

Coordinated Space-Based Observations of Equatorial Plasma Bubbles Using TIMED/GUVI and DMSP

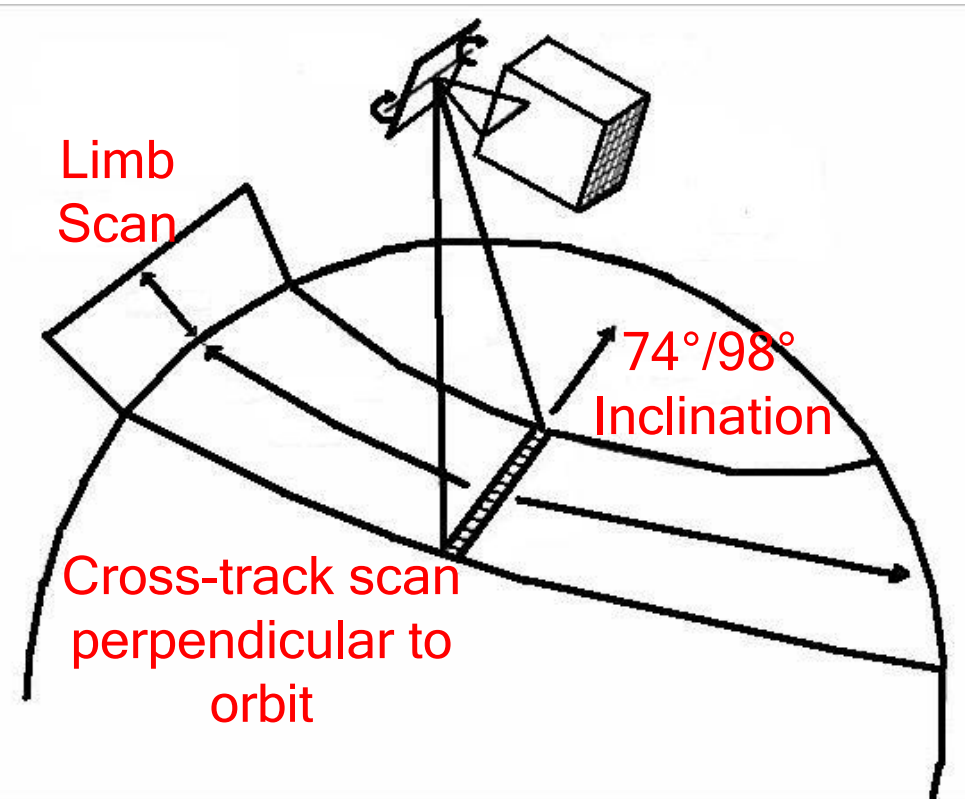
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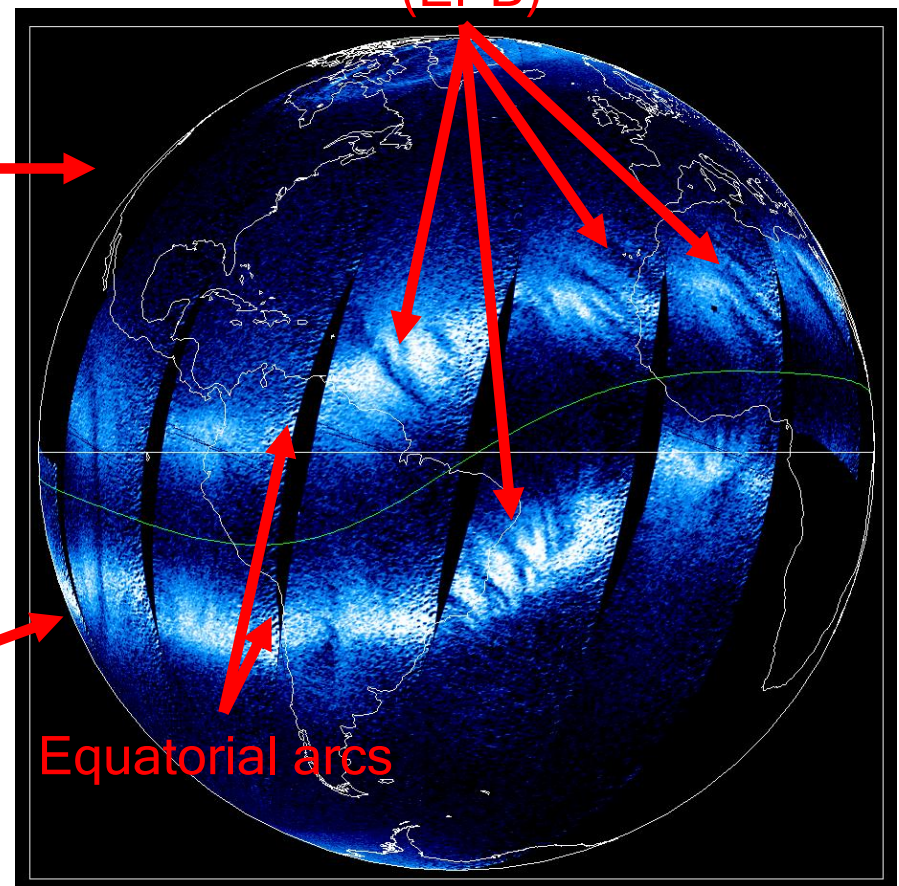
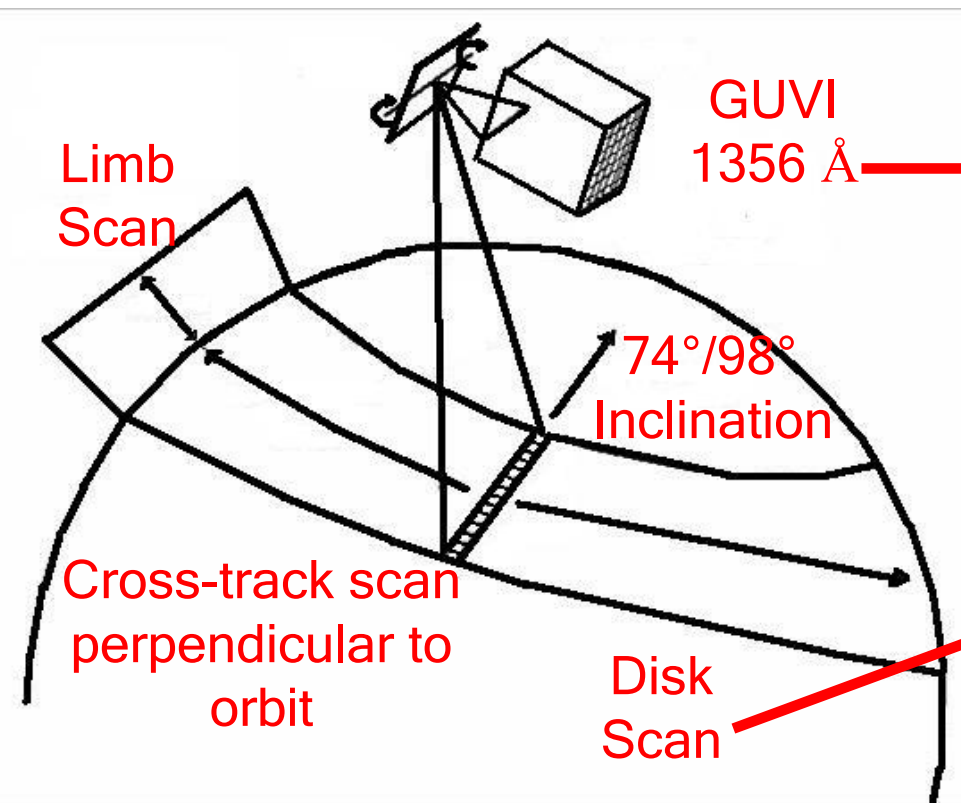
June 28, 2007

