Global Model of Whistler Mode Chorus from Multiple Satellite Observations

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IMC2 Workshop, UCLA
19th- 22nd March, 2012

Introduction

- Gyroresonant wave particle interactions with whistler mode chorus play a key role in radiation belt dynamics

- Knowledge of the variability of the chorus wave power as a function of location and geomagnetic activity, required for computation of pitch angle and energy diffusion rates, is thus a critical input to radiation belt models

VLF Wave Database

- To improve our radiation belt models and forecasts for SPACECAST we have developed a VLF wave database utilising wave data from Dynamics Explorer 1, CRRES, Cluster 1, Double Star TC1, and THEMIS

- For each satellite we bin the average wave intensity and number of samples as a function of
  - Frequency (8 fixed and 13 variable frequency bands)
  - L*
  - MLT
  - MLAT
  - Location with respect to the plasmapause
  - Magnetic activity

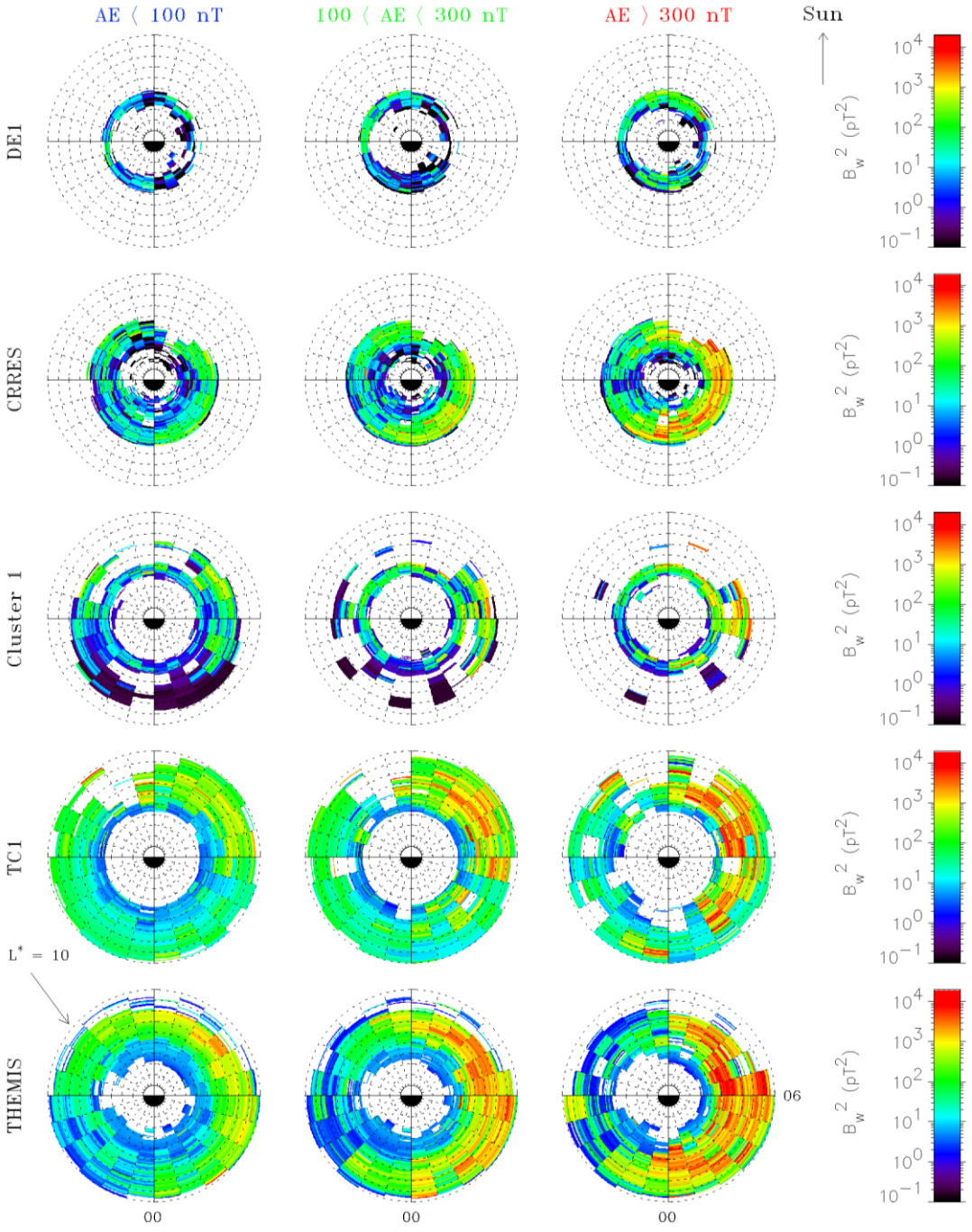
Statistical Analysis

- Here we conduct a statistical analysis of the average wave intensities of lower (0.1fce < f < 0.5fce) and upper (0.5fce < f < fce) band chorus as a function of spatial location and geomagnetic activity

- We split the magnetic activity into three levels which we define as
  - Quiet AE < 100 nT
  - Moderate 100 < AE < 300 nT
  - Active AE > 300 nT

Equatorial Lower Band Chorus

- Average wave intensity outside the plasmapause as a function of L* and MLT for the region $-15^o < \lambda_m < 15^o$
- Combined coverage extends from the plasmapause out to L* = 10



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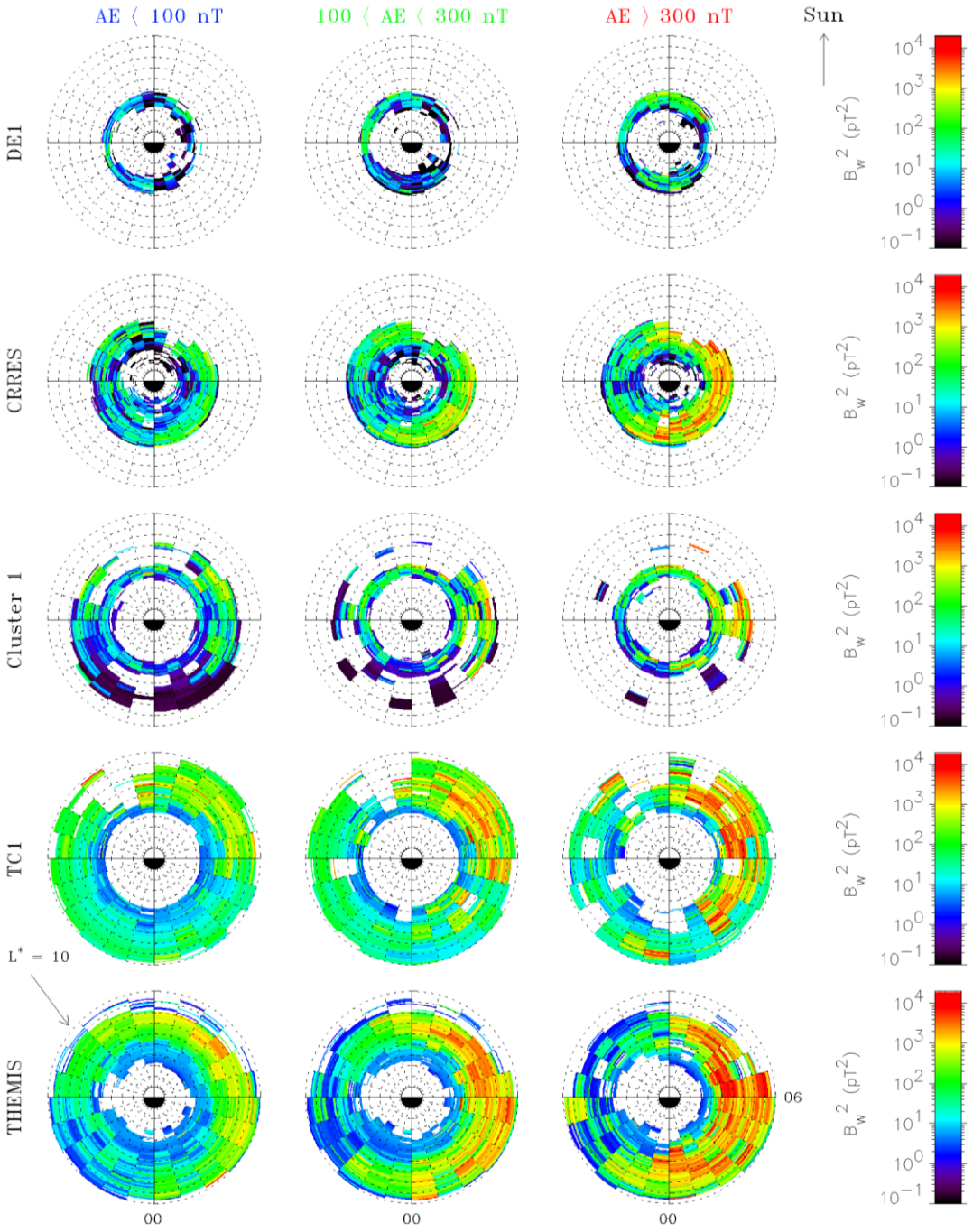
Equatorial Lower Band Chorus

