SPACE ENVIRONMENT TECHNOLOGIES

Space Research   Space Operations   Space Standards

AF Operational Real-Time Thermospheric Density Monitoring Project HASDM

Bruce R Bowman
W. Kent Tobiska

SPACE ENVIRONMENT TECHNOLOGIES

*Space Research   Space Operations   Space Standards*

- HASDM Overview

- HASDM Upgrade Improvements

- New Solar and Geomagnetic Indices

- HASDM Density Accuracies

- HASDM Density Research Applications

Variation	Change	Frequency
Solar cycle	1600 %	11 year
Semiannual	125 %	1 year
Solar rotation	250 %	27 days
Geomagnetic storm	800 %	days
Diurnal	250 %	1 day

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- HASDM – High Accuracy Satellite Drag Model started in 2000

- DCA – Dynamic Calibration Atmosphere program using AF Space Surveillance Network observations every orbit from multiple radars

- Produces density corrections every 3 hours using multiple calibration satellites (~75-85) consisting of spheres, R/B, debris at altitudes from 200 to 800 km

- Corrected operational Jacchia 1970 density model (J70MOD)

  - Correction varies with latitude, longitude, altitude, and time

  - Density correction predicted out 3 days as a function of predicted solar/ geomagnetic indices

Goal: Improve 24-72 hour satellite position predictions

- Project started in 2005

- Developed new atmospheric model (Jacchia-Bowman-2008 derivative) for all solar conditions and geomagnetic storms