GUVI/SSUSI Disk Imaging



GUVI/SSUSI Disk Imaging

Equatorial
Plasma Bubbles
(EPB)



Goal: Recover Altitude Information from LEO Disk Images

- Algorithm for tomographically reconstructing multi-dimensional ionospheric electron density profiles from GUVI (or SSUSI) disk observations
- Statistical inversion of discrete forward model of UV brightness from ionospheric electron density

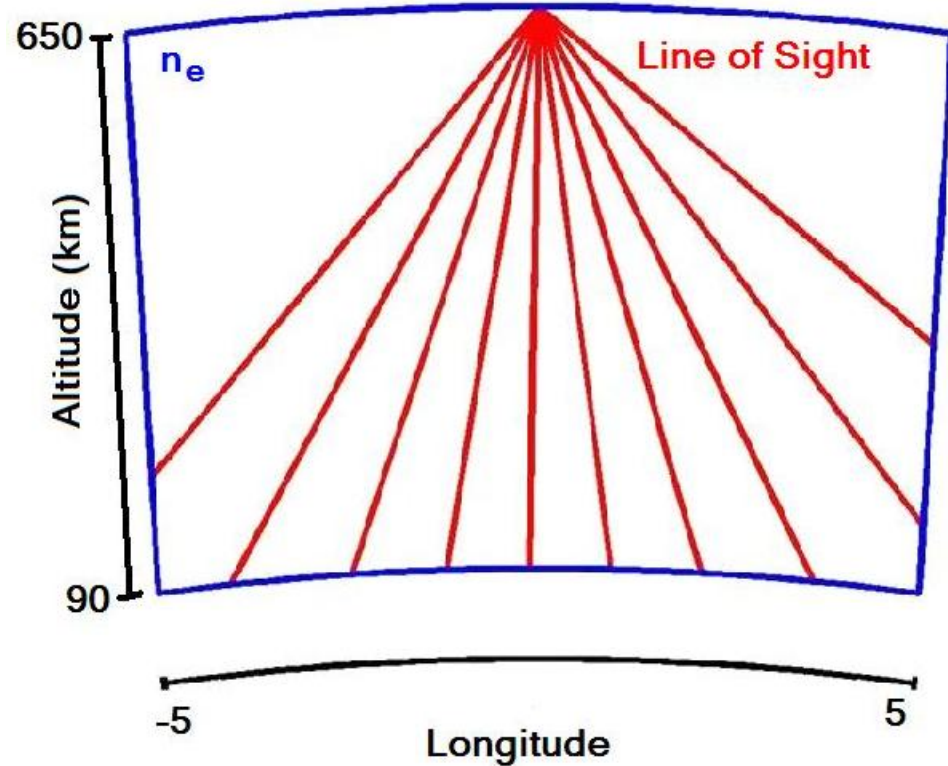
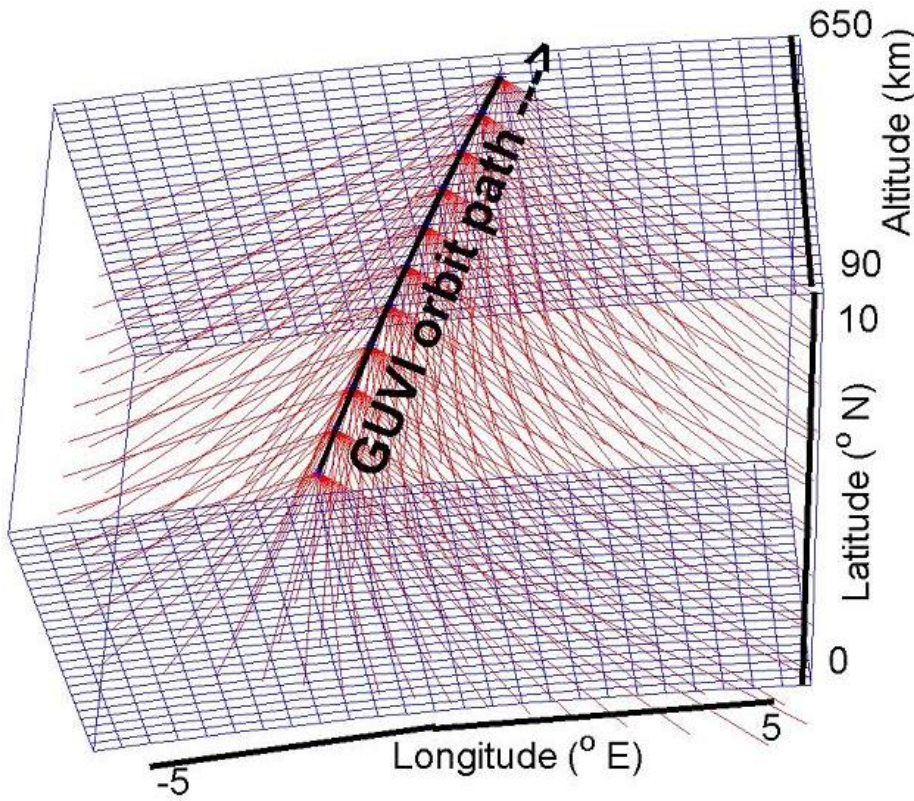
Tasks for the CEDAR Postdoc Award