- Lower band chorus is substorm dependent
- Largest intensities, of the order 2000 pT^2 are seen during active conditions on the dawn-side



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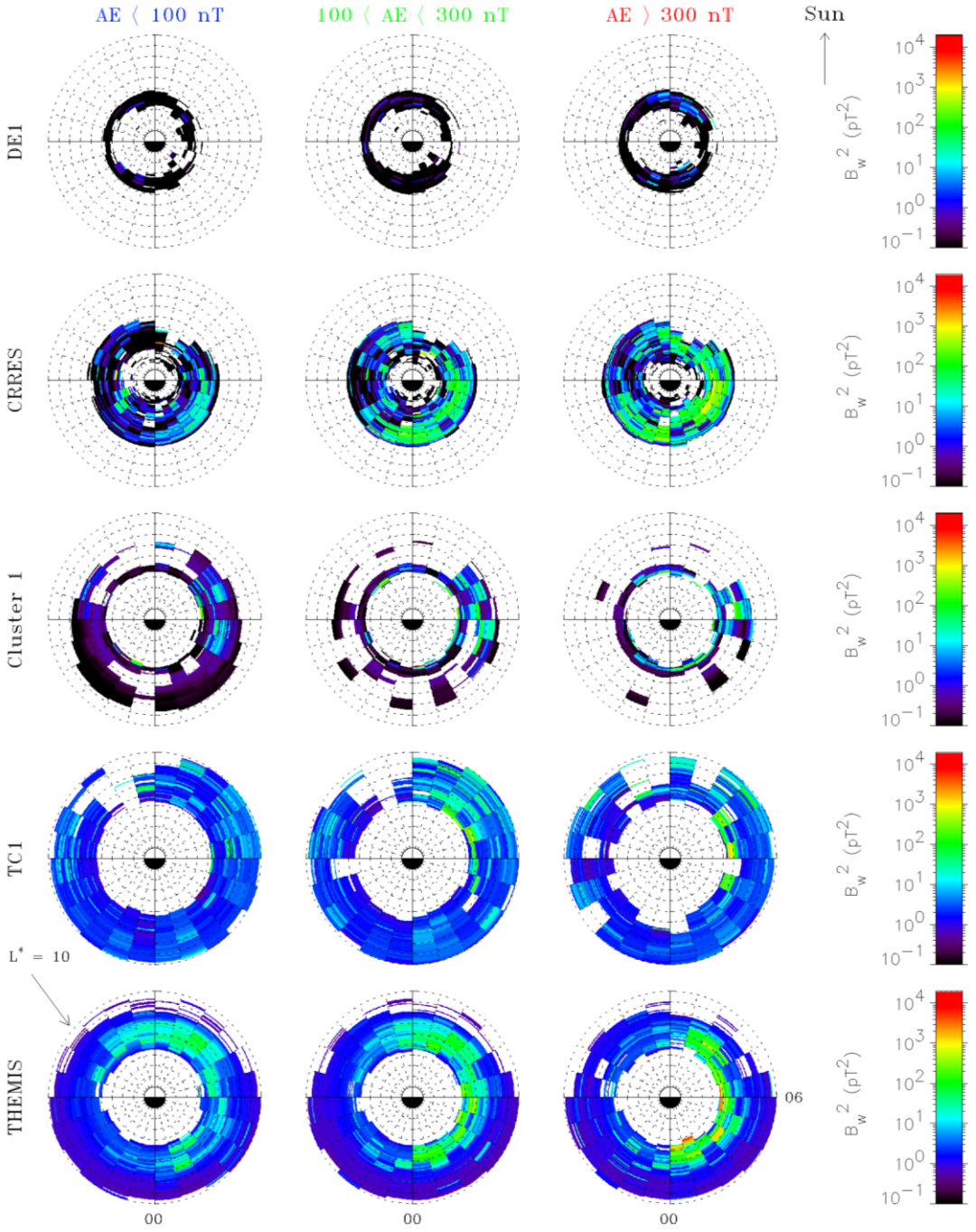
Equatorial Upper Band Chorus

- Upper band chorus is also substorm dependent but much weaker and less extensive
- Largest intensities, of the order 200 pT^2 are seen during active conditions on the dawn-side



