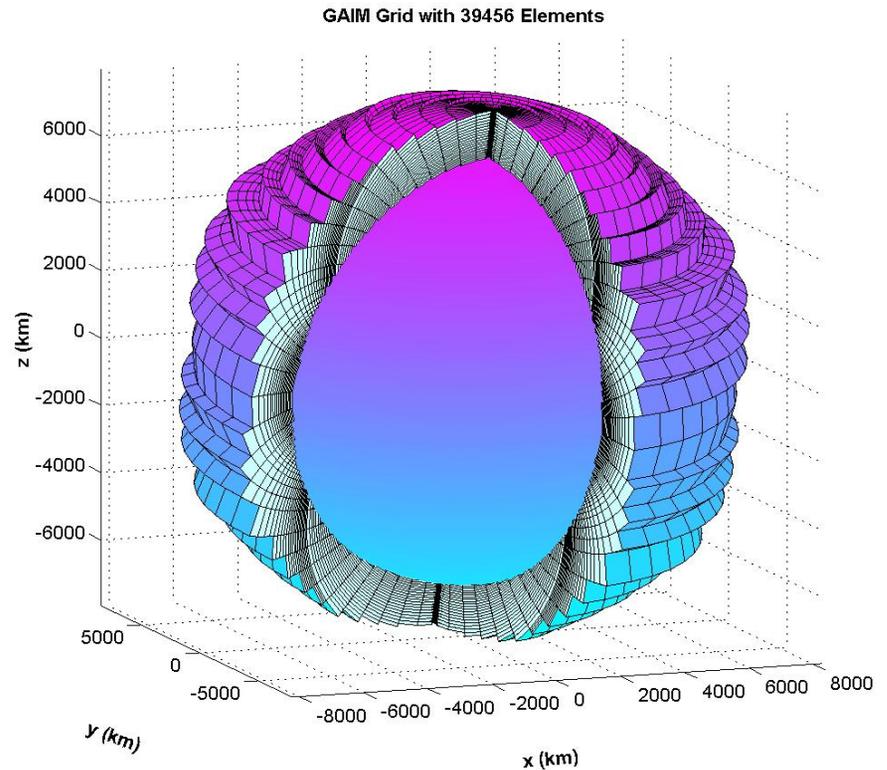


Three Shell Model





Kalman Filter



- Provide real-time software and consulting
 - + SATLOC wide-area differential GPS
 - + FAA wide-area augmentation system
 - + FAA local-area augmentation system
- Provide real-time/near real-time products
 - + Results generated in-house and transferred via secure protocol
 - + Naval Oceanographic Office: ionosphere calibrations for GEOSAT Follow-On mission
 - + Near real-time TEC to Air Force Weather Agency
 - Input to internal models
- GAIM model
 - + Software transfer to Air Force Research Laboratory
 - For C/NOFS satellite program
 - + Model assessment and development
 - + Pentagon Special Projects office
 - + National Reconnaissance Organization
 - + Navy/AFOSR – MURI program

Applications

- Deep-space tracking
- Earth remote sensing

- Propagation

- Global-scale calibration

- Space environment

- Space environment
- Multi-sensor fusion

Calibrate Ionospheric
Propagation Delay

GPS Sensors in
Low-Earth
Orbit

Global
Ionosphere
Maps

Worldwide
GPS
Network

Numerical
Space Weather
Prediction

Products

- Operational media cals
- Calibrated soundings, atm

- Electron density profiles

- Wide-area differential GPS
- Operational ocean altimetry

- Near real-time TEC

- Space weather nowcasts

- **JPL has been working closely with FAA and Raytheon for nearly one decade on GPS Augmentation Systems**
 - + Wide-area and local
- **JPL has advanced ionospheric models that operate in real-time**
- **Advanced models provide more accuracy for non-safety of life applications**