Jan-June 2007	Automated Bubble Detection Algorithm Midlatitude hmF2/NmF2 Retrievals
July-Dec. 2007	GUVI EPB Climatology SSUSI F16/F17 EPB Imaging
2008	SSUSI/GUVI Coordinated Observations EPB Prediction/Growth Studies

Tomographic Reconstruction of n_e

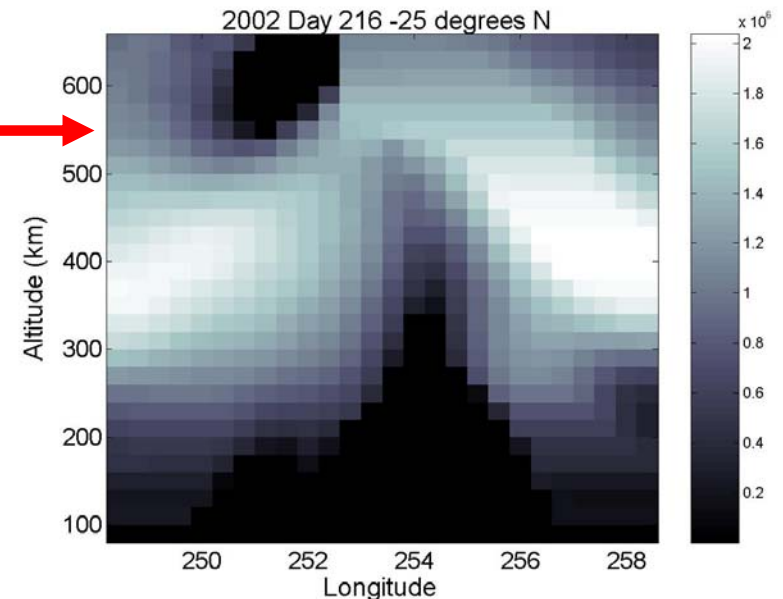
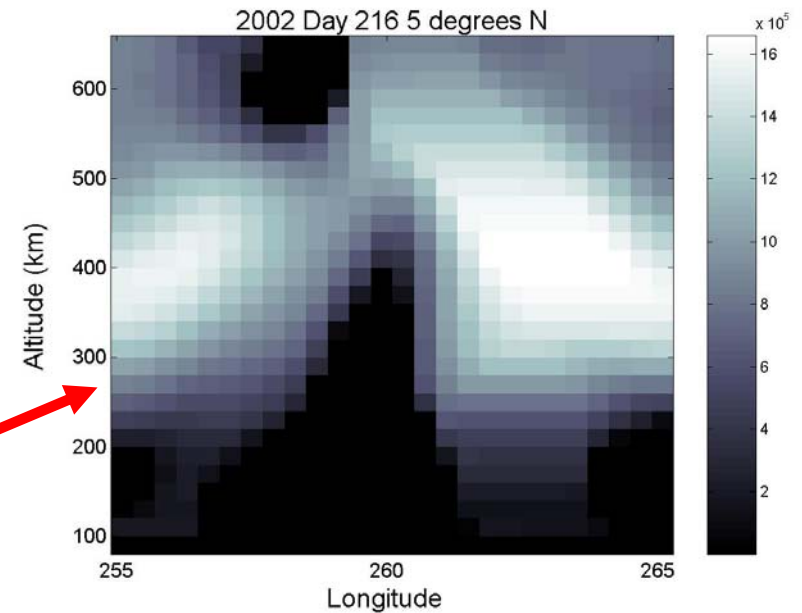
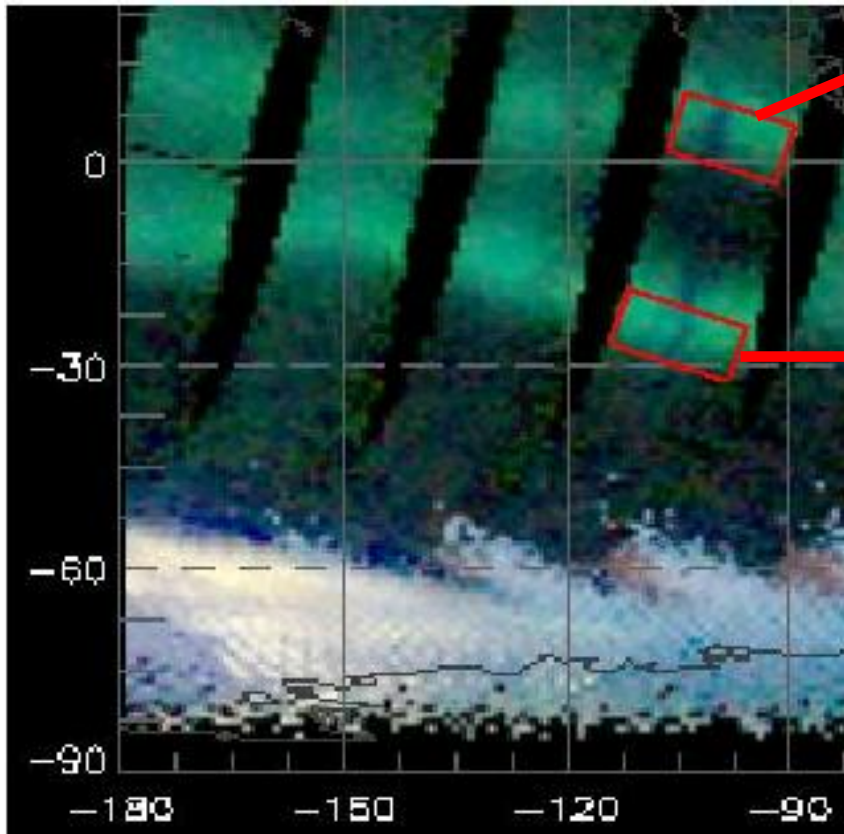
- 3-D section of ionosphere along orbit path
- Assume invariance along field lines for that segment
- Distinct overlapping scans with respect to altitude vs. longitude profile allow for tomography