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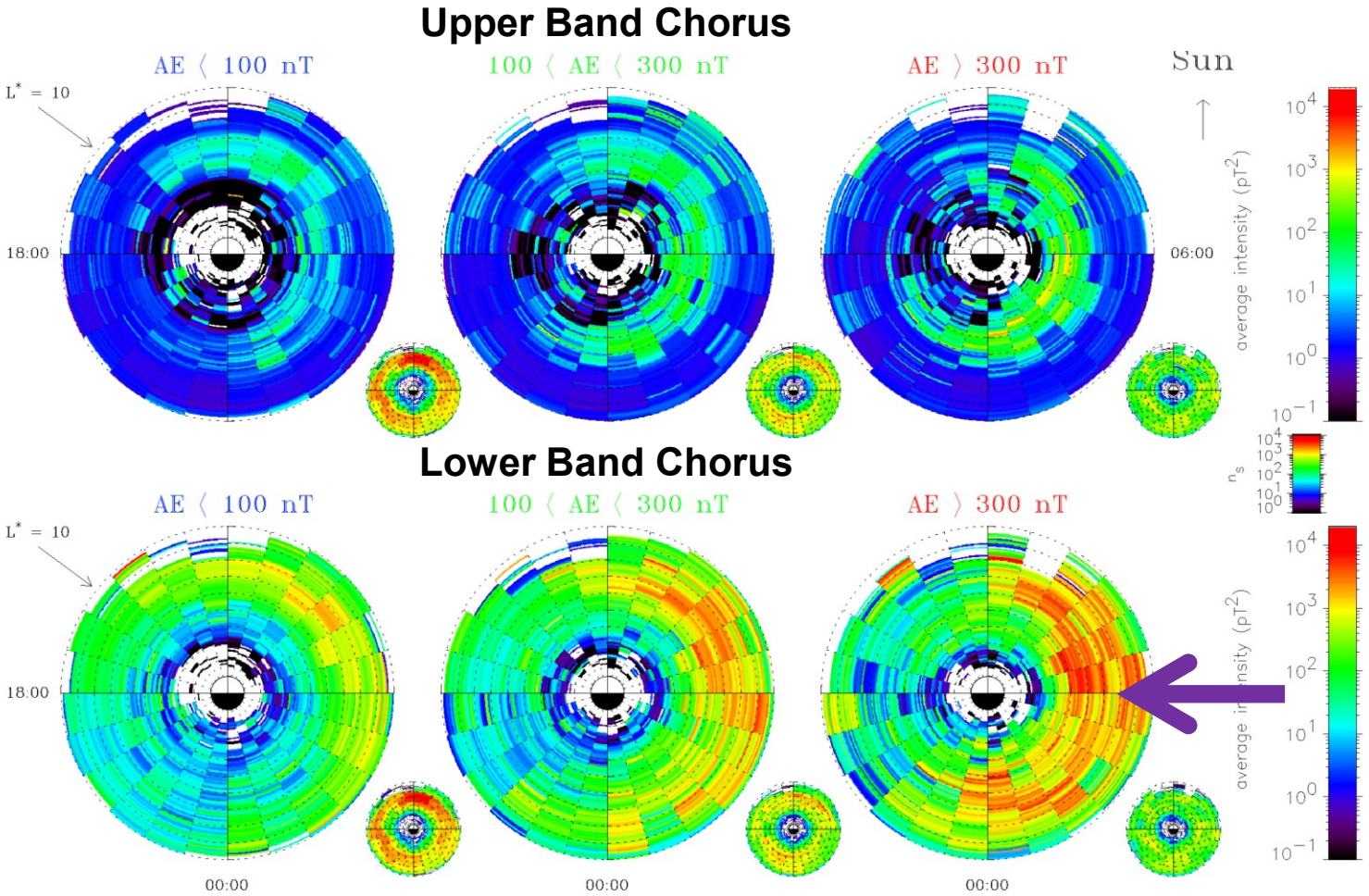
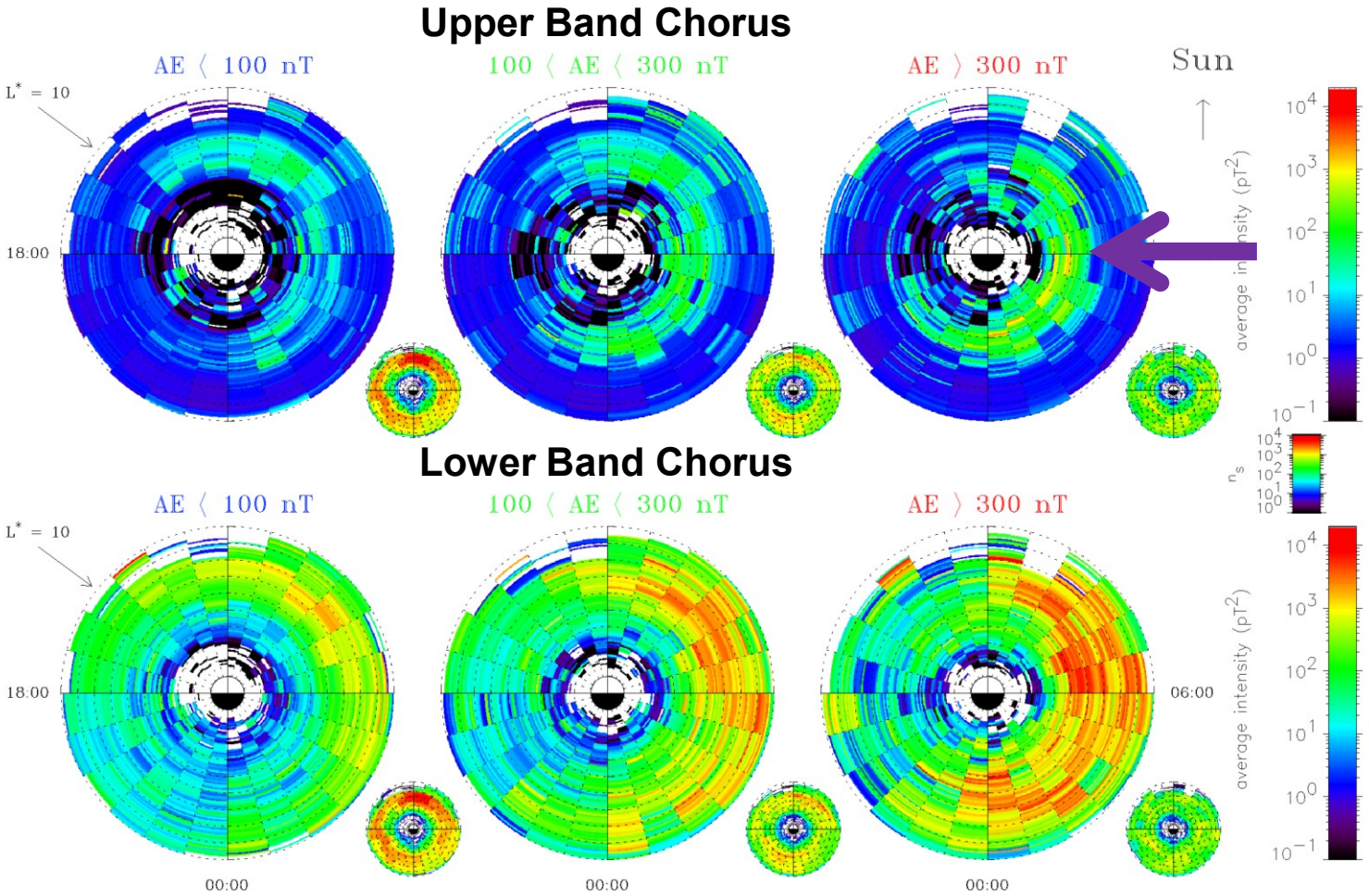
Combined Global Model of Equatorial Chorus