- Developed new solar EUV indices and a new geomagnetic storm index to be used for computing density values using real-time satellite observations
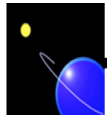
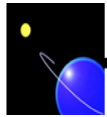## Altitude of Maximum Rate of Absorption of Solar UV Radiation
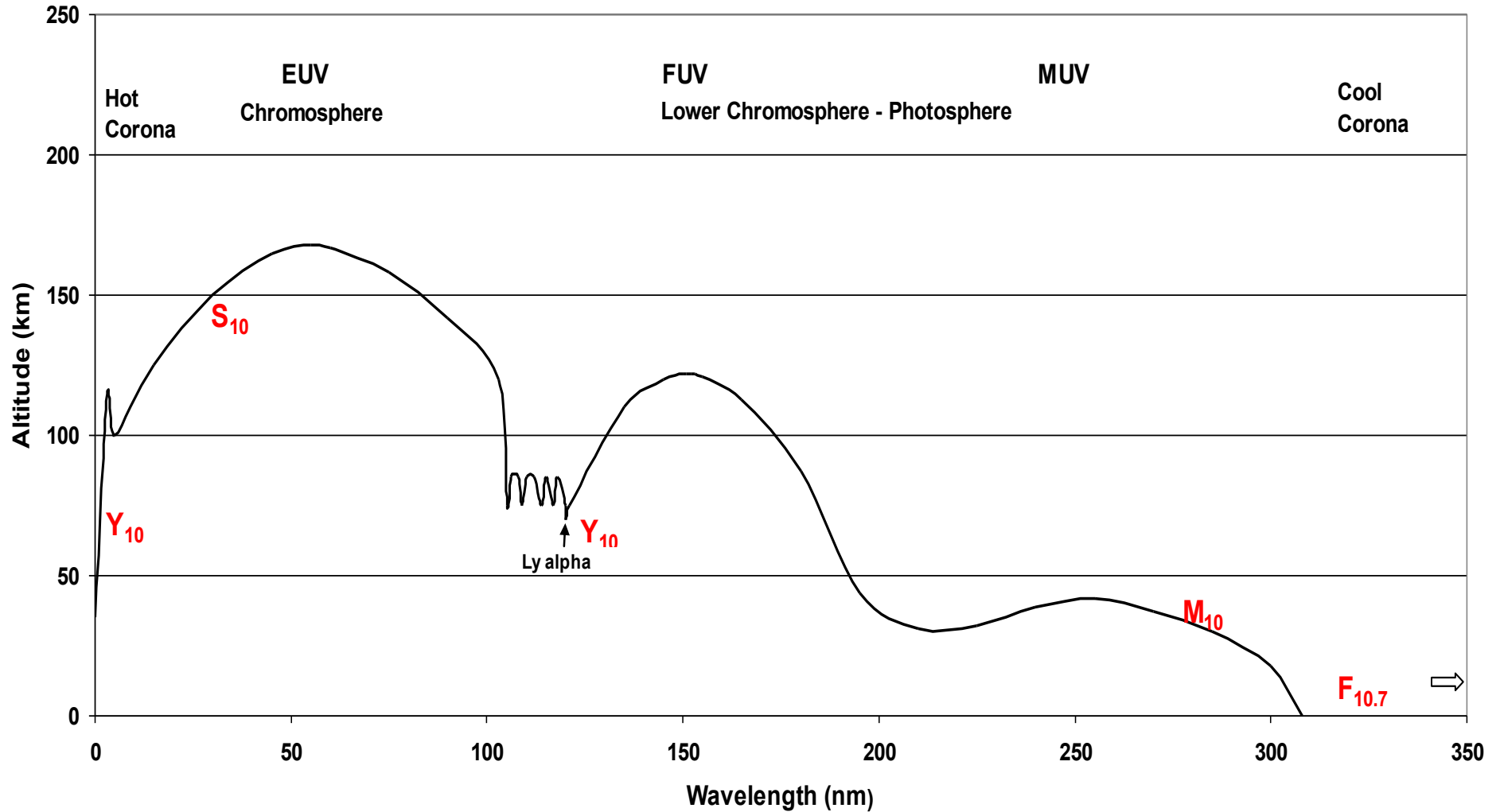
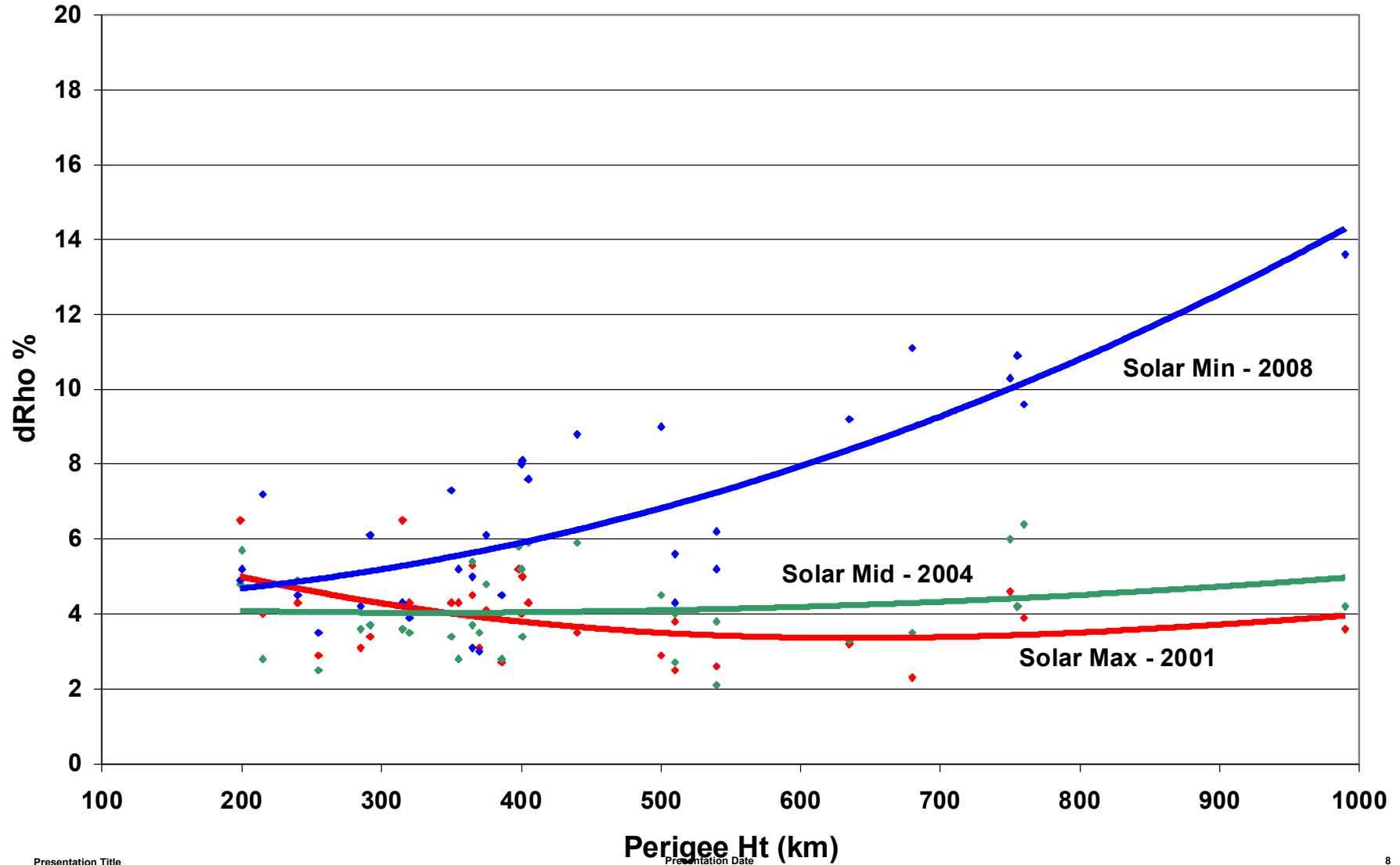## SET LEO Alert and Prediction System (LAPS)