$$I_{1356} \sim \int n_e^2$$



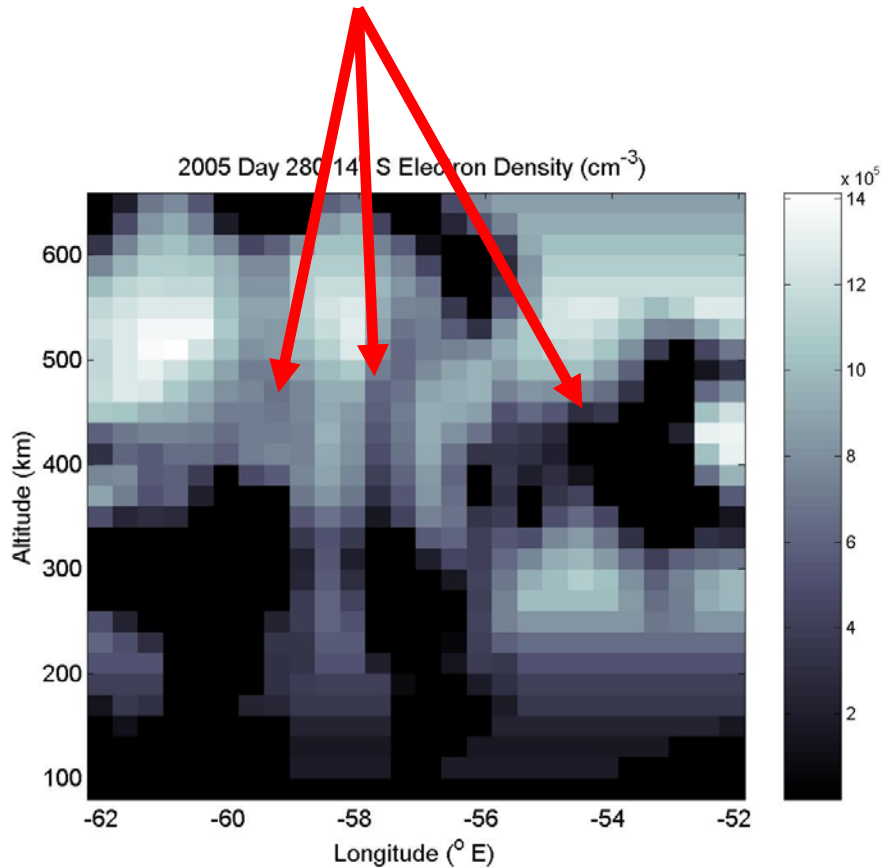
EPB Observations at Conjugate Locations

- Compares with GUVI summary image
- Location and width of bubble
- Structure consistent along field lines