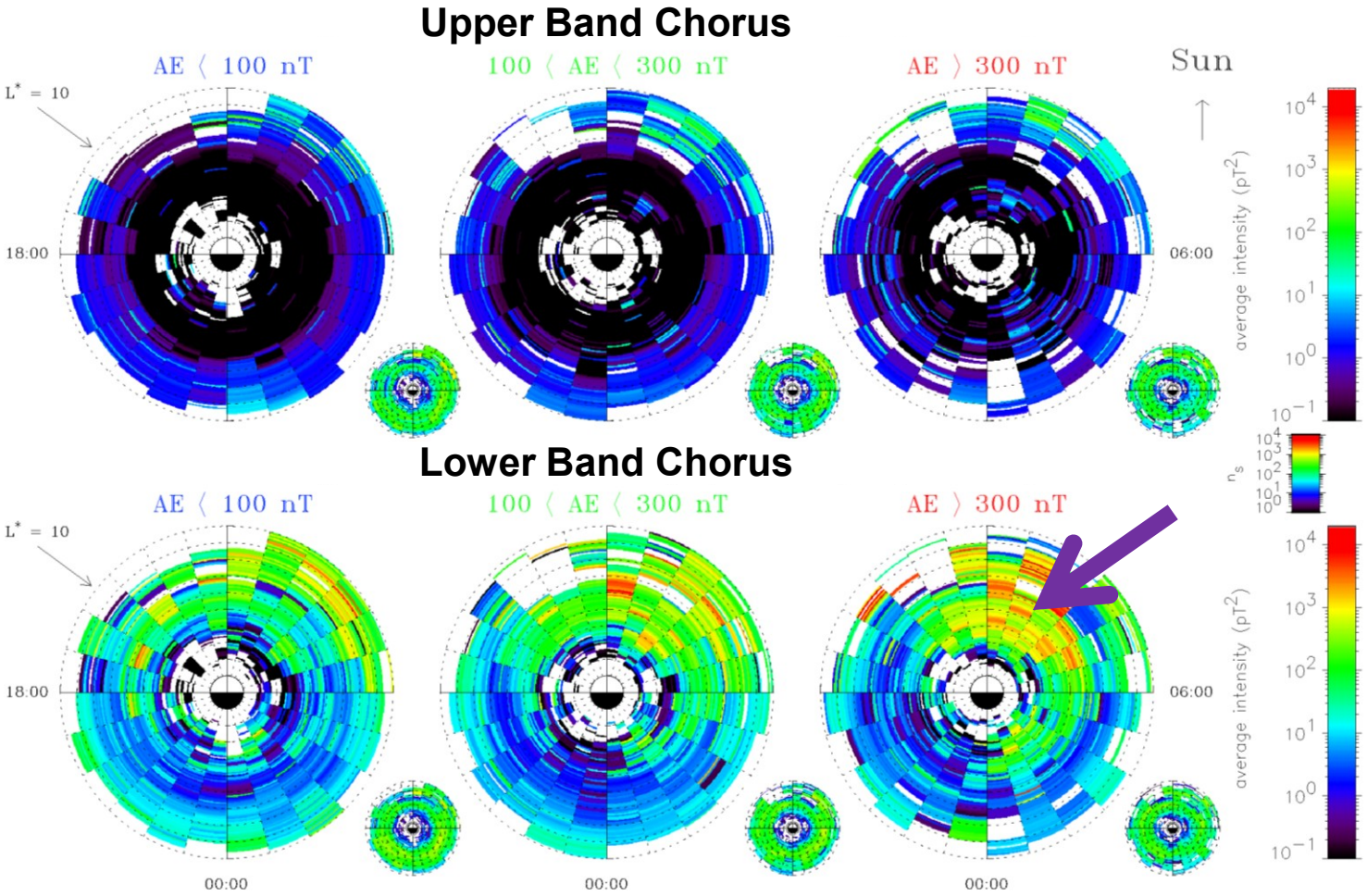
- Strongest lower band chorus, with intensities typically greater than 2000 pT^2 seen during active conditions in the region $4 < L^* < 10$ from 23-12 MLT

Combined Global Model of Equatorial Chorus



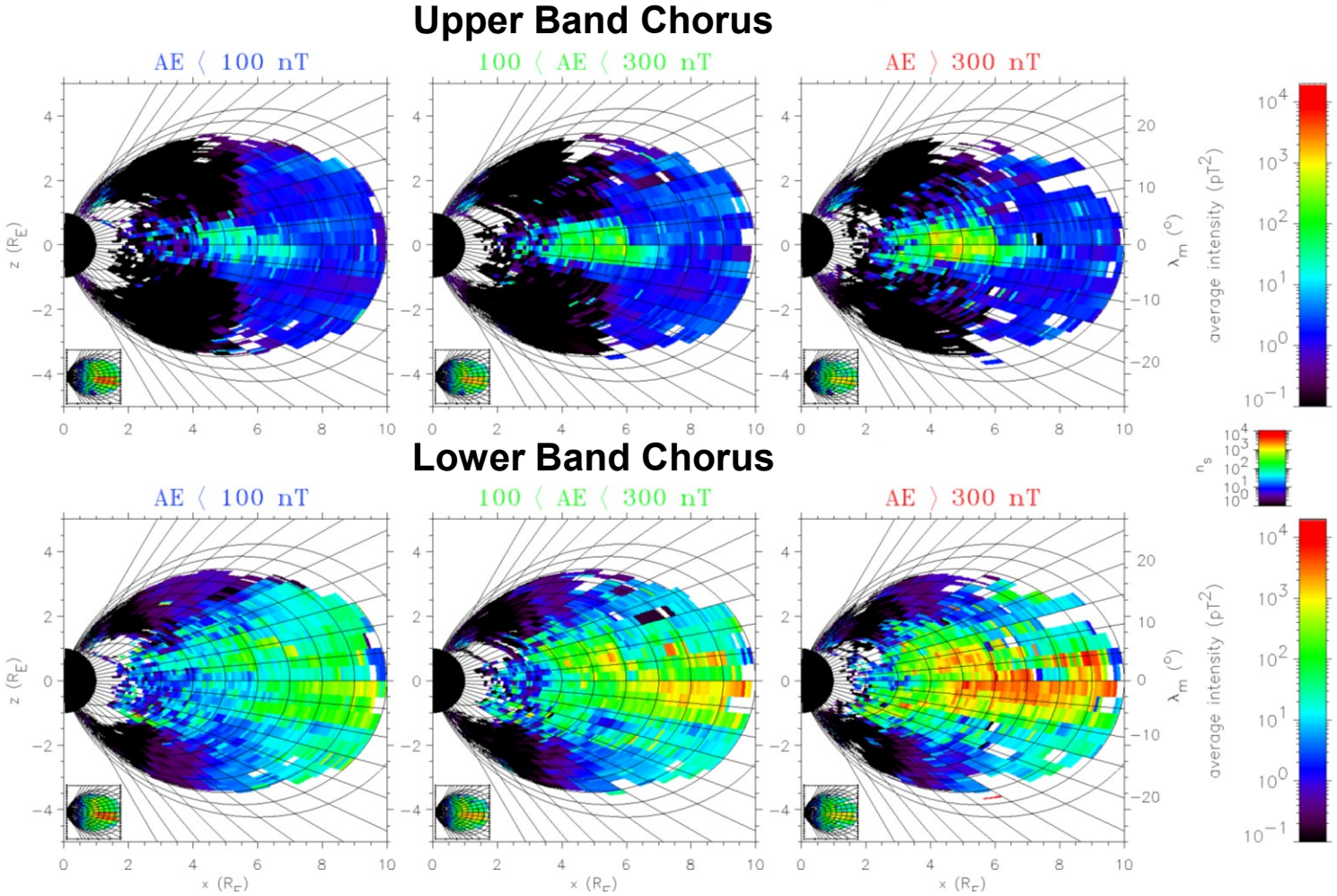
- Strongest upper band chorus, with intensities of the order a few hundred pT^2, seen during active conditions in the region $4 < L^* < 7$ from 22-11 MLT