Solar indices

- **S10:**
  - A (GOES/EUVS)
  - B (SDO/EVE; TIMED/SEE; SOHO/SEM)
- **M10:**
  - A (NOAA 16/SBUV)
  - B (METOP-A,-B/GOME-2; NOAA 18/SBUV)
- **Y10:**
  - A (GOES/XRS, GOES/EUVS)
  - B (SDO/EVE, TIMED/SEE)
- **F10:**
  - A (Penticton/Radio)
  - B (AFRL F10, SET/E10)

Geomagnetic indices

- **Dst:**
  - A (real-time: WDC/Kyoto; forecast: NOAA/ENLIL/Rice)
  - B (real-time: SEC/RDst, USGS/Dst, AER/DMSP, SET/DMSP; forecast: SET/Anemomilos)
- **Ap:**
  - A (real-time: NOAA/ESWDS; forecast: NOAA/ESWDS)
  - B (real-time: SET/ApOps; forecast: SET/ApOps)

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HASDM Density Accuracy

Density % Error (1 Sigma) HASDM DCA Values

Solar Min - 2008

Solar Mid - 2004

Solar Max - 2001

Perigee Ht (km)

dRho %

- Calibration of on-orbit accelerometer density data
  - CHAMP 2001 – 2010
  - GRACE 2002 – Current
  - GOCE 2009 – 2013
  - DANDE 2013 – Current
  - SWARM 2014 –

- Atmospheric Model Research
  - Development of new empirical models
  - Validation of thermospheric density variations
  - Accurate geomagnetic storm modeling
  - Physics-based global density assimilation

- Satellite Drag Coefficient Modeling

- Air Force is maintaining an accurate real-time operational thermospheric density monitoring program

- The High Accuracy Satellite Drag Model (HASDM) is used to maintain the entire low earth orbit satellite drag catalog including all potential satellite conjunction analyses for DOD, NASA, and NOAA

- Real-time satellite observed solar and geomagnetic indices from SET are used as operational HASDM input for historical through 6 day predictions

- HASDM thermospheric density values are extremely valuable in thermospheric density research and for physics-based density modeling assimilations

- HASDM accurate 3-hour thermospheric density values from 200-800 km can be obtained from SET for years 2000 to current time