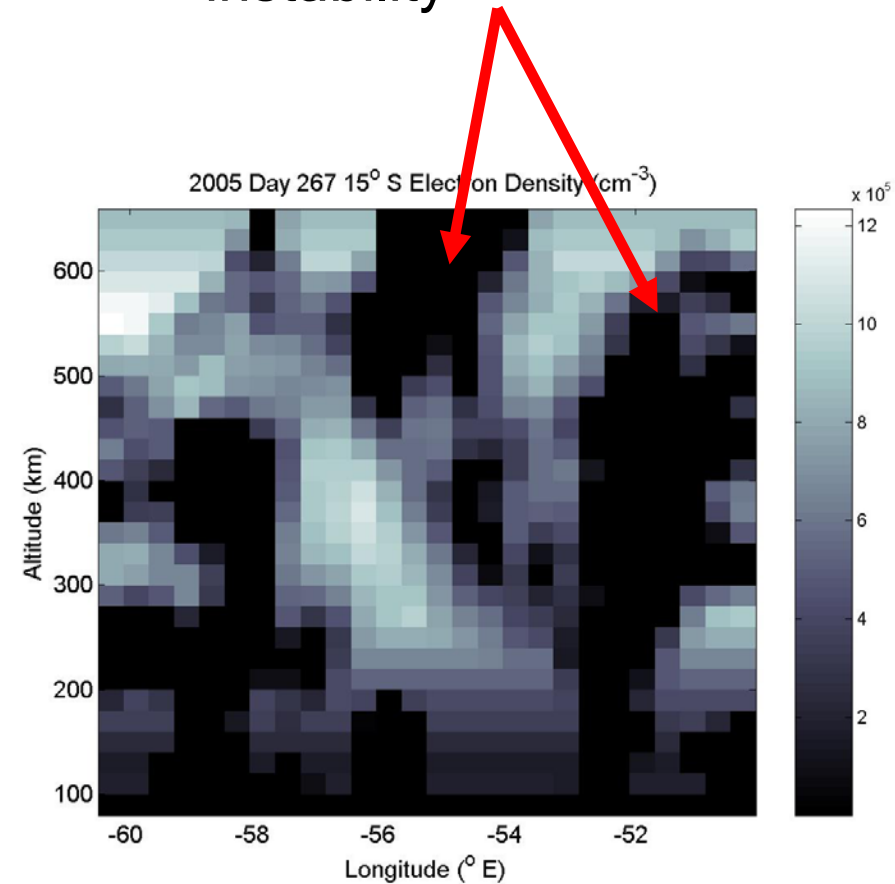


Bubble Structures Seen by GUVI

- Multiple bubble structures, 40 km longitudinal resolution



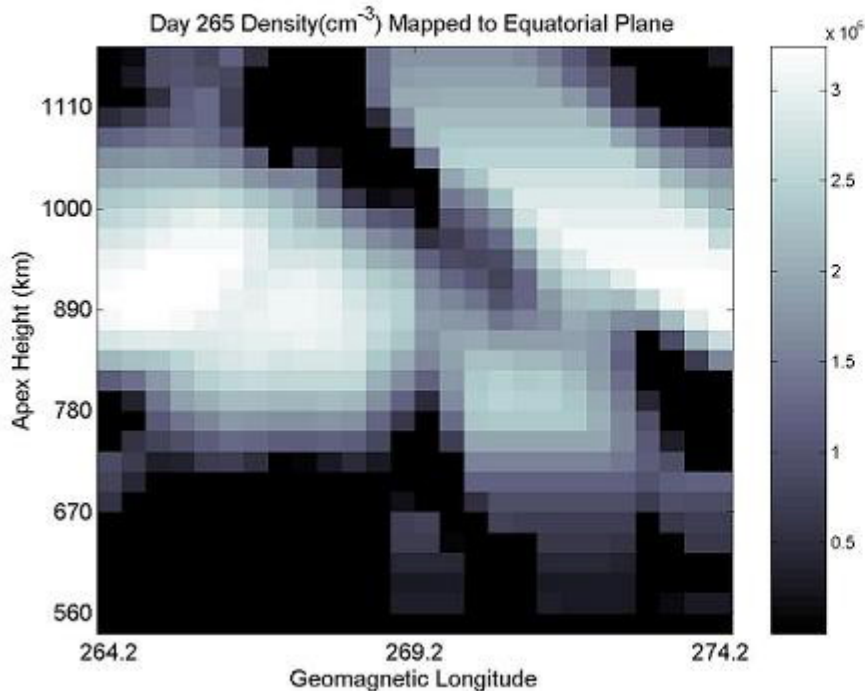
- Bifurcated structure seen with secondary instability



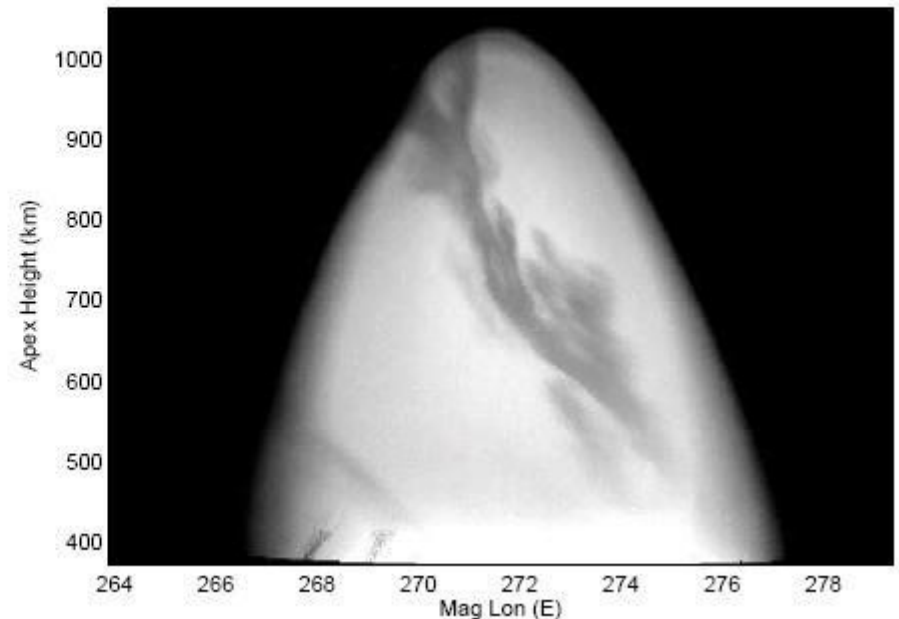
Cornell Narrow Field Imager Comparison

- Comparison with 7774 Å ground-based imager
- Reconstructed image shows excellent agreement with the CNFI image
- Westward tilt, overall shape, and bubble width all agree