Combined Global Model of Mid-Latitude Chorus



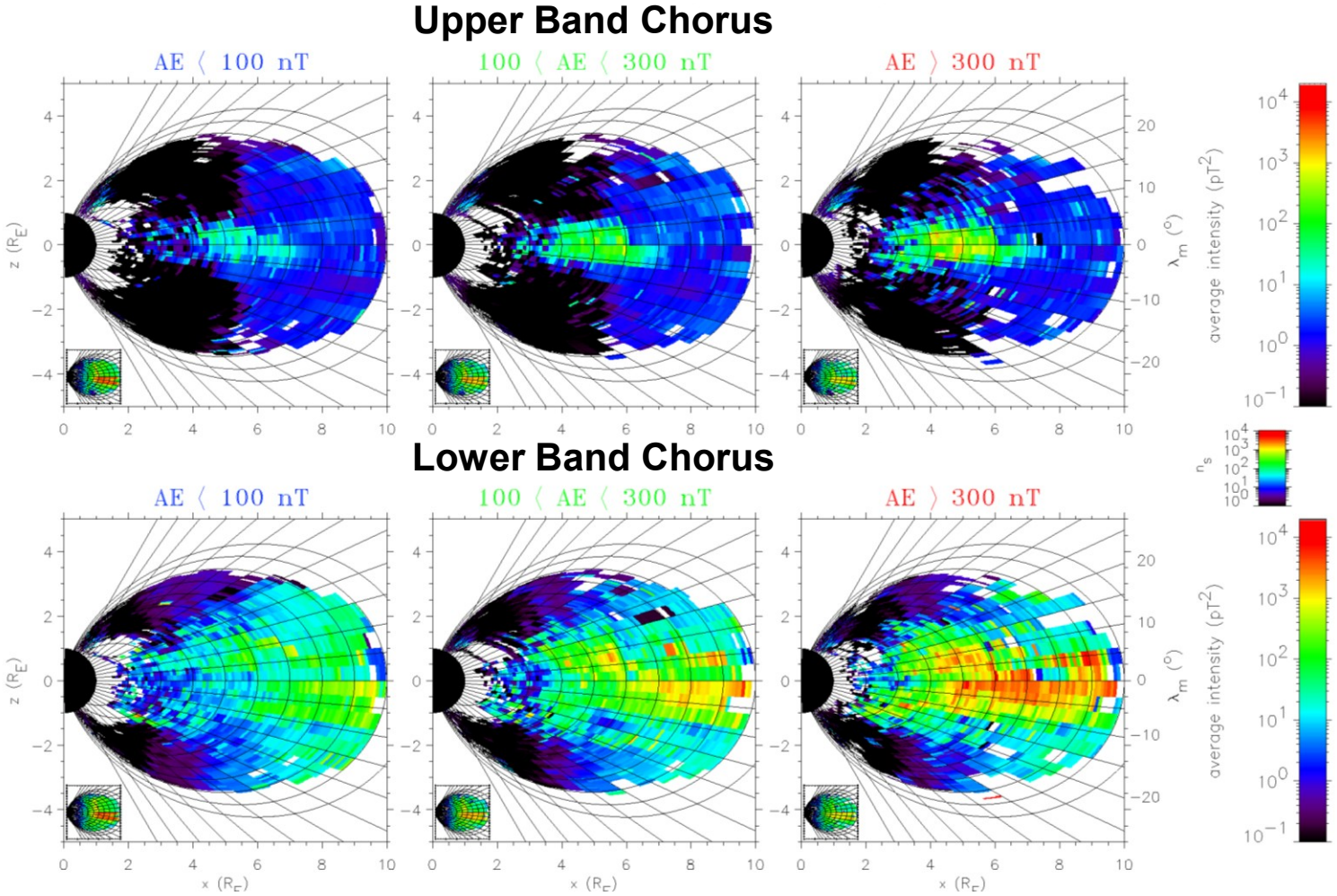
- Strongest lower band chorus, seen during active conditions in the region $4 < L^* < 10$ but restricted to dayside from 07-13 MLT

Combined Global Model of Nightside Chorus



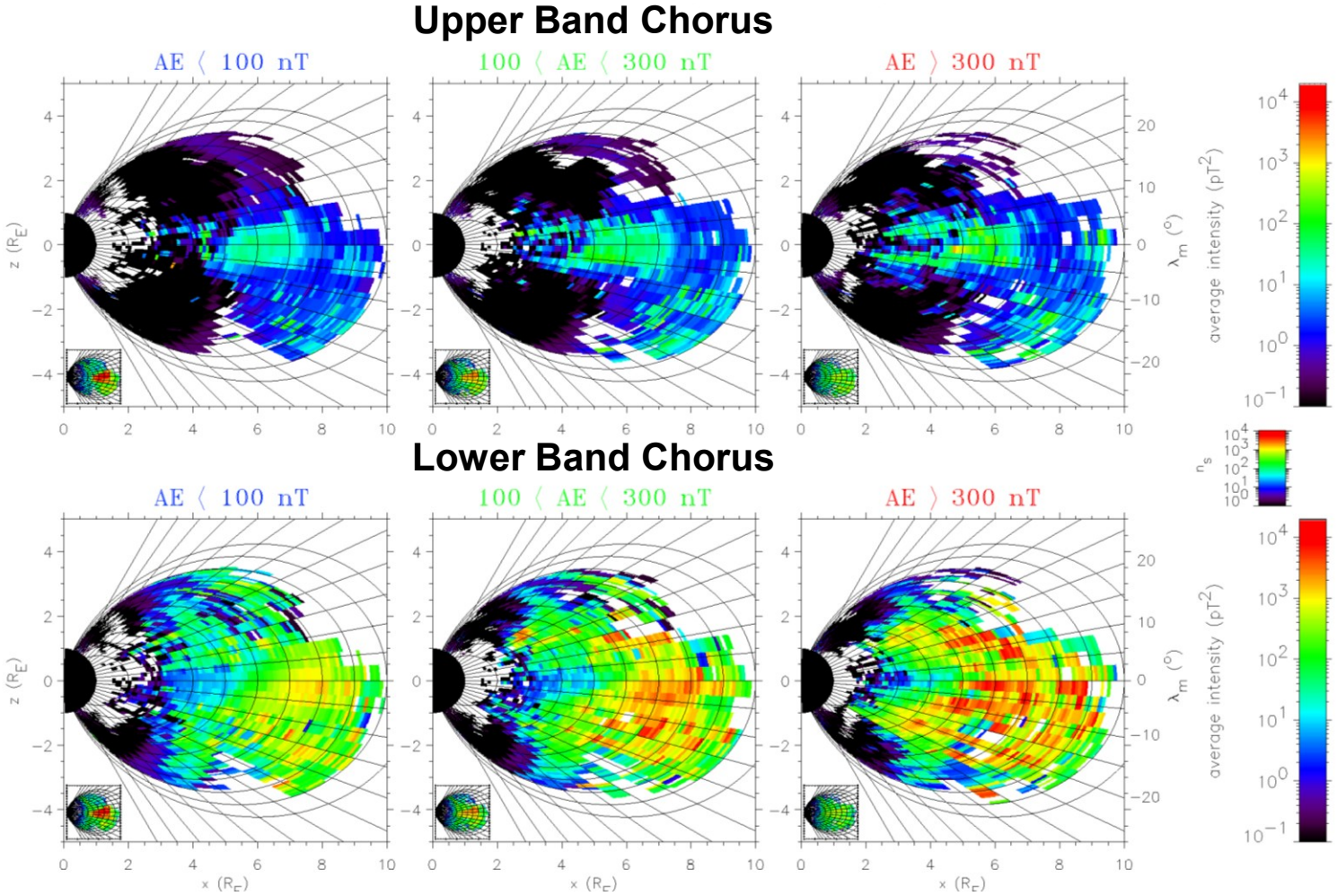
- Nightside lower band chorus intensities are strongest during active conditions in the region $4 < L^* < 10$ and are confined to $|\lambda_m| < 10^o$.