Reconstructed image for 2002 day 265

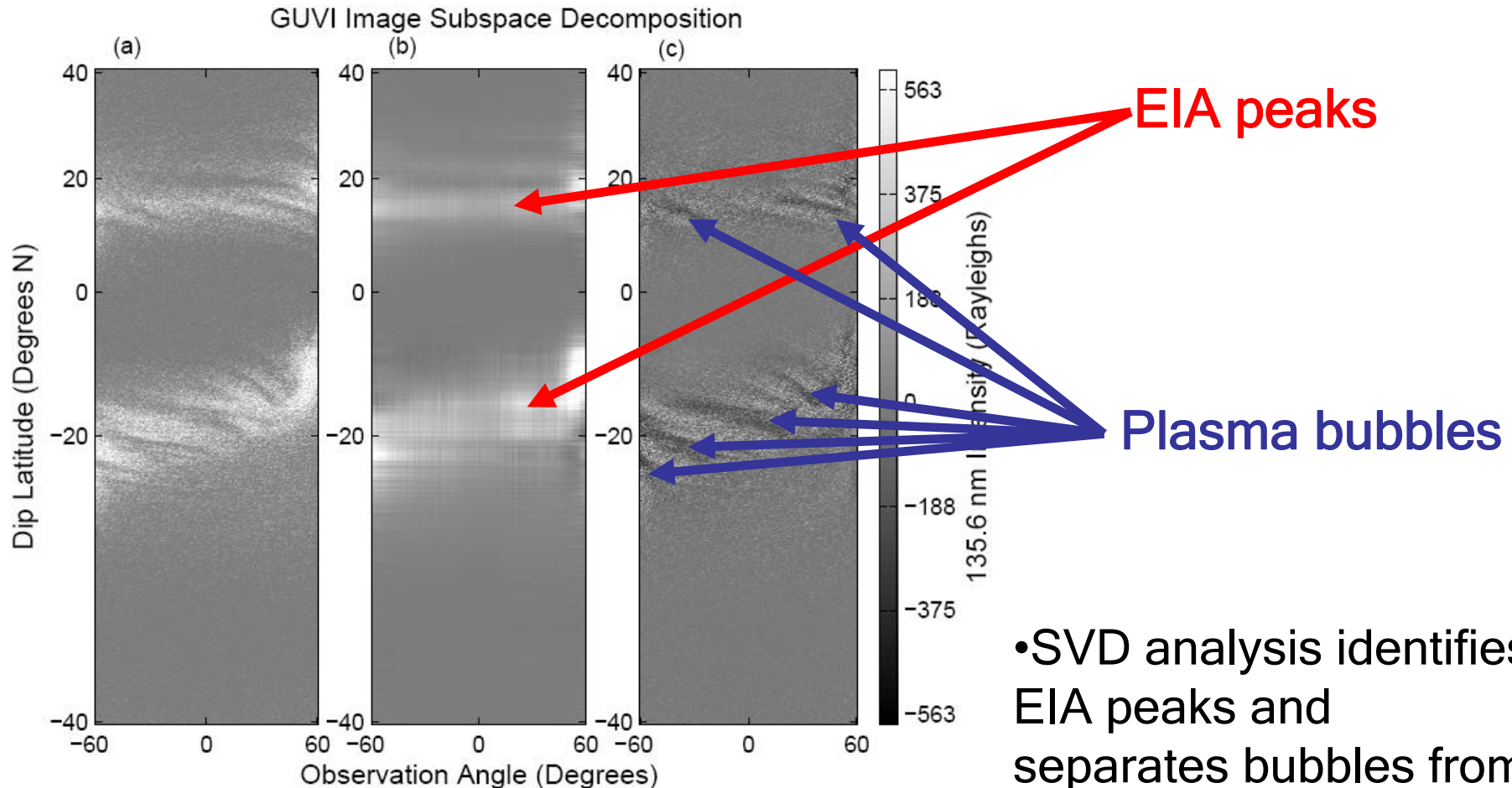


Hawaii imager data for 2002 day 265



Courtesy of M. Kelley (Cornell) & J. Makela (UIUC)

Automated EIA and EPB Detection



[from *Henderson 2006*]

- SVD analysis identifies EIA peaks and separates bubbles from background
- Inversions run at North and South EIA peaks

Implications for EPB Science

- Observations of separation, symmetry, and density of EIA peaks
- Long-term observations contribute to plasma bubble climatology
- Characterization of bubble structures

Atlantic Longitudes

	Summer	Equinox	Winter
Total Instances	47	90	68
# of Bubbles	5	48	42
# of Nonbubbles	42	42	26
% Occurrence	10.64%	53.33%	61.76%

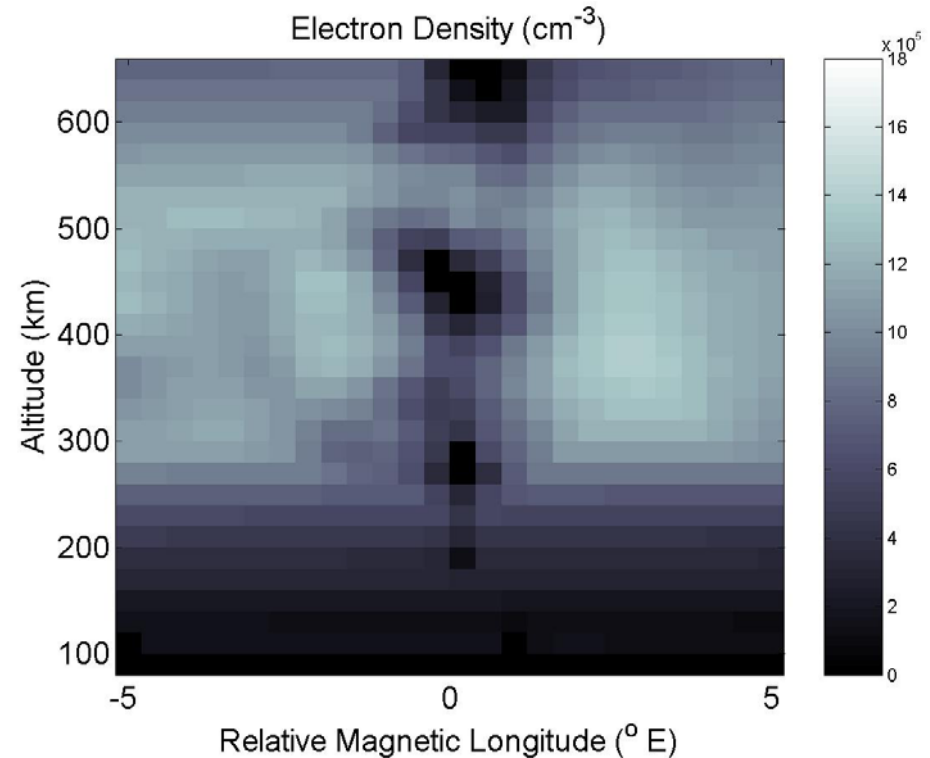
Indian Longitudes

	Summer	Equinox	Winter
Total Instances	47	90	68
# of Bubbles	6	44	28
# of Nonbubbles	41	46	40
% Occurrence	12.77%	48.89%	41.18%

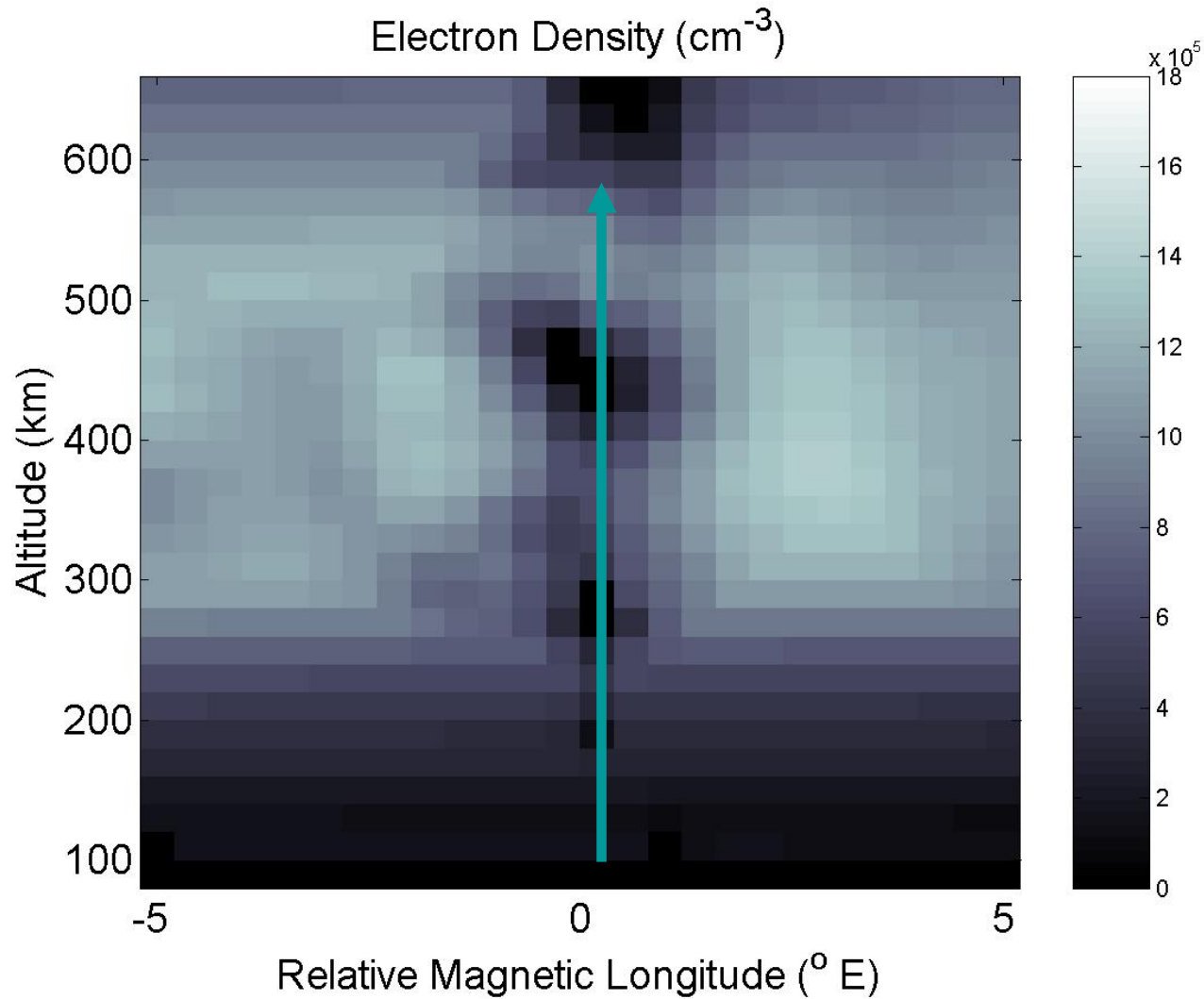
Pacific Longitudes

	Summer	Equinox	Winter
Total Instances	47	90	68
# of Bubbles	10	60	28
# of Nonbubbles	37	30	40
% Occurrence	21.28%	66.67%	41.18%