Combined Global Model of Nightside Chorus



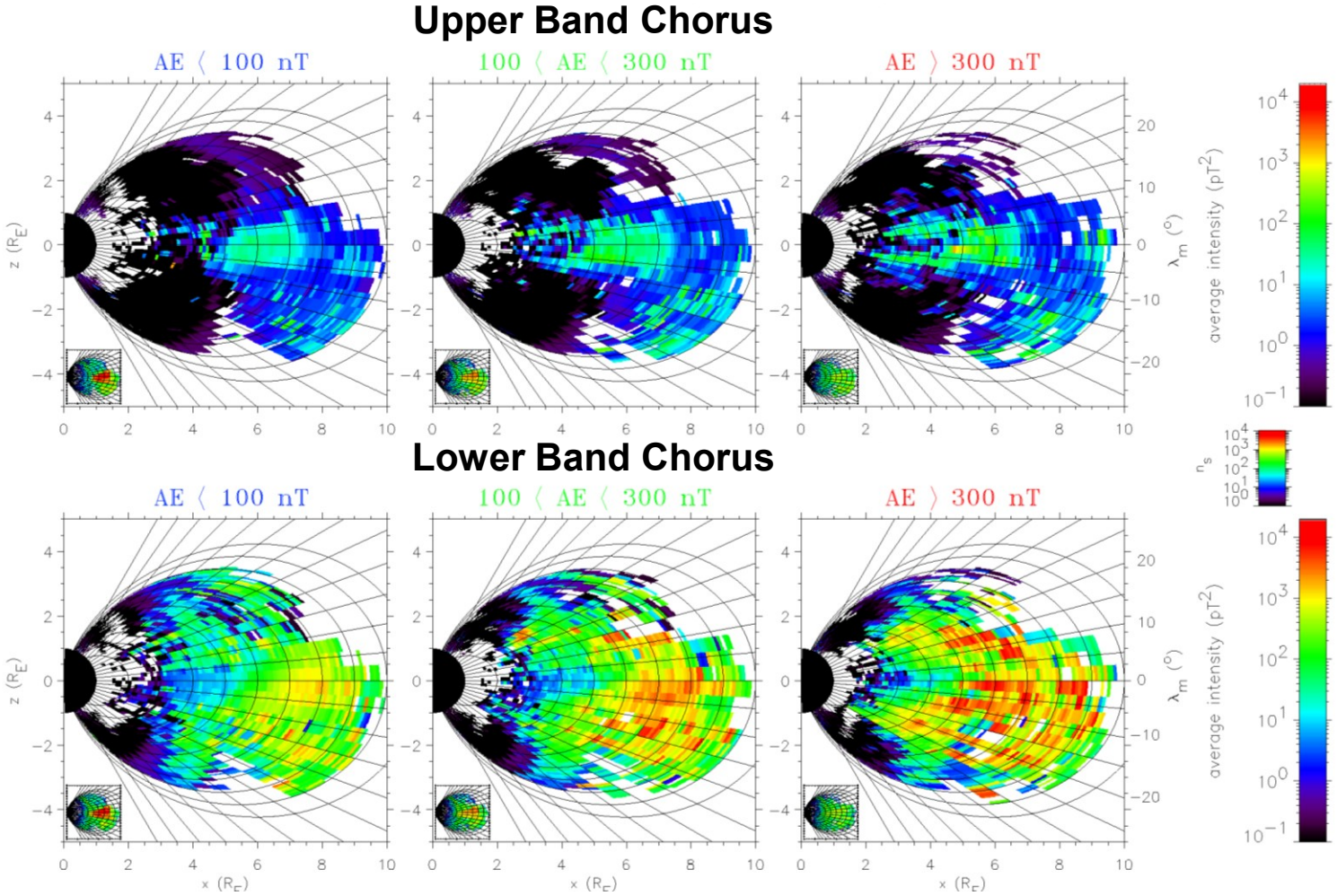
- Nightside upper band chorus intensities are strongest during active conditions in the region $4 < L^* < 7$ and are confined to $|\lambda_m| < 5^o$.

Combined Global Model of Dayside Chorus



- Dayside lower band chorus intensities are strongest during active conditions in the region 4 < L* < 10 and extend to higher latitudes

Combined Global Model of Dayside Chorus



- Dayside upper band chorus intensities are weaker, show little or no substorm dependence and are confined to $|\lambda_m| < 5^o$.

Conclusions

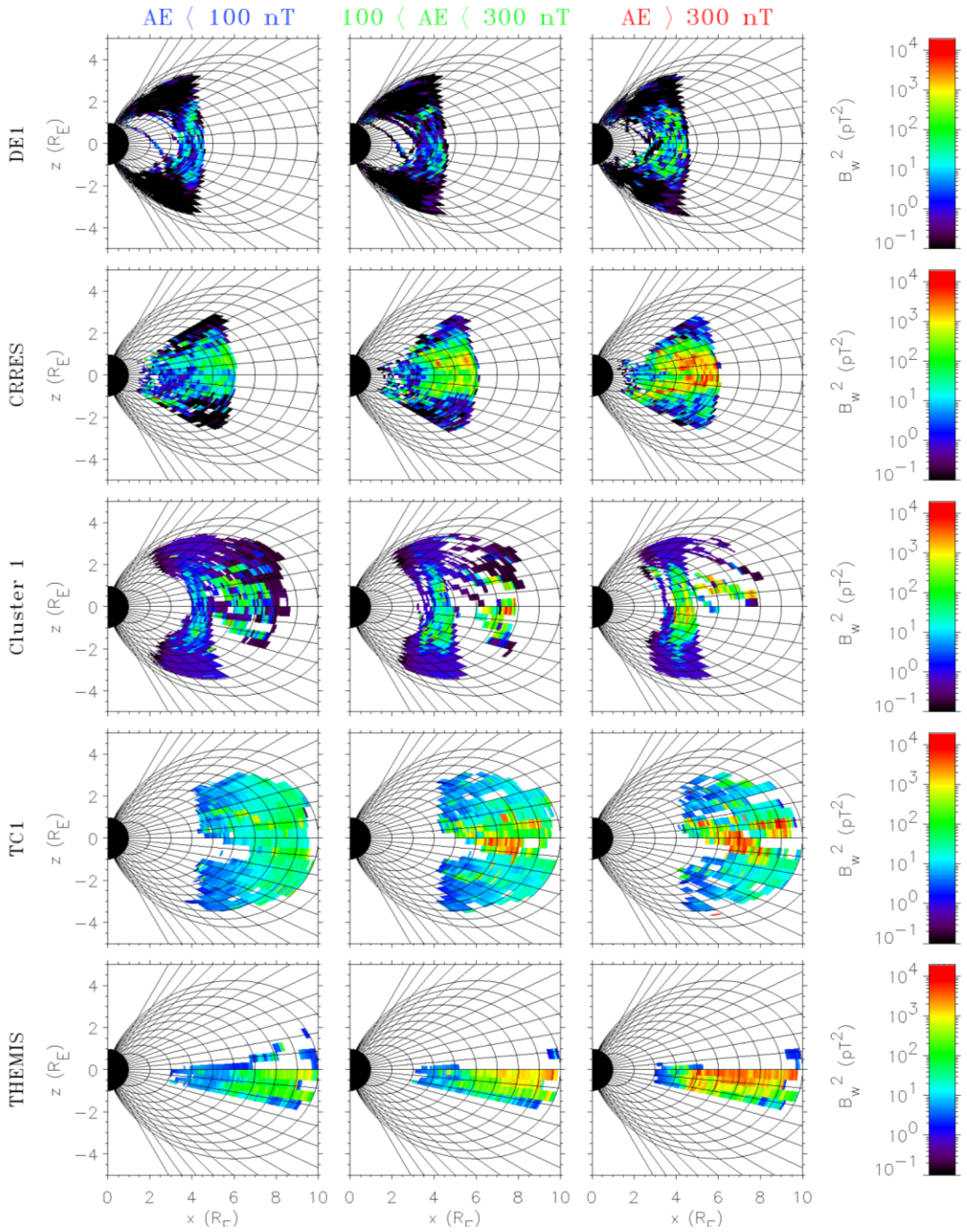
- Our new global model of whistler mode chorus extends the coverage and improves the statistics of existing models. The principle conclusions are:

  - Equatorial chorus is strongest in the lower band during active conditions with peak intensities of the order 2000 pT^2 in the region $4 < L^* < 9$ in the region 23-12 MLT
  - Mid-latitude chorus is strongest in the lower band during active conditions with peak intensities of the order 2000 pT^2 in the region $4 < L^* < 9$ between 07-14 MLT

- We have developed a VLF wave database using data from five satellites. The resulting models of whistler mode chorus and other wave modes will be used to improve our radiation belt models and forecasts

Nightside Lower Band Chorus

- Average wave intensity outside the plasmapause as a function of L* and λ_m for the region 21 – 06 MLT
- Strongest emissions confined to within 10^o of the equator



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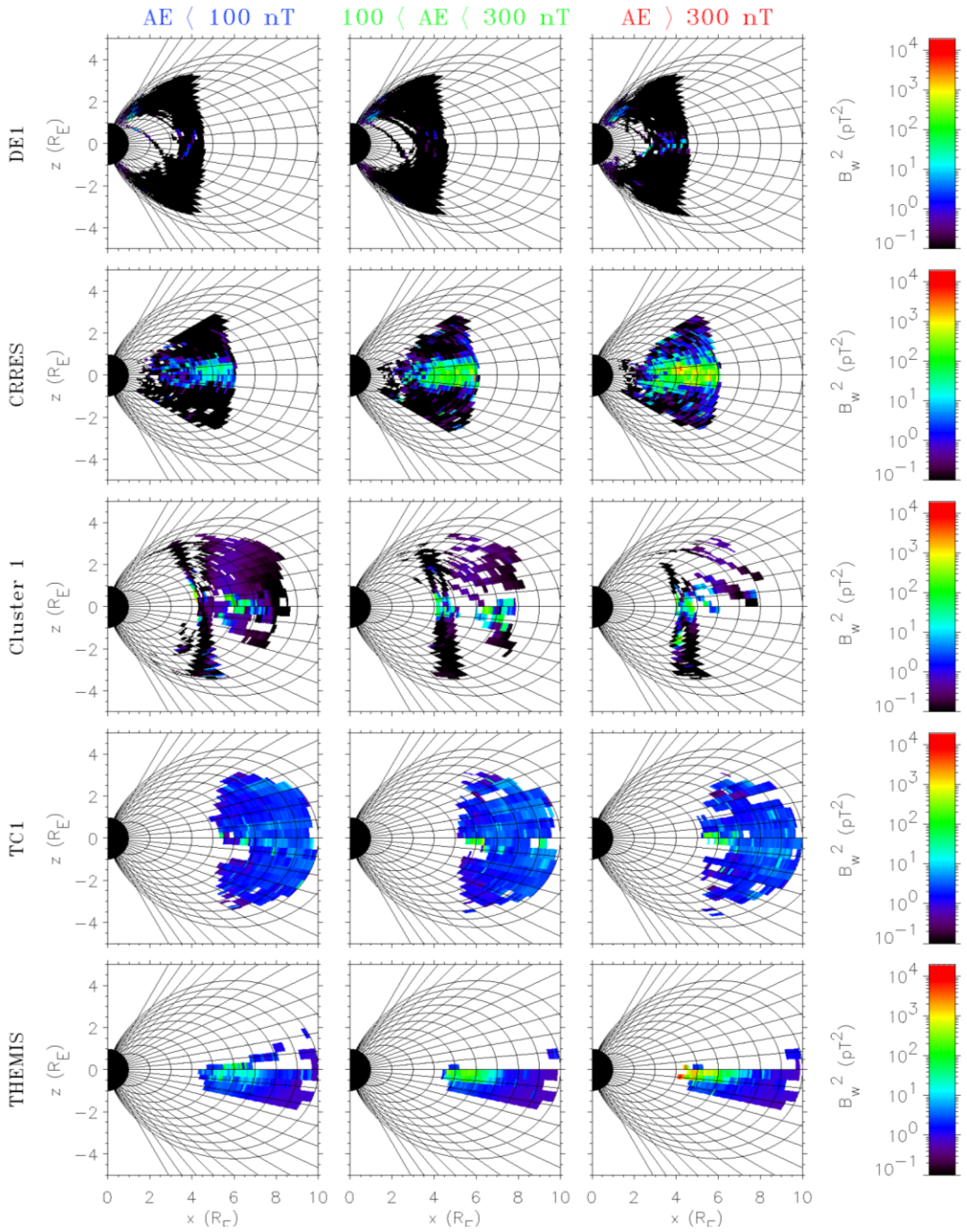
Nightside Upper Band Chorus