Typical, simple EPB

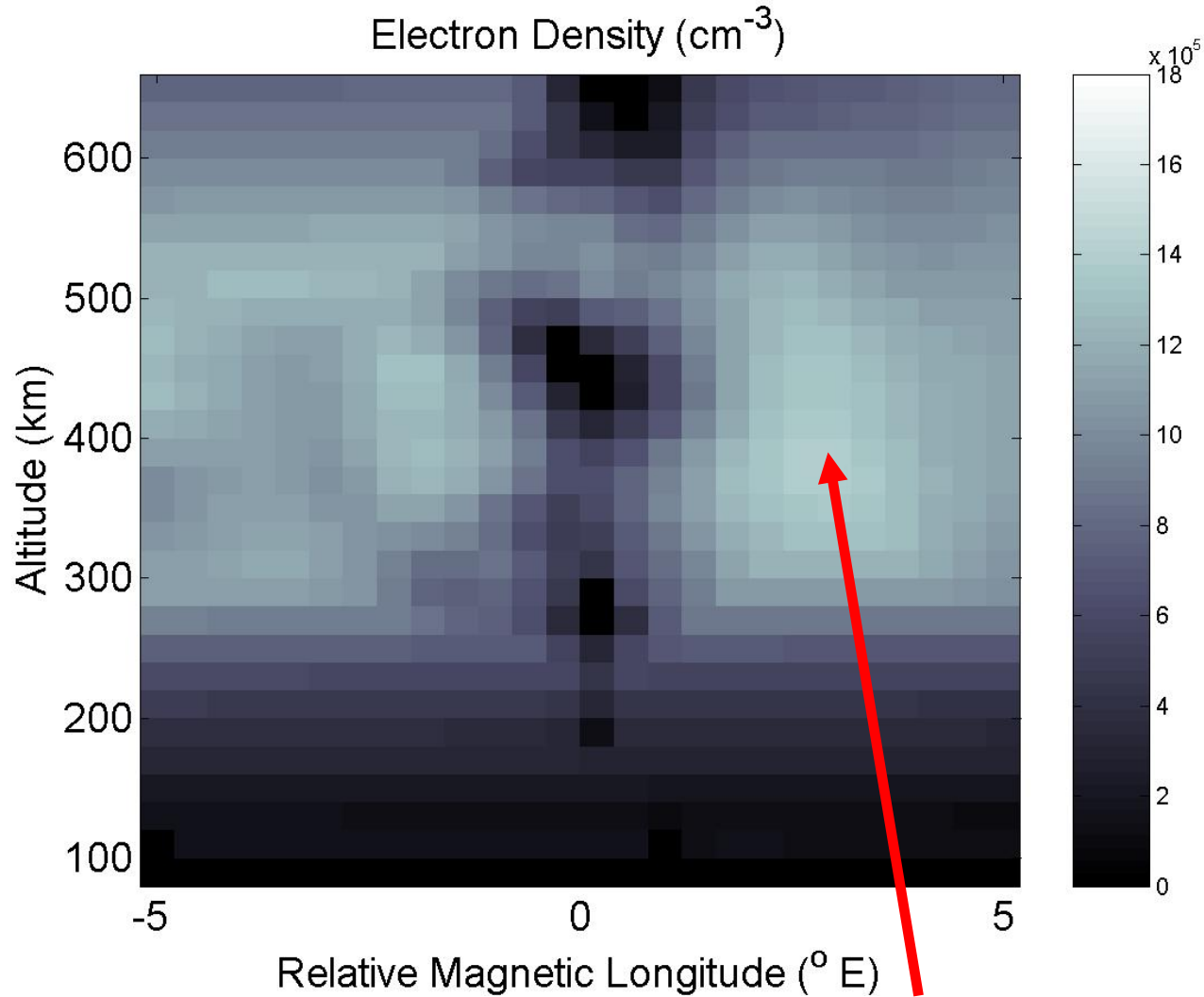


Characterization of EPB



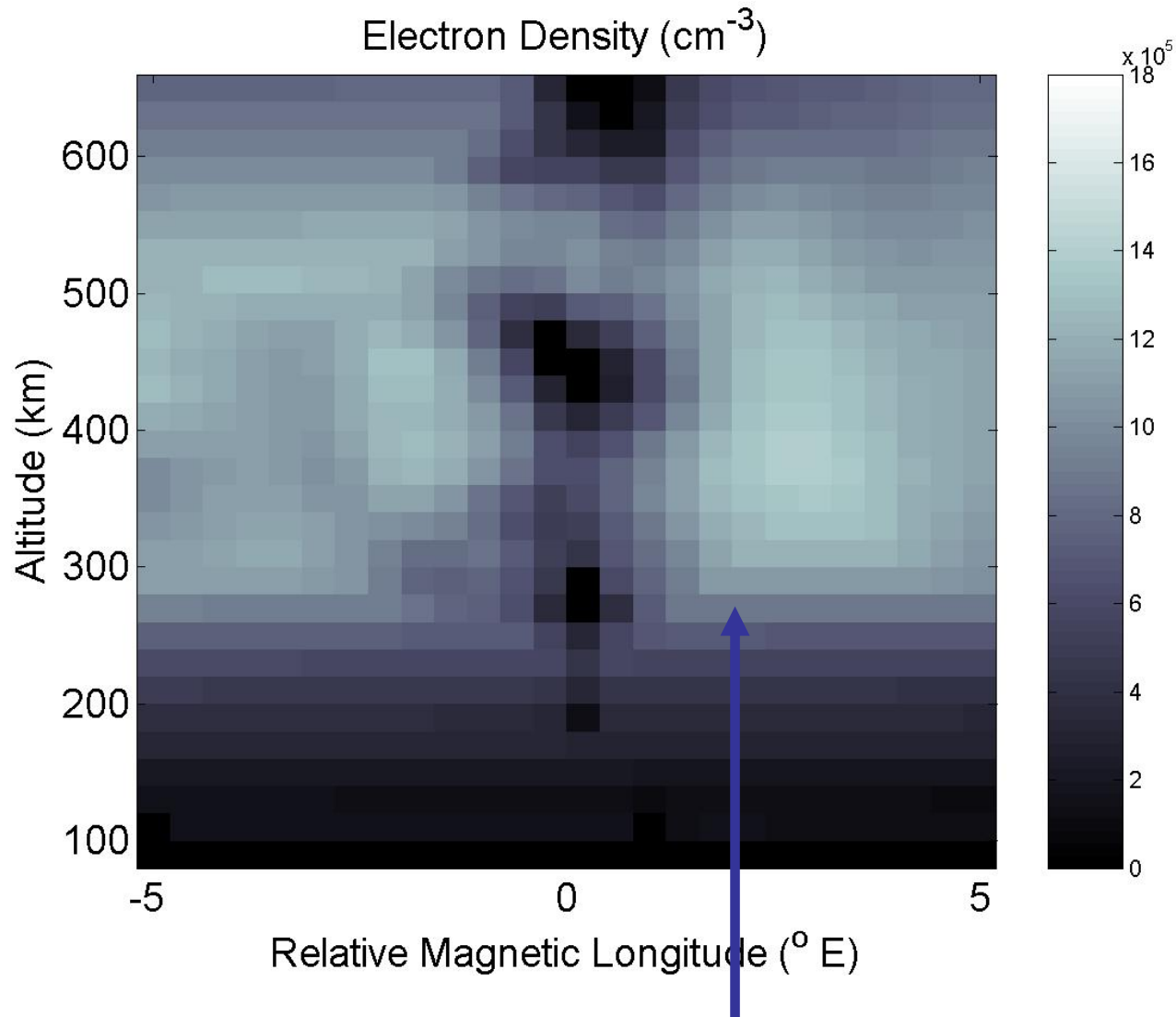
- No tilt: bubble recently formed

Characterization of EPB



- $n_m F_2 = 1.4 \times 10^6 \text{ cm}^{-3}$, $h_m F_2 = 380 \text{ km}$

Characterization of EPB



- $\partial n / \partial h \approx 10^4 \text{ cm}^{-3} / \text{km}$ for bottomside

What's Next?

- Long-term database of EPB reconstructions
- Climatological studies of EPB occurrence (extension to 2005-2007)
- Quantitative characterization of bubble structure
- Validation of hmF2, NmF2 with models (GAIM, IRI, etc.) and data
- Application of inversion technique to SSUSI data
- GUVI and SSUSI coordinated observations of EPBs
- More coordinated observations with ground-based instruments (radars, imagers, ionosondes)