- Strongest emissions more tightly confined to within 5^{o} of the equator



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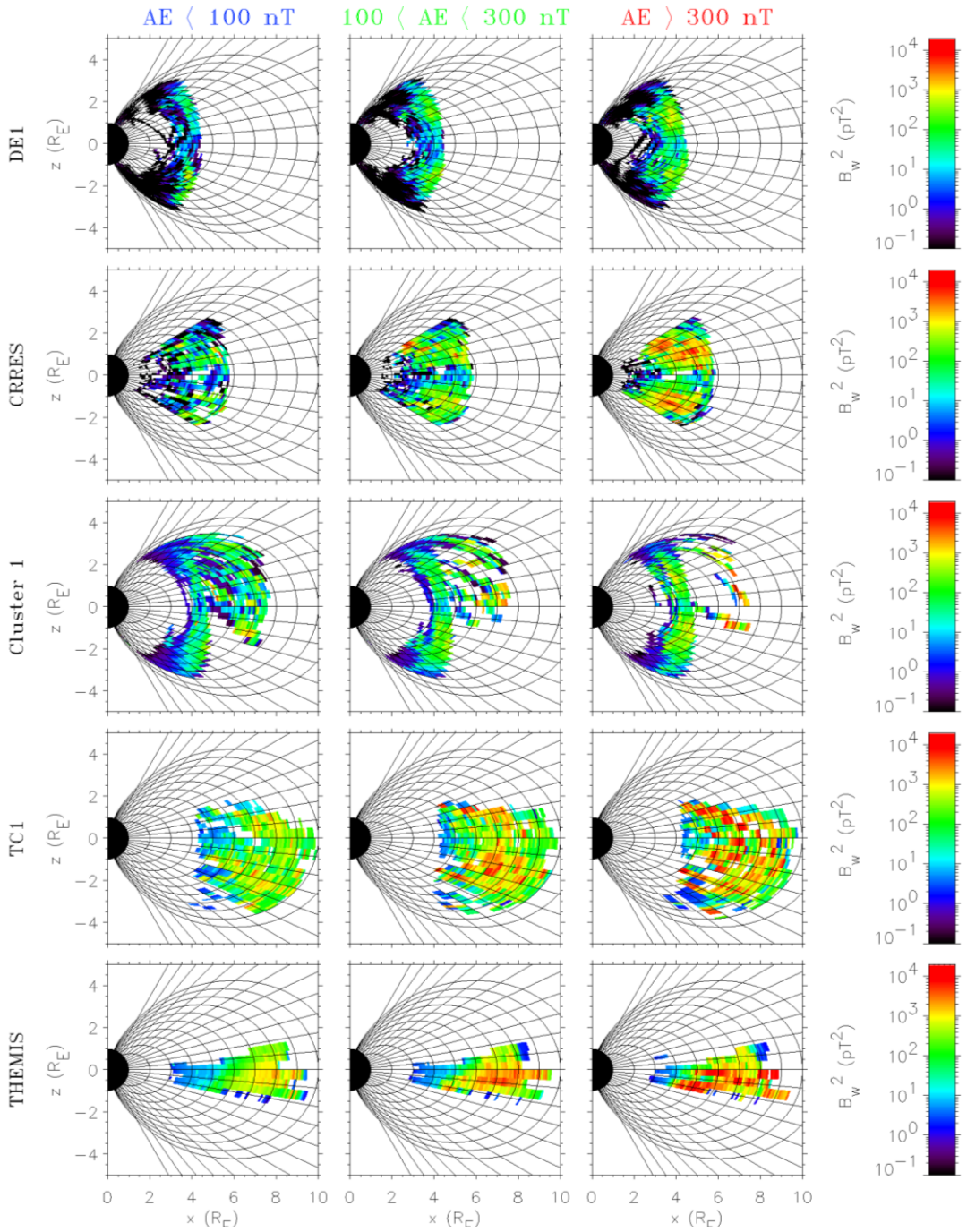
Dayside Lower Band Chorus

- Average wave intensity outside the plasmapause as a function of L* and λ_m for the region 06 – 15 MLT
- Strongest emissions extend to higher latitudes



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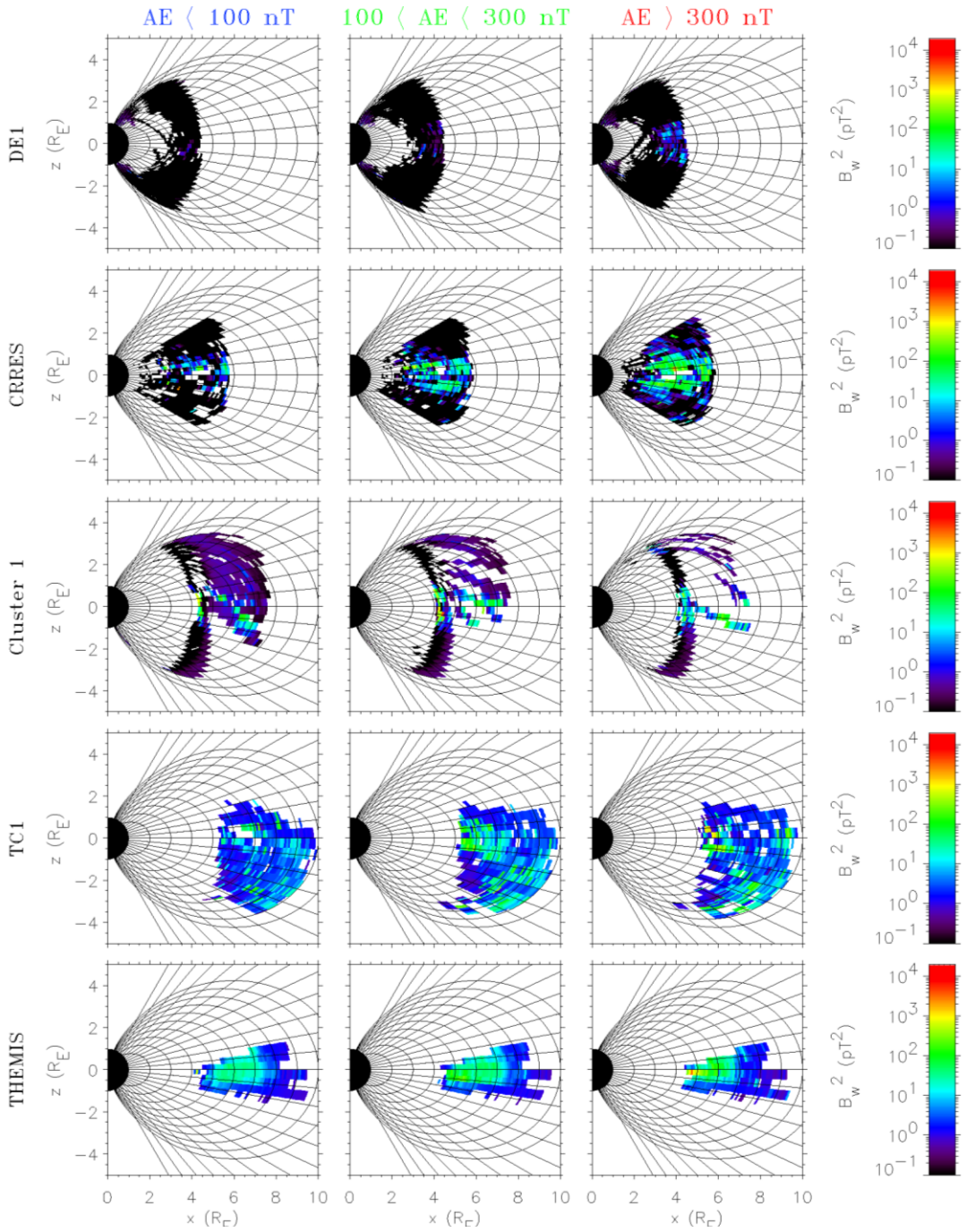
Dayside Upper Band Chorus

- Dayside upper band chorus is much weaker and less extensive being confined to within about 5^{o} of the magnetic equator



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